Title: PDP-X Instruction Simulator

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Index Keys: Instruction Set
                    Simulator

Distribution
 Key: A, B, C

Obsolete: None

Revision: None

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Index

0. Introduction

An instruction simulator for PDP-X has been written to run on a PDP-9 or PDP-7. Model II is simulated with:

a) Traps
b) Two interrupt levels
c) Teletype and paper tape IO
d) Extended Instruction set
e) Advanced Console features
f) The Multiplexor Channel is not simulated

The simulator is designed to allow debugging of systems and diagnostic software as well as to gain insight into the implementation of PDP-X. At some later time, a logic simulator will be developed to verify the logic design and to aid in the analysis of diagnostic software.

On a PDP-9, the simulator speed will be between 250 and 400 microseconds per PDP-X memory cycle. The more complicated instructions, i.e. shifts, multiply and divide, will run disproportionately slower on the simulator. The simulator requires approximately 2400 (decimal) words of PDP-9 memory leaving the remainder (5600, 13,600, etc.) for the PDP-X memory.

Since the PDP-X teletype is full duplex, the teletype control on the PDP-9 has to be slightly modified. A switch will be provided on the programming PDP-9 to facilitate this.

1. Console

The PDP-X console is simulated by using the teletype and the
AC switches. PDP-X memory can be examined or modified. The
PDP-X may be started or continued, the IO system may be reset
and readin mode may be initiated. These console functions are
accomplished through commands similar to those given to DDT.

The AC switches are used to control single step, address stop,
repeat, memory stop and hard stop.

When the console mode is entered (initial start-up or because
the PDP-X program was stopped), commands may be typed on
the teletype.

1.1 Examine

The contents of a PDP-X memory location may be examined by
typing in its address followed by slash(/). The contents
will be typed in octal:

61/   177777

If line-feed is typed on the console, the next location
will be examined:

0062/   024100

The contents of a memory location may be printed in an alternate
instruction format if colon(:) is typed after the registers
contents have been typed:

00062/   024100   :1,2,0,100

The format corresponds to OP, AC, X, DI and hence location 62
contains the instruction STA 2, 100.

After examining a register, any one of the following characters
may be typed to produce the indicated action:

Line Feed	Close this register and examine the next registe
Colon	Print the contents in instruction format
Carriage Return	Close the register
Alt mode	Continue PDP-X program

A new value may also be typed in:

1.2 Deposit

After a register has been opened (examined), a value may be
deposited into it. This value may be typed in octal or in
instruction format. The new value should be terminated by a
carriage-return, a line-feed or alt mode.

00062/   024100   :1,2,0,100 1,3,,100 CR

The content of location 62 is changed to

STA 3, 100

(Note: In instruction format, blank fields are treated as zeros. All fields are truncated to the number of bits required:

00062/   026100   :1,3,0,100 1,17,0,2100 CR

00062/   036100   :1,7,0,100

After a new register value has been typed, any one of the following characters may be typed to produce the indicated action:

Line Feed	Close this register and examine the next register
Carriage Return	Close this register
Alt mode	Continue PDP-X program

Typing any other character will cause
??
to be printed. The contents of the opened register will not be changed and the register will be closed.

(Note: After a register has been closed with carriage return, it may be opened again by typing /.)

1.3 Input Format

Register locations must be typed-in in octal. Register contents may be typed in octal or in instruction format with octal fields.

An octal number consists of +, -, 0 - 7. Any other character acts as a terminator. The signs (+, -) are unary operators only:
        6-7 has the value -7.

Negative numbers (preceded by -) are two's complement.

00062/   036100   -1 CR

/   177777   1,3,1,-2 CR

/   026776   :1,3,1,376

1.4 Reset

If the single character I is typed, the IO system is reset and RG is set to 0. The status words of both interrupt levels are set to 0.

1.5 Readin

If the single character R is typed, readin mode (from the high-speed paper tape reader) is initiated.

1.6 Start

The PDP-X program is started by typing in a starting address followed by alt mode:

732 (alt mode)

will start PDP-X at location 732. Start in no way alters the state of the PDP-X other than to load the program counter and begin execution.

1.7 Continue

If alt mode is typed without a preceeding address, the PDP-X program is continued from its stopping point. If no program had been stopped or if the system had been reset (1.4), the message

CAN'T CONTINUE

will be typed.

1.8 Address Stop

The PDP-X can run in mode in which, before every memory reference, the memory address is compared with an address stop register. If the two are equal, action depends upon the setting of the address stop switch (see Sec. 2.5). The address stop register may be examined by typing A. A new value (in octal) may be deposited in it (see 1.2):

A   02400   220 CR

Carriage return must be typed to close the register. The address stop register may not be set to either zero or one.

2. Run Control

2.1 Single Instruction (ACS 17)

If the Single Instruction switch is up, the PDP-X will stop
at the completion of every instruction.

2.2 Hard Stop (ACS 16)

If the processor is stopped at the completion of an instruction
because Single Instruction was up or because halt was executed,
the simulator examines the Hard Stop switch. If it is a zero,
the values of the Program Counter, Condition Codes and RG are
printed on the teleprinter. The simulator the examines repeat.
If Hard Stop is up, the PDP-9 is halted with the PDP-X program
counter in the PDP-9 accumulator. If PDP-9 continue is pressed,
PDP-X will execute the next instruction.

2.3 Repeat (ACS 15)

If the PDP-X is stopped because of Single Instruction being on
or because halt was executed, and Hard Stop was off, the PC,
CC, RG are printed on the teleprinter. The simulator then
examines Repeat. If it is a zero (down), control passes to the
console. If it is a one (up), the PDP-X is restarted.

2.4 Memory Disable (ACS 14)

If a reference to non-existant memory is made and Memory
Disable is a one (up), the PDP-X processor is stopped and
the memory address is printed. The PC, CC, RG are then
printed. The simulator then examines Repeat (see 2.3). If
Memory Disable is a zero (down), the PDP-X continues.

2.5 Address Stop (ACS 13)

If a reference is made to memory and the memory address and
the address stop register are equal and the Address Stop
switch is a one (up), the PDP-X processor is stopped and the
memory address is printed. The PC, CC, RG are then printed.
The simulator then examines repeat (see 2.3). If the
Address Stop is a zero (down), the PDP-X continues.

2.6 Halt Instruction

If the PDP-X program executes a Halt instruction, the effective
word is printed on the console. The simulator then proceeds
as if PDP-X was stopped by Single Instruction.

3. Summary

(Alt Mode)	Continue
XXXXX (Alt Mode)	Start at location XXXXX
/	Open last opened register
XXXXX/	Open location XXXXX and print its value in octal
:	Retype opened value in instruction format
X,X,X,X	Value in instruction format
Carriage Return	Close opened register.
Line Feed	Close opened register, open next register
A	Open address stop register
I	IO reset
R	Readin
ACS 17	Single Instruction
ACS 16	Hard Stop
ACS 15	Repeat
ACS 14	Memory Disable
ACS 13	Address Stop

4. Operation

The simulator is loaded as follows:

a. Place Tape in high-speed reader
b. Set Address Switches to 17720 (PDP-9)
c. Press Readin (PDP-9)
d. The Simulator will load and self-start.