HEWLETT PACKARD

BENCH BRIEFS

SERVICE INFORMATION FROM HEWLETT-PACKARD

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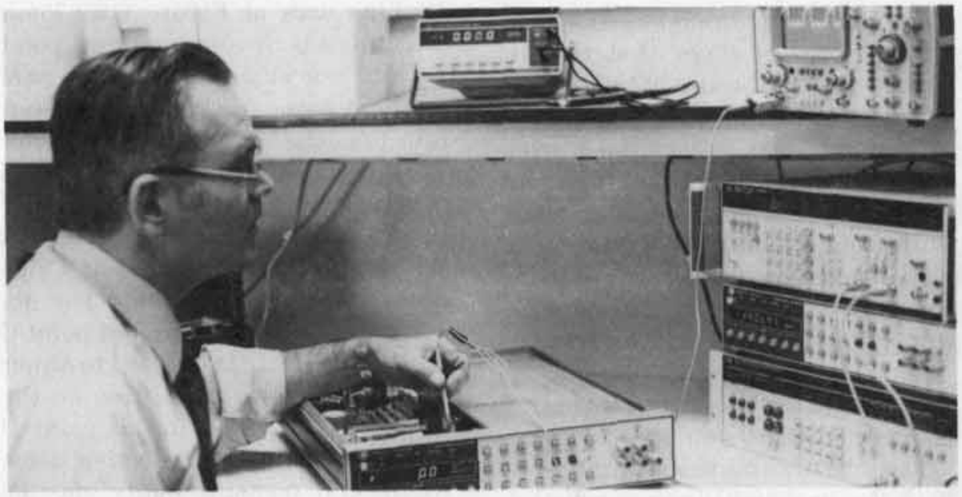
Logical Troubleshooting



Where should the next measurement be made? Having a logical procedure will help you find the failure with the least number of measurements. This article tells how.

Problem solving is a daily activity for the service technician. The person who is well organized in their approach to problem solving is much more efficient than those who are not.

Organized or not, most of us use some procedure in solving our problems, such as when a technician is faced with troubleshooting an unfamiliar electronic instrument. Having a successful problem-solving technique will provide the most efficient and economical way of repairing the instrument. This is one of the characteristics that separate the professionals from the beginners.

Editor's Note: This is an updated article that originally appeared in a 1974 issue of Bench Briefs. Additional material has been incorporated from the book Digital Troubleshooting by Richard E. Gasperini, HP part number 90500E.

This article will describe a logical approach to troubleshooting an unfamiliar electronic instrument. The procedure will then be applied in a practical example.

Logical Procedure

Getting started involves asking three questions which are equally applicable to repairing a complex electronic product as they are to fixing the family car.

1. What is the Product Supposed to Do?

The answer is located in the specifications for the product. Understanding what the unit does eases the task of selecting the required troubleshooting equipment.

2. Does the Product Do What It Was Designed to Do?

Probably not, since you have it on your bench. But what about the non-specific problems? The repair tag says "low output". What if the user was trying to make the unit do something it was not designed to do?

Most service manuals contain a detailed performance test procedure. If no procedure is available, use the specifications and devise your own. If the product meets specifications, it is a good indication that more information is needed or that the unit has no problem. Search for more information. Question the user. Heat, cool and shake the unit to determine if the problem is intermittent.

3. Has Anyone Seen the Problem Before?

The answer can be found in several sources: troubleshooting information in the service manual, service notes, or other documents from the manufacturer. Another technician is also a good source of information. This is where the professional stands out — he (or she) knows that it is impossible to have all of the answers and willingly asks for help. Spending a few minutes on the telephone with an expert may be time well spent. Availing yourself to the experiences of others will make you more productive (and more valuable!)

If no one else has seen the problem, you must solve it yourself. At this stage, apply the Rules of Logical Troubleshooting. This consists of "milking" the instrument for all symptoms available. Use your eyes, ears and nose. Are lights lit? Readouts active? Are there any signs of heat or broken components? Are there any abnormal sounds? Pops, hissing, hum? Is there a smell associated with a particular area? Essence of carbon comp? The symptoms are next sorted by functions — try to localize the fault to a particular function. Many times this can be done by using switches on the front panel. With practice, the technician can become quite skilled at isolating the fault to a function and sometimes to a particular block or circuit within the functional circuitry. With the symptom determined, the abnormal path of circuitry is identified.

Bracketing

The problem can now be isolated with a technique called "bracketing", which is simply a means of establishing the broad limits around the areas to be tested. For example, if you connect a signal to the antenna terminals of a radio receiver (see Figure 1) and hear no output in the speaker, you have bracketed the problem to somewhere between the antenna circuits and the speaker cone (i.e., the entire receiver). If, however, the signal strength meter shows a strong indication, the circuits from the antenna terminals to the detector are probably good (since the signal strength meter is usually driven from one of the detector's output). Therefore, the problem is now isolated to the audio section. We also know that at least some of the power supplies are working, and this is valuable information.

The Information Funnel

Now we come to another consideration in the information-seeking process. Once a decision has been reached as to where a check or measurement is to be made, there still remains the related question of what type of check to make. You must decide, for example, whether to flip a switch, take a measurement or replace a part.

The information funnel means making the type of check that is most appropriate to the size of the trouble brackets at a given time. The rule is: As you progress in locating a trouble, vary the type of measurement you make in a specific order. Start with front-panel checks, then make adjustments, take waveforms, measure voltages, measure resistances, and finally, replace parts.

Performing the checks in this funnel sequence assures you wide coverage of trouble possibilities initially, but with low precision. Then, gradually, as you proceed to localize the trouble, the checks become more precise.

Half-Splitting

In our example, we know the problem exists somewhere between the detector and loudspeaker. Where should the first measurement be made? One technique used all too often is to measure point A (to verify that the detector is really working) and then to make measurements at B,C, and D until the defective stage is finally isolated. While this "serial method" works, the fastest approach is to use "halfsplitting" technique.

The main principle of half-splitting is that a check is made at the midpoint of the remaining part of the circuit that has not yet been checked.

Looking back at Figure 1 we know that there is no audio output (point E) and we suspect that a signal exists at point A. (We know for certain that one output of the detector is ok because of the reading on the signal strength meter.) Now what??

We should measure at point C because this is halfway into the abnormal path. If the signal at point C is ok, the trouble is isolated to either the audio power amplifier or the loudspeaker. Measuring at point D would indicate the defective area. Additional measurements may be used to determine the defective component.

Half-Split vs. Serial

Comparing the half-split method with the serial (or "daisy chain") will emphasize the difference. Assume that we are troubleshooting a linear path with eight stages as shown in Figure 2. Assume also that there is a signal at the input (point A) but no

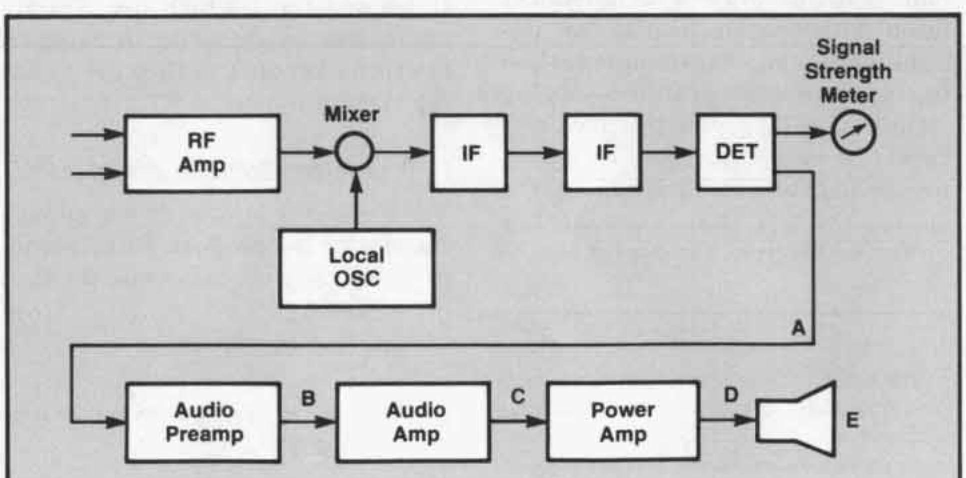


Figure 1. Simple radio receiver.

