MODEL
980 SERIES COMPUTER
PROGRAMMING CARD
943000-9701

22 JULY 1974

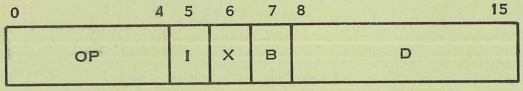
TEXAS INSTRUMENTS
INCORPORATED

P.O. BOX 2909
AUSTIN, TEXAS 78767
512 258-5121

MACHINE LANGUAGE INSTRUCTION FORMATS

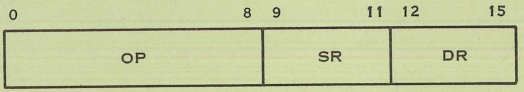
REGISTER-MEMORY

1



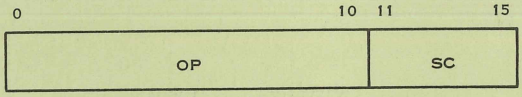
REGISTER TO REGISTER

2



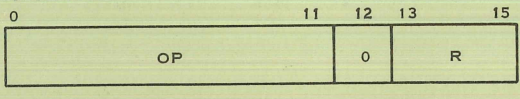
REGISTER SHIFT

3



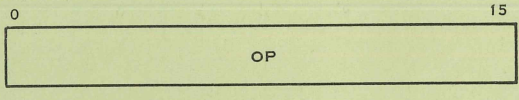
REGISTER SKIP

4

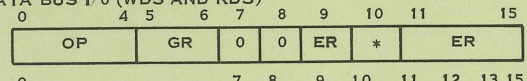


STATUS INDICATOR SKIP

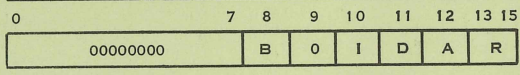
5



DATA BUS I/O (WDS AND RDS)

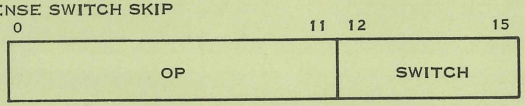


6



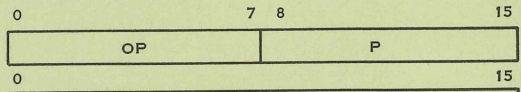
SENSE SWITCH SKIP

7



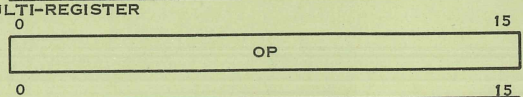
AUXILIARY PROCESSOR

8



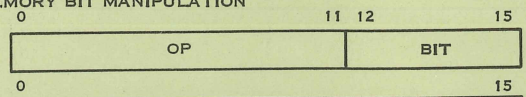
MULTI-REGISTER

9



MEMORY BIT MANIPULATION

10



NOTE. NUMBERS INDICATE FORMAT TYPE.
(SEE ALPHABETICAL LISTING.)

MACHINE LANGUAGE INSTRUCTION FORMAT DEFINITIONS

OP --- OPERATION CODE
I --- INDIRECT ADDRESS MODE INDICATOR
X --- INDEX ADDRESS MODE INDICATOR
B --- BASE REGISTER ADDRESS MODE
D --- DISPLACEMENT VALUE
SC --- SHIFT COUNT
SR --- SOURCE REGISTER INDICATOR
DR --- DESTINATION REGISTER INDICATOR
R --- REGISTER
S --- SENSE SWITCH
BIT --- BIT TO BE MANIPULATED
Y --- MEMORY ADDRESS
P --- DEVICE DEPENDENT INFORMATION
GR --- EXTERNAL REGISTER GROUP NUMBER
ER --- EXTERNAL REGISTER NUMBER
* --- 1 = WRITE, 0 = READ
B --- BUSY CHECK INDICATOR (FORMAT 6)
I --- INCREMENT INDICATOR (FORMAT 6)
D --- DECREMENT INDICATOR (FORMAT 6)
A --- INDIRECT ADDRESS INDICATOR (FORMAT 6)
R --- INTERNAL REGISTER NUMBER (FORMAT 6)

BINARY CHAR. INTERNAL CODE TO CARD OBJECT CODE

INTERNAL CODE	CARD CODE	INTERNAL CODE	CARD CODE
MOST SIGNIFICANT DIGIT	COLUMNS 12-11-0-9	LEAST SIGNIFICANT DIGIT	COLUMNS 8-1-2-3-4-5-6-7
0	BLANK	0	BLANK
1	9	1	1
2	0	2	2
3	0-9	3	3
4	11	4	4
5	11-9	5	5
6	11-0	6	6
7	11-0-9	7	7
8	12	8	8
9	12-9	9	8-1
A	12-0	A	8-2
B	12-0-9	B	8-3
C	12-11	C	8-4
D	12-11-9	D	8-5
E	12-11-0	E	8-6
F	12-11-0-9	F	8-7

