HEWLETT PACKARD

BENCH BRIEFS

SERVICE INFORMATION FROM HEWLETT-PACKARD

May/June 1986

The Basics of Switching Regulators

TROUBLESHOOTING BASICS

dc power supplies

Barry Halm,
HP New Jersey Division

Basic Switching Regulator

The series pass regulator is the simplest but least efficient method of regulation. The output is kept constant by using the series pass transistor as a variable resistance between the output and input. With the advent of high-current, high-speed, and low forward drop transistors, a more efficient means of voltage regulation became available.

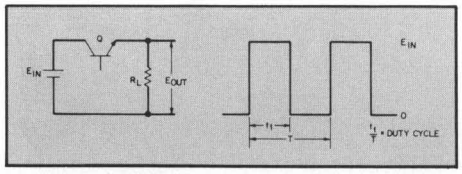


Figure 1. Waveform of series pass transistor being turned full-on then full-off

Enter the series switching regulator. If the series pass transistor is turned full-on (saturated) then full-off (cut-off), we get the waveform as shown in Figure 1. The dc or average value of this waveform is:

$$Eout = Ein * t1/T$$

where t1 is the time the transistor is full-on and T is the switching frequency in time. The ratio of the on-time to the switching frequency is called the duty cycle. If the on-time is one-half the switching frequency, the duty cycle will be 50 percent and the output voltage will equal to 0.5 times the input voltage. Example, if the input voltage is 10 Vdc and the duty cycle is 50 percent, then the output voltage will be 10*0.5 = 5 Vdc. This is fine as long as the input voltage stays at 10 Vdc. What if Ein changes? If Ein increases then Eout will also increase, unless the duty cycle is changed. The duty cycle has to be decreased to bring the output down. This is usually accomplished with a pulse-width modulator that tracks the output and controls the duty cycle. Therefore, with the pulse-width modulator, when Ein goes above 10 volts the transistor on-time is decreased, which decreases the duty cycle keeping the output voltage at 5 volts. This is how the switching regulator maintains a constant or regulated output voltage, by varying the duty cycle.

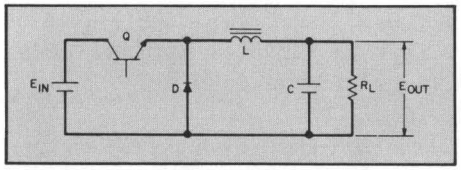


Figure 2. Series pass transistor with filtering added

The ac ripple will have a peak-to-peak value of Ein. To smooth the ripple we add a low-pass filter, L and C as shown in Figure 2. If we select the reactance of L to be much greater than the reactance of C, the ripple component can be reduced to a low value.

What about the rectifier D? When the transistor is turned on, the load current and charging current for L and C will flow from Ein through the transistor. When the transistor opens, interrupting the current flow, the input of L swings negative since the current in L cannot change instantaneously. The input will swing negative until it goes one diode drop below −Ein, at which time the rectifier D will start to conduct. During the time that the transistor is off, the load current is supplied by C and by L through the rectifier. When the transistor turns on, the rectifier is reverse biased and stops conducting. This rectifier is called the "catch" or "freewheeling" diode.

This is the basic series switching regulator. Any desired voltage less than the input can be obtained by varying the on-time or pulse-width of the transistor. This voltage regulation can be achieved at high efficiency since the only losses are the transistor dissipation during switching and saturation.

There are some disadvantages in this circuit, such as the output must be lower than the input and the output is not isolated from the input.

Let us reconfigure the circuit to obtain isolated and/or higher voltages.

Driven Half-Bridge Converters

The basic series switching regulator is fine for low dc input voltages and nonisolated outputs. Now let's look at a circuit that can be used for high dc input voltages, as found in "off-line" switching supplies, and that also provides an output voltage that is isolated from the input.

Two basic advantages of switching power supplies are small size and

Pub. No. 5952-0125

light weight. This is due partly to the removal of the low frequency input power transformer, which is normally the largest and heaviest component in a power supply. To eliminate the input transformer, most switching supplies use the configuration shown in Figure 3. This circuit allows operation from either a 120V, 60 Hz source or 240V, 50 Hz source.

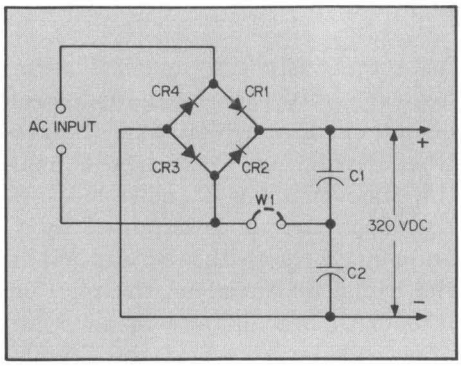


Figure 3. Dual input configuration

With a 240 Vac input, jumper W1 is open and the circuit is configured as a full-wave bridge. The dc "rail voltage" across capacitors C1 and C2 is approximately 320 Vdc.