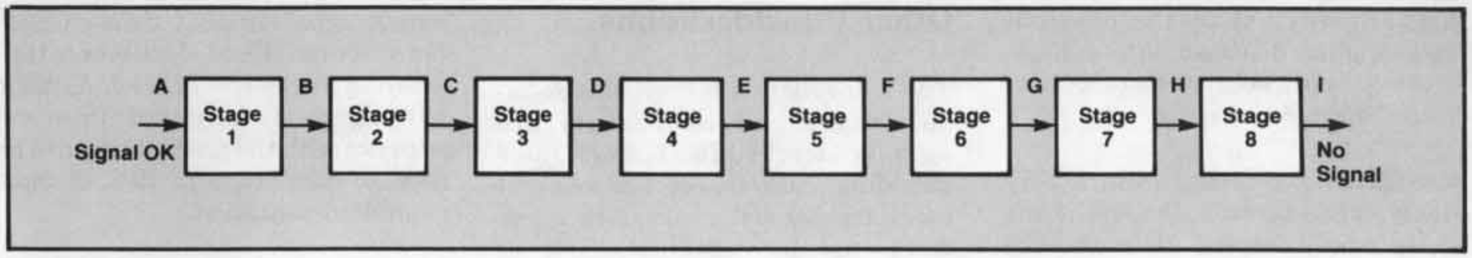


Figure 2. Eight-stage circuit.

signal at the output (point I). Using the half-splitting technique will lead you to the problem with the least number of measurements (and presumably the least amount of time, so you are more effective in your job).

Serial Method

How many measurements will be needed, on the average, to find a problem using the serial method? This technique (which is NOT recommended) will be to measure each successive point until the signal goes away.

Figure 3 lists the number of measurements required to find a circuit failure in the various stages. Note that very few measurements are needed if the failure happens to occur in Stage 1 or 2, but many tests are required to find a failure near the end of the chain.

The average number of measurements required to find a failure in this eight-stage circuit is 4-3/8. Of course, you cannot make a fraction of a measurement; that is just an average. Another way to look at it is 4375 measurements would be needed to repair 1000 instruments.

Half-Splitting Method

Now let's use the half-splitting method to find the problem. Assume that Stage 1 has failed. Split the chain into two sections by measuring at point E. Finding no signal there, we would next measure point C and find no signal there. Next measure point B and find no signal there. Therefore, three measurements are needed to find the failure. Assume Stage 2 has failed. Measure points E and C. Finding no signal at either point, measure point B and find a signal present. Therefore, Stage 2 has failed. Three measurements are needed.

Similarly, any other stage can be isolated with three measurements, a sharp contrast to the "serial" method which required an average of 4-3/8 — an increase of 45%! Or to repair 1000 instruments, 3000 measurements would have to be made using the halfsplit method vs. 4375 for the serial method. Is anyone interested in making 1375 unnecessary measurements? The difference in effectiveness of these two techniques becomes even more dramatic as the number of stages is increased.

High Failure History

In the calculations above, we assumed that each stage has an equal chance of failing (i.e., similar reliability). This is probably a good assumption if we don't have any prior experience or knowledge of the product being repaired.

Many times, though, we do have additional information that is useful. If previous experience indicates that one stage is particularly prone to failure, this should be considered in deciding where to make the measurements.

Looking back on Figure 2, assume that Stage 8 has poor reliability. This is often the case because of

PROBLEM EXISTS IN	TEST POINTS MEASURED	TOTAL NUMBER OF MEASUREMENTS
Stage 1	B	1
Stage 2	B, C	2
Stage 3	B, C, D	3
Stage 4	B, C, D, E	4
Stage 5	B, C, D, E, F	5
Stage 6	B, C, D, E, F, G	6
Stage 7	B, C, D, E, F, G, H	7
Stage 8	B, C, D, E, F, G, H	7

Figure 3. Serial method (not recommended).

PROBLEM EXISTS IN	TEST POINT MEASURED	TOTAL NUMBER OF MEASUREMENTS
Stage 1	E, C, B	3
Stage 2	E, C, B	3
Stage 3	E, C, D	3
Stage 4	E, C, D	3
Stage 5	E, G, F	3
Stage 6	E, G, F	3
Stage 7	E, G, H	3
Stage 8	E, G, H	3

Figure 4. Half-split method (recommended).

higher power than the previous stages, plus, if it's an output stage, possibly being subjected to excessive loads, short circuits, etc.

Recognizing that the failure very likely exists towards the end of the chain would suggest that we shift our initial measurement point toward the troublesome area. Therefore, a good rule of thumb about troubleshooting is to half-split at the point where there is approximately an equal chance of finding the failure on either side of the test point. The odds are good that you will only make one or two measurements.

In our example, specific failure rates could be used in a calculation to prove the validity of this method. However, exact failure rates are not needed nor should you perform any calculations. Just recognize that a high failure rate in one end of the string should cause you to shift the initial point measured toward the troublesome circuit. A good rule of thumb is 50%. Unless a particular circuit has at least 50% of the failures, do not modify the initial method. In fact, when a failure rate is high enough, it may make sense not to even make a measurement — simply change the suspected part.

Other Considerations

The half-splitting technique also assumes that all test points are equally accessible. Many times shielding, gaskets, cover plates and other mechanical restrictions make test points inaccessible, especially in high frequency products. This will similarly alter how you split the abnormal path.

Taking time to decide where to make a measurement will usually save time, but only if the decision takes less time than the measurement. Pondering two minutes about a measurement that could be made in one minute is not an effective technique either.

It is also worthwhile to point out that when making a measurement, you must have information available that tells you whether or not the signal is correct. The main reasons for the popularity of the highly inefficient "serial" method are lack of good documentation and lack of experience. It is sometimes difficult to measure in the middle of a long chain and determine if the measurement just observed is correct. It may appear easier to move along one stage at a time comparing input and output signals in light of the particular circuits. Good documentation showing waveforms or other data for key test points is needed. Prior experience with the product can also be used to advantage in lieu of thorough documentation.

In conclusion, half-splitting will lead you to the problem in the least time. If you know nothing about the reliability of the circuits under test, make the test measurement midway between the point of a known good signal and the point of a known bad signal. If one end of the signal path has a bad failure history, shift the initial measurement closer to the troublesome area.

Using a logical troubleshooting approach will make you more effective in your job. Let's try it on the following problem.

A Troubleshooting Example

This problem concerns a typical malfunction in the electrical system of a car. Referring to Figure 5, let's make a brief rundown of the way the system is supposed to operate. At the left of the diagram is the generator. The shaft or armature, is driven by

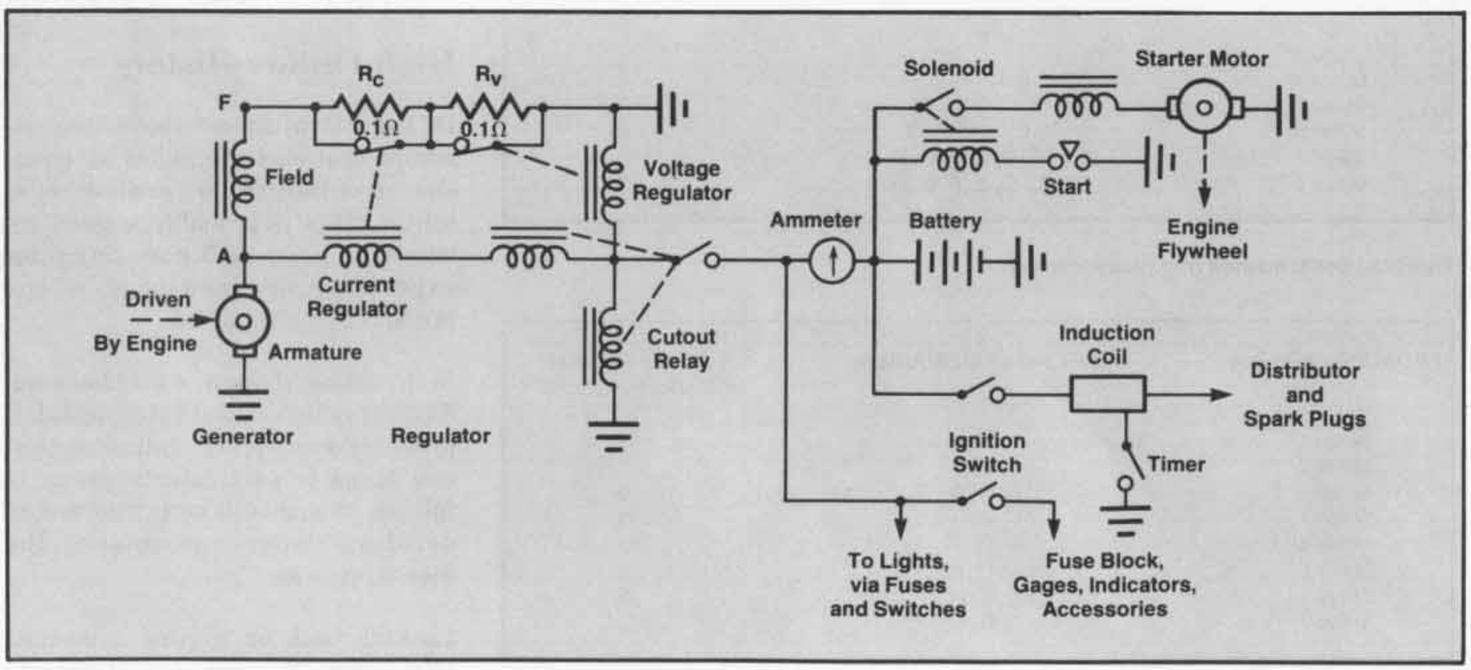


Figure 5. Simplified diagram of an automobile electrical system.

the engine via the fan belt. As the armature windings turn through the magnetic field generated by the field winding, electric energy is produced at terminal A (armature). The magnetic field winding is excited by the regulator which provides the feedback path and control.

