CALIBRATION PROCEDURE

NI 4070/4072 6½-Digit FlexDMM™

This document contains step-by-step instructions for writing an external calibration procedure for the National Instruments PXI/PCI-4070 and NI PXI-4072 digital multimeters (DMMs). Each of these National Instruments DMMs is a 6½-digit FlexDMM and 1.8 MS/s isolated digitizer. For more information on calibration, visit `ni.com/calibration`.

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Conventions

The following conventions are used in this document:

» The » symbol leads you through nested menu items and dialog box options to a final action. The sequence **File»Page Setup»Options** directs you to pull down the **File** menu, select the **Page Setup** item, and select **Options** from the last dialog box.

♦ The ♦ symbol indicates that the following text applies only to a specific product, a specific operating system, or a specific software version.

This icon denotes a note, which alerts you to important information.

This icon denotes a caution, which advises you of precautions to take to avoid injury, data loss, or a system crash. When this symbol is marked on a product, refer to the *Read Me First: Safety and Radio-Frequency Interference* document included with the device for information about precautions to take.

bold Bold text denotes items that you must select or click in the software, such as menu items and dialog box options. Bold text also denotes parameter names.

italic Italic text denotes variables, emphasis, a cross-reference, hardware labels, or an introduction to a key concept. Italic text also denotes text that is a placeholder for a word or value that you must supply.

`monospace` Text in this font denotes text or characters that you should enter from the keyboard, sections of code, programming examples, and syntax examples. This font is also used for the proper names of disk drives, paths, directories, programs, subprograms, subroutines, device names, functions, operations, variables, filenames, and extensions.

Software Requirements

NI-DMM supports a number of programming languages including LabVIEW, LabWindows™/CVI™, Microsoft Visual C++, and Microsoft Visual Basic. When you install NI-DMM, you need to install support for only the language you intend to use to write your calibration utility.

Note NI-DMM version 2.1 or later supports NI PXI-4070 calibration, NI-DMM version 2.2 or later supports NI PCI-4070 calibration, and NI-DMM version 2.3 or later supports NI 4072 calibration.

The procedures in this document are described using C function calls. You also can program in LabVIEW using the VIs that correspond to the C function calls.

Documentation Requirements

In addition to this calibration document, you may find the following references helpful in writing your calibration utility. All of these documents are installed on your computer when you install NI-DMM. To locate them, select **Start»All Programs»National Instruments» NI-DMM»Documentation**.

- *NI Digital Multimeters Help*
- *NI Digital Multimeters Getting Started Guide*

NI recommends referring to the following document online at `ni.com/manuals` to ensure that you are using the latest NI 4070/4072 specifications:

- *NI 4070/4072 Specifications*

You may need the following documents, which are available at `ni.com/manuals`, to perform the optional frequency verification procedure:

- *TB-2715 Terminal Block Installation Guide*
- *About Your NI 6608 Device*

Calibration Function Reference

For detailed information about the NI-DMM calibration functions used in this procedure, refer to the *LabVIEW Reference* or the *C/CVI/VB Reference* sections of the *NI Digital Multimeters Help*, located at **Start» All Programs»National Instruments»NI-DMM»Documentation**.

Password

The default calibration password in NI-DMM is `"NI"`.

Calibration Interval

The accuracy requirements of your measurement application determine how often you should calibrate the NI 4070/4072. NI recommends performing a complete calibration at least once every two years. NI does not guarantee the absolute accuracy of the NI 4070/4072 beyond this two-year calibration interval. You can shorten the calibration interval based on the demands of your application. Refer to *Appendix A: Calibration Options* for more information.

Test Equipment

This section describes the required and optional equipment for calibration.

Required Test Equipment

Requirements for All NI 4070/4072 Devices

The following equipment is required for calibrating the NI 4070/4072:

- Fluke 5700A multifunction calibrator calibrated within the last 90 days, or a Fluke 5720A multifunction calibrator calibrated within the last year
- Two sets of Fluke 5440 low thermal electromotive force (EMF) copper cables
- Pomona 5145 insulated double banana plug shorting bar (or another means of creating a short with low thermal EMF (≤150 nV) across the *HI* and *LO* input banana plug connectors on the NI 4070/4072)
- Two Pomona B-4 banana-to-banana patch cords (cables) or similar banana-to-banana cables with length not to exceed 4 in.
- National Instruments PXI chassis and controller, or a personal computer (PC) with an available slot for the NI 4070/4072

Additional Requirements for the NI 4072

The following equipment is required for calibrating the capacitance and inductance modes of the NI 4072:

- 25 Ω, 125 Ω, 5 kΩ, and 100 kΩ resistors with thermal drift ≤5 ppm/°C and tolerance ≤1%. The distance between the resistor leads and the NI 4072 terminals should be ≤1 in.
- Verification capacitors calibrated to at least four times the accuracy of the NI 4072, with temperature coefficients ≤250 ppm/°C. The values of the verification capacitors should cover the complete capacitance range. NI suggests using traceable capacitor standards with values ≥10% of full range for all ranges, except the 300 pF range. For the

300 pF range, a capacitor with values between 90–100% of full scale should be used. NI suggests using the capacitance standards of the SCA Series from IET Labs. This calibration procedure assumes the use of 270 pF, 1 nF, 100 nF, 10 µF, and 1000 µF standards.

- If you are using cables to connect the verification capacitors to the NI 4072 banana plug connectors, NI recommends using Pasternack PE3005 banana-to-banana coaxial cables with length ≤4 inches and total capacitance ≤40 pF. Before performing the verification procedure, you should know the total capacitance up to the end of the banana connectors that plug into the NI 4072.

Optional Test Equipment

The following equipment is optional for calibrating the NI 4070/4072 and is only used for frequency verification:

- NI PXI-6608 timing and digital I/O module
- National Instruments SH68-68-D1 shielded cable
- National Instruments TB-2715 terminal block
- Pomona MDP 4892 double banana plug with strain relief
- Coaxial cable (for example, RG178)

Test Conditions

Follow these guidelines to optimize the connections and the environment during calibration:

- Ensure that the PXI chassis fan speed is set to *HI* (if calibrating the NI PXI-4070/4072) and that the fan filters are clean.
- Use PXI filler panels in all vacant slots to allow proper cooling.
- Plug the PXI chassis or PC and the calibrator into the same power strip to avoid ground loops.
- Power on and warm up both the calibrator and the NI 4070/4072 for at least 60 minutes before beginning this calibration procedure.
- Maintain an ambient temperature of 23 ±1 °C.
- Maintain an ambient relative humidity of less than 60%.
- Allow the calibrator to settle fully before taking any measurements. Consult the Fluke 5700A/5720A user documentation for instructions.
- Allow the thermal EMF enough time to stabilize when you change connections to the calibrator or the NI 4070/4072. The suggested time periods are stated where necessary throughout this document.
- Keep a shorting bar connected between the *V GUARD* and GROUND binding posts of the calibrator at all times.

- Clean any oxidation from the banana plugs on the Fluke 5440 cables before plugging them into the binding posts of the calibrator or the banana plug connectors of the NI 4070/4072. Oxidation tarnishes the copper banana plugs so that they appear dull rather than shiny and leads to greater thermal EMF.
- Keep the blue banana plugs on the Fluke 5440 cables connected to the *V GUARD* binding post of the calibrator at all times.
- Prevent the cables from moving or vibrating by taping or strapping them to a nonvibrating surface. Movement or vibration causes triboelectric effects that can result in measurement errors.

Calibration Procedures

The calibration process includes the following steps:

1. *Initial Setup*—Set up the test equipment.
2. *Verification Procedures*—Verify the existing operation of the device. This step confirms whether the device is operating within its specified range prior to calibration. Figure 4 shows the procedural flow for verification.
3. *Adjustment Procedures*—Submit the device to NI for a factory calibration to adjust the calibration constants. Figure 5 shows the procedural flow for adjustment.
4. Reverification—Repeat the verification procedure to ensure that the device is operating within its specifications after adjustment.

These steps are described in more detail in the following sections.

Note In some cases, the complete calibration procedure may not be required. Refer to *Appendix A: Calibration Options* for more information.

Initial Setup

Note This section is necessary for pre-adjustment verifications only. If you are performing a post-adjustment verification, skip the setup and go directly to the *Verifying DC Voltage* section.

To set up the test equipment, complete the following steps:

1. Remove all connections from the four input banana plug connectors on the NI 4070/4072.
2. Verify that the calibrator has been calibrated within the time limits specified in the *Required Test Equipment* section, and that DC zeros calibration has been performed within the last 30 days. Consult the

Fluke 5700A/5720A user documentation for instructions on calibrating these devices.

Note Ensure that both the calibrator and the NI 4070/4072 (installed in a powered-on PXI chassis or PC) are warmed up for at least 60 minutes before you begin this procedure.

3. Call `niDMM_init` with the resource name of the device to create a session.

Note You use this session in all subsequent function calls throughout the verification procedures.

For more information on using `niDMM_init`, refer to the *NI Digital Multimeters Help*.

4. Call `niDMM_SelfCal`. This step is optional if you have adjusted the NI 4070/4072 within the last 24 hours and the temperature has remained constant to within ±1 °C of the calibration temperature (T_{cal}).

