Burroughs Corporation
Field Engineering Training
Detroit

Course No. BMG. . . 320526
INT.. . . 353360

Burroughs

B1700 I/O CONTROLS

STUDENT GUIDE

Printed in U.S. America 4-1-77

Form 1104783

B1700 I/O CONTROLS

STUDENT GUIDE

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FIELD ENGINEERING TRAINING

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COURSE LENGTH: 10 DAYS (80 HOURS)

COURSE NUMBER: 320526

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3/22/77
Date

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INTRODUCTION TO I/O

I/O BASE T/M SEC 2 P 1

1. YOU SHOULD BE AWARE OF THE LOCATION AND ROUTING OF SIGNAL CABLES WHICH CONNECT THE PROCESSOR TO THE I/O SECTION.

PRACTICE

LOCATE AND TRACE THE SIGNAL CABLES CONNECTING THE PROCESSOR TO THE I/O DISTRIBUTION CARD, INCLUDING CLOCK CABLES.

I/O BASE T/M SEC 6 P3

2. YOU SHOULD BE ABLE TO DETERMINE WHAT CONTROLS ARE INSTALLED ON ANY SYSTEM.

PRACTICE

LOCATE AND IDENTIFY THE VARIOUS CONTROL CARDS INSTALLED IN THE I/O BASE ON YOUR SYSTEM.

I/O BASE T/M SEC 6 P 3

3. YOU SHOULD BE ABLE TO DETERMINE IF THE CABLES FROM THE I/O CONTROLS TO THE PERIPHERAL DEVICES ARE PROPERLY INSTALLED.

PRACTICE

LOCATE AND TRACE THE CABLES CONNECTING THE I/O CONTROLS TO THEIR RESPECTIVE DEVICES.

TRN PRT T/M SEC 1 P 17

4. DEFINE THE VARIOUS FIELDS ASSOCIATED WITH AN I/O DESCRIPTOR.

P3/ Student Guide

E-Field Exiting Address

RS- Result Status - 24 bit Result descriptor field which contains info on the status of the last operation

Link - 24 bit field

OP Code - field contains descriptor

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INTRODUCTION TO I/O

I/O BASE T/M SEC 2 P 6,7	5. DEFINE THE EVENTS THAT TAKE PLACE DURING STATUS COUNTS 1 THRU 23. Learn
I/O BASE T/M SEC 2 P4,5,6	6. DEFINE THE USE OF EACH OF THE SIX BASIC I/O COMMANDS.
B1700 REF CARD PANEL 4 & I/O BASE T/M SEC 2 P5	7. DEFINE THE SIGNIFICANCE OF EACH OF THE 24 BIT POSITIONS IN EACH OF THE BASIC I/O COMMANDS.
I/O BASE T/M SEC 1 P 1	8. DEFINE THE FOLLOWING I/O CONTROL TERMS: A. CA B. RC Learn C. SR D. IOS

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INTRODUCTION TO I/O

I/O BASE T/M SEC 2 P 3 THRU 6

9. YOU SHOULD BE ABLE TO UTILIZE THE B1700 CONSOLE SWITCHES TO EXECUTE ~~ANY~~ All OF THE SIX BASIC I/O COMMANDS.

PRACTICE

THROUGH THE USE OF THE CONSOLE, LOAD AND EXECUTE 1C MICROS THAT WILL COMMUNICATE WITH THE SPO CONTROL USING THE FOLLOWING I/O COMMANDS:

A. XFROUTA

B. XFRIN

C. TEST STATUS

D. CLEAR AND TEST STATUS

E. TEST SERVICE REQUEST

F. TERMINATE DATA

I/O BASE T/M SEC 2 P 3 THRU 6, SPO T/M SEC 2 P 1, SEC 2 P 3, SEC 2 P 9

10. YOU SHOULD BE FAMILIAR WITH THE PROPER SEQUENCE OF STATUS COUNTS IN THE CONTROL AND THE FUNCTIONS THAT TAKE PLACE DURING VARIOUS STATUS COUNTS.

PRACTICE

THROUGH THE USE OF THE CONSOLE, CAUSE THE SPO CONTROL TO STEP THROUGH STC 1 THRU 23, FOR A READ OPERATION USING A COMBINATION OF ALL NECESSARY I/O COMMANDS. DURING THE OPERATION, CHECK TO MAKE SURE A SERVICE REQUEST WAS RAISED AND AT THE END MAKE SURE A VALID RESULT DESCRIPTOR WAS SENT TO THE PROCESSOR.

INTRODUCTION TO I/O

B1700 PROCESSOR T/M SEC 1 P 12 THRU 24, I/O BASE T/M SEC 2 P 3 THRU 6, SPO T/M SEC 2 P 1, SEC 2 P 9

11. YOU SHOULD BE ABLE TO COMMUNICATE WITH AN I/O DEVICE THROUGH THE USE OF A MICRO STRING.

PRACTICE

WRITE, LOAD INTO S MEMORY AND EXECUTE A MICRO PROGRAM TO PRINT YOUR FIRST NAME ON THE CONSOLE PRINTER.

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PCAP PERIPHERAL CONTROL ANALISIS PROGRAM

PCAP LISTING, SPO T/M

1. YOU SHOULD BE ABLE TO USE PCAP TO PERFORM AN I/O OPERATION.

PRACTICE

USING PCAP, PERFORM A TEST OP AND REPORT IMMEDIATELY ON THE SPO CONTROL WITH THE TRACE OPTION SET USING ONE DESCRIPTOR. USING THE TRACE OUTPUT, VERIFY THE STATUS COUNTS WERE IN PROPER SEQUENCE.

PCAP LISTING, SPO T/M

2. YOU SHOULD BE AWARE THAT I/O CONTROLS CAN BE MADE TO REPORT WHEN AN OPERATOR HAS MADE A CHANGE IN THE STATUS OF THE I/O DEVICE CONNECTED TO THE CONTROL.

PRACTICE

USING PCAP, PERFORM A TEST AND WAIT FOR ENQUIRY OP TO THE SPO CONTROL WITH THE TRACE OPTION SET USING ONE DESCRIPTOR. USING THE TRACE OUTPUT VERIFY THE STATUS COUNTS WERE IN PROPER SEQUENCE. CHECK THE RESULT DESCRIPTOR ALSO.

PCAP LISTING

3. THE STUDENT SHOULD BE ABLE TO UTILIZE THE CAPABILITY OF PCAP TO EXECUTE UP TO FOUR DESCRIPTORS AT ONE TIME.

PRACTICE

USING PCAP, PERFORM A TEST AND REPORT IMMEDIATELY OP TO THE FOLLOWING CONTROLS WITH THE TRACE OPTION SET USING FOUR DESCRIPTORS:

A. SPO

B. LINE PRINTER

C. DISK DEVICE

D. CARD DEVICE

PCAP PERIPHERAL CONTROL ANALISIS PROGRAM

PCAP LISTING, SPO CNTL T/M, DSK CTG CNTL T/M, MFCU CNTL T/M, TRN PRT CNTL T/M

4. USING THE PRINTOUT OBTAINED IN THE PREVIOUS OBJECTIVE, DETERMINE THE FOLLOWING FOR EACH DEVICE:

   A. DEVICE ID & CHANNEL NUMBER
   B. REFERENCE ADDRESS
   C. SEQUENCE OF STATUS COUNTS
   D. RESULT DESCRIPTOR

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CONSOLE PRINTER CONTROL

SPO MTR TEST ROUTINE
MANUAL

1. INSURE THAT THE SPO IS OPERATING PROPERLY.

PRACTICE

RUN THE SPO MTR IN DEFAULT MODE. AFTER SUCCESSFUL COMPLETION OF THE TEST IN DEFAULT MODE, RUN THE SPO MTR TEST IN SECTION 3 ONLY. INVOKE USERS OPTION TO BROADSIDE TYPE CHARACTER 1 AS "M"S AND CHARACTER 2 AS "Z"S.

PCAP LISTING

2. USING PCAP TO EXECUTE A READ OP FOR THE SPO, OBTAIN THE FOLLOWING:

   A. MEMORY ADDRESS OF THE I/O DESCRIPTOR.
   B. ADDRESS OF THE BUFFER.
   C. A PRINTOUT OF THE BUFFER.

PCAP LISTING

3. USING PCAP, PERFORM A WRITE OP TO THE SPO USING THE FA REGISTER AS THE DATA BUFFER. PRESET THE FA REGISTER TO THE EBCDIC CHARACTERS"1A3". OBTAIN THE FOLLOWING FROM THE TRACE OUTPUT:

   A. MEMORY ADDRESS OF THE I/O DESCRIPTOR.
   B. ADDRESS OF THE DATA BUFFER.
   C. A PRINTOUT OF THE DATA BUFFER.

CARD READER CONTROL

CARD READER MTR TEST ROUTINE MANUAL

1. INSURE THAT THE CARD READER IS OPERATING PROPERLY.

PRACTICE

EXECUTE THE CARD READER MTR IN DEFAULT MODE.

PCAP LISTING

2. YOU SHOULD BECOME FAMILIAR WITH THE OP CODES NECESSARY TO READ CARDS AND TO RECOGNIZE DATA THAT IS PUNCHED IN THE CARDS.

PRACTICE

USING PCAP, EXECUTE THE NECESSARY OPS TO READ A DECK OF CARDS AND PRINT THEM ON THE PRINTER. SEE YOUR INSTRUCTOR FOR A DECK OF CARDS.

PCAP LISTING

3. YOU SHOULD BE AWARE OF THE VARIOUS STATUS COUNTS THAT CAN OCCUR IN THE CARD READER CONTROL.

PRACTICE

USING PCAP, CAUSE AN ENTIRE READ OPERATION USING THE SINGLE STEP TOGGLES . USE THE TRACE OPTION ALSO. VERIFY THE STATUS COUNTS ON THE TRACE.

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96 COL CARD DEVICE CONTROL

MFCU MTR TEST ROUTINE
MANUAL

1. INSURE THAT THE CARD DEVICE IS OPERATING PROPERLY.

PRACTICE

RUN THE MFCU MTR TEST IN ALL SECTIONS. VERIFY THE RESULTS OF EACH SECTION BY READING THE MFCU MTR LISTING.

PCAP LISTING

2. YOU SHOULD BECOME FAMILIAR WITH THE VARIOUS OP CODES FOR THE MFCU.

PRACTICE

USING PCAP, PERFORM THE FOLLOWING OPS TO THE 96 COL. CARD DEVICE:

A. READ

B. PUNCH

C. PRINT

D. READ AND PRINT

PCAP LISTING

3. YOU SHOULD BE FAMILIAR WITH THE VARIOUS STATUS COUNTS ENTERED IN A CARD READ OPERATION ON THE MFCU CONTROL.

PRACTICE

USING PCAP, WITH THE TRACE TOGGLE SET, CAUSE A READ OP TO SINGLE STEP THROUGH ITS OPERATION. VERIFY CORRECT STATUS COUNTS WITH THE MFCU T/M.

DISK CARTRIDGE CONTROL

DISK CARTRIDGE MTR TEST ROUTINE MANUAL

1. INSURE THAT THE DISK CARTRIDGE IS OPERATING PROPERLY.

PRACTICE

USE THE DISK CARTRIDGE MTR TEST ROUTINE. PERFORM ALL SECTIONS.

PCAP LISTING

2. YOU SHOULD BE FAMILIAR WITH THE VARIOUS OPS FOR THE DSK CART. CONTROL.

PRACTICE

USING PCAP, PERFORM THE FOLLOWING OPS ON THE DISK SUBSYSTEM:

A. READ BURROUGHS FORMAT

B. WRITE BURROUGHS FORMAT

C. WRITE INITIALIZE

PCAP LISTING

3. YOU SHOULD BE ABLE TO INITIALIZE A CARTRIDGE BY USING PCAP.

PRACTICE

USING PCAP, FIRST WRITE INITIALIZE SECTOR 0, SECTOR 32, SECTOR 64, ETC. NEXT, WRITE BURROUGHS FORMAT , SECTORS 1 THRU 31, 33 THRU 63, 65 THRU 94, ETC. PROVE THAT IT IS INITIALIZED BY PERFORMING A READ BURROUGHS FORMAT ON THE ENTIRE SURFACE. IF HELP IS NEEDED, SEE YOUR INSTRUCTOR.

DISK CARTRIDGE CONTROL

PCAP LISTING

4. YOU SHOULD BECOME FAMILIAR WITH THE OPTIONS IN PCAP ASSOCIATED WITH DISK CARTRIDGE CONTROLS.

PRACTICE

USING PCAP, WRITE A KEYED ADDRESS PATTERN OVER AN ENTIRE DISK CARTRIDGE.

PCAP LISTING

5. YOU SHOULD BECOME FAMILIAR WITH THE OPTIONS IN PCAP ASSOCIATED WITH DISK CARTRIDGE CONTROLS.

PRACTICE

USING PCAP AND THE DISK CREATED BY THE PREVIOUS OBJECTIVE, READ THE INFORMATION BACK AND VERIFY THAT IT CORRECT.

PCAP LISTING

6. YOU SHOULD BE FAMILIAR WITH THE OPTIONS IN PCAP ASSOCIATED WITH DISK CARTRIDGE CONTROLS.

PRACTICE

USING PCAP, WRITE A ROTATING EBCDIC DATA PATTERN ON TEN SECTORS OF THE DISK CARTRIDGE.

PCAP LISTING

7. YOU SHOULD BE FAMILIAR WITH THE OPTIONS IN PCAP ASSOCIATED WITH DISK CARTRIDGE CONTROLS.

PRACTICE

USING PCAP AND THE DISK CREATED IN THE PREVIOUS OBJECTIVE, READ THE INFORMATION BACK, AND VERIFY THAT IT IS CORRECT.

DISK CARTRIDGE CONTROL

PCAP LISTING

8. YOU SHOULD BE FAMILIAR WITH THE OPTIONS IN PCAP ASSOCIATED WITH DISK CARTRIDGE CONTROLS.

PRACTICE

USING PCAP, PERFORM A CONTINOUS READ OPERATION OF THE ENTIRE DISK, AND USE AN INCREMENTING REFERENCE ADDRESS PATTERN.

PCAP LISTING, DSK CTG T/M

9. YOU SHOULD BE FAMILIAR WITH THE STATUS COUNT SEQUENCE DURING WRITE OPS ON THE DISK CARTRIDGE CONTROL.

PRACTICE

USING PCAP, OBTAIN A TRACE OF A TWO SECTOR WRITE OPERATION AND VERIFY THE SEQUENCE OF STATUS COUNTS BY USING THE DSK CTG T/M.

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TRAIN PRINTER CONTROL

TRAIN PRINTER MTR TEST ROUTINE MANUAL

1. INSURE THAT THE TRAIN PRINTER IS OPERATING PROPERLY.

PRACTICE

USING THE TRAIN PRINTER MTR TEST ROUTINE, RUN ALL SECTIONS OF THE TEST.

PCAP LISTING, TRAIN PRINTER T/M

2. YOU SHOULD BE FAMILIAR WITH THE VARIOUS OP CODES AVAILABLE FOR THE TRAIN PRINTER CONTROL.

PRACTICE

USING PCAP, PERFORM THE FOLLOWING OPS TO THE LINE PRINTER:

A. PRINT, SINGLE SPACE

B. PRINT, NO SPACE

C. PRINT, SKIP TO BOTTOM OF FORM

D. SKIP TO TOP OF FORM

FILE PARAMETER BLOCK (FPB)

Compilers build a File Parameter Block (FPB) for each file declared in an object program. The length of each FPB is one disk segment. The FPB defines the file and its characteristics. At BOJ, the MCP stores both the File Parameter Block and the Program Parameter Block in the log area on disk (regardless of the LOG option setting) for reference during execution.

NOTE

The disk space used to store the PPB and the FPBs is returned at EOJ if the LOG option has not been set.

FILE INFORMATION BLOCK (FIB)

A File Information Block (FIB) is an MCP table residing in memory containing information concerning a file. There is a FIB for every file that is processed. It is created from information in the associated File Parameter Block, and is used during the processing of the file. For example, the record size and blocking factor are two of the parameters that the FIB receives from the FPB.

Other information maintained by the MCP in the FIB consists of the input/output mode and the current status of the file, as well as counters and data reference pointers.

CHANNEL TABLE

The MCP Value stack contains a set of eight contiguous 24-bit fields (Q-7). Each field contains either a zero or the Channel table memory address corresponding to that port.

Each Channel table is an area in memory containing 16 entries, each 48 bits in length.

INPUT/OUTPUT ASSIGNMENT TABLE (IOAT)

The Input/Output Assignment Table (IOAT) is a memory resident table, constructed, and used exclusively by the MCP. The purpose of the IOAT is to retain information concerning the status and availability of all peripherals on the system.

Each of these is utilized as follows:

1. Clock cable, takes early system clock from the processor (clock module on B1720) to the I/O Subsystem. On the distribution card, this clock is retimed and shaped and becomes the I/O Clock, and is distributed via coax cables throughout the I/O Subsystem (See Below).

2. Sixteen Line Control Cable, carries five control signals (command active, response complete, service request, clear, power-on) between the processor and the I/O's. It is connected via chip sockets on both ends, due to lack of F/P connector space on the distribution board.

3. 50 Line Data cable, carries the I/O Bus (I/O Data Lines) of 24 signals between processor and I/O's. It is connected to F/P connector X# on the I/O Base.

The signals contained on these cables will be distributed to the I/O Controls in the I/O Base via the Backplane.

I/O SUBSYSTEM EXPANSION

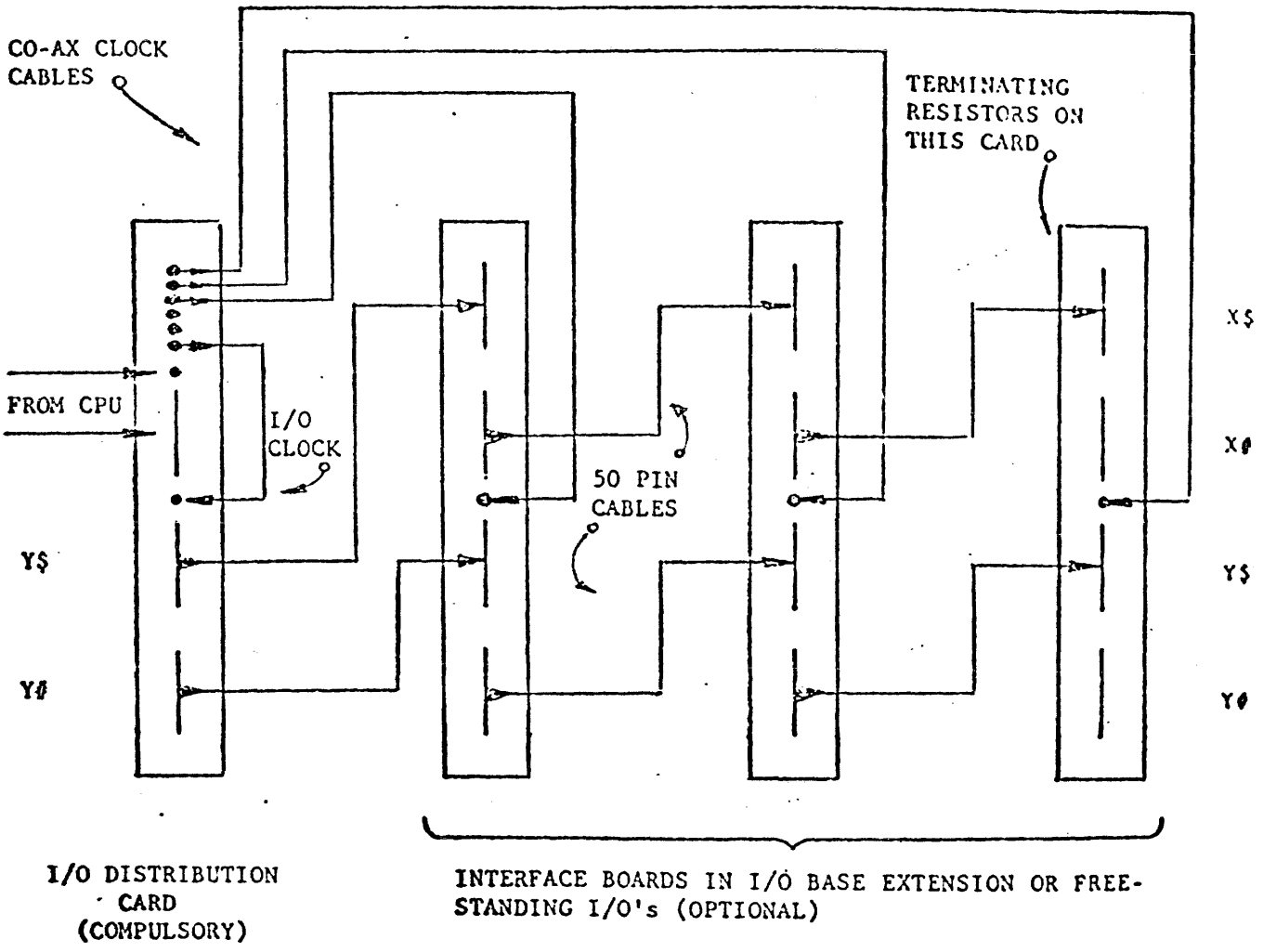
An I/O Base assembly is compulsory on all systems, but may not have sufficient space to contain all controls required. (e.g. three type B controls may be needed). There are two methods of expanding the I/O Subsystem, and they may be used singly, or together. The first is to add another I/O Base assembly, which is essentially the same as the first except for the interface board (now the sub-distribution board). This assembly is referred to as an 'I/O Base Extension', and one is allowed per system. It has identical capacity to an I/O Base.

The second is to add 'free standing' I/O Controls which come complete with their own backplane and interface card (e.g. Mag. Tape, Single Line). In either case interconnection to the I/O Base, and each other, is the same. A 'Daisy Chain' is created (via F/P Cables), and the I/O Bus and control signals are distributed along this chain, with termination of the signals always being on the last interface card in the chain, via pluggable load resistor packages.

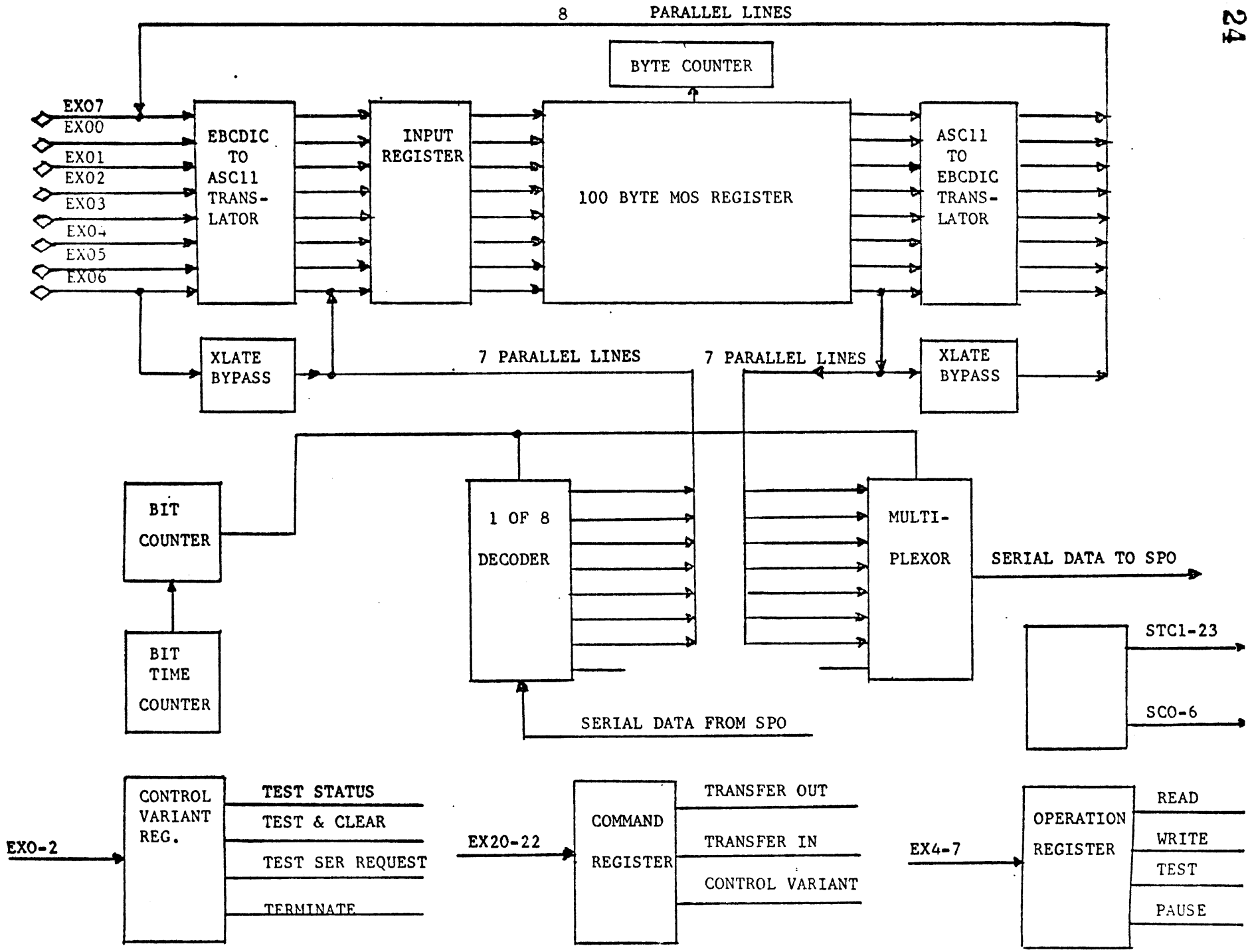
The interface card in any I/O Backplane (including the I/O Base) is always the right hand card as viewed from the frontplane. On most freestanding I/O's this is referred to as card 1, and will probably contain general control logic as well as the interface circuits for these controls.

