

EAI

640

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SCIENTIFIC COMPUTING SYSTEM

**PROGRAMMERS  
HANDBOOK**

**EAI**<sup>®</sup>

**640**

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**SCIENTIFIC COMPUTING SYSTEM**

**THIS DOCUMENT DESCRIBES THE  
INSTRUCTION SET OF THE EAI 640  
SCIENTIFIC COMPUTING SYSTEM**

**PRELIMINARY  
PROGRAMMERS  
HANDBOOK**

LIST OF RELATED PUBLICATIONS

<u>EAI PUBLICATION NO.</u>	<u>TITLE</u>
00 800.9037-0	SYSTEM AND INTERFACE MANUAL
00 800.9034-1	UTILITY and ASSEMBLY PROGRAMS
00 800.9035-0	FORTRAN MANUAL - VOLUME I
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## EAI 640 SPECIFICATIONS

### INTRODUCTION

The EAI 640 is a general purpose, parallel, two's complement binary, digital computer of considerable power, speed and flexibility. It offers an extensive command list, high speed input-output operations, memory protection, and communication with up to 64 devices, 1024 external lines and 4 interval timers.

It features addressing of up to 32,768 words of protected memory, provides multiple level indirect addressing capabilities with immediate or deferred indexing, and has data transfer rates of up to 600 Kilowords/second.

An extensive group of standard peripheral equipments are available.

These features, as detailed in the following pages, make the EAI 640 suitable for a wide variety of system applications.





## EAI 640 SPECIFICATIONS SUMMARY

### GENERAL:

Stored program, general purpose, fixed word length, parallel,  
binary digital computer.

### MEMORY:

Magnetic ferrite core.

### SIZE:

Basic - 4096 or 8192 words. Expandable to 32,768 words.

### WORD LENGTH:

16 data bits, 1 memory protect bit.

### CYCLE TIME:

1.65 microseconds read/write for all of memory.

### ADDRESSING:

Eight powerful addressing options including:

Fixed zone zero (512) words directly addressable.

Multiple level indirect addressing is provided.

Indexing before or after indirect addressing.

Floating zone (±256 words) directly addressable relative  
to present location.

### INDEX REGISTERS:

One hardware index register is provided. An indefinite number  
of memory words may be used as additional index registers.

## INSTRUCTION LIST:

Fifty instructions divided into 8 classes:

1. Load and Store - Whole words.
2. Arithmetic - Two's complement binary arithmetic.
3. Logical - Five logic operations.
4. Shifts - Arithmetic and logical shifts over single or double word length.
5. Jump and Skip - On index register, condition code, sign, etc.
6. Register Exchanges - Four register exchange commands are provided.
7. Control - Multiple precision, interrupt, etc.
8. Input/Output Commands - With extensive interrupt capability.

## INPUT/OUTPUT:

Two modes of input/output provided in the basic EAI 640:

1. Single-word Mode.

Input/Output through accumulator. Maximum rate 93 words/millisecond. (10.7 microseconds/word).

2. Record Mode.

Record transfer directly into or out of memory. Maximum transfer rate 600 words/millisecond. Time-out feature for unknown record length. Record inputs are monitored for violation of protected memory.

Interrupt Feature - Input/Output devices may be communicated with in an interrupt mode freeing the computer for other computation between

device service cycles without burdening the program with extensive status testing. Either the Single-word Mode, or the Record Mode may be selected.

#### OPTIONAL INPUT/OUTPUT MODE:

Direct Memory Access, on a cycle stealing basis, may be added with special peripheral equipment.

#### STANDARD FEATURES:

- 1) The EAI 640 provides for 12 levels of interrupt priority. The interrupt system has 156 memory locations committed for interrupt use.
- 2) Basic EAI 640 includes an operator's console, a maintenance panel and the interfacing for 4 interval timers.
- 3) Hardware Multiply, Divide and Square Root is standard with the basic computer.

The registers available to programmer, with switch register entry and readout from the control panel are:

P - Program Counter. This 16-bit hardware register contains the address of the next instruction.

A - Accumulator. A 16-bit hardware register used during arithmetic, load, store, logical and Input/Output instructions.

Q - Accumulator extension (Multiplier-Quotient). A 16-bit hardware register for double shifting, multiply, and divide.

X - Index Register. A 16-bit hardware register used in indexing operations.

PSW - Program Status Word. A 16-bit hardware register for use with interrupts, condition codes, and multiple precision.

Eight Sense Switches are part of the basic machine's control panel.

## EAI 640 INSTRUCTION SUMMARY

<u>CLASS</u>	<u>MNEMONIC</u>	<u>CYCLE</u>	<u>INSTRUCTION</u>
LOAD	LA	2	Load Accumulator
and	STA	2	Store Accumulator
STORE	LX	2	Load Index
	STX	2	Store Index
ARITHMETIC	A	2	Add
	S	2	Subtract
	M	11	Multiply
	D	11 1/2	Divide
	SQR	10	Square Root
	AOA	1	Add one to Accumulator
	AOM	3	Add one to Memory and Skip
	TCA	1	Two's Complement
LOGICAL	OR	2	Inclusive OR
	XOR	2	Exclusive OR
	AND	2	AND
	C	2	Compare
	OCA	1	One's Complement
SHIFTS	ALS	See Note	Arithmetic Left Single
	ARS	"	Arithmetic Right Single
	ARD	"	Arithmetic Right Double
	ALD	"	Arithmetic Left Double
	LLD	"	Logical Left Double
	LRD	"	Logical Right Double
	LRS	"	Logical Right Single
	LLS	"	Logical Left Single

NOTE: For N even, the number of cycles =  $(N + 4)/4$   
 For N odd, the number of cycles =  $(N + 3)/4$

## INSTRUCTIONS (Con't.)

<u>CLASS</u>	<u>MNEMONIC</u>	<u>CYCLE</u>	<u>INSTRUCTION</u>
JUMPS	J	1	Jump Unconditionally
and	L	2	Jump and Link
SKIPS	SSW	1 + 1/2	Skip on Sense Switch
	SKN	1	Skip if Accumulator Negative
	SKP	1	Skip if Accumulator Positive
	SAE	1	Skip if Accumulator Even
	SQE	1	Skip if Q Even
	SZ	1	Skip Zero
	SP	1	Skip Plus
	SM	1	Skip Minus
	SO	1	Skip Overflow
	SNZ	1	Skip Non-Zero
	SPZ	1	Skip Plus or Zero
	SMZ	1	Skip Minus or Zero
	SG	1	Skip Greater
	SE	1	Skip Equal
	SL	1	Skip Less
	SNE	1	Skip Not Equal
	SGE	1	Skip Greater or Equal
	SLE	1	Skip Less or Equal
	SKU	1	Skip Unconditionally
	NOP	1	No Operations
	SPO	1	Skip Plus or Overflow
	SMO	1	Skip Minus or Overflow
	SNO	1	Skip Not Overflow
	SPM	1	Skip Plus or Minus
	SZO	1	Skip Zero or Overflow

## INSTRUCTIONS (Con't.)

<u>CLASS</u>	<u>MNEMONIC</u>	<u>CYCLE</u>	<u>INSTRUCTION</u>
	SNP	1	Skip Not Plus
	SNM	1	Skip Not Minus
	SAO	1	Skip About to Overflow
	NAO	1	Skip Not About to Overflow
	ICX	1 + 1/2	Increase Index & Skip
	DCX	1 + 1/2	Decrease Index & Skip
EXCHANGES	EX	1	Exchange A & Index Register
	EQ	1	Exchange A & Q
	EP	1	Exchange A & P
	ES	1	Exchange A & Program Status Word
CONTROL	SMP	1	Set Multiple Precision Toggle
	RMP	1	Reset Multiple Precision Toggle
	SSP	1	Set Sign of Accumulator Positive
	SSN	1	Set Sign of Accumulator Negative
	SMI	1	Set Master Interrupt
	RMI	1	Reset Master Interrupt
	SPB	2	Set Protect Bit
	RPB	2	Reset Protect Bit
	P	1	Pause
	T	1	Trap



## INSTRUCTIONS (Con't.)

<u>CLASS</u>	<u>MNEMONIC</u>	<u>CYCLE</u>	<u>INSTRUCTION</u>
INPUT/ OUTPUT	DI	See Note	Data In
	DO	"	Data Out
	SI	"	Device Status Input
	DS	"	Device Select Command
	RI	"	Record In
	RO	"	Record Out
	TDI	"	Test Device Interrupt

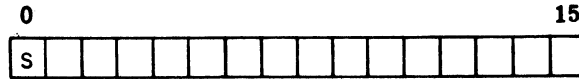
NOTE: The DI, DO, SI, DS, and TDI instructions require one cycle to fetch and one cycle to execute, providing the external device is buffered and ready.

The RI and RO instructions take one cycle to fetch, four cycles to set up after which they may execute instructions like DI at a 1/2 cycle rate.

## DATA FORMATS

### DATA FORMATS

The single precision data word is 16 bits in length.



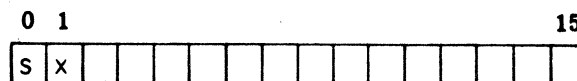
Positive numbers are in true fractional binary form with a sign bit equal to zero. Negative numbers are carried in two's complement fractional form with a sign bit equal to one. The number zero is represented by all bits being zero, and there is no negative zero. The maximum negative number, sign bit of one and the rest all zeros, is referred to as -1.0 in the fractional number system.

### CONDITION CODES

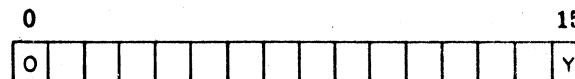
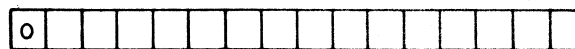
During the execution of arithmetic, logical and shift operations, a two-bit condition code located in the program status word, is set which reflects the results of the particular operation performed. Such results as equal, greater than, less than, plus, minus, zero, not zero, and overflow are captured. The program may then test the results of preceding operations with the skip on condition code instructions.

### MULTIPLE PRECISION

The multiple precision data word is more than one word in length.



X = most significant bit



Y = least significant bit

The sign of the multiple precision word occupies the sign position of the most significant word. The remaining sign positions must be made positive, even though the total contiguous data word may be negative.

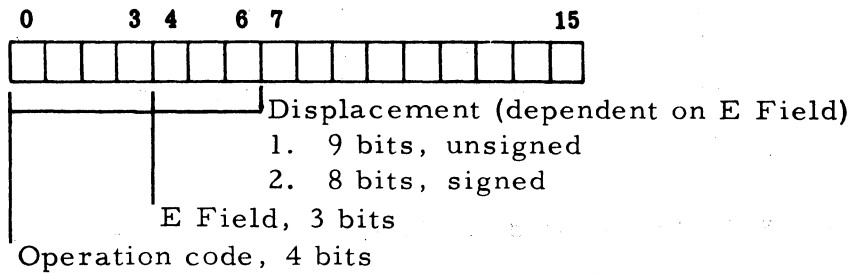
Normal multiple precision operations (ADD or SUB) operate over the least significant word first and then proceed to words of high significance. For this reason a carry (during ADD) or a borrow (during SUB) must be remembered from word to word, and used in the following operation. The carry or borrow condition is remembered in the carry/borrow toggle (and after each ADD or SUB, the sign of the results is made positive) as long as the multiple precision toggle is on. Thus, the multiple precision features may be used over any length of data. When the ADD or SUB is over the most significant word, however, the multiple precision toggle must be previously reset. This allows the last carry/borrow to be used, but doesn't allow a carry/borrow to be remembered, nor does it automatically cause the sign to be made positive.

The carry/borrow toggle is cleared when power is turned on, when ADD or SUB is executed and the multiple precision toggle is off, or when the multiple precision toggle is set with the SMP instruction.

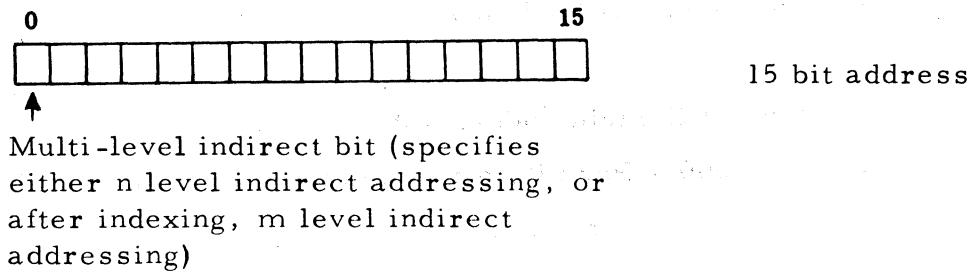
## INSTRUCTION FORMATS

### MEMORY REFERENCE INSTRUCTIONS

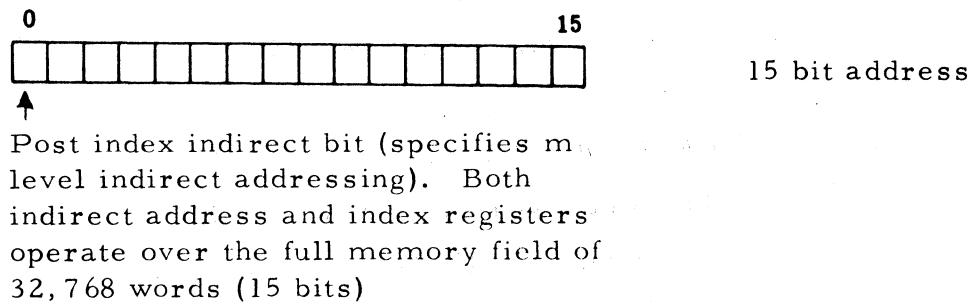
Instruction Format (16 bits)

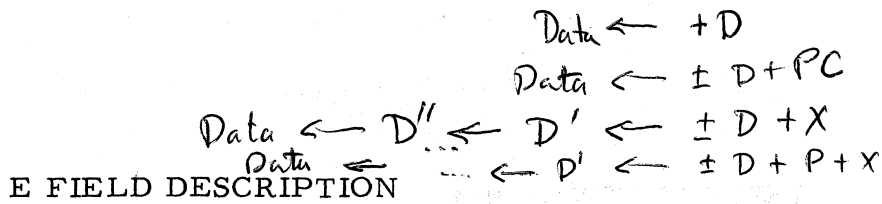


Indirect Address Format (16 bits)

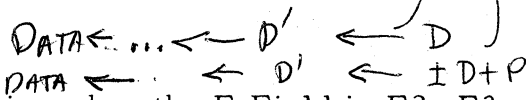


Index Register Format (16 bits)





	E Field 456	Cycles	Effective Address	Displacement Range
E0	000	2	$\leftarrow +D$ <i>page 0</i>	+512
E1	001	2	$\leftarrow \pm D + P$	$\pm 256$
E2	010	2+m	$\leftarrow (\pm D + X)m$	$\pm 256$
E3	011	2+m	$\leftarrow (\pm D + P + X)m$	$\pm 256$
E4	100	2+n	(D)n	+512
E5	101	2+n	( $\pm D + P$ )n	$\pm 256$
E6	110	2+n+m	((D)n+X)m	+512
E7	111	2+n+m	(( $\pm D + P$ )n+X)m	$\pm 256$



(Notice when the E Field is E2, E3, E6, or E7, m level indirect addressing is possible after indexing. This m level indirect addressing requires the post index indirect bit to be one. If the post index indirect bit is a zero, addressing is direct after indexing.)

