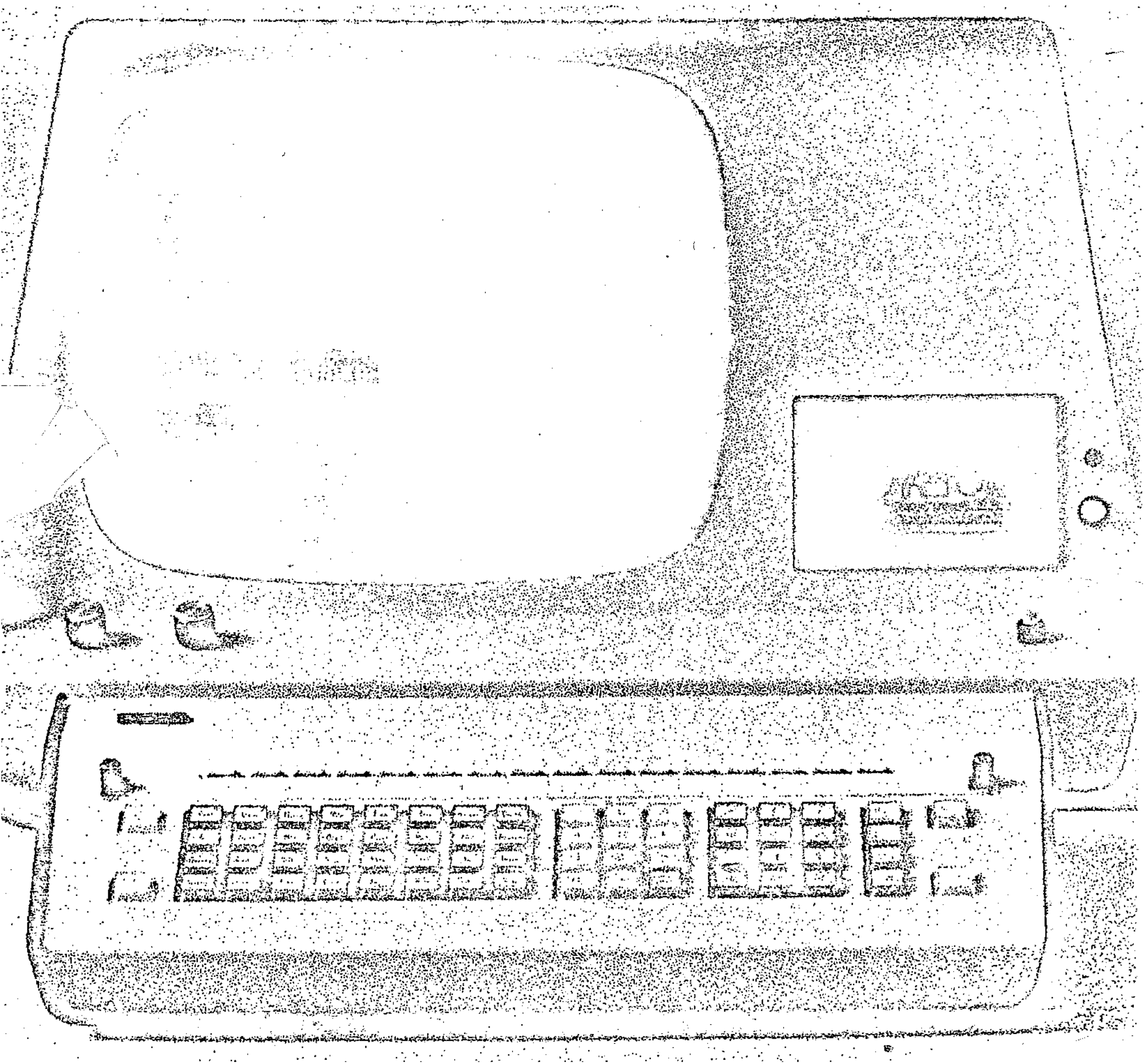
MODEL 2207A I/O
INTERFACE CONTROLLER
REFERENCE MANUAL
(Preliminary)

SYSTEM 2200



CHAPTER 1

2207A I/O

INTERFACE CONTROLLER

REFERENCE MANUAL

HOW TO USE THIS MANUAL

This manual provides an introduction to the operation and use of the Wang Model 2207A I/O Interface Controller.

Its primary purpose is to serve as a clear and concise reference manual for the users of the Controller Board; it is assumed that the reader is familiar with the operation of the System 2200 and its BASIC language features.

MODEL 2207A I/O INTERFACE CONTROLLER BOARD

Chapter 1. General Introduction

The Model 2207A I/O Interface Controller provides the capability to interface the Wang System 2200B CPU with a RS-232-C compatible teletype (not supplied by Wang) or teletype compatible peripherals terminal and laboratory instrumentation at up to 1200 baud.

This option is available on the System 2200A in limited use only where the teletype is used only as a "dumb" Input/Output terminal. The paper tape cannot be used with the System 2200A.

The Model 2207A describes two standard teletype signals: BREAK and ESCAPE (ESC) into HALT/STEP and RESET, respectively, to provide operational control in the System 2200B.

The System 2200B language contains features that can command the Teletype to perform input or output operations with data or programs. The Model 2207A operates at switch selectable baud rates (asynchronous) of 110, 150, 300, 600 and 1,200 with either of the following code formats: (a) 1 start bit, 8 data bits and 2 stop bits, or (b) 1 start bit, 7 data bits plus an even parity bit and 2 stop bits.

The Model 2207A has two modes of operation which can be selected by a switch. For the normal mode, for operations with a Teletype terminal or Teletype tape using ASCII characters, the data format of 7 data bits plus even parity bit is selected. The high order parity bit is stripped when each character is read. In addition, a break signal, when received, produces a HALT/STEP command in the System 2200B, and an ESC character (ESCAPE) produces a RESET command in the System 2200B. This functionally provides complete System 2200B keyboard operation using a Teletype.

In the second mode, where binary data is wanted from a Teletype tape or Teletype compatible instrument, the 8 data bit characters (code) format is selected. All eight data bits are received in the System 2200B. In addition, the BREAK and ESC character special decoding is inhibited.

