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A SIMPLE PDP15 INTERFACE
FOR THE
VERSATEC SERIAL PRINTER^(a)

Battelle

Pacific Northwest Laboratories
Richland, Washington 99352

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Prepared for the U.S. Atomic Energy
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A SIMPLE PDP15 INTERFACE FOR THE
VERSATEC SERIAL PRINTER^(a)

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A SIMPLE PDP15 INTERFACE FOR THE
VERSATEC SERIAL PRINTER (a)

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We have developed an interface between the PDP 15/30 computer and the Versatec printer/plotter, model 200A, operating in the serial print mode. The interface construction involved fabricating a cable with two twisted pairs for a signal and a control line, speeding up the clock in the existing foreground teletype controller and changing less than a dozen wires in it. The associated I/O device handler, which we have written, allows the printer to be used as the listing device in the Digital Equipment Corporation Advanced Monitor Software System. With the handler, the printer is capable of printing 80 character lines at approximately 120 lines per minute.

INTRODUCTION

We have a Digital Equipment Corporation (DEC) PDP 15/30 computer system which has the equipment configuration listed in Table I. In our application we do not use the foreground teleprinter, so its controller is available for other applications.

(a) This paper is based on work performed under United States Atomic Energy Commission Contract AT(45-1)-1830.

We also have a Versatec printer/plotter, model 200A, which was purchased for general laboratory use. We determined that with a few simple modifications, the foreground teletype controller in the PDP15 could be used as a controller for the printer portion of the Versatec and immediately give us a fast printer for the PDP15. Within a few days after deciding to modify the teletype controller, we completed the design, installation and debugging of the modification and then completed a handler that operates under the Advanced Software System (ADSS). The Versatec printer/plotter is currently being used as the listing device for the PDP15, printing 80 character lines at approximately 120 lines per minute.

Printer/Computer Interface

The interface design required the addition of a jumper in one of the Versatec signal connectors, construction of a signal and control cable with two twisted wire pairs and slight modification of the PDP15 foreground teletype controller.

Table 2 shows the Versatec connector pin assignments used for the interface. The nomenclature in the table is from the Versatec prints. Pin 13 of J1 has to be true (high TTL level) for parallel plotter operation and false (ground) for serial printer operation. The Versatec printer is kept in the serial mode by a mating connector on J1 that has pin 13 jumped to pin 20.

The signal and control cable for the interface has a mating connector for the Versatec serial input (J3 of Table 2) on one end and a cable card (DEC M-series M904) on the other end. The serial eleven-bit code is transmitted to pin 3 of J3 (Signal) of the Versatec via

a twisted pair in the cable, and the REDY control is transmitted from pin 25 of J3 of the Versatec via the other twisted pair in the cable. Figure 1 shows the wiring for the PDP-15 end of the interface cable. Signal and chassis ground on the M 904 card are on pins T1 and C2. The mounting panel slot for the M904 is wired with ground on T1 and C2.

The foreground teletype controller is called the LT 15-A Single Teletype Control by DEC and is mounted in their BA 15, CPU option. The schematics for the BA 15 and the LT 15 are found in Volume 2, Engineering Drawings, of the PDP -15 Maintenance Manual.

The M 904 cable card (Figure 1) on the PDP-15 side of the interface cable is plugged into slot B31 of the BA 15, a spare slot that is unused by DEC. Figures 1, 2.a., and 2.b in this report, as well as DEC engineering drawings BA 15-Ø-Ø5, LT15-A-Ø1, LT15-A-Ø2, and LT15-A-Ø3 will be used to describe the modifications that we made.

The frequency of the LT15 clock, which is an M452 module, shown in print LT15-A-Ø2, was increased from 880 HZ to 19,200 HZ.

Serial data, an eleven-bit ASCII code, appears at pin AD2 of the M707 (Figure 2.a) and is wired to pin D1 of the M904 cable board (Figure 1). REDY, the Versatec control signal (Figure 1) is connected to two gates in the modified LT15 (Figure 2.a). REDY is true (positive TTL level) when the Versatec can accept a serial character for printing, and false (ground) otherwise.