Verification Procedures

You can use the verification procedures described in this section for both pre-adjustment and post-adjustment verification. The steps of each verification procedure must be performed in the order listed; however, you can omit entire sections (for example, the entire *Verifying AC Current* section), if necessary.

The parameters **Range**, **Resolution**, and **Sample Interval** used in function calls throughout this section have floating point values. For example, if **Range** = `1`, the floating point value is `1.0`. The parameters **Trigger Count**, **Sample Count**, **Array Size**, and **ParamValue** have integer values. Refer to the *NI Digital Multimeters Help* for more information about parameter values.

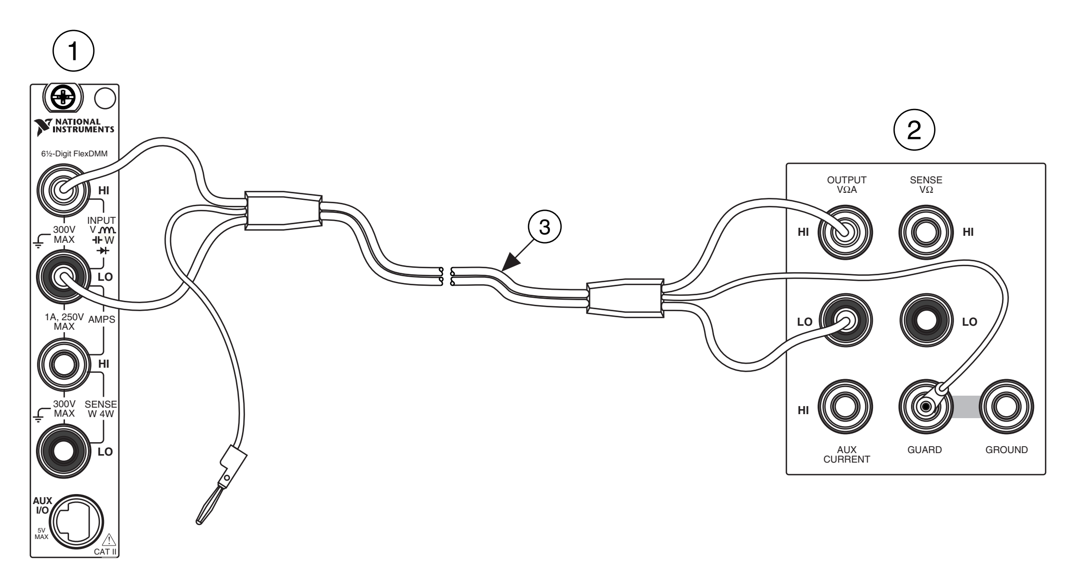
Note Many of the parameter values listed in this document are expressed in scientific notation. Some programming languages do not support the direct entry of numbers in this format. Be sure to properly enter these values with the appropriate number of zeros. For example, enter the scientific notation number 10e–6 as `0.00001` and the number 100e3 as `100000`. If your programming language supports scientific notation, NI recommends that you use this feature to minimize possible data entry errors.

Verifying DC Voltage

To verify DC voltage of the NI 4070/4072, complete the following steps:

1. Plug in the insulated banana plug shorting bar across the *HI* and *LO* banana plug connectors on the NI 4070/4072.
2. Wait one minute for the thermal EMF to stabilize.
3. Call `niDMM_reset`.
4. Call `niDMM_ConfigureMeasurement` with the following parameters:
   - **Function** = `NIDMM_VAL_DC_VOLTS`
   - **Range** = `1`
   - **Resolution** = `1e-6`
5. Set the input resistance of the NI 4070/4072 to >10 GΩ by calling `niDMM_SetAttributeViReal64` with the following parameters:
   - **Attribute_ID** = `NIDMM_ATTR_INPUT_RESISTANCE`
   - **Attribute_Value** = `NIDMM_VAL_GREATER_THAN_10_GIGAOHM`
6. Call `niDMM_Read`. Verify that this measurement falls between the limits listed in Table 15.
7. Set the input resistance of the NI 4070/4072 to 10 MΩ by calling `niDMM_SetAttributeViReal64` with the following parameters:
   - **Attribute_ID** = `NIDMM_ATTR_INPUT_RESISTANCE`
   - **Attribute_Value** = `NIDMM_VAL_10_MEGAOHM`
8. Call `niDMM_Read`. Verify that this measurement falls between the limits listed in Table 15.
9. Call `niDMM_ConfigureMeasurement` with the following parameters:
   - **Function** = `NIDMM_VAL_DC_VOLTS`
   - **Range** = `10`
   - **Resolution** = `10e-6`
10. Set the input resistance of the NI 4070/4072 to >10 GΩ by calling `niDMM_SetAttributeViReal64` with the following parameters:
    - **Attribute_ID** = `NIDMM_ATTR_INPUT_RESISTANCE`
    - **Attribute_Value** = `NIDMM_VAL_GREATER_THAN_10_GIGAOHM`
11. Call `niDMM_Read`. Verify that this measurement falls between the limits listed in Table 15.

12. Set the input resistance of the NI 4070/4072 to 10 MΩ by calling `niDMM_SetAttributeViReal64` with the following parameters:
    - **Attribute_ID** = `NIDMM_ATTR_INPUT_RESISTANCE`
    - **Attribute_Value** = `NIDMM_VAL_10_MEGAOHM`
13. Call `niDMM_Read`. Verify that this measurement falls between the limits listed in Table 15.
14. Call `niDMM_ConfigureMeasurement` with the following parameters:
    - **Function** = `NIDMM_VAL_DC_VOLTS`
    - **Range** = `100`
    - **Resolution** = `100e-6`
15. Set the input resistance of the NI 4070/4072 to 10 MΩ by calling `niDMM_SetAttributeViReal64` with the following parameters:
    - **Attribute_ID** = `NIDMM_ATTR_INPUT_RESISTANCE`
    - **Attribute_Value** = `NIDMM_VAL_10_MEGAOHM`
16. Call `niDMM_Read`. Verify that this measurement falls between the limits listed in Table 15.
17. Call `niDMM_ConfigureMeasurement` with the following parameters:
    - **Function** = `NIDMM_VAL_DC_VOLTS`
    - **Range** = `300`
    - **Resolution** = `300e-6`
18. Set the input resistance of the NI 4070/4072 to 10 MΩ by calling `niDMM_SetAttributeViReal64` with the following parameters:
    - **Attribute_ID** = `NIDMM_ATTR_INPUT_RESISTANCE`
    - **Attribute_Value** = `NIDMM_VAL_10_MEGAOHM`
19. Call `niDMM_Read`. Verify that this measurement falls between the limits listed in Table 15.
20. Remove the shorting bar from the NI 4070/4072.
21. Reset the calibrator.
22. Fasten the connectors on one end of the Fluke 5440 cable to the appropriate banana plug connectors of the NI 4070/4072, and fasten the connectors on the other end of the cable to the appropriate calibrator binding posts. Figure 1 shows the correct connections. Table 1 lists the cable connections.



1 NI 4070/4072	2 Fluke 5700A/5720A Calibrator	3 Fluke 5440 Cable

Figure 1. Cable Connections for Voltage and 2-Wire Resistance

Table 1. Fluke 5440 Cable Connections

Banana Plug Connector (NI 4070/4072)	Banana Plug Color (Fluke 5440 Cable)	Binding Post Label (Fluke 5700A/5720A Calibrator)
HI	Red	OUTPUT HI
LO	Black	OUTPUT LO
(No connection)	Blue	V GUARD

23. Wait two minutes for the thermal EMF to stabilize.
24. Generate 0 V on the calibrator.
25. Call `niDMM_ConfigureMeasurement` with the following parameters:
    - **Function** = `NIDMM_VAL_DC_VOLTS`
    - **Range** = `0.1`
    - **Resolution** = `100e-9`
26. Set the input resistance of the NI 4070/4072 to >10 GΩ by calling `niDMM_SetAttributeViReal64` with the following parameters:
    - **Attribute_ID** = `NIDMM_ATTR_INPUT_RESISTANCE`
    - **Attribute_Value** = `NIDMM_VAL_GREATER_THAN_10_GIGAOHM`

27. Call `niDMM_ConfigureMultiPoint` with the following parameters:
    - **Trigger Count** = `1`
    - **Sample Count** = `10`
    - **Sample Trigger** = `NIDMM_VAL_IMMEDIATE`
    - **Sample Interval** = `-1`
28. Call `niDMM_ReadMultiPoint` with the following parameters:
    - **Maximum Time** = `NIDMM_VAL_TIME_LIMIT_AUTO`
    - **Array Size** = `10`

    Average the results by summing the returned reading array of the function and dividing by the returned actual number of points. Store the result as the 100 mV >10 GΩ mode offset.
29. Set the input resistance of the NI 4070/4072 to 10 MΩ by calling `niDMM_SetAttributeViReal64` with the following parameters:
    - **Attribute_ID** = `NIDMM_ATTR_INPUT_RESISTANCE`
    - **Attribute_Value** = `NIDMM_VAL_10_MEGAOHM`
30. Call `niDMM_ConfigureMultiPoint` with the following parameters:
    - **Trigger Count** = `1`
    - **Sample Count** = `10`
    - **Sample Trigger** = `NIDMM_VAL_IMMEDIATE`
    - **SampleInterval** = `-1`
31. Call `niDMM_ReadMultiPoint` with the following parameters:
    - **Maximum Time** = `NIDMM_VAL_TIME_LIMIT_AUTO`
    - **Array Size** = `10`

