

ICL System Ten

MANAGEMENT SUMMARY

The System Ten is a distinctive small-scale computer system, both in terms of its history and its characteristics. Its introduction in April 1970 by Singer Business Machines represented a strong bid by Singer to become a major supplier of business data processing systems. Deliveries of the Singer System Ten began in September 1970. By late 1976, nearly 4000 systems were installed worldwide and a substantial backlog of orders existed. Installations are divided between small first-time computer users and larger organizations. The latter employ the System Ten either in supporting roles for large computers or in special data collection systems.

In December 1975, Singer announced its intention to close or sell its Business Machines Division. In March 1976, ICL agreed to acquire the international operations of Singer's Business Machines Division, and on April 1, 1976, ICL began managing the division for Singer. The System Ten became an ICL product on October 1, 1976, when ICL formally completed the acquisition of Singer's international operations.

Three months later, in January 1977, ICL initiated a strong commitment to the System Ten by announcing the new 220 Series, including a new processor (Model 22) and new configurations. At the same time, ICL announced it would stop manufacturing the Singer 110 Series and certain Singer peripherals such as card and paper tape devices. This discontinued equipment, however, is still provided by ICL on an "as available" basis. ICL believes that System Ten is now a viable, competitive product that will re-establish user confidence and end uncertainty caused by Singer's withdrawal from the market.

On January 6, 1977, ICL formed a new U.S. subsidiary—ICL, Inc.—to market the System Ten in America. Al- ➤

The small-scale System Ten business data processing system has a unique capability: It can process up to 20 independent programs concurrently under hardware control. A System Ten can be configured to function effectively as a small on-line interactive data processing system, as a multistation data entry system, or as the central processing element in specialized data collection and point of sale systems. Current system prices start at about £18,500.

CHARACTERISTICS

MANUFACTURER: International Computers Limited, ICL House, Putney, London SW15 1SW, England. Telephone 01-788-7272. ICL has offices in 80 countries worldwide.

MODELS: Various packaged 220 Series systems based on the Model 22 processor are available, varying in memory size and peripheral configuration. Typical packaged configurations are detailed in the pricing section of this report. The 110 Series, based on the earlier Singer Model 21 and Model 24 processors, is no longer actively marketed by ICL.

DATE ANNOUNCED: April 1970, Singer System Ten; February 1977, ICL 220 Series System Ten.

DATE OF FIRST DELIVERY: September 1970, Singer System Ten; April 1977, ICL 220 Series System Ten.

NUMBER INSTALLED TO DATE: Worldwide, there are approximately 4,000 System Tens installed, including those sold by Singer Business Machines.

DATA FORMATS

BASIC UNIT: 6-bit character. Each character position in core storage can represent one alphanumeric character. ➤



The ICL System Ten, using a hard-wired partitioning technique within the CPU to achieve multiprogramming, can concurrently process up to 20 independent jobs. The 220 Series Model 3 Entry-Level System shown here includes, from left, a Model 43 fixed/exchangeable disc drive for 8 million characters of on-line storage, a Model 22 processor with a 20,000 character memory, a Model 82 Visual Display Unit for user input and system control, and a 165-cps Model 51 serial printer.

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➤ though ICL directly services and maintains the product family in Europe and elsewhere, maintenance and field service in the U.S. are provided by TRW, which took over the maintenance contracts and rental base in the U.S. from Singer. Approximately 10 percent of the installed American systems are on rental.

The System Ten is dedicated to a novel concept in small-scale data processing: that a computer system should be "people-oriented" and instantly accessible to everyone who needs it within a company. The System Ten provides individual departments with control of their own records and the processing of these records, plus shared access to a central data bank. The System Ten is different from most of the competitive small-scale computer systems in three significant ways:

- As many as 20 independent jobs can be processed concurrently, with multiprogramming controlled by hardware rather than software.
- The system can be equipped with large amounts of both main and auxiliary storage; up to 160,000 characters of core memory and up to 160 million characters of on-line, removable disc pack storage.
- Visual Display Units and most peripherals can be connected to the central processor by a simple two-wire line from distances up to 600 meters away.

Although the System Ten employs large-scale integration (LSI) in its circuitry, it uses conventional magnetic core storage with a cycle time of 2.2 microseconds. This is 33 percent faster than the older Singer cycle time of 3.3 microseconds, but still comparatively slow. However, the use of static core instead of volatile semiconductor memory allows programs and data to be preserved during power failures. This capability is essential in a real-time processing environment. Also, because the System Ten is usually used as an operator-controlled transaction processing system, the comparatively slow operation times do not translate into inadequate terminal response time on a properly configured system.

The system's outstanding feature is unquestionably its ability to control multiprogramming of up to 20 independent jobs at the hardware level. This is achieved by a round-robin time-slicing technique that effectively divides the processor's computational power among the various programs. Hardware driven multiprogramming simplifies internal operations, reduces the overhead associated with software operating systems, and increases system reliability.

The basic software utilities, including the sort and the text editor, as well as the disc file management routines have been extensively field-tested and are exceptionally reliable. They also offer functions not generally available on systems of this size.

