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LOGIC SYMBOLS

By Tom Trompeter

Editor's Note:

In the course of publishing these articles on logic symbology, BENCH BRIEFS has come under some criticism along the line of, "why another standard — what is wrong with the MIL-STD-806?" It seems many readers felt these articles were just another rehash of logic symbols, nothing really new — just different. As Editor of BENCH BRIEFS I have been remiss in not pointing out from the beginning that this standard, IEEE 91-1973, replaces MIL-STD-806 and is approved for use by the Department of Defense. Hewlett-Packard is in the process of adopting this standard as has another major semi-conductor manufacturer.

This series of articles has raised many questions and that's good. Hopefully your appetite has been whetted enough that you will obtain a copy of IEEE 91-1973 and take up where we have left off. Remember, we are living in a world and working in an industry where ultra-rapid technological change is the rule. Logic devices are more complex now than they used to be and the old traditional approach is simply not adequate to deal with them. Complex symbols stem from complex circuits, not the Standard we follow. This means that you must address your needs for training and be willing to constantly re-educate yourselves and update the "tools" you use if you hope to keep up. Hewlett-Packard has gone to the IEEE Standard so that the HP instruments manufactured throughout the world will have consistent schematics from instrument-to-instrument. The ultimate benefactor will be the service technician who will have a much easier repair job since schematic symbology and abbreviations are consistent from product-to-product.

I want to thank Tom Trompeter for his series of articles reflecting one of the first HP divisions to produce schematics using the standard.

This is the fourth and final in a series of articles on the IEEE Standard 91-1973 Graphic Symbols for Logic Diagrams (two-state devices). This last article applies the qualifiers previously described to monostable flip-flops, various counters, and LED display drivers. The following illustrations describe some applications of the rules and guidelines brought out in the previous articles.

RETRIGGERABLE MONOSTABLE FLIP-FLOP

Two forms for a Retriggerable Monostable Flip-Flop are shown in Figure 1. Figure 1a shows the device drawn in rectangular form using elements from the standard. Figure 1b shows the same device redrawn in an equivalent form, still using elements from the standard.

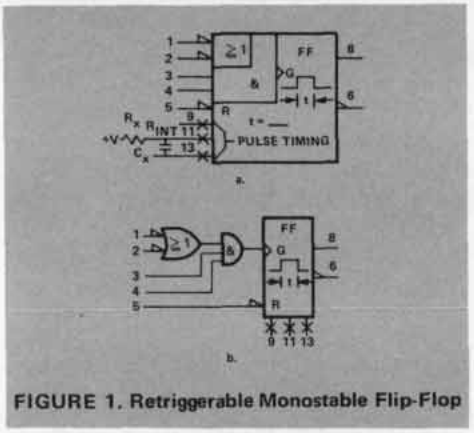

FIGURE 1. Retriggerable Monostable Flip-Flop

The Retriggerable Monostable Flip-Flop is described twice here. The first time in theory-of-operation form, and the second time using the description of the device operation to describe the logic notation.

Extremely long output pulses can be generated because of the retrigger capability. By triggering the inputs before the output pulse is terminated, the pulse duration is extended. The pulse duration is terminated by making the "R" (reset) input (pin 5) low at a predetermined time independent of the timing components.

The ORed inputs are active-low while the ANDed inputs are active-high. These are ANDed to produce "G". When "G" goes high, the output pulses from pins 8 (active high) and 6 (active low) start and continue for the preset time period "t". This preset time period is determined by either internal or external timing circuitry, or until an "R" (Reset) input occurs The reset input at pin 5 can terminate the output pulses whenever it is set active low.

Using the above theory-of-operation description of the device, we can show how the notations used in Figure 1a and 1b provide the same information. For example:

a. We said the ORed inputs are active low while the ANDed inputs are active high. Figure 2 graphically shows this.

b. We said these inputs are ANDed to produce "G". This is illustrated by the Contiguous Block diagram which shows the logic AND connection to produce "G". Refer to Figure 1b for a more graphic illustration.

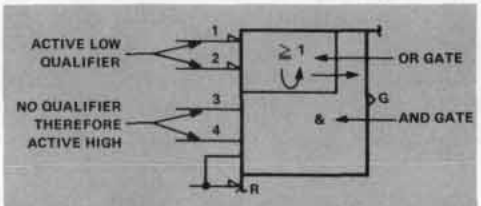

FIGURE 2. ORed and ANDed Inputs

PRESETTABLE DECADE COUNTER/LATCH

The symbol for a Presettable Decade Counter/Latch is shown in Figure 3. The Decade Counter consists of a divide-by-two and a divide-by-five counter formed by connecting pin 5 to pin 6 and taking the output from pin 12.

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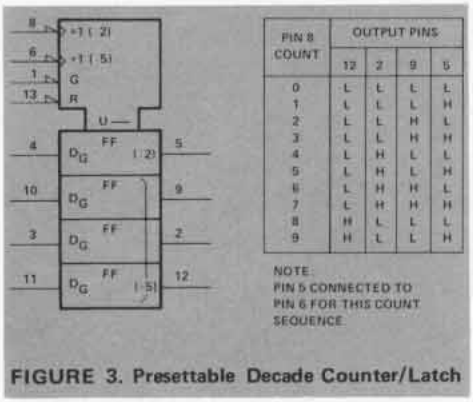

FIGURE 3. Presettable Decade Counter/Latch

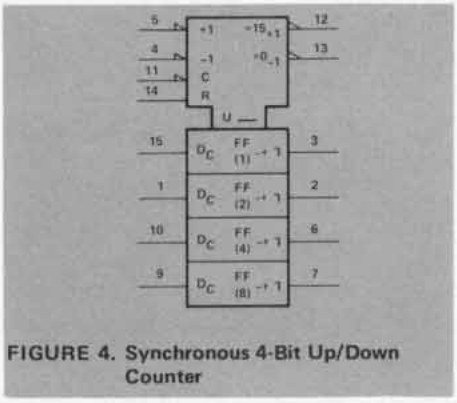

FIGURE 4. Synchronous 4-Bit Up/Down Counter

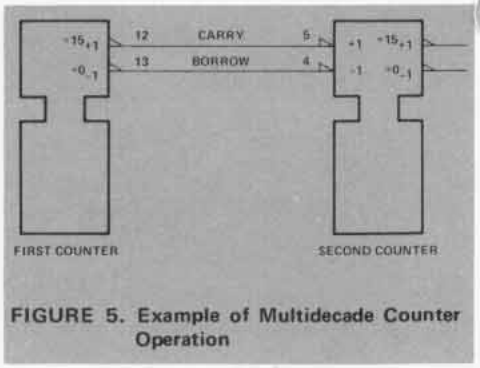

FIGURE 5. Example of Multidecade Counter Operation

The outputs may be preset to any state by making "G" active low and entering the desired data at the "D_C" inputs. The outputs at pins 5, 9, 2, and 12 will then correspond to the data inputs independent of the state of the count-up clocks at pins 6 and 8. An active high signal at pin 1 then enables the counter by latching the parallel data into the counter. The count-up clock at pin 8 clocks the ÷ 2 counter and pin 6 clocks the ÷ 5 counter. When the counter is clocked at pins 8 or 6, the outputs will change on the negative-going edge of the signal. An active low at the "R" (reset) input (pin 13) causes all the outputs to go low independent of the counting state.

SYNCHRONOUS 4-BIT UP/DOWN COUNTER

The symbol for a Synchronous 4-Bit Counter is shown in Figure 4. Operation of the counter is synchronous, with the outputs changing state after an active low signal at either the count-up clock (+1) or count-down clock (–1) (i.e. the counter responds to a clock pulse on either input by changing to the next appropriate state of the count sequence). The outputs actually change state on the trailing edge of the input signal as shown by the Output Delay Indicator (⅂). The direction of counting is determined by which clock input is pulsed with an active low signal while the other clock input is disabled with an active high. Incorrect (or undefined) counting will occur if both clock inputs are active low simultaneously.

