AUERBACH Guide to

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WITH
EXPANDED
COVERAGE

AUERBACH

Guide to Small Business Computers

The material contained in this publication will be included in *AUERBACH Computer Technology Reports*, an analytic reference service that provides comprehensive coverage of the information processing industry.

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The information contained herein has been obtained from reliable sources and has been evaluated by experienced technical personnel. Due to the rapidly changing nature of the technology and equipment, however, the information cannot be guaranteed.

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PREFACE

The prudent traveler to a foreign land packs a guidebook along with his checkbook, operating on the principle that what you don't know is almost certain to hurt you. Most small businessmen trying to come to grips with the world of the computer are entering a strange new land, which may be full of opportunity but also has its share of hazards. The novice needs advice and guidance, yet the vast bulk of the available literature concerns itself with medium and large computer systems, and is usually presented at a level that can only be digested by the technically sophisticated.

The **AUERBACH Guide To Small Business Computers** presents information in several levels of detail. A special report explains to the small businessman how to go about evaluating and selecting his own SBC. Each major SBC and some minor ones are covered in a separate analytical report.

The reader can look through the Table of Contents for a system which interests him. If the reader wants a quick view of the SBCs available on today's market, he should check the search chart. For more detailed information on a manufacturer's components, the reader should go to the individual product reports. One of a user's main concerns in choosing an SBC will be price, so the price list is included as part of each report. When the user has evaluated the SBCs and selected the ones that seem most likely to fulfill his needs, he can consult the list of suppliers for addresses and phone numbers.

This selection guide presents the following information:

- Device Reports
  - Text: describes characteristics of various small business computer systems. Each product report begins with a summary and then discusses configuration, software, design features, performance, maintenance, and company history.
  - Product Specifications: a chart that summarizes information on the components' performance, capacity, and design.
  - Price Data: detailed price list of equipment supplied.
- Search Chart — provides a quick way to compare the SBCs covered in the product reports. Lists the major peripheral devices and programming languages for all SBCs available on the market. The reports are a selection of this material.
- Suppliers: an alphabetical directory of SBC vendors.

To use the guide effectively, it is important to know what information is contained in each product report. Separate sections discuss a device's advantages and marketing, configuration possibilities, facilities requirements, performance characteristics, and service. The company's background is also covered.

The Summary or Overview gives the name of the company marketing the SBC, its special capabilities or unique features and their significance to the user, as well as the user group most likely to benefit from a particular SBC. The Performance section evaluates the SBC's competitive position, performance capabilities, special strengths and weaknesses, as well as its impact on other systems in the marketplace. Users are interviewed to show how effective the system is in operation. The company history is also included, telling the date the firm was established, its major business, and noting the growth of its SBC line.

The Configuration Guide identifies the major system components, states their performance as well as any relevant interface requirements, and lists available options. This section also gives information on such factors as capacities of main and auxiliary storage, data structure, and speeds of input/output devices.

The Software section identifies the major software available to the SBC under consideration. This includes discussions of the applications software offered by the vendor.

Since maintenance is another important aspect in selecting an SBC, a section of each report specifies the company providing maintenance and its experience.

SEARCH CHART

Small Business Computers

MANUFACTURER AND MODEL NUMBER	Year of First Delivery	COVERED IN			MAX MAIN MEM		AUX STORAGE AND PERIPHERALS							PROG LAN-GUAGES			MAJOR MARKETS					
		Small Business	Minicomputers	Intelligent Terminals	Under 32K Bytes	32K Bytes and Over	Disc/Drum	Magnetic Tape	Magnetic Ledger	Punched Cards	Paper Tape	Char Printer	Line Printer	Cobol	RPG	Other	Fed. Rep. of Germany	France	Italy	United Kingdom	United States	Other
Triumph-Adler																						
TA 10	71				X			X				X				X	X	X	X	X		X
TA 100	68	X			X			X	X	X	X	X				X	X	X	X	X		X
TA 1000	73	X				X	X	X	X	X	X	X				X	X	X	X	X		X
TA 1000 Model 20	73	X				X		X		X		X				X	X	X	X	X		X
TA 1000 Model 30	74	X				X		X	X	X		X				X	X	X	X	X		X
ADS 2100	68	X			X			X	X	X	X	X				X	X	X	X	X		X
Advanced Information Access																						
ADAM	73	X				X	X	X			X	X	X			X				X		
ALVAN	73	X				X		X				X						X				
Allied Bus Sys Multibus	72	X				X	X	X			X	X	X			X	X			X		
Basic Four																						
350	71	X				X	X	X		X	X	X	X			X	X			X	X	X
400	71	X				X	X	X		X	X	X	X			X	X			X	X	X
500	71	X				X	X	X		X	X	X	X			X	X			X	X	X
BME																						
daro-Soemtron 382	73	X			X		X				X	X				X	X	X		X		X
1842	73	X			X		X				X	X				X	X	X		X		X
Business Computers Ltd. (BCL)																						
Molecular 6M	73	X				X	X					X	X			X	X	X		X		X
Molecular 18		X				X	X	X	X	X	X	X	X		X		X	X		X	X	X
SADIE					X						X	X				X				X		
SADIE 10	74				X							X									X	
SUSIE					X						X	X				X				X		
Burroughs																						
700	73	X				X	X	X		X	X		X	X	X		X	X	X	X	X	X
1728	73	X				X	X	X		X	X		X	X	X	X	X	X	X	X	X	X
1712		X				X	X	X		X			X	X	X	X	X	X	X	X	X	X
1714		X				X	X	X		X			X	X	X	X	X	X	X	X	X	X
1726		X				X	X	X		X			X	X	X	X	X	X	X	X	X	X
L2000		X			X					X	X	X		X			X	X	X	X	X	X
L3000		X			X					X	X	X		X			X	X	X	X	X	X
L4000	70	X			X					X	X	X		X			X	X	X	X	X	X
L5000	70	X			X				X	X	X	X		X			X	X	X	X	X	X
L7000	71	X			X		X		X	X	X	X		X			X	X	X	X	X	X
L8000		X			X				X		X	X		X			X	X	X	X	X	X
Cascade Data																						
Cascade 80 Series	70	X				X	X	X		X	X		X		X						X	
Concept II Series		X				X	X	X		X	X		X		X	X					X	
Compudata 500		X			X			X	X	X	X	X				X	X	X				X
Codon CB 100		X				X	X	X			X		X		X	X					X	
CTM																						
70/400	72	X				X		X	X	X	X	X				X	X	X				X
70/500	73	X				X		X	X	X	X	X				X	X	X				X
70/600	73	X				X	X	X	X	X	X	X				X	X	X				X

SEARCH CHART — SMALL BUSINESS COMPUTERS

MANUFACTURER AND MODEL NUMBER		COVERED IN			MAX MAIN MEM		AUX STORAGE AND PERIPHERALS							PROG LAN-GUAGES			MAJOR MARKETS					
	Year of First Delivery	Small Business	Minicomputers	Intelligent Terminals	Under 32K Bytes	32K Bytes and Over	Disc/Drum	Magnetic Tape	Magnetic Ledger	Punched Cards	Paper Tape	Char Printer	Line Printer	Cobol	RPG	Other	Fed. Rep. of Germany	France	Italy	United Kingdom	United States	Other
Datapoint 2200	71	X			X		X	X		X		X	X		X	X	X	X		X	X	X
Datasaab-Facit																						
D 5/10				X	X						X	X			X		X	X	X	X	X	X
D 5/20				X	X		X	X			X	X			X		X	X	X	X	X	X
D 5/30		X				X	X	X			X	X	X			X	X	X	X	X	X	X
6501	72	X				X	X	X			X	X		X			X	X	X	X		X
Addo System M15	73	X			X			X			X	X				X	X	X	X	X		X
Datasystem Series 500	73	X				X	X	X		X	X	X			X	X	X	X	X	X	X	X
DEC Datasystem Series 300	73	X				X	X	X		X	X	X	X			X	X	X	X	X	X	X
Eldorado Electrodata Mdl 140		X				X	X	X		X	X	X	X			X						
Feiler		X			X				X		X	X					X	X				X
Four-Phase																						
IV/40	73	X				X	X					X	X	X		X					X	
IV/70	71	X				X	X	X		X		X	X	X		X					X	
Fujitsu Facom Mate	71	X			X		X	X			X	X		X								X
Hermes Datasystem 210	73	X			X			X	X			X				X	X	X	X	X		X
Hitachi																						
Hitac 1	70	X			X						X	X				X						X
Hitac 80/10	70	X			X						X	X				X						X
Hohner																						
GDC 505	72	X			X			X			X	X				X	X					
2000 S	71	X			X						X	X				X	X					
5000	70	X				X		X		X	X	X				X	X	X	X	X		X
6000	70	X				X		X		X	X	X				X	X	X	X	X		X
7000	72	X			X				X		X	X				X	X					
8000	70	X				X		X	X	X	X	X				X	X	X	X	X		X
9000	72	X				X	X	X		X	X	X				X	X					
Honeywell																						
53	68	X			X			X		X		X	X					X	X		X	X
55	66	X			X			X		X		X	X					X	X		X	X
Series 100, Mdl 15	71	X				X	X	X		X	X		X	X	X	X					X	
Series 50, Mdl 58	70	X			X		X	X		X	X	X	X	X		X	X	X	X	X	X	X
Series 200, Mdl 105	71	X			X		X	X		X	X	X	X	X	X	X					X	
Series 200, Mdl 115	70	X			X		X	X		X	X		X	X	X	X	X	X	X	X	X	X
Series 2000, Mdl 2020 & 2030	72	X				X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X
G105	69	X			X		X	X		X	X	X	X	X	X	X	X	X	X	X	X	X
G115	66	X			X		X	X		X	X		X	X	X	X	X	X	X	X	X	X
G118		X				X	X	X		X	X		X	X	X	X	X	X	X	X		X
G120	66	X												X	X	X	X	X	X	X	X	X
G130	68	X												X	X	X	X	X	X	X	X	X
H115	70	X			X		X	X		X	X		X	X	X	X	X	X	X	X	X	X
IBM																						
System/3 Mdl 6	70	X			X		X			X		X			X	X	X	X	X	X	X	X
System/3 Mdl 10	70	X				X				X		X	X	X	X	X	X	X	X	X	X	X

MANUFACTURER AND MODEL NUMBER	Year of First Delivery	COVERED IN: Small Business	COVERED IN: Minicomputers	COVERED IN: Intelligent Terminals	MAX MAIN MEM: Under 32K Bytes	MAX MAIN MEM: 32K Bytes and Over	AUX STORAGE AND PERIPHERALS: Disc/Drum	AUX STORAGE AND PERIPHERALS: Magnetic Tape	AUX STORAGE AND PERIPHERALS: Magnetic Ledger	AUX STORAGE AND PERIPHERALS: Punched Cards	AUX STORAGE AND PERIPHERALS: Paper Tape	AUX STORAGE AND PERIPHERALS: Char Printer	AUX STORAGE AND PERIPHERALS: Line Printer	PROG LAN-GUAGES: Cobol	PROG LAN-GUAGES: RPG	PROG LAN-GUAGES: Other	MAJOR MARKETS: Fed. Rep. of Germany	MAJOR MARKETS: France	MAJOR MARKETS: Italy	MAJOR MARKETS: United Kingdom	MAJOR MARKETS: United States	MAJOR MARKETS: Other
IBM (Contd.)																						
System/3 Model 15	74	X				X	X	X		X			X	X	X	X	X	X	X	X	X	X
360/20 Submdl 5	69	X				X	X	X		X		X	X		X	X	X	X	X	X	X	X
360/20 Submdl 6	71	X			X		X	X		X		X	X		X	X	X	X	X	X	X	X
370/115	74	X				X	X	X		X			X	X	X	X	X	X	X	X	X	X
ICL																						
1901	66	X				X	X	X		X	X		X	X		X	X	X		X		X
1901A	68	X				X	X	X		X	X		X	X		X	X	X		X		X
1901S	73	X				X	X	X		X	X		X	X		X	X	X				X
1901T	74	X				X	X	X		X	X		X	X		X	X	X		X		X
1902A	68					X	X	X		X	X		X	X		X	X	X		X		X
2903	74	X				X	X	X		X	X	X	X	X	X	X	X	X		X		X
iCS System 755	74	X				X	X		X	X	X	X	X			X	X	X				
IME 10001	73	X			X			X	X		X	X	X			X	X	X	X	X		X
Informatek Matek 1026	73	X				X	X					X	X			X		X				
Insel MAEL																						
3000	73	X			X				C		X	X						X	X	X		X
4000	70	X			X		X	X	X	X	X	X				X	X	X	X	X		X
4200	71	X			X				X	X	X	X					X	X	X	X		X
4400	73	X			X				X	X	X	X						X	X	X		X
4420	73	X			X			X	X	X	X	X						X	X	X		X
4425	73	X			X			X		X	X	X						X	X	X		X
4800	72	X			X				X	X	X	X					X	X	X	X		X
4820	73	X			X			X	X	X	X	X					X	X	X	X		X
4825	73	X			X			X		X	X	X					X	X	X	X		X
4850	73	X			X		X	X	X	X	X	X					X	X	X	X		X
4855	74	X			X		X	X		X	X	X					X	X	X	X		X
ISE																						
10/32	73	X			X							X				X	X					
20/64	73	X			X							X				X	X					
3000	72	X			X			X	X			X				X	X					
Kienzle Apparate																						
System 800	65	X			X				X	X	X	X					X	X	X	X		X
4300	73	X			X					X	X	X				X	X	X				X
4500	73	X			X					X		X				X	X	X				X
5000	68	X			X			X		X	X	X				X	X					X
5600	69	X			X			X		X	X	X				X	X	X	X	X		X
6000E	72	X				X		X	X	X	X	X				X	X	X	X	X		X
6000M	72	X			X				X	X	X	X				X	X	X	X	X		X
6000R	72	X			X				X	X	X	X				X	X	X	X	X		X
6000S	68	X			X			X	X	X	X	X				X	X	X	X	X		X
6100	72	X				X	X	X	X	X	X	X	X			X	X	X	X	X		X
Litton ABS																						
1220/1221		X			X						X	X					X	X	X	X	X	X
1231		X			X					X	X					X	X	X	X	X		
1241		X			X		X				X	X					X	X	X	X	X	X

SEARCH CHART — SMALL BUSINESS COMPUTERS

MANUFACTURER AND MODEL NUMBER	Year of First Delivery	COVERED IN: Small Business	Minicomputers	Intelligent Terminals	MAX MAIN MEM: Under 32K Bytes	32K Bytes and Over	AUX STORAGE AND PERIPHERALS: Disc/Drum	Magnetic Tape	Magnetic Ledger	Punched Cards	Paper Tape	Char Printer	Line Printer	PROG LAN-GUAGES: Cobol	RPG	Other	MAJOR MARKETS: Fed. Rep. of Germany	France	Italy	United Kingdom	United States	Other
Litton ABS (Contd.)																						
1252		X			X		X				X	X					X	X	X	X	X	X
1281		X			X				X	X	X	X				X	X	X	X	X	X	X
Lockheed System III	73	X				X	X	X		X			X		X						X	
LogAbax																						
LX 2200	70	X			X			X				X					X	X	X	X		X
LX 2600	73	X			X			X			X	X					X	X	X	X		X
LX 4100	72	X			X				X			X				X	X	X	X	X		X
LX 4200	71	X			X		X	X	X	X	X	X	X		X	X	X	X	X	X		X
Marme GMG 5000	73	X				X	X	X		X	X	X	X	X		X		X				
MBM Computers																						
MBM 7000 (PDP 11/05)	73	X			X		X			X	X	X	X	X		X				X		
MBM 7000 (PDP 11/35)	73	X				X	X			X	X	X	X	X		X				X		
Melcom System MCS 1600	74	X				X	X	X		X	X	X	X		X	X				X		
Mitsubishi Denke Melcom																						
81	68	X			X						X					X						X
82	68	X			X						X	X				X						X
83	69	X	X		X		X	X			X	X				X	X	X		X		X
84	70	X			X		X	X	X		X	X				X	X	X		X		X
88	71	X				X	X	X			X	X	X	X	X	X						X
NCR Century																						
50	71	X				X	X	X		X	X		X	X		X					X	
75, 101		X				X	X	X		X	X		X	X		X	X	X	X	X	X	X
100	68	X				X	X	X		X	X		X	X		X	X	X	X	X	X	X
150-656	73	X				X	X	X		X	X		X	X	X	X				X		X
399	73			X													X	X	X	X	X	X
N-500	65	X			X			X	X	X	X	X				X	X	X	X	X	X	X
Nihon-Denke Neac																						
1210	67	X			X						X	X		X		X						X
1240	67	X			X		X			X	X	X	X	X		X						X
Nihon-Musen Jac																						
110	67	X			X					X	X	X				X						X
322	67	X			X					X	X	X				X						X
322A	67	X			X		X			X	X	X				X						X
110G	68	X			X					X	X	X				X						X
110K	69	X			X						X	X				X						X
120	70	X				X	X	X		X	X	X		F	X	X						X
120M/520	70	X	X			X	X	X			X	X		F		X						X
Nihon-Shingo Pasca 3000	70	X				X	X				X	X				X						X
Nixdorf System																						
820/15	70	X			X			X	X	X	X	X				X	X	X	X	X	X	X
820/25	70	X			X			X	X	X	X	X				X	X	X	X	X	X	X
820/35	70	X			X			X	X	X	X	X				X	X	X	X	X	X	X
840/15	72	X			X			X	X	X	X	X				X	X	X	X	X		X

MANUFACTURER AND MODEL NUMBER	Year of First Delivery	COVERED IN			MAX MAIN MEM		AUX STORAGE AND PERIPHERALS							PROG LAN-GUAGES			MAJOR MARKETS					
		Small Business	Minicomputers	Intelligent Terminals	Under 32K Bytes	32K Bytes and Over	Disc/Drum	Magnetic Tape	Magnetic Ledger	Punched Cards	Paper Tape	Char Printer	Line Printer	Cobol	RPG	Other	Fed. Rep. of Germany	France	Italy	United Kingdom	United States	Other
Nixdorf System (Contd.)																						
840/25	72	X			X			X	X	X	X	X	X			X	X	X	X	X		X
840/35	72	X			X			X	X	X	X	X	X	X		X	X	X	X	X		X
880/45	73	X			X		X	X	X	X	X	X				X	X	X	X	X		X
880/55	71	X			X		X	X	X	X	X	X		X		X	X	X	X	X		X
880/65	72	X				X	X	X		X	X	X	X	X	X	X	X	X	X	X		X
880/85	72	X			X		X	X	X	X	X	X		X		X	X	X	X	X		X
Obbomatic		X			X							X						X				
Oki-Denki Okiminitac																						
500		X			X							X				X						X
510		X			X							X				X						X
610		X			X							X				X						X
710		X			X						X	X				X						X
Olivetti																						
P602	72	X			X			X			X	X				X	X	X	X	X		X
P603	73	X			X			X	X		X	X					X	X	X	X		X
P652	73	X			X			X	X		X	X				X	X	X	X	X		X
Auditronic 730	71	X			X						X	X				X	X	X	X	X	X	X
Auditronic 770	69	X				X			X		X	X				X	X	X	X	X	X	X
Olympia KC 7000	73	X			X							X				X	X					
Philips Electrologica																						
P351	70	X			X							X				X	X	X	X	X	X	X
P352	70	X			X		X	X		X	X	X				X	X	X	X	X	X	X
P353		X			X			X	X	X	X	X					X	X	X	X		X
P354		X			X		X	X	X	X	X	X				X	X	X	X	X	X	X
P355	73	X			X		X	X	X	X	X	X				X	X	X	X	X	X	X
P356		X			X		X	X		X	X	X				X	X	X	X	X	X	X
P358	71	X			X		X	X	X	X	X	X				X	X	X	X	X	X	X
P359	71	X			X		X	X	X	X	X	X				X	X	X	X	X	X	X
Qantel System		X				X	X	X		X	X	X	X		X	X					X	
Remington Rand OCS 1	73	X			X							X				X	X	X	X	X		X
Ricoh Ricom-8	71	X	X		X		X				X	X				X						X
Ricoh Typac																						
8B		X			X							X										X
16B		X			X							X										X
Ricoh Typer																						
200		X			X						X	X				X						X
240		X			X						X	X				X						X
600		X			X						X	X				X						X
Ruf Datensysteme																						
Series 40	73				X			X	X	X	X	X	X			X	X					
Series 70	70				X			X	X	X	X	X				X	X					
Series 80	73				X		X	X	X	X	X	X				X	X					

SEARCH CHART — SMALL BUSINESS COMPUTERS

MANUFACTURER AND MODEL NUMBER	Year of First Delivery	COVERED IN: Small Business	Minicomputers	Intelligent Terminals	MAX MAIN MEM: Under 32K Bytes	32K Bytes and Over	AUX STORAGE AND PERIPHERALS: Disc/Drum	Magnetic Tape	Magnetic Ledger	Punched Cards	Paper Tape	Char Printer	Line Printer	PROG LANGUAGES: Cobol	RPG	Other	MAJOR MARKETS: Fed. Rep. of Germany	France	Italy	United Kingdom	United States	Other
Ruf Praetor																						
3000	69	X			X					X	X	X				X		X				X
4000	69	X			X						X	X				X		X				X
5000	69	X				X		X		X	X	X				X		X				X
6000	69	X				X		X		X	X	X				X		X				X
8000	69	X				X		X		X	X	X				X		X				X
Sharp Hayac — 3000		X			X																	X
Siemens System																						
404/3	70	X	X			X	X			X	X	X	X	X	X	X	X					
4004/16	68	X			X		X	X		X	X		X		X	X	X	X	X			X
4004/26	68	X				X	X	X		X	X		X		X	X	X	X	X			X
4004/220	75	X				X	X	X		X	X		X	X	X	X	X	X	X			X
Singer																						
5800	71	X			X				X		X	X					X	X	X	X	X	X
6800	73	X			X		X						X			X					X	
System Ten Models 20 & 21	70	X				X	X	X		X	X	X	X		X		X	X	X	X	X	X
Sumlock Comptometer																						
R Series	70	X				X		X		X	X	X								X		
R3000	72	X			X					X	X	X				X				X		
R4000	72	X			X					X	X	X				X				X		
R5000	71	X				X		X		X	X	X				X				X		
R6000	71	X				X		X		X	X	X				X				X		
R8000	71	X				X		X	X	X	X	X				X				X		
SYNELEC SYN 9	74	X				X	X	X		X	X	X	X			X	X	X				
TEL System 720	73	X			X		X	X	X		X	X	X			X		X		X		
Terminal Display Systems (TDS) System 4007	73	X				X	X	X		X	X	X	X			X				X		
Toshiba Tosbac																						
1100 D		X			X						X	X				X						X
1100 E		X			X						X	X				X						X
1250		X			X		X	X		X	X	X	X			X						X
1200		X			X			X			X	X				X						X
RT-150	71	X																				X
Uchida-Yoco Usac																						
300		X			X																	X
400	70	X			X						X											X
720	71	X			X		X	X	X		X	X				X						X
1500	69	X			X		X			X	X	X		X		X						X
2500	68	X				X	X			X	X					X						X
5010	61	X				X		X				X				X						X
Ultimacc																						
Tape System	70	X				X	X					X	X			X					X	
Disc System	71	X																			X	
Unidata 7.720	75	X				X	X	X		X	X	X	X	X	X	X	X	X	X			X

MANUFACTURER AND MODEL NUMBER	Year of First Delivery	COVERED IN			MAX MAIN MEM		AUX STORAGE AND PERIPHERALS							PROG LAN-GUAGES			MAJOR MARKETS					
		Small Business	Minicomputers	Intelligent Terminals	Under 32K Bytes	32K Bytes and Over	Disc/Drum	Magnetic Tape	Magnetic Ledger	Punched Cards	Paper Tape	Char Printer	Line Printer	Cobol	RPG	Other	Fed. Rep. of Germany	France	Italy	United Kingdom	United States	Other
Univac																						
9200	67	X			X		X			X	X		X	X	X	X	X	X	X	X	X	X
9200 II		X				X	X	X		X	X		X	X	X	X	X	X	X	X	X	X
USAC System 720	73	X			X		X	X	X		X	X				X		X		X		
Wagner																						
WACTRONIC	70	X			X				X		X	X				X	X					
WAC 40	72	X				X	X	X	X	X	X	X				X	X					
WAC 400	72	X				X	X	X		X	X	X	X		X	X	X					
Wang 2200	73	X				X	X	X		X		X	X			X					X	

INTRODUCTION

There is no ideal computer on the market, there is no small business computer with the lowest possible price/performance ratio, and there is not a computer that is best for a particular user application. On the other hand, there are many good computers available, there are many computers with good price/performance ratios, and there are probably several computers that can do a particular job well.

The problem is, how does one find which computers can do the job for the least overall cost? Unfortunately, selecting a computer for a specific job is not easy. However, if done without panic and without haste, the rewards of the search can include raising the staff's technical competence, understanding the individual application better, and building a firm foundation for the decision making that will accompany future developments in the application.

The wise selection of a computer depends on the selector's full knowledge of the application. A number of people are usually involved, and cooperation among the ultimate users is essential. This group of end users must develop a set of criteria for selecting a suitable computer; and these criteria must reflect the needs of each user's application area, expressed in computer terms. Because it is human nature for each to consider his needs more important than anyone else's, some member of the selecting group must be responsible for leading the group towards satisfactory compromises.

Developing selection criteria is an educational process, which can be the hardest part of the selection procedure. Application areas must be viewed in terms of how they are presently handled, what can be done better by computers, and what can be done in the future. Each person in the group must learn, from the functional point of view, what computers can do; he must come to understand that computers vary in architecture because manufacturers have designed them differently for good reasons, and he must learn to think of applications vis-a-vis computers.

The computer salesman does have something to contribute and what he says should be considered as input to the development of selection criteria and as an information source for his computer's characteristics. However, the potential user who lets computer salesmen tell him what his selection criteria should be is guaranteeing a less than satisfactory system barring a statistical accident, and is removing the solid foundation his personnel need to use the system satisfactorily once it has been installed.

The architecture of computers varies for good reasons; the computer salesman will detail these, but he cannot be expected to discuss the compromises his firm made to attain that architecture at a reasonable cost.

Architecture is not the only criterion in evaluating a small business computer. Cost is another factor as is the vendor's ability to support the installation with adequate maintenance service.

SMALL BUSINESS COMPUTER ARCHITECTURE

The major factors that distinguish one small business computer from another are the central processor and memory, input/output structure, interrupt systems, available peripheral devices, and software.

Central Processor and Memory

The central processor and memory determine to a large extent the computing power of a computer system. Important memory characteristics are word length, cycle rate, and size. Ideally, the word length should correspond to the data precision required by the application. The cycle rate determines the speed of the computer, but the user must beware of considering cycle rate alone. Also he should consider whether the instruction set's efficiency meets his specific application. What use is lightning-speed addition if a communications interface is needed and two or three input/output instructions are required for each input/output operation?

The memory size determines the complexity and size of programs the computer can run and the type of software that can be supported. Additional features that may be important are memory parity for checking data accuracy and memory protection for preventing important data from being inadvertently erased or modified.

Input/Output Structure

The input/output structure is a major factor in determining how efficiently a computer can distribute its processing power between input/output operations and internal processing demands. With an adequate balance the computer can optimize throughput (i.e., enter data into main memory, perform calculations or data manipulation, and output results to a suitable peripheral device).

The amount of processor time devoted to input/output operations is a function of the number of peripheral devices in the system, their frequency of use, and the execution time of the software input/output handler routines. Input/output requirements for the application must be carefully analyzed and the criteria defined to eliminate from consideration all computer systems that do not have the minimum input/output facilities for a particular function.

The basic input/output facility for a small business computer consists of a channel shared by a number of peripheral devices (party-line). The input/output channel consists of data lines and control lines that synchronize the operation of the central processor and slower-speed peripheral devices.

Important factors in considering how well an input/output channel will satisfy your needs are the number of devices the channel can support, the input/output instructions, and the facilities for determining which devices need servicing. In addition, the maximum allowable distance that devices can be placed from the central processor can be particularly important to small business environments, especially if the processor will be centrally located for access by peripheral devices distributed throughout various offices.

One of the most important factors in determining input/output rates and evaluating the input/output structure for a particular application is the means for identifying the device that requires service. Generally, this can be achieved via software only or in combination with hardware.

Software routines are available for polling each device, testing its readiness for information transfer, and transferring data between the device and the computer. If many devices are connected to the input/output bus, the necessity of executing a device identification software routine can markedly increase the response time to a service request, use processor time and memory space, and cut down the number of peripheral devices the system can handle. Because of these problems, a large number of small business computer systems include groups of external priority interrupt lines as options; each line can interface to one or possibly two devices and thus eliminate a long device identification software routine.

The function of an interrupt system is to signal the processor that something requires attention. A priority interrupt system establishes a hierarchy for the attention-getting signals. Interrupt signals normally suspend execution of the program in progress when the current instruction is finished and begin executing the interrupt servicing routine selected by the contents of a core location dedicated to the interrupt line.

Peripheral Devices Available

Most small business computer manufacturers do not make their own peripheral devices but buy standard devices and provide the controllers and interfaces to their particular system. Most peripheral devices used with small business computers are essentially the same as those used with larger computer systems. Whereas the high cost of these peripherals is not an inordinately large fraction of the overall system cost for medium to large-scale computers, they can be fairly costly compared to small business computer central processor costs. However, manufacturers are beginning to produce these devices specifically for smaller applications. As a result each year their cost diminishes and they are now becoming more practical for use with small business computers.

Peripheral devices available for small business computers consist of input devices, output devices, and auxiliary storage memory that provides bulk storage to augment the central processor's memory.

Data Input. Data input provides the mechanism for entering the data to be processed. Three approaches most commonly used in small business computer systems for the data input function are console keyboards, punched paper tape, and punched card. Console keyboards are used in the interactive mode of operation in which the operator enters transaction data directly into the system. Input speeds are primarily a function of the operator's keying rate, typically two to four characters per second. Punched paper tape and cards are used in the batch mode of operation. Tapes or cards are prepared off-line on equipment independent of the central processor. Tape and card approaches provide faster speeds than the keyboard since the data rate is determined by the reading speed of an electromechanical device as opposed to that of an operator. Recently, however, magnetic tape cassettes have been replacing paper tape.

Printed Output. Printed output is the mechanism for presenting the processing results to the user. Three principal types of printed output units are available in small business computer systems — carriage, serial, and line. The carriage printer is limited in its printing rate by the mechanical movement of the carriage past the print station while the serial printer is restricted by the mechanical movement of the print unit across a line. Greater speeds are achieved with line printers than with carriage or serial printers. Typical capabilities available are 5 to

20 and 10 to 85 characters per second for carriage and serial printers, respectively, and 100 to over 1,000 lines per minute for line printers.

Auxiliary Storage. The auxiliary storage subsystem provides the mechanism for maintaining and accessing a master file of accounts. The access rate to master-file records is an important indicator of the total throughput of a small business computer system since it determines the number of records which can be processed. The extensive range of performance capabilities in this subsystem generates broad variations in the performance of small business computer svstems.

Four approaches most commonly used in small business computer systems for the master file function are: magnetic ledger cards, punched cards, magnetic tape, and magnetic disc. Magnetic ledger cards provide the minimum capability for a master file. The access rate to records is limited to less than one every 4 seconds with an operator retrieving each card and to approximately one record per second with an automatic card reader. While very slow in potential system throughput, the ledger card provides the capability to maintain an easily retrieved printed audit trail of all transactions relative to an account. This feature is an important advantage in many business applications.

Punched cards provide a higher access rate to the master file than magnetic ledger cards. However, punched card access rates are still limited by manual handling of the card decks and by the mechanical movement of cards in a reader. Magnetic tape and disc provide the highest performance in the auxiliary storage subsystem.

A precise comparison of the performance capabilities of the latter two alternatives for auxiliary storage is complex because many variables affect their performance. However, disc systems offer one unique advantage; they permit data to be accessed randomly rather than sequentially as with the other systems.

As a result, disc systems are more flexible and provide higher computer system throughput than tape, largely because they require fewer sorting and merging operations on the data files. Disc performance does have a price, in some cases from three to four times as much as tape systems with comparable storage, or as much as one cent per character of storage, but most users find that cost outweighed by the sharply improved performance.

Interfaces Available

A number of small business computer manufacturers provide interfaces to standard data communications devices and to sense and signal modules; these can turn an external device on/off or can sense the on/off state of an external device. Some of the larger manufacturers provide extensive amounts of data communications equipment as well as the software to support the equipment.

If the application requires interfaces to special-purpose devices, the selection criteria should include interface requirements. The cost of designing special interfaces can raise the price of an overall system to several times the initial small business computer cost.

Software

Software development for a specific application is the most frequently underestimated item in the computer budget. Because the cost of small business computers is small, most manufacturers do not provide much system software. The selection criteria should include the required software. Also consider the desired features for future as well as current needs.

If the manufacturer writes off software production costs in the hardware price, the system cost increases. On the other hand, if the user needs system software not produced by the manufacturer, the cost for its development must be added to the price of his computer. This cost will be much higher than if the manufacturer distributed a software charge over many computers. In other words, well-conceived system software is much cheaper to buy from the manufacturer than to develop, and the selection criteria should reflect this view.

What are the software selection criteria? Because software criteria are tied to an application area as closely as hardware criteria, they can vary from application to application. Despite the previous disclaimers, certain general software characteristics should be included in the software criteria.

Small hardware configurations lend themselves most readily to applications where repetitive tasks are performed. Because programs may require changing from time to time, however, even the smallest hardware configuration should have the facilities for changing programs and for developing programs and incorporating them in the system. The more the selection committee anticipates software changes, the more weight the group should give to the ease with which programs can be changed.

Utility routines should be supplied to debug source code and to edit output code. Input/output handlers should be provided. Loaders should be furnished to load all software supplied with the system and to load application programs.

Important system software components also include assemblers, compilers, and operating systems.

Assemblers. Assemblers are language translation programs that convert symbolic source language into numeric machine language usually with a one-to-one correspondence. The source language translated by an assembler is called the assembly language and is highly dependent on the computer's instruction set.

Assembly language programming is too complex for most small business computer users to perform themselves. However, assembly language capability can still be important for users who utilize packaged applications software rather than write their own programs. The flexibility of the packaged software is usually directly related to that of the assembly language.

Compilers. A compiler also translates source code into machine language, but each written statement in the computer language is translated into several machine instructions. Generally, the term "programming language" specifies the source language translated by compilers. Although programming languages are designed to be independent of any specific machine format, in most cases this goal is not completely achieved.

Compiler languages usually consist of terminology and procedures specifically to help the user write programs in a language capable of expressing concepts and relationships with which he is familiar. As a result, unless he is indeed a novice, the small business computer user can generally expect to write some programs in these languages. The two most common and useful programming languages available to business applications are Cobol, whose programs are stated in precise, easily learned English words and phrases, and RPG, a report generating language for producing programs that write reports in varying formats. Another language commonly encountered is Basic, which is used for interactive time sharing applications. Basic is so simple to learn and use that the novice programmer can begin writing programs almost immediately.

Operating Systems. An operating system is a comprehensive software facility consisting of a selection of routines that contribute to the efficient and convenient running of programs on a computer by assigning most housekeeping tasks to the computer and removing them from manual operator control.

A primary motivation for the use of operating systems results from the ability of computers to perform instructions at speeds that are orders of magnitude faster than a human being can ever achieve manually. Because of the complexity and variety of tasks an operating system is required to perform, however, the coding comprising an extensive operating system can occupy a significant portion of computer memory. Consequently, the development and growth of operating system technology are closely related to improvements in both computer memory and software technology.

The software that constitutes an operating system consists of a monitor or executive routine and a number of special-purpose housekeeping routines automatically controlled by the master routine. Actual facilities, however, vary widely. Some operating systems, designed to run on a minimum configuration system, provide only the bare essentials for controlling the operation of a computer; the user must code and insert any additional facilities desired. Other operating systems provide virtually complete control over the operating functions; operator communications with these operating systems is normally through job control statements entered via a dedicated systems device, such as a card reader, or perhaps through the console keyboard.

Operating systems for small business computers are particularly important for systems that include mass storage devices or are involved in interactive time sharing applications. However, a number of manufacturers don't offer operating systems, but incorporate control facilities via special hardware.

KNOW YOUR VENDOR

With increasing frequency, data processing personnel are selecting their equipment on the basis of vendor reputation. The ingredients that determine a vendor's reputation are hard to define. In fact, two equally perceptive users may strongly diasgree about the qualities of a specific vendor or his products. However, there are factors that will help you determine a vendor's stability and responsiveness to his customers' needs.

You can gauge the past performance of a vendor by checking how long the firm has been in business. Presumably, an established firm has been providing satisfactory products to its customers. Additionally, the firm will probably remain in business and continue to provide service, maintenance, and product upgrading. However, a new product can have bugs even if introduced by an established vendor, so you should know when the product was first delivered. Then you can decide whether it's been in the field long enough to perform satisfactorily.

As part of your investigation of the firm, find out the location of its sales offices. You'll tend to get better service from a local vendor. Since the vendor is not necessarily the manufacturer, investigate this point and learn the manufacturer's history. For example, what other equipment does the manufacturer produce? Does he also sell equipment to other manufacturers who use his product as components in their own systems? (This particular market is commonly called OEM for original equipment manufacturer.)

A significant OEM market can be a plus factor in favor of the vendor. OEM business expands a manufacturer's production volume, lowers his costs, and can improve his profitability via a more positive cash flow. As a result, the manufacturer is more financially sound and has a greater probability of survival. In addition, OEMs tend to make more technical demands than end users. Consequently, a manufacturer's involvement with OEM business leads to increased technical expertise and further product improvements.

A large company can usually offer considerably more services than a small manufacturer. Yet, a novice user will be small potatoes to those same giants, whereas his trade may be more important to a smaller outfit. The vital point to keep in mind is that once the deal is concluded, you should try to avoid being little more than an account number to the computer manufacturer. So, from the outset, try to gauge each supplier's future interest in and responsiveness to your problems, based on as much face-to-face discussion as possible.

We've presented general guidelines, but it's a good rule to make a full investigation of the vendor. If you're not satisfied with the vendor's credentials, look elsewhere.

INSTALLATION AND MAINTENANCE

The quality of a vendor's maintenance and service facilities can be as difficult to quantify as its reputation. But as mentioned in the discussion of vendor history, guidelines can give you some feeling for the type of service you can expect.

A number of vendors don't have their own maintenance facilities. Instead they contract with third-party firms to provide installation and maintenance service. This type of arrangement is a fairly recent innovation. According to our contacts in the user community, third-party maintenance firms generally offer no better or worse service than received from a vendor's maintenance personnel. The quality of service depends upon the specific firm.

It's very necessary to have good cooperation and scheduling between your staff and vendor field service personnel during the computer's installation. Unforeseen pitfalls can sometimes develop and and delay installation. Before the equipment arrives, try to have some assurance against unexpected bugs. For example, rather than discontinue your old operation, continue with it until the new installation is working. However, this approach can sometimes be expensive since you'll be paying for two installations while only one is being used. A less expensive approach would be to check whether the vendor has a backup system located nearby. In case of delays, the backup system can be used while the new system is debugged. Even after installation, a backup system located nearby can prove useful in case your system malfunctions. In fact, if you know that a system similar to yours is located within a reasonable traveling distance, try to arrange reciprocal privileges, with each installation included in the other's disaster plans.

Another aspect of installation that should not be overlooked is the type of training provided by the vendor. Although most training can be provided by the vendor at his classroom facility, the vendor should also be expected to provide on-site training as part of the installation procedure. Training should be detailed and supported by first-rate manuals covering both the hardware and software. Well-organized, well-written documentation is also vital if your computer is ever to be used to its full potential.

Maintenance can include a variety of services. Ask the vendor to enumerate them. Are parts replaced free of charge? How often is preventive maintenance performed and when — prime shift only or at the user's convenience? How long must you wait between placement of a service call and arrival of a technical representative? Are there additional costs, such as traveling expenses? If so, how are these costs calculated? In determining expected down-time, find out the distance between your firm and a spare-parts depot.

A service representative can respond to your call in a short time if he's located nearby, so a list of the cities housing service centers is important. Additional information that impacts a firm's service capabilities includes the number of service representatives employed and the different levels of employee experience. Do customer engineers have prior experience with small business computers? How are customer engineers trained (formal class, on-the-job-training, etc.)?

PRICING CONSIDERATIONS

Most vendors offer a variety of pricing arrangements. The optimum price can vary, but it reflects a balanced mixture of lease duration, maintenance and overtime terms, and cost. Generally, vendors offer a choice of short-term leases that are renewable at less than yearly intervals or longer fixed-term leases that can extend from over one year to (in some cases) five years.

Short-term contracts benefit users who decide to cancel in favor of more technologically advanced or less expensive equipment because there is no penalty. Short-term leases can also be advantageous for users who want to operate a vendor's equipment on a trial basis to test the vendor's service and maintenance capabilities as well as the reliability and performance of the equipment. On the other hand, short-term leases have disadvantages. It is usually more expensive to rent by month than for a longer term. Additionally, the user is subject to more frequent price changes if he renews his lease during each short-term interval.

Although long-term leases (extending above one year) involve smaller monthly rental rates, do you want to commit yourself so far in advance? You are protected against price increases, but you can also be prevented from taking advantage of any price decreases.

If a customer breaks his lease, he incurs a penalty. Most vendors explicitly state the penalty for cancelling, but there's still a certain amount of latitude. One vendor assures us that his company doesn't exact a penalty for upgrading if his firm provides the new equipment. The company's spokesman also said that no penalty would be applied if his firm didn't market the upgrade equipment. In this case the vendor is offering a verbal guarantee, and could change his mind after you sign an agreement. However, a check of the vendor's history and reputation should indicate his credibility.

If you decide to purchase the equipment after leasing it, can any of the rental money be applied to the purchase price? In other words, does the vendor offer a conversion-to-purchase option? If he does, you should know the formula. For example, a vendor may allow a customer to apply all rental payments to the purchase price. Other vendors set limits based on a percentage of the purchase price, the lease's duration, or the amount of rental already paid.

The overtime charge is another feature that varies in different vendors' leases. Some vendors offer unlimited usage. Others base the rental terms on a fixed number of hours per month, and charge an additional fee for use of the equipment beyond the specified time. Because overtime charges can be significant, remember to consider them when pricing a small business computer system.

Maintenance is usually included in the lease price, but maintenance hours vary and the price changes accordingly. Just like other employees, maintenance personnel expect to be paid a larger salary for working weekends and evenings. Consequently, the customer generally pays higher maintenance fees for service outside the normal five-day, 40-hour working week. Unfortunately, the normal working week is "prime time" for most computer installations. This results in a tradeoff decision. Should you pay extra for on-call maintenance during hours that won't interrupt your installation's activity, or should you pay a smaller fee and risk system downtime during your most productive hours? That decision depends on your own constraints and requirements.

CONCLUSION

Evaluating and selecting a small business computer is not a simple task. However, its complexity can be minimized if you proceed correctly. First, define the type of jobs your small business computer will be expected to perform. Next, establish a price ceiling based upon how much money you are willing to pay for getting the job done. Finally, match a system to these criteria.

To draw on the data processing experience of other businesses, check Table 1, which presents a summary of EDP costs encountered among five major industry groups. The table defines five standard SBC configurations, lists the typical size EDP staff employed and total annual EDP expenditures for each configuration, and relates the company size within each industry group to each SBC configuration by listing a range of the number of personnel employed.

As an additional aid, we have prepared a checklist for use during your evaluation and selection procedure. This should help you narrow the selection to several roughly similar computer systems, which can be studied further to gauge their relative value.

Table 1. SBC Configurations and EDP Costs for Five Major Industry Groups

Characteristics	Product Identifier				
	SBC-1	SBC-2	SBC-3	SBC-4	SBC-5
Data Input	Keyboard	Keyboard	Keyboard and/or low-speed punched card	Medium-speed punched card	High-speed punched card
Printed Output	Carriage printer	Serial printer	Serial or low-speed line printer	Low- or medium-speed line printer	High-speed line printer
Storage Media	Magnetic ledger	Serial (single-track) magnetic tape	Punched card, disc, or 7- or 9-track magnetic tape	Disc and/ or magnetic tape	Disc and/ or magnetic tape
Average Sales Price ($) Typical Rental ($/mo)	20,000 300-600	40,000 600-1,200	60,000 1,200-1,600	82,500 1,600-2,200	113,000 2,200-3,000
Typical Size of EDP Staff	1-2	1-3	3-4	4-6	6-8
Total Annual EDP Expenditures ($)	10,000-17,500	17,500-40,000	40,000-53,000	53,000-73,500	73,500-100,000
Employee Range					
Financial	13-23	24-53	54-70	71-97	98-131
Wholesale	32-56	57-129	130-171	172-237	238-322
Manufacturing	50-87	88-200	201-265	266-368	369-500
Retail	74-130	131-296	297-392	393-545	546-740
Transportation, Communications, and Public Utilities	38-66	67-151	152-200	201-278	279-378

SMALL BUSINESS COMPUTER SELECTION CHECKLIST

CORPORATE DATA

Headquarters ______________________ name

______________________ address

____

______________________ city, state

______________________ telephone

National marketing contact ______________________ name

______________________ title

______________________ telephone

Local sales office ______________________ name

______________________ address

____

______________________ city, state

______________________ telephone

Local marketing contact ______________________ name

______________________ title

______________________ telephone

Date system first announced ______________________

Date system first delivered ______________________

Number installed ______________________

Current System Users

Configuration	Corporate Name	Address	Telephone

Questions for References

Is vendor pleasant to deal with ________, have a good record of resolving problems ________, meet commitments ________, deliver system on time ________.

Vendor's Control over Product

Does he design ________, manufacture ________, inspect ________, test ________, recondition ________.

If subject to other firm's: Name ________________________,

Address ________________, Telephone ________________,

Functions performed ________________________________.

HARDWARE SYSTEM

Central Processor

Model ________________

Word size (bits) ________, Main memory size (Kbytes) ________,

Cycle time (μsec) ________, Add time (μsec) ________,

No. of instructions ________, Hardware multiply/divide ________,

Hardware multiple precision ________, No. programmable registers ________.

Addressing: Indirect ________, indexed ________, relative ________.

Interrupts: Hardware/software ________, no. levels ________.

Data Input/Output

Type	Input/Output	Model No.	Speed
Punched card			
Punched paper tape			
Magnetic cassette			
Line printer			
Character printer			
Other			

Auxiliary Storage

	Model No.	Capacity	Speed
Disc			
Drum			
Tape			
Magnetic Ledger			
Other			

SOFTWARE

	Name	Description
Assembler		
Compiler		
Operating System		
Application Library		

USER SUPPORT

Coding Assistance ______________________

	Title	Length (days)
Training Courses		

	Title	Type
Documentation	________________	________________
	________________	________________
	________________	________________
	________________	________________

MAINTENANCE

Preventive

How often performed ________, days of week ________, hours ________.

Emergency

Quoted response time (hours) ________, hours of availability ________.

Customer Engineer Experience

Training: formal ____________, on the job ________________.

Prior experience: previous work with small business computers ________.

Backup Facilities

Location of alternate site with comparable installation ________________

____.

Location of spare-parts depot ________________________________.

PRICING POLICY

Installation charge ________________________________

Cancellation penalties ________________________________

Upgrade and downgrade: alternatives ________________________,

restrictions ________________________,

penalties ________________________.

Effect of future price change ________________________________

Delivery guarantees ________________________________

Performance guarantees ________________________________

Purchase options ________________________________

Order cancellation before delivery ________________________________

Acceptance period (days) ________________________________

Policy on replacement hardware ________________________________

OVERVIEW

Basic/Four's series of small business computers is primarily marketed as an upgrade for users of electronic accounting machines. It bridges the wide gap between the simple, typewriter-oriented, interactive computers, which are preprogrammed with accounting-type programs, and the larger batch processing systems, which have compiler languages, extensive arrays of peripherals, and broad network capabilities.

The standard accounting-type applications such as invoicing and payroll are all available in customized form. The Basic/Four System provides easily programmed means of report generation, useful to the small business that is outgrowing simple management techniques. The Basic/Four Systems were introduced in 1971 and are presently marketed domestically by Basic/Four and in Europe, Canada, and Latin America by an affiliated company, MAI International Corporation. Both are subsidiaries of Management Assistance, Incorporated.

Designed for multiple-user, interactive processing, Basic/Four offers three models of a single basic machine, field expandable so that the simplest configuration can be converted to the most powerful as the user's requirements grow.

The 350 is the simplest model of the series; it uses only a single terminal. The other two models, the 400 and 500, can support networks of terminals. Model 500 can service up to eight terminals (each can use a different program) on a simultaneous basis. Thus, although each terminal is in interactive mode, system throughput is far greater than that of an ordinary interactive processor because the CPU can be used to capacity by the combined demands of the several terminals.

The series is available on a turnkey basis complete with software, operating system, and customized application programs; with operating system and customized application programs only; and with operating system alone. The user's staff can develop application programs in the system's conversational programming language. Basic/Four offers a variety of support and programmer training services.

CONFIGURATION GUIDE

Basic/Four consists of three models: the 350, 400, and 500. All models can be upgraded to the 500. The minimal configuration is the 350, which consists of a CPU with an 8K-byte memory, a Video Display Terminal (VDT), a disc memory unit, and a dot matrix printer. The printer uses a fully buffered 132-character line and prints at 165 characters per second. The CPU cabinet houses the disc memory unit, a dual-disc configuration with 2.1 million bytes of storage, as well as read-write memory.

The CPU includes 2,560 bytes of read-only memory and 16K bytes of read/write memory reserved for the Basic Operating System Software (BOSS). It is a disc-oriented operating system that includes the interpreter for Business Basic, the conversational mode programming language, as well as the system's executive and monitoring software.

Two channels are provided to connect all peripheral devices to the CPU. For high-speed access, a DMA channel can interface up to four disc drives (eight discs); transfer rate is 195K bytes per second. A programmed I/O channel transfers data 20K bytes per second between the CPU and peripherals. Communication adapters, operating over dialup or leased lines, can connect the CPU with remotely located terminals. Extra controllers for printers, magnetic tape drives, and readers are installed in the CPU as needed. Table 1 contains peripheral device characteristics information.

The Model 350's memory is expandable by modules to a maximum capacity of 48K bytes of user read/write core. In addition, 4.7 million bytes of disc storage can be added for a total of 16.8 million bytes of on-line disc capacity. The following peripherals are available: a buffered 120 and 200 line-per-minute line printer with a 132-character line; magnetic tape transports that can read or write on either 7-track or 9-track tape; a communication controller to link a remote VDT to the CPU; and punched card readers for 80- or 96-column cards with peak speeds of 800 cards per minute. A paper tape reader (300 characters per second) and punch (75 characters per second) are also available.

The video display terminal's CRT can display 1,998 characters in a 74-column by 27-row format and write up to 240 characters per second. The VDT has an alphanumeric keyboard and numeric keypad for data entry. In addition to its use as an interactive communications device, the CRT's 12-inch screen can be used to display data for review and correction prior to entering it into the CPU. Blank forms can be displayed, their outlines and section headings at reduced intensity, so that the operator can fill in the blanks with information in the desired format.

Table 1. Basic/Four Systems: Peripherals

Peripheral Device	Performance Characteristics	Comments
AUXILIARY STORAGE		
Model 2250 Disc	2 discs: 1 fixed, 1 removable; capacity each 2.1M bytes; access time 9 msec (min) and 35 msec (avg); peak transfer rate 196,000 bytes/sec	400-track disc; 110 bytes/sector; 960 bytes/track
Magnetic Tape		
Model 6100 Model 6200	9-track: 800 bpi 7-track: 800 bpi	Installation limit: 2; 800 bpi NRZI recording mode; 12.5 in./sec; rewind: 50 ips; compatibility: 7-track, industry-compatible; 9-track, ASCII; 7-in. reel diameter, IBM hub compatible
CONSOLE PRINTERS		
Model 3100	Matrix; 165 cps; 60 lpm (132-char lines) to 150 lpm (short lines); 63 char subset of ASCII	Installation limit: 2; full line buffer; can be operated remotely over telephone lines
Model 3400	Line printer (200 lpm avg); 64-char subset of ASCII (48-96 opt) 132 cols; full line buffer	Original plus 5 copies; belt printing mechanism
PAPER—TAPE		
Punch—Model 5200 (standard) and 5210 (advanced)	5-track (11/16-in. width) and 8-track (1-in. width); 75 cps	Installation limit: 1 Incremental back-spacing 4-10 steps
Reader—Model 5110	8-channel (1-in. width); 300 cps synch; straight feed or fanfold	Option: 6-channel (7/8-in. width) advance feed; auto reel take-up and supply
PUNCHED CARD		
Models 4100 and 4200 Card Readers	80-col Hollerith (stub cards opt); 96-col IBM System/3	Installation limit: 1; Dual capability, opt; Hopper capacity: 1,000 cards
Reading Speed		
Model 4100	80-col cards	
Continuous	400 cpm	
On Demand*	300 cpm	
Model 4200	80-col cards 96-col cards	
Continuous	400 cpm 800 cpm	
On-Demand	300 cpm 600 cpm	

*Start-stop reading computer-controlled.

Table 1. (cont.)

Peripheral Device	Performance Characteristics	Comments
TERMINALS		
Video Display Terminal Model 7200	Keyboard: 128-char ASCII; capacity of 1,998 char; 74 char/line; 27 lines; data transfer rate of 240 cps	Integral magnetic core memory; displays 64-char subset of ASCII
Executive Display Terminal Model 7400	64-char set (ASCII); capacity 512 char; 32-char line, 16 lines; data rate of 240 cps	Installation limits Model 350: 1 400: 4 500: 8 Solid state random access memory
Model 7300 KSR 33 Teletype	10 char/sec	
Model 7301 ASR 33 Teletype	10 char/sec	

Model 400 adds to Model 350 a multiterminal processor, capable of accommodating up to 4 interactive terminals. These terminals can be remotely located and linked to the CPU by telephone lines, and all can process the same or different programs concurrently.

Model 500 has the same basic components as Model 400, but it can handle up to 8 interactive terminals simultaneously. Terminals linked to Model 400 and Model 500 are serviced concurrently. All models have a maximum memory capacity of 64K bytes and all can be expanded in the field to the level of a 500 by adding the necessary components.

Multiterminal configurations in the series can support a far higher volume of business activity than a single terminal system. Each terminal can function as an independent I/O device for order entry, invoice preparation, and inventory monitoring; data entered once is always available to any authorized access for program execution. This feature eliminates multiple handling of files and the subsequent possibilities for error.

See Table 2 for a detailed description of the mainframe's characteristics.

COMPATIBILITY

A major feature of this series is that all models can be upgraded to Model 500, with its substantial networking capabilities. A user can initially acquire the smallest configuration that meets his needs. As his requirements grow, the system can be modularly expanded accordingly. This approach optimizes price/performance.

PERFORMANCE AND COMPETITIVE POSITION

The series performance is far superior to that of a punched card system even in its single-terminal configurations.

The chief design feature of the Basic/Four series is the main-memory partitioning that its operating system performs on a dynamic basis. This feature permits multiprogramming on a time-shared basis without the complex program software normally associated with such an operation. Since a terminal can call up any of the programs stored in the disc file library, a network can use more programs than there are terminals, with output data from each program buffered in core or on disc and printed out in turn. Furthermore, the operating system can be altered to accommodate new utility routines for additional peripheral devices.

Basic/Four cites as its competition the Honeywell-Bull Model 58, Singer System 6800, Qantel Answer, Burroughs B 700, Ultimacc Systems, Wang Laboratories 2200, DEC Datasystem 300, and upon occasion, the IBM System/3 and BCL Molecular 18.

Basic/Four can boast a very satisfied clientele. Its users report minimal downtime, excellent maintenance response supplied by Sorbus, ease of programming, and overall flexibility of the system. The customers contacted agreed they would buy another Basic/Four system or add to the system if the need arose. Half of these contacted have done so recently.

A distributor of electrical components employs 6 Video Display Terminals in a supermarket-type arrangement. With the aid of the VDTs, an invoice can be ready for the customer by the time he leaves the supply house. This procedure also accomplishes inventory control for the distributor. He had previously used an IBM System/3 Model 6 for his business and found its versatility too limited. He then purchased the Basic/Four and recently expanded his original system of 4 VDTs to 6 VDTs.

A Chicago-based CPA firm develops client account packages and maintains the clients' books of entry with a Model 500 and 2 VDTs. The company finds the system so easily programmed that it develops software for its clients for adjustments, accounts receivable, and sales reports.

Table 2. Basic/Four System: Mainframe Characteristics

Model	Characteristics
CENTRAL PROCESSOR	
General-Purpose Registers	5
Addressing	
Direct (words)	All of memory
Indexed	All of memory
Instruction Set	
Number (std)	
Decimal Arithmetic	Yes
Priority Interrupt System	
Levels (std; max)	8
MAIN STORAGE	
Type	Core
Cycle Time (μsec)	1.1
Basic Addressable Unit	Word
Bytes/Access	2
Min Capacity (bytes)	8K
Max Capacity (bytes)	48K (user)
Installation Limit	4 modules
Increment Size (bytes)	8K
Memory Parity	No
Memory Protect	Std; 16K byte
ROM	Yes
Use	Firmware
Capacity (words)	2,560
RAM	
Use	Operating system and applications programs
Capacity	8K-48K
I/O CHANNELS	
Programmed I/O	Yes
DMA Channels	1
Max Transfer Rate (bytes/sec)	195,000
—Within memory	20K
—Over DMA	195K
SOFTWARE	
Assembler	No
Operating System	Yes; BOSS available in single- and multiterminal versions
Language	Business Basic (instructions for: formatting input data and system printout; management of disc data files; incl password security arrangements; fixed-point standard decimal number representation and computation)

The only problem mentioned is that some keys on the display terminal keyboard (manufactured by Hazeltine) are nonoperational.

A New York publishing firm uses a Model 350 with 2 video terminals for all its billing, inventory, royalties, accounts receivable, and sales procedures. Compared with the Singer Friden and an outside service, the Basic/Four has saved this company money and personnel. The operators noticed a slower response time with the addition of a second terminal, but updated BOSS software speeded up response time beyond that of the one-terminal system. The company likes the ease with which components can be added but would prefer faster I/O time.

A major New York life insurance company, claiming to be one of Basic/Four's largest installations, uses 5 VDTs to process all group premium collection accumulations and to reconcile its incoming bank accounts. The firm likes the capability of entering data immediately, though it wishes the system were faster. This company has experienced scattered hardware problems, but downtime has been minimal and the maintenance response excellent.

Maintenance for the Basic/Four Series is available through Sorbus, Incorporated, a broad-based service company that has offices in more than 100 cities across the country. Sorbus, like Basic/Four, is a subsidiary of Management Assistance Incorporated. Service is provided by contract either during regular business hours, or at higher rates on a 24-hour basis.

PERIPHERALS

Table 2 describes the peripherals available with the Basic/Four system.

SOFTWARE

The Basic/Four Series uses both the Basic programming language in conversational mode and an operating system, an unusually flexible combination for computers in this price range.

Business Basic is Basic/Four's extended version of the widely known Basic language, developed at Dartmouth College to provide novice programmers with a powerful, yet easy-to-learn language. The additional features of Business Basic include: instructions for formatting input data and system printout to provide easily understood reports; instructions for management of disc data files, including password security arrangements to prevent unauthorized access to or alteration of stored data; and fixed-point (standard decimal) number representation and computation.

The Basic Operating System Software (BOSS) is available in two versions—one for the single-terminal Model 350 system and the other for the multiterminal Models 400 and 500 systems. BOSS assigns areas in core memory to the various users, implements the data file security features, manages the data files, and supports utility routines that include sort and merge, data format conversion, file copying and listing, and file updates. BOSS also contains the Business Basic interpreter and exercises control over all I/O devices including the scheduling of tasks.

Basic/Four offers a variety of applications programs and packages. All applications are written in Basic and are flexible to general business needs. The programs available are payroll, general ledger, accounts payable and accounts receivable with invoicing, sales analysis report printing, order entry, and inventory control. The following packages have been developed for these specific environments: fuel oil dealers, travel agencies, and Certified Public Accountants (CPAs). There is also a package for property management in the final stage of production.

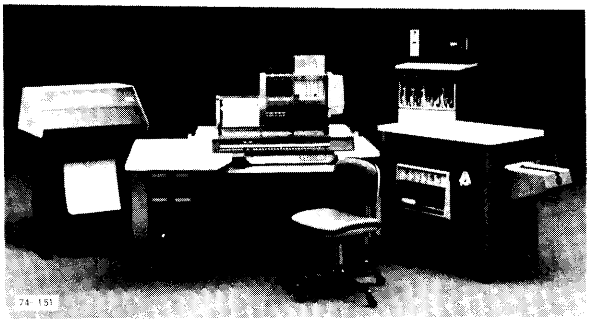
Basic/Four stresses the versatility of its application software, and its interest in developing existing programs to meet changing needs.

HEADQUARTERS

Basic/Four Corporation
18552 MacArthur Blvd.
Irvine CA 92702

PRICE DATA

Model Number	Description	Monthly Rental $	Purchase $	Monthly Maint $
	BASIC/FOUR			
	CENTRAL PROCESSOR AND WORKING STORAGE			
350	Central Processing Unit (8K; with video display terminal; 2100 disc system; 3100 printer)	895	32,400	183
400	Central Processing Unit (8K; with video display terminal and/or accounting machine terminal; 2100 disc system; 3100 printer)	954	34,900	186
500	Central Processing Unit (8K; with video display terminal and/or accounting machine terminal; 2100 disc system; 3100 printer)	1,023	37,900	189
	MASS STORAGE			
2200	Disc System (4.2 mc)	279	9,950	60
	INPUT/OUTPUT			
	Printers			
3100	Printer (60-150 lpm; 165-cps matrix)	197	6,450	55
3400	Printer (200-lpm)	285	9,950	66
	Punched Card			
4100	Card Reader (400-cpm; 80-col)	159	4,450	61
4200	Card Reader (400- or 800-cpm; 80/90 col)	170	4,950	61
	Paper Tape			
5110	Paper Tape Reader (300-cps; std)	124	4,450	26
5200	Paper Tape Punch (75-cps; std)	124	4,450	26
5210	Paper Tape Punch (75-cps; advanced)	124	4,450	26
	Magnetic Tape			
6100	Magnetic Tape System (9-track; 800-bpi; NRZI)	243	7,950	68
6200	Magnetic Tape System (7-track; 800/556-bpi; NRZI)	243	7,950	68
6201	Magnetic Tape System (7-track; 800/200-bpi; NRZI)	243	7,950	68
6202	Magnetic Tape System (7-track; 556/200-bpi; NRZI)	243	7,950	68
	DATA COMMUNICATIONS			
7200	Video Display Terminal (Models 400 and 500)	132	4,950	23
7400	Executive Display Terminal (inquiry only; Models 400 and 500 only)	74	2,450	20
7300	KSR 33 Teletype	76	2,500	21
7301	ASR 33 Teletype	90	3,000	24



OVERVIEW

The Burroughs L Series comprises a family of microprogrammed, "visible record" computers intended for small accounting applications. Individual members of the series differ in capabilities depending on the type of processor, memory, and peripherals in the system. Higher performance members can be used for data analysis and report generation. All models support a Cobol compiler, a powerful tool for programming business applications. The design emphasis is on interactive processing and simple control by novice users responding to the step-by-step guidance of indicator lights on the console.

The smaller members of the family are distinguishable from most other small business computers by the use of magnetic discs rather than core or semiconductor memory for both firmware control storage and working storage. The L2000, L3000, and L4000 Series models have no provisions for auxiliary magnetic storage; the L5000 allows auxiliary storage of sorts, in the form of magnetic stripe ledger cards, called Magnetic Memory Records (MMR) by Burroughs. The L7000 upgrades the line still further by using the higher speeds of MOS ROM for control firmware, while both working storage and auxiliary storage are master files on disc.

The most recent addition to the line, the L8000 Series, is not simply further extensions at the top end of the line, but the L8000 also provides alternative models at each L Series level with greater working storage capacity, higher processing speeds, and a new cassette-based, software-controlled "dynamic memory overlay" technique. None of the 8000 Series use discs. Instead, MOS LSI RAM stores the control firmware and operates as user working memory, while optional cassette tape drives provide auxiliary storage and support for the dynamic memory overlay feature at every level. Thus, for a modest increase in cost an L2000 or L3000 system can be upgraded to an 8200 or 8300 without cassette. The addition of the cassette drive and supporting software expands on-line and working storage at considerably less cost than upgrading from an L2000 to an L7000, for example.

Most L-Series models can be easily converted to a corresponding TC terminal computer model; the data communications memory and logic are housed in a separate unit. The TC 500, 1500, 2500, and 3500 Series roughly correspond to the L2000, L3000, L4000, and L8000 Series, respectively. Like the L8000, the TC 3500 straddles the entire series; certain TC 3500 models are direct upgrades for TC 500/1500/2500 models. The basic differences among L8000 Series models and the correspondence of L8000 models L-Series and TC-Series models are presented in Table 1.

PERFORMANCE AND COMPETITIVE ANALYSIS

The addition of the L8000 Series has enabled Burroughs to keep its popular L Series competitive in a market generally experiencing price drops as a result of the lower costs of large-scale MOS circuitry. Because the L Series design was originally innovative for its time, using microprogramming to implement Cobol on a small system, Burroughs has been able to upgrade the series with faster, *less* expensive, higher-performance models and still use the software developed for earlier systems.

NCR recently introduced the NCR299 Accounting Computer that can handle visible records (ledger cards). The NCR299 allows exceptionally easy and inexpensive program development through a mark-sense form that enters long macro instruction words that even novices can use. The NCR299 will be a formidable competitor for the L8000 Series, particularly for novices in accounting machine use, but it suffers from a lack of peripheral offerings at this point in time and limited-size programs. NCR's installed base in the world-wide accounting machine market numbers more than 375,000 machines; thus, it is one of Burroughs' major competitors.

IBM does not compete in the steadily growing accounting computer market; its accounting machines are still of the old electromechanical variety. Litton Industries, Singer-Friden, and the European-based Philips and Nixdorf companies have made substantial inroads into the U.S. market for small accounting computers. All provide for production of ledger cards; the Litton ABS and Singer Series use edge-punched cards while Philips and Victor also provide for the magnetic stripe ledger cards more popular in Europe.

Philips and Nixdorf, as well as Olivetti, Kienzle, and a number of other European-based manufacturers provide the major competition for Burroughs in Europe. Although NCR is also a formidable competitor, its NCR299 will have to be further developed before competing directly with the European accounting computers currently available with the range and price/performance of the Burroughs L Series.

User Reactions

We interviewed several small users for this report and discovered that all had recently upgraded from an old L-Series system to an L8000 model. A small manufacturer of replacement parts for appliances exchanged an L5000

Table 1. Burroughs L8000 Models Compared With Other L Series and TC Models

L8000 Models	Forms Feed	Type	Platen Width (in.)	Cassette Drive*	Corresponding Models: L Series	TC 3500	Other TC
L8200-100	Rear	Split	15.5	No	L2000	TC 3520	500
L8200-200	Rear	Split	15.5	Yes	L2000	TC 3520	500
L8300-100	Front	Split	15.5	No	L3000	TC 3530	1500
L8300-200	Front	Split	15.5	Yes	L3000	TC 3530	1500
L8400-100	Front	Split	26.0	No	L4000	TC 3540	2500
L8400-200	Front	Split	26.0	Yes	L4000	TC 3540	2500
L8541-100	MMR**	Split	26.0	No	L5000	TC 3570	—
L8541-200	MMR**	Split	26.0	Yes	L5000	TC 3570	—
L8541-104	MMR**	Solid	26.0	No	L5000	TC 3570	—
L8541-204	MMR**	Solid	26.0	Yes	L5000	TC 3570	—
L8542-100	MMR** (dual track)	Split	26.0	No	L7000	TC 3580	—
L8542-200	MMR* (dual track)	Split	26.0	Yes	L7000	TC 3580	—

Notes:
* Refers to L8000 and TC 3500 Series only.
** Magnetic Memory Reader; i.e., magnetic stripe ledger card reader. Unless otherwise stated, refers to single track holding 352 bytes.

for an L8500; a line printer was added to support billing and inventory control applications. An accounting firm, which markets its own client billing package for CPAs, exchanged an L2000 for an L8300. A software/services house that developed a mortgage-loan documentation package for banks, savings institutions, and mortgage companies switched from an L3000 to an L8300. All three users cited better performance at virtually no change in price (the CPA firm was actually paying a lower price when cassette tapes were substituted for paper tape I/O) and cassette tape storage as reasons for their switch.

All the firms interviewed chose the original Burroughs equipment after studying NCR and IBM; in one case, Litton and Philips systems were also considered. All checked the marketplace before converting and were satisfied with the reliability and maintenance support for the original system; all had some software investment. Thus, none really wanted to switch unless a significant price saving could be made. One user remarked that his market check showed the L8000 to be very price/performance competitive, and he thought it would be hard for other manufacturers to beat.

The upgrade from an old L Series model to the L8000 version can result in enormous performance benefits, at little change in cost. The software house with the mortgage loan documentation package wrote one subroutine that ran in 3 minutes 4 seconds on the L3000; it ran in 3 seconds on the L8300. The manufacturer of appliance parts upgraded because two shifts on the L5000 were needed to enter 1,000 to 1,200 line items daily. With the 8500, rarely was overtime required on the first shift to complete the day's entries; this performance was even better than the Burroughs specification of 800 to 900 line items daily.

For the manufacturer and the software house the type of visible record produced was an important part of the reason for using the L Series. The manufacturer likes the visible record with the magnetic stripe ledger card because it does not require a separate report run. The software house requires the front feed because its system prints legal documents than cannot be pin-fed forms. The CPA who markets software as a side business also mentioned that the L8000 is easier to convert to its corresponding TC 3500 communications version than earlier models had been to their corresponding communications version.

CONFIGURATION GUIDE

All L-Series accounting computers include keyboard, "golfball" printer, and processor in a single, large, desk-like unit. When magnetic stripe ledger handling equipment is included in the system, it is superimposed over the carriage. When up to four cassette drives are included, they are also integrated into the basic work station. The line printer, card reader and punch, paper tape and edge-punch card readers and punches, and the polling magnetic tape unit are all freestanding devices.

Table 2 outlines the configuration differences among the models or lines. Table 1, as mentioned previously, shows the characteristics of each L8000 Series processor

Table 2. Configuration Differences in the L Series

MODEL	L2000/L3000 L4000	L5000	L7000	L8000
MEMORY				
Cycle Time (μ sec)	0.5	0.5	0.5	0.3
Firmware Location	Disc	Disc	MOS ROM	MOS ROM
RAM (user memory)				
Type	Disc	Disc	Disc	MOS
Size (bytes)	512-6,144	512-6,144	512-6,144	4K to 44K
Data Structure				
Bits/Word	64	64	64;16	64
Bytes/Word	8	8	8;2	8
Auxiliary Memory	—	—	Disc	Cassette
PERIPHERALS, I/O				
Punch Cards				
80-Col Reader	A595; A596	A595; A596	9114	A9114-1
80-Col Punch	A149	A149	A149	A9119-1
96-Col Reader	—	—	—	A9119-2
96-Col Multifunction	—	—	—	A9119-6
P. Tape/EP Card				
Reader	A581	A581	A9122	A9122-1
Punch	A562	A562	A9222	A9222-1
Computer Tape	A1495	A1495	A1495	A1495
Transport Magnetic Stripe				
1-trk	—	A4005	A9161	A9161-1
2-trk	—	—	A9162	A9162-1
Console Forms Handler	—	—	—	A9361/A9362
Auxiliary Printers	—	—	A9249	A9249-1, -2
Magnetic Tape Cassette Transport	—	—	—	A9490-25

model and its related processor of the L2000, L3000, L4000, L5000, or L7000 Series and its corresponding TC 3500 model.

The L2000, L3000, and L4000 are essentially similar as far as I/O capabilities are concerned; the L2000 has a rear feed, the L3000 has a front feed, and the L4000 has a front feed with a larger platen (26.0 inches). The L5000, however, can handle Magnetic Memory Records (MMR), Burroughs' name for magnetic stripe ledger cards. The L7000 expands this capability further; it can handle dual tracks on each ledger card.

As far as technology is concerned, the L Series group themselves into three divisions, as shown in Table 2. The L2000, L3000, L4000, and L5000 use discs for both working storage and control memory microprogram storage. The L7000 stores control memory in a 32- to 256-word LSI/MOS ROM module which is not accessible to the user; disc provides working storage, and can also be used for auxiliary storage. The L8000 does not use disc storage; LSI/MOS modules provide both working storage and control storage. Cassette tapes are used for auxiliary storage.

The L8000 Series provides far greater memory capacity than that provided by the other L Series systems. Basic user memory (memory available for storage of user programs and data) is 4K bytes. Memory can be added in 2K-byte increments up to a maximum capacity of 20K bytes for firmware storage and 44K bytes for user memory. This is equivalent to more than 10 times the capacity of the 416-word maximum for the previous models; each word is eight bytes long.

Common Characteristics

All L-Series accounting computers use the same basic keyboards, platens, and printers. All use a similar processor architecture (to maintain compatibility), although the basic architecture is implemented with a variety of technologies as explained earlier. The L8000 uses more extensive buffering in keeping with its higher performance.

The accumulator, a fixed-storage, 16-digit field within normal memory, serves as a working register with 15-digit positions allocated to data storage. The sixteenth digit is reserved for special indicators. Shift, compare, and arithmetic operations manipulate data in the accumulator.

The keyboard incorporates two separate groups of keys: one set of 53 keys is arranged similar to a regular typewriter format and the other 21 keys incorporate a numeric 10-key set arranged like a calculator. Both groups contain control keys. Items entered via either key group are temporarily stored in a buffer. A typewriter instruction transfers nonnumeric characters from the keyboard buffer for printing, storage in memory, or both. Numeric characters from either group of keys are transferred from the buffer to the accumulator, where they can be manipulated under program control.

Program-select keys are positioned across the top of the keyboard, up to 16 on the L2000 and L3000 and 24 on all other models. They are used to select and execute instructions that have previously been stored in memory, such as the user's subroutines.

A 64-character removable type ball holds the character set for the printer. Peak printing speed is 20 characters per second; either red or black characters can be printed. Maximum line length is either 150 or 255 characters (15.5 or 26-inch platen) depending on the computer model. The friction-feed platen can be split to accommodate two independent forms. An optional continuous forms feed is available in three styles for flexible forms-feed arrangement.

The Magnetic Memory Record available for the L5000, L7000, and L8500 systems enables the system to read single- or dual-track (depending on model) magnetic stripe ledger cards 6, 8, 10, 12, or 14.5 inches in width. The L8500 systems include an A9362 Magnetic Record Handler that automatically feeds and stacks the magnetic records from a 150-record hopper. Alignment is automatic and based on data stored on the track or the controlling program. Single tracks hold 352 digits, dual tracks 704. The MMR forms handler can also handle normal (nonmagnetic) forms and continuous forms.

L2000/L3000/L4000/L5000 Peripherals

The following optional input and output peripherals are available for the older models: edge-punched-card perforator (A562) punches 40 characters per second; paper-tape, edge-punched-card reader (A581) reads 40 characters per second; an 80-column-card reader (A595) reads 100 BCL- or EBCDIC-punched cards per minute; a card keypunch (A149) punches 25 columns per second under control of one of the terminal computers or in response to the operation of its own character keys; and a computer-compatible magnetic tape unit (A1495). All speeds are rated speeds; effective speeds often depend upon such items as the controlling program.

The tape and edge-card punches and readers can handle paper, mylar, or aluminized 11/16- or 1-inch wide tape and individual, fanfold, paper, or mylar-reinforced 3- to 5-inch wide cards. Five-, 6-, 7-, or 8-level codes can be used. The A595 card reader and A149 keypunch use a stored table to translate between their own operating codes and the ASCII code used by the computers. The A596 card reader performs code conversion in the reader itself.

The basic magnetic tape unit incorporates two ports; up to three, two-port expansions are permitted, so as many as eight TC units can share a single tape drive.

L7000/L8000 Peripherals

The L7000 and L8000 can attach the same types of peripherals as previous models. Some have been upgraded, reflecting the more powerful performance of these systems, particularly the L8000 Series. The A9122-1 Paper Tape/Edge Punched Card Reader reads 40 characters per second and the A9222-1 Paper Tape/Edge Punched Card Perforator punches 40 characters per second, like their predecessors. The A9114-1 80-column card reader, however, reads 200 cards per minute; it automatically translates EBCDIC- or BCD-coded cards into machine language for the TC 3500; and its hopper holds 350 cards. The A9419-2 Card Reader Punch offers 96-column card I/O capabilities; it reads 300 cards per minute and punches 60 cards per minute; it has two feed hoppers and can be furnished with six stacking hoppers to permit off-line sorting and merging, then designated the A9419-6. The A9419-2 is also available in a read-only version, the A9419-1.

Two chain line printers are available, one rated at 90 lines per minute and the other at 180 lines per minute. Maximum line length is 132 characters.

Both a magnetic tape drive and a magnetic tape cassette are available. The tape drive records data at 800 bits per inch. The cassette unit records at 100 8-bit characters per inch. Read/write speed of the cassette is 10 inches per second; usable tape capacity is about 280 feet. The magnetic tape unit is the same one used on earlier series, allowing eight systems to be connected to a common polling tape subsystem.

COMPATIBILITY

The Burroughs L Series is upward compatible from the L2000 through the newer L8000 Series and between corresponding models of older and newer series, given the same peripheral complement. These relationships are best understood by examining Table 1. For compatibility purposes, the L2000 and L3000 can be grouped as a single system because the rear versus front feed does not affect the programming. Thus, a program written for the L4000, for instance, can run on an L5000, L7000, and an L8400 and up, but it can not run on an L2000, L3000, L8200, or L8300 because of the longer print line. An L8400 program, on the other hand, can not run on the L4000 because of the L4000's small memory size. Programs written for a system with tape cassettes and dynamic memory overlay feature implemented will not run on an L4000.

Members of the TC 3500 Series are upward compatible with the L Series in relationships paralleling L8000 Series compatibility relationships as listed in Table 1.

SOFTWARE

The L Series is unusual in terms of programming flexibility, because it still remains the only accounting computer of its size that permits Cobol programming for small operator-attended systems. Such Cobol programs must be compiled on a Burroughs B 3500 computer. If the L Series system has data communications ability (i.e., if it is a TC 3500), the program can be transmitted to a remote B 3500 for compilation.

This series can also be programmed in Assembler language. The programs are assembled either on the L Series machines or on a B 3500 if desired. The company provides, at no extra cost, preprogrammed routines to assist in program debugging, as well as several utility routines.

Burroughs offers the following wide range of standard application packages — accounts payable, general ledger and financial statements, payroll accounting with reports, public utility billing, hospital accounting, job costing, billing and account updating, cash receipts and posting, general ledger and month-end reports, payroll accounting, accounts receivable, age analysis, general billing, and many others. Currently, over 150 packages are on the Burroughs applications software list. System software is also supplied to all users.

In addition, Burroughs will either modify these standard packages to meet the user's specialized needs or write appropriate customized programs.

One of the users interviewed felt that Burroughs is not as oriented toward customized programming as is, for instance, Nixdorf. Consequently, when he bought the L Series system for the hardware/software package, he would resell for a particular specialized application (the home mortgage documentation system mentioned earlier). This user was not concerned about competition from his own supplier. The extensive list of applications software, which does include programs related to home mortgage documentation, seems to belie his remarks.

Dynamic Memory Overlay

The L8000 and its sister line, the TC 3500, make use of a software-controlled feature called "dynamic memory overlay." When operating in dynamic memory overlay mode, programs are automatically loaded from cassette tape stations and are executed in segments. Programs larger than available main memory can be executed without operator intervention. The concept is similar to virtual memory, but it uses cassettes (slower but cheaper) as the auxiliary or virtual memory storage medium.

MAINTENANCE

L Series maintenance is performed by Burroughs service personnel available for on-call emergency service during normal business hours. Preventive maintenance is performed at mutually agreeable hours. Microcoded diagnostic routines use test cards and a dictionary to isolate memory failures.

First-year maintenance is covered by a warranty. A separate contract covers subsequent service. Maintenance personnel are located in more than 200 branches across the United States and in most computer-using countries in the world.

PRICE DATA

Model Number	Description	Monthly Rental $*	Purchase $	Monthly Maint $
	BURROUGHS L SERIES			
	CENTRAL PROCESSOR AND WORKING STORAGE			
L2000	Processors (with keyboard)			
L2000-008	(128 user words)	243	6,995(1)	NA
L2000-208	(256 user words)	276	7,995(1)	NA
L2101-008	(128 user words)	280	8,490	NA
L2101-208	(256 user words)	313	9,490	NA
L2101-408	(384 user words)	346	10,490	NA
L2101-608	(512 user words)(2)	379	11,490	NA
L2301-008	(128 user words)	290	8,790	NA
L2301-208	(256 user words)	323	9,790	NA
L2301-408	(384 user words)	356	10,790	NA
L2301-608	(512 user words)(2)	389	11,790	NA
L2302-908	(768 user words)(2)	455	13,790	NA
L3000	Processors (with keyboard)			
L3111-008	(128 user words)	326	9,890	NA
L3111-208	(256 user words)	359	10,890	NA
L3111-408	(384 user words)	392	11,890	NA
L3111-608	(512 user words)(2)	425	12,890	NA
L3311-008	(128 user words)	336	10,190	NA
L3311-208	(256 user words)	369	11,190	NA
L3311-408	(384 user words)	402	12,190	NA
L3311-608	(512 user words)(2)	435	13,190	NA
L3312-908	(768 user words)(2)	495	14,190	NA
L3231-307	(256 user words)	297	8,990	NA
L3231-608	(320 user words)	363	10,990	NA
L3331-608	(288 user words)	396	11,990	NA
L4000	Processors (with keyboard)			
L4111-009	(128 user words)	372	11,290	NA
L4111-209	(256 user words)	406	12,290	NA
L4111-409	(384 user words)	439	13,290	NA
L4111-609	(512 user words)(2)	472	14,290	NA
L4311-209	(256 user words)	415	12,590	NA
L4311-409	(384 user words)	448	13,590	NA
L4311-609	(512 user words)(2)	481	14,590	NA
L4312-909	(768 user words)(2)	514	15,590	NA
L5000	Processors (with keyboard)			
L5012-619	(608 user words)	660	19,990	NA

PRICE DATA (cont.)

Model Number	Description	Monthly Rental $	Purchase $	Monthly Maint $
L5112-689	(608 user words)(2)	710	21,500	NA
L5112-619	(608 user words)(2)	759	22,900	NA
	INPUT/OUTPUT FOR L2000/ 3000/4000/ 5000			
	Punched Card			
A595	Card Reader	97	2,950	NA
A596	Card Reader	115	3,490	NA
A509	Card Punch Control Unit	33	1,000	NA
A149	Card Punch (GPV product)	120	5,990	NA
	Card/Tape			
A581	Paper Tape/Edge Punched Card Reader	46	1,390	NA
A562	Paper Tape/Edge Punched Card Perforator	52	1,590	NA
	Magnetic Tape			
A1495	MTU and Controller	365	11,500	NA
	Document Reader			
A4005	Magnetic Record Reader (L5000 only)	148	4,490	NA
	CENTRAL PROCESSOR AND WORKING STORAGE			
L7000	Processors (with console)(3)			
L7300-300	Processor	495	15,000	62
L7300-350	Processor	500	15,150	63
L7400-400	Processor	541	16,400	64
L7400-450	Processor	546	16,550	65
L7500-501	Processor	843	25,550	86
L7500-551	Processor	848	25,700	86
L7500-502	Processor	888	26,900	94
L7500-552	Processor	893	27,050	95
	Processor Options			
A2311	Extended Memory Controller	42	1,275	3
A5400	Scratchpad Memory Module (32 words)	15	45	1
A7311	Extended Memory Module Control	6	175	1
A7312	Cable for Third Extended Memory Module	7	200	1
A9371	Extended Memory Module (2,048 words)	83	2,500	5
	INPUT/OUTPUT FOR L7000			
	Punched Card			
A3111	Card Reader Control	10	310	1
A9114	Card Reader	70	2,120	20
A8111	Card Reader Code Conversion (BCL)	2	60	
A8112	Card Reader Code Conversion (EBCDIC)	2	60	
A3211	Card Punch Control	31	775	3
A 149	Card Punch	120	5,990	28
A8211	Card Punch Code Conversion (BCL)	2	60	
A8212	Card Punch Code Conversion (EBCDIC)	2	60	

Model Number	Description	Monthly Rental $	Purchase $	Monthly Maint $
	Card/Tape			
A3121	Paper Tape/Edge Punched Card Reader Control	14	425	2
A3222	Paper Tape/Edge Punched Card Punch Control	14	425	2
A9222	Paper Tape/Edge Punch Card Punch	38	1,165	12
A2321	Card/Tape Subsystem Controller		1,000	4
A6321	Card/Tape Subsystem Buffer No. 2 or No. 4		165	1
A6322	Card/Tape Subsystem Buffer No. 3		350	1
	Printers			
A9249	Line Printer		8,000	432
A3243	Line Printer Controller		500	30
	Document Reader			
A9161	Magnetic Record Reader (single-track)	148	4,490	25
A9162	Magnetic Record Reader (dual-track)	161	4,890	25
	BURROUGHS L8000			
	CENTRAL PROCESSOR AND WORKING STORAGE			
L8000	Accounting Computers with			
L8200-100	15-1/2" Rear Feed Forms Handler (4 Kb)	394	12,990	
L8200-200	15-1/2" Rear Feed Forms Handler (4 Kb; 1 cassette tape station)	424	13,990	
L8300-100	15-1/2" Front Feed Forms Handler (4 Kb)	409	13,490	
L8300-200	15-1/2" Front Feed Forms Handler (4 Kb; 1 cassette tape station)	440	14,490	
L8400-100	26" Front Feed Forms Handler (4 Kb)	446	14,690	
L8400-200	26" Front Feed Forms Handler (4 Kb; 1 cassette tape station)	476	15,690	
L8500	Magnetic Record Computers with			
L8541-100	26" MMR Forms Handler (6 Kb; 352-digit data track)	667	21,990	
L8541-200	26" MMR Forms Handler (6 Kb; 352-digit data track; 1 cassette tape station)	697	22,990	
L8541-104	26" MMR Forms Handler (6 Kb; 352-digit data track; solid platen)	637	20,990	
L8541-204	26" MMR Forms Handler (6 Kb; 352-digit data track; 1 cassette tape station; solid platen)	667	21,990	

PRICE DATA (cont.)

Model Number	Description	Monthly Rental $	Purchase $	Monthly Maint $
L8542-100	26" MMR Forms Handler (6 Kb; 704-digit data track)	697	22,990	
L8542-200	26" MMR Forms Handler (6 Kb; 704-digit data track; 1 cassette tape station)	727	23,990	
	Processor Options			
A4011	2-Kb Memory Module (up to 16-Kb total)	31	1,100	
A4011-1	2-Kb Memory Module (over 16 Kb)	21	810	
A2011	24-Kb Extended Memory Pot	21	750	
A2012	32-Kb Extended Memory Pot	22	800	
A7341	Upgrade Kit (to upgrade an L8000 MMR console, 704-digit MMR capacity)		1,500	
A7351	Upgrade Kit (to convert any Series L8000 to the corresponding single data comm TC 3500 style)		1,500	
	INPUT/OUTPUT			
	Punched Card			
A9114-1	Reader (200-cpm; 80-col)	78	2,790	
A9119-1	Reader (300-cpm; 96-col)	85	3,500	
A9419-2	Reader/Punch Data Recorder (300/60; 96-col)	240	9,490	
A9419-6	Multipurpose Card Unit (300/60; 96-col)	285	11,390	
A2331-1	Control (for A9119-1)	25	900	
A2331-2	Control (for A9419-2)	53	1,900	
A2331-3	Control (for A9419-6)	59	2,100	
	Card Tape			
A9222-1	PPT/EPC Punch (40-cps)	53	1,990	
A9122-1	PPT/EPC Reader (40-cps)	42	1,590	
A2322	PPT/EPC Control	28	1,000	
	Printers			
A9249-1	Line Printer (90-lpm)	240	8,500	
A9249-2	Line Printer (180-lpm)	280	11,200	
A2361-1	Controller	39	1,400	
A2361-2	Controller	42	1,500	
	Magnetic Tapes			
A9490-25	Cassette Tape Subsystem (1st station includes controller)	55	1,940	
A1495-1	MTU (2-port)	365	11,500	
A1495-2	MTU (4-port)	373	11,750	
A1495-3	MTU (6-port)	381	12,000	
A1495-4	MTU (8-port)	389	12,250	
A2392	Data Collection MTU Controller	28	1,000	
	Magnetic Record Reader			
A9161-1	352-Digit Data Track	148	4,790	
A9162-1	704-Digit Data Track	161	4,990	

Model Number	Description	Monthly Rental $	Purchase $	Monthly Maint $
A7141	Upgrade Kit (to upgrade A9161 magnetic record reader to 704-digit data track)		500	
	Consoles			
A9361	Magnetic Record Handler (stacker w/hold; includes PF29)	42	1,500	
A9362	Magnetic Record Handler (feeder/stacker/hold; includes PF29)	78	2,790	
PF 21	RF, Single Synch (15-1/2")	7	250	
PF 22	RF, Single Asynch (15-1/2")	7	250	
PF 23	RF, Dual (15-1/2")	14	500	
PF 24	FF, Single Synch (15-1/2")	7	250	
PF 25	FF, Single Asynch (15-1/2")	7	250	
PF 26	FF, Dual (15-1/2")	14	500	
PF 27	FF, Single Synch (26")	7	250	
PF 28	FF, Single Asynch (26")	7	250	
PF 29	FF, Dual (26")	14	500	

Notes:

(1) Prices given are for 3-month warranty. Same styles can be purchased with 1-year warranty for $7,350 and $8,350.

(2) User words may be fewer, depending on firmware requirements.

(3) Available user words on L7000 processors depend on interpreter requirement.

HEADQUARTERS

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SUMMARY

It's not certain that a "gap" really existed between the Burroughs Series L 8000 and the Burroughs B 1700 Series, but Burroughs has conveniently filled it by the introduction of the B 700 Series, the smallest of the Burroughs "700" family of computers. The B 700 Series is truly a small business machine. It offers hardware, an operating system, a license to programming products, training, and selected maintenance. Programs to be run are called by very simple commands. Data conversion, from card to disc, or from tape cartridge to disc, is simple and fast.

The B 700 system is aimed at first-installation users and is totally designed to be run with the Burroughs Business Management System (BMS). BMS is a comprehensive set of business programs developed for and being used with the Series L 8000 and the B 1700 Series computer systems, and now the 700 series. BMS is priced separately from the hardware and operating system software. According to users, it is sufficiently flexible to contain the needs of any business operation, world-wide.

It is the BMS, in fact, that separates the B 700 from a high-powered programmable accounting machine. Business reports of almost every usable genre can be produced easily, if not quickly.

Clearly, the Series L 8000, B 700, and B 1700 overlap. All use the Business Management System and all have Cobol. The larger two have RPG. The B 1700 and L 8000 can handle communications, the B 700 currently cannot (hints are being made about the B 700, however). The L 8000 cannot handle disc or full-sized magnetic tape reels. The B 700 and B 1700 both have operating systems. The B 1700 currently can handle IBM System/3 RPG, the B 700 cannot (more hints). Prices and core capacity overlap between the L 8000 and the B 700, and between the B 700 and the B 1700.

It appears that the deciding factor in which system to purchase should be the amount of data and the degree of general purpose flexibility desired. The B 1700 is technologically and operationally superior; at the low end it completely encompasses the B 700 for a slightly higher price. At the high end it overlaps the medium general purpose B 2700.

However, for a pure and simple business system, flexible within the constraints of small business requirements, and little else, the B 700 is a good system if not too much data needs to be readily accessible at any one time.

One of the better features of data entry is the Audit Entry capability. The operator/data-enterer is informed by a beep whenever illogical or invalid data is entered in a specific field. The console used for entering data is the same pleasantly pastel color-coded terminal used for the L 8000. The Audit Entry Terminal (AE 300) is available whenever input needs go beyond a single data enterer, or whenever data is to be encoded at a different location and transferred for entry to the machine. The AE 300 enters data onto a magnetic tape cassette, compatible with the L 8000. Information from the tape cassette is read by the B 700 processor and placed on disc.

Data and programs to be executed are stored on disc. This is different from the L 8000, for which programs are stored as object programs on tape cassettes, and require previous compilation on a B 3500, and data is stored on magnetic records. Disc-resident programs are the norm for the B 1700 Series, and the data can be stored on disc or tape. And of course, the B 700 offers the ever-present 80- or 96-column punched card.

Security procedures were not mentioned at the B 700's announcement, although the organization of data stored on disc for the B 700 series is key-oriented. Apparently, access to the machine and knowledge of report programs' names yield access to the data.

Another similarity with the B 1700 Series is that the B 700 series has an operating system, albeit a naive one. The operating system can assign resources, handle the checkpoint/restarting of the program running (Burroughs calls this facility "interrupt/resume"), and handle the invocation of general programs, sort, utilities, and the Cobol and RPG compilers.

Physically, the B 700 system is small, both in occupied floor space and number of units, and is quiet. It is also low to the ground; access to the disc cartridges, the printer, the terminal, and the tape storage area is best performed by continual and uncomfortable stooping.

COMPETITIVE POSITION

In addition to competing with other Burroughs products, the B 700 competes with the HIS 2020, the Univac 9200, the IBM System/3 Model 10, the Singer System Ten, and the NCR Century 50.

The HIS 2020 has a wider range of peripherals and available languages, and already offers communications capabilities. It also has a slightly more sophisticated operating system which, although not offering a checkpoint/restart, can handle two programs at one time by alternating I/O and CPU time. Both the B 700 and the HIS 2020 are disc-oriented. Both offer a wide range of applications programs for businesses, banks, wholesalers, etc.

The B 700 however is technologically more innovative than is the HIS 2020 and as a result operates at significantly faster speeds. The operating system on the B 700 is microprogrammed, as are all I/O instructions and the instructions for the Cobol interpreter, the sort program, and the utilities, that is, the B 700 is a mini-computer disguised as a small business machine. The HIS 2020 is a conventional smaller version of a larger general-purpose machine.

Both the HIS 2020 and the B 700 are upward compatible with their respective general-purpose machines at the source code level.

Users who want a larger choice of business and scientific applications software than is offered by the B 700, IBM System 360/370 compatibility, but not IBM prices, can opt for the Univac 9200. The Univac 9200 is completely upward compatible with the rest of the Univac 9000 series.

The nearest IBM competitor to the B 700 is the System/3 Model 10. The system is more flexible, offers a wider variety of programming support and of peripherals, and has a more sophisticated operating system. It is also more expensive. And it is completely incompatible with the larger general purpose computers in the IBM product line.

In the discussion of relatively isolated performers, i.e., machines that are not upward compatible with anything in particular, the Singer System Ten is a noteworthy competitor. Its strongest distinguishing factor when compared with the B 700 is its wide range of special purpose peripherals, including employee badge readers and cash-register-type terminals with merchandise tag readers. It also supports a CRT display.

The System Ten doesn't have an operating system, but it does have a sophisticated memory segmentation and I/O channel sharing that allows multiprogramming of up to 20 programs at one time.

The NCR Century 50 could be called the "plain vanilla" competitor of the B 700. It offers about the same functions, to approximately the same user base, for about the same price. However, its total core capacity is less. And it is not intended for any kind of conversational user-machine interaction. Its typewriter keyboard is an optional feature that serves primarily for communication with the CPU.

CONFIGURATION GUIDE

Two central processors are available for the B 700 series; the B 705 and B 711. Both have 1 microsecond cycle times, although processor speed for the B 705 is half as fast as processor speed for the B 711. The B 705 has a 32K byte basic memory which is field expandable to 40K. The B 711 has a 32K byte basic memory, field expandable in two 8K byte increments to 48K bytes. There is no technological reason why either of the processors could not be further expanded.

The processor logic, memory, peripheral controls, and power supplies are all included in one unit. Two buffered I/O controls, the minimum per processor, may be expanded to eight I/O controls.

Regardless of functional orientation, every basic configuration includes 32K bytes of memory, a 26-inch console, and a disc cartridge drive with 4.6 megabytes of storage. Every basic configuration can accommodate either of the two available processor speeds.

Tailoring of the basic configuration for audit entry includes addition of a 90-line-per-minute printer, a magnetic tape cassette drive, and an AE 300 audit entry terminal equipped with a magnetic tape cassette.

Tailoring of the basic configuration for a card system includes addition of a 90-line-per-minute printer, a 96-column card reader/punch/printer/data recorder, and an off-line 96-column card data recorder for data preparation.

Equipment announced as available, and a general comparison with the L 8000 and the B 1712/1714, appears in Table 1.

COMPATIBILITY

At the source code level, the B 700 Cobol and RPG programs are compatible with the B 1700 and therefore with the rest of Burroughs' medium systems (the B 2700, B 3700, B 4700, etc.).

Object code is in no way compatible. Data should be compatible. Cobol programs written for tape cassettes and with minimal I/O from the L 8000 will run on the B 700 with little or no modification.

The Cobol and RPG are not compatible with other manufacturer's versions of the same languages.

Peripheral compatibility appears in Table 1.

SOFTWARE

The most noteworthy feature of the software is the Burroughs Management System, which is indeed the set of applications programs of the same name that exists for the L 8000 and the B 1700.

The BMS is actually a collection of over 350 modules, each of which performs a single, common business function. The modules are collected into different groups to perform the required functions of the user. The same modules are used in whatever functional group requires them.

For example, a hospital accounting routine payroll subsystem may require deductions of various natures. Even though the function and performance results of the entire package may differ from the results of a wholesaler's payroll subsystem, the chances are that exactly the same BMS module is being used in both packages to perform the desired payroll deductions. To the user, this modularity means desirable flexibility, comprehensiveness, and ease of use.

The BMS is heavily report oriented. Its data base is key-oriented, which makes production of reports much simpler. Key-oriented data bases lend themselves to cross-referencing.

Table 1. Available B 700 Peripheral Devices

B 700 Characteristic or Device	Compatible with L 800	Compatible with 1712/1714
B 9343 Console	No	No
AE 300 Audit Entry Computer	No	No
Disc Cartridge		
A 9480 (4.6 megabyte)	No	Yes
A 9481 (9.2 megabytes)	No	Yes
Magnetic Tape Cassette		
A 9490-25 (240,000 char, 800 bpi, 10 inches per second)	Yes	No
A 9491-2 (9-channel, 800 bpi, NRZI, 10 kb)	No	Yes
Line Printers		
A 9249-1 (90 lpm, 132 char. print line)	Yes	Yes
A 9249-2 (180 lpm, 132 char. print line)	No	Yes
A 988 (164 lpm, 120 char. print line)	No	No
A 9247-2 (400 lpm, 120 char. print line)	No	No
Card Reader		
A 9114-1 (80-col, 200 cpm)	Yes	No
A 9119-1 (96-col, 300 cpm)	No	Yes
Card Reader/Punch/Data Recorder		
A 9419-2 or -6 (96-col, 300/60 cpm)	No	Yes
Paper Tape Reader		
A 9122	No	No
Paper Tape Perforator		
A 9222-1	No	No

Registers, reports, journals, statements, and inventories of many descriptions are available.

Other software functions available are a sort program, and various data conversion utilities.

The B 700 operates under the control of the System Control Program (SCP) which is primarily a serial batch processor. The SCP handles interrupts (I/O and operator), I/O transfer (including parallel I/O), and checkpoint/restart (which Burroughs calls "interrupt/resume"). The checkpoint/restart facility means that an executing program (including a utility, or sort) can be temporarily suspended. Another program can then be invoked and executed. The first program can then be resumed, without omission or duplication of any function.

The SCP is disc-oriented. Programs are read to disc before being executed. This allows for much faster processing than in the L 8000, for example.

TECHNOLOGY

Burroughs has a marketing habit — annoying to people who prefer technical accuracy — of stressing design features that are sometimes inaccurately named. For the MCP it was "virtual memory", for the B 1700 it was "bit addressability". For the B 700 the design feature inaccurately named is "Dynamic Interpreter Configuration".

Classically, an interpreter is a fixed set of routines designed to provide immediate execution of a series of programming language instructions, as each instruction is encountered.

Burroughs when it refers to an interpreter, means an organized group of micro-instructions used to control the processor functions. Immediate execution of sequential instructions does not enter into the picture at all. Also, Burroughs' interpreter refers not just to the programming language "compilers", but also to the various sort and utilities routines.

What Burroughs means by "dynamic interpreter configuration" is the following. Memory on the B 700 is divided into a shared memory (magnetic core) and nanomemory (bipolar ROM). The shared memory is used for all applications programs, utilities, sort, and the microcoded operating system. The nanomemory holds the microcode for every basic function that the machine is capable of performing. The functions in the nanomemory are language-independent. They are a group of 256 carefully chosen instruction primitives designed to represent a composite of the basic desirable functions of Cobol, RPG, sort, various utilities, and the operating system, including I/O.

When each application program is compiled, a list is made of the micro-instructions it will use, and the proper execution sequence for the instructions. These lists are read onto disc. When the program is called into memory, micro-memory collapses to include only those micro-instructions needed for execution; the remainder of memory is therefore expanded and can be used for the processing of the application.

There is overhead in I/O transfer from memory to disc; but generally this overhead should be offset by the increased available core.

Again, as it did with the B 1700's variable word length, Burroughs has chosen not to promote what seems to be the most exciting technological aspect of the B 700 — that is, the modular treatment of the language-independent primitive instructions of the machine.

The difference between this concept and, say, the way IBM operates, is that IBM designs its basic machines around the functions represented by the Assembler language.

Burroughs in the B 700 has designed basic functions irrespective of any one particular language.

What this means for the B 700 is that any application program can have access to whatever micro-instructions are best suited to the tasks it is performing. It does not have to suffer through a series of micro-instructions that are makeshift substitutes for its preferred functions. This means that processing time and core resources are being much more effectively used.

Burroughs engineers probably learned this from their application program designers. The Business Management System, for example, is composed exactly the same way: it is a clearly defined group of basic, company-independent functions, able to be combined in a wide variety of ways to perform almost every conceivable business function (hospitals, wholesalers, banks, etc.).

The use of microprocessors will very likely give the B 700 a processing edge with respect to its competitors.

MAINTENANCE AND TRAINING

Maintenance test routines exist that will convert the system to a diagnostic tester. Micro-coded diagnostics routines use test cards and a dictionary to isolate memory failures.

Maintenance of hardware, operating system software, and program products is provided if the user buys the entire package of hardware, operating system, licensing of program products, and the training of personnel. No mention was made of maintenance agreements available if the entire package is not purchased.

OVERVIEW

In July, 1973, Burroughs Corporation announced the latest and largest processor in its 1700 line of business-oriented general purpose computers. Target areas for its use are industries such as banking, wholesaling, distributing, manufacturing, hospitals, government, and education.

The announcement of the B 1728 is significant because it extends what was originally a line of small business machines into the small-to-medium area. In fact, the 1728 overlaps the capabilities of Burroughs current entry into the Medium Systems area, specifically, the "700" series B 2700/3700 computers.

The B 1728 has all of the characteristics and capabilities of the formerly announced members of the 1700 line: the B 1712 and 1714 (the so-called "1710" systems) and the 1726. (The 1726 and 1728 together are called the "1720" systems.) These features include compatibility with Burroughs' B 300/B 500 (achieved through emulation or straight compatibility, depending on model), and emulation capabilities for IBM's 1401/1440/1460. Other characteristics shared by the new arrival with the series are its orientation towards communications (a multiline controller was announced), and its ability to use the peripherals and subsystems available on the 1712, 1714, and 1726. It also shares a market thrust towards small or new businesses as well as large firms that require satellite data processing computers.

COMPARISON WITH OTHER BURROUGHS PRODUCTS

The B 1728 is similar to the 1726 in that both have the same control memory/main memory stratifications and speeds, although the 1728 control memory can be expanded from 6,144 bytes to 8,192 bytes, double that of the 4K maximum available on the 1726.

They have similar I/O channel schemes, and all of the peripherals that can be attached to the 1726 can also be attached to the 1728.

Both use the MCP-II multiprogramming operating system, and the same programming languages: Cobol, Fortran, RPG, Basic, NDL (Network Definition Language), and UPL (User Programming Language). Also, both can use the same applications software, including the Burroughs-authored business management system software.

Both the 1726 and the 1728 can use the multiline controller announced simultaneously with the 1728. Use of this controller provides a maximum of 8 lines on the 1726 and 16 lines on the 1728. The controller uses direct memory access and transmits data at 9,600 bits per second. It is very similar to the Data Communications Processor in use with the Burroughs Medium Systems.

The B 1728 differs from the B 1726 in that the main memory capacity of the B 1728 is larger: 64K bytes expandable in 16K increments to 262K bytes.

Another difference between the B 1728 and B 1726 is that a head-per-track systems disc memory with integrated controller is included in the basic price of the 1728; it is available at separate cost on the 1726. The disc is a modified version of the head-per-track discs available with the Medium Systems processors: it has the same access time (20 milliseconds); its capacity is slightly lower (8.1 million bytes) because of modifications necessary to adapt the disc to the 1728. Disc expansion is the same as that available for the Medium Systems — up to 5 units can be attached for a total of 40.5 million bytes for the 1728. The disc is used to store systems programs and, additionally, user programs and data.

Also announced were phase-encoded, 1,600 bpi tape drives for use on the 1726 and the 1728. Transfer speeds for the 3 drives announced are 40, 80, and 120 kilobytes per second, respectively.

Other devices that have been announced for the 1728 seem to be modified versions of devices available on the Medium Systems; these include an 80-column card reader with a reading speed of 800 cards per minute, and an 80-column card punch with a punching speed of 300 cards per minute; paper tape equipment with respective read/punch speeds of 1,000 and 100 characters per second; and a chain printer with a 48-character set and a speed of 400 lines per minute. High-speed devices that also seem to be modified Medium Systems devices are the 9-channel magnetic tape unit with a 96-kilobyte transfer rate and a 7-channel tape unit with a 72-kilobyte transfer speed.

Because a pattern of adapting Medium Systems peripherals to the "1700" line is developing, a relevant question is, what does the emergent "1700" line have over the existent "700" line?

For one thing, the "1700" series uses the more modern stratified approach to memory technology. Control memory is bipolar semiconductor and operates at 167 nanoseconds (2 bytes). Main memory, also integrated circuit memory, cycles at 667 nanoseconds (3 bytes). This layered approach yields faster execution times than the core technology of the "700" series.

Secondly, the "1700" series can be configured at lower monthly rentals than their "700" series counterparts.

Thirdly, the operating system of the "1700" series computers is more sophisticated than that of the "700" series Medium Systems. The MCP-II uses a pure paging scheme (similar to that used on the multiprocessing 6700/7700 machines) and dynamically reconfigures microcode instructions. These features give it a performance edge over the "700" series MCP-V, which uses a segmentation form of virtual addressing and a fixed microcode instruction set.

Competitive Position

The first obvious target for comparison is Burroughs' own Medium Systems processors, the B 2700/3700. The B 1728 has several distinct advantages. Analysis of monthly rental costs for comparable configurations of the B 1728 and B 2700/3700 indicate that the B 1728 is less expensive. The maximum memory capacity of the B 1728 outstrips that of the smaller B 2700 configurations, and maximum memory of the B 3700 is only 38 kilobytes greater than that of the B 1728.

Other factors in favor of the B 1728 are its more modern technology already discussed, and the somewhat more sophisticated MCP-II.

The major advantage of the B 2700/3700 series over the B 1728 is the significantly greater on-line storage capacity, but future announcements may alter this.

Other more modern competition includes the IBM System/370 Model 125. The B 1728 was scheduled for first delivery September, 1973. Comparisons therefore can only be speculative, pending actual throughput analyses.

The B 1728 is good for applications that need large amounts of on-line storage; it has in excess of a half-billion bytes of on-line storage. However, the S/370 Model 125 dual-density 3330 Model 11 drives give it an 800 million-byte capacity. Model 1 packs give a 400-million byte capacity, which is less than that offered on the 1728.

The 1728 is also good for applications that are oriented toward communications; the single line controller of the earlier 1700 systems is available, plus the multiline controller, as announced (an independent processor), can connect up to 16 lines. The IBM System/370 Model 125 can support 6 synchronous lines or 16 start-stop lines with one optional adapter or double that with a second optional adapter. IBM offers a Network Control Program that eases the user's network definitions, but Burroughs Network Definition Language offers more flexibility and it is easier to use.

As far as operating systems go, the MCP as defined in the main 1700 report is better than any of the competing operating systems for increased throughput without unnecessary overhead.

Both operating systems require some user sophistication. IBM's DOS/VS is not for the novice, since throughput on a virtual memory machine as implemented by DOS/VS, where core is a strict limitation, requires considerable planning to avoid "thrashing". Job mix and balancing functions must be performed by the user with DOS/VS. MCP-II, on the other hand, performs these functions and allocates system resources. The 1728 is a good system. The only truly negative feature that we have found lies not in the 1728 hardware, but in the business management system software available for applications. Users of this system, which is available on other Burroughs machines, have complained that its extreme modularity makes it slow and unnecessarily redundant.

CONFIGURATION GUIDE

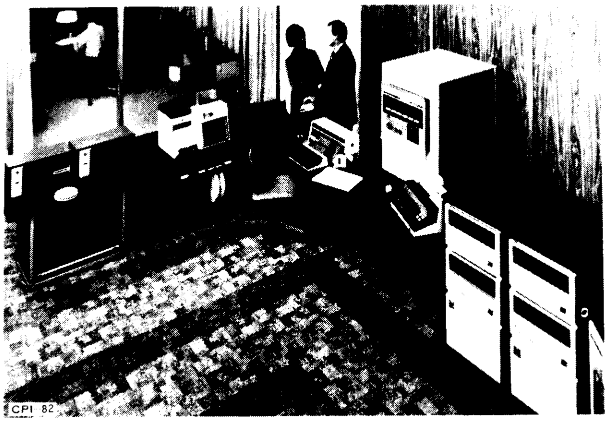
The B 1728-1 Basic System includes a central processor; 6,111 bytes of control memory (167 nanoseconds for 2 bytes); 65,536 bytes of main memory (667 nanoseconds for 3 bytes); an I/O subsystem with 14 I/O positions; a console printer and control; a head-per-track disc file control (partly integrated); and a head-per-track systems disc. The latter comprises one disc file electronics unit and one disc file storage unit (capacity: 8.1 million bytes, average access time: 20 milliseconds).

The basic system is modular and can be expanded as follows:

- Main memory (LSI) from 65,536 bytes to a maximum of 262,144 bytes, in 16K-byte increments.
- IC control memory from the standard 6,144 bytes to 8,192 bytes.
- Head-per-track disc from the standard 8.1 million bytes to 40.5 million bytes in 8.1 million-byte increments.
- Removeable disc subsystems up to a maximum of 525 million bytes.

Addition of a second electronics unit as available on the "700" series disc system, but not yet announced for the 1728, would allow a 1 x 2 exchange and the addition of another 40.5 million bytes of on-line storage. Additionally, a disc pack memory controller connects the modular disc pack memory subsystem. Transfer rate is 625,000 bytes per second. The maximum disc capacity is 525 million bytes.

The I/O subsystems offer buffered controls for the following devices: 96- and 80-column card equipment, line printers, the head-per-track memory, disc cartridge memory, magnetic tape, paper tape, MICR reader/sorters, and the data communications single line control. Buffered controls speed up I/O transfer considerably, which is important in systems with I/O bound applications, such as business systems invariably use.



OVERVIEW

Burroughs B 1700 computers are small-scale general business systems aimed at both small and/or new businesses as well as large firms that need satellite data processing installations. They provide efficient competition for the IBM System/3, Honeywell Models 2020 and 2030, NCR 50, and Univac 9200.

The 3 models currently in the B 1700 series — B 1712, B 1714, and B 1726 — vary essentially in processor cycle rate, size range of main memory, and available peripherals. The B 1726 also has a control memory that operates at 4 times its main memory operating rate of 666 nanoseconds per 24 bits.

Peripheral equipment available includes 80- and 96-column card readers and punches, 96-column card sorters, and multifunction units, disc units, line printers, magnetic tape units, a data communications interface, and a console printer. Also available is a new series of MICR document reader-sorters, which are of special interest for banking applications. All devices are buffered; up to 8 individual I/O controls are available on any of the 3 systems.

Two versions of the Master Control Program (MCP) operating system have been announced for the 1700 series: MCP I and MCP II. MCP I is a serial programming system which is not released to date. MCP II provides a multiprogramming environment. Both MCPs are responsible for dynamic control of memory and resource assignment, I/O operations, operator communications, library management, logging, and other functions. The commands for the MCP, entered via the console or via control cards, are simple to use and understand.

Burroughs supplies a comprehensive library of business management software (BMS) for customers who do not have or cannot afford to develop their own software. The BMS package is functionally general enough so that it can be tailored to almost any user environment. This generality, however, has resulted in some user complaints in relation to slow processing.

The programming languages available are Cobol, Basic, Fortran, and RPG. The language compilers in each case generate "s-code," Burroughs' version of machine language. The s-code is then executed by interpreters for each language. RPG is handled somewhat differently; the RPG compiler generates Cobol s-code, which is then executed by the Cobol interpreter.

A design feature, strongly emphasized by Burroughs, is "bit addressability." Burroughs claims that this is the ability of the B 1700 processors to address an individual bit in memory. It is true that the 1700 microinstructions are capable of direct bit manipulation and that memory fetch addresses are at the bit level. However, the B 1700 memory is physically divided into 8-bit words. The CPU addresses main memory physically on byte boundaries so that parity bits can be checked and created. What the microinstructions can do that is noteworthy is access memory in either positive or negative increments respective to a referenced bit, for a specified number of words of variable length.

The variable instruction, operand, and word lengths are the design features that Burroughs should really be emphasizing. At the s-code level, the Burroughs word (or "unit") can be defined as 1 to 65,535 bits (8,191 characters). This flexibility allows improved utilization of available space and faster execution. In regard to space savings, Burroughs is making a claim of a 20 to 40% reduction in the amount of memory needed to execute programs. Users of variable word length machines from other manufacturers have reported space savings of as much as 70%. Burroughs' 40% is probably a conservative estimate.

Configuration Guide

Tables 1 and 2 show the variations in processor speed, memory size, and supported peripherals of the three B 1700 series models. It also contains configuration information. A minimum entry configuration for the B 1700 series could include a B 1714 with 16,384 bytes of memory, an A 9350 console printer, an A 9419-2 96-column reader-punch (300/60 card per minute), an A 9245-16 32-column line printer, and an A

Table 1. Burroughs B 1700: Series Comparison and Configuration Information

Characteristic or Device	B 1712	B 1714	B 1726	Comments
Processor Speed (msec)	0.5	0.25	0.125	
Memory Size (bytes)	16-40K	16-65K	24-98K	
Increment Sizes	8K	8K	8K to 65K; 16K to 98K	On the 1726, main memory increments replace the basic configuration memory. MOS/LSI semiconductor.
Control Memory	—	—	x	2K or 4K available for 1726.
9340 Console Printer & Control	x	x	x	Required.
I/O Channels (max without I/O expansion feature)	5	5	8	On the 1726, there are 5 types of I/O subsystem connections. 1 each std.
I/O Channels (max with I/O expansion feature)	8	8	8	Max 2 expansion features on 1726; adds 1 each of 3 types of subsystem connections.
HIGH-SPEED PERIPHERALS				
Direct Access Devices				At least 1 dual drive required. Max 2 for 1714, unless MICR reader/sorter is used, then max 1. Need I/O expansion feature when 2 disc subsystems or when 1 disc and 1 MICR are used.
9480 Single Disc Cartridge Drive (2.3 or 4.6 mb; 90 msec)	x	x	x	Data in cartridges is recorded in 180-byte segments; avg head positioning is 60 msec; rotational delay 20 msec; transfer rate is 193 kb/sec.
9481 Dual Disc Cartridge Drive (4.6 or 9.2 mb; 90 msec)	x	x	x	
9486-2 Dual Disc Pack Drive (95.5 mb; 42.5 msec)	—	—	x	Max 1/control.
9371 Head-per-Track Memory Bank (7 or 14 mb; up to 5 units; 20 and 40 msec, respectively.)	—	—	x	Max 1/control.
Magnetic Tape				Max 1 control/processor.
9491-2 9-Channel Magnetic Tape Unit (10 kb; NRZ; 800 bpi)	x	x	x	Max 4/control.
9381-12/13/14 9-Channel Magnetic Tape Cluster (18 kb; 2/3/4 stations)	—	x	x	
9381-22/23/24 9-Channel Magnetic Tape Cluster (36 kb; 2/3/4 stations)	—	x	x	
9390-3 7-Channel Magnetic Tape Unit (18/50 kb; NRZ; 200 or 556 bpi)	—	—	x	

9480-2 dual disc cartridge file (4.6 million bytes). Every system must include a console printer and a disc subsystem.

Expansion within the series, except for the 1726, is eased by add-on memory modules and compatibility of peripherals. On the 1726, the basic configuration memory is replaced during upgrading. Also, the 1726 will not handle the slow-speed printers of the 1712 and 1714.

Expansion to larger computers in the Burroughs 700 series (the B 2700, B 3700, and B 4700) is eased by the fact that the larger computers are designed to run in a similar multiprogramming environment. They also accept without modification the higher-level languages, especially Fortran and Cobol, that can be run on the B 1700s.

Upgrading from Burroughs commercial minicomputers and the B 500 systems is eased by

Table 2. Burroughs B 1700: Configuration Information

Characteristic or Device	B 1712	B 1714	B 1726	Comments
Card Equipment				Max 2 controls/processor. Max 3 readers on 1726.
9115 80-Col Card Reader (300 cpm)	x	x	x	
9116 80-Col Card Reader (600 cpm)	—	x	x	
9111/2 80-Col Card Readers (800, 1,400 cpm)	—	—	x	
9210 80-Col Card Punch (100 cpm)	x	x	x	
9119-1 96-Col Card Reader (300 cpm)	x	x	x	Max four 96-col readers, or if MICR used, probably 3.
9319-2 96-Col Card Reader-Punch (300/60 cpm)	x	x	x	
9319-4 96-Col Reader-Punch (500/120 cpm)	—	x	x	
9419-2 96-Col Reader-Punch Data Recorder	x	x	x	
9419-6 96-Col Multifunction Card Unit (includes sorter)	x	x	x	
Line Printers				Max 1 control/processor.
132-Col Line Printers (90-300 lpm)	x	x	—	
132-Col Line Printer (400 lpm)	—	x	—	
132-Col Line Printers (475-750 lpm)	—	x	x	
132-Col Line Printer (1,040 lpm)	—	—	x	
Reader-Sorters				Max 1 control/processor. If used, requires I/O expansion feature. If used, only 1 disc subsystem can be used on 1714.
MICR Reader-Sorters (600 cpm; 8 or 12 pockets)	—	x	x	
MICR Reader-Sorters (900 cpm; 8 or 12 pockets)	—	x	x	
MICR Reader-Sorter (1,000 cpm; 13 pockets)	—	—	x	
MICR Reader-Sorter (1,625 cpm; 4-16 pockets)	—	—	x	
Data Communications Single Line Control	—	x	x	Max 2 controls/processor, controls need line adapters.

their high-level language programs that will run on the B 1700 and make full use of the B 1700 configurations. B 300 programs can run under an emulator.

Performance and Competitive Position

B 1700 is well suited for the typical scope of small business data processing needs. The provision of customer-oriented software packages, and the high-level language compatibility with the 700 series computers make the B 1700 an excellent entry system for a small business or for a large firm that requires satellite data processing installations. The interfaces possible between computers in the 700 series in a communications environment, and the compatibility of other peripherals establish the B 1700 as a growth system. The multiprogramming facilities, albeit limited, are an encouraging step in a small system.

Burroughs is marketing the B 1700 series as implicit competition for the IBM System/3. Similar to System/3, Burroughs offers both 80- and 96-column card peripherals and data preparation equipment. Both systems offer Basic, RPG, Fortran, and Cobol. IBM also offers Assembler and a desk calculator. Burroughs, however, is aiming at the Cobol market; this is indicated by the facts that RPG is interpreted by the Cobol interpreter for the B 1700, and that Burroughs offers COFIRS (Cobol from IBM RPG Specifications), which is designated to automatically convert IBM's RPG to Burroughs' Cobol.

Multiprogramming can be done in both series. Burroughs' operating environment is suitable for multiprogramming because of the larger available core capacity and better space allocation. On the System/3 Model 10, IBM realistically offers 2 levels of multiprogramming as an option. Both systems apply variations on the theme of virtual memory. The System/3 Model 6 employs disc storage, and swapping to handle Basic programs that would not normally fit into main storage. The B 1700 MCP II uses a paging technique of programmer-defined or compiler-defined segments to accomplish a similar end.

System/3 offers time sharing; B 1700 does not, although release of an interactive Basic compiler is planned. Both systems have communications capabilities. The configuration of Burroughs' communications system should be greatly facilitated by the use of the Network Definition Language (NDL), a high-level language originally designed for the medium systems in the 700 series.

A major difference, from the users' point of view, is that source code on the B 1700 is upward compatible with the rest of the 700 series. This is not the case with System/3 code or data files.

History

Burroughs, founded in 1905, is one of the 2 largest manufacturers of electronic accounting machines, as well as one of the largest computer manufacturers. The company employs over 52,000 people, grosses approximately $900 million a year, and maintains a worldwide marketing force.

The B 1700 is currently the second smallest system in the 700 series of computers. The Burroughs chain now extends from the L Series terminal computers introduced in 1968 through the B 700 and B 1700 small business computers to the B 2700, 3700, 4700, 5700, 6700, and 7700 medium- and large-scale computers. All are programmable in Cobol; most of the computers operate in multiprogramming mode and share many of the same peripherals. This enables expansion within a computer line that ranges from the very small to the very large.

MAINFRAME

All systems in the B 1700 series use large-scale integrated (LSI) circuit main memory. This small-size, high-density circuitry is faster, more reliable, and more easily maintained than conventional magnetic core. Main memory operates with a 666-nanosecond cycle time; control memory (B 1726) cycles in 167 nanoseconds. These speeds are significantly faster than the speeds of most competitive systems.

Bit Addressability

For the B 1700 Burroughs is advertising "bit addressability," a concept that has been existent at least since IBM's ill-fated STRETCH. Burroughs claims that this is the ability of the B 1700 processors to address an individual bit in memory. Microinstructions' memory fetch addresses are at the bit level. However, the CPU addresses main memory physically only on byte boundaries in order to check and create parity bits for the 8-bit words (into which the memory is physically divided). The difference with Burroughs' access of main memory is that it can be done either in negative or positive increments respective to the desired bit; the data can be rotated to isolate the appropriate starting bit during the memory fetch.

Normally, bit manipulation at this level isn't noteworthy. However, Burroughs has thoughtfully provided a varying word length which optimally means that storage can be allocated in bits. The interpreters can directly invoke calls to microinstructions that operate on bits. More importantly, this avoids the crime of wasted storage classically committed by higher-level languages that require byte boundaries for values that could be represented in less than a byte. This manipulation of individual bits — generally a systems programmer's concept — is an interesting development from a manufacturer whose machines are oriented toward the higher-level languages.

One result is that bit addressability gives the ease of higher-level language coding, plus some of the storage utilization of a systems language, namely, Assembler — an almost ideal blend. Add to this, the microcoded interpreters, which allow dynamic reconfiguration of the hardwired microinstructions on the basis of a series of software microinstructions tailored to the appropriate higher-level language, and the B 1700 becomes a technological blend of minicomputer sophistication and general-purpose computer flexibility.

A logical extension of this sophistication is that the 1700 systems are well suited to be "universal emulators." Technologically, the 1700 systems are so flexible at the microcode level that they could emulate any machine.

PERIPHERALS

Tables 1 and 2 contain peripheral device characteristics and configuration information for the three B 1700 series models.

Slow-Speed Peripherals

The operator's console features a built-in magnetic cassette unit intended for the initial entry of systems software and, when needed, the entry of diagnostic software.

The card reader controls will allow a dynamically determinable card size; for example, the readers will handle only 36 columns of a card instead of the full 80 or 96.

A new series of MICR document reader-sorters provide 8 to 12 distribution pockets and sorting speeds of 600 or 900 documents per minute, or 4 to 16 pockets at 1,000 or 1,625 documents per minute.

High-Speed Peripherals

Disc storage is available in 3 different forms; their respective capacities and access times appear in Table 1. Suitability for on-line random access is relative to access time, with the cartridge disc file least suited and the head-per-track disc best suited. The latter is available only on the B 1726.

Magnetic tape equipment is a subset of the equipment that is offered for the larger 700 series computers. Both slow-speed tape units and slow-speed tape clusters are available for B 1700.

Data Communications

For data communications, the B 1700 can interface with other models in the series and with larger Burroughs 700 systems, either as a "host" or a remote batch collection terminal system. The data communications single-line control option can handle up to 2 lines on the B 1714 and 3 lines on the B 1726. Synchronous or asynchronous lines, that operate at a maximum of 9,600 bits per second, can be controlled. The 1700 is best suited for remote terminal processing for a larger central computer. Presently the option is capable of operation with all Burroughs data communications terminals (namely, the TC, RT, and TU series). Burroughs states that the option later will be expanded to include standard synchronous and asynchronous communications conventions of other manufacturers' terminals.

SOFTWARE

Burroughs "soft" machines offer a sophisticated operating system and a very flexible set of applications packages.

Operating System

Two versions of the Master Control Program operating system have been announced for the B 1700: MCP I and MCP II. The installed base is operating under MCP II, since MCP I is not available yet. MCP I is planned as an entry-level (minimum 16K main memory) batch serial operating system that handles all I/O scheduling, dynamic control of memory and resource assignments (including the addition of memory and peripherals), disc program library management, operator and system communication (via console or control cards), job status and logging, program compilation and loading, file management, and utilities. MCP I is expected to need a minimum of 4K for resident requirements.

MCP II, currently available, does all of the functions of MCP I, plus the system handles communications controllers, MICR reader-sorters, and scheduling and loading of programs in a multiprogramming environment. It also provides spooling in the form of pseudo readers and disc backup for printers. The MCP II requires at least 8K bytes of main storage.

The MCP is a paging operating system; page sizes are controlled either by the MCP or by the programmer (the Cobol SEGMENT-LIMIT clause, for example). Paging is facilitated by code (not data) that is entirely reentrant; therefore, there is no need to write back to disc. Data, however, is always written to disc if space is required. Associated with the programs in core is a run status nucleus, tables/stacks, and a segment dictionary, which at any time indicates the pages resident in main storage. If space is needed, it is allocated dynamically in the following page order: available memory, not in use code, in use code, not in use data, and in use data. This is the optimum order with respect to minimized disc access.

Interrupts in the 1700 are soft interrupts; for example, there is a timer bit set every 100 milliseconds, and software must test the bit in order to realize a "timer" interrupt.

The 1700 interpreters reside in 4K or less of core and can be overlayed. On the 1712 and 1714, the MCP resides in whatever core is available. On the 1726, the interpreters reside in control memory, which is either 2K or 4K.

The MCP's paging technique will allow it to run faster as more core is made available. Therefore, we feel that in the 98K bytes (max) available for the 1726, 3 programs are a reasonable multiprogramming mix. Burroughs claims that the 1710 systems also can multiprogram effectively.

We were sceptical about the ability of the 1710 systems (1712, 1714) to multiprogram effectively. A meeting with Burroughs was arranged to discuss the machines and watch a 1714 with 48K, running MCP II. We had 3 Burroughs-authored demonstration programs, subsets of BMS programs, that performed the following: card input; inventory totaling and printing; and file updating. The programs could be further characterized as heavy card input, light processing, light printing; light input, light processing, heavy printing; and light input, heavy processing, light printing. Each of the 3 programs was run serially; the timings were recorded. The programs were than multiprogrammed.

Their order of entry into the system was 2, 3, 1. In this order, the programs ran in 69% of the time required by the serial execution. We then requested that the programs be run in the order 1, 3, 2. In this order, the programs ran in 93% of the time required by serial execution. The pseudo-reader of MCP II was not used in either multiprogramming example. We feel that if this option had been used, more favorable timings would have resulted. Disc backup for the printers, however, was used.

Clearly, for the 1714 to multiprogram effectively, the order of job submission can be critical. This in itself requires knowledge of the job types in terms of resource utilization.

Applications Software

Burroughs offers a comprehensive library of business management software in wholesaling, distribution, and manufacturing, including reports; invoicing, accounts receivable, and inventory control; accounts payable; payroll; and general ledger. Other management systems exist for contractors, credit unions, automobile dealers, utilities, and government.

The firm also offers bank management software in proof and transit; demand deposit accounting; savings accounting; installment loan accounting; and general ledger accounting.

Hospital management software includes reports; patient accounting; medical records; payroll and personnel reporting; and general and responsibility accounting.

All of Burroughs' software is modular in design, which allows modification of packages to suit individual users' needs. This generality of design has aroused some user complaints of lengthy execution times.

Programming Languages

Users intending to write their own software can do so in Basic, Cobol, Fortran, or RPG.

Basic is batch only. Cobol is an extended ANS Cobol. Fortran is also an extended ANS. Cobol programs can run on a 16K entry level system. RPG is handled as if it were Cobol, below the compiler level.

The "variable micrologic" of the B 1700 series computers allows dynamic respecification of the micrologic to fit the particular parameters and requirements of a specific language. For example, Cobol and Fortran vary in their needs for transfers of large data areas. The Cobol compiler might invoke a specially designed move instruction that is not subject to the traditional limit of 256 characters; whereas, the Fortran compiler could still use the traditional instruction. The sequence of (software) microinstructions is changed by the specific interpreter called by the control program.

The minimum number of interpreters per purchased machine is 2: one for SDL (Systems Definition Language, Burroughs' high-level language version of Assembler), and 1 for the language that the users' applications programs employ (Cobol/RPG or Fortran).

