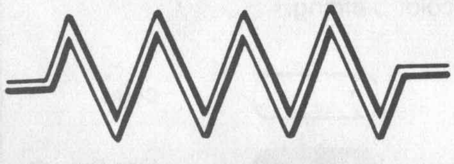
HEWLETT PACKARD

BENCH BRIEFS

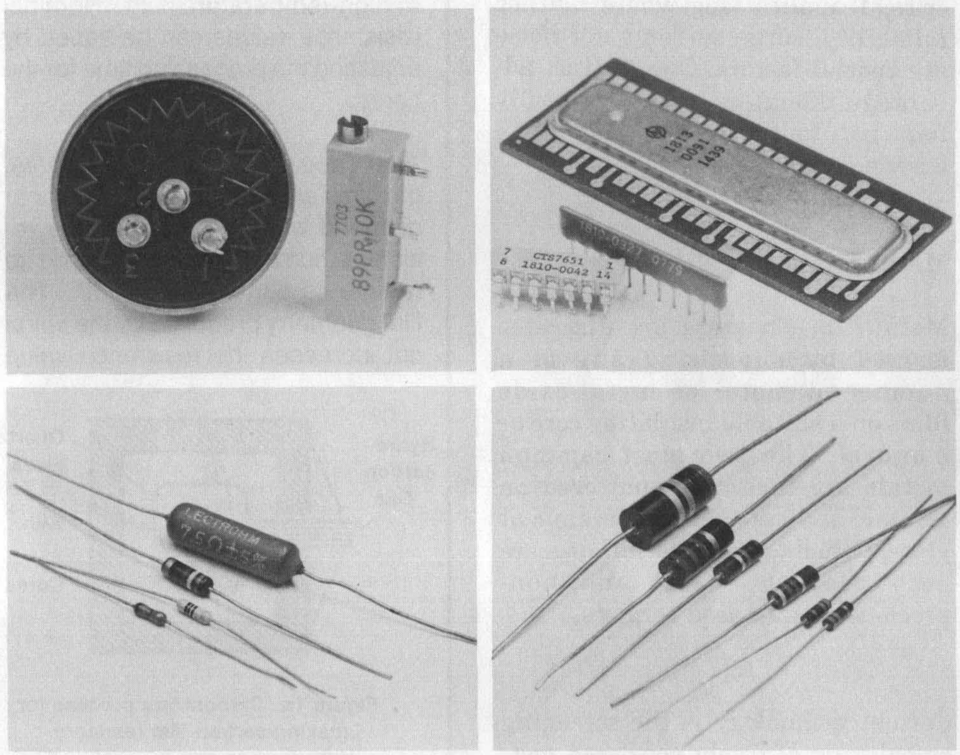
SERVICE INFORMATION FROM HEWLETT-PACKARD

JANUARY-FEBRUARY 1981

Basic Resistor Technology



Resistors seem simple and common enough — they have been fundamental components in electronic circuitry from the early days of radio. But are they really simple? Not when you consider that a precision potentiometer is actually a precise instrument-grade sensor. Or that resistor networks are now laser trimmed for accuracy. And that leadless resistors, developed in Japan approximately three years ago, are beginning to appear in U.S. products.



A Closer Look at the Products

Carbon Comps

Carbon composition resistors are either hot- or cold-molded from mixtures of carbon and a clay binder. In some versions, the composition forms a monolithic rigid structure; in others, the composition is applied to a ceramic core or armature. The hot-molded version is basically the same product today that it was when first introduced more than 40 years ago. These resistors are still widely used in applications requiring low-cost, reliable resistors with resistive tolerances of ±5% to ±10%.

Carbon comp resistors are manufactured with resistive values of 10 ohms to megohms, and power ratings of 1/8 to four watts. The largest use, however, focuses on the 1/4-watt units with values of 1000 to 100,000 ohms. Carbon comps offer well-established reliability and are still being specified for military and aerospace equipment. They also can withstand higher surge currents than carbon-film resistors. Resistance values, however, are subject to change upon absorption of moisture and increase rapidly at temperatures much above 60°C. Noise also becomes a factor when carbon comp resistors are used in hi-fi and communication applications. A carbon core resistor, for example, generates electronic noise that can reduce the readability of a signal or even mask it completely.

Editor's Note:
Notice the HP part number below? Each issue of Bench Briefs will be identified by a similar part number that increments with each successive issue. Use this part number to order extra copies and back issues (as stock permits).

IN THIS ISSUE

Carbon Films

Carbon-film resistors are leaded ceramic cores with thin films of carbon applied (see Figures 1a and 1b). Although carbon films are said to offer closer tolerances and better temperature coefficients than carbon comps, most characteristics are virtually identical for a large number of general-purpose, non-critical applications where neither reliability, surge currents nor noise are crucial factors. One distinct advantage though is price — typically less than half that of a comparable carbon comp.

Metal Films

Metal-film resistors are discretes formed by depositing any of a number of metal or metal-oxide films on a suitable insulating core or mandrel. The two most common metals are nichrome sputtered on ceramic and tin-oxide on ceramic or glass. Other common techniques are both precious metal and non-precious metal-based cermets.

Cermet technology is the screening or painting of finely powdered metals and powdered glass or frit in a suitable liquid vehicle to form an ink or paste on a porous ceramic substrate. Firing in an oven permanently bonds the metal to the ceramic and evaporates the vehicle.

Metal-film resistors are laser-trimmed or helixed (formed into a spiral) to obtain the precise resistance value before a protective insulation coating is applied. As in the case of carbon resistors, the 1000-ohm to 100,000-ohm resistors with 1/4-watt ratings are in greatest use. Precision usually runs ±1% and Temperature Coefficient of Resistance (TCR) is in the ±100 ppm/degree C range for all three technologies. Yet there are subtle differences:

- Cermet covers a wider resistance range and handles higher power than nichrome deposition.
- Nichrome is generally preferred over tin-oxide in the upper and lower resistance ranges and can provide TCRs that are lower than 50 ppm/°C.
- Tin oxide is better able to stand higher power dissipation than nichrome.

Wirewounds

Wirewound resistors have resistive wire wound on a central ceramic core. One of the oldest technologies, wirewounds provide the best known characteristics of high temperature stability and power handling ability. Nichrome is the wire in widest use for this application.

The greatest number of wirewound resistors is in the 10-ohm to 1-megohm region. Resistive tolerances are ±2% or better, and TCRs are generally ±10 ppm/°C or better.

Carbon Film in Profile

Carbon-film resistors are manufactured by pyrolyzing a hydrocarbon gas and depositing the carbon that is produced onto cylindrical ceramic cores; the process takes place inside a quartz flask that is rotated in a high-temperature kiln. Nominal resistance values can be varied by adjusting the processing time for the cores.

After capping the carbon-film cores, the films are spiral cut with a laser or diamond wheel to increase the resistor's current path length and to reduce its current path width. The film geometry produced by the spiral cut increases the resistance value by several orders of magnitude. The cut is automatically stopped when the desired resistance value is reached. The remaining processing includes welding lead wires onto the caps, encapsulation, testing and color banding.

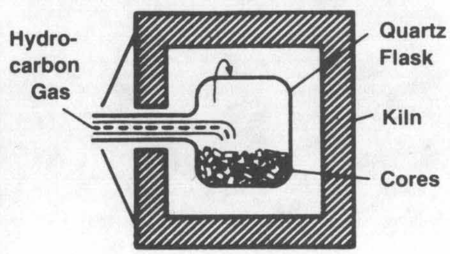


Figure 1a. Carbonizing process for making carbon-film resistors. Hydrocarbon gas is pyrolyzed, producing carbon that is deposited onto ceramic cores.

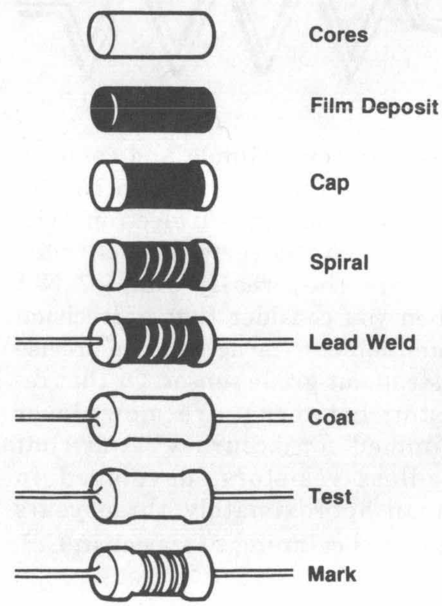


Figure 1b. Carbon-film production sequence, from ceramic core to finished resistor.

A Description of Resistor Characteristics

Resistors will change value as a result of applied voltage, power, ambient temperature, frequency change, mechanical shock, or humidity.

The *voltage coefficient* is the rate of change of resistance due to applied voltage, given in percent per volt. This characteristic is negative for most resistors, although some semiconductor devices actually increase in resistance with applied voltage. The voltage coefficient of very high valued carbon-film resistors is usually rather large, while in wirewound types the effect is usually negligible. Varistors are resistive devices designed to have a large voltage coefficient.

The *temperature coefficient* (TC or TCR) is the rate of change of resistance with ambient temperature, usually stated as a percentage or parts per million (ppm) per degree Celsius. Many types of resistors increase in value as temperature is increased, while others, particularly hot-molded carbon types, have a maximum or minimum in their resistance curves which gives a zero temperature coefficient at some temperature. Metal-film and wirewound types generally have temperature-coefficient values of less than 100 ppm/°C. Thermistors are resistance devices designed to have a large temperature coefficient.

The *power coefficient* is the product of temperature coefficient and temperature rise per watt, which gives a power coefficient in percent per watt and indicates the change in value resulting from applied power.