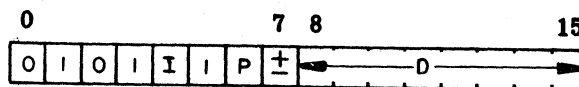
Functions of E Field codes: E0-E3

- 000 - Permits direct addressing of operands in zone zero (512 locations).
- 001 - Permits direct addressing relative to the program counter.
- 011, 010 - Permits multi-level (m) indirect addressing after indexing with either of the above options.

Functions of E Field codes: E4-E7

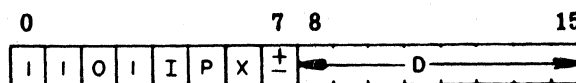
- 100 - Permits multi-level (n) indirect addressing via zone zero (512 locations).
- 101 - Permits multi-level (n) indirect addressing relative to the program counter.
- 111, 110 - Permits multi-level (n) indirect addressing via zone zero, or relative, followed by indexing and multi-level (m) indirect addressing.





The content of the index register replaces the content of the effective address. The only effective address options available with this command are E = 2, E = 3, E = 6, and E = 7. The index register is preserved.

Condition code result: Unchanged

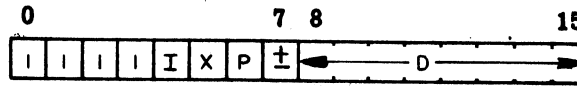


The content of the memory location specified by the effective address and the carry/borrow toggle are added to the accumulator. Two's complement arithmetic is used.

If the carries out of the sign bit position and the high order numeric bit agree, the sum is correct; if they disagree, an overflow occurs.

If two like signed numbers overflow and the multiple precision toggle is on, a carry will be generated, the carry/borrow toggle set, and the accumulator set positive. If the multiple precision toggle is off, the carry/borrow toggle will be reset.

Condition code result:	Skip	Non-Skip
result zero	SZ	SNZ
result greater than zero	SP	SNP
result negative	SM	SNM
overflow	SO	SNO



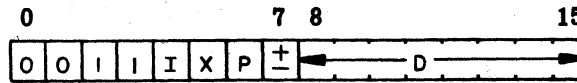
The content of the memory location specified by the effective address and the carry/borrow toggle are subtracted from the accumulator. Two's complement arithmetic is used.

If the carries out of the sign-bit position and the high-order numeric bit agree, the sum is correct; if they disagree, an overflow occurs.

If the content of the memory (subtrahend) is greater than the accumulator (minuend) and the multiple precision toggle is on, a borrow will be generated, the carry/borrow toggle set, and the accumulator set positive. If the multiple precision toggle is off, the carry/borrow toggle will be reset.

Condition code result:	Skip	Non-Skip
result zero	SZ	SNZ
result greater than zero	SP	SNP
result negative	SM	SNM
overflow	SO	SNO

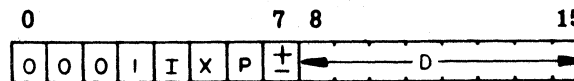




The content of the A register and the memory location specified by the EA forms a double length product, 30 bits, in A and Q. The most significant bits of the product are in the accumulator.

The sign of A is the algebraically determined sign of the product; the sign of Q is made positive. Overflow will occur if  $-1.0$  is multiplied by  $-1.0$ .

Condition code results:	Skip	Non-Skip
overflow	SO	SNO
no overflow	SNO	SO



The content of the accumulator (A) and Q, a 30-bit double precision word, is divided by the content of the memory location specified by the effective address. The quotient is in A and the remainder in Q. The sign of the remainder will be the same as the dividend.

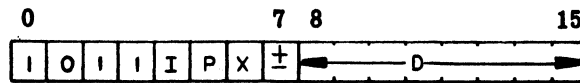
If the quotient exceeds the range  $+1.0 \cdot 2^{-15}$  to  $-1.0$ , an overflow occurs. The overflow condition results in unpredictable values remaining in A and Q.

Condition code results:	Skip	Non-Skip
overflow	SO	SNO
no overflow	SNO	SO

AND

AND

130000



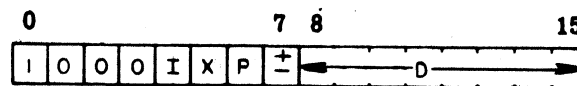
The logical product of the bits of the accumulator and the content of the memory location specified by the EA replaces the content of the accumulator. Operands are treated as 16 bit integers.

Condition code result:	Skip	Non-Skip	Truth Table		
			<u>A</u>	<u>EA</u>	<u>Result</u>
result zero	SZ	SNZ	0	0	0
result not zero	SNZ	SZ	0	1	0
			1	0	0
			1	1	1

OR

OR

100000



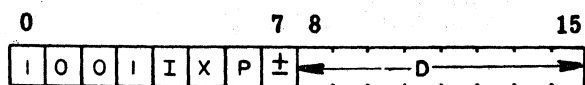
The logical sum of the bits of the accumulator and the content of the memory location specified by the EA replaces the content of the accumulator. Operands are treated as 16 bit integers.

Condition code result:	Skip	Non-Skip	Truth Table		
			<u>A</u>	<u>EA</u>	<u>Result</u>
result zero	SZ	SNZ	0	0	0
result not zero	SNZ	SZ	0	1	1
			1	0	1
			1	1	1

EXCLUSIVE OR

XOR

110000



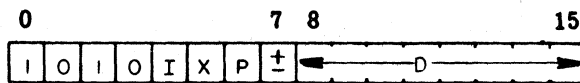
The modulo two sum of the bits of the accumulator and the content of the memory location specified by the EA replaces the content of the accumulator. Operands are treated as 16 bit integers.

Condition code result:	Skip	Non-Skip	Truth Table		
			<u>A</u>	<u>EA</u>	<u>Result</u>
result zero	SZ	SNZ	0	0	0
result not zero	SNZ	SZ	0	1	1
			1	0	1
			1	1	0

COMPARE

C

120000



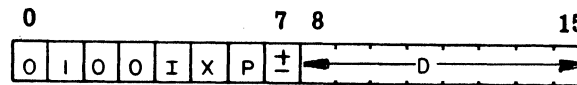
The content of the memory location specified by the EA is compared algebraically with the content of the accumulator. The content of (A) remains unchanged.

Condition code result:	Skip	Non-Skip
operands equal	SE	SNE
accumulator low	SL	SGE
accumulator high	SG	SLE

JUMP UNCONDITIONALLY

J

040000



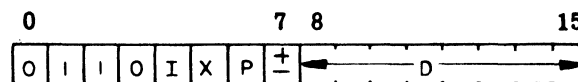
The effective address is computed and replaces the program counter.

Condition code result: Unchanged

JUMP LINK

L

060000



The next instruction location is stored in bits 1-15 of the memory location specified by the EA (bit 0 is preserved). The EA plus one replaces the program counter.

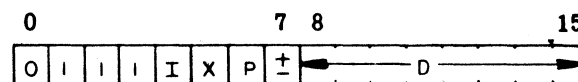
This instruction effects entrance into a subroutine. To exit from the subroutine, execute a Jump indirect with the content of the first word of the subroutine as the effective address.

Condition code result: Unchanged

ADD ONE TO MEMORY AND SKIP

AOM

070000



The content of the effective address (EA) is incremented by one. Two's complement arithmetic is used for the algebraic sum. If the result in memory is equal to zero, the next instruction is skipped. If the result is not zero, the next sequential instruction is executed.

Condition code result: Unchanged

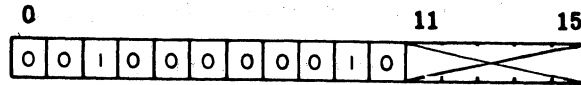
6-7/6-8

## NON-MEMORY REFERENCE INSTRUCTIONS

TWO'S COMPLEMENT A

TCA

020100



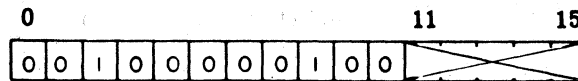
The two's complement of the accumulator replaces the content of the accumulator. The complement of the maximum negative number (-1.0) results in an overflow condition.

Condition code result:	Skip	Non-Skip
result zero	SZ	SNZ
result greater than zero	SP	SNP
result less than zero	SM	SNM
overflow	SO	SNO

ONE'S COMPLEMENT A

OCA

020200



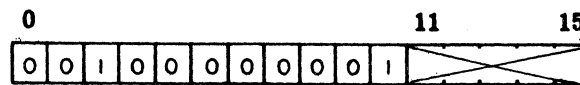
The one's complement of the accumulator replaces the content of A.

Condition code result:      Unchanged

ADD ONE TO ACCUMULATOR

AOA

020040



The contents of the accumulator are incremented by one. Two's complement arithmetic is used. If the carries out of the sign-bit position and the high-order numeric bit agree, the sum is correct; if they disagree, an overflow occurs.

Condition code result:	Skip	Non-Skip
result zero	SZ	SNZ
result greater than zero	SP	SNP
result negative	SM	SNM
overflow	SO	SNO

SQUARE ROOT

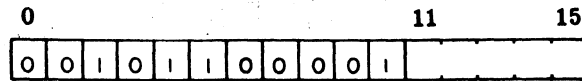
SQR

021400



The content of the accumulator (A) and Q, form a 30 bit double precision word, the square root of which is left in A and the remainder in Q. If the original number is negative, an overflow occurs and the results in A and Q are unpredictable.

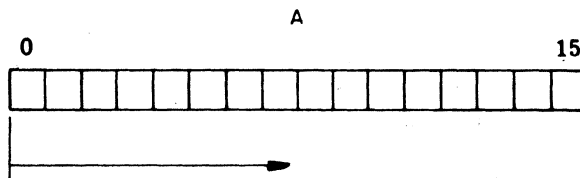
Condition code result: Unchanged, except for minus producing an overflow.

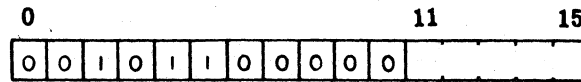


The accumulator is shifted right, the number of bits specified by bits 11 through 15.

The sign bit of the accumulator is propagated to the right. Low order bits of the accumulator are shifted out. Accumulator right shift zero is equivalent to no operation. Bit 15 is the least significant and bit 11 is the most significant for the number of shifts in all shift commands.

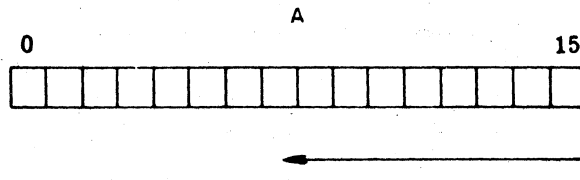
Condition code result: Unchanged





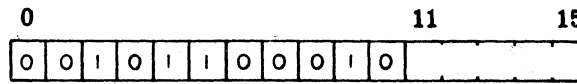
The accumulator is shifted left, the number of bits specified by bits 11 through 15. If a bit unlike the sign bit is shifted out of position 1, an overflow occurs. Vacated bit positions are reset to zero. If no true overflow occurs, but one more shift would cause an overflow, the condition code will be set accordingly.

Condition code result:	Skip	Non-Skip
no overflow	SNO	SO
about to overflow	SAO	SNO
no overflow	SNO	SO
overflow	SO	SNO







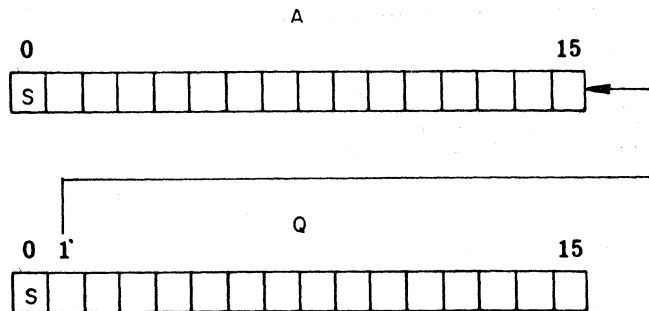


The accumulator and Q register are shifted left, the number of bits specified by bits 11 through 15.

The operand is treated as a 30 bit register plus sign. The sign bit of Q does not participate in the shift. Vacated bit positions are reset to zero. If no true overflow occurs, but one more shift would cause an overflow, the condition code will be set accordingly.

If a bit unlike the sign is shifted out of bit position 1, an overflow occurs.

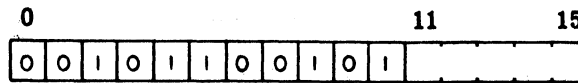
Condition code result:	Skip	Non-Skip
no overflow	SNO	SO
about to overflow	SAO	SNO
no overflow	SNO	SO
overflow	SO	SNO



SHIFT LOGICAL RIGHT SINGLE

LRS

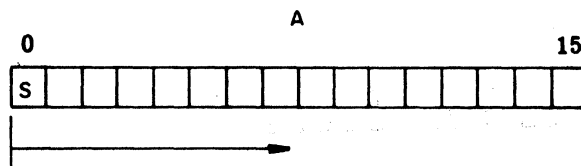
026240



The accumulator is shifted right, the number of bits specified by bits 11 through 15.

The operand is treated as a 16 bit register. Vacated bit positions are reset.

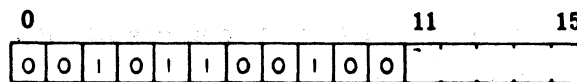
Condition code result: Unchanged



SHIFT LOGICAL LEFT SINGLE

LLS

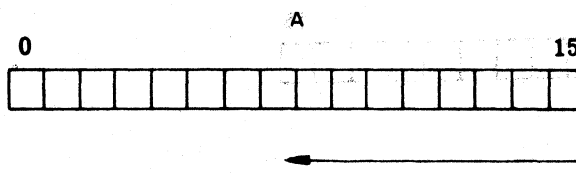
026200

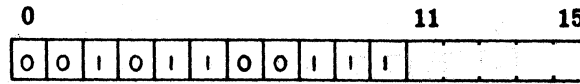


The accumulator is shifted left, the number of bits specified by bits 11 through 15.