Burroughs also offers COFIRS for users of IBM's RPG who may wish to convert their programs to Burroughs' Cobol. Input to COFIRS is an RPG source deck. Output is Burroughs' Cobol.

Users who plan on a communications environment will have their configuration definition (for Burroughs-supported terminals) eased by the use of the Network Definition Language (NDL). Parameter statements to the NDL compiler create instructions and tables for handling the Burroughs-supported terminals. NDL also handles respecification of the communications network as terminals are added or deleted.

MAINTENANCE

Maintenance for the B 1700 series is performed by Burroughs service personnel available on-call during mutually agreeable business hours and operating from over 200 branch locations throughout the country. First-year maintenance is included in the lease or provided by a separate contract.

PRICE DATA

Model Number	Description	Monthly Rental $	Purchase $	Monthly Maint $
	BURROUGHS B 1712/B 1714 SYSTEMS			
	CENTRAL PROCESSOR AND WORKING STORAGE			
B1712	Processor (includes I/O base; 16K bytes main memory; console; table; corner table)	560	27,225	90
B1714	Processor (includes I/O base; 16K bytes main memory; console; table; corner table)	780	34,225	95
	Processor Options			
A1305	I/O Expansion Feature	30	1,500	5
	For B 1712 Only			
B1012-24	Total Memory (24K)	150	5,000	10
B1012-32	Total Memory (32K)	400	12,000	16
B1012-40	Total Memory (40K)	550	17,000	27
	For B 1714 Only			
B1014-24	Total Memory (24K)	200	6,500	13
B1014-32	Total Memory (32K)	400	12,500	18
B1014-40	Total Memory (40K)	550	20,000	25
B1014-49	Total Memory (48K)	700	26,000	36
B1014-57	Total Memory (56K)	850	32,000	48
B1014-65	Total Memory (64K)	1,000	38,000	61
	MASS STORAGE			
	Discs			
	Disc Cartridge Drives (60-msec avg seek time; 20-msec avg latency; 80-msec avg data access time)			
A9480-1	Single-Cartridge Drive (2.3-mb)	250	10,000	31
A9480-2	Dual-Cartridge Drive (4.6-mb)	365	15,450	53
A9481-1	Single-Cartridge Drive (4.6-mb)	310	13,200	47
A9481-2	Dual-Cartridge Drive (9.3-mb)	480	21,600	72
A1480	Control (for A9480-1 and A9480-2 Drives)	90	2,700	14
A1481	Control (for A9481-1 and A9481-2 Drives)	100	3,500	15
A9985-2	Disc Cartridge (for A9480 Drives)	—	170	—
A9985-3	Disc Cartridge (for A9481 Drives)	—	225	—
	INPUT/OUTPUT			
	Punched Card			
A9115	Reader (80-col; 300-cpm)	110	4,500	25
A9116	Reader (80-col; 600-cpm)	195	6,500	35
A1115	Control (for A9115)	45	900	7
A1116	Control (for A9116)	55	1,200	8
A9119-1	Reader (96-col; 300-cpm)	85	3,500	25
A1119-1	Control for A9119-1	45	900	7
A9210-1	Punch (100-cpm; 80-col)	250	12,000	67
A1210-1	Control (for A9210-1)	90	4,320	14
A9319-2	Reader/Punch (reads 300 cpm; punches/prints 60 cpm; 96-col)	200	7,990	60
A9319-4	Reader/Punch (reads 500 cpm; punches/prints 120 cpm; 96-col)	310	11,190	91
A1319-2	Control (for A9319-2)	65	1,900	10
A1319-4	Control (for A9319-4)	70	2,300	11
	Recorders			
A9419-2	Reader/Punch Data Recorder (reads 300 cpm; punches/prints 60 cpm; 96-col)	240	9,490	71
A9419-6	Reader/Punch Data Recorder (reads 300 cpm; punches/prints 60 cpm; 6-pocket sorting at 300 cpm; 96-col)	285	11,390	85
A1419-2	Control for A9419-2	65	1,900	10
A1419-6	Control for A9419-6	70	2,100	11
	Printers			
A9240-1	Printer (475-lpm 132 PP)	475	19,500	174
A9240-2	Printer (700-lpm 132 PP)	625	31,000	179
A9245-16	Printer (300-lpm 132 PP)	475	20,000	149
A9245-19	Printer (400-lpm 132 PP)	575	23,000	154
A9247-3	Printer (750-lpm 132 PP)	710	35,000	138
A9249-1	Printer (90-lpm 132 PP)	240	8,500	60
A9249-2	Printer (180-lpm 132 PP)	280	11,200	70
A1240-1	Control (for A9240-1)	50	1,400	9
A1240-2	Control (for A9240-2)	70	1,500	11
A1245-16	Control (for A9245-16)	50	1,400	8
A1245-19	Control (for A9245-19)	70	1,500	11
A1247-3	Control (for A9247-3)	215	2,800	44
A1249-1	Control (for A9249-1)	35	1,000	5
A1249-2	Control (for A9249-2)	40	1,100	6
A9949-2	Format Tape Reader (for A9247-3; 12-chnl)	61	3,050	15
	Consoles			
A9340	Console Printer	55	2,640	15
A1340	Control (for A9340)	60	1,800	5
	Magnetic Tapes			
A9381-12	18-Kb Cluster (2-station; NRZ; 9-channel; 800-bpi)	525	25,200	179
A9381-13	18-Kb Cluster (3-station; NRZ; 9-channel; 800-bpi)	570	26,960	200
A9381-14	18-Kb Cluster (4-station; NRZ; 9-channel; 800-bpi)	680	32,160	241

PRICE DATA (Contd.)

Model Number	Description	Monthly Rental $	Purchase $	Monthly Maint $
	BURROUGHS B 1712/B 1714 SYSTEMS (Contd.)			
A9381-22	36-Kb Cluster (2-station; NRZ; 9-channel; 800-bpi)	700	33,600	205
A9381-23	36-Kb Cluster (3-station; NRZ; 9-channel; 800-bpi)	900	43,200	236
A9381-24	36-Kb Cluster (4-station; NRZ; 9-channel; 800-bpi)	1,100	52,800	267
A9491-2	10-Kb Tape Unit (NRZ; 9-channel; 800-bpi)	215	8,600	21
A1381	Tape Cluster Control	250	6,000	38
A1491-2	Tape Control (10-Kb)	200	3,900	30
	Sorters			
A9135-2	8-Pocket (900 doc/min; E13-B; off-line sorting)	1,000	45,500	431
A9135-3	12-Pocket (900 doc/min; E13-B; off-line sorting)	1,300	55,900	467
A9136-5	8-Pocket (600 doc/min; E13-B; off-line sorting)	700	34,000	225
A9136-6	12-Pocket (600 doc/min; E13-B; off-line sorting)	850	39,000	270
A1135	Control (for A9135)	150	6,000	30
A1136	Control (for A9136)	150	6,000	30
	DATA COMMUNICATIONS			
A1351	Single-Line Control	50	2,000	8
	Line Adapters			
A1650-1	Asynch Data Set Connect (up to 1,200 bps)	50	1,500	8
A1650-2	Asynch Data Set Connect (up to 1,800 bps)	65	1,800	10
A1650-5	Asynch Direct Connect (up to 2,400 bps)	50	1,500	8
A1650-6	Asynch Direct Connect (up to 4,800 bps)	65	1,800	10
A1650-7	Asynch Direct Connect (up to 9,600 bps)	80	2,100	12
A1651-1	Synch Data Set Connect (up to 2,400 bps)	50	1,500	8
A1651-2	Synch Data Set Connect (up to 4,800 bps)	65	1,800	10
A1651-3	Synch Data Set Connect (up to 9,600 bps)	80	2,100	12
A1652-1	Asynch Data Set Connect (for TTY)	50	1,500	8
A1652-5	Asynch Direct Connect (for TTY)	50	1,500	8

Note:
Maintenance rates are higher outside metropolitan area.

Model Number	Description	Monthly Rental $	Purchase $	Monthly Maint $
	BURROUGHS B 1726 and B 1728 SYSTEMS			
	CENTRAL PROCESSOR AND WORKING STORAGE			
B1726	Processor (includes I/O base; 24K bytes main memory; 2,048 bytes control memory; console; and table)	1,740	78,300	140
B1728	Processor (includes I/O base, 64K bytes of memory, 6,144 bytes control memory, console and table, console printer and control, disc file control, disc file electronics unit, 8.1 million bytes H-P-T 20 ms systems disc)	3,825	181,688	498
	Processor Options			
B1097-3	Corner Table	15	720	NC
B1305	I/O Expansion Feature (2 allowed)	30	1,500	5
	Control Memory Options			
B1026-2	Additional 2,048 Bytes	400	9,600	30
	Main Memory Options for B1726			
B1026-32	32K Bytes	85	5,400	10
B1026-40	40K Bytes	205	10,800	16
B1026-49	48K Bytes	325	16,200	22
B1026-57	56K Bytes	460	21,600	28
B1026-65	64K Bytes	610	27,000	35
B1026-81	80K Bytes	935	42,190	47
B1026-98	96K Bytes	1,285	57,380	60
	Main Memory Options for B1728			
B1028-81	80K bytes	250	11,000	12
-98	96K bytes	450	19,800	25
-114	112K bytes	650	28,600	37
-131	128K bytes	850	37,400	49
-147	144K bytes	1,050	46,200	61
-163	160K bytes	1,250	55,000	73
-180	176K bytes	1,450	63,800	85
-196	192K bytes	1,650	72,600	97
-212	208K bytes	1,850	81,400	109
-229	224K bytes	2,050	90,200	121
-245	240K bytes	2,250	99,000	133
-262	256K bytes	2,450	107,800	145
	MASS STORAGE			
	Discs			
	Disc Cartridge Drives (70-msec avg seek time; 20-msec avg latency; 90-msec avg data access time)			
B9480-1	Single-Cartridge Drive (2.3-mb)	250	10,000	31
B9480-2	Dual-Cartridge Drive (4.6-mb)	365	15,450	53
B9481-1	Single-Cartridge Drive (4.6-mb)	310	13,200	47

PRICE DATA (Contd.)

Model Number	Description	Monthly Rental $	Purchase $	Monthly Maint $
	BURROUGHS B 1726 and B 1728 SYSTEMS (Contd.)			
B9481-2	Dual-Cartridge Drive (9.2-mb)	480	21,600	72
B1480	Control (for B9480)	97	4,665	15
B1481	Control (for B9481)	97	4,665	15
B9985-2	Disc Cartridge (for B9480) (purchase only)	8	170	NA
B9985-3	Disc Cartridge (for B9481) (purchase only)	8	225	NA
	Disc Pack Drives (30-msec avg seek time; 12.5-msec avg latency; 42.5-msec avg data access time)			
B9486-2	Dual Drive (95.5-mb)	1,000	46,750	129
B1486	Control (for B9486-2)	950	45,600	108
B9974-1	Disc Pack (for B9486-2)	25	575	NC
B9974-4	Disc Pack, certified at 200 tpi for B9484-4, 9485-4, and 9486-4	30	690	NA
B1484-4	Disc Pack Control for B9484-4 drive	950	45,600	108
B9484-4	Dual Drive (174.4M bytes)	1,550	74,400	201
B9486-45	Increment for B9484-4, 9485-4 (87.2M bytes, 30 ms aver access)	800	38,400	108
B9486-4	Increment for B9484-4, 9485-4 (174.4M bytes; limit 3 increments per 9484-4 and 9485-4)	1,400	67,200	177
	Head-per-Track Memory Banks (incl 1 EU)			
B9371-7	Storage (7-mb, 20-msec)	600	28,800	215
B9371-14	Storage (14-mb, 40-msec)	750	36,000	210
	Head-per-Track Memory Bank Add-On Units			
B9374-10	Storage (14-mb, 40-msec)	550	26,400	94
B9374-17	Storage (7-mb, 20-msec)	400	19,200	115
B1374	Control (for Head-per-Track Memory Banks)	200	9,600	12
B1674-1	1x2 Disc File Adapter	45	1,980	7
B1764-2	2x2 Disc File Exchange	40	1,760	5
	INPUT/OUTPUT			
	Punched Cards			
	Card Readers (80-col)			
B9111	800-cpm	350	17,550	90
B9112	1,400-cpm	450	23,600	126
B9115	300-cpm	110	4,500	25
B9116	600-cpm	195	6,500	35
	800-cpm	250	9,000	43
B1111	Card Reader Control (for B9111 and B9112)	48	2,332	7
B1115	Card Reader Control (for B9115 and B9116)	45	2,160	8
B9917	Card Counter (for B9111 and B9112)	5	240	NC
B9918	Postal Money Order Feature (for B9111/2)	30	1,440	5
B9919	40-Column Read Switch (for B9111 and B9112)	–	–	–
B9119-1	Card Readers (96-col; 300-cpm)	85	3,500	25
B1119	Control (for B9119-1)	48	2,332	7
B9210-1	Card Punch (80-col; 100-cpm)	250	12,000	70
B1210	Control (for B9210-1)	90	4,320	14
B9213	Card Punch (300-cpm, 80-col)	530	25,440	145
B1213	Control (for B9213)	90	4,320	90
	Card Reader/Punches (96-col)			
B9319-2	(Reads 300 cpm; punches/prints 60 cpm)	200	7,990	60
B9319-4	(Reads 500 cpm; punches/prints 120 cpm)	310	11,190	91
B1319	Control (for B9319)	75	3,628	11
B9419-2	Card Reader/Punch/Data Recorder (reads 300 cpm; prints/punches 60 cpm; keyboard; 96-col)	240	9,490	71
B9419-6	Multipurpose Card Unit (reads 300 cpm; prints/punches 60 cpm; keyboard; 96-col)	285	11,390	85
B1419	Control (for B9419)	75	2,332	11
	Printers			
B9240-1	475-lpm (132 PP)	475	19,500	189
B9240-2	700-lpm (132 PP)	625	31,000	195
B9240-3	1,040-lpm (132 PP)	900	43,500	211
B9247-2	400-lpm (120 PP)	460	19,500	100
B9247-3	750-lpm (132 PP)	750	35,000	148
B1240	Control (for B9240-1, 2, or 3)	60	2,880	9
B1247	Control (for B9247 Printers)	90	4,320	14
B9942-2	Additional 12 Print Positions for B9247-2/3	40	2,000	11
B9942-9	Additional Train Module for B9247-2/3	65	3,500	18
B9949-2	12-Channel Format Tape Reader (for B9247 series printers)	61	3,050	15
	Magnetic Tapes			
B9381-12	18-Kb Cluster (2-station; NRZ; 9-channel; 800-bpi)	525	25,200	179
B9381-13	18-Kb Cluster (3-station; NRZ; 9-channel; 800-bpi)	570	26,960	200
B9381-14	18-Kb Cluster (4-station; NRZ; 9-channel; 800-bpi)	680	32,160	241
B9381-22	36-Kb Cluster (2-station; NRZ; 9-channel; 800-bpi)	700	33,600	205
B9381-23	36-Kb Cluster (3-station; NRZ; 9-channel, 800-bpi)	900	43,200	236
B9381-24	36-Kb Cluster (4-station; NRZ; 9-channel; 800-bpi)	1,100	52,800	267
B9390	18/50-Kc Mag Tape Unit (7-channel; 200/556-bpi)	330	15,860	149

PRICE DATA (Contd.)

Model Number	Description	Monthly Rental $	Purchase $	Monthly Maint $
	BURROUGHS B 1726 and B 1728 SYSTEMS (Contd.)			
B9391	18-50-72-Kc Mag Tape Unit (7-channel; 200/556/800 bpi)	375	18,000	169
B9394-2	96-Kb Mag Tape Unit (9-channel; 800-bpi)	425	20,400	174
B9496-2	40-Kb Mag Tape Unit (9-channel; 1,600 bpi)	270	12,800	65
B9496-4	80-Kb Mag Tape Unit (9-channel; 1,600-bpi)	320	15,300	69
B9495-2	120-Kb Mag Tape Unit (9-channel; 1,600-bpi)	400	16,650	74
B9491-2	10-Kb 9-Channel Tape Unit	215	8,600	21
B1381	Tape Cluster Control	250	6,960	38
B1390	18/50-Kc 7-Channel Tape Control	250	6,960	38
B1491	10-Kb Tape Control	216	10,368	30
B1394-2	9-Channel Tape Control	300	12,300	40
B1496-4	Single Control for B9496 Series	325	15,740	53
B1495-2	Single Control for B9495 Series	460	19,130	53
B9499-30	1x4 Master Electronics Exchange (for B9496 Series only)	125	5,500	20
B9499-32	2x8 Master Electronics Exchange (for B9496 Series only)	300	13,200	43
B9499-31	1x8 Master Electronics Exchange (for B9496 Series only)	200	8,800	20
B9499-10	1x4 Master Electronics Exchange (for B9495 Series only)	125	5,500	20
B9499-11	1x8 Master Electronics Exchange (for B9495 Series only)	200	8,800	20
	Sorters			
	Reader Sorters			
B9131-1	13-Pocket (1,000 doc/min)	1,200	57,600	486
B9134-1	4-Pocket (1,625 doc/min; requires B9938-1)	1,025	49,200	351
B9135-2	8-Pocket (900 doc/min, E13B; off-line sorting)	1,000	45,500	431
B9135-3	12-Pocket (900 doc/min, E13B; off-line sorting)	1,300	55,900	467
B9136-5	8-Pocket (600 doc/min; E13-B; off-line sorting)	700	34,000	225
B9136-6	12-Pocket (600 doc/min; E13-B; off-line sorting)	850	39,000	270
	For 9131-1			
B1131	Control	150	6,480	23
B9930-1	Mobile Carrier and Tray	6	240	NC
B9930-2	Document Tray (purchase only)	–	15	–
B9931-1	Item Separation (B9131)	20	960	NC
B9932	Endorser (factory-installed)	200	9,000	54
B9934	Start/Stop Bar (B9131)	7	275	NC
B9935	Special Field Ending	10	450	NC
B9935-4	Canadian Check Feature (B9131)	NA	180	NC
B9936	Override Code (specify type)	10	450	NC
B9937	Validity Checking-Sort Field	10	450	NC
B9938	Reverse Override (specify type)	10	450	NC
B9939-1	Resettable Counter	5	240	NC
B9939-2	Nonresettable Counter	5	240	NC
	For B9134-1			
B1134	Control	200	6,480	30
B9930-3	Mobile Carrier	NA	150	NC
B9930-4	One-Tray Document Rack	NA	60	NC
B9932-1	Endorser	200	9,000	54
B9932-4	Batch Ticket Detector	10	480	1
B9932-5	Short Document Read Feature (factory installation only)	10	480	2
B9932-6	Short Document Module Expander (factory installation only)	5	240	NC
B9933-1	Two-Field Basic Off-Line Sort	25	1,200	5
B9933-2	Two-Field 8-Pocket Off-Line Sort	30	1,440	5
B9933-3	One-Field Expanded Off-Line Sort (max 8)	5	240	NC
B9933-4	Extended Sort Control	50	2,400	16
B9933-5	Zero Kill	10	480	1
B9933-6	No Field – No Digit	10	480	1
B9933-7	Digit Override	10	480	1
B9933-8	Digit Edit	10	480	1
B9933-9	Field Override	10	480	1
B9933-10	Field Edit	10	480	1
B9935-2	Four-Pocket Module (up to 16 pockets)	300	14,400	38
B9936-1	Stacker Overflow	10	480	1
B9937-1	Valid Character Check	5	240	1
B9938-1	Multitrack E13-B Read	375	18,000	59
B9939-3	Resettable Item Counter	5	240	1
B9939-4	Nonresettable Item Counter	5	240	1
B9939-5	Running Time Meter	5	240	1
B1135	Control for B9135-2/3	200	6,480	30
	For B9136-5/6			
B1136	Control	150	6,480	23
B9931-3	Extended Sort Control	NA	NA	NA
B9931-4	51-Column Card Read	NA	NA	NA
B9931-5	Valid Character Check Option	NA	NA	NA
	DATA COMMUNICATIONS			
B1351	Single Line Control	50	2,000	8

PRICE DATA (Contd.)

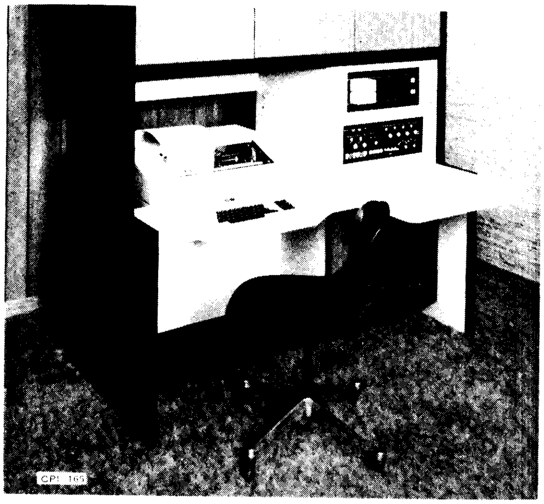
Model Number	Description	Monthly Rental $	Purchase $	Monthly Maint $
	BURROUGHS B 1726 and B 1728 SYSTEMS (Contd.)			
B1352	Multiline Controller (8 lines)	200	13,000	28
B1353	Multiline Controller Extension (8 lines; B1728-1 only)	150	6,750	21
	Line Adapters			
B1650-1	Asynch Data Set Connect (up to 1,200 bps)	50	1,500	8
B1650-2	Asynch Data Set Connect (up to 1,800 bps)	65	1,800	10
B1650-5	Asynch Direct Connect (up to 2,400 bps)	50	1,500	8
B1650-6	Asynch Direct Connect (up to 4,800 bps)	65	1,800	10
B1650-7	Asynch Direct Connect (up to 9,600 bps)	80	2,100	12
B1651-1	Synch Data Set Connect (up to 2,400)	50	1,500	8
B1651-2	Synch Data Set Connect (up to 4,800)	65	1,800	10
B1651-3	Synch Data Set Connect (up to 9,600)	80	2,100	12
B1652-1	TTY Asynch Data Set Connect	50	1,500	8
B1652-5	TTY Asynch Direct Connect	50	1,500	8
B1653-1	Binary Synch Data Set Connect (up to 2,400 bps)	200	8,800	32
B1653-2	Binary Synch Data Set Connect (up to 4,800 bps)	225	9,900	34
B1653-3	Binary Synch Data Set Connect (up to 9,600 bps)	250	11,000	36

Notes:
– Not Applicable
NA Not Available
NC No Charge

HEADQUARTERS

Burroughs Corporation
6071 Second Avenue
Detroit MI 48202

CASCADE DATA
Concept II Series



OVERVIEW

Cascade Data's Concept II Series is a customer-tailored system for the new data processing user. While the Concept II is designed for operation by clerks and secretaries, it can also be used in more complex data processing applications. Both interactive and batch processing models are available. Concept II Series is specifically aimed at business applications for companies with annual sales in the range of $1 to $10 million.

Concept II comes in 10 basic models that can be configured by the vendor to fit the specific needs of a company. A full complement of peripheral devices can be field installed on most of these models.

The Concept II Series is either magnetic tape or magnetic disc oriented, but magnetic tape capability can be retained with a disc-oriented system. Both tape and disc operating systems are available.

Cascade Data is a wholly owned subsidiary of APECO. As a matter of policy, Cascade will bring up the user's actual application programs and demonstrate on the user's data, for acceptance, before requiring any contractual agreement to purchase or lease.

CONFIGURATION GUIDE

Ten basic models are available (Table 1):

- 3010 – direct-entry, interactive data processing system.
- 3510 – batch processing version of the 3010.
- 3011 – direct-entry, interactive magnetic tape system with a higher-speed printer replacing the console printer used in 3010.
- 3511 – batch processing version of the 3011 with a 16K CPU.
- 3512 – a 3510 with an additional matrix printer.
- 3513 – replaces the matrix printer on the 3512 with a 200 line-per-minute line printer.
- 4011 – direct-entry interactive system with a 16K CPU, 5-million-byte disc drive, and a matrix printer for output.
- 4511 – batch processing version of the 4011.
- 4512 – a 4511 with a console printer in addition to the matrix printer.
- 4513 – replaces 4512 matrix with a 200 line-per-minute line printer.

The CPU has a basic 8K core storage memory for the interactive tape systems and a 16K core storage memory for interactive disc and all batch processing systems. Most models can expand core storage memory to 65K. The CPU responds to 65 different hardware instructions. All models include a standard typewriter keyboard with a 10-key, adding-machine-type, numeric subset. A keypunch-style, 10-key keyboard is also available for the user who is data processing oriented. All models are field expandable to provide upgrade capability from the simplest configuration to the most powerful. Table 2 lists the Concept II specifications.

Peripherals for the Concept II Series include the following.

- Visual Display CRTs: TV/Xaminer (TVX) is a self-contained visual display unit and keyboard device for data entry or inquiry applications; it accommodates up to 16 stations. TVX is available in two models – 640 or 1,280 characters. Both have a full 96-character set, which includes all upper- and lowercase letters, and a data protect mode, which insures input accuracy.
- High-Speed Line Printer: A 600 line-per-minute line printer is available for most models.
- Magnetic Disc Drive: Duo-Disk 412 (an integral component of Models 4011, 4511,

Table 1. Cascade Concept II Series: Basic Models

Features	Model									
	3010	3011	3510	3511	3512	3513	4011	4511	4512	4513
Main Storage (kb)										
Min	8	8	8	8	8	8	16	16	16	16
Max	8	8	16	16	32	32	65	65	65	65
Console Keyboard	x	x	x	x	x	x	x	x	x	x
4005 Mag Tape System	x	x	x	x	x	x	—	—	—	—
601 Console Printer (30 cps)	x	—	x	—	x	x	—	—	x	x
601 Matrix Printer (165 cps)	—	x	—	x	x	x	x	x	x	—
650 Card Reader (300 cpm)	—	—	x	x	x	x	—	x	x	x
620 Line Printer (200 lpm)	—	—	—	—	—	x	—	—	—	x
412 Disc System (5 mb)	—	—	—	—	—	—	x	x	x	x

Table 2. Cascade Concept II Series: Specifications

CENT PROCESSOR	
Word Size (bits)	8; 16
Capacity (words)	8K-64K; 4K-32K
Cycle Time (μsec)	0.900
Working Storage	Core
AUX STORAGE	Disc; mag tape
DATA OUTPUT	
Line Printer (lpm)	90; 200; 600
Serial Printer	Yes
Card (cpm)	—
Paper Tape (cps)	60
DATA INPUT	
Keyboard	Standard
Card (cpm)	300
Paper Tape (cps)	300
SOFTWARE	
Assembler	Yes
Operating System	Yes
Compiler	RPG

4512, and 4513) is a dual-disc configuration with 5 million bytes of on-line storage. Up to four drives can be added to single controller, providing 20 million bytes of on-line storage.

- Card and Tape Readers: Besides the 300 card-per-minute Data Speed 650 card reader, the Optiscan 660 optical card reader (also 300 cards per minute) is offered. The Optiscan 660 reads pencil-marked cards. A paper tape reader (300 characters per second) and punch (75 characters per second) are available.

- Magnetic Tape Storage: A four-drive cartridge tape unit is an integral component of Models 3010, 3011, 3510, 3511, 3512, and 3513. Communicator 421, a nine-channel magnetic tape unit, is available on most systems. This unit comes with 10-1/2 inch reel size and 800 or 1,600 bit-per-inch packing density.

SOFTWARE

Concept II Series software includes translators and compilers for programming languages, support software, and application programs.

Programming language support includes Cascade Basic Assembler Language (BAL) and Report Program Generator (RPG). These languages are compatible with those offered by other major computer manufacturers and are supported by a library of preprogrammed subroutines that simplify computer programming and operating. The code generated by the language system is processed by an allocator, which optimizes the final computer program.

Support software includes a resident supervisor that requires 2K memory. The supervisor serves as a focal point for control of the operating hardware. A library of utility programs handles routine data processing. The support software is available under two operating systems: TESS (Tape Environment Supervisory System) and DESS (Disk Environment Supervisory System). When operating under TESS, all software resides on magnetic tape; under DESS all software resides on magnetic disc.

Application programs are the user programs that are modified and customized to a user's specific needs. An extensive library of applications packages is available and includes: order entry, billing, inventory control, sales and gross profit analysis, accounts receivable, accounts payable, payroll labor distribution, job costing, general ledger, and financial statement preparation. Special industry packages are available for accounting firms, auto dealers, fuel oil distributors, tire dealers, contractors, printers, hospitals, and nursing homes. There is also a material requirements and production control system for manufacturers, which includes multilevel bill of materials and parts explosion.

DESIGN FEATURES

The main design features of the Concept II Series are ease of operation, upgrade compatibility throughout the product line, and a large maximum on-line auxiliary storage capacity. Plug-in modules simplify maintenance because any device in the system can be entirely and quickly replaced on-site.

PERFORMANCE

Concept II Series performance is geared for acceptance by nondata processing oriented businesses. Cascade is emphasizing the first-time processing user by providing customer-tailored software, the ability of the customer to actually see what he is getting before contract signing, and complete installation procedures.

Another important aspect of this series' performance is Cascade's rapid startup with previously untrained personnel as operators. Reportedly, clerks, secretaries, and bookkeepers become efficient operators after only several hours of training.

MAINTENANCE

Maintenance for the Concept II Series is available through all Cascade Data offices and a growing number of APECO offices throughout the country. Service is available on a 24-hour basis.

HISTORY

Cascade Data was founded in June 1969 exclusively to manufacture and distribute small business computers. During 1972, Cascade became a wholly owned subsidiary of APECO and presently maintains 48 sales offices throughout the country. The first Cascade system was delivered in January 1970; and during early 1972, the firm's one hundredth system was installed.

PRICE DATA

Model Number	Description	Monthly Rental $	Purchase $	Monthly Maint. $
	CASCADE DATA CONCEPT II SERIES			
	BASIC CONFIGURATIONS			
	Tape Systems			
3010	Computer System (16K)	–	27,500	188
3011	Computer System (16K with matrix printer)	–	33,500	258
	Disc Systems			
4010	Computer System (16K; 5M disc)	–	38,500	220
4011	Computer System (16K; 5M disc)	–	39,900	286
4020-C	Computer System (24K; 1 1,280-char CRT)	–	48,500	280
4021-C	Computer System (same as 4020-C but with larger console printer)	–	49,900	345
4030-M	Multi-Programming System (32K; 1 1,290-char CRT)	–	53,000	301

Note:
Rental arrangements are not available. Maintenance prices are based on the average use of 175 hours per month.

HEADQUARTERS

Cascade Data Inc.
3000 Kraft Ave. SE
Grand Rapids MI 49508

Datapoint recently announced a number of additions to its 2200 line. New software, storage devices, an IBM 360/20 HASP emulator, and a card reader are now available to Datapoint 2200 users.

NEW SOFTWARE PACKAGES

Datapoint has added three new software packages to support the 2200: RPG II business language; a new version of Datashare III; a multiuser job language; and a disc-based version of Dataform data entry language.

RPG II runs under DOS; it requires 16K words of memory. Application programs written in RPG II can access data files by using ISAM (Indexed Sequential Access Method). ISAM allows extended record lengths, up to 9,999 characters. RPG II also expands disc handling facilities for fixed and variable length blocks. RPG II files are compatible with other Datapoint programs for the 2200.

To aid the user in creating RPG II programs, Datapoint offers RPG PREP, which allows program preparation directly from the keyboard. Newly typed material is checked for correct structure and syntax displayed; on the screen, errors can be corrected line by line. Thus, the step of punching cards is bypassed completely. RPG PREP requires a 2200 with 16K words of memory and 2.4 million bytes of disc storage.

The new Datashare III requires a 2200 with 16K words of memory and at least 2.4 million characters of disc storage. A multiport communications adapter enables eight video display terminals, usually Datapoint 3360s, to be connected either locally or remotely over standard telephone channels. A servo printer, usually a Datapoint 300 line-per-minute drum printer, can be attached to any terminal.

Each terminal user can call up both public files and his own protected files from disc. Public files can be locked to certain terminals. With virtual memory resources, 128K words of memory are available for user programs.

Datashare III uses ISAM to open, combine, delete, and sort files. ISAM links sectors, creates disc space tables, and handles file lengths so these functions are transparent to the user. This new version also provides variable partitioning of user space and includes a new arithmetic package.

A typical Datashare system rents for about $1,300 per month for a 2-year lease that includes maintenance.

According to Datapoint, the new disc-based version of Dataform reduces program development time for new data entry application software by at least 60 percent. Forms developed on the disc can be used on cassette-based machines without any changes.

NEW STORAGE DEVICES

Users of Datapoint equipment can now increase their systems' memory capacity with three new storage devices: diskette, magnetic tape drive, and 2314-type disc.

The diskette unit is housed in a freestanding cabinet or in a console cabinet; the controller can handle up to four diskette drives. Each diskette can store over 256,000 characters; average latency time is 83 milliseconds. The diskette architecture is similar to that of the larger Datapoint disc. Four 256-character buffers, which together form a 1,024-character addressable buffer, correspond to sectors on the disc. Thus, software formatted for the larger disc can be used on the smaller diskette with only minor modifications. Software is available to format the diskettes so they are interchangeable with IBM's 3741 diskette. The new Datapoint diskette rents for $110 a month on a 2-year lease that includes maintenance.

The new magnetic tape drive was developed for users who maintain a magnetic tape library or collect large amounts of data from remote terminals. The new tape is 9-track, records at 1,600 bits per inch, and has a 2,048-character buffer. The addressable buffer allows the tape to be written or read asynchronously. The unit is packaged in an office-styled console: it rents for $371 per month with maintenance under a 2-year contract.

With the 2314-type, 20-million character disc, a Datapoint 2200 system has a storage capacity equal to that of a medium to large business system. In many business applications, the user does not need the computing power of a large mainframe computer but needs large mass storage for files which are used occasionally.

The architecture of the new disc is similar to the diskette and employs 16 sector buffers. Each sector is randomly accessible. The storage capacity is 20 million bytes (characters) per drive, and each 2200 processor can handle two drives for a maximum storage capacity of 40 million bytes. Maximum data transfer rate is 2.5 million bits per second. Average access time is 35 milliseconds. The disc is fully buffered and the buffer is totally addressable. Data need not be transferred into the processor memory, most disc operations can be carried out in the disc buffer.

The new disc and controller for two discs rents for $672 per month on a 2-year lease basis. Maintenance is included.

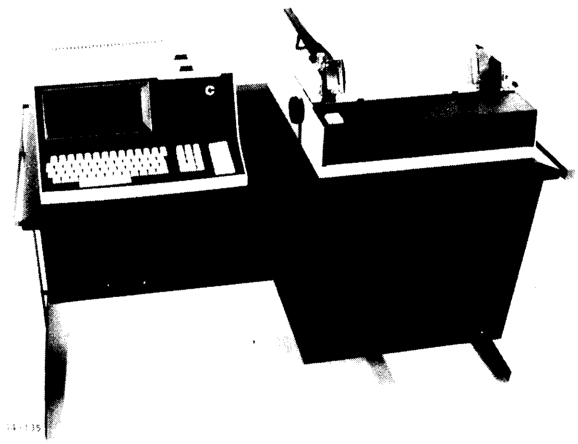
IBM 360/20 HASP Emulator

Datapoint has recently announced a batch processing systems line, built around the Datapoint 2200. The IBM 360/20 HASP Workstation Emulator handles all the usual IBM data and communication functions. The 2200 is used on-line; its synchronous communications adapter follows the line discipline of the IBM 360/370 computers.

Other emulators available from Datapoint are for the IBM 2780 and 3780, the Univac DCT 2000, and the Control Data UT200. Because the 2200 is a programmable computer, the user gains flexibility over a conventional batch terminal. When not being used as a remote batch terminal, the 2200 can function as a small business computer, handling business computing tasks.

Card Reader

A new Datapoint card reader is available for use in remote batch or job entry applications. The card reader is fully buffered and reads at 300 cards a minute. It is tolerant of cards that are bent or damaged and of cards that are out-of-punch registration. The unit leases for $154 a month including maintenance on a 2-year basis.



Datapoint Corporation has added the Diablo 30 character-per-second impact data processing printer to the line of peripheral attachments available with the Datapoint 2200 business computer system. The Diablo printer, pictured adjacent to a 2200, offers a print quality that equals or surpasses that of most office typewriters.

OVERVIEW

The Datapoint 2200 is a communications-oriented small business computer designed to operate either as a small stand-alone system or as a local terminal-processor in a distributed processing network. It evolved from the 2200 intelligent terminal which developed two versions early in its history: Version I remained a terminal; the higher-speed Version II expanded into the present small business system. Although Version I is still supported, the new Datapoint 1100 system is a higher-speed, lower-cost, more competitive system and is being actively marketed in its place. This report describes Version II, now marketed as the 2200 small business system proper.

The heart of the 2200 system is a byte-oriented processor with 4K to 16K bytes of MOS main memory, 1.2-microsecond cycle time. Standard processor features include 14 registers, a 16-deep push-pop stack, a 1-millisecond hardware interrupt facility and I/O facilities for up to 16 peripherals. The processor is housed in a single desktop unit that includes a 960-character CRT with keyboard and dual magnetic tape cassette drives. This basic system can be expanded by 2.4M-byte cartridge disks, magnetic tape drives, printers, card readers, up to eight slave CRTs that can access memory independently via a multiport adapter, and a variety of communication adapters.

One strong point of the 2200 system is the extensive body of system software that the company has developed over the years: three operating systems (COS, TOS, and DOS), several assemblers, seven versions of a special high-level language called Databus, Basic and RPG compilers, and a variety of utility routines (including sort-merge). A package called "Dataform" provides data entry capabilities; one called "Scribe" allows the 2200 to function as a powerful automatic typewriter/word processing system. A program called "Datashare" permits the simultaneous execution of Databus programs on up to eight slave CRTs. Software packages provide compatibility with IBM 2780, IBM 2741, IBM 2265, CDC 200, Univac DCT-2000, and Teletype (RS232C). Datapoint has no standard business application packages, but the company does offer system engineering support for user programming efforts. Datapoint will also supply the names of all software houses they know of who supply packages and customized programming services.

Until recently, Datapoint specialized in two basic product lines, the 3000/3300 Series of interactive computer display terminals and the Datapoint 2200 Systems. The 2200 was introduced in 1971 as an intelligent terminal. Version II with the software and support needed for the small-business and distributed processing market was announced in January 1972. By mid-1973, the company had delivered more than 4,300 of the 3000/3300 systems, 2,500 of the 2200 systems, and had achieved a solid financial status as well as a profitable operation. In early 1974, the company announced the new 1100 and 5500 Series. The 5500 is a larger, faster distributed processing/small business computer system than the 2200; thus it allows 2200 users to upgrade and expand their capabilities. The 1100 is upward compatible with the 2200, which is upward compatible with the 5500.

Datapoint markets its systems through 18 direct sales offices and a number of sales representatives in the United States. It markets the systems through sales representatives in other parts of the world. Sales representatives in the United States include AIDES, Inc., PLS Associates, and the Systems Corporation (in Hawaii). TRW Communications directly markets the systems in Canada and Switzerland. Scandinavian sales offices include Regnecentralen (Denmark and Holland), Oy Nokia Ab Electronik (Finland and Sweden), and Scanips (Norway). Ventek, Ltd handles sales in the British Isles. Western Europe sales offices include Matras, A. (France), Gier Electronics (Germany), and Sart Electronics (Belgium) in addition to the aforementioned companies in Switzerland and Holland. CJK Company, Ltd handles marketing in Japan, Control Y Proceso Electronico SA in Mexico, Segma Data in Australia, Information Systems Ltd in Israel and Computer Advances in South Africa. TRW Electronics in Los Angeles, Toronto, and Berne is the exclusive international distributor of Datapoint system, and appoints the companies that maintain, service, and support systems outside the United States.

PERFORMANCE AND COMPETITIVE POSITION

The Datapoint 2200 competes in a rapidly growing market for small business computers; this market has already begun to segment itself into sectors. One large sector is "distributed processing." Large businesses with many small branches allow as much local processing as possible (together with related record maintenance); only important summary records are transmitted to a large central mainframe for further processing. The second sector is that of a small stand-alone system for a small business as an alternative to time sharing or a service bureau. The small business may want communications capability for certain jobs it cannot handle itself. Also, the size of the branch office as well as the small business determines the computer size and speed needed. Thus, there is considerable overlap between markets. A third sector markets to large businesses that dedicate computers to different departments instead of having a single central facility. (Banks frequently fall into this category.)

Two clear areas of differences arise among these three sectors:

- The small businessman is more interested in turnkey systems, standard software or systems that can be easily programmed to cut costs of in-house program development or of service bureaus. Branches in a distributed processing network or departments in a large business, on the other hand, frequently rely on in-house software development at a central facility.

- The small businessman or a department in a large business may or may not opt for communications, whereas this is an essential element of a distributed processing network.

Small business systems can also be subdivided into systems that provide interactive processing and those that do batch processing. Interactive processing is ideal for extensive key entry (keypunch-replacement) functions and word-processing. It appeals to the small user who needs a system that can do many things in order to be cost justified. It also appeals to large users for specific applications. The large batch-oriented systems appeal to the more experienced growing small business, to larger branches of a distributed processing network and to specific applications within a business. Frequently, these batch-type systems function like remote batch terminals The two system types are not predetermined by processor hardware,as shown in the ubiquitous IBM System/3, with the interactive Model 6 and the batch-oriented Models 10 and 15; all essentially the same processor.

The 2200 competes in all small business markets. Because of its strong communications capabilities and experience, however, it is particularly competitive in the distributed processing market. In this market it competes vigorously with the Four Phase IV/40 (the Datapoint's new 5500 is more competitive with the IV/70), Singer System Ten, and NCR 399.

Unquestionably, the main contender for the small businessman's computing dollar is IBM's System/3. Larger 2200 configurations compete with the smallest of the System/3 models, the interactive Model/6. Like the Model 6, support for high-level languages (Basic, RPG II) is provided. The 2200 disc storage is optional. The tape or cassette systems can provide cost advantages to a small user looking for something like System/3 Model 6, but with less on-line storage and throughput requirements. Other larger manufacturers like Burroughs (1700), DEC (300 and 500), and NCR (50, 100) compete with System/3 across the board; small configurations or submodels compete with Model 6 and larger configurations or submodels compete with Models 10 and 15. The new upward-compatible 5500 allows Datapoint to compete with System/3 Model 10. Although Datapoint does not provide the software support the larger manufacturers offer, the popularity of the 2200 has stimulated independent software houses to supplement Datapoint's own software offerings.

A considerable market exists for systems for first time small computer users—businesses that can not afford a System/3. A number of manufacturers have tackled this market with programmable accounting machines: Burroughs, Litton, NCR, Singer, Ultimac, and Nixdorf. These programmable calculators have capabilities that overlap those of small business systems, such as the Wang 2200, that also bridge the gap below computers the size of System/3 (Basic/Four, Burroughs 1700, Cascade Data, Eldorado, HIS 2020, Litton, Qantel, Singer System 10). Many intelligent terminals also compete in this market. The smaller configurations of the Datapoint 2200 have proven to be attractive to many users of this category in spite of the fact that Datapoint does not supply a complete turnkey system. The stability of the company and the software support for user-written high-level language programs, combined with the low cost and flexibility of the system, are responsible for these users' choices.

User Reactions

Users of the 2200 fit into all categories of applications. The following descriptions of 2200 systems now in use are only a sampling of Datapoint customers.

Although the system is very flexible and can be used for a variety of purposes, our contacts with users also point up the constant danger of over- or underestimation of the 2200's capability and of putting the unit in wrong applications. A New York bank, for instance, used five 2200s for over a year and then replaced them with IBM 2260s. The 2200s were used as data entry terminals for an on-line corporate trust system and for remote printing of stock certificates. It appears that the company overestimated the capabilities of the units. Later experience proved that certain applications originally planned were impractical because the total cost per terminal was too high and throughput was not as high as originally expected.

In most cases, however, careful analysis of requirements and the machine's capabilities has led to satisfactory installations. The following applications using 2200 systems are grouped according to type of processing.

Distributed Processing. A leading men's clothing manufacturer uses 2200s to move data quickly between central offices, field facilities, and their central warehouse in another state. Incoming sales orders pass through the central computer facility and are transmitted to the warehouse via two 2200s. The orders are filled, verification is transmitted to the central computer, and invoices are generated and mailed in the same day. The company also uses other 2200 systems in their accounts receivable and payroll offices as data entry devices. The intelligent terminals not only saved the company money over competing methods for performing the same functions but they also added three years to the life of the mainframe because of the reduced central processing load.

A Midwest food producer is using 12 Datapoint 2200 Version Is as minicomputers, time-sharing terminals, and remote batch terminals. Installed at scattered plant locations, the units process inventory and accounts receivable data as a small computer and communicate with the main computer at the company headquarters in straight conversational mode. Production and management data is generated at each plant location and recorded on Datapoint 2200 cassettes; the data is periodically transmitted in batch mode to the main computer. This user was impressed by the combination of keyboard entry, communication, and computing capabilities in the Datapoint 2200.

A service bureau that supplies health care data processing to over 100 institutions uses 2200s in a variety of ways. Most frequently, the 2200 is a data entry terminal that can adapt to the institution's peculiarities in format yet submit data in a suitable form for central programs at the service bureau. The service bureau finds the terminals are more and more for on-site processing as users become more sophisticated.

Small Business. A California winery uses two 2200s to maintain their customer mailing list. This is extremely valuable because marketing is mostly done by direct mail. The 2200s average 1,000 changes per day to their data base, and they incorporate the changes quickly and accurately. The 2200s are also used to print the personalized labels affixed to outgoing shipments.

Departmental Processing/Data Entry. A prestigious scientific publication uses 2200s to update their master international circulation list. The 2200s quickly pre-process renewals, gifts, new subscriptions, address changes, and other alterations. In most cases, they incorporate the changes into the data base the same day they are received.

Another user of the Datapoint 2200, a West Coast retailer, replaced a number of popular stand-alone key-to-tape units with the 2200 to enter accounts payable and payroll data directly onto cassette tape at the source. One of the seven 2200s used is equipped with a standard tape drive to convert data recorded on cassette tapes onto standard half-inch tape. Compared to the stand-alone key-to-tape units, reported a company spokesman, the 2200 is simpler to operate and doesn't require a specially trained operator. The regular payroll clerk operates the 2200. In addition, the 2200 prevents most data entry errors from getting through to tape, keeping a good portion of the pre-processing chores off the shoulders of the host computer.

CONFIGURATION GUIDE

A basic Datapoint 2200 includes an alphanumeric keyboard (both upper and lowercase letters) plus an 11-key numeric pad for data entry, a 960-character CRT screen to display data entered and error messages, a general-purpose minicomputer, two magnetic tape cassette drives (one for program storage and one for data storage), and a built-in power pack, all housed in a typewriter-like desktop unit weighing 48 pounds. Table 1 lists the system characteristics.

Peripheral devices include a 132-column, 30 character-per-second impact printer, a thermal printer, a 135 line-per-minute line printer, a 600 card-per-minute card reader, a standard tape drive (seven- or nine-track), up to four single or dual disc drives with control, and a number of communication adapters with modems.

The input lines transfer either status information or data from any of the system components to the central processor. Output lines transfer status information or data, as well as device addresses, to select the device that will transfer information. Devices integral to the 2200—the CRT, keyboard, and cassette tape transport—connect directly to the I/O bus, which originally flowed into a common buffer known as the A-register.

Thus, all information (both status and data exchanged between the processor and peripheral or integral devices) had to pass through a single point. This was no problem on the older Version I because of the long memory access (500 microseconds) time. With the greatly increased memory access speed of Version II, a single A-register was too slow, so the Datapoint 2200 Version II has seven additional I/O registers to alleviate this difficulty. The real-time clock and hardware interrupt facility also ease the handling of I/O operations.

A single address is utilized by both the keyboard and CRT because the keyboard performs only input; the CRT only output.

Keyboard/CRT

The integral keyboard provides a basic 41-key alphanumeric key group, an 11-key numeric pad plus five system control keys. A multikey roll-over feature assures maximum ease for typing. Transfer of keyboard characters is under control of the 2200 processor, which makes an audible feedback signal to the typist each time a character is recorded. The CRT screen has a 7-inch by 2.5-inch viewing area, which can display 960 characters (12 lines of 80 characters each). All 94 characters of the

Table 1. Datapoint 2200: Mainframe Specifications

SYSTEM MICROPROCESSOR	
Memory Size (bytes)	4-16K
Word Size (bits)	8
Cycle Speed (msec)	1.2
Transmission Code	Any 7-11 bit code
Maximum I/O Devices	16
DISPLAY UNIT	
Screen Size (char)	960
Characters/Line	80
Lines/Display	12
Character Set	Full 94-char ASCII, upper/lower
Character Generation	5 x 7 dot matrix
PERIPHERALS	
Cassette	Dual drive, ECMA std, 100-cpi density
Magnetic Tape	IBM cmptble 7- or 9-track
Printers	30-cps thermal; 30-cps impact; 135 lpm
Punch Card (cpm)	80-col; reads 400 cpm
Disc	2.4 Mb/removable cartridge, 1-4 cartridges/system
COMMUNICATIONS	
Line Interface	Synch or asynch
Control Procedures	IBM BSC
Standard Features	Autodial; auto answer
Optional Features	Programmable to accomplish most features
DATA TRANSMISSION	
Network	Leased; switched
Line Speed (bps)	Asynch: 37.5-9,600 synch: up to 9,600
Error Control	CRC; LRC; VRC
COMPATIBILITY	
Computer System	IBM 360; 370
Terminals	IBM 2265; 2741 2780: Mdl 4; 33 ASR ASR; Univac DCT 2000; CDC 200
Bell Data Set	103; 201; 202
SOFTWARE	Cassette, tape and disc operating systems, word processing pkg, emulators (above), data entry pkg, forms generator, control pkg for 1-8 slave terminals
FIRST DELIVERY	April 1971

ASCII character set can be displayed. The CRT also features a refresh rate of 60 frames per second, 5 x 7 matrix for character generation, a blinking cursor, single control line erasure, frame erasure, and page rollup.

Minicomputer/Cassette Decks

The Version II minicomputer provides all control functions for the system. The central processor includes the following components: 50 different instruction types (including push and pop instructions for stack manipulation), 14 addressable registers, 16-deep pushdown stack, 8-bit memory word length, up to 16K words of memory, complete parallel I/O system, 1-millisecond hardware interrupt, and automatic power-up restart. The two read-write cassette tape decks accept ECMA standard Philips-type cassette tapes and provide: 100 character-per-inch density, dual-capstan forward-reverse operation, processor-controlled data transfer, direction control, head engagement, and high-speed rewind.

Disc

From one to four cartridge disc drives can be added to the 2200 for a maximum of 9.6 million bytes of on-line random access storage (2.4M bytes per cartridge).

Printers

Datapoint offers three types of printers for the 2200: a line printer (135 lines per minute), thermal printer (30 characters per second) and a Diablo printer (30 characters per second). In addition, a Selectric interface allows the attachment of the user's IBM Selectric typewriter.

Communications

The optional communication adapters are available in seven versions, as shown in Table 2. The adapters permit program selection of the desired bit rate, character length, and character set to offer versatile communications capability. The Multiple Port Adapter is a particularly important option; coupled with the Datashare package it permits up to eight "slave" Datapoint CRT terminals to operate simultaneously using different programs.

CRT Terminals

Datapoint supplies three different slave terminal models, the 3000, 3300, and 3600. The 3000 displays 25 lines of 72 characters each for a total of 1,800 characters, and transmits data at speeds up to 300 bits per second. The 3300 displays the same amount of data but can transmit at up to 2,400 bits per second. The 3360 displays 25 lines of 80 characters for a total of 2,000 characters that can be transmitted at rates up to 4,800 bits per second. A special version of the 3360 with 82 characters per line (2,048 total) has been particularly designated as the terminal to be used with the Datashare package.

COMPATIBILITY

Compatibility on the Datapoint 2200 is provided by both hardware and software. The seven- and nine-track

Table 2. Datapoint 2200: Data Communications Capability

Model No.	Name	Interface	Model	Transmission Rate (bps)	Duplex
400	Communications	EIA RS232	Asynch	37.5-9,600	Full; half
401	Communications Adapter with Modem	Bell 103 equivalent	Asynch	300	Full
402	Communications Adapter with Modem	Bell 202 equivalent	Asynch	1,200	Half
403	High-Level Keyer	Telegraph lines	Asynch	37.5	—
404	Synchronous Communications	Bell 201 or equivalent	Synch	Up to 9,600	Half
420	Parallel Data	Other mfrs peripherals		Parallel	—
460	Multiport Adapter	EIA RS232C, for attachment of 8 interactive peripherals	Asynch	100, 300 or 1,200 baud	Full

tape drives are industry compatible. A variety of communications adapters may be plussed into the parallel data I/O bus. One is Datapoint's own parallel data communications adapter, which can connect to many peripheral devices available from other manufacturers.

The programmable nature of the 2200 theoretically enables it to simulate any terminal. As a practical matter, terminal simulation is limited to the manufacturer's prewritten packages: IBM 2265, IBM 2741, IBM 2780 Model 4, Univac DCT 2000, CDC 200, Teletype 33 ASR, and Bell System 202 compatible modems. The Datapoint 1100, 2200, and 5500 Series systems software packages are upward compatible; all 1100 software can run on the 2200 and 5500, and all 2200 software can run on the 5500. The 2200 Version I has some compatibility problems with time-dependent programs to be run on Version II because Version I software used programmed loops for lack of a clock. The new 1100 and 5500 systems both have clocks.

SOFTWARE

Datapoint 2200 offers three operating systems (disc, tape, cassette), an assembly language, terminal emulators for IBM 2265, 2741, and 2780 terminals, and for CDC 200 and Univac DCT 2000 terminals; a Datashare multiple terminal control package, "Databus," Basic and RPG II compilers, a text processing package and many useful utilities as well as diagnostic programs. These programs are maintained and fully supported by the company.

Operations on Datapoint 2200 are usually under control of the operating system. A source code editor is available for program preparation. Programs can then be assembled and cataloged in the library. A number of programs for debugging and device control are also supplied by Datapoint.

Operating Systems

The Datapoint 2200 operating systems (COS, TOS, and DOS) enable the user to catalog, load, debug, and run programs. In addition, other programs, such as Editor and Assembler, can be cataloged into an operating system tape or disc file for use when needed. This arrangement is necessary because the Master segment is a relatively large program, and it is normally overlayed when user programs are loaded. It should be noted that most intelligent terminal operating systems work this way. User programs are entered through a loader that lets other programs load files from tapes even when the tape is not at the beginning of the file. All three operating systems require at least 8K words of memory.

High-Level Languages

The Datapoint Basic language is patterned after Dartmouth Basic; it runs under COS with 16K bytes of memory. Datapoint RPG II is a disc-based system, with source programs and data written in Databus 6 or Dataform, described below.

Databus, a high-level, string-oriented language especially designed for the 2200, currently has seven versions.

- Databus 1—Requires 8K bytes of memory; it is the simplest form for stand-alone processing and data capture applications; includes keyboard, display, tape cassette, printer I/O, and string arithmetic capability.

- Databus 2—The same as Databus 1, plus string handling and indexing facilities; possible program size is slightly reduced.

- Databus 3—Requires 8K bytes of memory; simple instructions are used for complex functions like originating and answering automatically dialed data calls, automatic polling of multipoint networks, and transferring data between 2200s with error control; includes keyboard, display, printer, tape cassette, nine-track magnetic tape, and Bell 202 compatible communications.

- Databus 4—A simplified version of Databus 2; it restricts the arithmetic and printer capabilities so that it can operate with only 4K bytes of memory; principal application is low-cost key-to-tape data capture.

- Databus 5—Companion to Databus 4, but does not have the extensive string-handling instructions; principal application is low-cost communication and printing of tapes under Databus 4.

- Databus 6—Designed to be programmed by the operator; features buffered keypunch and automatic batch communication, facilities for program "cards," insertion and deletion of cards, verifying previously input data, and send and receive tape cassette files with full error control; requires 2K bytes of memory, divided into six callable overlays; tapes are fully compatible with other Databus tapes.

Assembly Language

The 2200 Assembler has gone through a number of revisions as the 2200 terminal/business system has developed. In addition to the versions now used under COS and TOS 3, other versions are in current use to operate under DOS:

Version 5—Features conditional assembly, list control directives, and expanded arithmetic; internal loader, allows programmer to perform entry point/external linking with address register relocation for a form of relocatable object code.

Version 6—Adds directives for user-defined macros to Version 5.

Version 7—Adds completely relocatable object capability to Version 6, together with a linking loader; program relocation makes overlay generation much easier.

Datashare Package

The Datashare interpreter, which runs under DOS, uses virtual memory techniques to allow simultaneous execution of up to eight Databus programs. Each program deals with a slave Datapoint 3300 terminal. All program execution is under control of the Databus language.

Dataform 1

The Dataform interpreter allows the user to generate and use more than 100 forms to control the cassette-based entry process. After the data has been processed, checked, and formatted by Dataform, it can be further processed using assembly language, Scribe, Databus, RPG II, or Basic programs or the cassette can be directly converted to a disc file.

Scribe

Scribe is a text processing and printing utility for use with the general-purpose text editor called GEDIT, to provide a complete automatic typing/word processing system. The typist can either format the text on the screen as it is to be printed, or type free form, imbedding printing control symbols. In either case, data on the screen can be checked and corrected before the final copy is printed.

Communications

Databus Communication Converters provide simple means for the 2200 user to transmit data between a Datapoint 2200 and a larger computer by telecommunications. A communications converter is a manufacturer-supplied Databus program called in subroutine form. The user can also program macroinstructions if he prefers to write his own subroutines.

Terminal emulators are available for IBM's 2780, 2265, and 2741, as well as for CDC 200, Univac DCT 2000, and teletypewriters. The emulators permit the 2200 to act as a plug-to-plug replacement for the appropriate terminal because line disciplines are identical. Datapoint states that no hardware or software changes are required for any of its emulators, providing the Datapoint system has the same peripherals as the emulated system.

The IBM 2265 program operates at a maximum of 1,200 bits per second with an internal modem and 2,400 bits per second with an external modem. It requires an operating system and a 6K or 8K-word memory. The EM2741 requires only 2K bytes of memory. It transmits EBCDIC over an external modem. Another emulator, DB 2780, transmits and receives 80-column card images using IBM's Binary Synchronous Communications (BSC) techniques. At the same time, it can simulate the IBM 2780 Model 4 terminal. The package requires 4K bytes of memory, the Synchronous Communication Adapter (2200-404), and a Bell 201 compatible modem.

Datapoint's CDC 200 Emulator performs all tasks that the CDC 200 does. In addition it performs such tasks as code conversion of IBM 026 or 029 card decks (normally done on a CDC 6000), and data entry by means of cassettes.

The standard Univac DCT 2000 emulator includes many of Univac's extra-cost options as standard features, such as unattended answering, off-line listing, etc. Like the CDC 200, the DCT 2000 is card-oriented; Datapoint's system, however, provides the additional convenience of cassettes.

Other emulator programs are for Teletype Model 33 ASR and a Bell System 202 modem interface.

Utilities

Utilities include floating-point transcendental routines, floating-point/string conversion, tape lister, string print subroutines, 9-track tape drive subroutines, 9-track tape dump, and others. A new sort/merge package, important to business users, enables sorting and/or merging of disc files up to 2,000,000 bytes long.

Diagnostics

Diagnostics programs include testers for combined memory and tape endurance, printer, parallel interface, display, 2200/disc, disc controller buffer memory, keyboard, processor, and others.

Software Available From Other Vendors

Standardized packages and software services for the 2200 are available from a number of independent software houses. Among these are Bristol Information Systems (Fall River MA), Computerm (Bellevue WA), Dialogue Systems (Richardson TX), Diana M. Engel (Washington DC), F & S Systems (Framingham MA), Goal Systems Corp (Westport, CT), Jammar (San Bruno CA) and PBS Systems (Bellevue WA). Packages currently offered include accounts receivable, perpetual inventory, sales analysis, payroll, accounts payable, general ledger, mailing list maintenance, medical billing, and a variety of utility routines (sort, etc) extending Datapoint's own offerings. Datapoint has nothing to do with these packages, except that the company will provide a list of the independent packages it knows about. As the number of terminals and small business systems increases, the number of independent software offerings is also bound to increase.

MAINTENANCE

In the United States, Datapoint provides maintenance support for the 2200 through a staff of service engineers in 35 service centers located throughout the country. Replacement parts are also stocked at all major cities. Datapoint quotes from four to six hours average response time for user maintenance calls. The lease price does not include maintenance service and each user must negotiate a maintenance contract with Datapoint. These contracts can be on an 8-hour, 24-hour, or per-call basis (price quoted in price data chart is for 8-hour contract); they generally cover units located within 15 miles of a Datapoint maintenance service area. Emergency maintenance service can be prearranged.

Installation of new systems takes an average of two hours per system. The installation charge is in addition to purchase or lease price. New systems carry a 90-day warranty.

Datapoint also maintains a Datapoint training center at its manufacturing facilities in San Antonio, Texas, where a series of comprehensive courses acquaints potential customers and new customers with the product line. Some customers with purchased systems have been trained to do their own maintenance work.

Outside of the United States, Matra Engins, Regnecentralen and the other companies mentioned earlier are responsible for maintenance in their territories. Companies marketing the Datapoint system were chosen partly because they have marketed other peripheral systems and thus have already established service networks. Regnecentralen, for instance, has a particularly dense network of sales and service centers in Denmark and West Germany, from which it has serviced RC 3600 peripheral processing systems. Matra is also well-represented in France and Belgium. All distributors outside the United States are appointed by TRW, Inc. in Los Angeles, under a master distributorship agreement.

HEADQUARTERS

Datapoint Corporation
9725 Datapoint Drive
San Antonio TX 78284

PRICE DATA

Model Number	Description	Monthly Rental: 1-year lease, $	Monthly Rental: 3-year lease, $	Short-term lease	Purchase, $	Monthly Maint, $
	DATAPOINT 2200					
	Basic Configuration					
2200-102	Datapoint 2200 V1 2K	167	151	302	6,040	30
2200-104	Datapoint 2200 V1 4K	183	166	332	6,630	30
2200-106	Datapoint 2200 V1 6K	198	180	370	7,210	30
2200-108	Datapoint 2200 V1 8K	215	195	390	7,800	30
2200-114	Datapoint 2200 V2 4K	240	195	390	8,571	35
2200-118	Datapoint 2200 V2 8K	280	227	454	10,003	35
2200-122	Datapoint 2200 V2 12K	320	260	520	11,650	42
2200-126	Datapoint 2200 V2 16K	360	292	584	13,297	42

PRICE DATA (cont.)

Model Number	Description	Monthly Rental: 1-year lease, $	Monthly Rental: 3-year lease, $	Short-term lease	Purchase, $	Monthly Maint, $
	Configuration Options					
2200-141	Datapoint 2200 Swedish Keyboard Option	–	–	–	6.25	–
2200-150	Blank Tape Cassette, 300'	–	–	–	2	–
2200-151	Pad Coding Forms 25/Pad	–	–	–	95	–
2200-152	Extender Card, Processor	–	–	–	75	–
2200-153	Extender Card Mod-Demod, I Decode	–	–	–	95	–
2200-154	Extender Card, Kb Logic	–	–	–	95	–
2200-155	Extender Card, Display Logic	–	–	–	60	–
2200-156	Extender Card Tape Deck	–	–	–	45	–
2200-158	Tape, Alignment	–	–	–	280	–
2200-159	Tool, Head Alignment	–	–	–	–	–
2200-163	230-Vac, 50-Hz Option for 2200	–	–	–	–	–
2200-701	Special Display Option	11	9	17	375	–
2200-702	Special Display Option	26	24	43	950	–
	Mass Storage					
2200-350	Disc Controller/Drive, Console	282	245	490	9,800	35
2200-351	Disc Controller/Drive, Freestanding	282	245	490	9,800	35
2200-352	Disc Controller/Dual Drive, Console	391	340	680	13,600	52
2200-353	Disc Controller/Dual Drive, Freestanding	391	340	680	13,600	52
2200-354	Single Disc Drive Extension	245	213	426	8,500	35
2200-355	Dual Disc Drive Extension	372	323	646	12,900	52
2200-362	Disc Cartridge	–	–	–	150	–
	Peripherals					
	Printers					
2200-200	Printer 30 cps, 132-Col, Console	135	112	224	4,480	35
2200-201	Printer 30 cps, 132-Col, Freestanding	135	112	224	4,480	35
2200-203	230 Vac, 50 Hz Opt., 2200-200/1	–	–	–	30	–
2200-240	IBM Selectric Interface	24	19	50	750	10
2200-242	Centronics Printer Interface	–	–	–	1,088	–
2200-244	Centronics 101 A	220	192	401	6,678	50
2200-245	Centronics 102 A	245	213	503	8,388	50
2200-246	Centronics Printer Table	12	11	24	210	–
2200-250	Servo Printer, 132-Col, Console	156	141	312	6,300	35
2200-251	Servo Printer, 132-Col, Freestanding	156	141	312	6,300	35
	Magnetic Tape					
2200-300	Tape Transport, 9-Track, Console	245	213	426	8,500	35
2200-301	Tape Transport, 9-Track, Freestanding	245	213	426	8,500	35
2200-302	Tape Transport, 7-Track, Console	245	213	426	8,500	35
2200-303	Tape Transport, 7-Track, Freestanding	245	213	426	8,500	35
2200-304	Tape Cleaning Kit For Tape Transports	–	–	–	–	–
2200-305	230-Vac, 50-Hz Tape Transport Option	–	–	–	–	–
2200-306	Extender Card for 2200-300/1-3/50-53	–	–	–	95.00	–
2200-307	556 bpi Opt For 2200-300/1/2/3	–	–	–	–	–
	Card Reader					
2200-500	80-Column Card Reader	122	106	212	4,210	25
	Communications					
2200-400	Comm Adaptor, Async, EIA	28	23	58	910	10
2200-401	Comm Adaptor, Async, Bell 103-Compat	46	38	88	1,500	10
2200-402	Comm Adaptor, Async, Bell 202-Compat	46	38	88	1,500	10
2200-403	Comm Adaptor, Async, Current Loop Comp	46	38	88	1,500	10
2200-404	Comm Adaptor, Synchronous, EIA	28	23	58	910	10
2200-420	Comm Adaptor, 8-Bit Parallel Data	24	19	50	750	10
2200-450	Mult. Comm. Adapt. Tray (No Table)	64	54	128	1,944	15
2200-451	Comm Adaptor, EIA, U/W, 2200-450	27	22	44	710	10
2200-452	Comm Adapt., Bell 103-Comp, U/W 2200-400	46	38	76	1,300	10
2200-453	Comm Adapt., Bell 202-Comp, U/W 2200-450	46	38	76	1,300	10
2200-460	Multiple Port Communications Adaptor	42	36	84	1,250	15

Notes:

(1) One-year lease prices for 2200-102/4/6/8 apply for renewals or add-ons only. Software support will not be supplied by Datapoint on those models for new accounts or applications.

(2) Shipping costs not included; customers will be billed actual costs.

(3) Lease price shown does not include maintenance.

(4) Maintenance price includes all maintenance for units located within a Datapoint maintenance service area. Additional charges are made for maintenance outside this area.

(5) Minimum installation charge is $60.00 if installation site is outside of Datapoint maintenance area and $30.00 if inside a maintenance area. Lower rates apply only when these items are installed with other units having installation charges totalling at least $60.00 or $30.00, respectively.

(6) Any upgrade in memory will have a minimum installation charge of $30 per machine inside a service area. Port-to-port charges of $21.50/hr outside the service area. Versions I and II will have an installation cost of $80.00. Minimum renewals for less than two years will be at the 1-year price.

(7) Quotes for full payout leases will be made upon submission of required credit information.

(8) All 2200/printers, 2200/tapes, and 2200/discs can be leased as part of a leased 2200 system.

OVERVIEW

The Datapoint 5500 is a dispersed data processing/small business computer system with an 8-bit processor design that provides more capabilities and higher performance than the company's popular 2200 Series, while remaining upward-compatible with the 2200. The 5500 is a brand new system due to be delivered the fourth quarter of 1974. While most of the system architecture has been worked out, certain specifications are not yet available; core cycle time, for instance, has not yet been released because the final choice of supplier for the memory clip had not been made at the time of writing. The material in this report is preliminary.

The 5500 resembles the 2200 in external appearance, with a keyboard/CRT display and dual cassette drives housed in a single unit with processor and memory. Peripheral expansion at present is restricted to 2200-type peripherals, but higher-speed devices will be added in the future.

The basic differences between the 5500 and the 2200 are in the handling of memory, the expansion of the instruction set with the attendant possibilities in software development, and the greater variety of error checking facilities. Up to 64K bytes of ROM and RAM memory can be included in the system; memory mapping, protection scheme, and virtual memory techniques can all be implemented using page- and sector-storage and addressing methods. The instruction set provides for multibyte (field) operations and address manipulation to support the memory scheme, as well as the 2200's stack manipulation instructions for efficient context switching. Optional parity checking is supported by an expansion of the interrupt system to include I/O parity as well as memory parity faults. Memory protect and privileged instruction violations have also been added.

Peripherals originally used on the 2200 provide an extensive base on which the 5500 can build. The 2200 peripheral line includes cartridge discs, industry standard magnetic tape drives, printers, card readers, a variety of communications adapters, and "slave" CRTs (up to eight on the 2200) that can access memory independently via a multiport adapter. The 5500 I/O throughput will be over twice that of the 2200. In addition, it will allow optional parity checking for new devices that can be mixed with the nonparity 2200 peripherals on a system. Some of the 2200 peripherals will require minor modifications to operate at the higher speed, but these will be handled through the factory.

Datapoint systems are distributed directly by Datapoint in the United States and by TRW International through its network of distributors located throughout the world.

PERFORMANCE AND COMPETITIVE POSITION

While it is premature to make an extensive analysis of the 5500's position in the small business market without more details on software development and especially pricing, certain elements of the 5500 system design indicate it will strengthen Datapoint's entire product line. The greater sophistication and speed of the processor, the larger memory capacity with support for development of a multiprogramming operating system provide a new upward mobility for 2200 users. Not only can they increase the processing volume, but the system is large enough to enable a shift from primarily preprocessing data that is communicated to a larger processor to primarily in-house processing for total applications, including processing input from intelligent terminals. Transmissions can be mostly summary data to a larger central computer. For certain businesses, the 5500 could handle preprocessed input from a number of other Datapoint 1100, 2200, or similar terminals, perhaps transmitting data to a larger computer only for certain infrequent large jobs. For other businesses, the 5500 could function as a front-end communications processor with added processing capabilities.

The 5500 together with the 1100 and 2200 make Datapoint one of the few manufacturers able to set up a large dispersed data processing network with a wide variety of terminal capabilities. Each terminal can be geared to the load volume at a particular branch, and each is capable of relatively painless expansion if business should grow. In this respect, the 5500 occupies an important position in Datapoint's product line. Evaluation of the system against small business systems such as those of IBM, Basic Four, Burroughs, Qantel, Cascade Data, Four-Phase, Singer, NCR, and Univac cannot be made at this time.

Several manufacturers have product lines similar to Datapoint's in providing a range of processors and terminals for dispersed data processing. Four-Phase Systems recently added a processor at the top of its intelligent terminal line to provide breadth in the same way the 5500 does; the Four-Phase line has a large body of well developed software but does not have an intelligent terminal comparable to the 1100. The Singer line goes one step further—the 4300 is an inexpensive "dumb" terminal, the 1500 (the old Cogar System 4) is like the 2200, and System Ten can be compared to the 5500. The elements of the Singer line, however, are not compatible with each other and the 1500 software is not as well developed as the 2200 software. The Mohawk 2400 system, especially when combined with communicating Data Recorders, can also be configured to provide a wide range in price and processing capability.

CONFIGURATION GUIDE

The basic Datapoint 5500 processor is housed in a typewriter-like desktop unit together with a keyboard, a 960-character CRT, two magnetic tape cassette drives and a built-in power pack. This basic processor can attach all 2200 peripherals with the 5500 high-speed option added. Details of I/O control and configuration limitations are not yet available.

Peripheral devices include a 132-column, 30 character-per-second impact printer, a thermal printer, a 135 line-per-minute line printer, a 600 card-per-minute card reader, standard tape drives (seven- or nine-track), single or dual disc drives with control, and a number of communications adapters with modems.

Processing Unit

The 5500 processing unit differs in architecture from the 2200 and 1100. It uses an 8-bit word and a push down stack like the 2200 and 1100 processors but the 5500 has additional base registers and it uses paging registers and a memory sector table to divide logical memory into 16 4K-byte sectors. Each sector can be mapped into any physical 4K-byte memory section, which can be designated as access-protected or write-protected. The system features allow reentrant coding, memory swapping for implementing virtual storage, and locking out faulty memory sections so the system can operate as long as enough memory for a job is functional.

Physical RAM memory is on four 12K-byte boards, with a fifth 16K-byte board of combined ROM and RAM for "System Memory." The ROM contains loader, debug, memory test, and fixed operating system facilities, while the RAM portion of System Memory is reserved for the operating system.

The processor can operate in either the "system" or "user" mode. The system mode permits all instructions to be executed, while the user mode restricts the execution of certain privileged instructions. All interrupts except Power Up turn off the user mode, push the contents of the program counter on the stack, and continue program execution at the interrupt vector location. Interrupts are generated for Memory Parity Fault, Input Parity Fault, Output Parity Fault, Write Protect Violation, Access Protect Violation, Privileged Instruction Violation, Clock, User System Call Restart, and Power-Up.

The 2200 has 28 basic instruction types. The 5500 includes all these instructions plus 41 instructions of five different kinds.

- Additional register referencing capability.
- Multibyte operations—block transfers, both binary and decimal field arithmetic compare and shift, and multiple I/O.
- Context switching—stack and register save and restore.
- Address manipulation including double and paged load and store.
- Operating system control—system call, user return, etc.

System specifications are listed in Table 1.

Power

The power supply of the 5500 has been completely redesigned to meet all known safety requirements of different countries, enabling Datapoint to obtain UL, CSA, and VDE approval.

Keyboard/CRT

The integral keyboard provides a basic 41-key alphanumeric character set, an 11-key numeric pad, plus five system control keys. An infinite roll-over feature assures maximum ease of typing. Transfer of characters from the keyboard is under control of the processor, and at the programmer's option, an audible feedback signal can be given to the typist each time a character is recorded. The CRT viewing screen area is 7 x 3.5 inches; it can display a maximum of 960 characters (80 characters x 12 lines). All 94 characters of the ASCII character set can be displayed. The CRT also features a refresh rate of 60 frames per second, 5 x 7 dot matrix character generation, 5 x 7 solid, blinking cursor, single control line erasure, frame erasure, and page rollup.

Cassette Decks

The two read-write cassette tape decks accept Philips-type cassette tapes. They record 50 characters per inch, use dual-capstan drives, operate both forward and reverse, and transfer data under processor control. I/O instructions also provide control of tape direction, check for head engagement, and rewind.

Communications

The optional communications adapter is available in the seven versions shown in Table 2.

The adapter permits program selection of the desired bit rate, character length, and character set to offer versatile communications capability.

COMPATIBILITY

Datapoint 2200 Version II programs should run without modification on the 5500. Programs sensitive to instruction timing and programs generated on compilers or assemblers other than those supplied by Datapoint may not be compatible with the 5500. The Datapoint 1100, 2200, and 5500 Series systems software packages are upward compatible; 1100 software can run on the 2200 and 5500, and 2200 software can run on the 5500.

The programmable nature of the 5500 theoretically enables it to simulate any terminal. As a practical matter, terminal simulation is currently limited to the manufacturer's prewritten 2200 packages: IBM 2265, IBM 2741, IBM 2780 Models 1 through 4, Univac DCT 2000, CDC 200, Teletype 33 ASR, and Bell System 202-compatible modems.

SOFTWARE

As yet no software has been released specifically for the 5500; only the 2200 software is available for the

Table 1. Datapoint 5500: Specifications

PROCESSOR	
No. of Registers	NA
Memory	
Size (wds)	To 64K
Bits/Word	8
Parity/Protect	Both
Cycle Time (μsec)	NA
Paging	Yes
ROM	Control memory
Instructions	
Number	69
Double Precision	Yes
(Hardware) Multiply/Divide	NA
Floating Point	NA
Stack Manipulation	Yes
Priority Interrupt	10 levels
DISPLAY UNIT	
Screen Size (char)	960
Characters/Line	80
Lines/Display	12
Character Set	94-char ASCII
Character Generation	5 x 7 dot matrix
PERIPHERALS	
Cassette	Dual drive std
Magnetic Tape	7- or 9-track
Printers	30-cps thermal; 30-cps impact; 135- and 300-lpm line printer
Punch Card (cpm)	400-cpm reader
Disc	2.4 Mb; removable cartridge
COMMUNICATIONS	
Line Interface	Synch or asynch
Control Procedures	IBM BSC
Standard Features	Autodial; auto answer
Optional Features	Programmable for most features
DATA TRANSMISSION	
Network	Leased; switched
Line Speed (bps)	Asynch: 37.5-9,600 synch: up to 9,600
Error Control	CRC; LRC; VRC
COMPATIBILITY	
Computer System	IBM 360; 370
Terminals Emulated	IBM 2265, 2741, 2780, Md1 4; 33 ASR; Univac DCT 2000; CDC 200
Bell Data Set	103; 201; 202

Table 1. (Contd.)

SOFTWARE	Cassette, tape, disc operating systems, emulators (above) DATAFORM editor, forms generator, data entry pkg
FIRST DELIVERY	4th quarter 1974

5500. The 2200 software is quite extensive: three operating systems (disc, tape, and cassette); an assembly language; terminal emulators for IBM 2265, 2741, and 2780 terminals, and for CDC 200 and Univac DCT 2000 terminals; DATASHARE multiple terminal control package, "DATABUS," Basic, and RPG II compilers; a text processing package; and many useful utilities as well as diagnostic programs. These programs are maintained and fully supported by the company.

Software Available From Other Vendors

Standardized packages and software services for the 2200 are available from a number of independent software houses. Among these are Bristol Information Systems (Fall River, Massachusetts), Computerm (Bellevue, Washington), Dialogue Systems (Richardson, Texas), Diana M. Engel (Washington, DC), F & S Systems (Framingham, Massachusetts), Goal Systems Corporation (Eastport, Connecticut), Jammar (San Bruno, California), and PBS Systems (Bellevue, Washington). Packages currently offered include Accounts Receivable, Perpetual Inventory, Sales Analysis, Payroll, Accounts Payable, General Ledger, Mailing List Maintenance, Medical Billing, and a variety of utility routines (sort, etc.) extending Datapoint's own offerings. Datapoint does not support these packages, however, it will provide a list of those independents it knows about. As the number of terminals and small business systems increase, the number of independent software offerings is also bound to increase.

MAINTENANCE

Datapoint provides maintenance support for the 3500 through a staff of service engineers in 30 service centers located throughout the U.S. Replacement parts are stocked in major cities. Datapoint quotes the average response time for user maintenance calls is from 4 to 6 hours. Maintenance contracts can be for an 8-hour or 24-hour day or on a per call basis and generally cover units located within 15 miles of a Datapoint maintenance service area. Emergency maintenance service can be prearranged.

Installation of new systems takes an average of two hours per system. The charge is in addition to purchase or lease price. New systems carry a 90-day warranty.

Table 2. Data Communications Capability

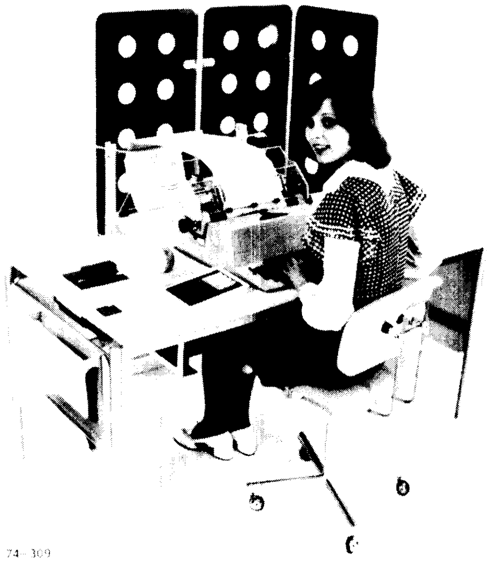
Model No.	Name	Interface	Model	Transmission Rate (bps)	Duplex
400	Communications	EIA RS 232	Asynch	37.5-9,600	Full; half
401	Communications Adapter with Modem	Bell 103 equivalent	Asynch	300	Full
402	Communications Adapter with Modem	Bell 202 equivalent	Asynch	1,200	Half
403	High-Level Keyer	Telegraph lines	Asynch	37.5	—
404	Synchronous Communications	Bell 201 or equivalent	Synch	Up to 9,600	Half
420	Parallel Data	Other mfrs peripherals	—	Parallel	—
460	Multiport Adapter	EIA RS 232C for attachment of 8 interactive peripherals	Asynch	100, 300, or 1,200 baud	Full

Datapoint also maintains a Datapoint training center at its manufacturing facilities in San Antonio, Texas where a series of comprehensive courses acquaints potential customers and new customers with the product line. Some customers with purchased systems have been trained to do their own maintenance work.

Outside of the United States, the distributors are responsible for maintenance in their territories. All distributors outside the United States are appointed by TRW, Incorporated in Los Angeles, under a master distributorship agreement.

HEADQUARTERS

Datapoint
9725 Datapoint Drive
San Antonio TX 78284



74-309

OVERVIEW

The Datasaab 6501 is a multistation, keyboard-oriented disc processing system for small businesses and specialized real-time applications in large companies. It is best suited for in-house data capture and on-line order entry, sales invoicing, ledger accounting, and inventory monitoring. It can be readily adapted to any other keyboard-oriented file enquiry/updating application.

Datasaab 6501 systems comprise a central control group and 1 to 16 workstations that can be located up to 2,000 metres (6,540 feet) cable distance from the central control group. The central control group comprises a 16K- to 64K-byte processor, 2.5 million to 20 million bytes of disc storage for programs and files, and optional magnetic tape drives and synchronous data communications modem controllers. Data communications lines can link the 6501 control group to satellite 6501 systems controlling remote workstations or to host 6501, IBM System/360 or 370, or other general-purpose EDP systems.

The 6501 workstations can be any of five types up to a combined maximum of 16 stations. One workstation type offers a 1024-character alphanumeric CRT display and an alphanumeric keyboard is typewriter or keypunch layout. The remaining four workstations are highly modular keyboard-printer units. Each workstation can support up to two input and four output devices, which include alphanumeric and numeric input keyboards, serial printers, indicator displays, and batch I/O devices for paper tape and single-track magnetic tape cassettes.

Software includes a virtual memory operating system and LOGIC-3 text editors, translators, and interpreter. LOGIC-3 is a high-level, hardware-independent Cobol dialect developed by Datasaab. Most 6501 systems delivered to date have been turnkey programmed by Datasaab in LOGIC-3, but the company is also developing some standard applications packages.

The 6501 is designed and assembled in Sweden and marketed throughout Europe and many overseas countries by Datasaab AB. Datasaab was formed in March 1974 from a merger between the data systems divisions of Saab-Scandia and Facit-Addo-Odhner. Facit-Addo-Odhner's Data Products Division manufactures almost all the components of the 6501 workstations; the serial printers and all central control group components are obtained on an OEM basis. In mid-1974, the Computer Automation Alpha/LSI 2 replaced the Inter-technique Multi-8 as the central processor.

PERFORMANCE AND COMPETITIVE POSITION

Datasaab 6501 was developed by the Facit-Addo-Odhner Data Systems Division before the recent merger with Datasaab. Its printing workstations use Facit-Addo peripheral device modules identical to those that Facit-Addo developed for the Datasaab D 5/10 and D 5/20 banking terminals. Delivery of these banking terminals began in 1972; and some 6,000 are due to be installed throughout Sweden, Finland, Denmark, and Norway by the end of 1975. The Type 3 key/display workstation is identical to the Facit-Addo M10 and M11 key-to-storage data entry keystations first delivered in 1972. All 6501 workstations can thus be regarded as fully tested.

The only difference between the 6501 and Datasaab D 5/10 and D 5/20 banking terminals lies in the central processor and other control group components. Initially the 6501 used Intertechnique Multi-8/M.304 processors but has used Computer Automation Alpha/LSI 2 processors since mid-1974. Both the Multi-8 and Alpha/LSI 2 are fully tested minicomputers available on the OEM market.

Datasaab 6501 was first shown at the Stockholm Data Fair in October 1971 and at the Hannover Fair in April 1972, but marketing other than on a test basis did not begin throughout Europe until April 1973. In the United Kingdom, the system was announced officially in March 1974. Deliveries of systems began on a test installation basis in late 1972.

Initial 6501 installations have been turnkey programmed by Facit-Addo in LOGIC-3. Applications are mostly in the areas of on-line order entry, invoicing, sales ledger accounting, inventory control, and production control. The system is especially popular for inventory control in warehouses and salesrooms; its workstations can be dispersed and placed at each order entry and delivery point within the warehouse.

The 6501 should be strong in Scandinavia and somewhat less so in West Germany. It was one of the first multikeyboard disc processing small business computers to be announced in both countries, preceded only by the Singer System Ten and (in West Germany) the MAI Basic

Four. It offers a larger choice of workstations than either of those systems, and its basic configurations are generally cheaper. In Scandinavia, it should also benefit from its status as a home-grown product and from its resemblance to the much publicized Nordic Banking System (D5/10 and D5/20) counter terminals.

In other European countries, especially France and the United Kingdom, the Datasaab 6501 was announced much later than it was in Scandinavia or West Germany—after or concurrently with many other multistation disc processing small business computers. They include the Allied Business Systems MULTIBUS, BCL Molecular 6M and 18, DEC Datasystem 500, Honeywell-Bull Model 58, Insel MAEL 4850 and 4855, Nixdorf Systems 880/65 and 880/85, and Singer 6800 and System Ten.

In the United Kingdom, the 6501 must also compete against the AIA ADAM, CTL Modular One Transaction Processing System, MBM 7000, and Melcom MCS 1600; in France it competes against the Marme GMG 5000. Most of these competing systems offer more expandable disc backing stores with maximum on-line capacities ranging from 78 to 200 million bytes, as compared to 20 million bytes on the Datasaab 6501. Most of the competing systems also offer line printers and 80-column card readers and punches among their batch I/O peripherals; these peripherals are currently unavailable on the Datasaab 6501.

Datasaab 6501's chief asset in this highly competitive situation is the large choice of workstations that it offers, greater than on any competing small business computer except the BCL Molecular 18 and the Nixdorf Systems 880/65 and 880/85. Nixdorf 880 workstations, however, are on much more expensive System 840 computers. Nixdorf is also the only competing manufacturer to offer the facility of connecting batch paper tape readers, punches, magnetic tape cassette drives, and high-speed serial printers to individual workstations rather than the central control group.

This type of connection is one of the 6501's most attractive features as well, because it allows workstations to be distributed throughout an office or factory (up to 2,000 metres cable distance from the central control group) to be used as full-fledged remote batch terminals with their own operator consoles. The terminals have full control over their own local batch I/O peripherals. Apart from the Datasaab 6501 and Nixdorf Systems 880/65 and 880/85, other competing systems offer remote workstations confined to keyboard input and display or printed output, suitable only for data entry and/or enquiry/response applications.

Another 6501 advantage is its sophisticated systems software. Its virtual memory operating system allows programs of any length to be written and held on disc, from where they are loaded into main memory in small segments as required. The high-level LOGIC-3 programming language makes the 6501 desirable for users who prefer to do their own programming. The only competing small disc processing business computers with equally sophisticated software are the AIA ADAM, DEC Datasystem 500, Honeywell-Bull Model 58, and MBM 7000.

Compatibility

Datasaab 6501 is programmed in the hardware-independent LOGIC-3 language. It is thus potentially compatible with any other computer system on which a LOGIC-3 interpreter has been implemented. LOGIC-3 programs written for Multi-8 based 6501 systems will run on Alpha/LSI 2 based 6501s.

With Data Entry Systems. The 6501 workstations that include the optional Facit 4001 or 4020 paper tape reader can read any industry-compatible 5- to 8-track paper tape, including tapes recorded on Facit-Addo 'X' card-programmed paper tape punches, and Datasaab M15 invoicing computers.

A 6501 workstation equipped with the alternative Facit 4203 magnetic tape cassette unit can read cassettes recorded on Datasaab M5, M7, and M10 key-to-cassette data preparation systems.

With IBM System/360 and 370. The 6501 can exchange data with IBM System/360 and 370 configurations in the following ways.

- Off-line on 9-track, 800 bit-per-inch, NRZI magnetic tape.
- On-line via a leased or switched voicegrade line, terminated by synchronous 1,200 to 4,800 bit-per-second modems.

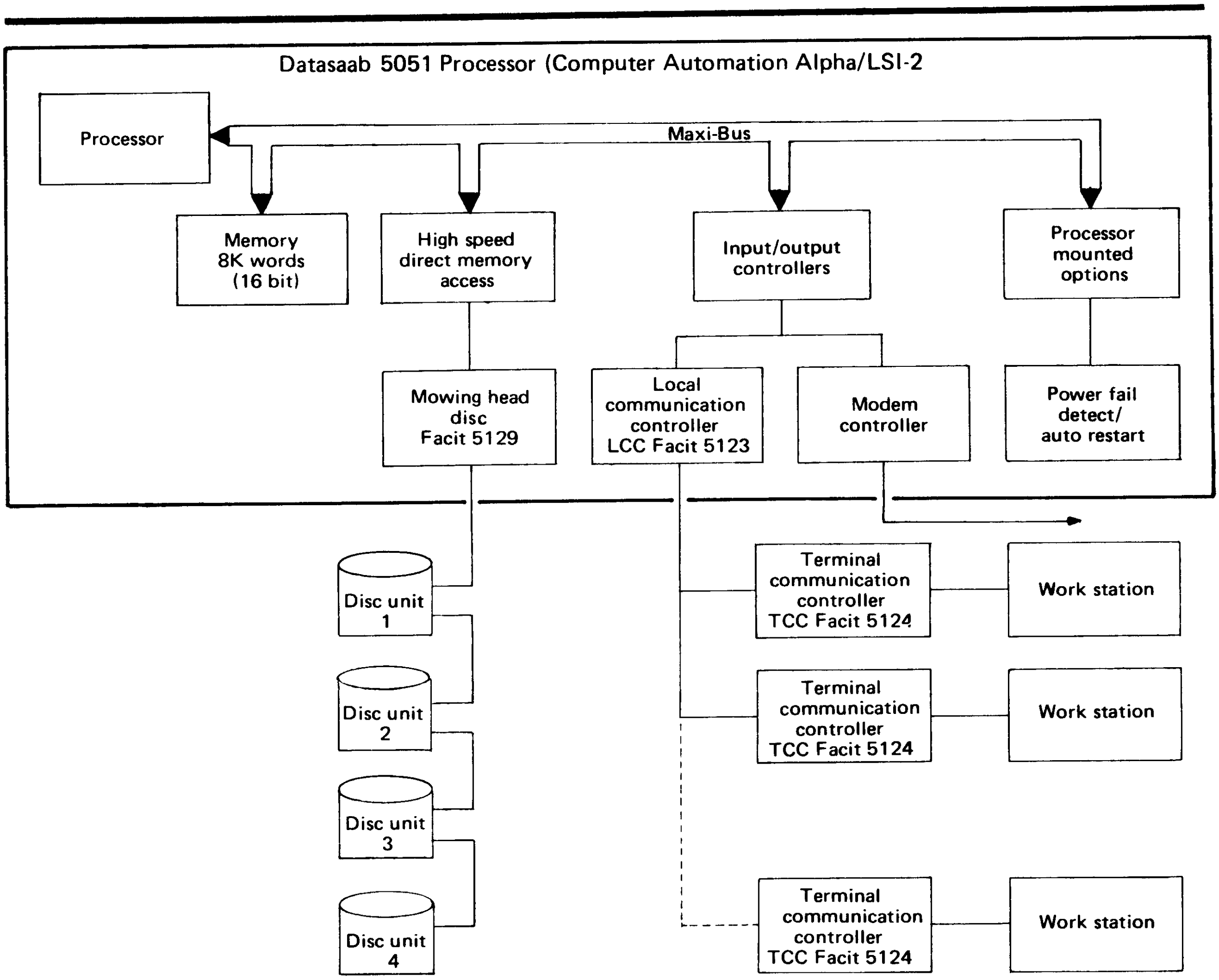
The 6501 can emulate IBM 2780 BSC line disciplines.

With Other General-Purpose Computers. Data can also be exchanged off-line on 9-track, 800 bit-per-inch magnetic tape with any other computer system able to read and record it. An ICL 7020 emulator is being developed for on-line communications with the ICL 1900 series.

CONFIGURATION GUIDE

Datasaab 6501 computers comprise a central control group and 1 to 16 workstations. Each workstation is connected to the central control group by a 2-wire cable that can be up to 2,000 metres (6,540 feet) long. A workstation located at a greater distance normally requires a 6501 control group of its own, which can be linked to the main 6501 system by a data communications line terminated by synchronous modems; see Figure 1.

Central Control Group. The central control group comprises a Datasaab 5051 processor and one to four 4801 disc drives. The 5051 processor can have 8K to 32K 16-bit words of MOS/LSI main memory. Each 4801 disc drive holds a 2.5-million-byte exchangeable disc cartridge; it can also handle an optional 2.5-million-byte fixed disc. Total on-line disc backing storage can therefore range from 2.5 to 20 million bytes.



Each system includes a computer and one or more disc drives as well as a two-wire communication system to which the work stations are connected. The computer and the disc drives, are the key parts of the central equipment. All processing and storage of data is performed in the central equipment. Facit 6501 can be connected to a central computer via a telephone line, using modem equipment.

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Figure 1. Datasaab 6501: System Configuration

The following optional devices can be attached to the central control group:

- One or two 4220 magnetic tape drives; 9-track, 800 bits per inch.
- 5132 synchronous modem controller for modems up to 4,800 bits per second.

These are used mostly as alternative methods for exchanging data off-line or on-line with a host IBM System/360 or 370 or other general-purpose EDP system. When on-line to an IBM 360 or 370, the 6501 central control group emulates IBM 2780 BSC line disciplines and control messages.

The 5132 synchronous modem controller can also be used to exchange data with a host or satellite 6501 control group for workstations located more than 2,000 metres away. Satellite 6501 control groups are not required to be equipped with their own discs.

Workstations. Datasaab offers a choice of five workstations for connection to the central control group: a key/display station and four types of keyboard-printer station. Each type of keyboard-printer station uses a different printer module as the main output device. Only two are suitable for printing business documents destined for outside customers or suppliers: the Facit 3851 typewriter in Type 2 workstations and the Facit 4561 (Centronics) serial matrix printer in Type 1 workstations.

Types 4A and 4B use the 4552 strip printer and/or 4553 serial page printer for pressure-sensitive paper, which is suitable only for recording system answers to internal file enquiries. They are less costly alternatives to the Type 3 key/display workstation for keyed data entry and enquiry/response applications.

Type 2 workstations are typically used in single-keyboard 6501 and small multikeyboard configurations. Their typing speed (12 characters a second) limits them to output generated immediately by a keyed input on their own keyboards in regular keyboard-oriented transaction processing.

Type 1 workstations are equipped with a Facit 4561 (Centronics) serial matrix printer that prints at a speed of 165, 330, or 660 characters per second. This is faster than required for the output generated by a single keyboard. Thus, Type 1 workstations are mostly used to print business documents at high speed, after the system has batch processed input data entered on a number of other Type 3, 4A, or 4B workstations. Type 1 is also suitable for the same real-time transaction processing applications as Type 2 workstations, using their own keyboards for data entry.

All four types of keyboard-printer workstation incorporate the Facit 5124 terminal communications controller, which can handle a maximum of two input and four output devices. The second input device can be a 4626 numeric keyboard for single-handed numeric data entry and/or programmed control functions; a 4001 or 4020 paper tape reader; or a 4626 magnetic tape cassette drive. If more than one of these additional input devices is required at different times in a working day, then they can be plugged into the second input socket when needed and unplugged later to make room for another input device module. The four output interfaces are usually adequate to connect permanently any required combination of printer(s), paper tape punch, magnetic tape cassette drive, and binary or numeric indicator.

MAINFRAME

The Datasaab 6501 mainframe is normally housed in the first workstation's pedestal, together with the disc drives of the central control group.

Central Processor

Until spring 1974 all 6501 systems delivered used the Intertechnique Multi-8/M.304 central processor operating under a special microprogram incorporating additional instructions. These systems are limited to a maximum of eight workstations. The 6501 systems delivered since then use the Datasaab 5051 processor based on the Computer Automation Alpha/LSI 2. Table 1 lists the mainframe specifications.

Model 5051 processor has a common mainframe architecture. The processor, main memory, DMA channel, and I/O controllers are all connected to a common parallel "Maxi-Bus" (see Figure 1).

Table 1. Datasaab 6501: Mainframe Specifications

Characteristics	Computer Automation Alpha/LSI-2
CENTRAL PROCESSOR	
General-Purpose Registers	8
Addressing	
Direct	768 words or bytes
Indirect	Multilevel, to 32K words or 64K bytes per level; 128K words max
Indexed	Yes
Instruction Set	
Number	1; 182
Floating-point arithmetic	No
Priority	
Interrupt Levels (std; max)	5; 256
MAIN STORAGE	
Type	Semiconductor; core can be mixed
Cycle Time (μsec)	1.6
Basic Addressable Unit	Word or byte
Min Capacity (bytes)	2,048
Max Capacity (bytes)	524,288
Increment Sizes (bytes)	8K, 16K, 32K (core); 2K, 4K, 8K (MOS)
Memory Parity	Opt
Memory Protect	No
ROM	Yes
RAM	Yes; can be mixed with core
I/O	
Transfer Rate	
DMA (wds or bytes/sec)	625,000 (1.25M with interleaved memory)
Block I/O (wds/sec)	131,579
Programmed I/O	34,247 via registers
Programmed (wds or bytes/sec)	24,631 direct to memory
Direct Memory Channels (wds or bytes/sec)	26,738
No. of DMA Channels (std; opt)	2; 64
Conditional I/O	Std
Max Addressable I/O Devices	248

Data Structure. The 5051 processor can address both 8-bit bytes and 16-bit words and process either in parallel. The ASCII alphanumeric character code is used most often, but EBCDIC can be handled. Arithmetic processing is two's complement, fixed-point binary on signed 7-, 15-, and 31-bit numbers.

Registers. The 5051 processor has seven addressable, 16-bit hardware registers, usable as accumulators and/or index registers. There is also an 8-bit byte register.

Instruction Set. A set of 168 basic hardware instructions is divided into seven classes: memory reference, byte immediate, conditional jump, shift, register change, control, and input/output. Fixed-point binary multiply and divide are implemented by hardware. Software subroutines perform floating-point arithmetic.

Addressing Facilities. Memory reference instructions include three control bits for specifying the address mode: self-relative or base-relative; relative to page '0' (scratchpad) or to the base address held in an index register (indexed); and direct or indirect. Up to eight combinations of addressing modes can be specified.

Interrupt Control. A 5-level interrupt system is associated with the I/O system.

Main Memory

The 5051 processor has a 1.6-microsecond MOS/LSI main memory with 16-bit-wide access. Minimum size is 8,192 words. It can be expanded in 8K-word increments up to a current maximum of 32,768 words. The Computer Automation Alpha/LSI can expand memory to 256K words, but Datasaab is not yet using the expansion facilities beyond 32K words.

Input/Output Control

Two I/O channels are connected to the Maxi-Bus: a programmed I/O channel and a direct memory access (DMA) channel.

Programmed I/O Channel. The programmed I/O channel is used for multiplexing single-byte transfers under CPU control. Each data byte is preceded by an address byte, and it is sent directly to or from a CPU register. Two I/O controllers are connected to the programmed channel.

- 5123 LCC (local communications controller) for transfers to or from each of the up to 16 workstations. It bit-serializes output bytes and byte frames input bytes that are exchanged bit-serially with the workstations via a 2-wire connection.
- 5132 Synchronous Modem Controller for data communications transfers to or from remote 6501 systems or EDP mainframes.

The 5132 Synchronous Modem Controller can store a concurrent instruction and thus transfer a block of bytes without interrupting the main CPU program.

DMA. The DMA channel transfers blocks of data word-serially directly into the main memory via the Maxi-Bus, bypassing CPU registers entirely. It is used by the 5129 Disc Controller and can also be used by the magnetic tape controller. Peak DMA transfer rate is 625,000 words per second.

Consoles

The front panel of the rack box containing the 5051 processor is equipped with switches and indicator lights for starting and stopping the system, loading the operating system at the beginning of a session, and diagnosing faults. Apart from system startup time, it is normally used only by maintenance engineers.

Once the system is running and the operating system has been loaded, applications programs can be loaded from disc by the operator of any workstation. Each type of keyboard-printer workstation is equipped with a 4628 Key Unit, which has a key slot for unlocking the workstation; it can only send data to and receive data from the central processor when the key has been inserted by an authorized operator. The key unit also incorporates a 6-position selector switch, used for applications program selection in conjunction with a keyboard.

Any keyboard-printer workstation can be equipped with an optional 4403 indicator panel, which has 18 binary indicator light fields for showing system status, indicating system errors, and directing the work of the operator.

PERIPHERALS

Datasaab 6501 offers a general range of high-speed disc and magnetic tape backing stores. Slow input/output peripherals, on the other hand, are currently restricted to paper tape readers and punches, magnetic tape cassette drives, keyboards, and serial printers. Neither line printers nor 80-column card readers and punches are available.

A design peculiarity of the 6501 is that all slow-speed peripheral devices — batch paper tape and magnetic tape cassette, as well as keyboards and serial printers — connect to individual workstations rather than to the central control groups. Some centrally located workstations can, however, print output generated by data entered on the keyboards of other workstations.

High-Speed Backing Stores

Discs. At least one 4801 disc memory drive is standard on all 6501 systems. Three additional drives are optional. Table 2 lists the disc characteristics.

Magnetic Tape. One or more 4220 magnetic tape drives can be directly connected to the central control group. Each drive can read or write 7-inch reels of 0.5-inch, 9-track, 800 bit-per-inch tape at 10,000 bytes per second.

Model 4203 cassette tape drives are also available. These read and write 0.15-inch, single-track, 800 bit-per-inch cassette tape at 375 or 750 bytes per second. They do not connect to the central control group but are optional peripherals on individual workstations.

Workstations

Up to 16 workstations connect to the 5123 LCC on the 6501 mainframe, by individual 2-wire cables up to 2,000

Table 2. Datasaab 6501: Disc Specifications

Characteristic	6501
4801 Drives per 5129 Controller	1-4
Disc Packs per 4801 Drive	1 exchangeable + 1 fixed opt
Cylinders per Disc Pack	203
Tracks per Cylinder	2
Addressable Sectors per Track	24
8-bit Bytes per Sector	256
per Cylinder	12,288
per Disc Pack	2,494,464
per 4801 Drive	2,494,464 or 4,988,928
per 5129 Controller	2,494,464 (min); 19,955,712 (max)
Avg Head Movement Time to Different Cylinder (msec)	35
Avg Latency (msec)	12.5
Transfer Rate (bps)	195,000

metres long. Table 3 lists the workstation peripherals that are available.

DATA COMMUNICATIONS

Datasaab 6501 systems can communicate on-line with up to 16 workstations located up to 2,000 metres away and with satellite 6501 systems or general-purpose computer systems located at any distance.

Controllers

The 5123 Local Communications Controller (LCC) can control up to 16 workstations on-line. Each workstation can be located as far as 2,000 metres away and is connected via a bit-serial 2-wire cable.

The 5123 Synchronous Modem Controller interfaces with any synchronous voicegrade line modem that operates at transfer rates up to 4,800 bits per second. The modem can terminate a leased or switched voicegrade line leading to a satellite or host 6501 system, an IBM System/360 or 370, or other general-purpose EDP system. Satellite 6501 systems are required to control any workstations located more than 2,000 metres cable length from the main 6501 control group.

Terminals

The up to 16 workstations of a Datasaab 6501 system function as local interactive and/or remote batch terminals. Satellite 6501 systems can be used as intelligent terminals and be linked over any distance by data communications lines.

A Datasaab 6501 system can function as an intelligent remote batch terminal to an IBM System/360 or 370 or other general-purpose computer system of similar size. A terminal control program emulating the line disciplines of the IBM 2780 Data Transmission Terminal is available. Another emulator for the ICL 7020 Communications Terminal is being developed.

SOFTWARE

Datasaab 6501 software includes a virtual memory operating system, high level language translator and interpreter, text editor, and program testing utilities. Datasaab also undertakes turnkey programming on behalf of most users. The company is developing standardized applications packages. Figure 2 illustrates software organization.

Operating System

The operating system performs all I/O transfers to/from disc memory, supervises the use of space on discs, and distributes CPU time among the active workstations on a round-robin, time slicing basis. Each workstation is allowed to execute up to five high-level instructions consecutively before the operating system passes control to the next waiting workstation.

Every active workstation is allocated a program buffer area in main memory. The workstation operator can select any application program with the key unit selector switch, and that program's master segment will then be loaded into the workstation's program buffer area. All applications programs are segmented and can have any number of segments. Individual segments are loaded into the workstation's main memory buffer area as they are

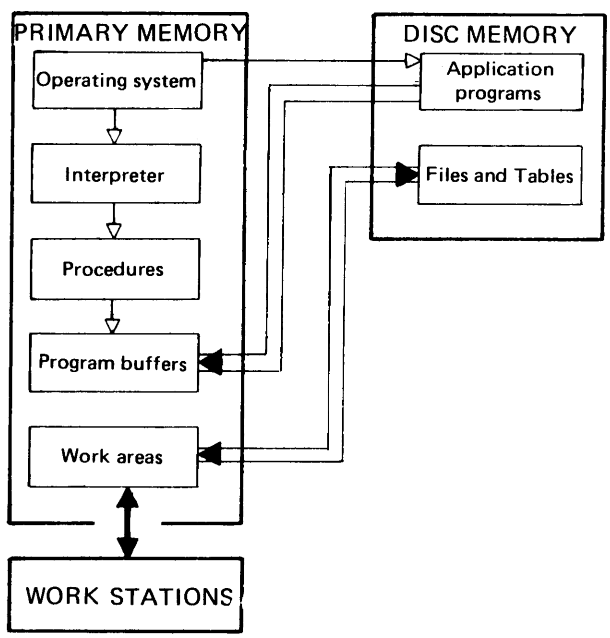

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Figure 2. Datasaab 6501: Software Organization

Table 3. Datasaab 6501: Workstation Peripherals

MODEL NO.	PERFORMANCE CHARACTERISTICS				USED WITH WORKSTATION TYPE 1	2	3	4A	4B
KEYBOARDS	No. of Keys/Field A/N	Numeric Pad	Arith Op	Control					
3851 Typewriter	50	–	–	–	–	Std	–	–	–
4626 Numeric	–	10	7	16	X	Std	–	Std	Std
4627 Alphanumeric	50	Opt(1)	–	8	Std	–	Std(1)	Std	–
PRINTERS	Char Set	Char/Line	No. of Copies	Speed (cps)					
3851 Typewriter	88	132-156	1 + 4	12	–	Std	–	–	–
4552 Strip	64	Unlimited	1	15	Std	Std	–	X	Std
4553 Serial Page	64	72	1	15	–	–	–	Std	–
4561 High-Speed Serial	64-96	132	1 + 4	165; 330; 660	Std	–	–	X	–
DISPLAYS	Char Set	Pos/Line	No. of Lines	Total Pos on Screen					
4403 Indicator Panel	1*	18(2)	1	18(2)	X	X	–	X	X
4404 Numeric Indicator	11	16 + sign	1	16 + sign	X	X	–	X	X
4406 CRT	64	64	16	1,024	–	–	Std	–	–
OTHER		Speed (cps)							
4001 Paper Tape Reader		1,000			X	(3)	–	(3)	X
4020 Paper Tape Reader		300			X	(3)	–	(3)	X
4070 Paper Tape Punch		70			X	X	–	X	X
4203 Magnetic Tape Cassette Unit (1-track)		375; 750			X	X(4)	–	X(4)	X

Notes:
Std = Standard workstation component.
X = Optional workstation component, subject to an overall maximum of 2 input devices and 4 output devices, including the standard components.
*Binary lights.
(1)When part of workstation Type 3, the 4627 can have an optional keypunch layout in which the 10 numeric keys are grouped for convenient single-handed operation.
(2)18 binary light fields.
(3)Can be plugged into this workstation temporarily, after standard 4626 numeric keyboard has been unplugged.
(4)The 4203 Magnetic Tape Cassette unit can be plugged in temporarily as an input device only when the standard 4626 numeric keyboard has been unplugged. It can also occupy a permanent output interface position.

addressed by the program, and they are subsequently displaced to make room for other program segments. The loading and unloading of individual program segments is performed entirely automatically by the operating system.

Language

All Datasaab 6501 application programs are written in LOGIC-3, a proprietary Cobol dialect. It has 52 high level commands, including powerful string handling commands for data stored in main memory and on disc backing store. Source programs are entered on a workstation keyboard and are immediately translated into a binary pseudo-code of macro commands. These are stored on disc and executed interpretively at run time.

The LOGIC-3 interpreter is reentrant, and it is held permanently in main memory to be used by all workstation programs. Individual workstation applications programs consist entirely of LOGIC-3 binary macro commands, which require comparatively little storage space. String and data area parameters for each program can be entered at run time from the keyboard.

Among the 52 LOGIC-3 commands are powerful instructions that operate on entire records or entire files. A record accessed by a workstation can be protected from being simultaneously updated by another workstation. A Sort-File command allows an entire file to be sorted in ascending or descending order per argument, and up to eight sorting arguments can be used per file without regard to the record structure.

Utilities

Utilities include a text editor for LOGIC-3 source programs, a LOGIC-3 translator for turning source code into interpretive binary code, and a test operating system.

HEADQUARTERS

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OVERVIEW

DEC Datasystem (DDS) 340 Series of computers are small business computers aimed at the "highly self-sufficient" end user capable of doing the applications software in-house. DEC supplies the systems software: easy-to-use high-level languages and commercial operating system. The Commercial Operating System (COS) 300 includes a DIBOL (Digital Business Oriented Language) compiler as well as system monitor, device handlers, system generation, maintenance programs, and a data entry package. It is designed for small business accounting operations, plus related applications such as inventory control, monitoring of sales and salesmen's activities, and management reports.

The DDS 340 Series is based on the 12-bit word PDP-8/E minicomputer. DEC introduced the PDP-8 computer line in 1965, a time when the prevalent trend was toward big, complex, expensive computers. The PDP-8 family went counter to this trend with a short 12-bit word, modular small memory of 4K to 32K words, simple instruction set, flexible I/O structure, and an $18,000 price tag. The system lent itself to many scientific and control applications that did not need a powerful computer, so the PDP-8 sold briskly. Its acceptance proved that a large market exists for minicomputers; over 20,000 PDP-8 computers have been installed.

Despite the proliferation of different minicomputers on the market, the PDP-8 family remains a significant system in the entire minicomputer field. It is a dynamic system. DEC keeps it competitive by introducing new PDP-8 models that reflect current technology; DEC continues to add extensive system and applications software, and DEC interfaces almost all of its broad range of peripheral devices to it. The PDP-8 also remains popular because of the amount of software users have developed for the system.

Competitive Position

The DDS 300 Series and the DDS 500 Series, announced at the same time as the 300, are the first systems DEC has marketed specifically to the commercially oriented end user. DEC has usually marketed its small computers as general-purpose systems for real-time, scientific, or time-sharing applications. Commercial processing has generally been done to use processor time left over from the primary application. Most commercial software was developed by users although DIBOL has been available for the PDP-8 for several years.

The DIBOL offered for the DDS-300, however, is a vast improvement over the older DIBOL. DEC also offers Fortran IV, Focal, and Basic for the PDP-8/E. In addition to its own software support groups, DEC supports DECUS (Digital Equipment Users Society), which maintains a library of programs contributed by users and available to all members. A special interest group has been formed for business users.

DEC was a pioneer in the small computer business and became a major computer manufacturer by catering to small computer users. DEC early recognized the need for mass storage devices, high-level languages, and operating systems for small computer systems. DECtape allowed small systems to be automatic long before discs were inexpensive enough to be used as mass storage devices for them. Focal gave users of small systems with 4K words of memory a high-level language that was easy to use. The OS-8 operating system provides features that make the PDP-8 a more versatile system than many much larger systems.

All these things have little bearing on the DDS 340 as a commercial processing system except to point out that DEC has been a real leader in developing small computer systems.

DEC recognizes that marketing small business systems is quite different from marketing general-purpose minicomputers. For one thing, small commercial users expect more help in getting their systems installed and running. DEC has set up a new commercial marketing group to handle only the DDS 340 and 500 systems. Secondly, small commercial users want to lease their equipment rather than buy it outright, and DEC offers 3- and 5-year leasing arrangements for its DDS systems.

One user of the DDS 340 is a Chicago realty company that operates 4,000 apartment buildings. It has been building its system since February 1970, two years before DEC announced the DDS 300 in December 1972. The realty company purchased a PDP-8/I with 8K words of memory, 4 tape units, a 100 line-per-minute printer, and a DECwriter terminal, and began using it with a preliminary version of DIBOL. The user replaced the system software with COS 300 as soon as it was available; the conversion took about 2 weeks. The company uses the system to do its own payroll and billing, and in addition, the bookkeeping for a small investment company and two insurance businesses. The DEC system was chosen in 1969 after evaluating many other small computer manufacturers, partly because the realty company felt it could rely on DEC for hardware maintenance and for support as it developed its software. The company now has about 200 programs and is extremely enthusiastic about the installation; it has been particularly pleased with the maintenance DEC has provided.

CONFIGURATION

The DDS 340 Series consists of four models that are based on the PDP-8/E minicomputer with 16K words of memory. The PDP-8/E CPU includes a chassis, power supply, Omnibus® with 20 slots, an asynchronous line unit for the console, and a hardware bootstrap loader. The optional Omnibus expander provides 20 more slots for connecting additional memory and peripherals to a system. Memory can be expanded to 32K words in modules of 4K words. Peripherals, such as a card reader, high-speed printer, paper tape reader/punch, magnetic

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tape drives, and an additional terminal can be added to a system.

Model 340-A includes two disc drives, totaling 6.4M bytes, a CRT system console, a 60 line-per-minute printer, and the COS-300 operating system with the DIBOL compiler.

The 340-B system uses the same configuration as the 340-A except that the DECwriter system console replaces the CRT system.

The 340-C model duplicates the 340-A system, including the CRT system console, but employs a faster line printer—245 to 1,100 lines per minute.

Finally, the 340-D system uses the 340-B configuration (the DECwriter included) with the faster 245 to 1,100 line-per-minute line printer.

The Omnibus, a back-plane, etched circuit board, is an internal bus that provides 20 quad slots to connect all circuit modules to the PDP-8/E. A 4K-word memory module requires three slots; peripheral device controllers require one or more slots depending on the peripheral. The Omnibus can be extended by a KA8-E external interface for positive I/O devices. A DW08A bus converter is required to interface older PDP-8 family (PDP-8/I, L, and S) peripherals to the PDP-8/E. Older PDP-8 peripherals require a negative bus and the Omnibus is positive. High-speed peripheral devices such as discs require the KD8-E data break interface to control the transfer of data directly between the devices and PDP-8/E memory.

The Omnibus can be expanded to 76 quad slots through the addition of BA8-AA and BA8-BA system expander boxes.

MAINFRAME

The COS 300 Operating System has a foreground/background multiprogramming capability for the 340 Series. It can process three data entry jobs in the foreground concurrently with one background job.

No multiprocessing software is available for any of the DDS 340 systems.

Central Processor

The PDP-8/E computer is a single-address, parallel binary processor that uses a 12-bit word. Two general-purpose registers are provided: an accumulator and an MQ register. All arithmetic operations are performed in two's complement form. Of the arithmetic operations, only singleword, fixed-point add is hardware implemented in the basic system. Hardware multiply and divide and a floating-point processor are available as options to the Basic, Focal, and Fortran IV systems. DIBOL achieves 15-place accuracy without any hardware arithmetic options. All other arithmetic operations can be performed through DEC-supplied subroutines.

The FPP-12P Floating-Point Processor operates as an I/O device asynchronously with and parallel to the central processor. It requires the KA8-E external interface for positive I/O devices.

The KM8-E Memory Expansion and Timeshare option establishes two processor modes, user and executive. Executive mode programs can execute any instruction. User mode programs cannot execute halt, I/O, or load console switch instructions. Central processor characteristics are listed in Table 1.

Data Structure. The basic unit of data is the 12-bit word, which can hold two 6-bit characters. Table 2 lists the data formats used.

Instruction Set. The instruction repertoire is divided into 3 basic categories: memory reference instructions, 3 groups of operate instructions, and separate

Table 1. DEC Datasystem 340: Processor Characteristics

Characteristic	DDS 340
Processor	PDP-8/E
No. of Internal Registers	2 (ACC & MQ)
Addressing	
Direct (no. of words)	256
Indirect	4,096[1]
Indexed	NA
Instruction Set	
Number (std, opt)	56, 16
Dec Arithmetic	Subroutine
Floating-Point Arithmetic	Opt
Priority Interrupt	
Line	1
Levels	Software
Main Storage	
Type	Core
Basic Addressable Unit	Word
Cycle Time (μ sec)	1.2
Min Capacity (words)	8,192
Max Capacity (words)	32,768
Increment Size (words)	4,096
Memory Parity	Opt
Memory Protect	Yes[2]
ROM	Opt
Use	Programs and constants
I/O Channels	
Programmed I/O	Std
DMA	1- and 3-cycle data break

Notes:

(1) Per user program.
(2) Ech program confined to 4K-word field; memory extension option establishes user and executive modes.

Table 2. DEC Datasystems 340: *Data Structures

Data Name	Representation
Word	12 bits
Character	6 bits of 2/word
Decimal Operand	No
Binary Operand	
Single Precision	12 bits
Double Precision	24 bits
Floating-Point	
Operand	3 words (exponent)
	11 bits + sign; fraction
	23 bits + sign

* DIBOL provides 15-place accuracy, a function of the COS 300 operating system.

instruction sets for each option and I/O device. There are no direct compare instructions, but comparisons can be performed through a combination of logical operations and skip-on-condition instructions. There are six memory reference instructions, and these constitute the main power of the instruction repertoire. The three groups of operate instructions perform shift, clear, rotate, skip, and interregister operations.

The only arithmetic instructions in the basic set are add, complement, and increment. The extended arithmetic element (EAE) option provides multiply, divide, and double precision add, complement, and increment. The floating-point processor provides 34 instructions for floating-point add, subtract, multiply, and divide. Table 3 gives typical instruction execution times.

Addressing. For addressing purposes, memory is divided into 4,096-word fields and each field is subdivided into 128-word pages. The format for memory referencing instructions includes a 3-bit operation code, an indirect addressing bit, a page selector bit and an 8-bit address. The page selector bit selects either the current page (the one containing the instruction) or the zero page (the first page in the field containing the instruction). The address selects the core location within the selected page.

PDP-8 has no index registers but does have a specialized form of indirect addressing called auto-indexing for which eight memory locations in each field are reserved. When any of these locations is directly addressed, it is treated as a normal access; when addressed indirectly, the contents of the location are incremented by one and the resulting quantity is used for the effective operand address. This auto-indexing technique satisfies the major indexing chore of loop control.

To address memory beyond 4,096 words, the PDP-8/E requires the KM8-E Memory Expansion option. KM8-E provides a 3-bit data field (DF) register, a 3-bit instruction field (IF) register, and instructions to control and use the registers. The contents of DF select the memory field when an indirect address is specified. The contents of IF select the field when an instruction is fetched or when a direct memory address is specified.

Interrupt Control. There is one common interrupt line and only one interrupt level for all interrupts, regardless of their origins. Each interrupt must be identified by subroutine. The interrupt facility provides for storing current processor status and transfers control to an interrupt servicing routine. The number of interrupting sources that can connect to the interrupt line is limited only by the ability of the program to handle them. An interrupt servicing subroutine can be interrupted if the interrupt inhibit is turned off by instruction. This feature permits the programming of a software priority interrupt system.

Table 3. DEC Datasystem 340: Typical Instruction Execution Times

Instruction Type	Number of Instructions	Execution Time (μ sec)
Memory Reference	5	2.6
Unconditional Jump	1	1.2
Literal Loads	16	1.2
Register Operate (complement, shift rotate, increment)	11	1.2
Skip, Halt, OR, or load A with switch register, clear A	21	1.2
Register to Register (MQ and A)	8	1.2
Control (interrupt on/off, test interrupt on/off, get/restore flags, etc.)	8	1.2
Extended Arithmetic Option*	16	—
Multiply	1	7.4
Divide	1	7.7
Normalize	1	1.2 + 0.3N
Shift	3	2.6 + 0.3N
Double Precision	5	1.8 to 5.2
Memory Extension Option	10	1.2
Floating Point	18	—
Add	—	—
Subtract	—	—
Multiply	—	—
Divide	—	—

* These hardware options are not used by COS 300 software. DIBOL statements perform addition, subtraction, multiplication, and division with 15-place precision.

Main Memory

Main memory consists of core modules available in 8K-word increments. Each word is 12 bits long. A memory parity bit is optional. Modules can be added for a maximum memory of 32,768 words. Cycle time is 1.2 microseconds per word.

Read/write core memory with a write protect feature is available in a 256-word increment. It requires 2 Omnibus quad slots; it can be used to protect the monitor, to store frequently used monitors, or to test out programs before they are committed to read-only memory.

Read-only memory (ROM) modules are available in 256-word and 1K-word increments. Any number of ROM modules can be incorporated in a system limited only by the addressing capability of the processor and the amount of read-write core memory. ROM is used to store constants or to protect a user monitor program in a time-sharing environment.

Transfer rate in core memory is 156,250 words per second within a page and 113,636 within a field.

Input/Output Control

Devices connected directly to the Omnibus transfer data one word at a time under program control between the accumulator and the peripheral device. Devices connected to the KA8-E external interface can transfer data one word at a time under program control or can transfer blocks of data directly to or from core memory under control of the KD8-E data break interface. Only one device can connect to a KD8-E unit, but up to 12 KD8-E units can connect to a PDP-8/E system.

A KD8-E unit operates as a 1-cycle transfer control register or a 3-cycle data break facility, depending on whether the interfaced peripheral device has word count and current address registers. If the device controller has transfer control registers, the device uses one memory cycle for each word transferred. If the device controller does not have control registers, core locations are used to store the word count and current address, and two memory cycles are used to access them before the data word is transferred. Thus, these devices use the 3-cycle data break facility and require three memory cycles for each word transferred.

Maximum I/O transfer rate is 833,333 words per second using the single cycle data break facility and 277,778 words per second using the 3-cycle data break facility. Maximum transfer rate, using programmed I/O transfers, is a function of the number of devices connected to the interrupt line and the length of the servicing routines.

Console

The operator's console is a VT05 alphanumeric keyboard display terminal that includes the keyboard, cathode ray tube (CRT), refresh memory, multiterminal software, and interface. It is portable and weighs 55 pounds. The CRT screen displays a total of 1,440 characters in 20 lines of 72 characters per line. A keyboard controller cursor is operated under program control to allow interactive data entry.

The characters on the CRT screen are refreshed 50 or 60 times per second, synchronized to the power line frequency. Characters are generated using a 5 x 7 dot matrix. The keyboard is the familiar typewriter keyboard. A 10-key numeric pad insert is added for entering all numeric fields. The keyboard has the following control keys and switches:

- Power on/off switch.
- Remote/local switch—in local mode data can be typed without entering it into the computer.
- Contrast and brightness controls—used to adjust display clarity and brightness.
- Vertical and horizontal sync controls—used to adjust picture on the CRT.
- CR key returns cursor to the left margin of screen.
- LF key moves cursor down one line in the same position in line.
- Rubout key works in remote mode in conjunction with monitor/editor to erase characters.
- Tab key moves cursor to the right to the next tab stop.
- Alt key has no effect on display but provides an alternate escape character for use in a user program—replaces carriage return or line feed.
- Ctrl key used in conjunction with character keys to perform special control functions.
- Shift lock enables shift function when in the down position.
- Space produces a blank and moves cursor one position to the right.

PERIPHERALS

Peripherals offered for the Datasystem 340 Series include discs, block-addressable DECtape, a serial printer, a card reader, a paper tape reader/punch, a CRT terminal, a high-speed line printer, magnetic tape drives, and a hardcopy terminal. Table 4 lists the specifications for these devices.

There are a large number of PDP-8/E peripherals not designated as peripherals for the Datasystem. If a user wants to convert his purchased PDP-8/E to a Datasystem or has special requirements for his application, DEC will try to accommodate him.

DATA COMMUNICATIONS

DEC provides optional asynchronous communication at up to 9,600 baud on all 340 Series processors. This option enables the Datasystem to communicate with another Datasystem or with an IBM System/360 or 370. The 340 Series does not have the extensive communication software required to use it as a communication processor or "front end."

Table 4. DEC Datasystem 340: Peripherals

Peripheral Device	Performance Characteristics	Comments
MASS STORAGE		
RK05-AA Removable Cartridge Drive	Capacity 1.6M words; positioning time 12 to 85 msec; avg latency 20 msec; transfer rate 250K words/sec; 2 surfaces; 200 tracks/surface; 16 sectors/track; 256 words/sector	Uses cartridge similar to IBM 2315; requires RK8-E controller for up to 4 drives for over 13M bytes of on-line storage
TD8-EM Dual DECtape Drive	Two drives; capacity 188,672 words; transfer rate 8,325 words/sec; block size 128 words	10-track tape; controller for up to 4 drives; control connects to Omnibus
CONVENTIONAL I/O		
CRF-8 Card Reader	Reads 300 cpm; input and output hoppers hold 550 cards	80-col cards; tabletop unit
PC8-E Paper Tape Reader/Punch	Reading speed 300 char/sec; punching rate 50 char/sec	Separate interrupt for reader and punch
LS8-EA Serial Printer	Prints 165 char/sec; 132 cols/line; 64-char set	Slew speed 4 in./sec; line advance time 45 msec; carriage return time 200 msec
LE8-JA Line Printer	Prints 356 lpm for 80-col lines and 245 lpm for 132-col lines; 64-char set	Prints on multiple forms of up to 6 parts; slew speed 13 in./sec; line advance time 20 msec
DS3TM-E Magnetic Tape Drive	800-bpi density; 9 tracks	Control and software utility included
TERMINAL		
VT05 Alphanumeric Keyboard Display	Display of 20 lines, 72 char/line; keyboard conventional typewriter plus control keys; normal transmission speed 240 char/sec; multiterminal software and interface	Optional switch selectable of 10, 15, 30, 60, and 120 char/sec; numeric key pad
LA30 DECwriter	Speed 30 char/sec; 250 msec for carriage return; 64-char print set; 97- or 128-char keyboard; 80 char/line	Prints 1 original and 1 copy; uses 5 x 7 dot matrix
Additional Terminals Available		

SOFTWARE

COS 300 includes the following programs:

- SYSGEN—configures system I/O handlers, assigns logical devices to physical I/O units, and prints table of device assignments.
- Editor—consists of a basic source language editor for input from source console keyboard, cards, or paper tape; and outputs file to line printer, paper tape, or console display.
- COMPiler—compiles source programs written in DIBOL.
- PIP (Peripheral File Interchange Program)—transfers files from one peripheral device to another and provides system file maintenance.
- BUILD (a key-word data entry package)—consists of a program to create data files.
- SORT/Merge—sorts data files in ascending or descending order; can also merge files.
- UPDATE—provides facilities to maintain a master file, change, delete, or insert records, and print all changes.
- Conversion program—converts PDP-8/E data files that run under OS-8 to the COS 300 environment.
- Monitor—provides master control via two segments: one core resident and the other system device resident through a monitor command language; contains I/O handlers, program loaders, editors, file directories, and operation message.

The Foreground Data Entry Option is an extension of COS 300 for the DDS 340. It allows an operated/initiated data entry or data inquiry program to operate concurrently with a background job stream. The background or system console can execute any system utility or application program. Up to six data entry terminals can operate concurrently in the foreground, with a seventh terminal handling data in the background. The terminals can be transcribing source data and creating a disc transaction file while interrogating and editing existing files. They may be sharing the line printer at the same time. Fifteen files may be open at a time.

The foreground entry package includes a format description program that allows the user to define data entry formats using a format descriptor language for display on the CRT. It permits interactive data validation; errors cause an audio signal and an error message to be displayed on the bottom two lines of the CRT screen. It provides cumulative hash totals for up to 10 fields, automatic duplication of identical information, initial value definition, and free-form data entry with automatic right justification of numeric fields. The operator can use either the keyboard or the numeric keypad for numeric fields.

The format descriptor language provides facilities to define the fields displayed on the screen, display coordinates, editing checks to be performed on the input fields, and field descriptions to be displayed.

The data entry option requires 4K words of memory in addition to the COS 300 minimum configuration for one terminal and 8K words for 2 or 3 terminals.

Assemblers and Compilers

The standard language compiler for COS 300 is the integral DIBOL compiler. DIBOL is a high-level language much like Cobol, Level 1. DIBOL offers 15-place accuracy, device independent data files, multivolume data files, interactive program debugging, program chaining or overlaying, line printer overlap, and internal subroutines. Typical compilation time is under 10 seconds. DIBOL uses simple English-like statements for the following categories:

- Compiler—tells the compiler the kind of statements to follow.
- Data Specification—describes type, size, and location of data elements.
- Device Control—opens and closes data files used by the application program.
- Data Manipulation—controls calculations and movement of data within memory.
- Control—sequences the execution of statements with a program.
- Input/Output—moves data within memory and between memory and peripheral devices.
- Debug—traces program execution.

Fortran IV, frequently used for scientific and mathematical applications, and Basic-Plus, an expansion of the Dartmouth time-sharing Basic language, are also optionally available on the 300.

Utilities

The SORT/Merge routine in COS 300 is a particularly powerful part of the software. The user can specify up to 8 subfields in the sort key, and unlike many other sorting routines, the size of the key does not affect sort timing. An 80-column card sort on 20,000-card image records takes 23 minutes on a DDS 340. SORT also has a merge file capability.

