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BENCH BRIEFS
SERVICE INFORMATION FROM HEWLETT-PACKARD

MARCH-APRIL 1975

HOW TO REMOVE ICs

by Dick Gasperini, Editor

Removing integrated circuits from printed circuit boards is a problem that sometimes is bewildering to repair personnel when initially encountering ICs. Here are several methods that may provide an interesting solution to your IC removal job.

I find that soldering techniques are a very personal subject. A method one person likes well may be hated by a co-worker. Therefore these are presented to acquaint you with the various methods that I have found helpful. Some work well in most situations, while others work best in unique circumstances.

CLIP OUT

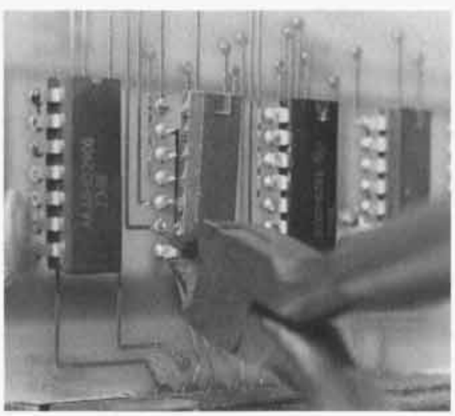

FIGURE 1

One of the easiest methods to master is the "clip out" — where each pin is cut off the IC as close as possible to the body of the IC. See Figure 1. The IC body is then removed, leaving all the pins still soldered in the board. The pins can then be removed one at a time by heating with a solder iron and pulling out with needle nose pliers. See Figure 2.

FIGURE 2

Then each hole must be cleared of solder. The most effective way I have found is by using a hand operated vacuum device such as the Soldapullt shown in Figure 3.

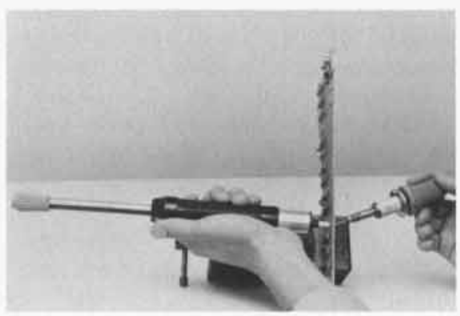

FIGURE 3

This is a spring-loaded plunger that can be cocked and released, pulling the solder into the Soldapullt. Periodically solder is removed from this desolder device.

Some service personnel regard the clip out method as crude, but it is very effective. While other methods may be faster, the clip out method is easy to learn and there is minimal chance of overheating and damaging the p.c. board. Many people prefer this for multilayer boards or other delicate boards.

VACUUM DEVICE

A faster method is to unsolder each lead of the IC by heating it on one side and using a vacuum device on the other. See Figure 4. Shown here is a smaller vacuum device called Soldavac. Each pin of the IC is unsoldered in this manner, taking care not to overheat the board. Too much heat will cause spots on the p.c. board, referred to as "measling".

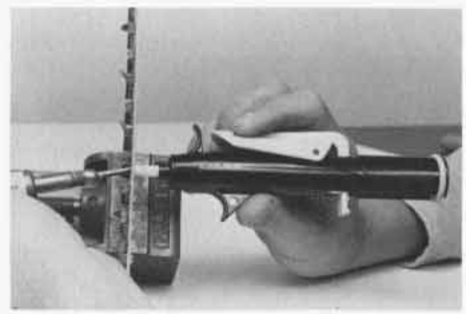

FIGURE 4

Many p.c. boards have traces on both sides and have eyelets or plated-through-holes connecting the two sides. It is important that each IC lead be dislodged from the plated-through-hole; this is easily accomplished by wiggling each lead gently with a long nose pliers. A distinctive click will be heard as the lead is pulled free. See Figure 5. After all leads are free, the IC should easily come out of the board with an IC puller. See Figure 6.

