HEWLETT PACKARD

BENCH BRIEFS

SERVICE INFORMATION FROM HEWLETT-PACKARD

JANUARY-FEBRUARY 1980

How Accurate Is Your ac Measurement?

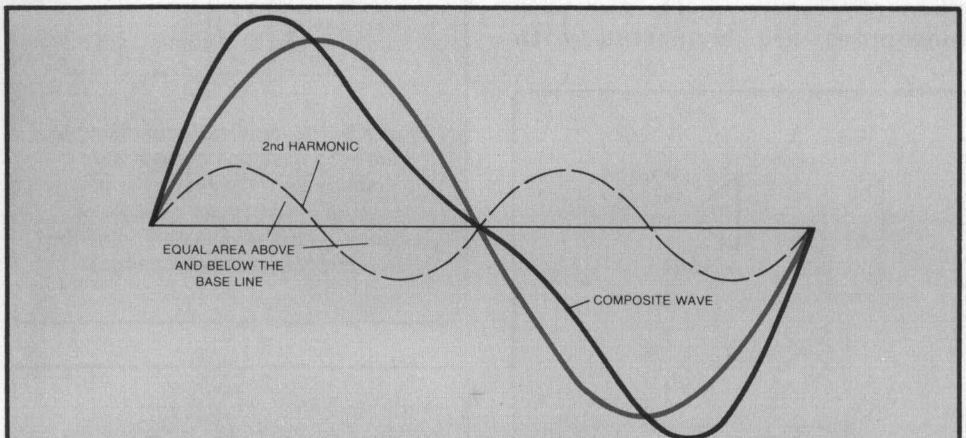

Figure 1. Second harmonic distortion adds no area to the composite waveform. For this reason, small amounts of in-phase second harmonic distortion have little effect on the accuracy of an average responding ac converter.

by Ken Jessen,
HP Loveland Division

Making ac measurements? Just hook up an ac meter and read the voltage. Right? Maybe. The vast majority of ac meters on the market today are average responding and calibrated to read the rms value of a sine wave. This type of meter works fine for many applications, but will produce large errors for distorted sine waves, square waves, pulses, or signals superimposed on noise.

Average responding ac meters are popular because they are easy to build. The internal circuitry consists of a diode bridge producing rectified output that is simply filtered into dc to drive the meter (very much like a common power supply). The meter may say "RMS VOLTS" on its face, but it actually measures average value and adds an 11% calibration factor to obtain the rms value. The 11% calibration factor is only accurate for pure sine waves. Suppose you take an average responding ac meter and use it to measure a signal composed of numerous frequencies mixed together — something other than a pure sine wave. An average responding meter will produce large errors for these complex signals. Only a pure sine wave devoid of harmonics will be read accurately. Even very small amounts of distortion, not visible on an oscilloscope, cause errors.

The accuracy of an average responding ac meter depends on many things such as the type of distortion and even its phase shift relative to the fundamental. Let's say that the fundamental is mixed with some second harmonic (Figure 1). During a half cycle, there is as much area above the base line as below for the second harmonic. For small amounts of second harmonic distortion, or any other even harmonic for that matter, little error is produced in an average responding ac meter.

For a third harmonic signal, an extra half cycle is either added (Figure 2a) or subtracted (Figure 2b) depending on phase. Readings taken with an average responding ac meter become unpredictable for odd harmonics. In this example, as the phase of the third harmonic is changed, an average responding ac meter will undergo fluctuations above and below the true rms value

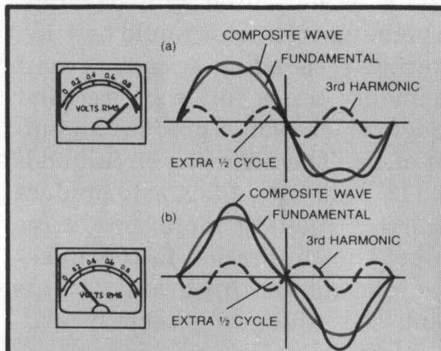

Figure 2. In-phase third harmonics (a) add an extra half-cycle to the composite waveform and cause a higher than rms reading on an average responding ac converter. Out-of-phase third harmonics (b) result in a lower than rms reading.