The counter has the ability to parallel load (asynchronous) input data (preset the counter). This is accomplished by making "C" active low and entering the desired data at the "D_C" inputs. The outputs at pins 3, 2, 6 and 7 will then correspond to the data inputs independent of the state of the count-up/down clocks at pins 4 and 5.

An active high signal at pin 11 then enables the counter by latching the parallel data into the counter. When the counter is clocked at pins 5 or 4, the outputs will change to the next appropriate state in the count sequence. The "D_C" inputs are inhibited while "C" is held high and have no effect on the counter.

The terminal count-up ($=15_{+1}$) or terminal count-down ($=0_{-1}$) outputs (carry and borrow respectively) allow multidecade counter operation without additional logic. As shown in Figure 5, the counters are cascaded by feeding the terminal count-up output of the first counter to the second counter's count-up clock input, and the first terminal count-down output to the second count-down clock input.

The counter is in state fifteen (generating a carry) when the terminal count-up output of the binary counter is active low. Similarly, when the terminal count-down output is active low the counter is in state zero (generating a borrow). Thus, when the binary counter is in state fifteen and counting up, or in state zero and counting down, a clock pulse on pin 5 or 4 will change the counter's state on the rising edge and simultaneously clock the second counter through the appropriate terminal count output. There are two gate delays per state when these counters are cascaded. When the asynchronous master reset "R" input goes active high, it overrides all other inputs and clears the counter. An active high signal at the "R" input causes all the outputs to go low independent of the counting state.

LED DISPLAY DRIVER

The symbol of a typical LED Display Driver is shown in Figure 6. The LED Display Driver accepts a 4-bit binary code and provides output drive to light the appropriate segments of a 7-segment numeric display. The truth table in Figure 6 shows the possible alpha-numeric codes.

Latches on the four data inputs are controlled by the Enable (G2) input. When "G2" is active low, the states of the outputs are determined by the input data code. When "G2" goes high, the last data code present at the input to the latches is stored and the output remains stable.

The LED Display Driver also has automatic blanking and zero suppression through the ripple blanking input (RBI) at pin 5, and the ripple blanking output (RBO) at pin 4. The "G1" line always serves as an input; the "G3" line typically serves as an output but can also be configured as an input by connecting it to an external source. When "G3" is held low by an external source, it overrides all other inputs to the LED Display Driver and causes it to provide blanking outputs to all segments of the associated display.

When "G3" is not connected to an external drive source it serves as a blanking output which is controlled by "G1". As shown in the Truth Table in Figure 6, the combination of an active low "G1" and a binary 0 code causes the LED Display Driver to set the RBO output low and to provide blanking outputs to all segments of the associated display. For zero suppression, the RBI line associated with the most significant digit is grounded and the RBO output is connected to the "G1" input of the next significant digit. Using this configuration a number such as 0010 would be displayed as 10. □

TRUTH TABLE

BINARY DATA INPUT	INPUTS													OUTPUTS								DISPLAY
	CONTROL			DATA																		
	G1	G2	G3	8	4	2	1	a	b	c	d	e	f	g	RBO	
–	•	H	**	X	X	X	X	STABLE							H	STABLE
0	L	L	**	L	L	L	L	H	H	H	H	H	H	H	L	BLANK
0	H	L	**	L	L	L	L	L	L	L	L	L	L	H	H	0
1	X	L	**	L	L	L	H	H	L	L	H	H	H	H	H	1
2	X	L	**	L	L	H	L	L	L	H	L	L	H	L	H	2
3	X	L	**	L	L	H	H	L	L	L	L	H	H	L	H	3
4	X	L	**	L	H	L	L	H	L	L	H	H	L	L	H	4
5	X	L	**	L	H	L	H	L	H	L	L	H	L	L	H	5
6	X	L	**	L	H	H	L	L	H	L	L	L	L	L	H	6
7	X	L	**	L	H	H	H	L	L	L	H	H	H	H	H	7
8	X	L	**	H	I	L	L	L	L	L	L	L	L	L	H	8
9	X	L	**	H	L	L	H	L	L	L	H	H	L	L	H	9
10	X	L	**	H	L	H	L	H	H	H	H	H	H	L	H	– (dash)
11	X	L	**	H	L	H	H	L	H	H	L	L	L	L	H	E
12	X	L	**	H	H	L	L	H	L	L	H	L	L	L	H	H
13	X	L	**	H	H	L	H	H	H	H	L	L	L	H	H	L
14	X	L	**	H	H	H	L	L	L	H	H	L	L	L	H	P
15	X	L	**	H	H	H	H	H	H	H	H	H	H	H	H	BLANK
X	X	X	L	X	X	X	X	H	H	H	H	H	H	H	**	BLANK

H = HIGH; L = LOW; X = DON'T CARE CONDITION

*The G1 input will blank the display only if a binary zero is stored in the latches.

**The RBO output (pin 4) when used as an input (G3) overrides all other input conditions.

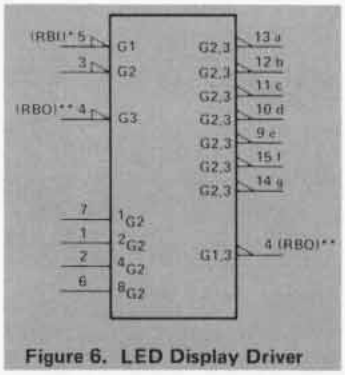

Figure 6. LED Display Driver

1976 APPLICATION NOTE INDEX

Hewlett-Packard Application Notes are a compilation of applications research and experience which have been written in collaboration with HP engineers and our customers.

Some notes are tutorial in nature, while others describe very specific "how to" procedures. Copies are available from your local field engineer or sales office (refer to the updated list in this issue of Bench Briefs).

The Application Note Index abstracts the current notes available. A listing of the HP instruments for which notes have been written is included as well as a subject index.

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ATTENTION 3490A MULTIMETER USERS

A new service note, 3490A-14, has been issued that provides detailed information on digital troubleshooting in the 3490A Multimeter. The topics covered are:

I Understanding Algorithmic State Machine (ASM) in the 3490A

II Interpreting Flowcharts

III Additional Logic Circuits

IV Identification of Logic Problems

V Troubleshooting

VI 3490A ASM Flowcharts

Owners of 3490A Multimeters can order the service note with the order form located on the inside last page of Bench Briefs.

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That's a phrase frequently seen in HP publications. It appears with shipping instructions, parts ordering information and service literature. That phrase reminds you to call your local HP office if you need help. But to do that you must know where to find your local HP office. As HP continues to grow, many offices find themselves outgrowing their facilities and moving to larger quarters. Occasionally an additional office is added to serve an area. These changes may mean that an HP office is now more conveniently located for you.

Although many HP manuals and other publications contain a complete list of HP offices, the list may not be completely current since it is revised only when the publication is reprinted.

To make sure that you can easily locate your local HP office to obtain the service you have come to expect of Hewlett-Packard, here's an up-to-date listing of field offices for all areas of the world.