➤ **FIXED-POINT OPERANDS:** Can range from 1 to 10 characters for arithmetic operations, or up to 100 characters for move, edit, and exchange operations. Operand lengths are specified either explicitly or implicitly by the referencing instructions.

FLOATING-POINT OPERANDS: There are no facilities for floating-point arithmetic.

INSTRUCTIONS: Each instruction word is 10 characters in length, and the address of its leftmost character must be a multiple of 10. The instruction format contains a 4-bit operation code and two decimal addresses, each with an associated field length designator, an index register designator, and an indirect address designator.

INTERNAL CODE: Data is stored internally character by character in a 6-bit subset of ASCII.

The six bits of each System Ten character code corresponds to ASCII bits 1, 2, 3, 4, 5, and 7, ruling out the use of lower-case letters. The System Ten input/output channels automatically perform 6-bit/8-bit code conversions by adding (during output) or deleting (during input) ASCII bit 6 and a parity bit from each character.

MAIN STORAGE

STORAGE TYPE: Magnetic core.

CAPACITY: 20,000 to 160,000 characters in 20,000-character modules.

CYCLE TIME: 2.2 microseconds per character.

CHECKING: None.

STORAGE PROTECTION: Memory is protected by hardware. Each program can access only the data stored within its partition and a common memory area. Physical partitioning is accomplished by wiring. A maximum of 20 partitions can be employed. Permissible partition sizes are in increments of 1K from 1K to 10K, and in 10K increments up to the maximum of 80K. The Common area can be any size from 1K to 80K in 1K increments. The first 300 characters of the Common area are protected for use by the hardware control system.

RESERVED STORAGE: The 700 characters following the protected areas of Common are reserved but may be accessed by any partition. The first 300 characters of each partition are reserved.

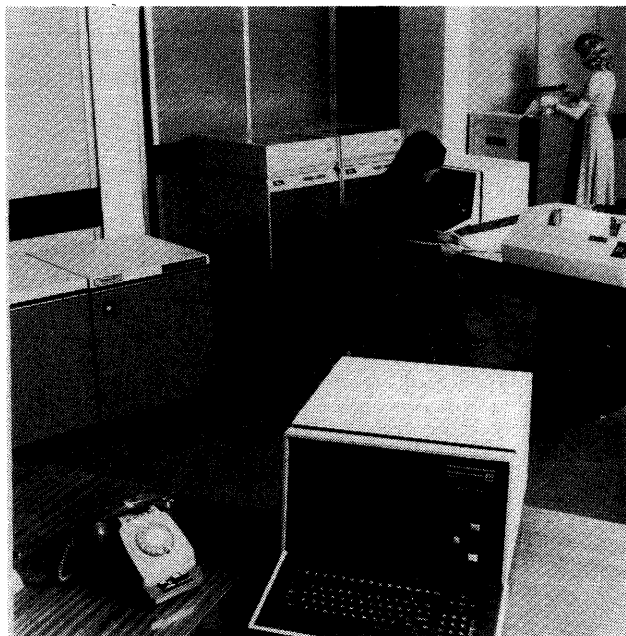
CENTRAL PROCESSOR

GENERAL: The System Ten is organized around the Model 22 processor. The processor consists of memory, an arithmetic and control unit (ACU), and input/output channels to control peripheral devices and provide processing capabilities. Multiprogramming is supervised by hardware and is based on storage divided into run-time fixed-size partitions. A partition and its associated program are fully protected from other partitions. Magnetic disc and tape file stores are connected to the processor by a File Access Channel (FAC) and are accessible to programs in any partition. A Common memory partition permits programs to share frequently used common routines.

INDEX REGISTERS: There are three index registers in each partition. They are referred to by number and occupy partition locations 11-14 (index register 1), 21-24 (index register 2), and 31-34 (index register 3). Either or both addresses of most instructions can be indexed.

➤ **INDIRECT ADDRESSING:** Single level only, after indexing. ➤

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The desk top Model 82 Visual Display Unit, foreground, is the principal input device for the System Ten. Connected by simple two-wire interface cables up to 600 meters in length, these terminals can be situated in each department that requires access to the computer. The terminal's typewriter keyboard and 1920-character display screen permit conversational-mode interaction with the system. In the center background are two Model 44-1 Disc Drives, providing 80 million characters of on-line data storage. At the left is a Model 22-1 Processor with a Model 22-2 Processor Extension Unit.

➤ PROCESSOR MODELS

ICL's first major enhancement to the System Ten after it became an ICL product was the announcement in January 1977 of a new processor, the Model 22, which supplants the earlier, but still supported, Model 21 and Model 24 processors. The new processor includes many improvements:

- A reduction in core cycle time of 33 percent from 3.3 microseconds to 2.2 microseconds.
- An increase in the maximum size of the Common memory area and of any user partition to 80,000 characters.
- An increase in the maximum main memory capacity from 110,000 characters to 160,000 characters.
- A decrease in disc access time by almost 50 percent, from 73 microseconds to 40 microseconds.

The minimum memory size on the System Ten is 20,000 characters. Memory, expandable in 20,000 character increments up to the maximum of 160,000 characters, can be physically divided into up to 20 fixed-sized partitions, each ranging in size from 1,000 to 80,000 characters. Each partition stores one program at a time and is serviced by its own input/output channel to which up to 10 low-speed peripheral devices can be connected. Access to disc

➤ **INSTRUCTION REPERTOIRE:** All arithmetic is performed in fixed-point decimal mode, using two-address, core-to-core instructions. There are 15 basic instructions.

