SPRINTER III

clock speed-up board for
TRS-80* Model III
and
Xerox** 820
computers

by

HOLMES ENGINEERING

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* * * * * IMPORTANT INFORMATION * * * * *

The SPRINTER III is the most reliable, easiest to install speed-up module available for the Model III/Xerox 820 computers. In order to ensure proper installation and operation of your SPRINTER III, please follow the instructions in this manual VERY CAREFULLY.

Your computer MUST have good RAM chips installed in order to run at high speeds. Some of the RAM chips Radio Shack used in their computers may not operate reliably with the SPRINTER III. If you have not yet purchased added RAM for your Model III, we suggest you purchase your RAM from HOLMES ENGINEERING; the RAM we sell is guaranteed to work in the Model III with the SPRINTER III.

HOLMES ENGINEERING also offers a set of specially prepared RAM chips with "pull-up" resistors installed to improve high-speed performance of the Model III system.

Unless you requested otherwise, your SPRINTER III is programmed as follows:

(1) With the SPRINTER III installed, your computer will run at normal speed (approximately 2 MHz) when power is first applied, and will revert to normal speed whenever the RESET switch is pressed.

(2) The SPRINTER III will switch to high speed (approximately 3.4 MHz) when the BASIC command OUT 95,1 is executed either from the keyboard or within a program.

(3) The SPRINTER III will temporarily revert to normal speed during any I/O operation, such as disk or tape access, as well as during video read/write. The SPRINTER III will switch back to high speed as soon as the I/O or video operation is completed.

(4) The SPRINTER III can be switched back to normal speed by executing the BASIC command OUT 95,0 either from the keyboard or within a program, or by pressing the RESET button.

All of the functions of the SPRINTER III can be altered by changing jumpers on the SPRINTER circuit board. Instructions for changing the SPRINTER configurations are listed at the end of this manual.

* * * * * * * INSTALLATION * * * * * * *

Installation of the SPRINTER III is very simple if you follow these instructions TO THE LETTER!!!

<> UNPLUG YOUR COMPUTER !!!!

<> You will be removing the cover from your Model III and laying it on its side next to the computer. Make certain the table you are using is large enough to hold everything. In addition, it is a good idea to lay a blanket or towel underneath your computer to prevent scratching the cover when you lay it on its side.

<> Place the Model III in front of you on the table in its normal operating position, with the keyboard facing toward you.

<> Now, carefully tip the computer on its back, and remove the 10 screws in recessed holes in the bottom of the case. Note that the screws are of different types and lengths; make notes if necessary to ensure that you get the right screws back into the right holes during re-assembly later on.

<> Holding the computer by the bottom half of the case, turn it "right side up" again.

<> Using a phillips screwdriver, remove the single screw at the top center of the back of the case.

<> Now for the tricky part! VERY CAREFULLY lift the case top STRAIGHT UP from the case bottom. The CRT screen will remain in the case top. Be VERY CAREFUL not to strike the neck of the CRT against the inside of the case or its support metal, or you may damage the CRT. Set the case top on its side at the left of the case bottom, with the screen facing toward you. Be careful not to strain the cables connected to the video board in the case top.

<> Now examine your Model III from the rear. If your Model III has a metal shield plate covering the main p.c. board, remove the screws holding it in place, and remove the shield. You may need to depress the small tabs which fit into holes in the shield plate to get the plate off.

<> Locate your Z-80 microprocessor "chip" at U-77 (it's called a chip because there is a tiny chip of silicon inside the relativlely large platic package; the package itself doesn't resemble a chip, but is about the same size as a large, thick piece of chewing gum!). Insert a small flat screwdriver, nail file or similar object under the Z-80 in your system, and carefully pry it out of its socket. First pry one end partly up, then the other, and go back and forth until the chip is free from the socket. Set the Z-80 chip aside.

<> Directly below the Z-80 socket in your system are the three Basic ROMs. These are usually made of black plastic, but some may be made of a grey or brown ceramic with a gold or silver metal plate attached. If any of your "ROMs have a metal top plate, cover it with tape to prevent the metal from touching the bottom of the SPRINTER board.

<> On the back of the SPRINTER III are two rows of pins which will fit into the socket your Z-80 chip occupied. Orient the SPRINTER III so the Z-80B chip is at the top of the SPRINTER board, with the notch at the end of the Z-80B facing to the right. Place the pins on the back of the SPRINTER into the openings of the Z-80 socket on the Model III, and "wiggle" the SPRINTER around a little until you are certain that all of the pins are lined up properly (make certain that every SPRINTER pin is in a socket opening). Once you are certain that the pins are lined up, firmly press the pins

into the socket until they are completely seated. Look at the pins from the top of the computer to make sure none are bent or mislocated.

<> On the end of the RED wire attached to the SPRINTER III is a small solderless clip. This clip is designed to allow you to connect the SPRINTER III to your Model III without soldering. The clip is installed by slipping it straight onto one of the pins of an integrated circuit on the Model III circuit board just as you would slip a paper clip onto a piece of paper, as shown in figure 1. Be careful not to twist the clip as you push it on, or it may not hold tightly when it is installed (use tweezers or needle-nose pliers if possible).

