

8860A

Digital Multimeter

Calibration Manual

P/N 541276
April 1980

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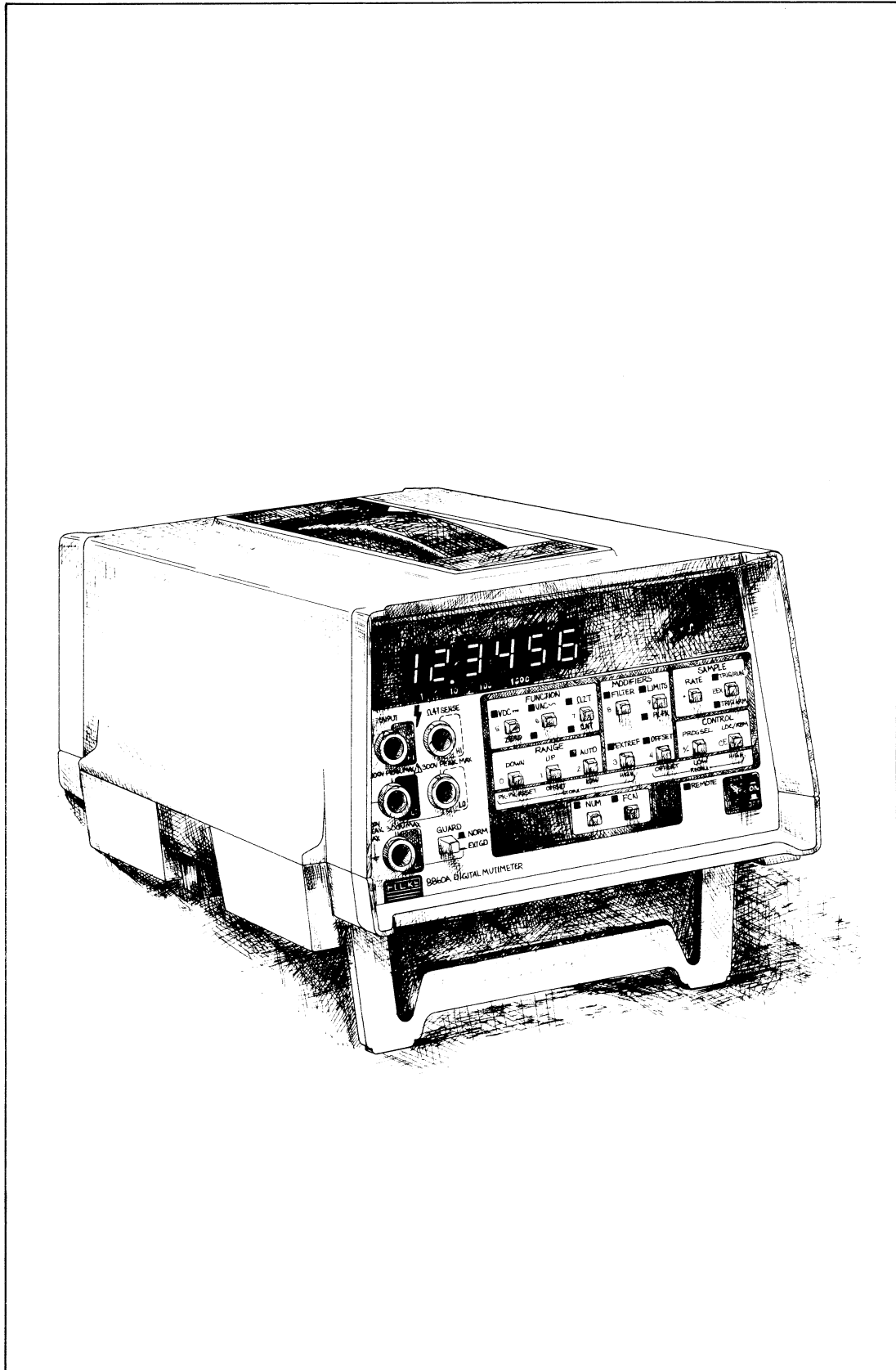
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8860A Digital Multimeter

Section 1

Introduction and Specifications

1-1. THE 8860A INSTRUCTION MANUAL SET

1-2. The John Fluke Model 8860A Digital Multimeter is documented by a set of five manuals: Operator, Calibration, Calculating Controller User Handbook, Service, and a Reference Guide. The Operator Manual includes a description of the unit, installation information, operating instructions, and routine operator maintenance. The Calibration Manual is designed for use by the Calibration Technician. It contains specifications, general maintenance information, access procedures, performance tests, and calibration adjustment procedures. The User Handbook contains the operating instructions for the Calculating Controller Option (-004). The Service Manual contains the theory of operation, troubleshooting information, a list of replaceable parts, and schematics. Condensed operating information for both the 8860A and the Calculating Controller are included in the Reference Guide. The five manuals can be separated for use in different areas or joined together in a single three-ring binder.

1-3. The Calibration Manual is divided into the following sections:

- | | |
|---------------------------------------|--|
| 1 INTRODUCTION AND SPECIFICATIONS | Introduces the 8860A Instruction Manual Set, lists the recommended test equipment required to complete the performance tests and the calibration adjustments, and lists the instrument specifications. |
| 2 SHIPPING AND SERVICE INFORMATION | Provides unpacking and shipping information. Instructions for contacting your local Fluke Service Center and the John Fluke Mfg. Co. Inc. are also included. |
| 3 ACCESS PROCEDURES | Describes how to access the calibration adjustments and general maintenance circuit areas. |
| 4 GENERAL MAINTENANCE | Includes procedures for fuse replacement, line voltage selection, and other general maintenance. |
| 5 PERFORMANCE TEST | Provides a set of procedures to verify that the 8860A is performing within the specifications listed in Section 1. All of these procedures are accomplished without removing the instrument from its case. |

6 CALIBRATION ADJUSTMENTS

Provides a set of step by step procedures for making all of the 8860A calibration adjustments. These procedures are performed when the 8860A does not meet the specifications listed in Section 1.

1-4. RECOMMENDED TEST EQUIPMENT

1-5. The equipment required to complete the Performance Test and the Calibration Procedure is listed in Table 1-1. If the recommended models are not available, instruments with equivalent specifications can be substituted.

1-6. SPECIFICATIONS

1-7. The specifications for the 8860A are listed in Table 1-2.

Table 1-1. Recommended Test Equipment

| INSTRUMENT TYPE | MINIMUM SPECIFICATIONS | RECOMMENDED MODEL |
|-------------------|--|-------------------|
| AC Calibrator | Voltage Range: 0-1000V ac Freq. Range: 20 Hz-300 kHz Voltage Accuracy: 0-100V ac: 20 Hz- 50 Hz .1% 50 Hz- 10 kHz .03% 10 kHz-100 kHz .03% 100 kHz-300 kHz .4% 100-1000V ac: 20 Hz- 50 Hz .15% 50 Hz- 10 kHz .05% 10 kHz-100 kHz .1% | JF 5200A, JF5205A |
| DC Calibrator | Voltage Range: 0-1000V dc Accuracy: .003% | JF 332B |
| Voltage Divider | Ratio Range: 0-1.0 Absolute Linearity: ± 1 ppm of input at dial setting | JF 720A |
| Resistor Decade | Resistance Accuracy: .005% | |
| Oscilloscope | General purpose with 10M probe | Tektronix T932A |
| Digital Voltmeter | Voltage Accuracy: .01% (V dc) 1.0% (V ac) for 1 volt input at 100 kHz Input Impedance: 10 Megohm or greater in V dc 1 Megohm in parallel with <100 pF in V ac | JF 8800A |

