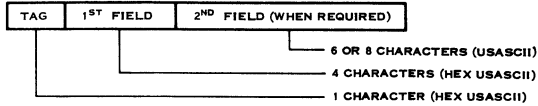


OBJECT RECORD FORMAT AND CODE



TAG	1ST FIELD	2ND FIELD	MEANING
0	LENGTH OF ALL RELOCATABLE CODE	PROGRAM ID (8-CHARACTER)	PROGRAM START
1	ADDRESS	(NOT USED)	ABSOLUTE ENTRY ADDRESS
2	ADDRESS	(NOT USED)	RELOCATABLE ENTRY ADDRESS
3	LOCATION OF LAST APPEARANCE OF SYMBOL	6 CHARACTER SYMBOL	EXTERNAL REFERENCE LAST USED IN RELOCATABLE CODE
4	LOCATION OF LAST APPEARANCE OF SYMBOL	6 CHARACTER SYMBOL	EXTERNAL REFERENCE LAST USED IN ABSOLUTE CODE
5	LOCATION	6 CHARACTER SYMBOL	RELOCATABLE EXTERNAL DEFINITION
6	LOCATION	6 CHARACTER SYMBOL	ABSOLUTE EXTERNAL DEFINITION
7	CHECKSUM FOR CURRENT RECORD	(NOT USED)	CHECKSUM
8	ANY VALUE	(NOT USED)	IGNORE CHECKSUM VALUE
9	LOAD ADDRESS	(NOT USED)	ABSOLUTE LOAD ADDRESS
A	LOAD ADDRESS	(NOT USED)	RELOCATABLE LOAD ADDRESS
B	DATA	(NOT USED)	ABSOLUTE DATA
C	DATA	(NOT USED)	RELOCATABLE DATA
D	LOAD BIAS	(NOT USED)	LOAD BIAS OR OFFSET (NOT A PART OF ASSEMBLER OUTPUT)
F	(NOT USED)	(NOT USED)	END OF RECORD
G	LOCATION	6 CHARACTER SYMBOL	RELOCATABLE SYMBOL DEFINITION
H	LOCATION	6 CHARACTER SYMBOL	ABSOLUTE SYMBOL DEFINITION

990 PSEUDO - INSTRUCTIONS

MNEMONIC	PSEUDO - INSTRUCTIONS	CODE GENERATED
NOP	NO OPERATION	1000
RT	RETURN	045B
XVEC	TRANSFER VECTOR	NOTE 1

NOTE 1. SDSMAC ONLY. SUPPLIES DATA, DATA, WPNT

ASSEMBLER ERROR CODES

- | | |
|--------------------------------|--|
| 1 - UNDEFINED SYMBOL | 6 - UNRECOGNIZABLE OPERATOR |
| 2 - SYNTAX ERROR | 7 - ILLEGAL FORWARD REFERENCE |
| 3 - ILLEGAL EXTERNAL REFERENCE | 8 - ILLEGAL TERM |
| 4 - TRUNCATION ERROR | 9 - ILLEGAL REGISTER NAME |
| 5 - MULTIPLY DEFINED SYMBOL | 10 - SYMBOLIC REFERENCE WITHIN WORKSPACE |


CRU SELECT ADDRESSES

TO SELECT CRU UNIT	W12 MUST CONTAIN	TO SELECT CRU UNIT	W12 MUST CONTAIN
0	0	16	200
1	20	17	220
2	40	18	240
3	60	19	260
4	80	20	280
5	A0	21	2A0
6	C0	22	2C0
7	E0	23	2E0
8	100		
9	120		
10	140		
11	160		
12	180		
13	1A0		
14	1C0		
15	1E0		

**MODEL
990 COMPUTER
PROGRAMMING CARD
943440-9701**

© TEXAS INSTRUMENTS
INCORPORATED 1975

1 NOVEMBER 1975

 **TEXAS INSTRUMENTS**
INCORPORATED
P.O. BOX 2909
AUSTIN, TEXAS 78767
512/258-5121

MEMORY MAPPING

MAP FILE

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
L1	1	1	1	0	1	1	1	1	0	0	0	X	X	X	X	X
B1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
L2	0	1	0	1	1	1	1	1	0	0	0	X	X	X	X	X
B2	0	0	0	1	1	0	0	1	0	0	0	1	1	1	1	1
L3	0	0	0	0	1	0	0	0	0	0	0	X	X	X	X	X
B3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0

