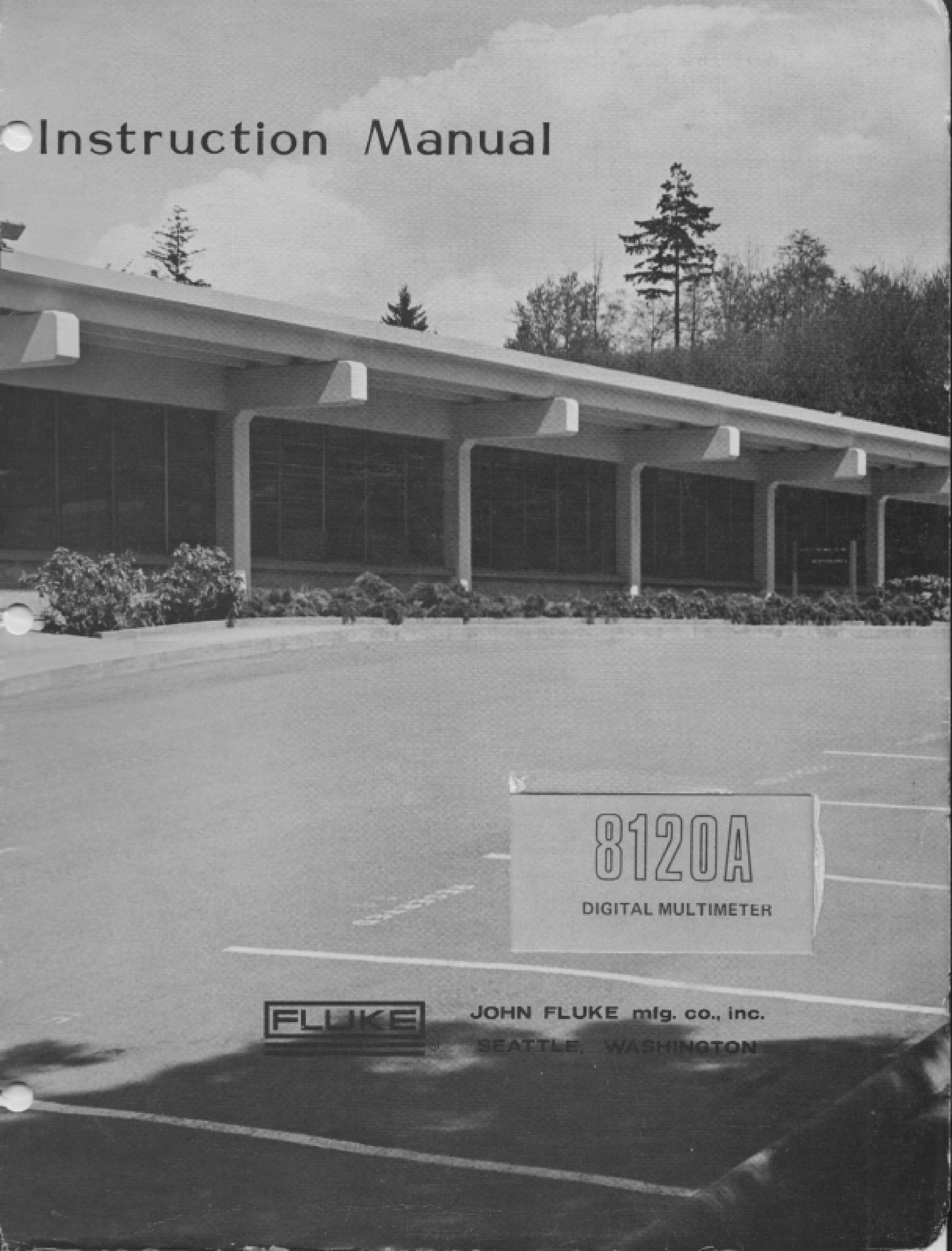
Instruction Manual



8120A

DIGITAL MULTIMETER

FLUKE

JOHN FLUKE mfg. co., inc.
SEATTLE, WASHINGTON

JOHN FLUKE MFG. CO., INC.

P. O. Box 7428
Seattle, Washington 98133

8120A

DIGITAL MULTIMETER

AUGUST 1972

WARRANTY

The JOHN FLUKE MFG. CO., INC.* warrants each instrument manufactured by them to be free from defects in material and workmanship. Their obligation under this Warranty is limited to servicing or adjusting an instrument returned to the factory for that purpose, and to making good at the factory any part or parts thereof; except tubes, fuses, choppers and batteries, which shall, within one year after making delivery to the original purchaser, be returned by the original purchaser with transportation charges prepaid, and which upon their examination shall disclose to their satisfaction to have been thus defective. If the fault has been caused by misuse or abnormal conditions of operations, repairs will be billed at a nominal cost. In this case, an estimate will be submitted before work is started, if requested.

If any fault develops, the following steps should be taken:

1. Notify the John Fluke Mfg. Co., Inc.,* giving full details of the difficulty, and include the Model number, type number, and serial number On receipt of this information, service data or shipping instructions will be forwarded to you.

2. On receipt of the shipping instructions, forward the instrument prepaid, and repairs will be made at the factory. If requested, an estimate of the charges will be made before the work begins, provided the instrument is not covered by the Warranty.

> "The foregoing warranty is in lieu of all other warranties, express or implied, including but not limited to, any implied warranty of merchantability, fitness or adequacy for any particular purpose or use. Fluke shall not be liable for any special, incidental or consequential damages."

SHIPPING

All shipments of John Fluke Mfg. Co., Inc.* instruments should be made via **Railway Express**** prepaid. The instrument should be shipped in the original packing carton, or if it is not available, use any suitable container that is rigid. If a substitute container is used, the instrument should be wrapped in paper and surrounded with at least four inches of excelsior or similar shock-absorbing material.

CLAIM FOR DAMAGE IN SHIPMENT

The instrument should be thoroughly inspected immediately upon receipt. All material in the container should be checked against the enclosed packing list. The manufacturer will not be responsible for shortages against the packing sheet unless notified immediately. If the instrument fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. A full report of the damage should be obtained by the claim agent, and this report should be forwarded to John Fluke Mfg. Co., Inc.* Upon receipt of this report, you will be advised of the disposition of the equipment for repair or replacement. Include the model number, type number, and serial number when referring to this instrument for any reason.

The John Fluke Mfg. Co., Inc.* will be happy to answer all application questions which will enhance your use of this instrument. Please address your requests to: JOHN FLUKE MFG. CO., INC., P. O. Box 7428, SEATTLE, WASHINGTON 98133*.

* For European customers: FLUKE (Nederland) B.V.
Ledeboerstraat 27
Tilburg, Netherlands

**For European customers, Air Freight prepaid.

FLUKE TECHNICAL SERVICE CENTERS

John Fluke Mfg. Co., Inc.
Bill Fetrow, Supervisor
7001 - 220th S.W.
Mountlake Terrace, WA 98043
Tel: 206-774-2206
TWX: 910-449-2850

Fluke Western Technical Center
Mike Nagy, Service Mgr.
1109 South Central Avenue
Glendale, CA 91204
Tel: 213-245-6716
TWX: 910-497-2086

Fluke Western Technical Center
Gary Priebe, Service Mgr.
4805 Mercury St.
San Diego, CA 92111
Tel: 714-565-4455
TWX: 910-337-1273

Fluke Western Technical Center
Howard McElroy, Service Mgr.
2359 De La Cruz Blvd.
Santa Clara, CA 95050
Tel: 408-244-1505
TWX: 910-338-0121

Fluke Midwestern Technical Center
Bruce Hunt, Service Mgr.
1287 North Rand Road
Des Plaines, ILL 60016
Tel: 312-298-7470
TWX: 910-233-4978

Fluke Canadian Technical Center
Herb Duval, Service Mgr.
6427 Northam Drive
Mississauga, Ontario
Tel: 416-678-1500
TWX: 610-492-2119

Fluke Eastern Technical Center
Bernard Ciongoli, Service Mgr.
101 Berkshire Ave.
Paterson, N.J. 07502
Tel: 201-742-3215

Fluke N. E. Technical Center
Dick Zemba, Service Mgr.
109 Massachusetts Avenue
Lexington, Massachusetts 02173
Tel: 617-861-8620
TWX 710-326-1715

Fluke Mideastern Technical Center
John Hines, Service Mgr.
11501 Huff Court
Kensington, MD 20795
Tel: 301-881-5300
TWX: 710-825-9645

Fluke S.E. Technical Center
Jesse Morse, Service Mgr.
P.O. Box 6578
940 North Fern Creek Avenue
Orlando, FLA 32803
Tel: 305-896-2296
TWX: 810-850-0185

Fluke S. E. Technical Center
Dwain Cox, Service Mgr.
P.O. Box 9619
1310 Beaman Place
Greensboro, N.C. 27408
Tel: 919-273-1918
TWX: 510-925-1173

FLUKE AUTHORIZED SERVICE LABS

Ball Brothers
Boulder Industrial Park
P.O. Box 1062
Boulder, CO 80302
Tel: 303-441-4710
TWX: 910-940-3241

Service Engineers
Larry Flood, Service Mgr.
28 Finney Street
Rochester, N.Y. 14605
Tel: 716-232-2300

Missouri Research Lab
630 Haines, NW
Albuquerque, NM 87102
Tel: 505-243-6772
TWX: 910-989-1656

Linear Standards Lab
8207 Millet
Houston, TX 77012
Tel: 713-923-2796
TWX: None

Tucker Electronics
Clay Aclin, Service Mgr.
1717 Jupiter
Garland, TX 75040
Tel: 214-348-8800
TLX: 73-0401

Rev. 8/73 LITHO IN USA

CHANGE/ERRATA INFORMATION

MANUAL — TITLE: 8120A DIGITAL MULTIMETER

ISSUE: August 1972

Please make changes in this manual according to the following change and/or errata information:

ERRATA # 1

Page 5-12

Change description of Q40, Q43, Q46 and Q49 from Xstr, Ge, PNP to Xstr, Ge, NPN.
Change stock number for Q40, Q43, Q46 and Q49 from 182709 to 182691.

Page 5-23

Change Manufacturers Part Number for Fluke Stock Number 271494 from 35853 to B5853ST.

Schematic Drawing 8120A 1001 (Sht 1)

Change the reference designator of operational amplifier from A1 to U1.
Add the following board description to the schematic title block: A1 MAIN ASSEMBLY PCB.

Schematic Drawing 8120A - 1001 (Sht 2)

Change the reference designator of operational amplifier from A2 to U2.
Add the following board description to the schematic title block: A1 MAIN ASSEMBLY PCB.

Schematic Drawing 8120A 1001 (Sht 3)

Add the following board description to the schematic title block: A1 MAIN ASSEMBLY PCB.

Schematic Drawing 8120A 1001 (Sht 4)

Add the following board description to the schematic title block: A1 MAIN ASSEMBLY PCB.

Schematic Drawing 8120A - 1001 (Sht 5)

Add the following board description to the schematic title block: A2 SHUNT ASSEMBLY PCB.

ERRATA # 2

Page 4-15

Add the following adjustment instructions to paragraph 4-66:

g. Remove the 100 volt input and apply - 0.10005 volts dc to the INPUT terminals.

h. Adjust the 100 MVDC CAL control for a readout of -100.05 ± 1 digit.

Page 5-3

Add the following use codes and effectivities:

- E Model 8120A serial number 123 through 1071
- F Model 8120A serial number 1072 and on
- G Model 8120A serial number 300 and on
- H Model 8120A serial number 1010 and on
- J Model 8120A serial number 1020 and on

Page 5-9/5-10

Locate C61 at center of pcb illustration. Change designation of R27 (connected to right side of C61) to R33.

Page 5-11

Change Use Codes for C53 from A and B to C and D, respectively.

Delete C55 from "C54, C55" Ref. Desig. column. List C55 separately with the following descriptions and note: Ref. Desig. - C55; Description - Cap, mica, 2pf ±1%, 500V; stock no. 175208; Tot. Qty. - 1. Follow with another listing for C55: Description - Cap, mica, 4pf ±5%, 500V; stock no. 190397; Tot. Qty. - REF. Add the following note: (One or none of the above values for C55 selected at factory.)

Add Use Code A to C61 listing. Add a second listing for C61 as follows: Description - Cap, plastc, 0.1μf ±10%, 250V; stock no. - 161992; Tot. Qty. - 1; Use Code - B.

Page 5-13

Delete R33 from REF DESIG column.

Page 5-14

Change listing of R33 to the following: Description - Res. Comp, 1k ±5%, ¼w; stock no. - 148023; Tot. Qty. - REF; Use Code - G.

Page 5-16

Change Use Code for R171 and R172 from A, B, C and D to C, D, A and B, respectively.

Page 5-17

Add component listing: Ref. Desig. - R211; Description - Res, comp, 560Ω ±5%, ¼w; stock no. - 147991; Tot. Qty. - 1; Use Code - B.

Add component listing: Ref. Desig. - R212; Description - Res, comp, 1.8k ±5%, ¼w; stock no. 175042; Tot. Qty. - 1; Use Code - H.

Page 5-19

To "SHUNT ASSEMBLY PCB", add reference designation A2.

Add component listing: Ref. Desig. - R195; Description - Res, comp, 10M ±10%, ½w; stock no. - 108142; Tot. Qty. - 1.

Page 5-19 (continued)

Add component listing:

Ref. Desig. - R197; Description - Res, comp, 27Ω ±5%, ¼w; stock no. - 160812; Tot. Qty. - 1.

Add component listing:

Ref. Desig. - R212; Description - Res, comp, 100Ω ±5%, ¼w; stock no. - 147926; Tot. Qty. - J.

Schematic, 8120A – 1001 (Sht 1)

Delete all reference to serial effectivity in "CHANGE (1), (2) and (3)" and add "NOTE 5" as follows:

5. See parts list for serial number effectivity of changes.

Delete R27 in CHANGE 3 and add: ADDED R33. Change (3) R27, 1k on diagram to (3) R33, 1k.

Add (4) to C55. Add under "CHANGES": (4) C55 can be 2pf, 4pf, or omitted.

Add to diagram between pins 6 and 7 of A1: R212 1.8k. Add under "CHANGES": (5) R212 added between A1 pin 7 and Q79 emitter for S/N 1010 through 2259. Location between pins 6 and 7 of A1 occurs at S/N 2260 and on.

Schematic, 8120A – 1001 (Sht 2)

Delete reference to serial effectivity in "CHANGES" and add under "NOTES":

9. See parts list for serial number effectivity of changes.

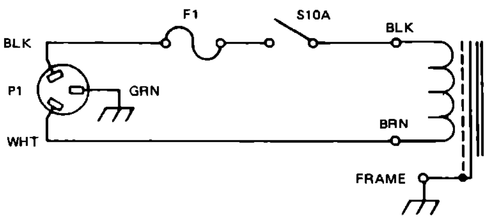
Add to diagram between SIE arm and common: R211 560Ω. Add under "CHANGES": (2) R211 added.

Schematic, 8120A – 1001 (Sht 3)

Resistor between junction of C21 and R53 should be designated R54.

Schematic, 8120A – 1001 (Sht 4)

Add Detail I, below, under diagram of T101 to depict primary wiring for 100V line transformer.



Schematic, 8120A – 1001 (Sht 5)

Add to diagram between arms of S18D and S20D: R212, 100.

ERRATA # 3

Page 4-8

In paragraph 4-32 step b, change FUNCTION VAC to FUNCTION VDC. Change step d to read as follows:

d. Select VAC FUNCTION and apply the test signals shown in Table 4-3 to the 8120A INPUT terminals. The readout should be as indicated.

Schematic, 8120A-1001 (Sheet 1)
Circuit line between S6G (100MV) and C14 ("1VHF") should be junctioned with line between CR40 anode and S2K (ACMA). Variable capacitor C47 should be labeled "100 MV HF". Adjustment R167 should be labeled "100 MV AC". Labeling of R157 should be changed to "100V DC". Labeling of potentiometer R179 should be changed from "ACV" to "100MV DC". Fixed resistor designated R179 connected to base of Q80 should be changed to R140.

CHANGE # 1

Page 5-17

Add to parts list resistor R213, 1:2MΩ ±5%, ¼W, composition, part number 188425, for instruments with serial numbers 70400 and on.

Schematic, 8120A-1001 (Sheet 4)
Add R213, 1.2MΩ, between +200V supply and common, parallel to C65.

Page 2-3 Paragraph 2-17 and Option –01, Page 6-1, Paragraph 6-2

Add after the paragraphs referenced above the following note:

Battery manufacturers recommend that nickle-cadmium batteries should not be stored for extended periods of time without recharging at least every 90 days. Storage temperatures below 25° C are recommended.

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(continued on page iii)

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(continued on page iv)

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List of Illustrations

List of Tables

Section 1
Introduction & Specifications

1-1. INTRODUCTION

1-2. The Model 8120A is a five digit multimeter. It allows measurement of ac and dc voltages to 1199.9V, ac and dc currents to 1.1999A, and resistance to 11.999MΩ. Five ranges are available in each function, thus providing a resolution of 10uV, 10uA, and 0.1Ω. Special features include full guarding, autopolarity, pushbutton function and range selection, and automatic overload protection.

1-3. Accessories and options are available to further increase the capability of the instrument. An 80-RF Probe is available to increase ac voltage measurement frequencies to 500 MHz. DC voltage measurement range can be increased to 5 kv or 15 kv using respective 80F-5 or 80F-15 High Voltage Probes. Battery power for portable applications is possible upon installation of a Rechargeable Battery Pack (−01 Option). Systems capability is enhanced upon installation of the Isolated Printer Output (−02 Option). Printer output is 8−4−2−1 coded with logic levels compatible with DTL or TTL logic. The −01 and −02 Options are mutually exclusive, thus only one or the other can be installed. Rack fixtures are available to allow single offset and multiple mounting in standard 19 inch equipment racks.

1-4. SPECIFICATIONS

DC VOLTS

Ranges	±100 MV, ±1V, ±10V, ±100V and ±1000V (20% overrange, all ranges)	
Resolution	0.01% of range. (10 uv on 100 MV range maximum)	
Accuracy	±1V to ±1000V Range	±100 MV Range
90 days, 15°C to 35°C	±(0.02% of input +0.01% of range)	±(0.05% of input +0.02% of range)

DC Input Resistance	Constant 10 megohms on all ranges		
Response Time to Rated Accuracy	1.5 seconds		
Noise Rejection	DC	60 Hz	50 Hz
Normal Mode	–	60 db	47 db
Common Mode (1k in low lead)	120 db	120 db	120 db

NOTE: Common mode rejection specifications are not degraded when the isolated printer output option is used and Common Mode Rejection approaches infinity when the instrument is battery operated.

Polarity	Automatic, instantaneous selection and display
Overload (without damage)	±1200 VDC or ±1700V peak AC applied continuously to any range

AC VOLTS

Ranges	100 MV, 1V, 10V, 100V and 1000V. (20% overrange, all ranges)	
Resolution	0.01% of range. (10 uv on 100 MV range maximum)	
Accuracy (all ranges)	50 Hz - 10 kHz	30 - 50 Hz and 10 - 20 kHz
90 days, 15°C to 35°C	±(0.2% of input +0.05% of range)	±(0.5% of input +0.1% of range)

Input Impedance	1 megohm shunted by <50 pf. (100k Ω, <100 pf. on 100 MV range)	
Response Time to Rated Accuracy	3 seconds	
DC Normal Mode Voltage	±1200V maximum (±250V on 100 MV range)	
Overload	1V to 1000V Range	100 MV Range
(dc to 20 kHz, without damage)	1200V applied continuously	250V applied continuously

RESISTANCE

Ranges	1k, 10k, 100k, 1000k and 10M. (20% overrange, all ranges)	
Resolution	0.01% of range (0.1 ohm on 1k range maximum)	
Accuracy	1K-1000K Range	10M Range
90 days, 15°C to 35°C	±(0.05% of input +0.01% of range)	±(0.1% of input +0.01% of range)

Configuration	Two terminal, constant current, +9V across open terminals	
Current in R measured	0.7 ma. on the 1k range, decreasing by an order of magnitude per range to 0.7 ua on the 1000kΩ range (0.1 ua on the 10MΩ range).	
Response Time to Rated Accuracy	2.0 seconds, (10 secs. on the 10MΩ range)	
Overload	10KΩ to 10MΩ Range	1kΩ Range
(without damage)	230V rms applied continuously	130V rms applied continuously

DC CURRENT

Ranges	±100 ua, ±1 MA, ±10 MA, ±100 MA, ±1000 MA (20% overrange, all ranges)
Resolution	0.01% of range (10 na. on 100 ua range, maximum)
Accuracy (all ranges)	
90 days, 15°C to 35°C	±(0.1% of input +0.02% of range)

Burden	100 MV @ 100 ua increasing to 300 MV @ 1200 MA
Response Time to Rated Accuracy . .	1.5 seconds
Overload	Protected with diodes and fused for 2 amps, any range.

AC CURRENT

Ranges	100 ua, 1 MA, 10 MA, 100 MA, 1000 MA (20% overrange, all ranges)	
Resolution	0.01% of range (10 na.on 100 ua range, maximum)	
Accuracy (all ranges) . .	50Hz - 5 KHz	30 - 50 Hz and 5 - 10 KHz
90 days, 15°C - 35°C .	±(0.3% of input +0.05% of range)	±(0.6% of input +0.05% of range

Burden	100 MV @ 100 ua increasing to 300 MV @ 1200 MA
Response Time to Rated Accuracy . .	3 seconds
Overload . .	Protected with diodes and fused for 2 amps, any range.

ISOLATED PRINTER OUTPUT (Option 8120A-02, factory installed)

Data Available . . .	Digits, Range, Functions, Polarity
Coding	8421 BCD Digits, individual lines for remaining data
Logic Levels and Definition	Logic "1" = +3.5V, Logic "0" =OV from TTL 7400 Series
Triggering	Two channels provide Logic "1" and Logic "0" triggering
Trigger to Reading Delay	400 ms. maximum
Print Commands	Logic "1" to Logic "0" and complement both provided

GENERAL

MTBF	10,000 hours
Filter	2-pole linear phase filter for dc volts, current and resistance always "in"
Selection	Manual via mechanically interlocked pushbuttons
Display	Four decade neon in-line readout with polarity neon for dc volts and fifth digit for 20% overrange. Automatic decimal location.
Sample Rate	3 samples per second
Maximum Inputs	
"HI" to "LO"	See "Overload" specification by function
"LO" to "GUARD"	100V dc or peak ac
"GUARD" to "CHASSIS"	1200V dc or 230V rms at 60 Hz
Operating Power	8 watts from 115V/230V, ±10%, 50-500 Hz line with internal battery option −01 installed. 8 hours continuous operation from the rechargeable nickel-cadmium batteries.
Weight	8 pounds without batteries. (3, 6 Kg) 10 pounds with batteries. (4, 5 Kg)
Size	3 1/2" H x 8 1/2 W X 15" D (88mm x 216mm x 381mm)
Storage Temperature . . .	−40°C to 75°C. (−40°C to +60°C with batteries)
Operating Temperature	0°C to +50°C

Temperature Coefficients (Apply outside of temperature limits of "Accuracy" specifications)

DC Volts (except 100 MV)	±(0.0025% of input +0.0005% of range)/°C	% of RANGE component can be reduced by zero control.
DC Current and 100 MV	±(0.0035% of input +0.005% of range)/°C	
AC, Volts and Current	±(0.015% of input +0.005% of range)/°C	
KΩ ranges	±(0.0035% of input +0.0015% of range)/°C	
10 MΩ Range	±(0.01% of input +0.002% of range)/°C	

Humidity Range	80% R.H. max. at temp. ≤35°C, 70% R.H. max. from 35°C to 50°C
Shock and Vibration	Meets requirements of MIL-T-21200G and MIL-E-16400F
Mounting	Tilt down carrying handle detents into custom non-marring feet and serves as a tilt-up bail for bench use.

OPTIONS

8120A–01	Rechargeable Battery Pack (factory installed)
8120A–01K	Rechargeable Battery Pack (field installed)
8120A–02	Isolated Printer Output (factory installed only)

ACCESSORIES

80-RF	RF Probe (ac voltage measurement to 500 MHz)
80F-5	HV Probe (dc voltage measurement to 5 kv)
80F-15	HV Probe (dc voltage measurement to 15 kv)
M03-200-607	Rack Mtg. Kit (single unit, right or left offset)
M03-200-606	Rack Mtg. Kit (dual units, side-by-side)

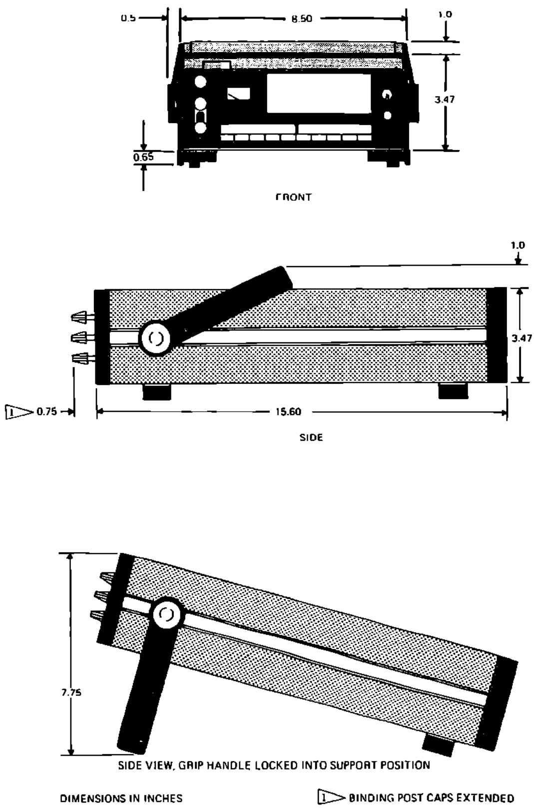

Figure 1-1. MODEL 8120A OUTLINE DRAWING

Section 2
Operating Instructions

2-1. INTRODUCTION

2-2. This section contains information regarding installation and operation of the Model 8120A. Operating procedures for options are also included. Before any attempt is made to operate the instrument, the contents of this section should be thoroughly understood. If difficulties are encountered during operation, please contact your nearest John Fluke sales representative or the John Fluke Mfg. Co., Inc. A list of sales representatives is located at the rear of the manual.

2-3. SHIPPING INFORMATION

2-4. This instrument was packaged and shipped in a foam packed cardboard carton. Upon receipt, a thorough inspection should be performed to reveal any damage in transit. Special instructions for inspection and claims are included in the carton.

2-5. If reshipment is ever necessary, the original container should be used. If it is not available, a new container can be obtained from the John Fluke Mfg. Co., Inc. Please reference the instrument Model number when requesting a new container.

2-6. INPUT LINE POWER

2-7. The 8120A can be operated from 100, 115, or 230V ac, 50 to 500 Hz line power. A decal on the rear panel indicates which line power input is required. Conversion to either 115 or 230V ac line power is done as follows:

a. Set the POWER switch on the front panel to OFF. Ensure that the power cord is disconnected.

b. Set the slide switch on the rear panel to the desired 115 or 230V ac line position.

c. Install the correct rated fuse in the fuse holder on the rear panel. Fuse types and ratings are given in the decal on the rear panel.

d. Connect the power cord to line power and then set the POWER switch to ON. If the –01 Option is installed, the meter on the front panel should indicate LINE OPR.

2-8. RACK INSTALLATION

2-9. The instrument is designed for bench-top use or it can be installed in a 19-inch equipment rack using the accessory Rack Mounting Kits shown in Figure 2-1. Information regarding installation of these accessories is given in Section 6.

2-10. OPERATING FEATURES

2-11. The location and function of all controls, connectors and indicators is shown in Figure 2-2.

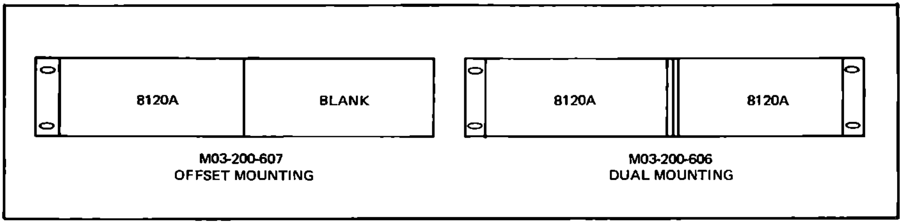

Figure 2-1. ACCESSORY RACK MOUNTING KITS

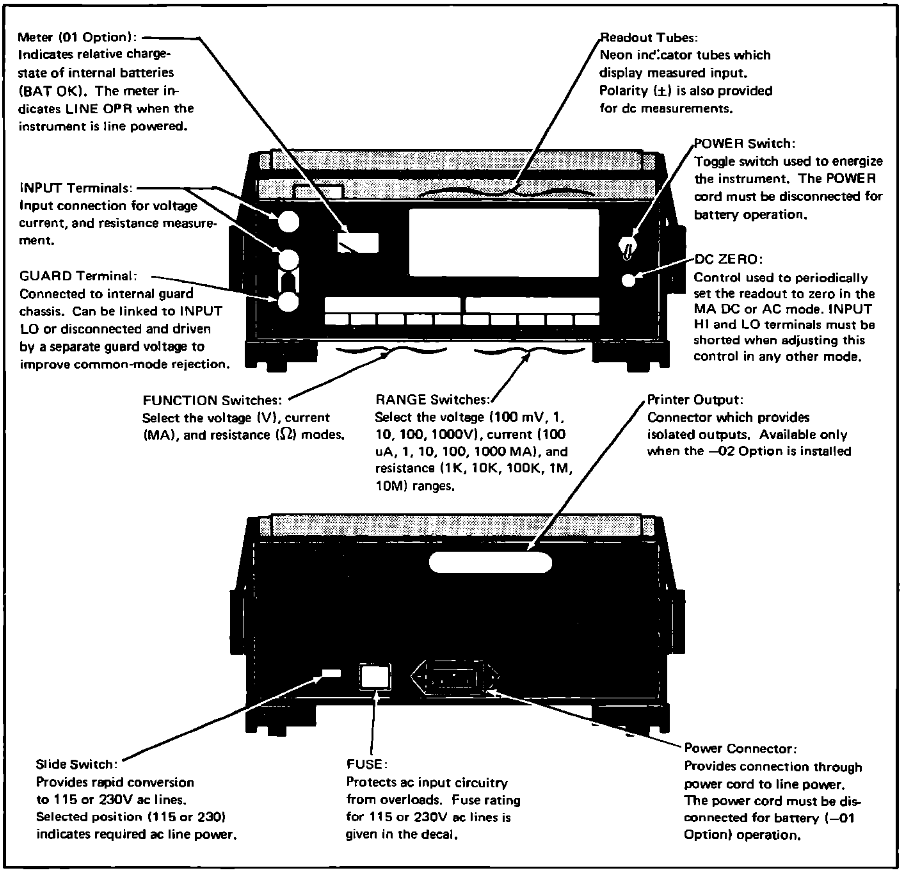

Figure 2-2. OPERATING FEATURES

2-12. OPERATING NOTES

2-13. The following paragraphs describe conditions which should be considered before operating the instrument.

2-14. AC Line Connection

2-15. The power cord has a three prong, polarized plug which connects to either 115 or 230V ac line power. The round pin on the plug connects the chassis of the instrument to earth ground; therefore, always ensure that the round pin is indeed connected to a high quality earth ground. The instrument is energized through a POWER switch on the front panel. If the –01 Option is installed, a front panel meter indicates LINE OPR when the instrument is energized from line power.

2-16. Battery Power (–01 Option)

2-17. When the –01 Option is installed, the instrument can be operated from an internal rechargeable battery. Battery operation is activated by disconnecting the power cord from line power and turning the instrument on with the POWER switch on the front panel. Relative state-of-charge of the battery is indicated by a meter on the front panel. Battery operation should only be done if the meter is indicating in the BAT OK region. Recharging of the battery is done whenever the instrument is operated from line power.

CAUTION

The chassis of the instrument is connected to earth ground through the round pin of the power cord. When battery operation is in effect, this ground connection is broken and the chassis is floating.

2-18. Input Connections

2-19. Three INPUT terminals (HI, LO, GUARD) provide connection to the source under measurement. The HI and LO terminals connect to respective high and low portions of the source. The GUARD terminal is normally connected (linked) to the LO terminal, except when guarded measurements described in paragraphs 2-20 are made. Maximum allowable voltage between the linked LO and GUARD terminals to chassis during ac line operation is 1200V dc or 230V rms at 60 Hz. If a guarded measurement is done, maximum voltage between the LO and GUARD terminal is 100V dc or peak ac. Subsequently, maximum voltage between the LO terminal and chassis during line operation and guarded measurements is 1300V dc or 393V ac rms at 60 Hz. No limitation is in effect when the line cord is disconnected and battery power (–01 Option) is in effect.

2-20. Guarded Measurements

2-21. Measurement errors caused by common-mode currents can be radically reduced by proper connection of the GUARD terminal. Normally, this terminal is connected (linked) to the LO terminal. Disconnection of the shorting link breaks the connection and isolates the inner chassis of the instrument. Upon application of a remote, guard voltage, measurement error is therefore reduced. Maximum voltage between the GUARD and LO terminal, however, cannot exceed 100V dc or peak ac. Total isolation is provided when the power cord is disconnected and battery power (–01 Option) is in effect.

2-22. Overload Protection

2-23. Most functions and ranges of the instrument are protected from overloads. DC voltage functions can sustain up to 1200V dc inputs on all ranges. The ac voltage function is protected to sustain 250V ac, dc or both in the 100 MV range; and 1200V ac, dc or both in the 1V to 1000V ranges. Resistance function (Ω) can receive up to a 130V rms input in the 1K range and a 230V rms input in the 10K through 10M ranges.

NOTE

The fuse which protects the current function (MA) is located in the inner bottom section of the instrument. Access is provided upon removal of the bottom dust cover. The fuse is located adjacent to the left, front side panel.

2-24. DC Zero

2-25. The digital multimeter readout can be set to zero periodically through the DC ZERO control on the front panel. To perform this zero adjustment, proceed as follows:

a. Turn on the instrument (see paragraphs 2-14 and 2-16).

b. Select the MA DC FUNCTION and any RANGE.

c. Adjust DC ZERO control for a 0.0000. The instrument is ready for operation.

2-26. OPERATION

2-27. DC Voltage

2-28. The 8120A can measure dc voltages in either polarity from 0 to 1000V. Five separate ranges provide a resolution of 10 uV to 0.1V. Overrange is 20% of any range, thus providing a total measurement capability of 10 uV to 1199.9V dc. To operate the instrument as a dc voltmeter, proceed as follows:

a. Turn on the instrument (see paragraphs 2-14 and 2-16).

b. Select the VDC FUNCTION and the desired full-scale 100 mV through 1000V RANGE.

c. Apply the voltage to be measured to the HI (+) and LO (–) INPUT terminals.

NOTE

Input terminal connections are described in paragraphs 2-18 and 2-20.

d. Observe the digital readout for the voltage polarity and magnitude.

2-29. AC Voltage

2-30. The 8120A can measure ac voltages from 0 to 1000V at frequencies of 30 Hz to 20 kHz. Five separate ranges provide a resolution of 10 uV to .1V. Overrange is 20% of any range, thus providing a total measurement capability of 10 uV to 1199.9V ac. To operate the instrument as an ac voltmeter, proceed as follows:

a. Turn on the instrument (see paragraphs 2-14 and 2-16).

b. Select the VAC FUNCTION and the desired full-scale 100 mV through 1000V RANGE.

c. Apply the voltage to be measured to the HI and LO INPUT terminals.

NOTE

Inp Input terminal connections are described in paragraphs 2-18 and 2-20.

d. Observe the digital readout for the voltage magnitude.

2-31. Ammeter

2-32. The 8120A can measure ac and dc current from 0 to 1A. AC frequency range is from 30 Hz to 10 kHz. Five ranges provide a resolution of 10 nA to 100 uA. Overrange is 20% of any range, thus providing a total measurement capability of 10 nA to 1.1999A. To operate the instrument as an ammeter, proceed as follows:

a. Turn on the instrument (see paragraphs 2-14 and 2-16).

b. Select the DC or AC, MA FUNCTION and the desired full-scale 100 uA through 1000 mA RANGE.

c. Apply the current to be measured to the HI (+) and LO (–) INPUT terminals.

NOTE

Ensure that the GUARD and LO INPUT terminals are connected (linked).

d. Observe the digital readout for the current magnitude. DC polarity will also be indicated.

2-33. Ohmmeter

2-34. The 8120A can measure resistances from 0 to 10M ohms. Five separate ranges provide a resolution of 0.1 ohms to 1K. Overrange is 20% of any range, thus providing a total measurement capability of 0.1 ohms (minimum on 1K range) to 11.999M ohms. Maximum current through R_X is 0.7 mA in the 1K range, decreasing by an order of magnitude per range to 0.7 uA in the 1M range (0.1 uA in the 10M range). Open terminal voltage is a maximum of +9V. To operate the instrument as an ohmmeter, proceed as follows:

a. Turn on the instrument (see paragraphs 2-14 and 2-16).

b. Select the Ω FUNCTION and the desired full-scale 1K through 10M RANGE.

c. Connect the unknown resistance to the HI and LO INPUT terminals.

NOTE

Ensure that the GUARD and LO INPUT terminals are connected (linked).

d. Observe the digital readout for the magnitude of the unknown resistance.

2-35. Isolated Printer Output (–02 Option)

2-36. The Isolated Printer Output is installed as the –02 Option. It provides isolated data output of digit, function, range, and overrange in 8-4-2-1 BCD format. Logic levels are compatible with DTL/TTL logic where:

Logic "0" = +0.4V maximum at 13 mA sink (OV no load)
Logic "1" = +2.4V @ 0.4 mA load (+3.5V maximum, open circuit)

3-37. The Isolated Printer Output enables interface with computer, printer, or a variety of data recording systems. Access is by means of a 36 pin connector mounted on the rear panel. Mating connector required is an Amphenol 57-30360 (FLUKE PART NO. 158451). Pin number assignments and descriptions are given in Table 2-1. Logic "1" is true, except as noted.

2-38. Triggering of printer output is done using either a positive true or negative true read command at pins 11 or 12, respectively. The read command can be a pulse or a steady-state logic level. If triggering is commanded with a pulse, data output will be provided within 450 msec and will remain until the next trigger is applied. Should a steady-state logic level be used as a trigger, the data output will be provided within 400 msec and up-dated accordingly at approximately the same rate.

Table 2-1. ISOLATED PRINTER OUTPUT PIN FUNCTIONS

PIN	FUNCTION
1, 2	LOGIC GROUND
3, 4	+5V dc OUTPUT
5	AC/DC FUNCTION: Logic "0" = DC Logic "1" = AC
6	MΩ
7	KΩ
8	MA
9	VOLTS
10	POLARITY: Logic "0" = – Logic "1" = +
11	Negative Read Command (Logic "0" = true)
12	Positive Read Command
	PRINT COMMAND:
13	Positive Output
14	Negative Output
	RANGE: (All logic "0" = 100 uA, 100 mV,)
15	1
16	10
17	100
18	1000

PIN	FUNCTION
	4th DECADE (LSD):
19	1 BITS
20	2 BITS
21	4 BITS
22	8 BITS
	3rd DECADE:
23	1 BITS
24	2 BITS
25	4 BITS
26	8 BITS
	2nd DECADE:
27	1 BITS
28	2 BITS
29	4 BITS
30	8 BITS
	1st DECADE:
31	1 BITS
32	2 BITS
33	4 BITS
34	8 BITS
35	NOT USED
36	OVERRANGE

SECTION 3

Theory of Operation

3-1. INTRODUCTION

3-2. This section contains the theory of operation of the Model 8120A Digital Multimeter. In the general discussion, the instrument function is examined at the block diagram level. The detailed circuit description is keyed to the schematics at the back of the manual.

3-3. GENERAL THEORY

3-4. System Description

3-5. The 8120A consists of three main sections: The buffer, the analog-to-digital (A/D) converter, and the display. A simplified block diagram of the instrument is shown in Figure 3-1. The buffer accepts the input signal and converts it into a voltage suitable to drive the A/D converter. It scales and conditions all inputs and it performs ac to dc conversion. The A/D converter accepts the buffer output, determines the polarity of the voltage, and converts the voltage into a binary coded decimal (BCD) output. The analog storage circuit is used to retain digit information between measurement cycles so that a continuous display is provided. The display circuit accepts the BCD output from the A/D converter and converts it into a 10-line decimal output, which operates the readout tubes. The power supplies provide operating voltages for each of the sections, a stable master reference voltage, and clock signals, which are the time base for the entire instrument.

