

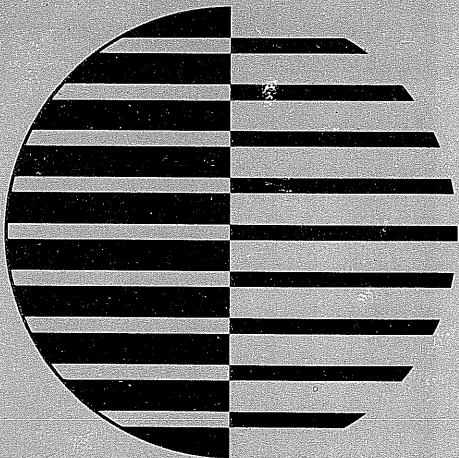
DAVID E. LEE

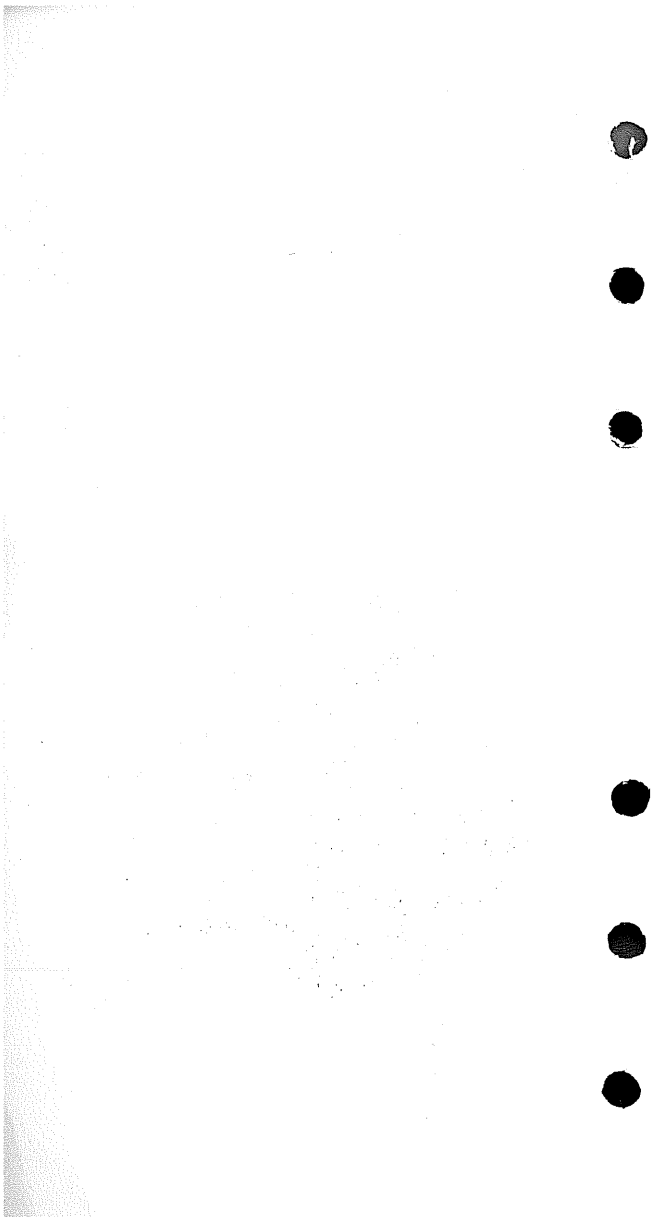
29-7-71

CODES/ CONTROL DATA®

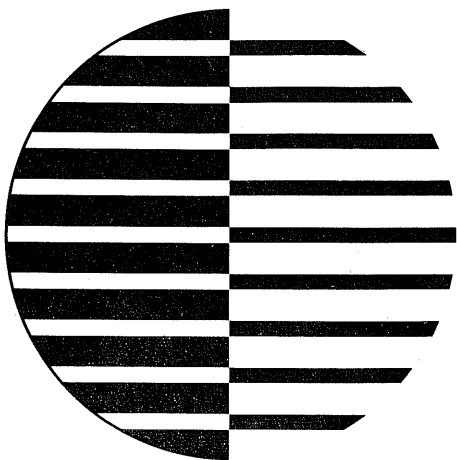
6400/6500/6600/6700

Computer Systems





CODES/CONTROL DATA[®]
6400/6500/6600/6700
Computer Systems

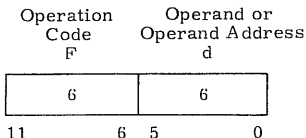


CONTENTS

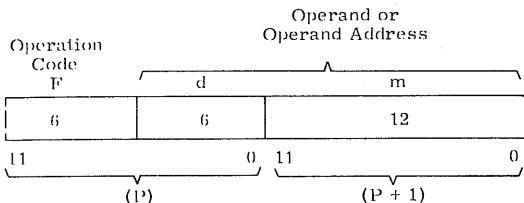
	Page
Peripheral and Control Processor Instructions	1
1. Numerical Listing	1
2. Alphabetical Listing	5
Central Processor Instructions	9
1. Numerical Listing	9
2. Alphabetical Listing	13
3. Exit Modes	16
4. Instruction Execution Times	17
External Function Codes and Status Responses	21
1. 6602/6612 Console Display	21
2. 6603 Disk System	22
3. 6622 Magnetic Tape Controller (626-B Magnetic Tape Unit)	23
4. 6638 Disk System	24
5. 6641 ECS Mass Storage Adapter	26
6. 6671-A Data Set Controller	27
7. 6673-A/6674-A Data Set Controller	30
8. 6681/84 Data Channel Converter (3000 Series Interface)	35
9. 6682/6683 Satellite Coupler	37
10. 6411/6416 Augmented I/O Buffer and Control	38
11. 1612 Printer	39
12. 170 Card Punch	40
13. 607-B Magnetic Tape Unit	41
14. 405-B Card Reader	42
Console Display Codes	43
Printer Codes (EXT. BCD)	44
Hollerith Punch Card Codes	45

EXPLANATION OF PERIPHERAL AND CONTROL PROCESSOR INSTRUCTION FORMATS

An instruction may have a 12-bit or a 24-bit format. The 12-bit format has a 6-bit operation code F and a 6-bit operand or operand address d .



The 24-bit format uses the 12-bit quantity m , which is the contents of the next program address ($P + 1$), with d to form an 18-bit operand or operand address.



EXPLANATION OF SYMBOLS USED IN PERIPHERAL AND CONTROL PROCESSOR INSTRUCTION LISTINGS

d	Implies d itself
(d)	Implies the contents of d
((d))	Implies the contents of the location specified by d
m	Implies m itself used as an address
$m + (d)$	The contents of d are added to m to form an operand (jump address)
(m + (d))	The contents of d are added to m to form the address of the operand
dm	Implies an 18-bit quantity with d as the upper 6 bits and m as the lower 12 bits

PERIPHERAL AND CONTROL PROCESSOR INSTRUCTIONS

All times are given in major cycles

One major cycle = 1000 nanoseconds

1. NUMERICAL LISTING

<u>F</u>	<u>MNE- MONIC</u>	<u>AD- DRESS</u>	<u>NAME</u>	<u>TIME (Major Cycles)</u>
00	PSN		Pass	1
01	LJM	m d	Long jump to m + (d)	2-3
02	RJM	m d	Return jump to m + (d)	3-4
03	UJN	d	Unconditional jump d	1
04	ZJN	d	Zero jump d	1
05	NJN	d	Nonzero jump d	1
06	PJN	d	Plus jump d	1
07	MJN	d	Minus jump d	1
10	SHN	d	Shift d	1
11	LMN	d	Logic difference d	1
12	LPN	d	Logical product d	1
13	SCN	d	Selective clear d	1
14	LDN	d	Load d	1
15	LCN	d	Load complement d	1
16	ADN	d	Add d	1
17	SBN	d	Subtract d	1
20	LDC	dm	Load dm	2
21	ADC	dm	Add dm	2
22	LPC	dm	Logical product dm	2
23	LMC	dm	Logical difference dm	2
24	PSN		Pass	1
25	PSN		Pass	1
260	EXN		Exchange jump*	
261	MXN		Monitor exchange jump**	