Note that although the control signals between the CPU and the I/O Base are carried via a 16 pin special cable, distribution of these signals from the I/O Base to other I/O subassemblies is via a regular 50 pin F/P cable.

Consult the I/O Base Technical Manual for further information on this subject, and for I/O Clock adjustment procedures.



FRONT-PLANE INTERCONNECTION, I/O SUBSYSTEM EXPANSION


8 PARALLEL LINES
BYTE COUNTER
EX07
EX00
EX01
EX02
EX03
EX04
EX05
EX06
EBCDIC TO ASC11 TRANS-LATOR
INPUT REGISTER
100 BYTE MOS REGISTER
ASC11 TO EBCDIC TRANS-LATOR
XLATE BYPASS
7 PARALLEL LINES
7 PARALLEL LINES
XLATE BYPASS
BIT COUNTER
BIT TIME COUNTER
1 OF 8 DECODER
MULTI-PLEXOR
SERIAL DATA TO SPO
STC1-23
SCO-6
SERIAL DATA FROM SPO
EX0-2
CONTROL VARIANT REG.
TEST STATUS
TEST & CLEAR
TEST SER REQUEST
TERMINATE
EX20-22
COMMAND REGISTER
TRANSFER OUT
TRANSFER IN
CONTROL VARIANT
EX4-7
OPERATION REGISTER
READ
WRITE
TEST
PAUSE

CONTROL SIGNALS

The five Control Signals, which along with the I/O Bus itself complete the I/O Interface, are defined as follows. Four of the levels are generated within the processor, and one within the I/O Controls.

CA - COMMAND ACTIVE. CA indicates to the I/O Controls that a command is being transmitted to either one or all of them. The Control(s) designated must receive the command at this time.

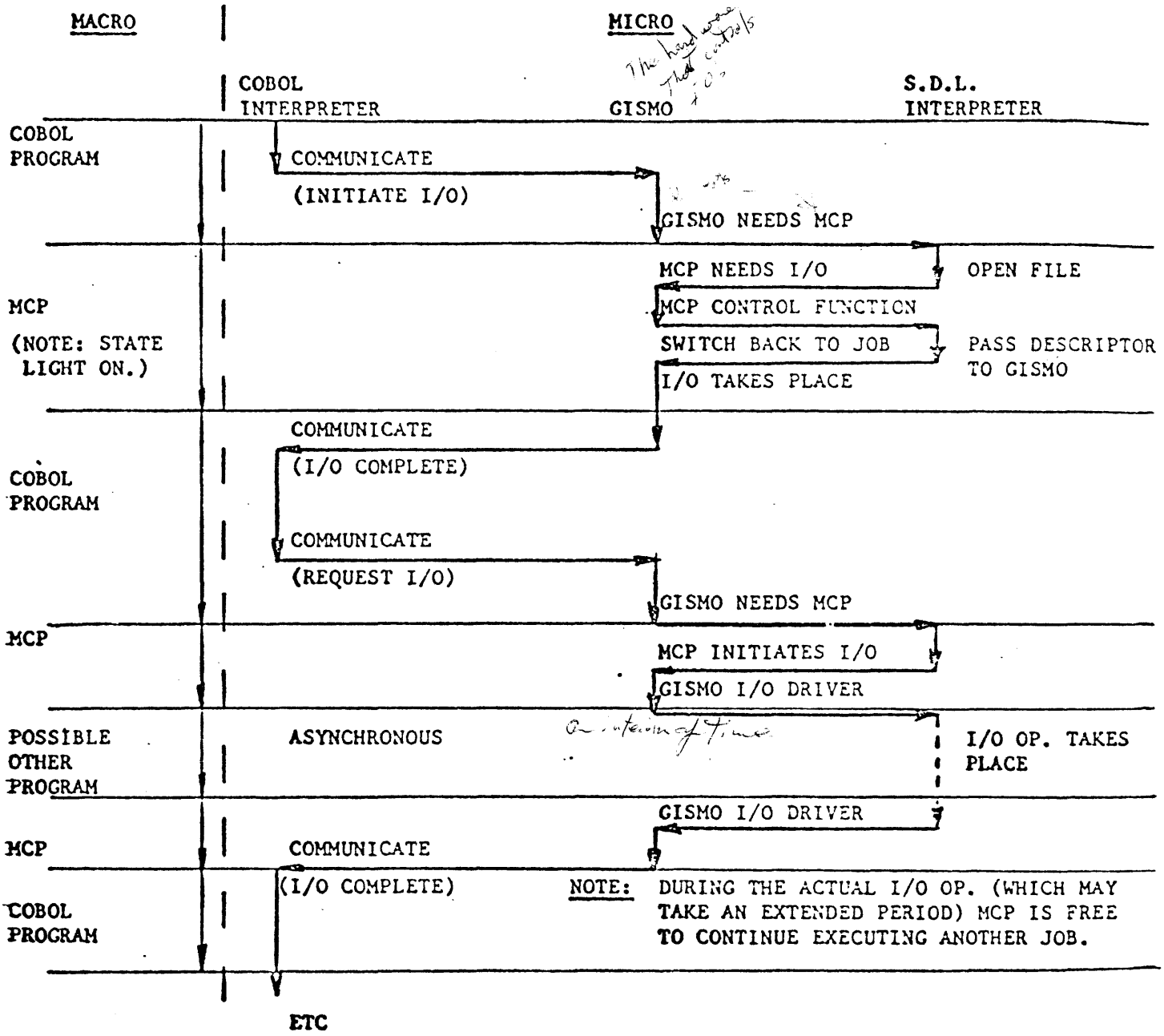
RC - RESPONSE COMPLETE. Normally indicates that a response to the command just issued by the processor is expected from an I/O Control or controls.

SR - SERVICE REQUEST. Is sent to the processor from an I/O Control when the control is at a point in its operation where it requires processor intervention - this is the only way an I/O can contact the CPU directly. SR true will set CC Register bit 1 true, and this should be picked up by the software currently active which should then initiate the appropriate I/O handling routine.

CLRB - CLEAR BUS. Is true when the console 'CLEAR' pushbutton is pressed. Most logic within the controls will be reset, and the controls will be set to idle status. (Note: The Clear Pushbutton is not activated in the 'Run' mode.)

PWRON - POWER ON. Is false during the Power-up period, thus preventing random logic activity at this time. Once DC Power is stable, PWRON will maintain a constant true.

IOS - The direction of transmission (to or from the Processor) is controlled by the signal 'I/O SEND' (IOS), which may be generated by any I/O Control in the Sub-system. IOS is normally false, enabling the input gates from the Processor. When an individual control is required to send information to the Processor (during the 'RC' portion of a CA-RC cycle), it will generate IOS, thus reversing the direction of the I/O Bus.



PROGRAM/GISMO/MCP INTERACTION FLOW

EXAMPLE OF HOW SYSTEMS SOFTWARE HANDLES AN I/O

1. Let us assume that a program is executing, and it reaches the point where it needs to begin reading cards from a card file for the first time (i.e. a card file is to be opened). This is a function which the program interpreter is not equipped to handle, and so it will 'communicate' a request for GISMO to handle it. A switch will occur and GISMO will become the active interpreter.

2. GISMO will examine the communicate message and decide that it requires MCP assistance, as this file is being accessed for the first time, thus it will pass control over the the MCP, and the SDL interpreter will become the active MICRO-PROGRAM.

3. MCP will check its "I/O Assignment Table" to see if there is an unassigned card reader on the system. (Note: although a card reader may be unassigned, the MCP will have automatically read the first card in any reader made ready, which should have been a control card or label (?date filename); thus if there is more than one reader on the system, the MCP will assign the one which contains the file requested by the job.) The unassigned reader will be assigned to this job, thereby preventing any other job from using it while this file is open. In order to do this the MCP will itself have to use the I/O Driver code in GISMO.

4. To communicate its request for an I/O operation to GISMO, the MCP will generate an 'I/O descriptor' which describes in detail the operation to be performed and the device on which it is to be performed. The 'I/O Descriptor' will be written into memory, where it will remain, at an address indicated by the 'Reference Address', until this file is closed. The descriptor describes just one I/O operation (e.g. read one card, print one line), thus, to read a file a single descriptor may be used many times. (See below.)

5. With the descriptor in memory, MCP hands back control to GISMO, which proceeds to perform the operation described in the I/O Descriptor given it by MCP. This is done by executing those MICRO-ROUTINES which constitute the 'I/O Driver' The operation is completed in two parts, GISMO first sets up the card reader control to perform the operation required, and then exits temporarily while the operation takes place, (this takes a long time relative to the speed of the system). The exit is to the MCP, which must decide what to do next.

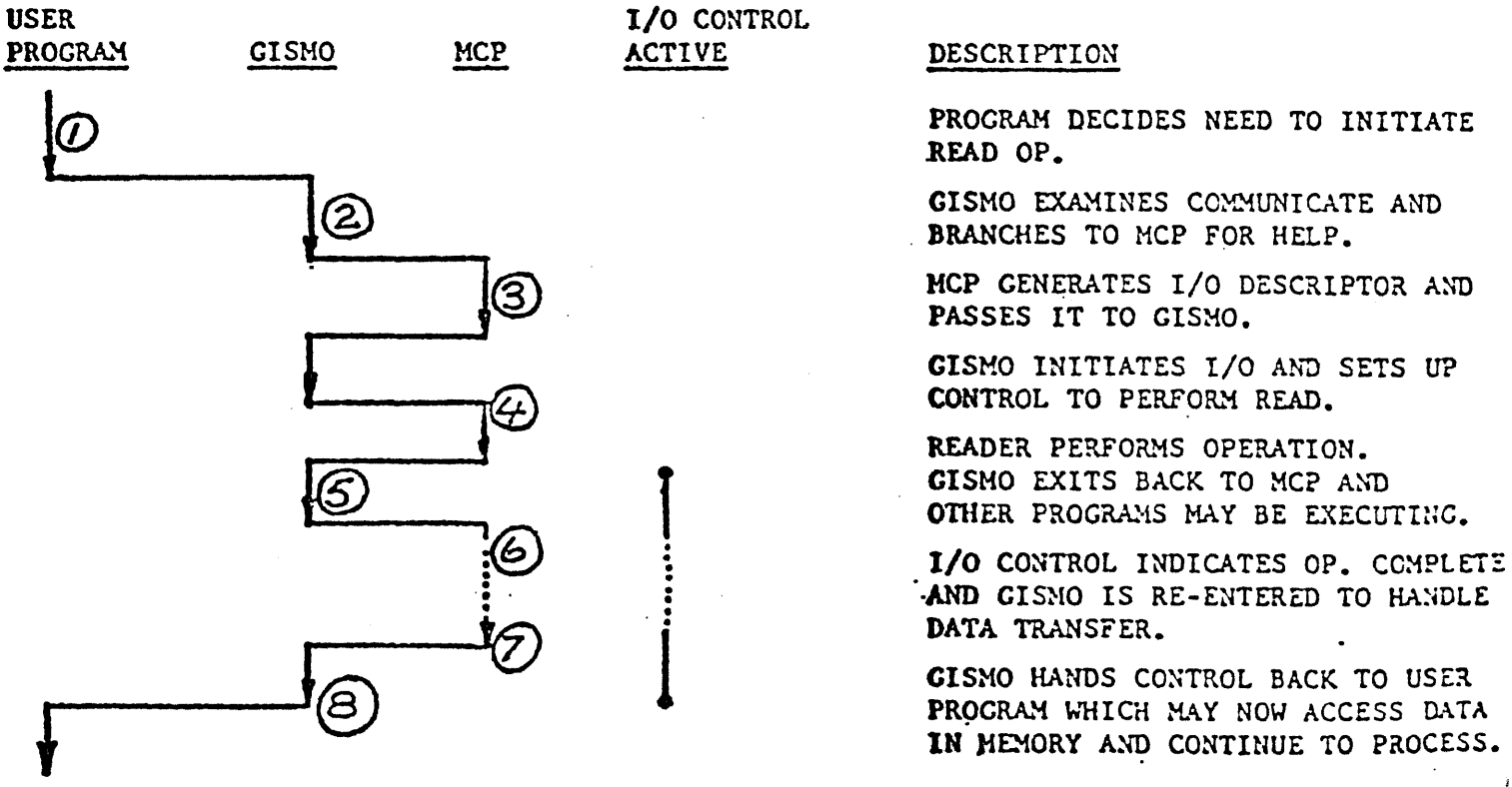
6. Having been set-up by GISMO, the reader control will go ahead and cause a card to be read by the reader. The information gathered during this operation will be stored in the buffer within the control. When the operation is complete, the control is able to communicate with GISMO (through the processor) that it needs attention (Hardware 'SOFT' interrupt).

Service Request

7. GISMO is re-entered from whichever interpreter was executing at the time the interrupt from the I/O Control took place (a check is made for such interrupts between MACRO instructions), and it will proceed through the second half of the I/O operation, which is placing the read information in memory. The location of the data in memory will have been determined by the MCP, and included in the I/O Descriptor.

8. A 'Result Descriptor' will be accepted from the control after the data transfer, indicating how the operation went, if any problems occurred, etc. This descriptor is written into a special field reserved for it in the I/O Descriptor. If a problem did occur, control is now handed back to the MCP as a user program cannot handle this. Otherwise, GISMO will now hand back control directly to the user program, with a communicate indicating a good result, and the location in memory of the card read data the program originally requested.

The above procedures are illustrated below in Flow form.



I/O INITIATION PROCESS FLOW

NOTE: A 'REPEAT READ' operation, i.e. a subsequent Read on a file after initiation as above has taken place will be handled a little differently. The I/O Descriptor can continue to be used again many times after it has first been created, thus it is only set up once by the MCP, at File Open Time.

usually Reader Sorter Ch. 14

After the user program, in the above example, has finished with the data it received during the I/O, it may decide it needs more data, so a further I/O operation is initiated. This time, however, when MCP receives the request, it merely "Re-Activates" the same I/O Descriptor as before, which is still in memory, and calls GISMO to execute it again. Thus, after the first I/O on a file, subsequent operations can be handled much more quickly.

'LINKED' DESCRIPTORS

In the above example, one descriptor has been created by the MCP for the particular file in question, and this in turn defines one area in memory, or 'Buffer' to contain the I/O data. It can be seen that in this case, each time the user program requires activity on this file, it must wait, after the I/O has been initiated, until the physical I/O has taken place, before the needed data is available. This will have a bad effect on program execution time, as the program will continually be in a "waiting for I/O" status. To alleviate this problem, it is possible for the program to request the MCP to allocate two or more 'Buffers', and hence Descriptors, to a file at 'Open' time. Each of these descriptors has in it a field which contains the address of the next descriptor in memory. The last descriptor points back to the first. Thus, the descriptors are formed into a closed chain, within which they are 'Linked' together. (See explanation of I/O Descriptors below.)

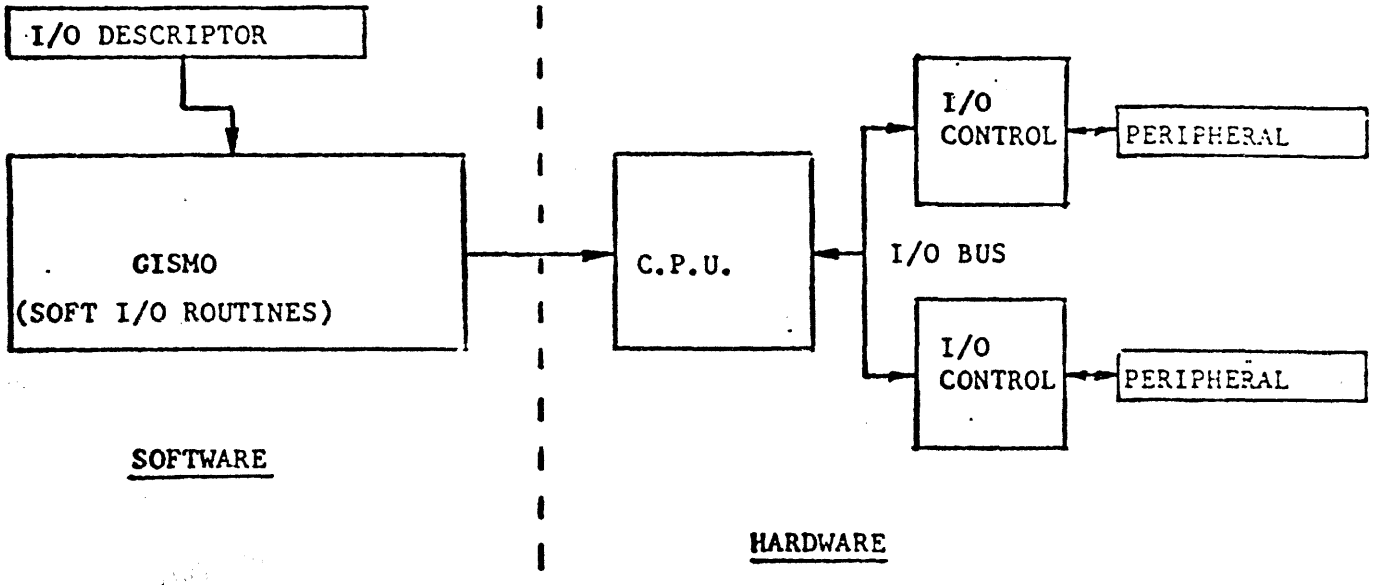
It is an automatic function of GISMO, once it is commanded to "execute" an I/O Descriptor (via its "Soft I/O" Routines), to pick up the next descriptor in a chain, and execute it after the previous one is completed. For example, in the program described above, the first I/O would take place as normal. However, if a second Buffer was assigned to this file, at the time the first Buffer load of information was passed to the program (first physical I/O complete), the second I/O Descriptor in the chain would automatically be initiated, prior to the program requesting it. Thus, when the program next requests an I/O, GISMO will find it already complete, and will pass the new data to the program immediately, instead of waiting for the physical activity of the peripheral. At the same time the first descriptor will now have been made 'Ready' again by the MCP (Program has finished with this data), and GISMO will re-execute it. In this way the I/O can be kept one or more steps ahead of program requirements, much improving system efficiency.

I/O HANDLING IN OFF-LINE ROUTINES

In the descriptions above we have been referring exclusively to I/O Operations in an 'On-Line' environment, i.e. under MCP control. There are many programs, particularly Test Routines, which do not operate in this environment, i.e. they are 'Off-Line'.

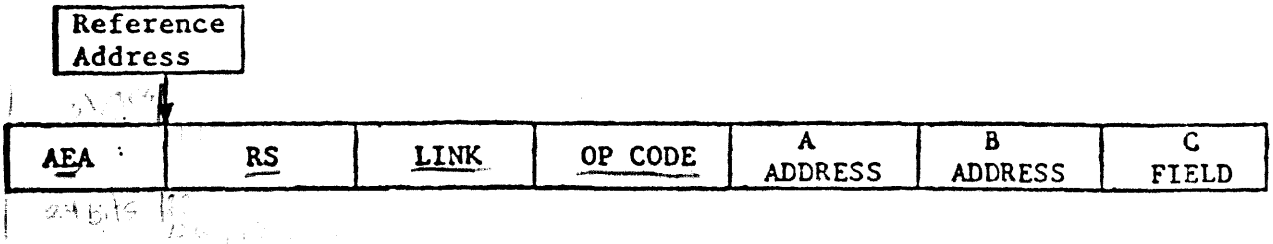
The I/O handling procedures within these routines are of necessity, similar to the On-Line procedures. Each program contains its own "I/O Driver" Routines (assuming the program is written in MICRO-CODE) and these are very similar to those contained in GISMO, with the addition perhaps, of more error diagnostic capability. The main body of the program, when it requires an I/O, will generate an I/O Descriptor identical to the one generated by the MCP, and branch into the I/O Driver to have it execute.

The purpose of Input/Output descriptors, as explained earlier, is to communicate control information to the I/O Drive Routines in GISMO (or some other soft I/O Driver Micro-Program) so that these routines may cause the I/O Control desired to perform the necessary operation on the Peripheral.



I/O DESCRIPTOR FORMAT

The format of the I/O Descriptor is the same for all I/O's, although for some devices certain fields may not be significant. It consists of 7 fields, each of which is 24 bits long, making the whole descriptor 168 bits long. Under On-Line conditions, the MCP suffixes several more fields to the descriptor for its own use, but these do not affect the I/O Driver, and will not be discussed here, for further information see the MCP Reference Manual.



THE REFERENCE ADDRESS

The location of a Descriptor in memory is contained in a separate 24-bit field called the 'Reference Address'. This address points to the beginning of the second field of the Descriptor, not to the absolute beginning. It is transferred to the I/O Control Hardware by the I/O Driver during the initiation of an I/O, and is passed back by the Hardware to the Drive during the completion of the same I/O. This address is then used by the I/O Driver to relocate the Descriptor for which this particular I/O was initiated.

The various fields of the I/O Descriptor itself are described in the following paragraphs:

ACTUAL ENDING ADDRESS

This field contains the address of the location in the memory data buffer (+1) where the last bit of information transferred to or from the I/O Control was located. This is used by all controls, but is especially important for variable record length devices (such as the SPO) where the actual buffer size may often be much larger than the data field transferred. Thus the software has a means of knowing where data received, or to be transmitted, on any given operation, stops, if it is not at the end of the buffer.

RESULT STATUS

At the end of every operation the I/O Control transmits back to the I/O Driver a 24-bit result descriptor field, which contains information on the status of the just completed operation. This result descriptor is written into the result status field of the I/O Descriptor.

Prior to the receipt of the result descriptor from the control, the result status field is used to store other information pertinent to the I/O operation, such as port and channel numbers for the control to be driven etc. This provides an extra communication link between the MCP and GISMO.

LINK ADDRESS

The Link Address is a 24-bit field which will provide the means of chaining I/O Descriptors to each other (see below). It will contain either the reference address of this descriptor if no chain exists, or the reference address of the next descriptor in the chain if one does exist.

OP CODE

This field contains the desired OP Code and its variants, defining the actual operation to be performed by the I/O.

A - ADDRESS

The A - Field contains the beginning binary address of the Input/Output Memory area reserved for this descriptor (i.e. the buffer).

B - ADDRESS

The B - Field contains the ending binary address (+1) of the buffer area reserved in memory for this descriptor.

Thus the 'A' and 'B' addresses between them define the buffer address and size for the descriptor.

C - FIELD

This field contains the 'File Address' needed for Disk Operations, and is redundant except for those operations. It contains an absolute sector address which will point to the beginning of the area to be accessed on a particular disk. Exactly which disk out of the several that may be on the system is defined in the OP-Code.

TYPICAL I/O DESCRIPTORS

Note that all numbering is hexadecimal.

(1) SPO READ OPERATION

	AEA	RS	LINK	OP	A	B	C
Descriptor: (Before Execution)	000000	000000	014740	000000	014ED8	014F78	000000
Descriptor: (After Execution)	014F20	800080	014740	000000	014ED8	014F78	000000

Note that the buffer was not completely filled so 'AEA' is not the same as 'B' after execution.

