Reference Manual

CONTROL DATA® 160-A COMPUTER



	RECORD of REVISIONS
REVISION	NOTES
A thru F	Included in this printing.
G	Pages A-6 and A-9 revised. Pages A-21 through A-24 replaced by A-21 through A-29. The
(3-22-65)	information in former Appendix VII now comprises Appendixes VII and VIII; former Appendixes
	VIII, IX and X are now Appendixes IX, X and XI respectively but otherwise unchanged.
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or use Comment Sheet in the back of this manual.

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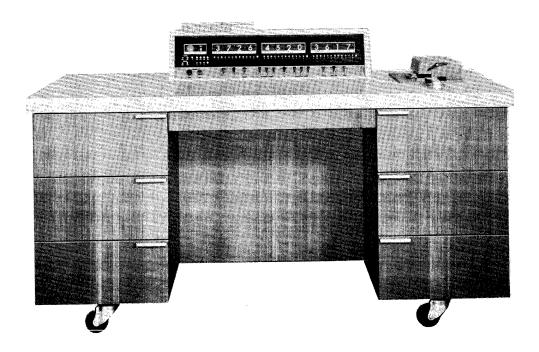
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160-A COMPUTER

Chapter I

DESCRIPTION

The CONTROL DATA* 160-A Computer is a small (desk size), highly flexible, stored program computer with many features normally found only in large scale computers. Using a high speed data transfer channel, the 160-A may communicate with other Control Data computers, allowing multi-computer processing and computer control of computers. Two computers may share input/output equipment such as magnetic tape stations to assure high computing performance at a minimum cost.

160-A CHARACTERISTICS

Buffered	input/	output
----------	--------	--------

Internal and external interrupt

An expandable magnetic core memory (8,192 to 32,768 words)

A 350 character/second paper tape reader

A 110 character/second paper tape punch

Transistor-diode logic

A 160-A system may be expanded to include the following external equipment:

Up to 40 magnetic tape stations

Input/output typewriters

Punched card readers, punches, and low speed line printers

High speed (1000 lines/minute) printers

Plotting and digital display equipment

Analog-to-digital and digital-toanalog equipment

Two or more Control Data computers operating together in a satellite system

Two CONTROL DATA 160-A Computers operating independently but sharing the same magnetic core memory

^{*}Registered trademark of Control Data Corporation

PHYSICAL DESCRIPTION

Physical characteristics and power requirements are:

Height - 29 inches

Width - 30 inches

Length - 61% inches

Weight - 810 pounds

Power - 26 amps, 110v, 60 cycle, single phase

The 160-A is a parallel, single address, electronic data processor. An internally stored program located in sequential addresses controls operation. The basic memory of the 160-A consists of two banks of magnetic core storage, each with a capacity of 4096 12-bit binary words and a storage cycle time of 6.4 usec. This basic memory may be expanded in modules of 8,192 words up to a maximum of 32,768 words. The bank approach permits increasing the storage capacity of the computer without increasing the size of the 12-bit storage address, and is implemented by executing storage bank control commands at the beginning of a program. Bank selections may be changed at any time during the program. Instructions are executed in one to four storage cycles; the time varies between 6.4 and 25.6 usec. An instruction is a 12-bit word comprising a 6-bit function or operation code (F) and a 6-bit code extension and/or execution address (E). The average program execution time for the 130 instructions is approximately 15 usec per instruction.

A CONTROL DATA 350 Paper Tape Reader is located in the desk top of the computer to the right of the display console, and a Teletype BRPE-11 paper tape punch is housed in the left pedestal of the computer cabinet.

REGISTERS

The registers are the storage units for all data transmission and computation in the 160-A. Contents of all but one of the registers are displayed on the console. Those registers available to the programmer by means of computer instructions are called addressable registers; the others are called non-addressable (figure 1). Unless otherwise specified, all registers are 12 bits long.

ADDRESSABLE REGISTERS

A Register

The A register receives the results of all arithmetic, logical, and shifting operations.

P Register

The P register contains the storage address of the current instruction. At the completion of an instruction which does not require program control to jump out of sequence, the P register is advanced by 1 or 2 to select the address of the next instruction. If control is to be transferred out of sequence the new control address is sent to the P register

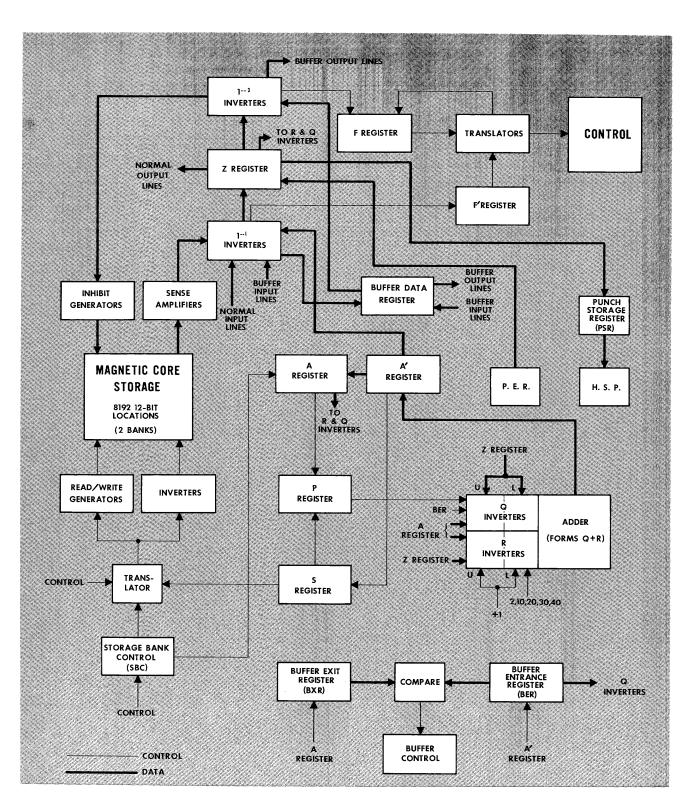


Figure 1. Block Diagram of Registers

and the P register is not advanced. If the P register contains 7776 and is advanced by 1 it will contain 0000; if P contains 7777, advancing it by 1 will change the number to 0001.

Buffer Entrance Register (BER) During buffered input/output operations, BER holds the address to or from which information is being transferred. The contents of this register may be transferred to storage and to the A register.

Buffer Exit Register (BXR) During buffered input/output operations, BXR holds the last word address + 1 to or from which information is being transferred.

NON-ADDRESSABLE REGISTERS

Z Register

Z, a transient register, holds information during transfers between storage and peripheral equipment on the normal input/output channel. The Z register also restores information read out of storage.

S Register

The S register contains the storage address currently being referenced either for an instruction or for an operand.

F Register

The F register contains the decoded instruction being executed. The upper 6 bits contain the effective function code and, in general, the lower 6 bits the effective E portion of the instruction.

Buffer Data Register (BFR) During a buffer operation, BFR holds the word of information being transferred to or from storage.

A' Register

The A' register acts as an auxiliary transmission register for information moving between the other registers. This is the output register of the borrow pyramid (adder).

Punch Storage Register (PSR) During output operations which use the paper tape punch, the 8-bit PSR releases the Z register, thereby permitting high-speed computation while the output characters are punched at a comparatively slow rate. The contents of PSR cannot be indicated on the display panel.

Chapter II

DESCRIPTION OF INSTRUCTIONS

ARITHMETIC

A 160-A computer word contains 12 binary digits. The bits within a computer word are numbered from 00 (least significant) to 11, starting on the right. All arithmetic is binary, one's complement notation. Any number may be represented as combinations of the two binary digits, 0 and 1. Although the computer operates in the binary system, the octal representation of a binary number is more convenient. The 160-A word can be considered as four octal digits. The following diagram shows the bit position numbering, the binary representation of a 12-bit quantity, and the octal equivalent of that quantity.

			08								
0	1	1	1	1	0	0	0	1	0	1	1
	3			6			1			3	

In one's complement notation, positive numbers are represented by their binary equivalent; negative numbers are represented by the one's complement of the equivalent positive number. To form the one's complement, reverse each bit of the word.

Example:

+5 is represented as: 000 000 000 101

-5 is represented as: 111 111 111 010

The internal arithmetic of the computer is based on subtraction. Addition is performed by subtracting the complement of the addend from the augend. In subtraction no complementing is necessary.

Example:

The computer is programmed to add +6 to +5. This operation is performed as follows:

$$+5 = 000 \quad 000 \quad 000 \quad 101$$

$$+6 = 000 \quad 000 \quad 000 \quad 110$$
Complementing +6 produces 111 111 111 001
and subtraction takes place,
$$-5 = 000 \quad 000 \quad 000 \quad 101$$

$$-(+6) = 111 \quad 111 \quad 111 \quad 001$$
Borrow (1) 000 000 001 100

Subtract the borrow - 1
$$-1$$
produces 000 000 001 011 = 138, the corrected answer

During the subtraction process, the borrow from the high order end was carried around and subtracted from the low order end of the word to provide the corrected result. This "end-around-borrow" is the feature which makes the arithmetic of the 160-A modulus 2^{12} -1.

The value zero can be represented in one's complement notation in either of two separate expressions:

Both plus and minus zero are acceptable as arithmetic operands. There are only two cases in which a zero arithmetic result will be minus zero; in all other cases, the result will be plus zero. These two cases are:

$$-0 + (-0)$$
 and $-0 - (+0)$

All positive numbers must have a "0" in bit 11; all negative numbers must have a "1" in bit 11. As is implicit in the illustrations above, the sign bit is extended to the most significant bit of the number.

HOLTATON

The following abbreviations are used throughout the remainder of this manual:

- A A register
- P P register
- Z Z register
- BER Buffer Entrance register
- BXR Buffer Exit register

BFR Buffer Data register

E 6 low order bits in the first word of a 160-A instruction

F 6 high order bits in the first word of a 160-A instruction

G 12 bits in the second word of all two-word 160-A instructions

X, Y Any octal digit, from 0 through 7

XXXX An octal operand or EF code

YYYY An octal address

- () Contents of whatever location or register is specified within the parentheses. The only exception to this is reference to a specific storage bank control in its numeric value. In this case, reference is to the storage bank number, e.g., (0) refers to storage bank zero. This is the only time a single digit will be enclosed in parentheses.
- (d) Contents of the direct storage bank control
- (r) Contents of the relative storage bank control
- (i) Contents of the indirect storage bank control
- (b) Contents of the buffer storage bank control
- → Function or quantity to the left of the arrow replaces the function or quantity to the right.
- FWA First word address. This term is used when reference is made to any block of data. Also, the core storage address of the first word of such a block.
- LWA Last word address. This term is used when reference is made to any block of data. Also, the core storage address of the last word of such a block.

ADDRESSING MODES

Eight addressing modes provide maximum flexibility of the 6-bit address:

No Address (N) When the E portion of the instruction is used as a 6-

When the E portion of the instruction is used as a 6-bit operand, it performs arithmetic and logical operations with a 6-bit constant contained in the instruction. This mode eliminates

the need for entering many constants into memory.

Direct Address

Refers to a 12-bit operand in one of the first 64 (100 octal)

(D) storage locations.

Indirect Address

(1)

Provides for operand references and jump addresses. Instructions employing indirect addressing use E to refer to one of 77 of the first 100 octal storage locations starting at location 0001. The contents of this address are used as the address of the operand or as the jump address.

Relative Address Forward (F)

Operand or jump address is obtained by adding E to the current contents of P to specify one of the 63 (77 octal) addresses immediately following the address of the current instruction.

Relative Address Backward (B)

Operand or jump address is obtained by subtracting E from the current contents of P to specify one of the 63 (77 octal) addresses immediately preceding the address of the current instruction.

Specific Address (S)

The effective address is always location 7777 (octal) in storage bank zero. The E portion of the instruction word is always equal to zero in the specific mode.

Two modes (C and M) use two sequential storage locations, the second of which is designated G. A prerequisite for these modes is that E must always be equal to zero.

(C)

Constant Address The G portion of the 24-bit instruction word contains the operand.

Memory Address (M)

The G portion of the 24-bit instruction word contains the address of the operand.

WORD FORMAT

A 160-A instruction word is divided into a 6-bit function code (F) and a 6-bit execution address (E). Most instructions require only one word of storage, but certain expanded instructions are available which occupy two words of storage. The format of two-word instructions is always as shown below; the first word contains a 6-bit function code and a 6-bit execution address. The execution address is always equal to zero. The second word contains a 12-bit address or operand (G), depending on the instruction. Words 1 and 2 must be located in sequential storage addresses of the same bank.

	Function Code (F)	Execution Address (E)
Word 1	6 Bits	0 0 0 0 0
Word 2	12 B	lits

F, and, in some cases, E determines which instruction in the 160-A repertoire will be executed. Because E contains only 6 bits, it is not possible for E to specify a complete storage address in all cases. Therefore, depending on F, the computer selects, for each instruction, one of eight addressing modes.

NO ADDRESS MODE (N)

In the no address mode, E is the lower 6 bits of an implied 12-bit operand, the upper 6 bits of which are always zero. Thus, the E portion of the instruction word becomes the operand.

Example: Location F E
(r)0100 LDN 43
(r)0101 next instruction

At location (r)0100 is a load no address (LDN) instruction.

A load instruction transmits the operand to the A register. The 12-bit operand for LDN 43 is 0043.* Therefore the number 0043 will be transferred to the A register. At the completion of a no address (N) instruction, control always continues at the location in the relative storage bank specified by the contents of P + 1. In this case, control will continue at location (r)0101.

DIRECT ADDRESS MODE (D)

In the direct address mode, E selects one of the first 64 (100 octal) locations in the direct storage bank (d) as the operand address.

Example: Location F E
(d)0076 12 34

(r)1075 LDD 76
(r)1076 next instruction

At location (r) 1075 is a load direct (LDD) instruction.

E specifies that the operand address is (d)0076. This address contains the quantity 1234 which will be transferred to the A register. At the completion of a direct address (D) instruction, control always continues at the location in the relative storage bank specified by the contents of P+1. In this case, control will continue at (r)1076.

INDIRECT ADDRESS MODE (I)

In the indirect address mode, E references 77 of the first 100 octal locations,

^{*} All numbers are in octal unless stated otherwise.

starting at location 0001, the direct storage bank (d). The location (d)00E is then referenced and the contents of (d)00E become the operand address in the indirect bank (i).

Example: Location F E (d)0045 33 65 (i)3365 46 57 (r)4121 LDI 45 (r)4122 next instruction

At location (r)4121 is a load indirect (LDI) instruction.

E calls for a reference to (d)0045, which contains the address 3365. A final reference is now made to (i)3365, which contains the number 4657. The quantity 4657 will be transferred to the A register. Notice that both the direct (d) and indirect (i) storage bank controls are involved in the indirect address (l) mode. At the completion of an (l) instruction, control always continues at the location in the relative storage bank specified by the contents of P+1. In the above example, control will continue at (r)4122.

There are two (I) instructions which are exceptions to the above rules, JPI and JFI:

- 1) In JPI, the initial reference is made to (d)00E. A transfer of control then takes place within the relative (r) bank to the location specified by the contents of (d)00E.
- 2) In JFI, the initial reference is relative forward. A transfer of control then takes place within the relative (r) bank to the address specified in the relative forward reference.

RELATIVE FORWARD ADDRESS MODE (F)

In the relative forward address mode, E is added to the contents of the P register. This sum then becomes the effective operand address in the relative storage bank (r).

Example: Location F E
(r)0233 LDF 22
(r)0234 next instruction
(r)0255 77 03

At location (r)0233 is a load forward (LDF) instruction.

E is added to the P register to yield the address (r)0255. The contents of (r)0255 will be transferred to the A register. At the completion of this instruction, A will contain the quantity 7703. At the completion of an (F) instruction which does not cause control to be transferred, control will continue in the relative storage

bank (r) at the location specified by the contents of P+1. In the above example, control continues at location (r)0234. Forward Jump instructions cause control to be transferred E locations forward in the relative bank (see instruction repertoire).

RELATIVE BACKWARD ADDRESS MODE (B)

The relative backward address mode functions in a manner analogous to the relative forward (F) mode except that (E) is subtracted from the contents of the P register to form an effective address in the relative storage bank.

SPECIFIC ADDRESS MODE (S)

In the specific address mode, E is always equal to zero. The effective address for an (S) instruction is always storage bank zero, location 7777, (0)7777.

Example: Location F E
(r)0177 LDS 00
(r)0200 next instruction
(0)7777 43 21

Location (r)0177 contains a load specific (LDS) instruction. The fact that E equals zero is used in address decoding to specify that the address of the operand of this instruction is (0)7777. Thus the quantity 4321 will be transferred to the A register. At the completion of an (S) instruction, control continues in the relative storage bank at the location specified by the contents of P+1. In the above example, control continues at (r)0200.

CONSTANT ADDRESS MODE (C)

All constant address mode instructions occupy two sequential storage locations

wherein the G portion of the 24-bit instruction word contains the operand. E is always equal to zero.

At location (r)0101 is a load constant (LDC) instruction. The operand address is (r)0102 and the quantity 7337 is transferred to the A register. At the completion of a (C) instruction, control continues in the relative storage bank (r) at the location specified by the contents of P+2. In this case, control continues at (r)0103. This address contains a store constant (STC) instruction. This causes the contents of the A register to be transferred to the operand address. In the above example, the operand address of the STC instruction is (r)0104. The quantity 7337, in the A register as a result of the LDC instruction in (r)0101, will be transferred to location (r)0104 and will replace the constant 2345 now in (r)0104. The final contents of (r)0104 will be 7337 and control will continue at (r)0105.

MEMORY ADDRESS MODE (M)

All memory address mode instructions occupy two sequential storage locations wherein the G portion of the 24-bit instruction word contains the address of the operand. E is always equal to zero.

Example:	Location	F	Ε	G
·	(r)3477	LDM	00	
				1111
	(r)3501	STM	00	
				0024
	(r)3 5 03	next	instru	ction
	(i)1111	67	66	
	(i)0024	02	34	

Location (r)3477 contains a load memory (LDM) instruction. The location (i)1111 becomes the operand address and the quantity 6766 is transferred to the A register. At the completion of an (M) instruction, control continues in the relative storage bank (r) at the location specified by the contents of P + 2. In this case, control continues at location (r)3501 which contains a store memory (STM) instruction. The operand address of this instruction becomes (i)0024 and the quantity 6766 in the A register will be stored in location (i)0024, replacing the quantity 0234. Control will continue at location (r)3503.

STORAGE CONTROL

Magnetic core storage in the 160-A is composed of two, four, six or eight separate banks of cores. Each bank contains 4,096 12-bit words. A minimum memory contains 8, 192 words and is expandable in modules of 8, 192 words to a total of 32,768 words. Each bank is assigned a number, from 0 through 7, which is never changed. Associated with these banks is a set of four 3-bit registers called storage bank controls; each control may be set by a computer instruction to reference any one of the eight possible banks. Each bank has its own set of 10000_8 addresses numbered from 0000 to 7777. When a bank control is set so that it references a non-existent bank, the computer will stop with a fault indication if an instruction is executed which uses that particular control.

RELATIVE BANK CONTROL (r)

This control selects which storage bank will be referenced to obtain all instructions for execution. All instructions are executed from the bank to which the (r) control has been set. (r) also selects the bank which will be referenced by all instructions whose operation codes indicate relative or constant addressing, and as a first address for memory instructions (see section on addressing modes).

DIRECT BANK CONTROL (d)

This control selects the storage bank referenced by all instructions having direct addressing operation codes. For operation codes indicating indirect addressing, (d) selects the bank used for the first direct address selection.

INDIRECT BANK CONTROL (i)

For instructions with indirect or memory addressing operation codes, (i)selects which bank will be referenced to select the final operand. An exception is the jump instructions which cause an indirect transfer of control. JPI and JFI cause control to be transferred within (r). During normal input/output operations, (i) selects the bank to or from which information will be transferred.

BUFFER BANK CONTROL (b)

During operations which use the buffer input/output channel, (b) selects the storage bank to or from which information will be transferred.

- Example: Assume (r) is set to reference bank 0
 - (i) is set to reference bank 1
 - (d) is set to reference bank 2
 - (b) is not used in this example

The following conditions exist within storage (the bank numbers in parentheses):

Memory Location	Contents
(1) 1577	7717
(1) 2345	5757
(2) 0005	1577
(2) 0067	2345
(2) 0070	temporary storage

Since (r) is set to 0, all program steps will be executed from bank 0.

LOCATION	CONTENTS		ENTS	COMMENTS
	Symbo F	lic E	Numeric	
(0)0100	LDF	10	2210	Load contents of $(r)0110 = (0)0110$ into A. Upon completion A contains 3333.
(0)0101	STD	70	4070	Store contents of A in location (d)0070 = (2)0070. Upon completion A and (2)0070 both contain 3333.
(0)0102	LDI	05	2105	(d)0005 = (2)0005 contains 1577. (i)1577 = (1)1577 contains the operand 7717. 7717 is loaded into A. Upon completion A contains 7717.
(0)0103	ZJF	02	6002	If A contains all zeros, read next instruction from $(r)0105 = (0)0105$.
(0)0104	JPI	67	7067	Jump via (d)0067 = (2)0067. 2345, the contents of (2)0067 becomes (r)2345 or (0)2345, the address of next instruction.
(0)0105	STB	01	4301	Store current contents of A in $(r)0104 = (0)0104$.
(0)0106	JFI	01	7101	Jump to address specified by contents of (r)0107 = $(0)0107$. 2121, contents of $(0)0107$ become $(r)2121$, or $(0)2121$, the address of next instruction.
(0)0107			2121	Jump address.
(0)0110			3333	Working constant.

Chapter III

OPERATION

160-A COMPUTER CONSOLE

The control console consists of a display panel and a switch panel (figure 2). The display panel contains a 2-module status display and three 12-bit octal register displays. All information is displayed in octal, using arabic numerals. Displays are not illuminated when the computer is in the run mode. Below each 12-bit register display are 13 push buttons. The 12 blue buttons are used to enter information into the register, and the white button is used to clear the register. The only registers which can be so entered or cleared are the P, A, and Z registers.

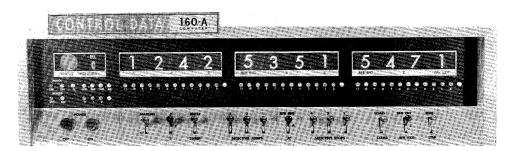


Figure 2. 160-A Console

REGISTER DISPLAY

The three 12-bit register displays can display the contents of nine 160-A registers. Centered beneath each register window is a three-position lever switch which determines the particular register to be displayed in that window.

P Register Group

Switch Position

F register

UP

Indicates the current effective function code
The most significant digit shows a green background

P register	CENTER	Indicates the address of the current instruction
S register	DOWN	Indicates the address of the word about to be transferred to or from storage
		Least significant digit shows a green background

A red background indicates a non-existent storage bank reference, usually a programming error. This fault can be cleared by a console master clear.

A Register Group

	Switch Position	
BFR	UP	Indicates the last word processed during the last buffer operation
		The most significant digit shows a green back- ground
A register	CENTER	Display indicates the current contents of the A register
A' register	DOWN	Display indicates the result of the last operation in the adder
		The least significant digit shows a green back- ground

A red background indicates a main timing fault in the computer; normally occurs when the computer is first turned on and can be cleared by performing a console master clear. If this condition appears at any other time and cannot be cleared, call maintenance.

A blue background in the two center digit positions indicates an interrupt lockout.

Z Register Group

BER	Switch Position UP	Indicates the address of the last word transferred on the buffer channel The most significant digit shows a green back- ground
Z register	CENTER	Indicates the current contents of the Z register
BXR	DOWN	Indicates the LWA + 1 of the last buffer operation The least significant digit shows a green back- ground

A blue background indicates the presence of an instruction in the Z register rather than a transient data word.

A red background in the two center digit positions indicates that the HSP is low on tape.

Status Mode Indicator

Green background Indicates the computer is in run status. This does

not necessarily indicate that the instructions are

being executed.

Red background Indicates that the computer is in either the stop

or step status. Appears when:

a) a HLT or ERR instruction is executed

b) a SLS or SJS is executed and the computer stops

c) the computer is manually taken out of run status

by lowering the Run/Step switch

Within the colored background, alphanumeric symbols are displayed which indicate computer conditions:

ERR

The computer has executed an ERR instruction

and is stopped.

SEL Displayed each time an EXF or EXC instruction

is executed; will remain displayed until the selection is completed. A constant display of SEL with no apparent input/output action usually indicates that the computer has attempted an illegal selec-

tion.

OUT Displayed during all normal output operations. A

constant display of OUT with no apparent output action usually indicates that output was attempted

without proper unit selection.

IN Displayed during all normal input operations. A constant display of IN with no apparent input action usually indicates that input was attempted

without proper unit selection. IN is also displayed when the computer is waiting for an external device to supply data, for instance, while data is being entered at the keyboard when typewriter

3 - 3

input is requested.

IBA Displayed during all buffer input operations. See

IN for additional comments.

OBA Displayed during all buffer output operations. See

OUT for additional comments.

A, B, C, or D Indicates which storage reference cycle will be

executed at the next operation of the Run/Step switch. Following a master clear, D is displayed. This indicates that the next operation executed (when the Run/Step switch is operated) will fetch the instruction from relative storage bank (r), at the address indicated by the P register, and insert

it in Z.

MCS Mode Indicator

This display indicates the storage bank number to which each of the four 160-A storage bank controls has been set. The display is divided into upper and lower sections. The upper (alphabetic) indicates which storage bank control is displayed in the lower (numeric). The upper display indicates the following:

REL Relative storage bank control (r)

IND Indirect storage bank control (i)

DIR Direct storage bank control (d)

BFR Buffer storage bank control (b)

The lower display will contain one of the digits from 0 through 7.

