

# **8508A**

Reference Multimeter

## **Service Manual**

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# **Chapter 1**

## ***Introduction and Specifications***

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## Introduction

The Fluke 8508A Reference Multimeter (hereafter "the Multimeter") is designed for the most demanding measurement applications and provides extremely high measurement precision in both stand-alone and systems applications.

This Service Manual provides the information necessary to maintain the Multimeter at a module (or board) level. A brief description of the information contained in the various chapters follows:

**Chapter 1** *Introduction and Specification* provides a brief description of the product, safety information regarding the product and its use, and a complete set of detailed specifications.

**Chapter 2** *Theory of Operation* provides an overall functional description of the internal workings of the Multimeter. The intent of the theory is to aid in locating and isolating a faulty PCA.

**Chapter 3** *Calibration and Verification* provides a thorough and complete description of both the Verification and the Calibration procedures for the Multimeter.

**Chapter 4** *Maintenance* provides detailed descriptions of how to disassemble the Multimeter to the PCA level. The purpose of the descriptions is to assist with equipment repairs at the PCA level.

**Chapter 5** *List of Replaceable Parts* provides all of the information required to identify and order replacement parts for repairing the Multimeter at the PCA level.

### Warning

**To avoid electric shock, personal injury, or death, carefully read the information under *Safety Considerations* before attempting to install, use, or service the Multimeter.**

## Safety Considerations

This instrument has been designed and tested in accordance with the European standard publication EN61010-1 : 2001 and U.S. / Canadian standard publications UL 61010-1:2004 and CAN/CSA-C22.2 No.61010.1-04. The instrument has been supplied in a safe condition.

This manual contains information and warnings that must be observed to keep the instrument in a safe condition and ensure safe operation.

Using or servicing this Multimeter in conditions other than as specified in the Service Manual could compromise your safety.

To use the Multimeter correctly and safely, read and adhere to the precautions on the *Safety Page* and follow all the safety instructions or warnings given throughout this manual and the Users Manual that relate to specific measurement functions. In addition, follow all generally accepted safety practices and procedures required when working with and around electricity.

## **Safety Information**

A **Warning** identifies conditions and procedures that are dangerous to the user.

### **Warning**

To prevent possible electrical shock, fire, or personal injury:

- Read all safety information before you use the Product.
- Carefully read all instructions.
- Use the Product only as specified, or the protection supplied by the Product can be compromised.
- Use extreme caution when the Product is in use. The Product can supply a lethal electric shock.
- Do not use the Product if it operates incorrectly.
- Examine the Product before use. Do not use the Product if it shows signs of damage. Carefully examine the insulation around the connectors.
- Do not use the Product around explosive gas, vapor, or in damp or wet environments.
- Do not use and disable the Product if it is damaged.
- Do not apply more than the rated voltage, between the terminals or between each terminal and earth ground.
- Do not touch voltages >30 V ac rms, 42 V ac peak, or 60 V dc.
- Measure a known voltage first to make sure that the Product operates correctly.
- Do not use test leads if they are damaged. Examine the test leads for damaged insulation, exposed metal, or if the wear indicator shows. Check test lead continuity.
- Use conductors of adequate gauge to make current measurements. High current can cause excessive heating of underrated conductors and can cause a fire.
- Use this Product indoors only.
- Use only the mains power cord and connector approved for the voltage and plug configuration in your country and rated for the Product.
- Make sure the ground conductor in the mains power cord is connected to a protective earth ground. Disruption of the protective earth could put voltage on the chassis that could cause death.
- Replace the mains power cord if the insulation is damaged or if the insulation shows signs of wear.
- If the mains power cord is to be the accessible disconnect device, the mains power cord must not be longer than 3 meters (118.1 inches).
- Remove all probes, test leads, and accessories that are not necessary for the measurement.
- Do not remove the cover until the test leads are removed.
- Turn the Product off and remove the mains power cord. Stop for two minutes to let the power assemblies discharge before you open the fuse door.

- Do not operate the Product with covers removed or the case open. Hazardous voltage exposure is possible.
- Disconnect the mains power cord before you remove the Product covers.
- Remove the input signals before you clean the Product.
- Use only specified replacement parts.
- Use only specified replacement fuses.
- The mains power service must be rated for 16 A, and if the mains power cord is internally fused, a 10 A fuse must be fitted in the mains power cord plug.
- Have an approved technician repair the Product.
- When the cover is removed, voltages more than 1.5 KV can be present.
- Properly terminate the sense leads to prevent exposure to hazardous voltages on the sense terminals. The voltage sense terminals are at output voltage when the two-wire function is set.
- Never touch a lead or terminal on the Product when a dangerous voltage is present.
- Do not use low voltage spade-terminated leads to connect to a hazardous voltage ( $>32$  V ac rms or  $>42$  V pk). A general purpose probe kit is supplied with the Product for safe measurement at higher voltages.
- Do not touch exposed metal on banana plugs, they can have voltages that could cause death.
- Do not use test leads if they are damaged. Examine the test leads for damaged insulation and measure a known voltage.
- Use the correct terminals, function, and range for measurements.
- Keep fingers behind the finger guards on the probes.
- Connect the common test lead before the live test lead and remove the live test lead before the common test lead.
- Remove signal connections before the protective ground connection is removed. For example, the mains power cord must be connected when the signal leads are connected.
- Do not connect or disconnect signal leads while they are connected to a hazardous voltage or current source.
- Disconnect power and discharge all high-voltage capacitors before you measure resistance, continuity, capacitance, or a diode junction.
- Before the Product is connected to a circuit to make a current measurement, check the fuses on the Product and turn off the power to the circuit.
- Limit operation to the specified measurement category, voltage, or amperage ratings.
- Do not connect measurement probes directly to mains.
- Complete safety tests after a part replacement to make sure the Product is safe.
- Do not connect an external capacitance greater than 50 nF to the Product terminals.

## Symbols

The following safety and electrical symbols may be used on the Multimeter or in this manual.

|                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                   |                                |
|-------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|--------------------------------|
|    | Risk of danger. Important information. See manual.                                                                                                                                                                                                                                                                                                                                                                                                                                                 |  | AC (Alternating Current).      |
|    | Hazardous voltage. Voltage >30 V dc or ac peak might be present.                                                                                                                                                                                                                                                                                                                                                                                                                                   |  | DC (Direct Current).           |
|    | AC or DC (Alternating or Direct Current)                                                                                                                                                                                                                                                                                                                                                                                                                                                           |  | Potentially hazardous voltage. |
|    | Digital signal.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |  | Power ON / OFF                 |
|    | Earth ground.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |  | Fuse.                          |
|    | Recycle.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |  | Double insulated.              |
| <b>CAT II</b>                                                                       | Measurement Category II is applicable to test and measuring circuits connected directly to utilization points (socket outlets and similar points) of the low-voltage MAINS installation.                                                                                                                                                                                                                                                                                                           |                                                                                   |                                |
| <b>CAT III</b>                                                                      | Measurement Category III is applicable to test and measuring circuits connected to the distribution part of the building's low-voltage MAINS installation.                                                                                                                                                                                                                                                                                                                                         |                                                                                   |                                |
| <b>CAT IV</b>                                                                       | Measurement Category IV is applicable to test and measuring circuits connected at the source of the building's low-voltage MAINS installation.                                                                                                                                                                                                                                                                                                                                                     |                                                                                   |                                |
|  | This product complies with the WEEE Directive (2002/96/EC) marking requirements. The affixed label indicates that you must not discard this electrical/electronic product in domestic household waste. Product Category: With reference to the equipment types in the WEEE Directive Annex I, this product is classed as category 9 "Monitoring and Control Instrumentation" product. Do not dispose of this product as unsorted municipal waste. Go to Fluke's website for recycling information. |                                                                                   |                                |
| <b>CE</b>                                                                           | Product conforms with the requirements of the applicable EC directives.                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                   |                                |

## Service Information

In case of difficulty within the 1-year Warranty period, return the Multimeter to a Fluke Service Center for Warranty repair. For out of Warranty repair, contact a Fluke Service Center for a cost estimate.

This service manual provides instructions for verification of performance, calibration, and maintenance. If you choose to repair a malfunction, information in this manual can help you to determine which module (PCA) has a fault. See Chapter 5 for cautions about handling the internal components.

## Contact Fluke Calibration

To contact Fluke Calibration, call one of the subsequent telephone numbers:

- Technical Support USA: 1-877-355-3225
- Calibration/Repair USA: 1-877-355-3225
- Canada: 1-800-36-FLUKE (1-800-363-5853)
- Europe: +31-40-2675-200
- Japan: +81-3-6714-3114
- Singapore: +65-6799-5566
- China: +86-400-810-3435
- Brazil: +55-11-3759-7600
- Anywhere in the world: +1-425-446-6110

To see product information and download the latest manual supplements, visit Fluke Calibration's website at [www.flukecal.com](http://www.flukecal.com).

To register your product, visit <http://flukecal.com/register-product>.

## Specifications

Figure 1-1 shows the overall dimensions of the 8505A Reference Multimeter.

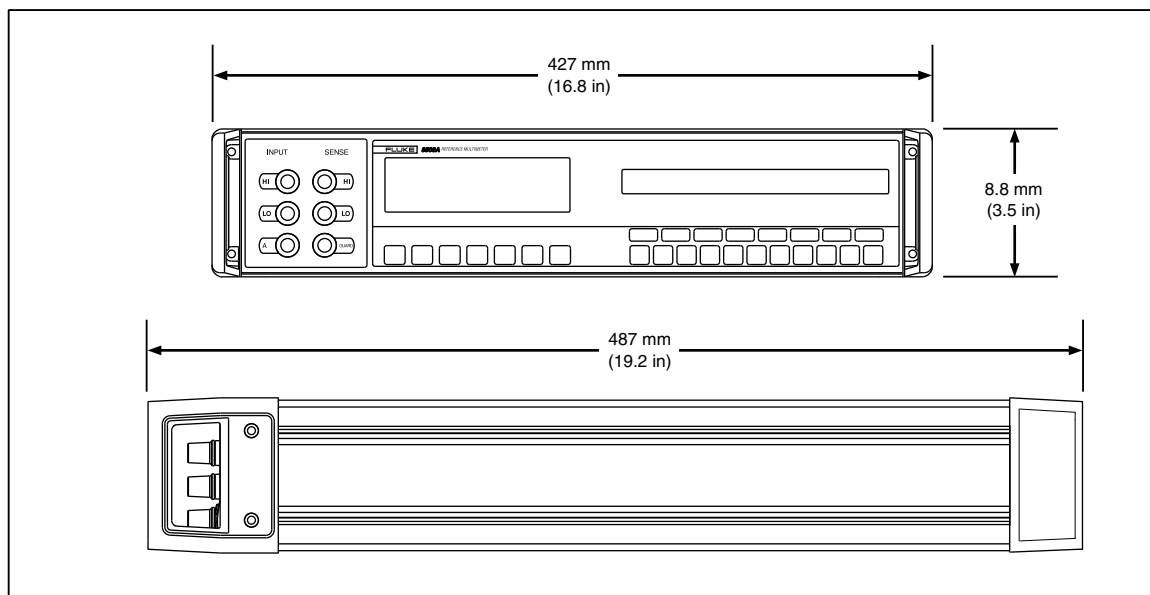


Figure 1-1. 8505A Dimensional Outline Drawing

avw001f.eps

## General Specifications

### Power

#### Voltage

|                     |                                                                             |
|---------------------|-----------------------------------------------------------------------------|
| 115 V Setting ..... | 100 V to 120 V rms designed for additional voltage fluctuations $\pm 10$ %. |
| 230 V Setting ..... | 200 V to 240 V rms designed for additional voltage fluctuations $\pm 10$ %. |

Frequency ..... 50 Hz to 60 Hz designed for additional frequency variation of  $\pm 3$  Hz.

Consumption ..... < 80 VA

Power Cord ..... NEMA 5-15 plug, IEC 60320-C13 receptacle, cable 3 core 18AWG to SVT

### Dimensions

Height..... 88 mm (3.5 inches)

Width..... 427 mm (16.8 inches)

Depth ..... 487 mm (19.2 inches)

Weight..... 11.5 kg (25.5 lbs)

### Environment

#### Temperature

Operating..... 0 °C to 50 °C

Specified Operation ..... 5 °C to 40 °C

Calibration (TCal)..... 20 °C to 25 °C

Factory Cal Temp ..... 23 °C

Storage ..... -20 °C to 70 °C

Warm Up..... 4 hours to full uncertainty specification.

#### Relative Humidity (non- condensing)

Operating<sup>[18]</sup> ..... 5 °C to 40 °C < 90 %.

Storage ..... 0 °C to 70 °C < 95 %

#### Altitude

Operating..... < 2000 meters

Storage ..... < 12000 meters

Vibration and Shock..... Complies with MIL-PRF-28800F Class 3.

**Safety** ..... Designed and tested to IEC/EN61010-1: 2001,  
UL 61010-1:2004,  
CAN/CSA-C22.2 No.61010.1-04,  
CE marked and ETL (US & C) listed.  
Pollution Degree 2.  
Installation Category II.  
Equipment Class I (single insulation / Earthed metal case).  
Protection against water ingress IP20 (general indoor conditions).

**EMC** ..... EN61326-1:2006 class B,  
FCC Rules part 15 sub part B,

### Measurement Isolation

Guard to Safety Ground ..... < 3300 pF, > 10 G $\Omega$ .

#### Lo to Guard

In Remote Guard ..... < 2800 pF, > 10 G $\Omega$  (Not in Resistance function).

In Local Guard ..... Lo and Guard terminals are internally shorted  
(in Resistance < 2800 pF, > 10 G $\Omega$ ).

### Autorange

Range Up..... 100 % of range.

Range Down ..... 9 % of range (18 % on 1000 V range).

**Remote Interface**..... IEEE 488.2

**Warranty** ..... 1 Year

## Maximum Voltage and Current Inputs

### Notes to maximum voltage and current input specifications

- Maximum DC input equal to maximum rms input. Maximum peak input is rms x 1.414
- Specifications apply equally to front and rear input terminals except where noted below.
- Front to rear isolation allows opposing polarity of maximum terminal voltage on each input.
- Digital I/O Ground (DigGnd) is internally connected to Safety Ground (Ground).
- Maximum Common Mode voltage with respect to Safety Ground is  $1.7 \times 10^5$  VHz.

### DC and AC Voltage

#### Maximum rms terminal voltages

|        |        |       |       |       |          |        | Sense Hi |
|--------|--------|-------|-------|-------|----------|--------|----------|
|        |        |       |       |       |          |        | 250 V    |
| Ground | DigGnd | Guard | A     | Lo    | Sense Lo | Hi     | 1000 V   |
|        |        |       |       |       |          |        | 1000 V   |
|        |        |       |       |       |          |        | 1000 V   |
|        |        |       |       |       |          |        | 1000 V   |
|        |        |       |       |       |          |        | 1000 V   |
|        |        |       |       |       |          |        | 1000 V   |
| Notes  | 0 V    | 650 V | 650 V | 650 V | 650 V    | 1000 V | 1000 V   |
|        |        |       |       |       |          |        | 1000 V   |

- The A terminal is open circuit in these functions.
- In 4wV mode Sense Hi is internally connected to Hi and Sense Lo is internally connected to Lo.

### DC and AC Current

#### Maximum rms terminal voltages

|        |        |       |       |       |          |        |  | Sense Hi |
|--------|--------|-------|-------|-------|----------|--------|--|----------|
|        |        |       |       |       |          |        |  | 250 V    |
| Ground | DigGnd | Guard | A     | Lo    | Sense Lo | Hi     |  | 1000 V   |
|        |        |       |       |       |          |        |  | 1000 V   |
|        |        |       |       |       |          |        |  | 1000 V   |
|        |        |       |       |       |          |        |  | 1000 V   |
|        |        |       |       |       |          |        |  | 1000 V   |
|        |        |       |       |       |          |        |  | 1000 V   |
| Notes  | 0 V    | 650 V | 650 V | 650 V | 650 V    | 1000 V |  | 1000 V   |
|        |        |       |       |       |          |        |  | 1000 V   |

#### Maximum rms terminal currents

|             | Guard | A    | Lo   | Sense Lo | Hi  | Sense Hi |
|-------------|-------|------|------|----------|-----|----------|
| Front Input | n.a   | 20 A | 20 A | n.a      | n.a | n.a      |
| Rear input  | n.a   | 2 A  | 2 A  | n.a      | n.a | n.a      |

#### Notes

- The Sense Lo, Sense Hi, and Hi Terminals are open circuit in these functions.
- The front input A terminal protection is automatic and self-resetting, and does not interrupt current flow. Damage is likely to occur if more than 20 A is applied.
- The rear input A terminal is protected by a fuse mounted on the rear panel.

### Resistance and Temperature

#### Maximum rms terminal voltages

|        |        |       |       |       |          |        |  | Sense Hi |
|--------|--------|-------|-------|-------|----------|--------|--|----------|
|        |        |       |       |       |          |        |  | 250 V    |
| Ground | DigGnd | Guard | A     | Lo    | Sense Lo | Hi     |  | 250 V    |
|        |        |       |       |       |          |        |  | 250 V    |
|        |        |       |       |       |          |        |  | 250 V    |
|        |        |       |       |       |          |        |  | 250 V    |
|        |        |       |       |       |          |        |  | 250 V    |
|        |        |       |       |       |          |        |  | 250 V    |
| Note   | 0 V    | 650 V | 650 V | 650 V | 650 V    | 1000 V |  | 1000 V   |
|        |        |       |       |       |          |        |  | 1000 V   |

- The A terminal is open circuit in these functions.

## Electrical Measurement Specifications

Note

Fluke guarantees 8508A performance verification using specifications stated to 99 % confidence level.

### DC Voltage

#### DC Voltage <sup>[1] [2] [3]</sup>

| Range                 | Full Scale <sup>[15]</sup> | Uncertainty Relative to Cal Stds           |                      |                       | Absolute Uncertainties |                       |
|-----------------------|----------------------------|--------------------------------------------|----------------------|-----------------------|------------------------|-----------------------|
|                       |                            | ± (ppm Reading + ppm Range) <sup>[4]</sup> |                      |                       |                        |                       |
|                       |                            | 24 hour<br>TCal ±1 °C                      | 90 day<br>TCal ±1 °C | 365 day<br>TCal ±1 °C | 365 day<br>TCal ±1 °C  | 365 day TCal<br>±5 °C |
| 95 % Confidence Level |                            |                                            |                      |                       |                        |                       |
| 200 mV                | 199.990 000                | 0.7 + 0.5                                  | 1.4 + 0.5            | 2.7 + 0.5             | 4.5 + 0.5              | 5.0 + 0.5             |
| 2 V                   | 1.999 900 00               | 0.5 + 0.2                                  | 1.4 + 0.2            | 2.7 + 0.2             | 3.0 + 0.2              | 3.5 + 0.2             |
| 20 V                  | 19.999 000 0               | 0.5 + 0.2                                  | 1.4 + 0.2            | 2.7 + 0.2             | 3.0 + 0.2              | 3.5 + 0.2             |
| 200 V                 | 199.990 000                | 1.0 + 0.2                                  | 2.6 + 0.2            | 4.0 + 0.2             | 4.5 + 0.2              | 5.5 + 0.2             |
| 1000 V                | 1050.000 00                | 1.0 + 0.5                                  | 2.6 + 0.5            | 4.0 + 0.5             | 4.5 + 0.5              | 5.5 + 0.5             |
| 99 % Confidence Level |                            |                                            |                      |                       |                        |                       |
| 200 mV                | 199.990 000                | 0.8 + 0.6                                  | 2.0 + 0.6            | 3.5 + 0.6             | 6.0 + 0.6              | 6.5 + 0.6             |
| 2 V                   | 1.999 900 00               | 0.6 + 0.25                                 | 1.8 + 0.25           | 3.5 + 0.25            | 4.0 + 0.25             | 4.5 + 0.25            |
| 20 V                  | 19.999 000 0               | 0.6 + 0.25                                 | 1.8 + 0.25           | 3.5 + 0.25            | 4.0 + 0.25             | 4.5 + 0.25            |
| 200 V                 | 199.990 000                | 1.2 + 0.25                                 | 3.5 + 0.25           | 5.2 + 0.25            | 6.0 + 0.25             | 7.0 + 0.25            |
| 1000 V                | 1050.000 00                | 1.2 + 0.6                                  | 3.5 + 0.6            | 5.2 + 0.6             | 6.0 + 0.6              | 7.0 + 0.6             |

#### DC Voltage (Secondary Specifications) <sup>[1] [2] [3]</sup>

| Range  | Transfer Uncertainty<br>20 mins $\pm 1^\circ\text{C}$ $\pm$ (ppm<br>Reading + ppm Range) | Temperature Coefficient             |                               |                              |
|--------|------------------------------------------------------------------------------------------|-------------------------------------|-------------------------------|------------------------------|
|        |                                                                                          | 15 °C - 30 °C                       | 5 °C - 15 °C<br>30 °C - 40 °C | 5 °C - 40 °C <sup>[16]</sup> |
|        |                                                                                          | $\pm$ ppm Reading/ $^\circ\text{C}$ |                               | $\pm$ V/ $^\circ\text{C}$    |
| 200 mV | 0.4 + 0.3                                                                                | 0.4                                 | 0.6                           | 100 n                        |
| 2 V    | 0.12 + 0.1                                                                               | 0.3                                 | 0.5                           | 200 n                        |
| 20 V   | 0.12 + 0.1                                                                               | 0.3                                 | 0.5                           | 1 $\mu$                      |
| 200 V  | 0.4 + 0.1                                                                                | 0.7                                 | 1.0                           | 20 $\mu$                     |
| 1000 V | 0.4 + 0.3                                                                                | 0.7                                 | 1.0                           | 100 $\mu$                    |

**Type** ..... Multi-slope, multi-cycle A-D Converter

**CMRR** (1 k $\Omega$  unbalance) <sup>[5]</sup> ..... 140 dB at DC and 1 - 60 Hz

**NMRR** <sup>[5]</sup>

Filter Out ..... 60 dB at 50/60 Hz  $\pm 0.09$  %

Filter In ..... 110 dB at 50/60 Hz  $\pm 0.09$  %

**Protection** (All ranges) ..... 1 kV rms

#### Input Impedance

200 mV to 20 V Ranges ..... > 10 G $\Omega$

200 V & 1000 V Ranges ..... 10.1 M $\Omega$   $\pm 1$  %

**Max Input Current** ..... 50 pA

#### Ratio Accuracy

Range to Range ..... Apply an RSS summation of Net Front Input Accuracy and Net Rear Input Accuracy <sup>[17]</sup>

Within Range ..... Using the 24 hour or 20 minute Transfer Uncertainty specifications as appropriate, apply an RSS summation of specified accuracy of the Front Input signal and the specified accuracy of the Rear Input signal <sup>[17]</sup>

#### Settling Time (to 10 ppm step size)

Filter Out ..... < 50 ms

Filter In ..... < 1 s

## DC Current

### DC Current <sup>[1][2][3]</sup>

| Range                 | Full Scale <sup>[15]</sup> | Uncertainty Relative to Cal Stds           |                      |                       | Absolute Uncertainties |                       |
|-----------------------|----------------------------|--------------------------------------------|----------------------|-----------------------|------------------------|-----------------------|
|                       |                            | ± (ppm Reading + ppm Range) <sup>[4]</sup> |                      |                       |                        |                       |
|                       |                            | 24 hour<br>TCal ±1 °C                      | 90 day<br>TCal ±1 °C | 365 day<br>TCal ±1 °C | 365 day<br>TCal ±1 °C  | 365 day<br>TCal ±5 °C |
| 95 % Confidence Level |                            |                                            |                      |                       |                        |                       |
| 200 µA                | 199.990 00                 | 5.5 + 2.0                                  | 6.0 + 2.0            | 6.5 + 2.0             | 12 + 2.0               | 12 + 2.0              |
| 2 mA                  | 1.999 900 0                | 5.5 + 2.0                                  | 6.0 + 2.0            | 6.5 + 2.0             | 12 + 2.0               | 12 + 2.0              |
| 20 mA                 | 19.999 000                 | 6.5 + 2.0                                  | 7.0 + 2.0            | 8.0 + 2.0             | 13 + 2.0               | 14 + 2.0              |
| 200 mA                | 199.990 00                 | 28 + 4.0                                   | 30 + 4.0             | 33 + 4.0              | 36 + 4.0               | 48 + 4.0              |
| 2 A                   | 1.999 900 0                | 80 + 8.0                                   | 125 + 8.0            | 170 + 8.0             | 170 + 8.0              | 185 + 8.0             |
| 20 A                  | 19.999 000                 | 200 + 20                                   | 290 + 20             | 380 + 20              | 380 + 20               | 400 + 20              |
| 99 % Confidence Level |                            |                                            |                      |                       |                        |                       |
| 200 µA                | 199.990 00                 | 7.0 + 2.0                                  | 7.5 + 2.0            | 8.0 + 2.0             | 15 + 2.0               | 16 + 2.0              |
| 2 mA                  | 1.999 900 0                | 7.0 + 2.0                                  | 7.5 + 2.0            | 8.0 + 2.0             | 15 + 2.0               | 16 + 2.0              |
| 20 mA                 | 19.999 000                 | 8.0 + 2.0                                  | 9.0 + 2.0            | 10 + 2.0              | 16 + 2.0               | 18 + 2.0              |
| 200 mA                | 199.990 00                 | 35 + 4.0                                   | 37 + 4.0             | 40 + 4.0              | 45 + 4.0               | 60 + 4.0              |
| 2 A                   | 1.999 900 0                | 100 + 8.0                                  | 150 + 8.0            | 205 + 8.0             | 210 + 8.0              | 225 + 8.0             |
| 20 A                  | 19.999 000                 | 250 + 20                                   | 350 + 20             | 450 + 20              | 455 + 20               | 500 + 20              |

### DC Current (Secondary Specifications) <sup>[1][2][3]</sup>

| Range       | Input Impedance ( $\Omega$ ) |      | Temperature Coefficient |                               |                              |
|-------------|------------------------------|------|-------------------------|-------------------------------|------------------------------|
|             |                              |      | 15 °C - 30 °C           | 5 °C - 15 °C<br>30 °C - 40 °C | 5 °C - 40 °C <sup>[16]</sup> |
|             | Front                        | Rear | $\pm$ ppm Reading/°C    |                               | $\pm$ A/°C                   |
| 200 $\mu$ A | 150                          | 150  | 0.4                     | 0.6                           | 50 p                         |
| 2 mA        | 15.2                         | 15.2 | 0.4                     | 0.6                           | 300 p                        |
| 20 mA       | 1.8                          | 1.9  | 1.2                     | 1.8                           | 3 n                          |
| 200 mA      | 1.2                          | 1.3  | 6.0                     | 9.0                           | 50 n                         |
| 2 A         | 0.3                          | 0.4  | 8.0                     | 12                            | 500 n                        |
| 20 A        | 0.04                         | -    | 15                      | 20                            | 10 $\mu$                     |

**Type**..... Multi-slope, multi-cycle A-D Converter

#### Protection

Front Input..... 20 A rms

Rear Input ..... 2 A rms, Rear Panel Fuse

#### Settling Time

200  $\mu$ A to 200 mA Ranges, to 10 ppm step size .... Filter Out < 50 ms, Filter In < 1 s

#### 2 A Range

to 100 ppm step size..... < 1 s

to 75 ppm step size..... < 30 s

to 30 ppm step size..... < 5 minutes

#### 20 A Range (at 10 A)

to 300 ppm step size..... < 1 s

to 250 ppm step size..... < 30 s

to 100 ppm step size..... < 5 minutes

## AC Voltage

### AC Voltage <sup>[1] [2] [6] [7] [9]</sup>

| Range                 | Full Scale <sup>[15]</sup>          | Frequency (Hz) | Uncertainty Relative to Cal Stds           |                      |                       | Absolute Uncertainties |                       |
|-----------------------|-------------------------------------|----------------|--------------------------------------------|----------------------|-----------------------|------------------------|-----------------------|
|                       |                                     |                | ± (ppm Reading + ppm Range) <sup>[4]</sup> |                      |                       |                        |                       |
|                       |                                     |                | 24 hour<br>TCal ±1 °C                      | 90 day<br>TCal ±1 °C | 365 day<br>TCal ±1 °C | 365 day<br>TCal ±1 °C  | 365 day<br>TCal ±5 °C |
| 95% Confidence Level  |                                     |                |                                            |                      |                       |                        |                       |
| 200 mV                | 199.990 0                           | 1 - 10         | 80 + 70                                    | 120 + 70             | 120 + 70              | 160 + 70               | 165 + 70              |
|                       |                                     | 10 - 40        | 80 + 20                                    | 120 + 20             | 120 + 20              | 130 + 20               | 140 + 20              |
|                       |                                     | 40 - 100       | 60 + 20                                    | 100 + 20             | 100 + 20              | 110 + 20               | 115 + 20              |
|                       |                                     | 100 - 2 k      | 40 + 10                                    | 100 + 10             | 100 + 10              | 105 + 10               | 110 + 10              |
|                       |                                     | 2k - 10 k      | 60 + 20                                    | 100 + 20             | 100 + 20              | 105 + 20               | 135 + 20              |
|                       |                                     | 10k - 30 k     | 250 + 30                                   | 300 + 40             | 300 + 40              | 305 + 40               | 340 + 40              |
|                       |                                     | 30k - 100 k    | 400 + 100                                  | 700 + 100            | 700 + 100             | 705 + 100              | 765 + 100             |
| 2 V, 20 V &<br>200 V  | 1.999 900<br>19.999 00<br>199.990 0 | 1 - 10         | 70 + 60                                    | 100 + 60             | 100 + 60              | 140 + 60               | 150 + 60              |
|                       |                                     | 10 - 40        | 70 + 10                                    | 100 + 10             | 100 + 10              | 105 + 10               | 115 + 10              |
|                       |                                     | 40 - 100       | 50 + 10                                    | 80 + 10              | 80 + 10               | 85 + 10                | 90 + 10               |
|                       |                                     | 100 - 2 k      | 30 + 10                                    | 60 + 10              | 60 + 10               | 65 + 10                | 75 + 10               |
|                       |                                     | 2 k - 10 k     | 50 + 10                                    | 80 + 10              | 80 + 10               | 85 + 10                | 110 + 10              |
|                       |                                     | 10 k - 30 k    | 100 + 20                                   | 200 + 20             | 200 + 20              | 205 + 20               | 220 + 20              |
|                       |                                     | 30 k - 100 k   | 250 + 100                                  | 500 +100             | 500 +100              | 505 + 100              | 570 + 100             |
|                       |                                     | 100 k - 300 k  | 0.15 % + 0.1 %                             | 0.3 % + 0.1 %        | 0.3 % + 0.1 %         | 0.3 % + 0.1 %          | 0.3 % + 0.1 %         |
| 300 k - 1 M           | 1 % + 0.5 %                         | 1 % + 1 %      | 1 % + 1 %                                  | 1 % + 1 %            | 1 % + 1 %             |                        |                       |
| 1000 V <sup>[8]</sup> | 1050.000                            | 1 - 10         | 70 + 70                                    | 100 + 70             | 100 + 70              | 140 + 70               | 150 + 70              |
|                       |                                     | 10 - 40        | 70 + 20                                    | 100 + 20             | 100 + 20              | 110 + 20               | 120 + 20              |
|                       |                                     | 40 - 10 k      | 50 + 20                                    | 80 + 20              | 80 + 20               | 95 + 20                | 115 + 20              |
|                       |                                     | 10 k - 30 k    | 100 + 40                                   | 200 + 40             | 200 + 40              | 205 + 40               | 225 + 40              |
|                       |                                     | 30 k - 100 k   | 250 + 200                                  | 500 + 200            | 500 + 200             | 510 + 200              | 580 + 200             |
| 99% Confidence Level  |                                     |                |                                            |                      |                       |                        |                       |
| 200 mV                | 199.990 0                           | 1 - 10         | 90 + 80                                    | 140 + 80             | 140 + 80              | 200 + 80               | 210 + 80              |
|                       |                                     | 10 - 40        | 90 + 25                                    | 140 + 25             | 140 + 25              | 145 + 25               | 160 + 25              |
|                       |                                     | 40 - 100       | 70 + 25                                    | 115 + 25             | 115 + 25              | 125 + 25               | 135 + 25              |
|                       |                                     | 100 - 2 k      | 45 + 12                                    | 115 + 12             | 115 + 12              | 125 + 12               | 135 + 12              |
|                       |                                     | 2 k - 10 k     | 70 + 25                                    | 115 + 25             | 115 + 25              | 125 + 25               | 165 + 25              |
|                       |                                     | 10 k - 30 k    | 270 + 35                                   | 340 + 50             | 340 + 50              | 345 + 50               | 395 + 50              |
|                       |                                     | 30 k - 100 k   | 450 + 120                                  | 750 + 120            | 750 + 120             | 755 + 120              | 855 + 120             |
| 2 V, 20 V &<br>200 V  | 1.999 900<br>19.999 00<br>199.990 0 | 1 - 10         | 80 + 70                                    | 115 + 70             | 115 + 70              | 180 + 70               | 190 + 70              |
|                       |                                     | 10 - 40        | 80 + 12                                    | 115 + 12             | 115 + 12              | 120 + 12               | 135 + 12              |
|                       |                                     | 40 - 100       | 60 + 12                                    | 90 + 12              | 90 + 12               | 95 + 12                | 110 + 12              |
|                       |                                     | 100 - 2 k      | 35 + 12                                    | 70 + 12              | 70 + 12               | 75 + 12                | 90 + 12               |
|                       |                                     | 2 k - 10 k     | 60 + 12                                    | 90 + 12              | 90 + 12               | 95 + 12                | 135 + 12              |
|                       |                                     | 10 k - 30 k    | 115 + 25                                   | 240 + 25             | 240 + 25              | 245 + 25               | 260 + 25              |
|                       |                                     | 30 k - 100 k   | 270 + 120                                  | 550 + 120            | 550 +120              | 555 + 120              | 650 + 120             |
|                       |                                     | 100 k - 300 k  | 0.15 % + 0.12 %                            | 0.3 % + 0.12 %       | 0.3 % + 0.12 %        | 0.3 % + 0.12 %         | 0.3 % + 0.12 %        |
| 300 k - 1 M           | 1 % + 0.6 %                         | 1 % + 1.2 %    | 1 % + 1.2 %                                | 1 % + 1.2 %          | 1 % + 1.2 %           |                        |                       |
| 1000 V <sup>[8]</sup> | 1050.000                            | 1 - 10         | 80 + 80                                    | 115 + 80             | 115 + 80              | 180 + 80               | 190 + 80              |
|                       |                                     | 10 - 40        | 80 + 25                                    | 115 + 25             | 115 + 25              | 135 + 25               | 145 + 25              |
|                       |                                     | 40 - 10 k      | 60 + 25                                    | 90 + 25              | 90 + 25               | 110 + 25               | 140 + 25              |
|                       |                                     | 10 k - 30 k    | 115 + 50                                   | 240 + 50             | 240 + 50              | 250 + 50               | 265 + 50              |
|                       |                                     | 30 k - 100 k   | 270 + 250                                  | 600 + 250            | 600 + 250             | 615 + 250              | 700 + 250             |

**AC Voltage (Secondary Specifications)<sup>[1] [2] [9]</sup>**

| Range                | Frequency (Hz) | Temperature Coefficient |                               |
|----------------------|----------------|-------------------------|-------------------------------|
|                      |                | 15 °C - 30 °C           | 5 °C - 15 °C<br>30 °C - 40 °C |
|                      |                | ± ppm Reading/°C        |                               |
| 200 mV               | 1 - 10         | 5                       | 10                            |
|                      | 10 - 40        | 5                       | 10                            |
|                      | 40 - 100       | 5                       | 10                            |
|                      | 100 - 2 k      | 5                       | 10                            |
|                      | 2 k - 10 k     | 12                      | 20                            |
|                      | 10 k - 30 k    | 15                      | 20                            |
|                      | 30 k - 100 k   | 40                      | 60                            |
| 2 V<br>20 V<br>200 V | 1 - 10         | 5                       | 10                            |
|                      | 10 - 40        | 5                       | 10                            |
|                      | 40 - 100       | 5                       | 10                            |
|                      | 100 - 2 k      | 5                       | 10                            |
|                      | 2 k - 10 k     | 10                      | 15                            |
|                      | 10 k - 30 k    | 12                      | 20                            |
|                      | 30 k - 100 k   | 40                      | 60                            |
|                      | 100 k - 300 k  | 60                      | 90                            |
| 1000 V               | 300 k - 1 M    | 80                      | 120                           |
|                      | 1 - 10         | 5                       | 10                            |
|                      | 10 - 40        | 5                       | 10                            |
|                      | 40 - 10 k      | 10                      | 15                            |
|                      | 10 k - 30 k    | 12                      | 20                            |
|                      | 30 k - 100 k   | 40                      | 60                            |

**Type** ..... True rms, AC coupled measures AC component with up to 1000 V DC bias on any range. DC coupled gives  $\sqrt{(ac^2 + dc^2)}$

**CMRR** (1 k $\Omega$  unbalance) <sup>[5]</sup> ..... > 90 dB DC - 60 Hz

**Crest Factor**

200 mV to 200 V ranges ..... 10:1 at 12 % range, 5:1 at 50 % range, 2.5:1 at full range

