PURPOSE

The Teletype-High Speed Paper Tape Driver services I/O operations on the Console Teletype, the High Speed Paper Tape Reader and the High Speed Paper Tape Punch. The driver is fully re-enterable and can service simultaneous I/O on all three devices.

USAGE

Refer to the I/O Monitor documentation (DN 391476) for the description of the IOS calls and FIOT configuration used to operate the driver. This driver can perform the following functions:

1. Read a record - Teletype and High Speed Reader
2. Write a record - Teletype and High Speed Punch
3. Write a file mark - Teletype and High Speed Punch
4. Punch leader - Teletype and High Speed Punch
RECORD FORMATS

This driver reads and writes formatted or unformatted records. Two formats, alpha and binary, are used for formatted records. The binary format includes a record size, in bytes, at the beginning of the record.

The binary record format is shown in Figure 1, and the alpha format in Figure 2.

<table>
<thead>
<tr>
<th>L / F</th>
<th>No. Bytes</th>
<th>DATA</th>
<th>C B B B</th>
<th>L L L</th>
<th>K K K</th>
</tr>
</thead>
</table>

Figure 1

<table>
<thead>
<tr>
<th>L / F</th>
<th>DATA</th>
<th>C B B B</th>
<th>L L L</th>
<th>K K K</th>
</tr>
</thead>
</table>

Figure 2

As shown in the diagrams, a line feed character (L/F, 8A₁₆) will be the first character in each record. The binary record follows with two characters of byte count. This is the total number of data bytes contained in the binary record.

The alpha record does not have a byte count. The area shown as data in the diagrams is the information to be moved during the I/O operation. Each record closes with a carriage return character (C/R, 8D₁₆). There are three blank characters (BLK, A₀₁₆) after each record on tape. These will allow an operator to position the tape between records. The blanks are not necessary when input is from a keyboard.

When the requested operation is alpha mode input, the first C/R following the initial L/F terminates the record regardless of how many input words had been requested. This means there can be no C/R characters within an alpha input record. When the requested number of words have been input, the device will be disconnected even if there has been no C/R. The
number of bytes in a binary record is a similar delimiter. If a user requests 100 words input and the binary record contains 25, only 25 words would be input. If a record is larger than the number of characters requested to input, the remainder is skipped before the input is terminated.

For output operations bit 0 of FIOT word 2 determines whether the record will be output as a binary or alpha record. For input operations the driver determines whether the incoming record is alpha or binary and sets bit 0 of word 2 accordingly.

For alpha mode input two control characters are recognized. These are primarily to permit easy operator correction of mis-typed teletype input records; however, they function for paper tape records as well. The first character is RUBOUT (FF₁₆). Instead of storing this character the driver backs up the buffer pointer one character for each RUBOUT character, thereby permitting mis-typed characters to be retyped. For example, if the record

:QU, AKPH

were typed, when the operator intended to type

:QU, ALPH

he may correct it by continuing

(RUBOUT)(RUBOUT)(RUBOUT) LPH

Since the RUBOUT doesn't print the resulting record will appear on the printout as

:QU, AKPH LPH

however, it will be corrected internally. The second character is the horizontal arrow (←). This will delete the entire record, which should be then restarted including the initial line feed. Both of these characters must be input before the closing carriage return. Once the carriage return has been input, the record is processed and no correction is possible.

When reading formatted records, if an ASCII BELL (X'87') character is encountered between records, prior to the Line Feed character, the I/O operation is terminated and end-of-file status (bit 10 true) is returned in word 3 of the FIOT. The driver accepts a WEOF call and outputs this character to the device.
Unformatted records, some time referred to as special format contain no added formatting characters. The contents of the number of words specified are transferred to or from the external medium. Unformatted records are specified by setting bit 0 of FIOT word 6 true.

Notice that no positioning of paper tape input records occur for unformatted record; data transferring begins with the first frame of tape read and continues until the requested number of frames has been read.

INDIVIDUAL DEVICES

The following section details considerations applicable to each of the device operated by this driver.