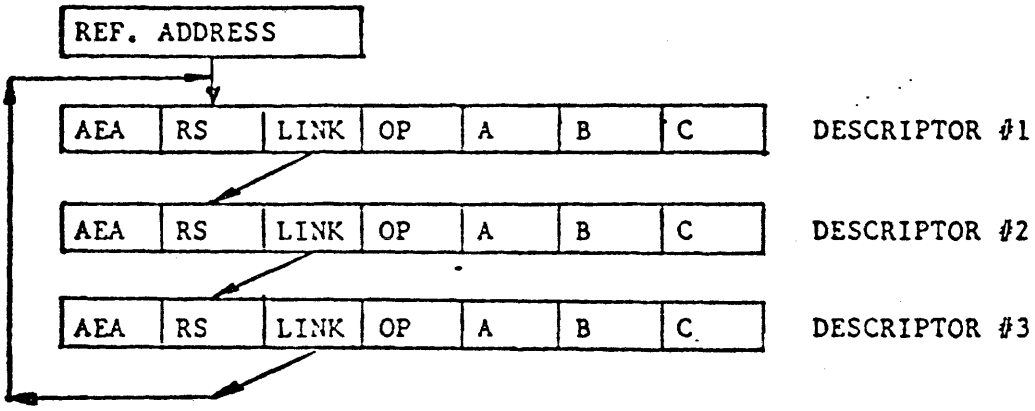
(2) DISK WRITE OPERATION (2 SECTORS, ADDRESS @15@)

	AEA	RS	LINK	OP	A	B	C
Descriptor: (Before Execution)	000000	000000	014740	400000	014ED8	015A18	000015
Descriptor: (After Execution)	015A18	804080	014740	400000	014ED8	015A18	000015

In the above examples the reference address was @014740@

I/O DESCRIPTOR CHAINING

The ability to link or chain together I/O Descriptors provides for the maximum utilization of the Processor and Peripheral devices. Illustrated here is a sample chain consisting of three descriptors:



Each descriptor within a chain will have associated with it its own buffer area. In the example above the program would have requested 3 buffers for this file, and the MCP will have automatically generated a linked chain of 3 descriptors to accomodate this.

In a serial processing operation (e.g. Reading cards) where each operation must occur in a fixed sequence, the I/O Driver software will not initiate a descriptor in a linked chain until the previous descriptor is completed. However, it will initiate a new descriptor before the user program has requested the data to which that operation relates (if this is a Read operation) and so the I/O can keep ahead of the program, increasing its execution speed. On a printing (Write Serial) operation using multiple buffers a program may dump data into a buffer for printing while the hardware is still handling a previous descriptor, thus there is no delay in program execution, as there would be on a single buffer operation, as the program would have to wait for the buffer to become available before continuing execution.

The linking from one descriptor to the next, and the initiation of that next descriptor is a GISMO controlled operation. If while linking, GISMO hits a descriptor that cannot be initiated (e.g. it is already running) then it will exit the I/O Routines, and will not return until told to do so by the MCP.

Linking methods for disk and tape differ somewhat from other types of unit, and the MCP reference manual should be consulted for more information on this subject.

OPERATION

Information flow to and from the B 1700 I/O controls is managed by means of I/O Descriptors. The I/O Descriptor used for the B 1700 Magnetic Tape Control II consists of seven 24-bit fields as shown in figure 1-7. The function of each field is as follows:

E field At the completion of a magnetic tape operation, the E field will contain the information end address. For Read Operations, the address will point to the memory location where the next bit of data is to be stored. If a timeout or memory access error occurs during the operation, the address will be incorrect. For Write Operations, the address will be equal to the address contained in the B field unless a timeout or memory access error occurs. The E field address is not applicable for Lock, Space-to-EOF, Rewind, Test or Stop Operations.

RS field The RS field is used to store the result descriptor at the end of a magnetic tape operation. The first two bits of the RS field are also used to determine the status of the descriptor. The function of these two bits is as follows:

BIT CONFIGURATION	FUNCTION
00	Descriptor is not in use.
01	Not applicable.
10	The previous magnetic tape operation has been completed but the result descriptor has not been checked by the MCP.
11	The previous magnetic tape operation has been completed but the result descriptor has not been checked by the MCP. The result descriptor also contains an exception condition.

L field The L field contains a link address that points to the RS field of the next I/O Descriptor. ~~If the descriptor is a Lock Descriptor, the link address points to the L field of the next Lock Descriptor.~~

OP field The OP field contains the operation code, variants, and the magnetic tape device unit number.

A and B fields The A and B fields contain the beginning and end addresses of the data for Read, Write or Erase Operations. These addresses must be in bytes (eight bits equal one byte). The A and B fields are not used for Space-to-EOF, Rewind, or Test Operations.

C field The C field contains an address that points to the Lock Descriptor of the magnetic tape unit used by this I/O Descriptor.

BIT 0	BIT 24	BIT 48	BIT 72	BIT 96	BIT 120	BIT 144	BIT 168
E (END ADDRESS)	RS (RESULT STATUS)	L (LINK ADDRESS)	OP (OPERATION CODE)	A (DATA START ADDRESS)	B (DATA END ADDRESS PLUS 1)	C (LOCK DESCRIPTOR ADDRESS	

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Figure 1-7. B 1700 Magnetic Tape Control II I/O Descriptor

In addition to the I/O Descriptors, a Lock Descriptor is assigned to each magnetic tape station in the magnetic tape subsystem. The Lock Descriptor is used as an entry to and exit from a string of I/O Descriptors assigned to a given magnetic tape station. Each string consists of one or more sequential I/O Descriptors.

The Lock Descriptor also provides a means of locking out all other requests to the string until all available I/O operations in that string have been completed. A block diagram of the Lock Descriptors and I/O Descriptors used on a magnetic tape subsystem is shown in figure 1-8.

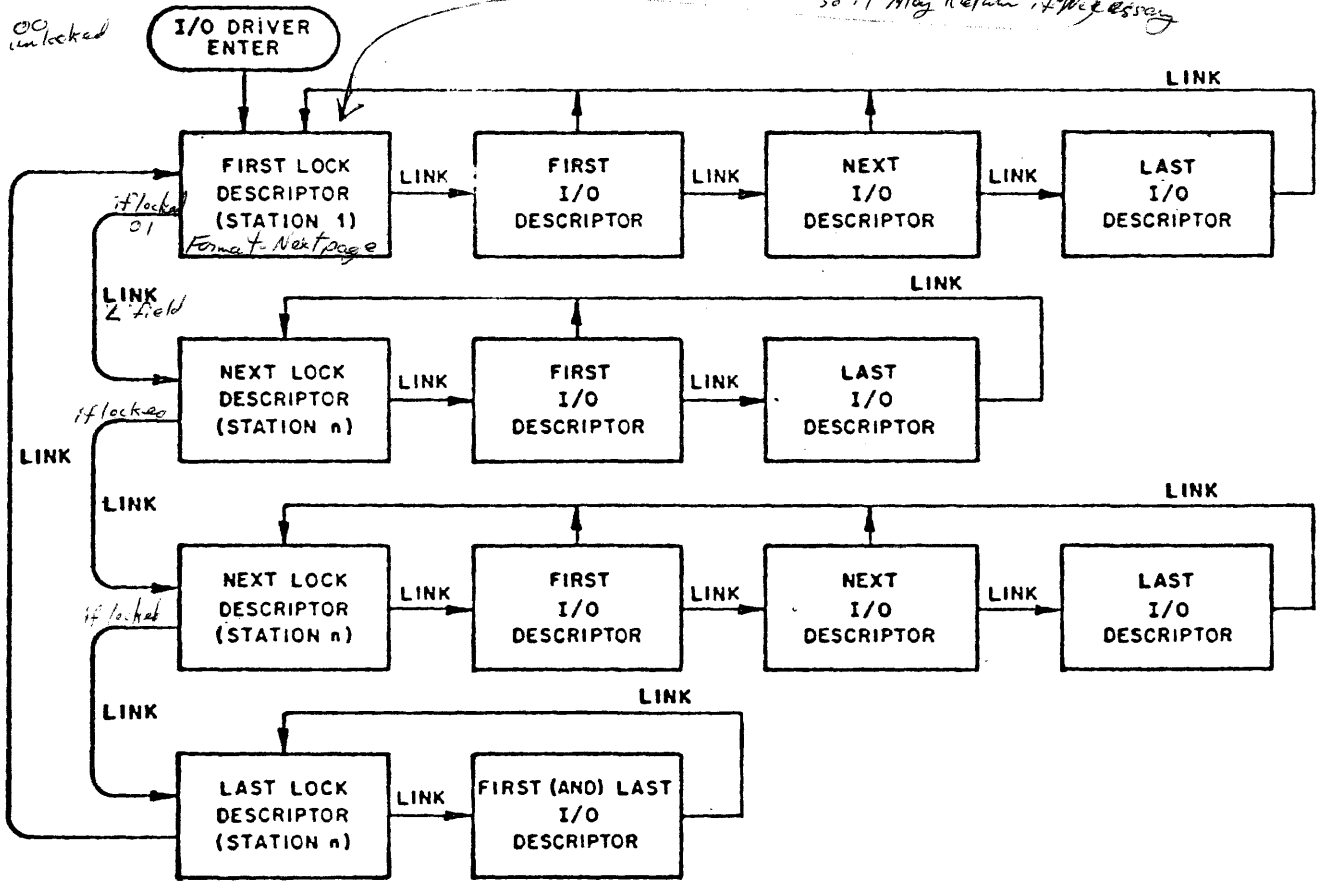

Figure 1-8. Basic Block Diagram of Magnetic Tape I/O Descriptor Strings

The Lock Descriptor consists of six 24-bit fields as shown in figure 1-9. The function of each of these fields is as follows:

E field — The E field of the Lock Descriptor is not used.

RS field — The first two bits of the RS field are used to "lock" a string of I/O Descriptors. If the first two bits are equal to 00 (unlocked), they are changed by the I/O Driver to 01 (locked) and a branch to a I/O Descriptor in the string is accomplished by means of the B field address. If the first two bits are equal to 01, the I/O Driver exits by means of the L field address to the next Lock Descriptor.

L field — The L field address is used as a link address to the next Lock Descriptor.

OP field — The OP field contains the Lock Operation code.

A field — The A field is used to store the link address of the first I/O Descriptor in the string.

B field — The B field is used to store the address of the I/O Descriptor that is currently in operation.

C field — The C field is used to store the address of the previous lock

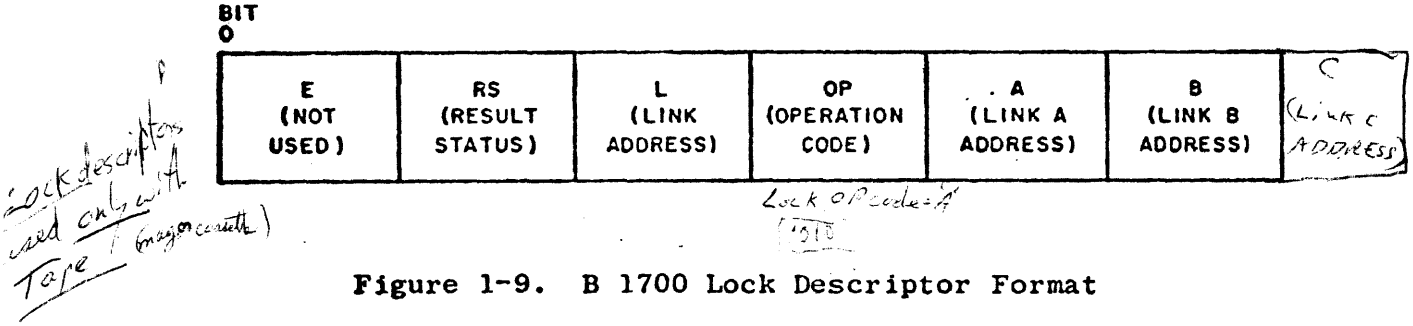

Figure 1-9. B 1700 Lock Descriptor Format

All communicates to and from the I/O control are handled by a micro-coded program labeled CSM (Central Service Module). Specifically, a portion of CSM labeled I/O Driver handles all I/O operations. The I/O Driver is initiated with a start address pointing to the RS field of a Lock Descriptor. (Refer to figure 1-10.) The first two bits of the Lock Descriptor RS field are checked for an unlocked (00) configuration. If an unlocked configuration is not found, the I/O Driver exits by fetching the Link address (L field) of the Lock Descriptor which points to the next Lock Descriptor. The I/O Driver then checks the first two bits of this Lock Descriptor RS field for an unlocked configuration. If an unlocked descriptor is found, the I/O Driver locks the descriptor by transferring a 01 into these 2-bit positions, then transferring the previous contents of these two bits back to the I/O Driver. If the lock is not successful (00 not received by the I/O Driver), the I/O Driver exits by means of the L field address as previously described.

If the lock is successful, the I/O Driver checks the OP field of the descriptor. Since the OP field contains a Lock Operator, the I/O Driver exits by means of the B field address to the first I/O Descriptor in the string. The first two bits of the I/O Descriptor RS field are checked for a Ready condition (00). If the I/O Descriptor is Not Ready (these two RS field bits contain a 10 or 11), the pointer to this descriptor is saved by storing it into the B field of the associated Lock Descriptor. The I/O Driver exits the I/O Descriptor by means of the C field address which points to the RS field of the associated lock descriptor.

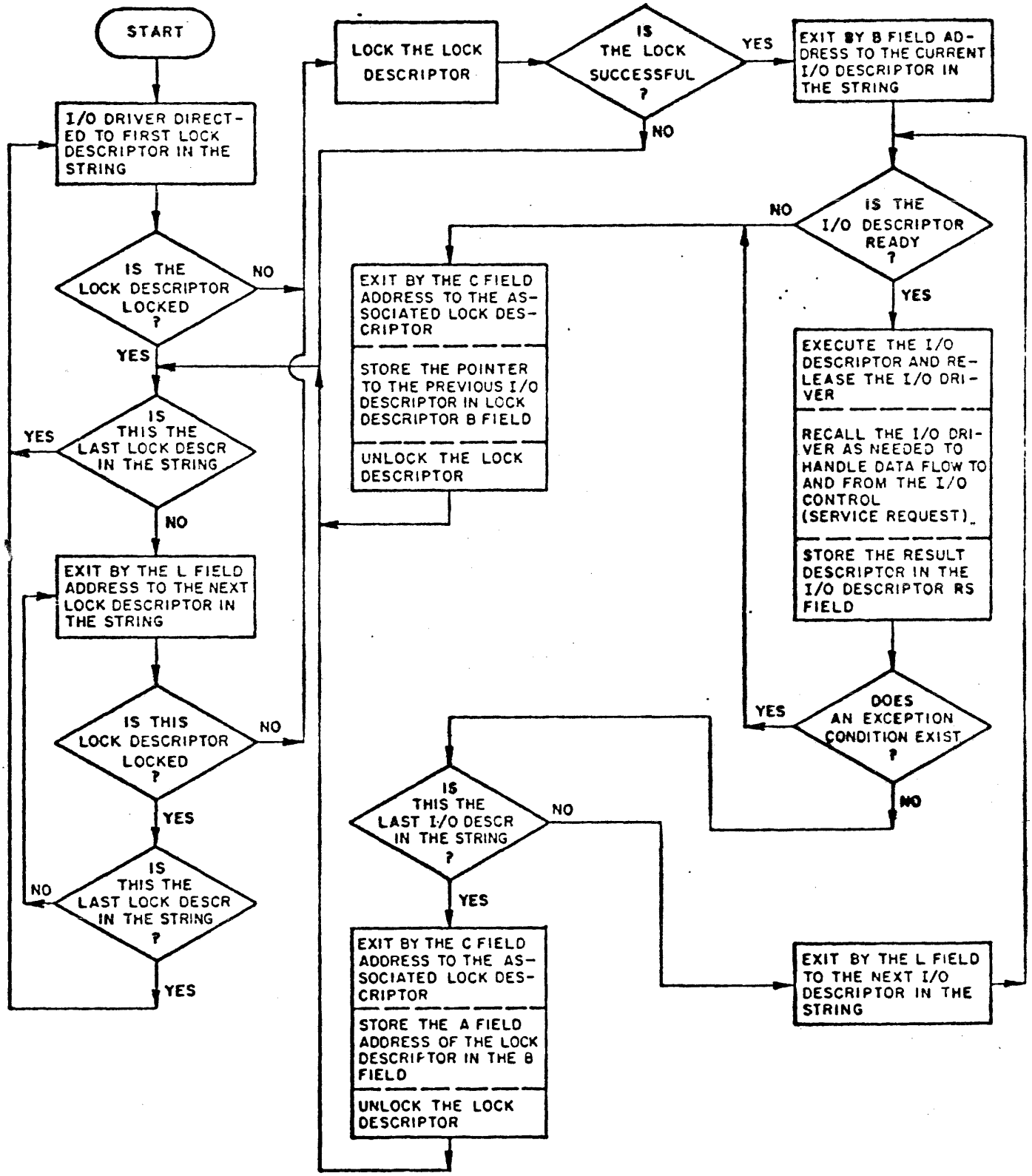

Figure 1-10. Magnetic Tape I/O Driver Operation

SPO TEST-OP & REPORT IMMEDIATELY

```
DESCRIPTOR #1----------------------------------------------------------------------------------------
MAIN SPEC    CHANNEL C   ID 2C    RA 014740   MAIN TOGS 0AC0C0   C INC VAL C00C00   DATA E7E8E9       LENGTH 0001E0
ADD  SPEC    DUMMY REFERENCE ADDRESS 014740   ADD  TOGS 1CC000   MAX DISK SECTOR ADDRESS 0032BF   TIME DELAY 010000
             DUMMY REF ADD INCREMENT.000000
DESCRIPTOR: 006C00 000C00 000000 800000 014E08 015088 C0C0C0
(BEFORE EXECUTION)

TEST STS100001 C1C02C C10C2C* XFROUTA 200080 010000 02002C* XFRCUTA 200000 020C00 C3002C* XFRCUTA 200000 030000 04C02C*
XFROUTA 200000 040C00 C5CC2C* XFROUTA 200000 050000 06002C* XFRCUTA 200000 060C00 07002C* XFROUTA 200001 070000 08C02C*
XFROUTA 200047 080C00 C90C2C* XFROUTA 200040 090000 0AC02C* TEST S R1C0005 000C01 12002C* XFRIN   400000 120001 13C02C*
XFRIN   400C00 130047 14CC2C* XFRIN   400000 140040 15002C* XFRIN   4C0000 150C80 16002C* XFRIN   400000 160000 17002C*
XFRIN   400000 1700AC C10C2C*
DESCRIPTOR: 014ED8 8000AC 000000 80000C 014ED8 015088 000000
(AFTER EXECUTION)  80C080 DESIGNATED RESULT

0123456789-$*-,?+ABCDEFGHIJKLMNOPQRSTUVWXYZ(){}=?"[<&]}/?>#=\&
```

SPO TEST-OP & REPORT ON ENQUIRY

```
DESCRIPTOR #1----------------------------------------------------------------------------------------
MAIN SPEC    CHANNEL 0   ID 2C    RA 014740   MAIN TOGS 0A0000   C INC VAL 000C00   DATA E7E8E9       LENGTH 0001E0
ADD  SPEC    DUMMY REFERENCE ADDRESS 014740   ADD  TOGS 10C000   MAX DISK SECTOR ADDRESS 0032BF   TIME DELAY 010000
             DUMMY REF ADD INCREMENT 0C0000
DESCRIPTOR: 00C000 00CC00 000000 9C000C 014ED8 015088 C0C000
(BEFORE EXECUTION)

TEST STS1C0001 01CC2C C10C2C* XFROUTA 2C0090 010000 02C02C* XFROUTA 200000 020C00 03C02C* XFROUTA 200CC0 030000 04002C*
XFROUTA 2CC0C0 04CC00 C5002C* XFROUTA 2C00C0 050000 06C02C* XFROUTA 2C0000 060C00 C7C02C* XFROUTA 200001 070000 08C02C*
XFROUTA 200047 08CC00 C9002C* XFROUTA 200040 090000 0A002C* TEST S R100005 000C01 12002C* XFRIN   400000 120001 13002C*
XFRIN   400C00 130C47 14002C* XFRIN   400000 140040 15002C* XFRIN   400000 150CC1 16002C* XFRIN   400000 160000 17002C*
XFRIN   400000 1700AC C10C2C*
DESCRIPTOR: 014ED8 C1C0AC 0000CC 9C0000 014ED8 015088 00C0C0
(AFTER EXECUTICN)  80C080 DESIGNATED RESULT

01234567 89-$*-,?+ABCDEFGHIJKLMNOPQRSTUVWXYZ( ):;=^[<&!;/%>#=\&
```

SPO READ -OP

Trace

```
DESCRIPTOR #1----------------------------------------------------------------------------------
MAIN SPEC     CHANNEL 0    IO 2C     RA 014740    MAIN TOGS 040000    C INC VAL 000000    DATA E7E8E9        LENGTH 0001E0
ADD  SPEC     DUMMY REFERENCE ADDRESS 014740    ADD  TOGS 100000    MAX DISK SECTOR ADDRESS 00328F    TIME DELAY 010000
              DUMMY REF ADC INCREMENT 000000
DESCRIPTOR: 000000 000000 000000 000000 014EC8 015088 000000
(BEFORE EXECUTION)
TEST STS100001 010020 010020• XFROUTA 200000 010000 020020• XFROUTA 200000 020000 030020• XFROUTA 200000 030000 040020•
XFROUTA 200000 040000 050020• XFROUTA 200000 050000 060020• XFROUTA 200000 060000 070020• XFROUTA 200001 070000 080020•
XFROUTA 200047 080000 090020• XFROUTA 200040 090000 0A0020• TEST S R100005 000001 0B0020• XFRIN   400000 0B0001 0C0020•
XFRIN   400000 0C0047 0D0020• XFRIN   400000 0D0040 0F0020• XFRIN   400000 0F0CE3 0F0020• XFRIN   400000 0F00C8 0F0020•
XFRIN   400000 0F00C9 0F0020• XFRIN   400000 0F00E2 0F0020• XFRIN   400000 0F0040 0F0020• XFRIN   400000 0F00C9 0F0020•
XFRIN   400000 0F00C1 0F0020• XFRIN   400000 0F004C 0F0020• XFRIN   400000 0F0CE2 0F0020• XFRIN   400000 0F0007 0F0020•
XFRIN   400000 0F00D6 0F0020• XFRIN   400000 0F004C 0F0020• XFRIN   400000 0F0CD9 0F0020• XFRIN   400000 0F00C5 0F0020•
XFRIN   400000 0F00C1 0F0020• XFRIN   400000 0F00C4 0F0020• XFRIN   400000 0F0040 0F0020• XFRIN   400000 0F00C3 0F0020•
XFRIN   400000 0F00D6 0F0020• XFRIN   400000 0F00D4 0F0020• XFRIN   400000 0F0CD4 0F0020• XFRIN   400000 0F00C1 0F0020•
XFRIN   400000 0F00D5 0F0020• XFRIN   400000 0F00C4 0F0020• XFRIN   400000 0F0040 0F0020• XFRIN   400000 0F00E3 0F0020•
XFRIN   400000 0F00D6 0F0020• XFRIN   400000 0F004C 0F0020• XFRIN   400000 0F0C7F 0F0020• XFRIN   400000 0F00D7 0F0020•
XFRIN   400000 0F00C3 0F0020• XFRIN   400000 0F00C1 0F0020• XFRIN   400000 0F0CD7 0F0020• XFRIN   400000 0F007F 110020•
XFRIN   400000 110003 150020• TRM DATA100006 150000 150020• XFRIN   400000 150080 160020• XFRIN   400000 160000 170020•
XFRIN   400000 170080 010020•
DESCRIPTOR: 014FFC 800080 000000 00000C 014EC8 015088 000000
(AFTER EXECUTION)  800080 DESIGNATED RESULT

THIS IA SPO READ COMMAND TO "PCAP"
```

