

# Model 2100 6 1/2-Digit Resolution Digital Multimeter

## Calibration Manual

2100-905-01 Rev. B April 2020



2100-905-01B

# Model 2100

## 6½-Digit Resolution Digital Multimeter

### Calibration Manual

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The following safety precautions should be observed before using this product and any associated instrumentation. Although some instruments and accessories would normally be used with nonhazardous voltages, there are situations where hazardous conditions may be present.

This product is intended for use by personnel who recognize shock hazards and are familiar with the safety precautions required to avoid possible injury. Read and follow all installation, operation, and maintenance information carefully before using the product. Refer to the user documentation for complete product specifications.

If the product is used in a manner not specified, the protection provided by the product warranty may be impaired.

The types of product users are:

**Responsible body** is the individual or group responsible for the use and maintenance of equipment, for ensuring that the equipment is operated within its specifications and operating limits, and for ensuring that operators are adequately trained.

**Operators** use the product for its intended function. They must be trained in electrical safety procedures and proper use of the instrument. They must be protected from electric shock and contact with hazardous live circuits.

**Maintenance personnel** perform routine procedures on the product to keep it operating properly, for example, setting the line voltage or replacing consumable materials. Maintenance procedures are described in the user documentation. The procedures explicitly state if the operator may perform them. Otherwise, they should be performed only by service personnel.

**Service personnel** are trained to work on live circuits, perform safe installations, and repair products. Only properly trained service personnel may perform installation and service procedures.

Keithley products are designed for use with electrical signals that are measurement, control, and data I/O connections, with low transient overvoltages, and must not be directly connected to mains voltage or to voltage sources with high transient overvoltages. Measurement Category II (as referenced in IEC 60664) connections require protection for high transient overvoltages often associated with local AC mains connections. Certain Keithley measuring instruments may be connected to mains. These instruments will be marked as category II or higher.

Unless explicitly allowed in the specifications, operating manual, and instrument labels, do not connect any instrument to mains.

Exercise extreme caution when a shock hazard is present. Lethal voltage may be present on cable connector jacks or test fixtures. The American National Standards Institute (ANSI) states that a shock hazard exists when voltage levels greater than 30 V RMS, 42.4 V peak, or 60 VDC are present. A good safety practice is to expect that hazardous voltage is present in any unknown circuit before measuring.

Operators of this product must be protected from electric shock at all times. The responsible body must ensure that operators are prevented access and/or insulated from every connection point. In some cases, connections must be exposed to potential human contact. Product operators in these circumstances must be trained to protect themselves from the risk of electric shock. If the circuit is capable of operating at or above 1000 V, no conductive part of the circuit may be exposed.

Do not connect switching cards directly to unlimited power circuits. They are intended to be used with impedance-limited sources. NEVER connect switching cards directly to AC mains. When connecting sources to switching cards, install protective devices to limit fault current and voltage to the card.

Before operating an instrument, ensure that the line cord is connected to a properly-grounded power receptacle. Inspect the connecting cables, test leads, and jumpers for possible wear, cracks, or breaks before each use.

When installing equipment where access to the main power cord is restricted, such as rack mounting, a separate main input power disconnect device must be provided in close proximity to the equipment and within easy reach of the operator.

For maximum safety, do not touch the product, test cables, or any other instruments while power is applied to the circuit under test. ALWAYS remove power from the entire test system and discharge any capacitors before connecting or disconnecting cables or jumpers, installing or removing switching cards, or making internal changes, such as installing or removing jumpers.

Do not touch any object that could provide a current path to the common side of the circuit under test or power line (earth) ground. Always make measurements with dry hands while standing on a dry, insulated surface capable of withstanding the voltage being measured.


For safety, instruments and accessories must be used in accordance with the operating instructions. If the instruments or accessories are used in a manner not specified in the operating instructions, the protection provided by the equipment may be impaired.


Do not exceed the maximum signal levels of the instruments and accessories. Maximum signal levels are defined in the specifications and operating information and shown on the instrument panels, test fixture panels, and switching cards.

When fuses are used in a product, replace with the same type and rating for continued protection against fire hazard.

Chassis connections must only be used as shield connections for measuring circuits, NOT as protective earth (safety ground) connections.


If you are using a test fixture, keep the lid closed while power is applied to the device under test. Safe operation requires the use of a lid interlock.


If a  screw is present, connect it to protective earth (safety ground) using the wire recommended in the user documentation.

The  symbol on an instrument means caution, risk of hazard. The user must refer to the operating instructions located in the user documentation in all cases where the symbol is marked on the instrument.

The  symbol on an instrument means warning, risk of electric shock. Use standard safety precautions to avoid personal contact with these voltages.


The  symbol on an instrument shows that the surface may be hot. Avoid personal contact to prevent burns.

The  symbol indicates a connection terminal to the equipment frame.

If this  symbol is on a product, it indicates that mercury is present in the display lamp. Please note that the lamp must be properly disposed of according to federal, state, and local laws.

The **WARNING** heading in the user documentation explains hazards that might result in personal injury or death. Always read the associated information very carefully before performing the indicated procedure.

The **CAUTION** heading in the user documentation explains hazards that could damage the instrument. Such damage may invalidate the warranty.

The **CAUTION** heading with the  symbol in the user documentation explains hazards that could result in moderate or minor injury or damage the instrument. Always read the associated information very carefully before performing the indicated procedure. Damage to the instrument may invalidate the warranty.

Instrumentation and accessories shall not be connected to humans.

Before performing any maintenance, disconnect the line cord and all test cables.

To maintain protection from electric shock and fire, replacement components in mains circuits — including the power transformer, test leads, and input jacks — must be purchased from Keithley. Standard fuses with applicable national safety approvals may be used if the rating and type are the same. The detachable mains power cord provided with the instrument may only be replaced with a similarly rated power cord. Other components that are not safety-related may be purchased from other suppliers as long as they are equivalent to the original component (note that selected parts should be purchased only through Keithley to maintain accuracy and functionality of the product). If you are unsure about the applicability of a replacement component, call a Keithley office for information.

