



# System/370 Reference Summary

## MACHINE INSTRUCTIONS

(2)

NAME	MNEMONIC	OP CODE	FOR- MAT	OPERANDS
Add (c)	AR	1A	RR	R1,R2
Add (c)	A	5A	RX	R1,D2(X2,B2)
Add Decimal (c)	AP	FA	SS	D1(L1,B1),D2(L2,B2)
Add Halfword (c)	AH	4A	RX	R1,D2(X2,B2)
Add Logical (c)	ALR	1E	RR	R1,R2
Add Logical (c)	AL	5E	RX	R1,D2(X2,B2)
AND (c)	NR	14	RR	R1,R2
AND (c)	N	54	RX	R1,D2(X2,B2)
AND (c)	NI	94	SI	D1(B1),I2
AND (c)	NC	D4	SS	D1(L,B1),D2(B2)
Branch and Link	BALR	05	RR	R1,R2
Branch and Link	BAL	45	RX	R1,D2(X2,B2)
Branch on Condition	BCR	07	RR	M1,R2
Branch on Condition	BC	47	RX	M1,D2(X2,B2)
Branch on Count	BCTR	06	RR	R1,R2
Branch on Count	BCT	46	RX	R1,D2(X2,B2)
Branch on Index High	BXH	86	RS	R1,R3,D2(B2)
Branch on Index Low or Equal	BXLE	87	RS	R1,R3,D2(B2)
Clear I/O (c,p)	CLRIO	9D01	S	D2(B2)
Compare (c)	CR	19	RR	R1,R2
Compare (c)	C	59	RX	R1,D2(X2,B2)
Compare and Swap (c)	CS	BA	RS	R1,R3,D2(B2)
Compare Decimal (c)	CP	F9	SS	D1(L1,B1),D2(L2,B2)
Compare Double and Swap (c)	CDS	BB	RS	R1,R3,D2(B2)
Compare Halfword (c)	CH	49	RX	R1,D2(X2,B2)
Compare Logical (c)	CLR	15	RR	R1,R2
Compare Logical (c)	CL	55	RX	R1,D2(X2,B2)
Compare Logical (c)	CLC	D5	SS	D1(L,B1),D2(B2)
Compare Logical (c)	CLI	95	SI	D1(B1),I2
Compare Logical Characters under Mask (c)	CLM	BD	RS	R1,M3,D2(B2)
Compare Logical Long (c)	CLCL	0F	RR	R1,R2
Convert to Binary	CVB	4F	RX	R1,D2(X2,B2)
Convert to Decimal	CVD	4E	RX	R1,D2(X2,B2)
Diagnose (p)		83		Model-dependent
Divide	DR	1D	RR	R1,R2
Divide	D	5D	RX	R1,D2(X2,B2)
Divide Decimal	DP	FD	SS	D1(L1,B1),D2(L2,B2)
Edit (c)	ED	DE	SS	D1(L,B1),D2(B2)
Edit and Mark (c)	EDMK	DF	SS	D1(L,B1),D2(B2)
Exclusive OR (c)	XR	17	RR	R1,R2
Exclusive OR (c)	X	57	RX	R1,D2(X2,B2)
Exclusive OR (c)	XI	97	SI	D1(B1),I2
Exclusive OR (c)	XC	D7	SS	D1(L,B1),D2(B2)
Execute	EX	44	RX	R1,D2(X2,B2)
Halt I/O (c,p)	HIO	9E00	S	D2(B2)
Halt Device (c,p)	HDV	9E01	S	D2(B2)
Insert Character	IC	43	RX	R1,D2(X2,B2)
Insert Characters under Mask (c)	ICM	BF	RS	R1,M3,D2(B2)
Insert PSW Key (p)	IPK	B20B	S	
Insert Storage Key (p)	ISK	09	RR	R1,R2
Load	LR	18	RR	R1,R2
Load	L	58	RX	R1,D2(X2,B2)
Load Address	LA	41	RX	R1,D2(X2,B2)
Load and Test (c)	LTR	12	RR	R1,R2
Load Complement (c)	LCR	13	RR	R1,R2
Load Control (p)	LCTL	B7	RS	R1,R3,D2(B2)
Load Halfword	LH	48	RX	R1,D2(X2,B2)
Load Multiple	LM	98	RS	R1,R3,D2(B2)
Load Negative (c)	LNR	11	RR	R1,R2
Load Positive (c)	LPR	10	RR	R1,R2
Load PSW (n,p)	LPSW	82	S	D2(B2)
Load Real Address (c,p)	LRA	B1	RX	R1,D2(X2,B2)
Monitor Call	MC	AF	SI	D1(B1),I2
Move	MVI	92	SI	D1(B1),I2
Move	MVC	D2	SS	D1(L,B1),D2(B2)
Move Long (c)	MVCL	0E	RR	R1,R2
Move Numerics	MVN	D1	SS	D1(L,B1),D2(B2)
Move with Offset	MVO	F1	SS	D1(L1,B1),D2(L2,B2)
Move Zones	MVZ	D3	SS	D1(L,B1),D2(B2)
Multiply	MR	1C	RR	R1,R2
Multiply	M	5C	RX	R1,D2(X2,B2)
Multiply Decimal	MP	FC	SS	D1(L1,B1),D2(L2,B2)
Multiply Halfword	MH	4C	RX	R1,D2(X2,B2)
OR (c)	OR	16	RR	R1,R2

GX20-1850-3

Fourth Edition (November 1976)

This reference summary is a minor revision and does not obsolete the previous edition. Changes include the addition of some new DASD and 3203 printer commands, the EBCDIC control characters GE and RLF, and minor editorial revisions.

The card is intended primarily for use by S/370 assembler language application programmers. It contains basic machine information on Models 115 through 168 summarized from the *System/370 Principles of Operation* (GA22-7000-4), frequently used information from the VS and VM assembler language manual (GC33-4010), command codes for various I/O devices, and a multi-code translation table. The card will be updated from time to time. However, the above manuals and others cited on the card are the authoritative reference sources and will be first to reflect changes.

To distinguish them from instructions carried over from S/360, the names of instructions essentially new with S/370 are shown in italics. Some machine instructions are optional or not available for some models. For those that are available on a particular model, the user is referred to the appropriate systems reference manual. For a particular installation, one must ascertain which optional hardware features and programming system(s) have been installed. The floating-point and extended floating-point instructions, as well as the instructions listed below, are not standard on every model. Monitoring (the MC instruction) is not available on the Model 165, except by field installation on purchased models.

Conditional swapping	CDS, CS
CPU timer and clock comparator	SCKC, SPT, STCKC, STPT
Direct control	RDD, WRD
Dynamic address translation	LRA, PTLB, RRB, STNSM, STOSM
Input/output	CLRIO, SIOF
Multiprocessing	SIGP, SPX, STAP, STPX
PSW key handling	IPK, SPKA

Comments about this publication may be sent to the address below. All comments and suggestions become the property of IBM.