The generator output goes to the regulator with its three coils. The cutout relay (otherwise known as a circuit breaker), keeps the battery from discharging through the generator when the motor is off. The other two coils regulate the voltage and maximum current.

The regulated output of the generator feeds several divergent paths which include the lights, ignition, various dials, gauges, indicators, and other accessories in the automobile. The ammeter usually indicates whether enough current is being supplied by the generator to carry the load plus charge the battery. The ignition circuitry is usually not metered by the ammeter and the current for the starter motor is definitely not read by the ammeter. (Note: Some cars have just a generator-not-charging light instead of an ammeter). The ammeter usually has a maximum deflection of 30-50 amps.

Let's take an actual problem. You are driving home at night and suddenly you notice that the ammeter is showing heavy discharge (or the red GEN light begins to glow ominously). Since you are close to home you decide to press on and hope for the best. Everything holds together and you make it with lights to spare.

The next morning you begin the troubleshooting procedure by performing halfsplitting to try and bracket the trouble area. The first check is the fan belt. If it's too loose, the generator will not be driven fast enough to generate the required current. The fan belt is good and tight so the left bracket in Figure 5 goes between the engine and generator.

The next check is to test the battery. A simple voltage check (under load) is a fair indicator, but really not conclusive. The best check is to test each cell for specific gravity with a hydrometer and get a cell tester to check the individual cell discharge current under load for each cell in the battery. Of course, the easiest method is to borrow a good battery from another car and substitute it in the circuit.

With a known, good battery in your car, start the engine and check the ammeter.

This is a front-panel milking check, and it applies the half-split rule, as you would like to determine whether the trouble is in the battery or in the generator and regulator circuits.

The result of watching the ammeter is that it shows no charge, or possibly a slight positive charging rate, when you rev the engine up a little. You do find, however, when you turn the lights on, that the ammeter shows a heavy discharge in the left-hand side of the dial. Since the problem is still there, even with the substitute battery, you can establish the right bracket in Figure 5 in front of the battery.

Now let's establish exactly how the charging system is supposed to work so we can make some further tests.

There are three different coils or relays in the regulator. The first is the circuit breaker (or cutout relay). Whenever the voltage generated by the armature is sufficient, the relay automatically closes the circuit between the generator and battery through the ammeter. It opens the circuit when the engine is idling or stopped because the series winding opposes the magnetic field generated by the shunt winding. The magnetic fields cancel which causes the relay armature to drop out. This keeps the battery from discharging through the generator.

When the voltage put out by the generator becomes too high, the voltage-regulator contact opens, thereby unshorting the 0.1 ohm resistor labeled R_V. When this happens, the current through the field of the generator decreases. With less field current, even though the armature is rotating at the same engine speed as before, there is less voltage generated. This decreased voltage makes the voltage-regulator arm drop back, reshorting the resistor R_V, thereby letting the generator field current increase again. Thus the voltage regulator keeps vibrating to adjust the voltage.

The current regulator coil works in much the same fashion as the voltage regulator except that it controls the current instead of the voltage. The current control resistor is R_C.

Again, looking at Figure 5, the trouble area is bracketed to include the generator, regulator and the divergent path to the accessories.

The best check at this point, is to see if the generator is capable of generating current. This is accomplished by grounding the F, or field, terminal at the generator with a screw driver or piece of wire, and run the engine at a fast or idle for a moment. Simultaneously, watch the ammeter for an indication of charge. This is a good example of further front-panel milking, and it's an excellent example of how you work with a feedback path. The feedback path in this case is the current in the field circuit. It is controlled by two resistors, in turn controlled by the voltage and current regulators. Remember the feedback rule states that you should modify, such as open, short, or change, the feedback path at or near the point where it rejoins the forward flow. In this particular case, if you short the forward flow at A in Figure 5, you would have sparks. In normal operation, the two series resistors R_V and R_C are intermittently shorted out, so if you short terminal F to ground, you are simulating normal regulator operation.

The result of grounding the field terminal on the generator is this. The ammeter goes to maximum in the positive charge direction even though the engine is turning over at a fairly slow rate, so it appears that the generator is functioning and capable of producing a large enough current. You can move the left bracket a step to the right now and eliminate the generator, since it is outside the bracketed area. And since the lights are still on (aren't they?), you can add a bracket across that divergent path. What's left then? The regulator.

The next check is to shut off the engine (and lights) and remove the cover of the generator regulator. Restart the engine and visually inspect the voltage and current regulators for operation as you let the engine idle. Then increase motor speed to a point where the regulators should operate. This is another check that is similar to front-panel "milking".

The result of watching the voltage and current regulators while you vary engine speed is that neither relay operates. Now turn the lights on and see what happens. The result is that the cutout relay opens up. Is this normal? Yes. When the generator does not supply enough current and voltage to operate the accessories (for whatever reason), the relay should open up to prevent the battery from discharging through the generator.

Up to this point, you have made all your checks and tests using only the car's ammeter (assuming it has one). Now you need to apply the information funnel rule and get out the VOM for some serious measurements.

But before we take any measurements, let's review the brackets and circuit and determine what results we expect to get from the measurements.

Originally you found that the battery was not being charged, as shown by a zero or insignificantly small positive charge rate on the ammeter. You eliminated the fan belt, battery and accessory divergent path from the problem which left the generator/regulator. When you shorted the F terminal of the generator, you found that the charge rate on the ammeter increased to a very high value. What sort of information was this? Well, it moved the left bracket in the past generator to the left of the two series control resistors. The two resistors were suspect as well as the contacts of the two regulators. The current regulator coil was eliminated since you were able to reach a high charge rate by shorting the F terminal (i.e., you knew that you had to have a good series path from the generator through the ammeter).

However, there is one other concept under suspicion. Let's puzzle out what would happen if the voltage-regulator coil were open. How would this affect the charging amperes? If the voltage-regulator coil were open, then it would never operate, and the resistor R_V would be permanently shorted. And if the resistor were permanently shorted, then the field resistance would be low, you'd have lots of field current, high magnetic field, and you should have a high charging rate limited only by the other series resistor, which would become unshorted when the current became too high. But that doesn't fit the facts in this case. The field current is low, keeping the charging current low.

The next check at this point is to go ahead and measure the resistance of the voltage-regulator coil. The result of measuring the resistance of the voltage-regulator coil after you have disconnected it is this: Your ohmmeter reads 80 ohms to ground verifying what you had assumed — that the coil was ok.

The next check is to disconnect the F wire to the field of the generator and measure the resistance of each of the control resistors R_V and R_C, while you hold the regulator armature down to remove the short across either resistor. This is an application of the half-split rule and information funnel rule.

The result of measuring the resistances is 0.1 ohms for each one — a normal indication.

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Now what? Remember when we were discussing what the effect would be if the voltage regulator coil were open? It wouldn't operate and the resistor R_V would be permanently shorted, causing high field current and high charging current. But our problem is the opposite — low charging current. So what would the symptom be if the voltage regulator (or current regulator) contacts were open (dirty), which would cause resistors R_V and R_C to always be in the circuit? Low charging current!

The best check here is to visually inspect the voltage-regulator contacts, or clean them with ordinary paper or a burnishing tool. The easiest way to do this is to take a piece of coarse paper (not sandpaper), insert it between the contacts, and apply light pressure with your finger on the armature as you pull and push the paper back and forth. As a result of cleaning the contacts, you find that the generator is back in operation.

Let's review how we tracked this problem through to conclusion. We started with front-panel milking and noted that we had zero, or a very small, charging rate as shown on the ammeter. When we shorted the field terminal of the generator, the ammeter jumped to a very high rate, showing that the main series path of the car's electric system was alright. The trouble appeared to be in the feedback path. Then we inspected the regulators and found them not operating. When we found the series control resistors okay, we promptly suspected the regulator contacts. We found that the series resistor R_V was always in the circuit, so the generator voltage was always low and the current consequently never got very high. When we cleaned the contacts the generator ran the accessories and charged the battery.

This example shows the power of establishing brackets, half-splitting, and using the information funnel. As a test for yourself to prove the power of halfsplitting, take a standard deck of 52 playing cards and remove one without looking at it. How many tests or questions do you have to ask to determine exactly what card you have chosen? Look for the algorithm in the next issue of Bench Briefs.