Normally the storage bank to be used with the next storage reference is displayed in the MCS mode indicator. However, any of the other controls may be temporarily displayed by pressing one of the four buttons directly under the MCS mode indicator: BFR, DIR, IND, REL. A second, lower row of four buttons is used to set any of the storage bank controls from the console as follows:

The rightmost button (white) is a clear button which sets the bank number to zero; the other three buttons control the binary bit value of the bank number.

- 1) Press the button on the upper row corresponding to the bank control to be set. Hold this button down while performing the remaining steps.
- 2) Press the white clear button on the lower row and then release it. This will set the bank number to zero.
- 3) Enter the bank number into bank control by pressing the correct lower buttons. For instance, buttons 1 and 2 set the bank number to 6.
- 4) Release all buttons.

The relative storage bank control is set to zero when a console master clear is performed, but the direct, indirect, and buffer storage bank controls are unaltered.

The Switch Panel

The Switch Panel	
Power On/Off	Blue button turns on power to the 160-A Red button turns off power to the 160-A
Margin	Maintenance control for varying the bias on mag- netic core storage sense amplifiers This switch should not be used by the operator
F, P, S	3-position switch that chooses the register to be displayed in the P register group
Enter/Sweep	ENTER is used for entering information into the core storage of the 160-A from the console SWEEP is used to display the contents of core storage
Selective Jump Switches (4, 2, 1)	UP selects jump conditions for interrogation by SLJ and SJS instructions
BFR, A, A'	3-position switch that chooses the register to be displayed in the A register group
Selective Stop Switches (4, 2, 1)	UP selects stop conditions for interrogation by SLS and SJS instructions
Load/Clear	Momentary CLEAR performs a computer master clear which: a) clears the P, A, Z, F and F1 registers b) clears the control flip-flops c) sets (r) = 0 d) clears all waiting interrupts and removes interrupt lockout This master clear does not alter core storage LOAD position enables specially prepared paper tapes to be read into storage by the 350 reader
BFR ENT, Z, BFR EXIT	3-position switch that chooses the register to be

displayed in the Z register group

Run/Step

- In RUN position, a program is executed at high speed starting at the location specified by the P register.
- The center (neutral) position stops the computer. If the switch is in RUN and an ERR, SLS, SJS, or HLT instruction is executed, the switch must be returned to neutral and then placed in RUN to continue computation.
- In STEP position, one storage cycle of an instruction is executed each time the switch is set. In this manner, a program may be executed one instruction at a time for debugging.
- By simultaneously holding down the step switch and any one of the selective jump switches the computer is placed in the automatic step mode. In this mode, a program is executed at a rate of about 3 instructions per second with console display.

STARTING THE 160-A

- Be sure the computer is plugged into the proper power source and that the room temperature is within the prescribed limits.
- 2) Press the Power On button on the console.
- 3) The P and A registers will normally appear against a red background. Master clear by momentarily pressing the Load/Clear switch to the CLEAR position.
- 4) The red backgrounds should go out. This indicates that the computer is ready to operate. If repeated master clears do not remove the red background from P and A, turn the 160-A off by pressing the Power Off button, and call maintenance.

LOADING A PROGRAM OR DATA IN PAPER TAPE LOAD FORMAT

- 1) Master clear
- 2) Turn on 350 reader by pressing the Reader On button, left side of the console.
- 3) Insert paper tape in reader (see page 3-8).
- 4) Set P to starting location.

- 5) Set relative storage bank control to select the bank into which the tape will be read.
- 6) Set the Load/Clear switch to LOAD.
- Set the Run/Step switch to RUN. The paper tape will load and the computer will stop.

ENTERING DATA FROM THE CONSOLE

- 1) Master clear. Set the Enter/Sweep switch on ENTER.
- Set relative storage bank control to select the bank into which data is to be entered.
- 3) Set P to the location into which data is to be entered.
- 4) Enter one word of data into the Z register.
- 5) Press the Run/Step switch to STEP, once. At this point Z is clear, the data word is in storage and in A, and P has been advanced by 1. (P advances each time except the first time.)
- 6) If data is to be entered into consecutive locations, go to step 4. If data is to be entered into non-consecutive locations, clear P. Go to step 3.

EXAMINING THE CONTENTS OF STORAGE AT THE CONSOLE

- 1) Master clear. Set the Enter/Sweep switch on SWEEP.
- 2) Set relative storage bank control to select the bank to be examined.
- 3) Set P to the location to be examined.
- 4) Press the Run/Step switch to STEP, once. The contents of the location specified by P will appear in Z, and P will be advanced by 1. (P advances each time except the first time.)
- 5) To examine consecutive locations, go to step 4. To examine non-consecutive locations, clear P. Go to step 3.

CLEARING AN ENTIRE STORAGE BANK

- 1) Master clear. Set the Enter/Sweep switch on SWEEP.
- 2) Set the relative storage bank control to select the bank to be cleared.

- 3) Set the Run/Step switch on RUN.
- 4) Press the Z-clear button and hold for about a second.

OPERATING THE 350 PAPER TAPE READER

The 350 reader is turned on and off from the 160-A console.

TAPE LOADING

- 1) Turn reader on.
- 2) Rotate the tape release handle clockwise to separate the idler rollers and raise the tape guide plate.
- 3) Set the tape width guide by pressing down the guide to release the locking fingers and slide it so that the marker rests above the correct etched mark on the tape deck surface.
- 4) Set the tape level switch for 5, 7, or 8 channel reading.
- 5) Insert the tape in the reader between the idler rollers (figure 3). The highest level hole is toward the open side. Be sure the tape is seated correctly in the tape guide.
- 6) Engage the tape release handle by turning it counterclockwise.

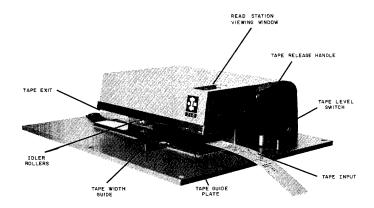


Figure 3. Paper Tape Reader

SPLICING PAPER TAPE

Improperly spliced tape can cause tape snagging or twisting. Avoid any splice

with a loose edge capable of rising in the direction of tape travel. Align feed holes on the strips before joining. Acceptable splices are shown below.

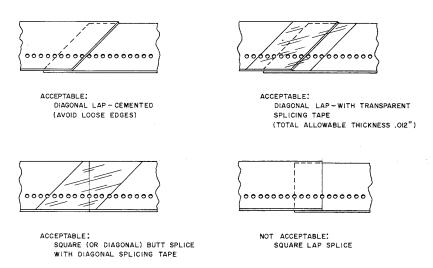


Figure 4. Tape Splices

OPERATING THE PAPER TAPE PUNCH

The 110 character per second punch is turned on and off from the 160-A console. To the right of the punch On/Off buttons is a button labeled TL (tape load). When the punch is on, press and hold down the TL button to feed blank tape (with sprocket hole only) through the punch.

The punch may be operated with the unit remaining in the left pedestal of the computer as the tape feeds out of a special slot in the left side of the computer desk. However, the left pedestal door may be opened and the punch extended.

LOADING A NEW ROLL OF TAPE

- 1) Turn punch on.
- 2) Tear off old tape and run all tape out of the punch block by pressing the TL button.
- 3) Turn off punch.
- 4) Lift the tape reel out of the punch and remove the old reel by unscrewing the X-shaped side plate.
- 5) Place a new roll of tape on the reel so that the tape unwinds counterclockwise, and attach the side plate.

- 6) Place the tape reel in the punch. Thread the tape through the loop on the reel brake arm, through the loop at the front of the punch, around the two rollers and into the tape guide.
- 7) Slowly slide the tape through the punch block. Pull the tape through the punch block, lift the tape tension lever and feed the tape between the tape tension lever and the tape feed wheel.
- 8) Turn punch on.
- 9) Gently pull on the tape and press the tape feed lever. The tape will begin to feed automatically into the punch block. After about 6 inches of tape have been fed, the sprocket holes will be correctly punched.



Figure 5. Paper Tape Punch

160-A INSTRUCTIONS

- 1) All instruction times are in storage cycles where 1 cycle equals 6.4 usec.
- 2) All numbers are in octal notation unless otherwise stated.
- 3) In the description of an operation code, the operations involved are listed in sequence if more than one operation is performed.
- 4) Instructions are described by general function rather than in numerical sequence. Instructions which may assume more than one address mode are listed under the general function. The operand formation for each addressing mode is described in the section on addressing modes.
- 5) The G portion of an instruction is shown with only those instructions which occupy two words of storage.

STOP INSTRUCTIONS

This group of instructions stops the computer unconditionally.

<u>F</u>	<u>E</u>	Mnemonic	<u>Name</u>	Timing
00	00	ERR	Error Stop	1
77	00	HLT	Halt	1
77	77	HLT	Halt	1

Description:

Stop computation. When switch is in RUN position on the console, control continues at (r) (P) + 1. After the computer stops as the result of an ERR instruction, the letters ERR will be displayed in the status mode indicator. There is no difference in the action of the two HLT instructions, 7700 and 7777.

F	E	Mnemonic	Name	Timing
00	0X	NOP	No Operation	ī

Description:

When a NOP instruction is executed the computer does not perform any function but passes on to the next instruction at location (r)(P) + 1.

DATA TRANSMISSION INSTRUCTIONS

This group of instructions transfers information to and from the accumulator within or between storage banks, and also between the internal registers.

F	E	G	Mnemonic	Name	Timing
01	00	YYYY	BLS	Block Store	(no jump) 1 (jump) 2
Des	scripti	on:	If the buffer is busy, If the buffer is not b Start the cycle:		
			If (BER) ≠ (BXR), go If (BER) = (BXR), to	o to * erminate buffer operation	

BLS is used to set selected positions of storage to any desired value. The FWA of the area to be set is placed in BER, the LWA $+\ 1$ of the area to be set is placed in BXR. (b) is then set to reference the storage bank that is to be set. The value to which the area is to be set is placed in A and then BLS is given. If, at the time a BLS is given, the buffer is in operation, the program jumps to (r)YYYY. If buffer is not in operation when BLS is given, the store operation takes place and control continues at (r) (P) $+\ 2$.

The buffer storage bank control (b) may be set at any time prior to executing BLS. Note that, although BLS is a buffer operation, because of the need to constantly refer to storage for the store operation the next instruction will not be executed until BLS is completed. The total execution time for the BLS operation is 1+N cycles, where N is the number of locations to be set ± 1 .

<u>F</u> <u>E</u>	Mnemonic	Name	Timing
01 01	PTA	Transfer P to A	1
Description:	(P) → A (P) + 1 → P		

Transfer the contents of P to A. Control continues at (r)(P) + 1. At the time PTA is executed, P will contain the address of the PTA instruction.

F	E	G	Mnemonic	Name	Timing
01	05	YYYY	ATE	A to Buffer Entrance Register	(no jump) 1 (jump) 2
Des	scripti	on:		s busy, YYYY → P s not busy, (A) → BER (P) + 2 → P	

Transfer the contents of A to BER. Control continues at (r)(P) + 2. If the buffer

is in operation when an ATE is given, A is not transferred and control continues at (r)YYYY.

<u>F</u>	<u>E</u>	G	Mnemonic	Name	Timing
01	06	YYYY	ATX	A to Buffer Exit Register	(no jump) 1 (jump) 2
Description:				busy, YYYY \rightarrow P not busy, (A) \rightarrow BXR (P) + 2 \rightarrow P	

Transfer the contents of A to BXR. Control continues at (r)(P) + 2. If the buffer is in operation when an ATX is given, A is not transferred and control continues at (r)YYYY.

<u>F</u> <u>E</u>	Mnemonic	Name	Timing
01 07	ETA	Buffer Entrance Register to A	1
Description:	(BER) → A (P) + 1 → P		

Transfer the contents of BER to A. This instruction may be given at any time, even while the buffer is in operation. Control continues at (r)(P) + 1.

F	<u>E</u>	Mnemonic	Name	Timing
01	30	СТА	Bank Controls to A	1
Des	cription:	(b) $\rightarrow A_{11} - 9^*$ (d) $\rightarrow A_{8} - 6$ (i) $\rightarrow A_{5} - 3$ (r) $\rightarrow A_{2} - 0$ (P) $+ 1 \rightarrow P$		

Transfer the contents of the four storage bank controls to A as octal digits which occupy the A register bit positions shown above. Control continues at (r)(P)+1. Note that the storage bank controls are not changed by the execution of a CTA instruction.

Example:	Assume (b) is set to reference bank 4	
	(d) is set to reference bank 0	
	(i) is set to reference bank 1	
	(r) is set to reference bank 2	

Under the above conditions, if a CTA were given, A would contain the number 4012 at the completion of the instruction.

^{*}Subscripts indicate bit positions in A.

<u>F</u> <u>E</u>	<u>Mnemonic</u>	Name	Timing
01 5Y	STP	Store P at Location 5Y	3
Description	n: $(P) \rightarrow (d) \ 005Y$ $(P) + 1 \rightarrow P$		

Transfer the contents of P to storage location (d) 005Y, where Y is any octal digit from 0 through 7. Control continues at location (r)P + 1. This instruction allows the contents of P, which will contain the address of STP, to be stored in the direct storage bank at any of the locations 0050 - 0057.

F	E	G	Mnemonic	Name	Timing
04	ХХ		LDN	Load No Address	1
20	ΥY		LDD	Load Direct	2
21	00	YYYY	LDM	Load Memory	3
21	ΥY		LDI	Load Indirect	3
22	00	XXXX	LDC	Load Constant	2
22	XX	,,,,,,,,	LDF	Load Forward	2
23	00		LDS	Load Specific	2
23	XX		LDB	Load Backward	2

Description: operand → A

Transfer the operand to A. The operand in storage is not altered by the execution of a load instruction. The proper operand is formed for each address mode and control continues as described in the section on address modes.

F	<u>E</u>	Mnemonic	Name	Timing
01	6Y	STE	Store Buffer Entrance Register at Location 6Y and Transfer A to Buffer Entrance Register	3
Des	cription:	(BER) → (d) 006Y (A) → BER (P) + 1 → P		

Transfer the contents of BER to storage location (d) 006Y, where Y is any octal digit from 0 through 7, and transfer the contents of A to BER. A is unchanged by this instruction. Control continues at location (r)(P) + 1. This instruction allows the contents of BER to be exchanged whenever desired, even while the buffer is in operation. The old contents of BER will be stored in the direct storage bank (d) at any of the locations 0060 - 0067.

Note that the E portion of LDI, LDF, and LDB instructions cannot be zero or the operation code is interpreted as LDM, LDC, and LDS, respectively.

<u>F</u>	E	<u>G</u>	Mnemonic	Name	Timing
05 24	XX YY		LCN LCD	Load Complement No Address Load Complement Direct	1
25 25	00 YY	YYYY	LCM LCI	Load Complement Memory Load Complement Indirect	3
26	00	XXXX	LCC	Load Complement Constant	3 2
26 27	X X 00		LCF LCS	Load Complement Forward Load Complement Specific	2 2
27	XX		LCB	Load Complement Backward	2

Description: operand → A

Transfer the one's complement of the operand to A. The operand in storage is not altered by the execution of a load complement instruction. The one's complement of a number is the arithmetic negative of that number. The proper operand is formed for each address mode and control continues as described in the section on address modes.

Note that the E portion of LCI, LCF, and LCB instructions cannot be zero or the operation code is interpreted as LCM, LCC, and LCS, respectively.

F	E	<u>G</u>	Mnemonic	Name	Timing
40	ΥY		STD	Store Direct	3
41	00	YYYY	STM	Store Memory	4
41	ΥY		STI	Store Indirect	4
42	00	XXXX	STC	Store Constant	3
42	XX		STF	Store Forward	3
43	00		STS	Store Specific	3
43	XX		STB	Store Backward	3

Description: (A) → operand address

Transfer the contents of A to the operand address. The contents of A are not altered by a store instruction. The proper operand address is formed for each address mode and control continues as described in the section on address modes.

Note that the E portion of STI, STF, and STB instructions cannot be zero or the operation code is interpreted as SFM, STC, and STS, respectively.

<u>F</u>	<u>E</u>	Mnemonic	Name	Timing
76	ΥΥ	HWI	Half Write Indirect	4

Description:

(A) $L \rightarrow$ operand address L

 $(P) + 1 \rightarrow P$

Transfer the lower order 6 bits of A into the lower order 6 bits at the operand address. A and the higher order 6 bits at the operand address remain unchanged. The proper operand address is formed as described in the section on address modes. Control will continue at (r)(P) + 1.

Example:	Location	F	Ε
	(r) 3777	HWI	23
	(d) 0023	41	14
	(i) 4114	75	01
	(A)	46	57

When the HWI instruction at location (r)3777 is executed, the lower 6 bits of A will be transferred to the lower 6 bits of location (i)4114. At the completion of the instruction, A will contain the quantity 4657, location (i)4114 will contain the quantity 7557, location (d)0023 will be unchanged, and control will continue at location (r)4000.

If the E portion of the HWI instruction is equal to 00 or 77, the operation code will be interpreted as INA or OTA, respectively. The effective indirect address reference ranges from (d)0001 to (d)0076.

ARITHMETIC INSTRUCTIONS

This group of instructions performs various arithmetic operations. The accumulator is always used when initiating these instructions; however, only a replace type instruction affects storage. There are no single instructions to multiply or divide, but there are special instructions that multiply by 10^{1} or 10^{2} .

<u>F</u> <u>E</u>	Mnemonic	Name	Timing
01 12	MUT	Multiply A by 10	1
Description:	$10_{10}(A) \rightarrow A$, (P) + 1 \rightarrow P		

Multiply the contents of A by 10_{10} . The result is placed in A at the completion of the instruction. For the range of numbers -314_8 to $+314_8$, the result will be algebraically correct. If (A) $> +314_8$ or $< -314_8$, the result will be correct modulo 2^{12} -1. Control will continue at location (r)(P) + 1.

F	<u>E</u>	Mnemonic	Name	Timing
01	13	MUH	Multiply A by 100	1

$$100_{10}(A) \rightarrow A$$

(P) + 1 \rightarrow P

Multiply the contents of A by 100_{10} . The result is placed in A at the completion of the instruction. For the range of numbers -24_8 to $+24_8$, the result will be algebraically correct. If (A) $> +24_8$ or $< -24_8$, the result will be correct modulo 2^{12} –1. Control will continue at location (r)(P) + 1.

F	<u>E</u> .	<u>G</u>	Mnemonic	Name	Timing
06 30 31 31 32 32 33 33	XX YY 00 YY 00 XX 00 XX	YYYY XXXX	ADN ADD ADM ADI ADC ADF ADS ADB	Add No Address Add Direct Add Memory Add Indirect Add Constant Add Forward Add Specific Add Backward	1 2 3 3 2 2 2
JJ	^^		ADD	Add Dackward	2

Description:

(A) + operand $\rightarrow A$

Place in A the sum of the original contents of A and the operand. The operand is unchanged by an add instruction. The correct operand is formed for each address mode and control will continue as described in the section on address modes.

Note that the E portion of ADI, ADF, and ADB instructions cannot be zero or the operation code is interpreted as ADM, ADC, and ADS, respectively.

F	<u>E</u>	<u>G</u>	Mnemonic	Name	Timing
07	XX		SBN	Subtract No Address	1
34	ΥY		SBD	Subtract Direct	2
35	00	YYYY	SBM	Subtract Memory	3
35	YY		SBI	Subtract Indirect	3
36	00	XXXX	\$BC	Subtract Constant	2
36	XX		SBF	Subtract Forward	2
37	00		SBS	Subtract Specific	2
37	XX		SBB	Subtract Backward	2

Description:

(A) - operand → A

Place in A the difference between the original contents of A and the operand. The operand is unchanged by a subtract instruction. The correct operand is formed for each address mode and control continues as described in the section on address modes.

Note that the E portion of SBI, SBF, and SBB instructions cannot be zero or the operation code is interpreted as SBM, SBC, and SBS, respectively.

F	E	G	Mnemonic	Name	Timing
50	ΥΥ		RAD	Replace Add Direct	3
51	00	YYYY	RAM	Replace Add Memory	4
51	ΥY		RAI	Replace Add Indirect	4
52	00	XXXX	RAC	Replace Add Constant	3
52	ХX		RAF	Replace Add Forward	3
53	00		RAS	Replace Add Specific	3
53	XX		RAB	Replace Add Backward	3

Description:

(A) + operand → A

(A) → operand address

Place in A the sum of the original contents of A and the operand, and transfer this sum to the operand address. At the completion of the replace add instruction, both the operand address and A will contain the new sum. The proper operand is formed for each address mode and control continues as described in the section on address modes.

Note that the E portion of RAI, RAF, and RAB instructions cannot be zero or the operation code is interpreted as RAM, RAC, and RAS, respectively.

F	E	G	Mnemonic	Name	Timing
54	ΥΥ		AOD	Replace Add One Direct	3
55	00	YYYY	AOM	Replace Add One Memory	4
55	ΥY		AOI	Replace Add One Indirect	4
56	00	XXXX	AOC	Replace Add One Constant	3
56	XX		AOF	Replace Add One Forward	3
57	00		AOS	Replace Add One Specific	3
57	XX		AOB	Replace Add One Backward	3

Description:

operand → A

 $(A) + 1 \rightarrow A$

(A) → operand address

Form in A the sum of the operand plus one and transfer this sum to the operand address. At the completion of the replace add one instruction, both the A register and the operand address will contain the original operand increased by 1. The proper operand is formed for each address mode and control continues as described in the section on address modes.

Note that the E portion of AOI, AOF, and AOB instructions cannot be zero or the operation code is interpreted as AOM, AOC, and AOS, respectively.

SHIFT INSTRUCTIONS

This group of instructions moves information within the accumulator. When the left shift is initiated, the information moves in a circular path. When the right shift is initiated, the information drops off on the open right end of the accumulator.

F	<u>E</u>	Mnemonic	Name	Timing
01	02	LS1	Left Shift One	1
01	03	LS2	Left Shift Two	1
01	10	L\$3	Left Shift Three	1
01	11	LS6	Left Shift Six	Ī
01	14	R\$1	Right Shift One	1
01	15	RS2	Right Shift Two	1

Description:

Shift A right or left the number of bit positions specified. Control continues at (r)(P) + 1.

All left shifts in the 160-A are circular; bits shifted out of bit position 11 are shifted into bit position 00. From bit position 00, bits are shifted into bit position 01, etc.

Example:	Location	F	Е	
	(r)6173	LS3		
	(A)	61	02	

At location (r)6173 is an LS3 instruction. E is not specified since all of the above shift instructions use E as part of the operation code. A contains the number 6102. At the completion of LS3, A will contain the number 1026 and control will continue at (r)6174.

All right shifts in the 160-A are end-off shifts; for each bit position shifted, the sign is extended and the bit in position 00 is shifted off and lost.

Example:	Location	F	E	
	(r)2234 (A)	RS1 40	01	

At location (r)2234 is an RS1 instruction. Again, E is not specified since it is part of the operation code. A contains the number 4001. At the completion of RS1, A will contain the number 6000 and control will continue at location (r)2235.

F	_ <u>E</u>	G	Mnemonic	Name	Timing
44	ΥY		SRD	Shift Replace Direct	3
45	00	YYYY	SRM	Shift Replace Memory	4
45	ΥY		SRI	Shift Replace Indirect	4
46	00	XXXX	SRC	Shift Replace Constant	3
46	XX		SRF	Shift Replace Forward	3
47	00		SRS	Shift Replace Specific	3
47	XX		SRB	Shift Replace Backward	3

Description:

operand $\rightarrow A$

shift A left circular 1 bit position

 $(A) \rightarrow operand address$

The operand is placed in A, shifted left one bit position (left shift), and the contents of A are transferred back to the operand address. The operand for each address mode is formed and control will continue as described in the section on address modes. At the completion of a shift replace instruction, both A and the operand address will contain the shifted original operand.

Note that the E portion of SRI, SRF, and SRB instructions cannot be zero or the operation code is interpreted as SRM, SRC, and SRS, respectively.

LOGICAL INSTRUCTIONS

This group of instructions complements or extracts any portion of the accumulator according to a prescribed bit pattern.

F	<u>E</u> _	G	Mnemonic	Name	Timing
02	хх		LPN	Logical Product No Address	1
10	YY		LPD	Logical Product Direct	2
11	00	YYYY	LPM	Logical Product Memory	3
11	YY		LPI	Logical Product Indirect	3
12	00	XXXX	LPC	Logical Product Constant	2
12	XX		LPF	Logical Product Forward	2
13	00		LPS	Logical Product Specific	2
13	XX		LPB	Logical Product Backward	2

Description:

Form in A the logical product of the operand and the original contents of A. The operand in storage is not altered by a logical product instruction. The proper operand is formed for each address mode and control will continue as described in the section on address modes.

The logical product of two operands is defined as follows:

operand 1 (bit value)	0 0 1 1
operand 2 (bit value)	0 1 0 1
logical product of 1 and 2	0 0 0 1 (bit value)

From the above definition it will be seen that, using the proper operand as a mask, selected portions of A may be cleared or retained in A.

Note that the E portion of LPI, LPF, and LPB instructions cannot be zero or the operation code is interpreted as LPM, LPC, and LPS, respectively.