<> Refering to fig. 2, push the solderless clip at the end of the red wire onto pin 1 of U-62 on the Model III main circuit board. Place a small piece of tape on or under the wire to keep it in place.

<> Referring once again to fig. 2, push the solderless clip on the end of the white wire onto pin 9 of U-60 (this is the VIDEO signal used to slow the SPRINTER III to normal speed during video operations.) * * SPECIAL NOTE * * YOU MAY BE ABLE TO USE YOUR SPRINTER WITH THE WHITE WIRE DISCONNECTED, ESPECIALLY IF YOU ARE RUNNING AT LESS THAN 5 MHz. YOU MAY WISH TO TRY THE SPRINTER WITHOUT THE WHITE WIRE CONNECTED, THEN CONNECT IT IF YOU HAVE VIDEO PROBLEMS. LEAVING THE WHITE WIRE DISCONNECTED MAY INCREASE THE OPERATING SPEED OF YOUR SYSTEM.

Your SPRINTER III is now installed! Let's test your system and make sure everything is OK.

* * * * * * SYSTEM CHECKOUT * * * * * *

First, make sure that there are no tools or wires touching anything inside the case. Plug your Model III in and turn it on. You should be able to operate your system, including disks and tape, just as you normally would. If your system doesn't operate properly at this point, here are some possible problems:

(1) The RED wire is either connected to the wrong pin of U-62, or to the wrong I.C., or it is shorting pin 1 of U-62 to pin 2 or an adjacent trace.

(2) The white wire is either connected to the wrong pin of U-60, or to the wrong I.C., or it is shorting pin 9 of U-60 to pin 10 or to another trace.

(3) The pins on the back of the SPRINTER III may not be properly or fully inserted into the socket, or a pin may be bent over and touching another pin. Remove the SPRINTER III and repair the pins, then carefully re-install it.

(4) If the above checks out correctly, remove the SPRINTER and place your original Z-80 in it's socket, then test your computer.

If it runs OK, your SPRINTER may be defective or improperly programmed. Contact your dealer for assistance, or return your SPRINTER III for testing.

In either Level II or Disk BASIC, type in and RUN the following short program:

```
10 OUT 95,1
20 PRINT MEM;:IF MEM >100 GOSUB 20 ELSE RUN
```

This program will continuously call itself as a subroutine, pushing it's return address into the top of RAM and decreasing available memory until available memory is less than 100 bytes, at which time the whole process starts over again. Run the test program at least 15 minutes. If it crashes or stops at any time, you probably have problems with slow RAM chips (especially if you have Radio Shack chips, which are notoriously slow even if they bear fast specs); read on to find out what to do, or contact your dealer for assistance.

Next, while still in high speed mode (out 95,1, remember?), hold down the shift key and press the '0' key to enter the lower case mode. Type each character on the keyboard several times and observe the screen to see if any character(s) produce unexpected results. If you have problems with your keyboard at high speed, you will need to replace resistor pack RP-5 (at the left edge of the main circuit board), which is currently an array of nine 3.3K resistors, with a 1K resistor pack (available from your dealer or HOLMES ENGINEERING). If you can't or don't want to replace RP-5, your dealer can sell you a small p.c. board to plug onto your keyboard connector which should fix the keyboard problem.

Finally, boot up your disk system (if you have one) and run some programs. Keep in mind that the SPRINTER (1) is reset to normal speed whenever the RESET switch is pressed (unless you have it "hard wired" for high speed), and (2) reverts to normal speed for approximately 3 seconds after the reset switch is pressed even if it is hard wired for high speed (to allow time for the operating system to boot up; most ROMs and many operating systems won't boot at high speed without extensive modification). If you have a word processing program, or any other fast machine language program, use it at high speed to determine if your system is working OK. If you are having problems with "slow" RAM (even RAM rated at 200 nsec. can look slow to the computer if its other specs aren't right), the word processor will probably "die", or insert random characters on the screen, or randomly change text characters as the screen scrolls.

If you cannot get your system to run reliably at high speed, you probably have a RAM problem. The Model III is capable of running at high speed IF THE SYSTEM RAM IS CAPABLE OF RUNNING AT HIGH SPEED IN THE MODEL III. Some RAM chips rated at high speeds have characteristics which will not allow them to run at their rated speed IN THE MODEL III; many of the RAM chips used by Radio Shack fall into this category. So now what do you do? Here are a couple of suggestions:

(1) If your system seems to run OK some of the time, but seems to have some minor problems, you may be able to acheive reliable high-speed operation by replacing the first 16K of RAM with some "special" RAM chips available from your dealer or HOLMES ENGINEERING. These enhanced chips have pull-up resistors soldered to the data lines which improve the high speed performance of the enhanced chips AND ANY OTHER RAM CHIPS INSTALLED IN THE MODEL III! (If microcomputer designers would read the manuals published by the comapnies who manufacture the RAM chips, they would put these resistors on the computer's circuit board in the first place!)