EXAMPLE: THE BINARY CARD CHARACTER FOR HEXADECIMAL CA IS 12-11-8-2

OBJECT CODE FORMAT TO CASSETTE

16-BIT MEMORY WORD	CASSETTE CODE
ABCDEFGHIJKLMNOP	11XABCD
	1EFGHIJ
	1KLMNOP

WHERE X = 0 IF MEMORY WD ODD PARITY
1 IF MEMORY WD EVEN PARITY

MACHINE INSTRUCTION INDEX

ALPHABETICAL				NUMERICAL	
MNE-MONIC	FOR-MAT	HEX CODE	NAME	HEX CODE	MNE-MONIC
ADD	1	2000	ADD TO REGISTER A	0000	LDA
ALA	3	C880	ARITHMETIC LEFT SHIFT A	0800	LDE
ALD	3	C8A0	ARITHMETIC LEFT SHIFT DOUBLE	1000	LDX
AND	1	3800	LOGICAL AND WITH REGISTER A	1800	LDM
API	8	DD00	AUXILIARY PROCESSOR INITIATE	2000	ADD
ARA	3	C800	ARITHMETIC RIGHT SHIFT A	2800	SUB
ARD	3	C820	ARITHMETIC RIGHT SHIFT DOUBLE	3000	IOR
*ATI	8	D900	AUTOMATIC TRANSFER INITIATE	3800	AND
BIX	1	4000	BRANCH ON INCREMENTED INDEX	4000	BIX
BRL	1	7000	BRANCH AND LINK	4800	DMT
BRU	1	7800	BRANCH UNCONDITIONAL	5000	IMO
CLC	5	DF80	COMPARE LOGICAL CHARACTER STRING	5800	DIV
CLD	3	CB80	CIRCULAR LEFT SHIFT DOUBLE	6000	CPL
CPA	1	6800	COMPARE ALGEBRAIC TO REGISTER A	6800	CPA
CPL	1	6000	COMPARE LOGICAL TO REGISTER A	7000	BRL
CRA	3	CA00	CIRCULAR RIGHT SHIFT A	7800	BRU
CRB	3	CB60	CIRCULAR RIGHT SHIFT B	8000	STA
CRD	3	CBC0	CIRCULAR RIGHT SHIFT DOUBLE	8800	STE
CRE	3	CA20	CIRCULAR RIGHT SHIFT E	9000	STX
CRL	3	CB40	CIRCULAR RIGHT SHIFT L	9800	MPY
CRM	3	CA60	CIRCULAR RIGHT SHIFT M	A000	DST
CRS	3	CB20	CIRCULAR RIGHT SHIFT S	A800	DSB
CRX	3	CA40	CIRCULAR RIGHT SHIFT X	B000	DLD
DAD	1	B800	DOUBLE LENGTH ADD	B800	DAD
DIV	1	5800	DIVIDE	**C000	RSU
DLD	1	B000	DOUBLE LOAD REGISTERS	**C080	RAD
DMT	1	4800	DECREMENT MEMORY AND TEST	**C100	RCO
DSB	1	A800	DOUBLE SUBTRACT	**C200	RIV
DST	1	A000	DOUBLE LENGTH STORE	**C280	REO
*IDL	4	CE00	IDLE	**C300	RIN
IMO	1	5000	INCREMENT MEMORY BY ONE	**C400	RCA
IOR	1	3000	INCLUSIVE OR WITH REGISTER A	**C480	ROR

MACHINE INSTRUCTION INDEX (CONT'D)

ALPHABETICAL				NUMERICAL	
MNE-MONIC	FOR-MAT	HEX CODE	NAME	HEX CODE	MNE-MONIC
LDA	1	0000	LOAD REGISTER A	**C500	RMO
LDE	1	0800	LOAD REGISTER E	**C600	RCL
LDM	1	1800	LOAD REGISTER M	**C680	RAN
LDX	1	1000	LOAD REGISTER X	**C700	RDE
LLA	3	C8C0	LOGICAL LEFT SHIFT A	**C780	REX
LLD	3	C8E0	LOGICAL LEFT SHIFT DOUBLE	C800	ARA
LRA	3	C840	LOGICAL RIGHT SHIFT A	C820	ARD
LRD	3	C860	LOGICAL RIGHT SHIFT DOUBLE	C840	LRA
LRF	9	D8A0	LOAD REGISTER FILE	C860	LRD
*LSB	9	D880	LOAD STATUS BLOCK	C880	ALA
*LSR	9	D890	LOAD STATUS BLOCK AND RESET INTERRUPT	C8A0	ALD
LTO	3	C980	LEFT TEST FOR ONES	C8C0	LLA
LTZ	3	C9C0	LEFT TEST FOR ZEROS	C8E0	LLD
MPY	1	9800	MULTIPLY	C900	RTO
MVC	5	DF00	MOVE CHARACTER STRING	C940	RTZ
NRM	5	CA9F	NORMALIZE	C980	LTO
**RAD	2	C080	REGISTER ADD	C9C0	LTZ
**RAN	2	C680	REGISTER AND	CA00	CRA
**RCA	2	C400	REGISTER COMPARE ALEGEBRAIC	CA20	CRE
**RCL	2	C600	REGISTER COMPARE LOGICAL	CA40	CRX
**RCO	2	C100	REGISTER COMPLEMENT	CA60	CRM
**RDE	2	C700	REGISTER DECREMENT	CA9F	NRM
*RDS	6	D800	READ DIRECT SINGLE	CB20	CRS
**REO	2	C280	REGISTER EXCLUSIVE OR	CB40	CRL
**REX	2	C780	REGISTER EXCHANGE	CB60	CRB
**RIN	2	C300	REGISTER INCREMENT	CB80	CLD
**RIV	2	C200	REGISTER INVERT	CBC0	CRD
**RMO	2	C500	REGISTER MOVE	CC00	SZE
**ROR	2	C480	REGISTER OR	CC10	SSE
**RSU	2	C000	REGISTER SUBTRACT	CC20	SOO
RTO	3	C900	RIGHT TEST FOR ONES	CC40	SOD
RTZ	3	C940	RIGHT TEST FOR ZEROS	CC60	SMI
SABO	7	DB50	SET REGISTER A BIT TO ONE	CC80	SNZ
SABZ	7	DB40	SET REGISTER A BIT TO ZERO	CC90	SSN
SEQ	5	CD20	SKIP ON EQUAL	CCA0	SNO
SEV	4	CCC0	SKIP ON EVEN	CCC0	SEV
SGE	5	CD80	SKIP ON GREATER THAN OR EQUAL	CCE0	SPL
SGT	5	CD40	SKIP ON GREATER THAN	CD00	SLT