Table 1-2. 8860A Specifications

DC VOLTS

| | |
|--------------------------------|---|
| Ranges | ± 200 mV, 2V, 20V, 200V, 1000V |
| Ranging | Fully automatic or manual |
| Polarity of Input | Automatic polarity selection and display |
| Resolution (Max.) | 0.0005% of full scale (1 μ V on 200 mV range) with 5-1/2 digit display. |
| Accuracy | Using front panel zero, \pm (% input + no. of digits) |

5-1/2 DIGIT DISPLAY*

| RANGE | 24 HR 23°C \pm 1°C | 90DAY 18°C - 28°C | 1 YR 18°C - 28°C | NORMAL MODE REJECTION | |
|---------|-------------------------|----------------------|---------------------|-----------------------|----------------------|
| | | | | NO FILTER | FILTER |
| 200 mV | (0.004 + 3) | (0.008 + 3) | (0.01 + 3) | >60 dB 50, 60 Hz | >100 dB 50, 60 Hz |
| 2V-200V | (0.004 + 2) | | | | |
| 1000V | | | | | |

4-1/2 DIGIT DISPLAY*

| RANGE | 90DAY 18°C - 28°C | 1 YR 18°C - 28°C | NORMAL MODE REJECTION | |
|-------|----------------------|---------------------|-----------------------|----------------------|
| | | | NO FILTER | FILTER |
| All | (0.01 + 2) | (0.015 + 3) | >60 dB 50, 60 Hz | >100 dB 50, 60 Hz |

*Settling Time: 30 ms to within .01% of input step size, with filter 300 ms.

3-1/2 DIGIT DISPLAY (Available with -004 or -005 options only)

| RANGE | 1 YR 18°C - 28°C | NORMAL MODE REJECTION | |
|-------|---------------------|-----------------------|---------------------|
| | | NO FILTER | FILTER |
| All | (0.1 + 1) | None | >40 dB 50, 60 Hz |

Settling Time: 5 ms to within .1% of input step size, with filter 250 ms.

Common Mode Rejection

| | |
|-------------------------|--|
| CONDITIONS | Line frequency switch properly set. Line frequency at 50 or 60 Hz \pm 0.1%. One kilohm in either lead. |
|-------------------------|--|

4-1/2 AND 5-1/2 DIGIT RATE

| | |
|-------------------------------|---------|
| Normal Guard | >130 dB |
| External Guard (Driven) | >150 dB |

3-1/2 DIGIT RATE

| | |
|-------------------------------|--------|
| Normal Guard | >70 dB |
| External Guard (Driven) | >90 dB |

DC, ALL READING RATES

>160 dB

Input Resistance

| | |
|-------------------------------|--------------------|
| 200 mV, 2V RANGES | >10,000 M Ω |
| 20V, 200V, 1000V RANGES | 10 M Ω |

Table 1-2. 8860A Specifications (cont)

Input Bias Current (@ 23°C) <100 pA

Zero Stability

(after 1 hour warmup) ± 10 μ V for 90 days

Maximum Input ± 1000 V Pk input HI to LO
 ± 500 V Pk input LO to Earth
 ± 30 V Pk input LO to Guard

AC VOLTS (True RMS, AC only or AC + DC)

Ranges 200 mV, 2V, 20V, 200V, 700V

Ranging Fully automatic or manual

Resolution (Max) 0.0005% F.S. (1 μ V on 200 mV range) with 5-1/2 digit display.

Accuracy \pm (% INPUT + DIGITS), 0.5% F.S. to F. S. AC only*

| FREQUENCY | RANGE(S) | 90 DAY 18°C-28°C | | | 1 YR 18°C-28°C | | |
|-----------------|----------|---------------------|--------|-------|-------------------|--------|-------|
| | | % INPUT | DIGITS | | % INPUT | DIGITS | |
| | | | 5-1/2 | 4-1/2 | | 5-1/2 | 4-1/2 |
| 20 Hz-50 Hz | All | 0.25 | 70 | 10 | 0.25 | 100 | 13 |
| 50 Hz-10 kHz | All | 0.15 | 70 | 10 | 0.15 | 100 | 13 |
| 10 kHz-50 kHz | 2V-700V | 0.4 | 150 | 18 | 0.4 | 300 | 33 |
| | 200 mV | 0.7 | 150 | 18 | 0.7 | 300 | 33 |
| 50 kHz-100 kHz | 2V-700V | | | | 1.0 | 350 | 38 |
| | 200 mV | | | | 2.5 | 350 | 38 |
| 100 kHz-300 kHz | All | | | | 8.0 | 700 | 73 |

*For AC + DC operation, add 0.1% of input +50 digits for 5-1/2 digit resolution.

For AC + DC operation, add 0.1% of input + 5 digits for 4-1/2 digit resolution.

Bandwidth (typical) ≤ 3 dB @ 1 MHz

Crest Factor 3 at full range, increasing down range

Input Impedance 10 M Ω , ≤ 70 pF

Maximum Input 700V rms, 1000V Pk, or 2×10^7 volt/Hz, whichever is less.

OHMS (2-terminal or 4-terminal)

Ranges 200 Ω , 2 k Ω , 20 k Ω , 200 k Ω , 2 M Ω , 20 M Ω

Ranging Fully Automatic or Manual

Resolution (Max) 0.0005% F.S. (1 m Ω on 200 Ω range) with 5-1/2 digit display

Table 1-2. 8860A Specifications (cont)

Accuracy Using front panel zero, ±(% of input + no. of digits)

5-1/2 DIGIT DISPLAY

| RANGE | 24 HR 23°C ±1°C | 90 DAY 18°C - 28°C | 1 YR 18°C - 28°C |
|-----------|--------------------|-----------------------|---------------------|
| 200 | (0.008 + 4) | (0.012 + 4) | (0.015 + 4) |
| 2k-200 kΩ | (0.006 + 2) | (0.01 + 2) | (0.013 + 2) |
| 2M | (0.01 + 3) | (0.014 + 3) | (0.017 + 3) |
| 20M | (0.07 + 3) | (0.09 + 3) | (0.10 + 3) |

4-1/2 DIGIT DISPLAY

| RANGE | 90 DAY 18°C - 28°C | 1 YR 18°C - 28°C |
|------------|-----------------------|---------------------|
| 200 - 2 MΩ | (0.01 + 2) | (0.02 + 3) |
| 20 MΩ | (0.1 + 2) | (0.14 + 3) |

3-1/2 DIGIT DISPLAY

| RANGE | 1 YR 18°C - 28°C |
|-------------|---------------------|
| 200Ω - 2 MΩ | (0.1 + 1) |
| 20 MΩ | (0.3 + 1) |

INPUT CHARACTERISTICS

| RANGE | CURRENT THRU RX | OPEN CIRCUIT VOLTAGE |
|--------|-----------------|----------------------|
| 200 | 1 mA | 6.0V MAX |
| 2 kΩ | 1 mA | |
| 20 kΩ | 100 uA | |
| 200 kΩ | 10 uA | |
| 2 MΩ | 1 uA | |
| 20 MΩ | .1 uA | |

Maximum Input 300V DC or Peak AC

Ohms Settling Times

| RANGE | 5-1/2 and 4-1/2 DIGIT (TO .01% OF STEP) | | 3-1/2 DIGIT (TO .1% OF STEP) | |
|-------------|--|---------|---------------------------------|---------|
| | NO FILTER | FILTER | NO FILTER | FILTER |
| 200 - 20 kΩ | 100 ms | <300 ms | <15 ms | <300 ms |
| 200 kΩ | | <1.1s | | <800 ms |
| 2m | | <650 ms | <70 ms* | <500 ms |
| 20m | <1.5s* | <6.8s | <600 ms* | <4.5s |

*For these ranges the filter is recommended. This will reduce the effects of noise pick-up common to all high impedance measurements.

