HEWLETT PACKARD

BENCH BRIEFS

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JANUARY-FEBRUARY 1982

Functional Analyzing

By Jim Bechtold, Editor

Introduction

Functional analyzing usually provides the most direct and efficient means of isolating a problem in an electronic instrument. As another term for logical troubleshooting, functional analyzing is more appropriate and descriptive of the process used in everyday bench service. Functional analyzing is antithetic to shotgun troubleshooting because functional analyzing involves analyzing the unit in logical, sequential steps in order to isolate the defective circuit, rather than jumping around replacing components at random until the problem goes away.

A bonus to this logical, sequential diagnosis is that when you do discover the cause of the problem, you acquire a kernel of knowledge that is added to your bank of experiences. Then, if a similar problem occurs again, you can draw upon your bank of past experiences and mentally bracket the problem area. Troubleshooting an instrument by the shotgun method will generally effect a repair, but you will gain no knowledge of what caused the trouble since you have only treated the symptom — not diagnosed its cause.

Functional Analyzing Applied to a Real Life Example

The last issue of Bench Briefs described the theory of logical troubleshooting (see accompanying box for a thumbnail description), and showed how the step-by-step procedure could be used to isolate a problem in the electrical charging system of an automobile — a rather simple example. This article shows how these same basic procedures are applied in troubleshooting a complex electronic instrument — a microprocessor controlled 6½-digit integrating digital voltmeter (see Figure 1).

Figure 1. Mike Keenan, HP Technical Specialist, substitutes part of a good DVM into a faulty unit as a form of half-splitting.

To document the procedure, I sat at the bench with one of Hewlett-Packard's repair center technicians, Technical Specialist Mike Keenan, and observed him use the troubleshooting procedures we have been discussing on an HP 3455A DVM. In less than 15 minutes he isolated the cause of a complete failure to a single component.

The Customer Complained that the DVM Locked Up at Turn-On

The first clue of trouble was the customer's complaint that when the unit was turned on, all annunciator lights were illuminated and the display remained blank. The DVM would not respond to any switch settings. Before Mike applied AC power, he removed the covers and looked and smelled for evidence of broken components or heat. Everything seemed OK so Mike connected the DVM power cord and switched the unit on — in fact, he switched it on and off several times. The DVM repeatedly locked up at turn-on just as the customer had indicated. Milking the front panel revealed only that all the lights worked (except for the display, which was blank).

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Logical Troubleshooting

The goal of logical troubleshooting is to isolate the defective area in the instrument in as few steps as possible. Getting started involves asking three questions:

1. What is the product supposed to do? This may seem simple-minded but it will help you select the required troubleshooting equipment.

2. Does the product do what it was designed to do? In other words, was the customer trying to make the instrument do something it was not designed to do?

3. Have you or anyone else seen the problem before? Or, is the symptom listed in the service manual? Many times there is a list of troubles and probable causes in the manual's troubleshooting/service section.

The next logical step is to milk the instrument for all symptoms available. Use your eyes, ears and nose.

Then you want to bracket the problem, which is simply a means of establishing broad limits around the areas to be tested. This usually involves the next step which is half-splitting.

Half-splitting involves making checks at the midpoints of the remaining parts of the circuit that have not yet been checked until you find the faulty portion of the circuit.

In conjunction with half-splitting you will want to use the information funnel approach; i.e., deciding what type of check to make that is most appropriate to the size of the trouble brackets at a given time.

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

The next step was to see if anyone else had experienced the same problem. We could either ask other techs in the area, or see if the problem was listed in the service manual — it was listed. We had now completed several preliminary steps in the logical troubleshooting process (see accompanying box). We had:

— Verified the product was not doing what it is supposed to do.
— Milked the insides and front panel for clues.
— Looked to see if the problem was common enough to be documented.

The Service Manual's Troubleshooting Section Helps Us Bracket the Problem

The manual's troubleshooting section told us to first verify that the raw power supplies were working properly. Mike checked and the power supplies were fine.

The next troubleshooting step told us to half-split the instrument since either of its two main sections could hang up the turn-on sequence.

Explanation. This DVM is electrically and physically divided into two major sections (with two major printed circuit boards). The inguard section, which consists of the measuring circuitry, a controller, and power supplies; and the outguard section, which consists of most logic circuits and their power supplies. The outguard circuits function as the internal main controller, HP-IB interface, and front panel interface of the instrument (see Figure 2).

The Manual Recommends a Second Working DVM for Effective Half-Splitting

Both the inguard and outguard sections have their own separate microprocessor controllers that handshake back and forth. Both sections are interconnected through a single cable that can be easily unplugged. The manual troubleshooting procedure recommends using a test cable (available from HP) and a second, functional 3455 DVM. The test cable is

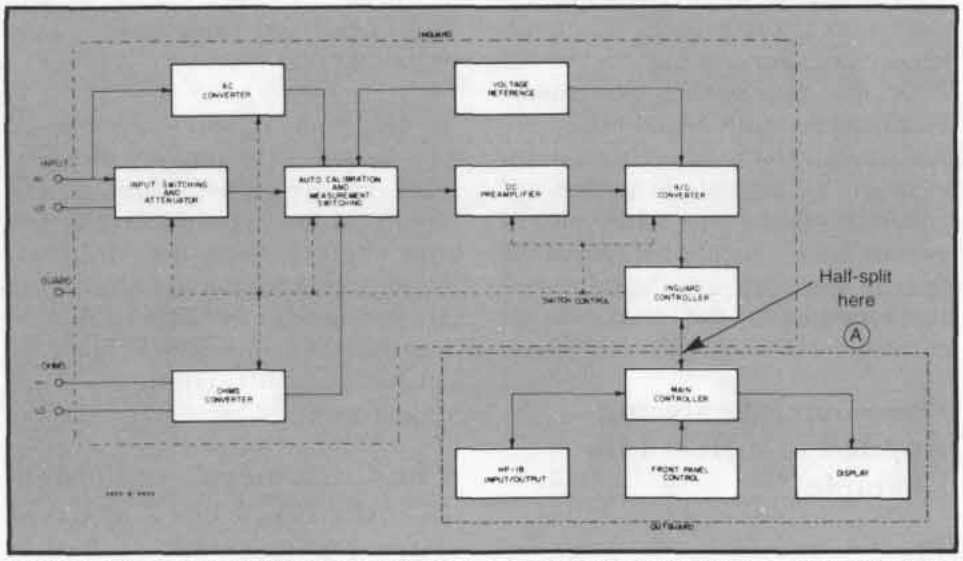

Figure 2. This complex DVM can be easily half-split where the inguard and outguard sections are interconnected at point (A).

used to connect the inguard section of the good instrument to the outguard section of the bad instrument, or vice versa. In this manner the faulty DVM is half-split and the bad section (inguard or outguard) is quickly identified. Refer to Figures 2 and 3.

Editor's Note: This same principle can be applied to many instruments even if they don't have a convenient interconnect cable. For example, in some cases new power supplies can be wired into a circuit, or an even more basic substitution is replacing printed circuit boards.