SPO WRITE-OP


```
DESCRIPTOR #1----------------------------------------------------------------------------------------------------
MAIN SPEC    CHANNEL 0    ID 2C     RA 014740    MAIN TOGS 0AC000    C INC VAL 000C00    DATA E7E8E9        LENGTH 0001E0
ADD  SPEC    DUMMY REFERENCE ADDRESS 01474C    ADD  TOGS 10C000    MAX DISK SECTOR ADDRESS 00328F    TIME DELAY 010000
             DUMMY REF ADD INCREMENT 000000
DESCRIPTOR: 00C000 CCCC00 000CCC 40000C 014ED8 015088 C0C000
(BEFORE EXECUTION)

TEST STS100001 01002C C1002C* XFROUTA 200040 010000 02002C* XFROUTA 200000 02CC00 C3002C* XFROUTA 200C00 030000 04002C*
XFROUTA 200009 04CC00 C5002C* XFROUTA 200CC0 050000 06C02C* XFROUTA 2C0000 060C00 CE002C* XFROUTA 2000E3 0E0C30 0EC02C*
XFROUTA 2000CA CECC00 CE002C* XFROUTA 200009 0E000C 0EC02C* XFROUTA 2000E2 0E0C00 CE002C* XFROUTA 200040 0E0030 0EC02C*
XFROUTA 2000C9 0ECC00 CECC2C* XFROUTA 2C00C1 0E000C 0E002C* XFROUTA 2C004C CECC00 CEC02C* XFROUTA 2000E2 0E0C00 0EC02C*
XFROUTA 2000D7 CE0000 CE0C2C* XFROUTA 2CC0D6 0E000C 0EC02C* XFROUTA 200040 0ECC00 CEC02C* XFROUTA 200009 0E000C 0EC02C*
XFROUTA 2000C5 0ECC00 CE002C* XFROUTA 2000C1 0E0000 0EC02C* XFROUTA 2000C4 0ECC00 CEC02C* XFROUTA 200C4C 0E0000 0EC02C*
XFROUTA 2000C3 CECC00 CE0C2C* XFROUTA 2C00C6 0E0000 0EC02C* XFROUTA 2000D4 0E0C00 CE002C* XFROUTA 200004 0E0000 0EC02C*
XFROUTA 2000C1 0ECC00 CE0C2C* XFROUTA 2000C5 0E0000 0E002C* XFROUTA 2000C4 0E0C00 CE002C* XFROUTA 200C40 0E0000 0EC02C*
XFROUTA 2000E3 0E0C0C GE0C2C* XFROUTA 2C00C6 0E000C 0EC02C* XFROUTA 200040 0E0C00 0EC02C* XFROUTA 20007F 0E0000 CEC02C*
XFROUTA 2CCCD7 0E0C0C CE0C2C* XFROUTA 2C00C3 0E000C 0EC02C* XFROUTA 2C00C1 CE0C00 CEC02C* XFROUTA 200007 0E000C 0EC02C*
XFROUTA 20007F CECCC0 CECC2C* XFROUTA 2C00C3 0E000C 11C02C* XFROUTA 2C000C 11CC00 C7C02C* TRM DATA1C0CC6 07000C C7002C*
XFROUTA 2C0001 C7CC00 C8CC2C* XFROUTA 200047 080000 09C02C* XFROUTA 2C004C 09CC00 CA002C* TEST S R100005 000001 12C02C*
XFRIN   400000 12CC01 13002C* XFRIN   400CC0 130047 14002C* XFRIN   400C00 140C40 15002C* XFRIN   400C0C 150080 16002C*
XFRIN   4CC000 160C00 17CC2C* XFRIN   400CC0 170080 01C02C*
DESCRIPTOR: 014FF8 8CC080 000CC0 400000 014ED8 015088 C00000
(AFTER EXECUTION)  800080 DESIGNATED RESULT

THIS IA SPC READ COMMAND TO "PCAP"
```

PRINTER TEST-OP

```
DESCRIPTOR #1----------------------------------------------------------------------------------------------------------------------
MAIN SPEC     CHANNEL 3   ID 10    RA 014740   MAIN TOGS 0AC000   C INC VAL 000C00   DATA E7E8E9       LENGTH 0001E0
ADD  SPEC     DUMMY REFERENCE ADDRESS 014740   ADD  TOGS C0C000   MAX DISK SECTOR ADDRESS 0032BF   TIME DELAY 01000C
              DUMMY REF ADD INCREMENT 000000
DESCRIPTOR: 00C000 0C0000 000000 80000C 014EC8 015088 C000C0
(BEFORE EXECUTION)

TEST STS130C01 010C1C 01C010* XFROUTA 230080 010000 C2C010* XFROUTA 230C00 020C00 C30010* XFROUTA 230C00 030000 04C010*
XFROUTA 230000 040C00 05CC10* XFROUTA 230000 05000C 060010* XFROUTA 230000 060C00 C70010* XFROUTA 230C01 070000 08C010*
XFROUTA 230047 08CC00 090C10* XFROUTA 230040 09000C 120010* TEST S R100005 00CC08 120010* XFRIN   430C00 120001 13C010*
XFRIN   430000 130C47 14C010* XFRIN   430000 140040 150010* XFRIN   430000 150C80 160010* XFRIN   430C00 160008 17C010*
XFRIN   430000 17009C C10C10*
DESCRIPTOR: 014ED8 8C0890 00000C 80000C 014EC8 015088 C000C0
(AFTER EXECUTION)  8CCC80 DESIGNATED RESULT

0123456789.$*-,7+ABCDEFGHIJKLMNOPQRSTUVWXYZ():@"[<&];/%>#=\!
```

PRINTER PRINT & SINGLE SPACE

```
DESCRIPTOR #1----------------------------------------------------------------------------------------
MAIN SPEC    CHANNEL 3   ID 10    RA 014740   MAIN TOGS 0A0000   C INC VAL 000C00   DATA E7E8E9      LENGTH 0001E0
ADD  SPEC    DUMMY REFERENCE ADDRESS 014740   ADD  TOGS 00CC00   MAX DISK SECTOR ADDRESS 00328F   TIME DELAY 01000C
             DUMMY REF ADD INCREMENT 0C0000
DESCRIPTOR: 00C000 0C000C 000000 5E000C 014ED8 015088 00C000
(BEFORE EXECUTION)
0123456789-$*-,?+ABCDEFGHIJKLMNOPQRSTUVWXYZ():=2"[<{];/%>#=\¢

TEST STS130001 010C1C C10C10* XFROUTA 23C05E 010000 02C010* XFROUTA 230000 02CC00 030010* XFROUTA 230C00 030000 04C010*
XFROUTA 230000 040000 050C10* XFROUTA 230CC0 050000 060010* XFROUTA 230000 06CC00 CE0010* XFROUTA 2300F0 0E000C 0EC010*
XFROUTA 2300F1 0EC000 CECC10* XFROUTA 2300F2 0E000C 0EC010* XFROUTA 2300F3 0ECC00 CE0010* XFROUTA 2300F4 0E0000 0EC010*
XFROUTA 2300F5 0ECC00 CE0C10* XFROUTA 2300F6 0E000C 0EC010* XFROUTA 2300F7 0E0C00 0EC010* XFROUTA 2300F8 0E0000 0EC010*
XFROUTA 2300F9 0ECCC0 0E0010* XFROUTA 230048 0E000C 0E0010* XFROUTA 230058 0E0C00 CE0010* XFROUTA 23005C 0E0000 0EC010*
XFROUTA 230060 0EC000 CECC10* XFROUTA 230068 0E0000 0EC010* XFROUTA 23006F 0ECC00 CEC010* XFROUTA 23004E 0E0000 0EC010*
XFROUTA 2300C1 0ECCC0 CECC10* XFROUTA 2300C2 0E000C 0EC010* XFROUTA 2300C3 0E0C00 CE0010* XFROUTA 2300C4 0E0C00 CEC010*
XFROUTA 2300C5 0E0000 CECC10* XFROUTA 2300C6 0E000C 0EC010* XFROUTA 2300C7 0E0C00 CEC010* XFROUTA 2300C8 0E0000 0E0010*
XFROUTA 2300C9 0ECC0C CECC10* XFROUTA 2300D1 0E0000 0E0010* XFROUTA 2300D2 0EC000 CEC010* XFROUTA 2300D3 0E0000 CEC010*
XFROUTA 2300D4 0EC000 CEC010* XFROUTA 2300D5 0E000C 0ECC10* XFROUTA 230006 0E0C00 CE0010* XFROUTA 2300C7 0E000C 0EC010*
XFROUTA 2300D8 0EC000 CECC10* XFROUTA 2300C9 0E0000 0EC010* XFROUTA 2300E2 0ECC00 0EC010* XFROUTA 2300E3 0E0000 CEC010*
XFROUTA 2300E4 0ECCC0 CE0010* XFROUTA 2300E5 0E0000 0EC010* XFROUTA 2300E6 0ECC00 CE0010* XFROUTA 2300E7 0E0000 0EC01C*
XFROUTA 2300E8 0EC000 CE0C10* XFROUTA 23C0E9 0E000C 0E0010* XFROUTA 23004D 0ECC00 CE0010* XFROUTA 23005C 0E000C 0EC010*
XFROUTA 23007A 0E0000 0E0C10* XFROUTA 23007C 0E0000 CEC010* XFROUTA 23007F 0E0C00 CE0010* XFROUTA 23004A 0E0000 0EC01C*
XFROUTA 23004C 0ECC00 CECC10* XFROUTA 23C050 0E000C CEC010* XFROUTA 23005A 0E0C00 CE0010* XFROUTA 23005E 0E0000 0EC010*
XFROUTA 23C061 0ECC0C 0ECC10* XFROUTA 23006C 0E000C CEC010* XFROUTA 23006E 0E0C00 CEC010* XFROUTA 230078 0E000C 0EC010*
XFROUTA 23007E 0ECC00 CEC010* XFROUTA 23CCE0 0E000C 0EC010* XFROUTA 23004F 0E0C00 CE0010* TRM DATA130006 0E0000 07C010*
XFROUTA 230001 070C00 C8CC10* XFROUTA 230047 080000 090010* XFROUTA 230040 090C00 0A0C10* TEST S R100005 000038 120010*
XFRIN   430000 12CCC1 13CC10* XFRIN   43CCC0 130047 140010* XFRIN   430000 140C40 150010* XFRIN   430000 150080 160010*
XFRIN   430000 160C00 170C10* XFRIN   43CCC0 17008C 010010*
DESCRIPTOR: 0150B8 80CC80 0C00C0 5E000C 014ED8 015088 00C000
(AFTER EXECUTION)  80C080 DESIGNATED RESULT

0123456789-$*-,?+ABCDEFGHIJKLMNOPQRSTUVWXYZ():=2"[<{];/%>#=\¢
```

DISK CARTRIDGE TEST-OP

```
DESCRIPTOR #1----------------------------------------------------------------------------------------------------
MAIN SPEC    CHANNEL 5    ID 1A     RA 01474C    MAIN TOGS 0AC0CC    C IAC VAL 000C00    DATA E7E8E9        LENGTH 0001E0
ADD  SPEC    DUMMY REFERENCE ADDRESS 014740    ADD  TOGS 000000    MAX DISK SECTOR ADDRESS 0032BF    TIME DELAY 010000
             DUMMY REF ADD INCREMENT 0CCC0C
DESCRIPTOR: 000000 000000 000000 80000C 014ED8 015088 C0C000
(BEFORE EXECUTION)

TEST SIS15C001 C10C1A C10C1A* XFROUTA 250080 010000 02C01A* XFRCUTA 250000 020C00 03001A* XFRCUTA 250000 030000 04001A*
XFROUTA 250000 040000 050C1A* XFROUTA 250C00 050000 06001A* XFRCUTA 250000 060C00 07001A* XFRCUTA 250001 070000 08C01A*
XFROUTA 250047 080C00 09C01A* XFROUTA 250040 090000 12C01A* TEST S R100005 000C20 12C01A* XFRIN   450000 120001 13C01A*
XFRIN   450000 130C47 140C1A* XFRIN   450000 140040 15C01A* XFRIN   450000 150C80 16001A* XFRIN   450000 160048 17001A*
XFRIN   450C00 17009A C1CC1A*
DESCRIPTOR: 014ED8 80489A C00000 80000C 014ED8 015088 C0C000
(AFTER EXECUTION)  8CCC8C DESIGNATED RESULT

0123456789-$*-,?+ABCDEFGHIJKLMNOPQRSTUVWXYZ():=?"[<&!;/%>#=\@
```

DISK CARTRIDGE READ-OP


```
DESCRIPTOR #1----------------------------------------------------------------------------------------
MAIN SPEC    CHANNEL 5   ID 1A    RA 014740   MAIN TOGS 0A0000   C INC VAL 000C00   DATA E7E8E9       LENGTH 0001E0
ADD  SPEC    DUMMY REFERENCE ADDRESS 014740   ADD  TOGS C0CC00   MAX DISK SECTOR ADDRESS 0032BF   TIME DELAY 010000
             DUMMY REF ADD INCREMENT 0C0000
DESCRIPTOR: 000000 000C00 000000 00000C 014EC8 015088 C0C0C0
(BEFORE EXECUTION)

TEST STS150001 010C1A 01001A* XFROUTA 250000 010000 020C1A* XFROUTA 250000 020C00 030C1A* XFROUTA 250000 030C00 040C1A*
XFROUTA 250000 040C00 050C1A* XFROUTA 250000 050000 060C1A* XFROUTA 250000 060C00 070C1A* XFROUTA 250001 070000 080C1A*
XFROUTA 250047 080000 090C1A* XFROUTA 250040 090000 0A0C1A* TEST S R100005 0C0C20 0B0C1A* XFRIN   450000 080001 0C0C1A*
XFRIN   450000 0C0047 0D0C1A* XFRIN   450000 0D0040 0FC01A* XFRIN   450000 0FFCF0 CFC01A* XFRIN   450000 0FF0F0 0FC01A*
XFRIN   450000 0FFCFC CF0C1A* XFRIN   450000 0FF0F0 0F001A* XFRIN   450000 0FFCF0 CFC01A* XFRIN   450000 0FF0FC CF001A*
XFRIN   450000 0FF0F0 CF0C1A* XFRIN   450000 0FF0FC 0FC01A* XFRIN   450000 0FFCF0 CFC01A* XFRIN   450000 0FF0F0 CF001A*
XFRIN   450000 0FF0F0 0F001A* XFRIN   450000 0FF0F0 0FC01A* XFRIN   450000 0FFCF0 CFC01A* XFRIN   450000 0FF0F0 0F001A*
XFRIN   450000 0FFCF0 0F001A* XFRIN   450000 0FF0FC 0FC01A* XFRIN   450000 0FFCF0 CF001A* XFRIN   450000 0FF0F0 0FC01A*
XFRIN   450000 0FFCF0 0F001A* XFRIN   450000 0FF0FC 0FC01A* XFRIN   450000 0FFCF0 CFC01A* XFRIN   450000 0FF0F0 0F001A*
XFRIN   450000 0FFCF0 CF0C1A* XFRIN   450000 0FF0FC 0F001A* XFRIN   450000 0FFCF0 CFC01A* XFRIN   450000 0FF0F0 0FC01A*
XFRIN   450000 0FF0F0 0F001A* XFRIN   450000 0FF0F0 0FC01A* XFRIN   450000 0FFCF0 0FC01A* XFRIN   450000 0FF0F0 0F001A*
TRM DATA150006 0F0C00 150C1A* XFRIN   450000 150080 160C1A* XFRIN   450000 160C40 170C1A* XFRIN   450000 170080 010C1A*
DESCRIPTOR: 015088 804080 000000 00000C 014EC8 015088 C00000
(AFTER EXECUTION)  800080 DESIGNATED RESULT

000000000000000000000CC00C0000000C000000CC0000000000000000C0C0C0
```

DISK CARTRIDGE WRITE-OP

```
DESCRIPTOR #1----------------------------------------------------------------------------------
MAIN SPEC    CHANNEL 5   ID 1A    RA 014740   MAIN TOGS 0A0000   C INC VAL 000C00   DATA E7E8E9       LENGTH 0001E0
ADD  SPEC    DUMMY REFERENCE ADDRESS 01474C   ADD  TOGS 00C000   MAX DISK SECTOR ADDRESS 00328F   TIME DELAY 010000
             DUMMY REF ADD INCREMENT 000000
DESCRIPTOR: 00C000 0C0C00 000000 40000C 014EC8 0150B8 000080
(BEFORE EXECUTION)

TEST STS150001 C1001A 01001A* XFROUTA 250040 010000 02C01A* XFROUTA 250000 020C00 03001A* XFROUTA 2500C0 030000 04C01A*
XFROUTA 250000 04CC00 050C1A* XFROUTA 2500C0 050000 06C01A* XFROUTA 250080 060C00 CE001A* XFROUTA 25FCFC 0E0000 0EC01A*
XFROUTA 25F0F0 0EC000 CECC1A* XFROUTA 25F0F0 0E000C 0EC01A* XFROUTA 25FCF0 0E0C00 CEC01A* XFROUTA 25F0F0 0E0000 0E001A*
XFROUTA 25F0F0 0EC000 0E0C1A* XFROUTA 25F0F0 0E0000 0EC01A* XFROUTA 25FCF0 0E0C00 CEC01A* XFROUTA 25F0FC 0E000C 0EC01A*
XFROUTA 25F0F0 0EC000 0E0C1A* XFROUTA 25F0F0 0E000C 0EC01A* XFROUTA 25F0FC 0E0C00 CEC01A* XFROUTA 25F0F0 0E0000 0EC01A*
XFROUTA 25F0F0 0EC000 CE0C1A* XFROUTA 25F0F0 0E0000 0EC01A* XFROUTA 25FCF0 0E0C00 CEC01A* XFROUTA 25FCF0 0E000C 0EC01A*
XFROUTA 25F0F0 0EC000 CE0C1A* XFROUTA 25F0F0 0E0000 0EC01A* XFROUTA 25F0F0 0EC000 CEC01A* XFROUTA 25F0F0 0E0000 0E001A*
XFROUTA 25F0F0 0EC000 CEC01A* XFROUTA 25F0F0 CE000C 0EC01A* XFROUTA 25F0F0 CE0C00 CEC01A* XFROUTA 25FCF0 0E000C 0EC01A*
XFROUTA 25F0F0 0E0C00 CE0C1A* XFROUTA 25F0F0 CE0000 0EC01A* XFROUTA 25FCF0 0E0C00 CEC01A* XFROUTA 25F0F0 0E000C 0EC01A*
XFROUTA 25F0F0 0EC000 CEC01A* TRM DATA15C0C6 0E0000 07C01A* XFROUTA 250C01 C7CC00 08001A* XFROUTA 250C47 080000 09C01A*
XFROUTA 250040 090000 0A0C1A* TEST S R100005 000020 12C01A* XFRIN   450000 120C01 13001A* XFRIN   450000 130047 14001A*
XFRIN   450000 140040 15CC1A* XFRIN   45C0C0 15008C 16C01A* XFRIN   450000 160C40 17C01A* XFRIN   450000 170000 01001A*
DESCRIPTOR: 0150B8 020C00 000000 400000 014E08 0150B8 000080
```

Burroughs
Field Engineering

ADVANCE
TECHNICAL
INFORMATION (ATI)

Originator: TIO- Santa Barbara Product: B1700 Disk Cartridge Cont-II

Title: FUNCTIONAL DESCRIPTION OF DISK CARTRIDGE CONTROL-II

Publications Affected: (Insert ATI Number on document page(s) as indicated)

None

Purpose: General Information

The B1700 Disk Cartridge Control-II (DCC-II) differs from Disk Cartridge Control-I (DCC-I) in several functional areas. In addition to these functional differences, there are several enhancements in the DCC-II that improve systems reliability and allow easier operations procedures that were not available with DCC-I.

An example of this is that the DCC-I provides for the attachment of from one to four drives with a capacity of either 203 cylinders or 406 cylinders at 2200 BPI while the DCC-II provides for the attachment of from one to four drives with a capacity of 406 cylinders at 4400 BPI in addition to those handled by DCC-I.

9482-32 uses DCC 3

Operational Functions

Address Search (DCC-I or DCC-II)

Before the control performs a Burroughs Read or Burroughs Write operation it must determine the position of the read/write head by means of an address search. Stored within the control during these operations is the complete address of the sector for which the control is searching. For a Burroughs Read, this is the address of the next sector to be read. For a Burroughs Write, it is the address of the sector preceding the sector to be written. As each sector is read or written, the search address is increased by one.

In the address search, the control causes the attainment of bit synchronization at each sector. The method and timing are identical to those in the Burroughs Read operation, described in the Burroughs Read paragraph that follows later in this document.

When both types of synchronization have been obtained, the control compares the sector address with the address for which the control is searching. There is no attempt to verify an address compare by checking the length of the data field or the accuracy of the LPC or postamble. (In a Burroughs Read, however, an error in data field length or in LPC of a sector actually read is detected and reported, preventing use of erroneous data. In Burroughs Write, such detection does not occur).

F.E. Dist. Code BB

Address Compare

DCC-I will accept a single address compare, and will then read or write, as indicated by the OP code.

DCC-II requires two address compares before performing a read or write decreasing the probability of address search error. The first compare is used essentially to verify that the drive is positioned to the required cylinder. (Only cylinder and track compares are necessary.) A second address compare is then necessary before DCC-II will perform the read or write. These two compares need not occur in the sequence appropriate to the positions of the sectors on disk. The address compares are required for the first sector operation following each internal seek.

Seek Complete Report (DCC-II Only).

In order to inform software that an implicit seek has been completed, DCC-II will raise Service Request any time all the following conditions are true:

a. Control is in Status Count=1
b. Seek Status flip-flop for a drive is true
c. Seek Complete is true for same drive.

Under these conditions, DCC-II raises Service Request and responds to the Test Service Request command in the normal manner. (There is no indication to software which drive(s) has completed an implicit seek.) Service Request is maintained until the control is advanced from Status Count=1.

By means of a Test Status Command, the I/O driver determines that the control is not in Status Count=10, and therefore will not return a Reference Address. The driver proceeds through the queue, and the operation which initiated the implicit seek will be performed. At the completion of this operation, if another drive has completed an implicit seek, Service Request is raised as the control enters Status Count=1.

Write Next Sector (DCC-I Only).

DCC-I, in addition to the Write Initialize operation, performs the Write Next Sector operation. Upon receiving this operation, DCC-I writes the sector following the next sector pulse, on the current cylinder and addressed track. The system provides up to two full buffers of information, followed by a Terminate Data command. Beginning at the sector pulse, the control writes the information as received, without adding preamble, sync address, LPC, or postamble. Writing begins as soon as possible following receipt of the first bufferload. Response to the control's request for the second bufferload of data must be extremely rapid or the second bufferload of data will be replaced by zeroes. This condition is not reported by the DCC-I.

Write Next Sector operation is provided for maintenance purposes. In general, the operation is not appropriate for software use, as the sector written cannot be predetermined.

No equivalent of the Write Next Sector operation is provided on DCC-II.

Burroughs Read.

The usual method of reading from the disk cartridge is called the "Burroughs Read." Upon receiving a Burroughs Read operation the control first determines whether the head is positioned to the addressed cylinder by reading the addresses from the disk.

If the cylinder address is correct, the control checks that sector and subsequent sectors for the required cylinders, track, and sector address. When the required address is detected, the data from that sector is read into the first data buffer. The control then signals the system to empty that buffer, and concurrently begins searching for the next higher numbered sector. While this should be the following sector, the control does not check for position on disk.

If the control determines that the head is not positioned to the correct cylinder address (and if the Seek Status flip-flop is not set), the control sets the Seek Status flip flop, commands the drive to move the head to the desired cylinder, then exists by returning a result status with Bit 17=0. This leaves the operation in the queue and frees the control to perform one or more operations on other drives during the resulting head motion.

If a sector is ready to be read when all buffers are full, the control will wait until a buffer has been made available and the sector is again in position. DCC-II will wait indefinitely. DCC-I will wait approximately 160 milliseconds, and will then exit, reporting Address Coincidence Not Achieved.