MACHINE INSTRUCTION INDEX (CONT'D)

ALPHABETICAL				NUMERICAL	
MNE-MONIC	FOR-MAT	HEX CODE	NAME	HEX CODE	MNE-MONIC
SLE	5	CDC0	SKIP ON LESS THAN OR EQUAL	CD20	SEQ
SLT	5	CD00	SKIP ON LESS THAN	CD40	SGT
SMBO	10	DB70	SET MEMORY BIT TO ONE	CD60	SOV
SMBZ	10	DB60	SET MEMORY BIT TO ZERO	CD80	SGE
SMI	4	CC60	SKIP ON MINUS	CDA0	SNE
SNC	5	CFE0	SKIP ON NO CARRY	CDC0	SLE
SNE	5	CDA0	SKIP ON NOT EQUAL	CDE0	SNV
SNO	4	CCA0	SKIP ON NOT ONES	*CE00	IDL
SNV	5	CDE0	SKIP ON NO OVER-FLOW	CF60	SOC
SNZ	4	CC80	SKIP ON NOT ZERO	CFE0	SNC
SOC	5	CF60	SKIP ON CARRY	*D800	RDS
SOD	4	CC40	SKIP ON ODD	*D820	WDS
SOO	4	CC20	SKIP ON ONES	*D880	LSB
SOV	5	CD60	SKIP ON OVER-FLOW	*D890	LSR
SPL	4	CCE0	SKIP ON PLUS	D8A0	LRF
SRF	9	D8E0	STORE REGISTER FILE	D8C0	SSB
SSB	9	D8C0	STORE STATUS BLOCK	D8E0	SRF
SSE	7	CC10	SKIP ON SENSE SWITCH EQUAL	*D900	ATI
SSN	7	CC90	SKIP ON SENSE SWITCH NOT EQUAL	DB00	TABZ
STA	1	8000	STORE REGISTER A	DB10	TABO
STE	1	8800	STORE REGISTER E	DB20	TMBZ
STX	1	9000	STORE REGISTER X	DB30	TMBO
SUB	1	2800	SUBTRACT FROM REGISTER A	DB40	SABZ
SZE	4	CC00	SKIP ON ZERO	DB50	SABO
TABO	7	DB10	TEST REGISTER A BIT FOR ONE	DB60	SMBZ
TABZ	7	DB00	TEST REGISTER A BIT FOR ZERO	DB70	SMBO
TMBO	10	DB30	TEST MEMORY BIT FOR ONE	DD00	API
TMBZ	10	DB20	TEST MEMORY BIT FOR ZERO	DF00	MVC
*WDS	6	D820	WRITE DIRECT SINGLE	DF80	CLC

*PRIVILEGED INSTRUCTIONS

**PRIVILEGED INSTRUCTIONS WHEN THE STATUS REGISTER IS THE DESTINATION REGISTER.

SUPERVISOR CALLS

X'C380' INPUT/OUTPUT REQUEST
X'C381' END OF PROGRAM, RETURN TO SYSTEM
X'C382' SET FLOATING-POINT PACKAGE ADDRESS
X'C383' GET MEMORY LIMITS
X'C384' SET CONTROL STATUS FLAG (TESTED BY //SKIPCS FUNCTION)

REGISTER-MEMORY FORMAT SYMBOLIC INTERPRETATION

@	||	*	MODE EXPRESSION	IN RANGE P-RELATIVE	IN RANGE B-RELATIVE	BASE REGISTER ASSUMED VALUE GIVEN BY PSEUDO-OP	ASSEMBLER ACTION
NO	NO	NO	NONE	YES	N/A	N/A	IXB=0,D=P RELATIVE
NO	NO	NO	X	YES	N/A	N/A	IXB=2,D=P RELATIVE
NO	NO	NO	I	YES	N/A	N/A	IXB=4,D=P RELATIVE
NO	NO	YES	NONE OR I	YES	N/A	N/A	IXB=4,D=P RELATIVE
NO	NO	NO	NONE	NO	YES	YES	IXB=1,D=B RELATIVE
NO	NO	NO	X	NO	YES	YES	IXB=3,D=B RELATIVE
NO	NO	NO	I	NO	YES	YES	IXB=5,D=B RELATIVE
NO	NO	YES	NONE OR I	NO	YES	YES	IXB=5,D=B RELATIVE
NO	NO	NO	B	N/A	N/A	NO	IXB=1,D= ABSOLUTE
NO	NO	NO	XB	N/A	N/A	NO	IXB=3,D= ABSOLUTE
NO	NO	NO	IB	N/A	N/A	NO	IXB=5,D= ABSOLUTE
NO	NO	YES	B OR IB	N/A	N/A	NO	IXB=5,D= ABSOLUTE
NO	NO	NO	B	N/A	YES	YES	IXB=1,D=B RELATIVE
NO	NO	NO	XB	N/A	YES	YES	IXB=3,D=B RELATIVE
NO	NO	NO	IB	N/A	YES	YES	IXB=5,D=B RELATIVE
NO	NO	YES	B OR IB	N/A	YES	YES	IXB=5,D=B RELATIVE
NO	NO	NO	IX	YES	N/A	N/A	IXB=6,D=P RELATIVE
NO	NO	YES	X OR IX	YES	N/A	N/A	IXB=6,D=P RELATIVE
NO	NO	NO	M	N/A	N/A	N/A	IXB=7,D= ABSOLUTE
NO	NO	YES	XB OR M	N/A	N/A	N/A	IXB=7,D= ABSOLUTE
NO	YES	N/A	N/A	N/A	N/A	N/A	IXB=7,D= ABSOLUTE
YES	YES	N/A	NONE	N/A	N/A	N/A	IXB=0,D=0, 2ND WORD= IMMEDIATE VALUE
YES	NO	N/A	NONE	N/A	N/A	N/A	IXB=4,D=0, 2ND WORD= INDIRECT ADDRESS
YES	NO	N/A	X	N/A	N/A	N/A	IXB=6,D=0, 2ND WORD= INDIRECT ADDRESS

