FLUKE
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Help available for troubleshooting the IBM PC

by Gary Aiken
Diversified Data Corporation

John Fluke Mfg. Co., Inc., in collaboration with Diversified Data Corp. of Springfield, Virginia, is pleased to announce that a software package will soon be available for troubleshooting the IBM PC using the 9010A or 9005A Micro-System Troubleshooter. These program cassettes, which have been engineered and produced by Diversified Data Corp., utilize many of the 9010A/9005A's features, particularly the automatic tests and programmed routines. By using well designed troubleshooting program tapes, test personnel with a variety of skill levels will be able to successfully troubleshoot microprocessor-based IBM PCs.

Troubleshooting the IBM PC can be greatly simplified by using the 9010A/9005A. Complete fault location with a fully programmed 9010A/9005A requires only that the PC contain a functional power supply, system clock and microprocessor socket. Testing can begin immediately upon powering up the PC, and the technician can choose to test any portion of the system he wishes. In programming a set of test tapes for the PC, Diversified Data Corp. set out to realize several goals:

- The test set should provide cost effective support by putting affordable hardware and software into the hands of technicians.
- The automatic tests should transcend the capabilities of available disk-based diagnostics and support troubleshooting to the component level.
- The accompanying user documentation must prove to be an asset rather than a hindrance, serving to minimize time spent on activities other than troubleshooting.

The challenges that confronted this effort began with the PC itself. A repair shop sees many different PC configurations which include IBM or third party expansion boards and several different memory sizes. The test set would have to support these various configurations. In addition, many of the signals being tested are asynchronous, independent of bus timing. This is particularly true on display adapters and certain other expansion boards. This would necessitate use of guided probe tests in unsynchronized modes.

The PC also has very few socketed chips (fortunately, the processor is socketed) which not only frustrates most attempts at trial-and-error or "shotgun" troubleshooting, but makes fault insertion more difficult during software testing. Finally, the magnitude of the anticipated effort due just to the number of nodes and chips in the system placed great importance on the software documentation and user's manual development.

The final product is a modular set of tapes and documentation which has been tested and proven to allow relatively unskilled technicians to troubleshoot the

(continued inside)

Using the 9010A with a Tektronix 7D02

by E. Hegar

Martin Marietta Aerospace, Denver, Colorado

This article discusses the increased diagnostic power that is available when the 9010A is used in conjunction with the Tektronic 7D02 logic analyzer. These routines were worked through on a Z80 based test tool.

Usually during debugging, little confidence exists concerning the accuracy of the design, the fabrication, the software and the documentation of the tool. The Tektronix 7D02 analyzer is extremely useful in tracing the flow of the program software, but it is limited when very fast and meaningful observations are needed, or when setting breakpoints. On the other hand, the 9010A has no timing measurement capability.

Since the 9010A is connected in parallel with the 7D02 and the 9010A substitutes for the microprocessor in the UUT, an obvious improvement would be to connect the logic analyzer to the UUT via the processor socket. Instead of installing a processor in the logic analyzer pod, replace it with the 9010A pod. A quick examination of the schematics for the 9000A-Z80 pod and the Tek Z80 Pod for the 7D02 show that this will cause no damage to either item.

Once you have made this interconnection, you will be amazed at the increase in the system's power.

Now the 9010A will allow:

- immediate downloading of object code into UUT RAM,
- full front panel control of the UUT resources,
- rapid examination of the contents of memory,
- start address specification,
- many other control and observations functions.

The disassembly capabilities of the 7D02 will allow:

- examination of address and data bus contents,
- precise timing measurements,
- glitch capture.

In addition, the logic analyzer is now able to look at resources not directly connected to the processor bus or isolated by intermediate resources. Since the analyzer allows masking of interrupt cycles, you can now examine only those states you are interested in, without having to wade through several hundred bus cycles of information.

Inclusion of a RAM flag check in the UUT ROM is another technique that has been developed for debugging the Z80 testing tool. This technique could also be applied in similar situations. Depending on the status of this flag, the UUT would either execute out of UUT ROM or it would branch to the address following the flag in UUT RAM. This allows the placing of object code other than the normal ROM code into RAM, and executing it in lieu of the ROM code. The flag, of course, could be set via the 9010A, which is also used to download the RAM object code.