    Average the results by summing the returned reading array of the function and dividing by the returned actual number of points. Store the result as the 100 mV 10 MΩ mode offset.
32. Output 100 mV on the calibrator with the range locked to 2.2 V. This range prevents a 50 Ω calibrator output resistance from creating a voltage divider with the internal resistance of the NI 4070/4072.
33. Call `niDMM_ConfigureMeasurement` with the following parameters:
    - **Function** = `NIDMM_VAL_DC_VOLTS`
    - **Range** = `0.1`
    - **Resolution** = `100e-9`

34. Set the input resistance of the NI 4070/4072 to >10 GΩ by calling `niDMM_SetAttributeViReal64` with the following parameters:
    - **Attribute_ID** = `NIDMM_ATTR_INPUT_RESISTANCE`
    - **Attribute_Value** = `NIDMM_VAL_GREATER_THAN_10_GIGAOHM`
35. Call `niDMM_Read`. Subtract the previously stored 100 mV >10 GΩ mode offset from this measurement, and verify that the result falls between the limits listed in Table 15.
36. Set the input resistance of the NI 4070/4072 to 10 MΩ by calling `niDMM_SetAttributeViReal64` with the following parameters:
    - **Attribute_ID** = `NIDMM_ATTR_INPUT_RESISTANCE`
    - **Attribute_Value** = `NIDMM_VAL_10_MEGAOHM`
37. Call `niDMM_Read`. Subtract the previously stored 100 mV 10 MΩ mode offset from this measurement and verify that the result falls between the limits listed in Table 15.
38. Output –100 mV on the calibrator with the range locked to 2.2 V. This range prevents a 50 Ω calibrator output resistance from creating a voltage divider with the internal resistance of the NI 4070/4072.
39. Set the input resistance of the NI 4070/4072 to >10 GΩ by calling `niDMM_SetAttributeViReal64` with the following parameters:
    - **Attribute_ID** = `NIDMM_ATTR_INPUT_RESISTANCE`
    - **Attribute_Value** = `NIDMM_VAL_GREATER_THAN_10_GIGAOHM`
40. Call `niDMM_Read`. Subtract the previously stored 100 mV >10 GΩ mode offset from this measurement, and verify that the result falls between the limits listed in Table 15.
41. Set the input resistance of the NI 4070/4072 to 10 MΩ by calling `niDMM_SetAttributeViReal64` with the following parameters:
    - **Attribute_ID** = `NIDMM_ATTR_INPUT_RESISTANCE`
    - **Attribute_Value** = `NIDMM_VAL_10_MEGAOHM`
42. Call `niDMM_Read`. Subtract the previously stored 100 mV 10 MΩ mode offset from this measurement and verify that the result falls between the limits listed in Table 15.
43. Output 1 V on the calibrator.
44. Call `niDMM_ConfigureMeasurement` with the following parameters:
    - **Function** = `NIDMM_VAL_DC_VOLTS`
    - **Range** = `1`
    - **Resolution** = `1e-6`

45. Set the input resistance of the NI 4070/4072 to >10 GΩ by calling `niDMM_SetAttributeViReal64` with the following parameters:
    - **Attribute_ID** = `NIDMM_ATTR_INPUT_RESISTANCE`
    - **Attribute_Value** = `NIDMM_VAL_GREATER_THAN_10_GIGAOHM`
46. Call `niDMM_Read`. Verify that this measurement falls between the limits listed in Table 15.
47. Set the input resistance of the NI 4070/4072 to 10 MΩ by calling `niDMM_SetAttributeViReal64` with the following parameters:
    - **Attribute_ID** = `NIDMM_ATTR_INPUT_RESISTANCE`
    - **Attribute_Value** = `NIDMM_VAL_10_MEGAOHM`
48. Call `niDMM_Read`. Verify that this measurement falls between the limits listed in Table 15.
49. Output –1 V on the calibrator.
50. Set the input resistance of the NI 4070/4072 to >10 GΩ by calling `niDMM_SetAttributeViReal64` with the following parameters:
    - **Attribute_ID** = `NIDMM_ATTR_INPUT_RESISTANCE`
    - **Attribute_Value** = `NIDMM_VAL_GREATER_THAN_10_GIGAOHM`
51. Call `niDMM_Read`. Verify that this measurement falls between the limits listed in Table 15.
52. Set the input resistance of the NI 4070/4072 to 10 MΩ by calling `niDMM_SetAttributeViReal64` with the following parameters:
    - **Attribute_ID** = `NIDMM_ATTR_INPUT_RESISTANCE`
    - **Attribute_Value** = `NIDMM_VAL_10_MEGAOHM`
53. Call `niDMM_Read`. Verify that this measurement falls between the limits listed in Table 15.
54. Output 10 V on the calibrator.
55. Call `niDMM_ConfigureMeasurement` with the following parameters:
    - **Function** = `NIDMM_VAL_DC_VOLTS`
    - **Range** = `10`
    - **Resolution** = `10e-6`
56. Set the input resistance of the NI 4070/4072 to >10 GΩ by calling `niDMM_SetAttributeViReal64` with the following parameters:
    - **Attribute_ID** = `NIDMM_ATTR_INPUT_RESISTANCE`
    - **Attribute_Value** = `NIDMM_VAL_GREATER_THAN_10_GIGAOHM`
57. Call `niDMM_Read`. Verify that this measurement falls between the limits listed in Table 15.

58. Set the input resistance of the NI 4070/4072 to 10 MΩ by calling `niDMM_SetAttributeViReal64` with the following parameters:
    - **Attribute_ID** = `NIDMM_ATTR_INPUT_RESISTANCE`
    - **Attribute_Value** = `NIDMM_VAL_10_MEGAOHM`
59. Call `niDMM_Read`. Verify that this measurement falls between the limits listed in Table 15.
60. Output –10 V on the calibrator.
61. Set the input resistance of the NI 4070/4072 to >10 GΩ by calling `niDMM_SetAttributeViReal64` with the following parameters:
    - **Attribute_ID** = `NIDMM_ATTR_INPUT_RESISTANCE`
    - **Attribute_Value** = `NIDMM_VAL_GREATER_THAN_10_GIGAOHM`
62. Call `niDMM_Read`. Verify that this measurement falls between the limits listed in Table 15.
63. Set the input resistance of the NI 4070/4072 to 10 MΩ by calling `niDMM_SetAttributeViReal64` with the following parameters:
    - **Attribute_ID** = `NIDMM_ATTR_INPUT_RESISTANCE`
    - **Attribute_Value** = `NIDMM_VAL_10_MEGAOHM`
64. Call `niDMM_Read`. Verify that this measurement falls between the limits listed in Table 15.
65. Output 100 V on the calibrator.

Caution Avoid touching the connections when generating a high voltage from the calibrator.

66. Call `niDMM_ConfigureMeasurement` with the following parameters:
    - **Function** = `NIDMM_VAL_DC_VOLTS`
    - **Range** = `100`
    - **Resolution** = `100e-6`
67. Set the input resistance of the NI 4070/4072 to 10 MΩ by calling `niDMM_SetAttributeViReal64` with the following parameters:
    - **Attribute_ID** = `NIDMM_ATTR_INPUT_RESISTANCE`
    - **Attribute_Value** = `NIDMM_VAL_10_MEGAOHM`
68. Call `niDMM_Read`. Verify that this measurement falls between the limits listed in Table 15.
69. Output –100 V on the calibrator.
70. Call `niDMM_Read`. Verify that this measurement falls between the limits listed in Table 15.

71. Call `niDMM_ConfigureMeasurement` with the following parameters:
    - **Function** = `NIDMM_VAL_DC_VOLTS`
    - **Range** = `300`
    - **Resolution** = `300e-6`
72. Call `niDMM_Read`. Before you apply the voltage, the DMM must be in the 300 V range.
73. Output 300 V on the calibrator.
74. Call `niDMM_Read`. Verify that this measurement falls between the limits listed in Table 15.
75. Output –300 V on the calibrator.
76. Call `niDMM_Read`. Verify that this measurement falls between the limits listed in Table 15.
77. Reset the calibrator for safety reasons.

You have completed verifying the DC voltage of the NI 4070/4072. Select one of the following options:

- If you want to continue verifying other modes, go to the *Verifying AC Voltage* section.
- If you do *not* want to verify other modes *and* you are performing a *post-adjustment* verification, go to the *Completing the Adjustment Procedures* section.
- If you do *not* want to verify any additional modes *and* you are performing a *pre-adjustment* verification, call `niDMM_close` to close the session.

