HEWLETT PACKARD

OPERATING AND SERVICE MANUAL

MODEL 3456A
DIGITAL VOLTMETER

SERIAL NUMBERS

This manual applies directly to instruments with a serial number prefix of 2201.

Instruments with a prefix of 2015, and serial numbers 2015A04595 and below, refer to Section VII (Manual Changes) of this manual. For information on instruments with a prefix other than listed in Section VII and on the title page, refer to the manual change sheet.

Hewlett-Packard Company
3000 Hanover Street, Palo Alto, California 94304

WARNING

To help minimize the possibility of electrical fire or shock hazards, do not expose this instrument to rain or excessive moisture.

Manual Part No. 03456-90004

Microfiche Part No. 03456-90054

Revision B

P.O. Box 301, Loveland, Colorado, 80537 U.S.A.

Revised: February 1982

Printed: January 1981

7-27. Change #11

7-28. For serial numbers 2201A04795 and below. Page 6-6/6-7, Table 6-4 (Replaceable Parts). Change RAMs A4U10 and U11 to the following:

Ref. Des.	hp Part Number	C D	Qty	Description
A4U10	1818-1213		2	IC NMOS 8192-BIT RAM
A4U11	1818-1213			IC NMOS 8192-BIT RAM

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CERTIFICATION

Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory. Hewlett-Packard further certifies that its calibration measurements are traceable to the National Institute of Standards and Technologies, to the extent allowed by the the Institute's calibration facility, and to the calibration facilities of other International Standards Organization members.

WARRANTY

This Hewlett-Packard instrument product is warranted against defects in materials and workmanship for a period of one year from date of shipment [,except that in the case of certain components listed in Section I of this manual, the warranty shall be for the specified period]. During the warranty period, Hewlett-Packard Company will, at its option, either repair or replace products which prove to be defective.

For warranty service or repair, this product must be returned to a service facility designated by -hp-. Buyer shall prepay shipping charges to -hp- and -hp- shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to -hp- from another country.

Duration and conditions of warranty for this instrument may be superceded when the instrument is integrated into (becomes a part of) other -hp- instrument products.

Hewlett-Packard warrants that its software and firmware designated by -hp- for use with an instrument will execute its programming instructions when properly installed on that instrument. Hewlett-Packard does not warrant that the operation of the instrument, or software, or firmware will be uninterrupted or error free.

LIMITATION OF WARRANTY

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation or maintenance.

NO OTHER WARRANTY IS EXPRESSED OR IMPLIED. HEWLETT-PACKARD SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

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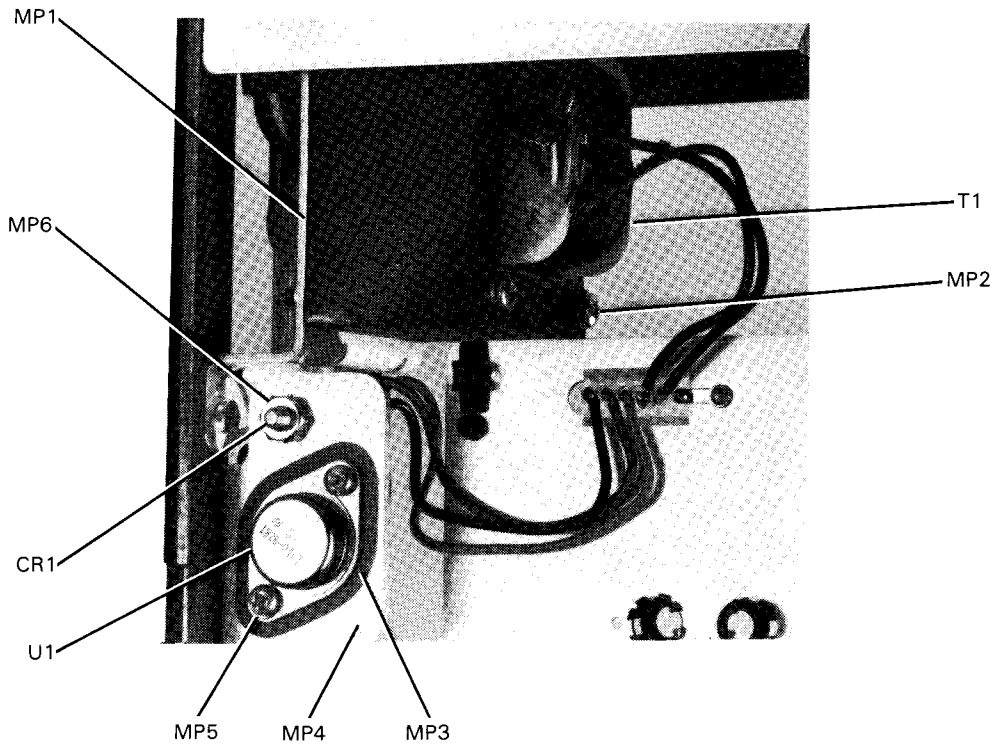
ASSISTANCE

Product maintenance agreements and other customer assistance agreements are available for Hewlett-Packard products.

For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

NOTE

The MP Designations used on this page apply only to those parts called out in Figure 6-11.



Reference Designation	-hp- Part Number	C D	Qty	Description
MP1	03456-01201	7	1	Bracket-Transformer
MP2	0515-0216		4	Screw-Mach M4 x 0.7 50MM-LG Pan-HD
MP3	0340-0580	3	1	Insulator-XSTR THRM-CNDCT
MP4	03456-01202	8	1	Bracket-Regulator
MP5	0624-0034		2	Screw-Tapping 6-20 0.5 Pan-HD
MP6	2740-0003		1	Nut-Hex 10-32 x .375 AF
CR1	1902-1217	8	1	Diode-Znr 6.2V 5%
T1	9100-0469	8	1	Transformer-Power
U1	1826-0181	1	1	Voltage Regulator-LM323K

Figure 7-10. Change #10 in Figure 6-11

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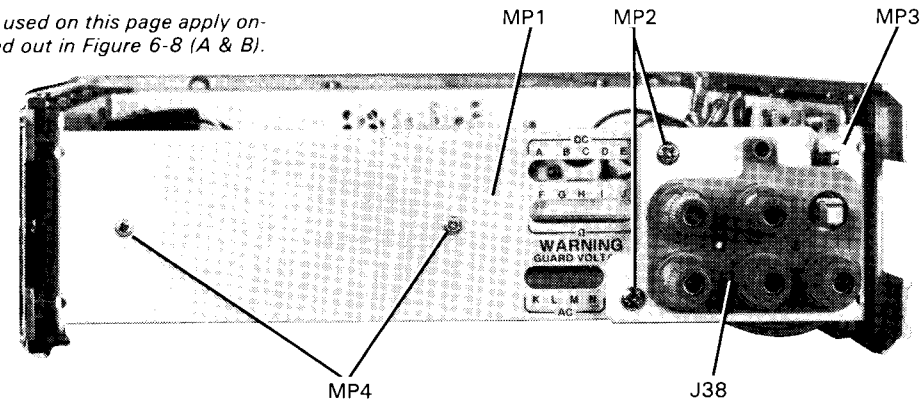
j. Page 6-27, Figure 6-8 (Inguard Chassis-Front and Rear Panel). Replace Figure 6-8 with Figure 7-9.

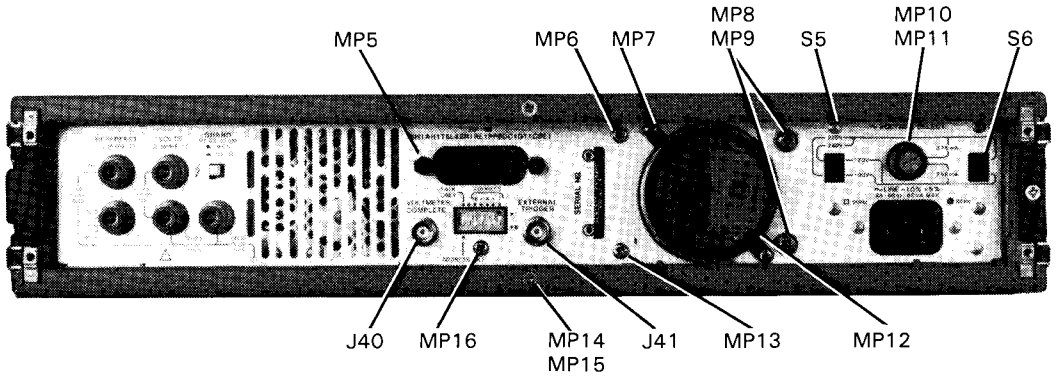
k. Page 6-30, Figure 6-11 (Power Transformer and Bracket; ec.). Replace Figure 6-11 with Figure 7-10.

NOTE

The MP Designations used on this page apply only to those parts called out in Figure 6-8 (A & B).



A. Inguard Chassis Hardware—Front.



B. Rear Panel.

Reference Designation	-hp- Part Number	C D	Qty	Description
MP1	03456-00102	5	1	Chassis-Inguard-Left
MP2	0515-0212		2	Screw-Mach M3.5 x 0.6 6MM-LG Pan-HD
MP3	03456-00101	4	1	Chassis-Inguard-Right
MP4	0624-0314		2	Screw-Tapping 4-20 x .375 Pan-HD Plastite
MP5	0380-1214		2	Standoff Screw-HPIB, Metric
MP6	0515-0225		1	Screw-Mach M3.5 x 0.6 10MM-LG Pan-HD
MP7	0515-0211	8	2	Screw-Mach M3 x 0.5 6MM-LG Pan-HD
MP8	2680-0265		2	Screw-Mach 10-32 x 1.0 Pan-HD w/Helical Lock
MP9	0380-1208		2	Spacer .194 I.D. x .5 O.D. x .625 Long
MP10	2110-0564	8	1	Fuseholder Body
MP11	2110-0565	9	1	Fuseholder Cap
MP12	3150-0300	5	1	Air Filter
MP13	0515-0212		1	Screw-Mach M3.5 x 0.6 6MM-LG Pan-HD
MP14	0570-1171		3	Screw-Cover Mtg
MP15	0510-0043		3	Ring-Ret Ext-E-.141 Dia
MP16	0515-0215		1	Screw M3.5 x 0.6 20MM-LG Pan-HD
J38	5060-7478	3	1	Terminal Assembly-Front Input
J40, J41	1250-0083	1	2	Connector-RF BNC
S5, S6	3101-2298	1	2	Switch-Slide Voltage Select

Figure 7-9. Change #10 in Figure 6-8

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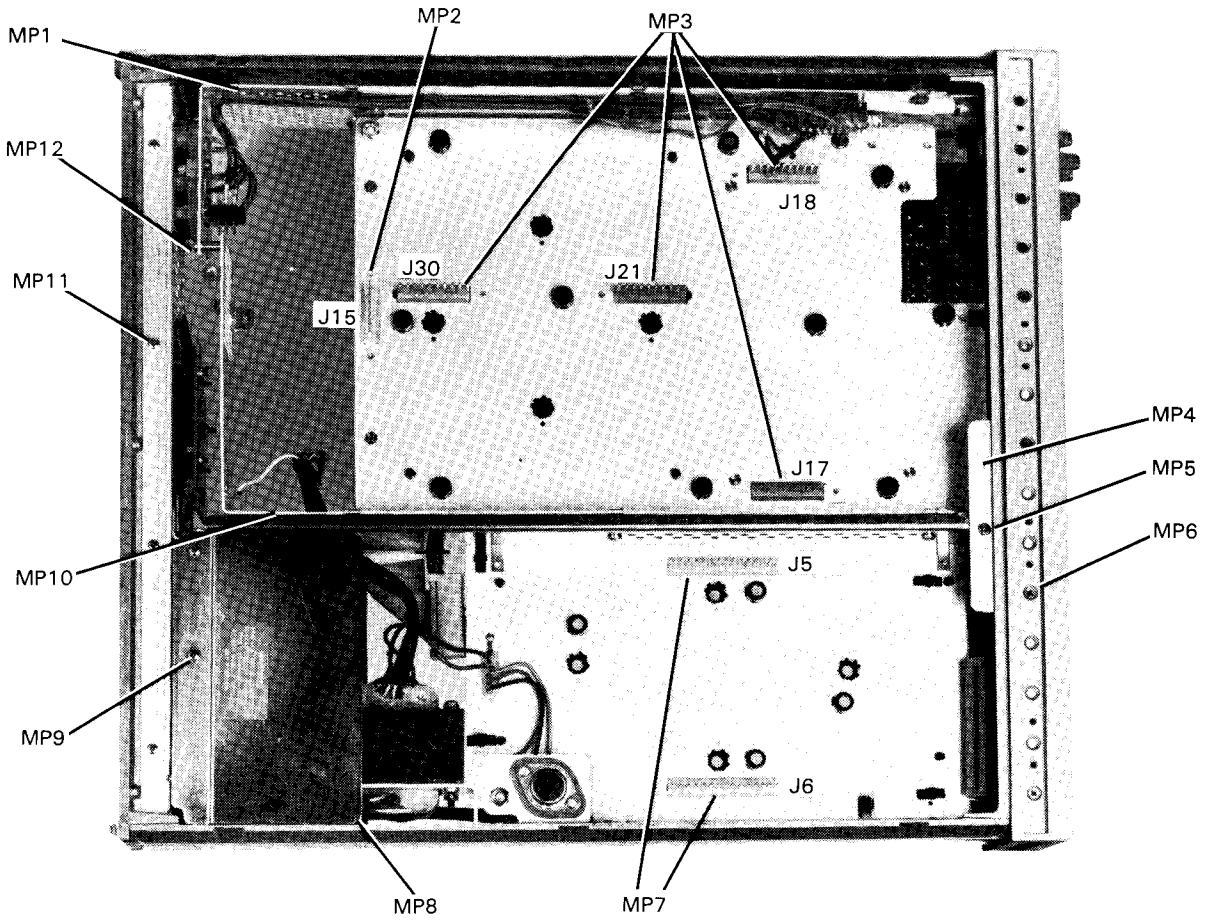
NOTE

The MP Designations used on this page apply only to those parts called out in Figure 6-3.



Reference Designation	-hp- Part Number	C D	Qty	Description
MP1	03456-00101	4	1	Chassis-Inguard-Right
MP2	1251-6184	7	1	Connector 8 Pin M Post Type
MP3	1251-6194	9	4	Connector 10 Pin M Post Type
MP4	03456-00204	8	1	Sub-Panel
MP5	0515-0212		1	Screw-Mach M3.5 x 0.6 6 MM-LG Pan-HD
MP6	0515-0219		4	Screw-Mach M3 x 0.5 6MM-LG Flat-HD
MP7	1251-6192	7	2	Connector 15-Pin M Post Type
MP8	03456-00601	9	1	Fan Shield, Top
MP9	0515-0211	8	2	Screw-Mach M3 x 0.5 6MM-LG Pan-HD
MP10	03456-00102	5	1	Chassis-Inguard-Left
MP11	0515-0211	8	4	Screw-Mach M3 x 0.5 6MM-LG Pan-HD
MP12	0515-0212		4	Screw-Mach M3.5 x 0.6 6MM-LG Pan HD

Figure 7-8. Change #10 in Figure 6-3

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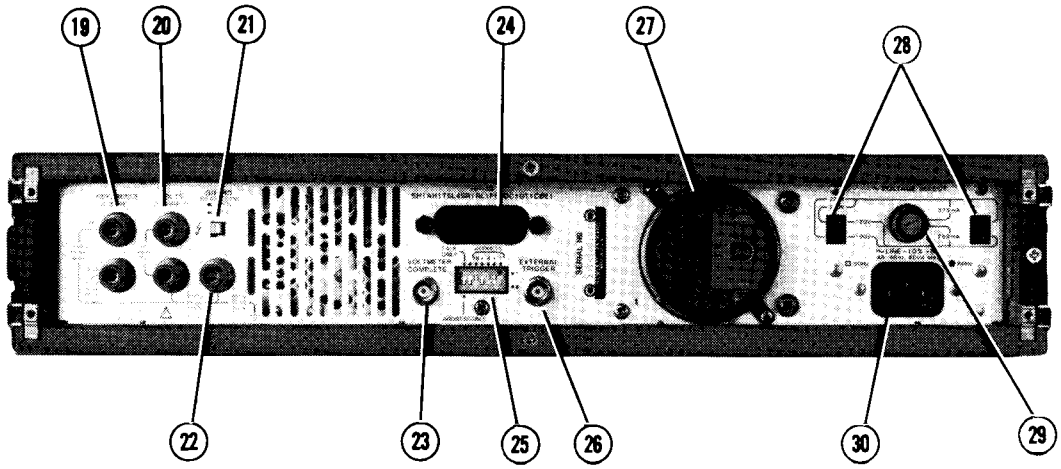


(19) Ratio Ref/4WRΩ Sense Terminals - are used for the Ratio Reference Voltage or 4-Wire Ohms measurement.

(20) Volts/2WRΩ/4WRΩ Terminals - input terminals for the ACV, DCV, ACV + DCV, and 2-Wire Ohms measurements. In addition, the terminals supply the current for a 4-Wire Ohms measurement.

(21) Rear Guard Switch - internally connects the GUARD terminal to the VOLTS LOW terminal.

(22) Rear Guard Terminal.

(23) Voltmeter Complete Connector - Outputs pulse during measurement cycle.

(24) HP-IB Connector used to connect to HP-IB.

(25) HP-IB Address Selection Switch - Sets 3456A HP-IB Address.

(26) External Trigger Input Connector.

(27) Cooling Fan.

(28) Power Line Voltage Selection - Refer to Paragraph 2-8.

(29) Fuse -90 V to 126 V -.75 amp, 198 V to 252 V -.375 amp.

(30) AC Power Connector.

Figure 7-6. Change #10 in Figure 3-1

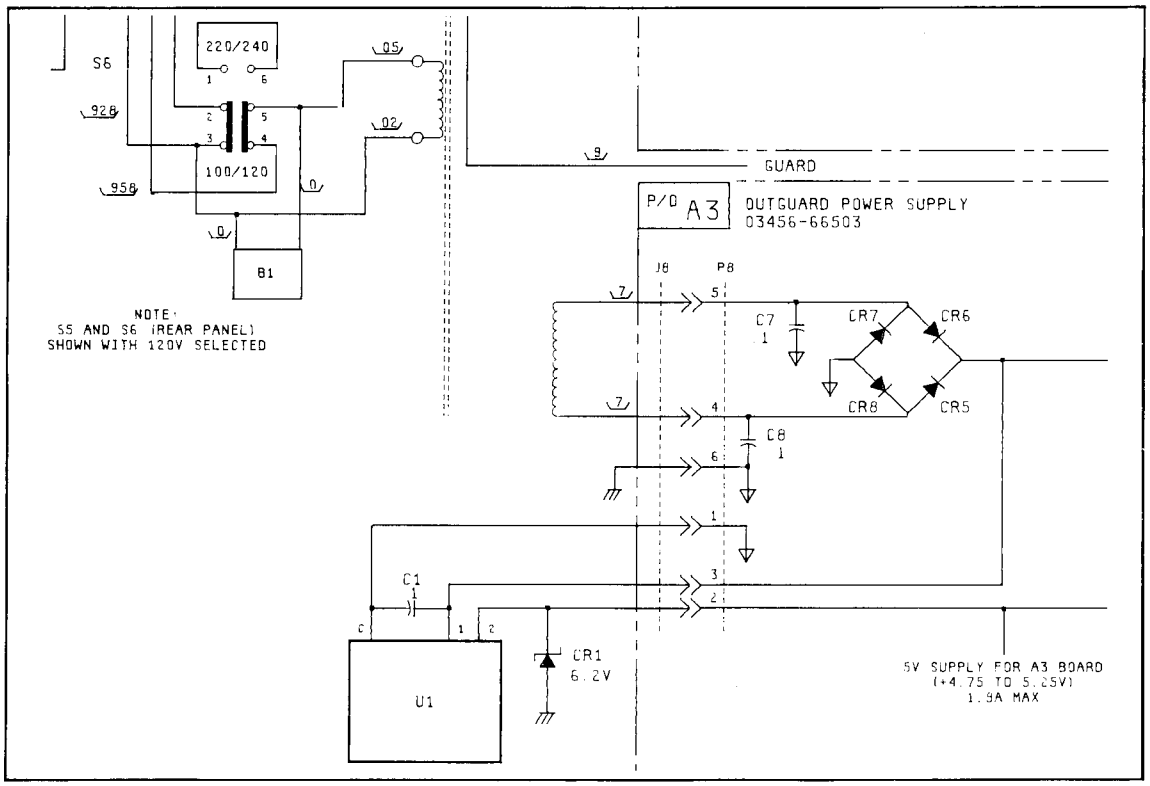


Figure 7-7. Change #10 on Schematic 14

LIST OF ILLUSTRATIONS

I.C.	Pin #	Signature	Replace
A3U8	10	0F76	A3U8
A3U8	14	3501	A3U8
A3U14	2	FF8A	A3U14
A3U14	6	421U	A3U14
A3U14	10	3501	A3U14

f. Page 8-A-16, paragraph 8-A-26 step m. Change the signatures in step m of paragraph 8-A-26 to the following:

m. Check the following signatures and if any are bad, replace the recommended Integrated Circuit in the given order:

I.C.	Pin #	Signature	Replace
A3U4	10	1180	A3U4,U8
A3U4	12	0000	A3U12,U7,U8,U4
A3U8	15	1180	A3U8
A3U8	5	2P23	A3U8
A3U8	11	4H88	A3U8
A3U8	13	C66C	A3U8
A3U14	13	3931	A3U14

g. Page 8-A-16, paragraph 8-A-26 step o. Change the signatures in step o of paragraph 8-A-26 to the following:

o. Check the following signatures and if any are bad, replace the recommended Integrated Circuit in the give order:

I.C.	Pin #	Signature	Replace
A3U12	3	2P23	A3U12,U7
A3U12	5	1180	A3U12,U7
A3U12	11	C66C	A3U12,U7
A3U12	13	3931	A3U12,U7,U8
A3U12	2	2P23	A3U12
A3U12	6	1180	A3U12
A3U12	10	C66C	A3U12
A3U12	14	3931	A3U12
A3U7	2	2P23	A3U7
A3U7	6	4H88	A3U7
A3U7	10	C66C	A3U7
A3U7	14	3931	A3U7
A3U8	2	3931	A3U8

7-25. Change #10

7-26. For serial numbers 2015A04595 and below. This change applies to 3456A which did not have their Fan (B1) removed. If the Fan is defective and needs to be replaced, retrofit the 3456A to a fanless instrument. Refer to Service Note 3456A-12 on how to retrofit the instrument. Because no fans will be replaced, if defective, the information given here should only be used to to adapt this manual for instruments which still have their fans. If the instrument is retrofitted (i.e., the fan is removed), ignore this change and use the information which is presently in this manual.

a. Page 3-3, Figure 3-1 (Front and Rear Panel Features (Cont'd)). Replace Figure 3-1 with Figure 7-6.

b. Page 8-93/8-94, Figure 8-75 (Schematic 14, Power Supply Schematic). Change bridge rectifier A3CR5 to diode rectifiers A3CR5 through A3CR8, as shown in Figure 7-6. Add fan B1, and change fuse F1 to 750MA and 375MA, as shown in Figure 7-7.

c. Page 6-5, Table 6-4 (Replaceable Parts). Change and add the following:

Ref. Des.	Part Number	C D	Description
A3CR5	1901-0662	3	DIODE-PWR RECT 100V 6A
A3CR6	1901-0662	3	DIODE-PWR RECT 100V 6A
A3CR7	1901-0662	3	DIODE-PWR RECT 100V 6A
A3CR8	1901-0662	3	DIODE-PWR RECT 100V 6A

d. Page 6-7, Table 6-4 (Replaceable Parts). Change Heat Sink A10H1 through A10H4 to Part Number: 1205-0462.

e. Page 6-18/6-19, Table 6-4 (Replaceable Parts). Add and change the following:

Ref. Des.	Part Number	C D	Descripton
B1	3140-0604	1	FAN MOTOR
	3160-0307	3	FAN BLADE
	3150-0300	5	FILTER-AIR
F1	2110-0033	6	FUSE .75A 250V 1.25X.25 (FOR 100V/120V OPERATION)
F1	2110-0065	4	FUSE .375A 250V NTD 1.25X.25 UL (FOR 220V/240V OPERATION)
	03456-00103	6	GAUSSET-OUTGUARD
	03456-00104	7	GAUSSET-SHROUD
	03456-00203	7	PANEL-REAR
	03456-00601	9	FAN SHIELD-TOP
	03456-00602	0	FAN SHIELD-BOTTOM
	03456-01202	8	BRACKET-REGULATOR
	03456-04102	3	SHIELD-OUTGUARD
	5040-8304	4	SHROUD-FAN
	5060-9835	0	TOP COVER
	5060-9852	1	SIDE COVER-NO HANDLE

f. Page 6-18/6-19, Table 6-4 (Replaceable Parts). Delete bridge rectifier CR5 (Part Number: 1906-0205) from the table.

g. Page 6-20, Figure 6-1 (Chassis/Cabinet Parts). Change the following in the table located in Figure 6-1.

Ref. Des.	-hp- Part Number	C D	Qty	Description
MP15	5060-9835	0	1	TOP COVER
MP17	5060-9852	1	1	SIDE COVER, NO HANDLE

h. Page 6-22, Figure 6-3 (Top View of Chassis with PC Boards Removed. Replace Figure 6-3 with Figure 7-8.

i. Page 6-23, Figure 6-4 (Bottom View of Chassis with PC Boards Installed). Change the following in the table in Figure 6-4.

Ref. Des.	-hp- Part Number	C D	Qty	Description
MP1	03456-00602	0	1	Fan Shield, Bottom

LIST OF ILLUSTRATIONS (Cont'd)

a. Page 6-6, Table 6-4 (Replaceable Parts). The changes are as follows:

Ref. Des.	Part Number	C D	Description
A4U5	1818-1367	0	IC MEMORY, ROM
A4U7	1818-1368	1	IC MEMORY, ROM
A4U8	1818-1369	2	IC MEMORY, ROM

b. Page 8-A-3/8-A-4, Table 8-A-1 (Data Bus [D0-D7] Signatures, Service Group A). Replace Table 8-A-1 with Table 7-2.

NOTE

Make sure the ROMs in the 3456A agree with ones listed in Table 6-4. Update the table only if the ROMs are different from the ones that are listed.

Table 7-2. Data Bus (D0-D7) Signatures

Data Bus	A4P5 Pin #	Signature
D0	7	2AP3
D1	8	FH1U
D2	9	FFP5
D3	10	C09F
D4	11	P505
D5	12	HH8A
D6	13	7967
D7	14	A089

Note. Set the Signature Analyzer to:
Start: (⌝⌞) A4TP3-A
Stop: (⌝⌞) A4TP3-B
Clock: (⌝⌞) A4TP3-C
The "1" (High, +5 V) signature is: 0003.

c. Page 8-A-3/8-A-4, Table 8-A-4 (Individual ROM Signatures, Service Group A). Replace Table 8-A-4 with Table 7-3.

Table 7-3. Individual ROM Signatures

ROM	Start/Stop Connection	ROM Pin #	Signature
A4U5	A4U6 pin 10	9	2P23
		10	4H88
		11	C66C
		13	3931
		14	0654
		15	OF76
		16	3574
		17	441P
A4U7	A4U6 pin 9	9	1A11
		10	9751
		11	3PUH
		13	CA4A
		14	7CA7
		15	480A
		16	11F6
		17	878C
A4U8	A4U6 pin 7	9	5632
		10	4631
		11	A8AA
		13	1P22
		14	3A6P
		15	24H5
		16	UUHA
		17	02HA

Note. Set the Signature Analyzer to:
Start: (⌝⌞) see Table
Stop: (⌞⌜) see Table
Clock: (⌝⌞) A4TP3-C
The "1" (High, +5V) signature is: 1180.

d. Page 8-A-16, paragraph 8-A-26 step h. Change the signatures in step h of paragraph 8-A-26 to the following:

h. Turn the 3456A On and check the following signatures. If any signatures are bad, try the recommended integrated circuit(s) in the given order. Replace the one on the left first and then replace the one next to it, if the signature was still bad.

I.C.	Pin #	Signature	Replace
A3U4	11	1180	A3U4
A3U4	10	0000	A3U4,U8
A3U4	12	1180	A3U12,U7,U8,U4
A3U14	15	1180	A3U14
A3U12	3	2P23	A3U12
A3U12	5	4H88	A3U12
A3U12	11	C66C	A3U12
A3U12	14	3931	A3U12,U14
A3U12	13	3931	A3U12
A3U7	3	0654	A3U7
A3U7	5	0F76	A3U7
A3U7	11	3574	A3U7
A3U7	14	441P	A3U7,U8
A3U7	13	441P	A3U7
A3U8	3	441P	A3U8
A3U14	13	3931	A3U14

e. Page 8-A-16, paragraph 8-A-26 step j. Change the signatures in step j of paragraph 8-A-26 to the following:

j. Check the following signatures and if any are bad, replace the recommended Integrated Circuit in the given order:

I.C.	Pin #	Signature	Replace
A3U8	5	U280	A3U8,U14
A3U8	11	0F76	A3U8,U14
A3U8	13	6P07	A3U8,U14
A3U8	6	U280	A3U8

Ref. Des.	Part Number	C D	Description
A40C3	0160-2202	8	CAPACITOR-FXD 75pF 300V
A40C11	0160-3502	3	CAPACITOR-FXD .3pF 500VDC
A40C12	0160-4807	5	CAPACITOR-FXD 33pF 300VDC
A40C22	0160-0302	5	CAPACITOR-FXD .018μF 200VDC
A40R21	0698-4470	5	RESISTOR 6.98K 1% .125W
A40R24	0757-0279	0	RESISTOR 3.16K 1% .125W
A40R60	0757-3486	2	RESISTOR 301 1% .125W

7-17. Change #6

7-18. For serial numbers 2015A02160 and below.

a. Page 8-65/8-66, Figure 8-61 (Schematic 1, Input Switching Schematic). Change A20C111 from 100pF to 150pF. Do not change the capacitor if U106 has been replaced by an op amp with part number 1820-0478.

b. Page 6-8/6-12, Table 6-4 (Replaceable Parts). When replacing A20U106, replace with the part number (1820-0478) shown in Table 6-4. The old part number is 1820-0477. If U106 has been replaced, replace C111 with the part number (0160-3336) shown in Table 6-4. The old part number is 0160-4814.

c. Page 6-8, Table 6-4 (Replaceable Parts). When replacing A20C701, replace with the part number (0180-0269) shown in Table 6-4. The old part number is 0180-0230.

7-19. Change #7

7-20. For serial numbers between 2015A01866 and 2015A02905.

a. Page 8-79/8-80, Figure 8-68 (Schematic 7, AC Converter Schematic. Change A40R21 from 6.98K ohm to 9.09K ohm.

b. Page 6-16, Table 6-4 (Replaceable Parts). Change A40R21 to 9.09K ohms (Part Number 0757-0288). If the resistor is to be replaced, use the value and part number shown in Table 6-4 (6.98K ohms, Part Number 0689-4470).

7-21. Change #8

7-22. For serial numbers 2015A02970 and below.

a. Page 8-79/8-80, Figure 8-68 (Schematic 7, AC Converter Schematic). Change the Input Attenuator Circuitry of the AC Converter as shown in Figure 7-5. Note that in the change, the value of R3 is 51 ohms instead of 1K ohms.

b. Page 6-15, Table 6-4 (Replaceable Parts). Change the following:

Ref. Des.	Part Number	C D	Description
A40R3	0683-5105	4	RESISTOR 51 5% .25W

7-23. Change #9

7-24. For serial numbers 2015A03070 and below. The following is a ROM change and requires some changes of the signatures listed in Service Group A of the manual. If a ROM (A4U5, U7, or U8) is to be replaced in the 3456A because of a failure, make sure the new ROMs used as replacements are the ones listed in Table 6-4 (Part Number of U5 is 1818-1629, U7 is 1818-1630, and U8 is 1818-1631). In addition, all ROMs (U5, U7, and U8) need to be replaced, even though only one ROM may be defective. If the ROMs presently in the instrument are the new ROMs, then only the defective ROM need to be replaced. The old ROMs listed in step a (which follows this paragraph), are no longer available.

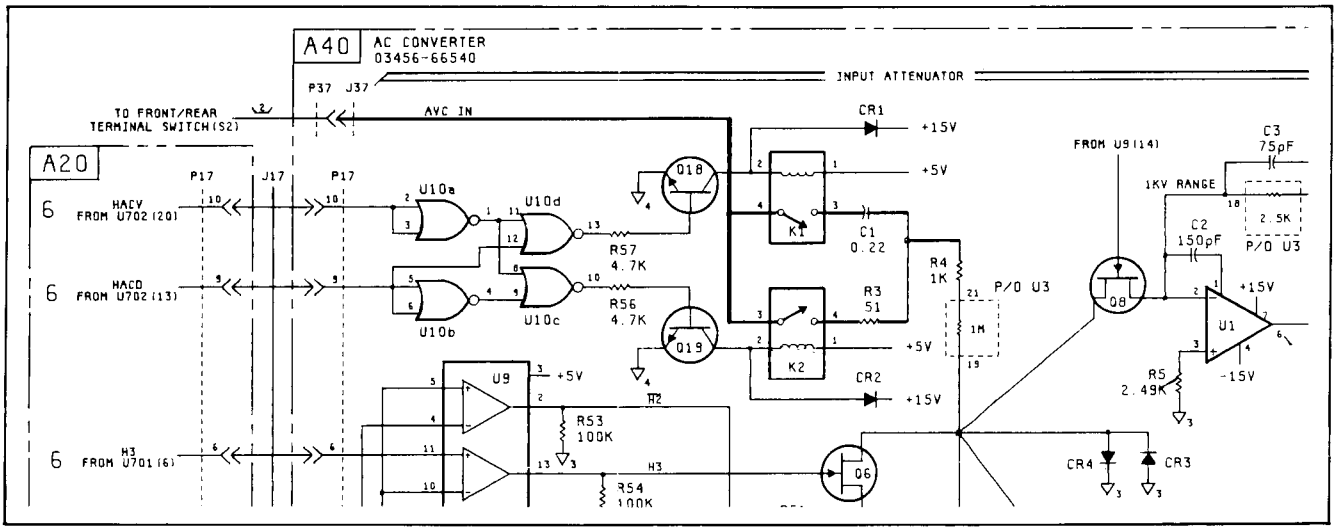


Figure 7-5. Change #8 on Schematic 7

HEWLETT PACKARD

SAFETY SUMMARY

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Hewlett-Packard Company assumes no liability for the customer's failure to comply with these requirements. This is a Safety Class 1 instrument.

GROUND THE INSTRUMENT

To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. The instrument is equipped with a three-conductor ac power cable. The power cable must either be plugged into an approved three-contact electrical outlet or used with a three-contact to two-contact adapter with the grounding wire (green) firmly connected to an electrical ground (safety ground) at the power outlet. The power jack and mating plug of the power cable meet International Electrotechnical Commission (IEC) safety standards.

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE

Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

KEEP AWAY FROM LIVE CIRCUITS

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified maintenance personnel. Do not replace components with power cable connected. Under certain conditions, dangerous voltages may exist even with the power cable removed. To avoid injuries, always disconnect power and discharge circuits before touching them.

DO NOT SERVICE OR ADJUST ALONE

Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to a Hewlett-Packard Sales and Service Office for service and repair to ensure that safety features are maintained.

DANGEROUS PROCEDURE WARNINGS

Warnings, such as the example below, precede potentially dangerous procedures throughout this manual. Instructions contained in the warnings must be followed.

WARNING

Dangerous voltages, capable of causing death, are present in this instrument. Use extreme caution when handling, testing, and adjusting.

7-15. Change #5

7-16. For serial numbers 2015A01865 and below. All changes pertain to the A40 Assembly.

a. Page 8-79/8-80, Figure 8-68 (Schematic 7, AC Converter Schematic). Do the following:

1. Add C11 (a 0.3pF capacitor) to the schematic, as shown in Figure 7-4. Do not add the capacitor if missing from the A40 assembly or hybrid U3 has been replaced.

2. Change C3 from 62pF to 75pF. Do not change the capacitor if C11 is missing from the A40 assembly or hybrid U3 has been replaced.

3. Change C22 from .015μF to .018μF. Do not change the capacitor if C11 is missing from the A40 assembly or hybrid U3 has been replaced.

4. Change R21 from 9.09K ohms to 6.98K ohms. Do not change the resistor if C11 is missing from the A40 assembly or hybrid U3 has been replaced.

5. Change R24 from 4.99K ohms to 3.16K ohms. Do not change the resistor if C11 is missing from the A40 assembly or hybrid U3 has been replaced.

6. Change R60 from 232 ohms to 301 ohms. Do not change the resistor if C11 is missing from the A40 assembly or hybrid U3 has been replaced.

b. Page 6-14/6-15/6-16, Table 6-4 (Replaceable Parts). Do not make the following changes or additions if capacitor C11 is missing from the A40 assembly or hybrid U3 has been replaced.

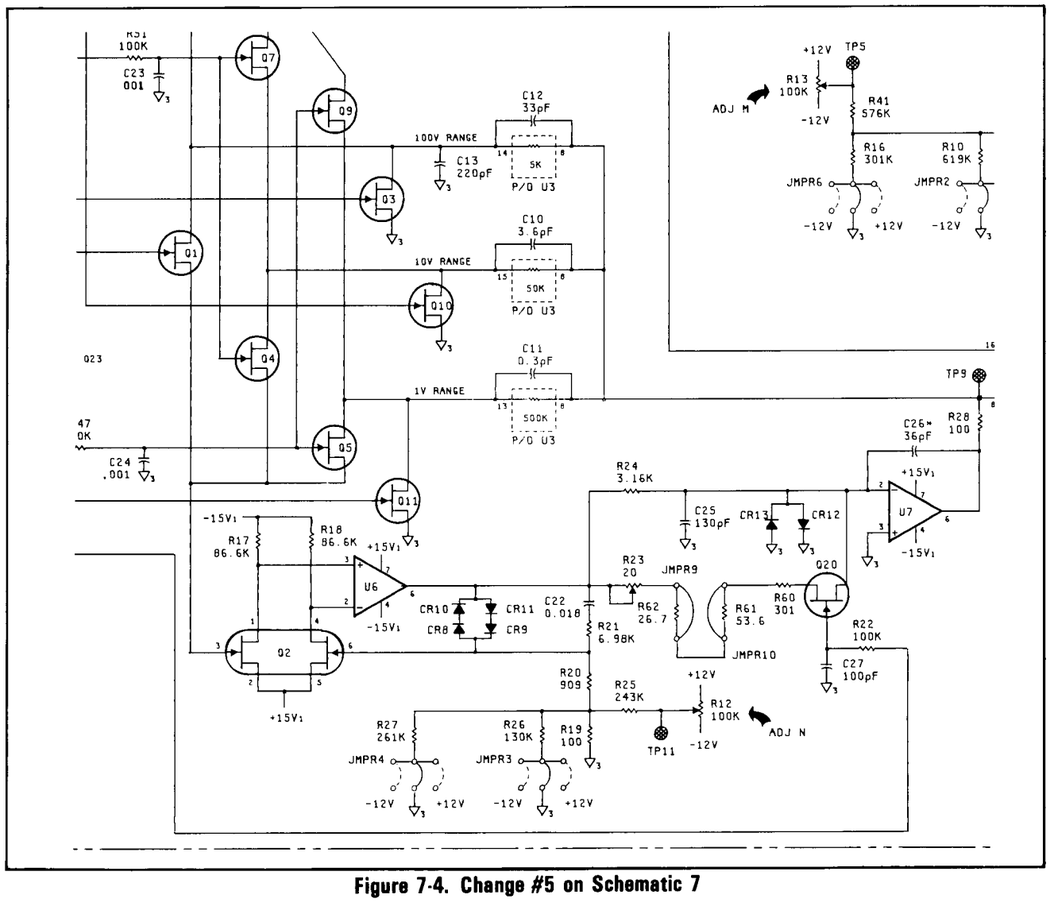


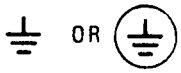
Figure 7-4. Change #5 on Schematic 7

SAFETY SYMBOLS

General Definitions of Safety Symbols Used On Equipment or In Manuals.

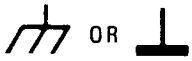
Instruction manual symbol: the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect against damage to the instrument.

Indicates dangerous voltage (terminals fed from the interior by voltage exceeding 1000 volts must be so marked).



Protective conductor terminal. For protection against electrical shock in case of a fault. Used with field wiring terminals to indicate the terminal which must be connected to ground before operating equipment.

Low-noise or noiseless, clean ground (earth) terminal. Used for a signal common, as well as providing protection against electrical shock in case of a fault. A terminal marked with this symbol must be connected to ground in the manner described in the installation (operating) manual, and before operating the equipment.



Frame or chassis terminal. A connection to the frame (chassis) of the equipment which normally includes all exposed metal structures.

Alternating current (power line).

Direct current (power line).

Alternating or direct current (power line).

The WARNING sign denotes a hazard. It calls attention to a procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in injury or death to personnel.

The CAUTION sign denotes a hazard. It calls attention to an operating procedure, practice, condition or the like, which,if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product.

NOTE: The NOTE sign denotes important information. It calls attention to procedure, practice, condition or the like, which is essential to highlight.

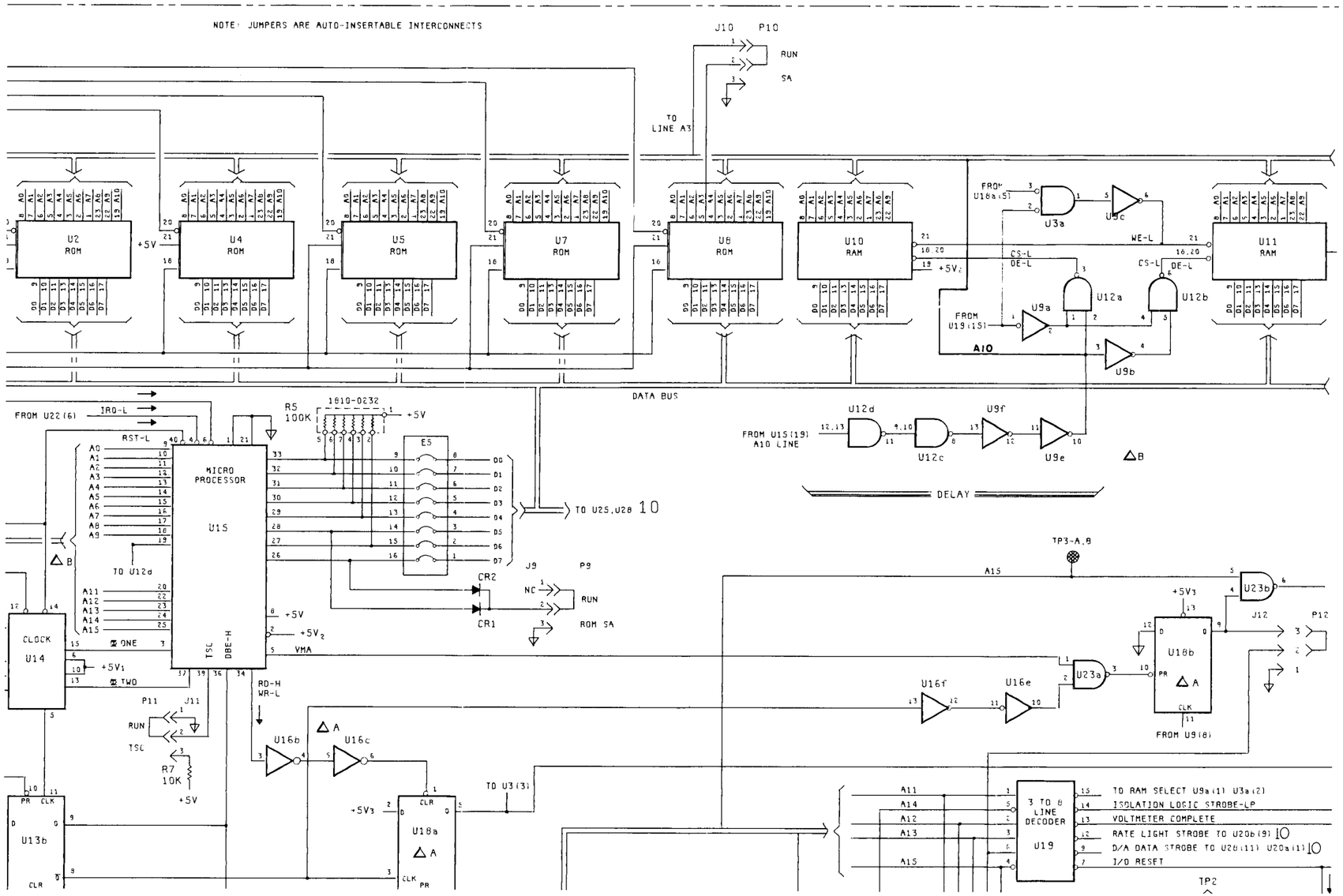


Figure 7-3. Change #3 on Schematic 9
Rev B 7-3

HEWLETT PACKARD

Herstellerbescheinigung

Hiermit wird bescheinigt, daß das Gerät/System HP 3456A in Übereinstimmung mit den Bestimmungen von Postverfügung 1046/84 funkentstört ist.

Der Deutschen Bundespost wurde das Inverkehrbringen dieses Gerätes/Systems angezeigt und die Berechtigung zur Überprüfung der Serie auf Einhaltung der Bestimmungen eingeräumt.

Zusatzinformation fur Meß- und Testgeräte

Werden Meß- und Testgeräte mit ungeschirmten Kabeln und/oder in offenen Meßaufbauten verwendet, so ist vom Betreiber sicherzustellen, daß die Funk-Entstörbestimmungen unter Betriebsbedingungen an seiner Grundstücksgrenze eingehalten werden.

Manufacturer's declaration

This is to certify that the equipment HP 3456A is in accordance with the Radio Interference Requirements of Directive FTZ 1046/84. The German Bundespost was notified that this equipment was put into circulation, the right to check the series for compliance with the requirements was granted.

Additional Information for Test- and Measurement Equipment

If Test- and Measurement Equipment is operated with unscreened cables and/or used for measurements on open set-ups, the user has to assure that under operating conditions the Radio Interference Limits are still met at the border of his premises.

NOTICE

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Hewlett-Packard assumes no responsibility for the use or reliability of its software on equipment that is not furnished by Hewlett-Packard.

e. Page 8-83/8-84, Figure 8-70 (Schematic 9, Main Controller Schematic). Change Address Line A10 connection as shown in Figure 7-3.

7-13. Change #4

7-14. For serial numbers 2015A00950 and below. Use new part number (1855-0460) shown in Table 6-4, when replacing A20Q406. The old number is: 1855-0246.

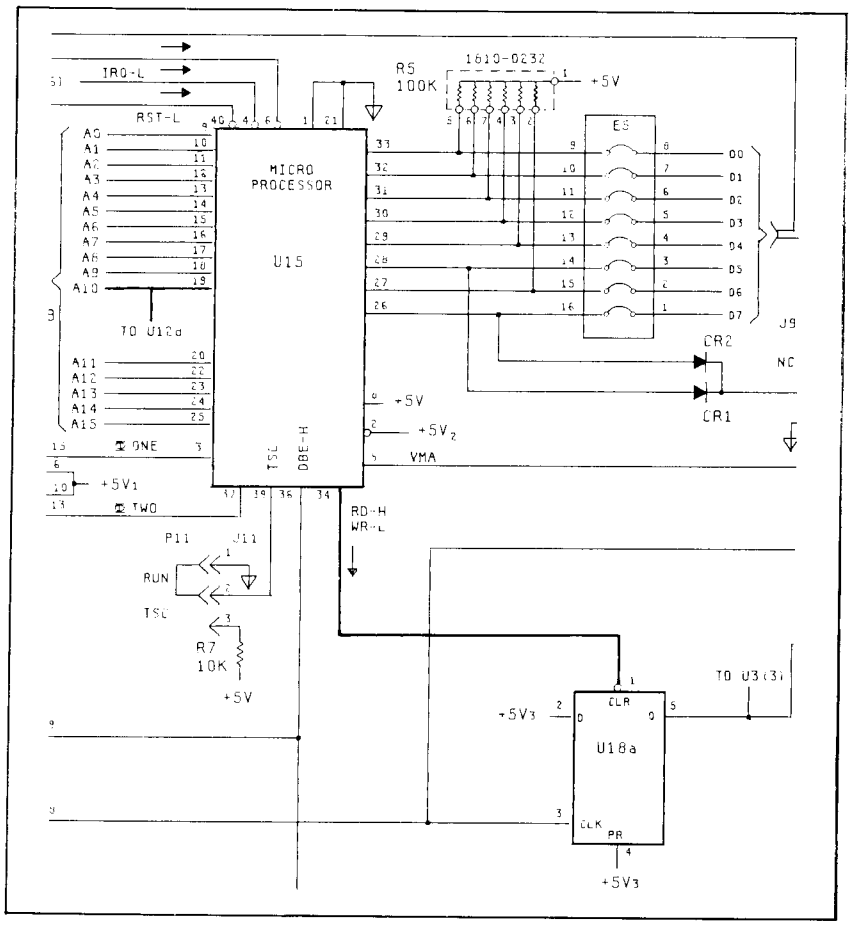


Figure 7-1. Change #1 on Schematic 9

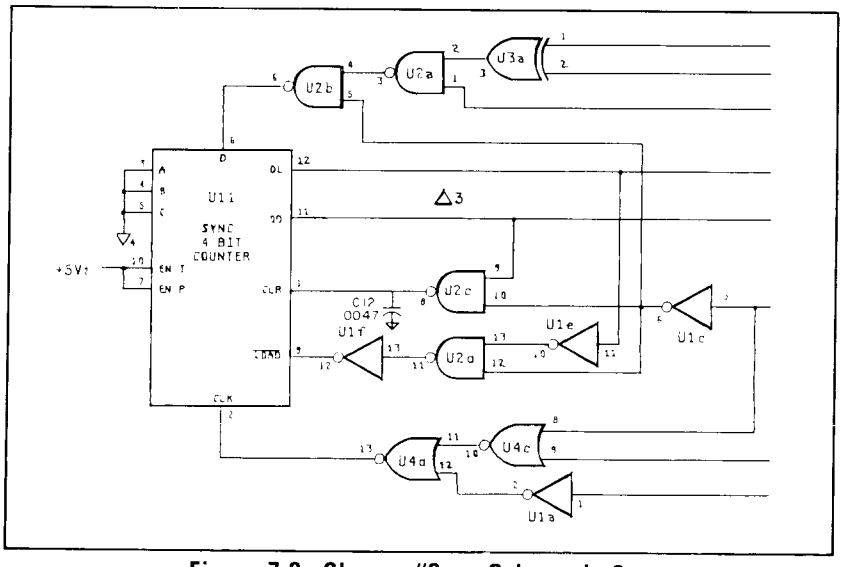


Figure 7-2. Change #3 on Schematic 8

SECTION VII
MANUAL CHANGES

7-1. INTRODUCTION

7-2. This section of the manual has information to adapt this manual for instruments with serial number prefixes other than shown on the title page. In addition, changes to instruments with the serial prefix given on the title page may also be included in this section.

7-3. MANUAL CHANGES

7-4. To adapt this manual to your 3456A, refer to Table 7-1 and make all the manual changes listed opposite your instrument's serial number. Perform these changes in the sequence listed.

7-5. If your instrument serial number is not listed on the title page of this manual or in Table 7-1, it may be documented in a yellow MANUAL CHANGES supplement.

Table 7-1. Manual Changes

Instrument Serial Number	Make Manual Changes
2015A00260 and Below	1
2015A00379 and Below	1,2
2015A00529 and Below	1,2,3
2015A00950 and Below	1,2,3,4
2015A01865 and Below	1,2,3,4,5
2015A02160 and Below	1,2,3,4,5,6
2015A01866 thru 2015A2905	7
2015A02970 and Below	1,2,3,4,5,6,8
2015A03070 and Below	1,2,3,4,5,6,8,9
2015A04595 and Below	1,2,3,4,5,6,8,9,10,11
2201A04596 thru 2201A4795	11

7-6. MANUAL CHANGE INSTRUCTIONS

7-7. Change #1

7-8. For serial numbers 2015A00260 and below.

a. Page 8-83/8-84, Figure 8-70 (Schematic 9, Main Controller Schematic). Delete inverters A4U16b and U16c, as shown in Figure 7-1. Since part of U16 is also used in other circuits, only delete U16b and U16c.

b. Page 6-7, Table 6-4 (Replaceable Parts). Change A4U18 from 1820-0693 to the following:

Ref. Des.	Part Number	C D	Description
A4U18	1820-1112	8	IC SN74LS74AN

7-9. Change #2

7-10. For serial numbers 2015A00379 and below.

a. Page 8-71/8-72, Figure 8-64 (Schematic 4, A/D Converter Schematic). Resistors A20R424 and R427 where origionally 56.2K ohms, and R425 and R426 where 44.2K ohms. They where changed to 52.3K ohms and 47.5K ohms for R424 and R427, and R425 and R426, respectively. They where changed to improve the A/D Converter's Overload Circuitry operation when the 3456A's is configured to the 50Hz power option. If the resistor values are other than shown on schematic 4, change them to the values shown on the schematic (52.3K for R424 and R427, and 47.5K for R425 and R426).

b. Page 6-11, Table 6-4 (Replaceable Parts). The values for A20R424 through R427 should be as shown Table 6-4, if the 3456A is updated to those values.

7-11. Change #3

7-12. For serial numbers 2015A00529 and below.

a. Page 8-79/8-80, Figure 8-68 (Schematic 7, AC Converter Schematic). Change capacitors A40C17 and C18 from 10pF to 15pF.

b. Page 6-15, Table 6-4 (Replaceable Parts).

Ref. Des.	Part Number	C D	Description
A40C17,C18	0140-0202	2	CAPACITOR-FXD 15pF 500VDC

c. Page 8-81/8-82, Figure 8-69 (Schematic 8, Inguard Logic Schematic). Change the following:

1. Delete A30U25a from the schematic, as shown in Figure 7-2.

2. Connect a .0047μF capacitor (A30C12) from pin 1 of A30U11 to ground, as shown in Figure 7-2.

d. Page 6-13/6-14, Table 6-4 (Replaceable Parts). Delete A30U25 from the table and add the following:

Ref. Des.	Part Number	C D	Description
A30C12	0160-4298	6	CAPACITOR .0047μF

SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. The information contained in this Manual is for the Installation, Operation, HP-IB Programming and Service of the Hewlett-Packard Model 3456A Digital Voltmeter.

NOTE

HP-IB is Hewlett-Packard's implementation of IEEE Std. 488-1975, "Standard Digital Interface for Programmable Instrumentation."

1-3. The Installation, Operating, and HP-IB Programming information in this Manual is also contained in the Operating Manual.

1-4. This section in the manual contains general information concerning the 3456A Digital Voltmeter. Included are instrument description, specifications, supplemental characteristics, instrument and manual identification, options, accessories, and other information on the instrument.

1-5. DESCRIPTION.

1-6. The Hewlett-Packard Model 3456A is a versatile Digital Voltmeter with ac, dc, ohms, and various math functions. This voltmeter is an excellent bench meter and since it is remotely programmable it is an exceptional system measurement device. Other features for which you may have some good uses are the selection of power line cycles integrated, the selection of certain number of readings/trigger, settling delay, ratio, and other unique and useful functions.

1-7. The 3456A also employs a feature called AUTO ZERO. This feature of the instrument is very useful for good stability. The internal reference device and reference resistors are also selected for good accuracy and stability. Another good feature is the TEST function of the 3456A. With this function the instrument's operation can be partially verified for correct operation by the operator.

1-8. SPECIFICATIONS.

1-9. Specifications of the 3456A are the performance characteristics of the instrument which are warranted. These specifications are listed in Table 1-1, and are the performance standards or limits against which the instrument can be tested. Included in Table 1-1 are also some supplemental characteristics of the 3456A and should be considered as additional and general information for you, the user. Because of the many operational capablities of the 3456A, exercise care when determining the instrument's specifications.

1-10. Any changes in the specifications due to manufacturing changes, design, or traceability to the National Bureau of Standards will be covered in a manual change supplement or revised manual pages. The specifications listed here supercede any previously published.

1-11. INSTRUMENT AND MANUAL IDENTIFICATION.

1-12. Instrument identification is by a serial number located on the rear panel of the instrument. Hewlett-Packard uses a two-part serial number. The first part (prefix) identifies a series of instruments and the last part (suffix) identifies a particular instrument within a series. A letter between the prefix and suffix identifies the country in which the 3456A is manufactured.

1-13. This manual applies to instruments with serial number indicated on the title page. Updating of the manual is accomplished either by a change sheet or revised pages.

1-14. OPTIONS.