Table 1-2. 8860A Specifications (cont)

| GENERAL | | | | |
|---------|-------------------|-----------------|-----------------|-------------------------|
| DISPLAY | RESOLUTION (% FS) | MAX READING/SEC | LINE FREQ. (HZ) | A/D INTEGRATE TIME (MS) |
| 5-1/2 | 0.0005 | 2.5 | 50, 60 | 100 |
| 4-1/2 | 0.005 | 15 12 | 60 50 | 16-2/3 20 |
| 3-1/2* | 0.05 | 30 | 50, 60 | 2 |

*Accessible through IEEE-488 or Calculating Controller options only.

Temperature 0°C to +50°C operating; -40°C to +75°C non-operating.

Temperature Coefficient ±0.1 x applicable accuracy specification per °C

Relative Humidity ≤80% to +35°C; ≤70% to +50°C

Shock & Vibration MIL-T - 28800B, class 4

Power 100, 129, 220, 240V AC ±10%, 250VAC MAX., 50 Hz or 60 Hz

Size 13.08 cm x 20.45 cm x 32.69 cm (HxWxL)
(5.15 in x 8.05 in x 12.85 in) See Figure 1-1.

Weight 3.39 kg (7.48 lbs.)

Protection Class 1 Relates solely to insulating or grounding properties defined in IEC 348

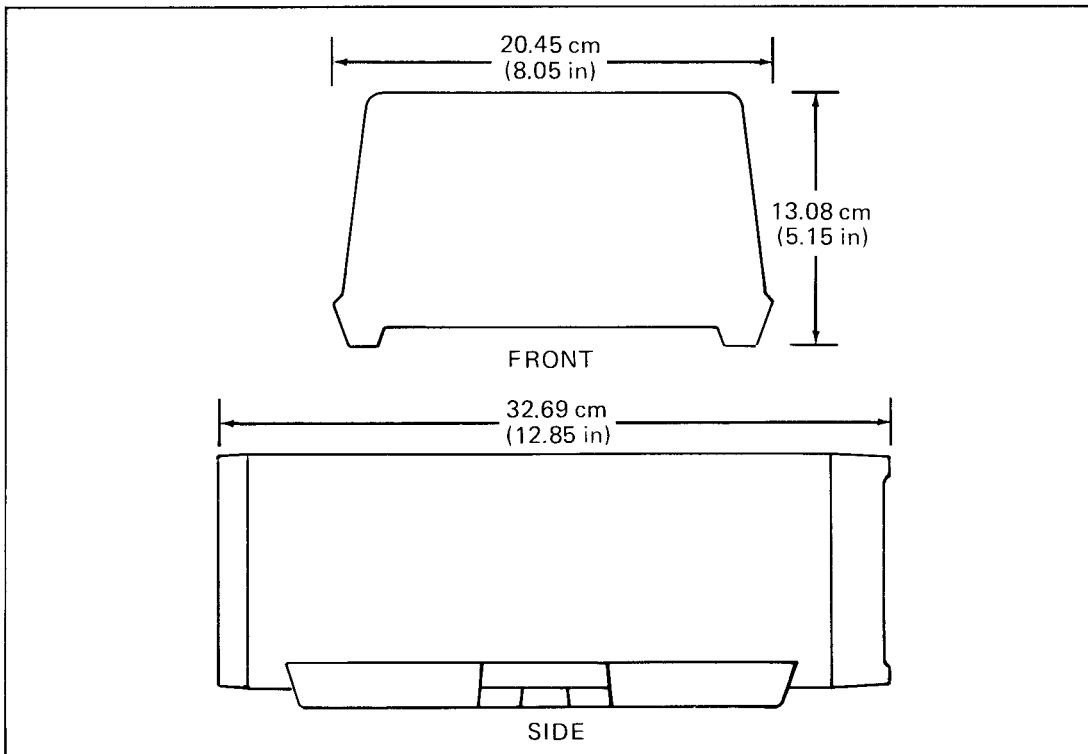


Figure 1-1. Outline Drawing

Section 2

Shipping and Service Information

2-1. SHIPPING INFORMATION

2-2. The 8860A is packaged and shipped in a foam-packed container. When you receive the 8860A, inspect it thoroughly for possible shipping damage. Special instructions for inspection and claims are included on the shipping container.

2-3. If reshipment is necessary, use the original container. If the original container is not available, order a new container from John Fluke Mfg. Co., Inc./P.O. Box 43210/Mountlake Terrace, WA 98043, telephone (206)774-2211.

2-4. SERVICE INFORMATION

2-5. Each John Fluke Model 8860A Digital Multimeter is warranted for a period of 1 year upon delivery to the original purchaser. The WARRANTY is located at the front of this manual.

2-6. Factory authorized calibration and service for each Fluke product is available at various worldwide locations. A complete list of these service centers is given in Appendix A. If requested, Fluke will provide an estimate before any work begins on instruments that are beyond the warranty period.

2-7. QUESTIONS/PROBLEMS

2-8. For any additional information, contact your nearest John Fluke Sales Representatives (see Appendix A), or the John Fluke Mfg. Co., Inc. at the address or telephone number given above.

WARNING

THE SERVICE INSTRUCTIONS CONTAINED IN THIS MANUAL ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID ELECTRIC SHOCK, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN THE OPERATOR MANUAL UNLESS YOU ARE QUALIFIED TO DO SO.

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Section 3

Access Procedures

WARNING

TO AVOID ELECTRICAL SHOCK HAZARDS WHEN THE TOP COVER IS REMOVED FROM THE 8860A, DO NOT WORK IN THE AREA OF THE POWER CONNECTOR IF LINE POWER IS APPLIED, AND DO NOT TOUCH THE INTERNAL GUARD COVER (FIGURE 6-1) WHEN VOLTAGES HIGHER THAN 30 VOLTS ARE APPLIED TO THE INPUT TERMINAL.

3-1. INTRODUCTION

3-2. This section of the manual contains the procedures required to access the 8860A line voltage selection switches and the calibration adjustments.

3-3. ACCESS

3-4. To access the line voltage switches and the calibration adjustments proceed as follows:

1. Remove line power from the instrument.
2. Turn the instrument over, bottom-side up.
3. Remove the four Phillips-head screws from the bottom cover.
4. Holding the top and bottom covers together, turn the instrument right-side up.
5. Using the case handle, pull the top cover up and off of the unit. See Figure 3-1. Both the front and rear panels should remain with the bottom half of the instrument.
6. Logically reverse this procedure to install the top cover. Carefully guide the front and rear panels into the top-cover slots.

CAUTION

Handle the unit carefully while the top cover is removed. The internal assemblies, and the front and rear panels are not secured to bottom case cover. They will fall out if the unit is turned over and they are not supported.