When the primary power source is 120 Vac, jumper W1 is connected and the circuit is now configured as a half-wave voltage doubler. The dc rail voltage remains at 320 Vdc.

This dc rail voltage of 320 Vdc has to be converted to a more usable voltage, possibly 5 to 18 Vdc, for TTL or MOS applications.

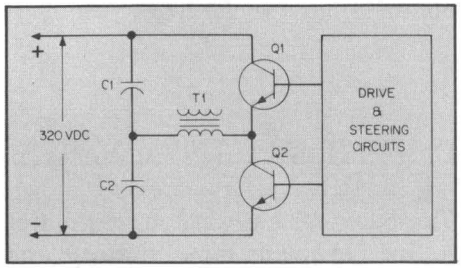


Figure 4. Half-bridge converter

One method of converting this voltage to something more usable is by using the half-bridge converter circuit shown in Figure 4.

The half-bridge converter is so named because there are only two active components in the bridge circuit

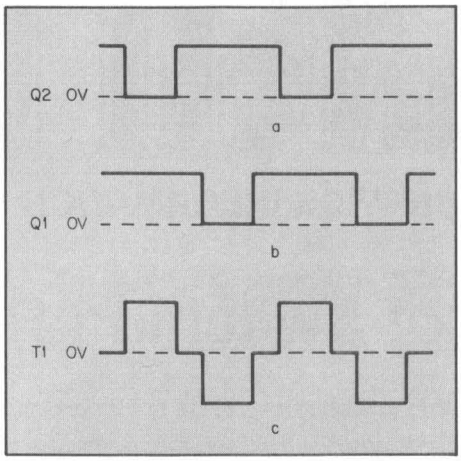


Figure 5. Half-bridge converter primary waveforms

formed by Q1, Q2, C1, C2, and T1. The transistors are driven alternately between saturation (on) and cut-off by the drive and steering circuits. When Q1 is on, the primary current for T1 flows from the positive rail through Q1 and C2 to the negative rail. Conversely, when Q2 is on, current flows from the positive rail to the negative rail through C1 and Q2. Note that at this time the current has reversed its direction through the primary of T1.

Figures 5a and 5b show the relationship of the voltage waveform across Q1 and Q2, while Figure 5c shows the bipolar output waveform across the primary of T1.

Note that there is a period of time when both transistors are off and the voltage across T1 is at zero. This period is called "dead-time" and insures that both transistors are never on at the same time. If both Q1 and Q2 were on together, a short would be created across the power rail that would destroy both transistors.

To complete the converter, rectifiers and a low-pass filter are added to the secondary of T1 (Figure 6). Rectifiers D1 and D2 not only provide the rectification, but also act as "freewheeling diodes" during the time that both switching transistors are off.

The waveforms in Figure 7 represent the normal waveforms of a 50 percent duty cycle converter. Waveform 7a

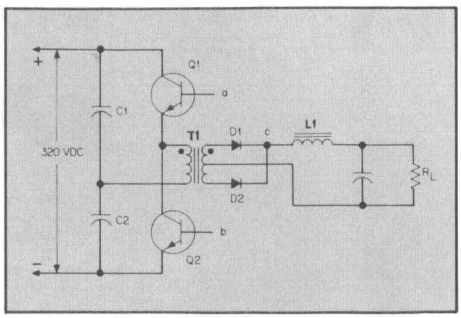


Figure 6. Half-bridge converter

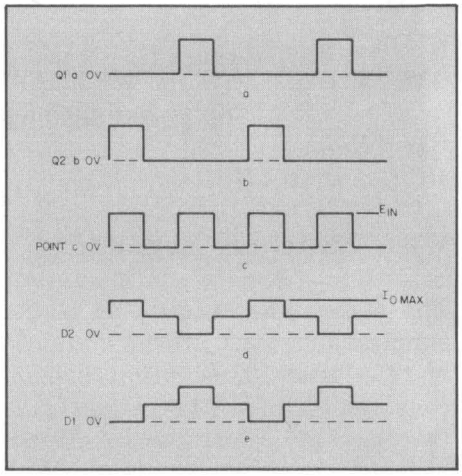


Figure 7. Half-bridge converter secondary waveforms

and 7b are the base drive voltage waveforms for transistors Q1 and Q2. When either transistor is on, both primary and secondary current will flow in T1.

Waveform 7c is the dc output voltage waveform of rectifiers D1 and D2. The waveform goes to some value (Ein) when either Q1 or Q2 is on, and returns to zero when both Q1 and Q2 are off. Ein would be 10 Vdc if the required output voltage was 5 Vdc. Remember that the dc or average value of this waveform is Eout, which equals Ein times the duty-cycle:

Eout = Ein * duty cycle.