COMPARISON RESULT

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

GREATER THAN

PROCESSOR ADDRESS

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
PROCESSOR ADDRESS	0	0	0	1	0	0	0	1	1	1	1	1	1	1	1	1
B2	0	0	0	1	1	0	0	1	0	0	0	1	1	1	1	1
+	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
=	0	0	0	1	1	0	0	1	0	0	0	1	1	1	1	1
MEMORY ADDRESS	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
MEMORY ADDRESS	0	0	0	1	1	0	0	1	1	1	1	1	1	1	1	1

MACRO LANGUAGE

STATEMENT	SYNTAX
Macro	<macro name>b...\$MACROb...{<parm>}...b...{<comment>}
Variable	b...\$VARb...<var>{<var>}...b...{<comment>}
Assign	b...\$ASGb... {<expression>} b TO b <var>b...{<comment>}
Name	<label> b...\$NAMEb...{<comment>}
Go to	b...\$GOTO b...<label>b...{<comment>}
Exit	b...\$EXITb...{<comment>}
Call	b...\$CALLb...<macro name>b...{<comment>}
If	b...\$IF b...<expression>b...{<comment>}
Else	b...\$ELSE b...{<comment>}
End if	b...\$ENDIF b...{<comment>}
End	<label>b...\$ENDb...<macro name>b...{<comment>}

USASCII / HOLLERITH CHARACTER CODES

CHAR.	USASCII (HEXADECIMAL)	HOLLERITH*	CHAR.	USASCII (HEXADECIMAL)	HOLLERITH*
NUL	00		3	33	3
SOH	01		4	34	4
STX	02		5	35	5
ETX	03		6	36	6
ENQ	05		7	37	7
ACK	06		8	38	8
BEL	07		9	39	9
BS	08		A	3A	2-8
HT	09		B	3B	11-6-8
LF	0A		C	3C	12-4-8
VT	0B		D	3D	6-8
FF	0C		E	3E	0-6-8
CR	0D		F	3F	0-7-8
SO	0E	A/a	40		4-8
SI	0F	B/b	41/61		12-1
DLE	10	C/c	42/62		12-2
DC1	11	D/d	43/63		12-3
DC2	12	E/e	44/64		12-4
DC3	13	F/f	45/65		12-5
DC4	14	G/g	46/66		12-6
NAK	15	H/h	47/67		12-7
SYN	16	I/i	48/68		12-8
ETB	17	J/j	49/69		12-9
CAN	18	K/k	4A/6A		11-1
EM	19	L/l	4B/6B		11-2
SUB	1A	M/m	4C/6C		11-3
ESC	1B	N/n	4D/6D		11-4
FS	1C	O/o	4E/6E		11-5
GS	1D	P/p	4F/6F		11-6
RS	1E	Q/q	50/70		11-7
US	1F	R/r	51/71		11-8
SPACE	20	S/s	52/72		11-9
!	21	T/t	53/73		0-2
"	22	U/u	54/74		0-3
#	23	V/v	55/75		0-4
\$	24	W/w	56/76		0-5
%	25	X/x	57/77		0-6
&	26	Y/y	58/78		0-7
'	27	Z/z	59/79		0-8
(28	BLANK	5A/7A		0-9
)	29	11-2-8	5B		12-2-8
*	2A	11-5-8	5C		-
+	2B	11-4-8	5D		12-7-8
,	2C	12-6-8	5E		11-7-8
-	2D	0-3-8	5F		0-5-8
.	2E	11	60		-
/	2F	12-3-8	61		-
0	30	0-1	62		-
1	31	0	63		-
2	32	2	64		-
			65		-
			66		-
			67		-
			68		-
			69		-
			70		-
			71		-
			72		-
			73		-
			74		-
			75		-
			76		-
			77		-
			78		-
			79		-
			80		-
			81		-
			82		-
			83		-
			84		-
			85		-
			86		-
			87		-
			88		-
			89		-
			90		-
			91		-
			92		-
			93		-
			94		-
			95		-
			96		-
			97		-
			98		-
			99		-
			DEL		-