The system's editor is interactive, allowing a number of types of input. The SYSGEN routine allows the user to reconfigure or modify the current system using simple English-like statements. COS 300 also has a Peripheral Interchange Program (PIP) to transfer files from one device to another. The BUILD routine allows the user to create data files from a data entry terminal. An UPDATE routine provides facilities to maintain master files. Conversion programs allow the use of PDP-8/E OS-8 data files in the COS 300 environments. A Monitor controls all program operations.

Service is provided by DEC through its network of sales and service offices in more than 48 cities in the United States and 50 cities in Europe, Canada, Central and South America, Australia, India, and Japan. Maintenance is included in the lease; it can be obtained for purchased systems on a per-call basis or through a variety of service contracts. Field offices also have software specialists to provide users with a fast response to software problems.

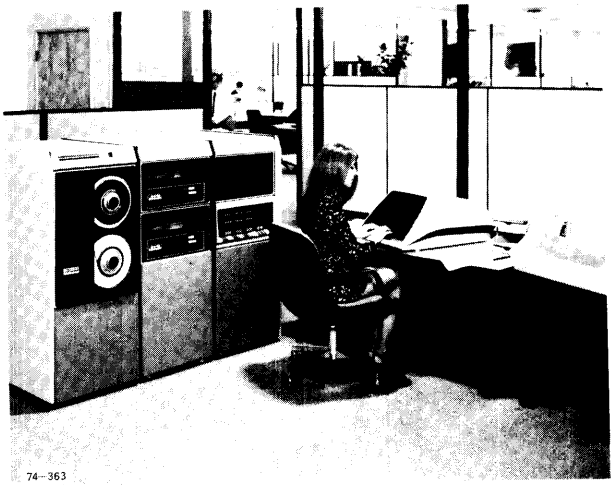
Training in 300 system software is provided by DEC usually in either Maynard, Massachusetts, or Sunnyvale, California. The training courses, which last from two to three weeks, are free of charge to users of purchased systems.

HEADQUARTERS

Digital Equipment Corporation
DEC Datasystem 300
146 Main Street, Building PK3-1
Maynard MA 01754

PRICE DATA

Model Number	Description	Monthly Rental: 3-Year Lease ($)	Monthly Rental: 5-Year Lease ($)	Purchase ($)	Monthly Maint. ($)
	DEC DATASYSTEM 340 SERIES				
	Central Processor and Working Storage				
DS-340-A	PDP-8/E 16K-byte Processor 2-RK05 Disc Drives (6.4M bytes total) 1-VT05 CRT System Console 1-LS8E Line Printer (60 lpm) COS-300 Commercial Operating System with DIBOL Compiler	1,216	818	37,180	288
DS-340-B	PDP-8/E 16K-byte Processor 2-RK05 Disc Drives (6.4M bytes total) 1-LA30 DECwriter System Console 1-LS8E Line Printer (60 lpm) COS-300 Commercial Operating System with DIBOL Compiler	1,211	815	37,030	294
DS-340-C	PDP-8/E 16K-byte Processor 2-RK05 Disc Drives (6.4M bytes total) 1-VT05 CRT System Console 1-LE8-JA Line Printer (245 to 1,100 lpm) COS-300 Commercial Operating System with DIBOL Compiler	1,633	1,098	49,925	315
DS-340-D	PDP-8/E 16K-byte Processor 2-RK05 Disc Drives (6.4M bytes total) 1-LA30 DECwriter System Console 1-LE8-JA Line Printer (245 to 1,100 lpm) COS-300 Commercial Operating System with DIBOL Compiler	1,628	1,095	49,775	324
MM8-E	8K-12-bit Words of Core Memory	82	55	2,500	20
MM8-EJ	16K Bytes Core Memory	128	86	3,900	40
	MASS STORAGE				
RK05-AA	DEC pack Disc Drive (3.2M bytes)	167	112	5,100	60
TD8-EM	Dual DECtape Drive and Control	164	110	5,000	40
	INPUT/OUTPUT				
	Punched Card				
CR8-F	Punched Card Reader (300 cpm)	159	107	4,860	50
CM8-F	Mark Sense Card Reader	159	107	4,860	50
	Paper Tape				
PC8-E	Paper Tape Reader/Punch	128	86	3,900	30
	Printer				
LS8-E	Line Printer and Control (60 lpm)	193	130	5,915	48
LE8-JA	Line Printer and Control (245-1,100 lpm)	572	385	17,500	75
	MAG TAPE				
DS3TM-E	9-Track, 800-bpi Tape Drive Control and Software Utility	441	297	13,500	95
	Terminals				
DS3D1-AA	First VT05 CRT Terminal, Multiterminal Software, and Interface	153	103	4,675	32
DS3D2-AA	Additional VT05-CRT Terminal and Interface	117	79	3,575	32
DS3D3-AA	First LA30 DECwriter Terminal, Multiterminal Software, and Interface	166	112	5,075	40
DS3D4-AA	Additional LA30 DECwriter Terminal and Interface	130	87	3,975	40



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OVERVIEW

DEC's 500 Series DATASYSTEMS are small business computers aimed at the "highly self-sufficient" end user capable of doing the applications software in-house. In contrast to offering a turnkey system with completely customized applications software, Digital supplies the systems software for the series and offers easy-to-use high-level languages, assistance in software design, and a lower price.

There are three choices of operating systems, the time-sharing CTS 500 (a general-purpose, interactive multiuse time-sharing system that supports up to 16 users), the time-sharing and data base management CTS 500/E (an extended version of CTS 500 for up to 32 users, optionally), and the management-oriented CDMS (a multiterminal data base management system that provides a hierarchical structure of the data base).

All models of the series use the PDP-11/40,45, and 50 processors, Digital's most technically advanced members of the 16-bit PDP-11 line. In fact, the DATASYSTEMS are functionally identical to certain configurations of the PDP-11 that have already been supplied to minicomputer users in the past. What has been added is business-type packaging, leasing arrangements, commercially oriented operating systems, and the kind of service and support needed for end users with business applications.

DATASYSTEMS/PDP-11s have an average main memory cycle time of 900 nanoseconds and range in memory size from 32K to 248K bytes. Available options include ROM and semiconductor read/write memories; hardware multiply/divide and a floating-point processor; memory management options that permit virtual addressing; discs, tapes, printers, card and paper tape equipment; and terminals of several kinds. Digital does not have a magnetic stripe ledger card reader or a printing terminal with the double platen found on some small business computers that are more like programmable accounting machines.

This report is confined to details of Digital's commercial marketing of the PDP-11 minicomputer as the Datasystem 500 and presents only a broad outline of the system's architecture. Tables 1, 2, and 3 summarize specifications for the PDP-11 processor, main storage, and data structure.

Table 1. DEC DDS 500 Series: PDP-11 Central Processor Characteristics

Model	No. of Registers	Addressing: Direct	Addressing: Indirect	Addressing: Indexed	No. of Instructions (Std; Opt)	Arithmetic: Decimal	Arithmetic: Floating Point	Interrupts: Lines	Interrupts: Levels
11/40	9	No	1 level	Yes	70; 10	No	Hardware option	4	Multilevel
11/45	16	No	1 level	Yes	83; 50	No	Hardware option	8	20 (7 software levels)
11/50	16	No	1 level	Yes	83; 50	No	Hardware option	8	20 (7 software levels)

Table 2. DEC DDS 500 Series: PDP-11 Main Storage Characteristics

Model	Cycle Time (msec)	Parity	Addressable Units	Bytes per Access	Capacity (bytes): Min	Capacity (bytes): Max	Capacity (bytes): Increments	Memory Protection
11/40	0.90	No	Byte, word	1 or 2	8K	248K	16K, 32K	Option
11/45	0.90 (1)	Opt on MOS only	Byte, word	1 or 2	32K	496K	4K, 8K, 16K, 32K	Option
11/45	0.45 (2)	Opt	Byte, word	1 or 2	8K	64K	8K	Option

Notes:
(1) Time listed is for core. MOS (0.45 msec) and bipolar (0.30 msec) memory also available.
(2) MOS memory only on the 11/50.

Table 3. DEC DDS 500 Series: PDP-11 Data Structures

Characteristic	500 Series
DATA FORMAT	
Bits per Word	16
Bits per Byte	8
Operand Lengths (bits)	16; 32; 48
ARITHMETIC	
Operands	
Decimal	No
Binary	8, 16 bits
Floating Point	
Exponent (bits)	8
Fraction (bits)	23 or 55 + sign

COMPETITIVE POSITION

Digital introduced its DATASYSTEM 500 Series along with the 300 Series as the company's first products aimed exclusively at the commercial market for small business computers. Both series were for limited application areas based on older systems that had been marketed but without much vigor. Digital's introduction of DIBOL for the PDP-8 took place several years ago; but it had small success, primarily due to the language limitations. Digital cleaned up and improved DIBOL for the DATASYSTEM 300.

The DATASYSTEM 500 Series is based on RSTS-11 (Resources Time Sharing System), which Digital introduced initially for the education time-sharing market. RSTS-11 supports interactive Basic for a number of terminals. DATASYSTEM 500 extends RSTS-11 to support interactive Basic/Plus for up to 32 terminals. The system is primarily marketed for on-line multiterminal applications.

Within the DATASYSTEM 500 Series, Digital initially pushed the DATASYSTEM 520 model, which supports RPG II and batch-oriented applications. Although it is still available, it is no longer actively marketed. Apparently Digital's marketing strategists had second thoughts about competing directly with IBM's System Model 3/10. Digital's RPG II is not completely compatible with IBM's RPG: collating sequences differ and Digital has no equipment comparable to IBM's multifunction card unit. In addition, the initial software had some bugs in it that caused support problems.

While Digital paused to clean up its RPG II software, sales for the other DATASYSTEMS snowballed. These systems are sold in markets that Digital understands very well. Thus, Digital has chosen, probably wisely, to market to its proven strength: on-line multiterminal applications. RPG II (COS 500 software) is now bug free, but it is used primarily as a transition language while users are converting programs to Basic/Plus.

Competitors for the DATASYSTEMS include some of Digital's traditional minicomputer rivals: Hewlett-Packard 3000, Data General Nova/Supernova, and Honeywell System 700. Other competitors include Singer System Ten and IBM System Model 3/15.

Digital has recently expanded the market for the DATASYSTEM 500 with the introduction of a hardware/software package that emulates the IBM 2780 Model 1. This allows communication with other DATASYSTEMS, both 300 and 500, or an IBM System/360 or 370 running HASP, ASP, DOS/POWER, or RJE software plus 270X or 370X hardware. The 2780 communications can operate concurrently with interactive multiterminal processing. Thus, the DATASYSTEM 500 can operate as a stand-alone processing system locally at the same time it operates as part of a distributed processing network.

Digital appears to have clearly defined the market for the DATASYSTEM 500. It is a market Digital knows. Furthermore, the Series 500 is based on one of the most powerful minicomputers available today. This combination should give competitors a system that is hard to beat on the basis of price/performance.

USER INTERVIEWS

The users interviewed were very pleased with the performance of their DATASYSTEMS. All spoke of sound reliability and very good maintenance. All agreed the Basic/Plus language is powerful and effective for on-line terminal use.

A manufacturer of small parts uses the DATASYSTEM for production control, scheduling, engineering bill-of-material control with inventory control and accounting functions. Eventually this user hopes to handle on-line order entry also. He is using the RSTS-11E operating system with Basic/Plus. Although the language is powerful, this user finds the lack of meaningful variable names slightly annoying. The company had startup problems with the 600 line-per-minute printer, but Digital's maintenance has been excellent. For this company, price/performance was the deciding factor in choosing the DATASYSTEM 500. This firm plans to add two terminals and more core memory to the present system. The only time this company experienced problems with its system was when the building was struck by lightning!

A midwestern systems house buys DATASYSTEMS based on the PDP-11/45 (Model 550) on an OEM basis. This company has two main users of the DATASYSTEM: one is developing applications programs for on-line life insurance policy processing, and the second uses the system to control electrical parts distribution. The DATASYSTEM handles on-line order entry, accounts payable and receivable, cash receipts and purchase inventory. It provides verification of purchase orders while checking back orders.

The operating system for the DATASYSTEM is RSTS-11E with Basic/Plus. This user's system provides good response times and it is highly flexible for on-line applications. The LOCKOUT feature is very useful; it prevents access to a record while it is being updated. After the update is completed, the file becomes accessible again. This user bought the DATASYSTEM because of the operating system and Basic/Plus. While this user did experience initial hardware bugs, the system has run for 250 hours with no downtime. When 32 users run on the system, the response time is a bit slow but is never more than 2 seconds.

A northeastern bank uses the DATASYSTEM in a time-sharing mode, with many terminals located throughout the bank. The DATASYSTEM handles bank planning and forecasting, portfolios, pricing, personnel functions, management information systems reports, corporate financial planning, and analytical research. The bank uses RSTS-11E operating system with Basic/Plus. Cost and reliability were the major reasons for purchasing Digital's equipment over its competitors. This user has enjoyed very good maintenance and few problems. The bank has added about $30,000 worth of equipment to the original system and will add more as its needs change.

A midwestern railroad uses extensive configurations of PDP-11/40s, 11/45s, and dual 11/50s. The DATASYSTEMS monitor activity in train terminals where the cars are switched and interconnected, forming new trains. The system keeps a perpetual inventory of the location of railroad cars. The method of accounting for cars had been done manually, using a punched card to represent each car. When the car moved from one track to another, the card was physically removed from one pigeonhole, representing a specific track, to another pigeonhole. A card reader then output a listing of the cars on a track. Sorting to determine status or position of a car or track was often a lengthy procedure.

With the DATASYSTEM, track files are kept to replace the pigeonhole inventory. A yardmaster sitting at a CRT receives a message from the central system that cars bound for a particular destination usually follow a specified pattern. The yardmaster approves or disapproves the plan. After compiling all information, the system outputs a listing, with orders to switch specific cars. Utility programs now perform sorts on data, to search for a particular car and to provide a summary of cars destined for a particular destination. These sorts can be done in a minute rather than the 45 minutes or more previously required. The dual 11/50 systems effectively handle a distributed processing network. Digital is marketing this railroad's particular configuration to other railroads. The railroad provides the software it has developed, current updates, and instruction in the use of the system.

CONFIGURATION GUIDE

ALL DATASYSTEM 500s are configured around PDP-11 Processor as a primary building block. Many configurations are available of memory modules, mass storage devices, operator terminals, standard peripherals, and operating systems available to the user. The primary DATASYSTEM 500 configurations are DS-530, 535, 540, 550, and 560.

The DS-530 processor is a PDP-11/40 with 32K bytes of core memory expandable to 56K bytes. A desk, real-time clock, bootstrap loader, and LA30 DECwriter console are also included. A DS-530 will support Commercial Timesharing System (CTS 500) or Commercial Data-Base Management System (CDMS 500) or the Commercial Operating System (COS 500 RPG II).

The DS-535 is the newest addition to the DATASYSTEM family. It includes a PDP-11/40 with 96K bytes of core memory, expandable to 128K bytes. Memory management, real-time clock, bootstrap loader, extended arithmetic unit, desk, two RK05 disc drives with 4.9M bytes capacity, LA30 DECwriter console, four terminal interfaces and CTS 500/E Operating System software. This can be expanded with a magtape drive, line printer, and 2780 communications capabilities.

The DS-540 is also based on the PDP-11/40 with 32K bytes of core memory expandable to 248K bytes. The DECwriter console, extended arithmetic and memory management are included in the system cabinets with the real-time clock and bootstrap loader.

The DS-550 is identical to the DS-540 except the 550 is built around the powerful PDP-11/45 processor, which allows 32K bytes of high performance, solid-state memory to be added for system upgrade, for computer bound job, or large number of users.

The most powerful DATASYSTEM is the DS-560 which includes 32K bytes of MOS solid-state memory, 450-nanosecond cycle time, for those users requiring extensive computing power for their commercial applications.

The DATASYSTEM 500 has a wide selection of peripherals. Discs can be either the RS11 fixed-head type or the removable RK05 with 2.4M-byte capacity or RP03 with 40M-byte capacity per drive. Magnetic tape support is available using the TU10 in 800-bpi format in either 7 or 9 tracks. The choice of controllers allows each system to be configured with two disc controllers capable of supporting 8 drives each or total of 16 disc units, with or without magtape units. Line printers include a choice between 60-lpm and 300-lpm models.

Digital recently enhanced the communications capability of the DATASYSTEM 500 with the CTS-500/E 2780 package, which includes both hardware and software components that allow a DS-500 to emulate an IBM 2780 Data Transmission Terminal. The new 2780 package can communicate transactions, summary information, reports or data files between a DATASYSTEM 500 and another remote computer system simultaneous with the execution Basic/Plus application jobs.

Running under the CTS-500/E operating system a DATASYSTEM 500 can communicate in 2780 mode with another DATASYSTEM 300 or 500 or an IBM System/360 or 370 running HASP, ASP, DOS/POWER, or RJE software plus 270X or 370X hardware. The DS-500 central processor requires a minimum of 96 bytes of core memory to support 2780 communications.

COMPATIBILITY

The DEC DATASYSTEM 500 is based on the PDP-11 processor: the 530, 535, and 540 on the 11/40, the 550 on the 11/45, and the 560 on the 11/50. Thus, the 500 Series is upward compatible with other members of the PDP-11 line. All can use the same core memory modules and peripheral devices. The PDP-11/50 uses solid-state semiconductor memory that is unavailable for the 11/40. The PDP-11/40, 11/45, and 11/50 use supersets of the basic instruction set used on the other members of the PDP-11 line.

DATASYSTEM 500 is not compatible with the DATASYSTEM 300 Series, which is based on the PDP-8/E and supports DIBOL, a Cobol derivative. The 500 series supports Basic/Plus as the primary programming language and RPG II as a secondary language.

MAINFRAME

The PDP-11 line has three characteristics that distinguish it from other computers in its class: the UNIBUS, multiple general-purpose registers, and the manner of handling I/O operations.

Every PDP-11 model except the PDP-11/45 is organized around a single, fast UNIBUS that connects all system components. The processor, memory, and peripheral devices operate as UNIBUS subsystems; the processor allocates UNIBUS time to system components, which communicate with each other in a master-slave relationship.

Distances between devices and the speeds of the connected devices are immaterial because of the master-slave communications technique. This means, for example, that memory modules with different speeds can be connected to one system. A single UNIBUS inherently limits system speed to that of the UNIBUS because units in the system must time-share it. PDP-11/45 overcomes this limitation because it is a dual-bus system.

The 11/40 processor optionally has two processor modes and a floating-point arithmetic option, in addition to all the features of the PDP-11 line. The memory management option allows addressing 248K bytes of core and provides for programmed memory protection.

The PDP-11/45 is a major upward expansion of the PDP-11 line and offers many features unavailable for the other models, including semiconductor bipolar or MOS memory and three processing modes. It is designed for applications requiring large memories, fast computation speeds, or multiprocessor configurations.

The PDP-11/45 memory segmentation option is functionally similar to the 11/40 memory management option but differs because of the larger number of registers and processing modes on the 11/45. Memory segmentation (memory management) provides virtual addressing for memories larger than 64K bytes and is a means of providing memory protection for multiprogramming environments.

The PDP-11/50 uses the same processor as the 11/45. The only difference between them is that MOS semiconductor memory is the standard main memory on the 11/50, but it is optional on the 11/45.

SOFTWARE

There are three basic operating systems for the Datasystem:

CTS 500, CTS 500/E, and CDMS 500. COS 500, based on RPG II, is still available but no longer actively marketed. CTS 500 provides time-sharing facilities for up to 16 terminal users. It consists of the basic features of DOS, a monitor, and the Basic/Plus language interpreter and run-time system. CTS 500 requires 40K bytes of memory, 512K words of fixed-head disc storage, two DECtapes, a real-time clock, and user terminal interfaces.

CTS 500/E (Commercial Timesharing 500 Extended) is a disc- or tape-resident operating system for Models 540, 550, and 560. It allows 16 or 32 users (optional) to access common files and to process interactively large amounts of data. Twelve files can be simultaneously accessed by each user. Job size can range from small "desk calculator" tasks to 32K-byte-long programs. Files can contain numeric or alphanumeric data and be random, indexed, or sequential. Files can be controlled either from the user's terminal (high-speed CRT, DECwriter, or Teletype) or under program control. File protection is available on an individual, group, or universal basis.

CTS 500/E uses a commercial version of Basic/Plus. Basic/Plus is a significant extension of Dartmouth Basic and includes four conditional statements; CHAIN statement; ON ERROR, GOTO and RESUME statements; and eight matrix statements. Basic/Plus has a total of 50 program statements, 34 system commands, 24 operators, 3 kinds of variables (floating point with up to 17 digits of accuracy, integers for indices and counters, and character strings of unlimited length), and 40 functions. It includes a variety of mathematical functions, such as logarithmic, trigonometric, absolute value, truncation, pi, random number generator, and square root. All program commands are checked for errors upon entry. Applications include on-line order entry; inventory control; payroll; text processing, such as Computer Assisted Instruction (CAI); and automatic letter or document editing and production.

Numeric data can be arranged in 1- and 2-dimensional arrays or matrices. Matrix commands allow addition, subtraction, multiplication, and inversion of entire matrices in one operation. A virtual memory capability expands main memory to the size needed. In-core 256-word buffers are used when processing virtual memory arrays. Programmable timing control is another feature. The user can control certain operations in actual time. A SLEEP function suspends a program for a specified amount of time, then resumes its execution when the time elapses. Two date functions and five time functions are also under programmable timing control.

CTS 500/E features disc sort, indexed file access, decimal arithmetic, and line printer spooling.

Up to 15 fields can be selected to sort on; the sequencing on each key can be specified as ascending or descending. Keys can be of varying length and can consist of alphanumeric, integer, floating-point, or decimal data. Input files can contain up to 32,650 records of up to 512 characters each. The sort can be initiated from the user terminal or the parameters can be specified in a command file.

The user can access disc files by key rather than by disc address with the use of the Indexed File Access Method (IAM), then specify the function (inquire, update, add, delete, and peek) to be performed on the specified file. A utility program provides a file builder and a file reorganizer.

The decimal arithmetic option replaces the standard floating-point arithmetic with fixed-point arithmetic (4-word). The line printer spooling package enables the user to specify the output device, either disc or magnetic tape.

CTS 500/E supports up to eight discs, for maximum storage of 343 million bytes. Discs can be fixed head, moving head, moving-head disc packs, or any combination of the three types. The RECORDSIZE option provides for more buffer space than is normally allocated. Programs can be stored on disc in source or object code format.

Record input/output files can be accessed using fixed-length data transfers with no special conversion between data formats. This feature permits data to be written and accessed in a format compatible with all computer systems.

CTS 500/E, through the system manager, dynamically allocates processor time, memory space, file space, and peripherals for optimum system performance. User access can be controlled by the system manager, which can send messages to the terminals. System status is determined through the SYSTAT program; MONEY is a more detailed status utility to obtain status of a specific user or of all users. A ROLLIN/ROLLOUT feature and a BACKUP feature (selective copying of files on a file-by-file basis) are included. Terminal response time is never more than 2 seconds. Data can be entered from user terminals or punched cards.

CTS 500/E differs from its predecessor, the CTS 500, in that:

- It is available only for Models 535, 540, 550, 560. CTS 500 is available for all 500 Series models, including 530.
- Memory capacity ranges from 80K to 248K characters. CTS 500 supports up to 56K characters.
- It uses RS11, RP03 or RP05 swapping disc. CTS 500 uses RS11 or RK05.
- It allows 32 users standard. CTS 500 allows 16 users maximum.
- It can reside in high-speed MOS memory; CTS 500 cannot.
- It has high-speed hardware floating-point processor that is unavailable with CTS 500.
- Its maximum program size is 16K bytes compared to 32K bytes for CTS 500.
- Its standard communication is via 16-line individual interfaces; 8-line interfaces are used for CTS 500.
- It supports an LP11 line printer 1,200 lines per minute, multiple line printers, and comprehensive error logging. None of these are supported on CTS 500.

CDMS 500 is a compact time-sharing system designed primarily for data management. It was originally developed for the PDP-15 by the Laboratory of Computer Sciences of the Department of Medicine, Massachusetts General Hospital, and the Harvard Medical School. The development effort was supported by grants from the National Institute of Health and the National Center for Health Service Research and Development.

The CDMS 500 time-sharing monitor contains facilities to support the DEC disc, the RP02 Disc Pack, DECtapes, paper tape reader/punch, and a set of terminal scanners used to interface remote devices, such as Teletypes, buffered display scopes, line printers, and so forth. Core memory, exclusive of space required by the monitor and the interpreter, is divided into partitions; each partition contains an application program and its local data. All active users are assigned partitions of core memory. Activating a program requires finding an available partition and loading it with a program from the disc; as long as the program is active, it remains in core. The monitor also automatically overlays external program segments when required by an active program.

Proper linkages are set up to return automatically to the program when execution of the segment terminates. Typically, 20 to 30 users can be simultaneously active; as many interactive terminals as required can interface to the system.

MAINTENANCE

Service is provided by Digital through its network of sales and service offices in more than 48 cities in the United States and 50 cities in Europe, Canada, Central and

South America, Australia, India, and Japan. Maintenance is included in the lease; it can be obtained for purchased systems on a per-call basis or through a variety of service contracts. Field offices also have software specialists to provide users with a fast response to software problems.

Training in 300 or 500 system software is provided by Digital usually in either Maynard, Massachusetts, or Sunnyvale, California. The training courses, which last from two to three weeks, are provided free of charge for users of purchased systems.

PRICE DATA

Model Number	Description	Monthly Rental 3-year lease $	Monthly Rental 5-year lease $	Purchase $	Monthly Maint. $
	DEC DATASYSTEM 500 Series				
	CENTRAL PROCESSORS and WORKING STORAGE				
DS-530-A	PDP-11/40 32K-Byte Processor (with LA30 DECwriter system console, desk, bootstrap loader, and real-time clock)	731	541	22,529	133
DS-535-A	PDP-11/40 96K-Byte Processor (with 1 LA30 DECwriter console, 2 RK05 disc drives, CTS-500/E operating system, 4 terminal line interfaces, bootstrap loader, real-time clock, memory management, desk, and extended instruction set)	1,809	1,242	54,000	419
DS-540-A	PDP-11/40 32K-Byte Processor (with Extended Instruction Set, 1 LA30 DECwriter system console, memory management, bootstrap loader, real-time clock and desk)	915	676	28,149	170
DS-550-A	PDP-11/45 32K-Byte Processor (with 1 LA30 DECwriter system console, real-time clock, memory management, bootstrap loader, desk; can support up to 32K Bytes of MOS memory)	1,255	925	38,544	230
DS-560-A	PDP-11/50 32K-Byte MOS Memory Processor (with 1 LA30 DECwriter system console, memory management, bootstrap loader, extended instruction set, real-time clock and desk; additional mounting space for peripherals)	1,543	1,136	47,344	384
	Processor Options				
	System Memory (model numbers refer to total system storage)				
DS5MC-UP	56K-Byte Memory System	201	148	6,160	27
DS5MD-UP	64K-Byte Memory System	291	213	8,888	27
DS5MF-UP	96K-Byte Memory System	517	380	15,818	53
DS5MH-UP	128K-Byte Memory System	719	527	21,978	80
DS5MK-UP	160K-Byte Memory System	945	694	28,908	106
DS5MM-UP	192K-Byte Memory System	1,147	842	35,068	133
DS5MP-UP	224K-Byte Memory System	1,373	1,008	41,998	159
	MASS STORAGE				
	Controllers				
DS5X1	RK05 Controller (max 8)	212	156	6,490	42
DS5X2	RK05 & TU10 Controller (max 8 each)	329	241	10,055	69
DS5X3	RK05 & RS11 Controller (max 8 each)	406	331	13,773	69
DS5X4	RP03 & TU10 Controller (max 8 each)	544	399	16,630	101
DS5X5	RP03, TU10 & RS11 Controller (max 8 each)	738	574	23,913	127
DS5X6	RK05, TU10 & RS11 Controller (max 8 each)	523	416	17,338	95
	Discs				
RS11-E	512K-Byte Fixed Head Disc Drive	324	261	10,880	42
RK05-C	2.4M-Byte DECpacks Disc Drive	174	128	5,335	60
RP03-A	40M-Byte Disc Pack Drive	654	480	20,000	150
	INPUT/OUTPUT				
	Magnetic Tape				
TU10D-E	Magtape Drive (9-track; 800 bpi)	270	198	8,255	74
TU10D-F	Magtape Drive (7-track; 200/556/800 bpi)	270	198	8,255	74
	Printers				
LS11-C	Line Printer & Control (60 lpm)	193	142	5,915	58
LP11-VA	Line Printer & Control (300 lpm)	572	238	9,900	72

PRICE DATA (cont.)

Model Number	Description	Monthly Rental 3-year lease $	Monthly Rental 5-year lease $	Purchase $	Monthly Maint. $
	Punched Card				
CR11-A	Punched Card Reader (300 cpm)	159	117	4,860	53
	Terminals				
LA30	DECwriter (30 cps) Hard-copy Terminal	104	77	3,195	32
VT05B-AA	CRT Terminal (240 cps; for local connections)	91	67	2,795	23
VT05B-AX	CRT Terminal (for remote connections using EIA modem)	94	69	2,870	23
LT33-C	Keyboard Printer (10 cps; for local connection)	42	34	1,400	32
	DATA COMMUNICATIONS				
DS5C1	Type I Communication Subsystem (supports up to 4 lines, 2 subsystems/processor)	7	7	275	NC
DS5C3-AA	Local Terminal Interface	15	13	550	6
DS5C4-AA	Remote (dialup) Interface	16	15	605	6
DS5C6-A	Type II Communications Subsystem (supports up to 16 lines)	220	161	6,715	42
DS5C7-AA	Type II Communications Expander (expands Type II to 32 lines)	216	159	6,620	48
DS5C5-AF	4-Line Interface (local terminals)	6	4	187	5
DS5C5-AA	4-Line Interface (dialup lines)	77	52	2,370	23
DS5C5-AG	4-Line Dialup Expander (adds additional lines to DS5C5-AA)	31	23	946	5
DS5CA-A	CTS-500/E 2780 Communication System (includes hardware and software options for 2780 communications)		159	6,050	11

HEADQUARTERS

Digital Equipment Corporation
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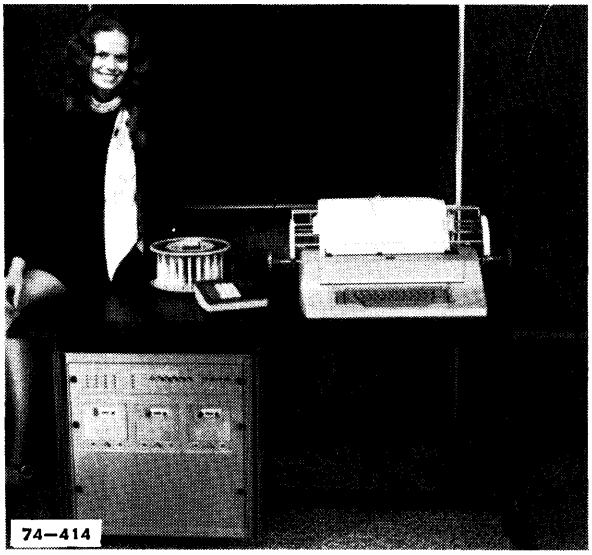
Maynard MA 01754



OVERVIEW

The Fedder System III consists of a series of small business computer and terminal systems particularly aimed at small accounting firms but able to be used for a variety of applications. The line ranges from a small communicating remote batch processor with 4K-byte memory, cassette tape drive, and I/O typer to a disc-based small business system with CRT console and extensive I/O capabilities. The smallest model is suitable for remote batch terminal applications; the next model has more memory and a cassette drive to allow stand-alone processing. A diskette-based model that can handle both cassette and disc cartridge record formats serves as a pivot point in the line. The largest model can include up to 40 million bytes of on-line disc cartridge storage as well as peripheral devices such as tape drives, card and tape readers, printers, and communications adapters. Table 1 summarizes system characteristics.

System III software is oriented toward small accounting firms. A small Disc Operating System is available for appropriate configurations, supported by a sort/merge package, utility library, editor, assembler, communications package, and diagnostics. The business Basic interpreter can run under DOS or operate as a stand-alone system. A variety of stand-alone software packages can be run by the user, and any model can act as a remote batch terminal with access to the Fedder service bureau programs.

Fedder has been in the service bureau business since 1959. The SPT-1000 terminal, which is the same as the System III Model 02 terminal, was introduced in 1970 for distributed processing. It allowed the service bureaus to receive summaries via unattended transmissions of records that had been keyed and preprocessed at the accountant's own firm. Fedder originally OEMed the processor, designed around LSI, fourth generation technology, and subsequently obtained permission to build the system. Over 175 systems have currently been installed.

Table 1. Fedder Computer Systems: System III Characteristics

PROCESSOR	
Main Memory (byte)	4K-64K
Word Length (bits)	8
Addressable Registers	256 (16 bits)
Cycle Time (μsec)	0.8
Program Languages	BASIC
Max No. of Devices	
AUXILIARY STORAGE	
Diskette	Yes, 384K byte/diskette
Disc Cartridge	Yes, 10M byte/drive
I/O	
Keyboard	Typewriter, adding machine
CRT	1,920-char display with AN keyboard, numeric pad, and control keys
Card Reader	RPQ
Card Punch	No
Paper Tape Reader	RPQ
Paper Tape Punch	No
Printers	300, 600, 1,250 lpm; 100, 165, 300 cps
Magnetic Tape Cassette	Some models
Computer Tape	Opt
COMMUNICATIONS	
Line Facility	Leased or voicegrade
Transmission Code	ASCII
Data Rate (baud)	To 1,200, async; to 9,600 sync
Interface	202C
COMPATIBILITY	
Emulation	None

PERFORMANCE AND COMPETITIVE POSITION

The Fedder System III is aimed at the same market as the Fedder service bureau business, small accounting firms that usually consist of from two to 12 partners. The interactive software provided with the Fedder systems allows relatively untrained personnel to use the system for accounting data with a minimum of problems. The smaller Models 02 and 03 are print-bound, that is, most input operations are suspended during the printing process. Larger models with more flexibility provide room for growth as the firm grows, while a variety of additional accounting software packages can be accessed by using the system as a remote batch terminal in conjunction with the service bureau.

Although the System III, like most communicating small business systems, is capable of development for competition in a wide variety of markets, successful competition in any of them usually requires heavy expenditures in sales and marketing and a heavy investment in the system software and support. The small size of the company and its current service bureau with its customers from small accounting firms suggest that the growth path for the system will continue to be a slow expansion of the accounting functions for small accounting firms, rather than a systematic attack on other well-populated fronts such as general-purpose data entry, word processing, IBM-terminal emulation, and so on.

Because of the turnkey nature of the systems usually sold in this way, the Fedder System III competition is mostly from other service bureaus and from small systems houses that, like itself, take a minicomputer and provide "customized" or "turnkey" installations to a local clientele. Many minicomputer manufacturers have been marketing both hardware and system software to service bureaus like Fedders; among them are DEC, Wang, Texas Instruments, Hewlett-Packard, and Lockheed. Fedder also competes with large manufacturers like IBM with its popular System/3, which IBM can also provide as turnkey systems. The chief attraction of the Fedder system in the face of the present market lies in the local service bureau with the nearby system support, expertise, and particular applications focus it implies.

CONFIGURATION GUIDE

The basic configuration for a Model 02 remote batch terminal system includes a heavy-duty Selectric I/O typer, 16-key numeric keyboard, two cassette drives, an asynchronous 202C-type modem (to 1,200 baud), and 4K words of memory housed in a single unit. The modem can be exchanged for a higher-speed device, memory can be expanded to 64K words in 4K-word increments, and peripherals can be added. Optional peripherals include printers, floppy discs, cartridge discs, IBM-compatible tape drives, and CRTs. Paper tape and card readers are also available on an RPG basis.

Model 03, 06, and 10 small business systems are outgrowths of the 02 hardware, with expanded main and auxiliary memories so the system can operate as a stand-alone small business computer. Model 03 has an extra tape cassette drive and expands main memory to 8K words. Model 06 substitutes three floppy disc drives for the three tape cassette drives. Model 10 represents a considerable jump over the capabilities of the Model 06, with 16K words of memory, a cartridge disc drive, CRT console, and a Centronics printer; the disc and printer are housed separately.

All models can be expanded in the field, including upgrades to the next highest model. Model 06 is a convenient pivot point between the 03 and 10, because the diskette subsystem can handle both cassette and cartridge disc formats via microprogrammed emulation in the diskette controller. Low-speed peripherals have integrated controllers but auxiliary memory subsystems controllers handle multiple drives. The cassette drive controller can handle three drives housed in the CPU cabinet; the floppy disc controller handles up to eight drives (but only three are housed in the CPU cabinet); and the cartridge disc controller handles four drives, all housed separately. Table 2 summarizes the differences among the models.

Table 2. Differences Among Fedder System III Submodels

MODEL	02	03	06*6B	10
STORAGE				
Main Memory Capacity (K bytes)	8-64	8-64	8-64	32-64
Disc				
Floppy Disc Subsystem	No	No	Std	No
Disc Cartridge Subsystem	Opt	Opt	No	Std
I/O Speed (K bytes/sec)	312	312	248	312
Drive Capacity (M bytes)	10	10	0.384	10
Subsystem Capacity (M bytes)	40	40	1.15	40
Magnetic Tape Cassette				
No. of Cassette Drives	2	3	None	None
Card Reader (cols/sec)	No	400 (RPQ)	400 (RPQ)	400 (RPQ)
Paper Tape Reader (cps)	No	300, 500, 1,000 (RPQ)	300, 500, 1,000 (RPQ)	300, 500, 1,000 (RPQ)
SOFTWARE				
Assembler	No	Yes	Yes	Yes
Compilers	No	Basic	Basic	Basic
Applications	Remote batch	Remote batch or stand-alone	Remote batch or stand-alone	Remote batch or stand-alone
FIRST DELIVERY	3/71	1/73	9/74	10/74

Note:
*Model 06B includes display console in place of the Selectric console used on the Model 06.

MAINFRAME

The System III mainframe is an 8-bit, bus-oriented system with 256 16-bit addressable registers, indirect addressing, push-down stack processing, and both 8-bit singleword and 16-bit doubleword instruction lengths. The instruction set includes packed and unpacked decimal arithmetic and many editing instructions to facilitate data entry. Add time is 0.6 microsecond per word. Sixteen interrupt levels with 16 associated registers are used for the internal and external priority interrupt systems.

Main memory consists of all MOS memory modules with a cycle time of 800 nanoseconds. Intel and Texas Instruments 4K RAM MOS modules, with up to 32K words per board, are used for main memory. Minimum memory for a Model 02 system is 4K words; memory can be expanded up to 64K words. CPU, memory modules, integral controllers, and interface boards are all contained on plug-in modules for easy maintenance.

PERIPHERALS

Low-Speed Peripherals

- Selectric I/O Typer— Console for Models 02, 03, and 06. Includes typewriter keyboard, 30 characters per second printer with 15-inch single-platen carriage, pin-fed forms handler, 132 columns.
- CRT Display with Keyboard — Console for Model 06B; includes 1,920-character display, full AN keyboard, numeric pad, and control keys.
- Centronics Printers — Model 10 includes dot matrix printer; 15-inch platen; pin-fed forms; 132 columns, 100, 165, and 600 characters per second; optional for other models.
- Line Printers — 300, 600, or 1,250 lines per minute.
- Card Readers — Decision Data 80- or 96-column reader, 400 columns/second; available on RPQ basis.
- Punched Paper Tape Readers — 300, 500, or 1,000 characters per second; available on RPQ basis.

High-Speed Peripherals

- Magnetic Tape Cassette — Up to three drives/controller; 200,000 bytes capacity per cassette; 5,004 bits/second transfer rate.
- Floppy Disc — Shugart drives; up to eight drives per controller but only three can be housed in CPU cabinet; diskette capacity 384,000 bytes with 400 bytes per sector, 12 sectors per track; controller microprogramming allows both cassette and cartridge disc formatting, 248K-character transfer rate.
- Cartridge Disc — Control Data 2315-type drives with one fixed and one removable platter each; 5M bytes per platter, 10M bytes per drive; up to four drives per controller, 312K characters per second transfer rate.
- Computer-Compatible Magnetic Tape — IBM-compatible, half-inch tape; 200, 556, or 800 bits per inch; NRZI; 7-track; NRZI, 800 bpi, 9-track; 1,600 bits per inch, PE, 9-track tape; 25, 37.5, or 75 inch-per-second tape speeds.

Communication Controllers

- Asynchronous Controller — Standard on all systems; up to 1,200 baud; integral 202C-type modem; attended or unattended operation
- Synchronous Controller — Optional; up to 9,600 baud; for external modem; IBM bisynchronous communications line discipline.

SOFTWARE

System software for the System III includes a Disc Operating System with spooling capabilities, a Business Basic Interpreter and Assembler, supported by a sort/merge package, text editor, utility library, and diagnostic library. Communications software provides control over asynchronous Teletype-like transmissions; emulation of other manufacturers' terminals and IBM bisynchronous line discipline.

A variety of stand-alone programs are available in addition to the Basic Interpreter, most of them with interactive features like prompting messages to the operator to ensure entry of the correct parameters and data in the correct format. Stand-alone programs include a complete accountant's system, accounts receivable system, accounts payable, payroll processing, utility billing, feed lot accounting, royalty accounting, hospital accounting, mortgage loan accounting, word processing, depreciation schedules, and amortization schedules.

A complete order processing, billing, and inventory control system is available with integrated accounts receivable, accounts payable, sales analysis, gross profit, vendors' analysis, back order control, and salesmen's commissions.

Service bureau programs that can be accessed through the terminal's remote batch capability include an accountant's data processing system, professional time and cost recordkeeping, professional billing system, medical billing system, accounts receivable, sales management information system, country club billing, automated rent control/real estate management, job cost analysis, accounts payable with expense analysis, mail list maintenance and addressing, hospital and clinic patient billing, Form 1099 preparation, payroll and recordkeeping, stockholder accounting, and co-op membership accounting.

MAINTENANCE

Maintenance is provided by Sirvess, Indeserv, Raytheon, and Fedder Computer Systems in all major cities in the United States.

PRICE DATA

Model Number	Description	Purchase $
	FEDDER SYSTEM III CENTRAL PROCESSORS AND WORKING STORAGE	
03	CPU (8K-byte memory, heavy duty Selectric® I/O writer, 3 cassette drives, integrated electronics cabinet and desk; power supplies; cables; forms tractor; 16-key numeric data entry device)	24,950
03B	Same as Model 03 except Selectric I/O Writer, forms tractor and 16-key numeric data entry device replaced by 1,920-char CRT	24,950
06	CPU [8K-byte memory, heavy duty Selectric I/O Writer, 3 Shugart flexible disk drives (software compatible with cassette drives), integrated electronics cabinet and desk; power supplies; cables; forms tractor; 16-key numeric data entry device]	24,950
06B	Same as Model 06 except Selectric I/O writer, forms tractor and 16-key numeric data entry device replaced by 1,920-char CRT	24,950
10	CPU [16-byte memory; 1,920-char CRT; 10M byte control data disk drive; integrated electronics cabinet and desk; power supplies; cables; direct memory access feature; disk interface and control; 4-channel multiplexor supports up to 4 CRTs (1 included in system); Centronics 165 cps printer]	34,950
	Memory*	
	8K – MOS	4,000
	16K – MOS	5,000
	24K – MOS	6,000
	32K – MOS	7,000
	Peripherals	
	Disc	
	Dual Disk Drive (10M-byte capacity with controller and DMA)	12,500
	Additional Disk Drives (to 4/controller)	8,000

PRICE DATA (Contd.)

Model Number	Description	Purchase $
	Flexible Disk Drive System	
	Interface and Controller	1,800
	Each Drive (to 8)	1,300
	Printers**	
	165 cps [dot matrix (7 x 9); interface; 132 print positions]	6,000
	330 cps [dot matrix (7 x 9); interface; 132 print positions]	7,500
	600 lpm line printer (interface; 132 print positions)	15,500
	Magnetic Tape Units	
	DMA and Controller (for up to 4 units)	6,000
	Tape Drive; 251PS; 7- or 9-track; 556, 800, or 1,600 bpi)	6,500
	CRTs	
	Controller (supports to 4 CRTs)	1,500
	1,920-char CRT (numeric cluster; control keys)	3,500
	Data Communications	
	Integrated 1,200-Baud (202C compatible) modem (interface; error free unattended communications package)	1,500

®Registered IBM trademark

Notes:

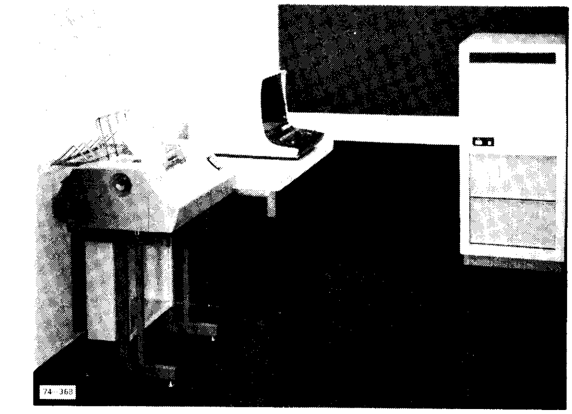
* *To upgrade a system's memory size at time of initial order, incremental add-on memory costs are $1,000 for each 8K high-speed MOS memory segment up to 32K. Over 32K, a new 8K board is required, which can be expanded to 32K for an overall total of 64K.*

** *To upgrade System 10 from 165 cps printer to 330 cps printer, add difference between prices shown.*

HEADQUARTERS

Fedder Computer Systems Incorporated
412 W. Redwood St.
Baltimore MD 21201

GRI COMPUTER
GRI System 99



OVERVIEW

The GRI System 99 is a disc-based interactive small business system aimed chiefly at systems houses, software houses, and OEM manufacturers. GRI is a minicomputer manufacturer with much of its business in the OEM market; System 99 is based on the new 9950 processor, a recent addition to the 16-bit GRI-99 line. A basic system includes 16K words of memory, cartridge disc, keyboard/display, and printer. More memory, disc storage, magnetic tape, higher-speed printers, and card readers can be added to the system.

The system software supplied by GRI includes a multiuser disc operating system (OS/99) or a single-user disc operating system with a basic interpreter. The multi user OS/99 can run the interactive RPG II compiler, RPG II subroutine library, and relocatable assembler. Disc file maintenance and utility routines (including a sort program), editors, loader, library utility programs, and an interactive execution control language (corresponding to the job control language on a batch system) are all available.

The system architecture is centered around a unique, dual universal bus* that connects all system components, including memory, peripheral interfaces, registers and instruction logic modules. This type of architecture is highly modular. The instruction set, register complement, and other elements of the system can be extended by the simple addition of printed circuit cards like those used for I/O interfaces. All devices are logically capable of DMA transfers occurring simultaneously with certain types of processing in the CPU; a selector channel is usually included, however, if the device interface does not have the logic to maintain count on block transfers and handle initiation and termination procedures. The System 99 processor has push/pop stack-handling instructions as well as block manipulation instructions, which facilitates the management of multitask environments.

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* Patented by GRI Computer

Under GRI's standard Distribution Agreement, which runs for 18 months, the distributor's name may be attached to the system, with either the System 99 label or another of the customer's choosing. Distributors need not maintain a spare parts inventory, but can instead rent local availability of a spare complement. Systems are purchased under an arrangement that allows increasing discounts as dollar volume increases. Payments can also be extended over a period of time. The system is available both in the United States and Europe.

PERFORMANCE AND COMPETITIVE POSITION

GRI joins the ranks of several minicomputer manufacturers that have recently entered the small business systems market via arrangements with distributors and OEM manufacturers of various kinds. Rather than build up its own applications software, the minicomputer manufacturer sells the system to a software house or similar organization, and then the house supplies turnkey systems for local customers. Some of the more sophisticated small business users will buy directly from the minicomputer manufacturer and do their own programming, with support from the manufacturer, but the large number of small business users like to begin with either a turnkey system or one with at least the majority of the software customized to some extent.

The success of this arrangement is indicated by the increasing numbers of minicomputer manufacturers entering into this type of marketing. Microdata, Wang, and Lockheed, for instance, have entered into the market with very similar strategies. This type of marketing offers a lower price and the convenience of a local software house that can often be more responsive to the user (because of small size and consequent flexibility) than the larger computer manufacturers who make small business systems like IBM, Burroughs, and NCR.

Several small business system companies in Europe are based on the GRI system, notably the Allied Business Systems Multibus. Although GRI is a relatively small company, it has been firmly established, with about 1,000 systems sold in the United States and 500 outside the United States.

USER REACTIONS

The accounting department of a company that moves oil tugs and barges has obtained two System 99s for general ledger, accounts payable, accounts receivable, check writing, and a number of other applications. The company needed a more customized system because it deals with "all kinds of weird invoices" denoting sources and destinations of ships and cargo. The first system was obtained from Focus IV, a local software house that went bankrupt about a year ago. The user had been doing most of his own programming by then so there was no great tragedy; he simply negotiated with GRI for maintenance. Actually he had few problems — humorously, the only downtime he suffered last year was right after a preventive maintenance visit from a new GRI serviceman who hastily found out what he had done wrong and remedied it. This user then obtained his second system from another local distributor, KR Systems.

The accounting department liked the GRI system because it allowed them a time-sharing environment where several operators can operate concurrently. They had thoroughly surveyed available systems before making their choice. IBM's System/3 and Burroughs B1700 were rejected immediately — both were much too expensive. DEC's PDP-11 couldn't be delivered until 150 days later, so they rejected it too. Singer's System/10 was closer to their specifications but it had no compilers, and the partitions could not be reallocated. Texas Instruments' 960A came closest to the GRI-99, but used a straight foreground/background type of operating system that did not give the same degree of simultaneity, so they decided on the GRI-System 99. Their first system was delivered three days later and was up and running a day later. The next system was delivered around three weeks after placing the order.

CONFIGURATION GUIDE

A typical System 99 consists of a central processor with 8K 16-bit words of memory, a 10.6M-byte disc subsystem with one fixed and one removable disc, a keyboard display unit, and a printer. The CPU memory and disc are housed within a single "data cabinet."

Main memory can be expanded in 8K-word increments to a maximum of 32K words (64K bytes). Three more drives can be added to the disc subsystem for a total of 42.4M bytes. Additional remote or local keyboard displays can be added to the OS 99 system for multiuser configurations. Additional peripherals can be attached. Users can choose from 12 different printer models with speeds up to 1,250 lines per minute. Both 80-column and 96-column card units, as well as a magnetic tape subsystem can also be attached; the magnetic tape subsystem, which will support up to four drives per controller. Table 1 gives GRI System 99 specifications.

Compatibility

The use of the RPG II languages allows the GRI System 99 to be source program-compatible with a number of manufacturers' systems, provided similar configurations are used.

MAINFRAME

System 99 is a 16-bit word-based system, but both byte-handling and block handling instructions allow considerable flexibility in data manipulation. Register-to-register instructions are usually one word long while memory reference instructions are two words long. The standard set of 233 instructions includes stack manipulation instructions as well.

Table 1. GRI System 99: Specifications

CENTRAL PROCESSOR	
Microprogrammed	Yes
No. of Registers	17
Max No. of Devices (I/O slots)	25-unlimited
No. of Instructions	255
Block Manipulation/ Stack Handling	Yes
Extended Arithmetic	Yes
Priority Interrupt Levels	16-unlimited
Indirect Addressing	1 or 2 levels
Core Cycle Time (msec)	1.76
Memory Capacity (min/ max bytes)	16K-64K
Memory Protect	No
DMA Transfer Rate (bytes/sec)	1,136,000
PERIPHERALS	
Disc	Cartridge, 2.5M, 5.3M and 10.6M bytes/drive
Magnetic Tape	"Grisette II" cassette; 9-track computer tape
Card I/O	96 or 80-col units
Printer	15 models, 60 lpm-1,250 lpm
Display	640-char, 960-char
Communications	Up to 9,600 baud
SOFTWARE	
Operating Systems	Single-user (DOS), multiuser OS 99
Compilers	Interactive RPG II
Assembler	Yes
Interpreter	Single-user Basic

Addressing modes include combinations of direct, indirect, indexed, and relative addressing. Up to 32,768 words (65,536 bytes) of memory can be directly addressed. One or two levels of indirect addressing can be employed. Memory can be increased from an 8K-word (16-byte) minimum system to a 32K-word (64K-byte) maximum in 86K-word increments. There are no memory protect or parity options.

The interrupt subsystem determines device priority generally on the proximity of devices to the CPU. When several devices share a single data line connected to a single bit in the interrupt status register, the priority is the same and the service routine determines priority. DMA interrupts have priority over program interrupts.

PERIPHERALS

Low-Speed Peripherals

92X1	Keyboard/Display Subsystem (640-char)
92X2	Keyboard/Display Subsystem (960-char)
9303	Character Printer (80-col, 100-cps)
9304	Character Printer (132-col, 100-cps)
9305	Character Printer (132-col, 165-cps)
9306	Character Printer (132-col, 300-cps)

9307	Character Printer (132-col, 330-cps)
9308	Character Printer, (132-col, 600-cps)
9311	Line Printer (300-lpm, 136-col)
9312	9311 with u/lc
9313	Line Printer (600-lpm, 136-col)
9314	9313 with u/lc
9315	Line Printer (1,250-2,400 lpm, 132-col)
9316	9315 with u/lc
9401	Card Reader (96-col)
9402	Card Reader/Punch (96-col)
9403	Printing Reader/Punch (96-col)
9304	Data Recorder (96-col)
9405	Sorting Data Recorder (96-col)
9406	Interpreting Data Recorder (96-col)
9411	Card Reader (80-col, 300-cpm)
9412	Reader/Punch (80-col)
9413	Printing Reader/Punch (80-col)
9414	Data Recorder (80-col)
9415	Interpreting Data Recorder (80-col)

High-Speed Peripherals

9502	1,600-bpi Magnetic Tape Subsystem
9512	1,600-bpi Magnetic Tape Drive
9102	Fixed Disc Sub (2.5M bytes controller + 1 drive, up to 4 drives/controller)
9112	Fixed Disc Drive (2.5M bytes)
9103	Moving Head Disc Subsystem (2.5M bytes controller + 1 drive, up to 4 drives)
9113	Disc Drive (2.5M bytes)
9104	Moving Head Disc Subsystem (5.3M bytes, controller + 1 drive, up to 4 drives/ controller)
9114	Disc Drive (5.3M-byte)
9105	Disc Subsystem (10.6M-byte)
9115	Disc Drive (10.6M-byte)

SOFTWARE

The basic System 99 software includes three disc operating systems (single-user DOS and two multiple-user DOS systems), an interactive RPG II compiler, Basic interpreter, relocatable assembler, execution control language, editors, and a variety of utilities including a SORT package.

Operating Systems

The Single-User DOS system (DOS-99) is a straightforward system allowing a single job to operate in a batch or interactive mode. It requires 2K words of core and can support CRTs, Teletypes, discs, and printers. It is aimed at OEM manufacturers developing their own software. The Basic Interpreter runs under this system.

The multiuser OS99 system is highly modular and can support numbers of I/O devices. A multiterminal system requires 16K words of core with 8K words reserved for the executive. This operating system is "event-driven" rather than "time-sliced" with real-time service of I/O devices on a priority basis. Programs can be compiled and assembled on-line. The multiuser system supports RPG II but not Basic.

PRICE DATA

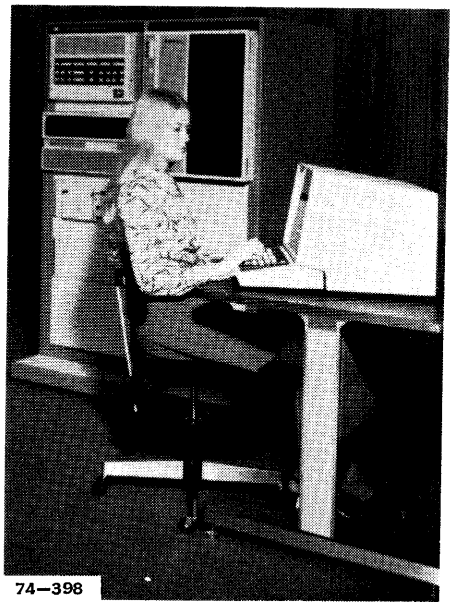
Model Number	Description	Purchase $	Monthly Maint. $
9016	Data Processor (with 16K memory)	22,600	132
9024	Data Processor (with 24K memory)	26,890	157
9032	Data Processor (with 32K memory)	31,180	182
9008	8K x 16-bit Memory	4,290	25
92X1	Keyboard/Display Subsystem (640-char)	3,475	25
92X2	Keyboard/Display Subsystem (960-char)	4,170	25
9303	Character Printer (80-col, 100-cps)	4,945	29
9304	Character Printer (132-col, 100-cps)	6,882	41
9305	Character Printer (132-col, 165-cps)	8,368	60
9306	Character Printer (132-col, 300-cps)	9,468	65
9307	Character Printer (132-col, 330-cps)	9,910	65
9308	Character Printer (132-col, 600-cps)	10,468	70
9311	Line Printer (300-lpm, 136-col)	14,754	86
9312	9311 with u/lc	16,897	89
9313	Line Printer (600-lpm, 136-col)	19,897	116
9314	Same as 9313 with u/lc	21,985	129
9315	Line Printer (1,250-2,400 lpm, 132-col)	43,677	255
9316	9315 with u/lc	46,857	274
9401	Card Reader (96-col)	3,914	32
9402	Card Reader/Punch (96-col)	12,142	71
9403	Printing Reader/Punch (96-col)	14,000	82
9304	Data Recorder (96-col)	13,928	83
9405	Sorting Data Recorder (96-col)	18,500	108
9406	Interpreting Data Recorder (96-col)	16,500	97
9411	Card Reader (80-col, 300-cpm)	4,785	35
9412	Reader/Punch (80-col)	13,142	77
9413	Printing Reader/Punch (80-col)	15,000	88
9414	Data Recorder (80-col)	15,214	89
9415	Interpreting Data Recorder (80-col)	17,214	100
9502	1,600-bpi Magnetic Tape Subsystem	17,557	103
9512	1,600-bpi Magnetic Tape l Drive	10,800	63
9102	Fixed Disc Sub (2.5M bytes controller + 1 drive, up to 4 drives/controller)	8,400	67
9112	Fixed Disc Drive (2.5M bytes)	4,550	36
9103	Moving Head Disc Subsystem (2.5M bytes controller + 1 drive, up to 4 drives)	10,560	84
9113	Disc Drive (2.5M bytes)	6,700	54
9104	Moving Head Disc Subsystem (5.3M bytes, controller + 1 drive, up to 4 drives/controller)	11,450	90

PRICE DATA (Contd.)

Model Number	Description	Purchase $	Monthly Maint. $
9114	Disc Drive (5.3M-byte)	8,115	65
9105	Disc Subsystem (10.6M-byte)	13,070	103
9115	Disc Drive (10.6M-byte)	9,282	74
9001	Multiuser Disc Operating System	Furnished with system	
9002	Interactive RPG II Software Package	Furnished with system	
9003	Single-User DOS with Basic Interpreter	Furnished with system	

HEADQUARTERS

GRI Computer Corp.
320 Needham Street
Newton MA 02164



74—398

OVERVIEW

The M230 Transaction Processing system and the M260 Data Base Management System are two small business-oriented systems based on Hewlett-Packard's 21MX Series of microprogrammed 16-bit computers. The M230 is aimed at source data entry and on-line inquiry applications. It is somewhat reminiscent of a key/disc entry system but with added powers for on-line inquiry and updating of a local data base that in turn can communicate with a remote data base. Unlike key/disc systems the M230 terminals are designed to be source transaction devices communicating with the Hewlett-Packard computer from a variety of local and remote locations. The M260, on the other hand, is a batch system in its simplest form, designed for updating and maintaining a large disc-based data base using batch I/O (but with on-line terminal inquiry and update options) expedited by the IMAGE/2000 file management software which allows access according to a number of parameters and keys.

The systems overlap in capabilities and can expand to the same configuration. The M230, for instance, can add the IMAGE/2000 software to implement a sizeable local data base. The M260, meanwhile, can add communications multiplexors and interfaces plus Terminal Control System (TCS) software for a multiterminal, on-line I/O system that can operate concurrently with "batch" processing. Both systems can communicate with an IBM System/360 or 370 using a 2780 RJE package that functions like a 2780 Model 1 or 3 communicating by way of HASP using BSC protocol at rates up to 4,800 baud.

The M230 is aimed at order entry, directory assistance, message handling, store and forward, reservation processing, and customer account inquiry processing applications. The immediate system goals are to assure the accuracy of transaction data as it is captured, to provide immediate feedback from the data bank to the transaction, to allow changes in the transaction, and to trigger timely business reactions.

The M260 system is designed for production control, shop loading, tooling and routing, inventory control, order processing, shipment status tracking, vehicle scheduling, equipment records updating, accounts receivable/payable, sales statistics production, budgeting, personnel file maintenance, customer information file maintenance, credit verification, portfolio status monitoring, medical histories/laboratory data analysis, and pharmacy prescription file applications. It is geared more toward solving in-house data management problems than toward solving the transaction problems occurring with the customer interface. Immediate goals are to maintain an up-to-date pool of interrelated information, reduce information storage costs, insure privacy and security of sensitive information, generate prompt and clear reports, and provide immediate and direct access to the data bank.

Both systems were first delivered in June 1974. Hewlett-Packard also markets a Model S/250 Scientific Data System in the series.

PERFORMANCE AND COMPETITIVE ANALYSIS

Hewlett-Packard with its Information Management series joins the growing number of minicomputer manufacturers who are entering the small business minicomputer market. This is a natural step for larger companies like Hewlett-Packard who have a substantial software base that already includes some general data entry, accounting, and business-type software. The M230 and M260 systems are configurations of the HP 21MX, utilizing software that can run on any 2100 mini with the appropriate configuration regardless of its label.

Hewlett-Packard's fine reputation for the 2100 series, precursors to the 21MX, and particularly their reputation for excellent software and support should make them serious contenders in the medium-sized business system market, dominated by IBM System/3 Model 10. The M260 competes with established systems made by manufacturers like Basic Four, as well as the many new systems available from minicomputer manufacturers like the DEC Datasystems.

The M230 can compete in these markets as well, but its real competition comes from the larger clustered-terminal distributed processing systems like those made by Four-Phase Systems, Incoterm, and Datapoint, as well as Honeywell. As the product of a major minicomputer manufacturer of reliable equipment, with a widely established service network and firm financial status, the Hewlett-Packard system should enjoy popularity.

Table 1. Differences Between Basic 230 and 260 Systems

	M230	M260
BASIC HARDWARE		
Main Memory Size (bytes)	16K	24K
Console	2615A CRT	2762A terminal printer
Communications Multiplexor	12920A	Option
Privileged Interrupt Card	12936A	No
SOFTWARE		
Operating System	DOS-IIIB (24307B)	DOS-IIIB (24307B)
Extended File Management	Std	Std
IMAGE/2000 Software	Opt	Std
Terminal Control System Software	Std	Opt
High-Level Languages	FORTRAN II; FORTRAN IV; ALGOL	FORTRAN II; FORTRAN IV; ALGOL

USER REACTIONS

Two users of the IMAGE/2000 Data Base Management System were interviewed. Both were satisfied with the hardware/software system and with Hewlett-Packard as a vendor. Both plan to expand their systems.

One user's application was a test site for the IMAGE/2000. Initially, a few bugs were found in the system, but those are now ironed out. The system has been operable since March 1974.

The configuration includes a 2100S processor with 32K words of memory, dual disc cartridge unit with one fixed and one removable disc, 4.6 million bytes each, and 8 EIA interfaces. One interface is used for the Teletype console, one connects to a remote ITT Asciscope terminal in another state, and six are connected to Research, Incorporated Teleray terminals located throughout the plant. Teleray terminals have a Teletype keyboard and a 24-line, 80-character per line display. This user has had virtually no hardware downtime with either the HP hardware or the Teleray terminals, but he is careful to perform regular maintenance and to keep the equipment clean. The room is air-conditioned but has no special facilities.

The application is a commercial one. Software includes DOS-IIIB operating system, Terminal Control System (TCS), the Data Base Management System, IMAGE/2000, decimal string arithmetic package, plus the on-top order system. The user has programmed his own order entry system with inquiry routines, accounts receivable, and inventory control packages. All terminals can inquire and update. Currently, this user is adding accounts payable. He seldom uses HP's Query package because it can be used at only one terminal and it can access only one file at a time. Thus, it cannot be used to write a meaningful report. He uses Query primarily for list type reports and for error checking.

This user's system is busy for about four hours a day. When accounts payable and other new additions go on-line, the system will be busy for a full 8-hour day. He is planning for an additional system in 1975 for process control applications for manufacturing counts and net weight monitoring in the factory.

When asked what improvements he would like to make in the system, this user stated he would like to make changes to the system on-line and he would like faster response times when six or seven terminals are in use.

When changes are required, the system must be taken down, the changes made, and the system rebuilt. This takes a minimum of 45 minutes to one hour, which this user feels is too much time.

The system response time is one or two seconds when only a few terminals are in use, but this stretches to 15 to 20 seconds when six or seven terminals are in use. The response time is a function of the amount of printing done and what is done from the terminal, updating files, or making inquiries. Hewlett-Packard has been responsive and has done a lot to improve response times.

When asked about the slow terminal response time reported by this user, a Hewlett-Packard spokesman emphasized that file updating is the most time-consuming procedure done under IMAGE/2000. It requires finding a record, getting the record, determining the field to be updated, updating the record, then writing the record. In contrast, an inquiry to a file requires only finding and getting the record. Response time can be improved by increasing the disc buffer size so that more data is stored in memory. Buffer size, however, must be balanced against the amount of memory required by the user's application programs, which may not allow a larger buffer. When the data base management system can support the larger memory now available with the 21MX computer, the response time for file updating from multiple terminals will be considerably improved and more memory will be available for user programs.

This user called the hardware "terrific" and the field service people "high quality" who give you no "song and dance" on service calls.

The second user we interviewed operates a system for a governmental agency that provides services to clients and subcontractors receiving manpower grants for job training and placement. The system was installed in July, and it has since operated under two different designs because of changes to the law.

The configuration consists of a 2100S CPU with 32K words of memory, 5M bytes of disc storage, paper tape reader, CRT display, printer, mark sense card reader, and console. No terminals are on-line as yet, but terminals will be added starting in January 1975 with six or seven on-line for data entry and inquiry by June 1975. This user checked the field for a data base management system and decided on a minicomputer. Five major minicomputer systems were surveyed: Data General Nova, Hewlett-Packard 2100, IBM System/3, Digital PDP-11/45, and Xerox 530. The two main advantages of the Hewlett-Packard system were software and price. None of the other systems matched the HP 2100 in these two areas.

This user finds the system flexible and able to do anything needed by the agency. The agency deals with four primary subdata bases and in some politically touchy situations which require reports on demand in addition to regular reports to the Department of Labor; it also provides services for 12 subcontractors and 4,000 clients. The main obstacles to implementation of applications on the system are related to management decisions, not to the system. This user found it easy to make changes to the system and they usually take about two hours. Changes are routinely saved until a number can be made at one time.

The main disadvantage of the system is somewhat related to machine size. Query, for example, can use only one file at a time and cannot produce very meaningful reports.

On the other hand, this user found it amazing that an agency with a $7,000,000 budget spends only about $1,300 per month on computer hardware. Also, Hewlett-Packard offers an identical system at its service center which the customer can use as backup. Salesmen and service personnel are technically competent and helpful. This user was most impressed that delivery was promised for July 15, and it was delivered on July 15.

CONFIGURATION GUIDE

A basic M230 system consists of CPU with 16K words of memory, 2,000-character CRT console, paper tape reader (500 characters per second), 9-track magnetic tape drive (1,600 bits per inch), 5M-byte cartridge disc or 24M-byte discpack, 16-channel asynchronous multiplexor, and I/O facility. The I/O interface can support an additional 16-channel MUX unit and two more interface cards: one card can be an I/O extender adding eight more slots, so a total of 40 I/O channels can be added to the basic system. Disc and tape subsystem controllers can handle up to four drives each. The Disc Operating System (DOS-IIIB) and Terminal Control Software (TCS) software are standard with each system; the IMAGE/2000 Data Base Management software is optional.

A basic M260 system consists of the CPU with 24K words of memory, keyboard/printer console (30 characters per second), paper tape reader (500 characters per second), 9-track magnetic tape drive (1,600 bits per inch), 5M-byte cartridge disc, or 24M-byte discpack. The DOS-IIIB operating system and IMAGE/2000 software are standard to the system; the TCS software and the requisite multiplexors and terminals are optional.

The basic differences between the two system orientations result from the differences in configurations and software. An M230 expanded to include file management capabilities could have the same configuration as an M260 expanded to include multiterminal on-line data entry.

An important option for both systems is a hardware serial interface to a back-up redundant processor; data transfer rate between the two CPUs is 2.5 million bits per second. A fast FORTRAN processor is also optional; it expedites some types of FORTRAN processing. Writable Control Store and a PROM writer are optional and software-supported. Both the M230 and M260 can attach the same optional peripherals; their consoles can be interchanged, for example. Optional peripherals include terminal printers (10 and 30 characters per second), CRTs (10 to 960 characters per second) with one model operating in character mode and another in page mode, an optical mark card reader (300 cards per minute), punched card reader (600 cards per minute), line printer subsystems (200, 600, and 300-1,100 lines per minute; 132 columns for the first two, 80 columns for the last) with several types of character sets.

CPU. The CPU used in both systems is the 21MX Computer (16-bit word), a new compatible system that supersedes the 2100S. The 21MX includes a larger instruction set than the 2100S and uses 8K-word N-channel MOS memory boards. The 21MX has 128 standard instructions: 80 emulate the 2100S, 42 are new for indexing, byte and bit manipulation, byte and word moves, and byte string scanning, and six are single-precision floating-point arithmetic instructions. Like the 2100S, the 21MX is microprogrammable; it uses 178 microinstructions and can implement 4K words of bipolar ROM control store. Two of the four general-purpose registers can be used for indexing. DMA, memory parity checking, interrupt subsystem expandable to 60 levels, extended arithmetic, and memory protect are all standard features. Addressing facilities use various combinations of direct, multilevel indirect, relative, and indexed addressing.

Memory capacity for the 21MX has recently been expanded to 192,000 words, but currently the M230 and M260 support only 32K words.

COMPATIBILITY

The 21MX processor is upward-compatible with the earlier 2100S system. The 2100S standard 80-instruction set is a subset of the 21MX set. All peripheral devices developed for the 2100 can run on the 21MX. User-coded ROMs developed for the 2100S can also be used on the 21MX provided the coding does not conflict with the expanded 21MX instruction set.

The basic software modules for the M230 and M260 systems consist of the Disc Operating System (DOS-IIIB), the Terminal Control System (TCS), the IMAGE/2000 Data Base Management Software, and the RJE Communications Package. DOS-IIIB supports FORTRAN, FORTRAN IV, a macroassembler, and ALGOL.

Disc Operating System IIIB (DOS-IIIB)

DOS-IIIB is a modularized batch processing operating system that requires 4,500 words of core storage and approximately 400K bytes of disc storage. It can be generated for a specific configuration to optimize core use for a given application. Noncore-resident modules are rolled-in to an overlay area on an as-needed basis. DOS-IIIB consists of an executive kernel module, modular I/O drivers, and a set of general-purpose modules for such functions as file management and memory management. Executing programs communicate with DOS-IIIB through directives supplied from the system device or system console. The console operator can also activate utility and support functions for source code editing, program debugging, and file manipulation.

DOS-IIIB supports both logical and physical access methods to up to four disc drives; a drive is connected to two subchannels. The logical access method operates through the Extended File Management Package (EFMP) which allows the user to define record size, security codes, and status information. Standard call procedures include create/destroy, open/close, read/write, reset, repack, copy, change name, and post.

Programs written in FORTRAN, FORTRAN IV, ALGOL, or ASSEMBLY language can run under DOS-IIIB. Object programs can be segmented into a main program with subservient segments that can be stored on the disc and called by the main program. The main program can share a common memory area with segments.

IMAGE/2000

The IMAGE/2000 Data Base Management Software interfaces to the Extended File Management Package of the DOS-IIIB Operating System to provide data base management facilities.

The IMAGE/2000 has many features suggested by the CODASYL Data Base Task Group. The most notable exception is that IMAGE/2000 is data independent, thus the data base can be changed without requiring changes to the applications programs using the data base. IMAGE/2000 consists of four basic modules: Data Base Definition, Data Base Utility, Data Base Management, and Data Base Query.

Data Base Definition processes descriptive input (a schema) to create a root file describing the data base in terms of fields, records, and files, specifying keyed fields, read/write access levels associated with each field, and the relationships among files. Capacity is up to 255 data bases per system, 20 files per data base, 32,767 records per file, up to 512 bytes per record, 6 characters per field name and up to 126 bytes per field. Integers can range from -32767 to +32767, and floating-point numbers can vary from 10^{-38} to $10^{\pm 38}$. Character strings can be used for both numeric and nonnumeric data.

The master file is composed of manual or automatic records; each master record contains a single key value that can serve as a pointer for up to five detail records. Manual masters contain, in addition, field values. Automatic masters are the heads for one to five chains of detail files and can be accessed only by key value. Manual masters need not be linked to a detail file, thus they can be accessed by file number or by key value. When new detail files are set up or deleted, IMAGE/2000 automatically sets up or deletes the appropriate key value in the automatic master.

The Data Base Definition subsystem and Data Base Utility are used to set up the root file and organize, update, and restore records according to defined structures. The Data Base Management Subsystem supplies routines to open files and to read, enter, modify, or delete data in either batch or multiterminal environments. The QUERY language is designed to allow nontechnical people to retrieve, sort, report, update, add, or delete records using a simple English-like language.

The IMAGE/2000 package requires a minimum system with 24K words of main memory and the basic M260 configuration.

Terminal Control System (TCS)

TCS provides multitasking under DOS-IIIB allowing a single application program to consist of multiple program segments which process transactions. TCS allows different applications to run concurrently on multiple terminals in a multitasking, multiterminal environment. Programs are structured into main programs and overlay segments, each segment represents a different logical application module. TCS manages the overlay area in core and schedules I/O processing. TCS requires a minimum of 16K words of main memory and the basic M230 configuration.

Remote Job Entry (RJE)

The RJE package uses a binary synchronous driver to provide the functions of the IBM 2780 Models 1 and 3, communicating with IBM System/360/370 HASP. The RJE package requires a minimum of 24K words of main memory.

Language Processors

Language processors for the M230/M260 include an assembler and FORTRAN II, FORTRAN IV, and ALGOL compilers.

Assembler. The assembler is an extended assembler that provides one-to-one correspondence between instruction mnemonics and machine language codes. It also provides pseudo-operations to control the assembly and output listings. It produces absolute or relocatable output code. It has a macroinstruction to provide communication with programs written in microcode in the WCS.

FORTRAN. Two versions of FORTRAN are available: FORTRAN II, an extended version of USASI Basic FORTRAN, and FORTRAN IV. FORTRAN IV is a full implementation of Standard ANSI FORTRAN IV. Programs written in Hewlett-Packard FORTRAN can be compiled by the FORTRAN II or the FORTRAN IV compiler.

Hewlett-Packard FORTRAN II includes the following extensions to Basic FORTRAN.

- Format specifications can be entered at execution time.
- COMMON array declarations are permitted.
- A function subprogram can change the values of its arguments and of COMMON storage; that is, the arguments of function subprograms are "called by name."
- External functions are included for Boolean operations.
- The "S" sign is included in the character set.
- A 2-branch form of the IF statement is included.
- A facility for octal constant specification is provided.

The FORTRAN IV compiler requires 7K words of main memory.

ALGOL. Hewlett-Packard ALGOL incorporates all the features of the ALGOL language as described in the ALGOL 60 Revised Report, published in the *Communications of the ACM* for January 1963. I/O statements are the same as for FORTRAN II. All variables are treated as OWN variables. Other features of the source language include the following.

- Facilities for intermixing identifiers of types REAL and INTEGER in the same assignment statement.
- Provision for initializing variables and arrays.
- An EQUATE statement.

The compiler operates in a single pass of the source code and produces an object program in relocatable format for loading by the Basic Control System. Relocatable programs generated from source language can be linked to subprograms generated from FORTRAN or ASSEMBLY language source code. There are essentially no restrictions on the size of the ALGOL program that can be compiled.

Microprogramming Software. Hewlett-Packard supports its WCS and PROM Writer options with the HP I/O Utility Routine, Microassembler, Micro Debug Editor, Programmable ROM Writer, PROM Mask Generator, and diagnostic package. All packages run under DOS.

Microprograms are entered into the system by means of punched cards or magnetic tape, and the microassembler produces an interim disc file plus a microprogram listing. The microeditor reads the interim record, allows examination of any word in memory, and hence in WCS and outputs the microprogram. Output can be a block of words in WCS, a new edited interim disc file, a record suitable for use by the WCS I/O routines, or a record suitable for use by the mask generator.

The mask generator program produces six mask tapes for the manufacture of ROM packs. Six are needed to accommodate the 24-bit word because each pack consists of 256 4-bit locations. The PROM driver uses these tapes plus a card temporarily inserted into an I/O slot to fuse ROM chips controlled by the PROM writer software, which also enables verification of the chips and fusing of any missed bits.

Two companies, Wetherford and Semiconductor Specialists, will burn a board with a 1-day turnaround. Cost is about $50 per board.

The ultimate output of the two microprogramming options together with their supporting software can be a customized library of microprograms stored off-line on disc, or punched tape, a fully loaded Writable Control Store, and/or fused ROM packs that can be mounted on the Timing and Control or ROM Control cards. The WCS I/O driver can be called by Assembly Language, BASIC, FORTRAN, and ALGOL programs, allowing loaded WCS microprograms to be dynamically altered using a standard subroutine call.

PRICE DATA

Model Number	Description	Purchase $
19655B	Standard M260 System Microprogrammable, 24K-word 21MX(1)Systems Computer (2108 CPU)	50,500
12960A	5M-Byte Disc Subsystem	
12972A	Magnetic Tape Subsystem (1,600-bpi, 9-track, 45-ips; PE IBM/ANSI-compatible)	
2762A	Terminal-Printer System Console (30 cps, 118 col)	
2748B	Paper Tape Reader (500 cps)	
2860D	Double Bay Cabinet Table	
24307B	DOS-IIIB Disc Operating System Software with FORTRAN II, IV; ALGOL; ASSEMBLY Language and Extended File Management Package. Decimal string arithmetic routines	
25376B	IMAGE/2000 Data Base Management Software	
	M260 Options	
203	Multiple Terminal (Operation includes first 16 channel asynchronous multiplexor (12920A), privileged interrupt card (12936A), Terminal Control System TCS (24342A). Option 156 must be ordered	3,575

PRICE DATA (Contd.)

Model Number	Description	Purchase $
	M260 Options (Contd.)	
162	Replace 24K-Word Memory with 32K	2,150
001	Delete 5M-byte Disc and Add 23.5M-byte Disc Subsystem	18,600
200	Add 202 Data Set Capability to First Multiplexor	800
201	Add Second Multiplexor with 103 Capability	2,200
202	Add Second Multiplexor with 202 Capability	3,000
207	Add I/O Extender	3,850
003	Delete 1,600-cpi Tape Drive, Add 800-cpi Tape Drive	2,500
401	Delete System Console (2762A)	6,225
19662B	M230 Transaction Processing System	48,950
2108	CPU 21/X2 MOS Memory 16K words	
12960A	Cartridge Disc Subsystem	
12972A	Tape Drive Subsystem	
12925A	Paper Tape Reader	
2615A	CRT	
12920A	Multiplexor	
24307B	Disc Operating System	
24342B	Terminal Control System	
12936A	Privileged Interrupt Card. Two-Bay Cabinet	
	M230 Options	
160	Replace 16K-Word Memory with 24K-Word Memory	2,150
161	Replace 16K-Word Memory with 32K-Word Memory	4,300
162	Replace 24K-Word Memory with 32K-Word Memory	2,150
001	Replace 5M-Byte Disc with 23.5M-Byte Disc (replaces 12960A with 12965A)	18,600
003	Replaces 1,600-bpi tape with 800-bpi Tape Subsystem (replaces 12972A tape drive subsystem with 12970A)	2,500
300	IMAGE/2000 Data Base Management Software (24376B requires option 155)	2,125
200	Add 202 Data Set Capability to First Multiplexor (includes Multiplexor Option 12920A-001)	800
201	Add 2nd Multiplexor with 103 Capability (includes multiplexor 12920A)	2,200
202	Add 2nd Multiplexor with 202 Capability (includes multiplexor 12920A, multiplexor option 12920A-001)	3,000
402	Delete System Console, Replace with an Appropriate Accessory Device (removes 2615A CRT)	3,100
207	Add I/O Extender (includes 2155A)	3,850

Note:
(1) Includes:
Dual Channel Port Control
Memory protect
Disc loader ROM
Power Recovery System with battery power for 2-4 hours
Memory extender
Time-base generator

HEADQUARTERS

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OVERVIEW

Honeywell Series 60, Level 61 includes two keyboard-oriented, virtual memory, small business computers that can also be used as intelligent remote job entry terminals to larger Honeywell and IBM systems. They are marketed primarily to entry-level users and users upgrading from smaller keyboard-oriented accounting systems such as Honeywell's own Series 50. They can also be used by large companies in their outlying factories and offices for both local accounting and data entry tasks, and as intelligent message concentrators and batch terminals.

The small Model 61/58 is a batch processing system with direct keyboard input of variable transactions. It is available in card configurations from 5,000 French francs ($1,250) rental per month upwards, and in disc configurations from 8,316 French francs ($2,079) rental per month upwards. The three disc subsystems offer 4.6 million to 92 million bytes of on-line backing storage. Up to four local and/or remote teletypewriter and/or CRT display terminals can be connected to Model 61/58 disc systems. They are used primarily for on-line source data entry but they can also be used for simple file inquiries using up to 10 keys or criteria to reference individual file records.

The larger System 61/60 is a full-fledged, real-time, transaction processing system. It uses a front-end processor to contol up to 16 synchronous or asynchronous communication lines (110 to 4,800 bit-per-second) for local and/or remote teletypewriter and/or display terminals. The terminals can be used for direct data entry, file inquiries, real-time transaction processing, or conversational time sharing. Both the new Model 61/58 and the older Series 50 Model 58 disc configurations in the field can be upgraded to full System 61/60 specifications by adding a front-end processor and the required terminals. System 61/60 is available for rental at 15,000 French francs ($3,750) per month upwards.

Both the 61/58 and 61/60 disc systems run under the GCOS 61 operating system. Its job control language (JCL) is a fully compatible subset of the GCOS JCL used on all other Series 60 levels and on the Honeywell 6000 Series. Three Cobol compilers are available for commercial batch and real-time programming. The Cobol compilers, as well as the batch Fortran IV compiler, are also fully compatible subsets of the Cobol and Fortran compilers available at other Series 60 levels. An assembler is offered for Model 61/58 card and disc systems, and a Basic compiler is offered for System 61/60 conversational time sharing. Applications packages include the AGAP distributive trades sales management system, FACTOR industrial stock control system, and PERT critical path planning package.

Series 60 Level 61 was designed by Compagnie Honeywell-Bull SA (at Angers, France) who will also manufacture the system. It will be marketed throughout Europe and overseas by local Honeywell companies. Table 1 lists system specifications.

Compatibility

Within the Honeywell Series 60, Models 61/58 and 61/60 are fully upward compatible at all levels. A Model 61/58 in the field can be upgraded to full System 61/60 specifications by adding a front-end processor (FEP).

Both Level 61 models are source program upward compatible with the higher Series 60 levels. Programs written in Cobol or Fortran and incorporating GCOS 61 JCL statements need only by recompiled without alteration to run on Levels 62 (Cobol only), 64, or 66. Disc data bases may have to be recreated to take advantage of the more advanced data management facilities available at higher Series 60 levels.

For Series 50 Model 58, Models 61/58 and 61/60 are fully compatible at all levels, including GESAL assembler and machine code levels. Models 58 and 61/58 have virtually identical specifications and can execute each other's programs on each other's files without modification. More than 2,000 Model 58 configurations, including 300 multi-workstation systems, were installed or on order at 600 user sites when Series 60 Level 61 was announced in April 1974. These Model 58 systems can be used as backing systems and sources of applications experience by Model 61/58 users. Model 58 achieved a particularly strong penetration in the distributive trades, engineering assembly, and local government.

Both Series 50 Model 58 and Model 61/58 configurations in the field can be upgraded to full System 61/60 specifications by the addition of a front-end processor (FEP) and the required additional teletypewriter and/or display terminals.

For Series 100, 200, 400, and 2000, Level 61 Cobol and Fortran compilers are compatible with those of the older

Table 1. Honeywell Series 60 Level 61: Configuration Guide

System Components	Model 61/58 Card	Model 61/58 Disc	Model 61/58 MWS/B	System 61/60 MWS/TP	System 61/60 MWS/TP +B
CENTRAL PROCESSOR					
ROM Capacity, 350 ns (Kbytes)	5-7.5	7.5	7.5	10.0	10.0
MOS/LSI Main Store, 1.2 μs (Kbytes)	5-10	5-10	10.0	10.0	10.0
MOS/LSI EMS, 1 ms/page (Kbytes)	0-64(1)	0-64	0-64	0-64	0-64
FRONT-END PROCESSOR	NA	NA	NA	Std	Std
MOS/LSI Main Store, 1.6 μs (Kbytes)	NA	NA	NA	8-16	8-16
Twin MT Cassette Drive, 750 b/s	NA	NA	NA	1	1
CONSOLES	1	1	1	1-2	2
Card Reader Console	Std	Std	Std	Opt	Std
FEP Console	NA	NA	NA	Std	Std
Alphanumeric Keys	46	46	46	41	41+46
Numeric Keys	13	13	13	11	11+13
Functional Keys	2	2	2	5	5+2
Display (char positions)	6-10	6-10	6-10	960	960
DISC SYSTEMS (no. drives/sys)	NA	1 std	1 std	1 std	1 std
DSS 070: 100 cyl 2.3Mb, 312 Kbs	NA	2-4	2-4	NA	NA
200 cyl 4.6Mb, 312 Kbs	NA	2-4	2-4	3-4	3-4
DSS 110: 200 cyl 2.3Mb, 156 Kbs	NA	2-4	2-4	NA	NA
DSS 162: 200 cyl 5.6Mb, 156 Kbs	NA	2-4	2-4	2-4	2-4
DSS 178: 200 cyl 23Mb, 312 Kbs	NA	2-4	2-4	2-4	2-4
INPUT/OUTPUT DEVICES					
Card Reader (80-col) (100/200/300 cpm)	Std	Std	Std	Opt	Std
Line Printer, 96-128 Print Positions (100, 200, 400, or 800 lpm)	Std	1-2	1-2	Opt	1-2
Card Punch (80-col) (40 col/sec)	Std	Opt	Opt	Opt	Opt
Paper Tape Reader (125 cps)	Opt	Opt	Opt	Opt	Opt
Paper Tape Punch (105 cps)	Opt	Opt	Opt	Opt	Opt
Magnetic Tape Drives (30 Kbs)	NA	0-4	0-4	0-4	0-4
DATA COMMUNICATIONS					
Single-Line Controller (SLC) Synchronous (600-4,800 bps)	Opt	Opt	Opt	NA	NA
FEP Synchronous Adapter (1 line, 600-4,800 bps)	NA	NA	NA	Std	Std
Multi-Line Controller (MLC) (4 asynch lines, 110-1,200 bps)	NA	NA	Std	NA	NA
FEP Multi-Workstation Adapter (8 lines asynch/synch 110-4,800 bps)	NA	NA	NA	1-2	1-2
Number of Key-terminals/System chosen from among:	NA	NA	1-4	1-16	1-16
Teletype ASR 33 (10 cps)	NA	NA	Opt	Opt	Opt
Kode 33 RT/TS (10 cps)	NA	NA	Opt	Opt	Opt
GE TermiNet 300 (10/15/30 cps)	NA	NA	Opt	Opt	Opt
GE TermiNet 1,200 (120 cps)	NA	NA	Opt	Opt	Opt
DTS 7200 Display (25 lines, 72 char, asynch, TTY-compatible)	NA	NA	Opt	Opt	Opt
DTS 7513 Display (25 lines, 80 char, synch, message buffer, 2,000 char)	NA	NA	NA	Opt	Opt
SOFTWARE					
GCOS 61 Operating System, Level with Facilities for	NA	61.1	61.2	61.3	61.3
On-line Data Entry/Batch dual prog	NA	Opt	Opt	NA	Opt
On-line File Enquiry	NA	NA	Opt	Opt	Opt
Real-Time File Enquiry/Update	NA	NA	NA	Opt	Opt
Multiprogramming (16 programs)	NA	NA	NA	Opt	Opt
LANGUAGE COMPILERS					
GESAL Assembler	Opt	Opt	Opt	NA	NA
Mini-Cobol	Opt	Opt	Opt	Opt	Opt
ANSI Cobol 68	NA	Opt	Opt	NA	Opt
ANSI Cobol 74	NA	NA	NA	Opt	Opt
Basic	NA	NA	NA	Opt	Opt
Fortran IV	NA	Opt	Opt	NA	Opt

Table 1. (Contd.)

System Components	Model 61/58 Card	Model 61/58 Disc	Model 61/58 MWS/B	System 61/60 MWS/TP	System 61/60 MWS/TP +B
APPLICATIONS PACKAGES					
AGAP Retail/Wholesale Management	NA	Opt	Opt	NA	Opt
FACTOR Industrial Inventory Control	NA	Opt	Opt	Opt	Opt
PERT	NA	Opt	Opt	Opt	Opt

Notes

MWS	*Multi-Workstation System.*
MWS/B	*MWS designed for batch processing with distributed source data entry.*
MWS/TP	*MWS designed for multiterminal real-time transaction processing.*
MWS/TP+B	*MWS designed for a combination of batch processing and multiterminal real-time transaction processing.*
EMS	*Extended Main Store; an EMS can be fitted to Models 61/58 CPUs equipped with at least 7.5K bytes of ROM and 10K bytes of main store.*
Opt	*Device optionally available on this system.*
NA	*Device not available on this system.*

Series compilers, but GCOS JCL statements are not compatible. All source programs must be adapted to the appropriate operating system before they can be recompiled and transferred. Extensive changes are also required in disc data base formats.

For Series 6000, Level 61 is fully upward compatible at GCOS JCL statement, Basic, Cobol, and Fortran source program levels running under GCOS. Programs need only be recompiled without alternation.

For IBM System/360 and 370, Honeywell Series 60 Level 61 uses the same 8-bit byte data format as the IBM Systems/3, 360, and 370. This makes exchange of data via magnetic tape or data communications line straightforward. Source programs can only be exchanged, however, if written in a compatible subset of both Honeywell and IBM Cobol or Fortran definitions. In all cases, operating system JCL statements must be modified.

For other Manufacturers' Systems, the same considerations apply to exchange of data and/or programs with other byte-oriented computer systems, such as the Burroughs B 1700 and B 2700/B 3700/B 4700 Series, NCR Century, Philips P1000, Siemens System/4004, and Univac 9000 Series.

Communications procedures have been written allowing Series 60 Level 61 systems to exchange data on a processor-to-processor basis and/or be used as intelligent RJE terminals to the following computer systems.

- Other Series 60, Level 61 systems.
- Series 60, Levels 64 and 66.
- Series 50, Model 58.
- Honeywell Series 200, 400, 2000 and 6000.
- IBM Systems/360 and 370.

In exchanging data and jobs with IBM Systems/360 and 370, Level 61 systems use BSC (binary synchronous communications) procedures and emulate IBM 2780 data communications terminals.

PERFORMANCE AND COMPETITIVE POSITION

Honeywell's Series 60 Level 61 is available in three basic types of configuration: 61/58 card systems, 61/58 disc systems, and 61/60 multiterminal disc transaction processing systems.

Model 61/58 card systems are designed to update a file of 80-column cards on the basis of console keyboard transaction inputs and to print output documents simultaneously. Available for rental from 5,000 French francs ($1,250) per month upwards, they offer a choice of card readers (100, 200, and 300 cards per minute) for file input, and of printers for (100, 200, 400, and 800 lines per minute) report and business document output. Updated file cards are punched at 40 columns per second (20 to 100 cards per minute); the processing speed is essentially determined by the speed of the keyboard transaction input.

Competing keyboard-oriented card processing systems include Burroughs L2000 to L7000, Kienzle 5600, LogAbax LX 4200, Nixdorf System 820, Philips P352, and Ruf/Hohner 5000 and 6000.

Model 61/58 disc systems add from 4.6 to 92 million bytes of on-line disc capacity to the 61/58 card systems. Available for rental from 8,316 French francs ($2,079) per month upwards, they offer dual programming facilities between on-line key-to-disc data entry in random transaction order and either a disc sorting or a batch processing program with concurrent printed output. The console keyboard is the prime input keyboard for variable transactions; this can be complemented by up to four local and/or remote data entry stations, which can be either typewriter terminals (10 or 30 characters per second) or CRT display terminals (1,800-character screen). In addition to direct batch data entry, these systems can also be used for on-line file inquiries, which the system handles on a roll-in/roll-out basis interrupting the batch processing program.

Competing keyboard-oriented disc processing systems include Burroughs B 700, BCL Molecular 6M and 18, DEC Datasystem 300, IBM System/3 Model 6, ICL 2903, Kienzle 6100, LogAbax LX 4200, MAI Basic Four, and Nixdorf System 880. In France, other competitors include the Informatek Matek 1026, Marme GMG 5000, and Synelec SYN 9; in the United Kingdom also the MBM 7000 and Melcom MCS 1600.

Model 61/60 multiterminal disc systems add an 8K- to 16K-byte front-end processor (FEP) to Model 61/58 or older Model 58 disc systems. The FEP takes over all communications line handling and message buffering tasks; it can handle up to 16 synchronous or asynchronous lines (110 to 4,800 bits per second) leading to local and/or remote teletypewriter and/or CRT display terminals. They may be used for direct data entry and on-line file inquiries concurrently with central site batch processing. Alternatively, they may be used for full-fledged, terminal-oriented, real-time, transaction processing and file updating, as well as for conversational time sharing. Each terminal can call for and interact with a different program, and each can access the indexed sequential, disc-held, data base records on any of up to 10 alternative keys or criteria.

Available for rental from 15,000 French francs ($3,750) per month upwards, Model 61/60 competes against Allied Business Systems' MULTIBUS, AIA ADAM, Burroughs B 1726, CTL Modular One TPS, DEC Datasystem 500, Datasaab 6501, IBM System/3 Model 10, ICL 2903, Marme GMG 5000, MBM 7000, Melcom MCS 1600, and Nixdorf System 880/65.

Honeywell's published prices for all Level 61 systems compare favourably with those of competing Burroughs, IBM, and ICL systems; at first sight, they appear high compared with those of other listed small business manufacturers. This is because Honeywell's prices are bundled; they include a large selection of high-level language compilers and applications packages that enable users to be largely self-sufficient in applications programming. Most less expensive competing card and disc processing systems offer only assembly languages; thus, they require turnkey programming by the manufacturer at additional cost.

Entry-level Model 61/58 users will be attracted by the applications experience gained by the 600 users of the 2,000 Model 58 systems installed or on order, with which Model 61/58 is fully compatible at all levels. This applications experience is especially strong in engineering assembly, distributive trades, utilities, and local government. Installed Model 58s include 300 multiterminal configurations with remote source data entry.

Small and medium-size businesses who expect their data processing requirements to grow rapidly will be reassured by the "top cover" offered by Honeywell on the higher Series 60 levels. These have GCOS job control languages (JCL) and Cobol and Fortran compilers that are fully compatible supersets of the Level 61 languages. Users can thus transfer their Level 61 Cobol and Fortran programs to higher Series 60 levels without alteration; only source code recompilation and disc data base recreation will be required to take advantage of the more powerful systems architecture and data management facilities.

Source code compatibility between Level 61 and the higher Series 60 levels will also attract large companies to use Level 61 systems for their decentralized processing in remote offices and factories, especially if their central processing system is a Honeywell Series 60 or 6000. Even IBM System/360 or 370 users will be attracted by Level 61 for their decentralized processing because both Models 61/58 and 61/60 can communicate on-line with IBM systems, emulating IBM 2780 BSC procedures.

Level 61 has inherited from the Series 50 Model 58 the peculiar design feature that CPU main stores cannot be larger than 10K bytes. This compares with maximum main store sizes ranging from 32K and 256K bytes on competing batch and transaction processing small business computers. This restriction will not limit in any way the sizes of the programs that users may write for their Level 61 systems. Honeywell pioneered virtual memory paging techniques for small business disc systems as far back as 1969. Thus, GCOS 61, like Model 58 DOS, allows users to treat CPU main store and backing disc store as a single virtual memory. They can write programs of any size and GCOS will segment them automatically into 288-byte pages. Each page is called from disc into CPU main store only as it is addressed during execution; it is automatically displaced to make room for other pages when it has not been addressed for some time.

Page swapping does slow down processing, of course, but this hardly matters as long as the limiting factor on processing throughput is the speed of manual keyboard input of transaction data. Even the addition of up to four local and/or remote source data entry terminals on Model 58 multi-workstation systems has not pushed the system to its processing throughput limit; the additional keyboard terminals are restricted to source data entry and occasional on-line file inquiries. When direct page swapping to/from backing disc store becomes a limiting factor on throughput, Model 58 and Level 61 systems can be fitted with 16K to 64K bytes of immediate access "extended main store" (EMS). The transfer of a 288-byte page from EMS to CPU main store takes only one millisecond.

Real-time transaction processing for up to 16 teletypewriter and display terminals will impose much heavier demands on the new System 61/60, but these appear to have been foreseen by the system's designers. All communication line handling procedures, checks and error recovery routines, as well as message buffering have been delegated to a front-end processor (FEP) with its own 8K-, 12K-, or 16K-byte main memory. This will hand complete transaction messages to the CPU for processing. The FEP is restricted to a maximum combined throughput on all connected lines of 15,000 bits per second; thus it will be able to transfer at most a 20-byte message every 11 milliseconds or a 50-byte message every 27 milliseconds in either direction. During these time intervals, the CPU can transfer up to 10 or 20 program and/or data pages from EMS to main store, allowing up to 2,880 bytes of program per 20-byte message and up to 7,000 bytes of program per 50-byte message without slowing down the system. Much will depend, however, on the frequency of access to disc files by individual terminal transactions and the complexity of the transaction processing programs, as well as on the length of the transaction messages themselves. Only when the first System 61/60s are delivered at the beginning of 1975 will it be possible to assess with accuracy the maximum practical limit of transaction processing terminals for different task mixes before CPU thrashing occurs.

CONFIGURATION GUIDE

Series 60 Level 61 systems are offered in four basic configurations: 61/58 card system, 61/58 disc system, System 61/60 transaction processing system, and System 61/60 transaction/batch processing system. Each basic configuration has certain standard components and can be expanded by the addition of optional features and/or peripherals.

Model 61/58. All Model 61/58 systems use a card reader console into which all the main standard system components are integrated: central processor (built into the pedestal); alphanumeric, numeric, and functional input keyboards; 6- or 10-digit numeric display (of most recent numbers entered on numeric keyboard); card reader; and line printer. Three card reader models and four line printer models are available.

The Model 61/58 card system is completed by the addition of a card punch (40 columns per second). Model 61/58 disc systems are completed by the addition of two or four-disc drives chosen from among three available models. Both 61/58 systems have the following optional features: a paper tape reader and/or punch and a single-line communication controller for processor-to-processor communications with another Honeywell computer system or an IBM System/3, 360, or 370. The 61/58 disc system can also support up to four magnetic tape drives, and a multiline communication controller (MLC) for up to four asynchronous lines (110 to 1,200 bits per second) for teletypewriter and/or display terminals.

The 61/58 system must have the full 10K bytes of main store to support the MLC. A 61/58 disc system with an MLC and one to four teletypewriter and/or CRT terminals is known as a 61/58 MWS (multi-workstation system).

System 61/60. System 61/60 uses the same CPU as Model 61/58, but the 61/60 also includes a front-end processor (FEP) to interface to all data communications lines. The FEP is housed in a console that also houses the alphanumeric, numeric, and functional keyboards for operator instructions, a full 960-character CRT display for system status messages, and a twin magnetic tape cassette drive for system program loading and system dumps.

The FEP console has all the features required for controlling the system; the card reader console is not required on System 61/60 transaction processing systems, where all input and output utilizes up to 16 local and/or remote teletypewriter and display terminals. Mixed 61/60 transaction and batch processing systems, however, require a card reader console to house the card reader and line printer needed for input and output of central site batch data.

A System 61/60 transaction processing system can be upgraded to a mixed transaction/batch processing system in the field by the addition of a card reader console with card reader and line printer.

A Model 61/58 or Series 50 Model 58 disc system can be field upgraded to a System 61/60 mixed transaction/batch processing by the addition of an FEP. If the Model 58 or 61/58 was already a multi-workstation system and/or an RJE terminal, both the synchronous and asynchronous communications lines must be transferred to the appropriate adapters on the FEP. The SLC and/or MLC previously used cannot interface to FEP. Table 1 lists the standard and optional components of each Level 61 system.

HEADQUARTERS

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PRICE DATA

Identity	Monthly Rental (5-yr) ($)	Purchase $	Monthly Maint. With MiniCOBOL $
BASIC CONFIGURATION			
Model 61/58 batch system with 5,120 bytes of main memory; card console unit with 100 card per minute reader, 10-position display, alphanumeric keyboard and numeric keyboard; removable-disk mass storage subsystem with 3.46-million-byte capacity; 100-line-per-minute printer, and MiniCOBOL compiler.	1,405	66,590	447
Model 61/58 multiworkstation with 10,240 bytes of main memory; card console unit with 100-card-per-minute card reader, 10-position display, alphanumeric keyboard and numeric keyboard; removable-disk mass storage subsystem with 5.76-million-byte capacity; multiline controller; capability to attach one remote terminal and MiniCOBOL compiler.	1,937	91,400	561
Model 61/60 transaction processing system with 10,240 bytes of main memory; front-end processor unit; removable-disk mass storage subsystem with 46-million-byte capacity; 300-line-per-minute printer, capability to attach five remote keyboard terminals and MiniCOBOL compiler.	3,135	138,715	706

OVERVIEW

Honeywell's Series 60 Level 62 is a family of batch processing, multiprogramming small business computers with limited real-time transaction processing capabilities. It is marketed primarily as a system upgrade to small- and medium-sized businesses already committed to batch processing,using unit record accounting machines or card, magnetic tape, or small disc-oriented computers. Honeywell offers extensive program and file conversion software aids to current users of the Honeywell-Bull Gamma 10 and G-100 Series, IBM 360/20, NCR Century Series, and Univac 9000s.

As announced on April 23, 1974, Level 62 comprises two upward-compatible models. The small Model 62/40 available for rental at $4,000 per month upwards, offers 48K to 88K bytes of main memory, 5.6 to 23.2 million bytes of fixed/exchangeable cartridge disc backing storage, card reader (600 or 1,050 cards per minute) and line printer (400, 600 or 800 lines per minute). Optional peripherals include card punch, paper tape reader and punch, and a data communications controller for up to four asynchronous or synchronous lines. Teletypewriter, bank teller, and CRT display terminals can be connected to the data communication lines for real-time file inquiries and/or transaction processing. As yet the system does not support remote batch terminals. Peak aggregate I/O throughput for the up to six channels is 900,000 bytes per second.

The larger Model 62/60, available for monthly rental of $6,000 upwards, offers 64K to 128K bytes of main memory.and up to 116 million bytes of disc backing storage on multiplatter exchangeable discpack (IBM 2314 type) drives. Peak aggregate I/O transfer rate for the up to six channels is raised to 1.8 million bytes per second. One channel can be a multiplexer channel with four subchannels for the connection of slow I/O devices. Optional peripherals include magnetic tape drives (transfer rates of 30K and 60K bytes per second). Up to nine data communication lines (75 to 9,600 bits per second) can be connected to its data communication controller.

Level 62 processors are designed around advanced multiprocessor architecture with extensive error checking circuitry. All input/output functions are delegated to an Input/Output Processor (IOP). The IOP handles disc access optimization, communication line control, and all I/O channel error checking and retry procedures in parallel with central processor programs. Both the IOP and CPU have separate access to the main MOS/LSI memory.

Error checks provide duplicate arithmetic and address calculation circuits: The system accepts only arithmetic results and addresses on which both sets of circuits agree. Memory protection includes traditional lock-in circuitry to prevent user programs from accessing main memory not allocated to them. User memory areas are divided into "program areas" that are write protected from all programs and "data areas" that cannot store instructions for execution.

All Level 62 systems run under the GCOS 62 (also called GCOS 2 in some countries) operating system. It offers variable length multiprogramming facilities within the user area of main memory: uncompleted programs are dynamically relocated to consolidate all unused areas of main memory when a program is unloaded. An advanced disc data management system is fully compatible with GCOS data management facilities offered at Series 60 Levels 64 and 66. A choice of direct, indexed sequential, and sequential access methods to records are provided for disc files. The indexed sequential method allows records to be referenced by any number of different indexes based on different selection criteria. Sequential and indexed sequential files can be searched dynamically for records answering certain criteria.

ANSI Cobol 74 and RPG II are the only programming languages currently offered on Level 62. Honeywell has added extensions to both languages to allow them to be used for real-time transaction processing programming. The Cobol 74 language and GCOS 62 job control language (JCL) are fully compatible supersets of the languages available on Series 60 Level 61 and are subsets of those available at Levels 64 and 66.

Honeywell Series 60 Level 62 computers were designed by Honeywell Information Systems Italia S.p.A. and are manufactured for world-wide distribution at its plant in Caruso, Italy. They are marketed throughout Europe and in overseas countries by local Honeywell companies. Model 62/40 is not marketed in the United States and some other countries. Table 1 lists system specifications and configuration rules.

Compatibility

Honeywell Series 60 Level 62 was designed primarily for users upgrading from smaller and/or older computer systems. Therefore, it has an extensive range of software conversion aids to make transition easy for users.

Within Honeywell Series 60, all Level 62 processing systems are fully compatible with each other at all levels.

Table 1. Honeywell Series 60 Level 62: Configuration Guide

System Components	Model 62/40	Model 62/60
CENTRAL PROCESSOR		
Read-Only Store (ROS) Capacity: Bytes	30K	
Cycle Time: Nanoseconds	175/2 bytes	175/2 bytes
Number of Instructions	140	140
Registers: General	16(1)	16(1)
Base	8	8
Index	8(1)	8(1)
MAIN MEMORY		
Min Capacity (bytes)	49,152(2)	65,536
Increment (bytes)	8,192	8,192
Max Capacity (bytes)	90,112	131,072
of which: Reserved for firmware, GCOS	24,576	24,576
Cycle Time: Microseconds	1.05/2 bytes	1.05/2 bytes
INPUT/OUTPUT PROCESSOR		
Peak Throughput: Bytes/Sec	900,000	1,800,000
Maximum Number of Channels	6	6
of which: Multiplexer Channel	–	1
Subchannels/Multiplexer	–	4
Maximum Peripheral Simultaneity	6	9
DISCS: No. of subsystems	1 standard	1 standard
Chosen from among: (No. drives/subs)		
MSU 0112: 5.8Mb, 312 Kbs, 52.5 ms acc	2–4	2–4
MSU 0310: 29.2 Mb, 312 Kbs, 46.5 ms acc	No	2–4
Max on-line capacity (bytes)	23,200,000	116,800,000
CONSOLE	Standard	Standard
Keyboard	64 keys	64 keys
Serial Printer	30 cps	30 cps
Magnetic Tape Cassettes, 700 bytes/sec	1–2	1–2
OTHER INPUT/OUTPUT DEVICES		
Card Reader, 600 or 1,050 cards/min	1 standard	1 standard
Line Printer, 400, 600, or 800 lines/min	1 standard	1 standard
Card Punch, 120 cards/min	X	X
Paper Tape Reader, 600 or 1,000 chars/sec	X	X
Paper Tape Punch, 110 chars/sec	X	X
Magnetic Tape Drives, 30 or 60 Kbs	None	2, 4, or 6
DATA COMMUNICATIONS		
No. of Lines	0–4	0–9
Line Speeds (bps)	75–9,600	75–9,600
Terminals:		
Teletype 33, 35 10 cps	X	X
Teletype 37 15 cps	X	X
GE TermiNet 300, 10/15/30 cps	X	X
BTT 7300 Bank Teller Terminal	X	X
DTS 7200 Display, 1,800 chars, asynch	X	X
VIP 7700 Display, 2,024 chars, buffer, synch	X	X
SOFTWARE		
GCOS 62 Operating System	Standard	Standard
Batch Multiprogramming	X	X
Real-Time Transaction Processing	X	X
LANGUAGES		
Cobol 74	X	X
RPG 2	X	X

Notes: (1) *The 16 general registers include 8 index registers.*
(2) *Minimum 62/40 main memory capacity is 65,536 bytes in France, West Germany and other European countries under the jurisdiction of Compagnie Honeywell-Bull.*
X *Device optionally available on this system.*

Model 62/40 systems can be upgraded in the field to full Model 62/60 specifications.

The Cobol and GCOS job control languages for Level 62 systems are upward source code-compatible with other Series 60 levels. The Level 62 ANSI Cobol 74 and GCOS JCL are supersets of Cobol and JCL available at Level 61 and are subsets of Cobol 74 and JCL available at Levels 64 and 66. Cobol source programs can be transferred between Series 60 levels without alteration; recompilation is necessary, however.

A disc database must be recreated when it is transferred from a Level 61 to a Level 62 system to take advantage of the more sophisticated Level 62 data management system. The Level 62 data management system is fully compatible with the Level 64 and 66 data management systems, so database recreation is not necessary when transferring files to higher levels. Level 62 RPG II programs cannot be transferred to any other Series 60 levels.

For Honeywell-Bull Gamma 10 Systems, Honeywell offers the following software conversion aids:

- Object code program translator with output Level 62 object code; facilities are available for adding GCOS 62 JCL statements if required.
- File conversion from Gamma 10 card files to Level 62 discs or magnetic tape.
- Card sorter simulator.
- Card collator simulator.

For Honeywell Series 50, the Model 58 is fully compatible with the new Series 60 Level 61. Thus, Model 58 follows the same rules as Level 61 to Level 62.

For the Honeywell Series G-100 users, Honeywell offers the following software conversion aids:

- Code conversion generator incorporating GCOS 62 JCL statements.
- G-100 object code translator to Level 62 object code, with GCOS JCL statements specified by conversion generator.
- Two-pass G-100 to Level 62 disc file converter with intermediate storage on 9-track magnetic tape.

Honeywell marketing policy differs among countries as to which G-100 users will be offered these conversion aids. In Italy, all G-100 users are offered conversion to Level 62. In most other countries, the conversion aids are offered only for small G-115, G-118 and G-120 systems with 32K bytes or less of main storage, running under COS, TOS, DOS or DOS II operating system. Users of larger G-120 and G-130 systems running under ETOS or EDOS are encouraged to migrate directly to Level 64, where programs can be executed without any conversion in Series G-100 Program Mode.

For Honeywell Series 200 and 2000, no conversion aids are offered in either direction between these series and Level 62. Although Level 62 Cobol 74 is a compatible superset of Series 200/2000 Cobol, operating system JCL statements and data structures are quite different.

The Honeywell Series 6000 is fully compatible at all levels with the new Series 60 Level 66. Thus, it offers the same Cobol and GCOS 62 source code compatibility with Level 62 as does Level 66.

For IBM 360/20 users, Honeywell offers the following software conversion aids:

- IBM 360/20 to Level 62 conversion control language to incorporate GCOS 62 JCL statements.
- RPG to RPG II source program translator.
- Two-pass 360/20 to Level 62 disc file converter with intermediate storage on 9-track magnetic tape.

The RPG to RPG II translator produces a printed program conversion report and a Level 62 RPG II source deck. Users can write GCOS 62 JCL statements directly and incorporate them in the RPG II source deck or can use the conversion control language to produce GCOS JCL statement cards during the source code conversion pass.

For IBM System/3 Models 10 and 15 users, Level 62 RPG II is an upward-compatible superset of IBM System/3 RPG II. System/3 Model 10 source programs require the addition of GCOS JCL statements before recompilation for Level 62. Compilation efficiency is aided by the fact that the Level 62 machine code is virtually identical to the IBM System/3 machine code. However, Level 62 offers a larger character set than IBM System/3, and different disc file formats. As yet, no conversion aids are offered for these.

For NCR 4100 and Century series users, Honeywell offers a NEAT 3 to Level 62 Cobol source program translator. As yet, no disc file conversion aids are offered.

For Univac 9000 Series users, Honeywell offers a 2-pass disc file converter to Level 62 disc formats, but no special program conversion aids. These are virtually unnecessary, however, because the 9000 Series ANSI Basic Cobol is a compatible subset of Level 62 ANSI Cobol 74. Thus, Cobol source programs need only be recompiled after manual incorporation of GCOS 62 JCL statements.

The Univac 9000 Series RPG follows IBM 360/20 RPG definitions closely, so Univac 9000 Series users can use the RPG to RPG II translator available to IBM 360/20 users to produce Level 62 RPG II source code.

PERFORMANCE AND COMPETITIVE POSITION

Honeywell Series 60 Level 62 Systems are multiprogramming batch processing small business computers with a limited capability for real-time transaction processing. They are aimed at small- and medium-sized businesses which already possess a small computer, or at the very least, a unit record accounting system. These include Honeywell's own customer base of Gamma 10 card processor and small G-100 Series users. Level 62 offers an attractive migration path with adequate software conversion aids for these users as well as for users of comparable competitive equipment. More than any other level, Series 60 Level 62 has been designed to raid competitive customer bases. Both program and disc file conversion aids are offered for current users of the IBM 360/20, NCR 4100 and Century Series, and Univac 9000 Series.

Level 62's main competitors are the IBM System/3 Models 10 and 15: Level 62 uses the same machine instruction code as System/3 and a similar range of main store sizes, peripherals including disc subsystems, and programming languages. Competition between the two systems will be particularly fierce in Italy, where both systems are manufactured and the small-to medium-size market has been dominated in recent years by System/3 and the Honeywell G-100 Series.

Other competitors include the Burroughs B 1714 and B 1726, ICL 2903, NCR Century 75 and 150, Siemens System 404/3, and Univac 9200, 9200II, and 9300. How do Level 62's facilities compare with those of its competitors?

The Level 62 system architecture is more advanced than that of most of the competing small business computers: They use single-processor architecture; Level 62 uses multi-processor architecture, with all I/O functions, including error checking and retries, delegated to an autonomous I/O Processor which operates in parallel with the central processor. This should give the Level 62 CPU a higher throughput, but this will be apparent only on processor-limited tasks, which are mostly scientific/mathematical. Level 62 is not likely to compete in this market as long as it does not offer users at least a Fortran compiler. A Fortran compiler is currently being written in England, but no release date has yet been announced.

Users will find the Level 62's error checking and prevention features more relevant to their needs. The duplication of arithmetic and address calculation circuits means that machine errors caused by a component's intermittent failure will be prevented or detected more frequently at the time they occur, thus avoiding many costly reruns.

Level 62 GCOS offers more advanced multiprogramming facilities than IBM System/3, ICL 2903 and Siemens 404/3, but it is no more advanced than the Burroughs B 1700 series facilities. It offers variable-length multiprogramming of any number of user programs that will fit into main memory, with automatic dynamic relocation of uncompleted programs when a program is unloaded to consolidate all spare memory areas ("garbage collection"). Unlike Burroughs MCP II on the B 1700 Series— and GCOS on all other Series 60 levels – GCOS 62 is not a virtual memory operating system: apart from user defined overlays, entire programs must be loaded into main store to be executed.

Users will find it safer to use the Level 62 multiprogramming facilities for testing new programs during normal working hours. Protection features make it quite impossible for any untested rogue program to corrupt production programs or the operating system itself.

In some other respects, Level 62 is currently weaker than its competitors. The unavailability of a Fortran compiler has already been noted, but this is only temporary. More serious are its limitations in the data communication field: Up to four (62/40) or nine (62/90), Teletypewriter, bank teller and/or CRT display terminals can be connected for real-time file enquiries and simple transaction processing programs. At this time, Honeywell does not offer any software for using terminals as direct data entry stations, comparable to the IBM System/3 Model 10 and ICL 2903 facilities. Currently, remote batch terminals cannot be connected to Level 62 systems, whereas they can be connected to IBM Systems 3/10 and 3/15, Burroughs B 1726, NCR Century 75, and Univac 9200II. Unlike any of its competitors, including the ICL 2903 and Siemens 404/3, Level 62 systems cannot be used as intelligent remote job entry terminals or data concentrators to larger Series 60 systems.

Honeywell has imposed these limitations on Level 62 for marketing rather than technical reasons. They are designed to prevent costly duplication of facilities between the Italian-designed Level 62 and the French-designed Level 61. The latter offers all the direct data entry, data concentration, and intelligent RJE terminal facilities missing from Level 62. This weakens Level 62, nonetheless, in competing against manufacturers with less heterogeneous product lines.

In offering extensive software program and file conversion aids to current IBM 360/20, NCR Century, and Univac 9000 users, Level 62 will occasionally be in competition with substantially more powerful systems, such as the IBM System/370 Model 115, Unidata 7.720, and Univac 9480. Level 62 is substantially less powerful than these systems in I/O throughput and simultaneity, range of languages, data communications facilities, and, on IBM and Unidata, virtual memory programming. But it will also be substantially cheaper, and will appeal to users who do not require the additional power offered by IBM, Unidata, or Univac.

CONFIGURATION GUIDE

A minimum Model 62/40 configuration has the following components:

- Central Processor.
- MOS/LSI Main Memory of 49,152 bytes: The first 24,576 bytes are reserved for I/O firmware microprograms and the GCOS 62 operating system.
- Input/Output Processor with six channels.
- One MSU 0112 cartridge disc drive, with one fixed and one exchangeable disc drive, each drive holds 5.8 million bytes; the drive connects to IOP Channel 1.

- Card Reader, 600 or 1,050 cards per minute, connects to Channel 3.
- Line Printer, 400, 600 or 800 lines per minute, connects to Channel 2.
- System Console: Keyboard and 30 characters per second printer, connected to Data Communications Controller on Channel 5.
- Single or twin magnetic tape cassette drive, 700 bytes per second, connected to Channel 6.

The MOS/LSI main memory can be expanded in 8K-byte increments to a maximum of 90,112 bytes. An additional MSU 0112 fixed/exchangeable or MSU 0113 exchangeable cartridge disc drive can be added to the Mass Storage Controller on Channel 1 for an online disc capacity of 16.1 or 23.2 million bytes. Four data communication lines can be added to the Data Communications Controller on Channel 5 to connect local and/or remote teletypewriter, bank teller or CRT display terminals.

Channel 4 is a spare and can be used to connect either a card punch (120 cards per minute) or a paper tape subsystem with reader (600 or 1,000 characters per second) and punch (110 characters per second).

I/O operations are simultaneous on all channels under I/O Processor Control. Data communication transfers on Channel 5 to/from the console keyboard, printer and four communication lines to/from terminals are multiplexed.

The basic Model 62/60 configuration differs from the minimum 62/40 configuration in the following ways:

- Minimum 62/60 main memory is 65,536 bytes.
- The card reader and line printer are connected to two of the four subchannels of the Unit Record Multiplexer on Channel 4. This leaves two multiplexer subchannels, as well as Channels 2 and 3 as spares for additional peripheral subsystems.

In addition, Model 62/60 can be expanded much further than the 62/40.

The MOS/LSI main memory can be expanded in 8K-byte increments up to a maximum of 131,072 bytes. Online backing disc storage can be expanded beyond 23.2 million bytes by the substitution of MSU 0310 exchangeable multiplatter discpack drives. Each MSU 0310 drive can hold one 11-disc high pack with a capacity of 29.2 million bytes. Up to four MUS 0310 drives can be connected to the Mass Storage Controller, giving a maximum online disc capacity of 116.8 million bytes.

The spare I/O Channels 2 and 3 can be used to connect one or two industry-compatible magnetic tape subsystems. Each subsystem comprises two, four, or six tape drives. A choice of two subsystems is available: reading/recording 9-track, 1,600-bit-per-inch magnetic tape at 30,000 or 60,000 bytes per second. Each subsystem can include one or more 7-track NRZI drives for reading/recording 7-track tape at 556 or 800 bits per inch for transfer rates at 10,425/15,000 and 20,850/30,000 characters per second.

Five additional data communication lines can be connected to the Data Communications Controller on Channel 5, for a combined total of nine data communications lines. Individual lines can be asynchronous, 75 to 1,200 bits per second, or synchronous, 2,400 to 9,600 bits per second. Synchronous lines can connect only to buffered VIP 7700 CRT display terminals. Remote batch terminals or other computer systems cannot be connected on-line to any Level 62 system.

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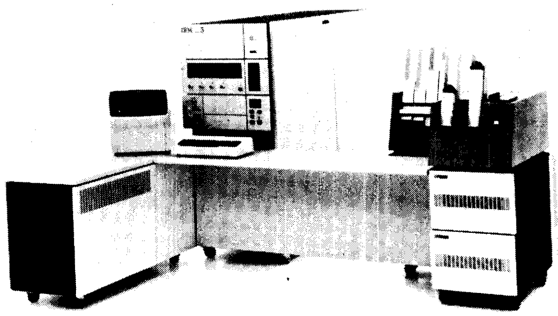

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OVERVIEW

IBM's System/3 is a line of small business computers that can satisfy the general-purpose EDP requirements of nearly all except the smallest of small computer users. The line runs the gamut from the Model 6, which is an interactive disc-based system with a minimum system only a few steps above programmable accounting machines, to the batch-oriented model 15 that in many ways can compete with the System/370 Model 115. The line as a whole, and particularly the Model 10, has proved to be one of IBM's most successful products. It is definitely the system against which all other small business systems compete in the marketplace.

The System/3 is probably the most popular single system that IBM has ever produced; over 25,000 systems have been installed. Part of its popularity lies in its surprisingly fast and efficient internal processing speeds and in the relatively low-cost power of the system. The versatility of the system makes it likely that it will have a longer life than IBM's larger computer series — satisfied System/3 users would frequently rather obtain multiple System/3s than move up to the 370 line although it remains to be seen whether this trend will continue when users expand to the limits of the Model 15 now available. Model 10 was announced in June 1969, Model 6 in October 1970, Model 15 in July 1973, and Model 8 in September 1974. All systems except Model 8 are delivered and currently in production. Model 8 is scheduled for delivery in June 1975.

Model 6

System/3 Model 6 is a small, general-purpose, commercial data processing and interactive, problem-solving system. A minimum Model 6 configuration consists of a central processor (the operator console-keyboard is part of the Model 6 CPU), a disc storage system (2.45 million bytes), and a serial printer. The system is aimed at the segment of the small business computer market that currently uses mixed data processing methods. Model 6 appeals to users with environments characterized by diverse applications now handled by manual methods, assisted by small calculators, bookkeeping machines, accounting machines or ledger card machines. These include novice users who require financial (bonds and lease analysis, rate of return) accounting; scientific or interactive processing; data input; and engineering and mathematical problem solution. The Model 6 is also intended for small businesses that subscribe to a time-sharing or service bureau system. In these settings, large data files and high-speed throughput aren't required. Rather, the prime criteria of the basic system design is to perform the wide range of tasks more effectively than by present methods.

Model 8

Model 8 is a disc-based system oriented toward batch processing but with facilities for on-line terminal applications and for remote communications via the Binary Synchronous Communications Adapter and an Integrated Communications Adapter. A minimum system includes CPU, 16K words of MOS memory, a printer, disc, and either a keyboard printer or a data station. The system can be expanded to include up to 64K words of memory, more disc, and a variety of peripherals including a 4-32 unit display subsystem. Model 8 peripherals are similar to Model 10 peripherals but lack the card I/O and I/O facilities available to all three of the other models. On the other hand, communications facilities are nearly comparable since two local and one remote medium-speed BSC terminal can be attached via ICA (although only one can be operative at any given moment), and an additional high-speed BSC adapter can also be attached. The communications and display subsystem capabilities, combined with the lower cost of the Model 8, make this system stronger in the intelligent terminal market against the clustered CRT terminal systems produced by several independents.

Model 10

Model 10 is a batch-oriented system that can be either card-based or disc-based. The two types of systems encompass different data storage media and data management techniques, each allowing a range of memory sizes running from 8K to 48K bytes and a variety of peripheral options. A minimum system in either case consists of CPU, 8K bytes of memory, printer, and card unit, with disc storage optional. Model 10 card-oriented systems appeal to present users of electromechanical punched card accounting systems; these users can keep the 80-column cards or switch to the more compact 96-column card handled by the multifunction card unit which can read, punch, interpret, sort, and collate cards. Model 10 can also serve as an upgrade for the Model 6 but not without severe growing pains. The versatility of the Model 10 system allows it to operate as a turnkey system for novice computer users or to perform the complex operations required by moderately experienced users.

Model 15

The Model 15 is currently the largest computer in IBM's System/3 series of small business computers. A minimum system includes the CPU, 48K bytes of memory, cartridge disc, printer, card unit, and display. Two lines of submodels are specified depending on whether or not the CPU can attach the 3340 Direct Access Storage Facility. Memory capacity is 48K, 64K, 96K, or 128K bytes. The Model 15 has more facilities than the Model 10: some new processor instructions, larger memory, more on-line disc storage, and a multiprogramming operating system. It also uses the MOS memory technology of IBM's System/370 Models 115 and 125 and the new System/3 Model 8 instead of the core storage used in the System/3 Models 6 and 10. The Model 15 has basically the same communication offerings as the Model 10; a special option, however, can provide for up to eight communications lines instead of the limit of two that are currently available as standard with both the Model 10 and the Model 15. IBM is stressing the system's use in a teleprocessing and remote data entry capacity. Model 15 represents, at least temporarily, the upgrade that Model 10 users have been hoping for; it offers more main storage capacity at prices reasonably proportionate to those of the Model 10; it offers twice the on-line disc capacity (over 80 million bytes, compared to the 40 million bytes of the Model 10); and it also offers multiprogramming and spooling that were available only from independent vendors for the System/3 Model 10.

SYSTEM DIFFERENCES AND CONVERSION PROBLEMS

While it is possible to move up from one system to the next higher one because of the RPG II language common to all systems, this type of upward movement has many attendant problems. The processors for all systems are different and cannot be field-upgraded. Model 15 A series systems can be field upgraded to B series processors, and Model 8 A14, A16, and A17 processors can be upgraded to a larger Model 8 A Series processor. Model 6 can use a BASIC compiler/interpreter not available on the other three models, so programs in this language must be rewritten. Peripherals for the smaller systems are not always used on larger systems; for example, a Model 6 user must change printers when moving to Model 8 or 10; depending on the model, he might have to change it again when moving to a Model 10 or 15. Tapes and cartridge discs, however, can be transferred, and the RPG disc file structure is identical on all systems; thus, Model 6 can use the Models 8, 10, and 15 RPG II files, for example. This kind of compatibility does not extend to the new B series Model 15 processor completely, since the 3340 uses a different "pack" and the B series cannot be operated as a Model 10 disc system. Models 8, 10, and 15 share the capabilities of FORTRAN and COBOL compilers as well as RPG II. The Models 8 and 10 both use Model 10's SCP, so these two systems have the greatest degree of program compatibility. The Model 15 can run object programs under the Model 10 SCP, provided the I/O is the same and Model 10 SCP is used instead of the Model 15's multiprogramming operating system. Model 8 programs can also run on the 15 in Model 10 simulation mode. Model 15 users must recompile all Model 10 programs if they choose the new multiprogramming operating system, however. Table 1 presents the main differences among the models.

Table 1. IBM System/3: Differences Among Models

Characteristic	Model 6	Model 8	Model 10	Model 15
SYSTEM				
Orientation	Interactive	Batch & interactive	Batch	Batch
Disc-Based	Std	Std	Opt	Std
Multiprogramming	No	Yes, 2	No, 2 opt	Yes, 2 levels
Max Main Memory (K bytes)	16	64	48	128
Max Disc Memory (M bytes)	9.8	9.8	50.7	91.7, 164
PERIPHERALS				
Disk Pack Subsystem	No	No	Option	Option
Magnetic Tape	No	No	Option	Option
Card Equipment	Std	No	Std	Std
Line Printer	No	Yes	Option	Option
Communications	1-line option	2 local, 2 remote	2-line option	2-line option
Magnetic Stripe Ledger	Yes	Yes	No	No
OMR	No	Yes	Yes	Yes
Data Station Keyboard	No	Yes	Yes	No
LANGUAGES				
BASIC	Yes	No	No	No
RPG II	Yes	Yes	Yes	Yes
FORTRAN	No	Yes	Yes	Yes
COBOL	No	Yes	Yes	Yes
Assembler	No	Yes	Yes	Yes

System/3 users know they can go nowhere without conversion pains except to more 3s. The System/360 and 370 computers are incompatible with the 3s.

IBM System/360 Model 20 simulation is unavailable for the System/3 Model 15 from IBM; it is available from independent vendors for the Model 10. System/3 Model 15 users who are upgrading from System/360 Model 20 will have to convert their RPG II programs, if they stick with only IBM offerings. In perhaps a year or two, System/3 Model 15 users will be exactly where the Model 10 users were before the Model 15 announcement — nowhere to go except to more 3s without conversion pains. Of course IBM could continue its commitment to System/3 by announcing still another model to move up to. So far their approach has been to expand the Model 15 disc storage capacity and to add the Model 8 in the middle of the line instead, so it is difficult to predict what the company will do.

PERFORMANCE AND COMPETITIVE POSITION

Because of the wide range of capabilities available with the System/3, the product line competes with most small business systems on the market, except perhaps at the very lowest level.