-or-

(2) If you don't mind cutting a trace on your computer's circuit board, cut the trace connecting U-61 pin 2 to U-61 pin 5 on the top side of the board (see fig. 2). THIS TRACE CUT WILL NOT AFFECT THE NORMAL OPERATION OF YOUR SYSTEM AT ANY SPEED; it will only speed up the timing signals being sent to the memory chips and help high-speed operation.

(3) As a last resort, you may have to replace your RAM chips. If you do so, purchase ONLY PRIME NEC 150 nanosecond chips (upD 416-3) from a reputable dealer (such as HOLMES ENGINEERING or an authorized HOLMES dealer)! Don't buy "bargain basement" chips regardless of their speed ratings or their brand name (there are some "black market" NEC chips around which are no better than unmarked chips). Bargain chips are not worth the lost time and frustration they cause.

In rare cases, the ROMs may be too slow to run at high speed even with the SPRINTER's high-speed enhancements. You should suspect your ROMs if your system runs machine-language programs (such as word processors or spreadsheets) OK at high speed but has problems with Basic programs, especially non-disk Basic. We have been able to solve the few ROM problems we have seen by soldering 1K resistors from pins 1 and 5 to pin 16 of U-60. Technically, U-60 is an "open collector" device; the pull-up resistors designed into the Model III do not pull up the outputs of U-60 fast enough for slow ROMs.

After you have your system running, you may wish to verify that it is indeed "speeding up"! Here is a short program which you can use to time the operating speed of your computer:

```
10 CLS:PRINT:PRINT @ 0,"RUNNING......."
20 OUT 95,0
30 POKE 16919,0
40 FOR X=0 TO 20000:NEXT
50 T1=PEEK(16919)
60 OUT 95,1
70 POKE 16919,0
80 FOR X=0 TO 20000:NEXT
90 T2=PEEK(16919)
100 S=T1/T2
110 PRINT"YOUR SYSTEM IS RUNNING ";S" TIMES NORMAL SPEED"
120 GOTO 20
```

This program uses the TIME$ function of the Model III to measure the time required to execute a long FOR/NEXT loop. The seconds portion of the TIME$ variable is set to zero, then a FOR/NEXT loop is executed. The TIME$ variable is read after the FOR/NEXT loop is finished to determine the approximate time required to execute the loop. The system is then switched to high speed, and the process is repeated. The "slow" time is divided by the "fast" time, and the result is printed on the screen.

Because of the way the TIME$ function operates, this routine is not extremely accurate; it is not unusual to see some periodic variation in the numbers printed on the screen, due mostly to round off error and interruption of the TIME$ routine by the system. Generally speaking, the fastest time printed on the screen is the EFFECTIVE increase in operating speed (throughput) of your system; the microprocessor and other components are actually running 2.5 times "normal" speed.

<> Once you have everything working correctly, UNPLUG YOUR SYSTEM.

<> If your system had a shield plate over the circuit board, put it on now and replace the screws. The Z-80 on the SPRINTER board will prevent the shield from fitting completely flat, but this is not a problem; many Model III's were shipped without the shield!

<> CAREFULLY place the cover/display back on top of the case bottom.

<> Partially install the single screw in the back of the case, but do not tighten it yet.

<> Tip the computer onto its back again and install the ten screws your removed earlier. Refer to your notes and make certain you get the screws in their correct positions. Tighten down the screws, tip the system right-side-up, and tighten the screw at the back of the case.

<> Congratulations! You are finished!

* * * * * TECHNICAL INFORMATION * * * * *

THEORY OF OPERATION:

The SPRINTER III can be programmed to run at one of eight differant speeds in each of its two speed modes. Thus, the SPRINTER III could be used in any Z-80 computer system which used a clock and I/O scheme similar to the TRS-80* Model III/Xerox 820 computers.

The SPRINTER III consists of five basic sections: a port address decoder, a data latch, a programmable divider, an I/O "slowdown" circuit, and a "wait state" generator. The port address decoder determines when an OUT command is being executed at port 95 (5FH). The data latch uses the signal from the address decoder to latch the content of data line 0. The programmable divider uses signals from the data latch and I/O slowdown circuits to divide the

system clock by a pre-programmed number to derive the CPU clock. The wait state generator stretches memory access cycles in the high speed mode to allow the BASIC ROMs and RAM to run at speeds in excess of 3MHz. The I/O slowdown circuit switches the SPRINTER to normal speed during disk and cassette read/write operations, to maintain full compatibility with existing hardware and software. The slowdown circuit also forces the SPRINTER into normal-speed mode for approximately 3 seconds after the RESET switch is pressed, to allow time for the system to boot a TRSDOS operating system, which can't "boot up" at high speed in its standard configuration.

PROGRAMMABLE OPTIONS:

SPRINTER functions are determined by the location of jumper traces or wire jumpers soldered to holes in the SPRINTER p.c. board. The following information is intended to enable you to change the standard configuration of the SPRINTER III to fit your own needs. PERFORMING THE FOLLOWING STEPS REQUIRES SKILL IN SOLDERING AND DE-SOLDERING WIRES FROM P.C. BOARDS. IF IN DOUBT ABOUT YOUR ABILITY TO SOLDER, PLEASE SEND YOUR SPRINTER TO YOUR DEALER FOR MODIFICATION. DAMAGE TO THE SPRINTER AS A RESULT OF ATTEMPTING THESE MODIFICATIONS IS NOT COVERED UNDER WARRANTY!

