IDENTIFICATION

Product Code: F-85

Product Name: Change Notice 4 - PDP-8 User's Handbook
(Changes Number 1, 2, and 3 Incorporated)

Date Created: May 9, 1967

Change Notice for PDP-8 User's Handbook - F-85

Page 4; line 13-14

Change FROM: is read from a memory location in 0.8 microsecond and rewritten in the same location in another 0.8 microsecond of one 1.6-microsecond memory cycle.

TO: is read from a memory location in 0.75 microsecond and rewritten in the same location in another 0.75 microsecond of one 1.5-microsecond memory cycle.

Page 13; Figure 6

Change FROM: Format diagram incorrect as shown.

TO: Format diagram shown as Figure 7 on page 17.

Page 17; Figure 7

Change FROM: Format diagram incorrect as shown.

TO: Format diagram shown as Figure 6 on page 13.

Page 20; line 9

Change FROM: Event Time: 1

TO: Event Time: 2

Page 39; line 24

Change FROM: Octal Code: 6104

TO: Octal Code: 6101

Page 39; line 25

Change FROM: Event Time 3

TO: Event Time 1

Page 39; line 33

Change FROM: Octal Code: 6102

TO: Octal Code: 6104

Page 39; line 34

Change FROM: Event Time 2

TO: Event Time 3

Page 45; line 10

Change FROM: 3. Give the MUL command.

TO: 3. Give the MUY command.

Page 68; line 26

Change FROM: Table 2 Analog-to-Digital Converter Type 139E Characteristics

TO: Table 2 Analog-to-Digital Converter Type 138E Characteristics

Page 95; line 5

Add after line 5: Clears the AC after execution.

Page 95; line 15

Add after line 15: Clears the AC after execution.

Page 128; line 24

Change FROM: AC1(0) = Sets the SPACE flip-flop

TO: AC1(0) = Sets the SPACE flip-flop, also enables the interrupt

Page 131; line 27

Change FROM:	TMP TW2	/GO TO A WRITE INSTRUCTION
TO:	JMP TW2	/GO TO A WRITE INSTRUCTION

Page 131; line 33

Change FROM:	TSZ CNTR	/COUNT THE NUMBER OF
TO:	ISZ CNTR	/COUNT THE NUMBER OF

Page 131; line 37

Change FROM:	TSDS	/WAIT FOR LAST
TO:	TSDF	/WAIT FOR LAST

Page 198; line 10

Change FROM:	Address Accepted ——▷	PF3S	PF10H	W640
TO:	Address Accepted ——▶	PF3S	PF10H	W640

Following page 72 insert the following:

CHAPTER 7A

EIGHT CHANNEL SAMPLE AND HOLD CONTROL TYPE AC01

The DEC Type AC01A Sample and Hold Control is provided as an input option to the Type 139E Multiplexer for skewless recording of analog data from as many as eight analog sources. Typical of the varied applications for this device is the Digital recording of data from seven-track analog tape recorders. The option uses the DEC type A400 Sample and Hold amplifiers for the number of channels desired.

The AC01A is contained in a Type 1943 Mounting Panel together with the standard 138E/139E interface to the PDP-8. This option therefore replaces the standard AA03 interface in PDP-8 systems.

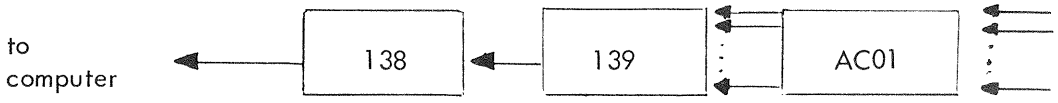
The first eight channels (0-7) into the 139E Multiplexer have been removed from the standard Cannon DD-50 connector. Connections to the first eight channels are routed through the Sample and Hold amplifiers, whose outputs are hardwired directly to the multiplexer input pins. Connection to the eight Sample and Hold channel inputs is via a Type W023 connector (location B17), supplied with the option.

Up to 8 channels can be randomly selected, held and sampled by three IOT commands. Accuracy of this system (using the 138/139E) is $\pm 0.052 \pm 1/2$ Least Significant Bit (LSB) (11 bits).

Normal operation (Simultaneous Mode) requires the following operation sequence:

1) Issue Simultaneous Sample command.
2) Wait for acquisition time. (Maximum acquisition time is 12 μsec. If the analog signal is changing slowly or accuracy to 0.01% is not required, shorter acquisition times are possible.)
3) Issue Simultaneous Hold command.
4) Select desired multiplexer channel.
5) Digitize analog signal and store.
6) Index (or Select) multiplexer channel address.
7) Digitize analog signal and store, etc., through all channels of interest.
8) Issue Simultaneous Sample command.