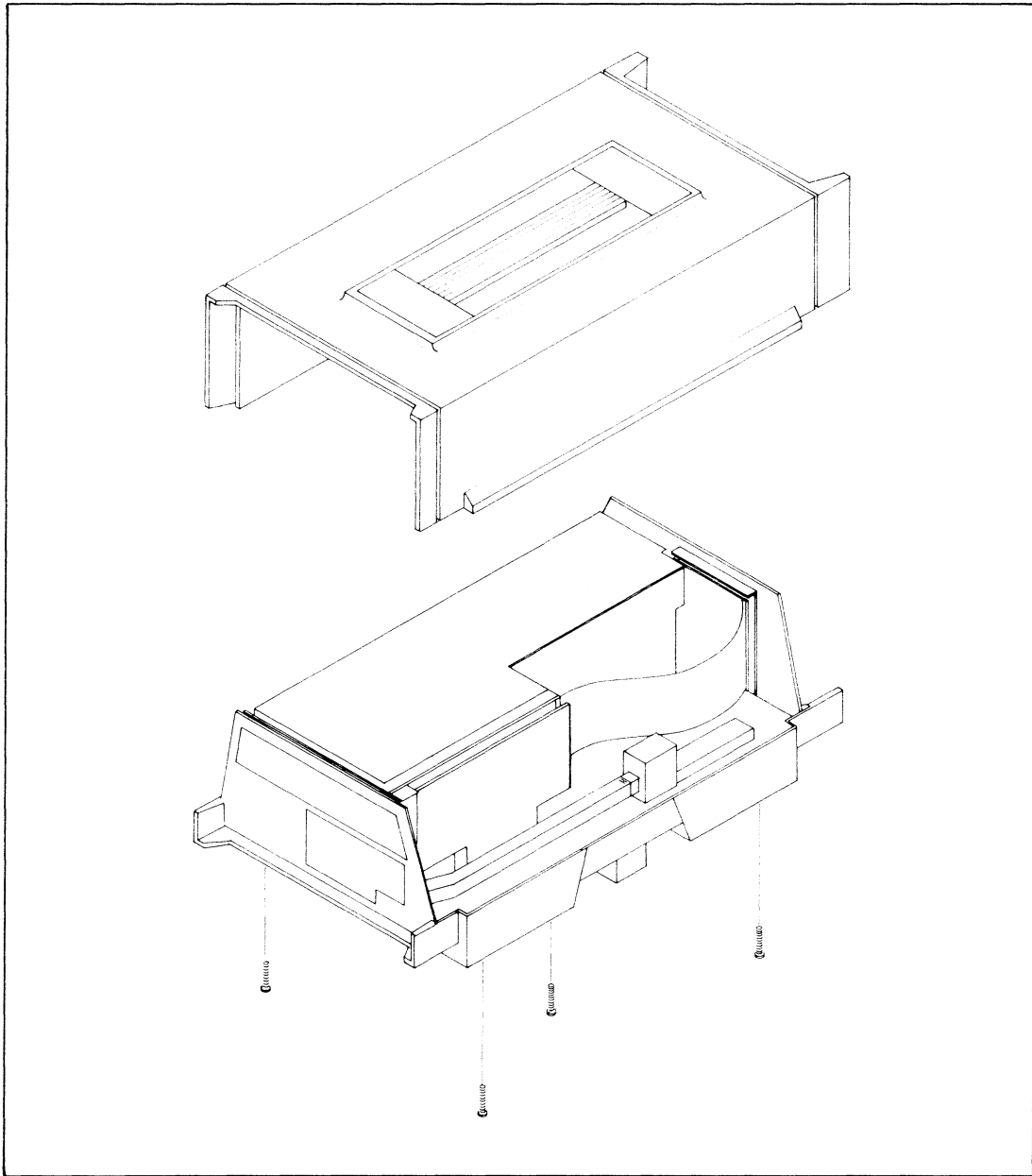


Figure 3-1. Switch and Calibration Adjustment Access

Section 4

General Maintenance

4-1. INTRODUCTION

4-2. This section of the manual contains the general maintenance procedures. These include cleaning instructions, line voltage selection, and fuse replacement. Do not perform any of these procedures when power is applied to the instrument.

4-3. CLEANING

4-4. Periodically clean the front panel using a soft cloth dampened with denatured alcohol or a mild solution of detergent and water. Use low pressure air (<20 psi) to clear dust from corners, crevices, and the interior of the 8860A.

WARNING

DO NOT USE AROMATIC HYDROCARBONS OR CHLORINATED SOLVENTS FOR CLEANING THE 8860A. THEY HAVE ADVERSE EFFECTS ON PLASTIC MATERIALS.

4-5. LINE VOLTAGE SELECTION

4-6. Input line voltage for the 8860A may be switch selected from one of four voltages (100, 120, 220, 240V ac $\pm 10\%$) at frequencies of 50 or 60 hertz. Two slide switches are used to select the desired line voltage. One is used to select line frequency. The three switches are located inside the 8860A. Refer to the access procedures for instructions on cover removal. Figure 4-1 shows the possible switch settings. Set the switches, as required, using the slots for position indicators. When the line voltage settings are changed, install the correct fuse for the new setting.

4-7. FUSE REPLACEMENT

4-8. The fuse is located in the lower-left corner of the rear panel. When fuse replacement is necessary, remove the fuse-cap by turning it 1/8 of a turn counterclockwise with a screw driver. The fuse will pull out with the fuse-cap. Replace the fuse with one of the proper rating:

For 100 or 120V ac, use 1/4A Slo Blo, 250V

For 220 or 240V ac, use 1/8A Slo Blo, 250V

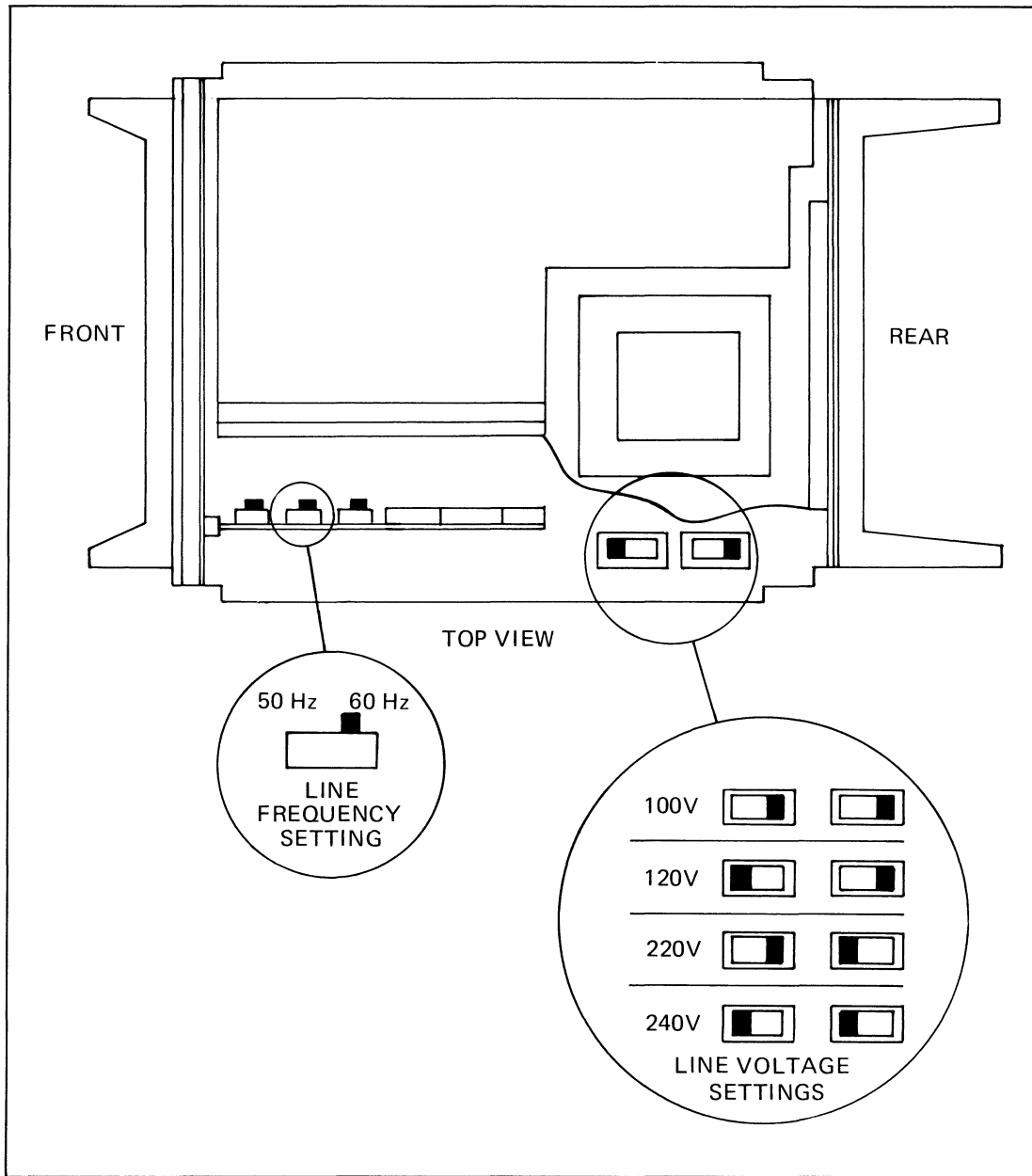


Figure 4-1. Line Voltage Switch Locations and Settings

Section 5

Performance Test

5-1. INTRODUCTION

5-2. The following paragraphs contain a performance verification test which compares the performance of the instrument to the specifications given in Section 1 of this manual. The test is recommended as an acceptance test when the unit is first received, and later as a calibration procedure to verify the 90-day accuracy specifications. It is also useful as an aid in troubleshooting.

5-3. Test equipment required for the performance test is listed earlier in Table 1-1. If the recommended equipment is not available, comparable instruments with equivalent specifications may be substituted. To ensure optimum results, the test must be performed at an ambient temperature of 18 to 28 degrees Celsius, with a relative humidity of less than 75%. Also, the instrument should be allowed to warm-up for a least 1-1/2 hours before starting the performance test.

5-4. If the instrument does not meet the performance test, troubleshooting, repair, and/or calibration adjustment is indicated. Procedures for calibration adjustment are given later in this manual. Troubleshooting procedures are given in the Service Manual.

5-5. EQUIPMENT PREPARATION

5-6. Perform the following procedure prior to beginning the performance test.

1. Verify the instrument is set for the applicable line voltage using the procedure previously given.
2. Install the top cover.
3. Connect the instrument to the input line power.
4. Depress the POWER switch to apply line voltage to the instrument.
5. Allow the instrument to operate for at least 1-1/2 hours before beginning the test.

5-7. DC VOLTS TEST

5-8. Use the following procedure to verify the accuracy of the dc voltage ranges:

1. Place a shorting link between the HI and LO INPUT terminals.
2. Select the VDC function.

3. Zero the display by pressing the FCN and then the ZERO push buttons. Remove the shorting link.
4. Connect the DC Calibrator and the Voltage Divider to provide a voltage input to the HI and LO INPUT terminals.

NOTE

The Voltage Divider is not required for voltages above 1.0V dc.

5. Select the slow sample rate, 5-1/2 digit display.
6. Refer to Table 5-1. Sequentially select each of the voltage ranges shown in steps a through f and set the calibrator for the input specified for each range. Verify that the display reading is within the limits shown.
7. Disconnect the DC Calibrator from the 8860A INPUT terminals and install the shorting link.
8. Sequentially select the 2V and 20V ranges. The display should read .00000 and 0.0000 ± 2 digits, respectively.
9. Remove the shorting link, and reconnect the DC Calibrator to the INPUT terminals.
10. Refer to Table 5-1 and verify that the display readings are correct using the range and input voltage given for steps g and h.
11. Select the fast sample rate, 4-1/2 digit display.
12. Using the range and input voltage specified in step i of Table 5-1, verify that the display reading is within the prescribed limits.
13. Disconnect the DC Calibrator from the 8860A INPUT terminals.

Table 5-1. DC Voltage Tests

| STEP | RANGE | INPUT | DISPLAY READING 5-1/2 DIGITS | |
|---|--------|----------|------------------------------|-----------|
| | | | LOW | HIGH |
| a | 200 mV | + 100 mV | +99.989 | +100.011 |
| b | 2V | + .1 mV | +0.00098 | +0.00102 |
| c | 2V | - .1 mV | -0.00098 | -0.00102 |
| d | 2V | + 1V | +99989 | +100011 |
| e | 2V | - 1V | -99989 | -100011 |
| f | 20V | + 10V | +99989 | +100011 |
| g | 200V | + 100V | +99.989 | +100.011 |
| h | 1000V | -1000V | -999.89 | -1000.11* |
| 4-1/2 DIGITS | | | | |
| i | 2V | + 1V | + .9997 | +1.0003 |
| * If the 8860A display reading is greater than or equal to 1000.00, the display will flash. | | | | |

5-9. AC VOLTS TEST

5-10. Use the following procedure to verify the accuracy of the ac voltage ranges:

1. Select the VAC function.
2. Connect the AC Calibrator to provide a voltage input to the HI and LO INPUT terminals.
3. Select the slow sample rate, 5-1/2 digit display.
4. Refer to Table 5-2. Sequentially select each of the voltage ranges shown, and set the calibrator for the input specified for each range. Verify that the display reading is within the limits shown.
5. Set the AC Calibrator output to 0 volts or standby, and disconnect it from the 8860A INPUT terminals.

Table 5-2. AC Voltage Tests

| RANGE | INPUT | 8860A READING | |
|-------|--------------|---------------|---------|
| | | LOW | HIGH |
| 2V | .01V, 300 Hz | .00930 | .01070 |
| 2V | 1V, 300 Hz | .99780 | 1.00220 |
| 2V | 1V, 100 kHz | .99000 | 1.01000 |
| 20V | 10V, 100 kHz | 9.9000 | 10.1000 |
| 200V | 100V, 10 kHz | 99.780 | 100.220 |
| 700V | 500V, 10 kHz | 498.60 | 501.40 |

5-11. OHMS TEST

5-12. Complete the following procedure to verify the accuracy of the ohms ranges:

1. Select the Ω 4T function.
2. Select the slow sample rate, 5-1/2 digit display.
3. Enable the 8860A filter.
4. Connect a shorting link between the HI and LO Ω 4T sense terminals and the INPUT LO terminal.
5. Zero the display by pressing the FCN and then the ZERO push buttons. Remove the shorting link.
6. Connect the Resistor Decade, using four-terminal connections (current and sense leads), to the INPUT and Ω 4T sense terminals on the 8860A.
7. Refer to Table 5-3. Sequentially select each of the voltage ranges shown, and set the Resistor Decade for the specified input. Verify that the display reading is within the limits shown.
8. Disconnect the Resistor Decade from the 8860A.

Table 5-3. Ohms Test

| RANGE | INPUT | 8860A READING | |
|-------|-----------|---------------|---------|
| | | LOW | HIGH |
| 2K | 1K ohms | .99988 | 1.00012 |
| 20K | 10K ohms | 9.9988 | 10.0012 |
| 200K | 100K ohms | 99.988 | 100.012 |
| 2M | 1M ohms | .99983 | 1.00017 |
| 20M | 10M ohms | 9.9910 | 10.0090 |

5-13. DC EXTERNAL REFERENCE TEST (OPTION -007)

5-14. Use the following procedure to verify the accuracy of the DC External Reference, Option -007:

1. Complete the equipment connections shown in Figure 5-1.
2. On the 8860A, select VDC, 2V range, EXT REF, and the 5-1/2 digit display.
3. Set the DC Calibrator for a 10V dc output, and adjust the Voltage Divider for a 1.0V dc input to the 8860A.
4. Read the display. It should read $+1.00000 \pm 16$ digits.
5. Reverse the connections at the External Reference Terminals. The display should read -1.00000 ± 16 digits.
6. Reverse the connections at the input to the Voltage Divider. The display should read $+1.00000 \pm 16$ digits.
7. Reverse the connections at the External Reference terminals. The display should read -100000 ± 16 digits.
8. Set the DC Calibrator for a 1.0V dc output. After settling, the display should read -1.00000 ± 70 digits.

