

DRIVER PROGRAM PROCEDURES



BCS HP 2767 LINE PRINTER DRIVER, D.16

HP Order No. HP 24167 (current version)

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BCS HP 2767 LINE PRINTER DRIVER, D.16

This driver provides input/output communication between user programs and the HP 2767 Line Printer Controller. The driver operates in an interrupt mode without DMA transfer capability, through the Input/Output Control (.IOC.) subroutine within the Basic Control System (BCS).

In addition to print commands, the driver performs various functions such as line spacing, page eject, and dynamic status. The driver is responsible for all equipment table (EQT) updates for the Line Printer unit and conforms to all BCS standards through Prepare Control System (PCS).

MODES OF OPERATION

This driver has three modes of operation: Plus, Normal, and TTY. The modes are selected by issuing the proper control subfunction or by selecting one of the following unit numbers at BCS configuration (PCS) time:

<u>Unit No.</u>	<u>Mode</u>
0 (Default Unit #)	Normal
2	Plus
4	TTY

For example, the Plus mode may be set at PCS time by supplying the following Equipment Table entry:

nn, D.16,U2

where *nn* is the channel number (select code) for the device.

In the Normal and Plus modes, the first character of the print buffer is used as control and is not printed. Instead, the second character of the buffer is printed in column one of the line printer paper.

In the Normal mode, if the first character is a "+", the driver interprets it as a blank (i.e., single space). In the Normal mode an attempt is made to drive the printer as a "space then print" device. Thus, if the command character says space 3 lines, the driver subtracts one and spaces 2 lines (one space was sent to terminate the last line, so the total is 3).

The Plus mode interprets a "+" in column one and overprints the current line on top of the last line. The driver sends a hold command at the end of each line and a single space before each line without a "+" in column one. The net effect is that the printer runs as a "space then print" device.

The TTY mode makes the Line Printer act like a teleprinter and prints the first character (in column one) of the buffer. Line space control for the TTY mode may be executed by using the print or control subfunction field. The TTY mode, if set, overrides the Plus and Normal modes and drives the printer as a "print then space" device. Two methods of spacing are permitted by using the print subfunction field.

The driver, in all modes, handles a line ending with a left arrow (←) by printing the first character in the buffer of the next request where the left arrow would have appeared had it been printed.

DRIVER ARCHITECTURE

Driver D.16 is constructed in two segments: the Initiator Section and the Continuator Section. Each of these sections is linked into the BCS System by the PCS preparation program.

Initiator Section

This section is called directly from .IOC. with calling parameters including the address of the second word of the user I/O request and the address of the EQT entry for the referenced device. .IOC. sets these parameters in A and B and performs a JSB to the entry point D.16. Return to .IOC. from this section must be indirectly through D.16.

On entry to D.16,

- (A) = Address of word 1 of 4-word EQT entry
- (B) = Address of word 2 of I/O request

The Initiator Section of this driver performs the functions described below:

- 1) Rejects the .IOC. request and returns to .IOC. (see step 6) if any of the following conditions exist:
 - a. the driver is busy operating another unit
 - b. the referenced device is busy or inoperable
 - c. the user request code is illegal for the device
- 2) Extracts the parameters from the user I/O request and saves them within the driver storage.
- 3) Configures all I/O instructions in the driver to include the channel number for the referenced device.
- 4) Indicates equipment in operation:
 - a. sets the "a" field in the EQT entry to 2 (busy) for the device called
 - b. sets an internal driver "busy" flag for the driver
- 5) Initializes operating conditions and activates the device.

- 6) Returns to .IOC. with the A and B registers set to indicate initiation or rejection and the cause of the reject:
- (A) = 0, operation initiated
 - = 1, operation rejected - reason in B-register
 - (B) = 100000, the device is busy or not ready
 - = 000000, the request code is illegal

Continuator Section

This section is entered by device interrupt to continue or complete an operation. It may also be called from the Initiator Section to begin an operation. The entry point to this section is I.16. There are no parameters on entry.

The Continuator Section of this driver performs the following functions:

- 1) Saves all registers which will be used by the continuator section.
- 2) Performs the input or output of the next data item. If the transfer is not completed, restore the "saved" registers and return control to the program (see steps 5 and 6).
- 3) When data transfer is completed (end-of-operation) or if a device malfunction is detected, the following information is set in the EQT entry:
 - a. The line count is set as a positive value in bits 14-9 of word 1.
 - b. 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 to indicate the mode of transfer (ASCII).

