

CONTROL DATA® 8092

Tele Programmer

PROGRAMMING REFERENCE MANUAL



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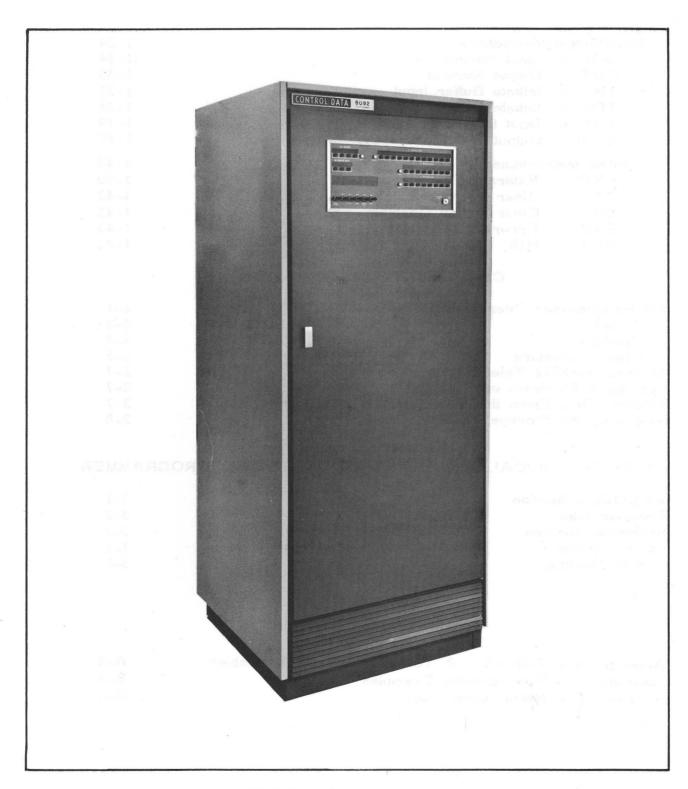
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8092 TeleProgrammer

CHAPTER ONE

PROGRAMMING

GENERAL CHARACTERISTICS

The CONTROL DATA* 8092 TeleProgrammer is a highly flexible and versatile stored program processor specially designed as a high speed buffer memory system for use in a variety of data communication applications.

Among the more important features are the following:

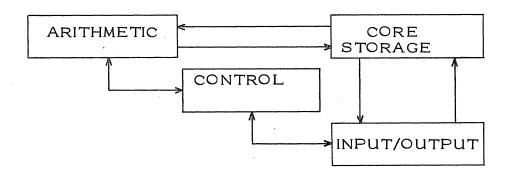
- · stored program
- · parallel mode of operation
- 8-bit word length
- 2048 words of core storage 4096 (optional)
- 1 Direct I/O Channel (8 bits)
- 1 Buffer I/O Channel (8 bits)
- · versatile instruction repertoire of 42 instructions
- · 3 Auxiliary Tag registers of 4 bits each
- · indirect and direct addressing and modification
- · interrupts
- · 12 bit external function address codes
- · 7 internal program registers
- physical size: height, 68 inches; width, 34 inches; depth, 30 inches
- · storage reference cycle time of 4 microseconds
- · The ability to use the OSAS or OSAS-A assembler for those who have a 160 or 160-A computer.

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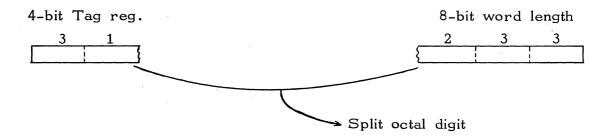
THE CENTRAL PROCESSOR

The TeleProgrammer is a parallel, single address electronic data processor. Operations are controlled by an internally stored program located in sequential addresses. The storage cycle time is 4 microseconds. The basic memory may be expanded from 2048 words to 4096 words. Each internal core word contains 8 bits. Instructions are executed in one to four storage cycle times; with times varying from 4 to 16 microseconds. The average instruction time is approximately 10 microseconds.

The Block Diagram indicates the principal functional divisions

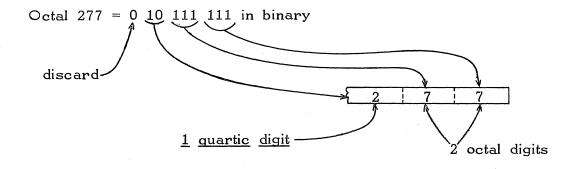


The TeleProgrammer has some unique features for programming. Most of these center around the word length of 8 bits. In order to carry addresses for 4096 words, 12 bits are required ($2^{12} = 4096$, where highest address is $2^{12} - 1$). To provide for 12 bits, the TeleProgrammer makes use of three 4-bit Tag registers (Tag registers 1, 2, and 3). The carry over from 8 bits to 4 additional bits, in the Tag register, causes a split in the second octal digit from the left. This is indicated below:



In this manual, the 8-bit word length will be represented as two full octal digits and one quartic digit (the leftmost 2 bits). The Tag registers will be generally represented as shown above, with one full octal digit (on the left) and a single bit (0 or 1) on the right. The jagged () ends of the registers indicate the split octal digit.

In addition, this manual will refer to numbers of "three octal digits" being contained in the 8-bit word length. Actually, this is physically impossible, since three octal digits occupy 9 bits and there are only 8 bits in the TeleProgrammer word. However, what is meant here, is that the leftmost bit of the three digit octal number is to be discarded. For example, show the octal number, 277, in a TeleProgrammer word.



This convention of representing the contents of the 8-bit words will be used many times in this manual. Looking at the above 9-bit configuration, one can see that to discard the leftmost bit, it must be zero. This means that the highest quartic digit of the word is 3. This, in turn, indicates the maximum "octal" of three digits which can be expressed in the 8-bit word length; --it is 377. The octal range 000 through 377 is equivalent to 256 registers. Since each Tag register holds 4 bits, there are 16 possible configurations for the 4 bits (0000 through 1111). Thus, 16 times 256 = 4096 total registers available.

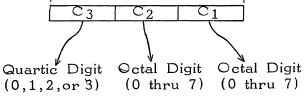
WORD FORMAT

People who work with computers are generally acquainted with the term, "octal". It is the number base associated with three bits --which in turn, provides eight possible number states (zero through seven). Since the 8092 TeleProgrammer has an 8-bit word length and partitioning by three bits over the complete word is inefficient; the number base of four with partitioning by two bits is used for the upper two bits of the word. The number base of four, is referred to, in this manual, as QUARTIC. Keep in mind, that only the upper two bits of the word length is expressed in Quartic. The lower six bits are expressed by two octal digits. The upper QUARTIC digit is represented by bits, as shown below:

<u>Bits</u>	The Upper QUARTIC Digit
00	0
01	1
10	2
11	3

Any binary digit above can be represented by any combinations of <u>ones</u> or <u>zeros</u>. Although the 8092 operates in binary, it is more efficient to consider the word format as containing 2 <u>octal</u> and 1 <u>Quartic</u> digits, as shown below:

Single Word Format With Two Octals and One Quartic



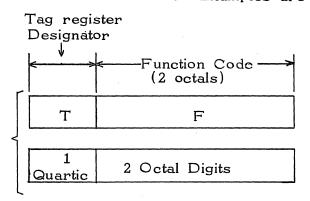
INSTRUCTION WORD FORMAT

The TeleProgrammer operates on a two word instructional set. Most instructions are contained in a set of two sequential storage locations. The first word contains the Function Code, in the lower 2 octal digits, and the Tag register designator, T, in the upper quartic digit. The second word of the instructional set holds: an operand of 2 octals and 1 quartic, or a partial address of 2 octals and 1 quartic. Three modes of operation are possible in the 8092; NO ADDRESS MODE, MEMORY ADDRESS MODE, and INDIRECT ADDRESS MODE. Examples are

shown below:

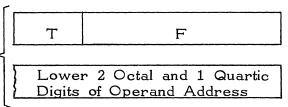
NO ADDRESS MODE

Where T = 0, since there is no Auxiliary Tag register used in this mode. The operand must contain 3 digits in the <u>octal</u> range of 000 thru 377.



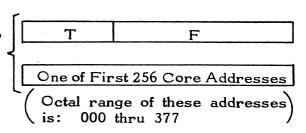
MEMORY ADDRESS MODE

Where T can equal 0, 1, 2, or 3. The lower 8 bits of the operand address appear in the second word and the upper 4 bits of the operand address appear in the Auxiliary Tag register designated by T. If T=0, the address of the operand is fully contained in the second word of the instructional set.



INDIRECT ADDRESS MODE

Where T can equal 0, 1, 2, or 3. At one of the first 256 core locations, given in the second word, is the lower 8 bits of the operand address. The upper 4 bits of this operand address will be found in the Auxiliary Tag register indicated by T.



Examples of the Three Operational Modes

Example 1.

Put the octal number, 277, into the A register.

Solution:

Since no Auxiliary Tag register is involved, T = 0. The octal code for "LOAD A" in this mode is 20; thus F = 20. The octal operand, 277, is placed in the second set as 2 octals (77), and 1 quartic (2).

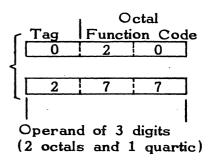
Example 2.

Load the contents of octal address, 3771, into the A register.

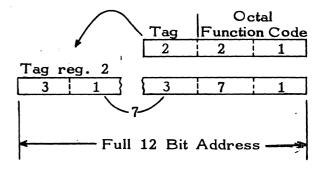
Solution:

The Tag, 2, indicates Auxiliary Tag register 2 holds the upper 2 quartic digits of the address whose lower 8 bits are given in the second instruction word. Note, octal 3771 is contained in the designated Tag register and the second word of the instruction set.

NO ADDRESS MODE



MEMORY ADDRESS MODE



Note: The quartic and 1 bit fit together to form octal, 7, the second digit of the address.

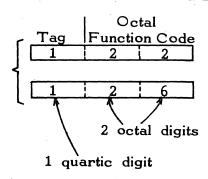
Example 3.

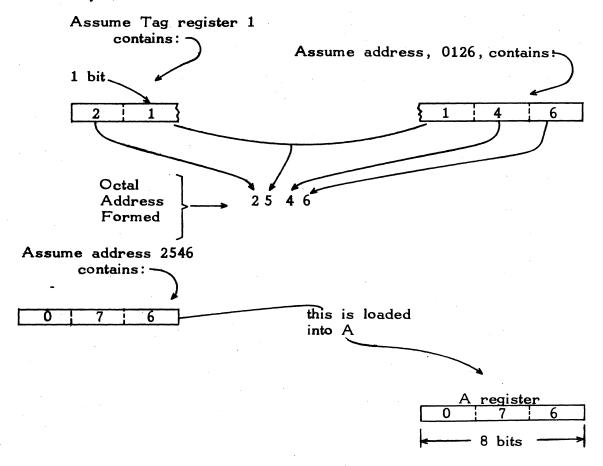
Load the operand whose complete address is in address 0126 and Tag reg. 1.

Solution:

Octal 126 is the address given in the second word. At this address, 0126, the lower 8 bits of the location of the operand are placed. The upper 4 bits of the operand location are placed in Auxiliary Tag register, 1, indicated by the Tag designator of the first word. Continuing this example, assume address 0126 and Tag register 1 contain the quantities shown below, show what finally is loaded into A.

INDIRECT ADDRESS MODE





THE 8092 TELEPROGRAMMER INSTRUCTION REPERTOIRE

Functions	Rel. Code	Octal Code	Cycle Time *	Functions	Rel. Code	Octal Code	Cycle Time *
LOADS:				ARITHMETICS:			
Load A (No.)	LDN	20	2	Add (No. Adr.)	ADN	30	2
Load A (Mem.)	LDM	21	3	Add (Mem.)	ADM	31	3
Load A (Ind.)	LDI	22	4	Add (Ind.)	ADI	32	4
Load Comp. (Mem.)	LCM	25	3	Subtract (No.)	SBN	34	2
Load Comp.(Ind.)	LCI	26	4	Subtract (Mem.)	SBM	35	3
Tag Reg. to A	TTA		1	Subtract (ind.)	SBI	36	4
Clear A	CLA	03***	1	Replace Add (Mem.)		51	4
BER to A	BER	06	1	Replace Add 1	RAO	55	4
STORES:		•		LOGICALS:			
Store A (Mem.)	STM	41	3	Log. Prod. (No.)	LPN	10	2
Store A (Ind.)	STI	42	4	Log. Prod. (Mem.)		11	3
A to Tag Reg.	ATT	02	i	Log. Prod. (Ind.)	LPI	12	4
A to BER	ABR	04	1/2	Log. Sum (No.)	LSN	14	2
A to BXR	ABX	05	1/2	Log. Sum (Mem.)	LSM	15	3
				Log. Sum (Ind.)	LSI	16	4
JUMPS: ****				IN-OUT:			
If $A = 0$	ZJP	60	. 2	Input Normal	INN	72	**
If A ≠ 0	NZP	61	2	Output Normal	оит	73	**
If A ≥ 0	PJP	62	2	Input Buffer	IBI	70	1/2
If A < 0	NJP	63	2	Output Buffer	IBO	71	1/2
Unconditional	UJP	64	2	Input to A	INA	76	2
Do Nothing	DON	02***	1	Output No. Adr.	OTN	74	2
SHIFTS:			.)	CONTROLS:			
A Left 1 bit	SHA	01	1	Ext. Function	EXF	75	3
		71		Clear Interrupt	CIL	13	1
				Clear Buffer	CBC	07	1
				Error Stop	ERR	00	_
				Halt	HLT	77	1

^{*} Cycle Times; each cycle = 4 microseconds.

^{**} 3 + 2(X = 1) + terminate time. Where X = No. of words.

^{***} No tag should be referenced.

^{****} Jump cycle time is 1 cycle, if jump is not made.

DESCRIPTION AND EXAMPLES OF INSTRUCTIONS

LOAD Instructions

Seven LOAD instruction are available. These are:

LDN - LOAD A (No Address Mode)

LDM - LOAD A (Memory Address Mode)

LDI - LOAD A (Indirect Address Mode)

LCM - LOAD Complement to A (Memory Address Mode)

LCI - LOAD Complement to A (Indirect Address Mode)

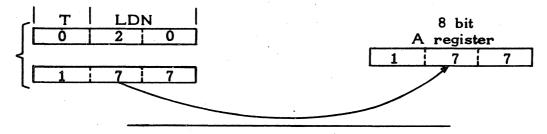
TTA - Tag Register Contents to A

BER - Contents of BER Register to A

LDN - (20) - LOAD A (No Address) 2 Cycles

Load the A register with the contents of the second word of the instructional set. Octal numbers 000 through 377 can be entered into A by this instruction.

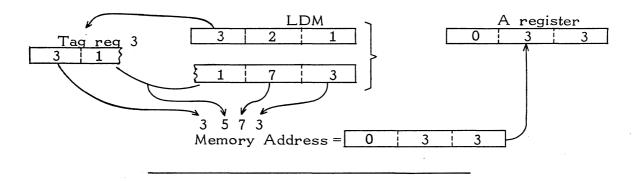
Example: Put the octal number, 177, into A



LDM - (21) - LOAD A (Memory) 3 Cycles

Load the A register with the contents of the memory address whose lower eight bits are given in the second instruction word and whose upper four bits are contained in the designated Auxiliary Tag register.

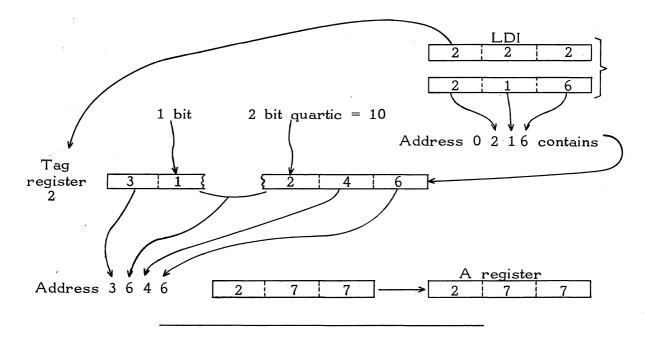
Example: Assume memory address 3573 (in octal) contains the octal quantity, 033. Load this into A.



LDI - (22) - LOAD A (Indirect) 4 Cycles

Load A with the contents of the address whose lower 8 bits are contained in one of the first 256 (decimal) addresses, and whose upper 4 bits are contained in a designated Auxiliary Tag register. The location in the core (one of the first 256 decimal addresses) is given in the second instruction word. The Auxiliary Tag register is indicated in the first word.

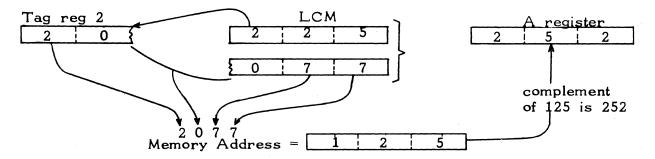
Example: Assume octal address, 3646, contains the octal number, 277. Load this number to A, using the indirect mode via octal address 0216.



LCM - (25) - Load Complement to A (Memory) 3 Cycles

Load the A register with the <u>complement</u> of the contents of the memory address whose lower 8 bits are given in the second instruction word and whose upper 4 bits are contained in the designated Auxiliary Tag register.

Example: Assume memory address 2077 (in octal) contains the octal quantity, 125. Load the complement of this quantity into A.

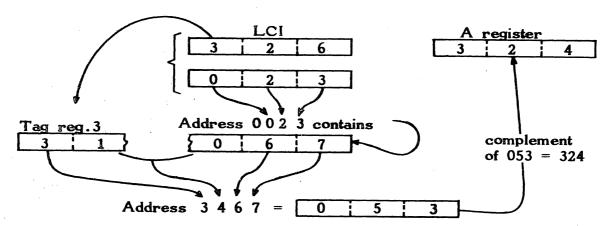


(Note: quartic complements are "three's complement". Thus, the complement of the quartic digit, 1, above is 2; whereas, the complements of the octal digits 2 and 5 are respectively 5 and 2.)

LCI - (26) - Load Complement to A (Indirect) 4 Cycles

Load A with the complement of the contents of the address whose lower 8 bits are contained in one of the first 256 (decimal) addresses and whose upper 4 bits are contained in the designated Auxiliary Tag register. The location in the core (one of the first 256 decimal addresses) is given in the second instruction word. The Auxiliary Tag register is indicated in the first word.

Example: Assume octal address 3467 contains the octal number, 053. Load the complement of this number into A, using the indirect mode and via octal location 0023.

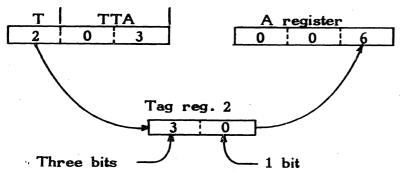


Note: The 1 bit of Tag register 3 and the quartic digit at address 023, form the bits, 100, which gives the octal digit, 4. Also note the complement of the quartic digit, 0, at address 3467 is equal to 3; whereas the complements of the octal digits 5 and 3 are respectively equal to 2 and 4

TTA - (03) - Tag Register to A 1 Cycle

Load the contents of the designated Auxiliary Tag register into the A register. Pack zero's in upper 4 bits.

Example: Load consents of Tag register, 2, into A.



Note: The four bits of the Tag register are: 0110. When packed to the right of A, they give the following: $00\ 000\ 110 = 006$.

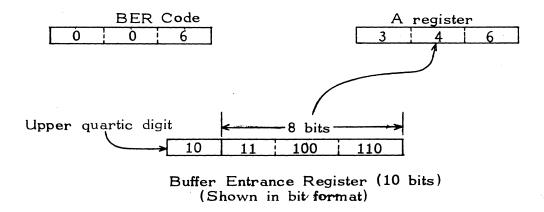
CLA - (03) - Clear A 1 Cycle

This instruction is the same as the preceding instruction (TTA) except that the TAG is not referenced. The A register is therefore cleared (all zeros).

BER - (06) - Buffer Entrance Register to A 1 Cycle

Load the A register with the lower 8 bits of the Buffer Entrance register.

Example: Load Buffer Entrance register into A



Note: On this instruction, the lower 8 bits (1 quartic and 2 octals) are transferred into the A register. The upper 2 bits (1 quartic digit) are not transferred. On the reverse transfer (A to BER), the right 2 bits of Tag register 3 are sent to the upper 2 bit locations of BER. This is explained in detail in the ABR instruction.

STORE Instructions

Five STORE instructions are available; these are:

STM - STORE A (Memory Address Mode)
STI - STORE A (Indirect Address Mode)

ATT - A to Tag Register

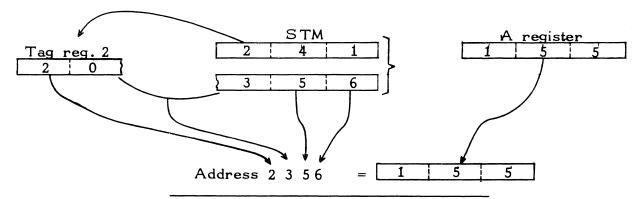
ABR - A to Buffer Entrance Register

ABX - A to Buffer Exit Register

STM - (41) - STORE A (Memory Mode) 3 Cycles

Store the contents of the A register into the location whose address is equivalent to the combined contents of the designated Tag register and the second word of the instruction set.

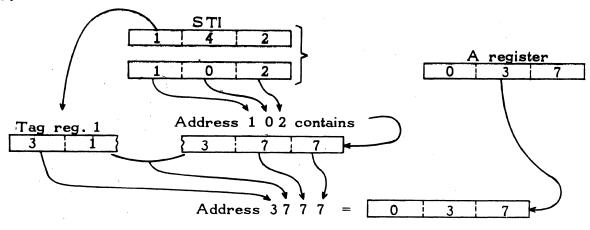
Example: Assume A contains the octal number, 155. Store this number at octal address, 2356.



STI - (42) - STORE A (Indirect Mode) 4 Cycles

Store the contents of the A register into the location whose address is equivalent to the combined contents of the designated Tag register and the contents of one of the first 256 decimal core registers. The exact location of one of these 256 registers is given, through its address, in the second instruction word.

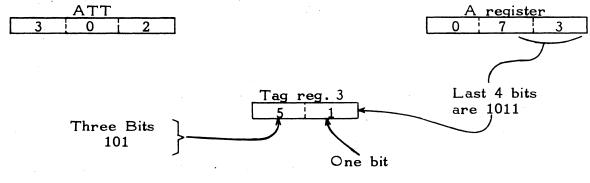
Example: Assume the A register contains the octal number, 037. Store this number in octal address, 3777, by using octal location 0102, and the indirect mode.



ATT - (02) - A to Tag Register 1 Cycle

Transfer the lower 4 bits of the A register into the designated Auxiliary Tag register.

Example: Assume the A register contains the octal number, 073. Store the A register at Auxiliary Tag register, 3.



DON - (02) - Do Nothing 1 Cycle

This instruction is the same as the preceding instruction (ATT), except that the tag is not referenced. This instruction has no operation. Control goes to the next instruction set.

