Model 2100 6 1/2-Digit Resolution Digital Multimeter

Calibration Manual

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WARRANTY

Keithley Instruments, Inc. warrants this product to be free from defects in material and workmanship for a period of one (1) year from date of shipment.

Keithley Instruments, Inc. warrants the following items for 90 days from the date of shipment: probes, cables, software, rechargeable batteries, diskettes, and documentation.

During the warranty period, Keithley Instruments will, at its option, either repair or replace any product that proves to be defective.

To exercise this warranty, write or call your local Keithley Instruments representative, or contact Keithley Instruments headquarters in Cleveland, Ohio. You will be given prompt assistance and return instructions. Send the product, transportation prepaid, to the indicated service facility. Repairs will be made and the product returned, transportation prepaid. Repaired or replaced products are warranted for the balance of the original warranty period, or at least 90 days.

LIMITATION OF WARRANTY

This warranty does not apply to defects resulting from product modification without Keithley Instruments' express written consent, or misuse of any product or part. This warranty also does not apply to fuses, software, non-rechargeable batteries, damage from battery leakage, or problems arising from normal wear or failure to follow instructions.

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NEITHER KEITHLEY INSTRUMENTS, INC. NOR ANY OF ITS EMPLOYEES SHALL BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES ARISING OUT OF THE USE OF ITS INSTRUMENTS AND SOFTWARE, EVEN IF KEITHLEY INSTRUMENTS, INC. HAS BEEN ADVISED IN ADVANCE OF THE POSSIBILITY OF SUCH DAMAGES. SUCH EXCLUDED DAMAGES SHALL INCLUDE, BUT ARE NOT LIMITED TO: COST OF REMOVAL AND INSTALLATION, LOSSES SUSTAINED AS THE RESULT OF INJURY TO ANY PERSON, OR DAMAGE TO PROPERTY.

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Safety Precautions

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 non-hazardous voltages, there are situations where hazardous conditions may be present.

This product is intended for use by qualified 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 Instruments products are designed for use with electrical signals that are rated Measurement Category I and Measurement Category II, as described in the International Electrotechnical Commission (IEC) Standard IEC 60664. Most measurement, control, and data I/O signals are Measurement Category I and must not be directly connected to mains voltage or to voltage sources with high transient over-voltages. Measurement Category II connections require protection for high transient over-voltages often associated with local AC mains connections. Assume all measurement, control, and data I/O connections are for connection to Category I sources unless otherwise marked or described in the user documentation.

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 30V RMS, 42.4V peak, or 60VDC 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 1000V, 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.

The instrument and accessories must be used in accordance with its specifications and operating instructions, or the safety of the equipment may be impaired.

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

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 safety earth 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 safety earth ground using the wire recommended in the user documentation.

The  symbol on an instrument indicates that the user should refer to the operating instructions located in the user documentation.

The  symbol on an instrument shows that it can source or measure 1000V or more, including the combined effect of normal and common mode voltages. 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 dangers 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.

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 Instruments. Standard fuses with applicable national safety approvals may be used if the rating and type are the same. 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 Instruments to maintain accuracy and functionality of the product). If you are unsure about the applicability of a replacement component, call a Keithley Instruments office for information.

To clean an instrument, use a damp cloth 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.

Table of Contents

Introduction

This section introduces the calibration procedure for the Keithley Instruments Model 2100 6½ -Digit Resolution Digital Multimeter. This procedure should be used whenever adjustment for the following functions is necessary: AC/DC voltage, AC/DC current, and resistance. This adjustment procedure is performed by remotely sending SCPI commands over the USB interface using 2100 KI-TOOL software.