VALUES GIVEN SYMBOLICALLY IN THE MODE EXPRESSION COLUMN HAVE THE FOLLOWING VALUES:

NONE = 0 X = 2 I = 4 IX = 6
B = 1 XB = 3 IB = 5 M = 7

RESERVED MEMORY LOCATIONS

LOC	IP	FUNCTION
0-1	0	POWER RESTORE START UP
2-3	1	INTERNAL INTERRUPT
4-5	3	DMAC INTERRUPT
6-7	4	DATA BUS INTERRUPT
8-87	2	INTERRUPT WHEN USING VECTORED INTERRUPT OPTION
88		ADDRESS OF FIRST LOGICAL DEVICE TABLE ENTRY
89		ADDRESS OF FIRST PHYSICAL DEVICE TABLE ENTRY
8A		ADDRESS OF FIRST DEVICE NAME TABLE ENTRY
8B		ADDRESS OF FLOATING-POINT PACKAGE
8C		STATUS FLAG FOR OPERATOR COMMUNICATION PACKAGE
8D-93		RESERVED
94		MP/PIF UPPER LIMIT ADDRESS (ABSOLUTE)
95		MP/PIF LOWER LIMIT ADDRESS (ABSOLUTE)
96		DMAC INTERRUPT STATUS
98-99		STATUS FROM DEVICE ON DMAC PORT 0
9A-9B		STATUS FROM DEVICE ON DMAC PORT 1
9C-9D		STATUS FROM DEVICE ON DMAC PORT 2
9E-9F		STATUS FROM DEVICE ON DMAC PORT 3
A0-A1		STATUS FROM DEVICE ON DMAC PORT 4
A2-A3		STATUS FROM DEVICE ON DMAC PORT 5
A4-A5		STATUS FROM DEVICE ON DMAC PORT 6
A6-A7		STATUS FROM DEVICE ON DMAC PORT 7

LOAD ERRORS

REGISTER M	LOADER STATUS CODE
0000	NO ERROR, LOAD COMPLETE
0001	INPUT READ ERROR
0002	CHECKSUM ERROR
0003	MISSING IDENTIFICATION RECORD
0004	ILLEGAL FORMAT CODE
0005	PROGRAM TOO LARGE
0006	NO ENTRY ADDRESS
0007	FILE NAME ERROR (DISC SYSTEMS ONLY)
0008	DISC DATA ERROR (DISC SYSTEMS ONLY)
0009	SYSTEM FILE NOT FOUND (DISC BOOT OPERATION ONLY)

SYSTEM INPUT/OUTPUT ERRORS

HEX ERROR NUMBER YYYY	PHYSICAL DEVICE	MEANING
0000	ALL	UNDEFINED OPERATION CODE
4000	MAGNETIC TAPE	WRITE - RING MISSING
2000		OFF - LINE
0800		PARITY ERROR
0080		END - OF - TAPE
0001	FILE MANAGEMENT	FILE NOT OPENED
0002		FILE NOT DEFINED
0003		END - OF - FILE EXTENT
0004		BUFFER MEMORY SPACE UNAVAILABLE
0005		HARDWARE FAILURE
0006		DISC VOLUME FULL
0007		ILLEGAL OPERATION CODE
0008		DICTIONARY FULL
0009		VOLUME NAME OR SERIAL NUMBER MISMATCH
0010		LOGICAL UNIT NOT DEFINED
0011		BUFFER OUTSIDE USER MEMORY SPACE
0040	EIA INTERFACE	HARDWARE ERROR

OPERATOR COMMUNICATION COMMANDS

// ASSIGN, LUN, PD, FILNAM.
// RELEASE, LUN.
// REWIND, LUN.
// SWAPCS, LUN.
// SKIPCS, NN.
// EXECUTE, PD, FILNAM.
// DEFINE, DISC, FILNAM, RECSIZ, TYPE, EXTENT.
// DELETE, DISC, FILNAM.
// COMPRESS, DISC, VOLNAM, NUMBER.
// CUR.
// LOAD, PD.
// ENDFIL, LUN.