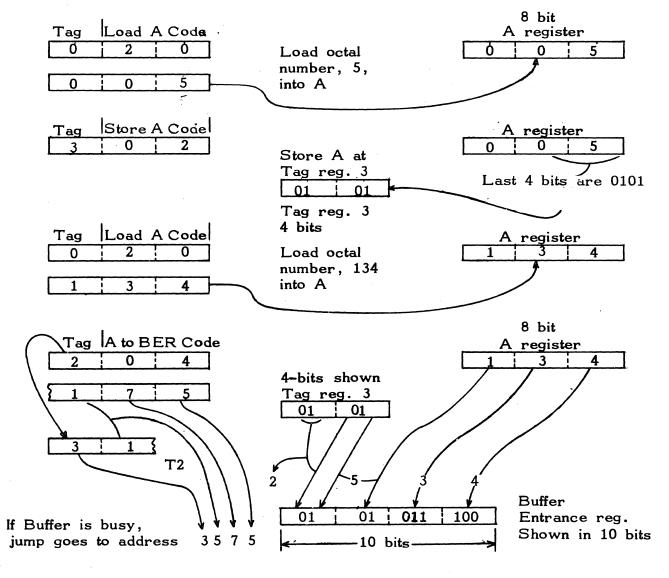
ABR - (04) - A to Buffer Entrance Register 1 Cycle, 2 Cycles if jump is made.

Transfer the contents of A to the lower 8 bit positions of the Buffer Entrance register. The rightmost 2 bits of Tag register 3 become the 9th and 10th bits

of the Buffer Entrance Register (BER); the upper two bits of Tag register 3 are <u>referenced</u> for bits 11 and 12 of BER. If the buffer is busy, a jump occurs to the combined address contained in the second word of the instruction set and the designated Tag register. If the buffer is not busy, control goes to the next instructional set.

Example: Assume one wants to effectively enter a starting octal address of 2534 into the Buffer Entrance register. Shown are the program steps involved.

To effectively enter a starting address, 2534 into BER



Since BER is a 10-bit register, there is not room for the full 12-bit address. The upper 2 bits (1 quartic) are obtained by <u>referencing</u> the left 2 bits of Tag register 3. In the above example, the left 2 bits of Tag register 3 and the leftmost bit of BER give the octal digit, 2.

ABX - (05) - A to Buffer Exit Register 1 cycle, 2 cycles if jump is made.

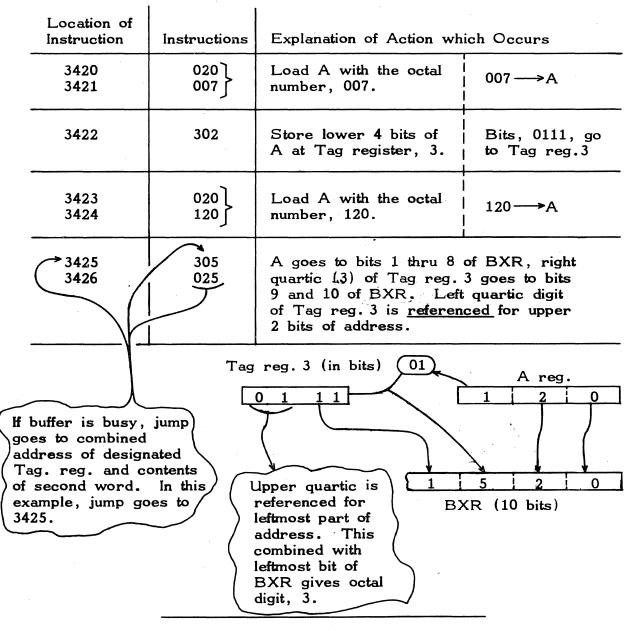
Transfer the contents of A to the lower 8 bits of the Buffer Exit register (BXR). The right quartic digit (2 bits) of Tag register 3 fills the 2 upper bits of BXR. The instruction is used to store the terminating address for buffer transfers. The left quartic digit of Tag register 3 is referenced by the TeleProgrammer to determine the highest order 2 bits of the address. For a Buffer Input instruction, enter the $\underline{LWA} + 1$, and for a Buffer Output instruction, enter the $\underline{LWA} + 2$.

If the buffer is busy a jump occurs to the combined address contained in the designated Tag register of the first word and the contents of the second word of the instruction set. If not busy, control continues to the next instruction set in sequence.

NOTE: The above concept may be clearer, if it is remembered that 12 bits, rather than 8 bits, are required to cover the whole possible address range of 4096 registers. As a consequence, it must be possible to perform buffer operations covering the complete address range. To accomplish this, the BER or BXR (of 10 bits) uses the 8 bits of the instruction operand, 2 bits from TAG register 3 (the lowest order 2 bits). By referencing the highest order 2 bits of Tag register 3, the full 12 bits are available.

The use of a 10 bit BER and BXR allows a maximum buffer operation of 2000g words. The first word address and last word address must be identical in the highest order 2 bits. The highest order 2 bits of Tag 3 must not be altered during buffer operations.

Example: Show a program which places octal address, 3520 into BXR; if the buffer is busy, wait until it is not busy.



JUMP INSTRUCTION

Five JUMP instructions are available, they are:

ZJP - JUMP, if contents of A = 0

NZP - JUMP, if contents of A ≠ 0

PJP - JUMP, if contents of A ≥ 0 (positive)

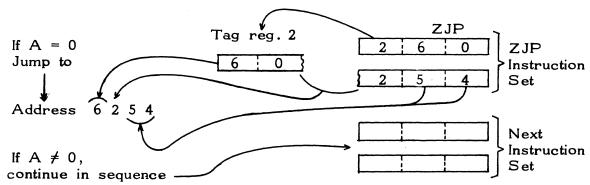
NJP - JUMP, if contents of A < 0 (negative)

UJP - Unconditional JUMP

ZJP - (60) - Zero JUMP 2 Cycles if jump is made; otherwise, 1.

If the contents of A equals zero, jump to the <u>combined</u> address contained in the designated Tag register and the second word of the instruction set. If the contents of A are not zero, continue in sequence with next <u>set</u> of instructions.

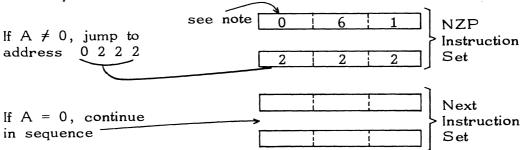
Example: Test A for zero, and jump to octal address, 6254, if A is zero; otherwise continue.



NZP - (61) - Not Zero JUMP 2 Cycles if jump is made; otherwise, 1.

If contents of A are not zero, jump to the combined address contained in the designated Tag register and the second word of the instruction set. If the contents of A are zero, continue in sequence with the next set of instructions.

Example: Test A, and if not zero, jump to octal address, 0222. If zero, continue in sequence.

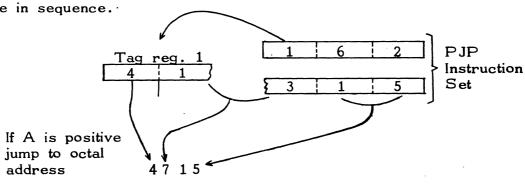


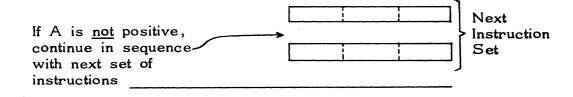
Note: Since the complete jump address can be expressed in 8 bits, no Tag register is required. Thus, the Tag designation = 0, in the first instruction word.

PJP - (62) - Positive JUMP 2 Cycles if jump is made; otherwise, 1.

If the contents of A are positive (equal or greater than zero), jump to the combined address contained in the designated Tag register and the second word of the instruction set. If the contents of A are not positive, continue in sequence. (If leftmost bit = 0, contents of A are positive.)

Example: Test A, and if positive, jump to octal address 4715. Otherwise, continue in sequence.

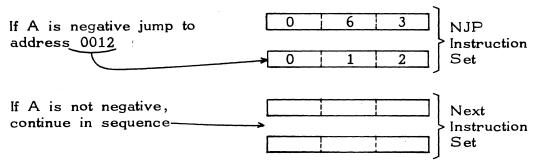




NJP - (63) - Negative JUMP 2 Cycles if jump is made; otherwise, 1.

If the contents of A are negative, jump to the combined address contained in the designated Tag register and the second word of the instruction set. If the contents of A are not negative, continue in sequence with the next set of instructions.

Example: Test A, and if negative, jump to octal address, 0012. If not negative, continue in sequence.

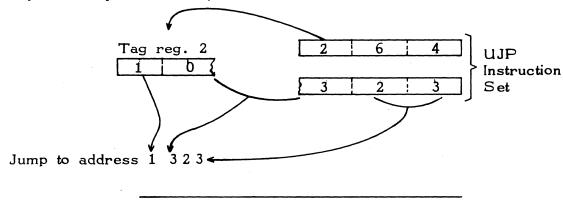


Since significant portion of the address can be contained in 8 bits, no Tag register is required and thus Tag designation of first instruction word is zero.

<u>UJP - (64) - Unconditional JUMP</u> 2 Cycles

Jump to the <u>combined</u> address contained in the designated Tag register and the second word of the instruction set.

Example: Jump to address, 1323.



SHIFT INSTRUCTION

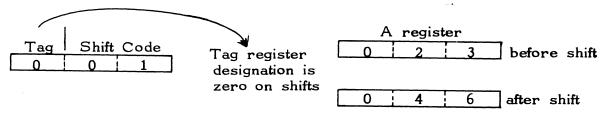
One shift instruction is available:

SHA = SHIFT A LEFT ONE BIT

SHA - (01) - Shift A Left 1 1 Cycle

Shift the contents of A left--end around--1 bit position. Bits coming off the left end of the A register enter the lowest bit position on the right end of the register.

Example: Assume A contains the octal number 023. Multiply the contents of A by 2, using the shift instruction.



Note: One shift instruction is required to shift A one place (1 bit) to the left. Each left shift is equivalent to one multiplication by 2. To shift 5 bits left, it is necessary to give 5 shift instructions, or loop through the single shift instruction 5 times.

ARITHMETIC INSTRUCTIONS

There are eight Arithmetic instructions: three adds, three subtracts, and two replace adds. These are:

ADN - ADD (No Address)

ADM - ADD (Memory Address)
ADI - ADD (Indirect Address)

SBM - SUBTRACT (No Address)

SBM - SUBTRACT (Memory Address)
SBI - SUBTRACT (Indirect Address)

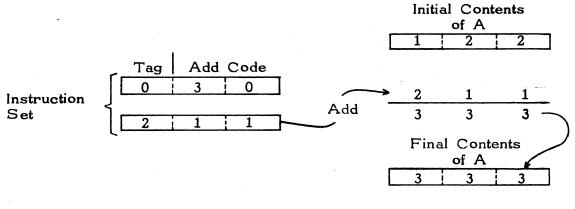
RAM - REPLACE ADD (Memory Address)

RAO - REPLACE ADD ONE (Memory Address)

ADN - (30) - ADD (No Address) 2 Cycles

Add to the A register the 8 bit number given in the second word of the instruction set. The sum is left in A.

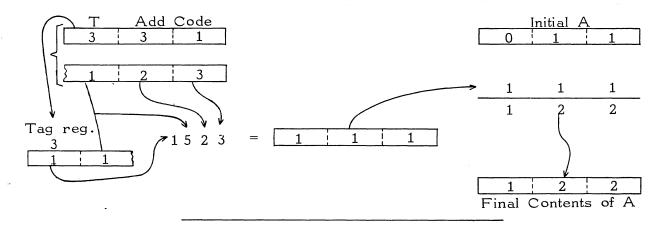
Example: Assume A contains the octal number, 122. Add the octal number, 211, to A.



ADM - (31) - ADD (Memory Address) 3 Cycles

Add to A the contents of the combined address given in the designated Tag register and the second word of the instruction set.

Example: Assume A contains the octal, 011. Add the contents of address 1523 to A. (Assume contents of address 1523 are 111.)



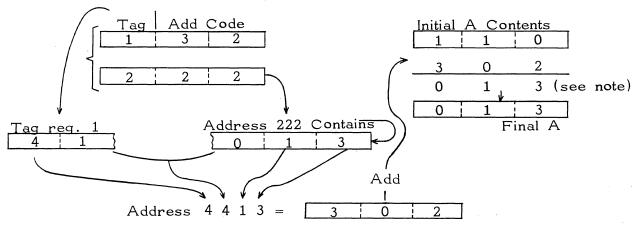
ADI - (32) - ADD (Indirect Address) 4 Cycles

Add to A the contents of the combined address contained in the designated

Tag register and one of the first 256 decimal locations indicated in the second

word of the instruction set.

Example: Assume A contains octal number, 110. Assume octal address, 4413 contains 302. Add the contents of address 4413 to A, by using the indirect mode and octal address, 0222.

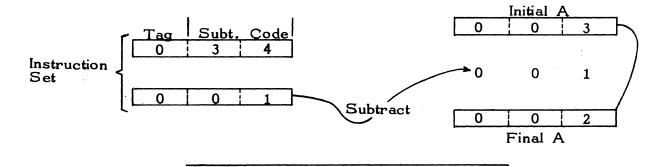


Note: The addition of 1 and 3 in the rightmost quartic digits overflows the register and the carry over (1) is added to the rightmost digit.

SBN - (34) - SUBTRACT (No Address) 2 Cycles

Subtract from the A register, the number contained in the second word of the instruction set. The difference is left in A register.

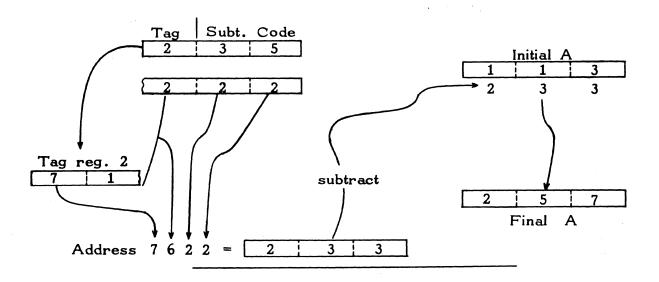
Example: Assume A contains 003. Subtract 001.



SBM - (35) - SUBTRACT (Memory Address) 3 Cycles

Subtract from the contents of A, the contents of the combined address contained in the designated Tag register and the second word of the instruction set.

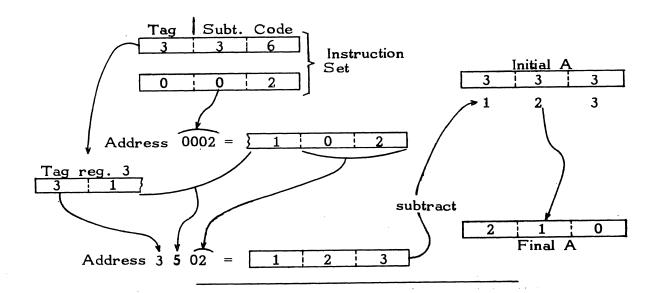
Example: Assume A contains the octal, 113. Assume address, 7622 contains 233. Subtract the contents of address 7622 from A.



SBI - (36) - SUBTRACT (Indirect Address) 4 Cycles

Subtract from the contents of A, the contents of the combined address contained in the designated Tag register and the location of one of the first 256 decimal registers, indicated by the second word of the instruction set.

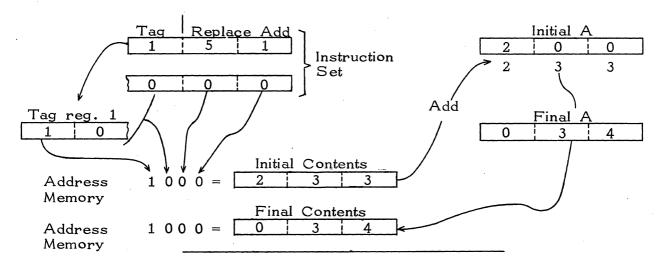
Example: Assume A contains the octal, 333. Assume address 3502 contains the octal number, 123. Reduce A by the contents of address 3502, using indirect mode and octal address, 0002.



RAM - (51) - REPLACE ADD (Memory Address) 4 Cycles

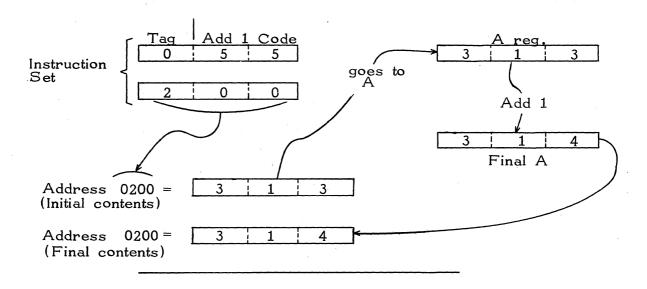
Add the contents of the A register to the contents of the memory address formed by the contents of the designated Tag register and the second word of the instruction set. The sum thus formed, remains in A, and replaces the initial contents of the memory address.

Example: Assume A contains the octal number, 200. Assume address 1000 contains the octal number, 233. Increase the contents of address 1000 by the contents of A.



RAO - (55) - REPLACE ADD ONE 4 Cycles

Add 1 to the contents of the memory address indicated by the combined contents of the designated Tag register and the second word of the instruction set. This sum is performed in A and remains in A at the end of the instruction. Example: Add 1 to the contents of memory address, 0200.



LOGICAL INSTRUCTIONS

There are six Logical instructions: three of which are Logical products; three are Logical sums. These are:

LPN - LOGICAL PRODUCT (No Address)

LPM - LOGICAL PRODUCT (Memory Address)
LPI - LOGICAL PRODUCT (Indirect Address)

LSN - LOGICAL SUM (No Address)

LSM - LOGICAL SUM (Memory Address)
LSI - LOGICAL SUM (Indirect Address)

Logical Product is defined as a "bit by bit" multiply which observes the following rules:

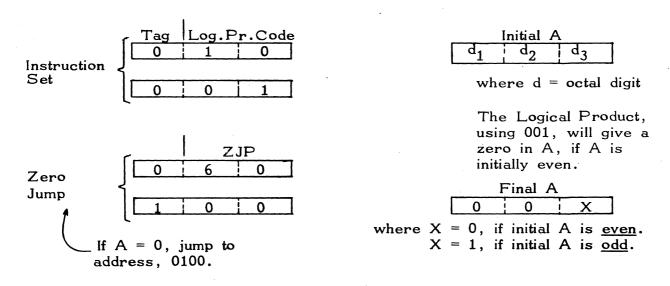
1 times 0 = 0 0 times 0 = 0 0 times 1 = 0 1 times 1 = 1

Logical Sum is a "bit by bit" sum without "carries" which observe the following rules:

LPN - (10) - LOGICAL PRODUCT (No Address) 2 Cycles

Form in A the Logical Product of the contents of A and the contents of the second word of the instruction set.

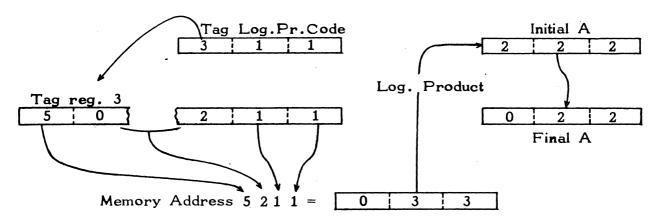
Example: Test A for "even". If even, jump to octal address, 0100.



LPM - (11) - LOGICAL PRODUCT (Memory Address) 3 Cycles

Form in A, the Logical Product of the contents of A and the contents of the memory location whose address is the combined contents of the designated Tag register, and the second word of the instruction set. The initial contents of the memory location remains unchanged.

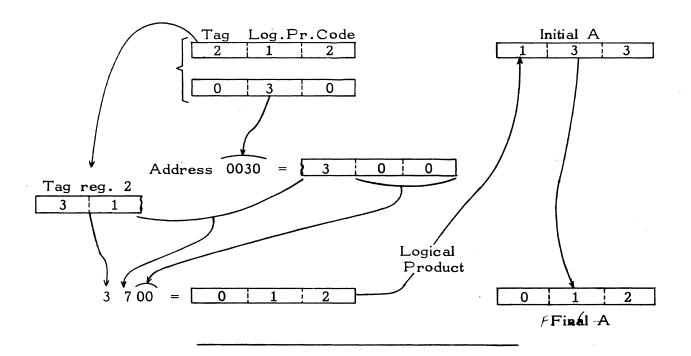
Example: Assume A contains the octal, 222. Assume memory address, 5211, contains 033. Form the Logical Product in A.



LPI - (12) - LOGICAL PRODUCT (Indirect Address) 4 Cycles

Form in A the Logical Product of the contents of A and the contents of the memory location whose address is the combined contents of the designated Tag register and the contents of one of the first 256 decimal locations. The address of this decimal location is given in the second word of the instruction set. The initial contents of the memory location remain unchanged.

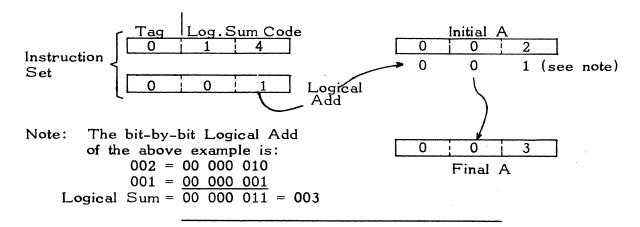
Example: Use the indirect mode to form the Logical Product of A and memory location 3700. Use octal location, 0030 in the process. Assume initial contents of A and location 3700 are respectively: 133 and 012.



LSN - (14) - LOGICAL SUM (No Address) 2 Cycles

Form in A the Logical Sum of the contents of A and the second word of the instruction set.

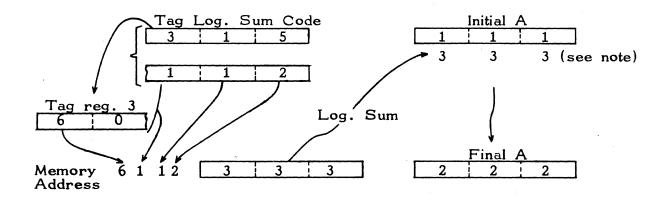
Example: Assume A contains octal number, 002. Set A to 003.



LSM - (15) - LOGICAL SUM (Memory Address) 3 Cycles

Form in A the Logical Sum of the contents of A and the contents of the memory location whose combined address is given in the designated Tag register and the second word of the instruction set.

Example: Assume A contains octal number, 111. Form in A the Logical Sum of the contents of A and the contents of memory location, 6112. Assume this location contains 333.



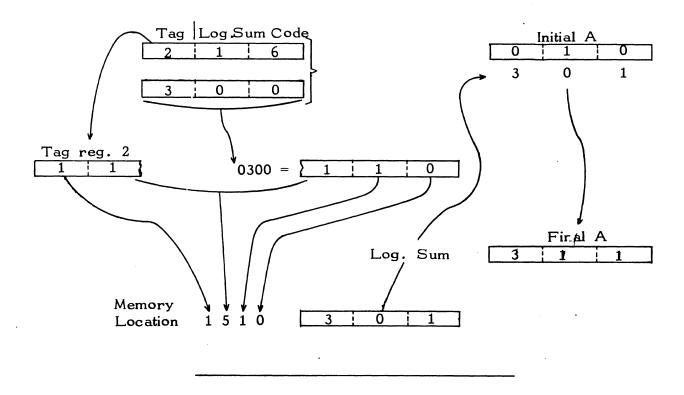
Note: The Logical Sum performed above, is shown below in bit form.

$$\begin{array}{rcl}
111, & = & 01 & 001 & 001 \\
333, & = & \underline{11} & \underline{011} & \underline{011} \\
\text{Logical Sum} & = & 10 & 010 & 010 & = & 222
\end{array}$$

LSI - (16) - LOGICAL SUM (Indirect Address) 4 Cycles

Form in A the Logical Sum of the contents of A and the contents of the memory location whose address is the combined contents of the designated Tag register and one of the first 256 (decimal) locations. The location of one of these 256 locations is given in the second word of the instruction set.

