HEWLETT PACKARD

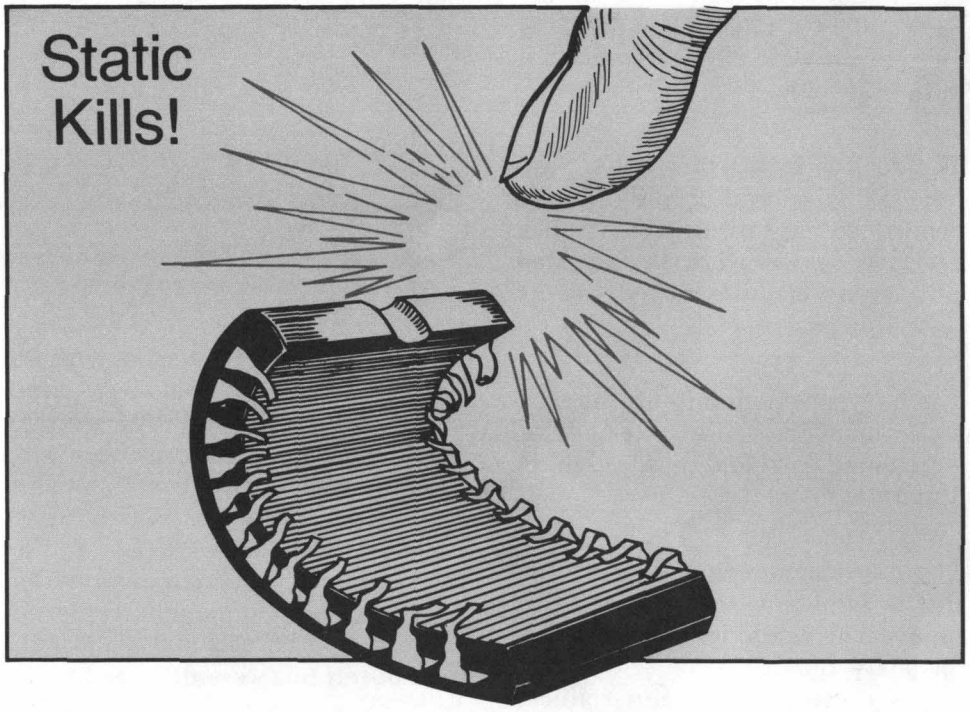
BENCH BRIEFS

SERVICE INFORMATION FROM HEWLETT-PACKARD

MARCH-MAY 1983

Static Zap Makes Scrap

Static electricity is a familiar phenomenon which, except for an occasional mild shock or annoying "static cling", doesn't seem very serious to most of us. In fact, many people in the electronics industry reject electrostatic discharge (ESD) as a major cause of component failure and hence, of equipment failure. It's not surprising that many people doubt the magnitude or even the reality of the ESD problem. In many cases a damaged part exhibits little or no physical damage when observed in a cursory microscopic investigation. Unfortunately, many electronic components can be damaged or destroyed by ESD at potentials well below a person's range of sensory perception. Passive as well as active components are susceptible and the damage ranges from a slight degradation of a parameter to catastrophic failures such as short circuits. The catastrophic failures are easy to discover and analyze, it's the "wounded" parts that fail sometime later that are hard to track down and prove ESD-caused damage.



It is this difficulty in recognizing ESD-related failures that is one of the main reasons for lack of ESD awareness. And this is the most important part of the battle against static ZAP—the need for static awareness—on the part of top management right on down to packing and shipping or receiving departments. ESD control measures must be implemented because the trend towards smaller geometry, lower power, and lower voltage technologies is also a trend towards much greater ESD susceptibility.

Who would have thought 10 years ago that engineers would ever have to worry about types of floors, floor polishes and cleaners, bench tops, shoes, carts and wheels, antistatic sprays, masking tape, plastic work order holders, and other ESD related articles? Today we do have to think of these things because the progress in internal protection circuits, in relation to the trend towards smaller geometry as mentioned above, does not appear to be able to keep up. Thus, ESD problems will be getting more severe in the immediate future.

How Severe You Ask?

One source in the electronics industry estimates we may be losing as much as ten billion dollars annually from ESD. There could be as much as 500 million dollars lost at the component level because of the extensive damage caused by ESD. Dick Moss, Hewlett-Packard Corporate Reliability Engineering Manager, states, "Through ESD control we can reduce in-house failures and field failures by at least ten percent." Mr. Moss foresees Hewlett-Packard, as a whole, spending over a million dollars in establishing static control programs. Over half our divisions have already incorporated electrostatic control programs. Several

Part No. 5952-0114

Hewlett-Packard divisions have implemented static elimination programs that have had significant documented measurable results.

Example 1

In March 1980, one HP Manufacturing Division conducted an experiment to determine the effects of handling unprotected integrated circuits. Eighty-seven circuits were tested and found good. Forty circuits were put in a plastic box as usual; forty-seven were carefully placed in antistatic foam.

The devices in the plastic box were handled by several people in the IC department and returned to the box. The forty devices were then retested. Thirty-one circuits failed the PC test, nine passed.

The forty-seven circuits in the antistatic foam were also retested. All were found good and returned to the antistatic foam.

This experiment eventually resulted in the reduction in time for board repair. For example, standard time for board repair on one of this division's systems has been reduced from 13 to 5.47 hours per unit. ESD handling procedures implemented in another production area improved the yield of a bipolar LSI part from 22% to 100%. And later, ESD protection procedures were implemented to lower failure of a hybrid chip used widely throughout the company. After this program was implemented, DOA line returns fell from 25% to 4% within two months.

Example II

Another HP Manufacturing Division made an informal test in August 1980 to determine component sensitivity on a PC board manufactured in large quantities. Ten boards were taken from line stores and verified as good. Using a static generator, the test personnel touched the edge connectors with an ESD probe. All ten boards were damaged by a 650 to 1000V electrostatic charge. The failures were verified by inserting the boards into an operating instrument. Repair work revealed that the LS TTL was the most sensitive component on the board—every component replaced was the LS TTL. The 8080s and TTL did not fail but were damaged.

