PDP-8 Simulator Usage
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This memorandum documents the PDP-8 simulator.

1 Simulator Files

sim/	scp.h
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	sim_fio.h
	sim_rev.h
	sim_sock.h
	sim_tape.h
	sim_timer.h
	sim_tmxr.h
	scp.c
	sim_console.c
	sim_fio.c
	sim_sock.c
	sim_tape.c
	sim_timer.c
	sim_tmxr.c
sim/pdp8/	pdp8_defs.h
	pdp8_cpu.c
	pdp8_ct.c
	pdp8_df.c
	pdp8_dt.c
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	pdp8_lp.c
	pdp8_mt.c
	pdp8_pt.c
	pdp8_rf.c
	pdp8_rk.c
	pdp8_rl.c
	pdp8_rx.c
	pdp8_sys.c
	pdp8_td.c
	pdp8_tsc.c
	pdp8_tt.c
	pdp8_ttx.c

2 PDP-8 Features

The PDP-8 simulator is configured as follows:

```
device names(s)   simulates

CPU               PDP-8/E CPU with 4KW-32KW of memory
-                 KE8E extended arithmetic element (EAE)
-                 KM8E memory management and timeshare control
TSC               TSC8-75 ETOS operating system timeshare control
FPP               FPP8A floating point unit
PTR,PTP           PC8E paper tape reader/punch
```

```
TTI,TTO          KL8E console terminal
TTIX,TTOX        KL8JA additional terminals, up to 16
LPT              LE8E line printer
CLK              DK8E line frequency clock (also PDP-8/A compatible)
RK               RK8E/RK05 cartridge disk controller with four drives
RF               RF08/RS08 fixed head disk controller with 1-4 platters
DF               DF32/DS32 fixed head disk controller with 1-4 platters
RL               RL8A/RL01 cartridge disk controller with four drives
RX               RX8E/RX01, RX28/RX02 floppy disk controller with two
                 drives
DT               TC08/TU56 DECtape controller with eight drives
TD               TD8E/TU56 DECtape controller with two drives
MT               TM8E/TU10 magnetic tape controller with eight drives
CT               TA8E/TU60 cassette tape controller with two drives
```

Most devices can be disabled or enabled, by the commands:

```
SET <dev> DISABLED
SET <dev> ENABLED
```

The simulator allows most device numbers to be changed, by the command:

```
SET <dev> DEV=<number>
```

The PDP-8 can support only one of the set {DF32, RF08, RL8A} using the default device numbers, since they all use device numbers 60-61. The default is the RF08. To change the disk at device numbers 60-61:

```
SET RF DISABLED              disable RF08
SET DF ENABLED, or           enable DF32
SET RL ENABLED               enable RL8A
```

The PDP-8 can only support one of the set {TC08, TD8E} using the default device numbers, since both use device number 77. The default is the TC08. To change the DECtape controller to the TD8E:

```
SET DT DISABLED              disable TC08
SET TD ENABLED               enable TD8E
```

The PDP-8 can only support one of the set {TM8E, TA8E} using the default device numbers, since both use device number 70. The default is the TM8E. To change the device at device number 70:

```
SET MT DISABLED              disable TM8E
SET CT ENABLED               enable TA8E
```

Alternately, the device conflict can be eliminated by changing device numbers:

```
SET RL DEV=50
SET RL ENA
SET TD DEV=74
SET TD ENA
SET CT DEV=73
SET CT ENA
```

However, devices can only be BOOTed with their default device numbers.

The PDP-8 simulator implements several unique stop conditions:

- If an undefined instruction (unimplemented IOT or OPR) is decoded, and STOP_INST is set
- If a simulated DECtape runs off the end of its reel

The LOAD command supports both RIM format and BIN format tapes. If the file extension is .RIM, or the r switch is specified with LOAD, the file is assumed to be RIM format; if the file extension is not .RIM, or the -b switch is specified, the file is assumed to be BIN format. For BIN format tape loading will stop at the first trailer code (0x80). If the tape contains multiple sections specify the –a flag to load all sections on the tape. The number of sections loaded will be printed. If the tape had non BIN format data following the last valid leader it may cause checksum errors or load unwanted data into memory.

