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2nd Quarter 1990

Operational Amplifier Basics

Introduction

It can be mathematically shown that if an amplifier has:

- an infinite high gain,
- an infinite bandwidth,
- an infinite high input impedance, and
- a zero output impedance,

then its characteristics can be totally determined by external components connected in feedback loops. Such an "ideal" operational amplifier (op amp) is shown in Figure 1. Since R_{IN} is infinite, there is no current flow into either input terminal and the differential input voltage is zero. If there is an output voltage E_O present, it can only be the result of an infinitesimal voltage at the input. These are theoretical considerations only.

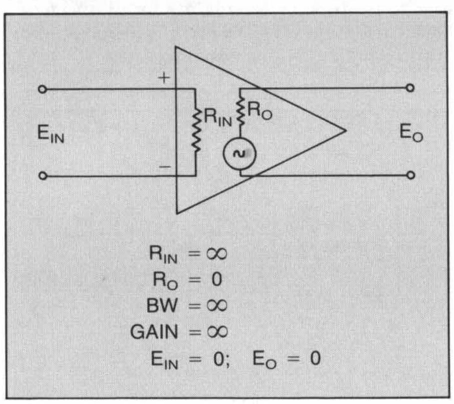


Figure 1. "Ideal" Operational Amplifier

The op amp is, therefore, an ideal building block for all kinds of analog tasks. In practice, no single characteristic listed above can be fully achieved. The values that can be practically obtained are nevertheless such that the resulting performance is extremely useful.

Op Amp Fundamentals

An op amp is a very high gain dc amplifier and usually has voltage gains in the range of 20,000 to 1,000,000. The detailed schematic symbol of an op amp is shown in Figure 2a with the simplified symbol shown in Figure 2b.

As shown in Figure 2a, the −input of the op amp is called the inverting input, and the +input is called the noninverting input. If an input signal is applied to the −input, with +input grounded, the polarity of the output signal will be opposite to that of the input signal. If an input signal is applied to the +input, with the −input grounded, the polarity of the output signal will be the same as that of the input signal. For an ac signal, this means that the output of the op amp will be 180 degrees out of phase with a signal applied to the −input, but in phase with a signal applied to the +input.

Ideal Op Amps With Negative Feedback

The most common op amp circuit configuration uses two external components: 1) an input component and 2) a feedback component (see Figure 3). When the feedback component is between the op amp output and the −input, the circuit is said to have negative feedback. When the feed-

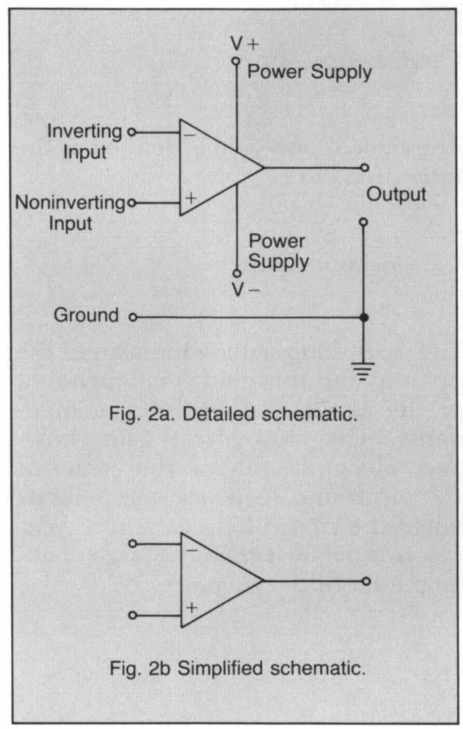


Figure 2. Op-amp schematic symbols

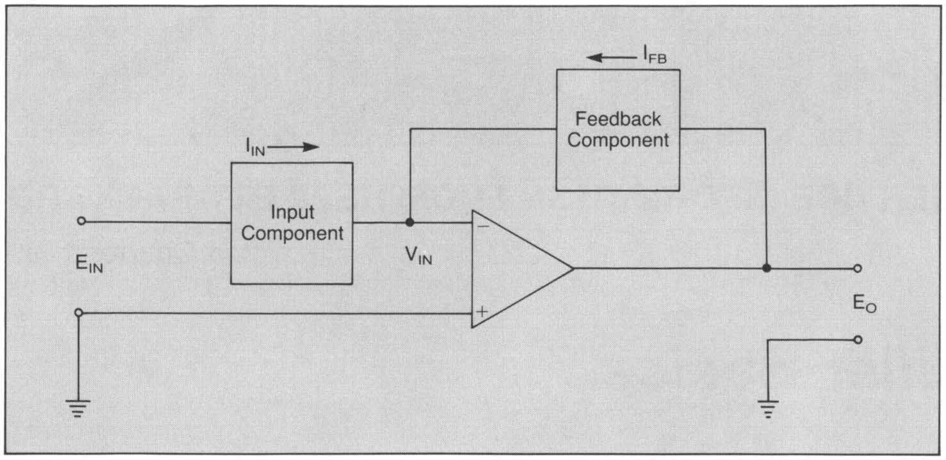


Figure 3. Op amp circuit with negative feedback

back component is between the op amp output and the +input, the circuit is said to have positive feedback.

In Figure 3, an op amp is shown with negative feedback. E_{IN} is the inut signal, V_{IN} is the differential input to the op amp, and E_O is the op amp output. The open loop gain is defined as the ratio of E_O to V_{IN}:

$$\text{Open-Loop Gain} = \frac{E_O}{V_{IN}}$$

The closed-loop gain is defined as the ratio of E_O to E_{IN}:

$$\text{Closed-Loop Gain} = \frac{E_O}{E_{IN}}$$

The open-loop gain is the gain of the op amp and this gain is independent of the input and feedback components. The closed-loop gain, however, depends only on the values of the input and feedback components when the closed-loop gain of the circuit is much less than the large open-loop gain of the op amp.

Input Current and Feedback Current

When an input signal (E_{IN}) is applied to the circuit of Figure 3, a current (I_{IN}) flows through the input component and a voltage (V_{IN}) develops across the input terminals of the op amp. The very high gain op amp amplifies the differential input voltage (V_{IN}) producing an output voltage (E_O) with a polarity opposite to that of V_{IN}. This output is fed back through the feedback component and opposes the input voltage that produced it.

Because the negative feedback signal opposes the input signal, V_{IN} is very small. Therefore, the higher the gain of the op amp, the smaller is V_{IN}. In fact, for some calculations, V_{IN} can be assumed equal to zero and the inverting input at virtually the same potential as the noninverting input.

The relationship between the input current (I_{IN}) and the feedback current (I_{FB}) is most important. Assuming that V_{IN} is equal to zero*, it follows from Ohm's law that no current can flow into the op amp. By applying Kirchhoff's current law (the algebraic sum of the currents toward any point in a network is zero) to the inverting-input terminal of the op amp, it can be seen that the input current must be equal and opposite to the feedback current. Extensive use will be made of this important result:

$$I_{FB} = -I_{IN}$$

The Equivalent Circuit

The schematic diagram of the op amp with negative feedback may be simplified, using the previous results, to the equivalent circuit shown in Figure 4. The equivalent circuit is obtained by recalling that I_{IN} is equal and opposite to I_{FB}, and so Figure 3 can be relabeled as shown in Figure 4.

Since V_{IN} is nearly zero, the inverting input of the op amp can be considered to be at ground potential. This simplifies the diagram of Figure 4 to the important equivalent circuit shown in Figure 5.

The equivalent circuit shown in Figure 5 shows why op amps with negative feedback are so useful. The input circuit is electrically isolated from the output circuit, yet the current flowing through the input com-

*If V_{IN} were actually equal to zero, the output of the op amp would also be zero and the op amp would be useless. In reality, V_{IN} is a very small voltage (usually less than a millivolt). But, for the purpose of calculating input and feedback currents, very little error is introduced by approximating V_{IN} as equal to zero.

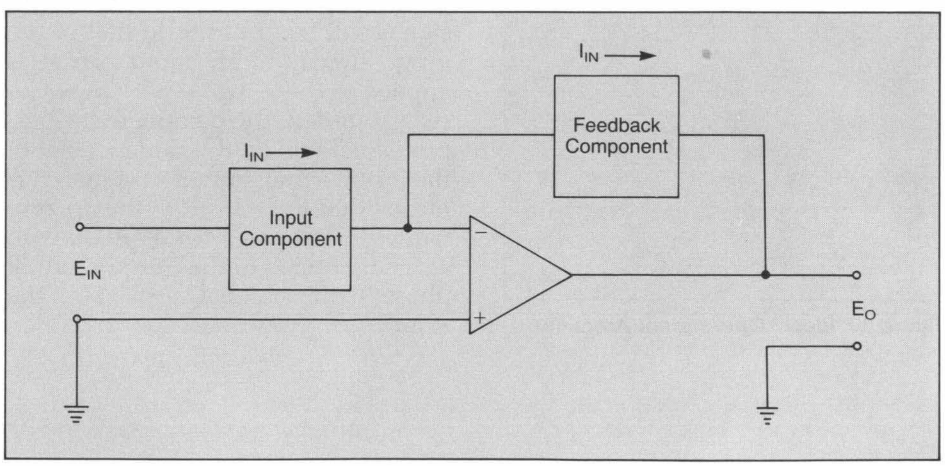


Figure 4. Negative feedback op amp circuit with equivalent feedback current shown

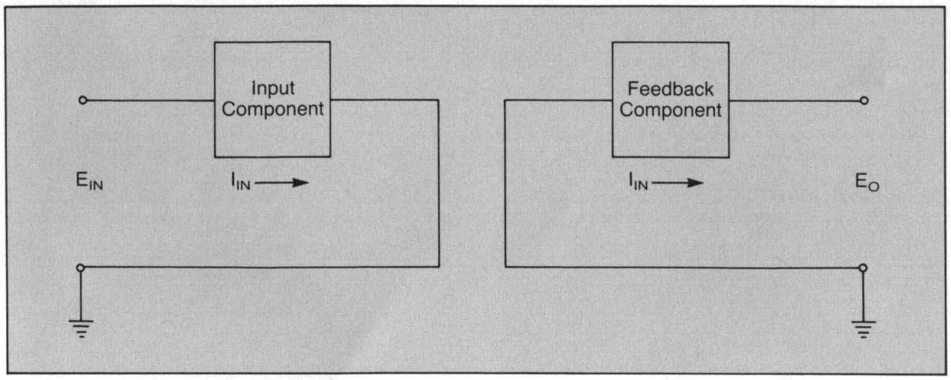


Figure 5. Equivalent circuit of Figure 4

ponent dictates what current must flow through the feedback component. By choosing different input and feedback components, different circuit functions can be performed. The circuit functions listed in Table 1 will be discussed later in this article.