PIN ASSIGNMENTS FOR 2207A

PIN NUMBERS	DESCRIPTION	TO TTY	FROM TTY	GROUND
1	Protective Ground			X
2	Transmitted Data		X	
3	Received Data	X		
4				
5	Clear To Send	X		
6	Data Set Ready	X		
7	Signal Ground (Common Return)			X
8	Received Line Signal Detector	X		
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20	Data Terminal Ready		X	
21				
22				
23				
24				
25				

MODEL 2207A FEATURES RS-232-C COMPATIBILITY

The EIA (Electronics Industry Association)

Standard specifications defining the pin assignment and signals for interconnection of Data Terminal Equipment with Communication Channel is called RS-232-C. The Model 2207A I/O Interface Controller is designed to be compatible with the widely used standard RS-232-C.

2200A CPU 2200B CPU

The 2207A can be purchased with either the 2200A ~~and~~ or the 2200B CPU ~~'s~~, however, if the 2200A CPU is ordered, only the keyboard and printer on the teletype can be used. The 2200A CPU cannot accommodate the paper tape reader, or punch paper tape, this capability is only available on the 2200B.

UNPACKING AND INSTALLATION

Call your Wang Service Representative and request installation of the Model 2207A I/O Controller Board.

The procedure for unpacking and installation ~~of~~ the system for ~~its~~ use, is as follows:

Carefully unpack all equipment and inspect the units for shipping damage. If damage is noticeable do not proceed; notify the shipping agency. Check each unit received against the purchase order, decals specifying model number can be found on all Wang equipment.

INSTALLATION

(1) Model 2207A controller should be plugged into the System 2200 CPU

(2) Connect CPU to power supply

(3) Connect teletype cable to 2207A controller board

(4) Plug in power cable of the teletype

(5) Plug in power cable of the power supply

TRANSMISSION TIMING 2207A

The transmission timing is expressable in either character-per-second or milliseconds per character. However, the data transfer rate is baud and the total bits-per-character in the format must be known.

TRANSMISSION TIMING IN CHARACTERS-PER-SECOND

TOTAL BITS PER CHARACTER / DATA RATE IN BAUD	7	8	9	10	11	12
110	15.71	13.75	12.22	11.00	10.00	9.16
150	21.42	18.75	16.66	15.00	13.63	12.50
300	42.85	37.50	33.33	30.00	27.27	25.00
600	85.71	75.00	66.66	60.00	54.54	50.00
1200	171.42	150.00	133.33	120.00	109.09	100.00

TRANSMISSION TIMING IN MILLISECONDS PER CHARACTER

TOTAL BITS PER CHARACTER / DATA RATE IN BAUD	7	8	9	10	11	12
110	63.63	72.72	81.81	90.90	100.00	109.09
150	46.66	53.33	59.99	66.66	73.33	80.00
300	23.33	26.66	30.00	33.33	36.66	40.00
600	11.66	13.33	15.00	16.66	18.33	20.00
1200	5.83	6.66	7.50	8.33	9.16	10.00
1800				4.17		
2400				2.08		

TELETYPE CONTROL KEYS

HALT/STEP = BREAK

To halt a program the BREAK key must be held down a minimum of 1/4 of a second.

RESET = ESC

EDITING KEYS

← = BACKSPACE

= LINE ERASE

NOTE:

Conversion of teletype equipment to EIA standard RS-232-C must be accomplished by the customer. See Appendix of suggested conversion kits.

MAXIMUM CABLE LENGTH

50 feet

CHAPTER 3

NON-PROGRAMMABLE COMMANDS

BASIC STATEMENTS

DATALOAD

TELETYPE STATEMENT SYSTEM 2200B ONLY

General Form: DATALOAD [#n, /xxx,] argument list

where #n = Logical file number to which a device address has been assigned (n is integer from 1 to 6).

4xx = Device address of Teletype. Output (41D, 41E or 41F)

If neither of the above is specified, the default device address (the device address currently assigned to TAPE (see SELECT)) is used.

argument list = {variable / array designator} , . . .

array designator = array name ( ) e.g., A$( ), B( )

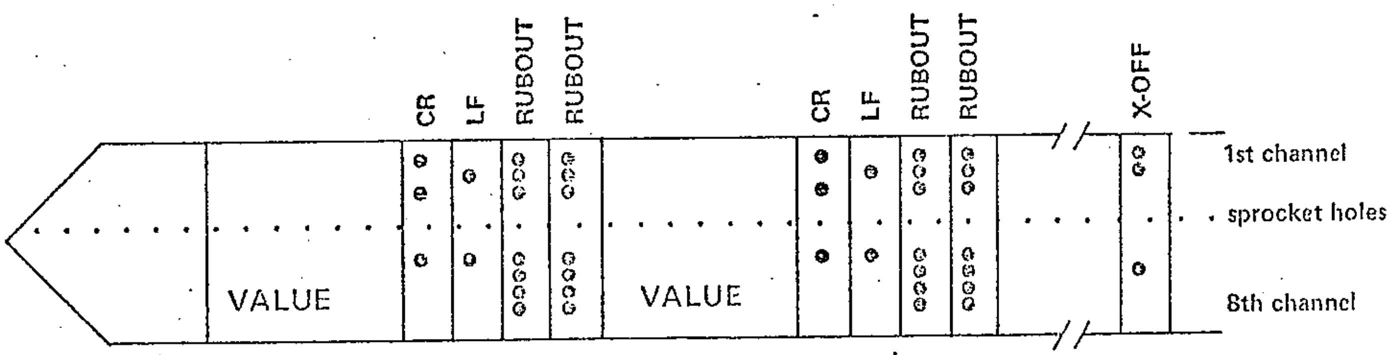
Purpose

This statement reads values from the Teletype paper tape and sequentially assigns those values to the variables in the argument list. Numeric values can be assigned to alphanumeric variables; values assigned to numeric variables must be legitimate BASIC numbers. Arrays are filled row by row.

Values are successively read from the tape until all variables in the list are satisified or until the end-of-file is encountered (i.e., an X-OFF character is read). When an end-of-file is encountered, the remaining variables in the list are left with their current values; an IF END THEN statement then causes a transfer to the specified line number.

The System 2200 will automatically transmit a X-ON character to the Teletype to start the tape reader, and a X-OFF character to stop it when reading is completed.