Example: Assume A contains 010. Assume memory location, 1510, contains 301. Using the indirect mode, and location 0300, form in A the Logical Sum of the contents of A and the contents of address 1510.



INPUT-OUTPUT INSTRUCTIONS

There are six instructions directly related to input-output functions. These are:

INN - INPUT NORMAL

OUT - OUTPUT NORMAL

IBI - INITIATE BUFFER INPUT
IBO - INITIATE BUFFER OUTPUT

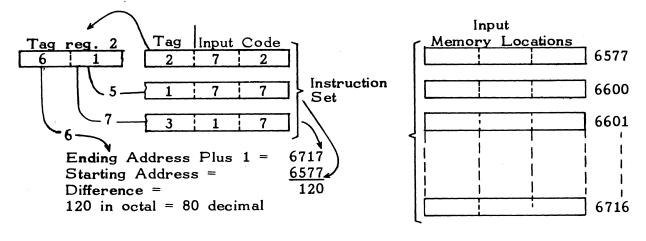
INA - INPUT TO A

OTN - OUTPUT NO ADDRESS

INN - (72) - INPUT NORMAL (see p. 9 for timing)

Input a number of words to memory starting at the memory address contained in the designated Tag register and the second word of the instruction. The ending address plus 1, is contained in a third word immediately following the second word. Thus, this instruction set is composed of three words. (The Tag register designation indicated in the first word is automatically assigned as the Tag register designation for the ending address plus 1, in the third word.)

Example: Input 80 words to memory starting at octal address, 6577.

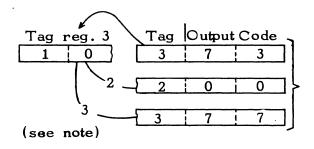


OUT - (73) - OUTPUT NORMAL

Output a number of words from memory starting at the memory address contained in the designated Tag register and the second word of the instruction set.

The ending address plus 1, is contained in a third word immediately following. Thus, this instruction set is composed of three words. (The Tag register designation, indicated in the first word is automatically assigned as the Tag register designation for the ending address plus 1, in the third word.)

Example: Output 300 (decimal) words from memory, starting at octal address, 1200.



First 127 (decimal) words are outputed from octal addresses shown:

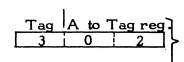
Ending Address Plus 1 = 1377

Starting Address = 1200

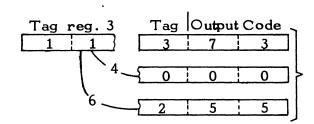
Number of Words = 177 = 12710

Tag	Load	A Code]
0	2	0	
			1
0	0	3	

Load A with 003.



Change Tag register, 3, by storing A at Tag register 3. Tag register 3 now contains 0011 (in bits).



Next 173 (decimal) words are outputed from octal addresses shown:
Ending Address Plus 1 = 1655

Starting Address = $\frac{1400}{255}$ = 173_1

127 + 173 = total 300 words

NOTE:

The "ending address plus 1" of 1377 above, resulted in a "gap"--that is, no output came from this register. The reason is that quartic address, 1377, falls at a "boundary address" as far as the addressing logic of the Tele-Programmer is concerned. "Boundary addresses" are those, which when incremented by 1, cause a change to occur in any one of the 4 leftmost address bits. This in turn, requires a change in the Tag register (as above). There are 16 such "boundary addresses" in the whole 4096 registers. This condition is not serious due to the following alternatives:

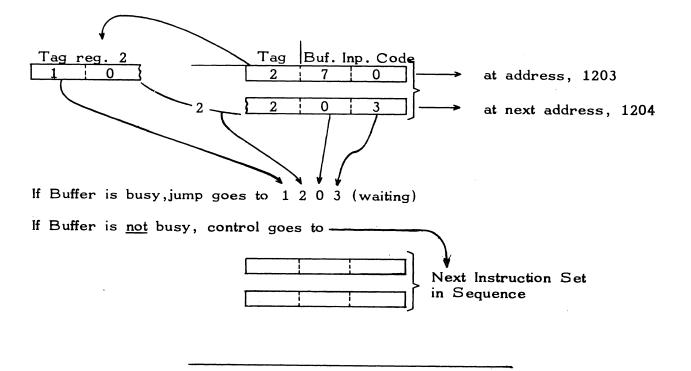
- (a) If output follows input or vice versa such "gaps" would have existed in the identical places anyway, and thus are of no consequence.
- (b) If one wishes, he can fill the gap location by loading one word into A and storing at the gap address.
- (c) By effective memory allocation, boundary addresses can often be entirely avoided.
- (d) Buffered operations do not have this situation.

The previous example was given to indicate that a change in address which changes any one of the 4 leftmost bits of the 12-bit address, requires a corresponding change in the contents of the Tag register. It should be apparent, that the maximum transfer without changing the Tag register is 256 (decimal words.

IBI - (70) - INITIATE BUFFER INPUT 1 cycle, 2 cycles if jump is made. Before using this instruction, the starting address of the buffer transfer is sent to BER, and the ending address plus 1 is sent to BXR (see these instructions).

This instruction initiates the input buffer cycle. If the buffer channel is not busy, control goes to the next instruction following the second word of the instruction set. If the buffer channel is busy, a jump occurs to the memory location whose combined address is contained in the designated Tag register and the second word of the instruction set.

Example: Initiate buffer input, and if busy wait until not busy. Assume the instruction is given at the location whose octal address is, 1203.



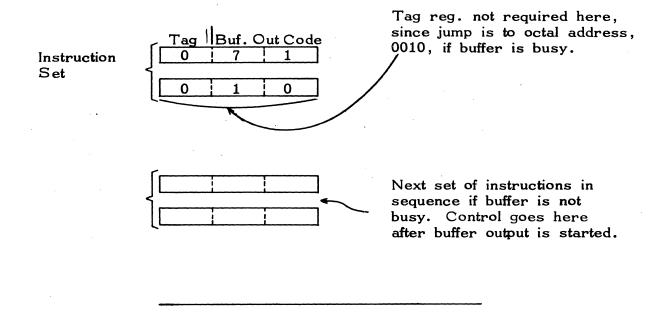
IBO - (71) - INITIATE BUFFER OUTPUT 1 cycle, 2 cycles if jump is made.

Before using this instruction, the starting address of the buffer transfer must

be sent to BER, and the ending address plus 1 must be sent to BXR (see these instructions).

This instruction initiates the output buffer cycle. If the buffer channel is busy, a jump occurs to the combined memory address given in the designated Tag register and the second word of the instruction set. If the buffer channel is not busy, control goes to the next sequential instruction following the instruction set.

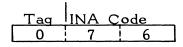
Example: Initiate buffer output and if busy jump to octal address 0010.



INA - (76) - INPUT TO A

This instruction <u>inputs</u> <u>one</u> word from a previously selected input device to the A register.

Example: Assume a previous instruction (see EXF) has selected the paper tape reader for input. Input one frame (one word) to A.



Note: This is a <u>single</u> word instruction, and the Tag register designation is <u>always</u> zero.

OTN - (74) - OUTPUT NO ADDRESS

This instruction outputs one word. This word is the second word of the instruction set.

Example: Assume a previous instruction has selected the Printer. Output the number 0102.



Tag Output Code

O 7 4

designation is always zero in this instruction.

CONTROL INSTRUCTIONS

Five Control instructions are available:

EXF - EXTERNAL FUNCTION

CIL - CLEAR INTERRUPT LOCKOUT

CBC - CLEAR BUFFER CONTROLS

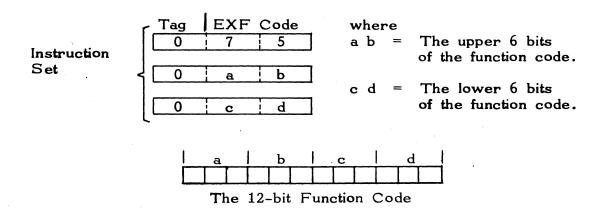
ERR - ERROR STOP

HLT - HALT

EXF - (75) - EXTERNAL FUNCTION

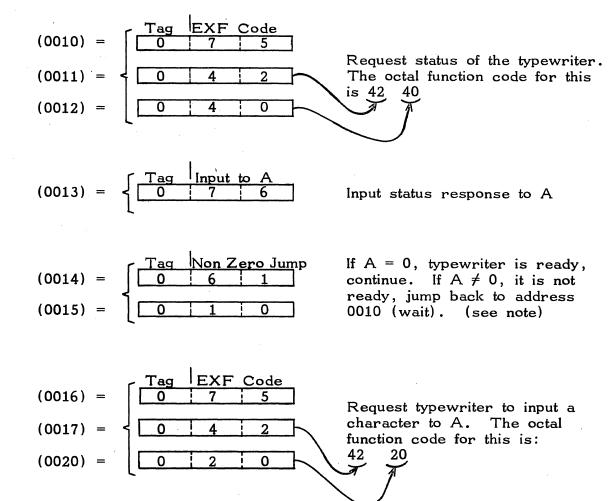
This instruction is used to <u>select</u> an external input or output device to communicate with the TeleProgrammer. The select function is accomplished by sending out on the output lines a 12-bit "function code". Each external device is capable of recognizing and interpreting only its own unique code. Thus, the programmer by selecting different external function codes can use this same instruction to select <u>all</u> external devices.

The 12-bit function code is contained in the <u>second</u> and <u>third</u> words of the three words which make up this instruction set. The format of the three words are best described by the following:



Note: If the external device cannot be selected the TeleProgrammer halts.

Example: Request the status of the typewriter (ready or not ready), if busy, wait; request typewriter input; and input to A.



Note: In the jump back to address 0010 above, no Tag register is required since the octal address is one whose significant bits can be expressed in 8 bits.

Input the character to A

CIL - (13) - CLEAR INTERRUPT LOCKOUT

NOTE

A do nothing (02) instruction should be used at interrupt locations 10, 20, 30 and 40 when such interrupt levels are used; then use the 013 or 113 instruction.

This instruction clears the interrupt lockout flip flop (FF). This instruction must be programmed at the end of every routine which is initiated by the interrupt. This instruction returns control to the main program.

Example: Assume an interrupt has occurred and a routine entered. At the end of this routine show the instruction required to clear the Interrupt Lockout and return control to the Main Program.

Tag	CIL C	ode
1	1	3

Note: In this instruction, the Tag designation becomes a part of the function code itself. It can only be 0 or 1. Thus, to return to main program after clearing interrupt lockout, the Tag designation must be 1. If zero, control continues in sequence.

CBC - (07) - CLEAR BUFFER CONTROLS

This instruction has the effect of sending a zero to buffer control and thus putting that device in a "ready state". If this instruction is used <u>during</u> a buffer operation, it will stop the buffer.

Example: Clear buffer control.

Tag	CBC	Code	
0	0	7	

A Tag register designation is ignored in this single word instruction.

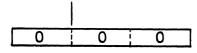
Two STOPS are available; these are:

ERR = ERROR STOP HLT = HALT STOP

ERR - (000) - ERROR STOP

This is an illegal instruction -- as such, it can be used as an Error Stop.

Example: Use the Error Stop instruction.



Error Stop

HLT - (77) - PROGRAM STOP

This instruction is used to bring the program to a halt.

Example: Use the STOP instruction.

Tag	Stop C	Code
0	7	7

Program Stop

CHAPTER TWO OPERATION

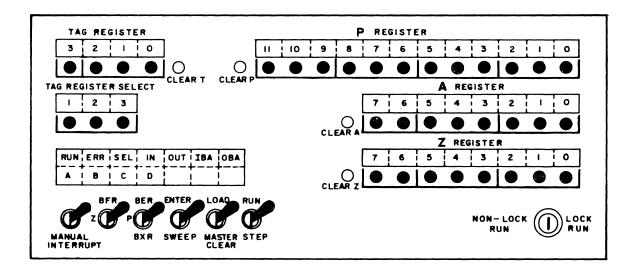


Figure 2-1 8092 Operator's Panel

TeleProgrammer OPERATOR's CONSOLE

The 8092 TeleProgrammer Operator's Panel consists of several displays and switches necessary for the operation of the TeleProgrammer. The panel (see figure 2-1) contains six display windows, six switches, and a lock switch. Four of the display windows can display in binary the contents of nine 8092 registers. Buttons beneath these displays clear and enter data into the P, A, Z, and Tag registers (the only registers into which data may be entered or cleared). A fifth window contains information as to which Tag register has been selected. The sixth window contains the operating lights which indicate the status of operation

of the TeleProgrammer. At the bottom of the panel are located all the operating and mode switches. The operation of these switches is explained below:

<u>SWITCHES</u>

Manual Interrupt

BFR.Z

BER, P, BXR

-Momentary depression causes the Tele-Programmer to enter an interrupt routine to determine the nature of the interrupt.

-This 3-position switch chooses the register that is to be displayed in the 8-bit Z register display.

Up - Displays the last word processed during the last buffer operation (BFR register)

Center - Shows the current contents of the Z register (Z register).

Down - Not assigned.

-This 3-position switch chooses the register to be displayed in the 12-bit P register display.

<u>Up</u> - Displays the lowest-order 10 bits of the address of the last word transferred out, or the next word to be transferred in on the buffer channel (BER) register.

Tag 3 must be referenced for the highest-order 2 bits of the address.

<u>Center</u> - Displays the address of the current instruction (P register).

<u>Down</u> - Displays the lowest-order 10 bits of the LWA + 1 of the buffer area (BXR) register. Tag 3 must be referenced for the highest-order 2 bits of the address.

-Sweep is used to display the contents of core storage locations. Enter is used for entering information into core storage from the console.

- LOAD position allows specially prepared paper tapes to be read into storage by the paper tape reader.

Master CLEAR performs a TeleProgrammer clear which:

- a. Clears the registers
- b. Clears the control flip-flops
- c. Clears all waiting interrupts and removes interrupt lockout.

Note: The master clear does not alter core storage.

<u>Up</u> - In RUN position, a program is executed at high speed starting at the location specified by the P register.

ENTER/SWEEP

LOAD/MASTER CLEAR

DIIN/STED

Center - Center position stops the computer program. If the switch is in RUN and an ERR or HLT instruction is executed, the switch must be returned to neutral and then placed in RUN to continue computation.

Down - In STEP position, one storage cycle of an instruction is executed each time the switch is set; a program may be executed one instruction at a time for debugging.

NON-RUN LOCK RUN LOCK

In the Lock position all other switches are disabled and the TeleProgrammer is locked in the RUN position.

In the non-lock position, the console switches are enabled and the TeleProgrammer programs can be operated and modified from the console.

DISPLAYS

Z REGISTER

-This display known as the Z register group displays the Z and BFR registers in accordance with the setting of the BFR, Z switch.

A Register

-Displays the current contents of the A register.

P Register

-This display known as the P register group displays the BER, P, and BXR registers in accordance with the setting of the BER, P, BXR switch.

TAG REGISTER

-This display indicates the Tag register currently being referenced by an instruction. The contents of any Tag register may be displayed by depressing one of the buttons directly below the select indicators. Depressing one of the select buttons also enables the Tag registers to be manually set or cleared.

STATUS INDICATORS

RUN

-Indicates that the TeleProgrammer is in RUN status. This does not necessarily indicate that instructions are being executed.

-Indicates that a timing fault has occurred.

-Displayed each time an EXF instruction is executed; remains until selection is completed. A constant display of SEL with no apparent input/output extion usually indicates the TeleProgrammer has attempted an illegal selection.

ERR SEL <u>IN</u>

<u>out</u>

IBA OBA

A, B, C, or D

-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 TeleProgrammer is waiting for an external device to supply data.

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.

Displayed during all buffer input operations.

Displayed during all buffer output operations.

Indicates which storage reference cycle will be executed at the next operation of the Run/Step switch. When a master clear is performed, D is displayed indicating that the next operation to be executed, when the Run/Step switch is operated, will be to fetch the instruction from memory at the address indicated by the P register.

STARTING THE 8092 TeleProgrammer

- 1) Be sure the TeleProgrammer is plugged into proper power source and room temperature is within the prescribed limits.
- 2) Turn on the cabinet power, then turn on the power supply.
- 3) Master clear by momentarily pressing Load/Clear switch to Clear.
- 4) When the ERR light goes out, the TeleProgrammer is ready to operate. If repeated master clears do not turn the Red ERR light off, turn off the 8092 and call maintenance.

LOADING A PROGRAM OR DATA

Paper Tape Load Format

- 1) Master Clear
- 2) Turn on reader
- 3) Insert paper tape in reader
- 4) Set P to starting location
- 5) Set Load/Clear switch to LOAD
- 6) Set Run/Step switch to RUN. Paper tape will load and TeleProgrammer will stop.

ENTERING DATA FROM THE TeleProgrammer CONSOLE

- 1) Master clear. Set Enter/Sweep switch to ENTER.
- 2) Set P to location into which data is to be entered.
- 3) Enter one word of data into the A register.
- 4) Set Run/Step switch to STEP, once. At this point A is clear and the data word is in storage and in Z.
- 5) If data is to be entered into consecutive locations, go to step 3 and P will be advanced by one on step 4. If data is to be entered into non-consecutive locations, clear P. Go to step 2.

EXAMINING THE STORAGE CONTENTS

- 1) Master clear. Set Enter/Sweep switch on SWEEP
- 2) Set P to location to be examined.
- 3) Press Run/Step switch to STEP, once. The contents of the location specified by P will appear in Z.
- 4) To examine consecutive locations, go to step 3 and P will be advanced by one on step 3. To examine non-consecutive location, clear P, go to step 2.

CHAPTER THREE

A BRIEF LOGICAL DESCRIPTION OF THE TELEPROGRAMMER

Input/Output Section

The input/output (I/O) Section contains one normal (or direct) channel and one buffered channel. Each channel can communicate with five units of peripheral equipment.

The normal channel communicates with external equipment under program control only. There are no provisions for the external equipment to initiate a data transfer except under program control.

The buffered channel communicates with external equipment asynchronously to the main program. It can transfer data in one direction only until changed by program control. In other words, the buffer channel can input to main storage or output from main storage while not under main program control. However, it cannot input and output alternately without having been so instructed by the main program. Once an input buffering or an output buffering operation is initiated, it continues until completed or until cleared by the main program.

The buffer I/O channel has three registers associated with it. These are the Buffer Entrance Register (BER register), the Buffer Exit Register (BXR register), and the Buffer Data Register (BFR register). The BER register holds the buffer starting address and is advanced by one for each buffer cycle. The BXR register holds the buffer ending address, and when BER = BXR the buffer operation is complete. The BFR register holds the input or output

word for transfer to or from external equipment.

The buffer channel may also be used as a normal channel whenever the buffer is not busy.

Interface control is maintained by the control section on a Ready-Resume basis. Within the control section is a separate buffer control section which controls the buffering operations on the same Ready-Resume basis.

Program Step

A program step in the TeleProgrammer is one storage reference cycle. Normally the steps proceed as: 1) Read instruction into control section, 2) Read address of operand (one or two steps) and 3) Perform indicated instruction.

The TeleProgrammer instruction is basically a 2-word instruction contained in 2 sequential storage locations. The first word of the instruction contains: the instruction in the lower 6 bits and the tag bits (TAG register reference bits) in the upper 2 bits. The second word of the instruction contains: the operand (no address mode), the lower 8 bits of a 12-bit address (memory address mode) or the address of one of the first 256 storage locations (indirect address mode).

Arithmetic Section

The arithmetic section of the TeleProgrammer consists of 3 registers and a borrow pyramid. The three registers are the A register, the A' register (which is the accumulator register) and the Z register.

All arithmetic functions (add, subtract and logical operations) are performed by the borrow pyramid which is integrated with the A' register. Inputs to the borrow pyramid are from the A register and the Z register.

Shifting of the A register is accomplished via the borrow pyramid and is confined to a left shift one bit, in the TeleProgrammer. This shifting is a circular shift where the highest order bit is shifted into the lowest order bit position.

The borrow pyramid forms the results of arithmetic operations in a subtractive manner; so that, addition is performed by complementing the Z register and subtracting. Subtraction is a direct process, and logical operations are performed similarly to addition.

Interrupt

The interrupt feature gives the TeleProgrammer four unique interrupt levels which can be utilized in the programming of the TeleProgrammer. The four interrupt levels in order of priority are:

- 1) Manual Interrupt 10
- 2) Buffer Interrupt 20
- 3) External Interrupt 30
- 4) External Interrupt 40

Recognition of an interrupt by the TeleProgrammer forces the TeleProgrammer to start an Interrupt recognition routine which starts at memory location 10 or 20 or 30 or 40 depending on the interrupt activated.

Interruption of the main program can only occur on a 'D' cycle and the occurrence of an interrupt causes the TeleProgrammer to store the address at which it was interrupted and jump to locations 10 or 20 or 30 or 40. At these locations must be the start of a routine which determines the nature of the interrupt. At the end of this routine must be a Clear-Interrupt Lock-out instruction which causes the TeleProgrammer to jump back into the main program at the same address it was at when interrupted. If the interrupt feature is to be used, memory locations 10, 20, 30 or 40 should not be used for the main program or storage.

Interface Control

At the interface of the TeleProgrammer are the same basic control lines and data lines as in the CONTROL DATA 160-A computer.

Storage Section

The storage section of the TeleProgrammer is a high-speed magnetic-core storage system providing non-volatile, random-access storage for 2048 or 4096 8-bit words. Transfer of the words into and out of storage is under control of the control section. For each storage reference cycle, the program-address register (P register) is advanced by 1 to form the address of the next storage location. This address is then entered into the storage access register (S register) where it is translated to a unique selection of one vertical line and one horizontal line selecting 1 core in each of the 8 planes.

After translation, the selected lines are pulsed simultaneously by Read/Write drivers to give a coincident current through the selected core. Normally this would write a "1" in the selected core. If that plane is "inhibited" however, an "0" will be written in that core. The inhibit effectively cancels the effect of the vertical write pulse so that only a half-write current will exist in the core.

Storage Sequence

The storage sequence is divided into four basic portions which accomplish the Read/Write control of the storage section. Every storage sequence is as follows:

- 1) Divert select one of eight vertical and one of eight horizontal lines from the Read/Write drivers.
- 2) Read select one of eight vertical and one of eight horizontal Read/Write drivers in the read mode which drives the core to its "0" state.

- 3) Inhibit cancel the effect of the write pulse and allow the core to remain in the "0" state.
- 4) Write select the same Read/Write driver as on read, and drive the core to its "1" state if the inhibit pulse is absent.

There are two basic registers associated directly with the storage section. These are the storage address register (S register) and the transfer register (Z register).

The S register is a 12-bit register that holds the storage address during the storage reference cycle. This register has storage capabilities only and is set from the P register, the Buffer Entrance Register (BER register), the A register or the Z register, depending on the instruction being performed.

The Z register is the main transfer and data handling register in the Tele-Programmer. All outputs from the core storage enter the Z or BFR registers, and all inputs to the core storage come from the Z or BFR registers. The Z register also has inputs from the A register, the normal input channel and the buffer input channel in the normal mode. Outputs from the Z register feed the borrow pyramid, the S register, the F register, the normal output channel, and the buffer output channel in the normal mode.

Control Section

The control section of the TeleProgrammer consists of the timing controls, the function translation, and the TAG registers.

Timing Controls

Timing of the operations of the TeleProgrammer is controlled by the timing chain and the primary timing controls. The timing chain is an 8-stage ring counter which recirculates three times for every storage reference cycle to produce a chain of 24, successive, unique pulses. A resynchronizing circuit is employed to insure the timing chain starting on the same clock phase each storage reference cycle.