PROGRAMMING CLOCK FREQUENCIES:

The SPRINTER III accepts the 10.1376 MHz system clock of the TRS-80 via the RED wire attached to U-62 pin 1 of the TRS-80. A programmable divider on the SPRINTER III board divides this system clock by an integer value and sends the divided signal to the Z-80B microprocessor on the SPRINTER board.

The Model III normally runs at 2.03 MHz; that is, it divides the 10.1376 MHz system clock by 5 to obtain its processor clock . The SPRINTER III is supplied programmed to run at 2.03 MHz in its "normal" speed mode, and will switch to this mode when the computer is first turned on, whenever the RESET switch is pressed, or whenever an OUT 95,X command is executed from BASIC or machine language (where X is any even number from 0 through 254). If you desire to re-program the SPRINTER to run at some other frequency in its "normal" speed mode, you may change the jumpers in the holes next to U-7 on the p.c. board. Refer to figure 3 and table 1 to determine where to place jumpers to get the speed you desire.

The higher speed of the SPRINTER III is selected by sending an odd number to port 95 and is also programmable. The SPRINTER is supplied programmed to divide the system clock by 3, which means that in a Model III computer, the SPRINTER III operates at about 3.4 MHz, about a 75% increase over normal speed. If you wish to attempt operation at 5 MHz, you must change the jumpers in the set of holes next to the three resistors between U-5 and U-3 on the SPRINTER p.c. board. Refer to figure 3 and table 1 to determine where to put the jumpers to get the "speed" you want.

HARDWARE SPEED SWITCHING:

It may be inconvenient or undesireable to switch the SPRINTER III to high speed using software commands. Refer to fig. 3 and find

two points labeled "high speed select". By connecting a wire between these points on the SPRINTER board, the SPRINTER will be forced into high speed mode at all times. This option WILL NOT defeat the auto slow-down and auto-timeout features of the SPRINTER III; these features have seperate controlling jumpers. If you wish to make the speed selection switchable, simply use an SPST switch in place of the wire. A toggle or slide switch will force the SPRINTER into high speed and will not allow the software command OUT 95,Ø to switch the SPRINTER to normal speed when the switch is closed. Using a push button switch (or returning the slide or toggle switch to it's open position after switching to high speed) will allow software control of the SPRINTER's speed.

The SPRINTER will also allow external switching to low speed, although you must not apply a signal to the low speed select point at the same time you apply a signal to the high speed select point or the speed selection will be unpredictable (for once, something that makes sense!). Directly underneath R-6 on the SPRINTER board are two holes connected by a thin trace, marked "low speed select" in fig. 3. Cut the trace connecting these holes, and install a wire in the hole which connects to U-4 pin 1. Your switch must be wired so that it places a logic Ø (ground) on pin 1 of U-4 when you wish to switch to the lower programmed speed. THIS LINE MUST BE PULLED HIGH AT ALL OTHER TIMES OR YOU WILL NOT BE ABLE TO SWITCH THE SPRINTER TO HIGH SPEED! NOTE: After cutting this trace, the SPRINTER does NOT revert to normal speed when the RESET switch is pressed, nor is the SPRINTER reset to normal speed when the system is first turned on unless the added control line goes low to reset the SPRINTER.

DEFEATING AUTOMATIC SLOWDOWN DURING I/O:

In it's initial configuration, the SPRINTER switches to "normal" speed whenever it senses an I/O operation in process. Thus, all disk and cassette operations, as well as RS-232 and any other port-based I/O operation, will temporarily force the SPRINTER to normal speed. In addition, the SPRINTER temporarily switches to normal speed whenever the video display is addressed, to prevent system crashes caused by the peculiar video "wait" circuitry used in the Model III.

If you wish to use 8" double density disks, you must prevent the SPRINTER from switching to normal speed during disk I/O operations. This may be accomplished in two ways:

(1) If you wish to defeat the auto slowdown only during certain operations, but wish to retain the auto slowdown during others, you can do so by providing a logic "1" (+5 volt) signal to the auto defeat terminal on the SPRINTER board. This signal should go to logic "1" ONLY during those times when you wish to defeat the auto slowdown feature of the SPRINTER; it MUST go to a logic "Ø" (<Ø.8 volt) when you wish the auto slowdown feature to be active. In addition, you will probably need to perform a simple modification to your Model III which will eliminate the generation of long WAIT signals during video operations. This will cause your display to flicker slightly during extensive video operations such as scrolling. This flickering is not objectionable. As a result of making this modification, your system will run a little faster-the

SPRINTER will not need to slow down for video access!

Referring to the schematic and fig. 3, you will find two points labeled "auto defeat". On the bottom of the SPRINTER board, these two points are connected by a thin trace. Cut the trace connecting the two auto defeat points. Connect the wire controllng auto defeat to auto defeat pad #1 (refer to fig. 3). Remember, this signal must be high to defeat automatic slowdown during all I/O operations, and low to enable automatic slowdown.