Reading entails two types of synchronization; bit synchronization and data synchronization. Bit synchronization is required for each sector, as the sector to sector transition is not bit-continuous. Reading is completely disabled for a fixed time following a sector pulse, preventing faulty bit synchronization during this sector-to-sector transition. Reading is then enabled for the purpose of bit synchronization of the disk cartridge drive electroinics. The pattern recorded on the disk for this phase of the operation must be all zeroes. A fixed time later, the control assumes that the drive has achieved correct bit synchronization and the search for the sync byte is begun. This procedure is performed for each sector, regardless of whether bit synchronization or data synchronization had been achieved on the previous sector. The following table indicates the time delays utilized for the various disk cartridge drives:

	DCC-I (2200BPI)	DCC-II (2200 BPI)
	USec	USec
Time from sector pulse to start of bit synchronization.	28-32	28-32
Time from start of bit synchronization to start of sync search	64-96	28
Total-Time from sector pulse to start of sync search	92-128	50-60

If, during the search for the sync byte, a one byte, is detected which is not part of a correct sync pattern, an error has occurred because either a one bit has been picked up in the preamble, or the sync byte has been missed. If the sync byte has been missed, DCC-I continues to search into the 180 bytes of data for the sync byte and will bypass any number of one bits and will accept a data byte of the bit pattern of the sync byte. To reduce the probability of false sync after missing the sync byte, DCC-II abandons sync search upon receipt of a one bit which is not part of a correct sync byte.

Read Absolute

On DCC-I, Read Absolute is performed only at sector 0 of any track. Indication of sector in the address is ignored, and the Read absolute is performed at sector 0 of the addressed cylinder and track. (This operation was formerly called Read Index).

Read Next Sector (DCC-I Only)

No equivalent of the Read Next Sector operation is provided on DCC-II.

Test (DCC-I or DCC-II

The Test operation causes the control to return a result indicating the staus and identification of the control.

Variants on the Test operation allow the software to be notified when the Ready/Not Ready status of the designated drive changes. This alerts the software when a disk cartridge is replaced, so that the label of the new cartridge can be read. (This function is not provided on DCC-I.)

Another variant on the Test operation causes the control to pause four milliseconds before returning a result. (This operation is provided on both DCC-I and DCC-II.)

Pause.

The Pause operation causes the control to wait four milliseconds, then return a result. (This operation is not provided on DCC-I. Pause on DCC-I is available only as a variant on the Test operation.) The I/O Driver does not store a result for a Pause operation.

Special Conditions

Address Coincidence Not Achieved.

In a Burroughs Read or Burroughs Write operation, the control searches for one or more sector addresses. If the control is unable to locate an address within the prescribed number of index pulses (four for DCC-I, two for DCC-II), the operation is terminated and Address Coincidence Not Achieved is reported.

Implicit Seek Loop.

DCC-I will perform an implicit seek if an incorrect cylinder address is detected and no internal seeks has occurred, even if data has already been transferred. If attempting to read a sector with faulty cylinder address, or attempting to write the sector following a sector with faulty cylinder address, DCC-I will perform an implicit seek (to the current cylinder) and leave the operation in the queue to be retried. The operation will be retried an indefinite number of times. Since the Seek Status flip-flop is set at the conclusion of each attempt, other programs are in general unable to communicate with that drive. Recovery from this condition, if required, must be provided by software.

DCC-II recovers from this condition without special handling by software. The first sector read on each attempt will vary somewhat. When one of these initial sector address searches indicates correct cylinder and track, an implicit seek is prevented. If the control is then unable to locate the required sector address, the control completes the operation, reporting Address Coincidence Not Achieved and Sector Address Error.

Hangup by Seek Status Flip-Flop

This condition occurs when the Seek Status flip-flop is set and the queue contains no operation for the cylinder to which the drive is currently positioned. (This is the usual result of an undetected seek error on implicit seek.) Any operation for the drive, including the one for which the implicit seek was performed, is returned to the queue to be retried later. The condition continues indefinitely.

Recovery from this condition, if required, must be provided by software. On DCC-II, the software can reset the Seek Status flip-flops by performing a Read Absolute operation or by a Test and Clear command. On DCC-I, the software can reset the Seek Status flip-flops by a Read Absolute or Read Next Sector operation.

I/O Descriptor Operation

Read	E	RS	L	000M V.....UU	A	B	C

Read data from the disk starting at the sector indicated by the file address (C) into ascending memory locations beginning at the location specified by the A address and ending at but not in the end location specified by the B address. A complete sector need not be stored but will be parity checked by the control.

MV = 00 Read data as described
MV = 01 Undefined
MV = 10 Read Absolute
MV = 11 Read Next Sector (DCC-I)
Read Absolute (DCC-II)

UU = 0...3 Unit number

Write [E] [RS] [L] [010M,V.....UU] [A] [B] [C]

Write data to the disk starting at the sector indicated by the file address (C) from ascending memory locations beginning at the location specified by the B address. Zero fill the last sector, if necessary.

MV = 00 Write data as described
MV = 01 Undefined
MV = 10 Write Initialize
MV = 11 Write Next Sector (DCC-I)
Write Initialize (DCC-II)

UU = 0...3 Unit number

Pause [111.....]

Return SR after pause of 4 milliseconds. Result returned by control is not to be stored, and must have bit #1=1, bit #17=0.

Note: This operation is generated by the I/O Driver. There is no explicit Pause operation in the linked list of I/O descriptors.

Note: This operation is not recognized by DCC-I, but is recognized by DCC-II.

Test [E] [RS] [L] [100VVP.....UU]

Test the drive and the control for the following conditions:

1. Drive Ready
2. Write Lockout
3. Peripheral Seek Timeout - peripheral was unable to reach required cylinder within 200 milliseconds. (Reported until another seek is initiated by control.)
4. Seek Status flip-flop set
5. Position settled (drive not seeking)
6. Control identification
7. Drive presence and type

VVP = 000 Store result unconditionally
= 100 Store result only if Ready; otherwise continue linking
= 010 Store result only if present and Not Ready; otherwise continue linking
= 110 Undefined
= XX1 Pause four milliseconds before fetching the next I/O descriptor. Do not store result. Ignore unit designation

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Page 8 of 9

Notes: DCC-I does not recognize VV, and returns a result with bit #17=1 in all cases except Pause, in which bit #17=0.

DCC-II recognizes VV, and returns a result with bit #17=0 if the result is not to be stored.

Result Status Information

1. Operation complete
2. Exception condition (3 through 7, 12, or 15 set*)
3. Not Ready - operation not performed or not completed (all operations)
4. Parity error (Burroughs Read)
5. Reserved
6. Memory parity error (Burroughs Write, Write Initialize) (software generated)
7. Write lockout - operation not performed (Burroughs Write, Write Initialize, Test)

8,9,10* Unit ID (All operations except Pause) (Field changeable)

8	9	10	
X	X	0	Not present
0	0	1	32 Sectors, 203 Cylinders
0	1	1	32 Sectors, 406 Cylinders
1	1	1	64 Sectors, 406 Cylinders
1	0	1	~~64 Sectors, 203 Cylinders~~

10 — Present
9 — 406 Cylinders
8 — 64 Sectors

11. Sector Address Error** (DCC-II only)
12. Illegal Address (any read or write)
(or) Seek Incomplete (Any operation except Pause)
(or) Address Coincidence Not Achieved (Burroughs Read, Burroughs Write)
13. Not Seeking (Test) (Position Settled)
14. Reserved
15. Seek Status flip-flop set (Test)
16. Reserved
17. Operation Complete***
18-24. Control ID = 0011000 (DCC-I) (Test)
= 0011010 (DCC-II) (Test)

*Bit #2 is also set on any operation for which bit #10=0, i.e. unit not present.

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Date 2-13-76

**DCC-II sets Bit 11 to indicate that the drive was positioned to the correct cylinder but the required sector could not be located. Bit 11 is never set when Bit 12 is not set. Bit 11 is never set by DCC-I.

***Control returns result with bit #17=1 if result is to be stored; bit #17=0 if result is not to be stored.

Installation requirements for DCC-II include use of an I/O Base-II. Information pertaining to conversion and re-conversion of I/O Bases is available in the F. E. Feature/Modification Installation Manual, section B1, page 4-5.

Printed in U. S. America

PERIPHERAL AND CONTROL ANALYSIS PROGRAM
PCAP

"FOR TRAINING USE ONLY"

check ksl Controls IO.

GENERAL DESCRIPTION

THIS PROGRAM IS INTENDED TO PROVIDE A MEANS OF VERIFYING CORRECT OPERATION OF THE B1700 SOFT I/O CONTROLS, OF EXERCISING SPECIFIC OPERATIONS ON I/O DEVICES, AND TO AID IN GENERAL DEBUGGING OF I/O BY PROVIDING A LARGE NUMBER OF OPTIONS FOR THE USER'S SELECTION.

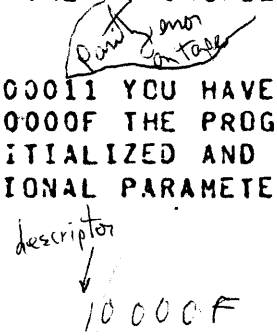
PCAP DOES NOT HANDLE SINGLE LINE CONTROLS NOR ANY DATA COMM DEVICES.

THIS PROGRAM REQUIRES THE MANUAL INSERTION OF DESCRIPTOR PARAMETERS (OP CODES, FILE ADDRESSES, PROGRAM TOGGLES, ETC). ANALYSIS OF RESULT STATUS INFORMATION IS THE RESPONSIBILITY OF THE USER. IT IS ADVISED THAT THE B1700 FIELD TECH MANUAL FOR ANY PARTICULAR SOFT CONTROL OR SUBSYSTEM BE USED IN CONJUNCTION WITH THIS PROGRAM.

INDEX TO INFORMATION ABOUT PCAP

PROGRAM LOADING ----------

0. CHECK TO INSURE THAT THE CASSETTE TAPE NUMBER AND REVISION MATCH THE CT-(NUMBER) AND REVISION PRINTED ON THE LISTING UNDER THE PROGRAM TITLE.
1. PLACE CASSETTE TAPE OF THIS PROGRAM IN CASSETTE READER.
2. MAKE SURE CASSETTE IS AT BOT AND BOT LIGHT IS ON.
3. TURN MODE SWITCH (UNDER RUN LIGHT) TO TAPE.
4. TURN REGISTER SELECT SWITCH (UNDER STATE LIGHT) TO POSITION 2.
5. PRESS CLEAR.
6. PRESS START.
7. WHEN TAPE STOPS CHECK THE FOLLOWING REGISTERS
   LR EQL HEX AAAAAA (GOOD TAPE LOAD TO THIS POINT).
   X EQL THE LAST 4 DIGITS OF THE CT-(NUMBER) IN HEX.
   Y EQL THE LAST 4 DIGITS OF THE T-(NUMBER) IN HEX.
   T EQL THE REVISION LETTERS OF THE CT-(NUMBER) IN EBCDIC.
   L EQL THE REVISION LETTERS OF THE T-(NUMBER) IN EBCDIC.
8. TURN MODE SWITCH TO RUN.
9. PRESS START.
10. IF THE TAPE HALTS WITH LR = HEX 000011 YOU HAVE A BAD TAPE.
11. IF THE TAPE HALTS WITH LR = HEX 10000F THE PROGRAM IS OPERATIONAL WITH ALL REGISTERS INITIALIZED AND IS IN A STATE READY TO ACCEPT OPERATIONAL PARAMETERS.



PROGRAM USE ----------

THE SELECT 2 REGISTERS (X,Y,T,L FIC) ARE USED TO SPECIFY I/O CONTROL, PARAMETERS FOR I/O DESCRIPTOR BUILDING, AND PROGRAM OPTION TOGGLES.
THESE REGISTERS ARE LOADED WHEN THE PROGRAM HALTS WITH LR DISPLAYING A SPECIFICATION HALT CODE BY TURNING THE LARGE REGISTER GROUP SWITCH TO DISPLAY THE REGISTER WANTED, SETTING THE DESIRED CONSOLE SWITCHES, AND PUSHING LOAD. INFORMATION FOR UP TO 4 I/O OPERATIONS (DESCRIPTORS) AND DATA FOR ONE PROGRAM DATA BUFFER CAN BE SPECIFIED. THESE SPECIFICATION HALTS ARE DIVIDED INTO MAIN SPECIFICATIONS, ADDITIONAL SPECIFICATIONS, AND DATA SPECIFICATIONS.

NOTE: HALT CODES AND OTHER VALUES ENCLOSED BY THE SYMBOL @ ARE IN HEXADECIMAL FORMAT. FOR EXAMPLE, "LR = @ 10000F @" MEANS THE CONSOLE LIGHTS WILL SHOW THE BINARY VALUE:

0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 1 1

WHEN LR IS DISPLAYED.

THE USER SHOULD ALSO NOTE THE DIFFERENT BIT-NUMBERING CONVENTIONS EMPLOYED.

THE FIRST LINE BELOW IS THE SOFTWARE CONVENTION
THE NEXT LINE BELOW IS THE HARDWARE CONVENTION

```
   MSB                                                                 LSB
Software 0  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Hardware 23 22 21 20 19 18 17 16 15 14 13 12 11 10 09 08 07 06 05 04 03 02 01 00
```

THIS LISTING USES THE SOFTWARE CONVENTION.

SPECIFICATIONS HALTS

MAIN SPECIFICATION HALT

LR = ₴ N0000F ₴ — N = 1,2,3, OR 4. MAIN SPECIFICATIONS MAY BE MADE FOR DESCRIPTOR #N. MAIN SPECIFICATION HALT LR = ₴ 10000F ₴ CAN BE REACHED ANY TIME BY PUSHING (HALT), CLEAR, START.

ADDITIONAL SPECIFICATION HALT

LR = ₴ N000FF ₴ — N = 1,2,3, OR 4. ADDITIONAL SPECIFICATIONS MAY BE MADE FOR DESCRIPTOR #N.

DATA SPECIFICATION HALT

LR = ₴ 00000D ₴ — DATA SPECIFICATIONS FOR THE PROGRAM DATA BUFFER MAY BE MADE.

NOTE: ANY REGISTER NOT LOADED DURING THESE HALTS WILL DEFAULT ITS CURRENT CONTENTS AS THE VALUE THE PROGRAM USES. IF THE USER IS AWARE OF A MISTAKE OR OMISSION MADE IN A PREVIOUS SPECIFICATION HALT WHILE LOADING PARAMETERS DURING THE CURRENT SPECIFICATION HALT, THE FOLLOWING PROCEDURE CAN BE USED TO SAVE CURRENT SPECIFICATIONS (OTHERWISE LOST BY CLEAR/START) AND RETURN TO THE PREVIOUS, INCORRECT SPECIFICATION HALT:

* COMPLETE LOADING OF ALL CURRENT SPECIFICATIONS
* CLEAR, THE CP REGISTER TO ₴002₴
* PUSH START

THE CURRENT SPECIFICATIONS WILL BE STORED AND THE PROGRAM WILL RETURN TO MAIN SPECIFICATION HALT, LR = ₴ 10000F ₴. THE USER CAN THEN CHANGE THESE PARAMETERS OR "FLAG FORWARD" TO THE INCORRECT SPECIFICATIONS FOR ANY CHANGES.

RUNNING THE PROGRAM ----------

MAIN, ADDITIONAL, AND DATA SPECIFICATIONS ARE GIVEN AFTER THIS SECTION. THIS SECTION PROVIDES AN OVERVIEW AND EXAMPLES OF RUNNING PCAP.

A. AFTER ALL SPECIFICATIONS HAVE BEEN MADE, PUSHING START WILL FIRST CAUSE THE PROGRAM TO EXECUTE DESCRIPTOR #1.

B. AFTER THE PROGRAM IS FINISHED WITH DESCRIPTOR #1 (OR ANY OTHER DESCRIPTOR), AND IF ADDITIONAL TOGGLES HAVE BEEN SET TO NEXT EXECUTE A DIFFERENT DESCRIPTOR, THE PROGRAM DESCRIPTOR COUNT WILL BE CHANGED TO THE NEXT DESCRIPTOR. IF NO ADDITIONAL TOGGLES FOR "NEXT DESCRIPTOR" HAVE BEEN SET, THE DESCRIPTOR COUNT WILL NOT BE CHANGED. and Rerun same descriptor

C. THE PROGRAM WILL THEN EXAMINE CC(3), THE CONSOLE INTERRUPT SWITHCH, TO DETERMINE IF THE USER WISHES TO CONTINUE.

IF CC(3) IS SET THE PROGRAM WILL BRANCH TO THE MAIN SPECIFICATION ~~HALT~~ FOR DESCRIPTOR #1. THE USER CAN THEN CHANGE ANY SPECIFICATIONS HE DESIRES AND REPEAT THE PROCESS (RETURN TO A.).

IF CC(3) IS OFF THE PROGRAM WILL EXECUTE THE DESCRIPTOR INDICATED BY THE PROGRAM DESCRIPTOR COUNT AND CONTINUE (RETURN TO B.) UNTIL THE USER STOPS THE PROGRAM.

IF THE CONTROL OR PROGRAM HANGS, THE USER MAY STILL GET A TRACE OF THE OPERATION TO THAT POINT BY DOING THE FOLLOWING:

PUSH HALT
PUSH CLEAR
LOAD THE A REGISTER WITH @0000020
PUSH START

THE TRACE WILL BE PRINTED AND THE PROGRAM WILL GO TO THE MAIN SPECIFICATION HALT FOR DESCRIPTOR #1.
THIS PROCEDURE ASSUMES THE PRINTER IS OPERATIONAL AND TRANSACTIONS WERE STORED.

MAIN SPECIFICATIONS. N0000F INLR

X = CONTROL ID: THE 7 BIT IDENTIFICATION CODE (SEE BELOW) IS LOADED RIGHT JUSTIFIED IN X. A PARTICULAR CHANNEL MAY BE SPECIFIED IN THE 4 MSB OF X.

Y = OP CODE: OPERATION CONTROL IS TO PERFORM (SEE BELOW). REFER TO TECH MANUAL FOR COMPLETE EXPLANATION.

T = FILE ADDRESS: THE C FIELD IN THE I/O DESCRIPTOR.

L = MAIN TOGGLES: SEE BELOW.

BR= C FIELD INCREMENT VALUE.

LR= MAIN SPECIFICATION HALT CODE. N0000F

FA= DATA: WHEN PROGRAM DATA BUFFER IS NOT USED.

FL= DATA LENGTH: NUMBER OF BITS READ INTO OR WRITTEN FROM PROGRAM DATA BUFFER (SEE ALSO, "SPECIAL INFORMATION FOR DISK OPERATION" BELOW).

MAIN TOGGLES

* L(0) = HALT TO LOAD ADDITIONAL SPECIFICATIONS FOR THIS DESCRIPTOR.

* L(1) = HALT TO LOAD MAIN SPECIFICATIONS FOR THE NEXT DESCRIPTOR. (THE FOLLOWING SEQUENCE IS OBSERVED: DESC.#1--DESC.#2--DESC.#3--DESC.#4--DESC.#1--ETC.)

* L(2) = HALT BEFORE EXECUTING THE DESCRIPTOR(S) TO SPECIFY DATA FOR PROGRAM DATA BUFFER. THIS TOGGLE NEED BE SET ONLY ONCE IN ANY MAIN SPECIFICATION HALT TO REACH DATA SPECIFCATION HALT.

NOTE: THESE TOGGLES (*) ARE RESET BY THE PROGRAM ONCE USED.

L(3) = USE THE FA REGISTER (OR THE AREA WHERE FA IS STORED) FOR WRITE DATA (OR AS A READ DATA BUFFER). WHEN L(3) IS RESET THE PROGRAM DATA BUFFER IS USED.

L(4) = TRACE EXECUTION OF THIS DESCRIPTOR ON LINE PRINTER AFTER EXECUTION TERMINATES. SEE "I/O EXCHANGE INFORMATION" BELOW FOR MEANINGS OF TRANSACTIONS RELEVENT TO TRACE. SEE DIAGNOSTIC DRIVER LISTED BELOW FOR FORMAT OF TRACE.

NOTE: THE TRACE IS STORED IN THE REMAINING FREE MEMORY ABOVE THE PROGRAM DATA BUFFER. ON MACHINES WITH SMALL S-MEMORIES, A VERY LARGE DATA LENGTH MAY PROHIBIT STORING AND PRINTING A FULL TRACE.

L(5) = PRINT PROGRAM DATA BUFFER ~~IN HEX~~ AFTER EXECUTION OF THIS DESCRIPTOR TERMINATES (AFTER TRACE IF ANY).
L(6) = PRINT PROGRAM DATA BUFFER IN EBCDIC.

NOTE: PRINT OUT OF PROGRAM DATA BUFFER IS LIMITED TO DATA LENGTH SPECIFIED FOR THIS DESCRIPTOR.

L(7) = SINGLE STEP EXECUTION OF THIS DESCRIPTOR HALTING AFTER EACH TRANSACTION WITH:
X=COMMAND ACTIVE
Y=RESPONSE COMPLETE
T=RESPONSE COMPLETE OF A TEST STATUS
L(8) = SINGLE STEP EXECUTION OF THIS DESCRIPTOR ONCE SERVICE REQUEST HAS OCCURRED. MAIN TOGGLE L(7) TAKES PRECEDENCE WHEN SET.
L(9) = DELAY BEFORE ANSWERING SERVICE REQUEST. MAIN TOGGLE L(0) MUST ALSO BE SET TO LOAD TIME DELAY AMOUNT. DEFAULT IS 20100002. milsec. (100 seconds)
L(10)= DONT HALT FOR BAD REFERENCE ADDRESS RETURNED FROM THE CONTROL

**L(11)= COMPARE DATA (SEE "COMPARING DATA" BELOW).

**L(12)= HALT WITH RESULT STATUS OF OPERATION IN T REGISTER. SEE "RESULT STATUS INFORMATION" BELOW.
**L(13)= DONT HALT IF EXCEPTION BIT REPORTED IN RESULT STATUS.

**L(14)= HALT WITH RESULT STATUS IN T FOR THE CONDITION SPECIFIED BY MAIN TOGGLES L(17), L(18). MAIN TOGGLE L(0) MUST ALSO BE SET TO DESIGNATE RESULT. DEFAULT IS 38000803.

NOTE: THE SETTING OF MAIN TOGGLE L(13) IS OBSERVED INDEPENDENTLY OF MAIN TOGGLE L(14).

**L(15)= PRINT THE TRACE OF THIS DESCRIPTOR'S EXECUTION FOR THE CONDITION SPECIFIED BY MAIN TOGGLES L(17), L(18).
**L(16)= RE-EXECUTE THIS DESCRIPTOR (IGNORE ADDITIONAL TOGGLES FOR EXECUTING THE NEXT DESCRIPTOR) FOR THE CONDITION SPECIFIED BY MAIN TOGGLES L(17), L(18).
**L(17), L(18)
=00 RESULT STATUS NOT EQUAL TO DESIGNATED RESULT.
=01 RESULT STATUS EQUAL TO DESIGNATED RESULT.
=10 RESULT STATUS ANDED WITH DESIGNATED RESULT NOT ZERO.
=11 RESULT STATUS BITS OFF FOR ALL CORRESPONDING 1-BITS IN DESIGNATED RESULT.

NOTE: THESE TOGGLES (**) ARE EXAMINED ONLY IF THE OPERATION ACHEIVES NORMAL TERMINATION.

THE FOLLOWING MEANING APPLIES ONLY TO DISK CARTRIDGE:

L(19)= SET UP SYNC AND FILE ADDRESS DATA FOR INDEX WRITE. PROGRAM DATA BUFFER NOT EFFECTED. DATA FIELD LENGTH SET BY PROGRAM.

THE FOLLOWING MEANINGS APPLY ONLY TO DISK CARTRIDGE, PACK OR FILE:

L(20)= AFTER EXECUTION OF DESCRIPTOR, INCREMENT THE FILE ADDRESS (C FIELD OF DESCRIPTOR) BY THE VALUE IN BR IF BR NEQ 0 OR BY 1 IF THE VALUE IS 0.

L(21)= IF MAIN TOGGLE L(20) IS SET, CHECK THE INCREMENTED FILE ADDRESS AGAINST THE SPECIFIED MAXIMUM FILE ADDRESS AND HALT THE PROGRAM IF IT EXCEEDS THE MAXIMUM. MAIN TOGGLE L(C) MUST ALSO BE SET TO LOAD MAXIMUM FILE ADDRESS; DEFAULT IS DECIMAL 12991. WHEN MAIN TOGGLE L(20) IS SET AND MAIN TOGGLE L(21) IS RESET, THE PROGRAM WILL CLEAR THE FILE ADDRESS TO @0000000 WHEN THE MAXIMUM IS EXCEEDED.