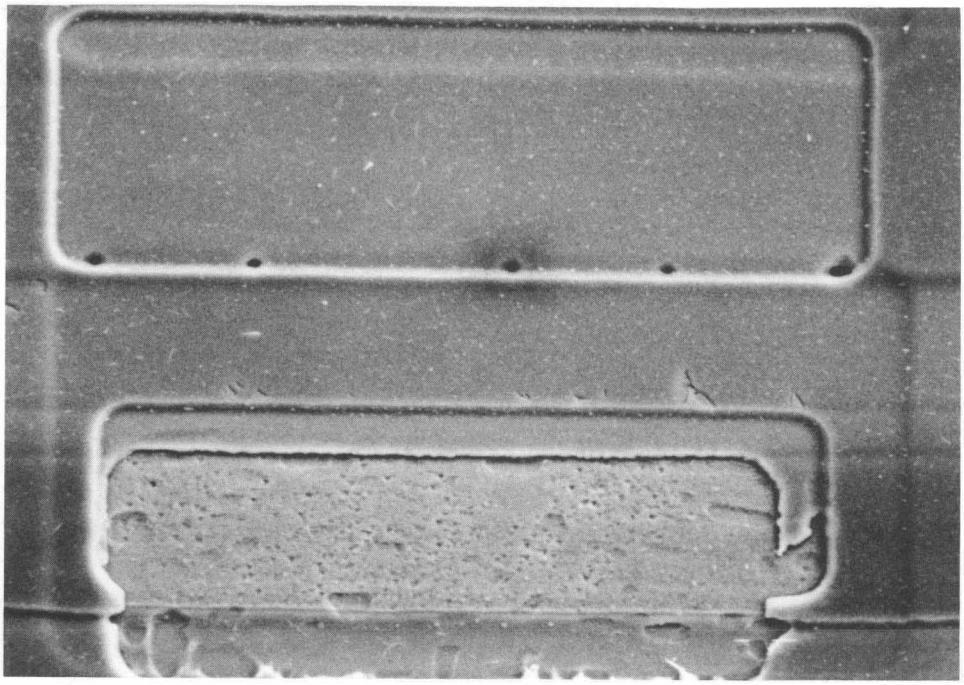


Figure 1. This is a MOS FET with the oxide and metal removed to show the craters in the gate. The rough area at the bottom is a metal pad for a connector. Magnification is 2200X.

This brings up two important points about ESD. 1—People can often carry 1000 to 5000 volts without ever feeling the sensation of any discharge under 3500 to 4000 volts. 2—Components mounted on a PC board have increased risk of ESD damage because each printed conductor (or wire) is a highway connecting to several devices. A discharge to that conductor stresses several devices at once rather than just one.

Example III

In mid 1980, one of our computer divisions implemented an aggressive ESD prevention program to lower their 23% in-plant failure rate on certain series of assemblies. Employees were trained on ESD and its prevention. Static-safe workstations were outfitted in production area. Within three months, failures dropped to less than 3%.

Understanding the Process

Static electricity is actually electronic charge at rest on a surface. When the charge becomes sufficiently large, an electrostatic discharge can take place. The discharge takes place of course when a charged person touches a part or a charged part touches another conductive surface. How does the surface become charged? There are three types of static generators.

Triboelectricity

The most common static generator is triboelectric charging, where two materials in contact are suddenly separated or rubbed together. A common demonstration of this principle is pulling mending tape off its roll to generate in excess of 5000 volts. A person can develop a significant charge on his or her body

with a relatively simple movement, such as walking across a floor or removing a coat. Strolling across a vinyl floor can generate as much as 12,000 volts which is enough static to give a slight shock. The simple act of shifting the body can generate hundreds of volts. The charged person then touches a device, say during a hand assembly operation. The energy in the body is transferred either to the device, or through the device to ground. And this discharge is usually much more than many circuit packs can handle.

So how do the parts themselves become charged by the triboelectric process? Consider for example, that most integrated circuits are transported and shipped in plastic tubes. Charges can be developed on these devices because of movement in the tube. When a charged device is emptied from the tube and grounded, the rapid discharge can cause the device to fail.

Induction

A second, more subtle type of charging is called "induction" because the electrostatic field of a charged surface induces polarization of a nearby conductive body. If there is a discharge path for this induced charge, an ESD may occur immediately.

A good example of this principle is when a person handles a printed circuit board assembly wrapped in plastic bubble wrap, or an individual integrated circuit located inside a plastic bag. The person handling the plastic induces a charge onto the plastic which in turn induces a charge on the piece inside. It does not matter if the person has a wrist strap on or not. When the person touches the piece to remove it from the plastic, the sudden discharge causes the ESD damage.

Capacitive

Capacitive charging is a third mechanism which can be responsible for increasing relatively harmless voltages to dangerous levels. The familiar equation Q = CV (charge equals capacitance times voltage) can be solved for voltage and we quickly see that if charge is constant, voltage increases as capacitance decreases. Thus a harmlessly low voltage on a component or human with a high capacitance to ground can become a harmful voltage as the object is moved further from a ground plane, for example when an assembly on the floor or table is picked up, you change its capacitance and hence voltage. Now, when you ground the assembly it will more than likely be damaged whereas before, the charge might not have been high enough to be harmful.

This brings us to the three myths of Electrostatic Discharge (ESD).

The Three Myths of ESD

Myth No. 1. Only Metal Oxide Semiconductor (MOS) Devices are Susceptible to ESD.

While it's true that MOS devices are extremely sensitive, tests have shown that other types of components are also just as sensitive. Table 1 shows a spectrum of sensitivities (note the non-MOS devices in the extremely sensitive group).

Table 1. ESC sensitivity of typical components (based on measurements using 100 picofarads discharged through 1.5 kilohms)

Extremely Sensitive
0 to 1 Kilovolt

- Unprotected MOS: Field Effect Transistors (FETs) and Integrated Circuits (ICs)—especially Very Large Scale Integration (VLSI)
- MOS Capacitors (Op Amp internal compensation)
- Junction FETs and low current Silicon Controlled Rectifiers (SCRs)—less than .15A
- Microwave and Very High Frequency (VHF) transistors, Microwave and VHF ICs—especially Schottky
- Precision IC voltage regulators—less than .5%
- Precision thin film resistors—less than .1%
- Low-power thin film resistors—less than .5w
- VLSI with dual-level metallization

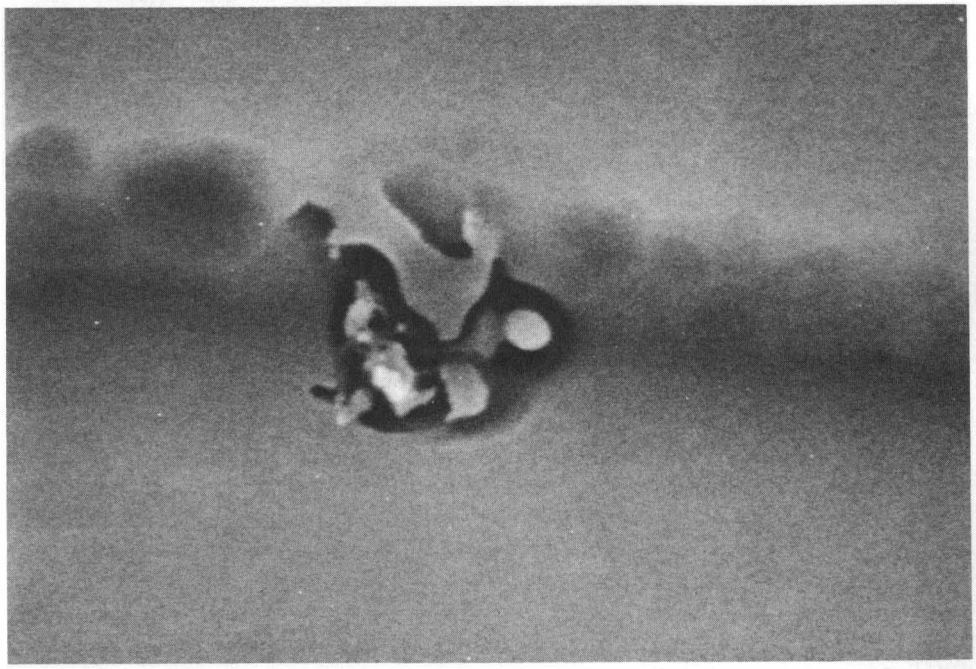


Figure 2. This is a blowup (23,000X) of one of the craters shown in Figure 1. The crater is ~1 micron wide and contains fragments of melted metal.