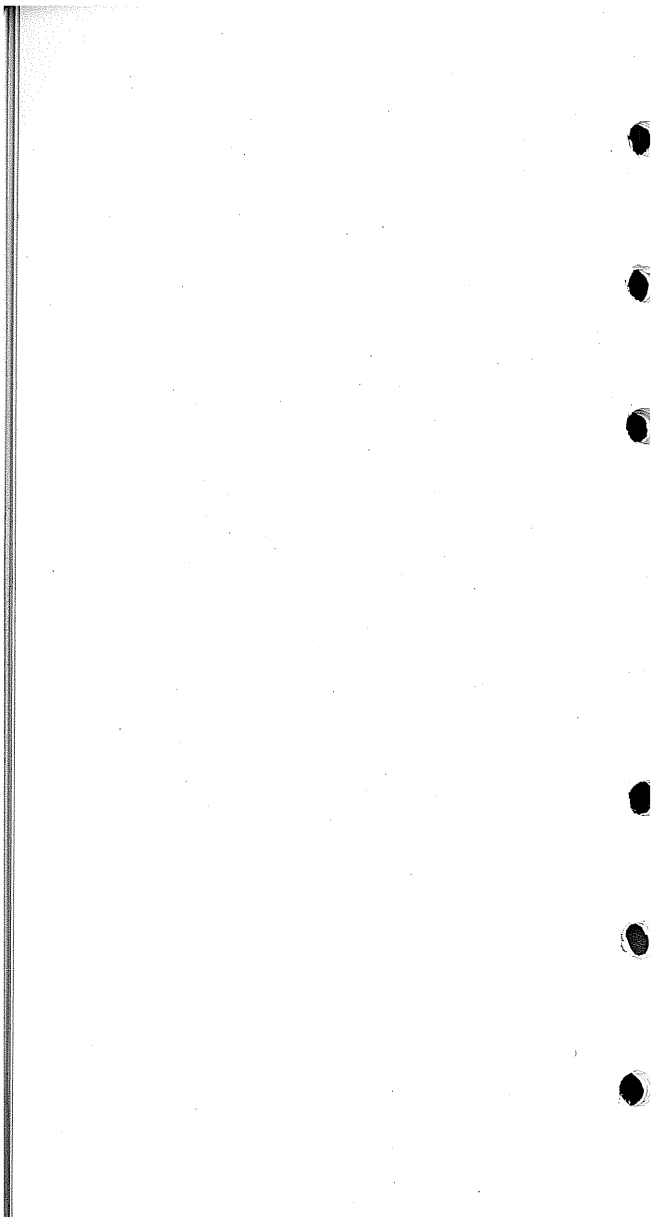
*In 6500/6700 System, Bit 0 specifies which CP the Exchange Jump will interrupt.

**Standard Option 10103 for 6400; Standard Option 10104 for 6600/6700.

<u>F</u>	<u>MNE- MONIC</u>	<u>AD- DRESS</u>	<u>NAME</u>	<u>TIME (Major Cycles)</u>
27	RPN		Read program address*	1
30	LDD	d	Load (d)	2
31	ADD	d	Add (d)	2
32	SBD	d	Subtract (d)	2
33	LMD	d	Logical difference (d)	2
34	STD	d	Store (d)	2
35	RAD	d	Replace add (d)	3
36	AOD	d	Replace add one (d)	3
37	SOD	d	Replace subtract one (d)	3
40	LDI	d	Load ((d))	3
41	ADI	d	ADD ((d))	3
42	SBI	d	Subtract ((d))	3
43	LMI	d	Logical difference ((d))	3
44	STI	d	Store ((d))	3
45	RAI	d	Replace add ((d))	4
46	AOI	d	Replace add one ((d))	4
47	SOI	d	Replace subtract one ((d))	4
50	LDM	m d	Load (m + (d))	3-4
51	ADM	m d	Add (m + (d))	3-4
52	SBM	m d	Subtract (m + (d))	3-4
53	LMM	m d	Logical difference (m + (d))	3-4
54	STM	m d	Store (m + (d))	3-4
55	RAM	m d	Replace add (m + (d))	4-5
56	AOM	m d	Replace add one (m + (d))	4-5
57	SOM	m d	Replace subtract one (m + (d))	4-5
60	CRD	d	Central read from (A) to d	min. 6

*In 6500/6700 System, Bit 0 specifies CPU number

<u>F</u>	<u>MNE- MONIC</u>	<u>AD- DRESS</u>	<u>NAME</u>	<u>TIME (Major Cycles)</u>
61	CRM	m d	Central read (d) words from (A) to m	5 plus 5/word
62	CWD	d	Central write to (A) from d	min. 6
63	CWM	m d	Central write (d) words to (A) from m	5 plus 5/word
64	AJM	m d	Jump to m if channel d active	2
65	IJM	m d	Jump to m if channel d inactive	2
66	FJM	m d	Jump to m if channel d full	2
67	EJM	m d	Jump to m if channel d empty	2
70	IAN	d	Input to A from channel d	2
71	IAM	m d	Input (A) words to m from channel d	4 plus 1/word
72	OAN	d	Output from a on channel d	2
73	OAM	m d	Output (A) words from m on channel d	4 plus 1/word
74	ACN	d	Activate channel d	2
75	DCN	d	Disconnect channel d	2
76	FAN	d	Function (A) on channel d	2
77	FNC	m d	Function m on channel d	2



2. ALPHABETICAL LISTING

<u>MNE-MONIC</u>	<u>F</u>	<u>AD-DRESS</u>	<u>NAME</u>	<u>TIME (Major Cycles)</u>
ACN	74	d	Activate channel d	2
ADC	21	dm	Add dm	2
ADD	31	d	Add (d)	2
ADI	41	d	Add ((d))	3
ADM	51	m d	Add (m + (d))	3-4
ADN	16	d	Add d	1
AJM	64	m d	Jump to m if channel d active	2
AOD	36	d	Replace add one (d)	3
AOI	46	d	Replace add one ((d))	4
AOM	56	m d	Replace add one (m + (d))	4-5
CRD	60	d	Central read from (A) to d	min. 6
CRM	61	m d	Central read (d) words from (A) to m	5 plus 5/word
CWD	62	d	Central write to (A) from d	min. 6
CWM	63	m d	Central write (d) words to (A) from m	5 plus 5/word
DCN	75	d	Disconnect channel d	2
EJM	67	m d	Jump to m if channel d empty	2
EXN	260		Exchange jump*	
FAN	76	d	Function (A) on channel d	2
FJM	66	m d	Jump to m if channel d full	2
FNC	77	m d	Function m on channel d	2
IAM	71	m d	Input (A) words to m from channel d	4 plus 1/word

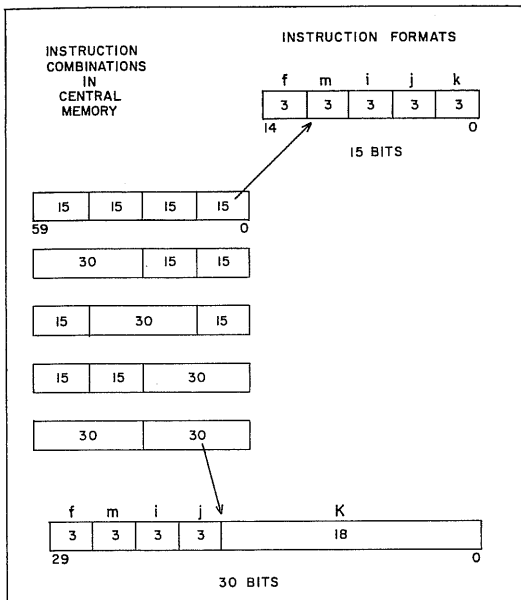
*In the 6500/6700 System, Bit 0 specifies which CP the Exchange Jump will interrupt.