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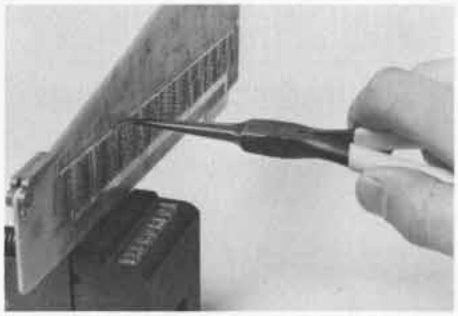

FIGURE 5

Use of excessive force would damage the p.c. board if traces are lifted or plated-through-holes are cracked. Either of these would cause long-term problems with reliability and serviceability. Philosophically speaking, it is important to leave the electronic gear in no worse condition after the repair than before the failure occurred. Therefore mastering an effective IC removal procedure is essential.

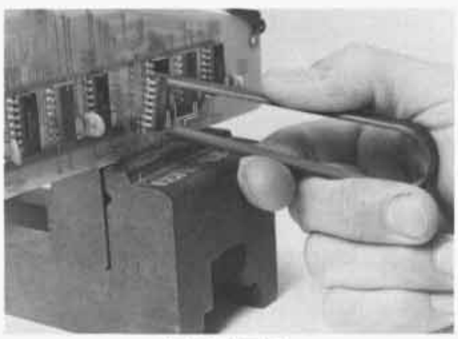

FIGURE 6

Any lead that cannot be wiggled is still soldered to the plated-through-hole and it must be unsoldered. An easy way to do this is to solder that lead and then again apply the desoldering vacuum tool. Attempting to pull solder out of a half-unsoldered hole is difficult.

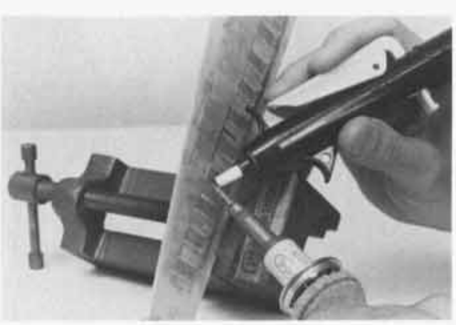

FIGURE 7

Another method of unsoldering is to heat and pull solder from the same side of the board, as in Figure 7. The procedure is to heat the pin, remove the solder iron, and very quickly move the vacuum device perpendicular to the board while pressing the trigger. While this method is satisfactory, generally more heat must be applied than with the technique in Figure 4.

The solder iron I use for these situations in an Ungar #776 body with a 42 watt element and chisel-shaped point. I prefer a chisel-shaped tip because I can heat two pins at once on an IC. The vacuum devices can also accommodate two at a time. If operated at full line voltage, a 42 watt element would get too hot for most p.c. boards. My work-bench has a variable voltage transformer with which I control the tip temperature.

Running this element at about 80 volts seems to work well for p.c. boards, and yet I still have enough power (at full line voltage or above) for fast warm-up and for ground planes on p.c. boards or wires on a terminal tiepoint. A simple heat control can be constructed with a diode and a switch where the diode is placed in series with the iron for low heat or by-passed for high heat (see the Nov-Dec 1973 *BENCH BRIEFS*).

FIGURE 8

More sophisticated solder irons have built-in temperature control. Some have a temperature sensor in the holder so the temperature gets monitored when the solder iron is at rest. Others have continuous temperature monitoring, such as the one shown in Figure 8.

COMBINATION IRON

Another iron that I like is Uniline Mark VII, shown in Figure 9. This is a solder iron with a hollow tip and a squeeze bulb. To use it, squeeze the bulb, apply the iron to the IC lead, and watch for evidence of melting solder on the component side of the board. When the bulb is released, the solder is sucked into the iron. After each joint the solder is ejected from the iron by squeezing the bulb. All the other leads are similarly done. The IC leads are then wiggled free of the plated-through-hole and the IC is removed.