If you add auto slowdown defeat to your SPRINTER, then discover that your system crashes during video operations when in high speed, you will need to modify your Model III by cutting the trace connected to U-16 pin 6, and adding a jumper between U-17 pin 2 and pin 13. You won't need the white SPRINTER wire if you make this modification.

(2) If you wish to permanently disable automatic slowdown during all I/O operations, simply remove diode D3 from the SPRINTER board. This will not affect the video slowdown capability of the SPRINTER; you do not need to make the video modification mentioned in (1), above. Keep in mind that the SPRINTER will NOT automatically slow down for disk, cassette or RS-232 operation; you will probably need to "patch" software used with the disk or RS-232 systems to use them with high speed I/O. We do not know how the cassette system will function at high speed, but if you are very lucky, you may be able to get 3000 baud operation of your cassette system! Don't be too disappointed if you can't, though; it was never meant to be run that fast!

AUTOMATIC SLOWDOWN ON RESET:

In its standard configuration, the SPRINTER will switch to normal speed whenever the RESET switch is pressed. If you have the SPRINTER hard wired for high speed operation, it will jump back to high speed as soon as the reset switch is released. This is a problem for TRSDOS and some other disk operating systems; the boot-up routines are looking for a system running at 2.03 MHz!

To allow the disk operating system time to read the boot sector and "get started", the SPRINTER temporarily switches to normal speed for about 3 seconds AFTER the RESET switch is pressed, even if it is hard wired for high speed operation. If you are trying to boot-up from 8 inch DD disks or a hard disk, you may want the SPRINTER to go right to high speed with no delay. Referring to fig. 3, you will find two pads labeled "reset slowdown timeout". To defeat reset slowdown timeout, simply cut the trace connecting these two pads and install a resistor at the location labeled R12 in fig. 3 (just about any value > 1K will work; 4.7K is a good choice.)

WAIT STATES:

What is a wait state? Technically, a wait state as implemented in the SPRINTER III is an extra 100 ns of time added to the beginning of every memory cycle initiated by the Z-80 microprocessor. In simpler terms, a wait state is a way of making the computer wait a little extra time whenever it tries to use the RAM or ROM in the system. Thus, the memory devices in the system

will be operated at a speed which is within their operating limits, while the microprocessor is allowed to execute instructions at a higher speed. The use of wait states reduces the operating speed of the system, but without wait states, the Model III would require extensive modification to run at high speed.

Because the Model III will not run at high speed without wait states, the wait function is NOT programmable. If you wish to attempt high speed operation without wait states, you will need to modify your computer and your SPRINTER. Refer to the schematics for technical information--and good luck! We have not found a reliable way to do this; we do not reccomend operating the SPRINTER III at 5.1 MHz without wait states.

* * * * * * * WARRANTY * * * * * * *

HOLMES ENGINERING guarantees the SPRINTER III to be free from defects in material and workmanship for a period of ninety days from date of purchase under normal use and operation. This warranty does not include the cost of any inconvenience, liability loss or damage to the customer or any other party caused or alleged to be caused by installation or failure of the SPRINTER III, nor does it cover damage caused by misuse, abuse or alteration. Returned SPRINTER III boards must be returned pre-paid to the place of purchase, to be repaired or replaced at HOLMES option at no charge within the warranty period. There are no other warranties granted, expressed or implied.

If you are not satisfied with your SPRINTER III for any reason, you may return it IN ORIGINAL CONDITION (postage pre-paid) within 30 days from date of purchase for a refund of your original purchase price (shipping not included). This offer is void if your SPRINTER III has been modified or damaged in any way! Please attach a short note explaining why you are returning the SPRINTER III.