<u>MNE- MONIC</u>	<u>F</u>	<u>AD- DRESS</u>	<u>NAME</u>	<u>TIME (Major Cycles)</u>
IAN	70	d	Input to A from channel d	2
IJM	65	m d	Jump to m if channel d inactive	2
LCN	15	d	Load complement d	1
LDC	20	m	Load dm	2
LDD	30	d	Load (d)	2
LDI	40	d	Load ((d))	3
LDM	50	m d	Load (m + (d))	3-4
LDN	14	d	Load d	1
LJM	01	m d	Long jump to m + (d)	2-3
LMC	23	dm	Logical difference dm	2
LMD	33	d	Logical difference (d)	2
LMI	43	d	Logical difference ((d))	3
LMM	53	m d	Logical difference (m+(d))	3-4
LMN	11	d	Logical difference d	1
LPC	22	dm	Logical product dm	2
LPN	12	d	Logical product d	1
MXN	261		Monitor exchange jump*	
MJN	07	d	Minus jump d	1
NJN	05	d	Nonzero jump d	1
OAM	73	m d	Output (A) words from m on channel d	4 plus 1/word
OAN	72	d	Output from A on channel d	2
PJN	06	d	Plus jump d	1

*Standard option 10103 for 6400, Standard option
10104 for 6600/6700.

<u>MNE- MONIC</u>	<u>F</u>	<u>AD- DRESS</u>	<u>NAME</u>	<u>TIME (Major Cycles)</u>
PSN	00		Pass	1
PSN	24		Pass	1
PSN	25		Pass	1
RAD	35	d	Replace add (d)	3
RAI	45	d	Replace add ((d))	4
RAM	55	m d	Replace add (m + (d))	4-5
RJM	02	m d	Return jump to m + (d)	3-4
RPN	27		Read program address	1
SBD	32	d	Subtract (d)	2
SBI	42	d	Subtract ((d))	3
SBM	52	m d	Subtract (m+(d))	3-4
SBN	17	d	Subtract d	1
SCN	13	d	Selective clear d	1
SHN	10	d	Shift d	1
SOD	37	d	Replace subtract one (d)	3
SOI	47	d	Replace subtract one ((d))	4
SOM	57	m d	Replace subtract one (m + (d))	4-5
STD	34	d	Store (d)	2
STI	44	d	Store ((d))	3
STM	54	m d	Store (m + (d))	3-4
UJN	03	d	Unconditional jump d	1
ZJN	04	d	Zero jump d	1

EXPLANATION OF CENTRAL PROCESSOR INSTRUCTION FORMATS



EXPLANATION OF SYMBOLS USED IN CENTRAL PROCESSOR INSTRUCTION LISTINGS

- | | |
|----|---|
| A | One of eight address registers (18 bits) |
| B | One of eight index registers (18 bits)
BO is fixed and equal to zero |
| fm | Instruction code (6 bits) |
| i | Specifies which of eight designated registers (3 bits). Is also used in 03X instructions as part of a 9-bit operation code. |
| j | Specifies which of eight designated registers (3 bits) |
| jk | Constant, indicating number of shifts to be taken (6 bits) |
| k | Specifies which of eight designated registers (3 bits) |
| K | Constant, indicating branch destination or operand (18 bits) |
| X | One of eight operand registers (60 bits) |

CENTRAL PROCESSOR INSTRUCTIONS

1. NUMERICAL LISTING

(Functional unit designation does not apply to 6400/6500).

BRANCH UNIT*

<u>fm</u> <u>(i)</u>	<u>MNE-</u> <u>MONIC</u>	<u>AD-</u> <u>DRESS</u>	<u>NAME</u>
00	PS		Program stop
010	RJ	K	Return jump to K
011	RE	Bj + K	Read extended core storage
012	WE	Bj + K	Write extended core storage
013	XJ		Central exchange jump**
02	JP	Bi + K	Go to Bi + K
030	ZR	Xj K	Go to K if Xj = 0
031	NZ	Xj K	Go to K if Xj ≠ 0
032	PL	Xj K	Go to K if Xj = plus (positive)
033	NG	Xj K	Go to K if Xj = negative
034	IR	Xj K	Go to K if Xj is in range
035	OR	Xj K	Go to K if Xj is out of range
036	DF	Xj K	Go to K if Xj is definite
037	ID	Xj K	Go to K if Xj is indefinite
04	EQ	BiBjK	Go to K if Bi = Bj
***04	ZR	Bi K	Go to K if Bi = B0
05	NE	BiBjK	Go to K if Bi ≠ Bj
***05	NZ	Bi K	Go to K if Bi ≠ B0
06	GE	BiBjK	Go to K if Bi ≥ Bj
***06	PL	Bi K	Go to K if Bi ≥ B0
07	LT	BiBjK	Go to K if Bi < Bj
**07	NG	Bi K	Go to K if Bi < B0

*Go to K + Bi and Go To K if Bi - tests made in increment unit.

Go to K if Xj - tests made in long add unit.

**Standard Option 10103 for 6400. Standard Option 10104 for 6600/6700. If option is not installed, this is an illegal instruction.

***For these instructions, COMPASS packs the instruction so Bi is compared with B0 rather than Bj.

BOOLEAN UNIT

<u>fm</u> <u>(i)</u>	<u>MNE-</u> <u>MONIC</u>	<u>AD-</u> <u>DRESS</u>	<u>NAME</u>
10	BXi	Xj	Transmit Xj to Xi
11	BXi	Xj*Xk	Logical Product of Xj & Xk to Xi
12	BXi	Xj+Xk	Logical sum of Xj & Xk to Xi
13	BXi	Xj-Xk	Logical difference of Xj & Xk to Xi
14	BXi	-Xk	Transmit the comp. of Xk to Xi
15	BXi	-Xk*Xj	Logical product of Xj & Xk comp. to Xi
16	BXi	-Xk+Xj	Logical sum of Xj & Xk comp. of Xi
17	BXi	-Xk-Xj	Logical difference of Xj & Xk comp. to Xi

SHIFT UNIT

20	LXi	jk	Left shift Xi, jk places
21	AXi	jk	Arithmetic right shift Xi, jk places
22	LXi	Bj Xk	Left shift Xk nominally Bj places to Xi
23	AXi	Bj Xk	Arithmetic right shift Xk nominally Bj places to Xi
24	NXi	Bj Xk	Normalize Xk in Xi and Bj
25	ZXi	Bj Xk	Round and normalize Xk in Xi and Bj
26	UXi	Bj Xk	Unpack Xk to Xi and Bj
27	PXi	Bj Xk	Pack Xi from Sk and Bj
43	MXi	jk	Form mask in Xi, jk bits

ADD UNIT

30	FXi	Xj+Xk	Floating sum of Xj and Xk to Xi
31	FXi	Xj-Xk	Floating difference Xj and Xk to Xi
32	DXi	Xj+Xk	Floating DP sum of Xj and Xk to Xi
33	DXi	Xj-Xk	Floating DP difference of Xj and Xk to Xi

ADD UNIT (Cont'd)

<u>fm</u> <u>(i)</u>	<u>MNE-</u> <u>MONIC</u>	<u>AD-</u> <u>DRESS</u>	<u>NAME</u>
34	RXi	$X_j + X_k$	Round floating sum of X_j and X_k to X_i
35	RXi	$X_j - X_k$	Round floating difference of X_j and X_k to X_i
36	IXi	$X_j + X_k$	Integer sum of X_j and X_k to X_i
37	IXi	$X_j - X_k$	Integer difference of X_j and X_k to X_i

MULTIPLY UNIT

40	FXi	$X_j * X_k$	Floating product of X_j and X_k to X_i
41	RXi	$X_j * X_k$	Round floating product of X_j & X_k to X_i
42	DXi	$X_j * X_k$	Floating DP product of X_j & X_k to X_i

DIVIDE UNIT

44	FXi	X_j / X_k	Floating divide X_j by X_k to X_i
45	RXi	X_j / X_k	Round floating divide X_j by X_k to X_i
46	NO		No operation
47	CXi	X_k	Count the number of 1's in X_k to X_i

INCREMENT UNIT

50	SAi	$A_j + K$	Set A_i to $A_j + K$
*50	SAi	$A_j - K$	Set A_i to $A_j + \text{comp. of } K$
51	SAi	$B_j + K$	Set A_i to $B_j + K$
*51	SAi	$B_j - K$	Set A_i to $B_j + \text{comp. of } K$
52	SAi	$X_j + K$	Set A_i to $X_j + K$
*52	SAi	$X_j - K$	Set A_i to $X_j + \text{comp. of } K$

*If the sign in the address field is minus, COMPASS complements the 18-bit quantity K.