Control Software

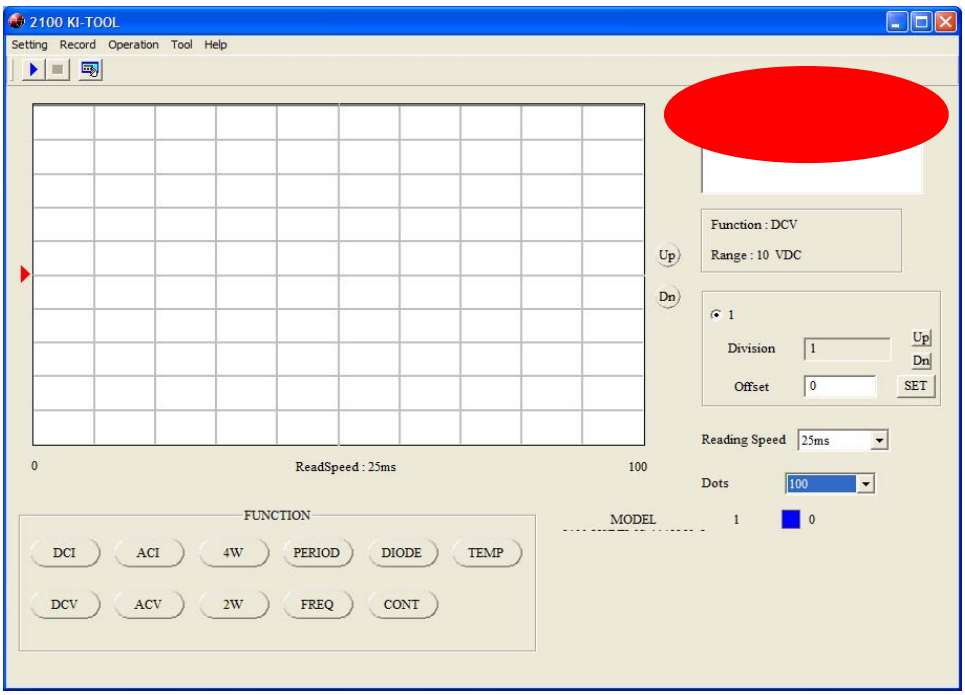
Note	You must have one of the following items installed on the remote interface in order to obtain the proper VISA layer:

- 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).

1. Install the USB device driver and KI-Tool Software from Keithley Instruments Model 2100 Product Information CD.
2. Connect the Model 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 Figure 1 for details.

Test the communications link between the Keithley Instruments Model 2100 and the control software by clicking several function buttons and verifying that the DMM responds accordingly. See Figure 1 for more details.

Figure 1
2100 KI-TOOL application



The adjustment procedure consists of connecting Fluke 5700A Calibrator and Fluke 5725A Amplifier (or equivalent) outputs to the Model 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 Model 2100. These commands should be entered into the **Send String** field followed by the **Write** button. To access command control window from 2100 KI-TOOL application, click on **Tool** > **Command Control**.

Note	Be sure that the correct model number is selected before sending any SCPI commands. Figure 2 shows the drop-down selection menu for the active units connected to the PC.

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 that the equipment is properly warmed up and connected to the appropriate input jacks. Also make sure that the correct input jacks are selected with the **INPUTS** switch.
- Make sure the calibrator is in **OPERATE** 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 an appropriate error message. Please refer to Model 2100 User's Manual for error code descriptions.
- 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, perform Section 3 (Performance Verification) to verify that the Model 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 Model 2100 multimeter adjustments.

Firmware revision

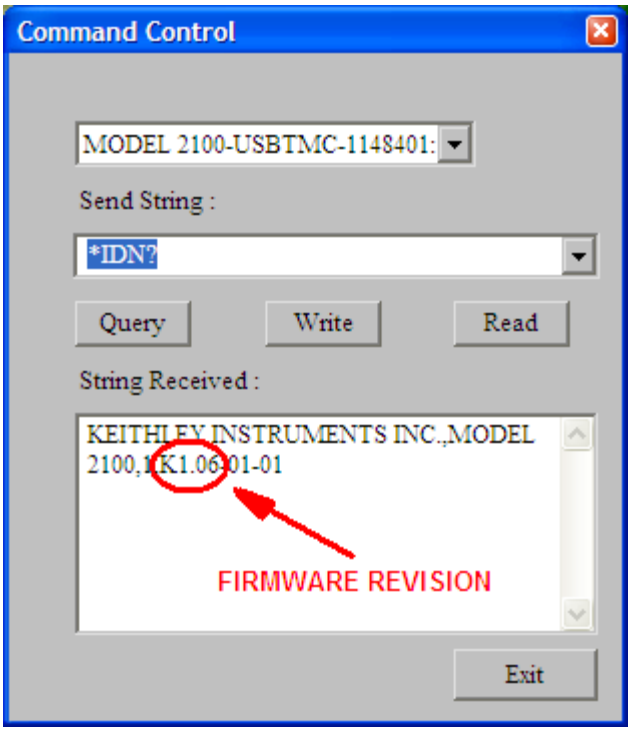
If your Model 2100 has firmware versions 1.03 or 1.04, the firmware must be updated to the latest version before this procedure can be performed. You may identify the firmware version as follows:

1. Press the **QUERY** button and enter the following SCPI command:

   `*IDN?`

2. Figure 2 shows the typical location of the firmware version number. If the firmware requires updating, refer to www.keithley.com for detailed instructions.