Mike connected the two DVMs together with the test cable using the inguard section of the good DVM to talk to the outguard section of the bad DVM. The manual recommended that the DVM with the active inguard section be turned on first, which Mike did. The faulty DVM proceeded to function in a normal manner, which indicated that its inguard section was bad. Just to make sure, we reversed the cable and used the outguard section of the good DVM and the inguard section of the bad DVM. The original fault appeared in the good DVM.

The Manual Recommends Further Half-splitting Within the Inguard Section

The inguard troubleshooting section related that the turn-on fault could be on the mother board and/or on a plug-in A/D converter board, and recommended replacing the A/D board as the first check. We removed the A/D board from the good DVM and substituted it into the bad DVM. The fault was still there, so we reset our brackets another step closer to the failure. It seemed that we were zeroing in on the mother board.

The manual told us that the next step was to check the clock signal at A10U26 pin 27. U26 is the inguard microprocessor and the clock signal is used by the inguard controller circuit. Mike hooked up his scope and checked the 4-volt clock signal. It was OK.

The next step was to check the ±10-volt reference at A10TP7 and TP8. We reswapped the A/D boards and used the good DVM. A quick check at the test points revealed that both of the reference voltages were low — they both measured approximately 0.6 volts. The 10-volt reference is used extensively in the input and auto-calibration switching circuits and the A/D converter circuit. The circuit description said that if this reference voltage was low, the instrument may not complete its auto-cal routine during turn-on. It sounded like we were on the right track.

The manual referred us to a particular schematic that showed the ±10-volt reference was derived from the A11 reference assembly board. A portion of this schematic is shown in Figure 4. Mike surmised that either something in the input and auto-calibration switching circuits was loading the reference down, or the A11 reference board itself was bad. Remember that the A/D board had been previously eliminated. Mike pulled the A11 board out of the good DVM and substituted it into the bad DVM. Using a scope set for DC measurements, Mike found that the ±10-volt reference was still low. The brackets were moved in another notch.

The only thing left was the input and auto-calibration switching circuits located on the A10 mother board (i.e., all the components fed by the ±10-volt reference). At this point we lost the luxury of half-splitting since most of the components were parallel attached to the reference line.

Shotgun or Logical Analysis??

Mike looked at the circuit and found several likely suspects. At this point he could have fixed the problem using the shotgun technique — replace groups of components until the 10-volt reference improved, or he could approach the problem logically and methodically until he found the fault. The difference, of course, would be that when he logically found the problem and diagnosed its cause, he would add that kernel of knowledge to his bank of experiences. The shotgun method would only treat the symptom. In other words, the next failure of this type that Mike came up against, he still wouldn't know what caused the problem.

We lifted a couple of diodes in the circuit that could have been shorted, and then unsoldered a transistor that isolated a portion of the circuit. No luck. Then Mike realized that 10 volts was being drawn down to 0.6 volts, which was almost ground. He looked for and found Q34, a transistor that, if shorted or leaky, would draw the 10-volt reference to ground. Refer to Figure 5. When we lifted one leg on the transistor, the voltage came right up.

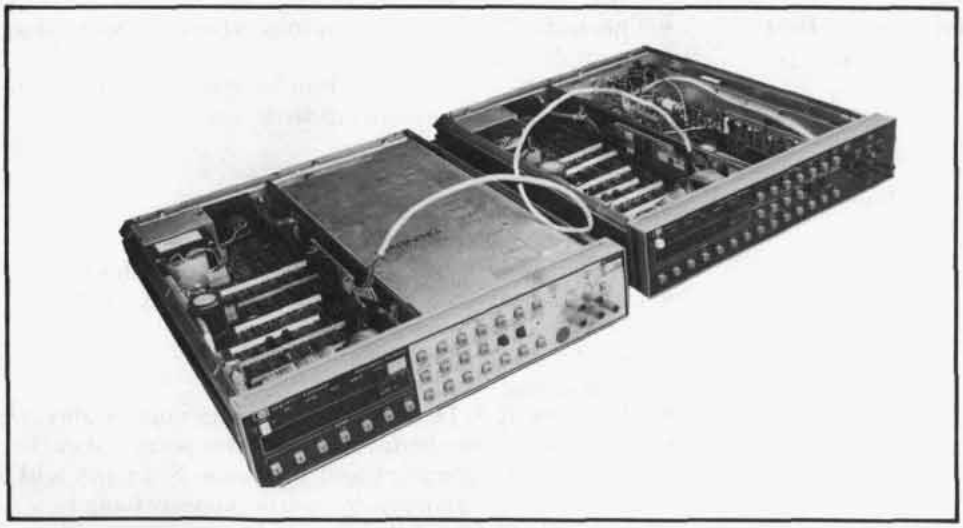

Figure 3. A second, good DVM is interconnected to the bad DVM to effectively half-split the overall circuits.

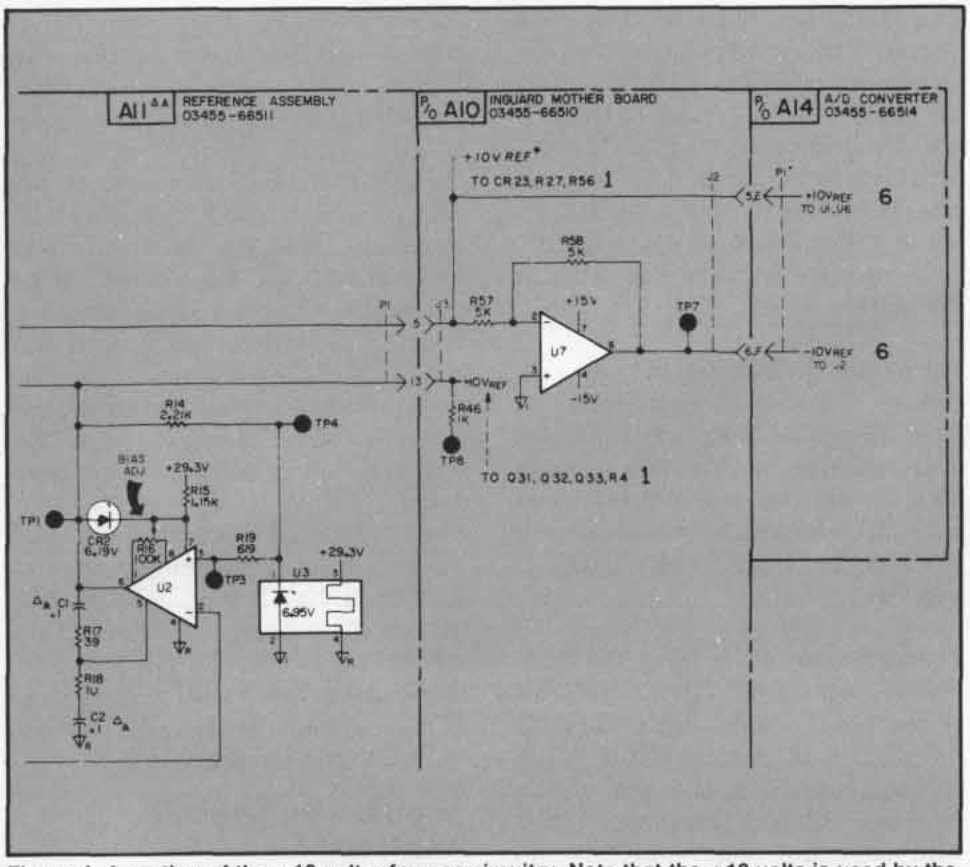

Figure 4. A portion of the ±10-volt reference circuitry. Note that the ±10 volts is used by the A/D converter as well as input and auto-calibration switching circuits, all shown on other schematics.