Console Teletype

The standard Teletype Mode 33/35 (Automatic Send-Receive) can be used to type in or print out information at a rate of up to ten characters per second, or to read in or punch out perforated paper tape at a ten characters per second rate.

The teletype unit can perform the following functions through the driver:

1. Read a Record from Keyboard - Function Code B

The keyboard is enabled, the keyboard light lights, and characters read are printed.

2. Read a Record from Reader - Function Code 9

The reader light lights and characters read are not typed. However, the keyboard is enabled.

The teletype reader is not controllable by command from the computer. It must be turned on and off manually. If the teletype keyboard is selected for input, the reader may be turned on and allowed to drive the keyboard. Similarly, when the reader is selected, the keyboard may be used instead, but what is typed will not be printed.

3. Write a Record - Function Code E

A record is output to the receive section of the teletype and will print if the ASR35 teletype mode switch is in the PRINT position, punched if the switch is in the PUNCH position and printed and punched if the switch is in the PRINT and PUNCH position. For the ASR33
record is always printed and will be printed and punched if the punch is turned on. These modes must be selected manually.

4. Write a File Mark - Call WEOF

The ASCII Bell character is output followed by approximately 60 blank frames. If the punch is on, it will appear as leader. Bit 0 of FIoT word 6 must be false, (not special format)

5. Punch Leader - Function Code E

If the buffer address is given as X'7FFF', no data is output; instead 60 blank frames are output.

High Speed Paper Tape Reader

The 703 paper tape reader is an unidirectional photoelectric reader capable of reading 300 characters per second continuously; or up to 100 characters per second intermittently.

The reader has an adjustable tape guide which makes it capable of reading 8-channel, 7-channel, or 5-channel tapes.

Control of reader power is provided by an ON/OFF switch located on the reader front panel. The RUN/LOAD switch is an integral part of the tape guide mechanism.

The high speed reader can perform the following function through the driver.

1. Read a Record - Function codes 8 or 9

A formatted or unformatted record is read from the reader device.

High Speed Paper Tape Punch

The 703 paper tape punch is capable of punching up to 110 characters per second. Each character consists of eight data bits plus a sprocket hole. A hole in a data bit position represents a "one"; no hole represents a "zero".

The controller contains a one-character buffer register that accepts data from the 703 in the form of eight-bit binary numbers.
Data transfer to the controller is under control of the central processor. There are no punch controls or indicators located on the computer console. Only a manual tape feed push-button is located on the punch assembly front panel. When the TAPE FEED pushbutton is pressed, power is applied to the punch mechanism whenever a character is transferred from the computer. If the punch is off, there is a one second delay which allows the punch to come up to speed before data is transferred to the punch. If the punch is already on, there is no delay. Once started, the punch remains on until a command from the computer turns it off.

The punch can perform the following functions through the driver.

1. **Write a Record - Function Code E**

   A formatted or unformatted record is output to the paper tape punch. This record will be identical to the same record punched on the teletype punch.

2. **Write a File Mark - Call WEOF**

   The WEOF call will cause a file mark (X'87') character to be punched followed by approximately 60 blank frames. Bit 0 of FIOT word 6 must be false, (not special format)

3. **Punch Leader - Function Code E**

   If the buffer address is X'7FFF', 60 blank frames are punched as leader.

After any punch operation, the punch motor remains on which will eliminate the one second delay when more than one record is to be output. When the user is entirely finished using the punch, he should turn off the motor by executing the instruction:

```
DOT PCHU, 3
```

when PCHU is the unit code for the punch, normally X'C'. This instruction may be given even when the device might not be the punch. If another user is using the punch, in a real-time system, the motor will be turned back on when the next character is transferred and the turn-off instruction is harmless.
TECHNICAL DISCUSSION

The following section is a discussion of the internal operation of the driver. It describes the way in which the FIOT is used within the driver. Refer to the I/O Monitor documentation (DN 391476) for a description of the FIOT from the user's point of view.