2.1 CPU

The only CPU options are the presence of the EAE and the size of main memory; the memory extension and time-share control is always included, even if memory size is 4K.

```
SET CPU EAE                 enable EAE
SET CPU NOEAE               disable EAE
SET CPU 4K                  set memory size = 4K
SET CPU 8K                  set memory size = 8K
SET CPU 12K                 set memory size = 12K
SET CPU 16K                 set memory size = 16K
SET CPU 20K                 set memory size = 20K
SET CPU 24K                 set memory size = 24K
SET CPU 28K                 set memory size = 28K
SET CPU 32K                 set memory size = 32K
```

If memory size is being reduced, and the memory being truncated contains non-zero data, the simulator asks for confirmation. Data in the truncated portion of memory is lost. Initial memory size is 32K.

CPU registers include the visible state of the processor as well as the control registers for the interrupt system.

```
name            size        comments

PC              15          program counter, including IF as high 3 bits
AC              12          accumulator
MQ              12          multiplier-quotient
L               1           link
SR              12          front panel switches
IF              3           instruction field
DF              3           data field
IB              3           instruction field buffer
SF              7           save field
UF              1           user mode flag
UB              1           user mode buffer
SC              5           EAE shift counter
GTF             1           EAE greater than flag
EMODE           1           EAE mode (0 = A, 1 = B)
ION             1           interrupt enable
ION_DELAY       1           interrupt enable delay for ION
CIF_DELAY       1           interrupt enable delay for CIF
PWR_INT         1           power fail interrupt
UF_INT          1           user mode violation interrupt
INT             15          interrupt pending flags
DONE            15          device done flags
```

```
ENABLE          15          device interrupt enable flags
PCQ[0:63]       15          PC prior to last JMP, JMS, or interrupt;
                            most recent PC change first
STOP_INST       1           stop on undefined instruction
WRU             8           interrupt character
```

The CPU attempts to detect when the simulator is idle. When idle, the simulator does not use any resources on the host system. Idle detection is controlled by the `SET IDLE` and `SET NOIDLE` commands:

```
SET CPU IDLE                enable idle detection
SET CPU NOIDLE              disable idle detection
```

Idle detection is disabled by default. At present, the CPU is considered idle if it is executing a KSF/JMP *-1 loop with interrupts disabled (OS/8, DMS-8) or a JMP * loop (TSS/8).

The CPU can maintain a history of the most recently executed instructions. This is controlled by the `SET CPU HISTORY` and `SHOW CPU HISTORY` commands:

```
SET CPU HISTORY             clear history buffer
SET CPU HISTORY=0           disable history
SET CPU HISTORY=n           enable history, length = n
SHOW CPU HISTORY            print CPU history
SHOW CPU HISTORY=n          print first n entries of CPU history
```

The maximum length for the history is 65536 entries.

2.2 TSC8-75 ETOS Timeshare Control (TSC)

ETOS is a timeshared operating system for the PDP-8, providing multiple virtual OS/8 environments for up to 32 users. It requires a special timeshare control option, the TSC8-75. The TSC8-75 is normally disabled; to run ETOS, it must be enabled with the command:

```
SET TSC ENABLED
```

The TSC8-75 implements these registers:

```
name            size        comments

IR              12          most recently trapped instruction
PC              12          PC of most recently trapped instruction
CDF             1           1 if trapped instruction is CDF, 0 otherwise
ENB             1           interrupt enable flag
INT             1           interrupt pending flag
```

Except for operation of ETOS, the TSC8-75 should be left disabled.

2.3 FPP8A Floating Point Unit (FPP)

The floating point unit (FPP) is an add-on device that provides floating point capabilities. It operates as a coprocessor to the main CPU, with its own program counter and instruction set. The FPP8A is normally disabled; to use it, it must be enabled with the command:

```
SET FPP ENABLED
```

The FPP8A implements these registers:

```
name              size        comments

FPACE             12          floating AC exponent
FPAC0..4          12          floating AC fraction words 0..4
CMD               12          FPP command register
STA               12          FPP status register
APTA              15          APT address pointer
APTSVF            3           APT save field
FPC               15          FPP program counter
BRA               15          base register pointer
XRA               15          index register pointer
OPA               15          operand pointer
SSF               12          single step flag
LASTLOCK          12          last lock bit
FLAG              1           FPP flag
```

Except for environments that explicitly support it, the FPP8A should be left disabled.