L(22)= IF OPERATION SHOULD REPORT 2ND OP COMPLETE BUT IT IS NOT REPORTED, HALT THE PROGRAM WITH AN ERROR CODE IN LR. IF MAIN TOGGLE L(22) IS RESET THE PROGRAM WILL RE-EXECUTE THIS DESCRIPTOR (OP NOT TEST OR PAUSE) UNTIL EXPECTED 2ND OP COMPLETE IS REPORTED.

THE FOLLOWING MEANINGS APPLY ONLY TO READER-SORTER:

L(19)= HALT ON TOO LATE TO POCKET SELECT.

NOTE: THE PROGRAM LOOPS TO EXECUTE A READ OPERATION FOR EACH SUCCESSIVE DOCUMET. THIS LOOP BY-PASSES ADDITIONAL TOGGLES FOR EXECUTING THE NEXT DESCRIPTOR UNTIL TERMINATE LINKING IS REPORTED IN RESULT STATUS, TOO LATE TO POCKET SELECT OCCURS, OR WHENEVER READ OPERATION DOES NOT ACHIEVE NORMAL TERMINATION.

L(20)= USE THE VALUE IN BR (16 LSB) FOR DOCUMENT COUNT. IF THE VALUE IS 0 (IS DOWN-COUNTED TO 0), SET THE HALT FEEDER VARIANT IN THE READ OP. DECREMENT THE VALUE BY 1 WHEN EACH READ OP IS EXECUTED. THE ORIGINAL VALUE LOADED IN BR IS REGAINED AFTER ANY OF THE CONDITIONS NOTED ABOVE.

L(21)= DELAY (TIME DELAY AMOUNT)MILLISECONDS BEFORE ANSWERING POCKET SELECT REQUEST. MAIN TOGGLE L(0) MUST ALSO BE SET TO LOAD TIME DELAY AMOUNT. DEFAULT IS @0100003 - ABOUT 1 MINUTE.

L(22)= IF MAIN TOGGLE L(20) IS RESET, INCREMENT THE CONTENTS OF THE DESCRIPTOR'S C FIELD AFTER A READ OP BY THE VALUE IN BR. IF THE VALUE IN BR=0, AN INCREMENT OF @0200003 IS USED.

L(23)= IF MAIN TOGGLE L(22) IS RESET, USE THE 4TH BYTE OF DATA TRANSFERRED IN ON A READ OP TO SELECT POCKET.

COMPARING DATA

THE USER MAY SET MAIN TOGGLE L(11) TO COMPARE THE CONTENTS OF THE PROGRAM DATA BUFFER AS A RESULT OF A READ OPERATION AGAINST DATA REGENERATED BY THE LAST DATA SPECIFICATIONS LOADED BEFORE THE THE READ OPERATION IS PERFORMED. DEFAULT DATA SPECIFICATIONS GENERATE 192 CHARACTERS FOLLOWED BY @40@.

THIS OPTION IS NOT PERMITTED FOR READER-SORTER.

IF IN THE LAST DATA SPECIFICATION HALT L WAS LOADED WITH EITHER @80000A@, @80000E@, OR @80000F@, THE USER SHOULD BE AWARE OF THE FOLLOWING:

1. THE USER IS RESTRICTED TO USING DESCRIPTOR #1 ONLY.
2. DIFFERENT DATA WILL BE REGENERATED FOR COMPARISON AFTER EACH EXECUTION OF THE READ OPERATION.

3.1 IF THE USER WISHES TO COMPARE THE ROTATING EBCDIC PATTERN:
- DESCRIPTOR #1 MUST HAVE THE SAME DATA LENGTH SPECIFICATION AS THAT WHEN DATA WAS WRITTEN.
- DATA SPECIFICATIONS MUST BE MADE AGAIN WITH L = @80000A@ AND THE 8LSB OF X = CORRECT STARTING CHARACTER.
- I/O DEVICE MUST BE READY TO READ CORRECT STARTING RECORD (I.E., REWIND TAPE, STARTING FILE ADDRESS LOADED, CORRECT CARD DECK IN READ HOPPER, ETC.)

3.2 IF THE USER WISHES TO COMPARE DATA TO CURRENT C FIELD PATTERN (MAINLY FOR READ AND COMPARE ON DISK):
- DESCRIPTOR #1 MUST HAVE THE CORRECT DATA LENGTH SPECIFICATION.
- I/O DEVICE MUST BE READY TO READ RECORDS WRITTEN WITH DATA SPECIFICATION OF L = @80000E@ OR @80000F@.

AFTER THE OPERATION COMPLETES WITH NORMAL TERMINATION, THE PROGRAM WILL COMPARE DATA READ WITH REGENERATED DATA, STARTING AT THE BEGINNING OF THE PROGRAM DATA BUFFER AND CONTINUING FOR THE DATA LENGTH SPECIFIED FOR THE DESCRIPTOR.
DATA IS COMPARED IN EITHER 1, 2, OR 3 BYTE SEGMENTS DEPENDING ON THE NUMBER OF BYTES TRANSFERRED PER TRANSACTION WITH THE CONTROL.

IF A BAD SEGMENT IS FOUND, THE PROGRAM WILL HALT WITH:
- AN ERROR CODE IN LR
- REGENERATED DATA RIGHT JUSTIFIED IN X
- READ DATA RIGHT JUSTIFIED IN Y
- ADDRESS OF DATA READ IN FA
- BITS LEFT TO COMPARE IN FL

THE USER MAY SET ANY OF L(4), L(5), OR L(6) IF HE HAD NOT ALREADY SET MAIN TOGGLES L(4), L(5), AND/OR L(6), TO CAUSE PRINT OUT OF THE TRACE AND/OR PROGRAM DATA BUFFER.

THE USER MAY THEN EITHER PUSH START TO CONTINUE COMPARING DATA OR CLEAR LR TO @0000000@ FIRST AND THEN PUSH START TO STOP COMPARING.

REFERENCE ADDRESS

THE REFERENCE ADDRESS SENT TO A CONTROL IS ASSUMED TO BE MERELY A BIT PATTERN; A POINTER TO THE I/O DESCRIPTOR (THE "REAL" REFERENCE ADDRESS) IS MAINTAINED INTERNALLY BY THE PROGRAM. THE USER MAY LOAD ANY BIT PATTERN IN FA DURING AN ADDITIONAL SPECIFICATION HALT. ALSO, AN INCREMENT VALUE MAY BE LOADED IN FB. EACH TIME THAT DESCRIPTOR IS EXECUTED, THE "DUMMY" REFERENCE ADDRESS IS INCREMENTED BY THIS VALUE (IT IS INITIALLY DEFAULTED TO 20000002).

ADDITIONAL SPECIFICATIONS. N000FF

X = DATA ADDRESS: THE A FIELD OF THE DESCRIPTOR (DISPLAY ONLY).

Y = DESIGNATED RESULT (DEFAULT GIVEN, LOAD DESIRED VALUE).

T = MAXIMUM DISK FILE ADDRESS (DEFAULT GIVEN, LOAD DESIRED VALUE).

L = ADDITIONAL TOGGLES: SEE BELOW.

BR= TIME DELAY AMOUNT (DEFAULT DISPLAYED, LOAD DESIRED VALUE).

LR= ADDITIONAL SPECIFICATION HALT CODE. N000FF

FA= DUMMY REFERENCE ADDRESS SENT TO CONTROL (LOAD DESIRED VALUE) SEE "REFERENCE ADDRESS" BELOW.

FB= DUMMY INCREMENT (LOAD DESIRED VALUE).

TAS= REAL REFERENCE ADDRESS USED BY PROGRAM.

ADDITIONAL TOGGLES

LA = 0001 EXECUTE DESCRIPTOR #1 AFTER THIS DESCRIPTOR.
= 0010 EXECUTE DESCRIPTOR #2 AFTER THIS DESCRIPTOR.
= 0011 EXECUTE DESCRIPTOR #3 AFTER THIS DESCRIPTOR.
= 0100 EXECUTE DESCRIPTOR #4 AFTER THIS DESCRIPTOR.

defaults to 1

NOTE: THIS DESCRIPTOR WILL BE EXECUTED NEXT IF ANY OTHER VALUE THAN 1,2,3, OR 4 IS LOADED.

ADDITIONAL SERVICE REQUEST OPTIONS

L(4) = USE TIME DELAY AMOUNT TO LIMIT THE AMOUNT OF TIME THE THE PROGRAM WILL WAIT FOR SERVICE REQUEST TO OCCUR. WHEN ADDITIONAL TOGGLE L(4) IS RESET, THE PROGRAM WILL WAIT UP TO 15 SECONDS (120 SECONDS FOR SPO) FOR SERVICE REQUEST. FAILURE TO RECEIVE SERVECE REQUEST AFTER WAITING MAXIMUM AMOUNT OF TIME CONSTITUTES A SERVICE REQUEST TIME OUT.

L(5) = RE-EXECUTE THIS DESCRIPTOR FOR SERVICE REQUEST TIME OUT.
IF ADDITIONAL TOGGLE L(5) IS RESET, THE PROGRAM WILL HALT WITH AN ERROR CODE FOR A SERVICE REQUEST TIME OUT.

ADDITIONAL SINGLE STEP OPTIONS

L(6) = SINGLE STEP EXECUTION OF THIS DESCRIPTOR
FROM STATUS COUNT 1 TRANSACTION
THRU STATUS COUNT 6 TRANSACTION.

L(9) = SINGLE STEP EXECUTION OF THIS DESCRIPTOR
FROM STATUS COUNT 7 TRANSACTION
THRU STATUS COUNT 9 TRANSACTION(S).

L(10)= SINGLE STEP EXECUTION OF THIS DESCRIPTOR
FOR TEST SERVICE REQUEST TRANSACTION(S).

L(11)= SINGLE STEP EXECUTION OF THIS DESCRIPTOR
FROM STATUS COUNT 11 TRANSACTION
THRU STATUS COUNT 13 TRANSACTION(S).

L(14)= SINGLE STEP EXECUTION OF THIS DESCRIPTOR
FOR STATUS COUNT 14 TRANSACTION(S).

L(15)= SINGLE STEP EXECUTION OF THIS DESCRIPTOR
FOR STATUS COUNT 15 TRANSACTION(S).

L(16)= SINGLE STEP EXECUTION OF THIS DESCRIPTOR
FOR STATUS COUNT 16 TRANSACTION(S).

L(17)= SINGLE STEP EXECUTION OF THIS DESCRIPTOR
FOR STATUS COUNT 17 TRANSACTION.

L(18)= SINGLE STEP EXECUTION OF THIS DESCRIPTOR
FROM STATUS COUNT 18 TRANSACTION
THRU STATUS COUNT 20 TRANSACTION.

L(21)= SINGLE STEP EXECUTION OF THIS DESCRIPTOR
FROM STATUS COUNT 21 TRANSACTION
THRU STATUS COUNT 23 TRANSACTION.

ADDITONAL OPTION CONCERNING TRACE

L(23)= DONT STORE TRANSACTIONS FOR TRACE. TRACE WILL NOT BE AVAILABLE. WHEN ADDITIONAL TOGGLE L(23) IS RESET, TRANSACTIONS WITH A CONTROL ARE STORED FOR PRINTING WHENEVER A TRACE IS REQUESTED. THIS TOGGLE MAY NEED TO BE SET WHEN CERTAIN ERRORS (ACCESS ERRORS, TOO LATE TO POCKET SELECT, ETC.) REQUIRE GREATER SPEED IN THE TRANSFER OF DATA.

DATA SPECIFICATIONS

X = DATA OR RANDOM BIT STRING.

Y = CASSETTE DATA MASK. default manual

L = DATA OPTION TOGGLES: SEE BELOW.

LR= 200000D2

FA= INITIAL OR CURRENT POINTER WITHIN PROGRAM DATA BUFFER.

DATA OPTION TOGGLES

L(0) = FILL PROGRAM DATA BUFFER AS SPECIFIED BY LF.

NOTE: ONLY THOSE OPTIONS WITH DATA OPTION TOGGLE L(0) SET CAN BE USED IN COMPARING DATA. DATA OPTION TOGGLES L(0), L(1) THRU L(5), AND L(6) ARE MUTUALLY EXCLUSIVE.

* L(1) = READ CONSOLE CASSETTE INTO PROGRAM DATA BUFFER UNTIL MICRO 0022 (CASSETTE STOP) OR WHEN 180 BYTES HAVE BEEN READ.

L(2) = ADD CHECK CHARACTER TO EACH BYTE READ FROM CASSETTE.

L(3) = USE 16 RIGHT-MOST BITS OF Y AS MASK TO BE EOR'd WITH EACH 16 BITS READ FROM CASSETTE. Random Bit Generator

L(4) = IF DATA OPTION TOGGLE L(3) IS SET, ROTATE MASK BY 1 FOR EACH 16 BITS READ FROM CASSETTE.

L(5) = DO NOT STOP CASSETTE AFTER 180 BYTES HAVE BEEN READ.

L(6) = WRITE THE 24 BITS IN X INTO PROGRAM DATA BUFFER. WRITE IN FORWARD DIRECTION AT THE MEMORY ADDRESS IN FA. DEFAULT DATA AND ADDRESS ARE GIVEN - LOAD DESIRED VALUES. PUSH START TO WRITE DATA. PROGRAM WILL HALT AFTER WRITE WITH LR=200000D2 FOR NEXT 24 BITS OF DATA AND NEW MEMORY ADDRESS. EITHER LOAD DESIRED VALUES TO CONTINUE OR SET LR=20000002 TO STOP WRITING DATA. PUSH START. MINIMUM PROGRAM DATA BUFFER SIZE IS 60 BYTES.

FILL PROGRAM DATA BUFFER WITH:

LF = 0000 THREE 64-CHARACTER EBCDIC SETS FOLLOWED BY @40@.
LF = 0001 FOUR 48-CHARACTER EBCDIC SETS FOLLOWED BY @40@.
LF = 0010 TWELVE 16-CHARACTER EBCDIC SETS FOLLOWED BY @40@.
LF = 0011 TWO 96-CHARACTER EBCDIC SETS FOLLOWED BY @40@.
LF = 0100 FOUR 48-CHARACTER FORTRAN SETS FOLLOWED BY @40@.
LF = 0101 FOUR 48-CHARACTER B500 SETS FOLLOWED BY @40@.
LF = 0110 FOUR 48-CHARACTER RPG SETS FOLLOWED BY @40@.
LF = 0111 UNASSIGNED -- PROGRAM DATA BUFFER WILL HAVE DEFAULT OR PREVIOUS DATA.
LF = 1000 THE 24 BITS IN X REPEATED FOR 60 BYTES OR THE LARGEST DATA LENGTH SPECIFIED FOR ANY DESCRIPTOR (WHICHEVER IS MAXIMUM).
LF = 1001 THE RIGHT-MOST 16 BITS IN X REPEATED FOR MAXIMUM.
***LF = 1010 ROTATING 64-CHARACTER EBCDIC SET STARTING WITH CHARACTER IN 8LSB OF X, GENERATED FOR DATA LENGTH OF DESC. #1. (1 CHARACTER ROTATION OCCURS BETWEEN EACH EXECUTION IF DESC. #1 IS A WRITE OPERATION.)
LF = 1011 RANDOM SELECTION OF 63-CHARACTER EBCDIC SET GENERATED FOR MAXIMUM (RANDOMNESS DEPENDENT ON ANY BIT STRING IN X).
LF = 1100 RANDOM BIT STRING GENERATED FOR MAXIMUM (RANDOMNESS DEPENDENT ON ANY BIT STRING IN X).
LF = 1101 RANDOM BIT STRING OF MOSTLY ZEROES - AVERAGE OF ONE 1-BIT IN 32 - GENERATED FOR MAXIMUM (RANDOMNESS DEPENDENT ON ANY BIT STRING IN X).
***LF = 1110 FILE ADDRESS (C FIELD OF DESC. #1) REPEATED 60 TIMES (180 BYTES) AND INCREMENTED BY 1 FOR EACH 180 BYTES FOR DATA LENGTH OF DESC. #1. (FILE ADDRESS AT RUN TIME USED IF DESC. #1 IS A WRITE OPERATION.)
***LF = 1111 SAME AS LF = 1110

NOTE: THESE TOGGLE SETTINGS (***) WILL PROGRAMMATICALLY LIMIT EXECUTION TO DESC.#1 UNTIL DIFFERENT DATA SPECIFICATIONS ARE MADE. ADDITIONAL TOGGLES TO EXECUTE THE NEXT DESCRIPTOR AFTER DESC. #1 MUST ALSO BE RE-ESTABLISHED BY THE USER.
FOR THESE TOGGLE SETTINGS ONLY, THE DATA IN THE PROGRAM DATA BUFFER WILL BE UPDATED BEFORE EACH SUCCESSIVE EXECUTION OF DESC. #1 IF IT IS A WRITE OPERATION.

IT SHOULD ALSO BE KNOWN THAT IDENTICAL RANDOM DATA PATTERNS CANNOT BE REPRODUCED AT A SUBSEQUENT DATA SPECIFICATION HALT.

PROGRAM HALTS

BESIDE SPECIFICATION HALTS, OTHER CONDITIONS WILL CAUSE THE PROGRAM TO HALT WITH A CODE INDICATING THE CONDITION IN THE LR REGISTER. THESE CODES ARE LISTED NEXT. WHEN "N" IS SHOWN IN A CODE, IT DENOTES THE ACTUAL HALT WILL SHOW 1,2,3, OR 4 IN PLACE OF "N" TO INDICATE THE DESCRIPTOR INVOLVED. AN @F@ IN THE 4MSB OF A CODE INDICATES THE ERROR OCCURRED WHEN INITIALLY TESTING THE SYSTEM'S PRINTER (IF ANY) OR DURING PRINT OUT OF PARAMETERS OR THE PROGRAM DATA BUFFER.

HALTS DURING INIALIZATION OR SETUP OF SPECIFICATIONS

LR =

@ 000011 @ ERROR IN LOADING PROGRAM - BAD CASSETTE OR M-FETCH PARITY ERROR. RELOADING PROGRAM MAY OR MAY NOT BE SUCCESSFUL.

@ N00012 @ MEMORY PARITY ERROR - ERROR NOT IN CONTROL, BUT MAY EFFECT PROGRAM EXECUTION. EITHER PUSH START AND HOPE FOR THE BEST OR RUN MEMORY TEST.
FOR THE BEST OR RUN MEMORY TEST.

TRACE OR PRINT OUT OF PROGRAM DATA BUFFER. PUSH START TO CONTINUE.

@ N00014 @ NO CHANNEL FOUND WITH SPECIFIED CONTROL ID. PUSHING START WILL RETURN TO MAIN SPECIFICATION HALT.

@ N00015 @ SPECIFED CHANNEL DOES NOT HAVE SPECIFIED CONTROL. PUSHING START WILL RETURN TO MAIN SPECIFICATION HALT.

@ N00016 @ SPECIFIED DATA LENGTH IS GREATER THAN AVAILABLE MEMORY. PUSHING START WILL RETURN TO MAIN SPECIFICATION HALT.

@ 000018 @ CHARACTER SPECIFIED IN X (8LSB) IS NOT IN 64-CHARACTER EBCDIC SET. LOAD ANOTHER CHACTER CODE IN X, THEN PUSH START.

HALTS WHEN ERROR IS DETECTED BY DIAGNOSTIC DRIVER

LR =

₴ N00001 ₴	STATUS COUNT TRANSITION ERROR - CONTROL WAS IN STATUS COUNT IN 8MSB OF X, WENT TO STATUS COUNT IN 8LSB OF X. PUSHING START WILL RESUME DRIVER EXECUTION FROM NEW STATUS COUNT.
₴ N00002 ₴	REFERENCE ADDRESS (DUMMY REFERENCE ADDRESS) SENT TO CONTROL DOES NOT MATCH REFERENCE ADDRESS RETURNED BY CONTROL. CORRECT REFERENCE ADDRESS IS IN X. THE REFERENCE ADDRESS RETURNED IS IN Y. PUSH START TO CONTINUE.
₴ N00003 ₴	CONTROL WENT TO AN ILLEGAL STATUS COUNT FOR THIS OPERATION. ILLEGAL STATUS COUNT IN 8LSB OF X. PUSHING START WILL ATTEMPT TO RESUME DRIVER EXECUTION FROM THE ILLEGAL STATUS COUNT.
₴ N00004 ₴	CONTROL ON (PORT)/CHANNEL IN T REPORTS INVALID ID (IN X). PUSHING START WILL ATTEMPT TO RESUME DRIVE EXECUTION.
₴ F00005 ₴	ERROR IN DRIVING PRINTER. PUSH START TO CONTINUE.
₴ N00006 ₴	SERVICE REQUEST TIME OUT. DEFAULT TIME WAS 15 SECONDS (120 SECONDS FOR SPO). (PORT)/CHANNEL IN T. PUSH START TO KEEP WAITING.
₴ N00008 ₴	CONTROL WOULD NOT CLEAR FROM STATUS COUNT IN 8LSB OF X BY TEST AND CLEAR COMMAND. PUSHING START WILL ATTEMPT TO RESUME DRIVER EXECUTION AT THIS STATUS COUNT.
₴ N00009 ₴	FOR HIGH SPEED CONTROL - INCORRECT BYTE COUNT RETURNED BY CONTROL. X HAS INCORRECT COUNT RETURNED. Y HAS COUNT DETERMINED AND EXPECTED BY DIAGNOSTIC DRIVER. PUSHING START WILL ATTEMPT TO RESUME DRIVER EXECUTION.
₴ N0000A ₴	FOR HIGH SPEED CONTROL - TOO MANY TRANSFERS. PUSHING START WILL ATTEMPT TO RESUME DRIVER EXECUTION.
₴ N000F0 ₴	NORMAL TERMINATION OF OPERATION NOT ACHIEVED AFTER RESUMPTION OF DRIVER EXECUTION. NO FURTHER RE-TRY WILL BE ATTEMPTED. PUSH START TO CONTINUE PROGRAM.

OTHER HALTS WHILE EXECUTING THE DESCRIPTOR(S).

LR =

2 N00051 2 TOO LATE TO POCKET SELECT (READER-SORTER).
PUSH START TO CONTINUE.

2 N00052 2 DIAGNOSTIC DRIVER REPORTS MISSING CONTROL.

2 N00053 2 SINGLE STEP HALT:
X=COMMAND ACTIVE.
Y=RESPONSE COMPLETE (SHOWS STATUS AT TIME OF COMMAND ACTIVE).
T=RESPONSE COMPLETE TO ENSUING TEST STATUS (SHOWS NEW STATUS OF CONTROL).

2 N00054 2 BAD COMPARE:
X HAS DATA AS GENERATED BY PROGRAM.
Y HAS READ DATA FROM PROGRAM DATA BUFFER.
FA HAS ADDRESS IN MEMORY OF READ DATA.
FL HAS BITS LEFT OF PROGRAM DATA BUFFER LEFT TO COMPARE.
SET L(4),L(5), AND/OR L(6) IF TRACE OR PRINT-OUT WANTED.
TO CONTINUE COMPARE - PUSH START.
TO STOP COMPARE - CLEAR LR, PUSH START.

2 N00055 2 NO OP COMPLETE IN RESULT STATUS (IN T).

2 N00056 2 NO 2ND OP COMPLETE IN RESULT STATUS (IN T).

2 N00057 2 HALT TO DISPLAY RESULT STATUS IN T REGISTER.

2 N00058 2 EXCEPTION BIT REPORTED IN RESULT STATUS (IN T).

2 N00059 2 EXCEPTION BIT NOT REPORTED YET NOT READY BIT IS REPORTED IN RESULT STATUS (IN T).
PROGRAM ALWAYS HALTS FOR THIS ERROR.

OTHER PROGRAM HALTS

LR =

@ 000091 @	DATA OPTION TOGGLE L(0), L(1), OR L(6) HAS NOT BEEN SET. PUSH START AND SET DESIRED DATA OPTION TOGGLE(S).
@ N00092 @	COMPARE DATA IMPOSSIBLE - LAST SPECIFIED DATA OPTION TOGGLES DID NOT HAVE L(0) SET. PUSH START TO CONTINUE.
@ N00093 @	COMPARE DATA IMPOSSIBLE - ACTUAL ENDING ADDRESS IN MEMORY FOR READ REVERSE OPERATION NOT EQUAL TO STARTING ADDRESS OF PROGRAM DATA BUFFER. PUSH START TO CONTINUE.
@ N00094 @	PROGRAM UNABLE TO FIND BEGINNING TO GENERATE DATA. PUSH START.
@ 00009D @	WRITE NOT PERMITTED - FA POINTS OUTSIDE PROGRAM DATA BUFFER. EITHER RELOAD A NEW ADDRESS IN FA (AND ANY NEW DATA IN X) AND PUSH START, OR FIRST CLEAR LR TO @0000000 AND PUSH START TO DISCONTINUE WRITING INTO PROGRAM DATA BUFFER.