Unless otherwise noted in product-specific literature, Keithley instruments are designed to operate indoors only, in the following environment: Altitude at or below 2,000 m (6,562 ft); temperature 0 °C to 50 °C (32 °F to 122 °F); and pollution degree 1 or 2.

To clean an instrument, use a cloth dampened with deionized water or mild, water-based cleaner. Clean the exterior of the instrument only. Do not apply cleaner directly to the instrument or allow liquids to enter or spill on the instrument. Products that consist of a circuit board with no case or chassis (e.g., a data acquisition board for installation into a computer) should never require cleaning if handled according to instructions. If the board becomes contaminated and operation is affected, the board should be returned to the factory for proper cleaning/servicing.

Safety precaution revision as of June 2017.

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## Contact information

If you have any questions after you review the information in this documentation, please contact your local Keithley Instruments office, sales partner, or distributor. You can also call the Tektronix corporate headquarters (toll-free inside the U.S. and Canada only) at 1-800-833-9200. For worldwide contact numbers, visit [tek.com/contact-us](http://tek.com/contact-us).

## Introduction

This manual introduces the calibration procedure for the Keithley Instruments Model 2100 6½-Digit Resolution Digital Multimeter. The procedures in this manual should be used whenever adjustment for the following functions is necessary:

- AC / DC voltage
- AC / DC current
- Resistance

These adjustment procedures are performed by remotely sending SCPI commands over the USB interface using the 2100 KI-TOOL software.

## Control software

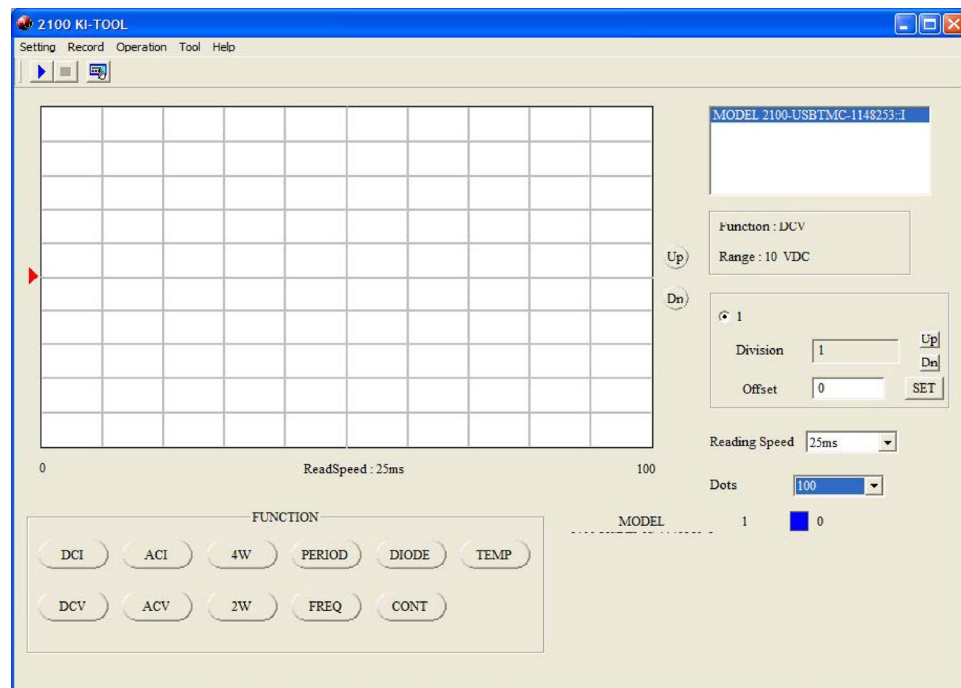
You must have one of the following items installed on the remote interface in order to obtain the proper VISA layer:

- Keithley Instruments I/O Layer 5.0 or greater.
- NI-VISA 3.1 or greater.
- Agilent I/O Library Suite 14.2 or greater (the I/O Layer 5.0 is included on the CD-ROM that comes with the Model 2100).

### To install the USB device drive

1. Install the USB device driver and KI-Tool Software from the Keithley Instruments Model 2100 Product Information CD.
2. Connect the 2100 to the USB port and launch the KI-Tool application.
3. Verify that the correct model number is displayed in the upper right-hand corner window. See the following figure for details.
4. Test the communications link between the 2100 instrument and the control software by selecting several function buttons and verifying that the DMM responds accordingly. See the following figure for details.

Figure 1: Model 2100 KI-TOOL application



The adjustment procedure consists of connecting the Fluke 5700A Calibrator and Fluke 5725A Amplifier (or equivalent) outputs to the 2100 front panel input, setting up appropriate ranges, and performing adjustment functions by sending specific SCPI commands. In the following sections, you will be provided with SCPI commands to be sent to the 2100. These commands should be entered in the **Send String** field followed by the **Write** button. To access the command control window from the 2100 KI-TOOL application, click on **Tool > Command Control**.

---

## NOTE

Make sure the correct model number is selected before sending any SCPI commands.

---

## Environmental conditions

Conduct the calibration procedures in a location that has:

- An ambient temperature of 5 °C to 40 °C.
- A relative humidity of less than 80% unless otherwise noted.

## Calibration considerations

When performing the calibration procedure:

- Make sure the equipment is properly warmed up and connected to the appropriate input jacks. Also, make sure the correct input jacks are selected with the **INPUTS** switch.

---

## NOTE

The specifications are valid after a 2-hour warm up. Refer to [Performance verification](#) (on page 8-1) for more information.

---

- Make sure the calibrator is in **OPERATE** mode before you complete each calibration step.
- Do not connect test equipment to the Model 2100 through a scanner or other switching equipment.
- If an error occurs during calibration, the Model 2100 will generate the appropriate error message. Please refer to the *Model 2100 6½-Digit Resolution Digital Multimeter User's Manual* (document number 2100-900-01) for error code descriptions. This manual is available online at [tek.com/keithley](http://tek.com/keithley).
- During the adjustment process, the Model 2100 may not display the correct amplitude of the applied signal. This condition is normal.
- After the adjustment procedure is completed, complete [Performance verification](#) (on page 8-1) to verify that the 2100 is operating within the manufacturer's specifications.