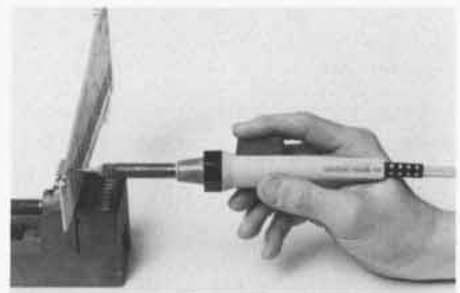

FIGURE 9

This iron gives me the fastest results of any method I've tried, although some people prefer other techniques. This iron also has a 3-wire cord so the tip is connected to ground (earth). You may be shocked (no pun intended) to measure the AC voltage on your solder iron tip. A small amount of leakage can result in sufficient potential to destroy sensitive devices such as MOSFETS.

FIGURE 10

Other manufacturers also make similar irons, such as the Weller DS40-3 shown in Figure 10. This particular model is available with either two- or three-wire cord.

LEAKAGE AND ISOLATION

When repairing a piece of electronic gear, the chassis is almost always connected to ground (earth), even with the power cord disconnected. There may be a signal generator giving a test signal, an oscilloscope making a measurement or a power supply providing a bias, and each instrument will be completing a path to ground.

If a leaky solder iron is used, strong currents may flow in adjacent circuits, causing extensive and mysterious failures.

The use of solder guns is generally not recommended because of the huge transients that may be induced in sensitive circuits.

And needless to say, anyone not disconnecting power before attempting a soldering operation is merely creating problems since the solder iron tip will be shorting the circuit to ground.

One way around all of this is to use an isolated solder iron such as the Wahl Cordless Solder Iron in Figure 11. This iron, which has a rechargeable nicad battery supplying the power, is equivalent to about a 35 watt element. A combination holder and charging unit is supplied so the iron is charged while not in immediate use. This iron works very well for field use because of its portability and small size. In addition, the built-in light is handy for improved visibility.

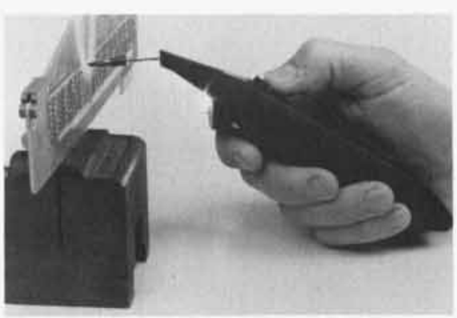

FIGURE 11

More elaborate desoldering fixtures are available that combine a temperature controlled heating element with an electric vacuum pump. While these may be the solution for a number of installations such as a manufacturing plant or a high-volume p.c. board repair area, their lack of portability may be a deterent for service personnel who must repair electronic gear on site. The initial investment is also rather substantial.

Some solder iron manufacturers offer attachments that heat all pins of an IC simultaneously. While some people are happy with the results, most people seem to have trouble and end up overheating (and damaging) the p.c. board.

DESOLDERING WICK

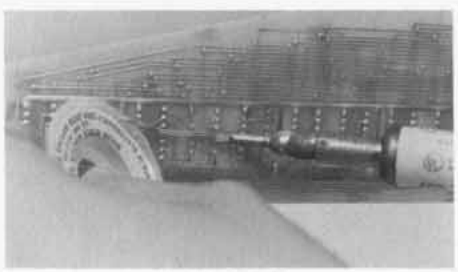

FIGURE 12

One other method that has some merit is desoldering wick, which is braided wire treated such that solder easily flows to it. Use is simple; merely place it between the solder iron and the point to be unsoldered. Solder flows onto the braid. See Figure 12.

Its use on printed circuit boards with plated-through-holes is nowhere near as effective as the vacuum devices. However, desoldering braid can be very useful in high density point-to-point wiring (such as an oscilloscope) where a vacuum device won't fit. It may be helpful to keep a small roll in your toolbox for use in the appropriate circumstances. Best results are obtained by dipping the wick in liquid flux immediately before use.

INSTALLATION AND CLEANING

After the defective IC is removed and the holes in the p.c. board are all clean, install the new IC and solder into place. (Double check the orientation of the IC before soldering. It is very embarassing to complete a soldering operation and then realize that the IC is in backwards.) See Figure 13. Be certain to get each pin hot enough so solder flows up into the plated-through-hole. Some service people suggest soldering the lead from both sides of the board. Next, clean the board with a flux remover such as Freon TF Degreaser. A small brush with short bristles can be a helpful tool. See Figure 14.