Originally, two control signals, "LTØ3 Teleprinter Flag" and "LTØ3 TTU Skip" provided the PDP-15 with information on the status of the LT15 printer control operation. One signal, which appears at pin BK2 (see Figure 2.a and DEC print LT15-A-Ø3), and is called "LT03 Teleprinter Flag" on print LT15-A-Ø3, falls from a TTL positive

level to ground at the beginning of the stop bits in a serial character transmission. This was inverted and then connected to an M104 module, shown in print LT15-A-01, to interrupt the PDP-15 when a character had been transmitted. For the Versatec, the LT15 is modified so that the signal at BK2 of the M707 module of Figure 2.a is inverted, combined with REDY in the logical AND gate formed by the NAND gates on the M113 modules in slots B30 and 29, and then applied to the M104 module in place of the inverted "LT03 Teleprinter Flag". Thus, when the LT15 is finished transmitting a character code, and the Versatec is ready to accept another code, the PDP-15 is interrupted.

"LT03 TTO SKIP" was originally generated in the LT15 (DEC print LT15-A-03) whenever: 1) a test instruction was issued by the PDP15, and 2) the M707 was finished transmitting the code for a character. To change this for Versatec operation, "LT03 TTO SKIP" has been removed from the BA15 and is inverted and combined in the NAND gate in the M113 module in slot B29. This logical combination is then transmitted to the BA15 unit. This modification causes the same results as the original "LT03 TTO SKIP" signal, but only when the Versatec is actually ready to accept another character.

Figure 2.b shows the changes that are necessary in the teletype connector (W078 module) shown in the DEC print LT15-A-02. The current loop that was originally operated by a teletype keyboard is kept closed by a short for Versatec operation, since it does not have a keyboard.

Versatec Printer I/O Handler

An I/O device handler for the Versatec operating in the serial printer mode was written to run in the Advanced Monitor Software System. Instructions for writing the handler and definitions of the different macros it responds to were taken from the DEC publication "Advanced Monitor Software System for PDP15/20/30/40". Appendix 1 is a summary of the Versatec serial printer handler that is in our system library as VSP.

Acknowledgement

The writer wishes to thank R. T. Brodaczynski for his help in fabricating and debugging the interface.

Central Processor with 16,384 Word Core Memory
Background Teletype
Foreground Teletype
Foreground Teletype Controller
High Speed Paper Tape Reader and Punch
Extended Arithmetic Element
Automatic Priority Interrupt
Memory Protect
Real Time Clock
Dectape Controller
Four Dectape Transports

Table 1. PDP15/30 Computer System

<u>Number</u>	<u>Connector Name</u>	<u>Pin Number</u>	<u>Function</u>
J1	Parallel	13	Parallel/Serial Control
J1	Parallel	20	Ground
J3	Serial	1	Chassis Ground
J3	Serial	3	Signal
J3	Serial	7	Signal Ground
J3	Serial	25	REDY

Table 2. Versatec Connector Pin Assignments

FIG. 1. VERSATEC INTERFACE CABLE CARD WIRING

FIG. 2.a LT15 AND BA15 WIRING CHANGES

NOTE 1. PDP15 REFERENCE SCHEMATIC - LT15-A-03

NOTE 2. SIGNAL TO M904, B31

NOTE 3. THIS SIGNAL IS THE LOGICAL AND OF LT03 TTO SKIP L (LT15-A-03) AND REDY, THE SIGNAL FROM THE VERSATEC

NOTE 4. BEFORE MODIFICATION, LT03 TTO SKIP L CONNECTED HERE (PDP15 REFERENCE SCHEMATIC BA15-0-05)

NOTE 5. REDY FROM VERSATEC CABLE CARD, M904, B31

NOTE 6. BEFORE MODIFICATION, LT03 TELEPRINTER FLAG L CONNECTED HERE (PDP15 REFERENCE SCHEMATIC LT15-A-01)