1000 V range ..... 10:1 at 25 % range, 5:1 at full range

**Protection** (All ranges)..... 1 kV rms

**Input Impedance** ..... 1 M $\Omega$  in parallel with 150 pF

**DC Accuracy** (DC Coupled)..... Add  $\pm(50 \text{ ppm Reading} + 50 \text{ ppm Range} + 20 \mu\text{V})$

**Ratio Accuracy**

Range to Range..... Apply an RSS summation of Net Front Input and Rear Input Accuracy <sup>[17]</sup>

Within Range ..... Using the 24 hour specifications as appropriate, apply an RSS summation of specified accuracy of the Front Input signal and the specified accuracy of the Rear Input signal <sup>[17]</sup>

**Settling Time** (to 100 ppm step size)

100 Hz filter ..... < 0.5 s

40 Hz filter ..... < 1.25 s

10 Hz filter ..... < 5 s

1 Hz filter ..... < 50 s

**Frequency Measurement**

Signal Amplitude Range ..... 5 % of range to limit set by maximum V/Hz

Gate Mode ..... Normal ..... Fast

Resolution ..... 6.5 digits ..... 4.5 digits

Frequency Range ..... 10 Hz - 1 MHz ..... 200 Hz - 1 MHz

Accuracy (1 year, 13 °C - 33 °C) .....  $\pm (10 \text{ ppm of Reading} + 2 \text{ digits})$  .....  $\pm 2 \text{ digits}$

Sample Interval ..... 1 s ..... 50 ms

## AC Current

### AC Current <sup>[1] [2] [6] [9]</sup>

| Range                | Full Scale <sup>[15]</sup> | Frequency<br>(Hz) | Uncertainty Relative to Cal Stds           |                      |                       | Absolute Uncertainties |                       |
|----------------------|----------------------------|-------------------|--------------------------------------------|----------------------|-----------------------|------------------------|-----------------------|
|                      |                            |                   | ± (ppm Reading + ppm Range) <sup>[4]</sup> |                      |                       |                        |                       |
|                      |                            |                   | 24 hour<br>TCal ±1 °C                      | 90 day<br>TCal ±1 °C | 365 day<br>TCal ±1 °C | 365 day<br>TCal ±1 °C  | 365 day<br>TCal ±5 °C |
| 95% Confidence Level |                            |                   |                                            |                      |                       |                        |                       |
| 200 μA               | 199.990 0                  | 1 - 10            | 200 + 100                                  | 250 + 100            | 250 + 100             | 475 + 100              | 500 + 100             |
|                      |                            | 10 - 10 k         | 200 + 100                                  | 250 + 100            | 250 + 100             | 475 + 100              | 500 + 100             |
|                      |                            | 10 k - 30 k       | 500 + 100                                  | 600 + 100            | 600 + 100             | 650 + 100              | 710 + 100             |
|                      |                            | 30 k - 100 k      | 0.35 % + 100                               | 0.4 % + 100          | 0.4 % + 100           | 0.4 % + 100            | 0.4 % + 100           |
| 2 mA &<br>20 mA      | 1.999 900<br>19.9990 00    | 1 - 10            | 200 + 100                                  | 250 + 100            | 250 + 100             | 290 + 100              | 310+ 100              |
|                      |                            | 10 - 10 k         | 200 + 100                                  | 250 + 100            | 250 + 100             | 280 + 100              | 300 + 100             |
|                      |                            | 10 k - 30 k       | 500 + 100                                  | 600 + 100            | 600 + 100             | 650 + 100              | 710 + 100             |
|                      |                            | 30 k - 100 k      | 0.35 % + 100                               | 0.4 % + 100          | 0.4 % + 100           | 0.4 % + 100            | 0.4 % + 100           |
| 200 mA               | 199.990 0                  | 1 - 10            | 200 + 100                                  | 250 + 100            | 250 + 100             | 290 + 100              | 310 + 100             |
|                      |                            | 10 -10 k          | 200 + 100                                  | 250 + 100            | 250 + 100             | 250 + 100              | 290 + 100             |
|                      |                            | 10 k - 30 k       | 500 + 100                                  | 600 + 100            | 600 + 100             | 600 + 100              | 625 + 100             |
| 2 A                  | 1.999 900                  | 10 - 2 k          | 500 + 100                                  | 600 + 100            | 600 + 100             | 600 + 100              | 620 + 100             |
|                      |                            | 2 k - 10 k        | 600 + 100                                  | 700 + 100            | 700 + 100             | 710 + 100              | 735 + 100             |
|                      |                            | 10 k - 30 k       | 0.25 % + 100                               | 0.3 % + 100          | 0.3 % + 100           | 0.3 % + 100            | 0.3 % + 100           |
| 20 A                 | 19.999 00                  | 10 - 2 k          | 700 + 100                                  | 800 + 100            | 800 + 100             | 800 + 100              | 820 + 100             |
|                      |                            | 2 k - 10 k        | 0.2 % + 100                                | 0.25 % + 100         | 0.25 % + 100          | 0.25 % + 100           | 0.25 % + 100          |
| 99% Confidence Level |                            |                   |                                            |                      |                       |                        |                       |
| 200 μA               | 199.990 0                  | 1 - 10            | 250 + 120                                  | 300 + 120            | 300 + 120             | 590 + 120              | 620 + 120             |
|                      |                            | 10 - 10 k         | 250 + 120                                  | 300 + 120            | 300 + 120             | 590 + 120              | 620 + 120             |
|                      |                            | 10 k - 30 k       | 600 + 120                                  | 700 + 120            | 700 + 120             | 775 + 120              | 800 + 120             |
|                      |                            | 30 k - 100 k      | 0.35 % + 120                               | 0.4 % + 120          | 0.4 % + 120           | 0.4 % + 120            | 0.4 % + 120           |
| 2 mA &<br>20 mA      | 1.999 900<br>19.999 00     | 1 - 10            | 250 + 120                                  | 300 + 120            | 300 + 120             | 380 + 120              | 400 + 120             |
|                      |                            | 10 - 10 k         | 250 + 120                                  | 300 + 120            | 300 + 120             | 340 + 120              | 370 + 120             |
|                      |                            | 10 k - 30 k       | 600+ 120                                   | 700 + 120            | 700 + 120             | 775 + 120              | 800 + 120             |
|                      |                            | 30 k - 100 k      | 0.35 % + 120                               | 0.4 % + 120          | 0.4 % + 120           | 0.4 % + 120            | 0.4 % + 120           |
| 200 mA               | 199.990 0                  | 1 - 10            | 250 + 120                                  | 300 + 120            | 300 + 120             | 380 + 120              | 400 + 120             |
|                      |                            | 10 - 10 k         | 250 + 120                                  | 300 + 120            | 300 + 120             | 305 + 120              | 360 + 120             |
|                      |                            | 10 k - 30 k       | 600 + 120                                  | 700 + 120            | 700 + 120             | 700 + 120              | 740 + 120             |
| 2 A                  | 1.999 900                  | 10 - 2 k          | 600 + 120                                  | 700 + 120            | 700 + 120             | 705 + 120              | 725 + 120             |
|                      |                            | 2 k - 10 k        | 700 + 120                                  | 800 + 120            | 800 + 120             | 815 + 120              | 860 + 120             |
|                      |                            | 10 k - 30 k       | 0.25 % + 120                               | 0.3 % + 120          | 0.3 % + 120           | 0.3 % + 120            | 0.3 % + 120           |
| 20 A                 | 19.999 00                  | 10 - 2 k          | 800 + 120                                  | 900 + 120            | 900 + 120             | 900 + 120              | 920 + 120             |
|                      |                            | 2 k - 10 k        | 0.2 % + 120                                | 0.25 % + 120         | 0.25 % + 120          | 0.25 % + 120           | 0.25 % + 120          |

**AC Current (Secondary Specifications)** <sup>[1] [2] [6] [9]</sup>

| Range                   | Frequency (Hz) | Temperature Coefficient |                               | Input Impedance (Ω) |       |      |
|-------------------------|----------------|-------------------------|-------------------------------|---------------------|-------|------|
|                         |                | 15 °C - 30 °C           | 5 °C - 15 °C<br>30 °C - 40 °C |                     |       |      |
|                         |                | ± ppm Reading/°C        |                               | Range               | Front | Rear |
| 200 µA, 2 mA &<br>20 mA | 1 - 10         | 10                      | 15                            | 200 µA              | 150   | 150  |
|                         | 10 - 10 k      | 10                      | 15                            | 2 mA                | 15.2  | 15.2 |
|                         | 10 k - 30 k    | 12                      | 20                            | 20 mA               | 1.8   | 1.9  |
|                         | 30 k - 100 k   | 40                      | 60                            |                     |       |      |
| 200 mA                  | 1 - 10         | 10                      | 15                            |                     | 1.2   | 1.3  |
|                         | 10 - 10 k      | 15                      | 20                            |                     |       |      |
|                         | 10 k - 30 k    | 15                      | 20                            |                     |       |      |
| 2 A                     | 10 - 2 k       | 10                      | 15                            |                     | 0.3   | 0.4  |
|                         | 2 k - 10 k     | 15                      | 20                            |                     |       |      |
|                         | 10 k - 30 k    | 20                      | 30                            |                     |       |      |
| 20 A                    | 10 - 2 k       | 20                      | 25                            |                     | 0.04  | -    |
|                         | 2 k - 10 k     | 25                      | 30                            |                     |       |      |

**Type**..... True rms, AC coupled. DC coupled gives  $\sqrt{(ac^2 + dc^2)}$

**Crest Factor**..... 3:1 at 50 % range, 1.5:1 at full range

**Protection**

Front Input..... 20 A rms

Rear Input..... 2 A rms, Rear Panel Fuse

**Settling Time**

|                    | 200 µA to 200 mA Ranges | 2 A Range          | 20 A Range (at 10 A) |
|--------------------|-------------------------|--------------------|----------------------|
|                    | to 100 ppm of step      | to 100 ppm of step | to 300 ppm of step   |
| 100 Hz filter..... | < 0.5 s                 | < 1 s              | < 1 s                |
| 40 Hz filter.....  | < 1.25 s                | < 2 s              | < 2 s                |
| 10 Hz filter.....  | < 5 s                   | < 10 s             | < 10 s               |
| 1 Hz filter.....   | < 50 s                  | < 50 s             | < 50 s               |

## Resistance

| Resistance <sup>[1][2][3]</sup> |                            |                      |                                            |                      |                       |                        |                       |
|---------------------------------|----------------------------|----------------------|--------------------------------------------|----------------------|-----------------------|------------------------|-----------------------|
| Range                           | Full Scale <sup>[15]</sup> | Mode <sup>[10]</sup> | Uncertainty Relative to Cal Stds           |                      |                       | Absolute Uncertainties |                       |
|                                 |                            |                      | ± (ppm Reading + ppm Range) <sup>[4]</sup> |                      |                       |                        |                       |
|                                 |                            |                      | 24 hour<br>TCal ±1 °C                      | 90 day<br>TCal ±1 °C | 365 day<br>TCal ±1 °C | 365 day<br>TCal ±1 °C  | 365 day<br>TCal ±5 °C |
| 95% Confidence Level            |                            |                      |                                            |                      |                       |                        |                       |
| 2 Ω                             | 1.999 900 00               | Normal               | 5.0 + 2.0                                  | 8.0 + 2.0            | 10 + 2.0              | 15 + 2.0               | 17 + 2.0              |
| 20 Ω                            | 19.999 000 0               | Normal               | 2.5 + 0.7                                  | 4.5 + 0.7            | 7.0 + 0.7             | 9.0 + 0.7              | 9.5 + 0.7             |
| 200 Ω                           | 199.990 000                | Normal               | 1.5 + 0.25                                 | 4.0 + 0.25           | 7.0 + 0.25            | 7.5 + 0.25             | 8.0 + 0.25            |
| 2 kΩ                            | 1.999 900 00               | Normal               | 1.0 + 0.25                                 | 3.5 + 0.25           | 7.0 + 0.25            | 7.5 + 0.25             | 8.0 + 0.25            |
| 20 kΩ                           | 19.999 000 0               | Normal               | 1.0 + 0.25                                 | 3.5 + 0.25           | 7.0 + 0.25            | 7.5 + 0.25             | 8.0 + 0.25            |
| 200 kΩ                          | 199.990 000                | Normal               | 1.0 + 0.25                                 | 3.5 + 0.25           | 7.0 + 0.25            | 7.5 + 0.25             | 8.0 + 0.25            |
| 2 MΩ                            | 1.999 900 00               | Normal               | 2.0 + 0.5                                  | 4.0 + 0.5            | 7.0 + 0.5             | 8.5 + 0.5              | 9.0 + 0.5             |
| 20 MΩ                           | 19.999 000 0               | Normal               | 3.5 + 5.0                                  | 6.0 + 5.0            | 9.0 + 5.0             | 15 + 5.0               | 20 + 5.0              |
| 200 MΩ                          | 199.990 000                | Normal               | 20 + 50                                    | 25 + 50              | 30 + 50               | 60 + 50                | 120 + 50              |
| 2 GΩ                            | 1.999 900 00               | Normal               | 250 + 500                                  | 350 + 500            | 500 + 500             | 525 + 500              | 1510 + 500            |
| 2 Ω                             | 1.999 900 00               | Lo Current           | 5.0 + 2.0                                  | 8.0 + 2.0            | 10 + 2.0              | 15 + 2.0               | 17 + 2.0              |
| 20 Ω                            | 19.999 000 0               | Lo Current           | 2.5 + 0.7                                  | 4.5 + 0.7            | 7.0 + 0.7             | 9.0 + 0.7              | 9.5 + 0.7             |
| 200 Ω                           | 199.990 000                | Lo Current           | 2.5 + 0.7                                  | 5.0 + 0.7            | 7.0 + 0.7             | 7.5 + 0.7              | 8.0 + 0.7             |
| 2 kΩ                            | 1.999 900 00               | Lo Current           | 2.5 + 0.7                                  | 5.0 + 0.7            | 7.0 + 0.7             | 7.5 + 0.7              | 8.0 + 0.7             |
| 20 kΩ                           | 19.999 000 0               | Lo Current           | 2.5 + 0.7                                  | 5.0 + 0.7            | 7.0 + 0.7             | 7.5 + 0.7              | 8.0 + 0.7             |
| 200 kΩ                          | 199.990 000                | Lo Current           | 5.0 + 0.5                                  | 6.5 + 0.5            | 7.0 + 0.5             | 7.5 + 0.5              | 8.0 + 0.5             |
| 2 MΩ                            | 1.999 900 00               | Lo Current           | 7.0 + 0.5                                  | 8.0 + 0.5            | 9.0 + 0.5             | 10 + 0.5               | 15 + 0.5              |
| 20 MΩ                           | 19.999 000 0               | Lo Current           | 20 + 5.0                                   | 20 + 5.0             | 25 + 5.0              | 35 + 5.0               | 90 + 5.0              |
| 200 MΩ                          | 199.990 000                | Lo Current           | 250 + 500                                  | 350 + 500            | 500 + 500             | 515 + 500              | 1505 + 500            |
| 2 GΩ                            | 1.999 900 00               | Lo Current           | 250 + 500                                  | 350 + 500            | 500 + 500             | 525 + 500              | 1510 + 500            |
| 20 MΩ                           | 19.999 000 0               | High Voltage         | 2.0 + 0.5                                  | 4.0 + 0.5            | 7.0 + 0.5             | 15 + 0.5               | 17 + 0.5              |
| 200 MΩ                          | 199.990 000                | High Voltage         | 3.5 + 5.0                                  | 6.0 + 5.0            | 9.0 + 5.0             | 60 + 5.0               | 65 + 5.0              |
| 2 GΩ                            | 1.999 900 00               | High Voltage         | 20 + 50                                    | 25 + 50              | 30 + 50               | 150 + 50               | 180 + 50              |
| 20 GΩ <sup>[18]</sup>           | 19.999 000 0               | High Voltage         | 250 + 500                                  | 350 + 500            | 500 + 500             | 525 + 500              | 1510 + 500            |
| 99% Confidence Level            |                            |                      |                                            |                      |                       |                        |                       |
| 2 Ω                             | 1.999 900 00               | Normal               | 6.0 + 2.5                                  | 10 + 2.5             | 12 + 2.5              | 19 + 2.5               | 22 + 2.5              |
| 20 Ω                            | 19.999 000 0               | Normal               | 3.0 + 0.9                                  | 5.5 + 0.9            | 8.5 + 0.9             | 11.5 + 0.9             | 12.0 + 0.9            |
| 200 Ω                           | 199.990 000                | Normal               | 1.8 + 0.3                                  | 5.0 + 0.3            | 8.5 + 0.3             | 9.5 + 0.3              | 10 + 0.3              |
| 2 kΩ                            | 1.999 900 00               | Normal               | 1.2 + 0.3                                  | 4.5 + 0.3            | 8.5 + 0.3             | 9.5 + 0.3              | 10 + 0.3              |
| 20 kΩ                           | 19.999 000 0               | Normal               | 1.2 + 0.3                                  | 4.5 + 0.3            | 8.5 + 0.3             | 9.5 + 0.3              | 10 + 0.3              |
| 200 kΩ                          | 199.990 000                | Normal               | 1.2 + 0.3                                  | 4.5 + 0.3            | 8.5 + 0.3             | 9.5 + 0.3              | 10 + 0.3              |
| 2 MΩ                            | 1.999 900 00               | Normal               | 2.5 + 0.6                                  | 5.0 + 0.6            | 8.5 + 0.6             | 10.5 + 0.6             | 12 + 0.6              |
| 20 MΩ                           | 19.999 000 0               | Normal               | 4.5 + 6.0                                  | 7.5 + 6.0            | 12 + 6.0              | 20 + 6.0               | 25 + 6.0              |
| 200 MΩ                          | 199.990 000                | Normal               | 25 + 60                                    | 30 + 60              | 35 + 60               | 75 + 60                | 150 + 60              |
| 2 GΩ                            | 1.999 900 00               | Normal               | 325 + 600                                  | 450 + 600            | 650 + 600             | 675 + 600              | 1810 + 600            |
| 2 Ω                             | 1.999 900 00               | Lo Current           | 6.0 + 2.5                                  | 10 + 2.5             | 12 + 2.5              | 19 + 2.5               | 22 + 2.5              |
| 20 Ω                            | 19.999 000 0               | Lo Current           | 3.0 + 0.9                                  | 5.5 + 0.9            | 8.5 + 0.9             | 11.5 + 0.9             | 12.0 + 0.9            |
| 200 Ω                           | 199.990 000                | Lo Current           | 3.0 + 0.9                                  | 6.5 + 0.9            | 8.5 + 0.9             | 9.5 + 0.9              | 10.0 + 0.9            |
| 2 kΩ                            | 1.999 900 00               | Lo Current           | 3.0 + 0.9                                  | 6.5 + 0.9            | 8.5 + 0.9             | 9.5 + 0.9              | 10.0 + 0.9            |
| 20 kΩ                           | 19.999 000 0               | Lo Current           | 3.0 + 0.9                                  | 6.5 + 0.9            | 8.5 + 0.9             | 9.5 + 0.9              | 10.0 + 0.9            |
| 200 kΩ                          | 199.990 000                | Lo Current           | 6.0 + 0.6                                  | 8.0 + 0.6            | 9.0 + 0.6             | 9.5 + 0.6              | 10.0 + 0.6            |
| 2 MΩ                            | 1.999 900 00               | Lo Current           | 8.0 + 0.6                                  | 10.0 + 0.6           | 12.0 + 0.6            | 13.0 + 0.6             | 17.0 + 0.6            |
| 20 MΩ                           | 19.999 000 0               | Lo Current           | 25 + 6.0                                   | 25 + 6.0             | 30 + 6.0              | 45 + 6.0               | 110 + 6.0             |
| 200 MΩ                          | 199.990 000                | Lo Current           | 325 + 600                                  | 450 + 600            | 650 + 600             | 670 + 600              | 1810 + 600            |
| 2 GΩ                            | 1.999 900 00               | Lo Current           | 325 + 600                                  | 450 + 600            | 650 + 600             | 675 + 600              | 1810 + 600            |
| 20 MΩ                           | 19.999 000 0               | High Voltage         | 2.5 + 0.6                                  | 5.0 + 0.6            | 8.5 + 0.6             | 19 + 0.6               | 20 + 0.6              |
| 200 MΩ                          | 199.990 000                | High Voltage         | 4.5 + 6.0                                  | 7.5 + 6.0            | 12 + 6.0              | 75 + 6.0               | 80 + 6.0              |
| 2 GΩ                            | 1.999 900 00               | High Voltage         | 25 + 60                                    | 30 + 60              | 35 + 60               | 195 + 60               | 230 + 60              |
| 20 GΩ <sup>[18]</sup>           | 19.999 000 0               | High Voltage         | 325 + 600                                  | 450 + 600            | 650 + 600             | 675 + 600              | 1810 + 600            |

**Resistance - Normal Mode (Secondary Specifications)** <sup>[1] [2] [3] [10]</sup>

| Range          | Measurement Current | Transfer Uncertainty<br>20 mins $\pm 1^{\circ}\text{C}$<br>$\pm$ (ppm Reading<br>+ ppm Range) | Temperature Coefficient                       |                                                                                               |                                                              |
|----------------|---------------------|-----------------------------------------------------------------------------------------------|-----------------------------------------------|-----------------------------------------------------------------------------------------------|--------------------------------------------------------------|
|                |                     |                                                                                               | 15 $^{\circ}\text{C}$ - 30 $^{\circ}\text{C}$ | 5 $^{\circ}\text{C}$ - 15 $^{\circ}\text{C}$<br>30 $^{\circ}\text{C}$ - 40 $^{\circ}\text{C}$ | 5 $^{\circ}\text{C}$ - 40 $^{\circ}\text{C}$ <sup>[16]</sup> |
|                |                     |                                                                                               | $\pm$ ppm Reading/ $^{\circ}\text{C}$         |                                                                                               | $\pm$ $^{\circ}\text{C}$                                     |
| 2 $\Omega$     | 100 mA              | 2.0 + 2.0                                                                                     | 1.5                                           | 2.5                                                                                           | 1.5 $\mu$                                                    |
| 20 $\Omega$    | 10 mA               | 0.8 + 0.7                                                                                     | 0.6                                           | 1.0                                                                                           | 15 $\mu$                                                     |
| 200 $\Omega$   | 10 mA               | 0.2 + 0.15                                                                                    | 0.5                                           | 0.8                                                                                           | 20 $\mu$                                                     |
| 2 k $\Omega$   | 1 mA                | 0.2 + 0.15                                                                                    | 0.5                                           | 0.8                                                                                           | 200 $\mu$                                                    |
| 20 k $\Omega$  | 100 $\mu\text{A}$   | 0.2 + 0.15                                                                                    | 0.5                                           | 0.8                                                                                           | 2 m                                                          |
| 200 k $\Omega$ | 100 $\mu\text{A}$   | 0.2 + 0.15                                                                                    | 0.5                                           | 0.8                                                                                           | 10 m                                                         |
| 2 M $\Omega$   | 10 $\mu\text{A}$    | 0.5 + 0.5                                                                                     | 0.6                                           | 1.0                                                                                           | 100 m                                                        |
| 20 M $\Omega$  | 1 $\mu\text{A}$     | 2.5 + 5                                                                                       | 2                                             | 3                                                                                             | 1                                                            |
| 200 M $\Omega$ | 100 nA              | 15 + 50                                                                                       | 20                                            | 30                                                                                            | 10                                                           |
| 2 G $\Omega$   | 10 nA               | 200 + 500                                                                                     | 200                                           | 300                                                                                           | 100                                                          |

**Resistance - Lo Current Mode (Secondary Specifications)** <sup>[1] [2] [3] [10]</sup>

| Range          | Measurement Current | Transfer Uncertainty<br>20 mins $\pm 1^{\circ}\text{C}$<br>$\pm$ (ppm Reading<br>+ ppm Range) | Temperature Coefficient                       |                                                                                               |                                                              |
|----------------|---------------------|-----------------------------------------------------------------------------------------------|-----------------------------------------------|-----------------------------------------------------------------------------------------------|--------------------------------------------------------------|
|                |                     |                                                                                               | 15 $^{\circ}\text{C}$ - 30 $^{\circ}\text{C}$ | 5 $^{\circ}\text{C}$ - 15 $^{\circ}\text{C}$<br>30 $^{\circ}\text{C}$ - 40 $^{\circ}\text{C}$ | 5 $^{\circ}\text{C}$ - 40 $^{\circ}\text{C}$ <sup>[16]</sup> |
|                |                     |                                                                                               | $\pm$ ppm Reading/ $^{\circ}\text{C}$         |                                                                                               | $\pm$ $^{\circ}\text{C}$                                     |
| 2 $\Omega$     | 100 mA              | 2.0 + 2.0                                                                                     | 1.5                                           | 2.5                                                                                           | 1.5 $\mu$                                                    |
| 20 $\Omega$    | 10 mA               | 0.8 + 0.7                                                                                     | 0.6                                           | 1.0                                                                                           | 15 $\mu$                                                     |
| 200 $\Omega$   | 1 mA                | 0.8 + 0.7                                                                                     | 0.6                                           | 1.0                                                                                           | 150 $\mu$                                                    |
| 2 k $\Omega$   | 100 $\mu\text{A}$   | 0.8 + 0.7                                                                                     | 0.6                                           | 1.0                                                                                           | 1.5 m                                                        |
| 20 k $\Omega$  | 10 $\mu\text{A}$    | 0.8 + 0.7                                                                                     | 0.6                                           | 1.0                                                                                           | 15 m                                                         |
| 200 k $\Omega$ | 10 $\mu\text{A}$    | 0.5 + 0.5                                                                                     | 0.6                                           | 1.0                                                                                           | 20 m                                                         |
| 2 M $\Omega$   | 1 $\mu\text{A}$     | 2.0 + 0.5                                                                                     | 2                                             | 3                                                                                             | 200 m                                                        |
| 20 M $\Omega$  | 100 nA              | 15 + 5                                                                                        | 20                                            | 30                                                                                            | 2                                                            |
| 200 M $\Omega$ | 10 nA               | 200 + 500                                                                                     | 200                                           | 300                                                                                           | 20                                                           |
| 2 G $\Omega$   | 10 nA               | 200 + 500                                                                                     | 200                                           | 300                                                                                           | 100                                                          |

**Resistance - High Voltage Mode (Secondary Specifications)** <sup>[1] [2] [3]</sup>

| Range                         | Measurement Current | Transfer Uncertainty<br>20 mins $\pm 1^{\circ}\text{C}$<br>$\pm$ (ppm Reading<br>+ ppm Range) | Temperature Coefficient                       |                                                                                               |                                                              |
|-------------------------------|---------------------|-----------------------------------------------------------------------------------------------|-----------------------------------------------|-----------------------------------------------------------------------------------------------|--------------------------------------------------------------|
|                               |                     |                                                                                               | 15 $^{\circ}\text{C}$ - 30 $^{\circ}\text{C}$ | 5 $^{\circ}\text{C}$ - 15 $^{\circ}\text{C}$<br>30 $^{\circ}\text{C}$ - 40 $^{\circ}\text{C}$ | 5 $^{\circ}\text{C}$ - 40 $^{\circ}\text{C}$ <sup>[16]</sup> |
|                               |                     |                                                                                               | $\pm$ ppm Reading/ $^{\circ}\text{C}$         |                                                                                               | $\pm$ $^{\circ}\text{C}$                                     |
| 20 M $\Omega$                 | 10 $\mu\text{A}$    | 0.5 + 0.5                                                                                     | 0.6                                           | 1.0                                                                                           | 2                                                            |
| 200 M $\Omega$                | 1 $\mu\text{A}$     | 2.0 + 0.5                                                                                     | 2.0                                           | 3                                                                                             | 20                                                           |
| 2 G $\Omega$                  | 100 nA              | 15 + 50                                                                                       | 20                                            | 30                                                                                            | 200                                                          |
| 20 G $\Omega$ <sup>[18]</sup> | 10 nA               | 200 + 500                                                                                     | 200                                           | 300                                                                                           | 2k                                                           |

**Type**..... True 4-wire with Ohms guard. 2-wire selectable.

**2 Wire Adder**.....  $\pm(10 \text{ pA}/I_r) \times 10^6$  ppm of Reading  $\pm 50 \text{ m}\Omega \pm 3 \text{ m}\Omega/^{\circ}\text{C}$ , where  $I_r$  is the measurement current, where the temperature related factor is based on the temperature difference between the present operating temperature and the temperature where the instrument was last zeroed.

**Max Lead Resistance**..... 10  $\Omega$  in any or all leads, 1  $\Omega$  on 2  $\Omega$  range

**Full Scale Measurement Voltage**

Normal Mode ..... 200 mV/2 V/20 V

Lo Current Mode ..... 200 mV/2 V/20 V

High Voltage Mode ..... 200 V

**Protection** (All ranges) ..... 250 V rms, 360 V pk

### Ratio Accuracy

Range to Range..... Apply an RSS summation of Net Front Input and Rear Input Accuracy <sup>[17]</sup>  
 Within Range ..... Using the 24 hour or 20 minute Transfer Uncertainty specifications as appropriate, apply an RSS summation of specified accuracy of the Front Input signal and the specified accuracy of the Rear Input signal <sup>[17]</sup>

Settling Time ..... Up to 200 kΩ range generally the same as DC Voltage Filter In but depends on external connections

## Temperature

### Temperature Readout <sup>[1] [2] [3]</sup>

| Resistance Range           | Absolute Resistance Measurement Uncertainty<br>365 day Tcal $\pm 1\text{ }^{\circ}\text{C}^{[4]}$<br>$\pm(\text{ppm Reading} + \text{m}\Omega)^{[11]}$ | Typical Equivalent Temperature Measurement Uncertainty <sup>[12]</sup> |                                            |                         |                                       |
|----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|--------------------------------------------|-------------------------|---------------------------------------|
|                            |                                                                                                                                                        | Probe Type                                                             | Nominal Temperature ( $^{\circ}\text{C}$ ) | Resistance ( $\Omega$ ) | Accuracy $\pm$ ( $^{\circ}\text{C}$ ) |
| 95% Confidence Level       |                                                                                                                                                        |                                                                        |                                            |                         |                                       |
| 0 - 199.990 000 $\Omega$   | 7.5 + 0.14                                                                                                                                             | 25 $\Omega$ PRT/SPRT                                                   | -200                                       | 5                       | 0.0016                                |
|                            |                                                                                                                                                        | 25 $\Omega$ PRT/SPRT                                                   | 0                                          | 25                      | 0.0033                                |
|                            |                                                                                                                                                        | 25 $\Omega$ PRT/SPRT                                                   | 660                                        | 84                      | 0.0096                                |
|                            |                                                                                                                                                        | 100 $\Omega$ PRT/SPRT                                                  | -200                                       | 20                      | 0.0007                                |
|                            |                                                                                                                                                        | 100 $\Omega$ PRT/SPRT                                                  | 0                                          | 100                     | 0.0023                                |
|                            |                                                                                                                                                        | 100 $\Omega$ PRT/SPRT                                                  | 232                                        | 185                     | 0.0042                                |
| 200 - 1999.900 00 $\Omega$ | 7.5 + 0.5                                                                                                                                              | 100 $\Omega$ PRT/SPRT                                                  | 400                                        | 250                     | 0.0069                                |
| 99% Confidence Level       |                                                                                                                                                        |                                                                        |                                            |                         |                                       |
| 0 - 199.990 000 $\Omega$   | 9.5 + 0.18                                                                                                                                             | 25 $\Omega$ PRT/SPRT                                                   | -200                                       | 5                       | 0.0021                                |
|                            |                                                                                                                                                        | 25 $\Omega$ PRT/SPRT                                                   | 0                                          | 25                      | 0.0042                                |
|                            |                                                                                                                                                        | 25 $\Omega$ PRT/SPRT                                                   | 660                                        | 84                      | 0.0122                                |
|                            |                                                                                                                                                        | 100 $\Omega$ PRT/SPRT                                                  | -200                                       | 20                      | 0.0009                                |
|                            |                                                                                                                                                        | 100 $\Omega$ PRT/SPRT                                                  | 0                                          | 100                     | 0.0029                                |
|                            |                                                                                                                                                        | 100 $\Omega$ PRT/SPRT                                                  | 232                                        | 185                     | 0.0053                                |
| 200 - 1999.900 00 $\Omega$ | 9.5 + 0.6                                                                                                                                              | 100 $\Omega$ PRT/SPRT                                                  | 400                                        | 250                     | 0.0086                                |

### Temperature Readout (Secondary Specifications) <sup>[1] [2] [3]</sup>

| Resistance Range    | Resistance Measurement Uncertainty                                                                         |                  |                  |                                  |                               |
|---------------------|------------------------------------------------------------------------------------------------------------|------------------|------------------|----------------------------------|-------------------------------|
|                     | Transfer Uncertainty<br>20 Minute $\pm 1$ °C<br>$\pm(\text{ppm Reading} + \text{m}\Omega)$ <sup>[11]</sup> | 2-Wire Adder (Ω) | 3-Wire Adder (Ω) | Temp Coeff. $\pm$ ppm Reading/°C |                               |
|                     |                                                                                                            |                  |                  | 15 °C - 30 °C                    | 5 °C - 15 °C<br>30 °C - 40 °C |
| 0 - 199.990 000 Ω   | 0.8 + 0.14                                                                                                 | 0.1              | 0.005            | 0.6                              | 1.0                           |
| 200 - 1999.900 00 Ω | 0.2 + 0.5                                                                                                  | 0.1              | 0.005            | 0.5                              | 0.8                           |

Type ..... 4-wire current reversal resistance measurement with readout of equivalent temperature. 2-wire and 3-wire selectable without current reversal. Refer to Resistance specifications for additional details.

Temperature Range ..... -200 °C to 660 °C, readout also available in °F or K.

Linearization ..... ITS-90 or Callendar van Dusen. Entry and storage of coefficients and nominal resistance for up to 100 probes.

Current Source ..... 1 mA

## Read Rate and Additional Uncertainty

**Read Rate and Additional Uncertainty**

| Function                                   | Resolution | Filter Frequency (Hz) | Read Rate (readings/second) |      | Additional Errors <sup>[13]</sup><br>± (ppm Reading + ppm Range) |         |
|--------------------------------------------|------------|-----------------------|-----------------------------|------|------------------------------------------------------------------|---------|
|                                            |            |                       | Normal                      | Fast | Normal                                                           | Fast    |
| <b>DCV, DCI &amp; Ohms</b> <sup>[10]</sup> | 8          |                       | 1/25                        | 1/6  | 0 + 0                                                            | 0 + 0.1 |
|                                            | 7          |                       | 1/6                         | 1/2  | 0 + 0.1                                                          | 0 + 0.5 |
|                                            | 6          |                       | 2                           | 35   | 1.0 + 0.5                                                        | 0 + 2.5 |
|                                            | 5          |                       | 35                          | 150  | 0 + 5                                                            | 0 + 25  |
| <b>ACV &amp; ACI</b> <sup>[6]</sup>        | 6          | 1                     | 1/50                        |      | 0 + 0                                                            |         |
|                                            |            | 10                    | 1/5                         |      | 0 + 0                                                            |         |
|                                            |            | 40                    | 1/2                         |      | 0 + 0                                                            |         |
|                                            |            | 100                   | 1                           |      | 0 + 0                                                            |         |
|                                            | 5          | 1                     | 1/50                        |      | 0 + 5                                                            |         |
|                                            |            | 10                    | 1/5                         |      | 0 + 5                                                            |         |
|                                            |            | 40                    | 1/2                         |      | 0 + 5                                                            |         |
|                                            |            | 100                   | 2                           |      | 0 + 5                                                            |         |
| <b>ACV Transfer Off</b> <sup>[6]</sup>     |            | 1                     | 1/25                        |      | 200 + 20                                                         |         |
|                                            |            | 10                    | 1/2.5                       |      | 200 + 20                                                         |         |
|                                            |            | 40                    | 1                           |      | 200 + 20                                                         |         |
|                                            |            | 100                   | 4                           |      | 200 + 20                                                         |         |
| <b>PRT &amp; Tru Ohms</b> <sup>[14]</sup>  | 8          | -                     | 1/90                        | 1/30 | 0 + 0                                                            |         |
|                                            | 7          | -                     | 1/30                        | 1/10 | 0 + 0.1                                                          |         |
|                                            | 6          | -                     | 1/4                         | 1/3  | 1.0 + 0.5                                                        |         |
|                                            | 5          | -                     | 1/3                         | 1/3  | 0 + 5                                                            |         |

## Notes to Performance Specifications

- [1] Specifications apply for max resolution in each function, normal mode
- [2] Assumes 4 hour warm-up period
- [3] Input zero or offset null required whenever the temperature moves more than ±1 °C from the temperature at which the previous null/zero was performed.
- [4] TCal = Ambient calibration temperature
- [5] Integration time >1 Power Line cycle
- [6] Valid for signals >1 % Full Scale, Transfer Mode On. Signals must be DC coupled <40 Hz.
- [7] Max Volt.Hertz  $3 \times 10^7$
- [8] >300 V, <10 kHz add:  $\pm 0.0004 \times (\text{Reading} - 300)^2 \text{ ppm}$  >300 V, 10 kHz - 30 kHz add:  $\pm (0.0004 + (\text{Frequency} - 10000) \times 10^{-7}) \times (\text{Reading} - 300)^2 \text{ ppm}$  >300 V, >30 kHz add:  $\pm 0.0024 \times (\text{Reading} - 300)^2 \text{ ppm}$
- [9] Typical below 10 Hz for ACV, below 10 Hz and above 10 kHz for ACI.
- [10] Tru Ohms mode available on 2 Ω to 20 kΩ ranges. Read Rate reduced in Tru Ohms Mode. Specification for Tru Ohms same as corresponding Normal or Lo Current range
- [11] Valid for 4-wire sensor
- [12] Not including sensor uncertainty
- [13] Assume Range and Full Scale = 2000 V when calculating for 1000 V Range. For DCI, additional errors only apply in 5 digit resolution
- [14] Fast mode not available in PRT
- [15] The maximum display value for the Analog to Digital converter is 199 990 000 counts. This sets the maximum value measurable on each range to be a one followed by four nines. For example, the maximum measured values on the 2 V range on DC Voltage are ±1.999 900 00 V. However, the 1000 V ranges are limited to a maximum 1050 V.
- [16] The zero TC specification only needs to be applied if an input zero has not been performed within ±1 °C of the current operating temperature.
- [17] RSS (Root Sum Square). For more information refer to the Ratio Measurements portion of the "Applying the Specifications" area of these specifications
- [18] >2 GΩ Relative Humidity Operating <80 % to 30°C <70 % to 40°C

## Applying the Specifications

### Introduction

The Fluke 8508A has been designed specifically for metrologists. Not only does it provide the performance metrologists need, but it is specified in a way to allow users to really understand the uncertainties of the measurements, and easily make allowance for those uncertainty contributions when performing measurement uncertainty analyses and compiling uncertainty budgets. Contemporary metrology practices, including ISO17025 based laboratory accreditation schemes, require uncertainty analysis to be performed in accordance with the statistically based techniques described in the ISO Guide to the Expression of Uncertainty in Measurement (often referred to as the 'GUM'). For convenience, the 8508A specifications are quoted at a coverage factor of  $k=2$ , equivalent to a confidence level of approximately 95 %, as required by these methods. Specifications are also provided at a confidence level of 99 %.

