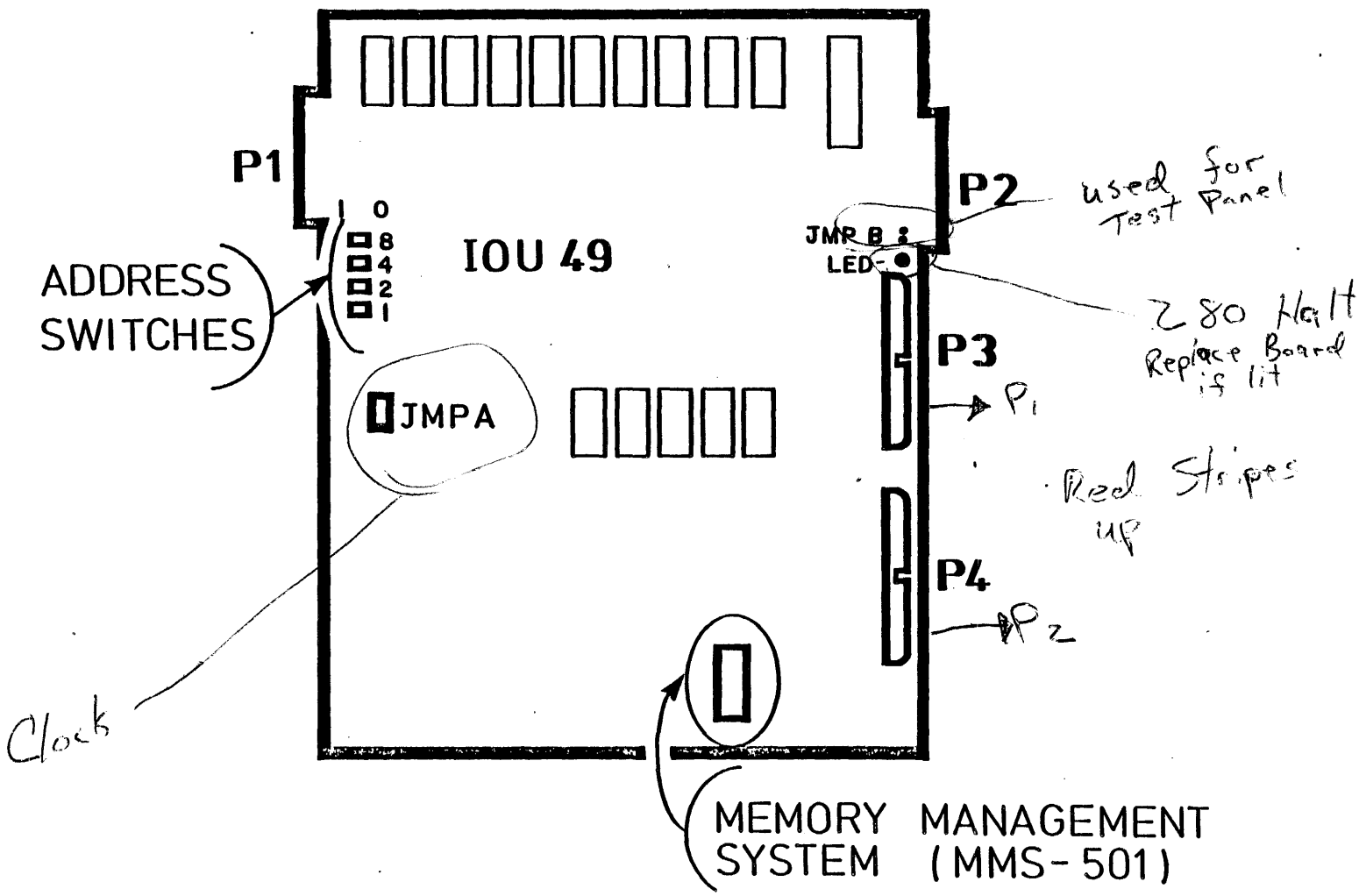
IOU 49


P1
0
8
4
2
1
ADDRESS SWITCHES
IOU 49
JMPA
P2
used for Test Panel
JMP B
LED
Z 80 Halt Replace Board if lit
P3
P1
Red Stripes up
P4
P2
Clock
MEMORY MANAGEMENT SYSTEM (MMS-501)

EQUIPMENT CHARACTERISTCS

The IOU-49 is an intelligent, buffered 1/2 inch Streaming Tape Drive Controller. It utilizes a Z-80B Micro-processor and two 4k Byte EPROMS for onboard intelligence and has a maximum of 26k Bytes of RAM for buffer memory or for downloadable intelligence. In IPL mode it is compatable to an IOU21.

The IOU-49 is capable of controlling up to eight 30 IPS START/STOP tape drives via two daisy-chain cables.

Interface signals are LOW ACTIVE (TRUE is 0.0 to 0.4 vdc) is 0.0 to 0.4 vdc).

A MMS (MEMORY MANAGEMENT SYSTEM) is used to control what has access to the controller, the Z80, the Tape Transport or the CPU.

INSTALLATION

DC VOLTAGES AND POWER REQUIREMENTS

+5 vdc ±5%
+12 vdc ±10%

CURRENT REQUIREMENTS

+5 volts at 3.7 amps, surge to 4.8 amps.
+12 volts at 15 milliamps.

NOISE

The maximum allowable noise and ripple from D.C. to 2.5 MHZ is 50 millivolts peak to peak on the 5 volt supply and 250 millivolts peak to peak on the 12 volt supply.

GROUNDING

Earth ground is not used on the controller. The controllers logic ground is connected to the tape transport via the two daisy chain cables.

SWITCH SETTINGS

Jumper switches 1,2,4 and 8 Controller Address (normally set to 8).

JMP A installed enables the 10.0 MHZ oscillators output to the IOU 49.

JMP B is absent for normal operation, it is used to start and stop the Z80 for allowing diagnostic routines to be performed.

CABLING

P2 is used only for the DPPI Panel.

P3 is connected via a 50 conductor flat cable to P1 on the Tape Transport.

P4 is connected via a 50 conductor flat cable to P2 on the Tape Transport.

The Red Stripes are up on the IOU 49 and to left rear on the Tape Transport.

ADJUSTMENTS AND ALIGNMENTS

NONE

REMOVAL AND REPLACEMENT

Power Off

MAINTENANCE & TROUBLESHOOTING

If LED 1 is on, a Z-80A halt is indicated. This is a serious controller fault, and the IOU 49 should be replaced if one of the following steps do not stop LED 1 from lighting.

