DRIVER PROGRAM PROCEDURE

BCS MAGNETIC TAPE DRIVER 7-TRACK WITH DMA

HP Part Number 13027-60001 (current version)

HEWLETT (hp) *PACKARD*

BCS DRIVER FOR THE HP 7970 MAGNETIC TAPE UNIT

7T WITH DMA

The BCS driver for the HP 7970 magnetic tape unit operates in an interrupt mode for magnetic tape operation through the Input/Output Control (.IOC.) subroutine of the Basic Control System. This BCS driver operates with the Direct Memory Access (DMA) and within the buffered version of .IOC. This driver may not be loaded across a page boundary. When operating with buffered .IOC. and this driver, if you get an error return (EOT, Logical EOT, Tape Unit not on-line, and no write enable ring) from the driver, the buffered .IOC. will come to a HLT 70B.

The BCS driver for the HP 7970 consists of three parts: the Initiation, Continuation, and Completion Sections. A user calling sequence through .IOC. allows entry to the Initiation Section; a DMA interrupt signalling that the DMA word count equals 0 enters the Continuation Section, and the end-of-operation interrupt from the command channel enters the Completion Section.

CALLING SEQUENCE

```
        JSB         .IOC.
        OCT         <function subfunction> <unit-reference>
        JMP         <reject address>
        DEF         <buffer address>
        DEC         <buffer length>
        OCT
           {normal return}

               .
               .
               .

        EXT         .IOC.
```

where:

function (specified in bits 15-12)   Specifies the type of input/

subfunction (specified in bits 11-6)   output operation being requested:

Clear, Read, Write, Control, Status.

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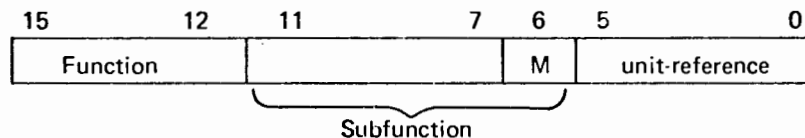| unit-reference | Specifies the unit-reference number of |
(specified in bits 5-0)	the device used for input/output opera-
	tions.
reject address	.IOC. returns control to the user at this
	location.
buffer address	Address of the first word of the user's
	buffer.
buffer length	The value in the buffer length field is
	specified in words (positive integer)
	or characters (negative integer). A
	buffer length of zero causes the driver
	to take no action on a write. A zero
	buffer length on binary READ causes the
	driver to make a forward skip of one
	record, while a zero buffer length on
	BCD READ causes no action to be taken
	by the driver.

The second word of the request determines the function to be performed and the MT unit-reference for which the action is to be taken.

```
  15        12   11          7   6    5            0
 ┌──────────────┬────────────┬─────┬────────────────┐
 │   Function   │            │  M  │  unit-reference │
 └──────────────┴────────────┴─────┴────────────────┘
                 _____/
                       Subfunction
```

The maximum I/O request must be no greater than the equivalent of 8,192 words.

COMMANDS

Mode for Read/Write Operation

Setting the mode (m) bit 6 (on) causes the computer to transmit binary data as it appears in memory or on magnetic tape.

Clearing the mode bit 6 (off) causes the computer to transmit BCD data as it appears in memory or on tape.

I/O Reject

If the input/output operation cannot be performed, control is transferred to the third word of the calling sequence. When control is transferred, the computer system provides status information which can be checked by the user's program. The contents of the A-register indicate the physical status of the equipment, and the contents of the B-register indicate the cause of reject.

       a.   If bit 15 is 1, the driver is busy (unavailable).

       b.   If bit 0 is 1, a DMA channel is not yet available to operate the device.

       c.   If both bit 15 and bit 0 are 0, the subfunction selected is illegal.

Allowable Motion Requests

Operation	Octal value of bits 15-6
Read BCD record (RCC)	0100
Read Binary Record (RCC)	0101
Write BCD record (WCC)	0200
Write Binary Record (WCC)	0201
Write End-of-file mark (GFM)	0301
Backspace record (BSR)	0302
Forward space record (FSR)	0303
Rewind (REW)	0304
Rewind/Off line (RWO)	0305
Erase four inches of tape (GAP)	0306
MTS Relocating Loader Skip record	0307
Forward Space Record (FSF)	0320
Backspace File (BSF)	0321
Status	0400
Clear	0000

Read and Write Requests

Bit 6 is an indication of the request type (BCD or Binary); it selects one of two physical modes on the magnetic tape controller.

Rewind or Backspace Record Requests

This request performs no action if the tape unit addressed is at load-point. The Status word indicates the SOT condition before and after the request is made. A Rewind/Off-Line Request when MT Unit is at Load Point will cause this driver to automatically forward space one record before Rewinding and going off-line.

Read Parity Error Conditions

The driver attempts to read a given record up to three times before declaring an irrecoverable parity error. If there is an irrecoverable parity error, the last try is transmitted to the user buffer and a normal completion return occurs. The status word indicates the parity and/or timing error.

Write Parity Error Conditions

The driver tries to rewrite a given record until either the record is successfully written or the end-of-tape is encountered.