2.4 Programmed I/O Devices

2.4.1 PC8E Paper Tape Reader (PTR)

The paper tape reader (PTR) reads data from a disk file. The POS register specifies the number of the next data item to be read. Thus, by changing POS, the user can backspace or advance the reader.

The paper tape reader supports the `BOOT` command. `BOOT PTR` copies the RIM loader into memory and starts it running.

The paper tape reader implements these registers:

```
name              size        comments

BUF               8           last data item processed
DONE              1           device done flag
ENABLE            1           interrupt enable flag
INT               1           interrupt pending flag
POS               32          position in the input file
TIME              24          time from I/O initiation to interrupt
STOP_IOE          1           stop on I/O error
```

Error handling is as follows:

```
error          STOP_IOE       processed as

not attached       1          report error and stop
                   0          out of tape

end of file        1          report error and stop
                   0          out of tape

OS I/O error       x          report error and stop
```

2.4.2 PC8E Paper Tape Punch (PTP)

The paper tape punch (PTP) writes data to a disk file. The POS register specifies the number of the next data item to be written. Thus, by changing POS, the user can backspace or advance the punch. The default position after ATTACH is to position at the end of an existing file. A new file can be created if you attach with the -N switch.

The paper tape punch implements these registers:

name	size	comments
BUF	8	last data item processed
DONE	1	device done flag
ENABLE	1	interrupt enable flag
INT	1	interrupt pending flag
POS	32	position in the output file
TIME	24	time from I/O initiation to interrupt
STOP_IOE	1	stop on I/O error

Error handling is as follows:

error	STOP_IOE	processed as
not attached	1	report error and stop
	0	out of tape
OS I/O error	x	report error and stop

2.4.3 KL8E Terminal Input (TTI)

The terminal interfaces (TTI, TTO) can be set to one of four modes, KSR, 7B, 7B, or 8B:

mode	input characters	output characters
KSR	lower case converted to upper case, high-order bit set	lower case converted to upper case, high-order bit cleared, non-printing characters suppressed
7P	high-order bit cleared	high-order bit cleared, non-printing characters suppressed
7B	high-order bit cleared	high-order bit cleared
8B	no changes	no changes

The default mode is KSR.

The terminal input (TTI) polls the console keyboard for input. It implements these registers:

name	size	comments
BUF	8	last data item processed
DONE	1	device done flag
ENABLE	1	interrupt enable flag
INT	1	interrupt pending flag
POS	32	number of characters input
TIME	24	input polling interval

The terminal input is normally polled synchronously with the real-time clock. To avoid data loss, a poll is scheduled 'TIME' instructions after the CPU reads a character.

2.4.4 KL8E Terminal Output (TTO)

The terminal output (TTO) writes to the simulator console window. It implements these registers:

```
name            size        comments

BUF             8           last data item processed
DONE            1           device done flag
ENABLE          1           interrupt enable flag
INT             1           interrupt pending flag
POS             32          number of characters output
TIME            24          time from I/O initiation to interrupt
```

2.4.5 LE8E Line Printer (LPT)

The line printer (LPT) writes data to a disk file. The POS register specifies the number of the next data item to be read or written. Thus, by changing POS, the user can backspace or advance the printer. The default position after ATTACH is to position at the end of an existing file. A new file can be created if you attach with the -N switch.

The line printer implements these registers:

```
name            size        comments

BUF             8           last data item processed
ERR             1           error status flag
DONE            1           device done flag
ENABLE          1           interrupt enable flag
INT             1           interrupt pending flag
POS             32          position in the output file
TIME            24          time from I/O initiation to interrupt
```

Error handling is as follows:

```
error         STOP_IOE      processed as

not attached      1         report error and stop
                  0         out of paper

OS I/O error      x         report error and stop
```

2.4.6 DK8E Line-Frequency Clock (CLK)

The real-time clock (CLK) frequency can be adjusted as follows:

```
SET CLK 60HZ                set frequency to 60Hz
SET CLK 50HZ                set frequency to 50Hz
```

```
SET CLK NORMAL                set clock to calibrated timing
SET CLK DIAG                  set clock to fixed timing
```

The default is 60Hz.

The clock implements these registers:

```
name              size        comments

DONE              1           device done flag
ENABLE            1           interrupt enable flag
INT               1           interrupt pending flag
TIME              24          clock interval
```

The real-time clock autocalibrates; the clock interval is adjusted up or down so that the clock tracks actual elapsed time.