1-15. The following options are available for use with the 3456A:

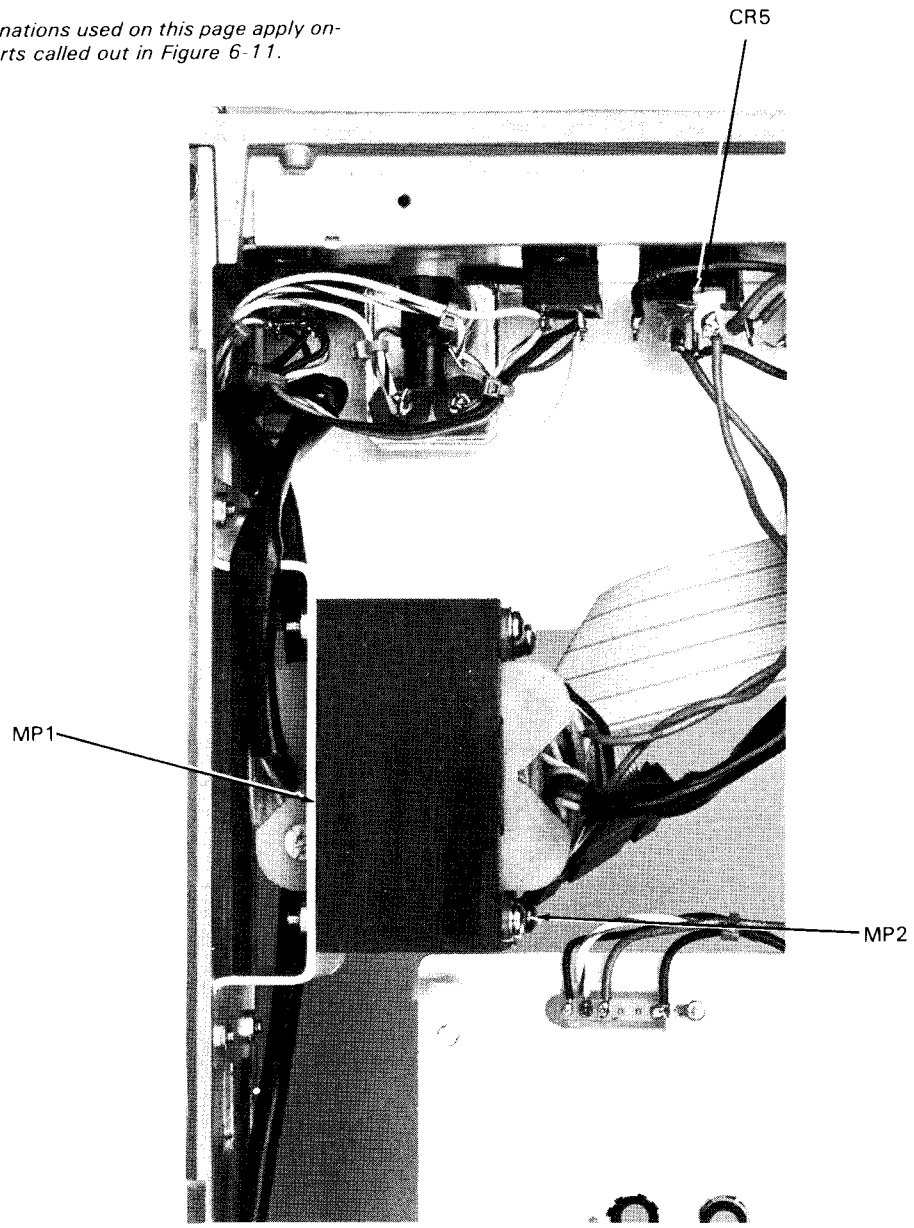
Option 350: for 50 Hz Power Source
Option 360: for 60 Hz Power Source
Option 907: Front Handle Kit
Option 908: Rack Mounting Kit
Option 909: Front Handle and Rack Mounting Kit
Option 910: Additional Set of Manuals

1-16. ACCESSORIES SUPPLIED.

1-17. The 3456A is supplied with a 3/8 amp, 250V fuse for the 220V and 240V power line voltages.

NOTE

The MP Designations used on this page apply only to those parts called out in Figure 6-11.



Reference Designation	-hp- Part Number	C D	Qty	Description
MP1	03456-01201	7	1	Bracket-Transformer
MP2	0515-0216	3	4	Screw-Mach M4 x 0.7 50MM-LG Pan-HD
CR5 Δ_{10}	1906-0205	0	1	Diode Assembly Bridge

Figure 6-11. Power Transformer and Bracket; Voltage Regulator, Zener Diode, and Bracket.

Table 1-1. Specifications.

DC VOLTAGE

Input Characteristics

Range	Maximum Reading (5 digit)	Resolution 6 Digit	Resolution 5 Digit	Resolution 4 Digit	Input Resistance	Maximum Input Voltage
0.1V	.119999V	100 nV	1 μV	10 μV	> $10^{10}\Omega$	±1000V peak
1.0V	1.19999V	1 μV	10 μV	100 μV	> $10^{10}\Omega$	
10.0V	11.9999V	10 μV	100 μV	1mV	> $10^{10}\Omega$	
100.0V	119.999V	100 μV	1mV	10mV	10MΩ ± .5%	
1000.0V	1000.00V	1mV	10mV	100mV	10MΩ ± .5%	

Guard to Chassis: ±500V peak
Guard to Low: ±200V peak

Measurement Accuracy: ± (% of Reading + Number of Counts).
Auto-zero on and filter off.

24 hours: 23°C ± 1°C

Range	6 Digit (≥ 10 PLC*)	6 Digit (1 PLC)	5 Digit (.1 PLC)	4 Digit (.01 PLC)
0.1V	.0022 + 24	0.0024 + 32	0.007 + 14	0.06 + 3
1.0V	0.0009 + 4	0.0012 + 5	0.007 + 3	0.06 + 2
10.0V	0.0008 + 2	0.0011 + 3	0.007 + 2	0.06 + 2
100.0V	0.0011 + 3	0.0014 + 4	0.007 + 2	0.06 + 2
1000.0V[1]	0.0011 + 2	0.0013 + 3	0.007 + 2	0.06 + 2

90 Day: 23°C ± 5°C

Range	6 Digit (≥ 10 PLC)	6 Digit (1 PLC)	5 Digit (.1 PLC)	4 Digit (.01 PLC)
0.1V	0.0034 + 24	0.0035 + 32	0.008 + 14	0.06 + 3
1.0V	0.0024 + 4	0.0025 + 5	0.007 + 3	0.06 + 2
10.0V	0.0023 + 2	0.0024 + 3	0.007 + 2	0.06 + 2
100.0V	0.0026 + 3	0.0027 + 4	0.007 + 2	0.06 + 2
1000.0V[1]	0.0024 + 2	0.0025 + 3	0.007 + 2	0.06 + 2

[1]Add $.012\left(\frac{\text{Input Voltage}}{1000}\right)^2$% to % reading.

> 90 days: 23°C ± 5°C
Add ± .0006% of Reading/month to 90 day accuracy.

Temperature Coefficient: (5 digit)[2] ± (% of Reading + Number of Count)/°C

Range	0.1V	1.0V	10.0V	100.0V	1000.0V
Temp. Coef.	0.0002 + 0.2	0.0002 + 0.02	.0002 + .002	0.0002 + 0.02	0.0002 + 0.02

Auto-Zero OFF: (5 digit)[2]
For a stable environment ± 1°C, add 10 counts for .1V range, 1 count for 1V and 100 ranges, and .1 count for 10V and 1000V ranges.

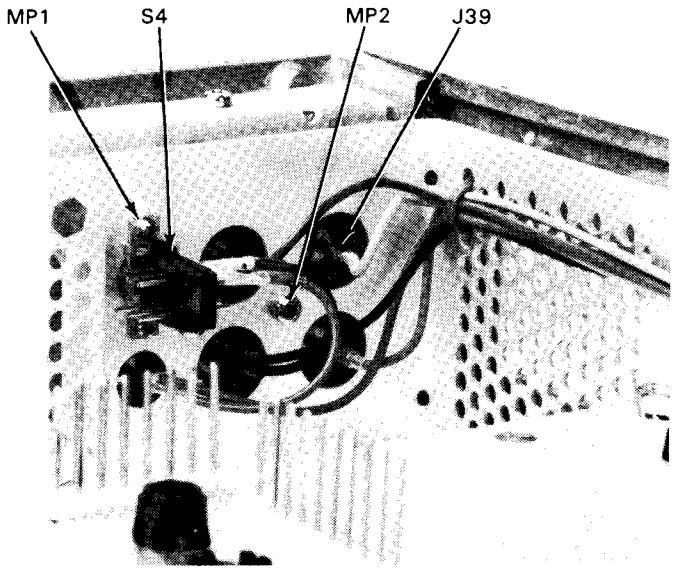
Filter ON: Rejection is > 60 dB at 50 Hz. Add 2μV for .1V, 1.0V and 10V range and 200 μV for 10V and 1000V range.

[2]For 6 digits, multiply counts by 10
For 4 digits, multiply counts by .1

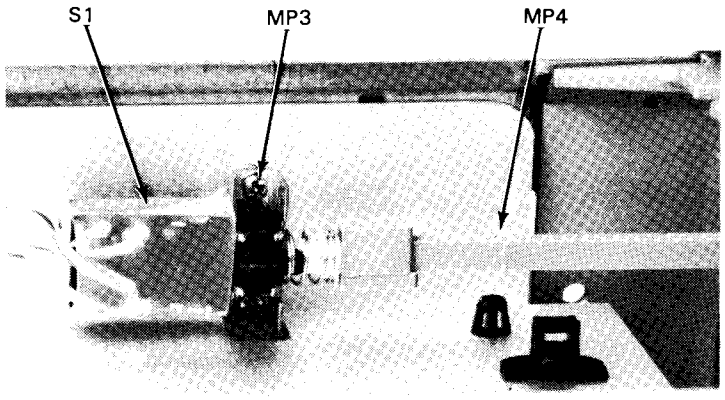
*Integration in POWER LINE CYCLES

NOTE

The MP Designations used on this page apply to those parts called out in Figure 6-10 (A & B).



A. Inside View of Rear Terminal Assembly and Guard Switch.



B. AC Power Switch.

Reference Description	-hp- Part Number	C D	Qty	Description
MP1	0515-0214		2	Screw, Mach M2 x 0.4 6MM-LG Pan-HD
MP2	0515-0211	8	2	Screw, Mach M3 x 0.5 6MM-LG Pan-HD
MP3	0515-0217		2	Screw, Mach M2 x 0.4 4MM-LG Pan-Hd
MP4	5040-7023	2	1	Pushrod for S1
J39	5060-7478	3	1	Terminal Assembly-Rear Input
S1	3101-2216	3	1	Switch-PB DPDT ALTNG 4A 250 VAC
S4	3101-1299	0	1	Switch-Guard PB DPDT

Figure 6-10. Inside View of Rear Terminal Assembly and AC Power Switch.

Table 1-1. Specifications (Cont'd).

Response Time:
Filter OFF - For default delay (0.0 seconds), error is < .0005 % of input voltage step.

Filter ON: For default delay (.65 seconds), error is < .01% of input voltage step.

Integration Time in Power Line Cycles (PLC)	Noise Rejection (dB)		
	AC[3, 4] NMR	AC[3, 4] ECMR[4]	DC ECMR[4]
.01 PLC or .1 PLC	0	90	140
> 1 PLC	60	150	140
> 1 PLC with Filter	120	160	140

[3]For 50, 60 Hz (depending on option) ± .09%.
[4]1 KΩ unbalance in Lo

AC RMS VOLTAGE

Input Characteristics

Range	Maximum Reading (5 Digit)	Resolution 6 Digit	Resolution 5 Digit	Resolution 4 Digit	Input Impedance	Maximum Input Voltage
1.0V	1.19999V	1 μV	10 μV	100 μV	1MΩ ±.5%	±1000V
10.0V	11.9999V	10 μV	100 μV	1mV	shunted by	peak
100.0V	119.999V	100 μV	1mV	10mV	< 75pF	(700V rms)
1000.0V	700.00V	1mV	10mV	100mV		10^8VHZ

Guard to Chassis: ±500V peak
Guard to Low: ±200V peak

Measurement Accuracy: ± (% of Reading + Number of Counts)
Auto-zero on, > 1% of full scale, and DC component < 10% of AC Component.
For inputs > 500V rms add .07% of reading.

24 hours: 23°C ± 1°C

Integration Time In Power Line Cycles (PLC)	Frequency in Hz				
	Filter Off→ 20 to 30	400-20k 30-20k	20k to 50k 20k to 50k	50k to 100k 50k to 100k	[1]100k to 250k [1]100k to 250k
6 Digit (≥ 1 PLC)	.33 + 300	.05 + 550	.15 + 1500	.53 + 2700	5.0 + 6300
5 Digit (.1 PLC)	.34 + 33	.06 + 55	.16 + 150	.54 + 270	5.0 + 630
4 Digit (.01 PLC)	.39 + 5	.11 + 7	.21 + 17	.59 + 29	5.1 + 65

90 day: 23°C ± 5°C

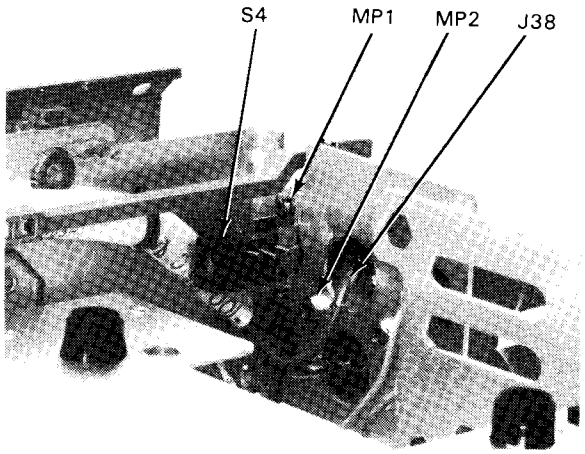
Integration Time in Power Line Cycles (PLC)	Frequency in Hz				
	Filter Off→ 20 to 30	400-20k 30-20k	20k to 50k 20k to 50k	50 k to 100k 50k to 100k	[1]100k to 250k [1]100k to 250k
6 Digit (≥ 1 PLC)	.35 + 500	.07 + 700	.17 + 1700	.55 + 2900	5.0 + 6500
5 Digit (.1 PLC)	.36 + 53	.08 + 73	.18 + 173	.56 to 293	5.0 + 653
4 Digit (.01 PLC)	.41 + 7	.13 + 9	.23 + 19	.61 + 31	5.1 + 67

[1]Frequencies > 100 kHz are specified for 1.0V and 10V ranges only.

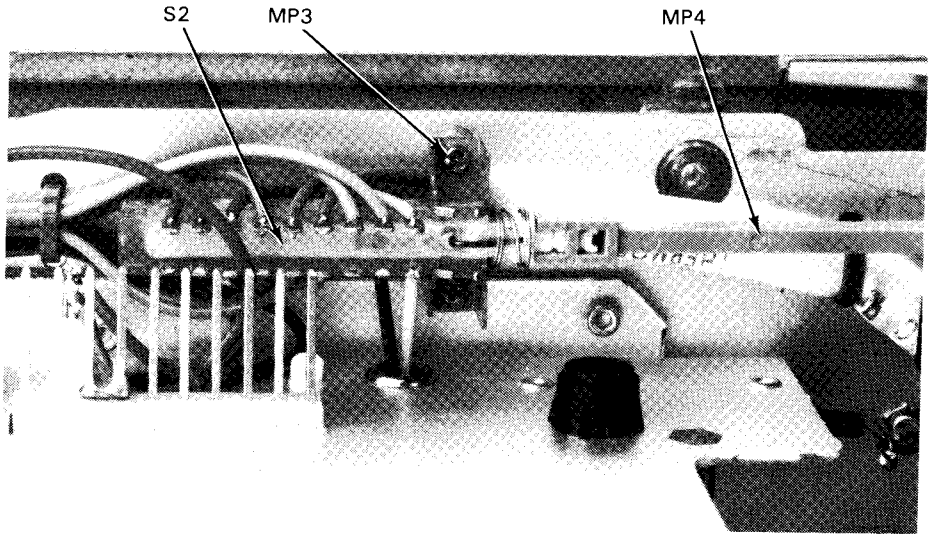
> 90 day: 23°C ± 5°C (5 digit)[2]
Add ± (.004% of Reading + 12 counts)/month to 90 day accuracy.

NOTE

The MP Designations used on this page apply only to those parts called out in Figure 6-9 (A & B).



A. Inside View of Front Terminal Assembly and Guard Switch.



B. Front/Rear Switch (F/R).

Reference Designation	-hp- Part Number	C D	Qty	Description
MP1	0515-0214		2	Screw-Mach M2 x 0.4 6MM-LG Pan-HD
MP2	0515-0211	8	2	Screw-Mach M3 x 0.5 6MM-LG Pan-HD
MP3	0515-0214		2	Screw-Mach M2 x 0.4 6MM-LG Pan-HD
MP4	5040-7023	2	1	Pushrod for S2
J38	5060-7478	3	1	Terminal Assembly-Front Input
S2	3101-0461	6	1	Switch-Front/Rear-PB 6PDT
S4	3101-1299	0	1	Switch-Guard-PB DPDT

Figure 6-9. Inside View of Front Terminal Assembly, Guard Switch, and Front/Rear Switch.

Table 1-1. Specifications (Cont'd).

Temperature Coefficient: (5 digit)[2]
± (% of Reading + Number of Counts)/°C
± (.008 + 6)/°C for DC component < 10% AC component
± (.008 + 12)/°C otherwise

[2]For 6 digit, multiply counts by 10.
For 4 digit, multiply counts by .1.

DC Component > 10% of AC Component: (5 digit)[2]
Add ± (.05% of Reading + 50 counts) to accuracy.

Crest Factor: > 7 at full scale.

Common Mode Rejection (1kΩ unbalance in Lo): > 90 dB DC to 60 Hz

Auto-Zero Off: For stable environment ± 1°C no accuracy change.

Default Delays:
Filter Off - .06 seconds
Filter On - .80 seconds

Response Time: For default delay, error is < .1% of input voltage step.

RESISTANCE

Input Characteristics

Range	Maximum Reading (5 Digit)	6 Digit	Resolution 5 Digit	4 Digit	Current Through Unknown	Maximum Valid Reading Voltage	Maximum Open Circuit Voltage
100Ω	119.999Ω	100μΩ	1mΩ	10mΩ	1mA	1.2V	5.5V
1kΩ	1199.99Ω	1mΩ	10mΩ	100mΩ	1mA	1.2V	5.5V
10kΩ	11.9999kΩ	10mΩ	100mΩ	1Ω	100μA	1.2V	5.5V
100kΩ	119.999kΩ	100mΩ	1Ω	10Ω	50μA	6V	9.5V
1MΩ	1199.99kΩ	1Ω	10Ω	100Ω	5μA	6V	9.5V
10MΩ	11.9999MΩ	10Ω	100Ω	1kΩ	500nA	6V	9.5V
100MΩ	119.999MΩ	100Ω	1kΩ	10kΩ	≤ 500nA[1]	5V	5.5V
1GΩ	1000.00MΩ	1kΩ	10kΩ	100kΩ	≤ 500nA[1]	5V	5.5V

Non-destructive overload: 350V peak.

Measurement Accuracy: ± (% of Reading + Number of Counts)
Auto-Zero on, filter off, and 4-wire ohms.

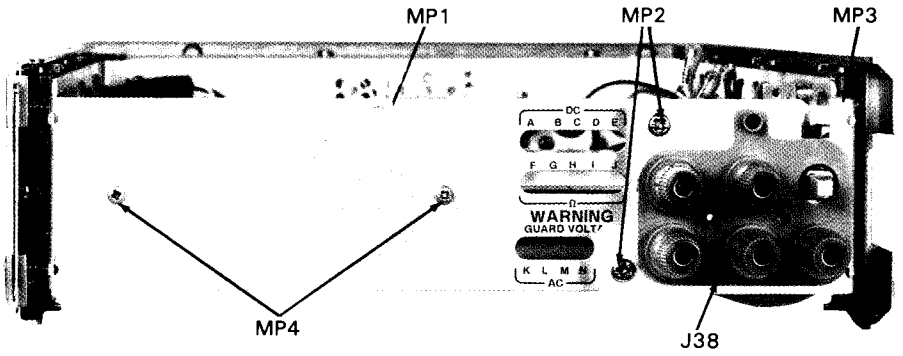
24 hours: 23°C ± 1°C

Range	6 Digit (≥ 10 PLC)	6 Digit (1 PLC)	5 Digit (.1 PLC)	4 Digit (.01 PLC)
100Ω	0.003 + 24	0.003 + 32	0.009 + 14	0.07 + 3
1kΩ	0.002 + 4	0.003 + 5	0.008 + 3	0.07 + 2
10kΩ	0.002 + 4	0.003 + 5	0.008 + 3	0.07 + 2
100kΩ	0.002 + 2	0.003 + 3	0.008 + 2	0.07 + 2
1MΩ	0.006 + 2	0.006 + 3	0.012 + 2	0.07 + 2
10MΩ	0.041 + 2	0.041 + 3	0.07 + 2	0.12 + 2
100MΩ	1.3 + 1	1.3 + 1	1.5 + 1	1.5 + 1
1GΩ	11 + 1	11 + 1	13 + 1	13 + 1

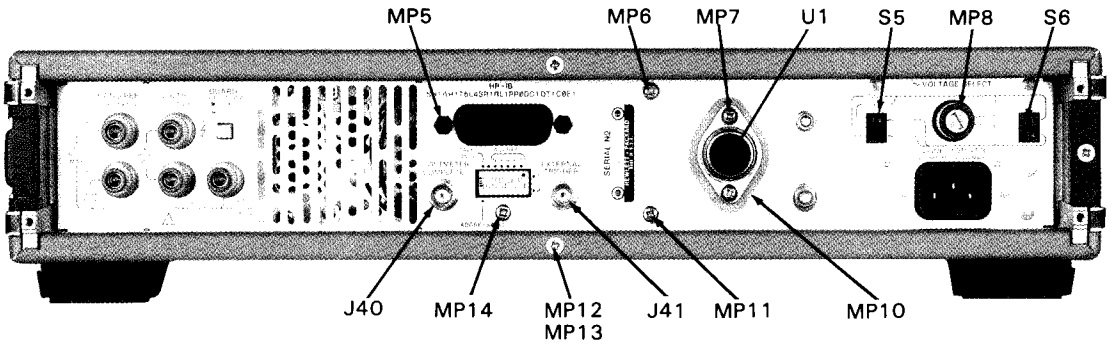
[1]Ohms source is a 500nA current source in parallel with a 10MΩ resistance.

NOTE

The MP Designations used on this page apply only to those parts called out in Figure 6-8 (A & B).



A. Inguard Chassis Hardware—Front.



B. Rear Panel.

Reference Designation	-hp- Part Number	C D	Qty	Description
MP1	03456-00102	5	1	Chassis-Inguard-Left
MP2	0515-0212	9	2	Screw-Mach M3.5 x 0.6 6MM-LG Pan-HD
MP3	03456-00101	4	1	Chassis-Inguard-Right
MP4	0624-0314	3	2	Screw-Tapping 4-20 x .375 Pan-HD Plastite
MP5	0380-1214	6	2	Standoff Screw-HP-IB, Metric
MP6	0515-0225	4	1	Screw-Mach M3.5 x 0.6 10MM-LG Pan-HD
MP7 Δ_{10}	0624-0034	4	2	Screw-Taping 6-20 0.5 Pan-HD
MP8 Δ_{10}	2110-0564	8	1	Fuseholder Body
MP9 Δ_{10}	2110-0565	9	1	Fuseholder Cap
MP10 Δ_{10}	0340-0580	3	1	Insulator-XSTR THRM-CNDCT
MP11 Δ_{10}	0515-0212	9	1	Screw-Mach M3.5 x 0.6 6MM-LG Pan-HD
MP12 Δ_{10}	0570-1171	7	3	Screw-Cover Mtg.
MP13 Δ_{10}	0510-0043	4	3	Ring-Ret Ext-E-.141 Dia
MP14 Δ_{10}	0515-0215	2	1	Screw M3.5 x 0.6 20MM-LG Pan-HD
J38	5060-7478	3	1	Terminal Assembly-Front Input
J40, J41	1250-0083	1	2	Connector-RF BNC
S5, S6	3101-2298	1	2	Switch-Slide Voltage Select
U1 Δ_{10}	1826-0181	1	1	Voltage Regulator-LM323K

Figure 6-8. Inguard Chassis—Front and Rear Panel.

Table 1-1. Specifications (Cont'd).

90 days: 23°C ± 5°C

Range	6 Digit (≥ 10 PLC)	6 Digit (1 PLC)	5 Digit (.1 PLC)	4 Digit (.01 PLC)
100Ω	0.004 + 24	0.004 + 32	0.01 + 14	0.07 + 3
1kΩ	0.003 + 4	0.004 + 5	0.009 + 3	0.07 + 2
10kΩ	0.003 + 4	0.004 + 5	0.009 + 3	0.07 + 2
100kΩ	0.003 + 2	0.004 + 3	0.009 + 2	0.07 + 2
1MΩ	0.007 + 2	0.007 + 3	0.013 + 2	0.07 + 2
10MΩ	0.042 + 2	0.042 + 3	0.07 + 2	0.12 + 2
100MΩ	1.8 + 1	1.8 + 1	2.0 + 1	2.0 + 1
1GΩ	16 + 1	16 + 1	18 + 1	18 + 1

> 90 days: 23°C ± 5°C
Add ± .0004% of Reading/month to 90 day accuracy.

2-Wire Ohms Accuracy: Same as 4-wire ohms except add < .2 ohm offset.

Auto-Zero Off Accuracy: (5 digit)[2]
For a stable environment ± 1°C, add 10 counts for 100Ω range, 1 count for 1kΩ range and 10kΩ ranges, and .2 counts for ≥ 100kΩ ranges.. Changes in lead resistance are not corrected for a 4-wire ohms.

Range	Maximum Lead Resistance for 4-Wire Ohms	Maximum Offset Voltage for Offset Compensated Ohms	Default Delay in Seconds
100Ω	10Ω	.01V	0
1kΩ	100Ω	.1V	0
10kΩ	1000Ω	.1V	0
100kΩ	1000Ω	.5V	.001
1MΩ	1000Ω		.008
10MΩ	1000Ω		.08
100MΩ	1000Ω		.08
1GΩ	1000Ω		.08

Offset Compensated Ohms Accuracy: Same as 2-wire and 4-wire except maximum reading may be reduced by 9% for large offset voltages. 100Ω - 100kΩ range are used.

Response Time: With default delay and < 200pF of capacitance, first reading is in specification.

Filter is not operational in ohms.

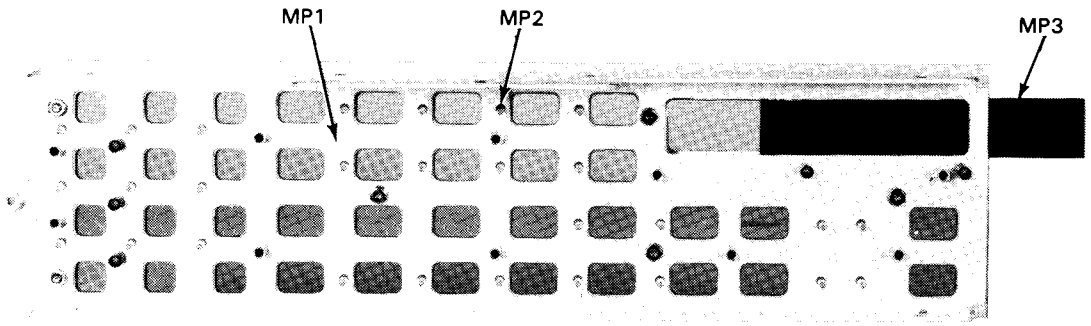
Temperature Coefficient: (5 digit)[2] ± (% of Reading + Number of Counts)/°C

Range	100Ω	1kΩ 10kΩ 100kΩ	1MΩ	10MΩ	100MΩ	1GΩ
T.C.	.0004 +.2	.0004 +.02	.0004 +.004	.0010 +.004	.16 +0	1.6 +0

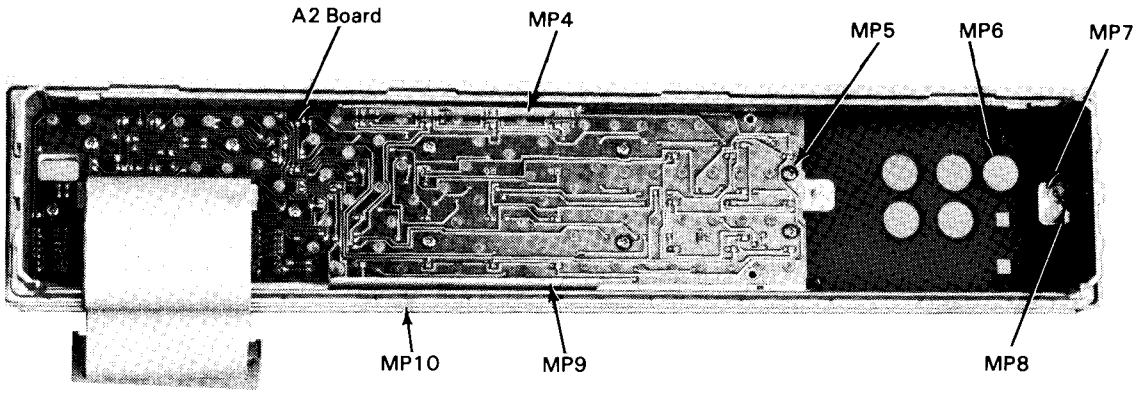
[2]For 4 digit, multiply counts by .1.
For 6 digit, multiply counts by 10.

NOTE

The MP Designations used on this page apply only to those parts called out in Figure 6-7 (A & B).



A. Front Panel.



B. Front Frame, Cal. Panel, Sub Panel, and A2 Board Assembly.

Reference Designation	-hp- Part Number	C D	Qty	Description
MP1	03456-00201	5	1	Front Panel
MP2	4040-1645	1	33	Light-Pipes
MP3	4114-0868	5	1	Window—Display
MP4	03456-00204	8	1	Sub-Panel
MP5	0515-0211		10	Screw-Mach M3 x 0.5 6MM-LG Pan-HD
MP6	03456-00202	6	1	Panel-Calibrate
MP7	03456-01203	9	1	Bracket-Panel Mount
MP8	2510-0133		1	Screw-Mach 8-32 x .188 Pan HD
MP9	03456-01204	0	1	Bracket, Sub Panel
MP10	5020-8801	4	1	Front Frame

Figure 6-7. Front Assembly (Inside View).

Table 1-1. Specifications (Cont'd).

RATIO

Type: DC/DC, AC/DC, or (AC + DC)/DC

Method: 4-Wire with Volts Lo input common.

$$\text{Ratio} = \frac{\text{Signal Voltage}}{\text{Ref. Hi Voltage} - \text{Ref. Lo Voltage}}$$

Signal Measurement: Same as DC Volts, or AC + DC Volts.

Reference Measurement: Automatically selects .1V, 1V, or 10V DC Volts range and a 0.0 msec. settling time. Filter is off.

Maximum Reference Voltage:

Ref. Hi:	± 12V
Ref. Lo:	± 9% of Ref. Hi.
Ref. Hi-Ref. Lo:	± 11.9999V
Protection:	± 350V peak

Accuracy: Total % signal error + total % reference error (same as .1V, 1V, or 10V DC volts)

MEMORY

Reading Store:

- Can store up to 350 most recent readings.
- Can be recalled from the HP-IB interface or the front panel.

Program Memory:

- Can execute an internal program which controls instrument configuration and measurement sequence.
- Program is input from the HP-IB interface with up to 1400 ASCII characters.

Memory Size:

- Total size = 1400 bytes
- Memory used = 1 byte per ASCII character + 4 bytes per reading stored.

READING RATE

Reading rates are with autorange, math, display and filter off. Output is to internal memory using internal trigger and packed Mode. Packed output in place of internal memory adds .35 msec; ASCII output adds 2.3 msec.

Rates vs. Integration Time and Auto-Zero: DC Volts and 100Ω thru 10kΩ ranges with default (-0.0 sec.) delay. Also, AC or AC + DC Volts and 100kΩ thru 10MΩ ranges with 0.0 sec. delay.

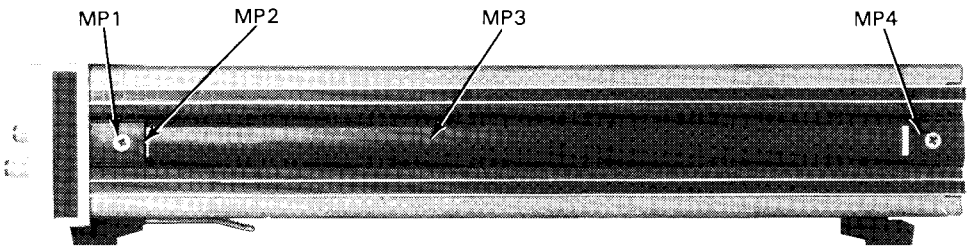
Integration Time in Power Line Cycles (PLC)	Rates			
	Auto-Zero Off		Auto-Zero On	
	60 Hz	50 Hz	60 Hz	50 Hz
0.01	330	290	210	180
.10	210	180	120	100
1.00	48	40	25	20.8
10.00	5.8	4.8	2.9	2.4
100.00	.57	0.47	.29	0.24

Rates with 1 Power Line Cycle Integration and Default Delays.

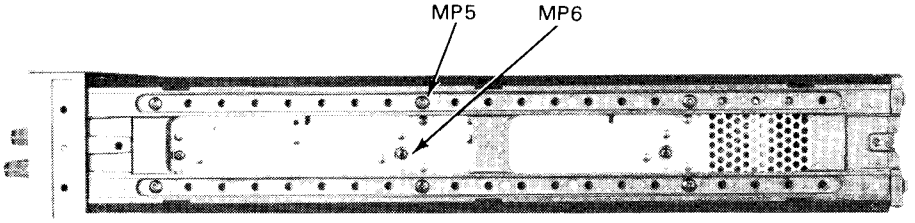
	Rates	
	60 Hz	50 Hz
– DC Volts and 100Ω thru 10kΩ, Auto-zero Off	48.0	40.00
– DC Volts, Filter ON	1.48	1.47
– AC or AC + DC Volts, Auto-zero OFF	12.0	11.00
– AC or AC + DC Volts, Filter ON	1.2	0.95
– 100kΩ range, Auto-zero OFF	46.0	35.0
– 1MΩ range, Auto-zero OFF	34.0	28.0
– 10MΩ range, Auto-zero OFF	9.9	9.0
– 100MΩ and 1GΩ range, Auto-zero OFF	6.6	6.10
– DC/DC ratio	5.2	4.40
– Offset Compensated Ohms	10.0	9.00

NOTE

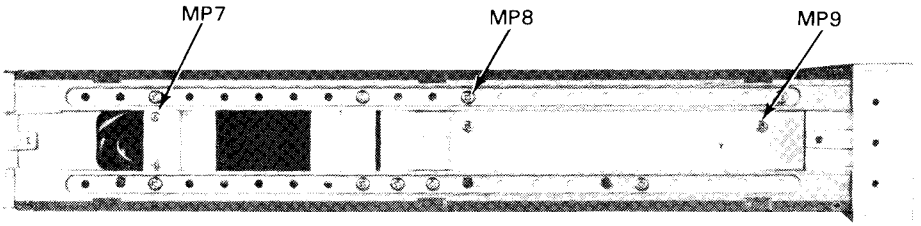
The MP Designations used on this page apply only to those parts called out in Figure 6-6 (A, B, & C).



A. Side View of Chassis Showing Handle/Hardware.



B. Side View of Chassis with Side Cover Removed.



C. Opposite Side of Chassis with Side Cover Removed.

Reference Designation	-hp- Part Number	C D	Qty	Description
MP1	2680-0172		2	Screw-Mach 10-32
MP2	5040-7219	8	1	Strap Handle Cap-Front
MP3	5060-9804	3	1	Strap Handle-18 In
MP4	5040-7220	1	1	Strap Handle Cap-Rear
MP5	0624-0461		6	Screw-Tapping 8-16 x .5 Pan Head Plastite
MP6	0515-0211	8	3	Screw-Mach M3 x 0.5 6MM-LG Pan-HD
MP7	0515-0211	8	2	Screw-Mach M3 x 0.5 6MM-LG Pan-HD
MP8	0515-0210		9	Screw-Mach M4 x 0.7 x 8MM-LG Pan-HD
MP9	0515-0212		2	Screw-Mach M3.5 x 0.6 6MM-LG Pan-HD

Figure 6-6. Side Views of Chassis.

Table 1-1. Specifications (Cont'd).

MATH FUNCTION SPECIFICATIONS

General: Math function specifications do not include error in X (instrument reading) or in entered values (R,L,U,Y,Z). Range of values input or output is ± (0.000000 x 10^{-9} to 1999999 x 10^{9}). Out of range values send "LL" to display and + 1999999. x 10^{9} to HP-IB.

PASS/FAIL: Displays: "HI" for values > upper limit (U), "LO" for values < lower limie (L), and X for values between the limits, with no introduced error.

SRQ mask can be programmed to respond to HI or LO conditions.

Maximum execution time: 20ms

STATISTICS:

$$\text{Mean (M)} = X_1 + \frac{1}{C} \sum_{i=1}^{C} (X_i - X_1)$$

$$\text{Variance (V)} = \frac{\sum_{i=1}^{C} (X_i - X)^2 - \frac{1}{C}\left[\sum_{i=1}^{C} (X_i - X_1)\right]^2}{C - 1}$$

Maximum (U) and Minimum (L) are the most positive and negative instrument readings, respecitvely. X is displayed during calculation of statistics.

X_1 is the first reading taken after enabling statistics and is stored in the Z register. The number of readings taken (C) is stored in the count register.

$$\text{Accuracy of Mean: } < \pm \frac{C(U-L)}{10^{11}} + 1 \text{ LSD}$$

$$\text{Accuracy of Variance: } < \pm \frac{C(U-L)^2}{10^{8}} + 1 \text{ LSD}$$

Maximum execution time: 50ms

NULL: $X - X_1$ (X_1 is the first valid reading taken after enabling null and is stored in the Z register).

Maximum execution time: 15ms

dBm(R): $10 \log \frac{x^2/R}{1mW}$ R is the user-entered impedance.

Output range: -280 to +340 dBm

Accuracy: ± .001 dBm

Maximum execution time: 150ms

THERMISTOR (°F): Converts resistance of thermistor HP0837-0164 to temperature in °F.

Output range: -112 to 302°F

Accuracy: $-103 \leq T \leq +266$ °F: ± 11°F max.
$-116 \leq T \leq +320$°F: ± 27°F max.

Maximum execution time: 150ms

THERMISTOR (°C): Converts resistance of thermistor HP0837-1064 to temperature in °C.

Output range: -80 to 150°C

Accuracy: $-75 \leq T \leq +130$°C ± 06°C max.
$-80 \leq T \leq +150$°C ± 15°C max.

Maximum execution time: 100ms

SCALE: (X-Y)/Y

Accuracy: ± 1 LSD

Maximum execution time: 60ms

% ERROR: 100% x (X-Y)/Y

Accuracy: ± 1 LSD

Maximum execution time: 60ms

dB: $20 \log \frac{x}{y}$

Output Range: -620 to +620 dB

Accuracy: .001 dB

Maximum execution time: 100ms

GENERAL

Voltmeter Control Functions: Description: The voltmeter control function in the math section of the front panel is designed to control the measurement parameters of the 3456A. Included in this front panel section is the:

1) Number of digits displayed.
2) Number of readings per trigger.
3) Delay time between readings.
4) Integration time in number of power line cycles (PLC).

Number of Digits Displayed allows selection of 3 to 6 digits displayed plus sign and exponent. The range of the display is ± 1,999,999 ± 9.

Number of Readings per Trigger allows selection of specific number of readings to be taken with just one trigger. The time between readings is controlled by the delay time selected.

Delay Time allows selection of the time between measurement cycles. It is provided to allow the selection of settling time. The range is from 0 to 999.999 sec. in 0.001/sec. increments. Accuracy is 1% of time selected.

Integration Time in Power Line Cycles allows the selection of the time for measurement integration. The units of integration time in power line cycles (PLC) apply for both 50 and 60 Hz power line frequencies. The range of integration time selection is from 0.01 to 100 power line cycles (PLC) per measurement.

Front-Rear Terminal Switch - On the front panel. Operated manually. Its status can be read via software.

The actual measurement time is a function of the integration time, the delay time, auto zero, filter, etc., voltmeter complete, external trigger, and function selected.

Operating Temperature: 0 C to 50 C

Warmup Time: One hour to meet all specifications

Humidity Range: 95% R.H., 0 C to 40 C

Storage Temperature: -40 C to +75 C

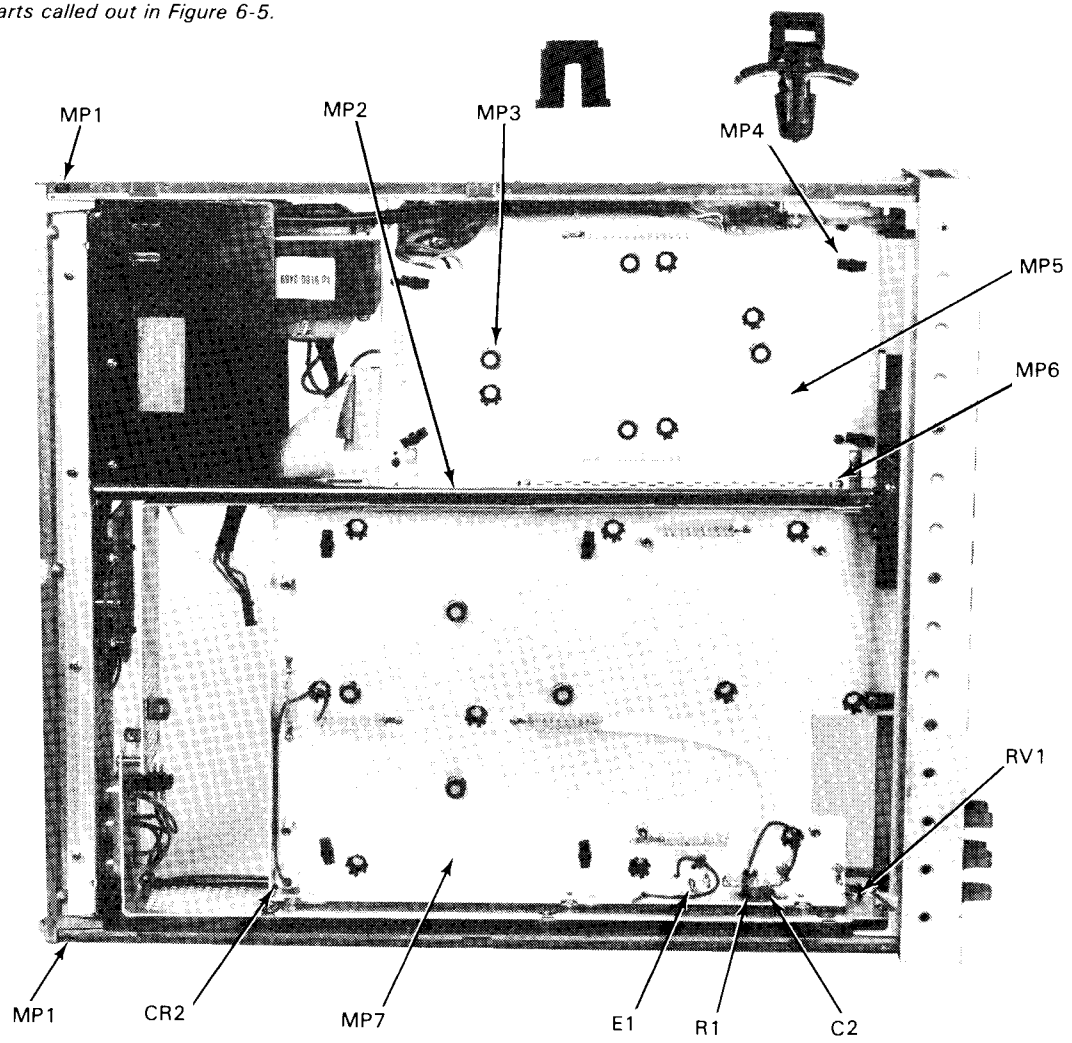
Power: 100/120/240V + 5%, -10% 48 Hz to line operation 80VA; 220V ± 10% 48 Hz to line operation 80VA.

Size: 88.9mm high x 425.5mm wide x 527.1mm deep (3½" high x 16¾" wide x 20¾" deep)

Weight: Net 10.49 kg (23.13lbs.)

NOTE

The MP Designations used on this page apply only to those parts called out in Figure 6-5.



Reference Designation	-hp- Part Number	C D	Qty	Description
MP1	2510-0192		8	Screw-Mach 8-32 x .25 100° Flat-HD
MP2	03456-00103	6	1	Gusset-Outguard
MP3	4040-1415		8	Spacer-Insl
MP4	0380-1267		8	Spacer-Poly
MP5	03456-04102	3	1	Shield-Outguard
MP6	0624-0461		6	Screw-Tapping 8-16 x .5 Pan HD Plastite
MP7	03456-04101	2	1	Shield-Inguard
C2	0150-0012	3	1	Capacitor-Fxd .01 μF
CR2	1902-1217	8	1	Diode-Znr 6.2 V
E1	1970-0085	9	1	Tube-Electron Surge Protector
R1	0764-0028	2	1	Resistor, 100K 5% 2W
RV1	0837-0196	0	1	MO Varistor 430 V RMS

Figure 6-5. Bottom View of Chassis with PC Boards Removed.

1-18. ACCESSORIES AVAILABLE.

1-19. The following is a list of available accessories for the 3456A:

Accessory No.	Description
10631A	HP-IB Cable 1 Meter (39.37 in.)
10631B	HP-IB Cable 2 Meter (78.74 in.)
10631C	HP-IB Cable 4 Meter (157.48 in.)
10631D	HP-IB Cable 0.5 Meter (19.69 in.)
11000A	Test Leads, Dual Banana Both Ends
11002A	Test Leads, Dual Banana to Probe and Alligator
34111A	High Voltage Probe (40 kV dc)
44414A	4 Thermistors

1-20. SAFETY CONSIDERATION.

1-21. The 3456A is a safety class 1 instrument (provided with a protective earth connection). The instrument and manual should be reviewed for safety symbols and instructions before using.

1-22. RECOMMENDED TEST EQUIPMENT.

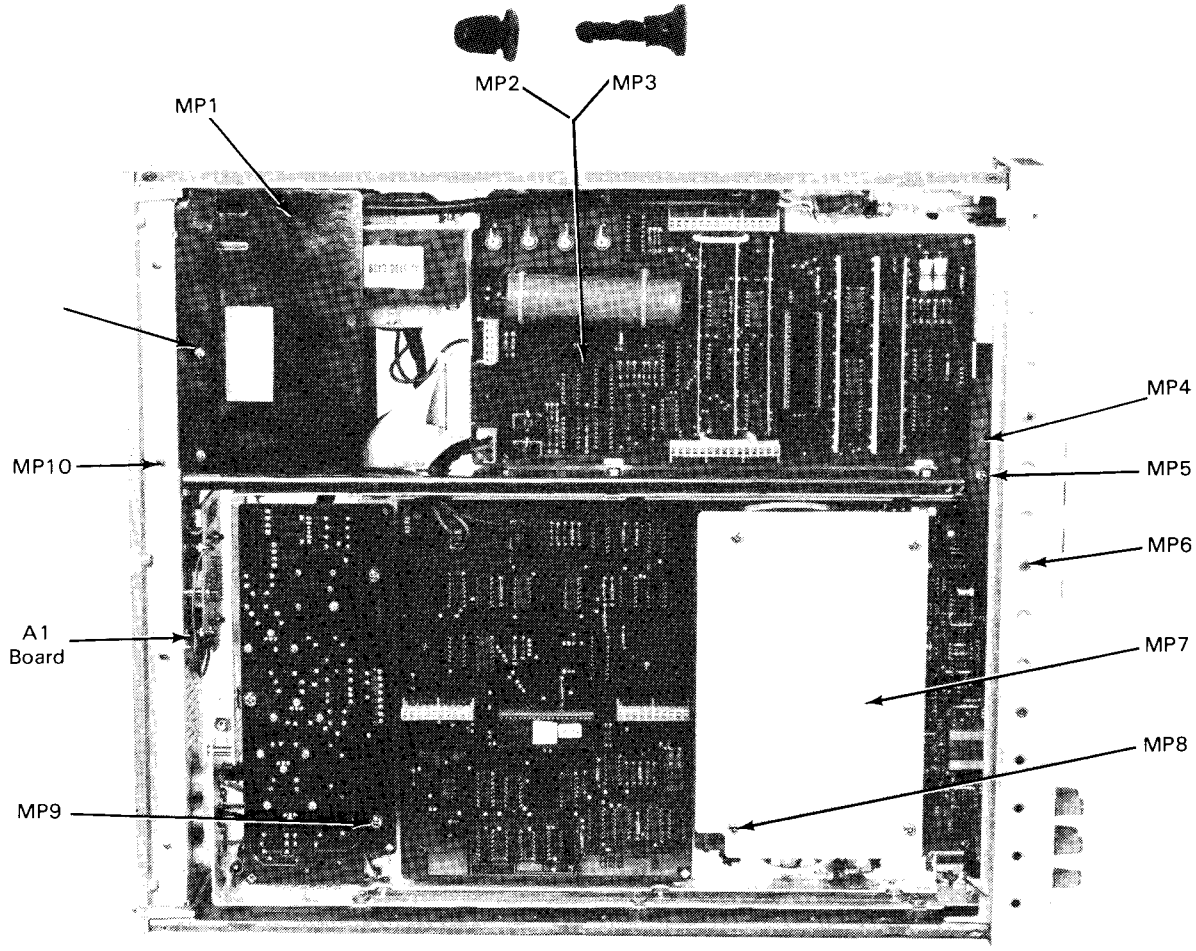
1-23. Required equipment to maintain the Model 3456A is listed in Table 1-2. Other equipment may be substituted if it meets the requirements listed in the table. The table is also repeated in Section IV of the Operating and Service Manual.

Table 1-2. Recommended Test Equipment.

Instrument	Critical Specification	Recommended Model	Use
DC Voltage Standard	Voltage: 10mV to 1000V Accuracy: ±.005%	Systron Donner Model M107	PAT
DC Transfer Standard	Output Voltages:1V, 10V, 1.018V, 1.019V Accuracy: ±5ppm Stability: ±.001% (30 Days)	Fluke Model 731B	PA
AC Calibrator	Frequency: 20 Hz to 250 kHz Output Level: 100mV to 1000V Accuracy: ±.1% Voltage Stability (6 mos.) ±.02%	Fluke Model 5200A and Model 5215A	PAT
Reference Divider	Division Ratio Accuracy: ±.001% Output Voltage Range: 1V to 1kV	Fluke Model 750A	PA
Resistance Standard	Resistance: 100Ω Accuracy: ±.0005%	Guildline Model 9330/100 or 9330A/100	P
	Resistance: 1kΩ Accuracy: ±.0005%	9330/1K or 9330A/1K	PA
	Resistance: 10kΩ Accuracy: ±.001%	9330/10K or 9330A/10K	PA
	Resistance: 100kΩ Accuracy: ±.001%	9330/100K or 9330A/100K	PA
	Resistance: 1MΩ Accuracy: ±.002%	9330/1M	PA
	Resistance: 10MΩ Accuracy: ±.01%	9330/10M	PA
	Resistance*: 1GΩ Accuracy: ±2%	-hp- Part No. 03456-67902	P
DC Null Voltmeter	Voltage Range: 1μV to 10V	-hp- Model 419A	PA
Bus System Analyzer**	HP-IB Control Capability	-hp- Model 59401A	T
Desktop Computer	HP-IB Control Capability serves as printer for output data	-hp- Model 9825A, 9825B, 9835A, 9845B, or 85A	OT
Oscilloscope**	Bandwidth: DC to 100 MHz Sweep Time: 50ns to 20ms/div	-hp- Model 1740A	T
Digital Voltmeter**	Voltage Range: 100μV to 1000V Resolution: 1 μV	-hp- Model 3456A (or 3455A)	T
Resistors	Resistances: 1 kΩ ± 10%	-hp- Part No. 0684-1021	
Signature Analyzer**		-hp- Model 5004A	T
Test Program Cartridges*		-hp- Part Number 03456-10001 (9825A/B) 03456-10002 (9835A, (9845A/B) 03456-10003 (85A)	T

NOTE

The MP Designations used on this page apply only to those parts called out in Figure 6-4.



Reference Designation	-hp- Part Number	C D	Qty	Description
MP1 Δ_{10}	03456-04109	0	1	Power Shield
MP2	1390-0458	0	4	Fastener-Snap-In Grommet
MP3	1390-0457	9	4	Fastener-Snap-In Plunger
MP4	03456-01204	0	1	Bracket-Gusset
MP5	0515-0212		1	Screw-Mach M3.5 x 0.6 6MM-LG Pan-HD
MP6	0515-0219		4	Screw-Mach M3 X 0.5 6MM-LG Flat-HD
MP7	03456-04103	4	1	Shield-RMS Converter
MP8	0515-0215		4	Screw-Mach M3.5 x 0.6 20MM-LG Pan-HD
MP9	0515-0212		3	Screw-Mach M3.5 x 0.6 6MM-LG Pan-HD
MP10	0515-0211	8	4	Screw-Mach M3 x 0.5 6MM-LG Pan-HD
MP11	0515-0211	8	2	Screw-Mach M3 x 0.5 6MM-LG Pan-HD

Figure 6-4. Bottom View of Chassis with PC Boards Installed.

Table 1-2. Recommended Test Equipment (Cont'd).

Instrument	Critical Specification	Recommended Model	Use
Isolation Logic Test Jumper*		-hp- Part No. 03456-61602	T
HP-IB Signature Analysis Modules*,**		-hp- Part Number 5061-1153 5061-1154 5061-1155	T

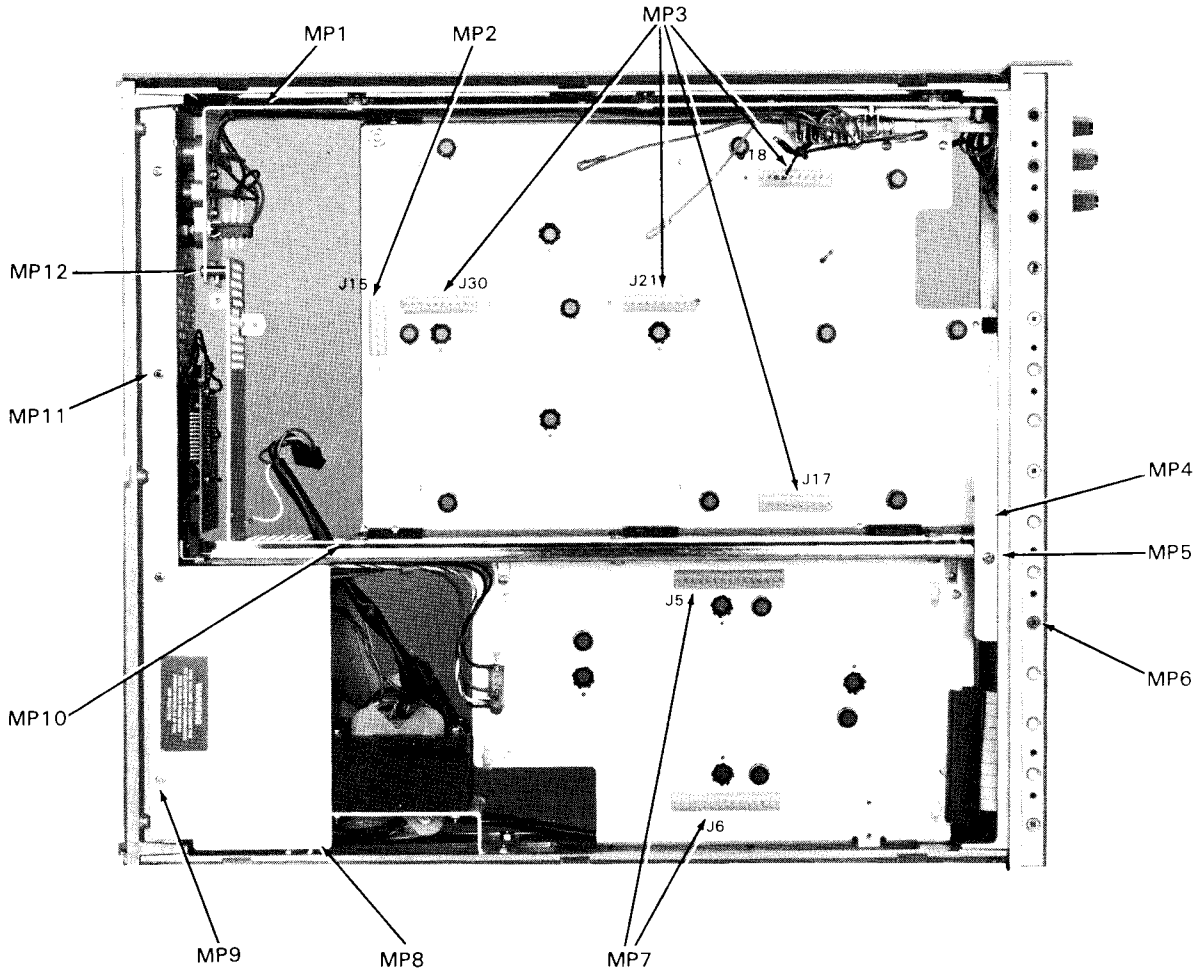
*These items included in 3456A Digital Voltmeter Service Kit for Component Level Repair (-hp- Part Number 03456-69800)

**These items are not required if a board level repair strategy is to be used. This strategy does require a 3456A Digital Voltmeter Service Kit for Board Level Repair (-hp- Part Number 03456-69801).