## MACHINE INSTRUCTIONS (Contd)

NAME	MNEMONIC	OP CODE	FOR-MAT	OPERANDS
OR (c)	O	56	RX	R1,D2(X2,B2)
OR (c)	OI	96	SI	D1(B1),I2
OR (c)	OC	D6	SS	D1(L,B1),D2(B2)
Pack	PACK	F2	SS	D1(L1,B1),D2(L2,B2)
Purge TLB (p)	PTLB	B20D	S	
Read Direct (p)	RDD	85	SI	D1(B1),I2
Reset Reference Bit (c,p)	RRB	B213	S	D2(B2)
Set Clock (c,p)	SCK	B204	S	D2(B2)
Set Clock Comparator (p)	SCKC	B206	S	D2(B2)
Set CPU Timer (p)	SPT	B208	S	D2(B2)
Set Prefix (p)	SPX	B210	S	D2(B2)
Set Program Mask (n)	SPM	04	RR	R1
Set PSW Key from Address (p)	SPKA	B20A	S	D2(B2)
Set Storage Key (p)	SSK	08	RR	R1,R2
Set System Mask (p)	SSM	80	S	D2(B2)
Shift and Round Decimal (c)	SRP	F0	SS	D1(L1,B1),D2(B2),I3
Shift Left Double (c)	SLDA	8F	RS	R1,D2(B2)
Shift Left Double Logical	SLDL	8D	RS	R1,D2(B2)
Shift Left Single (c)	SLA	8B	RS	R1,D2(B2)
Shift Left Single Logical	SLL	89	RS	R1,D2(B2)
Shift Right Double (c)	SRDA	8E	RS	R1,D2(B2)
Shift Right Double Logical	SRDL	8C	RS	R1,D2(B2)
Shift Right Single (c)	SRA	8A	RS	R1,D2(B2)
Shift Right Single Logical	SRL	88	RS	R1,D2(B2)
Signal Processor (c,p)	SIGP	AE	RS	R1,R3,D2(B2)
Start I/O (c,p)	SIO	9C00	S	D2(B2)
Start I/O Fast Release (c,p)	SIOF	9C01	S	D2(B2)
Store	ST	50	RX	R1,D2(X2,B2)
Store Channel ID (c,p)	STIDC	B203	S	D2(B2)
Store Character	STC	42	RX	R1,D2(X2,B2)
Store Characters under Mask	STCM	BE	RS	R1,M3,D2(B2)
Store Clock (c)	STCK	B205	S	D2(B2)
Store Clock Comparator (p)	STCKC	B207	S	D2(B2)
Store Control (p)	STCTL	B6	RS	R1,R3,D2(B2)
Store CPU Address (p)	STAP	B212	S	D2(B2)
Store CPU ID (p)	STIDP	B202	S	D2(B2)
Store CPU Timer (p)	STPT	B209	S	D2(B2)
Store Halfword	STH	40	RX	R1,D2(X2,B2)
Store Multiple	STM	90	RS	R1,R3,D2(B2)
Store Prefix (p)	STPX	B211	S	D2(B2)
Store Then AND System Mask (p)	STNSM	AC	SI	D1(B1),I2
Store Then OR System Mask (p)	STOSM	AD	SI	D1(B1),I2
Subtract (c)	SR	1B	RR	R1,R2
Subtract (c)	S	5B	RX	R1,D2(X2,B2)
Subtract Decimal (c)	SP	FB	SS	D1(L1,B1),D2(L2,B2)
Subtract Halfword (c)	SH	4B	RX	R1,D2(X2,B2)
Subtract Logical (c)	SLR	1F	RR	R1,R2
Subtract Logical (c)	SL	5F	RX	R1,D2(X2,B2)
Supervisor Call	SVC	0A	RR	I
Test and Set (c)	TS	93	S	D2(B2)
Test Channel (c,p)	TCH	9F00	S	D2(B2)
Test I/O (c,p)	TIO	9D00	S	D2(B2)
Test under Mask (c)	TM	91	SI	D1(B1),I2
Translate	TR	DC	SS	D1(L,B1),D2(B2)
Translate and Test (c)	TRT	DD	SS	D1(L,B1),D2(B2)
Unpack	UNPK	F3	SS	D1(L1,B1),D2(L2,B2)
Write Direct (p)	WRD	84	SI	D1(B1),I2
Zero and Add Decimal (c)	ZAP	F8	SS	D1(L1,B1),D2(L2,B2)

## Floating-Point Instructions

NAME	MNEMONIC	OP CODE	FOR-MAT	OPERANDS
Add Normalized, Extended (c,x)	AXR	36	RR	R1,R2
Add Normalized, Long (c)	ADR	2A	RR	R1,R2
Add Normalized, Long (c)	AD	6A	RX	R1,D2(X2,B2)
Add Normalized, Short (c)	AER	3A	RR	R1,R2
Add Normalized, Short (c)	AE	7A	RX	R1,D2(X2,B2)
Add Unnormalized, Long (c)	AWR	2E	RR	R1,R2
Add Unnormalized, Long (c)	AW	6E	RX	R1,D2(X2,B2)
Add Unnormalized, Short (c)	AUR	3E	RR	R1,R2
Add Unnormalized, Short (c)	AU	7E	RX	R1,D2(X2,B2)

c. Condition code is set.  
n. New condition code is loaded.

p. Privileged instruction.  
x. Extended precision floating-point.

## Floating-Point Instructions (Contd)

NAME	MNEMONIC	OP CODE	FOR-MAT	OPERANDS
Compare, Long (c)	CDR	29	RR	R1,R2
Compare, Long (c)	CD	69	RX	R1,D2(X2,B2)
Compare, Short (c)	CER	39	RR	R1,R2
Compare, Short (c)	CE	79	RX	R1,D2(X2,B2)
Divide, Long	DDR	2D	RR	R1,R2
Divide, Long	DD	6D	RX	R1,D2(X2,B2)
Divide, Short	DER	3D	RR	R1,R2
Divide, Short	DE	7D	RX	R1,D2(X2,B2)
Halve, Long	HDR	24	RR	R1,R2
Halve, Short	HER	34	RR	R1,R2
Load and Test, Long (c)	LTDR	22	RR	R1,R2
Load and Test, Short (c)	LTER	32	RR	R1,R2
Load Complement, Long (c)	LCDR	23	RR	R1,R2
Load Complement, Short (c)	LCER	33	RR	R1,R2
Load, Long	LDR	28	RR	R1,R2
Load, Long	LD	68	RX	R1,D2(X2,B2)
Load Negative, Long (c)	LNDR	21	RR	R1,R2
Load Negative, Short (c)	LNDR	31	RR	R1,R2
Load Positive, Long (c)	LPDR	20	RR	R1,R2
Load Positive, Short (c)	LPER	30	RR	R1,R2
Load Rounded, Extended to Long (x)	LRDR	25	RR	R1,R2
Load Rounded, Long to Short (x)	LRER	35	RR	R1,R2
Load, Short	LEF	38	RR	R1,R2
Load, Short	LE	78	RX	R1,D2(X2,B2)
Multiply, Extended (x)	MXR	26	RR	R1,R2
Multiply, Long	MDR	2C	RR	R1,R2
Multiply, Long	MD	6C	RX	R1,D2(X2,B2)
Multiply, Long/Extended (x)	MXDR	27	RR	R1,R2
Multiply, Long/Extended (x)	MXD	67	RX	R1,D2(X2,B2)
Multiply, Short	MER	3C	RR	R1,R2
Multiply, Short	ME	7C	RX	R1,D2(X2,B2)
Store, Long	STD	60	RX	R1,D2(X2,B2)
Store, Short	STE	70	RX	R1,D2(X2,B2)
Subtract Normalized, Extended (c,x)	SXR	37	RR	R1,R2
Subtract Normalized, Long (c)	SDR	2B	RR	R1,R2
Subtract Normalized, Long (c)	SD	6B	RX	R1,D2(X2,B2)
Subtract Normalized, Short (c)	SER	3B	RR	R1,R2
Subtract Normalized, Short (c)	SE	7B	RX	R1,D2(X2,B2)
Subtract Unnormalized, Long (c)	SWR	2F	RR	R1,R2
Subtract Unnormalized, Long (c)	SW	6F	RX	R1,D2(X2,B2)
Subtract Unnormalized, Short (c)	SUR	3F	RR	R1,R2
Subtract Unnormalized, Short (c)	SU	7F	RX	R1,D2(X2,B2)