<u> </u>	E	G	Mnemonic	Name	Timing
03	XX		SCN	Selective Complement No Address	1
14	ΥY		SCD	Selective Complement Direct	2
15	00	YYYY	SCM	Selective Complement Memory	3
15	ΥY		SCI	Selective Complement Indirect	3
16	00	XXXX	SCC	Selective Complement Constant	2
16	XX		SCF	Selective Complement Forward	2
17	00		SCS	Selective Complement Specific	2
17	XX		SCB	Selective Complement Backward	2

Description:

Form in A the bit complement of A for each bit in the operand equal to 1. The operand in storage is not altered by the selective complement instruction. The proper operand for each address mode is formed and control will continue as described in the section on address modes.

The selective complement operation is defined as follows:

(A) register (bit value)	0011
operand (bit value)	0 1 0 1
final contents of the A register	0 1 1 0 (bit value)

Note that the E portion of SCI, SCF, and SCB instructions cannot be zero or the operation code is interpreted as SCM, SCC, and SCS, respectively.

STORAGE BANK CONTROL INSTRUCTIONS

This group of instructions assigns address modes to the various storage banks before transferring program control to a given bank reference. When the relative mode is assigned to a storage bank, separately or collectively, program control

is relinquished to the relative bank address specified by the contents of the accumulator.

F	E	Mnemonic	Name	Timing
00	1X	SRJ	Set Relative Bank Control	
			and Jump	1
00	2X	SIC	Set Indirect Bank Control	1
00	3X	IRJ	Set Indirect and Relative Bank	
			Control and Jump	1
00	4X	SDC	Set Direct Bank Control	1
00	5X	DRJ	Set Direct and Relative Bank	
			Control and Jump	1
00	6X	SID	Set Indirect and Direct Bank	
			Control	1
00	7X	ACJ	Set Direct, Indirect, and Rela-	
			tive Bank Control and Jump	1
01	4X	SBU	Set Buffer Bank Control	1

Description:

Set the specified storage bank control or controls to reference bank X. For the instructions SIC, SDC, SID, and SBU, control will continue at (r)(P) + 1. The remaining instructions of this group, SRJ, IRJ, DRJ, and ACJ, are the only 160-A instructions which can be used to transfer program control between storage banks. It is the act of setting the relative bank control (r) which alters the bank from which the next program instruction will be taken. Whenever an instruction is given which sets (r), the next program instruction will be taken from the new (r) at the address specified by the contents of the A register. Notice that not only may (r) be set by itself but combinations of memory bank controls may be set at the same time.

Example:

Set (d) to reference storage bank 3. At the same time transfer program control to storage bank 3, location 2217.

Location	F	Ε	G
(r) a	LDC	00	22 17
(r) a + 2	DRJ	53	

In the above example, the program to transfer control was not located in any specific place in the (r) bank but rather the letter "a" was used to denote that, wherever the program was placed, the next instruction would be taken from "a + 2". This two-instruction sequence is all that is required to transfer program control and set (d) as specified. Executing the LDC instruction transfers the number 2217 to A. This number represents the jump address in the new relative (r) bank. The next instruction, DRJ, sets (d) to reference bank 3, sets (r) to reference bank 3, and then jumps to location 2217 (the contents of A) in bank 3.

The contents of A are not changed when the storage bank control instructions are executed.

JUMP INSTRUCTIONS

This group of instructions changes its sequencial references and resumes control at another address. Certain jump instructions unconditionally change the sequence. Other jump instructions are conditional depending on the content of the accumulator or the position of the jump switches on the console panel.

F	<u>E</u>	Mnemonic	Name	Timing
60	XX	ZJF	Zero Jump Forward	1
61	XX	NZF	Non-Zero Jump Forward	1
62	XX	PJF	Positive Jump Forward	1
63	XX	NJF	Negative Jump Forward	1
64	XX	ZJB	Zero Jump Backward	1
65	XX	NZB	Non-Zero Jump Backward	1
66	XX	PJB	Positive Jump Backward	i
67	XX	NJB	Negative Jump Backward	i

Description:

The above are conditional jump instructions; A is tested for the condition stated. If the condition is met, control is transferred forward or backward in the relative (r) bank XX locations as described in the section on address modes. If the condition is not met, control continues at location (r)(P) + 1.

The conditions for testing are:

- 1) A zero: the contents of A are equal to 0000, or plus zero. Minus zero is not considered equivalent to plus zero to meet the zero jump condition.
- 2) A not zero: A contains any quantity other than 0000.
- 3) A positive: bit 11 of A is 0.
- 4) A negative: bit 11 of A is 1.

<u>F</u> <u>E</u>	Mnemonic	Name	Timing
70 YY	JPI	Jump Indirect	2
Description:	((d) 00YY) → P		

Transfer program control to the location in the relative (r) bank specified by the contents of (d)00YY.

Example:	Location	F	Ε
	(r) a	JPI	43
	(d) 0043	36	62

At some location in the (r) bank is the instruction JPI 43. When this instruction is executed, since (d)0043 contains the number 3662, program control will be transferred to location (r)3662.

F	E	G	Mnemonic	Name	Timing
71	00	YYYY	JPR	Return Jump	3
Des	cripti	on:	(P) + 2 → (r)YYYY YYYY + 1 → P		

The contents of P are increased by 2 to give the address of the instruction following the JPR instruction. This address is transferred to location (r)YYYY. Program control is then transferred to location (r)YYYY + 1.

Example:	Location	F	Ε	G
	(r)1173	JPR	00	2100

At location (r)1173 is a JPR instruction. When this instruction is executed, the number 1175 will be transferred to location (r)2100. Program control will then continue at location (r)2101.

F E	Mnemonic	Name	Timing
71 XX	JFI	Jump Forward Indirect	2
Description:	$(r)((P) + 00XX) \rightarrow$	P	

Transfer program control to the address in (r) specified by the contents of the storage location XX positions forward of the JFI instruction.

Example:	Location	F	Ε
	(r)5162	JFI	07
	(r)5171	04	23

When the JFI instruction at (r)5162 is executed, a reference is made to the location in the relative bank 0007 positions forward, location (r)5171. This location contains the number 0423 and program control will be transferred to (r)0423.

Note that the E portion of the JFI instruction cannot be equal to zero or the operation code will be interpreted as a JPR instruction.

INPUT/OUTPUT INSTRUCTIONS

This group of instructions permits communication and transfer of information between the computer and the external equipment. The path of in/out transmission can be on the buffer channel or the normal channel.

<u>F</u>	E	Mnemonic	Name	Timing
01	04	CBC	Clear Buffer Controls	1

Description:

Stop all buffer operations in progress and clear the buffer controls. This instruction does not clear BER, BXR, or BFR, but it stops any buffer operation in progress. If an input/output operation is stopped when some piece of unit record equipment (such as magnetic tape, punched cards, etc.) is being read or written, the buffer will disconnect from the unit but the peripheral unit will move to the end of the unit record. The remaining data will not be stored. On non-unit record peripheral equipment, such as a paper tape input device, the paper tape* will stop in position to read the next frame of tape and the buffer controls will be cleared.

No buffer complete (interrupt 20) is generated when CBC is executed.

F	<u>E</u>	Mnemonic	Name_	Timing
01	20	CIL	Clear Interrupt Lockout	1

Description:

Clear the interrupt lockout and allow any waiting interrupts to function. When CIL is executed, interrupt lockout is not cleared until the instruction following CIL has been executed. Interrupt lockout is set by any of the following:

- 1) Execution of an interrupt.
- 2) Execution of an EXF instruction.
- 3) Execution of an EXC instruction. (See section on interrupt.)

<u>F</u>	<u>E</u>	G	Mnemonic	Name	Timing
72	00	YYYY	IBI	Initiate Buffer Input	(no jump) 1 (jump) 2

^{*}Paper tape is used as an example only, since the console paper tape reader cannot be read from the buffer input/output channel.

Description:

If buffer is busy, $YYYY \rightarrow P$ If buffer is not busy, $(P) + 2 \rightarrow P$

Start input buffering operation and, when complete,

generate an interrupt 20 signal.

The instruction IBI initiates an input buffer operation on the buffer input/output channel. Prior to an IBI, however, the external device must be selected and BER, BXR, and the buffer storage bank control (b) must be set up. If the buffer is in operation when an IBI is given, no buffer action will be taken and control will continue at location (r)YYYY. If the buffer is not in operation when IBI is given, the buffering operation will be started and control will immediately continue at location (r)(P) + 2. When the buffer operation terminates, an interrupt signal will appear on interrupt line 20.

<u>F</u>	<u>E</u>	G	Mnemonic	Name	Timing
73	00	YYYY	IBO	Initiate Buffer Output	(no jump) 1 (jump) 2

Description:

If buffer is busy, $YYYY \rightarrow P$ If buffer is not busy, $(P) + 2 \rightarrow P$

Start output buffering operation and, when complete,

generate an interrupt 20 signal.

The IBO instruction initiates an output buffer operation on the buffer input/output channel. Prior to an IBO the external device must be selected, and BER, BXR, and the buffer storage bank control (b) must be set up. If the buffer is in operation when IBO is given, no buffer action will be taken and control will continue at location (r)YYYY. If the buffer is not in operation when IBO is given, the buffering operation will be started and control will immediately continue at location (r)(P) + 2. When the buffer operation terminates, an interrupt signal will appear on interrupt line 20.

If either IBI or IBO is given and no external device has been selected, the computer will continue in operation but the buffer will be placed in an indefinite busy status and no input or output operation will take place. This busy status may be removed by a clear buffer controls (CBC) instruction or by a master clear from the console.

<u>F</u>	E	<u>G</u>	Mnemonic	Name	Timing
72 73		YYYY YYYY	INP OUT	Normal Input Normal Output	*
Description:			` ' ' '	the FWA of the input or output a	

^{*}Since INP and OUT are not buffered instructions, their execution time varies with the speed of the external equipment being used.

Read or write using the previously selected external device. The input/output area is defined as follows:

- 1) The FWA of the input/output area is found XX locations forward in the relative memory bank (r). This location (r) P + 00XX, specifies a FWA in the indirect memory bank (i).
- 2) The LWA + 1 of the input/output area is location YYYY in the indirect memory bank (i)YYYY.

If the external device has been properly selected, the input or output operation will take place and, at its completion, control will continue at (r)(P) + 2. If no external device has been properly selected, the computer will be indefinitely delayed and the operation mode (INP, OUT) displayed on the status mode indicator.

The instructions INP and OUT are used to read or write data on the normal input/output channel and are not buffered; that is, the computer will wait while the input or output operation is in progress and the next instruction will not be executed until the input/output operation is complete. The contents of A at the completion of an INP or OUT instruction will indicate the LWA + 1 actually read into or out of during the input or output operation. Although the FWA and LWA of the input/output area are found in the relative memory bank (r) they actually specify locations in the indirect memory bank (i).

Example:	Location	F	E	G
	(r)1134 (r)1136	INP	33	2000
	(r) 1167	10	00	

At location (r)1134 is a normal input instruction. The FWA of the input area is found in location (r)1167 and is (i)1000. The LWA + 1 of the input area is found in G and is (i)2000. The LWA itself is therefore (i)1777. Assuming an external device has been selected, INP is interpreted as "Read from selected device 1000 words and store them in the indirect storage bank starting at location 1000."

If 1000 words are read, A will contain the number 2000 at the completion of INP and control will continue at location (r)1136.

The E portion of INP and OUT instructions cannot be equal to zero, or the operation codes are interpreted as IBI and IBO, respectively.

F	E E	Mnemonic	Name	Timing	
74	XX	OTN	Output No Address	*	

^{*}Execution time varies with the speed of the external equipment being used.

Description:

Write, on the previously selected output device, one word with zero in the 6 high order bits and XX in the 6 low order bits. The output operation takes place under normal input output using either the normal or buffer channel. At the completion of the output operation, control continues at location (r)(P) + 1. If an OTN instruction is given and no external device has been properly selected, the computer will be indefinitely delayed and the operation mode (OUT) displayed on the status mode indicator.

F	<u>E</u>	Mnemonic	Name	Timing
76	00	INA	Input to A	*
76	77	OTA	Output from A	*

Description:

Read or write, on the previously selected external device, one word to or from A. The operation takes place under normal input/output using either the normal or buffer channel. On devices which transmit less than one full computer word at a time, such as the 350 paper tape reader, the information is transmitted to and from the low order portion of A. At the completion of the operation, control continues at location (r)(P) + 1. If an INA or OTA instruction is being executed and no external device has been properly selected, the computer will be indefinitely delayed and the operation mode (INP, OUT) displayed on the status mode indicator.

F	<u>E</u>	<u>G</u>	Mnemonic	Name	Timing
75	00	XXXX	EXC	External Function Constant	2
75	XX		EXF	External Function Forward	2

Description:

Transmit the 12-bit operand to the external equipments. The operand for the various address modes is selected and control continues as described in the section on address modes. At the completion of an external function instruction, A will contain the 12-bit external function code.

The 12-bit operand to be transmitted is known as an external function code. (A complete list of external function codes is found in appendix 2.) The external function instruction is used to select an external device to perform some specific function. With the exception of a status request code, if an illegal selection is attempted the computer will be indefinitely delayed and the operation mode (SEL) displayed on the status mode indicator. One example of an illegal selection is the attempt to select a magnetic tape for reading when the magnetic tape is turned off.

^{*}Execution time varies with the speed of the external equipment being used.

Most external devices have a status request code. When such a code is given and followed with an INA instruction, a 12-bit status response code will be sent to A. By examining this response code it is possible to determine whether further selection of the equipment is possible. A status request may be given even when an external device is turned off.

Only one device may be selected at any one time on each channel. Selection of any device automatically disconnects any other selected device. If a select is given and some other device on the same channel is busy, the computer will be delayed until a selection can be made. If a device is selected for some function and another select is made on the same device for some other function, the previous select is nullified. This applies to status request so that, if a device is selected for reading and then status is requested of that device, another read selection must be made before any further reading can take place on that device.

SELECTIVE STOP AND JUMP INSTRUCTIONS

This group of instructions expands the programming capability by making it possible to select certain conditions under which jumps or stops (or both) will be executed.

<u>F</u>	<u>E</u>	<u>G</u>	Mnemonic	Name	Timing
77	0 X		SLS	Selective Stop	1
77	X0	YYYY	SLJ	Selective Jump	(no jump) 1
					(jump) 2
77	XX	YYYY	SJS	Selective Stop and Jump	(no jump)]
					(jump) 2

Description:

The selective stop and jump instructions are controlled by six switches on the computer console: Stop switches 1, 2, and 4, and Jump switches 1, 2, and 4.

- 1) SLS: If the appropriate Stop switch is set, stop; otherwise do not stop. If the computer stops, computation may be resumed by placing the Run/Step switch in neutral and then back to the RUN position. Whether the computer stops or not, control will continue at location (r)(P) + 1.
- 2) SLJ: If the appropriate Jump switch is set, jump to location (r)YYYY; otherwise control continues at location (r)(P) + 2.
- 3) SJS: If the appropriate Jump switch is set, set up to jump to location (r)YYYY; otherwise set up to continue control at (r)(P) + 2. Then test the appropriate Stop switch. If the appropriate Stop switch is set, stop before executing the next instruction; control continues as selected by the Jump switches. If a stop

occurs, computation may be resumed by placing the Run/Step switch in neutral and then back to the RUN position.

The values of X and the switches they control are:

- X = 1 test switch 1.
- X = 2 test switch 2.
- X = 3 test switch 1 and 2. If either switch is set, a stop or jump will be made as defined above.
- X = 4 test switch 4.
- X = 5 test switch 1 and 4. If either switch is set, a stop or jump will be made as defined above.
- X = 6 test switch 4 and 2. If either switch is set, a stop or jump will be made as defined above.
- X = 7 test switches 1, 2, and 4. If any are set, a stop or jump will be made as defined above.

The three low order bits of the E portion of the instructions control the testing of the Stop switches and the three high order bits of E control the testing of the Jump switches.

Any combination of X's is legal except 00 and 77, which are treated as a halt instruction (see HLT instruction).

USING THE INSTRUCTIONS

INTERRUPT

The main program must be notified of certain internal and external conditions. An interrupt is the program signal which transfers computer control to some fixed location in memory without losing the information needed to return to the main program.

The 160-A has four interrupt lines: two internal, 10 and 20, and two external, 30 and 40. When an interrupt signal occurs on one of these lines, the computer stores the contents of P at location (d)0010, (d)0020, (d)0030, or (d)0040, depending on the line which generates the interrupt, and then takes its next instruction from (r)0011, (r)0021, (r)0031, or (r)0041.

Interrupt 10

Interrupt 10 is a manual interrupt activated from the 160-A control console by

momentarily pressing any combination of a Selective Stop switch and a Selective Jump switch. When interrupt 10 occurs, the computer stores P at location (d)0010 and transfers to (r)0011.

Interrupt 20

The interrupt 20 line is activated each time a buffer operation is completed or when terminated by an input disconnect. When interrupt 20 occurs, the computer stores P at location (d)0020, and transfers to (r)0021.

Interrupts 30 and 40

External interrupt lines 30 and 40 may be activated by any peripheral device which provides an interrupt signal. (The meaning of these interrupts is a function of the device causing the signal. Since several devices may be connected to each line, each must be interrogated following an interrupt to determine which device generated the signal.)

Interrupt signals are recognized in a priority sequence; the lower numbered lines are recognized first. If an interrupt 10 and 20 occur simultaneously, interrupt 10 will be recognized first. Once an interrupt signal is placed on a line it remains on the line until it is recognized or until a console master clear is performed.

Whenever any interrupt is recognized or whenever an external function instruction is executed, all further interrupts are locked out until a clear interrupt lockout (CIL) is executed. Any interrupt line which becomes active while interrupt lockout is imposed will remain active until a CIL is executed, at which time all interrupt lines will be checked for activity in priority sequence.

Whenever a console master clear is performed, all interrupt lines are set inactive and interrupt lockout is removed.

It is possible to internally impose interrupt lockout for as long as desired by executing any external function instruction (such as a status request) and not executing a CIL.

Once an interrupt has been recognized and the store P and jump executed, the programmer must have some program starting at locations (r)0011, (r)0021, (r)0031, and (r)0041, which will perform the function required by the interrupt.

Example 1: Problem: Whenever an interrupt 10 occurs, set location (i)2100 equal to zero and return to the main program.

Location	F —	<u>E</u>	<u>G</u>	Comments
(d)0010				Return address put here by interrupt's JPR
(r)0011	JFI	01		Jump to interrupt routine
(r)0012	02	00		Interrupt routine begins at loc (r)0200

(r)0200	STF 05		Save A in (r)0205 (see ****)
(r)0201	LDN 00		Set A equal to zero
(r)0202	STM	2100	Set (i)2100 equal to zero
(r)0204	LDC	****	Restore A
(r)0206	CIL		Clear interrupt lockout
(r)0207	JPI 10		Return to main program

Example 2: Problem: Whenever an interrupt 20 occurs, clear lockout and return to the main program.

Location	F	Ε	Comments
	_	_	
(d)0020			Return address put here by interrupt's JPR
(r)0021	CIL		Clear lockout
(r)0022	JPI	20	Return to main program

INPUT/OUTPUT

The 160-A has two input/output channels, the normal channel and the buffer channel. Both channels may be used simultaneously for any combination of input/output operations.

A device on the normal channel may be read or written on only the normal channel, but a device on the buffer channel may be read and written on either the normal or the buffer channel. A device connected to the buffer channel may not be read or written on the normal channel if the buffer channel is busy.

The 350 paper tape reader and BRPE-11 paper tape punch which are standard equipment on the 160-A are always connected to the normal channel and cannot be buffered. Any other peripheral device may be connected to either the normal or the buffer channel and may be easily changed from one channel to the other by use of jumper connectors.

For the purpose of recognizing external function codes, all input/output devices are connected to the normal channel output line. When any external equipment selection is made, all other external devices on both the normal and buffer channels are disconnected logically from the computer. They must be reselected for use except when a device on the normal channel is selected while the buffer channel is in operation. In this case, the normal channel is selected, the device on the buffer channel is not disconnected, and the buffer operation is completed.

When an input or output operation is performed on the normal channel, the computer is not free for computation but must wait until the operation is completed. Once an input or output operation is started on the buffer channel, however, the computer is free to either continue computing or perform some other input/output operation on the normal channel.

NOTE

If an Input Disconnectis generated while doing a normal input (72XX) instruction, the address which would have received the next data word will contain all 0's. This applies whether the 72XX uses the normal or the buffer input cable.

No O's are stored in this manner when doing a buffer input (7200) instruction.

If an automatic disconnect is generated by the 161 typewriter, the last data word will be followed by a location containing the carriage return $\cot(45_8)$, and by a second location containing all 0's.

The general procedure for performing an input/output operation is as follows:

- 1) Request the status of the selected unit.
- 2) Test the status of the unit for capability of performing the required function.
- 3) Select the unit to perform the input/output function.
- 4) Select the proper storage bank and initiate the input/output operation on the correct channel.
- 5) At the completion of the input/output operation, request the status of the selected unit and test to verify that the input/output operation was successfully completed.

Notice that three of the above five operations are concerned with status requests. To allow the 160-A to have proper input/output control, most peripheral units transmit codes to the 160-A which inform the computer whether or not a unit can be selected and whether or not an input operation was properly completed. External function codes and status response codes are listed in appendix 2.

Checking Status

Checking status is not mandatory for input/output operations; steps 3 and 4 may be used alone. However, if a selected unit is not capable of performing an input/output operation (power to the unit is off, for instance) when an external function instruction selects the unit, the computer will be indefinitely delayed and display SEL on the status mode indicator.

Even if a unit is turned off, its status may be requested and determined.

Example:

Test the status of the input/output typewriter and, if status is okay, select the typewriter for output. (Refer to appendix 2 for codes.)

Location	<u>F</u>	E	<u>G</u>	Comments
(r) a (r) a + 2 (r) a + 3 (r) a + 4		03	4240 W	Code 4240 requests typewriter status Read status response to A Go to select if typewriter ready Return jump to subroutine to determine status trouble
(r) a + 6 Continue		gram.	4210	Select typewriter

If the status response indicates that the unit is not ready, a jump is executed to the subroutine starting at location (r)W to determine the exact status response code and take the necessary action. Note from appendix 2 that a status response code of zero signifies that the typewriter is ready for input/output.

Status is also requested at the completion of an input/output operation to test for conditions which might have occurred during the operation. Not all peripheral devices have codes for such conditions (for example, the typewriter). A peripheral device such as magnetic tape, however, does check for such conditions as:

End of file End of tape Parity errors Length errors

After an initial status check is made, the external device is selected for input or output and the correct input or output instructions are given to perform the operation.

A status response code may be read using either INA or INP instruction. INP takes more time, however. In addition, a load instruction is necessary to put the response in A for checking the status conditions when INP is used.

Input on the Normal Channel

After the external device has been selected for input, use any combination of the following two instructions to read the incoming information into storage:

INP - reads from 1 to 7777 words into storage INA - reads 1 word into A

When INP is used, the information will be sent to the storage bank specified by the indirect storage bank control (i).

Example: Read 21 frames of paper tape into the area starting at (i)2222, and then read one more frame into A.

Location	<u>F</u>	E	G	Comments
(r) a (r) a + 2	EXC INP	04	4102 2243	Select 350 paper tape reader 2243 is the LWA + 1 of where information is to be stored
(r) a + 4 (r) a + 5 (r) a + 6	INA PJF 22	02 22		Read one frame to A Continue 2222 is the FWA of where the information is to be stored. That this location ((r) a + 6) is selected to hold the FWA is indicated by the 04 in the E portion of the INP instruction at (r) a + 2.

Output on the Normal Channel

After the external device has been selected for output, use any combination of the following instructions to write the outgoing information from storage onto the selected device:

OUT - writes from 1 to 7777 words from storage.

OTA - writes one word from A.

OTN - writes one word composed of 6 high order zero bits and the 6 low order bits from the E portion.

Example:

Punch 100 frames of paper tape from the area starting at location (i)3200 and then punch 120 frames from the area starting at (i)2701.

Location	<u>F</u>	E	<u>G</u>	Comments
(r) a (r) a + 2 (r) a + 4 (r) a + 6 (r) a + 7 (r) a + 10	EXC OUT OUT PJF 32 27	05 04 03 00 01	4104 3300 3021	Select the punch 3300 is the LWA + 1 of the first output area 3021 is the LWA + 1 of the second output area Exit to next program step 3200 is the FWA of the first output area 2701 is the FWA of the second output area

The Buffer Channel

Perform the following operations before an external device is selected for an input or output operation on the buffer channel:

- 1) Load the Buffer Entrance register with the FWA of the input/output area.
- 2) Load the Buffer Exit register with the LWA \pm 1 of the input/output area.
- 3) Select the proper storage bank for (b).

After the above steps are completed, the external device is selected and an IBI or IBO instruction starts the buffer operation. It is possible to give the external function instruction to select the external device prior to setting up the buffer registers and (b). However, on certain external equipments, such as magnetic tape, the external function instruction actually starts tape motion and the operation will not be properly completed if the correct data is not available to the tape unit at the time a data transfer request is issued by the tape unit.

If an interrupt 20 is wanted at the completion of the buffer operation, give a CIL instruction following the external function instruction. The execution of any external function instruction automatically sets interrupt lockout. If a CIL instruction is not given, all interrupts remain on the lines and do not take effect until a CIL instruction is given.

Example:

Read a message of not more than 50 characters from the input/output typewriter over the buffer channel into storage bank 3, location 3700.