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3200 Hillview Ave.
Palo Alto, California 94304
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TWX: 910-373-1267
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Telex: 034-8300, 034-8493

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Tel: (0222) 35 16 21 to 27
cable: HEWPAK Vienna
Telex: 75923 hewpak a

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S.A./N.V.
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Telex: 23 494 paloben bru

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Vyzkumnych Ustava v Bechovicich
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Bechovice u Prahy
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Telex: 121333

DDR
Entwicklungslabor der TU Dresden
Forschungsinstitut Meinsberg
DDR-7305
Waldheim/Meinsberg
Tel: 37 667
Telex: 518741

DENMARK
Hewlett-packard A/S
Datavej 52
DK-3460 **Birkerod**
Tel: (02) 81 66 40
Cable: HEWPACK AS
Telex: 166 40 hpas

Hewlett-Packard A/S
Navervej 1
DK-8600 **Silkeborg**
Tel: (06) 82 71 66
Telex: 166 40 hpas
Cable: HEWPACK AS

FINLAND
Hewlett-Packard OY
Nahkahousuntie 5
P.O. Box 6
SF-00211 **Helsinki** 21
Tel: 6923031
Cable: HEWPACKOY Helsinki
Telex: 12-1563

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Hewlett-Packard France
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Marseille-Marignane
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Hewlett-Packard France
Agence Régionale
Centre Vauban
201, rue Colbert
Entrée A2
F-59000 **Lille**
Tel: (20) 51 44 14
Telex: 820744

GERMAN FEDERAL REPUBLIC
Hewlett-Packard GmbH
Vertriebszentrale Frankfurt
Bernerstrasse 117
Postfach 560 140
D-6000 **Frankfurt** 56
Tel: (0611) 50 04-1
Cable: HEWPACKSA Frankfurt
Telex: 04 13249 hpffmd

Hewlett-Packard GmbH
Technisches Buero Böblingen
Herrenbergerstrasse 110
D-7030 **Böblingen**, Württemberg
Tel: (07031) 667-1
Cable: HEPAK Böblingen
Telex: 07265739 bbn

Hewlett-Packard GmbH
Technisches Buero Düsseldorf
Emanuel-Leutze-Str.1 (Seestern)
D-4000 **Düsseldorf**
Tel: (0211) 59 71-1
Telex: 085/86 533 hpdd d

Hewlett-Packard GmbH
Technisches Buero Hamburg
Wendenstrasse 23
D-2000 **Hamburg** 1
Tel: (040) 24 13 93
Cable: HEWPACKSA Hamburg
Telex: 21 63 032 hphh d

Hewlett-Packard GmbH
Technisches Buero Hannover
Mellendorfer Strasse 3
D-3000 **Hannover-Kleefeld**
Tel: (0511) 55 60 46
Telex: 092 3259

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D-8500 **Nuremberg**
Tel: (0911) 56 30 83/85
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Unterhachinger Strasse 28
ISAR Center
D-8012 **Ottobrunn**
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Telex: 0524985

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Technisches Buero Berlin
Keith Strasse 2-4
D-1000 **Berlin** 30
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Mir-Emad Avenue
14th Street No 13
P.O. Box 41/2419
IR-**Tehran**
Tel: 85 10 82/86
Telex: 21 25 74 Khrm ir

IRELAND
Hewlett-Packard Ltd.
King Street Lane
GB-**Winnersh,**Wokingham
Berks. RG11 5AR
Tel: (0734) 78 47 74
Telex: 847178/848179

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Casella postale 3645
I-20100 **Milano**
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Hewlett-Packard Benelux
S.A./N.V.
Avenue du Col-Vert, 1,
(Groenkraaglaan)
B-1170 **Brussels**
Tel: (02) 672 22 40
Cable: PALOBEN Brussels
Telex: 23 494

MOROCCO
Gerep
190, Blvd. Brahim Roudani
Casablanca
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Cable: Gerep-Casa
Telex: 23739

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Hewlett-Packard Benelux N.V.
Van Heuven Goedhartlaan 121
P.O. Box 667
NL- **Amstelveen** 1134
Tel: (020) 47 20 21
Cable: PALOBEN Amsterdam
Telex: 13 216 hepa nl

NORWAY
Hewlett-Packard Norge A/S
Nesveien 13
Box 149
N-1344 **Haslum**
Tel: (02) 53 83 60
Telex: 16621 hpnas n

POLAND
Biuro Informacji Technicznej
Hewlett-Packard
U1 Stawki 2 6P
00-950**Warsaw**
Tel: 39 67 43
Telex: 81 24 53 hepa pl

UNIPAN
Zaklad Doswiadczalny
Budowy Aparatury Naukowej
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Narodowej 51/55
00-800 **Warsaw**
Tel: 20 62 21
Telex: 81 46 48

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Medycznego
Plac Komuny Paryskiej 6
90-007 **Lodz**
Tel: 334-41, 337-83

PORTUGAL
Telectra-Empresa Técnica de
Equipamentos Eléctricos S.a.r.l.
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P.O. Box 2531
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Cable: INTERCAMBIO Lisbon

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BD.N. Balcescu 16
Bucharest
Tel: 158023/138885
Telex: 10440

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Bucharest-Sectorul 2
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Telex: 01183716

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Jerez No. 3
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E-**Barcelona** 17
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Hewlett-Packard Sverige AB
Enighetsvägen 3
Fack
S-161 20 **Bromma** 20
Tel: (08) 730 05 50
Cable: MEASUREMENTS
Stockholm
Telex: 10721

Hewlett-Packard Sverige AB
Frötallsgatan 30
S-421 32 **Västra Frölunda**
Tel: (031) 49 09 50
Telex: 10721 Via Bromma Office

SWITZERLAND
Hewlett-Packard (Schweiz) AG
Zürcherstrasse 20
P.O. Box 307
CH-8952 **Schlieren-Zurich**
Tel: (01) 730 52 40
Cable: HPAG CH
Telex: 53933 hpag ch

Hewlett-Packard (Schweiz) AG
9, Chemin Louis-Pictet
CH-1214 **Vernier-Geneva**
Tel: (022) 41 49 50
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Tel: 175622

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Milli Mudafaa Cad No. 16/6
Kizilay
TR-**Ankara**
Tel: 25 03 09
Telex: 42576 Ozek tr

UNITED KINGDOM
Hewlett-Packard Ltd.
King Street Lane
GB-**Winnersh,** Wokingham
Berks. RG11 5AR
Tel: (0734) 78 47 74
Cable: Hewpie London
Telex:847178/9

Hewlett-Packard Ltd.
"The Grafftons"
Stamford New Road
GB-**Altrincham**
Cheshire WA14 1DQ
Tel: (061) 9289021
Cable: Hewpie Manchester
Telex: 668068

Hewlett-Packard Ltd.
Lygon Court
Dudley Road
GB-**Halesowen**, Worcs
Tel: (021) 550 7053
Telex: (021) 550 7273

Hewlett-Packard Ltd.
Wedge House
799, London Road
GB-**Thornton Heath**
Surrey CR4 6XL
Tel: (01) 6840105
Telex: 946825

Hewlett-Packard Ltd.
c/o Makro
South Service Wholesale Centre
Wear Industrial Estate
Washington
GB-**New Town**, County Durham
Tel: Washington 464001 ext. 57/58

USSR
Hewlett-Packard Representative
Office USSR
Pokrovsky Boulevard 4/17, KV 12
Moscow101000
Tel: 294-2024
Telex: 7825 hewpak su

YUGOSLAVIA
Iskra-standard/Hewlett-Packard
Miklosiceva 38/VII
61000 **Ljubljana**
Tel: 31 58 79/32 16 74
Telex: 31300

MEDITERRANEAN AND MIDDLE EAST COUNTRIES NOT SHOWN PLEASE CONTACT:
Hewlett-Packard S.A.
Mediterranean and Middle
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35, Kolokotroni Street
Platia Kefallariou
GR-Kifissia-**Athens**, Greece
Tel: 8080337/359/429

SOCIALIST COUNTRIES NOT SHOWN PLEASE CONTACT:
Hewlett-Packard Ges.m.b.H.
P.O. Box 7
A-1205 **Vienna**, Austria
Tel: (0222) 35 16 21 to 27