Frequency Characteristics of Resistors. Resistors change value with frequency because of inductance, lumped and distributed capacitance, dielectric loss, skin effect, and eddy-current losses, plus a few other minor effects as well.

Standard Resistors. A good standard resistor is one that displays minimum change due to inductance, lumped and distributed capacitance, dielectric loss, skin effect, and eddy-current losses and, even more important, is very stable with time. Standard resistors up to 10 M Ω are usually wirewound. Stability is improved by low-tension winding, heat cycling, and sealing in a chemically inactive oil or gas.

The Thomas 1-Ω resistor, which has been the best available standard for a long time, is bifilar wound of heavy manganin wire in a sealed container. It has four terminals brought out so that any four-terminal measurement will be independent of the resistance of the connecting leads, the terminals, and the contact between them.

New 10-kΩ standards are coming into use. These use Evanohm wire which can be treated to have a temperature coefficient of less than 0.2 ppm/°C over a narrow temperature range. While these standards are also four-terminal, lead resistance is much less critical at this higher resistance value. However, at this resistance level, shunt leakage resistance must be kept very high and a guarded measurement is recommended.

The range of resistance standards extends down to 10 μΩ at which level precision four-terminal shunts used for high-current measurement have an accuracy of 0.04 percent. While wirewound resistors over 100 M Ω have been made, film types are usually used in this range and on up to 10^{13}Ω.

Wirewound resistors are generally classed as power or instrument-grade products. Power wirewounds, capable of handling as much as 50 watts, are wound from a coarser wire that is uninsulated at the time of winding in order to provide better heat dissipation. Once it has been wound, the unit is given an overall insulation coating of silicone.

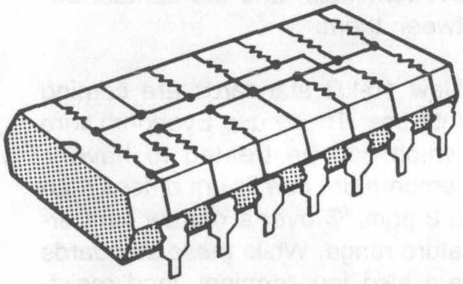
Instrument-grade precision wirewound resistors are made from long lengths of fine insulated wire. After winding, these are usually conformally coated with a ceramic material.

All wirewound resistors are classed as air-core inductors of the solenoid type. Therefore, inductive reactance at high frequency alters the resistive value. The seriousness of this problem is directly proportional with frequency. Special winding is useful to cancel reactance at low frequencies.

Networks

Networks are assemblies of resistive depositions and interconnecting conductors on ceramic substrates. The equivalent of from five to 15 resistors are typically placed on a small ceramic substrate, which may be packaged as a single in-line (SIP) or dual in-line (DIP) product.

The extraordinary growth rate of thick-film resistor networks is attributable to digital circuitry, particularly computers and computer peripherals where there is a need for clusters of similarly rated, low-power resistors. Networks are used to change voltage levels of digital logic or to match logic families with differing characteristics. They are also used to terminate lines and drive numeric displays.



The standard resistive tolerance for the deposited resistive elements in a thick-film network is ±2% (down to ±1/2% in some cases), with a TCR of ±100 ppm/°C over the temperature range of −55°C to +125°C. Precious metal inks are used in the preparation of most thick-film resistor networks. The inks are fired into the ceramics and the resistive elements are laser trimmed to achieve the desired resistance values.

The most popular parts are SIPs with six, eight and 10 pins and one less resistor per unit than the number of pins. The most popular DIPs are those with 14 or 16 pins and the most common configurations are seven or eight parallel resistors or 13 or 15 interconnected resistors with a common pin. Power dissipation is typically less than 1/8-watt per resistive ement.

It is estimated that 40% to 45% of all thick-film networks used are custom-made for specific customer requirements. The custom models are usually minor modifications of the standard products.

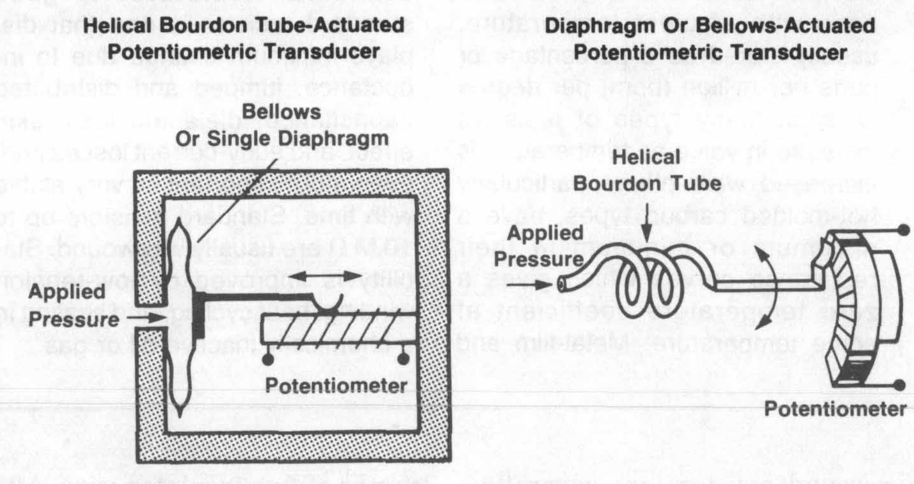
Thin-film resistor networks are even less standardized. They may be packaged in DIPs, flatpacks or may even be unpackaged. Thin-film products may be used where a higher performance is needed than that afforded by thick film. Thin-film networks use nickel-chromium, tantalum-nitride and chromium-cobalt vacuum depositions.

Thin-film networks are typically used in analog or linear circuits. Ladder networks for digital-to-analog converters and current summing networks are typical.

Variable Resistors

The three different potentiometers in common use are the precision multiturn potentiometer, the control or panel potentiometer and the trimming *potentiometer, simply* referred to as the trimmer.

Precision pots are actually instrument-grade sensors with outputs proportional to a precise shaft setting, sometimes in conjunction with a turns counting dial. Figure 2 shows two examples of how precision potentiometers can be used as sensors. These products have both wirewound and non-wirewound resistive elements. Primarily because of the need for longer mechanical life, the non-wirewound resistive elements were developed, with the conductive plastic type the most widely used. Later designs incorporated both elements into a hybrid of conductive plastic coating on wirewound. There are also some cermet high-temperature precision pots.



Pressure forces linear movement of potentiometer wiper

Internal pressure forces bourdon tube to untwist, shifting potentiometer wiper

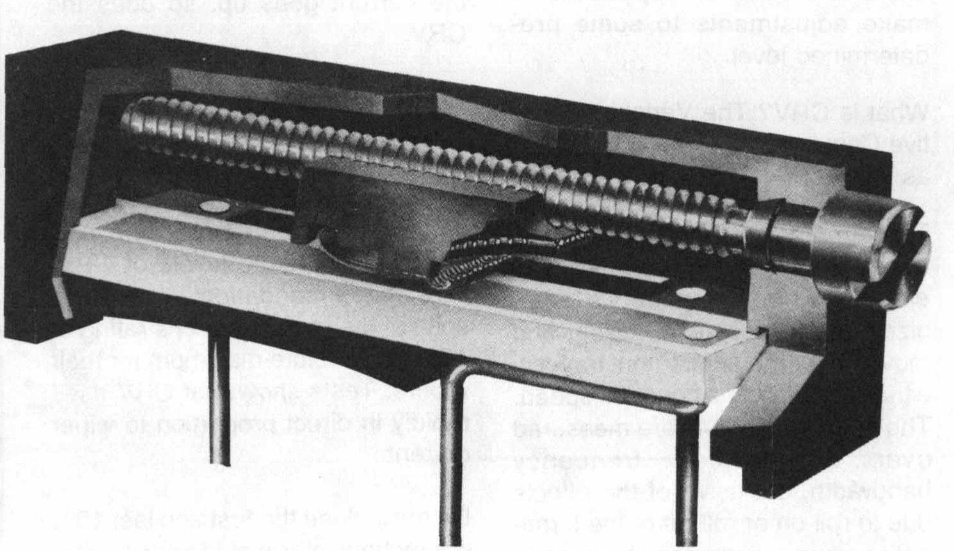
The potentiometric technique measures pressure by determining the position of a potentiometer tap that is set by the linear response of a bellows or diaphragm under pressure, or by the rotary response of a helical bourdon tube under pressure. The position of the potentiometer tap is converted to a proportional voltage output when a constant ac or dc voltage is applied across the potentiometer.

Figure 2. Two examples of a precision potentiometer used as a precise instrument-grade sensor.

Single-turn precision pots use all of the resistive elements, but the more complex multiturn pots are generally restricted to wirewound and hybrid resistive elements. The most common multiturn pots are the three-turn (1080°) and 10-turn (3600°) versions. Multiturn pots are more accurate than single-turn pots because of the longer resistive elements (single-turn pots usually have an effective length of 360°).

To qualify as a precision pot, the unit must be capable of linearities of at least 1%. However, off-the-shelf single-turn or multiturn precision pots typically offer 0.25%.

Control or panel potentiometers are made with carbon compositions, wirewound and cermet elements. There are also modular panel pots with interchangeable resistive elements that permit ganging and the addition of switches.



Trimmers are offered in wirewound, non-wirewound, multiturn, and single-turn designs with the largest use centering around non-wirewound cermet units. Cermet elements offer TCRs of ±100 to ±250 ppm/°C, tolerances as low as ±10% and resistive values of from 10 ohms to 2.5 megohms. Typical power ratings are 1.2 to 1 watt.