Mike replaced Q34 and turned the HP 3455 on. The DVM did not lock up and appeared to function properly. Mike pressed the self-test button and the DVM passed with no other problems.

The Same Approach is Used to Troubleshoot Any Circuit

The example we covered concentrated on isolating a problem in a complex digital voltmeter. The basic principle was to isolate the one defective stage in the circuit by confirming all of the other stages were working properly. We accomplished this through half-splitting. And the same simple principle will work in most any type of circuit. Remember, that as you are half-splitting and moving those brackets ever closer to the fault, you are learning the instrument and picking up those kernels of knowledge for future use.

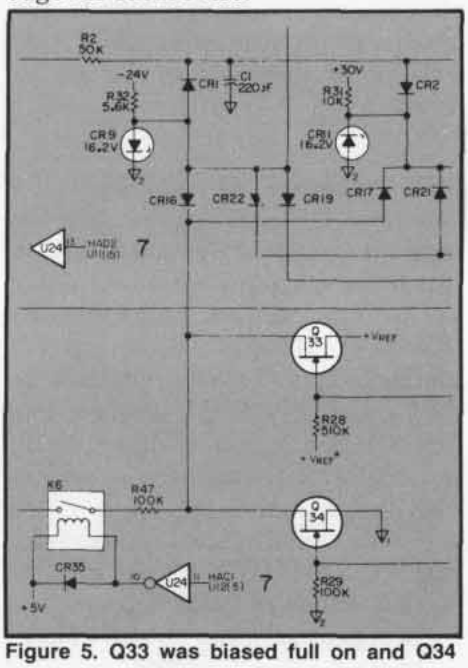

Figure 5. Q33 was biased full on and Q34 was shorted. Therefore, the 10-volt +V_{REF} was drawn to near ground potential (0.6 volts).

Customer Service Seminars

Digital Troubleshooting Techniques

An intensive, short service-oriented course that introduces modern digital technology to the analog repairman.

When — March 22–25
August 10–13

Where — Instrument Support Division
690 E. Middlefield Rd.
Mt. View, CA 94042
(415) 969-0880

Coordinator — Debra Mazenko

Cost — $350/student

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.

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

- ROMs/PROM (masked, E and UV).
- RAMs: bipolar and MOS (static and dynamic).
- Typical failures and the troubleshooting difficulties encountered with ROMs, PROMs and RAMs.
- 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.

Logic Analyzers

A service-oriented course for calibration and repair technicians that teaches application, circuit theory and calibration.

When — April 5–8
Where — Colorado Springs Division
1900 Garden of the Gods Road
Colorado Springs, CO 80907
(303) 598-1900
Coordinator — Mike Fredeen
Cost — $400/student

Hewlett-Packard, Colorado Springs Division, is offering Service Training Seminars to customers on most all models of Logic Analyzers. The courses are directed to calibration and repair technicians and will teach application, circuit theory, calibration, and troubleshooting to component-level repair. Attendees should have some prior knowledge of logic and oscilloscope circuits.

The course objective is to teach front panel control operations, circuit theory, and learn the fundamental components used throughout the unit. Other areas covered are the power supply, trigger recognition, data acquisition and storage, and the display circuitry.

The student is guided through the three fundamental areas of logic analyzers:

— Recognizing a trigger
— Storing the data
— Displaying the data

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.

Ordering Information — All courses must be ordered through your nearest HP Sales Office. If you desire additional information about a specific course, contact the coordinator at the course location.

Battery Cross Reference

When selecting a replacement battery for your HP product, you may notice that your manual will list only an HP part number, even though it appears that this part is actually a standard battery. Service personnel often ask why only HP part numbers are used.

It is a form of quality control. By listing only HP part numbers we are recommending that HP replacement parts be used to ensure that original performance of the product be retained. While some batteries used in HP instruments are identical to those that can be purchased at a local electronics distributor, many batteries are either specially manufactured to HP specifications, not available over the counter, or mechanically altered to fit certain HP applications.

However, there may be situations when you have a dead battery and therefore a dead instrument, and HP replacement parts are either not in stock or will take a few days to obtain. In these cases it may be worthwhile to see if a substitute battery will work in the circuit. Perhaps an HP battery could be ordered and installed at some later date.

To help you in these situations, here's a list of batteries, their HP part numbers, and the manufacturer's name and part number.

List of Battery Manufacturers

Number	Manufacturer
00029	Deac
01394	Gates Energy Products
01420	Burgess Inc.
01447	Gould Inc.
01921	RCA Corp. Solid State Div.
02000	Muirhead Inst. Inc.
02369	Gulton Battery Corp.
02413	Clevite Corp. Burgess Batt. Div.
02967	General Electric
03113	Eppley Lab Inc.
03551	Castall Inc.
03602	Sonotone GSD Marathon Battery
03941	Honeywell Inc.
04135	Universal Products Inc.
04304	Union Carbide Corp.
04781	Ray-O-Vac Div. ESB Inc.
04910	Union Supply Co.
05139	MacLeod & Handpol Inc.
05296	RCA Corp. Electronic Comp.
05452	Globe Battery Div. Globe-Union Inc.
05469	Duracell International Inc.
05980	Aglo La Pile S A R L
05987	Saft
06195	Varta Battery AG
06450	Yuasa Denki KK
06508	Japan Storage Battery Co.
07230	Sonnenschein GMBH
07245	*Panasonic*
07371	Sanyo Electric Inc.
08709	Panasonic
08781	Catalyst Research Corp.
08891	*Power Conversion Inc.*
09593	Electrochem Industries Inc.
09839	Plainview Electronics Corp.