FOR OTHER AREAS NOT LISTED CONTACT
Hewlett-Packard S.A.
7, rue du Bois-du-Lan
P.O. Box
CH-1217 Meyrin 2 - **Geneva**
Switzerland
Tel: (022) 41 54 00

CENTRAL AND SOUTH AMERICA

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Hewlett-Packard Argentina
S.A.
Av. Leandro N. Alem 822 - 12°
1001**Buenos Aires**
Tel: 32-4461/62/63/64
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La Paz
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Hewlett-Packard do Brasil
I.E.C. Ltda.
Rua Frei Caneca,
1140/52 Bela Vista
01307-**São Paulo**-SP
Tel: 288-71-11, 287-81-20,
287-61-93
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Rua Padre Chagas, 32
90000-**Pôrto Alegre**-RS
Tel: (0512) 22-2998, 22-5621
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I.E.C. Ltda.
Rua Siqueira Campos, 53, 4°
andar-Copacabana
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Telex: 391-212-1905 HEWP-BR
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Paraguay 494
Casilla 13910
Santiago
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Cable: GEMCO Santiago

COLOMBIA
Instrumentación
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Carrera 7 No. 48-75
Apartado Aéreo 6287
Bogotá, I.D.E.
Tel: 69-88-77
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Telex: 044-400

COSTA RICA
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Bulevar de los Heroes II-48
San Salvador
Tel: 252787

GUATEMALA
IPESA
Avenida La Reforma 3-48,
Zona 9
Guatemala City
Tel: 63627, 64786
Telex: 4192 Teletro Gu

MEXICO
Hewlett-Packard Mexicana,
S.A. de C.V.
Torres Adalid No. 21, 11° Piso
Col. del Valle
Mexico 12, D.F.
Tel: (905) 543-42-32
Telex: 017-74-507

Hewlett-Packard Mexicana,
S.A. de C.V.
Ave. Constitución No. 2184
Monterrey, N.L.
Tel: 48-71-32, 48-71-84
Telex: 038-843

NICARAGUA
Roberto Terán G.
Apartado Postal 689
Edificio Terán
Managua
Tel: 25114, 23412,23454
Cable: ROTERAN Managua

PANAMA
Electrónico Balboa, S.A.
P.O. Box 4929
Calle Samuel Lewis
Cuidad de Panama
Tel: 64-2700
Telex: 3431103 Curunda,
Canal Zone
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División: Aparatos y Equipos
Médicos
División: Aparatos y Equipos
Científicos y de Investigación
P.O. Box 676
Chile-482, Edificio Victoria
Asunción
Tel: 4-5069, 4-6272
Cable: RAMEL

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Compañía Electro Médica S.A.
Los Flamencos 145
San Isidro Casilla 1030
Lima 1
Tel: 41-3703
Cable: ELMED Lima

PUERTO RICO
Hewlett-Packard Inter-Americas
Puerto Rico Branch Office
P.O. Box 2908I
65th Inf. Station
San Juan 00929
Calle 272, Urb. Country Club
Carolina 00639
Tel: (809) 762-7355/7455/7655
Telex: HPIC-PR 3450514

URUGUAY
Pablo Ferrando S.A.
Comercial e Industrial
Avenida Italia 2877
Casilla de Correo 370
Montevideo
Tel: 40-3102
Cable: RADIUM Montevideo

VENEZUELA
Hewlett-Packard de Venezuela
C.A.
Apartado 50933, Caracas 105
Edificio Segre
Tercera Transversal
Los Ruices Norte
Caracas 107
Tel: 35-0I-07, 35-00-84,
35-00-65, 35-00-3I
Telex: 25146 HEWPACK
Cable: HEWPACK Caracas

FOR AREAS NOT LISTED, CONTACT:
Hewlett-Packard
Inter-Americas
3200 Hillview Ave.
Palo Alto, California 94304
Tel: (415) 493-1501
TWX: 910-373-1260
Cable: HEWPACK Palo Alto
Telex: 034-8300, 034-8493

UNITED STATES

ALABAMA
8290 Whitesburg Dr., S.E.
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Huntsville 35802
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Birmingham 35209
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TWX: 910-223-3613

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INDIANA
7301 North Shadeland Ave.
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Night: (319) 338-9467

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MARYLAND
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TWX: 710-828-9684

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TWX: 910-563-3734

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Omaha 68106
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TWX: 910-989-1185

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TWX: 910-983-0550

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Computer Park
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Tel: (914) 454-7330
TWX: 510-248-0012

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Rochester 14623
Tel: (716) 473-9500
TWX: 510-253-5981

5858 East Molloy Road
Syracuse 13211
Tel: (315) 454-2486
TWX: 710-541-0482

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High Point 27262
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TWX: 810-474-2818

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Columbus 43229
Tel: (614) 436-1041

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Oklahoma City 73132
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TWX: 710-795-3124

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King of Prussia 19406
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Richmond 23228
Tel: (804) 285-3431

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Bellevue 98004
Tel: (206) 454-3971
TWX: 910-443-2446

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Tel: (304) 345-1640

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9004 West Lincoln Ave.
West Allis 53227
Tel: (414) 541-0550

FOR U.S. AREAS NOT LISTED:
Contact the regional office nearest you: Atlanta, Georgia... North Hollywood, California... Rockville, Maryland...Rolling Meadows, Illinois.Their complete addresses are listed above.

***Service Only**

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CANADA

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11748 Kingsway Ave.
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915-42 Avenue S.E. Suite 102
Calgary T2G 1Z1
Tel: (403) 287-1672
TWX: 610-821-6141

BRITISH COLUMBIA
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TWX: 610-922-5059 VCR

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Hewlett-Packard (Canada) Ltd.
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Winnipeg R3H 0L8
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TWX: 610-671-3531

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Hewlett-Packard (Canada) Ltd.
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Ottawa K2C 0P9
Tel: (613) 225-6530
TWX: 610-562-8968

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Mississauga L4V 1M8
Tel: (416) 678-9430
TWX: 610-492-4246

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Hewlett-Packard (Canada) Ltd.
275 Hymus Blvd.
Pointe Claire H9R 1G7
Tel: (514) 697-4232
TWX: 610-422-3022
TLX: 05-821521 HPCL

Hewlett-Packard (Canada) Ltd.
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Tel: (418) 688-8710
TWX: 610-571-5525

FOR CANADIAN AREAS NOT LISTED:
Contact Hewlett-Packard (Canada) Ltd. in Mississauga.

SAFETY-RELATED SERVICE NOTES

Service Notes from HP relating to personal safety and possible equipment damage are of vital importance. To make you more aware of these important notes, HP has recently modified the Safety Service Note format. The note is now printed on paper with a red border, and a " – S" suffix has been added to the note's number. In order to make you immediately aware of any potential safety problems, we are high-lighting 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 rear of BENCH BRIEFS, each appropriate number is highlighted by being printed in color.

740A/B AND 3420A/B VOLTMETERS

These instruments have a POTENTIAL SHOCK HAZARD. If the instrument is floated above ground, control shafts (and control knob set screws) are above ground potential. In order to test your instrument for this potential shock hazard refer to the abbreviated test procedure below. Please note that more detailed instructions are available on the applicable Service Notes.

If the instrument fails the test it can be made to conform to current safety standards with one of the appropriate modification kits.

740A/B – Kit No. 00740-87901
3420A/B – Kit No. 03420-89501

TEST PROCEDURES

Turn the power switch OFF, disconnect all power cords and grounding straps from the instrument.

– Set the ohmmeter to the 1K ohm range.

740A/B

– Connect the Input Cable Assembly (11054A) to the 740A/B.

– Check for continuity between the – (minus) terminal on the cable assembly and all of the set screws of each control knob.