(Figure 3). Odd harmonics are the biggest source of errors; errors produced by even harmonics are not as severe. The point is that the type, phase, and amount of distortion are usually not known.

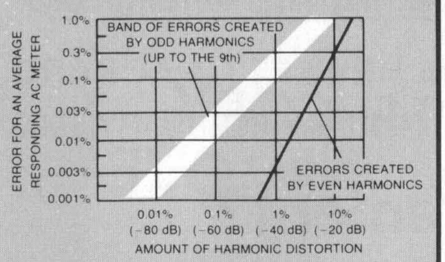

Figure 3. Error produced when an average responding ac meter is used to read the fundamental.

Trying to measure a square wave with an average responding ac meter is next to hopeless. For example, the square wave in Figure 4 has a peak-to-peak amplitude of 2V. The heating or rms value is 1V. This voltage as measured by an average responding voltmeter would be 1.1V. Average responding ac meters most commonly use a full wave rectifier bridge which would produce an output of 1V. The metering circuit adds an 11% calibration factor to produce a correct reading for a sine wave input. The calibration factor makes the reading too high and at this point, everything may seem bleak.

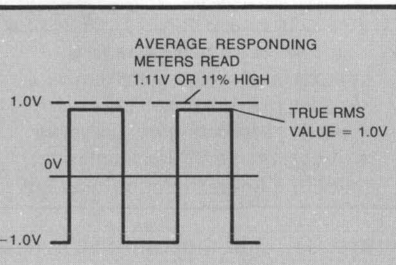

Figure 4. Average responding ac meters will read 11% higher than the true rms value of a symmetrical square wave.

Don't Give Up

If you are trying to measure the true rms value of something other than a sine wave, you need a true rms ac meter. The simplest type puts the ac signal into a fine heater wire. A thermocouple in close proximity to the wire measures the temperature rise in the wire. Obviously, a wire is insensitive to the ac signal's geometry.

One limitation to this technique is that ambient temperature adds to the heat produced by the ac signal. To overcome this, a second, carefully matched thermocouple is placed in series with the measuring thermocouple (Figure 5). The two thermocouples are connected with

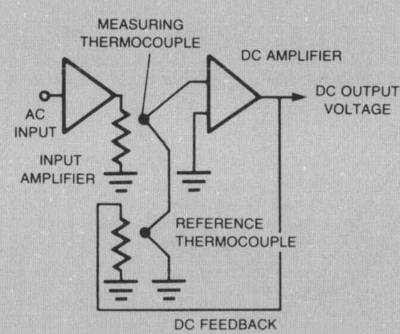

Figure 5. A thermal true rms converter uses dual matched thermocouples operated in opposition to cancel the effects of ambient temperature and to produce a linear output.

polarities opposing to offset changes in ambient temperature and also to remove any nonlinearities. Unfortunately, the fine heater wire is difficult to protect from overvoltage. Protection circuitry combined with the cost of the matched thermocouples makes this type of true rms responding ac meter expensive. However, you get what you pay for because the true rms ac meter can accurately measure a wide variety of wave shapes and pulses.

For a pulse originating at the zero base line (Figure 6), the dc component will be ignored when measured by most true rms meters because they are capacitively coupled. There are a few true rms responding meters, however, that do have a dc-coupled mode and are able to measure "ac + dc."

Average responding ac meters are inexpensive and are fine for measuring sine waves where high accuracy is not required. But for non-sinusoids, only a true rms responding ac meter will do.

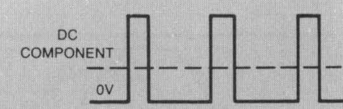

Figure 6. These pulses originating at the zero base line contain a dc component. Only a true rms responding ac meter capable of measuring ac + dc can determine the true rms value of such a signal.

Editor's Note

In the last issue of Bench Briefs the Capacitor article had two typesetting errors that affected readability and sense. On page 5, the formula under step c should read $f = \frac{1}{2\pi\sqrt{LC}}$. *And on page 5, the last line in the middle column should be moved to the space between the bottom of Figure 9 and the text that has "allowed" as the first word. The sentence would read – "If the amplified signal current was also allowed to flow in R1, the dc bias. . ."*

We also received a letter from Square D Company concerning my example 1.0 farad capacitor.