## EXTENDED MNEMONIC INSTRUCTIONS†

Use	Extended Code* (RX or RR)	Meaning	Machine Instr.* (RX or RR)
General	B or BR	Unconditional Branch	BC or BCR 15,
	NOP or NOPR	No Operation	BC or BCR 0,
After	BH or BHR	Branch on A High	BC or BCR 2,
Compare	BL or BLR	Branch on A Low	BC or BCR 4,
Instructions (A:B)	BE or BER	Branch on A Equal B	BC or BCR 8,
	BNH or BNHR	Branch on A Not High	BC or BCR 13,
	BNL or BNLR	Branch on A Not Low	BC or BCR 11,
	BNE or BNER	Branch on A Not Equal B	BC or BCR 7,
After	BO or BOR	Branch on Overflow	BC or BCR 1,
Arithmetic	BP or BPR	Branch on Plus	BC or BCR 2,
Instructions	BM or BMR	Branch on Minus	BC or BCR 4,
	BNP or BNPR	Branch on Not Plus	BC or BCR 13,
	BNM or BNMR	Branch on Not Minus	BC or BCR 11,
	BNZ or BNZR	Branch on Not Zero	BC or BCR 7,
	BZ or BZR	Branch on Zero	BC or BCR 8,
After Test under Mask Instruction	BO or BOR	Branch if Ones	BC or BCR 1,
	BM or BMR	Branch if Mixed	BC or BCR 4,
	BZ or BZR	Branch if Zeros	BC or BCR 8,
	BNO or BNOR	Branch if Not Ones	BC or BCR 14,

†Source: GC33-4010; for OS/VS,VM/370 and DOS/VS.

\*Second operand, not shown, is D2(X2,B2) for RX format and R2 for RR format.

## SOME EDIT AND EDMK PATTERN CHARACTERS (in hex)

20—digit selector	40—blank	5C—asterisk
21—start of significance	4B—period	6B—comma
22—field separator	5B—dollar sign	C3D9—CR

## CONDITION CODES

Condition Code Setting	0	1	2	3
Mask Bit Value	8	4	2	1

### General Instructions

Add, Add Halfword	zero	<zero	>zero	overflow
Add Logical	zero, no carry	not zero, no carry	zero, carry	not zero, carry
AND	zero	not zero	—	—
Compare, Compare Halfword	equal	1st op low	1st op high	—
Compare and Swap/Double	equal	not equal	—	—
Compare Logical	equal	1st op low	1st op high	—
Exclusive OR	zero	not zero	—	—
Insert Characters under Mask	all zero	1st bit one	1st bit zero	—
Load and Test	zero	<zero	>zero	—
Load Complement	zero	<zero	>zero	overflow
Load Negative	zero	<zero	—	—
Load Positive	zero	—	>zero	overflow
Move Long	count equal	count low	count high	overlap
OR	zero	not zero	—	—
Shift Left Double/Single	zero	<zero	>zero	overflow
Shift Right Double/Single	zero	<zero	>zero	—
Store Clock	set	not set	error	not oper
Subtract, Subtract Halfword	zero	not set	>zero	overflow
Subtract Logical	—	not zero, no carry	zero, carry	not zero, carry
Test and Set	zero	one	—	—
Test under Mask	zero	mixed	—	ones
Translate and Test	zero	incomplete	complete	—

### Decimal Instructions

Add Decimal	zero	<zero	>zero	overflow
Compare Decimal	equal	1st op low	1st op high	—
Edit, Edit and Mark	zero	<zero	>zero	—
Shift and Round Decimal	zero	<zero	>zero	overflow
Subtract Decimal	zero	<zero	>zero	overflow
Zero and Add	zero	<zero	>zero	overflow

### Floating-Point Instructions

Add Normalized	zero	<zero	>zero	—
Add Unnormalized	zero	<zero	>zero	—
Compare	equal	1st op low	1st op high	—
Load and Test	zero	<zero	>zero	—
Load Complement	zero	<zero	>zero	—
Load Negative	zero	<zero	—	—
Load Positive	zero	—	>zero	—
Subtract Normalized	zero	<zero	>zero	—
Subtract Unnormalized	zero	<zero	>zero	—

### Input/Output Instructions

Clear I/O	no oper in progress	CSW stored	chan busy	not oper
Halt Device	interruption pending	CSW stored	channel working	not oper
Halt I/O	interruption pending	CSW stored	burst op stopped	not oper
Start I/O, SIOF	successful	CSW stored	busy	not oper
Store Channel ID	ID stored	CSW stored	busy	not oper
Test Channel	available	interruption pending	burst mode	not oper
Test I/O	available	CSW stored	busy	not oper

### System Control Instructions

Load Real Address	translation available	ST entry invalid	PT entry invalid	length violation
Reset Reference Bit	R=0, C=0	R=0, C=1	R=1, C=0	R=1, C=1
Set Clock	set	secure	—	not oper
Signal Processor	accepted	stat stored	busy	not oper

## CNOP ALIGNMENT

DOUBLEWORD							
WORD				WORD			
HALFWORD	HALFWORD	HALFWORD	HALFWORD	HALFWORD	HALFWORD	HALFWORD	HALFWORD
BYTE	BYTE	BYTE	BYTE	BYTE	BYTE	BYTE	BYTE
0,4	2,4	0,4	2,4	0,4	2,4	0,4	2,4
0,8	2,8	4,8	6,8				

## ASSEMBLER INSTRUCTIONS†

Function	Mnemonic	Meaning
Data definition	DC	Define constant
	DS	Define storage
	CCW	Define channel command word
	START	Start assembly
	CSECT	Identify control section
	DSECT	Identify dummy section
Program sectioning and linking	DXD*	Define external dummy section
	CXD*	Cumulative length of external dummy section
	COM	Identify blank common control section
	ENTRY	Identify entry-point symbol
	EXTRN	Identify external symbol
	WXTRN	Identify weak external symbol
Base register assignment	USING	Use base address register
	DROP	Drop base address register
Control of listings	TITLE	Identify assembly output
	EJECT	Start new page
	SPACE	Space listing
	PRINT	Print optional data
Program Control	ICTL	Input format control
	ISEQ	Input sequence checking
	PUNCH	Punch a card
	REPRO	Reproduce following card
	ORG	Set location counter
	EQU	Equate symbol
	OPSYN*	Equate operation code
	PUSH*	Save current PRINT or USING status
	POP*	Restore PRINT or USING status
	LTOrg	Begin literal pool
	CNOP	Conditional no operation
	COPY	Copy predefined source coding
	END	End assembly
	Macro definition	MACRO
MNOTE		Request for error message
MEXIT		Macro definition exit
MEND		Macro definition trailer
ACTR		Conditional assembly loop counter
Conditional assembly	AGO	Unconditional branch
	AIF	Conditional branch
	ANOP	Assembly no operation
	GBLA	Define global SETA symbol
	GBLB	Define global SETB symbol
	GBLC	Define global SETC symbol
	LCLA	Define local SETA symbol
	LCLB	Define local SETB symbol
	LCLC	Define local SETC symbol
	SETA	Set arithmetic variable symbol
	SETB	Set binary variable symbol
	SETC	Set character variable symbol

## SUMMARY OF CONSTANTS†

TYPE	IMPLIED LENGTH, BYTES	ALIGNMENT	FORMAT	TRUNCATION/PADDING
C	—	byte	characters	right
X	—	byte	hexadecimal digits	left
B	—	byte	binary digits	left
F	4	word	fixed-point binary	left
H	2	halfword	fixed-point binary	left
E	4	word	short floating-point	right
D	8	doubleword	long floating-point	right
L	16	doubleword	extended floating-point	right
P	—	byte	packed decimal	left
Z	—	byte	zoned decimal	left
A	4	word	value of address	left
Y	2	halfword	value of address	left
S	2	halfword	address in base-displacement form	—
V	4	word	externally defined address value	left
Q*	4	word	symbol naming a DXD or DSECT	left

†Source: GC33-4010; for OS/VS, VM/370, and DOS/VS.  
\*OS/VS and VM/370 only.