Infinity = OK

3420A/B

– Check for continuity between the INPUT LOW terminal and all of the set screws of each control knob.

Infinity = OK

Hewlett-Packard continually offers training to customers on a world-wide basis to help keep service skills current with HP's extensive product line. Seminars are provided throughout Europe and the United States in an effort to bring our training facilities closer to your area.

EUROPEAN TRAINING

Service seminars in Europe are offered on a supply-and-demand basis. For HP to have a better idea of customer needs, please fill out the questionnaire form on page 14 of Bench Briefs and mail it to the Geneva address.

UNITED STATES TRAINING

Several service seminars are being offered by Hewlett-Packard next year in several locations around the U.S. The lectures are given in a lab-type environment so students will have ample opportunity for hands-on experience.

For registration please use the form on the last page of Bench Briefs or contact your Hewlett-Packard Sales and Service Office.

5345A ELECTRONIC COUNTER
FEB 7-9, PARAMUS, N.J.

COURSE CONTENT

LECTURE

I. General Features
II. Overall Block Diagram Description
III. Circuit Descriptions
  A. Input Circuits
  B. Control Circuits
  C. Scaler Circuits
  D. Processor Circuits
IV. Explanation of Algorithmic State Machine Flowcharts

LAB

I. Explanation of Troubleshooting Flowcharts using the HP 1600A Logic State Analyzer and the 5345A ASM Tester.

PREREQUISITES – Familiarity with digital logic and integrated circuits.

PRESTUDY – "The Fundamentals of Electronic Frequency Counters", Application Note 172. 5345A Users Handbook, HP Part Number 5952-0886D.

5340A MICROWAVE FREQ COUNTER
MAR 7-8, SANTA CLARA, CALIF.

COURSE CONTENT

LECTURE

I. Overall Block Diagram
II. Numerical Examples of Frequency Measurements
III. Input Phase Lock Loop Circuit Description
IV. Transfer Phase Lock Loop Circuit Description
V. Instrument Flow Diagram and Algorithmic State Machine
VI. Options

LAB

The lecture is given in a lab environment. Attendees make voltage and waveshape measurements at different times during the lecture. A familiarization with adjustment procedures is also included.

PREREQUISITES – Basic knowledge of microwave measuring techniques

PRESTUDY – April 1973 HP Journal describing 5340A. "The Fundamentals of Electronic Frequency Counters", Application Note 172.

8660 SYNTHESIZED SIG GEN
MAR 14-15, LOS ANGELES, CALIF.
MAR 28-29, RICHARDSON, TEXAS
MAR 30-31, PARAMUS, NJ

COURSE CONTENT

This course includes the following components of the 8660 System:

8660A	**Thumbwheel Mainframe**
8660C	**Keyboard Mainframe**
86601A	**RF Section 0–110 MHz**
86602B	**RF Section 1–1300 MHz**
86603A	**RF Section 1–2600 MHz**
86632B	**Modulation Section**
86633A	**Modulation Section**
86634A	**Modulation Section**
86635A	**Modulation Section**
11661B	**Frequency Extension Module**

LECTURE

I. Introduction to 8660 System
   - A. System Block
   - B. Specifications
   - C. General Operation
     1. Mainframe
     2. RF Section
     3. Modulation Section
   - D. Indirect Generation (Video Tape)

II. 8660 Theory
   - A. Reference and Loops
   - B. DCU
   - C. Remote Programming

III. 86601A
   - A. Operation and Controls
   - B. Mainframe Interface
   - C. Functional Block Theory
   - D. Adjustments
   - E. Module Level Troubleshooting
   - F. Lab

IV. 86632 thru 86635
   - A. Operation and Controls
   - B. Mainframe Interface
   - C. Functional Block Theory
   - D. Adjustments
   - E. Module Level Troubleshooting
   - F. Lab

V. 86602B/11661B/86603A
   - A. Operation and Controls
   - B. Mainframe Interface
   - C. Functional Block Theory
   - D. Adjustments
   - E. Module Level Troubleshooting
   - F. Lab

LAB

The lecture is given in a lab environment

PREREQUISITES – Good understanding of Digital Logic and Basic Phase-Lock circuits

PRESTUDY – 8660C Manual; View Video Tapes 90030__566 (Optional)

HAPPY HOLIDAYS

8640 AM/FM SIGNAL GENERATOR
MAR 16-17, LOS ANGELES, CA
MAR 28-29, PARAMUS, NJ
MAR 30-31, RICHARDSON, TEXAS

COURSE CONTENT

LECTURE

I. Introduction
II. Features and Model Options
III. Front Panel Features
  A. Video Tape
  B. Demonstration
IV. Theory
  A. Block Diagram
  B. Assembly Locations
  C. Schematic

LAB

I. Adjustments
II. Performance Tests
III. Troubleshooting

PREREQUISITES – Basic knowledge of digital logic circuits and general knowledge of electronics including operational amplifiers

PRESTUDY – Review digital logic and block diagram information in 8640B manual.

Read pages 1-48 in "Signal Generator Seminar" textbook.

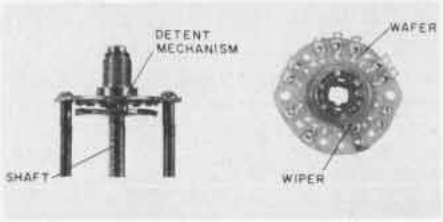
435A POWER METER RANGE DIAL CONVERSIONS

Depending on which power sensor you attach to your 435A, you can measure power from 0.3 nW (– 65 dBm) to 3W (+35 dBm) full scale. Each power sensor has its own calibrated range dial located on the RANGE knob that corresponds to the measurement capabilities of the sensor. In order to change ranges you must remove the RANGE knob and select one of the correct calibrated dials. One range dial has scales printed on both sides while the other dial has only one scale. The following table shows which range dial goes with which power sensor. Service Note 435A-2 provides complete details on changing the knob assembly (HP P/N 00435-60030) on 435A's with serials 1527A and below.

POWER SENSOR	RANGE DIAL
8481H/ 8482H	3 W to 0.3 mW +35 dBm to –5 dBm *(P/N 0350-0149)
8481A/ 8482A/ 8483A	100 mW to 3 μW +20 dBm to –25 dBm *(P/N 0350-0149)
8484A	10 μW to 0.3 nW –20 dBm to –65 dBm (P/N 0350-0148)

*This range dial has scales printed on both sides.

CLEANING AND LUBRICATING ROTARY SWITCHES



The following procedures can be used for rotary and pushbutton switch maintenance to extend the life of the switch and assure extended reliable performance.

Contamination on a switch in viscous or similiquid form can hold dirt and dust particles which, in turn, can cause leakage paths, abrasion of the switch contacts, etc. The lubricants used on switches can evaporate and deteriorate with time and exposure to the elements. As this happens, wear and galling are produced, particularly in high usage switches. The materials recommended for use in this article remove the contamination and provide a long-life, oxidation-resistant lubrication which will extend the life of the switch.

Kel-F (translucent plastic material), phenolic, and ceramic wafer switches are acceptable for this cleaning and lubrication process. This process is also satisfactory for the white or green wafers in the range switch of the HP 412A.

MATERIALS REQUIRED:

1. Cleaner spray
   16 oz. aerosol spray can
   Freon TF Cleaner
   HP Part No. 8500-0232
   Freon TF is also available from:
   Miller-Stephenson Chemical Co., Inc.
   Danbury, Connecticut 06810
2. Lubricant (High Impedance Switches)
   1/4 oz. bottle (paste)
   Electrolube 2G
   Electrical Contact Lubricant
   HP Part No. 5060-6086
   Electrolube 2G is also available in 1/2 lb. cans from:
   Electrolube Corporation
   Syosset, New York 11791
3. Lubricant (Low Impedance Switches)
   6 oz. aerosol spray can
   Electrolube 2A
   Electrical Contact Lubricant
   HP Part No. 6040-0300
   Electrolube 2A is also available from:
   Electrolube Corporation
   Syosset, New York 11791
4. Artist's brush
   A No. "1" or "0" artist's brush
   HP Part No. 8520-0004
   (Also available from office or art supply stores.)