Wirewound elements offer TCRs of ±50 ppm/°C and tolerances of ±5%. Resistive values are typically 10 ohms to 100 megohms and power ratings may exceed a watt.

Carbon elements have TCRs of ±400 to ±800 ppm/°C and tolerances of ±20%. Resistive range spans 100 ohms to 2 megohms and power ratings are generally less than a half watt.

Other Variable Resistors

There are other variable resistors that do not rotate or slide in order to change their resistance value. The thermal and light sensitive properties of certain elements can be used to produce heat or light variable resistors.

Thermistors (thermal-sensitive resistors), which are used to protect power transistors in audio amplifiers, and as temperature transducers, may decrease or increase their resistance as temperature rises. Their coefficient of resistance (if negative, resistance goes down as temperature increases; if positive, resistance increases with temperature) specifies how resistance will change for a one-degree Celsius change in temperature. They are also rated in catalogs by their resistance at 25°C, and by giving the ratio of resistances at 0°C and 50°C. Values vary from 2.5 ohms to 1 megohm (room temperature), with power ratings from 0.1 to 1 watt.

Photocells (light-sensitive resistors) are used in electric-eye circuits, streetlight control, and similar applications. They are rated by specifying their resistance at low and high light levels. These typically vary from 600 ohms to 110 kilohms (bright), and from 100 kilohms to 200 megohms (dark). Power dissipation lies between 0.005 and 0.75 watts.

Strain gauges and carbon microphones are examples of pressure-sensitive resistors. As the resistive element is physically deformed, its resistance varies. If a constant voltage is impressed across a carbon microphone element, a variable current, which is an electrical analog of the voice, will be generated. Most have resistances of 500 ohms or so in the absence of compression.

A final variety of variable resistors you are likely to encounter is the voltage-sensitive resistor (Varistor). It is chiefly used to protect equipment from power-line surges by limiting the peak voltage across its terminals to a certain value. Above this voltage, the resistance drops, which in turn makes the voltage decrease. Catalogs specify voltage-variable resistors by power dissipation (0.25 to 1.5 watts) and peak voltage (30 to 300 volts). Varistors typically cost $2.00 to $6.00 each.

Leadless Resistors

There are two types of leadless resistors currently in use: tubular and chip. The tubular style is similar in shape to the traditional resistor, but without leads, and can be soldered directly to PC boards. However, some studies indicate that as PC boards warp with handling and time, the stress that was previously absorbed by the resistor's leads must now be absorbed by the resistor itself, causing the component to crack. The square chip style, however, is designed to bend with the board, eliminating this cause of failure.

Another drawback to leadless resistors, and one that is preventing widespread use in the U.S., is the lack of readily available automatic insertion equipment. In Japan, many product manufacturers have solved the insertion equipment problem by manufacturing their own, and some U.S. firms are reported to be considering similar moves.

In terms of reliability, the leadless resistor eliminates many of the problems associated with axial-leaded components. There are no lead wires or end caps to become disattached, and in high frequency circuits where component lead length is critical, leadless resistors can be soldered directly into the HF circuit. Another benefit is that the chips can be soldered to the bottom side of the PC board which reduces component density.

Contact Resistance Variation

Defined As Potentiometer Dynamic Noise

By Jack Thayer, Hewlett-Packard

One of the more persistent problems that has plagued the electronics industry for many years has been "noisy pots." Generally, the gross portion of this noise is attributable to foreign material, corrosion and wear in the element-to-contact interface and is readily identified in both new and in-service pots.

While little has changed in the characteristics of wirewound pots and trimmers, the reverse is true of non-wirewound parts. These types have exhibited almost continuous improvement over the past several years as industry requirements pressured for better performance at lower and lower signal levels. Most sources of gross noise defects (except wear) have generally been eliminated or greatly reduced in the pots available today.

Still we have rejects. Some of these are traceable to application problems such as resolution (trying to set the pot near the end of its travel), or carrying excessive current through the wiper. Even if we determine that the applications are correct, there are still a lot of rejects.

This gets us down to the nitty gritty of the problem — Contact Resistance Variation (CRV). CRV is the plague of sensitive circuits that require adjustable elements. The net result of excessive CRV on a circuit is to make it difficult or impossible to make adjustments to some predetermined level.

What is CRV? The Variable Resistive Components Institute defines it as follows:

The apparent resistance seen between the wiper and the resistance element when the wiper is energized with a specified current and moved over the adjustment travel in either direction at a constant speed. The output variations are measured over a specified frequency bandwidth, exclusive of the effects due to roll-on or roll-off of the terminations and is expressed in ohms or % of Rt. (Industry limits this bandwidth to: 100 Hz to 50 kHz.)

Stated simply, CRV is the reflection of the non-perfect, non-uniform electrical connection that exists as the moving contact rubs the resistive element's surface, and is sometimes referred to as current noise.

Postulations

A rheostat (two teminal device) application of a trimmer will result in a higher CRV than the same trimmer used in a voltage divider (three terminal) application. This is because in rheostats, all the current passes through the wiper contacts, so as the current goes up, so does the CRV.

Minimizing CRV

Restrict wiper current to 10 mA maximum unless it can be shown that higher current levels do not produce unacceptable levels of CRV. This recommendation is made in spite of the manufacturer's rating of 100 mA absolute maximum for their wipers. Tests show that CRV rises rapidly in direct proportion to wiper current.

Do not include the first and last 10% of mechanical travel in your electrical adjustment range. These are the "roll-on" and "roll-off" areas which usually exhibit a noise spike of several times the magnitude of the CRV level of the rest of the trimmer. Note that industry does not consider these noise spikes to be CRV and therefore do not include them in their specifications.

Instrument Group Service Training For Customers

CUSTOMER SERVICE TRAINING CALENDAR FOR 1981

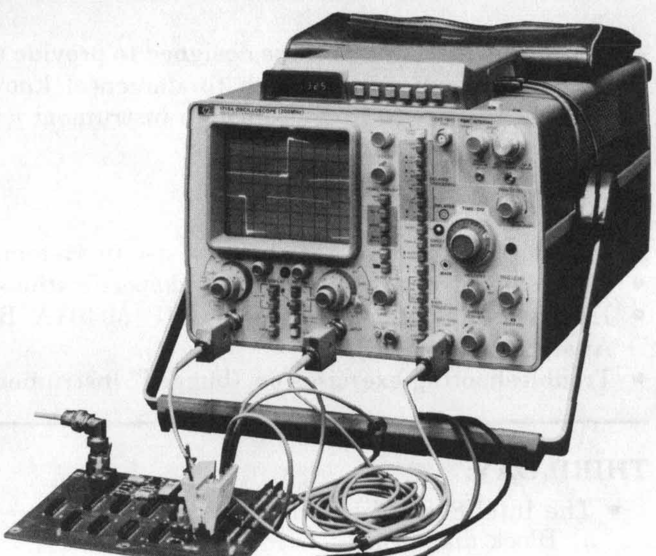
CONTENT	DATES	LOCATION	TUITION	COORDINATOR
Logic Analyzers				
Logic State Analyzer Maintenance Models 1610A/B, 1611A, 1615A, 1640A (2.5 days each)	March 16 – 27	Colorado Springs Division 1900 Garden of the Gods Road Colorado Springs, CO 80907 (303) 598-1900	$ 300/student	Jerry Lopez
Microcomputer Development System Model 64000	March 2 – 13 August 10 – 21	Colorado Springs Division	$1,250/student	Jerry Lopez
Scopes and Displays				
Models 1715A/1725A (Order HP No. 5955-4146)	March 23 – 25 October 5 – 7	Colorado Springs Division	$ 300/student	Dick Browne
Models 1740A/1741A/1742A/1744A (Order HP No. 5955-4147)	March 16 – 19 September 28 – October 1	Colorado Springs Division	$ 350/student	Dick Browne
Models 1980B/1950A/19860A (Order HP No. 5955-8046)	March 9 – 13 September 21 – 25	Colorado Springs Division	$ 400/student	Dick Browne
Models 1302A, 1304A P/N 5955-8049	March 2 September 21	Colorado Springs Division	$ 200/student	Margie Collins
Models 1310A/B, 1311A/B, 1317A/B, 1321A/B P/N 5955-8050	March 3 September 22	Colorado Springs Division	$ 200/student	Margie Collins
Models 1332A, 1333A, 1335A P/N 5955-8051	February 23 September 14	Colorado Springs Division	$ 200/student	Margie Collins
Model 1336S P/N 5955-8052	February 24 – 25 September 15 – 16	Colorado Springs Division	$ 250/student	Margie Collins
Model 1338A P/N 5955-8053	February 25 – 26 September 16 – 17	Colorado Springs Division	$ 250/student	Margie Collins
Model 1340A P/N 5955-8054	February 27 September 18	Colorado Springs Division	$ 200/student	Margie Collins
Model 1350A P/N 5955-8055	February 4 – 6 September 23 – 25	Colorado Springs Division	$ 300/student	Margie Collins
Automatic Test				
Circuit Test Systems Model 3060A	January 19 – 30 February 23 – March 6 March 30 – April 10 May 4 – 15 June 15 – 26 July 20 – 31 August 24 – September 4 September 28 – October 9 November 2 – 13 December 7 – 18	Loveland Instrument Division 815 Fourteenth Street, SW Loveland, CO 80537 (303) 667-5000	$2,100/student	Sandy Selleck
Model DTS-70	January 19 – 23 March 9 – 13 May 18 – 22 July 20 – 24 September 28 – October 2 November 16 – 20	Loveland Instrument Division	$1,000/student	Sandy Selleck
Technology Training				
Digital Troubleshooting Techniques	March 17 – 20 May 12 – 15	Instrument Service Center 333 Logue Avenue Mountain View, CA 94043 (415) 968-9200	$ 350/student	Debra Conley
Microprocessor Troubleshooting Techniques	March 23 – 26 May 18 – 21	Instrument Service Center	$ 350/student	Debra Conley
HPIB Fundamentals for Service Technicians	January 28 April 6 September 28	Instrument Service Center	$ 200/student	Debra Conley
DSA/Laser				
Fourier Systems & Maintenance Models 5451C/5427A	October 5 – 9	Santa Clara Division 5301 Stevens Creek Blvd. Santa Clara, CA 95050 (408) 246-4300	$ 700/student	Marshall Lollis
Microwave Instruments				
8671A Microwave Frequency Synthesizer 8672A Synthesized Signal Generator 436A Power Meter Klystron Generators	August 31 – September 4	Stanford Park Division 1501 Page Mill Road Palo Alto, CA 94304 (415) 857-2980	$ 400/student	Steve Thomas
8660 & 8662 Synthesized Signal Generators	October 5 – 8	Spokane Division 1620 Signal Drive Spokane, Washington 99220 (509) 922-4001	$ 350/student	Rodger Tracy
8640 AM/FM Signal Generator 8903A Audio Analyzer 8901A Modulation Analyzer	September 28 – October 2	Spokane Division	$ 400/student	Rodger Tracy
Signal Analysis				
Models 8566A Microwave/8568A Programmable	February 23 – 27 September 14 – 18	Santa Rosa Division 1400 Fountain Grove Parkway Santa Rosa, CA 95404 (707) 525-1400	$ 400/student	Jim Boyer
8565A Spectrum Analyzer	November 2 – 6	Santa Rosa Division	$ 350/student	Jim Boyer