Location	F	E	G	Comments
(r) a	LDC		3700	FWA of input area
(r) a + 2	ATE		a + 2	Put in BER; if busy, wait
(r) a + 4	LDC		3750	LWA + 1 of input area
(r) a + 6	ATX		a + 6	Put in BXR; if busy, wait
(r) a + 10	SBU	3		Set (b) to 3
(r) a + 11	EXC		4240	Request typewriter status
(r) a + 13	INA			Read status
(r) a + 14	ZJF	04		Go if status okay
(r) a + 15	SBN	20		Test to see if input waiting. If yes, go ahead. If
				no, status response indicates typewriter not ready.
(r) a + 16	ZJF	02		,
(r) a + 17	HLT			Stop if not ready
(r) a + 20	EXC		4220	Select typewriter input
(r) a + 22	CIL			Clear lockout
(r) a + 23	IBI		a + 23	Start buffer operation. Computer is now free to compute and will be interrupted when the buffer operation is complete.
(r) a + 25				Continue program while the input is in progress.

PROGRAMMING EXAMPLES

INTERNAL PROGRAMMING

The following are several internal programming problems with solutions which illustrate various uses of the 160-A instructions. Some of the problems can be programmed in more than one way; but the method chosen, although in some cases not the best, serves well for illustration.

One programming convention, occurring throughout the examples, is used in most utility and general purpose programs developed by Control Data: the locations 0070 - 0077 of all storage banks are used for temporary or transient storage of data, counters, etc. These locations should be avoided for program, table, or constant storage.

Problem:

Set up a program switch so that, as the switch is executed, program control is alternately transferred to locations (r)W and (r)V. (W and V are any two arbitrary locations.)

Location	F	E	G	Comments
(r) a	SRC		5252	5252 is an alternating pattern of "O" and "1" bits
(r) a + 2	PJF	03		If positive, jump to (r)W
(r) a + 3 (r) a + 4	JFI V	01		Jump to (r)V
(r) a + 5 (r) a + 6	JFI W	01		Jump to (r)W

Problem:

Starting at location (i)0200 are 10_8 words of packed BCD data. Unpack these words into a one character per word format starting at location (i)0300 with the character in the lower half of the word. Assume the unpacked area to be clear. A BCD character is 6 bits long.

Location	F	<u>E</u>	G	Comments
(r) a (r) a + 2 (r) a + 3 (r) a + 5 (r) a + 6 (r) a + 7 (r) a + 10 (r) a + 12 (r) a + 13 (r) a + 14 (r) a + 15	LDC STD LDC STD ADN STD LDC STD LDI HWI LS6	77 76 01 75 74 74 75	-10 0300 0200	Set loop counter (d)0077 is counter location FWA of unpacked area Put in (d)0076 A + 1 A - 0301 Put in (d)0075 FWA of packed area Put in (d)0074 Packed word to A Lower character to unpacked area Shift left 6

(r) a + 16	HWI	76	Upper character to unpacked area
(r) a + 17		74	Increase addresses
(r) a + 20	LDN	02	
(r) a + 21	RAD	75	
(r) a + 22	LDN	02	
(r) a + 23	RAD	76	
(r) a + 24	AOD	77	Loop counter + 1
(r) a + 25			Return if not done
• •			done - continue

Problem:

Transfer 100_8 words from location (i)0700 to location (i)2300 and perform this as a JPR subroutine whose entrance line is a.

Location	F	E	G	Comments
(r) a – 1	JFI	01		Exit line
(r) a				Return address stored here
(r) a + 1	LCC		100	Loop count to A
(r) a + 3	STD	77		(d)0077 is count location
(r) a + 4	LDC		0700	FWA or area one
(r) a + 6	STF	05		Initialize a + 13
(r) a + 7	LDC		2300	FWA of area two
(r) a + 11	STF	04		lnitialize a + 15
(r) a + 12	LDM		****	Parameterized FWA of area one
(r) a + 14	STM		****	Parameterized FWA of area two
(r) a + 16	AOB	03		FWA + Ī
(r) a + 17	AOB	02		FWA + 2
(r) a + 20	AOD	77		Count + 1
(r) a + 21	NZB	07		Loop if not complete
(r) a + 22	ZJB	23		Go to exit - all done

Problem:

Count the number of positive, negative, and zero numbers in a table stored in (i)0100 to (i)0200. Put the 3 counts in locations (d)0070, (d)0071, and (d)0072. The program should start at location (r)0500.

Location	<u>F</u>	E	<u>G</u>	Comments
(r)0500 (r)0502 (r)0503 (r)0504 (r)0505 (r)0506 (r)0507 (r)0511 (r)0512	LDC STF LDN STD STD STD LDM ZJF PJF	06 00 70 71 72 10	0100	Initialize table address Put in load command (r)0510 Set A - 0 to initialize counts Positive count - 0 Negative count - 0 Zero count - 0 Table word to A Jump if zero to (r)0521 Jump if positive to (r)0523

(r)0513 (r)0514 (r)0515 (r)0517 (r)0520 (r)0521 (r)0522 (r)0523 (r)0524	AOD AOB SBC NZB ZJF AOD NZB AOD NZB	71 04 10 05 72 06 70 10	0201	Negative count + 1 Table address + 1 Test for end of table Return to (r)0507 if table not finished Exit - all done Zero count + 1 Return to tally Positive count + 1 Return to tally
---	---	--	------	--

Problem:

Set all storage locations in storage bank (1) between the limits (1)0100 and (1)7700 inclusive, equal to zero.

Location	<u>F</u>	<u>E</u>	G	Comments
(r) a (r) a + 2 (r) a + 4 (r) a + 6 (r) a + 10 (r) a + 11 (r) a + 12 (r) a + 14	LDC ATE LDC ATX SBU LDN BLS Next i	l 00	7701 a + 6 a + 12	FWA of area to A FWA to BER; if buffer busy, delay LWA + 1 to A LWA + 1 to BXR; if buffer busy, delay Set (b) - 1 Set A - 0 Start clear operation using the buffer

INPUT/OUTPUT PROGRAMMING

Paper Tape Reader

The 350 paper tape reader reads 5, 7, or 8 level punched paper tape at a rate of 350 frames per second. Since each frame of paper tape can contain a character, 350 characters per second may be read. Tape made of paper, parchment, Mylar, or Mylar-aluminum laminate is acceptable in any color and either strips or loops of tape may be read.

The 350 reader can be programmed to read continually, stopping on any single character, or it can be programmed to read one character at a time and stop between each character. In order to keep the reader in a continual mode, an input instruction must be given no later than 250 usec following the completion of the previous input instruction. If not, a stop will be initiated and the paper tape will come to a complete stop before the next frame is read.

The 350 reader, which is standard equipment on the 160-A, is always connected to the normal input/output channel. Selection is made at the reader itself to transmit either 5, 7, or 8 bits of information per frame of tape. This data enters the 160-A in the least significant portion of each computer word, one frame of paper tape per word, with the upper bits zero.

The only external function code for the 350 reader is the code 4102. This code selects the reader, provided it has been turned on and is in proper working order. Once the 350 reader has been selected, it will remain selected until another external fuction instruction is executed. There are no status codes or responses for the 350 reader.

To read information under program control, select the 350 reader. Use either of the instructions INP or INA in any combination to transmit data from paper tape to the 160-A.

A sample 7 level paper tape is shown in figure 6. Bit Position When Read Levels 0 ١ 00 2 ١ 3 2 0 0 0 0 0 0 0 0 0 0 0 0 FH 4 3 4 5 5 6 6 7 Octal Code 11 10

Figure 6. Punched Paper Tape Levels

Example: Read the sample paper tape as shown in figure 6 into consecutive storage locations starting at

location (i)0400. Ignore any blank leader. Stop after the last data frame (octal 150) has been

read.

Location	F	<u>E</u>	G	Comments
(r) a (r) a + 2 (r) a + 3 (r) a + 4 (r) a + 6 (r) a + 7 (r) a + 10 (r) a + 11	EXC INA ZJB STM AOB INA NZB HLT	01 01 04	4102 0400	Select reader Read one frame If frame is part of blank reader, go back Store data starting at (i)0400 Increase store address Read next frame If data, go to store End of data-stop

When the example above has been executed using the paper tape shown in figure 6, the data read will appear as follows in storage:

Location	<u>F</u>	E	Location	F	<u>E</u>
(i)0400	01	77	(i)0407	00	11
(i)0401	00	62	(i)0410	01	12
(i)0402	01	14	(i)0411	00	27
(i)0403	00	01	(i)0412	01	64
(i)0404	01	55	(i)0413	00	36
(i)0405	00	10	(i)0414	01	50
(i)0406	0.1	43	(/	• •	•

Paper Tape Load Format

The 160-A has special circuits which allow automatic loading of programs and and data from specially prepared paper tapes. The information is prepared on paper tape in a two-frames-per-word format. The first frame of each word contains a 7th level punch and the six higher order bits of the word; the second frame contains the six lower order bits of the word and no 7th level punch.

Successive words must follow each other on tape. The automatic load will stop when a frame is read which should contain a 7th level punch and none exists. Tape may be placed in the reader any place on the leader; the automatic load will not begin until the first 7th level punch is sensed. Prior to starting automatic load, the FWA where the data is to be stored must be placed in P, and A should be cleared. When the load is completed, P will contain the LWA where data was stored and A will contain a check sum of the data read, modulus $2^{12}-1$.

Example:

If the paper tape shown in figure 6 had been read under paper tape load control and P had been set initially to zero, at the completion of the load memory the data would appear as follows:

Location	F	E	Location	F	E
(r)0000	77	62	(r)0004	12	27
(r)0001	14	01	(r)0005	64	36
(r)0002	55	10	(r)0006	50	00
(r)0003	43	11	Stop L	_oad	

Paper Tape Punch

The 110 character per second punch punches 5, 6, 7, or 8 level punched paper tape at 110 frames per second. This punch is always connected to the normal input/output channel and is standard equipment on the 160-A.

Each computer word transmitted to the punch punches one frame of paper tape. The 8 bits punched are taken from the least significant portion of the word. A "1" bit punches a hole in the corresponding level; a "0" bit leaves the corresponding level blank. The upper bits of the word are ignored.

The only external function code for the punch is the code 4104. This code selects the punch, provided it has been turned on and is in proper working order. Once the punch has been selected, it remains selected until another external function instruction is executed. There are no status responses for the punch.

To punch information, first select the punch. Then use any combination of the instructions OTN, OTA, or OUT to transmit data to the punch.

Example:

Punch out locations (i)0100 to (i)0200 in paper tape load format (see 350 Reader Programming). Punch a one-foot leader before and after the data.

Location	F	E	<u>G</u>	Comments					
(r) a - 1 (r) a + 1 (r) a + 3 (r) a + 4 (r) a + 5 (r) a + 6 (r) a + 10 (r) a + 12	EXC LDC OTN SBN NZB STM LDC STD	00 01 02	4104 0144 0072 0100	Select punch Number frames for leader (in A) Punch a blank frame Reduce count in A If count not zero, punch more Store FWA of punch area					
(r) a + 13	LDI	70		((i)0100) to A					
(r) a + 14 (r) a + 15	STD LPC	71	7700	Put lower half in (d)0071 Clear lower					
(r) a + 17	ADN LS6	01		Add 1 for 7th level Shift 6					
(r) a + 20 (r) a + 21	OTA			Output upper					
(r) a + 22	LDD	71		Lower half					
(r) a + 23 (r) a + 24	LPN OTA	77							
(r) a + 24 (r) a + 25	AOD	70		FWA + 1					
(r) a + 26	SBC		0201	Test for end					
(r) a + 30	NZB	15		Go back if not end					
(r) a + 31 (r) a + 32	LDB OTN	27 00		Number frames for leader					
(r) a + 33	SBN	01							
(r) a + 34	NZB	02		Punch leader loop					
(r) a + 35	HLT		_						
End of example.									

GLOSSARY

GLOSSARY OF PROGRAMMING TERMS

The following glossary gives the meaning of terms that are used in a relatively specialized sense in this manual.

ADDER In general, a device used to add two quantities. Spe-

cifically, the borrow structure in the subject computer.

ADDRESS The number designating a storage location; also the

storage location itself.

BANK A unit of core storage with provisions for storing 4096

words. The use of more than one bank permits increasing the storage capacity of a computer without increasing the word length implicitly necessary to extend the range of storage addresses. In the 160-A, this address is effectively increased by a separate instruction (set storage bank control) which determines which bank(s) will be used during a program. Although the total 160-A storage capacity may be extended to eight banks, no

more than four may be addressed at any time.

BIT Binary digit; may be either "1" or "0".

BORROW In a subtractive counter or accumulator, a signal in-

dicating that in stage n, a "1" was subtracted from

a "0".

BUFFER Noun: A device in which data are stored temporarily in

the course of transmission from one point to another.

Verb: To store data temporarily.

BUFFERED A term indicating that the computer may carry on high INPUT/OUTPUT speed computation at the same time it is each arrive.

speed computation at the same time it is exchanging data with a peripheral device. In the 160-A, this term must be distinguished from normal 1/0, during which

the computer cannot engage in computation.

CARRY In an additive counter or accumulator, a signal indicat-

ing that in stage n, a "l" was added to a "l".

CHANNEL A transmission path that connects the computer to a

given external equipment.

CHARACTER Information handled by the computer:

1) A group of 6 bits representing bi-octal information; may denote a binary quantity, a digit, letter or symbol. In load mode, two 6-bit characters are assembled into

one computer word.

2) A group of 7 bits representing an item of information. When the capacity of an input device is 6 or 7 bits, those bits will be deposited in the lower portion of the selected storage address, the remaining bits will be zeros.

CLEAR A command that removes a quantity from a register by

placing every stage in the "0" state.

COMMAND A signal that performs a unit operation, such as trans-

mitting contents of one register to another, shifting a

register, setting a flip-flop.

COMPLEMENT Noun: See One's Complement or Two's Complement.

Verb: A command which produces the one's complement

of a given quantity.

CONTENT The quantity or word held in a register or storage

location.

CORE A small ferromagnetic toroid used as the bistable de-

vice for storing a bit in a memory plane.

COUNTER A register with provisions for increasing or decreasing

its content by 1 upon receiving the appropriate com-

mand.

DIRECT ADDRESSING A mode of addressing wherein the execution address

portion (E) of the instruction word contains the address of the operand to be acted upon. In the 160-A, the 6-bit execution address limits direct addressing to the first 64 of the possible 4096 storage locations ($2^6 = 64$) in

the direct bank.

END-AROUND BORROW A borrow that is generated in the highest order of an

accumulator or counter, and is sent directly to the low-

est order stage.

ENTER To manually place in a register a quantity that is not

from storage. In the 160-A, quantities may be entered

in only the A, P, and Z registers.

EXECUTION ADDRESS The lower 6 bits of a 12-bit instruction. Most often

used to specify the storage address of an instruction

or operand. Sometimes used as the operand.

FUNCTION CODE The upper 6 bits of a 12-bit instruction.

INDIRECT ADDRESSING A mode of addressing which extends the length of the execution address (E) to a full computer word, thereby permitting operand references to be made upon any location in storage. All indirect addresses must be contained in storage locations which are available by means of direct addressing. In the 160-A, the constant and memory modes are special forms of indirect addressing.

INPUT DISCONNECT

During an input instruction, a signal sent to the computer by the external device to indicate that the device has completed all available transmissions to the computer.

INPUT REQUEST

A request, by the computer, for information from an external device. Occurs during input instruction only. (See Resume.)

INSTRUCTION

A 12-bit or 24-bit quantity consisting of a function (or operation) code and an execution address.

INTERRUPT

A signal (or class thereof) which, when received and recognized by the computer, forces the computer to forestall its current operation and jump to a subroutine, the starting address of which is determined by the class of the interrupt. A subroutine may have any number of options. It may merely stop the computer, it may determine the nature of the interrupt in order to take corrective measures, or it may return the computer to another phase of the main program.

LOAD

To place a quantity from storage in the A register.

LOCKOUT

Any function (usually of machine logic) that inhibits an action which would normally occur were the lockout not imposed.

LOGICAL PRODUCT

In Boolean algebra, the AND function of several terms. The product is "1" only when all the terms are "1"; otherwise it is "0". Sometimes referred to as the result of "bit-by-bit" multiplication.

LOGICAL SUM

In Boolean algebra, the OR function of several terms. The sum is "1" when any or all of the terms are "1"; it is "0" only when all are "0".

MASK

In the information of the logical products of two quantities, one of them may be used as a mask for the other. The mask determines what part of the other quantity is to be considered. Wherever the mask is "O", that part of the other quantity is cleared, but wherever the mask is a "1", the other quantity is left unaltered.

MASTER CLEAR (MC)

A general command produced by placing the Load/Clear switch in the down (CLEAR) position. An MC clears all of the crucial registers and control FFs to prepare for a new mode of operation.

MODULUS

An integer which describes certain arithmetic characteristics of registers, especially counters and accumulators, within a digital computer. The modulus of a device is defined by r^n for an open ended device and r^n -1 for a closed (end-around) device, where r is the base of the number system used and n is the number of digit positions (stages) in the device. Generally, devices with modulus r^n use two's complement arithmetic procedures, and devices with modulus r^n -1 use one's complement procedures.

NORMAL JUMP

An instruction that jumps from one sequence of instructions to a second, and makes no preparation for returning to the first sequence.

ONE'S COMPLEMENT

With reference to a binary number, that number which results from subtracting each bit of the given number from the bit "1". A negative number is expressed by the one's complement of the corresponding positive number.

OPERAND

Usually refers to the quantity specified by the execution address. This quantity is operated upon in the execution of the instruction.

OPERATION CODE

The upper 6 bits of a 12-bit instruction which identifies the instruction. After the code is translated, it conditions the computer for execution of the specified instruction. The letter F is used to designate this code, which is expressed by two octal digits.

OVERFLOW

The condition in which the capacity of a register is exceeded.

PARTIAL ADD

An addition without carries. Accomplished by toggling each bit of the augend where the corresponding bit of addend is a "1".

PROGRAM

A precise sequence of instructions that accomplishes a computer routine; a plan for the solution of a problem.

READ

To place a quantity from a storage location into a register. The quantity in storage remains unchanged.

READY

The input/output control signal sent by either the computer or an external equipment to alert the device that is to receive a transmission. The ready signal indicates that the word or character has been transmitted.

REFLECTED BINARY (COUNTER)

A reflected binary, or Gray-code counter is one in which only one element changes state for successive counts.

RELATIVE ADDRESSING

A mode of addressing wherein the address of the operand is determined by adding (or subtracting) the contents of the execution address portion (E) of the instruction word to (or from) the instruction address.

REPLACE

In the title of an instruction, the result of the execution of the instruction is stored in the location from which the initial operand was obtained.

RESUME

The output control signal sent by an external equipment to indicate that it is prepared to receive another word or character. The resume signal is thus a request for data. (See Input Request.)

RETURN JUMP

A jump instruction which prepares for continuing the first sequence after the second is completed.

ROUTINE

The sequence of operations which the computer performs under the direction of a program.

SHIFT

To move the bits of a quantity right or left.

SIGN BIT

The bit in the highest-order stage of the register (in registers where a quantity is treated as signed by use of one's complement notation). If the bit is "1", the quantity is negative; if the bit is "0", the quantity is positive.

SIGN EXTENSION

The duplication of the sign bit in the higher-order stages of a register.

STATUS

- 1) The condition of an external device, as reflected in the response given to a status request interrogation by the computer.
- 2) The condition of the computer as shown by the Status Mode indicator on the console. May variously indicate what it is presently doing, why it stopped, or what it will do when it next starts.

TRANSMISSION, FORCED

A transmission where both set and clear inputs, only one of which will be a "1", are simultaneously gated into a FF which has not been cleared previously.

TRANSLATION

An indication of the content of a group of bit registers. A complete translation gives the exact content, while a partial translation indicates only that the content is within certain limits.

TWO'S COMPLEMENT

That number which results from subtracting each bit of a number from "0". The two's complement may be formed by complementing each bit of the given number and then adding one to the result, performing the required carries.

WORD

A unit of information which has been coded for use in the computer as a series of bits. The normal word length is 12 bits.

WRITE

To enter a quantity into a storage location.

APPENDIX SECTION

APPENDIX I

Table of Instructions

F	Ε	MNE- MONIC	NAME	TIM	IING) F	E	MNE- MONI	C	TIMINO
 Q0	00	ERR	Error Štop	*****		-	_			TIMING
00	0X		No Operation		1	11			o memory	3
00	1X		Set Relative Bank Control &	1	1	11		Y LPI	= 5 · · · · · · · · · · · · · · · · · ·	3
00	2X		Set Indirect Bank Control	Jump	1	12	•••		•	2
00	3X			.	ı	12		(LPF	5	2
00	37	נאו	Set Indirect & Relative Bank	Control & Jump	1	13	•••		- F	2
00	4X	SDC	Set Direct Bank Control	,	1	13		LPB	0	2
00	5Y	DRJ	Set Direct & Relative Bank (Control	-	14	٠.		The Compression Direct	2
			8	k Jump	1	15	00 YY		The state of the s	3
00	6X	SID	Set Indirect & Direct Bank C	Control	1	16	00		Selective Complement Indirect	3
00	7X	ACJ	Set Direct, Indirect, & Relat			16	XX	SCC SCF	Selective Complement Constant	2
Λ1	00	DIC	Control 8	•	1	17	00	SCS	Selective Complement Forward	2
01	00	BLS		no jump) (jump)	l+n 2	17	XX		Selective Complement Specific	2
01	01	PTA	Transfer P to A	(Jomp)	1	20		LDD	Selective Complement Backward Load Direct	2
01	02	LS1	Left Shift One		1	21	00	LDM		2
01	03	LS2	Left Shift Two		1	21	ΥY		Load Indirect	3
01	04	CBC	Clear Buffer Controls		1	22	00	LDC	· · · · · · · · · · · · · · · · · · ·	3
01	05	ATE	A to Buffer Entrance Registe	er	•	22		LDF	Load Forward	2
			· .	no jump)	1	23	00	LDS	Load Specific	2 2
	٠,	4.77		(jump)	2	23	ΧХ	LDB	•	2
01	06	AIX	- ,	no jump) (jump)	1	24	ΥY	LCD		2
01	07	ETA	Buffer Entrance Register to A	,	1	25	00		Load Complement Memory	3
01	10	LS3	Left Shift Three	•	1	25	ΥY		Load Complement Indirect	3
01	11	LS6	Left Shift Six		1	26	00	LCC	Load Complement Constant	2
01	12	MUT	Multiply A by Ten		1	26	XX		Load Complement Forward	2
01	13	MUH	Multiply A by One Hundred		1	27	00	LCS	Load Complement Specific	2
01	14	RS1	Right Shift One		1	27	XX	LCB	Load Complement Backward	2
01	15	RS2	Right Shift Two		1	30	ΥY	ADD	Add Direct	2
01	20	CIL	Clear Interrupt Lockout		1	31	00	ADM	Add Memory	3
01	30	CTA	Bank Controls to A		1	31	ΥY	ADI	Add Indirect	3
01	4X	SBU	Set Buffer Bank Control		1		00	ADC	Add Constant	2
01	5X	STP	Store P at Location 5X		3			ADF	Add Forward	2
01	6Y	STE	Store Buffer Entrance Registe				00	ADS	Add Specific	2
			Location 6X & Transfer A t Buffer Entrance Register	0	3				Add Backward	2
00	vv	LPN	•		1			SBD	Subtract Direct	2
		SCN	Logical Product No Address	d			00	SBM	Subtract Memory	3
			Selective Complement No Add		1			SBI	Subtract Indirect	3
			Load No Address]		00	SBC	Subtract Constant	2
			Load Complement No Address		1			SBF	Subtract Forward	2
			Add No Address		1		00	SBS	Subtract Specific	2
			Subtract No Address		1			SBB	Subtract Backward	2
IU	1 1	LPD	Logical Product Direct		2	40	ΥY	STD	Store Direct	3

APPENDIX I

Table of Instructions (Cont'd)

F		MNE- MONIC	NAME	TIMING	MNE- F E MONIC NAME TIMIN	1G
-		CTH	Store Memory	4	61 XX NZF Non-Zero Jump Forward	1
41	00 YY	STM STI	Store Indirect	4	62 XX PJF Positive Jump Forward	1
41			Store Constant	3	63 XX NJF Negative Jump Forward	1
42	00 X X	STC STF	Store Forward	3	64 XX ZJB Zero Jump Backward	1
42	00	STS	Store Specific	3	65 XX NZB Non-Zero Jump Backward	1
43			Store Backward	3	66 XX PJB Positive Jump Backward	1
43		SRD	Shift Replace Direct	3	67 XX NJB Negative Jump Backward	1
44 45	00	SRM	Shift Replace Memory	4	70 YY JPI Jump Indirect	2
45	YY	SRI	Shift Replace Indirect	4	71 00 JPR Return Jump	3
	00	SRC	Shift Replace Constant	3	71 XX JFI Jump Forward Indirect	2
46 46	XX	SRF	Shift Replace Forward	3	72 00 IBI Initiate Buffer Input (no jump)	1
47	00	SRS	Shift Replace Specific	3	(jump)	2
47	XX		Shift Replace Backward	3	72 XX INP Normal Input	*
50	YY	RAD	Replace Add Direct	3	73 00 IBO Initiate Buffer Output (no jump)	1 2
51	00	RAM	Replace Add Memory	4	73 XX OUT Normal Output	*
51	ΥY	RAI	Replace Add Indirect	4	74 XX OTN Output No Address	*
52	00	RAC	Replace Add Constant	3	75 00 EXC External Function Constant	2
52	ХΧ	RAF	Replace Add Forward	3	75 XX EXF External Function Forward	2
5 3	00	RAS	Replace Add Specific	3	76 00 INA Input to A	*
53	ХΧ	RAB	Replace Add Backward	3	76 YY HWI Half Write Indirect	4
54	ΥY	AOD	Replace Add One Direct	3	76 77 OTA Output from A	*
55	00	AOM	Replace Add One Memory	4	77 00 HLT Halt	1
55	ΥY	AOI	Replace Add One Indirect	4	77 OX SLS Selective Stop	1
56	00	AOC	•	3	77 XO SLJ Selective Jump (no jump)	1
56	ХΧ	AOF	Replace Add One Forward	3	(jump)	2
57	00	AOS	Replace Add One Specific	3	77 XX SJS Selective Stop & Jump (no jump)	1
57	XX	AOB	Replace Add One Backward	3	(jump)	2
60	ХX	ZJF	Zero Jump Forward	1	77 77 HLT Halt	ı

NOTE:

- 1) All timings are given in memory cycles where 1 memory cycle equals $6.4\ \mathrm{usec.}$
- 2) All numeric operation codes not listed in the above table will be executed as if they were a NOP instruction.