CLEANING PROCEDURE:

CAUTION

During this procedure, keep the switch free from contamination to preserve accuracy and performance. If the switch is used in a high impedance circuit, clean rubber gloves should be worn at all times.

1. Place a paper towel or other suitable material under the switch to catch any residual cleaning spray.

CAUTION

Some components may be damaged with cleaning spray. Avoid prolonged direct contact with components and susceptible plastics.

2. Thoroughly spray the contact wiper blades with the recommended spray.
3. Rotate the switch from stop to stop and allow to dry completely.

LUBRICATION PROCEDURE:

The Electrolube 2G paste lubricant should be used rather than the Electrolube 2A aerosol lubricant for high impedance switches due to the contamination of the switch by the aerosol lubricant. Low impedance switches do not have serious contamination problems thus the aerosol lubricant can be used. The aerosol lubricant is much easier to apply and is as effective as the Electrolube 2G for lubrication of low impedance switches.

High Impedance Switch Lubrication

CAUTION

In the next four steps, do not permit the lubricant to come in contact with any components mounted on the switch; otherwise leakage paths may result and the lubricant may act as a solvent on some materials (Lexan, Polystyrene).

1. With the artist's brush, apply a small amount of Electrolube 2G sparingly to the wiper blade in one circular motion. (The amount referred to is the thinnest possible coat you can apply with the brush.)
2. With the artist's brush, apply a small amount of lubricant sparingly to the inside of each contact if possible.
3. Repeat the procedure (Steps 1 and 2) on each side of wafer.
4. If the wafers are relatively inaccessible, a small drop deposited on the wiper blade should provide reasonable distribution of the lubricant after several rotations of the switch.

CAUTION

Excessive amounts of the lubricant are not necessary for proper lubrication. Excessive amount of lubricant increases the dust and particle adhesion.

NOTE

Electrolube 2G contains an antioxidizing agent which turns a reddish-brown color when exposed to the air for several hours. This discoloration in no way affects the lubrication and conductive qualities.

Low Impedance Switch Lubrication

CAUTION

In the next two steps, the lubricant is applied from an aerosol spray can and caution should be used in spraying the switch contacts.

1. Spray the Electrolube 2A directly at the contacts and wiper assembly. (A light coat is sufficient).
2. Minimize the amount of spray allowed to make contact with the wafer and any components attached to the contacts.

Shaft and Detent Lubrication

There are a number of good lubricants available for use on detents and shafts.

The lubricant used for detents must be one that is in a grease form and will not liquify and splatter causing contamination of the area around the switch.

Lubriplate 630-2 or Mo-Lith No. 2, available from your local automotive parts dealer or Lubriplate dealer, is satisfactory for this use. The lubricant must be applied between the detent balls and the track the balls ride in. A light coating can be applied on the path the balls follow during rotation.

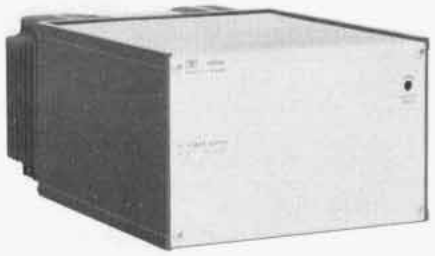
The shaft lubricant should be a liquid that can penetrate between the shaft and the bushing yet have enough viscosity to prevent splattering and dripping of the lubricant. A small amount of lubricant is sufficient to properly lubricate the shaft. A lightweight oil such as SAE 10 oil is satisfactory for this use.

Conclusions

The normal operating life of a rotary switch should be 25,000 operations or more. Tests have shown that as long as the lubricant is clean and unoxidized, 100,000 operations can be expected. Contact resistance should be 10 milliohms or less. An HP 4328A Milliohmmeter can be used to determine the actual contact resistance.

The procedures performed will extend the life of a switch, but it will not restore a switch that has been damaged. Judgement must be made by the technician whether a switch is already damaged and should be replaced.

TROUBLESHOOTING PROCEDURE FOR 626xxJ SERIES 200–600W DC POWER SUPPLIES



Owners of the 626xxJ Series Switching Power Supplies are urged to order Service Note 626xxJ-3 listed in this issue of Bench Briefs. The Service Note contains valuable troubleshooting information to supplement the Operating and Service manual. Included in the Note is a troubleshooting tree that utilizes waveforms to analyze and detect failures in the circuitry that drives the power switching transistors.

This Service Note (626xxJ-3) assumes that certain updating modifications to improve reliability of earlier serials has been performed according to Service Notes 626xxJ-2 and 626xxJ-1. You may order all three notes at the same time. Just pencil in the numbers on the form.

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supplement to

BENCH BRIEFS SERVICE NOTE INDEX

NEED ANY SERVICE NOTES?

Here's the latest listing of Service Notes available for Hewlett-Packard products. To obtain information for instruments you own, remove the order form and mail it to the nearest HP distribution center.

141B/T STORAGE OSCILLOSCOPE

141B/T-6. 141B all serials; 141T serial prefix 1516A and below. Required parts change when replacing CRT.

193A OSCILLOSCOPE

193A-4. All serials. CRT replacement procedure.

740A/B DC STANDARD/ DIFFERENTIAL VOLTMETER

740A-6A-S/740B-8A-S. Elimination of a potential safety hazard.

1201A/B OSCILLOSCOPE

1201A/B-8/1207A/B-7. 1201A serials 1234A and below; 1201B serials 1245A and below. Modification kit for CRT replacement.

1207A/B OSCILLOSCOPE

1201A/B-8, 1207A/B-7. 1207A serials 1132A and below; 1207B serials 1133A and below. Modification kit for CRT replacement.

1208A/B X-Y DISPLAY

1201A/B-8/1207A/B-7. This service note applies to 1208A/B Option H11/12/20 X-Y Displays as follows: 1208A/B Option H11/12 serials 1211A and below. 1208B Option H20 all serials. Modification kit for CRT replacement.

1220A OSCILLOSCOPE

1220A-11A. All serials. Part change to improve high voltage regulator adjustment.

1220A-24. Serials prefixed 1609A. Preferred parts replacement to improve reliability of the +95 volt supply and intensity limit circuit.

1222A OSCILLOSCOPE

1222A-2. Serials 1540A and below. Part change to eliminate channel A ringing.

1222A-3. All serial prefixes with an "A". Preferred parts replacement to improve reliability of the +95 volt supply and intensity limit circuit.

1222A-4. All serials. Part change to improve high voltage regulator adjustment.

HP MODEL 1331A/C DISPLAY

1331A/C-20. 1331A Serials 1135A and below; 1331C Serials 1149A and below. Modification kit for CRT replacement.

1332A DISPLAY

1332A-1B. Serials 1414A and below. Modification to correct possible insufficient range of intensity limit adjustment if CRT is replaced.

1332A-3. All serials. Alternate value for A1R61.

1700A/B OSCILLOSCOPE

1700A-6. All serials. Preferred replacement for the AC power module.

1700B-2. All serials. Preferred replacement for the AC power module.

1701A/B OSCILLOSCOPE

1701A-6. All serials. Preferred replacement for the AC power module.

1701B-1. All serials. Preferred replacement for the AC power module.

1702A OSCILLOSCOPE

1702A-2. All serials. Preferred replacement for the AC power module.

1703A OSCILLOSCOPE

1703A-4A. Serials 1331A and below. Low voltage power supply modification to prevent random fuse blowing during powerline interruptions or in "brown-out" situations.