## Recommended test equipment

Use a Fluke Model 5700A Calibrator and 5725A Amplifier (or the equivalent) to perform the 2100 multimeter adjustments.

## Firmware revision

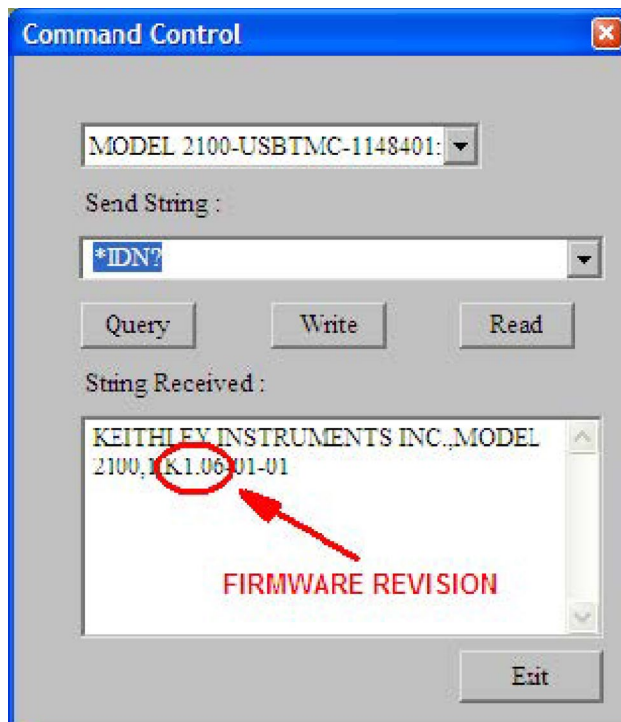
If your 2100 has firmware versions 1.03 or 1.04, the firmware must be updated to the latest version before this procedure can be performed.

To identify the firmware version, press the **QUERY** button and enter the following SCPI command:

```
*IDN?
```

The following figure shows the typical location of the firmware version number. If the firmware requires updating, refer to the [Keithley Instruments website \(tek.com/keithley\)](http://tek.com/keithley) for detailed instructions.

**Figure 2: Model 2100 Command Control**



## Calibration code

***To unlock the calibration function:***

1. Unlock the calibration function by sending the SCPI command:

```
CAL:PROT:CODE <up to 8-character string>
```

---

### NOTE

The default code command is: `CAL:PROT:CODE p8125652`

---

2. Initiate the calibration routine by sending the SCPI command:

```
CAL:PROT:INIT
```

---

## Zero calibration front panel

### In this section:

Front-panel calibration ..... 2-1

## Front-panel calibration

### *To use the front-panel calibration:*

1. Connect a low-thermal, four-wire short (Keithley Instruments Model 8610 or equivalent) to the instrument front-panel input terminals.
2. Set **INPUTS** select switch to front terminals. Allow the connections to stabilize for a minimum of five minutes before proceeding.

---

### NOTE

Make sure to connect the low-thermal short properly to the HI, LO, and SENSE terminals. Keep drafts away from low-thermal connections to avoid thermal drift, which could affect calibration accuracy.

---

3. Initiate the 2100 zero calibration by sending the following SCPI command:

```
cal:prot:dc:step 3,0
```

4. Wait until the following message is displayed on the 2100:

```
Cali ok
```

5. Remove the low-thermal, four-wire short from the front terminals.

---

## Zero calibration rear panel

### In this section:

Rear-panel calibration ..... 3-1

## Rear-panel calibration

### *To use the rear-panel calibration:*

1. Connect low-thermal, four-wire short (Keithley Instruments Model 8610 or equivalent) to the instrument rear panel input terminals.
2. Set **INPUTS** select switch to rear terminals. Allow connections to stabilize for a minimum of five minutes before proceeding.

---

### NOTE

Make sure to connect the low-thermal short properly to the HI, LO, and SENSE terminals. Keep drafts away from low-thermal connections to avoid thermal drift, which could affect calibration accuracy.

---

3. Initiate the 2100 zero calibration by sending the following SCPI command:

```
CAL:PROT:DC:STEP 4,0
```

4. Wait until the following message is displayed on the 2100:

```
Cali OK
```

5. Remove the low-thermal, four-wire short from the rear terminals.
6. Set the **INPUTS** select switch to front terminals.

---

## Voltage function adjustment (DC and AC)

### In this section:

Voltage function adjustment..... 4-1

## Voltage function adjustment

The ranges for dc voltage (dc V) adjustment are 100 mV, 1 V, 10 V, 100 V, and 1000 V. For ac voltage (ac V) adjustment, the ranges are 100 mV, 1 V, 10 V, 100 V, and 750 V RMS at 1 kHz.

---

### **WARNING**

**Do not apply more than 1000 V (peak) to the 2100 multimeter. Applying excess voltage may damage the meter or cause electric shock, resulting in personal injury or death.**

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---

### **NOTE**

To eliminate the thermal EMFs due to the differences between two metals, use copper leads to connect your source signal to the meter.