The Model 6 provides competition for interactive systems like those made by Basic Four, Cascade Data, Honeywell, and Burroughs. In addition to these systems, which are mostly disc-based interactive systems in the $25,000-$30,000 range for comparable configurations, there are a number of intelligent terminals that can be expanded to compete with System/3 Model 6 and even System/3 Model 10. Many of these have developed software to support business processing. Four Phase, Datapoint, and Mohawk all have competing systems.

System/3 Model 6 does not support multiprogramming, so a user with several data entry stations or terminals operating concurrently can often combine this with capabilities close to those of System/3 Model 6 in an expanded intelligent terminal or a system like the Basic Four. In addition, the upper end of several lines of programmable accounting machines (Burroughs, Litton, Nixdorf) compete with the smaller Model 6 configurations.

The most important feature of the new Model 8 is its price, which is substantially lower than that of any other model in the System/3 line. The purchase price of the 5408 processor with 16K bytes of main memory is $26,100 as compared to $35,900 for a 16K-byte 5406 and $29,100 for a 16K-byte, disc-system 5410. The 5408 with 48K bytes of memory costs $34,100 as compared to $63,000 for a 48K-byte 5415 that supports the 5444 disk drives. The new 5415B Models that support the 3340 cost even more; the B17 48K-byte 5415 Model costs $92,000.

The 5408 price is still not low enough to make it price competitive with disc-based systems from other manufacturers, such as the DEC Datasystem 500, but it is low enough to replace some disc-oriented Model 10s that require only the 5444 disk drives.

System/3 Model 10 can range from configurations as small as those used for the Model 6 that is, smaller than the Model 8 to configurations of considerable power and capacity inherent in a system with 48K bytes of core and 50.7M bytes of disc storage. Model 10 is a batch system, finding competition among systems that compete with Model 6 but that can be adapted for batch processing (which includes most of them). Offerings by major manufacturers, such as the Honeywell 105 and 115, Burroughs B 1700 Series, and Univac 9200, also compete directly with System/3 Model 10. Model 10 does not compete with on-line multiterminal systems such as the DEC Datasystems 500; the new Model 8 is better than the 10 for this market.

The System/3 Model 15 finds its competition mostly among major manufacturers including Burroughs, Honeywell, and Univac, as well as IBM's own System/370 Model 115. Given around 96K bytes of core, the Burroughs B 1728, IBM 370/115, Honeywell 2030, and Univac 9200 can all be configured into systems of comparable price, within $1,000 of each other. Most of the non-IBM systems can be expanded to memory capacities considerably beyond IBM's.

One notable weakness of all System/3 models in the face of their competition is the limitations on communications capability. At every level the user can find processing power comparable to that of System/3 but with greater numbers of communications channels and frequently more variety in terminals. Many have emulators enabling them to communicate with systems from several vendors, which is handy for mixed shops. Many can be multiprogrammed, allowing several (local or remote) terminals to operate concurrently.

IBM's advantage, aside from the inherent efficiency and power of System/3 lies in the excellent service, software support, and stability that is one of IBM's claims to fame. Software for System/3 is particularly extensive; other manufacturers find this element of System/3's reputation particularly hard to beat. On the other hand, independent vendors and other mainframe manufacturers offer lower prices and other added attractions to maintain a competitive profile against the industry giant.

Most of the American-based companies market in Europe and Japan, and many are slowly making their way in other parts of the world. There they meet additional competition particularly from Europe where small business systems are very popular. A great deal of the competition comes at the interactive level, but Nixdorf, Philips, and ICL offer lines that compete with System/3 at all levels.

USER REACTIONS

A random sampling of System/3 users produced evidence of overall satisfaction with the systems. The Model

10 is the preponderant model in the field, and it is usually disc-oriented. Typical applications for both Model 6 and 10 are invoicing, accounts payable and receivable, payroll, general ledger, sales statistics and reports, inventory control, and order processing. The users interviewed included a major Eastern city's traffic court center, clothing manufacturers, a dairy, a wholesale food distributor, various piece goods manufacturers, a realty firm, a holding company, a furniture company, and a manufacturer of picture frames.

Most users programmed in RPG II and found the language well-suited to the business-type applications. One user said RPG II is not good for complex file handling, but the language is quite satisfactory for his use. A few users programmed in COBOL. One COBOL user felt there would be fewer conversion problems with the COBOL programs when the company eventually expands to an IBM 370 machine. Another COBOL programmer used the language because he was familiar with it.

Users commented on ease of programming and running the System/3. Reliability was an often-used word describing the System/3. Most users found the maintenance to be good to excellent, with a response from IBM within a couple of hours. A rural manufacturer of novelty items chose IBM because of its good service in non-metropolitan areas.

We asked the users why they picked the System/3. In response, many said they had IBM equipment in the past, often a 360/20, and did not want to change vendors when changing equipment. One user expressed fear of other products and bought IBM's reputation. Another hired a consultant to evaluate his data processing needs and was urged to buy IBM systems. A great number of users went the IBM route because of IBM's software, back-up support, and training. One user said that even though the IBM equipment is more expensive in the beginning, the lack of downtime, the software, and system backup make IBM cheaper in the end. Another user thought converting from IBM equipment to another manufacturer's computer was too expensive.

When looking for a computer system, the users interviewed had variously investigated the Burroughs B 1700, Univac 9200, 9300, and 90/30, GE 200, NCR Century Series, Honeywell equipment, and the Singer-Friden machines. Some users investigated no manufacturer other than IBM and accepted IBM's recommendation on the type of equipment needed.

Most users realize that even though their present system is satisfactory for their needs, they may face more demanding data processing situations in the future. System/3 users plan to change from card-based to disc-based system, add more disc storage and a faster printer, or increase the core memory. Some users also see the need for a larger system than the Model 10. Two users have ordered Model 15s and another plans to order one within a year. In deciding on a Model 15, these users did not investigate any other manufacturers. They had been pleased with their Model 10s, and they said the cost of conversion from one manufacturer's system to another was too great. When the Model 15 arrives, one user plans to add dealers' sales figures to the present sales analysis report. Another user is looking forward to the Model 15's dual programming.

The System/3 can use either the 80-column card or the shorter 96-column card. Users' opinions on the cards were divided. One user said the 96-column card costs less to buy and is more compact to store. Another user found the 80-column card superior to the 96-column card, because the 80-column card is the industry standard. A third user bought the Model 6 three years ago because it was the only small system available at that time that used no cards.

One manufacturer of System/3 peripherals used his Model 10 as a test vehicle for his product. He admitted to using and abusing the system. IBM had difficulty servicing the system since the system was kept in an unenclosed state.

One Model 6 user suggested IBM develop a power fail option in the event of an electrical failure. This user maintains a back-up file of all work processed each day for protection.

Amidst the praises for IBM and the System/3 were some dissatisfied customers. A general construction company needed a computing system to handle payroll, accounts payable and receivable, job costing, purchase orders, and management and control system for an apartment house the company owns. This user felt he was sold the IBM image and psychology. He objected to two major points with the IBM system. The first was salesmanship. The user was assured that anyone could run the Model 6. IBM underestimated the talent required for the system. IBM wrote a fair payroll package for them, costing $10,000. This package required 2½ days to process 100 payrolls. The user has since rewritten the programs. Four hundred payrolls are now processed in less than half a day. The second objection the user had was that the system is over-priced and that expansion is too expensive. The user felt that in 1970 the System/3 was a good product; today, he feels it is not a marketable system because of the competition from other systems. In reviewing his position with IBM, the user feels IBM underestimated the complexity of the company's needs. He feels IBM should have sold them a Model 10 initially. As a result of these complaints, the company is considering a Basic/Four system and DEC DATASYSTEM 300 or 500 as primary contenders for a replacement of their System/3. The company has also considered a Burroughs B 1700 and the NCR Century Series. The cost of conversion is the only factor against changing vendors.

A manufacturer of welding equipment bought independent memory for their Model 10 and has experienced maintenance problems with IBM because of this. The user feels he is being pushed into dumping the independent core memory and converting to all IBM equipment. He experienced difficulty with the memory on his system, but he was not able to pinpoint whether the IBM memory, the independent memory, or the interaction of the two was causing erroneous error messages. The reaction of IBM to this intrusion of outside vendors was to blame any and all system problems on the independent memory. The user described a situation in which a moving part on a printer had snapped from wear, and IBM blamed the independent memory for the failure. The user is thinking of getting rid of the Model 10 and replacing it with a Univac 90/30, a Burroughs B 1700, or a Honeywell machine. (Again, conversion costs play a part in the decision.)The user is also considering taking the route that IBM wishes him to — remove the independent core memory and convert to all IBM memory.

CONFIGURATION GUIDE

Configurations for the System/3 vary considerably and as a consequence, the four models are neither field-upgradable nor completely compatible. For an overview of the product line, it is easier to deal with each system separately. Specific peripheral characteristics are also outlined later.

Configuring an IBM system involves paying particular attention to a variety of requirements, prerequisites, and limitations specified by the manufacturer. For example, use of RPG II Telecommunications feature on the Model 10 requires a 12,288-byte system. Attaching the binary synchronous communications (BSC) adapter or the 1255 MICR unit requires the processing unit expansion feature on the Model 6. Frequently, an adapter is required to attach a unit to the system, as well as an adapter for the system on the unit; this is true of the data recorders and MICR unit. On disc or tape subsystems, expansion may be the substitution of a higher density drive or a multiple-drive unit, instead of the simple addition of a slave unit.

This report does not present all the ins and outs of the configurations of these systems, but rather it presents the broad outline, minimum and maximum systems, plus indications of knotty configuration areas. It is almost axiomatic that the existence of independent peripheral manufacturers for System/3 peripherals will probably stimulate IBM to create more and more complicated attachments to discourage outside vendors — unless government pressure changes IBM's tendency in this regard. Table 2 presents a summary of the peripherals available on each system.

System/3 Model 6

A minimum configuration for the System/3 Model 6 includes a 5406 processor with 8K bytes of memory, a 5444 Disk Storage Drive with 2.45M bytes of storage, and either a 5213 or 2222 Printer.

A Model 6 system can be expanded to include 12K or 16K bytes of memory, and 4.9M, 7.35M, or 9.8M bytes of disc storage. A maximum of one printer, one card I/O device, either one diskette I/O device (the 3741 data entry station) or one binary synchronous communications adapter, one display unit, and one magnetic card reader can be attached. The card I/O device can be a Model 129 buffered 80-column card data recorder or the Model 5496 96-column card data recorder.

System/3 Model 8

The minimum System/3 Model 8 consists of a 5408 CPU with 16K (A14), 32K (A16), 48K (A17), or 64K (A18) bytes of MOSFET memory, 5203 Printer (100, 200, or 300 lines per minute), 5444 Disk Storage Drive, and either a 5471 Printer-Keyboard or a 3741 Data Station connected directly to the CPU.

The CPU can support the Dual Program option that allows two programs to be independently loaded and simultaneously executed. A Dual Feed Carriage Control option for the 5203 printer is required to attach a dual feed carriage. The 8642 Universal Character Set control is required if more than 48 characters are used on the 5203. Only one 5203 printer is allowed on each Model 8.

The initial 5444 disc system can be expanded in the same way a disc on Model 6 is expanded. Like all other System/3 models, the Model 8 has a diskette option, in the diskette facilities on the 3741 data entry station.

A 7081 Serial I/O Channel option is required to connect a 1255 magnetic character reader or a 3881 optical mark reader. Only one 7081 is allowed per system and it cannot be installed on a system with the 2074 BSCA option. A 3741 data station Models 1 or 2 requires an 8220 attachment and the 3265 I/O adapter for connection to the Model 8. The 3741 programmable data station Models 3 and 4 require the 8220 and the 3266 I/O adapter. The System/3 Model 8 does not support the Application Control Language (ACL) for Models 3 and 4.

The 4645 Integrated Communications Adapter (ICA) allows up to three interfaces, two local (8,000 or 2,400 bits per second) and one remote (the 6202 medium-speed BSC), but only one can be active at a time because a manual switch is used to select the interface.

The 2074 Binary Synchronous Communications Adapter (BSCA) also allows the Model 8 to communicate in BSC mode with other remote computers and remote terminals, functioning as the controller or as a tributary in a multipoint network or operating on a point-to-point switched or leased line. An integrated modem (1,200 bits per second) is available as a special feature. Only one 2074 is allowed per system and it cannot be installed on a Model 8 with the 7081 serial I/O channel.

The following optional features are available for the 2074: Auto Call; EIA Local Attachment for one 3271 control unit, one 3275 display station, or one 2972 remote communications controller; Internal Clock; Integrated Modem (1,200 bits per second); Station Selection (when

Model 8 acts as a tributary on a multipoint communication line); and Text Transparency (allows transmission of 8-bit byte binary data as well as EBCDIC).

The 3271 Control Unit provides for the attachment of four to 32 devices in increments of four devices. The devices can be a combination of 3277 Display Station Model 1 (480-character display) or Model 2 (1,920-character display), 3284 Printer Models 1 and 2, and 3286 Printer Models 1 and 2. The 3275 Display Station is a single CRT display of 480 or 1,920 characters. The 2972 Controller can attach up to fifteen 2790 area stations to the Model 8.

A 4110 attachment is used to connect the 5471 Printer-Keyboard to the Model 8. The 5471 is also used on the Model 10. It consists of a Selectric® typewriter and printer that operate independently under program control. The printer speed is 15.5 characters per second.

System/3 Model 10

The minimum configuration for a System/3 Model 10 includes a 5410 processor with 8K bytes of memory, 5203 or 1403 printer, 5422 Disk Storage Drive enclosure, and either a 5424 Multifunction Card Unit (96-column) or a 1442 Card Reader/Punch (80-column). The 5422 is required regardless of whether or not a 5444 Disk is included. Processor Models A2 through A7 use discs, while A12 through A17 do not use discs.

The minimum system can be expanded to include up to 9.8M bytes of disc cartridge storage in the same way the Model 6 is expanded. The System/3 Model 10 can connect the same drive as the Model 6 and, in addition, another series of faster drives with a number of high-performance features. In addition, a 2314-type of disc subsystem using 2316 packs allows up to 40.96M more bytes to be on-line: two 20.48M-byte drives or one 40.96M-byte drive. Like the Model 6, the Model 10 can also attach the 3741 data entry station which contains diskette drives.

Also Model 10 can attach a magnetic tape subsystem of up to four drives. Card equipment is entirely different on the two systems because Model 10 can't attach Models 5496 or 129 units, but it can attach Models 5424 (96-column) and 1442 (80-column); each is available for operation at several speeds. Printers available for the Model 10 are also faster: 5203 Line Printer or that old reliable 1403; here again, the printers for System/3 Model 6 cannot be used with Model 10. In addition, either a 5471 Printer-Keyboard or a 5475 Data Entry Keyboard can be attached.

Other special peripherals for the Model 10 are the 1255 MICR Reader and a 3881 Optical Mark Reader; note that these peripherals as well as the 5471 require disc subsystems and at least 12K bytes of memory. Another peripheral for the Model 10 that also requires a disc is a CRT display selected from several models. The CRT, like the diskette, uses a 4765 Local Communications Adapter that supplants the 2074 BSC Communications Adapter, but Model 10 allows attachment of a second 4765 which can in turn attach a Model 2084 BSC adapter, but not another diskette or CRT. If a 2074 is included in the system, a 2084 can be included without a 4765. This allows any combination of two items selected from the BSC adapter, the MICR Reader-Sorter, and the CRT, but only one unit of a kind per system except a system can support two BSC Adapters.

System/3 Model 15

The major differences between the Model 10 and the Model 15 as far as configuration is concerned is the larger main memory and disc storage available on the Model 15; less significant are some differences in the printers and card units available. A minimum Model 15 system consists of a 5415 processor with 48K bytes of memory, 1403 Printer, 5444 disc for A models or 3440 disc for B models, either 5424 or 2560 card unit, and 3277 CRT with keyboard.

A minimum system can be expanded to 64K, 96K, or 128K bytes of memory, and disc storage can be expanded on the A models to include a disc pack subsystem with a storage capacity of 81.92M bytes (two 40.96M-byte drives). The 3340 disc system used on B models can be expanded from a 82M-byte minimum system to 164M bytes maximum, but B models cannot attach the 80M-byte disc pack subsystem. The A models can be upgraded to B models in the field. Card I/O includes all models available to the Model 10 plus the 2560 and 2501 Card Units (80-column). The 5203 Printer, 5471 Printer and 5475 Data Entry Keyboard, are not available for the Model 15; instead the 3284 Serial Keyboard/Printer is provided. Other Model 10 peripherals, the 3410/3411 tape drives, 1255 MICR reader, 3881 mark sense reader, 3741 data entry station, and 2074/2084 BSC adapters can be attached to the Model 15. The same basic rules for Model 10 apply to Model 15 expansion over and above the basic configuration, but in a few cases different adapter models and slightly different procedures are required to attach corresponding models to the 5415 processor.

MAINFRAME

The System/3 is a small, single-processor business-oriented system. Most features of the mainframe architecture are similar for the three models. The mainframe contains the main storage and facilities for addressing main storage, for processing data arithmetically and logically, and for controlling the I/O units. The CPU utilizes monolithic systems technology (MST), for circuit logic. The cycle time is 1.5 microseconds, the same for all three machines.

The basic addressable unit is an 8-bit byte; a ninth bit is added for parity checking. Data is coded in EBCDIC. The card code is a 64-character set using 6 bits; the small card can store up to 96 columns of information.

System/3 uses a 16-bit address, which can address up to 64K bytes. The Model 15 uses an Address Translation Table (ATT) to address memory beyond 64K bytes. The ATT consists of 32 registers, which can address up to 128K bytes of storage. The Model 15 supervisor loads the appropriate values into the ATT registers, which are then used to convert the 16-bit addresses in a user program into the 17-bit addresses required to address all memory.

Model 15 features that differ from the Models 6, 8, and 10 are CPU storage protection; program check interrupt; eight levels of interrupt; a mask interrupt capability; privileged mode operation; and operation end interrupt. The main storage is Metal Oxide Semiconductor Field Effect Transistor (MOSFET), the same as that of the Model 8 and System/370 Models 115 and 125; Models 6 and 10 use core memory. Models 8 and 15 also use the same error correction and checking (ECC) as that used in System/370. The ECC corrects single bit errors and detects double bit errors with no loss of processor time.

All systems use a cycle-stealing technique for handling blocks of I/O data, providing overlap of I/O transfers with processing. Devices are connected to the computer via attachments, not by channels, with two exceptions. The 1255 MICR and 3881 OMR device require a serial I/O channel. Most peripherals, mass memory devices, and options are field installable.

Model 15 has a 2-byte wide data path feature to increase I/O transfer rate for discs. This reduces the number of processor cycles required to satisfy I/O requests, and these cycles can be used for other tasks. Another I/O enhancement is scan/read for discs (5445 only); this permits the system to retrieve the index from the disc in a single rotation instead of two.

PERIPHERALS

Peripheral devices can be selected from a variety of slow-speed, high-speed, and special peripheral offerings. Table 2 shows which devices can be attached to which System 3 model. Model 6 can attach up to six peripherals in addition to those in the minimum configuration while Models 8, 10, and 15 can attach up to 15 each.

Slow-Speed Peripherals

Printers, 80-column card units, and 96-column card units are available.

5424 Multi-Function Card Unit Model A1 or A2. Uses 96-column cards: A1 reads/punches/prints at 250/60/60 cards per minute; A2 reads/punches/prints at 500/120/120 cards per minute. For System 3/10 and 15 only.

1442 Card Read Punch Models 6 and 7. Uses 80-column cards: Model 6 reads at 300 cards per minute, punches at 80 columns per second; Model 7 reads at 400 cards per minute, punches at 160 columns/second. For System 3/10 and 15.

2560 Multi-Function Card Machine. Uses 80-column cards: Model A1 reads at 500 cards per minute, punches at 160 columns/second; can also collate, interpret, and print documents. For System 3/15 only.

1403 Printer Model 2, 5, or N1. 132 print positions; printing speed, respectively, is 600, 465, and 1,100 lines per minute. Model 5 for System 3/15 only, others for either System 3/10 or 15.

2501 Card Reader Model A1 or A2. Reads 80-column cards; 600 and 1,000 cards per minute, respectively. For System 3/15 only.

5213 Printer. 132 print positions, 85 or 115 characters per second, dot matrix; with pin-feed platen, vertical forms control tractor, or vertical forms control combined with bidirectional print. For System 3/6 only.

2222 Printer. 220 print positions and two sets of forms tractors, including ledger card device, with or without bidirectional print. For System 3/6 only.

5496 Data Recorder. 96-column cards; reads, punches, prints up to 22 cards per minute; keyboard, can be used off-line. For System/6 only.

129 Data Recorder. 80-column cards; buffered; reads 50 cards per minute; punches and/or prints 12 to 50 cards per minute; keyboard can be used off-line. For System 3/6 only.

5203 Line Printer. 96, 120, or 136 columns at 100, 200, or 300 lines per minute. Models 1 and 2 are chain printers, Model 3 is train printer; optional dual feed carriage. For System 3/8 or 10 only.

5475 Data Entry Keyboard. For dedicated on-line data recording using 5424 card unit and a system program. For System 3/10 only.

5471 Keyboard Printer. 15.5 card-per-second printing; requires 12K bytes memory and disc. For System 3/8 or 10 only.

3741 Data Station. 240-character CRT, keyboard (Model 1); Model 2 adds BSC (1,200/2,000/2,400 baud); Model 3 programmable in APL; Model 4 like Model 3 but with BSC added. For System/3 Models 6, 8, 10, and 15.

High-Speed Peripherals

Discs and magnetic tape drives are available. The tape and 3340 disc drives are those used on the System/370 models, but the cartridge discs are not.

Table 2. IBM System/3: Summary Configuration

SYSTEM	Model 6	Model 8	Model 10	Model 15
CENTRAL PROCESSOR				
Models	5406; B2-B4	5408; A14, A16, A17, A18	5410 A2-A17	5415; A17-A20, B17-20
Memory (K bytes)	8K, 12K, 16K	16K, 32K, 48K, 64K	8K, 12K, 16K, 24K, 32K, 48K	48K, 64K, 96K, 128K
DISC DRIVES				
Cartridge Max, M bytes	9.8	9.8	9.8	9.8
Models	5444* Mdls 1, 2,3	5444 Mdls A1, A2, A3	5444* Mdls 1, 2, 3, A1, A2, A3	5444* Mdls A2, A3 (for 5415 A Mdls only)
Pack, Max, M bytes	–	–	40.96	81.92; 82 to 164
Models	–	–	5445* Mdls 1, 2, 3	5445* Mdls 1, 2, 3 (for 5415 A Mdls only); 3340 Mdls A2, B1, B2 (for 5415B Mdls only)
DISKETTE	3741 Mdls 1-4, data station	3741, Mdl 1-4 data stations	3741 Mdls 1-4 data stations	3741 Mdls 1-4 data stations
DISPLAY	2265 Mdl 2	3275 or 3271 with multiple 3277s & 3284/3286 printers	3277 or 3275, Mdls 1, 2	3277 Mdl 1
PRINTERS				
Serial Printers	5213 Mdls 1, 2, 3, or 2222	5471	5471* Mdl 1	3284* Mdl 1
Line Printers	–	5203 Mdls 1, 2, 3	5203* Mdls 1, 2, 3, or 1403 Mdls 2, N1	3284* Mdl 1, 1403* Mdls 2, 5, N1
CARD I/O				
96-Column	5496 Mdl 1	–	5424* Mdls A1, A2	5424* Mdls A1, A2
80-Column	129 Mdls 1, 2, 3	–	1442* Mdls 6, 7	1442* Mdls 6, 7 2560* Mdls A1,A2 2501* Mdls A1, A2
Optical Mark Sense	–	3881	3881 Mdl 1	3881 Mdl 1
MICR	1255 Mdls 1, 2, 3	1255 Mdls 1, 2, 3,	1255 Mdls 1, 2, 3	1255 Mdls 1, 2, 3
BSC COMMUNICATIONS	2074	6202(1) and 2074	2074 (1st) 2084 (2nd)	2074 (1st), 2084 (2nd)
MAGNETIC TAPE	–	–	3410/3415* Mdls 1, 2, 3	3410/3411*, Mdls 1, 2, 3
OTHER PERIPHERALS	2222 includes ledger card device		5475 data entry keyboard	–

Notes:
* Denotes special attachments required.
(1) Attaches to 4645 Integrated Communications Adapter, which supports 2 local lines and 1 remote line.

5444 Disc Storage Drives. Combination unit with one removable and one nonremovable disc; 200 cylinders on each disc; 4.9 million bytes capacity per drive; usable with all processors. System 3/6 uses submodels 1, 2, and 3; System 3/15 uses A2, and A3; System 3/10 uses both sets of models plus an A1 model; System 3/8 uses the A1, A2, and A3 models.

5445 Disc Storage Drives, Models 1, 2, 3. Removable pack; 20.48M bytes capacity on Models 1 and 2, 40.96M on Model 3; 60-millisecond average access time; Model 2 is attached to Model 1, two Model 1 drives (and therefore two Model 2s) can be attached to System 3/10 and 15. One or two Models 3s or a combination of one Model 2 with a Model 3 can be attached to the System 3/15.

3340 Direct Access Storage Device. Uses 3348 data module with spindle, access arms, read/write heads, discs in sealed module; 41.04M bytes data and 9.83M bytes program support per module; 164M bytes data and 39M bytes program maximum/subsystem, 25 milliseconds average access, 885K bytes/second maximum transfer rate; for Model 15 B series processors only.

3410/3411 Magnetic Tape Unit and Control, Models 1, 2, 3. Recording density is 800 or 1,600 bits per inch; 7- or 9-track tape; transfer rates are 20K, 40K or 80K bytes per second; used with Systems 3/10 and 15 only.

3741 Diskette. I/O rates are 1,500 records per minute for reading and 1,000 records per minute for writing. These calculations are based on 128K-byte records, on a dedicated system without spooling, multiprogramming, or dual programming. The 3741 is double buffered. A direct attachment is available to connect the 3741 to the System/3. For Models 6, 10, and 15.

Special-Purpose Peripherals

A magnetic character reader and an optical mark reader can be attached via the optional Serial I/O Channel.

1255 Magnetic Character Reader, Models 1, 2, 3. Reads/sorts 6-inch documents at speeds of 500, 750, and 750 documents per minute. The units have 6, 6, and 12 stackers, respectively. Used with all System 3 models.

3881 Optical Mark Reader. Reads documents 3 by 3 inches to 9 by 12 inches with marks made by number 2 pencils or appropriately equipped printers; for Models 8, 10, and 15.

2265 Display. Screen capacity is 15 lines of 64 characters each, requires 12K-byte memory; it cannot be used with 2222; for System 3/6 only.

3275 Display Model 1, 2. Capacity is 480-character (Mod 1) or 1,920-character (Mod 2) display and keyboard; requires 4765 Local Communications Adapter; cannot be used with 2074. For Models 8, 10, and 15.

3277 Display Model 1, 2. Capacity of 480 characters (Model 1) or 1,920 characters (Model 2) for display; includes keyboard; requires 3271 Control Unit and 4765 Adapter. Cannot be used with 2074. For Models 8, 10 and 15.

3271 Display Subsystem Controller. On Model 8. Attaches 4-32 devices in increments of four devices; devices can be 3277 Models 1 and 2, 3284 Printer Models 1 and 2, and 3286 Printer Models 1 and 2 in various combinations; for Models 8, 10, and 15.

DATA COMMUNICATIONS

One 2074 or two 2084 Binary Synchronous Communication Adapters (BSCA) provide synchronous transmission rates of 600 to 50,000 bits per second, on Models 10 and 15. Model 8 has a medium-speed BSC adapter (to 7,200 baud) attaching to an Integrated Communications adapter (two local lines, one remote) as well as the BSCA option. The BSCA adapters allow the System/3 to function as a processor terminal or a host or sub-host system.

The BSCA supports communication with System/3, System/7, Systems/360/370, 2770 Data Communication System, 2780 Data Transmission Terminal, 2972/2980 General Banking Terminal System, 3270 Display System, 3735 Programmable Buffered Terminal, and 3741-2 Data Station.

An EIA local feature permits attachment of one 3271 control unit or one 3275 display station without using a data communication line or modem. The 3271 can support a 4- to 32-unit display subsystem on Model 8.

The 4765 Local Communications Adapter (LCA) allows direct local attachment to a 3741 data station with a diskette. A 3271 control unit or a 3275 display station can also be attached locally via the LCA to provide single or clustered CRT display capability. The LCA excludes the first BSCA but not the second. Thus System 3/6 can use either communications or LCA devices but System 3/8, 10, and 15 can combine the two.

A special feature that will be priced separately and available only on specific request is the Multiple Line Terminal Adapter (MLTA) that provides attachment capability for IBM's low-speed start/stop terminals. Connection of one to eight communication lines with multiple terminals per line is possible. MLTA supports the 1050 Data Communication System, the 2740 Terminals, the 2741 Terminals, the CMCST (Communicating Magnetic Card Selectric Typewriter), and System/7, which is supported as a 2740-1.

SOFTWARE

IBM software is unbundled. The "System Control Programs" (SCP), which are operating systems, are available with the hardware at no charge, but language processors, utilities for optional and special-purpose peripheral devices and special features, and all application programs cost extra. The SCPs include disc-based systems for Systems 3/6 and 3/8, both disc-based and card-based systems for System 3/10, and a 2-level multiprogramming system for the System 3/15. The only language processors for System 3/6 are Basic and RPG II; Fortran, Cobol, assembly language, and RPG II are available for Systems 3/8, 10, and 15.

Operating Systems

With the exception of the Basic compiler-interpreter and some programs generated by the assembler, all programs run under control of the appropriate SCP. SCP control functions differ somewhat for card and disc-based systems, but they have certain executive functions in common, similar utilities, and the same I/O drivers for the minimum configuration.

System 3/6

Programs within SCP include a Disc System Management program to maintain a disc-resident system for creating and executing programs. It permits selective loading of programs from disc; program execution is under control of an Operation Control Language(OCL), interpreter, which provides a limited set of statements for the user to communicate with SCP; I/O control; and roll-in/roll-out operations. Roll-in/roll-out lets the system suspend a program during its execution, place it on disc, and bring in an inquiry program. Upon completion of the inquiry, the suspended program is restarted from the point of interruption.

The disc utility permits the user to prepare and maintain disc files; it performs initialization, alternate track assignment and rebuilding, file and volume display, and file delete. An overlay linkage editor creates loadable programs from multiple relocatables modules. A copy-dump program and a library maintenance program are also included.

System 3/8 and 3/10 Disc-Based SCP. The Model 8/10 SCP contains all of the features of Model 6 SCP plus a number of important communications features. These include Remote Job Entry (RJE) work-station support, which permits a system equipped with BSCA and EBCDIC (Extended Binary Coded Decimal Interchange Code) text transparency to submit OS/360 jobs over communications facilities. The system must be a System/360 Model H40 (262,144 bytes of memory) or larger or a System/370. A BSCA multiline/multipoint feature provides communications support when used with System/3 macro feature. Program counters, used to gather performance information, are maintained on disc file. "Dual programming", allowing two programs to run in two partitions, can be included in an expanded version of the Disc System Management Program.

Also included in the Model 8/10 SCP is a macro feature for support of the assembler, system initialization program, device counter log-out, various magnetic tape utilities (Model 10 only), and utilities to support the 5445 Disc Pack Drive.

System 3/10 Card-Based SCP. Actually the card-based SCP is a subset of the disc-based system because all systems use card I/O. Almost all features of the disc-based SCP are included except disc-related routines, the overlay linkage editor, and several communications functions that need disc support.

System 3/15 SCP. The Model 15 SCP is similar to Model 8/10 SCP but features multiprogramming and spooling, plus it supports the additional peripherals available for the Model 15, particularly the extra discs. Three new commands — LOAD CPU, STORE CPU, and COMMAND CPU — are used to support the multiprogramming environment.

Multiprogramming allows two programs to run at the same time in two memory partitions. Partition 2 has priority over partition 1.

Spooling allows data in input or output queues to be stored on disc for reading, printing, or punching at a later time. This significantly faster way of handling I/O has been available from independent vendors for System 3/10, but it was not available from IBM.

The Model 8/10 SCP will run on the Model 15, but it will not take advantage of the new processor features or the new SCP instructions.

Communications Software. The Communications Control Programs (CCP) used with System 3 allow high-level language access to MLTA and BSCA attached terminals. This includes resource management to reduce contention between programs accessing the same files, concurrent program execution to allow multiple application programs within the available storage partition, and terminal monitoring to accept data and terminal commands. Concurrent program execution within a partition creates subpartitions that can handle multijob streams.

The CCP is available for Models 8, 10, and 15; it includes support for Cobol, Fortran; and RPG II. CCP requires no additional hardware over the minimum configuration except, of course, an MLTA or a BSCA and at least one terminal. The programs are slightly different for the models because of the differences in operator interface.

A Multi-Leaving Remote Job Entry Work Station (MRJE/WS) Program allows any System/3 to operate as an RJE terminal to a System/370 under OS.

Language Processors

Report Program Generator II (RPG II). RPG II, the language common to all System/3 models, is a programming language oriented towards generating reports. The language is output-oriented, because the primary concern is delivery of clear reports based on file or input data. RPG II uses preprinted specification sheets that permit the programmer to specify the form of the input data; the operation to be performed on the data; and the output format, including line layout, page and paragraph headings, and page numbering. It simplifies the programming task and enhances the novice's programming capability.

RPG II is available in both card-based and disc-based versions appropriate to the individual model.

Some additional features are available for RPG II:

- RPG Telecommunications feature -- enables the system to transmit and receive synchronous data over communications lines; available in both card and disc versions.
- RPG II Auto Report feature — simplifies programming in RPG II by reducing much of the preparation and coding normally required to prepare users' applications programs; available in disc-based version only.
- Card RPG II Braille feature — supplies an option to list compilations and object programs in braille.

System 3/6 Only: BASIC. The BASIC language is a stand-alone interactive programming system, which uses a virtual memory concept to permit compilation and execution of programs that do not fit into available core storage. An optional feature of BASIC, DCALC, provides macros for such mathematical functions as addition, subtraction, multiplication, division, roots, and reciprocals; it thus can be used just like a calculator. Users who are unfamiliar with programming languages can use DCALC with ease.

BASIC includes a set of programs for system generation and disc pack use. The system disc stores system programs and user data files and provides for continuous execution of stacked jobs without requiring operator intervention.

System 3/6 Only: Stat/Basic. A comprehensive, interactive application program, Stat/Basic uses statistical techniques for analysis of numerical data. It consists of 40 procedures designed to aid the statistician, engineer, researcher, or business analyst by supplying him with the most commonly used statistical methods. Stat/Basic is used in association with an IBM System/360 system.

For System 3/8, 10, and 15 Only: BASIC ASSEMBLER, ANSI COBOL, FORTRAN IV.

BASIC ASSEMBLER. The ASSEMBLER is a symbolic programming language, machine-oriented for System/3; used to produce object programs. Some run under SCP, others are stand-alone programs.

System/3 Subset. ANSI COBOL. This subset of COBOL furnishes the user with the most widely accepted and used standard higher-level programming language. COBOL, which was originally designed for business applications, is available to Models 8, 10, and 15 systems.

System/3 Disc FORTRAN IV. The FORTRAN IV compiler provides a high-level programming language for the solution of scientific and mathematical problems; also available to Models 8, 10, and 15.

Program Products Other Than Language Processors

Program products vary with the configuration because many of the optional I/O drivers and support utilities fall into this category. A card-based Model 10 is a subset of the disc-based systems because both systems handle cards. Typical utilities include reproduce, interpret, 96-column list, MFCU sort/collate, data recording, verifying, and 80 to 96-column conversion. Disc-based systems include a disc sort facilitating sorting of sequential, indexed, and direct file formats in either ascending or descending sequence. The program provides six means of recognizing records.

Application Programming Systems

There are numerous application programming systems that are completely operational; the customer supplies information and parameters, and the systems are tailored to his needs. The required level of user programming effort depends on the specific application; it varies from none to forms design to writing RPG source programs. Customer responsibilities are delineated for each system.

A sample of the numerous application programs includes:

Hospital Accounts Receivable, Card-Based	Optimum Blending
Order Point Technique for Inventory Management	Appropriation Accounting
Card Bill of Material and Requirements Planning	Citation Processing
Apparel Business Control	Inventory and Requirements Planning
Hospital Patient Billing	Job Analysis System/3
Property and Liability Agency Accounting	Business Analysis/Basic
Utility Billing System	Health Welfare and Pension Fund
Law Enforcement System	System for Radio and Television
Unit Inventory Techniques	Shop Loading and Control
Bill of Material Processor	Health Welfare and Pension Fund

Application Customizer Service

IBM Application Customizer Service was developed for the small computer user. Small businesses are not financially able to invest in personnel to develop integrated programming systems for their applications. The Application Customizer Service allows each user to fill out a questionnaire relating to a particular application; the user specifies the content and layout of records and reports, identifies calculations required, and chooses processing procedures. Related jobs can be linked into an integrated family. The user punches cards from the questionnaire and sends them to an IBM Basic System Center where the cards are read as input to a System/360 Model 20. The Model 20 is programmed to run IBM's Application Customizer Program.

The 360/20 output supplies the user with all the necessary materials to prepare the computer program at his installation. The user must code the program, which is the easiest step in the process of generating it.

The Application Customizer Service is available for six major business application areas: order writing and invoicing (prebilling and post billing, automatic backordering, automatic selection of item prices or discounts), accounts receivable (open-item or balance forward method), inventory accounting (stock status reports), sales analysis (reports classified by item, product class, customer, or salesman), payroll (registers, paychecks, earning statements, etc.), and general ledger accounting (internal or client basis).

User Groups, Vendors, IBM Newsletter

User Groups. There are four independent organizations of IBM customers, supplying a wealth of information related to System/3. The user groups are: COMMON, NASU (National Association of System/3 Users), GUIDANCE, and GROUP/3. These organizations enable interchange of information, routines, programs, and programming packages among their members. Information services in the forms of newsletters or publications allow members to keep posted on available System/3 hardware and software (IBM and non-IBM).

Vendors. Many application programs are available from independent software houses. The programs can either be rented or purchased outright from the vendor.

IBM Newsletter. One of IBM's newsletters, the *Management Services Update*, announces new program products and user applications programs that apply to any of the IBM systems. System/3 applications have been receiving thorough coverage in order to demonstrate the utility of the system.

PRICE DATA

Model Number	Description	Monthly Rental $	Purchase $	Monthly Maint. $
	CENTRAL PROCESSORS AND WORKING STORAGE			
	IBM SYSTEM/3 MODEL 6			
5406	Processing Units with Keyboard (disc systems)			
5406-B2	8K	649	29,300	137
5406-B3	12K	777	35,200	143
5406-B4	16K	903	35,900	143
	Processor Options			
1550	Command Keys 9-16	21	990	1
5732	Processing Unit Expansion	37	1,750	7
7081	Serial I/O Channel	165	7,490	5
	IBM System/3 Model 8			
	Basic Processor (contains main storage and facilities for addressing main storage, arithmetic and logical processing of data, and controlling I/O units; includes housing for one or two 5444 disc drives)(1)	650	26,100	115
A14	16K Bytes	750	30,100	120
A16	32K Bytes	850	34,100	150
A17	48K Bytes	950	38,100	155
A18	64K Bytes			
	Processor Options			
3500	Dual Programming (capability to independently load and process 2 programs simultaneously)	127	5,830	1
7081	Serial I/O Channel	175	7,940	5
5732	Processing Unit Expansion	37	1,750	7
	IBM SYSTEM/3 MODEL 10			
5410	Processing Units (card systems)			
5410-A2	8K	361	16,400	42
5410-A3	12K	447	21,700	46
5410-A4	16K	611	22,400	46
5410-A5	24K	881	40,000	62
5410-A6	32K	1,145	40,700	62
5410-A7	48K	1,490	59,000	86
5410	Processing Units (disc systems)			
5410-A12	8K	508	23,000	92
5410-A13	12K	622	28,300	96
5410-A14	16K	754	29,100	96
5410-A15	24K	1,025	46,600	112
5410-A16	32K	1,285	47,300	112
5410-A17	49K	1,630	65,600	136

Model Number	Description	Monthly Rental $	Purchase $	Monthly Maint. $
	IBM SYSTEM/3 MODEL 10 (Contd.)			
	Processor Options			
3500	Dual Program	127	5,830	1
5501	Power Supply Expansion	55	2,290	1
5732	Processing Unit Expansion A	40	1,850	3
5733	Processing Unit Expansion B	21	816	1
5734	Processing Unit Expansion C	60	2,240	1
5735	Processing Unit Expansion D	21	816	1
7081	Serial I/O Channel	175	7,940	5
	IBM SYSTEM/3 MODEL 15			
5415	Processing Units			
-A17	48K	1,630	63,000	227
-A18	64K	1,740	67,000	232
-A19	96K	2,010	78,000	238
-A20	128K	2,225	86,000	248
B17	48K	2,310	92,000	235
B18	64K	2,410	96,000	240
B19	96K	2,660	107,000	245
B20	128K	2,860	115,000	255
	Processor Options			
5501	Power Supply Expansion	54	2,250	1
5733	Processing Unit Expansion 1	21	800	1
5734	Processing Unit Expansion 2	59	2,200	1
5735	Processing Unit Expansion 3	21	800	1
7081	Serial I/O Channel	172	7,790	7
	MASS STORAGE			
	Disk For Models 6 and 10			
5444-001	Disk Storage Drive	180	8,720	52
5444-002	Disk Storage Drive	297	10,400	52
5444-003	Disk Storage Drive	180	8,720	52
6378	Second Disk Attachment	50	2,420	5
	For Model 8 and 10 Only			
5444-A1	Disk Storage Drive	220	8,610	72
5444-A2	Disk Storage Drive	330	10,200	72
5444-A3	Disk Storage Drive	220	8,610	72
	For Model 10 Only			
4501	Higher Performance (1st disc attachment)	21	999	1
4502	Higher Performance (2nd disc attachment)	21	999	1
5422-001	Disk Enclosure	110	4,990	13
5440	Disk Cartridge (for all 5444 drives)	–	175	TM
5445-001	Disk Storage Drive	386	16,000	93
5445-002	Disk Storage Drive	368	15,300	88
3901	First 5445 Disk Attachment	551	20,400	36
3902	Second 5445 Disk Attachment	15	612	1
2316-001	Disk Pack	20	525	TM
	For Model 15 A Models Only			
	Disks			
5444-A2	Disk Storage Drive	330	10,200	72
5444-A3	Disk Storage Drive	220	8,610	72
5445-001	Disk Storage Drive	386	16,000	93
3901	First 5445 Attachment	540	20,000	36
3903	Second 5445 Attachment	81	3,000	1
5440	Disk Cartridge (for 5444-A2)		175	TM
5422	Disk Enclosure	100	4,900	12
	For Model 15 B Models Only			
3340 A2	Direct Access Storage Facility (1 control and 2 drives)	1,059	40,000	80
B1	One additional drive	592	22,000	43
B2	Two additional drives	747	28,000	69
	INPUT/OUTPUT			
	Punched Card (For Models 6 and 10)			
129-001	Card Data Recorder (reading 80-col cards at 50 cpm, and punching at 12-50 cpm; applies to all 129 models)	135	6,240	42
129-002	Card Data Recorder	151	6,990	46
129-003	Card Data Recorder	162	7,490	47
5486-001	Card Sorter	98	4,780	42
5486-002	Card Sorter	133	5,470	64
1225	Alphabetic Sorting	7	226	1
2370	Auxiliary Card Counter·	10	525	3
7245	Sort Suppress/Digit Select	10	525	1

Model Number	Description	Monthly Rental $	Purchase $	Monthly Maint. $
	INPUT/OUTPUT (Contd.)			
	For Model 6 Only			
1020	Accumulate	20	999	3
1025	Additional Accumulate Program Levels	5	249	1
1201	Auxiliary Storage	8	399	1
3215	Direct Punch Control	6	300	1
3610	Expansion Feature	10	499	–
3950	Feed, Variable Length	25	1,240	6
4601	Interpret	15	561	2
5570	Production Statistics	10	499	1
6065	Reading Board Extension	–	20	–
7503	Card Input/Output Attachment	76	2,670	11
8705	Verifying Read Control	6	300	1
9671	Special Character Arrangement ASCII	150 S	80	–
9677	Special Character Arrangement EL	150 S	80	–
5496-001	Data Recorder	158	7,750	55
3210	Data Recorder Attachment	40	1,990	2
3666	8-Bit Read/Punch	30	1,470	2
7061/2	Self-Checking Number Mod 10/11	30	918	1
7501	System/3 Attachment	45	2,240	11
7801	3735 Attachment	45	2,240	5
7850	2772 Attachment	45	2,240	15
	For Models 10 and 15			
1442-006	Card Read Punch (300 cpm reading; 80 cpm punching)	286	15,260	61
1442-007	Card Read Punch (400 cpm reading; 160 cpm punching)	416	16,430	72
4130	1442-006/-007 Attachment	193	8,870	15
5424-A1	Multi-Function Card Unit (250 cpm)	314	10,200	153
5424-A2	Multi-Function Card Unit (500 cpm)	472	13,500	220
4100	MFCU Attachment 250/60/60	85	4,530	14
4101	MFCU Attachment 500/120/120	102	5,750	14
	For Model 15 Only			
2501-A1	Card Reader (600 cpm)	210	11,870	38
-A2	Card Reader (1,000 cpm)	276	12,080	54
3630	2501 Coupling	5	162	NC
8090	2501 Attachment	150	6,700	7
2560-A1	Multi-Function Card Machine	665	29,150	106
1575/6/7	Card Print (first/second/third 2 lines)	145	6,350	15
1580	Card Print Control	25	1,250	3
8100	2560 MFCM	150	6,300	16
	Magnetic Tape			
	For Models 10 and 15			
3411-001	Magnetic Tape Unit & Control	437	17,300	77
3411-002	Magnetic Tape Unit & Control	557	21,900	82
3411-003	Magnetic Tape Unit & Control	675	26,700	88
7951	3411 Magnetic Tape Attachment	160	4,800	10
	For Model 10 Only			
3410-001	Magnetic Tape Unit	199	7,850	50
3410-002	Magnetic Tape Unit	264	10,500	55
3410-003	Magnetic Tape Unit	330	13,000	61
3211	Single Density (1,600 bpi; phase encoded)	58	2,550	8
3221	Dual Density (800 or 1,600 bpi; NRZI; only for 002 and 003 models of 3410 and 3411)	86	3,670	30
6550	7-Track	86	3,670	14
7003	Attachment to System/3 (for 3411)	81	3,210	3
	Printers			
	For Model 6 Only			
5213-001	Printer (pin-feed platen)	173	6,320	53
5213-002	Printer (vertical forms control)	216	8,160	72
5213-003	Printer (vertical forms control)	270	8,360	82
3901/2/3	Printer Attachment (for 001/2/3)	71	3,490	19
3960	5213 Mdl 3 Enhanced Print Rate Attachment	122	4,890	21
4450	Forms Stand Stacker	–	51	–
2222-001	Printer (unidirectional)	378	16,800	115
2222-002	Printer (bidirectional)	416	17,000	126
7951/2	Printer Attachment (for 001/2)	71	3,490	19
	For Model 10 Only			
5203-001	Printer (100 lpm; 96 positions)	262	11,400	74
5203-002	Printer (200 lpm; 96 positions)	319	12,700	83
5203-003	Printer (300 lpm; 96 positions)	470	17,700	139
8642	Universal Character Set Control	15	487	1

Model Number	Description	Monthly Rental $	Purchase $	Monthly Maint. $
	Printers (Contd.)			
	For Model 8 Only			
3970	5203 Printer Attachment for 100-lpm Printer	63	3,160	11
3971	5203 Printer Attachment for 200-lpm Printer	63	3,160	11
3972	5203 Printer Attachment for 300-lpm Printer	104	4,610	14
	For Model 10 Only			
3475	Dual Feed Carriage	85	3,960	22
3480	Dual Feed Carriage Control	26	1,310	1
3970/1	Printer Attachment (for 001/2)	59	3,160	10
3972	Printer Attachment (for 003)	96	4,610	13
4730	Additional Interchangeable Chain Cartridge	85	3,960	1
4740	Additional Interchangeable Chain Cartridge	119	2,960	36
5532	Additional Print Chain	–	975	–
5558	Additional Print Positions (24)	53	1,590	2
5559	Additional Print Positions (12)	26	795	NC
5560	Additional Print Positions (36)	79	3,380	2
8371	Type Subs (1st slug; chain)	15 S	5	–
8372	Type Subs (each additional; chain)	7 S	5	–
8373	Type Subs (1st slug; train)	20 S	15	–
8374	Type Subs (each additional; train)	15 S	15	–
8639	Universal Character Set Attachment	10	324	1
9950	Artwork per Character	–	100	–
9951	Matrix (per slug; 2 char)	–	150	–
9952	Set Up (for 2 char)	–	50	–
9953	Matrix (per slug; 3 char)	–	150	–
9954	Set Up (for 3 char)	–	50	–
5421-001	Printer Control Unit for 1403	286	12,900	29
1403-002	Printer (60 lpm)	810	30,210	188
1403-NI	Printer (1,100 lpm)	946	36,680	216
1376	Auxiliary Ribbon Feeding	78	2,745	17
1416	Interchangeable Train Cartridge (for NI)	98	2,960	TM
4140	Printer Attachment (for 002)	122	5,250	21
4150	Printer Attachment (for 003)	178	5,760	21
4740	Interchangeable Chain Cartridge Adapter	78	2,790	NC
5110	Multiple Character Set Feature (for 002)	10	410	2
5111	Multiple Character Set Feature (for NI)	10	410	2
5381	Numerical Print	235	8,055	10
5523	Preferred Character Set Feature	41	1,335	2
5532	Additional Print Chain	975	975	NC
6410/1	Selective Tape Listing (for N1/002)	198	7,220	11
6413	Selective Tape Listing Stacker	–	265	TM
6420	Selective Tape Listing (for NI only)	293	10,600	26
8371	Type Subs (first slug; chain)	15 S		–
8372	Type Subs (each additional slug; chain)	7 S		–
8640/1	Universal Character Set (for N1/002)	10	410	2
9950	Special Chain Artwork	–		–
9951	Matrix (per slug)	–		–
9952	Set Up (2-char slug)	–		–
	For Model 15 Only			
1403-002	Printer (600 lpm)	810	30,210	188
1403-005	Printer (465 lpm)	626	28,940	135
1403-NI	Printer (1,100 lpm)	946	36,680	216
4140	Printer Attachment (1403-002)	120	5,150	21
4135	Printer Attachment (1403-005)	110	4,700	21
4150	Printer Attachment (1403-NI)	175	5,650	21
5421	Printer Control Unit (for 1403)	260	12,740	26
	Magnetic Character Readers			
	For Models 6 and 10			
1255-001	Magnetic Character Reader (500 doc/min; 6 stackers)	870	39,400	231
1255-002	Magnetic Character Reader (750 doc/min; 6 stackers)	1,060	45,100	368
1255-003	Magnetic Character Reader (750 doc/min; 12 stackers)	1,400	61,400	484
1470	Balance List	73	3,320	7
3215	Dash Symbol Transmission	54 S	35	NC
4380	51-Column Card Sorting	16	734	NC
4520	High-Order Zero and Blank Selection	32	1,460	5
6303	System/3 Adapter	130	5,930	4
7060	Self-Checking Number	52	2,370	3
7850	2772 Adapter	47	2,130	3

Model Number	Description	Monthly Rental $	Purchase $	Monthly Maint. $
	Displays			
	For Model 6 Only			
2265-001/002	Display Station	183	5,530	44
4766	Alphanumeric Keyboard (for -001)	31	918	5
7960	2265 Attachment for (-002)	76	3,740	2
	Keyboards			
	For Model 8 Only			
3741-001	Single Data Entry Station (240-char CRT)	159	6,000	39
-002	Same as 3741-001 except includes binary sync communications adapter; can be used as remote terminal transmitting at 1,200, 2,000, or 2,400 baud	194	7,250	50
-003	Programmable Work Station (executes programs written in APL)	253	8,600	59
-004	Same as 3741-003 except has binary sync communications capability	288	9,850	65
8220	3741 Attachment	205	8,200	17
5471-001	Printer-Keyboard	108	5,070	33
4110	Printer-Keyboard Attachment	58	3,020	5
	For Model 10 Only			
5471-001	Printer-Keyboard	117	5,070	35
4110	5471 Printer-Keyboard Attachment	54	3,020	5
5475-001	Data Entry Keyboard	45	2,420	8
4120	5475 Data Entry Keyboard Attachment	47	2,720	1
	Optical Mark Readers			
	For Model 10 Only			
3881-001	Optical Mark Reader	1,451	57,100	153
1471	BCD Read	60	2,390	2
3450	Document Counters	23	948	2
3801	Expanded Storage	60	2,390	1
6451	Serial Numbering	177	7,030	28
	DATA COMMUNICATIONS			
	For Models 6 and 10			
2074	Binary Synchronous Communications Adapter	292	13,200	72
4765	Local Communications Adapter	165	6,630	30
1315	Auto Call	43	1,990	1
4703	Internal Clock	27	1,240	1
7477	Station Selection	21	999	1
7850	Text Transparency	21	999	1
3872-001	Modem (2,400 bps)	91	3,030	26
3875-001	Modem (7,200 bps)	259	8,560	77
4872-001	Modem (4,800 bps; point-to-point)	–	4,549	20
	For Model 6 Only			
4872-003	Modem (4,800 bps; multipoint tributary)	–	4,947	23
	For Model 8 Only			
3872	Modem (2,400/1,200 bps)	86	3,030	24
3874	Modem (4,800/2,400 bps)	165	4,200	50
3875	Modem (7,200/3,600 bps)	224	8,560	71
4645	Integrated Communications Adapter	140	5,900	18
4801	Local Interface (8,000 bps)	25	1,020	1
4802	Local Interface (2,400 bps)	25	1,020	1
6202	Medium-Speed Sync Line	75	3,070	3
7851	Text Transparency	21	1,050	1
2074	Binary Sync Communications Adapter	308	12,500	72
1315	Auto Call	45	2,110	1
3601	EIA Local Attachment	27	1,020	1
4703	Internal Clock	28	1,320	1
4781	1,200-bps Integrated Modem (nonswitched)	16	535	4
4782	1,200-bps Integrated Modem (switched with auto answer)	21	714	6
5201	Modem Base	32	1,220	3
7477	Station Selection	22	1,050	1
7850	Text Transparency	22	1,050	1
	For Model 10 Only			
3601	SIA Local Attachment	27	1,020	1
4872-002	Modem (4,800 bps; multipoint tributary)	–	4,947	23
2084	Binary Synchronous Communications Adapter (2nd)	308	12,500	72
1325	Auto Call	45	2,110	1
3602	EIA Local Attachment	27	1,020	1

Model Number	Description	Monthly Rental $	Purchase $	Monthly Maint. $
4723	Internal Clock	28	1,320	1
7487	Station Selection	22	1,050	1
7851	Text Transparency	22	1,050	1
	For Model 15 Only			
2074	Binary Synchronous Communications Adapter (1st)	302	12,300	70
1315	Auto Call	45	2,075	1
3601	SIA Local Attachment	27	1,000	1
4703	Internal Clock	28	1,295	1
7477	Station Selection	22	1,035	1
7850	Text Transparency	22	1,035	1
2084	Binary Synchronous Communications Adapter (2nd)	302	12,300	70
1325	Auto Call	45	2,075	1
3602	EIA Local Attachment	27	1,000	1
4723	Internal Clock	28	1,295	1
7487	Station Selection	22	1,035	1
7851	Text Transparency	22	1,035	1
4765	Local Communications Adapter	162	6,500	30
3741-002	Data Station	206	7,250	54
3271-002	Control Unit	194	7,340	13
3275-002	Display Station	156	6,630	14

Notes:
– Not Applicable

NC – No Charge TM Time and Material Basis

OVERVIEW

The System/32 is the lowest cost system IBM offers to the small computer user, a minimum basic configuration leases for $770 per month. It is designed for first-time computer users who do not have a programmer on staff, and will welcome a turnkey system with a total hardware/software package. An RPG II compiler is available, however, for those users who want to do some programming. It is rumored that IBM bandied the name of System/3 Model 2 around before settling on System/32, which indicates it is a new system but has some connection with System/3. System/32 RPG II programs can be recompiled and run on System/3.

System/32 is a total system configuration that cannot be field upgraded but must be changed to a new system if upgraded.

Commercial software packages, called Industry Application Programs (IAPs) are available for five application areas: construction, wholesale food, wholesale paper and office products companies, hospitals, and membership organizations and associations. Each package consists of five or more modules that will be tailored to a customer's application to handle such things as accounts receivable, accounts payable, payroll, inventory control, billing, and so on. Data entry for the S/32 can be from the console or diskette, but it is meant to be via diskette prepared off-line on a 3741 Model 1 or 2 Data Station. Thus, total system cost will include the cost of the 3741 as well as the 5320 (the S/32 processor). First deliveries are scheduled for March 1975.

COMPETITIVE POSITION

Because of their investment in applications software, today's computer users are reluctant to switch from one computer vendor to another. Users are concerned that upgrade systems be software compatible with the system they are now using. An ever larger proportion of vendors' sales are to their own customers. Thus, it has become increasingly important for vendors to capture novices as they become first-time computer users.

Furthermore, small businesses are relatively virgin territory for computer sales, primarily because there are so many of them, but also because the support requirements are large in comparison with hardware requirements. Thus, this market must be served locally either by a large vendor with a very large service organization or by a local organization. Some minicomputer manufacturers with commercial configurations have gone to local distributors who will service customers in their areas.

Burroughs and NCR have done very well in this market with programmable accounting type machines: Burroughs with its L Series and NCR with its 299.

The System/32 is slightly higher up the scale than an accounting machine but it is below the smallest System/3. It is in a range comparable to the Burroughs B 700 and B 1710 and NCR 8200 (see Table 1). The S/32 serves notice that IBM intends to get its share of the entry level market, the fastest growing segment of the computer market.

COMPATIBILITY

The System/32 is compatible with the IBM System/3 at the RPG II source language level. Programs developed for System/32 can be recompiled and run on any System/3 model.

CONFIGURATION GUIDE

The basic System/32 configuration consists of the CPU with 16K, 24K, or 32K bytes of MOSFET memory; 600-nanosecond cycle time; disc storage; a read/write diskette unit; and an operator's console with display screen, keyboard, and printer. All system units are housed in the desk-sized 5320 unit.

Discs are available in two models for large files: one stores 5M bytes and the other 9.1M. Access time ranges from 13 to 180 milliseconds on the 5M-byte unit and from 14.2 to 167 on the 9.1M-byte drive; transfer rate is 889K bytes per second.

The diskette is the same as that used with the 3741 data entry station. It can store variable-length physical records of 1 to 128 characters that can be chained into 1,280-character logical records. A single diskette can hold 1,898 physical records.

The Operator's console has a standard typewriter keyboard in addition to a 10-key numeric cluster and function keys for up to 24 commands. The visual display screen uses a 64-character set and displays six lines with 40 characters per line. It is used for operator guidance, file inquiry, or other functions under program control.

Table 1. Comparison of IBM System/32 with Competitors

Characteristics	IBM System/32	Burroughs B 700	Burroughs B 1712	NCR 8200
Central Processor				
Microprogrammed	Yes	Yes	Yes	Yes
Memory				
Type	MOSFET	Core	MOS	—
Capacity (bytes)				
Min	16K	32K	16K	32K
Max	32K	48K	40K	48K
Cycle Time (nsec)	600	1,000	3,000/3 bytes	—
Disc Type	Cartridge			
Capacity (M bytes)	5/9.1	4.6/9.2	2.3/4.6/9.2(1)	4.9/9.8
Access Time avg (msec)	80.1/82.6	80	90	42.5
Char Printers	40/80	—		—
Speed (cps)				
Line Printer (132 cols)				
Speed (lpm)	50/100/155	90/180/400	90/300	125/300
Char Set	48/68	16/64/96	64/96	64/96
Price of a Configuration (with processor, 1 console, 32K-byte memory; printer, 125 lpm; 4.9M-byte disc)				
Purchase ($)	41,600	49,650	64,155	39,750
Monthly Rental ($)	1,082	1,242	1,735	1,285

(1) Also supports disc pack drives.

The console printer is a serial 7 by 7 matrix printer available in two models that operate at 40 or 80 characters per second.

The 3741 Data Entry System is used off-line to prepare the diskettes for data entry into the System/32.

Line printers are also available to print 132-column lines at 50, 100, or 155 lines per minute using a 48- or 68-character set.

A data communications adapter is optional for BISYNC or SDLC communications.

SOFTWARE

Software consists of a System Control Program (SCP) with Operator Control Language (OCL) for communication between system and operator, RPG II Compiler, and Utilities — Data File Utilities, Source Entry Utility, and SORT.

In addition, custom tailored Industry Application Packages (IAL) will be available for a particular application. Five will be available for initial deliveries of the System/32; others will be added.

DATA COMMUNICATIONS

The RPG II compiler supports the optional data communications adapter for both bisynchronous and synchronous data link control communications.

PRICE DATA

A new Term Availability Plan (TAP) is available in addition to a monthly availability charge (MAC) 30-day lease. The system can also be purchased. TAP is a 3-year lease plan that provides a 5 percent reduction over MAC rates. For the first year, the rate cannot be raised: it can be raised by 5 percent in the second and third years. The basic system price includes CPU with 16K bytes of memory, operator's console, and the various printer/disc combinations as shown in Table 2.

BASIC SYSTEM

These prices include CPU with 16K bytes, operator's console, and the printer/disc combination shown.

Table 2. IBM System/32: Prices

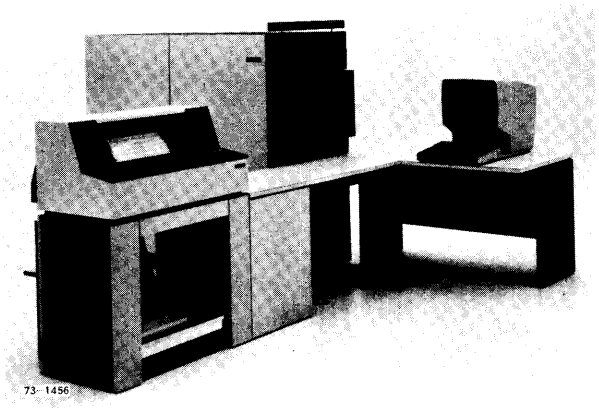
Printer	System/32 Lease Rates, $				Purchase Price/ Monthly Maintenance, $	
	Disc Size				Disc Size	
	5M Bytes		9.1M Bytes		5M Bytes	9.1M Bytes
	MAC	TAP	MAC	TAP		
40 cps	809	770	898	855	33,100/165	36,100/175
80 cps	851	810	940	895	33,300/170	36,300/180
50 lpm	914	870	1,003	955	37,500/185	40,500/195
100 lpm	982	935	1,071	1,020	37,600/195	40,600/205
155 lpm	1,050	1,000	1,139	1,085	37,800/205	40,800/215

OPTIONS

	MAC $	TAP $	Purchase Price $	Monthly Maintenance $
8K Memory Module	50	48	2,000	2.50
Bisync Communications	95	90	3,600	10.00
SDLC	116	110	4,400	15.00

SOFTWARE

	Initial Charge $	Monthly License $
Construction	470-2,330	20-100
Hospitals	2,000	868
Wholesale Food	2,975	140
Memberships	1,485	62
Wholesale Paper	2,500-2,975	120-455
RPG-II	—	25
Utilities	—	15



73-1456

OVERVIEW

System/370 Model 115 is a small general purpose computer marketed primarily for business applications. It supplants the System/370 Model 125 as the smallest, fully upward compatible member of IBM's System/370 family of computers, as well as the smallest entry-level computer into the System/370. It can also be considered an upgrade system for present users of System/360 Models 20, 22, and 25; System/3 Models 6, 10; and the 1130 system. Although the 115 may not be an upgrade system for System/3, Model 15 users, the 115 does offer a migration path into the System/370.

Conversion to the System/370 via the Model 115 allows all but the System/3 Model 15 users to benefit from a more efficient multiprogramming capability; more processor instructions; more modern hardware technology in CPU and main storage; cost-effective facilities of virtual storage; and faster, larger-capacity, lower cost-per-byte discs. Model 115 is directly compatible with the 360/22 and 25 and can emulate the 360/20. It offers no compatibility bridges to the System 1130, although it does offer similar applications programs. The 115 does, however, offer 1401/1440/1460 compatibility.

As for compatibility with System/3, the 115 can handle programs written in RPG II and Cobol, and it is equipped with both 80- and 96-column card equipment. IBM calls this "entry level" compatibility.

In fact, this compatibility with System/3 is no different from that offered by the Model 125; that is, the systems are not compatible. The 115 and System/3 record and handle data differently, and they use different addressing schemes. IBM has not yet announced any conversion aids. In effect, the Model 115 differs little from the Model 125; it has less total core capacity and costs less. Both systems offer the same improved performance over the 1130, 3/10, 360/20, 360/22, or 360/25.

Whether or not the 115 will offer improved performance over the System/3 Model 15 has yet to be seen. Both use the same memory technology. The 115's virtual storage operating system may be a little too sophisticated for the entry level user. A knowledge of program mixes is all-important to avoid operating system overhead and thrashing, and this knowledge requires training. The Model 15's operating system appears nicely suited for entry-level operation, and it probably can be run with on-hand personnel with minimum training. Neither system has been delivered yet, so it is too early to tell exactly how the 2 systems will compete. The 115, as well as the System/3 Model 15, is slated for first delivery in March, 1974. Figure 1 shows a plot of price versus memory capacity for various models of System/3, System/360 and System/370. According to this Figure, the only systems that can be upgraded to a 370/115 without increasing costs are a 360/30 with 64K-byte memory and a 360/25 with 48K-byte memory. In terms of performance, however, these systems should probably be upgraded to the 370/125.

To increase processing power beyond the Model 15, System/3 users must upgrade to the 125, not to the 115; and that upgrade costs more than double that of a System/3.

IBM is increasing its emphasis on the communications market, and the 115 can be used as a front-end processor, a host processor, or a remote job entry (RJE) workstation. A total of 4 synchronous and 8 asynchronous lines or 5 synchronous lines can be attached to integrated communications processors; that is, the lines are directly attached to the CPU.

Programming support for the Model 115 is DOS/VS. Language processors available are RPG II, Cobol, Fortran, PL/1, and Assembler. Conversational Basic, as enjoyed by System/3 Model 6 users, is not supported. Initial applications at which the 115 is targeted are banking, manufacturing, and automobile industries.

Compatibility

The Model 115 is totally upward compatible with other System/370s. Most DOS programs from 360s can run immediately under DOS/VS. Current Model 22 and 25 programs can be run using the optional System/360 I/O compatibility and 2311-1 compatibility features. The changes

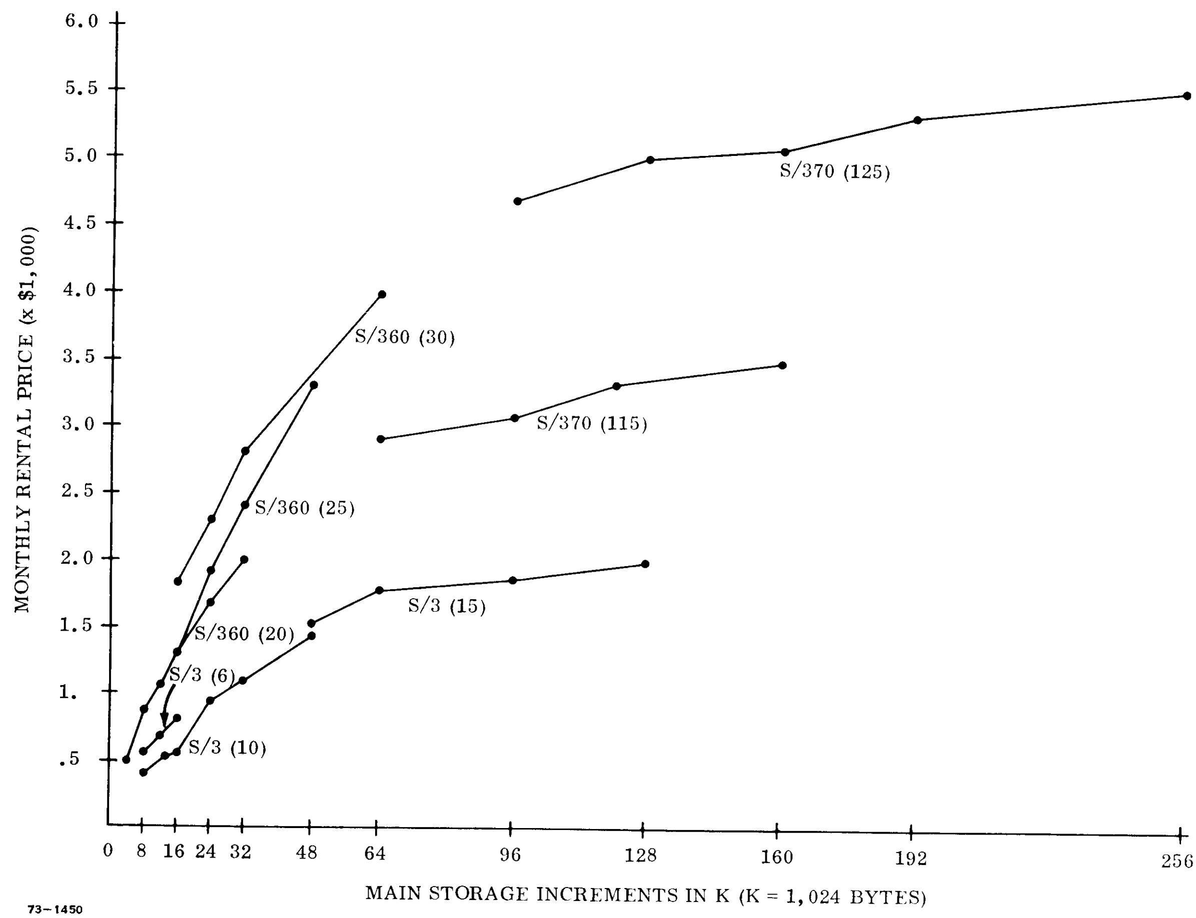


Figure 1. IBM S/3, S/370, and S/360 Storage: Rental Comparison

are reflected in the control language because disc storage under DOS is allocated by specific volume, track, and extent.

DOS/VS supports an integrated System/360 Model 20 emulator which includes access to pseudo-2311 discs.

DOS/VS allows the definition of 5 memory partitions. One will probably be dedicated to the spooler program (Power), which requires 18K bytes; another could be dedicated to teleprocessing; and perhaps another to background processing. Any memory below 128K bytes appears barely sufficient to use the virtual system fully. Albeit the 115 is a flexible, small general-purpose machine in terms of hardware, its software seems potentially ponderous and susceptible to thrashing.

PERFORMANCE AND COMPETITIVE POSITION

Systems that compete from the standpoint of performance with the S/370, 115 are the Burroughs B 1726, the HIS 2030, and others. Currently, the Burroughs B 1726 is a powerful machine very well suited for small- to medium-scale general-purpose processing with a business orientation. With optional equipment, the 1726 can accommodate over a half-billion bytes of on-line storage; up to 8 communications lines on a multiline controller; and addresses for up to 96K bytes of main storage. The MCP-II operating system utilizes the same paging technique used on the very large multiprogramming, multiprocessing B 6700/7700 machines.

Currently, the 1726 is most suitable for Cobol programs; however, the sophisticated architecture for reconfigurable microprograms is easily adaptable to other languages, to a multiprocessing environment, or to the emulation of other machines. To date, only emulation of the IBM 1400 series, however, has been announced. IBM recently announced the same capability on the 115.

The 115 has a larger main memory addressing capacity, (a current maximum of 160K bytes), fewer communications lines, and a more complicated operating system than the 1726. DOS/VS requires more processing overhead than does the 1726's MCP-II; that is, DOS/VS requires more main storage addresses, more direct access storage space, and more instructions for paging and address translation than the MCP-II. A specific example is the size of routines resident in main storage: 8K bytes for the MCP-II, and 18K bytes minimum for DOS/VS.

Both DOS/VS and MCP-II perform spooling operations; MCP-II allocates resources in a more sophisticated way than does DOS/VS. For ex-MCP-II assigns data sets dynamically while DOS/VS requires specific device information.

The HIS 2030 with a maximum core capacity of 96K bytes does not use modern storage technology, nor does it offer an operating system of the sophistication of DOS/VS or MCP-II. It does offer a large amount of on-line storage, and it is oriented toward communications processing. A dedicated system running under OS/2000 and the DATANET 2000 is a strong contender for communication applications, but the 2030, because of its limitations on main storage addressing, could do little else. Honeywell apparently realizes this because they have announced the MSR/2000 operating system for exclusive use of the 2030. This offers dual-programming capabilities and communication facilities that are slightly better than those of the 115, but they are not equivalent to the powerful DATANET 2000.

Certain characteristics are common to all of the competing systems; all offer Cobol, RPG, and Fortran. The 1726 does not offer an assembler language, but the other systems do. All are upward compatible with larger medium system models of general-purpose computers. All offer more or less industry compatible peripherals.

CONFIGURATION GUIDE

One central processor is available for the 115. The 3115 has a 480-nanosecond, 2-byte, memory cycle time; it provides arithmetic and logic circuits, plus a direct disc attachment, reloadable control storage (20K words of 22 bits, a concept borrowed from the 125), and main storage. The main and control storage use MOSFET (metaloxide semiconductor field-effect transistor) technology. Main storage is available in 4 sizes: 64K, 96K, 128K, and 160K bytes.

The 115 has also borrowed the "floppy disc" concept from the 125. The removable magnetic diskette contains the microcode for the basic system, the optional features ordered for the system, and CE diagnostics. Error logging therefore is on the diskette instead of in CPU registers, as is done on all larger 370s, except the 125.

Standard Features

Standard Model 115 features include a commercial instruction set, dynamic address translation (required for virtual storage; to address up to 16M bytes), channel indirect data addressing, program event recording, monitor call, interval timer, time-of-day clock, CPU timer and clock comparator, store and fetch protect, byte-oriented alignment, and special reliability, availability, and serviceability features. Also included are the Display Operator Console (DOC), a CRT plus keyboard, and direct attachment of the 3340 Model A2 two-disc drive storage. Additional 3340s, Model B1 or B2, are attached to the 3340, to a maximum of 4 drives.

The reloadable control storage is provided with the optional card I/O attachment, printer attachment, integrated communications adapter, and the byte multiplexor channel.

I/O devices attached via integrated controls or adapters are the 3340 direct access disc drive, the 3411 magnetic tape units, the 2560 and 5425 multifunction card units, the 5203 printer, and the communications adapter.

I/O devices connected via the byte multiplexor channel are the same as those that can be connected to the byte multiplexor channel on System/360 Models 22, 25, 30, and 40. The byte multiplexor channel has 32 subchannels (8 shared; 24 unshared), giving a maximum data rate of 29K bytes per second in burst mode and 19K bytes per second in byte mode. Devices requiring higher sustained data transfer rates cannot be attached. The multiplexor channel and the integrated card I/O attachment require special features to be installed together.

PERIPHERALS

Except for the 3330 disc storage facility and the 3803/3420 magnetic tape substations, the Model 115 supports the same peripheral devices as the Model 125. These devices attach as already described in the Configuration Guide.

Table 1 lists the specific punched card peripherals available and Table 2 the magnetic tape units. Other peripherals available include the 3203 printer, which is a faster and considerably more expensive version of the 1403 printer, and the 3340 disc storage and control. The 3340 can be used only under virtual storage operating systems. It uses the 3348 single cartridge data module to hold the disc recording surface, the access arms, and the read/write heads. The 3540 Diskette I/O unit can also be used.

Other peripherals available are the 1287 Optical Reader, the 3881 Optical Mark Reader and

Table 1. IBM S/370 Model 115: Card Equipment

Identity	Columns	Channel or Integrated Attachment	Control Unit Implementation
3504-A1, A2 Card Reader	80	I	Internal
3505-B1, B2 Card Reader	80	C	Internal
3525-P1, P2, P3 Card Punch	80	C/3505	Internal
1442-N1 Card Read Punch	80	C	Internal
1442-N2 Card Punch	80	C	Internal
2501 Card Reader	80	C	Internal
2520-B1 Card Read Punch	80	C	Internal
2520-B2, B3 Card Punch	80	C	Internal
2540 Card Read Punch	80	C/2821	In 2821
2560-A1 MFCM (360/20 device)	80	I	Internal
2596 Card Read Punch	96	C	Internal
5425-A1, A2 MFCU	96	I	Internal

Note:

(1) Channel is optional byte multiplexor.

(2) The 3525, 2560, and 5425 cannot coexist in integrated attachments, but either of the latter 2 can coexist with an integrated 3504.

Table 2. IBM S/370 Model 115: 3411/3410 Magnetic Tape

Characteristic	Model 1	Model 2	Model 3
Data Rate (kb/sec)			
at 1,600 bpi/PE	20	40	80
at 800 bpi/NRZI	10	20	40
at 556 bpi/NRZI	6.9	13.9	27.8
at 200 bpi/NRZI	2.5	5	10
Tape Speed (ips)	12.5	25	50
Interblock Gap Time (msec)			
9-track (0.6 in.)	48	24	12
7-track (0.75 in.)	60	30	15
Avg Read/Write Access Time (msec)	15	12	6
Full-Reel Rewind Time (min.)	3	3	2
Max Drives/Subsystem*	4	6	6

Note:

* The 3411 is a tape drive with a built-in control unit. It can attach a number of single-drive 3410 tape units having the same model number. Connection to a 115 requires an appropriate attachment.

the 3886 Optical Character Reader. The 7770 Audio Response Unit is also available.

Users considering a migration or a change from their present IBM system will find Table 3 interesting; it lists selected device availability on the probable growth/migration systems.

DATA COMMUNICATIONS

The Model 115 can be used as a stand-alone communications processor or as a front-end processor with other members of the System/360/370 family.

Software support includes BTAM (Basic Telecommunications Access Method) and QTAM (Queued Telecommunications Access Method) but not TCAM (Telecommunications Access Method).

An impressive array of terminals can attach via either the Integrated Communications Adapter (ICA) or a control unit on the multiplexor channel. The ICA is program compatible with the 2703 transmission control unit. It allows direct attachment of up to 5 synchronous or up to 4 synchronous and 8 asynchronous lines. The ICA is equivalent to 2701s, 2702s, or 2703s or 3704s/3705s in emulation mode attached by a byte multiplexor channel. The data transfer rate is 45.5 bits per second for asynchronous lines and up to 50,000 bits per second for synchronous lines.

The following terminals can be attached: the 3270 Information Display System units, the 3735 Programmable Buffered Terminal, the 3780 Data Communications Terminal, the 2922 Programmable Terminal, the 2740 and 2741 Communications Terminals, the 2760 Optical Image Unit,

Table 3. IBM S/370 Model 115: Comparison of Device Availability on Probable Growth/Migration Systems

S/370 Mdl 115 Characteristic or Device	1130	S/360			S/3			S/370	
		20	22	25	6	10	15	125	135
3340 Direct Access Storage Facility (34.9 or 69.8 mb; 25 msec seek; 885 kb/sec data rate)	–	–	–	–	–	–	–	X	X
3203 Printer Mdls 1 & 2 (600 or 1,200 lpm; 132 PP, 10 cpi; 30- to 240-char sets)	–	–	–	–	–	–	–	X	–
5213-1 Console Printer (85 cps)	–	–	–	–	X	–	–	X	–
3872, 3875 Communications Modem	X	X	–	X	X	X	X	–	X
5425 Multifunction Card Unit (96 col)	–	–	–	–	–	–	X	X	–
2560 Multifunction Card Unit (80 col)	–	X	–	X	–	–	X	X	–
5203 Printer Mdl 3	–	–	–	–	–	X	–	–	–
3410/3411 Magnetic Tape Units (20, 40, 80 Kb; 6 max/controller)	–	–	–	–	–	X	X	X	X
2260 Display Station	–	–	X	X	–	–	–	X	X
3271 Display Station	–	–	–	X	–	X	–	X	X
2501 Mdl A1 or A2 Card Reader	X	X	X	X	–	–	–	X	X
1231 Optical Mark Reader	X	–	X	X	–	–	–	–	–
1627 Plotter	X	–	–	–	–	–	–	–	–
Cobol	X	–	X	X	X	X	X	X	X
RPG	–	X	X	X	X	X	X	X	X
ASM	–	X	X	X	–	X	X	X	X
Fortran	X	–	X	X	X	X	X	X	X
PL/1	–	–	X	X	–	–	X	X	X

the 2770 and 2790 Data Communication Systems, the 2780 Data Transmission System and the 2260 and 2265 Display Stations.

Additional communications control beyond that provided by the ICA can be implemented using the 2701, 2702, or 2703 units or the 3705 communications controller. Line adapters (each of which requires a channel control unit position) are also available: the 2711 line adapter and the 3872, 2875, and 4872 modems.

SOFTWARE

The software available has already been discussed under OVERVIEW and PERFORMANCE AND COMPETITIVE POSITION. A thorough analysis of the DOS/VS operating system can be found in the System Software Segment of your AUERBACH Computer Technology Reports.

HEADQUARTERS

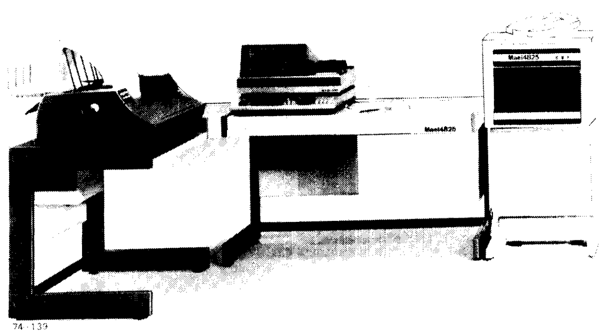
IBM Corporation
1133 Westchester Avenue
White Plains NY 10604

PRICE DATA

Model Number	Description	Monthly Rental $ *	Purchase $	Monthly Maint. $
	IBM SYSTEM/370 MODEL 115			
	Central Processor & Working Storage			
3115	Central Processing Unit (with display operator console; dynamic address translation; commercial instruction set, including decimal instructions; byte-oriented operand; storage protection; time-of-day clock, interval timer, CPU-timer, and clock comparator; error checking and correction; program event recording; channel indirect data addressing; monitor call; direct attachment for the 3340 direct access storage facility; and core storage)			
-F	65,563 bytes	2,945	142,900	250
-FE	98,304 bytes	3,145	152,600	255
-G	131,304 bytes	3,345	162,300	160
-GE	163,840 bytes	3,545	172,200	265
	Processor Options			
3898	External Signals	100	4,850	1
3900	Floating Point	NC	NC	NC
4640	Integrated Communications Adapter	205	9,950	21
4641	Integrated Communications Adapter Extension	75	3,650	1
4650	Integrated 3203 Attachment (4653 req'd)	75	3,700	6
4653	Integrated 3203/5203 Prerequisite	80	3,800	7
4670	Integrated 2560 Attachment	140	6,800	10
4690	Integrated 5203 Mdl 3 Attachment (4653 req'd)	75	3,700	6
4692	Integrated 5213 Model 1 Attachment	100	4,850	3
4695	Integrated 5425 Attachment	140	6,800	16
5248	Byte Multiplexer Channel	190	9,250	17
7520	S/360 Model 20 Compatibility	NC	NC	NC
	Mass Storage			
	Discs			
3340-A2	2 Drives	999	40,000	74
-B1	1 Drive	558	22,000	40
-B2	2 Drives	705	28,000	64
	Input/Output			
	I/O Attachments			
3540	Diskette I/O Unit			
-B1	One drive	535	22,000	25
-B2	Two drives	805	33,000	35
3411	Magnetic Tape Adapter (7361 req'd)	100	4,850	3
7361	S/370 Model 115/125 Attachment	100	4,200	4
	Printers			
1443	Printer (240 lpm; 52-char set)	850	36,500	87
3203-1	Printer (600 lpm; 4650 req'd;	940	38,000	185
-2	1,200 lpm; 4650 req'd)	1,234	49,000	240
5203	Printer (300 lpm; 4690 req'd)	435	17,400	127
5213	Printer (4692 req'd)	160	6,200	48
	Punched Cards			
1442-N1	Card Read/Punch (400 cpm read; 160 col/sec punch)	510	25,460	81
-N2	Card Punch (160 col/sec)	365	18,185	71
2501-B1	Card Reader (600 cpm)	260	14,590	51
-B2	Card Reader (1,000 cpm)	320	14,820	55
2520-B1	Card Read/Punch (500 cpm)	915	39,520	151
-B2	Card Punch (500 cpm)	810	35,000	142
-B3	Card Punch (300 cpm)	625	34,715	114

Model Number	Description	Monthly Rental $ *	Purchase $	Monthly Maint. $
	Input/Output (Contd.)			
2596	Card Read/Punch	845	29,575	330
2560-A1	Multi-functional Card Machine (500 cpm)	615	27,055	97
-A2	Multi-functional Card Machine (310 cpm)	480	19,885	97
5425-A1	Multi-functional Card Unit (250/60/60 cpm)	570	18,000	150
-A2	Multi-functional Card Unit (500/120/120 cpm)	740	22,000	295
	Paper Tape			
1017-1	Paper Tape Reader (120 cps; reads strips of tape)	49	2,330	14
-2	Paper Tape Reader (120 cps; reads strips or rolls)	73 †	3,565 †	17
1018	Paper Tape Punch (120 cps)	121 †	5,395 †	40
2671	Paper Tape Reader (1,000 cps)	140 †	6,305 †	21
2822	Paper Tape Control (controls one 2671)	210 †	9,410 †	8
2826	Paper Tape Control (for up to 2 1017s and/or 2 1018s)	275 †	14,380 †	35
5801	Punch Adapter – Line 1 (for first 1018)	97	4,945	9
5802	Punch Adapter – Line 2 (for second 1018)	82	4,220	5
6101	Reader Adapter – Line 1 (for first 1017)	82	4,220	8
6102	Reader Adapter – Line 2 (for second 1017)	68	3,470	5
	Magnetic Tapes			
2495	Tape Cartridge Reader (900 cps)	340	18,670	155
3410	Magnetic Tape Unit (1 tape drive)			
-1	20K bps at 1,600 bpi	185	7,700	45
-2	40K bps at 1,600 bpi	245	10,300	50
-3	80K bps at 1,600 bpi	305	12,800	55
3411	Magnetic Tape Unit and Control (single-channel control unit with 1 drive)			
-1	20K bps at 1,600 bpi	405	17,000	70
-2	40K bps at 1,600 bpi	515	21,600	75
-3	80K bps at 1,600 bpi	625	26,300	80
3211	Single-Density Tape Unit	55	2,500	7
3221	Dual-Density Tape Unit	80	3,600	27
6550	7-Track Tape Unit	80	3,600	13
	Magnetic Character Readers			
1255	Magnetic Character Reader			
-1	500 Documents/minute – 6 stackers	805	38,645	210
-2	750 Documents/minute – 6 stackers	980	44,260	335
-3	750 Documents/minute – 12 stackers	1,300	60,240	440
6360	S/360/370 Adapter (req'd)	450	21,600	31
1259	Magnetic Character Reader (max 1/system)	1,360	61,110	260
1419	Magnetic Character Reader	2,380	107,185	241
7720	S/360 Adapter (single address; req'd)	104	5,140	6
7730	S/360 Adapter (dual address; req'd)	282	12,705	8
	Optical Readers			
1287	Optical Reader (max 8/system; document reading only)	3,400	136,000	1,160
3881	Optical Mark Reader (max 8/system)	1,351	56,000	140
3886	Optical Character Reader (max 8/system)	2,315	91,000	475
	Audio Response			
7770	Audio Response Unit (up to 4 lines)	1,165	55,870	38
4668	I/O Line Frame (for more than 16 lines; max 1)	194	9,310	2
4677	I/O Line Expander (4 more lines; max 11)	170	8,150	12
4679	I/O Line Panel (for each increment of 8 lines beyond first 8; max 5)	73	3,490	2
	Displays			
1053-4	Printer (appropriate adapter req'd on 2848; max 1)	49	1,940	10
2250-1	Display Unit (for single display unit)	1,065	51,215	157
-2	Display Unit (max 4 per 2840)	1,550	31,025	177
1002	Absolute Vectors and Control	390	15,520	11
1498	Buffer (4,096 bytes; req'd on 2250 Model 1)	340	16,295	7
1499	Buffer (8,192 bytes; req'd on 2250 Model 1)	485	23,280	10
1880	Character Generator	365	17,460	15
2840	Display Control (controls and attachments for up to 2 2250 Model 3s)	3,880	72,000	141
3352	Display Multiplexer (add'l attachments for up to 2 more 2250 Model 3s)	390	8,000	13
2848	Display Control			
-1	Up to twenty-four 2260 Model 2s (240 char/2260)	360	15,715	23
-2	Up to sixteen 2260 Model 2s (480 char/2260)	390	16,480	23
-3	Up to eight 2260 Model 1s (960 char/2260)	420	17,975	24
-21	Up to twenty-four 2260 Model 2s (240 char/2260)	725	32,735	28
-22	Up to sixteen 2260 Model 2s (480 char/2260)	775	34,920	28
	Display Adapter (1 req'd for each two 2260s)			
3355	On Model 1 (3858 or 3859 req'd for more than 2)	40	1,505	2
3356	On Model 2 (3358 or 3859 req'd for more than 1)	80	3,005	4
3357	On Model 3 (3859 req'd for more than 1)	100	3,765	5

Model Number	Description	Monthly Rental $ *	Purchase $	Monthly Maint. $
	Input/Output (Contd.)			
3368	On Model 21 (3868 req'd for more than 6)	58	2,620	2
3369	On Model 22 (3868 req'd for more than 4)	116	5,240	3
	Expansion Unit			
3858	On Model 1 or 2 (for add'l display adapters and/or a 1053 adapter-7927)	55	2,260	NC
3859	On Model 1, 2, or 3 (for add'l display adapters; 3858 req'd on Model 1 or 2)	45	1,835	NC
3868	On Model 21 or 22 (for add'l display adapters)	49	2,180	NC
	1053 Adapter (to attach a 1053 Model 4; max 1)			
7927	On Model 1 or 2 (3858 req'd)	40	1,505	3
7928	On Model 3	40	1,505	3
7938	On Model 21 or 22	102	4,585	5
2260-1	Display Station (for use with 2848 Model 3)	30	970	8
-2	Display Station (for use with 2848 Model 1, 2, 21, or 22)	30	970	8
3272	Control Unit (basic unit provides for attachment of up to 4 devices; one 3277 Model 1 is req'd with a 3272 Model 1; one 3277 Model 2 is req'd with a 3272 Model 2)			
-1	480 Char	190	7,500	11
-2	1,920 Char	205	8,200	23
3250	Device Adapter (each attaches up to 4 add'l devices; max 7)	55	1,075	1
3277-1	Display Station (480 char; for 3272 Model 1 or 2)	75	3,400	7
-2	Display Station (1,920 char; for 3272 Model 2 only)	110	4,400	15
3284-1	Printer (40 cps; 480 char; for 3272 Model 1 or 2)	150	5,850	28
-2	Printer (40 cps; 1,920 char; for 3272 Model 2 only)	160	6,560	28
3286-1	Printer (480 char; for 3272 Model 1 or 2)	180	7,380	28
-2	Printer (1,920 char; for 3272 Model 2 only)	190	8,170	28
	Data Communications			
1201	Asynchronous Line Group	40	1,950	3
1231	Asynchronous Line Medium Speed	40	1,950	2
1241	Asynchronous Line Pair, Low Speed	55	2,650	3
1291	Auto Call Adapter, Line Position A1	20	950	1
1292	Line Position A2	20	950	1
1295	Line Position S1	20	950	1
1296	Line Position S2	20	950	1
2701	Data Adapter Unit (attaches up to 4 lines or adapters)	200	9,130	15
2702	Transmission Control (attaches up to 15 lines, max 600 bps; up to 32 lines, max 200 bps)	850	38,395	46
2703	Transmission Control	1,450	65,485	76
2715	Transmission Control Unit	1,550	77,600	185
3704-A1+	Communication Controller (attaches up to 32 lines)	646	26,000	115
3705-A1+	Communication Controller (attaches up to 352 lines, max 50K bps)	1,152	47,150	150
4743	IBM Leased Line Adapter	14	490	2
	IBM 1,200-bps Line Adapter			
4781	Nonswitched	15	525	2
4782	Switched with Autoanswer	20	700	3
4791	Switched with Autocall and Autoanswer	65	2,275	10
4792	Line Adapter Base 2	25	1,200	2
4793	Line Adapter Base 3	25	1,200	2
7100	Synchronous Line Group	40	1,950	3
7121	Synchronous Line High Speed	100	4,850	7
	Synchronous Line Medium Speed with Clock			
7141	Line Position S1	55	2,650	3
7142	Line Position S2	55	2,650	3
7143	Line Position S3	55	2,650	3
7144	Line Position S4	55	2,650	3
	Synchronous Line Medium Speed			
7151	Line Position S1	45	2,200	3
7152	Line Position S2	45	2,200	3
7153	Line Position S3	45	2,200	3
7154	Line Position S4	45	2,200	3
7881	Telegraph Line Pair	55	2,650	7



OVERVIEW

Insel's MAEL 3000 and 4000 Series are keyboard-oriented small business computers aimed at first-time computer users. MAEL 4000 Systems are dual-purpose and can also be used as programmable desk calculators by engineers and scientists. The largest MAEL 4000 configurations can also be used as multistation key-to-storage data entry and as input/output satellite systems for larger computers.

Small Business Computers

The MAEL 3000 and 4200 are simple single-keyboard invoicing and visible ledger accounting systems with 2K-byte CPUs. They are normally configured with keyboard, typewriter and paper tape/edge-punched card for input/output. Either system can be equipped with magnetic ledger processing facilities. These systems are not marketed in every country. MAEL 4200 systems can also be equipped with an 80-column mark-sensing card reader, high-speed serial matrix printer, graph plotter, and even an interface to control machine tools numerically.

MAEL 4200 systems can be field-expanded into a 4K-byte MAEL 4400 and an 8K-byte MAEL 4800 System with a choice of console keyboards and file storage media. Consoles can be equipped with either a 15-character-per-second I/O typewriter or a buffered 1,024-character CRT display. Programs and files can be held on paper tape or single-track magnetic tape cassettes. The largest MAEL 4850 and 4855 Systems offer 600,000 to 30,000,000 bytes of on-line disc backing storage for programs and data files on IBM 3740-compatible diskettes or IBM 2315-type fixed/exchangeable cartridge disc drives.

Desk Calculators

All MAEL 4000 Series system consoles are equipped with a comprehensive program keyboard that can call the 50 instructions by a single or double key depression. Execution modes allow instructions entered on the program keyboard to be obeyed directly or to be entered into the program area of main memory. Other execution modes allow programs to be executed from main memory or directly from paper tape or edge-punched cards. Standard software includes paper tape, magnetic tape cassette, and disc-oriented operating systems. A symbolic assembler is in preparation.

Key-to-Storage Data Entry. Insel offers a choice of off-line and on-line key display data entry stations for MAEL 4400 and 4800 Series systems. Both offer 1,024-character CRT display screens, an alphanumeric keyboard with typewriter layout, separate numeric keyboard, and control keys. Both are fully buffered and controlled by their own microprograms.

The off-line MAEL 4021 Data Capture Unit (DCU) records data on single-track magnetic tape cassettes for transmission to any MAEL 4420, 4425, 4820, 4825, 4850, or 4855 system equipped with a dual tape cassette station. Its 1,024-character screen can hold up to eight lines (512 characters) of formatting masks loaded from MT cassettes and up to eight lines (512 characters) of keyed input data. The DCU microprogram checks input data against the masks and validation parameters before releasing it to the tape cassette.

The on-line MAEL 4901 CRT Display Terminal sends data directly to the MAEL 4855 Disc Processing System in buffered message blocks; the main system performs validation checks. Seven or eight terminals can be connected locally by cable up to 1,000 metres long; and eight more terminals at remote sites can be connected via a single multidrop leased voicegrade line. Two or three of these terminals can also be used for real-time file enquiries and/or on-line transaction processing. Using any more terminals for anything other than data entry degrades system response time rapidly.

The main MAEL 4400 or 4800 Series system can process in batch mode the data received from off-line MAEL 4021 or on-line MAEL 4901 Key/Display Terminals. Alternatively, it can be confined to checking, merging, and sorting the data for transmission to a larger, general-purpose EDP system. MAEL 4400 and 4800 Series systems are the first European small business computers and data entry systems that can transmit data to other systems on 8-track paper tape or IBM 3740-compatible diskettes. Later in 1974, facilities will be available to transmit data on industry-compatible nine-track magnetic tape also.

MAEL 3000 and 4000 are manufactured in Italy by Insel S.P.A. They are marketed by agents throughout Europe and in many overseas countries. The main Western European agents are:

- West Germany, Switzerland, and Austria—Louis Beaugrand KG.
- France—ITC.

- Italy—SAGA.
- United Kingdom and Ireland—Computer Ancillaries LD.

Names of other national agents can be obtained from Insel International SA, Monaco, a subsidiary of the International Trading Corporation (ITC).

PERFORMANCE AND COMPETITIVE POSITION

MAEL 3000. MAEL 3000 is an integrated single-keyboard invoicing and visible record accounting computer in the same class as the Kienzle 4000, LogAbax LX 2200 and LX 2600, Olivetti Auditronic 730, Philips P351, Singer 5800, and Triumph-Adler TA 10 and TA 100. Announced in 1973, MAEL 3000 can be regarded as fully tested since it is a simplified version of the MAEL 4200, which has been available since 1971.

MAEL 4000 Series. MAEL 4200 and 4800 Series systems were launched in 1971 and have now been in the field for over two years. They were joined in 1973 by the MAEL 4400, an intermediate size system which is not yet marketed in all countries. The MAEL 4000 Series was the first dual-purpose system on the European market, usable as both an invoicing and accounting small business computer and a programmable desk calculator for engineers and scientists.

As a dual-purpose system, the MAEL 4000 competes directly against the more recently launched Hermes Datasystem 210 and IME 10001. These systems offer more powerful instruction sets and program keyboards and a slightly more expandable core memory (to 10K bytes) than MAEL 4000. These features make the Hermes Datasystem 210 and IME 10001 somewhat more attractive to engineers and scientists than the MAEL 4000. However, MAEL 4000 is unquestionably more attractive to commercial accounting users. It can be equipped with card reader and high-speed serial printer, while the larger MAEL 4400 and 4800 Series systems offer typewriter and CRT display consoles and paper tape, MT cassette, diskette and cartridge disc backing storage for programs and data files.

Used solely as commercial accounting systems, the MAEL 4000 Series competes against the Burroughs L 2000 and L 3000, Nixdorf Systems 820 and 840, Mitsubishi Melcom 83 and 84, Philips P350 Series, and against small configurations of Kienzle 5000, 5600, and 6000, and LogAbax LX 4200 systems.

MAEL 4850 and 4855. The MAEL 4850 and 4855 are the first European small business computers to offer inexpensive random access backing storage on fully IBM 3740-compatible diskette drives. Thus, they can be used not only as freestanding small business computers but also as data entry and preprocessing systems for IBM System/360 and 370 general-purpose systems. The only other European small business computers to offer inexpensive "floppy disc" backing storage at the beginning of 1974 are the recently announced iCS 755 and, in the UK, MBM 7000; neither offers IBM 3740 compatibility.

MAEL 4850 and 4855 have also been available since late 1972 with the IBM 2315-type Iomec 2002 (now 3002) fixed/exchangeable cartridge disc drives. Up to eight drives can be connected, giving a maximum on-line backing storage capacity of 30 million bytes. This capacity will be doubled in 1974 when double-density drives become available. These are useful upgrading facilities for existing MAEL 4000 Series users who have heavy investment in MAEL 4000 applications software or who particularly like the MAEL 4000 dual-purpose commercial accounting/desk calculator combination.

MAEL 4850 and 4855 are hardly the best buys for new users in the increasingly competitive cartridge disc processing market. Their basic prices are only marginally less than those of turnkey-programmed, single-keyboard BCL Molecular 18, DEC Datasystem 330 or 340, Melcom System MCS 1600, or Nixdorf System 880/55 configurations. They are substantially higher than the unbundled basic prices of BCL Molecular 6M and Nixdorf System 880/45 configurations for users requiring only one or two standard applications packages. Yet the MAEL 4000 CPU is substantially less powerful than the general-purpose minicomputers used on all these rival cartridge disc processing systems. It is limited to a maximum 8K-byte main memory, its main memory cycle and instruction execution times are 4 to 8 times slower, it has no hardware interrupt facilities, and the input bus transfer rate is limited to a maximum of 2,000 bytes per second. It is hardly the system to optimize the use of disc drives with transfer rates of 195,000 bytes per second, nor do MAEL 4850 and 4855 systems offer any high-level languages; an assembler is only now being written.

MAEL 4855 Systems can be equipped with up to 15 on-line MAEL 4901 CRT display terminals. Only two or three of these, however, can be used as real-time file enquiry and/or transaction processing terminals. All terminal polling is performed by software; system response times can be degraded rapidly.

Key-to-Storage Data Entry. MAEL 4850 and 4855 systems are attractive key-to-storage data entry systems when equipped with one to 15 on-line MAEL 4901 CRT display terminals and/or any number of off-line MAEL 4021 data capture units. Both off-line and on-line keystations have 1,024-character CRT display screens, half of which can be used for formatting masks. Off-line MAEL 4800/4021 configurations compete against IBM 3740 and Olivette DE 521/523 systems; on-line MAEL 4855/4901 systems against the Datapoint 2200, Facit-Addo Systems M10 and M11, Inforex 1300 Series, and Sanders 800 Series.

CONFIGURATION GUIDE

MAEL 3000 and 4000 Systems use identical central processors. They differ in the expandability of their main memory and the range of peripheral devices, as shown in Table 1.

MAEL 3000 Systems are integrated invoicing and visible record accounting systems. They are available in two standard configurations, one with and one without magnetic ledger processing facilities. The magnetic ledger processing configuration is not marketed in every country.

The 2,048-byte main memory of MAEL 3000 CPUs cannot be expanded. No substitutions are allowed for their standard systems components. All programs for MAEL 3000 systems must be prepared on a MAEL

Table 1. Insel MAEL 3000 and 4000: Configuration Guide

System Component	3000	4200	4420	4425	4855
CENTRAL PROCESSOR					
Main Memory Size (bytes)	2,048	2,048	4,096	4,096	8,192
Field Expandable to 4K/8K	No	Yes	Yes	Yes	—
No. of Instructions	33	36 + 9 opt	36 + 9 opt	36 + 9 opt	36 + 9 opt
CONSOLE					
27-key Program Keyboard	No	Stand.	Stand.	Stand.	Stand.
14-key Numeric Input Keyboard	Stand.	Stand.	Stand.	Stand.	Stand.
51-key Alphanumeric Keyboard incorporated in:					
• IBM 745 Selectric typewriter (15 cps)	Stand.	Stand.	Stand.	No	No
• MAEL 4902 CRT display, (1,024 char)	No	No	No	Stand.	Stand.
PERIPHERALS					
Chalco 5201 PT Reader, (520 char/sec)	—	1 std + 1 opt	x	x	x
GNT 24 PT/Edge-Punched Card Reader (30-40 char/sec)	1 std	x	x	x	x
GNT 34 PT/Edge-Punched Card Punch (30-35 char/sec)	1 opt	x	x	x	x
F1115 80-col Card Reader (200 cpm)	—	x	x	x	x
MCP 30 Marked Card Reader (40 cpm)	—	x	x	x	x
MGC 4051 Magnetic Stripe Ledger Card Unit	1 opt[1]	x	x	—	—
4101 Printer (165 char/sec)	—	x	x	x	x
4102 Printer (300 char/sec)	—	x	x	x	x
4104 MT Twin Cassette Drive (1,000 char/sec)	—	—	1 std	1 std	x
Shugart Diskette Drives (300K bytes)	—	—	—	—	1-2 opt[2]
Iomec 3002 Fixed/Exchangeable Cartridge Disc Drives, (3.8M bytes, 195,000 bytes/sec)	—	—	—	—	1-8 opt[2]
Polling Scanner (8 lines)	—	—	—	—	x
4901 CRT Display 1,024 - char local	—	—	—	—	1-8
Remote	—	—	—	—	1-8
ACP Data Transmission Adapter	—	—	—	—	x
4020 Off-Line Data Capture Units (1,024-char screens)	—	—	Any no.	Any no.	Any no.

NOTES

— Not available on this system.
x One unit optionally available on this system.
1 The MGC 4051 magnetic stripe unit is a standard component of MAEL 3000 magnetic ledger processing configurations. It cannot be added in the field to MAEL 3000 invoicing configurations.
2 At least one Shugart dual diskette drive or one Iomec 3002 fixed/exchangeable cartridge disc drive is a standard system peripheral. Additional drives of either model optional.

4000 system, usually by INSEL. Programs are entered into the system on eight-track paper tape or edge-punched cards.

MAEL 4000 Systems are much more modular expandable than the 3000 Systems. All can be used as dual-purpose systems, programmable desk calculators for engineers and scientists and keyboard-oriented commercial accounting and/or key-to-storage data entry systems. Main memory is field-expandable. Peripherals are connected via standard interfaces, allowing a wide diversity of configurations.

MAEL 4000 systems are, nonetheless, marketed mostly in a limited number of standard configurations. These have analytical model numbers, with each digit position indicating a certain system feature.

The second digit indicates *main memory* size: 42xx for a 2K-byte system, 44xx for a 4K-byte system; 48xx for an 8K-byte system. Any 4200 system can be converted to a 4400 or 4800 system on site. The 44xx systems are not marketed in every country, notably West Germany.

The third digit of model numbers indicates the main system *backing storage medium* for programs and user files:

- 0—Eight-track paper tape and/or edge-punched cards. This is the only backing storage medium available on 2K-byte 4200 systems. Programs held on paper tape or edge-punched cards can be executed directly without loading them into core.
- 2—Single-track magnetic tape cassettes. This option is available for 44xx and 48xx systems only.
- 5—Diskette and/or cartridge disc backing storage. Available on 4850 and 4855 systems only.

The fourth digit of 4000 Series model numbers indicates the type of *system console* used:

- 0—IBM 745 Selectric I/O writer, 15 characters per second.
- 5—MAEL 4902 CRT display console, 1,024-character screen.

This option is available on 4425 and 4825 MT cassette and 4855 diskette and/or cartridge disc processing systems only.

On the basis of MAEL 4000 configuration rules, the following configuration models are available: 4200, 4400, 4420, 4425, 4800, 4820, 4825, 4850, and 4855. Among these, the most frequently marketed are the 4200, 4420, 4425, and 4855; all these are described in Table 1. In West Germany, Switzerland, and Austria, Louis Beaugrand KG markets 4820 and 4825 systems instead of the 4420 and 4425.

Apart from MT cassette drives, diskette and cartridge disc drives, and data communications adapters, other I/O peripherals are optionally available on any configuration.

Key/Display Data Entry Stations. The MAEL CRT display station used in the MAEL 4902 console is also available in two other versions for data entry or source data capture keystations.

The MAEL 4021 Data Capture Unit (DCU) is an off-line device for recording data on single-track magnetic tape cassettes. These can then be processed in batch mode on any MAEL 4420, 4425, 4820, 4825, 4850, or 4855 System that has a MAEL 4104 dual MT cassette drive.

As freestanding off-line devices, MAEL 4021 DCU are self-sufficient in their format guidance and validation programs, which are held in a microprogrammed ROM. The screen and buffer are split between eight formatting mask lines and eight data entry lines, totaling up to 512 characters each.

The MAEL 4901 VDU terminal is an on-line device for transmitting buffered message blocks directly to a MAEL 4855, the only system to which it can be connected. The CRT screen holds both input messages and computer output messages. Input validation checks are performed by the MAEL 4855.

Up to eight local 4901 VDU terminals can be connected to a MAEL 4855 Polling Scanner. Each 4901 can be connected to the Polling Scanner by a two-wire connection up to 1,000 metres (3,300 feet) long, but system response is likely to be degraded if more than one or two terminals are connected by cables of more than 100 metres (330 feet).

Alternatively, one of the local VDU terminals can be replaced on the Polling Scanner by an ACP Data Transmission Adapter equipped with a 512-character buffer; which interfaces to a synchronous modem terminating a switched or leased point-to-point multidrop voicegrade line; transmission speeds are 2,400, 4,800 or 9,600 bits per second. Eight MAEL 4901 VDU terminals can be connected by individual or shared modems to the multidrop leased line. This gives a maximum configuration of 15 on-line MAEL 4901 VDU terminals on a MAEL 4855 system, in addition to its 4902 display console.

As on-line devices MAEL 4901 VDU terminals can be used as programmed data entry devices or as interactive file enquiry and/or transaction processing terminals. The MAEL 4855 has no interrupt facilities and relies on multiplexing by means of software polling. Thus, system response time is severely degraded if more than three on-line MAEL 4901 terminals are used for real-time file enquiries and/or processing. Larger configurations of up to 15 terminals should only be considered as multistation key-to-storage data entry systems. Table 2 lists the characteristics of the 4000 Series of data entry systems.

Table 2. MAEL 4000 Series: Key-to-Storage Data Entry Systems

SYSTEM	MAEL 4021 DCU	MAEL 4855 with 4901 Terminals
Shared Processor	No	Yes
Number of Stations	1	1-15
Character Set	64 ASCII (ISO-7)	64 ASCII (ISO-7)
Operating Modes (main)	Program load; data entry; verify; search	As required
DISPLAY		
Type	CRT	CRT
Display Capacity	1,024 chars (512 mask, 512 data)	1,024 chars
Number of Lines	16 (8 mask, 8 data)	16
Cursor Keys	6	6
Edit Function Keys	15	15
RECORDER		
Number	2	1-2
Density (bpi)	800 single-track	800 or IBM 3740-compatible diskettes
Capacity	160,000 bytes	292,000 (diskette)
Transfer Rate (char/sec)	1,000	
Tracks		
COMMUNICATIONS		
Rates (baud)	None	600; 1,200; 2,400; 4,800; 9,600
Codes		ASCII (ISO-7)
Error Checks		CRC; VRC; LRC
SPECIAL FUNCTIONS		
General	Single-track cassettes for processing on MAEL 4000	Data entered on-line on MAEL 4901 terminals can be processed by MAEL 4855
PHYSICAL		
Weight (lb.)	44 (20 kg)	
Width (in.)	19.5 (49.5 cm)	
Depth (in.)	22.7 (57.6 cm)	
Height (in.)	12.5 (31.7 cm)	
FIRST DELIVERY	1973	1974

MAINFRAME

MAEL 3000 and 4000 mainframes are housed in the console pedestal. The two systems differ only in the expandability of their memories and their peripheral interfaces. Single-processor architecture is used, with a central processor, main memory, and IO channels integrated into a common mainframe. No hardware interrupt, multiprogramming, nor multiprocessing facilities are provided.

Central Processor

Both MAEL 3000 and MAEL 4000 systems use the MAEL 4000E central processor model. The original MAEL 4000 processor is now used only on special-purpose systems, such as machine tool numerical control configurations.

Data Structure. MAEL 3000 and 4000 main memories are divided into separate, but dynamic, program and numeric data areas.

The basic addressable unit of storage in the program area of memory is the 8-bit byte, comprising seven data bits and one parity bit. The 128 code combinations are divided into 64 alphanumeric character codes, 14 numeric digits, and up to 50 program function codes. Function codes encountered in program memory during the execution of a program are treated as program instructions and executed. Alphanumeric character codes are treated as text constants and output to the device indicated by the current execution mode, as explained. The use of distinct 7-bit codes for program functions allows program instructions to be variable-length, ranging from one to six bytes in length.

In the numeric data area of main memory, groups of up to eight consecutive bytes are chained into numeric registers. These hold decimal numbers of up to 14 digits with a sign and decimal point indicator. Typical arithmetic speeds are given in Table 3.

Table 3. MAEL 4000: Typical Arithmetic Speeds

Operation	Execution Time
Addition, Subtraction	144 μsec (14-digit operands)
Multiplication	2 msec (14-digit operands)
Division	15 msec
Square root	15 msec

Registers. Five registers in numeric data storage have special functions: operation register, input register, program address counter, instruction register, and return address register. The remaining numeric data registers are used as working registers. A separate output register acts as an arithmetic accumulator and is displayed on the console.

Addressing Facilities. All addresses are page-relative within 1,024-byte pages. Each page can hold 1,000 program bytes and three numeric data registers, 128 numeric registers, or any intermediate combination of program bytes and numeric data registers.

Program bytes are individually addressable by 12-bit hexadecimal addresses. Numeric data registers are individually addressable by 8-bit hexadecimal addresses. Program bytes and numeric data registers outside the current page can be addressed indirectly.

Instruction Set. Thirty-three basic instructions are common to all MAEL 3000 and 4000 systems. These include seven set-up, four arithmetic, six register load/store, six logical and branching, three program modifying, and seven I/O commands.

MAEL 4000 Systems also implement square root, memory page selection, and an indirect addressing function. The optional Advanced Feature Package adds two more arithmetic instructions, one memory transfer, one output, two edit, and three logical and skipping functions.

The ENCODE command, introduced in 1972, facilitates the manipulation of both alphanumeric and program characters. It allows any character to be input from the console or backing store into any byte location in main store or on backing storage. Alternatively, the contents of any main or backing storage location can be output and/or displayed.

Execution Modes. MAEL 3000 and 4000 systems can run in any of 10 execution modes (EMDs). Six of these are input or output modes for programs, keyboard or peripheral inputs, or main memory contents. The remaining four EMDs are genuinely different modes of program execution.

In EMD 0 the computer executes programs stored in the program area of memory or entered from the console keyboard. EMD 4 allows execution of the program entered on the console typewriter or display alphanumeric keyboard. In EMD 1 and 5, core memory is ignored, and the program entered from the control console keyboard or the main paper tape reader is executed directly.

Programs entered from MT cassettes, diskettes, or cartridge discs cannot be executed directly. The EMD is set by control character commands. These can be entered like any other command from the console keyboard, paper tape/edge-punched card reader, or they can be read from core-resident programs. Programs mainly resident in core can thus branch into and exit from paper tape or edge-punched card subroutines that can vary between runs. Alternatively, programs held on paper tape or edge-punched card, or desk calculator programs entered directly on the keyboard can branch into and exit from core held subroutines.

Interrupt Control. The MAEL 4000E processor has no hardware interrupt facilities. The paper tape, magnetic tape cassette, and disc operating systems provide for software scanning of the console keyboards and typewriter or display at regular intervals. On systems to which more than one MAEL 4901 keydisplay terminal is connected, each terminal interface on the polling scanner is scanned at regular intervals by means of a software "Poll" command to check whether it has any data ready to be transmitted.

Main Memory

MAEL 3000 systems have a non-expandable main memory of 2,048 bytes; MAEL 4000 systems can include 2,048, 4,096, or 8,192 bytes of main memory. The smaller memory sizes can be field-expanded to the larger sizes. Memory cycle time is six microseconds per 8-bit byte access.

Input/Output Control

All peripheral devices are connected to a single input bus and/or an output bus. MAEL 3000 peripherals are connected via integrated adapters; MAEL 4000 peripherals are connected by standard interface connections.

Apart from console inputs, only one input or output transfer can take place at a time. Inputs are limited to a maximum transfer rate of 2,000 bytes per second, but output transfer rates are up to 100,000 bytes per second. High-speed backing storage devices thus require buffered controllers. The only exception is the 4902 CRT display console; its buffer can exchange data with the main CPU core store at 150,000 bytes per second in either direction.

Most peripherals input and output data to and from the program area of main memory. Numeric data is then transferred under program control to the numeric working registers. Numeric data can be input directly into numeric working registers only from the numeric input keyboard.

Console

All MAEL 3000 and 4000 systems have a 14-key numeric input keyboard for manual input; it includes digital and arithmetic function keys. An optional separate keyboard buffer allows processing to continue while input numbers are set up on the keyboard.

MAEL 4000 consoles have a more comprehensive keyboard which includes a large number of program command keys and "Code" keys for ENCODE, Cassette, and EMD (Execution Mode). Any MAEL 4000 instruction can be called by a single or double key depression. Whether the instruction is executed immediately or entered into the program area of core depends on the EMD setting.

MAEL 4000 consoles include a display. It displays contents of the output register (14 digits), current byte analysis (in binary), current program step's number, main memory page in use, and EMD mode. It also indicates PROGRAM LOAD status and the decade status of the current instruction.

Console Typewriter. The console of MAEL 3000, 4200, 4400, 4420, 4800, 4820, and 4850 systems also have an alphanumeric I/O typewriter (15 characters per second). It is based on an IBM 745 Selectric mechanism with interchangeable golfball movable printhead, but I/O electronics are proprietary.

The console typewriter can use a detachable ledger card front feed and/or a single continuous stationery feed. In some countries, it can also use an MGC 4051 magnetic stripe read/write unit connected to the ledger card front feed, which can read up to 200 bytes from a ledger card magnetic stripe on insertion and record updated data on it upon ejection.

Console Display. MAEL 4425, 4825 and 4855 consoles are equipped with a MAEL 4902 CRT display instead of the I/O typewriter. The CRT screen can display 16 lines of 64 characters each for input and output messages. The 4902 display is buffered. Input messages can be composed in local mode and edited on the screen without interfering with the CPU program. After the complete input message has been composed, the "SEND" key transmits it to the CPU's main memory. The 4902's buffer and the CPU main memory exchange data in either direction at 150,000 bytes per second.

In addition to the 1,024-character display screen, the MAEL 4902 also has a secondary display that is used in the same way as the console display is used on other MAEL systems. Its alphanumeric keyboard has a typewriter layout with a separate numeric keyboard and cursor control and screen editing keys.

MAEL 4902 console displays can accommodate as optional a dual magnetic tape cassette drive for dumping screen and buffer contents for later reinput.

PERIPHERALS

Table 1 lists the peripherals available on MAEL 3000 and the main MAEL 4000 Series configurations.

Standard Slow-Speed Peripherals

MAEL 3000 systems offer only console typewriter and paper tape input-output. All MAEL 4000 systems can use one or two slow input and one or two slow output devices. The first slow input device must be a paper tape reader, the second can be either a second paper tape reader or an 80-column or marked card reader.

Paper Tape and Edge-Punched Cards. Two paper tape readers are available. The GNT standard on MAEL 3000 systems can read both eight-track paper tape and edgepunched cards at 40 characters per second in continuous mode, or step-by-step at 30 characters per second. The GNT 24 can be used as an optional second input device on MAEL 4000 Series systems.

The Chalco 5201 bidirectional paper tape reader can read paper tape at 520 characters per second. It is standard on paper tape-oriented MAEL 4200, 4400 and 4800 systems, and optional on magnetic tape cassette- and disc-oriented MAEL 4420, 4820, and 4850 Series systems.

Either paper tape reader can be used to read program instructions directly into the instruction register in EMD 1 and 5, bypassing the program area of core memory. They can also be used to enter programs into core.

The GNT 34 can punch both 8-track paper tape and edge-punched cards at 35 characters per second in continuous mode or 30 characters per second in step-by-step mode. The GNT 34 is optional on all MAEL 3000 and 4000 Series systems.

Cards. The F1115 80-column card reader or the MCP 130 marked card reader can be connected to MAEL 4000 Series systems as second input device for data input only, not for programs. The MCP 30 marked card reader can read up to 32 marked columns per 80-column card at up to 40 columns per second (40 cards per minute).

Printers. The MAEL 4101 and 4102 are Centronics 101A and 102 serial matrix printers. They form characters at 5 by 7 (standard) or 7 by 9 (optional) dot matrices. They may also form specially elongated characters as 10 by seven dot matrices, at half-speed, to draw attention to text headings or particular texts. Either printer can be supplied with special character sets, including Swedish and Cyrillic.

At least one MAEL 4101 or 4102 printer is standard on all MAEL 4425, 4825, and 4855 configurations to print output data, because these systems are equipped with a MAEL 4902 console display instead of a console typewriter. Either printer can also be connected as optional auxiliary printer to any other MAEL 4000 Series system.

High-Speed Backing Storage

Magnetic Tape. MAEL 4420, 4425, 4820 and 4825 systems use a MAEL 4104 Dual Cassette as main backing storage for programs and data files. It can also be used as a batch input device for data recorded off-line on MAEL 4021 Data Capture Units (DCU). MAEL 4104 Dual Cassette drives can also be connected to MAEL 4850 and 4855 systems, as optional auxiliary storage and input device.

The MAEL 4104 system comprises two Philips-type cassette drives and a common controller. Recording is according to ECMA standards at 12.5 inches per second and 800 bits per inch on a single-track on either side of the cassette tape. Up to 160,000 bytes can be stored on each cassette in standard blocks of 200 bytes. Cassettes can be searched at 5,000 bytes per second for the appropriate block. Read/write speed is 1,000 bytes per second.

In 1974, one or two incremental magnetic tape drives for industry compatible 9-track magnetic tape recorded at 800 bits per inch will also be available. These tapes will be used mainly to record data that will be transmitted for further processing to a larger EDP system.

Discs. MAEL 4850 and 4855 systems can be equipped with either or both of two exchangeable disc systems to hold programs and data files. Table 4 lists the detailed disc specifications.

The Shugart dual diskette system is the first IBM 3740-compatible diskette system available on a European small business computer. On the MAEL 4000, data is recorded in 200-byte sectors. To optimize track capacity, sectors are recognized by software. But from the point of view of hardware, recording is in "free format." Shugart diskettes can be used for MAEL 4850 and 4855 program and file storage but also for off-line transmission of data

Table 4. MAEL 4000E: Fixed/Exchangeable Disc Drives

	Shugart	Iomec 3002
IDENTITY		
Max Drives/Controller	2	8
Packs/Drive	1 exchangeable	1 exchangeable + 1 fixed
Compatibility	IBM 3740	IBM 2315
PACK CAPACITY		
Unit of Storage	8-bit byte	8-bit byte
Bytes/Sector	200	200
Sectors/Track	20	24
Tracks/Cylinder	1	2
Cylinders/Pack	73	200 + 3 spare
Bytes/Track	4,000	4,800
Bytes/Cylinder	4,000	9,600
Bytes/Pack	292,000	1,920,000
DRIVE PERFORMANCE		
Bytes/Drive	292,000	3,840,000
Average Cylinder Access (msec)		95
Average Latency (msec)		20
Peak Transfer (bytes/sec)		195,000

to be processed further on IBM System/360 or 370 installations.

The alternative, Iomec 3002, is an IBM 2315-compatible fixed/exchangeable cartridge disc system. One to eight drives can be connected to a buffered controller equipped with a full 200-byte sector buffer. The controller exchanges data with the individual disc drives at their normal peak transfer rate of 195,000 bytes per second, but it exchanges data with the MAEL 4850 or 4855 CPU at the latter's peak input speed of 2,000 bytes per second and peak output speed of 100,000 bytes per second.

Both systems can be connected to a common MAEL 4850 or 4855 system. Maximum on-line capacity is currently 30 million bytes.

Special-Purpose Peripherals

All MAEL 4000 Series systems can also accommodate a graph plotter and/or a direct interface to numerically controlled machine tools.

Magnetic Stripe Ledger Card Units. In some countries, the console typewriter of MAEL 3000, 4200, 4400, 4420, 4800, 4820, and 4850 systems can accommodate an MGC 4051 magnetic stripe ledger card unit. It reads and records a standard 200-byte sector.

DATA COMMUNICATIONS

Data Communications facilities are optionally available only on MAEL 4855 disc processing systems equipped with a MAEL 4902 CRT display console. Currently only eight local, or seven local and eight remote MAEL 4901 CRT display terminals can be connected. Software is also being developed to allow two MAEL 4855 systems to communicate with each other or with larger general-purpose EDP systems.

Controllers

The Polling Scanner and the ACP Data Transmission Adapter are available to handle data communications.

The Polling Scanner connects eight CCITT V.24 two-wire interfaces to common standard interface positions on the input and the output bus. A MAEL 4901 CRT display terminal can be connected to each two-wire interface by cable, up to 1,000 metres (3,300 feet) long. When the CPU program gives the POLL command, the scanner polls each interface in turn to see if it has any data to transmit. Data transmission is bit-serially at 9,600 bits per second (1,200 bytes per second) in either direction. The disc operating system's polling routine allows bytes from the interfaces to be interleaved with each other, thus the Polling Scanner is, in effect, a software multiplexor.

The eighth interface on the Polling Scanner can be used by the *ACP Data Transmission Adapter* instead of a MAEL 4901 terminal. The ACP Adapter includes a 512-byte message buffer, line control and error checking electronics, and CCITT V.24 voice-grade line modem interface. The modem should be a synchronous modem with a transfer rate of 600, 1,200, 2,400, 4,800 or 9,600 bits per second. It can terminate a single point-to-point connection to the switched telephone network, or a leased point-to-point or multidrop line. Up to eight modems can be connected to a multidrop line, and each modem can interface with a MAEL 4901 CRT display terminal at a different remote site. Only one remote terminal can be exchanging a complete message block with the ACP adapter's buffer at any one time. When the ACP adapter's buffer has a fully checked input message to transmit, it signals "Ready" to the Polling Scanner as soon as it is polled.

Terminals

MAEL 4901 CRT display terminals resemble 4902 console displays in their capacity and general appearance. They are fully buffered for local message composition as well as screen image regeneration. Screens have a 1,024-character capacity, arranged as 16 lines of 64 characters. Any part of the screen can be used for input message composition, or for output messages, as determined by the cursor and cursor controls. Screen contents can be partially transmitted. Maximum message block length is 512 characters. A MAEL 4104-compatible dual cassette station can be connected.

The MAEL 4901 terminal differs from the 4902 display console primarily in its interface and control keys. The 49 O/S buffer is connected by a serial two-wire interface; a maximum transfer rate is 9,600 bits per second (1,200 bytes per second). The control keys on the keyboard are also simpler, and are more concerned with the control of screen formats and line procedures than with MAEL 4000 system control. The alphanumeric and numeric clusters on the keyboard are identical to those of the MAEL 4902 console display.

Input messages can be composed on MAEL 4901 terminals in local mode. When the SEND key is depressed, the terminal buffer puts data on the line. The keyboard is then locked until the lock is released by a signal from the Polling Scanner or the ACP Data Transmission Adapter, depending on whether the terminal is locally or remotely connected. If the message was a data entry message, the keyboard is released as soon as the complete message is received. If the message is a file enquiry, the keyboard is not released until the enquiry has been processed and answered; polling of other MAEL 4901 terminals may also be held up.

It may thus be unsafe to use more than three to five MAEL 4901 terminals as local and/or remote file enquiry and/or transaction processing terminals on MAEL 4855 disc processing systems. Any number of MAEL 4901 terminals, up to the current maximum of eight local or seven local and eight remote terminals, can be used as on-line source data entry stations.

MAEL 4901 terminals can be replaced by numeric input keyboards at local and/or remote sites for pure numeric data entry. Table 5 lists the detailed characteristics of the 4901 terminal.

KEY-TO-STORAGE DATA ENTRY

MAEL 4901 on-line CRT display terminals are used mainly as data entry terminals on MAEL 4855 disc configurations. In addition, any number of MAEL 4021 off-line Data Capture Units (DCU) can be used as data entry stations to any MAEL 4420, 4425, 4820, 4825, 4850, or 4855 System equipped with a MAEL 4104 Dual Cassette station as main or auxiliary backing storage and I/O device. MAEL 4021 Data Capture Unit (DCU). The MAEL 4021 DCU is the third version of the MAEL CRT display. Like the MAEL 4901 terminal and the MAEL 4902 console displays, it offers a 1,024-character CRT screen, arranged in 16 lines of 64 characters. On the MAEL 4021 DCU, eight lines (512 characters) are formatting masks, and eight lines (512 characters) are for input data.

The MAEL 4021 DCU is designed to be used as a freestanding off-line data entry device. It has a 1K-byte microprogrammed ROM and a 1K-byte format mask and data buffer. The formatting program is read from the input drive on the dual cassette station. This displays format guidance messages to the operator in the eight

Table 5. MAEL 4000: MAEL 4901 CRT Display Terminal

IDENTITY	MAEL 4901
CONTROL UNIT	
Configuration	Single-station
Buffer Size (char)	1,024
Max No. of Displays	1 @
@ No. of Chars/ Screen	1,024
Type of Memory	MOS
DISPLAY UNIT	
Display Area	18 cm x 31 cm (7.2 x 12.4 in.)
Screen Capacity (char)	1,024 (incl 512 data max)
Char/Line	64
Lines/Screen	16 all data
Paging Capacity (char)	—
Displayable Character Set	64
Char Generation Technique	Dot matrix
Char Size	—
MANUAL KEYBOARD ENTRY	
Keyboard Layout	Std typewriter
Output Code	ASCII
No. of Data Codes	64
No. of Control Codes	21
Numeric Cluster	10-key pad
Switchable Speeds	—
Operator Controls	Field Load/Block Load
KEYBOARD EDITING	
Horizontal Tabulation	Yes
Char Insert/Delete	—
Line Insert/Delete	—
Partial Xmit	Yes
Scrolling/Wraparound	Yes
Protected Data/ Format Mode	No
Blinking Capability	Cursor
Other	Home; clear screen; vertical tab; report
SPECIAL FEATURES	
Portability	No
Modem Included	No
Detachable Keyboard	No
Output Printer	No
Magnetic Tape Casettes	Twin cassette
Other	Separate 2-line display for status indicators

Table 5. (Contd.)

DATA TRANSMISSION	
Multidrop capability	
Operating Mode	Half-duplex
Transmission Code	ASCII
Data Rate (bps)	9,600
Synchronization	Synch
Error Control	CRC

lines reserved for formatting messages and provides parameters to the format checking and validation microprogram. Input data keyed by the operator are displayed in the other eight lines and checked as they are entered against the program's formatting mask and validation parameters.

When an input message is complete and recognized as valid, a depression of the SEND key records it on the dual cassette station's output drive. Messages must be fixed-length. The MAEL 4021 offers a choice of four standard lengths: 64, 128, 256, and 512 characters, corresponding respectively to one, two, four, or eight lines. Table 2 lists the characteristics of MAEL 4021 data entry stations.