HP P/N	MFR NUMBER (1)	(2)	MFR P/N
1420-0001	01420	H	H5308
1420-0001	04304	H	H762S
1420-0001	04781	H	H709
1420-0002	01420	H	HZ30NX
1420-0002	04304	H	IW-350
1420-0002	04781	H	H711
1420-0003	01420	H	H210
1420-0003	04304	H	H1150
1420-0003	05469	H	IM-13X
1420-0004	01420	H	HHG-3R
1420-0004	05469	H	HRM-3R
1420-0005	05469	H	HTR-233R-316469
1420-0006	05469	H	HTR234R
1420-0007	02369	H	HW-4200 20-PC20 MOD.
1420-0007	03602	H	HSPEC. P/N23191
1420-0008	03602	H	HP/N 23957
1420-0009	01447	H	H401108
1420-0009	02967	H	H418001RD1761
1420-0010	05469	H	HTR 235R-316469
1420-0011	03602	H	H26042-5
1420-0012	03602	H	H10-20H120
1420-0014	01447	H	H403279
1420-0014	02967	H	H418004AA17
1420-0015	01447	H	H400703-049
1420-0015	04304	H	I5-B225T
1420-0016	05469	H	HRM12RT-2
1420-0017	05469	H	HTR-236R-316469
1420-0018	04304	H	IE-630T
1420-0018	05469	H	HPX-13T2
1420-0019	01447	H	H
1420-0019	02967	H	H418004RE01
1420-0020	05469	H	HRM-12-R
1420-0021	04304	H	HE 233
1420-0021	05469	H	HTR-233
1420-0022	01420	H	HTWI
1420-0022	01921	H	HVS-317
1420-0022	04304	H	H731
1420-0022	05469	H	IM 918
1420-0023	04304	H	HE-9
1420-0023	05469	H	HZM-9
1420-0024	04304	H	HE-12
1420-0025	04304	H	HE-42N
1420-0025	05469	H	HRM-42R
1420-0026	01420	H	HM30
1420-0026	04304	H	HNO. 482
1420-0027	05469	H	HRM 401
1420-0028	05469	H	HTR-164
1420-0029	04304	H	HE 216
1420-0030	01921	H	HVS102
1420-0030	04304	H	H763
1420-0031	04304	H	HE146X
1420-0031	05469	H	HTR146X
1420-0032	05469	H	HTR-289
1420-0033	04304	H	HE126
1420-0033	05469	H	HTR126
1420-0034	04304	H	H504
1420-0035	01420	H	HY15
1420-0035	04304	H	H505
1420-0036	04304	H	H416
1420-0037	04304	H	H457
1420-0038	03941	H	H362366
1420-0038	05469	H	H302651
1420-0039	05469	H	HTR-132R
1420-0040	05469	H	HTR-135-R
1420-0041	05469	H	HRM4R
1420-0042	05469	H	H316295 TYPE RM1R
1420-0044	03551	H	H
1420-0044	05139	H	H
1420-0045	05139	H	H
1420-0047	03113	H	HMIN I
1420-0048	02000	H	HD-845-C
1420-0049	01447	H	HCD25
1420-0049	04304	H	IY5671
1420-0050	05469	H	HRM415
1420-0051	03113	H	H100A
1420-0052	05469	H	HRM42R
1420-0053	02369	H	I20R200
1420-0053	02413	H	IMP607W
1420-0053	02967	H	HPPS2677R4
1420-0053	05987	H	I20R200
1420-0054	01447	H	H7.2V/225B
1420-0054	04304	H	HY5637
1420-0055	04304	H	IY-5511
1420-0057	04304	H	IE302905
1420-0057	05469	H	I302905
1420-0058	04304	H	HE-91
1420-0058	04781	H	H815
1420-0059	01447	H	H402517
1420-0060	01447	H	H
1420-0061	05469	H	HPX-1
1420-0062	01447	H	H405017
1420-0062	02967	H	H418001RD1AG1
1420-0063	04304	H	H509
1420-0064	00029	H	H1000DKZ
1420-0065	04304	H	H935
1420-0065	04781	H	H1C
1420-0066	01447	H	H402908
1420-0067	01420	H	HF4P1
1420-0067	01921	H	HVS-009
1420-0067	04304	H	H744
1420-0067	05469	H	IM-6
1420-0068	05469	H	HTR-115R
1420-0069	01420	H	HH-114R
1420-0069	04304	H	IE-114
1420-0069	05469	H	HTR-114R
1420-0070	01420	H	H5540

Notes:
(1) Replacement P/N
(2) Status; H = active

HP P/N	MFR NUMBER	(1)	(2)	MFR P/N
1420-0071	01420			HMN6
1420-0071	04304			H1222
1420-0073	01921			HVS074
1420-0073	04304			H912
1420-0073	04304	R		H912
1420-0073	04781			H400
1420-0073	04781	R		H400
1420-0073	05469			IM-24F
1420-0073	05469	R		HM-24F
1420-0074	04781			H20
1420-0076	06450			H12N9-48
1420-0077	01447			HCD29
1420-0078	04304			HEVEREADY E92
1420-0079	05469			HMN1400
1420-0080	06450			HB72-12
1420-0081	02967			HPPS 0850
1420-0082	04304			H522-VP
1420-0082	05469			HMN1604
1420-0083	01420			HN60
1420-0083	04304			H490
1420-0084	01447			H
1420-0084	04304			HNV-134
1420-0085	01447			H401997
1420-0086	05469			ITR-118
1420-0087	01420			HL6
1420-0087	04304			H206
1420-0088	04304			HCH15VP
1420-0088	05980			HAF0.5R6CF
1420-0088	05987			HVR0.5AA
1420-0089	01420			H532
1420-0090	01420			H410
1420-0090	04304			H735
1420-0091	02967			H41B905C010G1
1420-0091	04304			HN4175
1420-0092	01447			HPB 690
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1420-0095	02967			H41B001J014
1420-0095	04304			HN4427
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1420-0096	02967			H41B001TD08G1
1420-0097	02967			H26CW3.5ST
1420-0097	04304			HN4426
1420-0098	02967			H
1420-0099	06508			HPE7-6
1420-0100	02369			HRR010, 1/3 AA
1420-0100	02967			H41B901J001G1
1420-0123	07230			H90312 3G X 3S
1420-0201	02369			H8R010, 1/3AA
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1420-0202	04304			HN4240
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1420-0212	02369			HR190ST
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1420-0212	02967			HGCT1.5ST
1420-0212	02967	R		HGCT1.5ST
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1420-0214	05296			HVS034A
1420-0215	05452			HGC660-1A
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1420-0216	02967			H106CW3.5ST
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1420-0217	07371			IN-450AAF
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1420-0220	02967			H41B038AE00301
1420-0221	02967			H41B020BA00101
1420-0222	01420			HTW2
1420-0222	04304			H732
1420-0222	04304	R		H732
1420-0222	04781			H926
1420-0222	04781	R		H926
1420-0222	05296			HVS342
1420-0222	05296	R		HVS342
1420-0223	01394			H0800-0017
1420-0224	01420			HAL2
1420-0224	04304			HE95
1420-0224	04304	R		HE95
1420-0224	05469			HMN-1300
1420-0224	05469	R		HMN-1300
1420-0225	01420			HU-20
1420-0225	04304			H413
1420-0225	04304	R		H413
1420-0225	05469			IM-210
1420-0225	05469	R		HM-210
1420-0226	05452			HGC12200-B
1420-0226	05452	R		HGC12200-B
1420-0227	02967			H41B001ED69G1
1420-0227	04304			HN4393
1420-0228	05452			HGC1215-1-B