To be read, the paper tape must conform to the following format:



Values are punched in ASCII character code and are separated by CR LF RUBOUT RUBOUT. All other RUBOUTS and nonpunched frames on the tape are ignored when the tape is read. DATALOAD reads only the first seven channels of the tape; the 8th bit is always read as 0.

Paper tapes punched on a Teletype via DATASAVE statements conform to this format. To read tape not in this format, use the DATALOAD BT statement.

Example:

```
DATALOAD X, Y, A$, B$
DATALOAD #3, N( ), A$
DATALOAD /41D, A1$( ), X, Y
DATALOAD STR (A$, I, J)
```

General Form:

DATALOAD BT [([N=expression], [L= {xx / alpha-variable}], [S= {xx / alpha-variable}])] [#n, / /4xx,] {alpha variable / alpha array designator}

where N = Number of characters to read.

L = Leader code character (ignored when reading until a different character code is read).

If alpha variable is specified, the first character is used to specify the leader code.
If L is not specified, no leader code is assumed.

S = Stop character.

If alpha variable is specified, the first character is used to specify the stop code.

x = Hexadecimal digit (i.e., 0-9 or A-F).

#n = Logical file number to which a device address has been assigned (n is integer from 1 to 6).

4xx = Device address of Teletype. Output (41D, 41E, or 41F)

If neither of the above is specified, the default device address (the device address currently assigned to TAPE (see SELECT)) is used.

*Commas must separate N, L, S arguments if more than one is present.

Purpose

This statement reads a paper tape and stores the characters read in the alpha variable or alpha array designator specified. The tape is read until the stop character is encountered, the alpha variable or array is full, or the number of characters specified by N are read, whichever occurs first. All eight channels of the paper tape are read.

The System 2200 automatically sends out an X-ON character to start the Teletype tape reader and an X-OFF character to stop it. Because two additional characters are read after the X-OFF is sent, the following considerations should be observed. For termination by count (N parameter), the system normally sends out the X-OFF character after N-2 characters have been read. Therefore, if the number of characters to be read is specified by N, N should by ≥ 3. If N = 1 (or 2), the next 2 or (1) characters may be lost. Similarly, if reading is terminated by filling the variable or array, the number of characters in the variable or array should be ≥ 3. If a stop character is encountered, the stop character and the next 2 characters are read; the tape then stops. The 'L' parameter specifies the leader code on the paper tape; when a tape is read, leader code is ignored (i.e., all characters read which are equal to the specified leader code character are ignored until a character not equal to the leader code is recognized).

DATALOAD BT permits paper tapes in any format to be read by the System 2200. The data read then can be converted into a form usable by the System 2200 using System 2200 data manipulation statements.

Examples:

```
DATALOAD BT /41D, A$
DATALOAD BT (L=FF, S=0D) #1, A$( )
DATALOAD BT (N = 100) A$( )
DATALOAD BT (N=20, L=00, S=A$) A1$( )
```

General Form:

DATASAVE [#n, /4xx,] {OPEN "name" | END | argument list}

where #n = Logical file number to which a device address has been assigned (n is integer from 1 to 6).

4xx = Device address of Teletype. Output (41D, 41E, or 41F)

If neither of the above is specified, the default device address (the device address currently assigned to TAPE (see SELECT)) is used.

argument list = {literal string | alpha variable | expression | array designator} , . . .

array designator = variable name ( ) (e.g., A$( ), B( )

name = 1 to 8 characters (note, the name is required but is not used).

OPEN = Punch leader code (50 null characters).

END = Punch X-OFF character and trailer code (50 null characters).

Purpose

This statement causes the values specified in the argument list to be punched on paper tape. Numeric values are written in a form identical to that resulting from a PRINT statement:

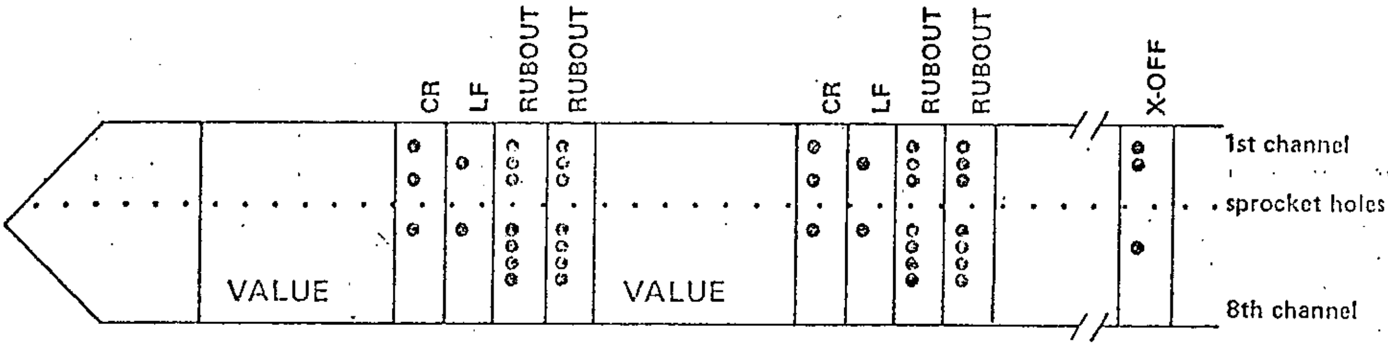
Format 1: SM.MMMMMMMMME+XX $10^{-1} > \text{value} \geq 10^{+13}$

Format 2: SZZZZZZ.FFFFFFF $10^{-1} \leq \text{value} < 10^{+13}$

where:
M = mantissa digits
X = exponent digits
F = fraction digits
Z = integer digits
S = minus sign if value < 0, or blank if value ≥ 0

Alphanumeric values are written identically to the character string data they contain; trailing spaces in values of alphanumeric variables are not written. Alphanumeric values must not contain any of the following characters; CR, RUBOUT, X-OFF, null. The OPEN parameter writes leader code (50 null characters). The END parameter terminates the data file by punching an X-OFF character and trailer code (50 null characters).

The paper tape is punched in the following format:



Values are punched in ASCII character code and are separated by CR LF RUBOUT RUBOUT.

If the Teletype has the facility for turning the tape punch on and off with TAPE-ON and TAPE-OFF codes these can be utilized under program control by transmitting the codes to the Teletype by a PRINT statement prior to and after punching.