Central Configurations. Data recorded off-line on MAEL 4021 DCUs or on-line on MAEL 4901 terminals can be processed in batch mode by the central MAEL 4420, 4425, 4820, 4825, 4850, or 4855 system. Alternatively, the central system can merge, validate and sort the data before it is transmitted to a larger general-purpose EDP system on IBM 3740-compatible diskettes or industry-compatible 9-track magnetic tapes.

SOFTWARE

Insel agents supply MAEL 3000 users with all their applications programs on paper tape or edge-punched cards. They will also do applications programming for MAEL 4000 users.

A large percentage of MAEL 4000 users who had no previous computer experience have written their own programs. Insel supplies them with operating systems tailored to their configuration and a mnemonic instruction code.

Operating Systems

Three operating systems are currently available. The *paper tape operating system* is designed for MAEL 4200, 4400, and 4800 systems equipped with two paper tape readers of either model and a paper tape punch. It supports other slow-speed I/O peripherals, including one auxiliary high-speed serial printer.

The magnetic tape cassette operating system is designed for MAEL 4420, 4425, 4820, and 4825 configurations equipped with a MAEL 4104 Dual Cassette Station. It supports all available slow-speed I/O peripherals in any combination.

The *disc operating system* is designed for MAEL 4850 and 4855 configurations equipped with a Shugart dual diskette drive and/or one to eight Iomec 3002 fixed/exchangeable cartridge disc drives. It supports all available MAEL 4000 peripherals, including up to 30 million bytes of on-line disc storage and up to 15 local and/or remote on-line MAEL 4901 CRT display terminals. The disc operating system includes an Indexed Sequential File Management System. This system simplifies operation, and provides a great deal of security against data corruption.

All operating systems provide logical file control facilities and macros to address files and records within files.

Language

A one-for-one mnemonic instruction code is the programming language for all MAEL models. Source programs are entered into MAEL 4000 CPUs via the console keyboard, on which there is a key or combination of keys for each command. Depending on the execution mode (EMD), each instruction is obeyed immediately, recorded in core for later execution or output to paper or magnetic tape or disc. An Assembly System is currently being considered.

Programs for MAEL 3000 systems must be entered on the console keyboard of a MAEL 4000 (usually by the supplier), output to paper tape or edge-punched cards, and transmitted to the MAEL 3000 user in this form.

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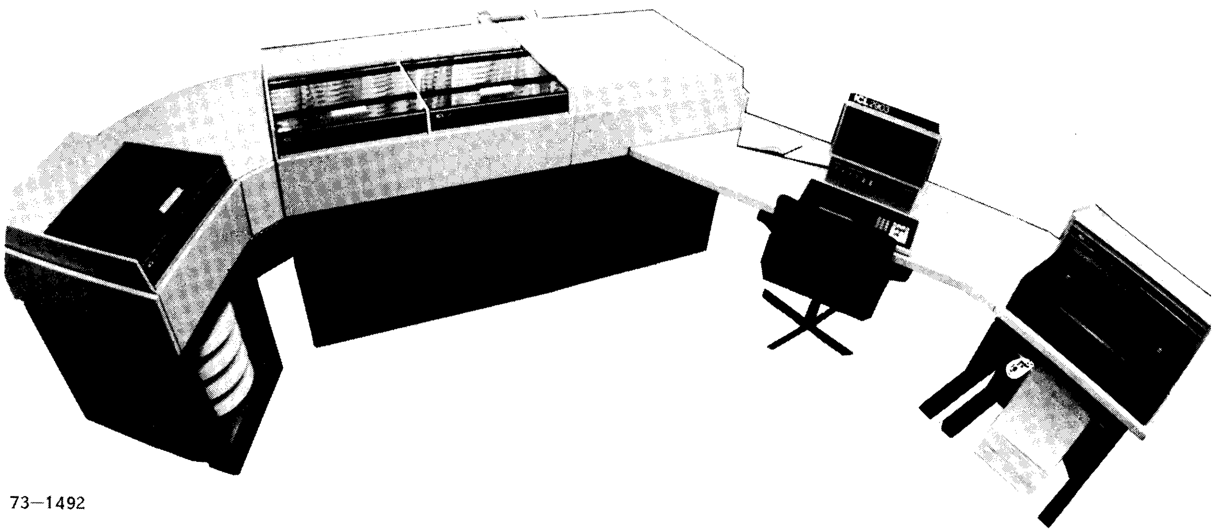

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OVERVIEW

The ICL 2903 is a small microprogrammed disc-processing business computer. It is designed for first-time computer users and for users converting from unit record or keyboard-oriented accounting systems or service bureau facilities. It is priced at 26,000 Pounds ($63,466) for the basic system to 137,500 Pounds ($335,637) for different configurations.

The highlight of the 2903 is its ability to serve as a multistation key-to-disc direct data entry system concurrently with batch processing or the real-time processing of file inquiries. Two to eight dedicated direct data entry (DDE) terminals with 256-character CRT displays can be connected by cable, up to 100 meters long (330 feet), to a 2903 processor equipped with a special DDE microprogram. This microprogram provides optional verification and selective search facilities.

The 2903 offers 64K to 192K characters of main store, 9.8 to 270 characters of fixed/exchangeable disc backing store, a card reader (300 or 600 cards per minute), a line printer (300 or 600 lines per minute), and an operator's console with a 1000-character CRT display. The console can also be used for on-line file interrogation. The system can be further equipped with up to eight local and/or remote 2000-character CRT display terminals to interrogate and update user files. It can also be used as an intelligent RJE terminal to the ICL 1900 series of computers.

The 2903 is fully compatible in object programs and data with the ICL 1900 series. It is priced between the cheaper 1901A and 1901S disc processing systems and the more expensive 1902A. Its internal speeds and I/O transfer rate of 750,000 characters per second are closer to those of the 1903A.

To discourage users of the existing 1901A, 1901S, 1902A, and 1902S from converting their installations to a 2903, source program compatibility with the 1900 series is restricted to Cobol, Fortran, and a few application packages. Neither the PLAN assembler nor the NICOL program generator is offered on the 2903; its main programming language is the IBM-compatible RPG 2. Except for the RPG 2 compiler and the basic single-program Executive, all 2903 software is unbundled. Unlimited RPG 2 programming, operator training, and program testing facilities are available to users at ICL Customer Centers.

The ICL 2903 was designed and is manufactured at the ICL works at Sevenage, Herts, England. The main office is at ICL House, Putney, London SW15 1SW: Tel 01-788 7272. It is marketed directly by ICL in South Africa, Australia, New Zealand, and all Western European countries except Italy, Greece, Spain, and Portugal. Deliveries begin in January 1974 and are 6 months from the date of order.

Competitive Position

The ICL 2903 competes with the IBM System/3 Models 10 and 15; Burroughs B 1700 Series;

Honeywell-Bull Model 58 and Models G-115 through G-130; NCR Century 75 (150-656 in the UK and Scandinavia); Nixdorf Systems 880/65 and 900; Siemens System 404/3 and System 4004/220; and Univac 9200II, 9300, and 9300 II.

At equivalent prices, the 2903 offers a larger main store and higher I/O throughput than its competitors, notably to or from its fixed/exchangeable and EDS 60 backing stores. The 2903, however, is not now available in card-only or magnetic tape-only configurations. The range of batch I/O devices available on the 2903 is more restricted than on the IBM System/3 and Burroughs B 1700; the 2903 includes neither 96-column card equipment nor MICR, OCR, or OMR document readers. Paper tape I/O devices are addressable only by Fortran programs.

These I/O limitations are related to the 2903's most attractive feature: its facility for accommodating direct data entry (DDE) keystations on line and multiprogramming their operation with normal batch processing and/or with on-line file inquiries. The 2251 DDE keystations offer 256-character CRT displays similar to those of the latest small multistation key-to-disc data preparation systems to appear on the market, such as ICL's own Key-Edit 50. Because the DDE stations share the central processor's logic and main store with batch processing programs, they are economical for configurations as small as two keystations, replacing two keypunches and one or two key verifiers.

On larger DDE configurations, the cost per keystation becomes progressively lower and more advantageous compared with the direct data entry solutions proposed on the IBM System/3 Models 10 and 15 and the smaller Burroughs B 700. On- or off-line IBM 3741 data entry stations, or Burroughs AE 300 audit entry terminals include their own processors on each keystation and are more expensive.

Configurations

The basic 2903 system comprises a central processor with 16K 24-bit words (64K characters) of MOS main storage; an operator's console with a 1000-character CRT display which can also be used for on-line file interrogation; a 300 or 600 card-per-minute card reader; a 150, 300, or 600 line-per-minute line printer; and 9.8 million 6-bit BCD characters of fixed/exchangeable backing disc storage (FEDS) on a drive holding a fixed disc (4.9 million characters) and an exchangeable disc (4.9 million characters). All these components are integrated into a common hardware frame. Software for this configuration includes an Executive and an RPG 2 compiler.

The central processor's main store can be expanded in 4K-word increments to 32K words and then in 8K-word increments to a current maximum of 48K words (192K 6-bit characters). At least 20K words are required to use the optional multislot Exec 1 and remote or local VDU inquiry terminals or the multiprogramming Exec 2, which can multiprogram up to four user batch and/or on-line programs. Exec 2 also requires the addition of the optional Teletype 33 RO hard copy device to the video console.

The backing FEDS disc storage can be expanded in increments of 4.9 million characters to 29.4 million characters by the addition of up to three 4.9-million character exchangeable disc drives, one drive can also be equipped with a 4.9-million character fixed disc. In addition, one to four 2815 EDS 60 exchangeable disc pack drives holding 60 million characters per disc pack drive can be substituted for the FEDS drives or can be intermixed with the FEDS drives up to a combined maximum configuration of four drives of each type for a total disc backing storage of 270 million characters on line. At least two EDS 60 drives must be used if they are the only disc backing stores.

Up to five additional peripheral controllers can be added to the configuration: one or two direct data entry couplers and three other controllers. The latter controllers can include a local and/or remote communication coupler.

Direct Data Entry. The F1551 and F1552 Direct Data Entry Couplers can each control up to four 2251 Direct Data Entry (DDE) keystations equipped with 256-character CRT screens for a total of eight DDE stations per 2903 configuration. The keystations must be locally connected with a cable, maximum length of 100 meters (330 feet). The keystations can be used only for key entry and key verification.

File Inquiry/Updating Terminals. The F1559 Local Communications Coupler offers local connection facilities to a 7181/2 Visual Display Terminal (VDT) or to a 7182/1 Transparent Line Sharing Adapter (LSA) to which up to eight 7181/2 VDTs can be cable connected; cable length can be up to 100 meters (2900 feet).

The F1560 Remote Communications Coupler connects a single voice-grade line terminated by a synchronous modem to the 2903; transmission speed is 1200, 2400, or 4800 bits per second. A maximum of eight 7181/2 VDTs can be connected to this line by way of individual modems at different sites if the line is a leased multidrop line or by way of a 7182/1 Transparent LSA and a single modem at a common site.

The maximum combined number of local and remote 7181/2 VDTs that the 2903 communication software can address is eight. The 7181/2 VDTs have 2000-character screens. They must be used for all file inquiries from sites other than the central processor (where the console display terminal can be used) and for all on-line file updating. Unlike 7181/2 VDTs connected to 1902A and larger systems, they cannot be used for direct data entry under the DATAFEED package. Both local and remote 7181/2 VDTs can be equipped with 7081/3 or 7081/4 RO Termiprinters to provide hard copy of the contents of the screen.

1900 Series Standard Interface Peripherals. A 2903 processor can be fitted with one, two, or three F1558 1900 series Standard Interface Couplers, depending on whether the 2903 has been equipped with an F1559 Local and/or an F1560 Remote Communications Coupler or couplers. Any combination of the following 1900 series peripherals can be connected to F1558 couplers:

- 1916/2 Paper Tape Reader (1000 char/second).
- 1920/2 Card Punch (100 cards/minute).
- 1925/2 Paper Tape Punch (110 char/second).
- 1934/5 Graph Plotter.
- 2508 9-track Magnetic Tape system (1600 bpi, 80,000 char/second).
- 7015/1 Telephone Data Terminal for a single voice-grade line terminated by a synchronous modem leading to a 1902A or larger system running under GEORGE 2, 3, or 4 (transmission speed 1200, 2400, or 4800 bits per sec).

Figure 1 shows a full implemented ICL 2903 System.

Compatibility

The current standard 2903 microprogram implements the full 1900 series order code. The 2903 is thus fully compatible in machine code with all members of the 1900 series, from the smallest 1901 to the largest 1906S. Some instructions, however, are available only on 1903T or 1906A and larger processors. Data is stored on the FEDS or EDS 60 backing disc store in fixed-length 128-word (512-character) sectors, conforming to UDAS standards.

In a reversal of the more usual situation, this compatibility in machine code is not matched by comparable compatibility in the source program. This is done for marketing rather than for technical reasons. The only source languages shared by the 2903 with other members of the 1900 series are Cobol, Fortran, and the six application packages: PERT, FIND 2, Statistics, LP, PROSPER, and COMPAY. ICL does not now offer either the PLAN assembler or the NICOL program generator for the 2903. Conversely, the RPG 2 compiler is not currently offered to ICL 1900 series users.

Users who plan to replace an existing 1901, 1901A, 1902, or 1902A system by a 2903 can retain only programs written in Cobol or Fortran from the earlier system. Such users also face a file conversion problem; the 2903 cannot connect to the EDS 4, EDS 8, and TEDS disc systems used on the 1901A and other 1900 Series systems.

These limitations do not apply to users who plan to add a 2903 to an existing 1900 Series system. The PLAN and NICOL compilers can continue in use on the existing 1900 Series system to produce object programs for the 2903. ICL is also prepared to make an RPG 2 compiler available to 1900 Series users who have ordered a 2903 to assist them in compiling and testing RPG 2 programs for the 2903 in advance of the delivery of the 2903 itself.

An RPG 2 compiler and FEDS connection facilities will become available on the 1903T and larger systems or their successors by January 1975. They will permit 2903 users to expand beyond the configuration capabilities of the 2903 itself.

The 2903 standard programming language, RPG 2, is a compatible superset of IBM's RPG II, used on the System/3, Burroughs B 700, B 1700, and a growing number of other small business computers. The RPG II is in turn a superset of the RPG used on the IBM System/360 Model 20.

The 2822 FEDS exchangeable disc packs used on the 2903 are identical to the System/3 5440 disc cartridges. Data is stored differently, however, and users converting from a System/3 to an ICL 2903 must reformat their files.

Data is transmitted to data communication lines in the ISO-7 (ASCII-8) code, which is accepted by most computer systems. Off-line data transmission, however, is more awkward because the 2903 currently follows the practice of the ICL 1900 Series and stores alphanumeric characters

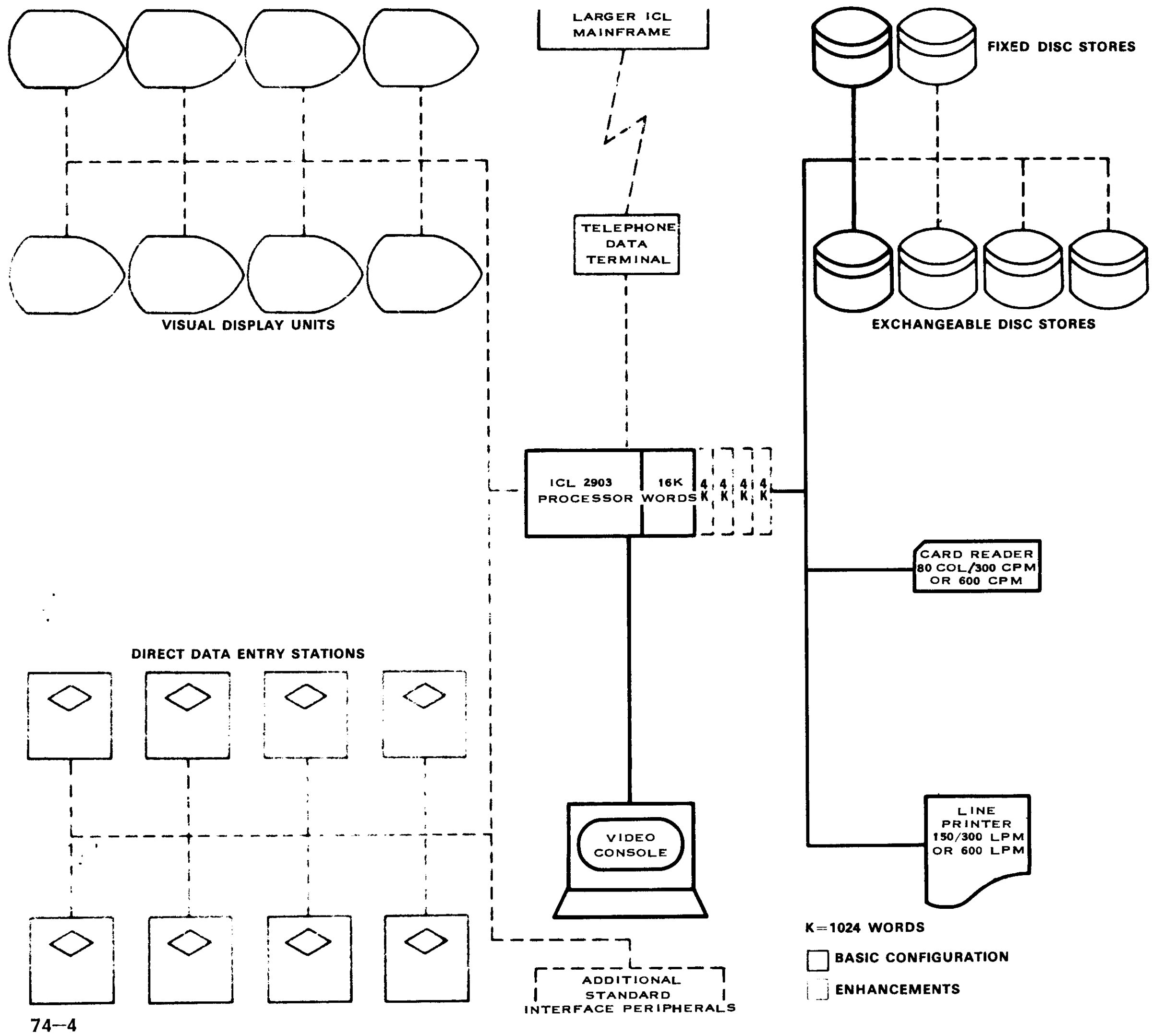


Figure 1. ICL 2903 System Configuration

as six-bit BCD characters instead of eight-bit EBCDIC or ASCII-9 characters. It stores numeric data as 24- or 48-bit binary numbers rather than 16-, 32-, or 64-bit binary numbers.

ICL 2903 systems equipped with 7015 Telephone Data Terminals and the optional RJE module in Executive 1 can be used as intelligent RJE terminals to larger 1900 Series systems. They are fully compatible with ICL 7020 line control procedures on line to the 1902A and larger 1900 series systems running under GEORGE 2 RTS, GEORGE 3, or GEORGE 4.

The 2251 Direct Data Entry (DDE) keystations used on the 2903 have keyboards identical to the new ICL Key-Edit 50 Key Display Stations. The 2903 DDE microprogram offers no screen format guidance, however, and is not program compatible with either the Key Edit 50 or the Key Edit 1000.

MAINFRAME

The 2903 uses advanced TTL/MSI circuitry to implement a conventional single-processor architecture; in the central processor, main store and input/output channels are integrated into a common mainframe. The basic 2903 mainframe also includes four integrated system peripherals: a console with CRT display, a card reader, a line printer, and a fixed/exchangeable disc backing store. Table 1 lists the mainframe characteristics.

Multiprogramming. The 2903 multiprogramming facilities are advanced for a system within its price range. At least one batch program can be multiprogrammed with I/O spooling on any 2903 system of any size. These operations can be further multiprogrammed with direct data entry from up to eight key stations and with RJE transmissions from the disc backing store to a data communication line on 20K-word configurations. On 32K-word systems, the multiprogramming Exec 2 can be used. It permits up to four user batch and/or on-line programs to be multiprogrammed.

Table 1. ICL 2903: Mainframe Characteristics

Characteristic	ICL 2903
Announced	April 1973
First Delivery	January 1974
Central Processor	
No. of Internal Registers	6
Use	Accumulators, instruction, program counter, status, etc.
No. of Registers in Main Store	8 per program
Use	GP accumulator and working, 3 index
No. of Instructions	
Standard	100
Optional	11
Fixed-Point Arithmetic	
Add/Subtract	Std
Multiply/Divide	Std
Floating-Point Arithmetic	Opt
Decimal Arithmetic	None
Priority Interrupt System	NA
Main Memory	
Type	Semiconductor
Cycle Time (μsec/word)	1.14
Word Length (bits)	24
Capacity (words)	
Minimum	16,384
Maximum	49,152
Increment	4K, 8K
Protect	NA
ROM	NA
Loadable Control Storage (LCS)	
Type	TTL/MSI
Cycle Time (nsec/word)	350
Word Length (bits)	32
Capacity (words)	
Minimum	4096
Maximum	8192
Function	Implement 1900 Series instruction code and DDE microprogram
I/O Channels	
Programmed	None
Multiplexed	11
Direct Memory Access	None
Maximum Transfer Rate (char/sec)	
Within memory	3,500,000
Multiplexed I/O	750,000

Multiprocessing. The 2903 has no multiprocessing configurations, but 2903s can be included in multiple processor configurations where several processors, each with its own store, communicate directly store to store. The 2903 systems can be connected by way of a 7015 Telephone Data Terminal and a synchronous leased telephone line to a 1902A or larger 1900 series system; thus, they fulfill the functions of an intelligent remote job entry terminal.

Central Processor

The 2903 central processor is microprogrammable. It uses a two-level store: a loadable control store (LCS) for implementing user instruction sets and a main semiconductor store for user programs and data. Neither the LCS nor the microstep instruction code is accessible to users. ICL now offers only two microprograms:

- Standard microprogram (4096 32-bit LCS words) implements the 1900 series instruction set.
- Optional direct data entry (DDE) microprogram (4096 32-bit LCS words) controls 2251 DDE terminals.

Data Structure. The basic addressable unit of processor main storage is the 24-bit word. It can represent a program instruction, a binary integer or fixed-point signed binary number, part of a double-length fixed or floating-point number, or four six-bit BCD alphanumeric characters. Table 2 lists the data formats.

Products and dividends are 47 bits long. The standard arithmetic format is fixed-point binary using signed 23-bit operands. Multilength arithmetic on signed 47-bit operands and larger operands is performed by subroutine.

Floating-point arithmetic is optional and uses 48-bit, double-length operands, divided into a signed eight-bit exponent (representing a power of 2) and a 37-bit fraction.

The standard alphanumeric code for internal storage and communication with on-line peripherals is the six-bit BCD code, which offers 64 code combinations. Three of these are treated as shift characters (uppercase, lowercase, and control), so that the character set can be extended to 88 or 120 characters. The seven-bit plus parity ISO-7 (ASCII-8) code is used for data communications and paper tape I/O.

Special registers. ICL has not published the register structure used by the 2903 microprograms. The standard microprogram that implements the 1900 series instruction code uses six nonaddressable processor registers, and eight program-addressable general-purpose registers.

The six nonaddressable processor registers are part of the arithmetic and logical circuitry.

- A is the main intermediate accumulator and working register.
- B is the subsidiary intermediate accumulator and working register in double-length and floating-point instructions.
- P is the carry, executive mode, and current instruction address register.
- N is the instruction address, operand address, and microinstruction cycle counter.
- F, X, M is a one-word register divided into three fields, holding the function code, accumulator register address, and modifier register address, respectively.
- Datum holds the absolute store address of word zero of the user program.

Each program has eight addressable general registers located in the first eight words of its core store area. There are separate sets of general registers for the Executive and the user program. Any of the registers, zero to seven, can be addressed by the three-bit X field of arithmetic, logical, and shift instructions as well as by the 12-bit N address of these instructions when required. Registers five, six, and seven can also be addressed by the two-bit M field of arithmetic and logical instructions to index the main store address.

Addressing Facilities. Main store address fields in instructions are either 12 or 15 bits long. The 15-bit address in branch instructions permit direct branching to any of 32K words. The 12-bit addresses in arithmetic and logical instructions permit direct addressing within the first 4096 words of any program, which is where frequently accessed working areas will normally be located. These 12-bit addresses can be modified by the 15-bit modifier field within one of the three 24-bit index registers. This permits the modified addresses of arithmetic and logical instructions to address up to 32K words.

Although these addressing facilities are adequate for small configurations where main store does not exceed 32K words, the direct or modified addresses of 2903 instructions are never treated as absolute addresses, but as relative addresses within a program. To convert them into absolute addresses, the processor adds the 15-bit contents of the Datum register which contains the absolute address of word 0 of that program. Thus, 2903 programs can be located in any part of main store, an important consideration for multiprogramming applications.

Arithmetic, logical, and shift instructions contain a three-bit register address, which permits the second operand of arithmetic and logical operations and the single operand of shift instructions to be located in any of the eight 24-bit general registers in the first eight words of each program. Three of these eight registers can be used as index registers for arithmetic and logical instructions.

Instruction Set

The 2903 can implement all but nine of the 120 instructions of the full 1900 Series instruction set. Eleven floating-point instructions are optional. All instructions are one word long.

The standard LCS microprogram always implements 85 instructions for conditional and unconditional branching; single-length, fixed-point addition; subtraction; multiplication and

Table 2. ICL 2903: Data Structure

Data Name	Representation
Character	6 bits
Byte	—
Halfword	12 bits
Word	24 bits; represents program instruction, binary integer or fixed-point signed binary number, part of a double-length fixed or floating-point number, or 4, 6-bit BCD alphanumeric characters.
Fixed-point binary arithmetic operand	23 bits plus sign; double precision arithmetic on signed 47-bit operands by subroutine; products and dividends 47 bits.
Floating-point arithmetic operand	48 bits: signed 8-bit exponent and 37-bit fraction.
Alphanumeric code for internal storage and communication with peripherals	6-bit BCD; 64 code combinations; extended by shifting to 88 or 120 characters.
Code for data communications and paper tape I/O	ASCII-8

division; logical operations; and single- and double-length shifts. Microprogrammed instructions also convert numbers from decimal to binary and from binary to decimal.

If the Scientific Computing Feature (SCF) is specified, the LCS microprogram is extended to implement eight floating-point arithmetic instructions on normalized or unnormalized 48-bit floating-point numbers. FIX, FLOAT, and one additional conditional branch instruction are also included.

The 11 input/output instructions and four control instructions are implemented by Extracode routines in the Executive. Table 3 summarizes the instruction set.

Interrupt Control. All 2903 systems run under the control of an executive program that implements all input/output and control instructions and handles all interrupts. Interrupts caused by an I/O or control instruction in the user program are called voluntary. External interrupts are caused by the completion of an I/O transfer, a message from the operator console, an incoming message from a communication terminal, or a machine malfunction.

Whatever the cause, all interrupts cause a branch to a predetermined location in the Executive. This location has its own set of general and index registers in the first eight words of its own store area; thus, it has little to do to preserve the state of the interrupted user program. When the Executive has dealt with the cause of the interrupt, it returns control to the user program at the point where the program was interrupted.

Main Memory

The 2903 has two levels of main storage: the loadable control store (LCS) and the main store.

Loadable Control Store (LCS). The LCS is not accessible to user programmers, and ICL has published little data about it. LCS uses a 32-bit word. Access time is 100 nanoseconds, and the microinstruction execution time is 350 nanoseconds. Two microprograms are now available.

- The standard microprogram (4096 words) implements the 1900 Series instruction set and the optional SCF (Scientific Computing Feature).

Table 3. ICL 2903: Instruction Set

Instruction	Description
No. Instructions	
Standard	111
Optional floating-point	11
Length of instructions	one word
Implementation	
85 instructions for branching, fixed-point arithmetic, logical operations shifting and decimal/binary code conversion	Standard LCS microprogram
8 floating-point instructions for the Scientific Computing Feature	Standard LCS microprogram
11 I/O and 4 control instructions	Extracode routines in the Executive.
Address Fields in Instructions	
Branch Instructions	15 bits, permit direct branching to any of 32K words
Arithmetic and Logical	12 bits, permit direct addressing of operands in first 4096 words of a program

- Optional Direct Data Entry (DDE) microprogram (4096 words) controls two to eight 2251 DDE terminals. Both microprograms can be in LCS concurrently.

Main Store. The main store for user programs and data is a MOS store with a read/write cycle time of 1.14 microseconds per 24-bit word. Memory modules are 4096 words up to 32K words and 8K words beyond 32K words. At least four modules totaling 16,384 words are included in a basic 2903. Four more modules can be added individually up to a main store size of 32K words. Modules can then be added in groups of two to a current maximum main store size of 49,152 words.

I/O Control

The 2903 can be equipped with up to 11 peripheral I/O couplers.

- Six can be dedicated couplers for standard system peripherals: video console, Teletypewriter console attachment, card reader, line printer, FEDS disc system, and EDS 60 disc system.

- Two can be direct data entry (DDE) couplers; four 2251 DDE keystations can be attached to each coupler.

- Four other peripheral couplers can be any combination of one or two local communication couplers, one or two remote communication couplers, and/or one to three 1900 Series standard interface couplers (SIC).

The dedicated couplers for system peripherals, DDE stations, and local and remote communications are associated with special I/O microprograms that perform all functions required to control the I/O device and to convert its data format. The 1900 Series standard interface couplers (SIC) segment data from the internal 24-bit format into four six-bit character frames for transmission to a standard interface and vice versa. All control functions and further data conversions are performed by a device controller on the other side of the interface.

Transfers between the 2903 main store and all peripheral couplers can be multiplexed by interleaving six-bit characters or 24-bit words, but only one disc transfer can take place to or from either FEDS or EDS 60. All I/O microprograms can transfer any number of characters or words, as instructed by the Executive after it interprets the user program I/O macros. Each microprogram requires the use of the processor's A and B registers to transfer each six-bit character or 24-bit word in and out of main store. The processor program hesitates during each six-bit or 24-bit transfer to or from a peripheral, but it resumes immediately afterward without branching into the Executive. An external interrupt signal, causing a branch into the Executive, is sent by an I/O coupler's microprogram only when it has completed an input or output block transfer.

Console

All 2903 systems use a 2255/1 Integrated Video Console for entering operating system messages and displaying data.

The 2255/1 has a standard typewriter keyboard and a CRT display, for up to 1000 characters in 50 lines. The first 48 lines are reserved for complete input messages and system responses. The bottom two lines display messages as they are keyed in by the operator.

In addition to its control functions, the 2255/1 console can be used to enter file inquiries and to display the responses. Data from the user's disc file, however, cannot be updated or altered by 2255/1 messages on-line. Local or remote 7181 VD terminals must be used for this purpose.

The 2255/1 console can be equipped with the optional 2421/1 Teletype RO 33 output printer for hard copy of selected messages from the operator and/or system. The RO 33 is attached to the mainframe by way of its dedicated coupler. It is required on any configuration running under the Multiprogramming Executive 2.

If the 2903 configuration does not include the 2421/1 console output printer, the systems will, if requested, maintain a log of all console input and output messages in a dedicated area of the system disc. This log can be printed at any time on the system's integrated line printer when the printer is not required for data output.

PERIPHERALS

Peripherals include standard slow-speed input/output devices, high-speed mass backing stores, communication couplers, and couplers for up to eight direct data entry (DDE) keystations. The most commonly used system and communication devices are connected by way of dedicated couplers, while 1900 Series standard interface couplers (SIC) are also available for a limited number of standard 1900 Series peripherals. Up to 11 I/O couplers can be connected to a system, of these only three can be F1558 standard interface couplers combined with F1559 and F1560 communication couplers.

Standard Slow-Speed I/O Devices

Every 2903 includes one 80-column card reader and one line printer chosen from among the devices listed in Table 4. All line printers are the drum barrel type and offer a 64-character print set and 132 print positions per line. Special national print barrels are available on request.

Optional additional slow-speed I/O devices include a card punch, paper tape reader, paper tape punch, and graph plotter. Each of these requires one F1558 standard interface coupler.

High-Speed Mass Backing Stores

Two disc backing storage systems are available on the 2903. Table 5 summarizes the disc characteristics.

The 2815 EDS 60 system uses double-density IBM 2316-type disc packs holding 60 million six-bit characters per disc pack and drive. The 2822 fixed/exchangeable disc store (FEDS) uses IBM 5440-type disc cartridges; each cartridge holds 4.9 million six-bit characters. Up to four drives can be connected to the integrated disc coupler. A minimum configuration of one 2822/1 FEDS drive holds 9.8M characters; a maximum configuration of four EDS 60 drives, one 2822/1, one 2822/2, and two 2822/3 FEDS drives offers a combined on-line storage capacity of 270M characters.

Although ICL uses industry standard disc cartridges and disc packs in both the FEDS and the EDS 60 system, block formats are different. A standard addressable segment length of 128 words (512 six-bit characters) is used in both systems, and their instantaneous transfer rate has been equalized at 416K characters per second. This rate is normal for an IBM 2314-type drive but substantially faster than most competing IBM 5444-type cartridge systems. Only one disc transfer per drive can take place at any one time.

2903 systems can also be optionally equipped with two-, three-, or four-drive magnetic tape systems using nine-track, 1600 bit-per-inch tapes. In this system, three nine-bit frames are used to record each 24-bit word or each group of four six-bit characters. The instantaneous transfer rate of 60,000 frames per second corresponds to an ICL transfer rate of 80,000 six-bit characters per second.

By a curious omission, no magnetic tape system is currently available on the 2903 for reading or writing either seven- or 9-track NRZ tapes at the usual recording density of 800 bits per inch.

Table 4. ICL 2903: Standard Slow-Speed Peripherals

Device	Performance Characteristics	Comments
Card Reader	80 cols	Required in configuration.
2108/1	300 cps	Connects to integrated card reader coupler.
2104/1	600 cps	Connects to F1549 SI coupler, replacing integrated card reader coupler.
Line Printer	64 chars; 132 cols	Required in configuration.
2411/3	300 lpm	Connects to integrated line printer coupler.
2409/3	600 lpm	Connects to F1550 SI coupler replacing integrated line printer coupler.
Card Punch		Optional.
1920	100 cpm	Connects to F1558 SI Coupler (SIC).
Paper Tape		Optional.
1916/2 Reader	1000 cps	Connects to F1558 SIC.
1925/2 Punch	110 cps	Connects to F1558 SIC.

Direct Data Entry Keystations

The 2551 DDE keystations are CRT display terminals with 256-character screens arranged in eight lines of 32 characters. They are equipped with detachable keyboards in IBM 029 keypunch layout, with a separate cluster of 20 function keys for program selection, editing, and cursor control. An alternative keyboard with typewriter layout and a separate 12-key numeric cluster may be offered later. Table 6 summarizes the DDE Keystation Characteristics.

The 2251 DDE keystations are unbuffered and use reserved areas of the central processor's main semiconductor member as buffers to refresh the screen and to edit the input. For this reason, the keystations can be cable connected to the 2903 by cables no longer than 100 millimeters (330 feet) long. Data keying is done in the TTY-compatible Echoplexing mode; that is, each character is sent to the central processor's store as it is keyed and appears on the screen at the next refresh cycle together with the other contents of the reserved buffer area. Function keys send control signals to the DDE microprogram and Executive.

The advantage of this centralization of DDE terminal buffering and control logic is that facilities can be improved simply by issuing more advanced DDE microprograms. The initial DDE microprogram provides no formatting masks; it provides only a running count of character number in record, record number, batch number, current running mode, and any machine-detected keying errors when the system is running in the Verify mode. This data is displayed on the bottom two lines. Lines 5 and 6 are used by the DDE station nominated as the supervisory station to interrogate the system and to display the system's answers. Keyed data is entered on the top four lines sequentially; the record size can be up to 128 characters.

The 2251 DDE system recognizes three operating modes: Enter, Verify, and Selective/Correction. In the Verify mode, records entered previously are retrieved individually and sequentially from the backing disc store and held in the processor's buffer memory for comparison with the data entered by the verify operator. In the Selective/Correction mode, records can be retrieved from the backing disc store at random, displayed on the screen, and amended.

DATA COMMUNICATIONS

Two types of data communication facilities are available on the 2903. First, up to eight 7181/2 Visual Display Terminals (VDT) can be locally and/or remotely connected to the system for on-line file inquiries and/or updating. Second, complete 2903 system can be used as an intelligent remote job entry (RJE) terminal to a larger 1900 Series configuration. Table 7 summarizes the direct data entry and communication facilities.

Controllers

The F1559 Local Communications Coupler (LCC) can connect a single 7181/2 VDT to the 2903 processor by way of a local direct cable, up to 900 millimeters (3,000 feet) long. Alternatively, it can interface a 7182/1 Transparent Line Sharing Adapter (LSA) by cable, 30 millimeters (100 feet) long. Up to eight 7181/2 VDTs

Table 5. ICL 2903: Mass Storage Systems

Peripheral Device	Performance Characteristics	Comments
Fixed Exchangeable Disc Store (FEDS)		
2822/1	One fixed disc, 4.9M chars and one exchangeable disc drive; 4.9M chars; access time 10 to 70 msec, avg 40 msec; latency 12.5 msec; transfer rate 417,000 char/sec	Required; connects to integrated FEDS coupler.
2822/2	One fixed disc, 4.9M chars and one exchangeable disc drive, 4.9M chars; performance same as 2822/1	Optional; extension drive, 1 can connect to 2822/1.
2822/3	One exchangeable disc drive only, 4.9M chars. Performance same as 2822/1	Optional; extension drive, 2 can connect to 2822/1, if 2822/2 also connected, otherwise 3.
Exchangeable Disc Store (EDS 60)	80M char	
2815/1 Drive and Controller	60M char; access time 10 to 60 msec, avg 35 msec; latency 12.5 msec, 416,000 char/sec transfer rate	Connects to integrated disc coupler.
2815/2 Drive	Same as 2815/1	Two to 4 drives/system; Connect to integrated disc coupler.
Magnetic Tape		
2508/1 Controller and Two Drives	9-track; 1600 bpi, PE; 37.5 ips; 80,000 (6-bit) char/second	Connects to F1558 SIC.
2508/2 Controller and Three Drives	Same as 2508/1	Connects to F1558 SIC.
2508/3 Controller and Four Drives	Same as 2508/1	Connects to F1558.

can then be connected to the 7182/1 by way of individual local cables, up to 870 millimeters (2,900 feet) long.

The F1560 Remote Communications Coupler (RCC) interfaces the 2903 processor to an asynchronous (600 or 1200 bits per second) or synchronous (2400 or 4800 bits per second) modem, which terminates a single point-to-point or multidrop switched or leased telephone line. The line leads to one or more remote sites at which 7181/2 VDTs are located. At each site a compatible modem interfaces either directly to a 7181/2 VDT or to a 7182/1 transparent LSA. Up to eight 7181/2 VDTs can be connected to the 7182/1. No more than eight 7181/2 VDTs can be addressed by the 2903 processor at any one time.

The 7015/1 Telephone Data Terminal interfaces the 2903 processor to a synchronous modem. Transmission rate is 1200, 2400, or 4800 bits per second. The modem terminates a single point-to-point leased or switched telephone line leading to a larger 1900 Series system running under GEORGE 2, 3, or 4. The 7015/1 can recognize and return the same control signals as the ICL 7020 Communications Terminal, and it permits the 2903 to emulate the 7020 as an intelligent RJE terminal to the larger system.

Terminals

The 7181/2 Visual Display Unit (VDU) is the only remote terminal that can be connected to 2903 systems. It is a buffered CRT terminal

Table 6. ICL 2903:
2251 Direct Data Entry (DDE) System

Characteristic	2251 DDE
System	
Shared Processor	Yes (using 2903 central processor)
No. of Stations	2-8
Character Set	64
Operating Modes	3: Enter, Verify, Selective/Correction
Display	
Type	CRT
Capacity (char)	256 (128 data)
No. Lines	8 (4 data)
Cursor Keys	—
Edit Function Keys	—
Recorder	None. Data recorded on disc is taken over directly by 2903 batch processing programs.
Communications (2903 system as a whole)	
Rates (bits/sec)	2400 or 4800 (7015/1 Telephone Data Terminal)
Codes	ISO-7 (ASCII-8)
Error Checks	VRC, LRC
First Delivery	January 1974

with a 2000-character screen and buffer. Data is displayed in 25 lines of 80 characters. Up to 96 displayable characters are available, including full uppercase and lowercase alphabetics in italic or Roman font to distinguish fixed format from variable data. The F1357 Rack-up Facility provides optional scrolling.

Both the 7181/8 and the 7181/9 keyboard offer 47 alphanumeric keys arranged in typewriter layout and a separate 12-key numeric keyboard for the one-hand input of all-numeric data. In conjunction with a control key, the numeric keys can be used as function keys to input single-character messages to the user program without display.

The keyboard has four directional cursor keys and various local editing and formatting functions including line insertion and deletion, character insertion and deletion, clear screen, and clear foreground data. Table 8 summarizes the 7181 VDU characteristics.

Each 7181/2 VDU can be equipped with a 7081/3 or 7081/4 RO Termiprinter for hard copy output. The 7081/4 prints 30 characters per second, it has 118 print positions and either a friction or a sprocket feed. Its 94-character set and print quality make it suitable for printing business documents such as invoices when remotely connected 7181/2 VDUs are used for on-line order entry and invoicing.

SOFTWARE

ICL offers a choice of three operating systems, three high-level programming languages, nine applications packages, and a wide variety of utility programs for the 2903. Executive O and the RPG 2 compiler are supplied free of charge to all installations. Also, unlimited free training in RPG 2 is given to operators and users' programmers at Customer Centers. All other software is unbundled and subject to monthly license fees. Table 9 lists the available software packages.

Operating Systems

The disc-overlay operating systems for the 2903 are Exec 0, Exec 1, and Exec 2. All can load, unload, and automatically sequence a string of user programs belonging to a common job. Job control statements are written in the GEORGE 1S job control language, which is also used on the ICL 1901A and 1901S Disc Systems.

Executive 0

Exec 0 is a single-program operating system that can control either a single batch processing user program or direct data entry from as many as eight keystations; the 2903 configuration must be dedicated to one purpose or the other. When Exec 0 is controlling a single batch processing user program, however, it can handle I/O spooling and console file inquiries concurrently.

The I/O spooling module allows Exec 0 to control card-to-disc input conversions and/or off-line printing from disc routines while it is running the single batch user program. The batch user program accesses the disc for all input and output files, even those labeled as card or printer files in the job description.

The console file inquiry option allows Exec 0 to accept from the system's video console on-line inquiries about the contents of any user file record held on disc. When Exec 0 detects an inquiry, it rolls the current batch processing program out to disc and replaces it with the file inquiry processing program from disc. When

Table 7. ICL 2903: Direct Data Entry and Communications Couplers

Device	Devices Connected by Coupler	Line Speed (Bits/Sec)
Direct Data Entry Coupler (DDC)		
F1551	2251 DDE terminals 1-4	Local up to 30m (100 ft)
F1552	2251 DDE terminals 5-8	Local up to 30m (100 ft)
Local Communications Coupler (LCC) F1559	7181/2 VDT (one) or 7182/1 Transparent Line Sharing Adapter	4800; local up to 900m (3000 ft)
Remote Communications Coupler (RCC) F1560	Asynchronous or synchronous modem terminating telephone line leading to up to 8 7181/2 VDTs and/or 7182/1 LSAs	600/1200, 2400, or 4800
Transparent Line Sharing Adapter (LSA) 7182/1	7181/2 VDTs. Up to 8 VDTs connected to F1559 or remote modem	2400 or 4800 line up to 870m (2900 ft)
Telephone Data Terminal (connected via F1558 SI Coupler) 7015/1	Synchronous modem terminating telephone line leading to remote 1902A or larger system	2400 or 4800

the inquiry has been answered, the batch processing program is brought back from disc and resumes at the point where it was interrupted. The video console, however, cannot be used to alter or update disc files nor can Exec 0 control 7181/2 VDU file inquiry/updating terminals.

Executive 1. Exec 1 offers all the facilities of Exec 0 plus more advanced "multislot" facilities. It can still control only one user program, but it can be either a batch processing program or a 7181/2 VDU terminal-oriented file inquiry and/or updating program. In addition, Exec 1 can handle concurrently any or all of the following operations which function as Exec 1 subroutines.

- I/O spooling as on Exec 0.
- RJE transfers between the backing disc store and the 7015/1 Telephone Data Terminal for transmission to or reception from a 1902A, System 4-50, or larger system to which the 2903 is connected by way of a leased telephone line.
- Direct data entry from up to eight keystations.

Table 9 gives the store requirements for all these operations. A minimum 20K-word store is required to run Exec 1 and to multiprogram DDE with a batch user program; at least 24K words of main store is required to multiprogram all the above operations, or to run DDE with an RPG 2 compilation.

When Exec 1 includes the optional communications module, on-line file inquiries can be made not only from the video console but also from any of eight local and/or remote 7181/2 VDU terminals. The batch processing program is rolled out to disc and replaced by a file inquiry and/or updating program when a VDU inquiry is made. Unlike the video console, 7181/2 VDU terminals can be used not only to interrogate but also to update disc files.

Executive 2. Exec 2 is a full multiprogramming Executive for up to four user-written programs, which can be any combination of batch programs and on-line file inquiry/updating programs. In addition direct data entry operations and file inquiries from the central console can also be multiprogrammed simultaneously, but I/O spooling can not. Each input conversion, output conversion, and RJE transfer occupies one of the four user program slots when it is run.

Exec 2's job control facilities are identical to those of the central module of the GEORGE 2 operating system used on the ICL 1902A and larger systems. GEORGE 2's input spooling and output spooling modules can also be used, but each module occupies one user program slot when it is run.

Language Processors

ICL offers RPG 2, Cobol, and Fortran on the 2903 but does not offer assembler language. Thus, the 1900 Series instruction set microprogram can be dropped at some future date and replaced with a more powerful microprogram implementing some or all of the high-level languages directly.

RPG 2. This is the standard 2903 programming language. It is supplied free to all installations, and training for users' programmers is free at ICL Customer Centers. RPG 2 is a compatible superset of RPG II used on the IBM System/3 and of RPG used on the IBM System 360/20. ICL has added features for users to write on-line file inquiry and updating programs to be run from 7181/2 VDU terminals.

Cobol. The standard 1900 Series disc-based Cobol compiler is offered for the 2903 for a monthly license fee. It implements Extended Cobol 61 with the optional direct-access verbs. Further, it permits 2903 file inquiry facilities to be included as subroutines within object programs.

Fortran. The 1900 Series, ANSI Fortran IV, disc-based compiler is offered for the 2903 for a monthly license fee. It accepts source programs from cards, paper tape, or FEDS files and outputs object programs to FEDS or magnetic tape.

Other System Software

Direct Data Entry. An optional module in Exec 0 or 1 controls entry from 2251 DDE keystations. The user specifies data formats on questionnaires, which are then copied on cards or DDE and are run by the DDE User Program Compiler.

Utilities. Utilities include a comprehensive library that contains a text editor, library update,

Table 8. ICL 2903: 7181 Visual Display Unit

Features	7181 Implementation
Control Unit 7181/2	
Configuration	Single
Buffer Size (char)	2000
Max I/O Supported	2 units
Max No. Displays	1
Char/Display	2000
Aux Printer	ICL 7081/3 or 7081/4
Aux Mag Tape Unit	No
Display Unit 7181/2	
Screen Size (char)	2000
Char/Line	80
Lines/Display	25
Paging Capacity	None
Char Set	96 ISO-7 (ASCII) char
Editing/Formatting	
Horizontal Tab	Yes
Char Typeover	Yes
Line Insert/Delete	Yes
Char Insert/Delete	Yes
Split Screen	Yes
Partial Transmit	Yes
Scrolling	Opt (F 1357 Rack-up Facility)
Data Transmission	
Line Facility	Voiceband (leased or switched)
Line Speed (bps)	2400, 600/1200 and 4800 opt
Line Mode	Half-duplex
Line Code	ISO-7 (ASCII)
Synchronization	Synchronous by message
Error Control	
Detection	Char parity and message block-sum check Auto retransmit
Features	
Integral Modem	No
Portability	No
Polling/Addressing	Yes
Numeric (keyboard) Cluster	7181/9 keyboard only
Switchable Speeds	Yes
Detachable Keyboard	Yes
Compatibility	
Computer System	ICL System 4, 1900 Series, 2903
Terminal	7181/2
First Delivery	July 1971 (7181/2)

Table 9. ICL 2903: Software

Software Package	Store Requirements (24-bit words)
Operating Systems	
Executive 0 Single Program: Basic	2704
Executive 1 Multi-Slot: Basic	4496
Executive 2 Multiprogramming: Basic	5632
Executive Options	
Available on all Executives	
Console File Inquiry facilities	512
Floating-Point Extracodes	300
Input Spooling	1024
Output Spooling	1024
Direct Data Entry: 1-2 stations	4096
Each additional station	350
Available on Executives 1 and 2 only:	
Communications (7181/2 VDUs)	400
Remote Job Entry (7020 Emulation)	1536
Available on Executive 2 only:	
GEORGE 2 central module	3840
Language Compilers	
RPG 2	12,032
Cobol	13,624
Fortran IV	10,728
Applications Packages	
2903 Stock Control	NA
2903 Bill-of-Materials Processor	NA
2903 On-Line Order Entry	NA
1900 Series COMPAY	NA
FIND 2	NA
Linear Programming	NA
PERT	NA
PROSPER	NA
Statistics	NA

card and paper tape listing, disc sort, file creation, update and dump, off-line print, and other routines. The 1900 Series magnetic tape utility programs are also available to 2903 installations with magnetic tape.

Application Packages

ICL has written three application packages especially for the 2903. They are offered for monthly license fees. They are supplied as RPG 2 source decks on 80-column cards together with source program listings. They can be easily modified to accommodate special features wanted by the users. The packages are the 2903 Stock Control, 2903 Bill-of-Materials Processor, and 2903 On-Line Order Entry system. The order Entry System was written especially for entering orders from local and/or remote 7181/2 VDU terminals.

Six 1900 Series application packages are also available to 2903 users for monthly license fees: COMPAY, FIND 2, Statistics, Linear Programming, PERT, and PROSPER. They are supplied by ICL as object program binary card decks or magnetic tape reels. Any modifications to accommodate features wanted by the user will be made by ICL on the user's behalf.

COMPAY is a UK payroll program. FIND 2 is an information retrieval package. PERT is a network planning system. PROSPER is a financial share evaluation package.

HEADQUARTERS

International Computers Limited
ICL House, Putney
London SW15 1SW, England

OVERVIEW

The Lockheed System III is a small business computer system based on Lockheed's SUE (System User Engineered) minicomputer. The basic hardware/software package includes a processor, memory, disc, printer, and CRT keyboard console together with the Disc Operating System, RPG II Compiler, Assembler, Sort-Merge Program, Data Editor, and Source Editor.

Software packages are similar to IBM System/3 software and provide the user with a total system which is easy to use and program. The Lockheed System III RPG II compiler is compatible with IBM System/3 Disc System RPG II in source language and file structure, with minor deviations in its implementation with specific devices. The system is housed in a desk suitable to an office environment; additional memory and peripherals, including magnetic tape and a data inquiry CRT can be added. Asynchronous low-speed data communications are available but high-speed communications are not currently supported.

SUE processors are 16-bit, word-oriented microprogrammed processors. The SUE computer systems, like their predecessors the MAC 16 and MAC Jr., are designed, marketed, and supported by the Lockheed Electronics Data Products Division primarily as an OEM product; but SUE systems are offered to the end user as well. SUE is designed to protect the user from system obsolescence by making it easy to add new technology on a function basis. This is accomplished by designing the system around a central bus system called the Infibus, over which system modules communicate with each other on a signal-response basis. System modules operate asynchronously with respect to each other and are synchronized only for information transfer cycles. The processor and memory, like all other pluggable system modules, connect to the Infibus, which is in turn controlled by the Infibus controller.

The System III version of SUE was announced in June 1973. The same basic system, including DOS and the RPG II compiler, was previously marketed then as the SUE Business System. The configuration was developed in 1972 for a CNA Systems application. Thus, the system has really been on the market over two years, and there are over 100 installations. LEC's market for it is as an "OEM small business system" to service bureaus and software houses instead of the end user.

COMPETITIVE ANALYSIS

The marketing approach for the System III should prove profitable for Lockheed and beneficial to the small business user who ends up with the system. Because most businesses customize their software to some extent, a large number of service bureaus and programming houses have sprung up to assist companies that do not want to support an in-house programming staff. These houses are proliferating at a great rate, riding on the wave of the small computer boom. Instead of developing software facilities to provide customized software needed to market to small businesses, Lockheed sells to the software houses and service bureaus who in turn sell, lease, or rent as they choose. The Lockheed name can appear on the hardware, or, as in cases like the CNA Systems (versus System 100) for independent insurance agents, the hardware is repackaged slightly and presented to the small business end-user under the CNA label. The end user of the service bureau can contract with Lockheed for maintenance or obtain it from another party, as they choose.

For a manufacturer using a small business computer for the first time, this marketing approach presents a number of attractive features. Lockheed has identified a sizeable market that by its very nature circumvented the problem of applications software support for small novice users, allowed systems to be sold rather than leased, and consisted of repeat customers. The software house gains experience with the manufacturer's software and makes an in-house investment in applications software. Thus it becomes increasingly profitable to continue marketing the same system.

Wang has been marketing the 2200 to some extent along the same lines, but the 2200 is a much smaller system and moreover, it has been designed with the idea that the small business user would be doing at least some of his own programming. Most other manufacturers of small business systems of a size comparable to Lockheed's system market directly to end users, and they must compete directly with the formidable IBM System/3.

LEC has one advantage over most minicomputer and small business computer manufacturers. It is a large core memory supplier to the computer industry as a whole, and consequently the cost of core memory for its system is low, and total system cost is low.

CONFIGURATION GUIDE

The basic System III configuration consists of a Lockheed SUE decimal processor and 16K bytes of core memory; IBM 5444-compatible cartridge disc (five million-byte capacity); and printer (100 characters per second). The system is housed in a desk with the CRT/keyboard recessed; alternatively, a desk without the recess for the CRT/keyboard can be specified at additional cost. A medium-speed (200 lines per minute), or high-speed (600 lines per minute) impact printer can replace the system printer.

In addition to these replacement options, a variety of options can be added to the basic system, see Table 1. Nine slots are available in the CPU for this purpose. The Heavy Duty Power Supply Package must be added for large configurations: more than 32K bytes of memory, 24K bytes of memory, and three additional single control board peripherals, or two disc interfaces.

Table 1. Lockheed Electronics System III: Mainframe Characteristics

CENTRAL PROCESSOR	
No. of Internal Registers	7 general-purpose plus "P" counter
Addressing	
Direct (no. of bytes)	64K (doubleword instructions); 512 (singleword)
Indirect	Multilevel
Indexed	Yes
Instruction Set	
Number	73
Decimal Arithmetic	Firmware plus subroutines
Priority Interrupt System	
Lines	4
Levels	4 (unlimited sharing)
MAIN STORAGE	
Type	Core
Cycle Time (nsec)	850; 250 (access)
Basic Addressable Unit	Byte/word
Bytes per Access	1 or 2
Min Capacity (bytes)	8K
Max Capacity (bytes)	64K
Increment Size (bytes)	8K; 16K
Parity	None
Protect	None
ROM	
Use	Control memory
Capacity (bytes)	2K
I/O CHANNELS	
Programmed I/O	Yes
DMA Channels (no.)	Yes (unlimited no.)
Multiplexed I/O	None
Max Transfer Rate (words/sec)	
Within Memory	2.2M (overlapped core)
Over DMA	5M

Additional memory is available in 8K-byte or 16K-byte modules; each module requires three slots, allowing a maximum of 62K bytes total; 2K bytes are devoted to control memory. Card readers and punches, more discs, cassette drives, and auxiliary inquiry CRT, and computer tape drives can also be added. Specifications for the individual items and the number of slots each requires are listed in Table 2. The maximum configuration size is determined by the number of slots required by the devices and by the DOS software. Disc drives include one fixed and one removable platter per drive; up to eight drives can be added to a system.

MAINFRAME

Central Processor

The System III is a 16-bit, word-oriented binary processor controlled by a microprogrammed control memory. The processor is organized around an arithmetic and logic unit, seven general-purpose registers, and a microcoded control memory. Internal bus lines connect the processor, control memory, and Infibus controller cards. The processor communicates with memory and I/O controller modules via the Infibus.

Data transfers on the Infibus are performed in a master-slave relationship. A module is a master if it can cause another system module to receive or transmit data; processors, I/O controllers, and control panels can be masters. Modules that receive or transmit data when addressed are slaves. A master module operates as a slave when addressed by another master module. Memory modules can only be slaves; when accessing instructions and operands from memory or transferring data to memory, the processor is the master.

The processor communicates with peripheral devices in the same way as with core memory. No special I/O instructions are required because the processor addresses I/O device registers with the same instruction set that addresses memory.

Some devices connected to the Infibus are able to assume master control of the bus, address a slave unit, and transfer data independently of the processor. Data transfer can be directly between any master device and any slave, although the usual path for data is between processor (master) and memory (slave) or between memory (slave) and device (master). Table 1 lists mainframe characteristics.

Data Structure. Each word consists of 16 bits divided into two 8-bit addressable bytes. The left byte has an even address that is also the word address; the right byte has an odd address. Negative numbers are in two's complement form with the most significant bit representing the sign.

Special Registers. The processor's register file contains seven general-purpose registers, a program counter, a status register, instruction register, and two registers used by the processor's microcode control registers. All registers are 16 bits long.

The general-purpose registers can function as accumulators, stack or address pointers, or index registers. All addressing is done through these registers for singleword instructions. Doubleword instructions can address memory directly. The program counter can be used with the autoincrement or autodecrement addressing modes for immediate operands.

Instruction Set. The System III instruction set is divided into 11 classes: seven general register, two branch, one shift, and one control. Instructions are one or two words long. The first word is divided into four 4-bit fields; the second word contains a data word address. The most significant field indicates the class of the instruction; the next most significant field gives the operation for all classes except branch. User of the two remaining fields varies with addressing mode and class designation. Instructions address bytes or words.

Interrupt Control. There are two classes of interrupts on a SUE computer: external interrupts (system interrupts that affect the flow of data across the Infibus) and internal interrupts (processor self-interrupts that do not use the interrupt lines on the Infibus). The external interrupt system is controlled by the Infibus controller

Table 2. Lockheed Electronics System III: Add-On Peripherals

Peripheral	Slots Required	Characteristics	Comments
DISCS			
380302, 303, 304 Disc drives (second, third and fourth drive)	3	1 fixed, 1 removable disc/drive; 5M-byte capacity/drive; IBM 5444-compatible	Up to 4 drives/system
CARDS			
380201 Reader and Interface	2	285 cpm	For 80-col cards
380210 Interpreting Data Recorder with Interface	1	Reads 300 cpm, punches 60-120 cpm	For 96-col cards; includes interpreter
380211 Data Recorder	1	Reads 300 cpm, punches 60-120 cpm	For 96-col cards; no interpreter
380212 Sorting Data Recorder	1	Reads 300 cpm, punches 60-120 cpm	For 96-col cards; includes interpreter
380213 Printing Reader Punch	1	Reads 300 cpm, punches 60-120 cpm	For 96-col cards; includes printer
380214 Reader Punch	1	Reads 300 cpm, punches 60-120 cpm	For 96-col cards; no printer
380220 Reader and Interface	1	300 cpm	For 96-col cards
PRINTERS			
380021 Line Printer	–	Prints 200 lpm; 132 cols	Heavy duty; replaces 100-cps printer
380030 Line Printer	–	Prints 600 lpm; 132 cols	Heavy duty; replaces 100-cps printer
380150 Line Printer	1	Prints 100 cps; 132 cols	Used for second printer
380160 Line Printer	1	Prints 200 lpm; 132 cols	Used for second printer
380170 Line Printer	1	Prints 600 lpm; 132 cols	Used for second printer

which first assigns priorities to modules primarily on the basis of the function of the service request line required, and then, if several devices request the save service line simultaneously, according to the priority of the device. Devices are assigned priority on the basis of physical proximity to the Infibus controller.

SOFTWARE

System III operates under control of a foreground/background Disc Operating System (DOS) which supports a System Control Language (SCL) interpreter, RPG II Language Compiler, and LEC LAP-2 assembler for easy generation of printed reports and for business processing. A powerful DOS utility package, Sort/Merge program, Data Editor and Source Editor are also standard components of the delivered software package. There are no plans to develop standardized applications packages (such as Accounts Payable, Accounts Receivable, Payroll, etc.) because of the company's "OEM" marketing thrust.

DOS allows one interactive program in the foreground while a batch program is being run in the background. Language processors, utility programs, and most application programs are executed in the background area of memory. These are transferred to the disc if a higher priority foreground program, such as an on-line data file inquiry, interrupts the background processing. Upon completion of the foreground program, or during intervals of waiting (for example, during an I/O request), the background program is rolled in and restarted at the point of interruption.

DOS has four basic functional components.

- System Control Monitor: Consists of an initialization module for the initial program loading, a resident control module to service and control all jobs, and nonresident (transient) facilities such as the background loader, background check point/restart, operator error messages, etc.
- Control Language Processor: Interprets the System Command Language (SCL) that provides the linkage between the user and the system. Has an optional interactive mode, allowing partial commands, and requesting additional parameters.
- Language Processors and Link Loader: Generates object code from disc, card, or other batch input, and either stores it in a work file or links it to system program library subroutines and catalogues it into the program library, to be loaded and executed later.

- Disc Utility Routines: Initializes and maintains disc files. Includes a disc initialization program for formatting new packs, a Library Allocate Program, a File and Volume Label Display Program, a Disc or File Copy/Dump Program, and a File Delete Program, all operating under control of the Control Maintenance Facility.

RPG II Language Compiler. The System III RPG II Compiler is compatible with the IBM System/3 Disc System RPG II (manual number SC21-7517-2) with regard to language structure and diagnostic message meanings, but some specifics vary because Lockheed peripherals differ from IBM peripherals. The Lockheed disc is recorded in ASCII, the IBM in EBCDIC; IBM supports communications while Lockheed supports magnetic tape, etc. Lockheed's file organization, the arrangement of records into indexed, sequential, and direct files, is compatible with IBM's.

The Lockheed RPG II compiler operates under DOS, using the resident DOS I/O handlers and IOCS. The compiler consists of multiple overlays residing on the disc system file. The object code is acceptable to the Link Loader, and can be organized into object code segments which can be executed in the overlay mode, if the user so specifies.

Sort/Merge. Disc sort/merge is an important utility for business applications that operates under DOS. It handles sequential, indexed or direct files and provides four types of output:

- SORTR—Sorted records with data and/or control fields (tag-along sort).
- SORTA—Sorted records containing relative disc record locations.
- SORTS—Sorted records containing control and/or summary data fields.
- MERGE—Merged records from presequenced input files.

Sorting is usually done in three phases: an assignment and checking phase, a dispersion sort that edits and sorts into a number of strings, and a final merge that combines the sequenced strings into one sequenced file for the disc. If certain conditions are met, the second phase can be bypassed. Sort/Merge enhances throughput and improves disc-file allocation, because records can be shortened and when selected from a file, require a smaller work area.

Editing Programs. Two programs enable editing of data already in the system. Data Edit can edit either original data or call out, edit, and replace data on the disc. Source Edit can go into the RPG source statement file and the user at the console can edit and replace RPG source statements.

HEADQUARTERS

Lockheed Electronics Company
6201 E. Randolph Street
Los Angeles CA 90040

PRICE DATA

Model Number	Description	Prices, $/Quantity 10-24	25-49	50-99	100-	Monthly Maint. $
	CENTRAL PROCESSOR AND WORKING STORAGE					
370000	Basic System III (includes decimal processor with 16K bytes of memory, 5M byte disc storage drive (IBM 5444 type), disc autoload, 100-cps line printer with stand, video display with keyboard console, power supply, control electronics, power distribution, and system cables, cooling fan, desk enclosure, and 9 expansion slots)(1)	26,240	24,570	23,785	22,995	290
	PROCESSOR OPTIONS					
380000	Heavy Duty Power Supply (required for systems with: over 32K bytes of memory; 24K bytes of memory and three additional peripheral interfaces, Replaces standard power supply)	900	850	800	770	5
380010	Desk without recessed CRT/Keyboard (replaces standard desk)	260	240	220	210	...
380021	Line Printer, Medium Speed, (features 200 lpm @ 132 columns. Heavy duty, drum impact type replaces 100-cps printer)	7,075	6,700	6,325	5,950	50
380030	Line Printer, High Speed (features 600 lpm @ 132 col. Heavy duty, drum impact type replaces 100-cps printer)	11,000	10,475	10,100	9,725	85
	MASS STORAGE					
380111	Memory (8K bytes; requires 3 slots).	1,900	1,740	1,580	1,425	22
380120	Memory (16K bytes; requires 3 slots)	3,500	3,250	2,750	2,295	38
	Discs (cartridges not included)					

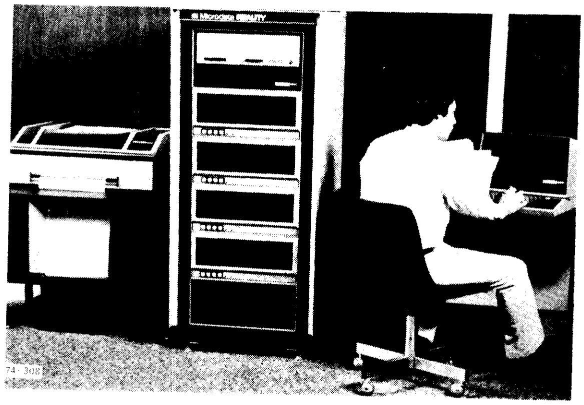
PRICE DATA (contd.)

Model Number	Description	Prices, $/Quantity 10-24	25-49	50-99	100-	Monthly Maint. $
380302	Disc Drive (second unit; IBM 5444 type, 1 removable disc; 1 fixed disc; total 5M bytes storage, cables)	5,610	5,500	5,390	5,290	60
380303	Disc Drive with Cabinet (third unit, IBM 5444 type, 1 removable disc, 1 fixed disc, total 5M bytes storage, cables, accommodates extra disc drive unit in cabinet)	6,110	5,955	5,800	5,650	60
380304	Disc Drive (fourth unit, IBM 5444 type, 1 removable disc, 1 fixed disc, total 5M bytes storage, cables)	5,610	5,500	5,390	5,290	60
380330	Disc Cartridge (IBM 5440 type)	180	165	155	150	–
	PERIPHERALS					
	Printers					
380150	Line Printer, Low Speed (features 100 cps @ 132 columns, wheel impact type, interface electronics and cable; requires 1 slot).	4,570	4,340	4,110	3,880	65
380160	Line Printer, Medium Speed (features 200 lpm @ 132 columns; drum impact type, heavy duty, interface electronics and cable; requires 1 slot)	12,050	11,475	10,900	10,325	105
380170	Line Printer, High Speed (features 600 lpm @ 132 columns; drum impact type, heavy duty interface electronics and cable; requires 1 slot)	15,590	14,915	14,260	13,605	140
	Punched Card					
380201	Card Reader (80-column, 285 cpm with interface electronics and cables; requires 1 slot).	4,095	3,690	3,480	3,275	44
380220	Card Reader (96-column. Features 300-cpm read with interface electronics and cable; requires 1 slot)	3,205	3,025	2,845	2,665	28
380213	Printing Reader/Punch (96-column. Features 300 cpm read, 60-120 cpm punch, printing, interface electronics and cable; requires 1 slot)	9,915	9,605	9,295	8,995	70
380214	Reader Punch (96-column. Features 300 cpm read, 60-120 cpm punch interface electronics and cable. Similar to 380213 except does not include print capability; requires 1 slot)	8,250	7,800	7,350	6,900	65
	Data Recorders					
380210	Interpreting Data Recorder (96-column. Features 300 cpm read, 60-120 cpm punch, interpreting [printing], keyboard, interface electronics and cable; requires 1 slot)	13,150	11,915	11,330	10,750	88
380211	Data Recorder (96-column. Features 300 cpm read, 60-120 cpm punch, keyboard interface electronics and cable. Similar to 380210 except does not include interpreting print capability; requires 1 slot)	11,800	10,610	10,080	9,550	75
380212	Sorting Data Record (96-column. Features 300 cpm read, 60-120 cpm punch, keyboard, interpreting [printing], off-line card sorting, interface electronics and cable. Similar to 380210 except includes card sort capability; requires 1 slot)	16,850	15,515	14,980	14,450	95
	ACCESSORIES					
380100	Control Panel (drawer-mounted. Note: Space allowance for control panel is mandatory)	895	850	805	760	11
	SOFTWARE					
	See Note (2)					

Notes:
(1) Rental agreements are not available for the System III. System III is sold in OEM quantities of a minimum of 10 units.
(2) With the first disc pack (380330), the following software is provided:

- *Disc Operating System (DOS).*
- *DOS Utilities.*
- *Disc Sort/Merge.*
- *RPG II Compiler.*
- *Source and Data Editors.*
- *Assembler (LAP-2).*

Additional software is available for $375/disc pack.



OVERVIEW

Microdata's new Reality™ system is a disc-based, interactive virtual memory system designed to give up to 32 small business users concurrent access to information stored in on-line data files. Users can update and/or retrieve information from the on-line files through remote or local terminals.

Extensive system software makes the system easy to use and includes the ENGLISH™ free-form information management and data retrieval language, RPG II for compatibility with IBM System/3 and other popular small business systems, Terminal Control Language (TCL), a job control language (PROC), macro assembly language, interactive debuggers and editor, and various disc file management packages including sort/merge.

The Virtual Memory Operating System used with the system is largely implemented through microprogrammed firmware to minimize resident core requirements and to enhance overall system performance. This operating system is supported by a 5-million-byte disc cartridge subsystem, which can be expanded to 40 million bytes of virtual storage. Magnetic tape drives are available for backup, and a printer is included for hard-copy output.

Included in the system is a standard full-duplex, 1,920-character, 12-inch display terminal with Teletype-style keyboard; it operates at speeds up to 9,600 baud. Although the system can be configured with only one terminal, larger configurations are more cost effective, and take advantage of the system architecture. Software support does not directly include extensive preprogrammed data entry control software, such as that provided for standard key/disc systems or terminal emulators; but packages of that type can be implemented easily with the system's standard software.

First Reality systems were delivered in July 1974. Table 1 gives Reality system specifications.

Reality™ and ENGLISH™ are registered trademarks of Microdata Corporation.

PERFORMANCE AND COMPETITIVE POSITION

With its Reality system, Microdata joins the ranks of the minicomputer manufacturers like DEC, GRI, and Lockheed who have recently come out with small business systems. Reality is aimed at time-sharing systems and software houses, as well as at the "sophisticated" system user who can do his own programming. The English language processor is an attempt to attract minicomputer users and the "somewhat sophisticated" end user who has no experience with large systems.

Microdata is marketing the system directly to the "top Fortune 1,200" for multiple systems and through distributors to smaller businesses who may need only one system. Most distributors are software houses, and a few are service bureaus; thus, they can supply turnkey systems and applications programming support to users who have no in-house programming staff.

The Microdata system, because of its orientation toward multiple terminals, competes with several business systems that have evolved from clustered intelligent terminal configurations, like the Four-Phase IV/40 and IV/70 Systems and the Sanders 800 Series. Singer System Ten and 6800 systems are also obvious competitors for the same type of market.

Like most minicomputer makers have done, Microdata has developed its present system from preexisting minicomputer software and hardware for the Microdata 1600 system. A partially field-proven body of software can compete with that of veteran minicomputer manufacturers, as well as IBM's System/3, better than most new entrants to the small business computer market. The English language processor is new and should appeal to the individual end user.

Several elements of the system design are noteworthy for enhancing system speed while cutting user memory costs. The placing of the operating system in microprogrammed firmware ROMs instead of core is the most obvious. Also important to the development of larger systems is the fact that many of the terminal handling routines and buffers are microprogrammed, with interrupts generated upon completion of a block (up to 140 characters) rather than on a per-character basis. This allows systems with large numbers of terminals to be handled efficiently without significantly degrading overall system response time.

Microdata is a medium-sized, expanding minicomputer company with around 5,000 to 6,000 installations. About 2,000 of these are 1600s. The firm has recently expanded its manufacturing facilities and started making OEM tape and disc drives as well as minicomputers; both the disc and tape drives used with Reality are made in-house. Also, Microdata has joined the parade to microcomputers with its Micro ONE system.

Table 1. Microdata — Reality: Specifications

PROCESSOR	
Microprogrammed	Yes
Main Memory (K bytes)	16-64
Virtual Memory (M bytes)	5-40
Char Size (bits)	8
Cycle Time (μ sec)	1.0
Addressable Registers	17/terminal
No. of Instructions	109
Stack Processing	Yes
Multiple Precision Arithmetic	Yes
No. of I/O Channels	4-32
Max No. of Devices	41
AUXILIARY STORAGE	
Disc	
Capacity (M bytes)	5-40
Transfer Rate (kc/sec)	200
Avg Access (μsec)	35
Tape	
Tracks, Density	9-trk at 800 or 1,600 bpi; 7-trk at 200, 556, or 800 bpi
Speed (ips)	45
DATA I/O	
CRT	80 char by 24 lines
Serial Printer (cps)	165 (132 col)
Line Printer (lpm)	300 (136 col)
Cards	No
Paper Tape	No
Communications	300 baud; full-duplex; async
SOFTWARE	
Operating System	Virtual Memory Operating System (VMOS)
Assembler	Macro Assembler
Compilers	English; RPG II; PROC
Utilities	File Manager; Message Processor; On-Line Editor; On-Line Debug
COMMENTS	Max 4,000 bytes of core required by VMOS

Microdata markets its products in the United States and Canada through a network of dealer representatives. Dealers buy the system from Microdata and sell it on a turnkey basis to end users. Of course, software houses can also do this on an OEM basis. All maintenance and system support is performed by Microdata.

A preliminary list of U.S. dealers for Reality includes DCTI (Verona, New Jersey), Systems Management (Des Plaines, Illinois), PPI Programs (New York, New York), Display Data Systems (Hunt Valley, Maryland), Datatel (Washington DC), Keystone Computer (Fort Washington, Pennsylvania), and Southern California Data Products (Irvine, California). Negotiations are currently underway with Intertechnique in France for marketing the system outside the United States.

CONFIGURATION GUIDE

The basic Reality system includes the CPU, 16K bytes of core, 4-channel I/O interface with one display terminal implemented, dual-disc controller with one disc (5 million bytes) included, and eight card slots for additional memory and I/O expansion. Standard CPU features include a real-time clock, power fail/auto restart, power supply, and operator control panel.

Memory expansion is usually related to the number of terminals implemented, with two additional 8K-byte modules required for 5 to 8 terminals, four additional 8K-byte modules for 9 to 16, and six additional 8K-byte modules for 17 to 32 terminals. Memory can be added above the terminal requirements to increase terminal response time.

A maximum system configuration can include a printer, four disc drives, four magnetic tape drives, 32 terminals and/or modems, and 64K bytes of memory. A line printer (300 lines per minute) can be substituted for the standard serial printer. Each disc drive contains one fixed and one removable disc cartridge with 200 or 400 tracks per disc for a capacity of 5 million or 10 million bytes per drive. Magnetic tape drives can be 7-track (200, 556, or 800 bits per inch) NRZI, 9-track (800 bits per inch) NRZI, or 9-track (1,600 bits per inch) PE units. Display units include teletypewriter keyboards with control keys and a numeric pad.

When all the available devices and memory modules are added to a system, the eight open slots on the minimum system must be expanded by adding an 18-slot expansion chassis. The basic system includes a 4-channel terminal interface, but an 8-channel interface can be substituted. Each 4-channel or 8-channel interface (for four or eight terminals, respectively) uses one slot. Additional interfaces also require one slot apiece, as does each 8K-byte memory module.

A second disc drive can be handled by the standard dual controller; but when a third drive is added to the system, two more slots are required. The fourth drive is handled by the same controller as the third drive and does not require extra slots. The second drive on a disc controller must have the same capacity as the first drive. There is an integral controller on the first magnetic tape drive that requires two slots; the controller can handle three more slave drives. Modems attach to the 4-channel or 8-channel terminal interface; 1- and 4-channel modems are available.

The basic system cabinet has 35 vertical inches available for the addition of an expansion chassis, disc drives, and/or tape drives; when this is filled, a second and a third cabinet can be added. The printer is a freestanding unit, while the CRT terminals are desktop units that can sit on a user's own desks or on desks provided by Microdata.

MAINFRAME

Central Processor

Reality's central processor is a microprogrammed word- and byte-oriented machine with not only the instruction set but also much of the virtual memory operating system implemented in firmware. In addition to the instruction set, the multi-user operating system executive, the virtual memory manager, the I/O processors and special data management instructions are all implemented in firmware rather than software. Although most of the operating system is implemented in microcode, it is discussed in total under SOFTWARE.

The instruction set includes 109 instructions: single- and double-precision arithmetic; byte string manipulations; register/memory operations; memory-to-memory moves of 8-bit bytes, 16-bit words, 32-bit doublewords, and 48-bit triplewords; a variety of branch-on-condition and bit manipulations; and others relating to stack processing, I/O handling, subroutine calls and program linkages.

CPU architecture is engineered so that more than 32 asynchronous processes can be handled concurrently. It has 16 8-byte address registers, a 32-deep return stack for recursive subroutine calls, and an extended accumulator for each terminal. The 16 address registers can address any byte in virtual memory.

All addressing is virtual memory addressing, with bytes, byte strings, words, doublewords, and triplewords referenced as the number of bytes/words relative to the first data byte of a frame. Each frame is 512 bytes long; when a virtual storage frame resides in core, it is called a buffer. References to instructions are always via a 12-bit frame number, so programs must be located in the first 4,096 frames (2 million bytes).

The first four buffers in core memory contain status information on each main storage buffer, a map of the frames in each buffer, a monitor program used to swap frames in and out, a bootstrap, a buffer queue, and an address register/return stack area. This region is hardware memory protected. The next three buffers in core are used for process identification blocks and an extension of the monitor software.

Process identification Blocks, each 32 bytes long, contain information on the status of the process associated with each terminal: status bits for peripheral I/O operations, error codes, special communications and disc status bits, counters, and various parameters. The three buffers used for process housekeeping are software protected from the rest of memory. The rest of the operating system is microprogrammed; and the remainder of memory (25 buffers on a basic system) can be used for user programs, system software, and data.

The logical capacity of the system is 16 million 512-byte frames or 8 billion bytes, but the current maximum capacity is 40 million bytes. A minimum of 511 frames of virtual memory must be reserved for programs shared by all users; this reserved area can be optionally expanded up to 4,095 frames. The first 399 of the 511 frames are further reserved for Microdata-supplied system software.

SOFTWARE

In addition to the firmware/software Virtual Memory Operating System (VMOS), the system software for Reality includes an assembler ("REAL"), four compilers (TCL, PROC, English, and RPG II), disc file management processors, a facility for identifying valid users and accumulating relevant accounting statistics (LOGON/LOGOFF), a message processor for storing and forwarding messages to other users (MESSAGE), a "BATCH" processor for batch file maintenance, an interactive debugger (DEBUG), an interactive editor (EDITOR), a spooler, and multiple-phase disc sort/merge.

VMOS

Like most operating systems for interactive processing, VMOS oversees the system as a whole, keeps records on core and disc allocation, determines priority of software routines and allocates CPU time and space accordingly, detects and responds to error conditions, and turns system control over to other system software as needed. As a virtual memory operating system, VMOS must also swap core buffers with disc frames and perform all the housekeeping tasks necessary to make these swaps transparent to the user. Logically linked frames are processed and presented to the user as physically sequential. Process-defined breakpoints are recognized and software traps generated.

VMOS also processes intermodule linkages, maintains return stacks, and processes implicit and explicit faults in requests for core/disc transfers. These operations are supported by a high-speed, moving-head disc subsystem (35 milliseconds access time) with overlapped seeks and DMA transfers over a block multiplex channel.

Language Processors

English. English is Microdata's name for its information management data retrieval language. It is a free-form order-independent language designed for nonprofessionals, so that they can easily access the data base with a minimum of time spent learning the language. When words like "a," "and," and "the" are inserted in sentences, they are ignored by the system, not rejected. The language is also designed to accept a variety of synonyms for nouns, verbs, and symbols.

Via English statements, the user can selectively or conditionally retrieve information, automatically generate reports, selectively update files, and assign security codes. A "chain reaction" feature allows a single update entry to revise all applicable records.

RPG II. Standard RPG II, like that used on IBM's System/3, is also available on the Reality system. This capability allows System/3 users to transfer their programs to a Reality system easily without expensive reprogramming.

TCL. The Terminal Control Language (TCL) processor is the entry point for the user and the rest of the system software. TCL expects a verb as the first entry; depending on the type of verb, control is retained by TCL-I or transferred to the English processor, TCL-II processor, PROC processor, or LOGON/LOGOFF processors. In general TCL and the other interactive processors work on one statement (verb plus nouns, qualifiers, conditionals, and connectives) at a time.

PROC. The PROC processor can be thought of as a macro TCL processor or a job control language processor. A programmer uses PROC to catalog a complex series of operations so that they can be called up by a single command. PROC's conditional capabilities allow it to be used to prompt the user interactively and to test and verify data input from a terminal keyboard. "PROCs" are stored as items in the user's master dictionary.

REAL. REAL is a 2-pass macro symbolic assembler that can be used to implement cross-assemblers for other computers.

HEADQUARTERS

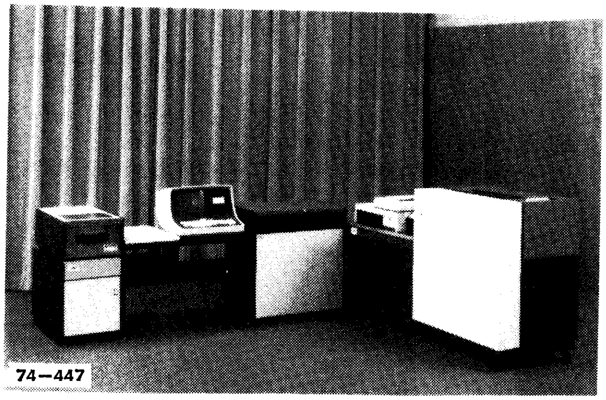
Microdata Corporation
17481 Red Hill Avenue
Irvine CA 92705
(714) 540-6730

PRICE DATA

Description	Purchase $	Monthly Maint. $
MICRODATA–REALITY		
Reality System includes CPU, 16K bytes of core memory, 4-channel I/O interface, data display terminal #1 with desk, disc controller (2-channel), disc unit #1 (5M bytes,) character printer with controller and desk, single bay cabinet	47,500	250
System Upgrade Options		
I/O Interface Upgrade (4 to 8 channels)	600	6
Disc Storage Upgrade (5M to 10M bytes)	700	15
Printer Upgrade (replaces char printer and desk with line printer)	6,000	NC
CPU Options		
Core Memory Module (8K bytes)	1,800	20
Additional I/O Interfaces		
4-channel	1,000	10
8-channel	1,600	16
Expansion Chassis	1,750	18
Peripheral Options		
Additional Data Display Terminal	2,500	25
Additional Disc Storage		
Unit #2 (5M bytes)	5,025	75
Unit #2 (10M bytes)	5,725	75
Unit #3 with controller (5M bytes)	9,000	80
Same (10M bytes)	9,700	80
Unit #4 (same as #3; 5M bytes)	5,025	75
Same (10M bytes)	5,725	75
Magnetic Tape Storage Unit with Controller		
Unit (10.5-in. reel)	6,100	75
Unit (8.5-in. reel)	5,900	75
Line Printer and Controller		
(64 char, 136 col.; width 4 to 16.75 in.; up to 6 copies)	10,500	100
Telephone Line Modems		
(2 required/terminal)		
Remote Modem	650	10
Local Modem (1-channel)	650	10
Local Modem (4-channel)	2,000	20

**Discounts range from 10% on purchases of $100,000 or over to 35% for purchases of $1,500,000.*
Rentals not available.

NC No Charge



OVERVIEW

The NCR SPIRIT (Sales Processing Interactive Real-Time Inventory Technique) is an on-line order entry system based on NCR's first minicomputer, the 8200. According to NCR, SPIRIT is the first of a number of systems that will be built around the 8200. The initial two order entry systems are the 8200-150 and the 8200-151. The 8200-150 supports one data entry terminal; the 8200-151 includes a multiplexor to support up to four data entry terminals. Both systems run under the SPIRIT software for order entry and registration, invoicing, shipping, and inventory control.

The NCR SPIRIT is centered around an 8200 minicomputer with 32K bytes of user memory, 16K bytes of control memory for simulations, a disc, line printer, card reader, and one or more NCR 796 visual display terminals. The processor includes an integral cassette tape unit to load control programs. Simulation of the NCR Century 101 is standard, and the SPIRIT order entry software, as well as batch processing for accounts payable, payroll, and general ledger are done in 101 simulation mode. Batch processing is done during off hours when the system is not needed on-line.

All SPIRIT software is bundled except for customization. The basic system with one terminal costs $39,750 and rents for $1,285. First delivery is scheduled for March 1975.

COMPETITIVE POSITION

The NCR SPIRIT Applied System is currently being marketed only in the United States. Up to now, the multiterminal on-line order entry market has been the domain of Singer's System Ten and such systems as the DEC Datasystem 500, Basic Four, and Four-Phase IV/40. This market has not been dominated by IBM because the System/3 is primarily batch-oriented. NCR adds to this market its experience in selling to relatively unsophisticated users, its large sales and service organization, and its well-known emphasis on compatibility. The 8200 operates in 101 simulation mode; thus all user programs generated will be upward compatible with the larger Century models. Also, NCR's price for the 8200 is competitive even with systems from smaller companies. For example, a Four-Phase IV/40 basic system with three terminals costs $27,125 as compared to the 8200-151 price of $42,750 for four terminals.

Table 1. NCR SPIRIT: Mainframe Characteristics

CHARACTERISTIC	SPIRIT
PROCESSOR	607-101
Microprogrammed	No
Word Size (bits)	16
Capacity (words)	32K-48K bytes (user space); 16K bytes (101 simulator)
Cycle Time (μsec)	1.2
Working Storage	Core
AUXILIARY STORAGE	4.2 - 19.6M-byte cartridge drives (1 fixed, 1 removable)
DATA I/O	
Keyboard	On CRT
CRT	1-4
Serial Printer	300-baud option for CRTs
Line Printer	125, 200, or 300 lpm
Cards	300-cpm reader
Other	Century 101 or 399 peripherals
SOFTWARE	
Assembler	NEAT/3
Operating System	Century 101 Simulator
Compiler	No

CONFIGURATION GUIDE

The basic 8200-150/151 consists of the following units:

- 607-101 Processor with 32K bytes of user memory, 16K bytes for Century 101 simulation, integrated cassette for loading simulator (cannot be used as file device), common trunk, and integrated disc controller.
- 656-311 Disc Unit (one fixed and one removable disc; capacity 4.9M bytes).
- 349-1 Line Printer (125 lpm).
- 796-101 CRT (1,200 baud).
- 368-1 Card Reader (300 cpm).
- 692-700 Async Adapter.

Memory can be expanded by 16K bytes for a total user memory of 48K bytes. The line printer can be upgraded to a 349-2 (200 lpm) or a 349-300 (300 lpm). Two disc units can be connected to the disc controller for a disc capacity of 9M bytes (one 656-321), 14.7M bytes (one 656-321 and one 656-331), or 19.6M bytes (two 656-321s). The 656-311 will not be available until July 1975 initially, the 656-321 will be delivered in its stead.

Only one CRT is included with the basic system, but a second, third, and fourth CRT can be added to an 8200-151 system. Standard cable length is 40 feet maximum but length is 1,000 feet.

The NCR 260-1 Thermal Printer can be connected to the CRT terminal for hard copy. The printer output is program-controlled and operates at 300 baud. This limits the 796-101 to 300 baud when the 260-1 is included. The 260-1 will not be available for March deliveries.

Software is bundled and includes order entry, inventory control, and accounts receivable for the on-line system. In addition, accounts payable, payroll, and general ledger applications packages for the 101 can be run in batch mode on the 8200.

MAINFRAME

The 607 minicomputer, the CPU in the 8200 system, is an in-house developed minicomputer which NCR uses in many of its applications-oriented systems, such as the NCR 399 and 755. It is a sophisticated minicomputer that can support up to 64 devices via six DMA channels. Memory consists of 1K to 64K bytes of core and a 1.2-microsecond cycle time.

Table 2 compares the 8200 processing capabilities with those of the Century 100 and 101. The 8200 is about half as fast as the Century 101 overall. The 607 is faster than that, but in the 8200, the speed of the 607 is reduced because it runs in 101 simulation mode.

Table 2. NCR SPIRIT (8200): Comparison with Century 100 and 101

	101*		100**		8200*		8200 vs 101
Program	Min.	Sec	Min.	Sec	Min.	Sec	
Sort/Merge	8	43	9	48	20	05	2.3x
Printing	24	28	19	16	43	33	1.8x
Compute	11	42	18	37	42	47	3.6x
General Mix	10	24	10	41	21	44	2.1x

Notes:
* 300-lpm printer.
** 450-lpm printer.

COMPATIBILITY

The SPIRIT (8200) system is both hardware and software compatible with the Century 101. It operates in 101 emulation mode; thus, all 101 programs can run on the SPIRIT system given adequate memory and comparable hardware. SPIRIT software generally has to be recompiled and the files remapped to accommodate changes in disc file sizes and the hardware complement. Both Century 101 and 399 terminal peripherals can be attached to the SPIRIT system.

SOFTWARE

Standard software, which is bundled, includes the SPIRIT group of on-line interactive order entry, inventory control, and accounts receivable application packages; a Century 101 emulator and three 101 batch packages — accounts payable, payroll, and general ledger. All system software is written in NEAT/3, the Century Series assembly language. The system is not designed to be user-programmable.

SPIRIT includes an on-line program that allows the user to enter orders via the CRT keyboard; allocate inventory to the order; perform pricing, discounting, and taxing; total the order and authorize credit; update the customer account; and produce pick lists, packing slips, and invoices. Stock receipts, shipments, purchases, price changes, and customer payments are also processed on-line.

The on-line functions are supported by SPIRIT software processed in "batch" mode: order and inventory update and reporting and accounts receivable update and reporting. Both involve updating, purging, and/or restructuring master files (on disc) used by the on-line program. These disc files can be used to produce a large variety of reports:

- Daily Orders Received/Shipped
- Daily Back Orders/Order Cancellations
- Back-Order Bin Tickets
- Customer Change Register
- Matrix Change Register
- Vendor Change Register
- Inventory Change Register
- Out-of-Stock/Below-Minimum
- Inventory File Listing
- Buyer's Listing
- Vendor File Listing
- Customer File Listing
- Matrix File Listing
- Batch Corrections
- Input Errors
- Transactions Deleted
- A/R Receipts Register
- Master File Changes
- Statements
- Aged Trial Balance
- Customer Status
- Delinquent Accounts
- Credit Exceptions
- Inactive Customers
- New Customer Listing.

The major master files include Batch Customer, Batch Inventory, Batch Vendor, Matrix, On-Line, and Order Status. Disc files are accessed through both random and index-sequential file processing methods.

The SPIRIT standard software has been designed for a 10-megabyte disc, with a maximum of 8,000 disc sectors allocated to the three Batch master files, 8 sectors reserved for the Matrix Master File, a maximum of about 8,000 sectors for the On-Line Master File, and a maximum of about 2,000 sectors for the Order Status file. NCR calculates user requirements based on a standard algorithm; if the customer exceeds limits for any of the master files indicated or adds peripherals above the standard 1-terminal system, files will have to be remapped and certain programs recompiled. When the customer's application has exceeded the limits of the 8,200, upgrade is to a Century 101 following a similar system generation procedure.

The following "batch processing" packages are standard for Century 101:

- General Ledger Accounting — performs file maintenance, item processing, report preparation, and daily reporting. Daily, month-end, period-end, and on-request reports comply with internal accounting and auditing standards established by various regulatory agencies.
- General Payroll — automated payroll accounting and labor division system with provisions for conversion, original implementation, and parallel operation.
- Accounts Payable — timely accurate administration of liabilities to vendors, preparation of vendor checks and itemized remittance statements, billing of debit balance accounts, distribution of costs to organizational units, and historical analysis of vendor activity.

MAINTENANCE AND SUPPORT

Maintenance is available through more than 300 service offices in the United States and Canada. NCR also has more than 900 service centers outside the United States, but SPIRIT is not yet being marketed in these areas. Like the compatible Century Series, the 8200 system hardware is modular, with a high degree of circuit standardization so that repairs involve only replacement of a plug-in circuit board.

NCR's standard maintenance contract provides for on-site preventive and emergency maintenance during any 8-hour period between 8:00 a.m. and midnight. Rates depend partly on the distance from the service center. Special arrangements can be made for round-the-clock service at higher rates.

PRICE DATA

Model Number	Description	Monthly Rental $	Purchase $	Monthly Maint. $
	NCR Century 8200-150 includes			
607-101	Processor with 32K Bytes User Memory and 16K Bytes for Century 101 Simulator Integrated Cassette 8-ft CRT Logic Cable* Common Trunk Integrated Disc Controller	1,285	39,750	265
656-311	Disc Unit 4.9MB (1 fixed and 1 removable)	1,285	39,750	265

PRICE DATA (contd.)

Model Number	Description	Monthly Rental $	Purchase $	Monthly Maint. $
349-1	Line Printer (125 lpm)	1,285	39,750	265
796-101	1,200-Baud CRT	1,285	39,750	265
368-1	Card Reader (300 cpm, rated speed)			
	NCR SPIRIT Applied System	1,285	39,750	265
692-700	Async Adapter	1,285	39,750	265
	NCR Century 8200-151 (same as 150 except can connect 4 terminals)	1,385	42,750	265
	Basic System Substitutions (add to basic system price)			
349-2	Line Printer (200 lpm)(1)	90	3,000	5
349-300	Line Printer (300 lpm)(2)	180	7,000	10
656-321	9.8MB Disc(3)	80	3,250	15
	Features & Peripherals			
8201	Multiple CRT Capability for NCR 8200-150	120	5,000	0
6071	Addl 16K Bytes Memory	190	5,850	20
656-331	4.9MB Disc (removable platter only)	320	9,800	80
656-331	Upgrade to 656-321(4)	85	4,200	17
656-321	9.8MB Disc	405	14,000	97
796-101	CRT	80	2,000	33
692-700	Async Adapter	45	1,500	7
260-1	Thermal Printer	75	1,960	8.25
998-8200	(40') CRT Cable(5)	NA	45	NA
956-1	Disc Pack**	NA	120	NA

Notes:

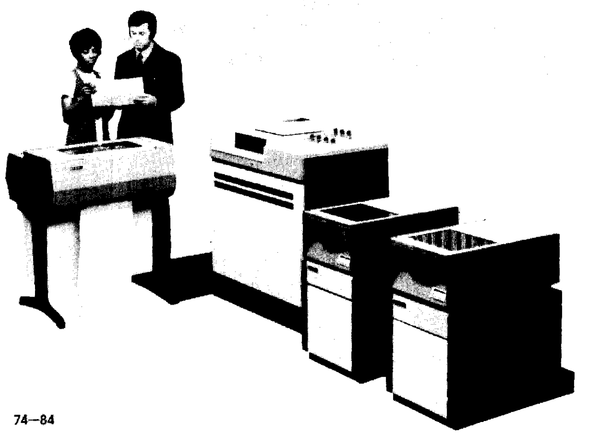
NA Not Available.
** Zone 1 maintenance rate.*
*** Current 956 disc pack quantity discounts apply.*
(1) Field upgrade for 349-1 Line Printer.
(2) Requires replacement of 349-1/349-2 Line Printer if field upgrade.
(3) Field upgrade for the 4.9MB dual disc drive in basic system.
(4) Field upgrade from 1 removable platter to 1 fixed and 1 removable platter.
(5) Cable for additional CRTs or additional length cable for 1st CRT. Customer will be charged $0.35 for each foot over the standard length. Max cable length is 1,000 ft.

HEADQUARTERS

NCR Corporation
Main & K Streets
Dayton OH 45409

NCR CORPORATION

Century 50 Mod I, 50, 101 (75/150), and 151



74–84

OVERVIEW

NCR's Century Series is a family of general-purpose computers designed for first-time computer users as well as for users who already have installed a small computer system. The series currently has eight members. The smaller members are the Century 50 Mod I, 50, 101, and 151; the larger members are the 200, 201, 251, and 300. The 101 is marketed in Europe under model numbers 75 and 150. The models differ from one another chiefly in processing speed, peripherals available, and maximum memory size. The two Century 50 models have a memory range of 16-32K words but one is slower than the other. The 101 (75/150) can be expanded to 64K words and can attach magnetic tape equipment. The 151 not only has the greater speed and compactness of MOS memories and larger memory, 128K words, but it can also attach larger disc subsystems 96 million bytes per drive.

The smaller members of the Century Series are particularly suited for upgrading from punched card or electronic accounting machine data processing to the more powerful and flexible facilities available with disc-oriented small computers.

A major advantage of the Century Series is that software is directly interchangeable between members of the series. When going upward in the series, recompilation may be desirable to take advantage of better hardware, but it is not necessary. Software is available to simulate any instructions absent from a computer's repertoire. Therefore, software is generally also downward compatible. In addition, the operating system used on the smaller Century models is a pure subset of the operating system used on the larger Century models. These features are distinct advantages in a market where most manufacturers offer incompatibilities and conversion problems.

The Century systems are all oriented toward batch data processing. Three-fourths of the installations have been for batch-oriented operations, namely, for service bureaus and for replacement of punched card systems.

Application packages in more than 24 major categories are available, including software for applications in manufacturing, distribution, and retailing. Software is also offered for standard accounting applications, hospital patient-account management, life insurance applications, law enforcement packages for central information file and traffic-violation fine collection, and utilities billing. Despite this library of software, NCR's marketing emphasis is not on turnkey systems, delivered complete with the desired software, but on systems where software is developed by the user's own EDP staffs. NCR provides a variety of support-service packages to assist during the system startup phase.

NCR, founded in 1882, is one of the two largest manufacturers of electronic accounting machines and one of the six largest computer manufacturers. Maintenance is available through over 300 service offices in the United States and Canada and 900 offices in the rest of the world. The firm manufactures a full line of data processing equipment and offers related products and services. Century 100 was introduced in 1968, the Century 50 in 1971, and the 101 in 1972. Both the Century 50 Mod I and the 151 were announced in 1974 with deliveries expected toward end of the year or early 1975.

PERFORMANCE AND COMPETITIVE POSITION

The NCR Century 50 Mod I, 50, and 101 compete domestically with such systems as the IBM System/3 Models 6, 8, and 10, Burroughs B1712 and B1714, the Univac 9200II, and the Singer System Ten. In the United Kingdom and Europe, the 101 (75 or 150) competes with the ICL 2903 and Siemens 404/3. Among the domestic competitors, the Singer System Ten, the Burroughs B1712, and the IBM System/3 Model 10 are price-competitive with the NCR 101. The Univac 9200II is performance-competitive, but comparable configurations are about 25 percent more expensive. Ironically, the Univac 9000 Series is the only series offering comparable upward expansion capabilities including compatibility among the processors moving upward. Burroughs and IBM offer limited upward expansion for the B1700 Series and System/3, respectively. Singer offers none.

Although NCR markets the Century 50s as direct competitors to System/3 Model 6, there is a basic difference in the orientation of the two. System/3 is intended for users who are novices in electronic data processing. Although it has a batch processing capability, its design emphasis is on interactive processing through a typewriter keyboard. The Century Series, however, is designed as an upgrade from punched card or electronic accounting machine installations and is intended strictly for batch processing. Its typewriter is an optional feature that serves primarily for communication with the CPU.

The price-competitive systems for the 101 all offer on-line communications capabilities and direct-access file capabilities. Burroughs, however, offers only disc cartridges; no removable disc pack storage devices are available on either the 1712 or the 1714. This limits the available on-line storage. Also, the current operating system for the B1700 is a little too sophisticated to be effectively operated easily.

The Singer System Ten shares with the 101 simplicity of use and straightforward operating system; it also shares a "configuration package" marketing philosophy and an orientation towards data communications. Singer, however, excels in multiprogramming, "multipartitioning" capabilities. Currently, the 101 is limited to two partitions, one dedicated to on-line foreground processing and one dedicated to serial batch processing on its largest configuration. Singer's System Ten can handle up to 20 separate jobs.

IBM's System/3 Model 10 is competitive with the 101 in price, in the number of available application packages, and in service. The 3/10 supports fewer lines and disc storage communication, but it has a more powerful operating system that requires a trained operator. The 3/10 is also limited in its expansion capabilities; thus far, after Model 10, Model 15 is the next available system for growth within a compatible line. Also, the 3/10 does not offer a conversational Basic compiler, which limits the orientation of its terminal environment considerably. While the System/3 Model 6 does offer Basic, it offers practically no expansion capability. The 101 is truly more flexible and versatile than the 3/10. This is not the case with the 3/15, but the 3/15 is considerably more expensive than the 101.

NCR's new 151 model is the direct competitor for the IBM System/3 Model 15, as well as for the Burroughs 1726. It bridges the gap between the 101 and the 200, providing higher speed, more memory, and more disc storage than competing systems while maintaining its compatibility with other members of the Century series.

The European market position of the NCR 101 (75, 150) is not so straightforward as the domestic market position. For example, the Century 75 is purchased unbundled; only a NEAT/3 compiler is included with the hardware; all other software is available at additional cost. Although the Century 150 is marketed at higher prices, it is bundled. The 150 also includes multiplatter discs.

The two strongest European competitors, in addition to U.S. systems marketed abroad, are the ICL 2903 and the Siemens 404/3. Neither system offers the range of batch I/O devices comparable to those available for the NCR, IBM, and Burroughs competitors.

The ICL 2903 can accommodate direct data entry key stations on-line and multiprogram their operation with normal batch processing and/or on-line file inquiries. At equivalent prices, the 2903 also offers larger main storage and higher I/O throughput than its competitors. Still another factor in favor of the 2903 is its full upward compatibility with all members of ICL's 1900 Series, which has a larger range than NCR's Century Series.

The Siemens 404/3 offers fast execution times for hard-ware-performed single- and double-word fixed-point binary operations as well as for the program-controlled multiplexing of almost all I/O operations. The 404/3 was initially designed for industrial control operations, but Siemens has extended its market to include small batch-oriented disc processing business applications. Its position is not particularly strong at this time. It should become more competitive, however, as Siemens continues to provide application packages that relieve the user of programming worries.

USER REACTIONS

Users of the small Century systems differ greatly in their backgrounds. Installations range from those with no EDP personnel to others with more than a dozen personnel; from first-time computer users to those who have used NCR equipment for over a decade.

All Model 50 users interviewed were quite pleased with their systems. These users had the standard Model 50 configuration and found it very reliable. The common Model 50 applications were general ledger, accounts payable and receivable, inventory control, sales analysis, billing and order processing, and payroll. For these small systems, the majority of users program in NEAT/3, NCR's own business application language. One user who likes NEAT/3 admitted there is more documentation available on Cobol, however. Another user programs in both NEAT/3 and Cobol. Since both are available, this user prefers to stay active in both languages. A third user said NEAT/3 is easier to use than Cobol.

All users found the maintenance "good to excellent" and described it as "very competent and conscientious." Users experienced some initial burn-in problems but said the machine performed beautifully after that. One user's memory had a bad rod, but NCR fixed the problem immediately.

The majority of users commented about the excellent price/performance of the machine and felt it outperformed the IBM System/3, Honeywell, and Burroughs comparable systems for the price. An advertising agency, specializing in direct mail campaigns, particularly liked NCR's system of file dating. The system is totally disc-oriented; the user never has to use tapes. This was the reason the user bought an NCR system. A manufacturer of ceramic tile found his 16K-byte system very flexible because it allows program overlays. He felt this capability will allow him to use the same system for another three years. When larger data processing capabilities were required, the search a few users made for new equipment was academic; they had used NCR equipment in the past and found it satisfactory. One user said he got a better bid from NCR because he had a contract with them earlier.

A few users had bought the packaged software available from NCR, namely the payroll package. With some modification, it was very effective.

All 101 users indicated that the system's hardware is most satisfactory; the 101's extreme sensitivity to temperature is the other factor agreed upon by users. They have reported that if air conditioning problems cause the temperature in the environment-controlled rooms to reach 80 degrees (only eight degrees above the recommended 72 degrees), read/write errors occur on discs and in memory. Problems also occur if the temperature falls below 58 degrees.

Users in areas near large cities or service centers are delighted with the service received for maintenance and trouble calls. Users in outlying areas are generally displeased with the maintenance, but they do add that representatives usually arrive at the location within a half-day after a problem occurs.

A bank with approximately 10,000 customers has installed a Central Information File (CIF) package (supplied by NCR) and "Unified Statement Banking" on its NCR 101. Installed in September 1973, the 101 now has 32K bytes of main memory, two removable spindles of 656 disc storage, a 670 MICR reader/sorter, 1,200 line-per-minute printer, and a 300 card-per-minute reader. The bank is a first-time computer user. It considered the System/3 Model 6, but felt it was "too small" with "no growth possible," and a small Burroughs system with "no removable discs" was rejected later, as was a Honeywell system. The Honeywell bid was received too late to be thoroughly considered. The NCR system was selected for three reasons: the bank is close to a service center; NCR is the only manufacturer of small computers with a CIF package available; and NCR offered the greatest capacity for the money. Although problems have occurred with the installation, the bank representatives called them minor and, at worst, "average for any installation." Expansion plans include adding communication facilities in the next two or three years.

A college specializing in business training has an NCR 101 and NCR 399. The 101 was chosen over a Burroughs B1700 because of price. Currently, the 101 has 32K bytes of main memory; an addition of 16K bytes is planned. Other equipment includes two card units (card-or-tape COT reader and high-speed reader/punch); dual-drive 655 disc; and four terminals, two NCR 260s connected by standard telephone interface and two hardwired Western Union KSR 33s.

Students run Basic 1 for three hours each day on the four terminals, during which time the system is dedicated. Batch programs, including NCR packages for payroll, accounts receivable, accounts payable, general ledger, inventory (ORBIT II), and class scheduling run afterwards for an average total of 20 hours daily, seven days a week. NEAT/3, Cobol, Fortran, RPG, and Basic languages are used.

Both preventive maintenance and maintenance in response to trouble have been excellent. The institution had serious problems with its air conditioning which led them to the conclusion that the 101 cannot run in temperatures above 80 degrees or below 58 degrees, however. The only other criticism this highly satisfied customer voiced was that NCR "releases its software programs a little too early. Patches are immediate, but . . ."

A second academic institution, a college, uses an NCR 101 alternately for on-line problem solving and batch processing. This user also looked at an IBM System/3 Model 10 for the application; the price was about the same as the 101 but the performance of the 101 is superior to the Model 10's. The 101 has 32K bytes of main memory (an extra 16K bytes is on order); a two-spindle 655 disc drive, printer input/output writer, and card reader. Five Western Union KSR 33 terminals are attached, one to each of five integrated communication adapters.

Forty hours weekly are dedicated to on-line processing with Basic I, "an acceptable subset of Dartmouth Basic." The college also runs programs written in Cobol and NEAT/3, including NCR's Budgeteering Package and Payroll Package.

The user is very pleased with the hardware, likes the software (which the college modified), but it is very unhappy with the service. This user acknowledges that the problem may be attributed to its location which is in an outlying area. NCR's service also annoys this user by "continually discouraging" applications the user deems possible and reasonable.

A farming cooperative has an NCR 101 with 32K bytes of main memory (an extra 32K bytes are on order), a two-spindle 655 disc (two 657s are on order), three tape handlers (800 bits per inch), printer (450-900 lines per minute), card reader/punch (300 cards per minute), and communication multiplexor using two integrated adapters. The 12 people at the installation wrote Cobol packages for feed mix, cost analysis, and production reporting. They also collect data and send user reports to free-standing terminals in the area. This user had a Univac 1005 card processor prior to the NCR 101. The 101 was chosen over IBM's System/3 Model 10, Burroughs B 1700 and 2500, and Univac's 9300 II because the 101 costs less and it uses a simple yet effective operating system ("B1").

This user feels that NCR's software support could be improved. Also this user has found that at 80 degrees Fahrenheit or above, disc read errors and some memory failures occur.

A commuter airline installed the 101 for a computerized reservation system to handle its more than 1,400 flights each week. The system has 64K-byte memory, disc (one controller and two drawers), input/output writer, card reader/printer, and almost 200 terminals connected via integrated multiplexor adapters. Bunker-Ramo supplied 36 of the CRT terminals, which are connected by four controllers to one of the integrated adapters. The other terminals are scattered throughout the airport and are connected to one port via telephone lines.

The airline is extremely pleased with the 101 and is proud of the speed with which the system was created and installed. This company had not evaluated competitive systems; the decision to go on-line was made very quickly, and NCR was contacted immediately because the airline had been an NCR customer for over 12 years. The combined efforts of NCR, Bunker-Ramo, and airline personnel had the system up and running in less than four months. NCR developed the software, I/O, and interfacing with Bunker-Ramo; the airline handled the user programming. The package, jointly developed by the three companies, is written in NEAT/3. The system runs under S2 (the dedicated on-line operating system).

CONFIGURATION GUIDE

The new Century 50/Mod I, smallest and lowest-priced member of the Century series, includes a 16K-byte memory, card reader, printer, and dual disc drive. It is similar to the Century 50, which also has a 16K-byte memory, 8.4 million-byte disc, 300 card-per-minute card reader, and 200 line-per-minute printer, but Mod I has lower performance capabilities. See Table 1.

Century 50 configurations can be upgraded by any or all of the following steps: doubling main memory to 32K bytes; replacing the card reader with a 1,000 character-per-second punched paper tape reader; replacing the 200 line-per-minute printer with either a 300 line-per-minute or a 450 line-per-minute model (rates are for alphanumeric data — purely numeric data is printed at 600 lines per minute and 900 lines per minute, respectively); replacing the original disc drive, which has an access time of 153 milliseconds, by a model with an access time of 65 milliseconds Further, an input/output typewriter console, a second disc drive, and a line printer can be added to the system.

The Century 101 basic configuration includes a processor with 16K bytes of main memory and control console; line printer (300 lines per minute); card or paper tape reader; and 4.9 megabytes of 656-101 disc file storage. The basic configuration also includes two channels (NCR calls them "trunks"), one multiplexor (low-speed) and one selector (high-speed).

The Century 101 was designed to replace the older Model 100 in the NCR Century product line. About 2.5 times as fast as the 100, the 101 has a more expandable core memory, more instructions (34 plus three optional), and greater I/O simultaneity and throughput. It accommodates more integrated I/O units: card or paper tape reader, control console, optional I/O writes for console messages (six character-per-second impact printer or a 30 character-per-second thermal printer), and optional communication multiplexor for up to 10 lines.

European versions of the 101 are slightly different in their basic configurations. The Century 75 (called the Century 150-656 in the United Kingdom and Scandinavia) has a dual-spindle master/slave of 656 disc storage unit with capacity of 9.96 megabytes standard, instead of the 4.9-megabyte master disc unit that is standard with the domestic 101. The Century 150 has 657-102 disc drives as standard. These IBM 2314-type discs have a capacity of 29.8 megabytes per disc pack, thus significantly increasing the basic storage capacity over that available for the 75.

Table 1. Comparison of Small NCR Century Systems

	50 Mod I	50	101	151
CENTRAL PROCESSOR				
Cycle Time, usec		0.80	1.20	0.75
No. of Instructions				
Main Memory, Min-Max K bytes	16-32	16-32	16-64	32-128
Word Size (bits)	8	8	16	16
Working Storage Technology	Rod (thin film)	Rod (thin film)	Core	MOS
PERIPHERALS				
Line Printers (lpm)	200-450	200-450	450-1,500	
Serial Printers	30 cps	30 cps		
Card Read (cpm)	560-750	560-750	300-1,200	
Card Punch (cpm)	60-180	60-180	240	
Paper Tape Read (cps)	1,500	1,500	1,000-1,500	
Paper Tape Punch (cps)	200	200	200	
Magnetic Tape	No	No	7/9 trk	7/9 trk
Magnetic Cards	No	No	Yes	Yes
Disc	Cartridge	Cartridge	Cartridge pack	Cartridge pack
MICR (doc/min.)	600	600	1,200	1,200

The new Century 151 system is not a replacement for the European 150 (really a 101) but bridges the gap between the 101 and the 200. The 151 uses a 32K-byte MOS memory with a 750-nanosecond cycle time; main memory can be expanded to 128K bytes. The basic system also has a 10-million-byte disc, 300 line-per-minute printer, 300 card-per-minute card reader and 30 character-per-second console. In addition to the higher speeds for these devices, the Century 151 can attach the optional 657 disc with capacity of 60 or 96 million bytes.

Two additional I/O channels can be added to Century 75, 101, 150, and 151 processors. They are designated "trunk one" and "trunk six;" trunk one operates at 166K bytes per second on models 75, 101, and 150 and at 120K bytes per second on the 151; trunk six operates at 276K bytes per second on the 75, 100, and 150, and at 900K on the 151. Each has eight positions to attach nonintegrated peripherals; each has the characteristics of a selector channel. A fully expanded Century 75, 101, 150, and 151 system is thus capable of up to 17-way I/O simultaneity in addition to computation, including up to three disc or magnetic tape transfers of up to 416K, 276K, and 166K bytes per second, respectively; four other central-site slow I/O transfers; and 10 data communication transfers. See Figure 1.

CENTRAL PROCESSOR

The same central processor architecture is common to all models; it performs all command setup, execution, and logical decisions. It uses its own registers, flags, and indicators, plus reserved areas of main memory.

Data Structure. The basic unit of data is the byte, eight bits plus one parity bit. Data formats can be eight-bit binary numbers, four- or eight-bit binary-coded decimal numbers, or eight-bit NCR Century characters (ASCII characters).

Special Registers. Certain hardware registers are used to store the contents of main memory locations. The registers are used during command setup and execution. They allow accessing selected information without using a memory cycle.

Addressing Facilities. NCR permits four types of addressing. This includes direct addressing of all of memory with 65,536 bytes maximum. Up to five levels of indirect addressing are permitted. Each indirect address in the chain can be indexed or incrementally indexed. The last address in an indirect addressing chain can also be a three-byte direct address (allowing direct

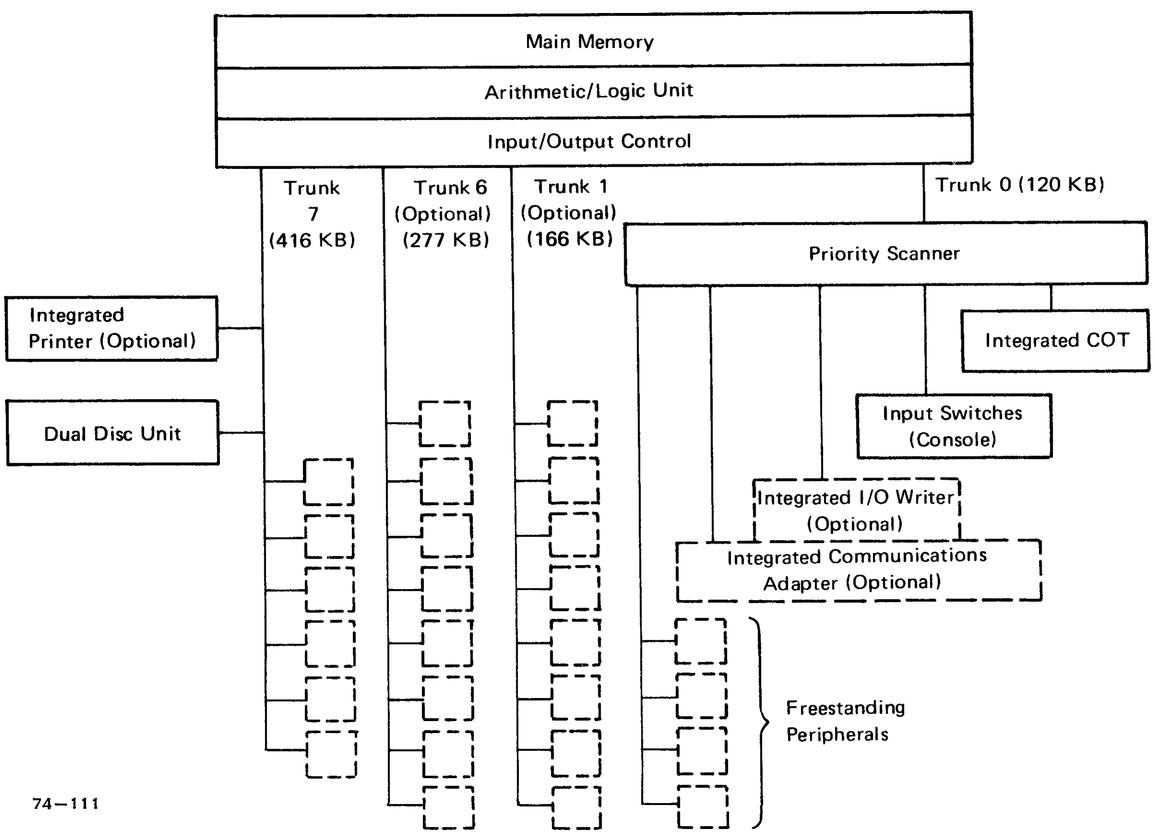


Figure 1. NCR Century 101: Basic and Maximum Configurations

addressing of all of memory in conjunction with an indirect addressing chain).

Each program has access to sixty-three 32-bit index registers implemented in main storage beginning with relative address zero of each active program. Conventionally, 19 index registers are reserved for use by the operating system.

The addressing facilities of the 50 MOD I, 50, 101, and 151 are more sophisticated than those usually found on a small business computer. This is due to their compatibility with the more powerful general-purpose processors higher in the Century Series. Flexible addressing is very beneficial in high data-movement applications such as those found in business environments.

Instruction Set. Each system's instruction repertoire is fully upward compatible with the full Century instruction set; it includes packed and unpacked decimal arithmetic instructions and hardware-implemented decimal multiply and divide. The following instructions are implemented: three fixed-point binary commands; nine decimal arithmetic commands; three move data commands; three logic commands; 12 transfer commands; and seven special commands used by software executives. The major additions to the 101's instruction set for the higher numbered Century processors are the floating-point instructions (long and short) and word (instead of byte) binary operands. Software routines are available to perform these instructions on the smaller systems.

Interrupt Control. Interrupt operations are largely hardware-implemented, with interrupt control performed by the I/O control unit in the CPU. The processor is interrupted for I/O transfers each time the buffers are full or an end-of-block is reached. An optional interval timer can be set to interrupt the processor at set intervals.

Main Memory

The Century series makes use of three memory technologies: core (Model 101), rod thin film (Model 50), and MOS (Model 151). Memory is byte-addressable; an attempt to access memory beyond the capacity results in an error signal. This differs from some other systems, the Burroughs B1700 for example, where such an error goes unnoticed by the hardware and where memory wrap-around occurs.

The first 1,280 bytes of main memory are reserved for registers, control words, and resident executive. Parity is created during write operations and checked during read operations. Parity check failure causes an interrupt.

Memory forms a single integrated unit with a single access path and cannot be interleaved.

Input/Output Control

One or two channels can be added for a maximum of four channels (zero, one, six, and seven): two are low-speed and two are high-speed channels. Each channel has eight device positions available. Some positions are pre-assigned: position zero on trunk seven (high-speed) is dedicated to an integrated printer (optional). Positions zero through three of trunk zero (low-speed) are dedicated, respectively, to the integrated card or tape reader (COT); the console input switches; the input/output writer (optional); and the communication interface (optional). All other positions can be used for freestanding peripherals; the only restriction is that the peripheral's transfer rate cannot exceed the channel (trunk) transfer rate.

All peripherals attach to the NCR processors via positions on channels. Some require control units; others have integrated controllers. For example, the first standard channel or "trunk," which is trunk zero, offers four integrated adapters for the COT, console, optional I/O write and optional integrated communication adapter (ICA) for 10 communications lines. These four adapters have separate ports on trunk zero's I/O control scanner; a fifth port is shared by four common trunk positions on the same channel.

The I/O control scanner gives trunk zero the characteristics of a multiplexor channel by allowing concurrent operation of all integrated peripherals (including up to 10 data communications transfers) and of one nonintegrated I/O peripheral connected to one of the four common trunk positions. On European Century 75 (150-656) systems, the 649 line printer is normally connected to one of the four common trunk positions. This arrangement serves to concentrate all slow I/O peripherals on trunk zero while allowing them to operate concurrently, subject to a maximum combined transfer rate of 166K bytes per second (120K bytes if the optional trunks one and six are also installed).

The second standard trunk, designated trunk seven, is a high-speed selector channel with a maximum 416K byte-per-second transfer rate, seven common trunk positions, and one integrated line printer adapter. The latter was used to connect a 640-102 or 640-200 printer to Century 101 and 150 systems ordered before the announcement of the new 640-300 and 649 nonintegrated line printers. It is not used on systems ordered since the beginning of 1973 including all Century 75 (150-656) systems. Integrated line printers connected to trunk seven can operate concurrently with one device connected to any one of the other seven trunks; otherwise only one transfer at a time can take place on trunk seven. A 656 or 657 disc subsystem always connects to trunk seven; magnetic tape subsystems also normally connect to this trunk.

PERIPHERALS

Slow-Speed Peripherals

Card Equipment:

- 682-100 Reader — integrated, 300 cards per minute.

- 686-102 Reader/Punch — reads 800, punches 83-294 cards per minute (not for Model 50).
- 686-201 Reader — 750 cards per minute.
- 686-111 Reader/Punch — reads 560, punches 60-180 cards per minute.
- 680-201 Reader — 1,200 cards per minute (not for Model 50).
- 687-301 Punch (also reads) — 100 cards per minute (not for Model 50).
- 686-302 Punch — 83-294 cards per minute (not for Model 50).
- 686-311 Punch — 60-180 cards per minute.

Printers:
- 640-102 (all models) — 450/900 lines per minute, 132 columns integrated.
- 640-200/210 — 1,500/3,000 lines per minute; 132/160 columns.
- 640-300 — 1,200 lines per minute, 132 columns.
- 640-205/215 — 750/1,500 lines per minute (OCR); 132/160 columns; 1,500/3,000 lines per minute; integrated (non-OCR).
- 649-150 — 150 lines per minute (127-character set), 132 columns; 127-character set print set 300 lines per minute (numeric only).
- 649-200 — 200 lines per minute, 132 columns; 64-character set.
- 649-300 — 300 lines per minute, 132 columns; 64-character set.

Paper Tape Equipment:
- 622-100 Reader — integrated, 1,000 characters per second.
- 660-101 Reader — 1,500 characters per second.
- 665-101 Punch — 200 characters per second.

MICR Equipment:
- 670-101 — 600 documents per minute, 11 pockets.
- 671-101 — 1,200 documents per minute, 18 pockets (not for Models 50 or 101).

OCR Equipment:
- 420-1 — 26 lines per second, up to 32 characters per line.
- 420-2 — 52 lines per second.

Accessing and transporting a card to the read/write heads requires 125 milliseconds; average latency is 24.25 milliseconds, peak transfer rate is 83K bytes per second.

DATA COMMUNICATIONS

The processor uses either an integrated communication interface (position three, trunk zero) or a freestanding communication multiplexor (621-103). The integrated communication interface can support a maximum of 10 adapters; the freestanding unit can support 253. Adapters can be used for single unit lines (one terminal per line), polled systems (many terminals per line), and satellite processing systems.

The 6002 Integrated Communications Adapter (ICA) allows up to 10 communication lines to use trunk zero's I/O control scanning and multiplexing ability without inhibiting any other I/O transfers on trunk zero. Each active communication line must be terminated by an adapter, either a 692-600 Asynchronous Data Adapter or a 693-600 Binary Synchronous Adapter.

Communication lines can be also controlled by a 621-101 or 621-103 Communication Controller connected to a common trunk position. Both controllers have multiplexing facilities for the communication lines and adapters connected to them; they inhibit other data transfers on the trunk, however, because these trunks have no processor-controlled multiplexing facilities.

The 621-103 Communications Multiplexor can multiplex 253 remote telegraph or telephone lines into a common trunk interface on any Century processor. Each active line must be terminated by an adapter.

Mass Storage Peripherals

Model 633 Magnetic Tape Transports are available for all Models except the 50. Six magnetic tape models include seven-track (200/556/800 bits-per-inch) and nine-track (800 bits-per-inch) NRZI models at 50 inches per second; single nine-track PE transports (1,600 bits per inch) operate at 50, 90, or 150 inches per second and one dual nine-track PE transport (1,600 bits per inch); controllers attach up to eight transports; NRZI units can be mixed on same controller.

Model 655 discs are dual-spindle units with three-platter interchangeable disc packs, for use with the 101 and higher numbered processors in the Century Series. Model 656 discs, similar to the IBM 5444 discs, read/record on two surfaces of a single-disc pack with one optional fixed disc and one interchangeable disc pack. The 656-10 master unit interfaces to a common trunk position; the 656-102 unit is slave. The 656 discs can be connected to common trunk positions, or they can be intermixed on configurations with larger 657 discs. Model 657 discs are similar to IBM 2314, 2319, and 5445 discs; the controller attaches to position on trunk seven. Up to eight spindles can be connected per controller. The 657 controllers can attach to common trunk positions on trunk seven, and they can be mixed on the same configuration with 655 or 656 disc systems.

Model 653-101 CRAM (Card Random Access Memory — not for Model 50) provides low-speed access to 384 magnetic cards in changeable cartridges; total capacities of 377,712 bytes per card and 145 million bytes per unit. Up to eight CRAM units can connect to an I/O channel via the CRAM controller.

The hardware-assisted software queue (HASQ) maintains a pointer in memory that aids the software in identifying the terminal requiring service. The HASQ feature is most effective when there are 32 or more lines in use. The multiplexor also has a standard interval timer.

The 692-100 Asynchronous Character Adapter is used with private or dialup voicegrade lines (Bell System 100 or 200 Series data sets), or TWX prime or Western Union async modems; speeds from 45-1,800 bps; any five- to eight-bit code with one start bit and one or two stop bits.

The 692-400 Polling Asynchronous Adapter was specifically designed for use with NCR on-line financial terminals and 795 Data Display Systems; it occupies two positions on a controller, one for I/O and one for polling.

The 692-600 Asynchronous Adapter can interface to the following terminals:

- NCR 260 Thermal Printer — 45, 50, 72, 72.6, 75 baud.
- NCR 270 Financial Terminal — 100, 110, 134.5 baud.
- NCR 280 Retail Terminal — 150, 165, 200 baud.
- NCR 399 Electronic Accounting Machine — 300, 600, 1,200, 1,800 baud.
- NCR 42 Window Machine.
- Data 100 Model 73 CRT.
- Teletype Models 33 and 35, ASR and KSR.
- Teletype Model 28.

The 693-200 Synchronous Adapter was specifically designed to interface Century systems to NCR 735 or 736 Model keytape encoders. Data communications rates of 1,200, 2,000 and 2,400 baud are available using 202C or 201A/B data sets.

The 693-300 Synchronous Adapter is used with sync (clocked) data sets such as Bell System 201B (2,400 bps), 301 (40,800 bps), or 303 (50,000 bps); it is intended for communication with other NCR Century systems and IBM BSC terminals.

The 693-600 Synchronous Adapter is used for terminals with hardware and software developed to conform to the IBM BSC discipline; transmission speed is 600 to 50,000 baud.

SOFTWARE

All Century Series software is disc-based. Just as each larger processor model includes the instruction sets of the smaller ones, so too the operating systems for the series are upward extensions of each other. Thus, programs for a Century 101 running under the B1 operating system can also run on a Century 200 under the B2 operating system.

To use the larger instruction repertoire of successive models, users must recompile their programs for the larger machine.

Operating Systems

Basically, the operating systems for the NCR Century Series are very straightforward. While most scheduling responsibilities fall upon the user, the fundamental simplicity of the operating environments permits users to maintain tight logical control of the system. For example, multiple copies of the simplest operating system form the vertebrae of the more complex ones.

NCR offers three disc-based operating systems for the smaller Century systems: B1, B2, and S2. B1 is a basic version, B2 is more sophisticated, and S2 allows the system to be dedicated to on-line processing. Each operating system is a logical extension of its functional predecessor.

All versions use a segmented overlay technique; executive routines remain memory resident during the run while others are called from disc as needed. Nonresident routines are overlayed into memory areas set aside by the system monitor for operating system use. During processing, the system notes the frequency with which overlays are called and keeps those most frequently used memory resident. This substantially reduces operating system overhead.

When a user writes programs, he must divide them into logical segments. The operating system automatically links the segments (no link-edit step is required after compilation) and calls segmented overlays into reserved memory regions during execution. The main advantage of this scheme is that programs can be made larger than the memory available to the system, like virtual memory. The disadvantage, however, is that application programmers must arrange programs into logical modules.

A roll-in, roll-out capability is missing from all versions of the operating system except B1. This lack is a definite drawback, particularly when emergency jobs must preempt processing jobs. Under the current setup, the operator must cancel running jobs. NCR claims that roll-in, roll-out is under development and will be incorporated into B2. Until such a capability becomes available, users can avail themselves of the system's checkpoint/restart feature to suspend jobs. At restart, the system cycles back to the last checkpoint, resets all files and registers, and resumes program execution.

B1. The B1 version is the basic operating system offered for the Century Series and can run on any Century system. It consists of an I/O executive; monitor system log maintenance; disc management; support for utility routines (such as the sort program generator); data utilities; source program utility routines (SPUR); object program utility routines (OPUR); an automatic flowcharting facility; symbolic debugging; and NEAT/3, Cobol, and Fortran compilers. All three compilers accept only disc input, so SPUR is used for program preparation prior to compilation.