The most obvious use of this technique is that it allows an engineer to put manually assembled routines in RAM, and in turn, will allow you to exercise small portions of UUT circuitry without blowing a new PROM. These small routines can be used to branch around code in the ROM that is discovered to be defective or to create alternate initialization states for simulated reset conditions.

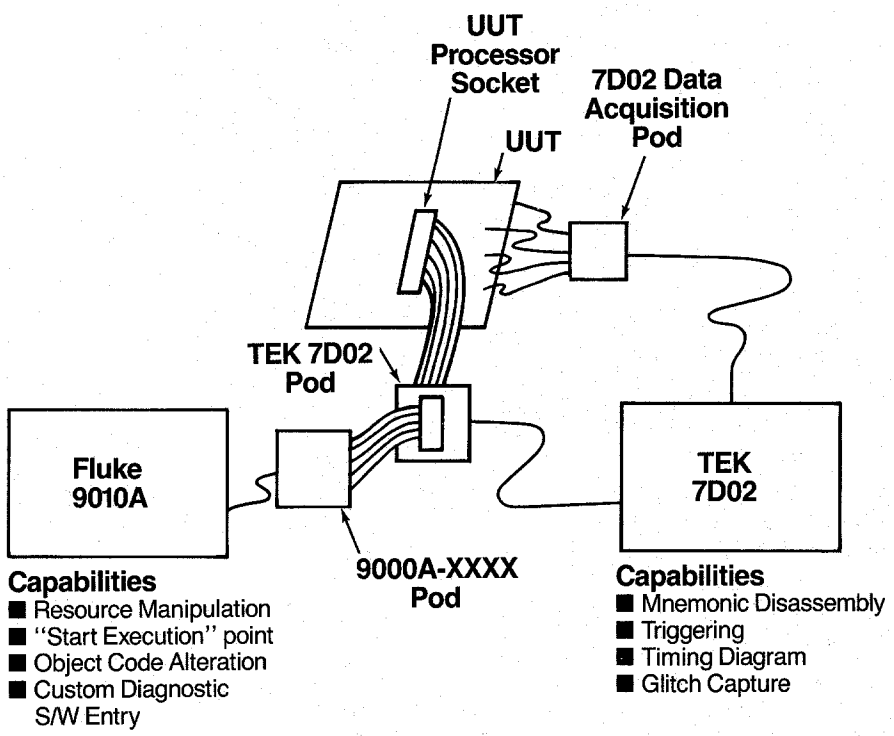

Figure 1.

9000 series user group

by Phyllis Levy

Joining a User Group can be an excellent way to share with or learn new applications from other people who work with the 9000 Series Micro-System Troubleshooter. User groups help to:

- increase communication between users
- increase professional training
- promote software exchange

Successful groups are currently meeting in Minneapolis, Atlanta and Dallas. The schedule (please contact the local office for location and time of meeting) is as follows:

Atlanta	meets quarterly, next meeting will be the 2nd Wednesday in April.
Dallas	next meeting will be Monday, March 4.
Minneapolis	meets quarterly, the next meeting will be April 17.

If you are interested in organizing a User Group in your area or learning if one is currently meeting, contact your local Fluke sales office.

IBM PC...

(continued from cover)

PC to the component level in a short time, frequently in less than fifteen minutes. The tapes have been shown to meet our software configuration, autotests, GFI, and documentation goals.

The basic test set consists of five minicassettes. The first two tapes are dedicated to autotests and functional tests and the remaining three contain GFI routines for the system board, monochrome adapter, and disk controller, respectively. Additions to this basic library will be made available in the future using a separate tape for each adapter or expansion board.

This one-tape-per-board approach allows the technician to load only the test routines most likely to be needed for a given set of symptoms. Each tape consists of an executive routine which "starts at the beginning," performing a sequence of tests which either point to faulty areas (autotest tape) or lead directly to the appropriate guided fault isolation routine (GFI tapes).