Sensitive
1 to 4 Kilovolt

- MOS with protection networks (CMOS, NMOS, PMOS)
- Schottky diodes
- High-speed bipolar logic: Emitter Coupled Logic (ECL), Low Power Schottky-Transistor
  Transistor Logic (LS-TTL), Schottky TTL (S-TTL)
- Linear ICs

Less Sensitive
4 to 15 Kilovolt

- Small signal diodes—less than 1w
- Small signal transistors—less than 5w
- Low-speed bipolar logic (TTL, Diode Transistor Logic [DT1], High Threshold TTL [H-TTL])
- Quartz and piezoelectric crystals

Myth No. 2. Only Unmounted Components are Susceptible to ESD.

This is only true if the assembly has protection circuits at all sensitive nodes, particularly where a sensitive device input is routed to a connector pin. What usually happens is that mounting components on printed circuit assemblies increases the risk of ESD damage because each printed conductor connects to several devices. A discharge to that conductor thus stresses several devices at once rather than just one.

CMOS circuits subjected to an ESD while they are powered have an additional risk—latchup. Latchup is a parasitic pnpn avalanche usually caused by an input or output "glitch" which exceeds the supply voltages so that the parasitic device is triggered "on." The CMOS then tries to shunt the power supply to common and the usual result is overheating and catastrophic failure. In some very low power CMOS devices used in battery operated products, the latchup is not damaging to the IC but increases the battery drain to the point of early discharge of the battery and consequent early replacement. In both these cases, ESD is often not suspected since the evidence seems to point elsewhere.

Myth No. 3. Only Low Humidity Environments Allow the Production of ESD.

There is a widely held belief that there are no static electricity problems when the humidity is high. It is true that the increased surface conductivity at high humidity tends to reduce triboelectric generation, to spread charges over larger surfaces so that the fields are less intense, and to allow charge to bleed off to ground more easily. But the real reason the myth is so widely believed is that the voltages encountered during high humidity are generally less than the threshold of perception of the average person, which is typically 3 to 4 kV. This is also the voltage necessary to cause a visible and audible spark from a fingertip or handheld tool to a conducting surface. Table 2 illustrates some typical sources of ESD and the relationship between relative humidity and the ESD value. Charge levels are reduced in high humidity environments, but are still well within the undesirable range.

Table 2. Typical electrostatic voltages versus relative humidity

Source	ESD Value	
	70-90% RH	10-20% RH
	Kilovolts	
Walking across vinyl floor	0.25	12
Walking across synthetic carpet	1.5	35
Sitting on foam cushion	1.5	18
Picking up standard plastic bag	0.6	20
Sliding plastic box on carpeted bench	1.5	18
Pulling tape from PC board	1.5	12
Skin packing PC board	3.0	16
Triggering standard solder remover	1.0	8
Cleaning circuit with eraser	1.0	12
Freon circuit spray	5.0	15

ESD Prevention

It is easier and more effective to remove static from the environment and bleed the charges from people off to ground than to rely on protective devices built into the circuitry (which seldom exceed 2 kV in protection). The design and effectiveness of protective circuitry varies between manufacturers. Zener diodes may not act quickly enough to protect the more sensitive components. The use of limiting resistors is restricted to the voltages they can withstand. Also, protective circuitry sometimes reduces the performance of the device. This could be a heavy penalty for applications requiring high-performance.

Self-control of ESD prevention involves a program revolving around the following basic rules.

Rule No. 1. Treat all electronic parts and assemblies as static sensitive.

- Don't touch leads, pins, or traces while handling.
- Keep parts in original containers until ready for use.
- Discharge static before handling devices by touching a grounded metallic surface such as a rack or cabinet. Better yet, use a wrist

strap grounded through a one megohm resistor.

- Do not slide static-sensitive devices over any surface.
- Notify your manager or static coordinator of mishandled parts—they may pass final test but be degraded enough to fail in the field;

Rule No. 2. Handle all sensitive parts and assemblies at "static-safe work stations."

A static-safe work station is defined as having:

- Conductive table mat grounded through a one megohm resistor. Each mat should have two swivel connectors, for connecting wrist straps, one for the worker, the other for supervisors, inspectors, etc.
- Conductive wrist strap in contact with bare skin and connected to swivel connector on mat through one megohm resistor. Alligator clips should never be fastened onto the table mats because their area of contact is too small to be effective as a ground conductor.
- All metal equipment grounded: soldering irons, work benches, machinery, electrical equipment, fixtures, cleaning nozzles, lazy susans, or turntables, stands, cabinets, and shelving made of metal must be grounded.
- One common ground at any one work station. Example: table mat and equipment must connect to same ground. Screws on metal junction boxes of a properly grounded AC power line are a good place to attach ground cable.
- Keep work area clear of nonconductors. No common plastics, polybags, cardboard, cigarette packages, candy wrappers, work envelopes, synthetic mats, or ungrounded metal plates. No rugs on floor, work surfaces, or shelving.
- Clothing must never come in contact with components or assemblies. Short sleeves are preferred and long sleeves must be either rolled up high enough to prevent contact with or close proximity to sensitive parts, or covered by a long-sleeved smock or sleevelets made of ESD protective material. Antistatic smocks are recommended for general wear and especially when handling class 1 (sensitive to 1000 volt) material.
- Use only proper containers for storage such as static protective bags, conductive or antistatic trays, and tubes of integrated circuits. No paper or cards are to be inside the containers.
- Gloves, if used, are to be cotton or antistatic; no synthetics.
- Carts, if used to transport sensitive items, should have carrying surfaces covered by conductive mats and at least two conductive wheels.
- A conductive floor mat, which is grounded, and conductive heel straps should be used where walking is necessary and wrist straps cannot be worn. A new heel strap must be used each day. An alternative to the heel straps are shoes with conductive soles designed to be worn in antistatic environments.
- Brushes, if needed must have natural bristles; no synthetics.

In addition, the following practices must be followed weekly to maintain the static-safe work station and a safe (free of electrical shock) work area.