INCREMENT UNIT (Cont'd)

<u>fm</u> <u>(i)</u>	<u>MNE-</u> <u>MONIC</u>	<u>AD-</u> <u>DRESS</u>	<u>NAME</u>
53	SAi	Xj+Bk	Set Ai to Xj + Bk
54	SAi	Aj+Bk	Set Ai to Aj + Bk
55	SAi	Aj - Bk	Set Ai to Aj - Bk
56	SAi	Bj+Bk	Set Ai to Bj + Bk
57	SAi	Bj - Bk	Set Ai to Bj - Bk
60	SBi	Aj+K	Set Bi to Aj + K
*60	SBi	Aj - K	Set Bi to Aj + comp. of K
61	SBi	Bj+K	Set Bi to Bj + K
*61	SBi	Bj - K	Set Bi to Bj + comp. of K
62	SBi	Xj+K	Set Bi to Xj + K
*62	SBi	Xj - K	Set Bi to Xj + comp. of K
63	SBi	Xj+Bk	Set Bi to Xj + Bk
64	SBi	Aj+Bk	Set Bi to Aj + Bk
65	SBi	Aj - Bk	Set Bi to Aj - Bk
66	SBi	Bj+Bk	Set Bi to Bj + Bk
67	SBi	Bj - Bk	Set Bi to Bj - Bk
70	SXi	Aj+K	Set Xi to Aj + K
*70	SXi	Aj - K	Set Xi to Aj + comp. of K
71	SXi	Bj+K	Set Xi to Bj + K
*71	SXi	Bj - K	Set Xi to Bj + comp. of K
72	SXi	Xj+K	Set Xi to Xj + K
*72	SXi	Xj - K	Set Xi to Xj + comp. of K
73	SXi	Xj+Bk	Set Xi to Xj + Bk
74	SXi	Aj+Bk	Set Xi to Aj + Bk
75	SXi	Aj - Bk	Set Xi to Aj - Bk
76	SXi	Bj+Bk	Set Xi to Bj + Bk
77	SXi	Bj - Bk	Set Xi to Bj - Bk

*If the sign in the address field is minus, COMPASS complements the 18-bit quantity K.

2. ALPHABETICAL LISTING

<u>MNE MONIC</u>	<u>fm (i)</u>	<u>AD- DRESS</u>	<u>NAME</u>
AXi	21	jk	Arithmetic right shift Xi, jk places
AXi	23	Bj Xk	Arithmetic right shift Xk nominally Bj places to Xi
BXi	10	Xj	Transmit Xj to Xi
BXi	11	Xj * Xk	Logical product of Xj & Xk to Xi
BXi	12	Xj + Xk	Logical sum of Xj & Xk to Xi
BXi	13	Xj - Xk	Logical difference of Xj & Xk to Xi
BXi	14	-Xk	Transmit the comp. of Xk to Xi
BXi	15	-Xk * Xj	Logical product of Xj & Xk comp. to Xi
BXi	16	-Xk + Xj	Logical sum of Xj & Xk comp. to Xi
BXi	17	-Xk - Xj	Logical difference of Xj & Xk comp. to Xi
CXi	47	Xk	Count the number of 1's in Xk to Xi
DF	036	Xj K	Go to K if Xj is definite
DXi	32	Xj + Xk	Floating DP sum of Xj and Xk to Xi
DXi	33	Xj - Xk	Floating DP difference of Xj and Xk to Xi
DXi	42	Xj * Xk	Floating DP product of Xj & Xk to Xi
EQ	04	Bi Bj K	Go to K if Bi = Bj
FXi	30	Xj + Xk	Floating sum of Xj and Xk to Xi
FXi	31	Xj - Xk	Floating difference Xj and Xk to Xi
FXi	40	Xj * Xi	Floating product of Xj and Xk to Xi
FXi	44	Xj / Xk	Floating divide Xj by Xk to Xi
GE	06	Bi Bj K	Go to K if Bi \geq Bj

<u>MNE-</u> <u>MONIC</u>	<u>fm</u> <u>(i)</u>	<u>AD-</u> <u>DRESS</u>	<u>NAME</u>
ID	037	Xj K	Go to K if Xj is indefinite
IR	034	Xj K	Go to K if Xj is in range
IXi	36	Xj+Xk	Integer sum of Xj and Xk to Xi
LXi	37	Xj-Xk	Integer difference of Xj and Xk to Xi
JP	02	Bi+Bk	Go to Bi + K
LT	07	BiBjK	Go to K if Bi < Bj
LXi	20	jk	Left shift Xi, jk places
LXi	22	Bj Xk	Left shift Xk nominally Bj places to Xi
XJ	013		Central exchange jump*
MXi	43	jk	Form mask in Xi, jk bits
NE	05	BiBjK	Go to K if Bi ≠ Bj
NG	033	Xj K	Go to K if Xj = negative
NG	**07	Bi K	Go to K if Bi < B0
NO	46		No operation
NXi	24	Bi Xk	Normalize Xk in Xi and Bj
NZ	031	Xj K	Go to K if Xj ≠ 0
NZ	**05	Bi K	Go to K if Bi ≠ B0
OR	035	Xj K	Go to K if Xj is out of range
PL	032	Xj K	Go to K if Xj = plus (positive)
PL	06	Bi K	Go to K if Bi ≥ B0
PS	00		Program stop
PXi	27	Bj Xk	Pack Xi from Xk and Bj
RE	011	Bj+K	Read extended core storage
RJ	01	K	Return jump to K
RXi	34	Xj+Xk	Round floating sum of Xj and Xk to Xi
RXi	35	Xj-Xk	Round floating difference of Xj and Xk to Xi
RXi	41	Xj*Xk	Round floating product of Xj & Xk to Xi

*Standard Option 10103 for 6400. Standard Option 10104 for 6600/6700. If option is not installed, this is an illegal instruction.