Function Translation

The instruction control or function control of the TeleProgrammer is achieved by the F register and the function translators. The F register is translated to determine the control and data transfer sequence for any given instruction. The translators are carefully integrated with the timing controls to insure proper operation of the TeleProgrammer.

Address-Tag Registers

Also in the control section are three address-Tag registers each of 4 bits length. These registers are referenced by the tag bits of the instruction word (which are also translated).

The Tag registers are capable of modification at any point in the program from the A register. The upper two bits of the Tag register 3 are used as the buffer channel Tag register. Also, if Tag register 0 is referenced, the address will automatically be one of the first 256 storage locations since Tag register 0 is non-existent.

APPENDIX

APPENDIX A

TOSAS -- A TELEPROGRAMMER ASSEMBLER

Preface

The TeleProgrammer is easily programmed in machine language using the previous descriptions and references of this manual. Those Control Data Customers and analysts who have recourse to either a 160 or 160-A Computer, can also use "TOSAS" - the TeleProgrammer One Sixty Assembler System. TOSAS is easily implemented by adopting very slight modifications of the OSAS or OSAS-A assembly language. These modifications are described in this Appendix. Full descriptive manuals of OSAS or OSAS-A are available and can be obtained by writing to:

Industrial Data Processing Division Control Data Corporation 9549 Penn Ave. South Minneapolis, Minnesota

Description of TOSAS

TOSAS uses all the rules of OSAS or OSAS-A. With the exception of minor changes in the coding forms used, along with the adoption of one or two limitations, the two assemblers are the same. The differences are listed in detail below and followed with an example program to indicate the changes.

Providing for Different Function Codes:

The 160 and 160-A Computers employ 6-bit function codes. The TeleProgrammer also uses 6-bit function codes. However, the octal codes are different. To overcome this difference, TOSAS requires a "function Code Identification Listing" as part of the TOSAS program. This identification simply lists the mnemonic codes of the TeleProgrammer under "LOCATION" (cols. 2 - 8 in OSAS coding form); the pseudo OP Code, EQU, under "OP" (cols. 10 - 13); and the TeleProgrammer octal Function Codes under "ADDITIVE" (cols. 23 - 29). "COMMENTS" can appear as usual. A sample of identification listing is shown on page A-6. (The octal addresses in the leftmost column on page A-6 were assigned by the assembler for the problem of which this listing is an example.

Use of "CON"

In OSAS, the pseudo OP, "CON" is used to set aside the first 64 registers (octal address, 0000 through 0077) for constants which follow the code, "CON". In TOSAS, this pseudo OP can be used exactly the same way. However, the TeleProgrammer provides for 256 low core address (octal addresses 0000 through 0377). This means that if the programmer desires to reserve low core area beyond the first 64 locations, he must use separate symbolic tags under "LOCATION" preceded by the pseudo OP, "PRG" or by using the EGU pseudo OP as shown.

Example: Assume one wants to store octal constants: 5, 27, 31 and LG at respective octal locations 0076, 0077, 0100 and 0101.

LOCATION	<u>OP</u>	<u>ADDRESS</u>	ADDITIVE	COMMENTS
	CON	76		
			5	
			27	
	PRG	100		
			31	
LG	EQU	101		

Size of Numerics Under ADDITIVE Column

Since the TeleProgrammer involves an 8-bit word length instead of 12 bits, the size of the octal numbers (quantities and addresses) must not exceed 8 bits. Thus, the effective range is 000 through 377. In addition, 100, 200, or 300, must appear in the ADDITIVE column opposite the mnemonic code to indicate respectively the use of Tag registers 1, 2, or 3. (See examples.)

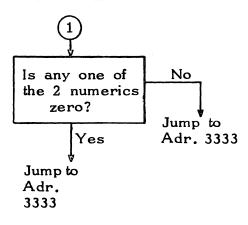
Difference in Coding

The same coding forms, as used in OSAS or OSAS-A, can be used in TOSAS. The difference is in the placement of mnemonic OP codes. In TOSAS, all TeleProgrammer mnemonic OP codes are placed under the "ADDRESS" column rather than the "OP" column. Symbolic addresses can be placed under the mnemonic, in the "ADDRESS" column, or in the "ADDITIVE" column. Octal numerics or decimal numerics (with letter "D") can be placed under "ADDITIVE". Also, 100, 200, or 300 must appear in the ADDITIVE column directly opposite the mnemonic code of the ADDRESS column to respectively indicate use of Tag register 1, 2, or 3. Thus in the example on the next page the third line of coding LDM 200 106 indicates that Tag register 2 is used with LDM, and contains the upper 4 bits of address 106 which follows.

To aid the reader in the TOSAS concept, a sample example is programmed, using TOSAS. A few sheets of the routine, on OSAS coding form, and the corresponding TOSAS listing are shown on pages A-7 through A-12. (Since this example used the lower 256 core memory locations, the reader should note that the use of 100, 200, or 300 opposite the mnemonic codes is reserved for the occasions when jumps or references beyond the first 256 registers are made. In such instances, Tag registers are required.

Example: Assume octal address 3106 and 3107 contain unknown numerics. If any one of these numerics is zero, jump to address, 3255; otherwise, jump to T1 (where T1 = Adr. 3333).

Flow Chart



TeleProgrammer Octal Code

{0LDN 0 06 2ATT	Store octal, 3, in three left bits of Tag Reg. 2
	Contents of Adr. 3106 to A
$ \left\{ \begin{array}{l} 2ZJP \\ 255 \end{array} \right\} $	If zero, jump to Adr. 3255
$ \begin{cases} 2LDM \\ 1 07 \end{cases} $	Contents of Adr. 3107 to A
$ \left\{ \begin{array}{c} 2ZJP \\ 255 \end{array} \right\} $	If zero, jump to Adr. 3255
2UJP }	Jump to Adr. 3333

TOSAS Coding (using OSAP Coding Form)

LOCATION	OP	ADDRESS	ADDITIVE	COMMENTS
		LDN		Octal 3 to Tag Reg. 2
			6	
		ATT	200	
		LDM	200	Contents of Adr. 3106 to A
			106	
		ZJP	200	If zero, jump to 3255
			255	
		LDM	200	Contents of Adr. 3107 to A
			107	
		ZJP	200	If zero, to Adr. 3255
			255	•
		UJP		Jump to T1
		T1*		-

^{**} Where T1 must be previously identified in the program by a statement such as: <u>LOCATION</u> <u>OP</u> <u>ADDRESS</u>

T1

EQU

3333

IDENTIFICATION LISTINGS

;	Location	OP	Additive	Comments
0000	ERR	EQU	0	ERROR STOP
0001	SHA	EQU		SHIFT A LEFT ONE BIT
0002	ATT	EQU	. 2	A TO TAG REGISTER
0003	TTA	EQU	3	TAG REGISTER CONTENTS TO A
0004		EQU	4	A TO BUFFER ENTRANCE REGISTER
0005		EQU	5	A TO BUFFER EXIST REGISTER
0006	BER	EQU	6	CONTENTS OF BER REGISTER TO A
0007		EQU	7	CLEAR BUFFER CONTROLS
0010		EQU	10	LOGICAL PRODUCT NO ADDRESS
0000	LPM	EQU		LOGICAL PRODUCT MEMORY ADDRESS
0012		EQU	12	LOGICAL PRODUCT INDIRECT ADDRESS
0013	CIL	EQU	13	CLEAR INTERRUPT LOCKOUT
0014	LSN	EQU	14	LOGICAL SUM NO ADDRESS
0015	LSM	EQU	15	LOGICAL SUM MEMORY ADDRESS
0016	LSI	EQU	16	LOGICAL SUM INDIRECT ADDRESS
0020	LON	EQU	20	LOAD A NO ADDRESS MODE
0021	LUM	EQU	21	LOAD A HEMORY
0022	LO1	EQU	22	LOAD A INDIRECT
0025	LCH	EQU	25	LOAD COMPLEMENT TO A MEMORY
0026	LCI	EQU	26	LOAD COMPLEMENT TO A INDIRECT
0030		EQU	30	ADD NO ADDRESS
0031		EQU	31	ADD MEMORY ADDRESS
0032	ADI	EQU	32	ADD INDIRECT ADDRESS
0034		EQU	34	SUBTRACT NO ADDRESS
0035		EQU	35	SUBTRACT MEMORY AUDRESS
0036	188	EQU	36	SUBTRACT INDIRECT ADDRESS
0041	STH	EQU	41	STORE A MEMORY
0042	STI	EQU	42	STORE A INDIRECT
0051	RAM	EQU	51	REPLACE ADD HEMORY ADDRESS
0055		EQU	55	REPLACE ADD ONE MEMORY ADDRESS
0060	ZJB	EQU	60	JUMPO IF CONTENTS OF A = 0
0061	NZP	EQU	61	JUMP: IF CONTENTS OF A (O
0062		EQU	62	JUMPO IF CONTENTS OF A O POSITIVE
0063		EQU	63	JUMP: IF CONTENTS OF A O NEGATIVE
0064		EQU	64	UNCONDITIONAL JUHP
0070		EQU	7 0	INITIATE BUFFER INPUT
0071		EQU	71:	INITIATE BUFFER OUTPUT
0072		EQU	72	INPUT NORMAL
0073		EQU	73	OUTPUT NORMAL
0074		EQU	74	OUTPUT: NO ADDRESS
0075		EQU	75	EXTERNAL FUNCTION
0076		EQU	76	INPUT TO A
0077	- : :	EQU		HALT
0000		ÊND	• •	COMPLETE ASSEMBLY



OSAS/OSAS-A CODING FORM

A TOSAS Assembly Program (Part of "XLATE" Routine)

PAGE NO. DATE _____ PROGRAMMER _

				PROGRAMMEN
2 LOCATION	₁₀ OP	15 ADDRESS	23 ADDITIVE	31. COMMENTS
I , N, P, U, T, A,		LDM,		ROUTINE M/T INPUT A
			F, L, A, G, 1, 3	
	10 kg	Z.J.B.		TEST FLAG IF 1st TIME
			I , N, P, U, T, 1,	NO JUMP
		L.D.N		
			0	
		STM		
		E, X, F,	F.L.A.G.1	T/H STATUS
			1,1, , , ,	RS1
			0,2, , ,	K51
		LNA		
		SBN		TEST IF T/H ON
			4.1	LØAD PØINT AND CØDE
		N,Z,P		
			I, N, P, U, T, 2,	NOT READY
INPUT. 1		E,X,C,		T/H STATUS
			1,1, , , ,	RS1
			0.2.	
		LNA		
		L.P.N.		SAVE BUSY BIT
			2.0.2.	
		N.Z.P.		TOV ACAIN
			I, N, P, U, T, 1,	TRY AGAIN
LNPUT. 6.		E.X.F.	1.1.	READ BCD LOW
			3,2,	READ BCD LOW
		INN	3,0,0,	
		I II X I	F. W. A.	
			L, W, A,	
I.NP.U.T.3.		E,X,F,		TAKE STATUS ØF
			1,1,	READ
Constitution of the contract o	Tido chode		The state of the s	is to an amount of OP code

PORM 1986 - REPLACES 1986 LE Use shaded columns only if first symbol character is + or -, or for 4 character OP code



OSAS/OSAS-A CODING FORM

PAGE NO. _____
DATE ____
PROGRAMMER ____

				I ROGRAMMEN
₂ LOCATION	10 OP	15 ADDRESS	23 ADDITIVE	COMMENTS
			0,2,,,	
		I.N.A.		
		S, T, M		STORE STATUS
			T, E, M, 2, , ,	
		LPN		
			2,0,0, , ,	
		$N_iZ_iP_i$		
			L.N.P.U.T. 2.	
		LDM.		LOAD STATUS
			T.E.M. 2	BACK IN
		LPN,		
			2,4, , , ,	SAVE EØF & PARITY
		ZJB	1,0,0, ,	
			W,O,R,K, , ,	JUMP TO WORK ROUTINE
		LPN,		CAVE DARIEN DIE
			0,4,,,,,	SAVE PARITY BIT
		NZP.		
		11 10	I , N, P, U, T, 4,	JUMP TO EØM ROUTINE
		$u, J_i P_i$	3,0,0, , , , , , , , , , , , , , , , , ,	JUMP TO EXM ROUTINE
I. N. P. U. T.2		LPN .	E VIM	SET RETURN
LINFIGURA			6.3	JUMP FOR
		STM	3,0,0	LOCAL TROUBLE
		~ 11111	R.E.T.U.R.N.	
		L ₁ D ₁ N ₁	IN LITTORIVIN	
			I , N, P, U, T, 1,	
		S,T,M,	3,0,0	
, , , , ,			J.U.M.P.	
		$u_{i}J_{i}P_{i}$	3,0,0,	JUMP TO LOCAL TROUBLE
		1 1 1 1 1	LO, T,R,O,U,	ROUTINE
L.N.P.U.T. 4	1 _ 1	E,X,F,		PARITY ON READ
			1,1,	

<u>مر</u>



OSAS/OSAS-A CODING FORM

PAGE NO. _____

DATE _____
PROGRAMMER _____

₂ LOCATION	₁₀ OP	15 ADDRESS	23 ADDITIVE	31 COMMENTS
			2,5	BACK SPACE ØNE RECORD
	1_1_1	$L_1D_1M_1$		
			T, R, Y, 3,	
		$N_i J_i P_i$		
			INPUT, 5,	
		S ₁ H ₁ A ₁ , ,		
	1 1 1	S, T, M, , ,		STØRE BACK AT
			T,R,Y,3, , ,	TRÝ 3
· · · · · · · · · · · · · · · · · · ·		$U_iJ_iP_i$		
			INPUT6	READ AGAIN
L ₁ N ₁ P ₁ U ₁ T ₁ 5 ₁		L _i D _i N _i , ,		
			0,2,1,,,,	SET TRY 3
		S.T.M.		
		, <u> </u>	T, R, Y, 3, , ,	
		$L_1D_1N_1$		
			0, 6, 3, , ,	
		S.T.M.	3, 0, 0, , , ,	
			$R_iE_iT_iU_iR_iI_i$	
		$L_iD_iN_i$		·
	<u> </u>		I ,N,P,U,T,6,	
		S.T.M.	3, 0, 0,	
			J,U,M,P,1, ,	
		$U_iJ_iP_i$	3, 0, 0,	
			TI ME	
	P,R,G		4,0,0, , ,	
<u> </u>			3	

FORM 1380 - REPLACES 1380&b Use shaded columns only if first symbol character is + or -, or for 4 character OP code

Listing From Previous TeleProgrammer "XLATE" Routine

0130	0021	INPUTA	LDM		ROUTINE H/T INPUTA
0131	0060		ρ	FLAGI	
0132	0060		ZJB		TEST FLAG IF IST TIME
0133	0173			INPUTI	NO JUMP
0134	0020		LON		
0135	0000			0	
0136	0041		STM		•
0137	0060			FLAGI	
0140	0075	INPUT7	EXF		TAKE STATUS OF TAPE
0141	0011			11	
0142	0002			2	
0143	0076		INA		
0144	0041		STM		SAVE STATUS
0145	0066			TEM4	
0146	0010		LPN		SAVE NOT READY BIT
0147	0002			2	
0150	0061		NZP		TAPE NOT READY
0151	0237			INPUT2	
0152	0021		LDH		BRING STATUS BACK
0153	0066			TEM4	
0154	0010		LPN		IS IT BUSY
0155	0200			200	
0156	0061		NZP		YES TRY AGAIN
0157	0140			INPUTY	
0160	0021		LDM		
0161	0066		TEH4		BRING STATUS BACK
0162	0034	•	SBN		CHECK LOAD POINT
0163	0041			41	
0164	0060		ZJB		GO ON TO READY
0165	0203		· · · · · · · · · · · · · · · · · · ·	INPUTE	
0166	0075		EXF		REWIND TAPE TO LOAD POINT
0167	0011			11	
0170	0022			22	
0171	0064		UJP		GO TAKE STATUS AGAIN
0172	0140			INPUT7	
0173	0075	INPUTI	EXF		T/H STATUS
0174	0011			11	RSI
0175	0002			2	
0176	0076		INA		
0177	0010		LPN		SAVE BUSY BIT
0200	0202			202	1
0201	0061		NZP		
0202	0173		-	INPUTI	TRY AGAIN

0203	0075	INPUTE	EXF		
0204	0011				
0205	0032			3 2	READ BCD LOW
0206	0372		INN	300	
0207	0000	•		0	FWA
0210	0120			120	LHA
0211	0075	INPUT3	EXF		TAKE STATUS OF
0212	0011			2	READ
0213	0002			2	
0214	0076		INA		
0215	0041		STM		STORE STATUS
0216	0064			TEM2	
0217	0010		LPN	· •.	
0220	0200			200	
0221	0061		NZP	•	
0222	0211			INPUT3	
0223	0021		LDM		LOAD STATUS
0224	0064			TEM2 .	BACK IN
0225	0010		LPN		
0226	0024			24	SAVE EOF AND PARITY
0227	0160		ZJB	100	
0230	1213		•	WORK	JUMP TO WORK ROUTINE
0231	0010		LPN		
0232	0004			4	SAVE PARITY BIT
0233	0061		NZP	_	
0234	0251			INPUT4	
0235	0364		UJP	300	JUMP TO EOM ROUTINE
0236	0676			EOM	
0237	0020	INPUT2	LDN		SET RETURN
0240	0063		:	63	JUMP FOR
0241	0341		STH	300	LOCAL TROUBLE
0242	0652			RETURN	
0243	0020		LON		
0244	0173			INPUT	
0245	0341		STM	300	
0246	0653			JUMP	
0247	0364		UJP	300	JUMP TO LOCAL TROUBLE
0250	0636			LOTROU	ROUTINE
0251	0075	INPUT4	EXF		PARITY ON READ
0252	0011			11	
0253	0025			25	BACK SPACE ONE RECORD
0254	0021		LDM		
0255	0115			TRY3	
0256	0063		NJP		
0257	0265			INPUTS	
0260	0001		SHA		
0261	0041	•	STM	TRY3	TRY3
0262					

TeleProgrammer "XLATE" Routine Listing (Con't)

0263	0064		UJP	
0264	0173			INPUTI READ AGAIN
0265	0020	INPUT5	LDN	
0266	0021			21
0267	0041		STM	SET TRY 3
0270	0115			TRY3
0271	0020		LDN	•
0272	0063			63
0273	0341		STM	300
0274	0672			RETURI
0275	0020		LDN	
0276	0173			INPUTI
0277	0341		STM	300
0300	0673	4		JUMPI
0301	0364		UJP	300
0302	0656			TIME

The previous listing is <u>part</u> of a Magnetic Tape input routine. As such, the reader should be aware of the fact that several symbolic tags are used (for example, FLAG 1, TEM 2, TEM 4, WORK, etc.) which were identified by "EQU" statements on other parts of the total program. Likewise, notes, page number, etc. refer to the total program from which the example was taken.

APPENDIX B

PROGRAMMING EXAMPLES

Example 1 Servicing the Interface

A small message switching system is composed of ten full duplex lines operating at rates of 100 words per minute. Each time the input interface is serviced (once each 100 milliseconds) each of the ten input terminal units (TTU) supplies one 8 bit character, where each character contains 7 bits of data and 1 parity bit).

The octal select codes of the ten TTU units are identical to the octal memory addresses that are used to store the inputs. These addresses are:

0420	0425
0421	0426
0422	0427
0423	0430
0424	0431

Each time the input interface is serviced, <u>one</u> character from each of the ten TTU locations is read into a corresponding Raw Data Register (RDR) in the TeleProgrammer memory. Assuming the Raw Data registers start at octal address, 0600, the program follows:

Program Location		uctions Codes	Cycles	Action Performed
0460 0461	0 0	LDN 01	} 2	Load A with 1
0462	1	ATT	} 1	Bits, 001, go to Tag reg. l
0463 0464 0465	0 0 0	EXF 04 20	} 3	Select the TTU, starting with the first TTU.
0466	0	INA	} 2	Input the character from the selected TTU to the A register.
0467 0470	1 2	STM 00	} 3	Store character in A at desired memory location
0471 0472	1 0	RAO 70	} 4	Add 1 to memory location where characters are stored.
0473 0474	1 0	RAO 65	4	Add 1 to TTU select address. This also tests last TTU address.
0475 0476	0	SBN 32	} 2	Subtract one more than number of lines being serviced.
0477 0500	1 0	NJP 63	} 2	If not last servicing, jump back to service next TTU.
0501	Co	ntinue		

^{*} Note: The above instructions contain mnemonic function codes in order to indicate the type of instruction being performed. Before program execution, these must be replaced by their equivalent numeric codes.

Example 2 Assuring Transmission Validity

Several techniques have evolved to assure message content validity. One such technique is a form of the Fire code which is described in the following problem. By this method, specific words of the data to be transmitted are added into eight "Check Sum" (S) words. After computing each of the eight sum words, at both origin and destination locations, comparisons of the corresponding sums indicate message validity. This technique provides the advantage of being able to use all bits of a message character as information bits. Thus the presence of a parity bit is not mandatory. However, the presence of a parity bit does not affect or degrade the method.

Assume a block of 240 words of 1 character per word is to be transmitted. This block is preceded by an 8 word header, and followed by 8 Check Sum words. Using a Fire code, the data in the header and information portions are to be checked through comparisons of the accumulated sums in the 8 Check Sum (S) words. The accumulated sums of the sum words are determined by the following algorithm:

$$S_{1} = W_{i} + W_{j} + W_{k} + ---- + W_{n}$$

$$S_{2} = W_{i+1} + W_{j+1} + W_{k+1} + --- + W_{n+1}$$

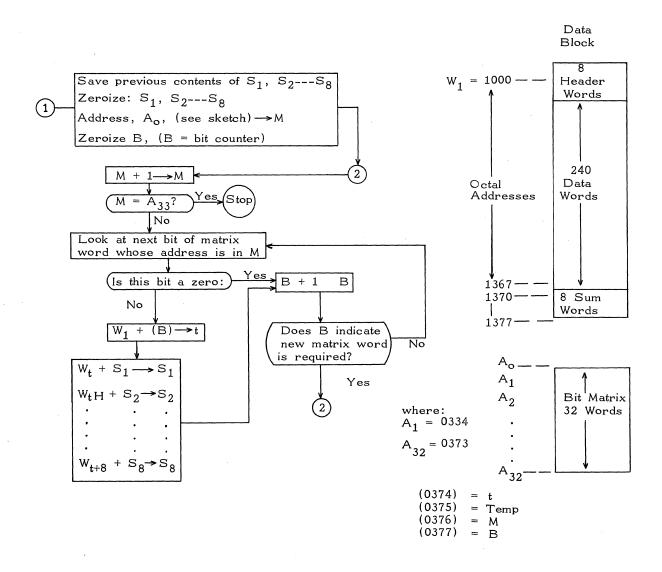
$$S_{3} = W_{i+2} + W_{j+2} + W_{k+2} + --- + W_{n+2}$$

$$S_{8} = W_{i+7} + W_{j+7} + W_{k+7} ---- + W_{n+7}$$

where i,j,k, --- n are the computer addresses containing the data words which are to be transmitted.

W = data words, thus W_j = data word at address j S_1 , S_2 , --- S_8 = Check Sum words In order to implement this method, a matrix of 32 words is used. Each of the 32 words contains 8 bits which indicate the computer addresses of the words which are to be added in the <u>first</u> Check Sum word, S_1 . Thus the bit locations within the matrix indicate: i, j, k, ---n addresses of the preceding algorithm.