Verifying AC Voltage

To verify AC voltage of the NI 4070/4072, complete the following steps:

1. Reset the calibrator.
2. Fasten the connectors on one end of the Fluke 5440 cable to the appropriate banana plug connectors on the NI 4070/4072, and fasten the connectors on the other end of the cable to the appropriate calibrator binding posts. Figure 1 shows the correct connections. Table 1 lists the cable connections.
3. Output 5 mV at 1 kHz on the calibrator.
4. Call `niDMM_reset` to reset the NI 4070/4072 to a known state.

5. Call niDMM_ConfigureMeasurement with the following parameters:
   - **Function** = NIDMM_VAL_AC_VOLTS
   - **Range** = 0.05
   - **Resolution** = 50e-9
6. Call niDMM_Read. Verify that this measurement falls between the limits listed in Table 16.
7. Call niDMM_ConfigureMeasurement with the following parameters:
   - **Function** = NIDMM_VAL_AC_VOLTS_DCCOUPLED
   - **Range** = 0.05
   - **Resolution** = 50e-9
8. Call niDMM_Read. Verify that this measurement falls between the limits listed in Table 16.
9. Output 50 mV at 30 Hz on the calibrator.
10. Call niDMM_ConfigureMeasurement with the following parameters:
    - **Function** = NIDMM_VAL_AC_VOLTS_DCCOUPLED
    - **Range** = 0.05
    - **Resolution** = 50e-9
11. Call niDMM_Read. Verify that this measurement falls between the limits listed in Table 16.
12. Refer to Table 2 for the appropriate calibrator outputs and parameter values as you complete the following steps:
    a. On the calibrator, output the value listed in the *Calibrator Output* column in Table 2 for the current iteration.
    b. Call niDMM_ConfigureMeasurement with **Mode** set to NIDMM_VAL_AC_VOLTS and the remaining parameters as shown in Table 2 for the current iteration.
    c. Call niDMM_Read. Verify that this measurement falls between the limits listed in Table 16.
    d. Call niDMM_ConfigureMeasurement again, changing **Mode** to NIDMM_VAL_AC_VOLTS_DCCOUPLED.
    e. Call niDMM_Read. Verify that this measurement falls between the limits listed in Table 16.

13. Repeat step 12 for each of the remaining iterations shown in Table 2.

Table 2. niDMM_ConfigureMeasurement Parameters

Iteration	Calibrator Output		niDMM_ConfigureMeasurement Parameters		
	Amplitude	Frequency	Function	Range	Resolution
1	50 mV	50 Hz	NIDMM_VAL_AC_VOLTS	0.05	50e-9
	50 mV	50 Hz	NIDMM_VAL_AC_VOLTS_DCCOUPLED	0.05	50e-9
2	50 mV	1 kHz	NIDMM_VAL_AC_VOLTS	0.05	50e-9
	50 mV	1 kHz	NIDMM_VAL_AC_VOLTS_DCCOUPLED	0.05	50e-9
3	50 mV	1 kHz	NIDMM_VAL_AC_VOLTS	0.5	500e-9
	50 mV	1 kHz	NIDMM_VAL_AC_VOLTS_DCCOUPLED	0.5	500e-9
4	50 mV	20 kHz	NIDMM_VAL_AC_VOLTS	0.05	50e-9
	50 mV	20 kHz	NIDMM_VAL_AC_VOLTS_DCCOUPLED	0.05	50e-9
5	50 mV	50 kHz	NIDMM_VAL_AC_VOLTS	0.05	50e-9
	50 mV	50 kHz	NIDMM_VAL_AC_VOLTS_DCCOUPLED	0.05	50e-9
6	50 mV	100 kHz	NIDMM_VAL_AC_VOLTS	0.05	50e-9
	50 mV	100 kHz	NIDMM_VAL_AC_VOLTS_DCCOUPLED	0.05	50e-9
7	50 mV	300 kHz	NIDMM_VAL_AC_VOLTS	0.05	50e-9
	50 mV	300 kHz	NIDMM_VAL_AC_VOLTS_DCCOUPLED	0.05	50e-9

14. Output 500 mV at 30 Hz on the calibrator.
15. Call `niDMM_ConfigureMeasurement` with the following parameters:
    - **Function** = `NIDMM_VAL_AC_VOLTS_DCCOUPLED`
    - **Range** = `0.5`
    - **Resolution** = `500e-9`
16. Call `niDMM_Read`. Verify that this measurement falls between the limits listed in Table 16.
17. Refer to Table 3 for the appropriate calibrator outputs and parameter values as you complete the following steps:
    a. On the calibrator, output the value listed in the *Calibrator Output* column in Table 3 for the current iteration.
    b. Call `niDMM_ConfigureMeasurement` with **Mode** set to `NIDMM_VAL_AC_VOLTS` and the remaining parameters as shown in Table 3 for the current iteration.

c. Call `niDMM_Read`. Verify that this measurement falls between the limits listed in Table 16.

d. Call `niDMM_ConfigureMeasurement` again, changing **Mode** to `NIDMM_VAL_AC_VOLTS_DCCOUPLED`.

e. Call `niDMM_Read`. Verify that this measurement falls between the limits listed in Table 16.

Table 3. niDMM_ConfigureMeasurement Parameters

Iteration	Calibrator Output		niDMM_ConfigureMeasurement Parameters		
	Amplitude	Frequency	Function	Range	Resolution
1	500 mV	50 Hz	NIDMM_VAL_AC_VOLTS	0.5	500e-9
	500 mV	50 Hz	NIDMM_VAL_AC_VOLTS_DCCOUPLED	0.5	500e-9
2	500 mV	1 kHz	NIDMM_VAL_AC_VOLTS	0.5	500e-9
	500 mV	1 kHz	NIDMM_VAL_AC_VOLTS_DCCOUPLED	0.5	500e-9
3	500 mV	1 kHz	NIDMM_VAL_AC_VOLTS	5	5e-6
	500 mV	1 kHz	NIDMM_VAL_AC_VOLTS_DCCOUPLED	5	5e-6
4	500 mV	20 kHz	NIDMM_VAL_AC_VOLTS	0.5	500e-9
	500 mV	20 kHz	NIDMM_VAL_AC_VOLTS_DCCOUPLED	0.5	500e-9
5	500 mV	50 kHz	NIDMM_VAL_AC_VOLTS	0.5	500e-9
	500 mV	50 kHz	NIDMM_VAL_AC_VOLTS_DCCOUPLED	0.5	500e-9
6	500 mV	100 kHz	NIDMM_VAL_AC_VOLTS	0.5	500e-9
	500 mV	100 kHz	NIDMM_VAL_AC_VOLTS_DCCOUPLED	0.5	500e-9
7	500 mV	300 kHz	NIDMM_VAL_AC_VOLTS	0.5	500e-9
	500 mV	300 kHz	NIDMM_VAL_AC_VOLTS_DCCOUPLED	0.5	500e-9

18. Output 5 V at 30 Hz on the calibrator.
19. Call `niDMM_ConfigureMeasurement` with the following parameters:
    - **Function** = `NIDMM_VAL_AC_VOLTS_DCCOUPLED`
    - **Range** = `5`
    - **Resolution** = `5e-6`
20. Call `niDMM_Read`. Verify that this measurement falls between the limits listed in Table 16.

21. Refer to Table 4 for the appropriate calibrator outputs and parameter values as you complete the following steps:

    a. On the calibrator, output the value listed in the *Calibrator Output* column in Table 4 for the current iteration.

    b. Call `niDMM_ConfigureMeasurement` with **Mode** set to `NIDMM_VAL_AC_VOLTS` and the remaining parameters as shown in Table 4 for the current iteration.

    c. Call `niDMM_Read`. Verify that this measurement falls between the limits listed in Table 16.

    d. Call `niDMM_ConfigureMeasurement` again, changing **Mode** to `NIDMM_VAL_AC_VOLTS_DCCOUPLED`.

    e. Call `niDMM_Read`. Verify that this measurement falls between the limits listed in Table 16.