Waveforms 7d and 7e represent the forward current of D2 and D1, respectively. Transformer T1 is polarized so that when Q1 is on, D1 is conducting and D2 is reversed biased. Conversely, when Q2 is on, D2 is conducting and D1 is reversed biased. When either transistor is on, its associated rectifier will conduct 100

percent of the required load current. When both transistors are off and no energy is being transferred from the primary, inductor L1 must supply the energy required by the load. During this period, both D1 and D2 act as freewheeling diodes and maintain the current flow in the inductor and through the load. When D1 and D2 are in the freewheeling mode, they are parallel to each other, so each will supply half of the required load current.

Some of the advantages of the half-bridge converter should now be obvious. The dc output voltage is isolated from the input power line and it can be a positive, negative, or floating output. The output voltage can be reduced to almost any potential desired by simply adjusting the turns ratio of the power transformer T1.

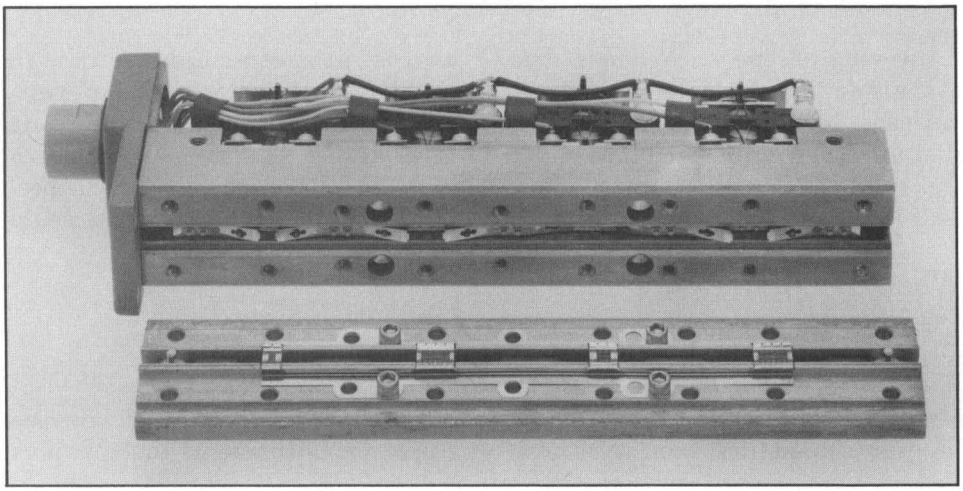
Our next article will discuss fly-back converters and pulse-width control circuits that control the drive and steering circuits of our switching regulators. □

Improvements in Programmable Step Attenuators Lead to Longer Life Ratings

John Minck,
HP Stanford Park Division

Who wouldn't like longer life, higher repeatability, and a better warranty? Especially if they involved programmable step attenuators that have mechanical moving parts? Now you get all three.

Research at Hewlett-Packard has led to significantly improved lifetime ratings and warranties for programmable step attenuators in the HP 8494/5/6/7 and HP 33320/1/2/3 families.



Effective immediately all newly-shipped HP programmable coaxial step attenuators belonging to those families will have a two-year warranty, double that of previous products. In addition, the minimum life rating of the units has been improved to five-million cycles-per-step, up from 500k cycles. HP defines a step cycle as an in-out-in cycle of each programmable pad step. And the attenuation repeatability specification has been improved to 0.01 dB (from 0.03), typical, after five-million cycles-per-section.

The new specifications are the result of an in-depth product-improvement program aimed at broadening our understanding of the physics of sliding contacts, of the wear of the solenoid and push rods, and the fatigue factor of the switching flippers.

The two attenuator families mentioned above consist of 14 models that cover three frequency ranges; dc to 4 GHz, dc to 18 GHz, and dc to 26.5 GHz, and four attenuation ranges; 11 dB in 1 dB steps, 70, 80, 90 and 110 dB in 10 dB steps. The attenuators are all programmable via the HP-IB interface bus (IEEE-488) using the HP 11713A attenuator/switch driver.

For more information, please contact your nearest HP sales office. □

HELI-COIL Repair Kits for Stripped Threads in Cabinet Frames

Horst Zittlau,
HP Manufacturing

Some HP Customer Service Centers have noted that when attempting to remove the top and bottom instrument covers, the top and bottom rear frame holes are being stripped.

The problem turns out to be that when the covers are on very tightly, there is more force required than the jacking screw is capable of overcoming in order to back the cover off. These resistances come from RFI bumps, trim strips and mechanical interferences. As the screw is backed out the threads in the frame may fail.

Temporary corrective action has been taken by inserting HELI-COILS into the top and bottom holes of all rear frames at the HP factory. HELI-COILS were chosen because:

- They have been found to be best suited in both size and strength in cases where a stronger thread was needed.
- We have used them successfully to replace damaged threads.
- They are used in military applications for threads put into aluminum parts.

For the repair of a 6-32 "inch" or a M3.5 × 0.6 "metric" threaded hole, order one of the following HELI-COIL insertion kits. These kits contain one HELI-COIL drill, one HELI-COIL tap, one insertion tool and 12 inserts.