**I/O COMMAND CODES**

7

**Standard Command Code Assignments (CCW bits 0-7)**

xxxx 0000	Invalid	†††† ††01	Write
†††† 0100	Sense	†††† ††10	Read
xxxx 1000	Transfer in Channel	†††† ††11	Control
†††† 1100	Read Backward	0000 0011	Control No Operation

x—Bit ignored. † Modifier bit for specific type of I/O device

**CONSOLE PRINTERS**

Write, No Carrier Return	01	Sense	04
Write, Auto Carrier Return	09	Audible Alarm	0B
Read Inquiry	0A		

**3504, 3505 CARD READERS/3525 CARD PUNCH**

Source: GA21-9124

Command	Binary	Hex	Bit Meanings
Sense	0000 0100	04	<u>SS</u> <u>Stacker</u>
Feed, Select Stacker	SS10 F011		00 1
Read Only*	11D0 F010		01/10 2
Diagnostic Read (invalid for 3504)	1101 0010	D2	<u>F</u> <u>Format Mode</u>
Read, Feed, Select Stacker*	SSD0 F010		0 Unformatted
Write RCE Format*	0001 0001	11	1 Formatted
<u>3504, 3505 only</u>			<u>D</u> <u>Data Mode</u>
Write OMR Format†	0011 0001	31	0 1—EBCDIC
<u>3525 only</u>			1 2—Card image
Write, Feed, Select Stacker	SSD0 0001		<u>L</u> <u>Line Position</u>
Print Line*	LLLL L101		5-bit binary value

\*Special feature on 3525.

†Special feature.

**PRINTERS: 3211/3811 (GA24-3543), 3203/IPA, 1403\*/2821 (GA24-3312)**

After Write Immed		Write without spacing	
Space 1 Line	09 0B	Sense	04
Space 2 Lines	11 13	Load UCSB without folding	FB
Space 3 Lines	19 1B	Fold†	43
Skip to Channel 0†	— 83	Unfold†	23
Skip to Channel 1	89 8B	Load UCSB and Fold (exc. 3211)	F3
Skip to Channel 2	91 93	UCS Gate Load (1403 only)	EB
Skip to Channel 3	99 9B	Load FCB (exc. 1403)	63
Skip to Channel 4	A1 A3	Block Data Check	73
Skip to Channel 5	A9 AB	Allow Data Check	7B
Skip to Channel 6	B1 B3	Read PLB†	02
Skip to Channel 7	B9 BB	Read UCSB†	0A
Skip to Channel 8	C1 C3	Read FCB†	12
Skip to Channel 9	C9 CB	Diag. Check Read (exc. 3203)	06
Skip to Channel 10	D1 D3	Diagnostic Write†	05
Skip to Channel 11	D9 DB	Raise Cover†	6B
Skip to Channel 12	E1 E3	Diagnostic Gate†	07
Adv. to End of Sheet (3203 only)	5B	Diagnostic Read (1403 only)	02

\*UCS special feature; IPA diagnostics are model-dependent.

†3211 only.

**3420/3803, 3410/3411 MAGNETIC TAPE**

(\*\*Indicates 3420 only)

See GA32-0020, -0021, -0022 for special features and functions of specific models.

Write	01	Density	Parity	DC	Trans	Cmd	
Read Forward	02	200	odd	on	off	13	
Read Backward	0C			off	off	33	
Sense	04			on	on	3B	
Sense Reserve**	F4		even	off	off	23	
Sense Release**	D4		on	on	on	2B	
Request Track-in-Error	1B		odd	off	off	53	
Loop Write-to-Read**	8B	556	odd	on	off	73	
Set Diagnose**	4B			off	on	7B	
Rewind	07			even	off	off	63
Rewind Unload	0F		on	on	on	6B	
Erase Gap	17		odd	off	off	93	
Write Tape Mark	1F		on	off	off	B3	
Backspace Block	27	800	odd	off	on	BB	
Backspace File	2F			on	off	off	A3
Forward Space Block	3F			even	off	on	AB
Forward Space File	3F		Mode Set 2 (9-track), 800 bpi		CB		
Data Security Erase**	97		Mode Set 2 (9-track), 1600 bpi		C3		
Diagnostic Mode Set**	0B		Mode Set 2 (9-track), 6250 bpi**		D3		

**DIRECT ACCESS STORAGE DEVICES**

8

3330-3340-3350 SERIES (GA26-1592, -1617, -1619, -1620, -1638);  
2305/2835 (GA26-1589); 2314, 2319 (GA26-3599, -1606)

See systems reference manuals for restrictions.

Command	MT Off	MT On*	Count	
Control	Orient (c)	2B	Nonzero	
	Recalibrate	13	Nonzero	
	Seek	07	6	
	Seek Cylinder	0B	6	
	Seek Head	1B	6	
	Space Count	0F	3 (a); nonzero (d)	
	Set File Mask	1F	1	
	Set Sector (a,f)	23	1	
	Restore (executes as a no-op)	17	Nonzero	
	Vary Sensing (c)	27	1	
	Diagnostic Load (a)	53	1	
	Diagnostic Write (a)	73	512	
	Search	Home Address Equal	39 B9	4
		Identifier Equal	31 B1	5
		Identifier High	51 D1	5
Identifier Equal or High		71 F1	5	
Key Equal		29 A9	KL	
Key High		49 C9	KL	
Key Equal or High		69 E9	KL	
Key and Data Equal (d)		2D AD	Number of bytes (including mask bytes) in search argument	
Key and Data High (d)		4D CD		
Key and Data Eq. or Hi (d)		6D ED		
Continue Scan		Search Equal (d)	25 A5	Number of bytes to be transferred
		Search High (d)	45 C5	
		Search High or Equal (d)	65 E5	
		Set Compare (d)	35 B5	
		Set Compare (d)	75 F5	
Read	No Compare (d)	55 D5	> Max. track len.	
	Home Address	1A 9A		5
	Count	12 92		8
	Record 0	16 96	Number of bytes to be transferred	
	Data	06 86		
	Key and Data	0E 8E		
	Count, Key and Data	1E 9E	Number of bytes to be transferred	
	IPL	02		
	Multiple Count, Key, Data (b)	5E		
	Sector (a,f)	22	1	
	Sense	Sense I/O	04	24 (a); 6 (d)
		Sense I/O Type (b)	E4	7
		Read, Reset Buffered Log (b)	A4	24
		Read Buffered Log (c)	24	128
		Device Release (e)	94	24 (a); 6 (d)
Device Reserve (e)		84	24 (a); 6 (d)	
Read Diagnostic Status 1 (a)		44	16 or 512	
Write		Home Address	19	5, 7, or 11
		Record 0	15	8+KL+DL of RO
		Erase	11	8+KL+DL
	Count, Key and Data	1D	8+KL+DL	
	Special Count, Key and Data	01	8+KL+DL	
	Data	05	DL	
	Key and Data	0D	KL+DL	

\* Code same as MT Off except as listed. d. 2314, 2319 only.  
a. Except 2314, 2319. e. String switch or 2-channel switch required.  
b. 3330-3340-3350 series only. f. Special feature required on 3340.  
c. 2305/2835 only.