**If the sign in the address field is minus, COMPASS complements the 18-bit quantity K.

<u>MNE- MONIC</u>	<u>fm (i)</u>	<u>AD- DRESS</u>	<u>NAME</u>
RXi	45	Xj/Xk	Round floating divide Xj by Xk to Xi
SAi	50	Aj+K	Set Ai to Aj + K
SAi	*50	Aj-K	Set Ai to Aj + comp. of K
SAi	51	Bj+K	Set Ai to Bj + K
SAi	*51	Bj-K	Set Ai to Bj + comp. of K
SAi	52	Xj+K	Set Ai to Xj + K
SAi	*52	Xj-K	Set Ai to Xj + comp. of K
SAi	53	Xj+Bk	Set Ai to Xj + Bk
SAi	54	Aj+Bk	Set Ai to Aj + Bk
SAi	55	Aj-Bk	Set Ai to Aj - Bk
SAi	56	Bj+Bk	Set Ai to Bj + Bk
SAi	57	Bj-Bk	Set Ai to Bj - Bk
SBi	60	Aj+K	Set Bi to Aj + K
SBi	*60	Aj-K	Set Bi to Aj + comp. of K
SBi	61	Bj+K	Set Bi to Bj + K
SBi	*61	Bj-K	Set Bi to Bj + comp. of K
SBi	62	Xj+K	Set Bi to Xj + K
SBi	*62	Xj-K	Set Bi to Xj + comp. of K
SBi	63	Xj+Bk	Set Bi to Xj + Bk
SBi	64	Aj+Bk	Set Bi to Aj + Bk
SBi	65	Aj-Bk	Set Bi to Aj - Bk
SBi	66	Bj+Bk	Set Bi to Bj + Bk
SBi	67	Bj-Bk	Set Bi to Bj - Bk
SXi	70	Aj+K	Set Xi to Aj + K
SXi	*70	Aj-K	Set Xi to Aj + comp. of K
SXi	71	Bj+K	Set Xi to Bj + K
SXi	*71	Bj-K	Set Xi to Bj + comp. of K
SXi	72	Xj+K	Set Xi to Xk + K
SXi	*72	Xj-K	Set Xi to Xj + comp. of K
SXi	73	Xj+Bk	Set Xi to Xj + Bk
SXi	74	Aj+Bk	Set Xi to Aj + Bk
SXi	75	Aj-Bk	Set Xi to Aj - Bk

*If the sign in the address field is minus, COMPASS complements the 18-bit quantity K.

<u>MNE-MONIC</u>	<u>fm (i)</u>	<u>AD-DRESS</u>	<u>NAME</u>
SXi	76	Bj+Bk	Set Xi to Bj + Bk
SXi	77	Bj-Bk	Set Xi to Bj - Bk
UXi	26	Bj Xk	Unpack Xk to Xi and Bj
WE	012	Bj+K	Write extended core storage
ZR	030	Xj K	Go to K if Xj = 0
ZR	*04	Bi K	Go to K if Bi = B0
ZXi	25	Bj Xk	Round and normalize Xk in Xi and Bj

3. EXIT MODES

EM	=	000000	Stop
	=	010000	Address out of range - an attempt to reference memory outside established limits.
	=	020000	Operand out of range - floating point arithmetic generated or regenerated an infinite result
	=	030000	Address or operand out of range
	=	040000	Indefinite operand - floating point arithmetic generated or regenerated an indefinite result
	=	050000	Indefinite operand or address out of range
	=	060000	Indefinite operand or operand out of range
	=	070000	Address or operand out of range, or indefinite operand
EM	=	Bits 48, 49, 50 of location n + 3 of Exchange Jump package. Other bits of EM word are irrelevant.	

*For these instructions, COMPASS packs the instruction so Bi is compared with B0 rather than Bj.

4. INSTRUCTION EXECUTION TIMES

All times are given in minor cycles:
One minor cycle = 100 nanoseconds

OCTAL CODE		6400/	6600/
		6500	6700
00	Stop	-	-
01	Return Jump to K	21	13
011	Read Extended Core Storage	††	††
012	Write Extended Core Storage	††	††
02	Go to K + Bi	†††13	14
030	Go to K if Xj = zero	†††13	9†
031	Go to K if Xj ≠ zero	†††13	9†
032	Go to K if Xj = positive	†††13	9†
033	Go to K if Xj = negative	†††13	9†
034	Go to K if Xj is in range	†††13	9†
035	Go to K if Xj is out of range	†††13	9†
036	Go to K if Xj is definite	†††13	9†
037	Go to K if Xj is indefinite	†††13	9†
04	Go to K if Bi = Bj	†††13	8†
05	Go to K if Bi ≠ Bj	†††13	8†
06	Go to K if Bi > Bj	†††13	8†
07	Go to K if Bi < Bj	†††13	8†
10	Transmit Xj to Xi	5	3
11	Logical Product of Xj and Xk to Xi	5	3
12	Logical Sum of Xj and Xk to Xi	5	3
13	Logical Difference of Xj and Xk to Xi	5	3
14	Transmit Xk comp. to Xi	5	3
15	Logical Product of Xj and Xk comp. to Xi	5	3
16	Logical Sum of Xj and Xk comp. to Xi	5	3
17	Logical Difference of Xj and Xk comp. to Xi	5	3

† Modify the execution time (T) according to this table.

	Branch	No Branch
Loop (in stack)	T	T+2
Jump (out of stack)	T+6	T+5

†† See ECS literature for timing information.

††† No branch condition requires 5 minor cycles.

OCTAL CODE		6400/6600/ 6500 6700	
20	Shift Xi Left jk places	6	3
21	Shift Xi Right jk places	6	3
22	Shift Xk Nominally Left Bj places to Xi	6	3
23	Shift Xk Nominally Right Bj places to Xi	6	3
24	Normalize Xk in Xi and Bj	7	4
25	Round and Normalize Xk in Xi and Bj	7	4
26	Unpack Xk to Xi and Bj	7	3
27	Pack Xi from Xk and Bj	7	3
43	Form jk Mask in Xi	6	3
30	Floating Sum of Xj and Xk to Xi	11	4
31	Floating Difference of Xj and Xk to Xi	11	4
32	Floating DP Sum of Xj and Xk to Xi	11	4
33	Floating DP Difference of Xj and Xk to Xi	11	4
34	Round Floating Sum of Xj and Xk to Xi	11	4
35	Round Floating Difference of Xj and Xk to Xi	11	4
36	Integer Sum of Xj and Xk to Xi	6	3
37	Integer Difference of Xj and Xk to Xi	6	3
40	Floating Product of Xj and Xk to Xi	57	10
41	Round Floating Product of Xj and Xk to Xi	59	10
42	Floating DP Product of Xj and Xk to Xi	57	10
44	Floating Divide Xj by Xk to Xi	56	29
45	Round Floating Divide Xj by Xk to Xi	57	29
46	Pass	3	1
47	Sum of 1's in Xk to Xi	68	8
50	Sum of Aj and K to Ai	†	3††
51	Sum of Bj and K to Ai	†	3††
52	Sum of Xj and K to Ai	†	3††
53	Sum of Xj and Bk to Ai	†	3††
54	Sum of Aj and Bk to Ai	†	3††
55	Difference of Aj and Bk to Ai	†	3††
56	Sum of Bj and Bk to Ai	†	3††
57	Difference of Bj and Bk to Ai	†	3††

† When i = 0; time = 6 minor cycles
i = 1-5, time = 12 minor cycles
i = 6-7; time = 10 minor cycles

†† 50-57 "A" register reserved for 3 minor cycles
When i = 1-5 then X: register reserved for 8 minor
cycles.
When i = 6-7 then Xi register reserved for 9 minor
cycles.

OCTAL
CODE

6400/ 6600/
6500 6700

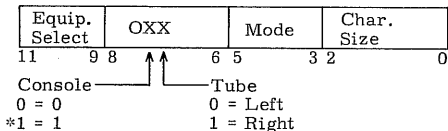
60	Sum of Aj and K to Bi	5	3
61	Sum of Bj and K to Bi	5	3
62	Sum of Xj and K to Bi	5	3
63	Sum of Xj and Bk to Bi	5	3
64	Sum of Aj and Bk to Bi	5	3
65	Difference of Aj and Bk to Bi	5	3
66	Sum of Bj and Bk to Bi	5	3
57	Difference of Bj and Bk to Bi	5	3
70	Sum of Aj and K to Xi	6	3
71	Sum of Bj and K to Xi	6	3
72	Sum of Xj and K to Xi	6	3
73	Sum of Xj and Bk to Xi	6	3
74	Sum of Aj and Bk to Xi	6	3
75	Difference of Aj and Bk to Xi	6	3
76	Sum of Bj and Bk to Xi	6	3
77	Difference of Bj and Bk to Xi	6	3



EXTERNAL FUNCTION CODES AND STATUS RESPONSES

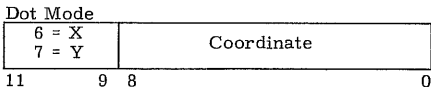
1. 6602/6612 CONSOLE DISPLAY

Function Word

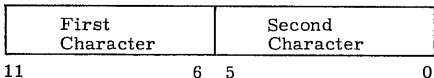


Console 0	Console 1	
7000	7200	Select 64 Char. /Line, Left Screen
7001	7201	Select 32 Char. /Line, Left Screen
7002	7202	Select 16 Char. /Line, Left Screen
7010	7210	Select 512 Dots/Line
7020	7220	Select Keyboard Input
7100	7300	Select 64 Char. /Line, Right Screen
7101	7301	Select 32 Char. /Line, Right Screen
7102	7302	Select 16 Char. /Line, Right Screen

Data Word



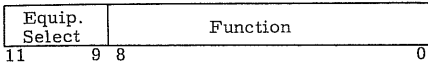
Character Mode



*Console 1 screen selection is not applicable on a 6612-F/G.