In either case, individual tests or GFI routines can be executed independently if desired. This is usually accomplished by manually passing information to or from a routine through a global register. For example, register 8 has been assigned, among other things, as an error status indicator, which may be examined by the operator after executing a module independently. (Most programs rely on a single subroutine to display test results based on register 8's contents).

The autotests were specified to be independent of the PC BIOS self tests, and to provide capabilities beyond those found in the IBM advanced diagnostics software. Thus, the 9010A/9005A would successfully troubleshoot UUTs which cannot boot due to problems in the kernel or disk drives, and would quickly identify problem areas more specifically than do the diagnostics.

The autotests first perform system initialization, including timer and DMA setup for memory refresh and video controller initialization which is required in the event that a display is connected (a display should not be powered-up at this point). Next, the 9010A BUS and ROM tests are invoked. The ROM test first examines location F000:FFF5 to determine the ROM BIOS version number, which is used to call in the appropriate set of signatures for comparison. The RAM tests are performed in two parts; the pod's quick-RAM test followed by a pattern sensitivity test which is down loaded from the 9010A/9005A to the PC's memory and executed at PC clock speed via RUN UUT.

Taken together, the full power of a combined RAM LONG and RAM SHORT test is achieved in a fraction of the time required for conventional RAM LONG. The initial memory test and download process take 2½ minutes; subsequently, each 64K bank of RAM requires only 3½ minutes to complete the combined quick RAM pattern sensitivity tests. In addition, the operator may specify smaller portions of memory to be tested if desired.

Following the above tests, I/O accessibility tests are performed for the system I/O chips. Finally, a number of tests are executed which require varying degrees of technician involvement, including display tests, keyboard tests, and optional disk I/O and alignment supported by a commercially available alignment disk. For autotests which do not require operator intervention, an option is provided to stop on the first error or to run to completion (so long as a 9010A/9005A built-in test has not assumed control). In either case, an error log is kept which may be examined on the 9010A/9005A display or printed out through the optional RS-232 port.

The guided fault isolation (GFI) routines and the user documentation work closely together to support component level troubleshooting. The GFI routines initiate normal signal conditions, test circuit response with the probe, and compare the probe register against the expected response. The sequence of steps is generally from function output back towards the derivations of the output. The GFI portion of the manual provides a kind of technician's toolbox containing concise, detailed information on each routine including which signal is tested, which IC is checked, and which other routines are called. Additional information is provided to support manual selection of the routine. If manual selection is not desired, Program 1 on each tape will call all the key modules in order, performing a checkout of major board functions, and will branch to the appropriate fault isolation routines if an error is detected.

The GFI routines will find a single failed IC in at least 90% of the cases. In very few instances, the routines stop at a cluster of two to four chips but clearly identify which chips they are. Since the probe alone cannot reliably identify which end of a circuit trace is causing a missing signal, use of a schematic and a current tracer may be recommended to avoid replacing several chips in shotgun fashion. The chips may be quite inexpensive, but the potential for costly damage to a circuit card is real, particularly on multilayer boards. There are several other instances when the probe alone cannot reliably locate a fault; these involve high frequency signals which can only be seen with an oscilloscope. The documentation will clearly describe these cases.

