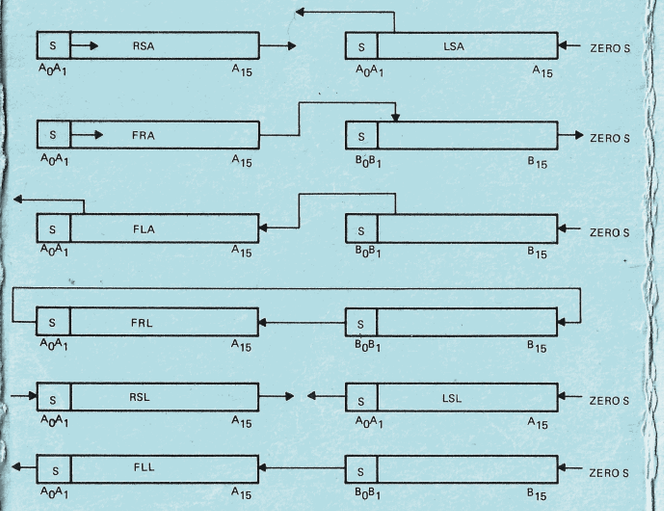
March 1, 1969

SEL 810
PROGRAMMER'S REFERENCE CARD
(810A/810B)

SHIFT INSTRUCTIONS

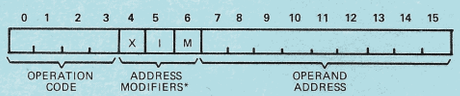


OCTAL UNIT NUMBERS (CEU FIRST WORD)

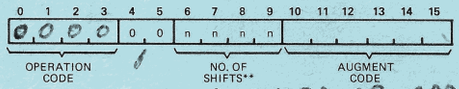
1	ASR-33
2	PAPER TAPE READER AND PUNCH
3	CARD PUNCH
4	CARD READER
5	LINE PRINTER
6	TCU 1
7	ADDITIONAL TCU 2
10	1ST OPTIONAL TYPEWRITER
11	1ST OPTIONAL X-Y PLOTTER
12	1ST OPTIONAL INTERVAL TIMER
13	MOVABLE HEAD DISC CONTROL UNIT
14	CRT
15	FIXED HEAD DISC

INSTRUCTION AND DATA WORD FORMATS

A. MEMORY REFERENCE INSTRUCTIONS

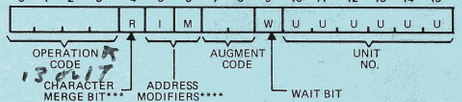


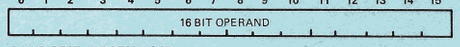
B. AUGMENTED INSTRUCTIONS DO NOT USE MEMORY