The technique is indicated by the flow chart and diagram of TeleProgrammer areas below:



THE PROGRAM

			•
Location	T Code	Cycles	Action Performed
2000 2001	0 LDN 0 02	} 1	Preset Tag register 1 to 0010 (in bits)
2002	1 ATT	} 1	
2003 2004 2005 2006 2007 2010 2011 2012 2013 2014 2015 2016	1 LDM 3 70 0 STM 3 24 2 RAO 0 04 2 RAO 0 06 0 SBN 3 34 2 NZP 0 03	3 3 4 4 2 2	Save the contents of the check sum words by storing initial contents at following addresses: S ₁ → 0324 S ₂ → 0325
2017 2020 2021 2022	0 LDN 0 00 1 STM 3 70	} 2 3	This loop presets each of the eight check sum words to zero.
2023 2024 2025 2026	2 RAO 0 22 2 NZP 0 17	} 4 2	
2027 2030	0 STM 3 77	} 3	Set Bit Counter, B, to zero. (B is located at octal address, 377.)

THE PROGRAM

Location	T Code	Cycles	Action Performed
2031 2032 2033 2034	0 LDN 3 33 0 STM 3 76	} 2	Store first address minus 1 of Bit Matrix at M; where M is at address 0376.
2035 2036	0 RAO 3 76	} 4	M + 1 → M
2037 2040 2041 2042	0 SBN 3 74 2 ZJP 1 12	} 2 2	Test address at M, and jump if last Matrix Word has been serviced.
2043 2044	0 LDI 3 76	} 4	Load next Matrix Word into A
2045	0 SHA	} 1	Shift Matrix Word left 1
2046 2047	0 STM 3 75	} 3	Store shifted Matrix Word at tempo- rary register (at address 0375).
2050 2051	0 LPN 0 001	} 2	Look at what previously had been the leftmost bit of Matrix Word.
2052 2053	2 NZP 0 66	} 2	If bit ≠ 0, jump; otherwise, continue.
2054 2055	0 RAO 3 77	} 4	B + 1> B (Increase bit count by 1.)
2056 2057	0 LPN 0 07	} 2	Look at last three bit positions of count at B.

THE PROGRAM

<u>Location</u>	T	Code	<u>Cycles</u>	Action Performed
2060 2061	2 0		} 2	If next Matrix Word is required, jump. Otherwise, continue.
2062 2063 2064 2065	0 3 2 0	LDM 75 UJP 45	} 3 2	Return the current Matrix Word to A and jump back to look at next bit.
2066 2067 2070 2071	0 3 0 3	LDM 77 STM 74	3 3	Bit Count -t, where t is at address 0374.
2072 2073 2074 2075	1 3 1 3	LDI 74 RAD 70	4 3	$W_t + S_1 \longrightarrow S_1$
2076 2077 2100 2101	3 2	RAO 74 RAO 75	} 4	Update parameters in above equation.
2102 2103		NZP 72	} 2	Loop back to location, 2072, if not zero.
2104 2105 2106 2107	t .	LDI 74 RAD 77	} 4	Store into last Check Sum Word at address 0777.
2110 2111	2 0	UJP 54	} 2	Loop back for next iteration.
2112	0	HLT	} 1	Stop

APPENDIX C - MATHEMATICAL TABLES

TABLE OF POWERS OF TWO

```
2"
                n 2<sup>-n</sup>
              1
                 0
                    1.0
             2
                  1
                    0.5
             4
                 2 0.25
             8
                    0.125
                 4 0.062 5
            16
                  5 0.031 25
            32
            64
                 6 0.015 625
                 7 0.007 812 5
            128
           256
                 8
                    0.003 906 25
           512
                 9 0.001 953 125
         1 024
                10 0.000 976 562 5
         2 048
                11 0.000 488 281 25
         4 096
                12 0.000 244 140 625
                13 0.000 122 070 312 5
         8 192
         16 384
                14 0.000 06.1 035 156 25
         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 18 0.000 003 814 697 265 625
        524 288 19 0.000 001 907 348 632 812 5
      1 048 576 20 0.000 000 953 674 316 406 25
     2 097 152 21 0.000 000 476 837 158 203 125
     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
                24 0.000 000 059 604 644 775 390 625
    16 777 216
    33 554 432
                25 0.000 000 029 802 322 387 695 312 5
                26 0.000 000 014 901 161 193 847 656 25
    67 108 864
    134 217 728
                27
                    0.000 000 007 450 580 596 923 828 125
   268 435 456 28 0.000 000 003 725 290 298 461 914 062 5
   536 870 912 29 0.000 000 001 862 645 149 230 957 031 25
  1 073 741 824 30 0.000 000 000 931 322 574 615 478 515 625
 2 147 483 648
                31 0.000 000 000 465 661 287 307 739 257 812 5
                32 0.000 000 000 232 830 643 653 869 628 906 25
 4 294 967 296
                33 0.000 000 000 116 415 321 826 934 814 453 125
 8 589 934 592
 17 179 869 184
                34
                    0.000 000 000 058 207 660 913 467 407 226 562 5
34 359 738 368
                35 0.000 000 000 029 103 830 456 733 703 613 281 25
68 719 476 736
                36 0.000 000 000 014 551 915 228 366 851 806 640 625
137 438 953 472 37 0.000 000 000 007 275 957 614 183 425 903 320 312 5
274 877 906 944 38 0.000 000 000 003 637 978 807 091 712 951 660 156 25
549 755 813 888 39 0.000 000 001 818 989 403 545 856 475 830 078 125
```

		1									ı	,								
			0	1	2	3	4	5	6	7			0	1	2	3	4	5	6	7
0000 to 0777 (Octal)	0000 to 0511 (Decimal)	0000 0010 0020 0030 0040 0050 0060 0070	0000 0008 0016 0024 0032 0040 0048 0056	0001 0009 0017 0025 0033 0041 0049	0002 0010 0018 0026 0034 0042 0050 0058	0003 0011 0019 0027 0035 0043 0051 0059	0004 0012 0020 0028 0036 0044 0052 0060	0005 0013 0021 0029 0037 0045 0053 0061	0006 0014 0022 0030 0038 0046 0054 0062	0007 0015 0023 0031 0039 0047 0055 0063		0400 0410 0420 0430 0440 0450 0460 0470	0256 0264 0272 0280 0288 0296 0304 0312	0257 0265 0273 0281 0289 0297 0305 0313	0258 0266 0274 0282 0290 0298 0306 0314	0259 0267 0275 0283 0291 0299 0307 0315	0260 0268 0276 0284 0292 0300 0308 0316	0261 0269 0277 0285 0293 0301 0309 0317	0262 0270 0278 0286 0294 0302 0310 0318	0263 0271 0279 0287 0295 0303 0311 0319
10000 - 20000 - 30000 - 40000 - 50000 - 60000 - 70000 -	8192 12288 16384 20480 24576	0100 0110 0120 0130 0140 0150 0160 0170	0064 0072 0080 0088 0096 0104 0112 0120	0065 0073 0081 0089 0097 0105 0113 0121	0066 0074 0082 0090 0098 0106 0114 0122	0067 0075 0083 0091 0099 0107 0115 0123	0068 0076 0084 0092 0100 0108 0116 0124	0069 0077 0085 0093 0101 0109 0117 0125	0070 0078 0086 0094 0102 0110 0118 0126	0071 0079 0087 0095 0103 0111 0119 0127		0500 0510 0520 0530 0540 0550 0560 0570	0320 0328 0336 0344 0352 0360 0368 0376	0321 0329 0337 0345 0353 0361 0369 0377	0322 0330 0338 0346 0354 0362 0370 0378	0323 0331 0339 0347 0355 0363 0371 0379	0324 0332 0340 0348 0356 0364 0372 0380	0325 0333 0341 0349 0357 0365 0373 0381	0326 0334 0342 0350 0358 0366 0374 0382	0327 0335 0343 0351 0359 0367 0375 0383
		0200 0210 0220 0230 0240 0250 0260 0270	0128 0136 0144 0152 0160 0168 0176 0184	0129 0137 0145 0153 0161 0169 0177 0185	0130 0138 0146 0154 0162 0170 0178 0186	0131 0139 0147 0155 0163 0171 0179 0187	0132 0140 0148 0156 0164 0172 0180 0188	0133 0141 0149 0157 0165 0173 0181 0189	0134 0142 0150 0158 0166 0174 0182 0190	0135 0143 0151 0159 0167 0175 0183 0191		0600 0610 0620 0630 0640 0650 0660	0384 0392 0400 0408 0416 0424 0432 0440	0385 0393 0401 0409 0417 0425 0433	0386 0394 0402 0410 0418 0426 0434	0387 0395 0403 0411 0419 0427 0435 0443	0388 0396 0404 0412 0420 0428 0436	0389 0397 0405 0413 0421 0429 0437	0390 0398 0406 0414 0422 0430 0438 0446	0391 0399 0407 0415 0423 0431 0439
		0300 0310 0320 0330 0340 0350 0360 0370	0192 0200 0208 0216 0224 0232 0240 0248	0193 0201 0209 0217 0225 0233 0241 0249	0194 0202 0210 0218 0226 0234 0242 0250	0195 0203 0211 0219 0227 0235 0243 0251	0196 0204 0212 0220 0228 0236 0244 0252	0197 0205 0213 0221 0229 0237 0245 0253	0198 0206 0214 0222 0230 0238 0246 0254	0199 0207 0215 0223 0231 0239 0247 0255		0700 0710 0720 0730 0740 0750 0760 0770	0448 0456 0464 0472 0480 0488 0496	0449 0457 0465 0473 0481 0489 0497 0505	0450 0458 0466 0474 0482 0490 0498 0506	0451 0459 0467 0475 0483 0491 0499 0507	0452 0460 0468 0476 0484 0492 0500 0508	0453 0461 0469 0477 0485 0493 0501 0509	0454 0462 0470 0478 0486 0494 0502 0510	0455 0463 0471 0479 0487 0495 0503 0511
											1	1								
1000 to 1777 (Octal)	0512 to 1023 (Decimal)	1000 1010 1020 1030 1040 1050 1060 1070	0 0512 0520 0528 0536 0544 0552 0560 0568	0513 0521 0529 0537 0545 0553 0561 0569	0514 0522 0530 0538 0546 0554 0562 0570	3 0515 0523 0531 0539 0547 0555 0563 0571	0516 0524 0532 0540 0548 0556 0564 0572	0517 0525 0533 0541 0549 0557 0565 0573	0518 0526 0534 0542 0550 0558 0566 0574	7 0519 0527 0535 0543 0551 0559 0567 0575		1400 1410 1420 1430 1440 1450 1460 1470	O 0768 0776 0784 0792 0800 0808 0816 0824	0769 0777 0785 0793 0801 0809 0817 0825	2 0770 0778 0786 0794 0802 0810 0818 0826	3 0771 0779 0787 0795 0803 0811 0819 0827	0772 0780 0788 0796 0804 0812 0820 0828	5 0773 0781 0789 0797 0805 0813 0821 0829	0774 0782 0790 0798 0806 0814 0822 0830	7 0775 0783 0791 0799 0807 0815 0823 0831
		1100 1110 1120 1130 1140 1150 1160 1170	0576 0584 0592 0600 0608 0616 0624 0632	0577 0585 0593 0601 0609 0617 0625 0633	0578 0586 0594 0602 0610 0618 0626 0634	0579 0587 0595 0603 0611 0619 0627 0635	0580 0588 0596 0604 0612 0620 0628 0636	0581 0589 0597 0605 0613 0621 0629 0637	0582 0590 0598 0606 0614 0622 0630 0638	0583 0591 0599 0607 0615 0623 0631 0639		1500 1510 1520 1530 1540 1550 1560 1570	0832 0840 0848 0856 0864 0872 0880 0888	0833 0841 0849 0857 0865 0873 0881 0889	0834 0842 0850 0858 0866 0874 0882 0890	0835 0843 0851 0859 0867 0875 0883 0891	0836 0844 0852 0860 0868 0876 0884	0837 0845 0853 0861 0869 0877 0885 0893	0838 0846 0854 0862 0870 0878 0886 0894	0839 0847 0855 0863 0871 0879 0887
		1200 1210 1220 1230 1240 1250 1260 1270	0640 0648 0656 0664 0672 0680 0688 0696	0641 0649 0657 0665 0673 0681 0689 0697	0642 0650 0658 0666 0674 0682 0690 0698	0643 0651 0659 0667 0675 0683 0691 0699	0644 0652 0660 0668 0676 0684 0692 0700	0645 0653 0661 0669 0677 0685 0693	0646 0654 0662 0670 0678 0686 0694	0647 0655 0663 0671 0679 0687 0695 0703		1600 1610 1620 1630 1640 1650 1660 1670	0896 0904 0912 0920 0928 0936 0944 0952	0897 0905 0913 0921 0929 0937 0945 0953	0898 0906 0914 0922 0930 0938 0946 0954	0899 0907 0915 0923 0931 0939 0947 0955	0900 0908 0916 0924 0932 0940 0948 0956	0901 0909 0917 0925 0933 0941 0949	0902 0910 0918 0926 0934 0942 0950 0958	0903 0911 0919 0927 0935 0943 0951
		1300 1310 1320 1330 1340 1350 1360 1370	0704 0712 0720 0728 0736 0744 0752	0705 0713 0721 0729 0737 0745 0753 0761	0706 0714 0722 0730 0738 0746 0754	0707 0715 0723 0731 0739 0747 0755 0763	0708 0716 0724 0732 0740 0748 0756 0764	0709 0717 0725 0733 0741 0749 0757 0765	0710 0718 0726 0734 0742 0750 0758 0766	0711 0719 0727 0735 0743 0751 0759 0767		1700 1710 1720 1730 1740 1750 1760 1770	0960 0968 0976 0984 0992 1000 1008 1016	0961 0969 0977 0985 0993 1001 1009 1017	0962 0970 0978 0986 0994 1002 1010 1018	0963 0971 0979 0987 0995 1003 1011 1019	0964 0972 0980 0988 0996 1004 1012 1020	0965 0973 0981 0989 0997 1005 1013 1021	0966 0974 0982 0990 0998 1006 1014 1022	0967 0975 0983 0991 0999 1007 1015 1023

	0	1	2	3	4	5	6	7		0	1	2	3	4	5	6	7		
2000	1024	1025	1026	1027	1028	1029	1030	1031	2400	1280	1281	1282	1283	1284	1285	1286	1287	2000	1024
2010	1032	1033	1034	1035	1036	1037	1038	1039	2410	1288	1289	1290	1291	1292	1293	1294	1295	to	to
2020	1040	1041	1042	1043	1044	1045	1046	1047	2420	1296	1297	1298	1299	1300	1301	1302	1303	2777	
2030	1048	1049	1050	1051	1052	1053	1054	1055	2430	1304	1305	1306	1307	1308	1309	1310	1311	1	1535
2040	1056	1057	1058	1059	1060	1061	1062	1063	2440	1312	1313	1314	1315	1316	1317	1318	1319	(Octal)	(Decimal)
2050	1064	1065	1066	1067	1068	1069	1070	1071	2450	1320	1321	1322	1323	1324	1325	1326	1327		
2060	1072	1073	1074	1075	1076	1077	1078	1079	2460	1328	1329	1330	1331	1332	1333	1334	1335	}	
2070	1080	1081	1082	1083	1084	1085	1086	1087	2470	1336	1337	1338	1339	1340	1341	1342	1343	Octal	Decimal
									ļ									10000	- 4096
2100	1088	1089	1090	1091	1092	1093	1094	1095	2500	1344	1345	1346	1347	1348	1349	1350	1351	20000	- 8192
2100	1096	1097	1098	1099	1100	1101	1102	1103	2510	1352	1353	1354	1355	1356	1357	1358	1359	1	- 12288
2120	1104	1105	1106	1107	1108	1109	1110	1111	2520	1360	1361	1362	1363	1364	1365	1366	1367	1	- 16384
2130	1112	1113	1114	1115	1116	1117	1118	1119	2530	1368	1369	1370	1371	1372	1373	1374	1375	1	
2140	1120	1121	1122	1123	1124	1125	1126	1127	2540	1376	1377	1378	1379	1380	1381	1382	1383	ł	- 20480
2150	1128	1129	1130	1131	1132	1133	1134	1135	2550	1384	1385	1386	1387	1388	1389	1390	1391		- 24576
2160	1136	1137	1138	1139	1140	1141	1142	1143	2560	1392	1393	1394	1395	1396	1397	1398	1399	70000	- 28672
2170	1144	1145	1146	1147	1148	1149	1150	1151	2570	1400	1401	1402	1403	1404	1405	1406	1407	Ĭ	
2200	1150	****			4450													ļ	
2200	1152	1153	1154	1155	1156	1157	1158	1159	2600	1408	1409	1410	1411	1412	1413	1414	1415	l	
2210 2220	1160	1161	1162	1163	1164	1165	1166	1167	2610	1416	1417	1418	1419	1420	1421	1422	1423	1	
2230	1168 1176	1169	1170	1171	1172	1173	1174	1175	2620	1424	1425	1426	1427	1428	1429	1430	1431	l	
2240	1184	1177 1185	1178 1186	1179	1180	1181	1182	1183	2630	1432	1433	1434	1435	1436	1437	1438	1439	1	
2240 2250	1192	1193	1194	1187 1195	1188	1189	1190	1191	. 2640	1440	1441	1442	1443	1444	1445	1446	1447	J	
2250 2260	1200	1201	1202	1203	1196	1197	1198	1199	2650	1448	1449	1450	1451	1452	1453	1454	1455	}	
2270	1200	1201	1210	1211	1204 1212	1205 1213	1206 1214	1207 1215	2660 2670	1456 1464	1457 1465	1458	1459	1460	1461	1462	1463	ł	
	1200	1200	1410	1411	1414	1213	14 14	1410	2070	1404	1403	1466	1467	1468	1469	1470	1471	ł	
2300	1216	1217	1218	1219	1220	1221	1222	1223	2700	1472	1473	1474	1475	1476	1477	1478	1479	1	
2310	1224	1225	1226	1227	1228	1229	1230	1231	2710	1480	1481	1482	1483	1484	1485	1486	1487	J	
2320	1232	1233	1234	1235	1236	1237	1238	1239	2720	1488	1489	1490	1491	1492	1493	1494	1495	1	
2330	1240	1241	1242	1243	1244	1245	1246	1247	2730	1496	1497	1498	1499	1500	1501	1502	1503	l	
2340	1248	1249	1250	1251	1252	1253	1254	1255	2740	1504	1505	1506	1507	1508	1519	1510	1511	ł	
2350	1256	1257	1258	1259	1260	1261	1262	1263	2750	1512	1513	1514	1515	1516	1517	1518	1519	i	
			1266	1267	1268	1269	1270	1271	2760	1520	1521	1522	1523	1524	1525	1526	1527	ł	
2360	1264	1265	1200	1207	1200				1 2700									l .	
2360 2370	1264	1265	1274	1275	1276	1277	1278	1279	2770	1528	1529	1530	1531	1532	1533	1534	1535		
												1530 2	1531	1532					
	1272	1 1 1537	1274	1275	1276	1277	1278	1279		1528	1529				1533	1534	1535	3000	1536
3000 3010	O 1536 1544	1 1 1537 1545	2 1538 1546	3 1539 1547	1276 4 1540 1548	5 1541 1549	6 1542 1550	7 1543 1551	3400 3410	O 1792 1800	1 1 1793 1801	2 1794 1802	3 1795 1803	4 1796 1804	1533 5 1797 1805	6 1798 1806	7 1799 1807	3000 to	1536 to
3000 3010 3020	O 1536 1544 1552	1 1 1537 1545 1553	2 1538 1546 1554	3 1539 1547 1555	1276 4 1540 1548 1556	5 1541 1549 1557	6 1542 1550 1558	7 1543 1551 1559	3400 3410 3420	O 1792 1800 1808	1 1 1793 1801 1809	2 1794 1802 1810	3 1795 1803 1811	4 1796 1804 1812	5 1797 1805 1813	6 1798 1806 1814	7 1799 1807 1815	to	to
3000 3010 3020 3030	O 1536 1544 1552 1560	1 1 1537 1545 1553 1561	2 1538 1546 1554 1562	3 1539 1547 1555 1563	1276 4 1540 1548 1556 1564	5 1541 1549 1557 1565	6 1542 1550 1558 1566	7 1543 1551 1559 1567	3400 3410 3420 3430	O 1792 1800 1808 1816	1 1 1793 1801 1809 1817	2 1794 1802 1810 1818	3 1795 1803 1811 1819	4 1796 1804 1812 1820	5 1797 1805 1813 1821	6 1798 1806 1814 1822	7 1799 1807 1815 1823	to 3777	to 2047
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7000 7010 7020 7030 7040 7050 7060 7070 7110 7120 7130 7140 7150 7150 71720 7220 7230 7250 7260 7270 7330 7330 7330	0 3584 3592 3600 3608 3616 3624 3632 3640 3656 3664 3672 3680 3704 3712 3720 3728 3736 3743 3752 3760 3768 3776 3788	1 3585 3593 3601 3609 3617 3625 3633 3641 3649 3657 3705 3713 3721 3721 3721 3723 3737 3745 3753 3761 3768 3777 3785 3783 3783 3783 3783 3783 378	2 3586 3594 3602 3610 3618 3626 3634 3642 3650 3658 3706 3714 3722 3730 3730 3730 3745 3750 3770 3786 3794 3892	3 3587 3595 3603 3611 3619 3627 3635 3643 3651 3659 3707 3715 3731 3731 3731 3775 3763 3771 3779 3803 3811 3819	3588 3496 3604 3612 3620 3628 3636 3644 3652 3700 3708 3716 3724 3740 3772 3780 3788 3796 3796 3796 3796 3798	3589 3605 3613 3629 3637 3645 3653 3661 3669 3701 3709 3717 3765 3773 3749 3757 3765 3773 3789 3797 3805 3813 3821	3590 3698 3606 3614 3622 3630 3638 3646 3652 3710 3718 3702 3710 3718 3726 3750 3750 3774 3782 3790 3798 3806 3814 3822	3591 3697 3615 3623 3631 3639 3647 3655 3703 3711 3719 3727 3735 3743 3751 3775 3783 3799 3897	7400 7410 7420 7430 7440 7450 7460 7470 7500 7520 7530 7540 7650 7650 7670 7600 7610 7720 7730 7730 7740 7750	0 3840 3848 3856 3864 3872 3880 3888 3896 3914 3920 3928 3936 3944 3952 4000 4016 4024 4032 4040 4044 4056 4064 4064 4072	3841 3849 3857 3863 3873 3881 3889 3993 3913 3921 3929 3937 3945 3953 3961 3969 4017 4025 4033 4041 4049 4049 4047 4046 4073	3842 3858 3858 3864 3892 3914 3914 3954 3954 3954 3978 3986 4002 4010 4018 4024 4050 4054 4054 4054 4054 4054 4054	3843 3851 3859 3867 3875 3883 3891 3915 3923 3931 3939 3939 3955 3963 3979 3987 4003 4011 4019 4027 4035 4051 4051 4051 4051 4051 4056 4075	3844 3852 3860 3868 3876 3884 3990 3900 3903 3916 3934 3948 3956 3964 4012 4020 4028 4036 4052 4068 4068 4076	3845 3861 3863 3867 3893 3901 3917 3925 3933 3941 3957 3967 3973 3981 4005 4001 4021 4021 4023 4045 4053 4064 4069 4077	3846 3854 3878 3878 3898 3992 3918 3926 3934 3950 3958 3966 3974 4022 4030 4030 4030 4044 4054 4064 4064 4064 4070 4078	3847 3863 3871 3893 3897 3897 3993 3991 3995 3995 3997 3995 4007 4023 4031 4031 4034 4047 4055 4063 4071 4079	to 7777	to 4095
7000 7010 7010 7020 7030 7040 7050 7060 71100 7100 7100 7100 7100 7100 7100 7100 7100 7100 7100 7100 7100 7100 710	0 3584 3592 3600 3608 3616 3624 3632 3640 3656 3664 3672 3680 3704 3712 3720 3728 3736 3744 3752 3760 3768 3768 3776 3784 3792 3784 3792 3798	1 3585 3593 3601 3609 3617 3625 3633 3641 3649 3657 3665 3673 3687 3793 3795 3793 3795 3793 3795 3793 3795 3793 3795	2 3586 3594 3610 3618 3613 3626 3634 3692 3698 3706 3714 3752 3730 3754 3776 3778 3778 3778 3788 3798	3 3587 3595 3603 3611 3619 3627 3635 3643 3651 3659 3707 3715 3723 3731 3747 3755 3775 3775 3775 3775 3777 3775 3777 3778 37787 37787 37787 37787 37787 37787 37787 37787 37787 37787 3778	3588 3604 3612 3620 3628 3636 3644 3652 3668 3676 3682 3700 3718 3732 3740 3748 3756 3772 3780 3788 3798 3798 3798	3589 3613 3621 3637 3645 3663 3667 3669 3677 3789 3713 3741 3749 3757 3773 3781 3789 3797 3781 3789 3797 3781 3789 3797 3781	3590 3598 3606 3614 3632 3630 3638 3646 3654 3670 37710 3718 3726 37740 3750 3750 3774 3782 3790 3790 3798 3790 3798	3591 3697 3615 3623 3631 3639 3647 3665 3673 3671 3793 3711 3719 3727 3743 3751 3767 3775 3783 3791 3793 3791 3793 3793	7400 7410 7420 7430 7440 7450 7450 7510 7520 7530 7540 7650 7650 7650 7650 7650 7670 7700 7710 7720 77320 77340	0 3840 3848 3856 3864 3872 3880 3898 3994 3912 3928 3936 3944 3952 3960 3952 3960 4008 4008 4016 4024 4040 4044 4048 4046 4046 4064	3841 3849 3857 3865 3873 3881 3889 3993 3921 3929 3937 3945 3953 3961 3969 3977 4001 4009 4017 4025 4033 4041 4049 4049 4049 4065	3842 3850 3858 3866 3874 3892 3993 3994 3954 3954 3954 3970 3978 4010 4012 4014 4058 4058 4066	3843 3851 3859 3867 3873 3893 3997 3915 3923 3931 3937 3955 3963 3971 3978 4003 4011 4027 4043 4054 4059 4067	3844 3852 3860 3868 3876 3990 3908 3918 3914 3932 3948 3956 3964 4012 4012 4028 4024 4028 4044 4050 4068	3845 3863 3861 3869 3873 3901 3909 3917 3925 3933 3941 3957 3965 4013 4015 4014 4029 4029 4037 4045 4061 4069	3846 3854 3870 3878 3894 3902 3910 3918 3926 3934 3958 3958 3996 4014 4022 4030 4038 4046 4054 4054 4070	3847 3863 3863 3871 3879 3893 3993 3911 3919 3959 3967 3975 3983 3999 4007 4015 4023 4031 4047 4055 4063 4071	to 7777	to 4095