^{*} Execution time varies with speed of external equipment in use.

APPENDIX I Table of Instructions Arranged by Functions

<u>F</u>	<u>E</u>	<u>G</u>	MNE- MONIC	NAME	TIMI	NG	l E	<u>E</u>	G	MNE- MONIC	NAME .	TIMINO
_		TRUCTION	ON S				_	_	TIC INS		············	TIMING
00	00		ERR	Error Stop		1			110 1143			
77	00		HLT	Halt		1	01			MUT	Multiply A by 10	1
 77	77		HLT			1	01	13		MUH	Multiply A by One Hundre	1 F
		ANSMISS		STRUCTIONS		•	1	ХХ		SBN	Subtract No Address	1
01		YYYY		Block Store	/m = :	,	34			SBD	Subtract Direct	2
٥.	-		DLJ	DIOCK STOLE	(no jump) (jump)	1	35		YYYY	SBM	Subtract Memory	3
01	01		PTA	Transfer P to A	VI F7	1	35			SBI	Subtract Indirect	3
01	05	YYYY	ATE	A to Buffer Entrand	e Register		36		XXXX	SBC	Subtract Constant	2
					(no jump)	1	36			SBF	Subtract Forward	2
01	04	VVVV	4 T V	4 · D // E · D	(jump)	2	37	00		SBS	Subtract Specific	2
01	06	YYYY	AIX	A to Buffer Exit Re	egister (no jump)	1	37	XX		SBB	Subtract Backward	2
					(jump)	2	06	XX		ADN	Add No Address	1
01	07		ETA	Buffer Entrance Re	gister to A	. 1	30	ΥY		ADD	Add Direct	2
01	30		CTA	Bank Controls to A		1	31	00	YYYY	ADM	Add Memory	3
01	5Y		STP	Store P at Location	5X	3	31	ΥY		ADI	Add Indirect	3
01	6Y		STE	Store Buffer Entran	ce		32	00	XXXX	ADC	Add Constant	2
				Register at Locat			32	XX		ADF	Add Forward	2
				Transfer A to Buf Entrance Register		3	33	00		ADS	Add Specific	2
04	ХΧ		LDN	Load No Address		1	33	ХХ		ADB	Add Backward	2
20	ΥY		LDD	Load Direct		2	50	ΥY		RAD	Replace Add Direct	3
21	00	YYYY	LDM	Load Memory		3	51	00	YYYY	RAM	Replace Add Memory	4
21	ΥY		LDI	Load Indirect		3	51	ΥY		RAI	Replace Add Indirect	4
22	00	XXXX	LDC	Load Constant		2	52	00	XXXX	RAC	Replace Add Constant	3
22	ХΧ		LDF	Load Forward		2	52	ΧХ		RAF	Replace Add Forward	3
23	00		LDS	Load Specific		2	53	00		RAS	Replace Add Specific	3
23	ХХ		LDB	Load Backward		2	53	XX		RAB	Replace Add Backward	3
05	XX		LCN	Load Complement N	o Address	1	54	ΥY		AOD	Replace Add One Direct	3
24	ΥY		LCD	Load Complement D		2	55	00	YYYY	AOM	Replace Add One Memory	4
25	00	YYYY	LCM	Load Complement M		3	55	ΥY		AOI	Replace Add One Indirect	4
25	ΥY		LCI	Load Complement Ir	ndirect	3	56	00	XXXX	AOC	Replace Add One Constant	3
26	00	XXXX	LCC	Load Complement C	onstant	2	56	XX		AOF	Replace Add One Forward	3
26	ХХ		LCF	Load Complement F	orward	2	57	00		AOS	Replace Add One Specific	3
27	00		LCS	Load Complement S	pecific	2	57	ХХ		AOB	Replace Add One Backward	l 3
27	XX		LCB	Load Complement B	ackward	2	SHIFT	INS	TRUCTI	ONS		
40	ΥY		STD	Store Direct		3	01				Left Shift One	1
41	00	YYYY	STM	Store Memory		4	01	03			Left Shift Two	1
41	ΥΥ		STI	Store Indirect		4		10			Left Shift Three	1
42	00	XXXX	STC	Store Constant		3	0.1	11			Left Shift Six	1
42	ХХ		STF	Store Forward		3	01	14			Right Shift One	1
43	00		STS	Store Specific		3	01	15			Right Shift Two	1
43	ХХ		STB	Store Backward		3	44	ΥΥ			Shift Replace Direct	3
76	ΥY		HWI	Half Write Indirect		4	45		YYYY		Shift Replace Memory	4

APPENDIX I

Table of Instructions Arranged by Functions (Cont'd)

_	_	_	MNE-	NAME TIME	NC 1	_	_	C	MNE- MONIC	NAME	TIMI	NG
<u>F</u>	E	<u>G</u>	MONIC	NAME TIMI	NG	<u>F</u>	Ē	<u>G</u>	MOINIC	NAWL	111011	nu .
SHIFT	INS.	TRUCTI	ONS (c					RUCTI				
45	ΥY		SRI	Shift Replace Indirect	4	60	XX		ZJF	Zero Jump Forward		1
46	00	XXXX	SRC	Shift Replace Constant	3	61			NZF	Non-Zero Jump For		1
46	ХХ		SRF	Shift Replace Forward	3	62			PJF	Positive Jump Forw		1
47	00		SRS	Shift Replace Specific	3	63	XX		NJF	Negative Jump Forv		1
47	ХХ		SRB	Shift Replace Backward	3		XX		ZJB	Zero Jump Backwar		1
				-			XX		NZB	Non-Zero Jump Bac		1
		NSTRU	CHON	S		66	XX		PJB	Positive Jump Back		1
02			LPN	· ·	1	67	XX		NJB	Negative Jump Back	cward	1
10	ΥY		LPD	Logical Product Direct	2	70	ΥΥ		JPI	Jump Indirect		2
11	00	YYYY	LPM	Logical Product Memory	3	71	00	YYYY	JPR	Return Jump		3
	ΥY		LPI	Logical Product Indirect	3	71	XX		JFI	Jump Forward Indire	ect	2
12	00	XXXX	LPC	Logical Product Constant	2	INPU	r/ou	TPUT I	NSTRU	JCT IONS		
-	XX		LPF	Logical Product Forward	2	01	04		СВС	Clear Buffer Contro	ols	1
	00		LPS	Logical Product Specific	2	01	20		CIL	Clear Interrupt Loc	kout	1
• •	XX		LPB	Logical Product Backward	2	72	00	YYYY	IBI	Initiate Buffer Inpu		
03	XX		SCN	Selective Complement No Address	1						(no jump) (jump)	1 2
	ΥY		SCD	Selective Complement Direct		73	00	YYYY	IBO	Initiate Buffer Outp		_
	00	YYYY	SCM	Selective Complement Memory	₇ 3						(no jump) (jump)	1 2
15	ΥΥ		SCI	Selective Complement	3	72	хх	YYYY	INP	Normal Input	(10111)	*
16	00	XXXX	SCC	Selective Complement		73		YYYY	OUT	Normal Output		*
				Constant	2	74	ХΧ		OTN	Output No Address		*
16	ХХ		SCF	Selective Complement Forward	2	76	00		INA	Input to A		*
17	00		SCS	Selective Complement	_		77	vvvv	OTA	Output from A External Function (Canatant	2
				Specific	2	75	00 X X	XXXX	EXC EXF	External Function		2
17	ХХ		SCB	Selective Complement Backward	2							_
				-	-	SELE	CTIV	/E STO	AND	JUMP INSTRUCTION	42	
STOR	AGE	BANK	CONTR	OL INSTRUCTIONS		00	0X		NOP	No Operation		1
00	ΊX		SRJ	Set Relative Bank Control		77	0 X		SLS	Selective Stop		1
00	2X		SIC	& Jump Set Indirect Bank Control	1	77	X0	YYYY	SLJ	Selective Jump	(no jump) (jump)	1
	3X		IRJ		-	77	ΧX	YYYY	SIS	Selective Stop & Ju		-
				Control & Jump	1	"	^^		030		(no jump) (jump)	1
	4X		SDC	Set Direct Bank Control	1							
	5X		DRJ	Set Direct & Relative Bank Control & Jump	1							
9 0	6X		SID	Set Indirect & Direct Bank Control	1							
00	7X		ACJ	Set Direct, Indirect, & Relative Bank Control & Jump	1	*				ies with speed of ex	ternal	
01	4X		SBU	Set Buffer Bank Control	1		equ	ipment i	n use.			

Table of External Function Codes and Status Responses

1. 350 PAPER TAPE READER

A. External Function Codes 4102 Select Reader

NOTE: There are no status responses for this equipment.

2. BRPE-11 PAPER TAPE PUNCH

A. External Function Codes4104 Select Paper Tape Punch

NOTE: There are no status responses for this equipment.

3. 161 INPUT/OUTPUT TYPEWRITER

A. External Function Codes

4210 Select typewriter output

4220 Select typewriter input

4240 Request typewriter status

B. Status Response Codes

0000 Typewriter ready

0004 Typewriter power off

0010 Typewriter not in computer status

0020 Input character ready

0040 Output in use

NOTE: If a second typewriter is added, the master bits will be 43.

4. 162 MAGNETIC TAPE SYNCHRONIZER

A. External Function Codes

Y11X Write if OUT is given

Y11X Write End-of-File mark if no OUT is given

Y12X Backspace one record if INA is given

Y12X Search backward to End-of-File mark if no INA is given

Y13X Read forward if INPUT is given

Y13X Search forward to End-of-File mark if no INPUT is given

Y14X Request status

Y15X Rewind unload

Y16X Rewind load

Y171 Set tapes to odd parity

Y172 Set tapes to even parity

210X High density

110X Low density

B. Status Response Codes

0000 Odd parity selected - no errors

0001 Even parity selected - no errors

0002 Tape X not ready

0004 Parity error

0015 | Illegal BCD detected on Write

0020 End-of-File mark read

0040 End-of-Tape or Load Point sensed

0100 High density

0200 Tape X busy

NOTES: Y = 1: 6-bit mode.

Y = 2: 12-bit mode.

X=(0 to 7): designates one of the four (eight) 60X's. The master bits 12, 13, 22, and 23 are used for second and third tape control. If the tape transport is a 606, a 6-bit, high density selection is illegal (a programmer consideration).

5. 165 PLOTTER

A. External Function Codes

4401 Select Plotter for Write operation

4440 Select Plotter for Read operation

B. Follow 4401 with Output instruction and transmit one of these:

0001 Move carriage and pen .01" in +X direction

0002 Move carriage and pen .01" in -X direction

0004 Rotate drum .01" in -Y direction

0005 Carriage and pen move .01" in +X direction, drum rotates in ~Y direction .01"

0006 Carriage and pen move .01" in -X direction, drum rotates in -Y direction .01"

0010 Rotate drum .01" in +Y direction

0011 Carriage and pen move .01" in +X direction, drum rotates in +Y direction .01"

0012 Carriage and pen move .01" in -X direction, drum rotates in +Y direction .01"

0020 Move pen down to paper

0040 Move pen away from paper

C. Status Response Codes

Status is obtained by selecting the unit for reading. The obtained status is the value of the 12 switches on the unit.

6. 166-2 LINE PRINTER

A. External Function Codes

0700 Asynchronous print

0710 Synchronous print

0740 Check status

072X Advance forms

B. Status Response Codes

0000 166-2 ready

0001 Buffer busy

0002 Out of paper

0004 Paper moving

0010 Drum stationary

0020 Off-line

7. 167-1 CARD READER

A. External Function Codes

4500 EF clear

4501 Free run read

4502 Single cycle read

4540 Check status

B. Status Response Codes

0000 Card Reader ready

0001 Hopper empty

0002 Stacker full

0004 Feed failure

0010 Program error

0020 Amplifier failure

0040 Motor power off

8. 167-2 CARD READER (Hollerith Facility)

A. External Function Codes

4500 EF clear

4501 Free run read

4502 Single cycle read

4504 NEGATE translate, H→BCD

4505 FRR, H→BCD and pack

4506 SCR, H→BCD and pack

4540 Check status

B. Status Response Codes

0000 Card Reader ready

0001 Hopper empty

0002 Stacker full

0004 Feed failure

0010 Program error

0020 Amplifier failure

0040 Motor power off

9. 168-1 AUXILIARY ARITHMETIC UNIT

A. External Function Codes

3300 Short divide

3301 Short multiply

3302 Long divide

3303 Long multiply

3304 Status request

3310 Reselect*

3323 Addition

3363 Subtraction

B. Status Response Codes

0000 Unit ready

0004 Add/Subtract overflow

0010 Divide fault

0020 Unload not completed

0040 Busy computing

10. 168-2 AUXILIARY ARITHMETIC UNIT

A. External Function Codes

3300 Divide 3314 Divide result
3301 Multiply 3315 Multiply result
3302 Left shift 3316 Left shift result
3303 Right shift 3317 Right shift result
3304 Status request
3310 Reselect*
3321 Addition 3335 Add to result

Norm. result & count

3375 Subt. from result

B. Status Response Codes

3361 Subtraction

0000 Unit ready

0010 Add/Subtract overflow

3342 Norm, & Count 3356

0020 Unload not completed

0040 Busy computing

4000 Divide fault**

*Reselect is used if another external equipment has been selected prior to receiving the result of a selected 168 operation. It cannot be used to initially select the unit.

**A divide fault occurs when the divisor is equal to or smaller than the most significant 27 bits of the dividend.

11. 169 AUXILIARY MEMORY UNIT

- A. External Buffer Select Codes
 - 4701 Select external buffer mode
 - 4702 Clear external buffer controls
 - 4704 Select BER read
 - 4710 Select channel extension mode
 - 4720 Clear channel extension mode
 - 4740 Select external buffer status

B. External Buffer Status Responses

- 1XXX Interrupt from other computer
- 2XXX Interrupt from peripheral equipment
- 4XXX Buffer interrupt
- X1XX This CHX active
- X2XX Other CHX active
- X4XX Illegal bank selection
- XX0X OBA-T
- XX1X IBA-T
- XX2X OBA-NT
- XX3X IBA-NT
- XX4X Buffer initiation
- XXX2-7 External bank selection
- 0000 External buffer ready

12. 170 CARD PUNCH CONTROL UNIT

- A. External Function Codes
 - 3002 Punch
 - 3040 Check status

B. Status Response Codes

- 0000 170 ready
- 0200 MS in 1604 position
- 2000 Punch not ready

13. 177 CARD READER

- A. External Function Codes
 - 4500 EF clear
 - 4501 Free run read
 - 4502 Single cycle read
 - 4505 Negate translate, H → BCD, free run read
 - 4506 Negate translate, H → BCD, single cycle read
 - 4510 Gate card
 - 4540 Status request

B. Status Response Codes

- 0001 Input tray empty
- 0002 Primary or secondary stacker full
- 0004 Feed failure
- 0010 Late input request
- 0020 Pre-read error
- 0040 Manual on or motor power off
- 0100 Read comparison error
- 0200 End of file
- 0400 Ready

14. 1610 CONTROL UNIT

- A. External Function Codes
 - 0301 Read from primary read
 - 0302 Read from secondary read
 - 0340 Request status of input
 - 3001 Print
 - 3002 Punch
 - 3040 Request status of output

B. Status Response Codes

- 0000 All units ready
- 0001 Reader not ready
- 0020 1604 selected on input
- 0200 1604 selected on output
- 2000 Punch not ready
- 4000 Printer not ready

15. 1612 HIGH SPEED PRINTER

- A. External Function Codes
 - 0600 Select printer and do not interrupt on ready
 - 0601 Space paper one line
 - 0602 Space paper two lines
 - 0603 Skip to format channel 7
 - 0604 Skip to format channel 8
 - 0605 Print information and advance paper
 - 0606 Do not advance paper after next print
 - 0607 Select printer and interrupt on ready
 - 0610 Clear monitor channels 1-6
 - 0611 Select monitor channel 1
 - 0612 Select monitor channel 2
 - 0613 Select monitor channel 3
 - 0614 Select monitor channel 4
 - 0615 Select monitor channel 5
 - 0616 Select monitor channel 6
- B. Status Response Codes
 - 0000 Printer not ready
 - 4000 Printer ready

NOTE: Status is always available on the 1612. No request is necessary.

16. 1614 CARD READER

EF and Status Codes same as 177 card reader.

17. 1615 MAGNETIC TAPE CONTROLLER

A. 160 External Function Codes (N = 1→7)

Write Operations

- 60N1 Select tape N to write binary
- 60N2 Select tape N to write coded
- 6001 Prepare selected tape to write binary
- 6002 Prepare selected tape to write coded
- 6003 Write End-of-File on selected tape
- 6005 Rewind selected write tape
- 6006 Backspace selected write tape
- 6007 Rewind-unload selected write tape
- 6010 Set Low Density on selected write tape
- 6020 Set High Density on selected write tape
- 6030 Skip bad spot on selected write tape
- 6053 Request status

Read Operations

- 50N1 Select tape N to read binary one record
- 50N2 Select tape N to read coded one record
- 52N1 Select tape N to read binary one file
- 52N2 Select tape N to read coded one file
- 5001 Prepare selected tape to read binary one record
- 5002 Prepare selected tape to read coded one record
- 5201 Prepare selected tape to read binary one file
- 5202 Prepare selected tape to read coded one file
- 5003 Move selected read tape forward one record
- 5203 Search file mark forward
- 5005 Rewind selected read tape
- 5006 Backspace selected read tape
- 5206 Search file mark backward
- 5007 Rewind-unload selected read tape
- 5010 Set Low Density on selected read tape
- 5020 Set High Density on selected read tape

B. Status Response Codes

- X2XX Ready to read
- X1XX Ready to write
- XX4X Read parity error
- XX2X Write reply parity error
- XX1X End-of-File mark
- XXX4 End-of-Tape mark

The following additional select and status codes are available under the program control mode of operation:

A. External Function Codes

Write Operations

- 6052 Release write control to 1604
- 6050 Release action request
- 5051 Set communication flag I
- 6055 Clear communication flag I
- 6051 Set communication flag II
- 6056 Clear communication flag II

Read Operations

- 5052 Release read control to 1604
- 5053 Select interrupt

17. 1615 MAGNETIC TAPE CONTROLLER (Cont'd)

B. Status Response Codes

Write Operations

2XXX Write control available XXX1 Communication flag | set

Read Operations

4XXX Read control available

1XXX Direct 160 to 1604

X4XX Direct 1604 to 160

XXX2 160 action request

18. 1619 DISK FILE CONTROLLER

A. Select Codes

7000 Select disc file - positioner power on

7001 Select clear disc file - positioner power off

7002 Select check mode type I - no buffer Select check mode type II - input

buffer activated

7003 Select checkword check

7004* Select interrupt on next available

7005* Clear interrupt on next available

7006* Select interrupt on next ready

7007* Clear interrupt on next ready

7010* Select interrupt on next fault

7011* Clear interrupt on next fault

7020 Request status

B. Status Response Codes

XXX0 Ready

XXX1 Not ready

XXX2 160 not selected

XXX4 1604 selected

XX1X Lost data

XX2X Checkword error

XX4X Internal fault

1XXX File off-line

2XXX File warning

4XXX Write lockout

^{* 160 -} A only

Use This Page for Additional Codes

Use This Page for Additional Codes

TABLE OF POWERS OF 2

```
2^{-n}
             2^n
                  n
             1
                  0
                      1.0
             2
                  1
                      0.5
             4
                  2
                      0.25
             8
                  3
                      0.125
                  4
                      0.062 5
            16
            32
                  5
                      0.031 25
            64
                  6
                      0.015 625
           128
                  7
                      0.007 812 5
           256
                  8
                      0.003 906 25
                       0.001 953 125
           512
                  9
         1 024
                 10
                      0.000 976 562 5
         2 048
                 11
                       0.000 488 281 25
         4 096
                 12
                       0.000 244 140 625
         8 192
                 13
                       0.000 122 070 312 5
                       0.000 061 035 156 25
        16 384
                 14
        32 768
                 15
                       0.000 030 517 578 125
        65 536
                 16
                       0.000 015 258 789 062 5
       131 072
                 17
                       0.000 007 629 394 531 25
       262 144
                       0.000 003 814 697 265 625
                 18
       524 288
                 19
                       0.000 001 907 348 632 812 5
                  20
                       0.000 000 953 674 316 406 25
     1 048 576
     2 097 152
                       0.000 000 476 837 158 203 125
                  21
     4 194 304
                  22
                       0.000 000 238 418 579 101 562 5
     8 388 608
                 23
                       0.000 000 119 209 289 550 781 25
    16 777 216
                       0.000 000 059 604 644 775 390 625
                  24
    33 554 432
                       0.000 000 029 802 322 387 695 312 5
                  25
    67 108 864
                  26
                       0.000 000 014 901 161 193 847 656 25
                       0.000 000 007 450 580 596 923 828 125
   134 217 728
                  27
                       0.000 000 003 725 290 298 461 914 062 5
   268 435 456
                  28
                       0.000 000 001 862 645 149 230 957 031 25
   536 870 912
                  29
                       0.000 000 000 931 322 574 615 478 515 625
  1 073 741 824
                  30
                       0.000 000 000 465 661 287 307 739 257 812 5
 2 147 483 648
                  31
                       0.000 000 000 232 830 643 653 869 628 906 25
                  32
 4 294 967 296
                       0.000 000 000 116 415 321 826 934 814 453 125
 8 589 934 592
                  33
                       0.000 000 000 058 207 660 913 467 407 226 562 5
                  34
 17 179 869 184
                       0.000 000 000 029 103 830 456 733 703 613 281 25
34 359 738 368
                  35
                       0.000 000 000 014 551 915 228 366 851 806 640 625
68 719 476 736
                  36
                       0.000 000 000 007 275 957 614 183 425 903 320 312 5
                  37
137 438 953 472
                       0.000 000 000 003 637 978 807 091 712 951 660 156 25
274 877 906 944
                  38
                       0.000 000 000 001 818 989 403 545 856 475 830 078 125
549 755 813 888
                  39
```

OCTAL-DECIMAL INTEGER CONVERSION TABLE

0000	0000
to	to
0777	0511
(Octal)	(Decimal)

	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		0017	0018	0019	0020	0021	0022	0023
0030	0024	0025	0026	0027	0028	0029	0030	0031
0040		9033	0034	0035	0036	0037	0038	0039
0050		0041	0042	0043	0044	0045	0046	0047
0060		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		0073	0074	0075	0076	0003	0078	0079
0120		0081	0082	0083	0084	0085	0086	0087
0130		0089	0090	0091	0004	0093	0094	0095
0140		0003	0098	0099	0100	0101	0102	0103
0150		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
	0120	0111	0122	0120	0121	0120	0120	0121
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
0200	0192	0193	0194	0105	0100	0100	0100	0100
0300 0310				0195	0196	0197	0198	0199
	0200	0201	0202	0203	0204	0205	0206	0207
0320 0330	0208 0216	0209 0217	0210 0218	0211 0219	0212	0213 0221	0214	0215
0340	0216	0217		0219	0220		0222	0223
0350	0232	0225	0226 0234	0237	0228	0229 0237	0230 0238	0231
0360	0232	0233	0234	0235	0236	0237	0238	0239
0370	0240	0241	0250	0243	0252	0253	0254	0247
0310	0240	0278	0200	0201	0232	0203	0234	0233