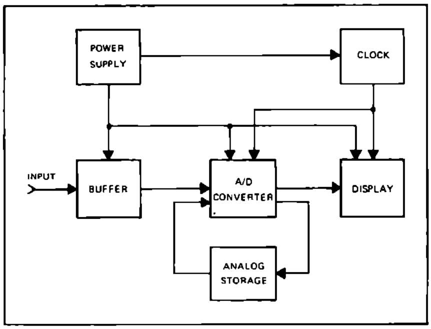

Figure 3-1 MODEL 8120A SIMPLIFIED BLOCK DIAGRAM

3-6. Buffer

3-7. The principal parts of the buffer are a network of shunts which convert input current to 100 millivolts full scale; a resistive input divider, which scales dc input voltages to 1 volt full scale; an active two-pole input filter, providing an instrument response of 1.2 seconds, which removes unwanted ac signals from the dc input; and a low-drift, high-gain amplifier having a high input impedance. Depending on the function called at the front panel, the buffer is connected in one of five modes of operation: dc voltage (VDC), resistance (Ω), ac voltage (VAC), dc current (MADC) or ac current (MAAC).

3-8. When the instrument is in dc voltage mode, the buffer is connected as shown in Figure 3-2. The dc input voltage (E_{in}) is applied to the resistive divider. The divider output is applied through the input filter to the buffer amplifier. The amplifier is connected as an inverting voltage follower and provides an output to the A/D converter which is the negative of the scaled-down input. The amplifier gain is switched to 10 for the 100 mv range. The two diodes inside the feedback loop provide a threshhold step, which supplies polarity information to circuitry in the A/D converter. Resistor R_L is the output load resistance.

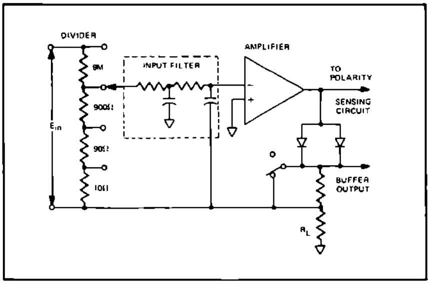

Figure 3-2. DC VOLTAGE MODE SIMPLIFIED DIAGRAM

3-9. In the resistance mode, the buffer is connected as shown in Figure 3-3. The same input divider, filter, and

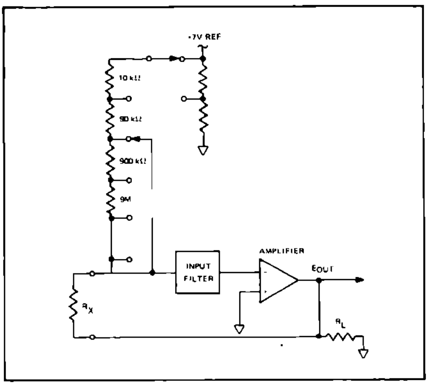

Figure 3-3. RESISTANCE MODE SIMPLIFIED DIAGRAM

amplifier are used, except the input divider is connected to a voltage reference. In this circuit arrangement, the input divider is the input resistor of an operational amplifier in which the voltage reference forms the input voltage and the unknown resistor (R_X) forms the feedback resistance. A voltage proportional to R_X is applied to the A/D converter and is equivalent to −0.7 volts full scale when the proper input divider tap is selected.

3-10. In ac voltage mode, the buffer is connected as shown in Figure 3-4. In this arrangement, the amplifier is

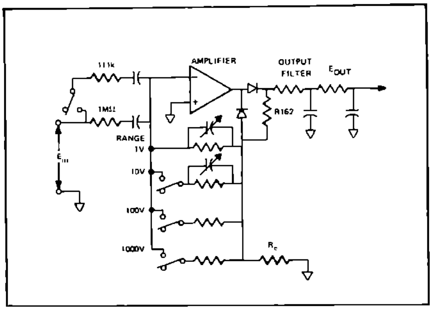

Figure 3-4. AC VOLTAGE MODE SIMPLIFIED DIAGRAM

used as an operational rectifier. A pair of rectifier diodes is placed inside a strong negative feedback loop, and a negative ac feedback signal proportional to the input voltage is developed across resistor R_e. A half wave rectified dc signal proportional to the input is developed across R162. The proper scale factor is determined by the feedback resistors, and the ac input resistors which are controlled by the front panel range switches. The positive half-cycles across R162 are filtered by a two-stage RC filter to provide a positive one volt output to the A/D converter that is scaled in terms of the rms value of a sine wave.

3-11. When the instrument is in dc current or ac current mode, the buffer is connected as shown in Figures 3-5 and 3-6, respectively. The shunts across the input terminals convert the full scale current to 100 millivolts ac or dc,

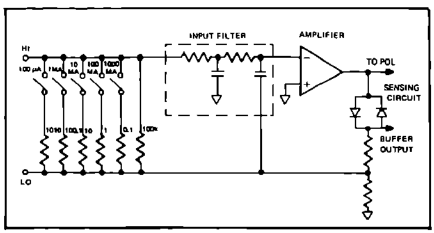

Figure 3-5. DC CURRENT MODE SIMPLIFIED DIAGRAM

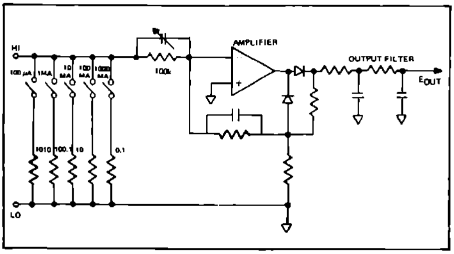

Figure 3-6. AC CURRENT MODE SIMPLIFIED DIAGRAM

depending on the called function. This voltage is then processed with the buffer in the appropriate voltage mode configuration and with the gain fixed for 100 millivolts full scale. Table 3-1 gives the full-scale buffer output for each of the instrument functions.

Table 3-1. BUFFER OUTPUTS

FUNCTION	FULL-SCALE BUFFER OUTPUT (VOLTS DC)
+VDC, +MADC	–1
–VDC, –MADC	+1
Ω	–0.7
VAC, MAAC	+1

3-12. A/D Converter

3-13. The A/D converter employs the unique recirculating-remainder (R^2) A/D conversion technique developed by FLUKE. A simplified diagram of the A/D converter and associated circuitry is shown in Figure 3-8. Accompanying the diagram is a chart showing the sequence of operation for an input of 0.6352 volts.

3-14. The A/D converter digitizes the input serially in four 4-millisecond time periods, with each period divided equally into digitizing and display periods, A and B. At the start of the measurement sequence, period 1A, the A to D converter samples the 0.6352 volt input. Then the analog output voltage from the X10 amplifier causes the comparator to output to the voltage controlled oscillator (VCO), and the VCO produces pulses which are entered into the counter. When the total pulse count equals the most significant digit of the input or 6, the counter stops. The ladder produces a series of six 0.1 volt steps which correspond to the counter output. The remainder of 0.0352 volts is amplified by the X10 amplifier and held in sample and hold capacitor C1. The display circuitry decodes the counter output and displays the 6 in period 1B. At the beginning of period 2, the 0.6352 volt input is disconnected from the input of the A/D converter and the 0.352 volt output of the sample and hold circuit is digitized and displayed as the new input. Successively, the remainders of 0.52 and 0.2 volts are digitized and displayed in the same manner. Although the four digits are digitized and displayed one at a time, the process proceeds at a sufficiently high rate of speed so that the display appears continuous to the eye.

3-15. The input voltage is sampled every 300 milliseconds. Since it only requires 20 milliseconds to digitize the input, a storage circuit is provided which stores a voltage representing each of the four digits on each of four capacitors. This stored information supplies the input during the remaining fourteen 20-millisecond periods, until the voltmeter is ready to sample the input voltage again.

3-16. Refer to the simplified A/D converter diagram in Figure 3-8 and assume that a +0.6352 volt signal is applied to FET switch Q16. The polarity sensing circuit turns on Q16 and turns off Q12 and Q17 in response to the positive input signal and the stage –1 signal from the ring counter. (Note: The positive input refers to the signal at the input of the A/D converter. The actual instrument input signal is negative, but is inverted by the buffer.) The input signal is thus applied to the positive input of amplifier A2. The feedback loop for A2 is closed through resistor R98, which is chosen to give an amplifier gain of 70. Thus, when the output of A2 is 7 volts, the voltage at e_s will be 0.1 volts. With 0.6352 volts at the positive input, amplifier A2 will attempt to place the same voltage at the negative input of A2; however, as the output of A2 swings past 7 volts, the comparator produces an output that turns on the VCO. The VCO produces a series of pulses, which are entered into the counter. The counter output causes the ladder to place a corresponding series of 0.1 volt steps into point e_s. When six pulses have entered the counter, the ladder output will be 0.6 volts and the output of A2 will drop below 7 volts. At this point, the VCO stops generating pulses and the voltage at e_s remains at 0.6 volts plus a remainder of 0.0352 volts which is applied to e_s through R98. The resulting voltage at e_R will then be exactly 0.352 volts or, in other words, ten times the remainder. The amplified remainder is applied through switch Q35 to the first sample and hold capacitor, C34.

3-17. Digitizing the 6 requires approximately 2 milliseconds or half of the first digitizing period, as shown in Figure 3-7. The 6, which is stored in the counter during

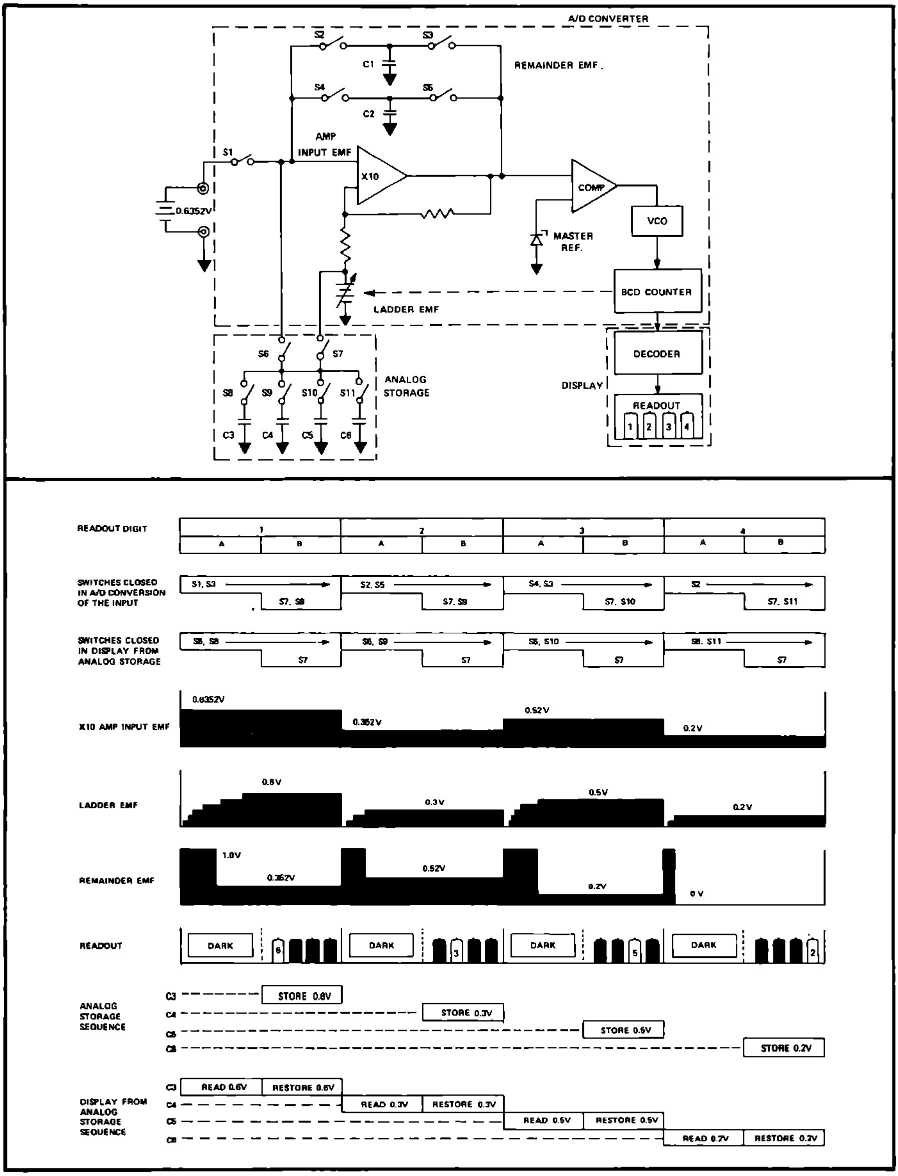

Figure 3-7. RECIRCULATING-REMAINDER A/D CONVERSION

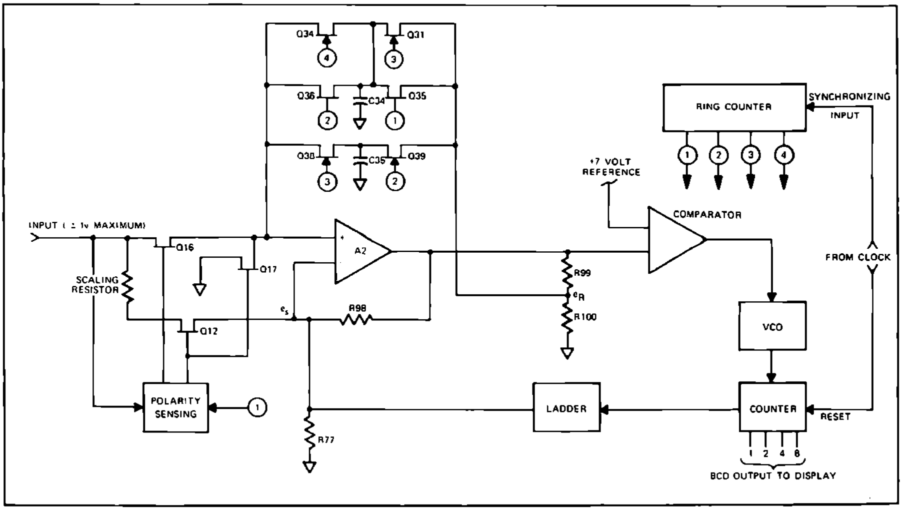

Figure 3-8. A/D CONVERTER SIMPLIFIED DIAGRAM

the digitizing process, is then displayed by the display circuit. After approximately 2 milliseconds of display time, the display is turned off and the counter is reset to zero. Switch Q35 is then turned off, leaving capacitor C34 charged to 0.352 volts. At the same time, Q16 is switched off, removing the input from the A/D converter for the duration of the digitizing cycle, and the ring counter switches to stage 2, turning on switches Q36 and Q39. The 0.352 volts is then applied through Q36 to the input of A2 and is digitized as the new input signal. The resulting amplified remainder of 0.52 volts is stored in the second sample and hold capacitor, C35, while the 3 is digitized and displayed in the second readout tube. The process is repeated twice more, digitizing both the 5 and the 2, with the amplified remainder alternately supplied by the two sample and hold capacitors.

3-18. If the A/D converter input voltage had been negative, the polarity sensing circuit would have turned on switch Q12 and Q17 instead of Q16 during the first period, and the voltage would have been applied to the negative input of A2, with Q17 holding the positive input of A2 at ground. With a negative input, both the ladder and resistor R98 are used as current summing resistors, since the negative input of amplifier A2 will be at virtual ground. The scaling resistor is the operational input resistance and is adjusted to set the amplifier gain to proper value. After the first digit is digitized, Q12 and Q17 are switched off and the remainder terms are digitized in the same manner as previously explained.

3-19. Analog Storage

3-20. A simplified diagram of the analog storage circuit is shown in Figure 3-9. This circuit accepts the 4-bit BCD output of the counter and converts it into an analog voltage which corresponds to the displayed digit. The analog voltage is applied to the storage capacitors through FET input switch Q28 during the display half of each clock cycle. Each of the four analog voltages is stored in a separate

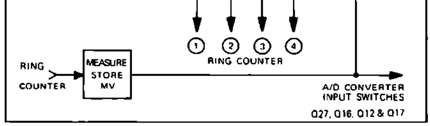

Figure 3-9. ANALOG STORAGE SIMPLIFIED DIAGRAM

capacitor which is switched into the circuit by the ring counter at the same time that the corresponding digit is being displayed. When the measure/store multivibrator switches to the storage mode, FET output switch Q29 is turned on and the input voltage is disconnected from the input of the A/D converter. The analog voltages in the storage circuit are then applied, digit by digit, to the A/D converter input. The voltages are digitized, displayed, and then re-stored in the analog storage circuit. The storage readout cycle lasts for approximately 300 milliseconds, after which time the measure/store multivibrator switches to measure mode and the A/D converter input is reconnected to the input signal. There are approximately 14 cycles of storage for every measurement cycle, which provides a continuous display that changes (input is sampled) three times per second.

3-21. Display

3-22. The 4-line BCD output from the A/D converter, containing the digit information, is applied to the decoder/driver. The decoder/driver provides a 10-line output, which is connected to the readout tube cathodes as shown in Figure 3-10. All readout tube cathodes are connected in

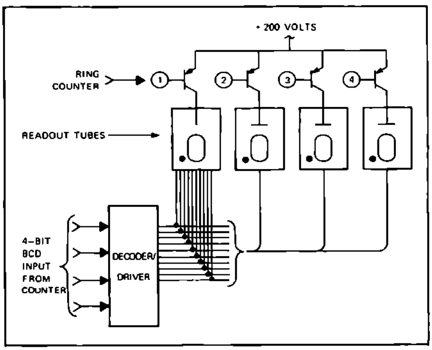

Figure 3-10. DISPLAY SECTION SIMPLIFIED DIAGRAM

parallel so that the same digit is turned on in each tube. However, only the readout tube corresponding to the proper digit will be turned on by the ring counter. Therefore, all four digits are displayed on a time-share basis using one counter and one decoder/driver. The display cycle occurs during the second half of each digitizing period, as shown in Figure 3-7, whereas digitizing in the A/D converter occurs during the first half of the period.

3-23. Power Supply and Clock

3-24. All operating voltages for the Model 8110A are produced by a series of regulated power supplies that derive their voltages from a −18 volt regulator (see Figure 3-11). In line operated instruments, the −18 volt regulator is supplied raw voltage by a transformer/rectifier; and in battery operated instruments, voltage is supplied by rechargeable batteries. The −18 volt regulator output is used throughout the instrument as an operating voltage and is also applied to the inverter input. The inverter provides +17 volts dc to the +15 volt regulator which, in addition to supplying instrument operating voltages, serves as source for the +7 volt reference. The inverter also provides 200 volts, which drives the readout tubes, and +5 volts to operate the integrated logic circuitry. Finally, the inverter supplies the 250 Hz clock signal.

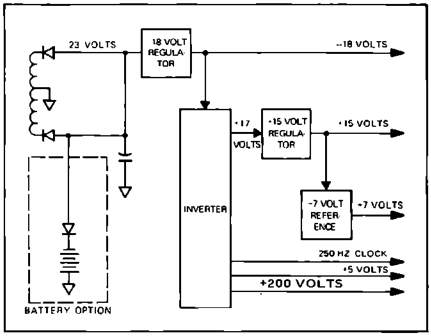

Figure 3-11. POWER SUPPLY AND CLOCK SIMPLIFIED DIAGRAM

3-25. CIRCUIT DESCRIPTION

3-26. Buffer

3-27. INPUT RANGE DIVIDER. In dc voltage mode, the input binding posts are connected across a four-position range divider consisting of three closely matched wirewound resistors, R158, R159, and R160 and a precision metal film resistor, R156. Resistor R157 is adjusted to provide an exact ratio between R156 and the other divider resistors. Depending on the range selected, the divider scales the input voltage down by a ratio of 1,10,100, or 1000 so that the output voltage of the divider will always be 1 volt full scale. In resistance ranges 1k through 1M, the bottom of the input divider (R160) is disconnected from the LO binding post and connected to the

+7 volt reference. When so connected, the divider acts as the current determining network for ohms measurement. Selection of the proper range places the required portion of the divider in series with the +7 volt reference. In 10 megohm range, the bottom end of the divider is connected to divider R152, R154, which is adjusted by R153 to provide an output of 0.7 volt. This 0.7 volt output sets the current through the entire divider to provide the proper scale factor. In all resistance ranges, the voltage developed across the unknown resistor is 0.7 volts at full scale.

3-28. INPUT FILTER The output of the range divider is applied to an active, two-pole filter consisting of resistors R27 and R28 and capacitors C10 and C12. The filter consists of R27 and C10 in the first section and R28 and C12 in the second section and provides a settling time of 1.2 seconds and noise rejection of 60 db at 60 Hz. Diodes CR11 and CR12, in conjunction with R27, protect both the filter and the buffer amplifier from excessive input voltages. In the 10 volt dc range, R27 is shorted out, since the output impedance of the range divider is 1 megohm and R27 is not needed.

3-29. BUFFER AMPLIFIER The buffer amplifier consists of transistors Q77, Q79, and Q80 and amplifier A1. The first stage amplifier is Q77, a low-noise, low-drift JFET pair operating in common-source configuration. Potentiometer R175 is the coarse zero adjustment control, which in conjunction with R176, R177, and R193 is used to reduce the initial offset of Q77 to zero. R192 is the front panel DC ZERO control, used for fine zero adjustment. The output of Q77 drives A1, a monolithic operational amplifier that provides most of the voltage gain. Capacitor C51 is placed around A1 to provide a smooth roll-off through unity gain. Transistor Q79 is a common base output stage which raises the output impedance of the amplifier as high as possible. To avoid degrading the high output impedance, Q79 operates into a constant current load, Q80.

3-30. In dc voltage and resistance modes, the feedback for the buffer amplifier is completed through diodes CR14 and CR15 which provide a voltage step around zero to drive the polarity sensing circuit. Resistor R150 is the load resistor for the amplifier. In ac voltage mode, the buffer amplifier is connected as an operational amplifier, with R24 functioning as the input resistor paralleled by R167, R168, R173 and C56 for the 100 mv range. The input signal is coupled to the gate of Q77 and the negative feedback loop is completed through the range resistors, R29, R30, R31, and R32. Diodes CR14 and CR15 act as an operational rectifier in ac voltage mode. A positive, half-wave rectified dc voltage, proportional to the average value of the ac input, is developed across R162. This voltage is smoothed by a two-stage filter composed of resistors R35 and R36 and capacitors C19 and C20. Potentiometer R34 (ACV CAL) is adjusted to provide a filter output of 1 volt for a full scale input on the 1 volt through 1000 volt ranges. R167 adjusts the 100 mv range. because of stray capacities, trimmer capacitors C14 and C15 are provided on the two lowest ranges to adjust the frequency response through 20 kHz. Frequency adjustment is not necessary on the upper two ranges because of the low resistance of R31 and R32.

3-31. A/D Converter

3-32. CLOCK The clock signal, which is the master timing signal for the A/D converter, is taken from several windings on the inverter transformer, T102. T102-2 supplies a gate control signal for the analog storage circuit. The signal at T102-10 is used to strobe the readout tubes and synchronize the ring counter. Both T102-10 and T102-8 signals are applied to NAND gate A3A to provide a delayed reset pulse for counter A4. The timing diagram for the A/D converter is shown in Figure 3-12. Note that the measurement cycle is actually one period longer than was shown in the simplified diagram of Figure 3-7. The added period is set aside at the beginning of each measurement cycle for removal of the zero offset of the A/D converter amplifier.

3-33. RING COUNTER. The five-stage ring counter consists of transistors Q19 through Q24 and associated components. The ring counter will free run at a frequency slightly less than the clock frequency. However, the clock signal forces the counter to speed up, thereby synchronizing the five counter periods with the clock. The purpose of Q24 is to prevent two pulses from entering the ring at one time. At the end of the fifth period in the measurement cycle, the ring counter supplies a synchronizing signal to the measure/store multivibrator.

3-34. POLARITY SENSING CIRCUIT . The polarity sensing circuit consists of transistors Q13, Q14, Q15, and associated components. At the beginning of the second period in every measurement cycle, Q13 is turned on by the second stage signal from the ring counter. As soon as Q13 turns on, the polarity sensing circuit responds to the voltage which appears at R40. If the instrument input voltage is negative, the voltage at R40 will be positive, transistor Q15 will conduct, and the signal at the collector of Q15 in conjunction with the signal from the measure/store multivibrator (Q25) will turn on FET switch Q16. Switch Q16 then connects the positive buffer output voltage at test point 9 (TP9) to the positive input of the A/D converter amplifier. If the instrument input is positive, Q14 will conduct and the signal at the collector of Q14 in

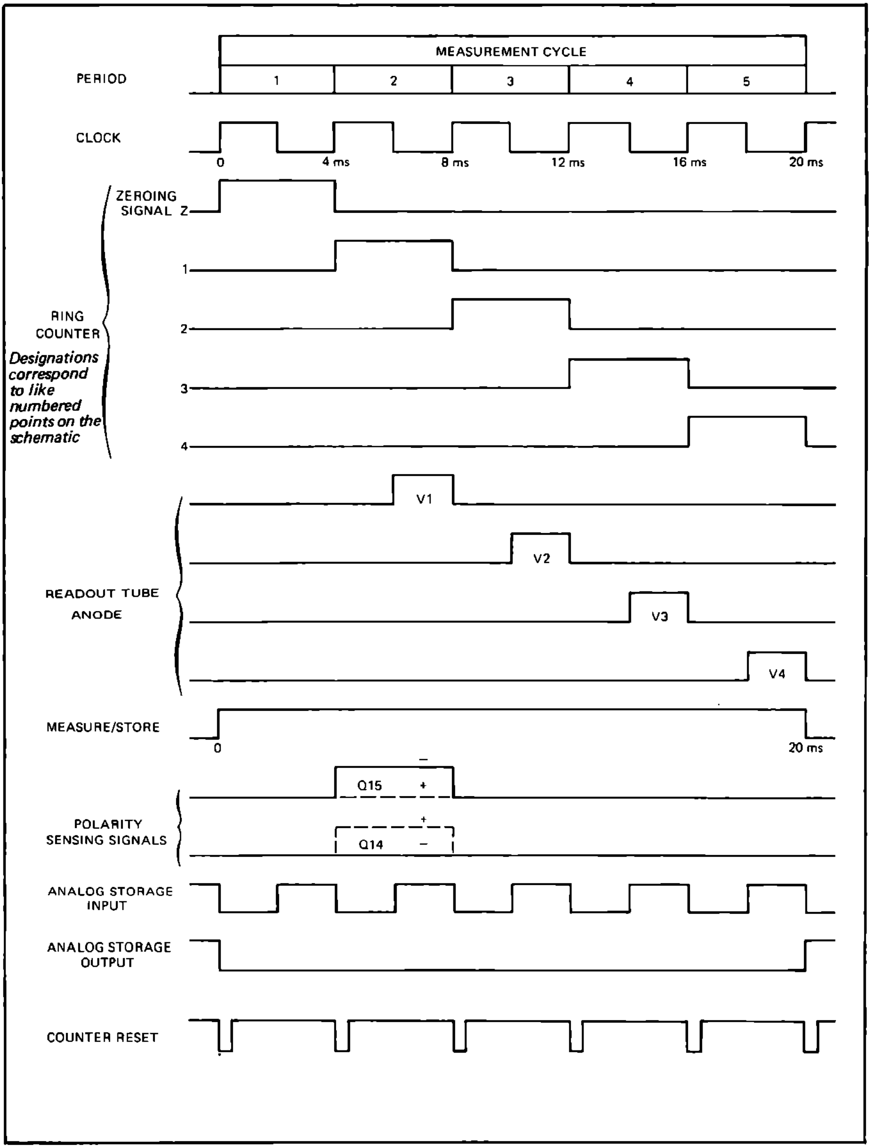

Figure 3-12. TIMING DIAGRAM

conjunction with the signal from Q25 will turn on FET switches Q12 and Q17. The negative buffer output will then be applied through scaling resistors R50 and R51 and switch Q12 to the negative input of the A/D converter amplifier. At the same time, the positive input of the amplifier will be connected to ground through switch Q17. Resistors R186 and R187 provide a small offset correction voltage to the positive input. The polarity indicator remains on during storage cycles, since the polarity sensing circuit monitors the input signal. During storage cycles, Q12, Q16 and Q17 are held off by a signal from the measure/store multivibrator.

3-35. A/D CONVERTER AMPLIFIER The amplifier consists of dual FET Q53, operational amplifier A2, and associated circuitry. Transistors Q76 and resistor R110 comprise a clamp which prevents amplifier A2 from saturating while the output is above 7 volts. Diode CR47 clamps the output of amplifier A2 on strong negative signals, such as FET switching transients. The remainder feedback loop is completed through the comparator, which consists of transistors Q86 through Q89, and through the remainder resistor R98 to the input of Q53. The amplifier is able to satisfy itself through these feedback loops as long as the input does not exceed 0.1 volt. When the input exceeds 0.1 volt, the output of A2 attempts to rise above 7 volts, which causes the comparator to output to the VCO through current source Q89. During the first period or zeroing period of each measurement cycle, transistors Q58, Q85 and Q18 are switched on by the ring counter. Transistor Q58 connects the output of the amplifier to the zero holding capacitor C37, while Q18 connects the positive input of the amplifier to ground. This operation places the offset of Q53 across C37 and effectively removes it for the balance of the measurement cycle.

3-36. VOLTAGE CONTROLLED OSCILLATOR The VCO consists of multivibrator Q59, Q60. The VCO has no output until it is supplied current by current source Q89. When the output of A2 exceeds 7 volts, the difference is passed on to Q89 by the comparator and Q89 begins to conduct. The pulse repetition rate of the VCO is proportional to the magnitude of the driving current. The greater the current flowing into the base of Q59, the greater the number of pulses per unit time. The output of the VCO is applied to the input, pin 1, of counter A4.

3-37. COUNTER The counter is a monolithic ripple counter, having an output which corresponds to a standard 8-4-2-1 binary code. The VCO output is applied to the clock input of the counter and the reset pulse from A3A is applied to the clear input. The output of counter A4 is applied to the decoder/driver, A5, and the ladder.

3-38. LADDER The output of counter A4 is applied to the ladder switches and their drivers, transistors Q40 through Q51. The ladder switches drive two ladders. The primary ladder consists of precision resistors R79, R84, R89, R94, and R77 and produces an output that corresponds to the actual value of the digital input. The secondary ladder, which drives only the analog storage circuit, consists of resistors R75, R78, R83, R88, and R93 and produces an output that is slightly in excess of the actual value of the digital input. Each ladder comprises a 4-bit, weighted-resistor digital-to-analog converter. The analog output of the ladders is weighted in terms of seventieths of the reference voltage (+7 volts) so that they can be programmed for a 0.1 volt output for each digital bit at the input.

3-39. SAMPLE AND HOLD The sample and hold circuit consists of FET switches Q34 through Q39 and capacitors C34 and C35. During the second period of the measurement cycle, the amplified remainder is applied to C35; however, Q35 is inhibited from conducting during the first half of the period by the clock signal which is coupled through diode CR36 to its gate. During the second half of the second period, Q35 is switched on and the amplified remainder is applied to capacitor C34. During the third period, Q35 is switched off, Q36 is switched on, and the remainder is applied through FET switches Q36 and Q27 to the input of amplifier A2. At the same time, Q39 is switched on and the next remainder is applied to capacitor C35. During the fourth period, Q39 is switched off and Q37 and Q38 are switched on. The input is then supplied by the remainder voltage held on C35, while the next amplified remainder is stored on C34. In the final period of the measurement cycle, only Q34 is switched on to supply the final remainder voltage to the input of A2. Upon completion of the fifth period, the A/D converter input is connected to the instrument input voltage (if in measure mode) or the analog storage output voltage (if in storage mode) and the circulation of the new remainder proceeds in the same manner as before.

3-40. Analog Storage

3-41. The analog storage circuit consists of the secondary ladder (discussed in paragraph 3-38), the measure/store multivibrator, and the storage circuit.

3-42. MEASURE/STORE MULTIVIBRATOR The measure/store multivibrator, consisting of transistors Q25 and Q26, is basically a one-shot multivibrator with dual synchronizing inputs. The measurement cycle, which is approximately 20 milliseconds in duration, is coincident with conduction of Q25; and the storage cycle, which is approximately 330 milliseconds in duration, is coincident with conduction of Q26. The multivibrator is triggered at the end of each measurement cycle by the trailing (negative) edge of the signal at the collector of Q24. During the measure cycle, a signal is coupled to the polarity sensing circuit from the collector of Q25. This signal enables switch Q16 for positive signal measurement or switches Q12 and Q17 for negative signal measurement. In storage mode, this signal is not present and, consequently, the input voltage will not be connected to the A/D converter.

3-43. STORAGE CIRCUIT The storage circuit consists of FET switches Q28 through Q33 and capacitors C30 through C33. The output of the secondary ladder is supplied to the appropriate storage capacitor through Q28, which is switched on during display time. The first digit is stored in C30, the second in C31, the third in C32, and the fourth in C33. When the measure/store multivibrator switches to storage mode, Q29 is switched on and the analog voltages stored in the capacitors are applied serially to the input of A2.

3-44. Display

3-45. The decoder/divider is a monolithic BCD-to-decimal decoder: It accepts the 4-bit BCD output of counter A4, decodes each digital word, and selects one of ten decimal output drivers. The ten driver outputs are applied to the readout tube cathodes.

3-46. The readout tubes are operated by the 200 volt power supply. During the second half of each clock period (display time), one readout tube anode is turned on by switch Q67, Q68, Q69 or Q70 and associated current source, Q71 through Q74. The switches, which are operated by the ring counter, turn on only one readout tube during each period of the measurement cycle. At the same time, the output of the decoder/driver is applied to the appropriate cathode of each of the four readout tubes and the digit is then visually presented in proper decimal position.

3-47. The overrange digit lamp, DS2, is operated by transistor Q66, which is connected in an AND configuration with gate A3C. When the output of counter A4 reaches ten, transistor Q66 conducts and turns on DS2. The function of gate A3B and transistor Q65 is to clamp the output of the VCO when counter A4 has a count of eleven during the first period of the measurement cycle (first digit) or a count of nine during any subsequent periods. The polarity sign indicator, V5, is operated by transistors Q81 and Q82 which are driven by the polarity sensing circuit.

3-48. Power Supply

3-49. Power of the Model 8120A is supplied either by the ac power line via power transformer T101 or by the internal rechargeable battery pack, BT1 (Option-01). The secondary of T101 is tapped for two output voltages. The higher voltage is rectified by diodes CR32 and CR33 and is used to charge the batteries through ballast lamp DS11. The ballast lamp regulates or limits battery charging current to ensure a safe level of charging current regardless of battery condition. The lower voltage is rectified by diodes CR1 and CR2 to provide operating voltage for the instrument. The voltage at filter capacitor C1 is always greater than the battery voltage during power line operation; therefore, diode CR34 is back biased, thereby preventing drain from the batteries during power line operation. The rectified power line voltage is fed through fuse F2 to a series regulator consisting of pass element Q1, driver Q2, and voltage amplifier Q3. This regulator provides −18 volts to operate the inverter and supply negative power supply voltages for the instrument. Meter M1 is placed across the pass element to provide an indication of battery condition.

3-50. The inverter is a transformer-coupled multivibrator consisting of driver transistors Q4 and Q5, transformer T102, and RC timing network C4, R6, and R7. The inverter derives its operating voltage from the −18 volt supply and is energized as soon as instrument power is applied. It operates at a frequency of approximately 250 Hz. The square wave at the primary of T102 is rectified by diodes CR5 and CR6 to provide positive voltage to operate the +15 volt regulator. The +15 volt regulator consists of pass element Q6, driver Q7, and voltage amplifier Q8. The +15 volt regulator obtains its reference from the zener diode portion of the reference amplifier Q11. In addition to supplying positive power supply voltages to operate the instrument, the +15 volt regulator also supplies the input for the +7 volt reference supply.

3-51. The +7 volt reference supply consists of compound emitter follower Q9, Q10, which is driven by reference amplifier Q11. The reference voltage is set precisely by R23 (−DC CAL control). Since the +7 volt reference must sink as well as supply current, resistor R181 is shunted across the output to draw a constant 2 milliamps from the supply. Also, diode CR10 is placed across the output of the supply to prevent current reversal during overload in the KΩ or 10 MΩ modes.

3-52. A high voltage tap in the primary of T102 supplies voltage to a halfwave voltage doubler consisting of diodes CR3 and CR45 and capacitor C6. The 200 volt output of the doubler is filtered by C65 and is used to operate the readout tubes, V1 through V4; the overrange indicator, DS2; and the polarity indicator, V5. Filtered dc voltage for operation of the integrated circuit logic is provided by diodes CR7 and CR8 and capacitor C44 in the secondary of T102.

Section 4
Maintenance

4-1. INTRODUCTION

4-2. This section contains information and instructions concerning preventive and corrective maintenance for the Model 8120A Digital Multimeter. Preventive maintenance consists primarily of cleaning the instrument and should be performed as often as operating conditions require. Corrective maintenance consists of troubleshooting, calibration, and performance test procedures, which are designed to aid in maintaining instrument operation within specifications. Section 3 of the instruction manual is an important supplement to the troubleshooting section, since a thorough knowledge of instrument theory is indispensable in troubleshooting.

4-3. A calibration interval of 90 days in recommended to ensure instrument operation within the 90-day specifications stated in Section 1.

4-4. SERVICE INFORMATION

4-5. Each instrument manufactured by the John Fluke Mfg. Co., Inc. is warranted for a period of one year upon delivery to the original purchaser. Complete warranty information is contained in the Warranty page located at the front of the manual. Factory authorized calibration and repair service for all Fluke instruments is available at various world wide locations. If requested, an estimate will be provided to the customer before any repair work is begun on instruments which are beyond the warranty period.

4-6. TEST EQUIPMENT

4-7. The equipment recommended for performance testing, troubleshooting and calibration of the 8120A is listed in Table 4-1. If the recommended equipment is not available, other equipment having equivalent specifications may be used.

4-8. GENERAL MAINTENANCE

4-9. Access/Disassembly

4-10. The following procedure may be used to gain access to all components except tubes; tube access procedure is given in paragraph 4-15.

a. Remove the top and bottom covers.

b. Remove the top guard by (1) disconnecting the snap-on guard wire from the spade-lug located on the rear of the guard, (2) disconnecting the two battery leads at the printed circuit board (if battery option is installed), and (3) removing the four guard mounting screws located on the side rails.

CAUTION!

Do not remove the six screws located on the top of the guard. These screws hold the optional battery pack in place and should not be removed until the guard is completely removed from the instrument.

Table 4-1. TEST AND CALIBRATION EQUIPMENT

EQUIPMENT NOMENCLATURE	RECOMMENDED EQUIPMENT OR REQUIREMENT	FUNCTION
DC Voltage Source	FLUKE Model 343A DC Voltage Calibrator	Performance Tests Troubleshooting Calibration
DC Current Source	FLUKE Model 382A Voltage/Current Calibrator	Performance Tests Troubleshooting Calibration
AC Voltage Source	Hewlett Packard Model 745A AC Calibrator	Performance Tests Troubleshooting Calibration
DC Current Measurement System	Measure 0.1 to 1000 mA at ± 0.03% Accuracy	Performance Tests Calibration
AC Amplifier	Hewlett Packard Model 746A High Voltage Amplifier	Performance Tests Troubleshooting Calibration
Precision Resistors 1.0000k 10.000k 100.00k 1000.0k	General Radio Type 1440 Standard Resistor	Performance Tests Calibration
Autotransformer	General Radio Model W5MT3AW Metered Variac	Calibration
Wattmeter		
High Impedence or Differential DC Voltmeter	FLUKE Model 885A DC Differential Voltmeter	Troubleshooting Calibration
Oscilloscope	Tektronix Type 545A Oscilloscope with Type 1A1 Dual Trace Plug-In	Troubleshooting

c. Remove the bottom guard by removing the snap-on guard wire at the rear of the guard and the four screws which hold it in place.

4-11. Fuse Replacement

4-12. The line fuse is located on the rear panel. The current protection fuse is accessible from the bottom of the instrument after removing the bottom cover. The power supply fuse is mounted in fuse clips which are attached to the printed circuit board near the power transformer. This fuse is accessible from the top of the instrument after removing the top cover. Correct values for the fuses are as follows:

F3	Current Protection Fuse	AGC 2 ampere

4-13. 115/230 Volt Conversion

4-14. The 8120A may be operated from either 115 or 230 volt ac power, depending upon the connection of the power transformer (T101) primary winding. Convert the instrument from one type of power line operation to the other by the following procedure:

a. Disconnect the instrument from the power line.

b. Place the 115/230 slide switch, located at the rear of the instrument, in the position which corresponds to the desired operating voltage.

c. Ensure that the proper line fuse for the selected voltage is installed (paragraph 4-11) before operating the instrument.

4-15. Lamp and Tube Replacement

4-16. Ballast lamp DS11 is soldered in place on the circuit board at the rear of the instrument, near the power transformer (Battery Option instruments only). It is accessible after removing the top and bottom covers. Readout tubes V1 through V4 and polarity indicator V5 are mounted in tube sockets and are located inside the black tube cover at the front of the circuit board. To gain access to V1 through V5, proceed as follows:

a. Remove the top cover.

b. Remove the small nut and washer from the stud bolt which is located just to the left of the meter on the inside of the front panel.

c. Remove the two screws which fasten the tube cover to the PCB.

d. Pull the end of the tube cover nearest the meter away from the panel far enough to clear the stud bolt, and lift the tube cover clear of the tubes.

e. All readout tubes except the overrange indicator are mounted in tube sockets. The overrange indicator is soldered to the PCB. Solder terminals are on the underneath side of the board and are accessible after removing the bottom dust cover and guard chassis.