Table 4. niDMM_ConfigureMeasurement Parameters

Iteration	Calibrator Output		niDMM_ConfigureMeasurement Parameters		
	Amplitude	Frequency	Function	Range	Resolution
1	5 V	50 Hz	NIDMM_VAL_AC_VOLTS	5	5e-6
	5 V	50 Hz	NIDMM_VAL_AC_VOLTS_DCCOUPLED	5	5e-6
2	5 V	1 kHz	NIDMM_VAL_AC_VOLTS	5	5e-6
	5 V	1 kHz	NIDMM_VAL_AC_VOLTS_DCCOUPLED	5	5e-6
3	5 V	1 kHz	NIDMM_VAL_AC_VOLTS	50	50e-6
	5 V	1 kHz	NIDMM_VAL_AC_VOLTS_DCCOUPLED	50	50e-6
4	5 V	1 kHz	NIDMM_VAL_AC_VOLTS	300	300e-6
	5 V	1 kHz	NIDMM_VAL_AC_VOLTS_DCCOUPLED	300	300e-6
5	5 V	20 kHz	NIDMM_VAL_AC_VOLTS	5	5e-6
	5 V	20 kHz	NIDMM_VAL_AC_VOLTS_DCCOUPLED	5	5e-6
6	5 V	50 kHz	NIDMM_VAL_AC_VOLTS	5	5e-6
	5 V	50 kHz	NIDMM_VAL_AC_VOLTS_DCCOUPLED	5	5e-6
7	5 V	100 kHz	NIDMM_VAL_AC_VOLTS	5	5e-6
	5 V	100 kHz	NIDMM_VAL_AC_VOLTS_DCCOUPLED	5	5e-6
8	5 V	300 kHz	NIDMM_VAL_AC_VOLTS	5	5e-6
	5 V	300 kHz	NIDMM_VAL_AC_VOLTS_DCCOUPLED	5	5e-6

22. Output 50 V at 30 Hz on the calibrator.

23. Call `niDMM_ConfigureMeasurement` with the following parameters:
    - **Function** = `NIDMM_VAL_AC_VOLTS_DCCOUPLED`
    - **Range** = `50`
    - **Resolution** = `50e-6`
24. Call `niDMM_Read`. Verify that this measurement falls between the limits listed in Table 16.
25. Refer to Table 5 for the appropriate calibrator outputs and parameter values as you complete the following steps:
    a. On the calibrator, output the value listed in the *Calibrator Output* column in Table 5 for the current iteration.
    b. Call `niDMM_ConfigureMeasurement` with **Mode** set to `NIDMM_VAL_AC_VOLTS` and the remaining parameters as shown in Table 5 for the current iteration.
    c. Call `niDMM_Read`. Verify that this measurement falls between the limits listed in Table 16.
    d. Call `niDMM_ConfigureMeasurement` again, changing **Mode** to `NIDMM_VAL_AC_VOLTS_DCCOUPLED`.
    e. Call `niDMM_Read`. Verify that this measurement falls between the limits listed in Table 16.

Table 5. niDMM_ConfigureMeasurement Parameters

Iteration	Calibrator Output		niDMM_ConfigureMeasurement Parameters		
	Amplitude	**Frequency**	**Function**	**Range**	**Resolution**
1	50 V	50 Hz	NIDMM_VAL_AC_VOLTS	50	50e-6
	50 V	50 Hz	NIDMM_VAL_AC_VOLTS_DCCOUPLED	50	50e-6
2	50 V	1 kHz	NIDMM_VAL_AC_VOLTS	50	50e-6
	50 V	1 kHz	NIDMM_VAL_AC_VOLTS_DCCOUPLED	50	50e-6
3	50 V	20 kHz	NIDMM_VAL_AC_VOLTS	50	50e-6
	50 V	20 kHz	NIDMM_VAL_AC_VOLTS_DCCOUPLED	50	50e-6
4	50 V	50 kHz	NIDMM_VAL_AC_VOLTS	50	50e-6
	50 V	50 kHz	NIDMM_VAL_AC_VOLTS_DCCOUPLED	50	50e-6
5	50 V	100 kHz	NIDMM_VAL_AC_VOLTS	50	50e-6
	50 V	100 kHz	NIDMM_VAL_AC_VOLTS_DCCOUPLED	50	50e-6
6	50 V	300 kHz	NIDMM_VAL_AC_VOLTS	50	50e-6
	50 V	300 kHz	NIDMM_VAL_AC_VOLTS_DCCOUPLED	50	50e-6

26. Call niDMM_ConfigureMeasurement with the following parameters:
   - **Function** = NIDMM_VAL_AC_VOLTS_DCCOUPLED
   - **Range** = 300
   - **Resolution** = 300e-6
27. Call niDMM_Read. The DMM must be in the 300 V range before you apply the voltage.
28. Output 219 V at 30 Hz on the calibrator.
29. Call niDMM_Read. Verify that this measurement falls between the limits listed in Table 16.
30. Refer to Table 6 for the appropriate calibrator outputs and parameter values as you complete the following steps:
   a. On the calibrator, output the value listed in the *Calibrator Output* column in Table 6 for the current iteration.
   b. Call niDMM_ConfigureMeasurement with **Mode** set to NIDMM_VAL_AC_VOLTS and the remaining parameters as shown in Table 6 for the current iteration.
   c. Call niDMM_Read. Verify that this measurement falls between the limits listed in Table 16.
   d. Call niDMM_ConfigureMeasurement again, changing **Mode** to NIDMM_VAL_AC_VOLTS_DCCOUPLED.
   e. Call niDMM_Read. Verify that this measurement falls between the limits listed in Table 16.

Table 6. niDMM_ConfigureMeasurement Parameters

Iteration	Calibrator Output		niDMM_ConfigureMeasurement Parameters		
	Amplitude	Frequency	Function	Range	Resolution
1	219 V	50 Hz	NIDMM_VAL_AC_VOLTS	300	300e-6
	219 V	50 Hz	NIDMM_VAL_AC_VOLTS_DCCOUPLED	300	300e-6
2	219 V	1 kHz	NIDMM_VAL_AC_VOLTS	300	300e-6
	219 V	1 kHz	NIDMM_VAL_AC_VOLTS_DCCOUPLED	300	300e-6
3	219 V	20 kHz	NIDMM_VAL_AC_VOLTS	300	300e-6
	219 V	20 kHz	NIDMM_VAL_AC_VOLTS_DCCOUPLED	300	300e-6
4	219 V	50 kHz	NIDMM_VAL_AC_VOLTS	300	300e-6
	219 V	50 kHz	NIDMM_VAL_AC_VOLTS_DCCOUPLED	300	300e-6
5	70 V	300 kHz	NIDMM_VAL_AC_VOLTS	300	300e-6
	70 V	300 kHz	NIDMM_VAL_AC_VOLTS_DCCOUPLED	300	300e-6

31. Reset the calibrator for safety reasons.

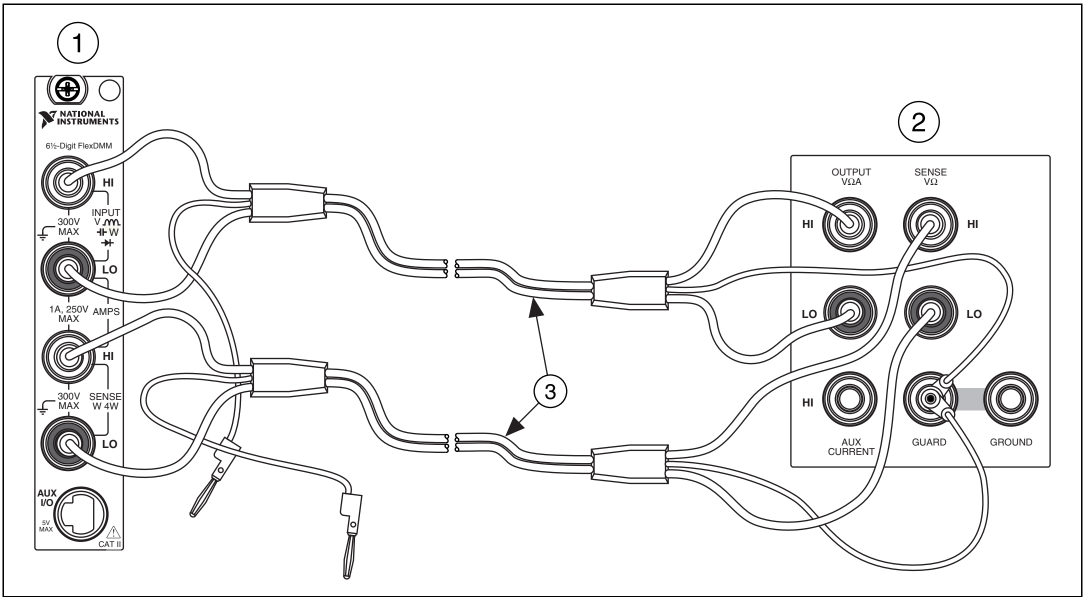
You have completed verifying the AC voltage of the NI 4070/4072. Select one of the following options:

- If you want to continue verifying other modes, go to the *Verifying 4-Wire Resistance* section.
- If you do *not* want to verify other modes *and* you are performing a *post-adjustment* verification, go to the *Completing the Adjustment Procedures* section.
- If you do *not* want to verify any additional modes *and* you are performing a *pre-adjustment* verification, call `niDMM_close` to close the session.

Verifying 4-Wire Resistance

To verify the 4-wire resistance of the NI 4070/4072, complete the following steps:

1. Reset the calibrator.
2. Fasten the connectors on one end of each Fluke 5440 cable to the appropriate banana plug connectors on the NI 4070/4072. Fasten the connectors on the other end of each Fluke 5440 cable to the appropriate calibrator binding posts. Figure 2 shows the Fluke 5440 cables. Table 7 lists the cable connections.



1	NI 4070/4072	2	Fluke 5700A/5720A Calibrator	3	Fluke 5440 Cables

Figure 2. Cable Connections for 4-Wire Resistance

Table 7. Fluke 5440 Cable Connections

Fluke 5440 Cable Identification	Banana Plug Connector (NI 4070/4072)	Banana Plug Color (Fluke 5440 Cable)	Binding Post (Fluke 5700A/5720A Calibrator)
First cable	HI	Red	OUTPUT HI
	LO	Black	OUTPUT LO
	(No connection)	Blue	V GUARD
Second cable	HI SENSE	Red	SENSE HI
	LO SENSE	Black	SENSE LO
	(No connection)	Blue	V GUARD

3. Wait two minutes for the thermal EMF to stabilize if the Fluke 5440 cables were not previously connected in this configuration.
4. Call `niDMM_reset`.
5. Refer to Table 8 for the appropriate calibrator output and function parameter values as you complete the following steps:
   a. On the calibrator, output the value listed in the *Calibrator Output* column in Table 8 for the current iteration. Make sure that the external sense is turned on but 2-wire compensation is turned off.