2.4.7 KL8JA Additional Terminals (TTIX, TTOX)

The simulator supports 1 to 16 additional terminals, with an initial default of 4 lines. The additional terminals consist of two independent devices, TTIX and TTOX. The entire set is modeled as a terminal multiplexer, with TTIX as the master controller. The number of lines is specified with a `SET` command:

```
SET TTIX LINES=n              set number of additional lines to n [1-16]
```

The `ATTACH` command specifies the port to be used:

```
ATTACH TTIX <port>            set up listening port
```

where port is a decimal number between 1 and 65535 that is not being used for other TCP/IP activities. The additional terminals are disabled by default.

The additional terminals can be set to one of four modes: UC, 7P, 7B, or 8B.

```
mode  input characters        output characters

UC    lower case converted    lower case converted to upper case,
       to upper case,         high-order bit cleared,
      high-order bit cleared  non-printing characters suppressed
7P    high-order bit cleared  high-order bit cleared,
                              non-printing characters suppressed
7B    high-order bit cleared  high-order bit cleared
8B    no changes              no changes
```

The default mode is UC. Finally, each line supports output logging. `The SET TTOXn LOG` command enables logging on a line:

```
SET TTOXn LOG=filename        log output of line n to filename
```

The `SET TTOXn NOLOG` command disables logging and closes the open log file, if any.

Once TTIX is attached and the simulator is running, the terminals listen for connections on the specified port. They assume that the incoming connections are Telnet connections. The connections remain open until disconnected either by the Telnet client, a `SET TTIX DISCONNECT` command, or a `DETACH TTIX` command.

Other special commands:

```
SHOW TTIX CONNECTIONS         show current connections
SHOW TTIX STATISTICS          show statistics for active connections
SET TTOXn DISCONNECT          disconnects the specified line.
```

The input device (TTIX) implements these registers:

```
name              size        comments

BUF[0:15]         8           input buffer, lines 0 to 15
DONE              16          device done flags (line 0 rightmost)
ENABLE            16          interrupt enable flag
TIME              24          initial polling interval
```

The input device is normally polled synchronously with the real-time clock. To avoid data loss, a poll is scheduled 'TIME' instructions after the CPU reads a character from any line.

The output device (TTOX) implements these registers:

```
name              size        comments

BUF[0:15]         8           last data item processed, lines 0-15
DONE              16          device done flag (line 0 rightmost)
ENABLE            16          interrupt enable flag
TIME[0:16]        24          time from I/O initiation to interrupt,
                              lines 0-15
```

The additional terminals do not support save and restore. All open connections are lost when the simulator shuts down or TTIX is detached.

2.4.8 TD8E/TU56 DECtape (TD)

The TD8E is a programmed I/O, non-interrupt controller, supporting two DECtape drives (0 and 1). The TD8E simulator puts a high burden on the host processor, because tape activity is simulated a line (3b) at a time. Unless the PDP-8 software requires the TD8E, the TC08 should be used to simulate DECtapes. The TD8E is disabled by default.

TD8E options include the ability to make units write enabled or write locked.

```
SET TDn LOCKED                set unit n write locked
SET TDn WRITEENABLED          set unit n write enabled
```

Units can also be set `ENABLED` or `DISABLED`. The TD8E supports the `BOOT` command, but only for unit 0.

The TD8E supports supports PDP-8 format, PDP-11 format, and 18b format DECtape images. `ATTACH` assumes the image is in PDP-8 format; the user can force other choices with switches:

```
-s                            PDP-11 format
-f                            18b format
-a                            autoselect based on file on file size
```

The TD8E controller is a data-only simulator; the timing and mark track, and block header and trailer, are not stored. Thus, read always produces standard values for mark track, header, and trailer words, and write throws mark track, header, and trailer words into the bit bucket.

The TD8E controller implements these registers:

```
name            size        comments

TDCMD           4           command register
TDDAT           12          data register
TDMTK           6           mark track register
TDSLF           1           single line flag
TDQLF           1           quad line flag
TDTME           1           timing error flag
TDQL            2           quad line counter
LTIME           31          time between lines
DCTIME          31          time to decelerate to a full stop
POS[0:1]        32          position, in lines, units 0 and 1
STATT[0:1]      18          unit state, units 0 and 1
STOP_OFFR       1           stop on off-reel error
```

The LTIME parameter should not be changed, or OS/8 may fail to run correctly. The DCTIME parameter should always be at least 100 times greater than LTIME. Acceleration time is 75% of deceleration time.