0 1 2 3 4 5 6 7 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 0299 0300 0301 0302 0303 0460 0304 0305 0306 0307 0308 0309 0310 0311 0315 0500 0320 0321 0322 0323 0324 0325 0366 0327 0510 0322 0321 0322 0323 0331 0333 0333 0333 0333 0334 0342 0342 0343 0520 </th <th></th>										
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 0286 0440 0288 0289 0290 0291 0292 0293 0294 0295 0450 0296 0297 0298 0299 0300 0301 0302 0301 0301 0302 0301 0301 0301 0301 0311 0311 0311 0311 0311 0311 0311 0311 0311 0318 0319 0500 0320 0321 0322 0323 0324 0325 0326 0327 0510 0328 0329 0330 0331 0332 0334 0335 0356 0357 0358 0359 0350 0351 0352 0356	_		0	1	2	3	4	5	6	7
0410	0	400	0256	0257	0258	0259	0260	0261	0262	0263
0420	10	410	0264	0265	0266	0267	0268	0269		0271
0440 0288 0289 0290 0291 0292 0293 0294 0295 0450 0296 0297 0298 0299 0300 0301 0302 0302 0460 0304 0305 0306 0307 0308 0309 0310 0311 0312 0313 0314 0315 0316 0337 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 0345 0530 0344 0345 0346 0347 0349 0350 0351 0540 0352 0351 0355 0356 0357 0358 0359 0550 0360 0361 0362 0363 0364 0365 0	0	420	0272	0273	0274	0275	0276	0277	0278	
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 0333 0333 0333 0333 0333 0334 0335 0520 0336 0337 0338 0339 0340 0341 0342 0343 0530 0344 0345 0346 0347 0348 0349 0350 0351 0550 0360 0361 0362 0363 0364 0365 0366 0367 0550 0368 0369 0370 0371 0372 0374 0375 0570 0376	0	430	0280	0281	0282	0283	0284	0285	0286	0287
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 0341 0342 0343 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 0355 0366 0366 0366 0366 0367 0373 0374 0373 0374 0373 0374 0373 0374 0373 <t< td=""><td>0</td><td>440</td><td>0288</td><td>0289</td><td>0290</td><td>0291</td><td>0292</td><td>0293</td><td>0294</td><td>0295</td></t<>	0	440	0288	0289	0290	0291	0292	0293	0294	0295
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 0334 0334 0334 0340 0341 0342 0343 0530 0344 0345 0346 0347 0349 0350 0351 0550 0360 0361 0362 0363 0364 0365 0366 0367 0560 0360 0361 0362 0363 0364 0365 0366 0367 0570 0376 0377 0378 0379 0380 0381 0382 0382 0600 0384 0385 0386 0387 0388 0389 0390 0391 0610 0392 0393 0394 0395 0396	0	450	0296	0297	0298	0299	0300	0301	0302	0303
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 0355 0355 0355 0355 0355 0355 0355 0355 0355 0355 0355 0355 0355 0355 0356 0366 0367 0366 0367 0366 0367 0366 0367 0373 0374 0373 0374 0373 0373 0373 0374 0373 0374 0375 0376 0377 0378 0379 0380 0381 0382 0383 0600 0344 0385 0386 0387 0388 0389 0399 0399 0399 0399	0	460	0304	0305	0306	0307	0308	0309	0310	0311
0510 0328 0329 0330 0331 0332 0333 0334 0335 0520 0334 0334 0334 0346 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 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	0	470	0312	0313	0314	0315	0316	0317	0318	0319
0510 0328 0329 0330 0331 0332 0333 0334 0335 0520 0334 0334 0334 0346 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 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	0:	500	0320	0321	0322	0323	0324	0325	0326	0327
0520 0336 0337 0338 0339 0340 0341 0342 0343 0530 0344 0345 0346 0347 0348 0349 0350 0351 0350 0351 0358 0359 0357 0358 0358 0359 0350 0351 0355 0355 0355 0356 0366 0367 0368 0369 0370 0371 0372 0373 0374 0375 0376 0377 0378 0379 0380 0381 0382 0383 0600 0344 0385 0386 0387 0388 0389 0391 0391 0382 0383 0600 0344 0385 0386 0387 0388 0389 0390 0391 0398 0399 0399 0399 0399 0399 0399 0399 0399 0399 0399 0399 0399 0399 0399 0399 0399 0399 0399 0399 <td></td>										
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 0365 0366 0367 0560 0388 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 0404 0405 0406 0407 0630 0408 0409 0410 0411 0412 0413 0414 0415 0640 0416 0417 0418	1 -									
0540 0352 0353 0354 0355 0356 0357 0358 0359 0550 0368 0361 0362 0363 0364 0305 0366 0367 0570 0378 0370 0371 0373 0373 0374 0375 0570 0376 0377 0378 0389 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 0416 0417 0428 0429 0430 0431 0660 04416 0417 0418 0419 0420 0433 0431										
0550 0360 0361 0362 0363 0364 0365 0366 0367 0560 0388 0389 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 0414 0414 0414 0414 0414 0414 0414 0414 0414 0414 0414 0414 0422 0423 0430 0431 0436 0437 0438 0439 0660 04242 0425 0426 <										
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	0	550	0360	0361	0362					
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 0412 0640 0416 0417 0418 0419 0420 0421 0422 0423 0431 0431 0433 0431 0436 0437 0438 0439 0450 0460 0461 0442 0443 0444 0445 0446 0447 0448 0443 0433 0434 0435 0436 0437 0438 0439 0670 0440 0441 0442 0443 0444 0445	0	560	0368							
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 0670 0440 0441 0442 0443 0444 0445 0446 0447 0700 0448 0449 0450 0451 0452 0453 0454 0457 0710 0458 0459 0460 0461 0462 0463 0710 0456 0457 0458 0459 0460 0461 0462 0463 0710 0456 0457 0458 0459 0460	0	570	0376	0377	0378	0379	0380			
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 0670 0440 0441 0442 0443 0444 0445 0446 0447 0700 0448 0449 0450 0451 0452 0453 0454 0457 0710 0456 0457 0458 0459 0460 0461 0462 0463 0710 0456 0457 0458 0459 0460 0461 0462 0463 0710 0464 0465 0466	06	300	0384	0385	0386	0387	0388	0389	0390	0391
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 0465 0460 0461 0462 0465 0720 0464 0465 0466 0466 0466 0469 0470 0471 0730 0472 0473 0474 0475 04	1									
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										
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 0478 0479 0730 0472 0473 0474 0475 0476 0477 0478 0479 0740 0480 0481 0482 0483 0484 0485 0486 0487 0750 0488										
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 0456 0710 0456 0457 0458 0459 0460 0461 0462 0465 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	06	340	0416	0417	0418	0419	0420			
0660 0670 0432 0440 0433 0441 0435 0442 0436 0444 0436 0446 0437 0446 0437 0446 0437 0446 0437 0446 0437 0446 0437 0446 0447 0447 0700 0448 0449 0457 0450 0450 0451 0450 0452 0460 0461 0461 0469 0462 0467 0453 0470 0471 0471 0471 0471 0471 0471 0471 0471 0471 0472 0472 0473 0472 0473 0472 0473 0472 0473 0473 0479 0473 0493 0493 0493 0494 0493 0494 0494 0494 0494 0494 0494 0494 0494 0494 0494 0494 0494 0494 0494 0494 0494 0494 0494 0494 0494 0494 0494 0494 0494 0494 0494 0494 0494 0494				0425						
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 0498 0490 0491 0492 0493 0494 0495 0760 0496 0497 0498 0499 0500 0501 0502 0503	06	360	0432	0433	0434	0435	0436	0437	0438	
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	06	370	0440							
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	07	001	0448	0449	0450	0451	0452	0453	0454	0455
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	1 -	1	-							
0730 0472 0473 0474 0475 0476 0477 0478 0479 0740 0480 0481 0482 0483 0484 0485 0486 0487 0750 0488 0489 0491 0492 0493 0494 0495 0766 0496 0497 0498 0499 0500 0501 0502 0503										
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										
0750 0488 0489 0490 0491 0492 0493 0494 0495 0760 0496 0497 0498 0499 0500 0501 0502 0503										
0760 0496 0497 0498 0499 0500 0501 0502 0503										
										0511

1000 | 0512 to to 1777 | 1023 (Octal) (Decimal)

	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
1								
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

		0	1	2	3	4	5	6	7
	1400	0768	0769	0770	0771	0772	0773	0774	0775
1	1410	0776	0777	0778	0779	0780	0781	0782	0783
	1420	0784	0785	0786	0787	0788	0789	0790	0791
1	1430	0792	0793	0794	0795	0796	0797	0798	0799
ı	1440	0800	0801	0802	0803	0804	0805	0806	0807
1	1450	8080	0809	0810	0811	0812	0813	0814	0815
1	1460	0816	0817	0818	0819	0820	0821	0822	0823
1	1470	0824	0825	0826	0827	0828	0829	0830	0831
-	1500	0832	0833	0834	0835	0836	0837	0838	0839
1	1510	0840	0841	0842	0843	0844	0845	0846	0847
1	1520	0848	0849	0850	0851	0852	0853	0854	0855
١	1530	0856	0857	0858	0859	0860	0861	0862	0863
1	1540	0864	0865	0866	0867	0868	0869	0870	0871
1	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
1	1610	0904	0905	0906	0907	0908	0909	0910	0911
1	1620	0912	0913	0914	0915	0916	0917	0918	0919
١	1630	0920	0921	0922	0923	0924	0925	0926	0927
١	1640	0928	0929	0930	0931	0932	0933	0934	0935
١	1650	0936	0937	0938	0939	0940	0941	0942	0943
Ì	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
1	1710	0968	0969	0970	0971	0972	0973	0974	0975
1	1720	0976	0977	0978	0979	0980	0981	0982	0983
1	1730	0984	0985	0986	0987	0988	0989	0990	0991
١	1740	0992	0993	0994	0995	0996	0997	0998	0999
1	1750	1000	1001	1002	1003	1004	1005	1006	1007
1	1760	1008	1009	1010	1011	1012	1013	1014	1015
1	1770	1016	1017	1018	1019	1020	1021	1022	1023

OCTAL-DECIMAL INTEGER CONVERSION TABLE

		OC.	TAL	- D E	CIM	۱AL	IN	TEC	GΕI	R
	0	1	2	3	4	5	6	7		
2000	1024	1025	1026	1027	1028	1029	1030	1031	ĺ	240
2010	1032	1033	1034	1035	1036	1037	1038	1039		241
2020	1040	1041	1042	1043	1044	1045	1046	1047		242
2030	1048	1049	1050	1051	1052	1053	1054	1055		243
2040		1057	1058	1059	1060	1061	1062	1063		244
2050		1065	1066	1067	1068	1069	1070	1071		245
2060	1072	1073	1074	1075	1076	1077	1078	1079		246
2070	1080	1081	1082	1083	1084	1085	1086	1087		247
2100	1088	1089	1090	1091	1092	1093	1094	1095		250
2110	1096	1097	1098	1099	1100	1101	1102	1103		251
2120 2130	1104	1105	1106	1107 1115	1108	1109	1110	1111		252
2140	1112	1113 1121	1114 1122	1113	1116 1124	1117 1125	1118 1126	1119 1127		253
2150	1128	1129	1130	1131	1132	1133	1134	1135		254
2160	1136	1123	1138	1139	1140	1141	1142	1143		255 256
2170	1144	1145	1146	1147	1148	1149	1150	1151		257
2200	1152	1153	1154	1155	1156	1157	1158	1159		260
2210	1160	1161	1162	1163	1164	1165	1166	1167		261
2220	1	1169	1170	1171	1172	1173	1174	1175		262
2230	1176	1177	1178	1179	1180	1181	1182	1183		263
2240	1184	1185	1186	1187	1188	1189	1190	1191		264
2250	1192	1193	1194	1195	1196	1197	1198	1199		265
2260		1201	1202	1203	1204	1205	1206	1207		266
2270	1208	1209	1210	1211	1212	1213	1214	1215		267
2300	1216	1217	1218	1219	1220	1221	1222	1223		270
2310	1224	1225	1226	1227	1228	1229	1230	1231		271
2320	1232	1233	1234	1235	1236	1237	1238	1239		272
2330	1240	1241	1242	1243	1244	1245	1246	1247		273
2340	1248	1249	1250	1251	1252	1253	1254	1255		274
2350 2360	1256 1264	1257 1265	1258 1266	1259 1267	1260 1268	1261	1262	1263		275
2370	1272	1273	1274	1275	1276	1269 1277	1270 1278	1271 1279		276 277
2310	1212	1210	16,4	12.13	1210	1211	1210	1215	L	211
	0	1	2	3	4	5	6	7		
3000	1536	1537	1538	1539	1540	1541	1542	1543		340
3010		1545	1546	1547	1548	1549	1550	1551		341
3020		1553	1554	1555	1556	1557	1558	1559		342
3030		1561	1562	1563	1564	1565	1566	1567	1	343
3040	1568	1569	1570	1571	1572	1573	1574	1575		344
3050	1576	1577	1578	1579	1580	1581	1582	1583		345
3060	1584	1585	1586	1587	1588	1589	1590	1591		346
3070	1592	1593	1594	1595	1596	1597	1598	1599		347
3100		1601	1602	1603	1604	1605	1606	1607		350
3110		1609	1610	1611	1612	1613	1614	1615		351
3120		1617	1618	1619	1620	1621	1622	1623		352
3130		1625	1626	1627	1628	1629	1630	1631		353
3140		1633	1634	1635	1636	1637	1638	1639		354
3150		1641	1642 1650	1643 1651	1644 1652	1645 1653	1646 1654	1647 1655		355 356
3160		1649 1657	1658	1659	1660	1661	1662	1663		357
3170	, 1036	1007	1000	1009	1000	1001	1002	1000		331

| 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 | 1720 | 1721 | 1722 | 1723 | 1724 | 1725 | 1726 | 1727 |

| 3300 | 1728 | 1729 | 1730 | 1731 | 1732 | 1733 | 1734 | 1735 | 13310 | 1736 | 1737 | 1738 | 1739 | 1740 | 1741 | 1742 | 1743 | 13320 | 1744 | 1745 | 1746 | 1747 | 1748 | 1749 | 1750 | 1751 | 3330 | 1752 | 1753 | 1754 | 1755 | 1756 | 1757 | 1758 | 1759 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750 | 1750

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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
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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
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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
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3420	1808	1809	1810	1811	1812	1813	1814	1815
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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
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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

2000	1024
to	to
2777	1535
(Octal)	(Decimal)

Octal Decimal
10000 - 4096
20000 - 8192
30000 - 12288
40000 - 16384
50000 - 20480
60000 - 24576
70000 - 286 72

3000	1536
to	to
3777	2047
(Octal)	(Decimal)

OCTAL-DECIMAL INTEGER CONVERSION TABLE

4000	2048
to	to
4777	2559
(Octal)	(Decimal

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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		2097	2098	2099	2100	2101	2102	2103
4070	2104	2105	2106	2107	2108	2109	2110	2111
4100		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		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

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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
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4670	2488	2489	2490	2491	2492	2493	2494	2495
4700	2496	2497	2498	2499	2 500	2501	2502	2503
4710	2504	2505	2 506	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

5000 | 2560 to to 5777 | 3071 (Octal) (Decimal)

	0	1	2	3	4	5	6	7
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5010	2568	2569	2570	2571	2572	2573	2574	2575
5020	2576	2577	2578	2579	2580	2581	2582	2583
5030	2584	2 585	2586	2587	2 588	2 589	2 590	2591
5040	2592	2593	2594	2595	2596	2597	2598	2599
5050	2600	2601	2602	2603	2604	2 605	2606	2607
5060	2608	2609	2610	2611	2612	2613	2614	2615
5070	2616	2617	2618	2619	2620	2 621	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	26 59	2660	2661	2662	2663
5150	2664	2665	2666	2667	2668	2669	2670	2671
5160	2672	2673	2674	2675	2676	2677	2678	2679
5170	26 80	2681	2682	2683	2684	2685	2686	2687
5200	2688	2689	269 0	2691	2692	2693	2694	2695
5210	2696	2697	2 698	2699	2700	2701	2702	2703
5220	2704	2705	27 06	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	27 50	2751
5300	2752	2753	2754	27 55	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	27 80	2781	2782	2783
5340	2784	27 85	2786	2787	2 788	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 2855 2851 2852 2853 2854 2855 5450 2856 2857 2858 2859 2860 2861 2862 2863 2864 2865 2866 2867 2868 2869 2870 2871 5470 2872 2873 2874 2875 2876 2877 2878 2879 5500 2880 2881 2882 2883 2884 2885 2866 2877 2878 2899 2900 2901 2902 2903 2911 2912 2913 2914									
5410 2824 2825 2826 2827 2828 2829 2830 2831 5420 2832 2833 2834 2835 2836 2837 2838 2837 5430 2840 2841 2842 2843 2844 2845 2845 2846 2847 5440 2848 2849 2850 2851 2852 2853 2854 2855 5450 2866 2867 2868 2869 2861 2862 2863 5470 2872 2873 2874 2875 2876 2877 2878 2879 5500 2880 2881 2882 2889 2890 2891 2892 2893 2894 2895 5510 2886 2889 2899 2900 2901 2902 2903 2894 2895 5510 2886 2889 2899 2900 2901 2902 2903 2911 2912 2		0	1	2	3	4	5	6	7
5420 2832 2833 2834 2835 2836 2837 2838 2839 5430 2840 2841 2842 2843 2844 2845 2846 2847 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 5500 2880 2881 2882 2883 2884 2885 2866 2867 5510 2888 2889 2890 2891 2892 2893 2894 2895 5520 2886 2897 2898 2899 2900 2901 2902 2903 5530 2904 2905 2906 2907 2908 2909 2910 2912 2913 2914 2915 2916 2917 2918 <t< td=""><td>5400</td><td>2816</td><td>2817</td><td>2818</td><td>2819</td><td>2820</td><td>2821</td><td>2822</td><td>2823</td></t<>	5400	2816	2817	2818	2819	2820	2821	2822	2823
5430 2840 2841 2842 2843 2844 2845 2846 2847 5440 2848 2849 2850 2851 2852 2853 2854 2855 5450 2865 2857 2858 2859 2860 2861 2862 2863 5460 2864 2865 2866 2867 2888 2869 2870 2871 5470 2872 2873 2874 2875 2876 2877 2878 2879 5500 2880 2881 2882 2883 2884 2885 2864 2887 5510 2888 2889 2890 2890 2901 2901 2902 2903 2894 2895 5530 2904 2905 2907 2908 2909 2910 2911 2918 2919 5540 2912 2913 2914 2915 2916 2917 2918 2919 2930 2	5410	2824	2825	2826	2827	2828	2829	2830	2831
5440 2848 2849 2850 2851 2852 2853 2854 2855 5450 2856 2857 2858 2859 2860 2861 2862 2863 5470 2872 2873 2874 2875 2876 2877 2878 2878 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 2912 2913 2914 2915 2916 2917 2918 2919 2910 2911 2912 2922 2923 2924 2925 2926 2927 2933 2934 2935 2943 2944 2945 2946	5420	2832	2833	2834	2835	2836	2837	2838	2839
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 2886 2897 2898 2899 2900 2901 2902 2903 5520 2896 2897 2898 2899 2900 2901 2902 2903 5530 2904 2905 2906 2907 2908 2909 2910 2911 5550 2920 2921 2922 2923 2924 2925 2926 2927 5560 2928 2929 2930 2931 2932 2934 2943 2942 2943 2943 5600 2944	5430	2840	2841	2842	2843	2844	2845	2846	2847
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 2886 2897 2898 2899 2900 2901 2902 2905 5520 2896 2897 2898 2899 2900 2901 2902 2901 5540 2912 2913 2914 2915 2916 2917 2918 2919 5550 2920 2921 2922 2923 2924 2925 2926 2927 5560 2928 2929 2931 2932 2931 2932 2931 2932 2933 2934 2945 5600 2944 2945 2946 2947 2948 2949 2950 2951 5610		2848	2849	2 850	2851	2852	2853	2854	2855
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 2918 2919 5550 2920 2921 2922 2923 2924 2925 2926 2927 5560 2920 2921 2922 2923 2924 2942 2942 2943 2942 2943 2934 2934 2934 2943 2943 2943 2944 2942 2943 2943 2943 2943 2943 2944 2943 2945 2946 2947 2948 2949	5450	2856	2857	2 858	2859	2860	2861	2862	2863
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5510 2888 2889 2890 2891 2892 2893 2894 2895 5520 2896 2897 2898 2899 2900 2901 2901 2901 2901 2901 2901 2901 2910 2911 2912 2913 2914 2915 2916 2917 2918 2919 2910 2911 2912 2923 2924 2925 2926 2927 2924 2925 2926 2927 2928 2929 2930 2931 2931 2932 2933 2934 2942 2943 2942 2942 2942 2942 2942 2942 2943 2942 2943 2942 2943 2942 2943 2942 2943 2942 2943 2942 2943 2942 2943 2942 2943 2942 2942 2943 2942 2943 2944 2945 2946 2947 2948 2949 2950 2956 2957 29	5500	2880	2881	2882	2883	2884	2885	2886	2887
5530 2904 2905 2906 2907 2908 2909 2910 2911 5540 2912 2913 2914 2915 2916 2917 2918 2919 2910 2911 2918 2919 2916 2917 2918 2919 2920 2923 2924 2925 2926 2927 2933 2934 2935 2934 2935 2934 2935 2931 2932 2933 2934 2935 2940 2941 2942 2943 2945 2948 2949 2940 2941 2942 2943 5600 2944 2945 2946 2947 2948 2949 2950 2951 5620 2960 2961 2962 2963 2964 2965 2966 2969 2970 2971 2972 2973 2974 2975 2963 2964 2965 2968 2989 2990 2991 2960 2991 2993 2994 <td>5510</td> <td>2888</td> <td>2889</td> <td>2890</td> <td>2891</td> <td>2892</td> <td></td> <td>2894</td> <td>2895</td>	5510	2888	2889	2890	2891	2892		2894	2895
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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 2969 5620 2961 2962 2963 2964 2965 2965 2966 2967 2974 2974 2974 2974 2974 2974 2974 2976 2966 2967 2966 2967 2966 2967 2974 2972 2973 2974 2975 2968 2980 2981 2982 2983 2984 2985 2986 2987 2988 2989 2999 2991 2999 2991	5530	2904	2905	2906	2907	2908	2909	2910	2911
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 2968 2961 2962 2963 2964 2965 2966 2967 5630 2968 2969 2970 2971 2972 2973 2974 2975 5640 2976 2977 2978 2979 2971 2972 2973 2974 2973 2974 2975 5650 2984 2985 2986 2987 2988 2989 2990 2991 5660 2992 2993 2994 2995 2996 2997 2998 2999 5670	5540	2912	2913	2914	2915	2916	2917	2918	2919
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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 2978 2972 2973 2974 2975 5640 2976 2977 2978 2980 2981 2982 2983 2989 2990 2991 2992 2993 2994 2995 2986 2987 2988 2989 2990 2991 2994 2995 2996 2977 2978 2996 2997 2998 2989 2990 2991 2996 2997 2998 2999 2990 2991 2998 2999 2999 2999 2999 2990 2991 2996 2997 2988 2989 2999 2990 2991 2996 297 2988 2989 2999 2990 2991 </td <td>5560</td> <td>2928</td> <td>2929</td> <td>2930</td> <td>2931</td> <td>2932</td> <td>2933</td> <td>2934</td> <td>2935</td>	5560	2928	2929	2930	2931	2932	2933	2934	2935
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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	5640	2976	2977	2978	2979	2980	2981	2982	2983
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	5650	2984	2 985	2986	2987	2988	2989	2990	2991
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	5660	2992	2993	2994	2995	2996	2997	2998	2999
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	5670	3000	3001	3002	3003	3004	3005	3006	3007
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	5700	3008	3009	3010	3011	3012	3013	3014	3015
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5760 3056 3057 3058 3059 3060 3061 3062 3063									
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OCTAL-DECIMAL INTEGER CONVERSION TABLE

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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
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6250	3240	3241	3242	3243	3244	3245	3246	3247
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6270	3256	3257	3258	3259	3260	3261	3262	3263
6300	3264	326 5	3266	3267	3268	3269	3270	3271
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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

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6500	3392	3393	3394	3395	3396	3397	3398	3399
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6670	3512	3513	3514	3515	3516	3517	3518	3519
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6710	3528	3529	3530	3531	3532	3533 3541	3542	3543
6720	3536	3537	3538	3539	3540			3551
6730	3544	3545	3546	3547	3548	3549 3557	3550 3558	3559
6740	3552	3553	3554	3555	3556	3565	3566	3567
6750	3560	3561	3562	3563	3564	3565	3574	3575
6760	3568	3569	3570	3571	3572	3573	3582	3583
6770	3576	3577	3578	3579	3580	3381	3302	3363

6000	3072
to	to
6777	3583
(Octal)	(Decimal)
	Decimal - 4096

Octal	Decima
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20000 -	
30000 -	
40000 -	
50000 -	
60000 -	
70000 -	28672

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7000 7010		3593	3594	3595	3596	3597	3598	3599
7010		3601	3602	3603	3604	3605	3606	3607
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		3633	3634	3635	3636	3637	3638	3639
7060		3641	3642	3643	3644	3645	3646	3647
7070	3040	5011	•••					
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7110		3657	3658	3659	3660	3661	3662	3663
7120		3665	3666	3667	3668	3669	3670	3671
7130		3673	3674	3675	3676	3677	3678	3679
7140		3681	3682	3683	3684	3685	3686	3687
7150	1	3689	3690	3691	3692	3693	3694	3695
7160		3697	3698	3699	3700	3701	3702	3703
	- 1	3705	3706	3707	3708	3709	3710	3711
7170	3104	3100	0.00	• • • •				
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7210		3721	3722	3723	3724	3725	3726	3727
7210	- 1 -	3729	3730	3731	3732	3733	3734	3735
		3737	3738	3739	3740	3741	3742	3743
7230	T		3746	3747	3748	3749	3750	3751
724		3753	3754	3755	3756	3757	3758	3759
725		7	3762	3763	3764	3765	3766	3767
726			3770	3771	3772	3773	3774	3775
727	0 3100	3103	3110	0		• • • •		
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		3785	3786	3787	3788	3789	3790	3791
731			3794	3795	3796		3798	3799
732			3802	3803	3804		3806	380
733			3810		3812			3815
734			3818	3819	3820		3822	382
735			3826		3828			
736								
737	0 3832	. 3033	3034	3033	3030	3031		