Reseat controller (clean edge connector), reseat ROMS and I/O cable.

P.M.

Controller should be kept free from dust accumulation.

WRITE CONTROL INSTRUCTIONS

1dyy9D d is Device Address yy is Control Byte

(I = IPL Mode, B = Buffer Mode, S = Streaming Mode)

CONTROL	FUNCTION
00	ERASE A BLOCK (I,B)
01	READ CHECK (I,B)
02	BACKSPACE (I,B)
03	REWIND (I,B)
04	UNLOAD (I,B)
10	DISABLE CPU INTERUPTS (B,S)
14	ENABLE CPU INTERUPTS (B,S)
15	RESET CPU INTERUPT (B,S)
20	ENTER IPL MODE (I,B,S)
21	ENTER BUFFER MODE (I)
22	ENTER STREAMING MODE (I)
31	BACKUP CHECK (I,B)
32	SEARCH FOR 2 EOF'S (I,B)
33	SET HIGH SPEED (I,B,S)
34	SET LOW SPEED (I,B)
35	SET HIGH DENSITY (I,B,S)
37	START A READ FROM THE TAPE (B)
51	START A BLOCK FOR STREAMING WRITE (S)
52	END OF BLOCK FOR STREAMING WRITE (S)
53	WAIT FOR STREAMING TO COMPLETE (S)

* 7F READ IDENTIFICATION (I,B)
  85 SET MEMORY I/O MODE (I)
  86 JUMP TO MEMORY CONTROLLER LOCATION (I)

* EXTENDED_STATUS , 21 byte field. Byte definition is:

1) $49 - packed decimal IOU 49
2) $51 - Cipher Microstreamer, and
3) Controller Mode
   $01 - IPL Mode
   $02 - Buffer Mode
   $04 - Streaming Mode
4) Interupt Status Byte
   $10 - Set $10 Bit on in Status 0
   $08 - Set Backplane Interupt
5 - 6) Sequence Number
7) Last Device Control
8 - 11) Rom date and version # (YYMMDD)
12) Tape Speed
   $80 - 100 IPS and 1600 BPI
   $40 - 25 IPS and 1600 BPI
   $20 - 50 IPS and 3200 BPI
13 - 14) Block Length work area
15) Extended Tape Status
   $80 - Tape Inoperable
   $40 - No ID found on tape (N/U)
   $20 - End of Tape found
   $10 - One end of File Mark found
16) Extended Tape Status, a Backspace needs to be done.
   $10 - Hard Tape Error
   $08 - Data Corrected Error
   $04 - Tape Parity Error
   $02 - Not enough Data received for block (Streaming)
   $01 - CPU problem during Block Write, this is a Streaming error, refer to byte 17 and 18 for reason.
17) Extended Programming Problems Status
   $80 - Control not supported by controller.
   $40 - No Data for this Read (no CTL $37)
   $20 - Invalid type in Parameters (CTL $22 and $31)
   $10 - Control not valid in this Mode.
18) Extended Streaming Programming problem Status
   $80 - Two short Writes
   $40 - Reads not allowed in Streaming Mode
   $20 - Sent more Data than Parameters allowed
   $10 - Sent less Data than Parameters allowed
   $08 - Invalid length in Parameter
   $04 - No Start of Block Control received
19) Extended Check Status
   $80 - Block Length Error (CTL $31)
20 - 21) Extended Status TBD

To Read Status
187F9D
0015F30100 08
0015F20100 B0

STATUS_IN_INSTRUCTIONS

Standard_Definition

4dyy9D d is Device Address yy is the Status Byte

BIT	DEFINITION

$01	READ BUSY
$02	WRITE BUSY
$04	END
$08	Sevice Request
$10	MODE DEPENDENT
$20	MODE DEPENDENT
$40	BOT/EOT/EOF Flag
$80	INOP.

IPL Mode Status 0 Definition

BIT	DEFINITION
$20	Corrected Data Read
$10	Hard Error/Parity Error

Valid CTL $7F Bytes for IPL Mode

Byte 15	Byte 16	Byte 17	Byte 19
$80	$10	$80	$80
$40	$08	$20	
$20	$04	$10	
$10			

Buffer Mode Status 0 Definition

BIT	DEFINITION
$20	Error (get CTL $7F for error decode)
$10	Interupt

Valid CTL $7F Bytes for Buffer Mode

Byte 15	Byte 16	Byte 17	Byte 19
$80	$10	$80	$80
$40	$08	$40	
$20	$04	$20	
$10		$10	

Streaming Mode Status 0 Definition

$20	Error (get CTL $7F for error decode)
$10	RAM space available or error

Valid CTL $7F Bytes for Streaming Mode

Byte 15	Byte 16	Byte 17	Byte 18
$80	$10	$80	$80
$40	$08	$20	$40
$20	$04	$10	$20
$10	$02		$10
	$01		$08

READ IDENTIFICATION (RID). Q29B and above

1dyy86 yy - Test bit value d - Controller address

MEMORY LOCATION	CONTENTS

```
23              Actual RS2 value
26              Controller IOU number in packed decimal
27              Controller type; (ex: $51 = Cipher)
                  $1x Terminal, $2x Disk, $3x Printer,
                  $4x Communications, $5x Magtape,
                  $6x Card Reader, etc.
28              Device Dependent,
                   $01 - IPL Mode
                   $02 - Buffer Mode
                   $04 - Streaming Mode
```

READ STATUS TWO

```
xdyy86      x - Don't care     yy - Test bit value
                  d - Controller address

Always $C7 returned in Byte 23
```

READ IDENTIFICATION (RID Instruction)

```
  Byte 23 - $C7       Read Status 2
  Byte 26 - $49       Packed Decimal IOU 49
  Byte 27 - $51       Cipher Microstreamer Tape
  Byte 28 - $XX       Controller Mode
                        $01 - IPL Mode
                        $02 - Buffer Mode
                        $04 - Streaming Mode
```