NOTE 7. BEFORE MODIFICATION, LT01 TELEPRINTER FLAG H CONNECTED HERE (LT15-A-01)

FIG. 2.b LT15 AND BA15 WIRING CHANGES

Appendix 1. Summary of the Versatec Serial
Printer I/O Handler Features

I. Functions

I/O Macros

Handler Response

•INIT	a) Return standard line buffer size (34 ₁₀) b) Setup automatic priority interrupt channel register 74g and program interrupt skip sequence. c) Output one blank line with a carriage return code
•DELETE	Ignored
•RENAM	
•FSTAT	
•SEEK	Illegal function
•ENTER	Ignored
•CLEAR	Ignored
•CLOSE	a) Allow previous output to terminate b) Output from feed c) Allow form feed to terminate
•MTAPE	Ignored
•READ	Illegal function
•WRITE	a) Allow previous output to terminate b) Output a line c) Output a form feed if page is full

.WAIT, .WAITR

- a) If I/O underway, return to the .WAIT call or to the address specified by .WAITR.
- b) If I/O finished, return after the .WAIT or .WAITR call.

II. Legal Data Mode

IOPS ASCII

III. Vertical Control Characters

- a) Carriage return (CR) or line feed (LF) causes same result as a CR/LF combination on a teletype and terminates the line.
- b) Form feed causes paper to advance to the top of the page.

IV. Horizontal Control Character

A horizontal tab causes N spaces to be printed, where N is the number necessary to start the next character in columns 9,17,25,33,.....

V. Recoverable Errors - None

VI. Unrecoverable Errors

- a) Illegal Function - A monitor error message is generated - .IOPS 06 XXXXXX - where XXXXXX is the address of the error CAL.
- b) Illegal Data Mode - A monitor error message is generated - .IOPS 07 XXXXXX - where XXXXXX is the address of the error CAL. This is caused by any mode other than IOPS ASCII.
- c) .INIT Flat Not Cleared - A monitor error message is generated - .IOPS 37.
- d) Illegal Interrupt - A monitor error message is generated - .IOPS 47.

VII. The Versatec printer in the serial-mode is interfaced via the LT15 and thus has both automatic priority and program interrupt available.

APPENDIX 2. I/O HANDLER LISTING

```

.TITLE VSP.
.GLOBL VSP.
/VSP.=IOFS VERSATEC **SERIAL** PRINTER HANDLER
/CONTROLLER IS MODIFIED LT15
/DECIMAL NO. OF WORDS=371
/J.R. KOSOROK/12/18/73
/CALLING SEQUENCE:
/      CAL+DAT SLOT(BITS 9-17)
/      FUNCTION(1-13(OCT))
/      N ARGUMENTS, WHERE N DEPENDS ON FUNCTION
/      NORMAL RETURN
VPTSF=704001 /SKIP ON TRANSMIT FLAG
VPTCF=704002 /CLEAR TRANSMIT FLAG
VPTLS=704004 /LOAD TRANSMIT BUFFER
.MED=3 /MONITOR ERROR DIAGNOSTIC
/
/VARIABLES
CHRPNT 0 /POINTS TO UNPACKED 5/7 CHR.
CHR1 .BLOCK 5 /UNPACKED 5/7 CHRS.
CLCN 0 /CHR/LINE CNTR.
CN5CH 0 /COUNTS NO. OF UNPACKED 5/7 CHRS.
DIFF 0 /NO. OF SPACES TO NXT FIELD
.DEC
HCHLC 79 /NO. OF CHRS./LN.
.OCT
IFLG 77 /CLEAR WHEN .INIT COMPLETE
INTFLG 0 /SET ON API OR PIC INTR.
LBAD 0 /PNTR TO USER'S LN. BUFF.
LNCHT 0 /NO. OF LINES BETWEEN FF
BUFG 0 /OUTPUT UNDERWAY FLAG
SPCH 0 /NO. OF SPACES CNTR.
TMP1 0 /TEMP. STORAGE
VPARGP 0 /CAL ARG. PNTR.
VPCALP 0 /CAL ENTRY PNTR.
VROUT 0 /INDIRECT INTERRUPT RETURN
VPSVAC 0 /AC
WPC 0 /WORD PAIR COUNTER
WPCNT 0 /USER'S WORD PAIR COUNT
WTFLG 0 /SET IF .WAITR; CLEAR IF .WAIT
AC2 0 /TEMP. STORE FOR
SC1 0 /ARS SUBROUTINE
WD1 0 /TEMP.STORE FOR 1ST ASCII WORD PAIR
/
VSP. DAC VPCALP /SAVE CAL POINTER
DAC VPARGP /SAVE ARG. POINTER
ISZ VPARGP /POINT TO FUNCTION
LAC* VPARGP /GET FUNCTION
AND (17 /REMOVE POSSIBLE UNIT NO.
ISZ VPARGP /POINT TO NEXT ARG.
TAD (JMP DSPCH
DAC DSPCH
DSPCH 0 /DISPATCH WITH MOD. JMP
JMP VINIT /1 .INIT
JMP VPIGN1 /2 .FSTAT, .DELET, .RENAM
JMP VPER06 /3 .SEEK
JMP VPIGN1 /4 .ENTER
JMP VPIGN2 /5 .CLEAR
JMP VPCLOS /6 .CLOSE
JMP VPIGN2 /7 .MTAPE
JMP VPER06 /10 .READ