Oscilloscopes

Hewlett-Packard, Colorado Springs Division, is offering service training seminars to customers on most all models of oscilloscopes including the new HP 1980 Oscilloscope Measurement System. All training will be conducted at Colorado Springs, CO, on the dates shown on the training calendar.

These seminars are directed to calibration and repair technicians and teach operation, circuit-theory, calibration and troubleshooting to component level repair. Attendees should have some prior knowledge of standard oscilloscope circuits, such as differential amplifiers, integrators, comparators and basic logic devices.

1700 Series, General Purpose Applications

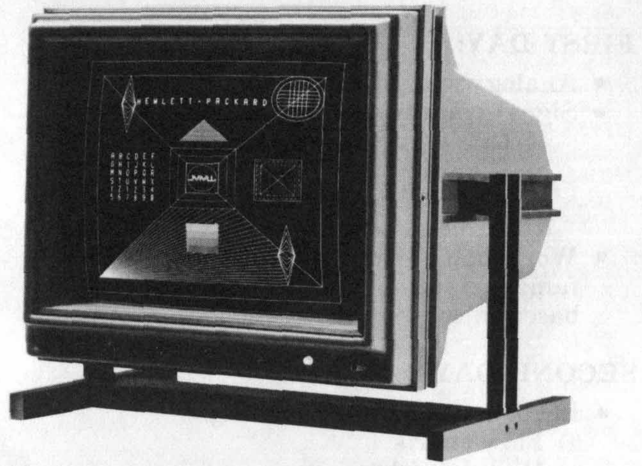


These 3 and 4-day oscilloscope seminars are taught to component-level of troubleshooting and repair. Popular options such as state-display and digital-multimeter and ΔT options are included.

1332A/1333A/1335A/1336S/1340A Small Screen Displays

These small-screen displays are covered in a 1-day class consisting of theory (including variable persistence and storage), calibration, troubleshooting and repair.

1302A/1304A/1310A/1311A/1317A/ 1321A Large Screen Displays



Large-screen displays are also covered in a 1-day course consisting of theory, calibration, troubleshooting and repair.

1980A/B Oscilloscope Measurement System with Optional 1950A 4-Channel Plug-in and 19860A Digitizer

This 5-day seminar is directed to calibration and repair technicians with prior knowledge of standard oscilloscope circuits, signature analysis, and digital/analog circuitry. A background in 8080 microprocessors and ANSII logic symbology (HP booklet 5951-6116) is also recommended to help the technician better understand the 30 schematics covered.

The first half of the first day covers CRT basics. Afterward instruction deals primarily with digital circuitry (control). Other areas covered are the power supply, analog circuitry (measurement) and the optional 4-channel and digitizer plug-ins.

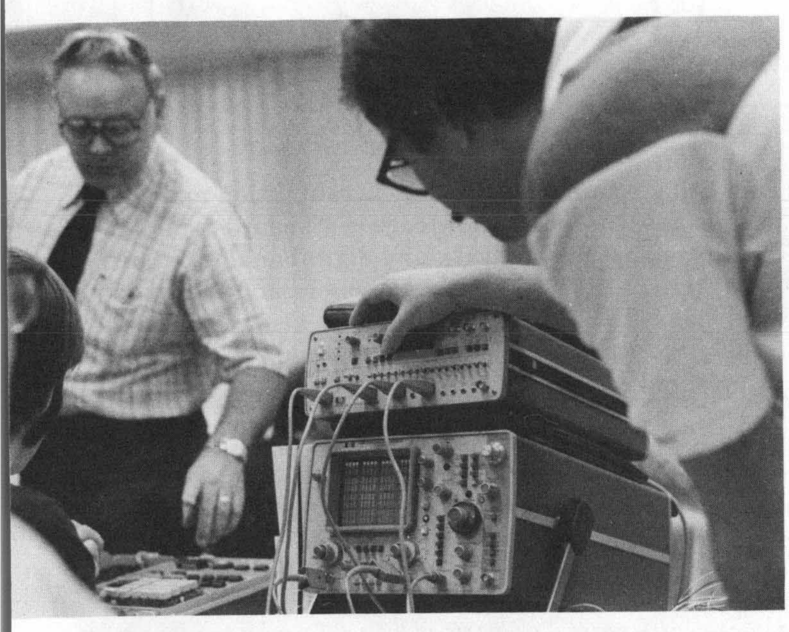
In case of insufficient enrollment, classes may be cancelled.

FIRST DAY:

- Analog vs. digital.
- Signal transmission techniques.
  - a) One wire, one signal.
  - b) Digital.
  - c) Open collector drivers.
  - d) Three-state drivers.
- Workshop — four hours of hands-on familiarization using an Intel 8085 based microprocessor trainer.

SECOND DAY:

- Introduction to programming.
  - a) Flow charts.
  - b) High level language.
  - c) Machine language.
  - d) 8085 Command set.
- Algorithmic State Machine Concepts
- Workshop — four hours of hands-on experiments using logic analyzers and oscilloscopes to view correct microprocessor operation.



Afternoon workshop sessions provide students with hands-on familiarization using the 5035T or 5036A Trainer and HP test equipment.

This is an intense 1-day course designed to provide the service technician with enough fundamental knowledge and expertise to troubleshoot an instrument with HP-IB type problems.

The day's activities will include:

- Introduction to IEEE-488 (history, use in systems)
- HP-IB bus structure, protocols, and specifications
- HP-IB troubleshooting tool — HP 59401A Bus Analyzer
- Troubleshooting exercises on "bugged" instruments

THIRD DAY:

- The Intel 8085 Microprocessor.
  - a) Block diagram.
  - b) Timing diagrams.
  - c) Analysis of pin functions.
  - d) Assessing improper operation.
- Workshop — four hours of troubleshooting experiments on the microprocessor trainer using pulsers, probes, current tracers and the signature analyzer.

FOURTH DAY:

- The micro-computer.
  - a) Micro-computer memories.
  - b) Input/output ports.
  - c) Keyboards.
  - d) Displays.
- Analyzing self-test features.
- Workshop — four hours of troubleshooting experiments on the microprocessor trainer using pulsers, probes, current tracers and the signature analyzer.

The course is roughly 40% lecture and 60% workshop. At the end of seminar the student will be able to:

- Describe the function and use of all 16 lines on HP-IB
- Control listeners and talkers with an HP 59401A Analyzer
- Identify bus problems down to the component level with the analyzer and decide on the next step towards repair.

THIRD DAY:

- Often encountered circuits containing flip-flops: Counters (BCD and binary, synchronous and ripple), dividers, shift registers, ring counters.
- Numbering systems including binary, BCD, octal and hexidecimal.
- Introduction to binary math including half and full adders.
- Workshop — four hours of hands-on time building and debugging counter circuits.

FOURTH DAY:

- ROM'S/PROM (masked, E and UV).
- RAM'S: bipolar and MOS (static and dynamic).
- Typical failures and the troubleshooting difficulties encountered with ROM'S, PROM'S and RAM'S.
- Typical memory addressing techniques.
- Modern display technologies, their application and common failure modes.
- Introduction to the ROM controlled device with emphasis on methods used to fault isolate.
- Workshop — four hours of experiments leading to the building of a functioning strobed display device.

FIRST DAY:

- Analog vs. digital.
- IC Technology: DCTL, RTL, DTL, CTL, TTL, ECL, EECL, HTL, MOS, I^2L.
- Specialized tools and techniques to troubleshoot these technologies.
- Workshop — four hours of hands-on experiments with gates and troubleshooting tools.

SECOND DAY:

- Logic Symbology.
- Positive/Negative logic notation.
- Understanding the implication of logic schematics.
- Implementation of logic gates: AND, OR, NOR, NAND, XOR, Wired-OR.
- Decoders and their uses.
- Comparators and their uses.
- Flip-flops: R-S, D, J-K (standard and master-slave).
- Workshop — four hours of hands-on experiments with decoders, comparators and flip-flops.

Students will also have an opportunity to use modern tools to troubleshoot faults in a printed circuit assembly.