Performance specifications for the 8508A consist of two elements, the first is a contribution expressed as parts-per-million of the Reading, and the second contribution is expressed as parts-per-million of the Range. These must be evaluated and combined for the relevant reading and range values applicable to the measurement being made, ensuring that both elements are evaluated on the same basis, such as parts per million of the measured value or in absolute terms (volts, amps, ohms, etc). The two elements are combined by adding algebraically. For example measuring 10 V on the 20 VDC range and applying the 365 day  $\pm 1^\circ\text{C}$  specifications:

First, expressing the contributions in terms of parts-per-million of the measured value:

$$= \pm \left( 3.0 + 0.2 \times \frac{20}{10} \right) = \pm (3.0 + 0.4) = \pm 3.4 \text{ ppm of } 10 \text{ V}$$

Second, expressing the contributions in volts:

$$= \pm (3.0 \times 10^{-6} \times 10 + 0.2 \times 10^{-6} \times 20) = \pm 3.4 \times 10^{-5} = \pm 34 \mu\text{V}$$

The 8508A is designed to provide accuracy and stability without the need for internal auto or self calibration routines which may otherwise compromise the continuity and traceability of measurement performance history. To realise the full potential of the 8508A performance accepted metrology practices should be employed, such as performing a zeroing or null operation to remove any offsets present in the measurement setup when making DC measurements. The 8508A specifications assume that these methods are employed.

### Absolute and Relative Specifications

The Relative to Calibration Standards specifications describe the performance of the 8508A itself for the time periods and temperature range listed excluding the uncertainty of the standards used to perform calibration of the 8508A during manufacture. The Absolute specifications include the uncertainty of the standards used to perform calibration of the 8508A at manufacture and may be used to determine the uncertainty of measurements made with the 8508A for periods up to 1 year and over a temperature range of  $\pm 5^\circ\text{C}$  from calibration. If the user has their 8508A calibrated with different uncertainties, the Relative specifications can be combined with the uncertainties applicable to that calibration to determine the effective absolute uncertainty following that calibration.

**Applying User's Calibration Uncertainties**

When the 8508A is calibrated by another laboratory the uncertainties of the calibration standards used may be applied by combining those uncertainties with the 8508A's Relative to Standards specifications. The applicable calibration uncertainties and the 8508A relative specifications must both be expressed at the same confidence level, and be combined in a RSS (Root Sum Square) summation. Accepted metrology practice mandates that calibration uncertainties are stated at 95 %. Check the applicable calibration uncertainties are stated at 95 % and then combine them with the 8508A 95 % Relative specifications. For example, if the 8508A is calibrated at 10 V DC with an uncertainty of 1.5 ppm at 95 %: The absolute uncertainty at 10 V for a period of 90 days and  $\pm 1^\circ\text{C}$  from calibration is:

$$= \pm \sqrt{1.5^2 + \left(1.4 + 0.2 \times \frac{20}{10}\right)^2} = \pm 2.3 \text{ ppm of } 10 \text{ V}$$

**Operating and Calibration Temperature Ranges**

As a metrology tool, the 8508A will commonly be used in a calibration laboratory where the temperature would be controlled to  $\pm 1^\circ\text{C}$ , and the 8508A  $\pm 1^\circ\text{C}$  specifications are applicable to those situations. The majority of electrical calibration laboratories operate at a nominal temperature of  $23^\circ\text{C}$ , the temperature at which the 8508A is calibrated by Fluke during manufacture and service. The 8508A is also capable of being calibrated at any temperature between  $20^\circ\text{C}$  and  $25^\circ\text{C}$  and the  $\pm 1^\circ\text{C}$  specifications will apply to operation within  $\pm 1^\circ\text{C}$  of that calibration temperature. In the 8508A specification tables the temperature of calibration is referred to as TCal. Specifications for  $\pm 5^\circ\text{C}$  are provided for situations where the 8508A is operated in environments with wider temperature variations up to  $\pm 5^\circ\text{C}$ . For applications where the knowledge of the effect of temperature on 8508A performance is important, temperature coefficients are listed in the 8508A specifications. If the operating temperature is within the range  $15^\circ\text{C}$  to  $30^\circ\text{C}$  the  $15^\circ\text{C}$  to  $30^\circ\text{C}$  temperature coefficient specifications are applicable otherwise use the  $5^\circ\text{C}$  to  $15^\circ\text{C}$ / $30^\circ\text{C}$  to  $40^\circ\text{C}$  figures, provided the temperature lies within that range. The 8508A may be operated at temperatures between  $0^\circ\text{C}$  and  $50^\circ\text{C}$ , but performance is not specified outside the range  $5^\circ\text{C}$  to  $40^\circ\text{C}$ .

**Applying Temperature Coefficient Specifications**

The 8508A specification tables include information for the typical operating conditions of  $\pm 1^\circ\text{C}$  for calibration laboratories with tight temperature control, and  $\pm 5^\circ\text{C}$  for calibration laboratories with looser temperature control or uncontrolled environments within that temperature range. For the majority of applications choosing the Absolute specifications for the most appropriate operating temperature range will be adequate. However performance at other temperatures may be determined by including an allowance for temperature coefficient over the additional temperature range. Care should be taken when making this calculation as an amount of temperature coefficient is already included in the 8508A specifications and those specifications are themselves based on combining contributions using techniques similar to those employed in uncertainty analysis. For example, consider operating at  $33^\circ\text{C}$ ,  $10^\circ\text{C}$  from the  $23^\circ\text{C}$  calibration temperature. The  $\pm 5^\circ\text{C}$  specifications already include a contribution for  $5^\circ\text{C}$  of temperature difference, so this amount of temperature effect must be removed before the effect of the  $10^\circ\text{C}$  difference is added. Consider 10 V on the 20 VDC range: 365 day absolute specification (95 %) at  $33^\circ\text{C}$  expressed in parts-per-million of 10 V is:

$$= \pm \sqrt{\left(3.5 + 0.2 \times \frac{20}{10}\right)^2 - (5 \times 0.3)^2 + (10 \times 0.5)^2} = \pm 6.16 \text{ ppm of } 10 \text{ V}$$

### Ratio Measurements

The 8508A Ratio mode will automatically take measurements of inputs applied to the front and rear terminals and display the result as a ratio in the voltage and resistance functions. The measurements can be made on the same range or different ranges. When making measurements on different ranges the error in each measurement is evaluated by applying the relevant specification for each range and combining the two specifications in an RSS summation, expressing the contributions in parts-per-million of the measured values. For example, making measurements of the ratio of 100 mV on the 200m VDC range and 100 V on the 200 VDC range, applying the 365 day  $\pm 1$  °C Absolute specifications:

$$= \pm \sqrt{\left(4.5 + 0.5 \times \frac{200 \times 10^{-3}}{100 \times 10^{-3}}\right)^2 + \left(4.5 + 0.2 \times \frac{200}{100}\right)^2} = \pm 7.37 \text{ ppm of the ratio}$$

Making measurements on the same range will eliminate range to range errors, such as drift since the time of calibration, and improve the result. When making measurements on the same range these errors will affect both measurements and effectively cancel, leaving short term noise and linearity as the dominant errors. The 20 minute Transfer Uncertainty Specifications are provided to describe the performance obtained when making ratio measurements on the same range. The error in each measurement is evaluated by applying the relevant 20 minute Transfer Uncertainty Specification for each value and combining the two specifications in an RSS summation, expressing the contributions in parts-per-million of the measured values. If the measurements are made within the same range, but independently (not using the ratio mode) with an elapsed time greater than 20 minutes but less than 24 hours between the measurements, then the 24 hour specifications should be applied instead.

For example, making measurements of the ratio of 5 V and 10 V on the 20 VDC range, applying the 20 minute Transfer Uncertainty specifications:

$$= \pm \sqrt{\left(0.12 + 0.1 \times \frac{20}{5}\right)^2 + \left(0.12 + 0.1 \times \frac{20}{10}\right)^2} = \pm 0.61 \text{ ppm of the ratio}$$

### Additional Errors

The 8508A specifications are listed for the maximum resolution in each function, using the Normal reading mode. For measurements taken in other resolutions or the Fast read mode additional error contributions listed in the Read Rate and Additional Uncertainty table must be included. These additional contributions must be added algebraically to the relevant specifications. For example measuring 10 V on the 20 VDC range at 5 digit resolution in Fast mode and applying the 365 day  $\pm 1$  °C Absolute specifications:

$$= \pm \left( (3.0 + 0) + (0.2 + 25) \times \frac{20}{10} \right) = \pm (3.0 + 50.4) = \pm 53.4 \text{ ppm of 10 V}$$

Other additional contributions apply in certain situations and are also to be added algebraically to the relevant specifications. These additional contributions include the DC Accuracy specification to be applied when making DC measurements on the AC Voltage function when DC coupled, and the High Voltage adder when making measurements above 300 V on the AC Voltage function.

## ***Chapter 2***

# ***Theory of Operation***

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**Introduction**

This chapter provides a board-level theory of operation for the 8508A Reference Multimeter. Functional block diagrams supplement the text when appropriate. In addition to providing a conceptual overview of the Multimeter’s operation, the descriptions are helpful for troubleshooting and isolating problems to a board level.

Reference Designators are used throughout this chapter to identify the major Printed Circuit Assemblies (PCAs) used in the Multimeter. These reference designators also appear in the List of Repaceable Parts (Chapter 5) to simplify the process of purchasing replacement modules and PCAs.

**Overall Functional Description**

**Main Assemblies**

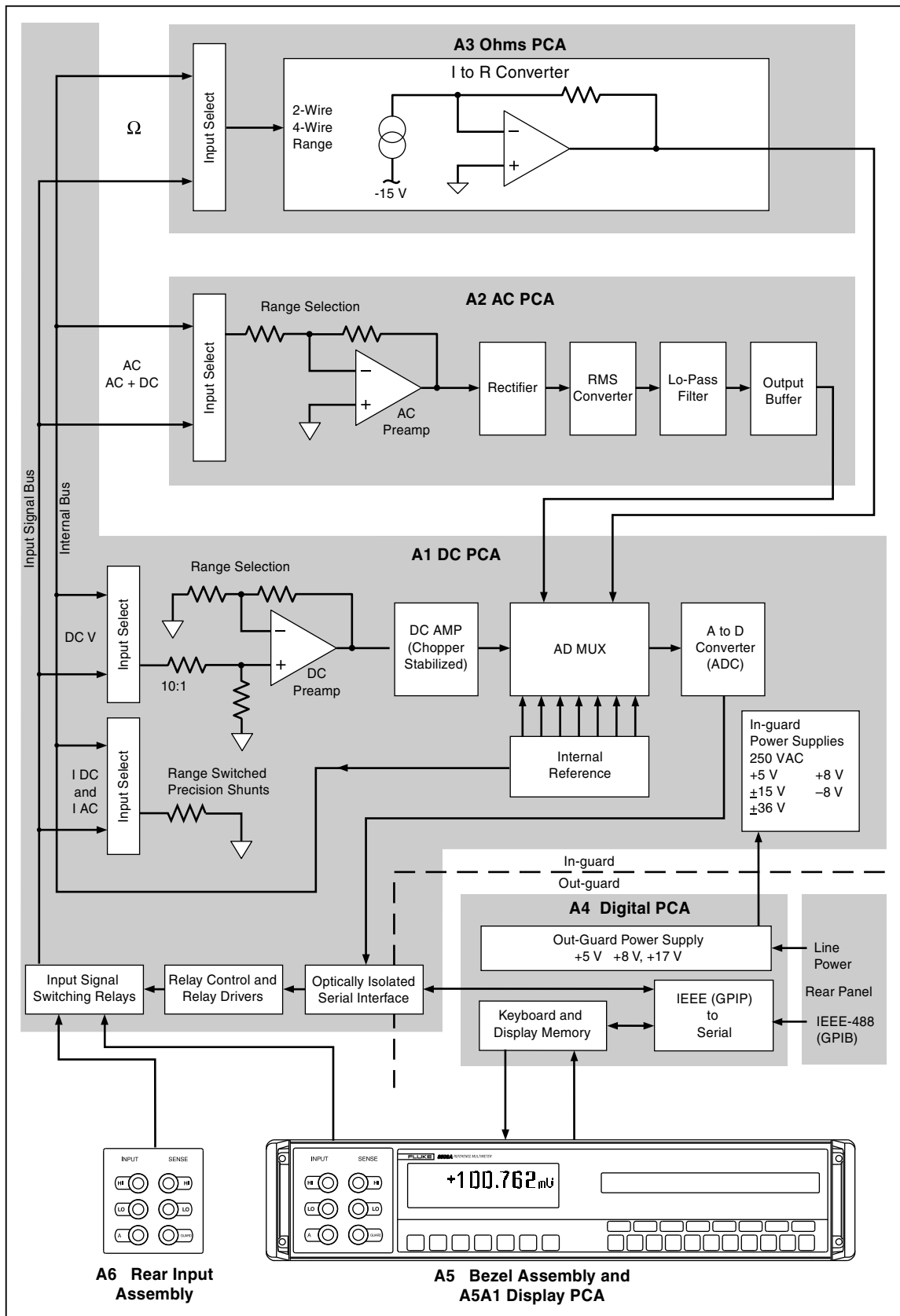
Refer to the functional block diagram shown in Figure 2-1 while reading this description. In addition to identifying all of the assemblies contained in the Multimeter, this diagram provides a functional view of the data flow between the assemblies. Assembly interconnections and cable identification is detailed in chapter 4, Maintenance.

The following list identifies the six major assemblies contained in the Multimeter and includes a description of the basic functions each assembly performs:

|    |                                |                                                                                            |
|----|--------------------------------|--------------------------------------------------------------------------------------------|
| A1 | DC PCA                         | Optical isolation; measurement configuration; V dc, I dc and I ac measurements             |
| A2 | AC PCA                         | True-rms measurement                                                                       |
| A3 | Ohms PCA                       | Resistance measurements: 2-wire, 4-wire, high-voltage, ratio, etc.                         |
| A4 | Digital PCA                    | Out-guard power supplies, control of IEEE (GPIB) and serial data (measurement and control) |
| A5 | Bezel Assembly                 | Front panel user interface, display and keyboard, includes the A5A1 Display PCA.           |
| A6 | Rear Input Assembly (optional) | Rear input connections, includes the A6A1 Rear Input PCA.                                  |

Normal operator interaction with the Multimeter begins at the front panel (A5) which includes a keyboard for entering measurement configurations (functions, ranges, etc.) and a display for verifying the selected configurations and for displaying measurement results. Both the keyboard switches and the display are included on the A5A1 Display PCA. A rubber keypad, whose keys include a conductive backing, provides switching information to A5A1. A controller on the A4 Digital PCA provides the addressing, strobing, and storage of data coming from and going to the A5A1 Display PCA. The data stored on the A4 Digital PCA includes both the manually entered configuration data for use by the display and other assemblies, as well as, the resulting measurement data for use by the display as measurement results.

Before being used by the Multimeter, the stored configuration data is converted on the A4 Digital PCA from a parallel to serial format. Similarly, the A4 Digital PCA receives serial measurement data from the instrument and converts it to a parallel format for use as display data. A rear panel IEEE-488 (GPIB) bus is intergrated into the format conversion process.



**Figure 2-1. 8508A Functional Block Diagram**

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A 16-pin cable (W3) enables serial control and measurement data to move between the A4 Digital PCA and the A1 DC PCA. Opto-isolators on the A1 DC PCA optically isolate the external control and display circuits of the Multimeter from the measurement circuits. This isolation minimizes problems associated with noise and current loops in the measurement circuits. Throughout this chapter, this isolation is referred to as in-guard (measurement circuits) and out-guard (control and data transfer circuits).

Control data from the A4 Digital PCA passes through the opto-isolators and serves as input to a series of tri-state latches. These latches retain the control data, and they provide the input to a series of relay drivers, which in turn drive a series of configuration relays. These relays establish the necessary connections between the various assemblies to perform the measurement called for from the front panel keyboard (or GPIB inputs). These relays also route analog data (and associated guarding) from the input terminals (front and rear) to the appropriate assemblies as defined by the measurement control data.

The A1 DC PCA, in addition to switching the measurement configurations and the routing of input and measurement signals, includes the circuits to perform the following functions:

- DC measurements  
Handles both DC voltage and dc current measurements
- Analog to digital conversion (ADC)  
The ADC processes all measurement data (volts, ohms, and current) before routing it (in digital form) to the A4 digital PCA for display and GPIB access.
- Current to voltage conversion  
Both the ac and dc current measurement functions (IDC and IAC) use the same current shunts.
- Self-Test  
Produces a variety of reference signals from -10 to +10 volts and places them on the internal signal bus for measurement and display. These tests provide a high degree of certainty that the Multimeter is functioning correctly, and they are useful for troubleshooting to the board level.

The A2 AC PCA performs the ac voltage and ac current measurements. The ac voltage portion of the assembly includes an associated collection of range, configuration, and filter circuits, as well as an ac preamplifier, and an rms-to-dc converter. The output of the rms-to-dc converter is a dc voltage proportional to the true-rms value of the input signal. The multiplexer on the A1 DC PCA receives the dc voltage and routes it to the ADC (Analog-to-Digital Converter) which, in turn, sends the digital results to the opto isolators. The opto isolators couple the digital data to the A4 Digital PCA for access by the display and GPIB.

The A1 DC PCA provides the configuration control required to connect the ac input signal to the A2 AC PCA. For ac voltage measurements the input signal is routed in much the same manner as a dc measurement signal. For ac current measurements, the ac input current is routed through the same set of current shunts used to make dc current measurements. To measure the ac current, the A2 AC PCA measures the voltage drop across the shunt and sends the results to the A4 Digital PCA as when making an ac voltage measurement.

The A3 Ohms PCA performs 2-wire, 4-wire, high-voltage, and ratio measurements. All of these measurements derive the unknown resistance value by passing a constant stimulus current through the unknown resistor and measuring the resulting voltage drop across it. By limiting the current to a value of  $1 \times 10^{-n}$ , the voltage drop is equal to the resistance value, e.g., 1 mA through  $2.12 \text{ k}\Omega = 2.12 \text{ V}$ . To accommodate range changes, the reference current changes to match the selected range. The reference current starts at 2nA for the  $2 \text{ G}\Omega$  range and increases to .1 mA for the  $2 \text{ }\Omega$  range. A high-gain inverting amplifier with low-input current and low-offset voltage performs the voltage

measurement across the unknown resistor. Configuration relays on the A1 DC PCA perform the change in terminal connections between two- and four-wire measurements.

The A3 Ohms PCA includes an alternative high-resistance measurement feature for resistance measurements above 20 M $\Omega$ . These measurements use 10 times the standard stimulus current and result in a 10 times increase in the voltage across the resistor. This high-voltage resistance feature enables the Multimeter to make quicker and faster measurements. It also enables the inclusion of a 20 G $\Omega$  resistance range.

Another feature included on the A3 Ohms PCA is true-ohms. This feature eliminates the input offset-voltage from the measurement circuit by continuously reversing the direction of current flow through the unknown resistance. The stimulus current reversal is timed so that the current flows continuously thus maintaining identical and constant self-heating of the unknown in both forward and reverse measurements. To ensure same-polarity measurements, voltage sensing of the unknown resistor synchronously reverses with the current.

The true-ohms ratio function uses a similar current reversal process. However, the current is applied to both unknown resistors simultaneously.

### **Power Supplies**

The Multimeter has two types of power supplies, out-guard supplies and in-guard supplies. The out-guard supplies provide power for the digital (earth ground) side of the Multimeter. This includes the A4 Digital PCA, the A5A1 Display (and keyboard), and the opto couplers on the A1 DC PCA. The in-guard supplies provide power for the analog (measurement) side of the Multimeter. This includes the A1 DC PCA, the A2 AC PCA, and the A3 Ohms PCA.

Two chassis-mounted transformers (T1 and T2) are the source of all the various voltages required for operation of the Multimeter. See Figure 2-2. Transformer T2 is the fused line-powered (mains) transformer. It has a single 24 V center-tapped secondary which provides ac power for both the out-guard and in-guard power supplies. On the A4 Digital PCA, the 24 V ac drives three conventional rectifiers and regulators to provide +5 V, +8 V, and +17 V sources for the out-guard circuits. The +5 and +8 volts provide power for out-guard digital logic circuits; the +17 volts, along with a driver on the A4 Digital PCA, supplies the power (17 V ac) to drive the primary of the in-guard transformer T1.

Transformer T1 has 3 secondaries which drive a series of conventional rectifiers and regulators located on the A1 DC PCA. These T1 supplies provide the following in-guard operating voltages:

- +5V dc regulated
- +8 V dc un-regulated
- $\pm 15$  V dc regulated
- $\pm 36$  V dc regulated
- 250 Vac

All of the in-guard PCAs use these in-guard voltages, with the exception of the 250 V ac which goes directly to the A3 Ohms PCA where it is rectified and filtered for use in making the high-voltage ohms measurements. The 250 V dc supply is active only when the High Voltage Ohms function is selected.

A few other in-guard voltages, which are uniquely developed and used on the A3 Ohms PCA, include +5 V, -15 V,  $\pm 6$  V, and +5.5 V. The in-guard voltages on the A1 DC PCA are the original source driving all of these uniquely developed voltages on the A3 Ohms PCA.

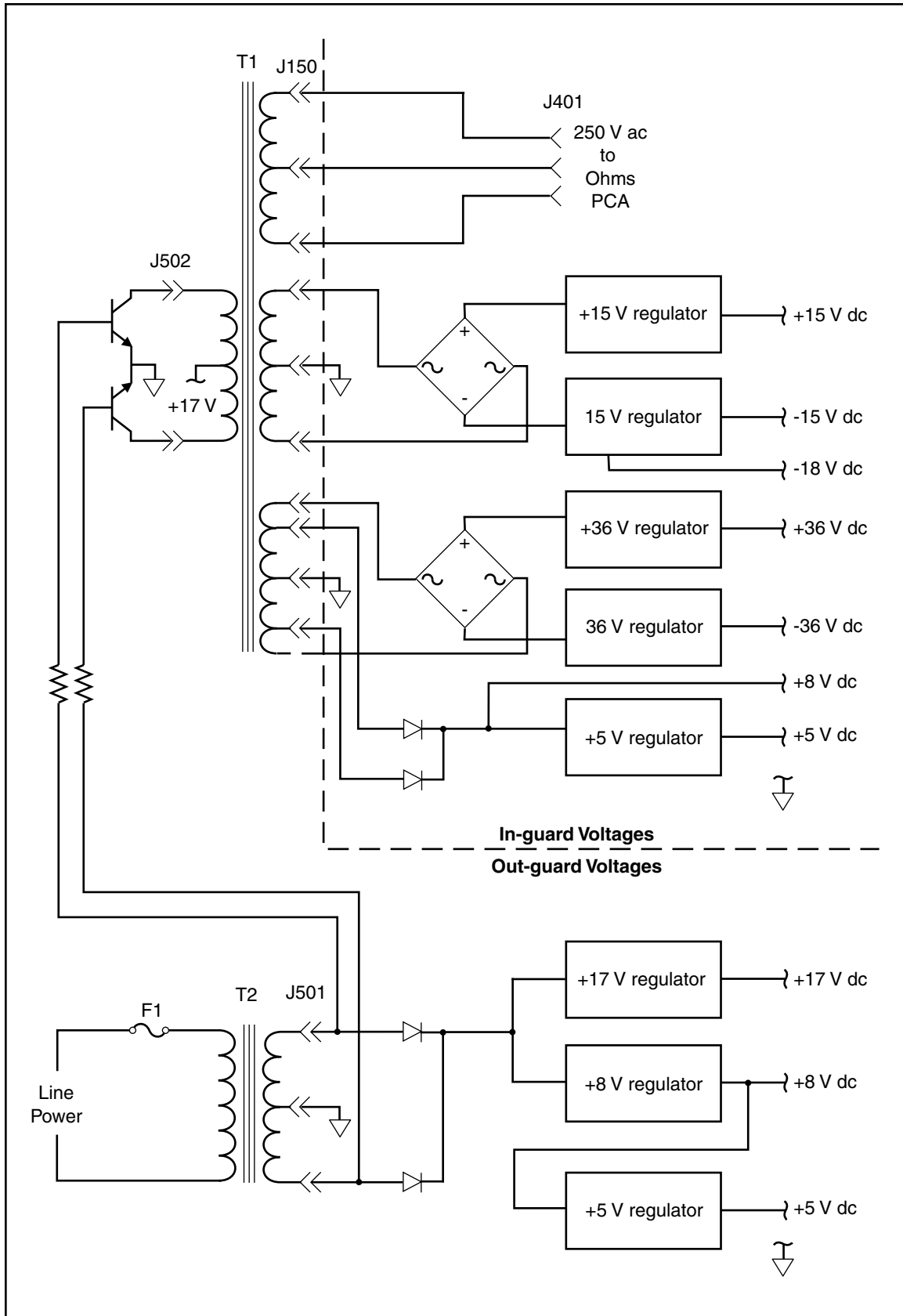


Figure 2-2. Power Supplies - Simplified Block Diagram

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## **Chapter 3**

# **Calibration and Verification**

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## Introduction

This chapter describes the calibration menus, and lists the calibration and performance verification procedures for the Multimeter. Remote commands for calibration of the Multimeter are described in Chapter 4 of the Users Manual, Remote Operations using the IEEE 488 Interface. In this chapter, menu and button selections are shown as all-caps text.

## Calibration Overview

An electronic autocal feature allows full calibration of all functions of the Multimeter from the front panel (or remotely via the IEEE 488.2 Interface). No hardware adjustments are necessary.

For each combination of function and range, an appropriate calibration standard (source) is input. At each setting, one keystroke immediately calibrates to the standard by updating an internal non-volatile calibration memory. The Multimeter automatically determines whether the operation is to be a Zero or Range Gain calibration; or for AC ranges whether it is to be a Zero, LF Gain or HF Gain calibration. As part of the calibration procedure, a non-volatile input-offset compensation is adjusted independently for the front and rear inputs. The autocal process can operate only when the rear panel Calibration switch is in the 'Enable' position. Applying an integrity seal or calibration sticker to prevent access to the rear panel Calibration switch is a convenient way to ensure the security of calibration. When a calibration operation is performed the Multimeter's internal calibration memory is immediately updated. It is possible to calibrate a single range or single point if the user chooses to do so. However, it is recommended that the calibration procedure listed later in this chapter be followed closely.

## Calibration Interval and Performance

It is recommended that the Multimeter be calibrated on either a 365-day or 90-day interval depending on the requirements of the applications for which the Multimeter is used and the performance specifications required. The performance of the Multimeter is specified for periods of 365 days and 90 days – if recalibration takes place on a 90-day cycle use the 90-day specifications for improved performance.

During manufacture, the Multimeter is calibrated with low uncertainties, reflected in the Absolute Specifications listed in Chapter 1 Introduction and Specifications. After recalibration, the user should apply the calibration uncertainties for the calibration standards and for the process applicable to that calibration by combining those calibration uncertainties with the Multimeter Relative to Standards specifications, as described in Chapter 1.

Many Multimeter owners prefer using Fluke calibration services instead of maintaining their own standards to support their Multimeter. To help ensure optimum performance from the Multimeter, Fluke offers our calibration service at a variety of worldwide locations. Our worldwide service network provides fast efficient calibration to ensure low uncertainties and optimum accuracy consistent with the original calibration at manufacture.

## Calibration Points

There is generally more than one calibration point for each range. An initial measurement (made when the calibration is triggered) determines the intended calibration point. The points for each range and function are listed later in this chapter.

### Non-Nominal Values

The Set facility allows the user to set the calibration target to the value of the calibration source available. This facility is most useful when the user's calibration source is not available at the nominal values specified, or when the user has knowledge of the actual output of the calibration source at the required points. In these cases, the use of the Set facility with a table of errors for the calibration source is recommended and will improve the accuracy of the Multimeter's calibration.

### Enabling Access to Calibration Mode

The setting of a Calibration-switch on the rear panel enables or restricts access to the calibration mode. Setting the switch to ENABLE allows access to the calibration mode via the front panel CAL key and the CALIBRATION menu, and also enables the remote IEEE 488 interface calibration commands. Setting the switch to DISABLE and applying an integrity seal or calibration sticker to cover the Calibration switch is a convenient way to ensure the security of calibration and to prevent unauthorized access to the switch.

### Calibration Menus

#### Accessing the Calibration Menus and Calibration Mode

Pressing the CAL key on the front panel causes the Multimeter to respond as follows:

1. Enters the calibration (CAL) mode
2. Displays and allows access to the CALIBRATION menu
3. Displays the CAL legend on the main display

To exit the CALIBRATION menu Press the Quit softkey. On exit the Multimeter displays the prompt to enter a calibration due date.

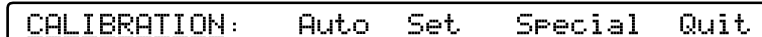
When in CAL mode the following front panel keys become inoperative: CLR, TEST, OFFSET, PRT and INPUT. Also the function of the SAMPLE key changes to become the trigger key for initiating a calibration operation.

#### Caution

**When in CAL mode with the CAL legend appearing on the main display the function of the SAMPLE key is modified from normal operation. If pressed, the SAMPLE key will initiate a calibration operation and permanently alter the Multimeter's calibration state. To avoid accidental mis-calibration do not attempt to operate the Multimeter in External Trigger mode from the front panel when in Cal, and only press the SAMPLE key when a calibration operation is intended to be performed.**

#### Calibration Menu

This menu allows calibration operations at the calibration point nominal values via Auto, or selection of calibration operations at non-nominal values via Set. It also offers access to the special calibration menu. The CAL legend appears in the left-hand display when in CAL mode.



```
CALIBRATION:  Auto  Set  Special  Quit
```

CALIBRATION Menu

adj134f.eps

This menu defines four *menu* keys:

|                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Auto</b>    | Indicates to the user that the calibration point is automatically set according to the amplitude (and frequency in ACV) of the signal detected. Auto is the default selection on entry to the CALIBRATION menu. Refer to the tables appearing later in this chapter for the calibration points for the selected range. An indication of the use of the <b>SAMPLE</b> key is also displayed                                                                          |
| <b>Set</b>     | The Set feature is available in all functions, allowing the user to enter the true value of the calibration standard where it differs from nominal calibration point value. Pressing Set displays the SET VALUE menu except in ACV Spot Frequency mode, when the SPOT CAL menu is displayed. Spot Frequency calibration reduces flatness errors within $\pm 10\%$ of the spot frequency. Set is not available for DCV, DCI, and Resistance range zero calibrations. |
| <b>Special</b> | Special Cal is indicated on the main display. The SPCL menu is displayed which allows pre-calibration of the Multimeter, calibration of the frequency counter, and entry to other calibration utilities.                                                                                                                                                                                                                                                            |
| <b>Quit</b>    | Exits from the CALIBRATION menu via the CALIBRATION DUE ? menu, where the recommended next calibration date can be entered, before finally quitting the calibration mode.                                                                                                                                                                                                                                                                                           |

### SET VALUE Menu

This menu is obtained by pressing the Set key in the CALIBRATION menu on all functions except ACV Spot Frequency.

SET VALUE =
Enter Quit

adj139f.eps

#### SET VALUE Menu

When this menu appears, it shows the nominal calibration point value, allowing the user to enter the true output value of the calibration standard at the point to be calibrated. The keyboard is activated, locking out all other keys. The Set value is entered in exponential format expressed in Volts, Amps, or Ohms, and must be above 20 % of range (40 % on the 1000V DCV and ACV ranges). The **SAMPLE** key has no effect until the **Set** value is stored by pressing the **Enter** key.

The Multimeter always chooses the most-recently stored **Set** value when calibrating. Set is not available for DCV, DCI, and Resistance range zero calibrations.

#### **⚠ Caution**

**Enter:** The new value is stored and the keyboard is deactivated. The set value remains on the dot-matrix display for comparison with the reading on the main display after the **SAMPLE** key has been pressed.

**Quit:** Reverts to the CALIBRATION menu, deleting the set value from store.

### SPOT CAL Menu

This menu is obtained by pressing the **Set** key in the **CALIBRATION** menu when the Multimeter is in **ACV Spot Frequency** mode. It provides a means of calibrating the Multimeter at any of six user-specific spot frequencies, at non-nominal calibration values for each **ACV** range. The Multimeter will already be set to an **ACV** range on entry to the menu.

```
SPOT_CAL:  SP1  SP2  SP3  SP4  SP5  SP6
```

adj140f.eps

#### SPOT CAL Menu

This menu allows a user to select a spot frequency (**Sp $x$** ) for the selected range. It defines six *menu* keys:

**SP1:** Displays the **SPOT 1 RMS** menu, where users define the RMS value for the Spot Frequency 1 calibration point on the currently selected range.

**SP2-6:** Same as **Sp1** but permitting their own RMS values to be defined.

### SPOT (1 to 6) RMS Menus

On entry to one of the six **SPOT** ( $x = 1$  to 6) **RMS** menus, the nominal cardinal point value is displayed and the keyboard is activated. A numeric value can be entered that represents the RMS value of the calibration source signal.

```
SPOT n RMS =                               Enter Quit
```

adj141f.eps

#### SPOT n RMS Menus

**Enter** Stores the displayed RMS value and de-activates the keyboard.  
The dot-matrix display moves to the **SPOT FREQUENCY (1 to 6)** menu, showing the calibration signal frequency.

**Quit** Reverts to the **SPOT CAL** menu, not storing any new Spot value.

#### Note

*The **SAMPLE** key is still enabled in the next menu.*

### SPOT FREQUENCY (1 to 6) Menu

Enter this menu by pressing **Enter** in the **SPOT (1 to 6) RMS** menu, which also stores the RMS value keyed in during this menu. The value in the **SPOT FREQUENCY (1 to 6)** menu is the measured frequency of the present calibration input signal.

```
SPOT FREQUENCY n =                               Quit  
Use SAMPLE to initiate CAL operation
```

adj142f.eps

#### SPOT FREQUENCY n Menu

Pressing the **SAMPLE** key causes the selected **ACV** range to be spot-calibrated at the calibration signal frequency. The frequency value is stored and can be viewed from the **UTILITY** menu. Any subsequent measurement on this range whose frequency is within

$\pm 10\%$  of the stored frequency is accuracy enhanced by reducing frequency response flatness errors.

#### Calibrate the spot at a new frequency:

To calibrate the spot at a new frequency, change the input signal to the desired new frequency and press **SAMPLE** as before.

**Quit** Reverts to the **SPOT CAL** menu with the original Spot calibration intact.

### Special Calibration

The **SPCL** menu provides alignment of the main ADC and calibration of the frequency counter.

It also allows the High Voltage Linearity Pre-Calibration to be performed and a section of the Non-Volatile memory to be cleared for test purposes. These facilities are used in the factory for initial pre-calibration processes; they should not require access during the life of the Multimeter unless repairs have been carried out. They appear here for completeness.

### SPCL Menu

The **SPCL** menu appears after pressing the **Spcl** key in the **CALIBRATION** menu. At the same time the Multimeter is placed in special calibration mode, and the Special **CAL** legend appears on the main display.