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**CODE TRANSLATION TABLE**

9

Dec.	Hex	Instruction (RR)	Graphics and Controls			7-Track Tape BCDIC(2)	Card Code EBCDIC	Binary
			BCDIC	EBCDIC(1)	ASCII			
0	00		NUL	NUL		12-0-1-8-9	0000 0000	
1	01		SOH	SOH		12-1-9	0000 0001	
2	02		STX	STX		12-2-9	0000 0010	
3	03		ETX	ETX		12-3-9	0000 0011	
4	04	S PM	PF	EOT		12-4-9	0000 0100	
5	05	BALR	HT	ENQ		12-5-9	0000 0101	
6	06	BCTR	LC	ACK		12-6-9	0000 0110	
7	07	BCR	DEL	BEL		12-7-9	0000 0111	
8	08	SSK	GE	BS		12-8-9	0000 1000	
9	09	ISK	RLF	HT		12-1-8-9	0000 1001	
10	0A	SVC	SMM	LF		12-2-8-9	0000 1010	
11	0B		VT	VT		12-3-8-9	0000 1011	
12	0C		FF	FF		12-4-8-9	0000 1100	
13	0D		CR	CR		12-5-8-9	0000 1101	
14	0E	MVCL	SO	SO		12-6-8-9	0000 1110	
15	0F	CLCL	S1	S1		12-7-8-9	0000 1111	
16	10	LPR	DLE	DLE		12-11-1-8-9	0001 0000	
17	11	LNR	DC1	DC1		11-1-9	0001 0001	
18	12	LTR	DC2	DC2		11-2-9	0001 0010	
19	13	LCR	TM	DC3		11-3-9	0001 0011	
20	14	NR	RES	DC4		11-4-9	0001 0100	
21	15	CLR	NL	NAK		11-5-9	0001 0101	
22	16	OR	BS	SYN		11-6-9	0001 0110	
23	17	XR	IL	ETB		11-7-9	0001 0111	
24	18	LR	CAN	CAN		11-8-9	0001 1000	
25	19	CR	EM	EM		11-1-8-9	0001 1001	
26	1A	AR	CC	SUB		11-2-8-9	0001 1010	
27	1B	SR	CU1	ESC		11-3-8-9	0001 1011	
28	1C	MR	IFS	FS		11-4-8-9	0001 1100	
29	1D	DR	IGS	GS		11-5-8-9	0001 1101	
30	1E	ALR	IRS	RS		11-6-8-9	0001 1110	
31	1F	SLR	IUS	US		11-7-8-9	0001 1111	
32	20	LPDR	DS	SP		11-0-1-8-9	0010 0000	
33	21	LNDR	SOS	!		0-1-9	0010 0001	
34	22	LTDR	FS	"		0-2-9	0010 0010	
35	23	LCDR	#	#		0-3-9	0010 0011	
36	24	HDR	BYP	\$		0-4-9	0010 0100	
37	25	LRDR	LF	%		0-5-9	0010 0101	
38	26	MXR	ETB	&		0-6-9	0010 0110	
39	27	MXDR	ESC	'		0-7-9	0010 0111	
40	28	LDR	(	(		0-8-9	0010 1000	
41	29	CDR	)	)		0-1-8-9	0010 1001	
42	2A	ADR	SM	*		0-2-8-9	0010 1010	
43	2B	SDR	CU2	+		0-3-8-9	0010 1011	
44	2C	MDR		-		0-4-8-9	0010 1100	
45	2D	DDR	ENQ	.		0-5-8-9	0010 1101	
46	2E	AWR	ACK	,		0-6-8-9	0010 1110	
47	2F	SWR	BEL	/		0-7-8-9	0010 1111	
48	30	LPER		0		12-11-0-1-8-9	0011 0000	
49	31	LNER		1		1-9	0011 0001	
50	32	LTER	SYN	2		2-9	0011 0010	
51	33	LCER		3		3-9	0011 0011	
52	34	HER	PN	4		4-9	0011 0100	
53	35	LRER	RS	5		5-9	0011 0101	
54	36	AXR	UC	6		6-9	0011 0110	
55	37	SXR	EOT	7		7-9	0011 0111	
56	38	LER		8		8-9	0011 1000	
57	39	CER		9		1-8-9	0011 1001	
58	3A	AER		:		2-8-9	0011 1010	
59	3B	SER	CU3	;		3-8-9	0011 1011	
60	3C	MER	DC4	<		4-8-9	0011 1100	
61	3D	DER	NAK	>		5-8-9	0011 1101	
62	3E	AUR		=		6-8-9	0011 1110	
63	3F	SUR	SUB	?		7-8-9	0011 1111	

- Two columns of EBCDIC graphics are shown. The first gives IBM standard U.S. bit pattern assignments. The second shows the T-11 and TN text printing chains (120 graphics).
- Add C (check bit) for odd or even parity as needed, except as noted.
- For even parity use CA.

TWO-CHARACTER BSC DATA LINK CONTROLS		
Function	EBCDIC	ASCII
ACK-0	DLE, X'70'	DLE, 0
ACK-1	DLE, X'61'	DLE, 1
WACK	DLE, X'6B'	DLE, ;
RVI	DLE, X'7C'	DLE, <

**CODE TRANSLATION TABLE (Contd)**

10

Dec.	Hex	Instruction (RX)	Graphics and Controls			7-Track Tape BCDIC(2)	Card Code EBCDIC	Binary
			BCDIC	EBCDIC(1)	ASCII			
64	40	STH	Sp	Sp	@	(3)	no punches	0100 0000
65	41	LA			A			12-0-1-9
66	42	STC			B			12-0-2-9
67	43	IC			C			12-0-3-9
68	44	EX			D			12-0-4-9
69	45	BAL			E			12-0-5-9
70	46	BCT			F			12-0-6-9
71	47	BC			G			12-0-7-9
72	48	LH			H			12-0-8-9
73	49	CH			I			12-1-8
74	4A	AH	†	†	J			12-2-8
75	4B	SH			K	B A 8 2 1		12-3-8
76	4C	MH	[	)	<	B A 8 4		12-4-8
77	4D		[	(	<	B A 8 4 1		12-5-8
78	4E	CVD	[	+	+	B A 8 4 2		12-6-8
79	4F	CVB	#			B A 8 4 2 1		12-7-8
80	50	ST	&+	&	&	B A	12	0101 0000
81	51				Q			12-11-1-9
82	52				R			12-11-2-9
83	53				S			12-11-3-9
84	54	N			T			12-11-4-9
85	55	CL			U			12-11-5-9
86	56	O			V			12-11-6-9
87	57	X			W			12-11-7-9
88	58	L			X			12-11-8-9
89	59	C			Y			11-1-8
90	5A	A		!	!			11-2-8
91	5B	S	\$	\$	\$	B 8 2 1		11-3-8
92	5C	M	*	*	*	B 8 4		11-4-8
93	5D	D	] )	] )	] )	B 8 4 1		11-5-8
94	5E	AL	:	:	:	B 8 4 2		11-6-8
95	5F	SL	Δ	—	—	B 8 4 2 1		11-7-8
96	60	STD	-	-	-	B	11	010 0000
97	61		/	/	/	A 1	0-1	010 0001
98	62				a		11-0-2-9	010 0010
99	63				b		11-0-3-9	010 0011
100	64				c		11-0-4-9	010 0100
101	65				d		11-0-5-9	010 0101
102	66				e		11-0-6-9	010 0110
103	67	MXD			f		11-0-7-9	010 0111
104	68	LD			g		11-0-8-9	010 1000
105	69	CD			h		0-1-8	010 1001
106	6A	AD			i		12-11	010 1010
107	6B	SD			j	A 8 2 1	0-3-8	010 1011
108	6C	MD	% (	%	%	A 8 4	0-4-8	010 1100
109	6D	DD	Y	-	-	A 8 4 1	0-5-8	010 1101
110	6E	AW	\	>	>	A 8 4 2	0-6-8	010 1110
111	6F	SW	#	?	?	A 8 4 2 1	0-7-8	010 1111
112	70	STE			p		12-11-0	0111 0000
113	71				q		12-11-0-1-9	0111 0001
114	72				r		12-11-0-2-9	0111 0010
115	73				s		12-11-0-3-9	0111 0011
116	74				t		12-11-0-4-9	0111 0100
117	75				u		12-11-0-5-9	0111 0101
118	76				v		12-11-0-6-9	0111 0110
119	77				w		12-11-0-7-9	0111 0111
120	78	LE			x		12-11-0-8-9	0111 1000
121	79	CE			y		1-8	0111 1001
122	7A	AE	†	:	:	A	2-8	0111 1010
123	7B	SE	#	#	#	8 2 1	3-8	0111 1011
124	7C	ME	@	@	@	8 4	4-8	0111 1100
125	7D	DE	:	'	'	8 4 1	5-8	0111 1101
126	7E	AU	>	=	=		6-8	0111 1110
127	7F	SU	✓	"	"	DEL	7-8	0111 1111