ABORT ERROR MESSAGES

ERROR NUMBER	EVENT
0000	POWER FAILURE (WHEN POWER IS RESTORED)
0001	ILLEGAL OPERATION
0002	PRIVILEGED INSTRUCTION VIOLATION
0003	MEMORY PROTECT VIOLATION

DISC FILE TYPES

0 - UNBLOCKED, TEMPORARY
1 - UNBLOCKED, PERMANENT
2 - BLOCKED, TEMPORARY
3 - BLOCKED, PERMANENT

REGISTERS

A--0--ARITHMETIC REGISTER
E--1--ARITHMETIC REGISTER
X--2--INDEX REGISTER
M--3--MAINTENANCE REGISTER
S--4--STORAGE REGISTER
L--5--LINK REGISTER
B--6--BASE REGISTER
PC--7--PROGRAM COUNTER (OR P)

STATUS REGISTER

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

0,1---COMPARE INDICATORS (00='<',01='=',10='>')
2---OVERFLOW INDICATOR
3---CARRY INDICATOR
* 4---PRIVILEGED INSTRUCTION AND MEMORY PROTECT CONTROL
* * 5---MEMORY PROTECT ADDRESS VIOLATION
* * 6---PIF INSTRUCTION VIOLATION
* 7---DATA BUS INTERRUPT CONTROL
* 8---EXPANDED INTERRUPT FEATURE
* 9---PIF LOWER LIMIT BIAS
10---INDEX CONTROL (1=PREINDEX, 0=POSTINDEX)
* 11---MEMORY PARITY ERROR CONTROL
* 12---DMAC INTERRUPT CONTROL
13---NOT USED
14---MEMORY PARITY ERROR INDICATOR (1=ERROR)
15---POWER FAIL INDICATOR (1=POWER FAILURE IMMINENT)

* ---0=DISABLED, 1=ENABLED
* * ---0=NO VIOLATION, 1=VIOLATION

HEXADECIMAL/DECIMAL CONVERSION

MSB	0	3	4	7	8	11	12	15	LSB
	HEX	DEC	HEX	DEC	HEX	DEC	HEX	DEC	
	0	0	0	0	0	0	0	0	
	1	4 096	1	256	1	16	1	1	
	2	8 192	2	512	2	32	2	2	
	3	12 288	3	768	3	48	3	3	
	4	16 384	4	1 024	4	64	4	4	
	5	20 480	5	1 280	5	80	5	5	
	6	24 576	6	1 536	6	96	6	6	
	7	28 672	7	1 792	7	112	7	7	
	8	32 768	8	2 048	8	128	8	8	
	9	36 864	9	2 304	9	144	9	9	
	A	40 960	A	2 560	A	160	A	10	
	B	45 056	B	2 816	B	176	B	11	
	C	49 152	C	3 072	C	192	C	12	
	D	53 248	D	3 328	D	208	D	13	
	E	57 344	E	3 584	E	224	E	14	
	F	61 440	F	3 840	F	240	F	15	

TO CONVERT A HEX NO. TO DECIMAL, ADD THE DECIMAL EQUIVALENTS FOR EACH OF THE FOUR POSITIONS. TO CONVERT FROM DECIMAL TO HEX, USE THE HEX EQUIVALENTS OF THE LARGEST DECIMAL NUMBERS IN EACH POSITION THAT ADD UP TO THE DESIRED NUMBER. BEGIN SUMMING THE NEAREST MSB NUMBER THAT IS LESS THAN (OR EQUAL TO) THE DESIRED DECIMAL NUMBER.

SOFTWARE LUN ASSIGNMENTS

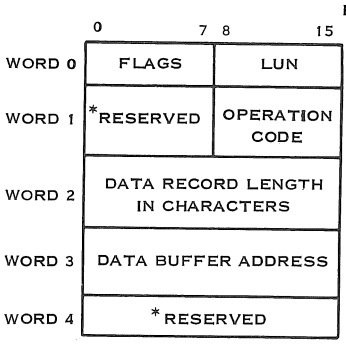
FUNCTION	SAPG	LINKG	FTN	CPYOBJ	DEBUG	EDIT AND TSE	CATLOG	CUR	SAP733	TILT
CONTROL	4	5		4		4		4	4	70
SOURCE IN	5					5	32	5	5	51
SOURCE IN PASS 1			5							
SOURCE IN PASS 2			8							
SOURCE OUT						7		7		61
LISTING	6	6	6			6	6	6	6	60
OBJECT IN		8		8	5			5		
1ST ALT. IN		9								
2ND ALT. IN		A								
MAIN LIBRARY		B								50
ALT. LIBRARY		C								
OBJECT OUT	7	7	7	7				7	7	
SCRATCH	10									
INSERTIONS						8		8		

TYPICAL BLOCKED FILE DISC RECORDS

PGM RCRD SIZE (CHAR-ACTERS)	DISC RECORD SIZE (SECTORS)	BLOCKING FACTOR (RCRDS/BLCK)	USE
32	1	2	DATA
64	*4	*4	OBJECT RECORDS AND SAPG SOURCE
72	9	8	FORTRAN SOURCE
80	5	4	HOLLERITH CARD IMAGE DATA
96	3	2	DATA
144	9	4	LINE PRINTER OUTPUT LINES

*A RECORD LENGTH OF 64 CHARACTERS IS A SPECIAL CASE FOR OBJECT RECORD STORAGE.

PHYSICAL RECORD BLOCK



FLAG BIT	1	0
*0	BUSY	NOT BUSY
1	ERROR	NO ERROR
2	EOF	NO EOF
3	OP CODE IGNORED	OP CODE PROCESSED
*4	INITIATE	EXECUTE
*5	RESERVED	
*6	RESERVED	
*7	RESERVED	

* NOT APPLICABLE IN BASIC SYSTEM - INCLUDED ONLY FOR COMPATIBILITY WITH OTHER SYSTEMS.