The device status (bits 7-0 of word 2) is not used for hardware status. See *Status Return Information*. The "a" field (bits 15-14) in word 2 is set to:

- 0 - device available (not busy)
- 1 - driver available; the operation could not be initiated because the device is not ready.

2 - device not available for another request; an operation is in progress.

Bits 13-8 of word 2 are not altered.

- 4) Clears all "busy" indicators and the driver busy flag, if end-of-operation.
- 5) Restores all registers saved at the entry.
- 6) Returns indirectly through the entry point I.16, with the following exception:

If end-of-operation and the operation completed was a print or Function request, return is made to the entry point ".BUFR" in .IOC.. This enables the Buffered version of .IOC. to perform the automatic output buffering function.

I/O REQUEST



The general form of the input/output request is:

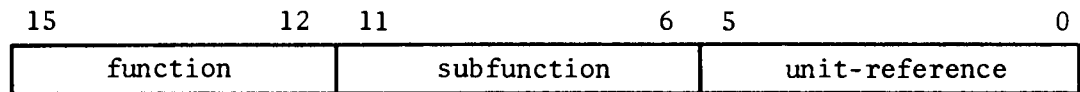
```
JSB   .IOC.
OCT   <function><subfunction> <unit-reference>
JMP   <reject address>
DEF   <buffer address>
{DEC} <buffer length>
{OCT}
<normal return>
.
.
.
EXT   .IOC.
```


Input/Output Control (.IOC.)

All input/output operations are requested by performing a JSB to entry point .IOC.. The input/output control subroutine returns control to the calling program at the first location following the last word of the I/O request.

Control Word

The second word of the I/O request determines the function to be performed and the line printer unit-reference for which the action is to be taken. The bit combinations that comprise the control word as follows:



I/O Functions & Subfunctions

The function (bits 15-12) is the basic input/output operation; it may be any of the following:

<u>Function Name</u>	<u>Code (Octal)</u>
Clear	00
Print	02
Control	03
Status	04

Write Function (02)

<u>Subfunction Bits (Ignore the x's)</u>		<u>Subfunction Description</u>
00x	xxx	Normal and Plus mode - first character is carriage control, the ASCII character in Table D.16-1. The second character is printed in column one of the line printer.
01x	xxx	TTY mode - first character is data. The carriage control character is the low 6 bits of the status word (second word of equipment table). The status word is set with an extended carriage control explained below.
11x	ddd	TTY mode - first character is data. Carriage control is tape level corresponding to <i>ddd</i> in Table D.16-1.
10x	xx0	Extended carriage control - first word in the buffer is sent as a carriage control command to the line printer. The first word is an octal code in bits 5-0, as defined in Table D.16-2. The buffer length (I/O request fifth word) should be set to 1.
10x	xx1	Extended carriage control - first word of buffer is set into status word to be used as TTY carriage control. The first word is an octal code in bits 5-0, as defined in Table D.16-2.

Control Function (03)

<u>Subfunction Bits</u> (Ignore the x's)		<u>Subfunction Description</u>
00x	000	Dynamic Status Request
00x	111	Clear TTY mode and Plus mode (and set Normal mode)
00x	110	Set TTY mode
00x	010 101	Set Plus mode
CCx	CCC	If not one of the above codes, CC1CCC will be sent to the line printer. (See Table D.16-1.)

I/O Reject

Control is transferred to the third word of the I/O request if the input/output operation cannot be initiated. On transfer, the system provides status information which may be checked by the user's program. See *Initiator Section*.

I/O Buffer Specifications

The buffer address is the location of the first word of data to be printed. The length of the buffer area may be specified in terms of words or characters. If the length is given as words, the value in the buffer length field must be a positive integer; if given as characters, a negative integer. A length of zero causes a blank line to be printed.

Table D.16-1
Allowable Motion Requests

	<u>Print Subfunction</u> <u>ddd code (octal)</u>	<u>Control Subfunction**</u> <u>CCx CCC code (octal)</u>	<u>ASCII</u> <u>Character in</u> <u>Column One</u>	<u>Action</u>
Printer Carriage Controls	7	67	0	Double space †
	6	66	1	Top of form †
	5	65	2	Bottom of form †
	4	64	3	Next sixth page †
	3	63	4	Next quarter page †
	2	62	5	Next half page †
	1	61	6	Next triple space line †
	0	60	7	Next double space line †
			8	Next single space line †
			9	Advance 55 lines *
		:	Advance 54 lines *	
		;	Advance 53 lines *	
		<	Advance 52 lines *	
		=	Advance 51 lines *	
		>	Advance 50 lines *	
		?	Advance 49 lines *	
		@	Advance 48 lines *	
	47	A	Advance 47 lines *	
	46	B	Advance 46 lines *	