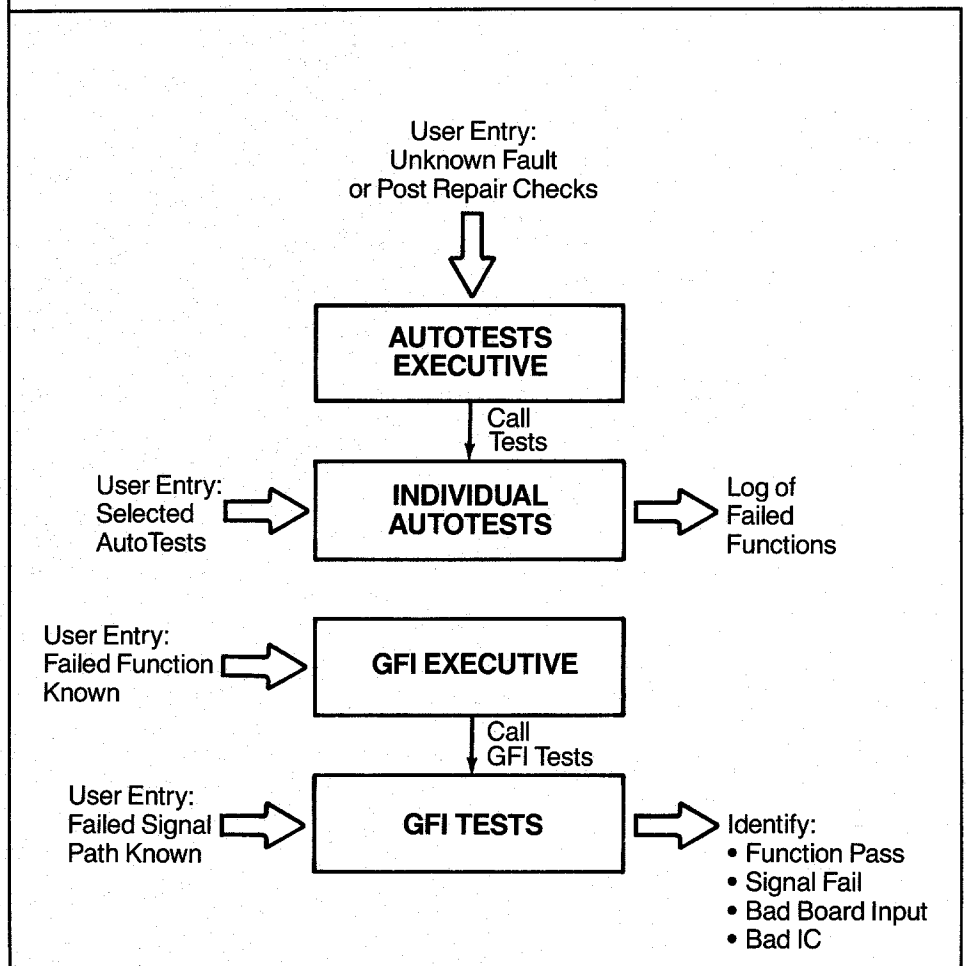

Figure 1. The user can choose among several entry points depending on skill level and knowledge of faults.

IBM PC...

A fully programmed troubleshooter requires careful preparation of user documentation that complements the modular software design and assists in supporting flexible troubleshooting. Thus, the user manual was designed to maintain internal consistency to ensure ease of use, and to provide individual program descriptions which support independent use of software modules. A modular design approach allows updates to be made as test software is developed for expansion boards. The manual remains independent of PC drawings or diagnostics, although some degree of optional references to PC schematics is provided to allow a technician to track nodes or paths being tested during the GFI routines.

The requirements to develop and maintain extensive internal documentation has been largely met by using the 9010A compiler (available from Fluke) for coding, compiling, commenting, and updating program listings. The compiler's support of symbolic label, register and program names has helped make listing more intelligible. Software design and maintenance has also made extensive use of detailed flowcharts and keying of GFI routines to published schematic diagrams. The user's manual, which was developed simultaneously with the software, has benefited greatly from well maintained software documentation.

The capabilities of the Fluke 9010A/9005A Micro-System Troubleshooter will be greatly expanded with fully programmed tapes supplied by Diversified Data Corporation. Troubleshooting of the IBM PC can be performed quickly by technicians at all levels of experience.

For more information about Diversified Data Corporation's TECHPRO™ troubleshooting software, contact your nearest Fluke sales office.

Introducing the 80186/80188 pods

by Jim Clodfelter

Fluke is proud to announce the development of the 16-bit 80186 and 8-bit 80188 Pods. Now, for the first time, you can troubleshoot microprocessors that are packaged in leadless chip carriers (LCC), or use the adapter for pin grid arrays. These "intelligent pods" incorporate many special features, features that are quickly becoming a standard in Fluke's newer pods.