A chart of the FIOT as it is used by the driver follows:

<table>
<thead>
<tr>
<th>FIOT</th>
<th>BB</th>
<th>IBA</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>M</td>
<td>ANW</td>
</tr>
<tr>
<td>2</td>
<td>JC</td>
<td>LUN</td>
</tr>
<tr>
<td>3</td>
<td>S</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>WA</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>DS</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>F</td>
<td>EAA</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>NB</td>
</tr>
</tbody>
</table>

The fields shown have the following meanings:

IBA - If IBA = 7FF, the driver will output 6" of blank paper tape.
     If IBA ≠ 7FF, it is used as the initial buffer address.

The user program should either directly or through the OPEN calling sequence, set in the mode bit of FIOT(1) when an output operation is being performed by the teletype driver. However, when a read request is made, the mode bit is set to reflect the correct input record format. The driver checks the first input character to determine how to set the first input character to determine how to set the mode and then reads the record.

Any time the left most bit of the first character is on, the mode is set to alpha. Any time the bit is off, the mode is set to binary. This can be done because all alpha characters have the left bit on. The first character read in binary mode is the left byte of the number of bytes in the record and, if the left bit was on, the record would be greater than 32,767 bytes. The record is read using the correct format.
JC - a 7-bit field used internally by the driver as a jump counter control.

S - 16-bit field which is the machine language command for the particular I/O operation. If it is an input operation, the sign bit is set; e.g. 82E916. If it is an output operation, the sign bit is not set; e.g. 03EE16.

WA - a 16-bit field which is the byte address of the next character to be stored. This address starts out as the initial buffer byte address and is incremented as characters are stored into the buffer.

DS - a 16-bit field which is the end buffer byte address. This is tested by the driver to insure the user's buffer doesn't overflow. DS is a byte address of the initial buffer address plus the number of words requested.

F - a 1-bit field used to specify the special format for input/output. When F is a 1, there is no formatting done by the teletype driver. The number of words specified by the user are transferred either in or out and the teletype is disconnected. If F is 0, then M of FIOT(1) is used to determine the format.

NB - a 16-bit field where the number of bytes in an input binary record are stored. The number is decremented as characters are stored into the user buffer. The input is terminated if NB goes to zero.
APPENDIX A