4-17. Switch Maintenance

4-18. The following procedures cover service and replacement of the pushbutton switches.

4-19. GENERAL

a. Remove the dust covers and guard chassis. See paragraph 4-9 for Guard removal instructions.

b. Set all switches to the nondepressed position.

c. If switch contacts are to be serviced, locate which of the 24 switch modules is to be disassembled (Figure 4-1) and refer to the corresponding disassembly procedure.

d. If a complete switch module is to be replaced, refer to paragraphs 4-22 through 4-24.

e. To remove pushbuttons, pry the button off by applying pressure to the rear of the button from the inside of the front panel. Note that on some instruments buttons are glued on the switch shaft. When replacing buttons, use a small amount of contact cement. Apply glue to shaft only.

4-20. DISASSEMBLY OF REAR SWITCHES (Figure 4-2)

a. Remove the extension shaft associated with the switch by depressing the switch shaft and removing the extension shaft as shown in Detail A, Figure 4-2.

b. Remove the retaining clip and spring from the switch shaft.

NOTE!

The retaining clip may be re-installed on the switch shaft from either the board side or from the opposite side (dust cover side). Either method is satisfactory.

c. Remove the switch shaft by pushing it slowly out the back of the switch module. The moveable switch contacts will spring out of their slots in the shaft as this is done (see Detail B, Figure 4-2).

CAUTION!

Under no circumstances should attempts be made to re-form or add tension to the contacts by bending them.

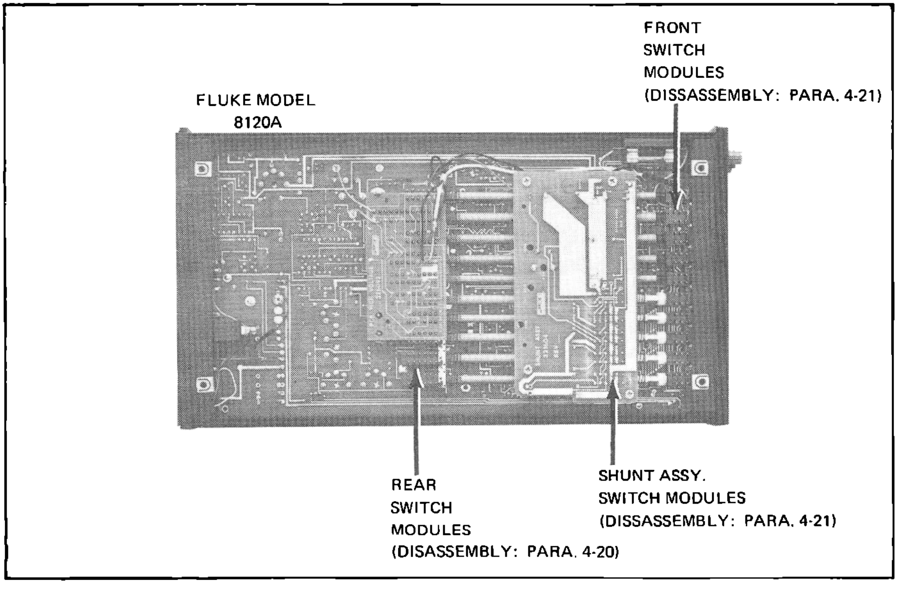

Figure 4-1. SWITCH MODULE LAYOUT AND CORRESPONDING DISASSEMBLY PROCEDURES

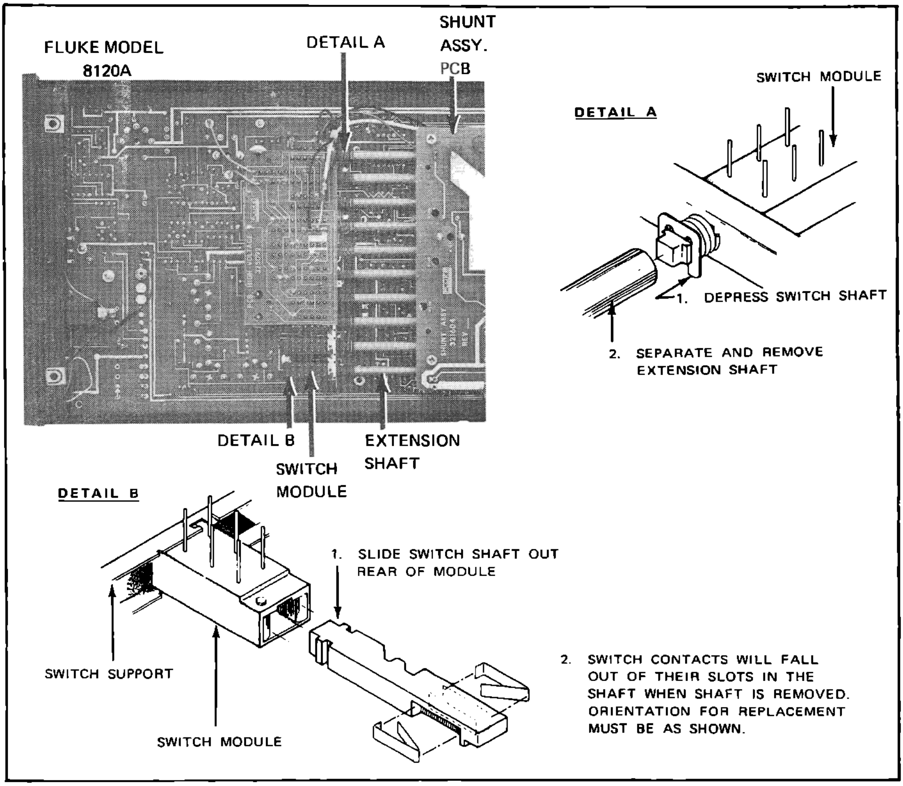

Figure 4-2. DISASSEMBLY OF REAR SWITCH MODULES

d. Inspect the switch contacts for contamination and, if necessary, clean them with a cotton swab saturated in alcohol. After cleaning, the contacts must be re-coated with a thin coat of grease: Use RYKON 2EP grease (American Oil Co.) or equivalent.

e. Assemble the switch by reversing the foregoing procedure. Exercise caution to ensure the contacts are not deformed during assembly.

4-21. DISASSEMBLY OF FRONT SWITCHES AND SHUNT ASSEMBLY SWITCHES (Figure 4-3).

a. Remove the four screws holding the Shunt Assembly pcb in place and tilt it away from the switches without putting undue strain on the pcb connecting wires.

b. For main pcb switches, remove the extension shaft associated with the defective switch by depressing the switch shaft and removing the extension shaft as shown in Detail A, Figure 4-2.

c. Remove the pushbutton from the switch.

d. Remove the switch shaft by sliding the latch bar to the side and pushing the shaft slowly out the back of the switch module (see Detail A, Figure 4-3). Use a pointed tool to move the latch bar. The latch bar is conveniently actuated from the shaft opening at an adjacent switch, in which case

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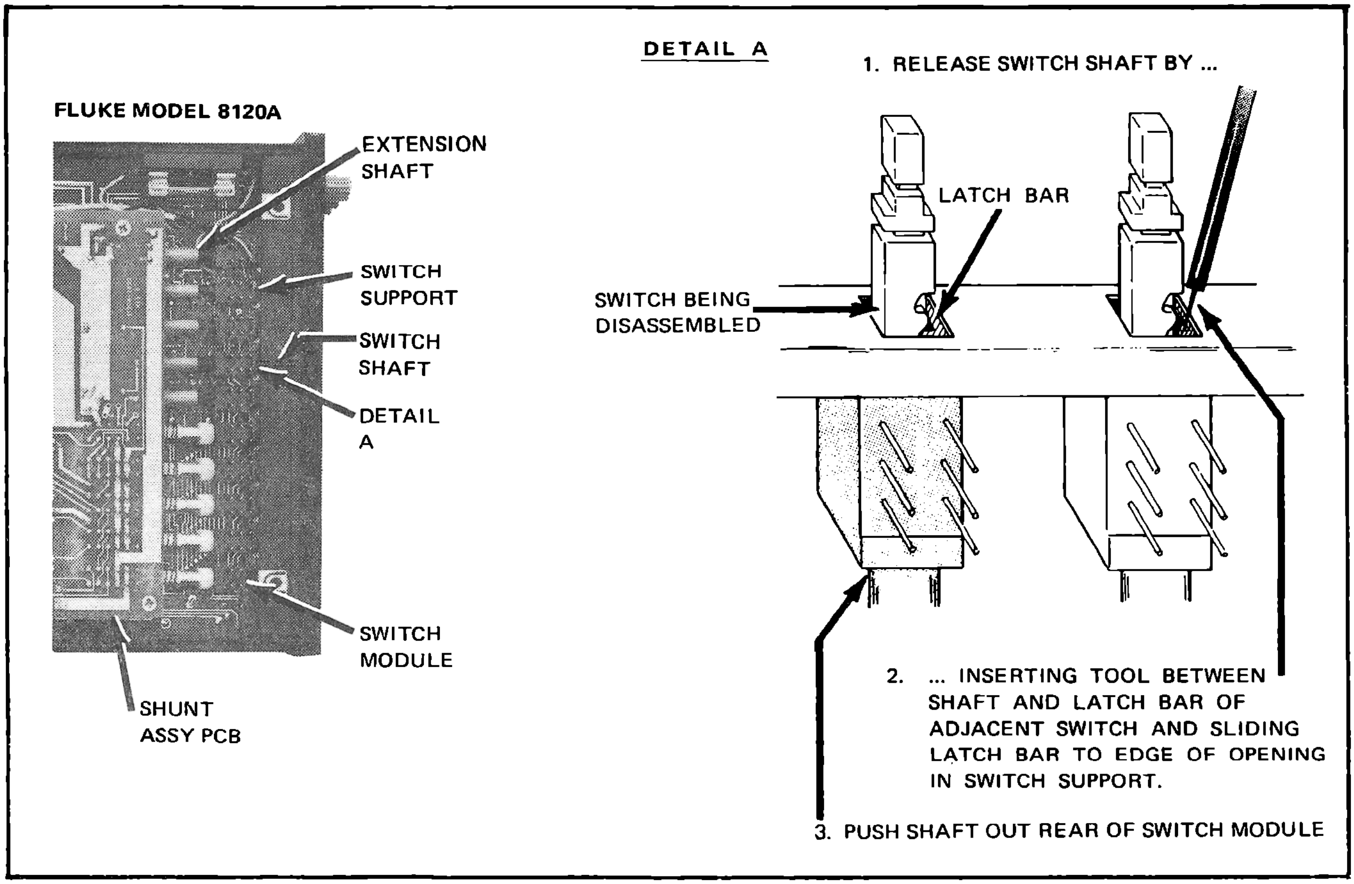


Figure 4-3. DISASSEMBLY OF FRONT SWITCH MODULES

the pushbutton will have to be removed from the adjacent switch shaft also. The moveable contacts will spring out of their slots in the shaft as the switch shaft is removed (see Detail B, Figure 4-2).

CAUTION!

Under no circumstances should attempts be made to re-form or add tension to the contacts by bending them.

e. Inspect the switch contacts for contamination and, if necessary, clean them with a cotton swab saturated in alcohol. After cleaning, the contacts must be re-coated with a thin coat of grease: Use RYKON 2EP grease or equivalent.

f. Assemble the switch by reversing the foregoing procedure. Exercise caution to ensure the contacts are not deformed during assembly.

NOTE!

The latch bar will have to be slid to the side, as in step (d), to replace the switch shaft.

g. For Shunt Assembly switches, perform applicable portions of the foregoing procedure.

4-22. SWITCH MODULE REPLACEMENT - REAR SWITCHES (Figure 4-4).

a. Unsolder and remove High Voltage pcb.

CAUTION!

Use a desoldering tool and exercise extreme caution to avoid damaging pcb.

b. Remove extension shaft, spring retaining clip, spring and switch shaft from defective switch module (Figure 4-2).

c. Unsolder defective switch module from main pcb.

CAUTION!

Use a desoldering tool and exercise extreme caution to avoid lifting land patterns or otherwise damaging the pcb.

d. Bend all locking tabs up slightly and slide switch support to the side and forward enough to remove defective module.

e. Install new module and associated parts by reversing foregoing procedure.

4-23. SWITCH MODULE REPLACEMENT - FRONT SWITCHES, MAIN PCB (Figure 4-4).

a. Remove shunt assembly as in paragraph 4-21 (a).

b. Unsolder three wires from front panel binding posts.

c. Remove POWER switch from front panel **without** unsoldering its wires.

d. Remove nut and washer from inside of front panel at meter end of black tube cover.

e. Remove four screws in side channels, which hold front panel in place, and remove front panel.

f. Remove two bronze locking springs by straightening holding tabs near pcb.

g. Remove pushbutton from shaft of defective switch.

h. Remove switch shaft clip and switch shaft from defective module (Figure 4-2).

i. Unsolder defective switch module from main pcb.

CAUTION!

Use a desoldering tool and exercise extreme caution to avoid lifting land patterns or otherwise damaging pcb.

j. Bend all locking tabs up slightly and slide switch support to the side and forward enough to remove defective module.

k. Install new module by reversing foregoing procedure.

NOTE!

Be sure to replace bronze locking springs and bend their holding tabs into place before replacing front panel.

4-24. SWITCH MODULE REPLACEMENT - SHUNT ASSEMBLY PCB (Figure 4-4).

a. Remove screws holding Shunt Assembly pcb in place and position it for access to switches on underside of pcb.

b. Remove spring retaining clip, spring and switch shaft from defective module. (Figure 4-2).

c. Unsolder wires from rear switch support.

d. Bend all locking tabs up slightly on rear switch support.

e. Unsolder defective module from Sheet Assembly pcb.

f. Slide switch support to the side and back enough to remove defective module.

CAUTION!

Use a desoldering tool and exercise extreme caution to avoid lifting land patterns or otherwise damaging the pcb.

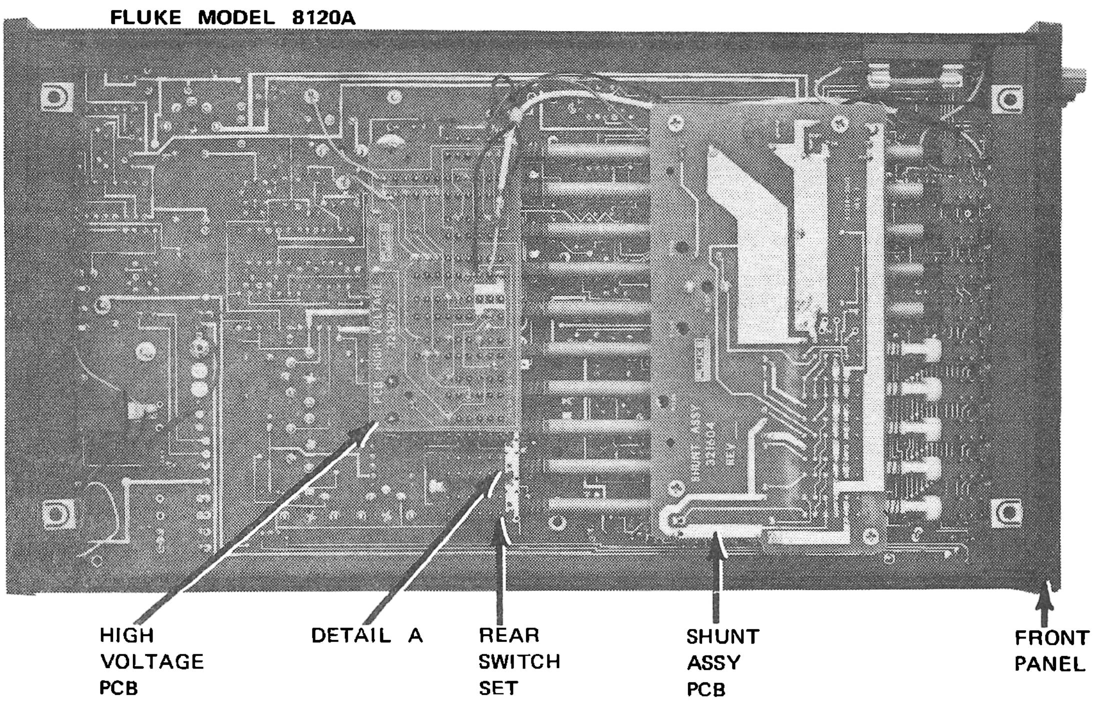
g. Install new module by reversing foregoing procedure.

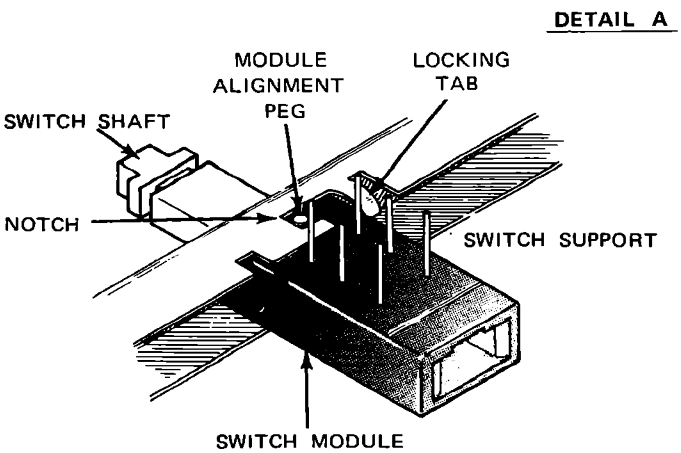
4-25. Cleaning

4-26. The instrument should be cleaned periodically to remove dust, grease, and other contamination. The following procedure should be adhered to when cleaning the instrument:

a. Remove loose contamination with low-pressure, clean, dry air. Pay particular attention to the front panel binding posts and binding post wiring.

b. The front panel and exterior surfaces may be cleaned with anhydrous ethyl alcohol or a soft





1. REMOVE SWITCH SHAFT
2. BEND ALL LOCKING TABS UP ON SWITCH SUPPORT
3. SLIDE SWITCH SUPPORT TO SIDE AND FORWARD ENOUGH TO REMOVE THE MODULE

Figure 4-4. MODULE REPLACEMENT

cloth dampened in a mild solution of detergent and water.

CAUTION!

Do not use aromatic hydrocarbons or chlorinated solvents on the front panel, because they will react with the Lexan binding posts.

4-27. PERFORMANCE TESTS

4-28. The following tests are intended for use in performance testing of the 8120A. The tests compare the instrument performance to the accuracy specifications and are especially suited to acceptance testing of new instruments. Tests should be conducted under the following conditions: ambient temperature 25°C ±5°C, relative humidity less than 70%.

NOTE!

Tolerances and test limits for performance tests are derived from the 90-day instrument specifications.

4-29. DC Voltage Test

4-30. In the following procedure, dc voltages are applied to the instrument at 100% of full-scale on the 100 millivolt and 10, 100, and 1000 volt ranges and at 10% and 100% of full-scale on the 1 volt range. A dc voltage source equivalent to the one shown in Table 4-1 is required for this test.

a. Connect the 8120A to the ac line.

b. Set the 8120A controls as follows:

POWER	ON
FUNCTION	VDC
RANGE	100MV

c. Short the INPUT terminals and adjust the DC ZERO control for ±00.00 readout ±1 digit.

d. Apply each of the input voltages shown in Table 4-2, in turn, to the INPUT terminals of the 8120A. The 8120A readout should be as indicated.

Table 4-2. DC VOLTAGE TEST REQUIREMENTS

INPUT (VOLTS DC)	MODEL 8120A	
	RANGE	READOUT LIMITS
+1000	1000	+999.8 to +1000.2
+100	100	+99.98 to +100.02
+10	10	+9.998 to +10.002
+1.0001	1	+0.9999 to +1.0003
+0.0999	1	+0.0998 to +0.1000
+0.1000	1	+0.0999 to +0.1001
+0.1000	100MV	+99.93 to +100.07

e. Repeat step d. with negative input voltages. The 8120A readout should be the same as for positive inputs, except that the polarity indication should be negative (–).

4-31. AC Voltage Test

4-32. In this test, full-scale voltages are applied to the instrument input at 100% of full-scale on the 100 millivolt and 1, 10, and 100 volt ranges and 10% of full-scale on the 1000 volt range. The 100 millivolt and the 1 and 10 volt ranges are checked at 1kHz, 10kHz, and 20kHz and the 100 and 1000 volt ranges are checked at 1kHz only. An ac voltage source equivalent to the one shown in Table 4-1 is required for this test.

a. Connect the 8120A to the ac line.

b. Set the 8120A controls as follows:

POWER	ON
FUNCTION	VAC
RANGE	100MV

c. Short the INPUT terminals and adjust the DC ZERO control for 00.00 readout ±1 digit.

d. Apply the ac test signals shown in Table 4-3 to the 8120A INPUT terminals. The readout should be as indicated.

Table 4-3. AC VOLTAGE TEST REQUIREMENTS

INPUT		MODEL 8120A	
FREQUENCY (KHZ)	RMS VOLTS	RANGE	READOUT LIMITS
1	0.1	100MV	99.75 to 100.25
1	1	1	0.9975 to 1.0025
1	10	10	9.975 to 10.025
1	100	100	99.75 to 100.25
1	100	1000	099.3 to 100.7
10	0.1	100MV	99.75 to 100.25
10	1	1	0.9975 to 1.0025
10	10	10	9.975 to 10.025
20	0.1	100MV	99.40 to 100.60
20	1	1	0.9940 to 1.0060
20	10	10	9.940 to 10.060

4-33. Ohms Test

4-34. The ohmmeter section of the instrument is checked by measuring standard resistors, whose values correspond to full-scale readings on each ohms range. Standard resistors equivalent to those given in Table 4-1 should be used.

a. Connect the 8120A to the ac line.

b. Set the 8120A controls as follows:

POWER	ON
FUNCTION	Ω
RANGE	1K

c. Short the INPUT terminals and adjust the DC ZERO control for .0000 readout ±1 digit.

d. Connect each of the standard resistors shown in Table 4-4, in turn, to the INPUT terminals of the 8120A (use short, low-resistance connecting leads). Set the RANGE and function switches as required. The 8120A readout should be as indicated.

Table 4-4. OHMS TEST REQUIREMENTS

STANDARD RESISTANCE	MODEL 8120A		
	FUNCTION	RANGE	READOUT LIMITS
1.0000k		1k	0.9994 to 1.0006
10.000k		10k	9.994 to 10.006
100.00k	Ω	100k	99.94 to 100.06
1000.0k		1M	0.9994 to 1.0006
10M		10M	9.989 to 10.011

4-35. Current Test

4-36. The current ranges are checked with dc input currents at 100% of full-scale on the 100μA, 1MA, 100MA and 1000MA ranges and 10% of full-scale on the 1000MA range. A dc current source and measurement system equivalent to the ones given in Table 4-1 are required for this test.

a. Connect the 8120A to the ac line.

b. Set the 8120A controls as follows:

POWER	ON
FUNCTION	MADC
RANGE	100μA

c. Short the INPUT terminals and adjust the DC ZERO control for ±00.00 readout ±1 digit.

d. Apply each of the input currents given in Table 4-5, in turn, to the INPUT terminals of the 8120A. The 8120A readout should be as indicated.

Table 4-5. DC CURRENT TEST REQUIREMENTS

INPUT (mA dc)	MODEL 8120A	
	RANGE	READOUT LIMITS
+0.1	100μA	+99.88 to +100.12
+1	1	+.9988 to +1.0012
+10	10	+9.988 to +10.012
+100	100	+99.88 to +100.88
+1000	1000	+998.8 to +1001.2
+100	1000	+099.7 to +100.3

4-37. TROUBLESHOOTING

4-38. This section contains information selected to assist in troubleshooting the 8120A. Before attempting to troubleshoot the instrument, however, it should be verified that the trouble is actually in the instrument and is not caused by faulty external equipments or improper control settings. The performance tests (paragraph 4-27) are suggested as a first step in troubleshooting, since they may help to localize the trouble to a particular section of the instrument. If they fail to localize the trouble, the following individual tests may be helpful. Figure 4-5 shows location of test points on the PCB and Figure 4-6 shows pin connections for integrated circuits used in the instrument.

4-39. Power Consumption

4-40. This test verifies proper power consumption by the instrument.

a. Connect the 8120A through an ammeter to the ac line.

b. Turn the POWER switch ON and observe the reading on the ammeter. With no switches depressed, the ammeter should indicate approximately 40 milliamps for an instrument without batteries and not more than 90 milliamps for an instrument with batteries.

4-41. Power Supply

4-42. Supply levels are referenced in such manner that unless all output levels are correct, most levels will be incorrect. This occurs because the −18 volt supply is referenced to the +15 volt supply, which is in turn referenced to the +7 volt supply. If the −18 volt supply is high, the +15 volt and the +200 volt supplies will also be high. If the −18 volt, +15 volt, or +7 volt supply is low, all supply output voltages will be low.

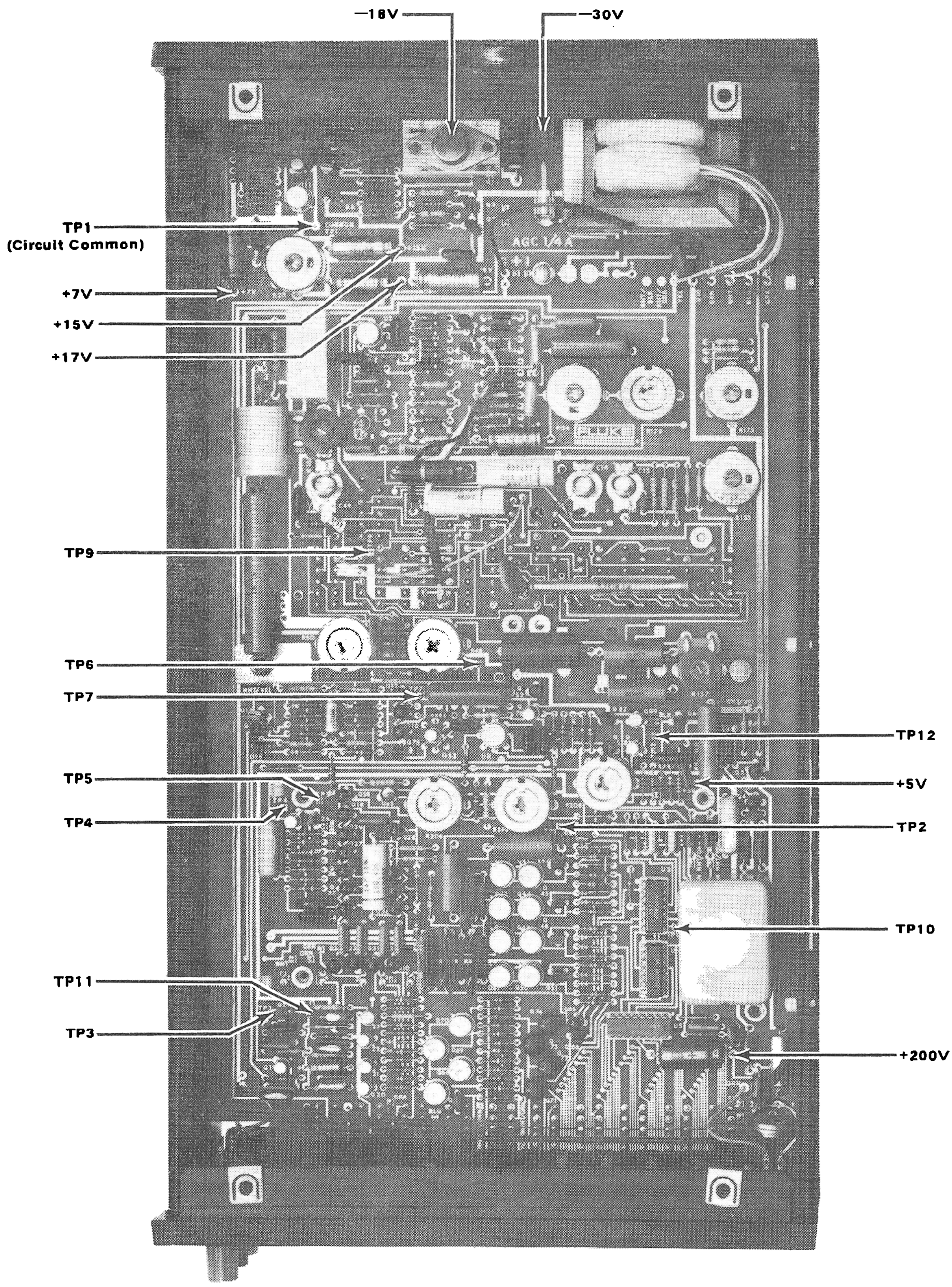


Figure 4-5. LOCATION OF TEST POINTS ON PCB

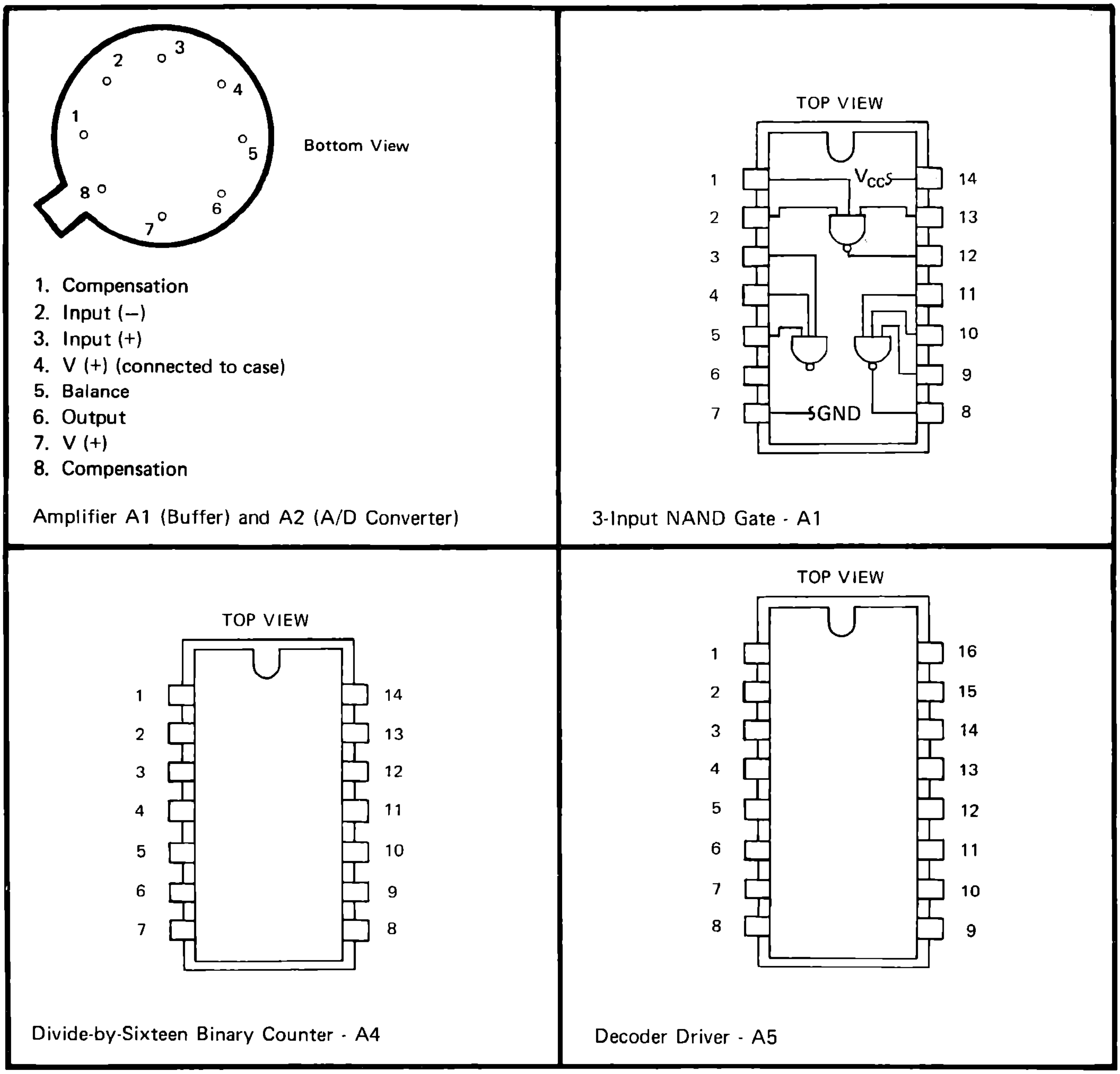


Figure 4-6. INTEGRATED CIRCUIT PIN ORIENTATION

4-43. To measure the output voltages, use a voltmeter accurate to at least ±0.025% and proceed as follows:

a. Set the FUNCTION and RANGE switches to any position.

b. Connect the voltmeter common to 8120A common (TP1) and measure the voltages shown in Table 4-6. Voltages should be as indicated.

Table 4-6. POWER SUPPLY VOLTAGE REQUIREMENTS

VOLTAGE TEST POINT	NOMINAL	LIMITS (VOLTS)
Either terminal of fuse F2	–30	–24 minimum
Collector (case of Q1)	–18	–17.8 to –18.8
+Terminal of C5	+17	+16.3 to +17.3
+Terminal of C7	+15	+14.7 to +15.6
+Terminal of C8	+7	+6.993 to 7.007
+Terminal of C44	+5	+4.75 to +5.25
+Terminal of C65	+200	+185 to +205

4-44. The following procedures can be used to isolate which supply output is low; either procedure makes the −18 volt supply independent of the other supplies for its reference. Disconnect the +15 end of resistor R5 and connect it to a stable external +15 volt source, or disconnect R5 from the base of Q3 and connect a 1330Ω ±1% resistor from the base of Q3 to signal ground.

4-45. Buffer

4-46. In 1 volt dc range, the voltage between INPUT LO and signal ground (TP1) should very nearly equal the input voltage between INPUT HI and LO. At full-range (−1.1999 or +1.1999 volts) the deviation should be less than 60 microvolts; at zero volts input, deviation should be less than 10 microvolts.

4-47. When measuring buffer performance, it should be noted that the INPUT LO terminal is not 8120A signal ground, as shown in Figure 4-7. This circuit may become unstable and oscillate if a large capacitance (500pf or more) is placed across R174. To avoid this problem, it is recommended that test equipment ground be connected to INPUT LO instead of TP1 when the 8120A is measuring dc volts. In ac voltage mode, INPUT LO and signal common are equivalent.

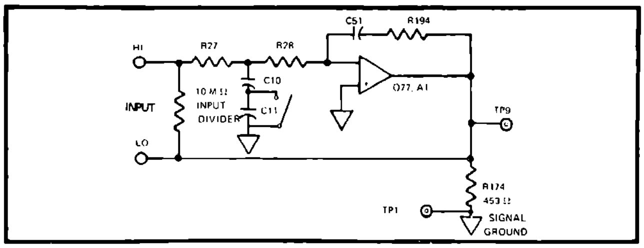


Figure 4-7. INPUT BUFFER CONFIGURATION - 1 VDC RANGE.

4-48. To check the buffer in both ac and dc voltage modes, proceed as follows:

a. Set the 8120A controls as follows:

POWER	ON
FUNCTION	VDC
RANGE	1

b. Connect +1.0000 volts dc to the INPUT terminals.

c. Connect a high impedance voltmeter between instrument common (TP1) and TP9. The voltmeter should indicate −1.0000 ±0.0003 volts dc.

d. Disconnect the voltmeter high lead from TP9 and connect it to the positive (+) terminal of capacitor C18.

e. Press the VAC function switch and connect a 1.0000 volt, 1kHz signal to the instrument INPUT terminals. The voltmeter should indicate +1.0000 ±0.0025 volts dc. If the A/D converter and display sections of the 8120A are working, the 8120A readout should correspond to the voltmeter indication.

4-49. A/D Converter

4-50. It is convenient to use VAC mode to check the A/D converter and display circuitry, because in this mode the INPUT LO terminal and 8120A circuit common are equivalent, as shown in Figure 4-8. The ac input signal is connected between INPUT HI and LO. If buffer problems are suspected, however, the buffer can be bypassed by connecting a low impedance (<<820k) dc source of zero to +1.999 volts dc between INPUT LO and TP9, (Figure 4-9). The resulting readout should correspond to the A/D converter input.

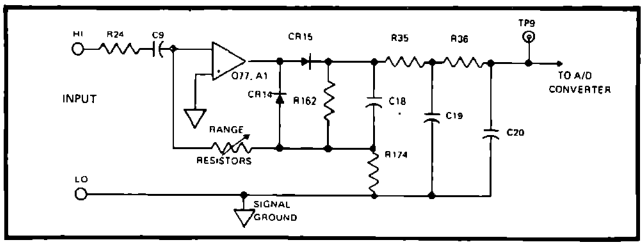


Figure 4-8. BUFFER CIRCUIT ARRANGEMENT - VAC MODE.

4-51. 300 MS Sample Rate Suppression

4-52. The A/D converter samples the input at a fixed rate of once each 300 milliseconds. The sampled reading is then stored on capacitors C30 through C33 and is read out of storage repeatedly until the next sample is taken. The storage mode can be eliminated for test purposes by installing a jumper between TP4 and TP5. This will force the A/D converter to sample the input during period 1 of every measurement cycle, i.e., once each 20 milliseconds.

4-53. Auto-Zero Suppression

4-54. Amplifier A2 in the A/D converter is zeroed auto-

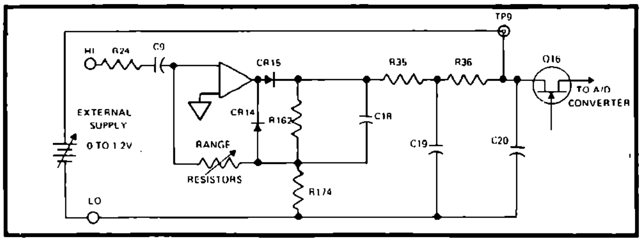


Figure 4-9. DIAGRAM OF INPUT BUFFER, VAC MODE, WITH EXTERNAL DC SIGNAL APPLIED DIRECTLY TO A/D CONVERTER.

matically by circuitry consisting of Q58, R180, and C37. Some failures in the converter may cause the auto-zero circuit to overcompensate and mask the trouble. To disable the auto-zero circuit, connect a jumper between TP6 and TP7. A few digits offset will be present in the readout and it will stay at zero for several digits of input on one polarity, but when the input is raised the output should follow properly.

4-55. Ring Counter

4-56. The signal at TP3 (Figures 4-10 and 4-11) is convenient for evaluation of the ring counter. The signals at the collectors of Q20 through Q24 are identical, but are displaced in time.

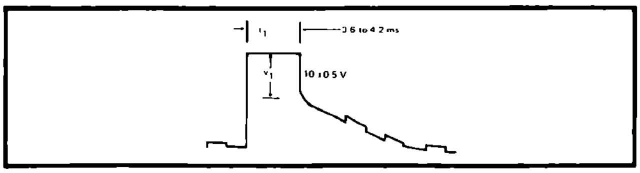


Figure 4-10. RING COUNTER SIGNAL - TP3 - CORRECT WAVEFORM.

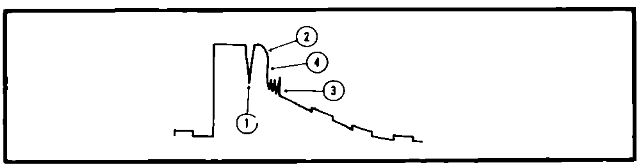


Figure 4-11. RING COUNTER SIGNAL - TP3 - MARGINAL WAVEFORM CONDITIONS.

a. In the waveform shown in Figure 4-10, t_1 should be 3.8 to 4.2 milliseconds. If t_1 is not correct, check clock signal duration. It should be 4 ±0.2 milliseconds duration.

b. The trailing edge of the signal at TP3 should be a 10 ±0.5 volt step. Factors which determine this step amplitude are repetition rate and the values of C26 and R56.

c. Marginal signal conditions are shown in Figure 4-11 and are described as follows:

1. Spike in center indicates near minimum pulse-repetition rate. Sync bias level, controlled by R61, and synchronizing signal amplitude affect center spike.

2. Trailing edge droop is mainly a function of Q19 gain: H_{FE} should be greater than 100 at 1 milliamp, 0.5 volts. Droop occurs at maximum pulse repetition rate.

3. Spikes following the pulse occur if the ring counter is near an oscillation condition: Check capacitor C57.

4. Trailing edge switching time should be between 2 and 15 microseconds. Switching time is a function of the transistor and the synchronizing signal. Fall times as long as 40 microseconds have been observed when sync bias is incorrect.

d. The ring is subject to failure if the output lines are loaded by a faulty transistor, such as Q65, Q30, Q34, or any other device connected to the ring output lines. This type of failure causes the ring to oscillate at random intervals. To isolate ring problems, connect TP11 to the +15 volt supply and check that each output line is between −17 and −18 volts. Remove the +15 volt connection from TP11 and check that each collector saturates to within −0.3 volts of signal ground when the corresponding transistor turns on. Test jumpers are provided at ring positions 1, 2, 3 and 4, and can be cut to isolate loading problems in the ring.

e. The ring counter synchronizing signal, TP11, should appear as shown in Figure 4-12.