Table D.16-1 (Continued)

<u>Print Subfunction</u> <u>ddd code (octal)</u>	<u>Control Subfunction**</u> <u>CCx CCC code (octal)</u>	ASCII <u>Character in</u> <u>Column One</u>	<u>Action</u>
	45	C	Advance 45 lines *
	44	D	Advance 44 lines *
	43	E	Advance 43 lines *
	42	F	Advance 42 lines *
	41	G	Advance 41 lines *
	40	H	Advance 40 lines *
		I	Advance 39 lines *
		J	Advance 38 lines *
		K	Advance 37 lines *
		L	Advance 36 lines *
		M	Advance 35 lines *
		N	Advance 34 lines *
		O	Advance 33 lines *
		P	Advance 32 lines *
	27	Q	Advance 31 lines *
	26	R	Advance 30 lines *
	25	S	Advance 29 lines *

Table D.16-1 (Continued)

<u>Print Subfunction ddd code (octal)</u>	<u>Control Subfunction** CCx CCC code (octal)</u>	<u>ASCII Character in Column One</u>	<u>Action</u>
	24	T	Advance 28 lines *
	23	U	Advance 27 lines *
	22	V	Advance 26 lines *
	21	W	Advance 25 lines *
	20	X	Advance 24 lines *
		Y	Advance 23 lines *
		Z	Advance 22 lines *
		[Advance 21 lines *
		\	Advance 20 lines *
]	Advance 19 lines *
		↑	Advance 18 lines *
		←	Advance 17 lines *
		(Blank)	Advance 1 line *
		!	Advance 15 lines *
		"	Advance 14 lines *
		#	Advance 13 lines *
	04	\$	Advance 12 lines *
	03	%	Advance 11 lines *



Table D.16-1 (Continued)

<u>Print Subfunction ddd code (octal)</u>	<u>Control Subfunction** CCx CCC code (octal)</u>	<u>Character in Column one</u>	<u>Action</u>
	02	&	Advance 10 lines *
	01	' (apostrophe)	Advance 9 lines *
		(Advance 8 lines *
)	Advance 7 lines *
		*	Overprint next line
		+	In Plus mode: overprint this line
		+	In Normal mode: Advance 1 line *
		, (comma)	Advance 4 lines *
		-	Advance 3 lines *
		. (period)	Advance 2 lines *
		/	Advance 1 line *

*Add six lines for any multiple skips crossing the page perforations. The HP 2767 line printer will not print in three lines before and after the page perforations. Continuous listings are not possible with this printer.

**The x (priority bit 9) has been set = 0 for this table.

†These control requests include an automatic page eject.

Table D.16-2
Extended Carriage Control Codes

<u>Octal Code</u> <u>(in bits 5-0)</u>	<u>Action</u>	<u>Octal Code</u> <u>(in bits 5-0)</u>	<u>Action</u>
77	Top of Form†	35	Advance 29 lines
76	Bottom of Form†	34	Advance 28 lines
75	Next sixth Page†	33	Advance 27 lines
74	Next quarter Page†	32	Advance 26 lines
73	Next half Page†	31	Advance 25 lines
72	Next triple space line†	30	Advance 24 lines
71	Next double space line†	27	Advance 23 lines
70	Next single space line†	26	Advance 22 lines
67	Advance 55 lines	25	Advance 21 lines
66	Advance 54 lines	24	Advance 20 lines
65	Advance 53 lines	23	Advance 19 lines
64	Advance 52 lines	22	Advance 18 lines
63	Advance 51 lines	21	Advance 17 lines
62	Advance 50 lines	20	Advance 16 lines
61	Advance 49 lines	17	Advance 15 lines
60	Advance 48 lines	16	Advance 14 lines
57	Advance 47 lines	15	Advance 13 lines
56	Advance 46 lines	14	Advance 12 lines
55	Advance 45 lines	13	Advance 11 lines
54	Advance 44 lines	12	Advance 10 lines
53	Advance 43 lines	11	Advance 9 lines
52	Advance 42 lines	10	Advance 8 lines
51	Advance 41 lines	7	Advance 7 lines
50	Advance 40 lines	6	Advance 6 lines
47	Advance 39 lines	5	Advance 5 lines
46	Advance 38 lines	4	Advance 4 lines
45	Advance 37 lines	3	Advance 3 lines
44	Advance 36 lines	2	Advance 2 lines
43	Advance 35 lines	1	Advance 1 line
42	Advance 34 lines	0	Advance 0 line
41	Advance 33 lines		
40	Advance 32 lines		
37	Advance 31 lines		
36	Advance 30 lines		

†These actions include an automatic page eject.