ASSEMBLY LISTING

of

TELETYPE - HIGH SPEED PAPER TAPE I/O DRIVER

Drawing No. 392292
ID Code BYM
SETUP AREA FOR TTY AND HSPT DRIVERS

<table>
<thead>
<tr>
<th>Instruction</th>
<th>Description</th>
<th>Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>TIRSA</td>
<td></td>
<td>VW 44180</td>
</tr>
<tr>
<td>M,THSPT</td>
<td></td>
<td>VW 44190</td>
</tr>
<tr>
<td>EOU</td>
<td></td>
<td>VW 44200</td>
</tr>
<tr>
<td>EOU</td>
<td>RELOAD FIOT ADDRESS</td>
<td>VW 44210</td>
</tr>
<tr>
<td>LDX</td>
<td>LOAD FIOT TO X REG</td>
<td>VW 44220</td>
</tr>
<tr>
<td>AND</td>
<td></td>
<td>VW 44230</td>
</tr>
<tr>
<td>AND</td>
<td></td>
<td>VW 44240</td>
</tr>
<tr>
<td>STW</td>
<td></td>
<td>VW 44250</td>
</tr>
<tr>
<td>JSX</td>
<td>SET FIOT VALUE</td>
<td>VW 44260</td>
</tr>
<tr>
<td>JDX</td>
<td></td>
<td>VW 44270</td>
</tr>
<tr>
<td>LDUX</td>
<td>LOAD FIOT ADDRESS</td>
<td>VW 44280</td>
</tr>
<tr>
<td>DW</td>
<td></td>
<td>VW 44290</td>
</tr>
<tr>
<td>TRUE</td>
<td>DID WE END UP WITH READ</td>
<td>VW 44300</td>
</tr>
<tr>
<td>CLB</td>
<td>KEYBOARD ON THE PHOTOREADER?</td>
<td>VW 44310</td>
</tr>
<tr>
<td>SNE</td>
<td></td>
<td>VW 44320</td>
</tr>
<tr>
<td>LHY</td>
<td></td>
<td>VW 44330</td>
</tr>
<tr>
<td>ENDW</td>
<td>FORCE WRITE MODE IF WEOF</td>
<td>VW 44340</td>
</tr>
<tr>
<td>LDX</td>
<td></td>
<td>VW 44350</td>
</tr>
<tr>
<td>AND</td>
<td></td>
<td>VW 44360</td>
</tr>
<tr>
<td>CLB</td>
<td></td>
<td>VW 44370</td>
</tr>
<tr>
<td>SXP</td>
<td></td>
<td>VW 44380</td>
</tr>
<tr>
<td>LHB</td>
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<td>VW 44390</td>
</tr>
<tr>
<td>ORI</td>
<td></td>
<td>VW 44400</td>
</tr>
<tr>
<td>ORI</td>
<td></td>
<td>VW 44410</td>
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<td>STORE DOT OR DIN DEVANDC</td>
<td>VW 44420</td>
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<td>VW 44430</td>
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<td>GET RETURN</td>
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<td>VW 44600</td>
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<td>VW 44630</td>
</tr>
<tr>
<td>EOU</td>
<td>RECOVER DEVICE FIOT ST</td>
<td>VW 44640</td>
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<tr>
<td>JSX</td>
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<tr>
<td>JMP</td>
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<td>VW 44730</td>
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<tr>
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<td></td>
<td>VW 44740</td>
</tr>
<tr>
<td>JMP</td>
<td></td>
<td>VW 44750</td>
</tr>
</tbody>
</table>
ENDC 3
LDH @ 3
AND X7FF
BTH MSPEC
TRUE IS SPEC
SRL 4
AND M3
SLC D 1
EXCHANGE
SLC D 19
EXCHANGE
SLM
STH Figure
STORE AWAY FIRST ADDRESS
ENDC
LDB M, DC
LOAD FIRST CHAR
NSPEC
D 0
SELECT THE DEVICE
H, TT
EQU MSPEC
JSX DRIVE
ALL DONE, EXIT
ATTYS D TTY5
SET FILLS FIRST WITH INIT BYTE ADD-END BYTE ADD, AND BYTE COUNT
SETF
STX M, DC
LDX M, DF
AND X1FF
RELOAD FC
CLB X1E1
TEST FOR OUTPUT
X1E1
TEST FOR OUTPUT
LDW M, OPN
GET NECF FLAG BIT 0
SAP
IS IT NECF
JMP DRED
YES FIX JUMP TTDISCONNECT
CLR
NOW SET JMP COUNTER FOR READ
SXP
TEST FOR SPECIAL FORMAT
LX16
SKIP READ FORMAT CHARACTERS
SBS
BUT IS IT WRITE
JMP M, TSCR
NO, SET JUMP COUNT
LX16
SKIP WRITE BYTE COUNT
SXP
IF IT IS SPECIAL FORMAT
JMP M, TSCR
IT IS
LDX 1
IT ISN'T, SET MODE
SXP
IS IT ALPHAD IF NOT X1E1 IS OK
LX1A
NO, SET PUNCH BYTE COUNT
M, TSCR
SLL 4
REPOSITION JUMP COUNT LEFT
LDX M, DF
LOAD FIGT ADD M
SLL 1
STORE JUMP COUNTER
GRI 2
SCH M1
WAS IT ZERO BEFORE 1 WAS ADDED
SLL 1
STORE INITIAL BYTE ADDRESS
LDX 1
DUMMY WORD COUNT FOR LEADER
LDX 1
AND USE IT IF LEADER CALL
LDN 0
LDX M, DF
STORE END BYTE ADDRESS - DONE WITH SETUP
SLL 1
SET BYTE COUNT FOR SPECIAL FMT
ADD 4
COMPUTE END BYTE ADDRESS
STH 9
STORE END BYTE ADDRESS- DONE WITH SETUP
CLB X'87' IS IT END OF FILE VW 49920
SEQ DID WE FIND IT VW 49930
JMP M,TIRR NO TRY AGAIN LATER VW 49940
LDW X'10' YES SET ESB BIT NA NA VW 49950
JMP M,TDISC GO DISCONNECT THE UNIT VW 49960