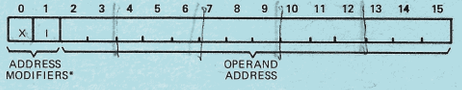
IMMED OR ADD MODE

C. INPUT/OUTPUT INSTRUCTION

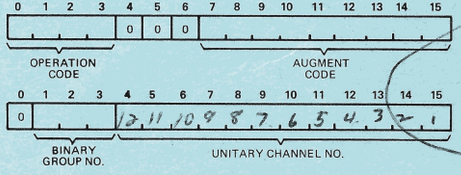




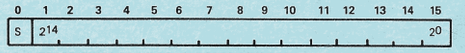
D. INDIRECT ADDRESS WORD



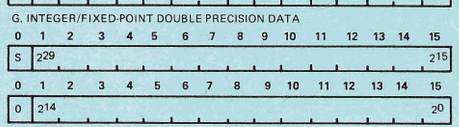
E. PIE AND PID INSTRUCTIONS



F. INTEGER/FIXED-POINT SINGLE PRECISION DATA



G. INTEGER/FIXED-POINT DOUBLE PRECISION DATA



*X = INDEX BIT
I = INDIRECT BIT
M = MAP BIT

**IF INSTRUCTION IS NOT A SHIFT, BITS 6-9 ARE USED FOR OTHER FUNCTIONS IN SOME INSTRUCTIONS

***AIP ONLY

****PRESENT IN CEU, TEU, MIP and MOP ONLY

Systems Engineering Laboratories

CEU SECOND WORD FORMAT

BIT	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	MAGNETIC TAPE FORMAT	P.I. CONNECT 1 / CONNECT 2	MEMORY TRANSFER PARITY INTERRUPT	END OF RECORD INTERRUPT	0	1	0	0	0	0	0	0	1	0	0	CHARACTERS PER WORD**
	MAGNETIC TAPE 1	BTC OVERFLOW	MEMORY TRANSFER PARITY OVERLATCH	END OF RECORD INTERRUPT	READER MODE	WRITE RECORD	WRITE END OF FILE	ERASE ZONE BLANKS OF TAPE	ECHO + 1 BINARY**	READ RECORD	BACKSPACE RECORD	DIRECT **	CURRENT WORD ADDRESS IN	CURRENT WORD ADDRESS OUT	REVERSE TAPE	CHARACTERS PER WORD**
	ASR-33 TTY		IN	OUT	PUNCH POWER ON	KEY MODE	CLEAR	READER ENABLE	ECHO	READER ENABLE	BACKSPACE FILE	ADVANCE RECORD		0	FORWARD TAPE	
	PAPER TAPE READER AND PUNCH		IN	OUT	PUNCH POWER OFF	PUNCH POWER ON	READ STACKER OFFSET	FEED CARD (PRIME)	PUNCH STACKER OFFSET	EJECT CARD (PRIME)					WRITE	
	CARD READER/PUNCH	BTC OVERFLOW	IN	OUT	FEED CARD	PEN DOWN	RAISE DOWN	FEED CARD	CARRIAGE LEFT	CARRIAGE RIGHT						
	X-Y PLOTTER		PROCESS COMPLETE		PEN DOWN	ADVANCE 1 FORMAT CHANNEL	TOP OF FORM	PRINT	CLEAR BUFFER	FILL BUFFER						
	LINE PRINTER		END OF TRANSFER	BUFFER PARITY BIT	ADVANCE 1 LINE				OR FORMAT N° (IF BIT 4							
	MOVABLE HEAD DISC DATA		SEEK ERROR	SEEK COMPLETE					NUMBER OF TRACKS TO BE MOVED		1				REVERSE TAPE	
	MOVABLE HEAD DISC DATA		SEEK ERROR	SEEK COMPLETE						HEAD NUMBER	0				WRITE	
	FIXED HEAD DISC SELECT TRACK		CHECKSUM ERROR OR PARITY ERROR	READ OVERFLOW OR PROGRAM ERROR											READ	
	FIXED HEAD DISC READ		CHECKSUM ERROR OR PARITY ERROR	READ OVERFLOW OR WRITE PROTECT												
	FIXED HEAD DISC WRITE		CHECKSUM ERROR OR PARITY ERROR	READ OVERFLOW OR WRITE OVERFLOW												
	CRT		OVERFLOW	STOP												

*INTERRUPT LEVELS:
BIT 2 = GROUP 1; LEVEL 1
BIT 3 = GROUP 1; LEVEL 2

**MAGNETIC TAPE DENSITY:

BITS 8	9	DENSITY
0	0	200 BPI
0	1	556 BPI
1	0	800 BPI

BITS 14	15	CHARACTERS PER WORD
0	1	1
1	0	2
1	1	3
0	0	4

***WHEN A ONE IS PRESENT IN BIT POSITION 4, ADVANCE TO THE FORMAT TAPE CHANNEL NUMBER (EXPRESSED IN OCTAL) REPRESENTED BY THE BITS PRESENT IN POSITIONS 7,8 AND 9.