Note After setting the calibrator output to 0 Ω in the seventh iteration, you do *not* need to continually set the calibrator to 0 Ω for iterations 8 through 12.

   b. Call `niDMM_ConfigureMeasurement` with the parameters set as shown in Table 8 for the current iteration.
   c. Call `niDMM_ConfigureOffsetCompOhms` with **OffsetCompOhms** set to either `NIDMM_VAL_OFFSET_COMP_OHMS_ON` or `NIDMM_VAL_OFFSET_COMP_OHMS_OFF` according to Table 8 for the current iteration.
   d. Call `niDMM_Read`. Verify that this measurement falls between the tolerances listed in Table 17. Tolerances are provided instead of absolute limits because your calibrator will have different discrete resistance values.

6. Repeat step 5 for each of the remaining iterations listed in Table 8.

Table 8. niDMM_ConfigureMeasurement Parameters

Iteration	Calibrator Output	niDMM_ConfigureMeasurement Parameters			OffsetCompOhms
		Function	Range	Resolution	
1	10 MΩ	`NIDMM_VAL_4_WIRE_RES`	`10e6`	`10`	OFF
2	1 MΩ	`NIDMM_VAL_4_WIRE_RES`	`1e6`	`1`	OFF
3	100 kΩ	`NIDMM_VAL_4_WIRE_RES`	`100e3`	`0.1`	OFF
4	10 kΩ	`NIDMM_VAL_4_WIRE_RES`	`10e3`	`0.01`	ON
5	1 kΩ	`NIDMM_VAL_4_WIRE_RES`	`1e3`	`1e-3`	ON
6	100 Ω	`NIDMM_VAL_4_WIRE_RES`	`100`	`100e-6`	ON
7	0 Ω	`NIDMM_VAL_4_WIRE_RES`	`10e6`	`10`	OFF
8	0 Ω	`NIDMM_VAL_4_WIRE_RES`	`1e6`	`1`	OFF
9	0 Ω	`NIDMM_VAL_4_WIRE_RES`	`100e3`	`0.1`	OFF
10	0 Ω	`NIDMM_VAL_4_WIRE_RES`	`10e3`	`0.01`	ON
11	0 Ω	`NIDMM_VAL_4_WIRE_RES`	`1e3`	`1e-3`	ON
12	0 Ω	`NIDMM_VAL_4_WIRE_RES`	`100`	`100e-6`	ON

You have completed verifying the 4-wire resistance of the NI 4070/4072. Select one of the following options:

- If you want to continue verifying other modes, go to the *Verifying 2-Wire Resistance* section.
- If you do *not* want to verify other modes *and* you are performing a *post-adjustment* verification, go to the *Completing the Adjustment Procedures* section.
- If you do *not* want to verify any additional modes *and* you are performing a *pre-adjustment* verification, call `niDMM_close` to close the session.

Verifying 2-Wire Resistance

To verify the 2-wire resistance of the NI 4070/4072, complete the following steps:

1. Plug in the insulated banana plug shorting bar across the HI and LO banana plug connectors on the NI 4070/4072.
2. Wait one minute for the thermal EMF to stabilize.
3. Call `niDMM_reset`.

4. Call `niDMM_ConfigureMeasurement` with the following parameters:
    - **Function** = `NIDMM_VAL_2_WIRE_RES`
    - **Range** = `10e3`
    - **Resolution** = `0.01`
5. Call `niDMM_ConfigureOffsetCompOhms` with **OffsetCompOhms** set to `NIDMM_VAL_OFFSET_COMP_OHMS_ON`.
6. Call `niDMM_Read`. Verify that this measurement falls between the limits listed in Table 18.
7. Call `niDMM_ConfigureMeasurement` with the following parameters:
    - **Function** = `NIDMM_VAL_2_WIRE_RES`
    - **Range** = `1e3`
    - **Resolution** = `1e-3`
8. Call `niDMM_ConfigureOffsetCompOhms` with **OffsetCompOhms** set to `NIDMM_VAL_OFFSET_COMP_OHMS_ON`.
9. Call `niDMM_Read`. Verify that this measurement falls between the limits listed in Table 18.
10. Call `niDMM_ConfigureMeasurement` with the following parameters:
    - **Function** = `NIDMM_VAL_2_WIRE_RES`
    - **Range** = `100`
    - **Resolution** = `100e-6`
11. Call `niDMM_ConfigureOffsetCompOhms` with **OffsetCompOhms** set to `NIDMM_VAL_OFFSET_COMP_OHMS_ON`.
12. Call `niDMM_Read`. Verify that this measurement falls between the limits listed in Table 18.
13. Remove the shorting bar from the NI 4070/4072.
14. Reset the calibrator.
15. Fasten the connectors on one end of the Fluke 5440 cable to the NI 4070/4072, and fasten the connectors on the other end of the cable to the appropriate calibrator binding posts. Figure 1 shows the correct connections. Table 1 lists the cable connections.
16. Wait two minutes for the thermal EMF to stabilize if the Fluke 5440 cable was not previously used in this configuration.
17. Output 0 Ω on the calibrator with 2-wire compensation turned on but with external sense turned off.
18. Call `niDMM_reset` to reset the NI 4070/4072 to a known state.

19. Call `niDMM_ConfigureMeasurement` with the following parameters:
    - **Function** = `NIDMM_VAL_2_WIRE_RES`
    - **Range** = `100e6`
    - **Resolution** = `100`
20. Call `niDMM_Read` and store the result as the 100 MΩ range offset.
21. Call `niDMM_ConfigureMeasurement` with the following parameters:
    - **Function** = `NIDMM_VAL_2_WIRE_RES`
    - **Range** = `10e6`
    - **Resolution** = `10`
22. Call `niDMM_Read` and store the result as the 10 MΩ range offset.
23. Call `niDMM_ConfigureMeasurement` with the following parameters:
    - **Function** = `NIDMM_VAL_2_WIRE_RES`
    - **Range** = `1e6`
    - **Resolution** = `1`
24. Call `niDMM_Read` and store the result as the 1 MΩ range offset.
25. Call `niDMM_ConfigureMeasurement` with the following parameters:
    - **Function** = `NIDMM_VAL_2_WIRE_RES`
    - **Range** = `100e3`
    - **Resolution** = `0.1`
26. Call `niDMM_ConfigureMultiPoint` with the following parameters:
    - **Trigger Count** = `1`
    - **Sample Count** = `4`
    - **Sample Trigger** = `NIDMM_VAL_IMMEDIATE`
    - **Sample Interval** = `-1`
27. Call `niDMM_ReadMultiPoint` with the following parameters:
    - **Maximum Time** = `NIDMM_VAL_TIME_LIMIT_AUTO`
    - **Array Size** = `4`

    Average the results by summing the returned reading array of the function and dividing by the returned actual number of points. Store the result as the 100 kΩ range offset.

28. Call `niDMM_ConfigureMeasurement` with the following parameters:
    - **Function** = `NIDMM_VAL_2_WIRE_RES`
    - **Range** = `10e3`
    - **Resolution** = `0.01`
29. Call `niDMM_ConfigureMultiPoint` with the following parameters:
    - **Trigger Count** = `1`
    - **Sample Count** = `4`
    - **Sample Trigger** = `NIDMM_VAL_IMMEDIATE`
    - **Sample Interval** = `-1`
30. Call `niDMM_ReadMultiPoint` with the following parameters:
    - **Maximum Time** = `NIDMM_VAL_TIME_LIMIT_AUTO`
    - **Array Size** = `4`

    Average the results by summing the returned reading array of the function and dividing by the returned actual number of points. Store the result as the 10 kΩ range offset.
31. Call `niDMM_ConfigureMeasurement` with the following parameters:
    - **Function** = `NIDMM_VAL_2_WIRE_RES`
    - **Range** = `1e3`
    - **Resolution** = `1e-3`
32. Call `niDMM_ConfigureMultiPoint` with the following parameters:
    - **Trigger Count** = `1`
    - **Sample Count** = `4`
    - **Sample Trigger** = `NIDMM_VAL_IMMEDIATE`
    - **Sample Interval** = `-1`
33. Call `niDMM_ReadMultiPoint` with the following parameters:
    - **Maximum Time** = `NIDMM_VAL_TIME_LIMIT_AUTO`
    - **Array Size** = `4`

    Average the results by summing the returned reading array of the function and dividing by the returned actual number of points. Store the result as the 1 kΩ range offset.
34. Call `niDMM_ConfigureMeasurement` with the following parameters:
    - **Function** = `NIDMM_VAL_2_WIRE_RES`
    - **Range** = `100`
    - **Resolution** = `100e-6`