When in Special **CAL** mode the following front panel keys remain inoperative: **CLEAR**, **TEST**, **OFFSET**, **PRT** and **INPUT**. Also, the function of the **SAMPLE** key changes to become the trigger key for initiating the **Hvlin** calibration operation.

```
SPCL: Adc Freq Hvlin    Clnv Ser# Quit
```

adj137f.eps

#### SPCL Menu

The **SPCL** menu provides the selection:

|              |                                                                                                                                                                                                                                                                                                                                                                       |
|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Ser#</b>  | Permits entry of the Multimeter's serial number.                                                                                                                                                                                                                                                                                                                      |
| <b>Adc</b>   | Aligns the different resolutions available from the Multimeter's main analog-to-digital converter, so that there are no significant differences in readings when changing resolutions with a constant input value. No external input signals are required for this calibration. Calibration is initiated directly by making this selection from the <b>SPCL</b> menu. |
| <b>Freq</b>  | Calibrates the frequency counter against an external source. Calibration is initiated directly by making this selection from the <b>SPCL</b> menu.                                                                                                                                                                                                                    |
| <b>Hvlin</b> | Selects the sequence required to correct the linearity of the 1kV DC range.                                                                                                                                                                                                                                                                                           |
| <b>Clnv</b>  | Provides the capability to clear a section of the non-volatile memory for 'test purposes only'.                                                                                                                                                                                                                                                                       |
| <b>Quit</b>  | Reverts to the <b>CALIBRATION</b> menu.                                                                                                                                                                                                                                                                                                                               |

### SER # = Menu

This menu is obtained by pressing **Ser#** in the **SPCL** menu. On entry to the menu, the most-recently-entered serial number is shown, and the keyboard is activated. A numeric value can be entered.

```
SER# = xxxxxx      Enter Quit
```

adj138f.eps

#### SER# Menu

The SER# menu provides the selection:

- Enter**      Stores the new serial number, de-activates the keyboard, and reverts to the SPCL menu.
- Quit**       Reverts to the SPCL menu, leaving the old serial number intact.

### Hvlin Menu

This menu sequence is obtained by selecting Hvlin from the SPCL menu. It allows the linearity of the 1kV DC range to be calibrated with the application of five input signals of -1000V, -500V, 0V, +500V and +1000V in turn, with the 1kV DC range selected. On entry to the menu, the user is prompted to apply the first input signal required and step through the sequence:

```
1st signal for Hvlin= -1000      NEXT  
Press SAMPLE to measure & save
```

```
2nd signal for Hvlin= -500      PREV NEXT  
Press SAMPLE to measure & save
```

```
3rd signal for Hvlin= 0.0       PREV NEXT  
Press SAMPLE to measure & save
```

```
4th signal for Hvlin= +500      PREV NEXT  
Press SAMPLE to measure & save
```

```
5th signal for Hvlin= +1000     PREV CALC  
Press SAMPLE to measure & save
```

adj135f.eps

#### Hvlin Menus

Pressing the **SAMPLE** key initiates the calibration operation at the signal level displayed for the step in progress and; also, saves the result for calculation of the Hvlin linearity correction factor at the end of the sequence.

- PREV**       Moves back to the previous menu allowing the user to repeat the previous step in the sequence if required.
- NEXT**       Moves forward through the sequence to the next step and signal level.
- CALC**       Initiates calculation and storage of the high voltage linearity correction factor, completing the Hvlin calibration process.

### Non-volatile input offset compensation

Good metrology practice should ensure that all high-precision measurements made with the Multimeter are preceded by an input zero of each measurement. However, a non-volatile input-offset compensation is independently available for the front and rear inputs and will be used whenever the input zero capability is not in use. The compensation is retained after power down, is unaffected by clearing the volatile input zeros, and is unaffected by range zero calibration adjustments. Compensation is available on all functions, and includes separate compensation of 2-wire and 4-wire measurements in the resistance functions.

Non-volatile input-offset compensation adjustment is available only when the rear panel calibration keyswitch is in the **ENABLE** position and the **CAL** legend is not shown on the main display.

Adjustment is performed by initiating an input zero operation with the Multimeter in this condition, using the **INPUT** menu as described in Chapter 3 or using the IEEE 488 input zeroing commands described in Chapter 4. Apply a high-integrity low-thermal emf 4-wire short to the input terminals for this operation. Following adjustment for a particular combination of function, range, and input a compensation is also stored for the corresponding volatile input zero, and the Zero legend is shown on the main display. The Zero legend may be removed from the display without affecting the stored non-volatile compensation by using one of the following operations:

1. Power the Multimeter down.
2. Press the **CLEAR** key and make any of the selections from the **CLEAR** menu.
3. Press the **CAL** key and entering **CAL** mode.
4. Use the corresponding IEEE 488 commands.

## **Routine Calibration**

The 8508A Digital Reference Multimeter offers state-of-the-art performance. This procedure is intended as a guide for qualified metrology personnel who have access to a standards laboratory with equipment available to support an Multimeter of this level of accuracy. It reflects the calibration process used by Fluke to perform Multimeter calibration implemented in an automated system, but as a manual procedure for users to follow. The procedure is based on the following assumptions:

1. Users are familiar with relevant best measurement practice.
2. Users will take precautions to avoid introducing errors from sources such as thermal emfs, leakages, electromagnetic interference, etc.
3. Users will make adequate allowance for equipment stabilization and measurement settling times.

This routine calibration procedure describes the calibration points and sequence of operations required to calibrate the Multimeter and assumes calibration references of adequate traceable uncertainty are available – in this case a Fluke 5720A calibrator and 5725A amplifier used with an 8508A-7000 Calibration Kit. The procedure assumes the user is able to calibrate and characterize the calibration standards, without describing the process required to do so.

Characterization of the 5720A/5725A combination allows the 8508A to be calibrated with uncertainties lower than otherwise available from that equipment. The characterization process determines the 5720A/5725A errors from nominal at the values required for 8508A calibration, and may be performed using Fluke's recommended verification procedures appearing in the 5700A/5720A Service Manual as a guide. If a characterized 5720A/5725A combination is available where the error from nominal at the various points required is known, those errors may be taken into account during calibration to reduce the uncertainties. The errors may be determined by measurement against suitable standards or may be taken from an applicable certificate of calibration. The uncertainty of the characterized calibrator should be combined with the Multimeter Relative to Standards specifications to determine Multimeter performance after calibration. (RSS summation is recommended).

If the calibrator is not characterized to determine its errors from nominal, its output should be assumed to be nominal at all points. Its performance specifications should be

used to provide calibration uncertainties to be combined with the 8508A Relative to Standards specifications to determine the achieved Multimeter performance after calibration. (RSS summation is recommended).

See Chapter 5 for more details of combining 8508A Relative to Standards specifications and calibration uncertainties.

*Note*

*The Multimeter should be thoroughly checked to ensure it is operating correctly before attempting calibration. A performance verification procedure appears later in this section.*

### **Equipment Required for Calibration**

The equipment required for Calibration and Performance Verification is listed in Table 3-1.

**Table 3-1. Required Equipment for Calibration Adjustments and Performance Verification**

| Equipment Name                                                                                                                                                                                                                                                                                    | Minimum Use Specifications<br>(ranges and accuracy)                                                     | Recommended Models            |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|-------------------------------|
| Multifunction Calibrator <sup>[1]</sup> <sup>[2]</sup>                                                                                                                                                                                                                                            |                                                                                                         | Fluke 5720A                   |
| Amplifier <sup>[2]</sup>                                                                                                                                                                                                                                                                          |                                                                                                         | Fluke 5725A                   |
| Signal Lead Set                                                                                                                                                                                                                                                                                   |                                                                                                         | Fluke 5440-7003, -7004, -7005 |
| Calibration Kit                                                                                                                                                                                                                                                                                   | One 1 G $\Omega$ Standard, two precision low thermal emf 4-wire shorting devices, and connecting leads. | Fluke 8508A-7000K             |
| PC/Network Printer/ Cables                                                                                                                                                                                                                                                                        | PC/Network Printer/ Cables                                                                              | Any                           |
| Metrology bd software                                                                                                                                                                                                                                                                             |                                                                                                         | Fluke MetBase                 |
| Metrology Calibration Software                                                                                                                                                                                                                                                                    |                                                                                                         | Fluke Metcal v6.11 or later   |
| <p>[1] Availability of a 1 MHz frequency reference signal may be required for 5720A frequency locking during 8508A frequency calibration procedure.</p> <p>[2] Best uncertainties are obtained by characterizing the outputs of the 5720A and 5725A at the points used for 8508A calibration.</p> |                                                                                                         |                               |

Alternate equipment may be used, but users should ensure it provides adequate calibration uncertainties. Performance of the Multimeter after calibration should be determined by combining the applicable calibration uncertainties provided by the calibration equipment with the 8508A Relative to Standards specifications. (RSS summation is recommended).

### **Preparing for Calibration**

The following procedures represent the recommended order of calibration, giving all the necessary setup commands.

1. Allow the Multimeter to warm-up under power in the specified environment for at least 4 hours.
2. Press the CLEAR key, select Pwr Up Dflt to restore the power up default configuration and display the DCV menu.

3. Set the rear panel Calibration switch to Enable. Removal of any calibration sticker or integrity seal covering the calibration switch will be necessary.
4. Press the CAL key.
5. The CALIBRATION menu is displayed.

The calibration menu appears, and the CAL legend appears on the main display. When entering CAL mode and selecting a function the optimum resolution for performing calibration in that function is automatically selected. Refer to Table 3-2 for the full multimeter calibration sequence.

*Note*

*It is recommended that the default resolutions are used for calibration purposes. Other resolutions may be selected and calibration operations performed, but accuracy of calibration will be degraded if calibration is performed in lower resolutions.*

**⚠ Caution**

**When in CAL mode with the CAL legend appearing on the main display, the function of the SAMPLE key is modified from normal operation. If pressed, the SAMPLE key will initiate a calibration operation and permanently alter the Multimeter's calibration state. To avoid accidental mis-calibration do not attempt to operate the Multimeter in External Trigger mode from the front panel when in Cal, and only press the SAMPLE key when a calibration operation is intended to be performed.**

**Table 3-2. Calibration Sequence**

| General Sequence for Full Multimeter Calibration <sup>[1]</sup>            |                                                                                                                                                                                                                                |
|----------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Enable Calibration<br>Enter Cal mode                                       | Set rear panel calibration switch to ENABLE.<br>Access CALIBRATION menu .                                                                                                                                                      |
| Adc Cal                                                                    | Analog to digital converter alignment. Performed only if required.                                                                                                                                                             |
| DCV                                                                        | Range Zeros and Range Gains (200 mV to 1 kV Ranges).                                                                                                                                                                           |
| ACV                                                                        | Range Zeros, Range LF Gains and Range HF Gains (200 mV to 1 kV Ranges).                                                                                                                                                        |
| Ohms                                                                       | Range Zeros and Range Gains:<br>Ohms: 2 $\Omega$ to 2 G $\Omega$ Ranges, then LoI Ohms.<br>Tru $\Omega$ : 2 $\Omega$ to 20 k $\Omega$ Ranges, then LoI Tru $\Omega$ .<br>HiV $\Omega$ : 20 M $\Omega$ to 20 G $\Omega$ Ranges. |
| DCI                                                                        | Range Zeros and Range Gains (200 $\mu$ A to 20 A Ranges).                                                                                                                                                                      |
| ACI                                                                        | Range Zeros and Range Gains (200 $\mu$ A to 20 A Ranges).                                                                                                                                                                      |
| Frequency                                                                  | Frequency counter cal at 1 MHz                                                                                                                                                                                                 |
| Exit Cal mode<br>NV input offsets                                          | Quit the CALIBRATION menu.<br>Front & rear non-volatile input offset adjustments:<br>DCV, Ohms, Tru $\Omega$ , HiV $\Omega$ (including LoI , 2 & 4-wire).                                                                      |
| Set CAL DUE                                                                | Set the date for the next external calibration                                                                                                                                                                                 |
| Disable Calibration                                                        | Set rear panel calibration switch to DISABLE.                                                                                                                                                                                  |
| [1] To meet user's need, just one range on one function can be calibrated. |                                                                                                                                                                                                                                |

**Interconnections**

The Fluke 8508A-7000K Calibration kit contains a specially designed lead set which connects directly to the terminals of the Multimeter, the 5720A, and the 5725A for the purpose of Multimeter calibration. It is recommended that this lead kit be used to avoid introducing measurement errors due to interconnections and to duplicate the

configuration used by Fluke for Multimeter calibration. Figure 3-1 shows the interconnections used in detail. If alternate leads are substituted, make sure they are metrology grade leads, and of adequate voltage and current ratings. Leads should be kept as short as possible, constructed from low capacitance low leakage dielectric material (PTFE) with low thermal emf terminations, and exactly duplicate the configuration and interconnections shown.

When calibrating the 2 G $\Omega$  and 20 G $\Omega$  resistance ranges the 1 G $\Omega$  standard resistor supplied in the Fluke 8508A-7000K Calibration kit plugs directly into the Multimeter's front input terminals, without any interconnecting leads. If alternate resistance standards are used for resistance calibration, refer to the resistance-measurements section of Chapter 3 *Making Measurements* for connection details.

The Fluke 8508A-7000K Calibration kit also contains two precision low-thermal emf 4-wire shorting devices for use when performing the non-volatile input offset adjustments at the front and rear input terminals. These devices link the input terminals in the following order: Input Lo to Input Hi to Sense Hi to Sense Lo. If these devices are not available it is recommended that a U-shaped piece of thick bare copper wire be used to link the terminals in the same manner.

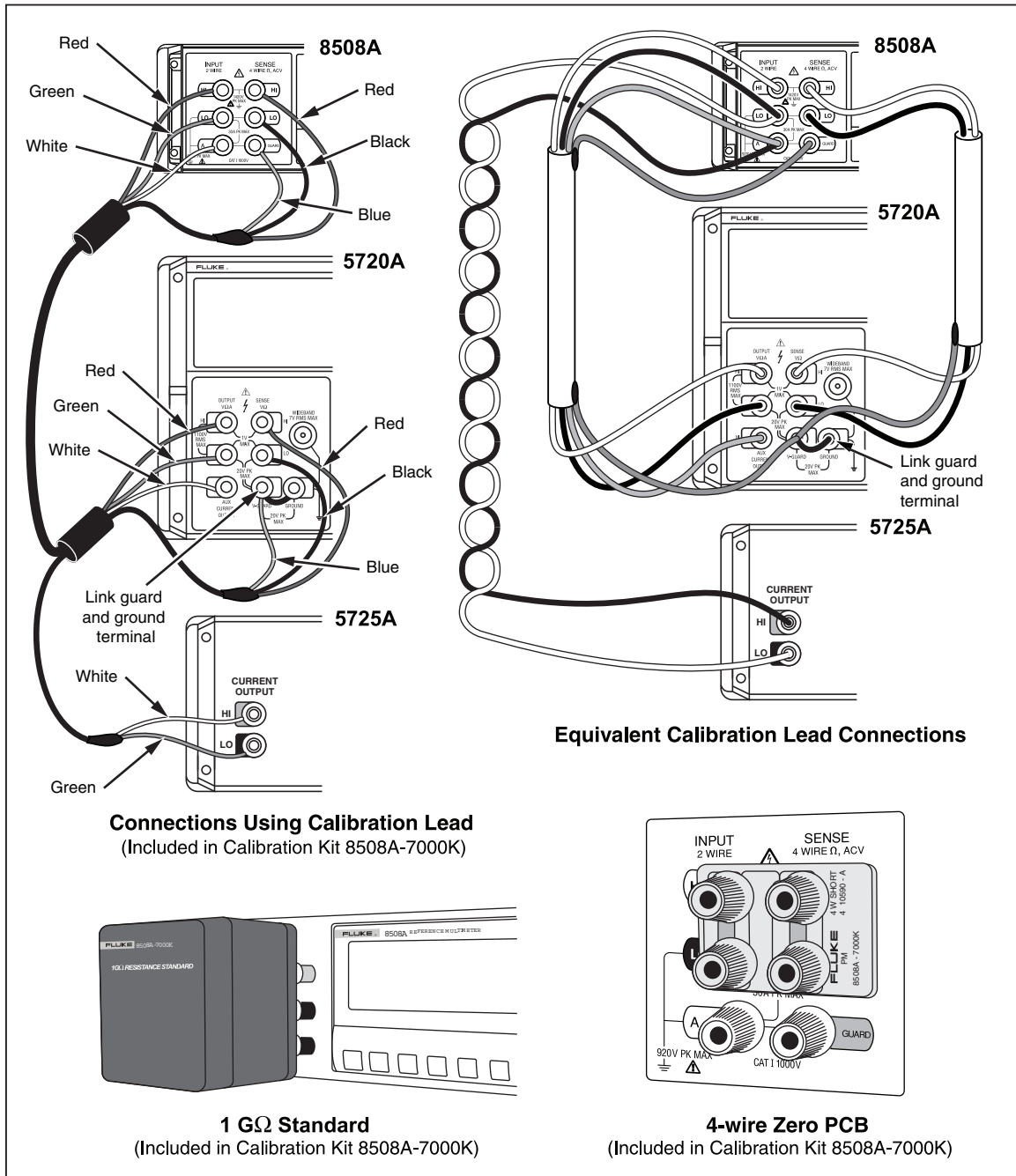


Figure 3-1. Equipment Connections Required for Calibration

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### **ADC Calibration**

ADC (analog to digital converter) calibration aligns the different resolutions available from the Multimeter's analog to digital converter, so that there are no significant differences in readings when changing resolutions with a constant input value. It is recommended that ADC CAL is only performed if performance verification indicates significant resolution differences. If required, it is recommended that ADC calibration is performed before any other calibrations.

No external equipment or signals are required to perform ADC calibration.

#### **Procedure**

1. Ensure that no signals are present on the Multimeter's inputs. The Multimeter may be left connected to the calibrator as shown above provided the calibrator output is set to STANDBY.
2. On the Multimeter, Press CAL to enter the CALIBRATION menu, and select SPCL.
3. Select Adc to initiate the calibration operation, which will take approximately 3 minutes to complete.

Calibration is complete when the Busy legend goes out.

### **DC Voltage Calibration**

#### **Warning**

**The Calibrator can deliver a lethal electric shock.**

**To avoid electric shock when performing the following calibration procedures:**

- **Never touch any lead or terminal unless you are absolutely certain that no dangerous voltage is present.**
- **Make sure that signal leads are in a safe condition before you handle them in any way.**

#### **Initial Setup**

1. Press the DCV key, select the 200 mV range.
2. Press the CONFIG key. Select Filt.
3. In calibration mode the resolution defaults to RESL7 in the DCV function. It is recommended that this resolution is used for calibration of all DCV ranges.
4. Reselect DCV.
5. Confirm that the Multimeter is configured for internal guard (External Guard is deselected) by checking that the Ext Grd legend does not appear on the left-hand display.
6. Ensure that the calibrator output is set to STANDBY and configured for Internal Guard (EXT GRD is deselected).
7. Connect the Calibrator to the Multimeter as shown above.

### Range Zero and Gain Calibration Procedure

After the initial setup and connecting up, use the following procedure to calibrate range zero, then positive and negative range gains on all DCV ranges. Just one range can be calibrated if required, but for a full calibration start with the 200 mV range and work up to the 1kV range, as shown in Table 3-3.

**Table 3-3. DC Voltage Calibration Points and Sequence**

| 8508A Range | Point          | Voltage |
|-------------|----------------|---------|
| 200 mV      | Zero           | 0 mV    |
|             | Range Gain +ve | +100 mV |
|             | Range Gain -ve | -100 mV |
| 2 V         | Zero           | 0 V     |
|             | Range Gain +ve | +1 V    |
|             | Range Gain -ve | -1 V    |
| 20 V        | Zero           | 0 V     |
|             | Range Gain +ve | +10 V   |
|             | Range Gain -ve | -10 V   |
| 200 V       | Zero           | 0 V     |
|             | Range Gain +ve | +100 V  |
|             | Range Gain -ve | -100 V  |
| 1000 V      | Zero           | 0 V     |
|             | Range Gain +ve | +1000 V |
|             | Range Gain -ve | -1000 V |

The procedure assumes the user has knowledge of the actual output value of the calibrator at the range gain values, from a measurement or from a certificate of calibration. The Set feature allows a user to enter the true output value of the calibration standard where it differs from the nominal range gain point. If the calibrator output is considered to be exactly nominal, use of the Set feature is not required, also **omit** steps 2-4 for the Range Gain Points.

On each range, the Multimeter automatically recognizes the appropriate value as range zero or range gain from the applied signal amplitude and polarity.

### Zero Point

1. On the Multimeter, select the required range.
2. On the Calibrator, set zero output and Operate.
3. On the Multimeter, press CAL to enter the CALIBRATION menu.
4. Press SAMPLE to initiate the calibration operation.

Calibration is complete when the Busy legend goes out and the calibrated measurement is displayed.

### **Range Gain Points**

1. On the Calibrator, select the positive Range Gain point Output value.
2. On the Multimeter, Press CAL to revert to CALIBRATION menu.
3. Select Set on the CALIBRATION menu.
4. Use the numeric keys with the SET VALUE menu to key in the true output value of the calibrator at the range gain value, then press Enter.
5. Press SAMPLE to initiate the calibration operation.  
Calibration is complete when the Busy legend goes out and the calibrated measurement is displayed.
6. On the Calibrator, select the negative Range Gain point Output value.
7. Repeat steps 3 to 5 above to calibrate the negative Range gain point.
8. On the Calibrator, set Standby.
9. Press the DCV key to revert to the ranges menu.

### **AC Voltage Calibration**

#### **Warning**

**The Calibrator can deliver a lethal electric shock.**

**To avoid electric shock when performing the following calibration procedures:**

- **Never touch any lead or terminal unless you are absolutely certain that no dangerous voltage is present.**
- **Make sure that signal leads are in a safe condition before you handle them in any way**

### **Initial Setup and Connections**

1. Press the ACV key, select the 200 mV range..
2. Press the CONFIG key. In calibration mode in the ACV function Transfer mode defaults to On for enhanced performance, resolution defaults to RESL6, and the 100Hz RMS filter is automatically selected. It is recommended that this resolution, Transfer On and 100Hz Filter is used for calibration of all ACV ranges.
3. Reselect ACV.
4. Confirm that the Multimeter is configured for internal guard (External Guard is deselected) by checking that the Ext Grd legend does not appear on the left-hand display.
5. Ensure that the calibrator output is set to STANDBY and configured for Internal Guard (EXT GRD is deselected).
6. Connect the Calibrator to the Multimeter as shown above.

### **Range Zero, LF, and HF Gain Calibration Procedure (not in Spot Frequency mode)**

Using the following procedure to calibrate range zero then range LF and HF gains on all ACV ranges at the voltages and frequencies detailed in Table 3-4. Just one range can be calibrated if required, but for a full-calibration start with the 200 mV range and work up to the 1kV range.

**Table 3-4. AC Voltage Calibration Points and Sequence**

| 8508A Range                                                                                                                                                                                                                    | Point              | Voltage | Frequency |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|---------|-----------|
| 200 mV                                                                                                                                                                                                                         | Zero (5 % Range)   | 10 mV   | 1 kHz     |
|                                                                                                                                                                                                                                | Range Gain LF      | 100 mV  | 1 kHz     |
|                                                                                                                                                                                                                                | Range Gain HF      | 100 mV  | 60 kHz    |
| 2 V                                                                                                                                                                                                                            | Zero (0.5 % Range) | 10 mV   | 1 kHz     |
|                                                                                                                                                                                                                                | Range Gain LF      | 1V      | 1 kHz     |
|                                                                                                                                                                                                                                | Range Gain HF      | 1V      | 60 kHz    |
| 20 V                                                                                                                                                                                                                           | Zero (0.5 % Range) | 100 mV  | 1 kHz     |
|                                                                                                                                                                                                                                | Range Gain LF      | 10 V    | 1 kHz     |
|                                                                                                                                                                                                                                | Range Gain HF      | 10 V    | 60 kHz    |
| 200 V                                                                                                                                                                                                                          | Zero (0.5 % Range) | 1 V     | 1 kHz     |
|                                                                                                                                                                                                                                | Range Gain LF      | 100 V   | 1 kHz     |
|                                                                                                                                                                                                                                | Range Gain HF      | 100 V   | 60 kHz    |
| 1000 V <sup>[1]</sup>                                                                                                                                                                                                          | Zero (0.5 % Range) | 5 V     | 1 kHz     |
|                                                                                                                                                                                                                                | Range Gain LF      | 500 V   | 1 kHz     |
|                                                                                                                                                                                                                                | Range Gain HF      | 500 V   | 30 kHz    |
| [1] 1000V range Gain calibrations may be performed at voltages above 500V. The 1000V range Gain and Zero calibrations should be performed together, with the Zero cal performed at 1 % of the nominal value used for Gain cal. |                    |         |           |

The procedure assumes the user has knowledge of the actual output value of the calibrator at each point, from a measurement or from a certificate of calibration. The **Set** feature allows a user to enter the true output value of the calibration standard where it differs from the nominal point. If the calibrator output is considered to be exactly nominal, use of the **Set** feature is not required, also **omit** steps 3-5.

On each range, the Multimeter automatically recognizes the appropriate value as range zero from the applied signal amplitude, and automatically recognizes the range LF and HF gain points from the applied signal frequency.

1. On the Multimeter, select the required Range.
2. On the Calibrator select Output Voltage and Frequency, Operate
3. On the Multimeter, Press **CAL** to revert to **CALIBRATION** menu.
4. Select **Set** on the **CALIBRATION** menu.
5. Use the numeric keys with the **SET VALUE** menu to key in the true output value of the calibrator, then press **Enter**.
6. Press **SAMPLE** to initiate the calibration operation.

Calibration is complete when the **Busy** legend goes out and the calibrated measurement is displayed. Note that HF gain calibrations are iterative, and repeating the HF calibration may improve the result.

7. On the Calibrator, set Output to **STANDBY**.
8. On the Multimeter, press **ACV** key to revert to the ranges menu.

## Resistance Calibration

When calibrating the resistance function, each of the resistance modes (Normal, LoI, TruΩ, TruΩ LoI and HiVΩ) must be individually calibrated. The following procedure assumes use of a multifunction calibrator and calibrates each resistance mode in turn, range by range. If individual standard resistors are used it may be more convenient to calibrate all the modes in turn for each resistance value to avoid connecting the same resistance standard several times during the calibration sequence. A 1 GΩ standard resistor provided in the 8508A-7000K calibration kit is used for ranges above 200 MΩ as the highest resistance available from the 5720A calibrator is 100 MΩ. Refer to Table 3-5 for the resistance calibration points and sequence.

**Table 3-5. Resistance Calibration Points and Sequence**

| 8508A Range                                                                                                                                                                                                                                                                  | Modes                                 | Point      | Resistance              |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|------------|-------------------------|
| 2 Ω                                                                                                                                                                                                                                                                          | Normal, Normal LoI,<br>TruΩ, TruΩ LoI | Zero       | 0 Ω                     |
|                                                                                                                                                                                                                                                                              |                                       | Range Gain | 1 Ω                     |
| 20 Ω                                                                                                                                                                                                                                                                         | Normal, Normal LoI,<br>TruΩ, TruΩ LoI | Zero       | 0 Ω                     |
|                                                                                                                                                                                                                                                                              |                                       | Range Gain | 10 Ω                    |
| 200 Ω                                                                                                                                                                                                                                                                        | Normal, Normal LoI,<br>TruΩ, TruΩ LoI | Zero       | 0 Ω                     |
|                                                                                                                                                                                                                                                                              |                                       | Range Gain | 100 Ω                   |
| 2 kΩ                                                                                                                                                                                                                                                                         | Normal, Normal LoI,<br>TruΩ, TruΩ LoI | Zero       | 0 Ω                     |
|                                                                                                                                                                                                                                                                              |                                       | Range Gain | 1 kΩ                    |
| 20 kΩ                                                                                                                                                                                                                                                                        | Normal, Normal LoI,<br>TruΩ, TruΩ LoI | Zero       | 0 Ω                     |
|                                                                                                                                                                                                                                                                              |                                       | Range Gain | 10 kΩ                   |
| 200 kΩ                                                                                                                                                                                                                                                                       | Normal, Normal LoI                    | Zero       | 0 Ω                     |
|                                                                                                                                                                                                                                                                              |                                       | Range Gain | 100 kΩ                  |
| 2 MΩ                                                                                                                                                                                                                                                                         | Normal, Normal LoI                    | Zero       | 0 Ω                     |
|                                                                                                                                                                                                                                                                              |                                       | Range Gain | 1 MΩ                    |
| 20 MΩ                                                                                                                                                                                                                                                                        | Normal, Normal LoI,<br>HiVΩ           | Zero       | 0 Ω                     |
|                                                                                                                                                                                                                                                                              |                                       | Range Gain | 10 MΩ                   |
| 200 MΩ                                                                                                                                                                                                                                                                       | Normal, Normal LoI,<br>HiVΩ           | Zero       | 0 Ω                     |
|                                                                                                                                                                                                                                                                              |                                       | Range Gain | 100 MΩ                  |
| 2 GΩ                                                                                                                                                                                                                                                                         | Normal, Normal LoI,<br>HiVΩ           | Zero       | 0 Ω                     |
|                                                                                                                                                                                                                                                                              |                                       | Range Gain | 1 GΩ                    |
| 20 GΩ                                                                                                                                                                                                                                                                        | HiVΩ                                  | Zero       | 0 Ω                     |
|                                                                                                                                                                                                                                                                              |                                       | Range Gain | Optional <sup>[1]</sup> |
| [1] 20 GΩ range gain is calibrated automatically during 2 GΩ HiVΩ range gain cal, but may be calibrated separately (after 2 GΩ HiVΩ range cal) at 10 GΩ if a standard is available. The 100 MΩ and 2 GΩ NormalΩ ranges must be calibrated before 2 GΩ HiVΩ range gain point. |                                       |            |                         |

### Initial Setup and Connections

1. Press the  $\Omega$  key and select the 200  $\Omega$  range.
2. Press the CONFIG key and select Filt and 4w $\Omega$ .
3. In calibration mode the resolution defaults to RESL7 in the resistance function. It is recommended that this resolution is used for calibration of all resistance ranges.
4. Reselect  $\Omega$ .
5. Confirm that the Multimeter is configured for internal guard (External Guard is deselected) by checking that the Ext Grd legend does not appear on the left-hand display.
6. Ensure that the calibrator output is set to STANDBY and configured for Internal Guard (EXT GRD is deselected). On the calibrator select EX SNS (4-wire).
7. Connect the Calibrator to the Multimeter as shown earlier in this chapter.
8. If using standard resistors in place of the calibrator refer to "Measuring Resistance" in Chapter 3 of the Users Manual for information regarding 4-wire resistance connections.

### Normal $\Omega$ Mode Calibration

1. Press the  $\Omega$  key and select the 2  $\Omega$  range.
2. Press the CONFIG key and select Filt and 4w $\Omega$ . Ensure LoI is deselected.

### Range Zero and Gain Calibration Procedure

After the initial setup and connecting up, use the following procedure to calibrate range zero and range gain for the ranges and points detailed in Table 3-5 for the Normal $\Omega$  mode. For the 2 G $\Omega$  range use the 1 G $\Omega$  standard resistor in place of the calibrator. Just one range can be calibrated if required, but for a full-calibration start with the 2  $\Omega$  range and work up to the 2 G $\Omega$  range.

Note that EX SNS (4-wire) is not available on the 5720A 100 M $\Omega$  range, and the 8508-7000K 1 G $\Omega$  standard resistor is used as a 2-wire device with the calibrator 2-wire resistance zero used for the corresponding zero points. 4W $\Omega$  is deselected on the Multimeter when calibrating the 200 M $\Omega$  and 2 G $\Omega$  range, range zero, and range gain points.

On each range, the Multimeter automatically recognizes the appropriate value as range zero or range gain from the applied resistance value.

#### Note

*It is unlikely that the resistance standard will be at exactly the nominal value required. The Set feature allows a user to enter the true output value of the calibration standard where it differs from nominal range gain point. If the resistance value is exactly the nominal value required, omit steps 2-4 for the Range Gain Point.*

### Zero Point

1. On the Multimeter, select the required range.
2. On the Calibrator, select zero and Operate. Alternatively if using a standard resistor connect the standard resistor for a 4-wire resistance zero. (For the 200 M $\Omega$  and 2 G $\Omega$  ranges, de-select EX SNS on the calibrator and de-select 4W $\Omega$  on the Multimeter.)
3. On the Multimeter, press CAL to enter the CALIBRATION menu.
4. Press SAMPLE to initiate the calibration operation.

Calibration is complete when the Busy legend goes out and the calibrated measurement is displayed

### **Range Gain Point**

1. On the Calibrator, select the Range Gain point resistance value. Alternatively if using a standard resistor re-connect the standard resistor to measure its resistance. (For the 2 G $\Omega$  range the 8508-7000K 1 G $\Omega$  standard resistor is used in place of the calibrator. For the 200 M $\Omega$  and 2 G $\Omega$  ranges, de-select EX SNS on the calibrator and de-select 4W $\Omega$  on the Multimeter.)
2. On the Multimeter, Press CAL to revert to CALIBRATION menu.
3. Select Set on the CALIBRATION menu.
4. Use the numeric keys with the SET VALUE menu to key in the true output value of the calibrator (or the value of the resistance standard) at the range gain value, then press Enter.
5. Press SAMPLE to initiate the calibration operation.  
  
Calibration is complete when the Busy legend goes out and the calibrated measurement is displayed.
6. On the Calibrator, set STANDBY.
7. Press the  $\Omega$  key to revert to the ranges menu.

### **LoI $\Omega$ Mode Calibration**

1. Press the  $\Omega$  key and select the 2  $\Omega$  range.
2. Press the CONFIG key and select Filt, LoI and 4w $\Omega$ .

### **Range Zero and Gain Calibration Procedure**

After the initial setup and connecting up, use the following procedure to calibrate range zero and range gain for the ranges and points detailed in Table 3-5 for the LoI mode. For the 2 G $\Omega$  range use the 1 G $\Omega$  standard resistor in place of the calibrator. Just one range can be calibrated, if required, but for a full-calibration start with the 2  $\Omega$  range and work up to the 2 G $\Omega$  range.

Note that EX SNS (4-wire) is not available on the 5720A 100 M $\Omega$  range, and the 8508-7000K 1 G $\Omega$  standard resistor is used as a 2-wire device with the calibrator 2-wire resistance zero used for the corresponding zero points. 4W $\Omega$  is deselected on the Multimeter when calibrating the 200 M $\Omega$  and 2 G $\Omega$  range, range zero, and range gain points.

On each range, the Multimeter automatically recognizes the appropriate value as range zero or range gain from the applied resistance value.

#### *Note*

*It is unlikely that the resistance standard will be at exactly the nominal value required. The **Set** feature allows a user to enter the true output value of the calibration standard where it differs from nominal range gain point. If the resistance value is exactly the nominal value required, omit steps 2-4 for the Range Gain Point.*

### Zero Point

1. On the Multimeter, select the required range.
2. On the Calibrator, select zero  $\Omega$  and Operate. Alternatively if using a standard resistor connect the standard resistor for a 4-wire resistance zero. (For the 200 M $\Omega$  and 2 G $\Omega$  ranges, de-select Ex SNS on the calibrator and de-select 4W $\Omega$  on the Multimeter.)
3. On the Multimeter, press CAL to enter the CALIBRATION menu.
4. Press SAMPLE to initiate the calibration operation.  
Calibration is complete when the Busy legend goes out and the calibrated measurement is displayed.

### Range Gain Point

1. On the Calibrator, select the Range Gain point resistance value. Alternatively if using a standard resistor re-connect the standard resistor to measure its resistance. (For the 2 G $\Omega$  range the 8508-7000K 1 G $\Omega$  standard resistor is used in place of the calibrator. For the 200 M $\Omega$  and 2 G $\Omega$  ranges, de-select Ex SNS on the calibrator and de-select 4W $\Omega$  on the Multimeter.)
2. On the Multimeter, Press CAL to revert to CALIBRATION menu.
3. Select Set on the CALIBRATION menu.
4. Use the numeric keys with the SET VALUE menu to key in the true output value of the calibrator (or the value of the resistance standard) at the range gain value, then press Enter.
5. Press SAMPLE.  
Calibration is complete when the Busy legend goes out and the calibrated measurement is displayed.
6. On the Calibrator, set STANDBY.
7. Press the  $\Omega$  key to revert to the ranges menu.

### Tru $\Omega$ Mode Calibration

1. Press the  $\Omega$  Plus key and select Tru $\Omega$ . From the Tru $\Omega$  menu select the 2  $\Omega$  range.
2. Press the CONFIG key and select Filt and 4w $\Omega$ . Ensure Lol is deselected.

### Range Zero and Gain Calibration Procedure

After the initial setup and connecting up, use the following procedure to calibrate range zero and range gain for the ranges and points detailed in Table 3-5 for the Tru $\Omega$  mode. Just one range can be calibrated, if required, but for a full-calibration start with the 2  $\Omega$  range and work up to the 20 k $\Omega$  range.

On each range, the Multimeter automatically recognizes the appropriate value as range zero or range gain from the applied resistance value.

#### Note

*It is unlikely that the resistance standard will be at exactly the nominal value required. The **Set** feature allows a user to enter the true output value of the calibration standard where it differs from nominal range gain point. If the resistance value is exactly the nominal value required, omit steps 2-4 for the Range Gain Point.*

### Zero Point

1. On the Multimeter, select the required range.
2. On the Calibrator, select zero  $\Omega$  and Operate. Alternatively if using a standard resistor connect the standard resistor for a 4-wire resistance zero.
3. On the Multimeter, press CAL to enter the CALIBRATION menu.
4. Press SAMPLE to initiate the calibration operation.

Calibration is complete when the Busy legend goes out and the calibrated measurement is displayed.

### Range Gain Point

1. On the Calibrator, select Range Gain point Output value. Alternatively if using a standard resistor re-connect the standard resistor to measure its resistance.
2. On the Multimeter, Press CAL to revert to CALIBRATION menu.
3. Select Set on the CALIBRATION menu.
4. Use the numeric keys with the SET VALUE menu to key in the true output value of the calibrator (or the value of the resistance standard) at the range gain value, then press Enter.
5. Press SAMPLE to initiate the calibration operation.