Example:

```
DATASAVE X, Y, A$
DATASAVE OPEN "TTY"
DATASAVE END
DATASAVE #1, A$( )
DATASAVE /41D, N( ), A$, X, Y, Z
DATASAVE STR(A$, I, J), HEX(FAFB)
```

General Form: DATASAVE BT [#n, | /4xx,] {alpha variable | alpha array designator}

where #n = Logical file number to which a device address has been assigned (n is integer from 1 to 6).

4xx = Device address of Teletype. Output (41D, 41E, or 41F)

If neither of the above is specified, the default device address (the device address currently assigned to TAPE (see SELECT)) is used.

alpha array designator = alpha array name ( ) (e.g., A$( ))

Purpose

This statement punches the values of an alpha variable or alpha array onto a paper tape with no control information (i.e., no CR LF RUBOUT RUBOUT separating values). Trailing spaces in alpha values are punched.

DATASAVE BT permits paper tapes to be punched in any format. Any 8-bit codes may be punched.

If the Teletype has the facility for turning the tape punch on and off with TAPE-ON and TAPE-OFF codes these can be utilized under program control by transmitting the codes to the Teletype by a PRINT statement prior to and after punching.

Example:

```
DATASAVE BT #2, A$( )
DATASAVE BT /41D, B1$
DATASAVE BT Q$( )
```

LOAD

TELETYPE COMMAND SYSTEM 2200B ONLY

General Form: LOAD [#n, /4xx,]

where #n = File number to which a device address is currently assigned (n - an integer from 1 to 6).

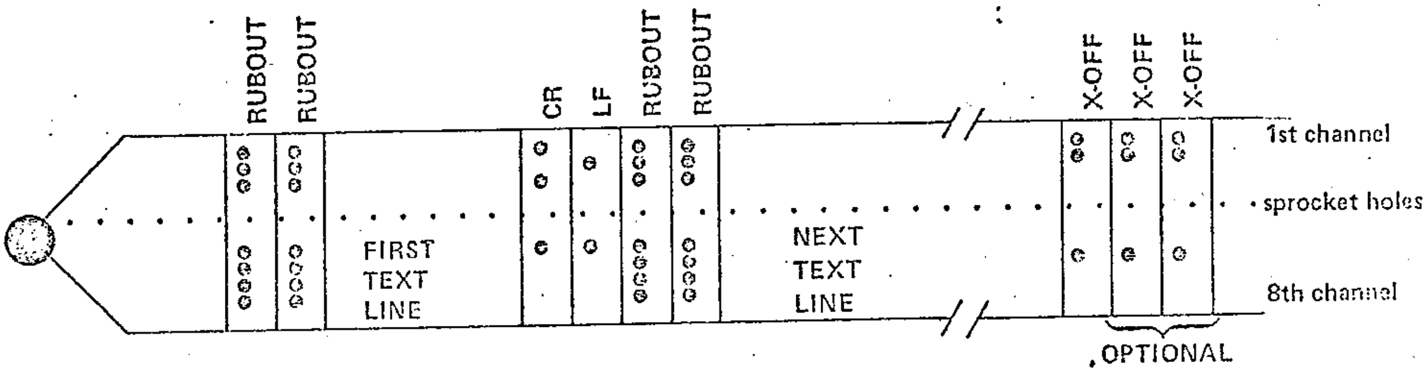
/4xx = Device address of device to load from. (41D, 41E, or 41F)

If neither of the above is specified, the default device address (the device address currently assigned to TAPE (see SELECT)) is used.

Purpose

When the LOAD command is entered, the program punched on the paper tape is loaded and appended to the current program in memory. This command permits additions to a current program, or if entered after a CLEAR command, entry of a new program.

To be read, the paper tape must conform to the following format:



Text lines are punched in ASCII character code and are separated by CR LF RUBOUT RUBOUT. The program is terminated by 3 X-OFF characters. LOAD reads only the first seven channels of the paper tape; the 8th bit is always read as 0. Nonpunched frames and RUBOUTS are ignored when reading the tape.

LOAD also can be used as a program statement, as described on the next page.

Examples:

```
LOAD
LOAD #1
LOAD /41D
```

Text lines are punched in ASCII character code and are separated by CR LF RUBOUT RUBOUT. The program is terminated by three X-OFF characters. LOAD reads only the first seven channels of the paper tape; the 8th bit is always read as 0. Nonpunched frames and RUBOUTS are ignored when reading the tape.

In immediate execution mode, LOAD is interpreted as a command (see LOAD command).

Example:

```
100 LOAD
100 LOAD #2
100 LOAD /41D
100 LOAD #2, 400, 1000
100 LOAD /41D, 100
```

LOAD

TELETYPE STATEMENT SYSTEM 2200B ONLY

General Form: LOAD [#n, /4xx,] [line number 1 [,line number 2]]

where

- #n = File number to which the device is currently assigned (n is an integer form 1 to 6).
- 4xx = Device address of Teletype.

  If neither of the above is specified, the default device address (the device address currently assigned to TAPE (see SELECT)) is used.
- line number 1 = The line number of the first line to be deleted from the program currently in memory, before loading the new program. After loading, execution continues at the line whose number is equal to 'line number 1'. An error will result if there is no line number = 'line number 1' in the new program.
- line number 2 = The line number of the last line to be deleted from the program currently in memory, before loading the new program.

Purpose

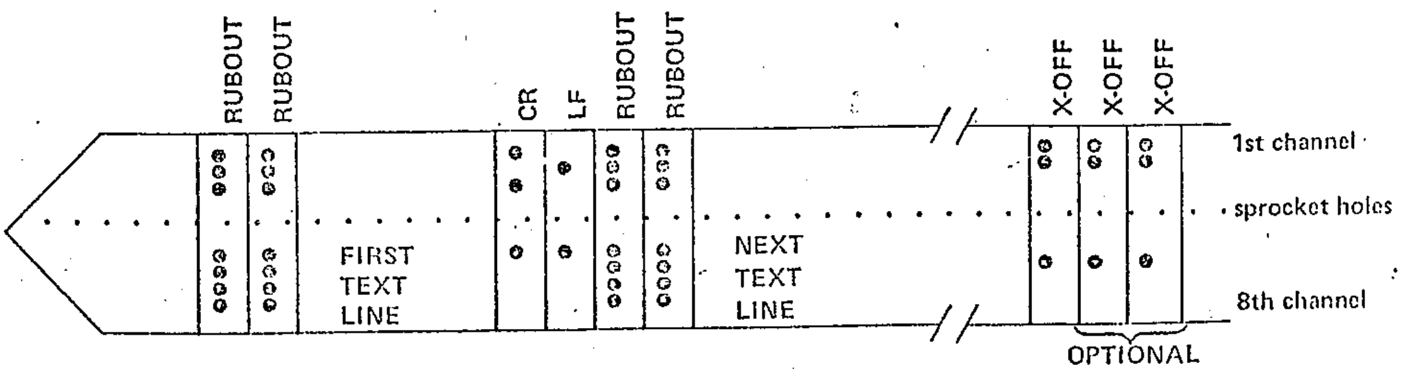
This is a BASIC program statement which, in effect, produces an automatic combination of the following:

STOP	(stop current program execution)
CLEAR P	[line number 1 [,line number 2]] (remove program text)
CLEAR N	(remove noncommon variables only)
LOAD	(load new program)
RUN	[line number 1] (run new program)

If only 'line number 1' is specified, the remainder of the current program is deleted starting with that line number. If no line numbers are specified, the entire current program is deleted, and the newly loaded program is executed from the lowest line number.

This permits segmented jobs to be run automatically without normal user intervention. Common variables are passed between program segments. LOAD must be the last statement on a statement line.

To be read, the paper tape must conform to the following format:



The LOAD statement must not be within a FOR/NEXT loop or subroutine; an error results when the NEXT or RETURN statement is encountered.

General Form: SAVE [#n, /4xx,] [line number [,line number]]

where #n = File number to which device address is assigned (#1 to #6).

4xx = Device address of Teletype. (41D, 41E, or 41F)

If neither of the above is specified, the default device address (the device address currrently assigned to TAPE, (see SELECT)) is used.

1st line number = Starting line number to be saved.

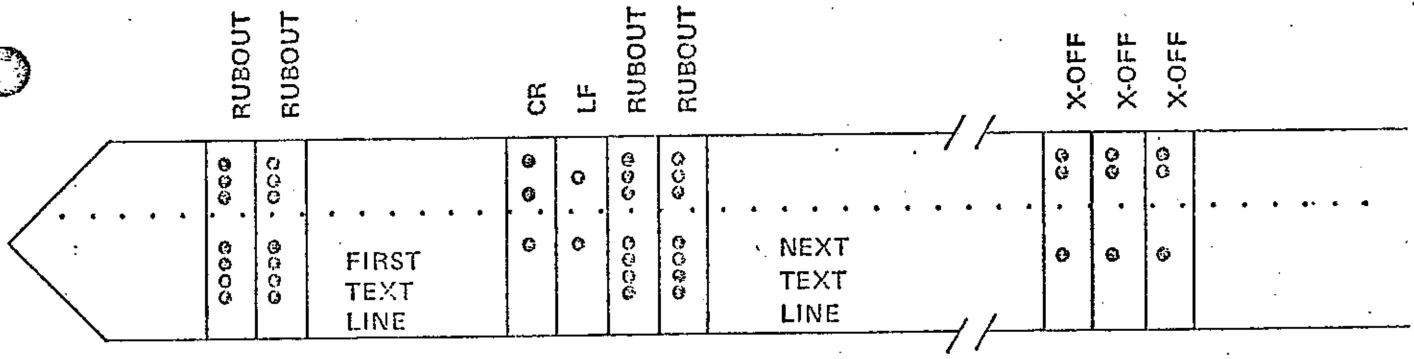
2nd line number = Ending line number to be saved.

Purpose

The SAVE command causes BASIC programs (or portions of BASIC programs) to be punched on paper tape.

If no line numbers are specified, the entire user program text is saved. SAVE with one line number causes all user program lines from the indicated line through the highest numbered program line to be punched on tape. If two line numbers are entered, all text from the first through the second line number, inclusive, is punched.

The paper tape format is:



Text lines are punched in ASCII character code and are separated by CR LF RUBOUT RUBOUT. The program is terminated by 3 X-OFF's.

Examples:

```
SAVE
SAVE #3
SAVE /41D
SAVE /41D, 100, 200
SAVE #5, 400
```

CHAPTER 4

APPENDIX

[illegible] – CHAINING

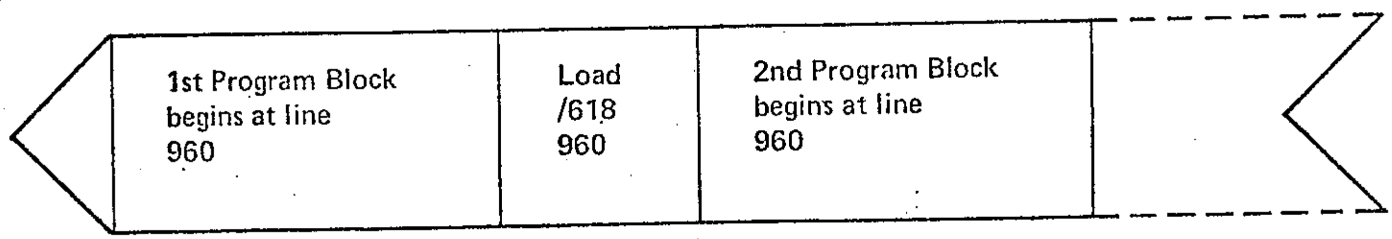
One important use of the LOAD statement is in the technique known as chaining. Chaining makes possible the execution of programs too large to be stored in memory. Although this technique is most commonly used with tape cassettes, it is readily adaptable for use with the paper tape reader. Suppose, for example, that you have written a program too large for the 8K memory of your machine (remember that 700 bytes are reserved for "housekeeping" and cannot be utilized for storage of program text or data; since an 8K machine actually has 8192 bytes of storage space, this leaves about 7500 bytes available for storing program text). Suppose, further, that your program incorporates a large number of subroutines which are referred to throughout the program. The following procedure would allow you to "chain" the program and run it despite the fact that it is too large for memory.

1. Store the subroutines which are common throughout the program in memory (assume they occupy lines 10-950 and take up 2400 bytes of memory).
2. Assume that 2100 bytes are required for the storage of variable data.
3. Write the main program and save it on punched paper tape. The program must be broken up into a series of segments, or 'blocks', designed to fit into the remaining memory space (in this case, 3000 bytes). Assuming that your main program occupies 6000 bytes, you will need to break it down into two blocks of 3000 bytes each (i.e., 2400 + 2100 + 3000 = 7500 bytes).