I/O EXCHANGE INFORMATION

THERE ARE TWO BASIC TYPES OF INFORMATION TRANSMITTED VIA THE I/O BUS BETWEEN PROCESSOR AND CONTROL:

"COMMAND ACTIVE" INFORMATION SENT FROM THE PROCESSOR TO A CONTROL,

AND

"RESPONSE COMPLETE" NORMALLY SENT TO THE PROCESSOR FROM THE CONTROL.

COMMAND ACTIVE INCLUDES:

0001 CCCC 0000 0000 0000 0001 - TEST STATUS OF CONTROL ON CHANNEL CCCC.

0001 CCCC 0000 0000 0000 0010 - INFORM CONTROL ON CHANNEL CCCC THAT LAST TRANSFER OF DATA CONTAINED ONLY 1 INSTEAD OF 2 CHARACTERS.

0001 CCCC 0000 0000 0000 0011 - TEST STATUS AND CLEAR CONTROL ON CHANNEL CCCC TO RESET CONDITION AFTER TEST.

0001 0000 0000 0000 0000 0101 - TEST ALL CONTROLS FOR SERVICE REQUEST.

0001 CCCC 0000 0000 0000 0110 - TERMINATE TRANSFER OF DATA WITH CONTROL ON CHANNEL CCCC.

0010 CCCC DDDD DDDD DDDD DDDD - TRANSFER DATA (LOW ORDER BITS, 1 OR 2 CHARACTERS) TO THE CONTROL ON CHANNEL CCCC.

0100 CCCC 0000 0000 0000 0000 - TRANSFER DATA IN FROM THE CONTROL ON CHANNEL CCCC.

FOR HIGH SPEED CONTROLS - Pack or Mag Tape

0110 CCCC 0000 0000 0000 0000 - TRANSFER IN FROM THE CONTROL ON CHANNEL CCCC, THE NUMBER OF BYTES OF DATA THE CONTROL WILL NEXT SEND.

0111 CCCC 0000 000N NNNN NNNN - TRANSFER TO THE CONTROL ON CHANNEL CCCC, THE NUMBER OF BYTES OF DATA (N NNNN NNNN) THE PROCESSOR WILL NEXT SEND.

RESPONSE COMPLETE INCLUDES:

OPRS SSSS DDDD DDDD DDDD DDDD

D=DDD CHARACTER BEING TRANSFERRED (MAG TAPE CONTROLS 1 AND 2).

P=POCKET SELECT INFORMATION REQUESTED (READER-SORTER CONTROL).

R=REVERSE OPERATION (MAG TAPE CONTROLS).

S SSSS=STATUS COUNT.

D=DATA, 1 OR 2 CHARACTERS. (ALL 24 BITS OF THE I/O BUS MAY BE DATA FOR HIGH SPEED CONTROLS. THE LOW ORDER 9 BITS MAY CONTAIN A BYTE COUNT IN RESPONSE TO A COMMAND ACTIVE OF 0110 CCCC 0000 0000 0000 0000).

OPRS SSSS 0000 0000 0III IIIO

I=CONTROL ID (IN RESPONSE TO TEST STATUS COMMAND OR TEST AND CLEAR).

0000 0000 MMMM MMMM MMMM MMMM

M=SERVICE REQUEST MASK (HARDWARE BIT-NUMBER WILL BE ON IN RESPONSE TO A TEST SERVICE REQUEST COMMAND FOR ALL CONTROLS REQUESTING SERVICE WHERE CHANNEL=HARDWARE BIT-NUMBER).

CONTROL ID

THE CONTROL ID IS LOADED INTO THE 7LSB OF X DURING A MAIN SPECIFICATION HALT. THEREAFTER THAT ID WILL BE USED UNTIL CHANGED BY THE USER DURING ANOTHER MAIN SPECIFICATION HALT FOR THAT DESCRIPTOR. IDS ARE LISTED BELOW IN HEX.

FOR 96 COLUMN CONTROLS THE ID INDICATES THE CAPABILITY OF THE DEVICE CONTROLLED. THEREFORE THE ID IS CHANGED IN THE CONTROL TO REFLECT THE DEVICE. REFER TO THE 96 COLUMN TECH MANUAL FOR MORE INFORMATION.

CONTROL	ID
80 COLUMN CARD READ/PUNCH/PRINT	20000022
80 COLUMN CARD PUNCH	04
80 COLUMN CARD READER	2A
96 COLUMN CARD READER-PUNCH-PRINTER	06
96 COLUMN CARD MFCU	08
96 COLUMN CARD DATA RECORDER	0A
96 COLUMN CARD READER	26
PAPER TAPE READER CONTROL-1	0C
PAPER TAPE READER CONTROL-2	0E
PAPER TAPE PUNCH	28
PRINTER	10
READER-SORTER CONTROL-1,2	14
DISK FILE CONTROL-1,2	18
DISK FILE CONTROL-3	24
DISK CARTRIDGE CONTROL-2	1A
DISK CARTRIDGE CONTROL-1	1C
DISK PACK	1E
SPO	2C
MAGNETIC TAPE CONTROL-1 (7-TRACK)	32
MAGNETIC TAPE CONTROL-2 (9-TRACK)	30
MAGNETIC TAPE CONTROL-4 (PE)	34
MAGNETIC TAPE CASSETTE	3C

OP CODES AND RESULT DESCRIPTORS

NOTE: FOR ALL CONTROLS, A PAUSE OP IS @E000000@ EXCEPT DCC-1 WHERE PAUSE = @8400000@

RESULT STATUS INFORMATION

THE PROGRAM WILL HALT TO DISPLAY RESULT STATUS OF AN OPERATION IF
THE PROGRAM WILL HALT TO DISPLAY RESULT STATUS OF AN OPERATION IF
THE USER SETS MAIN TOGGLE L(12). RESULT STATUS WILL BE IN THE

SPO

READ	000T0000	00000000	00000000
WRITE	010T0000	00000000	00000000
TEST	100V0000	00000000	00000000

T=0 ENABLE TRANSLATOR
T=1 NO TRANSLATION
V=0 TEST AND REPORT IMMEDIATELY
V=1 TEST AND WAIT FOR ENQ

SPO

0 OP COMPLETE
0 OP COMPLETE
1 EXECPTION (BIT(S) 2,3,7 SET)
3 NAK ERROR Hoy
7 ENQ RECEIVED
16 2ND OP COMPLETE
17-23= 010 1100 (TEST OP)

80 COLUMN CARD READER

```
READ    00080000 00000000 00000000
TEST    100VV000 00000000 00000000

          B=0 EBCDIC READ
          B=1 BINARY READ
        VV=00 TEST AND REPORT IMMEDIATELY
           01 TEST AND REPORT WHEN NOT READY
           10 TEST AND REPORT WHEN READY
```

```
 0 OP COMPLETE
 1 EXCEPTION (BIT(S) 2,3,6 SET)
 2 NOT READY
 3 VALIDITY ERROR (INVALID CHARACTER)
 6 READ CHECK
16 2ND OP COMPLETE
17-23= 010 1010 (TEST OP)
```

80 COLUMN CARD PUNCH

```
WRITE   010800SS 00000000 00000000
TEST    100VV000 00000000 00000000

   B=0  EBCDIC PUNCH
   B=1  BINARY PUNCH

   STACKER SELECTION
   B9210    B9212/9213    B9212/9213
SS CPC-2       CPC-2         CPC-1
00 NORMAL   NORMAL        ERROR
01 NORMAL   NORMAL        NORMAL
10 NORMAL   AUXILIARY     AUXILIARY
11 NORMAL   AUXILIARY     UNDEFINED
    VV=00  TEST AND REPORT IMMEDIATELY
    VV=01  TEST AND REPORT WHEN NOT READY
    VV=10  TEST AND REPORT WHEN READY
```

80 COLUMN CARD PUNCH

```
 0 OP COMPLETE
 1 EXCEPTION (BIT(S) 2,3 SET)
 2 NOT READY
 3 PUNCH ERROR
 6 ID BIT
16 2ND OP COMPLETE
17-23= 000 0100 (TEST OP)
```

9418 9419 80 COLUMN READ/PUNCH/PRINT
96 COLUMN READER-PUNCH

Sec. II p.1 MFCU control/mem

```
        READ  000YOSSS ZOIHOBOC 00000000
PUNCH-PRINT   OPPROSSS OWIHOBOC 00000000
        TEST  100VV000 00000000 00000000
```

Tech Manual

SSS=000 ERROR STACKER (STACKER 2) MAX 6
=001 STACKER #1
THRU
=110 STACKER #6
=111 OVERFLOW (REMAINS UNTIL MANUALLY CLEARED)

YZ=01 STACK THIS CARD
YZ=10 STACK THE PRIOR CARD
PP=01 PRINT DATA
PP=10 PUNCH DATA
PP=11 PUNCH AND PRINT DATA same data if W=0
R=1 PUNCH-PRINT AND READ
I=0 DO NOT INHIBIT CARD FEED
I=1 INHIBIT CARD FEED
W=0 PUNCH DATA = PRINT DATA (VALID FOR PUNCH
W=1 PUNCH DATA NEQ PRINT DATA AND PRINT ONLY)
H=0 FEED CARD FROM PRIMARY HOPPER
H=1 FEED CARD FROM SECONDARY HOPPER
B=0 ENABLE TRANSLATOR
B=1 BINARY, DO NOT TRANSLATE
C=0 REPORT INVALID CHARACTER
C=1 DO NOT REPORT INVALID CHARACTER
VV=00 TEST AND REPORT IMMEDIATELY
VV=01 TEST AND WAIT FOR NOT READY
VV=10 TEST AND WAIT FOR READY

80

80 COLUMN CARD READ/PUNCH/PRINT

```
 0 OP COMPLETE
 1 EXCEPTION (BIT(S) 2,3,6,7,8,9,10 SET)
 2 NOT READY
 3 VALIDITY ERROR (READ,STACK PRIOR CARD OP)
 6 READ CHECK
 7 PUNCH CHECK
 8 PRIMARY HOPPER EMPTY
 9 SECONDARY HOPPER EMPTY
10 INPUT CHECK
16 2ND OP COMPLETE
17-23= 000 0010 (TEST OR PAUSE)
```

96 COLUMN CARD

```
 0 OP COMPLETE
 1 EXCEPTION (BIT(S) 2,3,6,7,8,9,10 SET)
 2 NOT READY
 3 CARD CONTROL ("?" READ IN COLUMN 1)
 6 READ CHECK
 7 PUNCH CHECK
 8 PRIMARY HOPPER EMPTY
 9 SECONDARY HOPPER EMPTY
10 FEED CHECK (CONTROL-2)
16 2ND OP COMPLETE
17-23= 000 0110 (READER-PUNCH-PRINTER)   (TEST OP)
17-23= 000 1000 (MFCU)                   (TEST OP)
17-23= 000 1010 (DATA RECORDER)          (TEST OP)
17-23= 010 0110 (READER)                 (TEST OP)
```

PRINTER

opcode of 4

```
          PRINT  010ESSSS 00000000 00000000 00000000
  SPACE/SKIP     101ESSSS 00000000 00000000
       TEST      100V0000 00000000 00000000
LOAD TRANSLATOR  011T0000 00000000 00000000 (PC-2)
```

clear start

SSSS=0000 NO PAPER ADVANCE
=1110 SINGLE SPACE AFTER PRINTING
=1111 DOUBLE SPACE AFTER PRINTING
=0001 SKIP TO CHANNEL-1 AFTER PRINTING
THRU
=1100 SKIP TO CHANNEL-12 AFTER PRINTING (PC-2)
=1101 SKIP TO NEXT CHANNEL AFTER PRINTING (PC-2)

E=1 IF EOP, INHIBIT REPORTING EOP AND SKIP TO CHANNEL 1
V=0 TEST AND REPORT IMMEDIATELY
V=1 TEST AND WAIT FOR READY
T=1 ENABLE HARD TRANSLATION FOR 3C03 AND 3D03 (PC-2)

PRINTER

0 OP COMPLETE.
1 EXCEPTION (BIT(S) 2,3,4,6 SET)
2 NOT READY
3 PRINT CHECK (PC-3)
4 INVALID CODE DETECTED (PC-2)
6 END OF PAGE
7-9= CHARACTER SET ID (PC-2) SWITCH POSITION

000	64 CHAR. EBCDIC	1
001	48 CHAR. EBCDIC	2
010	16 CHAR. EBCDIC	3
011	96 CHAR. EBCDIC	4
100	48 CHAR. FORTRAN	5
101	48 CHAR. B500	6
110	48 CHAR. RPG	7
111	UNASSIGNED	

12 PAPER IN MOTION (TEST OP) (PC-2,PC-3)
13 TRANSLATOR UNLOADED (PC-2)
16 2ND OP COMPLETE
17-23= 001 0000 (TEST OP)

192 char. on frame

DISK CARTRIDGE

```
 READ   000MOV00 00000000 000000UU
WRITE   010MOV00 00000000 000000UU
 TEST   100TT000 00000000 000000UU
PAUSE   10000100 00000000 00000000 (DCC-1)

  MV=00 READ OR WRITE, BURROUGHS FORMAT
  MV=10 READ ABSOLUTE OR WRITE INITIALIZE
        READ ABSOLUTE ONLY SECTOR 0 ON ANY TRACK
        FOR DCC-1
  MV=11 READ NEXT SECTOR OR WRITE NEXT SECTOR (DCC-1)
         UU=00  UNIT 0
            01  UNIT 1
            10  UNIT 2
            11  UNIT 3
  TT=00 TEST AND REPORT IMMEDIATELY
  TT=01 TEST AND REPORT IF PRESENT BUT NOT READY
  TT=10 TEST AND REPORT IF READY
```

DISK CARTRIDGE

```
 0 OP COMPLETE
 1 EXCEPTION (BIT(S) 2,3,6,11,14 SET)
 2 NOT READY
 3 PARITY ERROR (BURROUGHS READ)
 6 WRITE LOCKOUT - WRITE NOT PERFORMED
 7-9= UNIT ID
      --0  NOT PRESENT
      001  32 SECTORS, 203 CYLINDERS
      011  32 SECTORS, 406 CYLINDERS
      101  64 SECTORS, 203 CYLINDERS
      111  64 SECTORS  406 CYLINDERS
10 SECTOR ADDRESS ERROR (DCC-2)
11 ILLEGAL ADDRESS, ADDRESS COINCIDENCE NOT ACHIEVED, OR SEEK
   INCOMPLETE
12 NOT SEEKING  (TEST OP)
14 SEEK STATUS FLIP-FLOP SET   (TEST OP)
16 2ND OP COMPLETE
17-23= 001 1010 (DCC-2)   (TEST OP)
17-23= 001 1100 (DCC-1)   (TEST OP)
```

SPECIAL INFORMATION FOR DISK OPERATION

THE DATA LENGTH IS LOADED INTO THE FL (FIELD LENGTH) REGISTER AT A MAIN SPECIFICATION HALT FOR A GIVEN DESCRIPTOR. FOR DISK OPERATIONS THE DATA LENGTH DETERMINES THE NUMBER OF SECTORS READ OR WRITTEN. THE CHART BELOW GIVES THE HEX VALUE TO LOAD IN FL TO READ OR WRITE A GIVEN SECTOR LENGTH.

SECTOR LENGTH	SET FL TO	SECTOR LENGTH	SET FL TO	SECTOR LENGTH	SET FL TO
1	0005A0	16	005A00	31	00AE60
2	000B40	17	005FA0	32	00B400
3	0010E0	18	006540	33	00B9A0
4	001680	19	006AE0	34	00BF40
5	001C20	20	007080	35	00C4E0
6	0021C0	21	007820	36	00CA80
7	002760	22	0078C0	37	00D020
8	002D00	23	008160	38	00D5C0
9	0032A0	24	008700	39	00D360
10	003840	25	008CA0	40	00E100
11	003DE0	26	009240	41	00E6A0
12	004380	27	0097E0	42	00EC40
13	004920	28	009D80	43	00F1E0
14	004EC0	29	00A320	44	00F780
15	005460	30	00A8C0	45	00FD20

THE FILE ADDRESS IS LOADED INTO THE T REGISTER AT A MAIN SPECIFICATION HALT FOR A GIVEN DESCRIPTOR.

FOR DISK CARTRIDGE:

NUMBERING THE BITS LEFT TO RIGHT, 0 TO 23, THEIR SIGNIFICANCE ARE AS FOLLOWS:

10-17	CYLINDER ADDRESS (LSB IS BIT 17)
18	TRACK ADDRESS (TOP OR BOTTOM HEAD)
19-23	SECTOR ADDRESS (LSB IS BIT 23)

FOR EXAMPLE AN ADDRESS OF CYLINDER 100 TRACK 1 SECTOR 3 WOULD BE LOADED AS FOLLOWS:

0000 0000 0001 1001 0010 0011

DISK FILE
DFC-1,2
DFC-3

```
READ    000MW000 00000000 0000UUUU (DFC-1,2)
READ    000MW0ED 00000000 0000UUUU (DFC-3)
WRITE   010MW000 00000000 0000UUUU
TEST    10000000 00000000 0000UUUU

   M=1  READ OR WRITE ONLY MAINTENANCE SECTOR
   W=1  WAIT ON BUSY EU OR DE
   E=1  RETURN ERROR CORRECTION CODE WITH DATA
   D=1  RETURN EXTENDED STATUS DATA
UUUU=0000 UNIT #0
      THRU
     =1111 UNIT #15
```

DISK FILE - DFC-1, DFC-2

```
 0 OP COMPLETE
 1 EXCEPTION (BIT(S) 2,3,6,11 SET)
 2 NOT READY
 3 READ DATA PARITY ERROR
 6 WRITE LOCKOUT
 7-9= UNIT ID   (TEST OP)
      000  NOT PRESENT
      001  SYSTEM MEMORY
      011  1C-3
      100  1C-4
      101  1A-3
      110  1A-4
10-11=CONFIGURATION       (TEST OP)
      00   NO EXCHANGE
      01   EXCHANGE #1
      10   EXCHANGE #2
      11   EXCHANGE #3
11 TIMEOUT (READ, WRITE)
12-13=CONTROL
      00   CONTROL #0
      01   CONTROL #1
      10   CONTROL #2
      11   CONTROL #3
16 2ND OP COMPLETE
17-23= 001 1000 (TEST OP)
```

DISK FILE - DFC-3

```
 0 OP COMPLETE
 1 EXCEPTION (BIT(S) 2,3,6*,10*,11*,13,15,22 SET)  (* NOT EXCEPTION
 2 NOT READY                                        FOR TEST OP)
 3 READ PARITY ERROR OR TEST AND BUSY
 6 WRITE LOCKOUT
 7 SLIP OCCURRED
 8-9= UNIT ID (TEST OP)
      00  NOT PRESENT
      01  SN
10 ADDRESS ERROR
11 TIMEOUT
10-11=CONFIGURATION (TEST OP)
      00   DIRECT CONNECT TO DFEC
      01   DFC CONNECTED TO EXCH #1
      10   DFC CONNECTED TO EXCH #2
      11   DFC CONNECTED TO EXCH #3
13 COMMAND PARITY ERROR - PARITY ERROR (RESULT PHASE)
15 DATA TRANSMISSION ERROR (DATA PHASE)
   PARITY ERROR (RESULT PHASE)
16 2ND OP COMPLETE
17-23= 010 0100 (TEST OP)
22-23= 01 READ OP WITH E=1 COMPLETED
       11 EXTENDED STATUS INFORMATION AVAILABLE
```

FOR DISK CONTROLLED BY DISK FILE CONTROL-1,2:

THE CONTROL ACCESSES CONSECUTIVE SECTORS BY SEQUENCING THROUGH A DFEU BY DFSU'S, THROUGH DFSU BY FACES, AND THROUGH A FACE BY LOGICAL TRACK'S. A LOGICAL TRACK IS ONE PHYSICAL TRACK IN EACH OF THREE ZONES. FIFTY LOGICAL TRACKS ARE PRESENT ON EACH FACE. THE NUMBER OF SECTORS IN A LOGICAL TRACK FOR THE VARIOUS UNITS AND THE MAXIMUM FILE ADDRESS FOR EACH FOLLOW:

	1C-3	1C-4	1A-3	1A-4
ZONE 0	73	69	27	50
1	95	89	36	64
2	110	120	50	86
LOGICAL TRACK	278	278	113	200
MAX FILE ADDRESS (5 SU'S)	555,999 20878DF8	555,999 20878DF8	225,999 20372CF8	399,999 2061A7F8

FOR DISK CONTROLLED BY DISK FILE CONTROL-3:

SECTORS ARE CONTINUOUS ACROSS DISK STORAGE UNITS. THE NUMBER OF SECTORS IN A PHYSICAL TRACK IS 64. THE NUMBER OF PHYSICAL TRACKS PER DS FACE IS 256. THE MAXIMUM FILE ADDRESS IS 131,071 (201FC78B). THERE ARE 32,768 SECTORS PER DS (20080008).