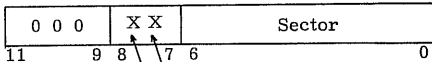
2. 6603 DISK SYSTEM

Function Word



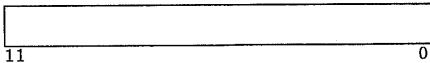
10XX	Read Sector XX (sectors 00-77)
11XX	Read Sector XX (sectors 100-177)
12XX	Write Sector XX (sectors 00-77)
13XX	Write Sector XX (sectors 100-177)
14XX	Select Track XX (tracks 00-77)
15XX	Select Track XX (tracks 100-177)
16YX*	Select Head Group X
1700	Status Request

Status Reply Word



0 = Ready	}	0 = No Parity Error
1 = Not Ready		1 = Parity Error

Data Word



*Y is a function of the read sample time. Normal sampling occurs when Y = 0.

3. 6622 MAGNETIC TAPE CONTROLLER (626-B MAGNETIC TAPE UNIT)

Function Word

Equip. Select	Function	Unit
11	9 8	3 2 0

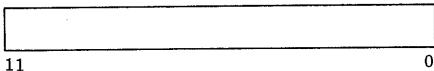
300X	Select
301X	Write Binary
302X	Read Binary
303X	Backspace
306X	Rewind
307X	Rewind Unload
3100	Status Request
361X	Write File Mark

(X = Unit = 0-7)

Status Reply:

- 0000 = Ready
- 0001 = Not Ready
- 0002 = Parity Error
- 0004 = Load Point
- 0010 = End of Tape
- 0020 = File Mark
- 0040 = Write Lockout

Data Word



4. 6638 DISK SYSTEM (6639 DISK FILE CONTROLLER)

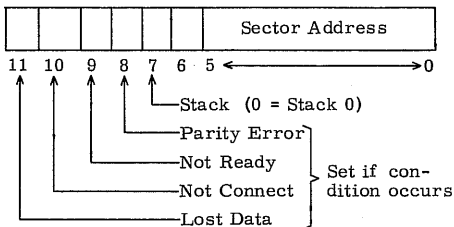
Connect and Status Function Code

Equip Select	Connect/Status Function	All Zeros	Unit Select
11 ← → 9	8 ← → 6	5 ← → 1	0

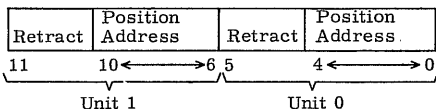
- 17X0 Connect and Request Status Word 1 for Unit 0
- 17X1 Connect and Request Status Word 1 for Unit 1
- 15X0 Connect and Request Status Word 2 for Unit 0
- 15X1 Connect and Request Status Word 2 for Unit 1

Note: Bit 0 is not used is Standard Option 10037 is installed.

Status Word 1



Status Word 2



Note: Unit 1 is all zeros if Standard Option 10037 is installed.

Position Select Function Code

Equipment	Position Select	Retract	Position Address
11 ← → 9	8 ← → 6	5	4 ← → 0

- 14 1xx X Position Select and Retract Heads*
 14 0xx X Position Select and do not Retract Heads.*

Head Group Select Function Code

Equipment	Function	Sector Address
11 ← → 9	8 ← → 6	5 ← → 0

16 XX Head Group Select Function Code

Read/Write Function Code

Equipment	Function	Sector Address
11 ← → 9	8 ← → 6	5 ← → 0

- 1 01x XX Write Function Code*
 1 00x XX Read Function Code*

Disconnect Function Code

Equipment	Function	Not Used
11 ← → 9	8 ← → 5	4 ← → 0

- 1 1x1 1xx X Disconnect Function Code*

*Small digits are binary numbers; large digits are octal numbers.

5. 6641-A ECS/MASS STORAGE ADAPTER

ADAPTER FUNCTION CODES

<u>CODE</u>	<u>DEFINITION</u>
S000*	Override Reserve
S00X	Release
Bit 0	Release Data Channel Interface
Bit 1	Release ECS Interface
Bit 2	Release Peripheral Interface
S010	Return Status
S011	Return Byte Count
S020	Load Address
S021	Load Word Count
S022	Inhibit Word Count
S023	Load Byte Count
S024	Inhibit Byte Count
S030	PPU to Buffer
S031	Buffer to PPU
S040	Peripheral to Buffer
S041	Buffer to Peripheral
S050	ECS to Buffer
S051	Buffer to ECS
S052	Function Flag Register
S077	Clear Buffer

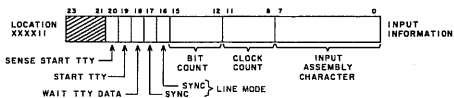
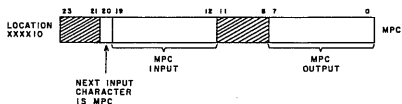
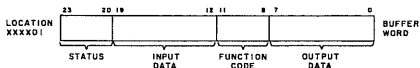
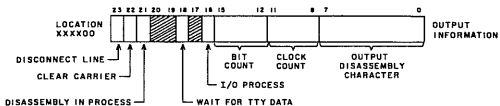
*S=Adapter Equipment Number

STATUS RESPONSES

<u>CODE</u>	<u>DEFINITION</u>
0001	ECS Interface Busy
0002	Peripheral I Interface Busy
0004	Peripheral II Interface Busy
0010	Buffer Input Busy
0020	Buffer Output Busy
0040	Peripheral Interface Deactivated
0100	Fake Response, Peripheral Interface
0200	ECS Abort
0400	ECS Parity Error
1000	ECS Accept

6. 6671-A DATA SET CONTROLLER

Memory Word Formats



6671-A FUNCTION SELECT CODES

<u>OCTAL CODE</u>	<u>DESCRIPTION</u>
X001*	Select Output
X002	Select Status Request
X003	Select Input

*The X portion must correspond to the setting of the Equipment Number switches.

Note: Additional codes are used for diagnostic test routines (see CE Manual).

CONTROLLER DATA WORD FUNCTION CODES

<u>CODE</u>	<u>DESCRIPTION</u>
0XXX	A do-nothing function; no data is transferred.
1XXX	Enables the receiver section of the DCS to resync*. Does not affect the carrier or the line connection. No data should be contained in this word.
2XXX	Turns off the carrier. No data should be contained in this word.
3XXX	Turns off the carrier and allows the receiver to resync. No data should be contained in this word. The valid data character preceding this function code is transmitted prior to carrier turn-off. Note that MPC's appended to a clocked-data modem message are considered to be valid data characters.
4XXX	Turns on the carrier. Must be appended to all data words (see 5XXX code description).
5XXX	Turns on the carrier and resyncs the receiver. Can contain data to be transmitted; primarily a function for Full-Duplex operation. Should be used whenever it is desirable to resync the receiver and transmit data simultaneously.

*The resynchronization is immediate and does not wait for completion of the input character.