5.1.3 SIGNAL NAMES:

CONNECTOR P1

PIN NUMBER	SIGNAL	DESCRIPTION
1	+5V	D.C. Power Vcc
2	+5V	D.C. Power Vcc
3	SSTROBE-	Strobe Signal for IOE Bus
4	Gnd	Ground
5	+12V	D.C. Power
6	SIOE0-	LSB of IOE Bus
7	SIOE1-	IOE Bus
8	SIOE2-	IOE Bus
9	SIOE3-	MSB of IOE Bus
10	Gnd	Ground
11	SYINT-	System Interrupt
12	Gnd	Ground
13	DA00	LSB of IOB Bus
14	DA01	IOB Bus
15	DA02	IOB Bus
16	DA03	IOB Bus
17	DA10	IOB Bus
18	DA11	IOB Bus
19	DA12	IOB Bud
20	DA13	MSB of IOB Bus
21	Gnd	Ground
22	Gnd	Ground
23	Gnd	Ground
24	Gnd	Ground
25	PFL-	Power Fail Warning
26	Gnd	Ground
27	-12V	D.C. Power
28	SRST-	System Reset (IPL)
29		Not Connected
30		Not Connected

CONNECTOR P2

PIN NUMBER	SIGNAL	DESCRIPTION
1	Gnd	Ground
2	Gnd	Ground
3	+5V	D.C. Power Vcc
4	+5V	D.C. Power Vcc
5	IORQ-	I/O Request Z80
6	BUSACK-	Bus Acknowledge Z80
7		Not Connected
8	RD-	Read Z80
9	MZAB6	Address Bit 6
10	ZRST-	Z80 Reset
11	MZAB1	Address Bit 1
12	MZAB7	Address Bit 7
13	MZAB3	Address Bit 3
14	MZAB0	Address Bit 0
15	IORD	I/O Port Read
16	MZAB5	Address Bit 5
17	MRQ-	Memory Request Z80
18	WR-	Write Z80
19	MONE-	M-1 Cycle Z80
20	MZAB4	Address Bit 4
21	RF-	Refresh Z80
22	MZAB2	Address Bit 2
23	IOWR	I/O Port Read
24	NMI-	Z80 Non-maskable Interrupt
25	MZDB6	Data Bit 6
26	MZAB12	Address Bit 12
27	MZDB1	Data Bit 1
28	MZAB14	Address Bit 14
29	MZDB0	Data Bit 0
30	MZAB8	Address Bit 8
31	MZDB4	Data Bit 4
32	MZAB15	Address Bit 15
33	MZDB5	Data Bit 5
34	MZAB9	Address Bit 9
35	MZDB3	Data Bit 3
36	MZAB10	Address Bit 10
37	MZDB2	Data Bit 2
38	MZAB11	Address Bit 11
39	MZDB7	Data Bit 7
40	MZAB13	Address Bit 13
41	BUSREQ-	Z80 Bus Request
42	ZINT-	Z80 Interrupt
43	HALT-	Halt Z80
44	WAIT-	Z80 Wait
45	CLK5	5MHz Z80 Clock
46	CLK10	10MHz TTL Clock
47	+5V	D.C. Power Vcc
48	+5V	D.C. Power Vcc
49	Gnd	Ground
50	Gnd	Ground

CONNECTOR P3

PIN NUMBER	SIGNAL	DESCRIPTION
2	IFBY-	Formatter Busy (in)
4	OLWD-	Last Word (out)
6	OW4-	Write Data 4 (out)
8	OGO-	Initiate Command (out)
10	OW0-	Write Data 0 (out)
12	OW1-	Write Data 1 (out)
14	ISGL-	Malfunction(Pertec) (in)
16	OLOL-	Load and On-line(Pertec) (out)
18	OREV-	Reverse (out)
20	OREW-	Rewind (out)
22	OWP-	Write Data Parity (out)
24	OW7-	Write Data 7 (out)
26	OW3-	Write Data 3 (out)
28	OW6-	Write Data 6 (out)
30	OW2-	Write Data 2 (out)
32	OW5-	Write Data 5 (out)
34	OWRT-	Write (out)
36	OSPS-	Speed(Pertec)/Gap Length(Digi)
38	OEDIT-	Edit (out)
40	OERASE-	Erase (out)
42	OWFM-	Write File Mark (out)
44	OGAPL-	Gap Length(Pertec) (out)
46	OTAD0-	Transport Address 0 (out)
48	IR2-	Read Data 2 (in)
50	IR3-	Read Data 3 (in)

CONNECTOR P4

PIN NUMBER	SIGNAL	DESCRIPTION
1	IRP-	Read Data Parity (in)
2	IR0-	Read Data 0 (in)
3	IR1-	Read Data 1 (in)
4	ILDP-	Load Point (in)
6	IR4-	Read Data 4 (in)
8	IR7-	Read Data 7 (in)
10	IR6-	Read Data 6 (in)
12	IHER-	Hard Error (in)
14	IFMK-	File Mark Detected (in)
16	IDENT-	Id. Burst Detected (in)
18	OFEN-	Formatter Enable (out)
20	IR5-	Read Data 5 (in)
22	IEOT-	End of Tape (in)
24	ORWU-	Rewind/Unload (out)
26	IDACK-	Diagnostic Ack.(Pretec) (in)
28	IRDY-	Ready (in)
30	IRWD-	Rewinding (in)
32	IFPT-	File Protect (in)
34	IRSTB-	Read Strobe (in)
36	IWSTB-	Write Strobe (in)
38	IDBY-	Data Busy (in)
40	ISPEED-	High-Speed Status (in)
42	ICER-	Corrected Error (in)
44	IONL-	Online (in)
46	OTAD1-	Transport Address 1 (out)
48	OFAD-	Formatter Address (out)
50	OHISP-	Speed(Cipher)/Density(Pertec)

Table 10-1. Interface Signals, Transport to Controller

PLUG NO.	LIVE PIN	GROUND PIN	SIGNAL DESCRIPTION	SIGNAL NAME
P1	2	1	Formatter Busy	IFBY
P1	14	13	Reserved	-
P1	48	47	Read Data 2	IR2
P1	50	49	Read Data 3	IR3
P2	1	-	Read Data Parity	IRP
P2	2	-	Read Data 0	IR0
P2	3	-	Read Data 1	IR1
P2	4	-	Load Point	ILDP
P2	6	5	Read Data 4	IR4
P2	8	7	Read Data 7	IR7
P2	10	9	Read Data 6	IR6
P2	12	11	Hard Error	IHER
P2	14	13	Filemark	IFMK
P2	16	25	Identification	IIDENT
P2	20	19	Read Data 5	IR5
P2	22	21	End of Tape	IEOT
P2	26	25	Reserved	-
P2	28	27	Ready	IRDY
P2	30	29	Rewinding	IRWD
P2	32	31	File Protect	IFPT
P2	34	33	Read Strobe	IRSTR
P2	36	35	Write Strobe	IWSTR
P2	38	37	Data Busy	IDBY
P2	40	39	High Speed Status	ISPEED
P2	42	41	Corrected Error	ICER
P2	44	43	On Line	IONL