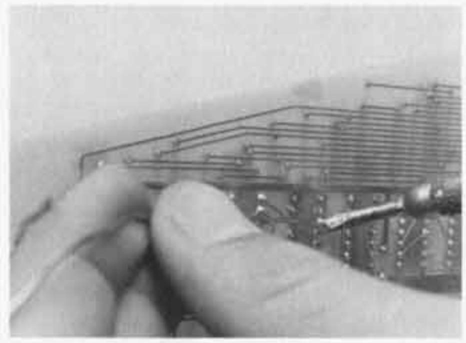

FIGURE 13

FIGURE 14

A clean board is advantageous for several reasons, one of which is a reduced susceptibility to dust sticking and the resulting high humidity leakage path that would result. Another is esthetics. It just plain looks unprofessional to see flux remaining on a board. A neat looking repair job is a sign of a true professional.

SOURCES OF TOOLS

This article is not intended as a listing of all the tools available for unsoldering, since there is a myriad of equipment sold. Your local electronics supply may stock the tools and supplies mentioned in this article. He also may be able to recommend other products available locally.

The manufacturer's model number and address are included for the tools mentioned in case your local hardware house does not stock a desired tool and you want to write directly to the manufacturer to determine who handles the product in your area. The tools are listed in the same order as in the pictures.

Many of these tools are used within the HP service organization and thus HP part numbers have been assigned to facilitate handling within HP facilities. While purchasing tools locally is encouraged, some readers may find it convenient to order from HP if other alternatives are not available. Thus the HP part number is included if one exists. For prices and delivery information in your area, please contact your local HP office.

Klein diagonal cutters D219-4C (HP p/n 8710-0012) and Klein needlenose pliers D310-6C (HP p/n 8710-0003) manufactured by

Klein Mathias and Son
7200 McCormick Road
Chicago, Illinois 60645

Ungar #775 solder body (HP p/n 8690-0009), #237 42 watt element (HP p/n 8690-0044), #PL113 tip (HP p/n 8690-0007) manufactured by

Ungar
Division of Eldon Industries
Compton, California 90220

Soldapulldt (Fig. 3) (HP p/n 8690-0060) and Soldavac (Fig. 4) (HP p/n 8690-0143) manufactured by

Edsyn, Inc.
15954 Arminta Street
Van Nuys, California 91406

Replacement tips are also available for these vacuum devices (HP p/n 8690-0082 for Soldapulldt and 8690-0126 for Soldavac).

Augat IC extractor (Fig. 6) (HP p/n 8710-0585) manufactured by

Augat, Inc.
33 Perry Avenue
Attleboro, Massachusetts 02703

Uniline Mark VII (Fig. 9) (iron plus deluxe accessory kit, HP p/n 8690-0089) manufactured by

Uniline, Inc.
200 East 4th Street
Newton, Kansas 67114

Weller DS40-3 Desoldering Tool (Fig. 10) and Weller WRCP Soldering Station (Fig. 8) manufactured by

Weller
100 Wellco Road
Easton, Pennsylvania 18042

Wahl Cordless Solder iron (Fig. 11) manufactured by

Wahl Clipper Corp.
Sterling, Illinois 61081

(No HP part number). Wahl evidently is also distributing these through several large retailers, such as Sears.

Desoldering braid (Fig. 12) many brands and sizes from which to choose. One manufacturer is

Wik-It Electronics Corp.
140 Commercial Avenue
Sunnyvale, California

(5 foot spool 0.025 inch wide HP p/n 8690-0124); 5 foot spool 0.050 inch wide HP p/n 8690-0125)

Freon TF Degreaser MS180 (Fig. 14) (HP p/n 8500-0232) manufactured by

Miller-Stephenson Chemical Company
7614 N. Paulina Street
Chicago, Illinois

Brush (Fig. 14) many manufacturers from which to choose. One is Osborn #9501 (HP p/n 8520-0015) manufactured by

Osborn Mfg. Company
5401 Hamilton Avenue
Cleveland, Ohio 44114

Machinist's vice used to hold the p.c. boards is HP p/n 8770-0004, manufactured by

Steel Products
8355 S. Chicago Avenue
Chicago, Illinois 60617

This article copyrighted 1975 by Richard E. Gasperini for publication in a book on Digital Troubleshooting.