P = Performance Test T = Troubleshooting
A = Adjustment O = Operators Check

NOTE

The MP Designations used on this page apply only to those parts called out in Figure 6-3.

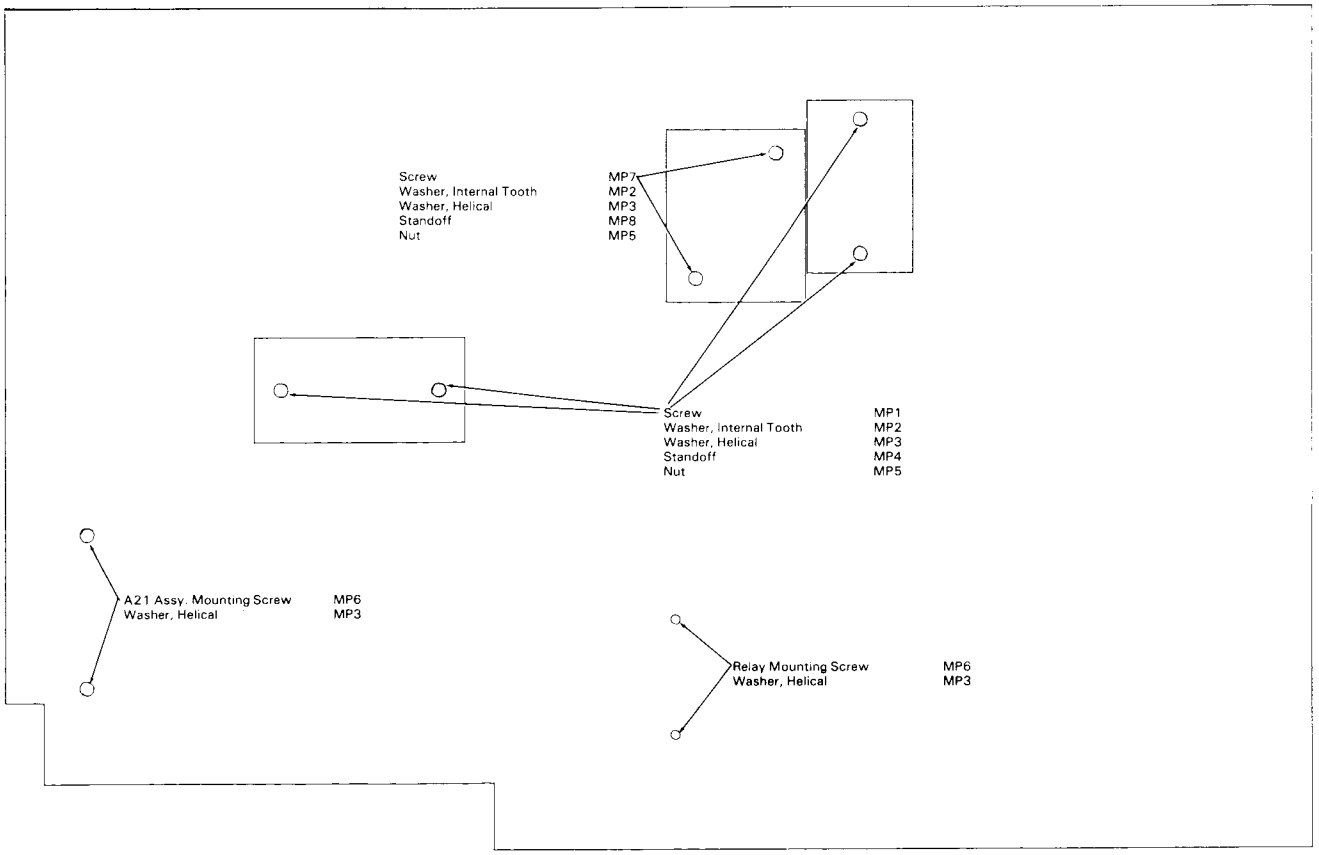


Reference Designation	-hp- Part Number	C D	Qty	Description
MP1	03456-04109	4	1	Chassis-Inguard-Right
MP2	1251-6184	7	1	Connector 8 Pin M Post Type
MP3	1251-6194	9	4	Connector 10 Pin M Post Type
MP4	03456-00204	8	1	Sub-Panel
MP5	0515-0212		1	Screw-Mach M3.5 x 0.6 6 MM-LG Pan-HD
MP6	0515-0219		4	Screw-Mach M3 x 0.5 6MM-LG Flat-HD
MP7	1251-6192	7	2	Connector 15-Pin M Post Type
MP8 Δ_{10}	03456-04109	0	1	Power Shield
MP9	0515-0211	8	2	Screw-Mach M3 x 0.5 6MM-LG Pan-HD
MP10	03456-00102	5	1	Chassis-Inguard-Left
MP11	0515-0211	8	4	Screw-Mach M3 x 0.5 6MM-LG Pan-HD
MP12	0515-0212		4	Screw-Mach M3.5 x 0.6 6MM-LG Pan HD

Figure 6-3. Top View of Chassis with PC Boards Removed.

NOTE

The MP Designations used on this page apply only to those parts called out in Figure 6-2.



Reference Designation	-hp- Part Number	C D	Qty	Description
MP1	0515-0064	9	4	SCREW-MACH M3 X 0.5 16 MM-LG PAN-HD
MP2	2190-0521	5	6	WASHER-LK INTL T 3 MM 2.3-MM-ID
MP3	2190-0584	0	10	WASHER-LK HLCL 3.0 MM 3.1-MM-ID
MP4	0380-1217	9	4	STANDOFF-HEX 7.6-MM-LC 4.8-MM-A/F
MP5	0535-0003	8	6	NUT-HEX DBL-CHAM M3 X 0.50 1.8 MM-THK
MP6	0515-0211	8	4	SCREW-MACH M3 X 0.5 6MM-LG PAN-HD
MP7	0515-0057	0	2	SCREW-MACH M3 X 0.5 20MM-LG-PAN-HD
MP8	0380-1256	6	2	STANDOFF, THREADED-M3 X 6.0

Figure 6-2. A20 Board Miscellaneous Fastener Parts.

SECTION II
INSTALLATION

2-1. INTRODUCTION.

2-2. This section of the manual contains the necessary information and instructions to install and interface the Model 3456A Digital Voltmeter. Included are initial inspection procedures, power and grounding requirements, enviromental information, and instructions for repacking the instrument for shipment.

2-3. INITIAL INSPECTION.

2-4. This instrument was carefully inspected both mechanically and electrically before shipment. It should be free of mars or scratches and in perfect electrical order upon receipt. The instrument should be inspected for any damage that may have occurred in transit. If the shipping container or cushioning material is damaged, it should be kept until the contents of the shipment have been checked for completeness and the instrument has been mechanically and electrically checked. Procedures for checking the electrical performance of the 3456A are given in Section IV. If there is mechanical damage, or the contents are incomplete, or the instrument does not pass the performance tests, notify the nearest Hewlett-Packard Office (a list of the -hp- Sales and Service Offices is located at the back of the manual). If the shipping container is damaged, or the cushioning material shows signs of stress, notify the carrier as well as the Hewlett-Packard Office. Save the shipping materials for the carrier's inspection.

2-5. PREPARATION FOR USE.

2-6. Power Requirements.

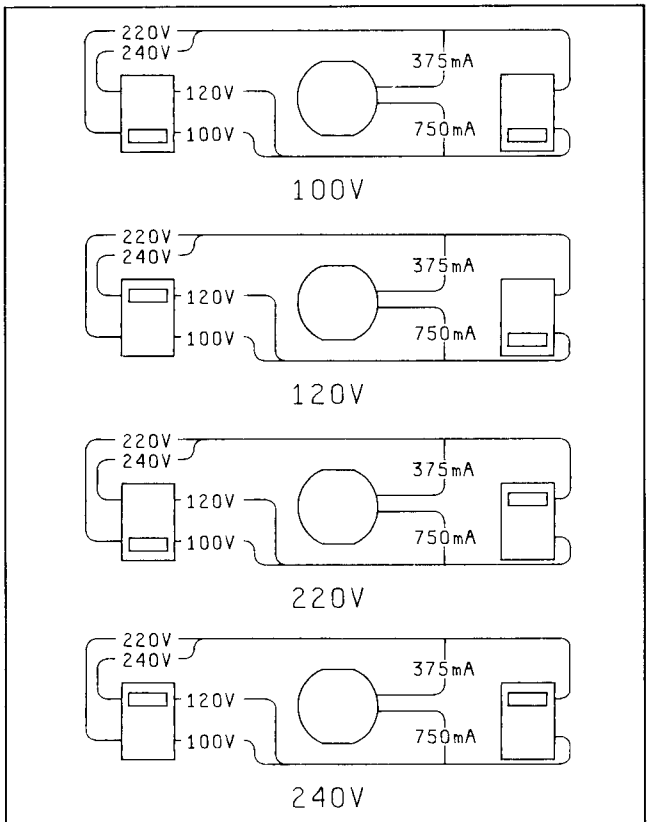
2-7. The Model 3456A requires a power source of 100, 120, 220, or 240 V ac (−10%, +5%), 48 Hz to 66 Hz single phase. Maximum power consumption is 80 VA.

2-8. Line Voltage Selection.

2-9. Figure 2-1 provides information for line voltage and fuse selection. Make sure the rear panel line selector switches are in the correct position and the correct fuse is installed in the 3456A, before applying ac power to the instrument.

2-10. Power Cords and Receptacles.

2-11. Figure 2-2 illustrates the different power plug configurations that are available to provide ac power to the 3456A. The -hp- part number shown directly below the individual power plug drawing is the part number for the power cord set equipped with the appropriate mating plug for that receptacle. If the appropriate power cord is not included with the instrument, notify the nearest -hp- Sales and Service Office and a replacement cord will be provided.



NOMINAL VOLTAGE	OPERATING RANGE −10%, +5% OF NOMINAL	FUSE
100 V	90 to 105 Volts	750 mA
120 V	108 to 126 Volts	750 mA
220 V	198 to 231 Volts	375 mA
240 V	216 to 252 Volts	375 mA

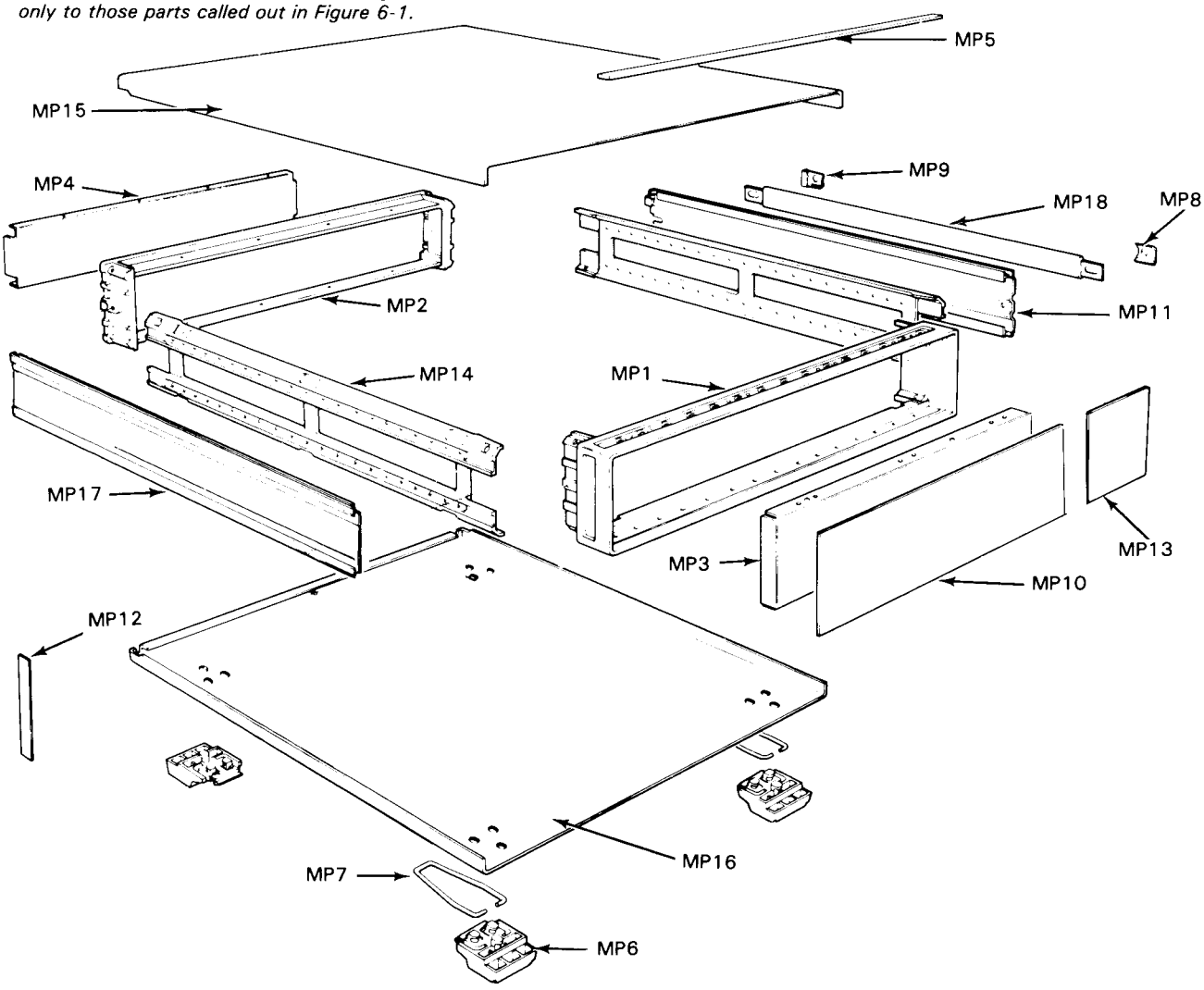
Figure 2-1. Line Voltage Selection.

2-12. Grounding Requirements.

2-13. To protect operating personnel, the National Electrical Manufacturer's Association (NEMA) recommendation is to ground the instrument panel and cabinet. The -hp-Model 3456A is equipped with a three conductor power cable which, when plugged into an appropriate receptacle, grounds the instrument.

NOTE

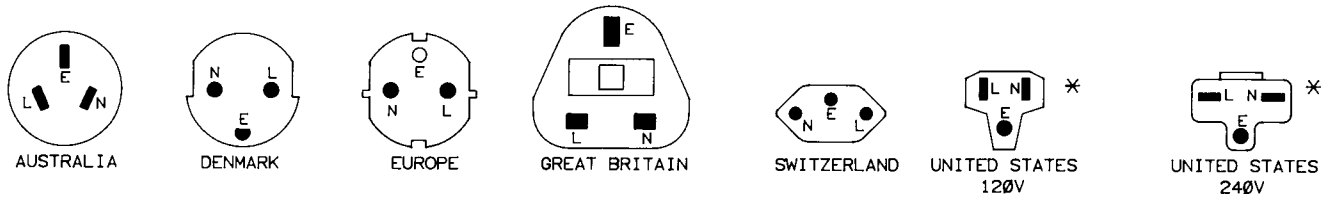
The MP Designations used on this page apply only to those parts called out in Figure 6-1.



Reference Designation	-hp- Part Number	C D	Qty	Description
MP1	5020-8801	4	1	FRONT-FRAME
MP2	03456-04401	5	1	REAR-FRAME MOD
MP3	03456-00204	8	1	SUB-PANEL
MP4	03456-00203	7	1	REAR PANEL
MP5	5040-7202	9	1	TOP TRIM, FRONT FRAME
MP6	5040-7201	8	4	FOOT
MP7	1460-1345	5	2	TILT STAND
MP8	5040-7219	8	1	STRAP HANDLE CAP-FRONT
MP9	5040-7220	1	1	STRAP HANDLE CAP-REAR
MP10	03456-00201	5	1	FRONT PANEL
MP11	5060-9876	9	1	SIDE COVER, W/HANDLE RECESS
MP12	5001-0438	7	2	SIDE TRIM, FRONT FRAME
MP13	03456-00202	6	1	PANEL-CALIBRATE
MP14	5020-8832	1	2	SIDE STRUT
MP15 Δ_{10}	03456-04108	9	1	TOP COVER
MP16	5060-9847	4	1	BOTTOM COVER
MP17 Δ_{10}	5060-9907	7	1	SIDE COVER, NO HANDLE
MP18	5060-9804	3	1	STRAP HANDLE-18 IN

Figure 6-1. Chassis/Cabinet Parts.

POWER CORDS



Country	Part Number	Opt.	Voltage
Australia	8120-1369	901	250V 6A
Denmark	8120-2956	912	250V 6A
Europe	8120-1689	902	250V 6A
Great Britain	8120-1351	900	250V 6A
Switzerland	8120-2104	906	250V 6A
*United States	8120-1378	903	120V 10A
*United States	8120-0698	904	240V 10A

Power cords supplied by HP have polarities matched to the power input socket on the instrument:

- L = Line or Active Conductor (also called "live" or "hot").
- N = Neutral or Identified Conductor
- E = Earth or Safety Ground

NOTE: Plugs are viewed from connector end. Shape of molded plug may vary within country.

* CSA certification includes only these Power Plugs

Figure 2-2. Power Cables.

2-14. Bench Use.

2-15. The Model 3456A is shipped with feet and tilt stands installed and is ready for use as a bench instrument. The feet are shaped to permit "stacking" with other full-module Hewlett-Packard instruments.

2-16. Rack Mounting.

2-17. The -hp- Model 3456A can be rack mounted by adding rack mounting kit Option 908 or Option 909. The basic hardware and instructions for rack mounting are contained in Option 908 and addition of front handles to the basic rack mount kit are contained in Option 909. The rack mount kits are designed to permit mounting of the 3456A in a standard 19 inch rack, provided that sufficient rear support is available. Also make sure the air intake at the rear of the instrument is unobstructed.

2-18. Interface Connections.

2-19. The -hp- Model 3456A is compatible with the Hewlett-Packard Interface Bus (HP-IB).

NOTE

HP-IB is Hewlett-Packard's implementation of IEEE Std. 488-1975, "Standard Digital Interface for Programmable Instrumentation."

The 3456A's HP-IB connection is made by an HP-IB Interface cable to the 24 pin HP-IB connector located at the rear panel. A typical interconnection of HP-IB is shown in Figure 2-3 in which system interconnection is made by three HP-IB Interface Cables. The ends of the cables have both a male and female connector to enable connections to other instruments and cables. As many as 15 instruments can be connected by the same interface bus. However, the maximum length of cable that can effectively be used to connect a group of instruments should not exceed 2 meters (6.5 feet) times the number of instruments to be connected, or 20 meters (65.6 feet), whichever is less. For a pictorial view of the HP-IB connector and its pin designation, refer to Figure 2-4.

2-20. Address Selection.

2-21. The HP-IB "talk" and "listen" address of the Model 3456A is set by the instrument's address switch, located at the rear panel. The talk and listen address is a 5-bit code which is selected to provide a unique address for each HP-IB instrument. The 3456A normally leaves the factory with the address switch set to decimal code "22." The corresponding ASCII code is a listen address code of "6" and a talk code of "V." Refer to Figure 2-5 for the factory address switch setting.

Table 6-4. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
				MISCELLANEOUS PARTS		
	03456-00101	4	1	CHASSIS-INGUARD, RIGHT	28480	03456-00101
	03456-00102	5	1	CHASSIS-INGUARD, LEFT	28480	03456-00102
	03456-00103	6	1	GUSSET-OUTGUARD	28480	03456-00103
Δ10	03456-00105	8	1	GAUSSET-OUTGUARD	28480	03456-00105
	03456-00201	5	1	PANEL-FRONT	28480	03456-00201
	03456-00202	6	1	PANEL-CALIBRATE	28480	03456-00202
	03456-00204	8	1	PANEL-SUB	28480	03456-00204
Δ10	03456-00205	9	1	REAR PANEL	28480	03456-00205
Δ10	03456-00603	0	1	SHIELD-OUTGUARD	28480	03456-00603
	03456-01201	7	1	BRACKET-TRANSFORMER	28480	03456-01201
	03456-01203	9	1	BRACKET-PANEL MOUNT	28480	03456-01203
	03456-01204	0	1	BRACKET-GUSSET	28480	03456-01204
	03456-04101	2	1	SHIELD-INGUARD	28480	03456-04101
	03456-04103	4	1	SHIELD-RMS CONVERTER	28480	03456-04103
	03456-04104	5	1	SHIELD-TOP	28480	03456-04104
	03456-04105	6	1	SHIELD-BOTTOM	28480	03456-04105
Δ10	03456-04108	9	1	TOP COVER	28480	03456-04108
Δ10	03456-04109	0	2	POWER SHIELD	28480	03456-04109
	03456-04401	5	1	FRAME-REAR MOD	28480	03456-04401
	0390-0006	3	4	INSULATOR-FLG-BSHG NYLON	28480	0390-0006
	1460-1345	5	2	TILT STAND SST	28480	1460-1345
	5061-0088	9	1	FRONT HANDLE KIT	28480	5061-0088
	0360-1996	9	1	TERMINAL-STUD DBL-TUR PRESS-NTG	28480	0360-1996
	5041-3076	4	2	CAP-LOCKING FOR TERMINAL SWITCH	28480	5041-3076
	4040-1645	1	33	LIGHT PIPE-PANEL	28480	4040-1645
	4114-0868	5	1	WINDOW-DISPLAY	28480	4114-0868
	5001-0438	7	2	TRIM STRIP	28480	5001-0438
	5020-8801	4	1	FRONT FRAME	28480	5020-8801
	5020-8832	1	2	SIDE STRUTS	28480	5020-8832
	5040-7023	2	2	PUSHROD-FOR S1 AND S2	28480	5040-7023
	5040-7201	8	4	FOOT(STANDARD)	28480	5040-7201
	5040-7202	9	1	TRIM-TOP	28480	5040-7202
	5040-7219	8	1	STRAP HANDLE CAP-FRONT	28480	5040-7219
	5040-7220	1	1	STRAP HANDLE CAP-REAR	28480	5040-7220
	5060-9804	3	1	STRAP HANDLE-IP-IN	28480	5060-9804
	5060-9847	4	1	BOTTOM COVER	28480	5060-9847
	5060-9876	9	1	SIDE COVER ASSEMBLY	28480	5060-9876
Δ10	5060-9907	7	1	SIDE COVER-NO HANDLE	28480	5060-9907
	7120-3528	6	1	LABEL-CAUTION	28480	7120-3528
	7120-4006	7	1	LABEL-INFORMATION	28480	7120-4006
	7120-8607	2	1	LABEL-METRIC	28480	7120-8607
				NOTE MANY OF THESE PARTS ARE ILLUSTRATED IN FIGURE 6-1 AND FIGURES 6-3 TO 6-11.		

See introduction to this section for ordering information
*Indicates factory selected value

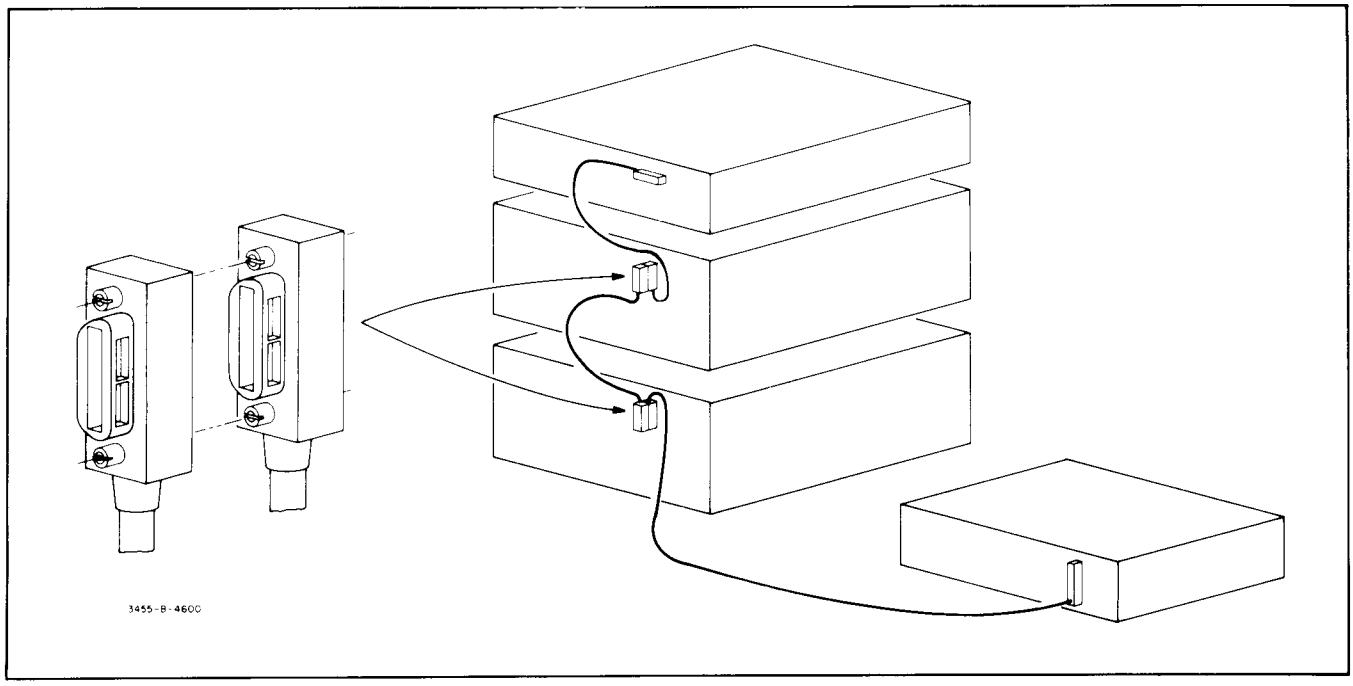
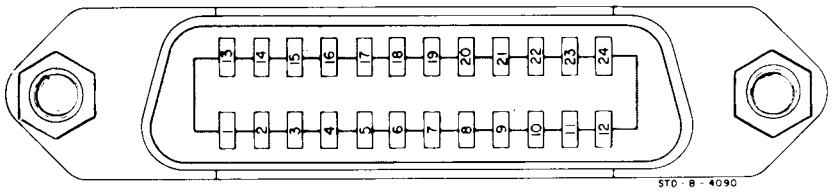


Figure 2-3. Typical HP-IB System Interconnections.



PIN	LINE	
1	DI01	
2	DI02	
3	DI03	
4	DI04	
13	DI05	
14	DI06	
15	DI07	
16	DI08	
5	EOI	
17	REN	
6	DAV	
7	NRFD	
8	NDAC	
9	IFC	
10	SRQ	
11	ATN	
12	SHIELD–CHASSIS GROUND	
18	P/O TWISTED PAIR WITH PIN 6	THESE PINS ARE INTERNALLY GROUNDED
19	P/O TWISTED PAIR WITH PIN 7	
20	P/O TWISTED PAIR WITH PIN 8	
21	P/O TWISTED PAIR WITH PIN 9	
22	P/O TWISTED PAIR WITH PIN 10	
23	P/O TWISTED PAIR WITH PIN 11	
24	ISOLATED DIGITAL GROUND	

CAUTION

The 3456A contains metric threaded HP-IB cable mounting studs as opposed to English threads. Metric threaded -hp-10631A, B, or C HP-IB cable lockscrews must be used to secure the cable to the instrument. Identification of the two types of mounting studs and lockscrews is made by their color. English threaded fasteners are colored silver and metric threaded fasteners are colored black. DO NOT mate silver and black fasterners to each other or the threads of either or both will be destroyed. Metric threaded HP-IB cable hardware illustrations and part numbers follow.

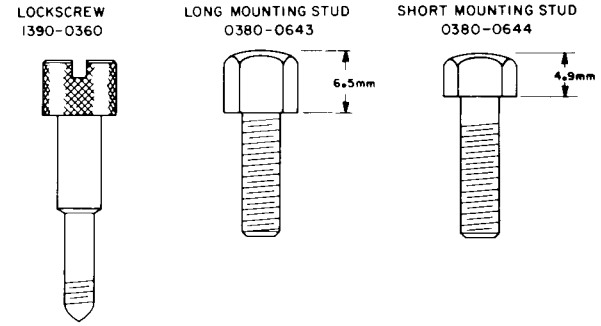


Figure 2-4. HP-IB Connector.

Table 6-4. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
				CHASSIS MOUNTED PARTS		
C1	0180-0291	3	1	CAPACITOR-FXD 10UF+-10% 35VDC TA	56289	150D106X9035A2
C2	0150-0012	3	1	CAPACITOR-FXD .01UF +-20% 1KVDC CER	56289	C023A102J103MS3A
CR1	1902-1217	A	2	DIODE-ZNR 6.2V 5% DO-4 PD=10W TC=+.035%	28480	1902-1217
CR2	1902-1217	A		DIODE-ZNR 6.2V 5% DO-4 PD=10W TC=+.035%	28480	1902-1217
CR5 Δ10	1906-0205	0	1	DIODE ASSEMBLY BRIDGE	28480	1906-0205
E1	1970-0085	9	1	TUBE-ELECTRON SURGE V PTCTR	28480	1970-0085
F1	2110-0033	6	1	FUSE .75A 250V 1.25X.25 (FOR 100/120V OPERATION)	28480	2110-0033
F1	2110-0065	4	1	FUSE .375A 250V NTD 1.25X.25 UL (FOR 220/240V OPERATION)	28480	2110-0065
	2110-0564	8	1	FUSEHOLDER BODY 12A MAX FOR UL	H9027	031.1657
	2110-0565	9	1	FUSEHOLDER CAP 12A MAX FOR UL	28480	2110-0565
	2110-0569	3	1	FUSEHOLDER NUT	28480	2110-0569
J5	1251-6192	7	2	CONNECTOR 15-PIN M POST TYPE	28480	1251-6192
J6	1251-6192	7		CONNECTOR 15-PIN M POST TYPE	28480	1251-6192
J8	1251-6193	8	1	CONNECTOR 6-PIN M POST TYPE	28480	1251-6193
J15	1251-6184	7	1	CONNECTOR 8-PIN M POST TYPE	28480	1251-6184
J17	1251-6194	9	4	CONNECTOR 10-PIN M POST TYPE	28480	1251-6194
J18	1251-6194	9		CONNECTOR 10-PIN M POST TYPE	28480	1251-6194
J21	1251-6194	9		CONNECTOR 10-PIN M POST TYPE	28480	1251-6194
J30	1251-6194	9		CONNECTOR 10-PIN M POST TYPE	28480	1251-6194
J38	5060-7478	3	2	TERMINAL ASSEMBLY-FRONT INPUT	28480	5060-7478
J39	5060-7478	3		TERMINAL ASSEMBLY-REAR INPUT	28480	5060-7478
J40	1250-0083	1	2	CONNECTOR-RF BNC FEM SGL-HOLE-FR 50-OHM	28480	1250-0083
J41	1250-0083	1		CONNECTOR-RF BNC FEM SGL-HOLE-FR 50-OHM	28480	1250-0083
J42	9100-3910	0	1	FILTER-LINE	28480	9100-3910
	8120-1348	5	1	CABLE ASSY 18AWG 3-CNDCT BLK-JKT	28480	8120-1348
R1	0764-0028	2	1	RESISTOR 100K 5% 2W MO TC=0+-200	28480	0764-0028
RV1	0837-0196	0	1	MO VARISTOR 430V RMS	28480	0837-0196
S1	3101-2216	3	1	SWITCH-PB DPDT ALTNG 4A 250VAC	28480	3101-2216
	5041-1682	9	1	KEY CAP-LINE	28480	5041-1682
S2	3101-0461	6	1	SWITCH-PB 6PDT ALTNG .5A 100VAC	28480	3101-0461
S3	3101-1299	0	2	SWITCH-GUARD, PB DPDT	28480	3101-1299
S4	3101-1299	0		SWITCH-GUARD, PB DPDT	28480	3101-1299
	0370-0603	4	3	KEY CAP .714 IN SQ 1.55. IN HT FOR	28480	0370-0603
S5	3101-2298	1	2	SWITCH-SLIDE, VOLTAGE SELECT	28480	3101-2298
S6	3101-2298	1		SWITCH-SLIDE, VOLTAGE SELECT	28480	3101-2298
T1	9100-0469	8	1	TRANSFORMER-POWER 100/120/220/240V	28480	9100-0469
U1	1826-0181	1	1	VOLTAGE REGULATOR- LM323K	27014	LM323K
X1	1200-0479	4	1	SOCKET-XSTR 2-CONT TO-3 SLDR-TUP	28480	1200-0479
	0340-0580	3	1	INSULATOR-XSTR THRM-CNDCT	28480	0340-0580
				NOTE MANY OF THESE PARTS ARE ILLUSTRATED IN FIGURES 6-3 TO 6-11.		

See introduction to this section for ordering information
*Indicates factory selected value

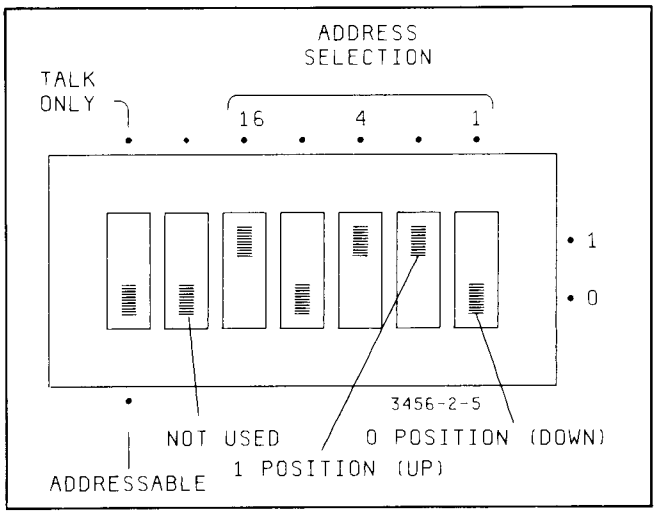


Figure 2-5. 3456A Address Switch.

NOTE

The 5-bit decimal code, consisting of bits A1 through A5, is often used by controllers which use this convention as a System Device Number for instruments.

2-22. "Talk-Only" mode. The instrument has a "Talk-Only" mode which can also be set by the address switch. The Remote Operation chapter in Section III of this manual gives a detailed description of the 3456A's "Talk-Only" mode, including the address codes.

2-23. External Trigger.

2-24. An External Trigger input to the 3456A is provided by a BNC connector located at the rear panel of the instrument. The trigger input should be driven by negative going TTL level signals. For more information refer to Section III in this manual.

2-25. Voltmeter Complete Connector.

2-26. A Voltmeter Complete output is also provided by the 3456A through a BNC connector located at the rear panel. This connector provides an output which is composed of a TTL level signal and is generated during a measurement cycle.

2-27. ENVIRONMENTAL REQUIREMENTS.

WARNING

To prevent electrical fire or shock hazards, do not expose the instrument to rain or excess moisture.

2-28. Operating and Storage Temperature.

2-29. In order to meet and maintain the specifications listed in Table 1-1, the 3456A should be operated within an ambient temperature range of 23°C +/−5°C (73°F +/−9°F). The instrument may be operated within an ambient temperature range of 0°C to 55°C (+32°F to 131°F) with less accuracy.

2-30. The 3456A may be stored or shipped within an ambient temperature range of −40C to +75C (−40F to +167F).

2-31. Humidity.

2-32. The instrument may be operated in environments with relative humidity of up to 95%. The instrument must, however, be protected from temperature extremes which may cause condensation within the instrument.

2-33. Altitude.

2-34. The instrument may be operated at altitudes up to 4572 meters (15,000 feet).

2-35. REPACKAGING FOR SHIPMENT.

NOTE

If the instrument is to be shipped to Hewlett-Packard for service or repair, attach a tag to the instrument identifying the owner and indicating the service or repair to be made. Include the model number and full serial number of the instrument. In any correspondence, identify the instrument by model number and full serial number. If you have any questions, contact your nearest -hp- Sales and Service Office.

2-36. Place instrument in original container with appropriate packaging material and secure with strong tape or metal bands. If the original container is not available, a replacement container can be purchased from your nearest -hp- Sales and Service Office.

2-37. If the original container is not to be used, do the following:

1. Wrap the instrument in heavy plastic before placing in an inner container.
2. Place packing material around all sides of the instrument and protect the front panel with cardboard strips.
3. Place the instrument in the inner container in a heavy carton and seal with strong tape or metal bands.
4. Mark shipping container "DELICATE INSTRUMENT," "FRAGILE," etc.

Table 6-4. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A40R81	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A40R82	0698-4486	3	1	RESISTOR 24.9K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2492-F
A40R83	0698-4519	3	1	RESISTOR 140K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1403-F
A40R84	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A40R85	0698-7332	4		RESISTOR 1M 1% .125W F TC=0+-100	28480	0698-7332
A40R86	2100-0569	2		RESISTOR-TRMR 1M 20% C TOP-ADJ 1-TRN	28480	2100-0569
A40U1	1820-0477	6		IC OP AMP GP 8-DIP-P	18324	LM301AN
A40U2	1826-0413	2	3	IC OP AMP LOW-BIAS-H-IMPD TO-99	34371	HA2-2605-5
A40U3 †	1906-0046	7	1	AC GAIN FINELINE	28480	1906-0046
A40U4	1826-0413	2		IC OP AMP LOW-BIAS-H-IMPD TO-99	34371	HA2-2605-5
A40U5	1826-0413	2		IC OP AMP LOW-BIAS-H-IMPD TO-99	34371	HA2-2605-5
A40U6	1826-0109	3	1	IC OP AMP WB TO-99	34371	HA2-2625-80593
A40U7	1826-0357	3	1	IC OP AMP WB TO-99	27014	LF357H
A40U8	1826-0138	8		IC COMPARATOR GP QUAD 14-DIP-P	01295	LM339N
A40U9	1826-0138	8		IC COMPARATOR GP QUAD 14-DIP-P	01295	LM339N
A40U10	1820-1144	6		IC GATE TTL LS NOR QUAD 2-INP	01295	SN74LS02N
A40U11	1826-0138	8		IC COMPARATOR GP QUAD 14-DIP-P	01295	LM339N
A40U12	1820-0493	6		IC OP AMP GP 8-DIP-P	27014	LM307N
A40U13	1820-0493	6		IC OP AMP GP 8-DIP-P	27014	LM307N
				A40 MISCELLANEOUS PARTS		
	0360-1641	1		TERMINAL-STUD FKD-TUR PRESS-MTG	28480	0360-1641
	0360-1916	3		TERMINAL-STUD SPCL-FDTHRU PRESS-MTG	28480	0360-1916
	0360-1917	4		TERMINAL-STUD SPCL-FDTHRU PRESS-MTG	28480	0360-1917
	0380-1217	9		STANDOFF-HEX 7.6-MM-LG 4.8-MM-A/F BRS	00000	ORDER BY DESCRIPTION
	1600-0870	7	2	CONNECTOR STRIP FOR U3 FINELINE	28480	1600-0870
	1600-0872	9	2	CONNECTOR STRIP FOR U3 FINELINE	28480	1600-0872

See introduction to this section for ordering information
*Indicates factory selected value

SECTION III
OPERATION

3-1. INTRODUCTION.

3-2. This is the information and instructions for the operation of the -hp- Model 3456A Voltmeter showing front panel and remote operations. In addition, you will find functional checks you can perform. For more advanced users a Quick Reference Guide is shipped with the instrument. The information in the guide is most of the 3456A's operating characteristics, including remote programming codes.

3-3. Before reading the operating information in this section, familiarize yourself with the front and rear panel features as indicated in Figure 3-1. Use the figure as a reference while reading this section.

3-4. Read the front panel operations of the 3456A before the remote operations since most front panel operations also apply to the remote operations.

3-5. PRE-OPERATING INSTRUCTIONS.

3-6. The 3456A's operation can be separated into five main areas. A good understanding of these areas is fundamental to learning the operation of the instrument. The five areas are:

a. Reset and Test Operation.

b. Function, Range and Trigger.

c. Voltmeter Control Functions, (Delay, Number of Readings/Trigger, Number of Digits Displayed).

d. Math.

e. Remote Operation.

3-7. Refer to Figure 3-1. Note that the 3456A's front panel can be separated into three areas: Display, Voltmeter Configuration, and Numbered Keyboard. Keep these areas in mind when you use the 3456A.

3-8. To learn the operation of the instrument, a logical approach is to ask yourself the following questions:

a. "What type of measurement do I want to make?" - FUNCTION

b. "Do I want autoranging?" - RANGE

c. "Do I want the input filter in?" - FILTER

d. "Is a math operation desired?" - MATH FUNCTION

e. "Do I want remote control of the 3456A?" -REMOTE OPERATION

Once you have decided what you want the 3456A to do, the next step is to learn how to do it.

3-9. GENERAL OPERATING CHARACTERISTICS.

3-10. These paragraphs describe some of the 3456A's General Operating Characteristics. Refer to Figure 3-2, the Display Area, for the following discussion.

3-11. Turn-On and Warm-Up.

3-12. Before connecting ac power to the 3456A, make sure the rear panel line selector switches are set to correspond to the available power line voltage. Be certain the correct fuse is installed in the instrument. To meet accuracy specifications, the 3456A should be warmed up for at least one hour.

3-13. Reset.

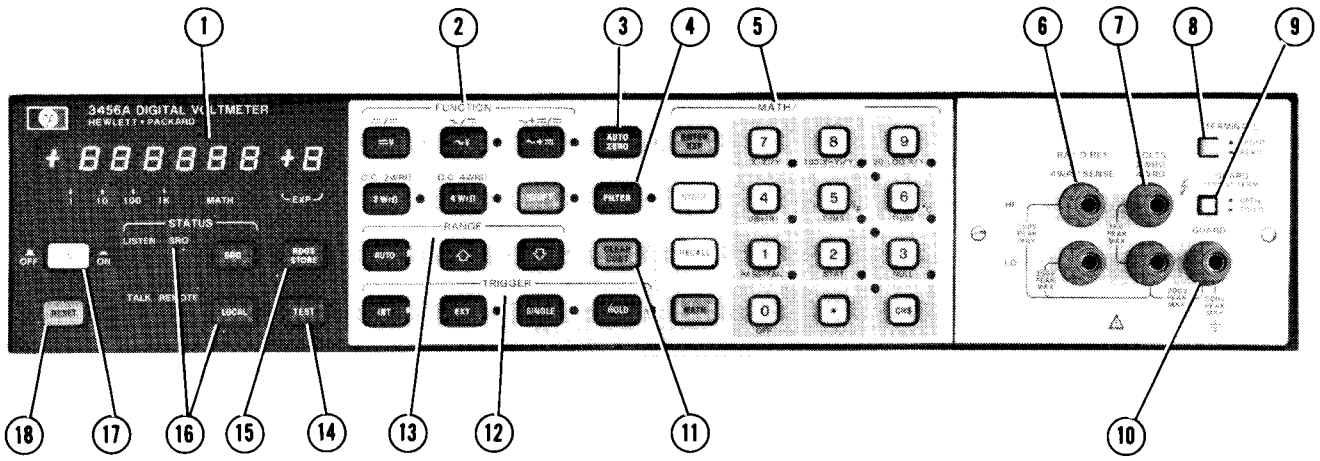
3-14. After power connection and warm-up, to make sure the instrument is in the "turn-on" state, press the RESET button. This places the instrument in the power-up condition without cycling power. This provides you a convenient starting place and avoids thermal and electrical shock to the instrument, therefore maintaining its accuracy and improving reliability. The turn-on state is:

FUNCTION	DC
RANGE	AUTO
TRIGGER	INTERNAL
MATH	OFF
DELAY	DEFAULT (0 SEC.)
NUMBER OF READINGS/TRIGGER	1
NUMBER OF POWER LINE CYCLES INT.	10
NUMBER OF DIGITS DISPLAYED	5
AUTOZERO	ON
OPERATING MODE	LOCAL
FILTER	OFF
READING STORAGE	OFF

Table 6-4. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A40R6	0683-1005	5		RESISTOR 10 5% .25W FC TC=-400/+500	01121	CB1005
A40R7	0683-1005	5		RESISTOR 10 5% .25W FC TC=-400/+500	01121	CB1005
A40R8	0698-4435	2		RESISTOR 2.49K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2491-F
A40R9	0698-4440	9	1	RESISTOR 3.4K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3401-F
A40R10 +	0757-0791	1	1	RESISTOR 619K 1% .125W F TC=0+-100	28480	0757-0791
A40R11	0757-0289	0		RESISTOR 13.3K 1% .125W F TC=+-100	24546	C4-1/8-T0-1330-F
A40R12	2100-3094	4		RESISTOR-TRMR 100K 10% C SIDE-ADJ 17-TRN	02111	43P104
A40R13	2100-3094	4		RESISTOR-TRMR 100K 10% C SIDE-ADJ 17-TRN	02111	43P104
A40R14	2100-3095	5		RESISTOR-TRMR 200 10% C SIDE-ADJ 17-TRN	02111	43P201
A40R15	2100-3094	4		RESISTOR-TRMR 100K 10% C SIDE-ADJ 17-TRN	02111	43P104
A40R16	0757-0476	9		RESISTOR 301K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3013-F
A40R17	0698-4511	5	2	RESISTOR 86.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-8662-F
A40R18	0698-4511	5		RESISTOR 86.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-8662-F
A40R19	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A40R20	0757-0422	5	3	RESISTOR 909 1% .125W F TC=0+-100	24546	C4-1/8-T0-909R-F
A40R21 Δ5,7	0698-4470	5	1	RESISTOR 6.98K 1% .125W F TC=0+-100	24546	C4-1/8-T0-6981-F
A40R22	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A40R23	2100-3409	5	1	RESISTOR-TRMR 20 10% C TOP-ADJ 1-TRN	28480	2100-3409
A40R24 Δ5	0698-3279	9	1	RESISTOR 4.99K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4991-F
A40R25	0757-0474	7	1	RESISTOR 243K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2433-F
A40R26	0757-0468	9	1	RESISTOR 130K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1303-F
A40R27	0698-3455	4	1	RESISTOR 261K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2613-F
A40R28	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A40R29	0698-7803	4	2	RESISTOR 576K 1% .125W F TC=0+-100	28480	0698-7803
A40R30	0698-4477	2	1	RESISTOR 10.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1052-F
A40R31	0698-3223	4	1	RESISTOR 1.24K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1241-F
A40R32	0757-0290	5	1	RESISTOR 6.19K 1% .125W F TC=0+-100	19701	MF4C1/8-T0-6191-F
A40R33	0757-0422	5		RESISTOR 909 1% .125W F TC=0+-100	24546	C4-1/8-T0-909R-F
A40R34	0757-0400	9	2	RESISTOR 90.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-90R9-F
A40R35	0698-4479	4	2	RESISTOR 14K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1402-F
A40R36	0757-0400	9		RESISTOR 90.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-90R9-F
A40R37	0757-0422	5		RESISTOR 909 1% .125W F TC=0+-100	24546	C4-1/8-T0-909R-F
A40R38	0698-4479	4		RESISTOR 14K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1402-F
A40R39	0698-3581	7	1	RESISTOR 13.7K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1372-F
A40R40	0698-3215	4	1	RESISTOR 499K 1% .125W F TC=0+-100	28480	0698-3215
A40R41	0698-7803	4		RESISTOR 576K 1% .125W F TC=0+-100	28480	0698-7803
A40R42	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A40R43	0698-8343	9	1	RESISTOR 590K 1% .125W F TC=0+-100	28480	0698-8343
A40R44	0698-4539	7		RESISTOR 402K 1% .125W F TC=0+-100	28480	0698-4539
A40R45	0757-0279	0		RESISTOR 3.16K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3161-F
A40R46	0757-0270	1	1	RESISTOR 249K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2493-F
A40R47	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A40R48	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A40R49	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A40R50	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A40R51	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A40R52	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A40R53	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A40R54	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A40R55	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A40R56	0683-4725	2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A40R57	0683-4725	2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A40R58	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A40R59	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A40R60 Δ5	0698-3486	1	1	RESISTOR 232 1% .125W F TC=0+-100	24546	C4-1/8-T0-232K-F
A40R61	0698-4383	9	1	RESISTOR 53.6 1% .125W F TC=0+-100	24546	C4-1/8-T0-53R6-F
A40R62	0698-4373	7	1	RESISTOR 26.7 1% .125W F TC=0+-100	03888	PME55-1/8-T0-26R7-F
A40R63	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A40R64	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A40R65	0698-3279	9		RESISTOR 4.99K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4991-F
A40R66	0757-0440	7	1	RESISTOR 7.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-7501-F
A40R67	0757-0433	8		RESISTOR 3.32K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3321-F
A40R68	0699-0152	4	1	RESISTOR 649K 1% .125W F TC=0+-100	28480	0699-0152
A40R69	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A40R70	0757-0281	4	1	RESISTOR 2.74K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2741-F
A40R71	0698-3382	6	1	RESISTOR 5.49K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5491-F
A40R72	0698-4513	7		RESISTOR 97.6K 1% .125W F TC=0+-100	03888	PME55-1/8-T0-9762-F
A40R73	0698-4473	8	1	RESISTOR 8.06K 1% .125W F TC=0+-100	24546	C4-1/8-T0-8061-F
A40R74	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A40R75	0698-7332	4	2	RESISTOR 1M 1% .125W F TC=0+-100	28480	0698-7332
A40R76	0698-3266	5	1	RESISTOR 237K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2373-F
A40R77	2100-0569	2	2	RESISTOR-TRMR 1K 20% C TOP-ADJ 1-TRN	28480	2100-0569
A40R78	0698-7962	6	1	RESISTOR 976K 1% .125W F TC=0+-100	07716	CEA-1/8-T0-9763-F
A40R79	0698-0509	1	1	RESISTOR 80.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-8062-F
A40R80	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F

See introduction to this section for ordering information
*Indicates factory selected value



(1) Display - Indicates polarity and amplitude of the measurement. Measurement results are indicated in either 3½, 4½, 5½, or 6½ digits, dependent on the Number of Digits displayed and the Number of Power Line Cycles Integrated. The LED at the bottom left hand corner of the display indicates the front panel sample rate.

(2) Function Selection Buttons - DCV, ACV, ACV+DCV, 2-Wire Ohms, and 4-Wire Ohms. Included is the SHIFT button which is used to place the 3456A into the shifted function consisting of: DCV/DCV Ratio, ACV/DCV Ratio, ACV+DCV/DCV Ratio, 2-Wire O.C. Ohms, and 4-Wire O.C. Ohms. The LED to the function button's right will also light when the button is pressed.

(3) Autozero Button - enables or disables the Autozero feature. The LED to the button's right is lit when the feature is enabled. Refer to Paragraph 3-48 for more information.

(4) Filter - enables or disables the Analog Filter. The LED to the button's right is lit when the Filter is enabled. Refer to Paragraph 3-52 for more information.

(5) Numbered Keyboard - is used to select math operations, storing a number value into registers which are used in some math operations and other operational changes (Number of Digits displayed, etc.). Refer to Paragraph 3-54 for more information.

(6) Ratio Ref/4WRΩ Sense Terminals - are used for the Ratio Reference Voltage or 4-Wire Ohms measurement.

(7) Volts/2WRΩ/4WRΩ Terminals - input terminals for the ACV, DCV, ACV+DCV, and 2-Wire Ohms measurement. In addition, the terminals supply the current for a 4-Wire Ohms measurement.

(8) Front/Rear Switch - With the switch "out" the front terminals are enabled and with the switch "in" the rear terminals are enabled.

(9) Front Guard Switch - internally connects the GUARD terminal to the VOLTS LOW terminal.

(10) Front Guard Terminal.

(11) Clear Cont - is used to continue with the 3456A's last operation after an attempt was made to store into a register. It is also used to clear the display after a register has been recalled.

(12) Trigger Buttons - permits selection of Internal, External, Single, or Hold Trigger modes. An LED to each of the button's right is lit when the button is selected. Refer to Paragraph 3-46 for more information.

(13) Range Selection Buttons - are used to manually or automatically uprange and downrange the 3456A. The LED to the AUTO button's right is lit when Autoranging is selected.

(14) Test Button - enables or disables the 3456A's Internal Test. Refer to Paragraph 3-17 for more information.

(15) Reading Storage Button - allows the 3456A to internally store a number of readings. The LED to the button's right is lit as long as readings are stored. The LED turns off when Reading Storage is disabled and when the 3456A's internal memory is full. Refer to Paragraph 3-101 for more information.

(16) HP-IB Control Buttons and Status Indicators defined as follows:

SRQ Button - enables the 3456A to send a "Require Service Message" when the button is pressed. Refer to Paragraph 3-198 for more information.

Local Button - takes the 3456A out of Remote.

SRQ Light - indicates a "Require Service" condition when lit. Refer to Paragraph 3-130 for more information.

Listen Light - is lit when the 3456A is addressed to "listen".

Talk Light - is lit when the 3456A is addressed to "talk".

Remote Light - indicates that the 3456A is in Remote when lit.

(17) Line Switch - With the switch "out" the 3456A is turned off and with the switch "in" the instrument is on.

(18) Reset Button - returns the 3456A to its turn-on condition when pressed.

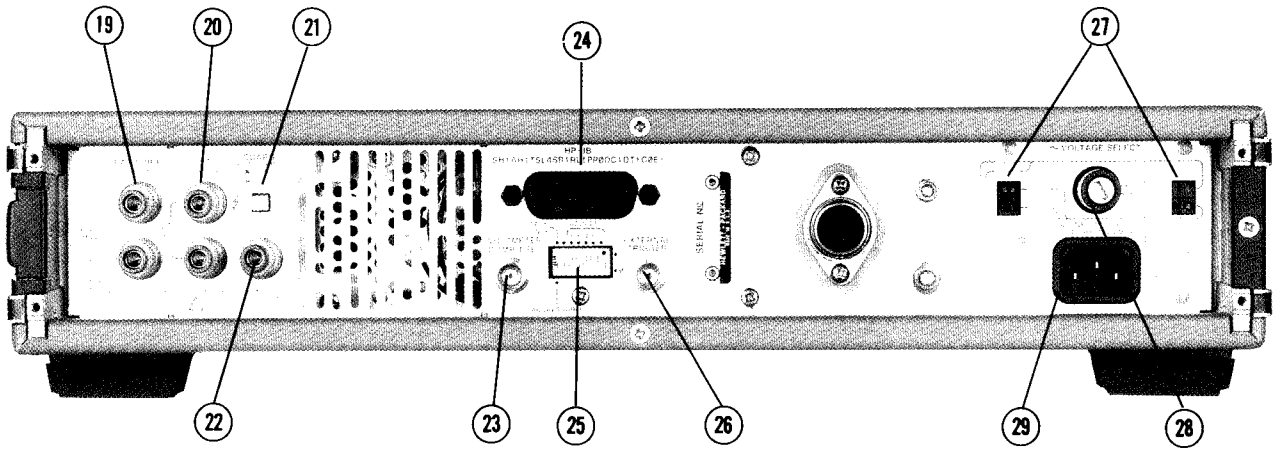
Figure 3-1. Front and Rear Panel Features.