2.4.9 TA8E/TA60 Cassette Tape (CT)

The TA8E is a programmed I/O controller supporting two cassette drives (0 and 1). The TA8E can be used with the MCPIP program under OS/8, and with the CAPS-8 operating system. Cassettes are simulated as magnetic tapes with a fixed capacity (93,000 characters). The tape format is always SimH standard. The TA8E is disabled by default.

TA8E options include the ability to make units write enabled or write locked.

```
SET CTn LOCKED              set unit n write locked
SET CTn WRITEENABLED        set unit n write enabled
```

Units cannot be set `ENABLED` or `DISABLED`. The TA8E supports the `BOOT` command, but only for CAPS-8, and only for unit 0.

The TA8E controller implements these registers:

```
name            size        comments

CTSRA           8           status register A
CTSRB           8           status register B
CTDB            8           data buffer
CTDF            1           data flag
RDY             1           ready flag
WLE             1           write lock error
WRITE           1           TA60 write operation flag
INT             1           interrupt request
BPTR            17          buffer pointer
BLNT            17          buffer length
STIME           24          operation start time
CTIME           24          character latency
STOP_IOE        1           stop on I/O errors flag
```

```
POS[0:1]          32          position, units 0-1
```

Error handling is as follows:

```
error             processed as

not attached      tape not ready; if STOP_IOE, stop

end of file       bad tape

OS I/O error      CRC error; if STOP_IOE, stop
```

2.5 Moving Head Disks

2.5.1 RK8E Cartridge Disk (RK)

RK8E options include the ability to make units write enabled or write locked:

```
SET RKn LOCKED                set unit n write locked
SET RKn WRITEENABLED          set unit n write enabled
```

Units can also be set `ENABLED` or `DISABLED`. The RK8E supports the `BOOT` command.

The RK8E implements these registers:

```
name              size  comments

RKSTA             12          status
RKCMD             12          disk command
RKDA              12          disk address
RKMA              12          current memory address
BUSY              1           control busy flag
INT               1           interrupt pending flag
STIME             24          seek time, per cylinder
RTIME             24          rotational delay
STOP_IOE          1           stop on I/O error
```

Error handling is as follows:

```
error         STOP_IOE        processed as

not attached      1           report error and stop
                  0           disk not ready

end of file       x           assume rest of disk is zero

OS I/O error      x           report error and stop
```

2.5.2 RL8A Cartridge Disk (RL)

RL8A options include the ability to make units write enabled or write locked:

```
SET RLn LOCKED                set unit n write locked
SET RLn WRITEENABLED          set unit n write enabled
```

Units can also be set ENABLED or DISABLED. The RL8A supports the BOOT command, but only for unit 0.

The RL8A implements these registers:

```
name              size        comments

RLCSA             12          control/status A
RLCSB             12          control/status B
RLMA              12          memory address
RLWC              12          word count
RLSA              6           sector address
RLER              12          error flags
RLSI              16          silo top word
RLSI1             16          silo second word
RLSI2             16          silo third word
RLSIL             1           silo read left/right flag
INT               1           interrupt request
DONE              1           done flag
ERR               1           composite error flag
STIME             1           seek time, per cylinder
RTIME             1           rotational delay
STOP_IOE          1           stop on I/O error
```

Error handling is as follows:

```
error         STOP_IOE        processed as

not attached      1           report error and stop
                  0           disk not ready

end of file       x           assume rest of disk is zero

OS I/O error      x           report error and stop
```

2.6 RX8E/RX01, RX28/RX02 Floppy Disk (RX)

The RX can be configured as an RX8E with two RX01 drives, or an RX28 with two RX02 drives:

```
SET RX RX8E                   set controller to RX8E/RX01
SET RX RX28                   set controller to RX28/RX02
```

The controller is set to the RX8E by default. The RX28 is not backwards-compatible with the RX8E and will not work with the standard OS/8 V3D floppy disk driver.