8660A/B SYSTEM MANUAL

A new system level manual has just been added to the documentation set for the 8660 system. This new Synthesized Signal Generator System Service Manual, HP part number 08660-90053, is designed to be used with any 8660A or 8660B system as an aid to effective troubleshooting by a repair technician. The troubleshooting procedure helps isolate a malfunction quickly to a specific section of the system. The information in the Operating and Service Manual for that section is then used to further isolate the malfunction to a specific component or replaceable module.

This manual is recommended for every technician repairing 8660 systems. It can be purchased by contacting your local HP office.

READERS CORNER

Here's your chance to share your ideas and views with other *Bench Briefs* recipients. In Reader's Corner, we will print letters to the Editor, troubleshooting tips, modification information, and new tools and products that have made your job easier. In short, Reader's Corner will feature anything from readers that is of general interest to electronic service personnel.

If there is something you have to share with other *Bench Briefs* readers, let us hear from you.

Editor:

We have been using 970A Probe Digital Multimeters both in the shop and in the field. They are very handy and useful, especially when checking floating circuits. Their one drawback is that the probes are too fat to use on the component side of our high-density P.C. boards. When they are used on the 7830s or 78200 series analog boards, for example, the prospect of shorting two adjacent points is a real hazard.

I have devised a simple, but effective modification for the 970s, which greatly increases its usefulness and reduces the hazard. Take the hollow tip probe, or an extra one, and strip back the plastic around the tip. Solder a common hat pin, or sewing pin onto the metal tip. Cover all exposed metal with shrink tubing (1/16 inch i.d. on pin, 3/16 inch i.d. on probe), strip off 1/16 inch off pin point. This gives a fine point with at least 3/4 inch reach.

I suspect that people using 970s all around the world are having the same problem. This may be a solution.

Dave Foss
HP Sales-Service Office
Skokie, Illinois

When constructing the tip, be certain to insulate it adequately. Also take care to store the tip properly after each use to reduce the chance of injury. Since this new tip will not collapse into the tip recess, the sharp point will be exposed and may be a threat to an operator.

An accessory probe is available that may provide added flexibility in using the 970. This can also be used with other voltmeters; it has HP p/n 00970-69500. Contact your local HP office to place an order.

Editor

TESTING TUNNEL DIODES

Reference Bench Briefs of September / October and November/December on the measurement of tunnel diodes.

The working bench tech is likely to encounter tunnel diodes in the trigger circuits of scopes (HP Model 180 plug-ins), frequency counter front ends (HP Models 5248 and 5360), and elsewhere.

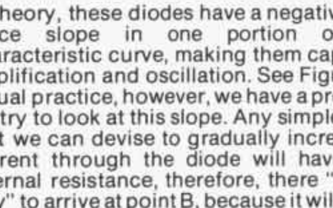

Figure 1

In theory, these diodes have a negative resistance slope in one portion of their characteristic curve, making them capable of amplification and oscillation. See Figure 1. In actual practice, however, we have a problem if we try to look at this slope. Any simple circuit that we can devise to gradually increase the current through the diode will have some internal resistance, therefore, there "ain't no way" to arrive at point B, because it will abruptly switch from A to C, and vice versa on the decreasing swing. This switch action results in about 0.5 volt change across the diode and occurs at nominally 5 to 15 mA current. The voltage change occurs very rapidly. Circuits like Figure 2 can produce discrete pulses at several hundreds of MHz.