Dear Sir:

The one farad capacitor exercise appearing in the September-October, 1979 issue of the "Bench Briefs" is grossly distorted by the use of an air dielectric and super-wide plate spacing. Using that same criteria, even a one pf. capacitor would have plates of over three square feet each.

In reality, one farad capacitors are available (with low working voltages) in sizes approximating that of a Coors beer can.

Yours truly,

William Keys
Supervisor,
Electronics and Controls

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HEWLETT PACKARD

CUSTOMER SERVICE SEMINAR TRAINING CALENDAR FOR 1980

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Logic Analyzers				
Logic State Analyzer Maintenance Models 1600A/1607	March 10 - 12	Colorado Springs Division 1900 Garden of the Gods Road Colorado Springs, CO 80907 (303) 598-1900	$300/student	Jerry Lopez
Model 1610A/B	April 21 - 23 October 22 - 24	Colorado Springs Division	$300/student	Jerry Lopez
Model 1611A	March 12 - 14 October 13 - 15	Colorado Springs Division	$300/student	Jerry Lopez
Model 1615A	April 16 - 18 October 15 - 17	Colorado Springs Division	$300/student	Jerry Lopez
Model 1640A	April 14 - 16 October 20 - 22	Colorado Springs Division	$300/student	Jerry Lopez
Microcomputer Development System Model 64000 (excludes Disc & 2608 Printer)	February 25 - March 7 June 16 - 27 November 10 -21	Colorado Springs Division	$1,250/student	Jerry Lopez
Scopes and Displays				
Models 1338A/1350A (order HP no. 5955-5034)	March 20 - 21 October 9 - 10	Colorado Springs Division	$250/student	Dick Browne
Models 1715A/1725A (order HP no. 5955-4146)	March 17 - 19 October 6 - 9	Colorado Springs Division	$300/student	Dick Browne
Models 1740A/1741A/ 1742/1744A (order HP no. 5955-4147)	March 10 - 13 September 29 - October 2	Colorado Springs Division	$350/student	Dick Browne
Automatic Test				
Circuit Test Systems Model 3060A	March 3 - 14 May 5 - 16 August 18 - 29 October 20 - 31	Loveland Instrument Division 815 Fourteenth Street, SW Loveland, CO 80537 (303) 667-5000	$2,000/student	Sandy Selleck
Model DTS-70	February 25 - 29 May 19 - 23 November 17 - 21	Loveland Instrument Division	$1,000/student	Sandy Selleck
Technology Training				
Digital Troubleshooting Techniques	March 18 - 21 May 6 - 9	Customer Service Center 333 Logue Avenue Mountain View, CA 94043 (415) 968-9200	$350/student	Claudia Hopkins
Microprocessor Troubleshooting Techniques	March 24 - 27 May 12 - 15	Customer Service Center	$350/student	Claudia Hopkins
DSA/Laser				
Fourier Systems & Maintenance Models 5451C/5427A	February 11 - 15 October 6 - 10	Santa Clara Division 5301 Stevens Creek Boulevard Santa Clara, CA 95050 (408) 246-4300	$700/student	Ted Tazeau
Models 5420A/5423A	September 22 - 25	Santa Clara Division	$600/student	Richard Buchanan
Microwave Instruments				
8640 AM/FM Signal Generator 8660 Synthesizers 435/6 Power Meter or 8672A Synthesize Signal Generator	August 25 - 29	Stanford Park Division 1501 Page Mill Road Palo Alto, CA 94304 (415) 856-2980 (415) 857-2980 (after February 1, 1980)	$400/student	Steve Thomas
Signal Analysis				
Spectrum Analyzers Models 8555A/8553B/ 8552B	August 6 - 8	Santa Rosa Division 1400 Fountain Grove Parkway Santa Rosa, CA 95404 (707) 525-1400	$300/student	Jim Boyer
Models 8566A Microwave/ 8568A Programmable	September 15 - 19	Santa Rosa Division	$400/student	Jim Boyer
Model 8559A (inc. 182T mainframe)	August 4 - 5	Santa Rosa Division	$250/student	Jim Boyer

supplement to

BENCH BRIEFS SERVICE NOTE INDEX

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495A MICROWAVE AMPLIFIER
495A-8B. Serials 826-01311 through 1717A02352. Modification to eliminate arcing in high voltage circuits.