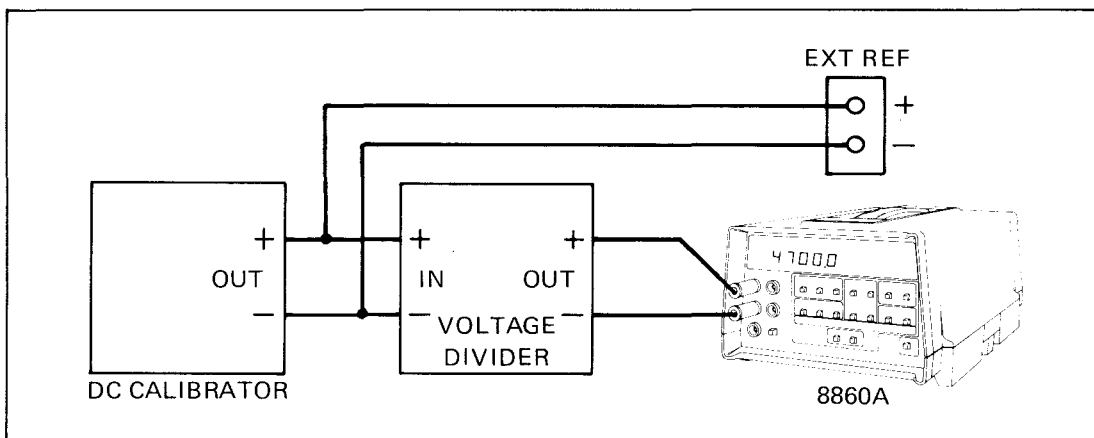


Figure 5-1. DC External Reference Test

Section 6

Calibration Adjustments

6-1. INTRODUCTION

6-2. The calibration adjustment procedures given in the following paragraphs should be performed after repair of the 8860A and/or when the unit fails the performance-test requirements. If the unit will not respond to, or meet the limits of the adjustment procedures, troubleshooting and repair are indicated. Equipment required for the calibration adjustments is listed earlier in Table 1-1.

6-3. All calibration adjustments are accessible when the top cover is removed from the 8860A. The locations of the test points, and adjustments that must be accessed to complete the calibration adjustment procedures are printed on the instrument guard cover shown in Figure 6-1.

6-4. To ensure optimum results, the calibration adjustments must be performed at an ambient temperature of 22 to 24 degrees Celsius, with a relative humidity of less than 75%. Also the unit should be allowed to warm-up for at least 1-1/2 hours before starting the adjustment procedures.

6-5. Instrument accuracies during the first 24 hours, 90 days, and 1 year after calibration are given in the instrument specification. Adjust the calibration cycle accordingly.

6-6. INITIAL PROCEDURE

6-7. Complete the following procedure before attempting to make any of the calibration adjustments:

1. Remove the top cover from the 8860A. See Access Procedure in Section 3.
2. Set the top cover back on the unit.
3. Connect the 8860A to line power and set the POWER switch to on.
4. Allow the unit to stabilize for 1-1/2 hours before proceeding with the adjustment procedures.

6-8. ADJUSTMENT PROCEDURES

6-9. Complete the adjustment procedures in sequence. Refer to Figure 6-1 for all test point and adjustment locations. Specified inputs assume the use of the appropriate equipment listed earlier in Table 1-1. Use the Voltage Divider for all dc voltage inputs that are less than 2V dc.

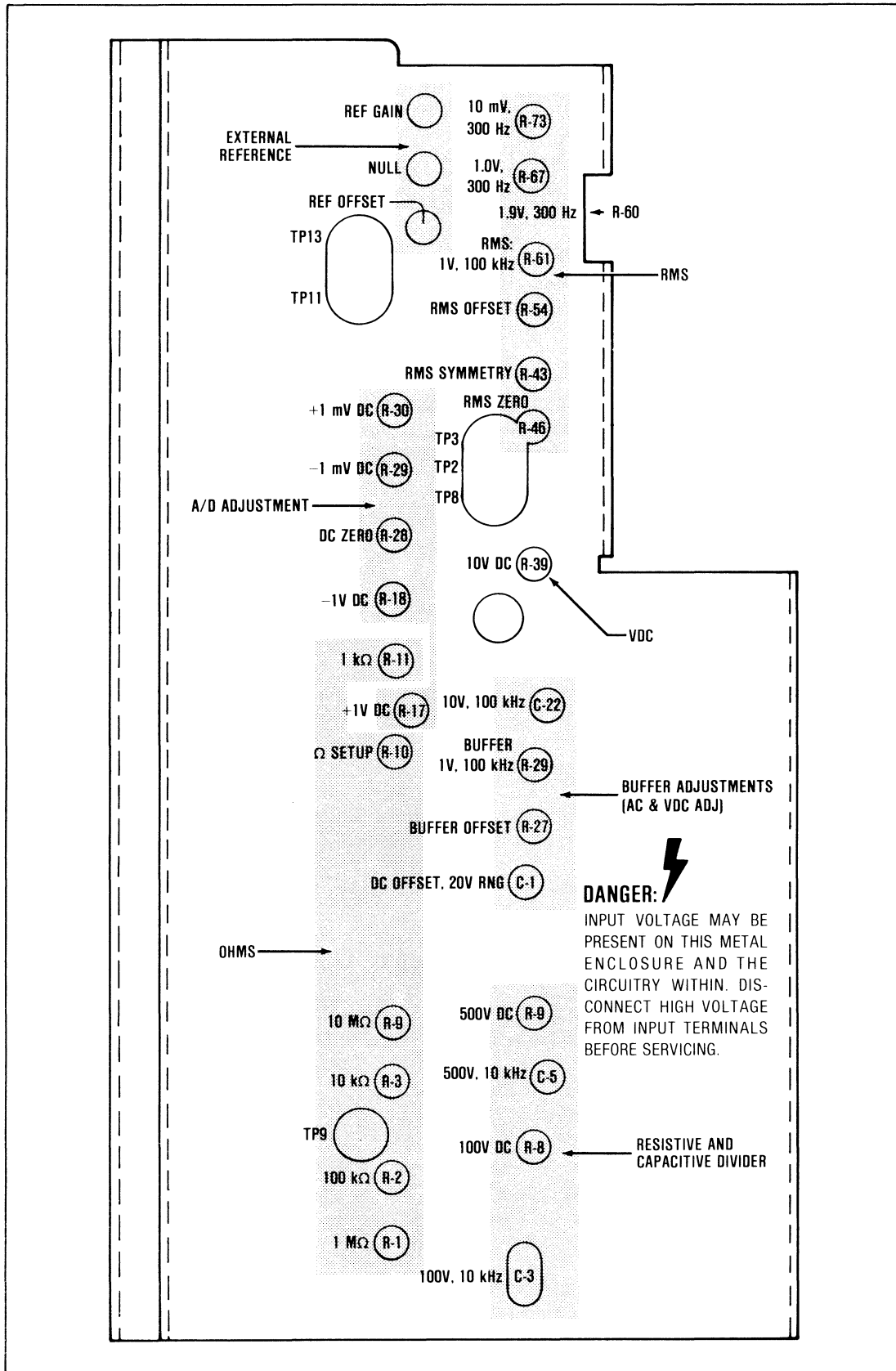


Figure 6-1. Test Point and Calibrations Adjustment Locations

6-10. DC Offset

6-11. Use the following procedure to calibrate DC offset:

1. Connect a shorting wire between the HI and LO INPUT terminals.
2. Select VDC and the 2V range.
3. Set the +1 mV DC (R30) and the -1 mV DC (R29) adjustments fully clockwise.
4. Adjust DC ZERO (R28) until the sign flashes + and - with equal frequency. Ignore the numeric reading.
5. Remove the short and apply +1.0 mV dc to the input. Adjust R30, +1 mV DC, until the display reads +.00100, with occasional readings of +.00099.
6. Apply a -1.0 mV dc input to the 8860A. Adjust R29, -1 mV DC, until the display reads -.00100, with occasional readings of -.00099.
7. Connect a shorting wire between the HI and LO INPUT terminals.
8. Select the 20V range on the 8860A.
9. Adjust DC OFFSET, 20V RNG, (C1) for a display reading of ± 0.0000 .
10. Select the 2V range and repeat steps 4-9 until no further corrections are required.

6-12. VDC Function and Ranges

6-13. The following procedure is used to calibrate the VDC ranges (VDC function and 2V range still selected):

1. Apply +1.0V dc and adjust +1 VDC (R17) until the display reads +1.00000, with occasional readings of +.99999.
2. Apply -1.0V dc and adjust -1 VDC (R18) until the display reads -1.00000, with occasional readings of -.99999.
3. Apply +1.9V dc and verify that the display reads +1.90000 ± 4 digits.
4. Apply -1.9V dc and verify that the display reads -1.90000 ± 4 digits.
5. Select the 200V range.
6. Connect a DC Calibrator to the HI and LO INPUT terminals of the 8860A.
7. Adjust the DC Calibrator to +100VDC.
8. Adjust the 100VDC resistor (R8) for a display of +100.000.
9. Select the 1000V range on the 8860A.
10. Adjust the DC Calibrator to +500V.
11. Adjust the 500 VDC resistor (R9) for a display of +500.00.

12. Repeat steps 5-11 until no further adjustments are required.
13. Adjust the DC Calibrator to 10V and select the 20V dc range on the 8860A.
14. Adjust 10 VDC (R39) for a display of +10.0000.
15. Select the 1000V range on the 8860A; connect the DC Calibrator to the 8860A and increase the input signal to +1000.00V. The display should read +1000.00 \pm 3 digits.
16. Apply -1000V dc to the input. The display should read -1000.00 \pm 3 digits. Decrease the calibrator output to a safe level, less than 30V dc, and disconnect it from the 8860A INPUT terminals.
17. Short the input with a shorting link and select the 200 mV dc range. Press FCN followed by ZERO on the front panel of the 8860A.
18. Using the Voltage Divider, apply +100.0 mV dc to the input. The reading should be +100.000 \pm 2 digits.
19. Apply -100.0 mV dc to the input. The reading should be -100.000 \pm 2 digits.

6-14. AC/RMS Offset Adjustments

6-15. The following procedure is used to initially zero the AC/DC buffer, and the linear components on the RMS converter.

1. Connect a shorting link between the HI and LO INPUT terminals of the 8860A.
2. Select VAC and the 20V range on the 8860A.
3. Connect a DC Voltmeter between TP5 and the LO INPUT terminal.
4. Adjust BUFFER OFFSET (R27) for a DC Voltmeter reading of 0.0 \pm 0.01 mV dc.
5. Connect the DC Voltmeter between TP2 and LO INPUT terminal.
6. Adjust RMS OFFSET (R54) for a DC Voltmeter reading of 0.0 \pm 0.01 mV dc.
7. Connect a scope and a 10X scope probe to TP3. Use the LO INPUT terminal for the ground connection.
8. Set the scope to 200 mV/division sensitivity, 1 ms/division horizontal sweep, and DC coupling on the input amplifier.
9. Zero the scope, and then adjust RMS ZERO (R46) for a 0V dc trace on the scope. (There is typically \pm 100 mV of ac noise on the trace.)
10. Repeat step 5 and verify that the voltage reading is 0.0 \pm 0.01 mV dc. If the reading is not correct, repeats steps 6 through 9.

6-16. Buffer Frequency Response

6-17. The following procedure is used to adjust the frequency response of the buffer.

1. Connect an AC Calibrator to the HI and LO INPUT terminals of the 8860A.
2. Select DC coupled VAC and the 2V range on the 8860A.
3. Connect an AC Voltmeter between the input terminals of the 8860A.
4. Adjust the AC Calibrator to 1.0V, 100 kHz, and record the reading on the AC Voltmeter.
5. Connect the AC Voltmeter between TP5 and LO INPUT terminal.
6. Adjust BUFFER: 1V, 100 kHz (R29) for an AC Voltmeter reading that is within 0.01% of the reading recorded in step 4.
7. Disconnect the AC Calibrator from the 8860A.

6-18. RMS Converter

6-19. The following procedure is used to adjust the scale factor and linearity of the RMS converter.

1. Select DC coupled VAC and the 2V range on the 8860A.
2. Connect a DC Calibrator to the HI and LO INPUT terminals on the 8860A.
3. Adjust the DC Calibrator to +1.0V dc.
4. Record the reading on the 8860A.
5. Apply -1.0V dc to the 8860A. Monitor the display.
6. Adjust RMS SYMMETRY (R43) until the display reads the value recorded in step 4.
7. Select VAC and the 2V range on the 8860A.
8. Disconnect the DC Calibrator, and connect an AC Calibrator to the HI and LO terminals.
9. Adjust the AC Calibrator to 1.0V, 300 Hz.
10. Adjust the 1.0V, 300 Hz resistor (R67) for an 8860A display reading of 1.00000 ± 5 digits.
11. Adjust the AC Calibrator for an output of 10 mV, 300 Hz.
12. Adjust the 10 mV, 300 Hz resistor (R73) for an 8860A display reading of 0.01000 ± 1 digit.
13. Adjust the AC Calibrator for an output of 1.9V, 300 Hz.
14. Adjust the 1.9V, 300 Hz resistor (R60) for a display reading of 1.90000 ± 10 digits.
15. Repeat steps 9-14 until no further corrections are required.

16. Adjust the AC Calibrator to 1.0V, 100 kHz.
17. Adjust the RMS: 1V, 100 kHz resistor (R61) for an 8860A display reading of 1.00000 ± 5 digits.
18. Select the 200 mV range. Apply 1 mV, 300 Hz. The reading must be within 40 digits of nominal.
19. Select the 20V range. Apply 100 mV, 300 Hz. The reading must be within 40 digits of nominal.

6-20. AC Divider Response

6-21. The following procedure is used to calibrate the AC dividers of the 8860A.

1. Select VAC and the 200V range.
2. Connect an AC Calibrator to the HI and LO INPUT terminals of the 8860A.
3. Apply 100V, 10 kHz to the 8860A.
4. Adjust the 100V, 10 kHz capacitor (C3) for an 8860A reading of 100.000 ± 10 digits.
5. Select the 700V range on the 8860A.
6. Adjust the AC Calibrator to 500V, 10 kHz.
7. Adjust the 500V, 10 kHz capacitor (C5) for an 8860A reading of 500.00 ± 10 digits.
8. Repeat steps 3-7 until no further corrections are required.
9. Apply 10V, 100 kHz to the input of the 8860A.
10. Adjust the 10V, 100 kHz capacitor (C22) for a display reading of between 9.9800 and 10.0200, nominally 10.0000.
11. Apply 100 mV, 100 kHz to the 8860A.
12. Select the 200 mV range on the 8860A. The reading should be 100.000 ± 900 digits.