---

## DC voltage range adjustment

### *To adjust DC voltage:*

1. Set the 5700A to 0 V dc, **RANGE: AUTO** and output to **STANDBY** mode.
2. Using shielded, low-thermal EMF cables, connect the Fluke 5700A output HI and LO to the 2100 input HI and LO terminals. Allow connections to stabilize for a minimum of five minutes before proceeding.
3. Set the 2100 to the 10 V dc voltage range by sending the following SCPI command:

```
CONF:VOLT:DC 10
```

4. Set the 5700A output mode to **OPERATE**.
5. Adjust the input offset by sending the following SCPI command:

```
CAL:PROT:DC:STEP 1,10
```

6. Wait until the following message is displayed on the 2100:

```
Cali OK
```

7. Set the 5700A output to 10 V dc.
8. Adjust the full-scale measurement by sending the following SCPI command:

```
CAL:PROT:DC:STEP 2,10
```

9. Wait until the following message is displayed on the 2100:

```
Cali OK
```

10. Set the 5700A output mode to **STANDBY**.
11. Set the 2100 to the 1 V range by sending the following SCPI command:

```
CONF:VOLT:DC 1
```

12. Set the 5700A 0 V dc and output to **OPERATE** mode.
13. Adjust the input offset by sending the following SCPI command:

```
CAL:PROT:DC:STEP 1,1
```

14. Wait until the following message is displayed on the 2100:

```
Cali OK
```

15. Set the 5700A output to 1 V dc.
16. Adjust the full-scale measurement by sending the following SCPI command:

```
CAL:PROT:DC:STEP 2,1
```

17. Wait until the following message is displayed on the 2100:

```
Cali OK
```

18. Set the 5700A output mode to **STANDBY**.
19. Set the 2100 to the 0.1 V range by sending the following SCPI command:

```
CONF:VOLT:DC 0.1
```

20. Set the 5700A to 0 V dc and output to **OPERATE** mode.
21. Adjust the input offset by sending the following SCPI command:

```
CAL:PROT:DC:STEP 1,0.1
```

22. Wait until the following message is displayed on the 2100:

```
Cali OK
```

23. Set the 5700A output to 0.1 V dc.

24. Adjust the full-scale measurement by sending the following SCPI command:

```
CAL:PROT:DC:STEP 2,0.1
```

25. Wait until the following message is displayed on the 2100:

```
Cali OK
```

26. Set the 5700A output mode to **STANDBY**.

27. Set the 2100 to the 100 V range by sending the following SCPI command:

```
CONF:VOLT:DC 100
```

28. Set 5700A to 0 V dc and output to **OPERATE** mode.

29. Adjust input offset by sending the following SCPI command:

```
CAL:PROT:DC:STEP 1,100
```

30. Wait until the following message is displayed on the 2100:

```
Cali OK
```

31. Set the 5700A output to 100 V dc.

32. Adjust the full-scale measurement by sending the following SCPI command:

33. Wait until the following message is displayed on the 2100:

```
Cali OK
```

34. Set the 5700A output mode to **STANDBY**.

35. Set the 2100 to the 1000 V range by sending the following SCPI command:

```
CONF:VOLT:DC 1000
```

36. Set the 5700A to 0 V dc and output to **OPERATE** mode.

37. Adjust the input offset by sending the following SCPI command:

```
CAL:PROT:DC:STEP 1,1000
```

38. Wait until the following message is displayed on the 2100:

```
Cali OK
```

39. Set the 5700A output to 1000 V dc.

40. Adjust the full-scale measurement by sending the following SCPI command:

```
CAL:PROT:DC:STEP 2,1000
```

41. Wait until the following message is displayed on the 2100:

```
Cali OK
```

42. Set the 5700A to 0 V dc and output mode to **STANDBY**.

## AC voltage range adjustment

### *To adjust the voltage range:*

1. Set the 5700A to 0.01 V at 1 kHz and output to **STANDBY** mode.
2. Using coaxial cable with dual banana terminals, connect the Fluke 5700A output HI and LO to the 2100 input HI and LO terminals. Allow connections to stabilize for a minimum of five minutes before proceeding.
3. Set the 2100 to 0.1 V range by sending the following SCPI command:

```
CONF:VOLT:AC 0.1
```

4. Set the 5700A output mode to **OPERATE**.
5. Adjust 10% of the range by sending the following SCPI command:

```
CAL:PROT:AC:STEP 1,0.01
```

6. Wait until the following message is displayed on the 2100:

```
Cali OK
```

7. Set the 5700A output to 0.1 V.
8. Adjust the full-scale measurement by sending the following SCPI command:

```
CAL:PROT:AC:STEP 2,0.1
```

9. Wait until the following message is displayed on the 2100:

```
Cali OK
```

10. Set the 5700A output mode to **STANDBY**.
11. Set the 2100 to the 1 V range by sending the following SCPI command:

```
CONF:VOLT:AC 1
```

12. Set the 5700A to 0.1 V and output mode to **OPERATE**.
13. Adjust 10% of the range by sending the following SCPI command:

```
CAL:PROT:AC:STEP 1,0.1
```

14. Wait until the following message is displayed on the 2100:

```
Cali OK
```

15. Set the 5700A output to 1 V.
16. Adjust the full-scale measurement by sending the following SCPI command:

```
CAL:PROT:AC:STEP 2,1
```

17. Wait until the following message is displayed on the 2100:

```
Cali OK
```

18. Set the 5700A output mode to **STANDBY**.
19. Set the 2100 to the 10 V range by sending the following SCPI command:

```
CONF:VOLT:AC 10
```

20. Set the 5700A to 1 V and output mode to **OPERATE**.
21. Adjust 10% of the range by sending the following SCPI command:

```
CAL:PROT:AC:STEP 1,1
```