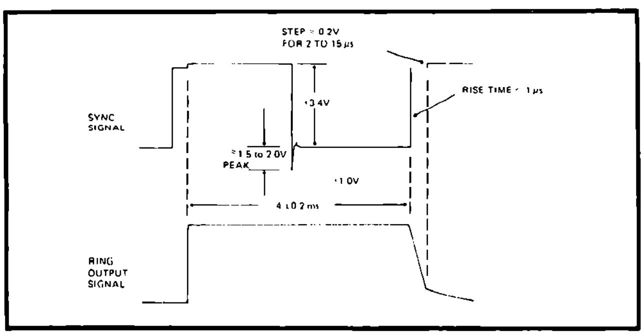


Figure 4-12. RING COUNTER - SYNC SIGNAL.

4-57. Measure/Store Multivibrator

4-58. Waveforms associated with the measure/store multivibrator are shown in Figure 4-13.

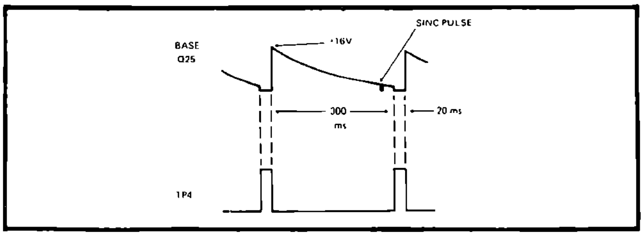


Figure 4-13. MULTIVIBRATOR WAVEFORMS.

4-59. Linearity

a. Set the 8120A controls as follows:

FUNCTION	VDC
RANGE	1

b. Apply each of the following voltages, in turn, to the INPUT terminals. The instrument readout should be as indicated.

NOTE!

The readout limits apply only to instruments that have just been calibrated.

INPUT (Volts DC)	MODEL 8120A READOUT LIMITS
−1.999	−1.1998 to −1.1999
−1.0999	−1.0998 to −1.1000
−0.9999	− .9998 to −1.0000
−0.8999	− .8998 to − .9000
−0.7999	− .7998 to − .8000
−0.6999	− .6998 to − .7000
−0.5999	− .5998 to − .6000
−0.4999	− .4998 to − .5000
−0.3999	− .3998 to − .4000
−0.2999	− .2998 to − .3000
−0.1999	− .1998 to − .2000
−0.0999	− .0998 to − .1000

c. If voltages are not correct, the ladder resistors should be checked for proper value.

4-60. Waveforms

4-61. In the following test, a dc test voltage is applied to the instrument and the main signal waveforms are examined, using an oscilloscope.

a. Set the 8120A controls as follows:

POWER	ON
FUNCTION	VDC
RANGE	1

b. Apply any stable dc voltage, within the range of the instrument, to the INPUT terminals.

c. Connect the oscilloscope between each of the test points shown in Table 4-7 and instrument common (TP1), using ac coupling; set the oscilloscope controls as shown. A stylized version of the desired signal is shown on the main schematic diagram. Note that the A/D converter amplifier and VCO waveforms will vary, depending on input voltage value.

Table 4-7. SIGNAL LOCATIONS AND OSCILLOSCOPE SETTINGS FOR WAVEFORM CHECK

	TEST POINT	OSCILLOSCOPE	
		VERTICAL SENSITIVITY	SWEEP SPEED
Clock	Junction of R53 and R54	1v/cm	0.5 ms/cm
Ring Counter	TP3	10v/cm	5 ms/cm
A/D Converter* Amplifier Output	TP2	5v/cm	2 ms/cm
VCO	Collector of Q60	5v/cm	2 ms/cm
Q35 Gate	Gate of Q35	10v/cm	5 ms/cm
Counter Reset	Pin 2 of A4	5v/cm	1 ms/cm

* Waveform will be slightly different every fifteenth reading.

4-62. CALIBRATION

4-63. Equipment required for calibration is given in Table 4-1. Calibration should be performed under the following test conditions: ambient temperature 25°C +5°C, relative humidity less than 70%. Adjustment locations are silk-screened on the bottom guard cover.

4-64. Preliminary

a. Connect the 8120A to an autotransformer adjusted for 115 volts.

b. Set 8120A FUNCTION to VDC and RANGE to 1000 volts.

c. Attach all covers and allow the 8120A to warm up for at least 1 hour.

4-65. Zero Adjustment

a. Set the 8120A to VDC and 100MV range and short the input terminals.

b. Remove the bottom dust cover.

c. Center the front panel DC ZERO control, R192.

d. Adjust the ZERO control (R175) for 00.00 ±1 digit readout. If unable to obtain zero by adjusting R175, refer to the detailed procedure given in Figure 4-14.

4-66. Input Divider Adjustment

a. Set the 8120A to the 1 volt dc range.

b. Apply −1.00000 volts dc to the INPUT terminals.

c. Record buffer output, measured between TP1 and INPUT LO terminals.

d. Set the 8120A to the 100 volt range.

e. Apply −100.00 volts dc to the INPUT terminals.

f. Adjust the INPUT DIV control (R157) for the same value measured in step (c) (±10μV).

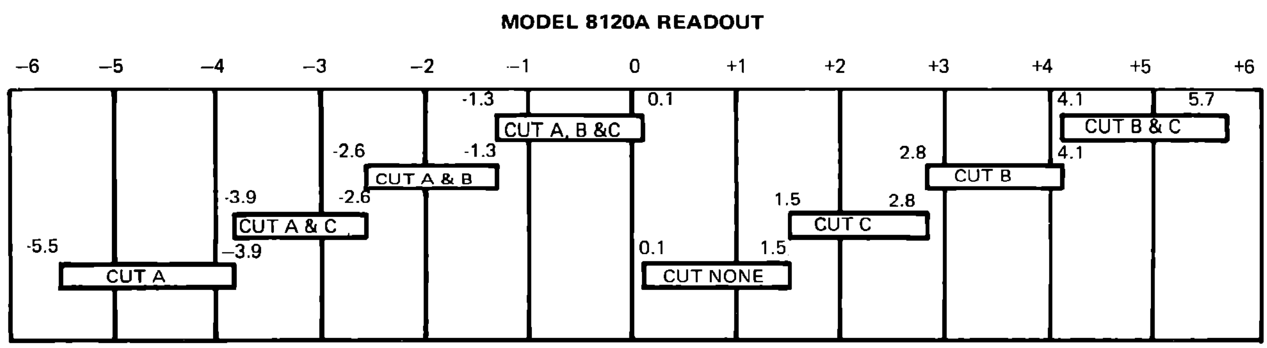
4-67. A/D Converter Offset

a. Disconnect the differential voltmeter from TP1.

b. Set the 8120A to the 1 volt dc range.

c. Apply +0.00055 volts dc to the input terminals.

d. Adjust the A-D OFFSET control (R206) for a readout alternating between .0005 and .0006. Check for proper adjustment by ensuring that the readout is (1) steady at +.0006 with a +0.00059 volt input and (2) steady at +.0005 with a +0.00053 volt input.



1. Connect jumpers A, B and C. Jumpers are identified on the PCB and on the schematic.
2. Set FUNCTION to VDC and RANGE to 1000.
3. Turn ZERO adjust (R175) fully counterclockwise.
4. Note the readout and polarity indication and determine from the above chart which jumpers to cut.
5. Adjust ZERO for a readout of 000.0

Figure 4-14. ZERO ADJUSTMENT PROCEDURE WHEN JUMPERS ASSOCIATED WITH Q77 MUST BE CHANGED.

e. Apply −0.00010 volts dc and ensure that readout is either steady at −.0001 or alternates between .0000 and −.0001.

f. Apply −0.00002 volts dc and ensure that readout is ±.0000.

4-68. −VDC Calibration.

a. Set the 8120A to the 1 volt dc range.

b. Apply −1.00055 volts dc to the INPUT terminals.

c. Adjust −DCV CAL control (R23) for a readout alternating between −1.0005 and −1.0006. Check for proper adjustment by ensuring that the readout is (1) steady at −1.0006 with a −1.00058 volt input and (2) steady at −1.0005 with a −1.00052 volt input.

4-69. +VDC Calibration.

a. Set the 8120A to the 1 volt dc range.

b. Apply +1.00055 volts dc to the INPUT terminals.

c. Adjust +DCV control (R50) for a readout alternating between +1.0005 and +1.0006. Check for proper adjustment by ensuring that the readout is (1) steady at +1.0006 with a +1.00058 volt input and (2) steady at +1.0005 with a +1.00052 volt input.

4-70. Trip Point Adjustment

a. Set the 8120A to the 1 volt dc range.

b. Apply −0.09995 volts dc to the INPUT terminals.

c. Adjust the DCV TRIP POINT control (R208) for a readout alternating between −.0999 and −.1000. Check for proper adjustment by ensuring that readout is (1) steady at −.0999 with a −0.09993 volt input and (2) steady at −.1000 with a −0.09997 volt input.

d. Reverse input polarity and ensure that readout is (1) steady at +.1000 with a +0.09998 volt input and (2) steady at +.0999 with a +0.09992 volt input.

4-71. Remainder Adjustment

a. Set the 8120A to the 1 volt dc range.

b. Apply −0.09965 volts dc to the INPUT terminals.

c. Adjust the REMAINDER control (R149) for a readout alternating between −.0996 and −.0997. Check for proper adjustment by ensuring that readout is (1) steady at −.0997 with a −0.09966 volt input (2) steady at −.0996 with a −0.09962 volt input, and (3) steady at +.0999 and −.0999 with +0.0999 and −0.0999 volt inputs respectively.

4-72. Kilohms Calibration.

a. Set the 8120A FUNCTION to Ω and RANGE to 100K.

b. Connect a 100.00kΩ resistor to the INPUT terminals.

c. Adjust K OHMS control (R48) for a 100.00 readout.

d. Set the 8120A to the 1K range.

e. Connect a 1.0000kΩ resistor to the INPUT terminals. Readout should be 1.0000 ±0.0001kΩ.

f. Set the 8120A to the 10K range.

g. Connect a 10.000kΩ resistor to the INPUT terminals. Readout should be 10.000 ±0.001kΩ.

h. Set the 8120A to the 1M range.

i. Connect a 1.0000MΩ resistor to the INPUT terminals. Readout should be 1.000 ±0.1MΩ.

j. Set the 8120A to the 1K range.

k. Short the INPUT terminals with a shorting bar. Readout should be ≤.0001.

4-73. 10 Megohm Calibration.

a. Set the 8120A function to Ω and RANGE to 10M.

b. Connect a 10MΩ resistor to the INPUT terminals.

Table 4-8. AC CALIBRATION

STEP	8120A RANGE	INPUT SIGNAL	OPERATION
d.	1	1V, 1kHz	Adjust ACV contro (R34) for a readout of 1.0000.
e.	1	1V, 20kHz	Adjust 1V HF control (C14) for a readout of 1.0000.
f.	1	1V, 10kHz	Readout should be between .9993 and 1.0008. If not. re-adjust C14 to bring reading within tolerance.
g.	100MV	0.1V, 1kHz	Adjust AC 100 MV control (R167) for readout of 100.00.
h.	100MV	0.1V, 20kHz	Adjust AC 100MV HF control (C47) for readout of 100.00.
i.	100MV	0.1V, 10kHz	Readout should be between 99.95 and 100.05.
j.	100MV	10MV, 1kHz	Readout should be between 09.98 and 10.02.
k.	100MV	10MV, 20kHz	Readout should be between 09.92 and 10.08.
l.	10	10V, 2kHz	Readout should be between 9.995 and 10.005
m.	10	10V, 20kHz	Adjust 10V HV control (C15) for a readout of 10.000.
n.	100	100V, 20kHz	Readout should be between 99.70 and 100.30
o.	100	100V, 2kHz	Readout should be between 99.93 and 100.07.
p.	100	100V, 10kHz	Readout should be between 99.93 and 100.07
q.	1000	1000V, 10kHz	Allow time for settling. Readout should be between 998.3 and 1001.7.
r.	1000	1000V, 20kHz	Readout should be between 996.0 and 1004.0.
s.	1000	1000V, 2kHz	Readout should be between 998.5 and 1001.5.

Table 4-9. MA CAL ADJUSTMENTS

RANGE	INPUT	OPERATION
1	1	Adjust MA control (R113) for 1.0000 readout
100μA	0.1	Verify readout between 99.94 and 100.06
10	10	Verify readout between 9.994 and 10.006
100	100	Verify readout between 99.94 and 100.06
1000	1000	Verify readout between 999.4 and 1000.6

c. Adjust the 10 MEG control (R153) for a readout of 10.000 ±2 digits. Allow adequate time for instrument to settle before finalizing adjustment.

4-74. VAC Calibration.

a. Set 8120A function to VDC and RANGE to 100MV. Short the INPUT terminals and ensure that readout is +00.00. If not, zero the instrument using the front panel DC ZERO control.

b. Set 8120A function to VAC and RANGE to 1000. Readout should be between 000.0 and 000.3.

c. Set 8120A RANGE as shown in Table 4-8 and perform the indicated operations.

4-75. MA Calibration.

a. Set 8120A to MADC on 100μA RANGE with INPUT terminals open. Verify that readout is 00.00. If not correct, adjust front panel DC ZERO control for proper readout.

b. Set 8120A RANGE as shown in Table 4-9, apply the corresponding input currents using the dc current source and measurement system given in Table 4-1 and perform the indicated operations.

c. Calibration of the Model 8120A is complete.

SECTION 5
List of Replaceable Parts

5-1. INTRODUCTION

5-2. This section of the manual is a complete illustrated parts list breakdown itemizing all assemblies and their components for this instrument. Illustrations for each listing aid in locating the assemblies and components. A Cross Reference List of Fluke stock numbers to original manufactures' part number is included at the rear of this section.

5-3. Assemblies and subassemblies are identified by a reference designation beginning with the letter A followed by a number (e.g., A1 etc). Electrical components appearing on the schematic diagram are identified by their schematic diagram reference designation. Components not appearing on the schematic diagram are identified by Fluke stock numbers on the illustrations. Flagnotes are sometimes used and refer to special ordering explanations.

5-4. PARTS LIST COLUMN DESCRIPTIONS

a. The REF DESIG column indexes the item description to the associated illustration. In general the reference designations are listed under each assembly in alpha-numeric order. Subassemblies of minor proportions are sometimes listed with the assembly of which they are a part. In this case, the reference designations for the components of the subassembly may appear out of order.

b. The DESCRIPTION column describes the salient characteristics of the component. Indention of the description indicates the relationship to other assemblies, components, etc. In many cases it is necessary to abbreviate in this column. For abbreviations and symbols used, refer to Appendix B located at the rear of the manual.

d. The TOT QTY column lists the total quantity of the items used in the instrument and reflects the latest Use Code. Second and subsequent listings of the same item are referenced to the first listing with the abbreviation REF. The TOT QTY column lists the total quantity of the item in that particular assembly.

e. Entries in the REC QTY column indicate the recommended number of spare parts necessary to support one to five instruments for a period of two years. This list presumes an availability of common electronic parts at the maintenance site. For maintenance for one year or more at an isolated site, it is recommended that at least one of every part in the instrument be stocked. In the case of optional subassemblies, plug-ins, etc. that are not always part of the instrument, or are deviations from the basic instrument model, the REC QTY column list the recommended quantity of the item in that particular assembly.

f. The USE CODE column identifies certain parts which have been added, deleted or modified during the production of the instrument. Each part for which a Use Code has been assigned may be identified with a particular instrument serial number by consulting the Serial Number Effectivity List, paragraph 5-9. Sometimes when a part is changed, the new part can and should be used as a replacement for the original part. In this event a parenthetical note is added in the DESCRIPTION column.

5-5. MANUFACTURERS' CROSS REFERENCE LIST COLUMN DESCRIPTIONS

a. The six-digit part number by which the item is identified at the John Fluke Mfg. Co., is listed in the FLUKE STOCK NO. column. Use this number when ordering parts from the factory or authorized representatives.

b. The Federal Supply Code for the item manufacturer is listed in the MFG column. An abbreviated list of Federal Supply Codes is included in the Appendix.

c. The part number which uniquely identifies the item to the original manufacturer is listed in the MFG PART NO. column. If a component must be ordered by description, the type number is listed.

5-6. HOW TO OBTAIN PARTS

5-7. Standard components have been used wherever possible. Standard components may be ordered directly from the manufacturer by using the manufacturer's part number, or parts may be ordered from the John Fluke Mfg. Co. factory or authorized representatives by using the Fluke part number. In event the part you order has been replaced by a new or improved part, the replacement will be accompanied by an explanatory note and installation instructions, if necessary.

5-8. You can insure prompt and efficient handling of your order to the John Fluke Mfg. Co., if you include the following information:

a. Quantity.

b. FLUKE Stock Number.

c. Description

d. Reference Desingation.

e. Instrument model and serial number.

Example: 2 each, 168708, Transistor, 2N3391, A1Q86 & Q87 for 8110A, S/N123.

If your must order structural parts not listed in the parts list, describe the part as completely as possible. A sketch of the part, showing its location to other parts of the instrument, is usually most helpful.

5-9. SERIAL NUMBER EFFECTIVITY

5-10. A Use Code column is provided to identify certain parts that have been added, deleted or modified during production of the Model 8120A. Each part for which a use code has been assigned may be identified with a particular instrument serial number by consulting the Use Code Effectivity List below. All parts with no code are used on all instruments with serial numbers above 123.

USE CODE	EFFECTIVITY	
A	Model 8120A serial number	123 thru 471
B	Model 8120A serial number	472 and on
C	Model 8120A serial number	123 thru 567, 569, 570, 571, 573 thru 626, 628 thru 634, 636 thru 696, 698 thru 777, 779 thru 851, 853, 854, 855, 857 thru 949, 951, 953 thru 987, 989 thru 992, 994 thru 1032, 1034, 1035, 1037, 1038, 1040 thru 1219
D	Model 8120A serial number	568, 572, 627, 635, 697, 778, 852, 856, 950, 952, 988, 993, 1033, 1036, 1039, 1220 and On

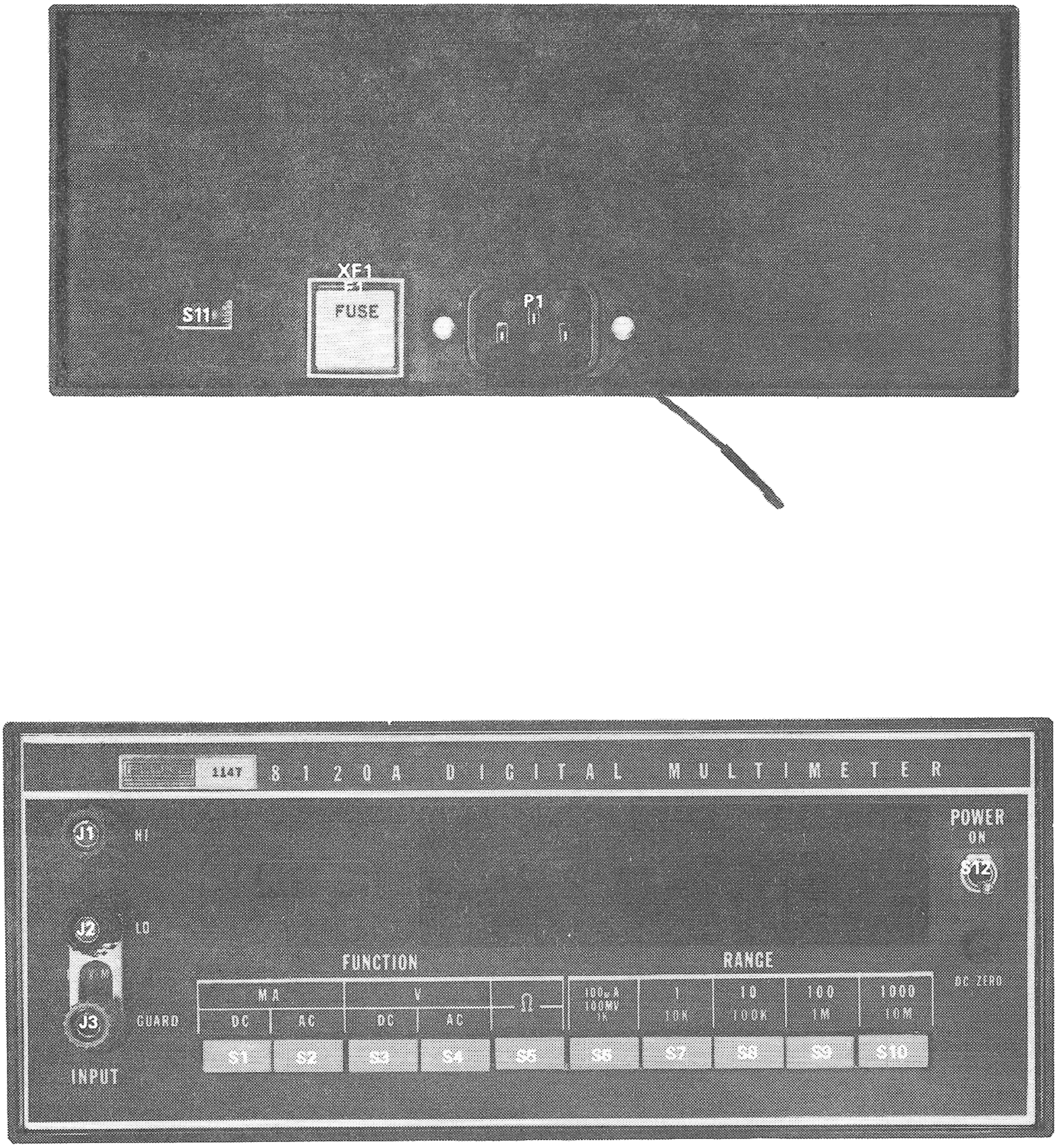
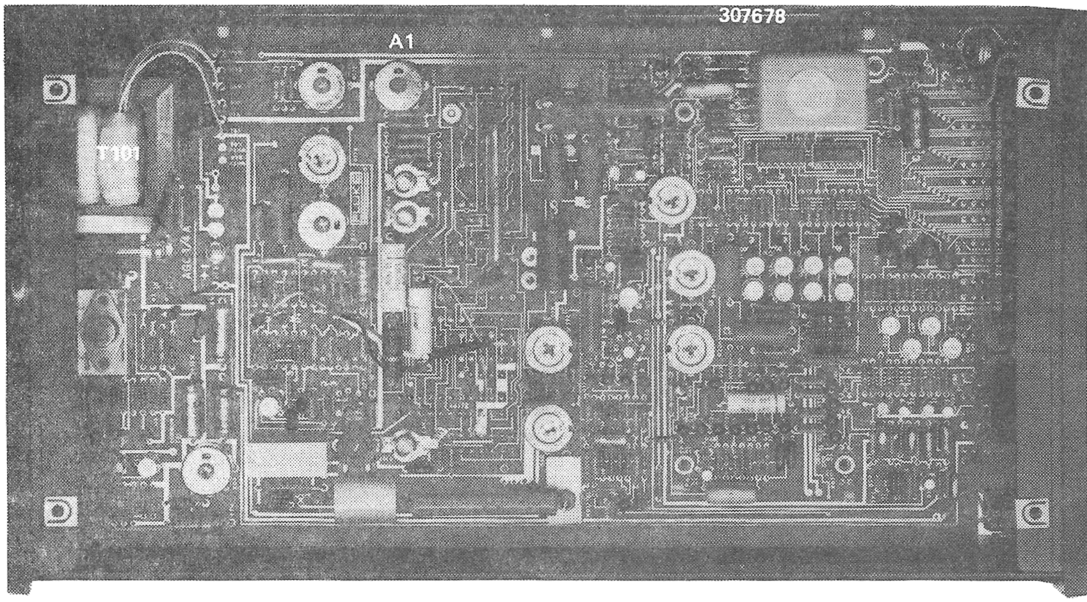


Figure 5-1. DIGITAL VOLTMETER (Sheet 1 of 2)



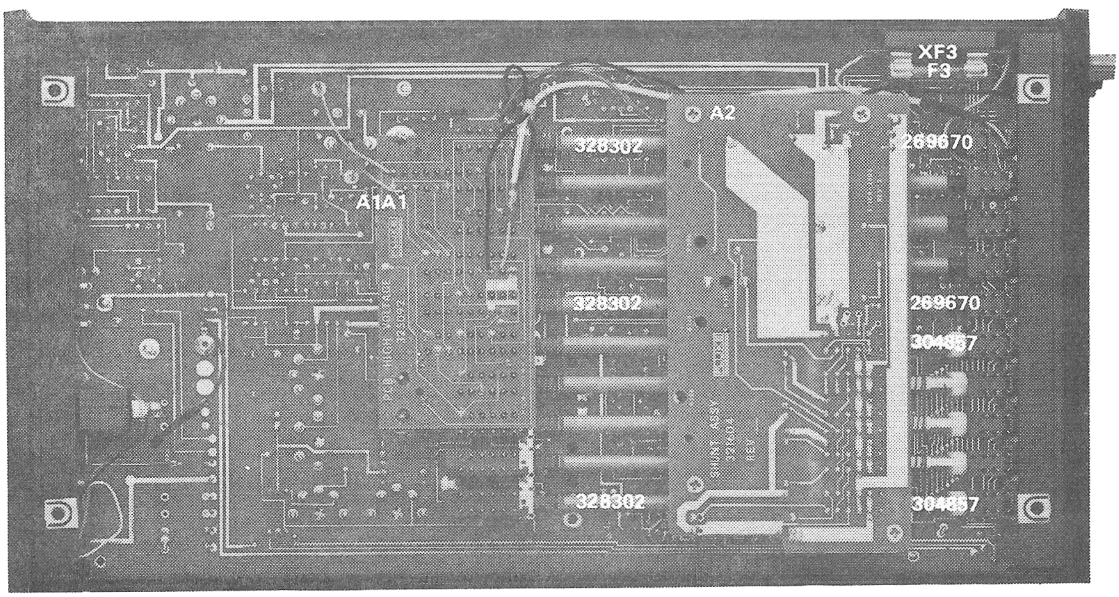


Figure 5-1. DIGITAL VOLTMETER (Sheet 2 of 2)

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
	DIGITAL MULTIMETER **Figure 5-1**	8120A			
A1	Main Assembly PCB (See Figure 5-2)	321612	1		
A2	Shunt Assembly PCB (See Figure 5-3)	321620	1		
F1	Fuse, slow blow, 1/8 amp, 250V	166488	1		
F3	Fuse, fast acting, 2 amp	109173	1		
J1	Binding post, Red, HI	275552	1		
J2	Binding post, black, LO	275560	1		
J3	Binding post, blue, Guard	275578	1		
P1	Connector, male, 3 contact	284166	1		
S11	Switch, slide, dpdt, line voltage	226274	1		
S12	Switch, toggle, dpdt, power	115113	1		
T101	Xfmr, power (115/230V)	327411	1		
	Xfmr, power (100V)	350298	1		
XF1	Fuseholder, low profile	295741	1		
XF3	Fuseholder	103283	1		
	Cable Assy, power switch	307678	1		
	Chassis, side	306688	2		
	Cover, bottom	303164	1		
	Cover, molded	291989	1		
	Decal, Front Panel	306639	1		
	Foot, bailstand	292870	1		
	Guard, bottom	327312	1		
	Guard, top	303396	1		
	Handle, frame	310045	1		
	Handle, grip	284836	2		
	Knob, male half, black	309047	2		
	Knob, female half, black	309054	2		
	Line cord with plug	284174	1		
	Shorting link	101220	1		
	Switch, coupler	304857	5		

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
	Switch, coupler, extension	269670	5		
	Switch, tube, extension	328302	10		
	OPTIONS:				
	DIGITAL MULTIMETER–KIT				
	BATTERY OPTION 8120A-01K	321554	1		
	PRINTER OUTPUT OPTION -02	321547	1		
	ACCESSORIES:				
	RF Probe	80-RF			
	HV Probe	80F-5			
	HV Probe	80F-15			
	Rack Mounting Kit (single unit)	MO3-200-607			
	Rack Mounting Kit (Dual Units)	MO3-200-606			

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
	MAIN ASSEMBLY PCB **Figure 5-2**	321612	REF		
A1A1	High Voltage PCB	325092	1		
C1	Cap, elect, 250uf +50/-10%, 40v	178616	1		
C2	Cap, cer, .0033uf ±20%, 1kv	106674	1		
C3,C7	Cap, elect, 50uf +75/-10%, 25v	148650	2		
C4	Cap, plstc, 0.47uf, factory selected	279422	1		
C5,C8,C18	Cap, elect, 50uf +50/-10%, 25v	168823	3		
C6	Cap, elect, 2uf +50/-10%, 150v	267310	1		
C9	Cap, plstc, 0.22uf ±10%, 1kv	275495	1		
C10	Cap, plstc, 0.1uf ±20%, 120v	167460	1		
C11	Not used				
C12	Cap, plstc, 0.068uf ±20%, 120v	260570	1		
C13	Not used				
C14,C49	Cap, var, 1 to 8pf, 500v	267906	2		
C15	Cap, var, 0.5 to 5pf, 500v	267914	1		
C16,C17	Not used				
C19,C37, C44	Cap, plstc, 1uf ±10%, 250v	190330	3		
C20	Cap, plstc, 0.22uf ±10%, 250v	194803	1		
C21	Cap, elect, 5uf +50/-10%, 64v	218966	1		
C22 thru C26	Cap, plstc, 0.1uf, factory selected	279430	5		
C27	Cap, mica, 330pf ±5%, 500v	148445	1		
C28	Cap, mica, 100pf ±5%, 500v	148494	1		
C29	Cap, plstc 0.47uf ±10%, 250v	184366	1		
C30 thru C33,C41, C59,C64	Cap, plstc, 0.022uf ±10%, 250v	234484	7		
C34	Cap, plstc, 0.047uf ±10%, 120v	260562	1		
C35,C50 C58,C66	Cap, plstc, 0.1uf ±10%, 250v	161992	4		

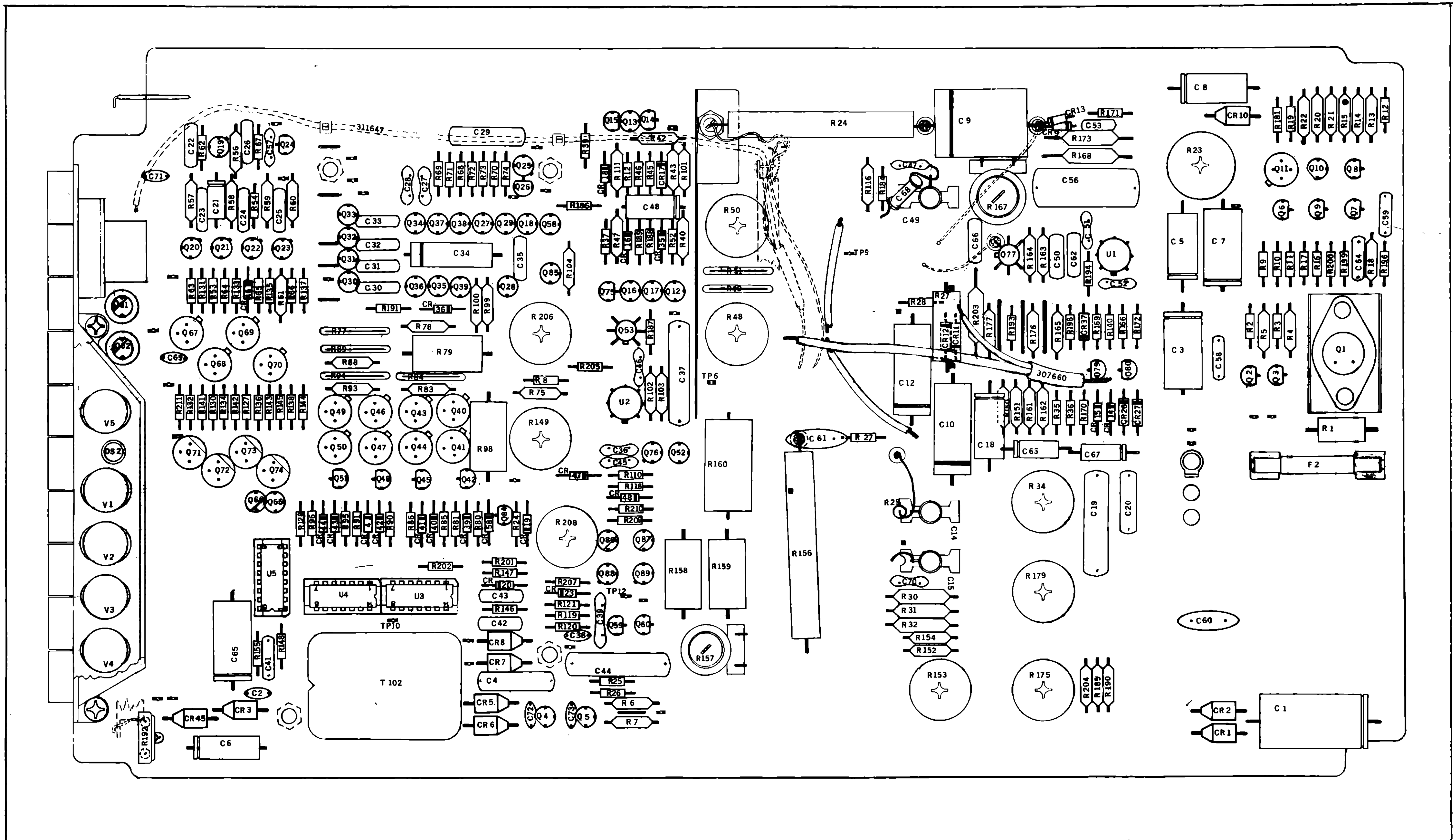


Figure 5-2. MAIN PCB ASSEMBLY

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
C36,C52, C57	Cap, mica, 33pf ±5%, 500v	160317	3		
C38	Cap, cer, 0.0012uf ±10%, 500v	106732	1		
C39	Cap, mica, 470pf ±5%, 500v	148429	1		
C40	Not used				
C42	Cap, plstc, 0.047uf ±10%, 250v	162008	1		
C43	Cap, plstc, 0.033uf ±10%, 250v	234492	1		
C45,C46	Cap, mica, 47pf ±5%, 500v	148536	2		
C47	Cap, mica, 8pf ±10%, 500v	216986	2		
C48	Cap, elect, 1uf +75/-10%, 25v	165886	1		
C51	Cap, mica, 150pf ±5%, 500v	148478	1		
C53	Cap, mica, 4pf ±5%, 500v	190397	1		A
C53	Cap, mica, 8pf ±10%, 500v	216986	REF		B
C54,C55	Not used				
C56	Cap, plstc, 2.2uf ±10%, 250v	222232	1		
C60	Cap, cer, 0.001uf ±20%, 3kv/5.25kv	105635	1		
C61	Cap, cer, 150pf ±20%, 3kv	277004	1		
C62	Cap, Ta, 1.0uf ±20%, 35v	161919	1		
C63,C67	Cap, Ta, 33uf ±10%, 10v	182832	2		
C65	Cap, elect, 3uf +50/-10%, 250v	306555	1		
C68	Cap, cer, 0.5pf ±0.25pf, 500v	174896	1		
C69	Cap, cer, 500pf ±10%, 1kv	105692	1		
C70,C71	Cap, cer, 0.005uf ±20%, 50v	175232	2		
C72,C73	Cap, cer, 100pf ±10%, 1kv	105593	2		
CR1,CR2, CR5,CR6, CR7,CR8, CR10	Diode, Si, 1 amp, 100 piv	116111	7		
CR3,CR45	Diode, Si, 1 amp, 600 piv	112383	2		
CR4,CR16, CR18,CR19, CR20,CR23, CR36,CR39,	Diode, Si, 150 mA	203323	17		

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
thru CR44, CR46,CR47					
CR9,CR13	Diode, Si, 150 mA	234468	2		
CR11,CR12	Diode, Si, 10 mA, 2 piv	180554	2		
CR14,CR15	Diode, Si, 75 mA, 25 piv	241422	2		
CR17,CR26 CR27,CR35	Diode, Si, 200 mA, 25 piv	190272	4		
CR21,CR22 CR24,CR25 CR28,CR34 CR36	Not used				
CR37	Diode, zener, 3.9v, 20 mA	113316	1		
CR38,CR45	Not used				
DS2	Lamp, neon	266478	1		
F2	Fuse, fast acting, 1/4 amp, 250v	109314	1		
Q1	Xstr, Si, NPN	288381	1		
Q2,Q3,Q6, Q9,Q14, Q15,Q24, Q26,Q79	Xstr, Si, PNP	195974	9		
Q4,Q5	Xstr, Si, NPN	272237	2		
Q7,Q8, Q42,Q45, Q48,Q51, Q59,Q60, Q75,Q80, Q84	Xstr, Si, NPN	218396	11		
Q10	Xstr, Si, NPN	168716	1		
Q11,R15, R22	Ref Amp Set	1			
Q12,Q52	Xstr, J-FET Set	265744	1		
Q13,Q16 Q17,Q18, Q27 thru Q39,Q58, Q65	Xstr, J-FET, N-Channel	288324	19		
Q19 thru Q23,Q25, Q76,Q88, Q89	Xstr, Si, PNP	288761	9		
Q40,Q43 Q46,Q49	Xstr, Ge, PNP	182709	4		

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
Q41,Q44, Q47,Q50	Xstr, Ge, PNP	182709	4		
Q53	Xstr, FET, dual, N-Channel	257501	1		
Q54 thru Q57,Q61 thru Q64	Not used				
Q66,Q81, Q82	Xstr, Si, NPN	245480	3		
Q67 thru Q70	Xstr, Si, NPN	218511	4		
Q71 thru Q74	Xstr, Si, PNP	266619	4		
Q77	Xstr, dual FET, Selected	287623	1		
Q78,83	Not used				
Q85	Xstr, FET, N-Channel	261578	1		
Q86,Q87	Xstr, Si, NPN	168708	2		
R1	Res, comp, 470Ω ±10%, 1w	109710	1		
R2,R9,R11, R33,R54, R199	Res, comp, 1k ±5%, 1/4w	148023	6		
R3,R120, R207	Res, comp, 33k ±5%, 1/4w	148155	3		
R4	Res, met flm, 38.3k ±1%, 1/8w	241372	1		
R5,R102, R103	Res, met flm, 34k ±1%, 1/8w	261602	3		
R6,R7, R40,R47	Res, met flm, 14.7k ±1%, 1/8w	226225	4		
R8,R35, R37,R52, R191	Res, comp, 220k ±5%, 1/4w	160937	5		
R10	Res, comp, 270Ω ±5%, 1/4w	160804	1		
R12,R184	Res, comp, 100k ±5%, 1/4w	148189	2		
R13	Res, met flm, 12.1k ±1%, 1/8w	234997	1		
R14	Res, met flm, 2.94k ±1%, 1/8w	261628	1		
R15,R22, Q11	Ref Amp Set	[1]			
R16,R73 R186	Res, comp, 47k ±5%, 1/4w	148163	3		

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
R17,R19, R53,R179, R181	Res, comp, 3.3k ±5%, 1/4w	148056	6		
R18	Res, met flm, 10k ±1%, 1/8w	168260	1		
R20	Res, met flm, 412Ω ±1%, 1/8w	261636	1		
R21,R101, R111	Res, met flm, 19.1k ±1%, 1/8w	234963	3		
R23,R34, R153	Res, var, ww, 10k ±10%, 2w	272740	3		
R24	Res, met flm, 1M ±0.1%, 2w	225953	1		
R25,R26, R148	Res, comp, 100Ω ±5%, 1/4w	147926	3		
R27	Res, comp, 1M ±10%, 2w	268227	1		
R28	Res, comp, 1.2M ±5%, 1/4w	188425	1		
R29 thru R32	Res, set, AC converter	2			
R33	Not used				
R36	Res, comp, 820k ±5%, 1/4w	220541	1		
R38	Not used				
R39	Res, comp, 18k ±5%, 1/4w	148122	1		
R41	Not used				
R42,R204	Res, met flm, 499k ±1%, 1/8w	268813	2		
R43	Res, met flm, 453k ±1%, 1/8w	295709	1		
R44	Not used				
R45,R46, R62 thru R66,R71	Res, comp, 22k ±5%, 1/4w	148130	8		
R48,R149	Res, var, ww, 200Ω ±20%, 1 1/4w	144766	2		
R49	Res, ww, 6.45k ±0.5%, 1/2w	184416	1		
R50	Res, var, ww, 10Ω ±10%, 1 1/4w	112672	1		
R51	Res, ww, 2.853k ±0.03%, 1/2w	291039	1		
R54,R55	Not used				
R56 thru R60,R165	Res, met flm, 46.4k ±1%, 1/8w	188375	6		
R61,R152	Res, met flm, 200k ±1%, 1/8w	261701	2		

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
R67	Res, comp, 270k ±5%, 1/4w	220061	1		
R68,R70	Res, comp, 150k ±5%, 1/4w	182212	2		
R69,R205	Res, comp, 470k ±5%, 1/4w	188441	2		
R72	Res, comp, 1.5 M ±5%, 1/4w	182857	1		
R74,R80, R85,R90, R95,R110, R118,R119, R128,R141 thru R144	Res, comp, 10k ±5%, 1/4w	148106	13		
R75	Res, met flm, 8.66k ±1%, 1/8w	260364	1		
R76	Not used				
R77,R79, R84,R89, R94,R98	Res, ladder set	[3]	1		
R78	Res, met flm, 422k ±1%, 1/8w	276626	1		
R81,R86, R91,R96, R170	Res, comp, 15k ±5%, 1/4w	148114	5		
R82	Not used				
R83	Res, met flm, 232k ±1%, 1/8w	276618	1		
R87	Not used				
R88,R93	Res, met flm, 121k ±1%, 1/8w	229369	2		
R92,R97	Not used				
R99	Res, met flm, 11.9k ±0.25%, 1/8w	290007	1		
R100	Res, met flm, 2k ±0.25%, 1/8w	289991	1		
R104	Res, met flm, 45.3k ±1%, 1/8w	234971	1		
R105 thru R109	Not used				
R112,R200	Res, comp, 2.2M ±5%, 1/4w	198390	2		
R113,R114, R115	Not used				
R116	Res, met flm, 100k ±1%, 1/8w	248807	1		
R117	Not used				
R121,R188, R189,R198, R201,R202, R211	Res, comp, 2.2k ±5%, 1/4w	148049	7		

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
R122,R123	Not used				
R124	Res, comp, 4.7k ±5%, 1/4w	148072	1		
R125,R126	Not used				
R127,R166	Res, comp, 12k ±5%, 1/4w	159731	2		
R129	Not used				
R130	Res, comp, 62k ±5%, 1/4w	220053	1		
R131 thru R138	Res, comp, 180k ±5%, 1/4w	193441	8		
R139,R140	Not used				
R145	Res, comp, 1.1k ±5%, 1/4w	267336	1		
R146,R147, R194	Res, comp, 1.6k ±5%, 1/4w	266197	3		
R150	Res, met flm, 360Ω ±0.1%, 1/8w	325951	1		
R151	Res, met flm, 3232Ω ±0.1%, 1/8w	325969	1		
R154	Res, met flm, 22.6k ±1%, 1/8w	288431	1		
R155	Res, comp, 15Ω ±5%, 1/4w	147876	1		
R156	Res, met flm 8.987M ±0.1%, 2w	261453	1		
R157	Res, var, car, 50k ±30%, 1/4w	281667	1		
R158,R159, R160	Res, set, input divider	4	1		
R161	Res, met flm, 22.1k ±1%, 1/8w	235234	1		
R162	Res, met flm, 1.91k ±1%, 1/8w	236877	1		
R163,R164	Res, met flm, 35k ±0.1%, 1/8w	229443	2		
R167	Res, var, car, 1000Ω ±30%, 1/4w	281642	1		
R168,R173	Res, met flm, 55.3k ±0.1%, 1/2w	325522	2		
R169	Res, comp, 150Ω ±5%, 1/4w	147934	1		
R171	Res, comp, 10M ±5%, 1/4w	194944	1		A
R171	Res, comp, 22M ±5%, 1/4w	221986	1		B
R172	Res, comp, 3.3k ±5%, 1/4w	148056	REF		C
R172	Res, comp, 2k ±5%, 1/4w	202879			D
R174	Not used				
R175	Res, var, ww, 200Ω ±10%, 2w	184465	1		

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
R176	Res, met flm, 28.7Ω ±1%, 1/8w	272823	1		
R177	Res, met flm, 13.7Ω ±1%, 1/8w	272815	1		
R178	Not used				
R179	Res, var, ww, 15Ω ±20%, 1 1/4w	163634	1		
R180,R182, R183	Not used				
R185	Res, met flm, 20Ω ±1%, 1/8w	236844	1		
R187	Res, comp, 3.3Ω ±5%, 1/4w	182279	1		
R190	Res, met flm, 487k ±1%, 1/8w	237206	1		
R192	Res, var, car, 100k ±30%, 1/4w	223149	1		
R193	Res, comp, 6.2Ω ±5%, 1/4w	272831	1		
R195	Not used				
R196	Res, comp, 470Ω ±5%, 1/4w	147983	1		
R197	Not used				
R203	Res, met flm, 2M ±1%, 1/2w	217760	1		
R204	Res, met flm, 715k ±1%, 1/8w	236836	1		E
R204	Res, met flm, 499k ±1%, 1/8w	268813	REF		F
R206	Res, var, ww, 5Ω ±20%, 1 1/4w	166348	1		
R208	Res, var, ww, 3k ±10%, 1 1/4w	112458	1		
R209	Res, comp, 82k ±5%, 1/4w	188458	1		
R210	Res, comp, 1M ±5%, 1/4w	182204	1		
S1 thru S10	Switch Assy, Front	327395	1		
S1 thru S10	Switch Assy, Rear	327403	1		
T102	Xfmr, inverter	253583	1		
U1,U2	IC, Operational Amplifier	271502	2		
U3	IC, DTL, 3-Input Nand Gate	266312	1		
U4	IC, DTL, Binary Counter	267153	1		
U5	IC, Decoder Driver	267211	1		
V1 thru V4	Tube, Readout	271494	4		

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
V5	Tube, Readout	272922	1		
	Base, 1 amp	279372	1		
	Cable Assy, Input	311647	1		
	Cable Assy, Coaxial	307660	1		
	Socket, IC, 14 pin (use with U3, U4)	276527	2		
	Socket, IC, 16 pin (use with U5)	276535	1		
	Socket, tube (Use with V1 thru V5)	268714	5		
	1 Q11, R15, R22 area matched set. For replacement order P/N 269803.				
	2 R29 thru R32 are a matched set. For replacement order P/N 327387.				
	3 R77, R79, R84, R89, R94, R98 are a matched set. For replacement order P/N 269795.				
	4 R158, R159, R160 area matched set. For replacement order P/N 269787.				