10.9.2 Interface connector pin assignments, controller to transport. See Table 10-2.

Table 10-2. Interface Signals, Controller to F880

PLUG NO.	LIVE PIN	GROUND PIN	SIGNAL DESCRIPTION	SIGNAL NAME
P1	4	3	Last Word	ILWD
P1	6	5	Write Data 4	IW4
P1	8	7	Initiate Command	IGO
P1	10	9	Write Data 0	IW0
P1	12	11	Write Data 1	IW1
P1	16	15	Reserved	-
P1	18	17	Reverse	IREV
P1	20	19	Rewind	IREW
P1	22	21	Write Data Parity	IWP
P1	24	23	Write Data 7	IW7
P1	26	25	Write Data 3	IW3
P1	28	27	Write Data 6	IW6
P1	30	29	Write Data 2	IW2
P1	32	31	Write Data 5	IW5
P1	34	33	Write	IWRT
P1	36	35	Reserved	-
P1	38	37	Edit	IEDIT
P1	40	39	Erase	IERASE
P1	42	41	Write File Mark	IWFM
P1	44	43	Reserved	-
P1	46	45	Transport Address 0	ITAD0
P2	18	17	Formatter Enable	IFEN
P2	24	23	Rewind/Unload	IRWU
P2	46	45	Transport Address 1	ITAD1
P2	48	47	Formatter Address	IFAD
P2	50	49	High Speed Select	IHISP

Table 10-3. Motion Command Decode

COMMAND	REVERSE	WRITE	WRITE FILEMARK	EDIT	ERASE
Read Forward	0	0	0	0	0
Read Reverse	1	0	0	0	0
Read Reverse Edit	1	0	0	1	0
Write	0	1	0	0	0
Write Edit	0	1	0	1	0
Write File Mark	0	1	1	0	0
Erase Variable Length	0	1	0	0	1
Erase Fixed Length	0	1	1	0	1
Security Erase (to EOT)	0	1	1	1	1
Space Forward	0	0	0	0	1
Space Reverse	1	0	0	0	1
File Search Forward	0	0	1	0	0
File Search Forward	0	0	1	0	1
File Search Reverse	1	0	1	0	0
File Search Reverse	1	0	1	0	1
3200	1	0	1	1	1
1600 (PE)	0	0	1	1	1
Diagnostic Routine	1	1	0	0	0
(Test 22)	0	0	0	0	0
(Test 11)	1	0	0	0	0
(Test 13)	0	1	0	0	0
(Test 12)	1	1	0	0	0
(Test 14)	1	1	0	0	0

PROM

The IOU-49 has two 4Kbyte 2732A EPROMS for onboard intelligence. The PROMs are addressed from $0000-$1FFF.

RAM

The IOU-49 has 26K bytes of RAM addressed from $8000 to $E7FF. The RAM is divided into five sections. The five sections are 1) RAM variables, 2) Streaming queue entries, 3) the Z80 stack, 4) the Z80 panel variables, and 5) buffers.

The RAM variables are defined below:

1 byte - mask for output port $80
See output port $80 for bit definitions

1 byte - mask for output port $B0
See output port $B0 for bit definitions

1 byte - mask for output port $F0
See output port $F0 for bit definitions

1 byte - device control flag byte
2**7 parity & block check parameters next
2**6 buffer read mode
2**5 streaming beginning of block next
2**4 streaming mode parameters next
2**3 read identification next
2**2 memory I/O mode data next
2**1 memory I/O mode address next
2**0 execute I/O next

1 byte - read routine status
2**7 set if file mark detected
2**6 set if data in buffer for buffered read
2**5 set if looking for tape ID

1 byte - streaming write routine status
2**7 waiting for CPU transfer to complete
2**6 waiting for a free queue
2**5 waiting for free data area
2**4 waiting for tape underflow
2**3 waiting for tape to not be busy
2**2 set if start of block indicator sent

	SHEET OF	DRAWING NO.	REV
		A51049-001	1

2 bytes - CPU queue table pointer

2 bytes - CPU queue address

2 bytes - CPU RAM address

2 bytes - tape queue table pointer

2 bytes - tape queue address

2 bytes - tape RAM address

1 byte - streaming type
2**0 set if write

2 bytes - streaming record length

21 bytes - read identification string
1) $49 - packed decimal IOU-49
2) $51 - Cipher Microstreamer
3) Controller Mode
2**0 - IPL Mode
2**1 - Buffer Mode
2**2 - Streaming Mode
4) Interrupt Status Byte
2**4 - Set $10 Bit on in Status 0
2**3 - Set Backplane Interrupt
5 - 6) Sequence Number
7) Last Device Control
8 - 11) Rom date and version # (YYMMDDVV)
12) Tape Speed
2**7 - 100 IPS & 1600 BPI
2**6 - 25 IPS & 1600 BPI
2**5 - 50 IPS & 3200 BPI
13 - 14) Block Length work area
15) Extended Tape Status
2**7 - Tape Inoperable
2**6 - No Identification Found on Tape
2**5 - End of Tape Found
2**4 - One End of File Mark Found
16) Extended Tape Status, A Backspace Is Needed
2**4 - Hard Tape Error
2**3 - Data Corrected Error
2**2 - Tape Parity Error
2**1 - Not Enough Data Received for Block
2**0 - CPU Problem During Block Write
(NOTE: This is a streaming error and bytes 17 and 18 should be checked for the exact reason for this error)

	SHEET OF	DRAWING NO.	REV
		A51049-001	1

17) Extended Programming Problems Status
2**7 - Control Not Supported By Controller
2**6 - No Data for This Read (No CTL $37)
2**5 - Invalid Type in Parameters
2**4 - Control Not Valid in This Mode
18) Extended Streaming Program Problem Status
2**7 - Two Short Writes
2**6 - Reads Not Allowed in Streaming Write
2**5 - Sent More Data Than Parameters Allow
2**4 - Sent Less Data Than Parameters Allow
2**3 - Invalid Length in Parameter
2**2 - No Start of Block Control Received
19) Extended Check Status
2**7 - Block Length Error (CTL $31)
20 & 21) Extended Status Not Yet Defined

2 bytes - I/O mode address or jump address

2 bytes - saved buffered read length

1 byte - saved input port $B0 status

1 byte - saved input port $F0 status

There are four 16-byte queues for streaming write.
Each queue is defined as follows:

1 byte - queue status
2**7 tape using queue
2**6 memory wrap to start of buffer
2**5 CPU using the queue
2**4 last record shorter than record length
2**3 CPU error in queue
2**2 tape error in queue
2 bytes - queue 1 start of table address
2 bytes - block length
2 bytes - block sequence #
9 bytes - not used

The stack and Z80 test panel variables are also in the RAM.