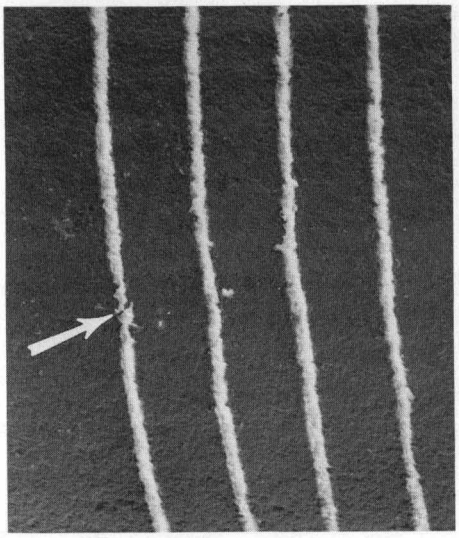


Figure 3. These are the spiral cuts in a precision one megohm metal film resistor. The arrow shows where ESD arced across the gap melting metal causing a bridge.

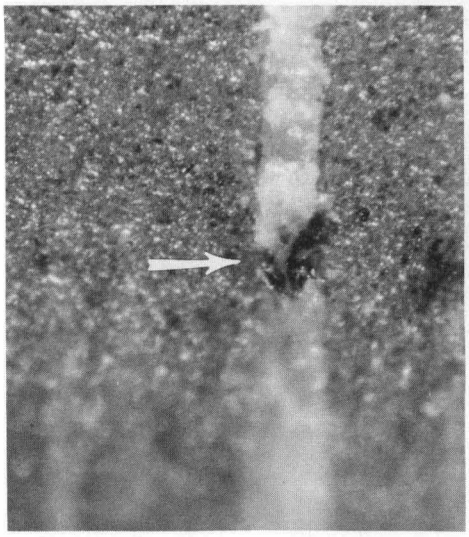


Figure 4. Closeup of damaged area shown in Figure 3. This is a good example of a "wounded" part just enough out-of-tolerance to cause a circuit problem—very difficult to troubleshoot due to parallel resistances.

- Work station must be monitored for proper grounding, for safe procedures and static hazards. Grounds and wrist strap continuity should be checked with an ohm meter. Work stations, including materials and containers should be checked with a static meter.
- Spray antistatic solution on a clean cloth and wipe top of work benches, hand tools, chair seats, and backs.
- Clean conductive mats with a mild detergent and water or with antistatic solution. (Dirt or wax can insulate the surface and prevent conductivity).

Rule No. 3. Package parts properly for storage or transportation.

- Envelopes or containers should have a warning label on the outside (JEDEC/EIA symbol preferred).

Figure 5. Approved label for electrostatic sensitive devices.

- Store and transport sensitive parts and assemblies only is ESD-protective enclosures. The best protective enclosure is a "Faraday cage." Metal, metallized plastic and carbon-loaded plastic are all examples of such containers, with the metallized plastic having the advantage that it is semitransparent so that the contents can be seen without opening it. The difference between the "Faraday cage" and the "pink-poly" bags is as follows: the "pink-poly" bag guards against static being created when the part slides around inside or when the outside of the bag is rubbed. But if a person's body is charged and picks up the "pink-poly" bag, the part inside the bag will become charged by the induction method. Then when the bag is opened and the part removed, the sudden grounding of the part can generate the ESD damage. On the other hand, the "Faraday cage" shunts any such inductive charges around the part providing complete protection.
- When packing parts for storage or transportation, use antistatic packaging and pack the parts tightly to prevent motion which could generate static.
- Makes certain that the tubes used to store and transport ICs are the antistatic type. Plastic tubes will cause a static charge build-up on the ICs when they slide out of the tube.
- Ensure that charts, wheels, caster, frames and shelves are conductive. If you are transporting sensitive electronic equipment on a cart with rubber wheels pushed by a person wearing crepe or heavy rubber soled shoes, you just have another form of a "Van de Graaff" high voltage generator.

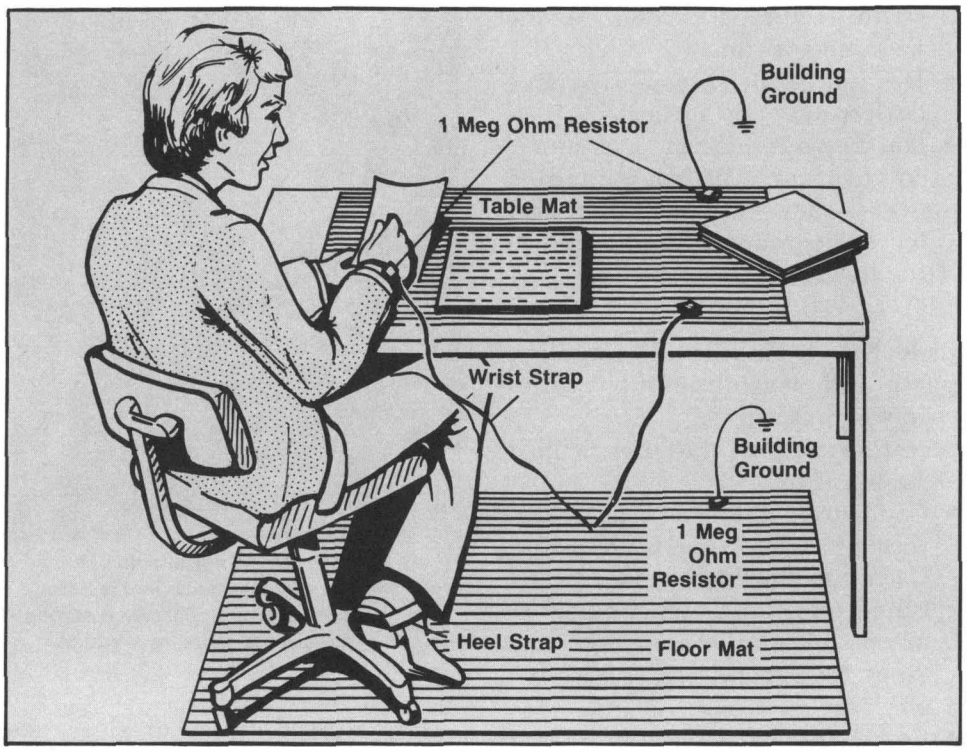


Figure 6. Example of a static-free workstation for board repair.

Conclusions

ESD damage is responsible for an unknown but significant percentage of electrical component failures and is likely to increase as the use of smaller, faster, lower-power components increases. Protective and preventive measures are fairly simple but won't succeed unless they are coupled with static awareness education. Static damage prevention is an example of a process which is only as good as its weakest link. The components remember!

Editor's Note: The recent explosive growth of the ESD protective products market has introduced a vast array of products to the potential buyer. Unfortunately, the multitude of voices and choices in the market place has tended to make the selection of an optimum product rather difficult.