* - PUNCH IN CARD ROWS

990 ASSEMBLER DIRECTIVES

MNEMONIC	DIRECTIVE	APPLICABILITY
AORG	ABSOLUTE ORIGIN	ALL
BES	BLOCK ENDING WITH SYMBOL	ALL
BSS	BLOCK STARTING WITH SYMBOL	ALL
BYTE	INITIALIZE BYTE	ALL
DATA	INITIALIZE WORD	ALL
DEF	EXTERNAL DEFINITION	ALL
DXOP	DEFINE EXTENDED OPERATION	ALL
END	PROGRAM END	ALL
EQU	DEFINE ASSEMBLY-TIME CONSTANT	ALL
EVEN	WORD BOUNDARY	ALL
IDT	PROGRAM IDENTIFIER	ALL
LIST	LIST SOURCE	ALL
PAGE	PAGE EJECT	ALL
REF	EXTERNAL REFERENCE	ALL
RORG	RELOCATABLE ORIGIN	ALL
TEXT	INITIALIZE TEXT	ALL
TITL	PAGE TITLE	ALL
UNL	NO SOURCE LIST	ALL
OPTION	OUTPUT OPTION	CROSS, SDSMAC
DORG	DUMMY ORIGIN	ALL
COPY	COPY SOURCE FILE	SDSMAC
WPNT	WORKSPACE POINTER	SDSMAC
DFOP	DEFINE OPERATION	SDSMAC

INSTRUCTION FORMATS

FORMAT (USE)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1 (ARITH)	OP CODE		B	T _D		D				T _S		S				
2 (JUMP)	OP CODE		SIGNED DISPLACEMENT													
3 (LOGICAL)	OP CODE		D				T _S		S							
4 (MPY, DIV, XOP)	OP CODE		C				T _S		S							
5 (SHIFT)	OP CODE		C				T _S		W							
6 (PROGRAM)	OP CODE		T _S				S									
7 (CONTROL)	OP CODE		NOT USED				NOT USED									
8 (IMMEDIATE)	OP CODE		IMMEDIATE VALUE				NOT USED		W							
WORD 1 (OPTIONAL)	OP CODE		IMMEDIATE VALUE				M		W							
10 (MEMORY MAP FILE OPTION)	OP CODE		IMMEDIATE VALUE				M		W							

KEY

- B = BYTE INDICATOR (1 = BYTE, 0 = WORD)
- D = D ADDR. MODIFICATION
- T_D = D ADDR. MODIFICATION
- S = SOURCE ADDR
- C = XFR OR SHIFT LENGTH (COUNT)
- W = WORKSPACE REGISTER NO.
- M = MAP CODE

T_D/T_S FIELD

CODE	EFFECTIVE ADDRESS
00: DIRECT	WP + 2 * (S OR D)
01: INDIRECT	(WP + 2 * (S OR D))
10: INDEXED	(WP + 2 * (S OR D)) + ((PC)); (PC) - (PC) + 2
11: INDIRECT WITH AUTO INCREMENT	(WP + 2 * (S OR D)); INCREMENT EFF. ADDR

STATUS REGISTER

0	1	2	3	4	5	6	7	11	12	15
L	A	=	C	O	P	X	PR	MP	RESERVED	INTERRUPT MASK

- 0 - LOGICAL GREATER THAN
- 1 - ARITHMETIC GREATER THAN
- 2 - EQUAL/TB INDICATOR
- 3 - CARRY FROM MSB
- 4 - OVERFLOW
- 5 - PARITY (ODD NO. OF BITS SET)
- 6 - XOP IN PROGRESS
- 7 - PRIVILEGED MODE (0=PRIVILEGED)-MODEL 990/10
- 8 - MAP FILE - MODEL 990/10 WITH NAP OPTION
- INTERRUPT MASK
- F = ALL INTERRUPTS ENABLED
- 0 = ONLY LEVEL 0 ENABLED

INTERRUPTS

LEVEL	ID	TRAP ADDR	LEVEL	ID	TRAP ADDR
0	PWR ON	0000	8	EXT	0020
1	PWR FAILING	0004	9	EXT	0024
2	ERROR	0008	10	EXT	0028
3	EXTERNAL	000C	11	EXT	002C
4	EXT	0010	12	EXT	0030
5	REAL TIME CLK	0014	13	EXT	0034
6	EXT	0018	14	EXT	0038
7	EXT	001C	15	EXT	003C

NOTE: XOP VECTORS 0 - 15 OCCUPY MEMORY LOCATIONS 0040 - 007C. RESTART VECTOR OCCUPIES MEMORY LOCATIONS FFFC, FFFE.