Size	HP P/N	HELI-COIL P/N
6-32	0590-1034	5401-06
M3.5	0590-1430	5403-3.5

For more information, please contact your nearest Hewlett-Packard sales office. □

Service Tip

Should You Clean Solder Flux from High-Impedance Printed Circuit Boards?

A previous issue of *Bench Briefs* contained an article titled "A Refresher on Removing ICs." In effect, that article recommended that solder flux not be cleaned from a board after a hand solder repair operation.

What About High-Impedance PC Boards?

The topic of solder flux removal has always raised questions when it comes to high-impedance boards. These boards are commonly found in Hewlett-Packard's precision voltmeters, data acquisition units and multiplexers. There is a valid concern that the ultra-high impedance specifications of these instruments could be jeopardized by solder flux.

Hewlett-Packard's Recommendation

HP recommends that you follow the procedure outlined in the previous *Bench Briefs'* article and leave the flux on all PC boards including high-impedance boards, **providing you are using an RMA type solder** (e.g., RMA-P2). This type of solder has negligible conductance. Do **not** use RA, SA, or OA type solder on high-impedance boards.

For more information on printed circuit board rework and repair procedures, write to the address on the back page of *Bench Briefs* and request publication number 5952-0111. □

Safety-Related Service Notes

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

3061A/3062A Board Test Systems

These two HP Board Test Systems may have a potential safety hazard in which all power to the device under test (DUT) is **not** removed when a reset is executed.

The problem lies within the Board Test Language software (BTL-200) Revision F, Date Code 2527; it may not recognize a reset. Some of the symptoms that the system has not reset are: all power to the DUT is not removed or the vacuum is not turned off.

Product Safety Service Note 3061A/62A-15A-S provides more information and the notification that the defective software (Date Code 2527 only) will be replaced with new software, Date Code 2550.

All customers that were known to have received Date Code 2527 should automatically receive the new 2550. If you have any questions please contact your nearest HP office.

HP 3065HX and HL Board Test Systems

A safety problem exists in HP 3065HX systems with serials below 2543A00117, and HP 3065HL systems with serials below 2541A00111. The problem involves the -5 volt scanner power supply (HP P/N 0950-1787). This single-board power supply contains three heatsinks, at least one of which is at a potential of 150 volts with respect to earth ground.

Although this power supply is not immediately accessible from outside the system, it is possible for service personnel working inside the system to come in contact with it.

A protective shield (HP P/N 03065-04122) has been designed to fit over the power supply board. Please order Product Safety Service Note 3065-41-S for more information.

HP 37203A HP-IB Extender

Product Safety Service Note 37203A-9A-S covers special rules for installing coaxial and fiber optic cables in dropped ceilings and raised floors used as air ducts for a building's heating/cooling system.

For details, order this note using the order form on the back page of this issue of *Bench Briefs*. □

Hewlett-Packard Offers ATS/1000 Service Training

Two ATS/1000 customer service training classes will be available on July 31, 1986 and October 23, 1986 at the Hewlett-Packard Automated Manufacturing Systems Organization (AMSO) in Cupertino, CA.

The class provides the student detailed ATS/1000 operation and service knowledge coupled with extensive hands-on lab work. Certain aspects of the RTE-A and RTE-4 controlling software will be discussed.

Interested customers should contact their HP sales representative to register. The 7-day course is listed as HP 50036 and priced at $3,100. For futher information, please contact Danny Shewey, ATS/1000 product support manager, (408) 725-8111, or Wei Huang, customer service training, (415)960-5295. □

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 form at the rear of *Bench Briefs* to order, free of charge, service notes for several instruments.

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

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

Library—	5951-6511
Subscription service—	5951-6517

Contact your local HP Sales Office for ordering information. □

HP 346A/B NOISE SOURCE

346A-2. Serials 2336A and below. New center pin & capacitor assembly to improve reliability.

346B-6. Serials 2614A and below. New center pin & capacitor assembly to improve performance.

HP 1345A DIGITAL DISPLAY

1345A-6. All serials. Installing memory option 704 in a standard instrument.

HP 1349A/D DIGITAL DISPLAY

1349A/D-2. Serials 2437A00829 and below. Intensity cutoff circuit modification to improve adjustment range.

HP 1630A/D/G LOGIC ANALYZER

1630A/D/G-9. 1630A serials 2515A and below; 1630D serials 2514A and below; 1630G serials 2510A and below. Power supply change requires new cooling fan.

1630A/D/G-10. 1630A/D/G serials 25XXA and below. TRW board connectors may not seat properly.

1630A/D/G-11. 1630A serials 2511A and below; 1630D serials 2511A and below; 1630G serials 2415A and below. New policy for 1630A/D/G ROM replacement. Supercedes 1630G-5, 1630G-5A and 1630A/D-6.

HP 1631A/D LOGIC ANALYZER

1631A/D-9. 1631A serials 2540A and below; 1631D serials 2518A and below. Power supply change requires new cooling fan.

