

III. OPERATIONAL FEATURES OF TIM

A. TIM Commands*

<u>Command</u>	<u>Description</u>
<u>↵</u>	Set line speed. After RESET, a carriage return is typed to allow TIM to measure the line speed. Display user registers. The format is: PC P A X Y S where: PC is the program counter P is the processor status A is the A (accumulator) register X is the X (index) register Y is the Y (index) register S is the stack pointer low byte (high byte is always 01)
<u>.G</u>	Go. Begin execution at user PC location (see R command).
<u>.M</u> <u>addr</u>	Memory examine. TIM will display the eight bytes beginning at address <u>addr</u> .
<u>.:</u> ADDR <u>data</u>	Alter registers or memory. TIM allows the user to alter registers (if R command precedes) or memory (if M command precedes). Values for registers or memory locations which are not to be changed need not be typed

* Characters typed by the user are underlined. All other characters are typed by the computer. ↵ means carriage-return.

—these fields may be skipped by typing spaces instead of data. The remainder of the fields in a line may be left unchanged by typing carriage return. The : command may be repeated to alter subsequent memory locations without the necessity of typing intervening M commands. Note that TIM automatically types spaces to separate data fields.

.LH

Load Hexadecimal. TIM responds with carriage return, line-feed and loads data in assembler output format from the terminal or high-speed paper tape reader. The format is:

Zero or more leading characters except
";" (usually blank leader)

Any number of records of the form:

;ccaaaadddd....ddssss

where:

cc is, the number of bytes in the
record in hex

aaaa is the hex address to store the
first byte of data

dddd....dd is the data (two hex digits
per byte)

ssss is the check-sum, which is the
arithmetic sum, to 16 bits, of all
the count, address and data bytes re-
presented by the record

A terminating record of zero length,
either: ;00 or ;↓

Note that read-after-write and check-sum tests are performed. An error will result in a "?" being typed at the point the error occurred. Data from records with bad check-sums is deposited in memory as received, prior to the error stop.

.H

High-speed/low-speed reader switch. This command switches the load device from the user's terminal to the high-speed reader or vice versa.

.WH addl addh

Write Hexadecimal. An assembler-format tape is generated at the user's terminal. Format is as described above in the LH command description. Note that the address range must be specified with the lower address first. As in the Alter command, TIM types the space between the address fields.

.WB addl addh

Write BNPF. A BNPF format tape is generated at the user's terminal. Format is one or more records as follows:

aaaa BdddddddF BdddddddF BdddddddF BdddddddF

where:

aaaa is the address of the first of the four bytes specified in the record.
(Note: BNPF conventions require that the letter "B" never occur in the address field. Blanks are substituted by TIM.)

B is the letter "B", meaning begin data.
dddddddd is eight data bits—P for logical true, N for logical false.

F is the letter "F", meaning finish.

Note that the BNPF format is output as multiples of four bytes. Thus, a multiple of four bytes will always be punched even if a non-multiple of four bytes is specified:

Cancel Command. While typing any command, its further effect may normally be terminated by typing one or two carriage returns, as required. During alter (:), carriage return means that no further bytes (or registers) are to be altered.

B. TIM Interrupt and Breakpoint Action

BRK

The BRK instruction causes the CPU to interrupt execution, save PC and P registers on the stack and branch through a vector at locations FFFE and FFFF. TIM initializes this vector to point to itself on RESET. Unless the user modifies this vector, TIM will gain control when a BRK instruction is executed, print an asterisk "*" and the registers (as in R command), and wait for user commands. Note that after a BRK which vectors to TIM, the user's PC points to the byte following the BRK; however, users who choose to handle BRK instructions themselves

should note that BRK acts as a two-byte instruction, leaving the PC (on return via RTI) two bytes past the BRK instruction.

IRQ

Interrupt Request is also vectored through location FFFE. The CPU traps (as with BRK) through this vector when IRQ goes low, provided interrupts are not inhibited. Since this vector is the same as for BRK, TIM examines the BRK bit in the P register after this type of interrupt. If a BRK did not cause the interrupt, then TIM will pass control through the UINT vector. Users should normally put the address of their interrupt service routine in the UINT vector location. If an IRQ occurs and UINT has not been set by the user, TIM reports the unexpected interrupt in the same way as an NMI (see below).

NMI

Non-Maskable Interrupts vector through location FFFA. TIM initializes this vector at RESET to point to itself. If an NMI occurs, a pound-sign character (#) precedes the asterisk and CPU registers printout. This action is the same for IRQ's if the user has not set this vector to point to his own routine.

RESET or POWER-UP

On RESET or POWER-UP, TIM takes control, initializes itself and the system, sets defaults for interrupt vectors and waits for a carriage-return input from the user to determine terminal line speed. After carriage-return is typed; control is passed to the user as in BRK. - 10 -

C. TIM Monitor Calls and Special Locations

<u>Call</u>	<u>Address</u>	<u>Action</u>	<u>Arg.</u>	<u>Result</u>	<u>Notes</u>
JSR WRT	72C6	Type a character	A	None	A,X cleared Y preserved
JSR RDT	72E9	Read a character	None	A	X cleared Y not preserved
JSR CRLF	728A	Type CR-LF and delay	None	None	A,X cleared Y preserved
JSR SPACE	7377	Type a space character	None	None	A,X,Y preserved
JSR WROB	72B1	Type a byte in hex	A	None	A,X cleared Y preserved
JSR RDHSR	733D	Read a character from high-speed paper tape reader	None	X-char read A-char trimmed to 7 bits	Y preserved

<u>Function</u>	<u>Locations</u>	<u>Notes</u>
Start Address	00F6,00F7	Set with hex tape on load
CR-LF Delay	00E3	Set on load or with user program (in <u>bit times</u> , minimum of 1. Zero means 256 bits-time delay).
UINT	FFF8	User IRQ vector
NMI Vector	FFFA	Hardware NMI vector
RESET Vector	FFFC	Hardware RESET vector
IRQ Vector.	FFFE	Hardware IRQ vector