990 CPU INSTRUCTIONS

MNEMONIC	OP CODE	FORMAT	STATUS AFFECTED	INSTRUCTION
A	A000	1	0-4	ADD (WORD)
AB	B000	1	0-5	ADD (BYTE)
ABS	0740	6	0-2	ABSOLUTE VALUE
AI	0220	8	0-4	ADD IMMEDIATE
ANDI	0240	8	0-2	AND IMMEDIATE
B	0440	6	-	BRANCH
BL	0680	6	-	BRANCH AND LINK (W11)
BLWP	0400	6	-	BRANCH; LOAD WORKSPACE POINTER
C	8000	1	0-2	COMPARE (WORD)
CB	9000	1	0-2,5	COMPARE (BYTE)
CJ	0280	8	0-2	COMPARE IMMEDIATE
CKOF	03C0	7	-	CLOCK OFF (NOTE 1,3)
CKON	03A0	7	-	CLOCK ON (NOTE 1,3)
CLR	04C0	6	-	CLEAR OPERAND
COC	2000	3	2	COMPARE ONES CORRESPONDING
CZC	2400	3	2	COMPARE ZEROES CORRESPONDING
DEC	0600	6	0-4	DECREMENT (BY ONE)
DECT	0640	6	0-4	DECREMENT (BY TWO)
DIV	3C00	9	4	DIVIDE
IDLE	0340	7	-	COMPUTER IDLE (NOTE 1,3)
INC	0580	6	0-4	INCREMENT (BY ONE)
INCT	05C0	6	0-4	INCREMENT (BY TWO)
INV	0540	6	0-2	INVERT
JEQ	1300	2	-	JUMP EQUAL (ST2=1)
JGT	1500	2	-	JUMP GREATER THAN (ST1=1)
JH	1B00	2	-	JUMP HIGH (ST0=1 AND ST2=0)
JHE	1400	2	-	JUMP HIGH OR EQUAL (ST0 OR ST2=1)
JL	1A00	2	-	JUMP LOW (ST0 AND ST2=0)
JLE	1200	2	-	JUMP LOW OR EQUAL (ST0 = 0 OR ST2 = 1)
JLT	1100	2	-	JUMP LESS THAN (ST1 AND ST2=0)
JMP	1000	2	-	JUMP UNCONDITIONAL
JNC	1700	2	-	JUMP NO CARRY (ST3 = 0)
JNE	1600	2	-	JUMP NOT EQUAL (ST2 = 0)
JNO	1900	2	-	JUMP NO OVERFLOW (ST4 = 0)
JOC	1800	2	-	JUMP ON CARRY (ST3 = 1)
JOP	1C00	2	-	JUMP ODD PARITY (ST5 = 1)
LDGR	3000	4	0-2,5	LOAD CRU
LDD	07C0	6	-	LONG DISTANCE DESTINATION (NOTE 1,2)
LDS	0780	6	-	LONG DISTANCE SOURCE (NOTE 1,2)
LI	0200	8	-	LOAD IMMEDIATE
LIMI	0300	8	12-15	LOAD INTERRUPT MASK IMMEDIATE (NOTE 1)
LMP	0320	10	-	LOAD MAP FILE (NOTE 1,2)
LREX	03E0	7	12-15	LOAD ROM AND EXECUTE (NOTE 1,3)
LWPI	02E0	8	-	LOAD IMMEDIATE TO WORKSPACE POINTER
MOV	C000	1	0-2	MOVE (WORD)
MOVB	D000	1	0-2,5	MOVE (BYTE)
MPY	3800	9	-	MULTIPLY
NEG	0500	6	0-2	NEGATE (TWO'S COMPLEMENT)
ORI	0260	8	0-2	OR IMMEDIATE
RSET	0360	7	12-15	RESET AU (NOTE 1,3)
RTWP	0380	7	0-15	RETURN FROM INT. SUBR. (NOTE 1)
S	6000	1	0-4	SUBTRACT (WORD)
SB	7000	1	0-5	SUBTRACT (BYTE)
SBO	1D00	2	-	SET CRU BIT TO ONE
SBZ	1E00	2	-	SET CRU BIT TO ZERO
SETO	0700	6	-	SET ONES
SLA	0A00	5	0-4	SHIFT LEFT ARITHMETIC
SOC	E000	1	0-2	SET ONES CORRESPONDING (WORD)
SOCB	F000	1	0-2,5	SET ONES CORRESPONDING (BYTE)
SRA	0800	5	0-3	SHIFT RIGHT (MSB EXTENDED)
SRC	0B00	5	0-3	SHIFT RIGHT CIRCULAR
SRL	0900	5	0-3	SHIFT RIGHT LOGICAL
STCR	3400	4	0-2,5	STORE FROM CRU
STST	02C0	8	-	STORE STATUS REGISTER
STWP	02A0	8	-	STORE WORKSPACE POINTER
SWPB	06C0	6	-	SWAP BYTES
SZC	4000	1	0-2	SET ZEROES CORRESPONDING (WORD)
SZCB	5000	1	0-2,5	SET ZEROES CORRESPONDING (BYTE)
TB	1F00	2	2	TEST CRU BIT
X	0480	6	-	EXECUTE
XOP	2C00	9	6	EXTENDED OPERATION
XOR	2800	3	0-2	EXCLUSIVE OR