```

```

      JMP      VPMWRIT /11 .WRITE
      JMP      VPMWAIT /12 .WAIT
      JMP      VPER06 /13 .TRAN
      JMP      VPER06 /14 ERROR
      JMP      VPER06 /15 ERROR
      JMP      VPER06 /16 ERROR
      JMP      VPER06 /17 ERROR
/ILLEGAL FUNCTIONS CODED ABOVE AS JMP VPER06
/ILLEGAL FUNCTION
VPER06 LAW      6      /ERROR CODE 6
      JMP*     (.MED+1) /TO MONITOR
/ILLEGAL DATA MODE
VPER07 LAW      7
      JMP*     (.MED+1)
/INIT NOT COMPLETE
VPER37 LAW      37
      JMP*     (.MED+1)
/RETURN FROM CAL WITH ONE MORE ARGUMENT
VPIGN1 ISZ      VPARGP
/NORMAL RETURN FROM CAL
VPIGN2 DBR      /BREAK FROM LEVEL 4
      XOT      .+1
      JMP*     VPARGP /RETURN AFTER CAL,FCN.,&ARG.
/
/INIT ROUTINE
/
/Dispatch Point
/VPINIT=SKP ON FIRST ENTRY AND AFTER .CLOSE
/      =NOP ON SUBSEQUENT ENTRIES
VPINIT SKP
      JMP      NTFT
/CHECK IF OUTPUT UNDERWAY
      LAC      OUFQ
      SZA
      JMP      NTFT /BYPASS .INIT
/First ENTRY OR AFTER .CLOSE
/CHANGE TO NOP
      LAC      (NOP
      DAC      VPINIT
      DZN      LNCNT /CLEAR LINE CNTR.
      ISZ      VPARGP /BYPASS USER RETURN ADDRESS
/RETURN STANDARD LINE BUFFER SIZE TO USER
      LAC      (42 /DEC 34
      DAC*     VPARGP
      ISZ      VPARGP /POINT TO CAL RETURN ADDR.
/SETUP API AND PIC
      CAL      74 /Lti5 API ADDR.
      16 /IOPS FUNCTION CODE
      VPTSF /SKIP IOT TO TEST FLAG
      VPINT /INTERRUPT ADDR/
/SET INTERRUPT POINTER TO .INIT-CR
      LAC      (JMP CLRiio
      DAC      INTPNT
/SET .INIT FLAG
      DAC      IFLG /ANYTHING SETS; CLEAR=0
/ET OUTPUT UNDERWAY FLAG
      DAC      OUFQ
/OUTPUT CR
      LAW      15
      JMS      VSOPT