By building testing features into the pod itself, we have successfully increased testing speeds. These features include:

Quick RAMP
Quick ROM
Quick LOOPING
Quick RAM
Quick FILL

Quick RAMP sends to a particular address a series of data words that start at zero and increment up to FFFF hex. The RAMP function has found widespread application as a stimulus for signature analysis in the Micro-System Troubleshooter.

When the RAMP function is implemented in the mainframe, the execution time for a 16-bit data bus is quite long, while the time for an 8-bit data bus is acceptable. By incorporating the Quick RAMP feature within the 16-bit 80186 Pod, interaction with the mainframe has been set to a minimum, allowing the Quick RAMP feature to be completed in a very short period of time.

Quick LOOPING provides an increased looping rate when executing Reads or Writes at a specified address. This function, due to the increased repetition rate, can be used to enhance viewing signal traces on an oscilloscope. You can do this by synchronizing the oscilloscope to the TRIGGER OUTPUT pulse which can be found on the rear panel of the mainframe.

Quick Fill allows you to visually test memory-mapped video displays and read and compare written data. These tests are executed by the Fill and Verify Functions and when combined into one step serve as a rapid way of exercising large blocks of memory.

The Fill function can fill the terminal display with a certain character or pattern. This is accomplished by writing the same data to all of the addresses in video memory. Now, it is very easy for the operator to visually check for errors in the display.

The Verify function reads the stored data and then compares each data word to the initial data at the first address. All errors are stored at a specified location in the pod and can be retrieved if needed.

Quick ROM allows you to rapidly detect faulty ROM devices. The pod computes a checksum based on the data within a specified address block and stores it in an addressable location within the pod. This can now be retrieved and compared with a good checksum for the same address block. This test can also be used to detect inactive data bits (bits that always read high or low regardless of which ROM address is read).

In addition to the standard Quick RAM tests (Read/Write and Decode tests), these pods can also perform a quick pattern verification of the RAM space.

Quick Pattern Verification of RAM Space is designed to test the refresh capability of dynamic RAM. If the Quick RAM test is completed without errors, a particular pattern is left in the memory space. This test will read this pattern at any time in the future and verify that the data has not changed, over time, due to deterioration of the Dynamic RAM refresh capabilities of the system.

For further information on Quick RAM and Quick ROM, see the article "New Microprocessor Pods Test Large RAMS 20 Times Faster", that appeared in two issues of the TROUBLESHOOTER: No. 2, May 1983 and the 1983 Annual.

These Pods have special interrupt handling capabilities and provide the ability to synchronize the probe to Interrupt Acknowledge signals. The probe may also be synchronized to the standard Address, Data, and Free-Run modes.

The 80186/80188 microprocessors have several programmable Chip Select lines which output from the pods. With these pods, the output from the chip select lines can be configured to behave as the UUT requires. You can test these lines using the BUS test function of the mainframe.

The 80186 and 80188 Pods have been designed for troubleshooting external UUT circuitry associated with internal peripheral devices of the 80186 or 80188 microprocessors. These internal peripheral devices include the chip select & wait-state generator, the DMA controllers, the timers, and the interrupt controller. The timers can be programmed to operate as if the microprocessor were in place (timer outputs are checked for driveability during Bus Test).

Special addresses exist in the pod for controlling special functions such as error reporting, error masking, and simulating DMA operations. Byte and word addressing are also possible but only with the 80186 pod. The 80186 and 80188 Pods contain extensive self-tests including a continuity test for the UUT cable, checking all but three of the signal lines.

For more information on the 80186/80188 pods, or a demonstration of any Fluke 9000 Micro-System contact your local sales representative.

Signetics 8X300 pod adapter

by Kirk E. Schuetz

Kentron International , Topeka, Kansas

Since Fluke does not offer an interface pod for a Signetics 8X300 microprocessor (μP) based system, it was necessary to build an adapter to allow an existing interface pod to communicate with a unit under test (UUT). The Z80 pod was chosen for its availability and for its 5 MHz maximum clock rate, its unmultiplexed address and data lines, and its single 5 volt supply. This article describes an interface pod adapter that allows the 9000 Series Micro-System Troubleshooter to test and troubleshoot a printed circuit board controlled by a 8X300 μP.