**CODE TRANSLATION TABLE (Contd)**

(11)

Dec.	Hex	Instruction and Format	Graphics and Controls BCDIC EBCDIC(1) ASCII	7-Track Tape BCDIC(2)	Card Code EBCDIC	Binary
128	80	SSM -S			12-0-1-8	1000 0000
129	81		a a		12-0-1	1000 0001
130	82	LPSW -S	b b		12-0-2	1000 0010
131	83	Diagnose	c c		12-0-3	1000 0011
132	84	WRD }SI	d d		12-0-4	1000 0100
133	85	RDD	e e		12-0-5	1000 0101
134	86	BXH	f f		12-0-6	1000 0110
135	87	BXLE	g g		12-0-7	1000 0111
136	88	SRL	h h		12-0-8	1000 1000
137	89	SLL	i i		12-0-9	1000 1001
138	8A	SRA			12-0-2-8	1000 1010
139	8B	SLA -RS	f		12-0-3-8	1000 1011
140	8C	SRDL	<		12-0-4-8	1000 1100
141	8D	SLDL	(		12-0-5-8	1000 1101
142	8E	SRDA	+		12-0-6-8	1000 1110
143	8F	SLDA	+		12-0-7-8	1000 1111
144	90	STM			12-11-1-8	1001 0000
145	91	TM }SI	j j		12-11-1	1001 0001
146	92	MVI	k k		12-11-2	1001 0010
147	93	TS -S	l l		12-11-3	1001 0011
148	94	NI }SI	m m		12-11-4	1001 0100
149	95	CLI	n n		12-11-5	1001 0101
150	96	OI	o o		12-11-6	1001 0110
151	97	XI	p p		12-11-7	1001 0111
152	98	LM -RS	q q		12-11-8	1001 1000
153	99		r r		12-11-9	1001 1001
154	9A				12-11-2-8	1001 1010
155	9B				12-11-3-8	1001 1011
156	9C	SIO, SIOF	□		12-11-4-8	1001 1100
157	9D	TIO, CLRIO	∩		12-11-5-8	1001 1101
158	9E	HIO, HDV	±		12-11-6-8	1001 1110
159	9F	TCH	■		12-11-7-8	1001 1111
160	A0				11-0-1-8	1010 0000
161	A1		~ o		11-0-1	1010 0001
162	A2		s s		11-0-2	1010 0010
163	A3		t t		11-0-3	1010 0011
164	A4		u u		11-0-4	1010 0100
165	A5		v v		11-0-5	1010 0101
166	A6		w w		11-0-6	1010 0110
167	A7		x x		11-0-7	1010 0111
168	A8		y y		11-0-8	1010 1000
169	A9		z z		11-0-9	1010 1001
170	AA				11-0-2-8	1010 1010
171	AB		∟		11-0-3-8	1010 1011
172	AC	STNSM }SI	∟		11-0-4-8	1010 1100
173	AD	STOSM	[		11-0-5-8	1010 1101
174	AE	SIGP -RS	≥		11-0-6-8	1010 1110
175	AF	MC -SI	●		11-0-7-8	1010 1111
176	B0		0		12-11-0-1-8	1011 0000
177	B1	LRA -RX	1		12-11-0-1	1011 0001
178	B2	See below	2		12-11-0-2	1011 0010
179	B3		3		12-11-0-3	1011 0011
180	B4		4		12-11-0-4	1011 0100
181	B5		5		12-11-0-5	1011 0101
182	B6	STCTL }RS	6		12-11-0-6	1011 0110
183	B7	LCTL	7		12-11-0-7	1011 0111
184	B8		8		12-11-0-8	1011 1000
185	B9		9		12-11-0-9	1011 1001
186	BA	CS }RS			12-11-0-2-8	1011 1010
187	BB	CDS	∩		12-11-0-3-8	1011 1011
188	BC		∩		12-11-0-4-8	1011 1100
189	BD	CLM }RS	]		12-11-0-5-8	1011 1101
190	BE	STCM	+		12-11-0-6-8	1011 1110
191	BF	ICM	-		12-11-0-7-8	1011 1111

Op code (S format)

B202 - STIDP    B207 - STCKC    B200 - PTLB  
 B203 - STIDC    B208 - SPT        B210 - SPX  
 B204 - SCK      B209 - STPT        B211 - STPX  
 B205 - STCK     B20A - SPKA        B212 - STAP  
 B206 - SCKC    B20B - IPK         B213 - RRB

**CODE TRANSLATION TABLE (Contd)**

(12)

Dec.	Hex	Instruction (SS)	Graphics and Controls BCDIC EBCDIC(1) ASCII	7-Track Tape BCDIC(2)	Card Code EBCDIC	Binary
192	C0		? {	B A 8 2	12-0	1100 0000
193	C1		A A A	B A 2	12-1	1100 0001
194	C2		B B B	B A 2	12-2	1100 0010
195	C3		C C C	B A 2 1	12-3	1100 0011
196	C4		D D D	B A 4	12-4	1100 0100
197	C5		E E E	B A 4 1	12-5	1100 0101
198	C6		F F F	B A 4 2	12-6	1100 0110
199	C7		G G G	B A 4 2 1	12-7	1100 0111
200	C8		H H H	B A 8	12-8	1100 1000
201	C9		I I I	B A 8 1	12-9	1100 1001
202	CA				12-0-2-8-9	1100 1010
203	CB				12-0-3-8-9	1100 1011
204	CC		J		12-0-4-8-9	1100 1100
205	CD				12-0-5-8-9	1100 1101
206	CE		Y		12-0-6-8-9	1100 1110
207	CF				12-0-7-8-9	1100 1111
208	D0		! }	B 8 2	11-0	1101 0000
209	D1	MVN	J J J	B 1	11-1	1101 0001
210	D2	MVC	K K K	B 2	11-2	1101 0010
211	D3	MVZ	L L L	B 2 1	11-3	1101 0011
212	D4	NC	M M M	B 4	11-4	1101 0100
213	D5	CLC	N N N	B 4 1	11-5	1101 0101
214	D6	OC	O O O	B 4 2	11-6	1101 0110
215	D7	XC	P P P	B A 4 2 1	11-7	1101 0111
216	D8		Q Q Q	B 8	11-8	1101 1000
217	D9		R R R	B 8 1	11-9	1101 1001
218	DA				12-11-2-8-9	1101 1010
219	DB				12-11-3-8-9	1101 1011
220	DC	TR			12-11-4-8-9	1101 1100
221	DD	TRT			12-11-5-8-9	1101 1101
222	DE	ED			12-11-6-8-9	1101 1110
223	DF	EDMK			12-11-7-8-9	1101 1111
224	E0		# \	A 8 2	0-2-8	1110 0000
225	E1				11-0-1-9	1110 0001
226	E2	S S S		A 2	0-2	1110 0010
227	E3	T T T		A 2 1	0-3	1110 0011
228	E4	U U U		A 4	0-4	1110 0100
229	E5	V V V		A 4 1	0-5	1110 0101
230	E6	W W W		A 4 2	0-6	1110 0110
231	E7	X X X		A 4 2 1	0-7	1110 0111
232	E8	Y Y Y		A 8	0-8	1110 1000
233	E9	Z Z Z		A 8 1	0-9	1110 1001
234	EA				11-0-2-8-9	1110 1010
235	EB				11-0-3-8-9	1110 1011
236	EC		∩		11-0-4-8-9	1110 1100
237	ED				11-0-5-8-9	1110 1101
238	EE				11-0-6-8-9	1110 1110
239	EF				11-0-7-8-9	1110 1111
240	F0	SRP	0 0 0	8 2	0	1111 0000
241	F1	MVO	1 1 1	1	1	1111 0001
242	F2	PACK	2 2 2	2	2	1111 0010
243	F3	UNPK	3 3 3	2 1	3	1111 0011
244	F4		4 4 4	4	4	1111 0100
245	F5		5 5 5	4 1	5	1111 0101
246	F6		6 6 6	4 2	6	1111 0110
247	F7		7 7 7	4 2 1	7	1111 0111
248	F8	ZAP	8 8 8	8	8	1111 1000
249	F9	CP	9 9 9	8 1	9	1111 1001
250	FA	AP				12-11-0-2-8-9
251	FB	SP				12-11-0-3-8-9
252	FC	MP				12-11-0-4-8-9
253	FD	DP				12-11-0-5-8-9
254	FE					12-11-0-6-8-9
255	FF		EO			12-11-0-7-8-9