Individual applications or problems are addressed during workshop sessions.

DTS-70 PCB Test System Service Seminar in Loveland, CO

See 1981 Calendar for Dates

COURSE CONTENT

LECTURE AND LAB

I. Product Familiarization

II. RTE Review
   A. FMGR
   B. RTE-IV B
   C. Editor
   D. Disc Organization
   E. Utilities

III. Testaid/Fastrace Overview

IV. System Troubleshooting
   A. System Functional Test Assy.
   B. DTS-70 Hardware
      1. Digital Test Unit
      2. Driver/Comparator Cards
      3. Power Supplies
      4. HP-IB Subsystem
   C. Preventative Maintenance
   D. System Functional Test

V. RTE Installation/Reconfiguration

VI. 91075C DTS-70 Software Installation

VII. Program Development

VIII. Virtual Memory System Overview

IX. System Transfer Files

X. Board Testing With Standard Files

XI. Hardware/Software Integration

XII. Warranty/Support Policies

PREREQUISITES

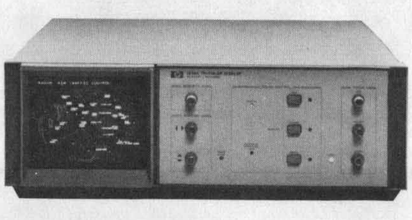
Some formal HP-1000 Disc-Based RTE course, preferably RTE-IV or RTE-IV B.

Tri-Color Graphics

1338A and 1350A Tri-Color Graphics Display and Translator

These are two separate courses on the display and translator with the objective to teach students how block-diagram troubleshooting can be utilized to get the student to the defective area within the instrument and finally the faulty component.

The seminar is directed to calibration and repair technicians and will teach operation, circuit theory, calibration and troubleshooting to the block and component level. Attendees should have some prior knowledge of standard oscilloscope circuits and the graphics concept.



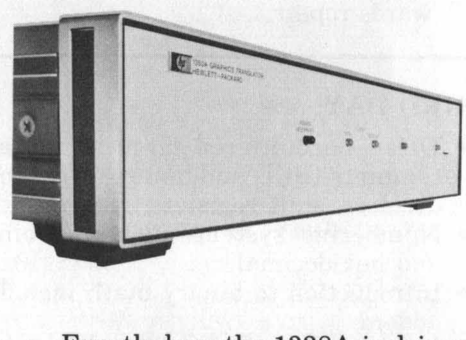
The course objective is to teach students how the 1338A Tri-color Display interfaces with the 1350A Graphics Translator so that block-diagram troubleshooting can be utilized to get the student to the defective area within the instrument and finally the component.

Toward this end, the student is shown:

— How circuits within the 1338A differ from those of B/W displays, including the CRT and Tri-color operation.

— How the color switching network operates.

— Fundamentals of the color logic board.



— Exactly how the 1338A is driven by the 1350A.

— How the I/O board in the 1350A operates.

— How to communicate to the 1350A via the RS232 or HP-IB interface.

— The command set and how to use the existing test tape.

This seminar does not confine students to "bit-chasing", but shows them how to isolate problems to an area within the total logic box.

3060 Circuit Test System Service Seminar in Loveland, CO

See 1981 Calendar for Dates

COURSE CONTENT

LECTURE AND LAB

I. Introduction to Course, System, and BTL.
II. Review of HPL and HP-IB
III. System Control Panel
IV. System Multiplexing
V. 3496A Scanner Troubleshooting
VI. 11353A/11453A Diagnostic Fixtures
VII. 34196A Scanner Power Supply
VIII. 11253A System Power Module
IX. Analog In-Circuit Testing
X. Transfer Testing
XI. 3253A Analog Stimulus/Response Unit Theory of Operation
XII. 3253A Analog Stimulus/Response Unit Calibration
XIII. 3253A Analog Stimulus/Response Unit Hardware Familiarization
XIV. 3253A Analog Stimulus/Response Unit Troubleshooting Exercises
XV. 3453A Digital Stimulus/Response Unit Programming
XVI. Static Pattern Testing
XVII D.U.T. Power Supplies ,
XVIII. D.U.T. Clock
XIX. 3453A Digital Stimulus/Response Unit Troubleshooting
XX. System Troubleshooting

PREREQUISITES
1. 9825A HPL Programming
2. 9885M HPL Programming
3. Knowledge of HP Logic Symbology
4. Knowledge of Operational Amplifier Circuits
5. Knowledge of Basic Logic Circuits

All the above prerequisites are mandatory.

Ordering Information

For the Customer

All courses must be ordered through your nearest Hewlett-Packard Sales Office.

Refer to the training calendar for course specifics (description, dates and HP part number if given), and submit a purchase order or check to your HP salesman for the course desired. Always specify "one each" for each attendee.

If you desire additional information about a specific course, contact the coordinator at the course location. Please do not attempt to register through the coordinator as the HP manufacturing divisions are not geared to accept customer purchase orders or money.

For the HP Sales Office

Transmit a HEART order to the division and list the seminar part number (if provided by the division) plus the code number M-32. Product description is listed as "Customer Training Seminar."

Logic Analyzers

Hewlett-Packard, Colorado Springs Division, is offering service training seminars to customers on most all models of Logic Analyzers including the HP 64000 Logic Development System. All training will be conducted at Colorado Springs, CO, on the dates indicated.

1611A — March 16, 17, and 1/2 18th (5955-4149)
1615A — March 1/2 18, 19, and 20th (5955-5033)
1610A/B — March 23, 24, and 1/2 25th (5955-4150)
1640A/B — March 1/2 25, 26, and 27th (5955-5032)

The courses are directed to calibration and repair technicians and will teach front panel controls, application, circuit theory, and troubleshooting to component-level repair. Other areas covered are the power supply, trigger recognition, data acquisition and storage, and the display circuitry. Attendees should have some prior knowledge of logic and oscilloscope circuits.

Toward the end of the course, the instructor summarizes by discussing overall troubleshooting from symptom to repair. The student is shown how to "milk" the front panel to learn how failures affect the instrument's behavior. From the behavior patterns, the student learns how to isolate the fault to a particular function within the instrument and finally to the faulty component.

64000 Logic Development System
March 2-13
HP No. 5955-6290

This course is directed toward the technician with a strong base of logic circuit troubleshooting with these added prerequisites:

1) ANSII logic symbology (HP booklet 5951-6116).

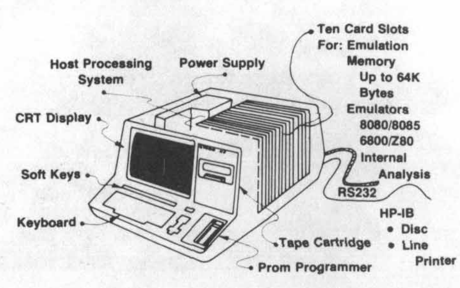
2) signature analysis

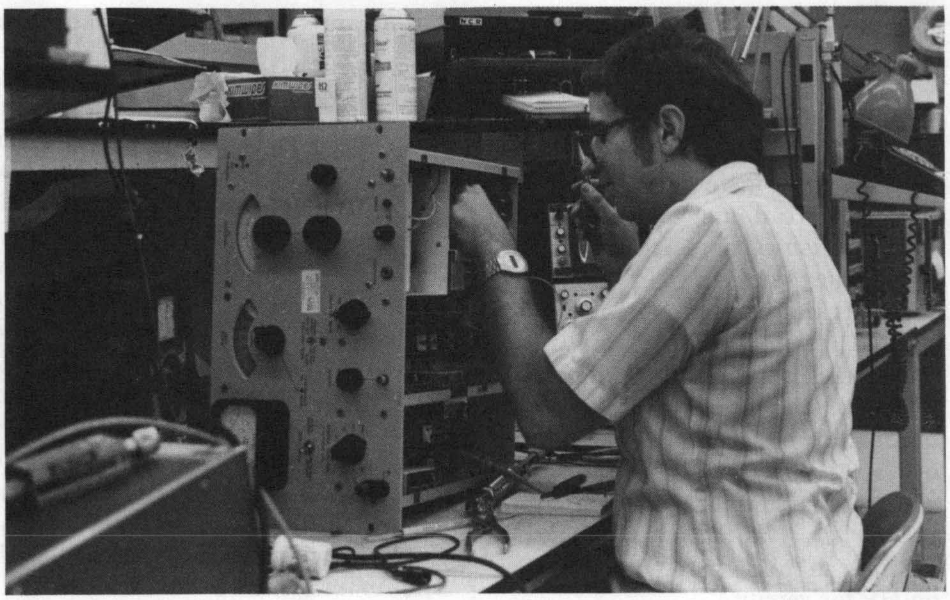
3) CPU, I/O, and memory hardware system architecture.

4) assembly level programming

Items 2, 3, and 4 are introduced in an excellent manner through the 5036A Microprocessor Lab self study course.

This two-week class covers the installation, performance verification, diagnostics, circuit theory, and troubleshooting of all 64000S hardware down to component-level repair where appropriate. The course does not cover the cartridge disc and 2608 printer. It is not an application seminar as system software study is limited to boot-up, troubleshooting, and a brief view of typical system applications.





HP Service Agreements: That Extra Measure of Confidence And Standard Repair and Calibration Prices: Where Costs Are Known in Advance

The age of hybrid microcircuits, LSI chips, and microprocessor-controlled instruments is here. More capability packed into a smaller package is a tremendous benefit, but these complex circuits and high-technology components can also mean more expensive repair and maintenance costs.

Hewlett-Packard has developed its own high-technology testing and troubleshooting instruments, and combined them with two programs to help reduce repair costs by reducing turn-around-time.