The operand is treated as a 16 bit register. High order bits are shifted out without inspection. The vacated bit positions are reset.

Condition code result: Unchanged

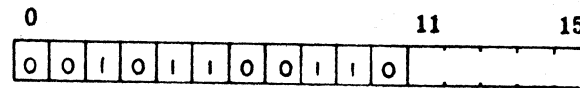
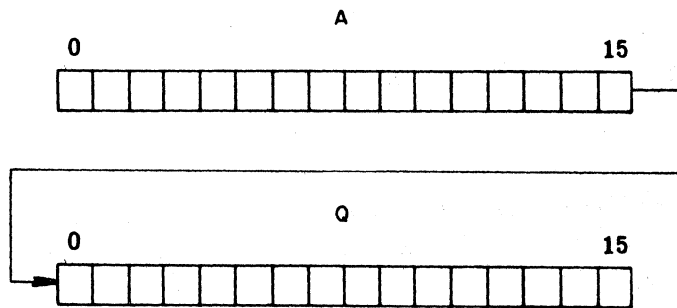




The accumulator and Q register are shifted right, the number of bits specified by bits 11 through 15.

All 32 bits participate in the shift. Vacated bit positions are reset.

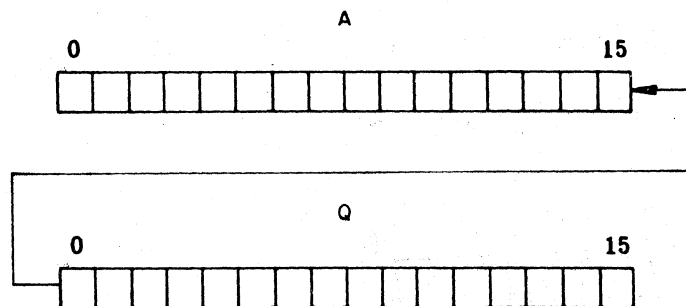
Condition code result: Unchanged



The accumulator and Q register are shifted left, the number of bits specified by bits 11 through 15.

All 32 bits participate in the shift. Vacated bit positions are reset.

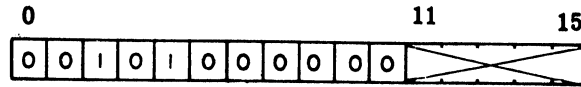
Condition code result: Unchanged



SKIP ON ACCUMULATOR NEGATIVE

SKN

024000



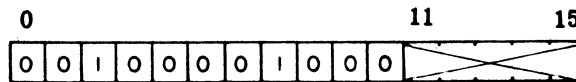
The sign of the accumulator is tested and if negative, the next instruction is skipped. If positive, the instruction is equivalent to a no operation. (See note below.)

Condition code result: Unchanged

SKIP ON ACCUMULATOR POSITIVE

SKP

024040



The sign of the accumulator is tested and if positive, the next instruction is skipped.

If negative, the instruction is equivalent to a no operation. (See note below.)

Condition code result: Unchanged

NOTE: These two instructions should not be confused with SP (Skip Plus) or any of the other skip on condition code mnemonics. At times the condition code toggles may not reflect the state of the accumulator sign.



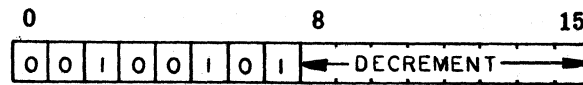
## SKIP ON CONDITION CODE

The condition code may be inspected by setting the desired mask in bits 12 through 15 of the instruction. The next instruction is skipped whenever the condition code corresponds to the mask.

### SKIP CODE TABLE

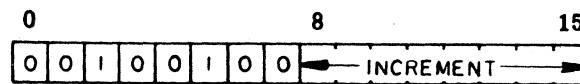
SKU	027417	Skip Unconditionally
NOP	027400	No Operation
SZ	027410	Skip Zero
SP	027404	Skip Plus
SM	027402	Skip Minus
SO	027401	Skip Overflow
SNZ	027407	Skip Non-Zero
SPZ	027414	Skip Plus or Zero
SMZ	027412	Skip Minus or Zero
SG	027402	Skip Greater
SE	027410	Skip Equal
SL	027404	Skip Less
SNE	027406	Skip Not Equal
SGE	027412	Skip Greater or Equal
SLE	027414	Skip Less or Equal
SPO	027405	Skip Plus or Overflow
SMO	027403	Skip Minus or Overflow
SNO	027416	Skip Not Overflow
SPM	027406	Skip Plus or Minus
SZO	027411	Skip Zero or Overflow
SNP	027413	Skip Not Plus
SNM	027415	Skip Not Minus
SAO	027404	Skip About to Overflow
NAO	027410	Skip Not About to Overflow

Condition code result: Unchanged



Bits 8 through 15 are used as a negative number, extended and algebraically added to the X register. The next instruction is skipped if the result (bits 1 through 15) has passed from positive to negative (see note on next page). Bit 15 is the least significant bit and bit 8 is the most significant bit for the number of decrements or increments to be added.

Condition code result: Unchanged



Bits 8 through 15 are used as a positive number, extended and algebraically added to the X register. The next instruction is skipped if the result (bits 1 through 15) has passed from negative to positive (see note on next page).

Condition code result: Unchanged



## Note on Decrement and Increment Index

Because bit 0 of the index register is used as the post index indirect bit, caution should be used after a skip condition has occurred because the post index indirect bit has been changed (complemented). The following binary examples of a "compressed" machine will show how increment and decrement take place. Two's complement arithmetic is used.

bit position

0	1	7		13	14	15	
0	0	0		0	1	0	= positive number in index register
0	0	0		0	0	1	= positive number in ICX instruction (bit 7 = 0)
0	0	0		0	1	1	= new contents of index register No skip.

0	1	1		1	1	1	
0	0	0		0	0	1	= positive number in ICX instruction
1	0	0		0	0	0	= new contents of index Skip will occur.

0	1	1		1	1	0	
1	1	1		1	1	1	= negative number in DCX instruction (bit 7 = 1)
0	1	1		1	0	1	= new contents of index No skip.

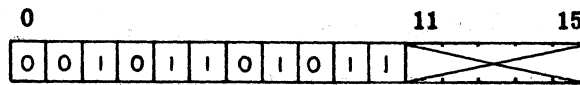
1	0	0		0	1	0	
1	1	1		1	0	1	= negative number in DCX instruction
0	1	1		1	1	1	= new contents of index Skip will occur.

Note that in the last example, the index register has "passed through" zero, but that a skip condition has been detected by the hardware. The post index indirect will not change then if a skip condition does not occur.

EXCHANGE INDEX

EX

026500



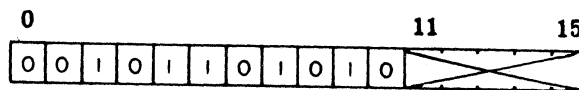
The content of the accumulator and X register are interchanged.

Condition code result: Unchanged

EXCHANGE Q

EQ

026540



The content of the accumulator and Q register are interchanged.

Condition code result: Unchanged

EXCHANGE P

EP

026600



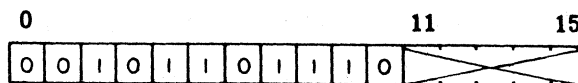
The content of the accumulator and the program counter are interchanged. This instruction is a jump-link with the link address stored in the accumulator. Bit zero of the accumulator is reset.

Condition code result: Unchanged

EXCHANGE PROGRAM STATUS WORD

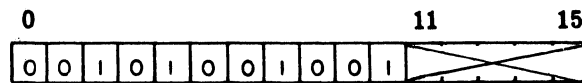
ES

026700



The content of the accumulator and PSW are interchanged. The condition code will be set by bits 14 and 15 of the accumulator since the condition code is the least significant two bits of the program status word.

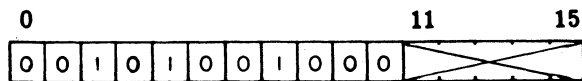
Condition code result: Unchanged



This instruction sets the multiple precision toggle and clears the carry/borrow toggle.

The multiple precision toggle is used in multiple precision arithmetic operations to allow the carry/borrow toggle to be saved for use in the next higher precision operation.

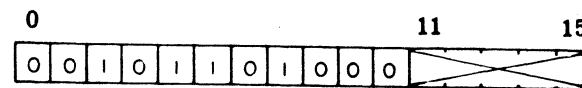
Condition code result: Unchanged



This instruction resets the multiple precision toggle (only).

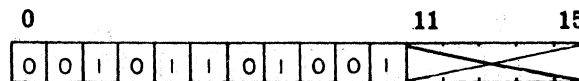
When the multiple precision toggle is in the reset condition, a previous carry or borrow will be used in Add or Subtract but a new carry or borrow will not be saved.

Condition code result: Unchanged



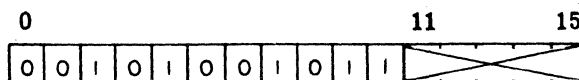
This instruction resets the sign bit of the accumulator.

Condition code result: Unchanged



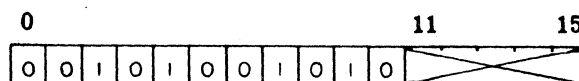
This instruction sets the sign bit of the accumulator to one.

Condition code result: Unchanged



This instruction sets the master interrupt toggle to a one following the next instruction, indicating that new or pending interrupts may then be processed if the corresponding interrupt mask bit is a one.

Condition code result: Unchanged



The master interrupt toggle is reset inhibiting further interrupts.

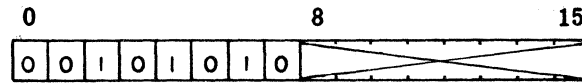
Condition code result: Unchanged



PAUSE

P

025000



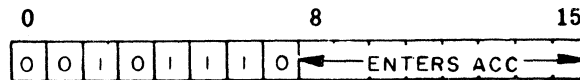
This instruction results in the computer being placed in a pause condition. It can be restarted manually or through an unmasked interrupt. A manual restart will result in a program continuation at the next instruction. The interrupt restart is determined by the instruction at the interrupt service routine.

Condition code result: Unchanged

TRAP

T

027000



The Trap instruction is associated with interrupt level 7 (Internal). When this mask bit is on and the Trap instruction is executed, an interrupt of priority 7 will occur. When the mask bit is off and the Trap is executed, no interrupt will occur and the next sequential instruction is executed. In either event, the D Field of the instruction enters bits 8 through 15 of the accumulator. Bits 0 through 7 of the accumulator are reset.

NOTE: Trap may be used as a fast calling sequence for pseudo instructions or as a "direct" instruction for loading A with an 8-bit constant.

## INPUT/OUTPUT SYSTEM

### GENERAL

The EAI 640 has been designed as a hardware-software system. Of paramount concern to the designers was the desire to create a versatile input/output system while reducing the software burden in communicating with external devices. These aims were accomplished with the design of two basic modes of communication and with the addition of a third as an option. These modes are as follows:

1. Single-word Mode (program control through the accumulator)

This mode will find general use in communication with slow devices at rates of about 10 words per millisecond or less.

This allows for many instructions to be executed between I/O transfers.

2. Record Mode - Operating in this mode, the running program is

halted and the processor devotes all of its time to handling the transfer of information to/from the peripheral device; the rate being controlled by the external device. A time-out feature may be set up. This mode will find general use with devices operating at rates of 25 words per millisecond up to 600 words per milliseconds.

Interrupt Feature - Input/Output devices may be communicated

within an interrupt mode freeing the computer for other computation between device service cycles without burdening the program with extensive status testing. Either the Single-word Mode, or the Record Mode may be selected.

3. Direct Memory Access - (an option). This mode operates on a cycle-stealing basis, its major advantage being the ease of programming.

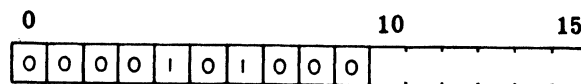


## INPUT/OUTPUT INSTRUCTIONS

DEVICE SELECT

DS

005000



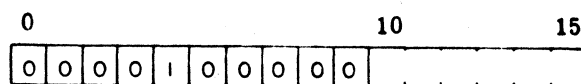
The Device Select (DS) command causes a 16 bit parallel word transfer from the accumulator to the specified device. This word may be a command or data to the device and it must be loaded into the accumulator before giving the DS instruction. The device select commands may cause devices to assume specified modes of operation if the accumulator was loaded with a command word. Included in the device select command is the ability to specify 8 bit or 16 bit transfer mode (2 characters) for appropriate devices as well as the ability to specify such interrupt criteria as:

- a. No interrupt
- b. Interrupt on next word
- c. Interrupt on next tape mark
- e. Etc.

DEVICE STATUS

SI

004000

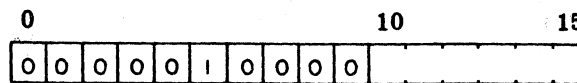


The device Status Input (SI) command causes a 16 bit parallel word transfer from the specified device to the accumulator. This word will be the device status and it will be left in the accumulator for further program examination.

SINGLE WORD MODE

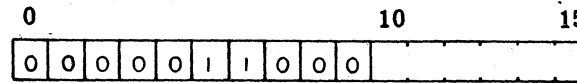
DI

002000



DO

003000

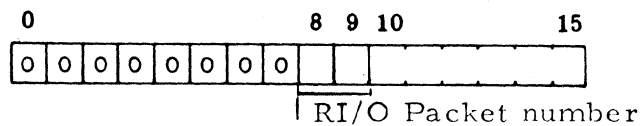


The two commands Data In (DI) and Data Out (DO) cause a 16 bit parallel word transfer to or from the accumulator using the data channel. These two commands, together with store and load, skip on index and jump permit successive word transfers into memory locations relative to the P counter every 6-1/2 cycles (10.7  $\mu$ sec) and to any location in memory every 7-1/2 cycles (12.3  $\mu$ sec).