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
	SHUNT ASSEMBLY PCB **Figure 5-5**	321620	REF		
C54	Cap, plstc, 0.22uf ±10%, 250v	194803	1		
CR21, CR22	Diode, Si, 1 amp, 100 piv	116111	2		
R22	Res, factory selected	[1]	1		
R23	Res, comp, 1Ω ±5%, 1/4w	218693	1		
R105	Res, 1.010k (Matched Set)				
R106	Res, 100.1Ω (Matched Set)				
R107	Res, 10Ω (Matched Set)	[2]	1		
R108	Res, 1Ω (Matched Set)				
R109	Res, 0.1Ω (Matched Set)				
R113	Res, var, car, 1k ±30%, 1/4w	281642	1		
S16 thru S20	Switch, pushbutton	320606	1		

[1] Factory selected at time of installation, depending on shunt group used.

[2] R105, R106, R107, R108 area matched set. For replacement order P/N 325175.

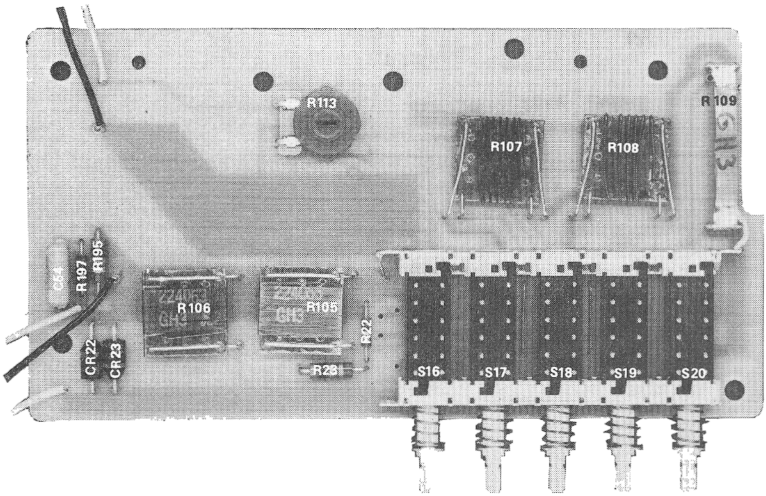


Figure 5-3. SHUNT ASSEMBLY

MANUFACTURERS' CROSS REFERENCE LIST

FLUKE STOCK NO.	MFR.	MFR. PART NO.	FLUKE STOCK NO.	MFR.	MFR. PART NO.
101220	24655	0938-9760	148122	01121	CB1835
103283	71400	4405	148130	01121	CB2235
105593	71590	DD-101	148155	01121	CB3335
105635	56289	29C300	148163	01121	CB4735
105692	71590	2DDH60N501K	148189	01121	CB1045
106674	56289	CO23B102G332M	148429	14655	CD19F471J
106732	71590	CF-122	148445	14655	CD15F331J
109173	71400	Type AGC	148478	14655	CD15F151J
109314	71400	Type AGC	148494	14655	CD15F101J
109710	01121	6B4711	148536	14655	CD15E470J
112383	05277	1N4822	148650	06001	76F02KL500
112458	71450	Type 110	149153	56289	C023B101F103M
112672	71450	Type 110	149161	56289	55C23A1
113316	07910	1N748	149187	93332	1N270
115113	95146	MST215N	158469	02660	57-40360
116111	05277	1N4817	159392	56289	192P2249R8
144766	71450	Type 110	159731	01121	CB1235
147876	01121	CB1505	160317	14655	CD15E330J
147926	01121	CB1015	160796	01121	CB8225
147934	01121	CB1515	160804	01121	CB2715
147983	01121	CB4715	160937	01121	CB2245
148023	01121	CB1025	161919	56289	196D105X0035
148031	01121	CB1525	161992	73445	C280AE/A100K
148049	01121	CB2225	162008	73445	C280AE/A47K
148056	01121	CB3325	163634	71450	Type 110
148064	01121	CB3925	165886	56289	30D1056025BA4
148072	01121	CB4725	166348	71450	Type 110
148080	01121	CB5625	166488	71400	Type MDL
148106	01125	CB1035	167460	84411	Type 863UW
148114	01121	CB1535	168260	91637	Type MFF 1/8

MANUFACTURERS' CROSS REFERENCE LIST

FLUKE STOCK NO.	MFR.	MFR. PART NO.	FLUKE STOCK NO.	MFR.	MFR. PART NO.
168708	03508	2N3391	195974	04713	2N3906
168716	07263	519254	198390	01121	CB2255
168823	73445	C426ARF50	202879	01121	CB2025
170423	14655	CD15F221J	203323	03508	DHD1105
170720	01121	CB2725	216986	14655	CD15C080K
174896	72982	301-000-COKO-508C	217760	91637	TYPE MFF 1/2
175232	56289	C023B101E502M	218396	07263	2N3904
178616	73445	C437ARG250	218511	95303	60994
180554	07910	CD12599	218966	73445	C426ARH5
182204	01121	CB1055	220053	01121	CB6235
182212	01121	CB1545	220061	01121	CB2745
182279	01121	CB33G5	220541	01121	CB8245
182691	01295	GA3937	221895	01121	CB2415
182709	01295	GA3938	221986	01121	CB2265
182832	56289	150D336X9010B2	222232	73445	C280MAE/A2M2
182857	01121	CB1555	223149	37942	TYPE MTC-1
182873	14655	CD19F562G	225953	03888	TYPE PME-80
184366	73445	C280AE/A470K	226225	91637	TYPE MFF 1/8
184416	89536	184416	226274	82389	46256-LF
184465	71450	Type 115	229369	91637	TYPE MFF 1/8
188375	91637	TYPE MFF 1/8	229443	91637	TYPE MFF 1/8
188425	01121	CB1255	234468	07910	CD9039
188441	01121	CB4745	234484	73445	C280AE/A22K
188458	01121	CB8235	234492	25403	C280AE/A33K
190272	93332	1N456A	234963	91637	TYPE MFF 1/8
190330	73445	C280AE/A1M	234971	91637	TYPE MFF 1/8
190397	14655	CD15C040K	234997	91637	TYPE MFF 1/8
193441	01121	CB1845	235234	91637	TYPE MFF 1/8
193623	56289	196D106X0015	236836	91637	TYPE MFF 1/8
194803	73445	C280AE/A220K	236844	91637	TYPE MFF 1/8
194944	01121	CB1065	236877	91637	TYPE MFF 1/8

MANUFACTURERS' CROSS REFERENCE LIST

FLUKE STOCK NO.	MFR.	MFR. PART NO.	FLUKE STOCK NO.	MFR.	MFR. PART NO.
237206	91637	TYPE MFF 1/8	268813	91637	TYPE MFF 1/8
241372	91637	TYPE MFF 1/8	269670	89536	269670
241422	03508	1N4009	269787	89536	269787
245480	07263	S24496	269795	89536	269795
248807	91637	TYPE MFF 1/8	269803	89536	269803
253583	89536	253583	271494	83594	35853
257501	17896	DN423	271502	27014	LM301A
260364	91637	TYPE MFF 1/8	272237	07263	2N4946
260562	01281	47391	272740	71450	Type 115
260570	84411	863UW68391	272815	91637	TYPE MFF 1/8
261453	91637	TYPE MFF-2	272823	91637	TYPE MFF 1/8
261578	15818	U2366E	272831	01121	CB62G5
261602	91637	TYPE MFF 1/8	272922	83594	B25866ST
261628	91637	TYPE MFF 1/8	275354	89536	275354
261636	91637	TYPE MFF 1/8	275495	84411	Type 663UW
261701	91637	TYPE MFF 1/8	275552	32767	820-65
265744	89536	265744	275560	32767	820-45
266197	01121	CB1625	275578	32767	820-55
266312	01295	SN1562N	276527	23880	TSA-2900-14W
266478	74276	A261	276535	23880	TSA-2900-16W
266619	07263	2N4888	276618	91637	TYPE MFF 1/8
267153	04713	MC839P	276626	91637	TYPE MFF 1/8
267211	12040	DM8840N	276758	56289	601D382F015
267310	56289	30D205F150BB4	277004	00656	HVD4150±20,3KV -2
267336	01121	CB1125	279372	89536	279372
267906	72982	532-000	279422	89536	279422
267914	72982	532-001	279430	89536	279430
268227	01121	HB1051	281642	71450	Type U-201
268540	18324	SP380A	281667	71450	Type U-201
268565	18324	SP370A	284166	82389	EAC301
268714	83594	SK207	284174	70903	17250

MANUFACTURERS' CROSS REFERENCE LIST

FLUKE STOCK NO.	MFR.	MFR. PART NO.	FLUKE STOCK NO.	MFR.	MFR. PART NO.
284836	89536	MOO-800-507	309047	89536	MOO-200-519
287623	89536	287623	309054	89536	MOO-200-520
288324	15318	U2412	310045	89536	MOO-803-522
288381	95303	40372	311647	89536	311647
288431	91637	TYPE MFF 1/8	320606	89536	320606
288761	49956	RS-2048	321612	89536	321612
288837	01295	SN74100N	321620	89536	321620
289991	91637	TYPE MFF 1/8	325092	89536	325092
290007	91637	TYPE MFF 1/8	325175	89536	325175
291039	89536	291039	325522	91637	TYPE MFF 1/2
291534	13511	583529	325951	91637	TYPE MFF 1/8
291542	13511	583527	325969	91637	TYPE MFF 1/8
291989	89536	291989	327312	89536	327312
292870	89536	292870	327387	89536	327387
292946	71785	133-59-02-011	327395	89536	327395
292979	01295	SN7400N	327403	89536	327403
292987	01295	SN7408N	327411	89536	327411
293399	01295	SN7496N	327981	27014	LM309K
294793	89536	294793	328302	89536	328302
295709	91637	TYPE MFF 1/8	328542	89536	328542
295741	75915	348-6-9-9			
295808	89536	295808			
295881	89536	295881			
303164	89536	303164			
303396	89536	303396			
304857	89536	304857			
306555	56289	500D305F250DC7			
306639	89536	306639			
306688	89536	306688			
307660	89536	307660			
307678	89536	307678			

Section 6
Option & Accessory Information

6-1. INTRODUCTION

6-2. This section of the manual contains information pertaining to the accessories and options available for your instrument.

6-3. ACCESSORY INFORMATION

6-4. The accessory information, if applicable, will contain details concerning accessories that may be used with this particular instrument.

6-5. OPTION INFORMATION

6-6. Each of the options available for this instrument, if any, are described separately under headings containing the option number. The option descriptions contain applicable operating and maintenance instructions and field installation procedures. A complete list of replaceable parts for each option is contained at the end of that option description.

Option –01
Rechargeable Battery Pack

6-1. INTRODUCTION

6-2. The Rechargeable Battery Pack is installed as the –01 Option. It can be installed at the factory during manufacture of the instrument or later in the field, as desired. The field installation kit is identified as the 8120A–01K.

6-3. Field Installation

a. Turn off the instrument and disconnect the power cord.

b. Remove the top and bottom covers and guard covers. The black leads must be disconnected from the guard covers to allow complete removal.

c. Install the 2Ω and 11.5k resistors on the pcb as shown in Figure 6-1.

d. Install the three diodes on the pcb as shown in Figure 6-1. Ensure that the diodes are correctly oriented according to the cathode markings and the etched markings on the pcb.

e. Install the ballast lamp on the pcb as shown in Figure 6-1. Three solder connections are required: The anchor lug on the component side of the pcb should be soldered to the lamp base, the two lamp terminals should be soldered on the land-pattern side of the pcb.

f. Refer to Figure 6-2 and install the meter as follows:

1. Remove the two transistors located near the black tube cover on the inside of the front panel.
2. Remove the nut and washer from the tube cover.

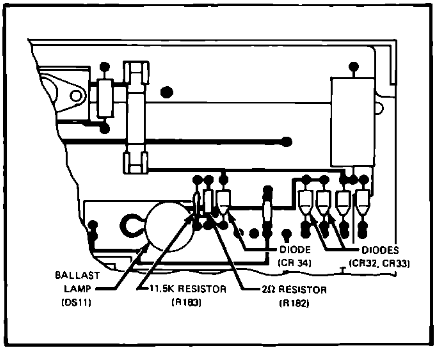


Figure 6-1. COMPONENT INSTALLATION MAIN PCB

3. Remove the two screws which secure the tube cover to the main pcb.
4. Remove the tube cover.
5. Install the meter together with the tube cover. The meter face is notched to slip into the slot on the front panel.

CAUTION!

Ensure that the tips of the readout tubes are correctly aligned with the slots in the tube cover during installation.

6. Install the tube cover mounting screws and nut and washer.
7. Bend the lugs on the meter until they are parallel to the main pcb.
8. Using a length of tinned copper wire, solder each meter lug to the main pcb connections directly below the lugs.

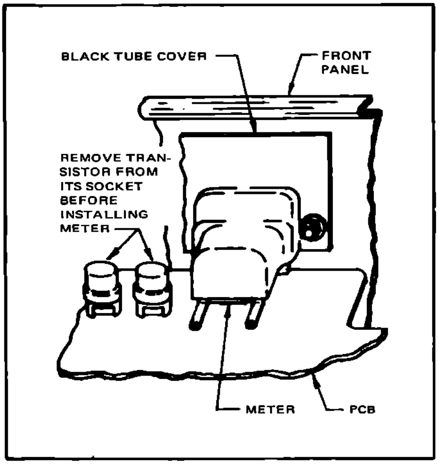


Figure 6-2. METER INSTALLATION

g. Install the battery pack on the inside of the top guard cover, using the battery pack holder and six machine screws, as shown in Figure 6-3. Orient the battery pack so that the battery leads pass through the grommeted hole in the guard cover.

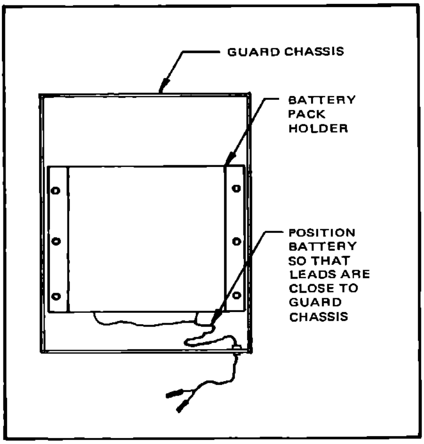


Figure 6-3. BATTERY PACK INSTALLATION
TOP GUARD COVER

h. Connect the red and black leads of the battery pack to respective + and – terminals on the main pcb. The ± terminals are located in the right rear section of the pcb.

i. Connect the black leads to the guard covers and install the covers.

j. Install the top and bottom covers.

k. Refer to Section 2 for operating procedures regarding the battery option.

6-4. PARTS LIST

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
	DIGITAL MULTIMETER – KIT, BATTERY OPTION	8120A–01K			
BT1	Battery Pack	269837	1		
M1	Meter, 0-1 ma	266494	1		
XBT1	Holder, battery pack	269712	1		
—	Wire, bus tinned copper #22AWG	115469	1		
—	Screw, FHMS, undercut 6-32 x 1/4	268169	6		
	Add the following components to the Printed Circuit Assembly (A1):				
CR32, CR33	Diode, silicon, 1 amp, 600 piv	112383	2		
CR34	Diode, silicon, 1 amp, 100 piv	116111	1		
DS11	Lamp, incandescent, 24v	218354	1	2	
R182	Res, comp, 2Ω ±5%, ½w	218735	1		
R183	Res, met flm, 11.5k ±1%, 1/8w	267138	1		

Option –02

Printer Output Unit

6-1. INTRODUCTION

6-2. The Printer Output Unit (POU) provides data output that is completely isolated from the analog input and is available in 8-4-2-1 BCD logic level format. Data is transferred serially via guarded transformers from the multimeter to the POU. Digit, range, function, and overrange data are provided.

6-3. SPECIFICATIONS

6-4. Electrical Specifications

DATA PROVIDED	Digits, range and function.
CODING	BCD Digits, four lines for range, individual lines for functions.
LOGIC LEVELS	"1" = 2.4V @ 0.4 ma load (3.5V maximum, open terminal). "0" = 0.4V maximum at 13 ma sink (0V no load).
INPUT TRIGGER DESCRIPTION	Positive or negative true triggering via two trigger channels using either a pulse or a steady state logic signal.
Channel 1 (Positive True)	
Pulse Width	> 500 ns
Transition	Logic "0" to logic "1"
Logic "1"	> 2.7V @ 360 ua max.
Logic "0"	< 0.6V @ no drain
Continuous Sample	Logic "1"
Input Definition	TTL (UTILOGIC II SERIES)
Channel 2 (Negative True)	
Pulse Width	> 500 ns
Transition	Logic "1" to logic "0"
Logic "1"	> 2.0V (4.7k pull up resistor) on input.
Logic "0"	< 0.8V @ 3.2 ma sink
Continuous Sample	Logic "0"
Input Definition	TTL (7400 SERIES)
PRINT COMMAND OUTPUT	Change of state from logic "1" to logic "0" and change of state from logic "0" to logic "1" are both provided.

6-5. Mechanical Specifications

OUTPUT CONNECTOR	36-pin Amphenol 57-40360 JF Part Number 158469
MATING CONNECTOR	36-pin Amphenol 57-30360 JF Part Number 158451

6-6. General Specifications

Code conversion and level translation are available; contact the factory for details.

Option –02 is a factory installed option and is not compatible with battery option.

Full CMRR specifications of a line operated 8100 series digital multimeter are met. Maximum potential between printer output common and power line ground is 250V dc or peak ac.

6-7. INSTALLATION

6-8. The Printer Output Unit is a factory installed option.

6-9. OPERATING INSTRUCTIONS

6-10. Description

6-11. The POU enables the multimeter to interface with a computer, printer, or a variety of data recording systems. POU access is by means of a single rear-mounted 36-pin connector. Connector location and pin assignments are given in Figure 6-1. The unit is self-powered. POU truth table is given in Table 6-1.

Table 6-1. POU TRUTH TABLE

DATA		NO. OF LINES	LOGIC LEVEL	
			LOGIC "0" 0 TO 0.4V	LOGIC "1" 2.4 TO 3.5V
Function:	VOLTS, AC/DC, MA, KΩ, 10 MΩ	5	Function not called.	Function called.
Polarity	(logic "0" for all functions except "+VDC")	1	Negative	Positive
Range:	1, 10, 100 and 1000	4	Range not called. (See Note 1)	Range called.
Digits:	8-4-2-1 BCD	16	Binary "0"	Binary "1"
Overrange Digit		1	Not overranged.	Overranged. (See Note 2)

NOTES:

1. All range lines at logic "0" indicates 100μA, 100mV, or 1k, depending upon function selected.
2. 11999 readout should be interpreted as "overranged and overloaded".

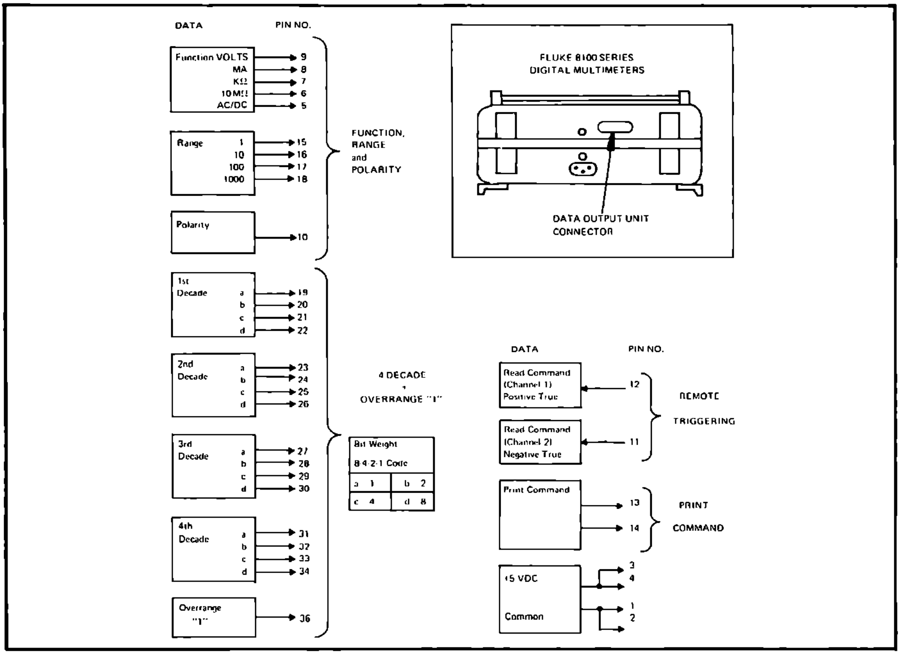


Figure 6-1. PRINTER OUTPUT UNIT CONNECTOR LOCATION AND PIN ASSIGNMENT

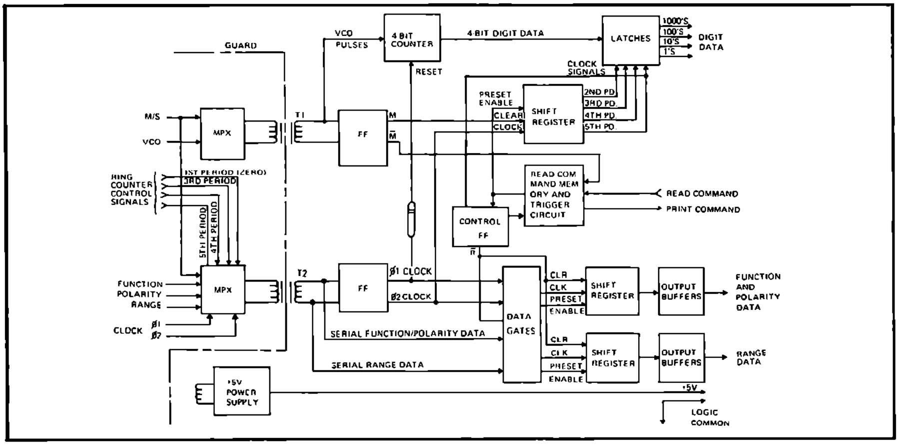


Figure 6-2. PRINTER OUTPUT UNIT BLOCK DIAGRAM

6-12. The Printer Output Unit can be triggered by either a positive true or negative true read command. The read command may be either a pulse or a steady state logic level. If triggered by a pulse, the unit will provide data derived from a sample of the multimeter input within 450 milliseconds of the read command. This data will be stored in the output register until the next read command is received. If triggered by a continuous logic level, data in the output register will be updated approximately every 400 milliseconds, as often as the instrument makes a measurement. Characteristics of the read command signal are given in Table 6-2.

NOTE!

The measurement cycle of the instrument is not altered by the read command.

6-13. THEORY OF OPERATION

6-14. General

6-15. The Printer Output Unit accepts multimeter measurement information, multiplexes it for serial transmission through the guard and enters this data into circuitry which provides BCD (8-4-2-1) decade outputs and function, polarity, and uncoded range outputs. A digital memory, comprised of four bistable latches provides 4-line, BCD digital data. A pair of 5-bit shift registers function as a serial in-parallel out memory for multimeter function, polarity and range data. The POU block diagram is shown in Figure 6-2. Timing signals mentioned in the following paragraphs are shown in Figure 6-3.

6-16. Multiplexer

6-17. Multimeter function, range, polarity, and digit inputs together with logic control signals are applied to multiplexer circuitry consisting of transistors Q1 through Q13 and NOR gates A1 and A2.

6-18. VCO pulses are applied to one input of dual-input NOR gate A1–A, and the measure/store signal is applied to the other input. The VCO pulses enable the gate and its output is applied to the trigger circuit composed of Q5 and T1. The VCO pulses are coupled into the secondary of T1 and applied to counter A10. Trigger pulses corresponding to the measure/store signal are produced by Q2, Q3, and Q5 in the primary of T1. The measure/store signal is reconstructed by flip-flop A4–C, D from the secondary of T1, producing M and $\overline{M}$ signals.

6-19. Multimeter clock signals, Ø1 and Ø2, are applied to trigger circuits Q11 and Q13, respectively. The trigger pulses are coupled into the secondary of T2 where they alternately set and reset flip-flop A4–A, B, producing reconstructed Ø1 and Ø2 clock signals.

Table 6-2. READ COMMAND SIGNAL REQUIREMENTS

READ COMMAND		CHANNEL 1	CHANNEL 2
TRIGGER:	Pulse Width	> 500 ns	> 500 ns
	Transition	Logic "0" to logic "1"	Logic "1" to logic "0"
LOGIC LEVEL:	Logic "1"	>2.7V at 360 ua max.	>2.0V (4.7k pull-up resistor) on input.
	Logic "0"	<0.6V at no drain	<0.8V at 3.2 ma sink
CONTINUOUS SAMPLE		Logic "1"	Logic "0"
INPUT DEFINITION		TTL (UTILOGIC II SERIES)	TTL (7400 SERIES)

6-20. The Ø1 clock signal is also applied to a one-shot, A1–B, D. The one-shot provides a delay for entry of function and polarity data into the trigger circuit to ensure that data pulses are not obscured by clock pulses. Function inputs (KΩ, VAC, 10MΩ, and FILTer) are controlled by FET buffers Q6 through Q9, which are sequentially enabled by ring counter signals corresponding to periods 1 (zeroing period), 3, 4, and 5 of the measurement cycle. If one or more of these functions are called, a low will appear at one input of NOR gate A1–C (FUNCTION RETURN) during the appropriate period of the measurement cycle; the one-shot, which controls the other input of gate A1–C, will time out, and A1–C will provide a pulse to the trigger circuit. The polarity input is NORed with the one-shot in A2–C and is also delayed.

6-21. The Ø2 clock signal is applied to one-shot A2–A, B to provide a delay for range inputs. Range information is derived from the readout tube decimal point circuitry and is applied to transistor Q12 in the multiplexer. Inverted range data is then applied to gate A2–D. After the prescribed delay, it enters the trigger circuit of Q13 and T2.

6-22. Digit Count and Memory Circuitry

6-23. Four-Bit counter A-10 accepts VCO pulses from Inverter A2-F and produces a 4-line BCD output corresponding to digit value. The counter is reset at the beginning of each digitizing period by a delayed reset pulse which is derived from the Ø2 clock signal. This delay duplicates the delay of the multimeter counter reset pulse so that the counters are synchronized. The reset pulse is produced by NOR gate A12–B, transistor Q4, and associated components.

6-24. The BCD output of A10, representing digit value in a 4-line code, is applied to two dual 4-bit bistable latches, A6 and A7. The latches are clocked by signals from A11, a 5-bit shift register. The clock signals appear at the input of the latches sequentially, beginning with the 2nd period of the measurement cycle. BCD information corresponding to the most significant digit is transferred to the output of the latches first and BCD outputs for the three remaining digits follow in order. The latches provide 4-line BCD storage for each digit.

6-25. Overrange indication is provided by AND gate A1–D which provides a logical "1" output whenever the first digit is 10 or more. Gates A1–A, B prevent the register from indicating greater than "9" for the first digit.

6-26. The M signal clears shift register A11 setting all outputs to logical "0". The read pulse, developed by the read command circuit, is applied to the preset enable input of the shift register; this pulse only occurs if an external trigger has been stored in flip-flop A5–C, D prior to the M signal. The preset input sets output 15 (pin 15) of A11 to the logical "1" state. The Ø1 clock signal is applied to the clock input of the register; and the next transistion of this clock signal from logical "1" to logical "0", occuring at the start of the 2nd period, shifts the register and provides a logical "1" at output 14 (pin 14) of the register. Succeeding clock signal transistions cause continued shift of the register until output 10 switches from the logical "1" state to the logical "0" state, which causes the read command and control flip-flops to be reset.

6-27. Read Command Memory and Trigger Circuit

6-28. Positive read command pulses or logic levels appear at pin 11 of flip-flop A5–C, D. Negative read commands appear at the same input after inversion in A2–B. The positive input sets the flip-flop, producing a low at one input of dual input NOR gate A12–C. Circuit conditions will hold until the start of the measurement cycle, at which time the negative transition of the $\overline{M}$ signal causes A12–C to produce the read pulse. This sets CONTROL flip-flop A5–A, B clearing A8 & A9 and enabling A3–B, A3–C and A12–D to allow transmission of Function and Range information to shift registers A8 and A9. At the end of the measure cycle, flip-flops A5–C, D and A5–A, B will be reset by the output of gate A12–A, producing negative and positive print commands, and storing range and function data by disabling clock pulses from A12–D to A8 and A9.

6-29. Function, Polarity, and Range Circuitry

6-30. Serial function and polarity data is applied to gate A3–C and serial range data is applied to gate A3–B. Each gate is controlled by one phase of the clock signal and a signal from control flip-flop A5–A, B. Function and polarity data appear as positive pulses at the preset enable input of A8 during the digitizing period (Ø1) of the clock. Range data appears as positive pulses at the preset enable input of A9 during the display period (Ø2) of the clock.

6-31. Shift registers A8 and A9 perform serial to parallel conversion of the function and range binary data. During the measurement cycle, registers A8 and A9 are shifted once for each of the five clock periods. The time

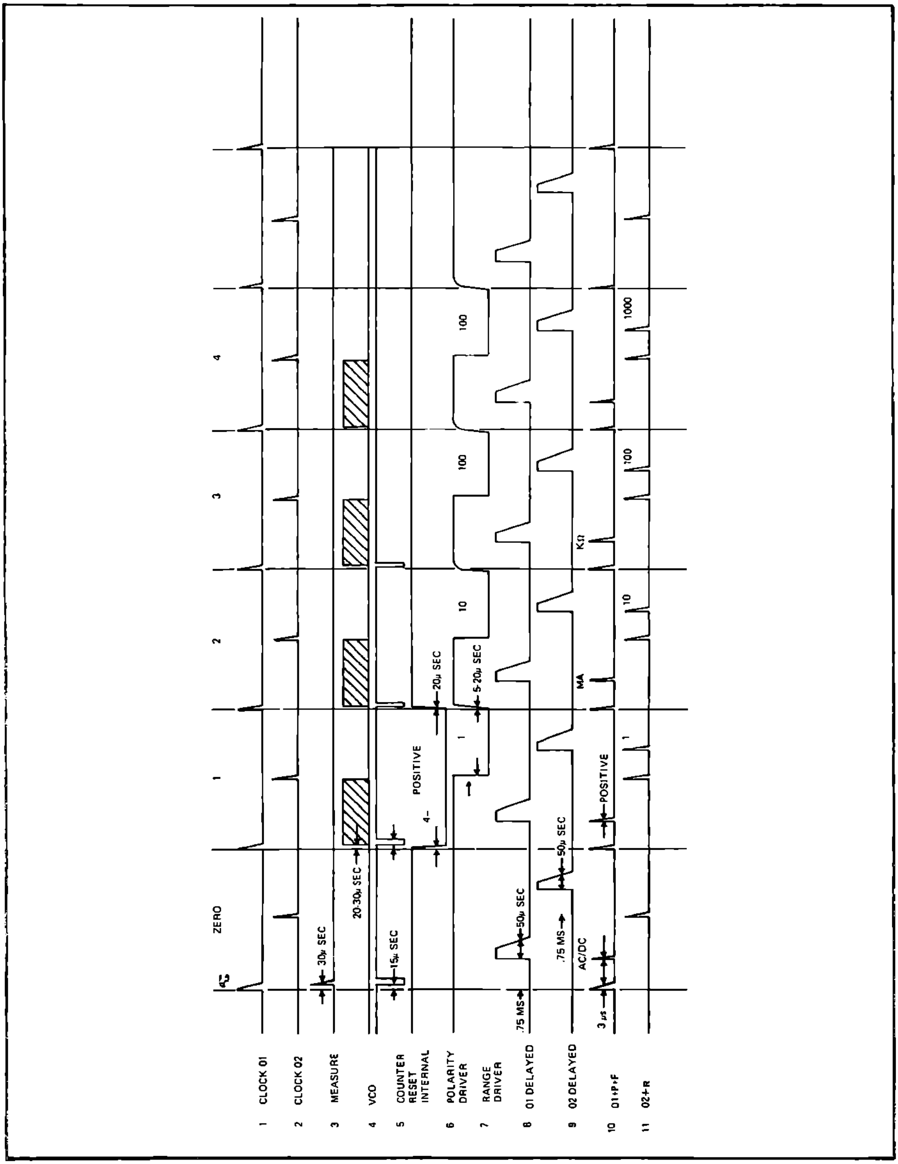


Figure 6-3. TIMING DIAGRAM

position of the serial input data, relative to the clock periods (see Figure 6-3), determines which output line will carry the data.

6-32. AND gates A13, and A14 are output buffer gates. NOR gate A3–A provides a logical "1" output when VOLTS function is called; it also enables AND gate A1–C for polarity indication, logic "0" = (–) and logic "1" = (+).

6-33. MAINTENANCE

6-34. General

6-35. General maintenance information, such as factory service and instrument cleaning procedures, is covered in Section 4 of the manual. The following information covers service procedures peculiar to the POU.

6-36. Access/Disassembly

6-37. POU circuitry is located on two separate PCBs. The Data Output Assembly PCB contains all POU circuitry located outside the multimeter guard and the Data Output Encoder Assembly contains all POU circuitry located inside the guard. The following procedure should be used to gain access to POU circuitry.

a. To gain access to the Data Output Assembly, remove the top dust cover. The assembly is mounted to the top of the guard chassis.

b. To gain access to the Data Output Encoder Assembly, remove the four guard chassis mounting screws located on the side rails and carefully lift the guard chassis out of the multimeter to the extent permitted by the POU wiring. The Encoder Assembly is mounted on the underneath side of the guard chassis.

c. To replace components on either PCB, remove the PCB mounting hardware to gain access to the soldered side of the board.

6-38. POU/Multimeter Wiring

6-39. All POU/Multimeter connections are made with pin connectors. The wires are color coded and the coding is indicated on the wiring diagram so that leads which are disconnected may be replaced correctly.

6-40. Test Equipment

6-41. Equipment required for testing, troubleshooting, and calibration of the POU is given in Table 6-3.

Table 6-3. TEST EQUIPMENT

EQUIPMENT NOMENCLATURE	RECOMMENDED EQUIPMENT	FUNCTION
DC Voltage Source	Fluke Model 343A DVM Calibrator	Performance Tests & Troubleshooting
DC Voltmeter	Model 8100A Digital Multimeter	Troubleshooting
Oscilloscope	Tektronix Type 545A Oscilloscope with Type 1A1 Dual Trace Plug-In	Troubleshooting

6-42. Performance Tests

6-43. Correct operation of the Printer Output Unit can be verified by applying various inputs to the multimeter and observing the POU outputs on a printer.

6-44. Troubleshooting

6-45. Before attempting to troubleshoot the unit, it should be verified that the trouble is actually in the POU and is not caused by faulty external equipment. As a first step, the POU should be exercised as described in "Performance Tests" to determine what fault is present. Once the fault is identified, consult the troubleshooting guide, Figure 6-4, as an aid in making a troubleshooting decision.

6-46. Check POU waveforms with an oscilloscope. Sync the scope with Measure/Store signal (TP7). Refer to the POU timing diagram, Figure 6-3, for correct signal timing.

6-47. CALIBRATION

6-48. No calibration is required in the POU.