22. Wait until the following message is displayed on the 2100:

```
Cali OK
```

23. Set the 5700A output to 10 V.

24. Adjust the full-scale measurement by sending the following SCPI command:

```
CAL:PROT:AC:STEP 2,10
```

25. Wait until the following message is displayed on the 2100:

```
Cali OK
```

26. Set the 5700A output mode to **STANDBY**.

27. Set the 2100 to the 100 V range by sending the following SCPI command:

```
CONF:VOLT:AC 100
```

28. Set the 5700A to 10 V and output mode to **OPERATE**.

29. Adjust 10% of the range by sending the following SCPI command:

```
CAL:PROT:AC:STEP 1,10
```

30. Wait until the following message is displayed on the 2100:

```
Cali OK
```

31. Set the 5700A output to 100 V.

32. Adjust the full-scale measurement by sending the following SCPI command:

```
CAL:PROT:AC:STEP 2,100
```

33. Wait until the following message is displayed on the 2100:

```
Cali OK
```

34. Set the 5700A output mode to **STANDBY**.

35. Set the 2100 to the 750 V range by sending the following SCPI command:

```
CONF:VOLT:AC 750
```

36. Set the 5700A to 75 V and output mode to **OPERATE**.

37. Adjust 10% of the range by sending the following SCPI command:

```
CAL:PROT:AC:STEP 1,75
```

38. Wait until the following message is displayed on the 2100:

```
Cali OK
```

39. Set the 5700A output to 750 V.

40. Adjust the full-scale measurement by sending the following SCPI command:

```
CAL:PROT:AC:STEP 2,750
```

41. Wait until the following message is displayed on the 2100:

```
Cali OK
```

42. Set the 5700A output mode to **STANDBY**. Press the **RESET** button on the 5700A front panel to reset the calibrator to its default settings.

---

## Ohms function adjustment

### In this section:

Ohms function adjustment ..... 5-1

## Ohms function adjustment

There are two resistance adjustments available:

- Resistance low range adjustment (100  $\Omega$  - 1 M $\Omega$ )
- Resistance high range adjustment (10 M $\Omega$  - 100 M $\Omega$ )

### Resistance low-range adjustment (100 $\Omega$ - 1 M $\Omega$ )

#### *To adjust the low-range resistance:*

1. Set the 5700A to 0  $\Omega$ , 2 WIRE COMP OFF, EX SNS button off, EX GRD button off, and output to **STANDBY** mode.
2. Using shielded, low-thermal EMF cables, connect Fluke 5700A output HI and LO to the 2100 input HI and LO terminals. Allow connections to stabilize for a minimum of five minutes before proceeding.
3. Set the 2100 to the two-wire, 1 M $\Omega$  resistance function by sending the following SCPI command:

```
CONF:RES 1E6
```

4. Set the measurement rate to 10 PLC by sending the following SCPI command:

```
RES:NPLC 10
```

5. Set the average function to 100 counts by sending the following SCPI command:

```
AVERAGE:COUNT 100
```

6. Set the 5700A output mode to **OPERATE**.

7. Adjust the input offset by sending the following SCPI command:

```
CAL:PROT:DC:STEP 1,1E6
```

8. Wait until the following message is displayed on the 2100:

```
Cali OK
```

9. Set the 5700A output to 1 M $\Omega$ .

10. Adjust the full-scale measurement by sending the following SCPI command:

```
CAL:PROT:DC:STEP 2,<ACTUAL CALIBRATOR OUTPUT>
```

---

## NOTE

Enter the actual output value in scientific notation format. For example, if the calibrator's display shows 0.9999615 M $\Omega$ , enter this value as: CAL:PROT:DC:STEP 2,0.9999615E6

---

11. Wait until the following message is displayed on the 2100:

```
Cali OK
```

12. Set the 5700A output mode to **STANDBY**.

13. Set the 5700A to 0 $\Omega$ , 2 WIRE COMP OFF, EX SNS button on, EX GRD button off, and output to **STANDBY** mode.

14. Using shielded, low-thermal EMF cables connect Fluke 5700A output HI, output LO, sense HI, sense LO to the 2100 input HI, input LO, sense HI, and sense LO terminals. Allow connections to stabilize for a minimum of five minutes before proceeding.

15. Set the 2100 to the four-wire, 1 M $\Omega$  resistance function by sending the following SCPI command:

```
CONF:FRES 1E6
```

16. Set the measurement rate to 10 PLC by sending the following SCPI command:

```
FRES:NPLC 10
```

17. Set the average function to 100 counts by sending the following SCPI command:

```
AVERAGE:COUNT 100
```

18. Set the 5700A output mode to **OPERATE**.

19. Adjust the input offset by sending the following SCPI command:

```
CAL:PROT:DC:STEP 1,1E6
```

20. Wait until the following message is displayed on the 2100 display:

```
Cali OK
```

21. Set the 5700A output to 1 M $\Omega$ .

22. Adjust the full-scale measurement by sending the following SCPI command:

```
CAL:PROT:DC:STEP 2,<ACTUAL CALIBRATOR OUTPUT>
```

23. Wait until the following message is displayed on the 2100 display:

```
Cali OK
```

24. Set the 5700A output mode to **STANDBY**.

25. Set the 2100 to the four-wire, 100 k $\Omega$  resistance function by sending the following SCPI command:

```
CONF:FRES 1E5
```

26. Set the measurement rate to 10 PLC by sending the following SCPI command:

```
FRES:NPLC 10
```

27. Set the average function to 25 counts by sending the following SCPI command:

```
AVERAGE:COUNT 25
```

28. Set the 5700A to 0 $\Omega$  and output mode to **OPERATE**.

29. Adjust the input offset by sending the following SCPI command:

```
CAL:PROT:DC:STEP 1,1E5
```

30. Wait until the following message is displayed on the 2100:

```
Cali OK
```

31. Set the 5700A output to 100 k $\Omega$ .

32. Adjust the full-scale measurement by sending the following SCPI command:

```
CAL:PROT:DC:STEP 2,<ACTUAL CALIBRATOR OUTPUT>
```

33. Wait until the following message is displayed on the 2100:

```
Cali OK
```

34. Set the 5700A output mode to **STANDBY**.

35. Set the 2100 to the four-wire, 10 k $\Omega$  resistance function by sending the following SCPI command:

```
CONF:FRES 1E4
```

36. Set the measurement rate to 10 PLC by sending the following SCPI command:

```
FRES:NPLC 10
```

37. Set the 5700A to 0 $\Omega$  and output mode to **OPERATE**.

38. Adjust the input offset by sending the following SCPI command:

```
CAL:PROT:DC:STEP 1,1E4
```

39. Wait until the following message is displayed on the 2100:

```
Cali OK
```

40. Set the 5700A output to 10 k $\Omega$ .

41. Adjust the full-scale measurement by sending the following SCPI command:

```
CAL:PROT:DC:STEP 2,<ACTUAL CALIBRATOR OUTPUT>
```