Table 1. Table of Circuit Functions

Circuit Function	Input Components	Feedback Component
Amplification	Resistor	Resistor
Integration	Resistor	Capacitor
Differentiation	Capacitor	Resistor

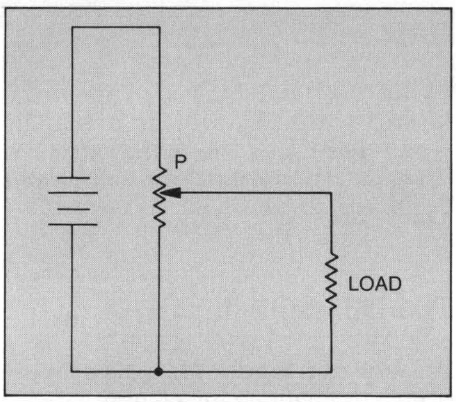


Figure 6. Simple voltage divider

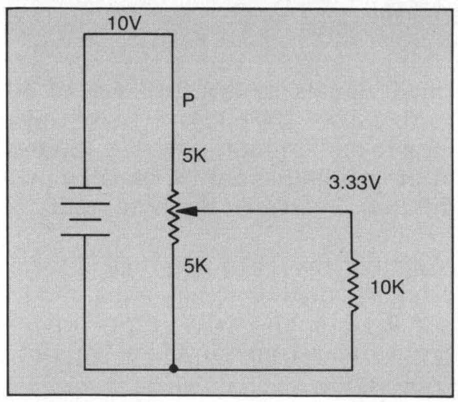


Figure 7. Simple voltage divider set at 50 percent

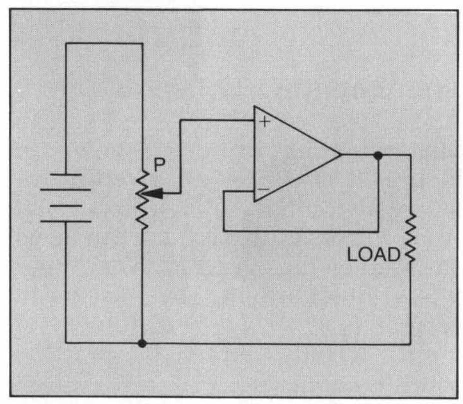


Figure 8. Simple voltage divider with op amp providing isolation

Figures 6 and 7 illustrate a very simple concept in conjunction with an op amp. The potentiometer P is used as a variable voltage divider and the voltage delivered to the load is in a linear ratio with the shaft rotation. This will only be the case if the load is an infinite resistance, or is very high in comparison to the resistance of P. As an example, if P and the load are each 10 kilohms and P is set at 50 percent, the division ratio will not be 1/2 but 2/5, as shown in Figure 7.

If an op amp is connected between the movable contact of P and the load as shown in Figure 8, the op amp will provide perfect isolation. The op amp must have a closed loop gain of one. This is possible with a 100 percent feedback. An op amp connected in this way is often referred to as a voltage follower or an impedance converter.

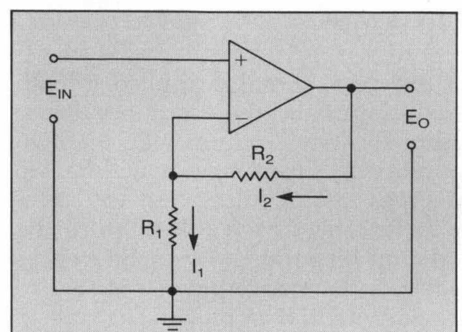
An additional characteristic that is important for an op amp is stability. If the input is zero, the output will also be zero. The op amp must be free of drift or offset voltage.

The Noninverting Op Amp

In the configuration shown in Figure 9, E_{IN} and E_O are in phase. The closed loop gain is controlled by the ratio of R_1 and R_2. If $R_2 = 0$, then the amplifier is simply a voltage follower and R_1 becomes meaningless. However, in practical applications, it will be made equal to the E_{IN} source impedance for balancing purposes of the differential input stage.

The Inverting Op Amp

E_{IN} and E_O are inverted as is indicated by the negative sign for the gain (see Figure 10). R_3 may be included instead of a ground connection of the noninverting input only because of a less than ideal amplifier (less than infinite input impedance). R_3 should be equal to R_1, again for balancing purposes. If the characteristics are close enough to ideal, then input B is at ground level. By definition, input A must also be at ground level since there shall be no potential difference between inputs A and B. Point A is called a virtual ground.



$$GAIN = \frac{R_1 + R_2}{R_1} = 1 + \frac{R_2}{R_1}$$

$GAIN = 1$ FOR $R_2 = 0$ OR $R_1 = \infty$

$R_{IN} = \infty$

$I_1 = I_2$ INDEPENDENT OF R2

Figure 9. Simple noninverting op amp

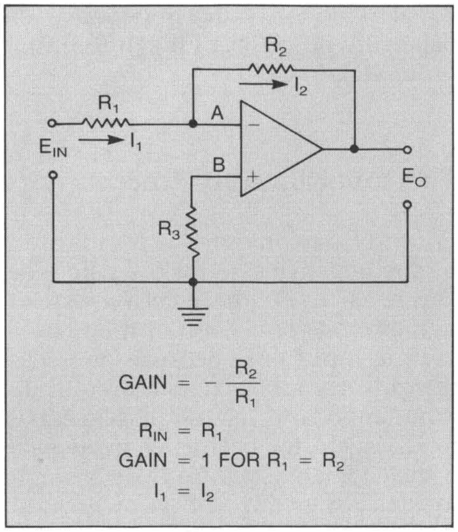


Figure 10. Simple inverting operational amplifier

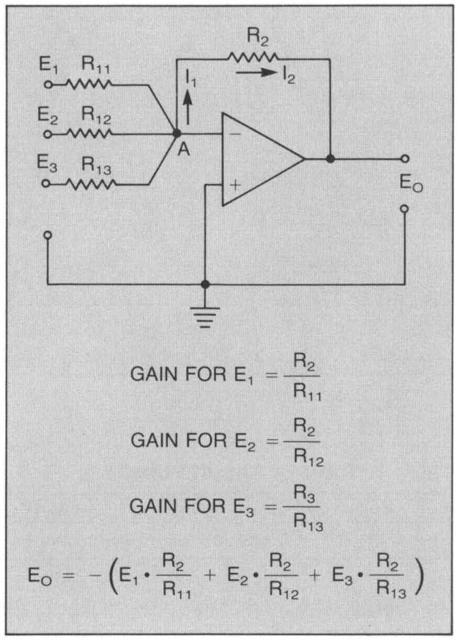


Figure 11. Simple summing operational amplifier

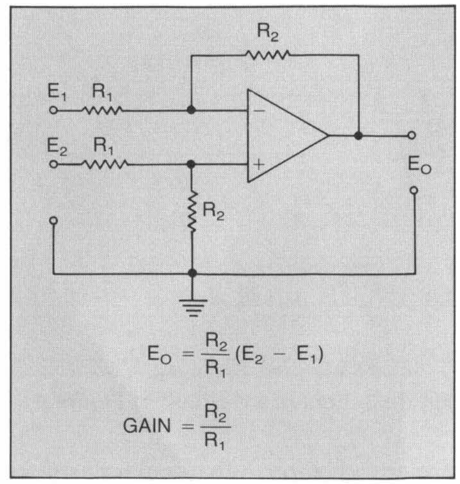


Figure 12. Simple differential operational amplifier

The Summing Op Amp

The summing op amp shown in Figure 11 is simply an inverting op amp with multiple inputs. Since input A is a virtual ground, there can be no current flowing over A from one input into another input. The total input current is $I_1 = I_2$. The number of inputs is only limited by practical considerations.

The Differential (Subtracting) Op Amp

If the same signal is applied to both the +input and the −input of the op amp shown in Figure 12, the two amplified output signals will be 180 degrees out of phase and will completely cancel each other. Since the op amp responds only to differences between its two inputs, it is said to be a differential amplifier. The voltage difference between the +input and the −input is called the differential input voltage. Since a differential amplifier amplifies only the differential input voltage and is unaffected by signals common to both inputs, it is said to have common-mode rejection. Common-mode rejection can be very useful, for example, when measuring small signals in the presence of 60 Hertz noise. The 60 Hertz noise common to both inputs is rejected and the op amp amplifies only the small signal difference between the two inputs.

Note that an ideal differential op amp produces neither a differential-mode nor a common-mode output in response to a common-mode interference input.

The Integrating Op Amp

The simple integrating op amp shown in Figure 13 produces an output signal proportional to the integral of the input signal and time variable of the resistance and capacitance charging rate. The capacitor connected across the input and output of the inverting op amp improves the performance by what is called the Miller Effect. The Miller Effect says that a capacitor connected as shown appears to the input as being multiplied by the gain of the amplifier.

If R = 1 megohm and C = 1 microfarad, according to the formula shown in the figure, E_O will increase at a rate of 1 volt per second, positive or negative, depending on the polarity of E_{IN}. If E_{IN} is a symmetrical square wave, E_O will be a triangle wave. For E_{IN} = sin X the output is −cos X. The output leads the input by 90°.

The Differentiator Op Amp

As shown in Figure 14, E_O is proportional to the rate of change of the input voltage. A dc input will make $E_O = 0$ because of the blocking capacitor C. A square wave at the input will produce a spike at the output triggered by the leading and trailing edges of the input signal. Because the top of the square wave is a constant value, the differential factor is zero and the integrating capacitor discharges towards zero.