Therefore, "Caveat Emptor," let the buyer beware, is especially germane to the purchase of ESD protective materials. For the maximum quality assurance, substantial purchases should only be made after a thorough review of the market, a formal product qualification program, and lot sample testing to assure consistent quality. As an aid toward this end, a document has been written as an aid to the buyer in making an intelligent choice by discussing the pros and cons, strengths and weaknesses and potential failure mechanisms of the various different generic materials presently available for ESD protection. The information and data contained in this document are not to be construed as an endorsement or prohibition of any specific product.

The document is:

ESD Protective Material and Equipment: A Critical Review

Spring '82

Order No. SOAR-1

Prepared by Norman B. Fuqua
IIT Research Institute
Under contract to:
Rome Air Development Center
Griffiss AFB, NY 13441

Contact:

Harold A. Lauffenburger
Reliability Analysis Center
at Griffiss AFB

Acknowledgements

The words, Figures and photos for this article were compiled from many different sources, both within and outside of Hewlett-Packard. Mr. Mike Ward, Product Assurance Manager at HP's Computer Support Division and Mr. Thomas Edmonds, Product Assurance Manager at HP's Instrument Support Division are actively engaged in ESD prevention programs for HP's major repair centers. Other companies are also heavily involved in ESD prevention programs. A lot of source material was contributed by Mr. George K. Hagge, Production Inspection Group Leader at the E. F. Johnson Company. He included material he had gathered from Mr. C. Fred Mykkanen, editor of a Honeywell publication called Component Comments. Final editing for technical accuracy was performed by Mr. Richard Moss, HP Corporate Reliability Engineering Manager, and producer of an HP video tape called "Static Zap Makes Scrap." Copies of this 30-minute tape are available through your local HP office. Order HP part number 90383R and specify A for VHS-SP, or B for Beta 1, or D for 3/4 " Umatic tape format. For example, 90383RB orders the tape in Beta 1 format.

New HP 3497A Manuals

We are pleased to announce that the following three-volume set is now available. These manuals were rewritten to provide information that is concise, accurate, and easy-to-use.

Because these manuals are significantly improved over the prior editions, we thought our customers would want to hear about the special limited time offer to purchase any one or all of them at half price. We will soon be mailing out a letter to nearly 1000 customers who have returned the "pink card" requests for manual information.

So look for your card in the mail, or if you just want to buy a great manual, get your order in soon. These new manuals are certainly an asset to the 3497A and we are sure that you will be pleased with them. Contact your local HP office for details.

New 3497A Documentation

HP Part Number	Title	Price: Before July 31	After Aug. 1
03497-90019	Operating, Programming and Configuration Manual	$35	$75
03497-90020	Installation and Service Manual	$25	$50
03497-90021	Plug-in Assemblies and 3498A Extender Service Manual	$25	$50

OPERATING, PROGRAMMING AND CONFIGURATION MANUAL (03497-90019)

This 665 page manual contains operating, programming and configuration information for the 3497A mainframe, for its plug-in assemblies (Options 010 through 140) and for the 3498A Extender.

MAINFRAME INSTALLATION AND SERVICE MANUAL (03497-90020)

This manual contains installation and component level maintenance information for the 3497A and the optional DVM (Option 001).

PLUG-IN ASSEMBLY/3498A EXTENDER SERVICE MANUAL (03497-90021)

This manual contains component level maintenance information for all plug-in assemblies (except Option 140 which is unserviceable) and for the 3498A Extender.

New Service Notes Provide Aid in Troubleshooting and Service

Calibration and Troubleshooting for the 1980A/B Oscilloscopes

This issue of *Bench Briefs* lists several service notes for the HP 1980A/B Oscilloscope Measurement System that will help you save time and money, and improve the reliability of your Hewlett-Packard product.

Troubleshooting for Random Intensity Level Changes

This troubleshooting tip is for 1980A/B Oscilloscopes with serial numbers prefixed 2126A and below.

Does your instrument show a random brightening of trace intensity? (The character display may or may not be affected.) Does a front panel key closure seem to correct the trace intensity level?

This condition can be traced to one of several different causes. The first step is to monitor the unblanking gate output with an oscilloscope, then the CRT grid and cathode voltages with a high voltage probe and meter. Should a change in any of these levels coincide with the intensity level change, it would indicate a circuit problem. Trace the problem to the source of the shift in level and correct.

If the gate or CRT grid and cathode levels remain constant during intensity shifts, it may indicate that one of the CRT grid-to-cathode protection neons (A2V1 or A2V2) is oscillating. To verify this condition, lift one end of either neon from the board and look for trace intensity level changes. If the problem dissappears, replace both neons with HP P/N 2140-0013. Refer to service note 1980A/B-13 for configuration instructions.

If lifting the neons did not cure the problem, the CRT itself is suspect.

New and Improved User Calibration Procedures

Service Note 1980A/B-14 is offered as a supplement to the Operating and Service manual and is recommended for all serial numbers.

Calibrating the HP 1980 Oscilloscope Measurement System is broken down into two different procedures. The first procedure, called hardware calibration, is similar to calibrating a standard oscilloscope. The second procedure, called software calibration, or in the case of the HP 1980, Front Panel Cal, is entirely new.

Hardware Calibration

Hardware calibration is often more time consuming than needed. Many technicians misunderstand (through no fault of their own) the intent of the service manual calibration procedure. Due to the way service manuals are structured, technicians are led to believe that all adjustments must be checked at each calibration. This is not true. Typically, a total hardware calibration procedure is necessary only after a major overhaul, or a repair affecting power supply levels, or a CRT replacement. Many adjustments relate only to the loading effects of the CRT and do not need to be checked unless the CRT is replaced.

This procedure and the HP 1980 service manual adjustment section are structured to direct you to only those adjustments necessary after specific repairs. Test equipment requirements are the same as any 100 MHz oscilloscope with the exception of a counter necessary to check the processor oscillator.

Software Calibration

Software calibration is an interactive process between the operator and the HP 1980 Oscilloscope. In simplified terms, you apply a known precision signal to the oscilloscope and observe the amount of deviation on the CRT. Then, following a procedure displayed on the CRT, you perform simple adjustments to correct for the deviation. These adjustments are stored in the HP 1980 in non-volatile memory (RAM) as "cal factors." The internal processor retrieves these numbers and uses them in formulas that convert them back to analog voltages that are used for positioning, balance gain, sweep timing, etc. The RAM is battery protected when the power is off. The numbers are also protected from being altered by a switch. Only when this switch is in the non-protected position can the software calibration routine be entered to change the numbers.

The precision signal source can be an external one traceable to NBS; or if less accuracy is acceptable, the oscilloscope contains convenient internal peak-to-peak and timing capabilities.

Software calibration may be accomplished at any interval the user deems necessary. Under normal operating conditions the specifications should hold for at least six months. If the user desires measurements to be better than specifications the calibration interval may be shortened. Best of all, this procedure can be performed while the instrument is in place without removing the covers.