42. Wait until the following message is displayed on the 2100:

```
Cali OK
```

43. Set the 5700A output mode to **STANDBY**.

44. Set the 2100 to the four-wire, 1 k $\Omega$  resistance function by sending the following SCPI command:

```
CONF:FRES 1E3
```

45. Set measurement rate to 10 PLC by sending the following SCPI command:

```
FRES:NPLC 10
```

46. Set the 5700A to 0 $\Omega$  and output mode to **OPERATE**.

47. Adjust the input offset by sending the following SCPI command:

```
CAL:PROT:DC:STEP 1,1E3
```

48. Wait until the following message is displayed on the 2100:

```
Cali OK
```

49. Set the 5700A output to 1 k $\Omega$ .

50. Adjust the full-scale measurement by sending the following SCPI command:

```
CAL:PROT:DC:STEP 2,<ACTUAL CALIBRATOR OUTPUT>
```

51. Wait until the following message is displayed on the 2100:

```
Cali OK
```

52. Set the 5700A output mode to **STANDBY**.

53. Set the 2100 to the four-wire, 100  $\Omega$  resistance function by sending the following SCPI command:

```
CONF:FRES 1E2
```

54. Set the measurement rate to 10 PLC by sending the following SCPI command:

```
FRES:NPLC 10
```

55. Set the 5700A to 0  $\Omega$  and output mode to **OPERATE**.

56. Adjust the input offset by sending the following SCPI command:

```
CAL:PROT:DC:STEP 1,1E2
```

57. Wait until the following message is displayed on the 2100:

```
Cali OK
```

58. Set the 5700A output to 100  $\Omega$ .

59. Adjust the full-scale measurement by sending the following SCPI command:

```
CAL:PROT:DC:STEP 2,<ACTUAL CALIBRATOR OUTPUT>
```

60. Wait until the following message is displayed on the 2100:

```
Cali OK
```

61. Set the 5700A output mode to **STANDBY**.

## Resistance high-range adjustment (10 M $\Omega$ - 100 M $\Omega$ )

### *To adjust the high-range resistance:*

1. Set the 5700A to 0  $\Omega$ , 2 WIRE COMP OFF, EX SNS button on, EX GRD button off, and output to **STANDBY** mode.
2. Using shielded, low-thermal EMF cables, connect the Fluke 5700A output HI, output LO, sense HI, and sense LO to the 2100 input HI, input LO, sense HI, and sense LO terminals. Allow connections to stabilize for a minimum of five minutes before proceeding.
3. Set the 2100 to the four-wire, 10 M $\Omega$  resistance function by sending the following SCPI command:

```
CONF:FRES 10E6
```

4. Set the measurement rate to 10 PLC by sending the following SCPI command:

```
FRES:NPLC 10
```

5. Set the average function to 100 counts by sending the following SCPI command:

```
AVERAGE:COUNT 100
```

6. Set the 5700A output mode to **OPERATE**.

7. Adjust the input offset by sending the following SCPI command:

```
CAL:PROT:DC:STEP 1,10E6
```

8. Wait until the following message is displayed on the 2100:

```
Cali OK
```

9. Set the 5700A output to 10 M $\Omega$ .

10. Adjust the full-scale measurement by sending the following SCPI command:

```
CAL:PROT:DC:STEP 2,<ACTUAL CALIBRATOR OUTPUT>
```

11. Wait until the following message is displayed on the 2100:

```
Cali OK
```

12. Set the 5700A output mode to **STANDBY**.

13. Set the 5700A to 0  $\Omega$ , 2 WIRE COMP OFF, EX SNS button off, EX GRD button off, and output to **STANDBY** mode.
14. Using shielded, low-thermal EMF cables connect the Fluke 5700A output HI and output LO to the 2100 input HI and input LO terminals. Allow connections to stabilize for a minimum of five minutes before proceeding.
15. Set the 2100 to the two-wire, 10 M $\Omega$  resistance function by sending the following SCPI command:  

```
CONF:RES 10E6
```
16. Set the measurement rate to 10 PLC by sending the following SCPI command:  

```
RES:NPLC 10
```
17. Set the average function to 100 counts by sending the following SCPI command:  

```
AVERAGE:COUNT 100
```
18. Set the 5700A output mode to **OPERATE**.
19. Adjust the input offset by sending the following SCPI command:  

```
CAL:PROT:DC:STEP 1,10E6
```
20. Wait until the following message is displayed on the 2100:  

```
Cali OK
```
21. Set the 5700A output to 10 M $\Omega$ .
22. Adjust the full-scale measurement by sending the following SCPI command:  

```
CAL:PROT:DC:STEP 2,<ACTUAL CALIBRATOR OUTPUT>
```
23. Wait until the following message is displayed on the 2100:  

```
Cali OK
```
24. Set the 5700A output mode to **STANDBY**.
25. Set the 2100 to the two-wire, 100 M $\Omega$  resistance function by sending the following SCPI command:  

```
CONF:RES 100E6
```
26. Set the measurement rate to 10 PLC by sending the following SCPI command:  

```
RES:NPLC 10
```
27. Set the average function to 25 counts by sending the following SCPI command:  

```
AVERAGE:COUNT 25
```
28. Set the 5700A to 0 $\Omega$  and output mode to **OPERATE**.
29. Adjust the input offset by sending the following SCPI command:  

```
CAL:PROT:DC:STEP 1,100E6
```
30. Wait until the following message is displayed on the 2100:  

```
Cali OK
```
31. Set the 5700A to 100 M $\Omega$  and output to **STANDBY**.
32. Adjust the full-scale measurement by sending the following SCPI command:  

```
CAL:PROT:DC:STEP 2,100E6
```
33. Wait until the following message is displayed on the 2100:  

```
Cali OK
```