Table 6-4. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A40C12 Δ5	0160-2150	5	1	CAPACITOR-FXD 33PF +-5% 300VDC MICA	28480	0160-2150
A40C13	0160-0134	1	1	CAPACITOR-FXD 22PF +-5% 300VDC MICA	28480	0160-0134
A40C14	0150-0091	8	2	CAPACITOR-FXD 1.5PF +-.25PF 500VDC CER	28480	0150-0091
A40C15	0150-0091	8		CAPACITOR-FXD 1.5PF +-.25PF 500VDC CER	28480	0150-0091
A40C16	0160-4532	1		CAPACITOR-FXD 1000PF +-20% 50VDC CER	28480	0160-4532
A40C17 Δ3	0160-2257	2	2	CAPACITOR-FXD 10PF +-5% 500VDC CER	28480	0160-2257
A40C18 Δ3	0160-2257	2		CAPACITOR-FXD 10PF +-5% 500VDC CER	28480	0160-2257
A40C19	0160-4532	1		CAPACITOR-FXD 1000PF +-20% 50VDC CER	28480	0160-4532
A40C20	0160-2261	9	1	CAPACITOR-FXD 15PF +-5% 500VDC CER 0+-30	28480	0160-2261
A40C21	0160-2308	5		CAPACITOR-FXD 36PF +-5% 300VDC MICA	28480	0160-2308
A40C22 Δ5	0160-0194	3	1	CAPACITOR-FXD .015UF +-10% 200VDC POLYE	28480	0160-0194
A40C23	0160-4532	1		CAPACITOR-FXD 1000PF +-20% 50VDC CER	28480	0160-4532
A40C24	0160-4532	1		CAPACITOR-FXD 1000PF +-20% 50VDC CER	28480	0160-4532
A40C25	0140-0195	2	1	CAPACITOR-FXD 130PF +-5% 300VDC MICA	72136	DM15E131J03000V1CR
A40C26*	0140-0190	7	1	CAPACITOR-FXD 39PF +-5% 300VDC MICA	72136	DM15E390J03000V1CR
A40C26*	0160-2150	5	1	CAPACITOR-FXD 33PF +-5% 300VDC MICA	28480	0160-2150
A40C26*	0160-2308	5	3	CAPACITOR-FXD 36PF +-5% 300VDC MICA	28480	0160-2308
A40C27	0160-3336	1		CAPACITOR-FXD 100PF +-10% 50VDC CER	28480	0160-3336
A40C28	0160-0164	7	1	CAPACITOR-FXD .039UF +-10% 200VDC POLYE	28480	0160-0164
A40C29	0160-3829	7	1	CAPACITOR-FXD .47UF +-10% 50VDC	28480	0160-3829
A40C30	0160-2453	1	1	CAPACITOR-FXD .22UF +-10% 80VDC POLYE	28480	0160-2453
A40C31	0180-0100	3		CAPACITOR-FXD 4.7UF+-10% 35VDC TA	56289	150D475X9035B2
A40C32	0160-0376	3	1	CAPACITOR-FXD 68PF +-5% 500VDC MICA	28480	0160-0376
A40C33	0160-0162	5	1	CAPACITOR-FXD .022UF +-10% 200VDC POLYE	28480	0160-0162
A40C34	0160-2266	4	1	CAPACITOR-FXD 24PF +-5% 500VDC CER 0+-30	28480	0160-2266
A40CR1	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A40CR2	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A40CR3	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A40CR4	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A40CR5	1901-0915	9	2	DIODE-SCHOTTKY	28480	1901-0915
A40CR7	1901-0915	9		DIODE-SCHOTTKY	28480	1901-0915
A40CR8	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A40CR9	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A40CR10	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A40CR11	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A40CR12	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A40CR13	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A40CR14	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A40CR15	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A40CR16	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A40K1	0490-0683	4		RELAY-REED 1A 500MA 1000VDC 5VDC-COIL	28480	0490-0683
A40K2	0490-0683	4		RELAY-REED 1A 500MA 1000VDC 5VDC-COIL	28480	0490-0683
A40P17	1251-6062	0		CONNECTOR 10-PIN F POST TYPE	28480	1251-6062
A40P18	1251-6062	0		CONNECTOR 10-PIN F POST TYPE	28480	1251-6062
A40Q1	1855-0425	7	10	TRANSISTOR J-FET N-CHAN D-MODE TO-92	22229	J304
A40Q2	1855-0308	5	1	TRANSISTOR-JFET DUAL N-CHAN D-MODE SI	28480	1855-0308
A40Q3	1855-0425	7		TRANSISTOR J-FET N-CHAN D-MODE TO-92	22229	J304
A40Q4	1855-0425	7		TRANSISTOR J-FET N-CHAN D-MODE TO-92	22229	J304
A40Q5	1855-0425	7		TRANSISTOR J-FET N-CHAN D-MODE TO-92	22229	J304
A40Q6	1855-0425	7		TRANSISTOR J-FET N-CHAN D-MODE TO-92	22229	J304
A40Q7	1855-0425	7		TRANSISTOR J-FET N-CHAN D-MODE TO-92	22229	J304
A40Q8	1855-0425	7		TRANSISTOR J-FET N-CHAN D-MODE TO-92	22229	J304
A40Q9	1855-0425	7		TRANSISTOR J-FET N-CHAN D-MODE TO-92	22229	J304
A40Q10	1855-0425	7		TRANSISTOR J-FET N-CHAN D-MODE TO-92	22229	J304
A40Q11	1855-0425	7		TRANSISTOR J-FET N-CHAN D-MODE TO-92	22229	J304
A40Q12	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A40Q13	1853-0020	4	1	TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A40Q14	1855-0081	1	1	TRANSISTOR J-FET N-CHAN D-MODE SI	01295	2N5245
A40Q15	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A40Q16	1854-0753	2	2	TRANSISTOR-DUAL NPN TO-52 PD=500MW	28480	1854-0753
A40Q17	1854-0753	2		TRANSISTOR-DUAL NPN TO-52 PD=500MW	28480	1854-0753
A40Q18	1854-0087	5		TRANSISTOR NPN SI PD=360MW FT=75MHZ	28480	1854-0087
A40Q19	1854-0087	5		TRANSISTOR NPN SI PD=360MW FT=75MHZ	28480	1854-0087
A40Q20	1855-0093	5	1	TRANSISTOR J-FET N-CHAN D-MODE TO-18 SI	28480	1855-0093
A40Q21	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A40Q22	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A40Q23	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A40R1	0683-1005	5		RESISTOR 10 5% .25W FC TC=400/+500	01121	CB1005
A40R2	0683-1005	5		RESISTOR 10 5% .25W FC TC=400/+500	01121	CB1005
A40R3 Δ8	0764-0016	8	2	RESISTOR 1K 5% 2W MO TC=0+-200	28480	0764-0016
A40R4	0764-0016	8	1	RESISTOR 1K 5% 2W MO TC=0+-200	28480	0764-0016
A40R5	0698-4435	2	2	RESISTOR 2.49K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2491-F

ΔA SEE NOTE ON SCHEMATIC 7

See introduction to this section for ordering information
*Indicates factory selected value



(19) Ratio Ref/4WRΩ Sense Terminals - are used for the Ratio Reference Voltage or 4-Wire Ohms measurement.

(20) Volts/2WRΩ/4WRΩ Terminals - input terminals for the ACV, DCV, ACV+DCV, and 2-Wire Ohms measurements. In addition, the terminals supply the current for a 4-Wire Ohms measurement.

(21) Rear Guard Switch - internally connects the GUARD terminal to the VOLTS LOW terminal.

(22) Rear Guard Terminal.

(23) Voltmeter Complete Connector - Outputs pulse during measurement cycle.

(24) HP-IB Connector used to connect to HP-IB.

(25) HP-IB Address Selection Switch - Sets 3456A HP-IB Address.

(26) External Trigger Input Connector.

(27) Power Line Voltage Selection - Refer to Paragraph 2-8.

(28) Fuse -90 V to 126 V -.75 amp, 198 V to 252 V -.375 amp.

(29) AC Power Connector

Figure 3-1. Front and Rear Panel Features (Cont'd).

3-15. When pressing the RESET button, the display will momentarily display this for about 1 second:

Add 022 0

3456A HP-IB Address in Decimal

Talk-Only Indicator (0 = Normal Mode, 1 = Talk-Only Enabled)

See Paragraph 3-150 for the HP-IB address setting and Paragraph 3-154 for the "Talk-Only" mode.

3-16. When power is cycled, "HP 3456" is momentarily displayed and then the address code is displayed.

3-17. Self Test Operation.

3-18. The 3456A's Test Operation consists of certain analog gain, offset, and digital checks when the TEST button is pressed. Make sure the 3456A's input terminals are completely floating and the GUARD switch is in the "IN" position, when selecting the test operation. The test may not pass if external connections are made to the input terminals, because certain input circuitry measurements are made. When the TEST button is pressed, the instruments displays

"+1.8.8.8.8.8.8.+ 8."

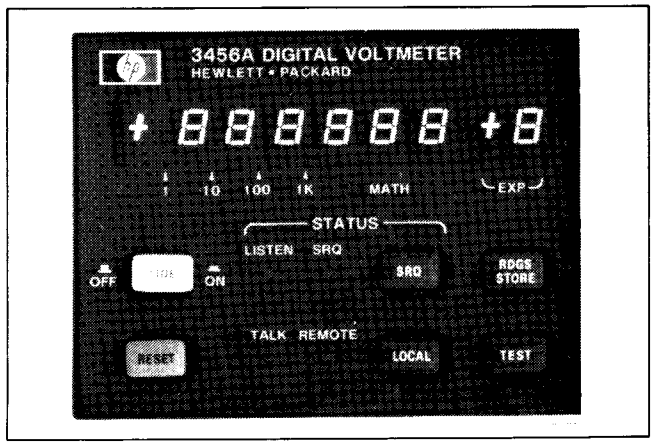


Figure 3-2. Front Panel Display Area.

Table 6-4. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A30J36	1251-4682	6		CONNECTOR 3-PIN M POST TYPE	28480	1251-4682
A30P7	1251-3167	0	1	CONNECTOR 4-PIN F POST TYPE	28480	1251-3167
	1251-3411	7	4	CONTACT-CONN U/W-POST-TYPE FEM CRP	28480	1251-3411
A30P21	1251-6062	0		CONNECTOR 10-PIN F POST TYPE	28480	1251-6062
A30P30	1251-6062	0		CONNECTOR 10-PIN F POST TYPE	28480	1251-6062
A30P34	1258-0141	8		JUMPER REMOVABLE	28480	1258-0141
A30P35	1258-0141	8		JUMPER REMOVABLE	28480	1258-0141
A30P36	1258-0141	8		JUMPER REMOVABLE	28480	1258-0141
A30Q1	1854-0071	7	3	TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A30R1	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A30R2	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A30R3	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A30R4	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A30R5	0683-4715	0	1	RESISTOR 470 5% .25W FC TC=-400/+600	01121	CB4715
A30R6	0683-3335	8		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A30R7	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A30R8	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A30R9	0683-2225	3		RESISTOR 2.2K 5% .25W FC TC=-400/+700	01121	CB2225
A30R10	0683-5125	8	1	RESISTOR 5.1K 5% .25W FC TC=-400/+700	01121	CB5125
A30R11	0683-3325	6		RESISTOR 3.3K 5% .25W FC TC=-400/+700	01121	CB3325
A30R12	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A30R13	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A30R14	0683-2225	3		RESISTOR 2.2K 5% .25W FC TC=-400/+700	01121	CB2225
A30R15	0683-3325	6		RESISTOR 3.3K 5% .25W FC TC=-400/+700	01121	CB3325
A30R16	0683-2225	3		RESISTOR 2.2K 5% .25W FC TC=-400/+700	01121	CB2225
A30R17	0683-3315	4		RESISTOR 330 5% .25W FC TC=-400/+600	01121	CB3315
A30R18	0683-3315	4		RESISTOR 330 5% .25W FC TC=-400/+600	01121	CB3315
A30T1	9100-2616	1		TRANSFORMER-PULSE BIFILAR WOUND; 1A.0 MM	28480	9100-2616
A30T2	9100-2616	1		TRANSFORMER-PULSE BIFILAR WOUND; 1A.0 MM	28480	9100-2616
A30U1	1820-1199	1		IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A30U2	1820-1197	9		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A30U3	1820-1211	8	1	IC GATE TTL LS EXCL-OR QUAD 2-INP	01295	SN74LS86N
A30U4	1820-1144	6		IC GATE TTL LS NOR QUAD 2-INP	01295	SN74LS02N
A30U5	1820-1197	9		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A30U6	1820-1112	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74AN
A30U7	1820-1112	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74AN
A30U8	1820-1199	1		IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A30U9	1820-1445	0	1	IC LCH TTL LS 4-BIT	01295	SN74LS375N
A30U10	1820-1202	7	1	IC GATE TTL LS NAND TPL 3-INP	01295	SN74LS10N
A30U11	1820-1432	5	1	IC CNTR TTL LS BIN SYNCHRO POS-EDGE-TRIG	01295	SN74LS163AN
A30U12	1820-1199	1		IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A30U13	1820-2539	9	1	IC MICPROC NMOS 8-BIT	28480	1820-2539
A30U14	1820-1197	9		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A30U15	1820-1975	1		IC SHF-RGTR TTL LS NEG-EDGE-TRIG PRL-IN	01295	SN74LS165N
A30U16	1820-1759	9		IC BFR TTL LS NON-INV OCTL	27014	DM81LS97N
A30U17	1820-1430	3		IC CNTR TTL LS BIN SYNCHRO POS-EDGE-TRIG	01295	SN74LS161AN
A30U18	1820-0514	2		IC GATE TTL NAND QUAD 2-INP	01295	SN7426N
A30U19	1820-1112	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74AN
A30U20	1820-1112	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74AN
A30U21	1820-1272	1	1	IC BFR TTL LS NOR QUAD 2-INP	01295	SN74LS33N
A30U22	1820-1207	2	1	IC GATE TTL LS NAND 8-INP	01295	SN74LS30N
A30U23	1821-0001	4		TRANSISTOR ARRAY 14-PIN PLSTC DIP	01928	CA3046
A30U24	1820-1433	6		IC SHF-RGTR TTL LS R-S SERIAL-IN PRL-OUT	01295	SN74LS164N
A30U25 ΔA3	1820-1112	8		IC FF TTL LS D-TYPE	01698	SN74LS74AN
A30X13	1200-0659	2		SOCKET-IC 40-CONT DIP-SLDR	28480	1200-0659
				A30 MISCELLANEOUS PARTS		
A30Y1	0410-1225	4	1	CRYSTAL-4.875 MHZ 50HZ	28480	0410-1225
A30Y1	0410-1226	5	1	CRYSTAL-5.85 MHZ 60HZ	28480	0410-1226
	1200-0546	6	1	SOCKET-XTAL 2-CONT HC-25/U DIP-SLDR	28480	1200-0546
	1390-0457	9		FASTENER-SNAP-IN PLGR 0.076 IN - .165 IN	28480	1390-0457
	1390-0458	0		FASTENER-SNAP-IN GROM 0.076 IN - .165 IN	28480	1390-0458
A40	03456-66540	3	1	PC ASSEMBLY-AC CONVERTER	28480	03456-66540
A40C1	0160-3986	7	1	CAPACITOR-FXD .22UF +-10% 400VDC	28480	0160-3986
A40C2	0140-0196	3		CAPACITOR-FXD 150PF +-5% 300VDC MICA	72136	DM15F151J0300AV1CR
A40C3 ΔA5	0160-0205	7	1	CAPACITOR-FXD 62PF +-5% 300VDC MICA	28480	0160-0205
A40C4	0180-0100	3	5	CAPACITOR-FXD 4.7UF+-10% 35VDC TA	56289	150D475X9035B2
A40C5	0180-0100	3		CAPACITOR-FXD 4.7UF+-10% 35VDC TA	56289	150D475X9035B2
A40C6	0160-2264	2	1	CAPACITOR-FXD 20PF +-5% 500VDC CER 0+-30	28480	0160-2264
A40C7	0160-4532	1	5	CAPACITOR-FXD 1000PF +-20% 50VDC CER	28480	0160-4532
A40C8	0180-0100	3		CAPACITOR-FXD 4.7UF+-10% 35VDC TA	56289	150D475X9035B2
A40C9	0180-0100	3		CAPACITOR-FXD 4.7UF+-10% 35VDC TA	56289	150D475X9035B2
A40C10	0160-2246	0	1	CAPACITOR-FXD 3.6PF +-.25PF 500VDC CER	28480	0160-2246

ΔA SEE NOTE ON SCHEMATIC 8

See introduction to this section for ordering information
*Indicates factory selected value

and light all the front panel LEDs. This remains until the test is completed. Once the test is completed, the display and the LEDs go blank for a time and the test operation starts again. If any of the internal checks do not pass, a negative integer corresponding to the check which did not pass is displayed. The displayed number is also output over the HP-IB with the 3456A in remote. A '100" is output when the test passes. To disable the test operation press the TEST button a second time.

NOTE

Make sure no connection is made at the 3456A's Input Terminals and the GUARD switch is in the "IN" position during the Test mode.

NOTE

Refer the 3456A to a Service Trained Person, if the Internal Test does not pass.

3-19. Display.

3-20. Refer to Figure 3-3 to see how readings are displayed. Note that the 1 V through 1000 V ranges are displayed as they are measured with the decimal point in the correct place like this:

1.00000 – 1 V Range
10.0000 – 10 V Range
100.000 – 100 V Range
1000.00 – 1000 V Range

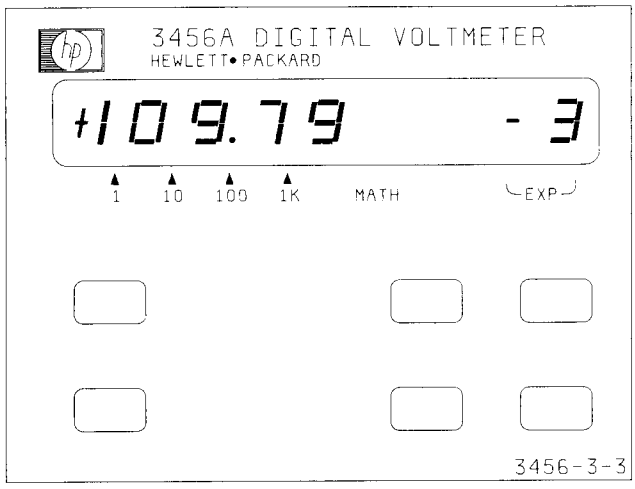


Figure 3-3. 3456A Display.

Additionally, a 1, 10, 100, and 1 K are marked on the front panel and are located below the decimal point of the respective ranges with the other ranges indicated in engineering notation. The position of the decimal point on the display marks the decade multiplier.The range is easily determined by multiplying the displayed exponent by the decade multiplier. For example:

	1	0	9 .	7	9	-3
decade multiplier →	1	10	100	1K		EXP

shows a reading of .10979 V or 109.79 mV. The decade multiplier is not used in the 3456A's Ratio and Math functions.

3-21. Error Messages.

3-22. Error Messages are displayed for invalid operating conditions. They are displayed like this:

E D

where "D" is the number indicating which error is generated. The instrument keeps displaying the Error Message until the condition producing the error is changed to a valid state. A listing of the various error messages is given in Table 3-1.

Table 3-1. Error Messages.

Error No.	Description
1	Autozero disabled in any Shifted Functions. Displayed in Remote only.
2	Analog Filter enabled in any Ohms Functions. Displayed in Remote only.
3	Any invalid Range and Function combination (Example: 10 M ohm Range selected for the DCV Function). Displayed in Remote only.
4	Attempt was made to store invalid number into a register (Example: a "9" is stored into the Number of Digits Displayed register).
5	Attempt was made to store any number into register C, M, or V.
6	Attempt was made to recall non-existent stored readings from memory.

3-23. OPERATING CHARACTERISTICS.

3-24. Refer to Figure 3-4, the front panel's Voltmeter Configuration area, for the following paragraphs.

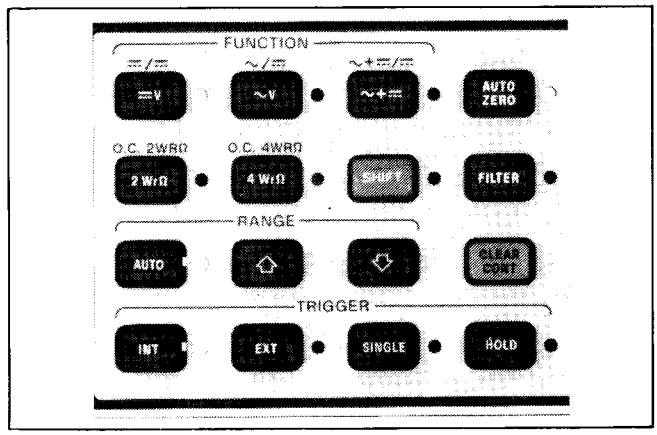


Figure 3-4. Front Panel Voltmeter Configuration Area.

3-25. DC Voltage Measurement.

3-26. The -hp- Model 3456A is capable of measuring dc

Table 6-4. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A25	03456-66525	4	1	PC ASSEMBLY-REFERENCE BOARD, NAT. ASSEMBLY NOT FIELD REPAIRABLE. NEW ASSEMBLY MUST BE ORDERED.	28480	03456-66525
A30	03456-66530	1	1	PC ASSEMBLY-INGUARD LOGIC	28480	03456-66530
A30C1	0180-0309	4		CAPACITOR-FXD 4.7UF+-20% 10VDC TA	56289	150D475X0010A2
A30C2	0180-0309	4		CAPACITOR-FXD 4.7UF+-20% 10VDC TA	56289	150D475X0010A2
A30C3	0160-2208	4	1	CAPACITOR-FXD 330PF +-5% 300VDC MICA	28480	0160-2208
A30C4	0140-0145	2	1	CAPACITOR-FXD 22PF +-5% 500VDC MICA	72136	DM15C220J500WV1CR
A30C5	0180-0309	4		CAPACITOR-FXD 4.7UF+-20% 10VDC TA	56289	150D475X0010A2
A30C6	0180-0309	4		CAPACITOR-FXD 4.7UF+-20% 10VDC TA	56289	150D475X0010A2
A30C7	0180-0291	3		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A30C8	0180-0309	4		CAPACITOR-FXD 4.7UF+-20% 10VDC TA	56289	150D475X0010A2
A30C9	0180-0309	4		CAPACITOR-FXD 4.7UF+-20% 10VDC TA	56289	150D475X0010A2
A30C10	0180-0291	3		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A30C11	0180-0309	4		CAPACITOR-FXD 4.7UF+-20% 10VDC TA	56289	150D475X0010A2
A30J31	1251-4682	6		CONNECTOR 3-PIN M POST TYPE	28480	1251-4682
A30J32	1251-4682	6		CONNECTOR 3-PIN M POST TYPE	28480	1251-4682
A30J33	1251-6185	8	2	CONNECTOR 3-PIN M POST TYPE	28480	1251-6185
A30J34	1251-6185	8		CONNECTOR 3-PIN M POST TYPE	28480	1251-6185
A30J35	1251-4682	6		CONNECTOR 3-PIN M POST TYPE	28480	1251-4682

See introduction to this section for ordering information
*Indicates factory selected value

voltages from 100 nanovolts through 1000 volts in five ranges: 100 mV, 1 V, 10 V, 100 V, and 1000 V. All ranges are overload protected from input voltages up to 1000 V peak. The DCV input impedance is greater than 10^{10} ohms in the 100 mV to 10 V ranges and 10 M ohms in the 100 V and 1000 V ranges.

3-27. The measurement data can be displayed either as a 6½, 5½, 4½, or a 3½ digit reading, depending on the Number of Power Line Cycles Integrated (see Paragraph 3-61) and the Number of Digits selected (see Paragraph 3-63). Refer to Table 1-1 for accuracy specifications.

3-28. AC Voltage Measurement.

3-29. The -hp- Model 3456A uses a True RMS convertor and is able to measure voltages from 1 μV to 700 V RMS in four ranges: 1 V, 10 V, 100 V and 1000 V. All ranges are protected from input voltages up to 1000 V peak or 700 V RMS, whichever is less. Measurement data can be displayed either as a 6½, 5½, 4½, or a 3½ digit reading, depending on the selected Number of Power Line Cycles Integrated (see Paragraph 3-61) and the Number of Digits selected (see Paragraph 3-63). The frequency response of the convertor is from 20 Hz to 250 kHz with a maximum input voltage of 1000 V peak (700 V RMS, 10^8 VHz). The input impedance of the convertor is 1 M ohms shunted by < 75 pF. Refer to Table 1-1 for accuracy specifications.

3-30. AC+DC Measurement.

3-31. The AC+DC mode of the 3456A measures the combined ac and dc components of the input signal and displays its RMS value. Other operating characteristics are the same as the ACV function. Refer to Table 1-1 for accuracy specifications.

3-32. One use of the AC+DC function is to determine the necessary power rating of an amplifier. Since many amplifiers have ac signals with dc components, the true RMS value of those complex waveforms may need to be known. The AC+DC feature of the 3456A can simplify these measurements since it can measure the RMS value of the sum of the ac plus the dc voltage on the waveform.

3-33. Resistance Measurement.

3-34. The Model 3456A is capable of measuring resistance from 100 micro-ohm to 1 giga-ohm in eight ranges. The ranges extend from the 100 ohm full scale to the 1000 Meg-ohm full scale range. Resistance Measurement can be made using either the 2-wire or the 4-wire configuration. Refer to Figure 3-5 for the correct ohms connection.

3-35. Resistance Measurements can be displayed as either a 6½, 5½, 4½, or a 3½ digit reading, depending on the Number of Power Line Cycles Integrated (see Paragraph 3-61) and the Number of Digits selected (see Paragraph 3-63). The 4-WIRE ohm sense terminals are protected to a maximum level of 350 V peak. Refer to Table 1-1 for accuracy specifications.

3-36. The 3456A displays negative (minus) resistance under two conditions:

a. The inputs to the 4 WIRE SENSE (RATIO REF) or the 2WRΩ/4WRΩ (VOLTS) terminals are reversed from each other in 4-wire ohms function.

b. Small negative voltages on measuring circuitry.

NOTE

With the measuring leads shorting or when measuring small resistances, negative readings may be displayed due to offsets in the ohms circuitry.

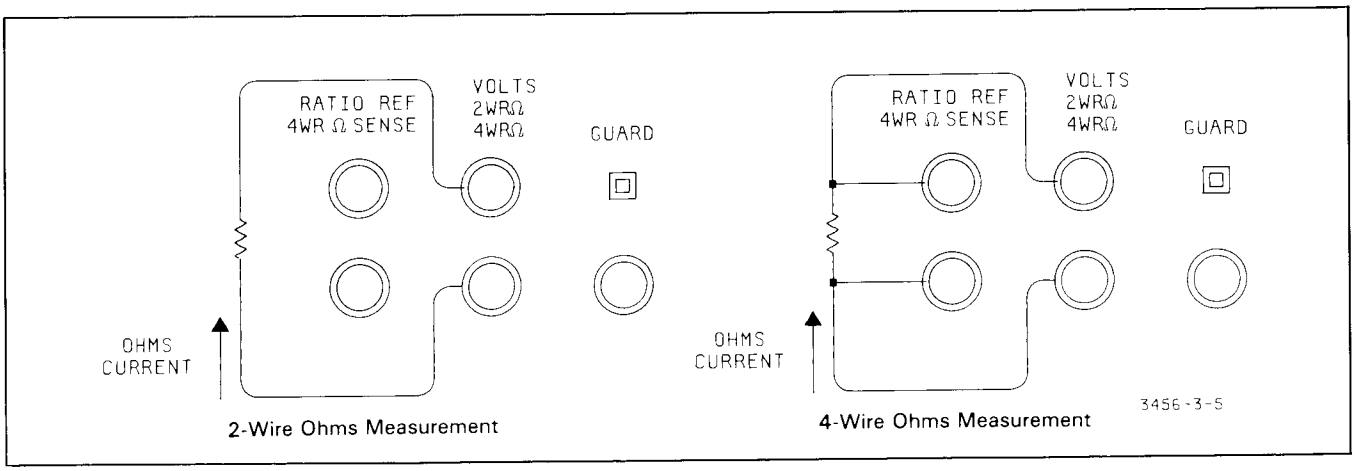


Figure 3-5. Ohms Connection.

Table 6-4. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A20U106 Δ6	1820-0478	7	1	IC OP AMP GP 8-DIP-P	18324	LM308H
A20U107	1820-1197	9		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A20U108	1826-0412	1	2	IC COMPARATOR PRCN DUAL 8-DIP-P	27014	LM393N
A20U200 †	1QD4-0044	1	1	SIG-COND G FINELINE	28480	1QD4-0044
A20U201	1826-0138	8	6	IC COMPARATOR GP QUAD 14-DIP-P	01295	LM339N
A20U202	1826-0138	8		IC COMPARATOR GP QUAD 14-DIP-P	01295	LM339N
A20U203	1820-0478	7	1	IC OP AMP LOW-BIAS-M-IMPD TO-99	27014	LM308H
A20U204	1826-0035	4	1	IC OP AMP LOW-DRIFT TO-99	27014	LM308AH
A20U205	1826-0025	2	1	IC OP AMP LOW-DRIFT TO-99	27014	LM208AH
A20U301	1826-0412	1		IC COMPARATOR PRCN DUAL 8-DIP-P	27014	LM393N
A20U302	1858-0054	4		TRANSISTOR ARRAY 14-PIN PLSTC DIP	28480	1858-0054
A20U303	1826-0059	2		IC OP AMP GP TO-99	01295	LM201AL
A20U304 †	1826-0347	1		IC COMPARATOR GP QUAD 14-DIP-P	01295	LM339 SPEC
A20U305	1826-0059	2		IC OP AMP GP TO-99	01295	LM201AL
A20U306	1820-1745	3	1	IC GATE CMOS NOR QUAD 2-INP	04713	MC14001BCP
A20U307 †	1826-0371	1	1	IC OP AMP BIFET TO-99	27014	LF256H
A20U308	1826-0059	2		IC OP AMP GP TO-99	01295	LM201AL
A20U401	1820-2258	5	1	IC FF CMOS D-TYPE POS-EDGE-TRIG COM	04713	MC14174BCP
A20U402	1820-1746	4	2	IC BFR CMOS INV HEX	04713	MC14049UBCP
A20U403	1820-1601	0	1	IC GATE CMOS EXCL-OR QUAD 2-INP	0192R	CD4070BE
A20U404	1820-1556	4	2	IC DCDR CMOS BIN 2-TO-4-LINE DUAL 2-INP	0192R	CD4555BF
A20U405	1826-0685	8		IC OP AMP LOW-BIAS-M-IMPD TO-99	27014	LF351H
A20U406	1826-0685	8		IC OP AMP LOW-BIAS-M-IMPD TO-99	27014	LF351H
A20U407	1820-1746	4		IC BFR CMOS INV HEX	04713	MC14049UBCP
A20U408	1826-0138	8		IC COMPARATOR GP QUAD 14-DIP-P	01295	LM339N
A20U409	1826-0138	8		IC COMPARATOR GP QUAD 14-DIP-P	01295	LM339N
A20U500 †	1QD5-0045	4	1	A/D, REF FINELINE, F/U/W A24 REF BOARD	28480	1QD5-0045
A20U500 †	1QE7-0057	3	1	A/D, REF FINELINE, F/U/W A25 REF BOARD	28480	1QE7-0057
A20U504	1820-0493	6		IC OP AMP GP 8-DIP-P	27014	LM307N
A20U505 †	1826-0471	2	1	IC OP AMP LOW-DRIFT TO-99	02180	OP-07CJ
A20U701	1820-1556	4		IC DCDR CMOS BIN 2-TO-4-LINE DUAL 2-INP	0192R	CD4555BF
A20U702	1820-2177	7	1	IC MICPROC-ACCESS NMOS 4-BIT	34649	P8243
A20W3	03456-61601	7	1	CABLE-INPUT SWITCHING TO INPUT AMPL.	28480	03456-61601
				A20 MISCELLANEOUS PARTS		
	0360-1641	1	8	TERMINAL-STUD FKD-TUR PRESS-MTG (FOR K101, K102)	28480	0360-1641
	0360-1916	3	29	TERMINAL-STUD SPCL-FDTHRU PRESS-MTG	28480	0360-1916
	0360-1917	4	47	TERMINAL-STUD SPCL-FDTHRU PRESS-MTG	28480	0360-1917
	0380-1217	9	6	STANDOFF-HEX 7.6-MM-LG 4.8-MM-A/F BRS	00000	ORDER BY DESCRIPTION
	0380-1256	6	2	STANDOFF-HEX 6-MM-LG 4.8-MM-A/F BRS NAT	00000	ORDER BY DESCRIPTION
	1390-0457	9	9	FASTENER-SNAP-IN PLGR 0.076 IN - .165 IN	28480	1390-0457
	1390-0458	0	9	FASTENER-SNAP-IN GROM 0.076 IN - .165 IN	28480	1390-0458
	1600-0868	3	1	CONNECTOR STRIP-14-PIN FINELINE (U500)	28480	1600-0868
	1600-0869	4	1	CONNECTOR STRIP-14-PIN FINELINE (U200)	28480	1600-0869
	1600-0871	8	1	CONNECTOR STRIP-11-PIN FINELINE (U200)	28480	1600-0871
	1600-0873	0	1	CONNECTOR STRIP-13-PIN FINELINE (U500)	28480	1600-0873
	2110-0598	8	2	FUSEHOLDER-SPR TYP.250-FUSE	28480	2110-0598
A21	03456-66521	0	1	PC ASSEMBLY-CALIBRATION	28480	03456-66521
A21P16	1251-6190	5	1	CONNECTOR 7-PIN M POST TYPE	28480	1251-6190
A21R601	2100-3094	4		RESISTOR-TRMR 100K 10% C SIDE-ADJ 17-TRN	02111	43P104
A21R602	2100-3054	6	3	RESISTOR-TRMR 50K 10% C SIDE-ADJ 17-TRN	02111	43P503
A21R603	2100-3054	6		RESISTOR-TRMR 50K 10% C SIDE-ADJ 17-TRN	02111	43P503
A21R604	2100-3054	6		RESISTOR-TRMR 50K 10% C SIDE-ADJ 17-TRN	02111	43P503
A21R605	2100-3161	6	1	RESISTOR-TRMR 20K 10% C SIDE-ADJ 17-TRN	02111	43P203
A21R606	0698-3454	3	1	RESISTOR 215K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2153-F
A21R607	0757-0463	4	1	RESISTOR 82.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-8252-F
A21R608	0757-0460	1		RESISTOR 61.9K 1% .125W F TC=0+-100	24546	C4-1/8-T0-6192-F
A21R609	0757-0460	1		RESISTOR 61.9K 1% .125W F TC=0+-100	24546	C4-1/8-T0-6192-F
A21R610	0698-4488	5		RESISTOR 26.7K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2672-F
	0380-1186	1	2	STANDOFF-PRESS-IN 10 MM LONG M3 X 0.5	28480	0380-1186
A24	03456-66524	3	1	PC ASSEMBLY-REFERENCE BOARD HP ASSEMBLY NOT FIELD REPAIRABLE. NEW ASSEMBLY MUST BE ORDERED.	28480	03456-66524

See introduction to this section for ordering information
*Indicates factory selected value

NOTE

The 3456A's Analog Filter (see Paragraph 3-52) should not be used with any ohms functions. The filter is disabled when the ohms functions are selected from the front panel.

3-37. Shift Operation.

3-38. The purpose of the SHIFT button is to place the 3456A in the Shifted Functions. To disable the shifted functions, press the SHIFT button again. The SHIFT button's color is green and corresponds to the green lettering and symbols above the function buttons to identify shifted functions. All shifted functions readings are made by taking multiple measurements.

NOTE

The 3456A's Autozero feature (see Paragraph 3-48) is automatically enabled in front panel selectable shifted functions.

3-39. Ratio.

3-40. The -hp- Model 3456A can either make DCV/DCV, ACV/DCV, or ACV+DCV/DCV Ratio Measurements. This is done by taking a Signal, Reference High, and Reference Low Voltage reading which are all referenced to a common point, the VOLTS LOW terminal. The Signal Voltage is measured from the VOLTS HIGH terminal to the VOLTS LOW common. The Reference High Voltage is measured from the RATIO REF HIGH terminal to VOLTS LOW and the Reference Low Voltage is from the RATIO REF LOW terminal and VOLTS LOW. Refer to Figure 3-6 for a typical Ratio Measurement. Select the Ratio functions using the DCV, ACV, ACV+DCV function buttons in the shifted mode (press the SHIFT button). The green symbols above the function buttons identify the Ratio functions. Refer to Table 1-1 for accuracy specifications.

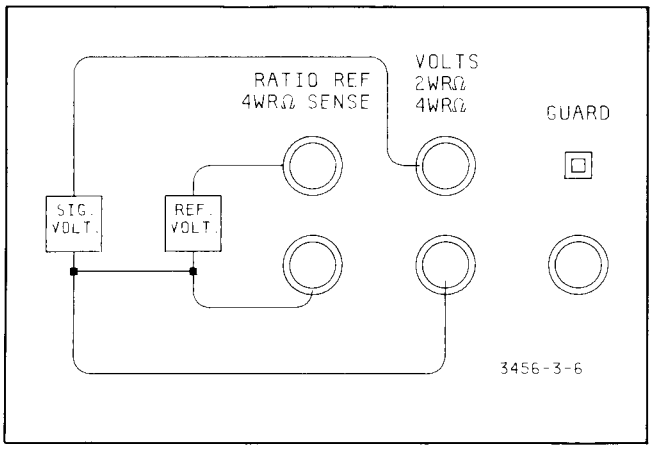


Figure 3-6. Ratio Connection.

a. Ratio Formula. A Ratio Measurement is a mathematical operation expressed in this formula:

$$\text{Ratio} = \frac{\text{Signal Voltage}}{\text{Reference Voltage}}$$

The 3456A Ratio Measurement formula is:

$$\text{Ratio} = \frac{\text{Signal Voltage}}{\text{Reference High - Reference Low}}$$

Remember, the three voltages are referenced to the VOLTS LOW terminal. The Reference Low voltage should be kept low for an accurate Ratio measurement (within ± 9% of Reference High Voltage). The voltage can be kept low by shorting or otherwise connecting the RATIO REF LOW and VOLTS LOW terminals to each other, either at the terminals or measuring point.

NOTE

For a three wire Ratio Measurement connect the REFERENCE LOW and VOLTS LOW terminals to each other.

b. Ratio Measurement. For a Ratio Measurement the Reference Voltage can be between 0 to ± 12 V dc. The 12 V level is the maximum Reference Voltage level the instrument is able to measure (the RATIO REF terminals are protected up to 350 V peak). The Signal Voltage, which is applied at the VOLTS terminals, can either be dc, ac, or ac+dc volts from 0 to 1000 V peak or 700 V RMS. In addition, the Analog Filter (see Paragraph 3-52) and Delay (see Paragraph 3-67) are not used for the Reference Measurement. These features can be selected for the Signal Voltage Measurement. The following is a typical Ratio Measurement procedure.

1. Measure your Signal and Reference Voltages and make sure they are within the range for a Ratio Measurement (refer to Table 1-1 for the limits). Use the instrument's unshifted functions for those measurements.

2. Connect the Reference Voltage between the HIGH and LOW REFERENCE terminals.

3. Connect the Signal Voltage between the HIGH and LOW VOLTS terminals and connect RATIO REF LOW to VOLTS LOW.

4. Set the 3456A to the desired range or to Autorange.

5. Place the instrument into the Ratio mode by pressing the appropriate button (DCV/DCV, ACV/DCV, or ACV+DCV/DCV in the shifted mode).

6. Read the Ratio reading on the display.

Table 6-4. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A20R326	0698-3451	0	2	RESISTOR 133K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1333-F
A20R327	0698-3451	0		RESISTOR 133K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1333-F
A20R328	0698-8824	1	2	RESISTOR 562K 1% .125W F TC=0+-100	28480	0698-8824
A20R329	0757-0449	6		RESISTOR 20K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2002-F
A20R330	0757-0449	6		RESISTOR 20K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2002-F
A20R331	0698-8824	1		RESISTOR 562K 1% .125W F TC=0+-100	28480	0698-8824
A20R332	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A20R333	0698-3151	1	1	RESISTOR 2.87K 1% .125W F TC=+-100	24546	C4-1/8-T0-2871-F
A20R334	2100-3383	4	1	RESISTOR-TRMR 50 10% C TOP-ADJ 1-TRN	28480	2100-3383
A20R401	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A20R402	0698-4307	7	1	RESISTOR 14.3K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1432-F
A20R403*	0698-4539	7	4	RESISTOR 402K 1% .125W F TC=0+-100	28480	0698-4539
A20R403*	0757-0465	5		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A20R403*	0757-0472	5	2	RESISTOR 200K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2003-F
A20R403*	0757-0476	9	2	RESISTOR 301K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3013-F
				(PADDING LIST FOR R403 = 3 EACH)		
A20R404	0698-4453	4	1	RESISTOR 402 1% .125W F TC=0+-100	24546	C4-1/8-T0-402R-F
A20R405	0698-4515	9	1	RESISTOR 107K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1073-F
A20R406	0698-4492	1		RESISTOR 32.4K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3242-F
A20R407	0757-0446	3		RESISTOR 15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1502-F
A20R408	0757-0446	3		RESISTOR 15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1502-F
A20R409	0757-0161	9	1	RESISTOR 604 1% .125W F TC=0+-100	24546	C4-1/8-T0-604R-F
A20R410	0757-0410	1	1	RESISTOR 301 1% .125W F TC=0+-100	24546	C4-1/8-T0-301R-F
A20R411	0757-0453	2	2	RESISTOR 30.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3012-F
A20R412	0698-3279	0	5	RESISTOR 4.99K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4991-F
A20R413	0757-0433	8	2	RESISTOR 3.32K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3321-F
A20R414	0698-4513	7	2	RESISTOR 97.6K 1% .125W F TC=0+-100	03888	PME55-1/8-T0-9762-F
A20R415	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A20R416	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A20R417	0698-3558	6		RESISTOR 4.02K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4021-F
A20R418	0757-0411	2	1	RESISTOR 332 1% .125W F TC=0+-100	24546	C4-1/8-T0-332R-F
A20R419	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A20R420	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A20R421	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A20R422	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A20R423	0757-0283	6		RESISTOR 2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2001-F
A20R424 Δ2	0757-0272	3	2	RESISTOR 52.3K 1% .125W	03292	C4-1/8-TO-5232-F
A20R425 Δ2	0757-0457	6	2	RESISTOR 47.5K 1% .125W	03292	C4-1/8-TO-4752-F
A20R426 Δ2	0757-0457	6		RESISTOR 47.5K 1% .125W	03292	C4-1/8-TO-4752-F
A20R427 Δ2	0757-0272	3		RESISTOR 52.3K 1% .125W	03292	C4-1/8-TO-5232-F
A20R428	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A20R429	0698-3279	0		RESISTOR 4.99K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4991-F
A20R430	0698-3279	0		RESISTOR 4.99K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4991-F
A20R431	0757-0273	4		RESISTOR 3.01K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3011-F
A20R432	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A20R433	0698-3279	0		RESISTOR 4.99K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4991-F
A20R508	0698-3228	9		RESISTOR 49.9K 1% .125W F TC=0+-100	28480	0698-3228
A20R509	0757-0453	2		RESISTOR 30.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3012-F
A20R510	0698-8390	8	1	RESISTOR 66.5 1% .125W F TC=0+-100	24546	C4-1/8-T0-66R5-F
A20R511	0757-0389	3	1	RESISTOR 33.2 1% .125W F TC=0+-100	24546	C4-1/8-T0-33R2-F
A20R512	0698-3911	1	1	RESISTOR 390 10% 1W CC TC=0+529	01121	GB3911
A20R611	0698-4539	7		RESISTOR 402K 1% .125W F TC=0+-100	28480	0698-4539
A20R612	0698-4539	7		RESISTOR 402K 1% .125W F TC=0+-100	28480	0698-4539
A20R613	0757-0401	0	3	RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A20R614	2100-3094	4	5	RESISTOR-TRMR 100K 10% C SIDE-ADJ 17-TRN	02111	43P104
A20R615	2100-3095	5	3	RESISTOR-TRMR 200 10% C SIDE-ADJ 17-TRN	02111	43P201
A20R616	2100-3095	5		RESISTOR-TRMR 200 10% C SIDE-ADJ 17-TRN	02111	43P201
A20R617	2100-3898	1		RESISTOR- 20 OHM .10	28480	2100-0398
A20R618	0757-0381	5	1	RESISTOR 15 1% .125W F TC=0+-100	19701	MF4C1/8-T0-15R0-F
A20R700	0683-3315	4		RESISTOR 330 5% .25W FC TC=-400/+630	01121	CB3315
A20R701	0683-5135	0		RESISTOR 51K 5% .25W FC TC=-400/+800	01121	CB5135
A20R702	0683-5135	0		RESISTOR 51K 5% .25W FC TC=-400/+800	01121	CB5135
A20R703	0683-5135	0		RESISTOR 51K 5% .25W FC TC=-400/+800	01121	CB5135
A20R704	0683-5135	0		RESISTOR 51K 5% .25W FC TC=-400/+800	01121	CB5135
A20R705	0683-5135	0		RESISTOR 51K 5% .25W FC TC=-400/+800	01121	CB5135
A20R706	0683-4725	2	5	RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A20R707	0683-4725	2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A20R708	0683-4725	2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A20S601	3100-3364	2	1	SWITCH-53137-1 HEX	28480	3100-3364
A20U101 *	1826-0347	1	4	IC COMPARATOR GP QUAD 14-DIP-P	01295	LM339 SPEC
A20U102 *	1826-0347	1		IC COMPARATOR GP QUAD 14-DIP-P	01295	LM339 SPEC
A20U103	1820-1144	6		IC GATE TTL LS NOR QUAD 2-INP	01295	SN74LS02N
A20U104 *	1826-0347	1		IC COMPARATOR GP QUAD 14-DIP-P	01295	LM339 SPEC
A20U105	1826-0059	2	4	IC OP AMP GP TO-99	01295	LM201AL

ΔA SEE NOTE ON SCHEMATIC 4

See introduction to this section for ordering information
*Indicates factory selected value

NOTE

It is important to remember that the RATIO REF LOW and VOLTS LOW terminals cannot be more than ± 12 V from each other.

c. Typical Ratio Measurement. Matching resistor values for an accurate voltage divider is one way to use the 3456A's Ratio feature. Try this by using the set up in Figure 3-7. Connect the instrument as indicated in the figure. Make sure that REFERENCE LOW is connected at the top of R2 and that Signal (Volts) Common is connected at the bottom of R1. Once the instrument is connected and placed in the DCV/DCV Ratio mode, a Ratio Measurement is made. The voltage drop across R1 and R2 is measured including any offset voltages between Signal Common and Reference Low. The offset voltage is used to compensate for any error causing voltages between the input and resistors. Once all the measurements are taken, the Ratio Measurement is displayed on the front panel. If the resistors are equal in value, the reading should be approximately "– 1.00000".

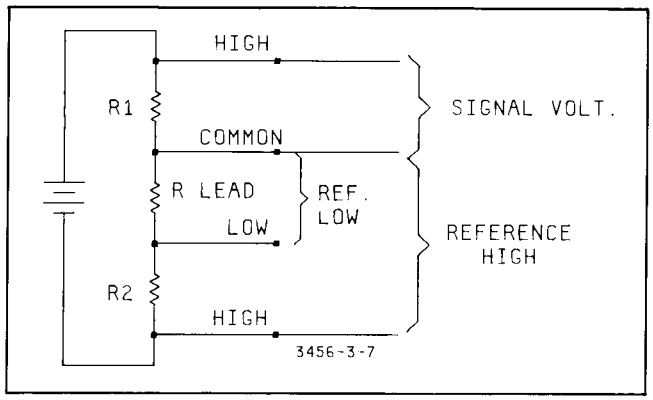


Figure 3-7. Typical Ratio Measurement.

3-41. Offset Compensated Ohms Measurement (O.C. Ohms).

3-42. This feature of the -hp- Model 3456A lets you take resistance measurements of components in the presence of small dc voltages. If this shifted function is selected, the instrument takes an ohms measurement and stores the reading into its internal memory. The ohms current source is then turned off and a dc reading is taken. This reading is subtracted from the previous reading and the resultant ohms reading is displayed on the front panel. Any small offset voltage on the measured component is compensated by the O.C. Ohms measurement. The maximum voltage level depends on the range selected (.01 V dc for the 100 ohm range, etc.). The O.C. Ohms ranges are from 100 ohm to 100 K ohm. Refer to Table 1-1 for the accuracy specifications.

NOTE

Due to internal switching in the 3456A, high capacitance(s) in parallel with the device or component being measured in the O.C. Ohms mode may cause erroneous readings.

3-43. You can use the O.C. Ohms feature of the 3456A to measure the contact resistance of a relay. Since some relay contacts may generate a small dc voltage (due to thermocouple effects), a normal ohms measurement technique may give incorrect readings. The O.C. Ohms feature subtracts this voltage from the ohms reading, and thereby gives an accurate resistance measurement of the relay.

3-44. Ranging.

3-45. The front panel range selection is controlled by three pushbuttons: the UPRANGE, DOWNRANGE, and AUTORANGE button. Their operation is as follows.

a. Uprange. The UPRANGE button's function is to set the 3456A to the next higher range, each time it is pressed. The highest selectable range depends on the function selected. For example, the 100 M ohm in the ohms function is not a valid range for the DCV or ACV functions and the 3456A defaults to the next highest valid range. The UPRANGE button is identified by an upward pointing arrow on its face.

b. Downrange. The function of the DOWNRANGE button is to set the 3456A to the next lower range, each time it is pressed. The lowest selectable range is the 100 mV or 100 ohms range. Similar to UPRANGE operation, the lowest range depends on the function. The ACV function, for example, has the 1 V range as the lowest range. If previously set to a lower range, the 3456A defaults to the 1 V range when the ACV function is selected. The DOWNRANGE button is identified by a downward pointing arrow on its face.

c. Autorange. With Autorange selected, the 3456A automatically selects the present reading's optimum range. Upranging is done when the reading is at or above 120% full scale. The downrange point is at or below 11% full scale. Try the following.

1. Place the 3456A into the Autorange mode; use a variable power supply and apply 1.0 V dc to the input. The range selected by the instrument is the 1 V range.

2. Increase the input voltage to > 1.2 V; the 3456A should then uprange to the 10 V range.

3. Decrease the input voltage to < 1.1 V; the instrument should then downrange back to the 1 V range.

Table 6-4. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A20R121	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A20R122	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A20R123	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A20R124	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A20R125	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A20R126	0757-0442	9	15	RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A20R127	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A20R128	0683-1045	3		RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A20R129	0683-1045	3		RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A20R130	0683-1045	3		RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A20R131	0683-1005	5	6	RESISTOR 10 5% .25W FC TC=-400/+500	01121	CB1005
A20R132	0683-1005	5		RESISTOR 10 5% .25W FC TC=-400/+500	01121	CB1005
A20R133	0683-1045	3		RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A20R134	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A20R135	0698-3572	6		RESISTOR 60.4K 1% .125W F TC=0+-100	24546	C4-1/8-T0-6042-F
A20R136	0698-4482	9	1	RESISTOR 17.4K 1% .125W F TC=0+-100	03888	PME55-1/8-T0-1742-F
A20R137	0683-1045	3		RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A20R138	0683-1045	3		RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A20R139	0683-1045	3		RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A20R140	0683-1045	3		RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A20R141 THRU R145	0683-1045	3		RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A20R146	0683-5135	0	9	RESISTOR 51K 5% .25W FC TC+-400/+800	01121	CB5135
A20R147, R148	2100-3253	7	2	RESISTOR-TRMR 50K 10% C TOP-ADJ 1-TRN	28480	2100-3253
A20R149	0698-3547	5	1	RESISTOR 1 OHM 5% .5W	01607	EB10G5
A20R150*	0699-0740	6	1	RESISTOR 12M 5% .125W	01121	BB12M
A20R150*	0698-6592	6	1	RESISTOR 6.8M 5% .125W	28480	0698-6592
A20R150*	0699-0741	7	1	RESISTOR 8.2M 5% .125W	01121	BB8.2M
A20R201	0698-3262	1	1	RESISTOR 40.2 1% .125W F TC=0+-100	24546	C4-1/8-T0-4022-F
A20R202	0698-3450	9		RESISTOR 42.2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4222-F
A20R203	0698-8690	9	1	RESISTOR 4.75 1% .125W F TC=0+-100	28480	0698-8690
A20R204	0757-0346	2	1	RESISTOR 10 1% .125W F TC=0+-100	24546	C4-1/8-T0-10R0-F
A20R205	0698-4366	8	1	RESISTOR 19.1 1% .125W F TC=0+-100	03888	PME55-1/8-T0-19R1-F
A20R206	0698-4377	1	1	RESISTOR 37.4 1% .125W F TC=0+-100	24546	C4-1/8-T0-37R4-F
A20R207	0757-0486	1	1	RESISTOR 750K 1% .125W F TC=0+-100	28480	0757-0486
A20R208	0683-3025	3	1	RESISTOR 3K 5% .25W FC TC=-400/+700	01121	CB3025
A20R209	0683-2025	1	1	RESISTOR 2K 5% .25W FC TC=-400/+700	01121	CB2025
A20R210	0683-5135	0		RESISTOR 51K 5% .25W FC TC=-400/+800	01121	CB5135
A20R211	0683-5135	0		RESISTOR 51K 5% .25W FC TC=-400/+800	01121	CB5135
A20R212	0683-5135	0		RESISTOR 51K 5% .25W FC TC=-400/+800	01121	CB5135
A20R213	0683-1335	4	1	RESISTOR 13K 5% .25W FC TC=-400/+800	01121	CB1335
A20R214	0811-1053	6	1	RESISTOR 30K .02% .25W PWW TC=0+-1	28480	0811-1053
A20R215	0683-1045	3		RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A20R216	0683-1045	3		RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A20R217	0683-1045	3		RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A20R218	0699-0072	7	1	RESISTOR 6.81M 1% .125W F TC=0+-100	28480	0699-0072
A20R219	0764-0028	2	1	RESISTOR 100K 5% 2W MO TC=0+-200	28480	0764-0028
A20R220	0698-4490	9		RESISTOR 29.4K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2942-F
A20R221	0757-0450	9	1	RESISTOR 22.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2212-F
A20R222	0683-1015	7	1	RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A20R301	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A20R302	0757-0283	6	2	RESISTOR 2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2001-F
A20R303	0757-0273	4	2	RESISTOR 3.01K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3011-F
A20R304	0757-0449	6		RESISTOR 20K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2002-F
A20R305	0757-0446	3	5	RESISTOR 15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1502-F
A20R306	0757-0455	4	1	RESISTOR 36.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3652-F
A20R307	0757-0449	6		RESISTOR 20K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2002-F
A20R308	0757-0446	3		RESISTOR 15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1502-F
A20R309	0757-0465	6	22	RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A20R310	0757-0469	0	1	RESISTOR 150K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1503-F
A20R311	0757-0274	5	1	RESISTOR 1.21K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1213-F
A20R312	0698-3496	0		RESISTOR 3.57K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3571-F
A20R313	0698-4121	3	1	RESISTOR 11.3K1% .125W F TC=0+-100	24546	C4-1/8-T0-1132-F
A20R314	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A20R315	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A20R316	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A20R317	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A20R318	0757-0280	3	6	RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A20R319	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A20R320	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A20R321	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A20R322	0757-0444	1	1	RESISTOR 12.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1212-F
A20R323	0757-0451	0		RESISTOR 24.3K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2432-F
A20R324	0757-0317	7	1	RESISTOR 1.33K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1331-F
A20R325	0698-3156	2	1	RESISTOR 14.7K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1472-F

See introduction to this section for ordering information
*Indicates factory selected value

d. Fast Autorange Feature. Autoranging by the 3456A is done quickly in both the upranging and downranging operations.

1. Upranging. When a voltage applied to the 3456A's input is higher than the range used at that time, an overload condition is detected. The overload condition is detected before the input measurement is complete. Upranging is done until the overload condition disappears and the optimum range is reached. Since the total measurement is never completed until the optimum range is reached, upranging is fast.

2. Downranging. Downranging is also done quickly by using a different method. When a non-overload measurement is made, the 3456A takes a complete measurement. Once the measurement is completed, the instrument then calculates the optimum range from the reading. A maximum of three ranges can be skipped at one time, enabling the 3456A to downrange quickly.

3-46. Instrument Trigger Modes.

3-47. The -hp- Model 3456A has four trigger modes: Internal Trigger, External Trigger, Single Trigger, and Hold. A description of each mode is as follows.

a. Internal Trigger. This trigger is internally generated by the 3456A and is used to initiate a measurement cycle. The instrument is placed into the Internal Trigger mode by pressing the INT (Internal Trigger) pushbutton located on the front panel. This trigger is also automatically selected when the RESET button is pressed and at turn on.

b. External Trigger. In the External Trigger mode, the instrument can be triggered by an externally applied trigger pulse. The pulse is applied to the External Trigger Input connector located on the rear panel and should be at least 500 nsec wide. The External Trigger Input is TTL compatible with actual instrument triggering occurring on the falling (negative) edge. By application of the pulse, the 3456A triggers and initiates a measurement cycle. After this cycle is completed, the instrument can be triggered again for a new cycle. If any triggering is done during the measurement cycle, the trigger is ignored until the cycle is completed. To start a new measurement, the 3456A has to be triggered again.

c. Single Trigger. The Single Trigger operation is similar to the External Trigger operation with triggering being accomplished by the front panel's SINGLE trigger pushbutton. Depressing the button first places the 3456A into the Signal Trigger mode (if the 3456A is in another trigger mode) and then triggers the instrument. A measurement cycle is then initiated. If the pushbutton is pressed again during the cycle, a new measurement cycle is started. The 3456A can be triggered again by depressing the SINGLE trigger pushbutton.

d. Hold. The Hold operation prevents the 3456A from accepting locally generated trigger commands, although an HP-IB trigger is accepted. Refer to the Remote Operation paragraphs for additional information on the HP-IB trigger.

3-48. Autozero.

3-49. The Autozero feature of the -hp- Model 3456A is used to compensate offsets in the dc input amplifier circuit of the instrument. Its main purpose is to correct for any zero drift in circuitry which may cause errors. The method used is to short the amplifier's input to circuit ground and take its offset reading. The reading is then stored in the instrument's internal memory and is later used to correct the following input measurement(s). Once the offset reading is taken, the short is removed and a regular input measurement is taken. As long as the Autozero feature is enabled, the 3456A takes an Autozero measurement and an input measurement. When the feature is disabled, an Autozero measurement is taken and is immediately stored into memory. No new Autozero measurements are made for the successive readings; only an input measurement is made. The stored Autozero reading is subtracted from the input measurement to correct the reading. Since only the input measurement is made, the 3456A's reading rate increases. This also makes the instrument more suitable for making measurements on high impedance circuitry, since no input switching is done. The 3456A's long term stability is affected (see Table 1-1) with the disabled feature, unless the Autozero reading is updated. Updating is done when any change in instrument state occurs. The only exception is that no updating is done by triggering, Front Panel SRQ, and HP-IB Local commands. The Autozero feature is enabled when the 3456A is first turned on and when pressing the RESET button.

3-50. Autozero Effects on 4-Wire Ohms Measurement.