> NOTE:
>
> *Since program text lines have varying lengths, it is often difficult to estimate how many bytes of memory a program requires. Refer to Appendix B of your* System 2200 BASIC Programming Manual, *"Estimating Program Memory Requirements".*

4. Number the program text lines in each program block with the same sequence of line numbers, starting with the line number immediately following the last line of programming in memory (in this case, since your subroutines occupy lines 10-950 in memory, you would begin numbering the text lines in each block on tape at 960).
5. At the end of the first block, as the final statement in that block, add a LOAD /618, 960 statement.
6. Insert the tape in the Paper Tape Reader and key a LOAD command (in Immediate Mode).

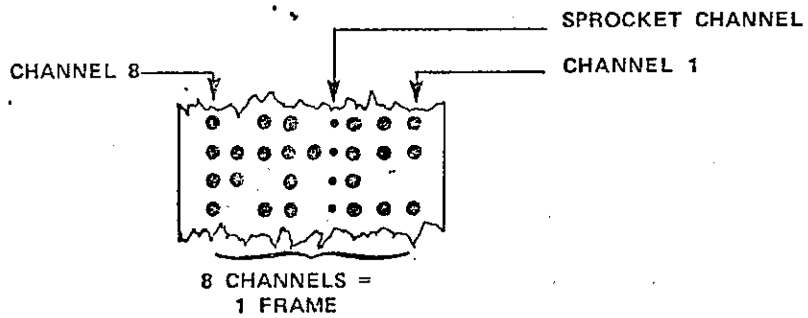
The calculator begins execution of the program immediately after it is stored in memory. It executes through the main program, diverging to subroutines as instructed, and comes finally to the LOAD statement. It then clears memory starting at line 960, and loads the next block of program text into the same space just occupied by the first block. This segment is executed until a second LOAD statement is encountered, and the process is repeated. In this way, extremely long programs can be broken down into segments which will fit into memory, be executed, and then discarded to make room for the next segment. Operations commonly used throughout the program can, on the other hand, be written as subroutines and permanently stored in memory.



[illegible] – ASCII CODES

ASCII character code is a standard coding system in which each number, letter, and symbol in the ASCII character set is assigned a unique 8-bit binary code (although in fact only 7 bits are actually used for the code, since the 8th bit is reserved in ASCII for parity). In the System 2200B, the 8th bit is automatically set equal to 0 when read in under LOAD and DATALOAD control; it is actually read only under DATA-LOAD BT control). This 8-bit binary code is, in turn, translated into a pattern of punches on paper tape.

Consider the following section of a paper tape:



> **NOTE:**
>
> *In order to read a paper tape properly, always position it so that the three data channels 1-3 are to the right of the sprocket channel and the five data channels 4-8 are to the left of the sprocket channel.*

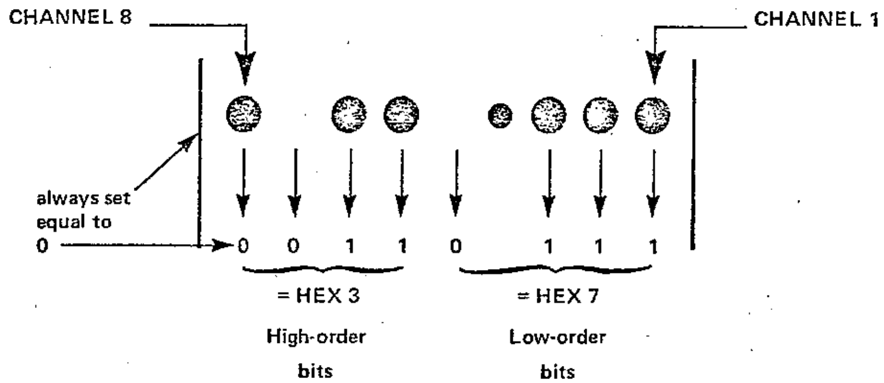
Each channel in which a hole is punched is read by the TELETYPE as a "1"; each channel in which no hole is punched is read as a "0". Thus each frame on the paper tape really represents a binary value, and each individual channel represents a binary digit, or bit (BInary digiT), either 1 or 0, depending on whether that channel is or is not punched.

The binary value punched in the first frame illustrated above is 10110111; remember, however, that the 8th bit is always set equal to 0 whether it is punched or not, under LOAD and DATALOAD control. Thus the binary value actually read into the system is 00110111. The table of ASCII codes on page [illegible] shows that 00110111 is the binary code in ASCII for the number 7. Therefore, this particular frame of a paper tape contains the number 7 in ASCII code. You can read any frame on tape in the same fashion, by checking the binary code in that frame and finding the character which corresponds to that code in the ASCII table.

Despite its value as a code which is readily translatable into a pattern of punches on tape, however, the notation of the binary system is somewhat ponderous to work with. For this reason, the Hexadecimal system has been developed as a means of expressing binary values in a shorthand notation. The Hexadecimal system is to the base 16. Every 4-bit binary value can be expressed by one of the 16 Hexadecimal digits. Thus every 8-bit binary value can be expressed as a 2-digit HEX number, and therefore every 8-bit binary code in ASCII is expressible as a 2-digit HEX number. Frequently in dealing with ASCII codes it is more efficient to refer to the 2-digit HEX code for a particular character than its equivalent 8-bit binary code. The 16 HEX digits with their binary as well as decimal equivalences are listed below (for a more detailed discussion of the Hexadecimal counting system and the System 2200 HEX function, consult your System 2200 BASIC Programming Manual).