Status and Dynamic Status Requests

Either of the following types of status requests may be made:

- a. Normal status -

JSB .IOC.

OCT 0400 <unit-reference>

<normal return>

- b. Dynamic status -

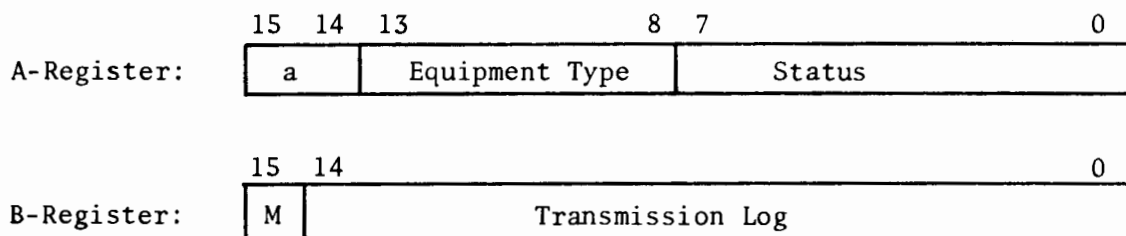
JSB .IOC.

OCT 0300 <unit-reference>

<normal return>

The dynamic status request is used to obtain the actual status of a line printer unit. The normal status request returns the status of the line printer unit for the last time it was referenced. The dynamic status request goes to the driver for its operation; it returns only the status word in the A-register with nothing in particular in the B-register. The EQT status table entry is updated by this request.

Status Return Information



a = Availability (A-Register bits 15 and 14):

- 0 = The device is available; the previous operation is complete.
- 1 = The driver is available; the operation could not be initiated because the device is not ready.
- 2 = The device is not available for another request; an operation is in progress.

Equipment Type (A-Register bits 13 - 8):

16₈ = HP 2767 Line Printer



Status (A-Register bits 7 - 0):

<u>Bits</u>	<u>Meaning</u>
5-0	TTY termination code with bits 3-5 inverted.
6	Left arrow (←) last time flag; if true, bit 6 = 1
7	Asterisk (*) last time flag; if true, bit 7 = 1

M = data transmission mode (B-Register bit 15):

Always 0 = ASCII

Transmission Log (B-Register bits 14 - 0):

This field is a log of the number of characters or words transmitted. The value is given as a positive integer and indicates characters or words as specified in the I/O request.

Clear Request

The clear request terminates a previously issued input or output operation and sets all busy flags to "not-busy". A clear request has the following form:

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

On return, the contents of the A- and B-Registers are meaningless. The clear request checks for multi-unit operation based on the device; i.e., the I/O channel number. The driver is cleared only if the clear request is for the current operation I/O channel.

If a clear request is issued while operating the driver in the plus mode, either of the following two events may occur:

1. If the driver is busy, the clear request will print and space one line.
2. If the driver is not busy, the clear request will not print and space one line.

In either case, the next print request following the clear request prints without spacing ("overprint next line" has been set by the driver); i.e., if the line printer paper is resting at Top-Of-Form and the driver is not busy, the first line of the next print request prints on the first line of the paper. However, if the line printer has just printed a line prior to the clear request and the driver is not busy, the first line of the next print request overprints the last line printed. To alleviate this problem, a control request may be issued prior to the print request.

Equipment Table Flags

Bits 14-9 of word one of the equipment table contain the line count of the HP 2767 Line Printer; i.e., if the carriage is resting on line 20, the bits contain 20B. Word 2 contains no hardware status in bits 7-0. See *Status Return Information* for the meaning of these bits.

Illegal Character

Should an illegal character be encountered, the driver will output an "@" character. A legal character is defined as $\geq 40_8$ and $\leq 137_8$ (all ASCII characters are legal), and all other octal numbers are considered to be illegal characters.

Illegal Buffer Length

Should an illegal buffer length be encountered, the driver will use 80 characters (or 40 words) as a legal length. A legal buffer length is defined as ≤ 80 characters (or ≤ 40 words).