Channels may be randomly selected using AC bits 3-5 and the Selective Hold IOT (6571). All channels must be switched to Sample at once using the Simultaneous Sample IOT (6574).



The detailed IOT's associated with the AC01 are as follows:

Hold Selected Channel (HSC)

Octal Code:	6571
Event Time:	1
Indicators:	IOT, FETCH, PAUSE
Execution Time:	3.75 msec
Operation:	AC bits 3-5 select the channel to be switched to hold.

Simultaneous Hold All Channels (HAC)

Octal Code:	6572
Event Time:	2
Indicators:	IOT, FETCH, PAUSE
Execution Time:	3.74 msec
Operation:	All channels are switched to hold.

Simultaneous Sample (SAC)

Octal Code:	6574
Event Time:	3
Indicators:	IOT, FETCH, PAUSE
Execution Time:	3.75 msec
Operation:	All channels are switched to sample.

CHAPTER 7B
DEC TYPE A400 SAMPLE AND HOLD AMPLIFIER

The A400 Sample and Hold Amplifiers are used (one per 8 channels) in conjunction with the Eight Channel Sample and Hold Control Type AC01 described in Chapter 7A.

A400 Specifications (Standard Gain Options)

Acquisition Time to 0.01% (full-scale step)		<12 μsec
Aperture Time		<150 μsec
Hold Inaccuracy (droop)		<1 mv/ms
Temperature Coefficient		<0.1 mv/ms/C°
Gain (negative)	specify on order	3.53 1.0 0.5
Input Range (volts)		±1.414 ±5.0 ±10.5
Impedance		10K 10K 10K
Output Voltage		0 to -10 volts
Impedance		<1.0 ohms

Page 223 following line 15

Insert the following:

Eight Channel Sample and Hold Control Type AC01A (uses A400 Sample and Hold).

HSC	6571	Hold selected channel
HAC	6572	Simultaneous Hold (all channels)
SAC	6574	Simultaneous Sample (all channels)

Channel selection (0-7) is determined by the content of accumulator bits 3-5.

From line 8, page 58 through 60, replace with the following

KEYBOARD/READER

The keyboard and tape reader control contains an 8-bit buffer (TTI) which assembles and holds the code for the last character struck on the keyboard or read from the tape. Teletype characters from the keyboard/reader are shifted serially into the TTI. The Teletype code of a character is loaded into the TTI such that spaces correspond with binary 0s and holes (marks) correspond to binary 1s (as explained in the previous section). Upon program command the content of the TTI is transferred in parallel into the accumulator.

The keyboard flag is set to a binary 1 when an 8-bit computer character has been assembled in the TTI from a Teletype character. The program must sense the condition of this flag with a KSF micro-instruction and, if the flag is set, issue a KRB micro-instruction which will clear the AC and keyboard flag, transfer the contents of the TTI into the AC and allow the hardware to start assembling the next input character from keyboard or paper tape reader into the TTI.

Instructions for use in supplying data to the computer from the Teletype are:

SKIP ON KEYBOARD FLAG (KSF)

Octal Code: 6031

Event Time: 1

Indicators: IOT, FETCH, PAUSE

Execution Time: 3.75 microseconds

Operation: The keyboard flag is sensed, and if it contains a binary 1 the content of the PC is incremented by one so that the next sequential instruction is skipped.

Symbol: If Keyboard Flag = 1, then PC + 1 = > PC

CLEAR KEYBOARD FLAG (KCC)

Octal Code: 6032

Event Time: 2

Indicators: IOT, FETCH, PAUSE

Execution Time: 3.75 μsec

Operation: The AC is clear in preparation for another micro-instruction to transfer a character from the TTI into the AC. The keyboard flag is also cleared, this allows the hardware to begin assembling the next input character in the TTI. If there is tape in the reader and the reader is on, the character over the read head will be loaded into TTI and the tape advanced one frame. If there is no tape or the reader is turned off (STOP or FREE) the character struck on the keyboard will be assembled into the TTI. In either case, when the character is completely assembled in the TTI, the hardware causes the keyboard flag to be set to a binary 1.

Symbol: 0 = > AC

0 = > Keyboard flag allowing the hardware to cause:

Keyboard/Tape Character = > TTI

1 = > Keyboard flag when done

READ KEYBOARD BUFFER STATIC (KRS)

Octal Code: 6034

Event Time: 3

Indicators: IOT, FETCH, PAUSE

Execution Time: 3.75 μsec

Operation: The content of the TTI is transferred into bits 4 through 11 of the AC. This is a static command in that neither the AC nor the keyboard flag is cleared.