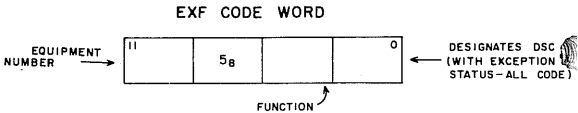
CONTROLLER DATA WORD FUNCTION CODES

<u>CODE</u>	<u>DESCRIPTION</u>
6XXX	Resyncs the receiver, turns off the carrier, and disconnects the telephone connection. No data should be contained in this word. Used primarily to disconnect the phone line.
<p>Note: The 2XXX, 3XXX, and 6XXX codes await the disassembly of the previous valid character before they affect the carrier; 4XXX and 5XXX codes act immediately. The 6XXX code does not wait for completion of the last bit of the last output character before becoming active. Software timing for the use of the 6XXX code is desirable.</p>	
7X X X	Resyncs the receiver and enables the telephone connections for data transmissions. This word contains no information to be transmitted.
X(1xx)XX (Bit 8 set)	Used to disconnect a modem when cutput operation has failed in the middle of a character. Indicates that any valid character in the Output Buffer should be ignored, and that any data accompanying the function code should be transferred into the buffer memory. The DSC does not recognize that it is disassembling a character on this terminal and it executes the incoming function.

7. 6673-A/6674-A DATA SET CONTROLLER

Function Codes

The 6673/6674 translates and interprets the external function (EXF) codes. The function codes represent commands or requests from the computer. The EXF code format is shown below.



EXF Code Format

EXTERNAL FUNCTION CODES

<u>DEFINITION</u>	<u>CODE</u>	<u>NOTES</u>
Request Status-all	S504	Enables 3 status-all bits from each of the four DSC's.
Request Status	S51N	Enables a status word (12 bits) from DSC N. N represents the number assigned to the selected DSC.
Select	S52N	Selects DSC N
Clear	S53N	Clears DSC N
Select Transmit	S54N	Selects DSC N for data transmission
Select Receive	S55N	Selects DSC N to receive data from the data set for transfer to the computer.

EXTERNAL FUNCTION CODES

<u>DEFINITION</u>	<u>CODE</u>	<u>NOTES</u>
Clear Interrupt Word Received Status Bit	S56N	Clears Interrupt Word Received FF and Status bit 2^0 in controller N (interrupt word = 7622).

S = Equipment number

STATUS RESPONSES

<u>DEFINITION</u>	<u>CODE</u>	<u>NOTES</u>
Interrupt Word Received	0001	Indicates that an interrupt word was received from the remote station and that this station wants attention. The interrupt word is received when the 6673/6674 is not transmitting or receiving.
Control Busy	0002	Indicates that the controller is busy. The controller may be selected and waiting for a sync word, transmitting, or receiving (data or code word).
Sync Word Sent and Not Acknowledged	0004*	Indicates that the controller has sent out a sync word but has not received a response from the remote station.

*Data set controller at remote station must include sync word acknowledge circuit to enable status bit 4.

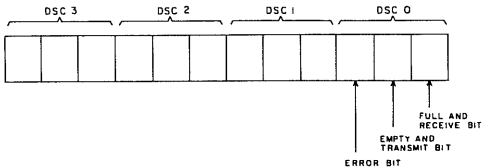
STATUS RESPONSES

<u>DEFINITION</u>	<u>CODE</u>	<u>NOTES</u>
Cyclic Code	0010	Indicates that the code word received from the remote station does not compare with the code generated by the cyclic decoder in the DSC.
Select for Receive and COO	0020	Indicates an equipment failure. This occurs when the DSC is selected to receive and the line carrier signal is not present at the data set (COO).
Select for Transmit and CS	0040	Indicates equipment failure. This occurs when the DSC is selected to transmit and the Clear-to-Send signal is not present at the data set (CS).
IT or COO	0100	Indicates equipment failure. COO indicates the line-carrier signal is lost; IT indicates a malfunction in the local data set.
Controller Not Connected or in Test Mode	0200	Indicates that the equipment referenced is not physically connected, or in the Test mode.

STATUS RESPONSES

<u>DEFINITION</u>	<u>CODE</u>	<u>NOTES</u>
Full and Receive	2000	Indicates that the 6673/6674 is selected for receive and I/O register is full.
Empty and Transmit	4000	Indicates that the 6673/6674 is selected for transmit and the I/O register is empty.

The status-all word (3 bits from each DSC) is requested before each multiplexer cycle (S504 EXF code). The status-all word is transferred over the 12 lines that transfer data to the computer.



Status-all Word

STATUS-ALL RESPONSES

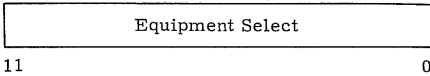
<u>DESCRIPTION</u>	<u>CODE</u>	<u>NOTES</u>
Full and Receive	XXX1	Selected for receive and I/O register full
Empty and Transmit	XXX2	Selected for transmit and I/O register empty

STATUS_ALL RESPONSES

<u>DEFINITION</u>	<u>CODE</u>	<u>NOTES</u>
Error	XXX4	Any of the following error conditions a) Selected for receive and not COO b) Selected for transmit and not CS c) Cyclic code error

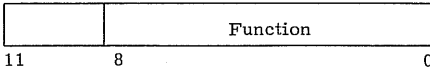
The above status-all responses are for DSC 0.

8. 6681/84 DATA CHANNEL CONVERTER (3000 SERIES INTERFACE)



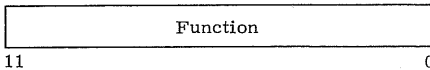
2000 Select*
2100 Deselect

Mode I Function Word



Connect:	4XXX	Connect External Equipment 4
	5XXX	Connect External Equipment 5
	6XXX	Connect External Equipment 6
	7XXX	Connect External Equipment 7
Function:	0XXX	Send 9-bit Function Code to External Equipment Connected

Mode II Function Word

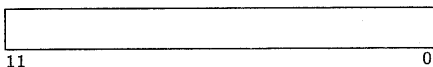


Connect:	1000	Select 6681 to Output a 12-bit Connect Code
Function:	1100	Select 6681 to Output a 12-bit Function Code to External Equipment Connected

*Where two converters share a common Data Channel, one of the converters is assigned different Select and Deselect codes such as 2200 and 2300, or 2400 and 2500.

Status:	1200	6681 Status Request
	1300	External Equipment Status Request
Status Reply:	XXX1	Reject (internal or external)
	XXX2	Internal Reject
	XXX4	Transmission Parity Error
	XX1X - 2XXX	Eight Interrupt Lines
Data I/O:	*1400	Input to End of Record
	*1500	Input until computer sends Inactive signal
	*1600	Output until computer sends Inactive signal
		A "1" in the lowest bit of Data I/O codes negates BCD conversion. The BCD negated is normal mode of operation.
	1700	Master Clear

Data Word

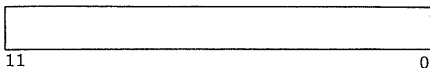


NOTE: For 3000 Series peripheral equipment codes, refer to Pub. No. 60113400.

*Bit 2³ in the 6684 only, determines which mode (A or B) data passes through the converter. When this bit is a "0" mode A (unaltered) is selected; when it is a "1" mode B (DCP) is selected.

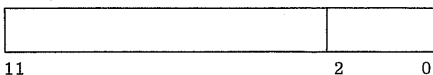
9. 6682/6683 SATELLITE COUPLER

Equipment Select



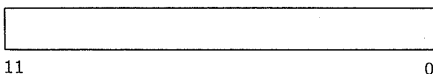
*S000 Output
S100 Input
S200 Status Request

Status



XXX1 Output Channel Request
XXX2 Input Channel Request
XXX4 Busy

Data Word



*S is determined by machine installation.