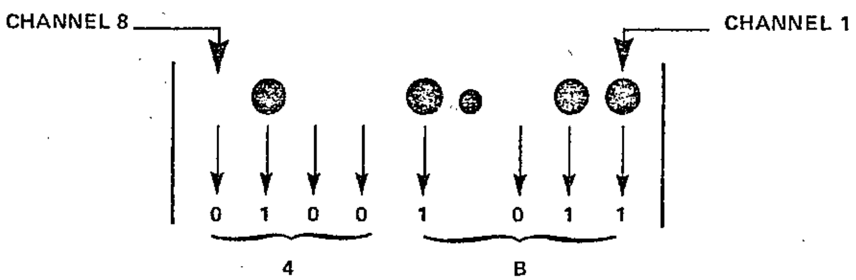
BINARY	HEXADECIMAL	DECIMAL EQUIVALENCE
0000	0	0
0001	1	1
0010	2	2
0011	3	3
0100	4	4
0101	5	5
0110	6	6
0111	7	7
1000	8	8
1001	9	9
1010	A	10
1011	B	11
1100	C	12
1101	D	13
1110	E	14
1111	F	15

The 2-digit HEX code for each frame of tape is related to the 8-bit binary code in the following way:



As you can see, the right 4 bits of each 8-bit binary value (tape channels 1-4) are represented by the right digit of the 2-bit HEX code; they are referred to as the "low-order" bits. The left 4 bits (channels 5-8) are represented by the left digit of the HEX code; they [illegible] called the "high-order" bits. The binary value in the above frame, then, is expressed in HEX shorthand as 37. The table on page [illegible] shows that HEX 37, like its binary equivalent 00110111, is the code in ASCII for 7. Often you'll find it convenient when reading a tape to convert each frame into a HEX code and then check the table for the characters corresponding to these HEX codes.

Letters and symbols are handled in a manner exactly analogous to numbers. The letter K, for example, is assigned the binary code 01000001 (HEX 4B) in ASCII. A frame punched with the letter K, then, would look like this:



[illegible] — Device Selection for System 2200 I/O Operations

Five address codes are designated as Primary Device Addresses in the System 2200 (see Table B-1). Devices with these default addresses are "selected" automatically whenever the system is Master Initialized (i.e., power is turned off and then on again).

TABLE B-1. PRIMARY DEVICE ADDRESSES FOR THE SYSTEM 2200

DEFAULT ADDRESS	I/O DEVICE CATEGORY	MODEL NUMBER	SELECT Statement I/O Class Parameter
001	Keyboards	2215 or 2222	CI (console input) INPUT
005	CRT	2216	CO (console output) PRINT LIST
10A	Tape drives	2217 or 2218	TAPE
310	Disks	2230 or 2240	DISK
413	Plotters	2202, 2212, or 2232	PLOT

Two or more model numbers in Table B-1 correspond to one default address in several cases. These models should be considered as "candidates" for the primary device address. Since device addresses within a configuration are unique, only one keyboard or one tape drive can be the primary device for a particular device category.

Input/output operations for the System 2200 are grouped in eight classes designated by the I/O "class parameters": CI, INPUT, CO, PRINT, LIST, TAPE, DISK, and PLOT. Chart B-1 identifies the I/O operations in each class, and Table B-1 gives the default device address for these classes of I/O operations.

To change the device address for particular I/O operations, use the SELECT statement. This statement has other uses; but, in every case, it requires a "select parameter" (see the Reference Manual). When selecting I/O peripheral devices, keep in mind that the select-statement-parameter is two-fold. It consists of an I/O class parameter and a three-digit device address.

For example, the statement

SELECT PRINT 215

instructs the system to access the Line Printer with address 215 for all subsequent output from Program Mode PRINT and PRINTUSING statements.

To reselect the CRT for this output, use the statement

SELECT PRINT 005

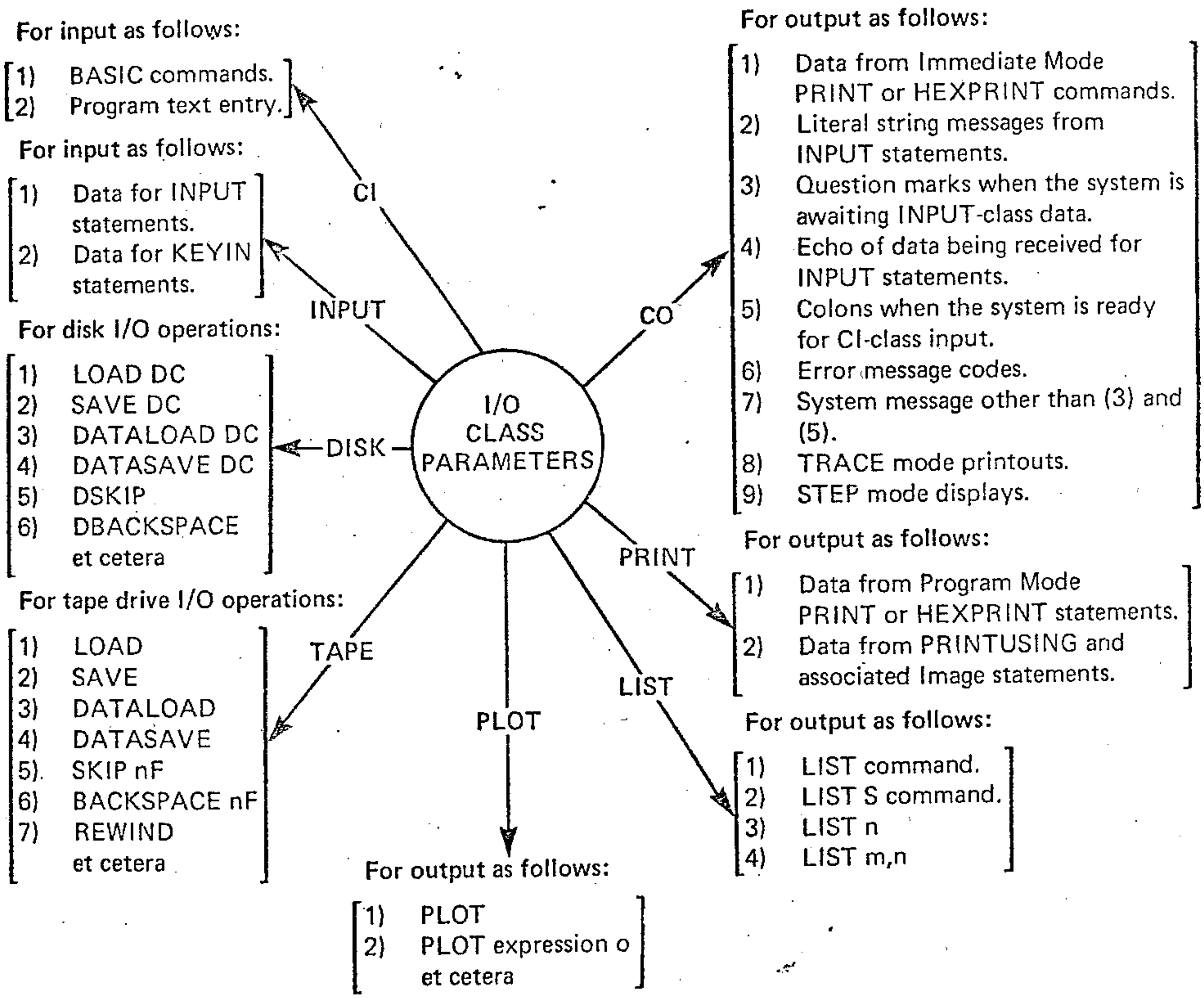
or Master Initialize the system if the memory can be cleared at this point.