Attempted Write Request

If a Write request is made to a magnetic tape unit without a Write enable ring, the driver makes an immediate completion return to the caller. Status bit 14 is set in the status word, causing the Formatter to print *EQR and halt. To proceed, insert a Write enable ring in the magnetic tape.

Forward Motion Request

If forward motion is requested when the tape unit is at end-of-tape, the MT driver ignores the request and makes a normal return with the "a" field of EQT word 2 set to 1. The exceptions of this situation are:

    a.   Write End-of-file mark request, and

    b.   Read record request.

Only one of these privileged requests can be made once the EOT has been encountered; after that, they are ignored by the driver.

Backward Motion Request (Rewind and Backspace Record and Backspace File)

This request restores the privileged nature of the Write-End-of-file and Read record requests.

Function/Subfunction Code Request 0307XX

Present in BCS MT drivers, the function/subfunction code request enables the Relocating Loader to operate within the Magnetic Tape System. If the request is followed by other I/O requests, they are treated as if the magnetic tape were not file-protected. The file protect features is turned on again when the tape unit is rewound.

This request is identical to the forward space record request with the additional capability of spacing records within files 1 and 2 (even when the MT unit is in the protected file mode).

Backspace File Request and Forward Space File Request

These two requests cause the tape unit to go forward or backward until a file mark is detected. Data is not transferred, and a parity error in any file record sets the parity error status bit.

The backspace file request positions the tape in front of a file mark or at load point, whichever comes first.

If the end-of-tape marker is sensed during execution of a forward space record request, the tape stops at the end of the current record. A status request should be used to check for this condition.

If 2, the magnetic tape unit is not available for another request, an operation is now in progress.

Bits 13-8 indicate the equipment type, i.e., specified as 25_8.

Bits 7-0 indicate the status of the device.

Bit	Condition
7	File Mark Sensed (EOF)
6	Load Point Status (BOT)
5	End-of-tape (EOT)
4	Data Timing Error
3	Command Rejected
2	File Protected (no Write enable ring)
1	Parity and/or Timing Error
0	Tape unit not on-line

NOTE: *Bit 3 cannot be set using the driver.*

B-Register contents

15	14	Transmission Log	0
	m		
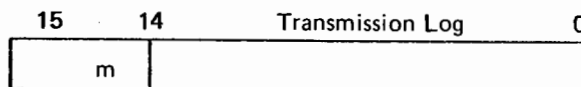
Bit 15, m, indicates the mode of data transmission (from the request)

If bit 15 = 0, BCD code transmission

If bit 15 = 1, binary code transmission

Bit 14-0 indicate the transmission log, a field that is the number of characters or words transmitted. The value is given as a positive integer and indicated characters or words as specified in the calling sequence of the Read or Write request. In the BCD mode the driver can read an odd number of characters; however, when writing the driver will always write an even number of characters with a minimum record length of four characters. A request for less willl be padded with blanks. Minimum binary records will be three characters and will be padded as above.

An end-of-file mark record returns the user request length in the transmission log after being read, therefore allowing the binary read operation to operate properly through the Formatter. A write end-of-file mark returns one in the transmission log.

Control requests with a subfunction between 02 and 21 set the transmission log to zero.

Function requests of type 03 set m = 1.

Clear Request

The clear request terminates a previously issued input or output operation before all data is transmitted. This request checks for multi-unit operation based on the device (i.e., I/O channel number). The driver is cleared only if the clear request is for the current operation I/O channel and physical unit number.

```
EXT        .IOC.
    .
    .
    .
JSB        .IOC.
OCT        0000 <unit-reference>
```

On return, the contents of the A- and B-Registers are not significant.

DRIVER ORGANIZATION

Initiation Section

Entry to the Initiation Section is by user calling sequence through .IOC., with calling parameters including;

        a.   The address of the second word of the user I/O request.

        b.   The address of the EQT entry for the referenced tape unit.

The Initiation Section performs the following functions:

        1.   Extracts the parameters from the .IOC. request.

2. Rejects the .IOC. request and does not perform steps 3-5 if:

    a. The driver is busy operating a magnetic tape unit.

    b. The user function request code is illegal.

    c. A DMA channel is not free and DMA is required for data transfer.

3. Sets all input/output instructions in the driver to include the magnetic tape controller channel numbers. Sets all DMA input/output instructions to include DMA channel numbers.

4. Indicates equipment in operation:

    a. Sets the "a" (availability of device) field in the EQT entry to "busy" for the magnetic tape called.

    b. Sets an internal driver "busy" flag for the driver.

    c. Sets a "busy" flag in .IOC.

5. Initializes various EQT flags and activates the tape unit operation.

6. Returns to .IOC. with the A-Register indicating the status of operation (initiation or rejection) and the B-Register indicating the cause of rejection.

    $A = 0$ Operation initiated.

    $= 1$ Operation rejected, reason in B-Register.

    $= 10000_8$ Immediate completion of driver function.

    $B = 10000_8$ The driver is busy.

    $= 1$ A DMA channel is required but all DMA channels are busy.