****TO SEEK TRACK 00 BOTH BITS MUST BE ZERO.

TEU SECOND WORD FORMAT

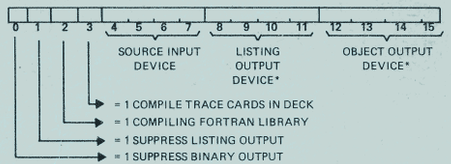
BIT	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	CARD READER PUNCH								SKIP ON PARITY ERROR		SKIP IF NO OVERFLOW	SKIP IF NO PARITY ERROR				
	MOVABLE HEAD DISC				SKIP IF NO DISC ERROR	SKIP IF NO DISC ERROR	SKIP ON BEGINNING OF DISC		SKIP IF NO OVERFLOW	SKIP IF NO DISC ERROR	SKIP IF NO DISC OVERFLOW	SKIP IF NO DISC ERROR	SKIP IF DISC READY			
	FIXED HEAD DISC		SKIP ON NO PROGRAM ERROR	SKIP ON NO OVERFLOW	SKIP ON NO DISC ERROR	SKIP ON FILE AREA PROTECTED	SKIP ON DISC CONTROLLER NOT BUSY		SKIP ON NO OVERFLOW	SKIP ON NO DISC ERROR	SKIP ON NO DISC OVERFLOW	SKIP ON NO DISC ERROR				
	MAGNETIC TAPE		SKIP ON NOT BUSY	SKIP ON NO END OF FILE	SKIP ON NO OVERFLOW	SKIP ON NO TAPE ERROR	SKIP ON END OF TAPE	SKIP ON NO TAPE ERROR	SKIP ON NO OVERFLOW	SKIP ON NO TAPE ERROR	SKIP ON NO OVERFLOW	SKIP ON NO TAPE ERROR	SKIP ON NOT AT TRACK ONE			
	LINE PRINTER				SKIP ON NO PROGRAM ERROR	SKIP ON NO OVERFLOW	SKIP ON BOTTOM OF FORM		SKIP ON NO OVERFLOW	SKIP IF PRINTER OPERABLE						
	INTERVAL TIMER				SKIP ON NOT BUSY	SKIP ON NO OVERFLOW	SKIP ON LOAD POINT		SKIP ON NO OVERFLOW	SKIP ON NO OVERFLOW	SKIP ON NO OVERFLOW	SKIP IF NOT BUSY	DISABLE ZERO INTERRUPT			

STANDARD SOFTWARE SWITCH SETTINGS

ASSEMBLER:	SS0	SET
	1	SET - NO LISTING; RESET - LISTING OUTPUT
	2	SET - NO OBJECT; RESET - OBJECT OUTPUT
	3 *	SET - ERROR LIST ONLY
	4	SET - LIST ON ASR; RESET - LIST ON LINE PRINTER
	5	SET - PAPER TAPE SOURCE; RESET - CARD SOURCE
	6	SET - OBJECT ON ASR; RESET - OBJECT ON H.S. PAPER TAPE
	7	SET - LIST SYMBOL TABLE
	8	SET - SOURCE ON ASR (READER); RESET - SOURCE ON H.S. PAPER TAPE
	9	SET - SOURCE ON KEYBOARD
	10	SET - PASS 2 AFTER PASS 2
	11	SET - SOURCE ON MAG. TAPE 1
	12	SET - OBJECT ON MAG. TAPE 2
	13	SET - LIST ON MAG. TAPE 3
LOADER (REL):	SS0	SET - LOAD ON H.S. PAPER TAPE; RESET - LOAD ON ASR
	1	SET - LIST ALL SUBROUTINES
	2	SET - LIST UNLOADED SUBROUTINES ONLY
	3	SET - LOAD FROM MAG. TAPE
LOADER (ABS):	SS0	SET - LOAD ON H.S. PAPER TAPE; RESET - LOAD ON ASR
	1	SET - LOAD INTERMAP REF. AT END
DUMP (ABS):	SS0	SET - DUMP ON H.S. PAPER TAPE; RESET - LOAD ON ASR
	1	SET - DUMP INTERMAP REF. AT END
DEBUG:	SS0	SET - LOAD & DUMP ON H.S. PAPER TAPE; RESET - LOAD & DUMP ON ASR

*NOTE: TO OBTAIN ERROR LIST ONLY, SWITCHES 1 AND 3 MUST BE SET.