* THIS ROUTINE EXCEPTS FIRST CHARACTER AFTER LINE FEED VW 49970
M,CHAR CLB 0 TEST FOR ALPHA CHAR VW 49980
SLS VW 49990
JMP M,TMWI NG, SET WORD COUNT VW 46010
STW M,YY SAVE IT VW 46020
LDX M,DF GET FIRST ADDRESS VW 46030
LDW * 2 GET JUMP COUNT VW 46040
ADD X'400' SKIP 2 VW 46050
STW * 2 PUT BACK VW 46060
LDW * 1 GET MODE WORD VW 46070
AND X'7FF' SET ALPHA MODE VW 46080
STW * 1 PUT BACK VW 46090
LDW M,YY GET THIS ALPHA CHARACTER VW 46100

* THIS ROUTINE SERVICES RECEIVING OF DATA TO BE STORED IN USER BUFFER VW 46110

M,TDATAI LDX M,TFW LOAD MODE VW 46120
LDX * 1 BIN OR ALPHA VW 46130
IXS 0 VW 46140
JMP TLWA VW 46150
CLB X'1DF' IS CHAR A DELETE RECORD VW 46160
SNE VW 46170
JMP UEL R YES VW 46180
CLB X'1FF' TEST FOR RUB OUT VW 46190
SNE VW 46200
JMP DELC YES VW 46210
CLB X'1BD' IS CHAR A C/R VW 46220
SNE VW 46230
JMP M,TDISC YES DISCONNECT UNIT VW 46240
EQA VW 46250
LDX M,DF LOAD FIRST VW 46260
LDX * 4 DO DIRTY DEFB VW 46270
STD * 0 VW 46280

* TEST FOR END OF BUFFER, COMMON SEQUENCE FOR TTY IN OR OUT VW 46290
CHEKEOB IXS 1 INCREMENT BYTE ADDRESS VW 46300
CXA DON'T KNOW IF IT WILL SKIP VW 46310
CXA VW 46320
LDX M,DF RECOVER FIRST ADDRESS VW 46330
STM * 4 REPLACE WORKING ADDRESS VW 46340
CMW * 5 COMPARE WITH END OF BUFFER VW 46350
SEQ WAS IT? VW 46360
JMP DNB W NG, JUST COUNT DOWN BYTE COUNT VW 46370
LDW * 2 YES VW 46380
ADD X'200' INCREMENT JUMP COUNT TO SKIP IF THERE VW 46390
STM * 2 ARE BYTES REMAINING IN THE RECORD VW 46400
DNB LDX M,DF JUMP ENTRY TO SKIP RECORD REMAINDER VW 46410
LDW * 7 GET BYTE COUNT VW 46420
SUB N1 DECALMEN ET ONE BYTE VW 46430
STM * 7 PUT IT BACK VW 46440
CMW NO IS IT ZERO? VW 46450
SEQ 7 VW 46460
JMP M,TIRR NO, KEEP GOING VW 46470
LDW * 2 YES, FINISH UP VW 46480
CLR
LDX 4
SEQ
CHEKED
LOAD NEW BYTES
OUTPUT A ZERO
GO TEST FOR BUFFER'S END
LOAD C/R FOR OUTPUT
LOAD FIOT ADDRESS
SHIFT AROUND THE NO WORDS
RESTORE NEW NO WORDS
TRUE ISARE= YES
DINS DATA X'200', X'200', X'2EO'
FIOTS RES 3
ENDC
REEL 1 FILE 1 400 RECORDS