The remaining RAM area is 24K and is used as buffer area. In IPL mode 2 8K buffers are defined and the remainder of RAM is not used. In buffer mode the full 24K bytes of RAM are used as a buffer. In streaming write the first 22K of RAM are used as buffer and the last 2K are used as queue table area. There are 4 queue tables which contain 128 four-byte entrys. The entry is defined as follows:

2 bytes - flags & length of the write
- 2**15 end of data entry(no data)
- 2**14 end of block(data valid)
- 2**13 - 2**0 length

2 bytes - start address of data in RAM

INITIALIZATION

The maskable interrupts are disabled. The Z80 stack pointer is set to the top of the stack. The RAM variables are set to $00's and then certain variables are initialized to their proper values.

The initialization routine sets the controller into IPL mode by setting the speed to 25IPS, 1600 BPI and sets the mode indicator to IPL mode. All commands to the tape unit are cleared. If the tape is at load point status 0 will reflect this fact and the density will be set low.

Finally write busy will be reset and the program continues to the main loop.

MAIN LOOP

The main control loop checks for CPU requests and if the tape unit is operable.

The CPU requests are checked in the following order READ, WRITE, and CONTROL. If there is a request, the program will branch to the proper routine. If there is no request, then the tape unit is checked for a change in the operablility of the drive. If the tape went from inoperable to operable, the density will be set to the requested density to reset a possible operator change of the density.

WRITE

The write routine uses three features of the IOU-49 1) to transfer from the CPU and to the tape at the same time, 2) the ability to hold up a data transfer to get the effect of a larger buffer (service request will stop being set until more data can be taken), and 3) the double parameters (what to do now and what to do next) which can be set up for the tape transfer.

First a CPU transfer of 16K and a holdup of the data transfer is set up. If the transfer is less than 16K, then the CPU transfer is terminated, the tape write is executed, errors are checked, the status is updated, and the program goes back to the main loop.

After 16K has been transferred, the CPU is set on hold and a 16K tape transfer is set up in the double parameters as 2 8K segments. After the first 8K is is sent to the tape, the CPU is set up to transfer 8K maximum and hold again after that. The CPU 8K transfer with hold and the double parameters with an 8K write keep being set up until the CPU transfer is complete. Then the CPU transfer is terminated, the second parameters are set up with the proper values, the tape write is completed, errors are checked, the status is updated, and the program goes back to the main loop.

READ

The read routine also uses the three features of the IOU-49 1) to transfer from the tape and to the CPU at the same time, 2) the ability to hold up a data transfer to get the effect of a larger buffer, and 3) the double parameters (what to do now and what to do next) which can be set up for the tape transfer.

Initially two 8K tape segments are set up in the tape parameters. If the tape block is less than 8K, the length is calculated and the CPU transfer is done. Errors are checked and the status is updated. Then the program branches to the main loop.

Otherwise, after 8K has been read from the tape, the program starts the CPU transfer for 8K and sets up a hold. The read routine then stays with the 2 8K segments setup for the tape and an 8K CPU transfer with hold until the tape block has been completely read. After the tape read the CPU count is changed from 8K to the number of bytes remaining. The CPU transfer is terminated, errors are checked, status is updated, and the program goes back to the main loop.

DEVICE CONTROL

The device control routine decodes the CPU control character and branches to the proper routine to execute the control. The control character is saved for read identification information. If the control character is not found or if the control is not supported in the current mode, then write busy is reset and the program continues in the main loop.

The decoding is performed thru a table. Each entry is four bytes in length. The first byte is the control character, the second byte defines which modes are supported, and the last two are the address of the routine to be executed.

STREAMING WRITE

The streaming write routine has its own main loop which is called the streaming loop. In the streaming loop tests are done to determine what action should be taken by the program. The tests are 1) a processor request, 2) CPU transfer complete, 3) RAM space available, 4) a free queue available, 5) start a tape write if needed, 6) process tape underflow, 7) process tape write complete, and 8) check if tape is inoperable.

The streaming write operates with four queues. Each queue is 16 bytes and is associated with a 512 byte table which holds the lengths and addresses of where data is stored for this queue (see the RAM variables for queue and table definitions). When a start of block device control is received, a queue is found, its table address is initialized, and the block and sequence numbers are stored in the queue. If there is enough RAM for a write, the interrupt bit will be set. Otherwise a "waiting for RAM space" bit is set and, when space becomes available, the interrupt will be set. When a write is received, an entry is placed in the table and the length of the write is checked. Then interrupt will be set when RAM space is available. The end of block will cause an ending entry to be placed in the table and a new queue to be found.

A write to the tape will be started when two entries are found in the table of the first queue. The queue is then marked as being used by the tape (the CPU can still be adding entries). The tape parameters are set up using the two entries and a flag is set to wait for a tape underflow. When a tape underflow occurs, another entry is taken from the table and set up as the second set of parameters. The waiting for underflow is also set. If the entry in the table indicates the end of the data, the waiting for tape complete bit will be set instead of waiting for underflow. When the tape write is complete, error checking is done. The tape queue pointer is set to the next queue. The procedure starts again looking for two entries in the queue.

GENERAL

Description

This document covers the interface characteristics of the IOU-49 with a Cipher F880 Microstreamer tape drive and a Qantel Q29, Q30, or Q64 backplane.

This specification only pertains to the PROM set labeled STTC-51( ) and STTC-52( ).

The firmware will handle one streaming tape unit. The firmware is designed to operate in three modes:

IPL mode
Buffer mode
Streaming mode

The CPU program is the only way that the speed and density of the CIPHER drive are set. If the density button on the CIPHER panel is pressed the firmware will override the operator action and set the speed and density back to the requested values of the CPU program.