The Logarithmic Converter Op Amp

If a nonlinear element such as a transistor is connected into the feedback path as shown in Figure 15, E_{IN} versus E_O follows a nonlinear function. The base-emitter junction of Q_1 represents the logarithmic element in the feedback loop.

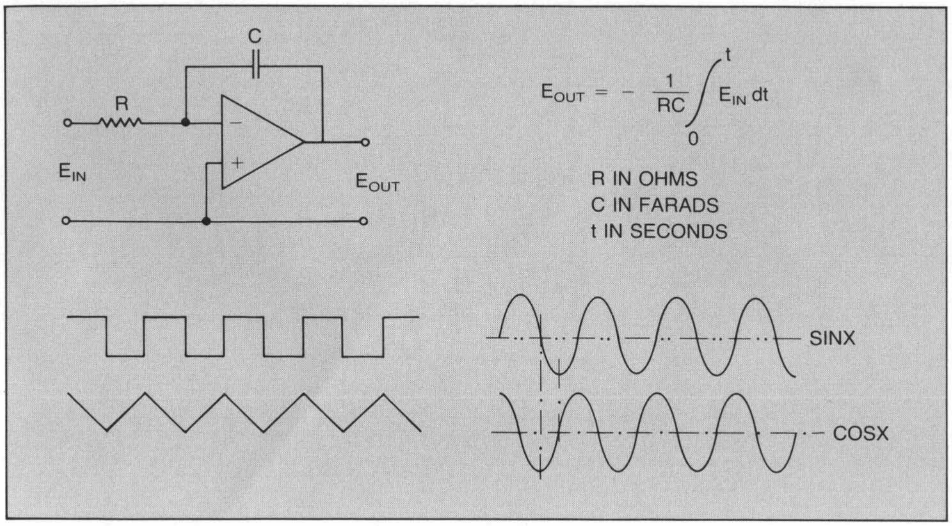


Figure 13. Simple integrating operational amplifier

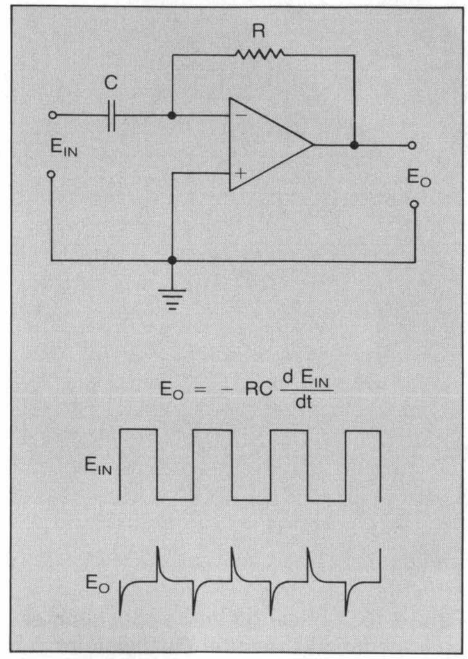


Figure 14. Simple differentiator operational amplifier

The Antilog Op Amp

By placing the nonlinear element in the input path as shown in Figure 16, the circuit becomes an antilog converter. For a logarithmic input E_{IN}, the output E_O will be a linear signal.

Multiplication (Division) With Log-Antilog Operational Amplifiers

Since log A + log B = log AB, and log A − log B = log A/B, a circuit using two log converters and a summing (subtracting) amplifier, followed by an antilog converter, will output the product or the division of the two input signals. Figure 17 illustrates the circuit for multiplication.

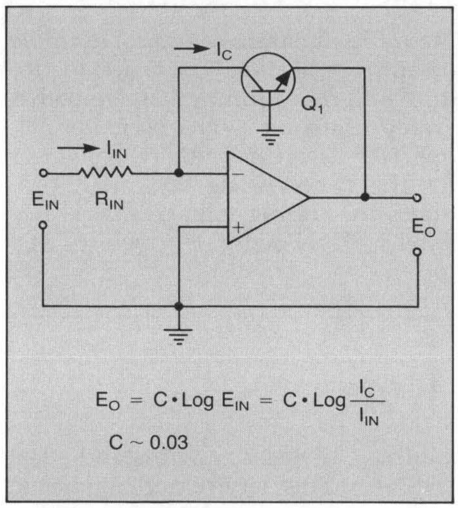


Figure 15. Simple logarithmic converter operational amplifier

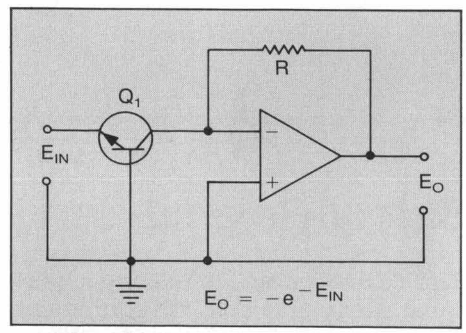


Figure 16. Simple antilog op amp

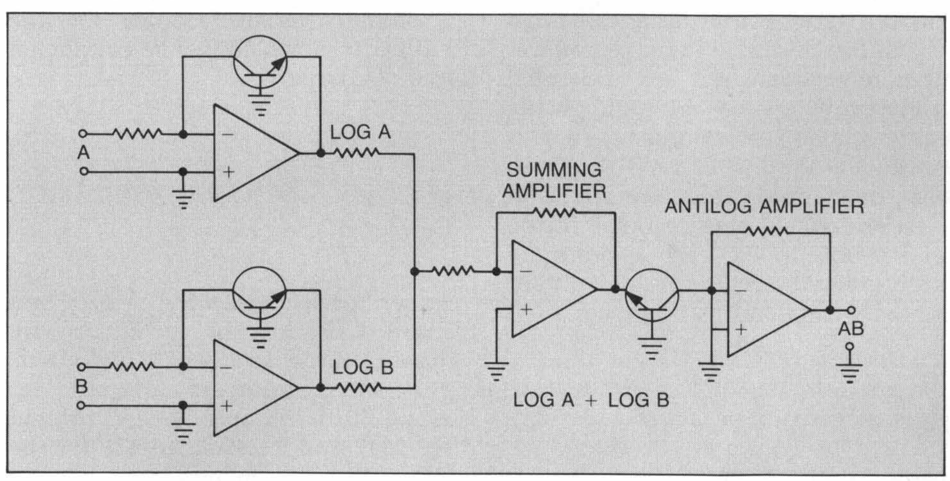


Figure 17. Multiplication circuit using log and antilog operational amplifiers

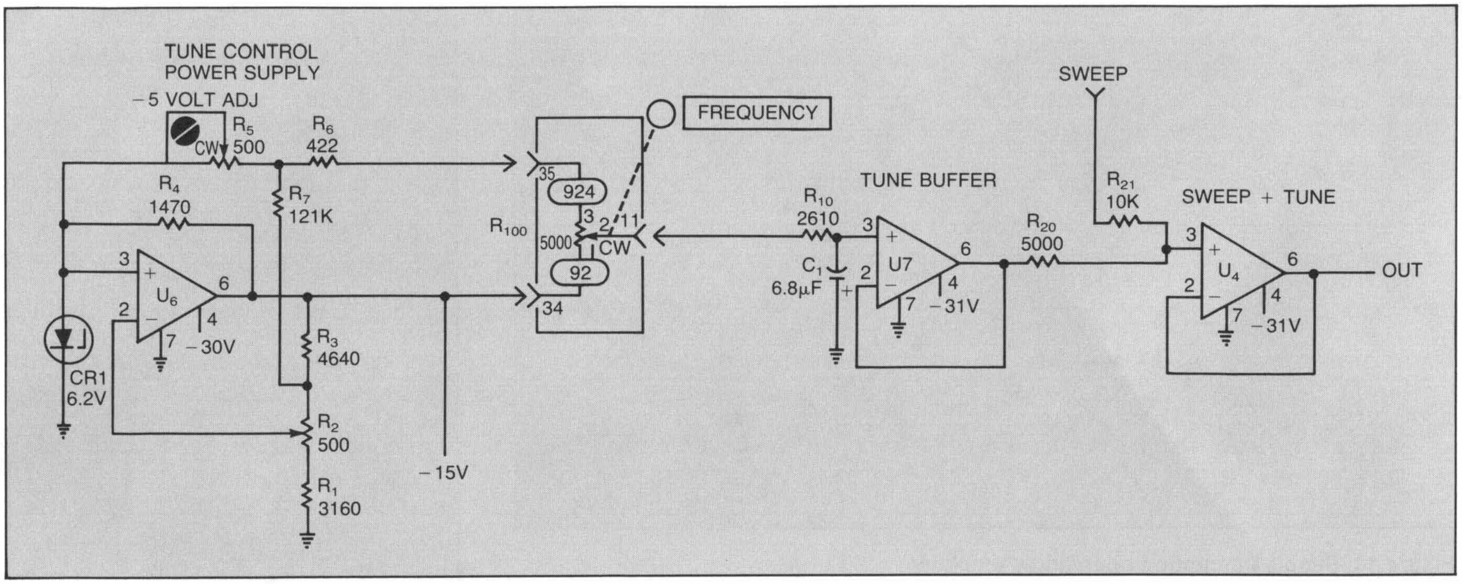


Figure 18. Typical op amp application as an impedance converter (U_6), isolator (U_7), and summing amplifier (U_4)

Typical Op Amp Circuit

Figure 18 illustrates a typical example op amp application. The task is to produce and mix a tuning voltage with a sweep ramp for a YIG oscillator. U_6 operates as an impedance converter for the zener diode CR_1. R_{100} produces the tuning voltage that is isolated by U_7. Finally, U_4 operates as a summing amplifier for the tuning and sweep voltage.

If you desire a more detailed and in-depth discussion of op amps, I suggest that you read *Understanding IC Operational Amplifiers*, by Roger Melen and Harry Garland, available from Howard W. Sams & Co. □

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 an "-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 in the service note index, each appropriate safety-related service note is highlighted with a contrasting color.