RX8E options include the ability to set units write enabled or write locked:

```
SET RXn LOCKED                set unit n write locked
SET RXn WRITEENABLED          set unit n write enabled
```

RX28 options include, in addition, the ability to set the unit density to single density, double density, or autosized; autosizing is the default:

```
SET RXn SINGLE                set unit n single density
SET RXn DOUBLE                set unit n double density
SET RXn AUTOSIZE              set unit n autosize
```

The RX8E and RX28 support the BOOT command.

The RX8E and RX28 implement these registers:

name	size	comments
RXCS	12	status
RXDB	12	data buffer
RXES	12	error status
RXTA	8	current track
RXSA	8	current sector
STAPTR	4	controller state
BUFPTR	8	buffer pointer
INT	1	interrupt pending flag
DONE	1	device done flag
ENABLE	1	interrupt enable flag
TR	1	transfer ready flag
ERR	1	error flag
CTIME	24	command completion time
STIME	24	seek time, per track
XTIME	24	transfer ready delay
STOP_IOE	1	stop on I/O error
SBUF[0:255]	8	sector buffer array

Error handling is as follows:

error	STOP_IOE	processed as
not attached	1	report error and stop
	0	disk not ready

RX01 and RX02 data files are buffered in memory; therefore, end of file and OS I/O errors cannot occur.

2.7 Fixed Head Disks

With default device addressing, either the RF08 or the DF32 can be present in a configuration, but not both.

2.7.1 RF08/RS08 Fixed Head Disk (RF)

RF08 options include the ability to set the number of platters to a fixed value between 1 and 4, or to autosize the number of platters:

SET RF 1P	one platter (256K)
SET RF 2P	two platters (512K)
SET RF 3P	three platters (768K)
SET RF 4P	four platters (1024K)
SET RF AUTOSIZE	autosized on ATTACH

The default is one platter.

The RF08 implements these registers:

name	size	comments
STA	12	status

```
DA                20          current disk address
MA                12          memory address (in memory)
WC                12          word count (in memory)
WLK               32          write lock switches
INT               1           interrupt pending flag
DONE              1           device done flag
TIME              24          rotational delay, per word
BURST             1           burst flag
STOP_IOE          1           stop on I/O error
```

The RF08 supports the `BOOT` command. The default bootstrap is for OS/8. To bootstrap the 4K Disk Monitor, use the `BOOT -D RF` command.

The RF08 is a three-cycle data break device. If BURST = 0, word transfers are scheduled individually; if BURST = 1, the entire transfer occurs in a single data break.

Error handling is as follows:

```
error          STOP_IOE        processed as

not attached       1           report error and stop
                   0           disk not ready
```

RF08 data files are buffered in memory; therefore, end of file and OS I/O errors cannot occur.

2.7.2 DF32/DS32 Fixed Head Disk (DF)

DF32 options include the ability to set the number of platters to a fixed value between 1 and 4, or to autosize the number of platters:

```
SET DF 1P                   one platter (32K)
SET DF 2P                   two platters (64K)
SET DF 3P                   three platters (98K)
SET DF 4P                   four platters (128K)
SET DF AUTOSIZE             autosized on ATTACH
```

The default is one platter.

The DF32 implements these registers:

```
name              size        comments

STA               12          status, disk and memory address extension
DA                12          low order disk address
MA                12          memory address (in memory)
WC                12          word count (in memory)
WLK               16          write lock switches
INT               1           interrupt pending flag
DONE              1           device done flag
TIME              24          rotational delay, per word
BURST             1           burst flag
STOP_IOE          1           stop on I/O error
```

The DF32 supports the `BOOT` command. The default bootstrap is for OS/8. To bootstrap the 4K Disk Monitor, use the `BOOT -D DF` command.

The DF32 is a three-cycle data break device. If BURST = 0, word transfers are scheduled individually; if BURST = 1, the entire transfer occurs in a single data break.

Error handling is as follows:

error	STOP_IOE	processed as
not attached	1	report error and stop
	0	disk not ready

DF32 data files are buffered in memory; therefore, end of file and OS I/O errors cannot occur.

2.8 TC08/TU56 DECtape (DT)

DT implements the TC08 DECtape controller and TU56 drives. TC08 options include the ability to make units write enabled or write locked.

```
SET DTn LOCKED                set unit n write locked
SET DTn WRITEENABLED          set unit n write enabled
```

Units can also be set `ENABLED` or `DISABLED`. The TC08 supports the `BOOT` command, but only for unit 0.