6-49. PARTS LIST

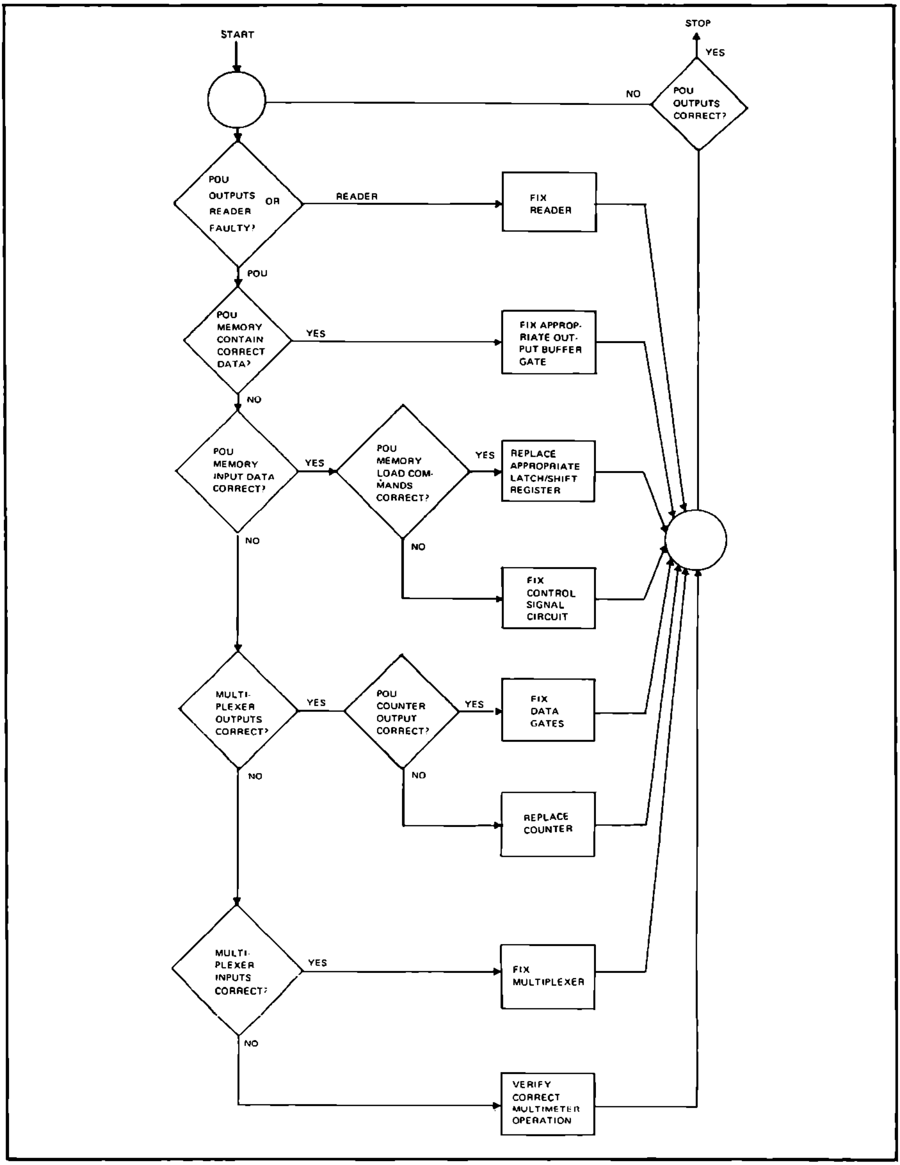


Figure 6-4. POU TROUBLESHOOTING GUIDE

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	ISOLATED PRINTER OUTPUT UNIT, OPTION –02	8120A-02					
A2	DATA OUTPUT PCB ASSEMBLY (See Figure 6-5)	295808	89536	295808	1		
A3	DATA OUTPUTENCODER PCB ASSEMBLY (See Figure 6-6)	294793	89536	294793	1		
	NOTE!						
	The following change to the basic instrument occurs when the Option –02 assembly is installed.						
	CHANGE:						
T101	Transformer, power From:	327411	89536	327411	1		
	To:	333542	89536	333542	1		

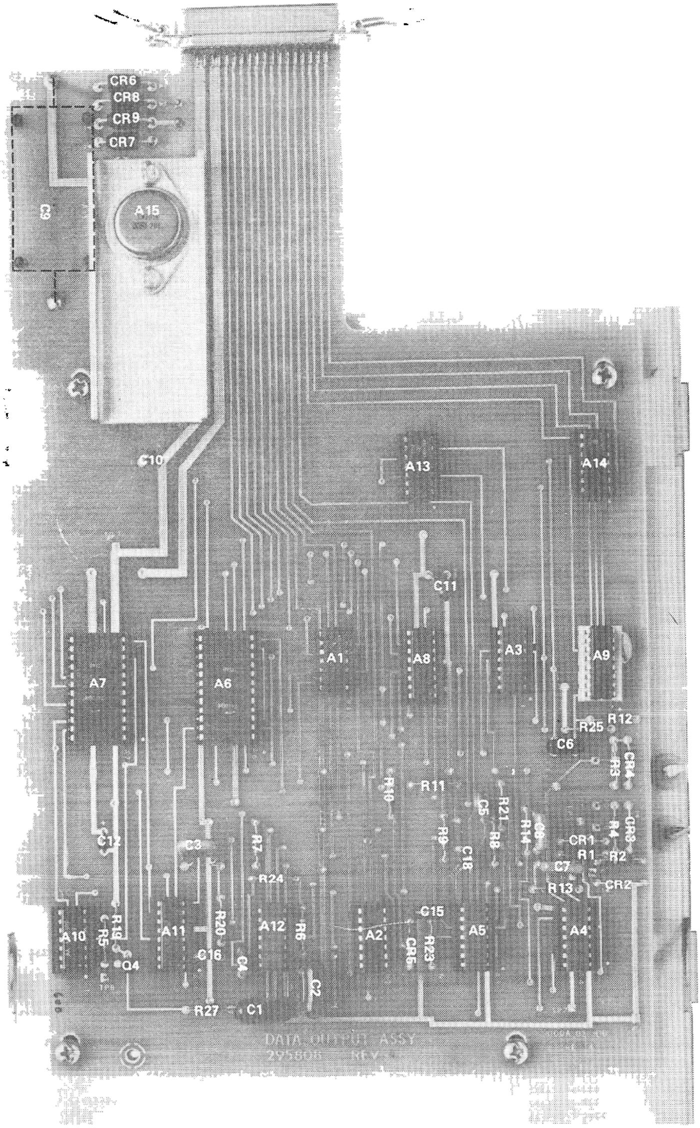


Figure 6-5. DATA OUTPUT ENCODER PCB ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A2	DATA OUTPUT PCB ASSEMBLY Figure 6-6	295808	89536	295808	REF		
A1	IC, TTL, Quad 2-Input + AND Gates	292987	01295	SN7408N	3		
A2	IC, TTL, Hex Inverter	292979	01295	SN7404N	1		
A3	IC, TTL, Triple 3-Input Nor Gate	268565	18324	SP370A	1		
A4	IC, TTL, Quad 2-Input Nor Gate	268540	18324	SP380A	3		
A5	IC, TTL, Quad 2-Input Nor Gate	268540	18324	SP380A	REF		
A6	IC, TTL, 8-Bit Latch	288837	01295	SN74100N	2		
A7	IC, TTL, 8-Bit Latch	288837	01295	SN74100N	REF		
A8	IC, TTL, 5-Bit Shift Register	293399	01295	SN7496N	3		
A9	IC, TTL, 5-Bit Shift Register	293399	01295	SN7496N	REF		
A10	IC, DTL, Binary Counter	267153	04713	MC839P	1		
A11	IC, TTL, 5-Bit Shift Register	293399	01295	SN7496N	REF		
A12	IC, TTL, Quad 2-Input Nor Gate	268540	18324	SP380A	REF		
A13	IC, TTL, Quad 2-Input + AND Gates	292987	01295	SN7408N	REF		
A14	IC, TTL, Quad 2-Input + AND Gates	292987	01295	SN7408N	REF		
A15	IC, Linear, voltage regulator	327981	12040	LM309K	1		
C1	Cap, mica, 5600 pf ±2%, 500V	182873	14655	CD19F562G	2		
C2	Cap, mica, 5600 pf ±2%, 500V	182873	14655	CD19F562G	REF		
C3	Cap, plstc, 0.022 uf ±10%, 250V	234484	73445	C280AE/A22K	3		
C4	Cap, cer, 0.0012 uf ±10%, 500V	106732	71590	CF122	2		
C5	Cap, cer, 0.0012 uf ±10%, 500V	106732	71590	CF122	REF		
C6	Cap, mica, 220 pf ±5%, 500V	170423	14655	CD15F221J	1		
C7	Cap, plstc, 0.022 uf ±10%, 250V	234484	73445	C280AE/A22K	REF		
C8	Cap, plstc, 0.022 uf ±10%, 250V	234484	73445	C280AE/A22K	REF		
C9	Cap, elect, 3800 uf +75/-10%, 15V (mounted on back)	276758	56289	196D106X0015	1		
C10	Cap, Ta, 10 uf ±20%, 15V	193623	56289	196D106X0015	5		
C11	Cap, Ta, 10 uf ±20%, 15V	193623	56289	601D388G015JL4	REF		
C12	Cap, Ta, 10 uf ±20%, 15V	193623	56289	196D106X0015	REF		

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
C14	Cap, cer, 0.01 uf ±20%, 100V	149153	56289	C023B101F103M	2		
C15	Cap, mica, 100 pf ±5%, 500V	148494	14655	CD15F101J	1		
C16	Cap, cer, 0.01 uf ±20%, 100V	149153	56289	C023B101F103M	REF		
C18	Cap, Ta, 10 uf ±20%, 15V	193623	56289	196D106X0015	REF		
CR1	Diode, germanium, 80 ma, 100 piv	149187	93332	IN270	5		
CR2	Diode, germanium, 80 ma, 100 piv	149187	93332	IN270	REF		
CR3	Diode, germanium, 80 ma, 100 piv	149187	93332	IN270	REF		
CR4	Diode, germanium, 80 ma, 100 piv	149187	93332	IN270	REF		
CR5	Diode, germanium, 80 ma, 100 piv	149187	93332	IN270	REF		
CR6	Diode, silicon, 1 amp, 100 piv	116111	05277	IN4817	4		
CR7	Diode, silicon, 1 amp, 100 piv	116111	05277	IN4817	REF		
CR8	Diode, silicon, 1 amp, 100 piv	116111	05277	IN4817	REF		
CR9	Diode, silicon, 1 amp, 100 piv	116111	05277	IN4817	REF		
J1	Connector, female, 36 contact	158469	02660	57-40360	1		
Q4	Tstr, silicon, NPN	218396	04713	2N3904	1		
R1	Res, comp, 240 Ω ±5%, ¼w	221895	01121	CB2415	4		
R2	Res, comp, 240 Ω ±5%, ¼w	221895	01121	CB2415	REF		
R3	Res, comp, 240 Ω ±5%, ¼w	221895	01121	CB2415	REF		
R4	Res, comp, 240 Ω ±5%, ¼w	221895	01121	CB2415	REF		
R5	Res, comp, 2.2k ±5%, ¼w	148049	01121	CB2225	4		
R6	Res, comp, 3.3k ±5%, ¼w	148056	01121	CB3325	1		
R7	Res, comp, 3.9k ±5%, ¼w	148064	01121	CB3925	1		
R8	Res, comp, 2.7k ±5%, ¼w	170720	01121	CB2725	2		

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R9	Res, comp, 2.7k ±5%, ¼w	170720	01121	CB2725	REF		
R10	Res, comp, 4.7k ±5%, ¼w	148072	01121	CB4725	1		
R11	Res, comp, 15k ±5%, ¼w	148114	01121	CB1535	1		
R12	Res, comp, 1k ±5%, ¼w	148023	01121	CB1025	3		
R13	Res, comp, 2.2k ±5%, ¼w	148049	01121	CB2225	REF		
R14	Res, comp, 2.2k ±5%, ¼w	148049	01121	CB2225	REF		
R19	Res, comp, 2k ±5%, ¼w	202879	01121	CB2025	1		
R20	Res, comp, 5.6k ±5%, ¼w	148080	01121	CB5625	1		
R21	Res, comp, 8.2k ±5%, ¼w	160796	01121	CB8225	1		
R22	Res, comp, 1k ±5%, ¼w	148023	01121	CB1025	REF		
R23	Res, comp, 1k ±5%, ¼w	148023	01121	CB1025	REF		
R24	Res, comp, 2.2k ±5%, ¼w	148049	01121	CB2225	REF		
R27	Res, comp, 1.5k ±5%, ¼w	148031	01121	CB1525	1		
R28	Res, var, ww, 1k ±20%, 1¼w	111575	71450	Type 110	1		
	Heat sink	328542			1		
	Socket, IC, 14 pin contact (use with A1, A2, A3, A4, A5, A10, A12, A13, A14)	291542	00779	583527	9		
	Socket, IC, 16 pin contact (use with A8, A9, A11)	291534	00779	583529	3		
	Socket, IC, 24 pin contact (use with A6, A7)	292946	71785	24DIP133-59-02011	2		

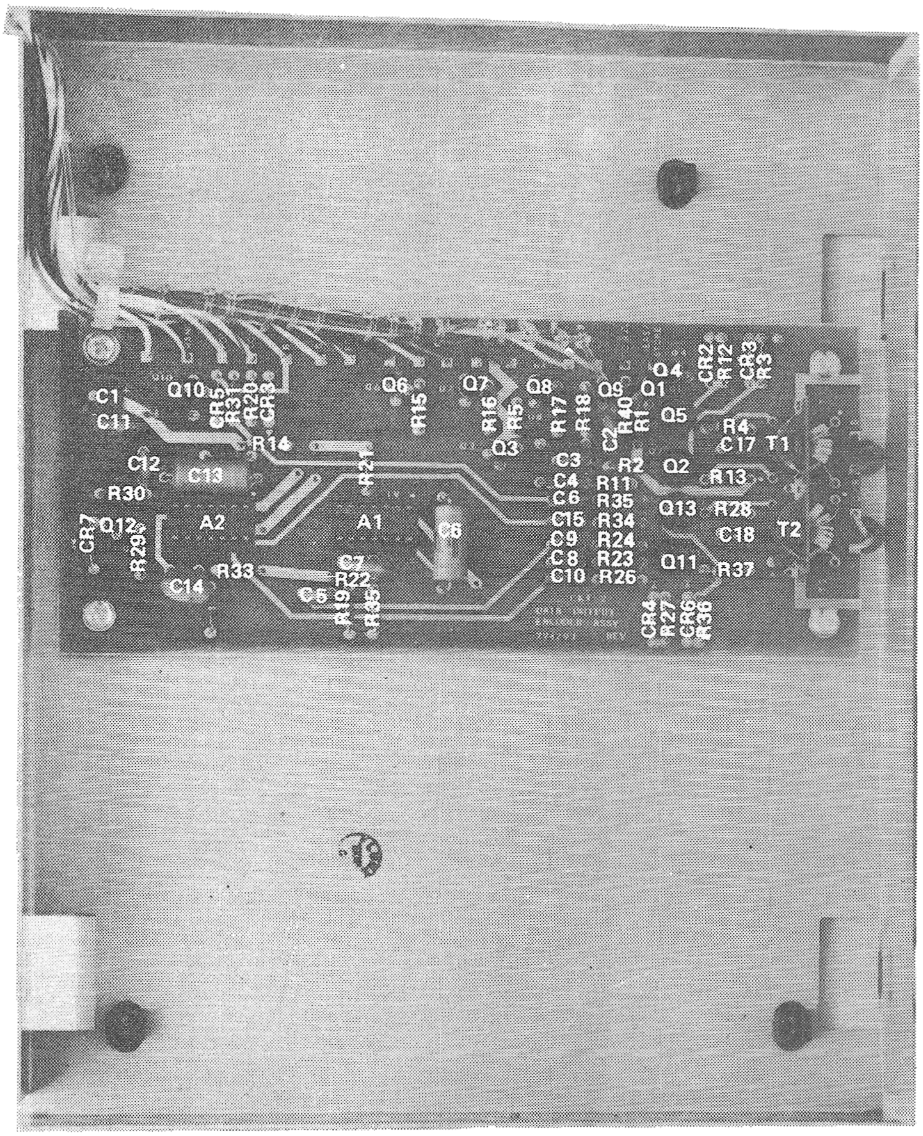


Figure 6-6. DATA OUTPUT PCB ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A3	DATA OUTPUT ENCODER PCB ASSEMBLY Figure 6-7	294793	89536	294793	REF		
A1	IC, TTL, Quad 2-Input Nor Gate	268540	18324	SP380A	2		
A2	IC, TTL, Quad 2-Input Nor Gate	268540	18324	SP380A	REF		
C1	Cap, Ta, 10 uf ±20%, 15V	193623	56289	196D106X0015	3		
C2	Cap, cer, 0.0012 uf ±10%, 500V	106732	71590	CF122	8		
C3	Cap, cer, 0.0012 uf ±10%, 500V	106732	71590	CF122	REF		
C4	Cap, cer, 0.0012 uf ±10%, 500V	106732	71590	CF122	REF		
C5	Cap, cer, 0.01 uf ±20%, 100V	149153	56289	C023B101F103M	2		
C6	Cap, plstc, 0.22 uf ±10%, 80V	159392	56289	192P2249R8	2		
C7	Cap, cer, 0.05 uf ±20%, 100V	149161	56289	55C23A1	3		
C8	Cap, cer, 0.0012 uf ±10%, 500V	106732	71590	CF122	REF		
C9	Cap, cer, 0.0012 uf ±10%, 500V	106732	71590	CF122	REF		
C10	Cap, cer, 0.0012 uf ±10%, 500V	106732	71590	CF122	REF		
C11	Cap, cer, 0.05 uf ±20%, 100V	149161	56289	55C23A1	REF		
C12	Cap, cer, 0.01 uf ±20%, 100V	149153	56289	C023B101F103M	REF		
C13	Cap, plstc, 0.22 uf ±10%, 80V	159392	56289	192P2249R8	REF		
C14	Cap, cer, 0.05 uf ±20%, 100V	149161	56289	55C23A1	REF		
C15	Cap, cer, 0.0012 uf ±10%, 500V	106732	71590	CF122	REF		
C18	Cap, Ta, 10 uf ±20%, 15V	193623	56289	196D106X0015	REF		
CR1	Diode, silicon, 150 ma	203323	03508	DHD1105	7		
CR2	Diode, silicon, 150 ma	203323	03508	DHD1105	REF		
CR3	Diode, silicon, 150 ma	203323	03508	DHD1105	REF		
CR4	Diode, silicon, 150 ma	203323	03508	DHD1105	REF		
CR5	Diode, silicon, 150 ma	203323	03508	DHD1105	REF		

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
CR6, CR7	Diode, silicon, 150 ma	203323	03508	DHD1105	REF		
Q1	Tstr, silicon, NPN	218396	04713	2N3904	3		
Q2	Tstr, silicon, NPN	182196	07263	2N3643	4		
Q3	Tstr, silicon, NPN	218396	04713	2N3904	REF		
Q5	Tstr, silicon, NPN	182196	07263	2N3643	REF		
Q6	Tstr, FET, N-channel	288324	15818	U1994E	REF		
Q7	Tstr, FET, N-channel	288324	15818	U1994E	REF		
Q8	Tstr, FET, N-channel	288324	15818	U1994E	REF		
Q9	Tstr, FET, N-channel	288324	15818	U1994E	REF		
Q10	Tstr, FET, N-channel	288324	15818	U1994E	REF		
Q11	Tstr, silicon, NPN	182196	07263	2N3643	REF		
Q12	Tstr, silicon, NPN	218396	04713	2N3904	REF		
Q13	Tstr, silicon, NPN	182196	07263	2N3643	REF		
R1	Res, comp, 1k ±5%, ¼w	148023	01121	CB1025	3		
R2	Res, comp, 470 Ω ±5%, ¼w	147983	01121	CB4715	1		
R3	Res, comp, 4.7k ±5%, ¼w	148072	01121	CB4725	11		
R4	Res, comp, 47 Ω ±5%, ¼w	147892	01121	CB4705	4		
R5	Res, comp, 4.7k ±5%, ¼w	148072	01121	CB4725	REF		
R6	Res, comp, 1.2k ±5%, ¼w	190371	01121	CB1225	2		
R11	Res, comp, 1k ±5%, ¼w	148023	01121	CB1025	REF		
R12	Res, comp, 4.7k ±5%, ¼w	148072	01121	CB4725	REF		
R13	Res, comp, 47 Ω ±5%, ¼w	147892	01121	CB4705	REF		
R14	Res, comp, 4.7k ±5%, ¼w	148072	01121	CB4725	REF		
R15	Res, comp, 20k ±5%, ¼w	221614	01121	CB2035	4		

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R16	Res, comp, 20k ±5%, ¼w	221614	01121	CB2035	REF		
R17	Res, comp, 20k ±5%, ¼w	221614	01121	CB2035	REF		
R18	Res, comp, 20k ±5%, ¼w	221614	01121	CB2035	REF		
R19	Res, comp, 4.7k ±5%, ¼w	148072	01121	CB4725	REF		
R20	Res, comp, 2.2k ±5%, ¼w	148049	01121	CB2225	2		
R21	Res, comp, 6.8k ±5%, ¼w	148098	01121	CB6825	2		
R22	Res, comp, 2.7k ±5%, ¼w	170720	01121	CB2725	2		
R23	Res, comp, 750 Ω ±5%, ¼w	218024	01121	CB7515	2		
R24	Res, comp, 910 Ω ±5%, ¼w	203851	01121	CB9115	1		
R25	Res, comp, 4.7k ±5%, ¼w	148072	01121	CB4725	REF		
R26	Res, comp, 750 Ω ±5%, ¼w	218024	01121	CB7515	REF		
R27	Res, comp, 4.7k ±5%, ¼w	148072	01121	CB4725	REF		
R28	Res, comp, 47 Ω ±5%, ¼w	147892	01121	CB4705	REF		
R29	Res, comp, 4.7k ±5%, ¼w	148072	01121	CB4725	REF		
R30	Res, comp, 4.7k ±5%, ¼w	148072	01121	CB4725	REF		
R31	Res, comp, 2.2k ±5%, ¼w	148049	01121	CB2225	REF		
R32	Res, comp, 6.8k ±5%, ¼w	148098	01121	CB6825	REF		
R33	Res, comp, 2.7k ±5%, ¼w	170720	01121	CB2725	REF		
R34	Res, comp, 1k ±5%, ¼w	148023	01121	CB1025	REF		
R35	Res, comp, 1.2k ±5%, ¼w	190371	01121	CB1225	REF		
R36	Res, comp, 4.7k ±5%, ¼w	148072	01121	CB4725	REF		
R37	Res, comp, 47 Ω ±5%, ¼w	147892	01121	CB4705	REF		
R38	Res, comp, 10k ±5%, ¼w	148106	01121	CB1035	2		
R39	Res, comp, 10k ±5%, ¼w	148106	01121	CB1035	REF		
R40	Res, comp, 4.7k ±5%, ¼w	148072	01121	CB4725	REF		
T1	Transformer, pulse	275362	01121	275362	2		
T2	Transformer, pulse	275362	01121	275362	REF		
	Socket, IC, 14 contact	276527	23880	TSA-2900-14W	2		

Accessory

Rack Mounting Fixtures

6-1. INTRODUCTION

6-2. The FLUKE half-rack instruments can be mounted in standard 19 inch equipment racks in various configurations. A single instrument can be rack mounted with either a left or right offset. Dual mounting of two instruments of the same type is also possible. Rack mounting kits are as follows:

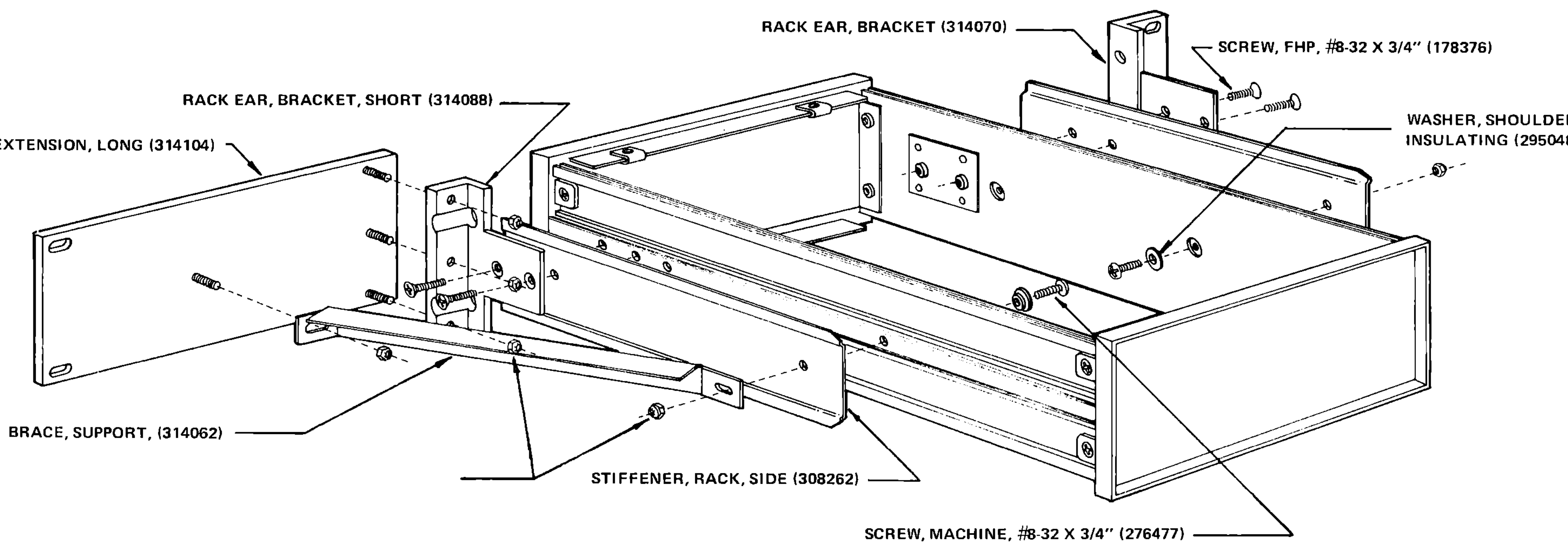
OFFSET	M03-200-607
DUAL	M03-200-606

6-3. INSTALLATION

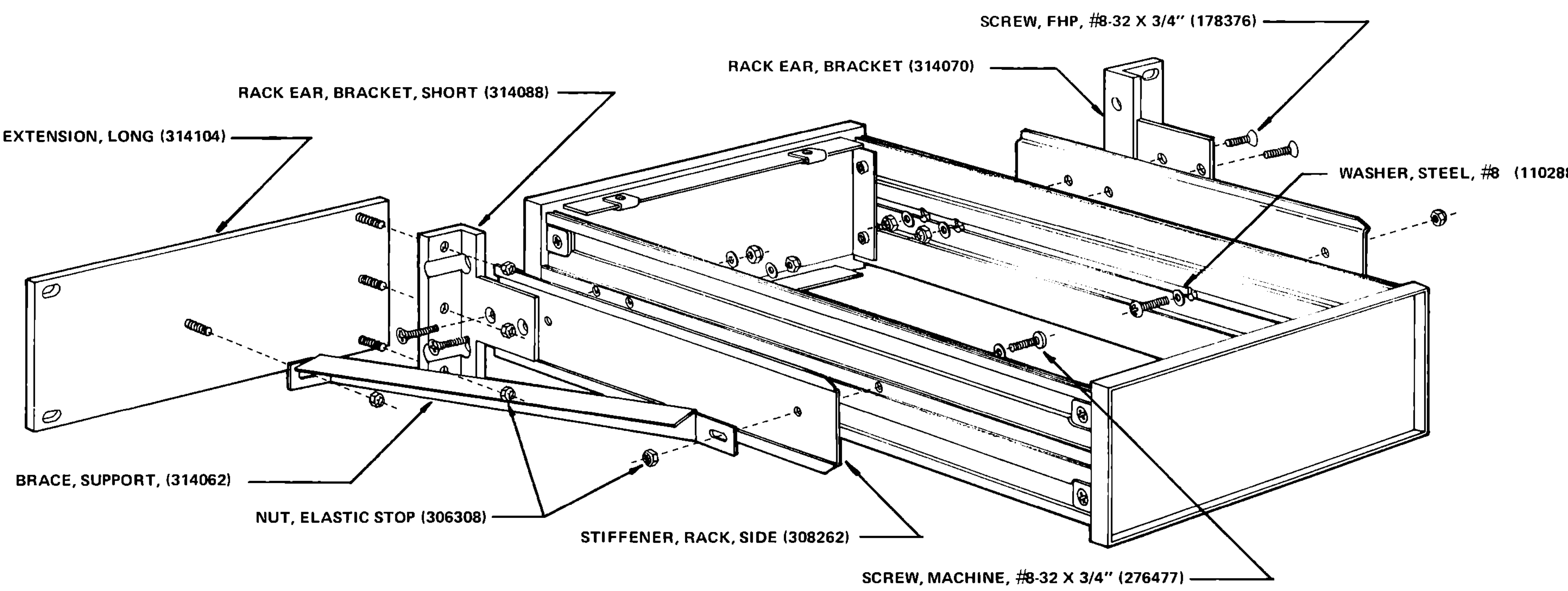
6-4. Procedures for installation of rack mounting kits are given in the following illustrations. Each illustration is identified with a form number in the lower left-hand corner. This form number is related to the kit number as follows:

FORM NO.	RACK KIT	CONFIGURATION
A409	M03-200-607	OFFSET
A410	M03-200-606	DUAL

RACK MOUNTING PROCEDURE FOR MOLDED MODULE SERIES INSTRUMENTS.



8200A



OTHER INSTRUMENTS

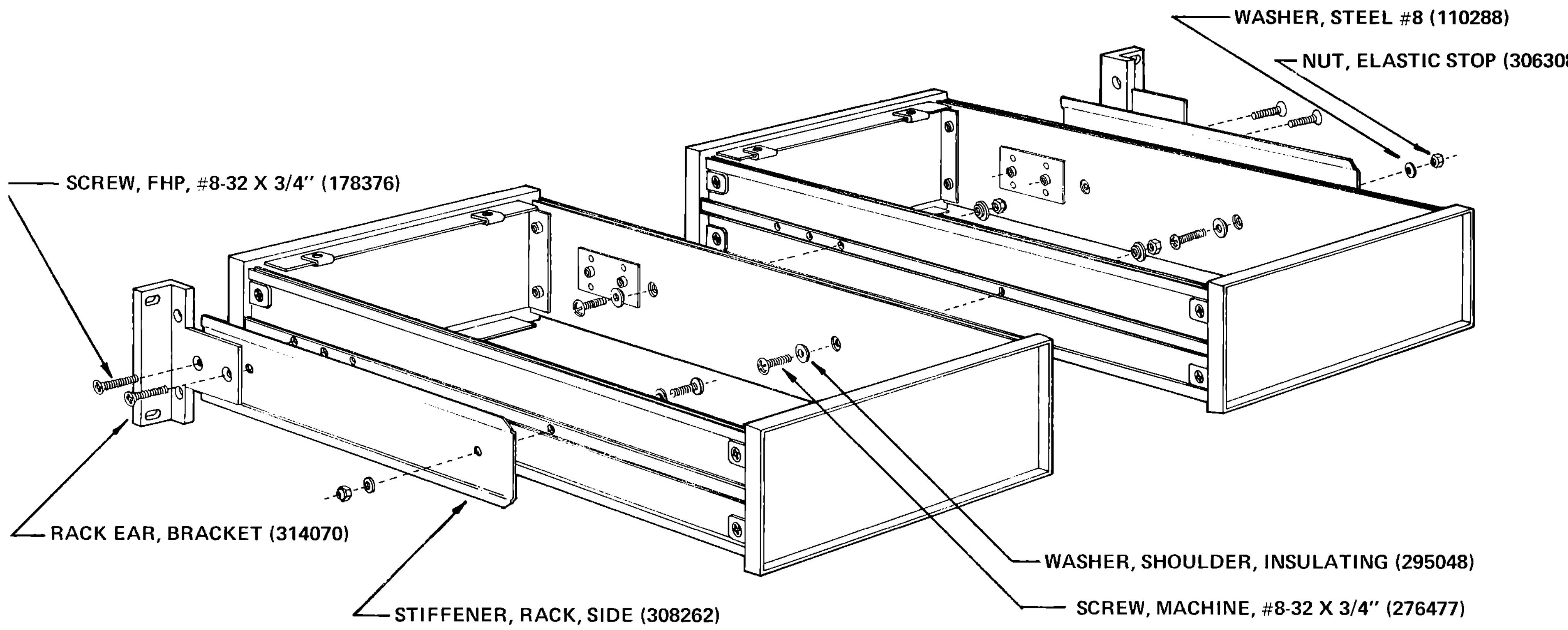
WARNING: ALL METAL CHASSIS PARTS IN THE 8200A ARE AT GUARD POTENTIAL. THE INSULATING SHOULDER WASHERS MUST BE IN POSITION BETWEEN THE MOUNTING SCREWS AND THE GUARD CHASSIS SIDE AT THE REAR MOUNTING HOLES AS SHOWN IN THE ILLUSTRATION, OR THE GUARD WILL BE VIOLATED.

1. THIS KIT IS A DUAL PURPOSE KIT. THERE WILL BE EXTRA FASTENERS IN ANY APPLICATION. PLEASE REFER TO THE ILLUSTRATION PERTAINING TO THE PARTICULAR INSTRUMENT AT HAND.
2. REMOVE TOP AND BOTTOM COVERS.REMOVE FEET FROM BOTTOM COVER.
3. REMOVE HANDLE DISK DECALS AND REMOVE HANDLE.
4. REMOVE SIDE TRIM DECALS TO EXPOSE MOUNTING HOLES.
5. ATTACH RACK EAR, BRACKET, SHORT (314088) TO RACK EAR, EXTENSION, LONG (314104) USING NUT, ELASTIC STOP (306308) 3 PLACES AS SHOWN.
6. (8200A): POSITION STIFFENER, RACK SIDE (308262) AGAINST THE SIDE OF THE INSTRUMENT, THEN INSERT 2 #8-32 SCREWS (178376) THROUGH THE RACK EAR, STIFFENER, AND SIDE CHASSIS, ENGAGING THE CAPTIVE NUTS.

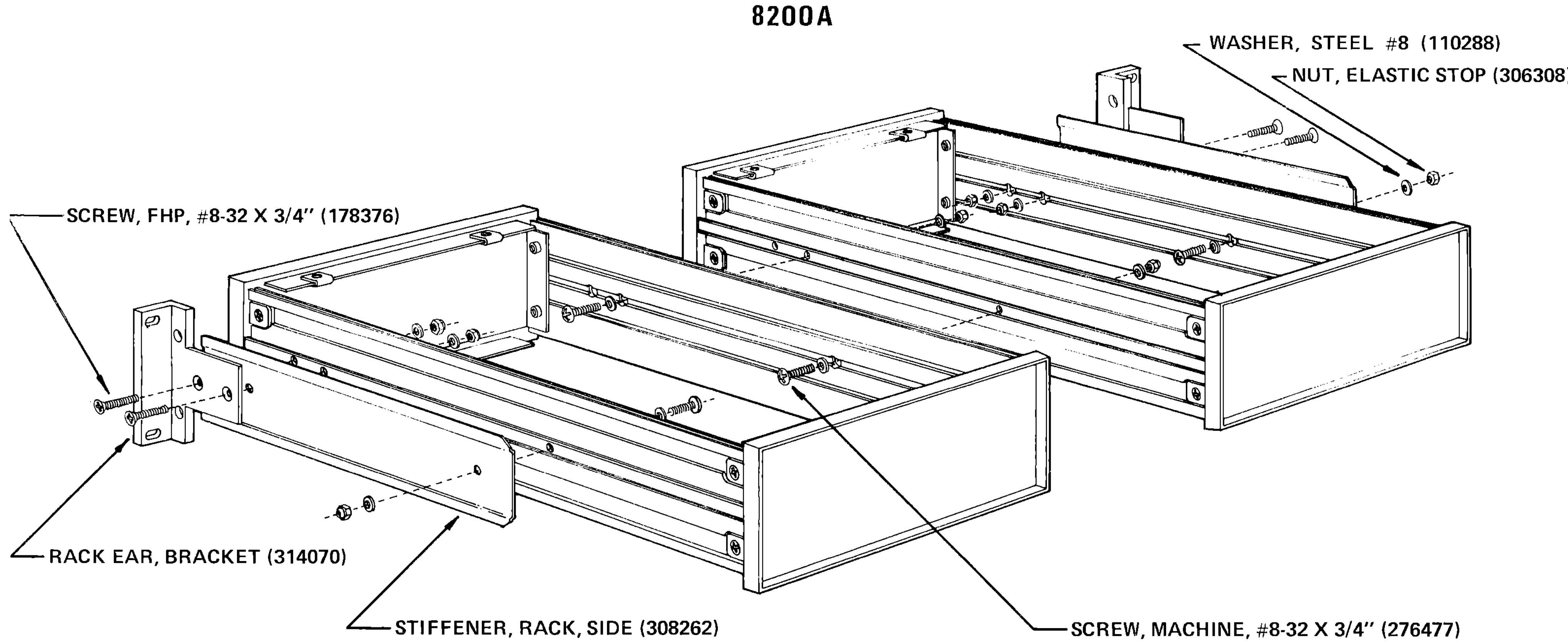
   (OTHER INSTR.): POSITION STIFFENER, RACK SIDE (308262) AGAINST THE SIDE OF THE INSTRUMENT, THEN INSERT 2 #8-32 SCREWS (178376) THROUGH THE RACK EAR, STIFFENER, AND SIDE CHASSIS, FASTENING WITH A WASHER (110288) AND A NUT, ELASTIC STOP (306308).
7. (8200A): INSERT A #8-32 SCREW (276477) AND WASHER, SHOULDER, INSULATING (295048) FROM THE INSIDE OF THE INSTRUMENT, THROUGH THE REAR MOUNTING HOLE IN THE SIDE CHASSIS, THEN THROUGH THE STIFFENER, AND FASTEN WITH NUT, ELASTIC STOP (306308), (SEE NOTE #8).

   (OTHER INSTR.): INSERT A #8-32 SCREW (276477) AND WASHER (110288) FROM THE INSIDE OF THE INSTRUMENT, THROUGH THE REAR MOUNTING HOLE IN THE SIDE CHASSIS, THEN THROUGH THE STIFFENER, AND FASTEN WITH NUT, ELASTIC STOP (306308), (SEE NOTE #8).
8. ON THE OFFSET SIDE MOUNT THE BRACE, SUPPORT (314062) USING 2 NUTS, ELASTIC, STOP (306308).
9. REPLACE THE TOP AND BOTTOM COVERS.

DUAL RACK MOUNTING PROCEDURE FOR MOLDED MODULE SERIES INSTRUMENTS



8200A



OTHER INSTRUMENTS

WARNING: ALL METAL CHASSIS PARTS IN THE 8200A ARE AT GUARD POTENTIAL. THE INSULATING SHOULDER WASHERS MUST BE IN POSITION BETWEEN THE MOUNTING SCREWS AND THE GUARD CHASSIS SIDE AS SHOWN IN THE ILLUSTRATION, OR THE GUARD WILL BE VIOLATED.

1. THIS KIT IS A DUAL PURPOSE KIT. THERE WILL BE EXTRA FASTENERS IN ANY APPLICATION. PLEASE REFER TO THE ILLUSTRATION PERTAINING TO THE PARTICULAR INSTRUMENT AT HAND.

2. REMOVE TOP AND BOTTOM COVERS AND REMOVE FEET FROM BOTTOM COVER.

3. REMOVE HANDLE DISK DECALS AND REMOVE HANDLE.

4. REMOVE SIDE TRIM DECALS TO EXPOSE MOUNTING HOLES.

5. (8200A): PLACE THE TWO INSTRUMENTS SIDE BY SIDE. INSERT AN #8-32 SCREW (276477), THROUGH: A WASHER, SHOULDER, INSULATING (295048); BOTH CHASSIS SIDES; ANOTHER WASHER, SHOULDER, INSULATING; AND FASTEN WITH A NUT, ELASTIC STOP (306308), IN EACH OF THE TWO HOLES PROVIDED IN THE CHASSIS SIDE.

(OTHER INSTR.): PLACE THE TWO INSTRUMENTS SIDE BY SIDE. INSERT AN #8-32 SCREW (276477) THROUGH: A WASHER, STEEL (110288); BOTH CHASSIS SIDES; ANOTHER WASHER, STEEL; AND FASTEN WITH A NUT, ELASTIC STOP (306308), IN EITHER ONE OF TWO FRONT MOUNTING HOLES AND THE REAR MOUNTING HOLE.

6. (8200A): POSITION A STIFFENER, RACK SIDE (308262) AGAINST THE SIDE OF THE INSTRUMENT, THEN INSERT TWO #8-32 SCREWS (178376) THROUGH THE RACK EAR (314070), STIFFENER, AND SIDE CHASSIS ENGAGING THE CAPTIVE NUTS. AT THE REAR OF THE CHASSIS SIDE, INSERT A #8-32 SCREW (276477) AND WASHER, SHOULDER, INSULATING (295048) FROM THE INSIDE OF THE INSTRUMENT, THROUGH THE REAR MOUNTING HOLE IN THE CHASSIS SIDE, THEN THROUGH THE STIFFENER AND A WASHER, STEEL, AND FASTEN WITH A NUT, ELASTIC STOP (306308). REPEAT ON OPPOSITE SIDE.