HP E2500 Frequency Agile Signal Simulator

Safety Service Note E2500A-01-S describes how to safety check the routine dielectric withstand test (HIPOT). This service note applies to instruments within the serial number range of 2845A00101/2935A00114. If you own one of these HP E2500As, you may return it to your nearest HP Customer Service Center for the HIPOT test, which will be conducted free of charge.

HP 5347A & 5348A Counter/ Power Meters

Safety Service Notes 5347A-02-S and 5348A-02-S describe an incorrectly manufactured power transformer. The serial numbers affected are 2924A00101-158 and 160-170 for the HP 5347 and 2924A00101-120 for the HP 5348. The manufacturing error concerns the transformer primary wires being improperly connected inside the transformer. The result is that when operating on the 220 volt line setting, the line fuse blows. Both the line module and power transformer must be replaced at an HP Customer Service Center. Do *not* attempt to rewire the transformer as this will invalidate the color coding used on the wires.

Safety Service Notes 5347A-03A-S and 5348A-03A-S concern the removal of unsafe carrying straps. This service note applies to all units. The clips on the ends of the carrying straps, which are part of Option 060 are defective and may fail in the normal use of the instrument. Damage to the instrument and/or injury to personnel may occur. The defective straps are identifiable as being *non*-adjustable in length. Also, there is concern over the strength of the front panel casting at the carrying strap holes. *Mis*-application of a customer furnished strap may apply sufficient leverage by weight of the instrument to cause breakage. *No* strap or other carrying appliance should be connected at these points.

Please remove the non-adjustable strap from the unit and return it to the following address. A new adjustable strap will be returned to you, in addition to a pair of plastic plugs to block the front panel carrying strap attachment holes.

Joe Dore 52U/19
Hewlett-Packard Co.
5301 Stevens Creek Blvd.
Santa Clara, CA 95052-8059

The solution to making the instrument portable is the design of a soft carrying case. This case has been designed to enhance portability with tough cordura nylon double-stitched construction that is padded on all six sides. The permanently attached adjustable strap provides a much safer means of carrying the product and allows easy measurements with the unit suspended from the shoulder.

If you originally purchased the product with the Option 060 portability option and have returned the strap as previously requested, you will receive this new soft carrying case at no charge.

If you did not order Option 060 and wish to buy the soft carrying case, order HP P/N 05348-60214. The price is $295 U.S. list.

For those customers ordering the instrument and specifying the portability option, please be advised that Option 060 has been discontinued. The portability option is now the soft carrying case and is listed as Option 070, $295 U.S. list.

HP 8340A/B Synthesized Sweepers
HP 8341A/B Synthesized Sweepers
HP 8719A Network Analyzers
HP 8720A/B Network Analyzers

The following Safety Service Notes describe possible injury from falling instruments due to damaged front panel handles.

8720A-05-S, 8720B-01-S, 8719A-01-S, 8340A-30-S, 8340B-30-S, 8341A-30-S, 8341B-30-S

If damaged handles are used to lift or support the instrument, the handles will break causing the instrument to fall, possibly resulting in personal injury. Exercise caution when using the front handles to lift the instrument. The damaged handles will be replaced at an HP Customer Service Center, or you may order the front handle replacement kit free of charge (HP P/N 5062-3990) and perform the replacement following the instructions in the product's service manual.

HP 8657B Synthesized Signal Generator

Safety Service Note 8657B-01-S describes a possible shock hazard that may exist if the instrument's toroidal mains transformer's insulation has been damaged by the A14 assembly's heatsink. The units affected are within the following serial number ranges:

2935U00470/2935U00543
2948U00544/2948U00576
2949U00577/2949U00585

The HP 8657B may present a shock hazard only if the following conditions exists:

- The mains transformer has *not* been manufactured by "NUVOTEM" *and*
- The A14 heatsink has damaged the mains transformer's insulation.

If your instrument is one of the above, please return the unit to an HP Customer Service Center for repair.

HP 8757C/E Scalar Network Analyzer

Safety Service Note 8757C/E-02-S describes a possible defective lithium battery contained on the CPU board of the instrument. The battery may leak electrolyte and damage the board. Symptoms include yellowing around the battery or in some cases, corrosion of the board and other boards in close proximity. The Safety Service Note contains a list of applicable serial numbers. Please return your unit to the nearest HP Customer Service Center for repair.

HP 85620A Mass Memory Module

Safety Service Note 85620A-03-S describes a possible defective lithium battery contained on the mass memory module of the instrument. The battery may leak electrolyte and damage the board. Symptoms include yellowing around the battery or in some cases, corrosion of the board and other boards in close proximity. The serial number range of affected instruments is 0000A00000/3003A00604. If you possess one of the affected units, please return it to the nearest HP Customer Service Center for repair.

HP 86792A Agile Upconverter

Safety Service Note 86792A-02-S describes how to safety check the routine dielectric withstand test (HIPOT). This service note applies to instruments within the serial number range of 2814A00105/2814A00108. If you own an HP 86792A within the serial number range listed, you may return it to your nearest HP Customer Service Center for the HIPOT test, which will be conducted free of charge. □

The Logistics Data Book 1990

The *Logistics Data Book* is designed to assist Hewlett-Packard's government customers with their logistics needs associated with the support of HP products. Information is drawn from HP records and Department of Defense information. It reflects logistics actions through October, 1989.

The types of HP products covered in this publication include electronic components, medical instruments and systems, computer equipment, calculators, instruments and systems for chemical analysis, and electronic test and measuring systems.

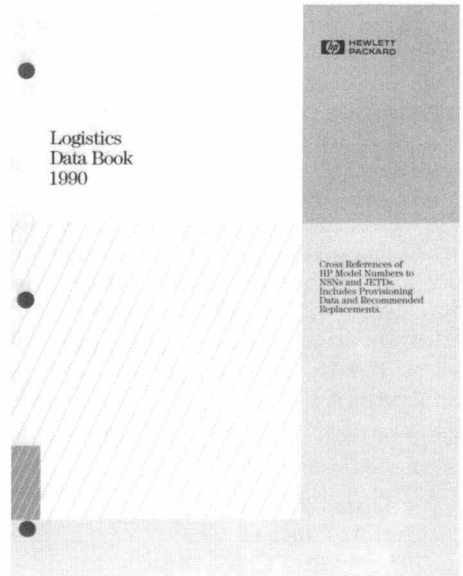
The intent of the *Logistics Data Book* is to include HP model numbers and their various options that are purchased by government customers. Additional information on all HP parts having National Stock Numbers may be found in the microfiche NSN/HP Cross Reference (Publication No. 5957-4171).

Options are usually identified in HP product literature by a three-digit number following the model number (e.g., HP 1234A Option 003). Other options may be designated as a letter and two numbers after the model number (e.g., HP 1234A Option H02). Modifications and systems may be identified in HP literature with a single alpha and two digits preceding the model number (e.g., E12-1234A).

For procurement purposes, all options and modifications in this book follow the model numbers and are connected to them by hyphens (e.g., 1234-001 and 1234A-E12). Where space is limited, option numbers may be shortened to less than three characters (e.g., 1234A-01-02-EI2).

Model numbers are arranged in typical computer sequence (i.e., left-justified, alpha-numeric sequence) so that all the "1s" (Model 1, 11, 111, 1111, etc.) are listed before the "2s" (Model 2, 22, 2222, etc.).

The Hewlett-Packard office nearest you will be pleased to work with you on procurement matters. Also note that the most currently-produced HP products are on GSA federal supply schedule multi-award contracts, and that GSA catalogs are available from your HP office. To order your *Logistics Data Book*, specify publication no. 5954-7744.



If you have any comments or suggestions about how we can make the *Logistics Data Book* more useful to you, please let us know by writing to:

Hewlett-Packard Co.
U.S. Field Operations
John Cloutier
19320 Pruneridge Avenue
Cupertino, CA 95014 □

What is Traceability and How Does It Relate to Calibration Uncertainty?

Jim Bechtold
Hewlett-Packard

Traceability is proof that measurements can be attributed to a national standard. The process involves the "tracing" of measurement comparisons made between the instrument used and the national laboratory. Technically, traceability involves the ability to quantify the measurement errors present in the test or measurement process in terms of the national standards. Agencies require us to objectively demonstrate that traceability exists. Usually through a series of reports attesting to the calibration of the instruments used in a test situation, the standards used to calibrate these standards, and so on back to the reports issued by national laboratory standards.

Calibration uncertainty is the ability to quantify the error sources present in the calibration measurement. Knowing that the act of making measurements is experimental, there have to be some guidelines that tell the person doing the measurement that the job is being performed satisfactorily. A rule-of-thumb method called the "accuracy ratio" is used in many laboratories to determine whether the uncertainty is reasonable. The desired ratio of accuracy between a source instrument and one to be calibrated is 10:1. If this cannot be met, it is permissible to reduce the ratio downward to a lower limit of 4:1.

This ratio is calculated by dividing the tolerance of the measurement to be made (e.g., 5%) by the tolerance assigned to the instrument used to make the measurement (e.g., 1%). In this example of accuracy, the ratio would be 5:1.

In some of today's instrumentation, the instrument being calibrated is almost as accurate as the source device, and therefore at a ratio of less than 4:1. In this situation, the method of calibration used is called "enhanced accuracy calibration." To achieve enhanced accuracy it is necessary to utilize a higher echelon standard during the calibration process. This will provide as much as another order of magnitude to the source equipment, which widens the ratio between the two instruments to maintain a good confidence level. We recommend that when you get below 4:1, contact your metrologist for advice.

A more specific method of determining uncertainty involves understanding the types of errors that exist during measurement and calibration, and ways of avoiding the most serious ones.

But before we get into the three types of errors, we should define two terms used in measurement that are quite often confused—*accuracy* and *precision*.

Accuracy

The accuracy of a measurement is an expression of the closeness of its result to the true value. A high accuracy indicates a close approach to the true value.

Precision

The precision of a measurement is a measure of its repeatability. A high precision indicates the ability to repeat measurements within narrow limits.

These two definitions form the basis for everything else that follows relative to measurement and calibration. The ultimate goal is to achieve both accuracy and precision in every measurement and in every calibration.

To eliminate the confusion that normally exists between accuracy and precision, the following example will serve to show the difference.