```

/WAIT FOR OUTPUT UNDERWAY FLAG TO CLEAR

```
LAC      OUFG
SZA
JMP      .-2
CMA
DAC      OUFG      /OUTPUT UNDERWAY
LAW      12
JMS      VSDPT      /OUTPUT LF
LAC      OUFG      /WAIT FOR LF TO FINISH
SZA
JMP      .-2
DZM      IFLG
```

/RETURN AFTER CAL

```
JMP      VPIGN2
```

/NOT FIRST TIME INTO .INIT

```
NTFT     ISZ      VPARGP      /BYPASS USER RETURN ADDR.
JMP      VPIGN1      /BYPASS LINE BUFFER SIZE AND
                        / RETURN AFTER CAL
```

/JMP HERE FROM INTERRUPT

```
CLRIFO   DZM      OUFG
JMP      VPDS
```

/CLOSE ROUTINE

/CHECK IF OUTPUT UNDERWAY

```
VPCLBS   LAC      OUFG
SNA
JMP      ONTU
```

/RETURN TO CAL-DO IT OVER

```
DOVR     DBR      /BREAK FROM LEVEL 4
XCT      +1
JMP*     VPCALP      /DO CAL OVER
```

/OUTPUT NOT UNDERWAY

```
ONTU     LAC      (JMP CKCLBS
DAC      INTPNT      /SET INTR. PNTR.
DAC      OUFG      /OUTPUT UNDERWAY
DAC      IFLG      /SET .INIT FLAG
LAW      14
JMS      VSOPT      /OUTPUT FORM FEED
```

/WAIT FOR TOP OF PAGE

```
LAC      OUFG
SZA
JMP      .-2
```

/RESTORE .INIT ENTRY

```
LAC      (SKP
DAC      VPINIT
```

/CLEAR LINE COUNTER

```
DZM      LNCNT
```

/RETURN AFTER CAL

```
JMP      VPIGN2
```

/JMP HERE FROM INTR.

```
CKCLBS   DZM      OUFG
JMP      VPDS
```

WRITE ROUTINE

```
VPWRIT   LAC      OUFG
SNA
JMP      NOOUT      /OUTPUT NOT UNDERWAY
```

```

/OUTPUT UNDERWAY
OUTUN  ISZ    VPARGP  /BYPASS USER BUFF. PNTR.
      JMP    VPIGN1  /BYPASS WORD COUNT AND
                        / BYPASS CAL

/DO OUT   LAC     IFLG
      SZA
      JMP    OUTUN  / INIT FLAG NOT CLEARED

/CHECK FOR TOO LONG A PAGE
      LAC     LNCNT
      SAD     (74
      JMS     PGTL

/DATA MODE IN CAL(BITS 6-8)
      LAM     7000
      AND*    VPCALP
      SAD     (2000
      JMP     .+2

/ILLEGAL DATA MODE
      JMP     VPER07

/DATA MODE OK
/GET USER'S LINE BUFF. PNTR.
      LAC*    VPARGP
      DAC     LBAD
      ISZ     VPARGP
      ISZ     VPARGP
      DAC     BUFG  /SET OUTPUT UNDERWAY FLAG

/READY TO OUTPUT A LINE
/GET USER'S WPC
VSPM   LAC*    LBAD
      ISZ     LBAD
      ISZ     LBAD  /MOVE POINTER TO 1st WORD PAIR
      AND     (377000 /WPC IN BITS 1-8
      CLL
      JMS     ARS
      LI
      DAC     WPCNT  /WORD PAIR COUNT
      LAC     (1
      DAC     WPC     /WORD PR. COUNTER
      DCM     CLCN    /CHAR./LINE CNTR.

/IF WPC<WPCNT, THEN MORE WORD PAIRS
CKWP   LAC     WPCNT
      SAD     WPC
      JMP     WRCR

/LOOP FOR PICKING UP 5 CHAR.
CHOT   LAC     HCHLC  /HANDLER CHAR/LINE COUNT
      SAD     CLCN
      JMP     WRCR  /MAX CHR/LN REACHED

/MORE CHR. ON LN. ALLOWED
/GET 5 MORE CHRS.
      LAC*    LBAD
      DAC     WD1
      ISZ     LBAD
      LAC*    LBAD
      RAR     /5TH CHR. IN Bits 11-17
      DAC     CHR1+4
      JMS     ARS
      7
      DAC     CHR1+3 /4TH CHR. IN Bits 11-17
      JMS     ARS
      7
      AND     .-1