The TC08 supports supports PDP-8 format, PDP-11 format, and 18b format DECtape images. `ATTACH` assumes the image is in PDP-8 format; the user can force other choices with switches:

```
-s                            PDP-11 format
-f                            18b format
-a                            autoselect based on file on file size
```

The TC08 controller is a data-only simulator; the timing and mark track, and block header and trailer, are not stored. Thus, the WRITE TIMING AND MARK TRACK function is not supported; the READ ALL function always returns the hardware standard block header and trailer; and the WRITE ALL function dumps non-data words into the bit bucket.

The DECtape controller implements these registers:

name	size	comments
DTSA	12	status register A
DTSB	12	status register B
INT	1	interrupt pending flag
ENB	1	interrupt enable flag
DTF	1	DECtape flag
ERF	1	error flag
CA	12	current address (memory location 7754)
WC	12	word count (memory location 7755)
LTIME	31	time between lines
DCTIME	31	time to decelerate to a full stop
SUBSTATE	2	read/write command substate
POS[0:7]	32	position, in lines, units 0 to 7
STATT[0:7]	31	unit state, units 0 to 7
STOP_OFFR	1	stop on off-reel error

It is critically important to maintain certain timing relationships among the DECtape parameters, or the DECtape simulator will fail to operate correctly.

- LTIME must be at least 6
- DCTIME needs to be at least 100 times LTIME

Acceleration time is set to 75% of deceleration time.

2.9 TM8E Magnetic Tape (MT)

Magnetic tape options include the ability to make units write enabled or write locked.

```
SET MTn LOCKED                set unit n write locked
SET MTn WRITEENABLED          set unit n write enabled
```

Magnetic tape units can be set to a specific reel capacity in MB, or to unlimited capacity:

```
SET MTn CAPAC=m               set unit n capacity to m MB (0 = unlimited)
SHOW MTn CAPAC                show unit n capacity in MB
```

Units can also be set `ENABLED` or `DISABLED`.

The magnetic tape controller implements these registers:

```
name              size        comments

CMD               12          command
FNC               12          function
CA                12          memory address
WC                12          word count
DB                12          data buffer
STA               12          main status
STA2              6           secondary status
DONE              1           device done flag
INT               1           interrupt pending flag
STOP_IOE          1           stop on I/O error
TIME              24          record delay
UST[0:7]          24          unit status, units 0 to 7
POS[0:7]          32          position, units 0 to 7
```

Error handling is as follows:

```
error             processed as

not attached      tape not ready; if STOP_IOE, stop

end of file       bad tape

OS I/O error      parity error; if STOP_IOE, stop
```

3 Symbolic Display and Input

The PDP-8 simulator implements symbolic display and input. Display is controlled by command line switches:

```
-a                display as ASCII character
-c                display as two packed sixbit characters
-t                display as two packed TSS/8 sixbit characters
-m                display instruction mnemonics
```

Input parsing is controlled by the first character typed in or by command line switches:

```
' or -a           ASCII character
" or -c           two packed sixbit characters
# or -t           two packed TSS/8 sixbit characters
alphabetic        instruction mnemonic
numeric           octal number
```

Instruction input uses standard PDP-8 assembler syntax. There are four instruction classes: memory reference, IOT, field change, and operate.

Memory reference instructions have the format

```
memref {I} {C/Z} address
```

where I signifies indirect, C a current page reference, and Z a zero page reference. The address is an octal number in the range 0 - 07777; if C or Z is specified, the address is a page offset in the range 0 - 177. Normally, C is not needed; the simulator figures out from the address what mode to use. However, when referencing memory outside the CPU (eg, disks), there is no valid PC, and C must be used to specify current page addressing.

IOT instructions consist of single mnemonics, eg, KRB, TLS. IOT instructions may be or'd together

```
iot iot iot...
```

The simulator does not check the legality of the proposed combination. IOT's for which there is no opcode may be specified as IOT n, where n is an octal number in the range 0 - 0777.

Field change instructions (CIF, CDF) have the format

```
fldchg field
```

where field is an octal number in the range 0 - 7. Field change instructions may be or'd together.

Operate instructions have the format

```
opr opr opr...
```

The simulator does not check the legality of the proposed combination. EAE mode A and B mnemonics may be specified regardless of the EAE mode. The operands for MUY and DVI must be deposited explicitly.