Safety-Related Service Notes

Service Notes from HP relating to personal safety and possible equipment damage are of vital importance to our customers. To make you more aware of these important notes, they are printed on paper with a red border, and the service note number has a "-S" suffix. In order to make you immediately aware of any potential safety problems, we are highlighting safety-related service notes here with a brief description of each problem. Also, in order to draw your attention to safety-related service notes on the service note order form at the back of Bench Briefs each appropriate number is highlighted by being printed in color.

7245A/B Plotter/Printer

A shock hazard may exist at the power cord socket (or at the male end of the power cord) of plotter/printer serial prefixes below 2047 when the power switch is in the OFF position.

If the power switch is OFF the line filter capacitors retain a charge at the power socket that can shock an operator.

To eliminate the possibility of this hazard, it is necessary to install a bleeder resistor across the line terminals of the power socket. Safety Service Note 7245A/B-3-S describes the procedure for installing the free safety modification kit HP part number 07245-60130.

BLUE TAG REPAIR

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Should one of your HP instruments need repair, the HP service organization is ready to serve you. However, you can help us serve you more effectively. When sending an instrument to HP for repair, please fill out this card and attach it to the product. Increased repair efficiency and reduced turn-around time should result.

COMPANY

ADDRESS

TECHNICAL CONTACT PERSON

PHONE NO. EXT.

MODEL NO. SERIAL NO.

P.O. NO. DATE

Accessories returned with unit

☐ NONE ☐ CABLE(S)

☐ POWER CABLE ☐ ADAPTER(S)

OTHER

over

Service needed

☐ CALIBRATION ONLY ☐ REPAIR

OTHER

Observed symptoms/problems

FAILURE MODE IS:

☐ CONSTANT ☐ INTERMITTENT

SENSITIVE TO:

☐ COLD ☐ HEAT ☐ VIBRATION

FAILURE SYMPTOMS

If unit is part of automatic system list model numbers of controller and other related components.

9320-3896 Printed in U.S.A.

Should one of your HP instruments need repair, the HP Instrument Repair Organization is always ready to serve you. Toward this end, we are promoting the use of the "Blue Repair Tag." These tags are available from your HP representative, and are filled out by you and attached to any instrument sent to HP for repair. Increased repair efficiency and reduced turnaround time are our goals. Please help us help you. Ask your HP representative for some of these cards today.

Correction

All About CRT's

In the previous issue of Bench Briefs (March-May '81) on page 4 under the heading VECTOR, I alluded that "dot writing" would be a good choice of displaying annotation on the CRT along with the main picture. In reality stroke writing may be the better choice since it uses far less memory than dot writing. The characters are formed from addresses and strokes burned into ROMs that are addressable using a single memory location. And Figure 4b is actually an example of this technique, not dot writing as originally stated.

Editor

Replacement Part Cross Reference

When selecting replacement parts for your HP products, you may notice that many manuals list only an HP part number for the part, even though it appears that this part is manufactured by one of the large semiconductor manufacturers. Service personnel often ask why only HP part numbers are listed.

It is recommended that HP replacement parts be used to ensure that original performance of the product will be retained. While some parts used in HP instruments are identical to those that can be purchased at a local electronics distributor, many times parts will be selected for certain characteristics, such as gain, bandwidth, capacitance, etc. There may also be slight mechanical differences, such as the shaping or length of leads. In some cases special quality checks are used to ensure that high reliability parts are used at the factory and at HP field offices.

Therefore, we suggest obtaining replacement parts from HP to maintain the quality that you have paid for in your instrument. There may be situations however where HP replacement parts are not in stock and substituting parts will allow you to return the product to service immediately. In these cases it may be worthwhile to see if a substitute part will work in the circuit. Perhaps an HP part could be ordered and installed at some later date.

To help you in these situations, here's a cross-reference of HP part numbers to JEDEC numbers for transistors and diodes.

HP P/N	JEDEC NO.	HP P/N	JEDEC NO.	HP P/N	JEDEC NO.	HP P/N	JEDEC NO.	HP P/N	JEDEC NO.
0122-0005 --	1N4810	1853-0039 --	*2N3638A	1853-0342 --	*2N5956	1854-0021 --	2N918	1854-0270 --	*2N4265
0122-0017 --	1N4804	1853-0051 --	2N4037	1853-0344 --	2N5876	1854-0026 --	2N335	1854-0278 --	2N3302
0122-0025 --	1N4811A	1853-0052 --	2N3740	1853-0349 --	2N5333	1854-0027 --	*2N2714	1854-0281 --	2N2194
0122-0062 --	1N5468A	1853-0057 --	3N91	1853-0351 --	2N6053	1854-0029 --	2N2712	1854-0282 --	2N3583
0122-0070 --	1N5456A	1853-0058 --	*2N3644	1853-0360 --	2N3799A	1854-0032 --	2N2221	1854-0286 --	2N5217
0122-0245 --	1N5139	1853-0059 --	2N3791	1853-0370 --	2N5782	1854-0033 --	2N3391	1854-0301 --	2N3261
0122-0247 --	1N5140	1853-0062 --	*2N3645	1853-0371 --	2N6107	1854-0036 --	2N2958	1854-0302 --	*2N3405
0122-0248 --	1N5140A	1853-0066 --	*2N4250	1853-0372 --	*2N5195	1854-0039 --	2N3053S	1854-0304 --	2N2483
0122-0249 --	1N5141	1853-0069 --	*2N4122	1853-0378 --	2N5987	1854-0048 --	2N2857	1854-0308 --	2N3553
0122-0251 --	1N5142	1853-0071 --	2N3494	1853-0381 --	2N6331	1854-0050 --	2N916	1854-0311 --	2N4240
0122-0253 --	1N5143	1853-0072 --	2N4034	1853-0383 --	2N6296	1854-0053 --	2N2218	1854-0313 --	2N3771
0122-0255 --	1N5144	1853-0076 --	*2N4062	1853-0391 --	2N6051	1854-0057 --	2N3855A	1854-0315 --	2N3633
0122-0256 --	1N5144A	1853-0077 --	*2N4249	1853-0392 --	2N3741	1854-0060 --	2N3565	1854-0323 --	2N2857
0122-0257 --	1N5145	1853-0080 --	*2N4888	1853-0396 --	*2N4899	1854-0062 --	2N1701	1854-0324 --	2N3739
0122-0259 --	1N5146	1853-0081 --	*2N4258	1853-0399 --	2N3467	1854-0063 --	2N3055	1854-0325 --	2N3478
0122-0261 --	1N5147	1853-0084 --	2N4918	1853-0405 --	*2N4209	1854-0064 --	2N3710	1854-0327 --	*2N3416
0122-0262 --	1N5147A	1853-0086 --	*2N5087	1853-0406 --	2N6476	1854-0066 --	2N2925	1854-0345 --	2N5179
0122-0263 --	1N5148	1853-0089 --	2N4917	1853-0407 --	2N5880	1854-0067 --	2N2102	1854-0347 --	2N4923
0122-0264 --	1N5148A	1853-0098 --	*2N5086	1853-0411 --	2N6050	1854-0072 --	2N3054	1854-0349 --	2N2913
1850-0035 --	2N174	1853-0100 --	*2N4355	1853-0413 --	2N6049	1854-0076 --	2N1973	1854-0352 --	2N2405
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1853-0029 --	*2N5447	1853-0327 --	2N2944A	1854-0010 --	2N834	1854-0263 --	2N3019	1854-0497 --	2N930
1853-0031 --	2N3789	1853-0328 --	2N6211	1854-0011 --	2N835	1854-0264 --	2N3715	1854-0518 --	2N5877
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*=ELECTRICALLY EQUIVALENT TO JEDEC NO.

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1854-0556 --	2N4237
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1854-0570 --	2N5189
1854-0576 --	2N6258
1854-0577 --	2N6259
1854-0586 --	2N5429
1854-0590 --	2N3054
1854-0596 --	2N5427
1854-0597 --	2N5943
1854-0599 --	2N6078
1854-0600 --	2N4233A
1854-0611 --	2N6055
1854-0613 --	2N1701
1854-0623 --	2N6306
1854-0624 --	2N6308
1854-0637 --	2N2219A
1854-0643 --	2N3585
1854-0648 --	2N6300
1854-0651 --	*2N3904
1854-0654 --	*2N5192
1854-0667 --	2N3053
1854-0669 --	2N6057
1854-0671 --	2N6282
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1854-0703 --	*2N3053
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1854-0737 --	*2N6477
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1854-0742 --	2N5886
1854-0743 --	2N5878
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1854-0748 --	2N2896
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1854-0767 --	2N6306
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1854-0784 --	2N3866A
1854-0785 --	2N6305
1854-0796 --	2N2540
1854-0787 --	2N6545
1854-0792 --	2N2920
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1854-0831 --	2N6429A
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1855-0038 --	2N3922
1855-0040 --	2N3819
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1855-0421 --	2N5114
1855-0430 --	2N368[illegible]
1855-0432 --	3N163
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1884-0016 --	2N688
1884-0018 --	2N418[illegible]
1884-0019 --	2N366[illegible]
1884-0021 --	3N83
1884-0022 --	2N417[illegible]
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1884-0027 --	2N1771A
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1901-0306 --	1N2158R
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1902-1203 --	1N2974RA
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1902-1205 --	1N2979RB
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1902-1305 --	1N5237B
1902-1306 --	1N5270B

*=ELECTRICALLY EQUIVALENT TO JEDEC NO.