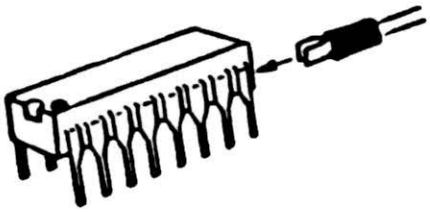

FIG. 1

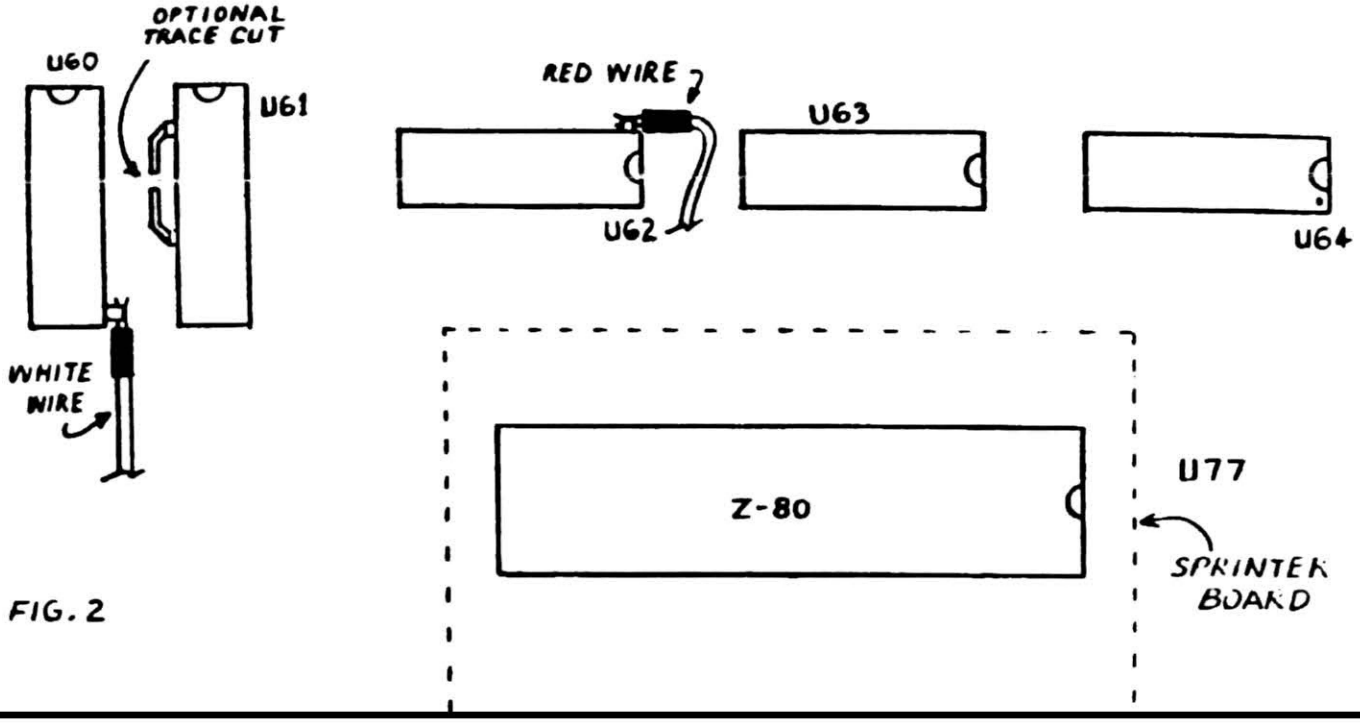

FIG. 2

CLOCK DIVISION RATIO	CLOCK FREQ., @ 10.1376 in	"LOW" SPEED:				"HIGH" SPEED:		
		A	B	C		D	E	F
2	5.Ø7 MHz	1	1	1		1	1	1
3	3.38 MHz	Ø	1	1		Ø	1	1
4	2.53 MHz	1	Ø	1		1	Ø	1
5	2.Ø3 MHz	Ø	Ø	1		Ø	Ø	1