- MC — move character.
- A — add.
- S — subtract.
- MA — move address field.
- MN — move numeric.
- M — multiply.
- D — divide.
- C — compare and set condition code.
- BC — branch conditional.
- R — read.
- W — write.
- FN — form numeric and right justify.
- AA — arithmetically modify an address
- E — edit.
- X — exchange contents of two fields.

INSTRUCTION TIMINGS: Following are average execution times, in microseconds, for two-address operations on five-digit decimal fields:

Add/Subtract:	80.3
Multiply:	324.5
Divide:	746.9
Move:	61.6

INTERRUPTS: The System Ten has as many internal interrupts as there are user partitions. These interrupts are taken on a round-robin 40 millisecond basis, with CPU control automatically passing on to the next partition. Control is similarly passed on via an internal interrupt when a partition begins an input/output operation. (That partition is passed over for control of the CPU resource until the I/O operation has been completed.) There are also internal interrupts for processor errors and decimal overflow.

System Ten has external interrupts for each data channel. An IOC external interrupt means that the channel's partition can accept CPU control when its round-robin sequence arrives.

PHYSICAL SPECIFICATIONS: The Model 22-1 processor is 762 mm (30 inches) high, 685 mm (27 inches) deep, and 660 mm (26 inches) wide. It weighs 68 kg (150 pounds). The processor operates within a temperature range of 10 to 35 degrees C. (50 to 95 degrees F.). The relative humidity can range from 20 to 80 percent. The Model 22-2 processor extension, having additional main storage and I/O channels, is of similar dimension, weight, and environmental tolerance.

INPUT/OUTPUT CONTROL

I/O CHANNELS: The System Ten processor employs a single File Access Channel (FAC), shared by all of the partitions, to attach disc and magnetic tape units. Each partition has a dedicated Input/Output Channel (IOC) to control low-speed devices such as visual display units, print-

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➤ and tape files is via a single file access channel shared by all partitions. I/O operations on the input/output channels are overlapped with one another and with computation.

Each system must also have a Common area of memory ranging in size from 1K up to an average of about 10K characters. This area is used to store system control information, to provide a "mailbox" for inter-partition communications, and to store input/output routines and file management software. It also can be used to store user-written subroutines, making them sharable by two or more partitions.

Central processing time is allocated in consecutive 40 millisecond "slices." If a program is unable to use any or all of the allocated time during a given slice (e.g., because it is awaiting completion of an I/O operation), control is automatically transferred to the program in the next partition. This hardware-controlled multiprogramming technique eliminates the need for a complex software operating system and its consequent processing overhead. Certain programming conventions must be observed carefully, however, especially when accessing the Common memory area and shared disc areas.

Under Singer Business Machines, the System Ten was marketed in a number of packaged configurations, all based on the same central processor and systems software, but with specific configuration limits. ICL has continued this marketing practice, but unlike the 110 Series packages, the 220 Series packages are far less rigidly defined and allow considerably greater enhancement.

The 220 Series packages are essentially entry-level configurations aimed at different levels of user requirements. A configuration tailored to the customer's needs is designed by adding memory and peripherals to the selected package. (The packaged models referred to in this report are those marketed in the U.K. and some European countries. Packaged systems marketed in other countries may include different features to match local user requirements.)

The new Model 22 CPU, operationally similar to and compatible with the earlier Model 21 and 24 processors, will support all existing System Ten peripherals and software. Current users of existing systems can upgrade their systems to the greater capacity, faster processor without worrying about peripheral and software compatibility problems. Many of the improvements embodied in the 220 Series are also available to users of existing System Ten systems by means of field modifications.

PERIPHERALS AND COMMUNICATIONS

One of the first steps ICL took upon acquisition of the System Ten was the withdrawal of card and paper tape peripheral devices. This action was based on ICL's desire to market the System Ten strictly as an on-line trans-

➤ ers, and communications adapters. Each processor is equipped with from 1 to 20 logical IOC's; the presence of an IOC and a portion of memory define a partition.

Multi-Terminal IOC's (MTIOC's) are used to attach printers and CRT's. Multi-Device IOC's (MDIOC's) are used to attach in-plant data collection units and POS units. Communications adapters (see Communications Control heading) and the optional digital clock count as logical input/output channels.

CONFIGURATION RULES: Each partition's dedicated IOC can control up to 10 low-speed peripheral devices. The devices plugged into an IOC can be accessed only by the program currently resident in the associated partition. A disc controller in the FAC can handle a maximum of 10 disc drives. The maximum data capacity of the system (160 million characters) can be achieved with fewer drives by selecting discs with higher individual capacities. The minimum configuration is one drive containing two discs with a combined capacity of 8 million characters. Up to four magnetic tape drives can be configured in a System Ten and are controlled by a tape controller within the FAC.