562A DIGITAL RECORDER
562A-2-S. All serials. Modification to eliminate shock hazard inside front panel door.

745A AC CALIBRATOR
745A-17B-S. Serials 00741-00101 through 1319A01670 and 745A-H18's 1319A01671 and above. Modification to eliminate safety hazard at Counter Output B and C.
745A-19. All serials. New troubleshooting and calibration procedure.

905A COAXIAL SLIDING LOAD
905A-1. All serials. Procedure to lubricate coaxial sliding load body.

907A COAXIAL SLIDING LOAD
907A-1. All serials. Procedure to lubricate coaxial sliding load body.

911A AND 911C COAXIAL SLIDING LOAD
911A-1/911C-1. All serials. Procedure to lubricate coaxial sliding load body.

1332A X-Y DISPLAY
1332A-10. Serials 1616A6800 and below. Recommended parts replacement for capacitors A2C16, C17, C33, and C34.
1332A-11. Serials 1616A6300 and below. Modification to improve +158V power supply stability.

1333A X-Y DISPLAY
1333A-4. Serials 1913A2400 and below. Recommended parts replacement for capacitors A2C16, C17, C33, and C34.
1333A-5. Serials 1533A2300 and below. Modification to improve +158V power supply stability.

1335A X-Y DISPLAY
1335A-8. Serials 1514A6300 and below. Recommended parts replacement for capacitors A2C16, C17, C33, and C34.
1335A-9. Serials 1514A6000 and below. Modification to improve +158V power supply stability.

1336P X-Y DISPLAY
1336P-1. Serials 1809A00650 and below. Modification to improve +250V power supply reliability.

1350A GRAPHICS TRANSLATOR
1350A-4. Serials 1750A00333 through 1906A00610. Modification to correct intermittent loss of memory.

1820A TIME BASE
1820A-8. All serials. Preferred replacement for transistors Q107.

1821A TIME BASE
1821A-10. All serials. Preferred replacement for transistors Q107 and Q305.

1821F TIME BASE
1821F-1. All serials. Preferred replacement for transistors Q107 and Q305.

2804A QUARTZ THERMOMETER
2804A-1. Serials 1744A00277 and below. Modification to correct EOI and line with HP-IB.

3312A FUNCTION GENERATOR
3312A-2. Serials 1432A03456 to 1432A04515. Modification to improve distortion at low end of frequency dial.

3325A SYNTHESIZER/ FUNCTION GENERATOR
3325A-1A. Serials 1748A01200 and below. Modification to the over-voltage protection circuit of the A2 power supply.
3325A-3. Serials 1748A01300 and below. Modification to improve status byte operation.
3325A-4. Serials 1748A01075 and below. Output fuse change.

3438A DIGITAL MULTIMETER
3438A-4. All serials. Correction of U726 signatures.

3455A DIGITAL VOLTMETER
3455A-12C. Serials 1622A04830 and below. Modification to improve ohms converter response time.
3455A-14. All serials. Modifications to improve A/D converter performance.

3467A LOGGING MULTIMETER
3467A-1. Serials 1821A00320 and below. Modification to protect A9U1 and A9U2 from damage when analog shield is removed.

3469B DIGITAL MULTIMETER
3469B-7. Serials 1233A01150 and below. Procedure to replace panel meter.

3710A IF/BB TRANSMITTER
3710A-21. Serials below 1438U-01012. Preferred replacement of diode A5CR1.

3745A/B SELECTIVE LEVEL MEASURING SET
3745A/B-14A. Serials between 1609U and 1720U; and all instruments which have been modified according to service note 3745A/B-4D. Modification to improve HP-IB cable configuration in remote systems.
3745A/B-18B. Serials 1812U and below. Retrofit kit for special option H07.
3745A/B-20B. Serials 1812U and below. Retrofit kits for special options H15 and H16.