Reference Documents

A30827	900/1400 Backplane Description and Protocol
A51049-001	Internal Specification Cipher Streaming Tape, IOU49
A54017-001	Design Specification, IOU49
A43914-TAB	I.C. Programmed, 2732 IOU49
CIPHER	Series F880 Microstreamer Tape Drive Product Spec
ZILOG	Z80A C

CPU Interface

The CPU interface is handled by the controller and the Z80 thru 4 input registers ($80, $A0, $C0, $F0) and 8 output registers ($50, $80, $90, $A0, $C0, $D0, $E0, $F0). The supported instructions are: CTL, RD, RDC, RID, RIO, RS2, SIN, and WRC.

Device Controls (CTL instruction)

The device controls are derined to be executed only in the proper mode. Following is a list of the controls. and an indication in parantheses of the proper modes for the control (I=IPL mode, B=Buffer mode, S=Streaming mode).

Control $00 - Erase A Block (I,B)
Control $01 - Read Check (I,B)
Control $02 - Backspace (I,B)
Control $03 - Rewind (I,B)
Control $04 - Unload (I,B)
Control $10 - Disable CPU Interrupts (B,S)
Control $14 - Enable CPU Interrupts (B,S)
Control $15 - Reset CPU Interrupt (B,S)
Control $20 - Enter IPL Mode (I,B,S)
Control $21 - Enter Buffer Mode (I)
Control $22 - Enter Streaming Mode (I)
Control $31 - Backup Check (I,B)
Control $32 - Search for 2 EOF's (I,B)
Control $33 - Set High Speed (I,B,S)
Control $34 - Set Low Speed (I,B)
Control $35 - Set Hign Density (I,B,S)
Control $37 - Start a Read From the Tape (B)
Control $51 - Start of Block for Streaming Write (S)
Control $52 - End of Block for Streaming Write (S)
Control $53 - Wait for Streaming to Complete (S)
Control $7F - Read Identification (I,B)
Control $85 - Set Memory I/O Mode (I)
Control $86 - Jump To Controller Memory Location (I)

Control $00 - Erase A Block. This control will erase the block where the tape is positioned. A maximum of 4 consecutive erases should be done to avoid a runaway error on reading. If the write enable ring is not on the tape, an unload will be executed. If the end of tape is detected $40 will be set in status 0. If enabled, the interrupt on the backplane and $10 in status 0 will be set at the completion of the erase. NOTE: A backspace is not done.

	SHEET OF	DRAWING NO.	REV
		A52050-001	1

Control $01 - Read Check. This control will read a block and check if the parity is valid. Status 0 reflects the block's status. The errors set in read check are hard tape error, parity error, corrected data, end of file and end of tape. If enabled, the interrupt on the backplane and $10 in status 0 will be set at the completion of the read check.

Control $02 - Backspace. This control will backspace a block on the tape. The status will be cleared before the backspace takes place. The errors set in backspace are hard tape error, parity error, corrected data, EOF, and beginning of tape. If enabled, the interrupt on the backplane and $10 in status 0 will be set at the completion of the backspace.

Control $03 - Rewind. This control will rewind the tape. The status will be cleared before the rewind takes place. The errors set in rewind are inoperable and beginning of tape. If enabled, the interrupt on the backplane and $10 in status 0 will be set at the completion of the rewind.

Control $04 - Unload The Tape. This control will rewind the tape and set status 0 to inop plus BOT. The status will be cleared before the unload takes place. If enabled, the interrupt on the backplane and $10 in status 0 will be set at the completion of the unload.

Control $10 - Disable CPU Interrupts. This control prevents the backplane interrupt and $10 in status 0 from being set. The backplane interrupt and $10 in status 0 will be reset.

Control $14 - Enable CPU Interrupts. This control allows the backplane interrupt and $10 in status 0 to be set when operations are complete. The current backplane interrupt and $10 in status 0 will be reset.

Control $15 - Reset An Interrupt. This control will reset the backplane interrupt and the $10 in status 0 that is pending.

Control $20 - Enter IPL Mode. This control will emulate the IOU-21 with the following exceptions:

1) Backspace from load point will cause status 0 to be $46 then $44.
2) Writing to a file-protected tape will cause the tape to go offline, rewind, and unload necessitating operator reload.
3) The unload control ($04) will cause the tape to go offline, rewind, and unload.
4) The read status 2 is $C7.

The CPU interrupts will be disabled. See IPL Mode Read, Write, and status 0.

Control $21 - Enter Buffer mode. This control will re-define status 0 so that the controller can run in a buffered mode by checking for the $10 bit on in status 0 or interrupt pending, if CTL $14 was executed, when an operation is complete. The maximum buffer size in this mode is 24K. See Buffer Mode Read, Write, and Status 0.

Control $22 - Enter Streaming Mode. This control will change the characteristics of the controller so that streaming of the tape will be possible. This control will also indicate that the next write will be three bytes of information. This control will define bit $10 in status 0 as an interrupt bit. See Streaming Mode Write and Status 0.

Byte 1 - Type of streaming
$01 - Write
Bytes 2&3 - Record Length
$0100 to $0800
(The last write an EOF mark are exceptions to the record length)

Control $31 - Backup Check. This control will do a parity and block length check of a tape. This control will also indicate to the firmware that the next write will be three bytes of parameters.

Byte 1 - Direction of Tape
$01 - Forward Check
$02 - Reverse Check
Byte 2&3 - Block Length of Records

After the parameters are received the number of successful blocks will be zeroed. A read in the proper direction will be performed. If a hard error, parity error, corrected data read, or the block length is incorrect, $20 in status 0 will be set and write busy will be reset. Otherwise 1 will be added to the # of successful blocks and the reads will keep being done until an error or BOT (Forward) or EOT (Reverse) is encountered. The CPU program should wait for busy to become false and then read status 0 to determine if the check was successful. The read identification control should be executed after busy goes away to read the extended status and the # of successful blocks read.

Control $32 - Search for 2 EOF's. This control does a forward high speed search for two consecutive end-of-file marks. This control is complete when write busy is false. If $80 is on in status 0, then the tape was inoperable before reaching 2 consecutive EOF's. If $40 is on in status 0, the end of tape was encountered before the 2 EOF's. If $80 and $40 are off, then the 2 consecutive EOF's have been found. If $20 is on this is a warning that a block or blocks were found bad while searching for the EOF's. If interrupt is enabled the backplane interrupt and $10 in status 0 will be set at the completion of the search.