6-22. Ohms Converter

6-23. Use the following procedure to calibrate the Ohms Converter:

1. Set the 8860A to the $\Omega 4T$ function, and enable the FILTER and AUTORANGE.
2. Connect the Decade Resistor to the 8860A using four-terminal connections.
3. Refer to Table 6-1, and set the Decade Resistor to the input values given for steps a and b. Make the adjustment shown for each input to obtain the specified display limits.

4. Repeat steps a and b for convergence.
5. Perform steps c through f as shown in Table 6-1.

Table 6-1. Ohms Converter Adjustments

| STEP | INPUT RESISTANCE | ADJUST | DISPLAY LIMITS |
|------|------------------|---------------------|-------------------|
| a | 10. M Ω | Ohms Setup (R10) | 9.9960 to 10.0040 |
| b | 1.0 k Ω | 1 k Ω (R11) | .99999 to 1.00001 |
| c | 10.0 k Ω | 10 k Ω (R3) | 9.9999 to 10.0001 |
| d | 100.0 k Ω | 100 k Ω (R2) | 99.999 to 100.001 |
| e | 1.0 M Ω | 1 M Ω (R1) | .99999 to 1.00001 |
| f | 10. M Ω | 10 M Ω (R9) | 9.9995 to 10.0005 |

6-24. DC External Reference

6-25. Use the following procedure to calibrate the DC External Reference, Option -007. Complete the Calibration Adjustments for the basic 8860A before performing this procedure.

1. Center each of the following external Reference Adjustments: REF GAIN (R1), NULL (R4), REF OFFSET (R5).
2. Complete the equipment connections shown in Figure 6-2A.
3. Use the DC Voltmeter to measure the voltage between TP13 and the INPUT LO Terminal.
4. Adjust REF OFFSET (R5) for a DC Voltmeter reading of 0.0 ± 5 μ V dc.
5. Modify the equipment connections to conform with those shown in Figure 6-2B. Set the DC Calibrator for a +10.0V dc output.
6. Adjust NULL (R4) until the voltage at TP13 reads 0.0 ± 5 μ V dc.
7. Modify the equipment connections to conform with those shown in Figure 6-2C.
8. Adjust REF GAIN (R1) for a DC Voltmeter reading of -1.00000 ± 1 digit at TP13.
9. Repeat steps 2 through 8 of this procedure until all requirements are met without adjustment.
10. Modify the equipment connections to conform with those given in Figure 6-2D.
11. Set the 8860A as follows: VDC, 2V range, EXT REF enabled.
12. Set the Voltage Divider for a 1.0V dc output.

13. Adjust REF GAIN (R1) for a display reading of $+1.00000 \pm 1$ digit.
14. Press EXT REF to turn off the EXT REF light.
15. Connect the DC Voltmeter between TP13 and the INPUT LO terminal.
16. Repeat steps 5 and 6 of this procedure.
17. Disconnect all equipment.
18. Verify operation of the active filter as follows:
 - a. Connect an AC Voltmeter between TP13 and INPUT LO.
 - b. Set the 8860A to: VDC, 2V range, and EXT REF light off.
 - c. Using the AC Calibrator, apply a 10V, 60 Hz signal between EXT REF terminals. Connect EXT REF (-) to the INPUT LO terminal.
 - d. The AC Voltmeter should read less than 0.010V ac.
 - e. Disconnect all equipment and install the cover on the 8860A.

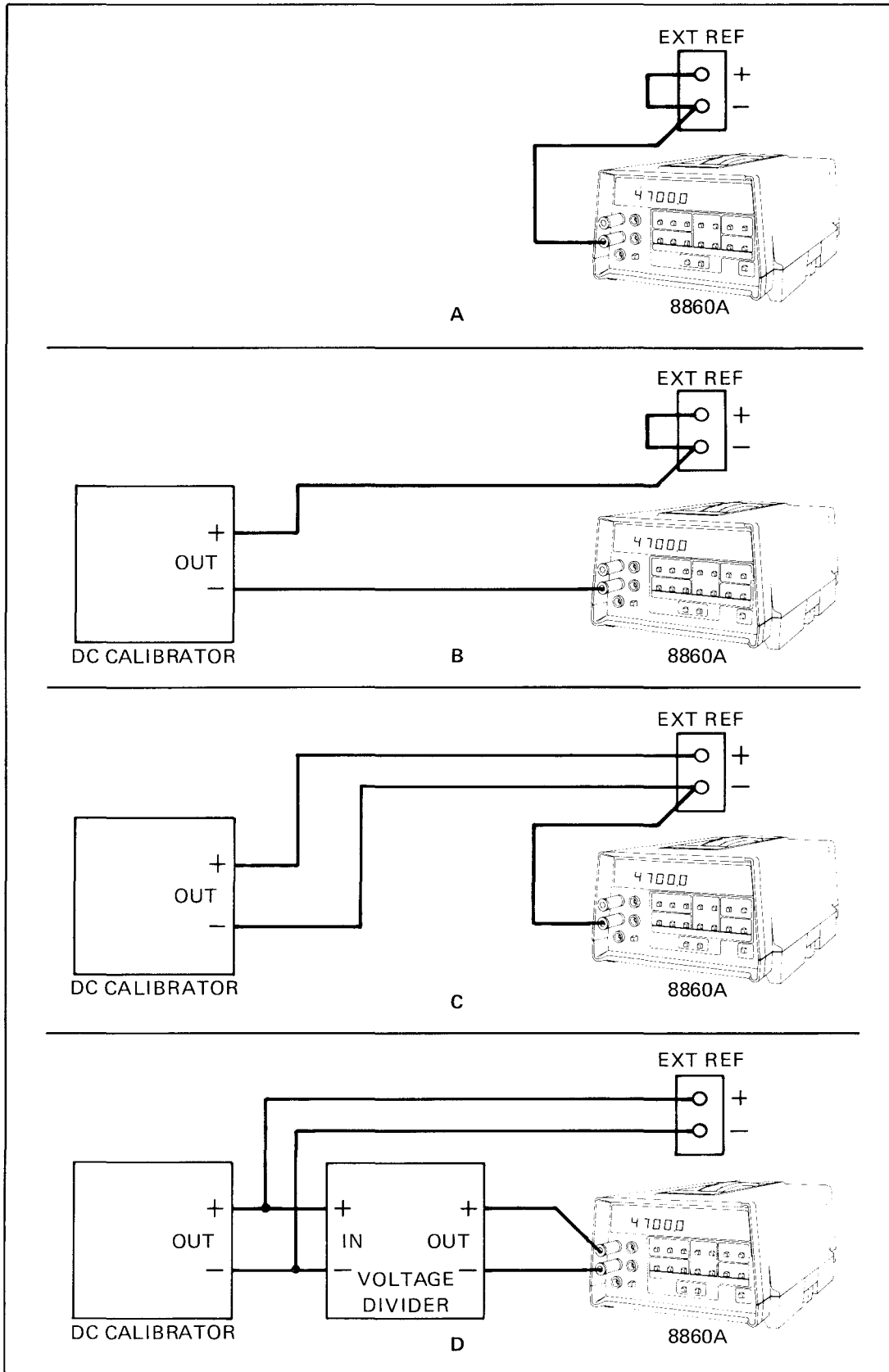


Figure 6-2. EXT REF Equipment Connections