PHYSICAL DEVICE RESPONSE TO LOGICAL DEVICE COMMAND

LOGICAL DEVICE COMMAND		PHYSICAL DEVICE RESPONSE										
			ASR 33 ASR 733 KSR 733 CRT		ASR33		ASR 733 CS2	CR	MT	DF	LP
OP CODE$_{10}$	MEANING	DMY	KB	PR	TTR	TTP	CS1				
00	READ ASCII	R_5	R	E	R	E	R	R_6	R	R	E
01	READ OBJECT	R_5	E	E	R_7	E	R	R_7	R	R	E
02	WRITE ASCII	R	E	R	E	R	R	E	R	R	R
03	WRITE OBJECT	R	E	E	E	R	R_7	E	R	R	E
04	REWIND	I	I	I	I	I	R	I	R	R	I
05	BACK-SPACE	I	I	I	I	I	R	I	R	R	I
06	FORWARD SPACE	I	I	I	I	I	R	I	R	R	I
07	OPEN	R	R_4	R_4	R_4	R_4	R_4	I	R_4	R_4	I
08	OPEN-REWIND	I	I	I	I	I_2	R	I	R	R	I_1
09	CLOSE	R	R	R	R	R_3	R_3	R	R	R	R
10	CLOSE-WRITE EOF	I	E	I	I	R_3	R_3	E	R	R	I
11	UNLOAD	I	I	I	I	I	R	I	R	I	I
12	READ DICTIONARY	E	E	E	E	E	E	E	E	R_5	E
13	DELETE	E	E	E	E	E	E	E	E	R	E
14	WRITE DISC ID	E	E	E	E	E	E	E	E	R	E
15	COMPRESS DISC	E	E	E	E	E	E	E	E	R	E
16	DEFINE	E	E	E	E	E	E	E	E	R	E
17	STATUS 733 ASR	E	E	E	E	E	R_9	E	E	E	E

* - USED BY BASIC SYSTEM PROGRAMS;OTHERWISE ERROR
R - RESPONSE (RESETS FLAG BIT 3 TO 0)
E - ERROR (SETS FLAG BIT 1 TO 1)
I - IGNORE (SETS FLAG BIT 3 TO 1)
1 - PAGE EJECT
2 - PUNCH LEADER
3 - PUNCH TRAILER
4 - SETS OR CHANGES RECORD SIZE
5 - RETURNS AN END-OF-FILE CONDITION (SETS BIT 2 IN PRB WORD 0)
6 - HOLLERITH CONVERSION IS PERFORMED IN THE DEVICE SERVICE ROUTINE
7 - OBJECT FORMAT CONVERSION IS PERFORMED
8 - THE DISC VOLUME DICTIONARY IN 5504 WORDS LONG
9 - RESPONSE ONLY IF CASSETTE IS PHYSICAL DEVICE; OTHERWISE, ERROR

MISCELLANEOUS I/O BUS INFORMATION

STANDARD EXTERNAL REGISTER NUMBER							DEVICE	FUNCTION
BIT 9	11	12	13	14	15	HEX		
0	0	0	0	1	0	02	PRIMARY TTY (OLD IF)	DATA
0	0	1	0	1	0	0A		CONTROL/ STATUS
0	1	1	0	1	0	1A		DISCONNECT
0	0	0	1	0	1	05	COMMUNICATION MODULE	DATA CONTROL
0	0	0	0	1	1	03	SECONDARY TTY (OLD IF)	DATA
0	0	1	0	1	1	0B		CONTROL/ STATUS
0	1	1	0	1	1	1B		DISCONNECT
0	1	1	0	0	0	18	HSR	DATA
0	1	0	0	0	0	10		CONTROL/ STATUS
0	1	1	0	0	0	18	HSP	DATA
0	1	0	0	0	1	11		CONTROL/ STATUS
0	1	1	1	1	1	1F	CARD READER	ALL
1	1	0	0	0	0	50	LOW SPEED LP	CONTROL/ STATUS
1	1	0	0	0	1	51		DATA
1	1	0	0	1	0	52		DATA STROBE
0	0	0	0	0	0	00	LOWER LIMIT REG.	
0	0	0	0	0	1	01	UPPER LIMIT REG.	
0	0	0	1	0	0	04	INTERVAL TIMER ADDR.	
0	1	0	0	1	1	13	INT. EXPANDER	READ INTERRUPT
1	1	0	1	0	0	54	VECTORED INT.	(I/O 1 OF 2) SET MASK
1	1	0	1	0	1	55		(I/O 1 OF 2) CLEAR MASK
1	1	0	1	1	0	56		(I/O 1 OF 2) SET INTERRUPT (T)
1	1	0	1	1	1	57		(I/O 3 OF 4) SET MASK
1	1	1	0	0	0	58		(I/O 3 OF 4) CLEAR MASK
1	1	1	0	0	1	59		(I/O 3 OF 4) SET INTERRUPT (T)

((T) TEST ONLY) (IF - INTERFACE)

BINARY INTERNAL CODE TO PAPER TAPE OBJECT CODE

INTERNAL CODE	TAPE CODE-FRAMES	INTERNAL CODE	TAPE CODE-FRAMES
0	00010 000	8	10011 000
1	00000 001	9	00011 001
2	00000 010	A	00011 010
3	10000 011	B	10011 011
4	00000 100	C	00011 100
5	00010 101	D	10011 101
6	00010 110	E	10011 110
7	10010 111	F	00011 111