HP P/N	MFR NUMBER	(1)	(2)	MFR P/N
1420-0228	05452	R		HGC1215-1-R
1420-0229	02967			H41B905CD20G1
1420-0230	05452			HGC-645-1-BHP
1420-0231	05452			HGC-645-1-B
1420-0232	04910			H
1420-0233	01394			H0810-0011
1420-0233	02967			H478025CD02001
1420-0234	04135			H
1420-0235	02967			H
1420-0236	04304			H357
1420-0237	02967			H41B040BA00901
1420-0238	02967			H41B905CD52G1
1420-0238	04304			HN4448
1420-0238	07371			H4N-450AAF
1420-0239	01447			H6IGNBP
1420-0240	05469			HTR-286
1420-0241	01447			HF4RP
1420-0241	04304			H510S
1420-0242	01447			HK10
1420-0242	04304			H417
1420-0243	01447			H402037-005
1420-0243	04304			HN4475
1420-0244	02967			H41B001CD39G1
1420-0245	05469			H303386
1420-0245	05469	R		HPX 675
1420-0246	04304			HEVEREADY 1209
1420-0247	02967			H
1420-0247	05987			H
1420-0249	01394			H0800-0079
1420-0250	02967			H41B020BE00201
1420-0251	01447			H405313
1420-0251	02967			HK02A113AA-GT1
1420-0252	02967			H4189058029
1420-0252	04304			HN4552
1420-0252	07371			H2N-450AAF
1420-0253	01394			H0800-0011
1420-0253	01394	R		H0800-0011
1420-0254	04304			HEPX4
1420-0254	04781			HRPX4
1420-0254	05469			HPX4
1420-0255	04304			HE90
1420-0255	04304	R		HE90
1420-0255	05469			HMN9100
1420-0255	05469	R		HMN9100
1420-0256	04781			HT312G
1420-0256	04781	R		HT312G
1420-0256	05469			H10L125
1420-0256	05469	R		H10L125
1420-0257	02967			H418903ED13-1
1420-0257	02967	R		H418903ED13-1
1420-0258	02967			H41B013AE00101
1420-0259	05469			HTR133
1420-0259	05469	R		HTR133
1420-0260	01447			H404544
1420-0260	02967			H41B013AG00401
1420-0260	02967	R		HTRB80SD1
1420-0261	05469			HRM401R
1420-0261	05469	R		HRM401R
1420-0262	01394			H0810-0016
1420-0262	01394	R		H0810-0016
1420-0262	02967			H478025FC03
1420-0262	02967	R		H478025FC03-1
1420-0263	01394			H0810-0004
1420-0263	01394	R		H0810-0004
1420-0263	02967			H0225
1420-0264	02967			H41B013AD00201 (DS3GT)
1420-0264	02967	R		H41B013AD00201 (DS3GT)
1420-0265	04304			HE1.E1N
1420-0265	05296			HVS143
1420-0265	05469			HRM1
1420-0266	02967			H41B020AG00401
1420-0267	02967			H41B017AG00101
1420-0268	02967			HDS3GT
1420-0269	01394			H0810-0142
1420-0270	02967			H41B020AB00201
1420-0271	02967			HDS350
1420-0272	02967			H41B020AD00501
1420-0272	04304			H
1420-0272	07371			H
1420-0273	08709			HBR-2/3AF1
1420-0274	06450			H5/225FZ
1420-0275	08781			H3440
1420-0276	01447			H1.0SCB
1420-0276	08709			HNR 2/3C
1420-0277	08891			H400S PC
1420-0278	08891			HB9511
1420-0279	01447			H
1420-0279	02967			H
1420-0280	01447			HPOLYTEMP 404040-001
1420-0280	02967			HGOLD TOP 418905AD04-2
1420-0281	08781			H2736
1420-0282	02967			HK03A113AAGT1
1420-0283	05469			HTR175
1420-0284	01447			H
1420-0284	02967			H
1420-0285	01447			H
1420-0285	02967			H
1420-0286	01394			H0800-0177
1420-0287	08709			HLCR-306P
1420-0288	02967			HGCT 1.8 ST
1420-0289	02967			HK048-111-AA-GT1
1420-0290	04304			HA-76
1420-0291	04781			H1604
1420-0292	05469			HMP146
1420-0293	08891			H400S
1420-0294	02967			H41B020AH00201
1420-0295	04304			HN4292
1420-0295	07371			HN-450AAF
1420-0296	09593			H3B64-TC-1/2 GRAM LT
1420-0297	01394			H0800-0192
1420-0298	08709			HBR 2/3 AP1
1420-0299	08709			HHM-2P-F1
1420-0300	07245			HBR-2/3A WITH 1-1/2 IN LEADS
1420-0574	02967			HXGCK 130 ST

Notes:
(1) Replacement P/N
(2) Status; H = active

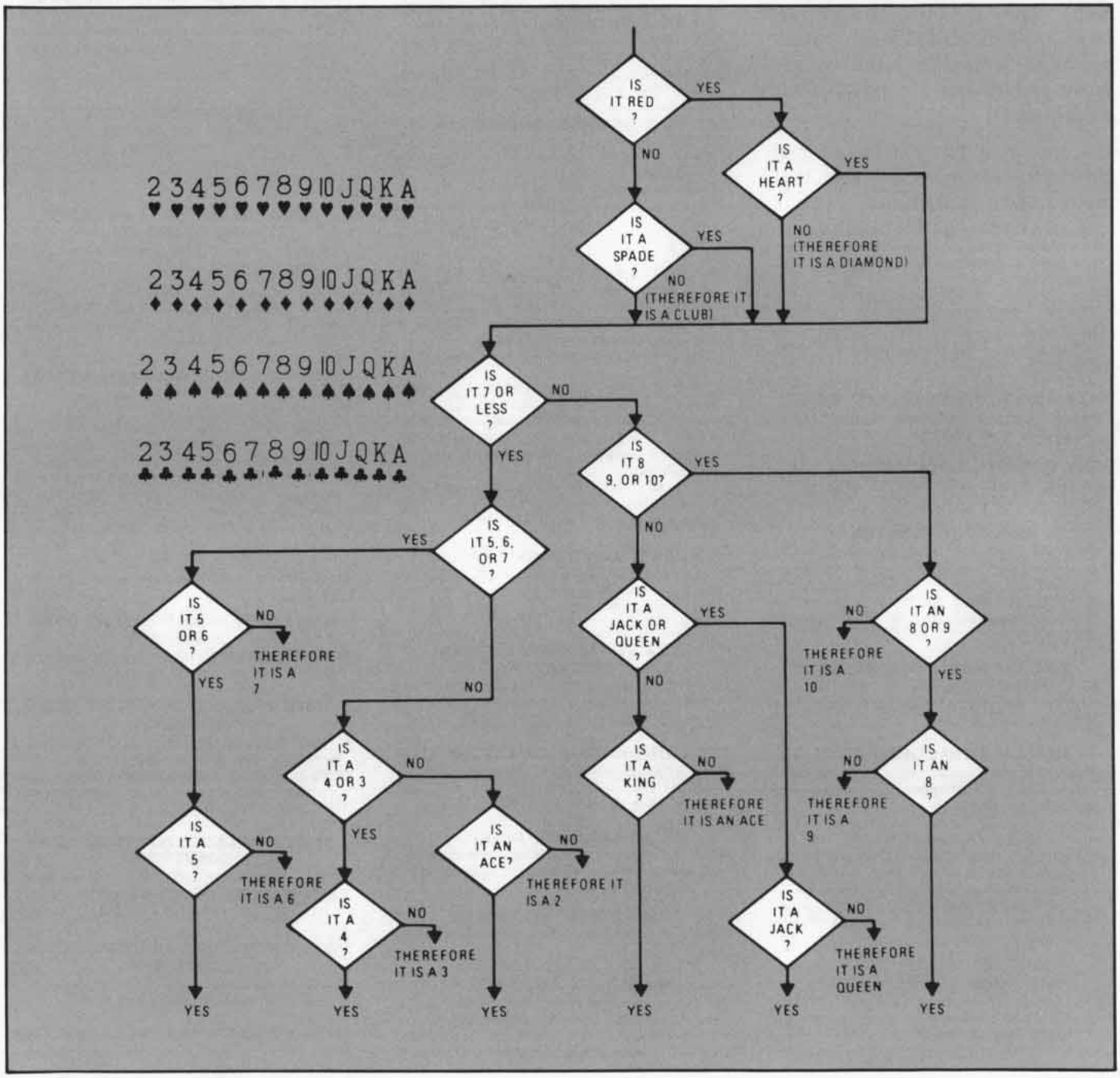
CUSTOMER SERVICE TRAINING CALENDAR FOR 1982