The Synchronous Communications Adapter (SCA), Asynchronous Communications Adapter (ACA), or Asynchronous Terminal Adapter (ATA), when used, is also dedicated to a particular memory partition and used in a fashion similar to a normal IOC. A Digital Clock IOC is available to provide real time (time of day) in digital form to a partition.

SIMULTANEOUS I/O OPERATIONS: The Input/Output Channels operate on an interrupt basis, so their operations are overlapped with one another and with computing in other partitions. Operations on the File Access Channel are fully overlapped.

I/O DATA RATES: Data is transmitted between the Input/Output Channels and the associated peripherals in bit-serial fashion at up to 2,700 characters/second. The File Access Channel accommodates data rates of up to 330,000 characters/second.

MASS STORAGE

MDC II MAGNETIC DISC CONTROL: This is the standard disc controller housed within the FAC. The MDC II is composed of the BDC II Basic Disc Controller plus 1-5 DDC II Dual Disc Couplers—see below. A basic Model 22 CPU is supplied with an MDC II consisting of a BDC II plus one DDC II.

The MDC II, which supports the Model 43, 44-1 and 44-3 disc drives (as well as the earlier Singer Model 40 and 42 drives) can be made available as an in-field enhancement to earlier processor models.

DDC II DUAL DISC COUPLER: Disc devices are connected to the File Access Channel (FAC) of the System Ten processor by means of data cables plugged into this unit. Each DDC II has the capability of accepting two data cables, and can attach up to ten physical disc drives or 16 logical disc volumes. Simultaneous seeks can be performed on other drives while a drive is transferring data.

MODEL 43 DISC DRIVE: The Model 43 uses one fixed disc and one removable disc pack. The resident (fixed) disc is used for active manipulation and filing of data. Data from the fixed disc can be duplicated onto the removable pack for backup.

There are 4 recording surfaces (2 fixed and 2 removable) with 400 tracks per surface and 50 sectors per track. The record length is 100 characters per sector yielding a total capacity of 8 million characters. The average head seek time

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▷ action-processing system. Users with significant batch processing requirements are now directed to ICL's 2903 small business system.

Until the 220 Series was introduced, ICL offered as input devices a simplified on-line keyboard printer terminal called the Model 70 workstation and local and remote versions of a CRT terminal. While all three of these devices are still supported, the Model 70 workstation is no longer manufactured and is available only on a restricted basis.

The Model 82 Visual Display Unit (VDU) is the key peripheral device in most new System Ten installations. The VDU is a buffered CRT display unit with a standard typewriter keyboard that features impressive editing and formatting capabilities. One or more VDU's can be located in each department of a company to provide immediate, conversational-mode access to the processing and file storage facilities of the central computer. The Model 81 VDU provides remote interactive processing capabilities at speeds up to 4800 bits per second.

Three types of disc storage devices can be used with the 220 Series. The Model 43 fixed/exchangeable disc is a replacement for the earlier Singer Model 40 and Model 42 drives no longer sold as new units by ICL. The device employs one fixed and one removable disc, each with a maximum capacity of 4 million characters. Model 44-1 is an exchangeable disc drive with a storage capacity of 40 million characters. Model 44-3 is a single density version of the Model 44-1 that provides 20 million characters of storage. The maximum on-line disc storage capacity for the System Ten is 160 million characters.

Magnetic tape storage is provided by the Model 45 tape drive. Up to four of these drives can be supported by the tape controller within the file access channel. Recording is 9-track, phase encoded at 1600 bits per inch in EBCDIC or ASCII.

A range of printers is offered for the System Ten to meet varied user requirements. Two matrix printers provide printing speeds of 165 and 330 characters per second, respectively. Character variants for several languages can be provided by adding read-only memory components. There are four drum printers that print on up to 6-part paper at speeds of 125, 200, 300, and 400 lines per minute. A variety of print barrels is offered for the drum printers to accommodate different language requirements.

Communications adapters enable a System Ten to communicate effectively with another System Ten, with a larger computer, or with remote hard-copy, CRT, and data collection terminals. Thus, a large corporation can install multiple System Tens in its outlying locations and equip them to communicate with a central computer complex. In addition to editing the input to and output from the central computer, the System Tens can perform local batch processing.

▶ is 40 milliseconds, average rotational delay is 13 milliseconds, rotational speed is 2400 rpm, and the data transfer rate is 229,000 characters per second.

MODEL 44-1 DISC DRIVE: The Model 44-1 uses interchangeable disc packs consisting of 11 discs with 20 recording surfaces. The pack is divided into 4 volumes, or logical drives, each of which can contain 10 million characters of data for a total of 40 million characters per drive. The average head seek time is 35 milliseconds, average rotational delay is 13 milliseconds, rotational speed is 2400 rpm, and the data transfer rate is 229,000 characters per second.

MODEL 44-3 DISC DRIVE: The Model 44-3 has a capacity of 20 million characters divided logically into two 10 million character volumes. In all other respects it is identical to the Model 44-1 described above. It can be field-upgraded to a 44-1.

INPUT/OUTPUT UNITS

System Ten peripherals, with the exception of disc and magnetic tape units, connect to the Model 22 processor via Input/Output Channels (IOC's). Each memory partition has one associated IOC which can control up to 10 devices. The peripheral units are connected via twisted wire-pair interfaces and can be located at distances of up to 600 meters (2,000 feet) from the processor. The currently available devices are described below.