(OTHER INSTR.) POSITION STIFFENER, RACK SIDE (308262) AGAINST THE SIDE OF THE INSTRUMENT, THEN INSERT 2 #8-32 SCREWS (178376) THROUGH THE RACK EAR (314070), STIFFENER, AND SIDE CHASSIS, FASTENING WITH A WASHER, STEEL (110288) AND A NUT, ELASTIC STOP (306308). AT THE REAR OF THE CHASSIS SIDE, INSERT A #8-32 SCREW (276477) AND WASHER, STEEL (110288) FROM THE INSIDE OF THE INSTRUMENT, THROUGH THE REAR MOUNTING HOLE IN THE CHASSIS SIDE, THEN THROUGH THE STIFFENER AND A WASHER, STEEL, AND FASTEN WITH A NUT, ELASTIC STOP (306308). REPEAT ON OPPOSITE SIDE.

7. REPLACE THE TOP AND BOTTOM COVERS.

FLUKE

JOHN FLUKE MFG. CO., INC.

P.O. BOX 7428 • SEATTLE, WASHINGTON 98133 • TEL. (206) 774-2211 • TWX 910-449-2850 • TLX 3-2213

DATE: February 13, 1974

TO: All FLUKE Customers

FROM: Customer Service Department

SUBJECT: Factory Service Facilities

FLUKE currently has ten Service Centers, each of which is staffed, stocked and equipped to service FLUKE equipment with an expertise and confidence equal to that of the factory. In addition, programs are in effect to assure NBS traceability in all required areas of measurement.

At the present time, the FLUKE Service Centers are turning instruments around in a much shorter time than is possible in the factory. This shorter turn-around time, coupled with the closer proximity of these Service Centers means better service to you, our Customer. In addition to our FLUKE Service Centers we also have authorized warranty repair facilities to provide local service in other areas. If you require more information regarding availability of local service other than the FLUKE Service Center, please contact your local sales representative.

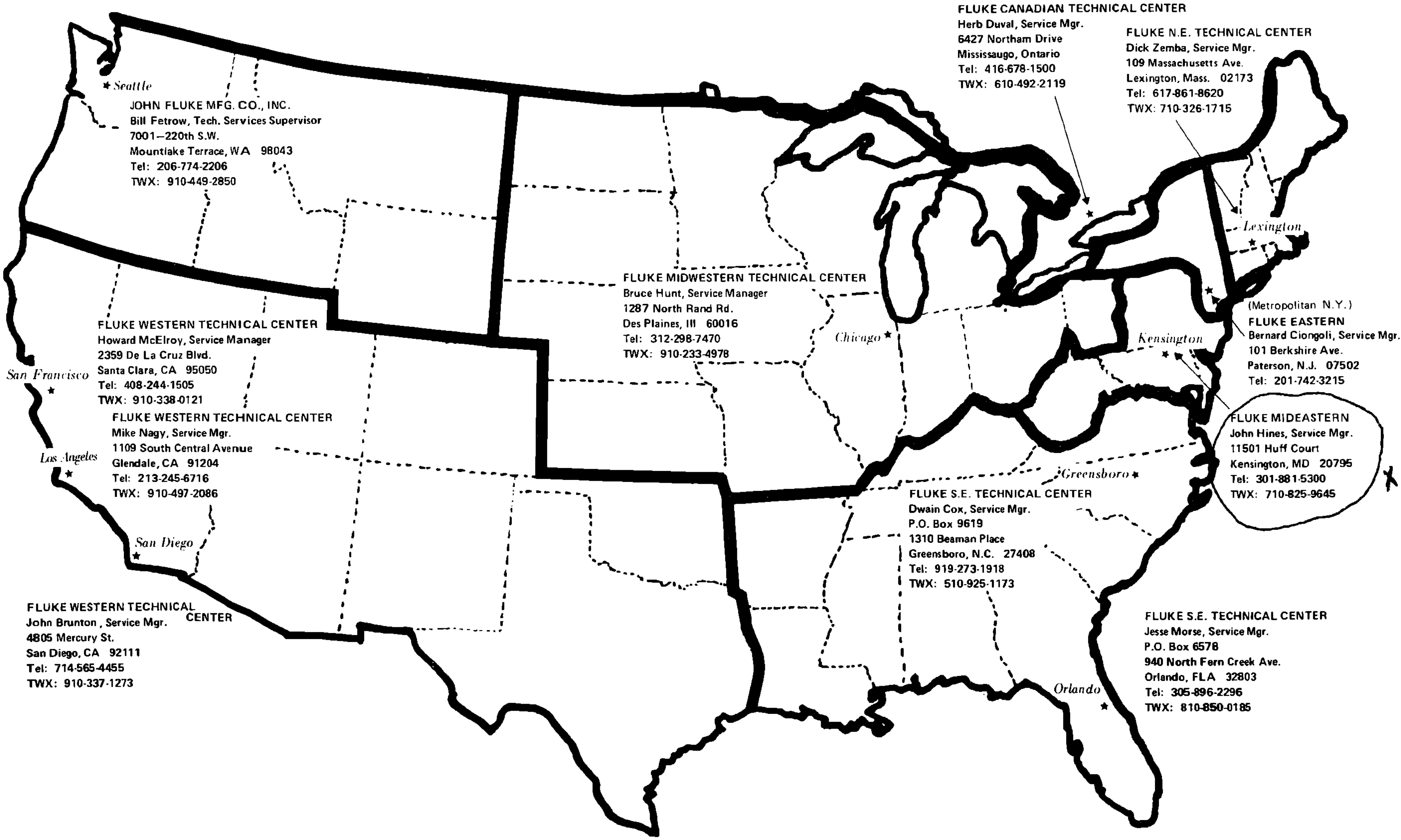
It is our intent to make maximum use of our Service Centers, therefore, it is essential that you contact the factory or nearest Service Center for shipping instructions prior to sending any instrument back to the factory for repair. In turn, we will make every effort to coordinate workloads at the Service Center to provide optimum turn-around of equipment.

Your cooperation in this matter is essential. Operating Service Centers and their areas of responsibility are indicated on the reverse side of this letter. Should you have any questions in this matter, please feel free to contact me or my staff at the factory.

Terry Brumfield
Manager
Customer Service

TB/gh

FLUKE® TECHNICAL SERVICE CENTERS



ACCESSORY INFORMATION

MODEL 80F-5 VOLTAGE DIVIDER

6-1. INTRODUCTION

6-2. The Accessory Model 80F-5 Voltage Divider allows measurement of up to 5k volts dc to be made using FLUKE 800, 900, and 8000 series voltmeters. Division ratio of this accessory is 1000:1. Accuracy and stability of the division ratio is ensured using special metal film resistors having matched temperature coefficients.

6-3. Physical design of the Model 80F-5 allows direct mating to the input terminals of the FLUKE voltmeters. A high voltage probe facilitates connection to the measure-

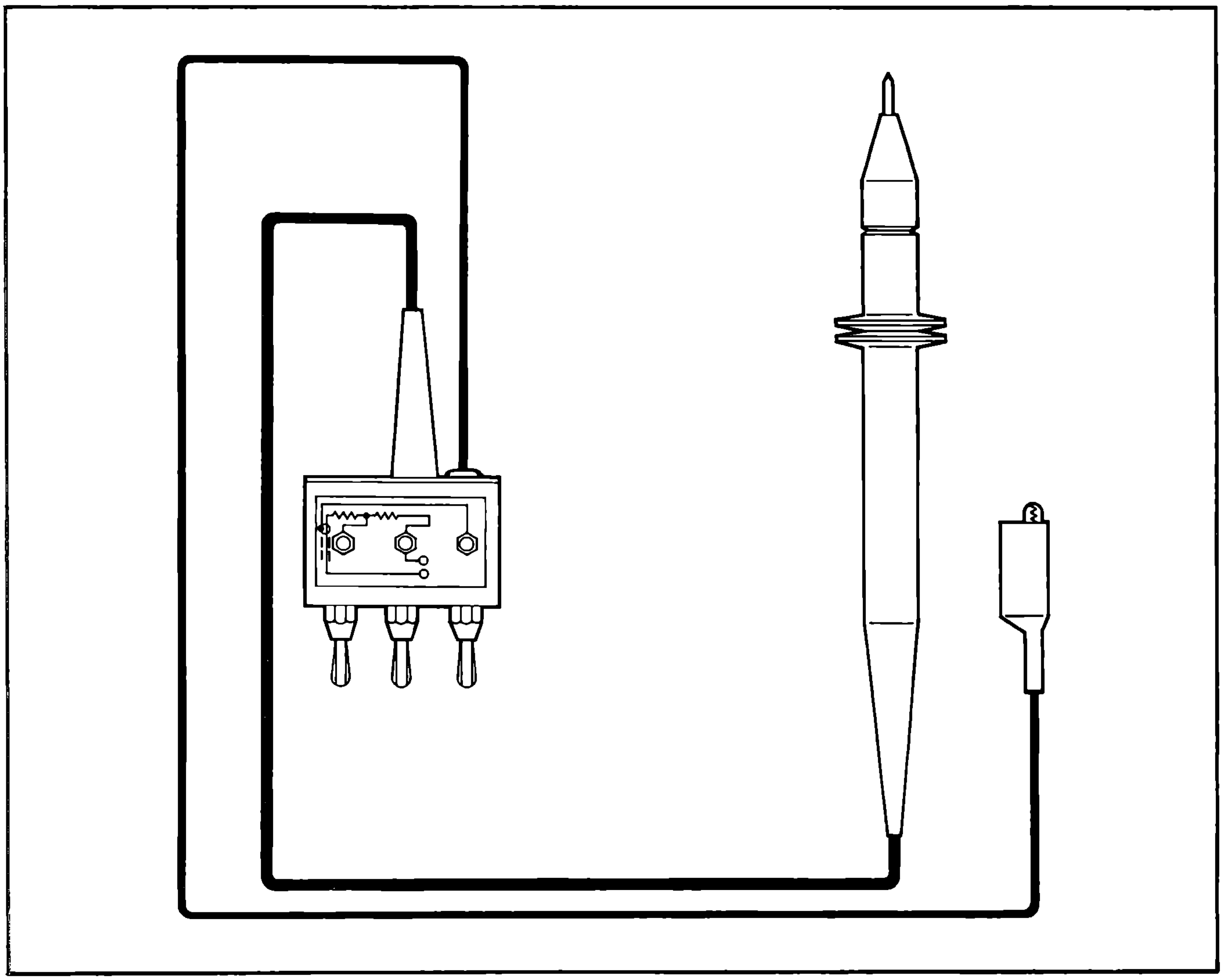


Figure 6-1. MODEL 80F-5 VOLTAGE DIVIDER

ment source. Maintenance is minimized by encapsulation of the divider components.

6-4. Three versions of the Model 80F-5 are available. The basic Model 80F-5 is used with voltmeters having a 10 megohm input resistance. An (01) Option is provided for voltmeters having an 11 megohm input resistance, and an (02) Option is provided for voltmeters having an infinite input resistance (10^3 megohms or greater) at null.

6-5. SPECIFICATIONS

6-6. Electrical

DIVISION RATIO:
1000:1

RATIO ACCURACY:
±0.01% of input from 500 to 5000 vdc.

RATIO ACCURACY STABILITY:
±0.01% per month
±0.05% per year
} Calibrated by internal adjustment

VOLTAGE COEFFICIENT:
Less than 20 ppm total from 0 to 5000 vdc.

TEMPERATURE COEFFICIENT:
0.001%/°C

INPUT RESISTANCE:
50 Megohms

MAXIMUM INPUT VOLTAGE:
5000 vdc

REQUIRED VOLTMETER INPUT RESISTANCE:

80F-5	80F-5 (01)	80F-5 (02)
10 Megohms	11 Megohms	Infinite at null (10^3 megohms or greater)

MAXIMUM OUTPUT VOLTAGE:
5 vdc

6-7. Environmental

OPERATING:
Temperature Range – 0°C to 50°C
Humidity – 0 to 80%
Altitude Range – 0 to 10,000 feet

NON-OPERATING:
Altitude Range – 0 to 50,000 feet

6-8. Mechanical

DIMENSIONS
2.28 inches high x 1.52 inches wide x 1.525 inches deep.

WEIGHT:
20 ounces (340 grams)

6-9. OPERATING INSTRUCTIONS

a. Connect the Model 80F-5 output terminals directly to the INPUT terminals of the FLUKE voltmeter.

b. Select the appropriate dc voltage range on the FLUKE voltmeter.

c. Deenergize the high voltage source to be measured.

d. Connect the ground clip (–) and probe (+) to respective low and high sections of the high voltage source.

WARNING!

Lethal voltages will be present between the ground clip and probe of the 80F-5 when the high voltage source is energized.

e. Energize the high voltage source. Multiply the FLUKE voltmeter indication by 1000 to obtain the magnitude of the high voltage.

6-10. MAINTENANCE

6-11. General

6-12. The Model 80F-5 requires a minimum amount of maintenance. All that is required is occassional cleaning and calibration.

6-13. Cleaning

6-14. Accumulation of dust or dirt particles between the output terminals of the Model 80F-5 can be removed using clean dry pressurized air. Stubborn particles can be removed following an application of isopropyl alcohol.

6-15. Calibration

6-16. The Model 80F-5 division ratio should be checked every month or every year depending on the accuracy requirement. Ratio accuracy stability is specified at ±0.01% per month and ±0.05% per year. Calibration should be accomplished only after the Model 80F-5 has been in non-operating state for at least four hours at a temperature of 23°C.

6-17. Test equipment requirements are a stable 1000 volt dc source such as the FLUKE Model 332B Voltage Calibrator and the FLUKE voltmeter. To calibrate the Model 80F-5, perform the following steps:

NOTE

The input resistance of the voltmeter must match that of the 80F-5. See paragraph 6-6, REQUIRED VOLTMETER INPUT RESISTANCE.

a. Calibrate the FLUKE voltmeter.

b. Install the Model 80F-5 on the FLUKE voltmeter input terminals.

c. Unscrew the strain relief on the input cable of the Model 80F-5 and remove the front cover.

d. Select the appropriate dc voltage range on the FLUKE voltmeter.

e. Apply 1000 volts dc to the Model 80F-5 high voltage probe.

f. Adjust the variable resistor on the Model 80F-5 for a 1.0 volt dc indication on the FLUKE voltmeter.

g. Remove the voltage from the Model 80F-5 high voltage probe.

h. Install the Model 80F-5 front cover and strain relief.

ACCESSORY INFORMATION

MODEL 80F-15 VOLTAGE DIVIDER

6-1. INTRODUCTION

6-2. The Accessory Model 80F-15 Voltage Divider allows measurement of up to 15k volts dc to be made using FLUKE 800, 900, and 8000 series voltmeters. Division ratio of this accessory is 1000:1. Accuracy and stability of the division ratio is ensured using special metal film resistors having matched temperature coefficients.

6-3. Physical design of the Model 80F-15 allows direct mating to the input terminals of the FLUKE voltmeters. A high voltage probe facilitates connection to the measurement

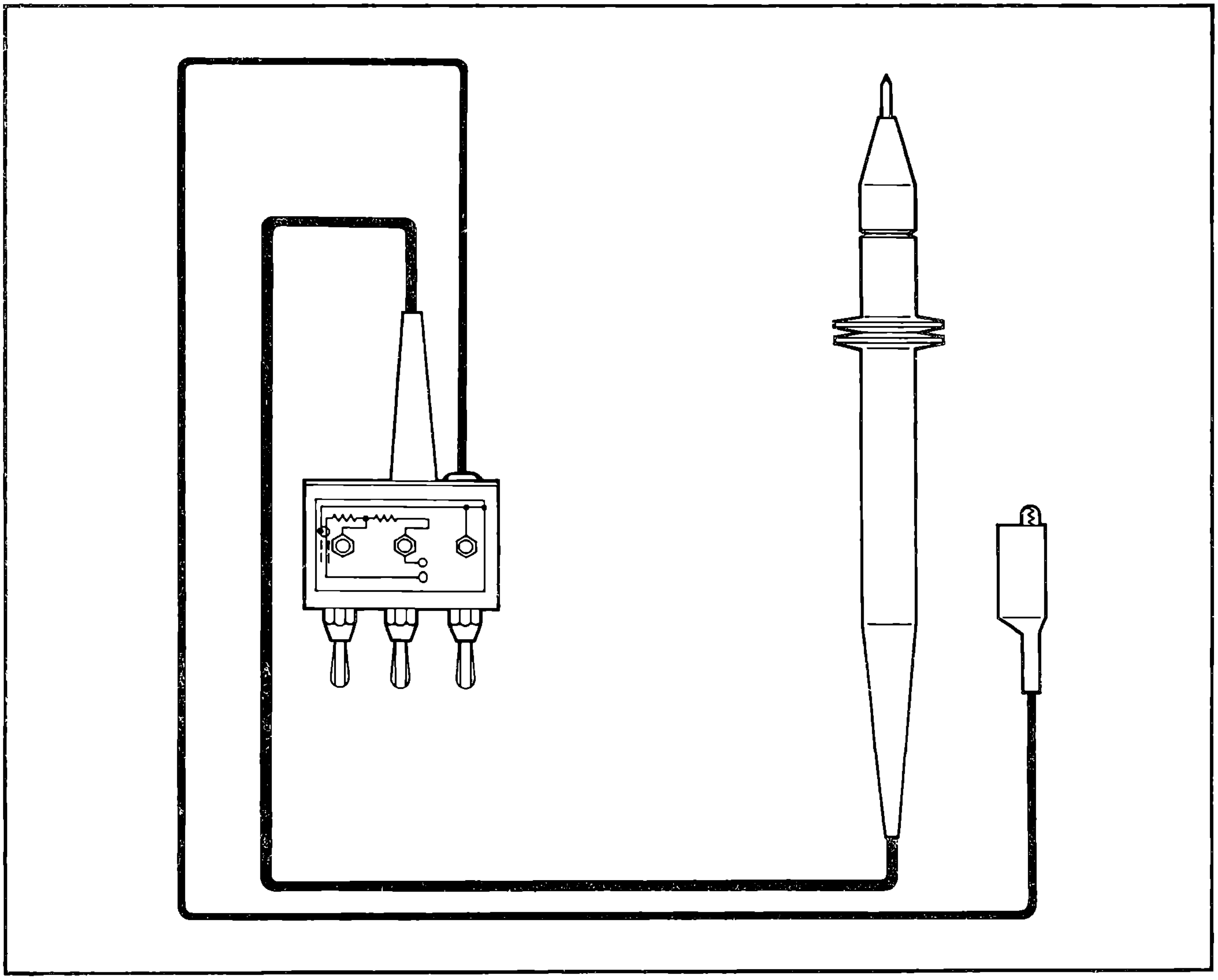


Figure 6-1. MODEL 80F-15 VOLTAGE DIVIDER

source. Maintenance is minimized by encapsulation of the divider components.

6-4. Three versions of the Model 80F-15 are available. The basic Model 80F-15 is used with voltmeters having a 10 megohm input resistance. An (01) Option is provided for voltmeters having an 11 megohm input resistance, and an (02) Option is provided for voltmeters having an infinite input resistance (10^3 megohm or greater) at null.

6-5. SPECIFICATIONS

6-6. Electrical

DIVISION RATIO:
1000:1

RATIO ACCURACY:
±0.01% of input from 1,000 to 15,000 vdc.

RATIO ACCURACY STABILITY:
±0.01% per month }
±0.05% per year } Calibrated by internal adjustment

VOLTAGE COEFFICIENT:
Less than 20 ppm total from 0 to 15,000 vdc.

TEMPERATURE COEFFICIENT:
0.001%/°C

INPUT RESISTANCE:
100 Megohms

MAXIMUM INPUT VOLTAGE:
15,000 vdc

REQUIRED VOLTMETER INPUT RESISTANCE:

80F-15	80F-15 (01)	80F-15 (02)
10 Megohms	11 Megohms	Infinite at null (10^3 megohms at greater)

MAXIMUM OUTPUT VOLTAGE:
15 vdc

6-7. Environmental

OPERATING:
Temperature Range – 0°C to 50°C
Humidity – 0 to 80%
Altitude Range – 0 to 10,000 feet

NON-OPERATING:
Altitude Range – 0 to 50,000 feet

6-8. Mechanical

WEIGHT:
24 ounces (680 grams)

DIMENSIONS:
2.725 inches high x 2.69 inches wide x 1.525 inches deep.

6-9. OPERATING INSTRUCTIONS

a. Connect the Model 80F-15 output terminals directly to the INPUT of the FLUKE voltmeter.

b. Select the appropriate dc voltage range on the FLUKE voltmeter.

c. Deenergize the high voltage source to be measured.

d. Connect the ground clip (–) and probe (+) to respective low and high sections of the high voltage source.

WARNING!

Lethal voltages will be present between the ground clip and probe of the 80F-15 when the high voltage source is energized.

e. Energize the high voltage source. Multiply the FLUKE voltmeter indication by 1000 to obtain the magnitude of the high voltage.

6-10. MAINTENANCE

6-11. General

6-12. The Model 80F-15 requires a minimum amount of maintenance. All that is required is occassional cleaning and calibration.

6-13. Cleaning

6-14. Accumulation of dust or dirt particles between the output terminals of the Model 80F-15 can be removed using clean dry pressurized air. Stubborn particles can be removed following an application of isopropyl alcohol.

6-15. Calibration

6-16. The Model 80F-15 division ratio should be checked every month or every year depending on the accuracy requirement. Ratio accuracy stability is specified at ±0.01% per month and ±0.05% per year. Calibration should be accomplished only after the Model 80F-15 has been in the non-operating state for at least four hours at a temperature of 23°C.

6-17. Test equipment requirements are a stable 1000 volt dc source such as the FLUKE Model 332B Voltage Calibrator and the FLUKE voltmeter. To calibrate the Model 80F-15, perform the following steps:

NOTE

The input resistance of the voltmeter must ma.. that of the 80F-15. See paragraph 6-6, REQUIRED VOLTMETER INPUT RESISTANCE.

a. Calibrate the FLUKE voltmeter.

b. Install the Model 80F-15 on the FLUKE voltmeter input terminals.

c. Unscrew the strain relief on the input cable of the Model 80F-15 and remove the front cover.

d. Select the appropriate dc voltage range on the FLUKE voltmeter.

e. Apply 1000 volts dc to the Model 80F-15 high voltage probe.

f. Adjust the variable resistor on the Model 80F-15 for a 1.0 volt dc indication on the FLUKE voltmeter.

g. Remove the voltage from the Model 80F-15 high voltage probe.

h. Install the Model 80F-15 front cover and strain relief.

ACCESSORY INFORMATION

MODEL 80-RF HIGH FREQUENCY PROBE

6-1. INTRODUCTION

62. The Model 80-RF High Frequency Probe allows measurements over a frequency range of 100 kHz to 500 MHz from 0.25 to 30 volts when using FLUKE voltmeters having an input impedance of 10 megohms ±10%. The accuracy of measurement is ±5% from 100 kHz to 100 MHz and +7% to 500 MHz. The probe operates into any dc voltmeter having an input impedance of 10 megohms ±10%. A shielded dual-banana plug on the probe permits direct connection to the voltmeter input.

6-3. SPECIFICATIONS

6-4. Electrical

VOLTAGE 0.25V to 30V

RESPONSE: Responds to peak value of input. Calibrated to read rms value of a sine wave input.

AC TO DC TRANSFER ACCURACY:

Loaded with 10 megohms ±10%.

	100 KHz – 100 MHz	100 MHz – 500 MHz
+10°C to +30°C	±5%	±7%
–10°C to +40°C	±7%	±15%

<±3 db at 10 kHz and 700 MHz.

INPUT IMPEDANCE: 4 megohms shunted by 2 ±0.5 pf.

MAXIMUM INPUT: 30 volts rms AC, 200 volts DC.

6-5. General

CABLE CONNECTIONS: Shielded dual banana plug Fits all standard 3/4-inch dual banana connectors.

CABLE LENGTH: 4 ft(121.9 cm) minimum.

WEIGHT: 3-½ oz. net.

ACCESSORIES SUPPLIED
- Ground Lead
- Straight Tip
- Hook Tip
- High Frequency Adapter

6-6. OPERATING INSTRUCTIONS

6-7. Connect the shielded dual banana plug directly to the voltmeter input terminals, GND to COMMON or LO. Affix the appropriate probe tip to the probe body, then connect the probe to the high frequency circuit under test. When using the Straight or Hook Tip the ground clip must be connected to the test circuit. When using the high frequency adaptor with appropriate 50 ohm connectors, the ground clip is not required.

6-8. The Straight Tip or Hook Tip supplied with the probe can be used for measurements up to 100 MHz. For measurements above 100 MHz the High Frequency Adapter allows connections to 50 ohm terminations. Ensure that the probe is used in conjunction with dc voltmeters having 10 MΩ ±10% input impedance to meet its specifications.

6-9. The maximum input to the probe is 30 volts rms ac, or 200 volts dc. These factors may be used in combination so that an ac signal may be measured riding on a dc voltage of up to 200 volts. However, it must be noted that if ac superimposed on dc is being measured, the dc level must not be changed by more than 200 volts or the resulting transient is apt to damage the diodes inside the probe.

6-10. THEORY OF OPERATION

6-11. Figure 6-1 contains a schematic diagram of the probe. C1 is a dc blocking capacitor, CR1 is used as a detector, and R1, R3, CR2, R2, and Rin form a divider network. C1, charging through CR1 during the negative half cycle of the input produces a positive dc voltage at the CR1-R1 junction which equals the negative peak value of the input signal. The divider network reduces this to the rms value of the input. It can be seen that the probe must be operated into a 10 MΩ load in order to maintain the proper division ratio.

6-12. CR2 provides compensation for the non-linearity of the detector. R3 is a selected part having a value of 50 kΩ to 100 kΩ, as required for proper divider action.

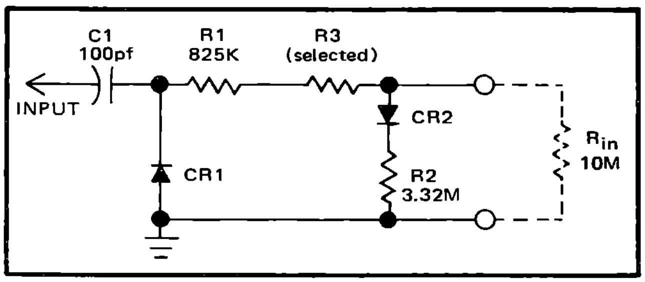


Figure 6-1. SCHEMATIC

6-13. MAINTENANCE

6-14. Performance Checks

6-15. The following checks verify the probe AC to DC Transfer accuracy.

6-16. LOW FREQUENCY RESPONSE. Connect equipment as shown in Figure 6-2, and perform the following steps.

a. With equipment as shown in connection "A" adjust the ac signal source for an output of 3.000 volts rms at 100 kHz as measured on the DVM.

b. In connection "B" with the DVM set to measure dc, observe a probe output of 3.15 to 2.85 volts.

c. Placing cables back in connection "A", decrease the ac signal source by 10db (0.95 volts).

d. Moving back to connection "B", observe a voltmeter indication of between 1.00 and 0.90 volts (10 db down from 3 volts).

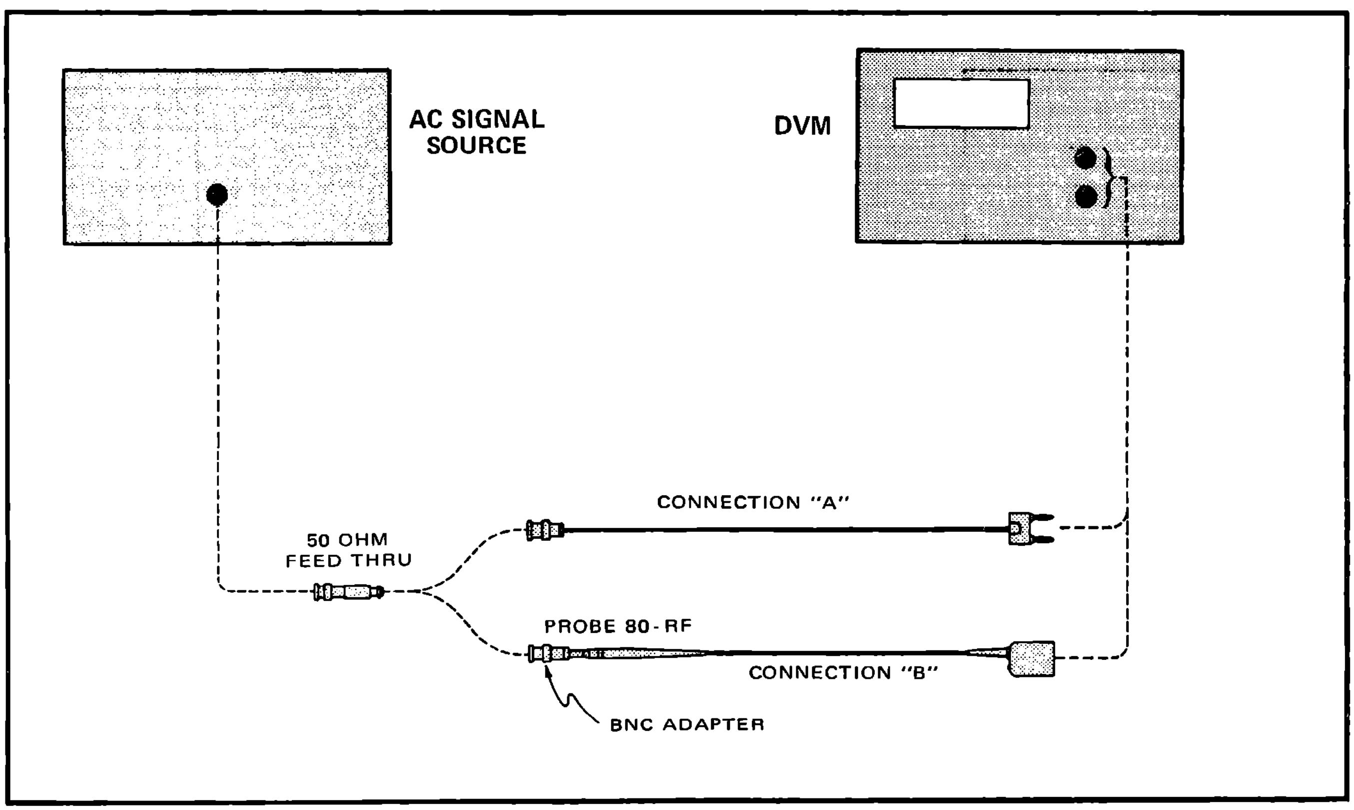


Figure 6-2. LOW FREQUENCY RESPONSE CHECK

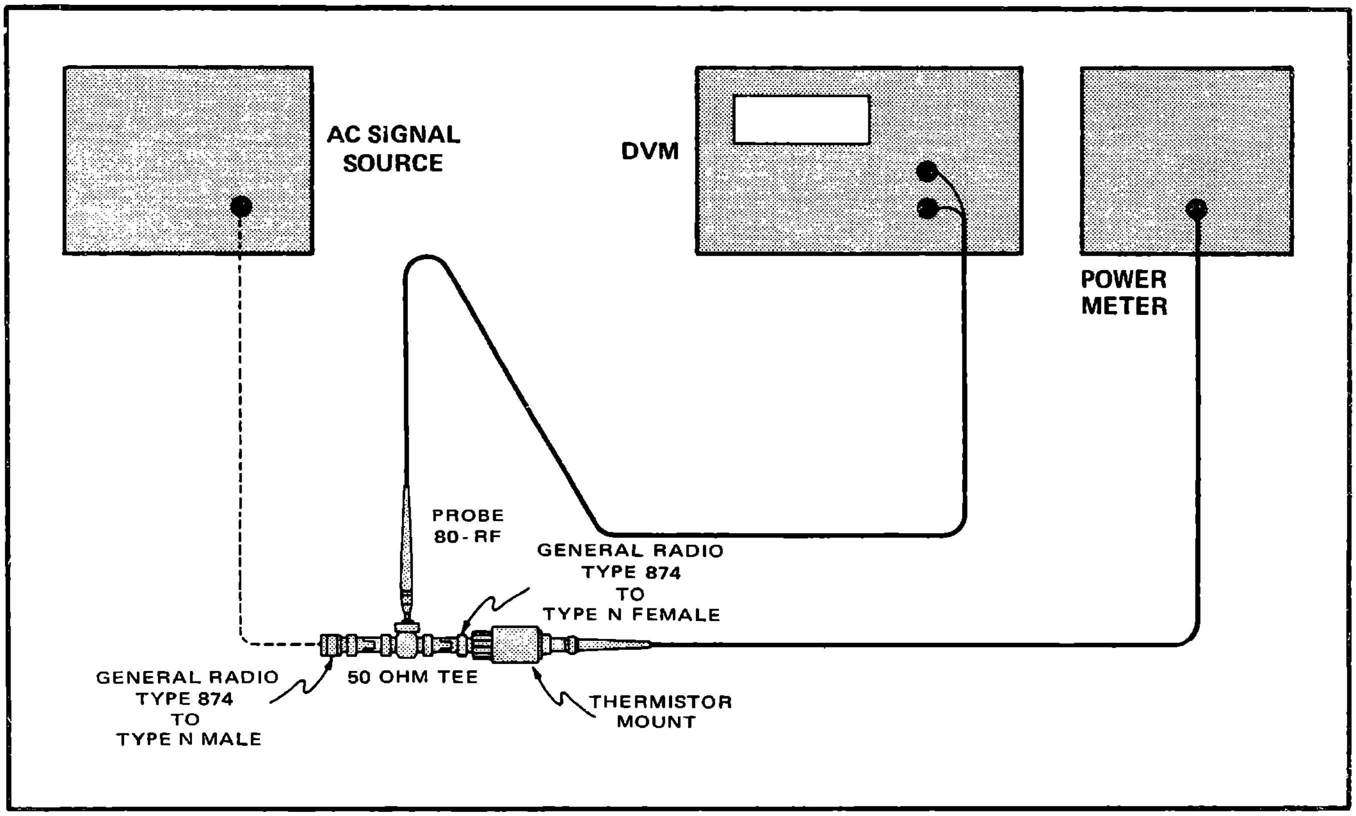


Figure 6-3. HIGH FREQUENCY RESPONSE CHECK

e. In connection "A", decrease the ac signal source an additional 10 db (to 0.3 volts) as indicated by the voltmeter in its ac function.

f. Back to "B", observe a voltmeter reading of .315 to .285 vdc.

g. Return the ac signal source back to 3.000 vrms.

h. Repeat steps a through g with frequencies of 500 kHz, 1 MHz, and 10 MHz.

6-17. HIGH FREQUENCY RESPONSE. Connect equipment to the 80-RF probe as shown in Figure 6-3, and perform the following steps:

a. Set the ac signal source ot 100 MHz with an output level of 10 milliwatts as indicated on the power meter. Ensure that the ac signal source has stabilized at 10 millivolts output.

b. Observe that the voltmeter indication is between 0.757 and 0.657 volts. (0.707 volts corresponds to 10 milliwatts in 50 ohms).

c. Repeat the above for frequencies of 200 MHz, 300 MHz, 400 MHz, and 480 MHz.

6-18. Calibration

6-19. Should the 80-RF require recalibration, perform the following steps:

a. Perform steps a and b in paragraph 6-16, with a frequency of 1 MHz.

b. Observe the dc voltmeter indication; a reading below 3 volts calls for a decrease in the value of R3, a reading above 3 volts calls for an increase in R3. Resistor R3 should be a 1/8 W metal film type. In a probe that is working properly, a 30 kΩ change in R3 will produce about a 1% reading deviation.

6-20. Cleaning

6-21. The Model 80-RF requires a minimum amount of cleaning. Accumulation of dust or dirt particles between the output terminals of the Model 80-RF can be removed using clean dry pressurized air. Stubborn particles can be removed following an application of isopropyl alcohol.

Appendix A

Federal Supply Code for Manufacturers

A-1. CODE TO NAME

A-2. The following five digit code numbers are listed in numerical sequence along with the manufacturer's name and address to which the code has been assigned. The Federal Supply Code has been taken from Cataloging Handbook H 4-2, Code to Name.