DISK PACK

```
READ            000MWVED NNN00000 P000UUUU
WRITE           0100WV00 00000000 0000UUUU
INITIALIZE      011IWVOS 00000000 0000UUUU
RELOCATE        1010WVOS NNN00000 0000UUUU
TEST            100TTQQ0 00000000 0000UUUU
```

M=1 READ SYNC CODE, FILE ADDRESS, DATA, DATA CHECK BITS, AND POSTAMBLE. RETURN 16 BIT RESULT FROM DPEC.
W=1 WAIT ON BUSY EXCHANGE
V=0 ENABLE AUTOMATIC RESTORE AFTER SEEK ERROR
V=1 DISABLE AUTOMATIC RESTORE
E=1 RETURN DATA, 32 BIT ERROR CHECK CODE, AND 16 BIT DPEC RESULT WORD
D=1 READ EXTENDED STATUS DATA FROM DPEC

NNN=000 NORMAL SECTOR ADDRESS
NNN=001 SPARE SECTOR #1 ON HEAD 0 (M OR P EQL 1
THRU
=101 SPARE SECTOR #5 ON HEAD 0 FOR READ OP)
NNN VARIANTS FOR READ OP, MP=00
NNN=001 OFFSET RIGHT (IN)
NNN=100 OFFSET LEFT (OUT)

P=1 VERIFY (M MUST = 0)
I=0 TRACK ONLY
I=1 ENTIRE PACK
S=1 WRITE DATA PATTERN WITH FIRST 16 BITS OF DATA RECEIVED FROM SYSTEM
UUUU=0000 UNIT #0 (SPINDLE 0)
THRU
=1111 UNIT #15

TT=00 TEST AND REPORT RESULTS
TT=01 TEST AND REPORT IF NOT PRESENT OR NOT READY
TT=10 TEST AND REPORT ONLY IF PRESENT, READY, AND NOT SEEKING
QQ=01 PLACE DRIVE OFF-LINE (TT=00)
QQ=10 EXECUTE PAUSE

DISK PACK

```
 0 OP COMPLETE
 1 EXCEPTION (BIT(S) 2,3,6,9*,10,11,12,14,15,22* SET)  (* NOT
 2 NOT READY                                            EXCEPTION
 3 READ DATA ERROR                                      FOR TEST OP)
 6 WRITE LOCKOUT
 7 SLIP OCCURRED
 8-9= UNIT ID   (TEST OP)
      00  NOT PRESENT
      01  203 CYLINDERS
      10  406 CYLINDERS
 9 ADDRESS PARITY ERROR OR SYNC CODE ERROR
10 SECTOR ADDRESS ERROR
11 TIMEOUT
10-11=CONFIGURATION (TEST OP)
      00   DIRECT CONNECT TO DPEC
      01   DPC CONNECTED TO EXCH #1
      10   DPC CONNECTED TO EXCH #2
      11   DPC CONNECTED TO EXCH #3
12 SEEKING (TEST OP)
14 SEEK STATUS FLIP-FLOP SET (TEST OP)
15 TRANSMISSION PARITY ERROR
16 2ND OP COMPLETE
17-23= 001 1110 (TEST OP)
22-23= 01 READ OP WITH E=1 COMPLETED
       11 DPEC ATTENTION
```

FOR DISK PACK:

THE FILE ADDRESS IS NOT DIRECTLY ENCODED, AS WITH CARTRIDGE. THIS IS BECAUSE PLATTER 0 HAS 55 USEABLE SECTORS (5 FOR RELOCATION) AND THE OTHERS HAVE 60 SECTORS. THE SEQUENTIAL BINARY FILE ADDRESS IS RELATED TO THE ACTUAL DISK PACK CYLINDER, HEAD, AND SECTOR ADDRESS AS FOLLOWS:

```
          0 LEQ FILE ADDRESS MODULO 1195 LSS 55          IS HEAD 0
55 + (N-1)*60 LEQ FILE ADDRESS MODULO 1195 LSS 55 + N*60 IS HEAD N,
                                                          N= 1 TO 19
 (N-1)*(1195) LEQ FILE ADDRESS LSS N*(1195) IS CYLINDER N, N= 0 TO 405
```

SECTORS ARE 0 THRU 54 FOR HEAD 0
SECTORS ARE 0 THRU 60 FOR OTHER HEADS (1 THRU 19)

CYLINDERS ARE 0 THRU 405 FOR TYPE 223/225 DISK PACK DRIVES
AND 0 THRU 203 FOR TYPE 220 DRIVES

READER-SORTER

```
READ            000HR000 00000000 00000000
BATCHCOUNT      10100000 00000000 00000000
POCKET LIGHT    010NNNNN 00000000 00000000
TEST            100V0000 00000000 00000000
```

H=1 HALT THE FEEDER
R=1 READ FIRST STATION

NNNNN=00000 LIGHT ON POCKET 0
THRU
=11110 LIGHT ON POCKET 30
=11111 LIGHT ON REJECT POCKET

V=0 TEST AND REPORT IMMEDIATELY
V=1 TEST AND WAIT FOR READY

READER-SORTER

0 OP COMPLETE
1 EXCEPTION (BIT(S) 2,3,5,9,10,11,12,13,14, SET)
2 NOT READY
3 UNENCODED DOCUMENT
5 CANNOT READ
7 OCR DATA (TEST OP)
9 DOUBLE DOCUMENT
10 TOO LATE TO READ
11 JAM
12 MISSORT
13 BATCH TICKET - LAST ITEM IN PATH
14 HALT VARIANT - LAST ITEM IN PATH
16 2ND OP COMPLETE
17-23= 001 0100 (TEST OP)
23 TERMINATE LINKING (BIT(S) 2,10,11,12,13,14 SET)

CASSETTE

```
READ              000R0000 00000000 000000UU
SPACE TO EOF      11000000 00000000 000000UU
WRITE             010ET000 00000000 000000UU
REWIND            01100000 00000000 000000UU
TEST              100VV000 00000000 000000UU
```

R=0 READ FORWARD
R=1 READ REVERSE
E=1 ERASE AMOUNT OF TAPE THAT WOULD OTHERWISE BE WRITTEN
T=1 WRITE TAPE MARK
UU=00 UNIT 0
01 UNIT 1
10 UNIT 2
11 UNIT 3

VV=00 TEST AND REPORT IMMEDIATELY
VV=01 TEST AND REPORT IF NOT READY
VV=10 TEST AND REPORT IF READY AND NOT REWINDING

MAG TAPE CASSETTE

0 OP COMPLETE
1 EXCEPTION (BIT(S) 2,3,4,6,7,8,9,10,11 SET)
2 NOT READY
3 DATA ERROR
4 ACCESS ERROR
6 END OF TAPE
7 BEGINNING OF TAPE
8 WRITE LOCKOUT
9 END OF FILE
9 UNIT PRESENT (TEST OP)
10 REWINDING
11 TIMEOUT
16 2ND OP COMPLETE
17-23= 011 1100 (TEST OP)

MAG TAPE
MTC-1 MTC-2

```
READ            000VCTTT PSX0000C 0000UUUU
SPACE           110VN000 PSX00000 0000UUUU
WRITE           010EM000 P0X00000 0000UUUU
REWIND          01100000 00000000 0000UUUU
TEST            100QQ000 00000000 0000UUUU

          V=0  FORWARD DIRECTION
          V=1  REVERSE DIRECTION
          C=1  CORRECT THE DESIGNATED TRACK (MTC-2, 9-TRACK)
                                          (READ FORWARD ONLY)

       TTT=000  TRACK #0
          THRU
          =111 TRACK #7   (TTT VARIANTS IGNORED BY MTC-1)

          P=0  EVEN PARITY(MTC-1)
          P=1  ODD PARITY (P VARIANT IGNORED BY MTC-2)
          S=1  REJECT NOISE BURSTS 6 CHARACTERS OR LESS
                                                  (MTC-2)
          X=0  NO TRANSLATION
          X=1  TRANSLATE BETWEEN BCL AND EBCDIC (MTC-1)
          N=0  SPACE PAST NEXT EOF RECORD
          N=1  SPACE ONE RECORD
          E=1  ERASE AMOUNT OF TAPE THAT WOULD OTHERWISE
               BE WRITTEN
          M=1  WRITE TAPE MARK (RESULTS UNDEFINED IF EM=11)
     UUUU=0001 UNIT #1
          THRU
         =1000 UNIT #8

         QQ=00 TEST AND REPORT IMMEDIATELY
         QQ=01 TEST AND REPORT IF NOT READY
         QQ=10 TEST AND REPORT IF READY AND NOT REWINDING
```

MAG TAPE MTC-1,MTC-2

FOR TEST OP

```
T  0 OP COMPLETE
T  1 EXCEPTION (BIT(S) 2,6,7,8,10 SET)
T  2 NOT READY
T  3-4= SUBSYSTEM #
T        00   NO ECHANGE
T        01   SUBSYSTEM #0
T        10   SUBSYSTEM #1
T        11   SUBSYSTEM #2
T  6 END OF TAPE
T  7 BEGINNING OF TAPE
T  8 WRITE LOCKOUT
T  9 DESIGNATED UNIT PRESENT
T 10 REWINDING
T 12-14=DENSITY SWITCH SETTING
T        000  7-T 200 BPI
T        001  7-T 556 BPI
T        011  7-T 800 BPI
T        100  9-T 200 BPI (INVALID)
T        101  9-T 800 BPI
T        110  (INVALID)
T        111  9-T 1600 BPI (PE,INVALID)
T 16 2ND OP COMPLETE
T 17-23= 011 0010 (MTC-1, 7-T NRZ)
T 17-23= 011 0000 (MTC-2, 9-T NRZ)
```

FOR OTHER OPERATIONS

```
   0 OP COMPLETE
   1 EXCEPTION (BIT(S) 2,3,4,6,7,8,9,10,11,12,13,14,15,19,20 SET)
   2 NOT READY
   3 ERROR
   4 ACCESS ERROR
   6 END OF TAPE
   7 BEGINNING OF TAPE
   8 WRITE LOCKOUT
   9 END OF FILE
  10 REWINDING
  11 NO DATA FROM READ HEAD (WRITE OP)
  11 TIMEOUT (READ OR SPACE FORWARD)
  12 CRC CORRECTION POSSIBLE (9-T ONLY)
  13-15=TRACK IN ERROR (9-T ONLY, SIGNIFICANT IF BIT 12 SET)
        000  TRACK #0
        001  TRACK #1
        010  TRACK #2
        011  TRACK #3
        100  TRACK #4
        101  TRACK #5
        110  TRACK #6
        111  TRACK #7
  19 DROPOUT (7-T ONLY)
  20 INITIATION LATE (9-T ONLY)
```

MAG TAPE
MTC-4

```
READ            000D0000 00000000 0000UUUU
SPACE           110DN000 00000000 0000UUUU
WRITE           010EM000 00000000 0C00UUUU
REWIND          011R0000 00000000 0000UUUU
TEST            100VV000 00000000 0000UUUU

                D=0  FORWARD DIRECTION
                D=1  REVERSE DIRECTION
                N=0  SPACE TO EOF
                N=1  SPACE ONE RECORD
                E=0  WRITE
                E=1  ERASE (PERFORMED IN FORWARD DIRECTION ONLY)
                M=1  WRITE TAPE MARK
                R=1  REWIND AND UNLOAD
          UUUU=0000  DRIVE UNIT #16
              =0001  DRIVE UNIT #1
               THRU
              =1111  DRIVE UNIT #15

              VV=00  TEST AND REPORT IMMEDIATELY
              VV=01  TEST AND REPORT IF NOT READY OR NOT PRESENT
              VV=10  TEST AND REPORT IF READY AND NOT REWINDING
```

```
  MAG TAPE  MTC-4
: SKIP 1
  0 OP COMPLETE
  1 EXCEPTION (BIT(S) 2,3,4,5,6,7,8,9,10,11,21 SET)
  2 NOT READY
  3 DATA ERROR
  4 ACCESS ERROR
  3-4= SUBSYSTEM ID (FIELD CHANGEABLE, TEST OP - EXCEPTION NOT SET
  5 TRANSMISSION ERROR (TEST OP)
  6 END OF TAPE
  7 BEGINNING OF TAPE
  8 WRITE LOCKOUT
  9 END OF FILE
  9 UNIT PRESENT (TEST OP)
 10 REWINDING
 11 TIMEOUT
 12-14=TAPE FORMAT
       101   800 BPI NRZ
       111  1600 BPI
 16 2ND OP COMPLETE
 17-23= 011 0100 (TEST OP)
 21 MEC DETECTED TRANSMISSION ERROR
 22 MTC-4 DETECTED TRANSMISSION ERROR
```

PAPER TAPE READER

READ	000TT000 00000000 00000000
SPACE FORWARD	101CC000 00000000 00000000
BACKSPACE	110CC000 00000000 00000000
REWIND	01100000 00000000 00000000
TEST	100V0000 00000000 00000000

TT=00 TRANSLATE BETWEEN BCL AND EBCDIC, CHECK ODD PARITY, DISREGARD DELETE CODES IF CONTROL SO STRAPPED

TT=10 NO TRANSLATION, CHECK EVEN PARITY, RETURN HIGH ORDER 0 BIT, DISREGARD DELETE CODES IF CONTROL SO STRAPPED

TT=11 NO TRANSLATION, NO PARITY CHECK

CC=00 OR10 DONT COUNT DELETE CODES IF CONTROL SO STRAPPED

CC=11 COUNT ALL CODES

V=0 TEST AND REPORT IMMEDIATELY

V=1 TEST AND REPORT WHEN READY AND NOT REWINDING

PAPER TAPE READER

0 OP COMPLETE
1 EXCEPTION (BIT(S) 2,3,6,7,8,9,10 SET)
2 NOT READY
3 TAPE PARITY ERROR
6 END OF TAPE
7 BEGINNING OF TAPE
8 NOT READY DURING OPERATION
9 STOP CODE DETECTED
10 REWINDING
16 2ND OP COMPLETE
17-23= 000 1100 (CONTROL-1, TEST OP)
17-23= 000 1110 (CONTROL-2, TEST OP)

PAPER TAPE PUNCH

```
WRITE          010T0000 00000000 00000000
TEST           100V0000 00000000 00000000
```

T=0 ENABLE TRANSLATOR
T=1 NO TRANSLATION

V=0 TEST AND REPORT IMMEDIATELY
V=1 TEST AND REPORT WHEN READY

PAPER TAPE PUNCH

```
 0 OP COMPLETE
 1 EXCEPTION (BIT(S) 2,6,8 SET)
 2 NOT READY
 6 LOW PAPER
 8 NOT READY WHILE PUNCHING
16 2ND OP COMPLETE
17-23= 010 1000
```

HIGH SPEED CONTROLS

THE DATA TRANSFER PORTION(S) FOR A HIGH SPEED CONTROL CONSIST OF A SINGLE CA CYCLE FOLLOWED BY MANY RC-S. EACH RC CYCLE WILL CONTAIN 24 BITS (3 BYTES) EXCEPT THE LAST TRANSFER OF THE LAST BUFFER WHICH MAY CONTAIN 1, 2 OR 3 BYTES.

ON INPUT, A CONTROL COMMAND 6 WILL OCCUR JUST PRIOR TO INITIATING DATA TRANSFER FOR EACH CONTROL BUFFER. THE CONTROL WILL RESPOND WITH THE NUMBER OF BYTES FOR THE CURRENT BUFFER DURING THE RC PHASE. FOR MAG TAPE, BIT 8 WILL BE RESET IF THE CURRENT BUFFER IS NOT THE LAST BUFFER; IN THIS CASE THE BYTE COUNT RETURNED IS INVALID AND A FULL BUFFER (300 BYTES) IS ASSUMED.

ON OUTPUT FOR MAG TAPE, A CONTROL COMMAND 7 WILL OCCUR JUST PRIOR TO INITIATING THE DATA TRANSFER TO FILL THE LAST CONTROL BUFFER. THIS COMMAND IS TO INFORM THE CONTROL AS TO THE NUMBER OF BYTES IN THE LAST BUFFER. A TERMINATE DATA IS ALSO SENT AFTER THE DATA TRANSFER IS COMPLETE.

THE DATA TRANSFER IS INITIATED WITH A CONTROL COMMAND 3 (XFER OUT PHASE B) OR A COMMAND 4 (XFER IN).

WHEN TRACING TRANSACTIONS, A TEST STATUS IS NOT SENT FOR EACH OF THE RC CYCLES. IN A TRANSACTION WHERE A CA OR RC DOES NOT OCCUR, THAT SIX DIGIT FIELD WILL BE @000000@ IN THE TRACE.

Pack & Mag Tape

EXAMPLES OF RUNNING PCAP

THE FOLLOWING EXAMPLES OF RUNNING PCAP ARE INTENDED FOR FAMILIARIZATION. FURTHER INFORMATION IS LISTED BELOW.

EXAMPLE OF EXECUTING A TEST OP TO THE SYSTEM SPO AND OBSERVING THE REFERENCE ADDRESS RETURNED AND RESULT STATUS OF THE TEST OP.

1. GIVEN THAT THE PROGRAM IS AT MAIN SPECIFICATION HALT
   LR = @ 10000F @.
   LOAD X WITH @00002C@, ID CODE FOR SPO
   CHECK THAT Y = @8000000@, TEST OP CODE
   T IS UNIMPORTANT
   LOAD L WITH @8008000@, MAIN TOGGLES FOR EXECUTING TEST OP
   L(0) IS SET TO CAUSE THE PROGRAM TO HALT FOR ADDITIONAL SPECIFICATIONS
   L(12) IS SET TO CAUSE THE PROGRAM TO HALT WITH RESULT STATUS OF THE OPERATION IN THE T REGISTER
   THE A REGISTER IS THE NEXT PROGRAM INSTRUCTION ADDRESS AND MUST NOT BE CHANGED
   M IS THE NEXT MICRO TO BE EXECUTED AND MUST NOT BE CHANGED
   BR IS UNIMPORTANT
   LR = @ 10000F @
   FA IS UNIMPORTANT
   FL IS UNIMPORTANT
   PUSH START

2. THE PROGRAM SHOULD HALT FOR ADDITIONAL SPECIFICATIONS WITH
   LR = @ 1000FF @
   X IS UNIMPORTANT
   Y IS UNIMPORTANT
   T IS UNIMPORTANT
   LOAD L WITH @0000200@, ADDITIONAL TOGGLES FOR EXECUTING TEST OP
   L(18) IS SET TO CAUSE THE PROGRAM TO SINGLE STEP TRANSFERRING THE REFERENCE ADDRESS FROM THE SPO CONTROL
   A MUST NOT BE CHANGED
   M MUST NOT BE CHANGED
   BR IS UNIMPORTANT
   LR = @ 1000FF @
   LOAD FA WITH @F1F2F3@, DUMMY REFERENCE ADDRESS
   FB IS UNIMPORTANT
   TAS IS UNIMPORTANT
   SET CONSOLE INTERRUPT SWITCH ON (UP POSTION)
   PUSH START

3. THE PROGRAM SHOULD HALT WITH LR = @ 100053 @. CHECK THAT:
   X = @4000000@, IF THE 4 BITS FOLLOWING @4@ ARE NOT @0@, THEN THE SYSTEM'S SPO CONTROL IS JUMPERED FOR SOME CHANNEL OTHER THAN 0
   Y = @1200F1@, IF THE 8MSB ARE NOT @12@ THE CONTROL WAS NOT IN THE CORRECT STATUS. EITHER A PROGRAM OR DRIVER ERROR OCCURRED.
   IF THE 8LSB ARE NOT @F1@ THE FIRST BYTE OF THE DUMMY REFERENCE ADDRESS RETURNED BY THE CONTROL WAS INCORRECT.
   T = @13002C@, IF THE 8MSB ARE NOT @13@ THE CONTROL HAS MADE AN INCORRECT STATUS COUNT CHANGE.
   IF THE 8LSB ARE NOT @2C@ THE CONTROL IS RETURNING THE WRONG ID CODE.
   PUSH START

4. GIVEN THAT STEP 3 CHECKED CORRECTLY, THE PROGRAM SHOULD HALT WITH LR = @ 100053 @. CHECK THAT:
   X = @4000000@
   Y = @1300F2@
   T = @14002C@
   PUSH START

5. GIVEN THAT STEP 4 CHECKED CORRECTLY, THE PROGRAM SHOULD HALT WITH LR = @ 100053 @. CHECK THAT:
   X = @4000000@
   Y = @1400F3@
   T = @15002C@
   PUSH START

6. IF NO ERRORS HAVE OCCURRED THUS FAR, THE PROGRAM WILL HALT WITH LR = @ 100057 @. CHECK THAT:
   T = @8000AC@
   T(0)=1 SHOWS TEST OP COMPLETED
   T(1)=0 SHOWS NO EXCEPTIONS OCCURRED
   T(16)=1 SHOWS TEST OP COMPLETED
   T(17 THRU 23)=2C SHOWS SPO ID
   PUSH START

7. THE PROGRAM SHOULD RETURN TO MAIN SPECIFICATION HALT LR = @ 10000F @.

EXAMPLE SHOWING MULTIPLE-DESCRIPTOR OPERATION (WRITE/READ) ON DISK CARTRIDGE (DCC-2, 100 TPI, CARTRIDGE READY ON UNIT #0, ALREADY INITIALIZED).

1. GIVEN THE PROGRAM IS AT MAIN SPECIFICATION HALT LR = @ 10000F @.
   LOAD X WITH @00001A@, ID CODE FOR DCC-2
   LOAD Y WITH @40000003, WRITE OP, UNIT #0
   CHECK THAT I = @0000000@, STARTING FILE ADDRESS
   LOAD L WITH @E20008@
   - L(0) IS SET TO CAUSE THE PROGRAM TO HALT FOR ADDITIONAL SPECIFICATIONS FOR THIS WRITE DESCRIPTOR.
   - L(1) IS SET TO CAUSE THE PROGRAM TO HALT FOR MAIN SPECIFICATIONS FOR THE NEXT DESCRIPTOR (WILL BE SPECIFIED AS A READ OPERATION IN STEP 3).
   - L(2) IS SET TO CAUSE THE PROGRAM TO HALT AFTER ALL DESCRIPTOR SPECIFICATIONS HAVE BEEN MADE TO ACCEPT DATA SPECIFICATIONS
   - L(6) IS SET TO CAUSE THE PROGRAM TO PRINT OUT DATA IN THE PROGRAM DATA BUFFER USED FOR THE WRITE OPERATION
   - L(20) IS SET TO CAUSE THE PROGRAM TO INCREMENT THIS WRITE DESCRIPTOR'S C FIELD (DISK FILE ADDRESS) AFTER THE WRITE OP COMPLETES

   LOAD BR WITH @0000020@, FILE ADDRESS INCREMENTED BY 32
   LOAD FL WITH @05A0@, DATA LENGTH IS 180 BYTES
   PUSH START

2. THE PROGRAM SHOULD HALT FOR ADDITIONAL SPECIFICATIONS TO THIS WRITE DESCRIPTOR (DESC. #1) WITH LR = @ 1000FF @.
   CHECK THAT I = @00328F@, MAXIMUM ALLOWED FILE ADDRESS
   LOAD L WITH @2000000@
   - LA IS SET = 2 TO CAUSE THE PROGRAM TO EXECUTE DESCRIPTOR #2 (WILL BE SPECIFIED AS A READ OP IN NEXT STEP) AFTER EXECUTION OF THIS DESCRIPTOR

   PUSH START

3. THE PROGRAM SHOULD HALT FOR MAIN SPECIFICATIONS TO DESCRIPTOR #2 WITH LR = @ 20000F @
   CHECK THAT X = @00001A@
   LOAD Y WITH @0000000@, READ OP, UNIT #0
   CHECK THAT I = @0000000@, STARTING FILE ADDRESS
   LOAD L WITH @82180C@
   L(0) IS SET TO CAUSE THE PROGRAM TO HALT FOR ADDITIOANL SPECIFICATIONS FOR THIS DESCRIPTOR (DESCRIPTOR #2)
   L(6) IS SET TO CAUSE THE PROGRAM TO PRINT THE DATA READ INTO THE PROGRAM DATA BUFFER FROM DISK
   L(11) IS SET TO CAUSE THE PROGRAM TO COMPARE DATA READ INTO THE PROGRAM DATA BUFFER AGAINST DATA GENERATED BY THE PROGRAM
   L(12) IS SET TO CAUSE THE PROGRAM TO HALT WITH RESULT STATUS OF THE READ OPERATION IN THE T REGISTER
   L(20) IS SET TO CAUSE THE PROGRAM TO INCREMENT THE READ DESCRIPTOR'S C FIELD (DISK FILE ADDRESS) AFTER THE READ OP COMPLETES
   L(21) IS SET TO CAUSE THE PROGRAM TO HALT IF INCREMENTING THE FILE ADDRESS MAKES IT GREATER THAN THE MAXIMUM
   CHECK THAT BR = @0000020@
   CHECK THAT FL = @05A0@
   PUSH START

4. THE PROGRAM SHOULD HALT FOR ADDITIONAL SPECIFICATIONS TO DESCRIPTOR #2 WITH LR = @ 1000FF @
   LOAD L WITH @1000000@
   LA IS SET = 1 TO CAUSE THE PROGRAM TO EXECUTE DESCRIPTOR #1 (THE WRITE OP) AFTER EXECUTING THIS DESCRIPTOR (READ)
   PUSH START

5. THE PROGRAM SHOULD HALT FOR DATA SPECIFICATIONS WITH LR = @ 00000D @
   LOAD L WITH @8000008@
   L(0) IS SET AND,
   LF IS SET = 8 TO CAUSE THE PROGRAM TO INITIALLY FILL THE PROGRAM DATA BUFFER WITH THE 24 BITS IN X REPEATED
   CHECK THAT X = @E7E8E9@, EBCDIC CODE FOR "XYZ"
   TURN OFF THE CONSOLE INTERRUPT SWITCH (DOWN POSITION)
   CHECK THAT THE SYSTEM LINE PRINTER (OR PRINTER ON LOWEST-NUMBERED CHANNEL) IS READY AND ON LINE
   PUSH START

6. ASSUMING NO ERRORS OCCUR THE PROGRAM WILL PRINT RESULTS OF EXECUTING DESCRIPTOR #1 AND INFORMATION ABOUT DESCRIPTOR #2 BEFORE EXECUTION STARTED. THE PROGRAM WILL THEN HALT WITH LR = @ 200057 @ RESULT STATUS OF THE READ OPERATION CAN BE SEEN IN THE T REGISTER.
   PUSH START

.00

start start start etc.

7. ASSUMING NO ERRORS OCCUR AND DATA COMPARES CORRECTLY, THE PROGRAM WILL PRINT THE RESULTS OF THE READ OPERATION AND THE PROGRAM DATA BUFFER AFTER THE READ OP WAS EXECUTED. THE PROGRAM WILL THEN CONTINUE BY EXECUTING DESCRIPTOR #1 AGAIN (FILE ADDRESS NOW 20000208), PRINT RESULTS OF EXECUTING THE WRITE OP, AND PRINT INFORMATION ABOUT THE READ DESCRIPTOR BEFORE IT EXECUTED AGAIN. THIS SEQUENCE CAN BE REPEATED UNTIL THE FILE ADDRESS OF DESCRIPTOR #2 IS GREATER THAN 20032BF8 OR THE CONSOLE INTERRUPT SWITCH CAN BE SET ON AT ANY TIME TO PRE-EMPT THE SEQUENCE.