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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
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7470	3896	3897	3898	3899	3900	3901	3902	3903
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7550	3944	3945	3946	3947	3948	3949	3950	3951
7560		3953	3954	3955	3956	3957	3958	3959
7570		3961	3962	3963	3964	3965	3966	3967
7600	3968	3969	3970	3971	3972	3973	3974	3975
7610		3977	3978	3979	3980	3981	3982	3983
7620		3985	3986	3987	3988	3989	3990	3991
7630		3993	3994	3995	3996	3997	3998	3999
7640		4001	4002	4003	4004	4005	4006	4007
7650		4009	4010	4011	4012	4013	4014	4015
7660		4017	4018	4019	4020	4021	4022	4023
7670		4025	4026	4027	4028	4029	4030	4031
7700	4032	4033	4034	4035	4036	4037	4038	4039
7710		4041	4042	4043	4044	4045	4046	4047
7720		4049	4050	4051	4052	4053	4054	4055
7730		4057	4058	4059	4060	4061	4062	406
7740		4065	4066	4067	4068	4069	4070	407
7750		4073	4074	4075	4076	4077	4078	4079
7760		4081	4082	4083	4084	4085	4086	408
7770	4088	4089	4090	4091	4092	4093	4094	409

7000 | 3584 to to 7777 4095 (Octal) (Decimal)

APPENDIX V

OCTAL-DECIMAL FRACTION CONVERSION TABLE

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.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	1	
.011	.017578	.111	.142578	1		.310	. 390625
.012				.211	. 267578	.311	.392578
	.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	1	
.030	.048828	. 131	.173828	.230	. 296875	.330	. 421875
.032	.050781	. 132	.175781			.331	. 423828
.032		I .		.232	.300781	. 332	. 425781
	.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	B .	
.051	.080078	.151				.350	.453125
.051	.082031	1	.205078	. 251	. 330078	.351	. 455078
		.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	l .	
070	.109375	. 170				.367	.482421
			. 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

APPENDIX V

OCTAL-DECIMAL FRACTION CONVERSION TABLE

OCTAL DEC. OCTAL DEC. OCTAL DEC. .000001 .000103 .000103 .000101 .000244 .000200 .000482 .000301 .00072 .000011 .000101 .000251 .000202 .000482 .000301 .00074 .000002 .000017 .001012 .000255 .000202 .000499 .000303 .000740 .000004 .000105 .000104 .000235 .000204 .000330 .000741 .000006 .000105 .000160 .000235 .000206 .000507 .000305 .000771 .000000 .000106 .000237 .000206 .000511 .000300 .000110 .000277 .000201 .000313 .000112 .000218 .000311 .00071 .000010 .000011 .000278 .000211 .00031 .000712 .00031 .000712 .000011 .000278 .000211 .000214 .00011 .000278 .000212 .000311 .000712 .000314 .0000				
0.000010	OCTAL DEC.	OCTAL DEC.	OCTAL DEC.	OCTAL DEC.
	22222	000100 000244	.000200 .000488	.000300 .000732
		• • • • • • • • • • • • • • • • • • • •	•	.000301 .000736
0000003	* * * * * * * * * * * * * * * * * * * *	- · · · · · · · · · · · · · · · · · · ·	• • • • • • • • • • • • • • • • • • • •	
000001		• • • • • • • • • • • • • • • • • • • •		
0000016 000013 000105 000285 000285 0002057 000305 000755 0000075 0000075 0000075 0000075 0000075 0000075 0000075 0000075 0000075 0000075 0000075 0000075 0000075 0000075 0000075 0000075 0000075 0000075 0000011 000030 0000110 000030 0000110 000030 0000111 000274 000011 000032 000031 000031 000013 000015 000003 000115 000287 000213 000054 000033 000116 000287 000213 000054 000033 000116 000287 000213 000054 000033 000116 000287 000213 000054 000033 000116 000287 000012 000054 000033 000116 000287 000012 000054 000003 000002 0000061 000102 0000061 00000061 00000061 00000061 00000061 0000061 0000061 00000061 000	-	-	-	
.000006		•	· ·	
.000007			· · · · · · · · · · · · · · · · · · ·	
.000010 .000036			-	
.000010 .000033 .000111 .000278 .000211 .000522 .000131 .000760 .000012 .000038 .000112 .000282 .000132 .000530 .000131 .000770 .000013 .000014 .000134 .000138 .000131 .000014 .000034 .000131 .000151 .000015 .000151 .000160 .000015 .000161 .000028 .000115 .000218 .000151 .000161 .000178 .000160 .000053 .000116 .0002297 .000218 .000051 .000171 .000131 .000171 .000181 .000021 .000053 .000121 .000221 .000541 .000131 .000021 .000061 .000120 .000020 .000064 .000121 .000222 .000054 .000023 .000068 .000122 .0000121 .000222 .000055 .000023 .000068 .000122 .000122 .000023 .000056 .000023 .000068 .000122 .000122 .000023 .0000564 .000023 .000068	.000007 .000026	• • •		
0.00011 .000034 .000111 .000278 .000212 .000532 .000112 .00070 0.00013 .000044 .000113 .000282 .000213 .000530 .000131 .000770 0.00013 .000044 .000114 .000238 .000214 .000534 .000114 .000718 0.00015 .000049 .000115 .000233 .000215 .000537 .000116 .000237 .000216 .000541 .000181 .000027 .000216 .000541 .000181 .00027 .000214 .000541 .000180 .000221 .000541 .000181 .000221 .000054 .000217 .000785 .000217 .000785 .000217 .000783 .000221 .000544 .000230 .000222 .000568 .000222 .000568 .000222 .000568 .000222 .000568 .000223 .000680 .000223 .000668 .000223 .000668 .000223 .000680 .000224 .000568 .000323 .000689 .000232 .000689	.000010 .000030	.000110 .000274	•	1
	.000011 .000034	.000111 .000278	-	
		.000112 .000282	•	
		.000113 .000286		•
	-	.000114 .000289	.000214 .000534	1
000016 000053 000116 000297 000217 000545 000317 000789 000017 000051 000117 000311 000121 000545 000317 000789 000020 000061 000120 000308 000221 000553 000321 000793 000021 000068 000122 000312 000222 000566 000322 000680 000023 000076 000124 000326 000224 000566 000323 00080 000025 000080 000125 000324 000225 000368 000125 000324 000225 000388 000326 000328 000226 000572 000328 000127 000331 000227 000576 000327 000818 000027 000087 000127 000331 000227 000576 000327 000823 000031 000103 000133 000333 0006823 000331 000823 000831 000333 000823	•		.000215 .000537	-
000017 000057 000117 000130 000217 0000549 0000320 000793 000020 000064 000121 000308 000221 000553 000322 000793 000021 000064 000121 000308 000221 000556 000322 000891 000022 000068 000122 000312 000223 000556 000322 000805 000022 000068 000122 000316 000223 000560 000323 000805 000023 0000676 000124 000330 000224 000564 000325 000805 000025 000805 000025 000805 000025 000805 000025 000805 000025 000805 000025 000805 000025 000805 000025 000805 000025 000805 000025 000805 000025 000805 000025 000805 000025 000805 000027	= -		.000216 .000541	.000316 .000785
000020 000061 000120 0000305 000221 000533 000321 000793 000021 000064 000121 0003312 000222 000556 000322 00081 000022 0000123 000312 000223 000566 000322 000801 000023 000077 000123 000316 000223 000566 000324 000880 000025 000080 000125 000324 000225 000558 000322 00081 000026 000083 000126 000332 000226 000572 000326 00081 000027 000087 000127 000331 000227 000576 000327 00082 000030 000131 000333 000230 000579 00033 00082 000031 000130 000333 000331 000332 000331 000824 000032 000133 000347 000234 000581 000333 000835 000034		• • • • • • • • • • • • • • • • • • • •	.000217 .000545	.000317 .000789
000021 000064 000121 000318 000221 000556 000322 000801 000022 000068 000122 000312 000223 000566 000323 000801 000023 000072 000123 000316 000223 000566 000323 000805 000023 000066 000323 000805 000023 000066 000323 000805 000024 000076 000124 000032 000224 000568 000325 000812 000025 000088 000126 000032 000224 000568 000325 000812 000026 000083 000126 000338 000226 0000576 000327 000827 000037 000027 000037 000037 000812 000030 000110 000335 000220 000576 000337 000820 000011 000335 000220 000576 000337 000823 000023 0000030 0000030 000110 000335 000220 000579 000331 000827 000031 0000035 000111 000339 000222 000587 000331 000827 000033 000102 000132 000347 000232 000587 000333 000823 000033 000102 000133 000347 000233 000591 000333 000833 0000034 000035 000114 000355 000234 000595 000334 000839 000035 000110 000135 000356 000234 000595 000334 000839 000035 000114 000135 000356 000235 000598 000335 000846 000037 000118 000137 000362 000235 000602 000335 000846 000037 000118 000137 000362 000237 000660 000337 000854 000037 000118 000137 000414 000366 000240 000610 000340 000854 000041 000340 000854 000041 000340 000854 000041 000125 000141 000366 000240 000610 000344 000585 000041 000340 000856 000041 000340 000856 000044 000460 000340 000856 000044 000460 000340 000856 000044 000460 000340 000856 0000460 000340 000856 0000460 000340 000856 0000460 000340 000856 0000460 000340 000856 0000460 000340 000856 0000460 000340 000856 0000460 000340 000856 0000460 000340 000856 000660 000340 000660 0000460 000340 000660 000660 000660 000660 000660 000660 000660 000660 00066	•			.000320 .000793
000021 000068 000122 000312 000222 000566 000322 000805 000023 000072 000123 000324 000560 000324 00086 000024 000076 000124 000320 000224 000564 000324 00083 000025 000080 000126 000328 000225 000588 000325 00081 000027 000083 000126 000328 000226 000572 000326 000221 000372 000821 000020 000091 000127 000331 000227 000579 000330 000823 000031 000131 000333 000221 000583 000331 000823 000032 000099 000132 000333 000232 000587 000333 000331 000033 000102 000133 000344 000589 000334 000836 000034 00016 000134 000356 0002237 000598 000334<				1
000022 0000072 000123 000016 000223 000564 000023 000828 000828 000824 000076 000124 000024 0000564 000324 000080 000125 000324 000025 000588 000325 000812 0000225 000572 000326 000812 000027 000576 000327 000037 000027 000572 000326 000812 000227 000576 000327 000327 000037 000327 000327 000327 000327 000327 000327 000327 000327 000331 000323 000579 000330 000823 000031 000095 000131 000333 000232 000587 000331 000823 000033 000102 000132 000344 000233 000587 000332 000831 000033 000102 000133 000350 000234 000595 000334 000350 000234 000595 000334 000350 000234 000595	•	• • • • • • • • • • • • • • • • • • • •	1	1
.000023 .000072 .000124 .000324 .000564 .000324 .000824 .000325 .000086 .000126 .000328 .000225 .000568 .000325 .00088 .000025 .000080 .000126 .000328 .000226 .000572 .000326 .000321 .000027 .000081 .000127 .000331 .000227 .000576 .000327 .000320 .000031 .000091 .000132 .000335 .000231 .000333 .000331 .000323 .000331 .000321 .000333 .000331 .000323 .000331 .000323 .000332 .000331 .000332 .000331 .000332 .000333 .000334 .000333 .000334 .000335 .000334 .000333 .000334 .000335 .000334 .000335 .000334 .000598 .000334 .000335 .000334 .000335 .000334 .000335 .000334 .000335 .000335 .000335 .000334 .000333 .000340 .000660 .000337	• • • • • • •		1	
.000024 .000076 .000125 .000324 .000225 .000588 .000325 .00081 .000026 .000083 .000126 .000324 .000226 .000572 .000326 .00081 .000027 .000081 .000127 .000331 .000227 .000576 .000327 .000331 .000031 .000095 .000131 .000335 .000221 .000583 .000321 .000321 .000321 .000321 .000321 .000323 .000821 .000332 .000831 .000322 .000587 .000332 .000831 .000821 .000333 .000831 .000832 .000831 .000832 .000831 .000832 .000831 .000333 .000831 .000333 .000331 .000831 .000333 .000331 .000333 .000333 .000333 .000334 .000235 .000599 .000333 .000334 .000335 .000622 .000599 .000335 .000834 .000235 .000598 .000335 .000834 .000034 .000620 .000662	-			
.000025 .000088 .000126 .000328 .000672 .000326 .000127 .000037 .000027 .000087 .000127 .000331 .000227 .000576 .000327 .00083 .000231 .000331 .000331 .000331 .000331 .000331 .000331 .000331 .000331 .000333 .000331 .000333 .000334 .000034 .000354 .000235 .00034 .000334 .000336 .00034 .000337 .00014 .000362 .000236 .000430 .000336 .000337 .00044 .000125 .000141 .00				
.000028	.000025 .000080			
000027 000087 .000127 .000335 .000227 .000576 .000228 .000030 .000031 .000335 .000231 .000583 .000331 .000831 .000232 .000583 .000331 .000827 .000032 .000099 .000132 .000334 .000232 .000587 .000333 .000831 .000034 .000106 .00134 .000350 .000234 .000595 .000334 .00035 .000350 .000235 .00035 .000356 .000237 .000666 .000336 .000355 .000356 .000237 .000666 .000337 .000666 .000337 .000666 .000337 .000644 .000125 .000141 .000377	.000026 .000083		1	1
.000030 .000091 .000130 .000335 .000230 .000579 .000331 .000831 .000831 .000831 .000831 .000831 .000832 .000331 .000831 .000831 .000332 .000831 .000332 .000831 .000333 .000581 .000333 .000831 .000333 .000831 .000333 .000831 .000333 .000833 .000833 .000833 .000833 .000834 .000235 .000585 .000334 .000336 .000484 .000335 .000484 .000335 .000484 .000336 .000484 .000337 .000184 .000336 .000484 .000337 .000606 .000337 .000846 .000240 .000660 .000337 .000841 .000865 .000240 .000614 .000341 .000865 .000240 .000614 .000341 .000858 .000241 .000614 .000341 .000858 .000241 .000614 .000341 .000865 .000241 .000614 .000341 .000858 .000440 .000617 .000441 <t< td=""><td></td><td>.000127 .000331</td><td></td><td>1</td></t<>		.000127 .000331		1
.000031 .000095 .000131 .000339 .000232 .000583 .000331 .000832 .000831 .000332 .000831 .000332 .000833 .000332 .000833 .000332 .000333 .000333 .000333 .000333 .000334 .000335 .000334 .000355 .000334 .000355 .000356 .000355 .000358 .00035 .00035 .00035 .00035 .00035 .00035 .00035 .00035 .00035 .00035 .00035 .00036 .00062 .000335 .00084 .00037 .000606 .00337 .000860 .000337 .000606 .000337 .000850 .00040 .000606 .000337 .000850 .00040 .00061 .000340 .000852 .000141 .000122 .000141 .000370 .000241 .000614 .000852 .000043 .000852 .00044 .000617 .00044 .000617 .00044 .000621 .00034 .000852 .00034 .000852 .00034 .000852 .00034 <td< td=""><td></td><td>.000130 .000335</td><td>.000230 .000579</td><td>1 '</td></td<>		.000130 .000335	.000230 .000579	1 '
.000032 .000099 .000132 .000034 .000033 .000033 .000033 .00033 .00033 .00033 .00033 .00033 .00033 .00033 .00033 .00033 .00033 .00033 .000335 .00033 .000335 .000335 .000335 .000336 .000336 .00036 .000114 .000136 .00038 .000236 .000662 .000336 .00037 .00088 .000237 .000660 .000337 .00086 .000240 .000660 .000337 .000858 .000240 .000660 .000337 .000858 .000241 .000660 .000337 .000858 .00041 .000125 .000141 .000373 .000241 .000614 .000341 .000858 .000241 .000614 .000341 .000858 .000424 .000617 .000342 .000865 .000043 .000853 .000441 .000373 .000241 .000617 .000342 .000853 .000644 .000337 .000441 .000373 .000441 .000373 .000644 .000334	•	.000131 .000339	.000231 .000583	1
.000033 .000102 .000134 .000350 .000234 .000595 .000334 .000839 .000034 .000110 .000134 .000350 .000235 .000595 .000334 .000839 .000036 .000114 .000136 .000358 .000236 .000602 .000336 .000848 .000040 .000118 .000137 .000386 .000237 .000606 .000336 .000840 .000040 .000122 .000141 .000370 .000241 .000614 .000341 .000858 .000041 .000125 .000141 .000373 .000241 .000614 .000341 .000858 .000043 .000133 .000142 .000373 .000241 .000617 .000342 .000852 .000043 .000133 .000144 .000381 .000244 .000625 .000344 .000852 .000044 .000137 .000144 .000385 .000245 .000629 .000344 .000852 .000044 .000145 .0	• • • • • • • • • • • • • • • • • • • •	.000132 .000343	.000232 .000587	
.000034 .000106 .000134 .000350 .000235 .000595 .000334 .000335 .000335 .000335 .000335 .000336 .000336 .000336 .000336 .000336 .000336 .000336 .000336 .000336 .000337 .000336 .000838 .000337 .000850 .000377 .000606 .000337 .000850 .000041 .000377 .000610 .000337 .000851 .000041 .000352 .000041 .000373 .000241 .000614 .000341 .000852 .000044 .000125 .000141 .000373 .000242 .000617 .000342 .000852 .000333 .000143 .000377 .000243 .000621 .000342 .000862 .000342 .000862 .000342 .000862 .000342 .000842 .000621 .000342 .000842 .000442 .000621 .000342 .000862 .000342 .000842 .000621 .000345 .000853 .000624 .000625 .000344 .000853 .000444 .000625 <t< td=""><td>•</td><td></td><td>.000233 .000591</td><td>.000333 .000835</td></t<>	•		.000233 .000591	.000333 .000835
.000035 .000110 .000135 .000354 .000235 .000583 .000336 .000436 .000114 .000136 .000358 .000236 .000602 .000336 .000856 .000037 .000118 .000137 .000362 .000240 .000610 .000337 .000856 .000041 .000125 .000141 .000373 .000241 .000614 .000341 .000858 .000042 .000129 .000142 .000373 .000242 .000614 .000342 .000858 .000043 .000133 .000143 .000373 .000243 .000621 .000343 .000865 .000044 .000137 .000144 .000385 .000245 .000629 .000345 .000873 .000046 .000141 .000146 .000385 .000245 .000629 .000345 .000873 .000047 .000148 .000147 .000389 .000246 .000637 .000347 .000881 .000050 .000152 .000150 .000386	• • • • • • • • • • • • • • • • • • • •		.000234 .000595	.000334 .000839
000036	• • • • • • • • • • • • • • • • • • • •		.000235 .000598	.000335 .000843
000037	• • • • • • • • • • • • • • • • • • • •	1		.000336 .000846
.000040 .000122 .000140 .000366 .000240 .000610 .000340 .000854 .000041 .000125 .000141 .000370 .000241 .000614 .000341 .000852 .000042 .000129 .000143 .000377 .000242 .000621 .000343 .000865 .000043 .000133 .000143 .000381 .000244 .000625 .000344 .000852 .000046 .000141 .000145 .000385 .000245 .000629 .000345 .000873 .000046 .000144 .000145 .000389 .000246 .000633 .000346 .000873 .000047 .000188 .000150 .000389 .000247 .000637 .000347 .000881 .000050 .000152 .000150 .000396 .000250 .000640 .000350 .000885 .000051 .000156 .000152 .000400 .000251 .000644 .000350 .000882 .000053 .000166 .0	• • • • • • • • • • • • • • • • • • • •			.000337 .000850
000040	= -		1	000340 .000854
.000041 .000129 .000142 .000133 .000142 .000377 .000242 .000621 .000342 .000865 .000043 .000133 .000144 .000381 .000244 .000625 .000343 .000865 .000045 .000141 .000145 .000385 .000245 .000629 .000345 .000873 .000046 .000144 .000146 .000389 .000246 .000633 .000346 .000877 .000047 .000188 .000150 .000392 .000250 .000350 .000877 .000050 .000152 .000150 .000392 .000250 .000350 .000888 .000051 .000151 .000150 .000392 .000250 .000644 .000351 .000888 .000052 .000160 .000152 .000404 .000252 .000648 .000352 .000888 .000053 .000164 .000153 .000408 .000252 .000648 .000352 .000889 .000054 .000167 .0	• • • • • • • • • • • • • • • • • • • •		I .	I .
.000042 .000143 .000143 .000143 .000133 .000133 .000143 .000341 .000343 .000343 .000865 .000044 .000137 .000144 .000381 .000244 .000625 .000344 .0009873 .000046 .000144 .000145 .000385 .000245 .000629 .000346 .000873 .000047 .000148 .000147 .000392 .000247 .000637 .000347 .000881 .000050 .000152 .000150 .000396 .000250 .000640 .000350 .000881 .000051 .000156 .000151 .000400 .000252 .000644 .000351 .000888 .000052 .000160 .000153 .000404 .000252 .000644 .000352 .000882 .000054 .000167 .000158 .000411 .000253 .000652 .000353 .00088 .000055 .000171 .000155 .000415 .000255 .000656 .000355 .000990 <td></td> <td>• • • •</td> <td>1</td> <td></td>		• • • •	1	
.000043 .000144 .000137 .000144 .000381 .000244 .000625 .000344 .000856 .000045 .000141 .000145 .000385 .000245 .000629 .000345 .000873 .000046 .000147 .000147 .000389 .000246 .000633 .000346 .000877 .000050 .000152 .000150 .000389 .000250 .000640 .000350 .000881 .000051 .000156 .000151 .000400 .000251 .000644 .000352 .000888 .000052 .000160 .000152 .000404 .000252 .000648 .000352 .000888 .000053 .000164 .000153 .000408 .000253 .000652 .000353 .000886 .000054 .000167 .000154 .000411 .000254 .000656 .000353 .000896 .000055 .000171 .000155 .000418 .000255 .000659 .000355 .000990 .000060 .0			1	
.000044 .000141 .000145 .000385 .000245 .000629 .000345 .000873 .000046 .000144 .000146 .000389 .000246 .000633 .000346 .000871 .000047 .000188 .00017 .000392 .000247 .000637 .000347 .000881 .000050 .000152 .000150 .000396 .000250 .000640 .000350 .000885 .000051 .000166 .000151 .000400 .000251 .000644 .000352 .00088 .000052 .000160 .000152 .000404 .000252 .000648 .000352 .000852 .000053 .000164 .000153 .000408 .000253 .000656 .000353 .000896 .000054 .000167 .000155 .000415 .000255 .000656 .000353 .000890 .000055 .000171 .000155 .000415 .000255 .000659 .000355 .00090 .000056 .000175 .0001	•		A Total Control of the Control of th	
.000046 .000144 .000146 .000389 .000246 .000633 .000346 .000877 .000047 .000148 .000147 .000392 .000247 .000637 .000347 .000881 .000050 .000152 .000150 .000396 .000250 .000644 .000351 .000888 .000052 .000160 .000152 .000404 .000252 .000644 .000352 .000888 .000053 .000164 .000153 .000408 .000253 .000652 .000353 .000896 .000054 .000167 .000154 .000411 .000253 .000656 .000353 .000896 .000055 .000171 .000155 .000419 .000255 .000663 .000355 .000904 .000056 .000175 .000156 .000419 .000256 .000663 .000355 .000907 .000067 .000183 .000160 .000427 .000260 .000671 .000360 .000918 .000061 .000186 .0	.000044 .000137	• • • • • • • • • • • • • • • • • • • •	1	
.000046 .000147 .000148 .000147 .000392 .000247 .000637 .000350 .000350 .000050 .000152 .000150 .000396 .000250 .000640 .000350 .000885 .000051 .000156 .000151 .000400 .000251 .000644 .000351 .000888 .000052 .000160 .000152 .000404 .000252 .000648 .000352 .000882 .000053 .000164 .000153 .000408 .000253 .000652 .000353 .000896 .000054 .000167 .000154 .000411 .000255 .000656 .000354 .000900 .000055 .000171 .000155 .000415 .000255 .000659 .000355 .000901 .000056 .000175 .000156 .000423 .000257 .000667 .000357 .000911 .000061 .000183 .000160 .000427 .000260 .000671 .000360 .000915 .000062 .0	.000045 .000141		1	
.000050 .000152 .000150 .000386 .000250 .000640 .000350 .000885 .000051 .000156 .000151 .000400 .000251 .000644 .000351 .000888 .000052 .000160 .000152 .000404 .000252 .000648 .000352 .00088 .000053 .000164 .000153 .000408 .000253 .000655 .000353 .000886 .000054 .000167 .000155 .000411 .000254 .000656 .000354 .000900 .000055 .000171 .000155 .000415 .000255 .000659 .000355 .000904 .000056 .000175 .000156 .000419 .000260 .000663 .000356 .000907 .000060 .000183 .000160 .000427 .000260 .000671 .000360 .000911 .000061 .000186 .000141 .000261 .000675 .000361 .000919 .000062 .000190 .000162 .00	.000046 .000144		1	
.000050 .000152 .000151 .000400 .000251 .000644 .000351 .000888 .000051 .000160 .000152 .000404 .000252 .000648 .000352 .000892 .000053 .000164 .000153 .000408 .000253 .000652 .000353 .000894 .000054 .000167 .000154 .000411 .000253 .000656 .000353 .000904 .000055 .000171 .000155 .000419 .000255 .000659 .000355 .000904 .000056 .000175 .000156 .000419 .000256 .000663 .000356 .000907 .000057 .000179 .000157 .000423 .000267 .000667 .000357 .000911 .000060 .000183 .000160 .000427 .000260 .000671 .000360 .00019 .000061 .000186 .000161 .000431 .000262 .000675 .000361 .000929 .000062 .000194 .00	.000047 .000148	.000147 .000392	1	ľ
.000051 .000156 .000151 .000400 .000251 .000644 .000351 .000882 .000052 .000160 .000152 .000404 .000252 .000648 .000352 .000882 .000053 .000164 .000153 .000408 .000253 .000656 .000353 .000886 .000054 .000167 .000155 .000415 .000255 .000656 .000355 .000904 .000055 .000171 .000156 .000415 .000255 .000663 .000356 .000907 .000057 .000179 .000157 .000423 .000257 .000667 .000357 .00091 .000060 .000183 .000160 .000427 .000260 .000671 .000360 .00091 .000061 .000186 .000161 .000431 .000261 .000675 .000361 .000919 .000062 .000190 .000163 .000434 .000262 .000679 .000362 .000923 .000064 .000198 .000	000050 .000152	.000150 .000396		1 '
.000052 .000160 .000152 .000404 .000252 .000648 .000352 .000832 .000896 .000053 .000164 .000153 .000408 .000253 .000652 .000353 .000896 .000054 .000167 .000155 .000415 .000255 .000659 .000355 .000904 .000056 .000175 .000156 .000419 .000256 .00063 .000356 .000907 .000057 .000179 .000157 .000423 .000257 .000667 .000357 .000911 .000060 .000183 .000160 .000427 .000260 .000671 .000360 .000919 .000061 .000186 .000161 .000431 .000261 .000675 .000361 .000919 .000062 .000190 .000162 .000434 .000262 .000679 .000362 .000363 .000928 .000063 .000194 .000163 .000438 .000263 .000682 .000363 .000928 .00	• • •	.000151 .000400	.000251 .000644	1 .
.000053 .000164 .000153 .000408 .000253 .000652 .000353 .000854 .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 .000061 .000183 .000160 .000427 .000260 .000675 .000361 .000919 .000062 .000190 .000162 .000431 .000261 .000675 .000361 .000923 .000063 .000194 .000163 .000438 .000263 .000682 .000363 .000928 .000064 .000198 .000164 .000442 .000264 .000686 .000364 .000934 .000065 .000202 .0	•	.000152 .000404		
.000034 .000167 .000154 .000411 .000254 .000656 .000354 .000900 .000055 .000171 .000155 .000415 .000255 .000659 .000355 .000904 .000056 .000175 .000156 .000419 .000255 .000663 .000356 .000907 .000057 .000179 .000157 .000423 .000257 .000667 .000357 .000911 .000061 .000183 .000160 .000427 .000260 .000675 .000361 .000915 .000062 .000190 .000162 .000431 .000261 .000675 .000362 .000923 .000063 .000194 .000163 .000438 .000263 .000682 .000363 .000926 .000064 .000198 .000164 .000442 .000264 .000686 .000364 .000930 .000065 .000202 .000165 .000466 .000265 .000694 .000366 .000934 .000066 .000205 .0	• • • • • • • • • • • • • • • • • • • •	• • • • • • • • • • • • • • • • • • • •	.000253 .000652	1 -
.000055 .000171 .000155 .000415 .000255 .000659 .000355 .000904 .000056 .000175 .000156 .000419 .000256 .00063 .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 .000163 .000434 .000262 .000679 .000362 .000923 .000063 .000194 .000163 .000438 .000263 .000682 .000363 .000926 .000064 .000198 .000164 .000446 .000266 .000686 .000365 .000365 .000934 .000065 .000202 .000166 .000450 .000266 .000694 .000366 .000366 .000366 .000366 <		1	.000254 .000656	1 -
.000056 .000175 .000156 .000419 .000256 .00063 .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 .000365 .000365 .000365 .000365 .000365 .000365 .000365 .000365 .000365 .000366 .000366 .000365 .000366 .000366 .000366 .000366 .000366 .000366 .000366 .000366 .000366 .000366 .000366 <td>• • • • • • • • • • • • • • • • • • • •</td> <td>•</td> <td></td> <td>.000355 .000904</td>	• • • • • • • • • • • • • • • • • • • •	•		.000355 .000904
.0000567 .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 .000466 .000265 .000690 .000366 .000367<	•			.000356 .000907
.000057 .000175 .000160 .000427 .000260 .000671 .000360 .000915 .000061 .000186 .000161 .000421 .000261 .000675 .000361 .000919 .000062 .000190 .000162 .000434 .000262 .000679 .000362 .000923 .000063 .000194 .000163 .000438 .000263 .000682 .000363 .000928 .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 .000171 .000457 .000270 .000701 .000370 .000948 .000071 .000221 .0	1 7 7 7	1 -	-	,
.000060 .000186 .000161 .000431 .000261 .000675 .000361 .000919 .000061 .000186 .000161 .000431 .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 .000365 .000938 .000070 .000213 .000170 .000457 .000270 .000701 .000370 .000948 .000071 .000217 .000171 .000461 .000271 .000705 .000371 .000948 .000072 .000221 .000172 .000465 .000272 .000709 .000372 .000953 .000073 .0	• • • • • • • • • • • • • • • • • • • •	1 *	· ·	
.00061 .00186 .000190 .000162 .000434 .000262 .000679 .000362 .000923 .000063 .000194 .000163 .000438 .000263 .000682 .000363 .000926 .000064 .000198 .000164 .000442 .000264 .000686 .000365 .00093 .000065 .000202 .000165 .000450 .000265 .000690 .000365 .00093 .000067 .000209 .000167 .000453 .000267 .000698 .000367 .00094 .000070 .000213 .000170 .000457 .000270 .000701 .000370 .000946 .000071 .000217 .000171 .000461 .000271 .000705 .000371 .000946 .000072 .000221 .000172 .000465 .000271 .000709 .000372 .000953 .000073 .000225 .000173 .000469 .000273 .000713 .000373 .000953 .000074 .000228	T	1 '	1	1 -
.000062 .000194 .000163 .000438 .000263 .000682 .000363 .000926 .000064 .000198 .000164 .000442 .000264 .000686 .000364 .000364 .000930 .000065 .000202 .000165 .000446 .000265 .000690 .000365 .000934 .000066 .000205 .000167 .000450 .000266 .000694 .000366 .000938 .000067 .000209 .000167 .000453 .000267 .000698 .000367 .000942 .000070 .000213 .000170 .000457 .000270 .000701 .000370 .000949 .000071 .000217 .000171 .000461 .000271 .000705 .000371 .000949 .000072 .000213 .000172 .000465 .000272 .000709 .000371 .000949 .000072 .000213 .000172 .000465 .000272 .000709 .000372 .000953 .000073 .000225 .000173 .000469 .000273 .000713 .000373 .000955 .000074 .000228 .000174 .000473 .000274 .000274 .000171 .000374 .000961 .000075 .000232 .000175 .000476 .000275 .000720 .000375 .000965 .000076 .000236 .000176 .000480 .000277 .000799 .000377 .0009377 .000965 .000077	1		-	
.000063 .000198 .000198 .000144 .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 .000270 .000701 .000370 .000948 .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 .000274 .000171 .000374 .000961 .000075 .000232 .000175 .000476 .000275 .000720 .000375 .000965 .000076 .000236 .000176 .000480 .000276 .000794 .000377 .000965 .000977 .000077	-	1	1	1
.000064 .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 .000948 .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 .000968 .000076 .000236 .000176 .000480 .000277 .00078 .000787 .000967	.000063 .000194	•		1 -
.000065 .000202 .000165 .000446 .000265 .000690 .000365 .000366 .000938 .000066 .000205 .000166 .000450 .000266 .000694 .000366 .000938 .000070 .000209 .000170 .000453 .000267 .000698 .000367 .000942 .000070 .000213 .000170 .000457 .000270 .000701 .000370 .000948 .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 .000724 .000375 .000965 .000076 .0	.000064 .000198			
.000066 .000205 .000166 .000450 .000266 .000694 .000366 .000367 .000367 .000942 .000070 .000213 .000170 .000457 .000270 .000701 .000370 .000371 .000370 .000948 .000071 .000217 .000171 .000457 .000270 .000701 .000371 .000948 .000072 .000217 .000171 .000461 .000271 .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 .000968 .000076 .000236 .000176 .000480 .00077 .00078 .000377 .000973		•	l .	1
.000067 .000209 .000167 .000453 .000267 .000698 .00037 .00037 .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 .000376 .000968 .000076 .000236 .000176 .000480 .00077 .000789 .000377 .000377 .000977			1	
.000070 .000213 .000170 .000457 .000270 .000701 .000370 .000370 .000071 .000217 .000171 .000461 .000271 .000705 .000371 .000948 .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 .000978		.000167 .000453	1	
.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 .000377 .000973	1 '	.000170 .000457	.000270 .000701	I .
.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 .000276 .000724 .000373 .000376 .00068 .000076 .000236 .000176 .000480 .000777 .00078 .000377 .000377 .000977	• • • • • • • • • • • • • • • • • • • •	1	1	.000371 .000949
.000072 .000215 .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 .000377 .000377 .000973	1 * *	1	-	.000372 .000953
.000074 .000228 .000174 .000473 .000274 .000717 .000374 .000961 .000075 .000232 .000175 .000476 .000275 .000720 .000375 .000965 .000076 .000236 .000176 .000480 .000276 .000724 .000376 .000968 .000076 .000236 .000176 .000480 .000277 .000377 .000978 .000978	1	1		
.000074 .000228 .000175 .000476 .000275 .000720 .000375 .000965 .000076 .000236 .000176 .000480 .000276 .000724 .000376 .000968	1	1	• • • • • • • • • • • • • • • • • • • •	1
.00075 .000252 .000176 .000480 .000276 .000724 .000376 .000968	1	1 -	1	1
.000076 .000236 .000170 .000400 .000277 .000979	1 • • • • • • • • • • • • • • • • • • •	1		1
.000077 .000240 .000177 .000404 .000217 .000120		1 -	1	
	.000077 .000240	.000177 .000464	.000211 .000125	