The B1 system is equipped to handle batch jobs only; therefore most users will probably select it for the Century 50 or 100, or in some cases, the Century 200. It requires a minimum of 16K bytes of main storage, of which the resident executive requires about 4K bytes. All jobs running under B1 are stacked on disc; a job is a series of related programs or tasks. Jobs are scheduled for processing on a first-in, first-out basis, unless a branch option call, IF, is employed. In this case, the system stops processing jobs in the stream and branches to the label indicated. From that point processing continues serially using those programs associated with the branch-to label.

During processing, the operating system maintains a log of all hardware errors to aid in determining that components are going "soft."

B2. The B2 operating system is intended primarily for Century 75,101, 150, and 151. It requires a minimum of 32K bytes of memory (the resident executive uses a minimum of 5.5K bytes). B2 incorporates the basic software concepts of B1, but can handle on-line real-time operations.

The system operates in a dedicated mode (either on-line or batch) or in a dual programming mode. In the latter, the foreground partition serves the on-line applications and the background partition serves the batch jobs. Foreground programs have processing priority over background jobs in all cases. The background partition must be at least 16K bytes; foreground can be any size.

The optional JETS (Job Executive and Transport Satellite) package allows the B2 dual programming mode to be used for multiprogramming two pseudo off-line I/O conversions in the foreground partition with a batch processing stream in the background partition. I/O conversions take place between card or paper tape readers and line printers, on the one hand, and discs or magnetic tapes, known as System External Storage (SES), on the other. The appropriate SES areas or devices are automatically substituted for the slow I/O devices that they replace in the job scheduling of background batch jobs.

Jobs submitted are queued on disc and serviced first-in, first-out. Tasks within a job can be assigned processing priorities by the programmer, however. A job selected for processing runs to completion unless "aggressively" interrupted by events such as an emergency job. Emergency jobs require the operator either to cancel processing jobs (if sufficient resources to serve the higher-priority job are unavailable) or, if they have been written to utilize the checkpoint/restart feature, suspend them.

For on-line applications employing multiple terminals, B2 permits chaining instructions to eliminate the need to dedicate fixed size storage areas to collect multiple message segments. Users can also use dynamic storage and chain memory regions containing related segments to a particular terminal.

S2. A Century 101 with a minimum of 16K bytes of main storage can be dedicated to on-line processing through use of the S2 operating system. S2 incorporates the basic software capabilities of B1 with the added concept of on-line processing. Its operational capabilities as they relate to queuing, dynamic storage allocation, and message chaining, are the same as B2. However, S2 has no provision for multitasking, dual programming, or dynamic storage allocation for I/O areas.

Language Processors

Language processors offered with Century Series systems are NEAT/3, Fortran, Cobol, Basic, and RPG.

NEAT/3. Implementation of NEAT/3, the Century Series assembly language, is on three levels:

- One level relies on extensive use of macros and requires little knowledge of hardware characteristics for first computer users.
- A second level relies on some, but not extensive, use of macros and requires some knowledge of hardware characteristics—equivalent to RPG compilers for other systems.
- A third level avoids the use of macros and is closely aligned with hardware characteristics, for systems software programming.

Fortran. Two Fortran compilers are offered. Century Basic Fortran requires 16K bytes of memory; Century IBM 1130-compatible Fortran requires 32K bytes of memory. Both comply with the ANSI standards for basic Fortran.

Both compilers operate under control of one of the Century operating systems. The source program can be retained on disc for recompilation if desired. This is accomplished by using page and line numbers in positions 75 through 80 of the source statement. These numbers can be either programmer or compiler assigned. The object program is stored on disc for rerunning when desired. It can be executed in a mixed system of programs, for instance, Cobol, NEAT/3, and Fortran. Fortran floating-point operations are simulated in software.

Cobol. Century Series Cobol is divided into three stages, two of which can be used on Century 101 and 151. Stage I is a subset of basic Cobol implemented for Century 101 and 151 with 16K or 32K bytes of memory; Stage II is a comprehensive set of Cobol elements based upon the ANSI standard, and implemented for the Century 101 and 151 with 32K bytes of memory.

Basic. Basic-I is a version of the popular Beginner's All-Purpose Symbolic Instruction Code developed at Dartmouth College. Data communication facilities are required for use of the Century Series Basic-I system.

The initial implementation of Basic allows communications between the computer and remote Teletype units via voicegrade lines. Only memory size influences the number of terminals that can be active at one time. The Basic compiler is oriented for compilation speed.

In order that certain routines need not be generated in each object program, they are resident in either memory or overlays and are shared by all Basic object programs. The remote rapid compilation feature and language simplicity make Basic an ideal language for quick solutions to complex mathematical problems.

RPG. Minimum system requirements for RPG are a CPU with 16K bytes of memory, dual disc units, a printer, and a card reader.

An RPG to NEAT/3 Translator is available to aid in the conversion of IBM System/360 Model 20 RPG source programs to NCR's NEAT/3 source programs. The translator generates NEAT/3 source code for each valid RPG card; optionally, it produces a listing of the card images of the RPG and NEAT/3 cards.

Applications Software

NCR provides a wide range of utility routines and programs. Utility routines include a general sort program and operating system routines for disc maintenance and system log maintenance. A flowcharting package generates flowcharts for NEAT/3 programs. A program debugging package is also available.

The following application packages are for the Century Series, a partial list of those available are:

- *Emphasis I Inventory Management System* utilizes input derived from actual item demand on punched cards or magnetic tape.
- *Sales Auditing System* furnishes verification, sorting, recording, and distribution of statistical information accumulated during the course of business operations.
- *Tape Accounts Receivable System* consists of a series of communication programs designed to provide the consumer-oriented business with an automated accounts receivable system. It is intended primarily for businesses with 50,000 or more accounts receivable customers.
- *Central Information File (CIF) Systems* comprises Demand Deposit Accounting which provides overall central information file processing of the highest volume bank operation.
- *General Ledger Accounting* performs all file maintenance item processing, report preparations, and daily reporting functions. Daily, month-end, period-end, and on-request reports comply with internal accounting and auditing standards established by the various regulatory agencies.
- *Installment Loan* is designed to perform the bookkeeping functions of a small loan operation.
- *On-Line Savings* handles a number of functions appropriate to on-line savings banking applications.
- *Hospital Accounts Receivable* provides for handling of hospital patient accounts after final bills have been prepared. It also handles outpatient accounts.
- *Student Scheduling/Grade Reporting* enables automated development of student schedules and grade reports.
- *Utility Billing* handles billing and collection for municipalities, investor-owned utilities, and REA offices; also handles electric, gas, or water billing in any combination.
- *Stewardship and Management Accounting* provides the means to collect, summarize, analyze, and report sources and uses of resources in monetary terms. The primary objective of Stewardship Accounting is to provide financial information to persons or groups outside an organization, such as governmental agencies, donors, loan funds, and creditors.
- *Hospital Inpatient Records* (IPR) is designed to process and report financial and administrative information about each patient in a hospital. IPR provides complete records and procedures for patient accounting; internal pricing of charges; insurance proration for up to four carriers; billing; revenue analysis; and extensive accumulation of statistics.
- *Building Contractors' Estimates* are used as a tool for the construction industry to analyze the critical item of labor cost and/or labor hours, material cost, and equipment for a job under consideration.
- *Production Scheduling* handles the information flow necessary to control the fabricating, machining, and assembly activity of a manufacturing concern.
- *Requirements Planning* provides the user with inventory status, bills of material, where-used lists, and production and/or purchase requirements.
- *General Input Validation* performs the necessary functions required of an entry program. It validates, balances, and distributes.
- *General Reporting System* provides a method for creating reports with minimum effort; such as extraction of information from files and reporting via the user's own program.
- *General Payroll* is a completely automated payroll accounting and labor distribution system which includes provisions for conversion, original implementation, and parallel operation.
- *Accounts Payable Applied Program* (Retail and General) performs timely, accurate administration of liabilities to vendors. Major functions of the program are preparation of vendor checks and itemized remittance statements, billing of debit balance accounts, distribution of costs to organizational units, and historical analysis of vendor activity.
- *Consumer Accounts Receivable* keeps current a master file from which the major part of a user's accounting reports can be produced. All financial transactions to the master file are posted and inserted in the file, yielding the current state of the master.
- *Order Billing* is designed for the distribution industries to provide wholesalers with the major processing functions to meet their requirements. It prepares the billing invoice in warehouse bin sequence by order.

MAINTENANCE

Maintenance is available through about 300 service offices in the United States and Canada, and 900 offices overseas. The 101 is easy to service because it has a high degree of circuit standardization: all logic appears on six basic cards. Thus, virtually all malfunctions can be connected with a handful of plug-in replacement circuit boards. System downtime therefore is kept to a minimum. The standard service contract offers maintenance during any selected eight-hour period between 8 a.m. and midnight. Special arrangements can be made for 24-hour service at higher rates.

PRICE DATA

Model Number	Description	Monthly Rental $	Purchase $	Monthly Maint. $
	CENTURY 50 CENTRAL PROCESSOR & WORKING STORAGE			
	Basic System			
615-50/ 616-200	Processor (with 16K* memory)	1,575	55,850	275
682-100	Card Reader (300 cpm)			
640-122	Printer (200 lpm)			
655-151	Disc Unit (8.4 mb; low speed)			
	Processor Options			
5621	Communications Package (6101 reqd)	425	19,500	75
5622	BASIC-1 Hardware Pkg (6101 reqd)	400	18,000	60
	Magnetic Tape			
624-119	9-Channel Control Unit (40 kc)	300	14,000	20
624-179	7-/9-Channel Control Unit (10/28/40 kc; 200/556/800 bpi)	350	16,500	20
633-117	7-Channel Control Unit (10/28/40 kc; 200/556/800 bpi)	350	17,000	65
633-119	9-Channel Unit (40 kc)	350	17,000	65
	Data Communications			
622-201	735/736 Encoder Adapter	175	8,250	10
	CENTURY 50/MOD-1 CENTRAL PROCESSOR AND WORKING STORAGE			
615-50/MOD-1 616-300	Basic Processor (16K bytes of memory)*	1,275	47,000	290
682-100	Card Reader (300 cpm)			
649-125	Line Printer (125 lpm)			
655-151	Disc (8.4M bytes)			
	Alternates for Basic System			
616-300	Processor with 32K bytes	300	12,500	10
662-100	Paper Tape Reader (1,000 cps)	–	–	-15
640-122	Printer (200 lpm)	250	8,850	-15
640-132	Printer (300/600 lpm)	400	14,850	–
640-102	Printer (450/900 lpm)	600	20,850	15
655-101	Disc (8.4M bytes – high-speed)	150	5,000	35
	Processor Features			
6103	CRT Switch and Interface	45	2,000	9
796-101	CRT I/O	80	2,000	30
	CENTURY 100 CENTRAL PROCESSOR & WORKING STORAGE			
	Century 100 Basic System includes:			
615-100/ 616-200	Processor (with 16K* memory)	2,500	71,500	385
682-100	Card Reader (300 cpm)			
640-102	Printer (450-900 lpm)			
655-101	Disc Unit (8.4 mb; high speed)			
	Alternate Devices (for Century 100 Basic)			
626-101	Printer Control Unit (price included with printers)	–	–	–
640-200	Printer (1,500 lpm; 132 col) or	925	35,500	75
640-210	Printer (1,500 lpm; 160 col) or	1,025	39,750	75
640-300	Printer (600 lpm; 132 col)	675	25,450	50
640-205	OCR Printer (650/1,500 lpm; 132 col)	1,025	38,300	85
640-215	OCR Printer (750/1.500 lpm; 160 col)	1,125	42,550	85

**Basic Systems are the minimum configurations that can be purchased. Prices for optional devices are added or subtracted from the basic price.*

Model Number	Description	Monthly Rental $	Purchase $	Monthly Maint. $
	Processor Options			
6105	I/O Writer Selector Switch Assembly	5	200	1

CENTURY 101
CENTURY PROCESSOR AND WORKING STORAGE

Model Number	Description	Monthly Rental $	Purchase $	Monthly Maint. $
	Basic System			
615-101 w/7001	Processor (w/16-Kb memory)*	2,025	89,520	325
682-101	Card Reader			
649-300	Printer (300 lpm)			
656-102	Disc Unit (4.9 mb)			
6561	Disc Unit Controller			
6562	Fixed Disc (4.9 mb)			
	Alternate Devices			
615-101/ 7002	Processor (w/24K-byte memory)	175	7,875	10
615-101/ 7003	Processor (w/32K-byte memory)	300	13,500	15
615-101/ 7004	Processor (w/48K-byte memory)	600	27,000	25
615-101/ 7005	Processor (w/64K-byte memory)	900	40,500	35
656-102's	Disc Unit w/Attachment (9.98-mb capacity)	225	9,195	47
657-102/ 625-201	Disc Unit & Controller (60 mb; 315 kb)	1,220	57,605	40
	Processor Options			
6003	I/O Common Trunks 1 & 6	100	4,500	10
6102	Thermal I/O Writer w/Interface	150	6,250	15
615-951	Auxiliary Cabinet	25	800	–
6106	Alternates for Century 50, Century 100, and Century 101 Software Initiated Alarm	10	400	2

CENTURY 151
CENTRAL PROCESSOR AND WORKING STORAGE

Model Number	Description	Monthly Rental $	Purchase $	Monthly Maint. $
	Basic System			
615-151/ 7102	Processor w/32K-Byte Memory*	2,975	133,695	468
682-101	Card Reader (300 cpm)			
649-300	Line Printer (300 lpm)			
656-102	Disc Unit (4.9 mb)			
6561	Disc Unit Controller			
6562	Fixed Disc (4.9 mb)			
6102	I/O Thermal Printer w/Interface			
615-953	Auxiliary Cabinet			
	Alternates for Basic System			
615-151/ 7104	Processor w/48K MOS Memory	250	11,250	10
615-151/ 7106	Processor w/64K MOS Memory	500	22,500	20
615-151/ 7108	Processor w/94K MOS Memory	750	33,750	30
615-151/ 7110	Processor w/128K MOS Memory	1,000	45,000	40
646-201/ 961-201	Printer (1,200 lpm)	650	29,700	185
647-201/ 961-201	Printer (2,000 lpm)	1,025	45,500	295
655-201/ 625-101	Disc Unit and Controller (8.2 mil. byte, 108kb)	345	16,455	30
(Two)656-102's	Gives Two Removable, No Fixed (9.8 mil. byte – total disc system cap.)	225	9,195	47
657-102/ 625-202	Disc Unit and Controller (96 mil. byte, 500kb)	1,420	66,805	NA
6011	I/O Common Trunks 1 and 6	125	5,625	10

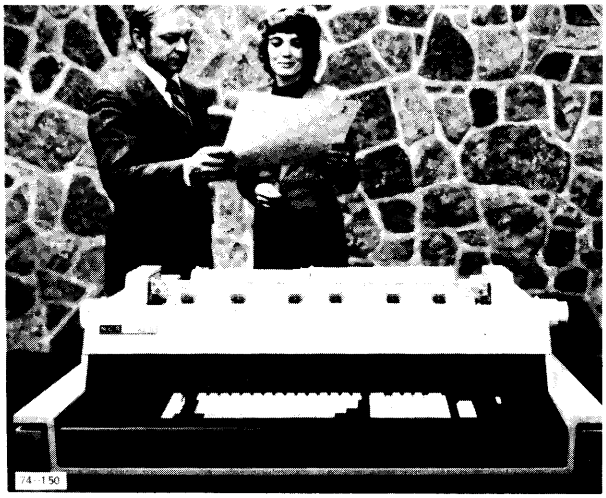
**Basic Systems are the minimum configurations that can be purchased. Prices for optional devices are added or subtracted from the basic price.*

Model Number	Description	Monthly Rental $	Purchase $	Monthly Maint. $
	Alternates for Century 50, Century 100, Century 101, and Century 151			
6101	Teletype I/O Writer with Interface	100	4,000	15
6107	Remote Audible Alarm	20	800	1
6108	Extra Loud Alarm	20	800	1
	Alternates for Century 101 and 151			
662-100	Paper Tape Reader (1,000 cps)	0	0	15
640-102	Integrated Printer (450-900 lpm)	150	10,100	5
640-102/ 626-101	Printer with Controller (450-900 lpm)	300	17,350	5
640-300	Integrated Printer (1,200 lpm)	575	23,800	30
640-300/ 626-101	Printer with Controller (1,200 lpm)	675	28,800	30
657-102/ 625-201	Disc Unit and Controller (60 mil. byte, 315 kb)	1,200	57,605	40
	Processor Options			
6001	Multiply/Divide	100	4,500	10
6002	Integrated Communications Multiplexor	175	7,875	40
6006	640-102 Integrated Printer Controller	75	3,375	10
6007	640-300 Integrated Printer Controller	125	5,625	10
6010	Logic Command	50	2,350	10
9511	640 Integrated Printer Attachment	75	3,375	15
	Discs			
656-102	Disc Unit (4.98 mil. bytes)	310	13,020	60
6561	Disc Unit Controller	150	6,750	25
6562	Fixed Disc (4.98 mil. bytes)	95	4,275	15
6563	Dual Disc Attachment	10	450	2

**Basic Systems are the minimum configurations that can be purchased. Prices for optional devices are added or subtracted from the basic price.*

HEADQUARTERS

NCR Corporation
Worldwide Headquarters
Main & K Streets
Dayton OH 45409



OVERVIEW

The NCR 299 is a programmable, low-cost accounting system designed for businesses with fewer than 150 employees. It belongs to that hybrid class of equipment variously called "programmable accounting machines" or "visible record computers." It adds the automatic computation and control capabilities of small computers to the visible recordkeeping processes of accounting machines. The NCR 299 features a low-cost, easy mark-sense method for entering programs, and a sizable memory (for this type of system). Memory consists of 4K to 8K 64-bit words of core in addition to the microprogrammed MOS/LSI ROM used for system control. Installation and custom programming of the system are so easy that NCR plans to handle both with its sales force rather than with systems analysts and other field support personnel.

The basic system combines an accounting machine keyboard; a golfball printer with split platen; and special mark-sense read head and CPU, all housed in a single desk-like unit. There are no extra peripherals available, but the instruction set has provisions for programming peripherals.

The 299 uses a simple programming technique that combines printing and editing, arithmetic operations, decision making; and forms handling into a program statement, that is a line on a coding form. Marking predefined locations on an assembly card produces a completed program that can be run on the NCR 299.

Programs are read from a special mark-sense form that divides each 64-bit instruction word into a number of fields that define the printing and editing of data, arithmetic and data manipulation, and related forms handling. All subfields of the instruction word can be coded on the preprinted mark-sense form with a single pencil or pen stroke. Numerical values (the number of print positions, for instance) are entered in a binary format. The predefined format, variety of instructions, and mark-sense entry method allow control programs to be developed rapidly even by novice users. In addition, an operator can use the system effectively after considerably less training than that of the usual accounting machine operator.

NCR anticipates an extremely high volume of business with this system because of its low price, versatility, and ease of operation. Market surveys indicate that more than half a million businesses or other organizations in the United States alone have fewer than 150 employees. Some of these businesses are as follows:

- 46,000 transportation companies: revenue analysis, compilation of freight bill statistics.
- 200,000 retail firms: cycle-billing, inventory control.
- 115,000 wholesale firms: order billing, sales analysis.
- 125,000 manufacturing companies: job-costing, work-in process, work center loading.
- 80,000 building and other contractors: estimating, job costing, maintenance of equipment records, daily labor reporting.
- 22,500 auto dealers: monitoring parts sales, new and used car sales, dealer trades, service and repair accounting, vehicle inventory.

NCR will install 5,000 of the 299 Systems in 1974 and anticipates 50,000 installations by 1979. The first NCR 299 was delivered in February 1974.

PERFORMANCE AND COMPETITIVE POSITION

NCR planned the 299 for users with some computer experience and for novices not only in computer use but also in accounting machine use. The system's low price enables it to compete with both small business computers and electromechanical accounting machines. Larger businesses with small branches can also use the 299, but these applications usually lend themselves more readily to intelligent terminals in a distributed processing network. One of the biggest advantages NCR has in this small-business market is its existing market penetration, which consists of over 375,000 carriage-type accounting machines, probably more than any other manufacturer. Owners of the small businesses addressed by this product probably have only a vague idea of what the market has to automate their accounting, and they probably don't have the personnel for market research. They tend to turn to large, well-known manufacturers like NCR for the support they need.

Because a larger sales organization is needed to contact a large number of small businesses, the only significant competition must come from manufacturers with an established name in accounting machines. In the United States, the major competitors are IBM, Burroughs, Litton, Singer-Friden and Philips; the Swedish based Facit-Addo company has also made some inroads into this market. Only the low end of the well-established Burroughs L Series approaches NCR's beginning prices in the current U.S. market. The L Series uses a very small read/write memory (128 to 256 words) and utilizes more conventional by more complicated programming techniques; but a variety of peripherals are available for all models of the L Series including sizable auxiliary mass storage for the upper models of the series. The other large U.S. manufacturers offer electromechanical accounting machines and small business computers that fall into higher price classes. Facit-Addo is perhaps an exception; its small system uses a control memory that operates something like a key-tape device buffer.

The competitive position is somewhat different in Europe, where there are a large variety of visible record systems offered by such manufacturers as Nixdorf, Kienzle, Olivetti, and Philips, as well as many smaller companies. The all-important factor of price, however, is not available to make a valid comparison. Many European manufacturers use magnetic-stripe ledger cards, which, for some reason, have gained wider popularity in Europe than in the United States.

CONFIGURATION GUIDE

Only the basic 299 system is currently available: keyboard, printer, and optical scanning read-head combined in a single unit with the CPU and 4K words of read/write core memory. This system can accumulate 10 totals and handle programs of up to 46 steps. Options include additional memory, more totals in increments of 20, programs of up to 63 steps and multiply/divide. A continuous forms feeder will be available in the second quarter of 1974.

Program coding forms include standard codes for paper tape/edge-punch card reader/punches, cassette transports, magnetic ledger card processing, and communications, so development along these lines is undoubtedly planned for the future. Standard system specifications are listed in Table 1.

COMPATIBILITY

The NCR 299 is not compatible with any other system, except at the forms level.

MAINFRAME

The golfball printer and optical scanner for the system are contained in a single mechanism which moves horizontally across the forms feeder. The serial printer prints the standard 88-character set at 15 characters per second on multiple part forms that may consist of an original and up to seven copies. The keyboard is typewriter-style with a 10-key numeric pad and nine control keys. A split platen can handle one or two forms totaling 4 to 23 inches in width; 10- and 12-inch platen sections are standard, but other splits are available.

A 64-bit microprogrammed minicomputer with a cycle time of 448 microseconds (7 microseconds per bit) controls the system. The processor, implemented by MOS/LSI circuitry, is modular and compact. All control and arithmetic operations are programmed and executed from nonvolatile core memory. Read/write core memory of 4K words expandable to 8K words is available for user data and programs. Each word is 64 bits long; it can store eight 8-bit bytes or 16 digits plus sign in ASCII-compatible format.

Table 1. NCR 299: Product Specifications

CENTRAL PROCESSOR	
Word Size (bits)	64
Capacity (bits)	8K
Cycle Time (μsec)	448
Working and Program Storage	Core
AUX STORAGE	None
DATA OUTPUT	
Line Printer (lpm)	None
Serial Printer	Golfball (std), 15 cps
Card (cpm)	None
Paper Tape	None
DATA INPUT	
Keyboard	Standard
Card (cpm)	Mark-sense
Paper Tape (cps)	None
SOFTWARE	
Assembler	None (Not needed)
Operating System	Firmware
Compiler	None

The two classes of instructions or "program steps" are "primary" and "secondary." Although the formats are similar, the fields in the 64-bit instruction word are interpreted differently depending on the format flag setting (0 = primary, 1 = secondary). All instructions except I/O instructions use the primary format; I/O instructions use the secondary format.

Table 2 presents both formats. The first field at the top of Table 2 corresponds to the leftmost field of the instruction word, the other fields follow in order of their position in the instruction word. Operations include Add, Subtract, Move, Multiply (optional), Divide (optional), Clear, Branch, Compare for Less Than and Greater Than, Compare for Equal To or Unequal To, Check Digit Verification, Distribution Code, Distribution Code Value In, Distribution Code Value Out, Input, Output, and Output Special.

The Distribution Code group of instructions allows totals to be accumulated separately by the type of part for sales analyses. The Output Special Instruction allows totals to be printed with a special identification if they are not to be printed in columns that automatically identify the type of total. The symbols, ◊, and CR are used to identify reverse conditions because carbons cannot print in two colors. The Source field provides for exceptions by branching for unusual cases.

SOFTWARE

All software is unbundled. NCR provides three kinds of programming support: standardized packages, slightly modified (less than 25 percent) standardized packages, and custom packages. The standardized packages include Invoicing, Billing and Charge, Accounts Receivable, Accounts Payable, General Ledger, Payroll, Job Costing Estimates, Wage Accrual, etc. The standardized packages are the least expensive, of course; but the custom programs are also inexpensive because they are easy to develop. Frequently, the salesmen can gather the required data in the morning and return with the program in the afternoon. Costs are determined by the number of steps in a program: An accounts receivable program typically requires 46 steps, while payroll preparation requires 63 steps. In addition, the customer can easily learn to program the machine himself.

Table 2. NCR 299: Instruction Formats

Number of Bits in Field	Primary Statement Format	Secondary Statement Format
8	Print Positions	Same
2	◊, CR, or No Sign	Same
1	Black or Red Ribbon	Same
5	Maximum Output Length	Same
1	Currency Symbol	Same
1	Edit/Omit	Same
2	Decimal Places (2, 3, 5, or None)	Same
4	Prime Operation, Non- I/O Instruction: Add, Sub, Mul, Div., etc.	Prime Operation Input, Output, or Output S
1	Format Flag (Primary/ Secondary Statement Format)	Same
7	Source (10-Key or Branch Key)	I/O Device
1	Clear Source	Clear A-B Operands
7	Operand A	Same
1	Add/Subtract	Numeric/ Alphanumeric
7	Operand B	Same
1	Add/Subtract or EOT	EOT
7	Operand C: 3-bit Output Device Code and 4-Bit Data Code Pointer	Same
8	Forms Handling Flags	Same (But"Additional Output" and "ERR Corr" Fields Omitted)
64	Total Number of Bits	

HEADQUARTERS

NCR Corporation
Dayton OH 45479

PRICE DATA

Model Number	Description	Monthly Rental $	Purchase $	Monthly Maint. $
299-100	Processor w/10 Totals & 46 Program Steps	NA	7,250	40
	Additional Memory (20 total increments)	NA	400	2
	63 Program Steps (17 program step increments)	NA	400	3
	Multiply/Divide	NA	395	2
	Side Table	NA	95	NA

NA Not Available.

SUMMARY

The National Cash Register 500 computer is primarily intended for computer novices who want to automate their small-business accounting procedures. The NCR 500 typically is run by operator-programmers who can and do modify NCR's standard software in addition to developing their own.

This system differs from most computers intended for the small business market usually emphasizing turnkey operation with no previous experience. No compiler language is available, and programs must be written in either machine language or a symbolic assembler language (SLIP). However, because the 500 can initiate multiple program instructions with only a single command, programming complexity is reduced. NCR contends that within several weeks a typical programmer can perform effectively. The firm provides, without charge, a 40-hour tape-recorded programmer training course and a package of programming-support, debugging, and training services.

The NCR 500 can handle both interactive and batch processing. Most installations include an interactive, magnetic stripe card handling capability, preferred by users accustomed to manual billing and accounting procedures. In interactive mode, using the standard, moving-carriage printer, the system can write 120 payroll checks an hour, a sufficient rate for a small company. However, in batch mode, using a 300 line-per-minute printer, approximately 2,000 checks can be written in an hour.

In addition to its use in standard accounting-type applications, the system has been used in financial, credit, retailing, real estate, and tax areas.

CONFIGURATION GUIDE

An NCR 500 consists of a central processor unit with up to 400 words (48 bits per word) of core memory, along with one of three consoles, the desired assortment of peripheral devices, as well as the buffers, controllers, and adapters these require in order to interface with the CPU.

The three console choices are:

C-521-1 — features a numeric keyboard, a numeric journal tape printer, and a set of seven operation control keys. Although instructions or numeric data can be entered into the CPU through the keyboard, it is mainly used to debug programs and to operate the system.

C-590-1 — has an alphanumeric keyboard used for interactive processing, operational control, and data entry to the CPU. It has a 26-inch, split-platen moving carriage printer; a dual, pin-feed forms-handling capability; and the ability to process magnetic stripe ledger cards.

C-590-2 — resembles the C-590-1 but can process only standard ledger cards.

In addition to the consoles, the following peripherals can operate as input devices to the CPU: up to two paper tape readers; an optical character recognition (OCR) reader replacing one of the paper tape readers; up to two punched card readers; and a magnetic stripe ledger card reader.

Either the C-590-1 or C-590-2 console can be used by the CPU for data output. In addition, the CPU can drive a paper tape punch, a serial card punch, and up to two different line printers. The latter three devices have buffers for maximizing system throughput. NCR also offers a number of devices for off-line preparation of punched paper tape and punched cards.

SOFTWARE

More than 100 programs are available from NCR, including a comprehensive set of accounting-type programs. Summary-report programs prepare IRS forms; and there are special packages for chains of department stores that include programs for the preparation of customer statements, for store-by-store sales analysis, and for sales-category analysis. Other packages include: gas and electric billing with hand-coded meter-reading cards; water and sewer assessment, billing, and account supervision; retail-route planning, analysis, and management, and so on. Several utility programs, such as file-to-file conversion, are also available.

DESIGN FEATURES

The 500's design is enhanced by a powerful instruction repertoire that provides multiple instruction execution with a single command. Storage space is efficiently utilized by allowing only active programs to be core resident.

Machine language instructions are 12 digits long, and typically contain four addresses in addition to the processing instruction. With such an addressing scheme, a single command can accomplish the same processing as four individual instructions performed by a single address processor. For example, a single instruction can access two memory locations, add their contents, enter the result into a third memory location, and direct the processor to access a fourth location for its next instruction. The same capability is available with the symbolic assembler program. Each instruction is a string of simple descriptive words, including the names of up to four addresses and processing instructions.

The programmable operation-control keys provide a highly flexible means of system control. They can be used to initiate processing, to interrupt a program, to insert subroutines, and for other functions. The OCR capability is a useful adjunct to the optical character printing capability of NCR cash registers, since it permits batch processing of the data contained in their optical-character-printed journal tapes.

PERFORMANCE

Although the 500 is strongly oriented toward processing data on an interactive, per-transaction basis, the system has a good batch processing capability, and even offers a high-speed, magnetic stripe ledger card reader for those users who want the best of both worlds. The fact that it can accept inputs from an OCR reader, coupled with the general use of OCR printing in NCR cash registers, permits the system to generate daily summary reports for large retail establishments.

MAINTENANCE

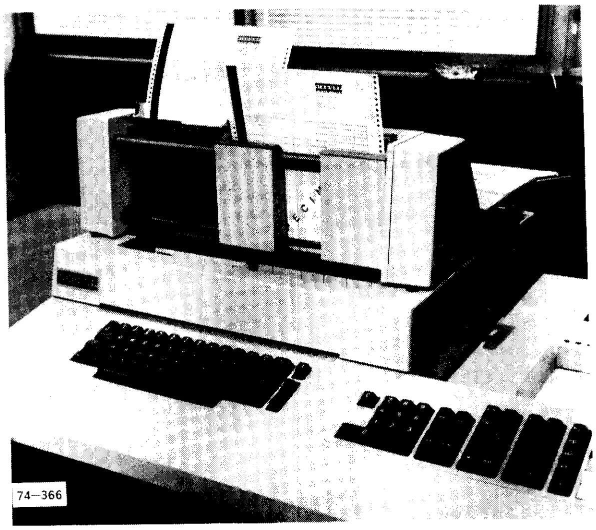
NCR provides maintenance for the 500 system under a warranty for the first year and by contract subsequently. The standard contract offers service during any desired 8-hour period between 8 a.m. and midnight, and special arrangements can be made for round-the-clock service at higher rates. Maintenance is available through the almost 300 service offices in the United States and Canada and through many sales and service centers overseas.

HISTORY

NCR, founded in 1882, is one of the two largest manufacturers of electronic accounting machines and is also one of the six largest computer manufacturers. Since 1965, when the NCR 500 was first marketed, approximately 4,000 units have been installed around the world. NCR also markets two more powerful small business computers, the Century 50 and the Century 100.

PRODUCT SPECIFICATIONS

CENT PROCESSOR	
Word Size (bits)	48
Capacity (words)	200-400
Cycle Time (μsec)	1,080
Working Storage	Core
AUX STORAGE	Magnetic stripe ledger
DATA OUTPUT	
Line Printer (lpm)	125; 300
Serial Printer	Yes
Card (cpm)	100
Paper Tape (cps)	30; 120
DATA INPUT	
Keyboard	Standard
Card (cpm)	100
Paper Tape (cps)	50; 650
SOFTWARE	
Assembler	Yes
Operating System	No
Compiler	No



OVERVIEW

Nixdorf Systems 820/15 and 820/35 are two current models of the famous System 820 family for direct keyboard-input invoicing, visible record, and magnetic ledger accounting computers for small businesses. More than 30,000 System 820s have been installed throughout the world since the system was first launched in 1965. More than half of these installations are in West Germany, where Nixdorf dominates the visible record computer market.

System 820/15 is Nixdorf's entry level system for new users or for users upgrading from 2- to 16-register invoicing machines. It offers 3,000 to 7,494 user program instructions in ROMs and core and storage for 16 to 738 data words. Each data word can hold a signal 14- or 15-digit decimal number, or either eight or 10 alphanumeric characters. In addition, 256K to 1 million bytes of on-line "floppy disc" backing storage can be included on systems delivered from the beginning of 1975. In West Germany, System 820/15 is available from DM 29.154 ($11,662) upwards for invoicing systems and from DM 59.115 ($23,646) upwards for magnetic ledger card processing configurations.

System 820/35 is a more powerful but fully compatible upgrade system for current System 820/15 users or for users of the older Systems 820/10, 820/20, 820/25, or 820/30. Main store can be expanded to 22,528 user program instructions and 496 data words or to 20,480 instructions and 1,008 data words. It can also handle a larger number of peripheral subsystems than System 820/15, but it cannot as yet use floppy discs.

Both systems offer comprehensive alphanumeric keyboard, numeric pad, and function keys on the console for source program and transaction data input. The console printer can be a golfball printer or a matrix printer. An auxiliary printer is optionally available. Other optional peripherals include a magnetic stripe ledger card processing unit with an optional automatic card feed, high-speed magnetic ledger card reader, magnetic tape cassette drives, paper tape and 80-column card readers and punches. System 820/15 can support up to four peripheral subsystems; System 820/35 can support up to six.

Nixdorf customizes applications programs for most System 820 installations on an unbundled basis. Users of System 820/15 magnetic ledger processing computers with no peripheral subsystems can use the inexpensive FIRM modular accounting package. FIRM has modules for on-line order entry, invoicing, sales ledger, stock recording and control, production scheduling, materials scheduling, purchase ledger, payroll, and general ledger. A program generator customizes these modules automatically to a user's individual requirements on the basis of questionnaire inputs.

Users of the larger System 820/35 configurations are supplied with an assembler and KEYBOL compiler for program preparation. They will still depend on Nixdorf for wiring their programs on ROM boards.

Nixdorf Computer AG manufactures System 820 computers at its plant in Paderborn, West Germany. Nixdorf markets them directly and through agents in all Western European countries, as well as in the USA, Japan, Australia, and South Africa. The two systems are also marketed in West Germany but Ruf Datensystem Hegnauer & Heilmann of Karlruhe, under the label "Ruf Series 70."

PERFORMANCE AND COMPETITIVE POSITION

Nixdorf System 820 is the oldest and most widely used family of keyboard-oriented visible record computers on the European market. Launched in 1965, over 30,000 were installed by the end of 1973. More than half are in West Germany where Nixdorf holds a 55 percent share of the market against competition from some 20 other manufacturers. Its main competitors are the Burroughs L series; Compudata Systems 500 and 600, CTM 70; Kienzle 5000, 5600, and 6000 series; LogAbax LX 4100 and LX 4200; NCR 399; Philips P350 series; Ruf/Hohner 505 to 8000 series; and Triumph-Adler TA 1000.

Several factors account for Nixdorf's continued dominance of the West German and European small business computer markets. The main factor is that Nixdorf was the first European manufacturer to offer an indigenous system to compete against the NCR 500. From 1965 to 1968, Nixdorf supplied System 820 processors primarily OEM to West German accounting machine manufacturers, Kienzle, Ruf, and Wanderer, who added their own peripherals and applications software. In 1968, Nixdorf took over the Wanderer marketing organisation and started marketing systems directly to end users. As a result of previous OEM relationships, Nixdorf's established customer base also included Kienzle and Ruf users who had System 820-based visible record computers. Former OEM customers (except the West German Ruf company) now compete against Nixdorf with systems of their own design, but the System 820 has consistently held the lead in numbers of systems installed.

Two other factors enabled Nixdorf to exploit this early lead. Installed systems have a high reputation for reliability, and the Nixdorf maintenance organization has an equally good reputation for speed and efficiency, especially in West Germany where the density of customer installations allows an equally dense network of service centres to be maintained. New features are always installed first at a dozen trial customer sites for exhaustive field testing before they are released for general marketing, first in West Germany and later in export markets.

Another factor in Nixdorf's success is the deliberate policy of program and data file compatibility with the earliest System 820 models. The system has been continuously redeveloped since 1965 to take advantage of new technology. The current System 820/15 is the fourth entry-level System 820 version since 1965, and it offers three times the data capacity and many more peripherals than the original System 820. But current System 820 models are nonetheless fully upward compatible with the earliest systems. Nixdorf has also stretched the power of the system to ever more powerful models to keep pace with customers' expanding data processing requirements. Current System 820-compatible transaction processing systems include not only the System 820/35 described in this report but also the System 840/25 and 840/35 terminal and accounting computers and the System 880/45 and 880/55 disc processing computers.

Unlike the customers of most competing keyboard-oriented small business computers, no Nixdorf System 820 user has ever had to redesign procedures or rewrite applications programs to upgrade to a larger and more powerful model. Entry-level users choosing between System 820/15 and one of its many competitors are offered higher top cover by Nixdorf than by any other manufacturer. The Burroughs L series is the only competing system to offer upward compatibility over the whole program and data store size range of the System 820/15 and 820/35, but even Burroughs does not offer full compatibility between its L series and its disc processing B 700 series.

These advantages have their trade-offs. To maintain full compatibility with the earliest System 820 models of the mid-sixties, Nixdorf has had to remain faithful to an outdated fixed data word structure of 14 or 15 decimal digits with sign and to plug-in ROM cassettes for most user as well as systems programs. This is far less flexible than the character or byte addressability, variable data word length, and stored user programs that are features of the more recently designed Kienzle 5000, 5600, and 6000, LogAbax LX 4100 and LX 4200, NCR 399, Triumph-Adler TA 1000 series, and Wagner WAC 40.

CONFIGURATION GUIDE

All Nixdorf System 820 computers comprise a keyboard, printer, and processor integrated into a common console. Current models offer a choice of console printers, between the previously standard golfball printer (15.6 characters per second) and the new 50 character-per-second matrix printer. Systems with either type of console printer can support a magnetic ledger card processing unit and/or a number of other I/O peripheral subsystems. Systems 820/15 and 820/35 differ primarily in the size of the read-only and core memories and the optional peripheral devices that are available. There are also differences between the combinations of memory and peripherals supported by the operating systems. See Table 1.

Magnetic Ledger Card (MLC) Processing

The basic MLC unit on any System 820 relies on hand-fed insertion of the MLC cards by the operator. When the cards have been inserted into the feed, stripe reading and line finding then become automatic.

All MLC units can also be upgraded to a new automatic card feed that relieves the operator of manual feeding; it feeds MLC cards automatically from an input stack as soon as the previously processed card has been ejected. Peak feeding rate is 20 cards per minute.

This new MLC card feed is not the high-speed magnetic ledger card reader that has been available for some time on System 820/35 and on some 820/15 configurations. The older unit feeds cards at 42 cards per minute, but it reads them for listing purposes only; it cannot update the data on the stripe.

Program Memory

A peculiarity of System 820 is that user applications programs are held primarily on exchangeable plug-in ROM (read-only memory) boards. A System 820/15 can be fitted with one 2K- or 4K-instruction "macroprogram" ROM board at a time; a System 820/35 can hold up to four boards for a total of 16K instructions. Users of either system can order as many boards as needed to hold the applications program library.

In addition to the exchangeable macroprogram ROM boards for user programs, there are also fixed microprogram ROM boards for system software, including I/O driver modules. System 820/15 has a fixed microprogram ROM capacity of 4,096 instructions. Any microprogram capacity not used by I/O driver modules is available for applications program subroutines, so the smaller the configuration the larger the ROM capacity available for user applications programs. This is not the case on System 820/35, where the microprogram ROM is always used exclusively by systems programs. The number of I/O driver modules merely determines whether the mainframe is equipped with 4K- or 6K-instruction capacity; 2K instructions can be added to hold the MONITOR or 6K to hold the assembler and the MONITOR.

Table 1. Nixdorf Systems 820/15 and 820/35: System Configuration

	820/15				820/35
SYSTEM					
Processor Chassis	3505	3505	3505	3505	3502
Operating System	MFA 1 or MFAGS 1	MFAGS 1A	MFAGS 1A-NDE	FIRM	Any
MEMORY					
ROM Capacity (18-bit instr)	6K to 8K	6K to 8K	6K to 8K	8K	6K to 28K
Basic Op System	2,144	2,141	2,196	4,096(1)	4,096
Opt I/O Driver Modules	326 to 1,897	507 to 1,902	507 to 1,900	–	2,048
Assembler and/or Monitor	–	–	–	–	2K to 6K
User Applications Programs	3,002 to 6,048	3,001 to 6,051	2,048 to 5,996	4,096(2)	2K to 16K
Core Memory (12-bit words)	256 to 2K*	4K	4K	4K	256 to 16K*
12-bit Scratchpad Registers	32 to 64	160	160	160	32 to 128
18-bit User Instructions	0 to 358	0 to 1,950	0 to 1,950	–	0 to 6K
64-bit Data Words	12 to 252*	123 to 738	123 to 738	738	12 to 1,008*
Maximum User Program Capacity (ROM+Core: 18-bit instr)					
Programs Maximised	6,080	7,494	7,439	4,096(2)	22,528
Data Capacity Maximised	6,048	6,051	5,996	4,096(2)	20,480
CONSOLE PRINTER	Golfball	Golfball	Matrix	Matrix	Either
Speed (cps)	15.6	15.6	50	50	15.6/50
Print Positions/Line	131	131	178	178	131/178
Characters Set	60 / 88	60 / 88	64 / 128	128	88 / 128
Dual Continuous Form Feed	Opt	Opt	Std	Std	Opt/Std
MAGNETIC LEDGER CARD UNIT	Opt*	Opt	Opt	Std	Opt*
2311 Automatic Ledger Card Feed	Opt(3)	Opt(4)	Opt(4)	Opt	Opt
4310 HS MLC Reader (42 cpm)	Opt	–	–	–	Opt
OTHER I/O PERIPHERALS (Opt)					
4130 Card Reader (90 cpm)	1	1(4)	1(4)	–	1/2
4180 Card Punch (50 cols/sec) or 4181 Printing Card Punch	1	1(4)	1(4)	–	1/2
4236 Paper Tape Reader (140 cps)	1(3)	1(5)	1(5)	–	1/2
4290 Paper Tape Punch (15 cps)	1(3)	1(5)	1(5)	–	1/2
5220 Add Serial Printer (15 cps)	–	–	–	–	1(6)
5310 HS Matrix Printer (165 cps)	–	1	1	–	1
6230 MT Cassette Drive (120 cps)	1/2(7)	1/2(5)(7)	–	–	1 to 4(8)
6231 MT Cassette Drive (436 cps)	1/2(7)	1/2(5)(7)	1/2	–	1 to 4(8)
Floppy Disc Drives (256 Kb)	–	–	1 to 4	–	–

Notes:

(1) FIRM Block 0.

(2) FIRM Block 1, comprising applications modules.

(3) The 2311 automatic MLC card feed cannot be combined with 4236 paper tape reader and/or 4290 paper tape punch on System 820/15 running under MFA 1 or MFAGS 1.

(4) The 2311 automatic ledger card feed cannot be combined with 4130 card reader and/or 4180 or 4181 card punch on System 820/15 running under MFAGS 1A or MFAGS 1A-NDE.

(5) Paper tape and MT cassette I/O facilities are mutually exclusive on System 820/15 running under MFAGS 1A or MFAGS 1A-NDE.

(6) Second serial printer can be connected only to System 820/35 with the golfball main console printer.

(7) 6230 and 6231 MT cassette drives are mutually exclusive on System 820/15.

(8) Up to four MT cassette drives can be connected to System 820/35; either all of one model or two of each.

** Magnetic Ledger Card processing systems require a minimum data storage capacity of 28 data words, and thus a core memory of at least 512 12-bit words.*

In addition to the programs in ROM, some user program overlays can also be held in core memory on systems equipped with at least one MT cassette drive or a paper tape reader. On System 820/15, the more core memory used by stored programs the less available for data. On System 820/35, on the other hand, the first 256 to 4K words (12-bit) core module is always reserved for data, and the third and/or fourth core modules can only be used for stored program instructions. Only the second 4K-word core module can be shared between data and stored program instructions. Maximum System 820/35 capacity is 22,528 instructions (ROM + core) and 496 data words if the second core module is used for program instructions, or 20,480 instructions and 1,008 data words if the second core module is used entirely for data.

COMPATIBILITY

Systems 820/15 and 820/35 are fully program and data compatible with each other and with earlier Models 820/10, 820/20, 820/25, and 820/30. They are also compatible with versions of the System 820 marketed by other companies under other labels. These include the former Kienzle System 800 and Ruf Praetor Mark I, as well as the current Ruf Datensystem Series 70.

Nixdorf offers System 820/15 and 820/35 users fully compatible upgrading paths to the System 840/25 and 840/35 terminal and accounting computers and to the System 880/45 and 880/55 disc processing computers.

Systems 820/15 and 820/35 can exchange data with any other Nixdorf system on magnetic tape cassettes. They can exchange data with other manufacturers' computer systems, including medium-size general-purpose EDP systems such as the IBM System/360 and 370, on 80-column cards or 8-track paper tape.

MAINFRAME

System 820 mainframe architecture has remained basically the same since the system was launched in 1965, but periodic improvements have been made to take advantage of changing technology. The same architecture is also used in System 720 intelligent terminals, System 840 communications-oriented processing systems, and System 880/45 and 880/55 disc processing systems.

Evolution

The original System 820 of 1965 was a second generation system restricted to firmwired ROM boards for user programs and up to 256 data words of core memory. Originally sold exclusively OEM, it was known by end users under the labels Kienzle System 800, Ruf Praetor, and Wanderer Logatronic. In 1968, Nixdorf started marketing it direct to end users under the System 820/10 label. At the same time, Systems 820/20 and 820/30 were launched; these systems could have up to 1K data words of core storage; and paper tape and 80-column card I/O facilities were optional.

In 1970, the original Systems 820/15, 820/25, and 820/35 replaced the earlier 820/10, /20, and /30 models. Redesigned on the basis of third-generation IC technology, the new systems optionally stored program facilities in core in addition to macroprogram ROM boards for user programs and optional MT cassette drives.

In 1972, Nixdorf introduced the System 840 dual-purpose terminal and local processing computers, based on the 3502, 3505, and 3506 processor chassis introduced at the same time. The 840 offered a wider choice of peripherals including a choice of console printers, operating at 15 or 50 characters per second.

In 1974, Nixdorf reengineered Systems 820/15 and 820/35 on the basis of the 3505 and 3502 chassis and offered the same choice of console printers as on the System 840. A new operating system supported the data storage provided by the 4K-word (12 bits) core memory modules. This also allowed the System 820/15 to replace System 820/25 in Nixdorf marketing.

In 1975, Nixdorf will deliver System 820/15 configurations with floppy disc backing storage. Table 2 lists the mainframe characteristics.

Central Processor

All System 820 models use an identical central processor design. This is modular divided into five types of standard functional units plus a power supply:

- Arithmetic and logical processor.
- Microprogram storage.
- Macroprogram storage.
- Magnetic core storage.
- I/O channels.
- Power supply.

These various units plug into a common chassis mounted into a desk. Peripherals are located either on top of the chassis or in the immediate vicinity.

Five chassis are in current production; two are used on current System 820 direct accounting computers. System 820/15 uses the new 3505 chassis, also used for the System 720 intelligent data entry terminals. System 820/35 uses the 3502 chassis, also used for the System 840/35 terminal and accounting computer.

Data Structure

The data structure is quite complex. All processing of user data is in decimal, and the smallest unit of data for most operations is the 4-bit digit. Some binary bit manipulation instructions, however, notably shifts, addresses, and index register incrementation, use binary arithmetic.

Decimal digits are never directly addressable; they can be addressed indirectly by field selection within a word. Within the scratchpad store at the beginning of the core store, the smallest addressable units are 64, 128, or 160

Table 2. Nixdorf Systems 820/15 and 820/35: Mainframe Characteristics

SYSTEM	820/15	820/35
CENTRAL PROCESSOR	3505	3502
No. of Internal Registers	32-160	32-128
Index Registers	8	8
Addressing		
Direct	2K instructions, 738 data words	2K instructions, 1K data words
Indirect	6K instructions	16K instructions
Indexed	Yes	Yes
Instruction Set	64 basic; 200 assembler	64 basic; 200 assembler
Decimal Arithmetic	Std	Std
Priority Interrupt System	None	None
MAIN MEMORY		
Type	Core	Core
Cycle Time (μsec)	2.5	2.5
Basic Addressable Unit	18-bit instruction, 64-bit data word	18-bit instruction, 64-bit data word
Bytes/Access	1 (12-bit)	1 (12-bit)
Min Capacity (bytes)	256 (4-bit)	256 (4-bit)
Max Capacity (bytes)	4K (12-bit)	16K (12-bit)
Increment size	256 to 2K (12-bit)	256 to 2K (12-bit)
Parity	None	None
ROM	Micro/macpro-gram	Micro/macpro-gram
Use	Op system/user programs	Op system/user programs
Capacity (instruct)	4K/2K to 4K	4K to 12K/2K to 16K
I/O CHANNELS	1 to 5	1 to 7
Programmed I/O	Yes	Yes
DMA Channels	1 opt (disc)	–
Multiplexed I/O	1 max (card/PT I/O)	1 max (card/PT I/O)
Max Transfer Rate (bytes/sec)		
Within Memory	400K	400K
Over DMA	30K	30K

12-bit registers including accumulator; accumulator extension; five index registers used frequently as working registers; and buffer registers for the keyboard, serial printer, and second serial printer (when present). The 12-bit register length is determined by the 12-bit width of the parallel adder in the arithmetic and logical processor.

Outside the scratchpad store, data in the remainder of the core is addressable in 64-bit words, which normally represent 15 4-bit decimal digits and a 4-bit sign. They can also represent a 14-digit number with sign and store reservation tag, when it is considered necessary to protect the store areas of each program against accidental interference by other programs concurrently in the processor.

Alphanumeric data can be represented in either of two codes: 6-bit BCD characters held two per scratchpad register, 10 per 64-bit word leaving four bits for the store reservation tag if used, and three per 18-bit instruction word in the firm-wired macroprogram store. Alternatively, they can also be represented as 8-bit EBCDIC bytes, held eight per 64-bit word with no space for store reservation tags, or one per 12-bit register with four bits unused.

All program instructions are 18 bits long. These are mainly held in the firm-wired microprogram and macroprogram stores and are therefore organized in 18-bit addressable words, which can hold three alphanumeric 6-bit character constants. Current computer models can also hold instructions in core store outside the scratchpad area, in which case each 18-bit instruction occupies five 4-bit digit positions; the last two bits are unused.

Special Registers

In addition to eight index registers, the scratchpad store also contains one instruction counter, five subroutine counters, line counters, and testable indicators.

The first five 64-bit words of store are used as follows:

- Numeric keyboard buffer, for input data entered on the numeric keyboard.
- Numeric output buffer for data going to the console printer.
- Numeric output buffer for data going to the second printer.
- Accumulator.
- Overflow of arithmetic operations.

Addressing Facilities

The System 820 addressing structure is as complex as its data structure. In principle, each 18-bit instruction is divided into a 6-bit function code, a 1-bit indexing indicator, and an 11-bit address field. Depending on the type of instruction, the 11-bit address field can contain either a single 11-bit address A; three addresses AD (three bits), ADm (four bits), and ADr (four bits); or two addresses, which are either a 3-bit AD address and an 8-bit combination of ADm and ADr, or a 7-bit combination of AD and ADm and a 4-bit ADr address.

A 3-bit AD address normally references one of eight index registers in the scratchpad store. All can be used as working registers when not used for address modification; these are 12 bits long. When used as address modifiers, the first bit is an indexing indicator (if set the contents of the index register is subject to modification) and the remaining 11 bits modify the 11-bit address field of the instruction whether that address field contains one, two, or three separate addresses.

Four-bit, 7-bit, and 8-bit addresses normally address the 16, 128, or 256 low-order words in core store. An 11-bit address can reference any one of the 2,048 words of a fully expanded 4-module core store of an 820/35 accounting computer, or one of the 2,048 instructions of a macroprogram circuit board.

Although complex, this addressing structure certainly permits optimal programming to save store space. The normal way of programming a System 820 is to initiate any subroutine by fetching a data word from any part of core by means of a single-address fetch instruction, and then to manipulate the word within the eight 12-bit working registers or 10 to 128 lowest numbered words of the core store by means of 2- or 3-address arithmetic and logical instructions, before storing the result in core by means of a single-address store instruction.

Instruction Set

The instruction set is not limited to 64 instructions as might be expected with a 6-bit op code. In some instructions the three bits of AD1 are used as a modifier to generate as many as eight specific instructions from the general instructions given in the 6-bit op code. In addition, ADm and ADr may be used for op-code modification with instructions that do not require core or index register addressing, namely, those involved in peripheral control. It is difficult to decide what is an "instruction" in such a system, but there are over 200 combinations of symbolic op codes based on the 64 basic op codes.

Basically the instruction set is oriented toward words, but there are also instructions for doubleword, character, and bit manipulation. Decimal arithmetic is primary, but some binary operations are possible; and the index registers are binary. Floating-point arithmetic is handled by software. In addition to data movement, arithmetic, comparisons, indicator setting and testing, branches, and index register usage instructions, there is a wide variety of editing instructions.

Execution times are noted in Table 3. Arithmetic operations are based on times for 13-digit operands. All times are in milliseconds.

Interrupt Control

The scratchpad store of every System 820 processor contains a number of testable indicators. The microprogram controlling the I/O channel to which peripherals are attached sets one of these indicators when an external peripheral sends an interrupt signal. It is then up to the operating system or the user program to test indicators at specified intervals.

MAIN MEMORY

System 820 mainframes have three memory levels: microprogram ROM, macroprogram ROM, and read/write core memory. Table 4 lists memory characteristics.

Table 3. Execution Times

Type of Operation	Execution Time (msec)
Addition/Subtraction	2.25
Multiplication	80
Division	125
Branches (all)	0.75
Move (core to index register)	2
Move (core to core – 64 bits)	2.25

Read-Only Memory (ROM)

Both microprogram and macroprogram stores are firm-wired ROMs with a 2-microsecond cycle time per 18-bit instruction. Up to 2,048 instructions can be wired at the Nixdorf factory on each circuit board, 8 by 11 inches, and one or two boards can be mounted on a program module. The two types of ROM differ only in the programs they store.

Microprogram

ROMS are intended primarily to store the microsteps that implement the main user instruction set, I/O control programs, and main core memory fetch and store sequences. These microprograms are normally fixed permanently at the factory, although they can be modified by maintenance engineers. The amount of ROM required by the operating system for a configuration is determined by the number of optional I/O modules included. On System 820/35 the size can vary from a minimum of 4K to a maximum of 12K instructions in 2K-instruction increments.

On the other hand, System 820/15 always includes a 4K-instruction ROM. Space not required for optional I/O modules can be used for user applications programs or subroutines; thus, the smaller the configuration, the larger this spare space will be. User programs in microprogram store are also fixed permanently at the factory, thus the most general-purpose subroutines should be stored in it. Table 5 lists the amount of microprogram store space required by the various I/O driver modules.

Macroprogram

ROMS are intended mainly for user applications programs and are thus built as exchangeable plug-in cassettes.

Core Memory

Core memory can be used either wholly for data or for data and stored user program instructions.

System 820/15 can support only one core memory module. When the configuration includes the golfball console printer and no auxiliary printer, any of the models listed in Table 4 can be used. Systems equipped with a console printer (50 characters per second) and/or an auxiliary printer must use the 4K-word Model 1607 core

Table 4. Nixdorf Systems 820: Memories

Model No.	Type	Cycle Time µsec	Width of Access (bits)	Capacity Store Words	Instructions (18-bit)	Data Words(1) (64-bit)
380	ROM	2.0	18	4,096	4,096	–
381	ROM	2.0	18	2,048	2,048	–
160	Core	2.5	4	256	–	16
1604	Core	2.5	12	512	0 to 50* +	16 to 32
1605	Core	2.5	12	1,024	0 to 144* +	16 to 64
1606	Core	2.5	12	2,048	0 to 358* +	16 to 128
1607	Core	2.5	12	4,096 (820/15)	0 to 1,950 +	123 to 738
				(820/35)	0 to 2,048 +	0 to 512

Notes:
(1) Including the working registers.
** Models 1604, 1605, and 1606 core modules can be used to store programs only on System 820/15 configurations with golfball console printer. Programs can be stored only in that part of the module beyond the first 256 words reserved for data storage.*

Table 5. Nixdorf Systems 820/15 and 820/35: Use of Microprogram ROM

SYSTEM	820/15				820/35
Operating System	MFA 1 or MFAGS 1	MFAGS 1A	MFAGS 1A-NDE	FIRM	Any
No. of Instructions (18-bit) in:					
Basic Operating System, incl Console I/O	2,144	2,141	2,196	4,096	4,096
General I/O (reqrd for any additional peripherals)	72	245	245	*	*
MT Cassette (120/40 cps)	453(2)	541(2)	–	–	(1)
MT Cassette (436 cps)	254(2)	262(2)	262(2)	–	(1)
Magnetic Ledger Card Unit	404	412	412	*	2,048(1)
MLC Unit with Read-after-Write	468	–	–	–	*
Automatic Ledger Card Front-Feed	50	52	–	–	*
Automatic MLC Card Feed	NA(3)	NA(4)	NA(4)	*	*
Card Reader and/or Punch I/O	524	532(4)	532(4)	–	*
Paper Tape Reader, Punch I/O	529(3)	538(2)	538(2)	–	*
HS Auxiliary Printer (165 cps)	–	231	231	–	*
Assembler Board	–	–	–	–	4,096
MONITOR Board	–	–	–	–	2,048
Total ROM Capacity Reqrd for System Software	2,144 to 4,041	2,141 to 4,043	2,196 to 4,096	4,096	4,096 to 12,288
leaving for: User Applications Programs	55 to 1,952	53 to 1,955	0 to 1,955	0	0
Total Microprogram ROM	4,096	4,096	4,096	4,096	4,096 to 12,288

Notes:
** This I/O module is included in another entry.*
(1) The basic System 820/35 4K-instruction operating system can include I/O drivers for the paper tape punch and either the MLC processing unit or one MT cassette system. If both MT cassettes and an MLC processing unit or any other I/O peripherals are connected to a System 820/35, the operating system ROM must be extended by 2K instructions.
(2), (3), and (4) Mutually exclusive I/O driver modules. Each operating system can include only one module marked (2), one marked (3), and/or one marked (4).

module. The first 256 words (4- or 12-bit) on each core module are always reserved for data; the remainder can be freely divided between data and program instructions, except on Model 1607 where a rather more sophisticated method of dividing space is used.

System 820/35 can be equipped with up to four core memory modules. The first is always reserved for data; it can be any of the Models 160 to 1607 listed in Table 4. The optional second, third, and fourth modules must always be 4K-word Model 1607. The second module can be freely divided between program instructions and data. The third and fourth modules can only be used to hold stored programs.

The first 32 to 80 12-bit words of each core memory module are used as 12-bit scratchpad registers; the exact number depends on the number of I/O modules incorporated in the operating system and the scratchpad space each requires. Apart from this scratchpad area, the remaining 12-bit words of each Model 1604, 1605, or 1606 core module are used to store 4-bit digits, eight bits of each word remaining unused. Groups of 16 consecutive 4-bit digits are chained together to form 64-bit data words, and groups of five consecutive digits hold 18-bit instructions.

Model 1607 is used more economically. On System 820/35, eight bits of each 12-bit word store two 4-bit digits: thus chains of eight consecutive words can hold a 64-bit data word. Program instructions require only two words: the first word stores the 6-bit function code, and the remaining six bits remain unused; the second word stores the 12-bit address portion.

On System 820/15, Model 1607 is used in an even more sophisticated manner. The first and last 80 words are used as a 160-register scratchpad memory. The remainder of the module is divided into a "low-order" memory of 1,968 words and a "high-order" memory of 1,968 words. Low-order words are divided into 8-bit and 4-bit rows. The 4-bit rows are always chained together to form 123 data words, the minimum data capacity of 4K-word System 820/15s. The low-order 8-bit rows and the high-order words can be chained in pairs to hold 1,968 program instructions or can be chained in groups of eight to hold up to 615 data words for a combined maximum of 738 data words per System 820/15.

Input/Output Control

A console keyboard and printer are standard on every System 820. The standard operating system microprogram includes input and output routines for these two devices. It transfers input characters to the user macroprogram one character at a time and accepts individual output characters from the user program. User programs are thus responsible for assembling input characters into messages and serializing output messages.

All other peripherals are optional and must connect to one of the external channels listed in Table 6. These are I/O control cards holding device interfaces and address diodes. They interface with optional I/O modules in the operating system microprogram.

Channel 184 is a multiplexor for character-serial I/O devices. It can control either any combination of card reader, card punch, and paper tape/edge-punched card reader and punch, or an auxiliary printer (System 820/35 only). It transfers input characters singly to the user macroprogram and accepts single output characters from it. This allows it to multiplex I/O transfers to/from all the devices connected to it.

All other channels input or output a complete message block in or out of the main core memory. Each channel is therefore specialized to control one type of device, and can transfer only data to/from one device at a time.

Console

The System 820 console is the main input medium for variable transaction data as well as operating instructions. Source programs and alphanumeric text are entered on a normal typewriter keyboard in QWERTZ, AZERTY, or any other national layout. All-numeric data can be entered directly from a 12-key numeric keypad for fast

Table 6. Nixdorf Systems 820/15 and 820/35: I/O Channels

TYPE	Channel Devices Controlled by Each Channel	No. of Channels of This Type Connected to System 820/15	820/35
184	Any Combination of: 4130 Card Reader, 4180 or 4181 Card Punch, 4236 Paper Tape Reader, 4290 Paper Tape Punch	1	1 to 2
	or		
	5220 Second Serial Printer Alone	–	1
186	Magnetic Ledger Card Processing Unit with or without 2311 Automatic MLC Card Feed as well as 4310 HS MLC Card Reader (when reqrd)	1	1
310	1 or 2 MT Cassette Drives (120/40 cps)	1	1 to 2
or	or	or	
318	1 or 2 MT Cassette Drives (436 cps)	1	1 to 2
333	H.S. Auxiliary Printer (165 cps)	1	1
	Maximum Total Number of I/O Channels	4	6

single-handed operation. There are also 29 function keys for program selection and operating control. The user macroprogram determines the meaning of some of these keys.

System 820 consoles are equipped with either of two output printers described in the PERIPHERALS section.

PERIPHERALS

Table 1 lists the standard and optional peripheral devices available on Systems 820/15 and 820/35.

Slow-Speed Peripherals

A console keyboard and printer are standard. Optional additional slow-speed peripherals include 80-column card and paper tape readers and punches. System 820/35 can also support a second printer.

Printers. Two console printers are available. The first uses an IBM 725 Selectric typewriter mechanism with moving exchangeable golfball printhead holding 88 distinct printable characters. An independent electronically controlled tabulating mechanism allows skipping at up to 150 print positions per second. Average printing and skipping rate for ordinary invoices and accounts is 40 positions per second.

The second console printer is a matrix printer that can print 60 characters (including uppercase alphabetics only) in a 7 by 5 dot matrix or 128 characters in a 9 by 9 dot matrix. Continuous printing and skipping speed (in any combination) is 50 characters per second; maximum line width is 178 print positions.

A dual continuous stationery feed with independent programmed advance is standard on the matrix printer, optional on the golfball printer. Magnetic ledger processing facilities can also be factory-installed to either type of console.

System 820/35 computers can also support an auxiliary printer: a golfball printer similar to the console printer or a high-speed Centronics matrix printer (165 characters per second). The Centronics printer can also be connected to 80/15 systems with 4K-word core memory.

Cards. One card reader and two punches are available. The punch can be an ordinary one or a printing punch that interprets cards simultaneously with punching.

Paper Tape. The paper tape reader and punch can handle not only 5- to 8-track paper tape but also cards edge-punched in 8-track paper tape code.

Magnetic Tape. The cassette drives record data bit-serially on 0.25-inch ECMA standard cassette tape at 800 bits per inch and 11 bits per byte in variable length blocks of three to 512 bytes. Two models are available: 6230 Drives read data at 120 bytes per second and record it at 40 bytes per second; they connect to the Type 310 I/O channel. These drives cannot be connected to System 820/15 configurations with the console matrix printer. The alternative 6231 Drives are controlled by the Model 318 I/O channel; they read and write data at 436 bytes per second.

Discs. Floppy disc drives will be available on 820/15 systems with a console matrix printer from the beginning of 1975. Data is recorded bit-serially at 30,000 bytes per second in fixed-length 256-byte sectors on 64 data tracks of an exchangeable floppy disc. Up to 32 sectors can be recorded on each track, giving a total disc capacity of 256K bytes. Up to four floppy disc drives can be connected to a common DMA disc channel, giving System 820/15 a maximum combined on-line backing storage capacity of one million bytes.

Magnetic Stripe Ledger Cards (MLC). The golfball printer console can include a factory installed Model 714 or 715 Magnetic Ledger Card (MLC) processing unit. Model 714 has a single card feeding mechanism. Model 715 has two independently controlled chutes that allow simultaneous handling of two adjacent, consecutive, or overlapping cards. The matrix printer console can include the wide carriage Model 718 MLC unit, which offers the same facilities as Model 715.

The standard version of each model relies on manual card input, with subsequent automatic line finding. A new automatic card feed that can feed up to 19 ledger cards per minute is optional.

System 820/15 computers with golfball console printers and System 820/35 computers can also include a 4310 high-speed Magnetic Card Reader connected to the same Type 186 I/O channel as the main MLC processing unit. This can read up to 42 stacked MLC cards per minute for listing purposes but it cannot update the stripes.

The MLC cards are 5.8 to 14.9 inches wide with a magnetic stripe on each side. Each stripe can store 1,024 4-bit numeric digits, 768 6-bit alphanumeric characters, 512 8-bit bytes, or any mixture of these data types.

SOFTWARE

Software support is a major Nixdorf sales point. The firm is prepared to write and test all the programs any customer needs. This allows small or medium-sized firms to install a system without employing an expensive staff of systems analysts and programmers. The only operator a System 820 requires is a qualified secretary who traditionally operates the invoicing or accounting machine in small European, especially German, firms.

Nixdorf applications programming support is unbundled. For System 820/15 users, however, programming charges will be small, if their programming requirements can be met by any combination of program modules in the standard FIRM accounting package. A questionnaire programming technique is used to select and link-edit the required modules.

For customers with less standardized applications, Nixdorf also offers a selection of free-form programming languages.

Operating System

Nixdorf supplies an operating system in the microprogram store of every System 820 processor. This is tailored to the particular System 820 peripheral configuration, although it normally consists of a number of standard modules. The operating system is responsible for the control of all peripheral operations at the request of the user program and thus plays the role of the supervisor or executive in larger EDP systems.

Languages

Nixdorf offers two free-form programming languages to System 820/15 and 820/35 users: assembler and KEYBOL. Because of their main store space requirements the assembler compiler and program testing monitor can run only on System 820/35. System 820/15 users who write their own assembler or KEYBOL programs must have them compiled and tested at the nearest Nixdorf customer support centre. All users depend on Nixdorf for wiring fully tested object programs on macroprogram ROM cassette boards.

Assembler. Nixdorf Assembler is a mnemonic language that supports symbolic addressing. It requires two passes for assembly. Program addresses are computed, but symbolic data addresses must be assigned at assembly time. I/O areas are not fixed, except for console numeric data, but are assigned in the program.

Because there are six instruction counters on the 820, a main program and five nested subprogram levels can be simultaneously maintained. Data can be in 6- or 8-bit code as well as 4-bit digits.

KEYBOL. KEYBoard Oriented Language is a version of ANSCII Cobol adapted to the requirements of a keyboard-oriented small business computer that has been developed and tested in Germany.

Applications Packages

The main applications package for System 820/15 magnetic ledger processing systems is the FIRM modular accounting and management information system. This is a series of program modules for order entry, invoicing, sales ledger, stock recording and control, materials scheduling, purchase ledger, production scheduling, production control, payroll, general ledger, and branches of statistics required by management. System 820/15 users can select any required combination of modules, which can be adapted to their own requirements by filling in standard Nixdorf questionnaires, which are input to a standard Nixdorf FIRM program generator at the nearest customer centre.

There is also a modular programmed instruction system for use with audio-visual education, geared particularly to users of the Bakkalaureus multiterminal teaching system based on the System 820/35 processor.

Utilities include a cassette tape sort/merge program. These standard utilities and programs are used by Nixdorf programming staffs when programming custom-made user programs.

HEADQUARTERS

Nixdorf Computer AG
4790 Paderborn, West Germany
Ponanusstrasse 55

PRICE DATA

Model No.	Description	Monthly Rental DM	Purchase DM	Monthly Maint. DM
820/15	Basic Invoicing/Accounting System comprising: 3505 chassis with processor, console with *15.6 cps golfball printer*, 4K microprogram ROM incl MFA 1, MFAGS 1, or MFAGS 1A operating system, 2K instruction macroprogram ROM board, and			
160	Core memory: 256 x 4-bit words	903	29,154	174
1604	512 x 12-bit words	1,102	35,553	213
1605	1 K 12-bit words	1,204	40,024	240
1606	2 K 12-bit words	1,325	42,753	256
1607	4 K 12-bit words	1,381	44,553	267
	Options:			
	Dual Continuous Form Feed	157	5,062	30
	Ledger Card Front Feed	84	2,715	16
	Magnetic Ledger Card Processing Unit	573	18,500	111
820/15	Basic Invoicing/Accounting System comprising: 3505 chassis with processor, console with *50 cps matrix printer*, 4K microprogram ROM incl MFAGS 1A-NDE operating system, 2K instruction mcaroprogram ROM board, and			
1607	Core memory: 4K 12-bit words	1,653	53,330	320

PRICE DATA (Contd.)

Model No.	Description	Monthly Rental DM	Purchase DM	Monthly Maint. DM
	Options: (Contd.)			
820/15	Magnetic Ledger Accounting System comprising: 3505 chassis with processor, console with *50 cps matrix printer* dual continuous form feed and magnetic ledger card processing unit, 4K microprogram ROM incl MFAGS 1A-NDE operating system, 2K instruction macroprogram ROM board, and			
1607	Core memory: 4K 12-bit words	2,226	71,830	431
FIRM	Integrated Accounting Software Package, including the following modules, also available separately:	–	12,000	–
	General Ledger – Basic programs	–	3,000	–
	– Opt programs	–	1,000	–
	Payroll – Basic programs	–	3,000	–
	– Opt programs	–	1,000	–
	Invoicing/Inventory Control – Basic Programs	–	3,000	–
	Production Control – Opt Programs	–	1,000	–
820/35	Basic Invoicing/Accounting System comprising: 3502 chassis with processor, console with *15.6 cps golfball printer*, 4K microprogram ROM incl operating system, 2K instruction macroprogram ROM board, and			
160	Core memory: 256 x 4-bit words	1,239	39,998	240
1604	512 x 12-bit words	1,438	46,397	278
1605	1 K 12-bit words	1,576	50,868	305
1606	2 K 12-bit words	1,661	53,597	321
1607	4 K 12-bit words	1,717	55,397	332
	Options:			
	Dual Continuous Forms Feed	76	2,475	14
	Ledger Card Front Feed	84	2,715	16
	50 cps matrix printer for console instead of 15.6 cps golfball printer, including standard dual continuous form feed	191	6,190	37
	Front form feed for 50-cps console printer	99	3,200	19
	Magnetic Ledger Card Processing Unit for either type of console (15.6 or 50 cps)	798	25,750	154
402	Switching Unit (reqrd when some programs are obeyed from core)	42	1,365	8
	Additional Microprogram ROM Boards:			
	2K Instructions	206	6,650	39
	4K Instructions	412	13,300	79
	Additional Core Memory Modules (max 3)			
1607	Core Memory: 4K 12-bit words	511	16,500	99
820/15 & 820/35	Options common to both systems:			
380	4K instruction macroprogram ROM board instead of 2K instruction board	93	3,000	18
380	Additional 4K instruction macroprogram ROM	269	8,700	52
381	Additional 2K instruction macroprogram ROM	176	5,700	34
2311	Automatic Magnetic Ledger Card Feed	193	5,850	46
4310	HS Magnetic Ledger Card Reader (for listing)	494	9,998	120
	Additional I/O Channels and Peripherals:			
184	Serial I/O Multiplexor Channel	89	2,890	17
4130	Card Reader, 80-col (ICL code) incl cable	232	7,085	55
4130	Card Reader, 80-col (IBM code) incl cable	239	7,300	56
4180	Card Punch, 80-col, incl cable	678	20,600	163
4181	Printing Card Punch, 80-col, incl cable	818	24,825	197
4236	Paper Tape Reader, incl spooler & cable	225	6,882	[illegible]
4290	Paper Tape Punch, incl spooler & cable	264	8,542	[illegible]
5220	Second Serial 15.6 cps Printer (820/35 only) incl own channel 184, cable, console with dual continuous form feed	397	12,584	82
		449	14,275	93
5310	HS Auxiliary Printer, 165 cps, incl channel 333, cable, console	584	18,900	111
6230	Magnetic Tape Cassette reader (120 cps) incl channel 310, and cable	245	7,905	47
	Addt 1 MT cassette drive for recording 40 cps	144	4,650	27
6231	Magnetic Tape Cassette drive (436 cps) incl channel 318, and cable	276	8,905	53
	Second MT cassette drive (436 cps)	175	5,650	33

Notes:

Prices listed are West German domestic prices excluding Value Added Tax, valid in April 1974. Prices in other European countries are not necessarily the equivalents at current exchange rates; Nixdorf has pursued a policy of price stability in all countries despite the changing exchange rates between the DM and other European currencies.

For comparison purposes with other small business computers priced in dollars, the above DM prices should be converted at the current rate of DM 1.00 = $0.40. The indicated monthly rentals are for systems rented on a 1-year contract; 3- and 5-year contracts are also available. Monthly rentals are 6 percent lower on 3-year contracts and 12 percent lower on 5-year contracts. Maintenance is included in rentals in all cases.

OVERVIEW

Nixdorf System 840 is a family of three keyboard-oriented, visible-record, small business computers that can be used simultaneously as intelligent interactive or remote batch terminals to a Nixdorf System 880 or 900, Telefunken TR 440, or other medium to large EDP system located at the same or a remote site. System 840 can be linked by a 50 to 1,200 bit-per-second asynchronous or a synchronous data communications line.

Nixdorf System 840 was announced in West Germany in April 1972 and is due to be released in other Western European markets as soon as local support staffs have been trained, which is expected in most cases to be by early autumn 1972. It is being marketed among both novice and experienced visible record computer users, especially users of System 820/15 to 820/35 direct accounting computers, who require a greater variety of input/output or file handling peripherals and/or on-line terminal processing facilities additional to their own on-site processing facilities.

The three systems announced in April 1972 — Systems 840/15, 840/25, and 840/35 — use the same processor and offer user program store and data store capacities comparable to the well-known System 820/15, 820/25, and 820/35 direct accounting computers. These capacities range from 4K to 22K user program instructions, and from 16 to 1,024 data words of 15 decimal digits and sign. Each 840 model, however, can handle a greater number and a greater variety of input/output peripherals.

The main input medium of System 840 computers is an alphanumeric and numeric/functional keyboard; the main output medium is a serial console printer. System 840 users are offered a choice, however, between the same golfball printer (15.8 characters per second) available on System 820 computers and a new 50 character-per-second dot-matrix printer with up to 178 print positions per line.

The console of all three systems can be optionally equipped with a magnetic ledger card processing unit able to read/record up to 1,024 decimal digits or 768 alphanumeric characters on each card. Other optional input facilities include the same 80-column card and paper tape readers and punches, quarter-inch magnetic tape cassettes, and 165 character-per-second fast matrix printer which are also available on System 820/15, 820/25, and 820/35 direct accounting computers. In addition, System 840 computers offer optional optical character and mark recognition readers, industry-compatible magnetic tape drives, a 256-character alphanumeric display, and a 300 line-per-minute line printer. Industry-compatible exchangeable disc drives cannot be connected directly to System 840 computers, but can be accessed indirectly via a System 880/65, or 900 computer to which any System 840 computer can be connected as an on-line terminal.

Any system 840 computer can be connected to the following devices, either locally or via 1,200 bit-per-second synchronous data communications lines: a Nixdorf System 880/65, System 900, or Telefunken TR 440 computer system; a Nixdorf System 820/51 off-line communications controller; or any medium or large EDP system front-ended by a Nixdorf System 820/52, 820/53, or 820/54 communications controller. System 840 computers can also be connected directly to any EDP system on the market via asynchronous/synchronous 50 to 1,200 bit-per-second data communications lines.

The wide variety of input/output peripherals available on System 840 enables these computers to be used either as interactive file enquiry/updating terminals to a larger EDP system, and/or as remote batch terminals that accumulate off-line, transmit by-product results of local processing for further processing by the larger EDP system, and print locally the results of the processing by the larger EDP system. 840's thus combine in a single unit all the processing and terminal features that were previously available only separately on the System 820/15, 820/25, and 820/35 direct accounting computers, the System 820/03/820/04/820/02 interactive alphanumeric printing terminal, the System 820/06 alphanumeric display terminal, and the System 820/55 remote batch Data Station.

Table 1 presents the product specifications for Nixdorf System 840.

CONFIGURATION GUIDE

Nixdorf System 840/15, 840/25, and 840/35 direct accounting computers differ from each other solely in the range of their program and data store sizes and in the number of external input/output channels with which each can be equipped. System 840/15 can have 2K to 6K user program instructions, 16 to 768 data words, and up to three external input/output channels; System 840/25 can have 2K to 12K user program instructions, 512 to 1,536 data words, and four external input/output channels; and System 840/35 can have 2K to 22K user instructions, 512 to 1,536 data words, and up to six external input/output channels.
All three models offer an alphanumeric, numeric,

Table 1. Nixdorf System 840: Specifications

CENTRAL PROCESSOR	
Word Size (bits)	64
Capacity (words)	16-1,024
Cycle time (μsec)	5.0 per 12 bits
Working Storage	Core
AUX STORAGE	Magnetic ledger card; 7-/9-track mag tape; cassette
DATA OUTPUT	
Line Printer (lpm)	300
Serial Printer (cps)	15.8 or 50; 165
Card (cpm)	50 col/sec
Paper Tape (cps)	20
DATA INPUT	
Keyboard	Standard
Card (cpm)	110
Paper Tape (cps)	140
SOFTWARE	
Assembler	Yes
Operating System	Yes (in ROM)
Compiler	KEYBOL (requires 840/35, 880/65, or 900)

and functional keyboard as main input device and a console printer as main output device. The console printer may be either a 15.8 character-per-second serial golfball printer with interchangeable character sets of up to 88 printable characters and with up to 132 print positions per line, or a 50 character-per-second serial dot-matrix printer that prints up to 60 distinct characters as 7 x 5 dot matrices or up to 88 distinct characters as 9 x 9 dot matrices and has up to 128 print positions per line.

The three, four, or six external input/output channels available on 840/15, 840/25, and 840/35 processors respectively for the connection of additional input/output devices can be any combination of channels subject to certain individual maxima. See Table 2 for the maximum number of peripheral devices of each type that may be connected to System 840 processors.

Channel 184 can be used to multiplex up to four character-serial card and/or paper tape I/O devices, including one card reader, one card punch, one paper tape reader, and one paper tape punch. These may be chosen from the following:

- 20031 card reader (80-column), 200 columns per second.
- 20035 paper tape reader (five- to eight-track), 140 characters per second.
- 20090 paper tape punch (five- to eight-track), 20 characters per second.
- 20091 card punch (80-column), 50 columns per second.
- 20092 printing card punch (80-column), 50 columns per second.

Alternatively, Channel 184 may be used to control a single 20817 fast serial matrix printer (165 characters per second) with 60 printable characters and 131 print positions per line.

Channel 186 may control any one of the following:

- 20714 console-mounted, single-feed magnetic account card processing unit.
- 20715 console-mounted, double-feed magnetic account card processing unit.
- 20720 freestanding magnetic account reader that can read up to 60 magnetic ledger cards per minute.

Up to 768 alphanumeric characters or 1,024 decimal digits can be stored on each card stripe.

Either one or two 20611 industry-compatible seven- or nine-track magnetic tape drives (200/556/800 bits per inch) or one 20811 line printer (300 lines per minute, 64 printable characters, 136 print positions per line) can be handled by Channel 317. Also available are a Channel 310 for controlling one or two 20732 magnetic tape cassette units, reading 136 bytes per second and writing 40 bytes per second and a channel 318 for controlling one or two 20733 magnetic tape cassette units that read and write at 400 bytes per second.

For communications capabilities, Channel 323 allows one synchronous 1,200 bit-per-second modem, asynchronous 200 to 1,200 bit-per-second modem, or asynchronous 50 to 200 bit-per-second telegraph line connection. Special-purpose channels may be included for one of each of the following.

Table 2. Nixdorf System 840: Maximum Number of Standard Peripherals

MODEL NUMBER	840/15	840/25	840/35
LOW-SPEED PERIPHERALS			
Card Reader	1	1-2	1-2
Card Punch	1	1-2	1-2
Paper Tape Reader	1	1-2	1-2
Paper Tape Punch	1	1-2	1-2
Second Serial Printer	—	1	1
Line Printer	—	1	1
MAGNETIC STORAGE			
Magnetic Card Read/Write	1	1	1
Magnetic Card Reader	—	—	1
Cassette Drive	1-2	1-4	1-4
Magnetic Tape Drive	—	1-2	1-2

- 213 Alphanumeric Display screen (console-mounted) holding up to 256 characters in eight lines of 32 characters.

- Optical Character Document Reader, reading up to 1,000 OCR-A or OCR-B numeric characters per second from up to 400 documents per minute.

- 4330 Optical Mark Recognition Page Reader, reading up to 75 lines of up to 20 marks per second from up to 25 pages per minute, each holding up to 70 lines.

COMPATIBILITY

In their capacity as independent visible-record and magnetic tape cassette file-processing, invoicing/accounting computers, the Nixdorf Systems 840/15, 840/25, and 840/35 have source-program and data compatibility at the assembler and KEYBOL levels with the less powerful Nixdorf System 820/15, 820/25, and 820/35 direct accounting computers, Nixdorf System 880/55 disc processing system, and Ruf Datensystem Series 70 (within the limitations of each system's program and data store and provided similar configurations cause such program compatibility to be relevant), all of which use the same processor as the System 840 but run under different microprogrammed operating systems. KEYBOL source programs written for a System 840 computer can also be compiled on Nixdorf System 880/65 and System 900 computers which use a different byte-oriented processor design.

In their capacity as on-line interactive and/or remote batch terminals, Systems 840/15, 840/25, and 840/35 can communicate via a Channel 320 with a System 880/85 disc controller at the same site. They can also communicate with any of the following systems at a local or remote site either via a Channel 320, 323, or 327 or via a 1,200 bit-per-second synchronous data communications line in synchronous message mode:

- Nixdorf System 880/65.

- Nixdorf System 900.

- Telefunken TR 440.

- Nixdorf System 820/50 and 820/51 off-line communications controllers and data collection systems.

- Nixdorf System 820/52-54 on-line communications controller for any of the following EDP systems:

  (1) IBM System/360 or 370.

  (2) Honeywell-Bull 200 and 2000 series.

  (3) ICL 1900 series.

  (4) Siemens System/4004.

  (5) Univac 9000 and 1100 series.

  (6) NCR Century Series.

System 840 computers can also communicate in asynchronous start-stop mode via 50 to 200 bit-per-second telegraph lines or 200 to 1,200 bit-per-second asynchronous telephone lines with any EDP system capable of supporting teletypewriters.

SOFTWARE

General

Software support is one of the major Nixdorf sales points. The firm is prepared to write and test all the programs for any of its customers who desire this service, enabling small- or medium-sized firms to install a System 840 invoicing/accounting computer without employing an expensive staff of systems analysts and programmers. The only operator required for a System 840 is the type of qualified secretary that traditionally operates the invoicing or accounting machine in small European, especially German, firms.

At the same time, Nixdorf does not attempt to tie all its customers to its coattails and provides adequate software to permit those who desire it to write their own programs.

Operating System

Nixdorf supplies an operating system in the microprogram store of every System 840 that it delivers to a customer. This is responsible for the control of all peripheral operations at the request of the user program and thus plays the role of the supervisor or executive in larger EDP systems. Each operating system is tailored to the requirements of a particular System 840 peripheral configuration, although it normally consists of a number of standard modules.

Languages

Two programming languages are currently available on the System 840: assembler and KEYBOL.

Nixdorf assembler is a mnemonic language that supports symbolic addressing. It requires two passes for assembly. Program addresses are computed, but symbolic data addresses must be assigned at assembly time. I/O areas are not fixed, except for console numeric data, but are assigned in the program.

Because there are six instruction counters on the 840, a main program and five nested subprogram levels may be simultaneously maintained. Data representation can be in six- or eight-bit code as well as four-bit digits. When in eight-bit code, each character takes two to four bit positions; when in six-bit code, three to four bit positions hold two- to six-bit characters.

An assembler program in microprogram storage assembles a condensed object deck. Storage requirements for this program prevent it from being run on any model but the 840/35. Testing takes place through a monitor program (available on the 840/25 and 35) which works via five special keys on the numeric keyboard. This monitor makes it possible to have stop addresses, to change instructions from the keyboard, and to display contents of memory locations, indicators, index registers, and subroutine counters.

KEYBOL, KEYBoard-Oriented Language, is a version of ANSCII Cobol adapted to the requirements of a keyboard-oriented small business computer that has been developed and tested in Germany.

In general, programs are assembled and tested on machines at Nixdorf centers until they run correctly; then the object program is used to generate wiring diagrams and is wired into macroprogram memory. Programs are maintained on tab cards at Nixdorf centers. When changes are necessary, they are made and tested at the Nixdorf center after which a technician is sent to the customer's installation to complete wiring alterations, which are relatively simple to execute on current models.

Applications Packages

Nixdorf offers many standard applications programs or program modules in the fields of invoicing, 80-column card file and magnetic-stripe ledger file accounting, inventory recording and management, and payroll.

Utilities include a cassette tape sort/merge program.

These standard utilities and programs are used by Nixdorf programming staffs when programming custom-made user programs.

Nixdorf is also developing a number of standard applications systems involving a division of processing responsibility between System 840 terminal computers at a central site or remote locations and a central Nixdorf System 880/65, System 900, or a Telefunken TR 440 computer system.

DESIGN FEATURES

Systems 840/15, 840/25, and 840/35 use the same processor as the System 820/15, 820/25, and 820/35 direct accounting computers described in another report, but they run under a completely redesigned operating system held in the read-only firmwired microprogram store. This redesigned microprogrammed operating system enables each System 840 processor model to support both a larger number of external input/output channels and a greater variety of channels and peripheral devices than the corresponding System 820 models.

A detailed description of the I/O peripherals common to the System 820/15 to /35 and System 840 computers will be found in the report on the Systems 820/15, /25, and/35. These peripherals include 80-column card readers and punches, a paper tape reader and punch, 20732 magnetic tape cassettes, magnetic ledger account card units, and the 20817 fast serial printer. In addition to these, however, System 840 processors can also support industry-compatible magnetic tape drives, optical character or mark recognition document readers, a visual display screen, and a 300 line-per-minute line printer.

The 20611 Magnetic Tape Station reads or writes data on industry-compatible half-inch, seven-track magnetic tape at densities of 200, 556, or 800 characters per inch, or on nine-track tape at a density of 800 bytes per inch. Tape movement speed is 10 inches per second, resulting in an instantaneous transfer rate of 8,000 characters or bytes per second when data is recorded at 800 characters or bytes per inch. One or two 20611 magnetic tape stations can be connected to any System 840 processor via a 317 channel, permitting System 840 computers to accumulate by-product data that can be transmitted off-line for further processing to a medium to large EDP system, or to process or print data received off-line from a medium-sized EDP system.

The 20811 Line Printer is a drum barrel printer with a 64-character set that prints lines of up to 136 print positions at up to 300 lines per minute. It will be used mostly for printing batch output data read from magnetic tape or received via an on-site processor-to-processor link from a System 880/65 or 880/85 disc processing system, a System 900, a Telefunken TR 440, or other EDP systems.

The 3212 Display can display up to eight lines of 32 characters and is console-mounted. It allows System 840 console operators to have a visual feedback of the data that they have keyed in and/or of data received from a System 880/65, 900, or other processing system to which the System 840 is on-line, and to make corrections before the data is printed.

The Optical Character Document Reader can read cheque-size documents ranging from 51 x 126 millimeters (2 by 5 inches) to 76 x 203 millimeters (3 by 8 inches) on which a single line of numeric and special characters is printed in OCR-A or OCR-B font. Reading speed is 1,000 characters per second and the document feeding rate up to 400 documents per minute. Two output stackers are available which can be chosen by program.

The 4330 Optical Mark Recognition Page Reader can read pages ranging from 76 x 127 millimeters (3 by 5 inches) to 304 x 457 millimeters (12 by 18 inches) and recognise printed or pencil marks in up to 20 columns on up to 70 lines. It reads up to 75 lines per second and can feed pages at the rate of 25 pages per minute.

The 325 I/O channel and a local connection cable of up to 100 metres (300 feet) connect System 840 configurations with System 820/51-54, 880/65, 880/85, 900, or Telefunken TR 440 processors on the same site. The channel and cable transfer data in either direction in 12-bit parallel rows at up to 200 rows per second.

System 840 processors can also be connected to any of the above systems except the System 880/85 over longer distances by leased or 323 switched data communications connected via an I/O channel. Synchronous binary message blocks are sent bit-serially at 1,200 to 9,600 bits per second to other Nixdorf or Telefunken computers at the other end of the line. Alternatively, data can be sent asynchronously at 50 to 1,200 bits per second in 11-bit data frames to any other computer system able to interface teletypewriters.

COMPETITIVE POSITION

Nixdorf System 840 computers are the natural upgrade for the following users:

- Existing users of Nixdorf System 820/10 to 820/35 invoicing/accounting computers who require on-line communications facilities with a larger EDP system to be added to their existing independent accounting facilities.

- Users of System 820/10 to /35 computers who require the OCR or OMR document reading facilities and/or facilities to output to industry-compatible magnetic tape or line printer that are only available on the System 840.

- Existing users of System 820/02, 820/03 or 820/04 alphanumeric printing terminals and/or System 820/55 remote batch Data Stations who require greater independent accounting facilities than are available on either of these two terminal systems.

For those users of large EDP systems who require intelligent on-line terminals with independent processing power at remote locations for the first time, the Nixdorf System 840 competes against the Burroughs TC 500 and 700, Honeywell-Bull 53, 55, and 58, IBM System/3 Model 6, Olivetti Auditronic 770, and Philips P 350T series. The 840 computer also competes with the Business Computers Molecular 18, but so far only in the UK, Belgium, and the Netherlands.

Among these competing systems, the BCL Molecular 18 is the only one to be as modular and expandable and to offer as large a choice of peripherals as the Nixdorf System 840. Unlike the System 840, however, the Molecular 18 is an entirely new design whose first customer installation is as recent as the beginning of 1972.

The Burroughs, Olivetti, and Philips systems are competitively cost-effective with the System 840/15 but are far less expandable, and offer no display, industry-compatible magnetic tapes, line printers, or optical character or mark recognition readers among their optional peripherals.

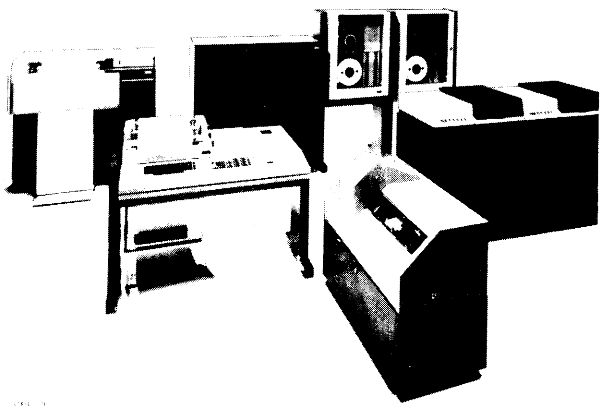
On the other hand, the Honeywell-Bull and IBM systems start at a much higher price range and can thus compete effectively only against the System 840/35. However, neither company's systems offer the magnetic ledger card processing facilities available on all System 840 models, while a display is available only on the IBM System/3 Model 6. However, users who do require intelligent terminals within this performance range and who do not require magnetic account card processing facilities, may find the Honeywell-Bull 50 series' and the IBM System/3's byte-addressable core stores and stored user programs more attractive than the System 840 with its fixed-length data words of 15 decimal digits and sign and its partially firmwired user program boards.

AVAILABILITY AND MAINTENANCE

Nixdorf Computer has a very dense network of 28 sales and service offices and 19 general agents in West Germany alone, and is represented in all other Western European countries by subsidiary companies or agents. Teams of maintenance engineers are based on all Nixdorf and agents' offices; from there they carry out preventive maintenance and answer emergency calls from customers during normal business hours.

One of the factors contributing to the Nixdorf's success in both West Germany and other countries is the high degree of reliability of Nixdorf equipment. Nixdorf does not normally release newly announced equipment outside West Germany until it has been thoroughly proved in the field in West Germany itself, and until both programmers and field engineers in each foreign market have been thoroughly trained. This accounts for the usual time-lag of from 6 to 24 months between the announcement of new Nixdorf systems in West Germany itself and their release to other markets.

Nixdorf sales and service centers are also staffed with systems analysts and programmers to program customers' applications and with training facilities for users who prefer to undertake their own programming. Fully tested object programs can be sent to the Nixdorf factory in Paderborn for wiring on macroprogram ROM boards.



OVERVIEW

Nixdorf System 880 is a family of interactive keyboard-oriented disc processing systems that implements the Nixdorf philosophy of "distributed data processing" by making exchangeable disc-based data bases of up to 24 million bytes accessible to from one to 31 keyboard-oriented visible record computers located at the same or different locations. The first two processors in the family were announced in West Germany in April 1971 and in other Western European countries in late 1971 or early 1972. They were first delivered in April 1972 when a third processor was also announced.

System 880 is currently available in three distinct models. The smallest of these, System 880/55, is itself a single-keyboard visible record computer that uses the same processor as the well-known System 820/35. The 880/55 also offers the same standard 16 character-per-second console printer and optional punched card, paper tape, magnetic tape cassette, and magnetic ledger card processing peripherals as the 820/35. It differs from the latter only by offering among its peripherals one or two exchangeable disc drives with combined on-line user-program and/or data capacities of 5 million to 12 million bytes.

System 880/55 is thus marketed primarily among present users of a single visible record computer (especially the Nixdorf System 820/25 or 820/35) who require random access disc file facilities for the first time, but who also need continued transitional file handling facilities for their existing magnetic ledger card files and upward compatibility for their program library. It is also marketed among novice users.

System 880/85, announced in West Germany in April 1972, is designed for slightly larger users who are currently using two or three visible record computers at the same site, for which they require access to a common disc-based data base. The 880/85 processor is thus a dedicated disc controller for on-line user files of 5 million to 12 million bytes; it provides access to these files for up to three System 840/15, 840/25, and/or 840/35 terminal computers that can be located up to a 200-metre (600-foot) cable length away.

The largest model in the family, System 880/65, is designed both for single visible record computer users requiring a large on-line data base of more than 12 million and up to 24 million bytes, and for users of up to 30 visible record computers and/or enquiry terminals at multiple sites who require on-line access to the same data base.

In its basic configuration, System 880/65 is a single-keyboard disc processing system that offers the same optional punched card, paper tape, and magnetic tape cassette processing peripherals as the System 880/55 and System 820, but no magnetic ledger card processing facilities. It can also be equipped, however, with industry-compatible magnetic tape drives, a 300 or 600 line-per-minute line printer, and a 1,000 card-per-minute high-speed card reader whose speed it can use by multiprogramming a keyboard-oriented foreground program with a background batch processing program. Its most important feature, however, is that its disc drives can be accessed by up to 30 System 820/03-06 and/or System 840/15-35 terminal computers connected via local connection cables or 50 to 9,600 bit-per-second data communications lines and a System 820/52 communications control unit.

User programs and/or data files can be held either on IBM 1316-compatible six-disc, ten-surface disc packs that offer 6.2 million bytes of user storage capacity in 40,000 fixed-length addressable sectors of 155 bytes; or in three-disc, four-surface "half-packs" that offer 2.48 million bytes of user capacity in 16,000 sectors. System 880 operating systems allow each 6.2 million-byte disc pack to be divided among up to 165 distinct user files of variable length organised in direct or sequential access format or among up to 10 distinct user files organised in indexed sequential format. The 2.48 million-byte half-packs can be divided among up to 62 direct or sequential files or among five indexed sequential files.

System 880/55 and 880/85 processors can control one or two disc drives; System 880/65 processors can handle up to four disc drives.

Each drive may hold either one six-disc, ten-surface disc pack, or two superimposed three-disc, four-surface half-packs. The drives are bought OEM from BASF and have the unusually fast average access time of 42.5 milliseconds, while the transfer rate is the industry-standard 156,000 bytes per second.

Table 1 presents the specifications for Nixdorf System 880.

CONFIGURATION GUIDE

System 880/55. The basic system consists of the central processor, input keyboard, and serial console printer integrated into a common desk-size cabinet as on System 820 and System 840 accounting computers.

The 880/55 processor is the same 12-bit parallel processor that is also used in System 820 and 840 computers, except that the 12K-instruction firmwired microprogram read-only store is used entirely for the operating system. User programs as well as data are held in a 5-microsecond ferrite core store, whose minimum size provides space for 2,048 user program instructions and 512 data words of 15 decimal digits and sign. This can be expanded to either 4,096 or 6,144 user instructions and 512 data words, or 4,096 user instructions and 1,024 data words.

The main input medium is the console keyboard comprising a 47-key alphanumeric keyboard, as well as a 10-key numeric and functional keyboard. The main output unit is a 15.8 character-per-second serial golfball printer with interchangeable character sets of up to 88 printable characters, and up to 132 print positions per line.

The console can be equipped at the factory, if required, with a 20714 single-feed or 20715 double-feed magnetic ledger card account unit. This unit reads from or writes on magnetic stripes with up to 512 bytes (1,024 decimal digits) of file data on each card. An additional 20720 magnetic account card reader that reads 42 ledger cards per minute can also be added to an external I/O channel.

System 880/65. The basic system consists of the central processor in a separate floor-standing cabinet, and an input keyboard and console printer mounted in a common desk.

The 880/65 processor is the same 18-bit parallel processor that is also used in the larger general-purpose System 900. It comprises a 12K-byte firmwired microprogram read-only store for implementing the user instruction code and the operating system, and an 8K-byte core store with 1.8-microsecond cycle time for user programs and data, expandable in 8K- or 32K-byte increments to a maximum of 64K bytes.

Table 1. Nixdorf 880: Specifications

CENTRAL PROCESSOR (1)	System 880/55	System 880/65
Word Size (bits)	64	8
Capacity (words)	512-1K	8 - 64K
Cycle Time (μsec)	5.0/ 12 bits	1.8
Working Storage	Core	Core
AUX STORAGE	Disc, mag tapes, mag ledger cards, cassettes	Disc, mag tapes, cassettes
DATA OUTPUT		
Line Printer (lpm)	—	300 or 600
Serial Printer (cps)	15.8; 165	50;165
Card (cpm)	50 col/ sec	50 col/ sec
Paper Tape (cps)	20	20
DATA INPUT		
Keyboard	Standard	Standard
Card (cpm)	110	110; 1,000
Paper Tape (cps)	140	140
SOFTWARE		
Assembler	Yes	Yes
Operating System	In ROS	In ROS
Compiler	KEYBOL	Cobol; RPG

Note:

(1) For specifications on the System 880/85 I/O and software, see specifications for the System 840 terminal in the Nixdorf 840 report. (Disc and 1 or 2 tape drives may be added to System 880/85.) CENTRAL PROCESSOR specifications are the same as for the 880/55.

The main input medium is the console keyboard comprising a 47-key alphanumeric typewriter keyboard, as well as a 10-key numeric and functional keyboard. The main output unit is a 50 character-per-second serial dot-matrix printer able to form up to 60 characters in 7 x 5 dot matrices. Its character set can be optionally expanded to 88 characters in 9 x 9 dot matrices. There are up to 188 print positions per line.

Optional I/O peripherals available on System 880/65 but not on the 880/55 or 880/85 include:

- 20811 line printer (300 lines per minute, 64 printable characters, 136 print positions per line).
- 20812 line printer (600 lines per minute, 64 printable characters, 136 print positions per line).
- High-speed card reader (80-column, 1,000 cards per minute).
- System 820/52 data communications control unit comprising firmwired operating system ROS, 4K 12-bit-word buffer core store, and channel interfaces for up to 30 local connection lines or 50 to 1,200 bit-per-second asynchronous or 1,200 to 9,600 bit-per-second synchronous data communications lines leading to local remote System 820/03-06 intelligent terminals and/or System 840/15-35 terminal and accounting computer systems.

The following I/O peripherals may be optionally connected to any System 880/55 or 880/65 configuration via channels appropriate to each system:

- 20031 card reader (80-column), 200 columns per second.
- 20035 paper tape reader (five-to-eight-track), 140 characters per second.
- 20090 paper tape punch (five-eight track), 20 characters per second.
- 20091 card punch (80-column), 50 columns per second.
- 20092 printing card punch (80-column), 50 columns per second.
- IBM 026 card reader/punch, 20 columns per second.
- 20732 magnetic tape cassette units, reading 136 bytes per second, writing 40 bytes per second one-four units per system).
- 20817 fast serial matrix printer, 165 characters per second, 60 printable characters, 131 print positions per line.
- 20621 exchangeable disc store drive for one IBM 1316-compatible six-disc, ten-surface disc pack holding up to 6.2 million bytes of user programs and data.
- 20622 exchangeable disc store drive for two superimposed three-disc, four-surface disc packs, each holding up to 2.48 million bytes of user programs and data; total capacity per drive is 4.96 million bytes.

One or two 20621 or 20622 drives may be connected to a System 880/55 processor, up to four drives to a System 880/65 processor via their disc controller.

One or two of the 20611 seven- or nine-track magnetic tape drives (200/556/800 bytes per inch, 8,000 bytes per second) are available on systems 880/65 and 880/85 but not on the 880/55.

System 880/85. A System 880/85 configuration includes a processor comprising firmwired operating system ROS and 4K or 8K 12-bit buffer core store, for disc address and block length parameters and for data in transit between disc files and terminals. In addition the following may be added:

- One or two 20621 or 20622 exchangeable disc store drives.
- One, two, or three 320 channels for direct processor-to-processor transfers with a System 840/15, 840/25, or 840/35 computer system up to a 200-metre (600-foot) cable length away.
- Optionally, one or two 20611 industry-compatible seven- or nine-track magnetic tape drives, for disc transaction records and file security.

Operator consoles as well as all I/O peripherals are part of or connected to the one, two, or three System 840 configurations with which the System 880/85 communicates. (See System 840 report for System 840 configuration guide.)

COMPATIBILITY

System 880/55 is upward compatible at the assembler and KEYBOL source program levels with the Nixdorf System 820/15, 820/25, and 820/35 direct accounting computers, System 840/15, 840/25, and 840/35 terminal and accounting computers, and Ruf Datensystem Series 70, all of which use the same processor as the System 880/55 but run under different microprogrammed operating systems. System 880/55 is also upward compatible with the earlier Nixdorf System 820/10, 820/20, and 820/30, Ruf Praetor Mark I, and Wanderer Logatronic, within the limitations of each system's program and data store, and provided similar configurations cause such program compatibility to be relevant.

In most cases, the limitations of program and data store will restrict source program compatibility to visible record processing, excluding disc programs except as a backing program store for the 880/55. However, disc data base programs written for a System 880/55 can be recompiled to run on a System 840 terminal computer on-line to a System 880/65 or System 880/85, and vice versa.

Recompilation will be necessary in most cases to run System 820 or System 840 source programs on a System 880/55, since the System 880/55, unlike the 820 or 840, holds all user programs entirely in core store, thus permitting use of advanced disc overlay techniques. Because of these overlay techniques, a System 880/55 which has a fully expanded core store allowing up to 6K user-program instructions and backed by a 5 million- to 12 million-byte disc data base can be every bit as powerful as a fully expanded System 820/35 or 840/35 computer with 22K program instructions on firmwired program boards and in core.

System 880/65 is source program-compatible at the assembler, RPG, and Cobol levels with the Nixdorf System 900, with which it shares a common processor structure. Program compatibility between the System 880/55 and the System/65, however, is limited to KEYBOL source programs written for a System 880/55 (or a System 820/35 or 840/35), which can in most instances be compiled by the ANSI Cobol compiler available on 32K-byte and larger System 880/65s. There is no downward compatibility or upward compatibility at the assembler level, as the processor designs of the 880/55 and 880/65 are quite different.

Systems 880/65 and 900 are upward compatible at the data level with System 880/55, System 820, and System 840 computer configurations that hold alphabetic characters in eight-bit byte format, but not with those System 820 configurations — mainly former System 820/30 magnetic ledger processing systems — that hold alphabetic characters in six-bit format. Downward data compatibility is restricted by the requirement on Systems 820, 840, and 880/55 to hold numeric data in fixed-length data words of eight bytes (15 decimal digits and sign), whereas the System 880/65 and System 900 have a much more flexible byte-oriented, variable word length data format.

SOFTWARE

General

Software support is one of the major Nixdorf sales points. The firm is prepared to write and test all the programs for any of its customers who desire this service, enabling small- or medium-sized firms to install a System 880 computer without employing an expensive staff of systems analysts and programmers. The only operator required for a System 880 is the type of qualified secretary that traditionally operates the invoicing or accounting machine in small European, especially German, firms.

At the same time, Nixdorf does not attempt to tie all its customers to its coattails and provides adequate software to permit those who desire it to write their own programs.

Operating System

Nixdorf supplies an operating system in the microprogram store of every System 880 that it delivers to a customer. This is responsible for the control of all peripheral operations at the request of the user program and thus plays the role of the supervisor or executive in larger EDP systems. Each operating system is tailored to the requirements of a particular System 880 peripheral configuration, although it normally consists of a number of standard modules.

System 880 operating systems include a disc input/output control system (IOCS) that is responsible for all reading from and writing to discs. User programs initiate IOCS routines by macro-instructions that address data held on disc by file and record names, leaving the IOCS to find the physical location of the appropriate files and records by means of look-up tables.

The System 880 disc IOCS can divide a 20621 six-disc, ten-surface disc pack into up to 165 distinct randomly or sequentially accessible files, or into up to 10 distinct indexed sequential files. On the 20622 three-disc, four-surface half-packs, the corresponding maximum numbers of files are 62 random or sequential files or five indexed sequential files. Files are further classified into input, output, and I/O files: input files cannot be written to; output files can only be written to cleared disc areas; and input/

output files are updated, and updated records are written back to the disc spaces from which they were read. Sequential files can only be input or output files; randomly addressable files are input or I/O; and indexed sequential files can be any of the three types of files.

The System 880 disc IOCS is also responsible for file security, by maintaining a copy of disc transactions and by performing periodic dumps of disc contents. On System 880/55, 20732 magnetic tape cassettes are the medium for disc file dumps and transaction records. On the System 880/65 and 880/85, 20611 industry-compatible tape drives are normally used.

The complete operating system, including disc IOCS, comprises up to 12K 18-bit instructions on System 880/55, and 12K bytes in its basic version on System 880/65. On the latter, there is a further optional 4K-byte operating system module providing for dual programming between a foreground keyboard-oriented program and a background batch program.

Languages

Nixdorf offers a choice between machine-oriented assemblers and higher-level languages on both System 880/55 and System 880/65.

Assemblers. System 880/55 and 880/65 assemblers are not mutually compatible, as the processor structures of the two systems are different. Both, however, are macro-assemblers which include IOCS macro-instructions for initialising I/O operations to or from any peripheral including the on-line disc files.

The System 880/55 assembler program makes extensive use of disc overlays, and therefore can run even on minimum System 880/55 configurations comprising at least one disc drive. The System 880/65 assembler, on the other hand, is a faster in-core assembler that requires a minimum core store of at least 16K bytes.

KEYBOL. KEYBOL, KEYBoard Oriented Language, is a version of ANSCII Cobol adapted by Nixdorf to the requirements of keyboard-oriented small business computers. It is the alternative programming language for the System 880/55.

Cobol. On System 880/65, there is a compiler for ANSI Cobol, Level 1, with Table Handling and Random Access disc processing extensions. The compiler requires a System 880/65 configuration with at least 32K bytes of core store.

RPG. Minimum System 880/65 configurations, as well as data communications configurations, can be programmed in RPG, whose compiler requires only an 8K-byte core store.

Applications Packages

Nixdorf offers many standard applications programs or program modules in the fields of order entry, production scheduling and control, invoicing, inventory recording and management, payroll, and general accounting on System 880/55 and 880/65 disc processing systems. These include the modular production control package PAT (Produktionsdatenerfassung, Auftragsüberwachung und Terminkontrolle) on the System 880/55, and an integrated accounting and management information system for wholesalers (Grosshandelspaket) on the System 880/65, which integrates inventory recording and accounting, invoicing, accounts payable and receivable, and sales and customer statistics.

Utilities include magnetic tape/cassette sort/merge programs; disc sort/merge programs; disc initialisation, reorganisation, and dump programs; and — on System 880/65 — general-purpose card-to-disc or card-to-tape and disc- or tape-to-printer conversion utilities.

DESIGN FEATURES

System 880/55. System 880/55 uses the same processor that is used in System 820/15, 820/25, and 820/35 direct accounting computers and which is described in full detail in the report on these systems. System 880/55, however, runs under a redesigned operating system held in the firmwired read-only microprogram store, that enables it to support also one I/O Channel 314 for controlling one or two 20621 or 20622 exchangeable disc drives and for using these as a backing store for user program overlays.

Unlike System 820 and System 840 accounting computers that use the same processor, System 880/55 has user programs that are held entirely in ferrite core store. System 880/55 processors can be equipped with two, three, or four Model 166 core modules (see System 820/15, /25, and /35 report), which can hold either up to 2,048 18-bit user program instructions or up to 512 user data words of 64 bits (14 or 15 decimal digits, sign, and optional program store reservation tag). At least one and up to three core modules can be used for program instructions, and at least one but no more than two modules can be used for user data areas. System 880/55 ferrite core capacity thus ranges from a minimum of 2,048 program instructions and 512 data words to a maximum of 6,144 program instructions and 512 data words, or 4,096 instructions and 1,024 data words.

Apart from the 20621 and 20622 exchangeable disc drives, System 880/55 can support the same peripherals as the System 820/35 direct accounting computer; these peripherals are fully described in the report on the System 820/15, /25, and /35 direct accounting computers.

System 880/65. System 880/65's processor is totally different from that of the smaller System 880/55. The 880/65 processor is a smaller and slightly slower version of that used on the small- to medium-sized general-purpose Nixdorf System 900, with which it is fully program compatible.

Unlike System 880/55 and the smaller System 820 and 840 accounting computers, System 880/65 uses a byte-oriented, variable word length processor structure. A 12K-byte operating system is held in a firmwired read-only store with a 3.5-microsecond cycle time; this can be expanded by the addition of a 4K-byte ROS module when foreground/background dual programming facilities are required.

User programs and data are held in a 1.8-microsecond cycle ferrite core store expandable from a minimum 8K bytes to a maximum 64K bytes in 8K-byte and/or 32K-byte modules. A powerful instruction code comprises variable-length instructions, with an average five-byte (40-bit) instruction length. Variable-length single-byte or multibyte data operands in store can be addressed directly in main store; they can also be addressed by multilevel indirect addressing and/or by multilevel indexing using up to 64 addressable index registers as well as up to 64 separate 18-bit arithmetic registers in core. Fixed-point decimal arithmetic is standard; floating-point facilities can be added optionally.

Optional dual programming facilities (requiring the addition of the optional 4K-byte module to the firmwired ROS microprogram store) permit one keyboard-controlled foreground program to be multiprogrammed with one batch background program that uses high-speed I/O peripherals such as the 1,000 card-per-minute card reader, the 300 or 600 line-per-minute line printer, and/or 8K-byte per second industry-compatible magnetic tape drives. The 20621 or 20622 exchangeable disc drives are accessible to both programs, as well as to all the System 820/03-06 or System 840 terminal computers connected to an on-line System 820/52 communications control unit.

System 880/85. System 880/85 is a dedicated disc controller that uses a "sawed-off" 880/55 processor, whose firmwired microprogram store operating system comprises all the disc IOCS sections of the 880/55 operating system, as well as special IOCS for up to three 320 processor-to-processor channels and one or two 20611 industry-compatible magnetic tape drives. Its 512-word core store is used entirely as a buffer store for data in transit between discs and magnetic tapes or between discs and the two or three connected System 840 computers. There is no microprogram or core store space for any user programs; however, these programs are held entirely in the ROS and core stores of the one to three System 840 computers that can be connected directly to a System 880/85 processor. These 840 computers are also responsible for the control of all slow I/O peripherals.

20621 and 20622 exchangeable disc drives. Nixdorf 20621 and 20622 exchangeable disc drives are obtained OEM from BASF. The 20621's specifications are identical to those of the BASF 6111 disc drive. The 20621 reads and writes on IBM 1316-compatible six-disc, ten-surface packs at the industry-standard speed of 156,000 bytes per second, but has the unusually fast average arm positioning time of 30 milliseconds, resulting in an average random access time (including latency) of 42.5 milliseconds.

The 20622 is a split-disc pack drive that reads and writes on two superimposed three-disc, four-surface half-packs, but is otherwise identical to the 20621, notably in number of tracks per surface, capacity per track, and arm movement and instantaneous transfer rates.

Each track on a 20621 or 20622 disc pack holds 3,625 bytes. Nixdorf disc IOCS segments each track, however, into 20 fixed-length addressable sectors of 181 bytes, 26 of which are used for block labels leaving 155 bytes for user program segments or data. Total user program/data capacity is thus 3,100 bytes per track, 31,000 bytes per cylinder, and 6.2 million bytes per disc pack and drive on 20621 drives; on 20622 drives the total capacity is 12,400 bytes per cylinder, 2.48 million bytes per disc pack, and 4.96 million bytes per drive.

COMPETITIVE POSITION

Nixdorf System 880/55 is the natural upgrade for existing users of Nixdorf System 820/10 to 820/35 invoicing/accounting computers, who require random access exchangeable disc file storage capacities to their system for the first time.

It enables them to continue using their existing program library and magnetic ledger card files on the new system during a gradual conversion of their files to disc and of their programs to more powerful disc processing programs written in KEYBOL. When that conversion is completed, they will be able to upgrade their installation further to a System 880/65.

A System 880/85 connected to two or three System 840/15, 840/25, or 840/35 terminal and accounting computers is the natural upgrade for existing users of two or three System 820/10 to 820/35 invoicing/accounting computers at the same site, who require all their keyboard systems to have access to the same exchangeable disc data base. The two or three System 840 terminal computers offer all the same upward compatibility to System 820 files and programs that single-keyboard computer users enjoy on the System 880/55.

However, the two smaller members of the System 880 family, usually employed by novice users, suffer from the disadvantages of limited main store expandability and rigidity of a fixed-word length data structure, but they are among the cheapest systems of their size on the market.

System 880/65, on the other hand, with its variable word length byte addressable core store expandable from 8K to 64K bytes is second to none of the competing keyboard-oriented disc processing systems on the market for processor speed and power. Its main store is more expandable than those of the IBM System/3 Models 6 and 10, Honeywell-Bull 58, Kienzle 6100, LogAbax LX 4200, and MAI Basic/Four, which compete with it in the same price/performance range. Unlike any of these except the HB 58, it can multiprogram a keyboard-oriented foreground with a fast batch background program. At the same time, it can also offer access to a common data base to a much larger number of keyboard terminals than the Singer-Friden System Ten, which can be placed not just at the same but also at remote sites. The latter's apparently more expandable core store is deceptive, because Singer-Friden System Ten's core store holds the user programs of all connected terminals, whereas the Nixdorf System 840 terminal computers connected to a System 880/65 or 880/85 have ROS and core stores of their own.

AVAILABILITY AND MAINTENANCE

Nixdorf Computer has a very dense network of 23 sales and service offices and 18 general agents in West Germany alone, and is represented in all other Western European countries by subsidiary companies or agents. Teams of maintenance engineers are based at all Nixdorf and agents' offices, from where they carry out preventive maintenance and answer emergency calls from customers during normal business hours.

One of the factors contributing to Nixdorf's success both in West Germany and in other countries is the high degree of reliability of Nixdorf equipment. Nixdorf does not normally release newly announced equipment outside West Germany until it has been thoroughly proved in the field in West Germany itself, and until both programmers and field engineers in each foreign market have been thoroughly trained. This accounts for the usual time lag of from 6 to 24 months between the announcement of new Nixdorf systems in West Germany, and their release to other markets.

Nixdorf sales and service centers are also staffed with systems analysts and programmers to program customers' applications and with training facilities for users who prefer to undertake their own programming. Fully tested object programs can be sent to the Nixdorf factory in Paderborn for wiring on macroprogram ROS boards.

PRICE DATA

IDENTITY	PURCHASE PRICE, $	MONTHLY MAINT $	COMMENTS
NIXDORF SYSTEM 880			
880/55-1 Basic General Disc Accounting Computer (with mag tape cassette, 026 25-cps serial printer, 701 dual continuous stationary feed, 310 magnetic tape cassette I/O channel, and 6230 magnetic tape cassette read/write unit)			Prices have been converted from DM at a rate of 1 Mark = $0.31.
1607 2 Ferrite Core Store Units (8K 12-bit words)	51,256.02	2,306,52	Basic systems also include 544 chassis, 154 arithmetic unit, 177 read-only store (4 units) for six 380 operating system program boards and part of user program (2,048 instructions), 314 exchangeable disc drive I/O channel,
1607 3 Ferrite Core Store Units (12K 12-bit words)	56,371.02	2,536.70	

PRICE DATA (cont.)

IDENTITY	PURCHASE PRICE, $	MONTHLY MAINT $	COMMENTS
1607 4 Ferrite Core Store Units (16K 12-bit words)	61,486.02	2,766.87	7120 divided exchangeable disc store drive (5.8 mb), 767 console, 017 keyboard cables, and electronics.
880/55-2 Basic General Disc Accounting Computer (with 80-col card reader input facilities, 026 15-cps serial printer, 701 dual continuous stationary feed, 184 card reader input channel, and 4130 60-cpm card reader)			
1607 2 Ferrite Core Store Units (8K 12-bit words)	51,897.72	2,335.40	
1607 3 Ferrite Core Store Units (12K 12-bit words)	57,012.72	2,565.57	
1607 4 Ferrite Core Store Units (16K 12-bit words)	62,127.72	2,795.75	
880/55-3 Basic Magnetic Ledger Card and Disc Accounting Computer (with 028 15-cps serial printer, 701 dual continuous stationary feed, 715 dual-feed magnetic ledger card processing unit, 186 magnetic ledger card I/O channel, 310 magnetic tape cassette I/O channel, and 6230 magnetic tape cassette read/write unit)			
1607 2 Ferrite Core Store Units (8K 12-bit words)	59.238.52	2,665.73	
1607 3 Ferrite Core Store Units (12K 12-bit words)	64,353.52	2,895.91	
1607 4 Ferrite Core Store Units (16K 12-bit words)	69,468.52	3,126.08	
880/55-4 Basic Magnetic Ledger Card and Disc Accounting Computer (with 028 15-cps serial printer, 701 dual continuous stationary feed, 715 dual-feed magnetic ledger card processing unit, 186 magnetic ledger card I/O channel, 184 card reader input channel, 4130 60-cpm card reader)			
1607 2 Ferrite Core Store Units (8K 12-bit words)	59,880.22	2,694.61	
1607 3 Ferrite Core Store Units (12K 12-bit words)	64,995.22	2,924.78	
1607 4 Ferrite Core Store Units (16K 12-bit words)	70,110.22	3,154.96	
5310 High-Speed Serial Matrix Printer (165 cps with 333 I/O channel and 768 console)	5,859.00	263.66	
7120 Divided Exchangeable Disc Store Drive or Exchangeable Disc Store Drive (for one 6-disc 10-surface pack; 7.25 mb)	14,105.00	634.73	

NC No Charge *– Not Applicable* *TM Time and Material Basis*
S Single Use Charge *NA Not Available*

HEADQUARTERS

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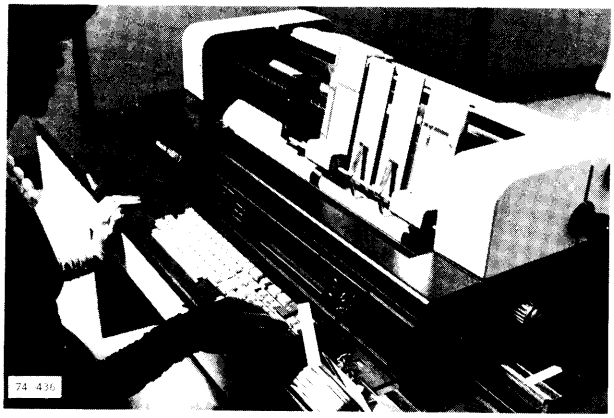

OVERVIEW

Olivetti Audit 5 and 7 are stored-program, keyboard-oriented business computers with optional batch terminal capabilities. They are designed to handle stand-alone processing for small- to medium-size businesses as well as distributed processing for large organisations, especially banks and financial institutions. The two systems cover the whole spectrum of single-keyboard computers, from entry level invoicing and source data entry to dual programming disc processing systems with up to 40 million bytes of random access backing storage.

Audit 5 is a small single program system processor with 512 to 2K bytes of memory and impact printer (16 characters per second). A magnetic card unit, a standard console feature, can read or record up to 256 bytes of instructions or data on a magnetic striped 80-column card. Though used mainly for program input, it can also serve as an inexpensive substitute for magnetic ledger card processing. Optional features include a manual or automatic ledger card front feed, one to three magnetic cassette tape drives, paper tape reader and/or punch, and a data communications line control unit. The system price ranges from $5,000 to $10,000.

Audit 5 can handle more complex programs than its maximum memory indicates. A 2K-byte system with at least one cassette tape drive can run under the Cassette Tape Operating System (CTOS) that uses the first cassette unit as a 256K-byte backing memory for program overlays as well as data. The microprogram controlling the first cassette unit can search the tape for addressed block labels.

Audit 7 is a medium system with processor, 4K to 16K bytes of memory, and impact printer. An optional dual programming capability allows a foreground keyboard program and a background batch program to run concurrently. Audit 7 is marketed in three models that differ solely in the I/O control microprograms; one model can be upgraded to another model in the field. Model 80, a visible record and serial file processing system is available from $11,400 upwards. Model 85, a small disc processing system with 40K to 160K bytes of fixed disc backing storage, is available from $18,000 upwards. Model 90, which offers 9.8 to 39.2 million bytes of fixed/exchangeable cartridge disc backing storage, costs $29,000 upwards. Models 85 and 90 run under the Extended Operating System (EOS), which uses the discs for program overlays as well as data storage.

Audit 7 has a console display for operator guidance and a magnetic card unit. One or two automatic ledger card front feeds, and/or magnetic ledger card processing units are optional. Magnetic ledger card capacity is 512 bytes, which can be used only for data. Up to 10 magnetic tape cassette units are optional; the first two tapes can be used as backing memories for program overlays by the Cassette or Extended Operating System. Both paper tape and 80-column card readers and punches, CMC 7 MICR document reader, and a choice of auxiliary printers are also available. The optional data communications line control unit incorporates its own microprocessor: it can interface to voicegrade lines and transmit data at 600 to 9,600 bits per second.

The standard data communications line control procedures are IBM 2780 BSC-compatible. Either Audit 5 or 7 can transmit batches of data on-line to/from another Audit 5 or 7, an IBM System/3, or an IBM 360 or 370 EDP system.

Olivetti expects to program most applications for all users. Olivetti offers two programming languages: BASIC Assembly Language (BAL) and Audit PL/1, a subset of the IBM language adapted to keyboard-oriented transaction processing. Cross-compilers for both languages are available on IBM System/360 and 370. BAL source programs can also be assembled on Audit 7 Models 85 and 90.

Olivetti announced the Audit 7 to the French market at SICOB in September 1974 and to Italy and most other Continental European countries in November 1974. The two systems will be announced in the United Kingdom in February 1975 and in the United States and Canada in June 1975. Selective marketing to certain user groups, notably public school boards, however, began in the fall of 1974, and initial systems were installed in December 1974. The Audit 7 Model 90 is scheduled for delivery in June 1975. Table 1 lists detailed mainframe characteristics.

Table 1. Olivetti Audit 5 and 7: Mainframe Characteristics

	Description	Audit 5	Audit 7
MAINFRAME			
Memory Capacity:	MOS/ROM (read-only)	8K-10K	16K(1)
	Access time	100 nsec	100 nsec
	MOS/RAM Live	512-2K	4K-16K
	Access time	800 nsec	800 nsec
Input/Output:	External Adapter Slots	3	9
	Addressable Channels for Controllers	9(2)	16
CONSOLE			
Keyboard:	A/N Keys (excl shift, space)	47	47
	Numeric Pad Keys	15	15
	Start Keys	6	7
	Program Switch Keys	4	8
	Buffer Size (bytes)	16	16
Operator Guidance:	Indicator Lights	15	7
	A/N Display (char)	—	16
Printer:	Type	Exch ball	Rotating wheel
	Printable Characters	64; 96; 128	64; 96; 128
	Legible Copies (bond paper)	1 + 8	1 + 7
	Printing Speed (char/sec)	16	35-40
	Tabulation/Skipping Speed (pos/sec)	180	330
	Max Print Positions/Line	180	256
	Look-Ahead Buffer Size (bytes)	22	48
Form Feeds:	Friction (for audit trails, etc.)	2 std	2 std
	Tractor (for continuous business forms)	1 std	1 std; 2 opt
	Manual Front Feed (MFF) (for unit docs, ledger cards, savings passbooks)	1 opt(2)	—
	Automatic Front Feed (AFF)	1 opt(2)	1-2 opt(3)
	Magnetic Ledger Card Unit (MLCU 7300) (512 bytes/stripe)	—	1-2 opt(3)
Magnetic Card Unit	(256 bytes/card)	1 std	1 std
	Feed	Manual	Automatic

Notes:

(1) Audit 7 ROM is organised as 8K 16-bit words.
(2) Manual and automatic front feeds are alternatives on Audit 5.
(3) AFF and MLCU 7300 are alternatives on Audit 7, but it is also possible to have one of each.

PERFORMANCE AND COMPETITIVE ANALYSIS

The Olivetti Audit 5 and 7 compete worldwide against the Burroughs L, TC, and B 700 Series; IBM 3735 and System/3 Model 6; NCR 299, 399, and Century 8200; Nixdorf Systems 720, 820, 840, and 880; Philips/Unidata 300 and P350 Series; and Triumph-Adler TA 10 and 1000. In Europe and some overseas countries, they also compete with the iCS 505 and 755; Insel Mael 3000 and 4000; Kienzle 4000, 5000/6000, and 6100 Series; LogAbax LX 2600 and LX 4000 Series; Ruf/Hohner 500, 2000/8000, and 9000; and Wagner WAC 4 and WAC 40.

In this crowded market, the Audit's main competitive advantage to new users is the broader spectrum over which it offers full program and file support compatibility: from $5,000 invoicing and source data entry systems to 40-million-byte disc processing systems, with optional on-line batch terminal facilities at all levels. All competitors except Nixdorf require at least one, and sometimes two, program and file conversions when upgrading customers over a comparable range. Many competitors, notably Burroughs, NCR, and Nixdorf, cover the same range with a larger number of models, resulting in more frequent hardware mainframe exchanges than the single exchange of an Audit 5 for an Audit 7.

Both Audit 5 and 7 offer a greater degree of I/O simultaneity than most of their comparably priced competitors. All I/O transfers, except for discs, are multiplexed on a byte-interleaving basis. The console keyboard and printer have their own buffers, so their operations do not delay processing in any way. The printer look-ahead buffer also allows the printheads to tabulate in either direction, at high speed, directly to the next addressed print position. This should largely offset the lower printing speeds of the console printers; impact printers are used rather than matrix printers on many competing systems for clarity and the large number of legible copies.

The console printers have a number of features that should appeal particularly to banks and financial institutions and perhaps shake the Burroughs domination of that market. Optional 96-character printheads are available with full upper- and lowercase alphabetics for each European language; 128-character Katakana printheads are also available for the Japanese market. The standard print font is OCR-B, although Olivetti does not guarantee legibility by all available OCR readers. The Audit 7 carriage is 256 print positions wide, matched only by Compudata 600, Philips P356, P358, and P359, and Unidata 300. Up to six sets of independently advanced forms in three partly or wholly overlapped layers can be processed simultaneously on the Audit 7 printer; up to four sets can be processed on the 180-print position Audit 5 carriage.