```



```

DAC      CHR1+2  /L.S. 3 bits of 3RD CHR.
LAC      WDI
JMS      ARS
4
DAC      CHR1+1  /2ND CHR.
JMS      ARS
7
DAC      CHR1     /1st CHR.
LAC      WDI
RTL
RAL
AND      (<170
TAD      CHR1+2
DAC      CHR1+2  /3RD CHR.
ISZ      LBAD     /POINTS TO NXT. WRD PR
ISZ      WPC      /WPC INC. ONCE
              / FOR EACH 5/7 PAIR

LAC      <CHR1
DAC      CHRPNTR  /CHR PNTR
DZM      CN5CH    /CHR CNTR

/GET A CHR LOOP
GCHLP    LAC      HCHLC
          SAD      CLCN
          JMP      WRCR    /MAX CHR/LN REACHED
          LAC      CN5CH
          SAD      <5
          JMP      CKWP    /5 CHRS. FROM THIS PAIR
              / NEED NEW PAIR

LAC*     CHRPNTR
ISZ      CN5CH
ISZ      CHRPNTR
AND      (<177
DAC      TMP1
SAD      <15        /CHECK FOR CR
JMP      WRCR      /CR
SAD      <11        /CHECK FOR HT
JMP      TBCH      /HT
SAD      <12
JMP      OTHCH     /CHECK FOR LF
SAD      <4         /CHECK FOR EOT
JMP      OTHCH     /EOT
SAD      <14        /CHECK FOR FF
JMP      OTHCH     /FF
TAD      <-40
SPA!CLL
STL
LAC      TMP1
TAD      <-140
SMA
STL
LAC      <40
CHL
LAC      TMP1
CLL

/CHR WAS NOT CR OR HT
ACH      DAC      TMP1
          LAC      <JMP GCHLP
          DAC      INTENT
          ISZ      CLCN
          LAC      TMP1

```

```

      JMS      VSOPT  /OUTPUT CHR.
      JMP      DTWREX
/OUTPUT CR AND TERMINATE OUTPUT
WRCR      LAC      <JMP TRMLN
      DAC      INTPT  /SET INTR. PNTR.
      ISZ      LNCNT  /INCR. LN. CNTR.
      LAW      15
      JMS      VSOPT  /OUTPUT CR
      JMP      DTWREX
/CR COMPLETE
TRMLN     DZM      OUEG
      JMP      DTWREX
/HT-HORIZ. TAB
TBCH      LAC      CLCN
/GET MODULO 8 COUNT
      CMA
      AND      <7
/ADD 1 to GET NO. OF SPACES to Next bdl. in acc
      IAC
      DAC      DIFF
CLSPC     DZM      SPCH
      LAC      <JMP BSPLP
      DAC      INTPT  /SET INTR. PNTR.
BSPLP     ISZ      SPCH
      ISZ      CLCN
      LAW      40
      JMS      VSOPT  /OUTPUT SPACE
/Exit FROM Write
DTWREX    LAC      INTFLG
      SZA
      JMP      VPDS   /RETURN to INTR.
      JMP      VPIGN2 /RETURN AFTER CAL
BSPLP     LAC      HCHLC /CHK CHR/LN
      SAA      CLCN
      JMP      WRCR   /LINE FULL
      LAC      DIFF   /CHK SP CNTR
      SAA      SPCH
      JMP      GCHLP  /AT START OF Nxt FIELD
      JMP      SPLP   /MORE SPACES
/PAGE TOO LONG
/ INSERT FORM FEED
PGTL      0
      LAC      <JMP TRMFF
      DAC      INTPT
      DAC      OUEG
      LAW      14
      JMS      VSOPT
      LAC      OUEG
      SZA
      JMP      -2
      JMP#     PGTL
TRMFF     DZM      OUEG
      JMP      VPDS
/
/ Wait AND WaitR RESPONSE
/
/ DETERMINE IF Wait OR WaitR
VPWnit    LAW      1000 /WTFLG 0 FOR Wait
      AND#     VPCALP / AND NE. 0
      DAC      WTFLG  / FOR WaitR