3770A AMPLITUDE/DELAY DISTORTION ANALYZER
3770A-38. Serials below 1905U-00503. Preferred replacement for power supply module.

3770B TELEPHONE LINE ANALYZER
3770B-14A. Serials below 1728U-00246. Modification to prevent oscillations on assembly A31.

3771A/B DATA LINE ANALYZER
3771A/B-4. Serials below 1926U. Modification to improve gain hits, dropouts and input balance.
3771A/B-5. Serials below 1851U-00123 (3771A) and 1851U-00120 (3771B). New carrying handle.

3779A PRIMARY MULTIPLEX ANALYZER
3779A-5. Serials 1909U-00140 and below. Modification to improve high accuracy gain measurement.
3779A-6. Serials 1909U-00145 and below. Modification to improve gain adjustment for the 12Hz and 40Hz selective filters.
3779A-7. Serials 1909U-00145 and below. Modification to improve performance during basic analog self-test.
3779A-8. Serials 1915U-00150 and below. Modification to improve performance during quantizing distortion D-A measurement.
3779A-9. Serials 1915U-00150 and below. Modification to improve performance.

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3779B-5. Serials 1909U-00145 and below. Modification to improve high accuracy gain measurement.
3779B-6. Serials 1909U-00145 and below. Modification to improve gain adjustment for the 12Hz and 40Hz selective filters.
3779B-7. Serials 1909U-00145 and below. Modification to improve performance during basic analog self-test.
3779B-8. Serials 1915U-00155 and below. Modification to improve performance during quantizing distortion D-A measurement.
3779B-9. Serials 1915U-00155 and below. Modification to improve performance.

3780A PATTERN GENERATOR/ERROR DETECTOR
3780A-9A-S. Serials between 1610U-00161 and 1620U-00230 inclusive. Modification to prevent short circuit in line input wiring.
3780A-14A. Serials 1620U-00211 and above. Modification to eliminate incorrect detection of systematic errors.
3780A-17. All serials. Retrofit kit instructions for option 100.

4940A TRANSMISSION IMPAIRMENT MEASUREMENT SET
4940A-15. Modification to improve low frequency phase jitter measurement.

5045A DIGITAL I.C. TESTER
5045A-17. Procedure to verify automatic IC handler signals.
5045A-18A. Serials 1852A00368 and below except 1852A-00210, 00301, 00326, and 00347. Modification to provide static protection.
5045A-19. Cable modification for Trigon T2000 automatic handlers.

5062C CESIUM TIME STANDARD
5062C-2A. Serials 1640 and below. Procedure to install reliability improvement kit.

5301A 10MHz COUNTER
5301A-U-1. Serials 1902U-01151 to 1902U-01180. Modification to improve addressable mode.

5314A UNIVERSAL COUNTER
5314A-2. Serials 1828 and below. New A2 power supply assembly.

5328A UNIVERSAL COUNTER
5328A-19B. Serials 1816 and below. Modification to improve trigger level settings.
5328A-22A. Series 1624 and 1632. Signature analysis troubleshooting procedure for option 011.

5328AF/096, 5328A/F098, 5328A/H42, C96-5328A MHz UNIVERSAL FREQUENCY COUNTERS
5328A-24. All serials. Revision of the A12 amplifier assembly sensitivity-offset adjustment procedure.

5340A FREQUENCY COUNTER
5340A-12. All serials. A1 and A2 preamplifier troubleshooting information.

5341 FREQUENCY COUNTER
5341-5. All serials. Preferred replacement part for assembly A4.

5342A MICROWAVE FREQUENCY COUNTER
5342A-13. All serials. Modification to eliminate talk only problem.

5345A ELECTRONIC COUNTERS
5345A-14. All serials. Elimination of shorting between circuit boards and board sockets.
5345A-15. Serials 1920A and below. Modification to improve mechanical interconnection with plug-ins.
5345A-16. A13 boards with series 1820 and 1912. Modification to prevent miscounting on REG CLK line.