10. 6411/6416 AUGMENTED I/O BUFFER AND CONTROL

All instructions are the same as 6600 Peripheral Processors except:

- | | | | |
|----|-----|---|--|
| 26 | ECT | d | Extended Core Transfer; initiate Extended Core Storage operation |
| 27 | RCS | d | Read Extended Core Coupler status |

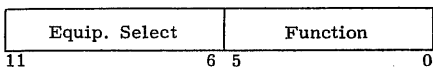
Status Reply: (Read into upper 3 bits of Peripheral Processor A Register)

- | | |
|--------|--|
| Bit 17 | Extended Core Storage Transfer in progress |
| Bit 16 | Parity error occurred during last Read Extended Core Storage operation |
| Bit 15 | At least one address of the last Extended Core Storage Transfer was not available (Power off, in Maintenance mode, address not in system). |

11. 1612 PRINTER

(Special Option 60022)

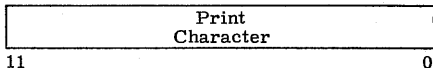
Function Word



- 0600 Select Printer
- 0601 Single Space
- 0602 Double Space
- 0603 Move Paper to Format Channel 7
- 0604 Move Paper to Top of Form
- 0605 Print
- 0606 Suppress Line Advance After Next Print
- 0607 Status Request
- 0610 Clear Format Channels
- 061X Select Format Channel X (X = 1-6)

Status Reply: 0000 Not Ready
 4000 Ready

Data Word



13. 607-B MAGNETIC TAPE UNIT

(Special Option 60028)

Function Word

Equip. Select	Function	Unit
11	9 8	3 2 0

200X	Select
201X	Write Binary
202X	Read Binary
203X	Backspace
206X	Rewind
207X	Rewind Unload
2100	Status Request
221X	Write BCD
222X	Read BCD
261X	Write File Mark

(X = unit = 0-7)

Status Reply: 0X00 = Ready
0X01 = Not Ready
0X02 = Parity Error
0X04 = Load Point
0X10 = End of Tape
0X20 = File Mark
0X40 = Write Lockout

X = 0: 800 bpi

X = 1: 556 bpi

X = 2: 200 bpi

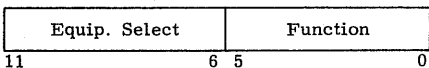
Data Word

First Char.	Second Char.
11	6 5 0

14. 405-B CARD READER

(Special Option 60029)

Function Word

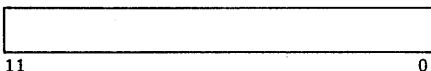


0700	Deselect
0701	Gate Card to Secondary Bin
0702	Read Non-Stop
0704	Status Request

Status Reply: 0000 = Ready
0001 = Not Ready
0002 = End of File
0004 = Compare Error

To read one card, execute successive S702 and S704 functions.

Data Word



CONSOLE DISPLAY CODES

<u>CHAR.</u>	<u>CODE</u>	<u>CHAR.</u>	<u>CODE</u>
(space)	00	X	30
A	01	Y	31
B	02	Z	32
C	03	0	33
D	04	1	34
E	05	2	35
F	06	3	36
G	07	4	37
H	10	5	40
I	11	6	41
J	12	7	42
K	13	8	43
L	14	9	44
M	15	+	45
N	16	-	46
O	17	*	47
P	20	/	50
Q	21	(51
R	22)	52
S	23	blank	53
T	24	=	54
U	25	blank	55
V	26	,	56
W	27	.	57

Keyboard codes are identical with the following exceptions:

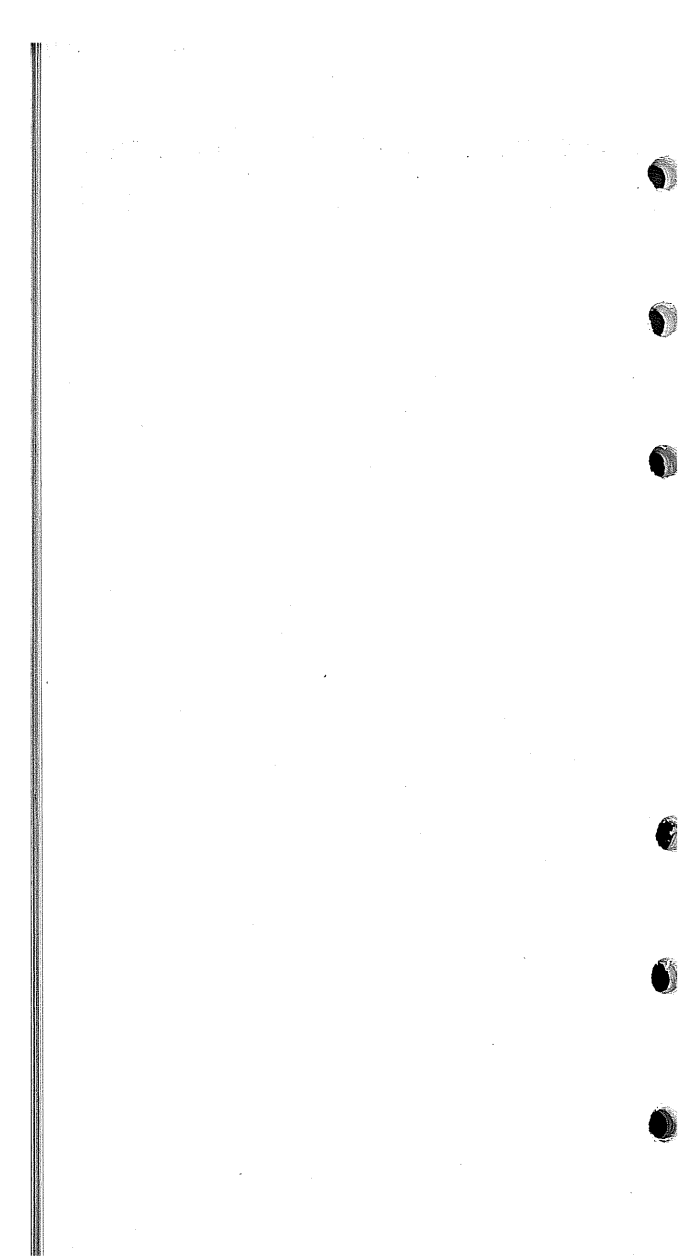
No Data	00
Carriage Return	60
Backspace	61
Space	62

PRINTER CODES (EXT. BCD)

<u>CHAR.</u>	<u>CODE</u>	<u>CHAR.</u>	<u>CODE</u>
(blank)	20	V	25
0	12	W	26
1	01	X	27
2	02	Y	30
3	03	Z	31
4	04	.	73
5	05	- (minus)	40
6	06	+	60
7	07	=	13
8	10	(34
9	11)	74
A	61	*	54
B	62	,	33
C	63	:	00
D	64	≠	14
E	65	/	21
F	66	≦	15
G	67	%	16
H	70	[17
I	71]	32
J	41	→	35
K	42	≡	36
L	43	∧ (and)	37
M	44	∨ (or)	52
N	45	\$	53
O	46	↑	55
P	47	↓	56
Q	50	>	57
R	51	<	72
S	22	≢	75
T	23	┘ (not)	76
U	24	;	77

HOLLERITH PUNCH CARD CODES

<u>CHAR.</u>	<u>CODE</u>	<u>CHAR.</u>	<u>CODE</u>
A	12-1	Y	0-8
B	12-2	Z	0-9
C	12-3	0	0
D	12-4	1	1
E	12-5	2	2
F	12-6	3	3
G	12-7	4	4
H	12-8	5	5
I	12-9	6	6
J	11-1	7	7
K	11-2	8	8
L	11-3	9	9
M	11-4	/	0-1
N	11-5	+	12
O	11-6	- (dash)	11
P	11-7	blank	space
Q	11-8	.	12-8-3
R	11-9)	12-8-4
S	0-2	\$	11-8-3
T	0-3	*	11-8-4
U	0-4	,	0-8-3
V	0-5	(0-8-4
W	0-6	=	8-3
X	0-7	-	8-4





CONTROL DATA

CORPORATION

8100 34th AVENUE SOUTH, MINNEAPOLIS 20, MINNESOTA