One program helps reduce the costs of routine repair of HP instruments which break down in normal use. The other program provides the equivalent of a health insurance policy for your instrument.

Both programs operate on the basis of fixed prices. The cost is guaranteed (for a maximum of 30 days) so even if actual service time and materials exceed this fixed price, you pay no more. (The only exceptions are damages incurred by abuse, misuse, or accidental damage.)

What Type of Service Can You Expect on Fixed Price Repairs and Calibration???

First of all let's establish the definition of "Instrument Repair" and "Calibration."

HP defines "Instrument Repair" as follows:

"Instrument Repair consists of correcting all malfunctions, both electrical and mechanical that restrict the instrument from meeting its published specifications. Repair includes an operation verification to gain reasonable confidence that the product is meeting its specifications."

The standard repair consists of the following steps:

1. The unit is inspected for damaged parts, missing hardware, burnt wiring or marginal components. All necessary repairs are performed.
2. The product safety service note file for the unit is reviewed and all mandatory safety modifications are performed. Copies of the relevant safety service notes describing the modifications are attached to the instrument.
3. If any other safety modifications and updates are recommended that will improve the reliability or performance of the instrument, the customer is first contacted for authorization. The cost of any such modifications is added to the standard repair price.
4. The operation verification is performed as outlined in the instrument's manual to gain reasonable confidence that the product is meeting its specifications.

or

If the customer has specified repair and calibrate to specifications, a complete calibration is performed as described below.

5. To make certain that the instrument conforms to current safety standards, an after-service safety test is performed.

HP defines "Instrument Calibration" as follows:

"Instrument Calibration consists of performance testing and any required adjustments that will bring the unit into conformance as specified in the Instrument Operating and Service Manual. In all cases, HP's calibrations are traceable to the National Bureau of Standards or other international standards organizations."

This calibration is documented with a "Certificate of Conformance" that is returned with the instrument.

Special requests for before/after data, or extra calibration points have an appropriate adjustment in price.

The standard calibration consists of the following steps:

1. The unit is visually inspected for mechanical or electrical defects. The customer is notified if the unit needs service and the fixed price repair is quoted.
2. The product's service note file is reviewed and all mandatory safety modifications are performed. Other modifications covered under warranty are also incorporated into the unit. Copies of all relevant service notes describing the modifications are attached to the instrument.
3. As described in step 3 above, other modifications may be recommended. The customer will be contacted for authorization.
4. The performance tests are now conducted and any required adjustments are completed that will bring the unit into conformance as specified in the instrument's manual.
5. To make certain that the instrument conforms to current safety standards, an after-service safety test is performed.
6. All applicable traceability numbers of transfer standards are listed on the customer service order. A "Certificate of Conformance" is completed and returned with the unit. An updated calibration label is attached to the front of the instrument in a prominent location.

HP Service Agreements

Standard Repair, Calibration and Maintenance Prices

This is a program that is the equivalent of a health insurance policy for your instrument. Your "policy cost" is kept low due to the broad customer base HP maintains. The service agreements are billed at a fixed annual fee, which means that you avoid unbudgeted "surprises." The cost is guaranteed (for a maximum of 30 days) so even if actual service time and materials exceed this fixed price, you pay no more. (The only exceptions are damages incurred by abuse, misuse, or accidental damage.) Thus, you can plan for instrument maintenance in your annual budget *in advance* without unexpected additional costs. And because quotations, approvals, and purchase orders are eliminated, you reduce overall turn-around time. If desired, these agreements allow the flexibility of using your own in-house lab for routine calibration, while relying on HP for repair.

Wide Choice of Service Plans

Because customer requirements differ, HP offers several service plans. The following brief description covers one of those plans called repair and calibration agreements and we recommend that you consult your nearest HP Service Center for prices and details. If this plan does not fit your needs, contact us. The HP Service Center may be able to recommend an alternative, such as an on-site service agreement, or tailor a solution to your specific requirements.

One Year Repair Agreement

This is the health insurance policy. A low annual fee covers the repair of all instrument failures except those resulting from abuse, misuse, or accidental damage. This service includes ALL labor and parts required to restore a product to normal operating condition. The repair includes an operation verification to gain reasonable confidence that the product is meeting its specifications.

For out-of-warranty instruments, an inspection/calibration audit may be required prior to entering into the agreement.

One Year Calibration Agreement

This plan supplements the warranty for new instruments and helps ensure on-going performance for older instruments. Calibration consists of performance testing and any adjustment required to achieve compliance to operating specifications. Under the plan, HP will calibrate your instrument according to the recommended cal cycle per year. If desired, before/after data, special calibration points, or other intervals may be specified with an appropriate adjustment in price. Each calibration is documented with a "Certificate of Conformance" returned with the instrument.

HP's calibration program satisfies the requirements of U.S. MIL-C-45662A and other similar international specifications.

One Year Full Service Agreement

Full service is a comprehensive plan that includes scheduled calibration plus ALL emergency repair services, including parts and labor. In essence, it combines all the advantages of both calibration and repair agreements.

Fixed Price Repair

Standard Charges for One-Time Repair and/or Calibration

This is a program commonly called STREP for Standard Repair (i.e., a fixed price for repairing your instrument on a one-time basis). In simple terms it means that when you return an instrument to HP for repair and that instrument is included in the program, you are immediately quoted a fixed price for the repair. If you only want the instrument calibrated, there is a reduced price for only that service.

In some cases, selected parts are specified as being excluded from the standard price. These are generally expensive parts that fail infrequently. If replacement of one of these parts is necessary, you will be contacted and quoted the additional cost before work is begun.

In addition to the standard repair price described above, there is a low "mini-repair price" which is common to all models on the program. Should the repair take less than an hour and require nominal parts ($10 or less), a "mini-repair price" of $55 will be charged.

STREP is intended to simplify the routine quotation of HP instruments which break down in normal use. Contact your local HP Service Center for a list of prices and eligible instruments. Instruments requiring overhaul or repairs necessitated by abuse, misuse or accidental damage are ineligible for the program. HP will, of course, continue to service such products, and provide quotations based on actual time and materials.

Other basic guidelines for the Standard Repair Program are as follows:

- Standard prices apply to repairs performed during regular HP working hours.
- Shipping costs and sales or use tax (if applicable) will be added to the standard price.
- Any consumables which are required, such as power cords, test cords, cables, test probes and cable assemblies, batteries, paper tape, and software, etc., will also be added to the standard prices (unless otherwise noted on price list).
- Customer-specified modification, kits, and updates to instruments are excluded from the program.
- Certain instruments with special options may be excluded from the program. We will notify you in this event.
- Instrument mainframes and plug-in units each have a standard repair price. In some cases the repair price could be the sum of the mainframe and plug-in(s) Standard Repair prices.

For nearly 40 years, Hewlett-Packard has helped customers obtain optimum performance from their instrument investment. The HP Service Agreement program provides that extra measure of confidence, and assures you of prompt attention and comprehensive maintenance — in other words, professional quality service to complement your professional quality instrument.

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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.

236A TELEPHONE TEST OSCILLATOR

236A-4. Approximate serials 1107A07800 to 1107A08100. Front cover modification to properly turn the instrument off when the cover is installed.

346B NOISE SOURCE

346B-1. Serials 2015A and below. Modification which reduces the time the source requires to turn off to improve noise-off measurements.

403B/BB PORTABLE AC VOLTMETER

403B/BB-9B. Serials 0986A20520 and below. Recommended battery replacement for improved performance.

410C ELECTRONIC VOLTMETER

410C-19. All serials. Recommended modifications to A3R5 and A6R20 during service due to vendor non-availability of parts.

412A VACUUM TUBE VOLTMETER

412A-9C-S. All serials. The set screws on the "volts" probe must be frequently checked to insure that the protective insulation is in place.

432C POWER METER

432C-4A. Serials 1906A and below. Recommended auto range assembly replacement to eliminate software related time-out problems when under computer control.

606A/B SIGNAL GENERATORS

606A/B-12. 606A all serials; 606B serials 1862A and below. Recommended replacement for modulation and RF output meters.

895A POWER SUPPLY

895A-3. Serials 1501A 01153 and below. Recommended part substitution in the event of SCR failure. Supersedes 895A-1.

1610A/B LOGIC ANALYZER

1610A-11. Serials 1936A and below. Notification that rebuilt power supplies are now available for replacement.

1610A-12. Serials 1940A. Recommended ROM replacement kits in event of a ROM failure.

1610B-2. Serials 1940B and below. Recommended ROM replacement kits in event of a ROM failure.

1640A/B SERIAL DATA ANALYZER

1640A-10. All serials. Modification to prevent latch up on ±12 volt supplies.

1640A-11. Serials 1827A and below. Recommended keyboard replacement to improve performance.

1640A-12. All serials. Recommended modifications to the CRC or SDLC options to improve performance.

1640B-1. Serials 2019A00294 and below. Modification to prevent latch up on ±12 volt supplies.

1640B-2. Serials 2028A and below. Recommended modifications to the CRC or SDLC options to improve performance.

1715A OSCILLOSCOPE

1715A-6. All serials. Recommended attenuator detent wheel replacement in the event of failure.

1725A OSCILLOSCOPE

1725A-6. All serials. Recommended attenuator detent wheel replacement in the event of failure.

1740A OSCILLOSCOPE

1740A-16. All serials. Modification to improve connector mating reliability between A3 vertical preamp and A5 vertical output PC boards.

1743A OSCILLOSCOPE

1743A-3. All serials. Modification to improve connector mating reliability between A3 vertical preamp and A5 vertical output PC boards.

1980A/B OSCILLOSCOPE

1980A/B-2. All serials. Recommended fast blow fuses for proper line fusing to protect internal circuitry.