3-51. The Autozero measurement is normally made with the input amplifier shorted to circuit ground. In the 4-Wire Ohms mode, the input amplifier is shorted to the 4-WRΩ SENSE Low terminal for the Autozero Measurement. With Autozero "ON", the Autozero reading is updated for each measurement cycle. With Autozero "OFF", the reading is not updated and causes an ohms measurement error if the measuring lead's impedance changes. To prevent this error, a new Autozero reading should be taken by changing or updating instrument state with the new measuring lead configuration. A disabled Autozero is useful in ohms measurements for a faster reading rate and where the 3456A's input switching may have affected the measurement.

Table 6-4. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A20P30	1251-6062	0		CONNECTOR 10-PIN F POST TYPE	28480	1251-6062
A20Q101	1855-0429	1	6	TRANSISTOR J-FET N-CHAN D-MODE TO-92	28480	1855-0429
A20Q102	1855-0298	2	23	TRANSISTOR J-FET N-CHAN D-MODE TO-92	28480	1855-0298
A20Q103	1855-0298	2		TRANSISTOR J-FET N-CHAN D-MODE TO-92	28480	1855-0298
A20Q104	1855-0298	2		TRANSISTOR J-FET N-CHAN D-MODE TO-92	28480	1855-0298
A20Q105	1855-0298	2		TRANSISTOR J-FET N-CHAN D-MODE TO-92	28480	1855-0298
A20Q106	1855-0298	2		TRANSISTOR J-FET N-CHAN D-MODE TO-92	28480	1855-0298
A20Q107	1855-0298	2		TRANSISTOR J-FET N-CHAN D-MODE TO-92	28480	1855-0298
A20Q108	1855-0298	2		TRANSISTOR J-FET N-CHAN D-MODE TO-92	28480	1855-0298
A20Q109	1855-0298	2		TRANSISTOR J-FET N-CHAN D-MODE TO-92	28480	1855-0298
A20Q110	1855-0298	2		TRANSISTOR J-FET N-CHAN D-MODE TO-92	28480	1855-0298
A20Q111	1855-0298	2		TRANSISTOR J-FET N-CHAN D-MODE TO-92	28480	1855-0298
A20Q112	1855-0298	2		TRANSISTOR J-FET N-CHAN D-MODE TO-92	28480	1855-0298
A20Q113	1855-0429	1		TRANSISTOR J-FET N-CHAN D-MODE TO-92	28480	1855-0429
A20Q114	1855-0429	1		TRANSISTOR J-FET N-CHAN D-MODE TO-92	28480	1855-0429
A20Q115	1855-0298	2		TRANSISTOR J-FET N-CHAN D-MODE TO-92	28480	1855-0298
A20Q116	1855-0298	2		TRANSISTOR J-FET N-CHAN D-MODE TO-92	28480	1855-0298
A20Q117	1855-0298	2		TRANSISTOR J-FET N-CHAN D-MODE TO-92	28480	1855-0298
A20Q118	1855-0298	2		TRANSISTOR J-FET N-CHAN D-MODE TO-92	28480	1855-0298
A20Q119	1855-0298	2		TRANSISTOR J-FET N-CHAN D-MODE TO-92	28480	1855-0298
A20Q120	1855-0243	7	2	TRANSISTOR-JFET DUAL N-CHAN TO-71 SI	28480	1855-0243
A20Q121	1855-0270	0	4	TRANSISTOR J-FET N-CHAN D-MODE TO-92 SI	28480	1855-0270
A20Q201	1855-0298	2		TRANSISTOR J-FET N-CHAN D-MODE TO-92	28480	1855-0298
A20Q202	1855-0298	2		TRANSISTOR J-FET N-CHAN D-MODE TO-92	28480	1855-0298
A20Q203	1855-0298	2		TRANSISTOR J-FET N-CHAN D-MODE TO-92	28480	1855-0298
A20Q204	1855-0298	2		TRANSISTOR J-FET N-CHAN D-MODE TO-92	28480	1855-0298
A20Q205	1855-0298	2		TRANSISTOR J-FET N-CHAN D-MODE TO-92	28480	1855-0298
A20Q206	1855-0298	2		TRANSISTOR J-FET N-CHAN D-MODE TO-92	28480	1855-0298
A20Q207	1855-0298	2		TRANSISTOR J-FET N-CHAN D-MODE TO-92	28480	1855-0298
A20Q208	1855-0429	1		TRANSISTOR J-FET N-CHAN D-MODE TO-92	28480	1855-0429
A20Q209	1855-0429	1		TRANSISTOR J-FET N-CHAN D-MODE TO-92	28480	1855-0429
A20Q210	1854-0079	5	2	TRANSISTOR NPN 2N3439 SI TO-5 PD=1W	01928	2N3439
A20Q211	1854-0079	5		TRANSISTOR NPN 2N3439 SI TO-5 PD=1W	01928	2N3439
A20Q301	1854-0215	1	1	TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	2N3904
A20Q302	1855-0386	9	4	TRANSISTOR J-FET 2N4392 N-CHAN D-MODE	04713	2N4392
A20Q303	1855-0386	9		TRANSISTOR J-FET 2N4392 N-CHAN D-MODE	04713	2N4392
A20Q304	1855-0386	9		TRANSISTOR J-FET 2N4392 N-CHAN D-MODE	04713	2N4392
A20Q305	1855-0247	1	2	TRANSISTOR-JFET DUAL N-CHAN D-MODE TO-71	28480	1855-0247
A20Q306	1855-0386	9		TRANSISTOR J-FET 2N4392 N-CHAN D-MODE	04713	2N4392
A20Q307	1855-0270	0		TRANSISTOR J-FET N-CHAN D-MODE TO-92 SI	28480	1855-0270
A20Q308	1855-0341	6	1	TRANSISTOR J-FET 2N4338 N-CHAN D-MODE	17856	2N4338
A20Q309	1855-0270	0		TRANSISTOR J-FET N-CHAN D-MODE TO-92 SI	28480	1855-0270
A20Q310	1855-0246	0	2	TRANSISTOR-JFET DUAL N-CHAN D-MODE TO-71	28480	1855-0246
A20Q311	1855-0247	1		TRANSISTOR-JFET DUAL N-CHAN D-MODE TO-71	28480	1855-0247
A20Q401	1853-0066	8	1	TRANSISTOR PNP SI TO-92 PD=625MW	28480	1853-0066
A20Q402	1855-0420	2	5	TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A20Q403	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A20Q404	1855-0414	4	1	TRANSISTOR J-FET 2N4393 N-CHAN D-MODE	04713	2N4393
A20Q405	1855-0270	0		TRANSISTOR J-FET N-CHAN D-MODE TO-92 SI	28480	1855-0270
A20Q406 Δ4	1855-0460	0		TRANSISTOR-JFET DUAL N-CHAN D-MODE TO-71	28480	1855-0460
A20Q407	1855-0243	7		TRANSISTOR-JFET DUAL N-CHAN TO-71 SI	28480	1855-0243
A20Q408	1855-0429	1		TRANSISTOR J-FET N-CHAN D-MODE TO-92	28480	1855-0429
A20Q501	1853-0049	5	1	TRANSISTOR PNP 2N4917 SI PD=200MW	07263	2N4917
A20Q701	1854-0087	5	5	TRANSISTOR NPN SI PD=360MW FT=75MHZ	28480	1854-0087
A20Q702	1854-0087	5		TRANSISTOR NPN SI PD=360MW FT=75MHZ	28480	1854-0087
A20Q703	1854-0087	5		TRANSISTOR NPN SI PD=360MW FT=75MHZ	28480	1854-0087
A20R101	0698-3179	9	1	RESISTOR 2.55K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2551
A20R102	0692-2735	9	4	RESISTOR 27K 5% 2W CC TC=0+765	01121	HB2735
A20R103	0686-1035	7	1	RESISTOR 10K 5% .5W CC TC=0+765	01121	EB1035
A20R104	0689-1045	5	1	RESISTOR 100K 5% 1W CC TC=0+882	01121	GB1045
A20R105	0693-1041	0	2	RESISTOR 100K 10% 2W CC TC=0+882	01121	HB1041
A20R106	0693-1041	0		RESISTOR 100K 10% 2W CC TC=0+882	01121	HB1041
A20R107	0698-3558	8	3	RESISTOR 4.02K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4021-F
A20R108	0698-3558	8		RESISTOR 4.02K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4021-F
A20R109	0692-2735	9		RESISTOR 27K 5% 2W CC TC=0+765	01121	HB2735
A20R110	0692-2735	9		RESISTOR 27K 5% 2W CC TC=0+765	01121	HB2735
A20R111	0683-1045	3	17	RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A20R112	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A20R113	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A20R114	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A20R115	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A20R116	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A20R117	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A20R118	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A20R119	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A20R120	0692-2735	9		RESISTOR 27K 5% 2W CC TC=0+765	01121	HB2735

See introduction to this section for ordering information
*Indicates factory selected value

3-52. Analog Filter.

3-53. The 3456A's Analog Filter is a 3 pole active filter with greater than 60 dB attenuation at frequencies of 50 Hz and higher. The filter is normally applied between the instrument's input terminals and input amplifier. An exception is when the 3456A is in the ACV or ACV + DCV unshifted or shifted functions. The filter is then applied between the output of the ac convertor and the input amplifier. In these modes, select the filter for accurate measurements below 400 Hz. Refer to Table 1-1 for the ACV and ACV/DCV accuracy specifications with the filter in or out. The Analog Filter is enabled (or disabled) by pressing the FILTER button.

3-54. NUMBERED KEYBOARD OPERATIONS.

3-55. Refer to Figure 3-8 for the 3456A's Numbered Keyboard selectable operations.

3-56. Storing Into Registers.

3-57. The next paragraphs explain the Number of Power Line Cycles Integrated, Number of Readings per Trigger, Settling Delay, and a variety of math operations. Except for math, other operations are changed by storing numbers into appropriate registers. The math operations are selected by pressing the appropriate math key. Table 3-2 gives a short description of the registers and math operations.

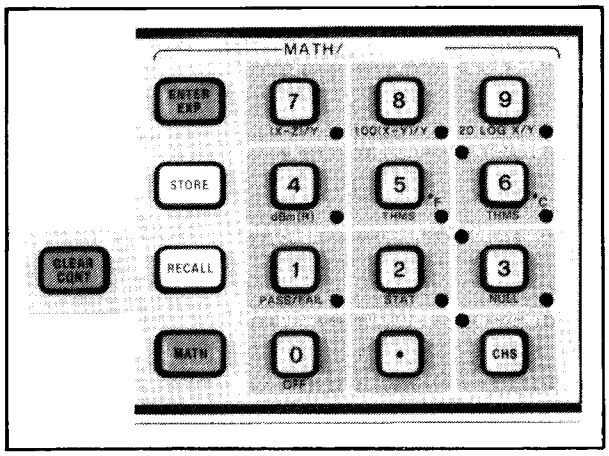


Figure 3-8. Front Panel Numbered Keyboard Area.

3-58. The Numbered Keyboard is very similar to those in pocket calculators with some keys performing more than two functions. Refer to the front panel. Note that the differences in key color, and the labeling above and below the keys determine the key's function. The blue color identifies the math operation, the white color identifies registers, and the black color identifies numbers, decimal point, and polarity. The white and blue color buttons located to the keyboard's left corresponds to the math and register operations.

3-59. Various LEDs on the keyboard annunciate which math function has been selected and which register contains a non-default number. For example, the LED next to the PASS/FAIL label lights if you select this math operation.

3-60. Storing numbers into registers:

a. Store. Numbers stored into registers changes the instrument's operation. For example, select the 100 Power Line Cycles Integrated mode (10 Line Cycles is the default value). To do this, "100" has to be stored into register N CYC INT. Try the following procedure.

1. Press the "1" key and the "0" key twice. These keys are on the Numbered Keyboard.

2. A "100" should now be displayed on the front panel.

3. Next press the white STORE button and then the CHS key (note, the white label above the CHS key is N CYC INT). The CHS key, which is normally the Change of Sign key, becomes the N CYC INT register key when the STORE button is pressed. (The CHS key is normally used to change the polarity of a number which is typed in from the keyboard, before storing into a register.)

4. The 3456A is now set to 100 Power Line Cycles Integrated. Use the same method to store numbers into the other registers.

Using this method you can select a six digit number (and a "1" as the overrange number) of any value and store it into a register. When a number is entered from the keyboard, the number is displayed before it is stored into a register. There is one important thing to remember when storing numbers. Some registers only accept certain numbers. The N DIG DISP (Number of Digits Displayed), for example, only accepts either a 3, 4, 5, or 6, since these are the only number of digits the 3456A can display. If you try to store an illegal number, Error 4 will be displayed.

NOTE

Since only a six digit number and overrange number can be entered, any additional numbers will be ignored.

b. EXP (Exponential). There are two ways to store numbers into registers using the Numbered Keyboard, Fixed Point and Floating Point. One way is to enter a number digit by digit and the other way is using the EXP (Exponential) key. A digit to digit entry looks like this: Enter "2". "0", "0", "0" to display "2000"

or

Enter "." "0", "2" to display ".02"

Table 6-4. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A20	03456-66520	9	1	PC ASSEMBLY-DC, A/D AND OHMS	28480	03456-66520
A20C101	0160-5231	5	4	CAPACITOR-FXD 470PF +-10% 100VDC POLYP	28480	0160-5231
A20C102	0160-5231	5		CAPACITOR-FXD 470PF +-10% 100VDC POLYP	28480	0160-5231
A20C103	0160-5231	5		CAPACITOR-FXD 470PF +-10% 100VDC POLYP	28480	0160-5231
A20C104	0160-5251	5	1	CAPACITOR-FXD 470PF +-10% 100VDC	28480	0160-5251
A20C105	0160-4078	0	2	CAPACITOR-FXD 1UF +-10% 100VDC POLYP	28480	0160-4078
A20C106	0160-0859	7	1	CAPACITOR-FXD 1UF +-10% 50VDC POLYE	28480	0160-0859
A20C107	0160-0970	3	1	CAPACITOR-FXD .47UF +-10% 80VDC POLYE	28480	0160-0970
A20C108	0160-0181	8	1	CAPACITOR-FXD 30PF +-5% 300VDC MICA	28480	0160-0181
A20C109	0180-0230	0		CAPACITOR-FXD 10UF+-20% 50VDC TA	56289	150D105X0050A2
A20C110	0180-0230	0		CAPACITOR-FXD 10UF+-20% 50VDC TA	56289	150D105X0050A2
A20C111 Δ6	0160-3336	1	2	CAPACITOR-FXD 100PF +-5% 100VDC CER	28480	0160-3336
A20C201	0160-3336	1	4	CAPACITOR-FXD 100PF +-10% 50VDC CER	28480	0160-3336
A20C202	0160-4461	5	1	CAPACITOR-FXD 150PF +-2.5% 100VDC POLYP	28480	0160-4461
A20C203	0160-3336	1		CAPACITOR-FXD 100PF +-10% 50VDC CER	28480	0160-3336
A20C204	0160-3336	1		CAPACITOR-FXD 100PF +-10% 50VDC CER	28480	0160-3336
A20C301	0160-4807	3	2	CAPACITOR-FXD 33PF +-5% 100VDC CER 0+-30	28480	0160-4807
A20C302	0160-4807	3		CAPACITOR-FXD 33PF +-5% 100VDC CER 0+-30	28480	0160-4807
A20C303	0160-0362	6	1	CAPACITOR-FXD 510PF +-5% 300VDC MICA	28480	0160-0362
A20C304	0160-4814	2		CAPACITOR-FXD 150PF +-5% 100VDC CER	28480	0160-4814
A20C305	0160-0158	8	1	CAPACITOR-FXD 5600PF +-5% 200VDC POLYE	28480	0160-0158
A20C401	0160-4571	8		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0160-4571
A20C402	0160-5231	5		CAPACITOR-FXD 470PF +-10% 100 VDC POLYP	28480	0160-5231
A20C403	0160-5104	5	1	CAPACITOR-FXD .0039MF .05 POLYP	28480	0160-5104
A20C404	0180-0197	8	1	CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A20C405	0160-4808	4	1	CAPACITOR-FXD 470PF +-5% 100VDC CER	28480	0160-4808
A20C406	0180-0230	0		CAPACITOR-FXD 10UF+-20% 50VDC TA	56289	150D105X0050A2
A20C407	0180-0230	0		CAPACITOR-FXD 10UF+-20% 50VDC TA	56289	150D105X0050A2
A20C408	0180-0230	0		CAPACITOR-FXD 10UF+-20% 50VDC TA	56289	150D105X0050A2
A20C409	0180-0230	0		CAPACITOR-FXD 10UF+-20% 50VDC TA	56289	150D105X0050A2
A20C410	0160-4831	3	1	CAPACITOR-FXD 4700PF +-10% 100VDC CER	28480	0160-4831
A20C411	0160-4078	0		CAPACITOR-FXD 1UF +-10% 100VDC POLYP	28480	0160-4078
A20C505	0180-0230	0		CAPACITOR-FXD 10UF+-20% 50VDC TA	56289	150D105X0050A2
A20C506	0160-4571	8		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0160-4571
A20C700	0180-0116	1	1	CAPACITOR-FXD 6.8UF+-10% 35VDC TA	56289	150D685X9035B2
A20C701 Δ6	0180-0269	5		CAPACITOR-FXD 10UF+-20% 150VDC TA	56289	150D105X9150A2
A20CR101	1902-1337	3	2	DIODE-ZNR 13V 2% DO-7 PD=.4W	28480	1902-1337
A20CR102	1902-1337	3		DIODE-ZNR 13V 2% DO-7 PD=.4W	28480	1902-1337
A20CR201	1901-0586	0	1	DIODE-GEN PRP 30V 25MA TO-72	28480	1901-0586
A20CR202	1901-0029	6	1	DIODE-PWR RECT 600V 750MA DO-29	28480	1901-0029
A20CR301	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A20CR302	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A20CR303	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A20CR304	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A20CR305	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A20CR306	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A20CR307	1901-0518	8	3	DIODE-SCHOTTKY	28480	1901-0518
A20CR308	1901-0518	8		DIODE-SCHOTTKY	28480	1901-0518
A20CR401	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A20CR402	1901-0376	6	5	DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A20CR403	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A20CR404	1901-0518	8		DIODE-SCHOTTKY	28480	1901-0518
A20CR502	1901-0704	4	1	DIODE-PWR RECT 1N4002 100V 1A DO-41	01295	1N4002
A20CR503	1902-3149	9	1	DIODE-ZNR 9.09V 5% DO-35 PD=.4W	28480	1902-3149
A20CR701	1901-0040	1	13	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A20CR702	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A20CR703	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A20CR704	1902-3182	0	1	DIODE-ZNR 12.1V 5% DO-35 PD=.4W	28480	1902-3182
A20E201	1970-0084	8	1	TUBE-ELECTRON SURGE V PTCTR	28480	1970-0084
A20F201	2110-0011	0	1	FUSE .062A 250V NTD 1.25X.25 UL	28480	2110-0011
A20J16	1251-4644	0	1	CONNECTOR 7-PIN F POST TYPE	28480	1251-4644
A20J24	1251-6064	2	1	CONNECTOR 5-PIN M POST TYPE	28480	1251-6064
A20J25	1251-6191	6	1	CONNECTOR 4-PIN M POST TYPE	28480	1251-6191
A20J26	1200-0867	4	3	SOCKET-STRP 8-CONT SIP DIP-SLDR	28480	1200-0867
A20J27	1200-0867	4		SOCKET-STRP 8-CONT SIP DIP-SLDR	28480	1200-0867
A20J28	1200-0867	4		SOCKET-STRP 8-CONT SIP DIP-SLDR	28480	1200-0867
A20J29	1251-6515	8	1	CONNECTOR 6-PIN M POST TYPE	28480	1251-6515
A20K101	0490-0683	4	4	RELAY-REED 1A 500MA 1000VDC 5VDC-COIL	28480	0490-0683
A20K102	0490-0683	4		RELAY-REED 1A 500MA 1000VDC 5VDC-COIL	28480	0490-0683
A20K103	0490-1238	7	1	RELAY-REED 2A 1200VDC 15VDC-COIL 15VA	28480	0490-1238
A20P15	1251-3962	3	1	CONNECTOR 8-PIN F POST TYPE	28480	1251-3962
A20P17	1251-6062	0	8	CONNECTOR 10-PIN F POST TYPE	28480	1251-6062
A20P18	1251-6062	0		CONNECTOR 10-PIN F POST TYPE	28480	1251-6062
A20P21	1251-6062	0		CONNECTOR 10-PIN F POST TYPE	28480	1251-6062
A20P29	1258-0141	8		JUMPER REMOVABLE	28480	1258-0141

See introduction to this section for ordering information
*Indicates factory selected value

To enter the same numbers using the EXP key, first enter all of the number's significant digits and then press the ENTER EXP button. Once this is done, the displayed number is then stored into the desired register. The exponent can also be changed from a "+" to a "-" by pressing the CHS key. This is done before or after you enter the exponent and after pressing the ENTER EXP key. To enter "2000", do this:

Enter "2", press ENTER EXP key, and enter "3" displaying "2 +3". The same as "2000"

To enter the number ".02" do this:

Enter "2", press the ENTER EXP button, enter "2", and press the CHS key displaying "2 -2". The same as ".02"

Table 3-2. Registers and Math Listing.

Key	Register	Registers Default Values	Description
CHS	N CYC INT	10	Used for changing and determining the Number of Power Line Cycles Integrated
.	VARIANCE	-00.000-3	Used for storing the varience value determined from Statistics Math Operation
0	MEAN	199999+9	Used for storing the Mean Value determined from the Statistics Math operation.
1	LOWER	-1999999+9	Used for storing the lower value for the Pass/Fail Math operation or the lowest reading taken in the Statistics Math operation.
2	UPPER	1999999+9	Used for storing the upper value for the Pass/Fail Math operation or the highest reading taken in the Statistics Math operation.
3	DELAY SEC	0	Used for changing and determining the 3456A's Settling Delay.
4	R	600	Used for storing the resistor value for the dBm Math operation or for recalling readings taken in the 3456A's Reading Storage mode.
5	COUNT	0	Used for storing the number of readings taken while in the Statistics Math operation.
1	N RD/TRIG	1	Used for changing and determining the Number of Readings taken or are to be taken per Trigger.
7	Z	0	Used for storing a number value for the Scale Math operation and stores the first statistics Reading.
1	Y	1	Used for storing a number value for the Scale and %Error Math operation.
9	N DIG DISP	5	Used for changing and determining the 3456A's Number of Digits Displayed.
	Math		
CHS	-		
.	_		
0	OFF		Disables Math operation.
1	PASS/FAIL		Used to determine if a reading(s) is within set limits.
2	STATS		Used to calculate the Mean, Variance, Upper, Lower, and Count of a reading(s).
3	NULL		Used for offset compensation of the following reading(s) taken.
4	DBM		dBm calculation.
5	THMS F		Used in calculating a Thermistor reading(s) in degrees Fahrenheit.
6	THMS C		Used in calculating a Thermistor reading in degrees Celsius.
7	(X-Y)/Y		Used for the Scale calculation.
8	100 (X-Y)/Y		Used for the %Error calculation.
9	20 LOG X/Y		Used for the dB calculation.

Table 6-4. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A4U11 Δ11	1818-1960	9		IC NMOS 8192-BIT RAM STAT 250-NS	28480	1818-1960
A4U12	1820-1197	9		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A4U13	1820-1112	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74AN
A4U14	1820-2036	7	1	IC DRVR NMOS CLOCK DRVR	04713	MC6875L
A4U15	1820-2137	9	1	IC MICPROC NMOS 8-BIT	04713	MC6802P
A4U16 Δ1	1820-1416	5		IC SCHMITT-TRIG TTL LS INV HEX 1-INP	01295	SN74LS14N
A4U17	1820-1216	3		IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A4U18 Δ1	1820-0693	8	1	IC FF TTL S D-TYPE POS-EDGE-TRIG	01698	SN74S74N
A4U19	1820-1216	3		IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A4U20	1820-1423	4	1	IC MV TTL LS MONOSTBL RETRIG DUAL	01295	SN74LS123N
A4U21	1820-2309	7	1	IC ENCDR CMOS	27014	MM74C922N
A4U22	1820-1112	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74AN
A4U23	1820-1197	9		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A4U24	1820-1112	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74AN
A4U25	1820-1759	9		IC BFR TTL LS NON-INV OCTL	27014	DM81LS97N
A4U26	1820-1931	9	1	IC GATE CMOS NAND 8-INP	04713	MC14068BCP
A4U27	1820-1144	6		IC GATE TTL LS NOR QUAD 2-INP	01295	SN74LS02N
A4U28	1820-1858	9	1	IC FF TTL LS D-TYPE OCTL	01295	SN74LS377N
A4U29	1820-2132	4	2	IC DRVR CMOS LED DRVR	32293	ICM7218A
A4U30	1820-2132	4		IC DRVR CMOS LED DRVR	32293	ICM7218A
A4XE5	1200-0473	8	1	SOCKET-IC 16-CONT DIP DIP-SLDR	28480	1200-0473
A4X15	1200-0659	2		SOCKET-IC 40-CONT DIP-SLDR	28480	1200-0659
A4Y1	0410-1292	5	1	CRYSTAL-6.00 MHZ	28480	0410-1292
A10	03456-66510	7	1	PC ASSEMBLY-INGUARD POWER SUPPLY	28480	03456-66510
A10C1	0160-4571	8		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0160-4571
A10C2	0160-4571	8		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0160-4571
A10C3	0160-4571	8		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0160-4571
A10C4	0160-4571	8		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0160-4571
A10C5	0180-3025	7	1	CAPACITOR-FXD 4000UF+100-10% 15VDC AL	28480	0180-3025
A10C6	0180-0230	0	16	CAPACITOR-FXD 1UF+-20% 50VDC TA	56289	150D105X0050A2
A10C7	0180-3009	7	1	CAPACITOR-FXD 47UF+-20% 50VDC AL	28480	0180-3009
A10C8	0180-2803	7	1	CAPACITOR-FXD 100UF+50-10% 50VDC AL	28480	0180-2803
A10C9	0180-0230	0		CAPACITOR-FXD 1UF+-20% 50VDC TA	56289	150D105X0050A2
A10C10	0180-0230	0		CAPACITOR-FXD 1UF+-20% 50VDC TA	56289	150D105X0050A2
A10C11	0180-0230	0		CAPACITOR-FXD 1UF+-20% 50VDC TA	56289	150D105X0050A2
A10C12	0180-0230	0		CAPACITOR-FXD 1UF+-20% 50VDC TA	56289	150D105X0050A2
A10C13	0180-2635	3	2	CAPACITOR-FXD 1000UF+50-10% 35VDC AL	28480	0180-2635
A10C14	0180-0230	0		CAPACITOR-FXD 1UF+-20% 50VDC TA	56289	150D105X0050A2
A10C15	0180-2635	3		CAPACITOR-FXD 1000UF+50-10% 35VDC AL	28480	0180-2635
A10C16	0180-3014	4	1	CAPACITOR-FXD 330UF+-20% 50VDC AL	28480	0180-3014
A10C17	0180-0230	0		CAPACITOR-FXD 1UF+-20% 50VDC TA	56289	150D105X0050A2
A10C18	0180-0230	0		CAPACITOR-FXD 1UF+-20% 50VDC TA	56289	150D105X0050A2
A10C19	0180-3008	6	1	CAPACITOR-FXD 470UF+50-10% 35VDC AL	28480	0180-3008
A10CR1	1906-0096	7	2	DIODE-FW BRDG 200V 2A	04713	MDA202
A10CR2	1906-0096	7		DIODE-FW BRDG 200V 2A	04713	MDA202
A10CR3	1902-0644	3	2	DIODE-ZNR 1N5363B 30V 5% PD=5W TC=+.29MV	28480	1902-0644
A10CR4	1902-0644	3		DIODE-ZNR 1N5363B 30V 5% PD=5W TC=+.29MV	28480	1902-0644
A10CR5	1902-1000	7	1	DIODE-ZNR 1N5366B 39V 5% PD=5W IR=500NA	04713	1N5366B
A10CR6	1901-0028	5	4	DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A10CR7	1902-1340	8	2	DIODE-ZNR 1N5355B 18V 5% PD=5W IR=500NA	04713	1N5355B
A10CR8	1901-0028	5		DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A10CR9	1901-0028	5		DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A10CR10	1901-0028	5		DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A10CR11	1902-1340	8		DIODE-ZNR 1N5355B 18V 5% PD=5W IR=500NA	04713	1N5355B
A10CR12	1902-1288	3	1	DIODE-ZNR 1N5358B 22V 5% PD=5W TC=+.75%	04713	1N5358B
A10H1 Δ10	1205-0462	5	4	HEAT SINK SGL TO-220-CS	28480	1205-0462
A10H2 Δ10	1205-0462	5		HEAT SINK SGL TO-220-CS	28480	1205-0462
A10H3 Δ10	1205-0462	5		HEAT SINK SGL TO-220-CS	28480	1205-0462
A10H4 Δ10	1205-0462	5		HEAT SINK SGL TO-220-CS	28480	1205-0462
A10J14	1251-5386	9	1	CONNECTOR 6-PIN M POST TYPE	28480	1251-5386
A10P14	1251-5391	6	1	CONNECTOR 6-PIN F POST TYPE	28480	1251-5391
	1251-6066	4	6	CONTACT-CONN U/W-POST-TYPE FEM CRP	28480	1251-6066
A10P15	1251-6014	2	1	CONNECTOR 8-PIN F POST TYPE	28480	1251-6014
A10R1	0757-0737	5	1	RESISTOR 1.62K 1% .25W F TC=0+-100	24546	C5-1/4-T0-1621-F
A10R2	0757-0403	2	1	RESISTOR 121 1% .125W F TC=0+-100	24546	C4-1/8-T0-121R-F
A10U1	1826-0122	0	1	IC 7805 V RGLTR TO-220	07263	7805UC
A10U2	1826-0396	0	1	IC 7815 V RGLTR TO-220	07263	7815UC
A10U3	1826-0214	1	1	IC V RGLTR TO-220	04713	MC7915CT
A10U4	1826-0527	9	1	IC 337 V RGLTR TO-220	27014	LM337T

ΔA SEE NOTE ON SCHEMATIC 9

See introduction to this section for ordering information
*Indicates factory selected value

NOTE

Pressing the EXP key before entering a number will display 1 + 0.

c. Recall. Any of the Registers can be recalled at any time. By pressing the RECALL button and the key for the Register to be displayed. (Remember, the registers are in white.) The Register's value is then displayed on the front panel.

d. Clear-Continue. The CLEAR-CONTINUE button, when pressed, clears the display and continues with the previous operation. This can be useful when accidently entering an incorrect number from the keyboard. The Clear-Continue feature clears the incorrect number and starts a new measurement cycle. This feature can also be used when a register is recalled and no changes in the register are desired.

3-61. Number of Power Line Cycles Integrated.

3-62. This feature of the -hp- Model 3456A allows you to select the integration time from .01 to 100 power line cycles in multiples of 10. Since a power line cycle of "1" has a time period of 1/60 second, 1/50 for the 50 Hz option, the intergration time is 1/60 or 1/50 second. The Number of Power Line Cycles Integrated determines measurement time. The slowest integration time of the 3456A is 100 Power Line Cycles Integrated and the fastest is .01 line cycles. For good power line frequency noise rejection (Normal Mode Rejection), use integration times of either 1, 10, or 100 power line cycles. Use the Store method in Paragraph 3-60 to select the various integration times (Number of Power Line Cycles). The default value of the Number of Power Line Cycles Integrated is 10 (at Turn-on and Reset).

3-63. Digits Displayed.

3-64. The 3456A can display either a 3, 4, 5, or 6 digit reading. Select any of these digits using the Store method in Paragraph 3-60. The Number of Power Line Cycles Integrated determines the maximum number of digits the 3456A can display. If the 1 to 100 Power Line Cycles Integrated are used, the 3456A can display from 3 to 6 digits. With .01 Integration Time the maximum number of digits then is 4 and with .1 Line Cycles Integrated the maximum is 5. Five is also the number of digits displayed at Turn-On or when the RESET button is pressed.

3-65. Number of Readings per Trigger.

3-66. The Model 3456A is capable of taking from 1 to 9999 Readings per Trigger. Selection of the Number of Readings per Trigger is accomplished by using the Store method in Paragraph 3-60. The selected number of readings are executed each time the instrument is triggered. Although the Internal, External, and Single Trigger modes will take the selected number of readings, it may be advantageous to use the External or Single Trigger modes. Using these modes, if a Single Trigger is sent the 3456A starts taking the readings and stops when all the readings are taken. Another trigger repeats the same operation. An Internal Trigger also does the same thing, but automatically triggers again when all readings are taken. The default value of the Number of Readings per Trigger at Turn-On or at Reset is "1".

3-67. Settling Delay.

3-68. This feature of the -hp- Model 3456A can be used to delay the 3456A's input measurement for a preselected time, before a measurement cycle (A/D operation) is started. The amount of Settling Delay is selected by using the Store method in Paragraph 3-60. In some modes (ACV, OHMS, and Analog Filter), a delay value is selected by the instrument. These selected delays are defined in Table 3-3 and can be changed to another value by using the Store method. Any number value from .001 second to 999.999 seconds (including 0) can be chosen for a delay in any mode. To return a 3456A selected delay to its default value store any negative number into the DELAY register.

Table 3-3. Default Delays.

3456A Set-Up Condition	Delay (in second)
DCV, Filter On	.650
ACV or ACV + DCV, Filter Off	.060
ACV or ACV + DCV, Filter On	.800
Ohms, 100 K Range	.001
Ohms, 1 M Range	.008
Ohms, 10 M Range	.080
Ohms, 100 M Range	.080
Ohms, 1 G Range	.080

3-69. Optimizing the Reading Rate.

3-70. The previous paragraph stated that the Number of Power Line Cycles Integrated has an effect on the Number of Digits displayed. In addition to that, the measurement accuracy and power line frequency noise rejection (NMR) are also affected. You can select a faster reading rate with a low Number of Power Line Cycles Integrated. But keep in mind that the 3456A's measurement error increases and that the ability to reject power line frequency noise rejection is lessened. Table 3-4 gives some ideas on how to optimize the 3456A's reading rate.

3-71. MATH FEATURE.

3-72. A variety of math operations can be done by the Model 3456A. Use the instrument's Numbered Keyboard to select a math operation and to enter values into registers used by the math operations. Refer to the Numbered Keyboard for the following discussion and make sure you know how to store values into registers

Table 6-4. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A4C1	0180-0309	4		CAPACITOR-FXD 4.7UF+-20% 10VDC TA	56289	150D475X0010A2
A4C2	0180-0309	4		CAPACITOR-FXD 4.7UF+-20% 10VDC TA	56289	150D475X0010A2
A4C3	0180-0309	4		CAPACITOR-FXD 4.7UF+-20% 10VDC TA	56289	150D475X0010A2
A4C4	0140-0196	3	2	CAPACITOR-FXD 150PF +-5% 300VDC MICA	72136	DM15F151J300WV1CR
A4C5	0180-0309	4		CAPACITOR-FXD 4.7UF+-20% 10VDC TA	56289	150D475X0010A2
A4C6	0180-0291	3	5	CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A4C7	0180-1743	2	1	CAPACITOR-FXD .1UF+-10% 35VDC TA	56289	150D104X9035A2
A4C8	0180-0309	4		CAPACITOR-FXD 4.7UF+-20% 10VDC TA	56289	150D475X0010A2
A4C9	0180-0309	4		CAPACITOR-FXD 4.7UF+-20% 10VDC TA	56289	150D475X0010A2
A4C10	0180-0309	4		CAPACITOR-FXD 4.7UF+-20% 10VDC TA	56289	150D475X0010A2
A4C11	0180-0309	4		CAPACITOR-FXD 4.7UF+-20% 10VDC TA	56289	150D475X0010A2
A4C12	0180-0309	4		CAPACITOR-FXD 4.7UF+-20% 10VDC TA	56289	150D475X0010A2
A4CR1	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A4CR2	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A4CR3	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A4CR4	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A4CR5	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A4CR6	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A4CR7	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A4E1	0360-1930	1		BUS 2 CONDUCTOR	28480	0360-1930
A4E2	0360-1930	1		BUS 2 CONDUCTOR	28480	0360-1930
A4E3	0360-1930	1		BUS 2 CONDUCTOR	28480	0360-1930
A4E4	0360-1930	1		BUS 2 CONDUCTOR	28480	0360-1930
A4E5	1810-0307	0	1	NETWORK-CNDCT MODULE DIP; 16 PINS; 0.100	28480	1810-0307
A4E6	0360-1930	1		BUS 2 CONDUCTOR	28480	0360-1930
A4E7	0360-1930	1		BUS 2 CONDUCTOR	28480	0360-1930
A4E8	0360-1930	1		BUS 2 CONDUCTOR	28480	0360-1930
A4E9	0360-1930	1		BUS 2 CONDUCTOR	28480	0360-1930
A4E10	0360-1930	1		BUS 2 CONDUCTOR	28480	0360-1930
A4J9	1251-4682	6	9	CONNECTOR 3-PIN M POST TYPE	28480	1251-4682
A4J10	1251-4682	6		CONNECTOR 3-PIN M POST TYPE	28480	1251-4682
A4J11	1251-4682	6		CONNECTOR 3-PIN M POST TYPE	28480	1251-4682
A4J12	1251-4682	6		CONNECTOR 3-PIN M POST TYPE	28480	1251-4682
A4L1	9100-1617	0	1	INDUCTORRF-CH-MLD 3.9UH 10%	28480	9100-1617
A4P5	1251-6061	9		CONNECTOR 15-PIN F POST TYPE	28480	1251-6061
A4P6	1251-6061	9		CONNECTOR 15-PIN F POST TYPE	28480	1251-6061
A4P9	1258-0141	8	8	JUMPER REMOVABLE	28480	1258-0141
A4P10	1258-0141	8		JUMPER REMOVABLE	28480	1258-0141
A4P11	1258-0141	8		JUMPER REMOVABLE	28480	1258-0141
A4P12	1258-0141	8		JUMPER REMOVABLE	28480	1258-0141
A4R1	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A4R2	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A4R3	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A4R4	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A4R5	1810-0232	0	1	NETWORK-RES 8-SIP100.0K OHM X 6	56289	216CM104X9PM
A4R6	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A4R7	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A4R8	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A4R9	0683-3335	8	2	RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A4R10	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A4R11	0683-5635	5	1	RESISTOR 56K 5% .25W FC TC=-400/+800	01121	CB5635
A4R12	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A4R13	0683-4735	4	1	RESISTOR 47K 5% .25W FC TC=-400/+800	01121	CB4735
A4R14	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A4R15	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A4R16	0683-4745	6	5	RESISTOR 470K 5% .25W FC TC=-800/+900	01121	CB4745
A4R17	0683-4745	6		RESISTOR 470K 5% .25W FC TC=-800/+900	01121	CB4745
A4R18	0683-4745	6		RESISTOR 470K 5% .25W FC TC=-800/+900	01121	CB4745
A4R19	0683-4745	6		RESISTOR 470K 5% .25W FC TC=-800/+900	01121	CB4745
A4R20	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A4R21	0683-4745	6		RESISTOR 470K 5% .25W FC TC=-800/+900	01121	CB4745
A4R22	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A4R23	0683-3315	4	4	RESISTOR 330 5% .25W FC TC=-400/+600	01121	CB3315
A4TP2	1251-5394	9	1	CONNECTOR 4-PIN M POST TYPE	28480	1251-5394
A4TP3	1251-4682	6		CONNECTOR 3-PIN M POST TYPE	28480	1251-4682
A4U1				NOT USED		
A4U2				NOT USED		
A4U3	1820-1144	6		IC GATE TTL LS NOR QUAD 2-INP	01295	SN74LS02N
A4U4				NOT USED		
A4U5 Δ9	1818-1629	7		IC MEMORY, ROM	28480	1818-1629
A4U6	1820-1216	3	3	IC DCDR TTL LS 1-TO-8-LINE 3-INP	01295	SN74LS138N
A4U7 Δ9	1818-1630	0		IC MEMORY, ROM	28480	1818-1630
A4U8 Δ9	1818-1631	1		IC MEMORY, ROM	28480	1818-1631
A4U9	1820-1199	1		IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A4U10Δ11	1818-1960	9	2	IC NMOS 8192-BIT RAM STAT 250-NS	28480	1818-1960

See introduction to this section for ordering information
*Indicates factory selected value

Table 3-4. Optimizing Reading Rate.

Your maximum reading rate with the 3456A is influenced by a large number of factors, not the least of which is the signal you are trying to measure. These factors can be divided into two categories; signal related and voltmeter related. Among signal related factors are:

- desired accuracy (or resolution)
- nature of the signal (dcv, acv, or ohms)
- signal environment (line related and broadband noise)

Among voltmeter related factors are:

- method of measurement transfer (Packed Output, Reading Storage, System Output)
- number of convenience features selected (Math operations, Autorange)

For all operations, an equally important consideration is what you're trying to accomplished by measuring fast. Are you

- scanning a large number of points so that faster readings mean a better picture of what is happening at a single point in time?
- trying to read fast so that you do not use up valuable computer time waiting for the measurement operation to complete?
- trying to digitize waveforms?

The 3456A can solve these application problems in many different ways.

AT TURN-ON

For most bench and system applications, the preprogrammed settling times assure accurate readings regardless of the signal and signal environment. However, knowledge about your signal and/or signal environment can let you achieve up to 330 rds/s (at 60 Hz) with noise rejection and 10 microvolt sensitivity.

YOUR SIGNAL ENVIRONMENT

Your signal is subject to line related and broadband noise which can interfere with the measurement. There are two ways of rejecting noise on the 3456A; integration and input filtering.

Integration is a process where the affect of line related noise is averaged to zero over the period of an integer number of Power Line Cycles (PLC) during the A to D conversion. The basic integrator is an Op Amp with a (integrator) capacitor in its feedback loop. The signal is connected to the input of the Op Amp for a period of the line frequency. This configuration theoretically provides infinite noise rejection at integer multiples of the inverse of the integration period and single pole roll-off (20 dB of amplitude attenuation for every decade increase in frequency above the knee frequency) for broadband noise. Refer to the graph for more detail.

The input filter provides excellent noise rejection. The price you pay is an additional 650 ms settling time which allows the filter output to settle to a final value before the input is measured. The fastest possible reading rate measuring widely varying signals with line rejection is provided by 1 PLC integration time. But, if you are looking at a slowly varying signal or scanning similar signals, you can get faster readings by overriding the preprogrammed settling time selecting 0.01 or 0.1 PLC integration time and the filter. The trade-off is less accuracy and resolution as well as more uncertainty about the filtered input.

SPEEDING THE MEASUREMENT CYCLE

The thermal stability of the measurement environment is important. By simply keeping the temperature of the 3456A at a fixed value, you can nearly double the reading rate by turning Auto Zero off. The 3456A is slightly less accurate but the faster reading rate may be worth it. In addition, any range, function, or filter change that takes place is automatically accompanied by an Auto Zero update which removes any accumulated offsets. Of course, if the measurement environment is quiet enough to omit NMR then only the accuracy and resolution of your desired measurement are the factors and you can achieve up to 210 or 330 rds/s with .1 and .01 PLC respectively (60 Hz).

Further, you can speed the measurement cycle by selecting a fixed range instead of using the Autorange function. Even at 1 PLC integration time there is a 10% reduction of the reading rate with Autorange on. Of course, if your signal is changing, Autorange is far faster than letting your software range the 3456A over the HP-IB.

AC Volts requires some special attention. With the filter off, you can measure signals of greater than 400 Hz frequency at a rate of 12 rds/s with the preprogrammed settling time of 60 ms. If you are monitoring a slowly changing ac signal or scanning similar signals, you can minimize the settling time to achieve up to 330 rds/s. Keep in mind that the input could change drastically before your readings would indicate a large change.

For signals of less than 400 Hz the input filter is connected in series with the ac converter to slow the signal response to the A to D converter. Again, you can override the preprogrammed settling time of 800 ms but beware! Large changes in the input signal level may let you read numerous wrong readings while the ac converter and the input filter are settling to a final value.

The 3456A can read resistance measurements as fast as dc volts up to the 10 K ohm range, but you can not use the input filter. Above the 10 K ohm range, additional settling time is required for stable resistance measurements. If all you want is an indication of the actual resistance above 10 K ohm, you can override the preprogrammed settling times. However, just considering the size of the resistance you are trying to measure and any associated stray capacitance in the measuring circuit, you may want to add settling time between reading for best accuracy.

Offset Compensated Ohms is very slow (10 rds/s) by comparison with a standard ohms measurement. But, for a single input reading, it is the fastest way to measure low value resistances accurately in the presence of thermally generated voltage offsets.

Before leaving the topic of Speeding the Measurement Cycle, it is important to ask why you would use 100 or 10 PLC integration times. The answer is increased accuracy and reduced internal noise. If you really need all the accuracy and repeatability you can get, the 100 PLC is the place you want to be.

SPEEDING THE READING TRANSFER

You might make many accuracy compromises to attain an acceptable reading rate and still not be able to read as fast as you could. Why? Because you have not optimally handled the transfer of data over the bus from the 3456A to your computer.

Let's take a closer look at the reasons for fast reading rates:

Table 6-4. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A3CR1	1901-0050	3	18	DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A3CR2	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A3CR3	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A3CR4	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A3E1	0360-1930	1	15	BUS 2 CONDUCTOR	28480	0360-1930
A3E2	0360-1930	1		BUS 2 CONDUCTOR	28480	0360-1930
A3E3	0360-1930	1		BUS 2 CONDUCTOR	28480	0360-1930
A3E4	0360-1930	1		BUS 2 CONDUCTOR	28480	0360-1930
A3E5	0360-1930	1		BUS 2 CONDUCTOR	28480	0360-1930
A3E6	0360-1930	1		BUS 2 CONDUCTOR	28480	0360-1930
A3J7	1251-4349	2	1	CONNECTOR 4-PIN M POST TYPE	28480	1251-4349
A3P5	1251-6061	9	4	CONNECTOR 15-PIN F POST TYPE	28480	1251-6061
A3P6	1251-6061	9		CONNECTOR 15-PIN F POST TYPE	28480	1251-6061
A3P8	1251-3961	2	1	CONNECTOR 6-PIN F POST TYPE	28480	1251-3961
A3R1	0683-1025	9	16	RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A3R2	0683-2225	3	6	RESISTOR 2.2K 5% .25W FC TC=-400/+700	01121	CB2225
A3R3	0698-3615	8	2	RESISTOR 47 5% 2W MO TC=0+-200	27167	FP42-2-T00-47R0-J
A3R4	0683-1035	1	34	RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A3R5	0698-3615	8		RESISTOR 47 5% 2W MO TC=0+-200	27167	FP42-2-T00-47R0-J
A3R6	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A3R7	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A3R8	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A3R9	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A3R10	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A3R11	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A3R12	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A3R13	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A3R14	0698-4485	2		RESISTOR 23.2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2322-F
A3R15	0698-4485	2		RESISTOR 23.2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2322-F
A3R16	0698-3228	9		RESISTOR 49.9K 1% .125W F TC=0+-100	28480	0698-3228
A3R17	0683-2225	3		RESISTOR 2.2K 5% .25W FC TC=-400/+700	01121	CB2225
A3R18	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A3R19	0683-3325	6	4	RESISTOR 3.3K 5% .25W FC TC=-400/+700	01121	CB3325
A3R20	0683-2225	3		RESISTOR 2.2K 5% .25W FC TC=-400/+700	01121	CB2225
A3R21	0683-3325	6		RESISTOR 3.3K 5% .25W FC TC=-400/+700	01121	CB3325
A3R22	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A3R23	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A3R24	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A3R25	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A3T1	9100-2616	1	4	TRANSFORMER-PULSE BIFILAR WOUND; 1A.0 MM	28480	9100-2616
A3T2	9100-2616	1		TRANSFORMER-PULSE BIFILAR WOUND; 1A.0 MM	28480	9100-2616
A3U1	1820-1430	3	2	IC CNTR TTL LS BIN SYNCHRO POS-EDGE-TRIG	01295	SN74LS161AN
A3U2	1820-1199	1	6	IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A3U3	1820-1197	9	7	IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A3U4	1820-1416	5	2	IC SCHMITT-TRIG TTL LS INV HEX 1-INP	01295	SN74LS14N
A3U5	1820-1112	8	10	IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74AN
A3U6	1820-1199	1		IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A3U7	1820-2058	3	4	IC MISC TTL S QUAD	28480	1820-2058
A3U8	1820-2058	3		IC MISC TTL S QUAD	28480	1820-2058
A3U9	1820-2428	1	1	HP-IB MC68A488P	28480	1820-2428
A3U10	1820-1975	1	2	IC SHF-RGTR TTL LS NEG-EDGE-TRIG PRL-IN	01295	SN74LS165N
A3U11	1820-1212	9	2	IC FF TTL LS J-K NEG-EDGE-TRIG	01295	SN74LS112AN
A3U12	1820-2058	3		IC MISC TTL S QUAD	28480	1820-2058
A3U13	1820-1144	6	6	IC GATE TTL LS NOR QUAD 2-INP	01295	SN74LS02N
A3U14	1820-2058	3		IC MISC TTL S QUAD	28480	1820-2058
A3U15	1820-1112	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74AN
A3U16	1820-1759	9	4	IC BFR TTL LS NON-INV OCTL	27014	DM81LS97N
A3U17	1820-1212	9		IC FF TTL LS J-K NEG-EDGE-TRIG	01295	SN74LS112AN
A3U18	1858-0054	4	2	TRANSISTOR ARRAY 14-PIN PLSTC DIP	28480	1858-0054
A3U19	1820-0514	2	2	IC GATE TTL NAND QUAD 2-INP	01295	SN7426N
A3U20	1820-1759	9		IC BFR TTL LS NON-INV OCTL	27014	DM81LS97N
A3U21	1821-0001	4	2	TRANSISTOR ARRAY 14-PIN PLSTC DIP	01928	CA3046
A3U22	1820-1433	6	2	IC SHF-RGTR TTL LS R-S SERIAL-IN PRL-OUT	01295	SN74LS164N
A3X9	1200-0659	2	3	SOCKET-IC 40-CONT DIP-SLDR	28480	1200-0659
A4	03456-66504	9	1	PC ASSEMBLY-MAIN CONTROLLER, DISPLAY DR,	28480	03456-66504

See introduction to this section for ordering information
*Indicates factory selected value

Table 3-4. Optimizing Reading Rate (Cont'd).

- High speed scanning
- Data Throughput
- Waveform Characterization

HIGH SPEED SCANNING

Typical applications of high speed scanning include temperature and strain profiling where a large number of measurements must be taken very quickly to "freeze" the phenomenon at some point in time. For this type measurement, data transfer from the voltmeter to the computer is not really required to go fast. As long as the scanner data does not exceed 350 measurements, the built-in memory can store all the measurements for one scanned sequence and transfer the data at the end of acquisition. In conjunction with Reading Storage, three other 3456A features make high speed scanning particularily easy to do:

- Program Memory
- Voltmeter Complete
- External Trigger

Program Memory can be used to store a series of measurement sequences and operate on the acquired data. For example, in a high speed scanning situation you could acquire the measurements as fast as possible in the Reading Store mode. Flag the computer and then output the data, perhaps already scaled, in ASCII format. It is almost a 10 to 1 savings in time during acquisition and the results are just as easy to use as if you load, acquire, and transfer individual readings. Voltmeter Complete can be used to increment the scanner sequentially without software interaction between the voltmeter, the scanner, and the computer.

To close the loop, the scanner can output a signal to the 3456A's internal trigger. The result is that once the measurements are initiated by your computer there is no additional need for computer interaction until the measurement sequence is complete.

The fastest possible reading rate for any integration time is achieved when:

- Autorange, Auto Zero, Math, Display and Filter are off.
- Measurements are stored in the built-in memory using internal trigger and the packed format mode.

Since the packed mode and Display off are functions only available over the HP-IB, the maximum reading rate is achievable only with remote operation. If your trigger source is fast enough, external triggering is just as fast as internal triggering.

Transferring the measurements in packed format over the bus to a 9825A Calculator using a Fast Read/Write Buffer transfer reduces the maximum reading rate by 10% and you have to unpack the stored data. But, you can store many more measurements using the computer's memory.

DATA THROUGHPUT

The 3456A solves many of the data throughput problems because Reading Store and Program Memory remove the constant control necessity from the computer. The ability to flag the computer from the front panel of the 3456A, store measurement sequences in its memory, and flag the computer when it is done, lets you use both the 3456A and the computer to their best advantage. To avoid overrunning the computer with data from the 3456A, you can select the Systems Output mode which updates the output only after handshake.

WAVEFORM CHARACTERIZATION

The 3456A can digitize sinewaves up to about 100 Hz with fairly good accuracy. All the high speed modes must be used to acquire at least two samples per cycle. The Delay generator gives you about 1% timing accuracy.

Waveform characterization should be performed with a System Voltmeter. These voltmeters use a sample and hold technique which allows the waveform to be "frozen" at a well-defined point in time. An integrating-type voltmeter, like the 3456A, will always average the waveform over its integration period giving less accurate results. System voltmeters also typically have higher speed, greater bandwidth, and much more precise delay generation.

To summarize, let's look at the fastest reading rate set up again. Note that all convenience and accuracy features are eliminated and that the data is stored internally in the packed mode. This may not be right for your use. You may want a final answer which the Math functions could provide without computer interaction.

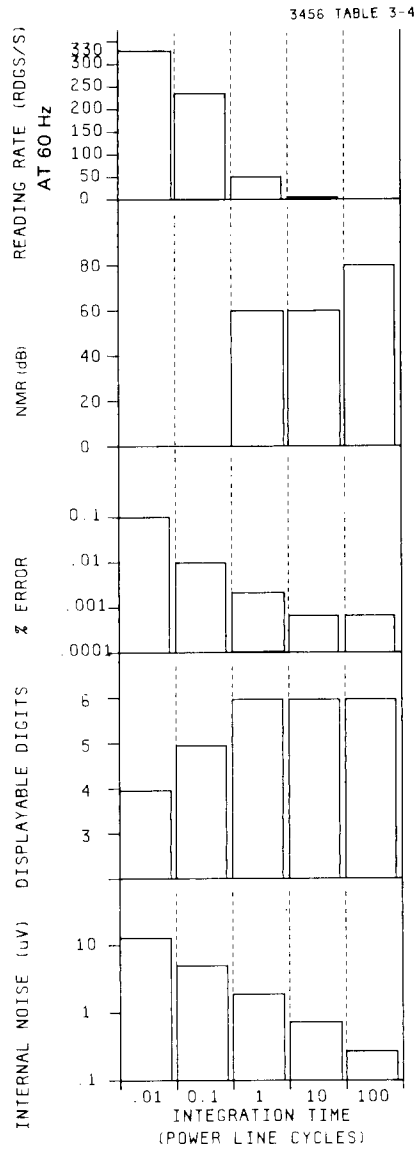


Table 6-4. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A2S21	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A2S22	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A2S23	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A2S24	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A2S25	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A2S26	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A2S27	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A2S28	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A2S29	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A2S30	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A2S31	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A2S32	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A2S33	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A2S34	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A2S35	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A2S36	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A2S37	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A2W2	8120-3042	0	1	CABLE ASSEMBLY-DISPLAY	28480	8120-3042
A2X1	1200-0508	0	9	SOCKET-IC 14-CONT DIP-SLDR	28480	1200-0508
A2X2	1200-0508	0		SOCKET-IC 14-CONT DIP-SLDR	28480	1200-0508
A2X3	1200-0508	0		SOCKET-IC 14-CONT DIP-SLDR	28480	1200-0508
A2X4	1200-0508	0		SOCKET-IC 14-CONT DIP-SLDR	28480	1200-0508
A2X5	1200-0508	0		SOCKET-IC 14-CONT DIP-SLDR	28480	1200-0508
A2X6	1200-0508	0		SOCKET-IC 14-CONT DIP-SLDR	28480	1200-0508
A2X7	1200-0508	0		SOCKET-IC 14-CONT DIP-SLDR	28480	1200-0508
A2X8	1200-0508	0		SOCKET-IC 14-CONT DIP-SLDR	28480	1200-0508
A2X9	1200-0508	0		SOC ETWIC 14-CONT DIP-S ORL	28480	1200-0508
				A2 MISCELLANEOUS PARTS		
	5041-0994	4	2	KEY CAP-UP RANGE	28480	5041-0994
	5041-1736	4	1	KEY CAP-AC+DC	28480	5041-1736
	5041-1792	2	1	KEY CAP-LOCAL	28480	5041-1792
	5041-1846	7	1	KEY CAP-CHS	28480	5041-1846
	5041-1847	8	1	KEY CAP-PERIOD	28480	5041-1847
	5041-1848	9	2	KEY CAP-1	28480	5041-1848
	5041-1849	0	1	KEY CAP-2	28480	5041-1849
	5041-1850	3	1	KEY CAP-3	28480	5041-1850
	5041-1851	4	1	KEY CAP-4	28480	5041-1851
	5041-1852	5	1	KEY CAP-5	28480	5041-1852
	5041-1853	6	2	KEY CAP-6	28480	5041-1853
	5041-1854	7	1	KEY CAP-7	28480	5041-1854
	5041-1855	8	1	KEY CAP-8	28480	5041-1855
	5041-1856	9	1	KEY CAP-9	28480	5041-1856
	5041-1857	0	1	KEY CAP-SRQ	28480	5041-1857
	5041-1858	1	1	KEY CAP-FILTER	28480	5041-1858
	5041-1859	2	1	KEY CAP-DCV	28480	5041-1859
	5041-1860	5	1	KEY CAP-AC VOLTS	28480	5041-1860
	5041-1861	6	1	KEY CAP-2WR OHM	28480	5041-1861
	5041-1862	7	1	KEY CAP-4WR OHM	28480	5041-1862
	5041-1863	8	1	KEY CAP-TEST	28480	5041-1863
	5041-1864	9	1	KEY CAP-INT	28480	5041-1864
	5041-1865	0	1	KEY CAP-MATH	28480	5041-1865
	5041-1866	1	1	KEY CAP-AUTO ZERO	28480	5041-1866
	5041-1867	2	1	KEY CAP-ENTER EXP	28480	5041-1867
	5041-1868	3	1	KEY CAP-CLR, CONT	28480	5041-1868
	5041-1869	4	1	KEY CAP-STORE	28480	5041-1869
	5041-1870	7	1	KEY CAP-RECALL	28480	5041-1870
	5041-1871	8	1	KEY CAP-SHIFT	28480	5041-1871
	5041-1872	9	1	KEY CAP-SINGLE	28480	5041-1872
	5041-1873	0	1	KEY CAP-RESET	28480	5041-1873
	5041-1874	1	1	KEY CAP-EXT	28480	5041-1874
	5041-1875	2	1	KEY CAP-AUTO	28480	5041-1875
	5041-1876	3	1	KEY CAP-HOLD	28480	5041-1876
	5041-1927	5	1	KEY CAP-RDG STOR	28480	5041-1927
A3	03456-66503	8	1	PC ASSEMBLY-OUTGUARD LOGIC, PWR SUPPLY	28480	03456-66503
A3C1	0180-0309	4	20	CAPACITOR-FXD 4.7UF+-20% 10VDC TA	56289	150D475X0010A2
A3C2	0180-0309	4		CAPACITOR-FXD 4.7UF+-20% 10VDC TA	56289	150D475X0010A2
A3C3	0160-2209	5	1	CAPACITOR-FXD 360PF +-5% 300VDC MICA	28480	0160-2209
A3C4	0180-0309	4		CAPACITOR-FXD 4.7UF+-20% 10VDC TA	56289	150D475X0010A2
A3C5	0180-0309	4		CAPACITOR-FXD 4.7UF+-20% 10VDC TA	56289	150D475X0010A2
A3C6	0180-3031	5	1	CAPACITOR-FXD .012F+75-10% 16VDC AL	28480	0180-3031
A3C7	0160-4571	8	10	CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0160-4571
A3C8	0160-4571	8		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0160-4571
A3C9	0160-2055	9	1	CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055

See introduction to this section for ordering information
*Indicates factory selected value

(read Paragraph 3-56). Figure 3-8, the Numbered Keyboard figure may also be helpful for the following discussion of the math operation. They are:

%Error
Scale
Pass/Fail (Limit Test)
dB
dBm
Null
Thermistor
  in Degrees C
  in Degrees F
Statistics
  Mean
  Variance
  Count
  Limits

3-73. Math operations can only be done on instrument acquired measurement data.