OCTAL-DECIMAL FRACTION CONVERSION TABLE

0.000	OCTAL	DEC.	OCTAL	DEC.	OCTAL	DEC.	OCTAL	DEC.
001 001953 101 126853 201 251983 301 376853 002 003906 102 128906 202 253966 302 378906 003 005869 103 1308699 203 255889 303 3808599 004 007612 104 132816 205 255766 305 384765 006 01718 106 134768 206 255766 305 384765 007 013671 107 136671 207 256825 310 30625 011 017578 111 140625 210 265625 310 39625 012 019531 112 144831 212 265525 310 394531 013 021464 113 144631 212 269521 312 394531 013 021464 113 144647 213 277433 314 394631 015 025								
002 003906 102 1288906 202 253906 302 378906 003 006869 103 130859 203 255899 303 380859 004 007812 104 132812 204 257812 304 382812 005 009765 105 134765 205 259765 306 384765 000 011718 106 134768 206 261718 306 386718 007 013671 110 140625 210 265625 310 390825 011 017578 111 144831 212 269531 312 394831 012 019521 112 144831 212 269531 312 394841 013 025330 115 150390 215 275390 315 4039062 016 027343 116 152243 216 277343 316 402343 017 03203								
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003 005859 103 1308659 203 255889 303 380859 004 007812 104 132812 204 257812 304 382812 006 .009765 105 134766 205 259765 305 384765 007 .013671 107 138671 207 253671 307 388671 010 .015625 110 140825 210 265625 310 390625 011 .017578 111 142578 211 269531 312 394531 012 .019531 112 144831 212 269531 313 394831 013 .024844 113 144684 213 271484 313 394831 015 .023393 115 163399 215 273389 315 402343 016 .023393 115 162396 216 217 279296 317 402343 017	.002	.003906	102	128906		253906	302	
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0006 011718 .106 .136718 .206 .261718 .306 .386718 007 .018671 .107 .138671 .207 .263671 .307 .388671 010 .015625 .110 .140625 .210 .265625 .310 .390625 .011 .017691 .111 .142878 .212 .286581 .312 .384581 .012 .021484 .112 .144814 .212 .286581 .312 .384581 .014 .023437 .114 .148437 .214 .273432 .316 .402390 .015 .0255390 .115 .150390 .215 .275390 .316 .402393 .016 .027343 .116 .152343 .216 .2777343 .316 .402343 .017 .02920 .031250 .120 .156250 .220 .281250 .320 .406250 .021 .033203 .121 .158205 .220 .281250								
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.010								
O11	.007	.010071	1	.100071	.207	.200071	.007	.500071
O12			110	.140625	.210	.265625	.310	.390625
O12	.011	.017578	.111	.142578	.211	.267578	.311	.392578
013 021484 113 146484 213 271484 313 3986487 014 023437 114 148437 214 273437 313 3986437 015 025390 115 150390 215 275390 315 A00390 016 027343 116 152343 216 277343 316 A02343 017 029296 117 154296 217 279296 317 A04296 020 031250 120 156550 220 281250 320 406250 021 033203 121 158269 221 288706 321 406203 023 037109 122 16106 223 287109 322 41260 024 139062 124 164062 224 289082 324 414062 025 041015 125 166015 225 291015 325 416015 026 1292968		019531						
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.017 .029296 .117 .154296 .217 .279296 .317 .404296 .020 .031250 .120 .156250 .220 .281250 .320 .406250 .021 .033203 .121 .156203 .221 .283203 .321 .408203 .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 .167988 .226 .292988 .326 .417980 .027 .044921 .127 .169921 .227 .294921 .327 .419921 .031 .046875 .130 .171875 .230 .298878 .330 .421875 .031 .048288 .131 .177824 .233 .30234 .4334 <				.150390	.215	.275390	.315	.400390
.017 0.29296 .117 1.54296 217 279296 .317 404296 .020 .031250 .120 1.56250 .220 281250 .320 .406250 .021 .033203 .121 .158203 .221 .283203 .321 .408203 .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 .200 .296875 .300 .421878 .031 .048288 .131 .1738282 .231 .298282 .311	.016	.027343	.116	.152343	.216	.277343	.316	.402343
.020 .031250 .120 .156250 .220 .281250 .320 .406250 .021 .033203 .121 .158203 .221 .283203 .321 .408203 .022 .035156 .122 .160156 .222 .285156 .322 .410156 .024 .039062 .124 .164062 .224 .289062 .324 .414062 .025 .041015 .125 .166015 .225 .291015 .325 .416015 .026 .042968 .126 .167968 .226 .292968 .326 .417968 .027 .044921 .127 .169921 .227 .294921 .327 .419921 .030 .046875 .130 .171875 .230 .296875 .330 .421875 .031 .048828 .131 .173828 .231 .298828 .331 .423828 .032 .050781 .132 .175781 .232 .300781 .332 <	.017	.029296	.117	.154296	.217			
021 033203 121 158203 221 283203 321 408203 022 035156 122 160156 222 285156 322 41015 024 039062 124 14062 224 289062 324 41209 025 041015 125 166015 225 291015 325 416015 026 042968 126 167988 226 292968 326 417968 027 044921 127 169921 227 294921 327 419921 030 048875 130 171875 230 296875 330 421875 031 048828 131 173828 231 298828 331 423878 032 050781 132 175781 232 300781 332 425781 033 052734 133 1777734 233 302734 433 427734 033 05640								
022 0351566 122 160156 222 285156 322 410156 023 037109 123 162109 223 287109 323 412062 024 039062 124 164062 224 289062 324 414062 025 041015 125 166015 225 291015 325 417968 026 042968 126 167988 226 292968 326 417988 037 044821 127 169921 227 294921 327 419921 030 046875 130 171875 230 296675 330 421875 031 048828 131 173828 231 298828 331 423828 032 050781 132 175781 232 300734 333 427734 033 052734 133 177734 233 302734 333 427734 034 0546640 <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>								
.023 .037109 .123 .162109 .223 .287109 .323 .414062 .024 .039062 .124 .1464062 .225 .291015 .325 .417988 .025 .041015 .125 .166015 .225 .291015 .325 .417988 .027 .044921 .127 .169921 .227 .294921 .327 .419921 .030 .046826 .130 .171875 .230 .296875 .330 .421875 .031 .048828 .131 .173828 .231 .298828 .331 .423828 .032 .050781 .132 .175781 .232 .300781 .332 .425781 .033 .052734 .133 .177744 .233 .307434 .334 .425881 .034 .054687 .134 .179887 .234 .304687 .334 .429687 .035 .056640 .135 .181640 .235 .306640 .335								
.023 .037109 .123 .162109 .223 .287109 .323 .414062 .024 .039062 .124 .164062 .225 .291015 .325 .416015 .025 .041015 .125 .166015 .225 .291015 .325 .417988 .027 .044921 .127 .169921 .227 .294921 .327 .419921 .030 .046875 .130 .171875 .230 .296875 .330 .421875 .031 .048828 .131 .173828 .231 .298288 .331 .423828 .032 .050781 .132 .175781 .232 .300781 .332 .425781 .033 .052734 .133 .177734 .233 .304887 .334 .425881 .035 .056640 .135 .181640 .235 .306640 .335 .431640 .035 .056640 .135 .181640 .237 .310546 .337 <	.022	.035156	.122	.160156	.222	.285156	.322	.410156
.024 .039062 .124 .164062 .224 .289062 .324 .414062 .025 .041015 .125 .166015 .225 .291015 .325 .416015 .026 .042968 .126 .167968 .226 .292988 .326 .417968 .027 .044921 .127 .169921 .227 .294921 .327 .419921 .030 .046875 .130 .171875 .230 .296875 .330 .421875 .031 .04828 .131 .173828 .231 .298828 .331 .425781 .033 .052734 .132 .177724 .233 .300734 .333 .422781 .034 .054687 .134 .179687 .234 .304687 .334 .425781 .035 .056640 .135 .181640 .235 .306840 .335 .31640 .036 .058893 .136 .183593 .236 .308593 .336 <td< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></td<>								
025 041015 125 166015 225 291015 325 417968 027 044921 126 167968 226 292988 326 417968 027 044921 127 169921 227 294921 327 419921 030 046875 130 171875 230 296875 330 421875 031 048828 131 173828 231 298828 331 423828 032 050781 132 175781 232 300781 332 425761 033 052734 133 177734 233 302734 333 427734 034 054687 134 179687 234 304687 334 429687 035 056640 135 181640 235 306640 335 431640 036 058593 136 183593 236 33593 336 433593 037 060546								
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.027 .044921 .127 .169921 .227 .294921 .327 .419921 .030 .046875 .130 .171875 .230 .296875 .330 .421875 .031 .048828 .131 .173828 .231 .298828 .331 .423828 .032 .050781 .132 .175781 .232 .300781 .332 .425781 .033 .052734 .133 .177734 .233 .302734 .333 .427734 .034 .054687 .134 .179687 .234 .304687 .334 .429687 .035 .056640 .135 .181640 .235 .306640 .335 .431640 .036 .058593 .136 .183593 .236 .308593 .336 .433593 .037 .060546 .137 .185546 .237 .310546 .337 .435540 .041 .064453 .141 .189453 .241 .314453 .341 <								
030 046875 130 171875 230 296875 330 421875 031 048828 131 173828 231 298828 331 423828 032 050781 132 175781 232 300781 332 425781 033 052734 133 177734 233 302734 333 427734 034 054687 134 179687 234 304687 334 429687 035 056640 135 181640 235 306640 335 431640 036 058593 136 183593 236 308593 336 433593 037 060546 137 185546 237 310546 337 435546 040 062500 .140 .187500 240 312500 340 437500 041 .064453 .141 .189453 241 314453 341 439453 042 .066406								
031 048828 1.31 1.73828 231 298288 331 423828 032 050781 1.32 1.75781 232 300781 332 425781 033 052734 1.33 1.77734 233 302734 333 427881 034 054687 1.34 1.79687 234 304687 334 429687 035 056640 1.35 1.81640 235 306640 .335 431640 036 058593 1.36 183593 236 308593 .336 433593 037 060546 1.37 1.85546 237 310546 .337 435546 040 062500 1.40 1.87500 240 312500 .340 437500 041 .066406 .142 .191406 242 .316406 .342 .441406 043 .068359 .143 .193359 .243 .318559 .343 .43359 04	.027	.044921	.127	.169921	· .227	.294921	.327	.419921
031 048828 131 173828 231 29828 331 423828 032 050781 132 175781 232 300781 332 425781 033 052734 133 177734 233 302734 333 427881 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 064606 142 191406 242 316406 342 441406 043 068359 143 193359 243 318359 343 443369 044 070212	030	046875	120	171975	220	206875	220	/2107E
032 050781 132 175781 232 300781 332 425781 033 052734 133 177734 233 302734 333 427887 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 44106 043 068359 143 193359 243 318359 343 443512 044 070312 144 195312 244 320312 344 44561 045 072265								
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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 318359 343 441366 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 447265 .047 .0	.033	.052734	.133	.177734	.233	.302734	.333	.427.734
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 318359 343 441366 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 447265 .047 .0	.034	.054687	.134	179687	234	304687	334	429687
.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 .064463 .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 .322265 .345 .447265 .047 .076171 .147 .201171 .247 .326171 .347 <								
.037 .060546 .137 .185546 .237 .310546 .337 .435546 .040 .062500 .140 .187500 .240 .312500 .340 .437500 .041 .064453 .141 .189453 .241 .314463 .341 .439453 .042 .066406 .142 .191406 .242 .316406 .342 .441406 .043 .068359 .143 .193359 .243 .318359 .343 .443359 .044 .070312 .144 .195312 .244 .320312 .344 .445312 .045 .072265 .145 .197265 .245 .322265 .345 .447265 .046 .074218 .146 .199218 .246 .324218 .346 .449218 .047 .076171 .147 .201171 .247 .326171 .347 .451171 .050 .078125 .150 .203125 .250 .328125 .350 <								
.040 .062500 .140 .187500 .240 .312500 .340 .437500 .041 .064453 .141 .189453 .241 .314453 .341 .439453 .042 .066406 .142 .191406 .242 .316406 .342 .441406 .043 .068359 .143 .193359 .243 .318359 .343 .443359 .044 .070312 .144 .195312 .244 .320312 .344 .445312 .045 .072265 .145 .197265 .245 .322265 .345 .447265 .046 .074218 .146 .199218 .246 .324218 .346 .449218 .047 .076171 .147 .201171 .247 .326171 .347 .451171 .050 .078125 .150 .203125 .250 .328125 .350 .453125 .051 .080078 .151 .205078 .251 .330078 .351 <								
.041 .064453 141 .189453 .241 .314453 .341 .439453 .042 .066406 .142 .191406 .242 .316406 .342 .441406 .043 .068359 .143 .193359 .243 .318359 .343 .43359 .044 .070312 .144 .195312 .244 .320312 .344 .445312 .045 .072265 .145 .197265 .255 .345 .447265 .046 .074218 .146 .199218 .246 .324218 .346 .449218 .047 .076171 .147 .201171 .247 .326171 .347 .451171 .050 .078125 .150 .203125 .250 .328125 .350 .453125 .051 .080078 .151 .205078 .251 .330078 .351 .455078 .052 .082031 .152 .207031 .252 .332031 .352 .457031	.037	.060546	137	.185546	.237	.310546	.337	.435546
.041 .064453 141 .189453 .241 .314453 .341 .439453 .042 .066406 .142 .191406 .242 .316406 .342 .441406 .043 .068359 .143 .193359 .243 .318359 .343 .43359 .044 .070312 .144 .195312 .244 .320312 .344 .445312 .045 .072265 .145 .197265 .255 .345 .447265 .046 .074218 .146 .199218 .246 .324218 .346 .449218 .047 .076171 .147 .201171 .247 .326171 .347 .451171 .050 .078125 .150 .203125 .250 .328125 .350 .453125 .051 .080078 .151 .205078 .251 .330078 .351 .455078 .052 .082031 .152 .207031 .252 .332031 .352 .457031	040	062500	140	187500	240	312500	340	437500
.042 .066406 1.42 .191406 2.42 .316406 .342 .441406 .043 .068359 1.143 .193359 2.43 .318359 .343 .443359 .044 .070312 .144 .195312 .244 .320312 .344 .445312 .045 .072265 .145 .197265 .245 .322265 .345 .447265 .046 .074218 .146 .199218 .246 .324218 .346 .449218 .047 .076171 .147 .201171 .247 .326171 .347 .451171 .050 .078125 .150 .203125 .250 .328125 .350 .453125 .051 .080078 .151 .205078 .251 .30078 .351 .455078 .052 .082031 .152 .207031 .252 .332031 .352 .457031 .053 .083984 .153 .208984 .253 .333984 .353 <								
.043 .068359 1.43 .193359 .243 .318359 .343 .443359 .044 .070312 1.144 .195312 .244 .320312 .344 .445312 .045 .072265 .145 .197265 .245 .322265 .345 .447265 .046 .074218 .146 .199218 .246 .324218 .346 .449218 .047 .076171 .147 .201171 .247 .326171 .347 .451171 .050 .078125 .150 .203125 .250 .328125 .350 .453125 .051 .080078 .151 .205078 .251 .330078 .351 .455078 .052 .082031 .152 .207031 .252 .332031 .352 .457031 .053 .083984 .153 .208984 .253 .333984 .353 .458984 .054 .085937 .154 .210937 .254 .35937 .354 <								
.044 .070312 .144 .195312 .244 .320312 .344 .445312 .045 .072265 .145 .197265 .245 .322265 .345 .447265 .046 .074218 .146 .199218 .246 .324218 .346 .449218 .047 .076171 .147 .201171 .247 .326171 .347 .451171 .050 .078125 .150 .203125 .250 .328125 .350 .453125 .051 .080078 .151 .205078 .251 .330078 .351 .455078 .052 .082031 .152 .207031 .252 .332031 .352 .457031 .053 .083984 .153 .208984 .253 .333984 .353 .458984 .054 .085937 .154 .210937 .254 .335937 .354 .460937 .055 .087890 .155 .212890 .255 .337890 .355 <								
.045 .072265 .145 .197265 .245 .322265 .345 .447265 .046 .074218 .146 .199218 .246 .324218 .346 .449218 .047 .076171 .147 .201171 .247 .326171 .347 .451171 .050 .078125 .150 .203125 .250 .328125 .350 .453125 .051 .080078 .151 .205078 .251 .330078 .351 .455078 .052 .082031 .152 .207031 .252 .332031 .352 .457031 .053 .083984 .153 .208984 .253 .333984 .353 .458984 .054 .085937 .154 .210937 .254 .335937 .354 .460937 .055 .087880 .155 .212890 .255 .337890 .355 .462890 .056 .089843 .156 .214843 .256 .339843 .356 <								
.046 .074218 .146 .199218 .246 .324218 .346 .449218 .047 .076171 .147 .201171 .247 .326171 .347 .451171 .050 .078125 .150 .203125 .250 .328125 .350 .453125 .051 .080078 .151 .205078 .251 .330078 .351 .455078 .052 .082031 .152 .207031 .252 .332031 .352 .457031 .053 .083984 .153 .208984 .253 .333984 .353 .458984 .054 .085937 .154 .210937 .254 .335937 .354 .460937 .055 .087890 .155 .212890 .255 .337890 .355 .462890 .056 .089843 .156 .214843 .256 .339843 .356 .464843 .057 .091796 .157 .216796 .257 .341796 .357 <	.044	.070312	.144	.195312	.244	.320312	.344	.445312
.046 .074218 .146 .199218 .246 .324218 .346 .449218 .047 .076171 .147 .201171 .247 .326171 .347 .451171 .050 .078125 .150 .203125 .250 .328125 .350 .453125 .051 .080078 .151 .205078 .251 .330078 .351 .455078 .052 .082031 .152 .207031 .252 .332031 .352 .457031 .053 .083984 .153 .208984 .253 .333984 .353 .458984 .054 .085937 .154 .210937 .254 .335937 .354 .460937 .055 .087890 .155 .212890 .255 .337890 .355 .462890 .056 .089843 .156 .214843 .256 .339843 .356 .464843 .057 .091796 .157 .216796 .257 .341796 .357 <	.045	.072265	.145	.197265	.245	.322265	.345	.447265
.047 .076171 .147 .201171 .247 .326171 .347 .451171 .050 .078125 .150 .203125 .250 .328125 .350 .453125 .051 .080078 .151 .205078 .251 .330078 .351 .455078 .052 .082031 .152 .207031 .252 .332031 .352 .457031 .053 .083984 .153 .208984 .253 .333984 .353 .458984 .054 .085937 .154 .210937 .254 .335937 .354 .460937 .055 .087890 .155 .212890 .255 .337890 .355 .462890 .056 .089843 .156 .214843 .256 .339843 .356 .464843 .057 .091796 .157 .216796 .257 .341796 .357 .466796 .060 .093750 .160 .218750 .260 .343750 .361 <								
.050 .078125 .150 .203125 .250 .328125 .350 .453125 .051 .080078 .151 .205078 .251 .330078 .351 .455078 .052 .082031 .152 .207031 .252 .332031 .352 .457031 .053 .083984 .153 .208984 .253 .333984 .353 .458984 .054 .085937 .154 .210937 .254 .335937 .354 .460937 .055 .087890 .155 .212890 .255 .337890 .355 .462890 .056 .089843 .156 .214843 .256 .339843 .356 .464843 .057 .091796 .157 .216796 .257 .341796 .357 .466796 .060 .093750 .160 .218750 .260 .343750 .360 .468750 .061 .095703 .161 .220703 .261 .347656 .362 <								
.051 .080078 .151 .205078 .251 .330078 .351 .455078 .052 .082031 .152 .207031 .252 .332031 .352 .457031 .053 .083984 .153 .208984 .253 .333984 .353 .458984 .054 .085937 .154 .210937 .254 .335937 .354 .460937 .055 .087890 .155 .212890 .255 .337890 .355 .462890 .056 .089843 .156 .214843 .256 .339843 .356 .464843 .057 .091796 .157 .216796 .257 .341796 .357 .466796 .060 .093750 .160 .218750 .260 .343750 .360 .468750 .061 .095703 .161 .220703 .261 .345703 .361 .470703 .062 .097656 .162 .222656 .262 .347656 .362 <						.020171		
.052 .082031 .152 .207031 .252 .332031 .352 .457031 .053 .083984 .153 .208984 .253 .333984 .353 .458984 .054 .085937 .154 .210937 .254 .335937 .354 .460937 .055 .087890 .155 .212890 .255 .337890 .355 .462890 .056 .089843 .156 .214843 .256 .339843 .356 .464843 .057 .091796 .157 .216796 .257 .341796 .357 .466796 .060 .093750 .160 .218750 .260 .343750 .360 .468750 .061 .095703 .161 .220703 .261 .345703 .361 .470703 .062 .097656 .162 .222656 .262 .347656 .362 .472656 .063 .099609 .163 .224609 .263 .349609 .363 <								
.052 .082031 .152 .207031 .252 .332031 .352 .457031 .053 .083984 .153 .208984 .253 .333984 .353 .458984 .054 .085937 .154 .210937 .254 .335937 .354 .460937 .055 .087890 .155 .212890 .255 .337890 .355 .462890 .056 .089843 .156 .214843 .256 .339843 .356 .464843 .057 .091796 .157 .216796 .257 .341796 .357 .466796 .060 .093750 .160 .218750 .260 .343750 .360 .468750 .061 .095703 .161 .220703 .261 .345703 .361 .470703 .062 .097656 .162 .222656 .262 .347656 .362 .472656 .063 .099609 .163 .224609 .263 .349609 .363 <	.051	.080078	.151	.205078	.251	.330078	.351	.455078
.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 <								
.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 <t< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></t<>								
.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 <								
.056 .089843 .156 .214843 .256 .339843 .356 .464843 .057 .091796 .157 .216796 .257 .341796 .357 .466796 .060 .093750 .160 .218750 .260 .343750 .360 .468750 .061 .095703 .161 .220703 .261 .345703 .361 .470703 .062 .097656 .162 .222656 .262 .347656 .362 .472656 .063 .099609 .163 .224609 .263 .349609 .363 .474609 .064 .101562 .164 .226562 .264 .351562 .364 .476562 .065 .103515 .165 .228515 .265 .353515 .365 .478515 .066 .105468 .166 .230468 .266 .355468 .366 .480468 .067 .107421 .167 .232421 .267 .357421 .367 <								
.057 .091796 .157 .216796 .257 .341796 .357 .466796 .060 .093750 .160 .218750 .260 .343750 .360 .468750 .061 .095703 .161 .220703 .261 .345703 .361 .470703 .062 .097656 .162 .222656 .262 .347656 .362 .472656 .063 .099609 .163 .224609 .263 .349609 .363 .474609 .064 .101562 .164 .226562 .264 .351562 .364 .476562 .065 .103515 .165 .228515 .265 .353515 .365 .478515 .066 .105468 .166 .230468 .266 .355468 .366 .480468 .067 .107421 .167 .232421 .267 .357421 .367 .482421 .070 .109375 .170 .234375 .270 .359375 .370 <								
.060 .093750 .160 .218750 .260 .343750 .360 .468750 .061 .095703 .161 .220703 .261 .345703 .361 .470703 .062 .097656 .162 .222656 .262 .347656 .362 .472656 .063 .099609 .163 .224609 .263 .349609 .363 .474609 .064 .101562 .164 .226562 .264 .351562 .364 .476562 .065 .103515 .165 .228515 .265 .353515 .365 .478515 .066 .105468 .166 .230468 .266 .355468 .366 .480468 .067 .107421 .167 .232421 .267 .357421 .367 .482421 .070 .109375 .170 .234375 .270 .359375 .370 .484375 .071 .111328 .171 .236328 .271 .361328 .371 <				214843	.256	.339843	.356	.464843
.061 .095703 .161 .220703 .261 .345703 .361 .470703 .062 .097656 .162 .222656 .262 .347656 .362 .472656 .063 .099609 .163 .224609 .263 .349609 .363 .474609 .064 .101562 .164 .226562 .264 .351562 .364 .476562 .065 .103515 .165 .228515 .265 .353515 .365 .478515 .066 .105468 .166 .230468 .266 .355468 .366 .480468 .067 .107421 .167 .232421 .267 .357421 .367 .482421 .070 .109375 .170 .234375 .270 .359375 .370 .484375 .071 .111328 .171 .236328 .271 .361328 .371 .486328 .072 .113281 .172 .238281 .272 .363281 .372 <	.057	.091796	.157	.216796	.257	.341796	.357	.466796
.061 .095703 .161 .220703 .261 .345703 .361 .470703 .062 .097656 .162 .222656 .262 .347656 .362 .472656 .063 .099609 .163 .224609 .263 .349609 .363 .474609 .064 .101562 .164 .226562 .264 .351562 .364 .476562 .065 .103515 .165 .228515 .265 .353515 .365 .478515 .066 .105468 .166 .230468 .266 .355468 .366 .480468 .067 .107421 .167 .232421 .267 .357421 .367 .482421 .070 .109375 .170 .234375 .270 .359375 .370 .484375 .071 .111328 .171 .236328 .271 .361328 .371 .486328 .072 .113281 .172 .238281 .272 .363281 .372 <	000	000750	100	040750	1	040750	600	400753
.062 .097656 .162 .222656 .262 .347656 .362 .472656 .063 .099609 .163 .224609 .263 .349609 .363 .474609 .064 .101562 .164 .226562 .264 .351562 .364 .476562 .065 .103515 .165 .228515 .265 .353515 .365 .478515 .066 .105468 .166 .230468 .266 .355468 .366 .480468 .067 .107421 .167 .232421 .267 .357421 .367 .482421 .070 .109375 .170 .234375 .270 .359375 .370 .484375 .071 .111328 .171 .236328 .271 .361328 .371 .486328 .072 .113281 .172 .238281 .272 .363281 .372 .488281 .073 .115234 .173 .240234 .273 .365234 .373 <								
.063 .099609 .163 .224609 .263 .349609 .363 .474609 .064 .101562 .164 .226562 .264 .351562 .364 .476562 .065 .103515 .165 .228515 .265 .353515 .365 .478515 .066 .105468 .166 .230468 .266 .355468 .366 .480468 .067 .107421 .167 .232421 .267 .357421 .367 .482421 .070 .109375 .170 .234375 .270 .359375 .370 .484375 .071 .111328 .171 .236328 .271 .361328 .371 .486328 .072 .113281 .172 .238281 .272 .363281 .372 .488281 .073 .115234 .173 .240234 .273 .365234 .373 .490234 .074 .117187 .174 .242187 .274 .367187 .374 <								
.063 .099609 .163 .224609 .263 .349609 .363 .474609 .064 .101562 .164 .226562 .264 .351562 .364 .476562 .065 .103515 .165 .228515 .265 .353515 .365 .478515 .066 .105468 .166 .230468 .266 .355468 .366 .480468 .067 .107421 .167 .232421 .267 .357421 .367 .482421 .070 .109375 .170 .234375 .270 .359375 .370 .484375 .071 .111328 .171 .236328 .271 .361328 .371 .486328 .072 .113281 .172 .238281 .272 .363281 .372 .488281 .073 .115234 .173 .240234 .273 .365234 .373 .490234 .074 .117187 .174 .242187 .274 .367187 .374 <		.097656	.162	.222656	.262	.347656	.362	.472656
.064 .101562 .164 .226562 .264 .351562 .364 .476562 .065 .103515 .165 .228515 .265 .353515 .365 .478515 .066 .105468 .166 .230468 .266 .355468 .366 .480468 .067 .107421 .167 .232421 .267 .357421 .367 .482421 .070 .109375 .170 .234375 .270 .359375 .370 .484375 .071 .111328 .171 .236328 .271 .361328 .371 .486328 .072 .113281 .172 .238281 .272 .363281 .372 .488281 .073 .115234 .173 .240234 .273 .365234 .373 .490234 .074 .117187 .174 .242187 .274 .367187 .374 .492187								
.065 .103515 .165 .228515 .265 .353515 .365 .478515 .066 .105468 .166 .230468 .266 .355468 .366 .480468 .067 .107421 .167 .232421 .267 .357421 .367 .482421 .070 .109375 .170 .234375 .270 .359375 .370 .484375 .071 .111328 .171 .236328 .271 .361328 .371 .486328 .072 .113281 .172 .238281 .272 .363281 .372 .488281 .073 .115234 .173 .240234 .273 .365234 .373 .490234 .074 .117187 .174 .242187 .274 .367187 .374 .492187								
.066 .105468 .166 .230468 .266 .355468 .366 .480468 .067 .107421 .167 .232421 .267 .357421 .367 .482421 .070 .109375 .170 .234375 .270 .359375 .370 .484375 .071 .111328 .171 .236328 .271 .361328 .371 .486328 .072 .113281 .172 .238281 .272 .363281 .372 .488281 .073 .115234 .173 .240234 .273 .365234 .373 .490234 .074 .117187 .174 .242187 .274 .367187 .374 .492187								
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.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	070	109375	170	234375	270	359375	370	484375
.072 .113281 .172 .238281 .272 .363281 .372 .488281 .073 .115234 .173 .240234 .273 .365234 .373 .490234 .074 .117187 .174 .242187 .274 .367187 .374 .492187								
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.074 .117187 .174 .242187 .274 .367187 .374 .492187								
.074 .117187 .174 .242187 .274 .367187 .374 .492187	.073	.115234	.173	.240234	.273	.365234	.373	.490234
11/5 (1914) 1/6 //////// 7/6 7/601//// 976 ///////	.075	.119140	175	.244140	.275	.369140	.375	.494140
.076 .121093 .176 .246093 .276 .371093 .376 .496093								
.077 .1230.46 .177 .2480.46 .277 .3730.46 .377 .4980.46	.077	.1230,46	1 .1//	.248046	.2//	.3/3046	.3//	.498046