1631A/D-10. 1631A/D serials 25XXA and below. TRW board connectors may not seat properly.

1631A/D-11. 1631A serials 2525A and below; 1631D serials 2446A and below. New policy for 1631A/D ROM replacement. Supercedes 1631A/D-1, 1631A/D-1A, 1631AD/-2, 1631A/D-3 and 1631A-4.

HP 3060A/61A/62A AND 3065 BOARD TEST SYSTEMS

3060A-65. All serials. Directions for changing from one power/frequency option to another.

3061/2A-15A-S. All serials. Notification of potential safety hazard.

3061A/62A-16. All serials. Directions for changing from one power/frequency option to another.

3065-28. All serials. HP 3065 family board test system cable test procedure.

3065-33. Troubleshooting the "faceless" ASRU.

3065C/CL/CX/H/HL/HX-40. All serials. Directions for changing from one power/frequency option to another.

3065-41-S. 3065HX serials 2543A00117 and below; 3065HL serials 2541A00111 and below. Notification of potential safety hazard.

HP 3325A SYNTHESIZER/FUNCTION GENERATOR

3325A-19B-S. Serials 2512A19654 and below. Burned power supplies linked to improper primary fuse.

HP 3335A SYNTHESIZER/LEVEL GENERATOR

3335A-11. Serials 1640A03247 and below. Modification to improve noise performance of Option 001 ovens.

HP 3336A/B/C LEVEL GENERATOR

3336A/B/C-16B-S. 3336A serials 2513A01253 and below; 3336B serials 2514A02483 and below; 3336C serials 2515A01057 and below. Burned power supplies linked to improper primary fuse.

HP 3421A DATA ACQUISITION AND CONTROL UNIT

3421A-14. Serials 2338A06935 and below. Improved transient voltage protection circuitry.

HP 3456A DIGITAL VOLTMETER

3456A-12A. Serials 2015A. Differences between instruments with fans and without fans.

3456A-21. Serials 2201A to 2512A17090. Recommended replacement fuses.

HP 3457A DIGITAL MULTIMETER

3457A-4. Updated calibration software HP P/N 03457-10200. Revision changes from 1.1 to 1.2

HP 3466A DIGITAL MULTIMETER

3466A-16. All serials. Identifying input resistance related problems.

HP 3468A/B DIGITAL MULTIMETER

3468A/B-4. All serials. 3468A/B verification program description.

HP 3478A DIGITAL MULTIMETER

3478A-6. All serials. 3478A verification program description.

HP 3488A SWITCH/CONTROL UNIT

3488A-0A. 3488A ERC change record.

3488A-4A. Applies to 44470A relay multiplexer module—ERC 2338; 44471A general purpose relay module—ERC 2338; 44473A matrix switch module—ERC 2338. Recommended resistor replacement to decrease the power dissipated in the driver transistors.

3488A-6. Serials 2240A05760 and below. Replacement of the program ROM (U401)—ERC 2341.

3488A-7. Applies to 44474A digital I/O module—ERC 2605 and below. Modification to ensure a known turn-on condition.

3488A-8. Recommended replacements for connectors.

HP 3562A DYNAMIC SIGNAL ANALYZER

3562A-1. Serials 2501A00812 and below. Installation of keying plug in W13 connector.

3562A-2. Serials 2502A00759 and below. Modification to prevent noise and distortion self-tests from failing.

HP 3575A GAIN-PHASE METER

3575A-7. Serials 1450A05237 and below. Recommended replacement BCD interface boards for Option 002 and 003.

HP 3585A SPECTRUM ANALYZER

3585A-10. Serials 2050A04740 and below. Intermittent calibration errors may be due to lack of fiber washer.

3585A-11. Serials 2504A0440 and below (approximate). Overvoltage protection circuit modification to prevent inadvertent line fuse blows.

HP 3586A/B/C SELECTIVE LEVEL METER

3586A/B/C-12. 3586A Serials 2509A01337 and below; 3586B Serials 2510A03958 and below; 3586C Serials 2511A01723 and below. Timing problem causes HP-IB failures.

HP 3708A NOISE AND INTERFERENCE TEST SET

3708A-4A. All serials. New adjustment check procedure on the noise bandwidth soft constants and Appendix B.

3708A-6. All serials. Operation verification test 4-17 tolerance change.

3708A-7. Serials 2414U00290 and below. Preferred replacement for A306C20 capacitor.

3708A-8. Serials 2515U00330 and below. Preferred replacement for A201U9 EEPROM and associated +21V power supply modification.

HP 3710A IF/BB TRANSMITTER

3710A-21A. Serials 1438U01012 and below. Preferred replacement for A5CR1.

HP 3711A IF/BB RECEIVER

3711A-0. Service note index.

HP 3712A IF/BB RECEIVER

3712A-0. Service note index.

HP 3717A 70MHz MODULATOR/DEMODULATOR

3717A-0. Service note index.

HP 3724A BASEBAND ANALYZER

3724A-0. Service note index.