---

## Current function adjustment (DC and AC)

### In this section:

Current function adjustment (DC and AC)..... 6-1

## Current function adjustment (DC and AC)

There are two current function adjustments available:

- DC current range adjustment
- AC current range adjustment

### DC current range adjustment

#### *To adjust the DC current range:*

1. Set the 5700A to 0 A, CURRNT OUTPUT: 5725, RANGE: AUTO, and output to **STANDBY** mode.
2. Using shielded, low-thermal EMF cables, connect the Fluke 5725A current output HI and output LO to the 2100 input AMPS and input LO terminals. Allow connections to stabilize for a minimum of five minutes before proceeding.
3. Configure 2100 to 0.01 A dc current range by sending the following SCPI command:

```
CONF:CURR:DC 0.01
```

4. Set the measurement rate to 10 PLC by sending the following SCPI command:

```
CURR:NPLC 10
```

5. Set the 5700A output mode to **OPERATE**.
6. Adjust the front input offset by sending the following SCPI command:

```
CAL:PROT:DC:STEP 1,0.01
```

7. Wait until the following message is displayed on the 2100 display:

```
Cali OK
```

8. Set the 5700A output to 0.01 A dc.
9. Adjust the full-scale measurement by sending the following SCPI command:

```
CAL:PROT:DC:STEP 2,0.01
```

10. Wait until the following message is displayed on the 2100 display:

```
Cali OK
```

11. Set the 5700A output mode to **STANDBY**.

12. Set the 2100 to the 0.1 A dc current range by sending the following SCPI command:

```
CONF:CURR:DC 0.1
```

13. Set the measurement rate to 10 PLC by sending the following SCPI command:

```
CURR:NPLC 10
```

14. Set the 5700A to 0 A and output mode to **OPERATE**.

15. Adjust the front input offset by sending the following SCPI command:

```
CAL:PROT:DC:STEP 1,0.1
```

16. Wait until the following message is displayed on the 2100:

```
Cali OK
```

17. Set the 5700A output to 0.06 A dc.

18. Adjust the mid-region of the range by sending the following SCPI command:

```
CAL:PROT:DC:STEP 2,0.06
```

19. Wait until the following message is displayed on the 2100:

```
Cali OK
```

20. Set the 5700A output to 0.12 A dc.

21. Adjust the full-scale measurement by sending the following SCPI command:

```
CAL:PROT:DC:STEP 2,0.12
```

22. Wait until the following message is displayed on the 2100:

```
Cali OK
```

23. Set the 5700A output mode to **STANDBY**.

24. Set the 2100 to the 1 A dc current range by sending the following SCPI command:

```
CONF:CURR:DC 1
```

25. Set the measurement rate to 10 PLC by sending the following SCPI command:

```
CURR:NPLC 10
```

26. Set the 5700A to 0 A and output mode to **OPERATE**.

27. Adjust the front input offset by sending the following SCPI command:

```
CAL:PROT:DC:STEP 1,1
```

28. Wait until the following message is displayed on the 2100:

```
Cali OK
```

29. Set the 5700A output to 1 A dc.

30. Adjust the full-scale measurement by sending the following SCPI command:

```
CAL:PROT:DC:STEP 2,1
```

31. Wait until the following message is displayed on the 2100:

```
Cali OK
```

32. Set the 5700A output mode to **STANDBY**. Press the **RESET** button on 5700A front panel to reset the calibrator to its default settings.



## AC current range adjustment

### *To adjust the AC current range:*

1. Set the 5700A to 0.1 A at 1 kHz, CURRNT OUTPUT: 5725, and output to **STANDBY** mode.
2. Using coaxial cable with dual banana terminals connect the Fluke 5725A current output HI and LO to the 2100 input AMPS and LO terminals. Allow connections to stabilize for a minimum of five minutes before proceeding.
3. Set the 2100 to the 1 A ac current range by sending the following SCPI command:

```
CONF:CURR:AC 1
```

4. Set the 5700A output mode to **OPERATE**.
5. Adjust 10% of the range by sending the following SCPI command:

```
CAL:PROT:AC:STEP 1,0.1
```

6. Wait until the following message is displayed on the 2100:

```
Cali OK
```

7. Set the 5700A output to 1 A at 1 kHz.
8. Adjust the full-scale range by sending the following SCPI command:

```
CAL:PROT:AC:STEP 2,1
```

9. Wait until the following message is displayed on the 2100:

```
Cali OK
```

10. Set the 5700A output to 0.01 A at 1 kHz.
11. Adjust 1% of the range by sending the following SCPI command:

```
CAL:PROT:AC:STEP 3,0.01
```

12. Wait until the following message is displayed on the 2100:

```
Cali OK
```

13. Set the 5700A output mode to **STANDBY**.
14. Set the 2100 to the 3 A ac current range by sending the following SCPI command:

```
CONF:CURR:AC 3
```

15. Set the 5700A to 0.2 A at 1 kHz and output mode to **OPERATE**.
16. Adjust the lower region of the range by sending the following SCPI command:

```
CAL:PROT:AC:STEP 1,0.2
```

17. Wait until the following message is displayed on the 2100:

```
Cali OK
```

18. Set the 5700A output to 2 A at 1 kHz.
19. Adjust the upper region of the range by sending the following SCPI command:

```
CAL:PROT:AC:STEP 2,2
```

20. Wait until the following message is displayed on the 2100:

```
Cali OK
```

21. Set the 5700A output mode to **STANDBY**. Press the **RESET** button on the 5700A front panel to reset the calibrator to its default settings.

---

## Calibration date

### In this section:

Calibration date ..... 7-1

## Calibration date

### *To adjust the calibration date:*

1. Update the calibration date by sending the following SCPI command:

```
CAL:PROT:DATE <MM/DD/YYYY>
```

---

### NOTE

The date string must be enclosed in double quotes ("`<string>`"). For example, if the calibration date is 5 Jan 2020, send the following SCPI command: `CAL:PROT:DATE "05/01/2020"`

2. Save the calibration constants in EEPROM by sending the following SCPI command:

```
CAL:PROT:SAVE
```

3. Lock the calibration function by sending the following SCPI command:

```
CAL:PROT:LOCK
```

The calibration due date is automatically calculated for 12 months.