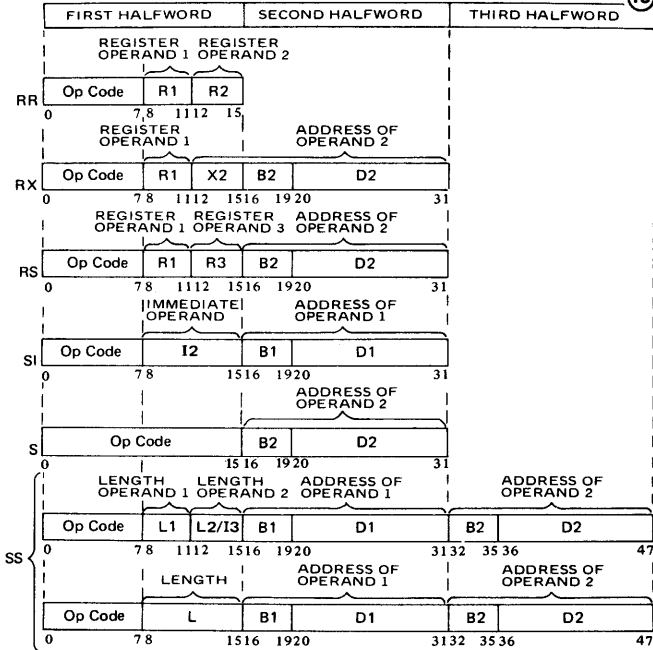
**ANSI-DEFINED PRINTER CONTROL CHARACTERS**

(A in RECFM field of DCB)

Code	Action before printing record
blank	Space 1 line
0	Space 2 lines
-	Space 3 lines
+	Suppress space
1	Skip to line 1 on new page

# MACHINE INSTRUCTION FORMATS

13

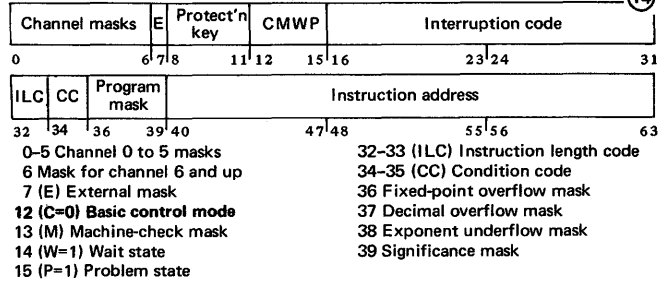


## CONTROL REGISTERS

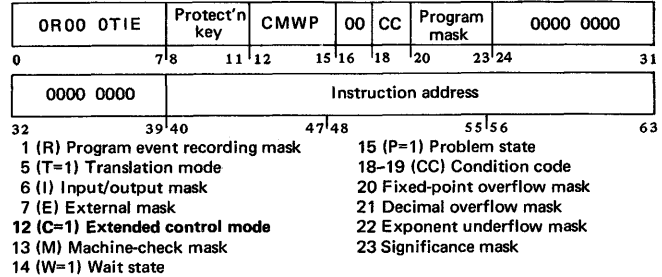
CR	Bits	Name of field	Associated with	Init.	
0	0	Block-multiplex'g control	Block-multiplex'g	0	
	1	SSM suppression control	SSM instruction	0	
	2	TOD clock sync control	Multiprocessing	0	
	8-9	Page size control	Dynamic addr. transl.	0	
	10	Unassigned (must be zero)		0	
	11-12	Segment size control		0	
	16	Malfunction alert mask		0	
	17-26	17	Emergency signal mask	Multiprocessing	0
		18	External call mask		0
		19	TOD clock sync check mask		0
		20	Clock comparator mask		Clock comparator
		21	CPU timer mask	CPU timer	0
24		Interval timer mask	Interval timer	1	
25		Interrupt key mask	Interrupt key	1	
26		External signal mask	External signal	1	
1		0-7	Segment table length	Dynamic addr. transl.	0
		8-25	Segment table address		0
2	0-31	Channel masks	Channels	1	
8	16-31	Monitor masks	Monitoring	0	
9	0	Successful branching event mask	Program-event record'g	0	
	1	Instruction fetching event mask		0	
	2	Storage alteration event mask		0	
	3	GR alteration event mask		0	
	16-31	PER general register masks		0	
10	8-31	PER starting address	Program-event record'g	0	
11	8-31	PER ending address	Program-event record'g	0	
14	0	Check-stop control	Machine-check handling	1	
	1	Synch. MCEL control		1	
	2	I/O extended logout control	I/O extended logout	0	
	4	Recovery report mask	Machine-check handling	0	
	5	Degradation report mask		0	
	6	Ext. damage report mask		1	
	7	Warning mask		0	
	8	Asynch. MCEL control		0	
	9	Asynch. fixed log control		0	
15	8-28	MCEL address		Machine-check handling	512

# PROGRAM STATUS WORD (BC Mode)

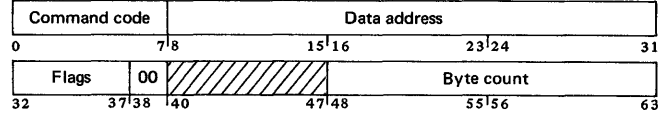
14



# PROGRAM STATUS WORD (EC Mode)

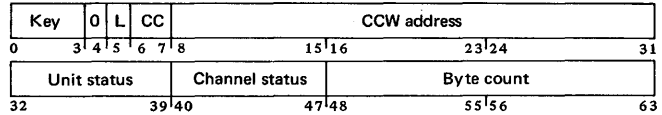


# CHANNEL COMMAND WORD



CD-bit 32 (80) causes use of address portion of next CCW.  
 CC-bit 33 (40) causes use of command code and data address of next CCW.  
 SLI-bit 34 (20) causes suppression of possible incorrect length indication.  
 Skip-bit 35 (10) suppresses transfer of information to main storage.  
 PCI-bit 36 (08) causes a channel program controlled interruption.  
 IDA-bit 37 (04) causes bits 8-31 of CCW to specify location of first IDAW.