Control $33 - Set High Speed. This control overrides the current speed select and sets high speed (1600 bpi and 100 ips). The density can only be changed at BOT; therefore, if this control is changing the density and the tape is not at BOT, the tape will be rewound to BOT.

Control $34 - Set Low Speed. This control overrides the current speed select and sets low speed (1600 bpi and 25 ips). This is the default in IPL mode. The density can only be changed at BOT; therefore, if this control is changing the density and the tape is not at BOT, the tape will be rewound to BOT.

Control $35 - Set High Density. This control rewinds the tape and selects high density (3200 bpi and 50 ips). The density can only be changed at BOT; therefore, if this control is changing the density and the tape is not at BOT, the tape will be rewound to BOT.

Control $37 - Start a Read From the Tape. This control will indicate to the controller to do a read from the tape. This control is used in conjunction with the buffer mode to get the data off the tape and into the controller buffer. Then it signals a completion/interrupt status to the CPU to do a RDC and get the data. The maximum buffer size is 24K. The status and extended status are reset before this control is executed.

Control $51 - Start of Block for Streaming Write.
This control will set up a queue for the following data so it will be written to the tape as a block. This control also indicates to the firmware that the next write must be 4 bytes.

Bytes 1&2 - Block Length ($0001 - $7FFF)
Bytes 3&4 - Sequence Number for this Block

After this control until the end of block control the data available bit ($10 and interrupt) will be set to indicate when a write can be done to the controller.

Control $52 - End of Block for Streaming Mode.
This control indicates that all the data for the present queue has been sent from the CPU. This control will also stop interrupts from being set.

Control $53 - Wait for Streaming Write to Complete.
This control will force the data in the queues that have not been written to tape to be written to tape. An interrupt will occur to indicate that the data was successfully written or if there was an error.

Control $7F - Read Identification. This control will set up an 21 byte field as the next data to be sent on a read. This control is used by the macro instruction RID to get only the first 3 fields of the read identification string. This control can also be used by the CPU programmer to get all 21 bytes by issuing the control followed by a read. The 21 bytes are:

1) $49 - packed decimal IOU-49,
2) $51 - Cipher Microstreamer, and
3) Controller Mode
   - $01 - IPL Mode
   - $02 - Buffer Mode
   - $04 - Streaming Mode
4) Interrupt Status Byte
   - $10 - Set $10 Bit on in Status 0
   - $08 - Set Backplane Interrupt

5 - 6) Sequence Number
7) Last Device Control
8 - 11) Rom date and version # (YYMMDDVV)
12) Tape Speed
   - $80 - 100 IPS & 1600 BPI
   - $40 - 25 IPS & 1600 BPI
   - $20 - 50 IPS & 3200 BPI

13 - 14) Block Length work area
15) Extended Tape Status
   - $80 - Tape Inoperable
   - $40 - No Identification Found on Tape(Not Used)
   - $20 - End of Tape Found
   - $10 - One End of File Mark Found

16) Extended Tape Status, A Backspace Needs to be Done
   - $10 - Hard Tape Error
   - $08 - Data Corrected Error
   - $04 - Tape Parity Error
   - $02 - Not Enough Data Received for Block(Streaming)
   - $01 - CPU Problem During Block Write(Note: This is a streaming error and bytes 17 and 18 should be checked for the exact reason for this error)

17) Extended Programming Problems Status
   - $80 - Control Not Supported By Controller
   - $40 - No Data for This Read (No CTL $37)
   - $20 - Invalid Type in Parameters (CTL $22&$31)
   - $10 - Control Not Valid in This Mode

18) Extended Streaming Programming Problem Status
   - $80 - Two Short Writes
   - $40 - Reads Not Allowed in Streaming Write
   - $20 - Sent More Data Than Parameters Allowed
   - $10 - Sent Less Data Than Parameters Allowed
   - $08 - Invalid Length in Parameter
   - $04 - No Start of Block Control Received

19) Extended Check Status
   - $80 - Block Length Error (CTL $31)

20 & 21) Extended Status Not Yet Defined

Control $85 - Set Memory I/O Mode. This control will indicate to the firmware that the next two byte write will contain the RAM address of where data should be read from or written to. After the two byte write of an address a read or write instruction will cause data to be passed between that address and the processor. This control can be used to download a program to RAM or access the RAM. This control applies to one access of the controller. An I/O mode read or write has a maximum length of $3FFF bytes. The RAM area that code should be downloaded into is $8800 to $E7FF.

Control $86 - Jump To Controller Memory Location. This control will indicate to the firmware that the next two byte write will contain the address that the firmware will give control to. This control allows a program which was downloaded to be executed. Once this control is issued the controller will take on the characteristics of the program downloaded. To get out of this mode a RIO or IPL must be executed.

Read A Block (RD, RDC instructions)

The RD and RDC instructions are handled the same with one exception. The RD will transfer a block of data read from the tape where the RDC will transfer a block of data or the number of bytes in the instruction whichever is the smallest number. The reads function differently for each firmware mode. If RDC takes less than a full tape block the rest of the data in the block will be discarded. Errors and interrupts are reset before each read.

IPL Mode Read

A read will get the next block of data on the tape, and transfer the data to the processor. The CPU is hung in the read instruction until a block has been read from the tape and the data is passed to the CPU. Then the CPU is free but the controller is still busy until it posts the status of the read, therefore status is not valid until write busy is false.

The upper four bits of status 0 during a read are $80 tape offline, $40 tape at BOT, EOT, or EOF, $20 error correction performed, and $10 hard error or parity error.

Example

```
@BUF    DA    1000              BUFFER
DEV     EQU   8                 DEVICE NUMBER

        RDC   BUF,DEV;.BUF      READ A TAPE BLOCK
        SIN   $03,DEV           WAIT FOR BUSY TO GO DOWN
        BNZ   *-3               .
        TBT   =$F0;23           ANY ERRORS?
        BNZ   ERROR             IF SO BRANCH
```

Buffer Mode Read

A start read command will cause the next block of data on the tape to be read. The processor will be notified when data is available to be read from the controller buffer. The CPU is hung in the read instruction until the data is passed to the CPU. Then the CPU is free but the controller is still busy until it posts the status of the read; therefore, status is not valid until busy is false. If the read is not preceeded by the CTL $37 an error will be set.