3724A-5A. Serials 2251U0017-2327U00195. Noise measurements in dBrnCO units.

HP 3730B DOWN CONVERTER

3730B-0. Service note index.

HP 3736B RF MODULE FOR 3730B DOWN CONVERTER

3736B-0. Service note index.

HP 3737B RF MODULE FOR 3730B DOWN CONVERTER

3737B-0. Service note index.

HP 3738B RF MODULE

3738B-0. Service note index.

HP 3739B RF MODULE FOR 3730B DOWN CONVERTER

3739B-0. Service note index.

HP 3743A IF AMPLIFIER

3743A-0. Service note index.

HP 3746A SLMS

3746A-0. Service note index.

3746A-10A. All Option 013 instruments. Preferred replacement for A41E1.

3746A-17. Serials 2508U00797 and below. Prevention of power interrupt problems associated with HP-85B controllers.

3746A-18. All serials. Preferred replacement for A5Q1.

3746A-19. All serials. Preferred replacement for A31CR4, A31CR5, A31CR6, A40CR91 and A54CR2.

3746A-20. All serials. Preferred replacement for A68U26.

HP 3747A/B SELECTIVE LEVEL MEASURING SET

3747A/B-0. Service note index.

HP 3757A ACCESS SWITCH

3757A-0. Service note index.

HP 3762A DATA GENERATOR

3762A-0. Service note index.

HP 3763A ERROR DETECTOR

3763A-0. Service note index.

HP 3764A DIGITAL TRANSMISSION ANALYZER

3764A-4A. Serials 2418U00244 and below. Modification to prevent incorrect AIS and SYNC loss messages to the 3764A printer/cassette.

3764A-9A. Serials 2419U00686 and below. Firmware revisions.

3764A-16. Serials 2615U and below. (For all options except Option 010.) Retrofit kit to upgrade the features (including CCITT recommendation G.821) on 3764A.

3764A-17. Serials 2615U and below. Retrofit kit to upgrade the features (including CCITT recommendation G.821) on 3764A Option 010.

3764A-18. Serials 2528U00857 (STD/002/003), 2528U01097 (Option 001) and below. New high stability clock oscillator assemblies now available.

HP 3776A/B PCM TERMINAL TEST SET

3776A-13C. All serials. Retrofitting instructions for data measurements Option 001.

3776A-18C. Serials 2444U00292 and below. Frequency update instructions for data measurement Option 001.

3776A-22C. Serials 2444U00292 and below. Firmware revision to change generated idle code.

3776A-23B. All serials. 3776 test programs data cartridge (HP P/N 03776-10001) modifications—update to Revision E.

3776A-24A. All serials. Inappropriate selection of "through PCM" causing errors 31/32 to be displayed while running a measurement.

3776A-26. Serials 2613U00457 and below. Preferred replacement of either A13 (processor card) or A14 (memory card).

3776A-27. All serials. Preferred replacement of analog switch HP P/N 1826-0417.

3776A-28. All serials. Preferred replacement of capacitor HP P/N 0160-4371.

3776B-13C. All serials. Retrofitting instructions for data measurements Option 001.

3776B-18C. Serials 2437U00642 and below. Frequency update instructions for data measurement Option 001.

3776B-24C. All serials. 3776 test programs data cartridge (HP P/N 03776-10001) modifications—update to Revision E.

3776B-28. Serials 2614U01152 and below (including Option 002). Preferred replacement of either A113 (processor card) or A114/A214 (memory card).

3776B-29. All serials. Preferred replacement of analog switch HP P/N 1826-0417.

3776B-30. Serials 2437U00642 and below. Firmware update to correct echo return loss measurement.

3776B-31. All serials. Preferred replacement of capacitor HP P/N 0160-4371.

HP 3779B/C/D PRIMARY MULTIPLEX ANALYZER

3779B-61. Serials between 2040U00316 and 2102U00346. Modification to correct performance test 4-47 (A-A noise with tone + QD with tone).

3779C-29. Serials between 00500 and 00558. Modification to correct intermittent analog selftest fail codes S50 to S56.

3779D-34. Serials between 00500 and 00575. Modification to correct intermittent analog selftest fail codes S50 to S56.

HP 3780A PATTERN GENERATOR/ERROR DETECTOR

3780A-27B. All serials. Retrofit of Option 101.

HP 3782B ERROR DETECTOR

3782B-10A. Serials 2512U and below. Preferred replacement of fan.

HP 4062B SEMICONDUCTOR PARAMETRIC TEST SYSTEM

4062B-2. 4062B Serials 2519J00154 and below; 4141B Serials 2519J00172 and below. Recommended replacement ROMs to correct failure of the SMU Test (Self Test failure) of the DIAG (diagnostics) or Performance Verification program after a Set_bsearch or Set_lsearch (TIS command) is executed.

HP 4191A RF IMPEDANCE ANALYZER

4191A-24. Serials 2515J01507 through 2515J01658. Defective counter IC replacement.