# CHANNEL STATUS WORD (hex 40)



5 Logout pending	40 (80) Program-controlled interruption
6-7 Deferred condition code	41 (40) Incorrect length
32 (80) Attention	42 (20) Program check
33 (40) Status modifier	43 (10) Protection check
34 (20) Control unit end	44 (08) Channel data check
35 (10) Busy	45 (04) Channel control check
36 (08) Channel end	46 (02) Interface control check
37 (04) Device end	47 (01) Chaining check
38 (02) Unit check	48-63 Residual byte count for the last CCW used
39 (01) Unit exception	

# PROGRAM INTERRUPTION CODES

0001 Operation exception	000C Exponent overflow excp
0002 Privileged operation excp	000D Exponent underflow excp
0003 Execute exception	000E Significance exception
0004 Protection exception	000F Floating-point divide excp
0005 Addressing exception	0010 Segment translation excp
0006 Specification exception	0011 Page translation exception
0007 Data exception	0012 Translation specification excp
0008 Fixed-point overflow excp	0013 Special operation exception
0009 Fixed-point divide excp	0040 Monitor event
000A Decimal overflow exception	0080 Program event (code may be combined with another code)
000B Decimal divide exception	

## FIXED STORAGE LOCATIONS

15

Area, dec.	Hex addr	EC only	Function
0-7	0		Initial program loading PSW, restart new PSW
8-15	8		Initial program loading CCW1, restart old PSW
16-23	10		Initial program loading CCW2
24-31	18		External old PSW
32-39	20		Supervisor Call old PSW
40-47	28		Program old PSW
48-55	30		Machine-check old PSW
56-63	38		Input/output old PSW
64-71	40		Channel status word (see diagram)
72-75	48		Channel address word [0-3 key, 4-7 zeros, 8-31 CCW address]
80-83	50		Interval timer
88-95	58		External new PSW
96-103	60		Supervisor Call new PSW
104-111	68		Program new PSW
112-119	70		Machine-check new PSW
120-127	78		Input/output new PSW
132-133	84		CPU address assoc'd with external interruption, or unchanged
132-133	84	X	CPU address assoc'd with external interruption, or zeros
134-135	86	X	External interruption code
136-139	88	X	SVC interruption [0-12 zeros, 13-14 ILC, 15:0, 16-31 code]
140-143	8C	X	Program interrupt. [0-12 zeros, 13-14 ILC, 15:0, 16-31 code]
144-147	90	X	Translation exception address [0-7 zeros, 8-31 address]
148-149	94		Monitor class [0-7 zeros, 8-15 class number]
150-151	96	X	PER interruption code [0-3 code, 4-15 zeros]
152-155	98	X	PER address [0-7 zeros, 8-31 address]
156-159	9C		Monitor code [0-7 zeros, 8-31 monitor code]
168-171	A8		Channel ID [0-3 type, 4-15 model, 16-31 max. IOEL length]
172-175	AC		I/O extended logout address [0-7 unused, 8-31 address]
176-179	B0		Limited channel logout (see diagram)
185-187	B9	X	I/O address [0-7 zeros, 8-23 address]
216-223	D8		CPU timer save area
224-231	E0		Clock comparator save area
232-239	E8		Machine-check interruption code (see diagram)
248-251	F8		Failing processor storage address [0-7 zeros, 8-31 address]
252-255	FC		Region code*
256-351	100		Fixed logout area*
352-383	160		Floating-point register save area
384-447	180		General register save area
448-511	1C0		Control register save area
512 <sup>†</sup>	200		CPU extended logout area (size varies)

\*May vary among models; see system library manuals for specific model.  
<sup>†</sup> Location may be changed by programming (bits 8-28 of CR 15 specify address).

## LIMITED CHANNEL LOGOUT (hex B0)

0	SCU id	Detect	Source	000	Field validity flags	TT	00	A	Seq.						
0	1	3	4	7	8	12	13	15	16	23	24	26	28	29	31
4	CPU		12	Control unit	24-25	Type of termination				00	Interface disconnect				
5	Channel		16	Interface address			00				Interface disconnect				
6	Main storage control		17-18	Reserved (00)	01	Stop, stack or normal									
7	Main storage		19	Sequence code	10	Selective reset									
8	CPU		20	Unit status	11	System reset									
9	Channel		21	Cmd. addr. and key	28(A)	I/O error alert									
10	Main storage control		22	Channel address	29-31	Sequence code									
11	Main storage		23	Device address											

## MACHINE-CHECK INTERRUPTION CODE (hex E8)

MC conditions	000	00	Time	Stg. error	0	Validity indicators			
0	8	9	13	14	16	18	19	20	31
0000	0000	0000	00	Val.		MCEL length			
32	39	40	45	46	48	55	56	63	
0	System damage	14	Backed-up	24	Failing stg. address				
1	Instr. proc'g damage	15	Delayed	25	Region code				
2	System recovery	16	Uncorrected	27	Floating-pt registers				
3	Timer damage	17	Corrected	28	General registers				
4	Timing facil. damage	18	Key uncorrected	29	Control registers				
5	External damage	20	PSW bits 12-15	30	CPU ext'd logout				
6	Not assigned (0)	21	PSW masks and key	31	Storage logical				
7	Degradation	22	Prog. mask and CC	46	CPU timer				
8	Warning	23	Instruction address	47	Clock comparator				

## DYNAMIC ADDRESS TRANSLATION

16

### VIRTUAL (LOGICAL) ADDRESS FORMAT

Segment Size	Page Size	Bits	Segment Index	Page Index	Byte Index
64K	4K	[ Bits ] are	8 - 15	16 - 19	20 - 31
64K	2K		8 - 15	16 - 20	21 - 31
1M	4K	[ ignored ]	8 - 11	12 - 19	20 - 31
1M	2K		8 - 11	12 - 20	21 - 31

### SEGMENT TABLE ENTRY

PT length	0000*	Page table address	00*	I			
0	3	4	7	8	28	29	31

\*Normally zeros; ignored on some models.

31 (I) Segment-invalid bit.

### PAGE TABLE ENTRY (4K)

Page address	I	00	Page address	I	0				
0	11	12	13	15	0	12	13	14	15

12 (I) Page-invalid bit.

13 (I) Page-invalid bit.

## HEXADECIMAL AND DECIMAL CONVERSION

**From hex:** locate each hex digit in its corresponding column position and note the decimal equivalents. Add these to obtain the decimal value.

**From decimal:** (1) locate the largest decimal value in the table that will fit into the decimal number to be converted, and (2) note its hex equivalent and hex column position. (3) Find the decimal remainder. Repeat the process on this and subsequent remainders.

**Note:** Decimal, hexadecimal, (and binary) equivalents of all numbers from 0 to 255 are listed on panels 9 - 12.

HEXADECIMAL COLUMNS					
6	5	4	3	2	1
HEX = DEC	HEX = DEC	HEX = DEC	HEX = DEC	HEX = DEC	HEX = DEC
0	0	0	0	0	0
1	1,048,576	1	65,536	1	4,096
2	2,097,152	2	131,072	2	8,192
3	3,145,728	3	196,608	3	12,288
4	4,194,304	4	262,144	4	16,384
5	5,242,880	5	327,680	5	20,480
6	6,291,456	6	393,216	6	24,576
7	7,340,032	7	458,752	7	28,672
8	8,388,608	8	524,288	8	32,768
9	9,437,184	9	589,824	9	36,864
A	10,485,760	A	655,360	A	40,960
B	11,534,336	B	720,896	B	45,056
C	12,582,912	C	786,432	C	49,152
D	13,631,488	D	851,968	D	53,248
E	14,680,064	E	917,504	E	57,344
F	15,728,640	F	983,040	F	61,440
0 1 2 3	4 5 6 7	0 1 2 3	4 5 6 7	0 1 2 3	4 5 6 7
BYTE		BYTE		BYTE	

### POWERS OF 2

2 <sup>n</sup>	n
256	8
512	9
1 024	10
2 048	11
4 096	12
8 192	13
16 384	14
32 768	15
65 536	16
131 072	17
262 144	18
524 288	19
1 048 576	20
2 097 152	21
4 194 304	22
8 388 608	23
16 777 216	24

### POWERS OF 16

16 <sup>n</sup>	n
	1
	0
	16
	1
	256
	2
	4 096
	3
	65 536
	4
	1 048 576
	5
	16 777 216
	6
	268 435 456
	7
	4 294 967 296
	8
	68 719 476 736
	9
	1 099 511 627 776
	10
	17 592 186 044 416
	11
	281 474 976 710 656
	12
	4 503 599 627 370 496
	13
	72 057 594 037 927 936
	14
	1 152 921 504 606 846 976
	15