CONTENT	DATES	LOCATION	TUITION	COORDINATOR
Logic Systems				
Models 1610, 1611, 1615	April 5–9	Colorado Springs Division 1900 Garden of the Gods Road Colorado Springs, CO 80907	$ 400/student	Jerry Lopez
Microcomputer Development System Model 64000 (Order HP No. 5955-6290)	August 9–20 September 14–25	Colorado Springs Division	$1,250/student	Jerry Lopez
Scopes and Displays				
Models 1740A, 1741A, 1742A, 1744A (Order HP No. 5955-4147)	March 1–5 September 20–24	Colorado Springs Division	$ 350/student	Dick Browne
1980 System (Order HP No. 5955-8046)	March 8–12	Colorado Springs Division	$ 400/student	Dick Browne
Automatic Test				
3054A/C System Verification & Board Level Repair	February 22–23	Loveland Instrument Division 815 Fourteenth, S.W. Loveland, CO 80537	$ 250/student	Larry Carlson
Circuit Test Systems Model 3060A	January 4–15 February 1–12 March 1–12 April 12–23 May 3–14 June 6–17 July 12–23 August 9–20 September 13–24 October 11–22 November 8–19 November 29 –December 10	Loveland Instrument Division	$2,500/student	Sandy Selleck
	January 18–29 February 1–12 March 15–26 April 12–23 May 3–14 June 6–17 July 26 – August 6 August 23 – September 4 September 27–October 8 October 25–November 5 November 29 – December 10	Eastern Sales Region 7121 Standard Drive Hanover, MD 21076	$2,500/student	Sandy Selleck (in Loveland)
Option 100 (3060A)	January 11–15 February 1–5 March 1–5 April 12–16 May 3–7 June 7–11 July12–16 August 9–13 September 13–17 October 11–15 November 8–12 December 6–10	Loveland Instrument Division	$1,250/student	Sandy Selleck
DTS-70	January 4–15 February 1–12 March 1–12 April 12–23 May 2–14 June 6–17 July 12–23 August 9–20 September 9–20 October 11–22 November 8–19 November 29 – December 10	Loveland Instrument Division	$2,500/student	Sandy Selleck
Technology Training				
Digital Troubleshooting Techniques	March 22–25 August 10–13	Instrument Support Division 690 E. Middlefield Road Mountain View, CA 94042	$ 350/student	Debra Mazenko
Microprocessor Troubleshooting Techniques	January 18–21 August 16–19	Instrument Support Division	$ 350/student	Debra Mazenko
Digital Troubleshooting Devices	January 11–13 July 19–21	Instrument Support Division	$ 350/student	Debra Mazenko
HPIB Fundamentals for Service Technicians	February 24 April 21 September 22	Instrument Support Division	$ 200/student	Debra Mazenko
9500D Automatic Test Systems Maintenance	September 20 – October 1	Instrument Support Division	$2,000/student	Debra Mazenko
Signal Analysis				
Models 8566A/8568A Spectrum Analyzers	January 25 – February 5 September 20 – October 1	Santa Rosa Division 1400 Fountain Grove Parkway Santa Rosa, CA 95404	$ 700/student	Jim Boyer
141T/8555A/8553B/8552B Spectrum Analyzers	June 21–25	Santa Rosa Division	$ 400/student	Jim Boyer
8565A/8569 Spectrum Analyzer	June 14–18	Santa Rosa Division	$ 400/student	Jim Boyer
DSA/Laser				
5501A/5526A Laser Transducer/Measurement	December 7–11	Santa Clara Division 5301 Stevens Creek Blvd. Santa Clara, CA 95050	$ 700/student	Lorraine Pineda
5420A/5423A DS Analyzer	March 1–5	Santa Clara Division	$ 700/student	Lorraine Pineda
5427A/5451C Fourier Systems & Maintenance	July 6–16	Santa Clara Division	$ 700/student	Lorraine Pineda

More on Logical Troubleshooting

The last issue of Bench Briefs contained a demonstration problem that was designed to prove the power of half-splitting. The problem was to take a standard deck of 52 playing cards and remove one without looking at it. Then determine which it is by asking questions (i.e., making measurements).

We solve the problem by half-splitting where the probability of finding the fault on one side of the split or the other is 50%. Therefore, the approach would be to repeatedly split the cards into two groups and meticulously zero in on the unknown card. How many questions are needed to determine the selected card? The first question can split between two items. The second splits those into two, for a total of four. The next question gets the total up to 8, the next 16, etc. Thus, 6 questions can pick one item out of a group of 64 (since $2^6 = 64$).



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.

197A OSCILLOSCOPE CAMERA

197A-9. Serials 1203A and below. UV scale illumination bulb (pn 2140-0254) is again available from stock.

204D OSCILLATOR

204D-3. All serials. Manual update to list the correct part number for output attenuator assembly AIR46 (HP pn 5061-0760).

312B/D SELECTIVE VOLT/LEVEL METER

312B/D-7. All serials. Troubleshooting procedure to test an intermittent meter circuit.

339A DISTORTION MEASUREMENT SET

339A-8. All serials. Troubleshooting procedure to test an intermittent meter circuit.

432B/C POWER METER

432B-3A. Serials 1913A and below. Improved replacement digital panel meter installation kit (HP pn 00432-60116).

432C-3A. Serials 1906A and below. Improved replacement digital panel meter installation kit (HP pn 00432-60117).

618C SHF SIGNAL GENERATOR

618C-15. All serials. Troubleshooting tip for the series regulator in the −1000 volt power supply. Supersedes 618C-14 dated 5/81.

620B SHF SIGNAL GENERATOR

620B-17. All serials. Troubleshooting tip for the series regulator in the −1000 volt power supply. Supersedes 620B-16 dated 5/81.

1302A (78309A) DISPLAY

1302A-4. Serials 1612A, 1643A, 1721A, and 1951A. (Instruments with serials 2102A have the modification incorporated in production.) Modification kit 01302-69505 and 01302-69506 (Option 012). Modification kit to improve reliability of the +158 volt power supply.

1311B LARGE SCREEN DISPLAY

1311B-2. All serials. Notification to check all 1311B Displays for the presence of grease in the P.A. lead connector. The recommended grease is Dow Corning 5 compound, Hewlett-Packard part number 8500-0059.

1311B-3. Modification to prevent arcing of post accelerator lead in high humidity operating conditions.

1311B-4. All serials. Modification to improve reliability of the A6 focus board.