Two or more devices performing different functions can be selected in one statement by using commas as device separators. For example,

SELECT LIST 215, PRINT 211, TAPE 10C

The SELECT verb "assigns" the specified device address to the specified I/O class parameter. Using a select-statement is analogous to setting an I/O-class rotor switch which includes the device-address-options for that class. All subsequent I/O operations in the I/O class are "switched" to the designated device until the system encounters another select-statement for that I/O class.

Chart B-1 I/O Operations and Class Parameters for the System 2200



NOTE:

This chart identifies the input/output operations in the eight System 2200 I/O classes. A class parameter (CI, INPUT, CO, PRINT, LIST, TAPE, DISK, or PLOT) with a device address is used in SELECT statements to change or reselect a device for I/O operations. The default address for CI and INPUT operations is 001 (the keyboard). The default address for CO, PRINT, and LIST operations is 005 (the CRT).

[illegible] – ASCII CONTROL AND GRAPHIC CHARACTERS IN HEXADECIMAL AND BINARY NOTATION

FORMATS:

HEXADECIMAL CODES: HEX (a_1 a_2)

7-BIT BINARY CODES: (b_7 b_6 b_5 b_4 b_3 b_2 b_1)

THREE BITS (HIGH ORDER) b_7 b_6 b_5 →		000	001	010	011	100	101	110	111
FIRST HEX DIGIT (HIGH ORDER) a_1 →		**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
SECOND HEX DIGIT (LOW ORDER) a_2	**FOUR BITS (LOW ORDER) b_4 b_3 b_2 b_1**								
0	0000	NUL	DLE	SP	0	@	P	`	p
1	0001	SOH	DC1	!	1	A	Q	a	q
2	0010	STX	DC2	"	2	B	R	b	r
3	0011	ETX	DC3	#	3	C	S	c	s
4	0100	EOT	DC4	$	4	D	T	d	t
5	0101	ENQ	NAK	%	5	E	U	e	u
6	0110	ACK	SYN	¢	6	F	V	f	v
7	0111	BEL	ETB	' (apos.)	7	G	W	g	w
8	1000	BS	CAN	(	8	H	X	h	x
9	1001	HT	EM	)	9	I	Y	i	y
A	1010	LF	SUB	*	:	J	Z	j	z
B	1011	VT	ESC	+	;	K	[	k	{
C	1100	FF	FS	, (comma)	<	L	\	l	¦
D	1101	CR	GS	— (dash)	=	M	]	m	}
E	1110	SO	RS	. (period)	>	N	↑	n	~
F	1111	SI	US	/	?	O	_ (underline)	o	DEL

CHARACTERS

LEGEND FOR ASCII CONTROL CHARACTERS

NUL	Null	DLE	Data Link Escape
SOH	Start of Heading	DC1	Device Control 1
STX	Start of Text	DC2	Device Control 2
ETX	End of Text	DC3	Device Control 3
EOT	End of Transmission	DC4	Device Control 4
ENQ	Enquiry	NAK	Negative Acknowledge
ACK	Acknowledge	SYN	Synchronous Idle
BEL	Bell (audible or attention signal)	ETB	End of Transmission Block
BS	Backspace	CAN	Cancel
HT	Horizontal Tabulation (punched card skip)	EM	End of Medium
LF	Line Feed	SUB	Substitute
VT	Vertical Tabulation	ESC	Escape
FF	Form Feed	FS	File Separator
CR	Carriage Return	GS	Group Separator
SO	Shift Out	RS	Record Separator
SI	Shift In	US	Unit Separator
		DEL	Delete

[redacted] — Device Addresses for System 2200 Peripherals

I/O DEVICE CATEGORIES	DEVICE ADDRESSES*
KEYBOARDS (2215, 2222)	001, 002, 003, 004
CRT (2216)	005, 006, 007, 008
TAPE CASSETTE DRIVES (2217, 2218)	10A, 10B, 10C, 10D, 10E, 10F
LINE PRINTERS (2221, 2231) (2261)	215, 216
OUTPUT WRITER (2201)	211, 212
THERMAL PRINTER (2241)	215, 216 (Revised 3/7/74)
PLOTTERS (2202, 2212, 2232)	413, 414
DISK DRIVES (2230-1, -2, -3) (2240-1, -2) (2242, 2243)	310, 320, 330
MARK SENSE (MANUAL) CARD READER (2214)	517
HOPPER FEED CARD READERS (2234, 2244)	629, (029)
PUNCHED TAPE READER (2203)	618
TELETYPE (2207)	019, 01A, 01B INPUT 01D, 01E, 01F OUTPUT
TELETYPE TAPE UNITS	41D, 41E, 41F
TELECOMMUNICATIONS (2227)	219, 21A, 21B INPUT 21D, 21E, 21F OUTPUT
PARALLEL I/O INTERFACE (2250)	23A, 23C, 23E INPUT 23B, 23D, 23F OUTPUT (Revised 3/7/74)
BCD INPUT INTERFACE (2252)	25A, 25B, 25C, 25D, 25E, 25F

*In some cases, more than one device address is listed for each device category. Unless otherwise noted, each peripheral device is assigned a unique address; device addresses are assigned sequentially. Therefore, if a System 2200 has only one device of a particular category (such as a tape drive), it is set up with the first device address listed (10A in the case of the tape drive). If it has two drives, they are set up with device addresses 10A and 10B. Each device address is printed on the interface card which controls that device.

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