Example

Assume that two meters are used to measure a perfect 100.00 volt power source. Ten readings are taken with each meter. Figure 1 shows a range from 97.16 to 97.24 volts, and Figure 2 shows a range from 99.1 to 100.7 volts.

When we compare the ranges of the two meters we find that meter #1 has a spread of 0.08 volts and meter #2 has a spread of 1.6 volts. This defines meter #1 as having 20 times the *precision* than meter #2 has (i.e., 1.6/.08 = 20).

But meter #2 is closer in its readings to 100.00 volts, which indicates that precision by itself does not necessarily produce accuracy. Meter #2 is more *accurate* than meter #1.

Now, as shown in Figure 3, if meter #1 were recalibrated, with adjustment, to agree with the "perfect" calibration source, the spread of its readings would likely range from 99.96 volts to 100.04 volts (a spread of 0.08 volts). While this shows that *precision* and *accuracy* combine to provide greater *confidence* in the use of an instrument, the two are truly independent. However, the best of both are desirable in any measurement situation.

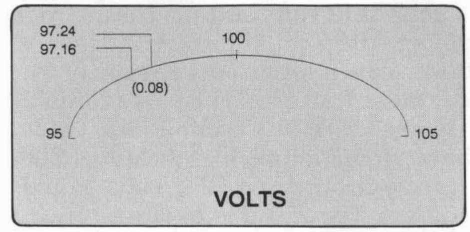


Figure 1. Reading of Meter #1

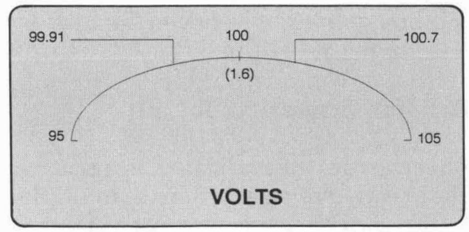


Figure 2. Reading of Meter #2

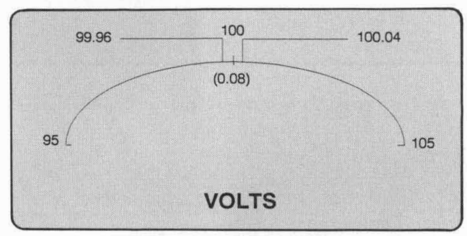


Figure 3. Altered Reading of Meter #1

Errors in Measurement

There are three types of errors by which you may be confronted. They are: gross errors, systematic errors, and random errors.

Gross Errors

These errors are strictly under the control of the individual, totally separate from the instrumentation. Example of gross errors are:

- Misreading the instruments
- Making an incorrect adjustment
- Applying instruments improperly
- Computational errors
- Recording interpolated data

As can be seen, these are errors that can be avoided by care and attention.

Systematic Errors

Systematic errors relate to the instrumentation or external influences to the instruments. Systematic errors cause the measured value to be offset by a fixed amount, as contrasted to random errors, which are bipolar in nature.

One example may be loading. All measuring systems are intrusive. That is, no matter what type of device is used to make a measurement, it will have some effect on the system being measured.

Consider the fact that no voltage source has the ideal zero impedance, and no current source has the ideal infinite impedance.

A voltage source may have a source resistance of as little as 0.01 ohm, and the ability to supply current of 25 milliamps at 10 volts output. The internal voltage drop could then be 250 microvolts, which represents 25 ppm of the 10 volt output (0.0025%). In addition, assume that the connecting leads have 10 milliohms of resistance. The voltage drop across the leads would add another 250 microvolts of error, or 25 ppm. These two elements alone constitute an error of 50 ppm, or 0.005%. Note that the obvious way to avoid these errors is to use 4-wire remote sensing whenever the load is less than 1 megohm.

Random Errors

These errors are indicated as a scatter about an average when a multiple number of measurements are taken. This can be the result of variations in the measuring system, or changes in the quantity being measured.

Random uncertainties are of a type that lend themselves to statistical analysis, since they can be considered to vary either positively or negatively around the measured value. They are due to totally unknown causes, and are detectable when repeated measurements are made with a seemingly constant set-up and consistent technique by the user.

An example may be a variation in impedance matching in high frequency instruments due to changes in characteristics when the lead connectors are removed and replaced. This may be due to the wear, or contamination, of BNC connectors, which are quite susceptible to this behavior.

When a succession of measurements are made which differ one from another, some preliminary observations can be made regarding random errors:

- The closest value to the true value is the mean value
- It is likely that values close to the mean value will be more numerous than values that are far away from the mean value
- There are likely to be as many readings that lie above the mean value as there are those that lie below the mean value

It is the general nature of a measured variable that there will be a distribution of values (both plus and minus) around the true, or actual, value.

Note that it is never possible to know the true value, since there will always be some small error. □

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supplement to BENCH BRIEFS SERVICE NOTE INDEX

Important Notice about Service Notes

Service notes contain product-specific service information for Hewlett-Packard's electronic products. Subjects include product improvements, modifications, and procedures for troubleshooting, maintenance, and repair. Service Notes are published as appropriate throughout the life of a product. All new notes are announced in *Bench Briefs*.

Please note that Hewlett-Packard has restructured the procedure for handling and distributing instrument-related service notes through *Bench Briefs* and the microfiche program.

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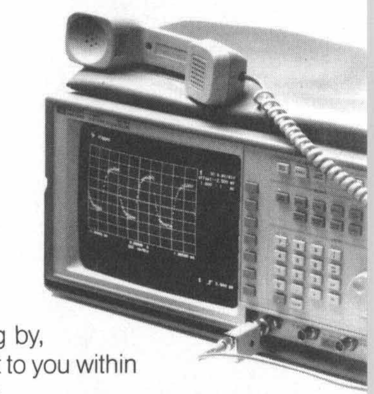

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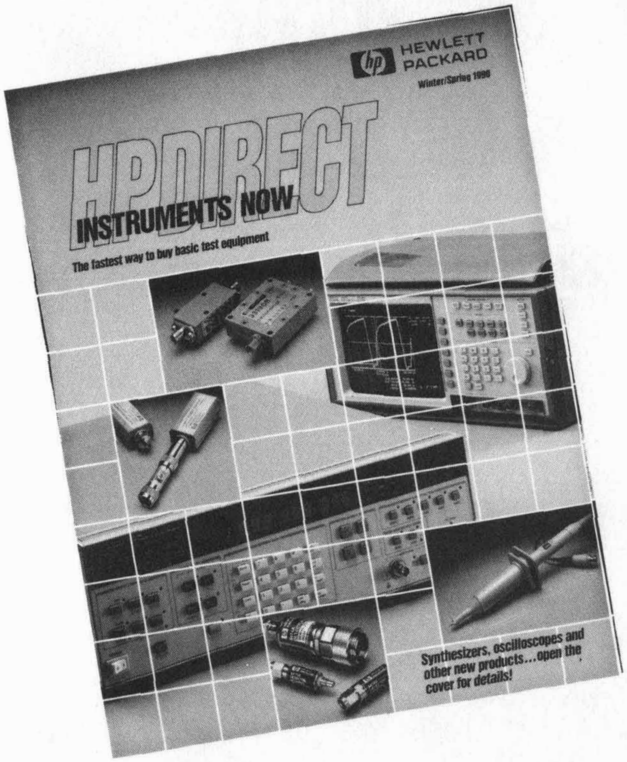
HP	Non-HP	
0015 ☐	A015 ☐	DVM/DMMs
0016 ☐	A016 ☐	Counters
0017 ☐	A017 ☐	Oscilloscopes
0018 ☐	A018 ☐	Pulse/Function Generators
0019 ☐	A019 ☐	Power Supplies
0008 ☐	A008 ☐	Logic Analyzers
0025 ☐	A025 ☐	Board Test Systems
0020 ☐	A020 ☐	Microprocessor Development Systems
0013 ☐	A013 ☐	Component and Semiconductor Analyzers
0005 ☐	A005 ☐	Data and/or Telecommunications Testers
0003 ☐	A003 ☐	RF and Microwave Analyzers
0009 ☐	A009 ☐	Microwave Power Meters
0014 ☐	A014 ☐	Vibration Analyzers
0004 ☐	A004 ☐	Data Acquisition and Control
0021 ☐	A021 ☐	X-Y and Strip Chart Recorders
0023 ☐	A023 ☐	Other ____________

TP03



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SN Type	SN No.	Abstract	Service Note Package
MA	436A-16B	Recommended replacement display driver assembly	017
MR	437B-03	Modification to prevent erroneous power meter readings	019
MR	437B-04	Mod. to overvoltage protection circuit	020
MR	438A-10	Recommended A4C14 and A4C16 capacitor replacement to improve performance	017
IO	1630A/D/G-14	Display system components available as a matched set (2090-0227)	021
IO	1631A/D/G-14	Display system components available as a matched set (2090-0227)	021
IO	1650A-09	Repair procedure for POD cable connectors J1-J5 (HP P/N 1251-8158)	017
IO	1650B-01	Repair procedure for POD cable connectors J1-J5 (HP P/N 1251-8158)	017
IO	1651A-09	Repair procedure for POD cable connectors J1-J5 (HP P/N 1251-8158)	017
IO	1651B-01	Repair procedure for POD cable connectors J1-J5 (HP P/N 1251-8158)	017
MR	3314A-03	Mod. to correct improperly crimped cooling fan power leads	020
IO	3562A-11	Instructions on how to service the HP 3562A Signal Analyzer with Option 063	019
MR	3563A-01	Modification prevents instrument lock-up when using systhesis table	022
IO	3577A-14	Required modification when replacing U13 on the A1 board	022
MA	3586A/B/C-13	Modification available when replacing U1 and U29 on A61 board	023
IO	3586A/B/C-14	Instructions on removing the internal Ni-cad battery for extended storage	023
SA	3588A-01-S	Notification that the fuse label contains the wrong replacement fuse information	022
MR	3588A-02	Metal flakes settling on the motherboard may cause intermittent H/W errors	022
IO	3708A-17	Semi-automatic performance test for the HP 3708A	017
IO	3708A-18	Preferred repl. for capacitor A501C5 on the power supply high current assy.	019
IO	3708A-19	Preferred replacement for D/A Converter A204U7 on the Var. Gain Cntl. Assy.	021
IO	3709B-04	Preferred repl. for the Mod. Scheme Switch A3S2 on the microprocessor assy.	019
IO	3746A-34A	Preferred repl. for the Fract. N cir. A30U16) on the Fract. N divided by N assy.	017
IO	3746A-35	Changes to the 3.1 kHz channel filter adjustment	017
IO	3746A-36	Preferred repl. for the 50 MHz crystal (A40Y90) on the A40 Frequency Ref. Assy.	019
IO	3776A-36	Preferred repl. of transistors A7Q21 and A7Q22	019
IO	3776A-37	Preferred replacement of A3U33 and A204U47	021
IO	3776B-44	Preferred replacement of A3U33 and A204U47	021
IO	3779A-61	Preferred replacement for EPROMS A24, U31 and U41	020
IO	3779A-62	Firmware upgrades	021
IO	3779B-65	Firmware upgrades	021
IO	3779C-12C	Preferred repl. board assemblies that comply with VDE specifications	019
MA	3779C-43	Small modification required when replacing A16 Assembly	019
IO	3779C-44	Alternative recommended test equipment for performance tests	021
IO	3779D-12C	Preferred repl. board assemblies that comply with VDE specifications	019
MA	3779D-47	Small modification required when replacing A16 Assembly	019
IO	3779D-48	Alternative recommended test equipment for performance tests	021
MA	3787B-04E	Newer features can be retrofitted to earlier 3787B instruments	019
IO	3787B-09	Notification of firmware updates	019
MR	3787B-10	Mod. to eliminate crosstalk when performing loopback in Near/Far mode	020
MR	3788A-01	Modification to prevent synchronization loss while measuring code errors on live data	022