OCTAL-DECIMAL FRACTION CONVERSION TABLE

OCTAL DEC. OCTAL DEC. OCTAL DEC. OCTAL DEC. .000000 .000000 .000000 .000000 .000010 .000201 .000201 .000020 .000488 .000300 .000736 .000001 .000101 .000102 .000211 .000221 .000230 .000485 .000320 .000740 .000004 .000018 .0001014 .000261 .000224 .000485 .000300 .000104 .000006 .000001 .000006 .000007 .000006 .000001 .000006 .000001 .000006 .000007 .000006 .000007 .000006 .000001 .000007 .000007 .000007 .000001 .0000000 .000000 .00000000 .0000000 .0000000 .0000	· · · · · · · · · · · · · · · · · · ·			1
0.00000	OCTAL DEC.	OCTAL DEC.	OCTAL DEC.	OCTAL DEC.
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0,00001	.000000 .000000		.000200 .000488	.000300 .000732
0.00002	.000001 000003	000101 000247		
0.00003 0.00011 0.00103 0.00255 0.00265 0.00269 0.00303 0.00743 0.00006 0.00019 0.00105 0.00268 0.00204 0.00503 0.00304 0.00745 0.00006 0.00021 0.00105 0.00268 0.00266 0.00507 0.00305 0.00755 0.00007 0.00268 0.00127 0.00207 0.00206 0.00511 0.00306 0.00755 0.00007 0.00270 0.00207 0.00207 0.00207 0.00207 0.00514 0.00307 0.00759 0.00207 0.00207 0.00207 0.00207 0.00514 0.00307 0.00759 0.00207 0.00				
0.00004 0.00015 0.00104 0.00289 0.00205 0.00503 0.00747 0.00006 0.00012 0.00106 0.00287 0.00206 0.00507 0.00306 0.00755 0.00007 0.000207 0.0				
0.000005 0.00019 0.00105 0.00263 0.00266 0.00567 0.00206 0.000755 0.000007 0.00026 0.00107 0.00270 0.00206 0.00511 0.00306 0.00755 0.00007 0.00026 0.00107 0.00277 0.00207 0.00514 0.00307 0.00759 0.00011 0.00274 0.00210 0.00518 0.00210 0.00526 0.00211 0.000765 0.00011 0.00278 0.00211 0.00526 0.00211 0.000774 0.00011 0.00278 0.00211 0.00526 0.00212 0.00770 0.00013 0.00074 0.00113 0.00286 0.00212 0.00526 0.00213 0.00774 0.00013 0.00044 0.00114 0.00288 0.00213 0.00530 0.00313 0.00774 0.00015 0.00049 0.00115 0.00283 0.00214 0.00534 0.00314 0.00778 0.00016 0.00049 0.00115 0.00283 0.00216 0.00534 0.00316 0.00785 0.00016 0.00057 0.00017 0.00067 0.00017 0.00067 0.00017 0.00067 0.00017 0.00067 0.00017 0.00067 0.00017 0.00067 0.00017 0.00067 0.00017 0.00067 0.00017 0.00067 0.00017 0.00067 0.00012 0.00308 0.00221 0.00566 0.00221 0.000787 0.00022 0.00068 0.00221 0.00068 0.00221 0.00068 0.00221 0.00068 0.00221 0.00068 0.00221 0.00068 0.00221 0.00068 0.00221 0.00068 0.00221 0.00068 0.00221 0.00068 0.00221 0.00068 0.00221 0.00068 0.00222 0.00684 0.00223 0.00805 0.00022 0.00684 0.00223 0.00805 0.00022 0.00684 0.00223 0.00805 0.00022 0.00684 0.00223 0.00805 0.00022 0.00684 0.00223 0.00805 0.00022 0.00684 0.00223 0.00805 0.00022 0.00684 0.00223 0.00805 0.00022 0.00684 0.00223 0.00805 0.00022 0.00684 0.00223 0.00805 0.00022 0.00684 0.00223 0.00805 0.00022 0.00684 0.00223 0.00805 0.00022 0.00684 0.00223 0.00805 0.00022 0.00684 0.00223 0.00805 0.00022 0.00684 0.00223 0.00805 0.00022 0.00684 0.00225 0.00805 0.00022 0.00805 0.00022 0.00805 0.00022 0.00805 0.00022 0.00805 0.00022 0.00805 0.00022 0.00805 0.00022 0.00805 0.00022 0.00805				
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.000012	.000011 .000034	.000111 .000278	.000211 .000522	.000311 .000766
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DO0031	000030 000001	000120 000225	000000 000570	000000 000000
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0.00035	.000033 .000102	.000133 .000347	.000233 .000591	.000333 .000835
0.00035	.000034 .000106	.000134 .000350	.000234 .000595	.000334 .000839
D00036				
.000037				
0.00040				
D00041	.000037 .000118	.000137 .000302	.000237 .000000	.000337 .000690
D00041	.000040 .000122	.000140 000366	.000240 000610	.000340 000854
000042 .000129 .000142 .000373 .000242 .000617 .000342 .000862 .000043 .000133 .000143 .000377 .000244 .000625 .000344 .000865 .000045 .000141 .000145 .000385 .000245 .000629 .000344 .000873 .000046 .000144 .000146 .000385 .000246 .000633 .000346 .000873 .000047 .000148 .000147 .000392 .000246 .000637 .000347 .000881 .000050 .000152 .000150 .000396 .000250 .000640 .000350 .000881 .000051 .000156 .000151 .000400 .000251 .000644 .000351 .000888 .000052 .000160 .000153 .000408 .000253 .000648 .000352 .000882 .000053 .000164 .000153 .000408 .000253 .0006652 .000353 .000892 .000054 .000167 .0				
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.000047	.000045 .000141	.000145 .000385	.000245 .000629	.000345 .000873
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.000050 .000152 .000150 .000396 .000250 .000640 .000350 .000885 .000051 .000156 .000151 .000400 .000251 .000644 .000351 .000888 .000052 .000160 .000152 .000404 .000252 .000648 .000352 .000892 .000053 .000164 .000153 .000408 .000253 .000652 .000353 .000896 .000054 .000167 .000154 .000414 .000255 .000656 .000354 .00990 .000055 .000171 .000156 .000415 .000256 .000659 .000355 .00990 .000057 .000179 .000156 .000419 .000256 .00663 .000356 .00991 .000060 .000183 .000160 .000427 .000260 .00671 .000360 .00915 .000061 .000186 .000161 .000431 .000261 .00675 .000361 .00919 .000062 .000190 .000162 <td>.000047 .000148</td> <td>.000147 .000392</td> <td>.000247 .000637</td> <td></td>	.000047 .000148	.000147 .000392	.000247 .000637	
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.000053	.000052 .000160			
.000054 .000167 .000154 .000411 .000254 .000656 .000354 .000900 .000055 .000171 .000155 .000415 .000255 .000659 .000355 .000904 .000056 .000175 .000156 .000419 .000256 .000663 .000356 .000907 .000060 .000179 .000157 .000423 .000257 .000667 .000357 .000911 .000061 .000183 .000160 .000427 .000260 .000675 .000361 .000915 .000062 .000190 .000162 .000434 .000262 .000679 .000362 .000923 .000063 .000194 .000163 .000438 .000263 .000682 .000363 .000926 .000064 .000198 .000164 .000442 .000264 .000686 .000364 .000926 .000065 .000202 .000166 .000442 .000264 .000686 .000365 .000934 .000066 .000205 .0				
.000055 .000171 .000155 .000415 .000255 .000659 .000355 .000904 .000056 .000175 .000156 .000419 .000256 .000663 .000356 .000907 .000060 .000183 .000160 .000427 .000260 .000671 .000360 .000915 .000061 .000186 .000161 .000431 .000261 .000675 .000361 .000919 .000062 .000190 .000162 .000431 .000262 .000679 .000362 .000919 .000063 .000194 .000163 .000438 .000263 .000682 .000363 .000926 .000064 .000198 .000164 .000442 .000264 .000686 .000363 .000926 .000065 .000202 .000165 .000446 .000266 .000690 .000365 .000934 .000066 .000205 .000166 .000450 .000266 .000694 .000365 .000936 .000938 .000070 .0				
.000056 .000175 .000156 .000419 .000256 .000663 .000356 .000907 .000057 .000179 .000157 .000423 .000257 .000667 .000357 .000911 .000060 .000183 .000160 .000427 .000260 .000671 .000360 .000915 .000061 .000186 .000161 .000431 .000261 .000675 .000361 .000919 .000062 .000190 .000162 .000434 .000262 .000679 .000362 .000923 .000064 .000198 .000164 .000438 .000263 .000682 .000363 .000926 .000065 .000202 .000165 .000446 .000265 .000690 .000365 .000934 .000066 .000205 .000166 .000450 .000266 .000694 .000366 .000938 .000070 .000213 .000170 .000457 .000270 .000698 .000367 .000946 .000071 .000217 .0				
.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 .000362 .000362 .000363 .000926 .000064 .000198 .000164 .000442 .000264 .000686 .000364 .000930 .000065 .000202 .000165 .000446 .000265 .000690 .000365 .000934 .000066 .000205 .000166 .000450 .000266 .000694 .000366 .000938 .000070 .000213 .000170 .000457 .000270 .000698 .000367 .000946 .000071 .000217 .000171 .000461 .000271 .000705 .000371 .000946 <td></td> <td></td> <td></td> <td></td>				
.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 .000264 .000682 .000363 .000926 .000064 .000198 .000164 .000442 .000264 .000686 .000364 .000365 .000930 .000065 .000202 .000166 .000450 .000266 .000690 .000366 .00038 .000067 .000209 .000166 .000450 .000266 .000694 .000366 .00038 .000070 .000213 .000170 .000457 .000270 .000701 .000367 .000946 .000071 .000217 .000171 .000465 .000271 .000705 .000371 .000946 .000072 .000				
.000061 .000186 .000161 .000431 .000261 .000675 .000361 .000919 .000062 .000190 .000162 .000434 .000262 .000679 .000362 .000923 .000064 .000198 .000164 .000438 .000263 .000682 .000364 .000364 .000930 .000065 .000202 .000165 .000446 .000265 .000690 .000365 .000934 .000066 .000205 .000166 .000450 .000266 .000694 .000366 .000938 .000070 .000209 .000167 .000453 .000267 .000698 .000367 .000942 .000071 .000213 .000170 .000457 .000270 .000701 .000370 .000946 .000072 .000221 .000171 .000465 .000271 .000705 .000371 .000949 .000073 .000221 .000172 .000465 .000272 .000709 .000372 .000953 .000074 .0	.00005/ .000179	.000157 .000423	.000257 .000667	000357 .000911.
.000061 .000186 .000161 .000431 .000261 .000675 .000361 .000919 .000062 .000190 .000162 .000434 .000262 .000679 .000362 .000923 .000064 .000198 .000164 .000438 .000263 .000682 .000364 .000364 .000930 .000065 .000202 .000165 .000446 .000265 .000690 .000365 .000934 .000066 .000205 .000166 .000450 .000266 .000694 .000366 .000938 .000070 .000209 .000167 .000453 .000267 .000698 .000367 .000942 .000071 .000213 .000170 .000457 .000270 .000701 .000370 .000946 .000072 .000221 .000171 .000465 .000271 .000705 .000371 .000949 .000073 .000221 .000172 .000465 .000272 .000709 .000372 .000953 .000074 .0	000060 000183	000160 000427	000360 000671	000360 000015
.000062 .000190 .000162 .000434 .000262 .000679 .000362 .000923 .000063 .000194 .000163 .000438 .000263 .000682 .000363 .000926 .000065 .000202 .000165 .000442 .000264 .000690 .000365 .000934 .000066 .000205 .000166 .000450 .000266 .000694 .000366 .000938 .000070 .000209 .000167 .000453 .000270 .000701 .000367 .000942 .000071 .000213 .000170 .000457 .000270 .000701 .000370 .000946 .000072 .000217 .000171 .000461 .000271 .000705 .000371 .000949 .000072 .000221 .000172 .000465 .000272 .000709 .000372 .000953 .000074 .000225 .000173 .000469 .00273 .000713 .000373 .000957 .000075 .000236 .00				
.000063 .000194 .000163 .000438 .000263 .000682 .000363 .000926 .000064 .000198 .000164 .000442 .000264 .000686 .000364 .000930 .000065 .000202 .000165 .000446 .000265 .000690 .000365 .000934 .000066 .000205 .000166 .000450 .000266 .000694 .000366 .000938 .000070 .000213 .000170 .000457 .000270 .000701 .000367 .000946 .000071 .000217 .000171 .000461 .000270 .000701 .000370 .000946 .000072 .000221 .000172 .000465 .000271 .000705 .000371 .000949 .000073 .000225 .000173 .000469 .000272 .000709 .000372 .000957 .000074 .000228 .000174 .000473 .000274 .000717 .000374 .000957 .000075 .000236 .0				
.000064 .000198 .000164 .000442 .000264 .000686 .000364 .000930 .000065 .000202 .000165 .000446 .000265 .000690 .000365 .000934 .000066 .000205 .000166 .000450 .000266 .000694 .000366 .000938 .000070 .000209 .000167 .000453 .000270 .000698 .000370 .000942 .000071 .000213 .000170 .000457 .000270 .000701 .000370 .000946 .000072 .000221 .000171 .000461 .000271 .000705 .000371 .000949 .000073 .000225 .000172 .00465 .000272 .000703 .000373 .000957 .000074 .000228 .000174 .000473 .000274 .000717 .000374 .000374 .000373 .000957 .000075 .000236 .000175 .000476 .000275 .000717 .000374 .000375 .000375 <				
.000065 .000202 .000165 .000446 .000265 .000690 .000365 .000934 .000066 .000205 .000166 .000450 .000266 .000694 .000366 .000938 .000070 .000209 .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 .00273 .000713 .000373 .000957 .000074 .000228 .000174 .000473 .000274 .000717 .000374 .000961 .000075 .000236 .000176 .000480 .000276 .000724 .000376 .000968				
.000065 .000202 .000165 .000446 .000265 .000690 .000365 .000934 .000066 .000205 .000166 .000450 .000266 .000694 .000366 .000938 .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 .000236 .000176 .000480 .000276 .000724 .000376 .000968	.000064 .000198	.000164 .000442	.000264 .000686	.000364 .000930
.000066 .000205 .000166 .000450 .000266 .000694 .000366 .000938 .000067 .000209 .000167 .000453 .000267 .000698 .000367 .000942 .000070 .000213 .000170 .000457 .000270 .000701 .000370 .000946 .000071 .000217 .000171 .000461 .000271 .000705 .000371 .000949 .000073 .000221 .000172 .000465 .000272 .000709 .000372 .000953 .000074 .000228 .000174 .000469 .000274 .000717 .000374 .000957 .000075 .000232 .000175 .000476 .000275 .000720 .000375 .000965 .000076 .000236 .000176 .000480 .000276 .000724 .000376 .000968				
.000067 .000209 .000167 .000453 .000267 .000698 .000367 .000942 .000070 .000213 .000170 .000457 .000270 .000701 .000370 .000946 .000071 .000217 .000171 .000461 .000271 .000705 .000371 .000949 .000072 .000221 .000172 .000465 .000272 .000709 .000372 .000953 .000074 .000225 .000173 .000469 .000274 .000717 .000374 .000957 .000075 .000232 .000175 .000476 .000275 .000720 .000375 .000965 .000076 .000236 .000176 .000480 .000276 .000724 .000376 .000968				
.000070 .000213 .000170 .000457 .000270 .000701 .000370 .000946 .000071 .000217 .000171 .000461 .000271 .000705 .000371 .000949 .000072 .000221 .000172 .000465 .000272 .000709 .000372 .000953 .000073 .000225 .000173 .000469 .000273 .000713 .000373 .000957 .000074 .000228 .000174 .000473 .000274 .000717 .000374 .000961 .000075 .000232 .000175 .000476 .000275 .000720 .000375 .000965 .000076 .000236 .000176 .000480 .000276 .000724 .000376 .000968				
.000071 .000217 .000171 .000461 .000271 .000705 .000371 .000949 .000072 .000221 .000172 .000465 .000272 .000709 .000372 .000953 .000073 .000225 .000173 .000469 .00273 .000713 .000373 .000373 .000373 .000373 .000374 .000374 .000374 .000374 .000374 .000374 .000374 .000375 .000375 .000375 .000375 .000965 .000076 .000236 .000176 .000480 .000276 .000724 .000376 .000376 .000968	.555557 .555255	.000107 .000433	.000000	.00007 .000342
.000071 .000217 .000171 .000461 .000271 .000705 .000371 .000949 .000072 .000221 .000172 .000465 .000272 .000709 .000372 .000953 .000073 .000225 .000173 .000469 .00273 .000713 .000373 .000373 .000373 .000373 .000374 .000374 .000374 .000374 .000374 .000374 .000374 .000375 .000375 .000375 .000375 .000965 .000076 .000236 .000176 .000480 .000276 .000724 .000376 .000376 .000968	.000070 .000213	.000170 .000457	.000270 .000701	.000370 .000946
.000072 .000221 .000172 .000465 .000272 .000709 .000372 .000953 .000073 .000225 .000173 .000469 .00273 .000713 .000373 .000957 .000074 .000228 .000174 .000473 .000274 .000717 .000374 .000961 .000075 .000232 .000175 .000476 .000275 .000720 .000375 .000965 .000076 .000236 .000176 .000480 .000276 .000724 .000376 .000968				
.000073 .000225 .000173 .000469 .000273 .000713 .000373 .000957 .000074 .000228 .000174 .000473 .000274 .000717 .000374 .000374 .000374 .000961 .000075 .000232 .000175 .000476 .000275 .000720 .000375 .000965 .000076 .000236 .000176 .000480 .000276 .000724 .000376 .000968				
.000074 .000228 .000174 .000473 .000274 .000717 .000374 .000961 .000075 .000232 .000175 .000476 .000275 .000720 .000375 .000965 .000076 .000236 .000176 .000480 .000276 .000724 .000376 .000376				
.000075 .000232 .000175 .000476 .000275 .000720 .000375 .000965 .000076 .000236 .000176 .000480 .000276 .000724 .000376 .000968				
000076 .000236				
	.000075 .000232	.000175 .000476	.000275 .000720	.000375 .000965
	.000076 .000236	.000176 .000480	.000276 .000724	.000376 .000968
		1.555		