NOTES

1. PRIVILEGED INSTRUCTIONS - MODEL 990/10
2. MODEL 990/10 WITH MAP ONLY
3. NOT IMPLEMENTED IN TMS9900

BLWP TRANSFERS

- (WP) → NEW (W13)
- (PC) → NEW (W14)
- (ST) → NEW (W15)

RTWP TRANSFERS

- (CURRENT W13) → (WP)
- (CURRENT W14) → (PC)
- (CURRENT W15) → (ST)

BL TRANSFER

- (PC) → (W11)

XOP TRANSFER

- EFF. ADDR. → NEW (W11)
- (WP) → NEW (W13)
- (PC) → NEW (W14)
- (ST) → NEW (W15)
- 1 → ST6

INSTRUCTIONS IN ORDER BY OP CODE

OP CODE	MNEMONIC	FORMAT	STATUS AFFECTED
0200	LI	8	-
0220	AI	8	0-4
0240	ANDI	8	0-2
0260	ORI	8	0-2
0280	CI	8	0-2
02A0	STWP	8	-
02C0	STST	8	-
02E0	LWPI	8	-
0300 (NOTE 1)	LIMI	8	12-15
0320 (NOTE 1,2)	LMF	10	-
0340 (NOTE 1,3)	IDLE	7	-
0360 (NOTE 1,3)	RSET	7	12-15
0380 (NOTE 1)	RTWP	7	0-15
03A0 (NOTE 1,3)	CKON	7	-
03C0 (NOTE 1,3)	CKOF	7	-
03E0 (NOTE 1,3)	LREX	7	-
0400	BLWP	6	-
0440	B	6	-
0480	X	6	-
04C0	CLR	6	-
0500	NEG	6	0-2
0540	INV	6	0-2
0580	INC	6	0-4
05C0	INCT	6	0-4
0600	DEC	6	0-4
0640	DECT	6	0-4
0680	BL	6	-
06C0	SWPB	6	-
0700	SETO	6	-
0740	ABS	6	0-2
0780 (NOTE 1,2)	LDS	6	-
07C0 (NOTE 1,2)	LDD	6	-
0800	SRA	5	0-3
0900	SRL	5	0-3
0A00	SLA	5	0-4
0B00	SRC	5	0-3
1000	JMP	2	-
1100	JLT	2	-
1200	JLE	2	-
1300	JEQ	2	-
1400	JHE	2	-
1500	JGT	2	-
1600	JNE	2	-
1700	JNC	2	-
1800	JOC	2	-
1900	JNO	2	-
1A00	JL	2	-
1B00	JH	2	-
1C00	JOP	2	-
1D00	SBO	2	-
1E00	SBZ	2	-
1F00	TB	2	-
2000	COC	3	2
2400	CZC	3	2
2800	XOR	3	0-2
2C00	XOP	9	6
3000	LDCR	4	0-2,5
3400	STCR	4	0-2,5
3800	MPY	9	-
3C00	DIV	9	-
4000	SZC	1	0-2
5000	SZCB	1	0-2,5
6000	S	1	0-4
7000	SB	1	0-5
8000	C	1	0-2
9000	CB	1	0-2,5
A000	A	1	0-4
B000	AB	1	0-5
C000	MOV	1	0-2
D000	MOVB	1	0-2,5
E000	SOC	1	0-2
F000	SOCB	1	0-2,5

ILLEGAL INSTRUCTIONS

MODEL 990/10 ONLY

INSTRUCTIONS

0000 - 01FF	*0320 - 033F
0210 - 021F	0341 - 035F
0230 - 023F	0361 - 037F
0250 - 025F	0381 - 039F
0290 - 029F	03A1 - 03BF
02B0 - 02BF	03C1 - 03DF
02D0 - 02DF	03E1 - 03FF
02E1 - 02FF	*0780 - 07FF
0301 - 031F	0C00 - 0FFF

*NOT ILLEGAL WITH MAP OPTION.

WORKSPACE MAP

	SHIFT COUNT	
		W 0
		W 1
		W 2
		W 3
		W 4
		W 5
		W 6
		W 7
		W 8
		W 9
		W 10
EFFECTIVE ADDRESS (XOP)		W 11
PC CONTENTS (BL)		W 11
CRU BASE ADDRESS		W 12
WP REGISTER CONTENTS		W 13
PC CONTENTS		W 14
ST REGISTER CONTENTS		W 15