    $= 0$ The subfunction is not legal for the device.

7. Transfers to IOERR (irrecoverable halt) if DMA is required for data transfer and DMA was not assigned at PCS time.

8.   Transfers to IOERR if, when retrying a bad write operation, a gap command produces a parity error. In this case the tape will be positioned at the bad point and should be stripped up to that place because the tape itself is most likely bad. The A-register will contain 4.

9.   If the referenced MT is off-line or a write attempt was made without a write enable ring:

    a.   Set a field in EQT entry equal to 1 for the MT unit called.

    b.   Do not initiate request.

    c.   Return to .IOC. with A = 100000.

Continuation Section

Entry to this section is caused by a DMA interrupt signalling that the DMA word count equals 0. The entry point to this section is I.25 whose address is set up at PCS time by specifying I.25 as a data channel interrupt entry point. Only two instructions are performed by this section:

1.   A CLC to the DMA channel is issued.

2.   A CLC,C to the data I/O channel is issued.

Completion Section

Entry to the Completion Section is caused by the interrupt on end-of-operation from the command channel. The entry point to this section is C.25. There are no parameters on entry. The completion section performs the following functions:

1.   Saves all registers.

2.   Updates the EQT entry:

    a.   The number of words or characters transferred (corresponding to the request) is set as a positive value in word 3. Bit 15 of word 3 is set to 0 or 1 to indicate mode of transfer;

b.   The device status is set in bits 07-00 of word 2 and the "a" field (bits

          15-14) in word 2 is set to: 0 - device available (not busy).

    c.   Bits 13-08 of word 2 will not be altered.

3.   Clears all "busy" indicators:

    a.   The driver busy flag;

    b.   If a DMA channel was used, then the appropriate DMA busy flag in 100.

4.   Restores all registers - saved at the entry.

5.   Returns to the interrupted program:

    a.   If a Read function, then return will be made through entry point C.25

          indirect;

    b.   For all function and Write requests return will be made through entry point

          "BUFR" in IOC. This enables the Buffered version of IOC to perform the

          automatic output buffering function.

BCD Buffer and Character Set

The Driver will contain an internal buffer capable of holding 132 characters. In the event a BCD record of
greater than 132 characters is declared for writing on the 7970A Mag Tape Unit, the characters in excess of
132 characters will be ignored by the driver. In the event a BCD record exists on the 7970A Mag Tape in
excess of the 132 character limit, action will be taken to insure no inadvertent destruction of core.

HARDWARE CONFIGURATION

Magnetic Tape Transports

This driver is designed to operate the HP 2116-7970 controller. The controller and driver operate from one
to four HP 7970 or HP 2020 magnetic tape units with the following characteristics:

    a.   Seven data tracks

    b.   Packing Density: 200, 556, 800 bytes per inch

    c.   Tape Speed: 12.5, 25, 37.5, or 45 inches per second

    d.   Data Transfer Rate: 10000, 20000, 30000 or 36000 bytes per second

    e.   Tape Unit designation by one of four interlocking push buttons numbered 0, 1, 2, 3.

Magnetic Tape Controller

The Magnetic Tape Controller is assigned the highest priority device in the computer with one exception: only a HP 2020 should be a higher priority device.

The Magnetic Tape Controller requires two I/O addresses. The Data Channel is assigned the higher priority address.

PCS-BCS SYSTEM GENERATION

Equipment Table Statements

To construct the Equipment Table, the operator must enter at least one of the following type entries:

        nn, D.25, D [, Uu]

where

        nn = The high priority (lower numbered) channel number (select code) for the tape controller.

        D = Operation of this entry with Direct Memory Access (DMA) channel.

        Uu = The physical unit number u, 0-7, for addressing a magnetic tape unit. If no entry is made, u = 0. To operate the EQT entry in the unprotected mode, enter a value between 0 and 3.

        To operate the EQT entry in the protected mode, enter a value between 4 and 7.

Physical Unit	Unprotected Mode	Protected Mode
0	0	4
1	1	5
2	2	6
3	3	7

In the protected mode, a maximum of 63 files can be maintained per magnetic tape. If an attempt is made to reference the sixty-fourth file, an "End-of-tape" is declared (even if there is more magnetic tape available).

NOTE: *In a MTS environment, because the BCS drivers provide the file protect feature, the programmer does not have to skip over files 1 and 2; i.e., these files may not be referenced by user programs when protected. A forward motion request to the magnetic tape unit will operate on the third file of the magnetic tape as if it were the first physical file. The Magnetic Tape driver can be set to the file protect mode, the unprotected mode, or both modes by means of various EQT entries.*

Interrupt Linkage Parameters

The BCS HP 7970 magnetic tape driver has two interrupt processors rather than one. Prepare Control System (PCS) is used to construct the BCS interrupt linkage area. When PCS requests interrupt linkage points, two responses (for the two interrupt processors) must be given, not just one. The continuator interrupt processor is identified with entry point I.25. The completion interrupt processor is identified with the entry point C.25.

Example of response to PCS:

INTERRUPT LINKAGE?

10,30,I.25
11,31,C.25

.
.
.

/E