5363A/B TIME INTERVAL PROBE
5363A-4/5363B-3. All serials. Preferred replacement part for diode assembly CR1.
5363B-1. Serials 1832A and below. Modification to prevent trigger output oscillations.
5363B-2. Serials 1920A00190 and below. Modification to prevent the metal mounting flange of the variable resistor R18, which is ground, from shorting to the +5V printed trace.

5420A DIGITAL SIGNAL ANALYZER
5420A-16. List of 5420A control cartridges.
5420A-20. 5441A display: serials 1836 and below. 5443A keyboard/controller: Serials 1904 and below. Modification to change LED's to prevent sticky keys.

5526A LASER INTERFEROMETER
5526A-5. 5500C laser head: Serials below 1920A. Replacement of the high voltage and PZT power supplies.

5500C LASER HEAD
5526A-5. 5500C laser head: Serials below 1920A. Replacement of the high voltage and PZT power supplies.

6824A DC POWER SUPPLY
6824A-1. Serials 1914A02730 and below. Preferred replacement part for transistor Q2, Q13, Q14.

8160A PROGRAMMABLE PULSE GENERATOR
8160A-1. Serials 1804G00187 and below. Modification to improve burst function.

8165A PROGRAMMABLE SIGNAL SOURCE
8165A-4. Serials 1821G00340 and below. Modification to improve remote operation.
8165A-5. Serials 1812G00340 and below. Modification to improve LED driver circuit.
8165A-6. Serials 1812G00400 and below. Modification to keep PC boards in position.
8165A-7. Serials 1812G00420 and below. Modification to improve sweep linearity.

8481A/8482A/8483A THERMOCOUPLE POWER SENSORS
8481A-2A/8482A-1/8483A-1. 8481A serials 1550A and below, 84482A serials 1551A and below, and 8483A serials 1602A and below. Preferred replacement for input amplifier assembly.

8481H/8482H THERMOCOUPLE POWER SENSORS
8481H-1/8482H-1. 8481H serials 1545A and below and 8482H serials 1545A and below. Preferred replacement for connector assembly.

8568A SPECTRUM ANALYZER
8568A-18. All serials. Improved A23FL1 low pass filter assembly.

8640A/B SIGNAL GENERATOR
8640A-29. All serials. Test procedure for modulation performance tests and adjustments.
8640B-34. All serials. Test procedure for alternate modulation performance tests and adjustments.

8660A/B/C SYNTHESIZED SIGNAL GENERATOR
8660A-19A. 8660A: All serials. Preferred power transformer replacement.
8660A-30. 8660A: All serials. List of A3A1 and A3A2 remote programming interface assemblies.
8660B-18C. 8660B serials 1343A and below. Recommended replacement for A7 power line module.
8660C-10. 8660C: All serials. List of A3A1 and A3A2 remote programming interface assemblies.

8672A SYNTHESIZED SIGNAL GENERATOR
8672A-6. All serials. Modifications necessary to allow an external signal generator to be substituted for the 20 to 30 MHz phase lock loop in the 8672A (option H04 retrofit).

8750A STORAGE-NORMALIZER
8750A-9. All serials. W2 digital interface cable assembly replacement kit.

8754A NETWORK ANALYZER
8754A-1. Serials 1825A00175 and below. New insulator for A7 source assembly heat sink.

9571A - DTS 70
9571A-4. All serials. DTS70 software BUG/DIR modification.
9571A-6. All serials. Modification to prevent DM, MP errors in regenerated systems.
9571A-7. All serials. Modification to the welcome file when memory is reconfigured.
9571A-8. All serials. Explanation of two bugs in Rev. D software used with F Series computers. New Rev. E software eliminates these bugs.

10264A LOGIC STATE ANALYZER
10264A-1. Serials 1837A01706 and below (1611A option 001). Modification to prevent randomly incorrect triggering.

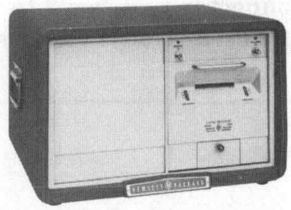
33311B/C COAXIAL SWITCHES
33311B-2/33311C-1. Serials 1560A and below. Modification to improve contact reliability of coaxial switches.

86245A RF PLUG-IN
86245A-1. Serials 1818A and 1837A. Installation of a clamp circuit to prevent frequency lock up.