SN Type	SN No.	Abstract	Service Note Package
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MA	3789B-04A	Mod. to eliminate noise from HP 3789B Input Port	020
MA	3789B-05A	PROM update kit information	020
IO	3789B-07	Firmware/hardware revisions and their impact on automated performance testing	020
IO	3789B-08	Retrofitting Option 100 (Weco 477 connectors)	021
IO	3789B-09	Retrofitting Option 200 (BNC connectors)	021
MA	3789B-10	Adding enhancements to older units	021
IO	3789B-11	Instructions to fit PROM upgrade kits	021
MR	4062C-02A	Rec. part repl. to prevent damage to the PSM by surge current	019
MR	4062C-02	Recommended part replacement to prevent damage to the PSM by surge current	017
MA	4062C-03	4142B upgrade for Revision 5.6 system software feature	019
MR	4062C-04	SMU repl. to eliminate AFU test failures	019
MR	4062UX-02A	Rec. part repl. to prevent damage to the PSM by surge current	019
MR	4062UX-02	Recommended part replacement to prevent damage to the PSM by surge current	017
MA	4062UX-03	4142B upgrade for Revision 5.6 system software feature	019
MR	4062UX-04	SMU repl. to eliminate AFU test failures	019
MR	4142B-04A	Rec. part repl. to prevent damage to the PSM by surge current	019
MR	4142B-04	Recommended part replacement to prevent damage to the PSM by surge current	017
MR	4142B-05	SMU repl. to eliminate AFU test failures	019
MA	4142B-06	Mainframe upgrade for the HP 41422A HCU	019
MR	4145A-13	Repl. PROMs prevent spikes when the SMU reaches compliance	019
MR	4145B-04	Repl. PROMs prevent spikes when the SMU reaches compliance	019
MR	4145B-05	Update Sys. Disk to Rev. 1.30 to improve perf. in HP-IB SRQ output function	019
IO	4193A-04	Instructions for mounting a new diode on the HP 4193A A20 Power Supply Bd.	022
MA	4194A-09	Modification to install Option 001 into a standard HP 4194A	019
MR	4195A-05	Modification to remedy uneven display color	019
MA	4195A-06	Modification to install Option 001 into a standard HP 4195A	019
MR	4195A-07	Modification to eliminate spurious vert. white line on the CRT display	019
MR	4195A-08	Mod. to improve the Second/Third IF converter gain adjustment range	020
MR	4195A-09	Mod. to improve source dc bias full scale adjustments	020
MR	4195A-10	Modification to improve the power sweep linearity	022
IO	4261A-01	Instructions for mounting a new diode on the HP 4261A A9 Power Supply Bd.	022
IO	4262A-18	Instructions for mounting a new diode on the HP 4262A A9 Power Supply Bd.	022
IO	4276A-05	Instructions for mounting a new Ni-Cad battery on the mother board	019
IO	4276A-06	Repair method for the A1 Logic Board	020
IO	4277A-09	Instructions for mounting a new Ni-Cad battery on the mother board	019
IO	4277A-10	Repair method for the A1 Logic Board	020
IO	4278A-06	New EEPROM sockets added to new A7 boards - check before ordering new board	019
IO	4279A-01	New EEPROM sockets added to new A7 boards - check before ordering new board	019
MR	4280A-08	Mod. to correct noise on the dc power lines due to misloaded capacitors	020
IO	4284A-09	Procedure for ordering new ROMless repl. brd. for the A7 CPU brd.	019
MA	4285A-01	Modification to install Option 002 in a standard HP 4285A	022
MA	4285A-02	Modification to install Option 201 in a standard HP 4285A	022
MA	4285A-03	Modification to install Option 202 in a standard HP 5285A	022
MA	4285A-04	Modification to install Option 301 in a standard HP 4285A	022
MA	4285A-05	Modification to install Option 001 in a standard HP 4285A	022
IO	4332A-01	Instructions for mounting a new diode on the HP 4332A A3 Power Supply Bd.	022

SN Type	SN No.	Abstract	Service Note Package
IO	4934A-04	Instructions for correcting step 6 of the Transmitter Distortion Performance Test	017
IO	4934A-05	Preferred replacement diode bridges on the transmitter receiver interface assy.	017
MA	4934A-06	Retrofit instructions for instaling special Option H05 (increased monitor volume)	019
IO	4934A-07	Incorrect battery P/N appears in the service manual - change to 1400-0378	019
IO	4934A-08	Some units were shipped with incorrect serial prefix of 2737U, should be 2937U	019
MR	4934A-09	Mod. to prevent battery power supply fuse failures during power-on	020
MA	4936A-02B	Retrofit for battery operation (Options 001 and 003)	017
IO	4936A-11	Preferred replacement diode bridges on the switch board assembly	017
IO	4936A-12	Preferred replacement top and bottom covers	022
IO	4947A-11	Preferred replacement for current bridge rectifier A55CR3,4	017
IO	4947A-12	Preferred replacement of A2U8	021
IO	4951A-21	Recommended replacement resistors if the display is dim	017
IO	4951B-05	Recommended replacement resistors if the display is dim	017
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IO	4951C-12	Cross reference of keyboard cable applications	022
MR	4952A-08C	Modification to improve the current output of the power supply	017
MR	4952A-10A	Modification to correct intermittent disk drive errors	019
MR	4952A-11A	Modification to reduce the current drain on the CIO chip (A1U209)	017
MR	4952A-11C	Modification to eliminate intermittent DLC errors	019
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MR	5061B-02	Faulty Q4 & Q10 transistors found in the A11 Ceasium Oven Controller	019
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IO	5334B-04	Must replace all 7-segment LEDs when one fails	017
IO	5334B-05	Repair of oven oscillator should be by replacement	017
IO	5342A-26B	Installation of amplitude measurement Option 002	021
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PR	5347A-03-S	Strap handle may break while carrying the instrument	019
PS	5347A-03A-S	Remove unsafe carrying straps and use caution with customer-furnished straps	020
MR	5348A-01	Modification to improve power supply relay reliability	017
SA	5348A-02-S	Modification to correct power transformer wiring	019
PR	5348A-03-S	Strap handle may break while carrying the instrument	019
PS	5348A-03A-S	Remove unsafe carrying straps and use caution with customer-furnished straps	020
MR	5361A-01A	-5.2 volt power supply modification	021
MA	5361A-02A	Instructions for retrofitting HP 5361A to HP 5361B	022
MR	5370B-03	Mod. to prevent intermittent HP-IB hang-up	020
MR	5370B-04	Mod. to prevent time interval miscount in the divide-by-10 mode	021
MR	5371A-02C	Modification to install Firmware Revision 3018 Upgrade kit	023
MR	5371A-13A	Modification to ensure operation of the oven oscillator in standby mode	017
IO	5372A-01	Instruction sheet for the HP 5372A Support Service Kit P/N 05372-67001	019
MR	5372A-02	Instructions for installing firmware revision 2947 retrofit kit, P/N 05372-67003	019
IO	6060A-01	Oper. inst. & procedures when using the EMPRO current shunts for calibration	019
MR	6060A-02	Modification to reduce source turn-on current overshoot	022
MR	6063A-01	Modification to reduce source turn-on current overshoot	022