OCTAL-DECIMAL FRACTION CONVERSION TABLE

OCTAL DEC. OCTAL DEC. OCTAL DEC. OCTAL DEC.							
	OCTAL DEC.	OCTAL	DEC.	OCTAL	DEC.	OCTAL	DEC.
0.00401							
0.00401	.000400 .000970	.000500	.001220	.000600	.001464	.000700	.001708
0.00402	.000401 .000980	.000501					
0.000403							
DO0404							
DO0405							
000406							
DODG-10							
0.00410			.001243	.000606	.001487	.000706	.001731
.000410	.000407 .00100:	.000507	.001247	.000607	.001491	.000707	.001735
000411		ļ		1			
000412			.001251	.000610	.001495	.000710	.001739
000412 001014 000612 001262 000613 001506 000713 001745 000413 0010613 001062 000614 0010506 000713 001750 000414 001022 000614 001262 000614 001616 000715 001754 000415 001029 000615 001270 000616 001514 000715 001758 000416 001029 000516 001277 000616 001518 000716 001768 000715 001753 000617 001037 000617 001052 000717 000617 001522 000717 000716 001769 000517 001027 000617 001522 000717 000717 000421 001041 000521 001285 000620 001525 000721 001773 000422 001045 000522 001285 000622 001533 000722 001777 000423 001052 0010523 0010293 000622 001533 000722 001778 000424 001052 000524 001293 000623 001537 000723 001781 000426 001060 000525 001300 000626 001544 000725 001789 000426 001060 000525 001300 000626 001544 000725 001789 000426 001060 000526 001300 000627 001562 000727 001796 000430 001088 000527 001318 000627 001580 000727 001580 000727 001580 000727 001580 000727 001580 000727 001580 000727 001580 000727 001580 000727 001580 000727 001580 000727 001580 000730 000530 001580 000631 001580 000730 001680 000632 001580 000631 001580 000730 001680 000632 001580 000633	.000411 .001010	.000511	.001255	.000611	.001499	.000711	.001743
000413	.000412 .001014	4 .000512	.001258	.000612	001502		001747
000414							
000415							
000416							
000447							
000420							
0.00421	.000417 .001033	.000517	.001277	.000617	.001522	.000717	.001766
0.00421	000400 00400	-					
0.00422							.001770
000422				.000621			.001773
0.00423	.000422 .00104!	5 .000522	.001289	.000622	.001533	.000722	
000424	.000423 .001049	.000523	.001293				
000425							
0.00426							
0.000427							
0.00430							
0.00431	.000427 .001062	.000527	.001308	.000627	.001552	.000727	.001796
0.00431	000430 001069	000530	001212	000630	001556	000720	001000
0.00432							
0.00433							
0.00434							
D00435		.000533	.001323	.000633	.001567	.000733	.001811
D00435	.000434 .001083	.000534	.001327	.000634	.001571	.000734	.001815
D00436							
0.00437							
.000440 .001098 .000540 .001342 .000640 .001586 .000740 .001831 .000441 .001102 .000541 .001346 .000641 .001590 .000741 .001834 .000442 .001110 .000543 .001350 .000643 .001598 .000742 .001838 .000443 .001113 .000544 .001358 .000644 .001602 .000744 .00183 .000445 .001117 .000545 .001361 .000645 .001605 .000745 .001850 .000446 .001121 .000546 .001365 .000646 .001609 .000746 .001850 .000447 .001125 .000547 .001369 .000647 .001613 .000747 .001851 .000450 .001129 .000550 .001377 .000651 .001617 .000751 .001851 .000451 .001132 .000550 .001384 .000651 .001621 .000751 .001861 .000452 .001136 .00							
0.00441	.000437 .001092	.000537	.001338	.000637	.001563	.000/3/	.001827
0.00441	.000440 .00109:	000540	.001342	000640	001586	000740	001831
0.00442							
0.00443							
0.00444							
0.00445							
0.00446							.001846
0.00446	.000445 .00111		.001361	.000645	.001605	.000745	.001850
0.00447	.000446 .00112	.000546	.001365	.000646	.001609	.000746	
.000450 .001129 .000550 .001373 .000650 .001617 .000750 .001861 .000451 .001132 .000551 .001377 .000651 .001621 .000751 .001865 .000452 .001136 .000552 .001380 .000652 .001625 .000752 .001869 .000453 .001144 .000553 .001384 .000653 .001628 .000753 .001876 .000454 .001144 .000555 .001392 .000654 .001632 .000754 .001876 .000455 .001148 .000555 .001392 .000655 .001636 .000755 .001880 .000456 .001152 .000556 .001396 .000656 .001640 .000756 .001880 .000460 .001159 .000560 .001403 .000661 .001647 .000760 .001882 .000461 .001163 .000561 .001407 .00661 .001651 .000761 .001892 .000462 .001167 .00							
0.00451							
0.00451			.001373	.000650	.001617	.000750	.001861
0.00452	.000451 .001133	.000551	.001377				
.000453 .001140 .000553 .001384 .000653 .001628 .000753 .001873 .000454 .001144 .000554 .001388 .000654 .001632 .000754 .001876 .000455 .001148 .000555 .001392 .000655 .001636 .000755 .001876 .000456 .001152 .000556 .001396 .000656 .001640 .000755 .001884 .000457 .001155 .000557 .001399 .000657 .001644 .000757 .001888 .000460 .001159 .000560 .001403 .000660 .001647 .000760 .001892 .000461 .001163 .000561 .001407 .000661 .001651 .000760 .001892 .000462 .001167 .000562 .001411 .000662 .001655 .000762 .001899 .000463 .001174 .000563 .001415 .000663 .001659 .000763 .001903 .000465 .001178 .0							
.000454 .001144 .000554 .001388 .000654 .001632 .000754 .001876 .000455 .001148 .000555 .001392 .000655 .001636 .000755 .001880 .000456 .001152 .000556 .001396 .000656 .001640 .000756 .001884 .000457 .001155 .000557 .001399 .000657 .001644 .000757 .001888 .000460 .001159 .000560 .001403 .000660 .001647 .000760 .001892 .000461 .001163 .000561 .001407 .000661 .001655 .000761 .001892 .000462 .001167 .000562 .001411 .000662 .001655 .000762 .001899 .000463 .001174 .000563 .001415 .000663 .001659 .000763 .001903 .000464 .001178 .000564 .001419 .000663 .001667 .000765 .00191 .000466 .001178 .00							
.000455 .001148 .000555 .001392 .000655 .001636 .000755 .001880 .000456 .001152 .000556 .001396 .000656 .001640 .000756 .001884 .000467 .001155 .000557 .001399 .000657 .001644 .000757 .001888 .000460 .001159 .000560 .001403 .000660 .001647 .000760 .001892 .000461 .001163 .000561 .001407 .000661 .001651 .000761 .001895 .000462 .001167 .000562 .001411 .000662 .001655 .000762 .001899 .000463 .001171 .000563 .001415 .000663 .001659 .000763 .001903 .000464 .001174 .000564 .001419 .000663 .001659 .000763 .001903 .000465 .001178 .000566 .001422 .006665 .001667 .000765 .001911 .000466 .001182 .0							
.000456 .001152 .000556 .001396 .000656 .001640 .000756 .001884 .000457 .001155 .000557 .001399 .000657 .001644 .000757 .001888 .000460 .001159 .000560 .001403 .000660 .001647 .000760 .001892 .000461 .001163 .000561 .001407 .000661 .001651 .000761 .001895 .000462 .001167 .000562 .001411 .000662 .001655 .000762 .001899 .000463 .001174 .000564 .001415 .000663 .001655 .000762 .001899 .000464 .001174 .000564 .001419 .000663 .001663 .000764 .001907 .000465 .001178 .000565 .001422 .000665 .001667 .000765 .00191 .000466 .001182 .000566 .001426 .000666 .001670 .000766 .001914 .000470 .001190 .00							
.000457 .001155 .000557 .001399 .000657 .001644 .000757 .001888 .000460 .001159 .000560 .001403 .000660 .001647 .000760 .001892 .000461 .001163 .000561 .001407 .000661 .001651 .000761 .001895 .000462 .001167 .000562 .001411 .000662 .001655 .000762 .001899 .000463 .001171 .000563 .001415 .000663 .001659 .000763 .001903 .000465 .001174 .000564 .001419 .000663 .001667 .000765 .001907 .000465 .001178 .000565 .001422 .000665 .001667 .000765 .00191 .000466 .001182 .000566 .001426 .000666 .001670 .000766 .00191 .000470 .001190 .000570 .001434 .000670 .001678 .000770 .001922 .000471 .001194 .000							
.000460 .001159 .000560 .001403 .000660 .001647 .000760 .001892 .000461 .001163 .000561 .001407 .000661 .001651 .000761 .001895 .000462 .001167 .000562 .001411 .000662 .001655 .000762 .001899 .000463 .001171 .000563 .001415 .000663 .001659 .000763 .001903 .000464 .001178 .000564 .001419 .000664 .001663 .000765 .00191 .000466 .001178 .000566 .001422 .000665 .001670 .000765 .00191 .000467 .001186 .000566 .001426 .000666 .001670 .000766 .00191 .000470 .001190 .000570 .001434 .000670 .001674 .000767 .001918 .000471 .001194 .000571 .001438 .000671 .001682 .000770 .001922 .000472 .001197 .0005							
.000461 .001163 .000561 .001407 .000661 .001651 .000761 .001895 .000462 .001167 .000562 .001411 .000662 .001655 .000762 .001899 .000463 .001171 .000563 .001415 .000663 .001659 .000763 .001903 .000464 .001174 .000564 .001419 .000664 .001663 .000764 .001907 .000465 .001178 .000565 .001422 .000665 .001667 .000765 .001911 .000466 .001182 .000566 .001426 .000666 .001670 .000766 .001914 .000470 .001190 .000570 .001434 .000670 .001674 .000770 .00192 .000471 .001194 .000571 .001438 .000671 .001682 .000771 .001926 .000472 .001197 .000572 .001441 .000672 .001686 .000772 .001930 .000473 .001201 .00	.000457 .00115	.000557	.001399	.000657	.001644	.000757	.001888
.000461 .001163 .000561 .001407 .000661 .001651 .000761 .001895 .000462 .001167 .000562 .001411 .000662 .001655 .000762 .001899 .000463 .001171 .000563 .001415 .000663 .001659 .000763 .001903 .000464 .001174 .000564 .001419 .000664 .001663 .000764 .001907 .000465 .001178 .000565 .001422 .000665 .001667 .000765 .001911 .000466 .001182 .000566 .001426 .000666 .001670 .000766 .001914 .000470 .001190 .000570 .001434 .000670 .001674 .000770 .00192 .000471 .001194 .000571 .001438 .000671 .001682 .000771 .001926 .000472 .001197 .000572 .001441 .000672 .001686 .000772 .001930 .000473 .001201 .00	000460 00115	000500	001400	000000	001017	000705	004666
.000462 .001167 .000562 .001411 .000662 .001655 .000762 .001899 .000463 .001171 .000563 .001415 .000663 .001659 .000763 .001903 .000464 .001174 .000564 .001419 .000664 .001663 .001663 .000764 .001907 .000465 .001178 .000565 .001422 .000665 .001667 .000765 .001911 .000466 .001182 .000566 .001426 .000666 .001670 .000766 .001914 .000470 .001190 .000570 .001434 .000670 .001678 .000770 .001922 .000471 .001194 .000571 .001438 .000671 .001682 .000771 .001926 .000472 .001197 .000572 .001441 .000672 .001686 .000772 .001930 .000473 .001201 .000573 .001445 .000673 .001686 .000772 .001930 .000475 .0							
.000463 .001171 .000563 .001415 .000663 .001659 .000763 .001903 .000464 .001174 .000564 .001419 .000664 .001663 .000764 .001907 .000465 .001178 .000565 .001422 .000665 .001667 .000765 .001911 .000466 .001182 .000566 .001426 .000666 .001670 .000766 .001914 .000467 .001186 .000567 .001430 .000667 .001674 .000767 .001918 .000470 .001190 .000570 .001434 .000670 .001678 .000770 .001922 .000471 .001194 .000571 .001438 .000671 .001682 .000771 .001926 .000472 .001197 .000572 .001441 .000672 .001686 .000772 .001930 .000473 .001201 .000573 .001445 .000673 .001689 .000773 .001934 .000475 .001205 .0							
.000463 .001171 .000563 .001415 .000663 .001659 .000763 .001903 .000464 .001174 .000564 .001419 .000664 .001663 .000764 .001907 .000465 .001178 .000565 .001422 .000665 .001667 .000765 .001911 .000466 .001182 .000566 .001426 .000666 .001670 .000766 .001914 .000470 .001190 .000570 .001434 .000670 .001678 .000770 .001922 .000471 .001194 .000571 .001438 .000671 .001682 .000771 .001926 .000472 .001197 .000572 .001441 .000672 .001686 .000772 .001930 .000473 .001201 .000573 .001445 .000673 .001686 .000772 .001934 .000474 .001205 .000574 .001449 .000673 .001689 .000774 .001934 .000475 .001209 .0			.001411	.000662	.001655	.000762	.001899
.000464 .001174 .000564 .001419 .000664 .001663 .000764 .001907 .000465 .001178 .000565 .001422 .000665 .001667 .000765 .001911 .000466 .001182 .000566 .001426 .000666 .001670 .000766 .001914 .000470 .001186 .000567 .001430 .000670 .001674 .000770 .001922 .000471 .001190 .000570 .001434 .000670 .001678 .000770 .001922 .000472 .001194 .000571 .001438 .000671 .001682 .000771 .001926 .000473 .001201 .000572 .001441 .000672 .001686 .000772 .001930 .000474 .001205 .000574 .001445 .000673 .001689 .000773 .001934 .000475 .001209 .000575 .001453 .000674 .001693 .000774 .001937 .000476 .001213 .0							
.000465 .001178 .000565 .001422 .000665 .001667 .000765 .001911 .000466 .001182 .000566 .001426 .000666 .001670 .000766 .001914 .000470 .001186 .000570 .001434 .000670 .001678 .000770 .001922 .000471 .001194 .000571 .001438 .000671 .001682 .000771 .001926 .000472 .001197 .000572 .001441 .000672 .001686 .000772 .001930 .000473 .001201 .000573 .001445 .000673 .001689 .000773 .001934 .000474 .001205 .000574 .001449 .000674 .001693 .000774 .001937 .000475 .001209 .000575 .001457 .000676 .001701 .000775 .001945							
.000466 .001182 .000566 .001426 .000666 .001670 .000766 .001914 .000467 .001186 .000567 .001430 .000667 .001674 .000766 .001918 .000470 .001190 .000570 .001434 .000670 .001678 .000770 .001922 .000471 .001194 .000571 .001438 .000671 .001682 .000771 .001926 .000472 .001197 .000572 .001441 .000672 .001686 .000772 .001930 .000473 .001201 .000573 .001445 .000673 .001689 .000773 .001934 .000474 .001205 .000574 .001449 .000674 .001693 .000774 .001937 .000475 .001209 .000575 .001453 .000675 .001697 .001697 .000775 .001941 .000476 .001213 .000576 .001457 .000676 .001701 .000776 .001945							
.000467 .001186 .000567 .001430 .000667 .001674 .000767 .001918 .000470 .001190 .000570 .001434 .000670 .001678 .000770 .001922 .000471 .001194 .000571 .001438 .000671 .001682 .000771 .001926 .000472 .001197 .000572 .001441 .000672 .001686 .000772 .001930 .000473 .001201 .000573 .001445 .000673 .001689 .000773 .001934 .000474 .001205 .000574 .001449 .000674 .001693 .000774 .001937 .000475 .001209 .000575 .001453 .000675 .001697 .001697 .000775 .001945 .000476 .001213 .000576 .001457 .000676 .001701 .000776 .001945							
.000470 .001190 .000570 .001434 .000670 .001678 .000770 .001922 .000471 .001194 .000571 .001438 .000671 .001682 .000771 .001926 .000472 .001197 .000572 .001441 .000672 .001686 .000772 .001930 .000473 .001201 .000573 .001445 .000673 .001689 .000773 .001934 .000474 .001205 .000574 .001449 .00674 .001693 .000774 .001937 .000475 .001209 .000575 .001453 .000675 .001697 .000775 .001941 .000476 .001213 .000576 .001457 .000676 .001701 .000776 .001945							
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GLOSSARY

GLOSSARY OF TeleProgramming 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. Specifically, the borrow structure in the subject computer.

ADDRESS

The number designating a storage location; also the storage location itself.

NO ADDRESS MODE The TeleProgrammer permits the performance of arithmetic and logical operations by an 8-bit constant associated with the instruction and using the memory location immediately following the instruction as an 8-bit operand.

MEMORY ADDRESS MODE A mode of addressing wherein an 8-bit operand in any storage location is addressed by the memory location (immediately following the instruction) and the contents of the Tag register as referenced by T.

INDIRECT ADDRESS MODE Instructions employing indirect addressing use the memory location immediately following the instruction to refer to one of the first 256 storage locations. The contents of this location are used along with the contents of the Tag register to form the address of the operand.

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

BORROW In a subtractive counter or accumulator, a signal

indicating that in stage n, a "1" was subtracted

from a "0".

BUFFER Noun: A device in which data are stored tem-

porarily in the course of transmission from one point to another. Verb: To store data temporarily.

BUFFERED INPUT/OUTPUT

A term indicating that the computer may carry on high speed computation at the same time it is exchanging data with a peripheral device. In the TeleProgrammer, this term must be distinguished from normal I/O, during which the computer cannot engage in computation.

CARRY

In an additive counter or accumulator, a signal indicating that in stage n, a "1" was added to a "1".

CHANNEL

A transmission path that connects the computer to a given external equipment.

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 transmitting contents of one register to another, shifting a register, setting a flip-flop.

COMPLEMENT

Noun: See One's Complement to 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 device 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 command.

END-AROUND BORROW

A borrow that is generated in the highest order of an accumulator or counter, and is sent directly to the lowest order stage.

ENTER

To manually place in a register a quantity that is not from storage. In the TeleProgrammer, quantities may be entered in only the Tag A, P, and Z registers.

FUNCTION CODE

The lower 2 octal digits of the first word in the instruction set.

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.)

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.

JUMP

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

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 "0", 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.

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

The quantity specified by the 8 bits of the second word of the instruction set. This quantity is operated upon in the execution of the instruction.

OPERATION CODE

The lower 2 octal digits of the first word in the instruction set also called Function Code and identified by the letter, F. After the code is translated, it conditions the computer for execution of the specified instruction.

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.

QUARTIC

A number system with a base of four. These numbers are normally partitioned into groups of two for ease of reading.

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.

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 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.)

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 highest-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 8 bits.

WRITE

To enter a quantity into a storage location.

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