86290B RF PLUG-IN
86290B-1. Serials 1852A and below. 10 kHz amplitude modulation on the RF output of the 86290B RF Plug-In.

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.



562A Digital Recorder

A shock hazard from the ac power switch terminals is present whenever the front panel door is open. This condition is corrected by insulating the terminals with silicone rubber compound (DOW Corning 731 RTV or equivalent, HP pn 0470-0012) according to the directions in Safety Service Note 562A-2-S.

1. Unplug the ac power cord and open the hinged front panel door.
2. Loosen the two printer mechanism retaining screws located on the lower front corners of the mechanism by turning them 1/4 turn CCW.
3. Slide the printer mechanism out of the cabinet.
4. Apply a 1/8 inch (.3cm) thick coating of silicone rubber to the power switch terminals. Allow the coating to dry.
5. Apply a second coating of silicone rubber over the first, covering the entire back side of the switch at least 1/8 inch (.3cm) thick.
6. Replace the printer mechanism.

Please order Safety Service Note 562A-2-S with the form at the back of *Bench Briefs*.

SERVICE NOTE ORDER FORM

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

Hewlett-Packard
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Palo Alto, California 94303

For European customers (ONLY)

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☐ 495A-8B	☐ 2804A-1	☐ 3779A-5	☐ 5341-5	☐ 8568A-18
☐ 562A-2-S	☐ 3312A-2	☐ 3779A-8	☐ 5342A-13	☐ 8640A-29
☐ 745A-17B-S	☐ 3325A-1A	☐ 3779A-9	☐ 5345A-14	☐ 8640B-34
☐ 745A-19	☐ 3325A-3	☐ 3779B-7	☐ 5345A-15	☐ 8660A-19A
☐ 905A-1	☐ 3325A-4	☐ 3779B-8	☐ 5345A-16	☐ 8660A-30
☐ 907A-1	☐ 3438A-4	☐ 3779B-9	☐ 5363A-4/5363B-3	☐ 8660B-18C
☐ 911A-1/911C-1	☐ 3455A-12C	☐ 3780A-9A-S	☐ 5363B-1	☐ 8660C-10
☐ 1332A-10	☐ 3455A-14	☐ 3780A-14A	☐ 5363B-2	☐ 8672A-6
☐ 1332A-11	☐ 3467A-1	☐ 3780A-17	☐ 5420A-16	☐ 8750A-9
☐ 1333A-4	☐ 3469B-7	☐ 4940A-15	☐ 5420A-20	☐ 8754A-1
☐ 1333A-5	☐ 3710A-21	☐ 5045A-17	☐ 5526A-5	☐ 9571A-4
☐ 1333A-8	☐ 3745A/B-14A	☐ 5045A-19	☐ 6824A-1	☐ 9571A-6
☐ 1335A-9	☐ 3745A/B-18B	☐ 5062C-2A	☐ 8160A-1	☐ 9571A-7
☐ 1336P-1	☐ 3745A/B-20B	☐ 5301-U-1	☐ 8165A-4	☐ 9571A-8
☐ 1350A-4	☐ 3770A-38	☐ 5314A-2	☐ 8165A-5	☐ 10264A-1
☐ 1820A-8	☐ 3770B-14A	☐ 5328A-19B	☐ 8165A-6	☐ 33311B-2/33311C-1
☐ 1821A-10	☐ 3771A/B-4	☐ 5328A-22A	☐ 8165A-7	☐ 86245A-1
☐ 1821F-1	☐ 3771A/B-5	☐ 5328A-24	☐ 8481A-2A/8482A-1/8483A-1	☐ 86290B-1
		☐ 5340A-12	☐ 8481H-1/8482H-2	

Does A Sliding Load Need Lubrication?

You bet it does. HP models 905, 907, and 911 50 ohm coaxial sliding loads require a small amount of PML grease (pn 6040-0024) between the connector and body to reduce friction. Please order Service Notes 905A-1, 907A-1, or 911A-1/911C-1 with the order form at the rear of *Bench Briefs*.

HEWLETT-PACKARD COMPANY
1820 Embarcadero Road
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