1715A OSCILLOSCOPE

1715A-7. Serials 2047A and below. Instructions for replacing Plastic T-Pack transistors A1A1Q3 and A2A1Q3 in vertical attenuator boards.

1722B OSCILLOSCOPE

1722B-4. Serials 2047A and below. Instructions for replacing Plastic T-Pack transistors A1A1Q3 and A2A1Q3 in vertical attenuator boards.

1725A OSCILLOSCOPE

1725A-8. Serials 2047A and below. Instructions for replacing Plastic T-Pack transistors A1A1Q3 and A2A1Q3 in vertical attenuator boards.

3060A BOARD TEST SYSTEM

3060A-0. Service note index.

3060A-5A. Serials 1801A00100 and up, CCD Revision 1938. Modification of confirmation/configuration diagnostic (CCD) programs "digitl" and ".M0802" for proper 3455A operation during receiver test.

3060A-14B. All serials. CCD modifications for revision 2027

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

3060A-16B. All serials. CCD modifications for revision 2036.

3060A-18. All serials. Instruction for configuring the device under test power supply interlock for all power supply options.

3060A-25. All serials. 11453B Diagnostic Test Fixture correction when operated in conjunction with Option 100.

3060A-26. All serials. Reduction of system noise effecting CCD system test 135 and similar models of component tests.

3060A-27. All serials. Revision 2124 of the configuration/confirmation/diagnostic software is available under part number 03060-10002.

3060A-28. All serials. Software BTL revision from 2014 to 2117.

3060A-29. All serials. Notification of BTL/IPG Update Tape for revision 2117.

3060A-30. All systems with Option 100 HSDFT. Notification of availability of DFT development/production software tapes 03060-10101 and 03060-10102.

3060A-31. All serials. Special installation instructions for installing additional power supply in 34196A power module in conjunction with option 100.

3310A/B FUNCTION GENERATORS

3310A/B-7. 3310A serials 1151A-11370 and below; 3310B serials 1201A-05020 and below. Modification to eliminate distortion in triangle and ramp modes.

3325A SYNTHESIZER/FUNCTION GENERATOR

3325A-10. Serials 1748A-04251 and above; and 1748-04401 and above. Notification of new and improved PC board connectors and cables.

3335A SYNTHESIZER/LEVEL GENERATOR

3335A-9. Serials 1640A00270 and below. Recommended replacement for the summation loop board (A8) or the divider filter board (A2).

3400A RMS VOLTMETER

3400A-11. Serials 1218A23475 and below. Recommended transformer replacement kit 03400-68701 for older instruments.

3435A DIGITAL VOLTMETER

3435A-7. All serials. List of user configured line voltage options.

3456A DIGITAL VOLTMETER

3456A-5. Serials 2015A02970 and below. Recommended modification for AC relay protection.

3456A-6. All serials. List of 50Hz/60Hz line frequency options vs crystal part numbers for the A30 Inguard Logic PC Board.

3456A-7. Serials below 2015A02161. Recommended modification to increase +33 volt reliability.

3456A-9. Serials below 2015A03071. Preferred ROM replacement.

3465B DIGITAL MULTIMETER

3465B-4. All serials. Table of jumper configurations for line voltage options.

3476A/B DIGITAL MULTIMETER

3476A-6. All serials. Information for exchanging the 3476A A1 PC Assembly using the HP Blue Stripe Exchange Program.

3476B-5. All serials. Information for exchanging the 3476B A1 PC Assembly using the HP Blue Stripe Exchange Program.

3496A SCANNER

3496A-3. All serials. Recommend replacement of DUT power supply relays 0490-1129 with date codes 8010 through 8037.

3497A DATA ACQUISITION/CONTROL UNIT

3497A-9. All serials. Instructions for removing the option ROM when making a blue stripe board exchange of the HP-IB mainframe outguard controller board.

3551A TRANSMISSION TEST SET

3551A-0. All serials. Service note index.

3551A-14. Serials 1550A08320 and below. Cure for auto ranging problems in high frequency and high level applications.

3555B TRANSMISSION AND NOISE MEASURING SET

3555B-4. All serials. Troubleshooting procedure to test an intermittent meter circuit.

3581A/C WAVE ANALYZER

3581A/C-7. All serials. Troubleshooting procedure to test an intermittent meter circuit.

3586A/B/C SELECTIVE LEVEL METERS

3586A/B/C-0. All serials. Service note index.

3586A/B/C-2A. 3586A serials 1927A00231 and below; 3586B serials 1928A00284 and below; 3586C serials 1929A00195 and below. Recommended ROM retrofit for revision B software.

3586A/B/C-6A. All serials. 3586A/B/C HP/IB verification program listing and operating instructions.

3586A/B/C-7. All serials. Improving 3586A/B/C - 9815S desktop computer HP-IB compatibility.

3586A/B/C-8. All serials. Modification to eliminate periodic signal dropouts or noise "hits" caused by the 3586's auto calibration feature.

3736B RF MODULE FOR 3730B DOWN CONVERTER

3736B-1. Serials 00141 and below. Improvement to ensure fast lock-up in the tracking mode.

3737B RF MODULE FOR 3730B DOWN CONVERTER

3737B-1. Serials 00166 and below. Improvement to ensure fast lock-up in the tracking mode.

3737B-2. Serials 00166 and below. Change to overvoltage protection to prevent damage to transistor A11Q4.

3738B RF MODULE FOR 3730B DOWN CONVERTER

3738B-2. Serials 00141 and below. Improvement to ensure fast lock-up in the tracking mode.

3739B RF MODULE FOR 3730B DOWN CONVERTER

3739B-1. Serials 00141 and below. Improvement to ensure fast lock-up in the tracking mode.

3779A/B PRIMARY MULTIPLEX ANALYZER

3779A-22. Serials 2005U and below. Modifications to software to remove various bugs and also to add the diagnostic software package.

3779B-23. Serials 2005U and below. Modifications to software to remove various bugs and also to add the diagnostic software package.

4061A SEMICONDUCTOR/COMPONENT TEST SYSTEM

4061A-1. Serials 2043J00154 and above. Software revision from version E to version F.

4083A SWITCHING CONTROLLER

4083A-2. Serials 1920J00171 and below. Modification to improve HP-IB control.

4191A RF IMPEDANCE ANALYZER

4191A-2. All serials. Troubleshooting instruction when using the 16341A Logic Test Box.

4274A MULTI-FREQUENCY LCR METER OPTION 101 HP-IB INTERFACE

4274A-16. Serials 1850J00143 and below. Modification to prevent malfunction in option 101 HP-IB interface.

4275A MULTI-FREQUENCY LCR METER OPTION 101 HP-IB INTERFACE

4275A-13. Serials 1843J00111 and below. Modification to prevent malfunction in option 101 HP-IB interface.

4304B DC VOLT-AMMETER

4304B-1. All serials. Installation instruction for the rechargeable battery Option 001.

4328A MILLIOHMMETER

4328A-8. All serials. Installation instructions for the rechargeable battery Option 001.

4961B PAIR IDENTIFIER FIELD UNIT

4961B-4. All serials. Troubleshooting instructions for the UART A4U4 (1820-1681).

5001C MICROPROCESSOR EXERCISER

5001C-1. All serials. Operating instructions regarding the READY line from a unit under test to the 5001C.