HP 4193A VECTOR IMPEDANCE METER

4193A-3. Serials 2516J00984 through 2516J01102. Defective counter IC replacement.

HP 4274A MULTI-FREQUENCY LCR METER

4274A-27. Serials 2434J02944 through 2515J03098. Defective counter IC replacement.

HP 4276A LCZ METER

4276A-3. Serials 2227J01642 through 2517J01822. Defective counter IC replacement.

HP 4277A LCZ METER

4277A-7. Serials 2228J01252 through 2515J01412. Defective counter IC replacement.

HP 4937A TRANSMISSION IMPAIRMENT MEASURING SET

4937A-1A. Serials 2418 and below. Modification to improve hold circuit operation.
4937A-2B. Serials 2523A and below. Loop start and noise to ground modification.
4937A-3A. Improved carrying handle.
4937A-4A. Serials 2545A and below. Revision 3.0 software.

HP 4951A PROTOCOL ANALYZER

4951A-18. All serials. Modification to increase servo motor speed.
4951A-19. All serials. Improved READ/WRITE multiplexer.
4951A-20. All serials. Rerouting ground cable eliminates CRT jitter.

HP 4953A PROTOCOL ANALYZER

4953A-6C. Serials prior to 2522A00626. Preferred EPROM replacements.

HP 4955A PROTOCOL ANALYZER

4955A-1C. Serials 2319A and below. Firmware upgrade.

HP 5340A FREQUENCY COUNTER

5340A-17B. All serials. Modification to A1 preamp assembly to improve performance.
5340A-18B. All serials. Modification to A2 preamp assembly to improve performance.

HP 5342A MICROWAVE FREQUENCY COUNTER

5342A-28B. All serials. Installation of Option 004 DAC retrofit kit HP P/N 05432-60202.
5342A-35B. All serials. Front panel replacement kit HP P/N 05342-60205.

HP 5508A MEASUREMENT DISPLAY

5508A-1. Serials 2516A01355 and below. Preferred air filter replacement.

HP 6010A DC POWER SUPPLY

6010A-1. All serials. W7 ribbon cable assembly replacement.

HP 6011A SYSTEM POWER SUPPLY

6011A-2. All serials. A2 control board interchangeability.
6011A-3. All serials. W7 ribbon cable assembly replacement.

HP 6012B SYSTEM POWER SUPPLY

6012B-1. All serials. A2 control board interchangeability.
6012B-2. All serials. W7 ribbon cable assembly replacement.

HP 6030A SYSTEM DC POWER SUPPLY

6030A-2. All serials. W7 ribbon cable assembly replacement.

HP 6031A AND 6031A OPTION 100 SYSTEM POWER SUPPLIES

6031A-4. All serials. A2 control board interchangeability.
6031A-5. All serials. W7 ribbon cable assembly replacement.

HP 6032A AND 6032A OPTION 100 SYSTEM POWER SUPPLIES

6032A-3. All serials. A2 control board interchangeability.
6032A-4. All serials. W7 ribbon cable assembly replacement.

HP 6942A MULTIPROGRAMMER

6942A-13. All serials. Recommended HP-IB PHI chip replacement.
6942A-14/6943A-6. Serials 2344A and below. Fan speed control board removal.

HP 6943A MULTIPROGRAMMER EXTENDER

6942A-14/6943A-6 Serials 2347A and below. Fan speed control board removal.

HP 8481A POWER SENSOR

8481A-3. All serials. Cartridge replacement instructions.

HP 8484A POWER SENSOR

8484A-1. Serials 2349A and below. Modification to reduce noise.

HP 8656A/B SIGNAL GENERATOR

8656A-22. All serials. New external covers improve RF shielding.
8656B-1. Serials 2451A and below. New external covers improve RF shielding.
8656B-2. Serials 2451A and below. Modification to improve output stability.
8656B-3. Serials 2511A and below. Modification to improve high frequency loop locking.
8656B-4. Serials 2509A and below. Modification to reduce FM distortion.

HP 8662A SYNTHESIZED SIGNAL GENERATOR

8662A-10A. Serials 2424A and below. Modification to add insulators to power supply.
8662A-12B. Serials 2424A and below. Modification to improve low frequency loop performance and eliminate intermittent status errors 03/04.
8662A-14. Serials 2545A and below. Modification to eliminate intermittent error 11.

HP 8663A SYNTHESIZED SIGNAL GENERATOR

8663A-5A. Serials 2419A and below. Modification to add insulators to power supply.
8663A-6B. Serials 2419A and below. Modification to improve low frequency loop performance and eliminate intermittent status errors 03/04.
8663A-8. Serials 2552A and below. Modification to eliminate intermittent error 11.

HP 8770A ARBITRARY WAVEFORM SYNTHESIZER

8770A-1. Serials 2601A00101 to 2601A00114. A18 English to metric conversion.