## Performance verification

### In this section:

Performance verification ..... 8-1

## Performance verification

### NOTE

After the adjustment is completed, the 2100 must be verified to make sure that its performance is within manufacturer's specifications. Also, specifications are valid after a 2-hour warm up.

Perform accuracy verifications using Fluke 5700A and 5725A standards and a function generator capable of sourcing frequency with an accuracy of 25 ppm or better. Refer to the following tables for limits of accuracy on specified ranges.

#### DC voltage accuracy verification

Range	Test point	Limits of accuracy	
		Lower limit	Upper limit
100 mV	100.0000 mV	99.9905 mV	100.0095 mV
	-100.0000 mV	-100.0095 mV	-99.9905 mV
1 V	1.000000 V	0.999947 V	1.000053 V
	-1.000000 V	-1.000053 V	-0.999947 V
10 V	10.00000 V	9.99956 V	10.00044 V
	-10.00000 V	-10.00044 V	-9.99956 V
100 V	100.0000 V	99.9943 V	100.0057 V
	-100.0000 V	-100.0057 V	-99.9943 V
1000 V	1000.000 V	999.935 V	1000.065 V
	-1000.000 V	-1000.065 V	-999.935 V

Specifications valid after 2-hour warm up:

- A dc set for continuous trigger operation.
- Input bias current: <30 pA at 25 °C.
- Input protection: 1000 V all ranges (two-wire input).
- Measurement rate set to 1 PLC.

**AC voltage accuracy verification**

Range	Test point	Limits of accuracy	
		Lower limit	Upper limit
100 mV	100.0000 mV @ 1 kHz	99.87 mV	100.13 mV
	100.0000 mV @ 35 kHz	99.79 mV	100.21 mV
1 V	1.000000 V @ 1 kHz	0.9988 V	1.0012 V
	1.000000 V @ 35 kHz	0.998 V	1.002 V
10 V	10.00000 V @ 1 kHz	9.988 V	10.012 V
	10.00000 V @ 35 kHz	9.98 V	10.02 V
100 V	100.0000 V @ 1 kHz	99.88 V	100.12 V
	100.0000 V @ 35 kHz	99.8 V	100.2 V
750 V	700.0000 V @ 1 kHz	699.14 V	700.86 V
	700.000 V @ 35 kHz	698.57 V	701.43 V
	*220.000 V @ 35 kHz	219.24 V	220.76 V

\*NOTE: Verify this point instead of 700 V if a Fluke 5725A is not available.

Specifications valid after 2-hour warm up:

- a. Slow ac filter (3 Hz bandwidth).
- b. Pure sine wave input greater than 5% of range.

**Resistance accuracy verification**

Range	Test point	Limits of accuracy	
		Lower limit	Upper limit
100 Ω	100.0000 Ω	99.9980 Ω	100.0200 Ω
1 kΩ	1.000000 kΩ	0.999830 kΩ	1.000170 kΩ
10 kΩ	10.00000 kΩ	9.99850 kΩ	10.00150 kΩ
100 kΩ	100.0000 kΩ	99.9830 kΩ	100.0170 kΩ
1 MΩ	1.000000 MΩ	0.999810 MΩ	1.000190 MΩ
10 MΩ	10.00000 MΩ	9.99530 MΩ	10.00470 MΩ
100 MΩ	100.0000 MΩ	98.9800 MΩ	101.0200 MΩ

a. Specifications for four-wire Ω mode (for two-wire Ω, use zero null or subtract lead resistance from displayed reading).

b. Maximum lead resistance is 10% of range per lead for 100 Ω and 1 kΩ ranges; add 1 kΩ per lead for all other ranges.

**DC current accuracy verification**

Range	Test point	Limits of accuracy	
		Lower limit	Upper limit
10 mA	10.00000 mA	9.992 mA	10.008 mA
	-10.00000 mA	-10.008 mA	-9.992 mA
100 mA	100.0000 mA	99.939 mA	100.061 mA
	-100.0000 mA	-100.061 mA	-99.939 mA
1 A	1.000000 A	0.99865 A	1.00135 A
	-1.000000 A	-1.00135 A	-0.99865 A
*2.1 A	2.10000 A	2.0961 A	2.1039 A
	-2.10000 A	-2.1039 A	-2.0961 A
3 A	3.00000 A	2.99475 A	3.00525 A
	-3.00000 A	-3.00525 A	-2.99475 A

\*NOTE: Verify this point instead of 3 A range if a Fluke 5725A is not available.

Specifications valid after 2-hour warm up:

- a. A dc set for continuous trigger operation.
- b. Input bias current: <30 pA at 25 °C.
- c. Input protection: 1000 V all ranges (two-wire input).
- d. Measurement rate set to 1 PLC.

**AC current accuracy verification**

Range	Test point	Limits of accuracy	
		Lower limit	Upper limit
1 A	1.000000 A @ 1 kHz	0.998 A	1.002 A
*2.1 A	2.10000 A @ 1 kHz	2.0937 A	2.1063 A
3 A	3.00000 A @ 1 kHz	2.9919 A	3.0081 A

\*NOTE: Verify this point instead of 3 A range if a Fluke 5725A is not available.

Specifications valid after 2-hour warm up:

- a. Slow ac filter (3 Hz bandwidth).
- b. Pure sine wave input greater than 5% of range.

**Frequency accuracy verification**

Range	Test point	Limits of accuracy	
		Lower limit	Upper limit
3 Hz	3.000000 Hz @ 1 Vpp	2.997 Hz	3.003 Hz
300 kHz	300.0000 kHz @ 1 Vpp	299.97 kHz	300.03 kHz

Specifications valid after 2-hour warm up:

- a. Slow ac filter (3 Hz bandwidth).
- b. Pure sine wave input greater than 5% of range.

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