Calibration is complete when the Busy legend goes out and the calibrated measurement is displayed.

6. On the Calibrator, set STANDBY.
7. Press the  $\Omega$  key to revert to the ranges menu.

### Tru $\Omega$ LoI Mode Calibration

1. Press the  $\Omega$  Plus key and select Tru $\Omega$ . From the Tru $\Omega$  menu select the 2 $\Omega$  range.
2. Press the CONFIG key and select Filt, LoI and 4w $\Omega$ .

### Range Zero and Gain Calibration Procedure

After the initial setup and connecting up, use the following procedure to calibrate range zero and range gain for the ranges and points detailed in Table 3-5 for the Tru $\Omega$  LoI mode. Just one range can be calibrated if required, but for a full calibration start with the 2  $\Omega$  range and work up to the 20 k $\Omega$  range.

On each range, the Multimeter automatically recognizes the appropriate value as range zero or range gain from the applied resistance value.

#### Note

*It is unlikely that the resistance standard will be at exactly the nominal value required. The **Set** feature allows a user to enter the true output value of the calibration standard where it differs from nominal range gain point. If the resistance value is exactly the nominal value required, omit steps 2-4 for the Range Gain Point.*

### Zero Point

1. On the Multimeter, select the required range.
2. On the Calibrator, select zero  $\Omega$  and Operate. Alternatively if using a standard resistor connect the standard resistor for a 4-wire resistance zero.
3. On the Multimeter, press CAL to enter the CALIBRATION menu.
4. Press SAMPLE to initiate the calibration operation.

Calibration is complete when the Busy legend goes out and the calibrated measurement is displayed.

### Range Gain Point

1. On the Calibrator, select Range Gain point Output value. Alternatively if using a standard resistor re-connect the standard resistor to measure its resistance.
2. On the Multimeter, Press CAL to revert to CALIBRATION menu.
3. Select Set on the CALIBRATION menu.
4. Use the numeric keys with the SET VALUE menu to key in the true output value of the calibrator (or the value of the resistance standard) at the range gain value, then press Enter.
5. Press SAMPLE to initiate the calibration operation.

Calibration is complete when the Busy legend goes out and the calibrated measurement is displayed.

6. On the Calibrator, set STANDBY.
7. Press the  $\Omega$  key to revert to the ranges menu.

### HiV $\Omega$ Mode Calibration

#### Warning

**The Multimeter can deliver a lethal electric shock when operating in the High Voltage Resistance mode. Voltages up to 240V may appear on the terminals.**

**To avoid electric shock when performing the following calibration procedures:**

- **Never touch any lead or terminal unless you are absolutely certain that no dangerous voltage is present.**
- **Make sure that signal leads are in a safe condition before you handle them in any way.**

1. Press the  $\Omega$  Plus key and select HiV $\Omega$ . From the HiV $\Omega$  menu select the 20 M $\Omega$  range.
2. Press the CONFIG key and select Filt and 4w $\Omega$ .

### Range Zero and Gain Calibration Procedure

After the initial setup and connecting up, use the following procedure to calibrate range zero and range gain for the ranges and points detailed in Table 3-5 for the HiV $\Omega$  mode. Just one range can be calibrated if required, but for a full calibration start with the 20 M $\Omega$  range and work up to the 20 G $\Omega$  range.

For the 2 G $\Omega$  range use the 1 G $\Omega$  standard resistor in place of the calibrator. To avoid the requirement for a 10 G $\Omega$  standard, the 20 G $\Omega$  range is automatically calibrated when the 2 G $\Omega$  range gain calibration is triggered. It is also necessary for the 100 M $\Omega$  and 1 G $\Omega$  Normal $\Omega$  ranges to be calibrated prior to the 2 G $\Omega$  HiV $\Omega$  range for the result to be valid. A 10 G $\Omega$  standard resistor may be used for calibrating the 20 G $\Omega$  range if available, but if performed, this operation must take place after the 2 G $\Omega$  range gain point calibration to avoid the automatic process overwriting the result.

Voltages of approximately 200V will be developed across the resistance standard at full scale, ensure the resistance standards used are suitable for operation at these voltages.

Note that EX SNS (4-wire) is not available on the 5720A 100 M $\Omega$  range, and the 8508-7000K 1 G $\Omega$  standard resistor is used as a 2-wire device with the calibrator 2-wire resistance zero used for the corresponding zero points. 4W $\Omega$  is deselected on the Multimeter when calibrating the 200 M $\Omega$  and 2 G $\Omega$  range, range zero, and range gain points.

On each range, the Multimeter automatically recognizes the appropriate value as range zero or range gain from the applied resistance value.

#### *Note*

*It is unlikely that the resistance standard will be at exactly the nominal value required. The **Set** feature allows a user to enter the true output value of the calibration standard where it differs from nominal range gain point. If the resistance value is exactly the nominal value required, omit steps 2-4 for the Range Gain Point .*

#### **Zero Point**

1. On the Multimeter, select the required range.
2. On the Calibrator, select zero  $\Omega$  and Operate. (For the 200 M $\Omega$  range and above, de-select Ex SNS on the calibrator and de-select 4W $\Omega$  on the Multimeter.) Alternatively if using a standard resistor connect the standard resistor for a 4-wire resistance zero.
3. On the Multimeter, press CAL to enter the CALIBRATION menu.
4. Press SAMPLE to initiate the calibration operation.

Calibration is complete when the Busy legend goes out and the calibrated measurement is displayed.

#### **Range Gain Point**

1. On the Calibrator, select Range Gain point Output value. Alternatively if using a standard resistor re-connect the standard resistor to measure its resistance. (For the 2 G $\Omega$  range the 8508-7000K 1 G $\Omega$  standard resistor is used in place of the calibrator. For the 200 M $\Omega$  range and above, de-select Ex SNS on the calibrator and de-select 4W $\Omega$  on the Multimeter. Calibration of the 20 G $\Omega$  range gain point takes place automatically when calibrating 2 G $\Omega$  range, and calibration against an external standard is optional if a suitable standard is available).
2. On the Multimeter, Press CAL to revert to CALIBRATION menu.
3. Select Set on the CALIBRATION menu.
4. Use the numeric keys with the SET VALUE menu to key in the true output value of the calibrator (or the value of the resistance standard) at the range gain value, then press Enter.

5. Press **SAMPLE** to initiate the calibration operation.  
Calibration is complete when the Busy legend goes out and the calibrated measurement is displayed.
6. On the Calibrator, set **STANDBY**.
7. Press the  $\Omega$  key to revert to the ranges menu.

### DC Current Calibration

#### **Warning**

**The Calibrator can deliver a lethal electric shock.**

**To avoid electric shock when performing the following calibration procedures:**

- **Never touch any lead or terminal unless you are absolutely certain that no dangerous voltage is present.**
- **Make sure that signal leads are in a safe condition before you handle them in any way.**

### Initial Setup

1. Press the **DCI** key, select the 200  $\mu$ A range.
2. Press the **CONFIG** key. Select **Filt**.
3. In calibration mode the resolution defaults to **RESL7** in the **DCI** function. It is recommended that this resolution is used for calibration of all **DCI** ranges.
4. Reselect **DCI**.
5. Confirm that the Multimeter is configured for internal guard (External Guard is deselected) by checking that the **Ext Grd** legend does not appear on the left-hand display.
6. Ensure that the calibrator output is set to **STANDBY** and configured for Internal Guard (**EXT GRD** is deselected).
7. Connect the Calibrator to the Multimeter as shown above.

### Range Zero and Gain Calibration Procedure

After the initial setup and connecting up, use the following procedure to calibrate range zero, then positive and negative range gains on all **DCI** ranges. Just one range can be calibrated if required, but for a full calibration start with the 200  $\mu$ A range and work up to the 20A range, as shown in Table 3-6.

**Table 3-6. DC Current Calibration Points and Sequence**

| 8508A Range | Point          | Current      |
|-------------|----------------|--------------|
| 200 $\mu$ A | Zero           | 0 $\mu$ A    |
|             | Range Gain +ve | +100 $\mu$ A |
|             | Range Gain -ve | -100 $\mu$ A |
| 2 mA        | Zero           | 0 mA         |
|             | Range Gain +ve | +1 mA        |
|             | Range Gain -ve | -1 mA        |
| 20 mA       | Zero           | 0 mA         |
|             | Range Gain +ve | +10 mA       |
|             | Range Gain -ve | -10 mA       |
| 200 mA      | Zero           | 0 mA         |
|             | Range Gain +ve | +100 mA      |
|             | Range Gain -ve | -100 mA      |
| 2 A         | Zero           | 0 A          |
|             | Range Gain +ve | +1 A         |
|             | Range Gain -ve | -1 A         |
| 20 A        | Zero           | 0 A          |
|             | Range Gain +ve | +10 A        |
|             | Range Gain -ve | -10 A        |

The procedure assumes the user has knowledge of the actual output value of the calibrator at the range gain values, from a measurement or from a certificate of calibration. The **Set** feature allows a user to enter the true output value of the calibration standard where it differs from the nominal range gain point. If the calibrator output is considered to be exactly nominal, use of the **Set** feature is not required, also **omit** steps 2-4 for the Range Gain Points.

On each range, the Multimeter automatically recognizes the appropriate value as range zero or range gain from the applied signal amplitude and polarity.

#### **Zero Point**

1. On the Multimeter, select the required range.
2. On the Calibrator, set to zero output and Operate.
3. On the Multimeter, press **CAL** to enter the **CALIBRATION** menu.
4. Press **SAMPLE** to initiate the calibration operation.

Calibration is complete when the Busy legend goes out and the calibrated measurement is displayed.

### Range Gain Points

1. On the Calibrator, select the positive Range Gain point Output value.
2. On the Multimeter, Press CAL to revert to CALIBRATION menu.
3. Select Set on the CALIBRATION menu.
4. Use the numeric keys with the SET VALUE menu to key in the true output value of the calibrator at the range gain value, then press Enter.
5. Press SAMPLE to initiate the calibration operation.
6. Calibration is complete when the Busy legend goes out and the calibrated measurement is displayed.
7. On the Calibrator, select the negative Range Gain point Output value.
8. Repeat steps 3 to 5 above to calibrate the negative Range gain point.
9. On the Calibrator, set STANDBY.
10. Press the DCI key to revert to the ranges menu.

### AC Current Calibration

#### Warning

The Calibrator can deliver a lethal electric shock.

To avoid electric shock when performing the following calibration procedures:

- Never touch any lead or terminal unless you are absolutely certain that no dangerous voltage is present.
- Make sure that signal leads are in a safe condition before you handle them in any way.

### Initial Setup and Connections

1. Press the ACI key, and select the 200 $\mu$ A range.
2. Press the CONFIG key. In calibration mode in the ACI function resolution defaults to RESL6 and the 100Hz RMS filter is automatically selected. It is recommended that this resolution and 100Hz Filter is used for calibration of all ACI ranges.
3. Reselect ACI.
4. Confirm that the Multimeter is configured for internal guard (External Guard is deselected) by checking that the Ext Grd legend does not appear on the left-hand display.
5. Ensure that the calibrator output is set to STANDBY and configured for Internal Guard (EXT GRD is deselected).
6. Connect the Calibrator to the Multimeter as shown above.

### Range Zero and LF Gain Calibration Procedure

Using the following procedure to calibrate range zero then range gain on all ACI ranges at the currents and frequencies detailed in Table 3-7. Just one range can be calibrated if required, but for a full-calibration start with the 200  $\mu$ A range and work up to the 20A range.

**Table 3-7. AC Current Calibration Points and Sequence**

| 8508A Range | Point              | Current     | Frequency |
|-------------|--------------------|-------------|-----------|
| 200 $\mu$ A | Zero (5 % Range)   | 10 $\mu$ A  | 300 Hz    |
|             | Range Gain         | 100 $\mu$ A | 300 Hz    |
| 2 mA        | Zero (0.5 % Range) | 10 $\mu$ A  | 300 Hz    |
|             | Range Gain         | 1 mA        | 300 Hz    |
| 20 mA       | Zero (0.5 % Range) | 100 $\mu$ A | 300 Hz    |
|             | Range Gain         | 10 mA       | 300 Hz    |
| 200 mA      | Zero (5 % Range)   | 10 mA       | 300 Hz    |
|             | Range Gain         | 100 mA      | 300 Hz    |
| 2 A         | Zero (5 % Range)   | 100 mA      | 300 Hz    |
|             | Range Gain         | 1 A         | 300 Hz    |
| 20 A        | Zero (5 % Range)   | 1 A         | 300 Hz    |
|             | Range Gain         | 10 A        | 300 Hz    |

The procedure assumes the user has knowledge of the actual output value of the calibrator at each point, from a measurement or from a certificate of calibration. The **Set** feature allows a user to enter the true output value of the calibration standard where it differs from the nominal point. If the calibrator output is considered to be exactly nominal, use of the **Set** feature is not required, also **omit** steps 3-5.

On each range, the Multimeter automatically recognizes the appropriate value as range zero or range gain from the applied signal amplitude.

1. On the Multimeter, select the required Range.
2. On the Calibrator select Output Current and Frequency, Operate.
3. On the Multimeter, Press **CAL** to revert to **CALIBRATION** menu.
4. Select **Set** on the **CALIBRATION** menu.
5. Use the numeric keys with the **SET VALUE** menu to key in the true output value of the calibrator, then press **Enter**.
6. Press **SAMPLE** to initiate the calibration operation.

Calibration is complete when the **Busy** legend goes out and the calibrated measurement is displayed.

7. On the Calibrator, set Output to **STANDBY**.
8. On the Multimeter, press **ACI** key to revert to the ranges menu.

### **Frequency Calibration**

The Multimeter frequency calibration operation requires a signal at exactly 1MHz (**Set** is not available on the Multimeter for frequency calibration). If the calibrator frequency output is not exactly nominal or sufficiently close to nominal it may be phase locked to an external reference frequency at the required output frequency applied to its rear panel phase lock input, for example from a laboratory frequency standard or off-air reference receiver. If used, the calibrator should be disconnected from the frequency reference and phase locking disabled before attempting any other calibration operations with the calibrator.

Alternatively, the 1MHz frequency reference may be used directly as an input signal for the Multimeter for frequency calibration.

### **Initial Setup and Connections**

1. Press the ACV key, select the 2 V range.
2. Confirm that the Multimeter is configured for internal guard (External Guard is deselected) by checking that the Ext Grd legend does not appear on the left-hand display.
3. Ensure that the calibrator output is set to STANDBY and configured for Internal Guard (EXT GRD is deselected).
4. Connect the Calibrator to the Multimeter as shown above.
5. If required, connect the calibrator rear panel phase lock input to a 1MHz reference frequency and enable phase locking via the front panel menus.

### **Procedure**

1. On the calibrator select 1V 1MHz, Operate.
2. On the Multimeter, Press CAL to enter the CALIBRATION menu, and select SPCL.
3. Select Freq to initiate the calibration operation.  
Calibration is complete when the Busy legend goes out.
4. On the Calibrator, set STANDBY.

### **Exit From Calibration Mode and Non-Volatile Input Offset Adjustment**

Use the following procedure to perform non-volatile input offset adjustment on all DCV and resistance ranges (including LoI, 2-wire, and 4-wire) for the front and rear inputs.

### **Initial Setup and Connections**

1. Press the CAL key and select Quit.
2. From the CAL DUE ? menu select Quit.
3. The Multimeter will exit from CAL mode, the CAL legend on the main display will extinguish, and the right-hand display will revert to the currently selected function menu.
4. Disconnect all calibration leads and connect a 8508-7000K precision 4-wire short device to the front input terminals and also, if fitted, to the input terminals as shown above.

### **Procedure**

Omit step 4 if the Multimeter is not fitted with rear input terminals.

1. Press the DCV key
2. Press the INPUT key and select Front.
3. From the INPUT menu select Zero Func to perform zero offset adjustment on all ranges.
4. From the INPUT menu select Rear. Repeat step 3.
5. Press the  $\Omega$  key and select the 2  $\Omega$  range.

6. Press the CONFIG key and select Filt, Lol and 4w $\Omega$ . Repeat steps 3 and 4.
7. Press the CONFIG key and select 2w $\Omega$ . Repeat steps 3 and 4.
8. Press the CONFIG key, select 4w $\Omega$  and de-select Lol. Repeat steps 3 and 4.
9. Press the CONFIG key and select 2w $\Omega$ . Repeat steps 3 and 4.
10. Press the  $\Omega$ PLUS key and select Tru $\Omega$ . From the Tru $\Omega$  menu the 2 $\Omega$  range.
11. Press the CONFIG key and select Filt and Lol. Repeat steps 3 and 4.
12. Press the CONFIG key and de-select Lol. Repeat steps 3 and 4.
13. Press the  $\Omega$ PLUS key and select HiV $\Omega$ . From the HiV $\Omega$  menu the 20M $\Omega$  range.
14. Press the CONFIG key and select Filt and 2w $\Omega$ . Repeat steps 3 and 4.
15. Press the CONFIG key and select 4w $\Omega$ . Repeat steps 3 and 4.
16. Press the DCV key and remove the shorting devices from the input terminals.

### **Cal Due Date Entry and Calibration Mode Disable**

On completion of all calibration operations it is recommended that the user updates the stored CAL due date with the date for next recalibration. For consistency, this date should be the same as the calibration due date shown on any calibration stickers the user may also attach to the Multimeter. It is also recommended that a calibration seal or integrity sticker is applied to prevent unauthorized access to the rear panel calibration enable switch.

#### **Set Cal Due Date**

1. Press the CAL key and select Quit.
2. From the CAL DUE ? menu select Enter.
3. Use the keypad to key in the calibration due date. Up to eight characters may be entered in any format. Any character available from the keypad may be used, but it is recommended that one of the common date formats such as dd.mm.yy or mm.dd.yy is used for ease of interpretation.
4. Press Enter to store the CAL due date.

#### **Disable cal mode**

1. Set the rear panel Calibration Enable switch to DISABLE .
2. Apply a security seal to cover the rear panel Calibration Enable switch to prevent unauthorized access.

### **ACV Spot Frequency Calibration**

The ACV Spot frequency mode calibration is not normally performed as part of routine calibration. ACV Spot frequency calibration is only performed if the user intends to make use of spot frequency mode. In spot frequency mode the accuracy of AC Voltage measurements can be improved by calibrating the Multimeter at specific frequencies of interest, reducing frequency response flatness errors at these points. The following procedure provides guidance on spot frequency calibration for users wishing to make use of Spot frequency mode.

### **To Calibrate at Spot Frequencies**

Spot Calibration is available only when in AC Voltage function with Spot already selected on the ACV CONFIG menu. Each spot (six per range) can be calibrated at a valid input frequency to a non-nominal RMS value. In subsequent use, frequency response flatness errors are reduced within  $\pm 10\%$  of the calibrated spot frequency.

Assuming that the Multimeter is in calibration mode and the setup is connected as described above under *Initial Setup and Connections* for routine calibration. The configuration defaults to Tfer and RESL6 (both required).

Proceed as follows:

1. Select ACV and select the required Range.
2. Press the CONFIG key and select Spot.
3. Press the CAL key.  
The CALIBRATION menu is displayed.
4. Select Set.  
The SPOT CAL menu is displayed.
5. Select the soft key for the required spot, 1 to 6 (Sp1 to Sp6).  
The SPOT (x = 1 to 6) RMS menu is displayed.
6. Key in the true RMS output value of the standard, then select Enter.  
The SPOT FREQUENCY menu is displayed, showing the frequency at which the spot will be calibrated.
7. Press SAMPLE to initiate the calibration operation.  
Calibration is complete when the Busy legend goes out and the calibrated measurement is displayed. The menu display reverts to the SPOT CAL menu.
8. On the Calibrator, set STANDBY.
9. On the Multimeter, select other spots as required, repeating the process for each selection.
10. Exit from the SPOT CAL menu by pressing any hard key.

### **Performance Verification**

The 8508A Digital Reference Multimeter offers state of the art performance. This procedure is intended as a guide for qualified metrology personnel who have access to a standards laboratory with equipment available to verify the performance of an instrument of this level of accuracy. The procedure assumes users are familiar with relevant best measurement practice, and will take precautions to avoid introducing errors from sources such as thermal emfs, leakages, electromagnetic interference, etc. It also assumes users will make adequate allowance for equipment stabilization and measurement settling times.

This routine performance verification procedure describes the test points and sequence of operations required to check the Multimeter and assumes calibration references of adequate traceable uncertainty are available – in this case a Fluke 5720A calibrator and 5725A amplifier used with an 8508A-7000 Calibration Kit. The procedure assumes the user is able to calibrate and characterize the calibration standards, without describing the process required to do so. Refer to the Routine Calibration section for more information on the characterization process.

### **Equipment Requirements**

The equipment required for performance verification of the Multimeter is identical to the equipment required for routine calibration listed in Table 3-1. Alternate equipment may be used, but users should ensure it provides adequate uncertainties, and consider the impact of those uncertainties on allowable tolerance limits.

### **Interconnections**

The Fluke 8508A-7000K Calibration kit contains a specially designed lead set which connects directly to the terminals of the Multimeter, the 5720A, and the 5725A for the purpose of Multimeter calibration and performance verification. It is recommended that this lead kit be used to avoid introducing measurement errors due to interconnections and to duplicate the configuration used by Fluke for Multimeter calibration. A diagram showing the interconnections used in detail appears in the Routine Calibration section. If alternate leads are substituted users must ensure they are metrology grade leads, and of adequate voltage and current rating. Leads should be kept as short as possible, constructed from low capacitance low leakage dielectric material (PTFE) with low thermal emf terminations, and exactly duplicate the configuration and interconnections shown.

When checking the 2 G $\Omega$  and 20 G $\Omega$  resistance ranges the 1 G $\Omega$  standard resistor supplied in the Fluke 8508A-7000K Calibration kit plugs directly into the Multimeter's front input terminals without any interconnecting leads. If alternate resistance standards are used for verifying performance of the resistance function, refer to the resistance measurements section of Chapter 3 *Making Measurements* for connection details.

### **Applicable Verification Tolerance and Conditions**

The tolerances\* listed in this verification procedure are derived from the Multimeter's 365 day Tcal  $\pm 1$  °C 99 % Confidence Level Absolute specifications, which include contributions for the performance of the Multimeter itself and the uncertainty of the calibration standards used to perform calibration adjustment of the Multimeter at the Fluke factory. They are applicable to a verification performed within a period of 365 days from calibration and at a temperature within  $\pm 1$  °C of the temperature at which calibration was performed (23 °C for calibrations performed by Fluke). It is recommended that these tolerances only be used for verification of the Multimeter following calibration by Fluke, and if the above time period and temperature conditions are met. No allowance has been made for the uncertainty of the equipment used for verification. If the required conditions are met but the temperature lies within  $\pm 5$  °C of factory calibration, it is recommended that the user applies the 365 day Tcal  $\pm 5$  °C Absolute specifications instead.

For other circumstances, such as following calibration by another laboratory, it is recommended that the user derive verification tolerances\* from the applicable Multimeter's 99 % Confidence Level Relative to Standards specifications (90 day or 365 day) combined with the calibration uncertainties applicable to the previous calibration. (RSS summation is recommended, with calibration uncertainties also expressed at 99 % confidence level).

The Multimeter's temperature coefficient specifications should also be applied if the temperature at verification is outside the range applicable to the Multimeter's specifications.

Refer to Chapter 1 for further information on applying specifications and combining uncertainties.

\* Fluke guarantees the Multimeter's performance verification using specifications stated to 99 % confidence level.

### Preparation

1. Allow the Multimeter to warm-up under power in the specified environment for at least 4 hours.
2. Press the CLEAR key, select Pwr Up Dflt to restore the power up default configuration and display the DCV menu.
3. Press the Test key and select Std to initiate a selftest. Should the Multimeter fail, contact your local authorized Service Center, ensuring that the full circumstances of the failure are reported.

### DC Voltage Checks

#### Warning

**The Calibrator can deliver a lethal electric shock.**

**To avoid electric shock when performing the following calibration procedures:**

- **Never touch any lead or terminal unless you are absolutely certain that no dangerous voltage is present.**
- **Make sure that signal leads are in a safe condition before you handle them in any way.**

### Equipment Configuration

1. Ensure that the calibrator output is set to STANDBY and configured for Internal Guard (EXT GRD is deselected).
2. Connect the equipment as described for Routine Calibration.
3. Press the DCV key
4. Press the CONFIG key. Select Filt and RESL7.
5. Confirm that the Multimeter is configured for internal guard (External Guard is deselected) by checking that the Ext Grd legend does not appear on the left-hand display.

### Procedure

Repeat the following sequence for each range, starting with the 200mV range and working up to the 1kV range, as listed in Table 3-8. An input zero operation is performed on each Multimeter range prior to performing the range verification measurements with the calibrator set to zero by range locking the calibrator in the range from which the output will be obtained.

1. Select the required Multimeter range.
2. On the calibrator set the output to zero. Select OPERATE.
3. On the Multimeter press the INPUT key, and select Zero Rng to initiate the zeroing operation.

The Busy legend will appear, and then extinguish when the zero operation has completed.

4. On the calibrator select the value required for verification in the positive polarity.

5. Note the Multimeter's reading. Compare the result with the allowable tolerance, taking into account any known error from nominal of the calibrator for this output.
6. On the calibrator select the value required for verification in the negative polarity.
7. Note the Multimeter's reading. Compare the result with the allowable tolerance, taking into account any known error from nominal of the calibrator for this output.
8. Set the calibrator output to STANDBY.

**Table 3-8. DC Voltage Verification Points and Sequence**

| 8508A Range                                                                                                                                                                                                                          | Voltage | Tolerance <sup>[1]</sup>                                            |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|---------------------------------------------------------------------|
| 200 mV                                                                                                                                                                                                                               | 0 mV    | Perform input zero operation to calibrator range locked zero output |
|                                                                                                                                                                                                                                      | +100 mV | $\pm 0.00072$ mV                                                    |
|                                                                                                                                                                                                                                      | -100 mV | $\pm 0.00072$ mV                                                    |
| 2 V                                                                                                                                                                                                                                  | 0 V     | Perform input zero operation to calibrator range locked zero output |
|                                                                                                                                                                                                                                      | +1 V    | $\pm 0.0000045$ V                                                   |
|                                                                                                                                                                                                                                      | -1 V    | $\pm 0.0000045$ V                                                   |
| 20 V                                                                                                                                                                                                                                 | 0 V     | Perform input zero operation to calibrator range locked zero output |
|                                                                                                                                                                                                                                      | +1 V    | $\pm 0.000009$ V                                                    |
|                                                                                                                                                                                                                                      | +10 V   | $\pm 0.000045$ V                                                    |
|                                                                                                                                                                                                                                      | +19 V   | $\pm 0.000081$ V                                                    |
|                                                                                                                                                                                                                                      | -1 V    | $\pm 0.000009$ V                                                    |
|                                                                                                                                                                                                                                      | -10 V   | $\pm 0.000045$ V                                                    |
|                                                                                                                                                                                                                                      | -19 V   | $\pm 0.000081$ V                                                    |
| 200 V                                                                                                                                                                                                                                | 0 V     | Perform input zero operation to calibrator range locked zero output |
|                                                                                                                                                                                                                                      | +100 V  | $\pm 0.00065$ V                                                     |
|                                                                                                                                                                                                                                      | -100 V  | $\pm 0.00065$ V                                                     |
| 1000 V                                                                                                                                                                                                                               | 0 V     | Perform input zero operation to calibrator range locked zero output |
|                                                                                                                                                                                                                                      | +1000 V | $\pm 0.0066$ V                                                      |
|                                                                                                                                                                                                                                      | -1000 V | $\pm 0.0066$ V                                                      |
| [1] Based on 365 day Tcal $\pm 1^{\circ}\text{C}$ 99 %CL Absolute specifications. See comments in Applicable Verification Tolerance section above regarding the impact of calibration uncertainties and use of other specifications. |         |                                                                     |

## AC Voltage Checks

### Warning

The Calibrator can deliver a lethal electric shock.

To avoid electric shock when performing the following calibration procedures:

- Never touch any lead or terminal unless you are absolutely certain that no dangerous voltage is present.
- Make sure that signal leads are in a safe condition before you handle them in any way.

## Equipment Configuration

1. Ensure that the calibrator output is set to STANDBY and configured for Internal Guard (EXT GRD is deselected).
2. Connect the equipment as described for Routine Calibration.
3. Press the ACV key
4. Press the CONFIG key. Select Tfer On and RESL6.
5. Confirm that the Multimeter is configured for internal guard (External Guard is deselected) by checking that the Ext Grd legend does not appear on the left-hand display.

## Procedure

Repeat the following sequence for each range, starting with the 200mV range and working up to the 1kV range, as listed in Table 3-9.

1. Select the required range on the multimeter.
2. On the Multimeter press CONFIG and select the appropriate filter for the point being verified as listed in Table 3-9.
3. On the calibrator set the output to the voltage and frequency for the point being verified as listed in Table 3-9. Set the output to OPERATE.
4. Note the Multimeter's reading. Compare the result with the allowable tolerance, taking into account any known error from nominal of the calibrator for this output.
5. Repeat steps 2 – 4 for each point to be verified on the Multimeter's range to be verified.
6. Repeat steps 1 – 5 for each Multimeter range to be verified.
7. Set the calibrator output to STANDBY.

**Table 3-9. AC Voltage Verification Points and Sequence**

| 8508A Range | Voltage | Frequency | 8508A Filter | Tolerance <sup>1</sup> |
|-------------|---------|-----------|--------------|------------------------|
| 200 mV      | 100 mV  | 20 Hz     | 10 Hz        | ± 0.0195 mV            |
|             | 100 mV  | 55 Hz     | 40 Hz        | ± 0.0175 mV            |
|             | 100 mV  | 1 kHz     | 100 Hz       | ± 0.0149 mV            |
|             | 100 mV  | 3 kHz     | 100 Hz       | ± 0.0175 mV            |
|             | 100 mV  | 10 kHz    | 100 Hz       | ± 0.0175 mV            |
|             | 100 mV  | 30 kHz    | 100 Hz       | ± 0.0445 mV            |
|             | 100 mV  | 60 kHz    | 100 Hz       | ± 0.0995 mV            |
|             | 100 mV  | 100 kHz   | 100 Hz       | ± 0.0995 mV            |
| 2 V         | 1 V     | 20 Hz     | 10 Hz        | ± 0.000144 V           |
|             | 1 V     | 55 Hz     | 40 Hz        | ± 0.000119 V           |
|             | 1 V     | 1 kHz     | 100 Hz       | ± 0.000099 V           |
|             | 1 V     | 3 kHz     | 100 Hz       | ± 0.000119 V           |
|             | 1 V     | 10 kHz    | 100 Hz       | ± 0.000119 V           |
|             | 1 V     | 30 kHz    | 100 Hz       | ± 0.000295 V           |
|             | 1 V     | 60 kHz    | 100 Hz       | ± 0.000795 V           |
|             | 1 V     | 100 kHz   | 100 Hz       | ± 0.000795 V           |
|             | 1 V     | 500 kHz   | 100 Hz       | ± 0.034000 V           |
|             | 1 V     | 1 MHz     | 100 Hz       | ± 0.034000 V           |
| 20V         | 1 V     | 1 kHz     | 100 Hz       | ± 0.00032 V            |
|             | 10 V    | 20 Hz     | 10 Hz        | ± 0.00144 V            |
|             | 10 V    | 55 Hz     | 40 Hz        | ± 0.00099 V            |
|             | 10 V    | 1 kHz     | 100 Hz       | ± 0.00119 V            |
|             | 10 V    | 3 kHz     | 100 Hz       | ± 0.00119 V            |
|             | 10 V    | 10kHz     | 100 Hz       | ± 0.00119 V            |
|             | 10 V    | 30 kHz    | 100 Hz       | ± 0.00295 V            |
|             | 10 V    | 60 kHz    | 100 Hz       | ± 0.00795 V            |
|             | 10 V    | 100 kHz   | 100 Hz       | ± 0.00795 V            |
|             | 10 V    | 500 kHz   | 100 Hz       | ± 0.34000 V            |
|             | 10 V    | 1 MHz     | 100 Hz       | ± 0.34000 V            |
|             | 19 V    | 1 kHz     | 100 Hz       | ± 0.00167 V            |

Table 3-9. AC Voltage Verification Points and Sequence (cont)

| 8508A Range                                                                                                                                                                                                       | Voltage | Frequency | 8508A Filter | Tolerance <sup>[1]</sup> |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|-----------|--------------|--------------------------|
| 200V                                                                                                                                                                                                              | 100 V   | 20 Hz     | 10 Hz        | ± 0.0144 V               |
|                                                                                                                                                                                                                   | 100 V   | 55 Hz     | 40 Hz        | ± 0.0119 V               |
|                                                                                                                                                                                                                   | 100 V   | 1 kHz     | 100 Hz       | ± 0.0099 V               |
|                                                                                                                                                                                                                   | 100 V   | 3 kHz     | 100 Hz       | ± 0.0119 V               |
|                                                                                                                                                                                                                   | 100 V   | 10 kHz    | 100 Hz       | ± 0.0119 V               |
|                                                                                                                                                                                                                   | 100 V   | 30 kHz    | 100 Hz       | ± 0.0295 V               |
|                                                                                                                                                                                                                   | 100 V   | 60 kHz    | 100 Hz       | ± 0.0795 V               |
|                                                                                                                                                                                                                   | 100 V   | 100 kHz   | 100 Hz       | ± 0.0795 V               |
| 1000 V                                                                                                                                                                                                            | 500 V   | 55 Hz     | 40 Hz        | ± 0.088 V                |
|                                                                                                                                                                                                                   | 500 V   | 1 kHz     | 100 Hz       | ± 0.088 V                |
|                                                                                                                                                                                                                   | 500 V   | 3 kHz     | 100 Hz       | ± 0.088 V                |
|                                                                                                                                                                                                                   | 500 V   | 10 kHz    | 100 Hz       | ± 0.088 V                |
|                                                                                                                                                                                                                   | 500 V   | 30 kHz    | 100 Hz       | ± 0.223 V                |
|                                                                                                                                                                                                                   | 1000 V  | 1 kHz     | 100 Hz       | ± 0.331 V                |
|                                                                                                                                                                                                                   | 1000 V  | 30 kHz    | 100 Hz       | ± 1.476 V                |
| [1] Based on 365 day Tcal ±1°C 99 %CL Absolute specifications. See comments in Applicable Verification Tolerance section above regarding the impact of calibration uncertainties and use of other specifications. |         |           |              |                          |

### Resistance Checks

When verifying the resistance function, each of the resistance modes (Normal $\Omega$ , Tru $\Omega$ , LoI $\Omega$  and HiV $\Omega$ ) must be individually checked. The following procedure assumes use of a multifunction calibrator and verifies each resistance mode in turn, range by range. If individual standard resistors are used it may be more convenient to check all the modes in turn for each resistance value to avoid connecting the same resistance standard several times during the calibration sequence. A 1 G $\Omega$  standard resistor is used for ranges above 200 M $\Omega$  as the highest resistance available from the 5720A calibrator is 100 M $\Omega$ .

### Equipment Configuration

1. Ensure that the calibrator output is set to **STANDBY** and configured for Internal Guard (EXT GRD is deselected).
2. Connect the equipment as described for *Routine Calibration*.
3. Press the  $\Omega$  key
4. Press the CONFIG key. Select Filt, RESL7, and 4W $\Omega$ .
5. Confirm that the Multimeter is configured for internal guard (External Guard is deselected) by checking that the Ext Grd legend does not appear on the left-hand display.

### Procedure

Perform the following sequence for each resistance mode and each range, as listed in Table 3-10, starting with the 2  $\Omega$  range and working up to the 2 G $\Omega$  range for the Normal $\Omega$  and Normal $\Omega$  LoI resistance modes. Then continue the sequence for the Tru $\Omega$  and Tru $\Omega$  LoI modes, starting with the 2  $\Omega$  range and working up to the 20 k $\Omega$  range. Finally complete the sequence for the HiV $\Omega$  mode, starting with the 20 M $\Omega$  range and working up to the 20 G $\Omega$  range. An input zero operation is performed on each Multimeter range prior to performing the range verification measurements with the calibrator set to zero  $\Omega$ . A separate zero operation is required on each range for each resistance mode.

Note that EX SNS (4-wire) is not available on the 5720A 100 M $\Omega$  range, and the 8508-7000K 1 G $\Omega$  standard resistor is used as a 2-wire device with the calibrator 2-wire resistance zero used for the corresponding zero point. 4W $\Omega$  is deselected on the Multimeter when checking the 200 M $\Omega$  and 2 G $\Omega$  range, range zero, and range gain points.

### Warning

**The Multimeter can deliver a lethal electric shock when operating in the High Voltage Resistance mode. Voltages up to 240V may appear on the terminals.**

**To avoid electric shock when performing the following calibration procedures:**

- **Never touch any lead or terminal unless you are absolutely certain that no dangerous voltage is present.**
- **Make sure that signal leads are in a safe condition before you handle them in any way.**

1. Press the  $\Omega$  key.
2. Press the CONFIG key and select Filt, RESL7, and 4W $\Omega$ . Ensure LoI is deselected.
3. Select the required Multimeter range.
4. On the Calibrator, select zero  $\Omega$  and Operate. Alternatively if using a standard resistor connect the standard resistor for a 4-wire resistance zero. (For the 200 M $\Omega$  range and above, de-select Ex SNS on the calibrator and de-select 4W $\Omega$  on the Multimeter.)
5. On the Multimeter press the INPUT key, and select Zero Rng to initiate the zeroing operation.  
  