MODEL 45-1 MAGNETIC TAPE DRIVE: Provides 9-track, phase-encoded recording on standard 1/2-inch tape at 1600 bits/inch in either EBCDIC or ASCII. Tape speed is 12.5 inches/second, data transfer rate is 20,000 characters/second, and rewind speed is 200 inches/second.

MATRIX PRINTERS: The single-head matrix printer Model 51S operates at 165 characters/second; the dual-head Model 51D operates at 330 characters/second. Both models employ a 64-character subset of ASCII; print 6, 8, or 10 lines/inch; and have 132 print positions. Characters are formed in a 9-by-7 dot matrix. A two-channel vertical format unit handles carriage control. Other read-only memory components are available to provide character variants for several languages.

DRUM PRINTERS: Four drum printers are offered for the System Ten. Print speeds are 125, 200, 300, and 400 lines/minute, respectively, for Models 53, 54, 55, and 56. All of the printers have 132 print positions, employ a 64-character subset of ASCII, and print 6 or 8 lines/inch. A 12-channel vertical format unit handles carriage control. Print barrels for several languages are available.

MODEL 81 REMOTE VISUAL DISPLAY UNIT (VDU): Connected to the System Ten by the Synchronous Communications Adapter (SCA), these terminals provide interactive processing capabilities from remote locations. The microprocessor-based terminal consists of a keyboard and a 1920-character CRT display. The 165-characters/second Model 5181 matrix printer can optionally be connected to the terminal for hard copy output. The printer is addressable either locally from the keyboard or remotely from the central processor. The terminal operates in synchronous mode at speeds up to 4800 bits/second; optionally, asynchronous operation is possible. Leased line and switched network operation are supported. A daisy-chain option permits two or more terminals to share the same line and modem.

MODEL 82 VISUAL DISPLAY UNIT (VDU): This VDU is a buffered CRT display unit with a standard typewriter keyboard. These units, which provide local conversational-mode access to the system, are connected by two-wire interface cables up to 600 meters in length. The display screen has a data capacity of 1920 characters in 24 lines of 80

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▷ MANUFACTURING SOURCES

ICL now manufactures the Model 22 CPU in both the U.K. (Letchworth and Kidsgrove) and U.S. (Utica, N.Y.) and purchases peripheral devices from leading industry suppliers, including its own subsidiaries.

SOFTWARE

The System Ten's ability to control multiprogramming at the hardware level largely precludes the need for an integrated operating system. A comprehensive Disc Management Facility package reduces the programming complexity involved in maintaining and processing disc files.

System Ten users have a choice of two programming languages for writing their own applications software. Assembler II is a macro-assembler language that employs a powerful set of only 15 instructions. RPG II for the System Ten is an industry standard language that can be used for both conversational and batch processing applications.

Applications software is a key element in the marketing of the System Ten, and the system is usually sold in conjunction with specific applications packages. This marketing approach follows ICL's philosophy that the System Ten is basically a small business system for entry-level users who may not have, nor wish to have, a programming department and its associated overhead. The packaged applications increase the system's attractiveness to first-time users and provide existing users with a variety of ready-made software.

A wide range of applications packages is currently available for the System Ten. As might be expected, the packages are largely business oriented and include:

- SYSTAR, STARS and STELLA — available in different parts of the world for sales order processing, invoicing, sales ledger, purchase ledger, and nominal ledger.
- PAYPAC — payroll.
- SALES and FICS — factory stock control, bills of materials, requirements planning, shop-floor loading, and operational costing.
- PADS — accounting and distribution system for publishers.

In addition to these packages, numerous others have been developed in various countries to meet the particular requirements of local users. Furthermore, compatibility of the 220 Series with its predecessors has left a substantial amount of Singer and third-party-developed applications packages available to System Ten users, and ICL has stated its intention to continue developing software for the system.

ICL also provides a series of utility routines for the System Ten that include system maintenance, sorting, and disc backup copying programs.

▶ characters each. Character generation is in 9-by-7 dot matrices using a 64-character subset of ASCII. Data transfer rate is 2700 characters/second.

COMMUNICATIONS CONTROL

SYNCHRONOUS COMMUNICATIONS ADAPTOR (SCA): Enables a System Ten Processor to communicate with remote Model 81 VDU's, another similarly equipped System Ten, or another mainframe such as an IBM 370 computer. Data is transmitted in synchronous mode at 2000, 2400, 3600, 4800, 7200, or 9600 bits per second, depending upon the type of line and modem employed. ICL states that the SCA will enable a System Ten to communicate with any other major computer system using ASCII.

An optional auto-dial feature for the SCA provides a "dial out" capability that enables it to initiate calls over a dialed line, where permitted by the local PTT. Each SCA replaces two adjacent Input/Output Channels and is associated with one specific partition address. The SCA operates in much the same manner as a regular Input/Output Channel. Computing in other partitions is overlapped with SCA data transmission or reception. No other peripheral devices can be connected to an SCA partition, and other partitions cannot address the SCA directly.