ASCII CHARACTER BY NUMERICAL SEQUENCE

HOLLERITH PUNCH CARD CODE	BINARY	HEX	ASCII CHAR./DEF
12-0-1-8-9	0000 000	00	NULL
12-1-9	0000 001	01	START HEADING
12-2-9	0000 010	02	START TEXT
12-3-9	0000 011	03	END TEXT
7-9	0000 100	04	END TRANSMISSION
0-5-8-9	0000 101	05	ENQUIRY
0-6-8-9	0000 110	06	ACKNOWLEDGE
0-7-8-9	0000 111	07	BELL
11-6-9	0001 000	08	BACKSPACE
12-5-9	0001 001	09	HORIZONTAL TAB
0-5-9	0001 010	0A	LINE FEED
12-3-8-9	0001 011	0B	VERTICAL TAB
12-4-8-9	0001 100	0C	FORM FEED
12-5-8-9	0001 101	0D	CARRIAGE RETURN
12-6-8-9	0001 110	0E	SHIFT OUT
12-7-8-9	0001 111	0F	SHIFT IN
12-11-1-8-9	0010 000	10	DATA LINK ESCAPE
11-1-9	0010 001	11	DEVICE CONTROL 1
11-2-9	0010 010	12	DEVICE CONTROL 2
11-3-9	0010 011	13	DEVICE CONTROL 3
4-8-9	0010 100	14	DEVICE CONTROL 4
5-8-9	0010 101	15	NEGATIVE ACKNOWLEDGE
2-9	0010 110	16	SYNCHRONOUS IDLE
0-6-9	0010 111	17	END TRANSMISSION BLOCK
11-8-9	0011 000	18	CANCEL
11-1-8-9	0011 001	19	END MEDIUM
7-8-9	0011 010	1A	SUBSTITUTE
0-7-9	0011 011	1B	ESCAPE
11-4-8-9	0011 100	1C	FILE SEPARATOR
11-5-8-9	0011 101	1D	GROUP SEPARATOR
11-6-8-9	0011 110	1E	RECORD SEPARATOR
11-7-8-9	0011 111	1F	UNIT SEPARATOR
NO PCH	0100 000	20	SPACE
12-7-8	0100 001	21	!
7-8	0100 010	22	"
3-8	0100 011	23	#
11-3-8	0100 100	24	$
0-4-8	0100 101	25	%
12	0100 110	26	&
5-8	0100 111	27	'
12-5-8	0101 000	28	(
11-5-8	0101 001	29	)
11-4-8	0101 010	2A	*
12-6-8	0101 011	2B	+
0-3-8	0101 100	2C	,
11	0101 101	2D	-
12-3-8	0101 110	2E	.
0-1	0101 111	2F	/
0	0110 000	30	0
1	0110 001	31	1
2	0110 010	32	2
3	0110 011	33	3
4	0110 100	34	4
5	0110 101	35	5
6	0110 110	36	6
7	0110 111	37	7
8	0111 000	38	8
9	0111 001	39	9
2-8	0111 010	3A	:
11-6-8	0111 011	3B	;
12-4-8	0111 100	3C	<
6-8	0111 101	3D	=
0-6-8	0111 110	3E	>
0-7-8	0111 111	3F	?

ASCII CHARACTER BY NUMERICAL SEQUENCE (CONT'D)

HOLLERITH PUNCH CARD CODE	BINARY	HEX	ASCII CHAR./DEF
4-8	1000 000	40	@
12-1	1000 001	41	A
12-2	1000 010	42	B
12-3	1000 011	43	C
12-4	1000 100	44	D
12-5	1000 101	45	E
12-6	1000 110	46	F
12-7	1000 111	47	G
12-8	1001 000	48	H
12-9	1001 001	49	I
11-1	1001 010	4A	J
11-2	1001 011	4B	K
11-3	1001 100	4C	L
11-4	1001 101	4D	M
11-5	1001 110	4E	N
11-6	1001 111	4F	O
11-7	1010 000	50	P
11-8	1010 001	51	Q
11-9	1010 010	52	R
0-2	1010 011	53	S
0-3	1010 100	54	T
0-4	1010 101	55	U
0-5	1010 110	56	V
0-6	1010 111	57	W
0-7	1011 000	58	X
0-8	1011 001	59	Y
0-9	1011 010	5A	Z
12-2-8	1011 011	5B	[
0-2-8	1011 100	5C	\
11-2-8	1011 101	5D	]
11-7-8	1011 110	5E	^
0-5-8	1011 111	5F	-
1-8	1100 000	60	`
12-0-1	1100 001	61	a
12-0-2	1100 010	62	b
12-0-3	1100 011	63	c
12-0-4	1100 100	64	d
12-0-5	1100 101	65	e
12-0-6	1100 110	66	f
12-0-7	1100 111	67	g
12-0-8	1101 000	68	h
12-0-9	1101 001	69	i
12-11-1	1101 010	6A	j
12-11-2	1101 011	6B	k
12-11-3	1101 100	6C	l
12-11-4	1101 101	6D	m
12-11-5	1101 110	6E	n
12-11-6	1101 111	6F	o
12-11-7	1110 000	70	p
12-11-8	1110 001	71	q
12-11-9	1110 010	72	r
11-0-2	1110 011	73	s
11-0-3	1110 100	74	t
11-0-4	1110 101	75	u
11-0-5	1110 110	76	v
11-0-6	1110 111	77	w
11-0-7	1111 000	78	x
11-0-8	1111 001	79	y
11-0-9	1111 010	7A	z
12-0	1111 011	7B	{
12-11	1111 100	7C	¦
11-0	1111 101	7D	}
11-0-1	1111 110	7E	~
12-7-9	1111 111	7F	DELETE