SN Type	SN No.	Abstract	Service Note Package
IO	6129C-05	Rec. repl. for the A13Q2, A14Q2, A15Q2 and/or A16Q2 transistors	019
IO	6130C-05	Rec. repl. for the A13Q2, A14Q2, A15Q2 and/or A16Q2 transistors	019
IO	6131C-05	Rec. repl. for the A13Q2, A14Q2, A15Q2 and/or A16Q2 transistors	019
IO	6140A-03	Rec. repl. for the A13Q2, A14Q2, A15Q2 and/or A16Q2 transistors	019
MR	6625A-01	Mod. to correct store/recall function	020
MR	6626A-01	Mod. to correct store/recall function	020
MR	6628A-01	Mod. to correct store/recall function	020
MR	6629A-01	Mod. to correct store/recall function	020
MA	8112A-06	New fan does not need a motor control assembly	019
MA	8116A-08	New fan does not need a motor control assembly	019
SA	8340A/B-30-S	Possible injury from falling instrument if the handles have been damaged	019
SA	8341A/B-30-S	Possible injury from falling instrument if the handles have been damaged	019
IO	8485A-01	New O & S manual (08485-90001) provides expanded troubleshooting info.	019
IO	8485A-01	New operating/service manual provides enhanced troubleshooting procedures	020
MA	8508A-01	A5U18 EPROM Assembly (HP P/N 08508-80010) replaced by HP P/N 08508-80012	017
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MR	8510B-03	Mod. to correct firmware revision 5.0 problems	020
MA	8516A-04B	Improved frequency converter requires new bias supply	019
MA	8559A-32	Availability of an extender cable reinforcing kit	018
MA	8560A-01B	New firmware upgrade kit is available	020
MA	8560A-01	Firmware upgrade kit	017
MA	8560A-02	Modifications required when replacing A5CR401 PIN diode	019
MR	8560A-03	Electrolytic capacitor changes on the A16 Cal oscillator assemblies	019
MR	8560A-04	Rec. Mod. to A14 to stabilize the -10 V reference	023
IO	8560A-07	Oven controlled crystal oscillator retrofit kit is available	020
MR	8560A-08	Mod. to correct intermittent connector to oven controlled oscillator	020
MR	8560A-10	Modification to prevent the display intensity from dimming intermittently	023
IO	8561A-02	Availability of a new temperature-controlled crystal oscillator	018
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MR	8561A-06	Modification to prevent intensity offset failure caused by parasitic oscillations	018
MR	8561A-07	Modification to reduce baseband noise when using 08562-60094 power supply assy.	018
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MR	8561A-09	Updating test and adj. modules to Test Later versions of portable spect. assys.	017
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MR	8561A-12	Modification to prevent the divide-by-two circuit from providing erroneous results	017
MR	8561A-13	Electrolytic capacitor changes on the A16 Cal oscillator assemblies	019
MA	8561A-15	Modifications required when replacing A5CR401 PIN diode	019
MR	8561A-16	Rec. Mod. to A14 to stabilize the -10 V reference	023
MA	8561A-18	New ROM upgrade kit is available	020
MR	8561A-20	Mod. to correct intermittent connector to oven controlled oscillator	020
MR	8561A-21	Recommended replacement of the A12 RF switch for improved reliability	023
MA	8561A-22	Modification available to upgrade the instrument to Option K-74	023
MR	8561A-23	Modification to prevent the display intensity from dimming intermittently	023
MA	8561B-01B	New firmware upgrade kit is available	020
MA	8561B-01	Firmware upgrade kit	017
MA	8561B-02	Modifications required when replacing A5CR401 PIN diode	019
MR	8561B-03	Electrolytic capacitor changes on the A16 Cal oscillator assemblies	019
MR	8561B-04	Rec. Mod. to A14 to stabilize the -10 V reference	023

SN Type	SN No.	Abstract	Service Note Package
IO	8561B-06	Oven controlled crystal oscillator retrofit kit is available	020
MR	8561B-07	Mod. to correct intermittent connector to oven controlled oscillator	020
MR	8561B-09	Recommended replacement of the A12 RF switch for improved reliability	023
MR	8561B-10	Modification to prevent the display intensity from dimming intermittently	023
MA	8562A-02D	ROM upgrade kit is available	020
MA	8562A-05A	Modification to reduce 80 kHz power supply sidebands	017
MR	8562A-27A	Modification to eliminate display flicker	019
MR	8562A-27B	Modification to eliminate display flicker	022
MA	8562A-27	Modification to eliminate display flicker	017
MA	8562A-31	Bypass capacitor added to A15 assembly to improve residual responses	019
IO	8562A-33	Availability of a new temperature-controlled crystal oscillator	018
IO	8562A-35	A new A12 RF switch is available for instruments without Option 026	017
IO	8562A-38	Recommended replacement for obsolete second converter	017
MR	8562A-39	Modification to prevent intensity offset failure caused by parasitic oscillations	018
MR	8562A-40	Modification to reduce baseband noise when using 08562-60094 power supply assy.	018
MA	8562A-42A	Modification available to install dc protection in the Low Band Input	023
MA	8562A-42	Mod. to add dc blocking capacitor in the low band input	020
MR	8562A-43A	Mod. to update test & adj. modules to test later ver. of port. SA assys.	020
MR	8562A-43	Updating test and adj. modules to Test Later versions of portable spect. assys.	017
MR	8562A-45	Modification to eliminate 1.8 MHz sampler buffer oscillation at high temperatures	017
MR	8562A-46	Electrolytic capacitor changes on the A16 Cal oscillator assemblies	019
MA	8562A-48	Modifications required when replacing A5CR401 PIN diode	019
MR	8562A-51	Rec. Mod. to A14 to stabilize the -10 V reference	023
MR	8562A-52	Mod. to correct intermittent connector to oven controlled oscillator	020
MA	8562A-53	Modification available to upgrade the instrument to Option K-74	023
MR	8562A-54	Modification to prevent the display intensity from dimming intermittently	023
MA	8562B-01D	ROM upgrade kit is available	020
MA	8562B-04A	Modification to reduce 80 kHz power supply sidebands	017
MR	8562B-26	Modification to eliminate display flicker	018
MA	8562B-29	Bypass capacitor added to A15 assembly to improve residual responses	019
IO	8562B-31	Availability of a new temperature-controlled crystal oscillator	018
IO	8562B-33	A new A12 RF switch is available for instruments without Option 026	017
IO	8562B-35	Recommended replacement for obsolete second converter	017
MR	8562B-36	Modification to prevent intensity offset failure caused by parasitic oscillations	018
MR	8562B-37	Modification to reduce baseband noise when using 08562-60094 power supply assy.	018
MA	8562B-39A	Modification available to install dc protection in the Low Band Input	023
MA	8562B-39	Mod. to add dc blocking capacitor to low band input	020
MR	8562B-40A	Mod. to update test & adj. modules to test later ver. of port. SA assys.	020
MR	8562B-40	Updating test and adj. modules to Test Later versions of portable spect. assys.	017
MR	8562B-42	Modification to eliminate 1.8 MHz sampler buffer oscillation at high temperatures	017
MR	8562B-43	Electrolytic capacitor changes on the A16 Cal oscillator Assemblies	019
MA	8562B-46	Modifications required when replacing A5CR401 PIN diode	019
MR	8562B-49	Rec. Mod. to A14 to stabilize the -10 V reference	023
MR	8562B-50	Mod. to correct intermittent connector to oven controlled oscillator	020
MA	8562B-51	Modification available to upgrade the instrument to Option K-74	023
MR	8562B-52	Modification to prevent the display intensity from dimming intermittently	023
MA	8563A-02	ROM upgrade kit is available	020

SN Type	SN No.	Abstract	Service Note Package
MR	8563A-03	Rec. Mod. to A14 to stabilize the -10 V reference	023
IO	8563A-04	Oven controlled crystal oscillator retrofit kit is available	020
MR	8563A-05	Mod. to correct intermittent connector to oven controlled oscillator	020
MR	8563A-07	Modification to prevent the display intensity from dimming intermittently	023
IO	8565A-23A	Replacement for obsolete attenuators	021
IO	8565A-23	Replacement of obsolete attenuators	017
MR	8566A-39	Mod. to correct oven oscillator thermal fuse failure	021
MA	8566B-11B	A15 controller assembly firmware repl. kit	019
MR	8566B-33	Mod. to correct oven oscillator thermal fuse failure	021
MA	8567A-01A	A15 controller assembly firmware repl. kit	019
MA	8567A-08	Rec. repl. for the LO amplifier kit	019
MR	8567A-11A	Mod. to eliminate frequency spurs to improve performance	020
MR	8567A-11	Frequency spur correction	019
MR	8567A-13	Rec. repl. of def. SAW resonators prevents 275 UNLOCK and low 280 MHz output	023
MR	8568A-46A	Mod. to eliminate frequency spurs to improve performance	020
MR	8568A-46	Frequency spur correction	019
MA	8568A-54	Rec. repl. for the LO amplifier kit	019
MR	8568A-55	Modification required when replacing A5AT1	019
MR	8568B-04A	Mod. to eliminate frequency spurs to improve performance	020
MR	8568B-04	Frequency spur correction	019
MA	8568B-10A	Option 462 Retrofit kit	019
MA	8568B-11B	A15 controller assembly firmware repl. kit	019
MA	8568B-21	Rec. repl. for the LO amplifier kit	019
MR	8568B-27	Mod. to correct oven oscillator thermal fuse failure	021
MR	8568B-28	Rec. repl. of def. SAW resonators prevents 275 UNLOCK and low 280 MHz output	023
IO	8569A-14A	Replacement of obsolete attenuators	021
IO	8569A-14	Replacement of obsolete attenuators	017
IO	8569B-12A	Replacement for obsolete attenuators	021
IO	8569B-12	Replacement of obsolete attenuators	017
IO	8570A-02A	Replacement for obsolete attenuators	021
IO	8570A-02	Replacement of obsolete attenuators	017
MR	8590A-14	Modification to the A14 Log Board assy. to assure proper switching of control lines	017
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MR	8673B-19	Recommended replacement of quartz oscillator thermal fuses to improve reliability	023
SA	8719A-01-S	Possible injury from falling instrument if the handles have been damaged	019
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SA	8720B-01-S	Possible injury from falling instrument if the handles have been damaged	019
MR	8752A-01	Firmware revision 1.00 problem corrections	017
MR	8753B-01	Modification to correct display flicker problem	017
MR	8753C-01	Firmware revision 4.00 problem corrections	017
SA	8757C/E-02-S	CPU battery may leak and damage the CPU board	019
MR	8770A-19A	Modification to improve the reliability of the 125 MHz oscillator	022
MR	8770A-19	Mod. improves tuning range for 125 MHz oscillator during extreme temp. changes	019
MR	8770A-20	Repl. covers improve RE2 test emissions for the 8770A	019
IO	8780A-01A	Firmware history	022
MR	8780A-07B	A7 FM BB Relay troubleshooting and replacement procedure	017
IO	8780A-09	Instructions for installing bias current adjustment resistor	017
MR	8780A-10	Recommended A15A2 RF output amplifier and firmware version 2.2	020