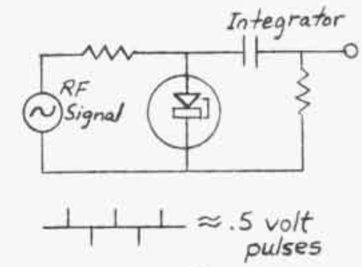

Figure 2

Due to very high impurity levels, the diodes quiescent forward voltage drop is very low and its reverse leakage current very high. This would lead your ohm meter to conclude that the darn thing is dead shorted in both directions. A first glance with your curve tracer will give the same appearance, but a little extra effort and a closer look may reveal that at or near its rated current the thing does, in fact, switch states. If your curve tracer has a 100 ohm sampling resistor, then 1 volt vertical deflection will correspond to 10 mA of junction current. Any reasonable facsimile will work so long as you can display about 0 to 30 mA vertically. The curve on a good diode will be similar to Figure 3, and not like the rendition in the Nov./Dec. issue. You should be able to discern the switch points and get a fair idea of the current magnitude.

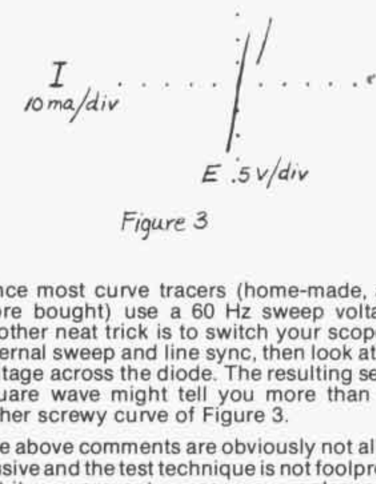

Figure 3

Since most curve tracers (home-made, and store bought) use a 60 Hz sweep voltage, another neat trick is to switch your scope to internal sweep and line sync, then look at the voltage across the diode. The resulting semi-square wave might tell you more than the rather screwy curve of Figure 3.

The above comments are obviously not all inclusive and the test technique is not foolproof, but it may prevent unnecessary replacement of a good part or detect a dud before it gets installed.

Bill Hubbard
HP Sales-Service Office
Richmond, Virginia

Author Stanley replies that the two figures will agree when the timebase and amplitude scope settings are changed, although the drawing in the article is not the most accurate representation.

The main point is to get a diode curve with a break in it — then you know it is not shorted.

Readers interested in viewing the tunnel diode curve on an oscilloscope may be interested in viewing the videotape "Troubleshooting Transistorized Circuits Faster", HP Videotape No. 90030_693.

Editor

supplement to BENCH BRIEFS SERVICE NOTE INDEX

NEED ANY SERVICE NOTES?

Here's the latest listing of Service Notes available for Hewlett-Packard products. To obtain information for instruments you own, remove the order form and mail it to the HP distribution center nearest you.

214A PULSE GENERATOR
214A-9. All serials. Improved 100 volt operation.

400E/EL AC VOLTMETER
400E/EL-10. 400E serial number 1208A18153 and below; 400EL serial number 1208A18053 and below. Improved input attenuator.

403B AC VOLTMETER
403B-8. Serial numbers below 0986A07651. Resistor replacement.

425A/AR DC MICROVOLT-AMMETER
425A-7. Elimination of potential shock hazard.

608E/F SIGNAL GENERATOR
608E/F-18. 608E serial number 637-00321 thru prefix 1201A; 608F serial prefix 610- thru 1221A. Filament rewiring to reduce excessive residual AM and FM.

970A PROBE MULTIMETER
970A-2. All serials. Improved display.

1000 SERIES TESTMOBILES
1000A-1. Models 1000A thru 1004A. Improved structural rigidity.

1106A/B—1108A TUNNEL DIODE MOUNTS
1160A/B-1A/1108A-1. All serials. Repair policy. Supersedes 1106A-1.

1208A OPTION H11 PERSISTENCE OSCILLOSCOPE
H11-1208A-10. Serial prefix 1330A and below. Preferred replacement for A3CR1 and A3CR2.

1220A/1221A OSCILLOSCOPES
1220A-19/1221A-8. All serials. Improved heat sink insulation.
1220A-20. Serial numbers below 1416A-03907. Sweep problems.