ASYNCHRONOUS COMMUNICATIONS ADAPTER (ACA): Enables a System Ten Processor to communicate with either local or remote terminals in asynchronous mode at 150, 300, 600, 1200, or 1800 bits per second. Permits communication with a variety of terminals that meet the EIA RS-232B or -C and CCITT-V.24 interface standards, including the 805 which is used in retail stores to collect and transmit point-of-sale information.

Each ACA handles a single terminal or line. For local use, at distances up to 50 feet, the ACA connects directly to the terminal. For remote use, either leased or dialed voice-grade lines and modems are used. An automatic "dial out" capability is optional where permitted by the local PTT. Up to nine ACA's can be installed in a System Ten Processor: each ACA replaces two adjacent Input/Output Channels.

ASYNCHRONOUS TERMINAL ADAPTER (ATA): Enables a System Ten Processor to communicate with either local or remote Teletype-compatible terminals in asynchronous mode at 110, 150, 200, or 300 bits per second. Each ATA handles a single terminal or line. For local use, at distances up to 50 feet, the ATA connects directly to the terminal. For remote use, either leased or dialed telephone lines and modems are used. An automatic "dial out" capability is optional where permitted by the local PTT. Up to 19 ATA's can be installed in a System Ten Processor: each ATA replaces one standard Input/Output Channel (or two adjacent I/O channels if the automatic dialing option is included).

LOCAL COMMUNICATIONS OPTION: Used to connect one processor to another within a 50 foot distance.

POINT OF SALE EQUIPMENT: The System Ten will support ICL's electronic point of sale system which is based on the acquired Singer Modular Data Transaction System (MDTS). ICL markets three intelligent programmable POS terminals. The ICL 902 and ICL 925 perform cash and credit transactions and are programmed for negative and positive credit authorization. The ICL 929 can also provide up to 69 flash totals and employs a full alphanumeric printer.

SOFTWARE

OPERATING SYSTEM: The System Ten's ability to control multiprogramming at the hardware level eliminates the need for many of the functions normally performed by ▶

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➤ COMPATIBILITY AND COMPETITION

The System Ten offers no direct program compatibility with any other computer currently on the market. Data compatibility is limited to the 9-track IBM-compatible magnetic tape. The disc pack recording format uses fixed 100-character sectors and is not compatible with any of the IBM disc drives. However, the System Ten's RPG II capability enables it to accommodate RPG II programs written for other small systems.

Competing with the ICL System Ten as basic business data processing systems are Basic Four's Model 350, 400, and 600 business computers; Burroughs' B 80; DEC's Datasystem 300; Honeywell's Series 60, Level 61; and IBM's System/32 and System/34.

USER REACTION

Because deliveries of the ICL System Ten 220 Series only began in April 1977, it was not feasible to conduct a user survey. However, in January 1975, Datapro interviewed six System Ten users for a report on the system as it was marketed by Singer. All of the interviewees were using a software package which employed a configuration that resembles the keystation-oriented systems now marketed by ICL.

While these ratings can be useful for evaluating at least the past performance of Singer and the System Ten, it must be remembered that they pre-date ICL's acquisition and subsequent modification of the system. Also, some of the categories (maintenance service, technical support, and credibility of vendor) obviously relate to Singer Business Machines, but are presented to keep the entire survey intact.

	Excellent	Good	Fair	Poor	WA*
Ease of operation	6	0	0	0	4.0
Reliability of mainframe	5	1	0	0	3.8
Reliability of peripherals	3	4	0	0	3.4**
Maintenance service:					
Responsiveness	3	2	0	1	2.7
Effectiveness	4	1	1	0	3.5
Technical support	3	3	0	0	3.5
Manufacturer's software:					
Compilers and assemblers	1	0	0	0	4.0**
Applications programs	6	0	0	0	4.0
Overall satisfaction	5	1	0	0	3.8
Credibility of vendor	4	1	1	0	3.5

* Weighted Average on a scale of 4.0 for Excellent.

**One user called reliability of peripherals "good to excellent," which was counted as two responses. Only one user was using a programming language. Since the System Ten has no operating system, the customary question on the operating system was omitted.

The systems in use often replaced the customers' use of service bureaus, although one user had previous time-sharing experience, one had used a Burroughs L2000, and one system had replaced Singer's own 5800 system. Five of the six firms interviewed had purchased their systems, while the other was leasing the system from Singer. None ➤

➤ a software operating system. File management is provided by a basic system support package called Disc Management Facility II (DMF II).

DMF II consists of a group of System Support Programs, used to create and maintain files, and a set of LIOCS (Logical Input/Output Control System) subroutines, called by macro-instructions, which handle file and record I/O operations in user programs.

LIOCS supports the following five file structures:

- **Linked Sequential**—handles fixed-length records with the last six characters of each sector containing the disc address of the next logical sector. Normal access method is serial.
- **Indexed Linked Sequential**—handles fixed-length records using a separate index file to uniquely address the data in a linked sequential file. Normal access method is random by key.
- **Relative Access**—handles fixed-length records organized serially with each record placed in the next physically available sector. Normal access method is either serial or random by record number.
- **Direct Access**—handles fixed-length records organized by employing an algorithm which determines where data records are stored within the file. Normal access method is random by key or record number.
- **Variable Sequential**—handles either fixed- or variable-length records with the block length stored in the first four positions and the record length stored in the first four positions of the record. LIOCS handles these files by the use of macros in the program. Normal access method is serial.