Symbol: TTI or AC 4-11 = > AC 4-11

READ KEYBOARD BUFFER DYNAMIC (KRB)

Octal Code: 6036

Event Time: 2, 3

Indicators: IOT, FETCH, PAUSE

Execution Time: 3.75 microseconds

Operation: This micro-instruction combines the functions of the KCC and KRS. The AC and keyboard flag are both cleared and the content of the TTI is transferred into bits 4-11 of the AC. Clearing the keyboard flag allows the hardware to begin assembling the next input character into the TTI (as discussed with the KCC). When the character is completely assembled in the TTI, the hardware causes the flag to be set indicating it again has a character ready for transfer.

Symbol: 0 = > AC C(TTI) V C(AC 4-11) = > AC 4-11

0 = > Keyboard Flag allowing the hardware to cause:

Keyboard/Tape Character = > TTI

1 = > Keyboard flag when done.

The following are examples of possible sequences of instructions to read a character into the AC from the Teletype:

```
        .
        .
LOOK,   KSF             /SKIP IF FLAG = 1
        JMP LOOK        /JMP BACK & TEST FLAG AGAIN
        KRB             /TRANSFER TTI CONTENTS INTO AC
```

This sequence waits for the TTI to set its flag, indicating that it has a character ready to be transferred. It then skips to the KRB command which causes the character to be read into the AC from the TTI.

By making this sequence of instructions a subroutine of a larger program, it can be accessed each time an input character is desired.

```
        .
        .
        .
READ,   0               /STORE DC HERE FOR RETURN ADDRESS
        KSF             /SKIP IF FLAG = 1
        JMP.-1          /TEST FLAG AGAIN
        KRB             /READ CHAR INTO AC
        JMP I READ      /EXIT TO MAIN PROGRAM
          .
          .
          .
```

The above sequence will operate properly on a PDP-8 since all flags are cleared upon pressing START, however, the flags are not cleared on the PDP-5 when START is pressed, hence the reader flag should be cleared by a KCC as part of the initialization done at the beginning of any program. Failure to clear this flag could cause an extraneous character to be input (whatever happened to be in the TTI buffer would be interpreted as the first input character).

```
        KCC             /CLEAR TTI FLAG
          .
          .
          .
READ,   0
        KSF             /SKIP IF FLAG = 1
        JMP.-1          /TEST FLAG AGAIN
        KRB             /READ CHARACTER INTO AC
        JMP I READ      /EXIT
          .
          .
          .
```

TELEPRINTER/PUNCH

On program command a character is sent in parallel from the accumulator (AC) to the TTO shift register for transmission to the teleprinter/punch unit. The control generates the start space, then shifts the eight character bits serially into the printer selector magnets of the Teletype unit, and then generates the stop marks. This transfer of information from the TTO into the teleprinter/punch unit is accomplished at the normal Teletype rate and requires 100 milliseconds for completion. The flag in the teleprinter control is again set to a 1 when the last of the character code has been sent to the teleprinter/punch, indicating that the TTO is ready to receive a new character from the AC. The flag is connected to both the program interrupt synchronization element and the instruction skip element. Unless using the interrupt, the program must check the flag and, upon detecting the ready or set (binary 1) condition of the flag by means of the TSF micro-instruction, the program must issue a TLS micro-instruction which clears the flag and sends a new character from theAC to the TTO to be shifted out to the teleprinter/punch. The process of sending a character to the TTO from the AC is a great deal shorter than that of shifting the character out to the teleprinter/punch, therefore, the program must account for the time differential by waiting for flag to be set (1) before issuing a TLS.

Instructions for use in outputting data to the Teletype are as follows:

SKIP ON TELEPRINTER FLAG (TSF)

Octal Code: 6041

Event Time: 1

Indicators: IOT, FETCH, PAUSE

Execution Time: 3.75 microseconds

Operation: The teleprinter flag is sensed, and if it contains a binary 1 the content of the PC is incremented by one so that the next sequential instruction is skipped.

Symbol: If Teleprinter Flag = 1, then PC + 1 = > PC

CLEAR TELEPRINTER FLAG (TCF)

Octal Code: 6042

Event Time: 2

Indicators: IOT, FETCH, PAUSE

Execution Time: 3.75 microseconds

Operation: The teleprinter flag is cleared to 0.