IN THE BINARY COLUMN, THE SPACE REPRESENTS THE SPROCKET WHEN ON PAPER TAPE. ASCII USES EIGHT BITS WITH THE MOST SIGNIFICANT BIT ON THE LEFT; THIS EIGHTH BIT IS NOT SHOWN ABOVE AND IS UNDEFINED. IN THE HEX COLUMN, THIS EIGHTH BIT IS CONSIDERED AS ZERO. THE ASSEMBLER PLACES A ONE IN THIS BIT.

DMAC STATUS WORDS

BIT	MHD	FHD	979	LP
0	OP COMPLETE	LIST TAKEN	OP COMPLETE	
1	WRT PROTECT ENABLE		NO WRITE RING	
2	OFFLINE		OFFLINE	
3	DATA TRANS-FER ERR		DEVICE BUSY	
4	END OF DISC		CPU/TCU PAR ERR	
5	PROGRAM ERR		MCU PAR ERR	
6	COMPARE ERR		END OF RE-CORD	
7	PARITY ERR		END OF FILE	
8	ID COMPARE ERR	TIMING ERR	END OF TAPE	
9	DEVICE BUSY	PROGRAM ERR	BEGIN OF TAPE	
10	CHAIN LIST TAKEN	COMPARE ERR	TIMING ERR	
11	WLO ON	PARITY ERR	RWD COM-PLETE NO.1	
12	SEEK COM-PLETE NO.3	CONTROL-LER BUSY	RWD COM-PLETE NO.2	CONTROLR BUSY
13	SEEK COM-PLETE NO.2	DISC NOT READY	RWD COM-PLETE NO.3	
14	SEEK COM-PLETE NO.1	WLD ON	COMMAND ERR	PRNTR NOT READY
15	SEEK COM-PLETE NO.0	OP COMP-PLETE	LIST TAKEN	OP COM-PLETE
PORT	1	0	2	5

ROM LOADER ADDRESS

LOCATION	DEVICE	LOCATION	DEVICE
0000	MHD	0004	HSR
0001	FHD	0005	TTY
0002	MT	0006	733 ASR
0003	CR	000F	LOAD IDLES

COMMUNICATIONS MODULE ADDRESS SWITCH SELECTION

	WDS/RDS WORD 1 ADDRESS BIT	SWITCH S1 POLE*	POLE ROCKER POSITION	
			LOGIC ONE	LOGIC ZERO
1ST HEX DIGIT	BIT 09	POLE 2	OFF SIDE DOWN (OPEN)	ON SIDE DOWN (CLOSED)
1ST HEX DIGIT	BIT 11	POLE 3		
2ND HEX DIGIT	BIT 12	POLE 4		
2ND HEX DIGIT	BIT 13	POLE 5		
2ND HEX DIGIT	BIT 14	POLE 6		
2ND HEX DIGIT	BIT 15	POLE 7		

*POLE 2 CORRESPONDS TO PIN 2, ETC.

BAUD RATE SELECTION

BAUD RATE	SWITCH S2 POLE		
	POLE 3	POLE 2	POLE 1
75	ON SIDE DOWN (CLOSED)	ON SIDE DOWN (CLOSED)	ON SIDE DOWN (CLOSED)
110			OFF SIDE DOWN (OPEN)
150		OFF SIDE DOWN (OPEN)	ON SIDE DOWN (CLOSED)
300			OFF SIDE DOWN (OPEN)
1200	OFF SIDE DOWN (OPEN)	ON SIDE DOWN (CLOSED)	ON SIDE DOWN (CLOSED)
2400			OFF SIDE DOWN (OPEN)
9600		OFF SIDE DOWN (OPEN)	ON SIDE DOWN (CLOSED)
4800			OFF SIDE DOWN (OPEN)

COMMUNICATIONS MODULE WORD LENGTH SELECTION

NUMBER OF DATA BITS	SWITCH S2 POLE	
	POLE 6	POLE 7
5	ON SIDE DOWN (CLOSED)	ON SIDE DOWN (CLOSED)
6		OFF SIDE DOWN (OPEN)
7	OFF SIDE DOWN (OPEN)	ON SIDE DOWN (CLOSED)
8		OFF SIDE DOWN (OPEN)

COMMUNICATIONS MODULE PARITY SELECTION

PARITY SELECTION	SWITCH S2 POLE	
	POLE 4	POLE 5
PARITY INHIBITED	OFF SIDE DOWN (OPEN)	—
ODD PARITY	ON SIDE DOWN (CLOSED)	ON SIDE DOWN (CLOSED)
EVEN PARITY		OFF SIDE DOWN (OPEN)

STOP BIT SELECTION

STOP BIT SELECTION	SWITCH S1 POLE 1
1 STOP BIT	ON SIDE DOWN (CLOSED)
2 STOP BITS	OFF SIDE DOWN (OPEN)

DEVICE	NO. OF STOP BITS	BAUD RATE
ASR 33	2	110
733 ASR	1	1200
733 KSR	1	300
CRT	1	*

*DEPENDS ON TYPE CRT USED

NOTES