```

/CHECK FOR OUTPUT UNDERWAY

LAC OUFQ
SNA
JMP NBSY /NOT BUSY

BUSY

LAC WIFLG
SZA
JMP WTRB /WAITR
JMP DOVR /WAIT, BUSY
WTRB LAC VPCALP /WAITR, BUSY
AND <700000 /L, EX, MP
DAC VPCALP
LAC* VPARGP
AND <77777 /BUSY ADDR.
XOR VPCALP
DAC VPCALP
JMP DOVR

/NOT BUSY

NBSY LAC WIFLG
SZA
ISZ VPARGP /WAITR
JMP VPIGN2

/VSOPt

/OUTPUT CHR. TO PRINTER

/CALLING SEQUENCE:

/ IOPS ASCII CHR. IN Rt. 7 BITS OF AC
/ JMS VSOPt

/VSOPt

0
AND <177
SAD <14 /CHECK FOR FF
DZM LNCNT /CLEAR LINE CNTR.
VPTCF!VPTLS
JMP* VSOPt

/END OF VSOPt

/INTERRUPT RESPONSE FOR API OR PIC

/VPPIC

DAC VPSVAC /SAVE AC
LAC* 0
DAC VPOUT /SAVE PC, L, EX, MP
LAC VPION /FORCE ION AT EXIT
JMP VPSTON

/VPINT

JMP VPPIC /PIC ENTRY
DAC VPSVAC /API ENTRY, SAVE AC
LAC VPINT
DAC VPOUT /SAVE PC, L, EX, MP
IORS /CHECK PIC STATUS
SMA!CLA / FOR RESTORATION At Exit
LAW 17740 /IOF, BIT0=0
TAD VPION /ION, BIT0=1

/VPSTON

DAC VPSWCH
VPTCF /CLEAR TRANSMIT FLAG

/VPION

ION /ENABLE PIC
CLA!CHA

/INTPNT

DAC INTFLG /SET INTR. FLAG
HLT /INTR PNTR CHANGED TO
/ JMP BY SEGMENTS THAT OUTPUT

/DISMISS FROM INT.

```

VPDS   DZM   INTFLG
       LAC   KJMP VPPIC   /RESTORE PIC ENTRY
       DAC   VPINT
       LAC   VPOUT
       RAL           /RESTORE LINK
       LAC   VPSVAC /RESTORE AC
VPSWCH ION    /ION OR IOF AS PER ENTRY
       DBR
       XCT   .+1
       JMP*  VPOUT
/SUBROUTINE TO SHIFT ACC RIGHT
/Y      JMS   ARS
/Y+1    XX    /SHIFT COUNT
/Y+2    RETURN POINT
ARS     0
       DAC   AC2
       LAC*  ARS   /GET SHIFT COUNT
       ISZ   ARS   /POINT TO RETURN
       TCA
       DAC   SC1
       LAC   AC2
       RAR
       ISZ   SC1
       JMP   .-2
       JMP*  ARS
/END OF ARS
       .END

```

DISTRIBUTION

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