1300A X-Y DISPLAY, 1308A/1309A MONITOR
1300A/1308A/1309A-10. 1300A serial prefix 1350A and below; 1308A serial prefix 1444A and below; 1309A serial prefix 1441A and below. Preferred replacements for high voltage regulator assembly and high voltage oscillator transistor; and required modification if high voltage oscillator transistor is replaced. Supersedes 1300A-9/1308A-8/1309A-8.

1310/11/17/21A LARGE-SCREEN DISPLAYS
1310/11A-13, 1317/21A-1. All serials. Recommended replacement and/or space printed circuit board assemblies.

1815A/B TDR SAMPLER
1815A/B-1B. Serial prefix 1241A and below. Required modification. Supersedes 1815A/B-1A.

3330A/B AUTOMATIC SYNTHESIZER
3330A/B-5. All serials. Replacement part numbers for LED displays.
3330A/B-6. All serials. Possible cause of frequency offsets.

3403A/C TRUE RMS VOLTMETER
3403C-3. HP part numbers 5060-9131/32/33. Replacement part numbers for LED displays.

3430A DIGITAL VOLTMETER
3430A-7. Elimination of potential shock hazard.

3469A/B MULTIMETER
3469B-3. HP part numbers 5060-9131/32/33. Replacement part numbers for LED displays.
3469B-4. Serial numbers 1233A03800 and below. Improved input attenuator.

3960A INSTRUMENTATION TAPE RECORDER
3960A-24. Serial prefix 1422A only. Option 050 (Remote Control) wiring error.

3480A/B MULTI-FUNCTION DIGITAL VOLTMETER
3480A/B-7A. All serials. Supersedes 3480A/B-7. Bottom cover shorted to guard.

3480C/D DIGITAL VOLTMETER
3480C/D-1. All serials. Replacement part numbers for LED display.

3482A DC RANGE UNIT
3482A-4. Serial numbers before 1133A00751. Proper use of the print command (flag) signal.

3484A MULTIFUNCTION UNIT
3484A-3. Serial numbers before 1124A01576. Proper use of the print command (flag) signal.

3575A GAIN PHASE-METER
3575A-2. HP part numbers 5060-9131/32/33. Replacement part numbers for LED displays.

4271A 1 MHz DIGITAL LCR METER
4271A-2. Serial number 1412J00350 and below. Improved Xtal Oscillator Circuit on A4 board.

5345A ELECTRONIC COUNTER
5345A-1. Serial prefix 1428- and below. Input amplifier failures.

7046A X-Y RECORDERS
7046A-2. Serial prefix 1503 and below. Eliminating oscillations in Model 7046A Power Amplifier stage.

7123A/B, OPTIONS 045 AND 048 ONLY
7123A/B-8. Serial prefixes before 1502. Stepper drive incorrect chart speeds.

7203A, 7210A, 9862A PLOTTERS
7203A-13/7210A-13/9862A-15. All serial prefixes before 1504A. Improved pen lift solenoid. Supersedes 7203A-3, 7210A-2, 7210A-5, 9862A-8.

8407A NETWORK ANALYZER MAINFRAME
8407A-7. Serial prefix 1144A and below. Power supply improvements. Supersedes 8407A-5.
8407A-8. All serials. Phase locked oscillator repairs.

8558B SPECTRUM ANALYZER
8558B-2A. All serials. Tune potentiometer replacement/operation TEST.
8558B-6. Serial prefix 1420A and below. Modification kit to install 7-segment LED digital Panel Meter.

8620/21A SWEEP OSCILLATORS
8620A-2C. Serial prefix 1218A and below. A9/A10 switch/interconnect board assembly replacement. Supersedes 8620A-2/2A/2B.
8620A-7. Serial number 1332A01875 and below. Modification required for 8410B compatibility.
8621A/B-1. 8621A all serials; 8621B serial number 1408A00840 and below. Modification required for 8410B compatibility.