On-Site Service Kits for 3455A and 3456A Digital Voltmeters

Service kit 03455-69801 for the 3455A and kit 03456-69801 for the 3456A are designed to facilitate on-site isolation and repair of failures in the 3455A and 3456A DVM's. Each kit contains pretested printed circuit boards that can be substituted for PC assemblies in a malfunctioning unit. In addition to other miscellaneous components, are diagnostic programs on tape cassettes that allow the user to test the DVM with several different HP controllers.

For more information, use the form at the rear of *Bench Briefs* and order Service Notes 3455A-20B and 3456A-1C.

5180A Waveform Recorder Modifications to Improve Peformance

Several Service Notes are listed in this issue of Bench Briefs that recommend modifications to improve performance and reliability of the 5180A Waveform Recorder. Use the order form on the last page to order Service Notes 5180A-2A, -3A, -4A, -6A, -7A, -12 and -13.

Simplify Calibration on Your Digital Voltage Source

Do you own an HP 6129C, 6130C, 6131C, or 6140C Digital Voltage/Current Source? The "Polarity Offset Switch" circuit has been modified to extend the range of the Current Offset Adjustment.

The Current Offset Adjustment is used during calibration to set the minus 0.5 mA (binary units) or the minus 0.0 (BCD units) current offset which acts as a reference for all output currents. This modification simplifies the "bit balancing" necessary during calibration.

For more information order the associated service notes listed on the last page of this issue of *Bench Briefs*.

READERS' CORNER

Missing BB copies

Editor:

I have been receiving the *Bench Briefs* publication for approximately the past three years. Evidently, they are also quite popular with other individuals in my office since I often do not receive various issues. I did receive the January-February issue, and was very interested in getting information on the printed circuit board repair article that appeared in the July-October 1982 issue.

I have not received any of the 1982 issues. If you have back copies of those, I would appreciate any of them you have on hand. I enjoy reading your publication and get a lot of valuable information out of it. Please keep up the good work. I hope to get the majority of my issues in the future.

Sincerely,
Larry Long, Technical Support
Lanier Business Products, Inc.

Many readers receive their copy at home. Then, after reading it, bring it in and route it to interested individuals at work.

The IPC has moved

Editor:

Subj: Conformal Coatings, comments
Ref: (a) Bench Briefs, Jan-Feb 1983 issue

1. On page 3 of reference (a) you state "IPC-CM-770B" "Guidelines for Printed Board Component Mounting" obtained from:

   The Institute for Interconnecting and Packaging Electronics Circuits
   1717 Howard St.
   Evanston, IL 60202

   NOTE: They moved 3 years ago; the current address is:

   3451 Church Street
   Evanston, IL 60203

2. Publication IPC-CM-770B has 116 pages, cost is $10.00 to members and $20.00 to non-members.

3. I find every issue of Bench Briefs informational and beneficial, keep up the good work and continue its publication.

Bernard H. Serota
Philadelphia Naval Shipyard

Thanks for the input Bernard. My book is dated 1979 so I should have guessed that they may have moved.

More on addresses

Many readers have requested more information on the products referenced in the Printed Circuit Board Cleaning article in the July-October 1982 issue. Here are the company names and addresses.

Description	Mfr. No.	Mfr. Name	HP Part No.
Low static, Solder sucker, Repl. tips	AS 196 Soldapullt	Edsyn Inc. 15958 Arminta St. Van Nuys, CA	8690-0227 8690-0253
Solder, RMA (rosin mildly active) 63/37 lead/tin .032 dia.	RMA P2	Alpha Metals 1001 South Lindwood Ave. Santa Ana, CA 92705	8690-0098
Solder, RA (rosin active) 60/40 lead/tin .050 dia.	RA P3	Alpha Metals 1001 South Lindwood Ave. Santa Ana, CA 92705	8690-0027
Gen. purpose solvent	MS-180	Freon TF Miller-Stephenson 1001 East 1st Los Angeles, CA 90012	8500-0232
Contact cleaner and protector	Cramolin Red FSN-6850-880-7007	Caig Laboratories P.O. Box J Escondido, CA 92025-0051	6010-0491
	No noise	Electronic Chemical Corp. P.O. Box 35 Guttenberg, NJ 07093	6030-0063
Foam-tipped swab	NA	NA	9300-0767
Lint-free industrial woven cloth	TX 309	Texwipe Co. 650 East Crescent Ave. Upper Saddle River, NJ 07458	9310-0039
Flux remover	Reliasolv No. 564	Alpha Metals 1001 South Lindwood Ave. Santa Ana, CA 92705	8500-1803
	MS-190HD	Miller-Stephenson 1001 East 1st Los Angeles, CA 92025-0051	8500-0735
	V-200	Baron-Blakeslee 2001 North Janice Ave. Melrose Park, IL 60160	8500-0735

supplement to

BENCH BRIEFS SERVICE NOTE INDEX

Need Any Service Notes?

They're free!

Here's the latest listing of Service Notes. They recommend modifications to Hewlett-Packard instruments to increase reliability, improve performance, or extend their usefulness.

Use the order form at the rear of Bench Briefs, to order free of charge, individual Service Notes documenting several instruments.

If you would like to purchase large quantities of Service Notes covering a wide range of instruments, or if you desire a complete history of all Service Notes documenting all changes to your instruments, Hewlett-Packard offers a microfiche library for a modest, one time charge, there is a microfiche subscription service available that automatically updates the library on a quarterly schedule.

The part numbers for the microfiche library and subscription service are:

Library of Service Notes—	5951-6511
Subscription service—	5951-6517

Contact your local HP Sales Office for ordering information.

181AR VARIABLE PERSISTENCE OSCILLOSCOPE

5451C-2A. Special bottom cover to eliminate electromagnetic interference.

435B POWER METER

435B-1. All serials. Modification to prevent zero carryover offset errors.

436A POWER METER

436A-5. All serials. HP-IB Option 022 retrofit.
436A-6. All serials. BCD Option 024 retrofit.
436A-7. Serials 2236A and below. Modification of HP-IB connector mounting.

1332A DISPLAY

1332A-9B. All serials. Preferred replacement for A2R90 astigmatism potentiometer.

1335A X-Y DISPLAY

1335A-5A. All serials. Recommended CRT change to improve performance.
1335-11A. All serials. Storage CRT appearance specification.
1335A-13A. All serials. Replacement part number for the model 1335A Mother Boards.

1345A X-Y DISPLAY

1345A-1A. Serials 2112A00475 and below. Loose post accelerator leads.

1740A OSCILLOSCOPE

1740A-20A. Serial numbers as follows: "A"—Prefix 2226A and below, "G" Prefix—all serials, "J" Prefix—all serials. Correcting delay line caused low bandwidth and slow risetime.

1741A OSCILLOSCOPE

1741A-13A. Serial numbers as follows: "A"—Prefix 2017A and below, "G" Prefix—all serials, "J" Prefix—all serials. Correcting delay line caused low bandwidth and slow risetime.

1742A OSCILLOSCOPE

1742A-5A. Serials 2021A and below. Correcting delay line caused low bandwidth and slow risetime.