RECORD MODE

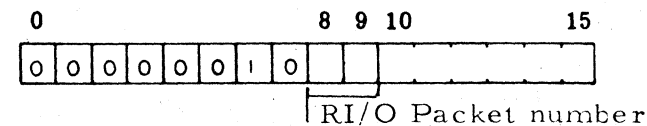
RI

000000



RO

001000



The Record Input (RI) and Record Output (RO) instructions cause 16 bit parallel word transfers to and from the data channel with direct access to memory. These two commands operate with a four word memory packet which controls the operating mode of the device and record length. There are four such packets available located at addresses 496, 500, 504, and 508. The contents of each packet are as follows:

RI/O Packet "00"

(496) = Device Select Control Word

(497) = Final Address

(498) = Starting Address

(499) = Terminating Address

RI/O Packet "01"

(500) = Device Select Control Word, and so on.

Before the execution of an RI or RO instruction, the Device Select Command, the Final Address, and the Starting Address must be initialized by the program, i. e. , stored in the first three words of the packet. Upon execution, the Device Select Command is sent to the appropriate device and the desired mode of operation begins. Data is transferred to or from the Starting Address in memory and proceeds one word at a time until the Final Address is reached or until the device terminates the transmission of data. The address of the last word transmitted is then stored in the last word of the packet, called the Terminating Address.

The record length called for is determined by the Starting and Final Addresses and may range from one to 32K words. It is not possible to call for a record length of zero. If the actual record length is shorter than the one called for, the Terminating Address will be less than the Final Address. If the actual record length is equal or longer, the Terminating Address will be identical with the Final Address. To sense a longer record length condition, the program must sample the Device Status Word where that information is made available.

Once the device has established its operating mode, the computer will repeat a DI or DO instruction automatically for each word transfer until the transfer is finished.

This mode of operation permits input-output transfers with memory at rates up to 600 Kilowords per second. During this instruction other operations in the computer are halted.

# INTERRUPT SYSTEM

## PRIORITIES

The computer interrupt interface of the EAI 640 consists of four classes broken into twelve categories as shown below:

### Interrupt Levels and Priorities

#### Internal Class

- 0 Trap
- 1 Illegal instruction
- 2 Illegal procedure in setting/resetting on protect bit
- 3 Memory protection violation
- 4 Machine check

#### Timer Class

- 5 Interval timer (4 devices)

#### Data Channel Class

- 6 Direct data channel No. 1
  - 7 Direct data channel No. 2
  - 8 Direct data channel No. 3
  - 9 Direct data channel No. 4
  - 10 Any alarm
- } 64 devices total

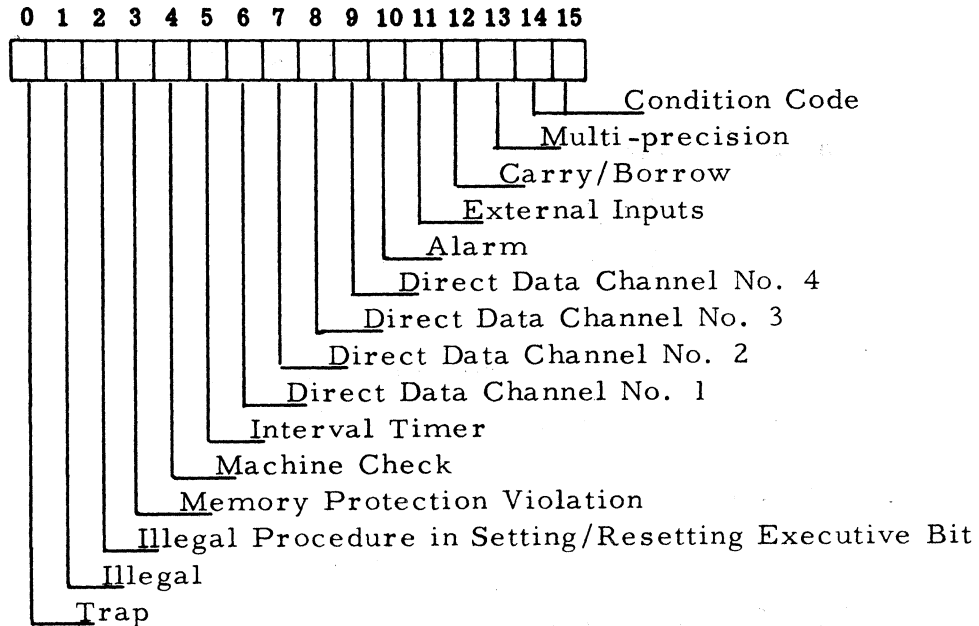
For testing, see TDI Instructions, page 10.9

#### External Class

- 11 External inputs (64 groups of 16 lines each)

## PROGRAM STATUS WORD

Each or all of the twelve categories of interrupts may be enabled through the setting of associated mask bits in the Program Status Word (PSW). The format of the PSW is as follows:



If a bit in the PSW is a "1", the corresponding interrupt is enabled (not masked); if the bit is a "0", the interrupt is masked. Bits 12 through 15 of the PSW consist of the carry/borrow indicator, the multiple precision toggle, and the condition code. No interrupt capability is associated with these controls.

By using the ES instruction (Exchange accumulator and PSW), the programmer may have access to the present status word and replace it with another.

## MASTER INTERRUPT

The Master Interrupt Toggle provides overall control of the interrupt feature. When it is on, the interrupt lines will be matched against the PSW at the end of every instruction cycle. When it is off, no match will occur and the interrupts, if there are any, must necessarily remain pending.

## GENERAL OPERATION

When an interrupt is accepted by the EAI 640, the normal program flow is "interrupted" before another instruction is executed.

The following events occur automatically in the hardware:

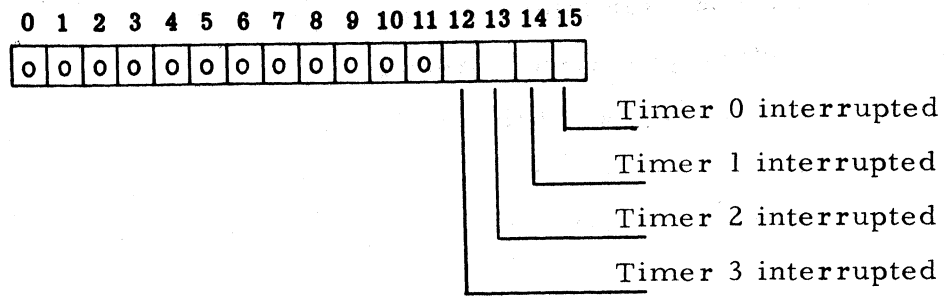
1. The master interrupt toggle is reset.
2. A fixed memory location, determined by the class of interrupt, is accessed for the starting address of the interrupt subroutine (called the "pointer").
3. The contents of the program counter (indicating the location of the next instruction in the normal program flow) are stored at the address designated by the pointer.
4. The contents of the accumulator are stored in the next sequential location (pointer + 1).
5. Computation begins at the next address (pointer + 2), with the accumulator set as follows:

### Interrupt

Trap	bits 8 through 15 of the trap instruction
Illegal instruction	old accumulator
Memory protection	old accumulator
Machine check	old accumulator

(continued on next page)

Interval timer



Data channel class	Old accumulator
Data channel alarm	Old accumulator
External inputs	16-bit data word from the device

Words associated with each interrupt, then, are distributed as follows:

- (fixed location) = pointer
- ⋮
- (pointer) = old program counter
- (pointer + 1) = old accumulator
- (pointer + 2) = first instruction of interrupt subroutine

INTERRUPT POINTERS

Pointers associated with each of the four classes of interrupts are shown in the following table. All addresses are given in octal numbers and in parenthesis is the decimal equivalent.

Data Channel Class

0	}	64 pointers in locations 644-743 (430-483) (one pointer associated with each of 64 possible devices)
1		
2		
3		
4		1 pointer in location 744 (484)



### External Class

5            64 pointers in locations 544-643 (356-419)  
              (one pointer associated with each of 64  
              possible groups)

### Timer Class

6            1 pointer in location 745 (485)

### Internal Class

7            1 pointer in location 752 (490)  
8            1 pointer in location 753 (491)  
9            1 pointer in location 754 (492)  
10           1 pointer in location 755 (493)  
11           1 pointer in location 756 (494)

## DATA CHANNEL INTERRUPTS

The EAI 640 requires no assigned configuration of the levels of data channel interrupts. As many as 64 devices may be assigned to channel "6" interrupt (priority 6) or as few as one device may be assigned to channels "6", "7", "8", and "9" (priorities 6, 7, 8, 9). Of course, a full range of possibilities exist between these two extremes. It is to be noted, however, that priority of interrupt is established according to configuration by channel and each system should be arranged individually for best efficiency. This is discussed later in the section on Nested Interrupts.

A total of 64 interrupt pointers are associated with the priority levels 6, 7, 8, and 9 corresponding to the 64 devices that may be selected. The tenth level is provided as an extra level for system alarm condition, etc., and has only one pointer associated with it. It is thought that this level may be made common to all devices in the system, but this requirement need not be adhered to. The operation of data channel interrupt is as follows.

One of 64 possible devices requests an interrupt. If the channel interrupt mask bit of the PSW allows interrupt, and if no higher priority interrupt is unmasked and pending, then the interrupt request is allowed and the master interrupt bit is reset. An interrupt acknowledge signal is then sent to the channel. The devices assigned to that channel are scanned sequentially in order of proximity to the computer. The device which requested the interrupt or the first device found to have an interrupt request pending transmits its address to the computer from which the fixed location of the pointer is derived. In this manner the priority within each channel is determined by the physical order of interconnection of the devices.

The interrupt service program, then, automatically knows which of the 64 devices requested the interrupt and proceeds to service the interrupt.

#### NESTED INTERRUPTS

Usually interrupts are serviced with all other interrupts locked out, and control returned to the main program before another interrupt is allowed. The EAI 640, however, has the ability to process nested interrupts. For example, the interrupt subroutine may load a new PSW which has the higher priority interrupts enabled, but not itself or any lower priority interrupts. The master interrupt bit is also made a "1". Then if a higher priority interrupt occurs during the processing of a lower priority interrupt, the second is "nested" in the first and will be serviced first. In this manner, many devices may be operated together with the higher priority device receiving preferential service.

On the other hand, if the interrupt subroutine is such that it enables all those interrupt levels in the PSW that have not yet occurred, then the effect will be to service the interrupts in the reverse order in which they occur.

In the event of simultaneous interrupts, the hardware chooses the higher priority level. The queing phenomena then is a function of (a) the assigned channel configuration, (b) the device number assignment within the channel, and (c) the method of using the PSW. The EAI 640 allows these variables to be adjusted for each system.

#### EXTERNAL INTERRUPTS

This class of interrupts is analogous to the data channel class but otherwise is not related. External devices may be event counters, telemetry apparatus, or other real-time process control equipment, such as switches. No instructions, such as DI, DO, SI, DS, are available for devices on the external channel. This is an input only channel with only TDI instruction available. Of 64 possible external groups, any one may request an external interrupt.

If the external interrupt mask bit of the status word mask allows interrupt and if no higher priority interrupt is unmasked and pending then the external group request is allowed and resets the master interrupt bit.

Then an interrupt acknowledge signal is sent sequentially by group number to the external devices. The group which requested the interrupt or the first group scanned which is found to have an interrupt request pending transmits its 6 bit address to the computer from which the location of the pointer is determined. Then 16 bits of data are entered into the accumulator automatically and computation proceeds under control of the interrupt subroutine.

#### INTERNAL TIMER

Timing pulses from four different devices can be accepted by the EAI 640. Each device has a counter associated with it in cells 746-751 (486-489). For each device pulse, the assigned counter is incremented by one. When the count reaches zero, on any counter, an interval timer interrupt request is generated which has priority level 5.

#### INTERNAL INTERRUPTS

Execution of a Trap instruction, violation of a protected portion of memory, an illegal instruction, or a machine check condition are all conditions which could cause an internal class of interrupts. Each has its own priority level assigned and an associated pointer in fixed memory. The Trap, in addition to causing an interrupt, places instruction bits 8 through 15 in the accumulator.

TEST INPUT/OUTPUT COMMAND

TDI

This instruction allows the program to test the condition of masked Input/Output devices and cause them to be services immediately if required. Service consists of processing as if a normal interrupt had been caused by the specified device. If no device service is required, the command becomes a "no operation" (NOP).

Test-Device-Interrupt Instruction Format Table:

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

Machine Code

Class

006000	XX = timer number
006600	Channel 0
006700	Channel 1
007000	Channel 2
007100	Channel 3
007200	Alarm
007300	External Inputs

## APPENDIX A

### FIXED MEMORY ASSIGNMENT (ZONE ZERO)

<u>Octal Address</u>	<u>Decimal Address</u>	<u>Use</u>
000-543	000-355	Available for bootstrap and zone zero addressing
544-643	356-419	Interrupt pointers (External inputs class)
644-743	420-483	Interrupt pointers (Direct data channel class)
744	484	Alarm interrupt pointer
745	485	Interval timer pointer
746-751	486-489	Counters for interval timers
752	490	Trap interrupt pointer
753	491	SPB/RPB interrupt pointer
754	492	Memory protect interrupt
755	493	Illegal instruction interrupt
756	494	Machine check interrupt pointer
757	495	Available
758-763	496-500	RI/O packet "00"
764-767	501-504	RI/O packet "01"
768-733	505-508	RI/O packet "10"
774-777	509-512	RI/O packet "11"