35. Call `niDMM_ConfigureMultiPoint` with the following parameters:
    - **Trigger Count** = `1`
    - **Sample Count** = `10`
    - **Sample Trigger** = `NIDMM_VAL_IMMEDIATE`
    - **Sample Interval** = `-1`
36. Call `niDMM_ReadMultiPoint` with the following parameters:
    - **Maximum Time** = `NIDMM_VAL_TIME_LIMIT_AUTO`
    - **Array Size** = `10`

    Average the results by summing the returned reading array of the function and dividing by the returned actual number of points. Store the result as the 100 Ω range offset.
37. Output 100 MΩ on the calibrator without external sense or 2-wire compensation.
38. Call `niDMM_ConfigureMeasurement` with the following parameters:
    - **Function** = `NIDMM_VAL_2_WIRE_RES`
    - **Range** = `100e6`
    - **Resolution** = `100`
39. Call `niDMM_Read`. Subtract the previously stored 100 MΩ range offset from this measurement. Verify that the result falls between the tolerances listed in Table 18.
40. Output 10 MΩ on the calibrator without external sense or 2-wire compensation.
41. Call `niDMM_ConfigureMeasurement` with the following parameters:
    - **Function** = `NIDMM_VAL_2_WIRE_RES`
    - **Range** = `10e6`
    - **Resolution** = `10`
42. Call `niDMM_Read`. Subtract the previously stored 10 MΩ range offset from this measurement. Verify that the result falls between the tolerances listed in Table 18.
43. Output 1 MΩ on the calibrator without external sense or 2-wire compensation.
44. Call `niDMM_ConfigureMeasurement` with the following parameters:
    - **Function** = `NIDMM_VAL_2_WIRE_RES`
    - **Range** = `1e6`
    - **Resolution** = `1`

45. Call `niDMM_Read`. Subtract the previously stored 1 MΩ range offset from this measurement. Verify that the result falls between the tolerances listed in Table 18.
46. Output 100 kΩ on the calibrator without external sense or 2-wire compensation.
47. Call `niDMM_ConfigureMeasurement` with the following parameters:
    - **Function** = `NIDMM_VAL_2_WIRE_RES`
    - **Range** = `100e3`
    - **Resolution** = `0.1`
48. Call `niDMM_Read`. Subtract the previously stored 100 kΩ range offset from this measurement. Verify that the result falls between the tolerances listed in Table 18.
49. Output 10 kΩ on the calibrator with 2-wire compensation turned on but with external sense turned off.
50. Call `niDMM_ConfigureMeasurement` with the following parameters:
    - **Function** = `NIDMM_VAL_2_WIRE_RES`
    - **Range** = `10e3`
    - **Resolution** = `0.01`
51. Call `niDMM_Read`. Subtract the previously stored 10 kΩ range offset from this measurement. Verify that the result falls between the tolerances listed in Table 18.
52. Output 1 kΩ on the calibrator with 2-wire compensation turned on but with external sense turned off.
53. Call `niDMM_ConfigureMeasurement` with the following parameters:
    - **Function** = `NIDMM_VAL_2_WIRE_RES`
    - **Range** = `1e3`
    - **Resolution** = `1e-3`
54. Call `niDMM_Read`. Subtract the previously stored 1 kΩ range offset from this measurement. Verify that the result falls between the tolerances listed in Table 18.
55. Output 100 Ω on the calibrator with 2-wire compensation turned on but with external sense turned off.
56. Call `niDMM_ConfigureMeasurement` with the following parameters:
    - **Function** = `NIDMM_VAL_2_WIRE_RES`
    - **Range** = `100`
    - **Resolution** = `100e-6`

57. Call `niDMM_Read`. Subtract the previously calculated 100 Ω range offset from this measurement. Verify that the result falls between the tolerances listed in Table 18.

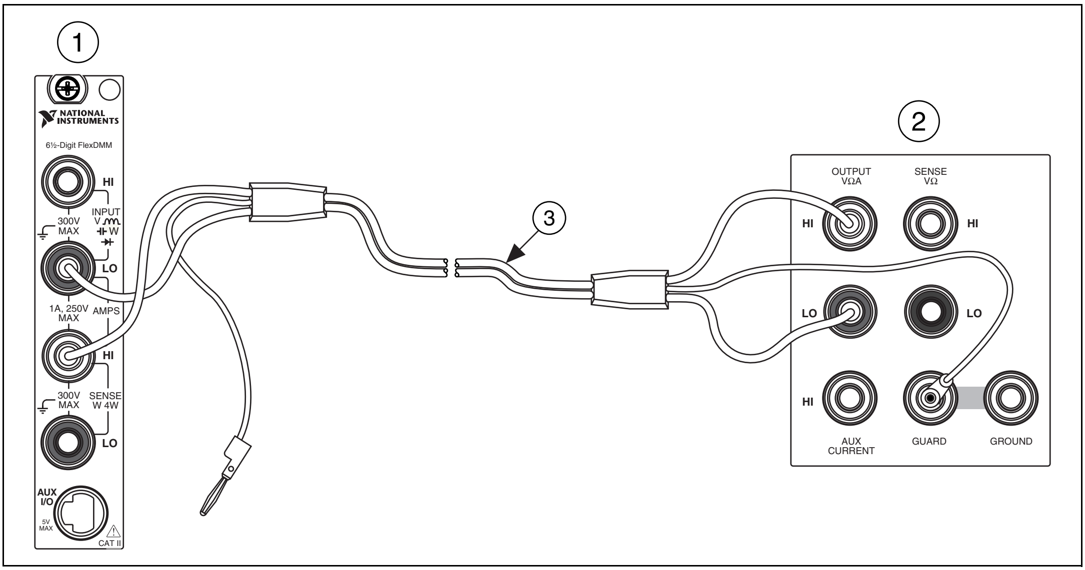
You have completed verifying the 2-wire resistance of the NI 4070/4072. Select one of the following options:

- If you want to continue verifying other modes, go to the *Verifying DC Current* section.
- If you do *not* want to verify other modes *and* you are performing a *post-adjustment* verification, go to the *Completing the Adjustment Procedures* section.
- If you do *not* want to verify any additional modes *and* you are performing a *pre-adjustment* verification, call `niDMM_close` to close the session.

Verifying DC Current

To verify the DC current of the NI 4070/4072, complete the following steps:

1. Reset the calibrator.
2. Fasten the connectors on one end of the Fluke 5440 cable to the NI 4070/4072 *HI SENSE* and *LO* banana plug connectors, and connect the connectors on the other end of the cable to the *HI* and *LO* calibrator binding posts. Figure 3 shows the correct connections. Table 9 lists the cable connections.



1	NI 4070/4072	2	Fluke 5700A/5720A Calibrator	3	Fluke 5440 Cable

Figure 3. Cable Connections for Current

Table 9. Fluke 5440 Cable Connections

Banana Plug Connector (NI 4070/4072)	Banana Plug Color (Fluke 5440 Cable)	Binding Post (Fluke 5700A/5720A Calibrator)
HI SENSE	Red	OUTPUT HI
LO	Black	OUTPUT LO
(No connection)	Blue	V GUARD

3. Call `niDMM_reset` to reset the NI 4070/4072 to a known state.
4. Set the current output on the calibrator to NORM and output 0 A.
5. Call `niDMM_ConfigureMeasurement` with the following parameters:
   - **Function** = `NIDMM_VAL_DC_CURRENT`
   - **Range** = `0.02`
   - **Resolution** = `20e-9`
6. Call `niDMM_Read`. Verify that this measurement falls between the limits listed in Table 19.
7. Call `niDMM_ConfigureMeasurement` with the following parameters:
   - **Function** = `NIDMM_VAL_DC_CURRENT`
   - **Range** = `0.2`
   - **Resolution** = `200e-9`
8. Call `niDMM_Read`. Verify that this measurement falls between the limits listed in Table 19.
9. Call `niDMM_ConfigureMeasurement` with the following parameters:
   - **Function** = `NIDMM_VAL_DC_CURRENT`
   - **Range** = `1`
   - **Resolution** = `1e-6`
10. Call `niDMM_Read`. Verify that this measurement falls between the limits listed in Table 19.
11. Call `niDMM_ConfigureMeasurement` with the following parameters:
    - **Function** = `NIDMM_VAL_DC_CURRENT`
    - **Range** = `0.02`
    - **Resolution** = `20e-9`
12. Call `niDMM_Read` to configure the NI 4070/4072 for a current mode before applying current.

13. Output 20 mA on the calibrator.
14. Call `niDMM_Read`. Verify that this measurement falls between the limits listed in Table 19.
15. Output –20 mA on the calibrator.
16. Call `niDMM_Read`. Verify that this measurement falls between the limits listed in Table 19.
17. Output 200 mA on the calibrator.
18. Call `niDMM_ConfigureMeasurement` with the following parameters:
    - **Function** = `NIDMM_VAL_DC_CURRENT`
    - **Range** = `0.2`
    - **Resolution** = `200e-9`
19. Call `niDMM_Read`. Verify that this measurement falls between the limits listed in Table 19.
20. Output –200 mA on the calibrator.
21. Call `niDMM_Read`. Verify that this measurement falls between the limits listed in Table 19.
22. Output 1 A on the calibrator.
23. Call `niDMM_ConfigureMeasurement` with the following parameters:
    - **Function** = `NIDMM_VAL_DC_CURRENT`
    - **Range** = `1`
    - **Resolution** = `1e-6`
24. Call `niDMM_Read`. Verify that this measurement falls between the limits listed in Table 19.
25. Output –1 A on the calibrator.
26. Call `niDMM_Read`. Verify that this measurement falls between the limits listed in Table 19.