The upper four bits of status 0 during a read are $80 tape offline, $40 tape at BOT, EOT, or EOF, $20 error correction performed, hard or parity error, or no data for this read, and $10 data ready to be read.

Example

```
@BUF    DA   1000          BUFFER
DEV     EQU  8             DEVICE NUMBER
.
        CTL  $37,DEV       TELL CONTROLLER TO READ FROM TAPE
        SIN  $10,DEV       WAIT TILL READ DONE
        BZ   *-3           .
        CTL  $15,DEV       RESET INTERRUPT
        SIN  $03,DEV       WAIT FOR VALID STATUS
        BNZ  *-3           .
        RDC  BUF,DEV;.BUF  READ THE DATA (MAXIMUM 24K)
        SIN  $03,DEV       WAIT FOR VALID STATUS
        BNZ  *-3           .
        TBT  =$E0;23       ANY ERRORS?
        BNZ  ERROR         IF YES BRANCH
```

Streaming Mode Read

This is not implemented. If a read is done in streaming mode bit $20 is status 0 will be set and the extended status error will be in byte 18, $40 reads not allowed in streaming write.

Read Status 0 (SIN instruction)

The status 0 definition is defined by the mode of the firmware. The lower 4 bits and the upper 2 bits are always the same. The firmware sets and resets $80, $40, $20, and $10. The firmware can reset $02. The The hardware sets and resets $08, $04, $02, and $01.

Standard Definition

Bit	Definition
$80	Inoperable
$40	BOT/EOT/EOF Flag
$20	Mode Dependent
$10	Mode Dependent
$08	Service Request
$04	End
$02	Write Busy
$01	Read Busy

The inoperable status will be set for the following reasons: the tape unit is offline, or the tape is file-protected during a write.

IPL Mode Status 0 Definition

Bit	Definition
$20	Corrected Data Read
$10	Hard Error/ Parity Error

The extended status bytes from the read identification (CTL $7F) which are valid for the IPL mode are:

Byte 15	Byte 16	Byte 17	Byte 18	Byte 19
$80	$10	$80		$80
$40	$08	$20		
$20	$04	$10		
$10				

Buffer Mode Status 0 Definition

Bit	Definition
$20	Error(get extended status for error decode)
$10	Interrupt

The extended status bytes from the read identification (CTL $7F) which are valid for the Buffer mode are:

Byte 15	Byte 16	Byte 17	Byte 18	Byte 19
$80	$10	$80		$80
$40	$08	$40		
$20	$04	$20		
$10		$10		

Streaming Mode Status 0 Definition

Bit	Definition
$20	Error(get extended status for error decode)
$10	RAM space available or Error

The extended status bytes from the read identification (CTL $7F) which are valid for the Streaming mode are:

Byte 15	Byte 16	Byte 17	Byte 18	Byte 19
$80	$10	$80	$80	
$40	$08	$20	$40	
$20	$04	$10	$20	
$10	$02		$10	
	$01		$08	
			$04	

Write A Block (WRC instruction)

IPL Mode Write

A write will transfer the data from the processor to the controller data area and then write the data to the tape. The CPU is hung in the write only until the data is transferred to the controller. The write busy status will be true until the write has been performed. When the status for this write is posted in Status 0, write busy will be false. Therefore errors should not be checked until busy is false. If a write is performed to an inop tape, the tape will be rewound and unloaded.

The upper four bits of status 0 during a write are $80 tape offline, $40 at end of tape, $20 corrected data read and $10 write while inop, error in writing EOF, and parity error.

Example

```
@BUF    DA   1000
DEV     EQU  8

        WRC  BUF,DEV;.BUF      WRITE A BLOCK OF DATA
        SIN  $03,DEV           WAIT FOR BUSY TO GO DOWN
        BNZ  *-3               .
        TBT  =$F0;23           ANY ERRORS?
        BNZ  ERROR             IF YES BRANCH
```

Buffer Mode Write

A write will transfer the data from the processor to the controller data area and then write the data to the tape. The CPU is hung in the write only until the data is transferred to the controller. Write busy status will be true until the write has been performed. When the status for this write is posted in Status 0, write busy will be false and the interrupt bit in status 0 will be true. Therefore errors should not be checked until the interrupt bit is true or the write busy bit is false. After the error status has been saved, the CPU must reset the interrupt status (CTL $15).

The errors during a write are $80 tape offline, $40 at EOT, $20 an error occured (see Buffer Mode Status 0 Definition), and $10 write complete/interrupt.

Example

```
@BUF    DA   1000          BUFFER
DEV     EQU  8             DEVICE NUMBER
STATUS  DA   1             STATUS SAVED

        WRC  BUF,DEV;.BUF  WRITE A BLOCK OF DATA
        SIN  $10,DEV       WAIT FOR COMPLETE TO BE TRUE
        BEQ  *-3           .
        MOV  23,1;STATUS   SAVE THE STATUS
        CTL  $15,DEV       RESET THE INTERRUPT
        SIN  $03,DEV       WAIT FOR VALID STATUS
        BNZ  *-3           .
        TBT  =$E0;STATUS   ANY ERRORS?
        BNZ  ERROR         IF YES BRANCH
```

Streaming Mode Write

Streaming mode indicates that data will be fed to the tape at a fast enough rate to keep the tape always moving forward and not re-positioning. To get the tape to stream while reading from the disk the firmware has controls which allow the CPU to define a block of data and send the data in segments so the disk can be serviced between sending these segments. The CPU will indicate the beginning of a block, a block sequence number, send segments, and then indicate the end of a block.

The firmware has four queues to hold the information for blocks of data. The firmware will take a segment from the CPU, store it in RAM, and save this information in a queue. The firmware is also checking the queues to see if there is data to write to the tape and, if so, will write it to the tape.

The CPU takes up RAM space and puts information into the queues. The tape frees the RAM space by writing with the information in the queues.

The CPU checks status 0 bit $10 to see if RAM area is available for a write. Bits $80, $40, and $20 should also be checked to see if an error or EOT has occurred. If any of these bits are true, the CPU program should enter IPL mode and do a control $7F followed by a read of the extended status bytes. The extended status bytes should be checked in the following order 1) if byte 15 is nonzero, then handle the inop or EOT, 2) if byte 16 is nonzero, then do a backspace, an erase, and start streaming again from the sequence # in bytes 5&6, and 3) if bytes 17 or 18 are nonzero, there is a possible problem with the communications between the CPU program and the controller.

The following example writes three blocks and an EOF mark.