APPENDIX C

SUBROUTINE DESCRIPTION

Document Number \_\_\_\_\_

Programmer \_\_\_\_\_ Date \_\_\_\_\_

Subroutine Title \_\_\_\_\_

Purpose \_\_\_\_\_

Input: A contains \_\_\_\_\_

Q contains \_\_\_\_\_

X contains \_\_\_\_\_

Output: A contains \_\_\_\_\_

Q contains \_\_\_\_\_

X contains \_\_\_\_\_

System Name Call \_\_\_\_\_

Calling Sequence:  $\alpha$  \_\_\_\_\_

$\alpha + 1$  \_\_\_\_\_

$\alpha + 2$  \_\_\_\_\_

$\alpha + 3$  \_\_\_\_\_

$\alpha + 4$  \_\_\_\_\_

$\alpha + 5$  \_\_\_\_\_

$\alpha + 6$  \_\_\_\_\_

$\alpha + 7$  \_\_\_\_\_

$\alpha + 8$  \_\_\_\_\_

$\alpha + 9$  \_\_\_\_\_

Average time: \_\_\_\_\_ MIN \_\_\_\_\_ MAX

Number of Instructions: \_\_\_\_\_

Relocatable

Independent

Subroutine is  Dependent: Needs \_\_\_\_\_



APPENDIX D

OCTAL-DECIMAL INTEGER CONVERSION TABLE

Octal 0000 to 0777		Decimal 0000 to 0511						
	0	1	2	3	4	5	6	7
0000	0000	0001	0002	0003	0004	0005	0006	0007
0010	0008	0009	0010	0011	0012	0013	0014	0015
0020	0016	0017	0018	0019	0020	0021	0022	0023
0030	0024	0025	0026	0027	0028	0029	0030	0031
0040	0032	0033	0034	0035	0036	0037	0038	0039
0050	0040	0041	0042	0043	0044	0045	0046	0047
0060	0048	0049	0050	0051	0052	0053	0054	0055
0070	0056	0057	0058	0059	0060	0061	0062	0063
0100	0064	0065	0066	0067	0068	0069	0070	0071
0110	0072	0073	0074	0075	0076	0077	0078	0079
0120	0080	0081	0082	0083	0084	0085	0086	0087
0130	0088	0089	0090	0091	0092	0093	0094	0095
0140	0096	0097	0098	0099	0100	0101	0102	0103
0150	0104	0105	0106	0107	0108	0109	0110	0111
0160	0112	0113	0114	0115	0116	0117	0118	0119
0170	0120	0121	0122	0123	0124	0125	0126	0127
0200	0128	0129	0130	0131	0132	0133	0134	0135
0210	0136	0137	0138	0139	0140	0141	0142	0143
0220	0144	0145	0146	0147	0148	0149	0150	0151
0230	0152	0153	0154	0155	0156	0157	0158	0159
0240	0160	0161	0162	0163	0164	0165	0166	0167
0250	0168	0169	0170	0171	0172	0173	0174	0175
0260	0176	0177	0178	0179	0180	0181	0182	0183
0270	0184	0185	0186	0187	0188	0189	0190	0191
0300	0192	0193	0194	0195	0196	0197	0198	0199
0310	0200	0201	0202	0203	0204	0205	0206	0207
0320	0208	0209	0210	0211	0212	0213	0214	0215
0330	0216	0217	0218	0219	0220	0221	0222	0223
0340	0224	0225	0226	0227	0228	0229	0230	0231
0350	0232	0233	0234	0235	0236	0237	0238	0239
0360	0240	0241	0242	0243	0244	0245	0246	0247
0370	0248	0249	0250	0251	0252	0253	0254	0255
0400	0256	0257	0258	0259	0260	0261	0262	0263
0410	0264	0265	0266	0267	0268	0269	0270	0271
0420	0272	0273	0274	0275	0276	0277	0278	0279
0430	0280	0281	0282	0283	0284	0285	0286	0287
0440	0288	0289	0290	0291	0292	0293	0294	0295
0450	0296	0297	0298	0299	0300	0301	0302	0303
0460	0304	0305	0306	0307	0308	0309	0310	0311
0470	0312	0313	0314	0315	0316	0317	0318	0319
0500	0320	0321	0322	0323	0324	0325	0326	0327
0510	0328	0329	0330	0331	0332	0333	0334	0335
0520	0336	0337	0338	0339	0340	0341	0342	0343
0530	0344	0345	0346	0347	0348	0349	0350	0351
0540	0352	0353	0354	0355	0356	0357	0358	0359
0550	0360	0361	0362	0363	0364	0365	0366	0367
0560	0368	0369	0370	0371	0372	0373	0374	0375
0570	0376	0377	0378	0379	0380	0381	0382	0383
0600	0384	0385	0386	0387	0388	0389	0390	0391
0610	0392	0393	0394	0395	0396	0397	0398	0399
0620	0400	0401	0402	0403	0404	0405	0406	0407
0630	0408	0409	0410	0411	0412	0413	0414	0415
0640	0416	0417	0418	0419	0420	0421	0422	0423
0650	0424	0425	0426	0427	0428	0429	0430	0431
0660	0432	0433	0434	0435	0436	0437	0438	0439
0670	0440	0441	0442	0443	0444	0445	0446	0447
0700	0448	0449	0450	0451	0452	0453	0454	0455
0710	0456	0457	0458	0459	0460	0461	0462	0463
0720	0464	0465	0466	0467	0468	0469	0470	0471
0730	0472	0473	0474	0475	0476	0477	0478	0479
0740	0480	0481	0482	0483	0484	0485	0486	0487
0750	0488	0489	0490	0491	0492	0493	0494	0495
0760	0496	0497	0498	0499	0500	0501	0502	0503
0770	0504	0505	0506	0507	0508	0509	0510	0511

Octal 1000 to 1777		Decimal 0512 to 1023						
	0	1	2	3	4	5	6	7
1000	0512	0513	0514	0515	0516	0517	0518	0519
1010	0520	0521	0522	0523	0524	0525	0526	0527
1020	0528	0529	0530	0531	0532	0533	0534	0535
1030	0536	0537	0538	0539	0540	0541	0542	0543
1040	0544	0545	0546	0547	0548	0549	0550	0551
1050	0552	0553	0554	0555	0556	0557	0558	0559
1060	0560	0561	0562	0563	0564	0565	0566	0567
1070	0568	0569	0570	0571	0572	0573	0574	0575
1100	0576	0577	0578	0579	0580	0581	0582	0583
1110	0584	0585	0586	0587	0588	0589	0590	0591
1120	0592	0593	0594	0595	0596	0597	0598	0599
1130	0600	0601	0602	0603	0604	0605	0606	0607
1140	0608	0609	0610	0611	0612	0613	0614	0615
1150	0616	0617	0618	0619	0620	0621	0622	0623
1160	0624	0625	0626	0627	0628	0629	0630	0631
1170	0632	0633	0634	0635	0636	0637	0638	0639
1200	0640	0641	0642	0643	0644	0645	0646	0647
1210	0648	0649	0650	0651	0652	0653	0654	0655
1220	0656	0657	0658	0659	0660	0661	0662	0663
1230	0664	0665	0666	0667	0668	0669	0670	0671
1240	0672	0673	0674	0675	0676	0677	0678	0679
1250	0680	0681	0682	0683	0684	0685	0686	0687
1260	0688	0689	0690	0691	0692	0693	0694	0695
1270	0696	0697	0698	0699	0700	0701	0702	0703
1300	0704	0705	0706	0707	0708	0709	0710	0711
1310	0712	0713	0714	0715	0716	0717	0718	0719
1320	0720	0721	0722	0723	0724	0725	0726	0727
1330	0728	0729	0730	0731	0732	0733	0734	0735
1340	0736	0737	0738	0739	0740	0741	0742	0743
1350	0744	0745	0746	0747	0748	0749	0750	0751
1360	0752	0753	0754	0755	0756	0757	0758	0759
1370	0760	0761	0762	0763	0764	0765	0766	0767
1400	0768	0769	0770	0771	0772	0773	0774	0775
1410	0776	0777	0778	0779	0780	0781	0782	0783
1420	0784	0785	0786	0787	0788	0789	0790	0791
1430	0792	0793	0794	0795	0796	0797	0798	0799
1440	0800	0801	0802	0803	0804	0805	0806	0807
1450	0808	0809	0810	0811	0812	0813	0814	0815
1460	0816	0817	0818	0819	0820	0821	0822	0823
1470	0824	0825	0826	0827	0828	0829	0830	0831
1500	0832	0833	0834	0835	0836	0837	0838	0839
1510	0840	0841	0842	0843	0844	0845	0846	0847
1520	0848	0849	0850	0851	0852	0853	0854	0855
1530	0856	0857	0858	0859	0860	0861	0862	0863
1540	0864	0865	0866	0867	0868	0869	0870	0871
1550	0872	0873	0874	0875	0876	0877	0878	0879
1560	0880	0881	0882	0883	0884	0885	0886	0887
1570	0888	0889	0890	0891	0892	0893	0894	0895
1600	0896	0897	0898	0899	0900	0901	0902	0903
1610	0904	0905	0906	0907	0908	0909	0910	0911
1620	0912	0913	0914	0915	0916	0917	0918	0919
1630	0920	0921	0922	0923	0924	0925	0926	0927
1640	0928	0929	0930	0931	0932	0933	0934	0935
1650	0936	0937	0938	0939	0940	0941	0942	0943
1660	0944	0945	0946	0947	0948	0949	0950	0951
1670	0952	0953	0954	0955	0956	0957	0958	0959
1700	0960	0961	0962	0963	0964	0965	0966	0967
1710	0968	0969	0970	0971	0972	0973	0974	0975
1720	0976	0977	0978	0979	0980	0981	0982	0983
1730	0984	0985	0986	0987	0988	0989	0990	0991
1740	0992	0993	0994	0995	0996	0997	0998	0999
1750	1000	1001	1002	1003	1004	1005	1006	1007
1760	1008	1009	1010	1011	1012	1013	1014	1015
1770	1016	1017	1018	1019	1020	1021	1022	1023

Octal	2000 to 2777	Decimal	1024 to 1535
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	0	1	2	3	4	5	6	7
2000	1024	1025	1026	1027	1028	1029	1030	1031
2010	1032	1033	1034	1035	1036	1037	1038	1039
2020	1040	1041	1042	1043	1044	1045	1046	1047
2030	1048	1049	1050	1051	1052	1053	1054	1055
2040	1056	1057	1058	1059	1060	1061	1062	1063
2050	1064	1065	1066	1067	1068	1069	1070	1071
2060	1072	1073	1074	1075	1076	1077	1078	1079
2070	1080	1081	1082	1083	1084	1085	1086	1087
2100	1088	1089	1090	1091	1092	1093	1094	1095
2100	1096	1097	1098	1099	1100	1101	1102	1103
2120	1104	1105	1106	1107	1108	1109	1110	1111
2130	1112	1113	1114	1115	1116	1117	1118	1119
2140	1120	1121	1122	1123	1124	1125	1126	1127
2150	1128	1129	1130	1131	1132	1133	1134	1135
2160	1136	1137	1138	1139	1140	1141	1142	1143
2170	1144	1145	1146	1147	1148	1149	1150	1151
2200	1152	1153	1154	1155	1156	1157	1158	1159
2210	1160	1161	1162	1163	1164	1165	1166	1167
2220	1168	1169	1170	1171	1172	1173	1174	1175
2230	1176	1177	1178	1179	1180	1181	1182	1183
2240	1184	1185	1186	1187	1188	1189	1190	1191
2250	1192	1193	1194	1195	1196	1197	1198	1199
2260	1200	1201	1202	1203	1204	1205	1206	1207
2270	1208	1209	1210	1211	1212	1213	1214	1215
2300	1216	1217	1218	1219	1220	1221	1222	1223
2310	1224	1225	1226	1227	1228	1229	1230	1231
2320	1232	1233	1234	1235	1236	1237	1238	1239
2330	1240	1241	1242	1243	1244	1245	1246	1247
2340	1248	1249	1250	1251	1252	1253	1254	1255
2350	1256	1257	1258	1259	1260	1261	1262	1263
2360	1264	1265	1266	1267	1268	1269	1270	1271
2370	1272	1273	1274	1275	1276	1277	1278	1279
2400	1280	1281	1282	1283	1284	1285	1286	1287
2410	1288	1289	1290	1291	1292	1293	1294	1295
2420	1296	1297	1298	1299	1300	1301	1302	1303
2430	1304	1305	1306	1307	1308	1309	1310	1311
2440	1312	1313	1314	1315	1316	1317	1318	1319
2450	1320	1321	1322	1323	1324	1325	1326	1327
2460	1328	1329	1330	1331	1332	1333	1334	1335
2470	1336	1337	1338	1339	1340	1341	1342	1343
2500	1344	1345	1346	1347	1348	1349	1350	1351
2510	1352	1353	1354	1355	1356	1357	1358	1359
2520	1360	1361	1362	1363	1364	1365	1366	1367
2530	1368	1369	1370	1371	1372	1373	1374	1375
2540	1376	1377	1378	1379	1380	1381	1382	1383
2550	1384	1385	1386	1387	1388	1389	1390	1391
2560	1392	1393	1394	1395	1396	1397	1398	1399
2570	1400	1401	1402	1403	1404	1405	1406	1407
2600	1408	1409	1410	1411	1412	1413	1414	1415
2610	1416	1417	1418	1419	1420	1421	1422	1423
2620	1424	1425	1426	1427	1428	1429	1430	1431
2630	1432	1433	1434	1435	1436	1437	1438	1439
2640	1440	1441	1442	1443	1444	1445	1446	1447
2650	1448	1449	1450	1451	1452	1453	1454	1455
2660	1456	1457	1458	1459	1460	1461	1462	1463
2670	1464	1465	1466	1467	1468	1469	1470	1471
2700	1472	1473	1474	1475	1476	1477	1478	1479
2710	1480	1481	1482	1483	1484	1485	1486	1487
2720	1488	1489	1490	1491	1492	1493	1494	1495
2730	1496	1497	1498	1499	1500	1501	1502	1503
2740	1504	1505	1506	1507	1508	1509	1510	1511
2750	1512	1513	1514	1515	1516	1517	1518	1519
2760	1520	1521	1522	1523	1524	1525	1526	1527
2770	1528	1529	1530	1531	1532	1533	1534	1535