3060A BOARD TEST SYSTEM

3060A-10A. All serials. Notification of 3060A system software revision. IPG revised to 2014.

3060A-14A. All serials. Notification of 3060A system software revision. CCD revised to 2027.

3060A-15. All serials. Software modification. CCD revision 2027 modification of "CNTRLR" program for proper operation during the controller test.

3060A-16. All serials. Notification of 3060A system software revision. CCD revised to 2036.

3253A ANALOG STIMULUS RESPONSE UNIT

3253A-2. All serials. Correction of source amp current compliance check test limits on ASRU calibration tape 03253-10002.

3403C TRUE RMS VOLTMETER

3403C-8. Serials 1452A04110 and below. Recommended modification to improve performance in certain applications when a small input signal with large common mode noise superimposed is measured.

3440A DIGITAL VOLTMETER

3440A-19. All serials. Modification to improve stability of display.

3465A DIGITAL MULTIMETER

3465A-5B. All serials. Correct replacement part numbers for batteries.

3497A DATA ACQUISITION/CONTROL UNIT

3497A-1. All serials. Instructions for making a blue stripe board exchange for the 03497-69510 thermocouple compensation connector board.
3497A-2. Serials 2011A00359 and below. Installing analog and digital extender connectors for interfacing between the 3497A and 3498A extender.
3497A-3. Serials 2011A00160 and below. Outguard EPROM to ROM update to improve performance.
3497A-4. All serials. Instructions for making a blue stripe board exchange for the 03497-69502 mainframe inguard controller board.

3555B TRANSMISSION AND NOISE MEASURING SET

3555B-3. Approximate serials 0992A06150 to 0992A06950. Front cover modification to properly turn the instrument off when the cover is installed.

3580A SPECTRUM ANALYZER

3580A-8. Serials 1415A-03440 and below. Recommended low voltage power supply modification to improve performance.

3581A/C WAVE ANALYZER

3581A/C-6. 3581A serials 1351A-01300 and below; 3581C serials 1411A-01015 and below. Recommended low voltage power supply modification to improve performance.

3582A SPECTRUM ANALYZER

3582A-8. All serials. Recommended replacement fans.
3582A-9. Serials 1809A 01866 and below. Front panel modifications to improve performance.

3585A SPECTRUM ANALYZER

3585A-4. Serials 1750A00740 and below. Identification and service compatibility between I.F. filter boards.

3745A/B SELECTIVE LEVEL MEASURING SET

3745A/B-18D. Serials 1812U and below. Retrofit kit for special Option H07.
3745A/B-30B. 3745A serials 2032U and below; 3745B serials 2030U and below. Preferred replacement of A109 memory assembly.
3745A/B-37. 3745A serials 1930U and below; 3745B serials 1942U and below. Modification that improves the suppression of line radiated RFI.
3745A/B-38A. All serials. Preferred replacement of varactor diode 0122-0059.
3745A/B-39. Serials 1532U and below. Preferred replacement of A108 CPU assembly.
3745A/B-40. Serials 1748U and below. Preferred replacement of A202 reference frequency assembly.
3745A/B-41. Serials 1726U and below. Preferred replacement of A203 N3 programmable divider.
3745A/B-42A. Serials 1726U and below. Preferred replacement of A206 SL2 VTO assembly.
3745A/B-43. Serials 1645U and below. Preferred replacement of A215 110 MHz filter assembly.
3745A/B-44. Serials 1645U and below. Preferred replacement of A216 10 MHz filter assembly.
3745A/B-45A. Serials 1751U and below. Preferred replacement of A502 regulator assembly.
3745A/B-46. Serials 1930U and below. Preferred replacement of A601 X Y driver assembly.
3745A/B-47. All serials. Preferred replacement of phase lock loop IC 1826-0407.
3745A/B-48. All serials. Preferred replacement for NPN transistor 1854-0071.
3745A/B-49. All serials. Preferred replacement of zener diode A313CR5, 11, and 17.
3745A/B-50. All serials. Preferred replacement of Option 050 ROM 5090-0805.

3747A/B SELECTIVE LEVEL MEASURING SET

3747A/B-17. 3747A serials 1950U and below; 3747B serials 1924U and below. Modification to eliminate excessive spurious signals from 2nd mixer A318.
3747A/B-18A. All serials. Preferred replacement of varactor diode 0122-0059.
3747A/B-19. All serials. Preferred replacement of phase lock loop IC 1826-0407.

3757A-1 8.5 MHz ACCESS SWITCH

3757A-1. Serials 1948U00230 and below. Modification to allow proper operation when two or more instruments are cascaded and the control path is via the coaxial cable.

3762A DATA GENERATOR

3762A-3. Serials below 1812U00421 (Options 201, 202, 330). Modification to eliminate incorrect error rate on ternary data output.

3779A/B PRIMARY MULTIPLEX ANALYZER

3779A-18. Serials 2003U-00205 and below. Modification to improve reliability of power supply.
3779A-19. All serials. Preferred replacement of encoder integrated circuit HP part number 1820-1851.
3779B-19. Serials 2005U-00265 and below. Modification to improve reliability of power supply.
3779B-20. All serials. Preferred replacement of encoder integrated circuit HP part number 1820-1851.

3780A PATTERN GENERATOR/ ERROR DETECTOR

3780A-20. Serials below 1915U-01048. Modification to prevent "sync loss" condition under mechanical vibration.

3968A INSTRUMENTATION TAPE RECORDER

3968A-19. Serials 2009A01192, 01193, 01194, 01195, 01202, 01205. Correction for possible HP-IB power socket miswire.

4140A pA METER/DC VOLTAGE SOURCE

4140A-5. Serials 1917J00270 and below. Remedy for malfunction of key controls.

4262A DIGITAL LCR METER

4262A-12. Serials 2022J02300 and below. Elimination of trouble caused by zener diode A13CR15/16 replacement.

4270A AUTOMATIC CAPACITANCE BRIDGE

4270A-13. All serials. Proper identification of the cable color code on T1 power transformer.

4274A MULTI-FREQUENCY LCR METER

4274A-1. Serials 1838J00114, 1838J00116, 1838J00118, 1838J00119, 1838J00120, 1838J00122, 1838J00129, and 1850J00136. Modification to improve DC bias voltage (Option 001/002) accuracy.
4274A-2. Serials 1850J00460 and below. Modification to improve oscillator level when performing the A3 "test signal level monitor adjustment" described in the service manual.
4274A-3. Serials 1850J00540 and below. Modification to provide sufficient current through the DUT.
4274A-4A. Serials 1850J00207, 1850J00209, 1850J00210, 1850J00212, 1850J00214, 1850J00220, 1850J00223 thru 1850J00230, and 1850J00232 thru 1850J00235. Recommended A9U1 and A9U5 PROM replacement to improve performance after "open and short zero-offset adjustment" has been performed.
4274A-5. Serials 1850J00160 and below. Modification to prevent parasitic oscillation at low frequencies.
4274A-6. Serials 1850J00235 and below. Modification of the A6 oscillator board to improve performance of the "zero offset adjustment".
4274A-7. Serials 1850J00235 and below. Recommended A9U1 and A9U5 PROM replacement to improve performance during "zero offset adjustment", and when measuring a low impedance DUT (approximately 0 Ω or 0 S).
4274A-8. Serials 1850J00175 and below. Recommended PROM replacement for Option 001/002 (DC bias) to improve performance and eliminate erroneous error message "Err 8" which may appear on DISPLAY A when the power switch is turned on and the DC bias switch on the rear panel is set to one for the INT positions.
4274A-9. Serials 1850J00235 and below. Modification to prevent illegal display "9.99999".
4274A-10A. Serials 1850J00385 and below. Modification to prevent newly installed integrators from creating erroneous counts causing the measured value to be out of the specified range in performance test.
4274A-11. Serials 1838J00135 and below. Modification to A7/A9 boards to prevent the instrument from periodically exhibiting a wide fluctuation of displayed measured values.
4274A-12. Serials 1838J00101, 106, 108, 110-116, 120, 121. Modification to improve memory backup battery.
4274A-13B. Serials 2031J00800 and below. Modification to prevent the cable assemblies on the bottom side of the mother board from being pierced by the sharp pins of the PC board connectors.
4274A-14. Serials 2019J00760 and below. Supplemental information to service notes 4274A-4, 7, and 11.

4275A MULTI-FREQUENCY LCR METER

4275A-1. Serials 1851J00302, 00301, 00299, 00296 to 00288, 00285 to 00281, 00278 to 00276, 00274, 00272 and below. Modification to improve 1 μH measurement at 10 MHz with 1 meter test leads.
4275A-2. Serials 1843J00129 and below. Recommended A9U1 and A9U5 PROM replacement to improve performance during the "open and short, zero-offset adjustment" procedure (described in Section III of the Operating Manual).
4275A-3. Serials 1851J00202 and below. Recommended A9U1 and A9U5 PROM replacement to improve performance during "zero-offset adjustment", and when measuring a low impedance DUT (approximately 0 Ω or 0 S).
4275A-4. Serials 1851J00129 and below. Recommended PROM replacement for Option 001/002 (DC bias) to improve performance and eliminate erroneous error message "Err 8" which may appear on DISPLAY A when the power switch is turned on and the DC bias switch on the rear panel is set to one for the INT position.
4275A-5. Serials 1851J00182 and below. Modification to prevent illegal display "9.99999".
4275A-6A. Serials 1851J00262 and below. Modification to prevent newly installed integrators from creating erroneous counts causing the measured value to be out of the specified range in performance test.
4275A-7. Serials 1843J00111 and below. Modification to A7/A9 boards to prevent the instrument from periodically exhibiting a wide fluctuation of displayed measured values.
4275A-8. Serials 1843J00106 to 00111. Modification to improve memory backup battery.
4275A-9. Serials 1851J00673 and below, 1851J00675 and 1851J00682, 1851J00684 to 1851J00692, 1851J00695, and 1851J00698 to 1851J00701. Addition of a filter to improve 1 MHz measurement.
4275A-10. All serials. Recommended RF filter for rejection of prober generated no se.
4275A-11B. Serials 2016J00852 and below. Modification to prevent the cable assemblies on the bottom side of the mother board from being pierced by the sharp pins of the PC board connectors.