8640A/B SIGNAL GENERATORS
8640A-25. All serials. Basic functional checks.
8640B-25. Serial prefix 1333A and below. Time base Vernier knob and pot replacement.
8640A-26/8640B-27. 8640A serial prefix 1428A and below; 8640B serial prefix 1440A and below. Input crowbar reliability improvement and recommended A12 replacement.
8640B-26. All serials. Basic functional checks.

8654A SIGNAL GENERATOR
8654A-4. Serial prefix 1450A and below. Meter support bracket.

8660A/B SYNTHESIZED SIGNAL GENERATOR
8660A-5B. Serial number 1445A00690 and below. Reference level output levels increased. Supersedes 8660A-5A.
8660B-24. All serials. Summary of DCU assembly changes.
8660B-27. Serial prefix 1448A and below. Improved accessability for A1A13 DCU annunciator board.
8660B-28. Serial number 1439A01000 and below. Reference section output levels increased.

8699B SOLID STATE RF UNIT FOR 8690B
8699B-4. Serial number 1406A02325 and below. Replacement for E4 Power Amplifier.

HP-IB CABLE
10631A/B/C-1. HP-IB Cable replaceable parts.

11661B FREQUENCY EXTENSION MODULE
11661B-1. All serials. Installation checks and adjustments.

34703A DCV/DCA/OHM METER
34703A-4. Serial numbers before 1251A01500. Improvement of reliability when measuring high voltage inputs.
34703A-5. Serial numbers before 1251A01500. Elimination of potential intermittent logic problems.

86200 SERIES SWEEPER PLUG-INS FOR 8620A
86210/20A-1. 86210A serial number 1215A00210 and below; 86220A serial number 1426A00930 and below. Modification required for 8410B compatibility.
86230A/B/86241A-1. 86230A all serials; 86230B serial number 1407A00320 and below; 86241A serial number 1409A00305 and below. Modification required for 8410B compatibility.
86242A/50A/B-2. 86242A serial number 1411A00-345 and below; 86250A all serials; 86250B serial number 1411A00480 and below. Modification required for 8410B compatibility.
86260A-1. Serial number 1339A00390 and below. Modification required for 8410B compatibility.

86300 SERIES SWEEPER MODULES FOR 8620A
86330/31B-1. 86330B serial number 1430A00321 and below; 86331B serial number 1430A00207 and below. Modification required for 8410B compatibility.
86341/42A-2. 86341A all serials; 86342A serial number 1411A00658 and below. Modification required for 8410B compatibility.
86342A-3, 86350A-4, 86351/52A-2. 86342A serial number 1410A00547 and below; 86350A serial number 1410A00570 and below; 86351A and 86352A all serials. Modification required for 8410B compatibility.

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TEST YOUR LOGIC

Here's another challenging quiz to test your logic. Since service work requires a very logical procedure, here's another exercise to test your ability to bring order and logic to a confusing situation.

This quiz is reprinted with permission from "Games for the Superintelligent" by James Fixx (Doubleday, Popular Library).

Batter Up!

1) Andy dislikes the catcher.
2) Ed's sister is engaged to the second baseman.
3) The center fielder is taller than the right fielder.
4) Harry and the third baseman live in the same building.
5) Paul and Allen each won $20 from the pitcher at pinochle.
6) Ed and the outfielders play poker during their free time.
7) The pitcher's wife is the third baseman's sister.
8) The pitcher, catcher, and infielders except Allen, Harry, and Andy, are shorter than Sam.
9) Paul, Andy and the shortstop lost $50 each at the racetrack.
10) Paul, Harry, Bill, and the catcher took a trouncing from the second baseman at pool.
11) Sam is involved in a divorce suit.
12) The catcher and the third baseman each have two children.
13) Ed, Paul, Jerry, the right fielder, and the center fielder are bachelors. The others are married.
14) The shortstop, the third baseman, and Bill each cleaned up $100 betting on the fight.
15) One of the outfielders is either Mike or Andy.
16) Jerry is taller than Bill. Mike is shorter than Bill. Each of them is heavier than the third baseman.

Using these facts, determine the names of the men playing the various positions on the baseball team.

Answer will appear in upcoming *BENCH BRIEFS*.

HEWLETT-PACKARD COMPANY
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