Octal	3000 to 3777	Decimal	1536 to 2047
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	0	1	2	3	4	5	6	7
3000	1536	1537	1538	1539	1540	1541	1542	1543
3010	1544	1545	1546	1547	1548	1549	1550	1551
3020	1552	1553	1554	1555	1556	1557	1558	1559
3030	1560	1561	1562	1563	1564	1565	1566	1567
3040	1568	1569	1570	1571	1572	1573	1574	1575
3050	1576	1577	1578	1579	1580	1581	1582	1583
3060	1584	1585	1586	1587	1588	1589	1590	1591
3070	1592	1593	1594	1595	1596	1597	1598	1599
3100	1600	1601	1602	1603	1604	1605	1606	1607
3110	1608	1609	1610	1611	1612	1613	1614	1615
3120	1616	1617	1618	1619	1620	1621	1622	1623
3130	1624	1625	1626	1627	1628	1629	1630	1631
3140	1632	1633	1634	1635	1636	1637	1638	1639
3150	1640	1641	1642	1643	1644	1645	1646	1647
3160	1648	1649	1650	1651	1652	1653	1654	1655
3170	1656	1657	1658	1659	1660	1661	1662	1663
3200	1664	1665	1666	1667	1668	1669	1670	1671
3210	1672	1673	1674	1675	1676	1677	1678	1679
3220	1680	1681	1682	1683	1684	1685	1686	1687
3230	1688	1689	1690	1691	1692	1693	1694	1695
3240	1696	1697	1698	1699	1700	1701	1702	1703
3250	1704	1705	1706	1707	1708	1709	1710	1711
3260	1712	1713	1714	1715	1716	1717	1718	1719
3270	1720	1721	1722	1723	1724	1725	1726	1727
3300	1728	1729	1730	1731	1732	1733	1734	1735
3310	1736	1737	1738	1739	1740	1741	1742	1743
3320	1744	1745	1746	1747	1748	1749	1750	1751
3330	1752	1753	1754	1755	1756	1757	1758	1759
3340	1760	1761	1762	1763	1764	1765	1766	1767
3350	1768	1769	1770	1771	1772	1773	1774	1775
3360	1776	1777	1778	1779	1780	1781	1782	1783
3370	1784	1785	1786	1787	1788	1789	1790	1791
3400	1792	1793	1794	1795	1796	1797	1798	1799
3410	1800	1801	1802	1803	1804	1805	1806	1807
3420	1808	1809	1810	1811	1812	1813	1814	1815
3430	1816	1817	1818	1819	1820	1821	1822	1823
3440	1824	1825	1826	1827	1828	1829	1830	1831
3450	1832	1833	1834	1835	1836	1837	1838	1839
3460	1840	1841	1842	1843	1844	1845	1846	1847
3470	1848	1849	1850	1851	1852	1853	1854	1855
3500	1856	1857	1858	1859	1860	1861	1862	1863
3510	1864	1865	1866	1867	1868	1869	1870	1871
3520	1872	1873	1874	1875	1876	1877	1878	1879
3530	1880	1881	1882	1883	1884	1885	1886	1887
3540	1888	1889	1890	1891	1892	1893	1894	1895
3550	1896	1897	1898	1899	1900	1901	1902	1903
3560	1904	1905	1906	1907	1908	1909	1910	1911
3570	1912	1913	1914	1915	1916	1917	1918	1919
3600	1920	1921	1922	1923	1924	1925	1926	1927
3610	1928	1929	1930	1931	1932	1933	1934	1935
3620	1936	1937	1938	1939	1940	1941	1942	1943
3630	1944	1945	1946	1947	1948	1949	1950	1951
3640	1952	1953	1954	1955	1956	1957	1958	1959
3650	1960	1961	1962	1963	1964	1965	1966	1967
3660	1968	1969	1970	1971	1972	1973	1974	1975
3670	1976	1977	1978	1979	1980	1981	1982	1983
3700	1984	1985	1986	1987	1988	1989	1990	1991
3710	1992	1993	1994	1995	1996	1997	1998	1999
3720	2000	2001	2002	2003	2004	2005	2006	2007
3730	2008	2009	2010	2011	2012	2013	2014	2015
3740	2016	2017	2018	2019	2020	2021	2022	2023
3750	2024	2025	2026	2027	2028	2029	2030	2031
3760	2032	2033	2034	2035	2036	2037	2038	2039
3770	2040	2041	2042	2043	2044	2045	2046	2047

Octal	4000	to	4777	Decimal	2048	to	2559
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	0	1	2	3	4	5	6	7
4000	2048	2049	2050	2051	2052	2053	2054	2055
4010	2056	2057	2058	2059	2060	2061	2062	2063
4020	2064	2065	2066	2067	2068	2069	2070	2071
4030	2072	2073	2074	2075	2076	2077	2078	2079
4040	2080	2081	2082	2083	2084	2085	2086	2087
4050	2088	2089	2090	2091	2092	2093	2094	2095
4060	2096	2097	2098	2099	2100	2101	2102	2103
4070	2104	2105	2106	2107	2108	2109	2110	2111
4100	2112	2113	2114	2115	2116	2117	2118	2119
4110	2120	2121	2122	2123	2124	2125	2126	2127
4120	2128	2129	2130	2131	2132	2133	2134	2135
4130	2136	2137	2138	2139	2140	2141	2142	2143
4140	2144	2145	2146	2147	2148	2149	2150	2151
4150	2152	2153	2154	2155	2156	2157	2158	2159
4160	2160	2161	2162	2163	2164	2165	2166	2167
4170	2168	2169	2170	2171	2172	2173	2174	2175
4200	2176	2177	2178	2179	2180	2181	2182	2183
4210	2184	2185	2186	2187	2188	2189	2190	2191
4220	2192	2193	2194	2195	2196	2197	2198	2199
4230	2200	2201	2202	2203	2204	2205	2206	2207
4240	2208	2209	2210	2211	2212	2213	2214	2215
4250	2216	2217	2218	2219	2220	2221	2222	2223
4260	2224	2225	2226	2227	2228	2229	2230	2231
4270	2232	2233	2234	2235	2236	2237	2238	2239
4300	2240	2241	2242	2243	2244	2245	2246	2247
4310	2248	2249	2250	2251	2252	2253	2254	2255
4320	2256	2257	2258	2259	2260	2261	2262	2263
4330	2264	2265	2266	2267	2268	2269	2270	2271
4340	2272	2273	2274	2275	2276	2277	2278	2279
4350	2280	2281	2282	2283	2284	2285	2286	2287
4360	2288	2289	2290	2291	2292	2293	2294	2295
4370	2296	2297	2298	2299	2300	2301	2302	2303
4400	2304	2305	2306	2307	2308	2309	2310	2311
4410	2312	2313	2314	2315	2316	2317	2318	2319
4420	2320	2321	2322	2323	2324	2325	2326	2327
4430	2328	2329	2330	2331	2332	2333	2334	2335
4440	2336	2337	2338	2339	2340	2341	2342	2343
4450	2344	2345	2346	2347	2348	2349	2350	2351
4460	2352	2353	2354	2355	2356	2357	2358	2359
4470	2360	2361	2362	2363	2364	2365	2366	2367
4500	2368	2369	2370	2371	2372	2373	2374	2375
4510	2376	2377	2378	2379	2380	2381	2382	2383
4520	2384	2385	2386	2387	2388	2389	2390	2391
4530	2392	2393	2394	2395	2396	2397	2398	2399
4540	2400	2401	2402	2403	2404	2405	2406	2407
4550	2408	2409	2410	2411	2412	2413	2414	2415
4560	2416	2417	2418	2419	2420	2421	2422	2423
4570	2424	2425	2426	2427	2428	2429	2430	2431
4600	2432	2433	2434	2435	2436	2437	2438	2439
4610	2440	2441	2442	2443	2444	2445	2446	2447
4620	2448	2449	2450	2451	2452	2453	2454	2455
4630	2456	2457	2458	2459	2460	2461	2462	2463
4640	2464	2465	2466	2467	2468	2469	2470	2471
4650	2472	2473	2474	2475	2476	2477	2478	2479
4660	2480	2481	2482	2483	2484	2485	2486	2487
4670	2488	2489	2490	2491	2492	2493	2494	2495
4700	2496	2497	2498	2499	2500	2501	2502	2503
4710	2504	2505	2506	2507	2508	2509	2510	2511
4720	2512	2513	2514	2515	2516	2517	2518	2519
4730	2520	2521	2522	2523	2524	2525	2526	2527
4740	2528	2529	2530	2531	2532	2533	2534	2535
4750	2536	2537	2538	2539	2540	2541	2542	2543
4760	2544	2545	2546	2547	2548	2549	2550	2551
4770	2552	2553	2554	2555	2556	2557	2558	2559

Octal	5000	to	5777	Decimal	2560	to	3071
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	0	1	2	3	4	5	6	7
5000	2560	2561	2562	2563	2564	2565	2566	2567
5010	2568	2569	2570	2571	2572	2573	2574	2575
5020	2576	2577	2578	2579	2580	2581	2582	2583
5030	2584	2585	2586	2587	2588	2589	2590	2591
5040	2592	2593	2594	2595	2596	2597	2598	2599
5050	2600	2601	2602	2603	2604	2605	2606	2607
5060	2608	2609	2610	2611	2612	2613	2614	2615
5070	2616	2617	2618	2619	2620	2621	2622	2623
5100	2624	2625	2626	2627	2628	2629	2630	2631
5110	2632	2633	2634	2635	2636	2637	2638	2639
5120	2640	2641	2642	2643	2644	2645	2646	2647
5130	2648	2649	2650	2651	2652	2653	2654	2655
5140	2656	2657	2658	2659	2660	2661	2662	2663
5150	2664	2665	2666	2667	2668	2669	2670	2671
5160	2672	2673	2674	2675	2676	2677	2678	2679
5170	2680	2681	2682	2683	2684	2685	2686	2687
5200	2688	2689	2690	2691	2692	2693	2694	2695
5210	2696	2697	2698	2699	2700	2701	2702	2703
5220	2704	2705	2706	2707	2708	2709	2710	2711
5230	2712	2713	2714	2715	2716	2717	2718	2719
5240	2720	2721	2722	2723	2724	2725	2726	2727
5250	2728	2729	2730	2731	2732	2733	2734	2735
5260	2736	2737	2738	2739	2740	2741	2742	2743
5270	2744	2745	2746	2747	2748	2749	2750	2751
5300	2752	2753	2754	2755	2756	2757	2758	2759
5310	2760	2761	2762	2763	2764	2765	2766	2767
5320	2768	2769	2770	2771	2772	2773	2774	2775
5330	2776	2777	2778	2779	2780	2781	2782	2783
5340	2784	2785	2786	2787	2788	2789	2790	2791
5350	2792	2793	2794	2795	2796	2797	2798	2799
5360	2800	2801	2802	2803	2804	2805	2806	2807
5370	2808	2809	2810	2811	2812	2813	2814	2815
5400	2816	2817	2818	2819	2820	2821	2822	2823
5410	2824	2825	2826	2827	2828	2829	2830	2831
5420	2832	2833	2834	2835	2836	2837	2838	2839
5430	2840	2841	2842	2843	2844	2845	2846	2847
5440	2848	2849	2850	2851	2852	2853	2854	2855
5450	2856	2857	2858	2859	2860	2861	2862	2863
5460	2864	2865	2866	2867	2868	2869	2870	2871
5470	2872	2873	2874	2875	2876	2877	2878	2879
5500	2880	2881	2882	2883	2884	2885	2886	2887
5510	2888	2889	2890	2891	2892	2893	2894	2895
5520	2896	2897	2898	2899	2900	2901	2902	2903
5530	2904	2905	2906	2907	2908	2909	2910	2911
5540	2912	2913	2914	2915	2916	2917	2918	2919
5550	2920	2921	2922	2923	2924	2925	2926	2927
5560	2928	2929	2930	2931	2932	2933	2934	2935
5570	2936	2937	2938	2939	2940	2941	2942	2943
5600	2944	2945	2946	2947	2948	2949	2950	2951
5610	2952	2953	2954	2955	2956	2957	2958	2959
5620	2960	2961	2962	2963	2964	2965	2966	2967
5630	2968	2969	2970	2971	2972	2973	2974	2975
5640	2976	2977	2978	2979	2980	2981	2982	2983
5650	2984	2985	2986	2987	2988	2989	2990	2991
5660	2992	2993	2994	2995	2996	2997	2998	2999
5670	3000	3001	3002	3003	3004	3005	3006	3007
5700	3008	3009	3010	3011	3012	3013	3014	3015
5710	3016	3017	3018	3019	3020	3021	3022	3023
5720	3024	3025	3026	3027	3028	3029	3030	3031
5730	3032	3033	3034	3035	3036	3037	3038	3039
5740	3040	3041	3042	3043	3044	3045	3046	3047
5750	3048	3049	3050	3051	3052	3053	3054	3055
5760	3056	3057	3058	3059	3060	3061	3062	3063
5770	3064	3065	3066	3067	3068	3069	3070	3071

Octal	6000	to	6777	Decimal	3072	to	3583
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	0	1	2	3	4	5	6	7
6000	3072	3073	3074	3075	3076	3077	3078	3079
6010	3080	3081	3082	3083	3084	3085	3086	3087
6020	3088	3089	3090	3091	3092	3093	3094	3095
6030	3096	3097	3098	3099	3100	3101	3102	3103
6040	3104	3105	3106	3107	3108	3109	3110	3111
6050	3112	3113	3114	3115	3116	3117	3118	3119
6060	3120	3121	3122	3123	3124	3125	3126	3127
6070	3128	3129	3130	3131	3132	3133	3134	3135
6100	3136	3137	3138	3139	3140	3141	3142	3143
6110	3144	3145	3146	3147	3148	3149	3150	3151
6120	3152	3153	3154	3155	3156	3157	3158	3159
6130	3160	3161	3162	3163	3164	3165	3166	3167
6140	3168	3169	3170	3171	3172	3173	3174	3175
6150	3176	3177	3178	3179	3180	3181	3182	3183
6160	3184	3185	3186	3187	3188	3189	3190	3191
6170	3192	3193	3194	3195	3196	3197	3198	3199
6200	3200	3201	3202	3203	3204	3205	3206	3207
6210	3208	3209	3210	3211	3212	3213	3214	3215
6220	3216	3217	3218	3219	3220	3221	3222	3223
6230	3224	3225	3226	3227	3228	3229	3230	3231
6240	3232	3233	3234	3235	3236	3237	3238	3239
6250	3240	3241	3242	3243	3244	3245	3246	3247
6260	3248	3249	3250	3251	3252	3253	3254	3255
6270	3256	3257	3258	3259	3260	3261	3262	3263
6300	3264	3265	3266	3267	3268	3269	3270	3271
6310	3272	3273	3274	3275	3276	3277	3278	3279
6320	3280	3281	3282	3283	3284	3285	3286	3287
6330	3288	3289	3290	3291	3292	3293	3294	3295
6340	3296	3297	3298	3299	3300	3301	3302	3303
6350	3304	3305	3306	3307	3308	3309	3310	3311
6360	3312	3313	3314	3315	3316	3317	3318	3319
6370	3320	3321	3322	3323	3324	3325	3326	3327
6400	3328	3329	3330	3331	3332	3333	3334	3335
6410	3336	3337	3338	3339	3340	3341	3342	3343
6420	3344	3345	3346	3347	3348	3349	3350	3351
6430	3352	3353	3354	3355	3356	3357	3358	3359
6440	3360	3361	3362	3363	3364	3365	3366	3367
6450	3368	3369	3370	3371	3372	3373	3374	3375
6460	3376	3377	3378	3379	3380	3381	3382	3383
6470	3384	3385	3386	3387	3388	3389	3390	3391
6500	3392	3393	3394	3395	3396	3397	3398	3399
6510	3400	3401	3402	3403	3404	3405	3406	3407
6520	3408	3409	3410	3411	3412	3413	3414	3415
6530	3416	3417	3418	3419	3420	3421	3422	3423
6540	3424	3425	3426	3427	3428	3429	3430	3431
6550	3432	3433	3434	3435	3436	3437	3438	3439
6560	3440	3441	3442	3443	3444	3445	3446	3447
6570	3448	3449	3450	3451	3452	3453	3454	3455
6600	3456	3457	3458	3459	3460	3461	3462	3463
6610	3464	3465	3466	3467	3468	3469	3470	3471
6620	3472	3473	3474	3475	3476	3477	3478	3479
6630	3480	3481	3482	3483	3484	3485	3486	3487
6640	3488	3489	3490	3491	3492	3493	3494	3495
6650	3496	3497	3498	3499	3500	3501	3502	3503
6660	3504	3505	3506	3507	3508	3509	3510	3511
6670	3512	3513	3514	3515	3516	3517	3518	3519
6700	3520	3521	3522	3523	3524	3525	3526	3527
6710	3528	3529	3530	3531	3532	3533	3534	3535
6720	3536	3537	3538	3539	3540	3541	3542	3543
6730	3544	3545	3546	3547	3548	3549	3550	3551
6740	3552	3553	3554	3555	3556	3557	3558	3559
6750	3560	3561	3562	3563	3564	3565	3566	3567
6760	3568	3569	3570	3571	3572	3573	3574	3575
6770	3576	3577	3578	3579	3580	3581	3582	3583