HP P/N	JEDEC NO.
1902-1307 --	1N5276B
1902-1308 --	1N4734A
1902-1312 --	1N989B
1902-1313 --	1N2988A
1902-1320 --	1N4566
1902-1323 --	1N5857B
1902-1330 --	•1N750
1902-1332 --	1N5851B
1902-1334 --	1N5533B
1902-1336 --	1N6001B
1902-1338 --	1N4557A
1902-1340 --	1N5355B
1902-1341 --	•1N974B
1902-1342 --	1N4742A
1902-1343 --	1N5338
1902-1345 --	1N5365B
1902-1346 --	1N5355B
1902-1348 --	1N4746A
1902-1350 --	1N5364B
1902-1351 --	1N5350B
1902-1353 --	1N2985B
1902-1354 --	1N2985RB
1902-1356 --	•1N4753A
1902-1357 --	1N5374B
1902-1361 --	1N4756A
1902-1362 --	1N967B
1902-1363 --	1N749A
1902-1367 --	1N5353
1902-1369 --	1N3316B
1910-0002 --	1N38B
1910-0003 --	1N55A
1910-0014 --	1N277
1910-0023 --	1N270
1910-0024 --	1N191
1910-0025 --	1N995
1910-0031 --	1N34A
1910-0033 --	1N279
1910-0041 --	1N2326
1911-0001 --	1N91
1912-0002 --	1N3716
1912-0006 --	1N3718
1912-0007 --	1N3714
1912-0009 --	1N3712
1912-0014 --	1N3720
1912-0015 --	1N3717
1912-0017 --	1N3719
1912-0019 --	1N3721

JEDEC NO.	HP P/N
1N21B	-- 1900-0001
1N21B	-- 1900-0017
1N21BMR	-- 1900-0010
1N23B	-- 1900-0012
1N23C	-- 1900-0018
1N26	-- 1900-0007
1N34A	-- 1910-0031
1N38B	-- 1910-0002
1N53	-- 1900-0008
1N55A	-- 1910-0003
1N76	-- 1900-0004
1N76A	-- 1900-0020
1N91	-- 1911-0001
1N191	-- 1910-0024
1N250C	-- 1901-0310
1N270	-- 1910-0023
1N277	-- 1910-0014
1N279	-- 1910-0033
1N415C	-- 1900-0015
1N416B	-- 1900-0006
1N416BM	-- 1900-0011
1N625	-- 1901-0071
1N628	-- 1901-0058
1N647	-- 1901-0129
1N660	-- 1901-0132
1N705A	-- 1902-0094
1N746	-- 1902-0095
1N749A	-- 1902-1363
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•1N750A	-- 1902-0697
1N751A	-- 1902-1255
•1N751A	-- 1902-0915
1N752A	-- 1902-1245
1N753A	-- 1902-0111
1N754A	-- 1902-0003
1N759	-- 1902-1246
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1N821	-- 1902-1275
1N823	-- 1902-0033
1N823	-- 1902-0509
1N825	-- 1902-0777
1N825	-- 1902-0973
1N825	-- 1902-1221
1N827	-- 1902-0680
1N829	-- 1902-0625
1N831	-- 1900-0019
1N914	-- 1901-0710
1N914	-- 1901-1029
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1N935	-- 1902-0772
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1N936	-- 1902-1241
1N937	-- 1902-0786
1N938	-- 1902-0787
1N938A	-- 1902-1216
1N941	-- 1902-0018
1N941	-- 1902-0569
1N941A	-- 1902-0698
1N942	-- 1902-0791
1N943	-- 1902-0792
1N944	-- 1902-0581
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1N965B	-- 1902-1304
1N967B	-- 1902-1362
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•1N979	-- 1902-0972
1N989B	-- 1902-1312
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1N1183A	-- 1901-0315
1N1183AR	-- 1901-0315
1N1184A	-- 1901-0317
1N1184AR	-- 1901-0318
1N1186AR	-- 1901-0319
1N1187A	-- 1901-0320
1N1187AR	-- 1901-0321
1N1200A	-- 1901-0002
1N1206A	-- 1901-0314
1N1347A	-- 1901-0309
1N1362	-- 1902-1195
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1N2158	-- 1901-0305
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1N2163	-- 1902-0762
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1N2242	-- 1901-0151
1N2326	-- 1910-0041
1N2565	-- 1901-0383
1N2620	-- 1902-0157
1N2820A	-- 1902-1298
1N2971RA	-- 1902-1225
1N2971RB	-- 1902-0191
1N2972A	-- 1902-0909
1N2973B	-- 1902-1198
1N2974A	-- 1902-0902
1N2974RA	-- 1902-1203
1N2976B	-- 1902-1194
1N2979	-- 1902-1229
1N2979B	-- 1902-0643
1N2979RB	-- 1902-1205
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1N2982RB	-- 1902-1223
1N2983B	-- 1902-0759
1N2984B	-- 1902-1204
1N2984RB	-- 1902-0910
1N2985B	-- 1902-1353
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1N2986B	-- 1902-0156
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1N2995B	-- 1902-0183
1N2997RB	-- 1902-0645
1N2999A	-- 1902-0028
1N3001B	-- 1902-0998
1N3003B	-- 1902-0088
1N3004B	-- 1902-0087
1N3004RA	-- 1902-0178
1N3009B	-- 1902-0935
1N3034B	-- 1902-1244
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1N3155	-- 1902-0789
1N3156	-- 1902-0790
1N3208	-- 1901-0421
1N3209	-- 1901-0032
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1N3212	-- 1901-0423
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1N3262	-- 1901-0312
1N3262R	-- 1901-0313
1N3289	-- 1901-0307
1N3289R	-- 1901-0308
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1N3491R	-- 1901-0343
1N3492	-- 1901-0424
1N3494	-- 1901-0426
1N3563	-- 1901-0742
1N3644	-- 1901-0752
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1N3718	-- 1912-0006
1N3719	-- 1912-0017
1N3720	-- 1912-0014
1N3721	-- 1912-0019
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•1N3889R	-- 1901-0735
1N3890R	-- 1901-0684
1N3891	-- 1901-0717
1N3891R	-- 1901-0774
1N3893	-- 1901-0890
1N3899R	-- 1901-0678
1N3958	-- 1901-0478
1N3993A	-- 1902-0999
1N3996A	-- 1902-1226
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1N3998A	-- 1902-1201
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1N4004	-- 1901-0743
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1N4100	-- 1902-1169
1N4101	-- 1902-1170
1N4103	-- 1902-1172
1N4104	-- 1902-1173
1N4105	-- 1902-0246
1N4106	-- 1902-1174
1N4110	-- 1902-1178
1N4115	-- 1902-1183
1N4148-1	-- 1901-1101
1N4150	-- 1901-1098
1N4154	-- 1901-1052
1N4156	-- 1901-0463
1N4530	-- 1901-0370
1N4531	-- 1901-1015
1N4557A	-- 1902-1001
1N4557A	-- 1902-1338
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1N4566	-- 1902-1320
1N4567	-- 1902-0649
1N4577	-- 1902-0991
1N4582	-- 1902-0992
1N4603	-- 1900-0016
1N4608	-- 1901-0894
1N4621	-- 1902-0983
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1N4725	-- 1901-0493
1N4732	-- 1902-1300
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1N4738A	-- 1902-0700
1N4742A	-- 1902-1342
1N4746A	-- 1902-1348
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1N4960	-- 1902-0974
1N5000	-- 1901-0775
1N5002	-- 1901-0492
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1N5003	-- 1901-0494
1N5139	-- 0122-0245
1N5140	-- 0122-0247
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1N5141	-- 0122-0249
1N5142	-- 0122-0251
1N5143	-- 0122-0253
1N5144	-- 0122-0255
1N5144A	-- 0122-0256
1N5145	-- 0122-0257
1N5146	-- 0122-0259
1N5147	-- 0122-0261
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1N5148	-- 0122-0263
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1N5353	-- 1902-1367
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1N5401	-- 1901-0907
1N5406	-- 1901-0759
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1N5468A	-- 0122-0062
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1N5533B	-- 1902-1334
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1N5554	-- 1901-0751
1N5616	-- 1901-0862
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1N5817	-- 1901-0868
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1N5818	-- 1901-0734
1N5821	-- 1901-0782
1N5823	-- 1901-0726
1N5828	-- 1901-0708
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1N5857B	-- 1902-1323
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1N6096	-- 1901-0833
1N6270A	-- 1902-0986
1N6303	-- 1901-0919
2N174	-- 1850-0035
2N335	-- 1854-0026
2N388A	-- 1851-0024
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2N685	-- 1884-0015
2N688	-- 1884-0016
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2N743	-- 1854-0004
2N834	-- 1854-0010
2N835	-- 1854-0011
2N910	-- 1854-0209
2N916	-- 1854-0050
2N918	-- 1854-0021
2N930	-- 1854-0497
2N941	-- 1853-0005
2N941	-- 1853-0022
2N964	-- 1850-0099
2N976	-- 1850-0137
2N1131	-- 1853-0019
2N1183	-- 1850-0064
2N1304	-- 1851-0017
2N1358	-- 1850-0150
2N1482	-- 1854-0214
2N1484	-- 1854-0235
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2N1523	-- 1850-0194
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2N1671A	-- 1855-0001
2N1671B	-- 1855-0021
2N1671C	-- 1855-0077
2N1672	-- 1851-0022
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2N1774	-- 1884-0028
2N1846	-- 1884-0051
2N1973	-- 1854-0076
2N2060	-- 1854-0761
2N2102	-- 1854-0067
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2N2218	-- 1854-0053
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2N2219A	-- 1854-0637
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2N2323	-- 1884-0247
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2N2402	-- 1850-0121
2N2405	-- 1854-0352
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2N2483	-- 1854-0304
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2N2538	-- 1854-0213
2N2540	-- 1854-0786
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2N2647	-- 1855-0027
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•2N2714	-- 1854-0027
2N2857	-- 1854-0048
2N2857	-- 1854-0323
2N2869	-- 1850-0126
2N2896	-- 1854-0748
2N2904	-- 1853-0013
2N2904A	-- 1853-0012
2N2905	-- 1853-0282
2N2905A	-- 1853-0314
2N2907	-- 1853-0205
2N2907A	-- 1853-0281
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2N2913	-- 1854-0349
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•=ELECTRICALLY EQUIVALENT TO JEDEC NO.