HP 8673C SYNTHESIZED SIGNAL GENERATOR

8673C-4. Serials 2332A00105, 2332A00106, 2332A00107, 2332A00109, 2332A00110, 2332A00111, 2332A00115, 2410A00108, 2410A00112, 2410A00113, 2410A00114, 2410A00116, 2410A00117, 2410A00118, 2410A00120, 2413A00127, 2413A00128. Incorrect fuse information.

HP 8673D SYNTHESIZED SIGNAL GENERATOR

8673D-4. Serials 2332A00103, 2410A00104 to 2410A00106. Incorrect fuse information.

HP 10306B/C 80186 INTERFACE MODULE

10306B/C-3. All serials. Modification to reduce excessive noise on the user cable.

HP 10342B/C BUS PREPROCESSOR

10342B/C-2. Serials 2534A only. Sheet metal modification.

HP 11729C CARRIER NOISE TEST SET

11729C-1. Serials 2524A and below. Improved reliability of HP-IB unlock indication.

HP 15425A TESTHEAD

15425A-1. Serials 2606G00221 and above. Instructions for adaption to HP 4141B DC Source/Monitor.

HP 37203A HP-IB EXTENDER

37203A-9A-S. All serials. Elimination of potential safety hazard.

HP 54100A/D DIGITIZING OSCILLOSCOPE

54100A/D-2. All serials. Preventing dust accumulation on the CRT screen.
54100A/D-3. All serials. The 11536A probing tee causes excessive ringing in the 54001A probe calibration procedures. Return tee for credit.
54100A/D-4. All serials. 54001A and 54003A probes may cause sampler, trigger, trigger qualifier board failure.
54100A/D-5. Serials 2547A and below. Firmware revision which adds the 54110D firmware features to the 54100A/D.

HP 54110D DIGITIZING OSCILLOSCOPES

54110D-1. All serials. The 11536A probing tee causes excessive ringing in the 54001A probe calibration procedures. Return tee for credit.
54110A/D-2. Serials 2613A and below. Firmware revision fixes problems.
54110A/D-3. All serials. 54001A and 54003A probes may cause sampler, trigger, trigger qualifier board failure.

HP 54200A/D DIGITIZING OSCILLOSCOPE

54200A/D-3. 54200A serials 2511A and below; 54200D serials 2513A and below. Trace on power supply board too close to rear panel.
54200A/D-4. All serials. "Keydown power up reset" clears display problems.
54200A/D-5. 54200A serials 2617A and below; 54200D serials 2618A and below. Firmware update to improve performance.

HP 54201A/D DIGITIZING OSCILLOSCOPE

54201A/D-1. 54201A serials 2602A00206 and below; 54201D serials 2602A00173 and below. ROM revision increases production yields.

HP 64220B 8086/8087 EMULATOR POD

64220B-1. Pod repair number 2521A00227 and below. Modifications to prevent improper arbitration of HOLD/HLDA and REQUEST/GRANT signals.

HP 64220C 80C86 EMULATOR POD

64220C-1. Pod repair number 2521A00127 and below. Modifications to prevent improper arbitration of HOLD/HLDA and REQUEST/GRANT signals.

HP 64221B 8088/8087 EMULATOR POD

64221B-1. Pod repair number 2521A00144 and below. Modifications to prevent improper arbitration of HOLD/HLDA and REQUEST/GRANT signals.

HP 64221C 80C88 EMULATOR POD

64221C-1. Pod repair number 2521A00119 and below. Modifications to prevent improper arbitration of HOLD/HLDA and REQUEST/GRANT signals.

HP 64243AA/AB 68000 EMULATOR POD

64243AA-1. Emulation pod repair number 2526A00455 and below. Modification to prevent address bus malfunction following a DMA handshake.
64243AB-1. Emulation pod repair number 2526A00165 and below. Modification to prevent address bus malfunction following a DMA handshake.

HP 64244AA 68008 EMULATOR POD

64244AA-1. Emulation pod repair number 2526A00165 and below. Modification to prevent address bus malfunction following a DMA handshake.

HP 64245AA/AB 68010 EMULATOR POD

64245AA-1. Emulation pod repair number 2526A00178 and below. Modification to prevent address bus malfunction following a DMA handshake.
64245AB-1. Emulation pod repair number 2526A00139 and below. Modification to prevent address bus malfunction following a DMA handshake.

HP 64253A Z80 EMULATOR SUBSYSTEM

64253A-2. Z80 Emulator pod—all serials. Explanation of peripheral interrupt problems during execution of RETI instructions.

HP 70001A MAINFRAME

70001A-1A. All serials. HP 70001A mainframe to System II cabinet interlock kit (HP P/N 5061-9061).

Service Note Order Form

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

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- ☐ 1631A/D-11
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- ☐ 3456A-21
- ☐ 3457A-4
- ☐ 3466A-16
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- ☐ 3478A-6
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- ☐ 3488A-4A
- ☐ 3488A-6
- ☐ 3488A-7
- ☐ 3488A-8
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- ☐ 3562A-2
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- ☐ 3585A-10
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