Octal	7000	to	7777	Decimal	3584	to	4095
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	0	1	2	3	4	5	6	7
7000	3584	3585	3586	3587	3588	3589	3590	3591
7010	3592	3593	3594	3595	3596	3597	3598	3599
7020	3600	3601	3602	3603	3604	3605	3606	3607
7030	3608	3609	3610	3611	3612	3613	3614	3615
7040	3616	3617	3618	3619	3620	3621	3622	3623
7050	3624	3625	3626	3627	3628	3629	3630	3631
7060	3632	3633	3634	3635	3636	3637	3638	3639
7070	3640	3641	3642	3643	3644	3645	3646	3647
7100	3648	3649	3650	3651	3652	3653	3654	3655
7110	3656	3657	3658	3659	3660	3661	3662	3663
7120	3664	3665	3666	3667	3668	3669	3670	3671
7130	3672	3673	3674	3675	3676	3677	3678	3679
7140	3680	3681	3682	3683	3684	3685	3686	3687
7150	3688	3689	3690	3691	3692	3693	3694	3695
7160	3696	3697	3698	3699	3700	3701	3702	3703
7170	3704	3705	3706	3707	3708	3709	3710	3711
7200	3712	3713	3714	3715	3716	3717	3718	3719
7210	3720	3721	3722	3723	3724	3725	3726	3727
7220	3728	3729	3730	3731	3732	3733	3734	3735
7230	3736	3737	3738	3739	3740	3741	3742	3743
7240	3744	3745	3746	3747	3748	3749	3750	3751
7250	3752	3753	3754	3755	3756	3757	3758	3759
7260	3760	3761	3762	3763	3764	3765	3766	3767
7270	3768	3769	3770	3771	3772	3773	3774	3775
7300	3776	3777	3778	3779	3780	3781	3782	3783
7310	3784	3785	3786	3787	3788	3789	3790	3791
7320	3792	3793	3794	3795	3796	3797	3798	3799
7330	3800	3801	3802	3803	3804	3805	3806	3807
7340	3808	3809	3810	3811	3812	3813	3814	3815
7350	3816	3817	3818	3819	3820	3821	3822	3823
7360	3824	3825	3826	3827	3828	3829	3830	3831
7370	3832	3833	3834	3835	3836	3837	3838	3839
7400	3840	3841	3842	3843	3844	3845	3846	3847
7410	3848	3849	3850	3851	3852	3853	3854	3855
7420	3856	3857	3858	3859	3860	3861	3862	3863
7430	3864	3865	3866	3867	3868	3869	3870	3871
7440	3872	3873	3874	3875	3876	3877	3878	3879
7450	3880	3881	3882	3883	3884	3885	3886	3887
7460	3888	3889	3890	3891	3892	3893	3894	3895
7470	3896	3897	3898	3899	3900	3901	3902	3903
7500	3904	3905	3906	3907	3908	3909	3910	3911
7510	3912	3913	3914	3915	3916	3917	3918	3919
7520	3920	3921	3922	3923	3924	3925	3926	3927
7530	3928	3929	3930	3931	3932	3933	3934	3935
7540	3936	3937	3938	3939	3940	3941	3942	3943
7550	3944	3945	3946	3947	3948	3949	3950	3951
7560	3952	3953	3954	3955	3956	3957	3958	3959
7570	3960	3961	3962	3963	3964	3965	3966	3967
7600	3968	3969	3970	3971	3972	3973	3974	3975
7610	3976	3977	3978	3979	3980	3981	3982	3983
7620	3984	3985	3986	3987	3988	3989	3990	3991
7630	3992	3993	3994	3995	3996	3997	3998	3999
7640	4000	4001	4002	4003	4004	4005	4006	4007
7650	4008	4009	4010	4011	4012	4013	4014	4015
7660	4016	4017	4018	4019	4020	4021	4022	4023
7670	4024	4025	4026	4027	4028	4029	4030	4031
7700	4032	4033	4034	4035	4036	4037	4038	4039
7710	4040	4041	4042	4043	4044	4045	4046	4047
7720	4048	4049	4050	4051	4052	4053	4054	4055
7730	4058	4057	4058	4059	4060	4061	4062	4063
7740	4064	4065	4066	4067	4068	4069	4070	4071
7750	4072	4073	4074	4075	4076	4077	4078	4079
7760	4080	4081	4082	4083	4084	4085	4086	4087
7770	4088	4089	4090	4091	4092	4093	4094	4095

APPENDIX E

OCTAL-DECIMAL FRACTION CONVERSION TABLE

OCTAL	DEC.	OCTAL	DEC.	OCTAL	DEC.	OCTAL	DEC.
.000	.000000	.100	.125000	.200	.250000	.300	.375000
.001	.001953	.101	.126953	.201	.251953	.301	.376953
.002	.003906	.102	.128906	.202	.253906	.302	.378906
.003	.005859	.103	.130859	.203	.255859	.303	.380859
.004	.007812	.104	.132812	.204	.257812	.304	.382812
.005	.009765	.105	.134765	.205	.259765	.305	.384765
.006	.011718	.106	.136718	.206	.261718	.306	.386718
.007	.013671	.107	.138671	.207	.263671	.307	.388671
.010	.015625	.110	.140625	.210	.265625	.310	.390625
.011	.017578	.111	.142578	.211	.267578	.311	.392578
.012	.019531	.112	.144531	.212	.269531	.312	.394531
.013	.021484	.113	.146484	.213	.271484	.313	.396484
.014	.023437	.114	.148437	.214	.273437	.314	.398437
.015	.025390	.115	.150390	.215	.275390	.315	.400390
.016	.027343	.116	.152343	.216	.277343	.316	.402343
.017	.029296	.117	.154296	.217	.279296	.317	.404296
.020	.031250	.120	.156250	.220	.281250	.320	.406250
.021	.033203	.121	.158203	.221	.283203	.321	.408203
.022	.035156	.122	.160156	.222	.285156	.322	.410156
.023	.037109	.123	.162109	.223	.287109	.323	.412109
.024	.039062	.124	.164062	.224	.289062	.324	.414062
.025	.041015	.125	.166015	.225	.291015	.325	.416015
.026	.042968	.126	.167968	.226	.292968	.326	.417968
.027	.044921	.127	.169921	.227	.294921	.327	.419921
.030	.046875	.130	.171875	.230	.296875	.330	.421875
.031	.048828	.131	.173828	.231	.298828	.331	.423828
.032	.050781	.132	.175781	.232	.300781	.332	.425781
.033	.052734	.133	.177734	.233	.302734	.333	.427734
.034	.054687	.134	.179687	.234	.304687	.334	.429687
.035	.056640	.135	.181640	.235	.306640	.335	.431640
.036	.058593	.136	.183593	.236	.308593	.336	.433593
.037	.060546	.137	.185546	.237	.310546	.337	.435546
.040	.062500	.140	.187500	.240	.312500	.340	.437500
.041	.064453	.141	.189453	.241	.314453	.341	.439453
.042	.066406	.142	.191406	.242	.316406	.342	.441406
.043	.068359	.143	.193359	.243	.318359	.343	.443359
.044	.070312	.144	.195312	.244	.320312	.344	.445312
.045	.072265	.145	.197265	.245	.322265	.345	.447265
.046	.074218	.146	.199218	.246	.324218	.346	.449218
.047	.076171	.147	.201171	.247	.326171	.347	.451171
.050	.078125	.150	.203125	.250	.328125	.350	.453125
.051	.080078	.151	.205078	.251	.330078	.351	.455078
.052	.082031	.152	.207031	.252	.332031	.352	.457031
.053	.083984	.153	.208984	.253	.333984	.353	.458984
.054	.085937	.154	.210937	.254	.335937	.354	.460937
.055	.087890	.155	.212890	.255	.337890	.355	.462890
.056	.089843	.156	.214843	.256	.339843	.356	.464843
.057	.091796	.157	.216796	.257	.341796	.357	.466796
.060	.093750	.160	.218750	.260	.343750	.360	.468750
.061	.095703	.161	.220703	.261	.345703	.361	.470703
.062	.097656	.162	.222656	.262	.347656	.362	.472656
.063	.099609	.163	.224609	.263	.349609	.363	.474609
.064	.101562	.164	.226562	.264	.351562	.364	.476562
.065	.103515	.165	.228515	.265	.353515	.365	.478515
.066	.105468	.166	.230468	.266	.355468	.366	.480468
.067	.107421	.167	.232421	.267	.357421	.367	.482421
.070	.109375	.170	.234375	.270	.359375	.370	.484375
.071	.111328	.171	.236328	.271	.361328	.371	.486328
.072	.113281	.172	.238281	.272	.363281	.372	.488281
.073	.115234	.173	.240234	.273	.365234	.373	.490234
.074	.117187	.174	.242187	.274	.367187	.374	.492187
.075	.119140	.175	.244140	.275	.369140	.375	.494140
.076	.121093	.176	.246093	.276	.371093	.376	.496093
.077	.123046	.177	.248046	.277	.373046	.377	.498046

OCTAL	DEC.	OCTAL	DEC.	OCTAL	DEC.	OCTAL	DEC.
.000000	.000000	.000100	.000244	.000200	.000488	.000300	.000732
.000001	.000003	.000101	.000247	.000201	.000492	.000301	.000736
.000002	.000007	.000102	.000251	.000202	.000495	.000302	.000740
.000003	.000011	.000103	.000255	.000203	.000499	.000303	.000743
.000004	.000015	.000104	.000259	.000204	.000503	.000304	.000747
.000005	.000019	.000105	.000263	.000205	.000507	.000305	.000751
.000006	.000022	.000106	.000267	.000206	.000511	.000306	.000755
.000007	.000026	.000107	.000270	.000207	.000514	.000307	.000759
.000010	.000030	.000110	.000274	.000210	.000518	.000310	.000762
.000011	.000034	.000111	.000278	.000211	.000522	.000311	.000766
.000012	.000038	.000112	.000282	.000212	.000526	.000312	.000770
.000013	.000041	.000113	.000286	.000213	.000530	.000313	.000774
.000014	.000045	.000114	.000289	.000214	.000534	.000314	.000778
.000015	.000049	.000115	.000293	.000215	.000537	.000315	.000782
.000016	.000053	.000116	.000297	.000216	.000541	.000316	.000785
.000017	.000057	.000117	.000301	.000217	.000545	.000317	.000789
.000020	.000061	.000120	.000305	.000220	.000549	.000320	.000793
.000021	.000064	.000121	.000308	.000221	.000553	.000321	.000797
.000022	.000068	.000122	.000312	.000222	.000556	.000322	.000801
.000023	.000072	.000123	.000316	.000223	.000560	.000323	.000805
.000024	.000076	.000124	.000320	.000224	.000564	.000324	.000808
.000025	.000080	.000125	.000324	.000225	.000568	.000325	.000812
.000026	.000083	.000126	.000328	.000226	.000572	.000326	.000816
.000027	.000087	.000127	.000331	.000227	.000576	.000327	.000820
.000030	.000091	.000130	.000335	.000230	.000579	.000330	.000823
.000031	.000095	.000131	.000339	.000231	.000583	.000331	.000827
.000032	.000099	.000132	.000343	.000232	.000587	.000332	.000831
.000033	.000102	.000133	.000347	.000233	.000591	.000333	.000835
.000034	.000106	.000134	.000350	.000234	.000595	.000334	.000839
.000035	.000110	.000135	.000354	.000235	.000598	.000335	.000843
.000036	.000114	.000136	.000358	.000236	.000602	.000336	.000846
.000037	.000118	.000137	.000362	.000237	.000606	.000337	.000850
.000040	.000122	.000140	.000366	.000240	.000610	.000340	.000854
.000041	.000125	.000141	.000370	.000241	.000614	.000341	.000858
.000042	.000129	.000142	.000373	.000242	.000617	.000342	.000862
.000043	.000133	.000143	.000377	.000243	.000621	.000343	.000865
.000044	.000137	.000144	.000381	.000244	.000625	.000344	.000869
.000045	.000141	.000145	.000385	.000245	.000629	.000345	.000873
.000046	.000144	.000146	.000389	.000246	.000633	.000346	.000877
.000047	.000148	.000147	.000392	.000247	.000637	.000347	.000881
.000050	.000152	.000150	.000396	.000250	.000640	.000350	.000885
.000051	.000156	.000151	.000400	.000251	.000644	.000351	.000888
.000052	.000160	.000152	.000404	.000252	.000648	.000352	.000892
.000053	.000164	.000153	.000408	.000253	.000652	.000353	.000896
.000054	.000167	.000154	.000411	.000254	.000656	.000354	.000900
.000055	.000171	.000155	.000415	.000255	.000659	.000355	.000904
.000056	.000175	.000156	.000419	.000256	.000663	.000356	.000907
.000057	.000179	.000157	.000423	.000257	.000667	.000357	.000911
.000060	.000183	.000160	.000427	.000260	.000671	.000360	.000915
.000061	.000186	.000161	.000431	.000261	.000675	.000361	.000919
.000062	.000190	.000162	.000434	.000262	.000679	.000362	.000923
.000063	.000194	.000163	.000438	.000263	.000682	.000363	.000926
.000064	.000198	.000164	.000442	.000264	.000686	.000364	.000930
.000065	.000202	.000165	.000446	.000265	.000690	.000365	.000934
.000066	.000205	.000166	.000450	.000266	.000694	.000366	.000938
.000067	.000209	.000167	.000453	.000267	.000698	.000367	.000942
.000070	.000213	.000170	.000457	.000270	.000701	.000370	.000946
.000071	.000217	.000171	.000461	.000271	.000705	.000371	.000949
.000072	.000221	.000172	.000465	.000272	.000709	.000372	.000953
.000073	.000225	.000173	.000469	.000273	.000713	.000373	.000957
.000074	.000228	.000174	.000473	.000274	.000717	.000374	.000961
.000075	.000232	.000175	.000476	.000275	.000720	.000375	.000965
.000076	.000236	.000176	.000480	.000276	.000724	.000376	.000968
.000077	.000240	.000177	.000484	.000277	.000728	.000377	.000972