The Busy legend will appear, and then extinguish when the zero operation has completed.
6. On the Calibrator, select Range Gain point Output value. Alternatively if using a standard resistor re-connect the standard resistor to measure its resistance.
7. Note the Multimeter's reading. Compare the result with the allowable tolerance, taking into account the actual value of the calibrator resistance output for this value or the calibrated value of the resistance standard used.
8. Repeat steps 3 – 7 for the remaining ranges of the selected resistance mode. (For the 2 G $\Omega$  and 20 G $\Omega$  ranges the 8508-7000K 1 G $\Omega$  standard resistor is used in place of the calibrator. For the 200 M $\Omega$  range and above, de-select Ex SNS on the calibrator and de-select 4W $\Omega$  on the Multimeter).
9. Set the calibrator output to STANDBY.

10. Press the  $\Omega$  key.
11. Press the CONFIG key and select Filt , RESL7, 4w $\Omega$ , and LoI.
12. Repeat steps 3 – 9 for the Normal $\Omega$  LoI ranges.
13. Press the  $\Omega$  Plus key and select Tru $\Omega$ .
14. Press the CONFIG key and select Filt , RESL7, and 4w $\Omega$ . Ensure LoI is deselected.
15. Repeat steps 3 – 9 for the Tru $\Omega$  ranges.
16. Press the  $\Omega$  Plus key and select Tru $\Omega$ .
17. Press the CONFIG key and select Filt , RESL7, 4w $\Omega$ , and LoI.
18. Repeat steps 3 – 9 for the Tru $\Omega$  LoI ranges.
19. Press the  $\Omega$  Plus key and select HiV $\Omega$ .
20. Press the CONFIG key and select Filt , RESL7, and 4w $\Omega$ .
21. Repeat steps 3 – 9 for the HiV $\Omega$  ranges.

**Table 3-10. Resistance Verification Points and Sequence**

| 8508A Range    | Resistance     | Tolerance <sup>[1]</sup>                                            |                                                         |
|----------------|----------------|---------------------------------------------------------------------|---------------------------------------------------------|
|                |                | Normal $\Omega$ and Tru $\Omega$ <sup>[2]</sup>                     | Normal $\Omega$ LoI and Tru $\Omega$ LoI <sup>[2]</sup> |
| 2 $\Omega$     | 0 $\Omega$     | Perform input zero operation to calibrator range locked zero output |                                                         |
|                | 1 $\Omega$     | $\pm 0.0000240 \Omega$                                              | $\pm 0.0000240 \Omega$                                  |
| 20 $\Omega$    | 0 $\Omega$     | Perform input zero operation to calibrator range locked zero output |                                                         |
|                | 10 $\Omega$    | $\pm 0.000133 \Omega$                                               | $\pm 0.000133 \Omega$                                   |
| 200 $\Omega$   | 0 $\Omega$     | Perform input zero operation to calibrator range locked zero output |                                                         |
|                | 100 $\Omega$   | $\pm 0.00101 \Omega$                                                | $\pm 0.00113 \Omega$                                    |
| 2 k $\Omega$   | 0 k $\Omega$   | Perform input zero operation to calibrator range locked zero output |                                                         |
|                | 1 k $\Omega$   | $\pm 0.0000101 \text{ k}\Omega$                                     | $\pm 0.0000113 \text{ k}\Omega$                         |
| 20 k $\Omega$  | 0 k $\Omega$   | Perform input zero operation to calibrator range locked zero output |                                                         |
|                | 10 k $\Omega$  | $\pm 0.000101 \text{ k}\Omega$                                      | $\pm 0.000113 \text{ k}\Omega$                          |
| 200 k $\Omega$ | 0 k $\Omega$   | Perform input zero operation to calibrator range locked zero output |                                                         |
|                | 100 k $\Omega$ | $\pm 0.00101 \text{ k}\Omega$                                       | $\pm 0.00107 \text{ k}\Omega$                           |
| 2 M $\Omega$   | 0 M $\Omega$   | Perform input zero operation to calibrator range locked zero output |                                                         |
|                | 1 M $\Omega$   | $\pm 0.0000117 \text{ M}\Omega$                                     | $\pm 0.0000142 \text{ M}\Omega$                         |
| 20 M $\Omega$  | 0 M $\Omega$   | Perform input zero operation to calibrator range locked zero output |                                                         |
|                | 10 M $\Omega$  | $\pm 0.000320 \text{ M}\Omega$                                      | $\pm 0.000570 \text{ M}\Omega$                          |
| 200 M $\Omega$ | 0 M $\Omega$   | Perform input zero operation to calibrator range locked zero output |                                                         |
|                | 100 M $\Omega$ | $\pm 0.01950 \text{ M}\Omega$                                       | $\pm 0.18700 \text{ M}\Omega$                           |
| 2 G $\Omega$   | 0 G $\Omega$   | Perform input zero operation to calibrator range locked zero output |                                                         |
|                | 1 G $\Omega$   | $\pm 0.0018750 \text{ M}\Omega$                                     | $\pm 0.0018750 \text{ M}\Omega$                         |

**Table 3-10. Resistance Verification Points and Sequence (cont)**

| 8508A Range                                                                                                                                                                                                        | Resistance | Tolerance <sup>1</sup>                                              |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|---------------------------------------------------------------------|
|                                                                                                                                                                                                                    |            | HIVΩ <sup>2</sup>                                                   |
| 20 MΩ                                                                                                                                                                                                              | 0 GΩ       | Perform input zero operation to calibrator range locked zero output |
|                                                                                                                                                                                                                    | 10 MΩ      | ± 0.0000202 MΩ                                                      |
| 200 MΩ                                                                                                                                                                                                             | 0 GΩ       | Perform input zero operation to calibrator range locked zero output |
|                                                                                                                                                                                                                    | 100 MΩ     | ± 0.0000870 MΩ                                                      |
| 2 GΩ                                                                                                                                                                                                               | 0 GΩ       | Perform input zero operation to calibrator range locked zero output |
|                                                                                                                                                                                                                    | 1 GΩ       | ± 0.0003150 GΩ                                                      |
| 20 GΩ                                                                                                                                                                                                              | 0 GΩ       | Perform input zero operation to calibrator range locked zero output |
|                                                                                                                                                                                                                    | 1 GΩ       | ± 0.012675 GΩ                                                       |
| [1] Based on 365 day Tcal ±1 °C 99 %CL Absolute specifications. See comments in Applicable Verification Tolerance section above regarding the impact of calibration uncertainties and use of other specifications. |            |                                                                     |
| [2] Ranges require separate input zero operation in each resistance mode.                                                                                                                                          |            |                                                                     |

## DC Current Checks

### Equipment Configuration

1. Ensure that the calibrator output is set to STANDBY and configured for Internal Guard (EXT GRD is deselected).
2. Connect the equipment as described for Routine Calibration.
3. Press the DCI key
4. Press the CONFIG key. Select Filt and RESL7.
5. Confirm that the Multimeter is configured for internal guard (External Guard is deselected) by checking that the Ext Grd legend does not appear on the left-hand display.

### Procedure

Repeat the following sequence for each range, starting with the 200μA range and working up to the 20A range, as listed in Table 3-11. An input zero operation is performed on each Multimeter range prior to performing the range verification measurements with the calibrator set to zero by range locking the calibrator in the range from which the output will be obtained.

1. Select the required Multimeter range.
2. On the calibrator set the output to zero. Select OPERATE.
3. On the Multimeter press the INPUT key, and select Zero Rng to initiate the zeroing operation.

The Busy legend will appear, and then extinguish when the zero operation has completed.

4. On the calibrator select the value required for verification in the positive polarity.
5. Note the Multimeter's reading. Compare the result with the allowable tolerance, taking into account any known error from nominal of the calibrator for this output.

6. On the calibrator select the value required for verification in the negative polarity.
7. Note the Multimeter's reading. Compare the result with the allowable tolerance, taking into account any known error from nominal of the calibrator for this output.

**Table 3-11. DC Current Verification Points and Sequence**

| 8508A Range                                                                                                                                                                                                                    | Current      | Tolerance <sup>[1]</sup>                                            |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|---------------------------------------------------------------------|
| 200 $\mu$ A                                                                                                                                                                                                                    | 0 $\mu$ A    | Perform input zero operation to calibrator range locked zero output |
|                                                                                                                                                                                                                                | +100 $\mu$ A | $\pm 0.00190 \mu$ A                                                 |
|                                                                                                                                                                                                                                | -100 $\mu$ A | $\pm 0.00190 \mu$ A                                                 |
| 2 mA                                                                                                                                                                                                                           | 0 mA         | Perform input zero operation to calibrator range locked zero output |
|                                                                                                                                                                                                                                | +1mA         | $\pm 0.0000190$ mA                                                  |
|                                                                                                                                                                                                                                | -1mA         | $\pm 0.0000190$ mA                                                  |
| 20 mA                                                                                                                                                                                                                          | 0 mA         | Perform input zero operation to calibrator range locked zero output |
|                                                                                                                                                                                                                                | +10mA        | $\pm 0.000200$ mA                                                   |
|                                                                                                                                                                                                                                | -10mA        | $\pm 0.000200$ mA                                                   |
| 200 mA                                                                                                                                                                                                                         | 0 mA         | Perform input zero operation to calibrator range locked zero output |
|                                                                                                                                                                                                                                | +100mA       | $\pm 0.00530$ mA                                                    |
|                                                                                                                                                                                                                                | -100mA       | $\pm 0.00530$ mA                                                    |
| 2 A                                                                                                                                                                                                                            | 0 A          | Perform input zero operation to calibrator range locked zero output |
|                                                                                                                                                                                                                                | +1A          | $\pm 0.0002260$ A                                                   |
|                                                                                                                                                                                                                                | -1A          | $\pm 0.0002260$ A                                                   |
| 20 A                                                                                                                                                                                                                           | 0 A          | Perform input zero operation to calibrator range locked zero output |
|                                                                                                                                                                                                                                | +10A         | $\pm 0.004950$ A                                                    |
|                                                                                                                                                                                                                                | -10A         | $\pm 0.004950$ A                                                    |
| [1] Based on 365 day Tcal $\pm 1^{\circ}$ C 99 %CL Absolute specifications. See comments in Applicable Verification Tolerance section above regarding the impact of calibration uncertainties and use of other specifications. |              |                                                                     |

### **AC Current Checks**

#### **Equipment Configuration**

1. Ensure that the calibrator output is set to STANDBY and configured for Internal Guard (EXT GRD is deselected).
2. Connect the equipment as described for Routine Calibration.
3. Press the ACI key
4. Press the CONFIG key. Select RESL6 and 100Hz Filter.
5. Confirm that the Multimeter is configured for internal guard (External Guard is deselected) by checking that the Ext Grd legend does not appear on the left-hand display.

### Procedure

Repeat the following sequence for each range, starting with the 200 $\mu$ A range and working up to the 20A range, as listed in Table 3-12.

1. Select the required Multimeter range.
2. On the calibrator set the output to the current and frequency for the point being verified as listed in Table 3-12. Set the output to OPERATE.
3. Note the Multimeter's reading. Compare the result with the allowable tolerance, taking into account any known error from nominal of the calibrator for this output.
4. Repeat steps 2 – 4 for each point to be verified on the Multimeter's range to be verified.
5. Repeat steps 1 – 5 for each Multimeter range to be verified.
6. Set the calibrator output to STANDBY.

**Table 3-12. AC Current Verification Points and Sequence**

| 8508A Range                                                                                                                                                                                                                    | Current     | Frequency | Tolerance <sup>[1]</sup> |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-----------|--------------------------|
| 200 $\mu$ A                                                                                                                                                                                                                    | 100 $\mu$ A | 300 Hz    | $\pm 0.0830 \mu$ A       |
|                                                                                                                                                                                                                                | 100 $\mu$ A | 1 kHz     | $\pm 0.0830 \mu$ A       |
|                                                                                                                                                                                                                                | 100 $\mu$ A | 3 kHz     | $\pm 0.0830 \mu$ A       |
|                                                                                                                                                                                                                                | 100 $\mu$ A | 5 kHz     | $\pm 0.0830 \mu$ A       |
|                                                                                                                                                                                                                                | 100 $\mu$ A | 10 kHz    | $\pm 0.0830 \mu$ A       |
| 2 mA                                                                                                                                                                                                                           | 1 mA        | 300 Hz    | $\pm 0.000580$ mA        |
|                                                                                                                                                                                                                                | 1 mA        | 1 kHz     | $\pm 0.000580$ mA        |
|                                                                                                                                                                                                                                | 1 mA        | 3 kHz     | $\pm 0.000580$ mA        |
|                                                                                                                                                                                                                                | 1 mA        | 5 kHz     | $\pm 0.000580$ mA        |
|                                                                                                                                                                                                                                | 1 mA        | 10 kHz    | $\pm 0.000580$ mA        |
| 20 mA                                                                                                                                                                                                                          | 10 mA       | 300 Hz    | $\pm 0.00580$ mA         |
|                                                                                                                                                                                                                                | 10 mA       | 1 kHz     | $\pm 0.00580$ mA         |
|                                                                                                                                                                                                                                | 10 mA       | 3 kHz     | $\pm 0.00580$ mA         |
|                                                                                                                                                                                                                                | 10 mA       | 5 kHz     | $\pm 0.00580$ mA         |
|                                                                                                                                                                                                                                | 10 mA       | 10 kHz    | $\pm 0.00580$ mA         |
| 200 mA                                                                                                                                                                                                                         | 100 mA      | 300 Hz    | $\pm 0.0545$ mA          |
|                                                                                                                                                                                                                                | 100 mA      | 1 kHz     | $\pm 0.0545$ mA          |
|                                                                                                                                                                                                                                | 100 mA      | 3 kHz     | $\pm 0.0545$ mA          |
|                                                                                                                                                                                                                                | 100 mA      | 5 kHz     | $\pm 0.0545$ mA          |
|                                                                                                                                                                                                                                | 100 mA      | 10 kHz    | $\pm 0.0545$ mA          |
| 2 A                                                                                                                                                                                                                            | 1 A         | 300 Hz    | $\pm 0.000945$ A         |
|                                                                                                                                                                                                                                | 1 A         | 1 kHz     | $\pm 0.000945$ A         |
|                                                                                                                                                                                                                                | 1 A         | 3 kHz     | $\pm 0.001055$ A         |
|                                                                                                                                                                                                                                | 1 A         | 5 kHz     | $\pm 0.001055$ A         |
|                                                                                                                                                                                                                                | 1 A         | 10 kHz    | $\pm 0.001055$ A         |
| 20 A                                                                                                                                                                                                                           | 10 A        | 300 Hz    | $\pm 0.01140$ A          |
|                                                                                                                                                                                                                                | 10 A        | 1 kHz     | $\pm 0.01140$ A          |
|                                                                                                                                                                                                                                | 10 A        | 3 kHz     | $\pm 0.02740$ A          |
|                                                                                                                                                                                                                                | 10 A        | 5 kHz     | $\pm 0.02740$ A          |
|                                                                                                                                                                                                                                | 10 A        | 10 kHz    | $\pm 0.02740$ A          |
| [1] Based on 365 day Tcal $\pm 1^{\circ}$ C 99 %CL Absolute specifications. See comments in Applicable Verification Tolerance section above regarding the impact of calibration uncertainties and use of other specifications. |             |           |                          |

## **Frequency Checks**

### **Equipment Configuration**

1. Ensure that the calibrator output is set to **STANDBY** and configured for Internal Guard (**EXT GRD** is deselected).
2. Connect the equipment as described for Routine Calibration.
3. Press the **ACV** key, select the **2V** range
4. Press the **CONFIG** key. Select **Tfer On**, **Filt 40Hz**.
5. Confirm that the 8508A is configured for internal guard (External Guard is deselected) by checking that the **Ext Grd** legend does not appear on the left-hand display.

### **Procedure**

1. On the 8508A press **MONITOR** and then **CONFIG**. Deselect **FREQ GATE Fast**.
2. Press the **MONITOR** key and select **FREQ**.
3. On the calibrator set the output to the voltage to **1V** and frequency to **1MHz**. Set the output to **OPERATE**.
4. Note the Multimeter's frequency reading. Check the result is within  $\pm 0.000012\text{MHz}$ , taking into account any known error from nominal of the calibrator output frequency for this point.
5. Set the calibrator output to **STANDBY**.

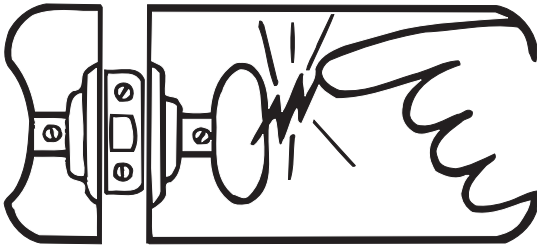




# static awareness



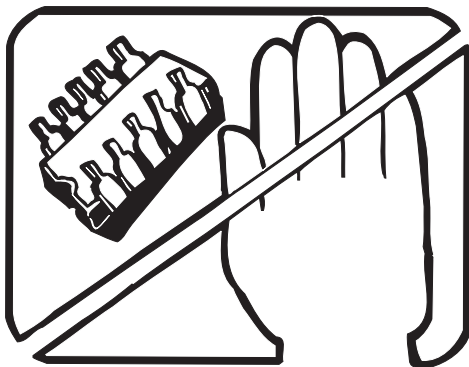
A Message From  
Fluke Corporation



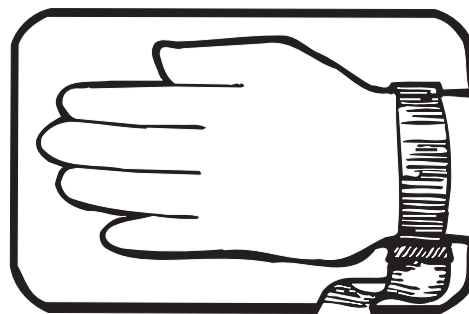
Some semiconductors and custom IC's can be damaged by electrostatic discharge during handling. This notice explains how you can minimize the chances of destroying such devices by:

1. Knowing that there is a problem.
2. Learning the guidelines for handling them.
3. Using the procedures, packaging, and bench techniques that are recommended.

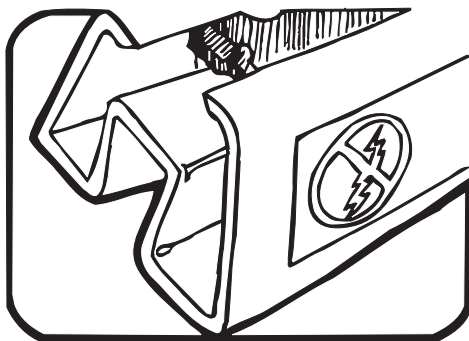
The following practices should be followed to minimize damage to S.S. (static sensitive) devices.



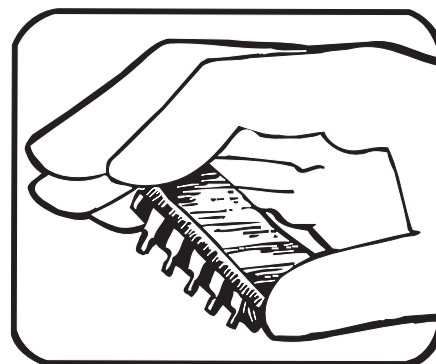
1. MINIMIZE HANDLING



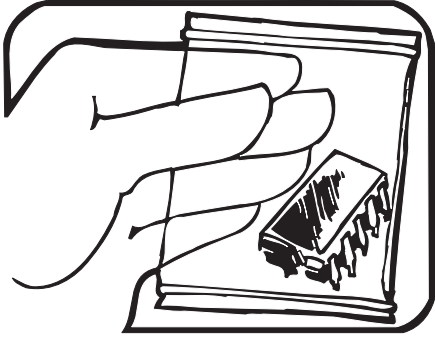
3. DISCHARGE PERSONAL STATIC BEFORE HANDLING DEVICES. USE A HIGH RESISTANCE GROUNDING WRIST STRAP.



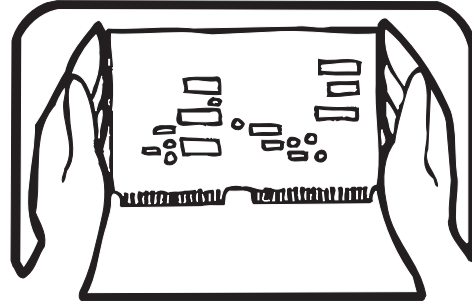
2. KEEP PARTS IN ORIGINAL CONTAINERS UNTIL READY FOR USE.



4. HANDLE S.S. DEVICES BY THE BODY.



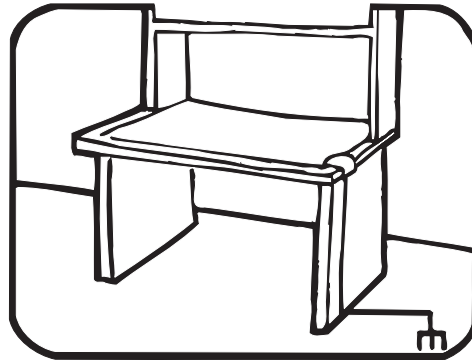
5. USE STATIC SHIELDING CONTAINERS FOR HANDLING AND TRANSPORT.



8. WHEN REMOVING PLUG-IN ASSEMBLIES HANDLE ONLY BY NON-CONDUCTIVE EDGES AND NEVER TOUCH OPEN EDGE CONNECTOR EXCEPT AT STATIC-FREE WORK STATION. PLACING SHORTING STRIPS ON EDGE CONNECTOR HELPS PROTECT INSTALLED S.S. DEVICES.



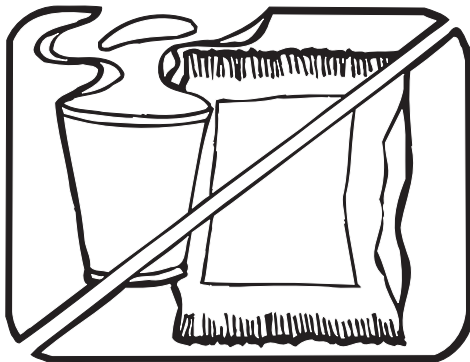
6. DO NOT SLIDE S.S. DEVICES OVER ANY SURFACE.



9. HANDLE S.S. DEVICES ONLY AT A STATIC-FREE WORK STATION.

10. ONLY ANTI-STATIC TYPE SOLDER-SUCKERS SHOULD BE USED.

11. ONLY GROUNDED-TIP SOLDERING IRONS SHOULD BE USED.



7. AVOID PLASTIC, VINYL AND STYROFOAM® IN WORK AREA.

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## ***Chapter 4***

# ***Maintenance***

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## **Introduction**

This chapter contains access procedures for replaceable assemblies (PCAs) and error messages associated with the self-test procedure. All of the access procedures describe how to remove a PCA or assembly. In all cases, unless otherwise noted, the re-assembly/replacement procedure is a logical reversal of the removal procedure.

## **Access Procedures**

This section of the manual includes access procedures for the following assemblies:

- A1 DC PCA
- A2 AC PCA
- A3 Ohms PCA
- A4 Digital PCA
- A5 Bezel Assembly
- A5A1 Display PCA
- A6 Rear Input Assembly

## **Before You Start**

To ensure your safety and for the protection of the Multimeter follow all of the considerations and recommendations that follow:

1. Unless you are qualified to service the the Multimeter do not remove the covers from the unit.
2. To avoid shock hazards and for the protection of the unit, disconnect all power cords, rear-panel cables, and front/rear test leads from the Multimeter.
3. Be aware that removing either or both of the cover(s) will void calibration of the Multimeter.
4. Before removing the covers, place the Multimeter on an appropriate bench top or work surface.
5. To avoid damage to the Multimeter from static electricity, use best practice anti-static techniques after the covers are removed from the Multimeter.
6. Do not unnecessarily touch any part of the PCAs or straighten component positions on the PCAs.

## Cabling and Wiring Connections

To help avoid making incorrect cable connections during reassembly, refer to the internal wiring and cabling diagram shown in Figure 4-1.

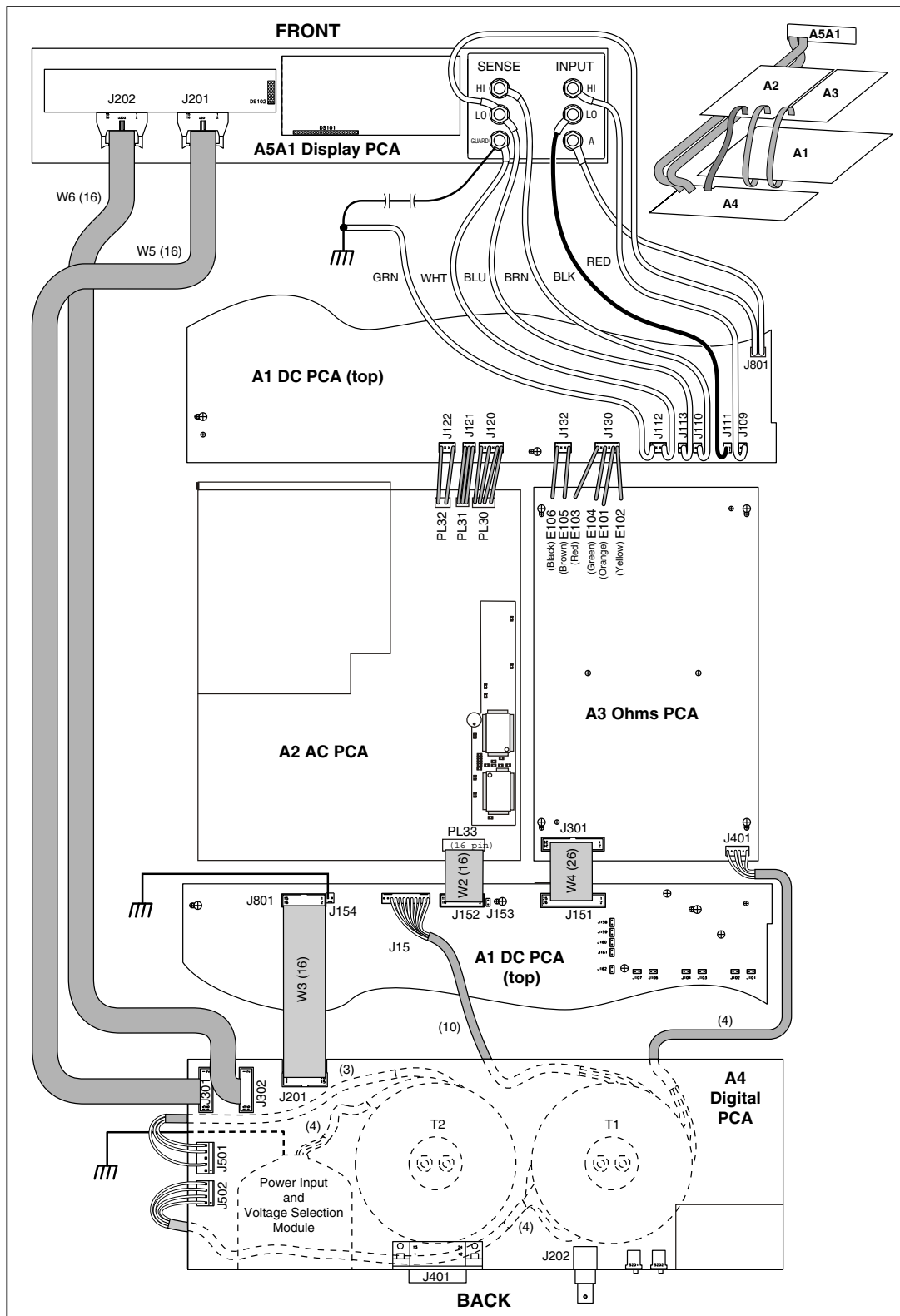


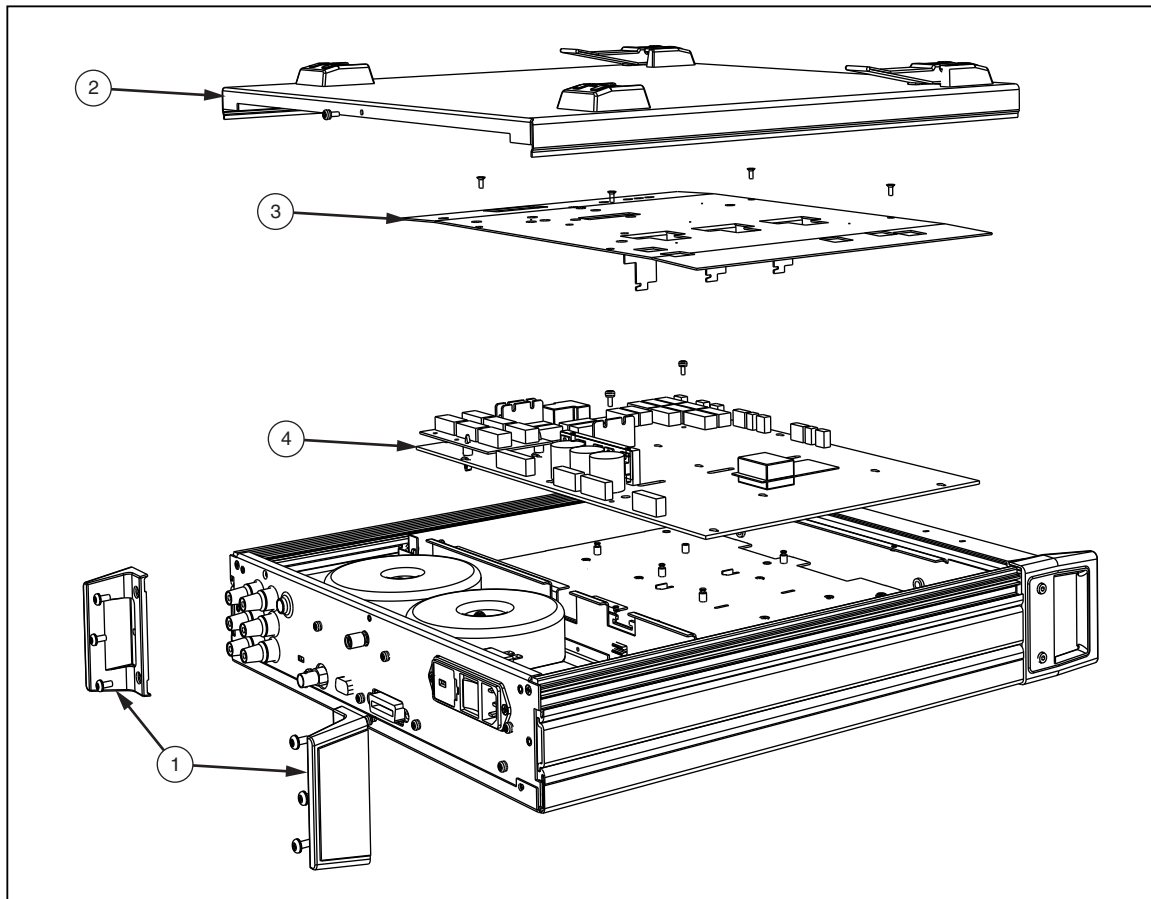
Figure 4-1. Internal Wiring and Cabling Diagram

avw032f.eps

**Removing the A1 DC PCA**

Use the following procedure to remove the A1 DC PCA. See Figure 4-2.

1. Position the unit on the work surface so it is bottom-side up.
2. Remove both rear feet ①.
  - a. Remove the three hex screws from each foot.
  - b. If the feet are still in place, pull them from the unit.
3. Remove the bottom cover ②.
  - a. Remove the one philips screw at rear of the bottom cover.
  - b. Slide the cover toward the back of the unit, and lift it off.
4. Remove the bottom shield ③.
  - a. Remove the six philips screws from the shield.
  - b. Slide the shield toward front of unit, and lift it out.
5. Remove the A1 DC PCA ④.
  - a. Disconnect the Rear Input PCA from the A1 DC PCA.
  - b. Disconnect the five connectors from the rear edge of the A1 DC PCA.
  - c. Disconnect the 10 connectors from the front edge of the A1 DC PCA.
  - d. Disconnect the red and black wires from the screw terminals on the PCA.
  - e. Remove the two philips screws from the A1 DC PCA.
  - f. Slide the A1 DC PCA to the side and lift it from the chassis.

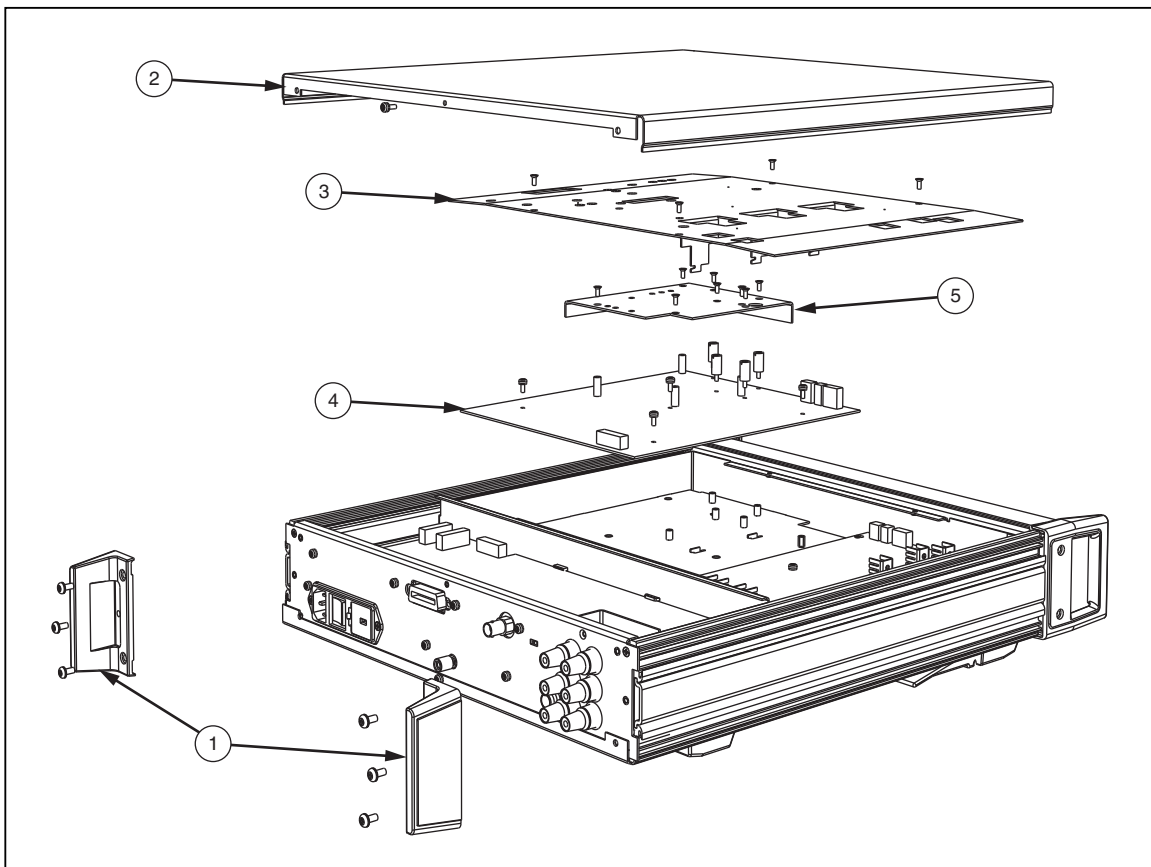


**Figure 4-2. Removing the A1 DC PCA**

### Removing the A2 AC PCA

Use the following procedure to remove the A2 AC PCA. See Figure 4-3.

1. Position the unit on the work surface so it is top-side up.
2. Remove both rear feet. ①
  - a. Remove the three hex screws from each foot.
  - b. If the feet are still in place, pull them from the unit.
3. Remove the top cover. ②
  - a. Remove the one philips screw at rear of the top cover.
  - b. Slide the cover toward the back of the unit, and lift it off.
4. Remove the top shield. ③
  - a. Remove the four philips screws from the shield. ④
  - b. Slide the shield toward front of unit, and lift it out.
5. Remove the A2 AC PCA. ⑤
  - a. Remove the eight philips screws holding the shield to the A2 AC PCA.
  - b. Lift the shield from the PCA.
  - c. Disconnect the one connectors from the rear edge of the A2 AC PCA.
  - d. Disconnect the three connectors from the front edge of the A2 AC PCA.
  - e. Remove the four philips screws from the PCA.
  - f. Using a flat-blade screwdriver, remove the four plastic standoffs from the PCA.
  - g. Lift the A2 AC PCA from the chassis.