3-74. A Math operation is selected by first pressing the front panel's blue MATH button and then pressing the desired math key. The blue label below the front panel's numbered keys shows the various math operations. An LED, located to the center and below the display also lights when a math operation is selected. The registers used in the math operations are identified by the white labels above the numbered keys. The range of numbers you can store into the registers or use in math is from $\pm$ 0.000000 x 10^{-9} to 1999999 x 10^{9}. The 3456A does, however, do internal calculations using 9 digit floating point numbers. If any of the math calculations are out of range, an "LL" is displayed. The following describes the 3456A's math operations.

3-75. %Error.

3-76. The %Error math feature of the 3456A can best be described by the formula:

$$\text{Results in percent} = \frac{X - Y}{Y} \times 100$$

where "X" is the present measurement value and "Y" is the value in register Y. This formula gives the percent difference between the reading taken by the 3456A and the value in register Y. The default (Turn-On or Reset)) value in register Y is 1. The %Error feature is selected by the "8" [100 (X - Y/Y)] key. Refer to Table 1-1 for the %Error accuracy specifications.

3-77. You can use the %Error function to determine the percent difference between an ideal voltage and a measured voltage. For example, you may wish to know the %Error of a 10 V dc measurement. The first thing to do is to store 10 into register Y. Then set the 3456A to the %Error math function and take a 10 V measurement. If the reading is exactly 10 V a "0" is displayed. If the reading is, for example, 10.1 V, the result becomes:

$$\text{Result} = \frac{X - Y}{Y} \times 100 = \frac{10.1 - 10}{10} \times 100 = .01 \times 100 = 1$$

showing that the measured value is 1% higher than the ideal value. The number displayed on the front panel would be "1".

3-78. Scale.

3-79. The Scale feature of the -hp- Model 3456A lets you modify a measurement value by a selected value. The modification can be done either by addition, subtraction, multiplication, or division, depending on how the Scale function is used. The Scale mode is represented by the formula:

$$\text{Results} = \frac{X - Z}{Y}$$

where "X" is the present measurement value, "Y" is the value in register Y and "Z" is the value in register Z. The default (Turn-On/Reset) values in register Y and Z are 1 and 0, respectively. The Scale math feature is selected by the "7" [(X - Z)/Y] key. Refer to Table 1-1 for Scale accuracy specifications.

3-80. To do an addition or a subtraction, first enter a "1" into register Y. If you wish to perform an addition, enter a negative number into register Z. If a subtraction is desired, enter a positive number into register Z. The Scale formula then becomes:

$$\text{Results} = \frac{X - (\pm Z)}{1} = X - (\pm Z)$$

To perform a division, enter a "0" into register Z and the divisor value into register Y. The Scale formula then becomes:

$$\text{Results} = \frac{X - 0}{Y} = \frac{X}{Y}$$

Multiplication is performed by dividing the measured value by the inverse of the multiplier value (a fraction). Here again, a "0" is to be entered into register Z with the inverse value going into register Y.

3-81. Pass/Fail (Limit Test).

3-82. The Pass/Fail math operation can be used to make a voltage or ohms measurement and to then determine if the reading falls within certain limits. The limits are selectable from the 3456A's front panel and should be stored into the instrument's UPPER and LOWER registers. Once the limits are stored and the Pass/Fail math operation is selected, the 3456A can then be set for a regular volts or ohms measurement. If the measured

Table 6-4. Replaceable Parts.

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1	03456-66501	6	1	PC ASSEMBLY-HP-IB	28480	03456-66501
A1J1	1251-5971	8	1	CONNECTOR 3-PIN M METRIC POST TYPE	28480	1251-5971
A1J2	1251-3841	7	1	CONNECTOR 24-PIN F AMP CHAMP	28480	1251-3841
A1P1	1251-4933	0	1	CONNECTOR HOUSING-0-PIN LOCKING	28480	1251-4933
	1251-6066	4	3	CONNECTOR CRIMP	28480	1251-6066
A1S1	3101-1973	7	1	SWITCH-SL 7-1A DIP-SLIDE-ASSY .1A 50VDC	28480	3101-1973
A1W1	8120-3041	9	1	CABLE ASSEMBLY-HP-IB	28480	8120-3041
	0380-1214	6	2	STANDOFF-HEX 6.8-MM-LG 7-MM-A/F STL	28480	0380-1214
A2	03456-66502	7	1	PC ASSEMBLY-DISPLAY AND KEYBOARD	28480	03456-66502
A2CR1	1990-0665	3	33	LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0665
A2CR2	1990-0665	3		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0665
A2CR3	1990-0665	3		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0665
A2CR4	1990-0665	3		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0665
A2CR5	1990-0665	3		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0665
A2CR6	1990-0665	3		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0665
A2CR7	1990-0665	3		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0665
A2CR8	1990-0665	3		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0665
A2CR9	1990-0665	3		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0665
A2CR10	1990-0665	3		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0665
A2CR11	1990-0665	3		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0665
A2CR12	1990-0665	3		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0665
A2CR13	1990-0665	3		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0665
A2CR14	1990-0665	3		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0665
A2CR15	1990-0665	3		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0665
A2CR16	1990-0665	3		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0665
A2CR17	1990-0665	3		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0665
A2CR18	1990-0665	3		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0665
A2CR19	1990-0665	3		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0665
A2CR20	1990-0665	3		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0665
A2CR21	1990-0665	3		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0665
A2CR22	1990-0665	3		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0665
A2CR23	1990-0665	3		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0665
A2CR24	1990-0665	3		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0665
A2CR25	1990-0665	3		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0665
A2CR26	1990-0665	3		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0665
A2CR27	1990-0665	3		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0665
A2CR28	1990-0665	3		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0665
A2CR29	1990-0665	3		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0665
A2CR30	1990-0665	3		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0665
A2CR31	1990-0665	3		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0665
A2CR32	1990-0665	3		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0665
A2CR33	1990-0665	3		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0665
A2DS1	1990-0649	3	2	DISPLAY-NUM-SEG	28480	5082-7616
A2DS2	1990-0730	3	7	DISPLAY-NUM-SEG 1-CHAR .3-H RED	28480	5082-7611
A2DS3	1990-0730	3		DISPLAY-NUM-SEG 1-CHAR .3-H RED	28480	5082-7611
A2DS4	1990-0730	3		DISPLAY-NUM-SEG 1-CHAR .3-H RED	28480	5082-7611
A2DS5	1990-0730	3		DISPLAY-NUM-SEG 1-CHAR .3-H RED	28480	5082-7611
A2DS6	1990-0730	3		DISPLAY-NUM-SEG 1-CHAR .3-H RED	28480	5082-7611
A2DS7	1990-0730	3		DISPLAY-NUM-SEG 1-CHAR .3-H RED	28480	5082-7611
A2DS8	1990-0649	3		DISPLAY-NUM-SEG	28480	5082-7616
A2DS9	1990-0730	3		DISPLAY-NUM-SEG 1-CHAR .3-H RED	28480	5082-7611
A2S1	5060-9436	7	37	PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A2S2	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A2S3	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A2S4	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A2S5	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A2S6	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A2S7	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A2S8	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A2S9	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A2S10	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A2S11	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A2S12	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A2S13	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A2S14	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A2S15	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A2S16	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A2S17	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A2S18	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A2S19	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A2S20	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436

See introduction to this section for ordering information
*Indicates factory selected value

reading is within the selected limits, the reading will be displayed. If the reading is above the upper limit, "HI" will be displayed. If the reading is below the lower limit, "LO" will be displayed. The default (Turn-On/Reset) values of the UPPER and LOWER registers are + 1999999+9 and −1999999+9, respectively. The Pass/Fail feature is selected by the "1" (PASS/FAIL) key. Refer to Table 1-1 for the Pass/Fail accuracy specificaitons.

3-83. A way to use the Pass/Fail feature, is to make sure that a certain number of 1 K ohm resistors are within a 1% tolerance. To do this, you first should store the upper and lower accuracy limits into the 3456A's respective registers. In this case "1010" is stored into the UPPER register and a "990" is stored into the LOWER register. The next step is to select the ohms function and the 1 K ohms range. After you have done this, select the Pass/Fail math feature and start to measure the resistors one at a time. If the resistor value is within the 1% tolerance, in other words between 1.01 K ohms and .99 K ohms, the actual value of the resistor will be displayed on the front panel. "HI" will be displayed for any readings above 1.01 K ohms and "LO" will be displayed for any readings below .99 K ohms.

3-84. dB.

3-85. This feature of the 3456A is a Ratio Measurement of two voltages which is calculated and displayed in Decibels (dB). The dB formula is:

$$dB = 20 \text{ Log} \left| \frac{X}{Y} \right|$$

where "X" is the present measurement value and "Y" is the value in register Y. The default (Turn-On/Reset) value in register Y is 1. The dB feature is selected by the "9" (20 LOG X/Y) key. Refer to Table 1-1 for the dB accuracy specifications.

3-86. You can use the dB feature to measure the voltage gain of an amplifier. First measure the input voltage to the amplifier and store it into register Y. (You can store the reading directly into Y without re-entering the reading from the keyboard.) For this example a voltage reading of .1 V is assumed. The next step is to measure the amplifier's output voltage and set the 3456A to the dB math operation. The gain of the amplifier is then displayed in decibels. Assuming that the amplifier's output voltage is 10 V, the dB equation becomes:

$$dB = 20 \text{ Log } \frac{X}{Y} = 20 \text{ Log } \frac{10}{.1} = 20 \text{ Log } 100 = 40$$

giving you a gain of 40 decibles.

3-87. dBm.

3-88. The dBm feature of the 3456A is used to calculate a power ratio using a resistance as the reference. The dBm equation is:

$$dBm = 10 \text{ Log} \left| \frac{X^2/R}{1 \text{ mW}} \right|$$

where "X" is the present measured value, "1 mW" is the power reference, and "R" is the resistance reference value to be entered by you. The default (Turn-On/Reset) value in register R is 600 ohms. The dBm math feature is selected by the "4" [dBm (R)] key. Refer to Table 1-1 for the dBm accuracy specifications.

3-89. The dBm feature can be used to measure the input power of a speaker. In this example we assume an 8 ohm speaker load and an input voltage of 10 volts. The formula now becomes:

$$dBm = 10 \text{ Log} \left| \frac{100/8}{.001} \right| = 40.97$$

giving you a value of 40.97 dBm.

3-90. Null.

3-91. The Null feature of the 3456A is described by the formula:

$$\text{Displayed Results} = X - X_1$$

where "X_1" is the first measurement taken after the Null feature has been selected and where "X" is the reading(s) after the first reading. When the "X_1" reading is first taken it is stored into register Z. That reading is then subtracted from the following reading(s) with the net present result displayed on the front panel. Since the first reading is stored in register Z, you can recall its value by recalling the register. The Null math feature is selected by the "3" (NULL) key.

3-92. The Null feature can be used to make more accurate 2-Wire Ohms measurements. To do this, short the input leads together at the measuring point and place the 3456A into the Null and 2-Wire Ohms mode. The first reading taken, which is the lead resistance, is stored into register Z. Remove the short from the input leads and take the unknown resistance measurement. The displayed reading is the total resistance measurement minus the lead resistance, giving you an accurate 2-Wire Ohms Measurement. The Null formula becomes.

$$\text{Unknown Resistance} = X - X_1 = X - R$$

where "X" is the total unknown resistance (including "R") and where "R" is the lead resistance.

3-93. Thermistor.

3-94. The 3456A makes temperature measurements using an externally connected thermistor, when selecting this mode. To correctly do this operation, set the 3456A

Table 6-2. Code List of Manufacturers.

Manufacturer Number	Manufacturer Name	Address
H9027	Schurter AGH	Luzern, Switzerland
00000	Any Satisfactory Supplier	
01121	Allen-Bradley Co.	Milwaukee, WI 53204
01295	Texas Instr Inc. Semicond Cmpnt Div.	Dallas, TX 75222
01928	RCA Corp Solid State Div.	Somerville, NJ 08876
02111	Spectrol Electronics Corp.	City of Ind, CA 91745
03888	KDI Pyrofilm Corp.	Whippany, NJ 07981
04713	Motorola Semiconductor Products	Phoenix, AZ 85062
07263	Fairchild Semiconductor Div.	Mountain View, CA 94042
07716	TRW Inc. Burlington Div.	Burlington, IA 52601
17856	Siliconix Inc.	Santa Clara, CA 95054
18324	Signetics Corp.	Sunnyvale, CA 94086
19701	Mepco/Electra Corp.	Mineral Wells, TX 76067
20940	Micro-Ohm Corp.	El Monte, CA 91731
22229	Solitron Devices Inc. (FETS ICS)	San Diego, CA 92123
24546	Corning Glass Works (Bradford)	Bradford, PA 16701
27014	National Semiconductor Corp.	Santa Clara, CA 95051
27167	Corning Glass Works (Wilmington)	Wilmington, NC 28401
28480	Hewlett-Packard Co Corporate HQ	Palo Alto, CA 94304
32293	Intersil Inc.	Cupertino, CA 95014
34371	Harris Semicon Div. Harris-Intertype	Melbourne, FL 32901
34649	Intel Corp.	Mountain View, CA 95051
56289	Sprague Electric Co.	North Adams, MA 01247
72136	Electro Motive Corp. Sub IEC	Williamantic, CT 06226
72982	Erie Technological Products Inc.	Erie, PA 16512

Table 6-3. Exchange Assemblies.

Assembly	Description	Part Number for New Assembly	Part Number for Exchange Assembly
A3	Outguard Interface Logic	03456-66503	03456-69503
A4	Main Outguard Logic	03456-66504	03456-69504
A20	Inguard DC-Ohms-A/D Converter Note: Includes A21 and A25	03456-66590	03456-69590
A30	Inguard Logic	03456-66530	03456-69530
A40	AC Converter	03456-66540	03456-69540

6-12. EXCHANGE ASSEMBLIES.

6-13. Exchange assemblies are factory repaired and tested assemblies and are available only on a trade-in basis; therefore, the defective assembly must be returned for credit. For this reason, assemblies required for spare parts stock must be ordered by the new assembly part number listed in Table 6-4.

6-14. Most of the plug-in assemblies that contain active components are available under the exchange program. This allows service to be performed by assembly replacement. Refer to Table 6-3 for the assemblies that may be replaced on an exchange basis.

6-15. SERVICE KITS.

6-16. Three service kits are available to aid in the repair of the 3456A.

1. **Service Kit—Component Level Repair.** This kit includes service aids and selected spare components necessary for efficient component level repair. The part number of this service kit is 03456-69800.

2. **Service Kit—Assembly Level Repair.** This kit includes a set of all PC assemblies that contain active components. This kit is designed to allow assembly level repair when used in conjunction with the exchange assembly program described in Paragraph 6-12. The part number of this service kit is 03456-69801.

3. **Replacement Component Inventory.** This kit contains a selected set of spare components that are most prone to failure. The kit does not include any service aids or carrying case. This kit may be purchased to obtain a larger inventory of spare components than is supplied with the component level repair service kit or to replenish depleted inventories without the need to order the components individually or purchase extra servicing aids. The part number of this kit is 03456-69802.

to the ohms function. It is advisable to first select an ohms range which corresponds closely to the resistance value of the thermistor for the temperature to be measured. When the Thermistor operation is selected, the ohms reading (thermistor resistance) is then calculated by the instrument and can be displayed either in degrees C or degrees F dependent on which math feature is selected. The Thermistor math operation with the results displayed in degrees C is selected by the "6" (°C) key. The "5" (°F) key is used for degrees F. Refer to Table 1-1 for the Thermistor accuracy specifications. The recommended Thermistor can be ordered by -hp Part Number 0837-0164. A package of 4 thermistors is also available under Accessory Number 44414A. The thermistor's corresponding resistor value at high and low temperature limits and at nominal room temperature is:

Temperature	Resistance
150°C	92.7 Ohms
25°C	5000 Ohms
-80°C	3684 K Ohms

3-95. Keep a couple of things in mind when using the Thermistor mode. Choosing an optimum ohms range for the termperature measurement has been mentioned in the preceding paragraph. This is important for a stable reading. You can use other ranges or autorange, but the reading may be unstable. To demonstrate this, choose a high ohms range for the thermistor. An ohms reading is still taken and the temperature is still calculated; but since a higher range is more sensitive for low ohms values, the reading is not as stable. Autorange may have the same effects, since there may be a difference from range to range. Another thing to keep in mind is lead resistance. If 2-Wire Ohms is used, any lead resistance is added to the thermistor resistance causing an inaccurate temperature reading.

3-96. Statistics.

3-97. The Statistics math feature of the -hp- Model 3456A is used to make a Mean and Variance calculation of reading(s) taken in any function. These calculations are made when the instrument is set to the Statistics (STAT) mode and after a measurement cycle is completed. The Mean value is then stored into the MEAN register with the number of readings taken stored into the COUNT register. The Variance value is stored into the VARIANCE register with highest reading taken stored into the UPPER register and the lowest reading into the LOWER register. In addition, the first reading taken is also stored into register Z. Except for the Variance calculation, all other statistics calculations are done after the first measurement cycle is completed. The Variance calculation needs at least two readings to calculate its value. The default values of the MEAN, VARIANCE, COUNT, UPPER, LOWER, and Z registers are 199999 +9, −00.000 −3 (0), 0, 1999999 +9, −1999999 +9, and 0 respecitvely. The Statistic mode is selected by the "2" (STAT) key. To reset the registers to their default values without pressing the 3456A's RESET button or cycling power, select the statistics function again by pressing the MATH button and STAT key. Refer to Table 1-1 for the Statistics Accuracy Specifications.

NOTE

Since the math calculations are made to 9 digits, certain accuracy limitations as shown in Table 1-1 should be kept in mind.

3-98. Mean. The Mean (Average) value is calculated by the formula:

$$\text{Mean (M)} = X_1 + \frac{1}{C}\sum_{i=1}^{C}(X_i - X_1) = \overline{X}$$

Where "X_i is the "ith" reading taken after enabling statistics, "X_1" is the first reading taken after enabling Statistics, and"C" is the total number of readings taken with the present reading (X) displayed on the front panel. The present Mean value is in the MEAN register and it, along with the other registers used in the Statistics mode, can be recalled at any time by recalling the appropriate register.

3-99. Variance. The Variance value is calculated by the formula:

$$\text{Variance (V)} = \frac{\sum_{i=1}^{C}(X_i - X)^2 - \frac{1}{C}\left[\sum_{i=1}^{C}(X_i - X_1)\right]^2}{C - 1}$$

Where "X_i" is the "ith" reading taken after enabling statistics, "X_1" is the first reading taken after enabling Statistics and "C" is the total number of readings taken with the present reading (X) displayed on the front panel. The present Variance value is in the VARIANCE register and it, along with the value(s) in the other register(s), can be recalled at any time by recalling the appropriate register.

3-100. Statistics Example. One way to use the Statistics feature is to calculate the average value of a number of resistors. Start by setting the 3456A to the ohms function and Single Trigger mode. Then select the Statistics Math mode. Next connect the first resistor to the input terminals and trigger the instrument (push the SINGLE trigger button). Do the same for the other resistors after the measurement cycle is completed. When all of the resistors are measured, you can determine the average value of the resistors by recalling the MEAN register. The Variance of the register values can be recalled by the VARIANCE register. To doublecheck the number of resistors you have measured, recall the COUNT

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering replacement parts. Table 6-4 lists parts in alphameric order of their reference designators and indicates the description, -hp- Part Number of each part, together with any applicable notes, and provides the following:

a. Total quantity used in the instrument (Qty column). The total quantity of a part is given the first time the part number appears.

b. Description of the part. (See abbreviations listed in Table 6-1.)

c. Typical manufacturer of the part in a five-digit code. (See Table 6-2 for list of manufacturers.)

d. Manufacturers part number.

6-3. Miscellaneous parts are listed at the end of Table 6-4.

6-4. ORDERING INFORMATION.

6-5. To obtain replacement parts, address order or inquiry to your local Hewlett-Packard Field Office. (Field Office Locations are listed at the back of the Manual.) Identify parts by their Hewlett-Packard Part Numbers. Include instrument model and serial numbers.

6-6. NON-LISTED PARTS.

6-7. To obtain a part that is not listed, include:

a. Instrument Model Number

b. Instrument Serial Number

c. Description of the part

d. Function and location of the part

6-8. PARTS CHANGES.

6-9. Components which have been changed are so marked by one of three symbols; i.e., Δ, Δ with a letter subscript, e.g., Δ_a, or Δ with a number subscript, e.g., Δ_{10}. A Δ with no subscript indicates the component listed is the preferred replacement for an earlier component. A Δ with a letter subscript indicates a change which is explained in a note at the bottom of the page. A Δ with a number subscript indicates the related change is discussed in backdating (Section VII). The number of the subscript indicates the number of the change in backdating which should be referred to.

6-10. PROPRIETARY PARTS.

6-11. Items marked by a dagger (†) in the reference designator column are available only for repair and service of Hewlett-Packard Instruments.

Table 6-1. Standard Abbreviations.

ABBREVIATIONS

Ag	silver	Hz	hertz (cycle(s) per second)	NPO	negative positive zero (zero temperature coefficient)	sl	slide
Al	aluminum					SPDT	single pole double-throw
A	ampere(s)	ID	inside diameter	ns	nanosecond(s) = 10^{-9} seconds	SPST	single-pole single-throw
Au	gold	impg	impregnated	nsr	not separately replaceable		
		incd	incandescent			Ta	tantalum
C	capacitor	ins	insulation(ed)	Ω	ohm(s)	TC	temperature coefficient
cer	ceramic			obd	order by description	TiO_2	titanium dioxide
coef	coefficient	kΩ	kilohm(s) = 10^{+3} ohms	OD	outside diameter	tog	toggle
com	common	kHz	kilohertz = 10^{+3} hertz			tol	tolerance
comp	composition			p	peak	trim	trimmer
conn	connection	L	inductor	pA	picoampere(s)	TSTR	transistor
		lin	linear taper	pc	printed circuit		
dep	deposited	log	logarithmic taper	pF	picofarad(s) 10^{-12} farads	V	volt(s)
DPDT	double-pole double-throw			piv	peak inverse voltage	vacw	alternating current working voltage
DPST	double-pole single-throw	mA	milliampere(s) = 10^{-3} amperes	p/o	part of	var	variable
		MHZ	megahertz = 10^{+6} hertz	pos	position(s)	vdcw	direct current working voltage
elect	electrolytic	MΩ	megohm(s) = 10^{+6} ohms	poly	polystyrene		
encap	encapsulated	met flm	metal film	pot	potentiometer	W	watt(s)
		mfr	manufacturer	p-p	peak-to-peak	w/	with
F	farad(s)	ms	millisecond	ppm	parts per million	wiv	working inverse voltage
FET	field effect transistor	mtg	mounting	prec	precision (temperature coefficient, long term stability and/or tolerance)	w/o	without
fxd	fixed	mV	millivolt(s) = 10^{-3} volts			ww	wirewound
		μF	microfarad(s)				
GaAs	gallium arsenide	μs	microsecond(s)	R	resistor		
GHz	gigahertz = 10^{+9} hertz	μV	microvolt(s) = 10^{-6} volts	Rh	rhodium		
gd	guarded)	my	Mylar ®	rms	root mean square	*	optimum value selected at factory, average value shown (part may be omitted)
Ge	germanium			rot	rotary	**	no standard type number assigned
gnd	ground(ed)	nA	nanoampere(s) = 10^{-9} amperes				selected or special type
		NC	normally closed	Se	selenium		
H	henry(ies)	Ne	neon	sect	section(s)		® Dupont de Nemours
Hg	mercury	NO	normally open	Si	silicon		

DESIGNATORS

A	assembly	FL	filter	Q	transistor	TS	terminal strip
B	motor	HR	heater	QCR	transistor-diode	U	microcircuit
BT	battery	IC	integrated circuit	R(pl)	resistor(pack)	V	vacuum tube, neon bulb, photocell, etc
C	capacitor	J	jack	RT	thermistor	W	cable
CR	diode or thyristor	K	relay	S	switch	X	socket
DL	delay line	L	inductor	T	transformer	XDS	lampholder
DS	lamp	M	meter	TB	terminal board	XF	fuseholder
E	misc electronic part	MP	mechanical part	TC	thermocouple	Y	crystal
F	fuse	P	plug	TP	test point	Z	network

register. For the lowest value, recall the LOWER register and the UPPER register for the highest value.

3-101. READING STORAGE.

3-102. The Reading Storage feature of the 3456A allows you to store into the instrument's internal memory a certain number of readings. The memory size is 1400 bytes and since each reading takes 4 bytes of memory up to 350 readings can be stored, depending on available memory space. This is because the Program Memory Operation of the 3456A (see Paragraph 3-200) also uses the internal memory and, if used, reduces memory space allowing fewer readings to be stored. The number of storable readings can be determined by this formula:

Memory Size - Memory Used = Memory Available (rounded off to the lowest value)

For example, if you use 85 bytes of memory for the Program Memory operation the total number of readings you can store is:

$$\frac{1400 - 85}{4} = 328.75$$

allowing you enough space for 328 readings.

3-103. The Reading Storage feature is enabled by pressing the front panel's RDGS STORE button. The LED next to the button then lights and the instrument starts storing a reading when triggered. The LED turns off when the feature is disabled or when the 3456A's internal memory is full. To turn the Reading Storage feature off, press the RDGS STORE button a second time. The readings in the memory are cleared when the Reading Storage is first turned on and the 3456A is triggered, by the Self Test mode, and at Turn-On.

3-104. Readings are stored into memory with the most recent reading as reading #1 and the preceding readings as #2, #3, and so on. For example if you take 350 readings, the reading taken after enabling the feature is #350 and the last reading taken is #1. The reading order is important to keep in mind when recalling the reading(s). Any or all of the readings can be recalled either one at a time or they can be scrolled. These two methods operate as follows.

a. Recalling Single Readings. To recall a single reading from memory

1. Set the 3456A to Trigger Hold and then turn Reading Storage on. The Trigger is set to Hold because a trigger restarts the Reading Storage, when enabled, and the previously stored readings are cleared.

2. Next store the number corresponding to the reading you wish to recall into register R (use store method in Paragraph 3-60).

3. Then recall the R register (by pressing the RECALL button and key "4").

The reading is then displayed on the front panel. When you press the RECALL button again without pressing the "4" key, the following reading is then displayed. Press the button again and the next reading is displayed, and so on. Try the following example in which reading #3 through #1 are recalled.

1. Press the HOLD trigger button and then press the RDGS STORE button.

2. Store "3" into register R by pressing the STORE button and then key 4.

3. Recall the register by pressing the RECALL button and key 4. Reading #3 is now displayed on the front panel.

4. Press the RECALL button again and reading #2 is displayed.

5. Reading #1 is next displayed when the RECALL button is again pressed.

b. Scroll Readings. This procedure is very similar in recalling a single reading. The only difference is that the reading number is entered into register R as a negative number. When that register is then recalled the reading which corresponds to the stored number is then displayed. The display time is determined by the DELAY register value. The next reading is then displayed and then the next reading and so on. Since the time between readings is very short and makes it impossible to see the readings, store a delay into the DELAY register. A 1 second delay, for example, will display each reading for 1 second. The last reading to be displayed is reading #1 and remains until the 3456A's operation is changed.

3-105. The 3456A can also perform other operations while recalling readings. When recalling a single reading, the reading number is displayed before displaying the actual reading. But since the display time is determined by the value in the DELAY register, the reading number may not be seen. Here again, a delay has to be stored into the DELAY register. The reading number is then displayed for a time determined by the delay. Another operation you can do is to select a math operation while the recalled readings are scolled. For instance, select the Statistics math operation to find the Mean, Variance, Upper, Lower, and Count values of the stored readings. An example on how to use this feature with 350 stored readings is as follows.

a. Press the HOLD trigger button and then the RDGS STORE button.

b. Enter "-350" into the R register to scroll the readings starting with reading #350.

2. Adjust calibration pot "M" for a minimum reading.

3. Continue adjusting calibration pot "M" in the same direction until the reading noted in Step 1 is reached (within ± 2 counts).

j. Repeat Steps h and i until both readings converge with each other (within ± 2 counts). Remove the short.

k. Set the 3456A to the ACV + DCV function and Autorange.

l. Set the DC Standard for a .01 V dc output and connect it to the 3456A's input terminals. Check the reading.

m. Remove the DC Standard. Set the AC Calibrator for a .01 V, 1 kHz output and connect it to the 3456A's input terminals.

n. Set the 3456A to the ACV function and check the reading.

o. Set the AC Calibrator to .1 V. Check the 3456A's reading.

p. Do the same for an AC Calibrator output of .5 V, 1 V, 10 V, 100 V, and 700 V.

q. Set the AC Calibrator for a .01 V, 100 kHz output. Check the reading.

r. Do the same for an AC Calibrator output of 1 V, 10 V, 100 V, and 1000 V.

s. Set the AC Calibrator for a 1 V, 250 kHz output. Check the reading.

t. Do the same for an AC Calibrator output of 10 V, 250 kHz.

u. Set the AC Calibrator for a 1 V, 20 Hz output and turn the 3456A's Filter "ON". Check the reading.

v. Set the 3456A to the ACV + DCV function. Check the reading.

w. Turn the 3456A's Filter "OFF" and disconnect the AC Calibrator from the input terminals.

x. Connect the DC Standard to the 3456A with its High output to the 3456A's RATIO REF HIGH and VOLTS HIGH terminals. Connects the Standard's Low output to the 3456A's RATIO REF LOW and VOLTS LOW terminals. Refer to Figure 5-5 for the connection.

y. Set the 3456A to ACV + DCV/DCV Ratio function. Check the reading.

z. Disconnect the test equipment from the 3456A. This completes the Combined Performance Test and Adjustments.

c. Select the Statistics math operation by pressing the MATH button and then the "2" (STAT) key.

d. Recall the R register by pressing the RECALL button and then the "4" (R register) key. The scrolled readings should now be displayed.

e. When the scrolling is completed (no updating of the display), the reading's Mean, Variance, and Count values can now be determined by recalling register MEAN, VARIANCE, and COUNT respectively.

3-106. VOLTMETER COMPLETE.

3-107. The voltmeter complete connector is a BNC connector which outputs a sync signal during the measurement cycle . The signal itself is composed of an approximately 330 nanosecond wide negative going TTL level pulse. One way to use the sync signal is to advance a scanner, like the -hp- Model 3497A. To do this, connect the 3456A's voltmeter complete output to the scanner's channel advance input. Once the connection is made, the scanner advances to the next channel during the 3456A's measurement cycle. The voltmeter complete output is designed to drive at least one TTL input.

3-108. GUARDING.

3-109. General.

3-110. The Guarding Terminals on the -hp- Model 3456A can be used to reduce or cancel error causing common-mode voltages. Figure 3-9 gives three methods of making guard connections. A Guard Terminal on the 3456A is used to make the connections. Both the front panel and the rear panel have a Guard Terminal. For most measurements the terminal should be connected to the common (Low) input terminal. This is done internally in the instrument when the Guard Switch is in the IN position. Each of the Guard Terminals use a separate switch for a connection to each of the common terminals, with the switches located above their respective Guard Terminals.

3-111. Guarding Information.

3-112. Detailed information on guarding methods and the purpose of guarding can be found in -hp- Application Note Number 123, "Floating Measurements and Guarding". This application note is available through your nearest -hp- Sales and Service Office.

3-113. FRONT/REAR SWITCH LOCKOUT.

3-114. The Model 3456A is provided with an interlock for the Front/Rear Switch. This has been provided for you to lock the switch either for the front or rear terminals, preventing any quick changes from front to rear. The switch is locked in the front position when the arrow marked on the lock is pointing toward the FRONT lettering. In the rear position the arrow is point to the REAR lettering. A procedure to install and remove the lock is given in Appendix B.

3-115. REMOTE OPERATION.

3-116. General.

3-117. The following gives instrument dependent information necessary to remotely operate the -hp- Model 3456A over the Hewlett-Packard Interface Bus (HP-IB). Directions for mechanical interface connections to the HP-IB are given in Section II (see Paragraph 2-18) of this Manual. You should be familiar with the front panel (local) operation of the instrument before attempting to use the 3456A in the remote (HP-IB) operating mode. The front panel operational information is located in the Operating Characteristics paragraphs (starting with Paragraph 3-10) in this section of the Manual.

NOTE

HP-IB is Hewlett-Packard's implementation of IEEE Std. 488-l975, "Standard Digital Interface for Programmable Instrumentation".

3-118. HP-IB Description (in Appendix A).

3-119. A general description of the HP-IB is in this Manual's Appendix A. Refer to it for any non 3456A related HP-IB information. Included in the appendix is a worksheet you can use to tabulate the 3456A's HP-IB capabilities and of other Bus compatible devices. It is assumed, in the following paragraphs, that you are knowledgeable about the HP-IB.

3-120. 3456A Response to Bus Messages.

3-121. The following paragraphs deal with the implementation of the HP-IB using the 3456A. The instrument's Bus capabilities are listed in Table 3-5. The following also explains the 3456A's response to Bus Messages, also known as Meta Messages.

Table 3-5. Interface Functions.

Mnemonic	Interface Function Name
SH1	Source Handshake Capability
AH1	Acceptor Handshake Capability
T5	Talker (Basic Talker, Serial Poll, Talk Only Model, Unaddressed to Talk if Addressed to Listen)
L4	Listener (Basic Listener, Unaddressed to Listen if Addressed to Talk)
SR1	Service Request Capability
RL1	Remote/Local Capability
PP0	No Parallel Poll Capability
DC1	Device Clear Capability
DT1	Device Trigger Capability
C0	No Controller Capability
E1	Open Collector Bus Drivers

m. Set the 3456A to the 4-Wire Ohms function and the 100 K ohm range. Connect the 10 K ohm resistor to the input terminals and check the reading.

n. Disable the 3456A's Autozero feature. Check the reading.

o. Set the 3456A to the 2-Wire O.C. Ohms function and enable the Autozero feature. Connect the 100 K ohm resistor to the input terminals and check the reading.

p. Set the 3456A to the 4-Wire O.C. Ohms function. Check the reading.

q. Disconnect the 100 K ohm resistor from the 3456A. This completes the Ohms Test and Adjustments.

5-31. ACV Test and Adjustments.

5-32. Refer to Table 5-4 for the ACV Test and Adjustment Limits.

5-33. Equipment Required.

AC Calibrator (Fluke Model 5200A/5215A)
DC Standard (Systron Donner Model M107)

5-34. Test and Adjustment Procedure.

a. Press the 3456A's RESET button. Set the instrument to the ACV function.

b. Set the AC Calibrator for a 1 V, 1 kHz output and connect it to the 3456A's input terminals.

c. Set the 3456A to the 100 V range. Adjust calibration pot "K" for a 01.000 ± 1 count reading.

d. Set the 3456A to the 1 V range and adjust calibration pot "L" for a 1.00000 ± 3 counts reading.

e. Set the 3456A to the 1000 V range and adjust either calibration pot "M" or "N" for a 001.00 ± 2 counts reading.

f. Repeat Steps c, d, and e in the given order until all the readings are within the limits.

NOTE

Calibration pots "K", "L", and "M or N" interact with each other and should be adjusted until the readings converge.

g. Disconnect the AC Calibrator from the 3456A. Short the 3456A's input terminals.

h. Set the 3456A to the ACV + DCV function and the 1 V range. Adjust calibration pot "N" for a minimum reading.

i. Set the 3456A to the ACV function and do the following:

1. Note the 3456A's displayed reading.

Table 5-4. ACV Test and Adjustment Limits.

Step #	Input to 3456A	Set-Up and Configuration	Adjust Pot	Test Limits
1	Open	Press RESET	- - -	- - -
2	1 V, 1 kHz	ACV, 100 V Range	K	00.999 to 01.001
3	1 V, 1 kHz	1 V Range	L	.99997 to 1.00003
4	1 V, 1 kHz	1 kV Range	M or N	000.98 to 001.02
5	Short	ACV + DCV, 1 V Range	N	Minimum
6	Short	ACV	M	± 2 counts of reading in Step 5
7	.01 V DC	ACV + DCV, Autorange	- - -	.00943 to .01057
8	.01 V, 1 kHz	ACV	- - -	.00944 to .01056
9	.1 V, 1 kHz	ACV	- - -	.09940 to .10060
10	.5 V, 1 kHz	ACV	- - -	.49920 to .50080
11	1 V, 1 kHz	ACV	- - -	.99895 to 1.00105
12	10 V, 1 kHz	ACV	- - -	9.9895 to 10.0105
13	100 V, 1 kHz	ACV	- - -	99.895 to 100.105
14	700 V, 1 kHz	ACV	- - -	698.61 to 701.39
15	.01 V, 100 kHz	ACV	- - -	.00725 to .01275
16	1 V, 100 kHz	ACV	- - -	.99200 to 1.00800
17	10 V, 100 kHz	ACV	- - -	9.9200 to 10.0800
18	100 V, 100 kHz	ACV	- - -	99.200 to 100.800
19	700 V, 100 kHz	ACV	- - -	693.10 to 706.90
20	1 V, 250 kHz	ACV	- - -	.94370 to 1.05630
21	10 V, 250 kHz	ACV	- - -	9.4370 to 10.5630
22	1 V, 20 Hz	Filter On	- - -	.99640 to 1.00360
23	1 V, 20 Hz	ACV + DCV	- - -	.99640 to 1.00360
24	.01 V DC to REF H to V H and REF L to V L	Filter Off ACV + DCV/DCV Ratio	- - -	.99889 to 1.00111

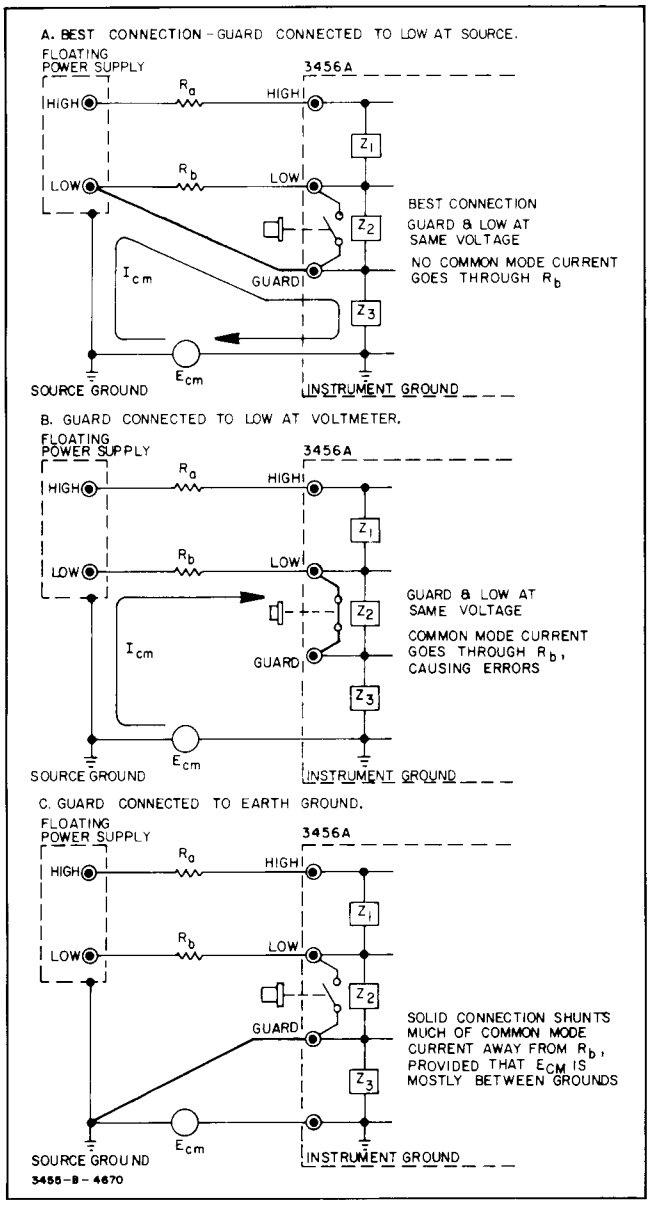


Figure 3-9. Guard Connections.

3-122. Data.

3-123. The Data Message is used to transfer information between the 3456A and the controller. It is used either to send data or receive data. A description is as follows.

a. Send Data is the 3456A's set up information (set to DCV, etc.). The instrument has to be in Remote and Listen (a listener) and the controller a Talker.

b. Receive Data is the 3456A's output. This includes readings and instrument status. To send the data, the 3456A is the talker and the controller is a listener.

3-124. Trigger.

3-125. The Trigger Message causes the 3456A to initiate a measurement cycle. It is an HP-IB Trigger and triggers the instrument in any front panel Trigger mode, since it has priority over other trigger conditions. If the 3456A is triggered during a measurement cycle, the cycle is aborted. If the instrument is executing a measurement cycle, it will be aborted upon receipt of a Bus Trigger. The 3456A has to be programmed to "listen" to execute the trigger.

3-126. Clear.

3-127. The Clear Message sets the 3456A to the turn-on state. This action is similar to pressing the RESET button on the instrument's front panel. The Clear, Turn-On, and Reset differences are listed in Table 3-6.

Table 3-6. 3456A Clear, Home, and Reset Differences.

	Status Byte Byte Reset	HP-IB Address Reset	Hardware Reset	Program Memory and Reading Storage Clear	Time
Power-On	Y	Y	Y	Y	= 3 sec
Reset	Y	Y	N	N	< .5 sec
Clear	Y	N	N	N	< 5 msec
Home	Y	N	N	N	< 5 msec

Note: Y = YES, N = NO

3-128. Remote.

3-129. The 3456A is in the local front panel mode when first turned on. A Remote Message allow the 3456A to be controlled over the HP-IB. In Remote, the front panel controls are disabled (except the LOCAL button) and are then controllable over the HP-IB. The instrument's initial set up is determined by the front panel setting before being placed in remote.

3-130. Local.

3-131. This message clears the remote operation of the 3456A and enables the front panel operation. Pressing the front panel LOCAL button also sets the instrument to local, provided the button has not been disabled by the Local Lockout Message (see next paragraph).

3-132. Local Lockout.

3-133. This message disables the 3456A's Local Front Panel controls, including the LOCAL button. The message is in effect until the message is cleared over the HP-IB or power is cycled.

3-134. Clear Lockout and Set Local.

3-135. This message places the 3456A to local and clears the Lockout.

3-136. Require Service (SRQ).

3-137. The Require Service Message (SRQ) is independent of all other HP-IB activity and is sent on a single

Table 5-3 Ohms Test and Adjustment Limits.

Step #	Input to 3456A	Set-Up and Configuration	Adjust Pot	Test Limits
1	Open	Press RESET	- - -	- - -
2	Open	Set to 6 dig. resolution	- - -	- - -
3	4-Wire Short	2-Wire Ohms	- - -	-00.0024 to 00.2024
4	4-Wire Short	4-Wire Ohms	- - -	-00.0024 to 00.0024
5	10 KΩ	4-Wire Ohms	F	9.99997 +3 to 10.00003 +3
6	1 KΩ	4-Wire Ohms	G	999.999 to 1000.001
7	100 Ω	4-Wire Ohms	- - -	99.9946 to 100.0054
8	100 KΩ	4-Wire Ohms	H	99.9999 +3 to 100.0001 +3
9	1 MΩ	4-Wire Ohms	I	999.999 +3 to 1000.001 +3
10	10 MΩ	4-Wire Ohms	J	9.99996 +6 to 10.00004 +6
11	1 MΩ	2-Wire Ohms	- - -	999.938 +3 to 1000.062 +3
12	10 KΩ	4-Wire Ohms 100 K Range	- - -	9.9996 +3 to 10.0004 +3
13	10 KΩ	Autozero Off	- - -	9.9994 +3 to 10.0006 +3
14	100 KΩ	Autozero On	- - -	99.9976 +3 to 100.0024 +3
15	100 KΩ	2-Wire O.C. 4-Wire O.C.	- - -	99.9978 +3 to 100.0022 +3

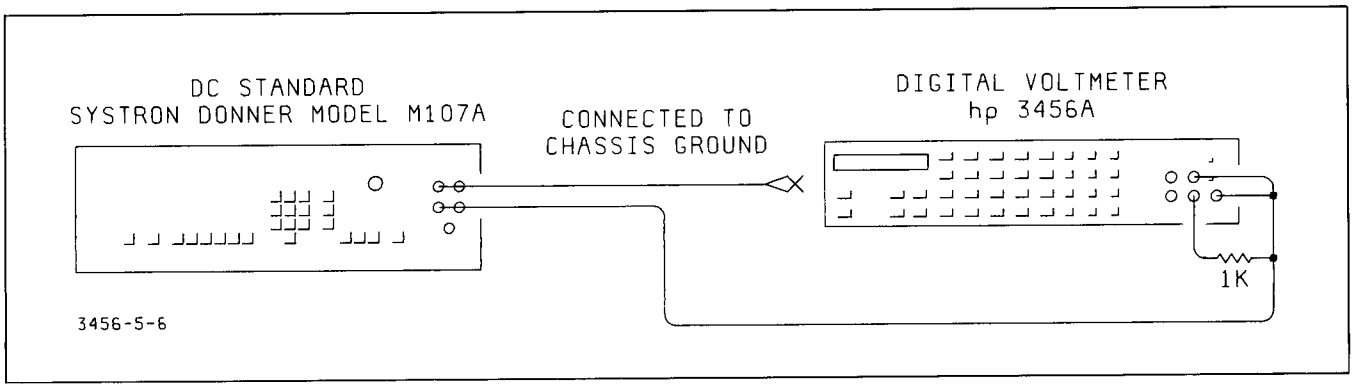


Figure 5-6. DC Common Mode Rejection Test.

e. Connect the 10 K ohm Standard Resistor to the 3456A's input terminals. Adjust calibration pot "F" for a 10.00000 +3 ±1 count reading. Refer to Figure 5-4 on how to connect the 10 K ohm and other Standard Resistors to the instrument.

f. Disconnect the 10 K ohm resistor from the 3456A and connect the 1 K ohm Standard Resistor to the input terminals. Adjust calibration pot "G" for a 1000.000 ±1 count reading.

g. Disconnect the 1 K ohm resistor and connect the 100 ohm resistor to the input terminals. Check the reading.

h. Disconnect the 100 ohm Standard Resistor and connect the 100 K ohm Standard Resistor to the input terminals. Adjust calibration pot "H" for a 100.0000 +3 ±1 count reading.

i. Disconnect the 100 K ohm Standard Resistor and connect the 1 M ohm Standard Resistor to the input terminals. Adjust calibration pot "I" for a 1000.000 +3 ±1 count reading.

j. Disconnect the 1 M ohm Standard Resistor and connect the 10 M ohm Standard Resistor to the input terminals. Adjust calibration pot "J" for a 10.00000 +6 ±4 count reading.

k. Disconnect the 10 M ohm Standard Resistor and connect the 1000 M ohm Resistor Assembly to the input terminals. Check the reading.

l. Set the 3456A to the 2-Wire Ohms function and connect the 1 M ohm resistor to the input terminals. Check the reading.

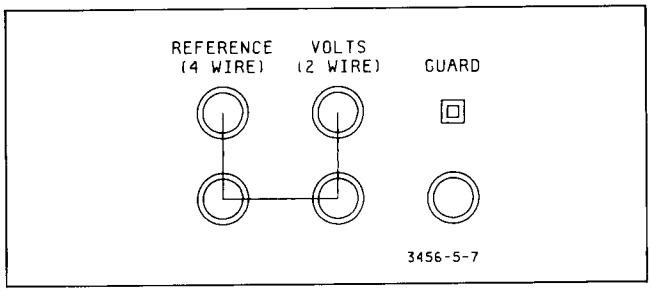


Figure 5-7. 4-Wire Ohms Short.

line called the SRQ line. Its state is either true or false, with low being true and high being false. When the Require Service Message is sent and more than one device on the HP-IB has the capability to send this message, the user must decide which device is sending the message. This is done by conducting a "Serial Poll" for the device(s) on the Bus. The device polled responds by sending a Status Byte. The Status Byte indicates whether the device has requested service and if so, for what reason. If the device polled shows that it did not send the Require Service Message, the other devices would typically be polled. Paragraph 3-140 describes the 3456A's Status Byte.

3-138. When the 3456A sends a Require Service Message, the front panel SRQ LED is on. The message and LED are cleared when the 3456A is polled, although some of the messages are cleared by the instrument (i.e. Front Panel SRQ, Program Memory Complete, and Data Ready). The following are the conditions that can cause a Require Service Message.

Front Panel SRQ (can be cleared by the 3456A)
Program Memory Execution Complete (can be cleared by the 3456A)
Data Ready (can be cleared by the 3456A)
Trigger Too Fast
Illegal Instrument State/Internal Error/Syntax Error
Program Memory Error
Limits Failure

3-139. The 3456A requires service only if told to do so. It has to be programmed to output the Require Service Message for the previously listed conditions. This is done by setting the Service Request Mask. The mask is set by sending certain program codes to the 3456A and is explained in Paragraph 3-169.

3-140. Status Byte.

3-141. The Status Byte Message is output by the 3456A in response to a Serial Poll. Each bit represents a message. Table 3-7 lists the bits which are defined as follows.

NOTE

Remember to set the SRQ mask to output the Require Service Message.

a. Front Panel SRO. A Require Service Message can be output when pressing the 3456A's front panel SRQ button. The button is only enabled in Local operation.

b. Program Memory Execution Complete. A Require Message is output when the 3456A's internally programmed operation, called Program Memory, is completed. Information on the Program Memory Operation is in Paragraph 3-200.

c. Data Ready. A Require Service Message is output when the 3456A's measurement cycle is completed (e.g. a DCV reading is taken). More information on Data Ready is in Paragraph 3-206.

Table 3-7. Status Byte Definition.

Octal Code	Decimal Code	Bit	Definition
101	65	0	Front Panel SRQ - When the front panel SRQ button is pressed, this Require Service is output. Pressing the button a second time will clear the Service Request.
102	66	1	Program Memory Execution Complete -Indicates to the controller that all the program codes in the 3456A's internal memory are executed. The Require Service condition is cleared when the Program Memory is executed again.
104	68	2	Data Ready - Indicates to the controller that measurement data is ready to be output. The Require Service is cleared when a new measurement cycle is initiated.
110	72	3	Trigger Too Fast - Indicates that the 3456A was triggered while executing a measurement cycle. This only occurs in External Trigger.
120	80	4	Illegal Instrument State - Indicates that the 3456A is unable to do an operation because of an invalid set-up (e.g. 10 M ohm range in DCV) Internal Error - Indicates a failure in the 3456A Syntax Error - Indicates to the controller that invalid Program Code(s) where sent to the 3456A (e.g. code F9)
140	96	5	Program Memory Error - Indicates that the Program Memory Execution command or the Test function was stored in memory, or an overflow of memory occurred while loading into memory.
300	192	7	Limits Failure - Indicates that the Pass/Fail measurement made is out of the selected limits.

Note: Bit 6 is not in this table, because it is the SRQ bit.

d. Trigger Too Fast. This Require Service Message is output if the 3456A is triggered while outputting data over the HP-IB. This can only be caused by the External Trigger.

e. Illegal Instrument State/Internal Error/Syntax Error. This Message is output for the following conditions:

1. Illegal Instrument State. An Illegal Instrument State is when the 3456A is, for example, unable to complete internal operations. An example is programming the instrument to the 10 M ohm range while in the DCV function. This range is invalid in the DCV function.

2. Internal Error. An Internal Error occurs is when a digital failure occurs in the 3456A. If this may

ee. Uprange the 3456A to the 1000 V range. Uprange the Reference Divider's Output Voltage switch to 1000 V. Check the 3456A's reading.

ff. Downrange the DC Standard to + 10 V and then downrange the Reference Divider's Input Voltage switch to 10 V.

gg. Downrange the Reference Divider's Output Voltage switch to 1 V and set the 3456A to the 10 V range (take out of Autorange).

hh. Reverse the 3456A's input leads for a -1 V reading. Check the reading.

ii. Set the Reference Divider's Output Voltage switch to 5 V. Check the 3456A's reading.

jj. Turn the DC Standard's Output off and disconnect the DC Standard, Transfer Standard, and 3456A from the Reference Divider.

kk. Set the Transfer Standard for a 10 V output and connect it to the 3456A with the input leads reversed ("+" output to VOLTS LOW and "-" output to VOLTS HIGH). Check the reading.

11. Change the Number Of Power Line Cycles Integrated on the 3456A to 100 by entering a "100" into the N CYC INT register. Check the reading.

mm. Change the Number Of Power Line Cycles Integrated to 1, .1, .01 then to 10 by entering "1", ".1", ".01", and "10" into the N CYC INT register, respectively. Check readings.

nn. Turn the 3456A's Filter "ON" and check the reading.

oo. Turn the 3456A's Filter and Autozero "OFF". Check the reading.

pp. Press the RESET button on the 3456A and connect the Transfer Standard's High Output to the 3456A's RATIO REF HIGH and VOLTS HIGH terminals. Connect the Standard's Low Output to the 3456A's RATIO REF LOW and VOLTS LOW terminals. Refer to Figure 5-5 for the connection.

qq. Set the 3456A to the DCV/DCV Ration function. Check the reading.

rr. Disconnect the Transfer Standard from the 3456A and set the 3456A to the DCV function and 1 V range.

ss. Connect the 1 K resistor (-hp- Part Number 0698-1021) between the 3456A's VOLTS HIGH and VOLTS LOW terminals, as shown in Figure 5-6. Make sure the GUARD terminal is connected to the VOLTS HIGH terminal (Guard Switch "OUT").

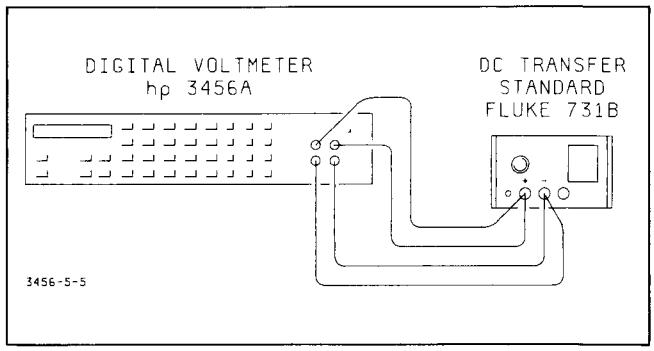


Figure 5-5. Ratio Test Connection.

tt. Record the 3456A's reading.

uu. With the DC Standard's Output off, connect it between the 3456A's chassis and VOLTS HIGH terminal, as shown in Figure 5-6.

vv. Set the DC Standard for a + 100 V output and turn its output on.

ww. The 3456A's reading should be within 0.000010 V of the recorded reading in Step tt.

xx. Disconnect the test equipment from the 3456A. This completes the DCV Test and Adjustments.