OCTAL	DEC.	OCTAL	DEC.	OCTAL	DEC.	OCTAL	DEC.
.000400	.000976	.000500	.001220	.000600	.001464	.000700	.001708
.000401	.000980	.000501	.001224	.000601	.001468	.000701	.001712
.000402	.000984	.000502	.001228	.000602	.001472	.000702	.001716
.000403	.000988	.000503	.001232	.000603	.001476	.000703	.001720
.000404	.000991	.000504	.001235	.000604	.001480	.000704	.001724
.000405	.000995	.000505	.001239	.000605	.001483	.000705	.001728
.000406	.000999	.000506	.001243	.000606	.001487	.000706	.001731
.000407	.001003	.000507	.001247	.000607	.001491	.000707	.001735
.000410	.001007	.000510	.001251	.000610	.001495	.000710	.001739
.000411	.001010	.000511	.001255	.000611	.001499	.000711	.001743
.000412	.001014	.000512	.001258	.000612	.001502	.000712	.001747
.000413	.001018	.000513	.001262	.000613	.001506	.000713	.001750
.000414	.001022	.000514	.001266	.000614	.001510	.000714	.001754
.000415	.001026	.000515	.001270	.000615	.001514	.000715	.001758
.000416	.001029	.000516	.001274	.000616	.001518	.000716	.001762
.000417	.001033	.000517	.001277	.000617	.001522	.000717	.001766
.000420	.001037	.000520	.001281	.000620	.001525	.000720	.001770
.000421	.001041	.000521	.001285	.000621	.001529	.000721	.001773
.000422	.001045	.000522	.001289	.000622	.001533	.000722	.001777
.000423	.001049	.000523	.001293	.000623	.001537	.000723	.001781
.000424	.001052	.000524	.001296	.000624	.001541	.000724	.001785
.000425	.001056	.000525	.001300	.000625	.001544	.000725	.001789
.000426	.001060	.000526	.001304	.000626	.001548	.000726	.001792
.000427	.001064	.000527	.001308	.000627	.001552	.000727	.001796
.000430	.001069	.000530	.001312	.000630	.001556	.000730	.001800
.000431	.001071	.000531	.001316	.000631	.001560	.000731	.001804
.000432	.001075	.000532	.001319	.000632	.001564	.000732	.001808
.000433	.001079	.000533	.001323	.000633	.001567	.000733	.001811
.000434	.001083	.000534	.001327	.000634	.001571	.000734	.001815
.000435	.001087	.000535	.001331	.000635	.001575	.000735	.001819
.000436	.001091	.000536	.001335	.000636	.001579	.000736	.001823
.000437	.001094	.000537	.001338	.000637	.001583	.000737	.001827
.000440	.001098	.000540	.001342	.000640	.001586	.000740	.001831
.000441	.001102	.000541	.001346	.000641	.001590	.000741	.001834
.000442	.001106	.000542	.001350	.000642	.001594	.000742	.001838
.000443	.001110	.000543	.001354	.000643	.001598	.000743	.001842
.000444	.001113	.000544	.001358	.000644	.001602	.000744	.001846
.000445	.001117	.000545	.001361	.000645	.001605	.000745	.001850
.000446	.001121	.000546	.001365	.000646	.001609	.000746	.001853
.000447	.001125	.000547	.001369	.000647	.001613	.000747	.001857
.000450	.001129	.000550	.001373	.000650	.001617	.000750	.001861
.000451	.001132	.000551	.001377	.000651	.001621	.000751	.001865
.000452	.001136	.000552	.001380	.000652	.001625	.000752	.001869
.000453	.001140	.000553	.001384	.000653	.001628	.000753	.001873
.000454	.001144	.000554	.001388	.000654	.001632	.000754	.001876
.000455	.001148	.000555	.001392	.000655	.001636	.000755	.001880
.000456	.001152	.000556	.001396	.000656	.001640	.000756	.001884
.000457	.001155	.000557	.001399	.000657	.001644	.000757	.001888
.000460	.001159	.000560	.001403	.000660	.001647	.000760	.001892
.000461	.001163	.000561	.001407	.000661	.001651	.000761	.001895
.000462	.001167	.000562	.001411	.000662	.001655	.000762	.001899
.000463	.001171	.000563	.001415	.000663	.001659	.000763	.001903
.000464	.001174	.000564	.001419	.000664	.001663	.000764	.001907
.000465	.001178	.000565	.001422	.000665	.001667	.000765	.001911
.000466	.001182	.000566	.001426	.000666	.001670	.000766	.001914
.000467	.001186	.000567	.001430	.000667	.001674	.000767	.001918
.000470	.001190	.000570	.001434	.000670	.001678	.000770	.001922
.000471	.001194	.000571	.001438	.000671	.001682	.000771	.001926
.000472	.001197	.000572	.001441	.000672	.001686	.000772	.001930
.000473	.001201	.000573	.001445	.000673	.001689	.000773	.001934
.000474	.001205	.000574	.001449	.000674	.001693	.000774	.001937
.000475	.001209	.000575	.001453	.000675	.001697	.000775	.001941
.000476	.001213	.000576	.001457	.000676	.001701	.000776	.001945
.000477	.001216	.000577	.001461	.000677	.001705	.000777	.001949

# APPENDIX F

## Code Table

640 Graphic	Typewriter Paper Tape Octal	Hollerith Card Code	Disk Magnetic Tape Octal	Line Printer Octal
0	260	0	12	12
1	261	1	01	01
2	262	2	02	02
3	263	3	03	03
4	264	4	04	04
5	265	5	05	05
6	266	6	06	06
7	267	7	07	07
8	270	8	10	10
9	271	9	11	11
:	272	8-5	15	15
;	273	11-8-6	56	56
<	274	12-8-6	76	76
=	275	8-3	13	13
>	276	8-6	16	16
?	277	12-0	72	72
Space	240			
!	241	11-0	52	52
"	242			
#	243			
\$	244	11-8-3	53	53
%	245			
&	246			
'	247		14	14
(	250	0-8-4	34	34
)	251	12-8-4	74	74
*	252	11-8-4	54	54
+	253	12-	60	60
.	254	8-4	33	33
-	255		40	40
.	256	12-8-3	73	73
/	257	0-1	21	21
@	300			
A	301	12-1	61	61
B	302	12-2	62	62
C	303	12-3	63	63
D	304	12-4	64	64
E	305	12-5	65	65
F	306	12-6	66	66
G	307	12-7	67	67
H	310	12-8	70	70
I	311	12-9	71	71
J	312	11-1	41	41
K	313	11-2	42	42
L	314	11-3	43	43
M	315	11-4	44	44
N	316	11-5	45	45
O	317	11-6	46	46
P	320	11-7	47	47
Q	321	11-8	50	50
R	322	11-9	51	51
S	323	0-2	22	22
T	324	0-3	23	23
U	325	0-4	24	24
V	326	0-5	25	25
W	327	0-6	26	26
X	330	0-7	27	27
Y	331	0-8	30	30
Z	332	0-9	31	31
[	333	12-8-5	75	75
\	334	0-8-6	36	36
]	335	11-8-5	55	55
↑	336			
←	337			
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Tab	211			
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## APPENDIX G

### Device Numbers and Operation

OCTAL	DEVICE
000	Paper tape reader, Teletype ASR-33
001	Paper tape punch, Teletype ASR-33
002	Card reader
003	Line printer
004	Reserved for Tape Cartridge Mass memory
005	Reserved for Tape Cartridge Mass memory
006	Reserved for Tape Cartridge Mass memory
007	Reserved for Tape Cartridge Mass memory
010	Disk No. 1,
thru	or
016	Magnetic Tape
017	Reserved for plotter
020	Disk No. 2,
thru	or
026	Magnetic Tape
027	Reserved for Display Monitor
030	Disk No. 3,
thru	or
036	Magnetic Tape
037 thru 077	Reserved for EAI 680, 8800 and linkage equipments or for special engineered systems

## ASR-33/35 OPERATION

The ASR-33 is a half or full duplex input/output device and is assigned two device number, one for input, the other for output.

Device No. 0 - Input

### Tape Reader/Keyboard

The tape reader/keyboard may be used in three different modes.

Mode 0. The ASR-33 is selected as a half duplex device; that is, the information read from the reader is printed on the typewriter. The least significant three bits of each character are assembled in an input register, and when six characters have been read, the word is transmitted to the accumulator or memory, depending on DI or RI instruction. The reader stops when an "X-OFF" code is read. If in the RI mode, a time-out releases the computer and is indicated in the status word.

Mode 1. The ASR-33 is selected as a full duplex device, i. e., the input characters are transmitted but not typed. All 8-bit character codes may be read from tape. Termination of this mode is by the controlling program.

Mode 2. Same as Mode 1 except two characters are assembled and transmitted. The first character is the most significant.

Device No. 1 - Output

### Typewriter

The typewriter may be used in two distinct modes.

Mode 0. Accepts characters from the computer and prints. All 8-bit codes are recognized although some result in no typing.

Mode 1. Accepts words from the computer as two characters and prints. The most significant character is in bits 0-7 of the word and printed first.

Punch - The punch operates whenever turned on and a character is transmitted to the typewriter.

## DISC OPERATION

To use these commands with a DISC type mass storage device, the DISC has been divided into sections as follows:

Tracks 1-32	Device No. 8
Tracks 33-45	Device No. 9
Tracks 46-58	Device No. 10
Tracks 59-71	Device No. 11
Tracks 72-84	Device No. 12
Tracks 85-97	Device No. 13
Tracks 98-110	Device No. 14

The Monitor initializes each separate section of the disc when a HOME instruction with the appropriate device is executed.

The tracks on the DISC contain 64 sectors of 34 words each.

The first word contains the TRACK/SECTOR mark as bit 0-7 for track, 8-15 for sector.

When a record is written on the DISC, the Monitor selects the next available track/sector and writes the number of words in the record as the second word, followed by the actual record. When the final word is written, a check sum is placed in the next word and the record is terminated. This procedure indicates that optimum record length is  $31 + n$  (32) words, where  $n$  is an integer used by the Monitor to check when finished writing all sectors. The Monitor operation results in the DISC appearing as one file of 32K and six files of 26K words of storage if information is stored in optimum record size.

The I/O Monitor does not allow a random access of the DISC although the ability is present at the basic machine language level of programming.

The I/O Monitor will not allow writing or reading of the first 32 tracks of the DSIC. This area is reserved for the basic Monitor and the system library.

## OPERATION OF THE MAGNETIC TAPE CONTROLLER

### Status word input

Condition indicated by a "1" bit in the given word position.

More than one condition may exist at a given time.

#### Bit

0	Busy
1	End of Record
2	Beginning of File
3	Beginning Tape Mark
4	Ending Tape Mark
5	
6	
7	
8	
9	
10	
11	Inoperative
12	Write
13	Read
14	Rewinding
15	Ready

### Device Select

#### Bit

0	Interrupt Next Word
1	Interrupt End of Record
2	Interrupt End of File
3	Interrupt on Begin File Mark
4	I/O Transfer Mode 8-Bits
5	I/O Transfer Mode 16-Bits
6	
7	

<u>Bit</u>	
8	
9	
10	
11	
12	Backspace
13	Rewind
14	Write
15	Read

The DI instruction results in the current mode configuration being read from tape and stored in the accumulator.

This can only happen when the tape unit is not already busy and the instruction is to be executed.

A time out will prevent total computer lock-up.

The DO instruction results in the content of the accumulator being transferred in the current mode configuration.

If the tape unit is busy, no action is performed and a time out prevents computer lock-up.

If on either a DI or DO instruction the tape is at the end tape mark, the tape unit ignores the instruction and causes an end of tape interrupt on the alarm channel.

NOTE: The following sequence allows one to check the status and avoid missing information in 3 and 4 above.

```

SI      ; Status In
SAE     Skip if Not Ready
JMP     Process this Word
.
.
.

```

## APPENDIX H

### Assembly Mnemonics

POOL	Set constant in zone zero
ORG	Program origin
REL	Relocatable
END	End of program
CON	Continue
BCI	Binary coded information
DEC	Decimal data, either fixed or floating point and single or double precision
HEX	Hexadecimal data
OCT	Octal data
DEX	Absolute decimal data
COMM	Common data location
LIST	Enable listing
CALL	Subroutine link
BSZ	Block of zeros
BSS	Block starting symbol
BES	Block ending Symbol
EQU	Equals
READ	Read from external device
WRITE	Write on external device
REWIND	Rewind to load point
HOME	Return to start track
ADR	Address



## Program Mnemonics

Program	Control Characters	Action
DEBUG	A	Type accumulator
	B	Set Begin
	C	Compare
	D	Decimal Format
	E	Set END
	G	Go To
	H	Hex Format
	I	Effective Address Opened
	L	List
	O	Octal Format
	P	Punch
	Q	Type Q
	R	Type Address of Open Register
	S	Symbolic Format
	T	Trap Set
	V	Verify
	X	Type Index
Z	Ignore	
/	Open	
C/R	Enter	
L/F	Close	
UPDATE	DXXXX;	Dupe to XXXX
	RXXXX;	Remove to XXXX
	A ;	Add from Typewriter
	;	Stop A
	C ;	Copy
	LXXXX;	List to XXXX
	ZXXXX;	Set record number
P ;	Print current record number	

Monitor

A	Assembler
D	Debug
F	FORTRAN
L	Loader
M	Matrix Interpreter
T	Trace
U	Update

.  
. .  
. .  
. .  
. .  
. .  
. .

following character

;	Load
\$	Add
:	Erase
Tab	Ignore
*	Remove

## INDEX

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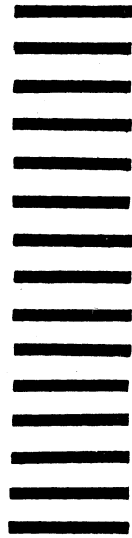
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