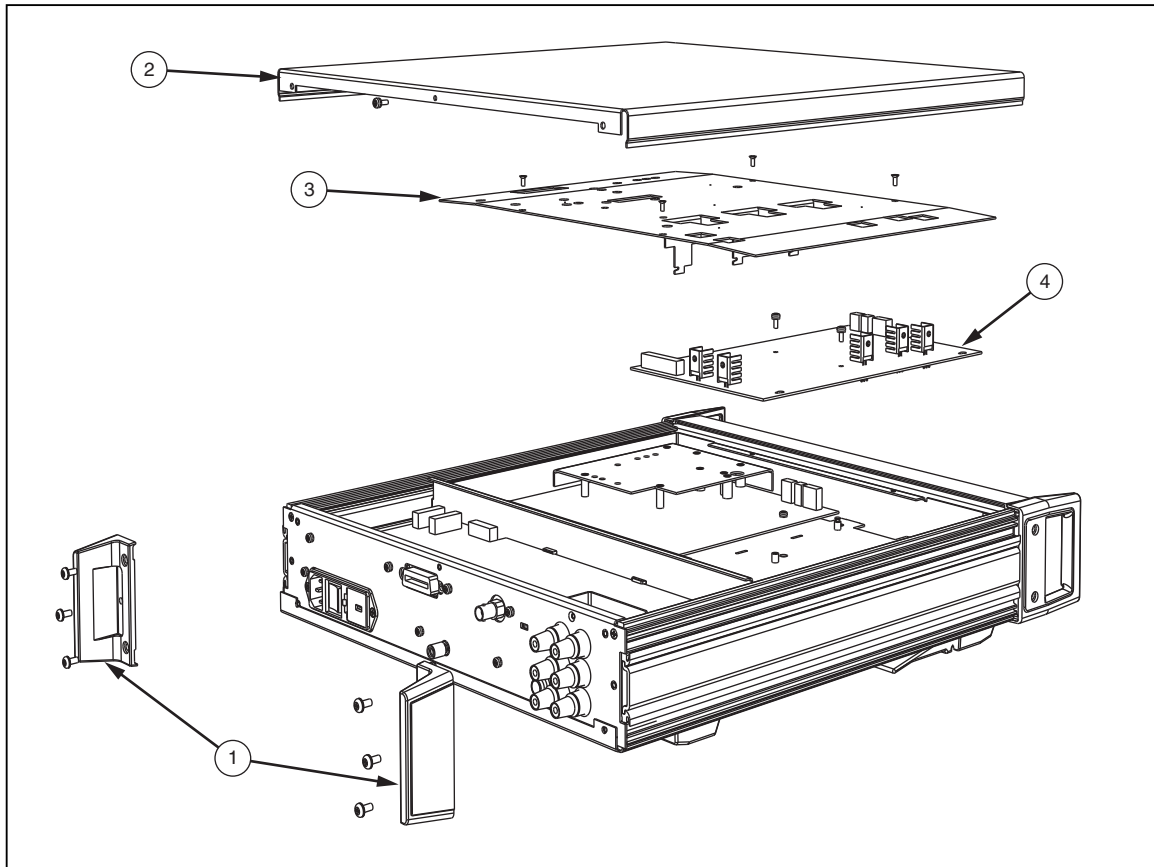
**Figure 4-3. Removing the A2 AC PCA**

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### **Removing the A3 Ohms PCA**

Use the following procedure to remove the A3 Ohms PCA. See Figure 4-4.

1. Position the unit on the work surface so it is bottom-side up.
2. Remove both rear feet. ①
  - a. Remove the three hex screws from each foot.
  - b. If the feet are still in place, pull them from the unit.
3. Remove the bottom cover. ②
  - a. Remove the one philips screw at rear of the bottom cover.
  - b. Slide the cover toward the back of the unit, and lift it off.
4. Locate the two connectors on the A1 DC PCA with the green, red, orange, yellow and the black, brown wires.
5. Disconnect both connectors from the A1 DC PCA. These cables are hardwired to the A3 Ohms PCA and must be disconnected before the A3 Ohms PCA can be removed.
6. Position the unit on the work surface so it is top-side up.
7. Remove the top shield. ③
  - a. Remove the four philips screws from the shield.
  - b. Slide the shield toward front of unit, and lift it out.
8. Remove the A3 Ohms PCA. ④
  - a. Disconnect the two connectors from the rear edge of the A3 Ohms PCA.
  - b. Remove the one philips screws from the A3 Ohms PCA.
  - c. Slide the A3 Ohms PCA toward the rear of the unit (about ¼ inch).
  - d. Lift the A3 Ohms PCA, and free the two hardwired cables before removing it from the unit.



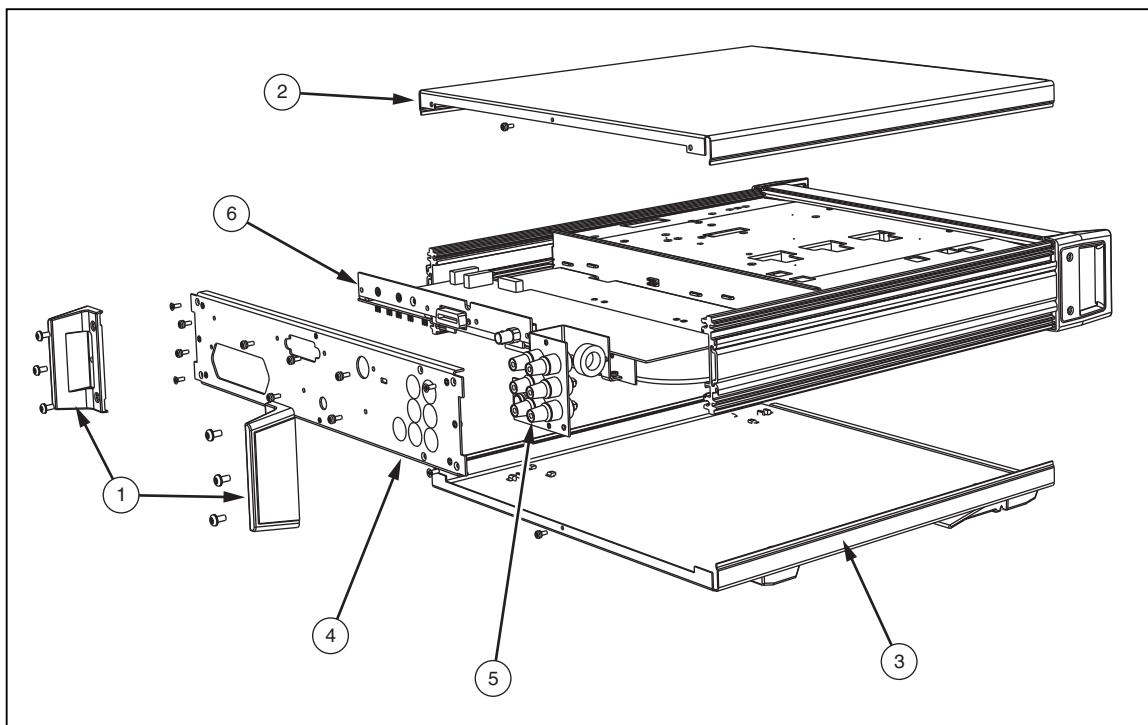
**Figure 4-4. Removing the A3 Ohms PCA**

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**Removing the A4 Digital PCA**

Use the following procedure to remove the A4 Digital PCA. See Figure 4-5.

1. Position the unit on the work surface so it is top-side up.
2. Remove both rear feet. ①
  - a. Remove the three hex screws from each foot.
  - b. If the feet are still in place, pull them from the unit.
3. Remove the top and bottom covers. ②③
  - a. Remove one philips screw at rear of each cover.
  - b. Slide the covers toward the back of the unit, and lift them off.
4. Remove the Rear Panel ④
  - a. Remove the six flat-head philips screws from the rear panel (two on either side of the panel and two with the input/sense connector group).
  - b. Remove the seven pan-head philips screws distributed across the rear panel.
  - c. Pull the gray sheet metal portion of the rear panel away from the unit.
5. Set the unit on its side, and remove the screw holding the input/sense connector group to the chassis. ⑤
6. Return the unit to its original position.
7. Disconnect the five cable connectors from the A4 Digital PCA.
8. Free the A4 Digital PCA by sliding it out the rear of the chassis. ⑥



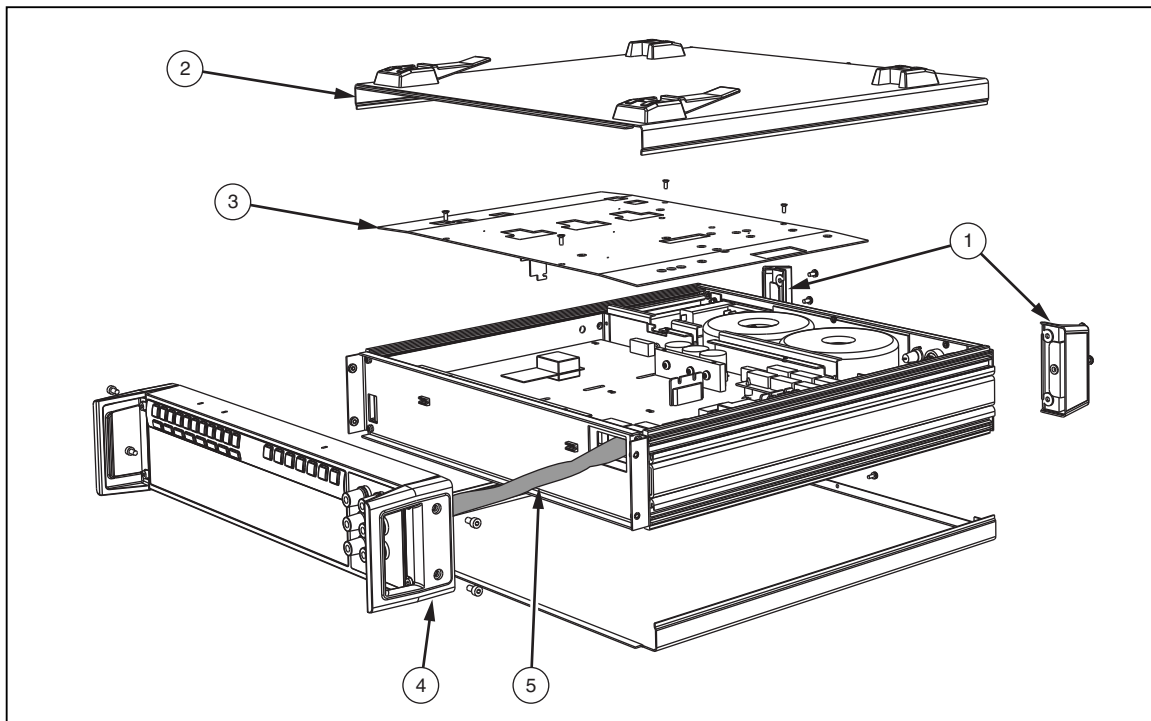
**Figure 4-5. Removing the A4 Digital PCA**

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### Removing the A5 Bezel Assembly

Use the following procedure to remove the A5 Bezel Assembly. See Figure 4-6.

1. Position the unit on the work surface so it is bottom-side up.
2. Remove both rear feet. ①
  - a. Remove the three hex screws from each foot.
  - b. If the feet are still in place, pull them from the unit.
3. Remove the bottom cover. ②
  - a. Remove one philips screw at rear of the bottom cover.
  - b. Slide the cover toward the back of the unit, and lift it off.
4. Remove the bottom shield ③.
  - a. Remove the six philips screws from the shield.
  - b. Slide the shield toward front of unit, and lift it out.
5. Locate the five connectors (J109 through J113) on the A1 DC PCA with the green and white, blue, brown, red, and black wires. (When reassembling the unit make sure you reconnect the connectors in the left to right color sequence described in this step).
6. Disconnect all five connectors from the A1 DC PCA. These cables are hardwired to the A5 Bezel Assembly and must be disconnected before the A5 Bezel Assembly can be removed.
7. Remove the two hex screws from the side of each of the front handles. ④
8. Thread the disconnected cables/wires through the chassis opening and pull the A5 Bezel Assembly a few inches away from the unit. ⑤
9. Free the A5 Bezel Assembly from the unit by disconnecting the two ribbon cables from the A5A1 Display PCA.



**Figure 4-6. Removing the A5 Bezel Assembly**

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**Removing the A5A1 Display PCA**

Use the following procedure to remove the A5A1 Display PCA. See Figure 4-7.

1. Remove the A5 Bezel Assembly (described earlier in this chapter).
2. Remove the seven small self-threading Philips screws holding the A5A1 Display PCA to the plastic bezel (front panel). ①
3. Lift the top of the A5A1 Display PCA until it clears the lip of the bezel, and then pull the A5A1 Display PCA toward the lip of the plastic bezel. ②

Before reassembling the A5 Bezel Assembly, check the position of the rubber key pads to ensure that all of the buttons are correctly seated in their holes. ③

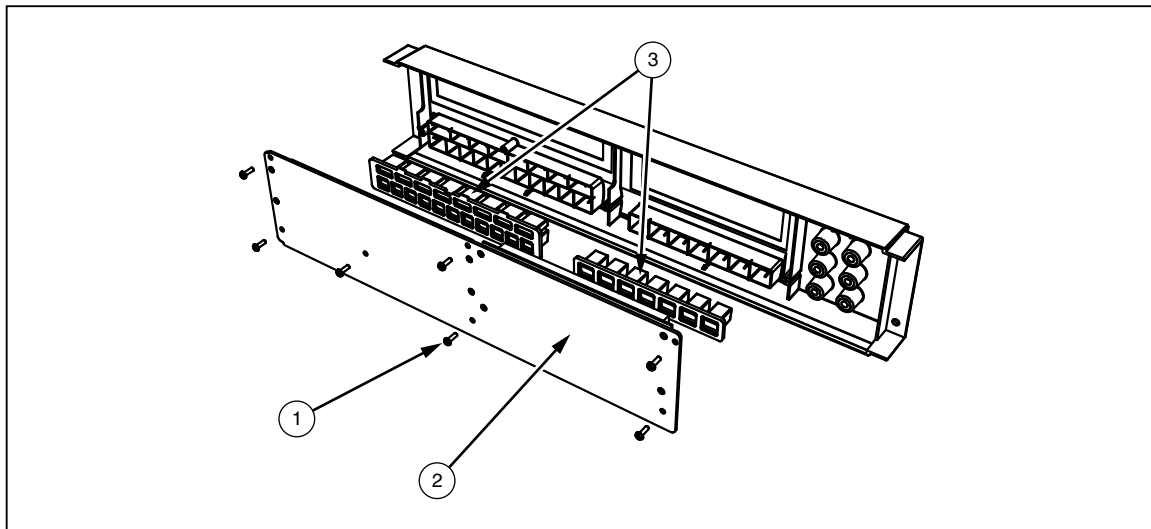


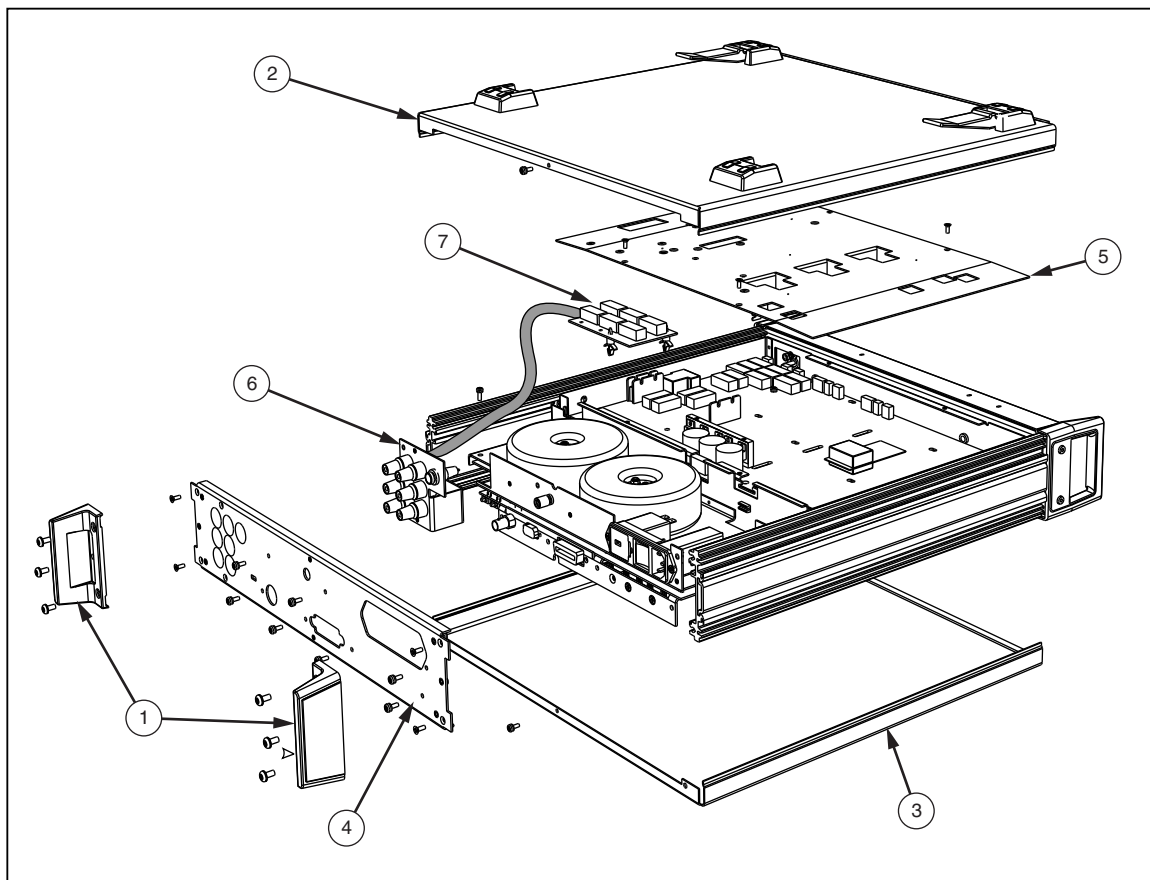
Figure 4-7. Removing the A5A1 Display PCA

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### **Removing the A6 Rear Input Assembly**

Use the following procedure to remove the A6 Rear Input Assembly. See Figure 4-8.

1. Position the unit on the work surface so it is bottom-side up.
2. Remove both rear feet. ①
  - a. Remove the three hex screws from each foot.
  - b. If the feet are still in place, pull them from the unit.
3. Remove the top and bottom covers. ②③
  - a. Remove the one philips screw at the rear of each of the covers.
  - b. Slide the covers toward the back of the unit, and lift them off.
4. Remove the Rear Panel. ④
  - a. Remove the six flat-head philips screws from the rear panel (two on either side of the panel and two with the input/sense connector group).
  - b. Remove the seven pan-head philips screws distributed across the rear panel.
  - c. Pull the gray sheet metal portion of the rear panel away from the unit.
5. Remove the bottom shield ⑤.
  - a. Remove the six philips screws from the shield.
  - b. Slide the shield toward front of unit, and lift it out.
6. Locate, and remove the screw holding the input/sense connector group to the chassis. ⑥
7. Cut the tie holding the input/sense connector cable to the chassis.
8. Using a pair of long-nose pliers, release (depress) the latch on each of the three standoff clips holding the A6A1 Rear Input PCA to the A1 DC PCA.
9. With all three latches released on the standoffs, gently unplug the A6A1 Rear Input PCA from the A1 DC PCA by lifting it straight up and away from its connectors on the A1 DC PCA. ⑦



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**Figure 4-8. Removing the A6 Rear Input Assembly**

Fuse Replacement and Line-Voltage Selection

⚠Caution

To avoid fire hazard, use only the fuse arrangements that appear in the fuse specification Tables 4-1 and 4-2 below.

Additionally, the supply network must be fused at a maximum of 16 A, and if the power cable plug is internally fused, a 10 A fuse must be fitted in the power cable plug.

To avoid shock hazards, disconnect all line-power and input terminal connections before attempting to access the fuse(s).

Line-Power Fuse F1 and Voltage Selection

The power-input and voltage-selection module on the rear of the Multimeter houses the line-power fuse F1. See Figure 4-9. A fuse tray to the right of the module serves as a fuse holder and a line-voltage-selection device. A small window on the fuse tray shows the currently selected line voltage, 115 or 230. The fuse rating is a function of the selected line voltage as shown in Table 4-1.

Use the following procedure to change the fuse or change the line power selection:

- 1. Remove the fuse tray by placing a small screwdriver blade under the tab on the fuse tray and pulling the tray from the module.
- 2. To change the voltage selection, rotate and position the fuse holder in the tray so the desired line voltage shows in the fuse-tray window.
- 3. As necessary, remove and replace the fuse with one that corresponds to the selected line voltage. See Table 4-1.
- 4. Slide the fuse tray back into the power-input and voltage-selection module, and secure it by firmly pressing it into place.

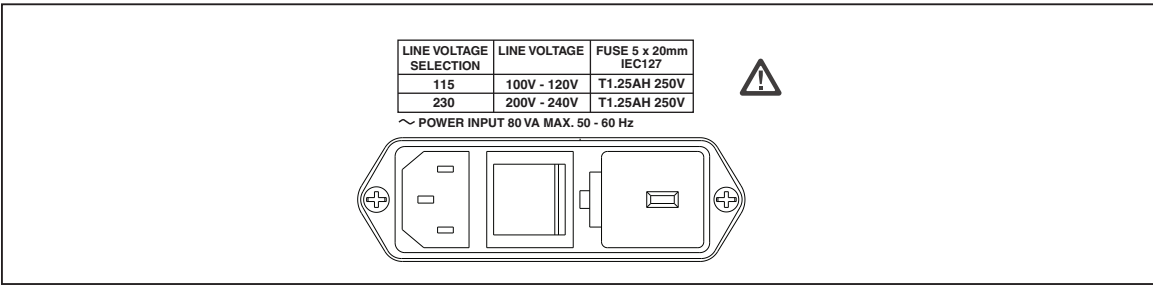


Figure 4-9. Rear Panel – Power Input Fuse and line Power Locations

Table 4-1. Power Input Fuse 1 - T 1.25AH 250V

| Power Input Fuse F1 | Fuse Action          | Fuse Rating IEC 127 (UL/CSA) | Fluke Part No. | Manufacturer & Type No. |
|---------------------|----------------------|------------------------------|----------------|-------------------------|
| 115 VAC, 230 VAC    | TH<br>Time delay HBC | 1.25 A (2 A) @ 250 V         | 2059740        | Schurter 0001.2505      |
|                     |                      |                              |                | Bussman S505-1.25-R     |
|                     |                      |                              |                | Littelfuse 215 1.25P    |
|                     |                      |                              |                | Bel Fuse 5HT 1.25-R     |

**Rear-Input Current Fuse F2 (Rear Inputs Option)**

The rear input option includes a fuse (F2) to limit the current at the rear-input A terminal to 2A. The fuse is located at the rear of the Multimeter just to the left of the current input terminal (A). A half-twist of the fuse cap releases the fuse for inspection or replacement. Use the fuse specified in Table 4-2 when replacement is necessary.

**Table 4-2. Current Function Rear Input Fuse 2 - F 1.6AH 250V**

| Fuse Action           | Fuse Rating<br>IEC 127 (UL / CSA) | Fluke Part No. | Manufacturer<br>& Type No. |
|-----------------------|-----------------------------------|----------------|----------------------------|
| FH<br>Fast acting HBC | 1.6 A (2 A) @ 250 V               | 1582072        | Bussman S501-1.6-R         |
|                       |                                   |                | Littelfuse 021601.6HXP     |
|                       |                                   |                | Littelfuse 021601.6MXP     |

**Self Test**

This section of the manual contains a collection of the error codes which might be generated either on the display of the Multimeter or by way of the IEEE-488 system bus. Error codes described in this section are shown in tabular form with both the error codes and the descriptions of the most likely faults, causes, or conditions. Typically, the error codes contain two parts, a four digit address code and a two digit id code. However, some error codes consist only of the four digit address. The combination for any given code is identified by the presence or absence of the id column in the error code table.

The error codes are classified as Self-Test Errors, Fatal Errors, Execution Errors, and Device Dependant Errors. All error conditions other than Fatal Errors are recoverable.

For help in determining what to do in the event of a self-test error, make a note of the full error message and contact your nearest Fluke Service Center.

**Self-Test Errors**

When a Self-Test is run and successfully completed no error messages result and the Multimeter is considered operational. If a self-test error does occur, an error message beginning with **self test failed** shows on the display. A function indicator and a test id number follow to complete the message. See Table 4-3 for descriptions of the self-test errors that might occur.

**Table 4-3. Self-Test Errors**

| DC VOLTS   |          |      |                                 |
|------------|----------|------|---------------------------------|
| Test No 10 | Err 2101 | P001 | Main Ref Check                  |
| Test No 11 | Err 2101 | P002 | 6.2V Ref Check                  |
| Test No 20 | Err 2201 | P003 | 100mV Range Zero Check          |
| Test No 21 | Err 2211 | P004 | 1V Range Zero Check             |
| Test No 22 | Err 2221 | P005 | 10V Range Zero Check            |
| Test No 23 | Err 2231 | P006 | 100V Range Zero Check           |
| Test No 24 | Err 2241 | P007 | 100mV Range Positive Gain Check |
| Test No 25 | Err 2251 | P008 | 100mV Range Negative Gain Check |
| Test No 26 | Err 2261 | P009 | 1V Range Positive Gain Check    |

|                   |          |      |                                                       |
|-------------------|----------|------|-------------------------------------------------------|
| Test No 27        | Err 2271 | P010 | 1V Range Negative Gain Check                          |
| Test No 28        | Err 2281 | P011 | 10V Range Positive Gain Check                         |
| Test No 29        | Err 2291 | P012 | 10V Range Negative Gain Check                         |
| Test No 30        | Err 2301 | P013 | 100V Range Positive Gain Check                        |
| Test No 31        | Err 2311 | P014 | 100V Range Negative Gain Check                        |
| <b>DC CURRENT</b> |          |      |                                                       |
| Test No 40        | Err 2401 | P032 | 100 $\mu$ A DC Range: Zero Input Check                |
| Test No 41        | Err 2411 | P033 | 100 $\mu$ A DC Range: 100 $\mu$ A Input Gain Check    |
| Test No 42        | Err 2421 | P034 | 1mA DC Range: Zero Input Check                        |
| Test No 43        | Err 2431 | P035 | 1mA DC Range: 1mA Input Gain Check                    |
| Test No 44        | Err 2441 | P036 | 10mA DC Range: Zero Input Check                       |
| Test No 45        | Err 2451 | P037 | 10mA DC Range: 10mA Input Gain Check                  |
| Test No 46        | Err 2461 | P038 | 100mA DC Range: Zero Input Check                      |
| Test No 47        | Err 2471 | P039 | 100mA DC Range: 100mA Input Gain Check                |
| Test No 48        | Err 2481 | P040 | 1A DC Range: Zero Input Check                         |
| Test No 49        | Err 2491 | P041 | 1A DC Range: 100mA Input Gain Check                   |
| <b>AC CURRENT</b> |          |      |                                                       |
| Test No 50        | Err 2501 | P042 | 1mA AC Range: Zero Input Check                        |
| Test No 51        | Err 2511 | P043 | 1mA AC Range: 1mA Input Gain Check                    |
| <b>RESISTANCE</b> |          |      |                                                       |
| Test No 60        | Err 2601 | P044 | Follower Offset Check                                 |
| Test No 61        | Err 2611 | P045 | Follower 100mA Output Check                           |
| Test No 62        | Err 2621 | P046 | Follower 10mA Output Check                            |
| Test No 63        | Err 2631 | P047 | Follower 1mA Output Check                             |
| Test No 64        | Err 2641 | P048 | 3.0V Clamp Check                                      |
| Test No 65        | Err 2651 | P049 | 6.7V Clamp Check                                      |
| Test No 66        | Err 2661 | P050 | 27V Clamp Check                                       |
| Test No 67        | Err 2671 | P051 | Current Sink Clamp Check                              |
| Test No 68        | Err 2681 | P052 | 10 $\mu$ A Current Sink and Follower 10V Output Check |
| Test No 69        | Err 2691 | P053 | 1 $\mu$ A Current Sink Check                          |
| Test No 70        | Err 2701 | P054 | 100nA Current Sink Check                              |
| Test No 71        | Err 2711 | P055 | 10nA Current Sink Check                               |
| Test No 72        | Err 2721 | P056 | HV Ohms Follower Offset Check                         |
| Test No 73        | Err 2731 | P057 | HV Ohms Follower Output Current Check                 |
| Test No 74        | Err 2741 | P058 | HV Ohms Output Voltage and 240V Clamp Check           |

| AC VOLTS   |                      |      |                                                             |
|------------|----------------------|------|-------------------------------------------------------------|
| Test No 80 | Err 2801             | P015 | 100mV AC Range: Zero Input Check                            |
| Test No 81 | Err 2811             | P016 | 100mV AC Range: +179mV DC Input Checks at PreAmp Output     |
| Test No 82 | Err 2821             | P017 | 100mV AC Range: -179mV DC Input Checks at PreAmp Output     |
| Test No 83 | Err 2831<br>2832 raw | P018 | 1V AC Range: Zero Input Check                               |
| Test No 84 | Err 2841             | P019 | 1V AC Range: +993mV DC Input Checks at PreAmp Output        |
| Test No 85 | Err 2851             | P020 | 1V AC Range: -993mV DC Input Checks at PreAmp Output        |
| Test No 86 | Err 2861             | P021 | 1V AC Range: +993mV DC Input Checks at RMS Converter Output |
| Test No 87 | Err 2871             | P022 | 1V AC Range: -993mV DC Input Checks at RMS Converter Output |
| Test No 88 | Err 2881<br>2882 raw | P023 | 10V AC Range: Zero Input Check                              |
| Test No 89 | Err 2891             | P024 | 10V AC Range: +9.78V DC Input Checks at PreAmp Output       |
| Test No 90 | Err 2901             | P025 | 10V AC Range: -9.78V DC Input Checks at PreAmp Output       |
| Test No 91 | Err 2911<br>2912 raw | P026 | 100V AC Range: Zero Input Check                             |
| Test No 92 | Err 2921             | P027 | 100V AC Range: +9.78V DC Input Checks at PreAmp Output      |
| Test No 93 | Err 2931             | P028 | 100V AC Range: -9.78V DC Input Checks at PreAmp Output      |
| Test No 94 | Err 2941<br>2942 raw | P029 | 1000V AC Range: Zero Input Check                            |
| Test No 95 | Err 2951             | P030 | 1000V AC Range: +9.78V DC Input Checks at PreAmp Output     |
| Test No 96 | Err 2961             | P031 | 1000V AC Range: -9.78V DC Input Checks at PreAmp Output     |

## Fatal Errors

Fatal errors are reported only via the front panel display. These messages are all coded as 9000 series faults. Each of the fatal errors that might occur are identified in the following paragraphs.

When a fatal error occurs the processor halts the operation of the multimeter. Cycling the power off and on may clear the message. However, fatal errors are generally caused by hardware or software faults which require repair by at a Fluke Service Center.

9000 System Kernel Fault           Addr id

This error is generated for system queue errors, stack overflows etc.

See Table 4-4 for descriptions of 9000 system kernel fault errors.

**Table 4-4. 9000 System Kernel Fault Errors**

| id | Fault                                                           |
|----|-----------------------------------------------------------------|
| 00 | user stack overwritten (addr = user stack pointer address)      |
| 01 | activity at head of queue not current (addr = address of queue) |
| 02 | current activity not at head of queue (addr = address of queue) |

9001 Run Time System Error

This error is detected and generated by the Pascal run time system support e.g. variable out of range.

9002 Unexpected Exception           Addr id

See Table 4-5 for descriptions of unexpected exception errors.

**Table 4-5. Unexpected Exception Errors**

| id | Exception                                                         |
|----|-------------------------------------------------------------------|
| 02 | bus error (usually due to addressing non-existent memory or IO)   |
| 03 | address error (due to attempting a word access to an odd address) |
| 04 | illegal instruction                                               |
| 05 | zero divide                                                       |
| 08 | privilege violation                                               |
| 09 | trace (trace facility is not used)                                |
| 10 | unimplemented instructions                                        |
| 11 | unimplemented instructions                                        |
| 24 | spurious interrupt (most likely cause is noise)                   |

9003 PROM Sumcheck Failure

9004 RAM Check Failure

## 9005 Serial Interface Fault      Addr id

When this fatal error occurs the system will continuously try to repeat whatever it was doing - the user interface will be inoperative.

See Table 4-6 for descriptions of the serial interface errors.

**Table 4-6. Serial Interface Errors**

| id | Fault                         |                                                                                                                                                                                                                                                                   |
|----|-------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 01 | Phase Error                   | The phase counter is either out of range for the current sequence or an interrupt from the serial interface or delay timer occurred the other was expected. Probably due to corruption of the phase counter. This could be either a software or a hardware fault. |
| 02 | NOT Transfer Complete         | a) Tx_complete status was false when "interrupt on Tx complete" received.<br><br>b) Tx_complete did not become true within timeout period when "on RTx" received.<br><br>Both caused by fault in interface hardware, probably digital ULA fault.                  |
| 03 | True Complement Error         | True_compl_error was true after a read transfer. Tested during read sequence on all transfers Can be because serial data coming from the analog subsystem to the digital ULA is corrupt. Could also be a serial clock or enable problem.                          |
| 04 | In Guard Error                | Indicates in_guard circuit latches corrupted, and new update required. Reported as fail after 20 consecutive errors. (This signal may be polled during updates, otherwise it causes an interrupt.)                                                                |
| 05 | State Change Timeout          | Interface state change between "read", "wait" and "write" states did not occur within timeout period. Interface hardware fault - suggests ULA (or associated signals) problem.                                                                                    |
| 06 | A-D timeout                   | A-D did not produce RTx within hardware timeout period after CI. A-D or hardware fault. Suggests A-D not being initiated or RTx not getting back to digital ULA. Could be an analog problem if the A-D locks up.                                                  |
| 07 | No RTx after abort            | Latched RTx did not appear after abort sent. A-D or CI hardware fault. Suggests A-D not being initiated or RTx not getting back to digital ULA Could be an analog problem if the A-D locks up.                                                                    |
| 08 | Switching counter inoperative | Switching counter in-operative when tested at power-on. suggests ULA (or associated signals) problem.                                                                                                                                                             |

9006 - Serial Loop Mismatch    xxxxxxxx    id

xxxxxxxx is the actual data received in binary format.

See Table 4-7 for descriptions of the serial loop mismatch errors.

**Table 4-7. Serial Loop Mismatch Errors**

| id | Fault                                                                  |
|----|------------------------------------------------------------------------|
| 00 | U901_C pattern mismatch – should be 00000001 (00000000 if rear fitted) |
| 01 | U901_B pattern mismatch – should be 00010000                           |
| 02 | U901_A pattern mismatch – should be 10100100                           |
| 03 | U902_C pattern mismatch – should be 00000000                           |
| 04 | U902_B pattern mismatch – should be 00000000                           |
| 05 | U902_A pattern mismatch – should be 00000000                           |
| 06 | U903_C pattern mismatch – should be 00010101                           |
| 07 | U903_B pattern mismatch – should be 01111111                           |
| 08 | U903_A pattern mismatch – should be 11111011                           |

9007 Unknown Engine Instruction    Addr    id

id indicates the code that the engine was attempting to interpret as an instruction.

### **Execution Errors**

An Execution Error is generated if a received command cannot be executed because it is incompatible with the current device state, or because it attempts to command parameters which are out-of-limits.

In remote operation, the EXE bit (4) is set true in the Standard-defined Event Status Byte, and the error code number is appended to the Execution Error queue.

The error is associated with status reporting, and the queue entries can be read destructively as LIFO by the Common query command EXQ?. There is no queue when execution errors occur during manual operation; instead, the description of the error is sent directly on the Menu display.

See Table 4-8 for descriptions of the execution errors.

Table 4-8. Execution Errors

|       |                                    |       |                                        |
|-------|------------------------------------|-------|----------------------------------------|
| 1000- | EXE queue empty when recalled      | 1024- | Illegal Range/Input Combination        |
| 1001- | Option not installed               | 1025- | Auto not available in Tru ratio        |
| 1002- | Calibration disabled               | 1026- | Probe identity unrecognized            |
| 1005- | Input Zero not allowed in Scan     | 1027- | Input Zero not allowed in PRT          |
| 1007- | Data entry error                   | 1028- | Only allowed in Voltage function       |
| 1008- | Must be in AC Function             | 1029- | Scan modes not allowed in PRT          |
| 1010- | Divide-by-zero not allowed         | 1030- | Scan modes not allowed in ACI/DCI      |
| 1012- | No more errors in list             | 1031- | 4wV not available via rear input       |
| 1013- | Data out of limit                  | 1032- | Input Zero not allowed in Cal          |
| 1014- | Illegal Range/Function combination | 1033- | Calibration not allowed in PRT         |
| 1015- | Command allowed only in Remote     | 1034- | PRT Ceof Limit @ a+, b+, c+ a-, b-, c- |
| 1016- | Not in Special Calibration         | 1035- | Cannot edit the default PRT            |
| 1021- | Test not allowed when Cal enabled  | 1036- | Block or Rolling average required      |

**Device Dependant Errors**

Device-dependent errors are associated mainly with test and calibration operations. A Device-Dependent Error is generated if the device detects an internal operating fault (e.g., during self-test). The DDE bit (3) is set *true* in the Standard-defined Event Status Byte, and the error code number is appended to the Device-Dependent Error queue.

In remote mode operations, the error is associated with status reporting, and the queue entries can be read destructively as LIFO by the Common query command DDQ?.

In local mode operations, the DDE status is checked at the end of the operation (e.g., Cal, Zero, Test). If *true*, an error has occurred, and the content of the last entry in the queue is displayed on the front panel.

If both bus and front panel users attempt to read the queue concurrently, the error data is read out destructively on a first-come, first-served basis. Thus one of the users cannot read the data on one interface as it has already been destroyed by reading on the other. This difficulty should be solved by suitable application programming to avoid the possibility of a double readout. Ideally the IEEE 488 interface should set the instrument into REMS or RWLS to prevent confusion. The bus can ignore the queue, but the front panel user will have to read it to continue.