DMF II is an enhancement to an earlier version called DMF I. Improvements include increased flexibility in constructing on-line data bases, greater independence for programs running in separate partitions, major expansions to the access methods, better contention controls, and additional logical operations. Peripheral device assignments are the same as with DMF I. Although DMF II can operate with as little as 1K characters of common memory, a full 10K is recommended for use by LIOCS.

DMF II enables the user to organize his data onto a System Residence volume and any number of interchangeable volumes, permitting several possible on-line configurations to be linked together as required, while static or backup information may be kept off-line until it is needed. Facilities are included for different partitions to run independently by accessing different System Residence drives. This means that up to 16 distinct systems with independent or overlapped data bases can run simultaneously. In this case, a shared Primary Residence drive need be used by all partitions only for the initial bootstrap procedures which occur between program runs.

To support partition independence as well as shared use of resources, full contention controls are included in both the maintenance utilities and the Common-resident DMF II LIOCS routines. Also, each partition has its own set of logical device assignments and its own job stream control information.

Job stream files are supported under DMF II for controlling the sequence of programs in a given job. Entire applications systems can be structured as job stream files containing control statements that will load the programs required for the system in the proper sequence, including all command statements. All DMF II utilities and system programs can be ➤

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▷ of these users was using remote terminals, but five of the six planned to do so soon. No "foreign" peripherals were being used. All of the users were using only one partition, but one of them was in the process of expanding to three.

The user comments were generous. Typical were: "It gave us what Singer said it would." "It does what we bought it to do." "We wouldn't change it for any system on the market; we were processing within two weeks after it was installed."

Complaints from the six users were few and minor. One reported having a faulty disc drive, but said that the problem was eliminated by service. The only user to rate any service category as "poor" added that the quality of service had improved dramatically.

In the first six months following introduction of the Model 220, ICL booked several hundred orders for the new system, many of which were placed by existing users of earlier System Ten models. This can be taken as an indication of the general satisfaction of users with the concept, usability, and reliability of the system.

Our conclusion from this sample of CPU users—and from the major POS contracts that Singer had with Sears and other retailers—is that the System Ten is now a major, mature computing system for business and specialized (e.g., retail) processing that should not be overlooked by any prospective user whose needs match its functions. □

▶ executed from job stream files, allowing them to be used as job steps in an application system.

LANGUAGES: The System Ten supports a symbolic assembly language and RPG II for the development of application programs.

Assembler II is a flexible macro-assembler which converts programs coded in a symbolic assembly language into executable machine-language programs. It consists of 15 commands (see Instruction Repertoire under the Central Processor heading) which all have a common format. The source program is entered on a visual display unit. A conversational text-editing program guides the entry of the program and checks for errors in syntax or labeling. If there are no errors, the machine-language instructions are generated.

Features of *Assembler II* include macro definition and expansion; conditional assembly; assembly-time variables, statements, and functions; instruction mnemonics; literals; relocatable object code; symbol cross-reference listing that gives "where set" and "where used"; assemble and execute capability; and disc storage of assembler work files, including the symbol table.

RPG II can be used on the System Ten for both conversational and batch jobs. The user, using preprinted forms, prepares specifications that describe the input data, the calculations to be performed, and the desired format of the output. These specifications are entered at a visual display unit for storage on disc. The RPG compiler then generates a relocatable machine-language object program to perform the specified functions. The specification sheets and language facilities are quite similar to those of the IBM RPG compilers. *RPG II* requires a 10K memory partition and 20K of the Common memory area.

UTILITY ROUTINES: A number of utility packages are available to assist users in the operation of their systems.

The *MAINT* program contains 20 macro commands. Parameters may be supplied by the operator or from disc. *MAINT* is used for a variety of housekeeping operations including building indices for standard indexed sequential files and for copying data from one file to another.

The *SORT* program is parameter driven and can be used to create a sorted output file on disc or to prepare print files. Sorting is performed in stages and requires the use of an intermediate work file. By specifying *INCLUDE* and *OMIT* parameters, specific input records may be selected. The records may optionally be reformatted under parameter control to provide more efficient processing and disc space utilization. The original file is not altered during the sort. Records can be sorted on up to 10 sort keys and up to five files can be sorted and merged to one output file. User coding can be incorporated during the input or output stages. Checkpoint and restart functions are included to provide interrupt facilities.

The *DMF II Sort* supports Linked Sequential, Relative Access, and Direct Access files on input and output. Variable Sequential files and Indexed Linked Sequential files are not supported. Direct Access files are handled in the same manner as Relative Access files.

Magnetic tape files are supported on input and output and must contain fixed-length records. Variable-length magnetic tape files are not supported.

The *SECURE* program provides copying facilities for creating backup disc files. Once loaded, the program is entirely memory resident. The system disc can then be removed so that copying of interchangeable volumes can be performed.

The *TEXT EDITOR* is a source-program editor for interactive entry and modification of user programs. It can be used to add, modify, or delete source statements.