JEDEC NO.	HP P/N
2N2944A	1853-0327
2N2946A	1853-0322
2N2958	1854-0036
2N2972	1854-0411
2N2996	1850-0172
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2N3014	1854-0842
2N3019	1854-0263
2N3053	1854-0667
•2N3053	1854-0703
2N3053S	1854-0039
2N3054	1854-0072
2N3054	1854-0590
2N3055	1854-0063
2N3134	1853-0006
2N3227	1854-0260
2N3250	1853-0008
2N3250	1853-0287
2N3251	1853-0007
2N3261	1854-0301
2N3262	1854-0242
2N3302	1854-0278
2N3304	1853-0014
2N3330	1855-0393
2N3382	1855-0390
•2N3390	1854-0202
2N3391	1854-0033
•2N3391	1854-0371
•2N3391A	1854-0201
•2N3393	1854-0099
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2N3415	1854-0393
•2N3416	1854-0327
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2N3436	1855-0005
2N3439	1854-0079
2N3440	1854-0234
2N3441	1854-0216
2N3442	1854-0217
2N3467	1853-0399
2N3478	1854-0325
2N3494	1853-0071
2N3501S	1854-0813
2N3502	1853-0283
2N3528	1884-0012
2N3553	1854-0308
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2N3569	1854-0466
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2N3633	1854-0315
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2N3762	1853-0429
2N3766	1854-0259
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2N3772	1854-0519
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2N3791	1853-0059
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●2N3904	1854-0215
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●2N3904	1854-0883
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•2N3906	1853-0036
2N3922	1855-0038
2N3933	1854-0238
2N3955	1855-0207
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2N3959	1854-0220
2N3966	1855-0286
2N3993	1855-0387
2N4028	1853-0206
2N4032	1853-0320
2N4033	1853-0422
2N4034	1853-0072
2N4035	1853-0258
2N4037	1853-0051
2N4044	1854-0248
2N4046	1854-0478
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2N4092	1855-0371
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2N4117	1855-0208
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2N4119	1855-0229
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2N4172	1884-0022
2N4186	1884-0018
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2N4236	1853-0213
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2N4392	1855-0386
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2N4401	1854-0467
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2N4403	1853-0271
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2N4416	1855-0327
2N4416A	1855-0276
2N4428	1854-0851
2N4441	1884-0082
2N4443	1884-0066
2N4444	1884-0245
2N4852	1855-0204
2N4853	1855-0099
2N4856	1855-0389
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2N4891	1855-0065
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2N4900	1853-0323
2N4902	1853-0223
2N4904	1853-0426
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2N4912	1854-0399
2N4917	1853-0089
2N4918	1853-0084
2N4919	1853-0222
2N4920	1853-0204
•2N4921	1854-0699
2N4922	1854-0389
2N4923	1854-0347
2N4924	1854-0468
2N4959	1853-0430
2N4990	1884-0091
2N4996	1854-0397
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2N5247	1855-0257
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2N5416	1853-0221
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2N5429	1854-0586
2N5432	1855-0292
2N5434	1855-0449
2N5444	1884-0255
2N5445	1884-0080
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2N5460	1855-0226
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2N5519	1855-0398
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2N5556	1855-0288
2N5565	1855-0232
2N5569	1884-0270
2N5573	1884-0202
2N5575	1854-0709
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2N6658	1855-0293
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2N6678	1854-0896
3N81	1884-0070
3N83	1884-0021
3N91	1853-0057
3N128	1855-0306
3N138	1855-0332
3N142	1855-0357
3N153	1855-0307
3N163	1855-0432
3N180	1855-0279
3N215	1855-0250

•=ELECTRICALLY EQUIVALENT TO JEDEC NO.

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 select the notes that relate to your instruments.

GENERAL

M59-2-S. Product safety service note index.
5083-7. CRT part numbers 5083-19XX, 5083-25XX (excluding 2511) and 5083-37XX. Increased screen uniformity for CRT serials 520637 and higher.

141T OSCILLOSCOPE

141T-11. All serials. Circuit board modification to correct +248 volt power supply.

181A/AR OSCILLOSCOPE

181A/AR-10. 181A serials 2045A and below; 181AR serials 2043A and below. Preferred replacement voltage reference tube for A8V1/V2 in ±100V supplies.

184A/B OSCILLOSCOPE

184A/B-4. Serials 1916A and below. Improved CRT performance.

239A LOW DISTORTION OSCILLATOR

239A-3. Serials 1814A-00805 and below. Solution to inadequate frequency vernier overlays.

331A DISTORTION ANALYZER

331A/332A/333A/334A-13. All serials. Modification to eliminate oscillation in voltmeter mode.

332A DISTORTION ANALYZER

331A/332A/333A/334A-13. All serials. Modification to eliminate oscillation in voltmeter mode.

333A DISTORTION ANALYZER

331A/332A/333A/334A-13. All serials. Modification to eliminate oscillation in voltmeter mode.

334A DISTORTION ANALYZER

331A/332A/333A/334A-13. All serials. Modification to eliminate oscillation in voltmeter mode.

1304A X-Y DISPLAY

1304A-4. Serials 1715A and 1920A. Modification kit that improves reliability of the +158 volt power supply and Z-axis circuit.

1310A DISPLAY

1310A-20. Serials 1921A. Modification to improve reliability of 250V low voltage power supply.

1317A DISPLAY

1317A-7. Serials 1916A. Modification to improve reliability of 250V low voltage power supply.

1321A DISPLAY

1321A-7. Serials 1915A. Modification to improve reliability of 250V low voltage power supply.

1744A OSCILLOSCOPE

1744A-2. Serials 2014A and below. Modification that improves CRT reliability.

3060A CIRCUIT TEST SYSTEM

3060A-19. All serials. Notification of availability of Field Service Inventory Kit (03060-69902) to assist onsite service and repair of Option 100.
3060A-21A. All serials. Revision 2114 of 3060A System Diagnostic/Confirmation Disk (CCD Rev. 2114).
3060A-22. All serials. Installation instructions for the Option 100 DSRU Stimulus Board.
3060A-23. All serials. Notification of availability of Field System Support Package (03060-69900) to help facilitate on-site isolation and repair of failures in the 3060A Board Test System.
3060A-24. All serials. Notification of availability of Customer Service Kit (03060-69802) to assist onsite service and repair of Option 100.

3253A ANALOG STIMULUS/RESPONSE UNIT

3253A-4A. All serials. Use CCD Rev. 2114 software to test MOA A23 boards.

3330A/B AUTOMATIC SYNTHESIZER

3330A/B-15. 3330A all serials; 3330B serials 1313A01160 and below. Replace slide switches on the A6 and A7 boards with short wire jumpers to improve reliability.

3335A FREQUENCY SYNTHESIZER

3335A-6. All serials. Test specification change for the integrated phase noise test.
3335A-7. All serials. Notification of availability of service kit (03335-69800) for 3335 synthesizer/level generator.
3335A-8. All serials. Equipment safety procedure for troubleshooting the controller (A13) assembly.