There are three categories of Device Dependant Errors: Correction Errors, Corruption Errors, and Miscellaneous Errors. The errors that may occur in each category are described in the Table 4-9.

**Table 4-9. Device Dependent Errors**

| Correction Errors |                            |                                                                   |
|-------------------|----------------------------|-------------------------------------------------------------------|
| 2000-             | Error During Zero Cal      | The input signal was outside : Zero +/- 1 % of Full Range         |
| 2001-             | Error During Gain+ Cal     | The input signal was outside : +full range +/- 10 % of full range |
| 2002-             | Error During Gain- Cal     | The input signal was outside : -full range +/- 10 % of full range |
| 2003-             | Error During HF trim Cal   |                                                                   |
| 2004-             | Error During Input Zero    | The input signal was outside : Zero +/- 1 % of full range         |
| 2005-             | Error During Lol Zero Cal  | The input signal was outside : Zero +/- 1 % of full range         |
| 2006-             | Error During Lol Gain Cal  | The input signal was outside : +full range +/- 10 % of full range |
| 2008-             | Error During A to D Cal    | error numbers between 2030 and 2089 (see section 2)               |
| 2010-             | Error During Frequency Cal |                                                                   |
| 2012-             | Error During DCcp Cal      |                                                                   |
| 2025-             | Error During HiV Lin Read  |                                                                   |
| 2026-             | Error During HiV Lin Calc  |                                                                   |
| 2027-             | Error During 2wr Ohms Calc |                                                                   |
|                   |                            |                                                                   |
| Corruptions       |                            |                                                                   |
| 2014-             | Serial Number Corrupt      |                                                                   |
| 2015-             | Cal Due Date Corrupt       |                                                                   |
| 2017-             | Bus Address Corrupt        |                                                                   |
| 2018-             | Line Frequency Corrupt     |                                                                   |
| 2020-             | Invalid Corrections (ram)  | Combined corrections – checksum error                             |
| 2021-             | Calibration Corrupt        |                                                                   |
| 2022-             | NV RAM Write Failure       |                                                                   |
| Micellaneous      |                            |                                                                   |
| 2109-             | Bad Data from Analog Sys   |                                                                   |
| 2022-             | NV Ram write failure       |                                                                   |
| 2023-             | Engine – Load factor err   |                                                                   |
| 2024-             | Engine – Store factor err  |                                                                   |

***Chapter 5***  
***List of Replaceable Parts***

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| How to Contact Fluke ..... | 5-3         |
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## Introduction

This chapter contains an illustrated list of replaceable parts for the 8508A Reference Multimeter to the board level only. Parts are listed by assembly; alphabetized by reference designator. Each assembly is accompanied by an illustration showing the location of each part and its reference designator. The parts lists give the following information:

- Reference designator
- An indication if the part is subject to damage by static discharge
- Description
- Fluke stock number
- Total quantity
- Any special notes (i.e., factory-selected part)

### Caution

**A \*** symbol indicates a device that may be damaged by static discharge.

## How to Obtain Parts

Electrical components may be ordered directly from the manufacturer by using the manufacturers part number, or from the Fluke Corporation and its authorized representatives by using the part number under the heading FLUKE STOCK NO. To order components directly from Fluke Corporation, call (toll-free) 800-526-4731. Parts price information is available from the Fluke Corporation or its representatives.

To ensure prompt delivery of the correct part, include the following information when you place an order:

- Fluke stock number
- Description (as given under the Description heading)
- Quantity
- Reference designator
- Part number and revision level of the pca containing the part.
- Instrument model and serial number

## How to Contact Fluke

To contact Fluke, call one of the following telephone numbers:

USA: 1-888-99-FLUKE (1-888-993-5853)

Canada: 1-800-36-FLUKE (1-800-363-5853)

Europe: +31 402-675-200

Japan: +81-3-3434-0181

Singapore: +65-738-5655

Anywhere in the world: +1-425-446-5500

Or, visit Fluke's Web site at [www.fluke.com](http://www.fluke.com).



Note

*This instrument may contain a Nickel-Cadmium battery. Do not mix with the solid waste stream. Spent batteries should be disposed of by a qualified recycler or hazardous materials handler. Contact your authorized Fluke service center for recycling information.*

## Parts Lists

The following tables list the replaceable parts for the **8508A Reference Multimeter**. Parts are listed by assembly; alphabetized by reference designator. Each assembly is accompanied by an illustration showing the location of each part and its reference designator. The parts lists give the following information:

- Reference designator
- An indication if the part is subject to damage by static discharge
- Description
- Fluke stock number
- Total quantity
- Any special notes (i.e., factory-selected part)

### Caution

**A \*** symbol indicates a device that may be damaged by static discharge.

**Table 5-1. 8508A Final Assembly**

| Reference Designator                                                                   | Description                                         | Fluke Part No | Tot Qty | Notes     |
|----------------------------------------------------------------------------------------|-----------------------------------------------------|---------------|---------|-----------|
| MP1                                                                                    | Top Cover                                           | 1988598       | 1       |           |
| MP2                                                                                    | Bottom Cover                                        | 1988604       | 1       |           |
| MP3                                                                                    | Cover, Stripe Side                                  | 2398145       | 2       |           |
| MP4                                                                                    | Bumper, Foot, Self Adhesive                         | 2398373       | 4       |           |
| MP5                                                                                    | Foot, Rear                                          | 1628388       | 2       |           |
| MP6                                                                                    | Bottom, Foot, Moulded                               | 868786        | 4       |           |
| MP7                                                                                    | Bail, Tilt Stand                                    | 1988619       | 2       |           |
| MP8                                                                                    | Label Calibration Sticker                           | 2398123       | 3       |           |
| MP9                                                                                    | Label, Barcode, Model/Serial Number                 | 2398138       | 1       |           |
| MP10                                                                                   | Label, Modification Record                          | 2398114       | 1       |           |
| H1                                                                                     | Washer, M4 Crinkle SS GKN                           | 2398274       | 6       |           |
| H2                                                                                     | Screw, 8-32 X 3/8 SH SKTHD Black                    | 295105        | 6       |           |
| H3                                                                                     | Screw, M3 X 8 Pozipan                               | 2398200       | 2       |           |
|  F1 | Fuse 630 mA 250V 20mm (TH)                          | 1582145       | 1       |           |
|  F1 | Fuse 1.6A 250V 20mm (F)                             | 1582072       | 1       |           |
|  F1 | Fuse 1.25A 250V 20mm (TH)                           | 1582150       | 1       |           |
|                                                                                        | Mains Lead (Power Cord)                             |               | 1       | Not shown |
|                                                                                        | Mains Lead IEC TO CEE7/7                            | 769422        |         |           |
|                                                                                        | Mains Lead IEC UK 5A 2m                             | 769455        |         |           |
|                                                                                        | Mains Lead IEC AUS/NZ 10A 2.5m                      | 658641        |         |           |
|                                                                                        | Mains Lead IEC USA/JAPAN                            | 284174        |         |           |
|                                                                                        | Mains Lead IEC SWISS 10A 2.5m                       | 769448        |         |           |
|                                                                                        | Mains Lead IEC INDIA 10A 2.5m                       | 782771        |         |           |
|                                                                                        | SPRT 25R5 -200 TO 660 DEG C                         | 1656430       |         |           |
|                                                                                        | PRT 100R -200 TO 660 DEG C                          | 1654000       |         |           |
|                                                                                        | Users Manual, 8508A                                 | 1673798       | 1       | Not shown |
|                                                                                        | Service Manual, 8508A (sold separately)             | 2150128       |         | Not shown |
|                                                                                        | Manual Set, CD, PDF files (includes Service Manual) | 2150143       | 1       | Not shown |

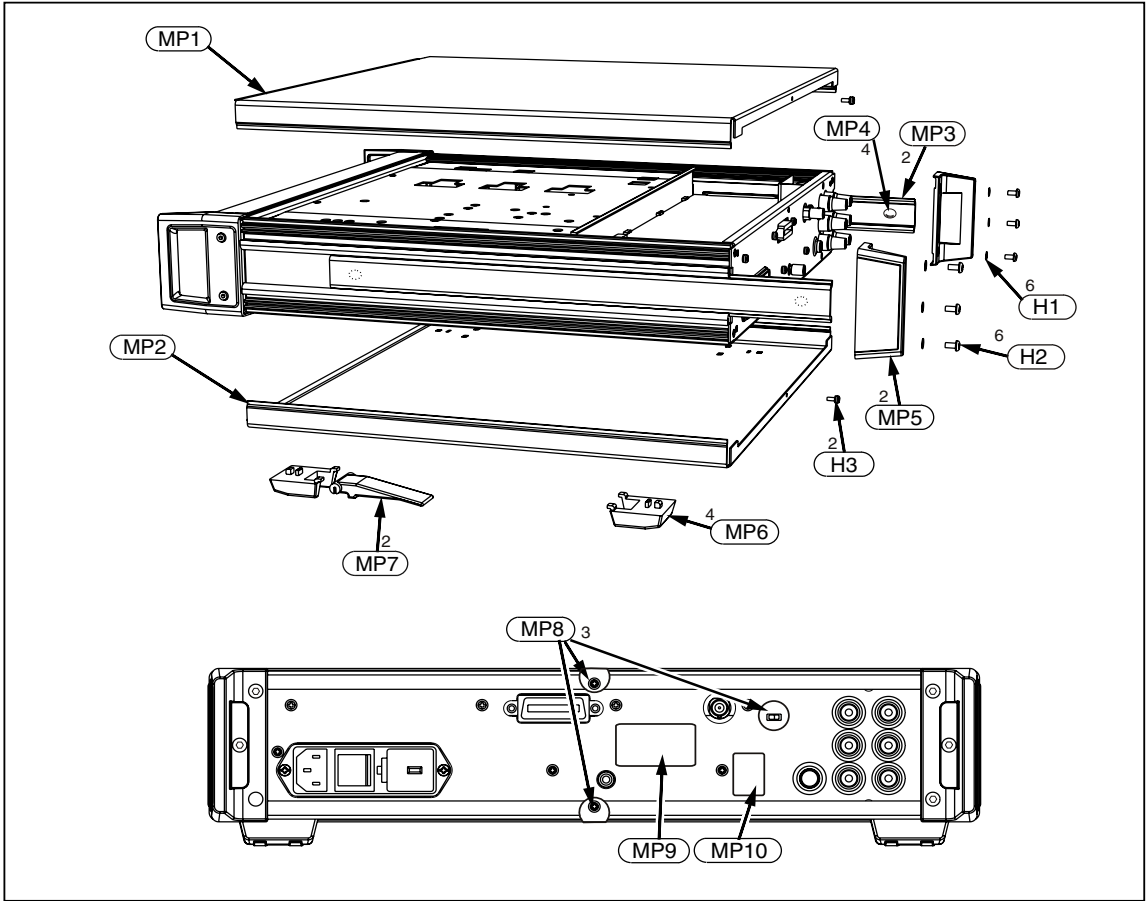


Figure 5-1. 8508A Final Assembly

avw025.eps

**Table 5-2. 8508A Chassis Assembly**

| Reference Designator                                            | Description                      | Fluke Part No | Tot Qty | Notes |
|-----------------------------------------------------------------|----------------------------------|---------------|---------|-------|
| A1                                                              | DC PCA                           | 1988709       | 1       | *     |
| A2                                                              | AC PCA                           | 1988727       | 1       | *     |
| A3                                                              | Ohms PCA                         | 1988748       | 1       | *     |
| A4                                                              | Digital PCA                      | 1988730       | 1       | *     |
| A5                                                              | Bezel Assembly                   | 1605337       | 1       |       |
| A6                                                              | Rear Input Assembly (optional)   | 2398049       | 1       |       |
| A401                                                            | Reference Module POS Assembly    | 2398024       | 1       | *     |
| H1                                                              | Screw 8-32 X 3/8 SH SKTHD BLK    | 295105        | 4       |       |
| H2                                                              | Screw M3 X 8 Pozipan             | 2398200       | 19      |       |
| H3                                                              | Binding Post Brass NiPL          | 102707        | 1       |       |
| H4                                                              | Binding Head Brass NiPL          | 102889        | 1       |       |
| H5                                                              | Clip Cable Flat Ribbon           | 2398320       | 4       |       |
| H6                                                              | Washer M3 INT-SHAKP SZP          | 2398239       | 2       |       |
| H7                                                              | Nut Full M3 SZP                  | 2398288       | 2       |       |
| H8                                                              | Washer M6 INT-SHAKP SZP          | 2398263       | 1       |       |
| H9                                                              | Nut Full 1/4-28 UNF BNP          | 2398301       | 1       |       |
| H10                                                             | Nut Nylock M4 SZP                | 2398295       | 4       |       |
| H11                                                             | Washer M4 Plain SZP              | 2398242       | 4       |       |
| H12                                                             | Screw M3 X 6 Pozicsk             | 2398189       | 22      |       |
| H13                                                             | Standoff M3 X 16 M/F Nylon       | 2398221       | 4       |       |
| H14                                                             | Screw M3 X 8 Pozicsk             | 2398192       | 6       |       |
| MP1                                                             | PCB Card Guide                   | 2398312       | 2       |       |
| MP3                                                             | Bush Insulating 8.8 ID Black     | 2398347       | 1       |       |
| MP2                                                             | Hole Plug 5/8" Black             | 2398358       | 7       | 1     |
| T1                                                              | Low Voltage Transformer Assembly | 2398036       | 1       |       |
| T2                                                              | Mains Transformer Assembly       | 2398060       | 1       |       |
| W1                                                              | Cable Sig I/P Assembly           | 2398008       | 1       |       |
| W2                                                              | Cable Ribbon Assembly 16W        | 2398013       | 1       |       |
| W3                                                              | Cable Ribbon DC-DIG Assembly     | 2398072       | 1       |       |
| W4                                                              | Cable Ribbon DC-OHM Assembly     | 2398085       | 1       |       |
| W5, W6                                                          | Cable Ribbon DIG-DS Assembly     | 2398097       | 2       |       |
| W7                                                              | Wire 7/2 PTFE 1 kV Green         | 2398150       | 1       |       |
|                                                                 | Lead Kit PTFE                    | 1886203       |         |       |
|                                                                 | Lead Kit Standard                | 2398911       | 1       |       |
| 1. These are removed when the Rear Input Assembly is installed. |                                  |               |         |       |

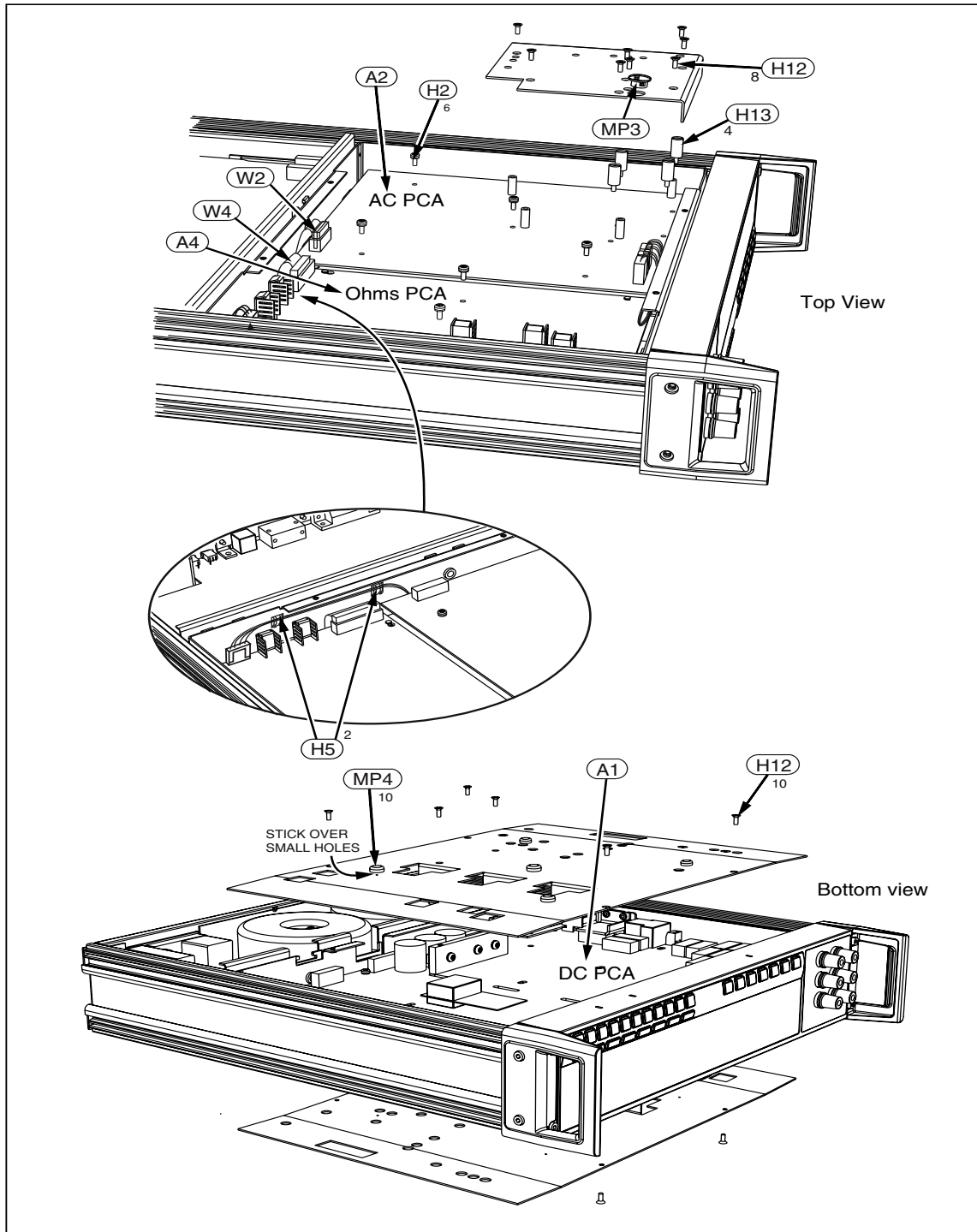
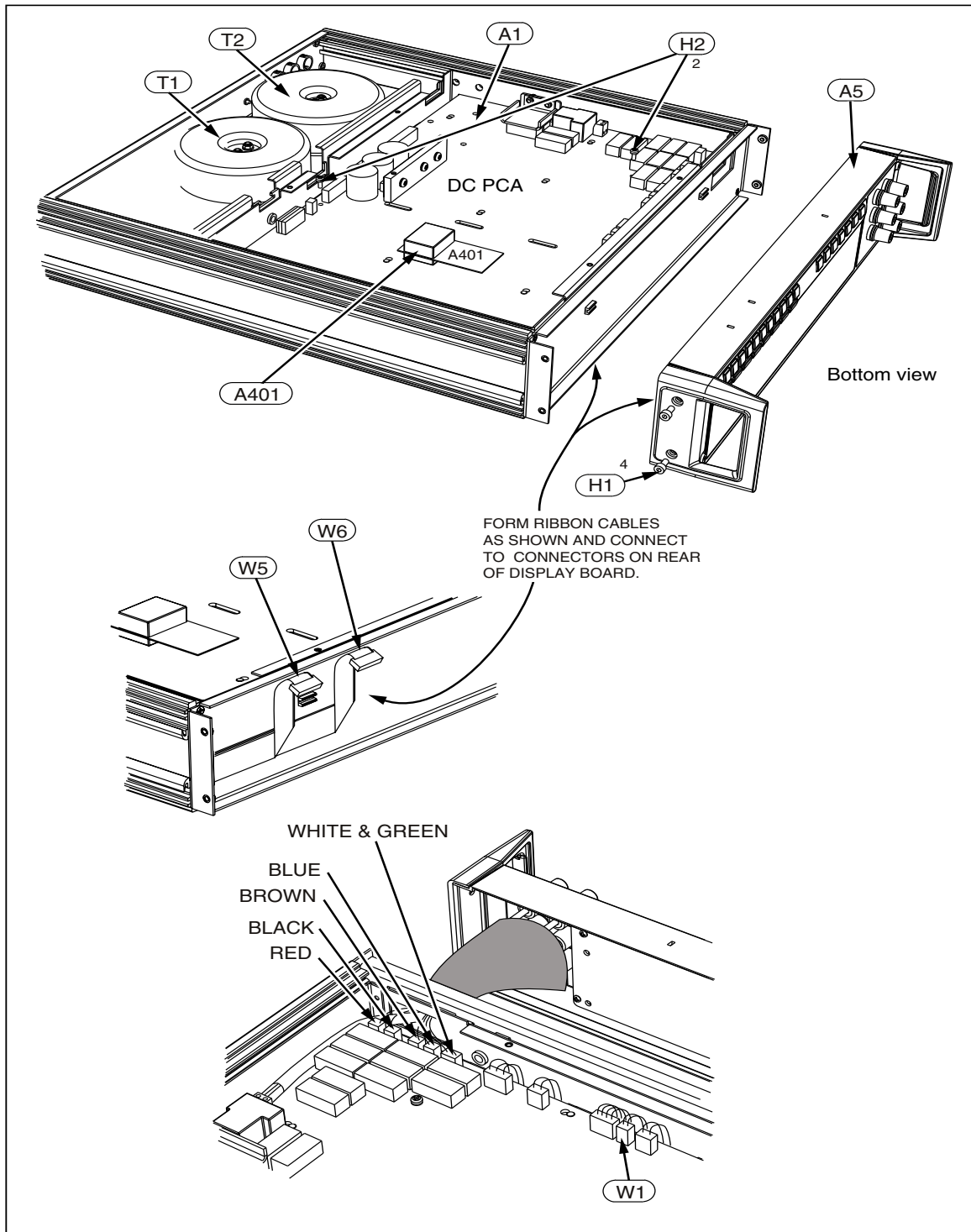


Figure 5-2. 8508A Chassis Assembly

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**Figure 5-2. 8508A Chassis Assembly (cont)**

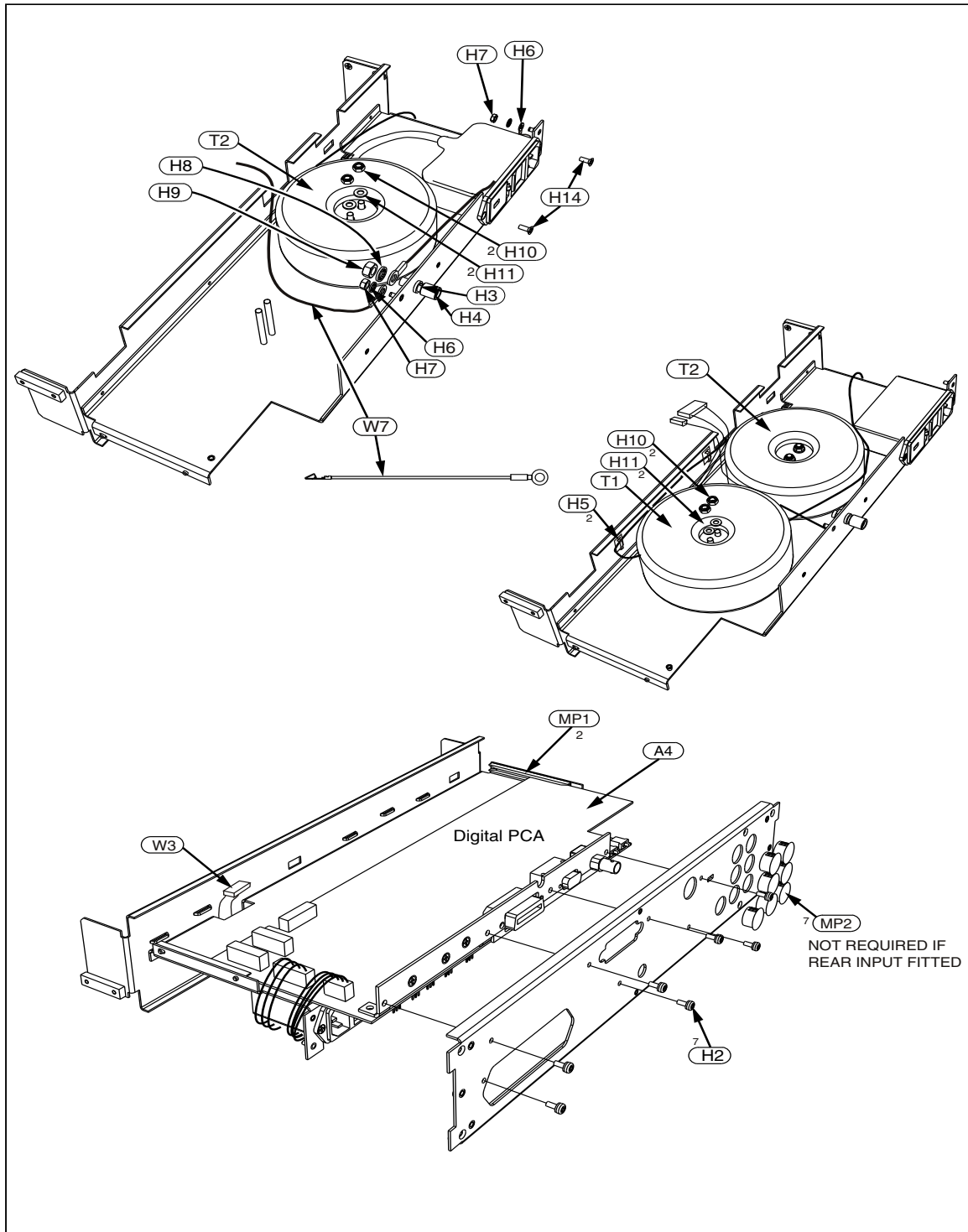
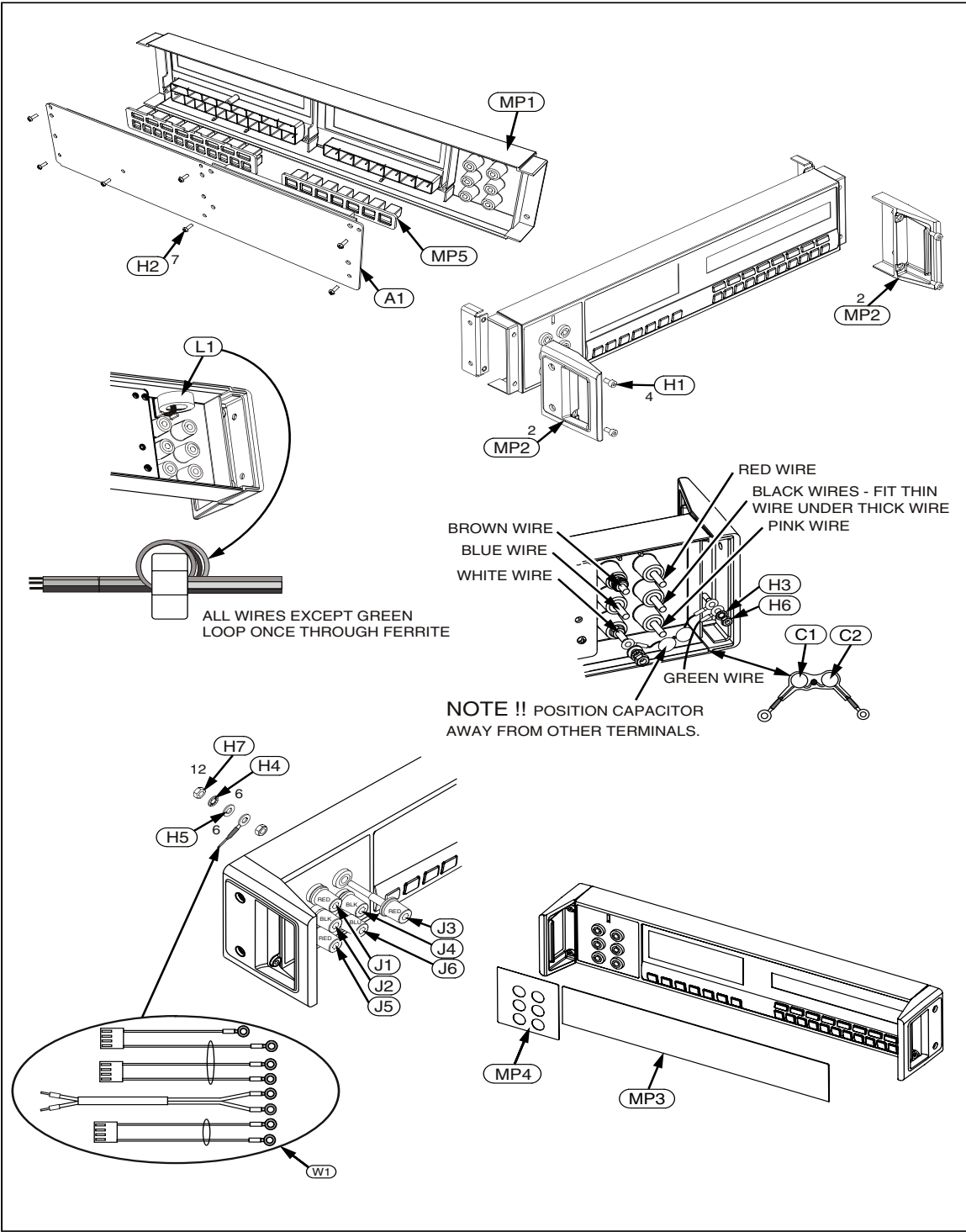


Figure 5-2. 8508A Chassis Assembly (cont)

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**Table 5-3. A5 Bezel (front panel) Assembly**

| Reference Designator | Description                         | Fluke Part No | Tot Qty | Notes |
|----------------------|-------------------------------------|---------------|---------|-------|
| A1                   | Display PCB Assembly                | 1988711       | 1       |       |
| C1, C2               | Capicator, ceramic, 470 pF 10% 2 kV | 2397993       | 2       |       |
| H1                   | Screws, 8/32 x 3/8                  | 295105        | 4       |       |
| H2                   | Screw, K25 x 8, POZIPAN SZP, ST     | 2398217       | 7       |       |
| H3                   | Washer M3, Int-SHAKP SZP            | 2398239       | 1       |       |
| H4                   | Washer M4, Int-SHAKP SZP            | 2398256       | 6       |       |
| H5                   | Washer, Terminal                    | 859939        | 1       |       |
| H6                   | Nut, Full, M3, SZP                  | 2398288       | 1       |       |
| H7                   | Nut Terminal 8-32 UNC               | 850334        | 12      |       |
| J1, J2, J3           | Terminal, Low Thermal, Red          | 886382        | 3       |       |
| J4, J5               | Terminal, Low Thermal, Black        | 886379        | 2       |       |
| J6                   | Terminal, Low Thermal, Blue         | 886366        | 1       |       |
| L1                   | Ferrite Core, 8680 nH               | 2398386       | 1       |       |
| MP2                  | Front Handle                        | 1605343       | 2       |       |
| MP3                  | Display Lens                        | 1607661       | 1       |       |
| MP5                  | Keypad Set                          | 1605272       | 1       |       |
| MP4                  | Front Panel Decal                   | 1607677       | 1       |       |
| W1                   | Cable Assembly, Front Input         | 2398051       | 1       |       |

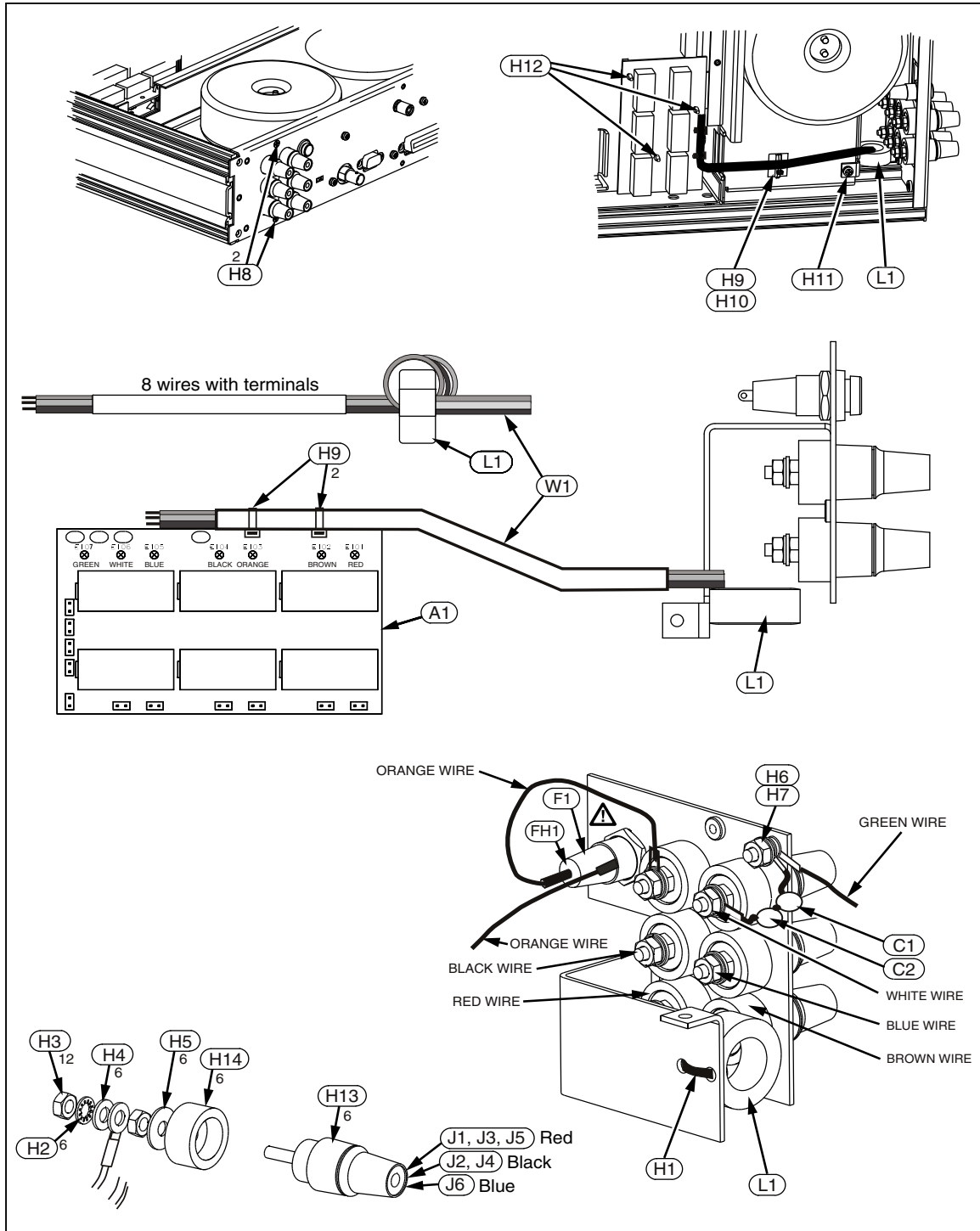


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Figure 5-3. A5 Bezel (front panel) Assembly

**Table 5-4. A6 Rear Input Assembly (optional)**

| Reference Designator                                                                 | Description                                      | Fluke Part No | Tot Qty | Notes |
|--------------------------------------------------------------------------------------|--------------------------------------------------|---------------|---------|-------|
| A1                                                                                   | Rear Input PCA                                   | 2399180       | 1       |       |
| C1, C2                                                                               | Capacitor CD 470 pF 10% 2 kV                     | 2397993       | 2       |       |
|  F1 | Fuse 1.6 A 250 V 20 mm                           | 1582072       | 1       |       |
| FH                                                                                   | Fuse Holder 20 mm Panel Mount                    | 2398399       | 1       |       |
| H1                                                                                   | Tie, Cable 3.6 x 142 mm                          | 2398161       | 1       |       |
| H2                                                                                   | Washer M4 Int-Shakp SZP                          | 2398256       | 6       |       |
| H3                                                                                   | Nut 8-32 UNC Terminal                            | 850334        | 12      |       |
| H4                                                                                   | Washer Terminal                                  | 859939        | 6       |       |
| H5                                                                                   | Washer Terminal Large                            | 613606        | 6       |       |
| H6                                                                                   | Washer M3 Int-Shakp SZP                          | 2398239       | 1       |       |
| H7                                                                                   | Nut Full M3 SZP                                  | 2398288       | 1       |       |
| H8                                                                                   | Screw M3 x 6 POSICSK SZP                         | 2398189       | 2       |       |
| H9                                                                                   | Tie Cable 2.5 x 115 mm                           | 2398177       | 3       |       |
| H10                                                                                  | Tie Holder                                       | 2398335       | 1       |       |
| H11                                                                                  | Screw M3 x 8 POZIPAN SEMS                        | 2398200       | 1       |       |
| H12                                                                                  | Circuit Board, Support                           | 2398364       | 3       |       |
| H13                                                                                  | Terminal Insulator                               | 894183        | 6       |       |
| H14                                                                                  | Terminal Base                                    | 885459        | 6       |       |
| J2, J4                                                                               | Terminal, Low Thermal, Black                     | 886379        | 2       |       |
| J1, J3, J5                                                                           | Terminal, Low Thermal, Red                       | 886382        | 3       |       |
| J6                                                                                   | Terminal, Low Thermal, Blue                      | 886366        | 1       |       |
| L1                                                                                   | Ferrite 26 x 14 x 11 8680 nF                     | 2398386       | 1       |       |
| W1                                                                                   | Cable Assembly Rear Input (8 wires w/ terminals) | 2398106       | 1       |       |



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Figure 5-4. Rear Input Assembly (optional)