5-27. Ohms Test and Adjustment.

5-28. Refer to Table 5-3 for the Ohms Test and Adjustment Limits.

5-29.Equipment Required.

Standard Resistor:

(100 ohm ± .0005%; Guildline Model 9330/100)
(1 K ohm ± .0005%; Guildline Model 9330/1K)
(10 K ohm ± .001%; Guildline Model 9330/10K)
(100 K ohm ± .001%; Guildline Model 9330/100K)
(1 M ohm ± .002%; Guildline Model 9330/1 M)
10 M ohm ± .01%; Guildline Model 95206)

Resistor Assembly:

(1000 M ohm ± .2%; -hp- Part Number 03456-67902)

5-30. Test and Adjustment Procedure.

a. Press the 3456A's RESET button and set the instrument to the 6 Digit display and 2-Wire Ohms configuration.

b. Short the VOLTS and RATIO REF (4WRΩ SENSE) terminals as shown in Figure 5-7.

c. Check the 3456A's reading.

d. Set the 3456A to the 4-Wire Ohms function. Check the reading.

happen, refer the instrument to a Service Trained Person.

3. Syntax Error. A Syntax Error is when invalid programs codes are sent to the 3456A. An invalid program code is F9.

f. Program Memory Error. This error occurs under the following two conditions.

1. When trying to execute the program memory from memory (program codes X1 in program memory) and when enabling the Internal Test from memory (program codes TE1 in memory). Both conditions terminate the Program Memory Operation.

2. When exceeding internal memory space during program memory loading (storing more than 1400 bytes into memory).

g. Limits Failure. A Limits Failure occurs when a limit is exceeded in the 3456A's Pass/Fail math operation. More information on the Pass/Fail feature is in Paragraph 3-81.

3-142. The Status Byte Message in Figure 3-10 is represented in octal code. Each bit, except for bit 6, indicates a particular Require Service condition. Bit 6 (seventh bit) is the Service Request bit and is true when service is required. The bit lets the controller know that a Require Service condition exists. Remember, set the SRQ mask to output the Require Service Message.

3-143. If the SRQ mask has been set for more than one condition, more than one bit of the Status Byte Message may be true. For example:

a. A Require Service condition sets bits 1, 2, and 6 true. (Remember, bit 6 is true for any Require Service.) The conditions are caused by Program Memory Execution Complete and Data Ready.

b. The Status Byte looks like:

b_7							b_0
0	1	0	0	0	1	1	0

NOTE

A "1" in this example indicates a true condition.

c. The byte is output in octal code and the corresponding octal number is:

01 000 110
└──106──┘

The resultant decimal number of octal 106 is 70.

3-144. Status Bit.

3-145. The 3456A does not respond to a Parallel Poll.

NOTE

The Status Bit is not part of the Status Byte Message and should not be confused with the bits in the Status Byte Message.

3-146. Pass Control.

3-147. The 3456A does not have controller capabilities.

3-148. Abort (Interface Clear).

3-149. All HP-IB communication is terminated, including the 3456A's Bus communication. Control is returned to the system controller. The Abort Message does not remove the 3456A from remote control.

3-150. 3456A Addressing.

3-151. HP-IB requires that a device on the Bus needs to be identified as a Listener or a Talker, in order to execute the Bus Messages and commands. Because of this requirement, each device on the HP-IB has a unique "listen" and "talk"address to distinguish themselves from each other. The device is then able to receive programming instructions when addressed to listen or sent data when addressed to talk.

3-152. The 3456A's address is set by the address switch located at the instrument's rear panel. The switch is a seven section "DIP" switch with five switches used for address selection, as shown in Table 3-8. The sixth switch is not used and the seventh switch sets the instrument to the "Talk-Only" mode (see Paragraph 3-154). The 3456A's allowable address settings are listed in Table 3-8. Its factory address setting is a listen address of 22 decimal (ASCII character "6") and a talk address of 54 decimal (character "V").

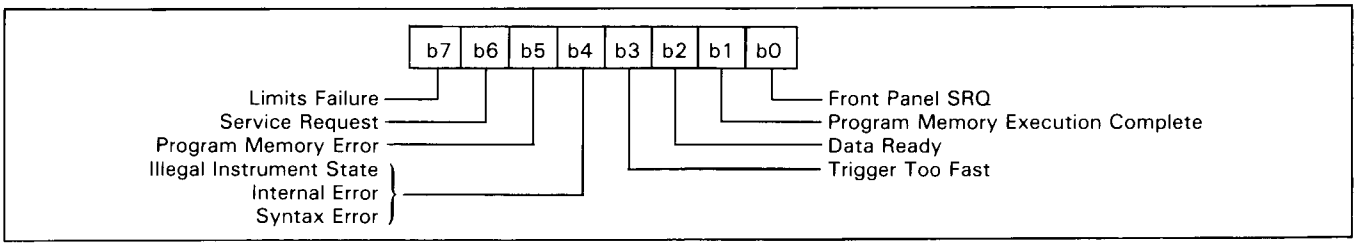


Figure 3-10. Status Byte.

e. Do the same for the 1 V, 10 V, 100 V, and 1000 V ranges.

f. Set the 3456A to Autorange and remove the short.

g. Set the DC Transfer Standard for a + 10 V output and connect it to the 3456A's VOLTS input terminals. Make sure the "+" output is connected to the 3456A's VOLTS HIGH terminal.

h. Adjust the 3456A's calibration potentiometer "B" for a + 10.00000 V ± 1 count reading on the display. If "unable" to adjust to the required reading, go to the next step. If "able" to adjust to the required reading, go to Step j.

i. Do the following:

1. Turn calibration potentiometer "B" completely counterclockwise.

2. Turn adjustment "A" until the 3456A's reading is as close to + 10 V as possible. If the reading is higher than + 10.00000 V, turn adjustment "A" one position for a less than + 10 V reading.

3. Adjust calibration pot "B" for a + 10.00000 ± 1 count reading.

j. Set the Transfer Standard for a + 1 V output.

k. Adjust calibration pot "C" for a + 1.000000 V ± 1 count reading.

l. Disconnect the DC Transfer Standard from the 3456A's input.

m. Set the 3456A to the 100 mV (100 -3) range and short its input terminals.

n. Turn on the 3456A's Null Math feature. Remove the short after the instrument has taken a reading.

o. Using short pieces of number 20 AWG (or thinner) insulated solid copper wires, connect the Transfer Standard and the DC Null Voltmeter to the Reference Divider as shown in Figure 5-2 and 5-3.

p. Turn the DC Standard's output off. Using 24 inch or shorter shielded cables equipped with banana-plug connectors, connect the DC Standard and the 3456A to the Reference Divider as shown in Figure 5-2 and 5-3.

q. Set the Standard Cell Voltage switches on the Reference Divider to correspond with the output voltage setting of the Transfer Standard. Normally the Transfer Standard's switches should be set to the voltage value of the Standard Cell used to calibrate the Transfer Standard.

r. Zero the DC Null Voltmeter on the 3 microvolt range and then set it to the 300 microvolt range.

s. Set the Reference Divider's Input Voltage switch to 100 V and center its Coarse and Fine Adjust controls.

t. Set the Reference Divider's Output voltage switch to .1 V.

u. Set the DC Standard for an output voltage of + 100 V and turn its output on.

v. Set the Reference Divider's Standard Cell switch to the "Locked" position. Adjust the DC Standards Output for a zero reading on the DC Null Voltmeter.

w. Downrange the DC Null Voltmeter and adjust the Reference Divider's Coarse and Fine controls for a "Null" reading (0 reading) on the Null Voltmeter's 3 microvolt range.

x. Set the Reference Divider's Standard Cell switch to the OPEN position.

y. Set the Reference Divider's Standard Cell switch to MOMENTARY, and if necessary, readjust the Divider's Fine Control for a null indication on the Null Voltmeter. Release the Standard Cell switch.

NOTE

The Divider's Fine Control may have to be readjusted, when the Output Voltage switch is set to another position.

z. Adjust the 3456A's calibration pot "D" for a + 100.0000 -3 V ± 5 counts reading.

aa. Turn the 3456A's Math operation off.

bb. Uprange the 3456A to the 100 V range.

cc. Uprange the Reference Divider's Output Voltage switch to 100 V. Adjust the 3456A's calibration pot "E" for a + 100.0000 V ± 1 count reading.

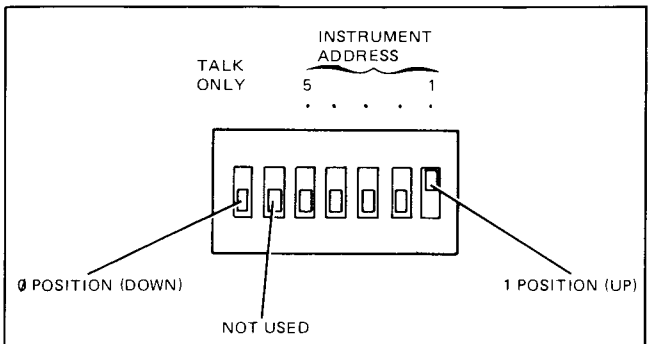
CAUTION

Always uprange the Reference Divider's Input Voltage switch before upranging Standard before downranging the Reference Divider's Input Voltage switch.

dd. Uprange the Reference Divider Input Voltage switch to 1000 V and then uprange the DC Standard to + 1000 V. Allow about ten minutes for the Reference Divider to warm-up and stabilize.

NOTE

Setting the 3456A's Address Switch to the Listen Address' corresponding decimal code will also set the Talk Address.



ASCII Code Character		Address Switches					5-bit Decimal Code	
Listen	Talk	A5	A4	A3	A2	A1		
SP	@	0	0	0	0	0	00	
!	A	0	0	0	0	1	01	
"	B	0	0	0	1	0	02	
#	C	0	0	0	1	1	03	
$	D	0	0	1	0	0	04	
%	E	0	0	1	0	1	05	
&	F	0	0	1	1	0	06	
'	G	0	0	1	1	1	07	
(	H	0	1	0	0	0	08	
)	I	0	1	0	0	1	09	
*	J	0	1	0	1	0	10	
+	K	0	1	0	1	1	11	
,	L	0	1	1	0	0	12	
-	M	0	1	1	0	1	13	
.	N	0	1	1	1	0	14	
/	O	0	1	1	1	1	15	
0	P	1	0	0	0	0	16	
1	Q	1	0	0	0	1	17	
2	R	1	0	0	1	0	18	
3	S	1	0	0	1	1	19	
4	T	1	0	1	0	0	20	
5	U	1	0	1	0	1	21	3456A
6	V	1	0	1	1	0	22	← FACTORY Setting
7	W	1	0	1	1	1	23	
8	X	1	1	0	0	0	24	
9	Y	1	1	0	0	1	25	
:	Z	1	1	0	1	0	26	
;	[	1	1	0	1	1	27	
<	\	1	1	1	0	0	28	
=	]	1	1	1	0	1	29	
>	~	1	1	1	1	0	30	

Table 3-8. 3456A Address Codes.

3-153. Instrument address commands are usually in this form:

universal unlisten, device talk, device listen.

The universal unlisten command removes all listeners from the HP-IB to allow only the addressed listener to receive information. The information is sent by a talker which is designated by the device talk code.

3-154. Talk-Only (No Controller).

3-155. Setting the 3456A to the "Talk-Only" mode can provide measurement data to another device, like a printer, without a Bus controller. The 3456A is placed to the "Talk-Only" mode by setting the rear "DIP" switch to the mode (set the seventh switch to "1"). Once this is done measurement data is output after each trigger. Instrument set up (function, range, etc.) is done from the front panel.

3-156. 3456A HP-IB Programming.

3-157. Now that the basic HP-IB operation is known, the next thing is to program and use the 3456A over the Bus. First, determine the measurement or instrument operation you want. Then determine the 3456A's program codes. The codes are ASCII characters transmitted over the HP-IB to the instrument.

3-158. Once you have defined the instrument criteria and program codes, next write an algorithm on how to make the measurement. When you have done this, convert the Algorithm to controller language. Refer to your controller's operating manual for the language.

3-159. Algorithm.

3-160. The algorithm should show exactly how to set up and use the instrument in a certain function. To simplify the algorithm, use the twelve Bus Messages as key words in the algorithm. The messages are repeated here for your reference.

1. DATA
2. TRIGGER
3. CLEAR
4. REMOTE
5. LOCAL
6. LOCAL LOCKOUT
7. CLEAR LOCKOUT AND SET LOCAL
8. REQUIRE SERVICE
9. STATUS BYTE
10. STATUS BIT
11. PASS CONTROL
12. ABORT

3-161. The definitions of the Bus Messages are given in this manual's Appendix A, Paragraph A-11. Remember, refer to your controller manual to convert the messages. If you have an -hp- Model 9825A Controller, the controller's Extended I/O Manual (-hp- Part Number 09825-90025) has a listing of the codes. For the 9835A/B, refer to the I/O Programming Manual (-hp- Part Number 09835-90060). If your controller manual does not have a code conversion chart, you may be able to use the technical description of the messages located in Appendix A.

3-162. Here is an example Algorithm for the 3456A. Note that only the key words are used, not the codes.

a. In this algorithm, the 3456A is set up to make a DCV measurement, output it over the HP-IB and print the reading. The program ends if the 3456A sends a Require Service Message. The algorithm is as follows.

k. Remove the short from the input terminals. This completes the ACV Adjustments.

5-21. COMBINED PERFORMANCE TEST AND ADJUSTMENTS.

5-22. The Combined Performance Test and Adjustments are separated into three main areas, DCV, Ohms, and ACV. The procedures must be followed in the order they are presented, starting with the DCV Test and Adjustments. Also read the general information pertaining to the Performance Test (excluding the test procedures) in this Manual's Section IV, if it has not been done. This information is necessary to do the Performance Test part of the following Test and Adjustment procedures. Allow a 1 hour warm-up time for the following tests and adjustments or inaccuracies may result.

5-23. DCV Test and Adjustments.

5-24. Refer to Table 5-2 for the DCV Test and Adjustment Limits.

5-25. Equipment Required.

Reference Divider (Fluke Model 750A)
DC Transfer Standard (Fluke Model 731B)
DC Standard (Systron Donner Model M107)
DC Null Voltmeter (-hp- Model 419A)

5-26. Test and Adjustment Procedure.

a. Disconnect the 3456A's input terminals from any external circuitry and press the TEST button. Make sure the instrument passes its Self-Test (see Paragraph 3-17). Press the TEST button again.

NOTE

Be sure the input terminals are open and the Guard switch is in the "IN" position when the Self-Test is enabled.

b. Press the 3456A's RESET button and short its VOLTS input terminals.

NOTE

Pressing the RESET button automatically sets the 3456A to DCV, Autorange, Internal Trigger, and 5 Digit Display.

c. Set the 3456A to the 6 Digit mode by storing "6" into the N DIG DISP register.

d. Set the 3456A to the 100 mV (100 -3) range. Make sure the reading is within the limits shown in Table 5-2.

Table 5-2. DCV Test and Adjustment Limits.

Step #	Input to 3456A	Set-Up and Configuration	Adjust Pot	Test Limits
1	Open	Self Test	- - -	- - -
2	Short	Press RESET	- - -	- - -
3	Short	Set to 6 dig. resolution	- - -	- - -
4	Short	.1 V Range	- - -	-00.0024 -3 to +00.0024 -3
5	Short	1 V Range	- - -	-.000004 to + .000004
6	Short	10 V Range	- - -	-0.00002 to + 0.00002
7	Short	100 V Range	- - -	-00.0003 to + 00.0003
8	Short	1 kV Range	- - -	-000.002 to + 000.002
9	+ 10 V DC	Autorange	A & B	+ 9.99999 to + 10.00001
10	+ 1 V DC	Autorange	C	+ .999999 to 1.000001
11	Short	.1 V Range Null Math On		
12	.1 V DC	.1 V Range Null Math On	D	+ 99.9995 -3 to + 100.0005 -3
13	- - -	Null Math Off	- - -	- - -
14	+ 100 V DC	100 V Range	E	+ 99.9999 to + 100.0001
15	+ 1000 V DC	1 kV Range	- - -	+ 999.867 to + 1000.133
16	-1 V DC	10 V Range	- - -	-.99997 to -1.00003
17	-5 V DC	10 V Range	- - -	-4.99994 to -5.00006
18	-10 V DC	10 V Range	- - -	-9.99990 to -10.00010
19	-10 V DC	Int. = 100	- - -	-9.99990 to -10.00010
20	-10 V DC	Int. = 1	- - -	-9.99986 to -10.00014
21	-10 V DC	Int. = .1	- - -	-9.9991 to -10.0009
22	-10 V DC	Int. = .01	- - -	-9.992 to -10.008
23	-10 V DC	Int. = 10, Filter On	- - -	-9.99990 to -10.00010
24	-10 V DC	Filter Off, Autozero Off	- - -	-9.99989 to -10.00011
25	Open	Press RESET	- - -	- - -
26	10 V DC to REF H to V H and REF L to V L	- - -	- - -	.99998 to 1.00002
27	- - -	CMR Test	- - -	- - -

1. ABORT all previous operations
2. Set the 3456A to REMOTE
3. CLEAR the 3456A
4. LOCAL LOCKOUT the Instrument
5. Send DATA to set up the 3456A to
   a) the dc function
   b) autorange
   c) hold trigger
   d) set SRQ mask to Illegal Instrument State, Internal Error, and Syntax Error.
6. TRIGGER the 3456A
7. Send the measurement DATA to the controller and store in a variable
8. Check the 3456A to see if it REQUIRE's SERVICE
9. If REQUIRE SERVICE, check the STATUS BYTE; otherwise skip the next step
10. If the 3456A sent the STATUS BYTE, it did REQUIRE SERVICE and the program is ended
11. Print out the DATA from the variable
12. CLEAR LOCKOUT AND SET LOCAL
13. End program

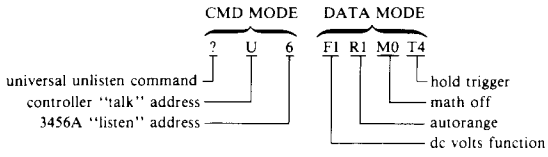
3-163. Programming the 3456A over the HP-IB.

3-164. Programming the 3456A is done by DATA messages. Remember, DATA is sent or received. The DATA received by the 3456A is for instrument set up (function, range, etc.). The DATA sent by the 3456A is output data. Included in the following paragraph are programming examples of the Bus Messages and the algorithm. They are given in the HP-IB format, HPL (9825A Controller Language), and Enhanced Basic (9835A/B and 9845B Controller Language).

3-165. Program Codes (Data received by the 3456A).

3-166. Program codes are used for the 3456A's set up information. A listing of the codes is in Table 3-9. The instrument must be in "remote" and "listen" to receive the codes. An example is as follows.

a. HP-IB Format:



b. HPL (9825A Controller Language).

```
wrt 722,"F1 R1 M0 T4"
```

c. Enhanced Basic (9835A/B, 9845B Controller Language).

```
OUTPUT 722;"F1 R1 M0 T4"
```

NOTE

The "7" in the "722" address code is the 9825A, 9835A/B and 9845B Controllers I/O Card select code.

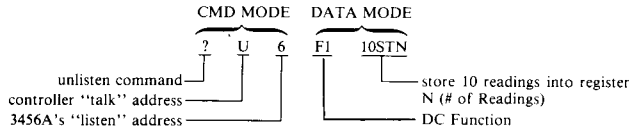
NOTE

The spaces between the program codes (F1spaceR1, etc.) shown in the example are not necessary. They are only included to separate the different program codes.

3-167. Storing into Registers (Y, Z, Delay, etc.) over the HP-IB.

3-168. Storing into register is similar to the front panel method. First enter the number to be stored and then store it into the register. The following examples shows how to do it, by storing "10" into the Number of Readings/Trigger register. The DCV function's program codes is also included in the example to show that other than register program codes can be in the same string.

a. HP-IB Format.



b. HPL (9825A Controller Language).

```
wrt 722,"F1 10STN"
```

c. Enhanced Basic (9835A/B, 9845B Controller Language).

```
OUTPUT 722;"F1 10STN"
```

In the example, "F1" and "10STN" is separated by a space to keep the numbers apart. This is not necessary but may be less confusing. You can, however, enter a "W" instead of a space. The "W" is ignored by the 3456A but can be used to separate numerical entries from commands. The same program string with "W" looks like this:

```
"F1W10STN"
```

5-15. OHMS ADJUSTMENT.

5-16. Equipment Required.

Standard Resistors:

1 K ohm ± .0005% (Guildline 9330/1K or 9330A/1K)
10 K ohm ± .001% (Guildline 9330/10K or 9330A/10K)
100 K ohm ± .001% (Guildline 9330/100K or 9330A/100K)
1 M ohm ± .002% (Guildline 9330/1M)
10 M ohm ± .01% (Guildline 95206)

5-17. Adjustment Procedure.

a. Press the 3456A's RESET button and set the instrument to the 6 Digit Display and 4-Wire Ohms configuration.

b. Connect the 10 K ohm Standard Resistor to the 3456A's input terminals. Adjust calibration pot "F" for a 10.00000 + 3 ± 1 count reading. Disconnect the Standard Resistor.

NOTE

The Standard Resistors are connected in the 4-Wire configuration, as shown in Figure 5-4.

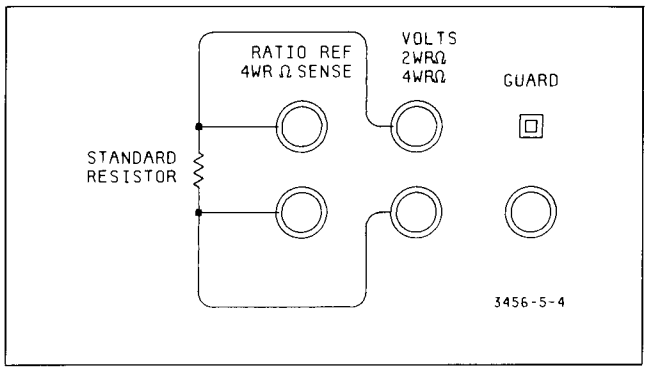


Figure 5-4. Standard Resistor Connection.

c. Connect the 1 K ohm Standard Resistor to the input terminals. Adjust calibration pot "G" for a 1000.000 ± 1 count reading. Disconnect the Standard Resistor.

d. Connect the 100 K ohm Standard Resistor to the input terminals. Adjust calibration pot "H" for a 100.0000 + 3 ± 1 count reading. Disconnect the Standard Resistor.

e. Connect the 1 M ohm Standard Resistor to the input terminals. Adjust calibration pot "I" for a 1000.000 -3 ± 1 count reading. Disconnect the Standard Resistor.

f. Connect the 10 M ohms Standard Resistor to the input terminals. Adjust calibration pot "J" for a 10.00000 + 6 ± 4 counts reading. Disconnect the Standard Resistor. This completes the Ohms Adjustments.

5-18. ACV ADJUSTMENTS.

5-19. Equipment Required.

AC Calibrator (Fluke Model 5200A)

5-20. Adjustment Procedure.

a. Press the 3456A's RESET button and set the instrument to the ACV fuction.

b. Set the AC Calibrator for a 1 V, 1 kHz output and connect it to the 3456A's VOLTS input terminals.

c. Set the 3456A to the 100 V range and adjust the instrument's calibration pot "K" for a 01.000 ± 1 count reading.

d. Set the 3456A to the 1 V range and adjust calibration pot "L" for a 1.00000 ± 3 counts reading.

e. Set the 3456A to the 1000 V range and adjust either calibration pot "M" or "N" for a 001.00 ± 2 counts reading.

f. Repeat Steps c, d, and e in the given order until all the readings are within the limits.

NOTE

Calibration pots "K", "L", and "M or N" interact with each other and should be adjusted until the readings converge.

g. Disconnect the AC Calibrator from the 3456A. Short the 3456A's input terminals.

h. Set the 3456A to the ACV + DCV function and the 1 V range. Adjust calibration pot "N" for a minimum reading.

i. Set the 3456A to the ACV function and do the following:

1. Note the 3456A's displayed reading.

2. Adjust calibration pot "M" for a minimum reading.

3. Continue adjusting calibration pot "M" in the same direction until the reading noted in Step 1 is reached (within ± 2 counts).

j. Repeat Steps h and i until both readings converge with each other (within ± 2 counts).

Table 3-9. 3456A Program Codes.

	Control	Program Code
FUNCTION	Shift Function Off (Unshifted)	S0
	DCV	F1
	ACV	F2
	ACV + DCV	F3
	2 Wire K Ohms	F4
	4 Wire K Ohms	F5
	Shift Function On (Shifted)	S1
	DCV/DCV Ratio	F1
	ACV/DCV Ratio	F2
	ACV + DCV/DCV Ratio	F3
	O.C. 2 Wire K Ohms	F4
	O.C. 4 Wire K Ohms	F5
RANGE	Auto	R1
	100 mV or .1 K Ohms	R2
	1000 mV or 1 K Ohms	R3
	10 V or 10 K Ohms	R4
	100 V or 100 K Ohms	R5
	1000 V or 1 M Ohms	R6
	10 M Ohms	R7
	100 M Ohms	R8
	1000 M Ohms	R9
TRIGGER	Internal	T1
	External	T2
	Single	T3
	Hold	T4
AUTOZERO	On	Z1
	Off	Z0
FILTER	On	FL1
	Off	FL0
TEST	On	TE1
	Off	TE0
REGISTERS	Storing into Registers	ST
	Recalling Registers	RE
	Number of Readings	N
	Number of Digits Displayed	G
	Number of Power Line Cyc. Int.	I
	Delay	D
	Mean Register (Read only)	M
	Varience Register (Read only)	V
	Count Register (Read only)	C
	Lower Register	L
	R Register	R
	Upper Register	U
	Y Register	Y
	Z Register	Z
MATH	Off	M0
	Pass/Fail	M1
	Statistic (Mean, Variance, Count)	M2
	Null	M3
	dBm	M4
	Thermistor (°F)	M5
	Thermistor (°C)	M6
	Scale [(X - Z)/Y]	M7
	%Error [(X - Y)/Y x 100]	M8
	dB (20 Log X/Y)	M9
READING STORAGE	On	RS1
	Off	RS0
SYSTEM OUTPUT MODE	On	SO1
	Off	SO0
DISPLAY	On	D1
	Off	D0
OUTPUT FORMAT	Packed Format On	P1
	Packed Format Off (ASCII Format)	P0
CLEAR-CONTINUE	Active	CL1
NUMERIC SEPARATOR	Separates Numbers (e.g. F1W10STN)	W
HOME COMMAND	Software Reset	H
FRONT/REAR SWITCH SENSE	1 = Front, 0 = Rear	SW1
EOI	Enable	01
	Disable	00
PROGRAM MEMORY	Load Program (Syntax) On	L1
	Load Program (Syntax) Off	Q
	Execute Program Memory	X1

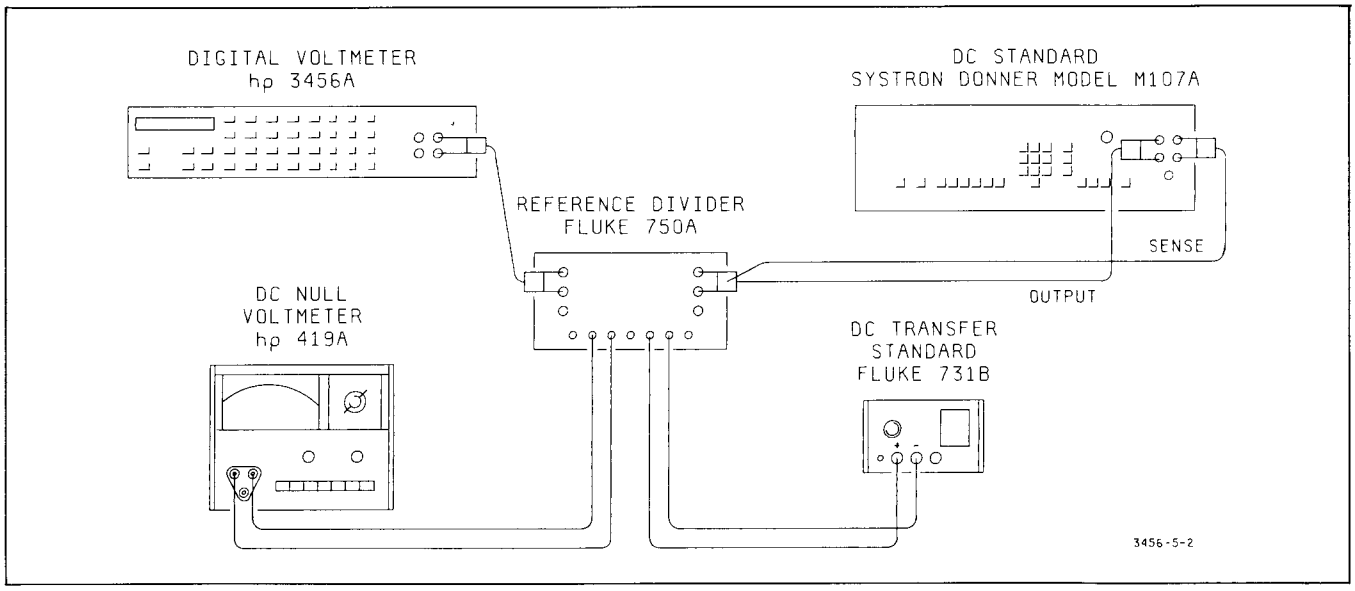


Figure 5-2. DCV Test Equipment Connection.

l. Set the Standard Cell Voltage switches on the Reference Divider to correspond with the output voltage setting of the Transfer Standard. Normally the Transfer Standard's output should be set to the voltage value of the Standard Cell used to calibrate the Transfer Standard.

m. Zero the DC Null Voltmeter on the 3 microvolt range and then set it to the 300 microvolt range.

n. Set the Reference Divider's Input Voltage switch to 100 V and center its Coarse and Fine Adjust controls.

o. Set the Reference Divider's Output Voltage switch to .1 V.

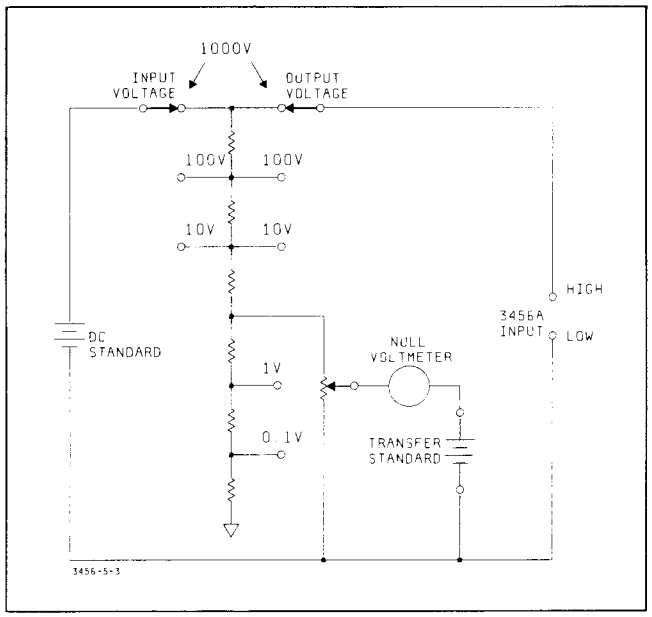


Figure 5-3. DCV Test Equipment Connection

p. Set the DC Standard for an output voltage of 100 V and turn its output on.

q. Set the Reference Divider's Standard Cell switch to the "Locked" position. Adjust the DC Standard Output for a zero reading on the DC Null Voltmeter.

r. Downrange the DC Null Voltmeter and adjust the Reference Divider's Coarse and Fine controls for a "null" reading (0 reading) on the Null Voltmeter's 3 microvolt range.

s. Set the Reference Divider's Standard Cell switch to the OPEN position.

t. Set the Reference Divider's Standard Cell switch to MOMENTARY, and if necessary, readjust the Divider's Fine Control for a null indication on the Null Voltmeter. Release the Standard Cell switch.

NOTE

The Divider's Fine Control may have to be readjusted, when the Output Voltage switch is set to another position.

u. Adjust the 3456A's calibration pot "D" for a 100.0000 -3 V ± 5 counts reading.

v. Turn the 3456A's Math off. Uprange the instrument to the 100 V range.

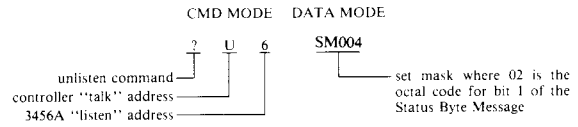
w. Uprange the Reference Divider's Output Voltage switch to 100 V. Adjust the 3456A's calibration pot "E" for a 100.0000 V ± 1 count reading.

x. Remove the test equipment from the 3456A. This completes the DCV Adjustments.

3-169. Programming the SRQ Mask.

3-170. Program codes are used to set the SRQ Mask. Use the programming procedure in Paragraph 3-165 to send the codes. Remember, the 3456A has to be in "remote" and "listen" to receive the codes. Since the Status Byte Message is in octal, the mask is programmed in octal by using the corresponding octal codes of the message. For example, bit 2 (Data Ready) is to be set and is done by sending its octal code, 004. The following example illustrates this.

a. HP-IB Format.



b. HPL (9825A Controller Language).

wrt 722, "SM004"

c. Enhanced Basic (9835A/B, 9845B Controller Language).

OUTPUT 722; "SM004"

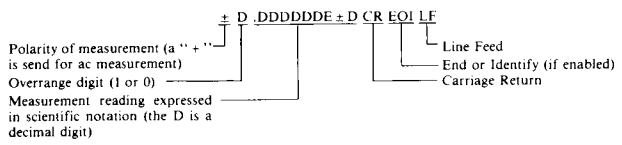
3-171. Any, all, or combinations of the Require Service conditions can be set by programming the SRQ mask. All the bits can be disabled by programming the mask to "000".

3-172. 3456A's Measurement DATA (Data sent by the 3456A).

3-173. 3456A measurement data can be sent to the controller in two different formats, ASCII or Packed Format. The following explains the formats.

3-174. ASCII Format.

3-175. Output Statement. The 3456A's output data in the ASCII Format consists of 14 bytes and is in this form:

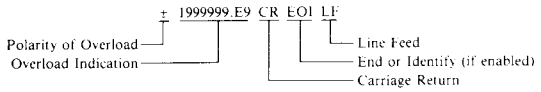


NOTE

The decimal point in the output statement is "free field" and can move to any place on the left side of the "E" and the right of the overrrange digit.

Each character in the output statement is one byte and adds up to 14 bytes (the Carriage Return and Line Feed are one character each). The first digit (D) is the overrange digit and is either "1" or "0". The decimal point can be anywhere between the right of the overrange digit (shown in this example) and the left of the exponent ("E"). The Carriage Return and Line Feed are used to terminate the output statement. The End or Identify (EOI) line is normally set by the 3456A prior to the Line Feed if enabled. The EOI statement can be disabled over the HP-IB (see Paragraph 3-186).

3-176. Overload Output Statement. The output statement from an overload condition is in this form:



The overload polarlity depends on the type of overload condition. A "+" is normally output when a measurement overload is present. A "-" can be output when a math overload condition is present.

3-177. Multiple Reading Output. The output statement for multiple readings (Number of Readings per Trigger feature) is similar to the normal output statement. The only difference is that no Carriage Return (CR), Line Feed (LF), and End or Identify (EOI) is output until all readings are taken. A comma (,) is used in their place to separate the readings. An example for 3 multiple readings is as follows:

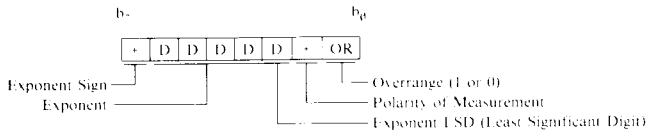
+ D.DDDDDDE + D,-DD.DDDDE + D,
+ DDD.DDDDE-D CR EOI LF

3-178. Packed Format.

3-179. Unlike the ASCII Format, the Packed Format outputs 4 bytes instead of 14. A faster reading transfer is possible using the Packed Format. Before the 3456A can output readings in the packed mode, it must be remotely programmed. The codes are "P1" (see Table 3-9) to enable and "P0" to disable the Packed Format. The ASCII Format is automatically selected at turn-on.

3-180. Output Statement. Once the 3456A is programmed to output data in the Packed Format, each measurement is output in 4 bytes. Each byte shows a certain part of the measurement data. Here is a graphic description of the packed mode.

First Byte



NOTE

The decimal point in the Packed Format is implied to the Overrange Digit's left.

5-9. ADJUSTMENT LOCATION.

5-10. All the adjustments for the 3456A are located behind a front panel section located at the front input terminals (see Figure 5-1). This section must be removed when doing any 3456A Adjustments. A procedure to remove the section is as follows:

a. Locate the front panel section.

b. Remove the section by loosening the hold down screws located at the section's left and right side.

c. Once the screws are loosened, remove the front panel section. One way to do it is to hold both of the loosened screws and pull the front panel section perpendicular and away from the 3456A's front.

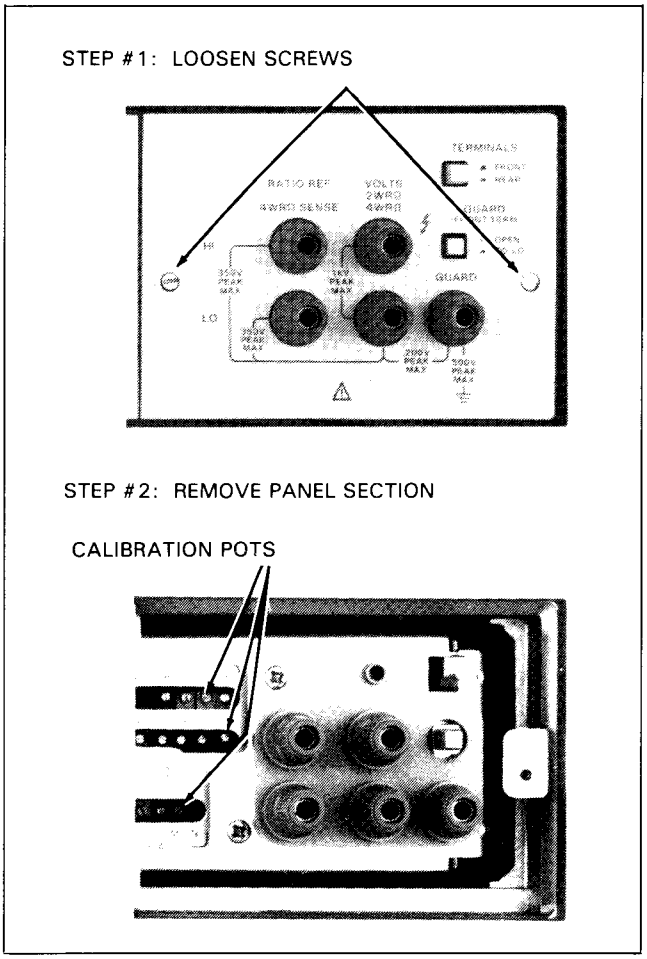


Figure 5-1. 3456A Adjustment Location.

5-11. DCV ADJUSTMENT.

5-12. The 3456A has to be warmed-up for at least 1 hour before doing any adjustments. The test equipment used for the DCV Performance Test is also used for the DCV Adjustments. Refer to Section IV, Paragraph 4-6 for the critical specifications and requirements.

5-13. Equipment Required.

Reference Divider (Fluke Model 750A)
DC Transfer Standard (Fluke Mode 731B)
DC Standard (Systron Donner Model M107)
DC Null Voltmeter (-hp- Model 419A)

5-14. Adjustment Procedure.

a. Press the 3456A's RESET button and set the instrument to the 6 digit mode by storing "6" into the N DIG DISP register.

b. Set the DC Transfer Standard for a 10 V output and connect it to the 3456A's VOLTS input terminals. Make sure the "+" output is connected to the 3456A's VOLTS HIGH terminal.

c. Adjust the 3456A's calibration potentiometer "B" for a +10.00000 V ± 1 count reading on the display. If unable to adjust to the required reading, go to the next step. If able to adjust to the required reading, go to Step e.

d. Do the following:

1. Turn calibration potentiometer "B" completely counterclockwise.

2. Turn adjustment "A" until the 3456A's reading is as close to +10 V as possible. If the reading is higher than +10.00000 V, turn adjustment "A" one position for a less than +10 V reading.

3. Adjust calibration pot "B" for a +10.00000 V ± 1 count reading.

e. Set the DC Transfer Standard to 1 V.

f. Adjust calibration pot "C" for a +1.000000 V ± 1 count reading.

g. Disconnect the DC Transfer Standard from the 3456A's input.

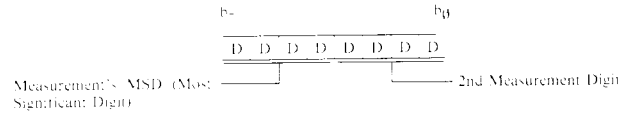
h. Set the 3456A to the 100 mV (100 -3) range and short the input terminals.

i. Turn on the 3456A's Null math feature, take an offset reading, and then remove the short.

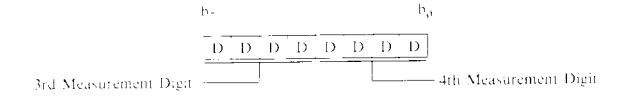
j. Using short pieces of number 20 AWG (or thinner) insulated solid copper wires, connect the Transfer Standard and the DC Null Voltmeter to the Reference Divider as shown in Figure 5-2 and 5-3.

k. Turn the DC Standard's output off. Using 24 inch or shorter shielded cables equipped with banana-plug connectors, connect the DC Standard and the 3456A to the Reference Divider as shown in Figure 5-2 and 5-3.

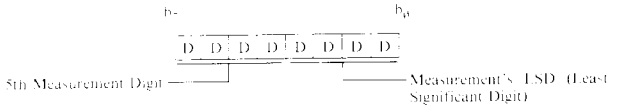
Second Byte



Third Byte



Fourth Byte



The sign (polarity) is indicated with "+" as a "0" and "-" as a "1". The exponent and the measurement digits are in packed Binary Coded Decimal (BCD). The decimal point is implied to the overrange digit's left. The End or Identify (EOI) line is normally set prior to the 4th byte.

3-181. Overload Output Statement. The Overload Output Statement in the Packed Format follows the same number convention as the ASCII overload statement. The difference is that the numbers representing the overload condition is output in the Packed mode.

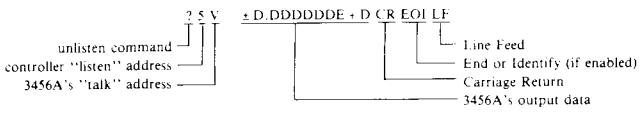
3-182. Multiple Reading Output. No delimiters are used between the readings with the End or Identify (EOI) being suppressed. The EOI will not be activated until all readings are output.

3-183. Unpacking the Packed Output. Since only four bytes of data is output in the Packed Format, some sort of unpacking should be done for the reading(s) to make sense. This is done simply by converting each 8 bit binary number to a decimal number. An unpacking program using Enhanced Basic (9835A/B, 9845B Controller Language) is in Appendix A.

3-184. Reading the 3456A's Output Data.

3-185. First choose the output format you wish to use. The ASCII Format is chosen in this example. To output data, the 3456A has to be addressed to "talk" and the device receiving the data is the listener. Here is an example.

a. HP-IB Format.



b. HPL (9825A Controller Language).

```
red 722,A
```

c. Enhanced Basic (9835A/B, 9845B Controller Language).

```
ENTER 722;A
```

NOTE

Although it is not specified in the HP-IB Format, the output of the 3456A is normally stored in a variable. This is the reason why variable "A" is used in the controller language examples.

3-186. Disabling the End or Identify (EOI) Statement.

3-187. The End or Identify (EOI) statement can be disabled over the HP-IB for a faster transfer of readings. This is done by sending program codes "O0" to the 3456A using the programming procedure in Paragraph 3-165. Disabling the EOI statement and using the 3456A's Internal Trigger mode allows the faster possible reading transfer. The EOI statement is enabled by sending codes "O1" and at turn-on.

3-188. System Output Mode.

3-190. With the 3456A's System Output Mode enabled, a new measurement cycle is not initiated until the present reading is output by the instrument. The reading is output by addressing the 3456A to "talk". Once this is done, a new measurement cycle is started. As long as the System Output mode is enabled and no reading is output, the instrument does not take any new readings. The mode is an advantage when using controllers slower than the 3456A. For example, if the Number of Readings per Trigger operation is selected to output readings, the readings are output one after another. A slow controller may not be able to accept the readings at the 3456A's output speed and loose some or all readings. The System Output mode prevents this from happening. The 3456A waits until the controller is able to receive data. The mode is enabled by sending program codes "SO1" and disabled by codes "SO0". Use the programming procedure in Paragraph 3-165 to send the codes.

3-191. Home Command.

3-192. The Home Command is used to reset the 3456A to the same conditions as sending the CLEAR message, except faster. The differences between Home, Clear, Reset, and Turn-On are listed in Table 3-6. The Home Command is sent by program code "H" using the programming procedure in Paragraph 3-165.

SECTION V
ADJUSTMENTS

5-1. INTRODUCTION.

5-2. This section of the manual has the complete adjustment procedure for the Model 3456A. After performing the adjustment procedure, the instrument should meet its 24 hour specifications. Included in this section is also a combined Performance Test and Adjustment Procedure. This may be used in place of the separate Performance Test and Adjustment procedure.

5-3. EQUIPMENT REQUIRED.

5-4. The test equipment required for each adjustment procedure is listed at the beginning of each procedure and also in Table 1-2 and 4-1. If the recommended test equipment is not available, use substitute equipment that meets the critical specification as listed in the tables. A summary of the test equipment's critical specifications and requirements is given in this Manual's Section IV Paragraph 4-4.

5-5. ADJUSTMENT INTERVAL.

5-6. The 3456A should be adjusted at a 90 day interval, after repair, or if it fails the Performance Test.

5-7. ADJUSTMENT SEQUENCE.

5-8. The 3456A Adjustments must be performed in the order they are presented in the procedure and Table 5-1, starting with the DCV Adjustment.

Table 5-1. 3456A Adjustments.

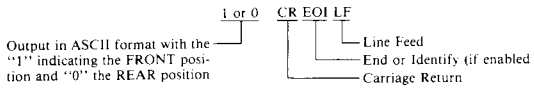
Step #	Adjustment Pot	3456A Function	3456A Range	Input to the 3456A	Displayed Reading	Tolerance in Counts	General and Set-Up Information
1							Reset the 3456A. Set to 6 digit. Connect GUARD to LOW.
2	A & B	DCV	10 V	+ 10 V DC	+ 10.00000	± 1	Adjustment "A" is coarse; "B" is fine.
3	C	DCV	1 V	+ 1 V DC	+ 1.000000	± 1	
4	D	DCV	100 mV	+ .1 V DC	+ 100.0000 -3	± 5	Enable the 3456A's Null Math feature to correct the 100 mV offset.
5	E	DCV	100 V	+ 100 V DC	+ 100.0000	± 1	
6							Set the 3456A to the 4-Wire Ohms function.
7	F	4-W Ohms	10 kΩ	10 K ohm	10.00000 + 3	± 1	
8	G	4-W Ohms	1 kΩ	1 K ohm	1000.000	± 1	
9	H	4-W Ohms	100 kΩ	100 K ohm	100.0000 + 3	± 1	
10	I	4-W Ohms	1000 kΩ	1 M ohm	1000.000 + 3	± 2	
11	J	4-W Ohms	10 MΩ	10 M ohm	10.00000 + 6	± 10	
12							Set the 3456A to the 5 Digit mode. Repeat Steps 13, 14, and 15 until readings converge.
13	K	ACV	100 V	1 V, 1 kHz	01.000	± 1	
14	L	ACV	1 V	1 V, 1 kHz	1.00000	± 3	
15	M or N	ACV	1000 V	1 V, 1 kHz	001.00	± 6	
16	N	ACV + DCV	1 V	Short	Minimum	± 2	
17	M	ACV	1 V	Short	See Note	± 2	Repeat Steps 16 and 17 until readings converge.

Note: For steps 16 and 17, do the following:

1. Note the 3456A's reading after adjusting pot "N".
2. Adjust pot "M" for a minimum reading and then continue adjusting the pot until the noted reading in Step 16 is reached.

3-193. Front/Rear Switch Position.

3-194. The Front/Rear Switch position can be remotely determined over the HP-IB. This is done by sending program codes "SW1" to the 3456A and then reading its output. If "0" is output, the switch is set to REAR and "1" indicates FRONT. Use the programming procedure in Paragraph 3-165 to send the codes and the procedure in Paragraph 3-184 to read the output data (switch position). The output is as follows:



3-195. Complete Program Example.

3-196. After you know how to program the 3456A using the HP-IB, the next step is to write a program of the algorithm in Paragraph 3-162. Again, the program is given in the HP-IB Format, HPL (9825A Controller Language), and Enhanced Basic (9835A/B, 9845B Controller Language).

a. HP-IB Format.

1. Interface clear	ABORT all previous operation
2. ?U6	REMOTE the 3456A
3. ?U6 *004*	CLEAR the instrument
4. *021*	LOCAL LOCKOUT the 3456A (including the other devices on the controller's select code)
5. ?U6 F1R1T4SM020 *15 12*	Send DATA to set up the instrument to the dc function, autorange, hold trigger, and set SRQ bit 4 mask (15 is CR and 12 is LF)
6. ?U6 *010*	TRIGGER the 3456A
7. ?U5V +D.DDDDDDE+D *015* EOI *012*	Send the measurement DATA to the controller and store in a variable
8. ?5V *030*	If REQUIRE SERVICE, check the STATUS BYTE; otherwise skip the next step (the 030 is the Serial Poll enable)
9, 10. *031*	No STATUS BYTE is sent by the 3456A (the 031 is the Serial Poll disable)
11. Controller Language	Print out the DATA in variable A
12. ?U, *001*	CLEAR LOCKOUT AND SET LOCAL (in this case, only for the 3456A)
13. Controller Language	Ends the program

b. HPL (9825A Controller Language).

0: cli 7	ABORT
1: rem 722	REMOTE 3456A
2: clr 722	CLEAR 3456A
3: llo 7	LOCAL LOCKOUT
4: wrt 722, "F1R1T4SM020"	DATA. Set up instrument
5: trg 722	TRIGGER 3456A
6: red 722,A	DATA.Output of 3456A into variable
7: rds (722) → S	REQUIRE SERVICE?
8: if S=0; gto 10	If no STATUS BIT, skip the next line
9: stp	Stop the program
10: prt A	Print output DATA in variable
11: lcl 722	CLEAR LOCKOUT AND SET LOCAL (3456A)
12: end	Ends the program

c. Enhanced Basic (9835A/B, 9845B Controller Language).

10 ABORTIO 7	ABORT
20 REMOTE 722	REMOTE 3456A
30 CLEAR 722	CLEAR 3456A
40 LOCAL LOCKOUT 7	LOCAL LOCKOUT
50 OUTPUT 722; "F1R1T4SM020"	DATA. Set up instrument
60 TRIGGER 722	TRIGGER 3456A
70 ENTER 722;A	DATA. Output of 3456A into variable
80 STATUS 722;S	REQUIRE SERVICE?
90 IF S=0 THEN GOTO 110	If no STATUS BIT, skip the next line
100 STOP	Stop the program
110 PRINT A	Print output DATA in variable
120 LOCAL 722	CLEAR LOCKOUT AND SET LOCAL
130 END	Ends the program

3-197. The information you have received in the preceding paragraphs should give you a good start in programming the 3456A over the HP-IB. The following paragraphs explain some more unique remote operations.

3-198. Front Panel SRQ.

3-199. The Front Panel SRQ feature of the 3456A outputs a Require Service Message when the Front Panel SRQ button is pressed. Before this can take place, set bit 0 on the SRQ mask (refer to Paragraph 3-169 to set the mask). Once this is done, press the SRQ button. The front panel SRQ LED will turn on and the Require Service Message is output. This condition will remain until

PERFORMANCE TEST RECORD

90 DAY LIMITS

HEWLETT–PACKARD MODEL 3456A

DIGITAL VOLTMETER

SERIAL NO. _____

Test Performed By _____

Date _____

ACV Test Temperature = 23°C ± 1°C

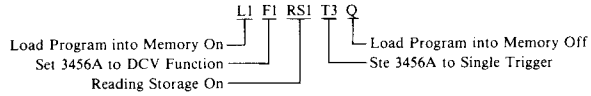
Step #	Input to 3456A	Set-Up and Configuration	High Limit	Reading	Low Limit	Test Pass	Test Fail
1	Open	Press RESET	- - -	- - -	- - -	- - -	- - -
2	.01 V DC	ACV + DCV	.01072	_____	.00928	_____	_____
3	.01 V, 1 kHz	ACV	.01071	_____	.00929	_____	_____
4	0.1 V, 1 kHz	ACV	.10077	_____	.09923	_____	_____
5	0.5 V, 1 kHz	ACV	.50105	_____	.49895	_____	_____
6	1.0 V, 1 kHz	ACV	1.00140	_____	.99860	_____	_____
7	10 V, 1 kHz	ACV	10.0140	_____	9.9860	_____	_____
8	100 V, 1 kHz	ACV	100.140	_____	99.860	_____	_____
9	700 V, 1 kHz	ACV	701.68	_____	698.32	_____	_____
10	.01 V, 100 kHz	ACV	.01296	_____	.00704	_____	_____
11	1.0 V, 100 kHz	ACV	1.00840	_____	.99160	_____	_____
12	10 V, 100 kHz	ACV	10.0840	_____	9.9160	_____	_____
13	100 V, 100 kHz	ACV	100.840	_____	99.160	_____	_____
14	700 V, 100 kHz	ACV	707.24	_____	692.76	_____	_____
15	1.0 V, 250 kHz	ACV	1.05650	_____	.94350	_____	_____
16	10 V, 250 kHz	ACV	10.5650	_____	9.4350	_____	_____
17	1.0 V, 20 Hz	Filter On	1.00400	_____	.99600	_____	_____
18	1.0 V, 20 Hz	ACV + DCV	1.00400	_____	.99600	_____	_____

the SRQ button is pressed a second time or a Serial Poll is done by the controller.

3-200. Instrument Program Memory Operation.

3-201. With this feature, you can store into the 3456A's internal memory any valid remote operations (excluding Test and Program Memory Execution) using program codes. Total available memory size is 1400 bytes. Because a program code takes one byte of memory you can store 1400 codes. The memory is also used with Reading Storage and any stored codes takes space away for storing readings.

3-202. Storing Program Codes. The 3456A has to be told to store into its internal memory. The program used are "L1" to enable the storage and "Q" to disables the storage. This is illustrated in the following example.



Program codes "L1" and "Q" are not stored into memory. The total memory used is 7 bytes. The codes remain in memory until the 3456A is turned off (Reset, Clear, and Home do not clear the memory). The memory can be cleared by sending codes "L1Q".

NOTE

Unlike regular remote operation, program memory only ignores blanks. Other invalid characters can produce a Syntax Error during program memory execution.

3-203. Program Execution. Once the program codes are stored in memory they can be executed. This is done by sending program codes "X1" to the 3456A. The instrument then performs the operation. In the previous example, when Program Memory is executed, a dc reading is taken and stored into memory.

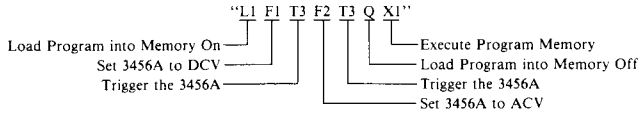
NOTE

The Execute (X1) and Internal Test (TE1) codes can cause a program memory execution error.

NOTE

With Home (H) command stored in program memory while executing the memory the 3456A is reset to the Turn-On state and stops the program memory operation.

3-204. Multiple Operations. You can store and execute more than one remote operation into memory. For example, the 3456A can be programmed to do a DCV measurement, Trigger it, do an ACV measurement, Trigger it, and so on. The next example illustrates this.



3-205. Recall of Readings from Memory. Readings are remotely recalled and output from memory similar to the front panel recall operation (see Paragraph 3-104). This is done by storing into register R the corresponding number of the reading you wish to recall. Then recall the register and output the reading. The following procedure illustrates this operation. In the procedure, reading #1 and #2 are to be recalled.

a. Set the 3456A to listen. Send the program codes for Hold Trigger, Reading Storage On, and store a "1" (reading #1) into register R.

"T4 RS1 1STR"

b. Send program codes to recall the R register.

"RER"

c. Set the 3456A to talk. Output the reading (#1) over the HP-IB.

d. Set the 3456A to listen. Send the program codes to store a "2" (reading #2) into register R.

"2STR"

e. Send program codes to recall the R register.

"RER"

f. Set the 3456A to talk. Output the reading (#2) over the HP-IB.

NOTE

Make sure the 3456A is programmed to Hold or Single Trigger when recalling readings.