A 50-pin header is needed to plug into the 8X300 socket. If a 50-pin header is unavailable, a suitable 50-pin configuration can be constructed by cutting up dual in-line package headers and glueing them to a fiberglass vector board.

1C	Type	VCC	GND
U1	74LS04	14	7
U2	74LS74	14	7
U3	74LS244	20	10
RM1	899-1-R180	—	14

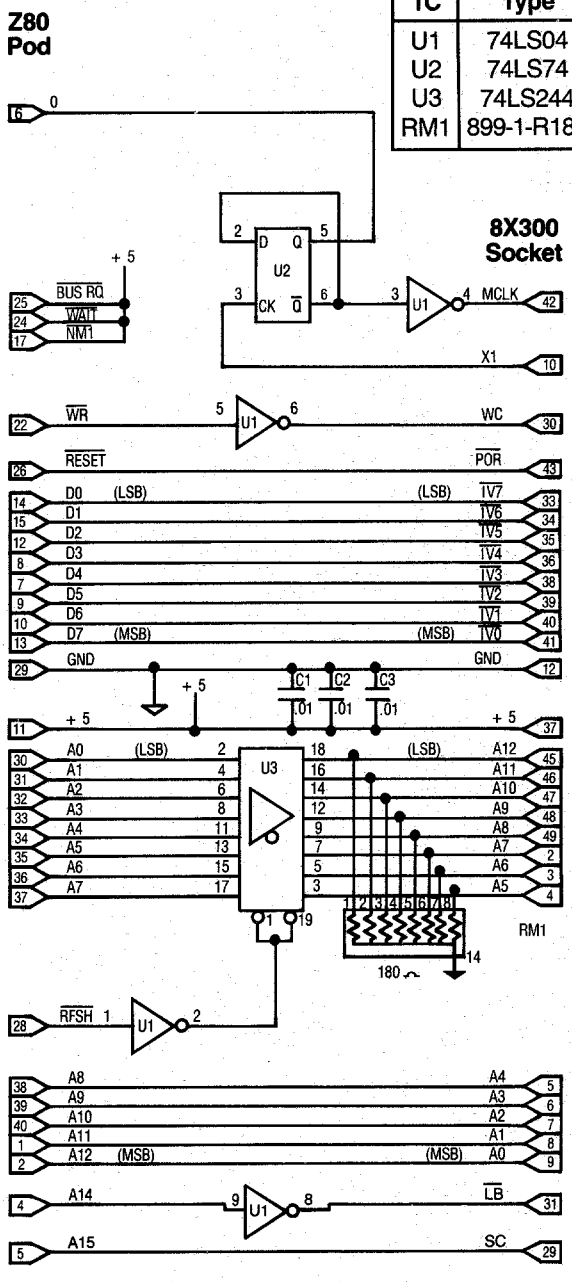

Figure 1. Signetics 8X300 to Z80 Pod Adapter

The 8X300 typically uses clock rates over 5 MHz which makes it necessary to divide the UUT clock to below 5 MHz. As the schematic (Figure 1) indicates, a D-type flip-flop, U2, is used to divide the UUT clock (X1) in half. This provides a satisfactory clock rate to run the pod and a proper rate for the MCLK signal normally coming out of the 8X300.

The 8X300 has three busses: the instruction bus (I0-I15), the address bus (A0-A12), and the interface vector bus ($\overline{IV0}$-$\overline{IV7}$). The instruction bus does not feed back to the Z80 pod, so these lines have to be probed for signatures. The address and interface vector lines for the 8X300 are defined differently than the address and data lines of the Z80. They are connected as follows:

	Address		Data	
	Z80	8X300	Z80	8X300
LSB	A0	A12	D0	$\overline{IV7}$
MSB	A15	A0	D7	$\overline{IV0}$

The Z80 $\overline{WR}$ output is inverted to provide the write command (WC) output, and the Z80 A15 output is used for the select command (SC) output. The Z80 A14 output is inverted to provide the left bank (LB) output. The unused Z80 A13 output, if needed, could be inverted to provide the right bank (RB) output.