00213	Sage Electronics Corp. Rochester, New York
00327	Welwyn International, Inc. Westlake, Ohio
00656	Aerovox Corp. New Bedford, Massachusetts
00686	Film Capacitors Passaic, New Jersey
00779	AMP Inc. Harrisberg, Pennsylvania
01121	Allen-Bradley Co. Milwaukee, Wisconsin
01281	TRW Semiconductors Lawndale, California
01295	Texas Instruments, Inc. Semiconductor Components Div. Dallas, Texas
01686	RCL Electronics Inc. Manchester, New Hampshire
01730	Deleted
01884	Dearborn Electronics Inc. Orlando, Florida
02114	Ferroxcube Corp. Saugerties, New York
02606	Replaced by 15801
02660	Amphenol-Borg Elect. Corp. Broadview, Illinois
02799	Arco Capacitors, Inc. Torrence, California
03508	General Electric Co. Semiconductor Products Syracuse, New York
03614	Replaced by 71400
03651	Replaced by 44655
03797	Eldema Corp. Compton, California
03877	Transitron Electronic Corp. Wakefield, Massachusetts
03888	Pyrofilm Resistor Co., Inc. Cedar Knolls, New Jersey
03911	Clairex Corp. New York, New York
03980	Muirhead Instruments, Inc. Mountainside, New Jersey
04009	Arrow Hart and Hegemen Electronic Company Hartford, Connecticut
04062	Replaced by 72136
04202	Replaced by 81312
04217	Essex Wire Corp. Wire & Cable Div. Anaheim, California
04221	Aemco, Div. of Midtex Inc. Mankato, Minnesota
04222	Aerovox Corp. (H-Q) Myrtle Beach, South Carolina
04645	Replaced by 75376
04713	Motorola Semiconductor Products Inc. Phoenix, Arizona
05082	Replaced by 94154
05236	Jonathan Mfg. Co. Fullerton, California
05277	Westinghouse Electric Corp. Semiconductor Dept. Youngwood, Pennsylvania
05278	Replaced by 43543
05397	Union Carbide Corp. Electronics Div. Cleveland, Ohio
05279	Southwest Machine & Plastic Co. Los Angeles, California
05397	Union Carbide Corp. Electronics Div. New York, New York
05571	Sprague Electric Co. Pacific Div. Los Angeles, California
05574	Viking Industries Chatsworth, California
05704	Alac, Inc. Glendale, California
05820	Wakefield Engineering Ind. Wakefield, Massachusetts
06001	General Electric Company Capacitor Department Irmo, South Carolina
06136	Replaced by 63743
06473	Amphenol Space & Missile Sys. Chatsworth, California
06555	Beede Electrical Instrument Co. Penacook, New Hampshire
06739	Electron Corp. Littletown, Colorado
06743	Clevite Corp. Cleveland, Ohio
06751	Semcor Div., Components, Inc. Phoenix, Arizona
06860	Gould National Batteries Inc. City of Industry, California
06980	Varian-Eimac San Carlos, California
07115	Replaced by 14674
07138	Westinghouse Electric Corp., Electronic Tube Division Elmira, New York
07256	Silicon Transistor Corp. Garden City, New York
07263	Fairchild Semiconductor Div. of Fairchild Camera & Instrument Corp. Mountain View, California
07344	Bircher Co., Inc. Rochester, New York
07792	Lerma Engineering Corp. Northampton, Massachusetts
07910	Teledyne Corp. (Continental Device) Hawthorne, California
08225	Industro Transistor Corp. Long Island City, New York
08530	Reliance Mica Corp. Brooklyn, New York
08792	Discontinued
08806	General Electric Co. Miniature Lamp Dept. Cleveland, Ohio
08863	Nylomatic Corp. Norrisville, Pennsylvania
08988	Skottie Electronics Inc. Archbald, Pennsylvania
09353	C and K Components Watertown, Massachusetts
09423	Scientific Components, Inc. Santa Barbara, California
09922	Burndy Corp. Norwalk, Connecticut
11236	CTS of Berne Berne, Indiana
11237	Chicago Telephone of Calif., Inc. (CTC) Paso Robles, California
11358	Discontinued
11403	Best Products Co. Chicago, Illinois

11503 Keystone Mfg.
Div. of Avis Industrial Corp.
Warren, Michigan

11726 Qualidyne Corp.
Santa Clara, California

12014 Chicago Rivet & Machine Co.
Bellwood, Illinois

12040 National Semiconductor Corp.
Danburry, Connecticut

12060 Diodes, Inc.
Chatsworth, California

12136 Philadelphia Handle Co.
Camden, New Jersey

12323 Presin Co., Inc.
Shelton, Connecticut

12327 Freeway Washer & Stamping Co.
Cleveland, Ohio

12400 Replaced by 75042

12617 Hamlin Inc.
Lake Mills, Wisconsin

12697 Clarostat Mfg. Co.
Dover, New Hampshire

12749 James Electronics
Chicago, Illinois

12856 Micrometals
Sierra Madre, California

12954 Dickson Electronics Corp.
Scottsdale, Arizona

12969 Unitrode Corp.
Watertown, Massachusetts

13103 Thermalloy Co.
Dallas, Texas

13511 Amphenol Corp.
Los Gatos, California

13606 Sprague Electric Co.
Transistor Div.
Concord, New Hampshire

13839 Replaced by 23732

14099 Semtech Corp.
Newbury Park, California

14193 California Resistor Corp.
Santa Monica, California

14298 American Components, Inc.
Conshohocken, Pennsylvania

14655 Cornell-Dubilier Electronics
Newark, New Jersey

14674 Discontinued, see 16299

14752 Electro Cube Inc.
San Gabriel, California

14869 Replaced by 96853

15636 Elec-Trol Inc.
Northridge, California

15801 Fenwal Electronics Inc.
Framingham, Massachusetts

15818 Amelco Semiconductor
Div. of Teledyne Inc.
Mountain View, California

15849 USECO, Inc.
Mt. Vernon, New York

15898 International Business
Machines (IBM)
Essex Junction, Vermont

15909 Replaced by 17870

16299 Corning Glass
Raleigh, North Carolina

16332 Replaced by 28478

16473 Cambridge Scientific Ind. Inc.
Cambridge, Maryland

16742 Paramount Plastics
Downey, California

16758 Delco Radio
Div. of General Motors
Kokomo, Indiana

17001 ITT Cannon
Santa Ana, California

17069 Circuit Structures Lab.
Upland, California

17856 Siliconix, Inc.
Sunnyvale, California

17870 Daven-Div of Thomas A. Edison
Ind. – McGraw - Edison Co.
Manchester, New Hampshire

18083 Deleted

18178 Vactec Inc.
Maryland Heights, Missouri

18612 Vishay Intertechnology
Inc.
Malvern, Pennsylvania

18736 Voltronics Corp.
Hanover, New Jersey

19429 Discontinued, use 89536

19451 Perine Machinery & Supply Co.
Seattle, Washington

19701 Electra Mfg. Co.
Independence, Kansas

20584 Enochs Mfg. Co.
Indianapolis, Indiana

20891 Self-Organizing Systems,
Inc.
Dallas, Texas

22767 ITT Semiconductors
Div. of ITT
Palo Alto, California

23050 Product Comp. Corp.
Mount Vernon, New York

23732 Tracor
Rockville, Maryland

23880 Stanford Applied Engrng.
Santa Clara, California

23936 Pamotor Div., Wm. J. Purdy Co.
Burlingame, California

24248 Southco
Div. of South Chester Corp.
Lester, Pennsylvania

24655 General Radio Co.
West Concord, Massachusetts

24759 Lenox-Fugle Electronics
Plainfield, New Jersey

25403 Amperex Electronic Corp.
Semiconductor & Receiving
Tube Division
Slatersville, Rhode Island

27014 National
Semiconductor
Corp.
Santa Clara, California

27264 Molex Products
Downers Grove, Illinois

28425 Bohannon Industries
Fort Worth, Texas

28478 Deltrol Controls,
Corp.
Milwaukee, Wisconsin

28480 Hewlett Packard
Co.
Palo Alto, California

28520 Heyman Mfg. Co.
Kenilworth, New Jersey

29083 Monsanto, Co., Inc.
Santa Clara, California

30323 Illinois Tool
Works, Inc.
Chicago, Illinois

32539 Mura Corp.
Great Neck, New York

32767 Griffith Plastic
Products Co.
Burlingame, California

32879 Advanced Mechanical
Components
Northridge, California

32897 Eric Technological
Products, Incorporated
Frequency Control Div.
Carlisle, Pennsylvania

33173 General Electric
Co., Tube Dept.
Owensboro, Kentucky

34333 Silicon General
Westminister, California

34335 Advanced Micro
Devices,
Sunnyvale, California

37942 Mallory, P. R. & Co., Inc.
Indianapolis, Indiana

42498 National Company
Melrose, Massachusetts

43543 Nytronics Inc.
Transformer Co. Div.
Alpha, New Jersey

44655 Ohmite Mfg. Co.
Skokie, Illinois

49671 Radio Corp. of America
New York, New York

49956 Raytheon Company
Lexington, Maine

53021 Sanamo Electric Co.
Springfield, Illinois

55026 Simpson Electric Company
Chicago, Illinois

56289 Sprague Electric Co.
North Adams, Massachusetts

58474 Superior Electric Co.
Bristol, Connecticut

60399 Torrington Mfg. Co.
Torrington, Connecticut

62460 Deleted

63743 Ward Leonard Electric Co.
Mount Vernon, New York

64834 West Mfg. Co.
San Francisco, California

65092 Weston Instruments Inc.
Newark, New Jersey

66150 Winslow Tele-Tronics Inc.
Asbury Park, New Jersey

70563 Amperite Company
Union City, New Jersey

70903 Belden Mfg. Co.
Chicago, Illinois

71002 Birnbach Radio Co., Inc.
New York, New York

71236 "ELMENCO"
Willimantic, Connecticut

71400 Bussmann Mfg.
Div. of McGraw - Edison Co.
Saint Louis, Missouri

71450 CTS Corp.
Elkhart, Indiana

71468 ITT Cannon Electric Inc.
Los Angeles, California

71482 Clare, C. P. & Co.
Chicago, Illinois

71590 Centralab
Div. of Globe Union Inc.
Milwaukee, Wisconsin

71707 Coto Coil Co., Inc.
Providence, Rhode Island

71744 Chicago Miniature Lamp Works
Chicago, Illinois

71785 Cinch Mfg. Co. & Howard
B. Jones Div.
Chicago, Illinois

72005 Driver, Wilber B., Co.
Newark, New Jersey

72092 Replaced by 06980

72136 Electro Motive Mfg. Co.
Willimantic, Connecticut

72259 Nytronics Inc.
Berkeley Heights, New Jersey

72354 Deleted

72619 Dialight Corp.
Brooklyn, New York

72653 G. C. Electronics
Rockford, Illinois

72665 Replaced by 90303

72794 Dzus Fastener Co., Inc.
West Islip, New York

72928 Gudeman Co. (Gulton
Industries)
Chicago, Illinois

72982 Erie Tech. Products Inc.
Erie, Pennsylvania

73138 Beckman Instruments Inc.
Helipot Division
Fullerton, California

73293 Hughes Aircraft Co.
Electron Dynamics Div.
Torrence, California

73445 Amperex Electronic Corp.
Hicksville, New York

73559 Carling Electric Inc.
Hartford, Connecticut

73586 Circle F Industries
Trenton, New Jersey

73734 Federal Screw Products, Inc.
Chicago, Illinois

73743 Fischer Special Mfg. Co.
Cincinnati, Ohio

73899 JFD Electronics Co.
Brooklyn, New York

73949 Guardian Electric Mfg. Co
Chicago, Illinois

74199 Quam Nichols Co.
Chicago, Illinois

74217 Radio Switch Corp.
Marlboro, New Jersey

74276 Signalite Inc.
Neptune, New Jersey

74306 Piezo Crystal Co.
Carlisle, Pennsylvania

74542 Hoyt Elect. Instr. Works
Penacook, New Hampshire

74970 Johnson, E. F., Co.
Waseca, Minnesota

75042 IRC Inc. (Div. of TRW)
Philadelphia, Pennsylvania

75376 Kurz-Kasch, Inc.
Dayton, Ohio

75382 Kulka Electric Corp.
Mount Vernon, New York

75915 Littlefuse Inc.
Des Plaines, Illinois

76854 Oak Mfg. Co.
Crystal Lake, Illinois

77342 Potter & Brumfield
Div. of Amer. Machine & Foundry
Princeton, Indiana

77969 Rubbercraft Corp. of Calif. LTD.
Torrance, California

78189 Shakeproof
Div. of Illinois Tool Works
Elgin, Illinois

78277 Sigma Instruments, Inc.
South Braintree, Massachusetts

78488 Stackpole Carbon Co.
Saint Marys, Pennsylvania

78553 Tinnerman Products
Cleveland, Ohio

79136 Waldes Kohinoor Inc.
Long Island City, New York

79497 Western Rubber Company
Goshen, Indiana

79963 Zierick Mfg. Corp.
New Rochelle, New York

80031 Mepco
Div. of Sessions Clock Co.
Morristown, New Jersey

80145 API Instruments Co.
Chesterland, Ohio

80183 Sprague Products
North Adams, Massachusetts

80294 Bourns Inc.
Riverside, California

80583 Hammarlund Co., Inc.
Mars Hill, North Carolina

80640 Stevens, Arnold Inc.
Boston, Massachusetts

81073 Grayhill Inc.
La Grange, Illinois

81590 Korry Mfg. Co.
Seattle, Washington

81312 Winchester Electronics
Div. of Litton Industries
Oakville, Connecticut

81439 Therm-O-Disc Inc.
Mansfield, Ohio

81483 International Rectifier Corp.
Los Angeles, California

81741 Chicago Lock Corp.
Chicago, Illinois

82305 Palmer Electronics
South Gate, California 90280

82389 Switchcraft Inc.
Chicago, Illinois

82415 Price Electric Corp.
Frederick, Maryland

82872 Roanwell Corp.
New York, New York

82877 Rotron Mfg. Co., Inc.
Woodstock, New York

82879 ITT Wire & Cable Div.
Pawtucket, Rhode Island

83003 Varo Inc.
Garland, Texas

83298 Bendix Corp.
Electric Power Division
Eatontown, New Jersey

83330 Smith, Herman H., Inc.
Brooklyn, New York

83478 Rubbercraft Corp. of America
New Haven, Connecticut

83594 Burroughs Corp.
Electronic Components Div.
Plainfield, New Jersey

83740 Union Carbide Corp.
Consumer Products Div.
New York, New York

84171 Arco Electronics, Inc.
Great Neck, New York

84411 TRW
Ogallala, Nebraska

86577 Precision Metal Products
Stoneham, Massachusetts

86684 Radio Corp. of America
Electronic Components & Devices
Harrison, New Jersey

86689 Deleted

87034 Marco-Oak Inc.
Anaheim, California

88245 Litton Products Inc.
Van Nuys, California

88419 Use 14655

88690 Replaced by 04217

89536 Fluke, John Mfg. Co., Inc.
Seattle, Washington

89730 Replaced by 08806

90201 Mallory Capacitor Co.
Indianapolis, Indiana

90215 Best Stamp & Mfg. Co
Kansas City, Missouri

90211 Square D Co.
Chicago, Illinois

90303 Mallory Battery Co.
Tarrytown, New York

91293 Johanson Mfg. Co.
Boonton, New Jersey

91407 Replaced by 58474

91502 Associated Machine
Santa Clara, California

91506 Augat
Attleboro, Mass.

91637 Dale Electronics Inc.
Columbus, Nebraska

91662 Elco Corp.
Willow Grove, Pennsylvania

91737 Gremar Mfg Co., Inc. (ITT)
Woburn, Massachusetts

91802 Industrial Devices, Inc.
Edgewater, New Jersey

91836 King's Electronics
Tuckahoe, New York

91929 Honeywell Inc.
Micro Switch Div.
Freeport, Illinois

91934 Miller Electric Co., Inc.
Pawtucket, Rhode Island

93332 Sylvania Electric Products
Semiconductor Products Div
Woburn, Massachusetts

94145 Replaced by 49956

94154 Tung-Sol
Div. of Wagner Electric Corp.
Newark, New Jersey

95146 Alco Electronics Products Inc.
Lawrence, Massachusetts

95263 Leecraft Mfg. Co.
Long Island City, New York

95264 Replaced by 98278

95275 Vitramon Inc.
Bridgeport, Connecticut

95303 Radio Corp. of America
Solid State & Receiving Tube Div.
Cincinnati, Ohio

95354 Methode Mfg. Corp.
Rolling Meadows, Illinois

95712 Dage Electric Co., Inc.
Franklin, Indiana

95987 Weckesser Co., Inc.
Chicago, Illinois

96733 San Fernando Electric Mfg. Co.
San Fernando, California

96853 Rustrak Instrument Co.
Manchester, New Hampshire

96881 Thomson Industries, Inc.
Manhasset, New York

97540 Master Mobile Mounts
Div. of Whitehall Electronics Corp.
Los Angeles, California

97913 Industrial Electronic Hdware Corp.
New York, New York

97945 White, S. S. Co.
Plastics Div.
New York, New York

97966 Replaced by 11358

98094 Replaced by 49956

98159 Rubber-Teck, Inc.
Gardena, California

98278 Microdot Inc.
Pasadena, California

98291 Sealectro Corp.
Conhex Div.
Mamaroneck, New York

98388 Accurate Rubber & Plastics
Culver City, California

98743 Replaced by 12749

98925 Deleted

99120 Plastic Capacitors, Inc.
Chicago, Illinois

99217 Southern Electronics Corp.
Burbank, California

99392 STM
Oakland, California

99515 Marshall Industries
Capacitor Div.
Monrovia, California

99779 Barnes Corp.
Lansdowne, Pennsylvania

Toyo Electronics
(R-Ohm Corp.)
Irvine, California 92664

National Connector
Minneapolis, Minn. 55436

List of Abbreviations

alternating current	ac	megahertz	MHz
ampere	A	megohm	MΩ
assembly	assy	meter	m
binary coded decimal	bcd	micro (10^{-6})	μ
bel	B	microsecond	μs
capacitor	cap	milli (10^{-3})	m
centimeter	cm	milliamperes	mA
ceramic	cer	millimeter	mm
clockwise	cw	millisecond	ms
common-mode rejection ratio	cmrr	millivolt	mV
composition	comp	minimum	min
counterclockwise	ccw	nano (10^{-9})	n
decibel	dB	nanosecond	ns
degree Celsius	°C	negative	neg
degree Fahrenheit	°F	ohm	Ω
digital voltmeter	dvm	oscilloscope	scope
direct current	dc	parts per million	ppm
electrolytic	elect	peak-to-peak	p-p
external	ext	pico (10^{-12})	p
farad	F	picofarad	pF
field effect transistor	FET	plus or minus	±
germanium	Ge	positive	pos
giga (10^{9})	G	plastic	plstc
gigahertz	GHz	printed circuit board	pcb
ground	gnd	radio frequency	rf
guard	gd	root mean square	rms
henry	H	second (time)	s
hertz	Hz	serial number	SN
high frequency	hg	silicon	Si
hour	h	tantalum	Ta
inch	in	temperature coefficient	TC
integrated circuit	IC	tera (10^{12})	T
intermediate frequency	if	transformer	xfmr
internal	intl	transistor	xstr
kilo (10^{3})	k	ultra high frequency	uhf
kilohertz	kHz	variable	var
kilohm	kΩ	very high frequency	vhf
kilovolt	kV	very low frequency	vlf
low frequency	lf	volt	V
maximum	max	voltage controlled oscillator	vco
mega (10^{6})	M	watt	W
		wirewound	ww

Appendix C

Sales Representatives

ALABAMA
HUNTSVILLE
BCS Associates, Inc.
3322 S. Memorial Parkway
P.O. Box 1273
Tel. (205) 881-6220
Zip 35801

ALASKA
SEATTLE
Showalter-Judd, Inc.
5616 4th Ave. South
Tel. (206) 762-2310
Zip 98108

ARIZONA
PHOENIX
Barnhill Associates
7329 E. Stetson Dr.
Tel. (602) 947-7841
Scottsdale, AZ 85251

CALIFORNIA
LOS ANGELES
Instrument Specialists, Inc.
1109 S. Central Ave.
Glendale, California 91204
Tel. (213) 245-9404

SANTA CLARA
Instrument Specialists, Inc.
2359 De La Cruz Blvd.
Tel. (408) 244-1505
Zip 95050

SAN DIEGO
Instrument Specialists, Inc.
4805 Mercury St., Ste. 1
Tel. (714) 565-2555
Zip 92111

COLORADO
DENVER
Barnhill Associates
1170 S. Sheridan Blvd.
Tel. (303) 934-5505
Zip 80226

CONNECTICUT
HARTFORD
Instrument Representatives, Inc.
P.O. Box 165
Glastonbury, Connecticut 06033
Tel. (203) 633-0777

FLORIDA
ORLANDO
BCS Associates, Inc.
940 N. Fern Creek Ave.
Tel. (305) 896-4881
Zip 32803

HAWAII
HONOLULU
Industrial Electronics, Inc.
646 Queen Street
P.O. Box 135
Tel. (808) 533-6095
Zip 96817

ILLINOIS
CHICAGO
Cozzens & Cudahy, Inc.
1301 N. Rand Rd.
Des Plaines, IL 60016
Tel. (312) 298-3600

INDIANA
INDIANAPOLIS
Cozzens & Cudahy, Inc.
Port O'Call Executive Ctr.
21 Beachway Drive
Tel. (317) 244-2456
Zip 46224

MARYLAND
BALTIMORE
Electronic Marketing Assoc. Inc.
11501 Huff Court
Kensington, Maryland 20795
Tel. (301) 881-5300, 744-7700

MASSACHUSETTS
BOSTON
Instrument Representatives, Inc.
109 Massachusetts Ave.
Lexington, MA 02173
Tel. (617) 861-8620

MICHIGAN
DETROIT
WKM Associates, Inc.
1474 East Outer Dr.
Tel. (313) 892-2500
Zip 48234

MINNESOTA
MINNEAPOLIS
Cozzens & Cudahy, Inc.
10800 Lyndale Ave. S.
Tel. (612) 884-4336
Zip 55420

MISSOURI
ST. LOUIS
Cozzens & Cudahy, Inc.
P.O. Box 10013
Lambert Field - Zip 63145
Tel. (314) 423-1234

NEW JERSEY
NEWARK
SBM Representatives
1519 Stuyvesant Avenue
Union, New Jersey 07083
Tel. (201) 687-8737

NEW MEXICO
ALBUQUERQUE
Barnhill Associates
1410 — D Wyoming N.E.
Tel. (505) 299-7658
Zip 87112

NEW YORK
NEW YORK
SBM Representatives
28 Hobby Street
Pleasantville, N.Y. 10570
Tel. (914) 769-1811

ROCHESTER
SBM Representatives
4515 Culver Rd.
Tel. (716) 226-1400
Zip 14622

NORTH CAROLINA
GREENSBORO
P.O. Box 9619
1310 Beahan Pl.
Tel. (919) 273-1918
Zip 27408

OHIO
CLEVELAND
WKM Associates, Inc.
16141 Puritas Ave.
Tel. (216) 267-0445
Zip 44135

DAYTON
WKM Associates, Inc.
6073 Far Hills Ave.
Tel. (513) 434-7500
Zip 45459

PENNSYLVANIA
PHILADELPHIA
Electronic Marketing Assoc.
210 Goddard Blvd., Ste. 100
King of Prussia, Pennsylvania
Tel. (215) 248-5050
Zip 19406

PITTSBURGH
WKM Associates, Inc.
90 Clairton Blvd.
Tel. (412) 892-2953
Zip 15236

TEXAS
DALLAS
Barnhill Associates
Suite 220
312 N. Central Express Wy.
Richardson, Texas 75080
Tel. (214) 231-2573

HOUSTON
Barnhill Associates
Suite 332
3810 Westheimer
Tel. (713) 621-0040
Zip 77027

WASHINGTON
SEATTLE
Showalter-Judd, Inc.
5616 4th Ave. South
Tel. (206) 762-2310
Zip 98108

CANADA

BRITISH COLUMBIA
VANCOUVER
Allan Crawford Associates, Ltd.
1820 Pandora St.
Tel. (604) 253-7136

ALBERTA
CALGARY
Allan Crawford Associates, Ltd.
640 - 11th Ave. S.W.
Tel. (403) 261-0780

ONTARIO
MALTON
Allan Crawford Associates, Ltd.
6427 Northam Drive
Tel. (416) 678-1500

OTTAWA, 3
Allan Crawford Associates, Ltd.
376 Churchill Ave., Suite 106
Tel. (613) 829-9651

QUEBEC
LONGUEUIL
Allan Crawford Associates, Ltd.
157 (rue) St. Charles Street W.
Tel. (514) 670-1212

INTERNATIONAL REPRESENTATIVES

ARGENTINA
Coasin S.A.
Virrey del Pino 4071
Buenos Aires, Argentina

AUSTRALIA
Elmeasco Instruments
P.O. Box 334
Brookvale, N.S.W. Australia 2100

AUSTRIA
Kontron GMBH & Co., Kg.
Lederergasse 16
1080 Vienna, Austria

BELGIUM
C.N. Rood S.A.
37 Place de Jamblinne de Meux
1040 Brussels, Belgium

BRAZIL
Ambriex S.A.
Rue Ceara, 104 - 2.º e 3.º Andares
ZC - 29
Rio de Janeiro GB, Brazil

Ambriex S.A.
Rua Tupi, 535
01233 Sao Paulo SP, Brazil

CARIBBEAN
West Indies Sales Co.
606 Calle Aboy
San Juan, Puerto Rico 00907

CHILE
Coasin Chile Ltd.
Casilla 14588 - Correo 15
Santiago, Chile

CHINA, Peoples Republic Of
May Lee Industries, Inc.
475 Park Avenue South
New York, N.Y. 10016

COLOMBIA
Marones Ltda.
Apartado Aereo 90687
Bogota 8, Colombia

DENMARK
Tage Olsen A/S
1, Rønnegade
Copenhagen Ø, Denmark

ECUADOR
Proteco Coasin Cia., Ltda.
Apartado 228A
Quito, Ecuador

FINLAND
Oy Findip AB
P.O. Box 25
00521 Helsinki 52, Finland

FRANCE
M.B. Electroniques S.A.
29, Rue Emile Duclaux
92, Suresnes
France

GERMANY
Fey Elektronische Messgerate
8 Muenchen 19
Horemansstrasse 28
West Germany

GREECE
Marios Dalleggio Representations
2 Alopekis Street
Athens 19 Greece

HONG KONG & MACAU
Gilman & Co., Ltd.
P.O. Box 56
Hong Kong

INDIA
Hinditron Services Pvt. Ltd.
69/A Nepean Sea Road
Bombay-6 India

IRAN
Berkeh Company Ltd.
20 Salm Road, Roosevelt Ave.
Tehran, Iran

ISRAEL
R.D.T. Electronics Engineering Ltd.
19 Prof. Shor Street
Tel-Aviv, Israel

ITALY
Sistrel S.P.A.
Via Giorgio da Sebenico 11-13
Rome, Italy

JAPAN
Toyo Trading Co. Ltd.
P.O. Box 5014
Tokyo International
Tokyo 100-31, Japan

Suzuki Bldg.
2-38 Junkeicho-dori
Minami-ku, Osaka

KOREA
Asia Science & Co.
Internaltion P.O. Box 1250
Seoul, Korea

MALAYSIA
O'Connor's (Pte) Ltd.
P.O. Box 1197
Kota Kinabalu
East Malaysia

P.O. Box 91
Petaling Jaya, Selangor
West Malaysia

MEXICO
Mexitek, S.A.
Eugenia 408
Departments 1 y 5
Mexico 12, D.F.
Mexico

THE NETHERLANDS
C.N. Rood B.V.
13 - Cort van der Lindenstraat
Rijswijk (Z.H.) 2100
Netherlands

Fluke (Nederland) B.V.
Ledeboerstraat 27
Industrieterrein Noord
Tilburg, Netherlands

NEW ZEALAND
David J. Reid (N.Z.) Ltd.
C.P.O Box 2630
Auckland 1, New Zealand

NIGERIA
Deemtee Electrotechnics Ltd.
P.O. Box 3073
Lagos, Nigeria

NORWAY
Morgenstierne & Co. A/S
P.O. Box 6688 Rodeløkka
Oslo 5, Norway

PAKISTAN
Pak International Operations
505 Muhammadi House-McLeod Rd.
P.O. Box 5323
Karachi, Pakistan

PERU
Importaciones y Representaciones
Electronicas S.A.
Avda. Franklin D. Roosevelt 105
Lima 1, Peru

PORTUGAL
Equipamentos De Laboratorio, Lda.
P.O. Box 1100
Lisbon, Portugal

SINGAPORE
O'Connor's (Pte) Ltd.
98 Pasir Panjang Road
Singapore 5, Singapore

SOUTH AFRICA
K. Baker Associates (Pty) Ltd.
P.O. Box 1257
Johannesburg
Republic of South Africa

P.O. Box 3641
Cape Town

SPAIN
Ataio Ingenieros S.A.
Enrique-Larretta 12
Madrid 16, Spain

SWEDEN
Teleinstrument AB
P.O. Box 490
S-16204 Vallingby
Sweden

SWITZERLAND
Kontron Electronic A.G.
Bernerstrasse Sud 169
8048 Zurich
Switzerland

TAIWAN-REPUBLIC OF CHINA
Heighten Trading Company, Ltd.
P.O. Box 1408
Taipei, Taiwan 104

THAILAND
G. Simon Radio Ltd.
30 Patpong Avenue
Suriwong
Bangkok, Thailand

THE UNITED KINGDOM
Fluke International Corp.
Garnett Close
Watford, WD2 4TT
England

URUGUAY
Coasin Uruguay S.A.
Cerrito 617 - 4º Pisco
Montevideo, Uruguay

U.S.S.R.
Codevintec Pacific Inc.
6263 Variel
Woodland Hills, Calif. 91364

VENEZUELA
Coasin C.A.
Apdo. Postal 50939
Sabana Grande No.1
Caracas 105
Venezuela

In Europe, contact FLUKE NEDERLAND, B. V., POST OFFICE BOX 5053, INDUSTRIETERREIN NOORD, TILBURG, THE NETHERLANDS

FLUKE REGIONAL SERVICE CENTER; THE NETHERLANDS

FLUKE (NEDERLAND) B.V.
P.O. BOX 5053
TILBURG, THE NETHERLANDS

FLUKE REGIONAL SERVICE CENTER, UNITED KINGDOM

FLUKE INTERNATIONAL CORP.
GARNETT CLOSE
WATFORD, WD24TT
ENGLAND

AUTHORIZED SERVICE LABORATORIES INTERNATIONAL

EACH INTERNATIONAL REPRESENTATIVE IS EQUIPPED WITH AN AUTHORIZED SERVICE LABORATORY. PLEASE REFER TO THE INTERNATIONAL REPRESENTATIVE LISTING FOR YOUR SERVICE NEEDS.

CHANGES:

① CHANGED VALUE OF R171 FROM 22M AND C53 FROM 8PF ON SER. NO. 201 AND ON.

② ADDED C70 ON SER. NO. 323 AND ON.

③ R27 ADDED AT S/N 372 AND ON

NOTES;

1. ALL RESISTANCES IN OHMS AND ALL CAPACITANCES IN MICROFARADS UNLESS OTHERWISE SPECIFIED.
2. ALL SWITCHES SHOWN IN OFF POSITION.
3. ⊘ DENOTES INTERNAL SCREWDRIVER ADJUSTMENT.
4. ▭ DENOTES FRONT PANEL LOCATION.

MODEL 8120A
DRAWING NO. 8120A-1001 (SHT 1)
REV. b

NOTES

1. ALL RESISTANCES IN OHMS AND ALL CAPACITANCES IN MICROFARADS UNLESS OTHERWISE SPECIFIED.
2. ALL SWITCHES SHOWN IN OFF POSITION.
3. ⊘ DENOTES INTERNAL SCREWDRIVER ADJUSTMENT
4. ▭ DENOTES FRONT PANEL LOCATION.
5. ▷1 R186 SELECTED IN FINAL CALIBRATION
6. ▷2 MATCHED FET PAIR
7. * "PLUS GATE" ON WITH POSITIVE INPUT "MINUS GATE" ON WITH NEGATIVE INPUT
8. ← CONNECTIONS TO 02 OPTION

CHANGES:

① R42 WAS 422K ON S/N 123 THRU 424

MODEL 8120A
DRAWING NO. 8120A-1001 (SHT. 2)
REV. b

CHANGES:

① CHANGED VALUE OF C71 FROM .025 ON SER. NO. 200 AND ON.

NOTES:

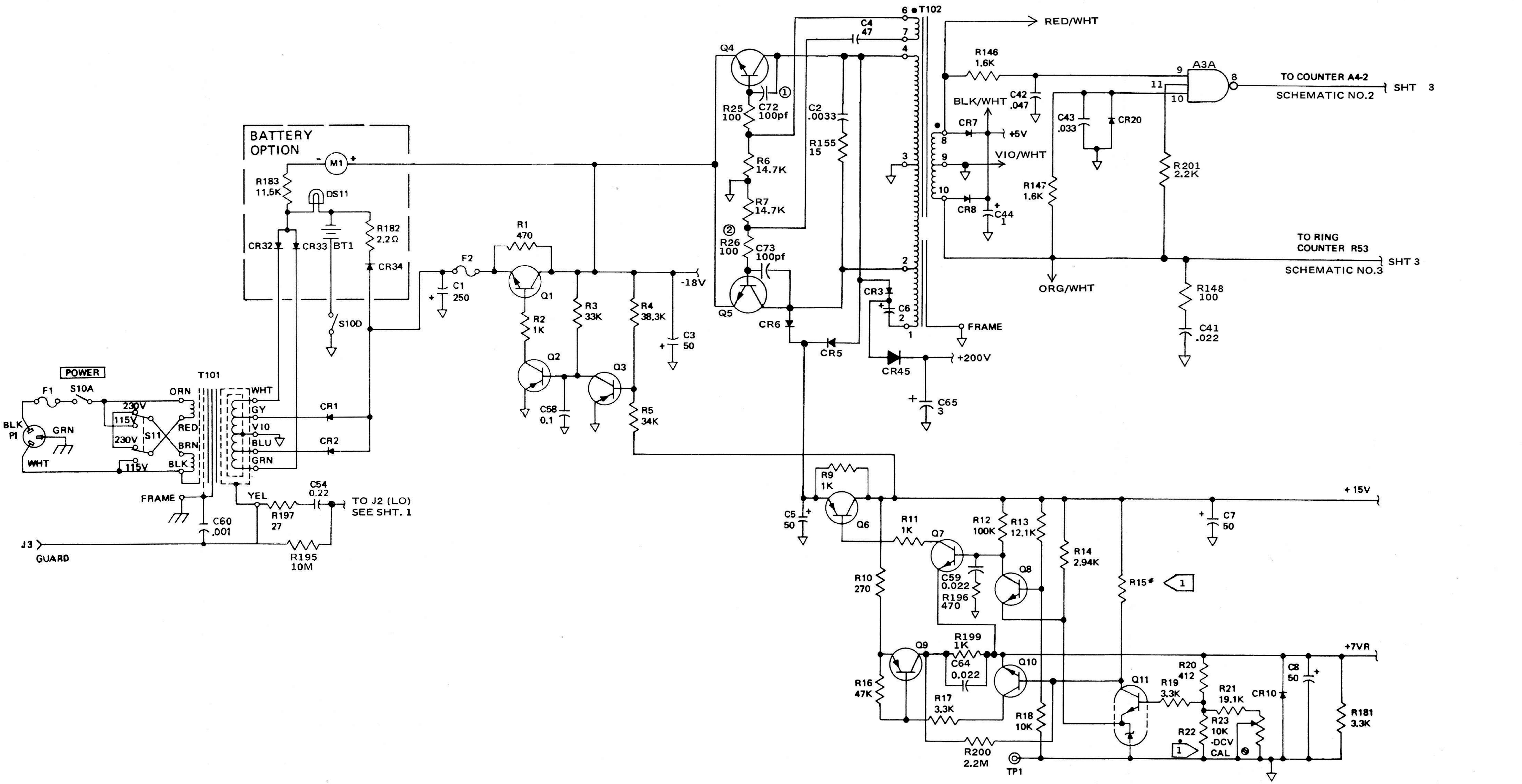
1. ALL RESISTANCES IN OHMS AND ALL CAPACITANCES IN MICROFARADS UNLESS OTHERWISE SPECIFIED.
2. ALL SWITCHES SHOWN IN OFF POSITION.
3. ⊘ DENOTES INTERNAL SCREWDRIVER ADJUSTMENT.
4. ▭ DENOTES FRONT PANEL LOCATION.
5. ▷ R186 SELECTED IN FINAL CALIBRATION.
6. READOUT TUBE PIN LAYOUT

1	0
2	9
3	A
4	8
5	7
6	A

BOTTOM VIEW

7. TLK TEST LINK.
8. ← CONNECTIONS TO −02 OPTION.

MODEL 8120A
DRAWING NO. 8120A-1001 (SHT 3)
REV. b



CHANGES:

① C72 AND C73 ADDED ON SER. NO. 123 AND ON.

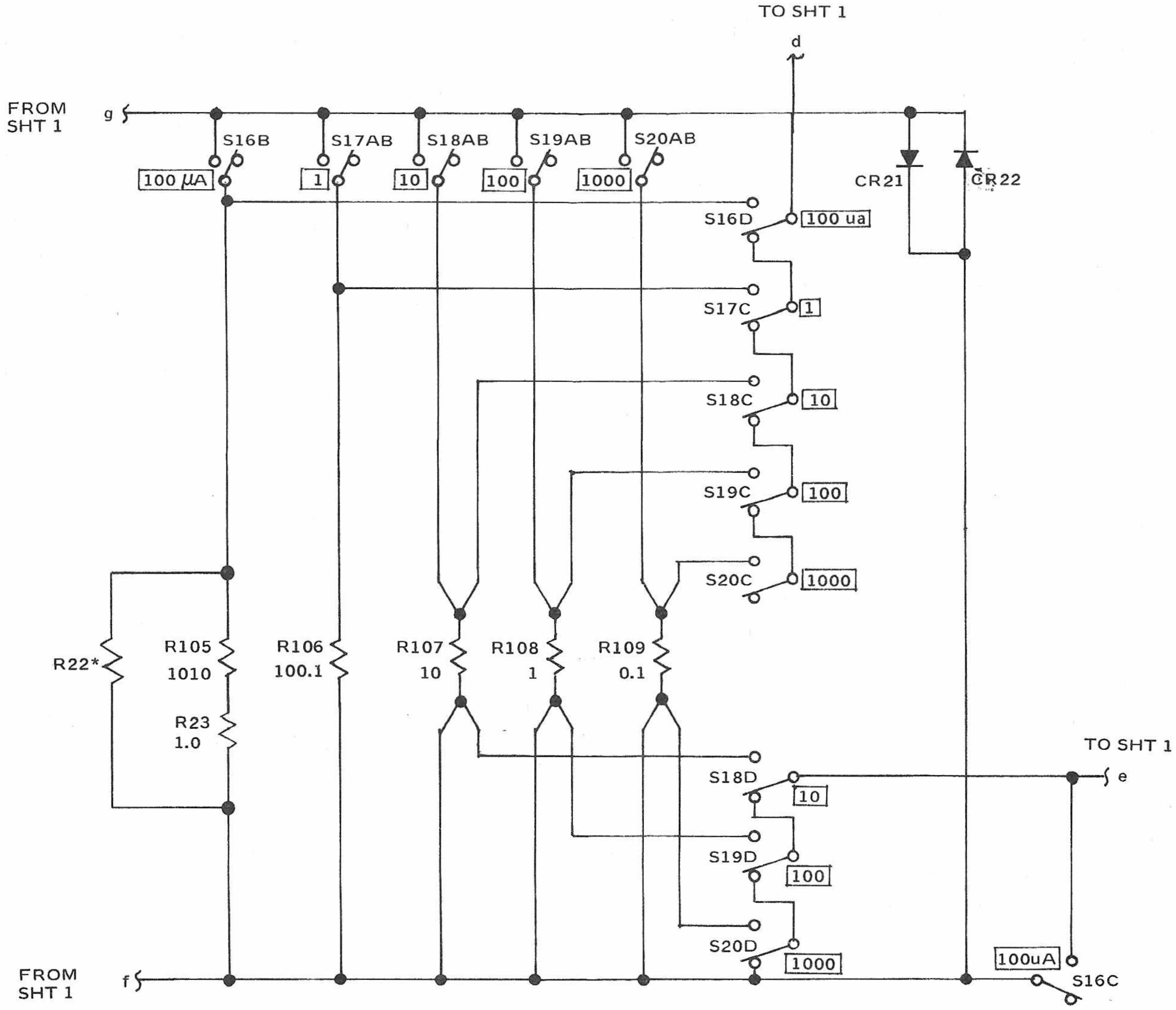
② R25 AND R26 ADDED ON SER. NO. 300 AND ON.

NOTES:

1 VALUE SELECTED AT TEST OF Q11

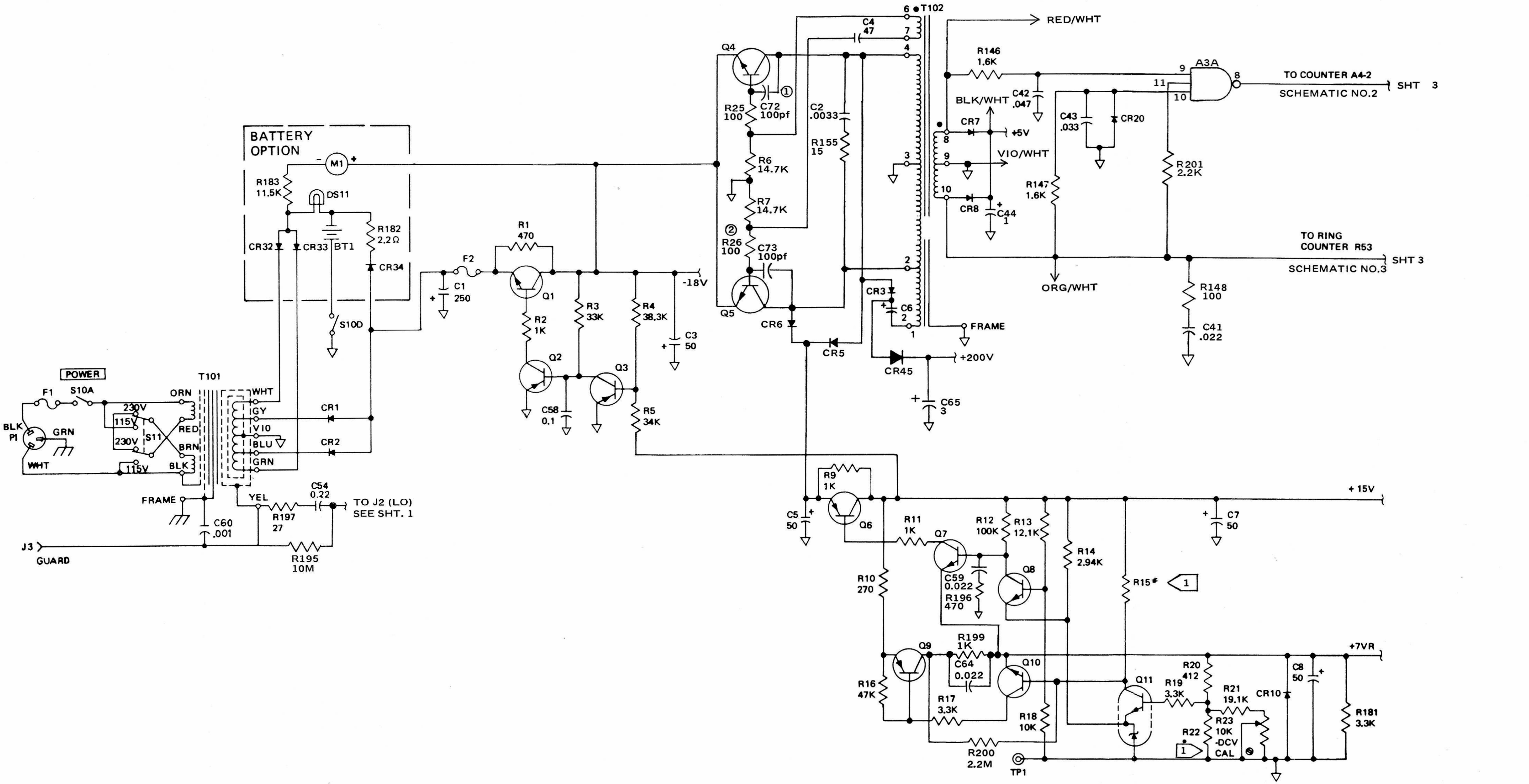
1. ALL RESISTANCE IN OHMS UNLESS OTHERWISE SPECIFIED.

MODEL 8120A
DRAWING NO. 8120A-1001 (SHT 4)
REV. b



NOTES:
* FACTORY SELECTED—DEPENDS ON SHUNT GROUP.

MODEL 8120A
DRAWING NO. 8120A-1001 (SHT 5)
REV. a



CHANGES:

① C72 AND C73 ADDED ON SER. NO. 123 AND ON.

② R25 AND R26 ADDED ON SER. NO. 300 AND ON.

NOTES:

<1] VALUE SELECTED AT TEST OF Q11

1. ALL RESISTANCE IN OHMS UNLESS OTHERWISE SPECIFIED.

MODEL 8120A
DRAWING NO. 8120A-1001 (SHT 4)
REV. b