1743A OSCILLOSCOPE

1743A-6A. Serials 2236A and below. Correcting delay line caused low bandwidth and slow risetime

1744A OSCILLOSCOPE

1744A-7A. Serials 2109A and below. Correcting delay line caused low bandwidth and slow risetime.

1745A OSCILLOSCOPE

1745A-1. Serials 2248A and below. Correcting delay line caused low bandwidth and slow risetime.

1746A OSCILLOSCOPE

1746A-1. Serials 2229A and below. Correcting delay line caused low bandwidth and slow risetime.

1980A/B OSCILLOSCOPE

1980A/B-12. 1980 serials 2209A and below; 1980B serials 2144A and below. Modification to prevent CRT arcing.
1980A/B-13. 1980B serials 2126A and below. Troubleshooting tip to isolate cause of random intensity level changes.
1980A/B-14. All serials. Manual supplement describing calibration procedure.

3060A CIRCUIT TEST SYSTEM

3060A-50A. All serials. Improved field diagnostic of analog relay failures.
3060A-53. All serials. Improved readings of BTL "trans" statement using the 3455A.

3421A DATA ACQUISITION/CONTROL UNIT

3421A-2. All serials. 44462A actuator/multiplexer jumper configuration.
3421A-3. All serials. Transfer restrictions of boards between the United States and Canada to Europe.

3437A SYSTEM VOLTMETER

3437A-9. Serials 1630A04431 and above. Modification to eliminate excess delay.

3450B DIGITAL MULTIMETER

3450B-5A. Serials 1229A01480 and below (approximately). Power supply transformer and rear panel replacements.

3455A DIGITAL VOLTMETER

3455A-20B. All serials. Introduction of on-site service kit for 3455A Digital Voltmeter.

3456A DIGITAL VOLTMETER

3456A-1C. All serials. Introduction of customer service kit for board level repair.

3466A MULTIMETERS

3466A-6A. Serials 1716A14170 and below. New true RMS converter improves AC accuracy.
3466A-12. Serials 12061 and below and serials 12110-12146. Improved common mode rejection of input amplifier.
3466A-13. All serials. Recommended low noise input amplifier.

3468A MULTIMETERS

3468A-1A. Battery retrofit kit installation for battery retrofit kit P/N 03468-68701.

3490A MULTIMETER

3490A-8B. Serials 1211A/2555 and below, and serials 1529A03905 and below. Recommended replacement for power supply capacitors C101 through C107.

3496A SCANNER

3496A-7A. Serials 2137A00990 and below. Eliminating fixture enable arc at paddle pins.

3724A BASEBAND ANALYSER

3724A-2. Serials 2217U-00161 and below. (Note, serials above 2212U-00156 will already have 03724-60123 fitted and +12V track cut on 3725A A18.) Power supply improvements to prevent instrument hang-ups at switch on.

3730A DOWN CONVERTER

3730A-6. Serials 1541U-00441 and below. Preferred replacement for mixer 0960-0174.

3746A SELECTIVE LEVEL MEASURING SET

3746A-3. All serials. Retrofit procedure for opt. 015/016 channel impairments.
3746A-4. All serials. Retrofit procedure for opt. 012—tracking generator.
3746A-5. All serials. Retrofit procedure for opt. 011—group filter.

3763A ERROR DETECTOR

3763A-7. All serials. Preferred replacement for A14 IC27 (1820-1755).

3779A/B PRIMARY MULTIPLEX ANALYSER

3779A-22A. Serials 2005U and below. Update of software. Supercedes 3779A-5 and 3779A-8.
3779B-23A. Serials 2005U and below. Update of software. Supercedes 3779B-5 and 3779B-8.

3780A PATTERN GENERATOR/ERROR DETECTOR

3780A-27. All serials. Retrofit of option 101.

3782B ERROR DETECTOR

3782B-2. Serials 2218U-00266 and below. Preferred replacement for A32 assembly.

3785A/B JITTER GENERATOR AND RECEIVER

3785A-6. Serials 2226U00237 and below. Prevention of possible damage to A35U27.
3785A-7. All serials. Preferred replacement for A30 Q9 and Q10.
3785B-5. Serials 2228U00156 and below. Prevention of possible damage to A35U27.
3785B-6. All serials. Preferred replacement for A30 Q9 and Q10.

5005B SIGNATURE MULTIMETER

5005B-1B. Serial numbers as follows: Prefix 2204A, numbers 00101, 00103, 00104, 00106, 00107, 00108, 00112, 00113, 00114 and 00115. Function select error when returning to remote.
5005B-2A. Serials 2228A and below. ROM change corrects Probe Switch/Local key depressions being ignored.
5005B-3. Serials 2248A00380 and below. Incorrect rear panel power label.

5061A CESIUM BEAM FREQUENCY STANDARD

5061A-13. Serials 944A00371 and above. Replacement kit for Cesium Oven Controller part number 05061-6173.

5065A RUBIDIUM VAPOR FREQUENCY STANDARD

5065-4A. All serials. Replacement kit for A10 oscillator assembly part number 05065-6097.

5180A WAVEFORM RECORDER

5180A-2A. Serials 2210A00220 and below. Modifications to Z OUT, +15V regulator and TRIG OUT circuits on the A25 Rear Panel assembly.

5180A-3A. Serials 2044A00200 and below. Modification to prevent possible oscillation of the +15V regulator circuit on A25 Rear Panel assembly.

5180A-4A. Serials 2224A00310 and below. Modification to prevent possible noise problems associated with the TRIG OUT circuit on the A25 Rear Panel assembly.

5180A-6A. Serials 2220A00300 and below. Input Amplifier static protection and frequency bandwidth modifications.

5180A-7A. Serials 2222A00310 and below. AC line protection (mains) fuse change.

5180A-12. Serials 2204A00191 and below. Change to the bottom cover and information pullout cards.

5180A-13. Serials listed in the note. Modifications to correct power-up reset and DMA problem.

5312A HP-IB INTERFACE

5312A-4B. All serials. Operational verification using the HP 85A controller.

5316A UNIVERSAL COUNTER

5316A-3B. All serials. HP-IB verification program using the HP 85A controller.

5328A UNIVERSAL COUNTER

5328A-33C. All serials. HP-IB verification program using the HP 85A controller.

5328A/H99, 5328AF/096, 5328AF/098, 5328A/H42, C96-5328A 500 MHz UNIVERSAL COUNTER

5328A-34C. All serials. HP-IB verification program using the HP 85A controller.

5342A MICROWAVE FREQUENCY COUNTER

5342A-40. Serials 2244A and below. Modifications required when changing A13U1/U2.

5343A MICROWAVE FREQUENCY COUNTER

5343A-18. Serials 2244A and below. Modifications required when changing A13U1/U2.

5451C FOURIER ANALYZER SYSTEM

5451C-2A. HP 181AR Variable Persistence Oscilloscope. Special bottom cover to eliminate electromagnetic interference.

6012A POWER SUPPLY

6012A-5. Serials 2147A-00810 and below. Modification to prevent FET oscillations.