The automatic refresh function of the Z80 puts unwanted signals on address lines A0-A7. This causes unstable UUT signatures. This problem is corrected by the tri-state buffer, U3. The buffer outputs are disabled during $\overline{RFSH}$, causing the buffer outputs to go to the high impedance state. The effects of the high impedance outputs are minimized by the 180 ohm pull-down resistors of RM1.

The adapter worked well to test and troubleshoot all or most of the circuits on the UUT. This is just another example of the versatility of the Fluke 9000 Micro-System Troubleshooter.

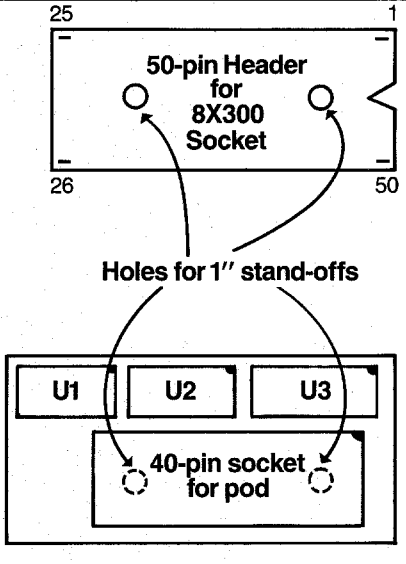

Figure 2.

9010A application support

The following individuals and their organizations have indicated their capabilities of, and interest in, providing independent 9010A support. The services offered are shown with each name.

If you would like your name added to the list, please let us know.

IFE Electronics
Moossfrasse 8
2545 Sel Zach
Switzerland
065-611573

Mr. Ali Mosleh
Computer Service Corp.
8300 Merrifield Ave.
Fairfax, VA 22031
(703) 560-5051 (office)
(703) 560-1316 (home)
Contract programming and troubleshooting.

Mr. Gary Aiken (Eng. Manager)
Diversified Data Corp.
6551 Loisdale Court
Springfield, VA 22150
(703) 922-9444
Contract programming, engineering support, integrated logistics support, documentation, and training.

Mr. Allan Cody
Electronics Corp. of America
1 Memorial Dr.
Cambridge, MA 02142
(617) 787-5980
Contract programming, testing and troubleshooting.

Mr. Thomas Bielecki
EMF Inc.
60 Foundry St.
Keene, NH 03431
(603) 352-8400
Contract programming and testing.

Mr. Dick Thomas
General Electric Co.
Instrument & Computer Equipment Repair Service
5096 Peachtree Rd.
Chamblee, GA 30341
(404) 452-4905
Contract programming, testing, and troubleshooting.

Mr. Quint Pierson
General Electric Co.
Schenectady Instrument Service
Bldg. 28, Rm. 503
Schenectady, NY 12345
(518) 385-5107
Contract programming, testing, and troubleshooting.

Mr. Julio Cordova
High-Technology Services
1301 W. Copans Rd., Bldg. F
Pompano Beach, FL 33064
(305) 973-4949
Contract programming, testing, and troubleshooting.

Mr. Mike Pearson
Mike Pearson & Associates
2013 Tiehick Lane
Garland, TX 75234
(214) 495-4510
Contract programming, testing, and troubleshooting.

Mr. John Schira
Quinton Instruments
2121 Terry Ave.
Seattle, WA 98121
(206) 223-7373
Contract programming.

Mr. A. Gallagher (System Eng.)
Wismer & Becker Engineers
7820 Folsom Blvd.
Sacramento, CA 95806
(916) 381-3930 Ext. 475
Contract programming, testing, and troubleshooting.

Mr. Dennis D. Norwood
O'Conner Distributing Co. Inc.
9030 Directors Row
Dallas, TX 75247
800-527-2432 Outside Texas
800-442-6586 Texas
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You can receive a Fluke 77 the same way. The TROUBLESHOOTER is looking for customer-written articles that cover solutions to difficult testing problems, and unique Troubleshooter applications. Articles should be submitted to:

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Benelux	Aug 19-23	'85
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