The remote recall operation is similar to the front panel operation. Scrolling is also done similar to front panel operation. An example to scroll the readings, starting with #10, is as follows.

a. Set the 3456A to listen. Send program codes for Hold Trigger, Reading Storage On, and store "-10" into register R. (The -10 is used to scroll the readings starting with reading #10.)

"T4 RS1 – 10STR"

PERFORMANCE TEST RECORD

90 DAY LIMITS

HEWLETT–PACKARD MODEL 3456A

DIGITAL VOLTMETER

SERIAL NO. _____

Test Performed By _____

Date _____

Ohms Test Temperature = 23°C ± 1°C

Step #	Input to 3456A	Set-Up and Configuration	High Limit	Reading	Low Limit	Test Pass	Test Fail
1	Open	Press RESET	- - -	- - -	- - -	- - -	- - -
3	Open	Set to 6 dig. resolution	- - -	- - -	- - -	- - -	- - -
4	4-Wire Short	2-Wire Ohms	00.2024	_____	-00.0024	_____	_____
5	4-Wire Short	4-Wire Ohms	00.0024	_____	-00.0024	_____	_____
6	10 kΩ	Autorange	10.00034 + 3	_____	9.99966 + 3	_____	_____
7	1 kΩ	Autorange	1000.034	_____	999.966	_____	_____
8	100	Autorange	100.0064	_____	99.9936	_____	_____
9	100 kΩ	Autorange	100.0032 + 3	_____	99.9968 + 3	_____	_____
10	1 MΩ	Autorange	1000.072 + 3	_____	999.928 + 3	_____	_____
11	10 MΩ	Autorange	10.00422 + 6	_____	9.99578 + 6	_____	_____
12	1 GΩ	Autorange	1160.001 + 6	_____	893.999 + 6	_____	_____
13	1 MΩ	2-Wire Ohms	1000.072 + 3	_____	999.928 + 3	_____	_____
14	10 kΩ	4-Wire Ohms 100 K Range	10.0005 + 3	_____	9.9995 + 3	_____	_____
15	10 kΩ	Autozero Off	10.0007 + 3	_____	9.9993 + 3	_____	_____
16	100 kΩ	Autozero On 2-Wire O.C.	100.0034 + 3	_____	99.9966 + 3	_____	_____
17	100 kΩ	4-Wire O.C.	100.0032 + 3	_____	99.9968 + 3	_____	_____

b. Send program codes to recall the R register.

"RER"

c. Set the 3456A to talk. The readings are now output over the HP-IB starting with reading #10 and ending with #1.

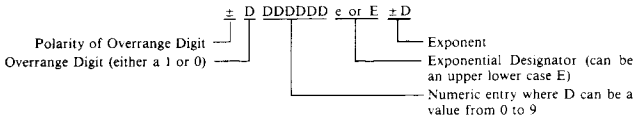
In the example, multiple readings are output the same as explained in paragraph 3-177. A program example using HPL (9825A Controller Language) and Enhanced Basic (9835A/B and 9845B Controller Language) is given in Appendix A.

3-206. Data Ready.

3-207. The Data Ready feature, when enabled, outputs a Require Service Message for a completed measurement cycle. The SRQ mask has to be set before the message is output. Set the mask by sending program codes "SM004" (for bit 2 of the Status Byte). When the Require Service message is sent, the front panel SRQ LED is on. The LED remains on until a new measurement cycle is started (the 3456A is triggered), when the present reading is output over the HP-IB, or when the 3456A is polled (Serial Poll). If the 3456A is set up to take a number of readings per trigger, the require service condition will be true, at the end of each reading, for about 320μs. The condition will remain true and the SRQ LED turns on, after all the readings are taken.

3-208. 3456A's Numeric Entry Format and other Input Considerations.

3-209. The 3456A's Numeric Entry Format (used in program codes) are in this form:



The decimal point is optional and ranges from the right of the overrange digit to the Exponential Designator's left.

3-210. When sending data to the 3456A in remote, all lower case (except "e") alpha characters, spaces, carrage return, and line feed are ignored. All other invalid ASCII characters are illegal. The optional "W" character can be used as a prefix to a numeric string like this"

F1W10STN

3-211. OPERATOR'S CHECK.

3-212. The following is an Operator's Check you can perform to check the major DCV, ACV, Ohms, and Digital circuitry. The checks are not used to verify performance accuracy. They are only used to check the operating capabilities of the 3456A. The following can be used as the Operator's Check.

a. Remove everything from the 3456A's input terminals.

b. press the TEST button. The display should go blank while doing an internal test. When the test passes and is completed, +1.8.8.8.8.8.8.+8. is displayed including all of the front panel LEDs. The cycle will then be repeated. If a negative integer is displayed, refer the 3456A to a service trained person. Press the TEST button a second time.

PERFORMANCE TEST RECORD

90 DAY LIMITS

HEWLETT-PACKARD MODEL 3456A

DIGITAL VOLTMETER

SERIAL NO. _____

Test Performed By _____

Date _____

DCV Test Temperature = 23°C ± 1°C

Step #	Input to 3456A	Set-Up and Configuration	High Limit	Reading	Low Limit	Test Pass	Test Fail
1	Open	Self Test	- - -	- - -	- - -	- - -	- - -
2	Open	Press RESET	- - -	- - -	- - -	- - -	- - -
3	Open	Set to 6 dig. resolution	- - -	- - -	- - -	- - -	- - -
4	Short	.1 V Range	+00.0024 -3	_____	-00.0024 -3	_____	_____
5	Short	1 V Range	+.000004	_____	-.000004	_____	_____
6	Short	10 V Range	+0.00002	_____	-0.00002	_____	_____
7	Short	100 V Range	+00.0003	_____	-00.0003	_____	_____
8	Short	1 kV Range	+000.002	_____	-000.002	_____	_____
9	+10 V DC	Autorange	+10.00025	_____	+9.99975	_____	_____
10	+1 V DC	Autorange	+1.000028	_____	+.999972	_____	_____
11	+.1 V DC	Autorange	+100.0058 -3	_____	+99.942 -3	_____	_____
12	+100 V DC	Autorange	+100.0029	_____	+99.9971	_____	_____
13	+1000 V DC	Autorange	+1000.146	_____	+999.874	_____	_____
14	-1 V DC	10 V Range	-1.00004	_____	-.99996	_____	_____
15	-5 V DC	10 V Range	-5.00014	_____	-4.99986	_____	_____
16	-10 V DC	10 V Range	-10.00025	_____	-9.99975	_____	_____
17	-10 V DC	Int. = 100	-10.00025	_____	-9.99975	_____	_____
18	-10 V DC	Int. = 1	-10.00027	_____	-9.99973	_____	_____
19	-10 V DC	Int. = .1	-10.0009	_____	-9.9991	_____	_____
20	-10 V DC	Int. = .01	-10.008	_____	-9.992	_____	_____
21	-10 V DC	Int. = 10, Filter On	-10.00025	_____	-9.99975	_____	_____
22	-10 V DC	Filter Off, Autozero Off	-10.00026	_____	-9.99974	_____	_____
23	Open	Press RESET	- - -	- - -	- - -	- - -	- - -
24	10 V DC to REF H to V H and REF L to V L	DCV/DCV Ratio	1.00005	_____	.99995	_____	_____
25	10 V DC to REF H to V H and REF L to V L	ACV+DCV/DCV Ratio	1.00143	_____	.99857	_____	_____
26	See Below	CMR Test	- - -	- - -	- - -	- - -	- - -

CMR Test

1. Connect a 1 K ohm resistor between the HIGH and LOW VOLTS terminals and connect GUARD to VOLTS HIGH.
2. Take a reading.
3. Apply 100 V dc between the 3456A's chassis and VOLTS HIGH terminal.
4. The 3456A reading should be within .00001 V of reading in Step 2.

NOTE

Do the tests in the order they are given since, for example, the Reset will set-up the 3456A to a certain configuration (5 digit mode, etc.).

PERFORMANCE TEST RECORD

24 HOUR LIMITS

HEWLETT–PACKARD MODEL 3456A

DIGITAL VOLTMETER

SERIAL NO. _____

Test Performed By _____

Date _____

ACV Test Temperature = 23°C ± 1°C

Step #	Input to 3456A	Set-Up and Configuration	High Limit	Reading	Low Limit	Test Pass	Test Fail
1	Open	Press RESET	- - -	- - -	- - -	- - -	- - -
2	.01 V DC	ACV + DCV	.01057	_____	.00943	_____	_____
3	.01 V, 1 kHz	ACV	.01056	_____	.00944	_____	_____
4	0.1 V, 1 kHz	ACV	.10060	_____	.09940	_____	_____
5	0.5 V, 1 kHz	ACV	.50080	_____	.49920	_____	_____
6	1.0 V, 1 kHz	ACV	1.00105	_____	.99895	_____	_____
7	10 V, 1 kHz	ACV	10.0105	_____	9.9895	_____	_____
8	100 V, 1 kHz	ACV	100.105	_____	99.895	_____	_____
9	700 V, 1 kHz	ACV	701.39	_____	698.61	_____	_____
10	.01 V, 100 kHz	ACV	.01275	_____	.00725	_____	_____
11	1.0 V, 100 kHz	ACV	1.00800	_____	.99200	_____	_____
12	10 V, 100 kHz	ACV	10.0800	_____	9.9200	_____	_____
13	100 V, 100 kHz	ACV	100.800	_____	99.200	_____	_____
14	700 V, 100 kHz	ACV	706.90	_____	693.10	_____	_____
15	1.0 V, 250 kHz	ACV	1.05630	_____	.94370	_____	_____
16	10 V, 250 kHz	ACV	10.5630	_____	9.4370	_____	_____
17	1.0 V, 20 Hz	Filter On	1.00360	_____	.99640	_____	_____
18	1.0 V, 20 Hz	ACV + DCV	1.00360	_____	.99640	_____	_____

SECTION IV
PERFORMANCE TEST

4-1. INTRODUCTION.

4-2. This section has the Performance Test procedures to verify the 3456A's Accuracy Specifications, as listed in Table 1-1. The tests are done without removing any instrument covers. An HP-IB test is not performed since the HP-IB Verification Tape is for that purpose. In addition, no Math Operation checks are made since math accuracy depends on instrument function accuracy.

4-3. In many instances, a Performance Test is done after adjusting the 3456A. Since both the Performance Test and Adjustment procedures use the same test equipment, a combined procedure is in this Manual's Section V, Paragraph 5-21.

4-4. EQUIPMENT REQUIRED.

4-5. All of the required test equipment for the tests is listed in Tables 1-2 and 4-1. The required equipment for each individual test is listed at the beginning of each test. If any recommended test equipment is not available, substitute equipment may be used. A short description of the required equipment and the critical requirements necessary to do the various tests is given in the following paragraphs. This information may be helpful in choosing substitute equipment.

4-6. DCV Test.

4-7. For the DCV Test a dc transfer standard is required which is calibrated to a 1.017 V to 1.019 V standard cell. The standard cell's accuracy should be calibrated by and traceable to the National Bureau of Standards (NBS). If the 3456A is to be calibrated to its 24 hour accuracy specifications, the transfer standard must be adjusted for an optimum 1 V and 10 V output using an NBS calibrated standard cell. The standard should be adjusted shortly before testing the 3456A's dc accuracy. It is also recommended to leave the transfer standard in a controlled environment where the ambient temperature is within one or two degrees of the temperature in which it was calibrated. The 3456A should also be tested in this environment. If the recommended transfer standard is not available, use an NBS calibrated standard cell (1.017 V to 1.019 V) or another transfer standard. If another standard is used, use the recommended reference divider, shown in Figure 4-2, for all DCV accuracy tests (including 1 V and 10 V). A simplified schematic of the reference divider and associated set-up is in Figure 4-3. The following lists some of the test equipment and their critical requirements.

a. DC Transfer Standard. The DC Transfer Standard chosen for the DCV Test is the Fluke Model 731B DC Reference Standard. The critical requirements are:

1. Required output voltage is 1.018 V or 1.019 V. A transfer standard with 1.017 V capability can also be used.

2. Additional required output voltages are 1 V and 10 V.

3. Accuracy requirement is at least ± 5 ppm (± .0005%).

4. Stability is better than ± 10 ppm (± .001%) for 30 days.

b. DC Voltage Standard. The DC Voltage Standard chosen for the DCV Test is the Systron Donner Model M107 Precision Voltage Source. The critical requirements are:

1. Output from 10 mV to 1000 V dc.

2. Within ± .005% full scale accuracy.

3. Short term stability better than .0002% per hour.

c. Reference Divider. The recommended reference divider is the Fluke Model 750A Reference Divider. The critical specifications are:

1. Output voltage range is from .1 V to 1000 V.

2. Division accuracy is better than ± .001%.

4-8. Ohms Test.

4-9. For the Ohms Test use the recommended standard resistors. If the resistors are not available, use substitutes that meet the critical requirements, as given below. If a substitute is not available you may be able to use a calibrated decade resistor with settings that range from 100 ohm to 10 M ohm. The correction factors on the decade resistor's calibration chart must be algebraically added to the 3456A's reading to achieve the required accuracy. The 1000 M ohm resistor, -hp- Part Number 03456-67902, is also required when using the decade resistors. The standard resistors and their critical requirements are:

a. 100 ohm and 1 K ohm standard resistors. The recommended resistors are the Guildline Model

PERFORMANCE TEST RECORD

24 HOUR LIMITS

HEWLETT–PACKARD MODEL 3456A

DIGITAL VOLTMETER

SERIAL NO. _____

Test Performed By _____

Date _____

Ohms Test Temperature = 23°C ± 1°C

Step #	Input to 3456A	Set-Up and Configuration	High Limit	Reading	Low Limit	Test Pass	Test Fail
1	Open	Press RESET	- - -	- - -	- - -	- - -	- - -
3	Open	Set to 6 dig. resolution	- - -	- - -	- - -	- - -	- - -
4	4-Wire Short	2-Wire Ohms	00.2024	_____	-00.0024	_____	_____
5	4-Wire Short	4-Wire Ohms	00.0024	_____	-00.0024	_____	_____
6	10 kΩ	Autorange	10.00024 + 3	_____	9.99976 + 3	_____	_____
7	1 kΩ	Autorange	1000.024	_____	999.976	_____	_____
8	100 Ω	Autorange	100.0054	_____	99.9946	_____	_____
9	100 kΩ	Autorange	100.0022 + 3	_____	99.9978 + 3	_____	_____
10	1 MΩ	Autorange	1000.062 + 3	_____	999.938 + 3	_____	_____
11	10 MΩ	Autorange	10.00412 + 6	_____	9.99588 + 6	_____	_____
12	1 GΩ	Autorange	1110.001 + 6	_____	889.999 + 6	_____	_____
13	1 MΩ	2-Wire Ohms	1000.062 + 3	_____	999.938 + 3	_____	_____
14	10 kΩ	4-Wire Ohms 100 K Range	10.0004 + 3	_____	9.9996 + 3	_____	_____
15	10 kΩ	Autozero Off	10.0006 + 3	_____	9.9994 + 3	_____	_____
16	100 kΩ	Autozero On 2-Wire O.C.	100.0024 + 3	_____	99.9976 + 3	_____	_____
17	100 kΩ	4-Wire O.C.	100.0022 + 3	_____	99.9978 + 3	_____	_____

9330/100 or 9330A/100 for the 100 ohm resistor and the Guildline Model 9330/1K or 9330A/1K for the 1 K ohm resistor. An accuracy of ± .0005% or better is the critical requirement.

b. 10 K ohm and 100 K ohm standard resistors. The recommended resistors are the Guildline Model 9330/10K or 9330A/10K for the 10 K ohm resistor and the Guildline Model 9330/100K or 9330A/100K for the 100 K ohm resistor. An accuracy of ± .001% or better is the critical requirement.

c. 1 M ohm standard resistor. The recommended resistor is the Guildline Model 9330/1M resistor with a ± .002% or better accuracy as the critical requirement.

d. 10 M ohm standard resistor. The recommended resistor is the Guildline Model 95206 with a ± .01% or better accuracy as the critical requirement.

e. 1000 M ohm standard resistor. The recommended resistor has the -hp- Part Number 03456-67902 with a ± 2% or better accuracy as the critical requirement.

4-10. ACV Test.

4-11. For the ACV Test an ac calibrator is required with a frequency range of 20 Hz to 250 kHz and a voltage range of 10 mV to 700 V. To minimize measurement uncertainties, especially below 50 Hz, the recommended ac calibrator should be calibrated. Additionally, any errors indicated on the calibrator's calibration chart should be adjusted out by adjusting its error measurement control. For example, the calibration chart indicates an output error of + .1% at 20 Hz. To output a precise 1 V, adjust the error measurement control to + .1%.

4-12. If a substitute calibrator is used which does not output a 250 kHz voltage, use the procedure in Paragraph 4-44 for the 250 kHz check. An -hp- Model 652A Test Oscillator in conjunction with the substitute calibrator is used to for the 250 kHz check. The ACV Test equipment is:

a. AC Calibrator. The recommended ac calibrator is the Fluke Model 5200A/5215A Precision AC Calibration System. The critical requirements are:

1. Frequency Response: 20 Hz to 250 kHz.

2. Output Voltage: 10 mV to 700 V.

3. Accuracy: ± .05%

4. Stability: ± .1% for a 6 months period.

b. DC Voltage Standard. The same as for the DCV Test.

4-13. TEST CARDS.

4-14. Performance Test Cards are provided at the end of this section to be used to record the 3456A's performance. It is recommended to remove the cards from the manual and fill them out while doing the test, since the test limits are printed on the cards. The cards can also be used as a permanent record and may be reproduced without a written permission from Hewlett-Packard.

4-15. CALIBRATION CYCLE.

4-16. A periodic performance verification is required for the 3456A. This should be done as part of an incoming inspection test and at a 90 day interval, depending on your environmental condition and accuracy requirements. The Performance Test can be performed for the incoming inspection test, 90 day test, and after adjustments.

4-17. TEST FAILURE.

4-18. If the 3456A fails any of the Performance Tests, perform the necessary adjustments as given in this Manual's Section V. It is also noted in the test procedures themselves when and what adjustment(s) should be performed when a certain test fails. For example, if the 3456A's 10 V reading fails, do the DCV Adjustment. This should be done before continuing with the rest of the test since an uncalibrated 10 V will probably show other DCV and Ohms failures. If the failure cannot be corrected by adjustments, refer the 3456A to a service trained person.

4-19. INSTRUMENT SET-UP.

4-20. Instrument set-up is specified in each test procedure. Also note that instument set-up is also determined by other parameters, like pressing the RESET button. This will automatically set the 3456A, for example, to the DCV function, Autorange, and 5 digit mode. Because of this, it is important to follow the procedures in the given order.

4-21. Unless otherwise specified, the Performance Test signals can be applied either to the FRONT or REAR input terminals. Make sure the FRONT/REAR switch is in the correct position before applying the signals.

PERFORMANCE TEST RECORD

24 HOUR LIMITS

HEWLETT—PACKARD MODEL 3456A

DIGITAL VOLTMETER

SERIAL NO. _____

Test Performed By _____

Date _____

DCV Test Temperature = 23°C ± 1°C

Step #	Input to 3456A	Set-Up and Configuration	High Limit	Reading	Low Limit	Test Pass	Test Fail
1	Open	Self-Test	- - -	- - -	- - -	_____	_____
2	Open	Press RESET	- - -	- - -	- - -	- - -	- - -
3	Open	Set to 6 dig. resolution	- - -	- - -	- - -	- - -	- - -
4	Short	.1 V Range	+00.0024 -3	_____	-00.0024 -3	_____	_____
5	Short	1 V Range	+.000004	_____	-.000004	_____	_____
6	Short	10 V Range	+0.00002	_____	-0.00002	_____	_____
7	Short	100 V Range	+00.0003	_____	-00.0003	_____	_____
8	Short	1 kV Range	+000.002	_____	-000.002	_____	_____
9	+10 V DC	Autorange	+10.00010	_____	+9.99990	_____	_____
10	+1 V DC	Autorange	+1.000013	_____	+.999987	_____	_____
11	+.1 V DC	Autorange	+100.0046 -3	_____	+99.9954	_____	_____
12	+100 V DC	Autorange	+100.0014	_____	+99.9986	_____	_____
13	+1000 V DC	Autorange	+1000.133	_____	+999.867	_____	_____
14	-1 V DC	10 V Range	-1.00003	_____	-.99997	_____	_____
15	-5 V DC	10 V Range	-5.00006	_____	-4.99994	_____	_____
16	-10 V DC	10 V Range	-10.00010	_____	-9.99990	_____	_____
17	-10 V DC	Int. = 100	-10.00010	_____	-9.99990	_____	_____
18	-10 V DC	Int. = 1	-10.00014	_____	-9.99986	_____	_____
19	-10 V DC	Int. = .1	-10.0009	_____	-9.9991	_____	_____
20	-10 V DC	Int. = .01	-10.008	_____	-9.992	_____	_____
21	-10 V DC	Int. = 10, Filter On	-10.00010	_____	-9.99990	_____	_____
22	-10 V DC	Filter Off, Autozero Off	-10.00011	_____	-9.99989	_____	_____
23	Open	Press RESET	- - -	- - -	- - -	- - -	- - -
24	10 V DC to REF H to V H and REF L to V L	DCV/DCV Ratio	1.00002	_____	.99998	_____	_____
25	10 V DC to REF H to V H and REF L to V L	ACV+DCV/DCV Ratio	1.00111	_____	.99889	_____	_____
26	See Below	CMR Test	- - -	- - -	- - -	- - -	- - -

CMR Test

1. Connect a 1 K ohm resistor between the HIGH and LOW VOLTS terminal and connect GUARD to VOLTS HIGH.
2. Take a reading.
3. Apply 100 V dc between the 3456A's chassis and VOLTS HIGH terminal.
4. The 3456A reading should be within .00001 V of reading in Step 2.

NOTE

Do the tests in the order they are given since, for example, the Reset will set-up the 3456A to a certain configuration (5 digit mode, etc.).

Table 4-1. Recommended Test Equipment

Instrument	Critical Specification	Recommended Model	Use
DC Voltage Standard	Voltage: 10mV to 1000V Accuracy: ± .005%	Systron Donner Model M107	PAT
DC Transfer Standard	Output Voltages:1V, 10V, 1.018V, 1.019V Accuracy: ± 5ppm Stability: ± .001% (30 Days)	Fluke Model 731B	PA
AC Calibrator	Frequency: 20 Hz to 250 kHz Output Level: 100mV to 1000V Accuracy: ± .1% Voltage Stability (6 mos.) ± .02%	Fluke Model 5200A and Model 5215A	PAT
Reference Divider	Division Ratio Accuracy: ± .001% Output Voltage Range: 1V to 1kV	Fluke Model 750A	PA
Resistance Standard	Resistance: 100Ω Accuracy: ± .0005%	Guildline Model 9330/100 or 9330A/100	P
	Resistance: 1kΩ Accuracy: ± .0005%	9330/1K or 9330A/1K	PA
	Resistance: 10kΩ Accuracy: ± .001%	9330/10K or 9330A/10K	PA
	Resistance: 100kΩ Accuracy: ± .001%	9330/100K or 9330A/100K	PA
	Resistance: 1MΩ Accuracy: ± .002%	9330/1M	PA
	Resistance: 10MΩ Accuracy: ± .01%	9330/10M	PA
	Resistance*: 1GΩ Accuracy: ± 2%	-hp- Part No. 03456-67902	P
DC Null Voltmeter	Voltage Range: 1μV to 10V	-hp- Model 419A	PA
Bus System Analyzer**	HP-IB Control Capability	-hp- Model 59401A	T
Desktop Computer	HP-IB Control Capability serves as printer for output data	-hp- Model 9825A, 9825B, 9835A, 9845B, or 85A	OT
Oscilloscope**	Bandwidth: DC to 100 MHz Sweep Time: 50ns to 20ms/div	-hp- Model 1740A	T
Digital Voltmeter**	Voltage Range: 100μV to 1000V Resolution: 1 μV	-hp- Model 3456A (or 3455A)	T
Resistors	Resistances: 1 kΩ ± 10%	-hp- Part No. 0684-1021	
Signature Analyzer**		-hp- Model 5004A	T
Test Program Cartridges*		-hp- Part Number 03456-10001 (9825A/B) 03456-10002 (9835A, (9845A/B) 03456-10003 (85A)	T
Isolation Logic Test Jumper*		-hp- Part No. 03456-61602	T
HP-IB Signature Analysis Modules*,**		-hp- Part Number 5061-1153 5061-1154 5061-1155	T

*These items included in 3456A Digital Voltmeter Service Kit for Component Level Repair (-hp- Part Number 03456-69800)

**These items are not required if a board level repair strategy is to be used. This strategy does require a 3456A Digital Voltmeter Service Kit for Board Level Repair (-hp- Part Number 03456-69801).

P = Performance Test T = Troubleshooting
A = Adjustment O = Operators Check

k. Set the AC Calibrator for a 1 V, 20 Hz output and turn the 3456A's Filter "ON". Record and check the reading.

l. Set the 3456A to the ACV + DCV function. Record and check the reading. If any of previous tests fail, do the ACV Adjustment in Section V. This completes the ACV Test.

4-45. Alternate 250 kHz ACV Test.

4-46. The following test is an alternate 250 kHz test which can be used with AC Calibrators that do not have 250 kHz output capabilities. Use a Test Oscillator, such as the -hp- Model 652A, to do the alternate 250 kHz accuracy test (specified for 1 V and 10 V ranges only). The accuracy is obtained by adjusting the oscillator until its 10 kHz output is the same as the AC Calibrator's 10 kHz output, as read on the 3456A. This reference level is maintained by the Oscillator within ± .25% when set-up for a 250 kHz output (using the Oscillator's expanded-scale meter).

4-47. Equipment Required.

AC Calibrator
Test Oscillator (-hp- Model 652A)

4-48. Test Procedure.

a. Press the 3456A's RESET button. Set the instrument to the ACV function.

b. Set the AC Calibrator for a 1 V, 10 kHz output and connect it to the 3456A's input terminals. Record the reading.

c. Set the AC Calibrator for a 6 V, 10 kHz output. Record the reading.

d. Disconnect the AC Calibrator from the 3456A.

e. Set the Test Oscillator for a 1 V, 10 kHz output and terminate its output with a 50 ohm load. Connect the Oscillator to the 3456A's input terminals.

f. Adjust the Test Oscillator's level controls for a reading on the 3456A to the noted reading in Step b. Set the Test Oscillator's meter switch to "expanded scale" and adjust the meter reference controls for a zero reading on the Oscillator's meter. Use the Oscillator's level controls to maintain the zero reading when varying the frequency.

g. Set the Test Oscillator for a 1 V, 250 kHz output while maintaining the reference level on the meter. Check and record the 3456A's reading.

h. Remove the 50 ohm termination from the Test Oscillator and reconnect the Oscillator to the 3456A. Set the Test Oscillator for a 6 V, 10 kHz output.

i. Adjust the Test Oscillator's level controls for a reading on the 3456A to the noted reading in Step c. Set the Test Oscillator's meter switch to "expanded scale" and adjust the meter reference controls for a zero reading on the Oscillator's meter. Use the Oscillator's level controls to maintain the zero reading when changing the frequency.

j. Set the Test Oscillator for a 6 V, 250 kHz output while maintaining the reference level on the meter. Check and record the 3456A's reading.

k. Disconnect the Test Oscillator from the 3456A. This completes the Alternate 250 kHz check.

Table 4-4. ACV Test Limits.

3456A Input	Frequency	3456A Range	3456A Set-Up	90 Day Limits	24 Hour Limits
.01 V DC	- - -	Autorange	ACV + DCV	.00928 to .01072	.00943 to .01057
.01 V AC	1 kHz	Autorange	ACV	.00929 to .01071	.00944 to .01056
0.1 V AC	1 kHz	Autorange	ACV	.09923 to .10077	.09944 to .10060
0.5 V AC	1 kHz	Autorange	ACV	.49895 to .50105	.49920 to .50080
1.0 V AC	1 kHz	Autorange	ACV	.99860 to 1.00140	.99895 to 1.00105
10 V AC	1 kHz	Autorange	ACV	9.9860 to 10.0140	9.9895 to 10.0105
100 V AC	1 kHz	Autorange	ACV	99.860 to 100.140	99.895 to 100.105
700 V AC	1 kHz	Autorange	ACV	698.32 to 701.68	698.61 to 701.39
.01 V AC	100 kHz	Autorange	ACV	.00704 to .01296	.00725 to .01275
1.0 V AC	100 kHz	Autorange	ACV	.99160 to 1.00840	.99200 to 1.00800
10 V AC	100 kHz	Autorange	ACV	9.9160 to 10.0840	9.9200 to 10.0800
100 V AC	100 kHz	Autorange	ACV	99.160 to 100.840	99.200 to 100.800
700 V AC	100 kHz	Autorange	ACV	692.76 to 707.24	693.10 to 706.90
1.0 V AC	250 kHz	Autorange	ACV	.94350 to 1.05650	.94370 to 1.05630
10 V AC	250 kHz	Autorange	ACV	9.4350 to 10.5650	9.4370 to 10.5630
1.0 V AC	20 Hz	Autorange	Filter On	.99600 to 1.00400	.99640 to 1.00360
1.0 V AC	20 Hz	Autorange	ACV + DCV	.99600 to 1.00400	.99640 to 1.00360

NOTE

Unless otherwise noted, make sure the 3456A's GUARD terminal is connected to the VOLTS LOW terminal (guard button in the "IN" position).

4-22. SPECIFICATION BREAKDOWN.

4-23. The 3456A's specifications are grouped according to function (ACV, DCV, etc.). Within each group are two main sets of specifications, the 24 hour and 90 day limits. The limits to which the 3456A conforms depends on when the instrument was last adjusted, either at the factory or according to this Manual's Section V. It is therefore necessary to determine which set of limits apply. If the instrument was received from the factory and an incoming inspection test is made, the 90 day limits apply. If the instrument has been adjusted (calibrated) within the last 24 hours, the 24 hour limits apply. Another important consideration is the temperature coefficients. These are not included in the limits but must be added when doing the Performance Tests.

4-24. Each set of specifications includes an accuracy specification for each voltage or ohms range. These are specified as a percentage of the reading and an add-on of a certain number of counts. For example, the 24 hour 10 V dc accuracy specification in the 6 digit mode is:

$$\pm .0008\% \text{ of reading} + 2 \text{ counts}$$

giving you a full scale accuracy of ± .0008% or 8 counts plus .0002% or 2 counts which is a total of ± .0010% or 10 counts. If the 5 digit mode is selected instead of the 6 digit mode, the percentage is the same but the count number is different. In this example, the percentage is still ± .0010% with the resultant count number of "1". At 1/10 scale, the total number of counts is different, since the percentage is specified at full scale. The resultant limit is ± .0008% of reading or .8 counts plus 2 counts giving you a total of 2.8 counts (rounded off to 3 counts).

4-25. TEST CONSIDERATION.

4-26. General.

4-27. Because the 3456A is able to make highly accurate measurements, certain requirements have to be met. For example, the standards being used for the accuracy measurements should be good enough so that its errors do not introduce any significant uncertainties in the 3456A's Performance Test. A standard which is ten times better than the accuracy of the 3456A nearly eliminates the uncertainties. Since standards with these accuracies are not readily available, a compromise is necessary. A primary in house standard, one which has been certified by the National Bureau of Standard (NBS) and which is capable of supplying the necessary outputs (.1 V to 1000 V dc, for example), is recommended. If these standards are not available, you can try one of the following.

a. Use a standard that is four or five times more accurate than the 3456A specificaions to be tested. But keep in mind the potential uncertainties these standards may produce (see next paragraph).

b. Use a highly stable calibrated standard and add the correction factors (usually given on the calibration charts) to the test reading.

c. Send the 3456A to an -hp- Service Center or some other NBS-certified standards facility for calibration.

4-28. Ambiguous Region.

4-29. Some of the available standards provide output accuracy, range, and resolution to test the 3456A's performance, although in general they are not an order of magnitude better than the 3456A. It is therefore important to be aware of these uncertainties or "ambiguities". An example is in the next paragraph.

4-30. A hypothetical case is to check the 3456A's 10 V full scale accuracy with a certain standard. The 3456A's accuracy to be checked is ± .0025% with the standard's accuracy at ± .00025% (ten times better). If the 3456A's reading is "10.00026" (.0026% high), the instrument may or may not meet its 90 day limits, depending on the standard's output. With the standard's output .0002% high, the 3456A's actual reading is "10.00024" or .0024% high (.0026% - .0002% = .0024%) which is within the 90 day limits. If the standard's output is right on, the 3456A's actual reading is "10.00026" (.0026% -0% = .0026% high), which is out of the 90 day limits. Although in both instances the standard is within its limits, it may show the 3456A to be in or out of specification and therefore creates an Ambiguous Region as shown in Figure 4-1. This region gets bigger when the 3456A's specifications are tighter and/or the standard's specifications are less accurate. The most accurate check is when you know your standard's actual output.

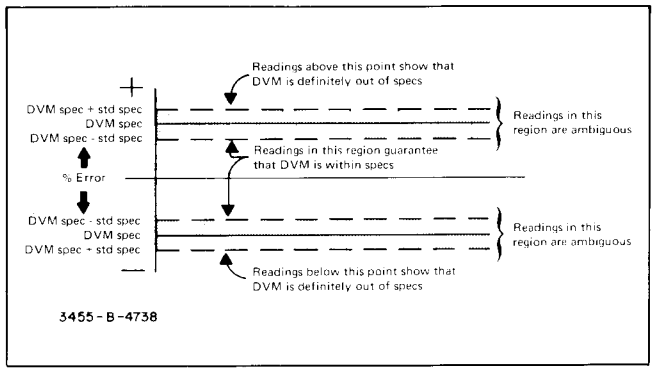


Figure 4-1. Ambiguous Regions.

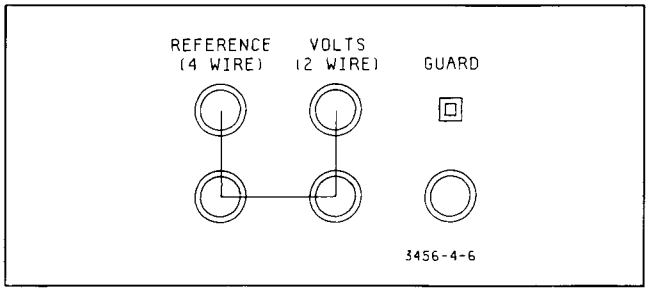


Figure 4-6. 4-Wire Ohms Short.

b. Set the 3456A to the 2-Wire ohms function and set it to the 6 digit mode by storing "6" into the N DIG DISP register.

c. Record the displayed offset reading on the Test Card and make sure the reading is within the limits indicated on the card and Table 4-3.

d. Do the same for the 4-Wire ohms function. Leave the 3456A in that function. If any of the offset tests fail, refer the 3456A to a service trained person.

e. Connect the 100 ohm resistor to the 3456A's input terminals. Refer to Figure 4-7 on how to connect the 100 ohm and other Standard Resistors to the instrument. Record and check the reading.

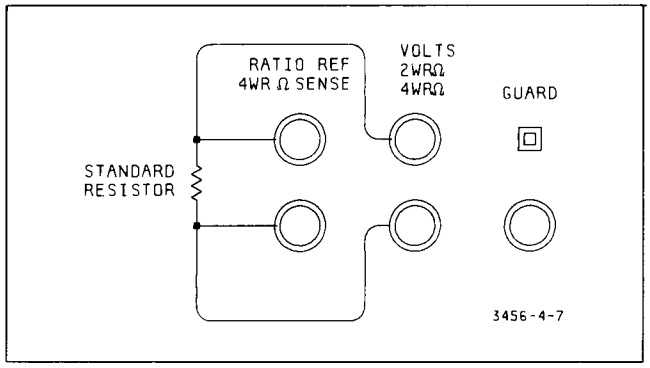


Figure 4-7. Ohms Test.

f. Do the same for the 1 K, 10 K, 100 K, 1 M, 10 M, and 1 G ohm ranges by connecting the 1 K, 10 K, 100 K, 1 M, 10 M, and 1000 M ohm resistors to the input terminals, respectively. (The ranges do not need to be changed since the 3456A is still in Autorange.) If any of the previous tests fail, do the Ohms Adjustment in Section V.

g. Set the 3456A to the 2-Wire ohms function and connect the 1 M ohm resistor to the input terminals. Check and record the reading.

h. Set the 3456A to the 4-Wire ohms function and to the 100 K ohm range. Connect the 10 K ohm resistor to the input terminals. Check and record the reading.

i. Turn the 3456A's Autozero "OFF". Check and record the reading.

j. Set the 3456A to the 2-Wire O.C. ohms function and turn Autozero "ON". Connect the 100 K ohm resistor to the 3456A's input terminals. Check and record the reading.

k. Set the 3456A to the 4-Wire O.C. ohms function. Check and record the reading. If any of the previous tests fail, do the Ohms Adjustment in this Manual's Section V. This completes the Ohms Test.

4-41. ACV Test.

4-42. Make sure the 3456A has been warmed-up for at least 1 hour. Refer to Table 4-4 and/or the ACV Performance Test Card for the ACV Test limits.

4-43. Equipment Required.

AC Calibrator (Fluke Model 5200A/5215A)
DC Standard (Systron Donner Model M107)

4-44. Test Procedure.

a. Press the RESET button on the 3456A.

b. Set the 3456A to the ACV+DCV function and apply .01 V dc from the DC Standard to the 3456A's input terminals. Record and check the reading. Make sure the reading is within the limits noted on the Test Card and Table 4-4.

c. Set the AC Calibrator for a .01 V, 1 kHz output. Remove the DC Standard from the input terminals and connect the output of the AC Calibrator to the input terminals.

d. Set the 3456A to the ACV function and record and check the reading.

e. Set the AC Calibrator to .1 V. Record and check the reading.

f. Do the same for the AC Calibrator's output of .5 V, 1 V, 10 V, 100 V and 700 V.

g. Set the AC Calibrator for a .01 V, 100 kHz output. Record and check the reading.

h. Do the same for voltage settings of 1 V, 10 V, 100 V, and 700 V.

i. Set the AC Calibrator for a 1 V, 250 kHz output. Record and check the reading.

j. Do the same for a 10 V output.

4-31. PERFORMANCE TEST.

4-32. The Performance Test is separated into three main tests, the DCV, Ohms, and ACV Test. Each step in the tests and the tests themselves should be done in order, starting with the DCV Test. Allow a 1 hour warm-up time for the Performance Tests. If the 3456A has been turned on less than 1 hours, inaccuracies may result.

4-33. DCV Test.

4-34. The DCV Test limits are printed on the associated Test Card (DCV Performance Test Card) and in Table 4-2.

4-35. Equipment Required.

Reference Divider (Fluke Model 750A)
DC Transfer Standard (Fluke Model 731B)
DC Standard (Systron Donner Model M107)
DC Null Voltmeter (-hp- Model 419A)

4-36. Test Procedure.

a. Disconnect the input terminals of the 3456A from any external circuitry and press the TEST button. Make sure the instrument passes the Self-Test (see Paragraph 3-17). Press the TEST button again.

NOTE

Be sure the input terminals are open when the Self-Test is enabled.

b. Press the RESET button and short the VOLTS input terminals.

NOTE

Pressing the RESET button automatically sets the 3456A to DCV, Autorange, Internal Trigger, and 5 Digit Display.

c. Set the 3456A to the 100 mV (100 -3) range and set it to the 6 digit mode by storing "6" into the N DIG DISP register.

d. Record the displayed offset reading on the test card and make sure the reading is within the limits indicated on the Test Card and Table 4-2.

e. Do the same for the 1 V, 10 V, 100 V, and 1000 V ranges. If any offset is out of the specified limits, refer the 3456A to a service trained person.

f. Set the 3456A to Autorange and remove the short.

g. Set the Transfer Standard for a 10 V output and connect the output to the 3456A's VOLTS input terminals.

h. Record the 3456A's reading on the Test Card and make sure it is within the indicated limits. If the 10 V reading is out of tolerance, do the DCV Adjustments in this Manual's Section V.

i. Set the Transfer Standard to the 1 V range. Record and check the reading. If the 1 V reading is out of tolerance, do the DCV Adjustment in Section V.

Table 4-2. DCV Test Limits.

3456A Input	3456A Range	3456A Set-Up	90 Day Limits	24 Hour Limits
Short	.1 V Range	DCV	-00.0024 -3 to +00.024 -3	-00.0024 -3 to +00.0024
Short	1 V Range	DCV	-.000004 to +.000004	-.000004 to +.000004
Short	10 V Range	DCV	-0.00002 to +0.00002	-0.00002 to +0.00002
Short	100 V Range	DCV	-00.0003 to +00.0003	-00.0003 to +00.0003
Short	1 kV Range	DCV	-000.002 to +000.002	-000.002 to +000.002
+10 V DC	Autorange	DCV	+9.99975 to +10.00025	+9.99990 to +10.00010
+1 V DC	Autorange	DCV	+.999972 to +1.000028	+.999987 to +1.000013
+.1 V DC	Autorange	DCV	+99.942 -3 to +100.0058 -3	+99.9954 -3 to +100.0046 -3
+100 V DC	Autorange	DCV	+99.9971 to +100.0029	+99.9986 to +100.0014
+1000 V DC	Autorange	DCV	+999.854 to +1000.146	+999.867 to +1000.133
-1 V DC	10 V Range	DCV	-.99996 to -1.00004	-.99997 to -1.00003
-5 V DC	10 V Range	DCV	-4.99986 to -5.00014	-4.99994 to -5.00006
-10 V DC	10 V Range	DCV	-9.99975 to -10.00025	-9.99990 to -10.00010
-10 V DC	10 V Range	DCV, PLC = 100	-9.99975 to -10.00025	-9.99990 to -10.00010
-10 V DC	10 V Range	DCV, PLC = 1	-9.99973 to -10.00027	-9.99986 to -10.00014
-10 V DC	10 V Range	DCV, PLC = .1	-9.9991 to -10.0009	-9.9991 to -10.0009
-10 V DC	10 V Range	DCV, PLC = .01	-9.992 to -10.008	-9.992 to -10.008
-10 V DC	10 V Range	DCV, PLC = 10	-9.99975 to -10.00025	-9.99990 to -10.00010
-10 V DC	10 V Range	Filter On Filter Off Autozero Off	-9.99974 to -10.00026	-9.99989 to -10.00011
10 V DC	10 V Range	DCV/DCV Ratio Autozero On	.99995 to 1.00005	.99998 to 1.00002
10 V DC	10 V Range	ACV + DCV/DCV Ratio	.998857 to 1.00143	.99889 to 1.00111

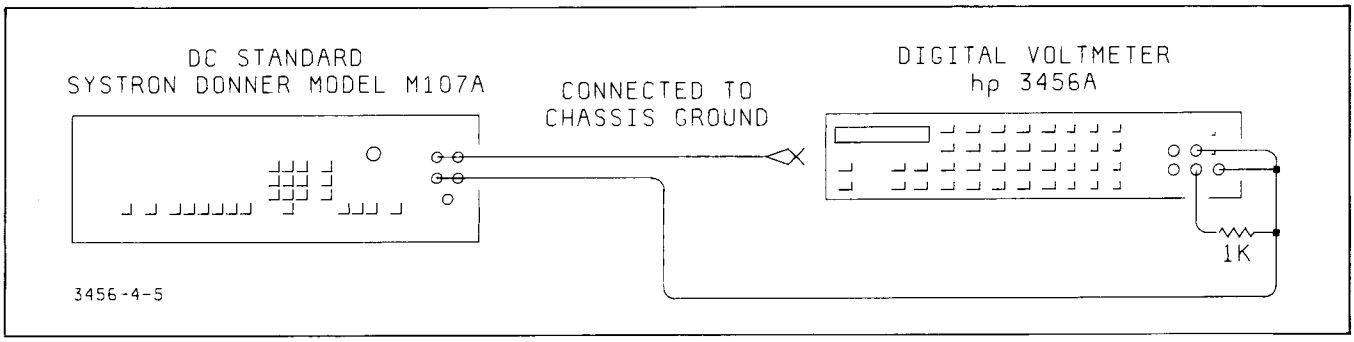


Figure 4-5. DC Common Mode Rejection Test.

VOLTS LOW terminals, as shown in Figure 4-5. Make sure the GUARD terminal is connected to the VOLTS HIGH terminal (Make sure the GUARD switch is "OUT").

oo. Record the 3456A reading.

pp. With the DC Standard's output off, connect it between the 3456A's chassis and VOLTS HIGH terminal as shown in Figure 4-5.

qq. Set the DC Standard for a + 100 V output and turn its output on.

rr. The 3456A's reading should be within 0.000010 V of the recorded reading in Step oo.

ss. Disconnect the test equipment from the 3456A. If the DC Common Mode Rejection Test fails, refer the 3456A to a service trained person. This completes the DCV Test.

4-37. Ohms Test.

4-38. Make sure the 3456A has been warmed-up for at least an hour, or inaccuracies may result or unstable readings may be indicated. Refer to Table 4-3 and/or the Ohms Performance Test Card for the Ohms Test limits.

4-39. Equipment Required.

Standard Resistor:

100 ohm ± .0005%; (Guildline Model 9330/100 or 9330A/100)
1 K ohm ± .0005%; (Guildline Model 9330/1K or 9330A/1K)
10 K ohm ± .001%; (Guildline Model 9330/10K or 9330A/10K)
100 K ohm ± .001%; (Guildline Model 9330/100K or 9330A/100k)
1 M ohm ± .002%; (Guildline Model 9330/1 M)
10 M ohm ± .01%, (Guildline Model 95206)

Resistor Assembly:

(1000 M ohm ± 2%; -hp- Part Number 03456-67902)

4-40. Test Procedure.

a. Press the 3456A's RESET button. Short across the VOLTS (2WR, 4WR) and RATIO REF (4 WR SENSE) terminals as shown in Figure 4-6.

Table 4-3. Ohms Test Limits

3456A Input	3456A Range	3456A Set-Up	90 Day Limits	24 Hour Limits
Short	Autorange	2-Wire Ohms	-00.0024 to 00.2024	-00.0024 to 00.2024
Short	Autorange	4-Wire Ohms	-00.0024 to 00.0024	-00.0024 to 00.0024
10 kΩ	Autorange	4-Wire Ohms	9.99966 + 3 to 10.00034 + 3	9.99976 + 3 to 10.00024 + 3
1 kΩ	Autorange	4-Wire Ohms	999.966 + 3 to 1000.034 + 3	999.976 to 1000.024
100 Ω	Autorange	4-Wire Ohms	99.9936 to 100.0064	99.9946 to 100.0054
100 kΩ	Autorange	4-Wire Ohms	99.9968 + 3 to 100.0032 + 3	99.9978 + 3 to 100.0022 + 3
1 MΩ	Autorange	4-Wire Ohms	999.928 + 3 to 1000.072 + 3	999.938 + 3 to 1000.062 + 3
10 MΩ	Autorange	4-Wire Ohms	9.99578 + 6 to 10.00422 + 6	9.99588 + 6 to 10.00412 + 6
1 GΩ	Autorange	4-Wire Ohms	893.999 + 6 to 1160.001 + 6	889.999 + 6 to 1110.001 + 6
1 MΩ	Autorange	2-Wire Ohms	999.928 + 3 to 1000.072 + 3	999.938 + 3 to 1000.062 + 3
10 kΩ	100 K	4-Wire Ohms	9.9995 + 3 to 10.0005 + 3	9.9996 + 3 to 10.0004 + 3
10 kΩ	100 K	Autozero Off	9.9993 + 3 to 10.0007 + 3	9.9994 + 3 to 10.0006 + 3
100 kΩ	100 K	2-Wire O.C. Autozero On	99.9966 + 3 to 100.0034 + 3	99.9976 + 3 to 100.0024 + 3
100 kΩ	100 K	4-Wire O.C.	99.9968 + 3 to 100.0032 + 3	99.9978 + 3 to 100.0022 + 3

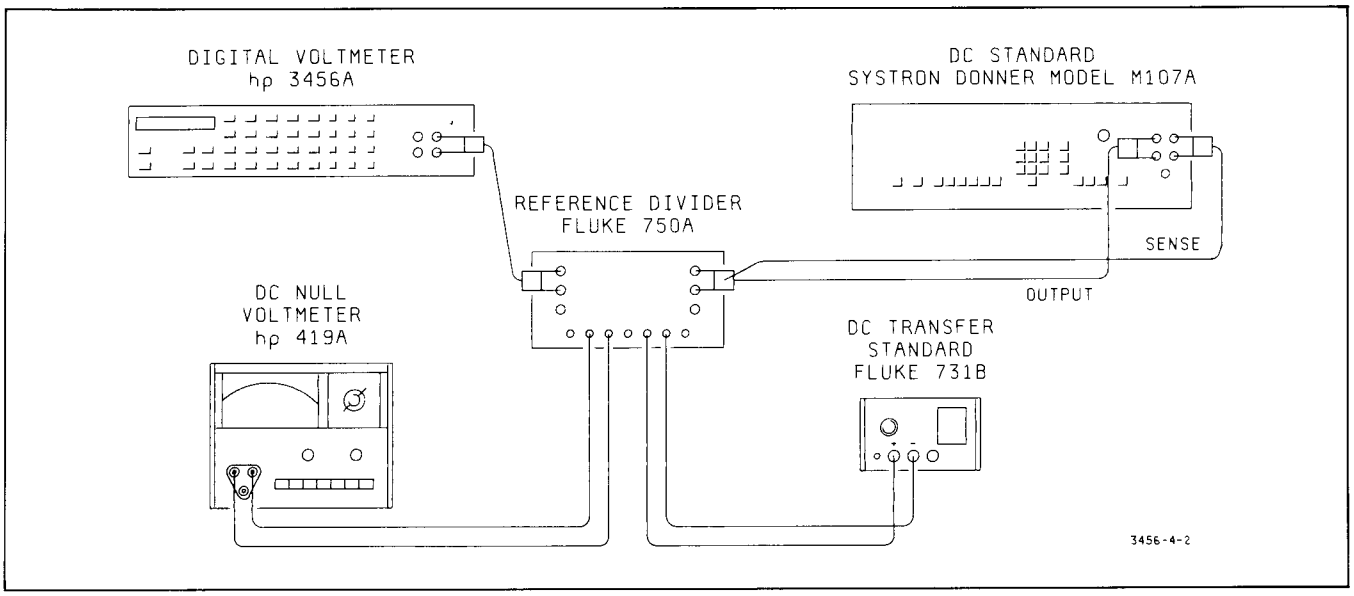


Figure 4-2. DCV Accuracy Test Set-Up.

j. Disconnect the Transfer Standard from the 3456A VOLTS terminals.

k. Using short pieces of number 20 AWG (or thinner) insulated solid copper wires, connect the Transfer Standard and the DC Null Voltmeter to the Reference Divider as shown in Figure 4-2 and Figure 4-3.

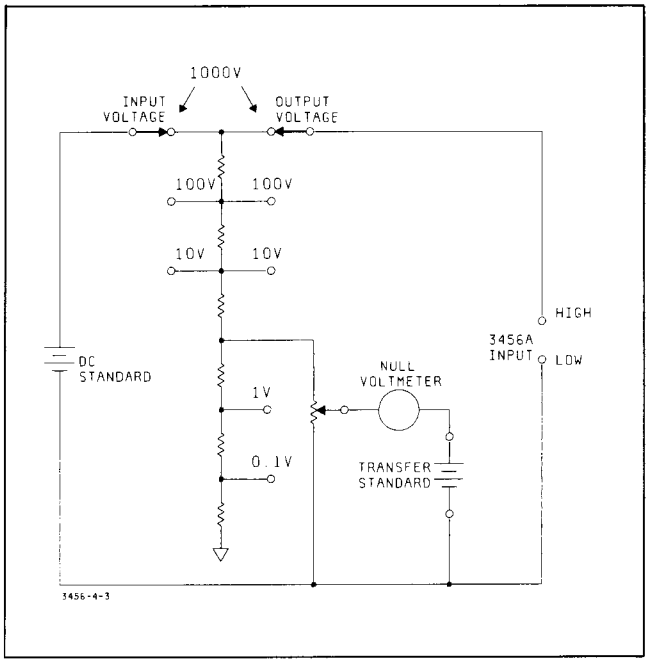


Figure 4-3. Schematic of the DCV Accuracy Test Set-Up.

l. Turn the DC Standard's output off. Using 24 inch or shorter shielded cables equipped with banana-plug connectors, connect the DC Standard and the 3456A to the Reference Divider as shown in Figure 4-2 and Figure 4-3.

m. Set the Standard Cell Voltage switches on the Reference Divider to correspond with the output voltage setting of the Transfer Standard. Normally the Transfer Standard's output should be set to the voltage value of the Standard Cell used to calibrate the Transfer Standard.

n. Zero the DC Null Voltmeter on the 3 microvolt range and then set it to the 300 microvolt range.

o. Set the Reference Divider's Input Voltage switch to 100 V and center its Coarse and Fine adjust controls.

p. Set the Reference Divider's Output Voltage switch to .1 V.

q. Set the DC Standard for an output voltage of + 100 V and turn its output on.

r. Set the Reference Divider's Standard Cell switch to the "Locked" position. Adjust the DC Standard's output voltage for a zero reading on the DC Null Voltmeter.

s. Downrange the DC Null Voltmeter and adjust the Reference Divider's Coarse and Fine controls for a "null" reading (0 reading) on the Null Voltmeter's 3 microvolt range.

t. Set the Reference Divider's Standard Cell switch to the OPEN position.

u. Set the Reference Divider's Standard Cell switch to MOMENTARY and, if necessary, readjust the Divider's Fine control for a null indication on the Null Voltmeter. Release the Standard Cell switch.

NOTE

The Divider's Fine control may have to be readjusted, when its Output Voltage switch is set to another position.

v. Record and check the 3456A's .1 V (100 mV) reading.

w. Uprange the Reference Divider's Output Voltage switch to 100 V. Record and check the 3456A reading. If the 100 V and .1 V reading is out of tolerance, do the DCV Adjustment in Section V.

CAUTION

Always uprange the Reference Divider's Input Voltage switch before upranging the DC Standard and downrange the DC Standard before downranging the Reference Divider's Input Voltage switch.

x. Uprange the Reference Divider Input Voltage switch to 1000 V and then uprange the DC Standard to + 1000 V. Allow about ten minutes for the Reference Divider to warm-up and stabilize. (The DC Standard may have to be readjusted for a null indication on the Null Voltmeter, after the Reference Divider has stabilized.)

y. Uprange the Reference Divider's Output Voltage switch to 1000 V. Record and check the 3456A's reading.

z. Downrange the DC Standard to + 10 V and then downrange the Reference Divider's Input Voltage switch to 10 V.

aa. Downrange the Reference Divider's Output Voltage switch to 1 V and set the 3456A to the 10 V range.

bb. Reverse the 3456A's input leads for a -1 V reading. Record and check the reading.

cc. Set the Reference Divider's Output Voltage switch to 5 V. Record and check the reading.

dd. Turn the DC Standard's output off and disconnect the DC Standard, Transfer Standard, and 3456A from the Reference Divider.

ee. Set the Transfer Standard for a 10 V output and connect the 3456A to the Standard with its input leads reversed (for a -10 V reading). Record and check the reading. If any of the tests in the previous tests fail, do the DCV Adjustments in Section V.

ff. Change the Number of Power Line Cycles Integrated on the 3456A to 100 by storing "100" into the N CYC INT register. Record and check the reading.

gg. Change the Number Of Power Line cycles Integrated to 1, .1, and .01 by storing "1", ".1", and ".01" into the N CYC INT register, respectively. Record and check the reading for each Power Line Cycle Integrated mode.

hh. Turn the 3456A's Filter "ON". Record and check the reading.

ii. Turn the 3456A's Filter and Autozero "OFF". Record and check the reading.

jj. Press the 3456A's RESET button. Connect the Transfer Standard's High Output to the 3456A's RATIO REF HIGH and VOLTS HIGH terminals. Connect the Standard's Low Output to the 3456A's RATIO REF LOW and VOLTS LOW terminals. Refer to Figure 4-4 for the connection.

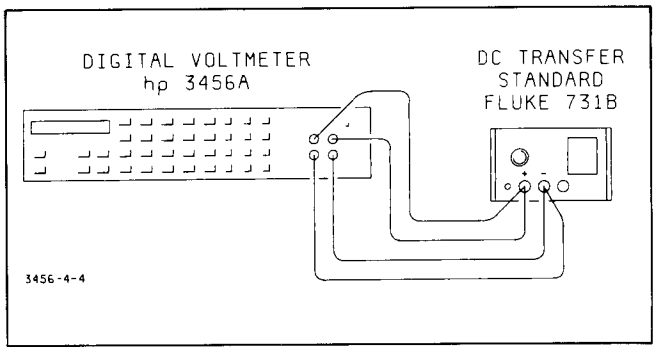


Figure 4-4. Ratio Test Connection.

kk. Set the 3456A to the DCV/DCV Ratio function. Record and check the reading. If this test fails, refer the 3456A to a serivce trained person.

ll. Set the 3456A to ACV + DCV/DCV Ratio function. Record and check the reading. If this test fails, do the ACV Adjustments in Section V.

mm. Disconnect the Transfer Standard from the 3456A. Set the 3456A to the DCV function and the 1 V range. The DC Common Mode Rejection Test is next.

nn. Connect the 1 K resistor (-hp- Part Number 0698-1021) between the 3456A's VOLTS HIGH and