3336A/B/C SYNTHESIZER/LEVEL GENERATOR

3336A/B/C-3. All serials. Notification of spare parts service kit 03336-68701.

3403C TRUE RMS VOLTMETER

3403C-9. All serials. Modification to improve performance when replacing op-amp A12IC4.

3437A SYSTEM VOLTMETER

3437A-6A. Serials 1630A03530 and below. Recommended nanoprocessor replacement.

3456A DIGITAL VOLTMETER

3456A-4. All serials. Notification of spare parts kit (03456-69802) for the 3456A Product Support Package.

3465A/B DIGITAL MULTIMETER

3465A-7B. All serials. Table of front panel switch information.
3465B-3B. All serials. Table of front panel switch information.

3466A MULTIMETERS

3466A-9. Serials 1716A02980 and below, and instruments in which U102 is replaced. Modification to improve low readings in the 200MV and 20MV DC ranges.
3466A-10. Serials 1716A08405 and below. Modification to reduce drift on the 20MΩ range.

3467A LOGGING MULTIMETER

3467A-4. All serials. Modification to correct erratic display when the printer is activated.

3476A/B DIGITAL MULTIMETER

3476A-5B. All serials. Front panel switch information.
3476B-4B. All serials. Front panel switch information.

3496A SCANNER

3496A-4A. All serials. Modification to improve the reliability of the Signature Analysis (Option 008) Tests in the 3060A System Confirmation.

3497A DATA ACQUISITION/CONTROL UNIT

3497A-7. All serials. Remove and save the microprocessor frequency crystal Y1 before sending in the Mainframe Inguard Controller Board for blue stripe repair.
3497A-8. All serials. Notification of availability of Service Kit 03497-69800.

3580A SPECTRUM ANALYZER

3580A-9. Serials 1415A-04280 and below. Retrofitting the new frequency control module to older instruments.

3585A SPECTRUM ANALYZER

3585A-5. Serials 1750A00716 and above. New revised A51 phase detector board that improves performance.
3585A-6. All serials. Nofitication of availability of Field Service Kit (03585-69900) for the 3585A Spectrum Analyzer.

3702B IF/BB RECEIVER

3702B-43. Serials 2025U-02898 and below. Field installation of logarithmic amplifier.

3705A DIFFERENTIAL PHASE DETECTOR

3705A-3A. Procedure to convert from Option 10 to Option 13.

3745A/B SELECTIVE LEVEL MEASURING SET

3745A/B-15B. All serials. Installation instructions for Option 021 CCITT weighted filter and phase jitter.
3745A/B-52/3747A/B-23. All serials. 3745A/B and 3747A/B semi-automatic performance checks using tape cartridge 03745-18003.

3747A/B SELECTIVE LEVEL MEASURING SET

3747A/B-12A. All serials. Installation instructions for Option 022 C-Message weighted filter and phase jitter.
3747A/B-21. All serials. Installation instructions for X-Y Recorder or CRT display Option 040.
3747A/B-22. Serials 1924U and below. Preferred replacement of A601 X-Y driver assembly.
3745A/B-52/3747A/B-23. All serials. 3745A/B and 3747A/B semi-automatic performance checks using tape cartridge 03745-18003.

3770B TELEPHONE LINE ANALYZER

3770B-25. All serials. Instrument rackmount retrofit kit.

3771A/B DATA LINE ANALYZER

3771A/B-20. 3771A serials 2107U-00295 and below; 3771B serials 2105U-00138 and below. Modification to prevent possible loss and blanking of dropouts display.

4140A pA METER/DC VOLTAGE SOURCE

4140A-13. All serials. Remedy for malfunction of key controls.
4140A-14. All serials. Modification to improve A6 ramp generator performance.
4140A-15. All serials. Modification to the A3 MPU board to improve V_B output.

4140B pA METER/DC VOLTAGE SOURCE

4140B-7. Serials 2034J00220 and below. Remedy for malfunction of key controls.
4140B-8. Serials 2034J00240 and below. Modification to improve A6 ramp generator performance.
4140B-9. Serials 2034J00250 and below. Modification to the A3 MPU board to improve V_B output.

4910F OPEN FAULT LOCATOR
4910F-3. Serials 1146A06470 and below. Recommended replacement of 4 tier potentiometer.

4960A PAIR IDENTIFIER
4960A-5. Serials 2032A00476 and below. Recommended replacement for bridge rectifier to improve performance.

5005A SIGNATURE MULTIMETER
5005A-1. Serial prefix 1952A; serials 00261-00285 and below. Modification to prevent +5 volt power supply oscillation.

5045A DIGITAL IC TESTER
5045A-25. Serials 2104A00625 and below. Modification to prevent indication of erroneous failure of a good device (IC).

5328A UNIVERSAL COUNTER
5328A-32. All serials. Cross reference table showing A1U37 Option ROMS to Channel C Options.

5335A UNIVERSAL COUNTER
5335A-4. All serials. Programmable input amplifier adjustment procedures (Option 040).

5340A MICROWAVE FREQUENCY COUNTER
5340A-19. All serial prefixes 2112A and above, and/or Assemblies A10 (VCO NO 2)/A12 (VCO NO 1) HP Part No. 05340-60008 (Series 2112 and above). Instructions for performing adjustments 5 and 6 (re, VCO 1 and VCO 2 outputs).

5345A ELECTRONIC COUNTER
5345A-17. All serials. Summary of A3 and A4 Assembly U1 and U2 changes, replacement part numbers, and bias adjustments.

5390A FREQUENCY STABILITY ANALYZER SYSTEM
5390A-1. All serials. Software modification to correct phase noise self-test problems at line frequencies.

5427A DIGITAL VIBRATION CONTROL SYSTEM
5427A-03. All serials. 5478C system interface adjustment procedure.

5478C SYSTEM INTERFACE
5427A-03. All serials. 5478C system interface adjustment procedure.

6259B LVR POWER SUPPLY
6259B-3A/6260B-2A/6261B-2/6268B-2A/6269B-4. Serials 2035A01215 and below. Recommended fan replacement to improve reliability.

6260B LVR POWER SUPPLY
6259B-3A/6260B-2A/6261B-2/6268B-2A/6269B-4. Serials 2031A02495 and below. Recommended fan replacement to improve reliability.

6261B LVR POWER SUPPLY
6259B-3A/6260B-2A/6261B-2/6268B-2A/6269B-4. Serials 2034A01590 and below. Recommended fan replacement to improve reliability.

6268B LVR POWER SUPPLY
6259B-3A/6260B-2A/6261B-2/6268B-2A/6269B-4. Serials 2034A04150 and below. Recommended fan replacement to improve reliability.

6269B LVR POWER SUPPLY
6269B-3A/6260B-2A/6261B-2/6268B-2A/6269B-4. Serials 2033A05820 and below. Recommended fan replacement to improve reliability.

6281A DC POWER SUPPLY
6281A-1. Serials 1935A-03461 and below. Modification to prevent oscillations.

6453A SCR-3 POWER SUPPLY
6453A-2/6456B-2/6459A-2. Serials 2038A00805 and below. Installation of new AC power connectors for 250 VAC (Opt. 001, 002) and 480 VAC (Opt. 003, 031, 032).

6456B SCR-3 POWER SUPPLY
6453A-2/6456B-2/6459A-2. Serials 2042A01383 and below. Installation of new AC power connectors for 250 VAC (Opt. 001, 002) and 480 VAC (Opt. 003, 031, 032).

6459A SCR-3 POWER SUPPLY
6453A-2/6456B-2/6459A-2. Serials 2043A01704 and below. Installation of new AC power connectors for 250 VAC (Opt. 001, 002) and 480 VAC (Opt. 003, 031, 032).

7100B STRIP CHART RECORDER
7100B-9. Serials 2042A and 2043A. Recommended pen drive pulley assembly and stop replacements.

7101B STRIP CHART RECORDER
7101B-9. Serials 2042A and 2043A. Recommended pen drive pulley assembly and stop replacements.

7240A PLOTTER/PRINTER
7240A-2B-S. Serials 2047 and below. Modification to eliminate a potential shock hazard at the plotter input power receptacle when the plotter power on/off switch is in the off position.

7245A/B PLOTTER/PRINTER
7245A/B-3-S. Serials 2047 and below. Modification to eliminate a potential shock hazard at the plotter input power receptacle when the plotter power on/off switch is in the off position.

7402A OSCILLOGRAPHIC RECORDERS
7402A-12. All serials. Recommended ink cartridge replacement for P/N 07402-60008 and 07402-60066.

7404A OSCILLOGRAPHIC RECORDERS
7404A-5. All serials. Recommended ink cartridge replacement for P/N 07402-60008 and 07402-60066.

8350A SWEEP OSCILLATOR
8350A-3. Serials 2024A and below. Recommended replacement masked ROM kit for the A3 microprocessor assembly.