Symbol: 0 = > Teleprinter Flag

LOAD TELEPRINTER AND PRINT (TPC)

Octal Code: 6044

Event Time: 3

Indicators: IOT, FETCH, PAUSE

Execution Time: 3.75 microseconds

Operation: The contents of bits 4-11 of the AC are sent to the TTO, then the hardware starts shifting the character out to the printer/punch unit. This micro-instruction does not clear the teleprinter flag.

Symbol: C(AC 4-11) = > TTO causing:

C(TTO) = > printed and (if punch on) punched

LOAD TELEPRINTER SEQUENCE (TLS)

Octal Code: 6046

Event Time: 2, 3

Indicators: IOT, FETCH, PAUSE

Execution Time: 3.75 microseconds

Operation: This micro-instruction combines the functions of the TCF and the TPC. The teleprinter flag is cleared (set to 0) then the contents of bits 4-11 of the AC are sent to the TTO, where the hardware shifts the character out to the printer/punch unit. When the printer/punch has finished outputting the character and is ready for another character, the hardware has again raised the teleprinter flag (set it to a 1) to indicate this free condition. The whole operation, from the time at which the TLS has cleared the flag and sent out the character until the time at which the hardware finishes with the character and sets the flag to a 1 again, requires 100 milliseconds with the time required for the character to travel from the TTO to the paper being considerably greater than that required for it to be sent from the computer to the TTO.

Symbol: 0 = > Teleprinter flag

C (AC 4-11) = > TTO causing:

C (TTO) = > Printed and (if punch on) punched

1 = > Teleprinter flag when done

The following are examples of possible ways to use these instructions to output a character to the Teletype. The last is recommended:

```
        .
        .
        .
        CLA
        TAD X           /PUT CHARACTER CODE INTO AC FROM LOCATION X
        TLS             /LOAD TTO FROM AC & PRINT/PUNCH
FREE,   TSF             /TEST FLAG TO SEE IF DONE PRINTING, SKIP IF = 1
        JMP FREE        /TEST FLAG AGAIN
        CLA             /CLEAR CHARACTER CODE FROM AC
        .
        .
        .               continue program
```

This sequence sends one character code to the TTO and waits for it to finish printing/punching before continuing program. It does not require that the flag be set, in order to output the character. By making this sequence of instructions a subroutine of a larger program, it can be accessed (by a JMS) each time a character is to be output. Assume that the subroutine is entered with the character code in the AC:

```
        .
        .
        .
TYPE,   0
        TLS             /LOAD TTO FROM AC AND PRINT/PUNCH
        TSF             /TEST FLAG, SKIP IF = 1
        JMP.-1          /JMP BACK & TEST FLAG AGAIN
        CLA             /CLEAR CHARACTER FROM AC
        JMP I TYPE      /EXIT TO MAIN PROGRAM
        .
        .
        .
```

By rearranging this subroutine, the time presently spent waiting for the character to be output and the flag to be set to 1 (100 milliseconds) can be used to continue the calculations, etc., of the main program, thus making more efficient use of time.

```
        .
        .
TYPE,   0
        TSF             /TEST FLAG TO SEE IF PRINTER FREE, SKIP IF YES OR...
        JMP.-1          /WAIT TIL IT IS BY TESTING AGAIN AND AGAIN
        TLS             /OUTPUT CHARACTER
        CLA
        JMP I TYPE      /EXIT TO CONTINUE PROGRAM
        .
        .
        .
```

This subroutine tests the flag first and waits only if a previous character is still being output. It clears the AC and exits immediately after sending the character to the TTO and is continuing to run the user's program instead of waiting while the Teletype (a much slower device) is off typing/punching the last character. The PDP-8 clears all flags which are on the clear flag bus (this includes Teletype flags) when key START is depressed. This means that the user program must account for setting the teleprinter flag initially and after each TCF (if any) or else theprogram will hang up in the wait loop of the print routine. The only way to set the flag to a 1 is through issuing a micro-instruction which leaves the flag set when alone. This instruction should appear among the first few executed and must appear before any attempt to output a character.

The following example initializes the flag with a TLS as the first instruction of the program and makes optimum use of the time that would be spent waiting for the Teletype to finish.

```
BEGIN, TLS              /INITIALIZE TELEPRINTER FLAG
         .
         .
         .
 TYPE, 0
       TSF              /SKIP IF FLAG = 1 or ...
       JMP.-1           /WAIT UNTIL IT IS LOAD TTO &
       TLS              /TYPE CHARACTER
       CLA
       JMP I TYPE       /EXIT & CONTINUE PROGRAM WHILE TELETYPE IS
         .               FINISHING CHARACTER
         .
         .
```