CONFIGURATION GUIDE

All systems include a stored program processor, magnetic card unit, buffered keyboard, operator guidance indicators, and buffered printer integrated into a common console. The Audit 5 console is desktop, but it can be mounted on a stand; the Audit 7 console is floor standing. There are differences in the basic console components of the two systems, notably in the processor and the printer. The Audit 7 includes a 16-character A/N display for system messages alternating with the contents of the keyboard buffer (see Table 1).

Both the Audit 5 and Audit 7 processors can address up to 16 I/O channels; a peripheral control unit (PCU) can be connected to each channel. The basic console uses the first four channel addresses on both systems, leaving 12 addresses for console options and external peripherals.

Apart from the 12 available channel addresses, the number of console options and external peripherals is also restricted by the number of external "adapter slots" available in each mainframe: three are available on Audit 5, nine on Audit 7. Unlike channel addresses, adapter slots do not necessarily have a one-to-one relationship with PCUs. These fall into three groups: integrated adapters, IPSO peripherals, and disc controllers.

Integrated Adapters. Each integrated adapter requires one slot in the mainframe. The CTU 5400 and CTU 7400 cassette tape drives, LCU 5800 and LCU 7800 data communications line control units, automatic ledger card front feeds (AFF), and magnetic ledger card processing units (MLCU 7300) have integrated adapters. A single adapter can control two AFFs or two MLCU 7300s on Audit 7.

IPSO Peripherals. The CTU 1000 cassette tape drives, paper tape and 80-column card readers and punches, CMC 7 MICR document reader, and auxiliary printers use standard Olivetti peripheral (IPSO) interfaces, and they can be interfaced to a large number of different Olivetti computer systems apart from Audit 5 and 7. Up to four IPSO peripheral controllers in any combination can share a single IPSO adapter, which requires only one slot of Audit 5 or 7. Each IPSO PCU, however, requires its own channel address.

CTU 1000 cassette tape drives connected via an IPSO adapter can only be used for sequential data files. In all other respects, they are fully compatible with the integrated CTU 5400 and CTU 7400 cassette tape drives.

Discs. The DAS 7100 fixed disc and DCU 7200 fixed/exchangeable cartridge disc unit controllers use one logical channel address but each requires two adapter slots on the Audit 7 mainframe. The DAS 7100 controller can control 40K to 160K bytes of fixed disc storage. Each DCU 7200 controller can control one or two DCU 7200 fixed/exchangeable cartridge disc drives.

The Audit 7 Model 85 supports only one DAS 7100 controller, while Model 90 supports two disc controllers: one DAS 7100 and one DCU 7200 controller, or two DCU 7200 controllers; for a combined on-line backing storage capacity of 39.2 million bytes.

I/O Simultaneity. Audit 7 Model 90 allows only one disc controller to transfer data at a time, but the other controller can perform a track seek simultaneously. When two to four IPSO peripherals share a common IPSO adapter, only one device can transfer data at a time. All other PCUs can transfer data simultaneously.

COMPATIBILITY

The Audit 7 models are fully upward compatible with Audit 5. They are not object program compatible with any other computer system, including other Olivetti small business computers and intelligent terminals.

Audit 5 and 7 systems can transmit data in on-line batch mode to each other and to IBM System/3, 360, or 370 configurations or other EDP systems that recognise BSC line control procedures. Olivetti will write special programs to allow Audit 7 to be interfaced to non-IBM EDP systems.

SOFTWARE

Standard software includes a choice of operating systems, two languages, and standard applications packages.

Operating Systems

Basic Operating System (BOS). The basic operating system (BOS) is used on the smallest Audit 5 and 7 configurations; stored programs are entered entirely from 256-byte magnetic cards. It provides I/O macros to address data files on any sequential I/O medium, including cassettes, but does not provide for program overlays.

Cassette Tape Operating System (CTOS). The cassette tape operating system (CTOS) for the Audit 5 and 7 allows programs to be segmented and distributed between magnetic card and cassette tape storage. Basic program segments are normally entered from magnetic cards, overlay segments from cassette tape. Data files can be accessed from any sequential I/O medium.

Audit 5 CTOS requires a full 2K-byte MOS/RAM main memory and a CTU 5400 cassette tape unit. Audit 7 CTOS will run on any system with one or two CTU 7400 cassette tape units.

Extended Operating System (EOS). The extended operating system (EOS) for Audit 7 Models 85 and 90 allows program and overlays to be stored on magnetic cards, CTU 7400 cassette units, or disc backing storage. It provides for program chaining and overlays as defined by user instructions written in the Job Set Language (JSL).

Languages

BASIC Assembly Language (BAL). BAL is a one-for-one assembler for both Audit 5 and 7; it includes input/output macros and program segmentation and file definition facilities. It can be assembled on any Audit 7 Model 85 or 90 running under EOS, or can be cross-assembled on an IBM System/360 or 370.

Audit PL/1. Audit PL/1 is a subset of the IBM-defined language, with a limited number of Olivetti-defined extensions to make it suitable for programming keyboard-oriented programs. Source programs are currently cross-compiled on IBM System/360 or 370, but a native compiler for Audit 7 Models 85 and 90 is in preparation.

Applications

Olivetti expects to program the majority of user programs, especially for the Audit 5. Applications packages will be available for the main user groups, adapted to each country's language, currency, accounting customs, and tax laws. The packages are modular and can be tailored for each individual user.

Banks. Standard Audit 5 and 7 programs are available for current account maintenance, direct credit transfers, savings accounts, foreign exchange, inter-branch accounting, and cash balancing.

MAINTENANCE

Olivetti markets and services its computers directly through a worldwide network of sales and service centres. Maintenance is normally priced separately.

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OVERVIEW

The Philips P350 series is a modular family of keyboard-oriented business computers with optional batch processing and intelligent terminal capabilities. It is marketed throughout Western Europe, North America, and many overseas countries primarily as a freestanding office computer to first-time users and to users of keyboard accounting machines upgrading to a more powerful system. It is also suitable for use in decentralised data processing networks of large companies. The series was launched in April 1969, and more than 25,000 systems have been installed worldwide. It is the second most widely used visible record computer series in West Germany and most other Western European countries.

The Philips P350 series owes its popularity to its low initial cost, and to its ability to grow with user requirements. Currently it consists of seven basic models, each with two or more variations; 13 external peripheral devices are optional. The seven basic models, P351 to P359, offer combinations of two basic memory sizes, two print carriage widths, and a magnetic stripe ledger card processing unit with up to 1,344 decimal digits of stripe capacity. All models include a stored program processor, comprehensive input keyboard, card reader for program input and console printer. The P350C and CT series models also include an integrated magnetic tape cassette reader/recorder on the console. The new P350D series, announced under that name in France in September 1974, can use 256K bytes of disc backing storage as virtual memory for program and working area overlays. The P350S series, marketed only in West Germany and the Netherlands, offers floating-point instructions. The P350T and CT models are intelligent terminals that can exchange data online via data communications lines with other P350T and CT systems, as well as with IBM System/3,360, and 370; Philips P1000 series, and Unidata 7.000 series systems.

Optional external peripherals available on models P352 to P359 and some of their variations include 9K to 28K bytes of mass core storage for program and working area overlays, 256,000 and 4.6 million bytes of disc drive storage, magnetic tape cassette drives, card and paper tape readers and punches, marked card reader, automatic magnetic ledger card feed, and auxiliary matrix line printer. A basic invoicing and visible record computer costs about \$12,500. A P350 system can be expanded on site up to a powerful disc database system with up to 9.2 million bytes of online storage, and online data communications to other P350s or medium-size general-purpose computer systems. Table 1 lists the characteristics of the basic P350 models.

Philips offers an assembler for user programming, as well as applications packages for magnetic ledger card processing systems. The company also offers turnkey systems, with all applications programs written by Philips or by an approved software house under contract.

The Philips P350 series is manufactured at Eiserfeld, West Germany. It is sold directly in all European and North American countries by Philips-Electrologica subsidiaries or by the new Unidata marketing companies formed jointly with CII and Siemens in many Western European countries.

PERFORMANCE AND COMPETITIVE POSITION

The Philips P350 was designed in the late 1960s as a keyboard-oriented visible record computer. Like competing systems designed in the same period, it has a fixed-word data structure of 16 numeric digits. This meets numeric processing requirements efficiently and inexpensively, but it complicates the handling of alphanumeric texts. As a microprogrammed system, its internal arithmetic speeds are rather slow, with a 2-millisecond add time and average 10-millisecond multiplication time. System speed is adequate, however, for a system restricted to keyboard input of variable transaction data and punched card or magnetic ledger card file storage.

When it was announced in April 1969, the P350 was the cheapest and most cost-effective visible record computer on the European market. It also offered a number of design advantages over its leading competitors. Unlike the Nixdorf System 820, Hohner and Ruf Praetor series, its applications programs were not firmwired on plug-in ROM boards but were read into processor main memory from a console card reader. A powerful three address instruction format gave its assembly language the character of a high-level RPG. Unlike the Burroughs L series, it used an immediate access core store as main processor memory, instead of a disc with all the attendant latency problems. All these factors, plus the financial strength and marketing power of the Philips group, explain why the P350 series rapidly became the second most widely used visible record computer on the European market (after the Nixdorf System 820).

During the last five years, many other visible record computer systems have been announced to take advantage of a growing market. In Europe, they include the Compudata 500 and 600, CTM 70, Datapoint 2200 and 5500, Hermes Data System 210, ICS 755, Insel Mael 4000, IME 10001, Kienzle 6000 series, LogAbax LX 4000 series, NCR 299 and 399, Triumph-Adler TA 1000, Wagner WAC 40, and the recently announced Olivetti Audit 7. All are stored-program computers like the P350, and, with the exception of the NCR 299, offer character- or byte-addressable main memories for variable length operands and, in some cases, variable length instructions. Programs are loaded more conveniently from MT cassettes or diskettes, rather than punched cards. Main memories are generally larger than those offered for the P350, with maximum memory size ranging from 16K bytes to 64K bytes depending on the system. Most systems offer faster printers either as a standard

Table 1. Philips P350 Series: Basic Processor and Console Facilities

	Model Nos.						
Characteristics	**P351**	**P352**	**P354**	**P355**	**P356**	**P358**	**P359**
MAIN MEMORY							
Word Length: 64 bits = 16 digits	Std	Std	Std	Std	Std	Std	Std
Capacity: 200 words = 1.6K bytes	Std	—	—	—	—	—	—
400 words = 3.2K bytes	—	X	X	X	X	X	X
600 words = 4.8K bytes	—	X	X	X	X	X	X
1,000 words = 8K bytes	—	X	X	X	X	X	X
CONSOLE							
Keyboard (44 A/N, 12 num, 9 funct)	Std	Std	Std	Std	Std	Std	Std
Printer (22.5 cps print, 160 cps skip)	Std	Std	Std	Std	Std	Std	Std
Print Positions/Line	164	164	164	164	256	256	256
Continuous Form Feeds	1	1	1	1	2	2	2
Ledger Card Front Feeds	1-2	1-2	2	2	1-2	2	2
Magnetic Ledger Card Processing Unit	—	—	Std	Std	—	Std	Std
4-bit Digits/Stripe	—	—	192, 336 or 672	1,344	—	336 or 672	1,344
P 132 Automatic Magnetic Ledger Card Feed	—	—	Opt	Opt	—	Opt	Opt

Notes:
X = Available
— = Not Available

console option, or auxiliary printer. The Datapoint 2200, LogAbax LX 4400 and LX 4600, and the Triumph-Adler TA 1000 also offer console CRT displays, either as standard features or as options.

Many of the newer systems are more expensive in their basic configurations than the various P350 models against which they compete, but the Compudata 500, Datapoint 2200, NCR 299, and Triumph-Adler TA 1000 are cheaper in their basic configurations. A basic 4K-byte TA 1000 invoicing system with one MT cassette drive and console printer has a recommended price of only $8,200, compared to the P351 basic price of $12,500 in West Germany. On the other hand, apart from the NCR 299, the cheaper competing systems are sold primarily through agents, and the service and maintenance network are rarely as dense and efficient as those of Philips-Electrologica. Nor do they as yet have a similar fund of applications experience and similar library of standard applications modules. The P356 to P359 also remain almost unique in offering a wide print carriage with up to 256 print positions per line; only the Compudata 600 offers the wide carriage, and it offers fewer peripherals than the P350 series. The P355 and P359 magnetic ledger cards also have the largest stripe capacity currently offered on the European market: 1,344 digits or 672 bytes.

Like its leading competitors from the earliest days — Burroughs L series, and Nixdorf System 820 — the P350 has been progressively stretched to allow existing installations to grow with user requirements. Card peripherals were available from the beginning. Paper tape peripherals were added in 1970, magnetic tape cassette drives and an optional data communications adapter in 1971, and up to 1.2 million bytes of on-line disc storage in 1972. Unlike most of its competitors, however, the P350 could not, until quite recently, use its magnetic tape cassette and disc peripherals to hold program overlays, as well as directly addressed data files. The basic processor design restricted maximum main memory capacity to 1,000 words for both programs and data; this was adequate for a visible record computer, but it is restrictive for an MT cassette or disc file processing system. To overcome some of the effects of this main memory limitation, 1.2K to 3.6K words (9K to 28K bytes) of mass core storage became available in 1973; it is used as an external peripheral on which program overlays and working areas can be held in reserve, but programs and operand cannot be drawn from this memory.

The latest stretching of the P350 design has been the announcement in France of the P350D series in September 1974. A new control microprogram allows 32,000 words of disc backing storage to be used as an effective virtual memory for program overlays as well as data; but the real memory from which the overlays are executed remains restricted to 1,000 words. At the same time, maximum on-line disc storage capacity for data files has been raised to 9.2 million bytes using one or two IBM 5444-type fixed/exchangeable disc cartridge drives. These are useful additional facilities for existing P350 users with investments in P350 applications software. They can expand their on-line data files and postpone the conversion of programs and data files to new formats. The P350D series is not, however, a credible interactive disc processing system for new users. An 8K-byte maximum main processor memory is not adequate to control on-line disc files of 4.6 to 9.2 million bytes, especially when it is addressable only in blocks of 1,000 64-bit words. Furthermore, neither the P350D series nor any other P350 model offer either a console CRT display or additional remote interactive enquiry stations to interrogate and/or update the central database.

Philips announced the Unidata 300, a cheaper, faster, byte-addressable visible record computer and intelligent terminal. This does not offer any magnetic file storage peripherals initially, but a magnetic ledger processing model — Unidata 320 — is due to be announced in January 1975. Further Unidata 300 series or compatible models offering most of the P350's peripheral options are bound to be announced by early 1976, if only to allow the initial Unidata 300 installations to grow, and these will replace the P350. Thus, 1975 will probably be the final year for P350 new sales.

CONFIGURATION GUIDE

The P350 series is currently available in seven basic models numbered P351 to P359, which have two to more variations each, denoted by the absence or presence of one of the suffixes C, D, S, CT, or T, see Table 1.

Common Characteristics

All P350 models and variations use a desk type console with integrated keyboard, card reader, processor, and printer.

Keyboard. The electronic input keyboard is divided into three fields. The main alphanumeric field has 44 character keys in standard ECMA typewriter layout, three shift keys, a tab key and a space bar. The numeric field has 12 digit keys for figures 0-9, 00 and 000, as well as a Clear key. The control field has eight keys for program selection, supplemented by four additional pushbuttons on the side of the carriage. Twelve lamps indicate various machine status modes.

Program Card Reader. The integrated console program card reader reads 80-column cards at 72 cards per minute. It can be used only to read stored programs into the processor main memory.

Processor. The processor is microprogrammed. It has a fixed word length of 64 bits. Each word can store one 3-address instruction or a signed 15-digit decimal number, or eight alphanumeric 8-bit characters or bytes. The instruction code and basic operating system are implemented in a 200-word read-only memory. User programs and data are held in a read-write core memory with 3.2-microsecond cycle time; core capacity varies according to individual models.

Printer. The console printer is a moving-head impact printer with a peak printing speed of 22.5 characters per second and a forward skipping speed of 165 characters per second in an average processing speed of 40 characters per second. At the end of a print line, the print head returns to its left hand margin starting position at 330 print positions per second.

Basic Models and Variations

P351. This is a basic invoicing and visible record computer marketed only in the Netherlands and West Germany. The main core memory has a fixed size of 200 words for stored programs and data. The printer has the medium width carriage, 164 print positions, with a single continuous forms feed. A single or dual ledger card front feed are optional. Optional external peripherals include a card or paper tape punch.

P352 to P359. The six P352 to P359 models with variations are marketed in all countries where Philips-Electrologica is represented. All have a basic 400-word main core memory, which can be expanded to 600 or 1,000 words. The differences between the basic models relate to the size of the console printer carriage, the use of a magnetic ledger card processing unit, and the capacity of the ledger card stripes.

Carriage Width. Models P352 and P355 have the same medium-size carriage as the P351, with a maximum of 164 print positions per line. A single continuous forms feed is standard.

Models P356 to P359 have a wide carriage with up to 256 print positions per line. A split platen with two independently programmable continuous form feeds is standard.

Magnetic Ledger Card Processing Unit. The medium carriage P352 and wide carriage P356 are invoicing and visible record computers without magnetic ledger card processing facilities. They can support one or two ledger card front feeds.

The remaining four models include two ledger card front feeds as standard features; one feed includes a magnetic stripe read/write unit. Maximum stripe capacity is 336 numeric digits (168 bytes) on the P354, 672 digits (336 bytes) on the P358, and 1,344 digits (672 bytes) on the P355 and P359.

P352C to P359C. The six models P352C to P359C are variations of the basic models. They differ from the basic models in that the console has an integrated magnetic tape cassette reader/recorder. It can record up to 256,000 bytes on each side of a single track 0.15-inch magnetic tape cassette (single track, 0.15-inch tape). It is used only to record data to be reprocessed in a subsequent run.

P352D to P359D. The six models P352D to P359D include a P140 disc controller and drive. The disc capacity is 256,000 bytes; it is used as a virtual memory of

32,000 words for program overlays and working areas. The D series is marketed only in France and some other Continental European countries.

P351S to P359S. The seven P351S to P359S models use a special microprogrammed ROM that implements floating-point arithmetic instructions. These systems can be used as desk calculators in addition to their normal invoicing and visible record processing functions. The S series is marketed only in the Netherlands and West Germany.

P352T to P359T. The six P352T to P359T models include an integrated data communications adapter and CCITT V.24 modem interface. They can be connected to a switched or leased point-to-point or multidrop voicegrade line via an unclocked modem; transmission speed is switchable between 600 to 1,200 bits per second. Line control microprograms are available for implementing ISO (ASCII), IBM 2780 BSC, or Philips P1000 synchronous line protocols. The integrated communications line adapter can be added in the field to any but the oldest P350 series models.

P352CT to P359CT. These six models include both an integrated console MT cassette drive and an integrated data communications adapter. In all other cases, the C, CT, T, D, and S features are mutually exclusive.

External Peripherals

In addition to the basic system, all models can be configured with a number of optional peripheral devices. The P351 and P351S are restricted to a card or paper tape punch. Models P352 to P359 and their C, D, S, CT, and T variations can support up to eight addressable external input devices, and up to eight addressable external output devices. These are listed in Table 2.

Card, Paper Tape. External input devices include a card reader (270 cards per minute) and a marked card reader (250 cards per minute). A paper tape reader, paper tape punch and card punch, all rated at 50 characters per second, are also available.

Automatic Magnetic Ledger Card Feed. The P132 is an automatic feed for magnetic ledger cards.

Magnetic Tape Cassettes. One, two, or three P145 magnetic tape cassette reader/recorders can be connected as external peripherals to any P352 or P359 model of the basic, C, CT, and T series. On P352C/CT and P359C/CT models, up to three external MT cassette drives may be added to the integrated MT cassette drive on the console. Thus, these systems have a maximum of four drives. The basic P350 and P350T models are restricted to a maximum of three MT cassette drives. The P350D and P350S series models cannot support cassettes; they are mutually exclusive with discs.

Discs. Two types of discs can be connected to P352 and P359 models in the basic and D series. The small disc used on the P140 and P141 drives has a capacity of 256 bytes on each side, but only one side can be read at a time because the drives have a single read/write head. The P142 and P143 drives (IBM 5440-type), on the other hand, have read/write heads for each side of the exchangeable and fixed disc, thus four tracks of data are available from each head position. Table 3 lists disc characteristics.

Generally speaking, discs are used on the P350 series only to hold data files addressed directly. To hold program overlays as well, the central processor must be equipped with a special microprogram. Systems with this microprogram are denoted by the D suffix in France and some other European countries. Discs are mutually exclusive with MT cassette drives and the data communications adapter, and cannot be connected to C, CT, S, and T series models.

Mass Core Storage. All P352 to P359 models can support 1,200, 2,400, or 3,600 words (9K to 28K bytes) of mass core storage to hold program overlays and additional working areas. This additional core storage is treated by the central system as an immediate access external peripheral. Programs cannot be executed directly from mass core storage; they must be transferred into the main core memory for execution.

Auxiliary Printer. The P150 auxiliary printer is a dual printhead matrix printer with up to 128 print positions per line. Lines are printed character-serially two characters at a time. The first head prints in columns one to 64; the second prints in columns 65 to 128. Effective print speed depends on the length of the print line. Full lines of 128 characters (or 64 characters in either half) print at 50 lines per minute, but shorter lines can be printed at speeds up to 140 lines per minute.

COMPATIBILITY

All P350 series systems except P350S series models are program and data compatible with each other, subject to availability of any configuration of the optional external peripherals required by the program. The P350S models (marketed only in the Netherlands and West Germany) offer some additional floating-point instructions that are not available on P350 models.

The P350 series is not program compatible with any computer series, including the new Unidata 300 series. Data can be exchanged with other computer systems only on 80-column cards and 8-track paper tape. Data can also be exchanged on-line via voicegrade data communications lines with the IBM Systems/3, 360, and 370; the Philips P1000 series; and the Unidata 7,000 series.

The P350T and P350CT models can be used as intelligent remote batch terminals to exchange data on-line

Table 2. Philips P350 Series: Peripherals and Other Options

Device	Speed	P351	P352 to P359 Model Variations: Basic	C	CT	D	S	T
PROCESSOR								
Decimal Arithmetic		Std	Std	Std	Std	Std	Std	Std
Floating-Point Arithmetic		S*	—	—	—	—	Std	—
CONSOLE PERIPHERALS								
Program Card Reader	72 cpm	Std	Std	Std	Std	Std	Std	Std
MT Cassette Drive (integ)		—	—	Std	Std	—	—	—
Data Communications Adapter 600/1,200 bps		—	—	—	Std	—	—	Std
EXTERNAL PERIPHERALS								
P 135 Mass Core, 1.2K, 2.4K or 3.6K Wds (9K-28K bytes)		—	X	X	X	X	X	X
P 140 Disc Controller + 1 Drive(1) 32,000 Wds = 256,000 Bytes		—	X(2)	—	—	Std(3)	—	—
P 141 Addtl 32,000 Drives		—	0-4	—	—	0-4	—	—
P 142 Disc Controller + 1 Drive(1) 4.6M bytes		—	X(2)	—	—	X(1)	—	—
P 143 Addtl 4.6M-byte Drive		—	1 opt	—	—	1 opt	—	—
P 145 MT Cassette Drives		—	0-3(2)	0-3	0-3	—	—	0-3
INPUT DEVICES								
P 115 Card Reader, 80-col	270 cpm	—	X	X	X	X	X	X
P 117 Mark Sensing Card Reader	250 cpm	—	X	X	X	X	X	X
P 125 Paper Tape Reader	50 cps	—	X	X	X	X	X	X
OUTPUT DEVICES								
P 110 Card Punch, 80-col	50 cps	X	X	X	X	X	X	X
P 120 Paper Tape Punch	50 cps	X	X	X	X	X	X	X
P 150 Auxiliary Printer, 128 Print Positions	50 to 140 lpm	—	X	X	X	X	X	X

Notes:
(1) The P140 and P142 Disc Controllers are mutually exclusive
(2) A basic P352 to P359 may be equipped with a disc controller or with 1-3 magnetic tape cassette drives, but not with both
(3) A P142 Disc Controller can be substituted
S P351S model only*
X May be optionally connected to this system
— Not available on this system

Table 3. Philips P350 Series: Disc Backing Storage

Model Nos.	Controller and First Drive	P 140	P 142
	Additional Drives	P 141	P 143
Characteristics			
Number of Drives/Controller/System		1-5	1-2
Number of Discs/Drive		1 exch	1 fixed and 1 exch
Capacity	16-Digit Words/Sector	10	30
	Bytes/Sector	80	240
	Sectors/Track	32	24
	Tracks/Cylinder	1	2 + 2
	Cylinders/Discpack/Drive	100	200
	Bytes/Exchangeable Disc	256,000	2,304,000
	Bytes/Drive	256,000	4,608,000
	Bytes/System: Max	1,280,000	9,216,000
Average Access Time (msec)	Head Positioning	410	40
	Latency	40	12
Maximum Transfer Rate (bytes/sec)		30,000	300,000

via data communications lines with the following systems:

- Other P350T and P350CT terminals.
- IBM Systems/3, 360, and 370 using IBM 2780 BSC line control procedures.
- Philips P1000 series, and Unidata 7.000 series using Philips synchronous communications procedures.

SOFTWARE

P350 systems are equipped at the factory with a basic microprogrammed operating system in ROM, which controls all input/output functions.

User programs can be written by Philips, an approved software house, or the user himself in the Philips Assembly Language (PAL), which offers a number of systems-oriented macro facilities. These include library facilities for handling peripherals and for tracing and debugging programs. PAL source programs can be compiled directly on P352 to P359 systems with 1,000-word core memories or cross-compiled on IBM System/360 or 370.

Philips offers standard applications packages for P354, P355, P358, and P359 magnetic ledger processing systems for payroll, stock control, invoicing, accounts receivable, accounts payable, general ledger, and similar accounting functions. These packages are written by each national Philips marketing organisation and are adapted to each country's currency, accounting customs, and tax laws.

The high-level Systems Oriented Language (SOL) planned at one time for the P350 series has now been dropped.

MAINTENANCE

Philips-Electrologica maintains a dense network of sales and service centres in all major European conurbations and in some North American cities. Maintenance agreements are separately priced.

In some European countries, the Philips-Electrologica marketing organisation has been merged into joint Unidata marketing companies with former CCI and/or Siemens marketing companies; the quality of service to customers has not been affected.

PRICE DATA

Model Number	Description	Monthly Rental $	Purchase $	Monthly Maint $
	PHILIPS 350 SERIES			
	CENTRAL PROCESSOR & WORKING STORAGE			
P-351	Central Processor (400 words)	200	NA	NA
P-352	Central Processor (1,200 words)	265-460	NA	NA
P-354	Central Processor (1,200 words)	360-550	NA	NA
P-356	Central Processor (1,200 words)	330-490	NA	NA
P-358	Central Processor (1,200 words)	480-600	NA	NA
P-359	Central Processor (1,200 words)	550-650	NA	NA
	INPUT/OUTPUT			
	Punched Cards			
P-115	Card Reader (280 cpm; for P-352, P-354, P-356, P-358, P-359)	105	NA	NA
P-110	Card Punch (37.5 cpm)	115	NA	NA
P-130	Auto Reader	125	NA	NA
	Printer			
P-150	Line Printer	160	NA	NA
	Paper Tape			
P-120	Paper Tape Punch (50 cps)	90	NA	NA

PRICE DATA (Contd.)

Model Number	Description	Monthly Rental $	Purchase $	Monthly Maint $
P-125	Paper Tape Reader (50 cps; for P-352, P-353, P-358, P-359)	90	NA	NA
	Magnetic Stripe Ledger Card (included in price of P-358, P-359)		NA	NA
P-351	Keyboard Input	176	NA	NA

Notes:
NA – Not available.
**Rental prices quoted are based upon a 1-year lease. Leases average 2.3% of purchase price. Maintenance fee under 12-month warranty. After first year, 7% of purchase price. Purchase prices range from $8,395 to $27,000. Average price of system is $21,000. Request price quotations from manufacturer.*

HEADQUARTERS

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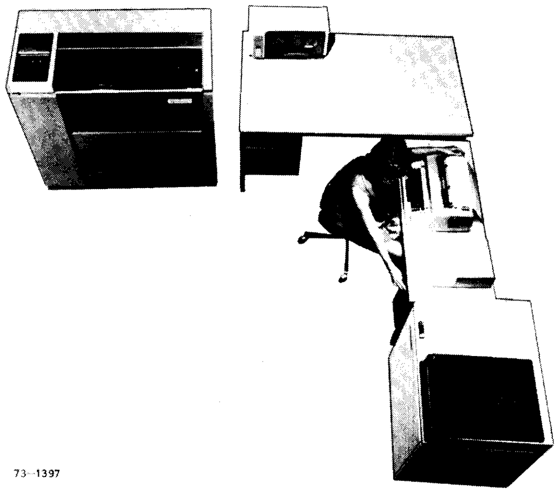


73-1397

OVERVIEW

The Qantel System is a small business computer actively marketed for banking, distribution and telecommunication applications. It is sold in 5 basic configurations that vary only in amount of main memory. The Qantel System enjoys widest acceptance in banking applications. Nine out of the top 20 banks in the country including 3 branch offices of the Federal Reserve System use the Qantel System as an integral component of their data processing installations. Qantel Systems are used for funds transfer, coupon securities collection, securities custody, broker accounting, and international letter of credit operations.

Qantel units are also functioning as self-contained systems for distributors, providing comprehensive inventory control, pricing, discounting, and complete accounting reports.

Qantel systems also provide complete data processing services for meat packers and processors. MIMS (Meat Information Management System) satisfies the need for tight receivables control, and for immediate adjustment to price fluctuations in the commodity market. It also provides payroll, discounting, and portion control in mixture blending.

Medical clinics constitute still another area of specialization for Qantel. In this market the systems provide faster receivables turnaround, more detailed reports than those available from service bureaus, more sophisticated appointment scheduling and better overall control of data and medical clinic management information.

The Qantel System can transparently communicate with host computers from many manufacturers, such as IBM, Univac, and Burroughs. It can simulate the IBM 2701, 2740, 2770, and 2780 as well as the Univac 1004, Burroughs TC 500, and Control Data UT200. It provides communication at rates up to 9,600 baud synchronously and 2,400 baud asynchronously, as well as at Telpak speeds (40K and 50K baud).

System peripherals include tape and disc, alphanumeric CRTs, line printers, card reader, paper tape reader/punch, and communication line controllers.

Along with business-oriented application software, Qantel supplies an assembler, an RPG compiler, and a number of housekeeping routines.

On-site maintenance is available from a field service organization of approximately 30 people located in 14 nationwide service centers. Maintenance contracts are available for leased systems. Purchased systems carry the typical 90-day warranty, with an optional contract available for maintenance. System engineering is available at offices located in New York and San Francisco.

CONFIGURATION GUIDE

A basic Qantel System includes a processor with 4K, 8K, 16K, 24K, or 32K bytes of memory, an I/O typewriter (with buffer), and a power supply. The I/O typewriter is an IBM Selectric Model 735. In a source data entry environment, the system uses an alphanumeric video display terminal, a 10-key numeric pad, and the I/O typewriter. Data entered into the processor is edited (or verified) and stored internally, or it is written onto magnetic tape or disc. Data stored on tape or disc can be transmitted for communications applications.

For other applications, output can be the I/O typewriter, line printer, paper tape, disc, or magnetic tape.

Input can be from a card or paper tape reader, disc, or magnetic tape as well as the I/O typewriter. Disc drives that store 7.6 million, 30.7 million, or 60 million bytes and 9-track magnetic tape drives that use 600- or 2,400-foot tape reels are available for storage. Three line printers provide printing speeds of 60, 200, and 245 lines per minute. They print up to 132 characters per line on multi-part paper for an original and up to 5 copies. Paper can be standard, continuous fold edge-punched, and from 4 inches to 19-7/8 inches wide. The card reader reads standard 80-column cards at a speed of 300 cards per minute. The paper tape reader/punch operates at 50 characters per second for reading or punching. It is unbuffered, thus it suspends processing while it is operating.

Three CC model controllers use a microprocessor with 2K bytes of memory to control data communications lines, to add 12 I/O channels to a Qantel System and to control up to 8 CRT displays in a data communication network.

Model CCA-1 handles transmission speeds up to 1,800 baud asynchronous, and 9,600 baud synchronous. It can also operate at Telpak speeds of 40K to 50K bits per second. It operates with any serial-by-bit data set or other data sets with an EIA interface and handles automatic calling units. It can also communicate with other computer systems using the IBM bisynchronous communication mode.

Model CCB-1 communication line multiplexer that includes a remote controller can handle up to 12 Qantel I/O controllers. Model CCC-1, a display concentrator can handle up to 8 CRT displays in a data communications network.

Communication controllers that do not use the microprocessor are available for unbuffered synchronous and asynchronous communications and buffered asynchronous communication.

A Qantel System is mounted in an office desk configuration. It comes in various colors to match office decor.

Performance and Competitive Position

The Qantel System has sufficient processing and communications capability plus supporting peripherals to compete on many fronts, as a small business computer, remote batch terminal, intelligent terminal, line controller, and communication processor.

It offers flexible system configurations. The microprocessor controller for data communications can effectively double I/O throughput. Other I/O features include a wide range of peripherals with paper tape, punched card reader, 3 printers, 5 tape drives, and 3 disc drives.

An interesting system asset is the ability to store microprograms in main memory as well as in ROM.

Communication features include modularity and high speed. Modularity is provided by low-cost communication controllers, and the higher-cost but more powerful microprocessor.

On the negative side, the peripheral line does not include a card punch (which could limit its use in a remote batch environment). Also, the Qantel system has no magnetic tape cassette capability.

Probably the most significant minus is software. The system lacks a full-scale operating system though one is currently in preparation and on schedule for November 1973 introduction. Qantel offers an assembler and an RPG compiler for program preparation. The application program library is still limited but growing. Qantel has conserved its resources by specializing and developing complete packages for specific applications.

Users that we contacted were unanimous in feeling that the Qantel system offered very good performance for its price. They also liked the use of an IBM Selectric for input because it requires no operator retraining for the system.

Users also mentioned that the Qantel is simple to install and operate, it is rugged, communication facilities are good, the system is flexible, and uptime is good. One user quoted an uptime of 93 to 94 percent.

The most consistent negative comment users made about Qantel was that maintenance service could be improved. Only 1 user that we contacted said the maintenance was good, another rated it fairly good. Two other users felt the service was improving. Another commented that the limit of 4 typewriters per system could cause some difficulty and that users needed more programming assistance such as turnkey application packages.

Despite the drawbacks mentioned, users were generally expanding their installations by buying more Qantel Systems.

MAINFRAME

Table 1 lists the Qantel mainframe characteristics.

The Qantel processor is a stored program minicomputer constructed almost entirely of integrated circuits. Program and data storage is provided by an integrated circuit, byte-oriented memory. The standard memory unit is 4,096 bytes. Field expansion to 8,192, 16,384, 24,576, or 32,768 bytes of memory is optional. Table 2 lists the data formats used by the system.

Internal processor control is a function of microinstructions executed in a read-only memory (ROM). ROM contains fixed nondestructive memory for the execution of user macroinstructions. The standard ROM is 1,540 bytes. Access time is 50 nanoseconds. If a different or special micro (control) program is needed, the user can simulate ROM in main memory by loading additional microprograms with a special instruction. Typical instruction execution times are listed in Table 3.

Table 1. Qantel System:
Mainframe Characteristics

Characteristic	Qantel System
Central Processor	QA-s, QB-2, QC-1, QF-1, QD-1
No. of Internal Registers	0
Addressing	
Direct (no. of words)	32,768
Addressing	
Direct (no. of words)	32,768
Indirect	Multi-level
Indexed	No
Instruction Set	
Number	51
Decimal Arithmetic	Yes
Floating Point	No
Priority Interrupt System	
Lines	1
Levels	Software
Main Storage	
Type	Core
Cycle Time (μsec)	1.5
Basic Addressable Unit	Byte
Bytes/Access	
Min Capacity (bytes)	4K, 8K, 16K, 24K, 32K
Max Capacity (bytes)	32K
Increment Size (bytes)	4K
Parity	No
Protect	No
ROM	Yes
Use	Control memory
Capacity (bytes)	1,540
I/O Channels	
Programmed I/O	Std
DMA Channels (no.)	12 Std
Max Transfer Rate (bytes/sec)	
Within Memory	6K
Over DMA	668K

Table 2. Qantel System: Data Formats

Name	Representation
Byte	8 bits
Word	1 byte
Operand	
Binary	1 to 16 bytes (unsigned)
Decimal	1 to 16 dec digits
Transfer Code	ASCII
Internal Code	Hexadecimal

Table 3. Qantel System: Typical Instruction Execution Times

Instruction	Execution Time (μsec)
Load/Store	32
Binary	
Add	40
Decimal	
Add	40
Subtract	40
Multiply	500
Divide	650

The system has 12 standard I/O channels. The CCB-1 multiplexer extends the I/O bus so that it can handle 12 additional device controllers. Up to 3 multiplexers can be added to a system.

Up to 9 of the 12 standard I/O channels can be used as direct access (to main memory) channels. The maximum direct access data transfer rate is 668K bytes per second.

PERIPHERALS

Table 4 lists the peripherals available for the Qantel System.

I/O Typewriter. The I/O typewriter is an IBM 735 heavy-duty Selectric®, which can be operated (off-line) as a normal typewriter. No separate DC power source is required. The basic system contains a buffered controller to provide proper interface with the Qantel processor.

The typewriter uses 15.5-inch paper. Horizontal spacing is 10 characters per inch, while

® Selectric is a registered IBM trademark

Table 4. Qantel System: Peripherals

Peripheral Device	Performance Characteristics	Comments
AA-2 Programmer's Control Console	Indicators and switches to display and modify contents of internal registers and memory	For program debugging and processor troubleshooting
AB-1 10-Key Numeric Input Module	32-char buffer; readout tube for no. of digits entered and 2 indicator flags	Desktop device
AF-1 Video Display Unit	CRT display area 12"; 27 lines; 74 char/line; 64 ASCII char set; A/N keyboard; 10-key numeric keyboard	Includes controller; normally configured with up to 6 system
AC-2 Card Reader	Reads 500 cpm; translates Hollerith to ASCII	Uses 80-col cards; reads col by col
AD-1 Paper Tape Reader/ Punch	Read and punch speed 50 char/ sec	Unbuffered
PA-1 Extra I/O Typewriter	Typing speed 15 char/sec; fully buffered	IBM Selectric Model 735
PO-1 Serial Printer	Print speed 60-100 lpm; 132-char lines; 63 ASCII char set; uses 5 x 7 dot matrix; 1 original and 4 copies	Has full line buffer; prints 10 char/inch horizontally and 6 lpi vertically; paper width up to 14.75 inches
PB-2 Line Printer	Print speed 200 lpm; 132 char/ line; 64 ASCII char set	Has full line buffer; prints 10 char/inch horizontally and 6 lpi vertically; paper width up to 14.75"
PC-1 Line Printer	Print speed 245-1,120 lpm; 24 to 132 char/line; 64 ASCII char set; 1 original and 5 copies	Has full line buffers; 10 char/ inch; 6/8 lines/inch; uses std continuous fold-paper 4 to 19.875" wide
PE-1 Line Printer	Print speed 700-1,800 lpm (depending on char printing); 132-col line; 64 ASCII char set; 1 original and 5 copies	Has full line buffer; 10 char/ inch; 6/8 lpi; uses std continuous fold paper 4 to 19.875" wide
MF-1 Magnetic Tape Drive	9-track; NRZI-IBM compatible format; 800 bpi; 10K byte/sec transfer rate	1 unit/controller; controller included; 600' reel
MJ-1 Magnetic Tape Drive	Same as MF-1 except 20K byte/ sec transfer rate	Requires CJ-1 controller for up to 4 drives; 600' reel
MK-1 Magnetic Tape Drive	Same as MJ-1 drive	Same as MJ-1 except uses 2,400' reel
ML-1 Magnetic Tape Drive	9-track; PE-compatible format; 1,600 bpi; transfer rate 40,000 bytes/sec	Requires CL-1 controller for up to 4 drives; 600' reel
MM-1 Magnetic Tape Drive	Same as ML-1	Same as ML-1 except uses 2,400' reel

Table 4. Qantel System: Peripherals (Contd.)

Peripheral Device	Performance Characteristics	Comments
MD-1 Disc Drive	Capacity 7.6M bytes; 380 bytes/ sector; 20K sectors; avg seek/ avg seek/write time 55 msec	Integral controller; rotation time 25 msec
ME-1 Disc Drive	Capacity 30.7M bytes; 768 bytes/ sector; 40K sectors; avg seek/ write time 55 msec	Integral controller; rotation time 25 msec
MP-1 Disc Drive	Capacity 61.4M bytes; 768 bytes/ sector; 80K sectors; avg seek/ write time 55 msec	Integral controller; rotation time 25 msec

vertical spacing is 6 lines per inch. Typing speed is approximately 15 characters per second. This low speed is partially prevented from degrading the system's normal operating speed through use of a 128-character buffer. In addition, the controller translates the processor ASCII code into typewriter correspondence code.

Serial Printer. One serial printer is available. The model PD-1 uses a 5 x 7 dot matrix, prints 132 characters per line (buffered), at a rate of 60 to 100 lines per minute, and makes an original and up to 4 copies.

Line Printer. Three models — PB-2, a chain printer, prints 140 to 250 lines per minute; PC-1, a drum printer, prints 245 to 1,100 lines per minute; and PE-1, also a drum printer, prints 700 to 1,800 lines per minute. All are impact printers and feature 132 print positions per line. All printer controllers have a 1-line buffer. All 3 printers use an ASCII character set and can produce an original and 5 copies.

Paper Tape. The AD-1 reads or punches 5-, 6-, 7-, or 8-channel paper or mylar tape at a speed of 50 characters per second. Reel capacity is 1,000 feet. It is unbuffered, thus processing is stalled while it is reading or punching.

Card Reader. AC-2 reads 80-column cards, at 500 cards per minute; it translates extended Hollerith (256 characters) code to ASCII.

CRT. AF-1 CRT has a 12-inch screen, a storage capacity of 1,998 characters, 27 lines of 74 characters each, a standard typewriter keyboard with the full 64-character ASCII set, plus a 10-key numeric pad. An integral controller allows the attachment of up to 6 CRTs. The display uses 2-level video intensity for distinction between background and foreground data. The cursor is programmable.

10-Key Numeric Input Module. Model AB-1 uses a standard 10-key adding machine style keyboard, is designed for numeric data entry, has a 31-digit buffer, and has an audible program-controlled signal that warns an operator of an incorrect procedure.

Programmer's Control Console. The model AA-2 console is used to troubleshoot the processor or debug user programs. It allows usual debug functions such as display or modify memory address register, memory locations, and other registers.

Voice Response Controller. The unit allows access to computer files from touch-tone telephones, and prerecorded human voice response. It is well suited for inquiry and verification since any touch-tone telephone can be used as an inquiry station. The effectiveness of voice response units for data entry is limited by the lack of normal input controls. A hard-copy record of entries is not recorded unless it is printed at the central computer site. The inexperience of the people using the units is overcome by verbal instructions preceding each step.

A vocabulary of up to 16,000 words can be stored on Qantel's 30.7 million-byte disc. The customer selected vocabulary can consist of phrases of up to 1,000 words. The phrases can be varied, and used in combinations. The controller is a 2K microprocessor connected to a direct access channel. Each controller can communicate with 2 telephones, and up to 4 controllers can be used with a Qantel.

Disc Drives. Three drive models are available: MD-1 with 10 read/write heads is in the IBM 2311; it has a capacity of 7.6 million bytes stored in 380-character sectors; ME-1 and MP-1 are in the IBM 2314 class; each has 20 read/write heads and stores data in 760-character sectors.

The ME-1 stores 30.7 million bytes and the MP-1 stores 61.4 million bytes. Rotation time is 25 milliseconds; average seek-and-write time is 55 milliseconds. To minimize search time, a randomizing routine rather than an index sequential routine is used to address disc sectors directly.

The drives contain their own controllers, which have full-sector buffers. This allows automatic write/read and check/rewrite operations independent of the program. Overlapped seeking and reading is possible through a seek-and-read instruction. Bad spots on the disc are recorded in the file directory by the disc handler.

Magnetic Tape Drives. The Qantel system has 5 tape drives available. All use 9-track, industry-compatible, 1/2-inch-wide tape and have hardware-buffered controllers.

DATA COMMUNICATIONS

Qantel offers 3 families of communication controllers to interface to its system: the CA Series, the CB Series, and the CC Series. Table 5 summarizes the available communication devices.

The CA Series are unbuffered, and they operate in the half-duplex mode serial-by-bit with any data set using the standard EIA interface. Synchronous transmission speed is up to 4,800 baud, and asynchronous transmission speed is 75 to 2,400 baud. Transmission and reception speeds and modes are switch selectable. The controller can handle an automatic calling unit, and can operate unattended with automatic answering.

The CB Series are buffered asynchronous communication controllers that operates in the half-duplex mode at standard transmission speeds up to 1,800 baud. Transmission speed is switch selectable. The buffer holds 156 bytes. This controller operates with 103 or 202 serial data sets or 402D parallel data sets. It uses a 7- or 8-bit code with 1 start bit, and 1 or 2 stop bits. It can handle an automatic calling unit and can operate unattended, providing automatic answering.

The CC Series controllers use a microprocessor with 2K bytes of integrated circuit memory. The microprocessor transfers data with the Qantel System memory via the direct memory access channel on a cycle stealing basis. A Qantel System can support 3 Model CC controllers.

The Model CCA-1 is a buffered communications controller that can operate in synchronous or asynchronous, full- or half-duplex modes. It can communicate with any bit serial, Bell data set, or any data set with the EIA standard interface. It can also communicate with any computer system in the IBM BSC mode. Transmission speeds are up to 1,800 baud asynchronous and up

Table 5. Qantel/System: Data Communication Devices

Peripheral Device	Performance Characteristics	Comments
CA-2 Unbuffered Synch/Asynch Communications Controller	Half-duplex; up to 4,800 baud synch and 75 to 2,400 baud asynch; transmission mode and speed switch selectable	Operates with any serial-by-bit data set with std EIA interface; handles auto call, auto answer
CB-2 Buffered Asynch Communications Controller	Buffer 156 bytes long; half-duplex; switch selectable speeds up to 1,800 baud; 7- or 8-bit code; 1 start bit; 1 or 2 stop bits	Operates with 103 or 202 serial data sets or 402D parallel data sets; handles auto call and auto answer
CCA-1 Buffered Synch/Asynch Controller	Transmission speeds up to 9,600 baud synch or 1,800 baud asynch communicates with other systems in IBM BSC mode	Transfers data with Qantel memory over DMA channel; operates with any serial-by-bit data set with EIA interface; handles auto call and auto answer
CCB-1 Communications Line Multiplexer	Extends I/O bus to handle up to 12 more I/O controllers	Includes remote control and power supply in cabinet; up to 3/system
CCC-1 Display Concentrator	For up to 8 CRTs in data comm system	Includes display multiplexer

to 9,600 baud synchronous. The controller can handle an automatic calling unit and can provide unattended service with automatic answering.

The Model CCB-1 is a Communications Line Multiplexer to extend the Qantel System's I/O capacity by 12 I/O controllers. It includes a remote control unit and power supply housed in a desk or cabinet. The CCB-1 can handle any Qantel I/O controller except a Model CC Series controller.

The Model CC-1 is a Display Concentrator in a data communications system. It includes a multiplexer for 1 to 8 display units.

SOFTWARE

There are 4 basic types of software available with the Qantel system: (1) an assembler and RPG Compiler, (2) the terminal simulators, (3) application packages, and (4) a program library supervisor and an interactive editor for program modification.

Assembler

Qantel's assembler is very similar to IBM's 1401 Autocoder. The instruction set contains 51 business-oriented instructions, which include decimal arithmetic, bit/byte manipulation, branching, and I/O. All instructions are of the 1- or 2-address type. Indirect addressing is included as a standard feature.

Actual program execution is accomplished by executing any number of the 87 microinstructions in the ROM. The microinstructions are addressed and initiated by the 51 user program instructions (macroinstructions). A special feature of Qantel's microinstructions is that they can also be loaded from main memory.

RPG

Qantel's RPG is a subset of the RPG language and its associated compiler. The compiler generates absolute object programs to run on any Qantel system. The compiler itself requires a Qantel system with a minimum of 8K, a system with a card reader and at least 1 magnetic tape.

This version of the language is not intended as either a file management tool or a system development tool. It is designed to simplify the writing of reports from existing fixed format files.

Software Simulators

The Qantel terminal simulation packages do not offer 100% plug-compatible replacement operations. Rather, they are about 90% functionally identical; the other 10% must be custom-written for a particular user. This is not necessarily a disadvantage. Customizing often allows the user to take advantage of some additional capability of the Qantel system over the terminal being simulated.

HEADQUARTERS

Qantel Corporation
3474 Investment Boulevard
Hayward, CA 94545

PRICE DATA

Model Number	Description	Monthly Rental $ *	Purchase $	Monthly Maint. $
	QANTEL SYSTEM			
	CENTRAL PROCESSOR & WORKING STORAGE			
QA-2	4K System (includes I/O typewriter and power supply mounted in desk, operates with up to 12 I/O controllers; each controller has either single device, multi-set device, or direct access to main memory capabilities)	300	12,315	65
QB-2	8K System (basic system with expanded memory; can be field or factory installed)	353	14,465	75
QC-1	16K System (basic system with expanded memory; can be field or factory installed; includes programmer's control console)	483	19,805	105
QF-1	24K System (basic system with expanded memory; can be field or factory installed; includes programmer's control console)	580	23,755	125
QD-1	32K System (basic system with expanded memory; can be field or factory installed; includes programmer's control console)	666	27,305	145
	MASS STORAGE			
	Discs			
MD-1	Disc Drive (7.6M bytes; sectored disc; 20,000 sectors; 380 bytes/sector; full sector buffer; auto detection and marking of defective sectors; CRC check/sector; decimal addressing; includes controller)	351	14,400	80

PRICE DATA (cont.)

Model Number	Description	Monthly Rental $	Purchase $	Monthly Maint. $
ME-1	Disc Drive (30.7M bytes; sectored disc; 40,000 sectors; 760 bytes/sector; full sector buffer; auto detection and marking of defective sectors; CRC check/sector; decimal addressing; includes controller)	482	19,750	121
MP-1	Disc Drive (60M bytes; sectored disc; 2314 type; 80,000 sectors; 768 bytes/sector; full sector buffer; auto detection and marking of defective sectors: CRC check/sector; decimal addressing; includes controller)	674	27,500	175
	INPUT/OUTPUT			
	Console			
AA-2	Programmer's Control Console	35	1,440	10
	Typewriter			
PA-1	Extra I/O Typewriter (heavy duty IBM Selectric 735; 15 cps; buffered)	96	3,950	30
AB-1	10-Key Numeric Input Module (adding machine style keyboard; readout tube; 32-char buffer; 2 indicator flags; termination interrupt provided at end of message)	15	1,440	10
	Paper Tape			
AD-1	Reader/Punch (50 cps; 5-, 6-, 7-, or 8-channel tape; 100-foot capacity)	57	2,350	20
	Punched Card			
AC-2	Reader (500 cpm; 80 col; photoelectric reader; translates extended Hollerith code to ASCII; reads col binary direct from card; controlled by Qantel Read and Set-Read instructions)	101	4,150	35
	Printers			
PD-1	Serial Printer (60-100 lpm; 132 pp; 132-char buffer; 63-char ASCII set; 1 original and 4 copies)	170	6,950	50
PB-2	Line Printer (200 lpm; 132 pp; 132-char buffer; 64-char ASCII set; chain type printer)	305	12,500	275
PC-1	Line Printer (245 lpm; 132 pp; 1,120 lpm-24pp; 132-char buffer; 64-char ASCII set; prints up to 6-part multicopy)	512	21,000	140
PE-1	Line Printer (700 lpm; 132 pp; 1,800 lpm-68 pp; 132-char buffer; 64-char ASCII set; prints up to 6-part multicopy)	817	33,500	185
	Magnetic Tape			
CJ-1	Magnetic Tape Drive Controller (20,000 bytes/sec; 800 bpi; handles up to 4 MJ-1 or MK-1 drives; all drives connected to CJ-1 controller must have same data densities and read/write speeds; controller board mounts in processor housing)	37	1,500	10
CL-1	Magnetic Tape Drive Controller (40,000 bytes/sec; 1,600 bpi; handles up to 4 ML-1 or MM-1 drives; all drives connected to CL-1 controller must have same densities and read/write speed; controller board mounts in processor housing)	49	2,000	12
MF-1	600' Magnetic Tape Drive (9-channel, NRZI-IBM format; 800 bpi; read/write speed is 10,000 bytes/second; single desktop cabinet or multiple units in free-standing cabinet; 1 drive per controller with controller included in unit price)	121	4,950	30
MJ-1	600' Magnetic Tape Drive (9-channel, NRZI-IBM format; 800 bpi; read/write speed is 20,000 bytes/ second; read-after-write capability)	121	4,950	32
MK-1	2400' Magnetic Tape Drive (9-channel, NRZI-IBM format; 800 bpi; read/write speed is 20,000 bytes/second; read-after-write capability; connects to CJ-1 controller)	194	7,950	50
ML-1	600' Magnetic Tape Drive (9-channel; PE compatible format; 1,600 bpi, read/write speed is 40,000 bytes/second; read-after-write capability; connects to CL-1 controller)	140	5,750	34
MM-1	2400' Magnetic Tape Drive (9-channel; PE compatible format; 1,600 bpi; read/write speed is 40,000 bytes/second; read-after-write capability; connects to CL-1 controller)	218	8,950	60
MFA-1	3-Tape Drive Cabinet (freestanding; mounts 3 MF-1, MJ-1, and ML-1 drives)	–	250	–
	Displays			
AF-1	Video Display Unit (12" CRT; 2,048 x 8-bit mag core memory; 1,998-char screen capacity; 74 char/line; 27 lines/display; programmable cursor; 64-char ASCII set; keyboard plus numeric keypack; configured with up to 6/system; includes controller)	121	4,950	30
	DATA COMMUNICATIONS			
	Model CC Series Communications Micro-Processor is a stored program microcomputer with a 2K by 8-bit IC memory. Direct access (cycle steal) channels provide programmed simultaneity and data exchange to processor main memory from the controller memoty. No more than 3 of these controllers should be configured on any 1 processor.			
CCA-1	Buffered Synch/Asynch Controller (9,600 baud synch; 1,800 asynch; handles auto call unit; can interrupt system during unattended operation to auto answer; operates with any Bell serial-by-bit data set or sets with EIA interface; can communicate with systems using IBM bi-sync mode)	98	4,000	30
CCB-1	Communications Line Multiplexor (I/O extender including remote control unit, controller housing, and power supply mounted in desk or cabinet; handles up			

PRICE DATA (cont.)

Model Number	Description	Monthly Rental $	Purchase $	Monthly Maint. $
	to 12 Qantel I/O controllers, other than model CC series controllers)	176	7,200	50
CCC-1	Display Concentrator (handles from 1 to 8 CRTs; includes display multiplexor)	96	3,950	30
CA-2	CA Series Unbuffered Synch/Asynch Communications Controller (operates half-duplex with any serial-by-bit data set with EIA I/O characteristics; transmission rates: synch, 4,800 baud; asynch, 75 – 2,400 baud; modes are switch selectable at time of installation; handles auto call unit and can interrupt system during unattended operation to auto answer)	49	2,000	20
CB-2	CB Series Buffered Asynch Communications Controller (half-duplex speed of 1,800 baud; simultaneity is provided by 156-byte buffer; data speeds are switch selectable at time of installation; operates with 103 or 202 serial data sets, or 402D parallel data set using 7-/ or 8-bit code, with 1 start bit and 1 or 2 stop bits, and byte-only transfer; can handle auto call unit; can interrupt system during unattended operation to auto answer)	49	2,000	20

Notes:

* *Based on 36-month lease; 60-month full payout lease is available; may require up to a 10% security deposit.*
** *Maintenance prices are slightly higher outside regular service area; maintenance contract is mandatory with all leases.*
– *Not Applicable*

OVERVIEW

The Siemens System 404/3 is a byte and 16-bit word-oriented minicomputer marketed since 1970, primarily as a small batch disc processing business computer, especially to food wholesalers and retailers for whom the LEDAS Food Distribution and Accounting Package has been designed. It is also available as an intelligent remote batch or conversational remote job entry terminal to larger System 4004 EDP systems, as a dedicated typesetting and graphical control computer, and as a military real-time computer.

As a small business computer, System 404/3 is marketed in 32K- to 64K-byte configurations, that include 1 or 2 disc drives with 5.8 to 11.6 million bytes on-line capacity, card or paper tape readers and punches, and a high-speed serial matrix printer. Up to 16 buffered printing or display terminals can be locally or remotely connected to the system. Facilities to connect unbuffered teletypewriter terminals will also be available by the end of 1973. An assembler, RPG, and the LEDAS program package are available on minimum configurations; indexed sequential disc access, Cobol, and Fortran compilers on 40K-byte and larger systems.

As an intelligent remote batch or conversational remote job entry terminal, System 404/3 can be connected to a System 4004/35 or larger EDP system via a 9,600 bit-per-second local processor-to-processor connection or a 2,400 to 4,800 bit-per-second synchronous voice-grade communications line, using MSV 2 synchronous communications procedures that closely resemble IBM BSC.

As a dedicated real-time typesetting or military control computer, System 404/3 is available with 8K- to 64K-byte store sizes, and can address up to 118 process peripherals via its programmable I/O multiplexer.

System 404/3 was designed by the former Zuse KG and announced in 1969 as the Zuse Z43 real-time minicomputer for graphical, typesetting, military, and process control applications. Brown-Boveri used System 404/3 for a time in its turnkey process control applications under the label DP 100. By 1970, Zuse KG was completely integrated into the Siemens Data Systems Division, and the Z43 was renamed Siemens System 404/3. It continues to be manufactured at the former Zuse works in Bad Hersfeld. System 404/3 was announced as a small disc processing business computer, running under the LEDAS package for food wholesalers and retailers in December 1970, and as a general-purpose small business computer in November 1972; but continues to be offered also as dedicated typesetting and graphical systems controller. System 404/3 has been marketed until now only in West Germany.

CONFIGURATION GUIDE

System 404/3 is sold mainly in standard configurations, complete with applications software, as a small business EDP system, intelligent remote batch terminal, or graphical or typesetting system controller.

System 404/3 business EDP systems must include at least one 43521 exchangeable disc drive, and a processor with at least 32K bytes core store. Other I/O peripherals optionally available on all systems include both card and paper tape readers and punches of various speeds, serial and high-speed printers, and a synchronous communications controller; however, magnetic tape drives are not yet available. An asynchronous communications controller will be available by the end of 1973.

Table 1 gives System 404/3 specifications.

Central Processor. System 404/3 processor is a 16-bit-word parallel binary processor, with 15 general-purpose registers usable as accumulators and/or index registers, and a 37 instruction set. System 404/3 has facilities for register-to-register, store-and-register, and register-and-immediate operand operations, as well as direct and indirect addressing of the main store.

The core store has a 1.6-microsecond cycle per 8-bit or 16-bit-wide access and is available in 8K-byte increments from a minimum of 8,192 to a max of 65,536 bytes. Disc processing configurations, including all business EDP systems, require a minimum of a 32K-byte store.

System 404/3 processor is equipped with a standard program-controlled I/O multiplexer channel with 8 control unit positions, one of which will always be used for the console typewriter. Up to 62 peripheral devices can be addressed via these 8 control unit positions, to/from which byte-serial I/O transfers can be multiplexed under program control. An interface distributor (Schnittstellenverteiler) for process peripherals allows up to 118 process peripherals to be addressed via the multiplexer channel.

The 404/3 processor can be optionally equipped with a direct memory access (DMA) channel with a 500K byte-per-second throughput rate, to which any of the multiplexers 8 control unit positions can be connected. This is normally used to connect disc controllers.

Discs. All System 404/3 business EDP configurations include a 43521 disc drive with built-in controller connected to the processor's DMA channel. The disc drive is a "split IBM 2311 type," whose packing density, rotational speed and transfer rates are those of the IBM 2311/1, but reads/records data on the 2 x 4 inside surfaces of 2 superimposed 3-disc half packs (instead of 10 inside surfaces of a single 6-disc pack). Each 3-disc half pack can store up to 2,993,000 bytes when recorded in whole-track sectors, and the total on-line capacity of the 43521 at any one time is 5,986,000 bytes.

On-line disc handling capacity can be extended to 11,972,000 bytes by the addition of a 43522 disc drive, that is identical to the 43521 except that it is controlled by the main 43521 controller.

Printers. The 43210 console typewriter is a 13.3 characters per second Siemens I/O teletypewriter with a 69 position line width. This is used only for operating messages.

The 43210 high-speed printer is the main output device for processing results in business configurations. It is a serial matrix printer with a 600 character-per-second speed, resulting in effective print speeds ranging from 290 lines per minute for 120 to 136 print position lines, to 1,600 lines per minute for lines of less than 30 print positions.

The 43238 data writer is an alternative output device for process configurations. It prints lines of up to 120 print positions at 22 characters per second and has a 96-character set.

Paper Tape. Both high and low-speed paper tape readers and punches are available to meet a wide range of different input/output volumes:

- 2123 paper tape punch (5 to 8 tracks; 30 characters per second).
- 4228 paper tape punch (5 to 8 tracks; 150 characters per second).
- 4229 paper tape reader (5 to 8 tracks; 1,200 characters per second).
- 43224 paper tape reader (5 to 8 tracks; 120 characters per second).

Table 1. Siemens System 404/3: Specifications

PROCESSOR	
Main Memory (bytes)	8K-64K
Word Length (bits)	16
Addressable Registers	15
Cycle Time (μsec)	1.6
Program Languages	Ass.; RPG; Cobol; Frtrn
No. of I/O Channels	8
Max. Devices/Channel	8
AUXILIARY STORAGE	
Storage Medium	Exchangeable discs
Capacity (bytes)	5.99M-11.97M
Transfer Rate (cps)	156,000
KEYBOARD ENTRY	
Console Layout	Typewriter
Code Generated	ASCII-8
CRT DISPLAY	
Char Set	64
Max Char/Line	54
Max No. Lines	20
PAGE PRINTER	
Char Set	96
Max Char/Line	120
Rated Speed (cps)	22
PERIPHERALS	
Card Reader	666 or 1,000 cpm
Card Punch	100 to 300 cpm
Paper Tape Reader	120 or 1,200 cps
Paper Tape Punch	30 or 150 cps
Line Printer	290 to 1,600 lpm
Mag Tape Units	None
Others	None
LINE TRANSMISSION	
Line Facility	Voice-grade, leased or switched
Transmission Code	ISO-7 (ASCII-8)
Data Rate (bps)	2,400-4,800
Synchronization	Synch
Interface	V.24
Error Control	VRC; CRC
COMPATIBILITY	
Computer System	Siemens S/4004
Terminal Emulation	—
Bell Data Set	—

Cards. Readers and punches for 80-column cards are available, but not available yet for IBM 96-column cards:

- 43241 card reader (1,000 cards per minute, 2 output stackers).
- 43242 card reader (666 cards per minute, 2 output stackers).
- 43245 card punch (100 to 300 cards per minute, depending on number of columns punched into each card).

Data Communications. The 43341 Synchronous Communications Controller is available with 2 alternative line interface units.

The MSV 1 interface allows up to 16 buffered terminals to be connected locally or remotely as inquiry/response terminals, via one or more multidrop or point-to-point voice-grade lines, terminated by a 2,400 or 4,800 bit-per-second synchronous modem. Currently available terminals include:

- Transdata 8110 buffered teletypewriter terminal (18 characters per second; 120 print positions; 96-character set).
- Transdata 8151 alphanumeric display terminal (1,080-character screen arranged as 20 lines of 54 characters).

The alternative MSV 2 interface is designed for a single processor-to-processor line linking System 404/3 to a System 4004/35 or larger EDP system. This may be a local 9,600 bit-per-second (1,200 bytes per second) line, or a long distance data communications line terminated by a 2,400 or 4,800 bit-per-second modem.

An Asynchronous Communications Controller is expected to become available by the end of 1973; the controller will allow unbuffered teletypewriters and Teletype-compatible displays to be connected also to System 404/3.

SOFTWARE

System 404/3 software is bundled and is supplied in standard packages with the various standard configurations.

Operating Systems. A firmwired bootstrap on the System 404/3 processor allows the loader to be read into store. This then takes charge of reading in the main operating system, which will be responsible for reading in user programs.

The Basic Operating System for graphical, typesetting, and industrial control configurations, as well as remote batch terminal configurations without discs, comprises program load/unload, I/O supervisor, interrupt servicing routines, and mathematical and logarithmic functions.

The Disc Operating System for disc configurations requires a processor with at least 32K bytes of core store. It organises data on disc by the direct or sequential methods of access. If the processor has at least 40K bytes of core storage, the optional indexed sequential access method (ISAM) module can be included as well.

Data communications software provides for the use of Siemens MSV 1 line control procedures for the exchange of data via synchronous communications line with buffered terminals and MSV 2 line control procedures for the exchange of data with other Siemens processing systems. These procedures are almost indistinguishable from the corresponding IBM BSC procedures.

Future asynchronous data communications transfers will be controlled by Siemens LAUF and PIN procedures.

Languages. A one-for-one assembler is available on all system sizes. An RPG compiler is available on 32K-byte disc systems, a Cobol compiler conforming to ANSI B-level with some exceptions on 40K-byte and larger disc systems. An ANSI Fortran IV compiler with some restrictions is also available on 32K-byte and larger disc systems.

Applications Programs. The LEDAS Food Trade Distribution and Accounting System was the first small business accounting package to become available on System 404/3, prior to the disc operating system and RPG compilers. It is an integrated accounting package for food wholesalers and retailers, of which customised versions are generated automatically on the basis of parameter sheets filled in by the user. The System comprises:

- Files for up to 15,000 products grouped into 20 major groups and 2,000 subgroups for statistical purposes.
- Order entry and invoicing routines for up to 1,600 invoices per working day, with up to 600 items per invoice.
- Order entry and distribution statistics routines.

- Customer statistics routines for up to 1,600 customers, including up to 100 subsidiary companies.
- Daily and monthly accounts ledgers.
- Payroll routines for up to 1,590 employees with deductions for up to 30 different insurance companies.

The preceding work volumes and file sizes can be handled by a 32K-byte single disc system, larger files and volumes on systems with larger core stores and/or a second disc.

The COSI graphical and typesetting control package is available in different levels for various System 404/3 configurations from minimum 8K-byte systems upward.

There is also a scientific and mathematical package of standard algebraic and logarithmic routines.

DESIGN FEATURES

System 404/3 is in the mainstream of third-generation, 16-bit-word minicomputer design. All hardware arithmetic and logical functions take place in fixed-point binary on the contents of 16-bit words or 32-bit doublewords. However, there are standard software subroutines for fixed-point arithmetic on 48-bit triple and 64-bit quadruple words, as well as for floating-point arithmetic on doublewords comprising a signed 7-bit exponent and 24-bit mantissa or on triple words comprising a signed 8-bit exponent and 39-bit mantissa. See Table 2 for typical instruction execution times.

The processor order code offers 37 instructions, each can belong to one or more of up to 4 different instruction classes, resulting in a total of 81 instruction/class combinations. The 4 instruction classes are:

- A — register and directly addressed indexed main store.
- C — register and immediate operand.
- R — register to register.
- S — register and indirectly addressed main store.

Table 2. Siemens System 404/3: Typical Instruction Execution Times

Instruction (μsec)	Operand Length: Words (bits)			
	One (16)	Two (32)	Three (48)	Four (64)
Add register-to-register	1.96	2.94	110*	130*
Add register-to-indexed store	5.88	7.84	115*	135*
Multiply register-to-register	13.72	410.0*(1)	250*(2)	—
Multiply register-to-store	17.64	—	—	—
Floating-point add/subtract	—	470*	600*	—
Floating-point multiply	—	400*	640*	—
Floating-point divide	—	450*	800*	—
Shift	1.96+ 0.49n	3.92+ 0.49n	—	—
Branch on condition	1.96+ 0.98(3)	5.88+ 0.98(3)	—	—

* Performed by subroutine.
n Number of bits operand is shifted.
Notes:
(1) Doubleword operand multiplied by doubleword.
(2) Tripleword operand multiplied by singleword.
(3) If condition fulfilled.

Class A instructions are 2 words (32 bits) long, and comprise a 5-bit order code, 1-bit instruction length indicator, 2-bit class indicator, 4-bit operand register address, 4-bit index register address, and 16-bit main store address displacement. All other instruction classes are a single word (16 bits) long. In R instructions the second addressed register holds an operand, in S instructions the main store address of the second operand; while in C instructions the second register address is replaced by a 4-bit constant.

Apart from the discs attached to the DMA channel, all I/O operations are multiplexed by software.

Since System 404/3 processor structure and its assembler are more suitable for real-time programming than for commercial user programming, Siemens has been reluctant until now to let commercial users have access to the assembler. Until the Disc Operating System, RPG, and Cobol compilers became available in the second half of 1972, commercial EDP users were only supplied with ready-made applications programs, notably the LEDAS Food Distribution and Accounting Package.

PERFORMANCE AND COMPETITIVE POSITION

System 404/3 is a 16-bit word parallel binary real-time minicomputer designed primarily for industrial control operations, including graphical system and typesetting control, for which it is still actively marketed by Siemens. This is reflected in its single-address order code, and in the fast execution times for hardware-performed single- and doubleword fixed-point binary operations, and the program-controlled multiplexing of all I/O operations, except the disc systems attached to its DMA channel.

Since the end of 1970, Siemens has also marketed System 404/3 as a small batch-oriented disc processing business computer and as an intelligent remote batch terminal. Initially System 404/3 was marketed only to small firms in the West German food distributive trade for whom the LEDAS accounting program package was designed, but since the end of 1972 the System was also marketed more generally. This brings System 404/3 into competition with the IBM System/3 Model 10, Burroughs B 1700, Honeywell-Bull G100 series, ICL 1901A and 1901S, and Univac 9200 and 9200 II.

Except for the ICL systems, these are all byte-addressable, variable length operand computers designed specifically for business data processing; while their instruction execution times are slower than the 404/3s hardware-performed single- and doubleword fixed-point binary operations, they are generally substantially faster than the 404/3s software subroutines for performing most variable length operand operations. Most of the competing small business computers also offer generally a much wider range of processor store and disc backing store on-line capacities, as well as a wider choice of I/O peripherals. On IBM System/3 Model 10 and Burroughs B 1700 these include: 96-column card readers, punches, and MFCUs. The Burroughs B 1700 also offers advanced fourth-generation variable micrologic and powerful multiprogramming facilities.

System 404/3's position in the market for user-programmed business systems is thus not particularly strong, but it should continue to sell well for those applications for which Siemens provides complete applications packages, relieving the user of all programming worries — notably food distribution — and as an intelligent remote batch terminal to Siemens System/4004 EDP installations.

MAINTENANCE

System 404/3 is sold and maintained by the Siemens Data Systems Division, which has regional sales centres in 14 West German cities and in West Berlin, and a larger number of maintenance service centres. Emergency calls will normally be answered within 4 hours during normal business hours.

First delivered in 1969 for real-time control applications and in 1971 for business applications, System 404/3 is now a fully tried and tested design.

OVERVIEW

The Siemens Systems 4004/16 and 4004/26 are two relatively low-cost, upward-compatible batch processing computers designed to be equally suitable as stand-alone processing upgrades for punched card equipment users converting to EDP, or as on- or off-line input/output conversion satellites for a System 4004/35 or larger processing system. The small System 4004/16 is also eminently suited to operation as an intelligent remote batch terminal.

In all these capacities, Systems 4004/16 and 4004/26 compete mainly with the IBM System 360/20, 360/22, and 360/25 and the Univac 9200 and 9300 whose byte-oriented data structure and variable length decimal processing capacity they share. The strongest Siemens markets are its West German home market and neighbouring Switzerland and Austria. In all of these the firm vies with Univac for second place, but the Siemens systems are also offered in most other European countries except the United Kingdom. Other competitors include the Honeywell G-105, G-115, G-120, and H-115; ICL 1901 and 1901A; and NCR Century 50 and 100.

Systems 4004/16 and 4004/26 can exchange data off-line with most third-generation computers via industry-compatible seven- and nine-track magnetic tapes and IBM 2311-compatible exchangeable disc packs. Their magnetic tape and disc pack file formats are identical to those of the System 4004/35 and larger Siemens systems, the IBM System/360 and System/370, and the Univac 9000 Series. They are also fully interface compatible with System 4004/35 and larger System 4004 computers, to which they can be connected on-line either at the same site via a data exchange control unit, or remotely via a synchronous voice-grade communications line and a single-channel communications control unit.

Both System 4004/16 and System 4004/26 are upward compatible with each other at the source language level, as well as with larger System 4004 computers, IBM System/360 and 370, and the Univac 9000 Series, because their instruction codes are subsets of the full System 4004/System 360 instruction set. Their only programming languages are assemblers and report program generators, and the applications programs offered by Siemens are largely confined to input/output conversion and sort utilities.

Table 1 lists product specifications.

Table 1. Product Specifications

Central Processor	4004/16	4004/26
Word size (bits)	8 + parity	8 + parity
Capacity (words)	8-16K	16-64K
Cycle time (μsec)	0.88	0.88
Working storage	Core	Core
Auxiliary Storage	564 Disc	568 Mass Storage
Capacity per cartridge (mb)	7.25	67.1
Capacity per drive (mb)	7.25	536.9
Capacity per channel	58.0	2,147.0
Average random access (msec)	87.5	508.0
Magnetic tape drives	7-track	9-track
Transfer rate (kcs)	25-120	30-240
Data Output		
Line printer (lpm)	750; 900; 1,600	
Serial printer (cps)	20 (operator messages only)	
Cards (80-column cpm)	100; 300	
Paper tape (cps)	150; 28 (edge-punched cards)	
Data Input		
Keyboard	Standard for operator messages	
Card (80-column cpm)	1,000; 1,435	
Paper tape (cps)	1,200; 120 (edge-punched cards)	
Software		
Assembler	Yes	
Operating system	BOS; DOS	
Compiler	RPG only	

CONFIGURATION GUIDE

System 4004/16 comes with a minimum of 8K bytes of core memory, expandable to 16K bytes. Its single input/output channel offers six standard interfaces for peripheral controllers, each of which can control up to 16 addressable devices. One input or output transfer can take place concurrently either with processing or with one other input or output transfer.

System 4004/26 comes with a minimum of 16K bytes of core memory, expandable to 32K and 64K bytes. Input and output transfers can take place concurrently with processing on up to eight selector channels, each of which offers one standard interface for one peripheral controller which can control up to 16 addressable devices.

Both systems are limited to a peak combined I/O throughput of 568K bytes per second, while on the System 4004/26 individual transfers on any one of the eight selector channels must not exceed 284K bytes per second.

Auxiliary on-line storage is available in the form of exchangeable disc packs, magnetic card files, and/or magnetic tape. Five dual-drive and four single-drive magnetic tape units are available with transfer rates ranging from 25 to 120 kilocharacters per second for seven-track magnetic tape and from 30 to 240 kilobytes per second for nine-track magnetic tape. Up to eight drives in a number of allowable combinations can be controlled by a variety of single-channel and dual-channel controllers. The latter require connection to two separate selector channels on 4004/26 processors and can then offer read/write, read/read, or write/write simultaneity on any two of the up to eight drives under their control.

Siemens 564 exchangeable disc drives can read and record data on IBM 1316-compatible disc packs with a maximum capacity of 7.25 million bytes. Up to eight drives can be controlled on one 4004/16 standard interface or one 4004/26 selector channel, offering a combined on-line capacity of up to 58 million bytes per channel and average random access time of 87.5 milliseconds.

Siemens 568-11 magnetic card mass storage units can hold up to eight exchangeable card magazines with individual capacities of 67.1 million bytes and a combined on-line capacity of 536.9 million bytes per 568-11 unit. Up to four units can be controlled by one controller on one 4004/16 standard interface or one 4004/26 selector channel, offering a combined on-line capacity of 2,147 million bytes and average random access time of 508 milliseconds.

The range of available input devices includes:

- Two 80-column card readers with speeds of 1,000 and 1,435 cards per minute, with optional facilities for reading 51-column card stubs and/or vertical or horizontal pencil marks as well as punched holes.

- A 1,200 character-per-second, five- to eight-track paper tape reader.

- An edge-punched card reader for cards punched in eight-track paper tape code, with a reading speed of 120 characters per second.

- Two optical character document sorter/readers and two document readers with speeds of 750 and 1,530 documents per minute.

- Two optical character page readers with speeds ranging from 40 to 825 pages per minute depending on the number of lines to be read per page.

The range of available output devices includes:

- Three drum-barrel line printers with speeds ranging from 900 to 1,600 lines per minute, and the range of printable characters from 64 to 96.

- Two 80-column card punches with speeds of 100 and 300 cards per minute.

- A 150 character-per-second five- to eight-track paper tape punch.

- An edge-punched card punch and printer with an eight-track paper tape code punching and simultaneous printing speed of 28 characters per second.

Data communications facilities are limited to the 656 single-channel communications control unit interfacing with a 2,400 bit-per-second synchronous leased voice-grade line leading to another System 4004 processor. System 4004/16 and 4004/26 processors can also be interfaced with other System 4004 processors on the same site via a 627 data exchange control unit giving a data throughput equal to that of the slower of the two processor channels to which it is connected.

All System 4004/16 and 4004/26 configurations include a 4217 20 character-per-second teletypewriter as an operator's console.

SOFTWARE

Software for the System 4004/16 and 4004/26 is organised into four operating systems for distinct configurations:

- Basic Operating System (BOS) 4004/16 — for card or magnetic tape oriented System 4004/16 configurations.

- Disc Operating System (DOS) 4004/16.

- BOS 4004/26 — for magnetic tape oriented System 4004/26 configurations.

- DOS 4004/26.

BOS 4004/16 features a simple program loader for object code programs stored on 80-column cards or magnetic tape. These object code programs have to issue input/output instructions directly and supervise their satisfactory conclusion, while program sequencing is in the hands of the operator.

The other three operating systems — DOS 4004/16, BOS 4004/26, and DOS 4004/26 — include permanently resident executive (BOS 4004/26) or monitor (DOS 4004/16 and DOS 4004/26) programs responsible for sequencing, loading, and unloading user programs from a tape- or disc-held program library, initiating and checking input/output transfers on the basis of macroinstructions in the user programs, and analysing and handling all interrupts and machine malfunctions. The DOS 4004/16 and DOS 4004/26 monitors are also responsible for organising both the program library and user data files on the disc backing stores, and retrieving programs and/or data from disc when required.

Each of the four operating systems offers a basic assembler language a report program generator (RPG), an input/output control system (IOCS), program testing aids, library maintenance programs, a sort/merge generator, and a set of input/output transcription (card-to-tape, card-to-disc, disc-to-printer, etc.) utility routines.

DOS 4004/26 macro assembler is a fully upward compatible superset of the DOS 4004/16 and BOS 4004/26 macro assemblers, all of whose input/output instructions are designed to be executed by executive or monitor routines, but not of the BOS 4004/16 assembler which includes special I/O instructions for direct execution.

DESIGN FEATURES

The System 4004/16 and 4004/26 processors are original Siemens designs using monolithic microintegrated TTL (transistor-transistor logic) circuit technology but are designed to be fully machine code compatible with the earlier (RCA-designed) transistorized 4004/15 and 4004/25 processors, respectively, which they replaced in the Siemens product line in 1968. The 4004/16 and 4004/26 both feature core stores with 0.88-microsecond cycle times per one-byte access, but with 8K and 16K byte store sizes on the 4004/16 and 16K, 32K, or 64K byte store sizes on the 4004/26.

System 4004/16's instruction set includes 17 processing and 10 input/output instructions. The processing instructions include both fixed-point binary and decimal addition, subtraction, logical comparison, and editing instructions on variable length operands of 1 to 16 bytes (1 to 31 decimal digits + sign or 7 to 127 binary digits + sign), a bulk move instruction for 1- to 256-byte blocks of data, and a conditional branch instruction. Both operand and branch store addresses are absolute, using the lowest 13 or 14 bits of a 16-bit address field in the instruction itself.

The 10 input/output instructions include a Read Simultaneous and a Write Simultaneous instruction besides the normal Read and Write instructions. The Read/Write Simultaneous instructions can be given to any peripheral controller that sends or receives data in externally identifiable blocks (thereby excluding paper tape and edge-punched card readers, punches, and teletypewriters), and the transfers that these instructions initiate are the only ones that can take place simultaneously with computing. Transfers initiated by normal Read and Write instructions inhibit all computing while they take place but can take place concurrently with a previously initiated Read Simultaneous or Write Simultaneous instruction.

A third potential level of I/O simultaneity is represented by the buffered line printers and card punches. These devices free the input/output channel as soon as their buffers have been filled for the next line of print or the next card to be punched.

System 4004/26's instruction set includes 25 processing and 8 input/output instructions. The processing instructions include all the 17 instructions of the 4004/16 set as well as decimal multiplication and division, (paper tape) code translation within store, three additional branch instructions including subroutine entry and exit instructions, and instructions for loading and storing the contents of any one of 16 general-purpose 16-bit (two-byte) general registers held in the core store. These are used mainly as base address registers, as the effective store addresses for both branch instructions and decimal or binary or logical operands are always calculated as the sum of the 16-bit contents of the general register selected by a four-bit base register address field in the instruction, and of the 12-bit contents of the displacement field of the instruction.

The 4004/26's eight input/output instructions are normally used only by the executive or monitor program, whose I/O routines are entered by user program I/O macros. Input/output transfers can occur simultaneously with computing on each of the eight selector channels, subject to a maximum transfer rate of 284K bytes per second on any one selector channel and a maximum combined transfer rate of 568K bytes per second on all channels.

PERFORMANCE AND COMPETITIVE POSITION

Internal execution speeds achieved by the System 4004/16 and 4004/26 processors are identical for the instructions that they have in common and differ substantially only for decimal multiplication and division, which must be performed by software subroutines on the 4004/16. These speeds are substantially faster than those of the IBM System 360/20, 360/22, and 360/25; Honeywell G-105, G-115, G-120 and H-115; ICL 1901 and 1901A; NCR Century 50 and 100; and Univac 9200 and 9300, and are only slightly slower than those of the IBM System/3 Model 10.

Input/output simultaneity on the 4004/16 is more restricted than on most rival systems, but the System 4004/26 offers potentially greater I/O simultaneity than any of its competitors except the Univac 9200 and 9300.

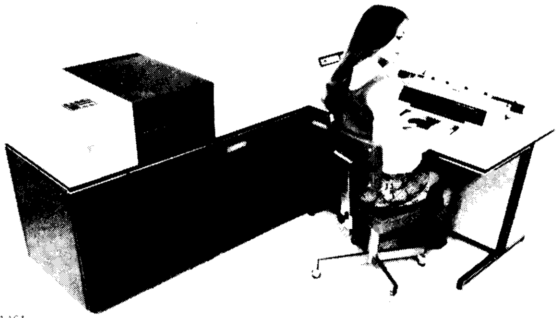
With programming languages restricted to an assembler and RPG, System 4004/16 and 4004/26 software is equal to that available on the IBM System/3 Model 10 and 360/20 but is not as comprehensive as that offered on the IBM 360/22 and 360/25, and all competing Honeywell, ICL, NCR, and Univac systems, on which Cobol and Fortran are also offered as well on 24K-byte and larger disc and magnetic tape configurations.

HISTORY

Siemens AG is the largest West German and one of Europe's largest electrical and electronic combines, with interests in heavy electrical engineering, power transmission, medical instruments, and telecommunications in addition to EDP, which is handled by only one out of six major divisions. The EDP Division has been manufacturing computers of its own design since the mid-1950s and the part-RCA-designed System 4004 since 1965. It currently employs about 15,000 personnel and manufacturers, besides the System 4004, the System 300, 320, and 404 real-time process control computers.

The System 4004/16 and 4004/26 processing systems were announced in 1968 and replaced the earlier RCA-designed 4004/15 and 4004/25 transistorised computers, which had been available only in card and magnetic tape oriented configurations. System 4004 includes also the larger 4004/35, 4004/135, 4004/45, 4004/46, 4004/150, and 4004/151 processing systems that compete against the IBM System/370 Models 135, 145, and 155. This range was developed in close cooperation with RCA until the latter's decision to withdraw from the EDP business in September 1971.

In February 1972, Siemens entered into a technical cooperation and marketing agreement with the French Compagnie Internationale pour l'Informatique (CII) for the joint marketing of their current computer ranges and the joint development of a new computer range that will be fully upward compatible with System 4004.



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OVERVIEW

The Singer Business Machines 6800 is a turnkey small business computer oriented toward interactive processing. Keyboard entries are processed by manufacturer-supplied programs, with data files stored on small disc packs; output is to 1 or 2 CRTs or printers.

The 6800 bridges the gap between the 5800 system, a very small, programmable visible-record accounting system that is an outgrowth of the Friden accounting machine line and Singer's System Ten computer line. The processor used for the 6800 is actually Singer's smallest System Ten CPU capable of maintaining a disc, but the 6800 package is less expensive than the identical configuration on the System Ten. User programming is limited on the 6800. The only hardware expansion allowed is the addition of one more CRT and 10K bytes of core memory. Users who need to expand further can move up to a System Ten with no change in software.

Although Singer itself is only a recent entrant to the ranks of computer suppliers, its Business Machines Division, formerly Friden, which originally manufactured and sold System Ten, was founded in 1934 and is currently one of the largest manufacturers of desk calculators and accounting machines. As a result, Singer has an excellent understanding of the data processing needs of the business community, considerable expertise in manufacturing and servicing equipment to meet those needs, and detailed knowledge of the specific requirements of its accounting machine customers, many of whom may want to change to electronic data processing.

Performance and Competitive Analysis

The 6800 System is designed for the novice computer user; it is also a replacement for an accounting machine. As a strictly turnkey system with limited expansion capability and no communication facilities offered, it provides a beginner with a minimum of trouble. After files have been developed and a user wants to expand his capabilities or to develop his own software he can move up to System Ten. The 6800 does allow disc storage of master files, unlike the smallest computers in the Burroughs series, for instance. At first glance, its lack of expandability seems to place it at a disadvantage with other small business computers like the Eldorado 140, Litton 1200, Burroughs L Series, Qantel Q Series, and Ultimacc systems. This apparent lack is in name only, however, because the 6800 is a very small System Ten and many of its limitations are imposed by the manufacturer, not the hardware. Upgrading to the System Ten is like moving up to another member of the same computer family rather than to a completely different computer system. Users with applications that fit the 6800 may prefer it over a System Ten because of its lower price.

CONFIGURATION GUIDE

The 6800 comes in 3 configurations.

- Minimum Configuration — Model 70 Workstation, Model 42 Disc, 1 IOC channel.
- Midi Configuration — Model 80 CRT, Model 42 Disc, Model 52 Printer, 1 IOC channel.
- Maximum Configuration — Model 80 CRT, Model 70 Workstation or second Model 80 CRT, Model 42 Disc, Model 52 Printer, 2 IOC channels.

Both of the minimum configurations use a processor with one memory partition of 10K words plus 10K words of common core. The maximum configuration uses 2 partitions plus 10K words of common core for a total of 30K words of memory.

COMPATIBILITY

The 6800 is upward compatible with System Ten, but 5800 files must be reformatted to be used on the 6800.

MAINFRAME

Product specifications for the 6800 appear in Table 1.

Central Processor

The central processor for the 6800 is a System Ten Model 20 with either 2 or 3 memory partitions.

Table 1. Singer System 6800: Specifications

Characteristic	Singer 6800
PROCESSOR	
Main Memory (kc)	30
Char Size (bits)	6
Addressable Registers	3/partition, except Common
Cycle Time (μsec)	3.3
No. of I/O Channels	1 slow-speed/user partition; 1 high-speed (FAC)
Max Devices/Channel	2 allowed
AUXILIARY STORAGE	
Storage Medium	Disc
Capacity (mc)	4.0
Transfer Rate (kc/sec)	229
DATA ENTRY	
Keyboard	Workstation; includes serial printer (15-25 cps)
CRT	Keyboard and 10-key numeric pad, 1,600 characters (1,500 cps)
Card Reader (cpm)	No
Paper Tape Reader (cps)	No
DATA OUTPUT	
Card Punch (cpm)	No
Paper Tape (cps)	No
Line Printer	132 col; 70 lpm
CRT Display	80 col by 20 lines
SOFTWARE	
Operating System	Multipartitioning via hardware
Assembler	No
Compiler	No

Data Structure. The System Ten processor on the 6800 uses 6-bit characters. Data fields are variable in length and can contain up to 10,000 characters, depending on the instruction being executed.

Instruction Set. The 6800 System Ten processor uses 13 basic types of machine instructions. The instruction word length is 10 characters (60 bits). Most instructions specify 2 operand addresses of 4 characters each. I/O instructions, however, use one operand for the address of the I/O area, and the other for the data count. If the addressed device is a disc, the second operand is treated as an indirect address. All disc transfers are in blocks of 100 characters.

Addressing Facilities. Every location in core memory can be addressed directly. A program instruction can directly address any location in its partition, and any location in the Common partition, each of which can be up to 10K characters. There is no indirect addressing. Indexed addressing is single-level, and it can be specified for either or both of the operands. Indexing of one operand address requires 31.1 microseconds, and indexing of both operand addresses requires 58.9 microseconds.

Interrupt Control

Interrupts occur as a result of program checks and initiation of I/O transfers. When a single character is ready for I/O transmission, an interrupt is signaled by the IOC. The processor temporarily stops processing in whatever partition it is currently working, transfers the character, then resumes processing where it left off. If the processor should switch to a partition in which an I/O operation is in progress, it immediately switches to the next partition. Interrupt processing is built into the hardwired operating system and is transparent to the software.

There are 5 causes of a program check: an out-of-limit address, a privileged area violation attempt, an attempt to store the protected area of Common, an invalid op code, and bit 5 in any character of an instruction not being a 1.

Main Memory

The 6800 (System Ten) memory is divided into a hardwired partition called Common and 1 or 2 user partitions; each partition shares the Common partition. The Common area stores subroutines and data that can be shared to avoid duplication. Control of the processor by each of the user partitions is hardware monitored through a round-robin, time-slicing priority system. Each partition can receive up to a nominal 37.5 milliseconds for execution. Common does not have its own time slice; instead, programs in that area are activated by branching from a partition's program, and remain active only for the duration of the calling partition's time segment.

In the 6800, Common is up to 10,000 characters long; the first 300 character locations are protected from program alteration although they can be examined.

In addition, minimum systems contain a single user partition with its associated IOC channel and up to 10,000 characters of storage. Because the round-robin time slicing does not apply to Common, there is no effective time slicing in minimum configurations. In the maximum 30K configuration, however, there are 2 user partitions of 10K characters each; here the time slices alternate between the 2 user partitions.

Input/Output Control. I/O control is established via the FAC (file access channel) for the high-speed magnetic disc, and via the IOC for all other 6800 peripherals. One dedicated IOC is associated with each user partition; usually the workstation or the CRT/line printer combination is associated with a partition, but not both. Data transfers via IOC are overlapped with processing on a cycle-stealing basis. Each IOC can support a data transfer rate up to 1.5K characters per second. In the maximum configuration with 2 user partitions, programs in Common can access either partition, and consequently can use all 3 peripherals.

FAC. Each user partition shares the single FAC to access the magnetic disc files. This architecture allows the same files to be used simultaneously by 1 or both partitions, although the software can allocate these resources selectively by partition; it also prevents overwriting of records in use. FAC supports data transfer rates up to 330K characters per second. Operations proceed sequentially and FAC transfers halt all processing activities, but operations can proceed on the IOCs.

PERIPHERALS

The 6800 has 4 possible peripherals: the Model 42 Disc Drive, the Model 70 Workstation, the Model 80 CRT Display, and the Model 52 Line Printer. There are no communication devices.

Model 52 Line Printer. The Model 52 Printer prints up to 70 lines per minute, with a maximum line length of 132 columns. A buffer stores data for 2 lines of print; buffering is necessary so that the output flow remains uninterrupted when the CPU is servicing another channel or peripheral device. Otherwise an interrupt would occur with every byte transferred.

Model 42 Disc Drive. A split-disc drive, Model 42, features 2 separate and removable disc packs — 1 mounted on top of the other in a single unit. The resident pack (Model 41A) is used for active manipulation and filing of data, which then can be duplicated onto the other pack (Model 41B), called the "removable pack,"(although both packs are removable) and stored for file backup. Maximum capacity is 4 million characters per pack, 8 million characters per drive. Average access time is 73 milliseconds and transfer rate is 229,000 characters per second.

Model 70 Workstation. A desk-type data entry keyboard and serial printer output device, the Model 70 Workstation provides interactive communication with the CPU and prints output at 15 to 25 characters per second. The workstation features a standard alphanumeric keyboard and prints a 170-character line using a pressure-platen forms handler. Optional features include a pin-feed forms handler. An operator panel assists the operator with indicator lights displaying system status. The workstation can serve as a load device when given device address zero. The Model 70 can be located up to 2,000 feet from the processor.

Model 80 CRT Display. The Model 80 CRT is another interactive device for communicating with the CPU. It adds a 10-key numeric cluster similar to those on adding machines and unavailable on the workstation. Also, instead of the workstation's serial printer, it uses a CRT to generate a 1,600-character display in an 80-column by 20-line format. This display is fully buffered so that the CPU simply reads into the buffer the 1,600 characters of the display and then goes on to service another channel or I/O device.

The CRT display can be programmed to resemble a blank form onto which the operator "types" entries before feeding the entered data to the CPU. This is an advantage to a new operator because it shortens the question and response time between the computer and operator, and only the response need be transmitted to the 6800. The unit can be located up to 2,000 feet from the CPU.

SOFTWARE

The 6800 is basically a turnkey system with programming for Sales Accounting and General Accounting fully developed. The processor has no operating system as such; the hardware partitioning takes care of multiprogramming 2 simultaneous users by its time-slicing priority scheme in the maximum 30K-character system.

Other systems have only one user partition; thus one program operates at one time. Devices are buffered interrupts are hardware-generated, and each partition has its own dedicated I/O device.

In addition to the specific application software, all systems have a disc file management package. This allows operators to add, update, display, or delete records. File descriptors can be coded to protect certain fields, so they cannot be altered or deleted unless they meet certain conditions. For example, a second field may have to be in a zero or blank condition, or the new data may have to go through a checking routine or itself meet certain conditions.

Sales Accounting. The Sales Accounting package can run on all 3 configurations, since it accepts I/O from either the workstation or the CRT/printer combination. It includes programs for order entry and invoicing, accounts receivable, inventory, and sales analysis. The inventory and sales analysis programs are based on entries to the order entry and invoice programs and are basically computer-generated reports. The inventory program posts receipts and adjustments, (including stock transfers, purchase orders, stock issues, changes in customer back-order requirements), and lists inventory in several ways, ranging from a simple warehouse list with stock number, description, and so on, to lists broken out into out-of-stock items, purchase order status, or valuation reports. The sales analysis programs analyze salesmen's commissions, quotas, customer totals and profit percentages, product classes, and so on.

The Accounts Receivable and Order Entry and Invoicing programs are basically interactive, providing the ease and accuracy of computer-assisted entry for normal entries and an ease in handling exceptions that is more characteristic of manual systems than batch-processing computer systems. During the posting of cash under control of the Accounts Receivable programs, the operator enters payments and any corrections required to the customer's account, which is completely displayed (or printed). Reports from Accounts Receivable include an aged trial balance, finance charge computation, customer statements, sales tax reports, and an exception report for nonstandard situations.

Order Entry and Invoicing programs differ slightly depending on whether the Workstation or CRT/printer combination is used for I/O. The workstation uses the method commonly called "finished form invoicing", which produces an invoice as data is entered into the system. This could be at the point of sale for a small business, prior to the shipment of the merchandise, or after the shipment of the merchandise. The Order Entry method used with the CRT/printer configuration, on the other hand, prints invoices in a batch, not at the time of data entry into the system. In either case, the program notifies the operator of out-of-stock items, performs automatic credit check, and provides back-order information.

General Accounting. The General Accounting Package, which should operate in a configuration with a CRT and printer because of the extensive. varied reports, consists of programs for Accounts Payable, General Ledger, and Payroll. Accounts Payable captures vendor invoice data via the CRT keyboard and releases and prints checks on the printer. It also projects cash requirements and distributes expenses to the General Ledger system. Payroll establishes standard pay data per employee, it makes any adjustments for exception entries such as overtime and special deductions. General Ledger accepts operator entries, audits them for validity, and posts them to the general ledger accounts. A journal is produced. A number of financial reports can be defined for production, for instance, a report of percentage comparisons or budget comparisons could be printed.

HEADQUARTERS

Singer Business Machines
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The System Ten 110 Models are basically canned or fixed System Ten configurations that allow users with standard applications, particularly wholesale or distribution businesses to obtain bargain-priced turnkey computer systems. This marketing approach has been prevalent in the minicomputer field for the last year. The old method of selecting configurations from a shopping list or menu, à la carte, is the expensive way to buy. The canned configuration, like the full course dinner, provides soup to dessert at a system price up to 20 percent cheaper than a comparable system selected à la carte. Apparently, the economies begin with the salesman who writes only one number for a standard configuration and continue through simplified production and delivery. Singer has adopted this canned configuration approach with the new system Ten 110 Models.

All System Ten 110 models are disc-based systems, and three of the four new systems are CRT-display oriented. The 110-1 and 110-3 are disc-based billing-type systems that can replace punched-card systems or accounting machines. The 110-4 and 110-5 are larger systems that feature multiprogramming with data entry from up to three terminals. The I/O terminals for all systems can be located up to 2,000 feet from the processor. Table 1 summarizes the system characteristics.

The keys to success for modern-day, small business computer systems are on-line data entry display terminals and disc storage. This combination allows the development of files for information management from online terminals. Transactions can be immediately reflected in the data base and retrieved for any number of functions: invoicing, accounts receivable, accounts payable, accounting, inventory control, and sales analysis. The new Singer Models fit this success mold, with up to 40 million characters of on-line disc storage and up to three data entry terminals. There are indications that other turnkey systems will follow the 110 Models. One obvious direction is to more on-line terminals.

Table 1. Singer System Ten: The 110 Configurations

	110-1	110-3	110-4	110-5
Processor	System 10	System 10	System 10	System 10
Core Memory (char)				
Min	20,000	20,000	30,000	30,000
Max	20,000	20,000	40,000	40,000
I/O Channels				
Min	1	1	2	2
Max	1	1	4	4
Disc Drive				
Model 42 (8M chars)	1	1	1(1)	
Model 40 (20M chars)				2
I/O Work-station				
Model 70 (25 cps)	1			
I/O CRT Display				
Model 82 (1,920 chars) (24 lines, 80 cols/line)		1	1, 2*	2, 1*
Printer				
Model 51S (165 cps)		1		
Model 52 (100 lpm)			1(2)	1(2)
Model 54 (200 lpm)			1*	1*
Price of Min Configuration	$25,000	$34,800	$43,300	$66,600

Notes: (1) Model 42 Disc can be field upgraded to a Model 40.
(2) Either a Model 52 or 54 Printer.
**Optional.*

Software for the 110 Models is the System Ten business application package called SPA (Systems Programmed Applications). The SPA package will be marketed internationally with national versions under the name of STELLA (Latin for "star" — Systems Programmed Applications Reporting. SPA includes the following modules.

- Order entry/invoicing.
- Finished forms invoicing.

- Accounts receivable.
- Accounts payable.
- General ledger accounting.
- Payroll.
- Inventory control.
- Sales analysis.

In addition, a set of routines, RPG II and a Client Accounting package for certified public accountants, will be available for Models 110-4 and 5.

First deliveries of Models 110-4 and 110-5 were in August 1974, and first deliveries of Models 110-1 and 110-2 are scheduled for November 1974.

OVERVIEW

WANTED: A small- to medium-scale business computer, flexible in terms of available peripherals, extensive communications capabilities, available on turnkey, competition for IBM System/360, System/3 and must be low cost, must not have operating system.

No operating system? In a third-generation machine that competes with IBM's 360/40?

In a world where the relationship between operating system software and hardware is finally being understood and developed, Singer has produced an operating-system-less computer that not only is selling well but has an impressive array of very satisfied customers.

Singer's System Ten is small- to medium-scale business computer used both by small businesses that do not need or cannot afford larger computers, and by very large organizations with scattered work locations needing a network of on-site terminals to provide input to larger computers.

What characterizes users in almost all cases is that jobs being run on the System Ten are all of equal priority and are, for the most part, continuous (in-house data capture, such as retail sales and inventory monitoring).

What characterizes the system in most cases is its comparatively modest cost and its flexibility and ease of operation.

The simple message is: If you want to run programs of equal priority, or remote processing, or with a remote job entry terminal, there probably is no system better able to give equal weight to all jobs.

System Ten's ease of operation means that little training is required for its standard and special-purpose I/O terminals to be used by clerical personnel, sales persons, factory workers, hospital orderlies, and others. Users report as little as 2 hours are needed before a previously untrained person can comfortably use the system. Part of the ease of use comes from the fact that the System Ten does not have an operating system; therefore, there is no "operator," per se.

The System Ten is flexible. It provides time sharing and on-line information storage and retrieval with up to 20 simultaneous users and 200 I/O devices on one system. It can serve as a remote processor and I/O terminal for a larger central computer such as an IBM System/360 or 370. The System Ten can combine batch processing with time sharing operations and offers multiprogramming.

The System Ten is available on a turnkey basis, complete with either standard or some customized application packages. A comprehensive set of utility routines facilitates programming. This includes routines for program loading, card and paper tape reading, punching, verifying, and duplicating. In addition, common calculating routines are available, as are sorting and merging programs for both disc and magnetic tape, and computer-to-computer communications programs.

Languages available are RPG and Assembler.

The availability of special-purpose peripheral equipment, which replaces such devices as automated time clocks and semiautomatic merchandise checkout terminals also lends flexibility to System Ten. Special-purpose peripherals include employee badge readers and cash-register-type terminals with merchandise tag readers.

The System Ten's flexibility is due to the modular design of the system architecture. The multiprogramming is provided by a round-robin, time slicing priority system that is monitored by hardware without the use of an operating system. Plug-in 10K increments of core memory expand the system from the smallest configuration up to a total of 110K. Simple 2-wire connections hook up I/O terminals up to 2,000 wire-feet away from the central processor.

System Ten's field expandability means that operator stations or more storage modules can be added at the installation site without interrupting the operation. As a result, users can start out with small systems and expand to larger configurations as needed.

Although Singer itself is only a recent entrant to the ranks of computer suppliers, its Friden division, which originally manufactured and sold System Ten, was founded in 1934 and is currently one of the largest manufacturers of desk calculators and accounting machines. As a result, Singer has an excellent understanding of the data processing needs of the business community, considerable expertise in manufacturing equipment to meet those needs, and detailed knowledge of the specific requirements of its accounting machine customers, many of whom may be considering a change to electronic data processing.

CONFIGURATION GUIDE

Two basic processors, Model 20 and 21, and three basic configurations exist. Each of the configurations, the 101, 104, and 106, has been designed for a specific application and requires certain minimum equipment. In addition, each configuration can add optional equipment or increased quantities of the minimum required items.

The minimum and maximum hardware configurations for the Model 20 processor appear in Table 1.

The Model 21 processor differs from the Model 20 in that its common area can be as large as 65K; it supports indirect addressing, has a new instruction, and does not support the "privileged common" feature of the Model 20. Singer also advises that users convert to Assembler II and DMF II to fully utilize the Model 21.

One result of the new processor is that users can now execute a program up to 75K bytes in length (65K common and 10K in the partition).

Series 20-101. There are 2 versions of the Series 101 Configuration: Model 101-RJ and Model 101-TP. Both versions are oriented toward communications facilities, either synchronous or asynchronous. Both units in this series use the Model 80 CRT Display as an input device, and offer punch card or other processing equipment only in the maximum configurations. Disc storage (8 million characters) is available only in the largest configurations of this series.

Series 20-104. The Series 20-104 configuration handles larger volumes of data that can be handled by the 20-101 configuration, and has more extensive terminal capacity and greater expansion capability than the 20-101, including the use of punched-card equipment.

Because of its greater memory, this configuration can use the more powerful versions of Singer's file management software. Disc capacity can be from 20 million to 100 million characters; and for each additional hardware partition (maximum 20) another 10 I/O devices can be added. This gives a theoretical maximum of 200 terminals with up to 20 simultaneous data entries.

In addition, the 20-104 configuration can be used not only as a local computer, but also as a front-end computer to process and summarize data before transmission to a larger central computer system via wires, tapes, or disc. It does not handle data communications devices.

Table 1. Singer System Ten: Hardware Configurations for Model 20 Processor

SERIES 101

Model 101-RJ

Minimum

1 Model 20-101 processor with 10K core
2 I/O channels; SCA, ATA, or ACA
1 Model 53, 54, 55 or 56 Line Printer
1 Model 80 CRT Display

Max Additional

20K additional core
1 additional I/O channel
Additional Model 80 CRT, Model 31 Card Readers, Mdl 35 Card Punches or Line Printers, depending on I/O ports

Model 101-TP

Minimum

1 Model 20-101 processor with 20K core,
1 FAC; 1 disc controller; 2 I/O channels,
1 SCA, ATA, or ACA
1 Model 42 Disc Drive
1 Model 53, 54, 55, or 56 Line Printer
1 Model 80 CRT Display

Max Additional

10K additional core
1 additional I/O channel
Additional Model 31 Card Readers, Model 35 Card Punches, Model 80 CRTs, or line printers, depending on I/O ports available

SERIES 104

Minimum

1 Model 20-104 processor, with 20K core, 1 FAC, 1 disc controller, and 2 I/O channels

2 Model 70 workstations or 2 Model 80 CRT Display (CRT requires line printer)

2 Model 40 disc drives

Max Additional

Any device except Model 42 split disc and SCA or ATA communications adapter; includes additional core to max 110K, workstation, CRT, regular disc, line printer, mag tape, card reader or punch, paper tape reader or punch, JIS, attendance terminal, digital clock; total disc capacity: 20-100 mc

SERIES 106

Minimum

1 Model 20-106 processor, with 20K core, 1 FAC, 1 disc controller, 3 I/O channels (for nondisc communications systems, omit FAC and disc controller).

Max Additional

Additional core to max 110K; any System Ten peripheral including SCA or ATA communications adapter, workstation, CRT, split or regular disc, line printer, mag, card reader or punch, paper tape reader or punch, communications terminal, JIS, attendance terminal, or digital clock; total disc capacity: 20-100 mc (same as 20-104).

Series 20-106. Communications-based remote batch processing is the key concept for the 20-106. The 20-106 processor configuration can use a wide variety of terminals and communications devices to process source data off-line before its transmission to the host computer. Of the 3 configurations, the 20-106 is the most flexible in variety of applications, and is the most easily expandable because it can accommodate any Singer peripheral device without restriction. It can serve as an intelligent terminal (for example, 1 or more processors can appear to the host computer as an IBM 2780 remote job entry terminal) and has advantages in cost/performance over the other 2 configurations.

Special Capabilities

Singer System Ten is distinguished by certain hardware features that give it a personality all its own.

Modularity. Memory, additional I/O channels, and additional peripheral devices are simply plugged in. All components are upward compatible.

Hardwiring of Peripherals. Slow-speed devices such as CRT and typewriter (workstation) terminals, line printers, card and paper tape readers and punches, are connected by a simple 2-wire interface and can be located as far as 2,000 feet from the central processor. In most cases special-purpose peripherals, for instance, point-of-sale cash-register-type terminals and badge readers, can be connected by the same 2-wire interface as far as 8 miles from the central processor. Each user partition has one I/O channel (IOC) and each IOC accommodates up to 10 terminals, depending on the terminal mix.

Disc and Magnetic Tape Capabilities. The System Ten magnetic disc and tape drives interface with the processor through a high-speed file access channel (FAC), which can handle up to 4 tape drives and up to 10 disc drives. This allows a generous maximum of 100 million characters of disc storage. Magnetic tape drives can handle either 7- or 9-track format that is compatible with other manufacturers' drives.

Easy-to-Use Terminals. Various I/O terminals, including CRT, keyboard, and special-purpose, have helpful console lights to guide an inexperienced user, so that little training is needed.

Hardware Multiprogramming. The System Ten memory is divided into a partition called Common and from 1 to 20 user partitions, each of which shares the Common partition. The Common area stores subroutines and data that can be shared, to avoid duplication. Control of the processor by each of the user partitions is hardware monitored through a round-robin, time slicing priority system. Each partition receives 37.5 milliseconds for execution. Partition sizes are specified at installation, with a minimum of 1K increments.

The round-robin, time slicing priority system means that in the System Ten environment there can be no thing such as a rush job, or a priority queue of express jobs; the fact that an I/O interrupt prematurely terminates a partition's time slice means that an I/O-bound program's chances of being executed in a reasonable length of time, comparative to other competitive machines, are relatively slim. The only environment totally suitable for a System Ten is one with approximately equal programs with respect to I/O-processing balance and priority. This makes it an excellent remote processor.

Software. Singer System Ten software consists of 2 levels of assemblers with comprehensive sets of utility routines; the software also includes 2 report program generators, software packages for use when System Ten is employed as remote processor or input device for a large computer, and an extensive group of modules for business data processing. None of these language implementations or software packages is compatible with those of other computer manufacturers. The user has the option of obtaining the System Ten on a turnkey basis, complete with either standard or customized applications packages.

Performance and Competetive Position

Singer's System Ten computer is intended for business data processing such as sales order entry, invoicing, accounts receivable and accounts payable processing, inventory control, sales analysis reporting, general ledger processing, and payroll processing. Some work environments in which it has proved useful include the following: wholesale and retail merchandising for point-of-sale data collection, inventory control, and sales analysis; garment design and manufacturing business for analysis of styles, control of manufacturing and inventory; aerospace manufacturing organization for on-site scheduling of manpower and work priorities; a large hospital that uses it for 24-hour on-line control of supplies inventory and billing of services to patients; a large film-rental library in a state university for statewide film bookings; a large computer installation for locating and scheduling the use of thousands of reels of magnetic tape.

Comments from users indicate that System Ten was selected after comparisons with all other makes on the market led them to believe that, for the price, no other system offered the same advantages of on-line interactive processing combined with the modularity that permits easy growth. Users feel that System Ten requires little training, because any clerk typist can operate a terminal after a few hours experience.

In addition, users of larger computers are finding System Ten a useful supplement to or substitute for the larger computer. They are installing System Ten because of the advantages of having 1 or more small flexible computers in-house and dedicated to a specific project, rather than having to share a larger computer located elsewhere.

Some recent applications using System Ten include the following.

Hospital. A large general hospital developed manual procedures over a period of 5 years, to identify where drugs, supplies, and services such as surgical, nursing, and laboratory were used; to control inventory of drugs and supplies; and to bill patients for these items.

This hospital eventually needed a system that could be on-line 24 hours per day, could be run by hospital orderlies or unskilled personnel, and would cost less than time on a large computer. The hospital investigated the capabilities of IBM System/360 Model 40 and DEC's PDP-15 Series before looking at Singer System Ten. Features of the System Ten that held appeal and led the system's installation in the hospital were the combination of lower-cost, hardware-controlled multiprogramming; on-line conversational terminals; simultaneous operation of programs; ease of expanding the system for future growth; and the convenience of having small functional units that are job-oriented. This hospital has installed System Ten, using 2 computers with 8 CRT terminals and 2 typewriter-type workstation terminals, for inventory control and billing of customers. Supplies used, and doctor's and nurse's services, can be billed to each patient. A simple system in which information is typed by hospital orderlies at a terminal, for use in billing as well as automatic inventory control and reordering of supplies, has enabled the hospital to perform more accurate inventory control 24 hours per day; the system has also reduced inventory from a 150-day stock level to a 30-day level, as well as to decrease losses on inventory items by more than $500,000 a year.

University. A large state university has installed a System Ten with 30K core for scheduling bookings of rental films that are distributed to schools across the state. The film library has more than 9,000 film titles, with 1 to 35 prints of each film. Schools order a film for as many days as needed. Scheduling must be done as much as 16 months in advance; there are as many as 120,000 bookings per year.

One requirement that the library expected the computer to meet was the on-line retrieval of information. Singer System Ten was the only computer that met the requirements of low cost, on-line processing, and flexibility to perform various functions. IBM System/3 was not on-line but merely card based.

Now with a System Ten and an on-line interactive terminal, the personnel can determine immediately if a request can be honored on the date requested, or if alternate dates are available. The computer prints shipping documents for confirmed bookings and can report on failures to book as requested, thus pinpointing the need for additional prints of some films. Use of its System Ten has enabled this film library to handle requests more efficiently and to reduce the costs of manpower and film rental.

Life Insurance. A large life insurance company uses a large computer, and has more than 65,000 computer reels that it needs in processing insurance transactions that used to be manually card indexed. The facility needed to improve turnaround time on jobs and cut down lost-reel searches; at the same time, the tape library was growing fast. There was an additional need for features that would enable keeping track of maintenance information.

Before deciding on the Singer System Ten, management compared prices of alternatives. The manual system was costing $98,000 a year; to use in-house telecommunications system (IBM) would cost $250,000 a year, while a modified version of this would cost $134,000 a year.

The Singer System Ten was estimated as $61,000 a year. It is used with on-line terminals to index tape reels, provide on-line reel status information, supply information needed to bill charges to user departments, and furnish maintenance reports needed for cleaning and recycling tapes. System Ten is on-line 24 hours per day, has saved up to $20,000 a year in employee time over the manual system, and has allowed the company to provide better service.

Auto Parts. An auto parts dealer with remote branches has installed a System Ten with on-line terminals, for inventory control and shipping of more than 45,000 auto parts.

Aircraft. A large aircraft manufacturer with 8 scattered facilities used to depend on manual clerical procedures to obtain information on the status of all manufacturing operations. Major considerations in the selection of a new system were flexibility to support a number of systems, capacity to handle more information, operating simplicity, and ability to handle transactions quickly with an audit of data entered. Singer System Ten met these requirements and within an economical price range.

Eleven System Tens are installed as remote processors and input terminals for large IBM System/360s. Input to the System Ten computers is from 492 job information stations and 140 attendance terminals (badge readers). Job information stations are programmed to display information pictorially. Data from 16,000 hourly workers forms a massive data base that supports 18 major information systems. The terminals are used to record time, attendance, and work in progress. At 7:00 a.m. each day, action reports are available for shop foremen to use in scheduling, determining priorities, and planning manpower and equipment requirements.

Sales. A company with many sales representatives, selling cosmetics directly to about 50,000 customers, has installed 3 System Ten's with 7 on-line CRT terminals and an array of data terminals for point-of-sale data collection that is being enlarged from about 20 terminals to about 70. One System Ten is used for inventory control, another for general ledger and accounts payable; the third System Ten is used for data on sales to the 50,000 customers. This system polls the remote locations. As the company opens more outlying locations, it plans to install more data terminals.

Retail/Mail Order. A very large chain of retail stores and mail-order catalog facilities, with 836 stores and more than 1,200 catalog sales offices, as well as warehouses and business offices, has installed a large network of System Ten computers with Singer Data Terminals for point-of-sale data collection; the systems serve as remote data collectors and processors for 33 IBM System/370s. There are 200 System Tens connected to up to 18,000 Data Terminals.

In addition, the chain of stores is experimenting with reading wands attached to the data terminals, for reading credit cards and sales tags. This technique not only speeds up checkout lines and cuts credit losses, but also it controls inventory, assists in ordering, provides sales data, handles numerous accounting and personnel records, and ties in about 1,000 of the company's largest suppliers to the purchasing offices.

Compatibility

All System Ten configurations are upward compatible with each other. Additionally, the System Ten is compatible with the various Singer special-purpose peripherals such as the MDTS point-of-sale system and the job information system (JIS). The languages supported by System Ten are not compatible with those of any other computer; however, data format is compatible with IBM System/360 and 370 equipment in all categories except disc files.

Internal data format in System Ten uses a 6-bit subset of ASCII. For 9-track magnetic tape output, data is converted to ASCII and written on the tape in a format compatible with that used by most other manufacturers' tape drives.

Evolution and Maintenance

The first customer delivery of System Ten was made in 1970, and by the end of 1972 more than 800 installations had been completed. The capabilities of the central processor, and the variety and nature of peripherals, have been expanded and refined as experience dictated. Singer offers maintenance for System Ten through its worldwide network of over 400 sales and service offices. Users interviewed commented that maintenance is dependable and available on short notice, often within an hour.

MAINFRAME

Product specifications for the System Ten appear in Table 2.

Central Processor

Data Structure. System Ten uses 6-bit characters. Data fields are variable in length and can contain up to 10,000 characters, depending on the instruction being executed.

Instruction Set. System Ten uses 13 machine instructions. Each machine instruction word is 10 characters long. Most instructions specify 2 operand addresses; each operand address is 4 characters long.

Table 2. Singer System Ten: Specifications

PROCESSOR	
Main Memory (kc)	10-110
Char Size (bits)	6
Addressable Registers	3/partition, except Common
Cycle Time (μsec)	3.3
No. of I/O Channels	1 slow-speed/ user partition; 1 high-speed (FAC)
Max Devices/Channel	10
AUXILIARY STORAGE	
Storage Medium	Disc
Capacity (mc)	4; 100
Transfer Rate (kc/sec)	229
DATA ENTRY	
Keyboard	Workstation; includes serial printer (15-25 cps)
Card Reader (cpm)	300
Paper Tape Reader (cps)	275
DATA OUTPUT	
Card Punch (cpm)	100
Paper Tape (cps)	150
Line Printer	132 col; 110-450 lpm
CRT Display	80 col by 20 lines
SOFTWARE	
Operating System	Multipartitioning via hardware
Assembler	Yes
Compiler	RPG

The operand fields have an alternate usage in I/O instructions. One operand field becomes the address of the I/O area, and the other the data count. If the addressed device is a disc, the second operand field is treated as an indirect address. All disc transfer must be 100 characters, so it is unnecessary to specify the count for disc operations.

Addressing Facilities. Every location in core can be addressed directly. A program instruction can directly address any location in its partition (10K max) and any location in Common (which is expandible to 65K in the Model 21 processor). Indirect addressing is available on the Model 21 processor. When an address in an instruction is indexed, the contents of the selected index register are added to the address. Indexing of 1 operand address requires 31.1 microseconds, and indexing of both operand addresses requires 58.9 microseconds. There is no double indexing in System Ten.

Interrupt Control

Interrupts occur as a result of program checks and imitiation of I/O instructions. When a single character is ready for I/O transmission, an interrupt is signalled by the IOC. The processor temporarily stops processing in whatever partition it is currently working, transfers the character, then resumes processing where it left off. If the processor should switch to a partition in which an I/O operation is in progress, it immediately switches to the next partition.

There are 6 causes of a program check: an out-of-limit address, a privileged area violation attempt, an attempt to store the protected area of Common, an invalid op code, bit 5 in any character of an instruction not being a 1 (Model 20 processor only), and a binary-coded-decimal value in excess of 9 in the numeric portion of a character fetched by the ACU.

Main Memory

Hardware partitioning divides main memory into partitions, with the size of each partition ranging from a minimum of 1,000 locations to a maximum of 10,000, in multiples of 1,000. In every System Ten computer, there must be 1 section of memory, called Common, of at least 1,000 locations, and from 1 to 20 user partitions. Thus, a minimum configuration of 10K might contain 1 core module divided into a 1,000-location Common area and a 9,000-location user partition. (Memory allocation is done by the Singer customer service representative at the time of installation, and can be changed easily by him when the need arises.)

Storage allocated to a partition is accessible in 1 of 2 ways: (to a program resident in that partition and to a program in Common that has been activated by the same partition. In either case, the storage is accessible only during the time slice alloted to that partition. Common does not have its own time slice; instead, programs in that area are activated by branching from a partition's program, and remain active only for the duration of the calling partition's time segment.

Reserved Storage. The first 300 character locations of Common are protected from program alteration although they can be examined by any program. In this protected area, each partition has 3 fields used for storage and maintenance of program status and I/O control information. In the remaining Common area, 1,000-character segments, which are contiguous, can be designated as privileged area of Common (Model 20 only).

Input/Output Control. I/O control is established via the IOC for slow-speed devices (card readers and punches, paper tape readers and punches, line printers, and terminals) and the FAC for high-speed devices (magnetic disc and tape). The channel concepts are second generation in origin and result from the lack of an operating system in the System Ten.

IOC. A dedicated IOC is associated with each user partition and can control up to 10 devices. Data transfer via IOC is overlapped with processing on a cycle-stealing basis. Each IOC can support a data transfer rate up to 1.5K characters per second.

FAC. Each user partition shares the single FAC to access the magnetic disc and tape files. This architecture is necessary in order not to duplicate files used simultaneously by several partitions. FAC supports data transfer rates up to 330K characters per second. FAC can handle 1 tape controller with up to 4 tape drives, as well as 1 disc controller with up to 10 disc drives (an additional controller is needed for more than 4 discs). Devices on the FAC are available to all partitions although, through programming, it is possible to allocate these resources selectively by partition. Operations on the FAC must proceed sequentially; they will halt all processing activities but not operations currently proceeding on the IOCs.

Special-Purpose Channels. System Ten supports optional synchronous (SCA) and asynchronous (ACA) communications adapters and an asynchronous terminal adapter (ATA). SCA and ACA each replace 2 regular I/O channels and each attach to 1 user partition. ATA replaces one I/O channel and is attached to 1 user partition. Other partitions communicate with the SCA, ACA, and ATA partitions via the Common partition or disc or magnetic tape.

SCA allows programs to be transmitted between System Ten and remote computers via voice-grade communications lines. Over SCA, transmission can be 2,400 bits per second when over a dedicated line using a Bell Series 201 data set, up to 9,600 bits per second over a dedicated line using non-Bell data set, or 2,000 bits per second over the switched (DDD) telephone network, respectively.

ACA allows data to be transmitted over voice-grade lines between System Ten and asynchronous ASCII terminals, and to receive from Model 800 individual store-and-forward modules. Over ACA, transmission rates up to 1,800 bits per second are selectable under program control.

ATA allows data transmission between System Ten and low-speed operator-oriented terminals over voice-grade lines. Nominal transmission rate is established by hardwired connection and is from 110 to 300 bits per second.

PERIPHERALS

System Ten has a complement of slow-speed, high-speed, and special peripheral devices.

Slow-Speed Devices

Models 50 and 52 Line Printers. Both Models 50 and 52 printers are 132-column devices used for rapid data printout. They differ only in print speeds; the Model 50 prints up to 450 lines per minute, while the Model 52 only prints up to 110 lines per minute. A buffer stores data for 2 lines of print; buffering is necessary so that the output flow remains uninterrupted when the CPU is servicing another channel or peripheral device. Otherwise, an interrupt would occur with every byte transferred. Line printers are attached to the central processor through the I/O channels.

Model 53, 54, 55, 56 Line Printers. All 4 printers use a standard 64-character print set, 6 lines per inch, and 120 print positions. Their respective speeds are 125 lines per minute, 200 lines per minute; 300 lines per minute; and 400 lines per minute. Options include 132 print positions per line, 8 lines per inch, OCR A and B print drums, and 12-channel VFU tape for vertical tabbing.

Model 30 Card Reader and Model 35 Punch. Model 30 Card Reader is an 80-column, 300 card-per-minute reader that attaches to the CPU via an I/O channel. The 100 card-per-minute, on-line Model 35 punch connects to the CPU through a multiterminal I/O channel. Up to 10 readers or 9 punches can be serviced by a single partition.

Model 31 Card Reader. The Model 30 Card Reader reads 20, 51, 80, or 96-column cards at a speed of 300, 600, or 1,000 cards per minute (selectable at time or purchase.)

Model 60 Paper Tape Reader and Model 65 Punch. An on-line paper tape reader, Model 60 can read either continuous reels or strips of punched paper or polyester tape at a rate of 275 characters per second. A Model 65 paper tape punch (companion unit to the reader) can punch 150 characters per second. Up to 10 readers and punches can be serviced by a single main memory partition.

High-Speed Devices

Model 40 Disc Drive. The disc pack (Model 41) is removable and accommodates 10 million characters. Average data access time is 73 milliseconds, and data transfer rate is 229,000 characters per second. Up to 10 drives can be on-line to the central processor, which provides up to 100 million characters of storage.

The disc drives are linked to the CPU through the disc controller on the FAC. When more than 4 drives are used, the fifth and successive disc drives require an auxiliary disc controller rather than the regular controller. Each disc read or write operation involves a 100-character transfer.

Model 42 Disc Drive. A split-disc drive, Model 42 features 2 separate and removable disc packs — 1 mounted on top of the other in a single unit. The resident pack (Model 41A) is used for active manipulation and filing of data, which then can be duplicated onto the other pack (Model 41B), called the "removable pack," and stored for file backup. Both the resident and the removable packs provide 4 million characters of storage capability. Access rate and data transfer rate are the same as for Model 40 disc drive. Up to 10 disc drives can be connected to a central processor.

Model 44 Disc Drive. The Model 44 Disc Drive uses removable and interchangeable disc packs with a total capacity of 40 million bytes. Two of these disc drives can be attached to the central processor through the disc controller and the FAC. Each Model 44 looks like 4 Model 40 drives (that is, has 4 logical subdivisions) to the central processor; the Model 44 can also be intermixed with Model 40 or 42 Disc Drives as long as the total number of logical devices does not exceed ten. Each disc pack constitutes 4 logical volumes.

Model 45 Magnetic Tape Drive. Model 45 reads and writes in a format compatible with most other manufacturer's tape drives. Magnetic tape, used as auxiliary storage or as backup for disc, is connected to the CPU via a tape controller attached to an FAC. Up to 4 units of the System Ten tape drives can be operated on-line.

Models are available for reading or writing on either 9-track or 7-track industry-compatible tape. Recording density on 7-track tapes can be either 556 or 800 bits per inch, and on the 9-track tapes is always 800 bits per inch. Both 7- and 9-track tape drives have maximum transfer rates of 20,000 characters per second. The 7-track drive normally reads and writes the System Ten 6-bit ASCII subset. The 9-track drive reads and writes in ASCII; it reads or writes unsigned numeric data in packed format or 8-bit codes, such as EBCDIC, by using a double-frame mode.

Special-Purpose Devices

Model 70 Workstation. A desk-type data entry keyboard and serial printer output device, the Model 70 Workstation provides interactive communication with the CPU and prints output at 15 to 25 characters per second. The workstation features a standard alphanumeric keyboard and prints a 170-character line using a pressure-platen forms handler. Optional features include a pin-feed forms handler. An operator panel assists the operator with indicator lights displaying system status. The workstation can serve as a load device when given device address zero.

Model 80 CRT Display. The Model 80 CRT is another interactive device for communicating with the CPU. It adds a 10-key numeric cluster similar to those on adding machines and unavailable on the workstation. Also, instead of the workstation's serial printer, it uses a CRT to generate a 1,600-character display in an 80-column by 20-line format. This display is fully buffered so that the CPU simply reads into the buffer the 1,600 characters of the display and then goes on to service another channel or I/O device.

The CRT display can be programmed to resemble a blank form onto which the operator "types" entries before feeding the entered data to the CPU. This is an advantage to a new operator because it shortens the question and response time between the computer and operator. The unit can be located up to 2,000 feet from the CPU, and 10 can be serviced by a single I/O channel.

MDTS Data Terminals (all models). Part of the Modular Data Transaction System (MDTS) for point-of-sale transactions, these cash-register-type terminals are used for remote data entry to the central processor. The MDTS terminals also have the capabilities of a freestanding calculator, receipt printer, and totalizer. The compact units are particularly useful in a retail environment. They can be used with automatic tag readers for both detachable and non-detachable merchandise tags, as well as with credit card readers. Every transaction is recorded on an internally stored audit tape that can hold the details of approximately 400 transactions.

The CPU can, at any time, poll each freestanding terminal by telephone line for its magnetic tape contents and use the data to update the files. Tapes from every terminal can be processed at the end of each day or sent out. Further, directly linked terminals can be on-line to magnetic disc and/or magnetic tape files to ascertain customer credit limits, special customer discounts, and so on. Up to 180 such terminals can be connected by a simple 2-wire line to a single System Ten CPU up to 8 miles distant.

When the MDTS with data terminal is employed with System Ten, other equipment provided by Singer for use with MDTS includes the following: Line Switching Unit (LSU), Model 191; Individual Store and Forward (ISF) Module, Model 800; Asynchronous to Synchronous Transmission Adapter (ASTA), Model 850, Asychronous Communications Adapter (ACA); and Modular Data System (MDS) I/O Channel.

Model 100 Job Information Station. The JIS is an intelligent terminal that guides the operator with a series of preprogrammed indicator lights on a display panel. It is used primarily for numeric data entry from a job station to a remote CPU. This device can read punch-coded employee badges and punched cards. It features a numeric keyboard for nonstandard data entry and a set of function keys.

JIS applications include monitoring work in progress, with regular reports directly from the manufacturing floor. Other manufacturing applications are stockroom, tool-room, and instrument-room inventory control. The JIS can also be used for check-in/check-out stations in libraries and warehouses, and as a nurses' reporting and communications station in hospitals. The badge reader with the JIS can be used separately as an on-line time and attendance recorder.

Model 105 Attendance Station. A special-purpose System Ten terminal, the Model 105 Attendance Station records employee in-and-out attendance. It is computer monitored, and holds information on up to 13 badges while establishing contact with the computer. Each station clock is synchronized with the processor system clock every 10 minutes.

SOFTWARE

The System Ten has no operating system in the conventional sense. It relies on its hardware interrupt schemes; buffered devices; hardware partitioning; and a round-robin, time slicing priority scheme to achieve its multiprogramming environment.

Even so, the environment achieved actually has no priority setup other than I/O interrupts and the 37.5 millisecond time slice (which in an I/O-bound program, or with an unbuffered device, can never be experienced).

Under normal circumstances, each partition must have dedicated to it whatever devices (except discs) that it will use. However, a multipartition loader is available that allows a "blind" partition (core allocated, but no devices) to be used to absorb data from devices otherwise dedicated to another partition.