1703A-5A. All serials. Modification to improve single sweep operation.

1703A-6. All serials. Preferred replacement for the AC power module.

1706A/B OSCILLOSCOPE

1706A-2. All serials. Preferred replacement for the AC power module.

1706B-1. All serials. Preferred replacement for the AC power module.

1707A/B OSCILLOSCOPE

1707A-4. All serials. Preferred replacement for the AC power module.

1707B-1A. Serials 1325A and below. Low voltage power supply modification to prevent random fuse blowing during powerline interruptions or in "brown-out" situations.

1707B-3A. All serials. Modification to improve single sweep operation.

1707B-5. All serials. Preferred replacement for the AC power module.

3420A/B DC DIFFERENTIAL VOLTMETER/RATIOMETER

3420A/B-5A-S. Elimination of a potential safety hazard.

3485A SCANNING UNIT

3485A-4. Not available.

3485A-5. All serials. Repair procedure for 3485A input connectors.

3490A MULTIMETER

3490A-14. All serials. Digital troubleshooting procedure.

3964A INSTRUMENTATION TAPE RECORDER

3964A-1/8864A-1. Serials 1620A and below. Modification to improve FM tape servo.

3964A-2/8864A-2. Serials 1624A and below. Replace old 1.25A fuse with 1.5A fuse.

3964A-3/8864A-3. Serials 1625A and below. Wiring change to the Motor Drivers/+5V(A) Regulator PCA(A2).

3968A INSTRUMENTATION TAPE RECORDER

3968A-1A/8868A-1A. Serials 1622A and below. Modification to improve FM tape servo.

3968A-3/8868A-3. Serials 1624A and below. Replace old 1.25A fuse with 1.5A fuse.

3968A-4/8868A-4. Serials 1626A and below. Wiring change to the Motor Drivers/+5V(A) Regulator PCA(A2).

5062C CESIUM BEAM FREQUENCY REFERENCE

5062C-1. Serials 1612A and below, with options 002, 003 and 010 (0-1695/U). Modification to Battery Charger to prevent intermittent phase jumps or loss of CONTINUOUS OPERATION light.

5306A MULTIMETER

5306A-6. Serials 1548A and below. Modification to prevent incorrect readings due to voltage reference turn-on.

7040A/7041A/7044A/7045A/ 7046A/7047A X-Y RECORDER

7040A-5A/7041A-3A/7044A-2A/7045A-2A/ 7046A-5A/7047A-1A. All serials. Procedure for applying thermal compound (silicon grease) PN 6040-0239 to X-Axis servo motor mounting assembly.

7040A-6/7041A-4/7044A-3/7045A-3/7046A-6/ 7047A-2. All serials. Modificiation to improve X and Y Axis Wiper Assembly and eliminate slidewire lubrication.

7200A/7201A/7202A/ 7203A/7210A X-Y RECORDER

7200A-14/7201A-5/7202A-14/7203A-15/ 7210A-15/7210A-15/9125A/B-3/9862A-18. All serials. Plotter slidewire maintenance (eliminating slidewire lubrication).

7200A-15/7201A-6/7202A-15/7203A-16/ 7210A-16/9125A/B-4/9862A-19. All serials. Proper periodic plotter platen purgation procedure (or, cleaning your autogrip table).

8660B/C SYNTHESIZED SIGNAL GENERATOR

8660B-23A. Serials 1439A00961 and below. Preferred digital I.C. replacement.

8660B-32. All serials. Modification for programming compatibility with HP 9825A calculator.

8660C-8. Serials 1615A00700 and below. Modification for programming compatibility with HP 9825A calculator.

8864A INSTRUMENTATION TAPE RECORDER

3964A-1/8864A-1. Serials 1620A and below. Modification to improve FM tape servo.

3964A-2/8864A-2. Serials 1624A and below. Replace old 1.25A fuse with 1.5A fuse.

3964A-3/8864A-3. Serials 1625A and below. Wiring change to the Motor Drivers/+5V(A) Regulator PCA(A2).

8868A INSTRUMENTATION TAPE RECORDER

3968A-1A/8868A-1A. Serials 1622A and below. Modification to improve FM performance.

3968A-3/8868A-3. Serials 1624A and below. Replace old 1.25A fuse with 1.5A fuse.

3968A-4/8868A-4. Serials 1626A and below. Wiring change to the Motor Drivers/+5V(A) Regulator PCA (A2).

9125A/B X-Y RECORDER

7200A-14/7201A-5/7202A-14/ 7203A-15/ 7210A-15/9125A/B-3/9862A-18. All serials. Plotter slidewire maintenance (eliminating slidewire lubrication).

7200A-15/7201A-6/7202A-15/7203A-16/ 7210A-16/9125A/B-4/9862A-19. All serials. Proper periodic plotter platen purgation procedure (or, cleaning your autogrip table).

9862A X-Y RECORDER

7200A-14/7201A-5/7202A-14/7203A-15/ 7210A-15/9125A/B-3/9862A-18. All serials. Plotter slidewire maintenance (eliminating slidewire lubrication).

7200A-15/7201A-5/7202A-15/7203A-16/ 7210A-16/9125A/B-4/9862A-19. All serials. Proper periodic plotter platen purgation procedure (or, cleaning your autogrip table).

626XXJ SERIES 200-600W MODULAR SWITCHING POWER SUPPLIES

626XXJ-3. All serials. Troubleshooting procedure for switching transistor failures.

86241A SINGLE BAND PLUG-IN

86241A-2. Serials 1611A and below, with option 001. Changes to the polarity output of the detector in the A6 modulator/detector assembly to improve the internal leveling flatness.

READERS CORNER

Here's your chance to share your ideas and views with other *Bench Briefs* recipients. In Reader's Corner, we will print letters to the Editor, troubleshooting tips, modification information, and new tools and products that have made your job easier. In short, Reader's Corner will feature anything from readers that is of general interest to electronic service personnel.

If there is something you have to share with other *Bench Briefs* readers, let us hear from you.

A CASE OF OVERKILL

Dear Sir:

I am an Electronic Technician employed under EG&G, and I have received again your brochure for ordering Bench Briefs. May I say, this is the tenth Bench Briefs order form I have filled out, besides giving my name and address to your representatives at our seminar. Therefore, I will fill this form out and return it to you, *one more time!*

I do enjoy reading your news sheets, but if it takes filling out twenty forms, I'd just as soon drop the whole thing!

Thank you very much for your cooperation.

Sincerely,

Gary L. Dahlberg
Las Vegas, Nevada

Most of HP's technical publications share the same mailing list on a computer file. Occasionally we do get our lists crossed and send out duplicate requalification forms, especially when more than one publication is correcting its file. I'm sorry for any inconvenience Mr. Dahlberg. Thank you for your letter.

Editor

BACK ISSUES

Sirs:

I am sure I have not received all Bench Briefs. How can I find out which ones I have missed? They have been a great help to me. I am presently on your mailing list. Also, is there any type of binder for the storage of these papers?

I always look forward to these "Briefs".

Thank you.

James J. Dinkins ET
Jackson, Tennessee

While we do not have a complete set, there are many back issues of Bench Briefs available at no charge. The way to tell if you are missing any issues is by the Volume and Issue numbers. Going back three years for example,

1973 covered Volume 13, Issues 1 thru 5; 1974 Volume 14, Issues 1 thru 6; 1975 Volume 15, Issues 1 thru 5; 1976 Volume 16, Issues 1 to present 4.

As for the binder, I'm afraid that you will have to supply your own.