SN Type	SN No.	Abstract	Service Note Package
MR	8780A-11	A6 FM RF Relay troubleshooting and replacement procedure	017
MR	8780A-12	Modification to correct baseband calibration errors	022
MR	8901A-03	Recommended modification to prevent HP-IB hangup	023
MR	8901B-04	Mod. of replacement A1 keybd. & disp. assy. for use in older inst.	020
MR	8901B-06	Recommended modification to prevent HP-IB hangup	023
MR	8902A-08	Modification to correct defective cable assembly	017
MR	8902A-09	Mod. of replacement A1 keybd. & disp. assy. for use in older inst.	020
MR	8902A-11	Recommended modification to prevent HP-IB hangup	023
MR	8903B-06	Mod. to prevent HP-IB hang-up	020
MR	8903E-06	Mod. to prevent HP-IB hang-up	020
MR	8970A-13A	Modification improves measurement repeatibility in measurement mode 9.2 special	019
MR	E1222M-02	Rec. mod. to use E1212B I/O boards with 126 Kbytes memory depth	023
IO	E1222M-03	Instructions for connecting power control module suppression capacitors	023
MA	E1222M-04	Mod. available to install a new Emergency Switch Off protector	023
SA	E2500A-01-S	Instructions for performing routine dielectric withstand test (HIPOT)	017
IO	E2500A-02	How to use the internal DSA capabilities to isolate faults	020
MR	10314D-01	Rec. mod. to prevent reading of bad status and address information	023
MR	10811A/B-03	Mod. to correct faulty thermal fuses inside the oscillator housing	020
MA	11990A-02	HP 11990A software upgrade is available	018
IO	16500A-07A	Repair faulty touchscreens with board replacement - not component-level repair	020
MA	16500A-09	New CPU board increases memory capacity from 1.0 to 2.5 megabytes	020
IO	16510A-02	Repair procedure for POD cable connectors J1-J5 (HP P/N 1251-8158)	017
IO	16510B-01	Repair procedure for POD cable connectors J1-J5 (HP P/N 1251-8158)	017
MR	18160A-01C	Modification to prevent turn-on and/or PV-loop POD errors	017
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IO	35651B-01	Procedure to program module ID info. into replaced digital assy, after repair	020
SA	35660A-04-S	Notification that the fuse label contains the wrong replacement fuse information	022
MR	37180A-01	Modification to prevent self test failure in large system installations	019
MA	37203A-12	Instructions for mating Option 001 to fiber-optic cable with ST connectors	017
MA	37204A-01C	Installation of fiber-optic interface upgrades	022
MA	37204A-03	Instructions for mating Option 001/002 to fiber-optic cable with ST connectors	017
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IO	54120A-03	List of 54120 Digitizing Oscilloscope system compatibility and upgrades	019
IO	54121A-02A	TDR system specification change	021
IO	54121A-02	1% specification change in the 54121A TDR System	019
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IO	54201A/D-15	Display system components available as a matched set (2090-0227)	021
MR	54502A-01	Replace firmware to correct bugs	017
IO	54502A-02	New test procedure improves voltage measurement accuracy test	019
IO	54502A-03	Replacing cabinet requires a new rear panel	020
IO	54503A-01	New test procedure improves voltage measurement accuracy test	019
IO	54503A-01	Replacing cabinet requires a new rear panel	021

SN Type	SN No.	Abstract	Service Note Package
MR	60501A-01	Rec. addition of a 0.5 amp fuse to protect the bias transformer circuit	019
IO	60501A-02	Oper. inst. & procedures when using the EMPRO current shunts for calibration	019
MR	60502A-01	Rec. addition of a 0.5 amp fuse to protect the bias transformer circuit	019
IO	60502A-02	Oper. inst. & procedures when using the EMPRO current shunts for calibration	019
MR	60504A-01	Rec. addition of a 0.5 amp fuse to protect the bias transformer circuit	019
IO	60504A-02	Oper. inst. & procedures when using the EMPRO current shunts for calibration	019
MA	70001A-12A	Mod. available to convert Mainline Switch actuator from pull ON to push ON	023
MA	70001A-12	Mainline switch conversion kit changes on/off positions	021
IO	70001A-13A	Replacing A1 Pwr. Sup. Assys. in mainframes with pull ON Mainline switches	023
IO	70001A-13	Mainline switch conversion kit changes on/off positions	021
IO	70004A-02	Rack mount with slides kit is now available	020
IO	70004A-03	Replacement of keypad retainer spring	021
MA	70300A-05	Recommended replacement for the RF converter HP P/N 5086-7737	017
IO	70300A-07A	Replacement for obsolete attenuators	021
IO	70300A-07	Replacement of obsolete attenuators	017
MR	70300A-08	Modification to update HP 70300A module verification software revision A.03.02	018
IO	70600A-01B	Replacement of A12 YIG driver board assy. or A13W1 MSIB cable assy.	021
IO	70600A-02A	Replacement for obsolete attenuators	021
IO	70600A-02	Replacement of obsolete attenuators	017
MR	70600A-05	Recommended modification to the module verification software	020
IO	70601A-01B	Replacement of A12 YIG driver board assy. or A12W1 MSIB cable assy.	021
IO	70601A-02A	Replacement for obsolete attenuators	021
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MR	70700A-02	HP 70700A performance software modification to Rev.A.00.00	019
MR	70700A-03	Mod. to correct power-up sequence failure	020
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MR	70810A-01B	New firmware upgrade kit corrects firmware problems	020
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MR	70900A-25	Mod. to correct FFS handshake error	020
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IO	70902A-04	Recommended replacements for A1, A2 and A3 board assemblies	017
IO	70902A-05	Procedure for replacing matched crystals and A1 or A2 board assemblies	017
MA	70903A-01	Availability of linear AGC video out upgrade kit	018
MR	70903A-02A	Module verif. S/W changes eliminate errors when performing module gain adj.	018
IO	70904A-02	Recommended replacement of the RF converter HP P/N 5086-7737	017
IO	70904A-03B	Replacement of A4 Power Supply/Cntl. Assy. or W13 MSIB cable assy.	021
IO	70904A-05A	Replacement for obsolete attenuators	021
IO	70904A-05	Recommended replacement for obsolete attenuators	018
MR	70904A-08	2nd converter phase lock loop align. adj. seq. is modified in S/W rev. A.03.00	018
IO	70905A-02B	Replacement of A4 Power Supply/Cntl. Assy. or W13 MSIB cable assy.	021

SN Type	SN No.	Abstract	Service Note Package
IO	70905A-05A	Replacement for obsolete attenuators	021
IO	70905A-05	Recommended replacement for obsolete attenuators	018
MR	70905A-08	2nd converter phase lock loop align. adj. seq. is modified in S/W rev. A.03.00	018
IO	70905B-01B	Replacement of A4 Power Supply/Cntl. Assy. or W13 MSIB cable assy.	021
MR	70905B-06	2nd converter phase lock loop align. adj. seq. is modified in S/W rev. A.03.00	018
IO	70906A-02B	Replacement of A4 Power Supply/Cntl. Assy. or W13 MSIB cable assy.	021
IO	70906A-05A	Replacement for obsolete attenuators	021
IO	70906A-05	Recommended replacement for obsolete attenuators	018
MR	70906A-08	2nd converter phase lock loop align. adj. seq. is modified in S/W rev. A.03.00	018
IO	70906B-01B	Replacement of A4 Power Supply/Cntl. Assy. or W13 MSIB cable assy.	021
MR	70906B-06	2nd converter phase lock loop align. adj. seq. is modified in S/W rev. A.03.00	018
IO	70907A-03A	Replacement for obsolete attenuators	021
IO	70907A-03	Recomended replacement for obsolete attenuators	018
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IO	70908A-02A	Identification of correct connector used with A1 LO leveling amplifier	020
MR	70908A-08	Module verification software modification	021
MR	85081A-01	Instructions for replacing faulty locking knobs	022
MR	85082A-01	Instructions for replacing faulty locking knobs	022
MR	85620A-01	Firmware update kit for the HP 8562A/B	019
MA	85620A-02	Firmware upgrade kit	017
SA	85620A-03-S	A1BT1 batteries may leak	019
MA	85629A-01C	Modification available to upgrade the ROM	023
MA	85629A-07B	Modification to upgrade an HP 85629A to an HP 85629B	019
IO	85629A-08	Rec. method for perf. LO distrib. amp. adj. with 85629A/B Test & Adj. Modules	018
MR	85629B-01A	Mod. to update test & adj. modules to test later ver. of port. SA assys.	020
MR	85629B-01	Updating test and adj. modules to Test Later versions of portable spect. assys.	017
MA	85629B-02B	Firmware (ROM) upgrade kit	017
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MR	85640A-03	Recommended replacement for the 230 V line fuse	023
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IO	86790A-01	How to use the internal DSA capabilities to isolate faults	020
MA	86792A-01A	Firmware history and upgrade procedures	020
SA	86792A-02-S	Instructions for performing routine dielectric withstand test (HIPOT)	017
IO	86792A-03	Method of using internal firmware and diag. routines to adj. det. offset & gain	021
IO	86792A-04	How to adjust 268 MHz step switch assembly for best 4/2 spur response	023

Service Note Types

IO	Information Only	MA	Modification Available
MR	Modification Recommended	SA	Safety
PR	Priority Safety		

Service Tip

Extend the Life of Your CRT

Cathode ray tubes are expensive components of your HP instrument; therefore, it is in your best interest to extend the life of your CRT as long as possible.

New Product Turn-On

Before you turn on your product for the first time, turn the intensity to the off position. Allow the CRT to warm up and the product's power supplies to stabilize for at least 30 minutes before turning the intensity up to a comfortable viewing level.

Extending Life

Most CRTs have an expected lifetime of 10,000 hours. At 2,000 hours per year, five years of CRT life could be expected (8 hours/day × 5 days/week × 50 weeks). If you leave the CRT on for two shifts per day, 2.5 years could be expected. To maximize the CRT lifetime, HP recommends turning the CRT filament off when not in use. ☐

Service Note Order Form

If you want to order a service note, refer to the list of service notes in the index and find the service note number belonging to the product you are interested in. Using the form on this page, order the number that appears in the "service note package" column. You will receive a package of service notes that includes the one you ordered.

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