The primary capabilities of the Text Editor are: records or lines may be printed, copied, deleted, replaced or inserted; characters within records may be deleted, replaced, or inserted; command input can be accepted from job stream files or from existing DMF files; new commands can be temporarily defined by expanding and executing macro definitions; and lines changed by edit commands can be displayed on the console.

The *TESTER* program is a conversational debugging aid that can be used to run a program and provide a trace on all or selected program instructions as they are encountered. For each instruction traced, diagnostic information on the condition existing at that point in the program is provided.

Programs written and assembled in modules are loaded in memory for execution by the *LINK EDITOR* program. It loads the object modules into one or more continuous program segments, matches up common labels, determines if the program requires loading in both the partition and the Common area, and specifies the use of overlays and overlay areas in memory.

The *TESTER* program can interface with a user program which is being debugged in one of the following modes:

Simulated Execution: In this mode, *TESTER* retains control of the user program, simulating the execution of each instruction, and at the user's option, printing the results of selected simulations.

Overlay Trap: In this mode the user is notified each time a new segment is loaded into core. Notification can be made ▶

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▶ before, after, or both before and after loading, with the user having the option of loading or not loading or starting or not starting execution of a specific segment. TESTER relinquishes control to the segment that has been trapped only when instructed to do so by the user.

Free Execution: In this mode, the TESTER program is used to load a user program, then relinquishes control, permitting the program to run normally. In this mode, the TESTER reports after the user program terminates.

The SETCOM program is used to clear and re-establish the contents of Common memory. It can also be used to load the required logical input/output control system, set the date and time of day, and display a brief description of the contents of Common memory.

COMMUNICATIONS SOFTWARE: Interactive communications with remote terminals and batch communications with other computers are facilitated by two communications software packages offered by ICL.

The Synchronous Communications Access Method (SCAM) package is a set of macros which can be assembled and linked in a System Ten to drive the communication line according to a subset of IBM's bisync protocol. The SCAM macros interface with user programs through Common memory.

Remote Job Facility (RJF) is a stand-alone package consisting of 15 modules. Its function is to execute the remote job entry function of an IBM 2780 terminal linked to a HASP system.

APPLICATIONS SOFTWARE: ICL offers a wide range of applications packages for the System Ten. Applications available include, but are not limited to the following:

- Order Entry
- Sales Invoicing
- Cash Receipts
- Aged Balances
- Customer Statements
- Invoices
- Despatch Notes
- Sales Analysis
- Sales Ledgers

- Credit Control
- Purchase Ledgers
- Nominal Ledger
- Budget Reports
- Payroll
- Stock Reports
- Stock Analysis
- Stock Recording and Control
- Production Control
- Bill of Materials
- Requirements Planning
- Purchase Ordering
- Operational Routing
- Shop Floor Loading
- Production Costing

These applications, plus other industry-oriented packages, are available in a variety of forms and from varying sources depending on policy in local county markets.

PRICING

POLICY: All comments in this section are based upon U.K. practices, and may vary in other country markets. System Ten computers are available for purchase and on one and five-year leases. The standard lease agreement includes equipment maintenance and permits single-shift operation.

SOFTWARE CHARGES: In line with ICL policy for other products, System Ten is now marketed as an unbundled system. Basic systems software charges are modest. A typical basic complement of software consisting of DMF utilities, sort, and assembler is available for a monthly license charge of approximately £50.

Under certain circumstances, ICL will provide limited modification of standard application programs. The price for customizing depends upon the application, the options chosen within each application, and the extent of the modifications.

SUPPORT: Technical support is provided at no extra cost for normal installations, but additional services are billed to the System Ten user.

EDUCATION: Courses are available in systems appreciation, programming and operations for users of System Ten. ▶

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EQUIPMENT PRICES*

		Purchase Price £	Monthly Rental** (1-Year Term) £	Monthly Maint. £
CONFIGURATION				
220 Series Model 3 Entry-Level System				
2322/01	Model 22 Processor, 20K Char. Store			
2343/01	Model 43 Fixed/Exchangeable Disc Drive, 8M Chars			
2382/07	Model 82 Visual Display Unit			
2351/02	Model 51D Matrix Printer, 330 cps			
TOTAL PRICE		19,240	499	161.30
220 Series Model 4 Basic Business System				
2322/01	Model 22 Processor with 40K Char. Store			
2343/01	Model 43 Fixed/Changeable Disc Drives (2), 8M Chars./drive			
2382/07	Model 82 Visual Display Units (2)			
F2610/00	Multi-Terminal I/O Channel			
2354/01	Model 54 Line Printer, 200 lpm			
TOTAL PRICE		35,210	962	277.90
220 Series Model 6 Small Business System				
2322/01	Model 22 Processor with 40K Char. Store			
2344/03	Model 44-3 Exchangeable Disc Drives (2), 20M Chars./drive			
2382/07	Model 82 Visual Display Units (2)			
F2610/00	Multi-Terminal I/O Channel			
2355/01	Model 55 Line Printer, 300 lpm			
TOTAL PRICE		46,810	1,215	338.10

*These prices are for standard, packaged configurations available as designated models directly from ICL.

**Note that 3- and 5-year lease agreements are also available at lower monthly rates, but vary from market to market. Monthly rental prices include maintenance.