OCTAL-DECIMAL FRACTION CONVERSION TABLE

OCTAL	DEC.	OCTAL DEC.	OCTAL DEC.	OCTAL	DEC.
.000400	.000976	.000500 .001220	.000600 .001464	222	
.000401	.000980	.000501 .001224	.000601 .001468	.000700	.00170
.000402	.000984	.000502 .001228	.000602 .001472	.000701	.00171
.000403	.000988	.000503 .001232	.000603 .001476	.000702	.00171
.000404	.000991	.000504 .001235		.000703	.00172
.000405	.000995	.000505 .001239		.000704	.00172
.000406	.000999	.000506 .001243		.000705	.00172
.000407	.001003	.000507 .001247		.000706	.00173
.000410	.001007	.000510 .001251	.000607 .001491	.000707	. 00173
.000411	.001010		.000610 .001495	.000710	.00173
.000412	.001014		.000611 .001499	.000711	.00174
.000413	.001014	.000512 .001258	.000612 .001502	.000712	.00174
.000414	.001018	.000513 .001262	.000613 .001506	.000713	.001750
.000414		.000514 .001266	.000614 .001510	.000714	.001754
	.001026	.000515 .001270	.000615 .001514	.000715	.001758
.000416	.001029	.000516 .001274	.000616 .001518	.000716	
.000417	.001033	.000517 .001277	.000617 .001522	.000717	.001762
.000420	.001037	.000520 .001281		1	.001766
.000421	.001041	.000521 .001285		.000720	.001770
.000422	.001045	.000522 .001289	.000621 .001529	.000721	.001773
.000423	.001049	1	.000622 .001533	.000722	.001777
.000424	.001043		.000623 .001537	.000723	.001781
.000425	.001052	.000524 .001296	.000624 .001541	.000724	.001785
000425		.000525 .001300	.000625 .001544	.000725	.001789
.000426	.001060	.000526 .001304	.000626 .001548	.000726	.001792
	.001064	.000527 .001308	.000627 .001552	.000727	.001796
000430	.001068	.000530 .001312	.000630 .001556	.000730	
000431	.001071	.000531 .001316	.000631 .001560		.001800
000432	.001075	.000532 .001319	.000632 .001564	.000731	.001804
000433	.001079	.000533 .001323		.000732	.001808
000434	.001083	.000534 .001327		.000733	.001811
000435	.001087	.000535 .001331	.000634 .001571	.000734	.001815
000436	.001091	.000536 .001335	.000635 .001575	.000735	.001819
000437	.001094		.000636 .001579	.000736	.001823
		.000537 .001338	.000637 .001583	.000737	.001827
000440	.00109	.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	
000444	.001113	.000544 .001358	.000644 .001602	1	.001842
000445	.001117	.000545 .001361	.000645 .001605	.000744	.001846
000446	.001121	.000546 .001365	.000646 .001609	.000745	.001850
000447	.001125	.000547 .001369		.000746	.001853
000450	.001129	.000550 .001373	1	.000747	.001857
000451	.001132		.000650 .001617	.000750	.001861
000452	.001136	.000551 .001377	.000651 .001621	.000751	.001865
000452	1	.000552 .001380	.000652 .001625	.000752	.001869
000453	.001140	.000553 .001384	.000653 .001628	.000753	.001873
	.001144	.000554 .001388	.000654 .001632	.000754	.001876
000455	.001148	.000555 .001392	.000655 ,001636	.000755	.001880
000456	.001152	.000556 .001396	.000656 .001640	.000756	.001884
00457	.001155	.000557 .001399	.000657 .001644	.000757	.001888
00460	.001159	.000560 .001403	.000660 .001647		
00461	.001163	.000561 .001407	.000661 .001651	.000760	.001892
00462	.001167	.000562 .001411		.000761	.001895
00463	.001171	.000563 .001415	1	.000762	.001899
00464	.001174	.000564 .001419	.000663 .001659	.000763	.001903
00465	.001178		.000664 .001663	.000764	.001907
00466	.001182		.000665 .001667	.000765	.001911
00467	.001186	.000566 .001426	.000666 .001670	.000766	.001914
		.000567 .001430	.000667 .001674	.000767	.001918
00470	.001190	.000570 .001434	.000670 .001678	.000770	.001922
00471	.001194	.000571 .001438	.000671 .001682	.000771	.001926
00472	.001197	.000572 .001441	.000672 .001686	.000772	
00473	.001201	.000573 .001445	.000673 .001689		.001930
00474	.001205	.000574 .001449	.000674 .001693	.000773	.001934
00475	.001209	.000575 .001453	1	.000774	.001937
00476	.001213	.000576 .001457	.000675 .001697	.000775	.001941
	.001216	.000577 .001461	.000676 .001701 .000677 .001705	.000776	.001945
			.000677 .001705	.000777	.001949

Input / Output Typewriter Codes

		mpor/ corps ://			2225
CHARA UC	CTERS LC	CODE	CHARA(UC	CTERS LC	CODE
A	a	30	x	x	27
В	ъ	23	Y	y	25
С	c	16	Z	Z	21
D	đ	22)	0	56
E	е	20	*	1	74
F	f	26	@	2	7 0
G	g	13	#	3	64
Н	h	05	\$	4	62
I	i	14	%	5	66
J	j	32	¢	6	72
K	k	36	&	7	60
L	1	11	$\frac{1}{2}$	8	33
M	m	07	(9	37
N	n	06	_	-	52
0	0	03	?	/	44
P	p	15	n	1	54
Q	q	35	0	+	46
R	r	12	•	•	42
s	8	24		;	50
T	t	01	,	,	40
U	u	34	•	=	02
v	٧	17	tab	tab	51
W	W	31	;	space	04
Bac	kspace	61	Car	riage Return	45
Low	er Case	57	Upp	er Case	47

1612 Printer Codes

CHARACTER	DATA (Bits 0-5) (Octal)	ROW (Print Cylinder) (& Memory)	1612 MASTER TIMING GENERATOR COUNTER (Stages 1-6) (Octal)
:	00	48	57
1	01	2	01
2	02	3	02
3	03	4	03
4	04	5	04
5	05	6	05
6	06	7	06
7	07	8	07
8	10	9	10
9	11	10	11
0	12	1	00
= # < 7 ////////////////////////////////////	13	40	. 47
7	14	46	55
त	A 15	49	60
% F	A 16	50	61
[blank	A 17	51	62
	20	64	77
/ S	21	43	52
${f T}$	$\begin{array}{c} 22 \\ 23 \end{array}$	29	34
Ü	$\frac{23}{24}$	30	35
V	24 25	31	36
$ vert_{ m W}$	26	32	37
X	27	33	40
Y	30	34	41
$\overset{ au}{Z}$	31	35	42
z]	A 32	36	43
	33	52	63
(34	45 41	54
ر. م	A 35	41 53	50
	A 36		64
^	A 37	54 55	65
-	40	38	66
J	41	20	45
K	$\frac{41}{42}$	20 21	23
L	43	22	24
	10	44	25

A - denotes Additional Characters

1612 Printer Codes (Cont'd)

CHARACTER	DATA (Bits 0-5) (Octal)	ROW (Print Cylinder) (& Memory)	1612 MASTER TIMING GENERATOR COUNTER (Stages 1-6) (Octal)
M NOPQRV\$** ^ → > + ABCDEF	44 45 46 47 50 51 A 52 53 54 A 55 A 56 A 57 60 61 62 63 64 65 66 67	23 24 25 26 27 28 56 47 44 58 59 60 39 11 12 13 14 15 16 17	26 27 30 31 32 33 67 56 53 71 72 73 46 12 13 14 15 16 17 20
G H I < ·) ≥ ¬;	70 71 A 72 73 74 A 75 A 76 A 77	18 19 61 37 42 62 57 63	21 22 74 44 51 75 70 76

A - denotes Additional Characters

166 PRINT-DRUM CHARACTER ARRANGEMENTS AND CODES

At the time of printing this volume, four drums were available for the printer. The customer has a choice between the first two standard drums at the time of ordering. The latter two drums are available as optional equipment. The following charts list the characters in order as they appear around the circumference of the drums. To the right of each character is the octal code found on the accompanying code wheel.

CODE DISC 46M50 (48 CHARACTER DRUM) 200 Imp

Drum Position	Character	Octal Code	Drum Position	Character	Octal Code
1	A	61	25	Y	30
2	В	62	26	Z	31
3	C	63	27	0	00
4	D	64	28	1	01
5	${f E}$	65	29	2	02
6	F	66	30	3	03
7	G	67	31	4	04
8	H	70	32	5	05
9	I	71	33	6	06
10	J	41	34	7	07
11	K	42	35	8	10
12	L	43	36	9	11
13	M	44	37	•	7
14	· N	45	38	-	40
15	Ο	46	39	+	60
16	P	47	40	=	13
17	Q	50	41	(34
18	\mathbf{R}	51	42)	74
19	S	22	43	/	21
20	${f T}$	23	44	*	54
21	U	24	45	,	33
22	V	25	46	#	14
23	W	26	47	\$	53
24	X	27	48	0	12

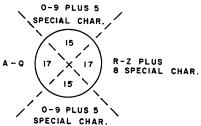
APPENDIX VIII 166 PRINTER CODES (Cont'd)

CODE DISC 46M39 (64 CHARACTER DRUM) 150 lmp

		150 1	mp		
Drum Positio n	Character	Octal Code	Drum Position	Character	Octal Code
1	Blank	20	33	L	43
2	0	12	34	\mathbf{M}	44
3	1	01	35	N	45
4	2	02	36	О	46
5	3	03	37	P	47
6	4	04	38	Q	50
7	5	05	39	${f R}$	51
8	6	06	40	S	22
9	7	07	41	${f T}$	23
10	8	10	42	U	24
11	9	11	43	V	25
12	•	73	44	W	26
13	-	40	45	X	27
14	+	60	46	Y	30
15	=	13	47	Z	31
16	‡	14	48	(34
17	1	21	49)	74
18	\sim	37	50	,	33
19	%	52	51	?	76
20	\$	53	52	;	77
21	*	54	53	t	16
22	Α	61	54	:	00
23	В	62	55	3	32
24	C	63	56	→	35
25	D	64	57	=	36
26	${f E}$	65	58	^	55
27	\mathbf{F}	66	59	₩	56
28	G	67	60	>	57
29	H	70	61	<	72
30	I	71	62	<u>></u> <	75
31	J	41	63	<u><</u>	15
32	K	42	64		17

166 PRINTER CODES (Cont'd) OPTIONAL DRUM 42M121A (DRUM TYPE B)

64 Character Drum: one alpha field, two numeric fields, 48 different characters. Layout Drawing:



Drum Position	Character	Octal Code	Drum Position	Character	Octal Code
1	A	61	33	R	51
2 3	В	62	34	S	22
ა 1	C	63	35	${f T}$	23
4	D	64	36	U	24
5 6	E	65	37	V	25
7	F	66	38	W	26
8	G	67	39	X	27
9	H I	70	40	$egin{array}{c} Y \ Z \end{array}$	30
10	J	71	41		31
11	K	$\begin{array}{c} 41 \\ 42 \end{array}$	42	+	60
12	L	43	43	=	13
13	$\stackrel{f L}{f M}$	$\frac{43}{44}$	44 45	% \$	52
14	N	45	45 46	\$ '	53
15	Ö	46	47	($\frac{34}{74}$
16	P	47	48	,	74
17	$ar{ ext{Q}}$	50	49	blank	$\begin{array}{c} 21 \\ 77 \end{array}$
18	o	12	50	0	12
19	1	01	51	1	01
20	1 2 3	02	52	$\overset{1}{2}$	02
21	3	03	53	3	03
22	4	04	54	4	04
23	5	05	55	5	05
24	6	06	56	6	06
25	7	07	5 7	7	07
26	8	10	58	8	10
27	9	11	59	9	11
28	•	73	60	•	73
29	-	40	61	-	40
30	9 .1.	33	62	,	33
31	*	54	63	*	54
32	:	00	64	:	00

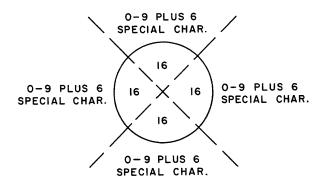
Result: 26 alpha, 10 numerics, and 13 special characters which are . - , :+ = %; \$ () / * total 48 characters.

NOTE: Code 20 will give blanks even though no blank is left on the drum. Any other code for a character which is not on the drum will also result in blanks.

OPTIONAL DRUM 42M122A (DRUM TYPE C)

64 Character Drum: four numeric fields, 16 different characters.

Layout Drawing:



Drum Position	Character	Octal Code	Drum Position	Character	Octal Code
1, 17, 33, 49	0	12	9, 25, 41, 57	8	10
2, 18, 34, 50	1	01	10, 26, 42, 58	9	11
3, 19, 35, 51	2	02	11, 27, 43, 59	•	73
4, 20, 36, 52	3	. 03	12, 28, 44, 60	-	40
5, 21, 37, 53	4	04	13, 29, 45, 61	,	33
6, 22, 38, 54	5	05	14, 30, 46, 62	+	60
7, 23, 39, 55	6	06	15, 31, 47, 63	\$	53
8, 24, 40, 56	7	07	16, 32, 48, 64	*	54

Result: 10 numeric and 6 special characters.

NOTE: Code 20 or any other illegal code will result in blanks being printed.

Flexowriter Codes

UC	LC	CODE	UC	LC	CODE
A	a	30	Y	y	25
В	b	23	Z	a	21
C	c	16	0	0	56
D	đ	22	1	1	74
E	е	20	2	2	70
F	f	26	3	3	64
G	g	13	4	4	62
H	h	05	5	5	66
I	i	14	6	6	72
J	j	32	7	7	60
K	k	36	8	8	33
L	1	11	9	9	37
M	m	07	-	-	52
N	n	06	t	1	44
0	O	03	(·)	54
P	p	15	+	,	46
Q	q	35	=	•	42
R	r	12	:	;	50
S	s	24	CR	- (tra)	45
T	t	01	Upper Co Lower C	ase (LC)	47 57
U	u	34	Back Spa Color Sh	ift (CS)	61 02
v	v	17	Tabulate Stop	(TAB)	51 43
W	w	31	Space Tape Fe	ed	04 00
X	x	27	Delete		77

Note:

Leader - Blank tape, Delete - Deleted characters.
 Stop - Stop Flexowriter reader,
 10, 40, 41, 53, 55, 63, 65, 67, 71, 73, 75, and 76 - illegal Delete - Deleted character

Magnetic Tape BCD Codes

Character	Code (Octal)	Character	Code (Octal)
A	61	2	02
В	62	3	03
С	63	4	04
D	64	5	05
E	65	6	06
F	66	7	07
G	67	8	10
Н	70	9	11
I	71	&	60
J	41	-	40
K	42	(blank)	2 0
L	43	1	21
M	44	. (period)	73
N	45	\$	53
О	46	*	54
P	47	, (comma)	33
Q	50	%	34
R	51	#	13
S	22	@	14
Т	23	Ħ	74
U	24	0 (numerical zero)	12
v	25	record mark	32
W	26	0 (minus zero)	52
X	27	0 (plus zero)	72
Y	30	group mark	77
Z	31	tape mark	17
0	12		
1	01		

APPENDIX X
Punched Card Codes

Char	Card	BCD	Char	Card	BCD	Char	Card	BCD	Char	Card	BCD
			+	12	60	-	11	40			20
1	1	01	A	12 1	61	J	11	41	1	0 1	21
2	2	02	В	1 2 2	62	ĸ	11	42	s	0	22
3	3	03	C	12 3	63	L	11 3	43	Ť	0 3	23
4	4	04	D	12 4	64	M	11 4	44	U	0 4	24
8	5	05	E	12 5	65	N	11 5	45	v	0 5	25
6	6	06	F	<u>12</u> 6	66	0	11 6	46	w	0 6	26
7	7	07	G	12 7	67	P	} 1	47	x	°	27
8	8	10	H	12 8	70	Q	11 8	50	Y	0 8	30
9	8	11	I	12 9	71	R	11	51	Z	9	31
0	0	12									
=	8,3	13	•	12 8,3	73	\$	11 8,3	53	,	o 8,3	33
	8,4	14)	12 8,4	74	*	11 8,4	54	(0 8, 4	34

COMMENT SHEET

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