COMPILER SETTINGS
(A ACCUMULATOR ENTRIES)



*LOGICAL DEVICE NUMBERS:

1. ASR KEYBOARD/PRINTER
2. H.S. PAPER TAPE READER/PUNCH
3. CARD READER/PUNCH
4. LINE PRINTER
5. ASR PAPER TAPE READER/PUNCH
6. MAGNETIC TAPE 0
7. MAGNETIC TAPE 1

NOTE: SENSE SWITCH 0 MUST BE SET FOR COMPILER – GENERATED OBJECT CODING TO BE LISTED WITH SOURCE STATEMENTS

MNEMONIC INSTRUCTIONS

MNEMONIC	OP CODE	FUNCTION	TIMING (CYCLES)
ABA'	00-27	AND A AND B	1
AIP'	1702	ACCUMULATOR WORD IN FROM UNIT	Note e
AMA	05	ADD MEMORY TO A	2
AMB	16	ADD MEMORY TO B	2
AOP'	1700	ACCUMULATOR WORD OUT TO UNIT	Note e
ASC'	00-20	COMPLEMENT A SIGN	1
BRU	11	UNCONDITIONAL BRANCH	1
CEU'	13.0IM.0	COMMAND EXTERNAL UNIT	Note e
CLA'	00-03	CLEAR A	1
CMA	15	COMPARE MEMORY AND A (3 WAY) n + 1 if (A) < (M) n + 2 if (A) = (M) n + 3 if (A) > (M)	3
CNS'	00-34	CONVERT NUMBER SYSTEM	1
CSB'	00-07	TRANSFER B SIGN TO CARRY AND SET B SIGN POSITIVE	1
DIV	10	DIVIDE A AND B BY MEMORY	Note g
FLA'	00-17	LEFT SHIFT A AND B	Note f
FLL'	00-13	LEFT LOGICAL SHIFT A AND B	Note f
FRA'	00-12	RIGHT SHIFT A AND B	Note f
FRL'	00-14	FULL ROTATE LOGICAL A AND B LEFT	Note f
HLT'	00-00	HALT	1
IAB'	00-06	INTERCHANGE A AND B	1
IBS'	00-26	INCREMENT B (INDEX) AND SKIP IF 0	1
IMS	14	INCREMENT MEMORY AND SKIP IF 0	3
• IXS'	00-51	INCREMENT INDEX AND SKIP IF 0	1-2
LAA	01	LOAD A FROM MEMORY	2
LBA	02	LOAD B FROM MEMORY	2
LCS'	00-31	LOAD CONTROL SWITCHES IN A	1
• LIX'	00-45	LOAD INDEX REGISTER	2
LOB'	00-36	LONG BRANCH	2
LSA'	00-11	LEFT SHIFT A	Note f
LSL'	00-16	LEFT LOGICAL SHIFT A	Note f
MIP'	17.0IM.6	MEMORY WORD IN FROM UNIT	Note e
MOP'	17.0IM.4	MEMORY WORD OUT TO UNIT	Note e
MPY	07	MULTIPLY B TIMES MEMORY	Note h
NEG'	00-02	NEGATE A	1
NOP'	00-33	NO OPERATION	1
OBA'	00-30	OR A AND B	1
• OVS'	00-37	SET OVERFLOW	1
PID'	130601	DISABLE INTERRUPT	2
PIE'	130600	ENABLE INTERRUPT	2
•• POF'	002041	PROTECT BIT OFF	2
•• PON'	002040	PROTECT BIT ON	2
RNA'	00-01	ROUND A BY MSB IN B	1
RSA'	00-10	RIGHT SHIFT A	Note f
RSL'	00-15	RIGHT LOGICAL SHIFT A	Note f
SAN'	00-23	SKIP IF A IS NEGATIVE	1
SAP'	00-24	SKIP IF A IS POSITIVE	1
SAS'	00-21	SKIP ON A SIGN (3 WAY) n + 1(-), n + 2(0), n + 3(+)	1

