

T H E U N I V E R S I T Y O F M I C H I G A N

Memorandum

USE OF DDT WITH "INTERRUPTS-ON" PROGRAMS

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This memo describes the modification and use of DEC-provided DDT with programs using the "program interrupt" hardware of the PDP-7.

1. Usage

DEC Debugging Tape (DDT) and user programs are loaded in the normal manner. The restart entry remains at 16000₈ and forces interrupts off. DDT may be used exactly like the original DDT without knowledge of these modifications.

The modifications to DDT are concerned with facilitating control of the "program interrupt" as control moves between DDT and user programs and back. Two status words control the program interrupt:

SAVIOS contains the input-output status word when DDT is entered via breakpoint.
FIXIOK contains a code indicating the desired state of the program interrupt on exit to user program.

FIXIOK is set by the following commands (which remain in effect until the next is given):

STIOF' leaves program interrupt off when exiting to user program. (This is the default condition.)
STION' turns program interrupt on when exiting to user program.
STIOC' turns program interrupt on when exiting to user program if it was on at the last breakpoint entry.

The latter is particularly useful when continuing a program with "!" . Note that a counted continue will have the desired effect.

commands are always executed with interrupts off.

The value of SAVIOS may be determined by examining register 15454₈. Interrupts may be easily "lost" since DDT runs with interrupts off and senses these devices' program flags directly.

The feature described in the next three paragraphs is normally suppressed. It may be invoked by storing a 'NOP' in location 15541₈.

In addition, after turning interrupts off on a breakpoint entry, DDT loops approximately 140 milliseconds to determine if a character is being printed. The teleprinter flag is tested at the end of this loop and the state saved.

When continuing with "!" or "" , DDT prints a null character just before transferring to the user program if the teleprinter flag was up on entry. This will result in a teleprinter flag coming up after reaching the user program.

This flag may be prevented by storing a one in location 15455₈. Conversely, this flag may be forced on with "DZM 15455 # " .

2. Modifications

(All page references are to "PDP-7 DDT, Digital-7-4-S-L, February 10, 1966.")

A symbol definition tape, identified as "TAPE 1b of 3," is provided that contains the basic symbols. Three additional symbols are defined as described above.

A modified second tape, identified as "TAPE 2b of 3," contains the modification to DDT. The following sections of code are inserted (on page 9) between FSY and KLIS. Code above KLIS (= 15564₈) does not move from the original DEC version.

.PATCH to .PATCH + 4

Saves the input/output status word on entry to DDT from a breakpoint. In particular, bit zero of this word is one if interrupts are enabled at that time.

A wait loop of approximately 140 milliseconds is provided by .PATCH + 3 to .PATCH + 6 . The printer flag is tested and recorded in TPF.

.STION to FIXIOK

Sets a switch (FIXIOK) to indicate whether return to a program, either by "prime" command or by exclamation command, is to be with interrupts on (.SION), interrupts off (.STIOF), or interrupts on if they were on at the last breakpoint entry to DDT (.STIOC). These do not affect the accumulator.

The following symbols are defined in DDT's symbol table:

STION = 15474/address of .STION

STIOF = 15502/address of .STIOF

STIOC = 15477/address of .STIOC

GOBB to GOBB + 3

Allows execute commands, i.e., #, to be performed without checking the interrupt conditions, i.e., with interrupts off.

FIXIO1 to FSTIOF

Some constants.

FIXIO to FIXIOF + 1

Just before exiting to a user program, control jumps to FIXIO which tests to see if the goal is one of the addresses .STION, .STIOF, .STIOC. If so, transfer is made with interrupts off. If not, FIXIO sets the program interrupt depending on the value of FIXIOK, and if FIXIOK contains 1, then depending on the value of SAVIOS. Next the saved printer flag is tested and if one, an octal 377 is transmitted to the teletype.

17250 to 17256

This print routine waits for the printer flag before exiting and hence prevents characters generated by DDT from causing interrupts (see page 27).

16550

This provides a patch to save the input-output status word (see page 21).

(These last three patches were made as absolute overrides on tape 2b to avoid modifying tape 3. Ideally, tape 3 should be symbolically updated and these three absolute patches removed.)

This version of DDT is assembled from tapes 1b, 2b, (i.e., 2B.1 and 2B.2) and 3 .