6034A POWER SUPPLY

6034A-4. Serials 2141A-00271 and below. Modification to increase regulation adjustment (R78).

6129C DIGITAL VOLTAGE SOURCE

6129C-5. Serials 2226A-00760 and below. All J20, J99, P05, 061, 062, 063 and 064 options. Modification to simplify calibration.

6130C DIGITAL VOLTAGE SOURCE

6130C-6. Serials 2231A-01950 and below. All J20, J99, P05, 061, 06, 063 and 064 options. Modification to simplify calibration.

6131C DIGITAL VOLTAGE SOURCE

6131C-5. Serials 2225A-01320 and below. All J20, J99, P05, 061, 062, 063 and 064 options. Modification to simplify calibration.

6140A DIGITAL CURRENT SOURCES

6140A-4. Serials 2227A-00484 and below. All J20, J99, P05, 061, 062, 063 and 064 options. Modification to simplify calibration.

6200B POWER SUPPLY

6200B-1. Serials 2230A-10676 and below. Improved voltage reference accuracy.

6203B POWER SUPPLY

6203B-1. Serials 2229A-03465 and below. Improved voltage reference accuracy.

6207B POWER SUPPLY

6207B-1. Serials 2230A-03785 and below. Improved voltage reference accuracy.

6209B POWER SUPPLY

6209B-1. Serials 2230A-06551 and below. Improved voltage reference accuracy.

6942A MULTIPROGRAMMER

6942A-6. All serials. Corrections to the 6942A manual troubleshooting tree for the +5 V main power supply.

7010B X-Y RECORDER

7010B-4. All serials. Timebase option control connections.

7123A STRIP CHART RECORDER

7123A-9. All serials. Disposable pen mechanical adjustment.

7143A STRIP CHART RECORDER

7143A-4. All serials. Disposable pen mechanical adjustments.

7220C/T GRAPHICS PLOTTER

7220C/T, 7221C/T, 9872C/T-2. Serials 2237 and above. Plotter design changes improve reliability.

7221C/T GRAPHICS PLOTTER

7220C/T, 7221C/T, 9872C/T-2. Serials 2237 and above. Plotter design changes improve reliability.

8405A VECTOR VOLTMETER

8405A-10. Serials 732A and above. Precautions to prevent damage when handling 8405A probes.

8505A OPTION 005 NETWORK ANALYZER

8505A-11A. Serials 1930A and below. Recommended mixer replacement kit, HP Part Number 08505-60240.

8552B SPECTRUM ANALYZER, IF SECTION

8552B-14. All serials. Modification to improve 10 Hz operation.

8553L SPECTRUM ANALYZER, RF SECTION

8553L-8A. All serials. Recommended replacement of scan width switch A2.

8557A SPECTRUM ANALYZER

8557A-7. Serials 2203A01816 and above. Instructions on how to fix coarse tune shaft friction drag.

8558B SPECTRUM ANALYZER

8558B-26. Serials 2147A08081 and above. Instructions on how to fix coarse tune shaft friction drag.

8559A SPECTRUM ANALYZER

8559A-16. Serials 2218A and above. Modified test procedure instructions to prevent possible damage caused by Second Converter (Second L.O. Shift) Adjustment Procedure.

8559A-17. Serials 2218A and above. Instructions on how to fix coarse tune shaft friction drag.

8750A STORAGE-NORMALIZER

8750A-4C. Serials 1808A and below. Selected resistor for use with 8750A Option 003 and 004 dedicated interface cards.

8901A MODULATION ANALYZER

8901A-1A. Serials 2201A and below. Summary of software changes and troubleshooting data.

9571A-DTS-70

9571A-24. Software serial number 2208A60100 and above. Notification of new 91080A/B/C OPT. 1/2/3 RTE-6 V/M Software System Rev. 2208.

9872C/T GRAPHICS PLOTTER

7220C/T, 7221C/T, 9872C/T-2. Serials 2237 and higher. Plotter design changes improve reliability.

11453A/B/C DIAGNOSTIC TEST FIXTURE

11453A/B/C-1. All serials. Upgrading the 11453A/B test fixture to the 11453C model.

59300-10002 HP 85A HP-IB TEST TAPE (REV. F)

59300A-2D. All serials. List of HP-IB test tapes and instructions for counter-type products from HP Santa Clara Division.

59403A COMMON CARRIER INTERFACE

59403A-6A. All serials. Modification to improve instrument reliability.

62605L, 62605M, 6215M MODULAR POWER SUPPLIES

62605L-4/62605M-5/62615M-2. All serials. Modification to improve reliability. Supersedes 62605L-2/62605M-3/62615M-1.

63312F, 63312F-P02, 63901F D.C. POWER SUPPLIES

63312F-3/63312F-P02-1/63901-1. 63312F serial 2222A-10653 and below; 63312F-P02 serial 2145A-05389 and below; 63901F serial 2218A-00965 and below. Modification to prevent pulse-width asymmetry created by current comparator offset voltage.

64110A LOGIC DEVELOPMENT STATION

64110A-6. Serials 2225A00231 thru 2240A00450. Modification to prevent reoccurance of slight blurring of the CRT screen and possible damage to CR16 or CR17.

642XX EMULATOR SUBSYSTEM

64222A-1. 64222A 8086 emulator subsystem. Serials 2134A and below. Faulty DMA operation in MIN mode.

64226A-1. 64226A 8088 emulator subsystem. Serials 2133A and below. Faulty DMA in MIN mode, improper SSO signal, 8088 uP upgrade.

64242A-3. 64242A 68000 emulator subsystem. Serials 2213A00491 and below. Intermittent 68000 emulation operation.

64242A-4. 64242A 68000 emulator subsystem. Serials 2124A00411 and below. Improper emulation responses to interrupt acknowledges.

Service Note Order Form

If you want service notes, please check the appropriate boxes below and return this form separately to one of the following addresses.

Hewlett-Packard
1820 Embarcadero Road
Palo Alto, California 94303

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- ☐ 436A-6
- ☐ 436A-7
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- ☐ 1335A-5A
- ☐ 1335A-11A
- ☐ 1335A-13A
- ☐ 1345A-1A
- ☐ 1740A-20A
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- ☐ 1742A-5A
- ☐ 1743A-6A
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- ☐ 1980A/B-12
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- ☐ 7143A-4
- ☐ 7220C/T, 7221C/T, 9872C/T-2
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- ☐ 8901A-1A
- ☐ 9571A-24
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- ☐ 59300A-2D
- ☐ 59403A-6A
- ☐ 62605L-4/62605M-5/62615M-2
- ☐ 63312F-3/63312F P02-1/63901-1
- ☐ 64110A-6
- ☐ 64222A-1
- ☐ 64226A-1
- ☐ 64242A-3
- ☐ 64242A-4

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HEWLETT-PACKARD COMPANY
1820 Embarcadero Road
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Editor: Jim Bechtold
Hewlett-Packard
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