Ø = point "0" in fig 3

1 = point "1" in fig 3

TABLE 1

SPRINTER III
component location and
jumper options

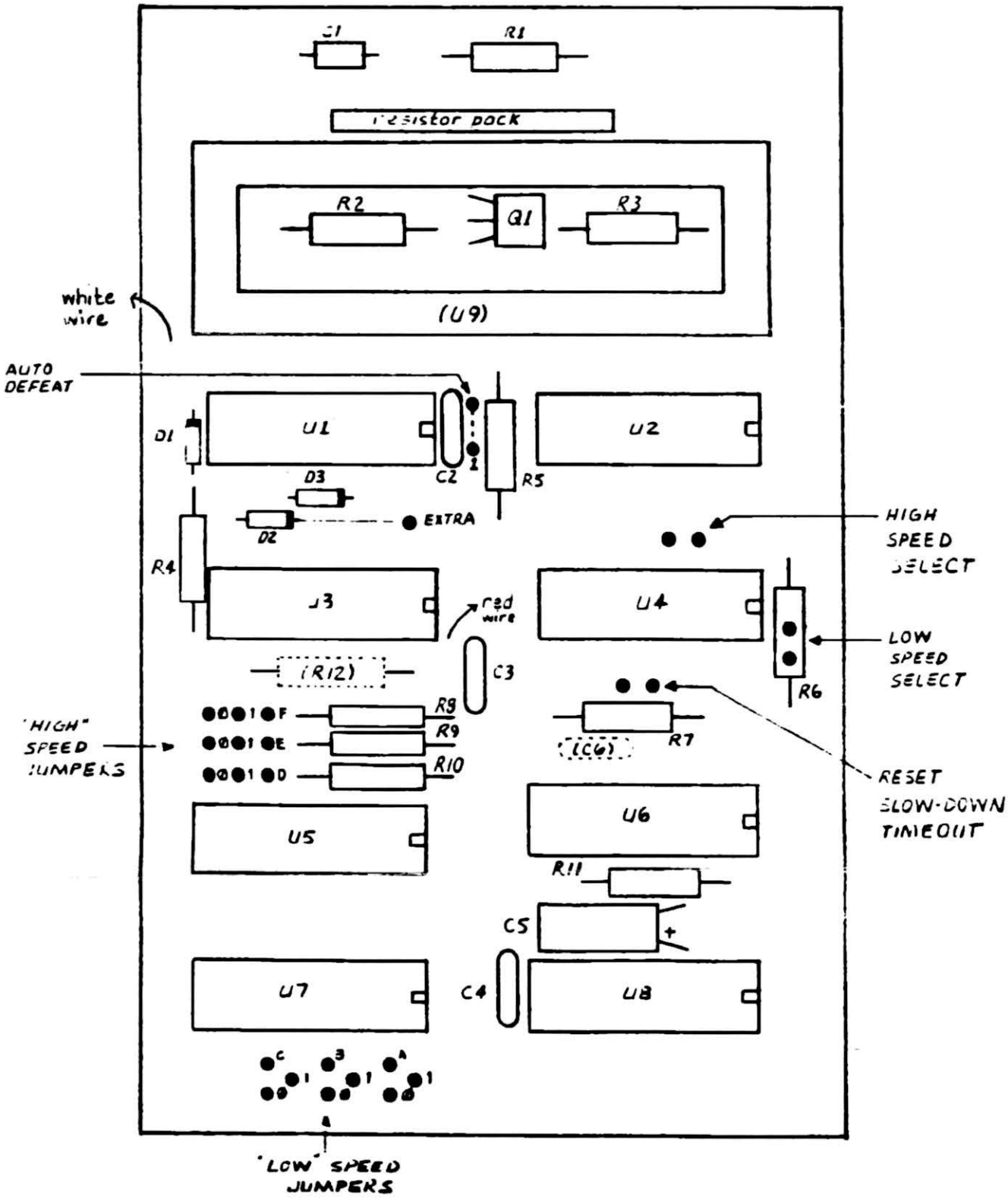

figure -3-

SPRINTER III
component location and jumper options

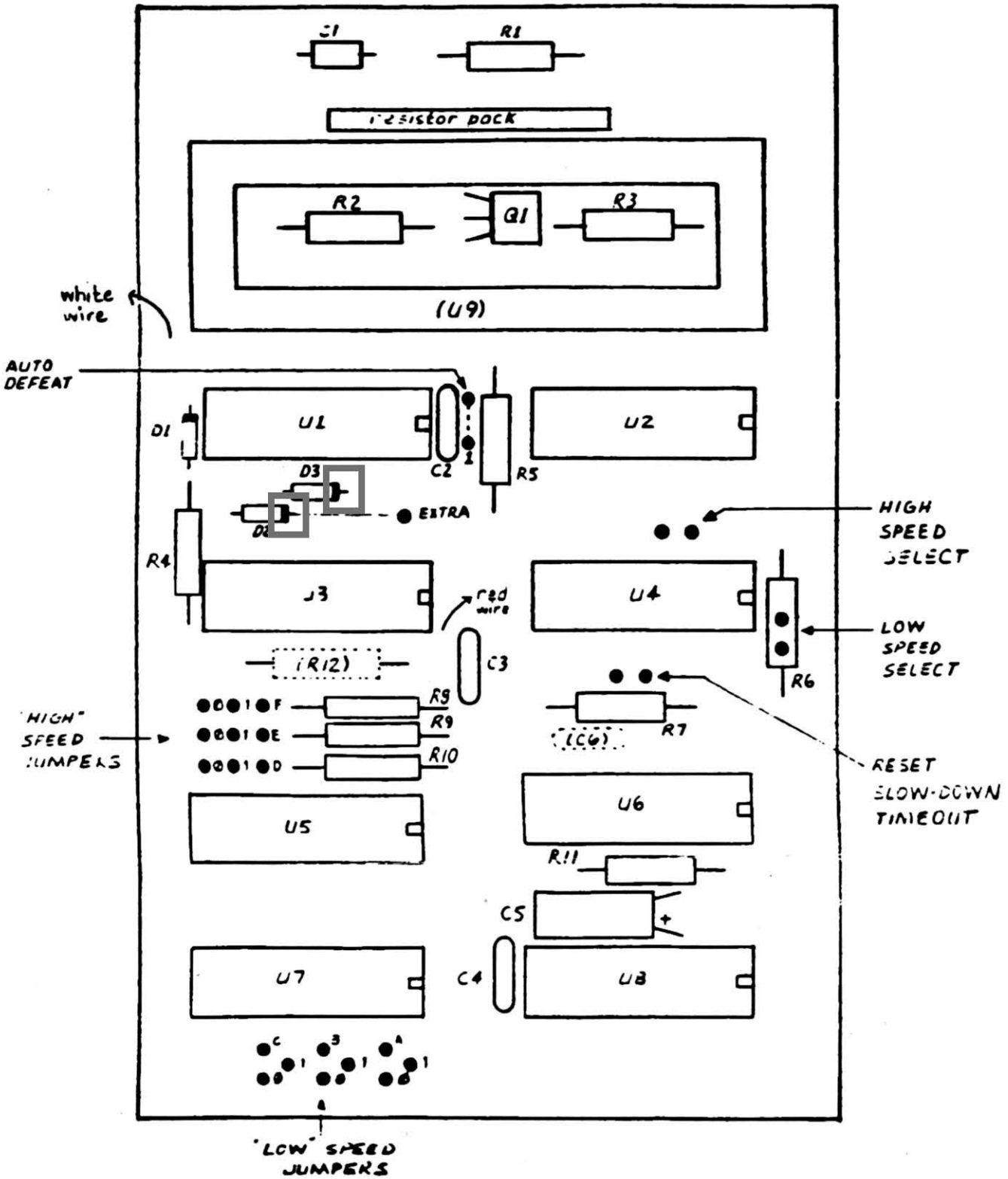

figure -3-

ORCH-90 Modification

1) Lift Banded End of D3 off Board
2) Replace D2 Diode and leave Banded End of D2 off Board
3) Wire from raised (banded) end of D3 to Pin 11 of U40 on Computer Motherboard
4) Wire from raised (banded) end of D2 to Pin 11 of U41 on Computer Motherboard