Figure 2
Command Control Window



Calibration code

Unlock the calibration routine by entering the following calibration code procedure:

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

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

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/rear)

Front panel zero calibration

1. Connect low thermal, 4-wire short (Keithley Instruments Model 8610 or equivalent) to the instrument front panel input terminals.

2. Set **INPUTS** select switch to front terminals. Allow connections to stabilize for a minimum of five minutes before proceeding.

Note	Be 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 Model 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 Model 2100 display:

```
Cali OK
```

Rear panel zero calibration

1. Connect low thermal, 4-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.

3. Initiate the Model 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 Model 2100 display:

```
Cali OK
```

5. Remove the low thermal, 4-wire short from the rear terminals.
6. Set the **INPUTS** select switch to front terminals.

Voltage function adjustment (DC and AC)

The ranges for DC voltage (DCV) adjustment are 100mV, 1V, 10V, 100V, and 1000V. For AC voltage (ACV) adjustment, the ranges are 100mV, 1V, 10V, 100V, and 750V RMS at 1kHz.

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

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

1. Set the 5700A to 0V DC, **RANGE: AUTO** and output to **STANDBY** mode.
2. Using shielded, low thermal EMF cables connect the Fluke 5700A output HI and LO to Model 2100 input HI and LO terminals. Allow connections to stabilize for a minimum of five minutes before proceeding.
3. Configure the Model 2100 to 10V 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 Model 2100 display:

```
Cali OK
```

7. Set the 5700A output to 10V 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 Model 2100 display:

```
Cali OK
```

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

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

12. Set the 5700A 0V 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 shown on the Model 2100 display:

```
Cali OK
```

15. Set the 5700A output to 1V 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 shown on the Model 2100 display:

```
Cali OK
```

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

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

20. Set the 5700A to 0V 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 shown on the Model 2100 display:

```
Cali OK
```

23. Set the 5700A output to 0.1V 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 shown on the Model 2100 display:

```
Cali OK
```

26. Set the 5700A output mode to **STANDBY**.
27. Configure the Model 2100 to 100V range by sending the following SCPI command:

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

28. Set 5700A to 0V DC and output to **OPERATE** mode.
29. Adjust input offset by sending the following SCPI command:

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

Wait until the following message is displayed on the Model 2100 display:

```
Cali OK
```

30. Set the 5700A output to 100V DC.
31. Adjust the full scale measurement by sending the following SCPI command:

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

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

```
Cali OK
```

33. Set the 5700A output mode to **STANDBY**.
34. Configure the Model 2100 to 1000V range by sending the following SCPI command:

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

35. Set the 5700A to 0V DC and output to **OPERATE** mode.
36. Adjust the input offset by sending the following SCPI command:

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

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

```
Cali OK
```

38. Set the 5700A output to 1000V DC.
39. Adjust the full scale measurement by sending the following SCPI command:

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

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

Cali OK

41. Set the 5700A to 0V DC and output mode to **STANDBY**.

AC voltage range adjustment

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

Cali OK

7. Set the 5700A output to 0.1V.
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 Model 2100 display:

Cali OK

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

CONF:VOLT:AC 1

12. Set the 5700A to 0.1V 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 Model 2100 display:

Cali OK

15. Set the 5700A output to 1V.
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 Model 2100 display:

Cali OK

18. Set the5700A output mode to **STANDBY**.
19. Configure the Model 2100 to 10V range by sending the following SCPI command:

CONF:VOLT:AC 10

20. Set the 5700A to 1V 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 Model 2100 display:

Cali OK

23. Set the 5700A output to 10V.
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 Model 2100 display:

Cali OK

26. Set the 5700A output mode to **STANDBY**.
27. Configure the Model 2100 to 100V range by sending the following SCPI command:

CONF:VOLT:AC 100

28. Set the 5700A to 10V 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 Model 2100 display:

Cali OK

31. Set the 5700A output to 100V.
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 Model 2100 display:

Cali OK

34. Set the 5700A output mode to **STANDBY**.
35. Configure the Model 2100 to 750V range by sending the following SCPI command:

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

36. Set the 5700A to 75V 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 Model 2100 display:

```
Cali OK
```

39. Set the 5700A output to 750V.
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 Model 2100 display:

```
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

Resistance low range adjustment (100Ω - 1MΩ)

1. Set the 5700A to 0Ω, 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 Model 2100 input HI and LO terminals. Allow connections to stabilize for a minimum of five minutes before proceeding.
3. Configure the Model 2100 for 2-wire, 1MΩ 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 Model 2100 display:

```
Cali OK
```

9. Set the 5700A output to 1MΩ.
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 MΩ, enter this value as:

```
CAL:PROT:DC:STEP 2,0.9999615E6
```

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

```
Cali OK
```

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

13. Set the 5700A to 0Ω, 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 Model 2100 input HI, input LO, sense HI, and sense LO terminals. Allow connections to stabilize for a minimum of five minutes before proceeding.
15. Configure the Model 2100 for 4-wire, 1MΩ 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 Model 2100 display:

```
Cali OK
```

21. Set the 5700A output to 1MΩ.
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 Model 2100 display:

```
Cali OK
```

24. Set the 5700A output mode to **STANDBY**.
25. Configure the Model 2100 for 4-wire, 100kΩ 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 0Ω 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 Model 2100 display:

```
Cali OK
```

31. Set the 5700A output to 100kΩ.
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 Model 2100 display:

```
Cali OK
```

34. Set the 5700A output mode to **STANDBY**.
35. Configure the Model 2100 for 4-wire, 10kΩ 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 0Ω 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 Model 2100 display:

```
Cali OK
```

40. Set the 5700A output to 10kΩ.
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 Model 2100 display:

```
Cali OK
```

43. Set the 5700A output mode to STANDBY.
44. Configure the Model 2100 for 4-wire, 1kΩ 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 0Ω 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 Model 2100 display:

Cali OK

49. Set the 5700A output to 1kΩ.
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 Model 2100 display:

Cali OK

52. Set the 5700A output mode to **STANDBY**.
53. Configure the Model 2100 for 4-wire, 100Ω 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 0Ω 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 Model 2100 display:

Cali OK

58. Set the 5700A output to 100Ω.
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 Model 2100 display:

```
Cali OK
```

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

Resistance high range adjustment (10MΩ - 100MΩ)

1. Set the 5700A to 0Ω, 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 Model 2100 input HI, input LO, sense HI, and sense LO terminals. Allow connections to stabilize for a minimum of five minutes before proceeding.
3. Configure the Model 2100 for 4-wire, 10MΩ 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 Model 2100 display:

```
Cali OK
```

9. Set the 5700A output to 10MΩ.
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 Model 2100 display:

```
Cali OK
```

12. Set the 5700A output mode to **STANDBY**.
13. Set the 5700A to 0Ω, 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 Model 2100 input HI and input LO terminals. Allow connections to stabilize for a minimum of five minutes before proceeding.
15. Configure the Model 2100 for 2-wire, 10MΩ 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 theModel 2100 display:

Cali OK

21. Set the 5700A output to 10MΩ.
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 Model 2100 display:

Cali OK

24. Set the 5700A output mode to **STANDBY**.
25. Configure the Model 2100 for 2-wire, 100MΩ 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 0Ω 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 Model 2100 display:

Cali OK

31. Set the 5700A to 100MΩ and output to **STANDBY**.
32. Adjust the full scale measurement by sending the following SCPI command:

```
CAL:PROT:DC:STEP 2,99.99750
```

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

```
Cali OK
```

Current function adjustment (DC and AC)

DC current range adjustment

1. Set the 5700A to 0A, 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 Model 2100 input AMPS and input LO terminals. Allow connections to stabilize for a minimum of five minutes before proceeding.
3. Configure Model 2100 to 0.01A 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 Model 2100 display:

```
Cali OK
```

8. Set the 5700A output to 0.01A 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 Model 2100 display:

```
Cali OK
```

11. Set the 5700A output mode to **STANDBY**.
12. Configure the Model 2100 to 0.1A 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 0A 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 Model 2100 display:

```
Cali OK
```

17. Set the 5700A output to 0.06A 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 Model 2100 display:

```
Cali OK
```

20. Set the 5700A output to 0.12A 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 Model 2100 display:

```
Cali OK
```

23. Set the 5700A output mode to **STANDBY**.
24. Configure the Model 2100 to 1A 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 0A 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 Model 2100 display:

```
Cali OK
```

29. Set the 5700A output to 1A 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 Model 2100 display:

```
Cali OK
```

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

AC current range adjustment

1. Set the 5700A to 0.1A at 1kHz, 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 Model 2100 input AMPS and LO terminals. Allow connections to stabilize for a minimum of five minutes before proceeding.
3. Configure the Model 2100 to 1A 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 Model 2100 display:

```
Cali OK
```

7. Set the 5700A output to 1A at 1kHZ.
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 Model 2100 display:

```
Cali OK
```

10. Set the 5700A output to 0.01A at 1kHZ.
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 Model 2100 display:

```
Cali OK
```

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

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

15. Set the 5700A to 0.2A at 1kHz 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 Model 2100 display:

```
Cali OK
```

18. Set the 5700A output to 2A at 1kHZ.
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 Model 2100 display:

```
Cali OK
```

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

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>"). Example: if calibration date is 1 Jan 2008, send the following SCPI command:

CAL:PROT:DATE "01/01/2008"

Calibration due date is automatically calculated for 12 months.

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

Performance verification

Note: After adjustment is completed, the Model 2100 must be verified to ensure that its performance is within manufacturer's specifications.

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 Tables 1 through 6 for limits of accuracy on specified ranges.

Table 1
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. ADC set for continuous trigger operation.
b. Input bias current: <30pA at 25 °C.
c. Input protection: 1000V all ranges (2-W input).
d. Measurement rate set to 1 PLC.

Table 2
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 for 2-hour warm-up at 6½ digits:
a. Slow ac filter (3Hz bandwidth).
b. Pure sine wave input greater than 5% of range.

Table 3
Resistance accuracy verification

Range	Test Point	Limits of Accuracy	
		Lower Limit	Upper Limit
100 Ω	100.0000 Ω	99.9755 Ω	100.0155 Ω
1 kΩ	1.000000 kΩ	0.999837 kΩ	1.000177 kΩ
10 kΩ	10.00000 kΩ	9.99863 kΩ	10.00163 kΩ
100 kΩ	100.0000 kΩ	99.9831 kΩ	100.0171 kΩ
1 MΩ	1.000000 MΩ	0.999784 MΩ	1.000164 MΩ
10 MΩ	10.00000 MΩ	9.99475 MΩ	10.00415 MΩ
100 MΩ	100.0000 MΩ	98.9817 MΩ	101.0218 MΩ

a. Specifications for 4-W Ohms mode (for 2-W Ohms, use zero null or subtract lead resistance from displayed reading).
b. Max lead resistance is 10% of range per lead for 100 Ω and 1 kΩ ranges; add 1 kΩ per lead for all other ranges.

Table 4
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	2.1039
	-2.10000 A	-2.1039	-2.0961
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. ADC set for continuous trigger operation.
b. Input bias current: <30pA at 25 °C.
c. Input protection: 1000V all ranges (2-W input).
d. Measurement rate set to 1 PLC.

Table 5
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 Fluke 5725A is not available.

Specifications valid for 2-hour warm-up at 6½ digits:
a. Slow ac filter (3Hz bandwidth).
b. Pure sine wave input greater than 5% of range.

Table 6
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 for 2-hour warm-up at 6½ digits:
a. Slow ac filter (3Hz bandwidth).
b. Pure sine wave input greater than 5% of range.

KEITHLEY

Service Form

Model No. _____ **Serial No.** _____ **Date** _____

Name and Telephone No. _____

Company _____

List all control settings, describe problem and check boxes that apply to problem. _____

_____

_____

❑ Intermittent
❑ Analog output follows display
❑ Particular range or function bad; specify _____
❑ IEEE failure
❑ Obvious problem on power-up
❑ Batteries and fuses are OK
❑ Front panel operational
❑ All ranges or functions are bad
❑ Checked all cables

Display or output (check one)

❑ Drifts
❑ Unable to zero
❑ Unstable
❑ Will not read applied input
❑ Overload

❑ Calibration only
❑ Certificate of calibration required
❑ Data required

(attach any additional sheets as necessary)

Show a block diagram of your measurement system including all instruments connected (whether power is turned on or not). Also, describe signal source.

Where is the measurement being performed? (factory, controlled laboratory, out-of-doors, etc.)

_____

_____

What power line voltage is used? _____ Ambient temperature?°F _____

Relative humidity? _____ Other? _____

Any additional information. (If special modifications have been made by the user, please describe.)

_____

_____

Be sure to include your name and phone number on this service form.

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