Editor

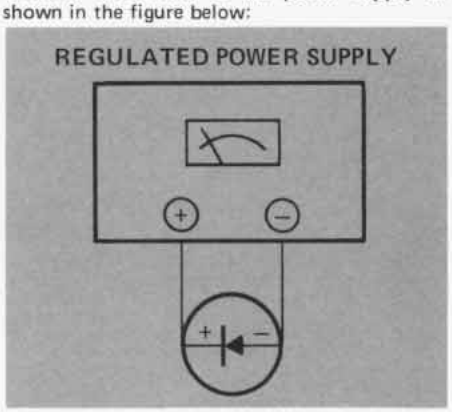
A QUICK TEST FOR ZENER BREAKDOWN VOLTAGE

Editor:

Here is a simple procedure for checking the breakdown voltage of voltage reference diodes. Perhaps it would be appropriate for inclusion in Bench Briefs.

The test simply uses the regulated power supply as a current source to properly bias the diode, and then the resultant VZ voltage is read from the power supply meter. If desired, a more accurate external meter could be used.

Connect the zener to the power supply as shown in the figure below:



ZENER DIODE UNDER TEST

1. Set the voltage to an optimum value of 12 volts. Of course this assumes the zener's breakdown value is below that setting.
2. Turn the current adjustment full CCW (off).
3. Switch the supply to lowest current range and short out test leads.
4. Set the current adjustment to 10 mA.
5. Switch back to voltage range.
6. Apply the zener diode across test leads as shown above.
7. Read zener breakdown voltage.
8. If there is no change, it's possible the breakdown value is greater than 12 volts.

Ned Bryant
Hewlett-Packard
San Diego, CA

EQUATIONS THAT CHANGED THE WORLD

This quiz is reprinted with permission from "Games for the Superintelligent" by James Fixx (Doubleday, Popular Library).

Nicaragua, a country that must be a mathematicians's paradise, not long ago issued ten postage stamps bearing LAS 10 FORMULAS MATHEMATICS QUE CAMBIARON LA FAZ DE LA TERRA (The 10 mathematical formulas that changed the face of the world). Here are the formulas along with their definitions. How many can you match?

(a) $1 + 1 = 2$

(b) $f = \frac{Gm_1m_2}{r^2}$

(c) $E = mc^2$

(d) $e^{1nN} = N$

(e) $A^2 + B^2 = C^2$

(f) $S = k \log W$

(g) $V = V_e 1n \frac{m_0}{m_1}$

(h) $\lambda = h/mv$

(i) $V^2E = \frac{Ku}{c^2} \frac{\delta^2 E}{\delta t^2}$

(j) $F_1x_1 = F_2X_2$

(1) Einstein's formula for the conversion of matter to energy.

(2) Pythagoras' formula for the relationship of the two sides and hypotenuse of a right triangle.

(3) Konstantin Tsiolkovskii's equation giving the changing speed of a rocket as it burns the weight of its fuel.

(4) The formula for tallying of possessions or exchange.

(5) Sir Isaac Newton's formula for gravitation.

(6) John Napier's logarithm formula, which provided a multiplication and division method simply by adding or subtracting the logarithms of numbers.

(7) Ludwig Boltzmann's equation for the behavior of gases.

(8) Archimedes' formula for the lever.

(9) Louis de Broglie's equation for light as a form of energy.

(10) James Clerk Maxwell's formula equating electricity and magnetism.

The answers will appear in the next issue of Bench Briefs.

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Live training sessions fall into three categories; *applications, service* and *tutorial*. *Application* seminars are aimed at increasing your utilization of general purpose test instrumentation. *Service* seminars are usually dedicated to the repair aspects of a singular large instrument. *Tutorial* seminars usually deal with the specific operation of dedicated systems.

Please complete this form and return it to the following address so HP can evaluate the level of demand for such training.

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To enroll in any of the seminars, fill out the registration form and mail it with your check to the address shown for the seminar location. Please use separate registration forms for each student. Make your check payable to Hewlett-Packard Company in U.S. currency.

Upon receipt of your registration and check we will confirm your enrollment by returning all necessary prestudy material along with a list of nearby motel accommodations and reservation forms. Attendees are responsible for their own transportation, accommodations, and meals.

OFFICE POSITION QUIZ SOLUTION

From the Editor

Finally, here is the solution to the puzzle submitted by Betty Haines in the January-April issue of BENCH BRIEFS. Betty informed me that the puzzle is 10-15 years old, therefore before the solution can be found, some puritanical (by today's standards) assumptions must be made. They are that the term Bachelor means never been married (as opposed to Widowed or Divorced), and Miss means never been married. Also that the Manager and Stenographer did not have children out-of-wedlock (i.e. they were or are married). The solution is then found by examining the clues and using your logic to analyze what they are really saying. Then form a matrix of names and office positions and place an x in the matrix when the clues rule out that particular combination. With analysis, some positions become evident. These are indicated with boxes. Numbers are placed inside to indicate sequence. As positions are deduced, other possibilities are ruled out and these are indicated with an x.

Clues:

a) The Assistant Manager is the Manager's grandson. Therefore:
   1. Assistant Manager is male
   2. Manager was or is married
   3. Manager is a grandfather, therefore realistically older than 25 (see clue "d").

b) The cashier is the Stenographer's son-in-law. Therefore:
   1. Cashier is a male
   2. Cashier is married
   3. Stenographer was or is married
   4. Stenographer has a daughter of marriagable age.

c) Mr. Able is a bachelor. Therefore:
   1. Mr. Able is *not* the Cashier (b-2).
   2. Mr. Able is *not* the Stenographer (b-3).
   3. Mr. Able is *not* the Manager (a-2).

d) Mr. Cook is 25 years old. Therefore:
   1. Mr. Cook is *not* the Manager (a-3)
   2. Mr. Cook is *not* the Stenographer (b-4)

e) Miss Jones is the Typist's step-sister. Therefore:
   1. Miss Jones is *not* the typist (e).
   2. Miss Jones is *not* the Cashier (b-1).
   3. Miss Jones is *not* the Assistant Manager (a-1).
   4. Miss Jones is *not* the Stenographer (b-3).
   5. Miss Jones is *not* the Manager (a-2).

Since there are only 6 positions, Miss Jones must be the Clerk and you have your first box with a number 1 inside.

f) Mr. Baker is a neighbor of the Manager. Therefore:
   1. Mr. Baker is *not* the Manager.

Deductions:

The first position filled is Miss Jones as the Clerk. An x is then placed in the Clerk column for the remaining names. Miss Fitt's position can be set next because she is ruled out of the same positions for the same reasons as Miss Jones. Since the only position left which she qualifies for is the Typist, she must be it.

The next position that becomes evident is the Manager. Miss Jones, Fitt, and Mr. Able are ruled out because they are not married (clue a-2). Mr. Baker is ruled out because of clue f (he can't be a neighbor of the Manager and the Manager at the same time). Mr. Cook is ruled out because he is too young (clue d-1). The only one left is Mrs. Smith. Since Mrs. Smith is the Manager she can't be the Stenographer so rule her out of that position. The rest of the matrix is filled in in much the same manner.

	MANAGER	ASSISTANT MANAGER	CASHIER	STENOGRAPHER	TYPIST	CLERK
Mr. Able	X(a-2, a-3, c)	6	X(b-2, c-1)	X(b-3, c-2)	X(2)	X(1)
Mr. Baker	X(f-1)	X(4)	X(4)	4	X(2)	X(1)
Mr. Cook	X(d-1)	X(5)	5	X(b-4, d-2)	X(2)	X(1)
Mrs. Smith	3	X(a-1)	X(b-1)	X(3)	X(2)	X(1)
Miss Jones	X(a-2)	X(a-1)	X(b-1)	X(b-3)	X(e-1)	1
Miss Fitt	X(a-2)	X(a-1)	X(b-1)	X(b-3)	2	X(1)

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