SPRINTER III
component location and jumper options

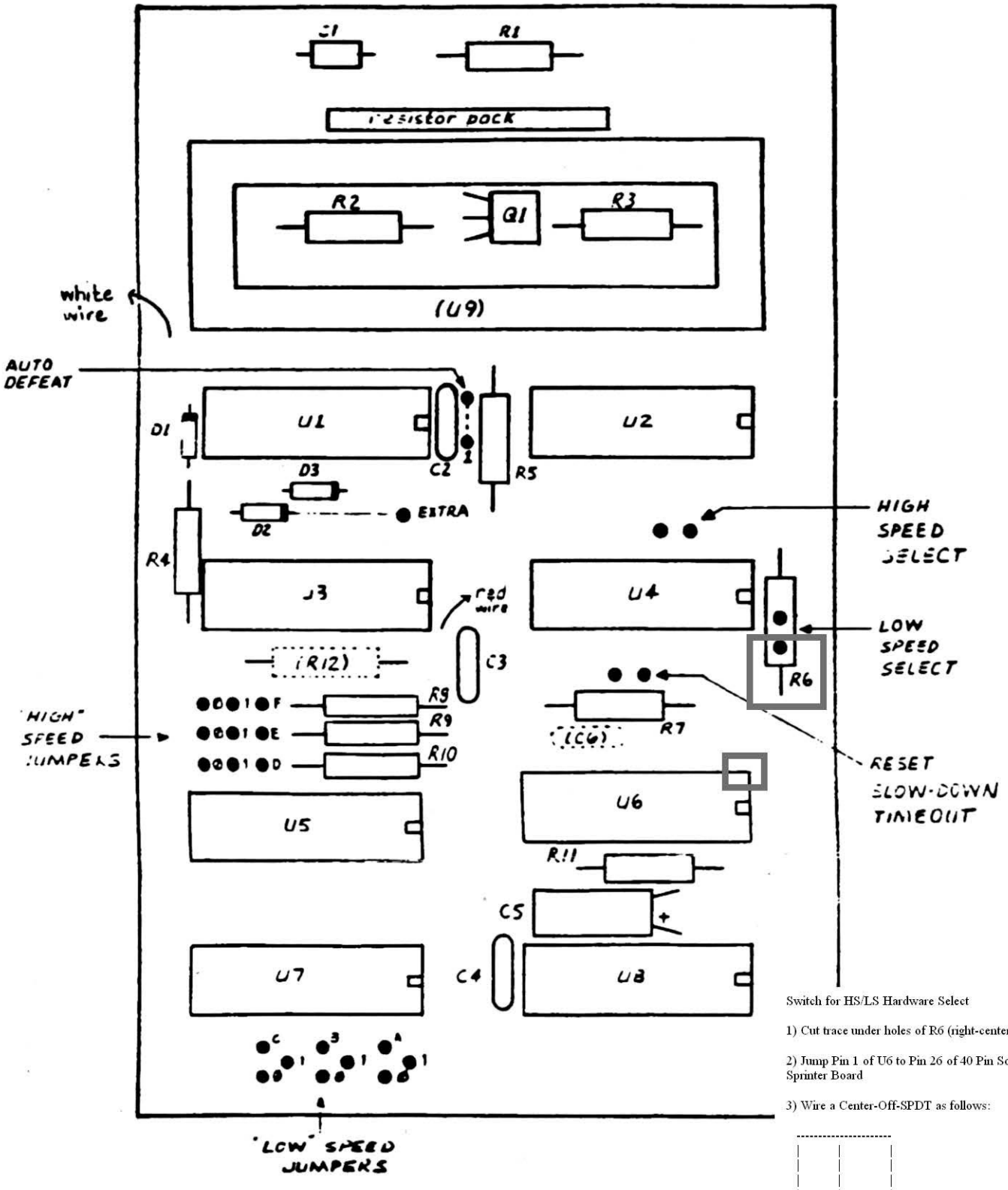

figure -3-

Switch for HS/LS Hardware Select

1) Cut trace under holes of R6 (right-center side of board)

2) Jump Pin 1 of U6 to Pin 26 of 40 Pin Socket under Sprinter Board

3) Wire a Center-Off-SPDT as follows:

Left Hole of HS Select	Right Hole of HS Select	Upper Hole of HS Select

4) Cut THIN trace between U39 and U4 (there is one wide and one thin)