4961A PAIR IDENTIFIER FIELD UNIT
4961A-2. Serials 1701A00419 and below. Recommended power supply IC to improve performance.

SPECIAL MODELS H01-5004A AND H03-5004A SIGNATURE ANALYZERS
H01-5004A/H03-5004A/K17-59994A-1. 5004A serials 1824A04281 and below. All H01-5004A and H03-5004 analyzers used with special model K17-59994A, serials A01181 and below. Modification to correct HP-IB signature reading.

5045A DIGITAL IC TESTER
5045A-23. All serials. New DAC (A1) adjustment specifications for the "DAC REF 7.5 V" part of the Performance Test.

5342A MICROWAVE FREQUENCY COUNTER
5342A-10B. All serials prior to 2020 and all serials 2020 and after with Option 002. Instructions for replacing low frequency input fuse.
5342A-20A. Serials after prefix number 2020. Addition of a fused BNC low frequency input connector for instrument protection.
5342A-26. Instructions for installing amplitude measurement Option 002. (Retrofit kit part number 05342-60200).

5359A TIME SYNTHESIZER
5359A-3. Serials 2024A00311 and below. Modification to A9 to prevent improper instrument operation on power up.

5370A UNIVERSAL TIME INTERVAL COUNTER
5370A-8. Serials 2024A00811 and below. Modification to A9 to prevent improper instrument operation on power up.
5370A-10. All serials. Notification of a software anomily when using the HP-IB command group execute trigger.

5501A LASER TRANSDUCER SYSTEM
5501A-7. 10763A English/metric pulse output serial prefix 2012A and above. Modification to improve performance by adding auxiliary reset capability.

6002A POWER SOURCE
6002A-2. Serials 1938A-03875 and below. Modification to assure overvoltage protection during a turn-on failure.

6128C DIGITAL VOLTAGE SOURCE
6128C-2/6129C-3/6130C-3/6131C-2. Serials 1925A-00257 and below. Modification to improve stability.

6129C DIGITAL VOLTAGE SOURCE
6128C-2/6129C-3/6130C-3/6131C-2. Serials 1834A-00474 and below. Modification to improve stability.

6130C DIGITAL VOLTAGE SOURCE
6130C-2/6129C-3/6130C-3/6131C-2. Serials 1852A-01370 and below. Modification to improve stability.

6131C DIGITAL VOLTAGE SOURCE
6128C-2/6129C-3/6130C-3/6131C-2. Serials 1934A-00920 and below. Modification to improve stability.

6940B MULTIPROGRAMMER
6940B-3/6941B-2. Serials 2008A-04410 and below. Modification to the overvoltage detector to improve performance.

6941B MULTIPROGRAMMER
6940B-3/6941B-2. Serials 2006A-01500 and below. Modification to the overvoltage detector to improve performance.

6942 MULTIPROGRAMMER WITH 14700A EXTENDER KIT
6942A-1. Serials 1920A-00155 and below. Modification to prevent 6942A system hang-up by 6943A extender crowbar.

7010A/B X-Y RECORDER
7010A/B-3. All serials. Options 145, 147, 175, 195, 196 and 404 for IRD mechanalysis. Recommended pen holder assembly replacement for listed Options to prevent breakage of the pen holder when the machine is installed in its carrying case.

7015B X-Y RECORDER
7015B-3. All serials. Recommended pen holder assembly replacement for improved performance.

7245A/B PLOTTER/PRINTER
7245A/B-2. All serials. Instructions for replacing HP-IB printed circuit assemblies that have new grounding hardware.

8406A COMB GENERATOR
8406A-2. All serials. Performance test and adjustment procedures.

8410A NETWORK ANALYZER
8410A-7/8410B-2. All serials. Recommended modifications to minimize size and number of "donuts" displayed on the CRT.
8410A-8/8410B-3. All serials. Modification to reduce susceptibility to phase lock on harmonics of RF signal.
8410A-9/8410B-4. All serials. Modification to optimize 8411A VTO frequency with the 8410A/B Sweep Stability control.

8410B NETWORK ANALYZER
8410A-7/8410B-2. Serials 1902A01892 and below. Plus serials 1902A01897, 1902A01900, 1902A01902, 1902A01906, and 1902A01907. Recommended modifications to minimize size and number of "donuts" displayed on the CRT.
8410A-8/8410B-3. Serials 1902A01610 and below. Modification to reduce susceptibility to phase lock on harmonics of RF signal.
8410A-9/8410B-4. Serials 2005A and below. Modification to optimize 8411A VTO frequency with the 8410A/B Sweep Stability control.

8411A HARMONIC FREQUENCY CONVERTER
8411A-5. Serials 1925A and below. Modification to improve stability and linearity.

8414A POLAR DISPLAY UNIT
8414A-6. Serials 1616A and below. Modification to replace an unstable high voltage oscillator that may emit an audible sound like that of arcing and at the same time cause the CRT's intensity to change.

8501A STORAGE NORMALIZER
8501A-3. All serials. Modification to improve intensity variation when switching between "storage off" and "storage on".
8501A-4. All serials. Internal adjustment procedure to make the 8501 compatible with the model 8754A network analyzer.

8554B/L SPECTRUM ANALYZER
8554B-7. All serials. Preferred replacement 500 MHz oscillator board.
8554L-8. All serials. Preferred replacement 500 MHz oscillator board.

8555A SPECTRUM ANALYZER
8555A-14. All serials. Instructions on the replacement of coarse and fine tune shafts.

8558B SPECTRUM ANALYZER
8558B-12. All serials. Modification that changes a standard 8558B into an 8558B Option 003.

8565A SPECTRUM ANALYZER
8565A-8. 8565A-Option 100 serials 1905A and below. Instructions for modifying a newly installed step gain amplifier assembly to make it compatible with older instruments.
8565A-9. Serials 1929A and below. Preferred replacement ROM A39U6 on the readout driver assembly.

8640B OPTION 004 SIGNAL GENERATOR
8640B-33A. Serials 1827A and below. Modification to improve AM phase shift when the AM meter function is selected.

8656A SYNTHESIZED SIGNAL GENERATOR
8656A-1. All serials. Instructions for installing a high stability time base (Option 001).

8672A SYNTHESIZED SIGNAL GENERATOR
8672A-4A. All serials. Retrofitting a standard 8672A or 8672A Option 001 to front or rear panel RF output.

8746B S-PARAMETER TEST SET
8746B-1. Serials 1521A00570 and below. Modification to minimize switch driver circuit oscillations to eliminate switch chatter and poor switch repeatability.

59300-10001 HP-IB TEST TAPE
59300-1. Revision K. List of HP-IB test tapes and instructions for counter-type products from HP Santa Clara Division.

59303A DIGITAL-TO-ANALOG CONVERTER
59303A-2. Serials 2012A01375 and below. Recommended IC change to guarantee DAC settling time specification.

59306A RELAY ACTUATOR
59306A-8. Serials 1920A02861 to 1920A03110. Instructions for replacing incorrect front panels.

62605L/M MODULAR POWER SUPPLIES
62605L-2/62605M-3/62615M-1. 62605L serials 2023A-04309 and below; 62605M serials 2029A-09409 and below. Modifications to improve reliability of output capacitors A5A4C1, C2 (0180-0589).

62615M MODULAR POWER SUPPLY
62605L-2/62605M-3/62615M-1. Serials 2025A-00628 and below. Modifications to improve reliability of output capacitors A5A4C1, C2 (0180-0589).

64000 LOGIC DEVELOPMENT SYSTEM
64203A-3A. 64203A EMULATOR SUBSYSTEM. Emulator pod repair number 2017A and below. Modification to disable improper HLDA signal.
64203A-5. 64203A 8085 EMULATOR SUBSYSTEM. Emulator pod repair number 2017A-00219 and above. Modification to prevent a random "write" after a "halt" instruction is executed.
64251A-1. 64250A Z80 EMULATOR SUBSYSTEM. Z80 Emulation Control Board repair number 2009A and above. Modification to disable the emulation memory during "mode 0" interrupts to allow the Z80 Emulation System to access the user's interrupting device for the entire "op code" instruction.
64251A-2. 64250A Z80 EMULATOR SUBSYSTEM. Z80 Emulation Control Board repair number 2009A and below. Modification to prevent illegal "op code" status during "mode 1" interrupt acknowledge.
64252A-1A1. 64250A Z80 EMULATOR SUBSYSTEM. All Z80 Emulator Pod Board repair numbers. Modification to allow user hardware to respond to peripheral interrupt routines executed from emulation memory. Supersedes 64252A-1.
64252A-1A2. 64250A Z80 EMULATOR SUBSYSTEM. Z80 Emulator Pod Board repair number 2003A-00126 and above. Modification to the user WAIT signal to allow emulation of the user system before the responding user hardware is physically in place. Supersedes 64252A-1.
64252A-2A. 64250A Z80 EMULATOR SUBSYSTEM. Z80 Emulator Pod Board repair number 2003A-00126 and above. Modification to synchronize user WAIT signal.
64940A-1. 64940A CARTRIDGE TAPE SYSTEM. All serials. Modification to prevent cartridge tape despooling.

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