MNEMONIC	OP CODE	FUNCTION	TIMING (CYCLES)
SAZ'	00-22	SKIP IF A IS ZERO	1
SMA	06	SUBTRACT MEMORY FROM A	2
SNO'	00-32	SKIP IF A IS NORMALIZED	1
SNS	13-4	SKIP IF CONTROL SWITCH NOT SET	1
SOF'	00-25	SKIP NO OVERFLOW	1
SPB	12	STORE PLACE AND BRANCH	2
STA	03	STORE A IN MEMORY	2
STB	04	STORE B IN MEMORY	2
• STX'	00-44	STORE INDEX REGISTER	2
• SXB'	00-50	SKIP IF INDEX POINTER IS SET TO B	1
TAB'	00-05	TRANSFER A TO B	1
• TAX'	00-52	TRANSFER A-ACCUMULATOR TO HARDWARE INDEX REGISTER	1
TBA'	00-04	TRANSFER B TO A	1
• TBP	00-40	TRANSFER B-ACCUMULATOR TO PROTECT REGISTER	1
TBV'	00-42	TRANSFER B-ACCUMULATOR TO VBR	1
TEU'	13.0IM.2	TEST EXTERNAL UNIT	Note e
TOI'	00-35	TURN OFF INTERRUPT	1
• TPB	00-41	TRANSFER PROTECT REGISTER TO B-ACCUMULATOR	1
TVB'	00-43	TRANSFER VBR TO B-ACCUMULATOR	1
• TXA'	00-53	TRANSFER HARDWARE INDEX REGISTER TO A-ACCUMULATOR	1
• XPB'	00-47	SET INDEX POINTER TO B-ACCUMULATOR	1
• XPX'	00-46	SET INDEX POINTER TO INDEX REGISTER	1

NOTES:

(a) • = 810B only
(b) •• = 810A only
(c) ' = Augmented
(d) Underlined instructions require optional hardware.
(e) 4 cycles on 810B, 3 cycles on 810A.
(f) $T = 2 + \left\lceil \frac{n}{4.1} \right\rceil$ where n is the number of shifts.
(g) 810A-6, 810B-11
(h) 810A-4, 810B-6

BINARY BOOTSTRAP LOADER

SYM. LOC.	OPER.	ADDRESS-INDEX	OCTAL LOC.	CODING
STRT	CEU	U,W	0	13010U
	DATA	'00X000	1	00X000
	AIP	U,W	2	17030U
	SAZ		3	000022
	BRU	* +2	4	111006
	BRU	* -3	5	111002
READ	AIP	U,W	6	17030U
	LSL	8	7	001016
	AIP	U,W,R	10	17430U
	STA*	DAC 1	11	033016
	SAZ		12	000022
	IBS		13	000026
	BRU*	DAC 2	14	113017
	BRU	READ	15	111006
DAC 1	DAC	CHAN-2, 1	16	107671
DAC 2	DAC	CHAN	17	007673

U = 1 FOR ASR-33
U = 2 FOR H.S. PAPER TAPE

X = 4 FOR ASR-33
X = 1 FOR H.S. PAPER TAPE

37673 - ABSL
36017 - REL LOADER
37561 - ABSD

TELETYPE CODES (OCTAL)

ALPHABETIC CHARACTERS	OCTAL CODES ASR-33/ASR-35	NUMERIC CHARACTERS	OCTAL CODES ASR-33/ASR-35	SPECIAL SYMBOLS	OCTAL CODES ASR-33/ASR-35
A	301	0	260	@	300
B	302	1	261	[	333
C	303	2	262	\(Form)	334
D	304	3	263	]	335
E	305	4	264	↑	336
F	306	5	265	←	337
G	307	6	266	Space	240
H	310	7	267	!	241
I	311	8	270	"	242
J	312	9	271	#	243
K	313			$	244
L	314	TELETYPE FUNCTIONS	OCTAL CODES ASR-33/ASR-35	%	245
M	315			&	246
N	316			'	247
O	317	Carriage Return	215	(	250
P	320	Line Feed	212	)	251
Q	321	Bell	207	*	252
R	322	Delete	377	+	253
S	323			,	254
T	324			-	255
U	325			.	256
V	326			/	257
W	327			:	272
X	330			;	273
Y	331			<	274
Z	332			=	275
				>	276
				?	277