5316A UNIVERSAL COUNTER

5316A-1. All serials. Troubleshooting instructions to find Channel C relay problems.

5340A MICROWAVE FREQUENCY COUNTER

5340A-20. Serials 2116 and below. Modification to prevent a random gating flaw (40 GHz indicated for a lower frequency signal input).

5342A MICROWAVE FREQUENCY COUNTER

5342A-27. Installation of extended dynamic range Option 003 retrofit kit part number 05342-60201.

5342A-28. Installation to Digital-to-Analog Conversion (DAC) Option 004 retrofit kit part number 05342-60202.

5370A UNIVERSAL TIME INTERVAL COUNTER

5370A-11. All serials. Recommended addition to front end checkout procedure.

5427A VIBRATION CONTROL SYSTEM

5427A-04. All serials. DAC Diagnostic Program procedure.

5501A LASER TRANSDUCER SYSTEM

5501A-8. Recommended cleaning procedure for optical instruments.

5526A LASER MEASUREMENT SYSTEM

5526A-6. Recommended cleaning procedure for optical accessories.

6114A PRECISION POWER SOURCE

6114A-1. Serials 1928A-02290 and below. Preferred replacement for the thumbwheel assembly.

6115A PRECISION POWER SOURCE

6115A-1. Serials 1937A-01000 and below. Preferred replacement for the thumbwheel assembly.

6129C DIGITAL VOLTAGE SOURCE

6129C-4. Serials 1943A-00658 and below. Modification to correct output amplifier (A7) oscillation.

6130C DIGITAL VOLTAGE SOURCE

6130C-4. Serials 1949A-01670 and below. Modification to correct output amplifier (A7) oscillation.

6131C DIGITAL VOLTAGE SOURCE

6131C-4. Serials 2114A-01160 and below. Modification to correct output amplifier (A7) oscillation.

6942A MULTIPROGRAMMER

6942A-2. Serials 2039A-1050 and below. Recommended front panel change to accommodate round LED indicators instead of the earlier rectangular LEDs.

6942A-3. Serials 2039A-01050 and below. Modification to eliminate unwanted self-test looping.

6942A-4. Serials 2013A00321 and below. Recommended modification to eliminate the "cold start" syndrome.

6943A MULTIPROGRAMMER EXTENDER

6943A-1. Serials 2040A-00180 and below. Recommended front panel change to accommodate round LED indicators instead of the earlier rectangular LEDs.

7100B STRIP CHART RECORDER

7100B-10. Serials 2042A and 2043A. Recommended replacement pen drive pulley and stop assembly.

7101B STRIP CHART RECORDER

7101B-10. Serials 2042A and 2043A. Recommended replacement pen drive pulley and stop assembly.

7580A DRAFTING PLOTTER

7580A-1. All serials. Recommended pinchwheel replacements.

8018A DATA GENERATOR

8018A-3. Serials 1826G00825 and below. Modification to the A6 memory board and to the A12 memory extention board to improve the timing conditions for the last bit signal (L) and signal N1023.

8405A VECTOR VOLTMETER

8405A-8. Serials 2014A and below. Recommended "APC UNLOCKED" indicator light replacement.

8405A-9. Serials 2014A and below. Isolation Amplifier transistor replacement to correct poor isolation between channels.

8411A HARMONIC FREQUENCY CONVERTER

8411A-6. Serials 934-01805 and below. Recommended stripline replacement kit.

8411A-7. Serials 930 and below. Recommended cable replacement kit.

8443A TRACKING GENERATOR-COUNTER

8443A-5. Serials 1821A and below. Low frequency counter replacement kit HP part number 08443-60096.

8500A/B MICROWAVE TEST SYSTEM

8500A-2A/85007A-1. All serials. Troubleshooting aids.

8555A SPECTRUM ANALYZER

8555A-12A. All serials. Frequency response adjustment after replacement of input mixer assembly HP part number 08555-60072.

8565A SPECTRUM ANALYZER

8565A-7. Serials 2027A and below. Recommended third converter assembly replacement kit.

8565A-10. All serials. Improved frequency response performance test.

8565A-11. All serials. Location of the input fuse to the 30V power supply.

8566A SPECTRUM ANALYZER

8566A-15. All serials. Field installation procedure of Option 650, Quasi-Peak Adapter Kit.

8568A SPECTRUM ANALYZER

8568A-39. All serials. Field installation procedure of Option 650, Quasi-Peak Adapter Kit.

8568A-40. IF-Display Section Serial Prefix 1745A and below. Modification to prevent oscillation when used with HP 85650A Quasi-Peak Adapter.

8569A SPECTRUM ANALYZER

8569A-1. All serials. Field modification to make the 8569A analyzer compatible with a 7225A graphics plotter and the 17601A I/O module (17601A serials 1939A and below).

8656A SIGNAL GENERATOR

8656A-9. Serials 2124A and below. Fan replacement procedure.

8656A-10. Serials 2135A and below. Modification to correct for spurious sidebands 60-110 MHz VCO.

8656A-11. Serials 2111A and below. Improved automatic FM calibration.

8656A-12. Serials 2117A and below. Modification to reduce 5.6 kHz spur offset from output frequencies of 99.9993 and 899.9993 MHz.

8656A-13. Serials 2111A and below. Modification to reduce 140 MHz spur with an output frequency of 80 MHz.

8656A-14. Serials 2111A and below. Modification to reduce spurs 17, 37 and 42 MHz offset from output frequencies of .1 to 123.5 MHz.

8662A SYNTHESIZED SIGNAL GENERATOR

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

8672A SYNTHESIZED SIGNAL GENERATOR

8672A-7A. All serials. New part number for A1CR1 leveling detector.

9571A — DTS-70 SYSTEM

9571A-19. Software serial numbers 2100A00100 and above. 91075D/E/F/J/K/L Software System, Rev. 2100.

17501A AND 17503A PLUG-IN MODULES (7100B and 7101B Strip Chart Recorders)

17501A-2A/17503A-2A. Serials 717 and below. Electric writing compatibility.

37203A HP-IB EXTENDER

37203A-6. All serials. Preferred replacement of IC A1U55 (New part number 1820-0681).

64300 LOGIC ANALZYER

64300-1. Serials 1927A00051 thru 1927A00077. Modification to prevent logic analysis trace errors.

645XX PROM PROGRAMMER

64503A-1. (Repair numbers are not assigned to this model.) Equipment safety procedure. Possible damage to the Programmer Module during performance verification.

64507A-1. (Repair numbers are not assigned to this model.) Equipment safety procedure. Possible damage to the Programmer Module during performance verification.

64509A-1. (Repair numbers are not assigned to this model.) Equipment safety procedure. Possible damage to the Programmer Module during performance verification.

64940A CARTRIDGE TAPE SYSTEM

64940A-1A. All serials. Recommended procedure to prevent cartridge tape despooling.

64940-2A. Instructions for overcomming tape transport system verification errors.

85007A DISPLAY GENERATOR

8500A-2A/85007A-1. All serials. Supplementary information on machine language programs as troubleshooting aids.

86633B MODULATION SECTION PLUG-IN

86633B-1. Serials 1851A and below. Modification to prevent a remote programming controller hang-up.

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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