System Ten supports 2 levels of assemblers and of RPG compilers, as well as software for communications, business data processing, and disc file management. Since the system is available turnkey, a user doesn't have to worry about being able to find (or having to write) his own application.

The Disc Management Facility (DMF) software, utilizes a file organization and access method that enables the user to perform a wide variety of disc operations by entering logical commands through an on-line workstation or other input device rather than by executing assembler language instructions. A DMF system can use 1 to 10 disc packs and is divided into segments called pools. Each pools is given a 1- to 6-character alphanumeric name. The user accesses pools and files by using pool and file names with the control statements.

Communications software is designed solely for data communications processing, in which a Singer System Ten is linked to a remote larger computer, and serves as a remote processor or remote job entry input device for the larger computer. A System Ten can also communicate with another System Ten.

Assembler

The System Ten supports 2 levels, Assembler I and II. Assembler I is the less sophisticated card version, while Assembler II is the disc version run under control of DMF. Source input can be a DMF file (accessed randomly by pool name and file name), or it can be input from any input device. Object code and listings can be output in DMF files or routed through any output device. Both assemblers require 9,000 locations in a partition; although Assembler I can use Common, Assembler II never does.

Both assemblers allow the user to process data; control the assembly process; format the assembly listing; and to define I/O areas, work areas, and constants. They also allow the insertion of debug instructions and provide an optional cross-reference listing. In addition, Assembler II provides for macro definition and expansion; conditional assembly; assembly-time variables, statements, and functions; extended mnemonics; literals; relocatable object code; a cross-reference listing that shows "where set" and "where used"; assemble-and-execute capability; additional assembler-control statements; indirect addressing; and disc storage of assembler work files, including a symbol table that allows the assembly of a larger program than can be handled by Assembler I.

Report Generator

RPG accepts input specifications from the user, specifying I/O devices, the format of the data file, and the calculations to be performed. Output of the report can be punched on cards, printed by a line printer, routed to a disc file or to a buffer area in Common. RPG requires 10,000 locations in a partition and can place the object program generated from the specifications either in a disc file or in a punched object deck.

Communications Software

Remote Job Entry Facility (RJF) comes in a basic version and a disc version. It is a set of programs used by System Ten for communicating over voice-grade lines while appearing as an IBM 2780 Remote Job Entry Terminal.

Thus, with RJF, a System Ten computer can serve as a remote I/O satellite for an IBM System/360 OS HASP system. In this manner, the 360 executes batch programs entered at the remote locations and transmits the output via communications lines to the original terminal, where the output can be printed or punched. One System Ten computer can accomplish up to 6 HASP-type remote operations. The disc version allows input to the data transmission system from DMF files resident on disc, without preparation of intermediate card decks or paper tape. Likewise, output received from the HASP system can be spooled to the disc.

Additional communications software includes the synchronous communications access method (SCAM), which is a set of 16 programs that control the synchronous communications adapter (SCA) I/O channel.

Modular Business Management System (MBMS).

The MBMS is a set of programs that provides business processing capabilities, including sales order entry, invoicing, accounts receivable processing, accounts payable processing, inventory control, sales analyses reporting, general ledger processing, and payroll processing. These parts are modular so that the user can purchase or lease only these modules that he needs. Each module can be individually adapted at modest cost. Minimum hardware configuration includes 1 workstation (used for messages from the system and responses with requested data from the operator), 1 disc drive, and a 10,000-location Common partition with one 10,000-location user partition.

Utility Software

System Ten's complement of utilities includes routines for text editing, code translation, conversational testing, loading object cards, tracing, disc sorts, file copying, providing dumps, retrieving and modifying individual records from a disc file, and editing.

HEADQUARTERS

Singer Business Machines
2350 Washington Avenue
San Leandro, CA 94577

PRICE DATA

Model Number	Description	Monthly Rental $	Purchase $	Monthly Maint. $
	SINGER SYSTEM TEN			
	CENTRAL PROCESSOR & WORKING STORAGE			
20-101RJ	Card-Oriented Remote Job Entry System Terminal (including processor, 10K core, 2 multiterminal I/O channels, communication adapter, and SCA)	205	10,660	NA
20-101TP	Disc-Oriented Remote Terminal Processor (including processor, 20K core, FAC, disc controller, 2 multiterminal I/O channels, communications adapter, and SCA; max increase 10K core)	495	22,335	NA
20-104	Processing Unit (20K (including file access channel (FAC), disc controller, 2 multiterminal I/O channels)	720	24,075	NA
20-106	Processing Unit (20K) (including file access channel (FAC), disc controller, 3 multiterminal I/O channels)	765	25,380	NA
21	Processor (expanded version of 20-104 and 20-106; includes additional 10K core; price shown to be added to 20-104 or 20-106)	190	7,500	NA
	10K Core Memory Unit	155	6,175	NA
	MASS STORAGE			
	Disc Controller	95	3,000	NA
	Auxiliary Disc Controller	28	715	NA
40	Disc Drive	415	14,500	NA
	Disc Pack	–	400	NA
42	Split Disc Drive	440	15,500	NA
	Disc Pack			NA
44	Disc Drive	1,000	35,000	NA
	Disc Pack			NA
	INPUT/OUTPUT			
	Magnetic Tapes			
50	Magnetic Tape Controller	95	2,970	NA
45	Magnetic Tape Drive	390	12,000	NA
	Punched Cards			
30	Card Reader	220	6,000	NA
31	Card Reader			
	300 cpm	200	6,250	NA
	600 cpm	290	9,750	NA
	1,000 cpm	315	10,750	NA
35	Card Punch	320	9,000	NA
	Paper Tape			
60	Paper Tape Reader	140	4,000	NA
65	Paper Tape Punch	180	5,000	NA
	Printers			
50	Line Printer (450 lpm)	585	18,000	NA
52	Line Printer (100 lpm)	315	12,600	NA
53	Line Printer (125 lpm)	410	17,500	NA
54	Line Printer (200 lpm)	470	19,000	NA
55	Line Printer (300 lpm)	550	22,000	NA
56	Line Printer (400 lpm)	635	25,000	NA
	DATA COMMUNICATIONS			
–	File Access Channel (FAC)	40	2,500	NA
–	Multiterminal I/O Channel	48	1,305	NA
70	Workstation	165	5,345	NA
80	CRT Display	160	5,950	NA
7102	Communications Terminal	140	4,750	NA
100	Job Information Station	145	5,616	NA
105	Attendance Terminal	70	2,592	NA
–	Synch Communications Adapter (SCA) (for 20-106 only)	180	6,520	NA
–	With Automatic Dialing Option	205	7,187	NA
–	With Local Communications Option	260	9,435	
	Asynch Terminal Adapter (ATA)			
–	Direct Connect	60	1,700	NA
–	Communicator	100	2,835	NA
–	With Automatic Dialing Option	113	3,402	NA
–	Digital Clock	38	1,134	NA
2024	Modem (selectable rates of 1,000/1,200/2,000/ or 2,400 bps)	60	1,600	NA

Notes:

– *Not applicable*

NA Not available

**Rental prices quoted are based upon a 1-year lease.*

For nondisc communications systems, delete price of FAC and disc controller. Lease rates include maintenance; Singer does not publish separate maintenance prices.

OVERVIEW

The Singer-Friden 5800 Billing/Accounting System is a keyboard-oriented visible record computer manufactured in the Netherlands and announced on the Western European market only in September 1970. It bridges the gap between the smaller 5610 Computyper and the larger System Ten multikeyboard disc processing system introduced earlier in 1970 on both sides of the Atlantic. With the 5800, Singer-Friden offers also magnetic-stripe ledger card processing facilities for the first time.

The Singer-Friden 5800 offers a processor with a stored-program capacity expandable from 256 to 1K instructions, a data storage area expandable from 22 to 90 addressable storage registers, and six working registers of 15 decimal digits and sign. It has keyboard and paper tape or edge-punched card input and serial printed output at up to 25 characters per second. The 5800 Standard Interface allows up to 14 input/output devices to be connected to the system, but at the time of writing the only optional peripherals offered by Singer-Friden are a 20 character-per-second paper tape or edge-punched card punch and a magnetic-strip ledger (MSL) card processor that is capable of reading and writing up to 204 alphanumeric or 408 numeric characters on each card stripe. An interesting feature of the MSL processor is that it is entirely separate from the remainder of the 5800 workstation and processor, and is equipped with both its own serial printer and three core buffers.

Table 1 presents specifications for the Singer-Friden 5800 Billing/Accounting System.

CONFIGURATION GUIDE

A basic 5800 Billing/Accounting System's integrated workstation consists of:

- 5805 central processor with a 31-instruction repertoire and stored-program core store expandable from 1,024 to 4,096 four-bit positions in increments of 512 positions; average instruction length is four positions which equal 16 bits. Central processor also has data storage expandable from six working registers and 26 storage registers of 15 decimal digits and sign to six working registers and 90 storage registers in increments of 32 storage registers.
- Alphanumeric typewriter keyboard generating full 128 code ISO-7 (equal to ASCII-7) character set, with 3-character buffer.
- Ten-key numeric keyboard with 16-character buffer allowing for overlapping operation.
- Typebar serial printer, 25 characters per second, 175 print positions per line, 16 tabulating positions program selected.
- 5822 integral paper tape/edge-punched card reader, reading paper tape or edge-punched cards punched in the eight-track ISO-7 (seven data bits, one parity bit) code at 20 characters per second.

Table 1. Singer-Friden 5800: Specifications

CENTRAL PROCESSOR	
Word Size (bits)	64
Capacity (words)	32 — 96
Cycle Time (μsec)	NA
Working Storage	6 15-digit registers
AUX STORAGE	Magnetic ledger cards
DATA OUTPUT	
Line Printer (lpm)	—
Serial Printer (cps)	25
Card (cpm)	—
Paper Tape (cps)	20
DATA INPUT	
Keyboard	Standard
card (cpm)	—
Paper Tape (cps)	20
SOFTWARE	
Assembler	Not for customer use
Operating System	No
Compilers	No

Up to 14 input/output units (including the above) can be connected to the 5800 Standard Interface, but at the time of writing the only available optional peripherals are:

- 5815 integral paper tape/edge-punched card punch, 20 characters per second.
- 5819 MSL magnetic-stripe ledger processor, comprising:
  (1) Separate 63-character serial helical printer, 25 characters per second.
  (2) Magnetic-stripe read/write unit for reading/writing up to 204 alphanumeric or up to 408 numeric characters on each card stripe.
  (3) Three buffer stores respectively for data to be printed on the MSL card, data read from or to be written to the magnetic stripe of the card being currently processed, and data read from a batch header card or to be written eventually to a batch summary card.

SOFTWARE

It is unusual for users to program their own applications, and the Singer-Friden organisation has two approaches to user program implementation on the 5800.

The first consists of standard applications which can be purchased separately for about 2% of the capital cost of the equipment. These cover mainly the areas of invoicing, sales analysis, inventory control, and all aspects of accounting.

The second approach consists of custom-designed user programs written for a user by the Singer-Friden programming staff, for a contract programming fee based on an estimate of the man-weeks of effort involved.

DESIGN FEATURES

Processors

The basic 5800 processor consists of an arithmetic control unit and areas of data storage and program storage. This processor is connected to input and output devices via a standard interface system which enables up to 14 I/O devices to be linked to a 5800 system.

The arithmetic control unit controls the sequential program for processing and uses six control and working registers. The arithmetic registers and the data storage sections of the processor are word oriented on a fixed-word length basis of 15 decimal digits plus sign. The execution of addition and subtraction takes 1.5 milliseconds; the average execution time for multiplication and division is about 10 milliseconds. The machine processing is geared in speed to the needs of a keyboard unit. The standard position for the decimal point within data storage and register use allows for six positions of fractional data. Field modification can be used on decimal point location, if required. The basic 5800 system configuration provides for 26 storage words. The modular expansion of data storage is in increments of 32 words, up to a total of 90 words.

Each data storage word is addressable by a two-digit address. Two of the six basic working registers are for general arithmetic; the result appears in the active register while the passive register remains unchanged. Two registers are used in hardware multiplication and division for backing storage. One register is used for containing the instruction address, and the sixth register is used for counting and controlling instruction execution. This register is called the Count and Mark register and interprets the mark bits used in identifying program instructions.

The variable nature of program layout is such that each four-bit instruction position can refer to either a command or an address, and the two additional mark bits distinguish between these uses. The minimum 5800 system configuration provides 1,024 positions of program storage. Additional modules of 512 positions can be added to the system up to a maximum of 4,096 program storage positions. The average length of complete instructions can be reckoned as four positions so that up to 1,000 instructions can be provided by a 5800 system.

The optional 5819 magnetic-stripe ledger (MSL) processor for the 5800 system uses three storage buffers and a self-contained printing unit. The print buffer has a capacity of 123 characters and uses space codes for blank positions. The printer mechanism is a single print wheel containing 63 characters. Print speed is 25 characters per second. The other two storage buffers are both of 220 alphanumeric eight-bit characters or 440 numeric four-bit positions, and they hold data referring to the contents of magnetic stripes. The contents of these buffers and of the card stripe can be divided into a maximum of 99 words of variable length.

At any one stage in processing these two buffers can be related to two MSL cards. If a card is in the unit and an instruction to 'move' is given, the card is automatically moved to a 'park' area and the related buffer is made into the secondary buffer. The next card to be read has its contents put into the alternate buffer which acts as the main stripe buffer until 'eject' or 'release' commands remove the parked card from the 'park' area. The ability to update a summary ledger card with the totals derived from many subsidiary cards is easily allowed by this MSL processing method. Since there are only two buffers to alternate as the main stripe buffer, only one card can be placed in the 'park' area at any one time.

PERFORMANCE AND COMPETITIVE POSITION

The Singer-Friden 5800 is comparable in processing power to the Burroughs L 2000 to L 5000, LogAbax LX 2200, Olivetti Auditronic 730, and Philips P-350 series of keyboard-oriented visible record computers. However, the 5800 offers fewer optional I/O media than its competitors, notably neither 80-column card nor magnetic tape cassette I/O facilities. It may also on occasion compete against smaller Kienzle 5000, 5600, or 6000M/R, LogAbax LX 4200, Nixdorf System 820/15, or Olivetti Auditronic 770 configurations, but it is far less expandable in both its program and data storage capacity than any of these systems.

The 5800 will thus appeal mainly to present users of Singer-Friden 5000 series Computypers who are fully committed to paper tape processing and who now require magnetic ledger processing facilities for the first time.

MAINTENANCE

The Friden Division of Singer is directly represented in all the major areas of Western Europe. The 5800 is produced in the Netherlands so that the European user is fully catered to in terms of both customer engineering and customer systems support.

HISTORY

The 5800 was launched in September 1970 and the first installation was made before the end of that year. The design is a departure from previous marketing efforts in that Friden had not previously used magnetic-stripe ledger cards or internally stored programs.

OVERVIEW

The Triumph-Adler TA 1000 is a modular keyboard-oriented small business computer designed both for first-time users and users upgrading from smaller invoicing and visible record processing systems such as Triumph-Adler's own TA 10 "Volkscomputer."

The TA 1000 is available in four basic configurations: Invoicing System from $8,200 upwards; Magnetic Ledger Processing System from $21,200; Magnetic Tape Cassette File Processing System from $15,000; and Mini Disc File Processing System. Its microprogrammed central processor has 16 index registers and uses variable length instructions and operands. Core memory expandable from 4K to 40K bytes is byte-addressable. The system can support one to three magnetic tape cassette drives and/or one to four mini disc drives offering up to 1 million bytes of on-line random access backing storage. The comprehensive accounting machine console can include a typelever (16 characters per second) or matrix printer (140 characters per second) as well as an optional CRT display (1056 characters). Other optional peripherals include up to three matrix printers, a card reader, and a paper tape punch. Interfaces for a card punch, paper tape reader, and 9-track industry-compatible magnetic tape are being prepared.

The TA 1000 can also be equipped with a synchronous V24 modem interface for on-line data communications with general-purpose EDP mainframes at 600 to 4,800 bits per second. It recognizes IBM 2780-compatible BSC line disciplines or Siemens System/4004 disciplines; thus, it can also be used as an intelligent source data entry and/or remote batch terminal by large companies, or it can combine terminal and local processing functions as a dual-purpose system. TA 1000 keyboard-printer terminals are available for $9,750 upwards; keyboard-display terminals for $12,120 upwards.

TA 1000 software includes a modular operating system, optional logical file control facilities, assembler, and integrated accounting packages for a growing number of industries, financial institutions, and public authorities. A high-level problem-oriented language compiler is in preparation.

The TA 1000, designed and manufactured by Triumph-Werke AG, a subsidiary of Litton Industries Inc. in Nürnberg, West Germany, was announced in 1973. It is now marketed throughout Europe and North America, both by the Triumph and Adler distribution networks of independent dealers, and by Litton Automated Business Systems as the successor to its LBS 1200 Series. In West Germany, it is also marketed by Taylorix Organization of Stuttgart under the label "System 9."

PERFORMANCE AND COMPETITIVE POSITION

Small- and medium-size business users will find the Triumph-Adler TA 1000 one of the most cost-effective computer systems currently on the market. It offers a highly expandable central processor with many advance features and a growing library of applications software; it is nonetheless price-competitive at all sizes. Unlike many other attractive systems currently on the market, it is offered by well-established, experienced marketing organizations, with a close network of sales and service centers in all countries, and it is backed by the resources of the Litton Industries group.

The TA 1000 offers 16 index registers, variable-length instructions and operands, byte-addressable core memory expandable from 4K to 40K bytes, and a universal bus that can connect to any combination of a growing selection of peripherals. Despite these advanced features, its starting price for an invoicing system with 4K-byte memory and 15 character-per-second printer is only DM 20,470 ($8,200). This is price-competitive with much less expandable systems, such as the Burroughs L2000 and L3000, Datapoint 2200, LogAbax LX 2200 and 2600, and NCR 299. It costs less than comparable competing systems such as the Burroughs L6000 and L8000; Compudata 500 and 600; CTM 70; Kienzle 5000, 5600, and 6000; LogAbax LX 4100 and 4200; NCR 399; Nixdorf Systems 820/15 and 820/35; Philips P350; Ruf/Hohner 2000S to 8000; Singer 6800; and Wagner WAC 40.

Triumph-Adler expects the TA 1000, with its data communications interface, IBM 2780-compatible BSC line disciplines, and 1,056-character CRT display, to do well in the intelligent source data entry terminal market against such systems as the Datasaab-Facit System M, IBM 3741, Nixdorf System 720, Olivetti DE 523 and Sanders 8000 Series. It should also compete well with the dual-purpose terminals that can also do local processing, such as the Burroughs TC Series, Datapoint 2200, IBM 3735, NCR 399, and Nixdorf System 840. TA 1000 terminal computers are price-competitive with all comparable systems, and they offer greater flexibility in peripheral combinations. Unlike most U.S.-designed intelligent terminals, they can support both a CRT display and either of two accounting machine consoles and printers, and they can handle multiple continuous form sets, ledger cards, and magnetic stripe ledger cards. The only systems that offer the same combination are the substantially more expensive Nixdorf System 840 and the less expandable Philips P350T Series. On the other hand, both Triumph-Adler and its distributors have had little experience in the field of data communications. By mid-1974, TA 1000 terminal computers had been installed only in West Germany, mainly as source data collection terminals to in-house EDP mainframes. In addition, many firms with accountants and tax advisers use them for remote access to the DATEV tax calculation service bureau in Nürnberg.

CONFIGURATION GUIDE

All TA 1000 computers comprise at least a processor, keyboard, one output device, and one magnetic tape cassette drive integrated into a common console. Three basic models are currently offered: Model 10 Terminal Computers; Model 20 Office Computers; and Model 30 Magnetic Ledger Card Processing Computers. They differ primarily in their standard console options. Model 10 terminals can use a CRT display or either of two printers as the main console output device; they also include a V.24 synchronous data communications interface. Model 20 office computers must have one of the two console printers. Model 30 magnetic ledger card processing computers must use the fast matrix console printer (140 characters per second), and magnetic ledger card processing unit; minimum main RAM memory size is 8K bytes.

In all other respects, the three models offer the same expansion capabilities and optional peripheral devices. User memory can be expanded in 4K-byte or smaller increments to a maximum of 40K bytes. All three models can support both a CRT display and a console printer, as well as up to three auxiliary printers and card and paper tape peripherals. The V.24 communications interface, standard on Model 10, is optional for Models 20 and 30. One to four 256K-byte minidisc drives can be added to any of the three models.

Although any combination of peripherals can be supported, Triumph-Adler and its agents concentrate on marketing a number of standard configurations for which operating systems have already been developed. Five standard Model 10 configurations differ in the console features: one has a 16 character-per-second printer, another the 140 character-per-second printer, one uses the CRT display, another the display and 16 character-per-second printer; and one uses the display and 140 character-per-second printer. Model 20 is marketed in the following three basic configurations:

- Basic invoicing system — processor with 4K-byte memory, 1 MT cassette drive, 16 character-per-second printer.
- Basic MT cassette file processing system — processor with 8K-byte memory, 2 MT cassette drives, 16 character-per-second printer.
- Medium-size MT cassette file processing system — processor with 12K-byte memory, 3 MT cassette drives, 140 character-per-second console printer.

Model 30 is offered in its basic 8K-byte memory configuration. A number of standard disc-oriented configurations will be available soon. Table 1 is a system configuration guide.

MAINFRAME

The TA 1000 mainframe uses a single bus processor architecture; the central processor, main memory, and input/output control units all interface to a common bus. The mainframe is housed in the pedestal of a console that also holds the main input keyboard and output printer. Table 2 lists the mainframe characteristics.

Central Processor

The central processor is microprogrammed. It has a repertoire of 139 microinstructions that are accessed by firmwired microprograms to implement a set of 80 macroinstructions. It has an 8-bit parallel adder, and it can process individual 8-bit bytes, byte strings, and 16-bit binary words.

Data Structure. The basic addressable unit of data is the 8-bit byte. This can represent an alphanumeric character, two 4-bit decimal digits, part of a program instruction, or half of a 16-bit binary word. Operands for arithmetic and logical instructions are 16-bit binary words or variable-length decimal numbers of 1 to 16 digits. The first byte of the operand designates the length of a decimal operand. The MOVE instruction can operate on alphanumeric strings of up to 256 bytes; the length of the string is defined in the instruction.

Registers. The microprogram implements 16 addressable 16-bit index registers in the main core memory. These can also be used as working registers. Both binary arithmetic and logical instructions are available to operate on their contents. A base address register defines the starting address in core for the user program in current control.

Instruction Set. The standard TA 1000 microprogram implements a set of 80 user machine instructions. These include 12 for conditional and unconditional branches, 7 for register manipulation, 14 for arithmetic, 22 for logical and control operations functions, and 20 input/output instructions. Instruction length is variable, from one to seven bytes. Memory referencing instructions can address one to two operands in main core memory.

Addressing Facilities. Operand addresses are two bytes long, and they can address single-byte operands, the leftmost byte of a 16-bit word or alphanumeric byte string, or the right-most byte of a decimal number. Up to

Table 1. Triumph-Adler TA 1000: System Configuration Guide

TA 1000 Model Features	10	20	30
MAIN MEMORY (bytes)			
Read-Only Memory (450-nanosec access)	10K-24K	6K-24K	10K-24K
Read/Write Memory (1.2 μsec cycle time)	4K-40K	4K-40K	8K-40K
AUXILIARY STORAGE			
Minidisc System	Opt	Opt	Opt
No. of Drives/System	1-4	1-4	1-4
Drive Capacity (bytes)	256K	256K	256K
Average Access Time (msec)	200	200	200
Transfer Rate (bytes/sec)	250,000	250,000	250,000
Magnetic Tape Cassette	Std	Std	Std
No. of Drives/System	1-3	1-3	1-3
Cassette Capacity (bytes)	250K	250K	250K
Transfer Rate (bytes/sec)	750	750	750
Magnetic Ledger Card Unit	None	None	Std
Numeric Digits/Stripe	–	–	342
CONSOLE KEYBOARD			
Alphanumeric Keys	56	56	56
Numeric Keys	14	14	14
Function and Control Keys	18	18	18 (+ 14 opt)
Indicator Lights	16	16	16
CONSOLE DISPLAY	Opt	Opt	Opt
No. of Lines/Screen	22	22	22
No. of Characters/Line	48	48	48
CONSOLE PRINTER	Opt	Std	Std
Speed (chars/sec)	16 or 140	16 or 140	140
Print Positions/Line	181/132	181/132	132
Max No. Legible Copies	10/4	10/4	4

Table 1. (Contd.)

TA 1000 Model Features	10	20	30
OTHER PERIPHERALS			
Auxiliary Printer (140-cps, 132-pp)	1-3 opt	1-3 opt	1-3 opt
Card Reader (80-col, 200-col/sec)	X	X	X
Card Punch (80-col)	Planned	Planned	Planned
Paper Tape Reader	Planned	Planned	Planned
Paper Tape Punch (75 cps)	X	X	X
DATA COMMUNICATIONS			
V.24 Interface, Sync 600-4,800 bps	Std	Opt	Opt

32K bytes can be addressed directly within any user program. Up to 64K bytes are addressed by resetting the program base address register.

Interrupt Control. Programs can be interrupted by internal interrupts set by overflows or machine errors, or by external interrupts activated by an I/O device. Each interrupt causes an automatic branch into the operating system.

Main Memory

TA 1000 memory consists of main read-write memory, and a firmwired read-only control memory (ROM). They share a common addressing system and their combined capacity can not exceed 64K bytes. Memory modules connect to the system via common mainframe bus; normally they should occupy no more than 13 of the 17 available slots.

Read-Write Memory. TA 1000 memory has a 500-nanosecond access time and 1.2-microsecond cycle time per 8-bit byte wide access. It consists of 4K-byte modules that occupy a single bus slot, 8K-byte modules, as well as smaller 1K- and 2K-byte modules.

The first 1K bytes of core memory are always used as a scratchpad store by the operating system. The optional tape cassette input/output control system (MIOCS) requires a further 1.6K bytes. The remaining memory up to 39K bytes is available for user programs and data.

Read-Only Memory. TA 1000 uses a read-only memory (ROM) to implement the user macroinstruction

Table 2. Triumph-Adler TA 1000: Mainframe Characteristics

CENTRAL PROCESSOR	TA 1000
Addressing	
Direct (bytes)	32,768
Indirect (bytes)	65,536
Instruction Set	
Microsteps	139
Number of Macro Instructions	80
Decimal Arithmetic	Yes
Priority Interrupt	Yes
MAIN MEMORY	
Type	Core initially; bipolar RAM planned
Cycle Time (μsec)	1.2/8-bit access
Word Length (bits)	Variable: 1-16 digits numeric; 1-256 bytes alpha (move inst)
Instruction Length	Variable, 1-7 bytes
Min Size (bytes)	1K
Max Size (bytes)	40,960
Increment (bytes)	1K; 2K; 4K; 8K
READ-ONLY MEMORY	Yes
Type	PROM or MOS/ROM (mask programmed)
Size	6K-24K bytes
Use	Macroinstruction set implementation, operating system
INPUT/OUTPUT	
Programmed I/O	Yes
Direct Memory Access	Yes, for minidisc system only
No. of Channels	Bus, with 17 slots for I/O cards, ROM and read/write memory boards

set and I/O control. Minimum ROM operating system size is 6K bytes for a basic TA 1000 120 invoicing configuration. Additional modules for optional peripheral devices can use up to a combined maximum of 24K bytes.

Two types of ROM are used on TA 1000. Initial production models used mainly electrically reprogrammable PROMs. The operating systems are now available on mask-programmed MOS ROMs. Both types of ROM can store up to 8K bytes per board. Access time is 450 nanoseconds to a 16-bit parallel word and 700 nanoseconds to an individual byte field within a word.

Input/Output Control

All input/output peripherals interface to a common I/O bus via interface control cards. Each card is specialized for a device and each occupies one bus slot.

Two I/O cards are standard on all TA 1000 systems. The first controls input from the console keyboard and output to the console printer or display. The second controls up to 3 magnetic tape cassette drives. Additional I/O cards are required for the floppy disc system, magnetic ledger card processing unit, data communications control unit, card reader, and paper tape punch.

Keyboard input and printer and paper tape output are character serial and programmed. Input and output between magnetic storage devices and the 80-column card reader and memory are blocked and controlled by ROM microprograms. Block length is variable for cassettes up to 256 bytes long, but it is fixed for 80-column card, MLC stripe cards and minidiscs.

A DMA (direct memory access) channel supports the minidisc system.

Console

The TA 1000 console has a comprehensive input keyboard for entering operating instructions as well as variable data. It has 64 alphanumeric keys in ECMA typewriter layout, 14 numeric keys (including 00 and 000) for fast single-handed input of numeric data, and 18 control keys with facilities for adding 14 more control keys. A console buffer allows n-key rollover. It has 16 indicator lights, eight system and eight program-controlled.

PERIPHERALS

All TA 1000 systems include a console keyboard, printer and/or display, and at least one magnetic tape cassette drive for program loading. Optional additional peripherals include one or two MT cassette drives, 104 minidisc drives second and third printer, 80-column card reader, paper tape/edge-punch card punch, and synchronous data communications control unit. Other peripherals in preparation include a card punch, paper tape reader, and 9-track magnetic tape drives.

Printers

TA 1000 consoles can support a 16 character-per-second typelever printer or a 140 character-per-second serial matrix printer.

The 16 character-per-second typelever printer can use either a 33.9-centimeter (13-inch) carriage with 127 print positions per line or a 47.7-centimeter (19-inch) carriage with 181 print positions per line. Either carriage may be fitted with a single and/or continuous form feed with adjustable form width. The wide carriage can also be fitted with a single or dual ledger card front feed, but it does *not* support magnetic ledger stripe read/write facilities.

The 140 character-per-second matrix printer has a fixed carriage with a maximum print line width of 132 print positions. This can be split into two to four independently driven sets of continuous forms. It can also be fitted with a single or dual ledger card front feed, with or without a magnetic stripe read/write unit. The moving matrix print head forms characters using 7 by 7 dot matrices, and it can print up to 4 legible copies. TA 1000 systems can also support one or more auxiliary matrix printers.

Other Slow-Speed Peripherals

Cards. An 80-column card reader reads at the rate of 200 columns per second. A card punch is in preparation.

Paper Tape/Edge-Punched Cards. The paper tape punch operates at 75 characters per second. It has programmable code conversion facilities. A paper tape reader is in preparation.

Magnetic Tape

An MT cassette I/O control card and at least one MT cassette drive for program loading is integral to each TA 1000 system. One or two additional MT cassette drives can be connected to the same controller. This allows an MT cassette file to be updated without disconnecting the program cassette drive.

TA 1000 MT cassettes are 3.81 millimeters (0.15 inch) wide and record data bit-serially on a single track on each side of the tape at 800 bits per inch. Maximum capacity is 255,000 bytes per side. Data is recorded and read at 750 bytes per second. Rewinding speed is 75 inches per second.

An I/O control card for industry-compatible half-inch 7- or 9-track magnetic tape drives is in preparation.

Discs

The optional minidisc control card can control up to 4 minidisc drives. It connects to the system via direct memory access (DMA) channel. Each exchangeable minidisc can hold up to 256K bytes on 64 tracks; data is stored in 32 addressable fixed-length sectors of 128 bytes each. Average access time is 200 milliseconds and the peak transfer rate is 250,000 bytes per second.

Magnetic Ledger Cards

TA 1000 systems with a console matrix printer can be fitted with a magnetic stripe ledger card read/write unit. It can store up to 342 numeric 4-bit digits on each stripe.

Display

TA 1000 systems console can support a Grundig DS 7150 CRT display; screen capacity is 1,056 characters arranged as 22 lines of 48 characters each. There are 64 displayable characters. Screen formats are entirely under central processor program control, which can display console keyboard inputs, data communications line inputs, and/or system messages.

DATA COMMUNICATIONS

The TA 1000 system can support a data communications control card. It provides a synchronous modem interface conforming to CCITT recommendation V.24, through which data can be transferred in synchronous message blocks at 600 to 4,800 bits per second.

Standard TA 1000 communications line control procedures conform to the BSC (binary synchronous communications) line discipline of IBM 2780 Communications Terminals, with CRC (cyclic redundancy checks) on each message block and automatic retransmission of blocks failing this check. An alternative control microprogram that conforms to Siemens synchronous line disciplines is also optionally available. Control microprograms that emulate other mainframe manufacturers' line disciplines will be developed.

Triumph-Adler intends to develop data communications facilities and software to allow TA 1000 terminal computers to be used by large companies as intelligent data collection and dissemination terminals for remote offices and factories.

SOFTWARE

Standard TA 1000 software includes a modular operating system with optional logical file control facilities, an assembler, and range modular applications packages.

Operating System

All TA 1000 systems run under an operating system that controls all physical input/output transfers to/from both standard and optional peripherals. It is stored in ROM or PROM. The operating system is modular; only the modules for peripherals in the configuration are included in the system. Depending on the configuration, the operating system can occupy from 6K to 24K bytes in ROM or PROM. It also requires the first 1K bytes of read/write memory as a scratchpad store.

TA 1000 configurations with two or three magnetic tape cassette handlers can also run under the optional Magnetic Tape Input/Output Control System (MIOCS). This complements the basic operating system's physical file control facilities with logical MT file control facilities. It allows users to address MT cassette files and records by label and performs all the housekeeping functions required to search an MT cassette file for the appropriate record. MIOCS requires an additional 1.6K bytes of read/write memory. A similar minidisc I/O control system is also available.

Languages

The TRIASS Assembler is a machine-oriented mnemonic assembly language offering 80 instructions paralleling those of the microprogrammed user macroinstruction code. A 2-pass Assembler translates mnemonic source code into machine macroinstructions that will be interpretively executed by the TA 1000 microprograms at run time. The Assembler is associated with a source language editor, machine code debugging system, and program tape file copy, duplicate, and sort-merge utilities.

A high-level problem-oriented language compiler is currently being written for release in 1975.

Applications

About 90 percent of the TA 1000 systems delivered to date have been entirely programmed by the supplier on the customer's behalf. Triumph-Adler is also developing a growing library of standard modular applications packages, from which modules appropriate to individual customers' requirements can be selected and linked by parametric questionnaire programming and program generator techniques.

The main TA 1000 applications package is the TRIASIS 1 integrated accounting package. This links together five smaller and more specialized packages: the TRIAG invoicing and accounts receivable program generator; BAB cost accounting system; materials scheduling and inventory control system; payroll; and general ledger. Customers need order only the packages they require and, in the case of the TRIAG invoicing and accounts receivable system, the program modules they require. Where customers require two or more TRIASIS 1 packages, the TRIASIS 1 memory module integrates them by linking the main and/or subsidiary data files via standardized file formats, and by providing intermediate data output to MT cassettes in some runs and automatic reinput of the same data to other programs. A more advanced version of this package, TRIASIS 10, is in preparation for TA 1000 minidisc system users.

Triumph-Adler is also developing a growing range of integrated accounting systems for specific industries. Packages for the following industries are currently available:

- Wholesale and retail distributive trades.
- Transport.
- Automobile distributors.
- Building industry.
- Property management.
- Food and drink.
- Banks, insurance, and other financial.
- Local and State governments.
- Hospitals.

PRICE DATA

Model No	Description	Purchase Price (DM)	($)
TA 1000/10	Terminal Computer TA 1000 processor, 10K-byte ROM, 4K-byte RAM, MT cassette I/O control, 1 MT cassette drive, data communications control unit & V.24 interface, console, keyboard, and		
	Printer 1 (16 cps) 19-in. carriage	24,390	9,756
	Printer 2 (140 cps), dual continuous forms feed	38,190	15,276
	Display, 1,056-char screen	30,290	12,116
	Display, and Printer 1	33,390	13,596
	Display, and Printer 2	47,790	19,116
TA 1000/20	Office Computer		
	Basic invoicing system TA 1000 processor, 8K-byte ROM, 4K-byte RAM, MT cassette I/O control, 1 MT cassette drive, console, keyboard, and		
	Printer 1	20,490	8,196
	Printer 2	33,190	13,276
	Basic magnetic tape cassette file processing system TA 1000 processor, 8K-byte ROM, 8K-byte RAM, MT cassette I/O control, 2 MT cassette drives, console, keyboard, and		
	Printer 1	37,390	14,956
	Printer 2	50,090	20,036
	Medium-size magnetic tape cassette file processing system TA 1000 processor, 8K-byte ROM, 12K-byte RAM, MT cassette I/O control, 3 MT cassette drives, console, keyboard, and Printer 2	66,990	26,796
TA 1000/30	Magnetic Ledger Card Accounting Computer TA 1000 processor, 10K-byte ROM, 8K-byte RAM, MT cassette I/O control, 1 MT cassette drive, console, keyboard, printer 2 with dual continuous forms feed magnetic ledger card processing unit	52,940	21,176
TA 1000	Peripherals (all models)		
	Display, 1,056-char screen, includes I/O card;	9,600	3,840
	Rotating stand for display	360	144
	Auxiliary printer, 140 cps, incl console;	18,600	7,440
	80-col card reader, incl I/O control card;	8,900	3,560
	Paper tape punch, incl I/O control card;	9,750	3,900
	Data communications control unit & V.24 interface	5,000	2,000

PRICE DATA (Contd.)

Model No	Description	Purchase Price (DM)	Purchase Price ($)
TA 1000 (contd.)	Options (for all models):		
	4K bytes additional RAM;	9,950	3,980
	MT cassette drive, each additional	6,950	2,780
	Console Printer 1 options:		
	Single continuous forms feed, incl control;	3,070	1,228
	Dual continuous forms feed, incl control;	4,270	1,708
	Ledger card front feed	1,300	520
	Console Printer 2 options:		
	Quad continuous forms feed, instead of dual;	600	240
	Ledger card front feed;	3,900	1,560
	Magnetic ledger card front feed & processing unit	11,200	4,480

Note:

TA 1000 computers are supplied to end users predominantly through independent agents who are free to fix their own prices. The above prices are the recommended retail prices, excluding Value Added Tax, in West Germany. The equivalent $ prices have been calculated at a conversion rate of DM 1.00 = $0.40.

HEADQUARTERS

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OVERVIEW

On September 12, 1974, Unidata — the partnership of three European manufacturers — CII, Philips, and Siemens — announced the Unidata 300 small business computer. This is a keyboard-oriented invoicing and ledger accounting system designed for small firms, but it can also be used for decentralised data collection and preprocessing in outlying offices of large organizations. It can also be used as an intelligent terminal on-line to an EDP mainframe.

The Unidata 300 has a stored program processor with 6K or 8K bytes immediate access core memory with 600-nanosecond access time. It can be programmed in PHOCAL, a proprietary macroassembler language. All peripherals connect to a universal bus. Standard peripherals with all configurations include an electronic input keyboard with 2-key rollover and 32-character buffer, matrix printer (30 characters per second with 239 print positions), and the PIOC mini-magnetic tape cassette reader/recorder (0.15-inch tape). The latter stores programs, but it can also record transaction data for later transmission to a larger EDP system. The only optional peripherals currently announced include a V24 data communications line interface and controller for on-line connection to a larger EDP system, a dual continuous forms feed, and single or dual ledger card front feeds for the console printer. Magnetic ledger card processing facilities are not currently available but will probably be announced at the beginning of 1975.

The Unidata 300 is manufactured at Eiserfeld, West Germany, by the Office Computers Division of Philips-Electrologica, who also manufacture the well-known Philips P350 Series. It is marketed throughout Europe either by joint Unidata marketing companies established in most Continental countries by CII, Philips, and Siemens or by Philips-Electrologica under its own name. Purchase prices range from \$5,000 to \$14,000 depending on the configuration. Table 1 lists detailed specifications.

PERFORMANCE AND COMPETITIVE POSITION

With purchase prices starting as low as \$5,000 excluding import duties and local taxes, the Unidata 300 is quite clearly an entry-level invoicing and visible record accounting computer for first time small business users. As such, it competes against the Triumph-Adler TA 10 "Volkscomputer" that pioneered this type of system two years ago, and more recent entries such as the Hohner-GDC 500 Series, LogAbax LX 2200 and 2600, and Remington Rand OCS 1 and 2.

Like competing systems, the Unidata is currently limited to keyboard input and printed or MT cassette output, but unlike competitors, it gives the impression of having a much greater growth potential. Its current limitations appear to be an expression of marketing policy rather than inherent limitations in design. Already it can be equipped with an optional V.24 data communications line interface, which is available only on the LogAbax LX 2600 among its competitors. The Unidata 300 offers a core memory of up to 8K bytes for stored programs and data, whereas most of its competitors offer ROM boards for user programs and comparatively small live memories for data. The Unidata 300's universal

Table 1. Unidata 300: Mainframe Characteristics

CENTRAL PROCESSOR AND WORKING STORAGE	
CPU Model	310
Word Length (bits)	8
I/O Channels	2
Type of Storage	Core
Capacity (words)	6K to 8K
Cycle Time (μsec)	1.2
SOFTWARE	
Assembler	Yes, PHOCAL
Operating System	No
Compilers	No
Other	Applications programs
PERIPHERALS	
Console Printer	Matrix; 30 char/sec; 239 cols/line
Console Keyboard	A/N kybd, numeric pad, function keys, 32-char buffer
Magnetic Tape Cassette	Program I/O and data storage; single track capacity 250K bytes
Data Comm Line Controller	CCITT V.24 voicegrade line interface

input/output bus can clearly accommodate a greater variety of input/output peripherals when Philips decides that the time is ripe to announce them. Probably, the main reason why these have not been announced immediately is to safeguard the market for the older and more expensive Philips P350 Series; it also controls the appeal to that market section able to generate the orders that Philips is able to fulfill in the initial production period.

A first time small business user who expects his data processing requirements and business volume to grow rapidly will probably find the Unidata 300 able to grow with business, whereas a competing system might need to be replaced at an early date by a larger but incompatible model from the same manufacturer. In addition, the Unidata 300 is marketed not only by the quite powerful Philips-Electrologica organisation (which has sold 20,000 P350 office computers worldwide since 1969) but also by the even more powerful Unidata partnership of Philips with CII and Siemens. The Unidata partners have substantial experience in the field of data communications and will supply the Unidata 300 with effective data communications line procedures and emulators to allow its use as an on-line intelligent data collection system to the IBM System/370 and other medium to large EDP systems as well as the Unidata 7.000 Series.

CONFIGURATION GUIDE

A basic Unidata 300 configuration includes a 6K-byte stored program processor, built into the console pedestal that includes an input keyboard, MT cassette reader, and output printer (30 characters per second) with single continuous forms feed. Options include an extension of core memory to 8K bytes, addition of a second continuous forms feed and/or one or two ledger card front feeds to the console printer, and V24 communications line interface.

Processor. The Unidata 300 uses a stored program processor with variable length instructions. Both instructions and data are held in a core memory with 6,144 or 8,192 bytes (8-bit) capacity; access time is 600 nanoseconds per byte. About half of the memory is available for applications software and data. A unique diagnostic test hardware package checks all parts of the system automatically when power is switched on.

Keyboard. The console keyboard is entirely electronic; it has a 32-character input buffer ensuring 2-key rollover. The keyboard has two key clusters: the main alphanumeric section includes 51 keys in ECMA typewriter layout plus space bar and backspace key; on the right-hand side, a 26-key numeric pad and function key cluster include 12 numeric keys, with keys for 00 and 000, four arithmetic function keys for +, −, decimal point, and Clear, and 10 control keys. A row of 16 indicator lights above the keyboard display system messages on error conditions or system status.

Printer. The console printer is Philips-designed and manufactured; it is a serial matrix printer with an instantaneous print speed of 30 characters per second. The fixed carriage is 70 centimeters (28 inches) wide with up to 239 print positions per line. Its basic version has a single continuous forms sprocket feed with adjustable margins. The following options are available.

- A second continuous forms sprocket feed under separate program control from the first, allowing two sets of forms to advance at different speeds.
- A single or dual ledger card front feed that can also be used for single form sets.

MT Cassette. A single mini-cassette read/write unit is standard on all Unidata 300 consoles. Data is recorded bit-serially on a single track of each side of MT cassette tape (0.15-inch). Maximum cassette capacity is 250K bytes per track, 500K bytes per cassette. The main use for the cassette is to load programs; a separate cassette is used for each application. Space not used for programs on each MT cassette can be used for recording transaction data for later off-line transmission to a larger EDP system.

Data Communications. A CCITT V.24 voicegrade communications line interface and controller are optional. Line procedure methods have not yet been published, but these will certainly allow compatibility with the Unidata 7.000 Series and probably with the IBM System/360 and 370.

SOFTWARE

Philips offers the PHOCAL macroassembler language for all programs to be written either by the user or the supplier. The company will also offer a number of standard applications packages.

MAINTENANCE AND SERVICEABILITY

Unidata 300 systems will be maintained from Unidata service centres in those European countries where joint Unidata marketing organisations have been established. In other countries, the system will be maintained by the extensive Philips-Electrologica servicing network built up to service the Philips P350 Series. Diagnosing faults is greatly aided by the automatic diagnostic test procedures built into central processor logic.

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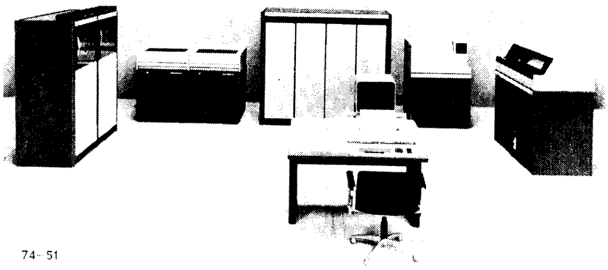

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OVERVIEW

Unidata 7.720 is a small general-purpose computer system designed to compete with the IBM System/370 Model 115 for the IBM 360/20 replacement market. It is also the natural upgrade for current users of Philips P1075 and P1100 and Siemens Systems 4004/16, 4004/26, and 4004/35. It is likely to be too expensive to compete for first-time users. Announced on January 15, 1974, Unidata 7.720 is marketed jointly by CII, Philips, and Siemens in all European countries except the United Kingdom and Ireland, as well as in South Africa and Brazil. Initial customer deliveries are scheduled for the beginning of 1975.

Unidata 7.720 has a microprogrammable central processor with 8K to 16K words (48-bit) of MOS/LSI reloadable control store (RCS), and 48K to 160K bytes of MOS/LSI main store. Peak I/O throughput is 1.4 million bytes per second and it can be divided among up to 12 peripheral adapters. These can be any combination of integrated card reader, line printer, and disc adapters; standard interface selector channels (Siemens System/ 4004); and standard interface byte-multiplexer channels. The system can address up to 256 peripheral devices.

Up to 16 multiplatter disc pack drives can be attached to the Unidata 7.720; individual disc drive capacity is 54.82 million bytes; maximum combined on-line capacity is 877 million bytes. Standard system peripherals include a card reader (300, 600, or 1,000 cards per minute) and a line printer (200, 600, 900, or 1,170 lines per minute). Optional additional I/O peripherals include a card punch (100 to 290 cards per minute), magnetic tape drives (30K or 60K bytes per second), and a multiplexer (20K bytes per second) for up to 30 communication lines with transfer rates of 50 to 19,200 bits per second.

Compatibility

One of the Unidata 7.720's most significant highlights is its compatibility with a large number of systems. Its standard instruction set is a fully machine code compatible superset of the Siemens System/4004 instruction set. Apart from privileged instructions, it is also identical to the IBM System/370 Universal Instruction Set, giving Unidata 7.720 source language compatibility with IBM at the Assembler as well as the compiler levels. Alternative Unidata 7.720 RCS microprograms are also available for implementing the CII Iris 45, 50, 55, and 60 and the Philips P1000 instruction set.

Siemens System/4004 compatibility allows Unidata 7.720 to run under the BS 1000 operating system, developed from the highly successful DOS/ 4004. It offers variable-length multiprogramming facilities for up to 14 user programs in main store, and it will become available in a virtual memory version by the beginning of 1975. The full range of BS 1000 language compilers is available on Unidata 7.720; they include IBM System/370 compatible Assembler, RPG, RPG 2, Cobol, Fortran IV, and PL/1. ANSI Cobol and Algol compilers are also available. Unidata's standard interface selector and byte-multiplexer channels have identical interface characteristics to the Siemens System/4004 standard interface, allowing any System/4004 peripheral device to be connected to the Unidata 7.720.

When running under the CII Iris 45 to 60 instruction set, Unidata 7.720 will run under a specially adapted version of the SIRIS 2 or 3 operating system. It can also run the ASSIRIS assembler. Using the Philips P1000 instruction set, it can run under the P1000 operating system and can support the P1000 assembler and compilers. CII Iris and Philips P1000 compatible standard interface I/O channels are also being developed.

Unidata 7.720's ability to run under any of the three currently available instruction sets and operating systems means that it can offer also the full range of standard applications packages developed by CII for the Iris 45 to 60 range, Philips for the P1000 family, and Siemens for the System/4004. Currently available packages include the HOREST wholesale and retail order entry and inventory control package; ISI, BASIS 35, and POKAL production scheduling and control systems; MISTRAL documentation retrieval system; SINETIK network scheduling package; and LP/ 4004, SIESTA 2, BMD, and MEB/METHAPLAN mathematical programming systems.

PERFORMANCE AND COMPETITIVE POSITION

Unidata 7.720 is the natural upward migration path for current users of Philips P1075 or P1100 systems and Siemens System 4004/16, 4004/26, and 4004/35 systems. The 4004/16 and 4004/26 users need only recompile their source programs to run them on the Unidata 7.720; P1075, P1100, and 4004/35 users can run their machine code programs without modification. Unidata 7.720 replaces the P1075 and P1100 in the Philips catalogue and the recently announced System 4004/220 in the Siemens catalogue without prejudicing outstanding deliveries of any of these systems. It also allows CII to offer for the first time a small general-purpose computer system that is fully compatible with its medium-sized Iris 45, 50, 55, and 60 systems.

Unidata 7.720's main marketing target, however, is the IBM 360/20 replacement market, in which it will compete primarily with the IBM System/370 Model 115 and the Burroughs B 1726 and B 1728. The Unidata system aims to provide all the most useful features of the IBM 370/115 at a slightly lower price; it also offers a number of additional facilities unavailable on either of its main competitors.

Unidata 7.720 resembles the IBM 370/115 in its instruction set, range of language compilers, main store sizes, and optional paging virtual memory facilities. The only IBM 370/115 feature that the Unidata 7.720 does not offer at this time is an IBM 360/20 emulator microprogram. This is regarded as unnecessary, as most European 360/20 users have written their source programs in RPG and can recompile these without alteration on the Unidata 7.720's RPG compiler.

Unidata 7.720 offers a greater degree of I/O simultaneity, more expandable on-line disc storage, and more powerful data communication handling and multiprogramming facilities than either the IBM 370/115 or the Burroughs B 1726 and B 1728.

Unidata 7.720 supports a maximum of 12 peripheral adapters; this compares with five adapters and one byte-multiplexor channel on the IBM 370/115 and eight I/O channels on the Burroughs B 1726 and B 1728. Two of Unidata 7.720's peripheral adapters can be disc adapters, the same number as on the Burroughs B 1726 and B 1728; the IBM 370/115 supports a single disc adapter. Maximum on-line disc capacity is 877 million bytes on the Unidata 7.720, 525 million bytes on the Burroughs B 1728, and 239 million bytes on the IBM 370/115. On the other hand, the Unidata 3440 disc subsystems have a transfer rate of 312K bytes per second each as compared with 885K bytes per second on the IBM 3340 DASF, although access and latency times are the same for both systems.

Unlike the IBM 370/115, Unidata 7.720 attaches other high-speed devices by means of standard interface selector channels instead of integrated adapters. In addition to the standard Unidata 3570 (30K bytes per second) and 3571 (60K bytes per second) magnetic tape systems, any Siemens System/4004 magnetic tape subsystem as well as IBM 2311- and 2314-compatible disc systems can be connected to the Unidata 7.720 selector channels. Standard interface channels will also be available for CII Iris and Philips P1000 peripherals.

Unidata 7.720's 12 peripheral adapters can include any number of byte-multiplexer channels for slow I/O devices (60K bytes per second) as compared with a single byte-multiplexor channel (19K to 29K bytes per second) on the IBM 370/115. The 7.720 offers a wider choice of line printers, including an inexpensive dot-matrix comb printer (200 lines per minute) and drum barrel printers (600 and 900 lines per minute) with exchangeable drum barrels for which there is no equivalent on the IBM 370/115. Unidata also offers a train printer (900 to 1,100 lines per minute) equivalent to IBM's 3203. When equipped with the 16-character extended numeric print set chain, the Unidata Printer operates at over 2,000 lines per minute.

Unidata's 3630 Data Communications Unit can multiplex up to 30 synchronous and/or asynchronous lines (50 to 19,200 bits per second) up to a combined throughput rate of 20K bytes per second. This is more powerful than either IBM 370/115 integrated communication adapter for five synchronous or four synchronous and eight asynchronous lines, or the 16-line Multiline Controller available on the Burroughs B 1726 and B 1728.

Unidata's BS 1000 operating system multiprogramming facilities for up to 14 variable-length user programs each can occupy any main store area that is a multiple of 2K bytes. Extensive use of disc overlay techniques allows its store residence requirements to range only from 8K to 20K bytes. This compares with a maximum of five user program partitions on IBM's considerably more store-demanding DOS/VS. DOS/VS offers virtual memory facilities. A virtual memory version of BS 1000 has been promised by Unidata for the beginning of 1975 when the first Unidata 7.720 systems will be delivered.

Unidata 7.720's main competitive weakness is that it is still largely a package of promises; tests of its actual performance on customer premises cannot be made until the beginning of 1975. While it is known that its reloadable control store has a 720-nanosecond cycle per 48-bit microinstruction, the number of microsteps needed to implement each of the 167 IBM-370 compatible macroinstructions is unknown, thus its internal execution speeds are unknown. Even less is known of the efficiency of its job throughput; any tendency to thrash in either real-memory disc overlays or virtual memory paging would be more disastrous on a Unidata 7.720 with its slower backing disc store (312K bytes per second) than on an IBM 370/115 with its faster discs (885K bytes per second).

Unidata has promised to announce, before the end of 1974, two medium-sized models competitive with the IBM 370/125 and 370/135. The first will probably be a renumbered Unidata version of the Siemens System 4004/230 announced in June 1973 and also due to be delivered in early 1975. This will be the natural upgrade path for Unidata 7.720 users. One reassuring aspect of the Unidata 7.720 is that its closeness to IBM System/370 would allow a user to migrate back into the IBM fold at any time as painlessly as he had left it if Unidata failed to offer him a satisfactory migration path when required.

With monthly rentals starting at DFl 16,000 ($5,000), the Unidata 7.720 is too expensive to compete with the IBM System/3 Model 15 for users upgrading from the System/3 Model 10. Nor can it compete for first-time users and users upgrading from keyboard or card-oriented accounting systems. A wide choice of much cheaper systems fit this market: Burroughs B 700 and B 1700 Series, Honeywell-Bull Model 58, IBM System/3, ICL 2903, NCR Century 75, Nixdorf Systems 880 and 900, and Univac 9000 Series.

CONFIGURATION GUIDE

The Unidata 7.720 central processor has an 8K 48-bit word, 720-nanosecond MOS/LSI reloadable control store (RCS), used to store the microprograms that implement the standard instruction set (167 instructions), CPU resource accounting, diagnostic checking, dynamic resource scheduling, and I/O transfers for the basic systems peripherals such as discs, card reader, and printer. RCS can be expanded in 1K-word increments to a current maximum of 16K words to implement additional I/O channels and/or additional instruction sets. Unlike the IBM 370/115, the Unidata 7.720 does not use a special "floppy disc" to load microprograms into the RCS but loads them from reserved tracks on the first system disc.

The MOS/LSI main store also has a 720-nanosecond cycle time per 4-byte access. Main store is currently available in 5 sizes: 48K, 64K, 96K, 128K, and 160K bytes. Hardware paging control logic is optionally available.

Four integrated adapters are standard on every Unidata 7.720 CPU to connect one 3440 disc subsystem, card reader, line printer, and operator's console. The console has a keyboard and CRT display console; it can also include an optional hard copy device.

Up to eight additional peripheral adapters can be connected to a 7.720 CPU. These can be any combination of integrated adapters (only one additional disc adapter), standard interface selector channels, and standard interface byte-multiplexor channels. Each integrated adapter and selector channel can control one I/O transfer up to 320K bytes per second at a time; the byte-multiplexor channel can handle multiple slow I/O transfers up to a combined transfer rate of 60K bytes per second. CPU I/O logic allows future connection of integrated disc adapters with transfer rates up to 900K bytes per second. Maximum combined I/O throughput on all channels is 1.4 million bytes per second.

PERIPHERALS

Table 1 lists the standard and optional peripheral subsystems and devices available on the Unidata 7.720. At least one card reader, line printer, and disc subsystem are standard on every system. Optional additional peripherals include magnetic tape subsystems, a card punch, and a data communications control unit. In addition to the Unidata peripherals, any Siemens System/4004 peripheral subsystem or I/O device can be connected to control unit positions on the standard interface selector or byte-multiplexer channels: these include OCR-A and OCR-B document readers, paper tape readers and punches, and a wide variety of older magnetic tape and disc systems.

Printers. Any of 4 line printer models can be connected to the integrated line printer adapter. The 3320 is a dot matrix comb printer that forms characters in its 64-character repertoire as 9 by 9 dot matrices. Its peak printing speed is 200 lines per minute irrespective of the range of characters used in any one line.

The 3330 and 3331 are drum barrel printers, with exchangeable 64-character print barrels. A range of national print barrels is available, including an OCR-B font barrel for printing turnaround documents. Peak printing speeds of 600 and 900 lines per minute can be maintained only if no more than 48 adjacent characters are used in any line. If the full 64-character print set is used, printing speeds drop to 480 and 720 lines per minute, respectively.

Table 1. Unidata 7.720: Standard and Optional Features and Peripherals

Device	Standard Features & Components	Optional Features & Additions
Mainframe	7.720 CPU microprogrammable	
	Reloadable control store (RCS) 8K 48-bit words, 720-nsec cycle	1K 48-bit word increments up to 16K wds
	MOS/LSI main store, 720 nsec/4 bytes, 48K-byte capacity	Main store extensions to 64K, 96K, 128K, and 160K bytes
I/O	4 integrated adapters for CRT display console, card reader, line printer, disc subsystem	Up to 8 additional I/O adapters, incl any combination of Addtl disc adapter (max 1); 320K bytes/sec Std interface selector channel; 320K bytes/sec Std interface byte-multiplexor channel; 8 trunks; 60K bytes/sec
Input	1 card reader (80-column) chosen from among	Additional card readers. Any standard Siemens System/4004 input peripheral, including paper tape and OCR document reader
	3140 card reader, 300 cpm, with column-binary and end-of-file features	51-column feature optional
	3141 card reader, 600 cpm, with column-binary and end-of-file features	51-column feature optional
	3150 card reader, 1,000 cpm	Optional features: column binary, mark-sense read, scored-card, end-of-file
Output	1 line printer chosen from	Additional line printers
	3320 matrix-dot comb printer 64-char set, 200 lpm	3160 card punch, 100 to 290 cpm Any std Siemens System/4004 output peripheral
	3330 drum printer, 64-char set, 480 to 600 lpm	OCR-B print barrel
	3331 drum printer, 64-char set, 720 to 900 lpm	OCR-B print barrel
	3340 train printer, 16-, 48-, 64-, 96-, 128-, and 192-char sets, 920 to 1,170 lpm, 2,135 lpm for 16-char set	OCR-A and OCR-B print train cartridges
Disc	1 3440 Disk Storage drive holding one disk pack: 11 platters, 19 surfaces, 400 tracks/surface + 6 spares, 54,820,000 bytes capacity, avg track seek time - 30 msec, avg latency - 12.5 msec, transfer rate - 312,000 bytes/sec	Up to 7 additional 3440 drives on first int disc adapter Up to 8 additional 3440 drives on second int disc adapter Maximum combined on-line capacity - 877,000,000 bytes

Table 1. (Contd.)

Device	Standard Features & Components	Optional Features & Additions
Magnetic Tape		Connectable to opt std interface selector channel
		3570 MT unit - control unit and 2 drives for 9-track, 1,600-bpi PE tape, 30,000 bytes/sec.
		3571 MT unit - control unit and 2 drives for 9-track, 1,600-bpi PE tape, 60,000 bytes/sec
		Any Siemens System/4004 MT subsystem
		Connectable to 3570 MTU, up to 4 addtl 3530 drives, 30,000 bytes/sec
		Connectable to 3571 MTU, up to four addtl 3531 drives, 60,000 bytes/sec
Data Communications		Connectable to opt std interface byte-multiplexor channel
		3630 Data Communications Unit, for multiplexing up to 30 synch or asynch lines, 50 to 19,200 bits/sec, max combined throughput 20,000 bytes/sec
		Connectable to 3630 comm lines Any std Siemens, CII, or Philips terminal, or compatible independent device

The 3340 is a train printer with print characters arranged in horizontally revolving train cartridges. A wide range of train cartridges is available, with 16, 48, 64, 96, 128, and 192 printable characters, different national character sets, and different fonts, including OCR-A and OCR-B fonts for turnaround documents. Peak printing speeds depend on the number of characters in the cartridge in use: 2,135 lines per minute for 16-character sets; 1,170 lines per minute for 48-character sets; 920 lines per minute for 64-character sets, and so forth.

Discs. Unidata 3440 Disk Storage specifications are identical to those of the Siemens GPL 4580 disc system available on System/4004. Each drive can accommodate one 11-platter, 19-surface, exchangeable disc pack, with 400 recording and six spare tracks per surface; data capacity is 54.82 million bytes. Up to eight drives can be connected to each integrated disc adapter, and up to two disc adapters can be connected to a 7.720 CPU; maximum combined on-line storage capacity is 877 million bytes.

Magnetic Tape. Unidata 3570 and 3571 magnetic tape units connect to standard interface selector channel control unit positions. Their design is identical to the Siemens 4420 magnetic tape units announced at the end of 1972 for the System/4004. Each 3570 and 3571 unit comprises a controller and two tape drives. Up to four additional 3530 drives can be connected in daisy chain to each 3570 unit, and up to four 3531 drives to each 3571 unit.

DATA COMMUNICATIONS

The Unidata 7.720 can be used as the central processing system of a small data communication network or as a front-end communication processor to a larger CII Iris 45, 50, 55, or 60; Philips P1200 or P1400; or Siemens System/4004 computer.

The Unidata 3630 Data Communications Control Unit connects to a control unit position on a standard interface byte-multiplexor channel. Its specifications are identical to those of the Siemens 4666 Multi-Channel Communications Control Unit for the System/4004. It can multiplex transmissions on up to 30 synchronous and/or asynchronous lines with individual transfer rates of 50 to 19,200 bits per second, subject to a combined maximum throughput rate of 20,000 bytes per second. It is supported by the DUS communications control module of the BS 1000 operating system.

Any Siemens terminal that can be interfaced to the 4666 MCCC can also be interfaced to the Unidata 3630 DCU. Compatible terminals include Siemens 200 Teleprinters; Siemens Transdata 8150, 8151, and 8153 CRT displays; Siemens Transdata 840 remote batch terminals; and Siemens 404/2 communication processors and intelligent terminals. Siemens-compatible CRT display terminals are also offered by AEG-Telefunken, CSEE, Grundig, and Sintra. CII and Philips also offer terminals that can be interfaced to the Unidata 3630 DCU.

SOFTWARE

Unidata 7.720 software has already been discussed in the Compatibility section of the OVERVIEW, and under PERFORMANCE AND COMPETITIVE POSITION. For a more detailed description of the BS 1000 operating system and language compilers, see the report on the Siemens System/4004 in the General-Purpose Computer Systems section of your AUERBACH Computer Technology Reports.

HEADQUARTERS

Philips-Electrologica NV
Oude Apeldoornseweg 41
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(7.720 design leader)

CII, Compagnie Internationale
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78430 Louveciennes, France

Siemens AG
Bereich Datenverarbeitung,
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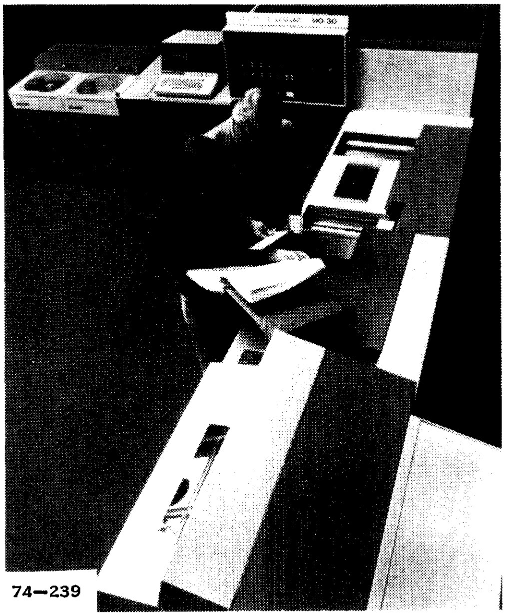
Philips-Electrologica is the Unidata 7.720 design leader and determines marketing policy in the Netherlands. CII determines marketing policy in France and Spain. Siemens determines marketing policy in West Germany, Switzerland, Austria, and Scandinavia. The jointly owned Unidata-Belgium SA is responsible for marketing in Belgium.



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OVERVIEW

Sperry Univac announced the Model 90/30 on June 20, 1974. The first 90/30 is scheduled for delivery with all system software in January 1975. The Model 90/30 is the lowest entry level system into the Series 90. It operates at about one-half the speed of the 90/60 and less than half that of the 90/70, see Table 1. The 90/30 is modular and has a broad range of configurations. Univac claims it competes favorably in price/performance with the Burroughs B 1700 line (1712, 1714, 1726, and 1728); IBM System/3 Models 10 and 15; and IBM System/370 Models 115, 125, and 135. Further, the 90/30's processing power, measured in terms of KOPS (thousands of operations per second), is over twice that of the IBM System/3/15 and System/370 Models 115 and 125 and is comparable to that of the IBM System/370 Model 135.

The smallest 90/30 system consists of a microprogrammed CPU with a basic instruction set of 84 instructions, emulation for the Univac 9200/9300 and IBM System 360/20, integrated peripheral channel with attached CRT console, card reader, card punch, and printer, and an integrated disc adapter with two disc drives, 28.9M bytes each. Optional features include memory to 262K bytes, data communications for up to 24 half-duplex or 12 full-duplex lines, disc drives with capacity up to 1,600 million bytes, and additional peripherals.

The 90/30 runs under a new operating system called OS/3, which features multiprogramming, multitasking, automatic job scheduling, remote job entry, and integrated communications. Up to seven jobs can run concurrently.

Univac has partially departed from its previously bundled pricing. The cost of three applications packages available for the 90/30 will be added to the contracted system price. These proprietary programs are PROFITS, UNIS Industrial System, and NEWSCOMP. Other applications packages will not be separately priced.

The 90/30 uses all MOS semiconductor memory composed of 1K chips. Circuitry consists primarily of T^2L logic. Systems will be manufactured in Japan, Germany, and the United States. Benchmarks will be available by November 1974. First deliveries will be during the first quarter of 1975. The first two system demonstrations were in Germany and at the DPMA conference.

Univac's recent past FY73 shows the company in a favorable financial position: shipments up 30 percent, orders up 18 percent, installed base up 12 percent to \$5.5 billion, gross income up to \$1.1 billion, fifth consecutive year of 15 percent growth.

COMPETITIVE POSITION

The 90/30 is an attractive addition to the Series 90 line and in the right direction, downward. No serious contender in the general-purpose computer market can let the thousands of small computer users get hooked on another system and expect very many of them to migrate to another system when their computer needs increase. These users want an easy, relatively painless upgrade path, as IBM System/3 customers have shown by using another System/3 rather than upgrade to the System/370.

Univac has chosen a sitting duck to go after, the IBM System 360/20, which is not really compatible with the 360 line and not readily upgradable by downgrading to the System/3. The path is relatively rocky for the System 360/20 user no matter what route he takes. So, why not go the 90/30 route which offers 360/20 emulation for an orderly upgrade?

The 90/30 is also an easy upgrade for the Univac 9200/9300, which it also emulates. The 90/30 is a much more powerful system with larger memory, powerful operating system, more disc storage, and more programming languages (RPG II, COBOL, FORTRAN, and ASSEMBLER).

In head-to-head competition with the Burroughs B 1700, IBM System/3 Models 10 and 15, and IBM System/370 Models 115, 125, and 135, the Univac 90/30 has considerably tougher competition. KOPS (thousands of operations per second) are only KOPS, not throughput. Univac's chances of liberating very many of these systems are relatively slim except for some System 3/15 upgrades. A Univac spokesman characterized the market as consisting of "those considering but not committed to the 370." When competing for new accounts, however, the 90/30 offers enough of a price/performance edge to get a hefty share of that business.

Honeywell will not be strong competition for the 90/30 in the United States until the company announces Series 60 Levels to replace the 2020 and 2030. In the important

Table 1. Comparison of the Univac 90/30 with the 90/60 and 90/70

Characteristic	90/30	90/60	90/70
Orientation	Disc	Disc	Disc
Memory			
Size (bytes)			
Minimum	32K	131K	131K
Maximum	262K	524K	1M
Bytes/Access	2	4	4
Cycle Time (nsec)	600/2 bytes	600/4 bytes	600/4 bytes
Operating System	OS/3	OS/7	OS/7
Disc Capacity	5.7M-1,600M	7.25-1,600M	7.25-1,600M
Data Comm Line			
Full-Duplex	12	15	64
Half-Duplex	24	30	128
Peripheral Subsystems	27	32	40
First Delivery	Jan 1975	Jan 1974	4th qtr 1973

European market, however, the Honeywell 60 Levels 58, 62, and 64 are quite competitive. Univac expects 35 to 40 percent of the 90/30 sales to be outside the United States.

As the trend toward smaller computer systems continues, it is good that the company whose name has become synonymous with computer has a price/performance leader in the field, for the moment at least. With LSI technology moving so rapidly these days, the newest system tends to be the leader for only a brief moment.

CONFIGURATION GUIDE

The basic 90/30 system includes a processor with 32K bytes of memory, 84 basic instructions, and 32 registers, an integrated peripheral channel (IPC), and an integrated disc adapter. Minimum systems also include a CRT console printer attached to the IPC.

The first main memory expansion within the CPU cabinet adds 16K bytes to make 64K; freestanding units of 32K-byte increments can be added thereafter until the maximum of 256K bytes is reached (K = 1,024). Processor capabilities can also be expanded through the addition of storage protect modules and various types of expansion to the system micrologic. Storage protection is added in increments of 512 bytes. Micrologic expansion capabilities include a floating-point processor with 44 more instructions and four more registers, IBM 360/20 compatibility with two more instructions, and a privileged/nonprivileged instruction set of 16 instructions. A special set of instructions designed for malfunction analysis and maintenance can replace a portion of the instructions.

Two types of peripheral expansion are available to the basic system without attachment of additional I/O channels. Up to eight 8416 disc drives can be supported by integrated disc adapter attached directly to the CPU. Four more peripheral devices can be supported by the IPC: the 0717 card reader, 0773 printer, 0605 card punch, and a communications adapter for up to 24 lines. Only one peripheral of each type can be added to the IPC.

To add more peripherals to the system or to increase I/O rates, one multiplexor channel and one or two selector channels can be added to the system. The multiplexor channel handles up to eight subsystems, including 0716 card reader, 0604 card punch, 2703 optical document reader, 0920 paper tape subsystem, 0770, 0768 printers, UNISERVO VIC subsystem (subject to availability), and 9000 series channel adapter. The channel adapter can be used to interface to a 9200 or 9300 computer. Selector channels handle up to eight control units each, such as those for 8430, 8414, and 8411 disc subsystems and UNISERVO 12, UNISERVO 16, and UNISERVO 20 tape subsystems. The 8430 and all three UNISERVO subsystem controllers can handle 16 drives each; thus the on-line mass storage capability of the system is considerable.

Although the subsystems that can be attached to the IPC are restricted to one of each type, the selector and multiplexor channels can attach any combination of the subsystem controllers. Older subsystems which are no longer in production are subject to availability, however. These include the 8414, 8411, and UNISERVO VIC subsystems.

COMPATIBILITY

The 90/30 emulates the IBM 360/20 and the Univac 9200/9300. At the higher-level language level, RPG II, COBOL, and FORTRAN compilers are implemented.

COBOL is based on the National Standard COBOL and is a Level 4 DoD (Department of Defense) compiler. It includes Level 2 features for the nucleus, sequential access, random access, sort, segmentation, and library. The table handling module for Level 3 is included. A smaller version runs on 32K-byte systems. The 90/30 FORTRAN language conforms to National Standard FORTRAN.

The 90/30 operating system OS/3 is not a subset of OS/7 used on the 90/60 and 90/70; the job control languages are not compatible. The instruction set of the 90/30 is a subset of that for the 90/60 and 90/70. The 90/30 ASSEMBLER is also a subset of the 90/60 and 90/70 ASSEMBLER. The higher-level languages are compatible but programs should be recompiled.

Any 9200 or 9300 Series system can attach to the 90/30 via a 9000 Series channel adapter.

MAINFRAME

The 90/30 mainframe characteristics are summarized in Table 2.

Table 2. Univac 90/30: Mainframe Characteristics

Characteristic	90/30 Implementation
System Orientation	Disc
Central Processor	
Type	Microprogrammed
Instruction	84 basic, 64 opt (including floating-point arithmetic)
Registers	16 for user program; 16 for operating system; 4 for floating-point arithmetic
Word Length	32 bits
Integrated Emulators	9200/9300, IBM System 360/20
Memory	
Type	MOS
Addressable Unit	Byte
Units/Access	2 bytes (halfword)
Cycle Time	600 nsec/halfword
Storage Protection	Opt
Page Size	512 or 1,024 bytes
INPUT/OUTPUT	
Integrated Peripheral Channel	Up to 5 subsystems: integrated CRT console/printer, card reader, card punch, and printer; optional comm adapter; 50K bytes/sec
Integrated Disc Adapter	Up to 8 disc drives: 2 integrated, 6 opt
Multiplexor Channel	Opt for up to 8 subsystems, 83K bytes/sec
Selector Channels	2 opt for up to 8 subsystems each, 825K bytes/sec each

Central Processor

The 90/30 CPU operates under microprogram control. The basic chassis includes an interval timer, register stack, integrated peripheral channel, and integrated disc adapter. Optional features are an integrated communications adapter, storage protection, multiplexer channel, one or two selector channels, and floating-point arithmetic.

The register stack includes 16 full-word registers for user programs, 16 for the supervisor program and four doubleword floating-point registers. Separate registers contain the program relocation bases for active programs.

The standard instruction set includes instructions that operate on 64-bit double words, 32-bit words, and 16-bit halfwords. Packed and unpacked decimal arithmetic and binary arithmetic are standard features. Instruction formats include halfwords, fullwords, and doubleword instructions, with the op code as the first byte, regardless of instruction length.

The microinstructions that implement the instruction set reside in a high-speed control memory that is partly read/write and partly read-only.

MAIN MEMORY

Main memory consists of high-speed, semiconductor memory modules. Up to 65K bytes can reside in the mainframe. Memory beyond 65K bytes is contained in freestanding units. Memory cycle time is 600 nanoseconds for a 2-byte access. Word length is 32 bits or four bytes.

Memory is available in capacities of 49K, 65K, 98K, 131K, 163K, 196K, 229K, and 262K bytes. Memory protect divides memory into pages of 512 bytes for systems with no more than 131,072 bytes of memory. Larger memories are divided into 1,024-byte pages.

INPUT/OUTPUT

After appropriate instruction parameters have been transferred to the I/O channel, data transfers occur concurrently with other processing. The standard Integrated Peripheral Channel (IPC) is the slowest I/O channel at 50,000 bytes per second; it handles only slow-speed and communications devices. The integrated disc adapter allows an 8416 to transfer data at up to 625,000 bytes per second. The multiplexor channel is somewhat faster than the IPC, with a maximum combined transfer rate of 83,000 bytes per second; subsystems connected to the channel operate concurrently; the channel transfers one byte from each operating subsystem at a time in a round-robin fashion. The selector channels, on the other hand, operate only in burst mode with each subsystem retaining control of the channel until the block transfer is complete.

PERIPHERALS

The 90/30 system peripherals include card, paper tape, printers, OCR subsystem, magnetic tape, and magnetic disc units.

Slow-Speed Peripherals

0717 Card Reader. Uses 80-column cards; 500 cards per minute; 2,400-card hopper, 2,000-card stacker; short-card feed optional; attaches to IPC.

0605 Card Punch. Uses 80-column cards; 75 to 160 cards per minute (28-80 columns); 700-card hopper; two 600-card stackers; optional card read at 160 cards per minute; attaches to IPC.

0773 Printer. Band printer, 500 lines per minute for 48-character set, 120 columns; format buffer, six or eight line-per-inch spacing, 22 inch-per-second skip speed; options include 132- or 144-column line, and 63-, 85-, 96-, 128-, or 256-character sets (speed is 400 lines per minute for 63-character set and 114 lines per minute for 256-character set); attaches to IPC.

0716 Card Reader. Uses 80-column cards; 1,000 cards per minute; image or translate mode; ASCII, EBCDIC, or compressed code standard to either mode, 2,400-column hopper, two 2,000-column stackers; attaches to MUX channel.

0604 Card Punch. Uses 80-column cards; 250 cards per minute; two output stackers; attaches to MUX channel.

0770 Printer. Band printer; maximum speed 2,000 lines per minute; 132 columns for 48-character set; vertical format buffer; power stacker; options include 800 line-per-minute and 1,400 line-per-minute submodels for 48-character set, and 64-, 96-, 128-, and 256-character set options; attaches to MUX channel.

0768 Printer. Drum printer series; three drums with 63-, 94-, and 132-character set; printing speed depends on number of contiguous characters used: 63-character drum prints 1,100 lines per minute for 49 characters; 94-character drum prints 840 lines per minute for 94 characters and 2,000 lines per minute for 14 characters; 132-character drum prints 1,200 lines per minute for 63 characters and 1,600 lines per minute for 43 characters; attaches to MUX channel.

0920 Paper Tape Reader/Punch. Uses 5- to 8-channel tape; reads 300 characters per second, punches 110 characters per second; optional spoolers; attaches to MUX channel.

High-Speed Peripherals

The new 8416 disc subsystem has been specially designed for the 90/30; it attaches directly to the system via an integrated adapter. The 8430 disc subsystem and the 8411 and 8414 subsystems as available can also be attached to a 90/30 via selector channels. Similarly UNISERVO 12, 16, and 20 magnetic tape subsystems can be attached to a 90/30 via a selector channel, but UNISERVO VIC, when available, must be attached to a slower-speed multiplexor (MUX) channel. Tables 3 and 4 list disc and magnetic tape specifications, respectively.

Table 3. Univac 90/30: Disc Subsystem Characteristics

Characteristic	8411*	8416*	8416(1)	8430(2)
Channel	Selector	Selector	IPS	Selector
Drives/Control	2-8	2-8	2-8	2-16
Heads/Drive	10	20	7	19
Usable Surfaces/Drive	70	20	7	19
Tracks/Surface	200	200	404	404
Bytes/Track	3,625	7,294	10,240	13,030
Capacity (bytes)	7.25M	29.2M	28.9M	100K
Access Time				
Head Positioning (msec)	25-135	25-130		7-50
Avg Access Time (msec)	75	60	33	27
Latency (msec)	12.5	12.5	10.8	8.33
Rotational Speed (rpm)	2,400	2,400	2,800	3,600
Transfer Rate (bytes/sec)	156K	312K	625K	806K

Notes:
(1) Designed specifically for 90/30 by new ISS division.
(2) Adapted Itel disc
* As available.

Table 4. Univac 90/30: Tape Subsystem Characteristics

Characteristic	Uniservo VIC	Uniservo 12	Uniservo 16	Uniservo 20
Channel	MUX	Selector	Selector	Selector
Units/Control	2-8	1-16	1-16	1-16
Number of Tracks	7/9	7/9	7/9	7/9
Tape Speed (ips)	42.7	42.7	120	200
Transfer Rate	34K	68K	192K	320K
Recording Mode	NRZI	PE; NRZI	PE; NRZI	PE

**As available.*

Special Peripherals

2703 Document Reader. Reads 300 6-inch documents per minute; document size 3.0 to 8.75 by 2.75 to 4.25 inches; OCR-A and Univac H14 fonts; 2,000-document hopper, three 1,000-document stackers; options include mark read, punch card feed, validity check, Mod 10 check digit verification, speed upgrade to 600 documents per minute; attaches to MUX channel.

Channel Adapter. Connects 90/30 with 9200, 9200II, 9300, or 9300II; attaches to MUX channel of both computers; housed in 9200A300 processor cabinet.

Console

The system console includes a keyboard and CRT display, which monitors all communication between the operator and the system. The console provides an alphanumeric keyboard, cursor control keys, editing keys, data control keys, and indicators. A printer for hard copy is optional.

DATA COMMUNICATIONS

Data communications is supported by the optional integrated communications adapter (ICA), which includes the communications adapter interface, communications multiplexor module and line adapters, mounted in the console. The standard ICA supports six full-duplex lines; an option expands the system up to 12 full-duplex or 24 half-duplex lines. The ICA module performs the proper sequencing when the IPC issues a connect signal or a device requests service, and it also performs functions relating the message discipline.

The ICA can recognize special characters or sequences of characters; it checks character parity; and it coordinates data transfers in and out of main memory. It supports auto dial/answer, private leased lines, public telephone networks, TWX networks, telegraph loops, Telex both United States and International, wideband and military communication networks, and new digital data networks.

Software to control communication is via ICAM (Integrated Communications Access Method), a modular component of OS/3. System generation allows three language interfaces to ICAM: BAL (Basic Assembly Language), RPG II, and IMS (Information Management System). ICAM software includes channel control routines, physical I/O control system, remote device handlers, network definition and control, message sequencing, journal control, IMS/90 software interface, and options for auditing, recovery, and restart.

Terminals

ICAM supports the IBM 2780 Data Transmission Terminal; Teletype Models 28, 32, 33, 35, 37, and 38; the Sperry Univac 9200/9300 computers; and the following Univac terminals.

Uniscope 100. Keyboard/CRT with 480, 512, 960, or 1,024 characters; hardcopy option; can be used for data entry or system display.

DCT 500. Keyboard/printer; RO, KSR, or ASR modes; field expandable; paper tape for ASR; 132 columns; ASCII code.

DCT 1000. Terminal printer (30 characters per second) can expand to include keyboard, card reader, card punch, paper tape reader/punch, and auxiliary printer; batch or conversational modes; two 160-character buffers; polling and address recognition allows up to 31 DCT 1000s per line.

DCT 2000. Batch terminal printer with optional card reader/punch; private line to 2,400 baud or dialup to 2,000 baud; EIA RS232C interface.

1004/1005 Card Processor. Processor, card reader/punch, and printer. Model 1005 has core storage and more local processing; several submodels per model with different I/O speeds, and magnetic tape option.

SOFTWARE

The 90/30 operating system, OS/3, is a modular batch-processing system that supports COBOL, FORTRAN, RPG II, and Basic Assembly Languages; Data Base Management System called IMS/90; ICAM communications package; IBM 360/20 and Univac 9200/9300 emulators; job control language; and a variety of utilities, diagnostic and application programs. Table 5 summarizes system software.

OS/3

The OS/3 Executive includes the supervisor and job control language. Important segments of the executive include:

- Generalized physical I/O control system handles queues, initiates I/O commands, and completes interrupt routines.
- Resource allocation controls main storage, processor time, and I/O channels with associated devices.

Table 5. Univac 90/30: Software Packages

Package	Description
OS/3	Specifically designed for 90/30
Compilers	
RPG II	Implementation of IBM RPG II
COBOL	Based on ASA COBOL
FORTRAN	Based on ASA FORTRAN
Assembler	Macro facility
SORT/MERGE	Subroutine and stand-alone package
Data Utilities	File to file routine, special-purpose routines and macroinstructions
Linkage Editor	
IBM 360/20 Emulation	Used in conjunction with the 360/20 emulator microcode
9200/9300 Emulation	Used in conjunction with the 9200/9300 emulator microcode
Application Programs	
UNIS Industrial System	Modular system for solution of management problems in manufacturing
NEWSCOMP	Newspaper production system
IMS/90	Information Management System
MCS	Management Control System — advanced PERT
LP/90	Linear Programming
UPACS	Hospital Accounting Package
MINIAPT	Automatically Programmed Tools
WIMS	Wholesale Inventory Management System
PROFITS	On-line package for financial institutions
LINCO III	Line-justification program

- Task control provides for up to seven jobs for concurrent execution.
- Timer and day clock services include time of day, elapsed time, and timer interrupts at various intervals.
- Program management helps the program use allocated memory space by loading programs, managing overlays, linking subroutines, terminating job/task, and checkpointing/restarting.
- Record and file protection prevents accessing a shared file while it is being updated.
- Console management provides for input and output via console.
- Spooling includes input readers, output writers, spool-in, and spool-out.
- Diagnostic and debugging aids include trace and monitor mode, snapshot display of memory, error messages, and uniform error response.

OS/3 Data Management software support provides four access methods for storage and retrieval of data: sequential access method (SAM), direct-access method (DAM), indexed-sequential access method (ISAM), and system access technique (SAT). System Service Programs include data utilities, linkage editor, librarian, tape/disc initialize display program, testing aids, sort/merge, and COBOL/FORTRAN libraries.

Language Processors

The FORTRAN, COBOL, and RPG II processors adhere to national standards. 90/30 COBOL is consistent with the American National Standard COBOL X3.23: 1968. Two FORTRAN compilers are available: a proper FORTRAN IV subset of American National Standard FORTRAN (ANSI-X3.9-1966) which is a compatible superset of IBM/DOS 360 FORTRAN IV and FORTRAN IV subset more compatible with IBM 1130 and System/3 FORTRAN.

Although the RPG II compiler includes a large number of enhancements, RPG II source code compatibility extends to programs written for IBM 360/20 and Univac 9200/9300 systems; features provide compatibility between OS/3 RPG II and compilers offered with IBM System/3 and 360/DOS.

The 90/30 assembler is a 2-pass macroassembler that produces either relocatable or absolute object code.

HEADQUARTERS

Sperry Univac
P. O. Box 500
Blue Bell PA 19422
(215) 542-3273

PRICE DATA

Model Number	Description	Monthly Rental $	Purchase $	Monthly Maint. $
	CENTRAL PROCESSOR AND WORKING STORAGE			
3029-00	CPU (includes 32K bytes storage, expandable to 256K, 600-nsec cycle time/4 bytes, 32 general registers, 2 timers, integrated peripheral channel, relocation registers, CRT/keyboard operator station, 9200/9300 compatibility mode, 360/20 compatibility mode)	1,635	78,480	320
-99	90/30 Processor (same as 3029-00 except has 48K bytes)	1,775	85,200	340
-98	90/30 Processor (same as 3029-00 except has 64K bytes)	1,915	91,920	360
-97	90/30 Processor (same as 3029-00 except has 96K bytes)	2,195	105,360	400
-96	90/30 Processor (same as 3029-00 except has 128K bytes)	2,475	118,800	440
-95	90/30 Processor (same as 3029-00 except has 160K bytes)	2,755	132,240	480
-94	90/30 Processor (same as 3029-00 except has 192K bytes)	3,035	145,680	520
-93	90/30 Processor (same as 3029-00 except has 224K bytes)	3,315	159,120	560
-92	90/30 Processor (same as 3029-00 except has 256K bytes)	3,595	172,560	600
	Processor Options			
8541-84	Console Printer (30 cps)	72	2,856	22
F1622-00	Storage Protect (provides read/write protection and accesses to main storage and 2 additional processor instructions; protection in 512-byte blocks for processors with up to 128K bytes of main storage, and 1K-byte blocks for processors with more than 128K bytes of main storage)	15	720	–
F1623-00	Micrologic Expansion (adds 64 instructions: 44 floating-point and 20 nonprivileged)	95	4,560	15
1921-00	Channel Cabinet (provides housing for multiplexor and up to 2 selector channels)	195	9,360	30
F1618-00	Selector Channel (8 subsystem max, 825-KB transfer rate, 2 max, cabinet reqrd)	170 each	8,160 each	30 each
F1620-00	Multiplexor Channel (8 subsystem max, 83-KB transfer rate, 1/system, cabinet reqrd)	125	6,000	30
	Memory			
	Expansion Storage			
F1775-00	16K Bytes	140	6,720	20
F1907-01	32K Bytes	280	13,440	40
	MASS STORAGE			
	Discs (can also use 8414/8411 disc subsystem, subject to availability)			
	Integrated Disc Storage			
F1621-00	Disc Adapter (provides interface and control for up to 4 8416-type disc drives; expandable to 8 drives with addition of IDA expansion; min of 2 drives reqrd)	200	9,600	50
	Features			
-99	IDA Expansion (expands disc adapter control to up to 8 8416 drives)	170	8,160	30
8416-02	Disc Storage (provides direct access of up to 28.9M bytes of data using removable disc packs; avg access is 33 ms; transfer rate is 625 KB/sec)	240	11,520	75
F1216-01	Disc Pack	20	450	–
	8430 Disc Subsystem			
5039-00	Control Unit (selector channel reqrd; controls up to 8 8430-type disc drives with access to 800M 8-bit bytes; min of 2 disc units/subsystem)	1,200	57,600	300

Model Number	Description	Monthly Rental $	Purchase $	Monthly Maint. $
	8430 Disc Subsystem (Contd.)			
8430-00	Disc Storage (provides single disc drive using removable disc pack; 1M byte/drive capacity; avg access time is 27 ms; transfer rate 806 KB)	520	24,960	130
	Features			
F1230-00	Disc Pack (provides up to 100M bytes of removable storage for 8430-type drive; maintenance NA)	40	750	–
	16-drive expansion (provides the capability to attach up to 16 8430 disc drives)	160	7,680	40
	INPUT/OUTPUT			
	Punched Card			
0605-00	Integral Card Punch (75-160 cpm serial punch; includes validity checking, 700-card input hopper, 600-card output stacker, eject stacker)	205	9,840	75
F1617-00	Punch Read Station (permits reading of 80-col cards)	15	720	5
0604-99	Row Punch Subsystem (250 cpm, 80-col multiplexor I/O channel reqrd; includes program control of stacker selection; input hopper 1,000 cards; 2 output stackers, 1,000 cards each)	386	16,443	101
F0875-00	Read/Punch	124	5,219	53
0717-00	Integral Card Reader (500-cpm, 80-col card; validity checking with a read check station; 2,400-card input hopper and 2,000-card output stacker)	190	9,120	60
	Features			
F1627-00	Short Card (permits read of 51-col card)	35	1,680	10
-01	Short Card (permits read of 66-col card)	35	1,680	10
	Card Reader Subsystem			
0716-99	Card Reader and Control (1,000 cpm, 80-col card; multiread checking, input hopper 2,400 cards, 2 output hoppers, 2,000 cards each)	305	14,364	95
	Features			
F1487-00, 01	51- or 66-col read	39	1,497	10
F1488-00	Validity Check	16	756	–
F1498-00	Alternate Stacker Fill	10	504	–
F1530-99	Dual Translate (adds ASCII translator; under program control)	22	1,008	5
	Paper Tape			
	Paper Tape Subsystem (requires multiplexor I/O channel feature; subsystem requires controller and reader and/or punch, reader spooler, and punch take-up spooler)			
0920-02	Controller	185	7,917	29
F1033-02	Reader (300 cps; 5, 6, 7, or 8 channels)	39	1,680	17
F1032-02	Punch (110 cps; 5, 6, 7, or 8 channels)	135	5,754	24
F1034-00	Reader Spooler (5" diameter spools)	39	1,680	5
F1035-00	Punch Take-Up Spooler (5" or 8" diameter spools)	16	688	5
	Printers			
0773-99	Integral Printer (prints 48 char at 500 lpm, 120 print positions expandable to 144; requires print cartridge)	460	22,080	175
	Features			
F1648-00	132 Print Positions (expands print positions from 120 to 132)	40	1,920	10
-01	144 Print Positions (expands print positions from 132 to 144)	40	1,920	5
-02	144 Print Positions (expands print positions from 120 to 144)	80	3,840	15
F1649-00	Extend Character Set (provides for use of print cartridges with more than a 64-char array)	45	2,160	8
F1647-xx	Print Cartridges (many available)	30 each	1,440 each	–
0768-00	Drum Printer and Control (multiplexor I/O channel required; 132 print positions; 63 char at 900 lpm, 49 char at 1,100 lpm; 6 or 8-lpi spacing)	1,001	42,709	354
-99	Drum Printer and Control (multiplexor I/O channel reqrd; prints 63 char at 1,200 lpm, 43 char at 1,600 lpm; 132 print positions; 6 or 8-lpi spacing)	1,242	52,989	438
F1071-00	Converts 0768-00 to 0768-99	241	10,280	84
F1820-00	Stacking/Acoustical Aid (provides additional sound suppression to 0768 printers; also provides power driven assistance to form stacking)	10	436	–
0770-00	Band Printer and Control (prints 48 char at 800 lpm, 132 print position/line; vertical spacing 6 or 8 lpi; max forms advance rate 50 ips; print cartridge not included)	1,066	45,539	221

Model Number	Description	Monthly Rental $	Purchase $	Monthly Maint. $
	Features (Contd.)			
-02	Band Printer and Control (same as 0770-00 except prints 1,400 lpm and max forms advance is 75 ips)	1,275	54,469	289
-04	Band Printer and Control (same as 0770-00 except prints 2,000 lpm and 100 ips)	1,806	77,128	368
	Features			
F1533-00	160 Print Positions (expands from 132 positions to 160 positions; factory installed only)	87	3,707	16
F1534-00	Expanded Character Set Control (provides control reqrd for print cartridges containing char sets other than 48-char)	57	2,400	5
F1536-xx	Print Cartridges (a variety of char sets and fonts available)	21	420	–
2703-00	Optical Document Reader (reads printed numeric data of a specific font style from various size documents; feeds documents of a 6" length at rates of up to 300/min)	937	44,100	197
F1108-00	600-dpm Speed Upgrade (permits speed to be increased to 600 documents per minute for 6" documents)	236	11,088	34
F1163-00	Modulus 10 Check Digit (computes by modulus 10 formula a check digit based upon numeric data printed on the document and compares the result with a check digit printed on the document)	22	1,008	5
F1106-00, 01	Mark Read – EBCDIC, ASCII (permits reading of vertical pencil marks located in columns on the document; marks can be read in image mode or translated into EBCDIC or ASCII)	177	8,316	39
F1149-00	Punch Card Read (permits reading of 80-col cards; F1106-00, 01 is reqrd)	59	2,772	10
F1154-00	Validity Check (F1106-00, 01 reqrd)	10	504	–
F1155-00	Univac H-14 Conversion	–	762	–
F1156-00	USASCSOR Conversion	–	762	–
F1557-00	OCR "B"	–	762	–
F1239-00, 01	EBCDIC, ASCII Conversion	–	–	–
F1249-00	EBCDIC Mark Read Convert (permits field conversion from ASCII mark read feature to EBCDIC mark read feature)	–	63	--
F1249-01	ASCII Mark Read Convert (permits field conversion from EBCDIC mark read feature to ASCII mark read feature)	–	300	–
0768-02	ASCII Printer and Control (multiplexor I/O channel reqrd; 132 print positions; 6 or 8-lpi spacing; 2,000 lpm-numeric, 1,000 lpm, 87-char set, 840-lpm, 94-char set)	1,146	48,873	398
F1522-00	Print Code Expansion (provides for expansion to 108-char set; special print drum reqrd)	5	252	–
	Magnetic Tape			
	Uniservo 12/16 subsystem involves either (a) Uniservo control plus (max of 4) masters and slave (max of 3/master), or (b) Uniservo 12/16 control and max of 16 tapes; selector channel reqrd.			
5017-99	Uniservo 12 Control (controls up to 16 9-track phase-encoded, 1,600-bpi Uniservo 12 tape units)	520	22,224	95
	Features			
F0825-00	Dual Channel (permits nonsimultaneous operation on selector channel from 2 CPUs)	87	3,885	16
	Simultaneous Operation (provides R/R, R/W, W/R, and W/W capability on 2 selector channels)			
F1029-99	For Uniservo 12 Control	332	14,162	63
-00	For Uniservo 12/16 Control		15,905	
F0823-99	7-Track NRZI (provides capability of adding 7-track tape units to control)	113	5,025	16
F0826-00	9-Track NRZI (enables read or write in NRZI mode at 800 bpi)	113	5,028	16
F1028-95	7-Track Addition (adds 7-track NRZI to 9-track NRZI)	82	3,654	10
-96	9-Track Addition (adds 9-track NRZI to 7-track NRZI)	82	3,654	10
F1131-99	Uniservo 16 Capability (permits use of Uniservo 16 tape units with Uniservo 12 control)	41	1,743	10
0861-00	Uniservo 12 Master (9-track phase-encoded; handles up to 3 slaves; 1,600 bpi, 68-KB transfer rate)	360	15,383	113
-01	Uniservo 12 Slave (9-track phase encoded)	289	12,333	78
-04	Uniservo 12 Master (7-track NRZI handles up to 3 slaves; 200/556/800-bpi density; transfer rate 8,540/23,741/34,160 cps)	313	13,334	113
-05	Uniservo 12 Slave (7-track NRZI)		10,963	

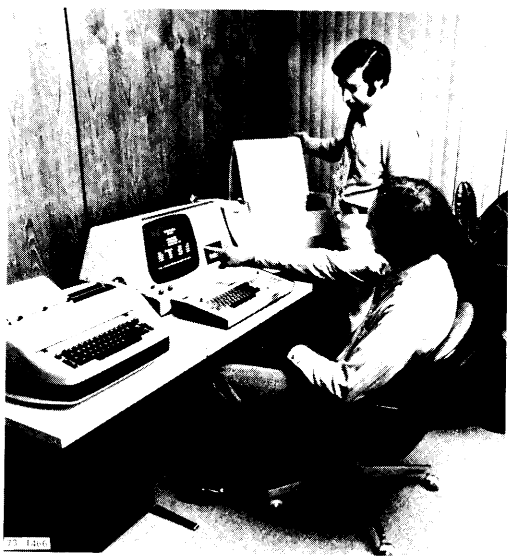
Model Number	Description	Monthly Rental $	Purchase $	Monthly Maint. $
	Features (Contd.)			
F0934-99	7- or 9-Track Simultaneity Phase-Encoded (1 reqrd for each master; control must have simultaneous feature)	80	3,429	17
-01	7- or 9-Track Simultaneity NRZI (1 reqrd for each master; control must have simultaneous and 7- or 9-track NRZI capability features)	91	3,885	17
F0935-00	Dual Density (reqrd in each master to read both NRZI and phase-encoded tapes)	53	2,284	10
F1041-00	7- to 9-Track Conversion (converts 7-track NRZI non-simultaneous master to phase-encoded master)	48	2,049	–
-01	7- to 9-Track Conversion (converts 7-track NRZI simultaneous Uniservo 12 master [0861-04] with F0934-98 to 9-track 1,600-bpi phase-encoded simultaneous master [equivalent to 0861-00 with F0934-99])	48	2,049	–
F034-98	Simultaneous Operation (reqrd in each master [0861-04] to achieve 7-track NRZI simultaneous operation; each control unit must contain F0823-99)	80	3,429	17
F1042-00	7- to 9-Track Conversion (converts 7-track NRZI slave to phase-encoded slave)	32	1,371	–
5017-00	Uniservo 12/16 Control (controls up to 16 9-track phase-encoded Uniservo 12 and/or 16 tape units); same options as Uniservo 12 control)	561	23,967	105
0862-00	Uniservo 16 Tape Unit (9-track phase-encoded; 1,600 bpi, 192-KB transfer rate)	459	19,609	116
-02	Uniservo 16 Tape Unit (7-track NRZI; 200/556/800-bpi, 24/66/96-KB transfer rate)	459	19,609	116
	Features			
F0936-99	Simultaneous Feature (reqrd for each unit for simultaneous operation)	21	914	–
F0937-00	Dual Density (reqrd in each unit to read or write both phase-encoded and NRZI)	51	2,284	–
	Uniservo 20 Tape Subsystem			
5034-00	Uniservo 20 Control (selector channel reqrd; controls up to 16 9-track phase-encoded Uniservo 12s, 16s, 20s, or a mixture of each; 1,600 bpi, 2 control units reqrd for dual-access operation)	765	32,681	95
	Features			
F0823-98	7-Track Capability (provides capability of adding 7-track NRZI Uniservo 12/16 tape units to control)	113	5,544	16
F1028-98	9-Track Addition (adds 9-track NRZI capability to 7-track capability feature)	113	5,544	16
F0826-99	9-Track NRZI (enables R/W operations in 9-track NRZI at 800 bpi and 9-track phase encoded 1,600 bpi on Uniservo 12 and 16 tape units; Uniservo 12/16 tape units must have appropriate features)	133	6,552	21
F1028-97	7-Track Addition (adds 7-track NRZI capability to 9-track NRZI option)	92	4,536	10
0864-00	Uniservo 20 (9-track phase-encoded tape unit; transfer rate 320,000 bytes/sec; 1,600 bpi; reads forward and backward; writes forward)	577	24,620	132
	Features			
F1510-00	Dual Access (provides for dual access and simultaneous R/R, R/W, W/R, and W/W operations when added to 2 or more Uniservo 20s; requires 2 control units)	51	2,284	10
	DATA COMMUNICATIONS			
	90/30 Communications Subsystem			
F1625-99	Communications Adapter (controls and coordinates transfer of data from up to 6 full-duplex or 12 half-duplex lines; each line requires adapter)	195	9,360	35
	Features			
F1625-98	Communications Adapter Expansion (expands the capability of the communications adapter to 12 full-duplex or 24 half-duplex lines; each line requires a line adapter)	195	9,360	35
	Line Adapters			
F1826-00	Synchronous Line Adapter (interface for data sets conforming to RS232 and CCITT)	18	864	7
-01	Synchronous Line Adapter (same as F1826-00 plus provides reverse channel of up to 150 baud async; requires 2 ports)	27	1,296	8

Model Number	Description	Monthly Rental $	Purchase $	Monthly Maint. $
	Line Adapters (Contd.)			
F1828-00	Asynchronous Line Adapter (provides interface to async data sets conforming to RS232 and CCITT)	14	672	6
-01	Asynchronous Line Adapter (same as F1828-00 plus provides reverse channel of up to 5 baud)	18	864	7
-02	Asynchronous Line Adapter (same as F1828-00 except provides reverse channel of up to 150 baud; requires 2 ports)	22	1,056	8
F1830-00	Wideband Line Adapter (provides a sync full-duplex interface to an AT&T 300 series data set operating at 40.8K bps with 56K-bps max speed)	22	1,056	8
-01	Wideband Line Adapter (provides a sync full-duplex interface with an AT&T 300 series data set at 50K bps; includes auto-answering capability)	22	1,056	8
F1831-00	Dial Adapter (provides the interface to both rotary or touch-tone auto dialing units; requires a line adapter location for each dialing unit)	14	672	6
F1832-00	Asynchronous Relay Line Adapter (provides async full-duplex interface optionally compatible with either 20-75 ma neutral or 10-40 ma polar telegraph lines)	14	672	6
F1835-00	TWX Line Adapter (provides interface to the USA TWX network)	14	672	6
F1836-00	Telex Line Adapter (provides interface to USA WU Telex network)	14	672	6
F1870-00	Active Line Indicator (provides display panel to display line activity on up to 12 communication lines; 2 permitted if F1625-98 is present)	7	336	2
F1001-01	Channel Adapter 9200/9300 (provides communication via respective multiplexor channels)	88	3,885	16

Model Number	Description	Monthly Rental $
	SOFTWARE	
	90/30 Newscomp	
	Basic 90/30 Newscomp	
6500-00	(Provides typesetting composition control routines instructed by commands for the automatic typesetting of textual material. Commands are provided for delimiters, space control, face selection, format control, language control, character string manipulation, justification modifiers, and auxiliary control)	100
	Editing Control	
F5000-00	(Adds the capability to edit information, via Uniscope 100 terminals, to Basic 90/30 Newscomp. Editing capabilities include: open text, compress text, scroll forward, scroll backwards, save text, insert text, duplicate text, restart, and terminate edit. Four levels of control commands include: log, route, release, delete, monitor, merge, copy, rename, unload, load, close system, and abort system.)	100
	Classified Ads	
F5001-00	(Adds classified ad processing capabilities to Basic 90/30 Newscomp. These capabilities include: sort by classification, content or optional key; ad extension; ship dates, and automatic ad deletion. The ability to output by classification or groups of classification is also provided. Editing/Control [F5000-00] is prerequisite)	100
	90/30 UNIS	
6501-00	Basic 90/30 UNIS (includes a Master Data Processor which provides for maintenance of the standard manufacturing data files, and for processing capabilities in the areas of bill materials retrievals and standard routings)	75
F5002-00	Production Planning and Scheduling to Infinite (This subsystem of 90/30 UNIS provides for backward scheduling, forward scheduling, splitting, overlapping, and reduction of wait times in scheduling to infinite capacity Excludes Finite [F5002-01])	75

Model Number	Description	Monthly Rental $
	90/30 UNIS (Contd.)	
-01	Production Planning and Scheduling to Finite. (This subsystem of 90/30 UNIS employs priority calculations, calculation of realistic start, and calculation of realistic end dates in scheduling to finite capacity. Excludes Infinite [F5002-00])	100
F5003-00	The Inventory Management Subsystem of 90/30 UNIS (adds capabilities in the areas of inventory control, statistical forecasting, requirements planning, order recommendation, order allocation, ABC analysis, and statistics)	75
F5004-00	The Work Order Management Subsystem of 90/30 UNIS (adds capabilities to Inventory Management [F5003-00] for order release and order control. Order release functions include on-hand availability control, creation of on-hand reservations, and shortage reporting. Order control includes work order status update, work in progress quantity, and reservation control. Inventory Management [F5003-00] is prerequisite)	25
	90/30 Profits	
6502-00	Profits/Time Deposits (provides overall communications and control and on-line time deposits transactions including: passbook update, cash, mail, check deposits [with/without holds]; interest calculations, cash, check, mail withdrawals, return check, rebate interest. Off-line support program for maintenance and reloading of data files are also provided)	420
-01	Profits/Loans (provides for on-line commitment record generation, on-line processing of transactions for mortgage, [capitalized and non-capitalized] commercial, and construction and discount loans. Off-line support programs are also provided for maintenance and file reload and generate the necessary information for off-line reports)	165

— Not Applicable



OVERVIEW

The Wang System 2200 is a small business computer that is an outgrowth of the large Wang calculator line. The basic System 2200 consists of a CPU with a 4K-byte read/write MOS memory, either a special basic statement keyboard or a regular alphanumeric keyboard, a CRT, one cassette drive, and I/O slots for six peripherals. An extended basic language interpreter and the control logic for the standard peripherals are hardwired into memory. The system does not require a software compiler. Arithmetic and trigonometric functions commonly used by scientists, educators, and businessmen are standard in the instruction set. Extended I/O capabilities needed to configure small interactive business systems, including several types of printers, plotters, marked sense and punched card readers, communications interfaces and discs, can be added to the basic system.

The processor operates in either program or intermediate mode. In program mode, a 1- to 4-digit line number precedes each line, and this number signals the mode. The CPU checks the line for grammatical syntax, stores it, and awaits further instructions. In the immediate mode, however, the absence of the line number causes the system to check the line and execute it immediately without saving the line. Furthermore, in the immediate mode, several statements separated by colons can be placed on a line to enhance the system's use as a calculating tool.

If a syntax error is found, the error code with an "up arrow" pointing to the error is displayed. Regardless of mode, the system returns control to the user, who can make the necessary changes by retyping the line.

Wang is a leading manufacturer of programmable calculators and word processing systems. The System 2200 is aimed partly at their traditional markets, which include various types of scientific applications, but primarily surveying and civil engineering, medical and clinical work, statistical and mathematical calculations for universities, automobile dealers, and banks (loan installments, for example). In addition, Wang markets the System 2200 for users first entering the general-purpose commercial computer market. Wang offers Invoicing, Accounts Receivable, Accounts Payable, Sales Analysis, Payroll, Inventory, and General Ledger software packages for that market.

One feature of particular interest to novice nontyping users is the standard keyboard for the basic System 2200. This keyboard arranges uppercase alphabetics in straight A to Z alphabetical order, supplemented with a 10-key numeric pad. The lowercase characters are used to enter whole Basic statements and system commands with a single keystroke, thus circumventing errors and increasing programming speed.

The first Wang System 2200 was delivered in June 1973; more than 3,800 systems have been delivered to date. Systems specifications are listed in Table 1.

PERFORMANCE AND COMPETITIVE ANALYSIS

With its first commercial system, Wang has created a product that is a cross between a calculator and a computer. It provides Wang's present calculator customers with a system to "move up" to, and provides the business community with a small interactive system that is easy to use, low priced, and reliable. Users of previous Wang calculators will find advanced calculator functions as standard parts of the system, plus program storage, printing, and plotting capability, at very reasonable prices. Small businesses will find certain features unique, such as the nonstandard keyboard and the extensive calculating ability, combined with features that are becoming standard with many small interactive systems now on the market. These include a low-cost CRT display-cassette-printer combination, microprogramming, and MOS circuitry for small size and reliability. Wang has solved the problem of software support for users who have no EDP staff — which is the case for most potential customers for this type of system — by contracting with various small software houses around the country for custom programs. Users contacted were quite happy with the performance of their systems; they did not experience problems as a result of the split hardware and software support.

Wang also offers standard business packages for the 2200.

USER REACTIONS

A southern automobile dealer has been a user of Wang products for more than two years and has had a System 2200 for three months. This business has the basic system with a Model 2222 alphanumeric keyboard and

Table 1. Wang System 2200: Specifications

Characteristic	Wang System 2200
PROCESSOR	
Main Memory (bytes)	4K-32K
Char Size (bits)	8
Addressable Registers	—
Cycle Time (μ sec)	1.6
No. of I/O Channels	6 Std; 5 opt
Max Devices/Channel	1
AUXILIARY STORAGE	
Storage Medium	Disc/tape cassette/flexible
Capacity (bytes)	disc 1.2M, 2.4M or 4.9M/ 78K/256K; 512K
Transfer Rate (bytes/sec)	200K/326/250K
DATA ENTRY	
Keyboard	Special Basic keyboard std; alphanumeric typewriter keyboard
Card Reader (cpm)	Mark-sense (hand-fed); punched (300)
Paper Tape Reader (cps)	300
DATA OUTPUT	
Card Punch (cpm)	NA
Paper Tape (cps)	NA except as option for Teletype (10)
Line Printer	132 cols, 60 to 200 lpm 80 cols, 60 to 150 lpm
CRT Display	16 lines by 64 cols
Thermal Printer	30 cps
SOFTWARE	
Operating System	No
Assembler	No
Compiler	Basic (hardwired interpreter)

one cassette drive. The system is used to calculate automobile financing charges, insurance, and other fees related to purchasing a car. The dealer buys loan money and lends it at a higher interest rate to the customer. Customers are more likely to borrow money from the automobile dealer when they can complete all the financial arrangements at the point of sale. The CRT display enables them to view all the calculations involved in their contract. This user reports he has had excellent service, both on his hardware from Wang and his software from the Creative Software house in nearby Atlanta.

A software service bureau in the South bought a Wang System 2200 to develop and debug programs for its many customers in the area. They believe few business customers buying a system as inexpensive as the Wang will do their own programming. An engineer, on the other hand, will probably program his computer. Wang does not have the programming staff to customize all user programs, and users rarely use manufacturer-supplied software without some alteration. This software company does a booming business programming for the System 2200. Its main customers have been automobile dealers, but it has also sold packages to a large number of savings and loan associations. The savings and loan applications are actually similar to those for the automobile dealers; the terminal performs calculations on loan payments. More importantly, it instantly adds extras into the payment — such as various types of insurance — so the savings institution (or automobile dealer) can make an additional profit. The software house has a special package that displays data to the salesman so he knows which extras can be shaved off to lower payments and still maximize profit on the transaction. This software house believes there is a very large market for the Wang system, particularly because of the low hardware cost.

Another software house uses a Wang System 2200 to develop customized programs for other users. The firm also has IBM System/3, Honeywell 58, DEC 340, and Basic Four systems. The firm has programmed a variety of applications for the System 2200, including programs for clinical laboratories, book distributors, a travel agency, a paper manufacturer (billing and materials), an engineering consulting firm (client billing), a furniture manufacturer (perpetual inventory), a small college (various financial applications), a construction firm (payroll and job-cost analysis), and a bank (mortgage, loan, and savings). The firm found the Wang System 2200 to have definite price/performance advantages over its principal competitors — the DEC 340, the Basic/Four, Cascade Data, and Qantel. System/3, of course, is aimed at larger users than those who would use the System 2200. In fact one user feels that Wang will soon have more installations than any other SBC manufacturer except IBM. This user feels the system is so inexpensive that even very small businesses can afford it. The minimum system this company recommends includes 8K bytes of memory, three cassette drives, and a Centronics printer. It costs about $13,800. The combination of the hardwired Basic interpreter and the lack of an operating system means it responds very quickly and is easy to use. Users noticed right away that keyed data appears "instantly" on the System 2200, whereas there is a discernible delay between entry and display on the DEC 340. The communications facility is quite fast. Even more important for business users, Wang has extended the Basic language with very good file handling capabilities (not a common feature of Basic extensions) which helps the software house provide efficient business programs. As for installation, all the user has to do is open the box, read the directions, put in a few plugs, and flip the switch.

CONFIGURATION GUIDE

Both the System 2200A and 2200B CPUs contain 4K bytes of read/write memory, a hardwired interpreter, 6 I/O slots, control electronics, and expansion capacity in the main chassis. They differ in that the System 2200B can be configured with discs and other peripherals unavailable for the System 2200A, and the 2200B also handles Boolean algebra. The System 2200A can be upgraded in the field to a System 2200B. To make a minimum fully operational system, a keyboard and CRT must be added to the basic configuration. A single magnetic tape cassette drive, which can be housed as a separate unit or combined with the CRT into a single module, rounds out the main chassis components.

Some peripherals, in addition to those already mentioned as standard, can be added to either processor model; some require the "B" model. The 2201 Output Writer, additional 2217 Tape Cassette Reader/Recorders, 2221 High Speed Printer (132 columns), 2222 Alphanumeric Keyboard, 2227 Telecommunications Option and 2231 High-Speed Printer (80 columns) can be used with either model. The 2202 Plotting Output Writer, 2203 Punched Paper Tape Reader, 2207 Teletype Interface Controller, 2212 Flatbed Plotter, 2232 Digital Flatbed Plotter, 2234 Stack-Feed Card Reader, 2214 Marked Sense Card Reader, the three 2230 Disc Models and 2240 Dual Flexible Disc Drives all require a System 2100B. Each of the six I/O slots can handle one device; an optional extended chassis adds five I/O slots for a maximum number of 11 peripherals per system.

A "matrix ROM" option extends the processor power by performing calculations on matrices rather than individual numbers. With one key depression, for instance, the user can add one matrix to another matrix. An ROM character editor option is also available to edit program source code.

MAINFRAME

Central Processor

The System 2200 processor is microprogrammed with a hardwired Basic interpreter (not a compiler) that is used for all application programs and for all communications with the system. Because there is no assembly language or machine language programming available to the user, none of the 32 internal registers can be accessed directly. Direct, indirect, and indexed addressing are all handled automatically by the CPU. The processor has no interrupt system.

Data and most instructions are stored in 8-bit bytes; floating-point numbers and certain instructions use 2 bytes. Parity checking is not offered. Floating-point operands are stored 13 digits plus sign in the mantissa, with a 2-bit exponent.

The Basic instruction set consists of 45 single-byte program instructions, two double byte instructions (DATA LOAD and DATA SAVE), and 20 mathematical functions. The Model B has an additional 54 instructions: Boolean algebra, binary add, plot, pack, unpack, and 30 I/O instructions. Matrix statements are optional on the 2200B. All of the 32 standard user-defined functions can be entered by a single programming keyboard stroke on both A and B models.

In a scientific environment, these functions frequently include normal distribution, inverse normal distribution, error function, binomial distribution, linear regression, gamma function, Poisson distribution, and the like. In a business environment, these functions can include data processing utilities such as "open file," "close file," and so on. A single key depression is also sufficient for initiating calculations on matrices if the matrix ROM option is included. Average arithmetic instruction execution times are listed in Table 2.

The programmable TRACE mode aids in program debugging by stepping through the program, producing a printout or display wherever a variable has been changed or a program transfer made. Entire programs or sections of programs can be saved on cassette or disc. Loading programs into the system can be done from either the keyboard or under program control. SAVE P prevents the program from being copied. Program chaining is available. Each program can use up to 286 variable names for numeric, numeric array, string, and string array variables. The COM (common data) stores the current value of certain variables for future use, or for transferring parameters between program segments. String variables and string arrays maximize storage space use. PACK and UNPACK (available on Model 2200B only) further maximize space use.

MAIN MEMORY

A 4K-byte MOS memory with a 1.6-microsecond cycle time is standard to the System 2200 processor. Memory can be added in increments of 4K bytes up to a maximum of 32K bytes, all internal to the standard chassis. Because the Basic compiler is hardwired, only 696 bytes are used for housekeeping. Thus, 3,400 bytes of the standard 4,096 bytes are available to the user. All peripheral handling routines are also stored in hardwired ROM modules. Consequently, adding peripherals does not impact on the amount of read/write memory available to the user.

INPUT/OUTPUT

Six I/O slots for the attachment of up to six peripherals are standard to both processors. The expansion option adds five slots to attach up to five peripherals for a maximum of 11 per system. The peripheral handling routines are all hardwired ROM modules delivered with the device. The exception is the disc management routine, which is an integral part of the Model 2200B processor, regardless of whether or not the system includes a disc. Certain peripherals attach only to the B processor.

Because it has no hardware interrupt system for handling multiple requests on the simple I/O channel, the System 2200 is not well-suited for real-time applications with multiple inputs. The system can be programmed to poll the various I/O devices, but simultaneous operations, such as a key entry while disc data is transferring, are not possible.

Table 2. Wang System 2200: Average Arithmetic Execution Times, with 13-digit Precision

Function	Avg Execution Time (msec)
Add/Subtract	0.8
Multiply	3.8
Divide	7.4
Square Root	46.4
E^X	25.3
Log^X	23.2
X^Y	45.4
Integer	0.24
Absolute Value	0.02
Sign Change	0.25
Sine	38.3
Cosine	38.9
Tangent	78.5
Arctangent	72.5

PERIPHERALS

A wide variety of peripherals can be added to the System 2200: discs, flexible discs, printers, cassette drives, Teletypes, plotters, paper tape, and both mark-sense and punched card readers. The standard system usually includes a CRT and a cassette drive within the CPU chassis and a portable keyboard.

CRT. Up to 1,024 characters are displayed on an 8- by 10.5-inch screen in 16 lines of 64 characters each.

Keyboards. The standard keyboard has 80 keys: 44 alphanumeric keys, 10 numeric keys and several groups of editing and special function keys. Uppercase alphabetic keys are arranged in order A to Z; the lowercase keys are used for the mnemonics for Basic statements, which can be entered with a single key stroke. An alternate keyboard with a key arrangement like a Teletype ASR 33 is also available.

Magnetic Tape Cassette Drive. A single tape cassette drive can be included within the chassis. The 150-foot cassette reels are recorded at 522 bytes per foot, allowing for redundant recording and a 0.6-inch inter-record gap between each 256-byte record. The effective transfer rate is approximately 326 characters per second. Additional cassette drives can be attached.

Printers. Three high-speed printers, a thermal printer, an output writer, and a plotting output writer provide a range of printing capabilities. Models 2221 and 2231 print 132 and 80 columns respectively on pin-fed forms at 150 and 100 characters per second respectively, using a dot-matrix impact printing technique. The OEM manufacturer for both printers is Centronics. The Model 2201 output writer is an IBM Selectric type unit printing pin- or friction-fed forms at 12 characters per inch; the 2202 adds plotting capability at approximately 400 steps per second (X or Y axis) using 0.01-in. steps. The Model 2241 thermal printer uses heat-sensitive paper. The print speed is 30 characters per second on an 80-character line. The printer uses a 63-character set and has automatic line feed after the 80th column. The Model 2261 high-speed printer prints at 330 characters per second on a 132-column line. The printer uses a full alphanumeric character set; the character printed is formed in a 9 by 7 dot matrix.

Conventional Peripherals. Several types of slow-speed input devices are available. These include a mark-sense card reader with a hand feed, a punched card reader (300 cards per minute) with a stack feed, and a paper tape reader (300 characters per second). Punched paper tape data can be input into the 2200 by either an ASR TTY or a high-speed optical punched paper tape reader.

Discs. Three of the disc models consist of one fixed and one removable disc. The Model 2230-1 stores 1.2 million bytes, Model 2230-2 stores 2.4 million bytes, and Model 2230-3 stores 4.9 million bytes. The disc management routines are part of the control memory that comes with the 2200B processor. The peak transfer rate is 200,000 bytes per second, yielding an effective transfer rate of 75,000 bytes per second. Each disc can operate in two modes: automatic file cataloging and absolute sector addressing.

The Model 640 and 740 Dual Removable Flexible Disc Drives consist of two flexible discs housed in one unit. The 640-1 and 740-1 submodels have a total capacity of 256K bytes; the 640-2 and 740-2 submodels have a capacity of 512 bytes. This flexible disc system is designed for scientific and commercial applications requiring small to medium storage capacity where speed is not the most important factor. The Model 740 has a software package called Disc Management System which sets up records and files, updates records, and copies files. Block length for the 740 disc can range from 1 to 256 bytes; the 640 uses a 256-byte format only. The 640 and 740 disc systems have the following features: (1) Address checking, where the operator is notified if the address is illegal. (2) CRC (Cyclic Redundancy Check), where CRC bytes are calculated and entered alongside the data on a WRITE command. On a READ command, the system recalculates the CRC and compares the result with the previously written number. (3) The system tries to READ or WRITE four times before an error signal is turned on.

Access is 220 milliseconds for both the 640-1 and the 740-1, and 400 milliseconds for both the 640-2 and the 740-2. The discs rotate at 375 rpm, thus average latency is 80 milliseconds.

DATA COMMUNICATIONS

The Model 2227 asynchronous adapter for half-duplex transmission of ASCII code allows the System 2200 to communicate with another System 2200 or any computer system that can handle ASCII transmissions. To the foreign computer, the 2200 appears as a Teletype. The adapter allows transmission rates of 110, 150, or 300 baud over voicegrade lines and 600 or 1,200 baud over dedicated lines. The transmission rate is switch selectable, and the input character code for carriage returns is also selectable.

The Model 2207 Teletype interface for asynchronous transmission at 110 baud allows the user to plug a Teletype into the System 2200. Wang suggests this controller is excellent for laboratory or medical instrument monitoring. A CRT is not required for this option.

The Model 2250 I/O interface controller uses an 8-bit parallel format to transmit data at 10,000 characters per second asynchronously between 2200s. Maximum cable length is 100 feet. This option is well-suited to mass data transfer between 2200 discs or other 8-bit parallel peripherals.

The 2200 can handle interactive and batch processing operations. With the use of the above communication options, the 2200 can act as a small business computer or an intelligent terminal.

SOFTWARE

Wang has developed software modules for common business procedures. These Basic Accounting Systems (BAS) use either magnetic tape cassette or disc for information storage. Wang describes the accounting modules as general guidelines, designed to be easily adapted to specific business environments. The modules are particularly designed for accounting, financial, and marketing areas.

Module One includes invoicing, accounts receivable, and sales analysis packages. Repetitive information like customer name and address and salesperson number is stored on cassette or disc. The entered data is used to produce the Invoice Register and is used again for Accounts Receivable, Sales Analysis, and Inventory Control. The system computes the total price, including taxes and discounts. The Accounts Receivable System allows the user to predict customers' payments and follow up on late payments. A balance forward or open item method can be used. The system produces reports on current accounts or accounts that are 30/60/90 days late. Statements are sent to the customer detailing the status of his account. The Sales Analysis System produces reports for sales periods and the percentage change between them. Reports can be generated daily, weekly, monthly, or yearly. Comparisons between present and past sales can be made. Each salesperson's total sales are recorded each month.

Module Two covers the Wang Payroll System, which calculates wages and deductions and outputs management reports and city, state, and federal reports and tax forms. Breakdowns according to employee status, pay group status, cash denomination, and payments or deposits are available.

Module Three includes Accounts Payable, Inventory, and General Ledger packages. Accounts payable, coupled with accounts receivable, gives a total picture of a company's financial status. The Cash Requirements Report produced under accounts payable aids in planning purchases and operating expenses. Files of outstanding vendor invoices are kept and payment checks and vouchers are issued. The information gathered via accounts payable is automatically carried to the general ledger. Accounts payable produces management reports like forecasted cash payment, purchase journal, aged trial balance, and an expense register. The inventory system monitors supplies and produces reports on inventory status, low stock status, physical inventory count, and stock activity. These reports allow the user to take advantage of discounts by knowing his needs in advance. The user can also accept rush orders if he knows his inventory. The general ledger system produces a balance sheet depicting current assets, liabilities, and net worth. Summary reports can include over 200 accounts. A trial balance detail and summary, and profit and loss statements are output.

Wang also has arranged with local software houses to customize user programs in addition to the programs it offers.

Wang has a mathematics general program library, a statistics/engineering library, and a finance/utility/games library for the System 2200. Programs range from those of general values (such as Chi-square testing, distribution and analysis, Poisson distributions, nominal interest rates, depreciation changes, and Fourier analysis) to those of more specific interest, such as a routine that "computes the headwater depth of culverts flowing full" or another that "calculates the number of years that an oil well will produce." Games include artillery, craps, Tic-Tac-Toe, one-armed bandit, and blackjack — but no chess.

PRICE DATA

Model	Description	Purchase Price $	Monthly Maint. $
	Central Processor and Working Storage (1)		
2200A-1	Central Processing Unit (CPU) (including 4,096 bytes of memory) (2)	3,900	20
2200B-1	Central Processing Unit (CPU) (including 4,096 bytes of memory with expandable peripheral capacity)	5,300	27
	Additional 4,096-step memory blocks for 2200A or B (CPU is expandable to a total of 32,768 bytes)	1,600	8

PRICE DATA (cont.)

Model	Description	Purchase Price $	Monthly Maint. $
	Processor Options		
OP-1*	Option 1 – Matrix ROM	500	3
OP-2*	Option 2 – General I/O ROM	500	3
OP-3	Option 3 – Character Edit ROM	400	2
OP-4	Option 4 – 2216 CRT Audio Signal	200	1
	MASS STORAGE		
	Discs		
2230-1*	Fixed/Removable Disk Drive (1,228,800 bytes)	10,000	100
2230-2*	Fixed/Removable Disk Drive (2,457,600 bytes)	12,000	100
2230-3*	Fixed/Removable Disk Drive (5,013,504 bytes)	13,500	100
2242*	Single Removable Flexible Disk Drive (262,144 bytes)	4,500	45
2243*	Triple Removable Disk Drive Drive (786,432 bytes)	8,000	80
2240-1*	Dual Removable Flexible Disk Drive (262,144 bytes)	6,000	60
2240-2*	Dual Removable Flexible Disk Drive (524,288 bytes)	7,000	70
2224-2*	Disk Multiplexer (2-station)	2,000	10
2224-3*	Disk Multiplexer (3-station)	2,500	13
2224-4*	Disk Multiplexer (4-station)	3,000	15
	INPUT/OUTPUT		
	Printers and Plotters		
2221**	Line Printer (132-column)	5,600	56
2231	Line Printer (80-column)	3,300	33
2241	Thermal Printer (80-column)	1,800	18
2261	High-Speed Printer (132-column)	7,300	73
2201	Output Writer	2,400	24
2202*	Plotting Output Writer	4,000	40
2212*	Analog Flatbed Plotter (10" x 15")	3,000	30
2232-A*	Digital Flatbed Plotter (31" x 48")	8,000	80
	Mark Sense Equipment		
2214	Mark Sense Card Reader	1,000	10
2244*	Hopper-Feed Mark Sense/ Punched Card Reader	4,500	45
	Paper Tape and Punched Card		
2203*	Punched Tape Reader	1,800	18
2234*	Hopper-Feed Punched Card Reader	3,200	32
	Magnetic Tape		
2217	Single Tape Cassette Drive	1,350	7
2218	Dual Tape Cassette Drive	2,600	26
2216/2217	Combined CRT Executive Display/Single Tape Cassette Drive	2,800	14
2216-A/17	Combined Upper/Lowercase CRT/Single Tape Cassette Drive	3,000	15
	Keyboards		
2215	BASIC Keyword Keyboard	700	4
2216	CRT Executive Display	1,800	9
2216-A	Upper/Lowercase CRT Display	2,000	10
2222	Alpha-Numeric Typewriter Keyboard	800	4

PRICE DATA (cont.)

Model	Description	Purchase Price $	Monthly Maint. $
	I/O Controllers		
2207-A	I/O Interface Controller (RS232C; selectable baud)	600	3
2250	I/O Interface Controller (8-bit parallel)	400	2
2252	Input Interface Controller (BCD 10-digit parallel)	400	2
2252-A	Input Interface Controller (BCD 10-digit parallel)	600	3
2227	Telecommunications Controller	900	5
2227-N	Null Modem	50	–
	Cabinets		
2219	I/O Extended Chassis	400	2
2290	CPU/Peripheral Stand	250	NA
2291	Plotter Stand for 2232-A	350	NA

Notes:
**Requires a 2200B Central Processing Unit to support these peripherals.*
***2221 non slash zero feature @ $150 with purchase of 2221.*
(1) When ordering additional memory blocks, change suffix number of CPU to correspond with number of desired memory blocks; i.e., Model 2200A or B-4 is a basic CPU with 4 memory blocks.
(2) Rental rates are available from manufacturer.

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M

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P

PHILIPS ELECTROLOGICA *(See NV Philips Electrologica)*

Q

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R

REMINGTON RAND OFFICE SYSTEMS *(See Sperry Rand Corp)*
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