8500A SYSTEM CONSOLE
8500A-1A. Machine language programs that will exercise the NCR printer.

8555A SPECTRUM ANALYZER
8555A-11. All serials. Revised performance test for 8555A frequency response.
8555A-12. All serials. Frequency response adjustment after replacement of input mixer assembly HP part number 08555-60072.

8558B SPECTRUM ANALYZER
8558B-2B. Serials 1612A and below. R1/R2 frequency tune operational tests.
8558B-6B. Serials 1829A and below. Modification Kit HP part number 08558-60099 for replacement of obsolete digital panel meters.
8558B-12A. Serials 1829A and below. RF input limiter modification.
8558B-14A. Serials 1707A03361 to 1738A04160. Short circuit prevention for third converter transistor A9Q2.

8559A SPECTRUM ANALYZER
8559A-1. Serials 1909A and below. Second converter input coupling loop replacement.
8559A-5. Serials 2019A00720 and below. Recommended transistor replacement (A14Q25) to prevent A14 log amplifier board oscillations.
8559A-7. Serials 2019A00820 and below. Recommended capacitor addition to prevent A7 frequency control board oscillations.
8559A-8. Serials 2109A01000 and below. Modification to improve A1A2 DPM Driver Board reliability.
8559A-9. Serials 2019A01000 and below. Modification to improve CAL output power level stability.

8566A SPECTRUM ANALYZER
8566A-16. All serials. When replacing the RF Attenuator, the matching calibration ROM must be used to achieve the specified amplitude accuracy.

8620C SWEEPER MAINFRAME
8620C-7. All serials. Checkout procedure for HP 86200 Series Upconverter Option RF plug-ins.

8656A SIGNAL GENERATOR
8656A-8. Serials 2107A and below. Procedure for replacing the Frame-casting bosses.

8662A SYNTHESIZED SIGNAL GENERATOR
8662A-4. Serials 2107A00680 and below. RF output connector modification.

8672A SYNTHESIZED SIGNAL GENERATOR
8672A-10. All serials. Procedure for installing Option 008 (Greater Power Output).

8903A AUDIO ANALYZER
8903A-1. All serials. Front to rear panel connector conversion.
8903A-2. All serials. Rear to front panel connector conversion.

37203A HP-IB EXTENDER
37203A-2. Serials 2040U00549 and below. Modification to prevent main clock generator failures.
37203A-3. All serials. Possible incorrect signatures in HP-IB section.
37203A-4. All serials. Installation of Option 001 Fibre Optic Interface.
37203A-5. All serials. Preferred replacement of ICs A1U62 and A1U63.

37210T 4800 BITS/S MODEM
37210/220T-1. Recommended exchange power supply replacement.

37220T 9600 BITS/S MODEM
37210/220T-1. Recommended exchange power supply replacement.

64000 LOGIC DEVELOPMENT SYSTEM
64000A-0A. Service note index.

64001S LOGIC DEVELOPMENT SYSTEM
64001S/006-0. Service note list for the 7906 disc drive.
64001S/006-1. Serials 2018 and below. Recommended part replacement to prevent power switch failures.
64001S/010-0. Service note list for the 7910 fixed disc drive.
64001S/010-1. Replacement DC power cable on 7910H fixed disc drive to improve performance.
64001S/010-2. Instructions for proper grounding of the 7910 spindle to prevent noisy 7910 fixed disc drive mechanism.
64001S/010-3. PROM replacement set allows recovery of inaccessible tracks on 7910 fixed disc drive.
64001S/020-0. Service note list for the 7920 disc drive.
64001S/020-1. Serials 2018 and below. Recommended part replacement to prevent power switch failures.
64001S/025-0. Service note list for the 7925 disc drive.
64001S/025-1. Serials 2018 and below. Recommended part replacement to prevent power switch failures.

64100A LOGIC DEVELOPMENT SYSTEM MAINFRAME
64100-3. Serials 2033A01402 and below. Recommended replacement USART 8251A to improve performance on RS232.

64151A STATIC RAM CONTROLLER

64151A-3. 64151-66501 boards with repair number 1924A00900 and below. Modification to prevent incorrect data display during "Logic Analysis Trace" mode.

64250A Z80 EMULATOR SUBSYSTEM

64251A-4. Z80 Emulation Control Board repair number prefix 2009A and below. Incorporation of Z80B microprocessor for enhanced performance.

64252A-4. Z80 Emulator Pod Board repair number prefix 2003A and below. Incorporation of Z80B microprocessor for enhanced performance.

645XX PROM PROGRAMMER

64501A-1. 64501A positive PROM programmer driver PC board (64501-66501) Rev. C and earlier. Recommended procedure for selection of integrated circuit U38.

64502-0. Service note list for the 64502A PROM programmer module.

64502-1. All serials. PROM programming procedure.

64503A-0. Service note list for the 64503A PROM programmer module.

64503-2. All serials. PROM programmer procedure.

64507A-0. Service note list for the 64507A PROM programmer module.

64507-2. All serials. PROM programming procedure.

64507A-3. All serials. Modification to enhance ability to program 2708 EPROMS.

64509A-0. Service note list for the 64509A PROM programmer module.

64509-2. All serials. PROM programming procedure.

64930A SERVICE KIT

64930A-1. Purge of old RAM ICs to prevent use on newer model boards.

64930A-1. 64930A Service Kit. Purge of old RAM ICs to prevent use on newer model boards.

64940A TAPE CARTRIDGE DRIVE

64940-0. Service note list for the 64940 Tape Drive Unit.

64940-2. Instructions for overcoming tape transport system verification errors.

New 1304A Display Power Supply Improves Reliability

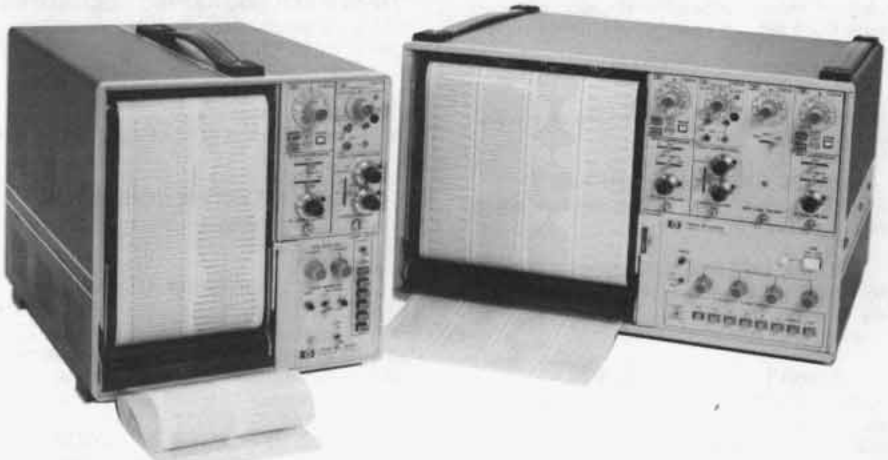
Early in 1980, all 1304A Displays being shipped received a newly designed low-voltage power supply. This change incorporated several design improvements which resulted in improved power supply and 1304A Display reliability.

HP's test data indicated that the old power supply's failure rate was a function of the display's operating environment. Therefore, if you have not experienced any problems with 1304A Displays that have been operational for some time, the application of these displays is such that the power supply will continue to operate satisfactorily.

Hewlett-Packard will replace the power supply (which requires replacing the A1 Mother Board Assembly) in all instruments returned for warranty repair, even if it has not experienced a power supply failure. Customers who have out-of-warranty units wishing to replace their old power supplies can obtain the modification kit (HP part number 01304-69501) free of charge from Hewlett-Packard at Colorado Springs, Colorado.

Oscillograph Pen Maintenance Kit

HP's 7402A and 7404A Oscillograph Recorders have the justified reputation of being the most reliable ink writers available. Nonethless, occasionally maintenance is required for the writing system. Customers who do their own maintenance should be aware that a Pen Maintenance Kit is available. It's the HP Model 17131A and contains wrenches, tension gauge, ink tube sleeves, replacement pen, crank adjustment tool, etc.—all the items that might ever be needed—even for major repairs.



M59-2-S Product Safety Service Note Index

This is a list of all the Safety Service Notes that have been issued by Hewlett-Packard as of March 1981.

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

For European customers (ONLY)

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Van Hueven Goedhartlaan 121
AMSTELVEEN—1134
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CITY ____________________

STATE ____________ ZIP _____

- ☐ M59-2-S
- ☐ 5083-7
- ☐ 141T-11
- ☐ 181A/AR-10
- ☐ 184A/B-4

- ☐ 239A-3
- ☐ 331A/332A/ 333A/334A-13
- ☐ 1304A-4
- ☐ 1310A-20

- ☐ 1317A-7
- ☐ 1321A-7
- ☐ 1744A-2
- ☐ 3060A-19
- ☐ 3060A-21A

- ☐ 3060A-22
- ☐ 3060A-23
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