DDT FOR LOGIC OF COMPUTERS PDP-7 TAPE 2B.1 OF 3
/REVISED 10 JUNE 1967 RONALD F. BRENDER

16000-355-30-110/

ZORCH,	LAC 17762
	AND ZORCHE
	XOR XFS
	DAC XFS
	AND ZORCHE
	XOR FSY
	DAC FSY
	ADD SYMEND
	DAC SYMEND
	LAC DSPDDT+6
	DAC 17662
	LAC DSPDDT+7
	DAC 17663
	LAC DSPDDT+10
	DAC 17664
	LAC ZORCHE+1
	DAC DONE
	JMP 17610
ZORCHE,	10000
	JMP GO

/SOME SYMBOLS FOR DDT S PERMANENT TABLE

16000-355-110/

BST,	40000	0	JMP PERIOD
	157014	341245	JMP PUNCHE
	141432	700245	JMP INPUT
	214024	064500	JMP ZERO
	240260	240245	JMP STARTA
	012460	324500	JMP TRAPP
CETI,	304650	062245	JMP AAR
	110660	444500	JMP LOAD
	016046	224045	JMP TABLE
	224046	702645	JMP DEBUG
	363022	224500	JMP KLL
	354500	000000	JMP QAN
	160614	500245	JMP CNS
	245216	460645	JMP SYM
	033402	602245	JMP OCT
	124022	600245	JMP RLT
	304444	244045	JMP ADR
	060602	450000	JMP NWD
	310624	444500	JMP WOD
	304500	000000	LAC AC
	234500	000000	LAC BPV
	514500	000000	CL
	474500	000000	M
	174500	000000	LAC VAL
	124500	000000	LAC PSX
	264500	000000	LAC FSX
	164500	000000	LAC I CUR
FST,	0	0	
CUR,	. 1	0	
BPV,	.-1		
VAL,	0		
FA,	0		
TBC,	0		
POI,	0		
AC,	0		
CL,	0		
M,	-0	0	17777
SYMEND,	CUR-BST		
FSY,	XOR BST -10000		

RFBRFB = .
/THE FOLLOWING ARE MODIFICATIONS INTENDED TO FACILITATE THE
/USE OF PDP-7 DDT WITH "INTERRUPTS ON" TYPE PROGRAMS. A WRITE-UP
/OF THESE CHANGES AND USAGE CONVENTIONS WILL BE FOUND IN THE
/SYSTEM LISTINGS. 10 JUNE 1967 RON BRENDER

SAVIOS, 0 /INPUT-OUTPUT STATUS MEMORY
TPF, 0 /TELEPRINTER FLAG MEMORY
TC, 700000
CD, 0
.PATCH, IORS
 IOF
 DAC SAVIOS
 LAC TC
 DAC CD
 ISZ CD
 JMP .-1 /WAIT ABOUT 100 MILLISEC
 DZM TPF /CLEAR TELEPRINTER INDICATOR
 TSF
 ISZ TPF /INCREMENT IF TELEPRINTER FLAG DOWN
 LAC BPX
 JMP BPY+1

.STION, DZM FIXIOK
 ISZ FIXIOK /RETURN WITH INTERRUPTS ON
 SKP
.STIOC, DZM FIXIOK /RETURN WITH INTERRUPTS ON IF ON AT BREAKPOINT
 ISZ FIXIOK
 SKP
.STIOF, DZM FIXIOK /RETURN WITH INTERRUPTS OFF
 JMP XXI+1
FIXIOK, 0

/THIS ALLOWS # TYPE COMMANDS TO BE EXECUTED WITHOUT SETTING UP
/THE INTERRUPT STATUS.

GOBB, DZM PRC
 JMS TCR
 LAC I BPV
 JMP GOB+3

/CONSTANTS - THIS IS DONE TO AVOID INTRODUCING NEW CONSTANTS
/AT THE END OF THE PROGRAM - HOW MUCH ROOM IS THERE, I SIMPLY
/COULD NOT DETERMINE.

FIXIO1, 1
FIXIO2, 2
FIXIOJ, JMP I FIXIOT
FIXIOT, FIXIOF
FIXIOC
FIXION
FSTION, .STION
FSTIOC, .STIOC
FSTIOF, .STIOF

/THIS IS WHERE THE NORMAL EXIT TO USER PROGRAM PASSES.
/THE INTERRUPT STATUS IS SET JUST BEFORE TRANSFERRING TO THE
/DESIRED LOCATION

FIXIO, LAC VAL
SAD FSTION
JMP NOTP
SAD FSTIOC
JMP NOTP
SAD FSTIOF
JMP NOTP
LAC FIXIOK
TAD FIXIOJ / (JMP I FIXIOT)
DAC .+1
HLT
HLT

FIXIOC, LAC SAVIOS
SPA
FIXION, ION
FIXIOF, JMP NOTP / NORMALLY SKIP THE TELEPRINTER CHECK. THIS
/ CHECK MAY BE INVOKED BY REPLACING THIS WORD
/ WITH A 'NOP'.

LAC TPF
RAR
LAW 377
SNL
TLS
NOTP, LAC I BPV
JMP GOB+3

RFBRFB+110/

/A PATCH TO TAPE 3 OF 3 (DDT)

RFB... = .

/THIS GOES AT "OTY"

17250/

Ø

JMS 15676 /IE. "JMS BTA"

TL5

TSF

JMP .-1

TCF

JMP I 17250

/THIS GOES AT "XXI-1"

16634/ JMP GOBB

/THIS GOES AT "BPY"

16550/ JMP .PATCH

RFB.../

PAUSE

UNIVERSITY OF MICHIGAN



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