You have completed verifying the DC current of the NI 4070/4072. Select one of the following options:

- If you want to continue verifying other modes, go to the *Verifying AC Current* section.
- If you do *not* want to verify other modes *and* you are performing a *post-adjustment* verification, go to the *Completing the Adjustment Procedures* section.
- If you do *not* want to verify any additional modes *and* you are performing a *pre-adjustment* verification, call `niDMM_close` to close the session.

Verifying AC Current

To verify the AC current of the NI 4070/4072, complete the following steps:

1. Reset the calibrator.
2. Fasten the connectors on one end of the Fluke 5440 cable to the NI 4070/4072 *HI SENSE* and *LO* banana plug connectors, and fasten the connectors on the other end of the cable to the *HI* and *LO* calibrator binding posts. Figure 3 shows the correct connections. Table 9 lists the cable connections.
3. Call `niDMM_reset` to reset the NI 4070/4072 to a known state.
4. Call `niDMM_ConfigureMeasurement` with the following parameters:
   - **Function** = `NIDMM_VAL_AC_CURRENT`
   - **Range** = `0.01`
   - **Resolution** = `10e-9`
5. Call `niDMM_Read` to configure the NI 4070/4072 for a current mode before applying current.
6. Output 1 mA at 1 kHz on the calibrator with the current output set to `NORM`.
7. Call `niDMM_Read`. Verify that this measurement falls between the limits listed in Table 20.
8. Output 10 mA at 1 kHz on the calibrator.
9. Call `niDMM_Read`. Verify that this measurement falls between the limits listed in Table 20.
10. Call `niDMM_ConfigureMeasurement` with the following parameters:
    - **Function** = `NIDMM_VAL_AC_CURRENT`
    - **Range** = `0.1`
    - **Resolution** = `100e-9`
11. Call `niDMM_Read`. Verify that this measurement falls between the limits listed in Table 20.
12. Output 100 mA at 1 kHz on the calibrator.
13. Call `niDMM_Read`. Verify that this measurement falls between the limits listed in Table 20.

14. Call `niDMM_ConfigureMeasurement` with the following parameters:
    - **Function** = `NIDMM_VAL_AC_CURRENT`
    - **Range** = `1`
    - **Resolution** = `1e-6`
15. Call `niDMM_Read`. Verify that this measurement falls between the limits listed in Table 20.
16. Output 1 A at 1 kHz on the calibrator.
17. Call `niDMM_Read`. Verify that this measurement falls between the limits listed in Table 20.

You have completed verifying the AC current of the NI 4070/4072. Select one of the following options:

- If you want to continue verifying other modes, go to the *Verifying Frequency* section.
- If you do *not* want to verify other modes *and* you are performing a *post-adjustment* verification, go to the *Completing the Adjustment Procedures* section.
- If you do *not* want to verify any additional modes *and* you are performing a *pre-adjustment* verification, call `niDMM_close` to close the session.

Verifying Frequency

Notes The frequency of the NI 4070/4072 is not user adjustable. If this verification procedure indicates that the frequency is out of specification, return the NI 4070/4072 to NI for repair.

This verification procedure is optional and requires additional test equipment. If you do *not* want to verify frequency, select one of the following options:

- If you are calibrating an NI 4072 and want to continue verifying other modes, go to the *Verifying Capacitance and Inductance (NI 4072 Only)* section.
- If you do *not* want to verify other modes *and* are performing a *post-adjustment* verification, go to the *Completing the Adjustment Procedures* section.
- If you do *not* want to verify any additional modes *and* you are performing a *pre-adjustment* verification, call `niDMM_close` to close the session.

To verify the frequency of the NI 4070/4072, complete the following steps:

1. Remove all connections from the NI 4070/4072.

Note Polarity is *not* important in steps 2, 3, and 5.

2. Connect one end of the coaxial cable to the Pomona 4892 double banana plug.
3. Tighten the other end of the coaxial cable in the screw terminal channels 5 and 39 of the TB-2715 terminal block.
4. Connect the TB-2715 with the coaxial cable attached to the NI 6608.
5. Plug the Pomona 4892 into the *HI* and *LO* terminals of the NI 4070/4072.
6. Call `niDMM_reset` to reset the NI 4070/4072 to a known state.
7. Call `niDMM_ConfigureMeasurement` with the following parameters:
   - **Function** = `NIDMM_VAL_FREQ`
   - **Range** = `1`
   - **Resolution** = `0`
8. Call `niDMM_ConfigureFrequencyVoltageRange` with **Voltage Range** set to `5`.
9. Call `GPCTR_Control` with the following parameters:
   - **deviceNumber** = *the device number of the NI 6608, assigned by Measurement & Automation Explorer (MAX)*
   - **gpctrNum** = `ND_COUNTER_0`
   - **action** = `ND_RESET`
10. Call `GPCTR_Set_Application` with the following parameters:
    - **deviceNumber** = *the device number of the NI 6608, assigned by MAX*
    - **gpctrNum** = `ND_COUNTER_0`
    - **application** = `ND_PULSE_TRAIN_GNR`
11. Call `GPCTR_Change_Parameter` with the following parameters:
    - **deviceNumber** = *the device number of the NI 6608, assigned by MAX*
    - **gpctrNum** = `ND_COUNTER_0`
    - **paramID** = `ND_COUNT_1`
    - **paramValue** = `10e6`

12. Call `GPCTR_Change_Parameter` with the following parameters:
    - **deviceNumber** = *the device number of the NI 6608, assigned by MAX*
    - **gpctrNum** = `ND_COUNTER_0`
    - **paramID** = `ND_COUNT_2`
    - **paramValue** = `10e6`
13. Call `GPCTR_Control` with the following parameters:
    - **deviceNumber** = *the device number of the NI 6608, assigned by MAX*
    - **gpctrNum** = `ND_COUNTER_0`
    - **action** = `ND_PROGRAM`
14. Call `niDMM_Read`. Verify that this measurement falls between the limits listed in Table 21.
15. Call `GPCTR_Control` with the following parameters:
    - **deviceNumber** = *the device number of the NI 6608, assigned by MAX*
    - **gpctrNum** = `ND_COUNTER_0`
    - **action** = `ND_RESET`
16. Repeat steps 10 through 15 with the following modification: in steps 11 and 12, change **paramValue** to `500` when you call the function `GPCTR_Change_Parameter`.
17. Repeat steps 10 through 15 with the following modification: in steps 11 and 12, change **paramValue** to `20` when you call the function `GPCTR_Change_Parameter`.

You have completed verifying the frequency of the NI 4070/4072. Select one of the following options:

- If you are calibrating an NI 4072 and want to continue verifying other modes, go to the *Verifying Capacitance and Inductance (NI 4072 Only)* section.
- If you do *not* want to verify other modes *and* you are performing a *post-adjustment* verification, go to the *Completing the Adjustment Procedures* section.
- If you do *not* want to verify any additional modes *and* you are performing a *pre-adjustment* verification, call `niDMM_close` to close the session.

Verifying Capacitance and Inductance (NI 4072 Only)

This verification procedure only applies to the NI 4072 and requires additional test equipment, as indicated in the *Additional Requirements for the NI 4072* section.

Note The NI 4072 inductance accuracy is theoretically verified if the capacitance accuracy meets the specifications. If you have access to precision inductors, you can verify the inductance measurements by comparing your results with the published accuracy specifications.

NI suggests using traceable capacitor standards with low thermal drift. You can use different verification capacitors to verify each capacitance range. You can verify two ranges with the same verification capacitor as long as its value is ≥10% of the higher capacitor range. For example, you can use a 1 nF verification capacitor to test both the 10 nF and 1 nF ranges.

After taking each measurement, verify that the measurement falls between the tolerances listed in Table 22. Tolerances are provided instead of absolute limits, because you can use capacitance verification values other than the values suggested, or the calibrated value may differ slightly from the nominal capacitance (for example, 272.43 pF instead of 270.00 pF). The tolerances shown in Table 22 correspond to the NI 4072 accuracy specifications.

The following verification procedure assumes the use of verification capacitors with the following values: 270 pF, 1 nF, 100 nF, 10 µF, and 1000 µF.

The configuration of the cables and fixtures should be consistent throughout each measurement. If you are using cables to connect the verification capacitors to the NI 4072 banana plug connectors, minimize noise by ensuring that the cables remain fixed and do not move during the measurement.

Keep direct contact with the verification capacitors to a minimum so that they are constantly kept at the ambient temperature. After connecting a capacitor to the NI 4072 terminals, NI recommends waiting 30 seconds for the capacitor temperature to stabilize.

Note You should know the total capacitance up to the banana connectors that plug into the NI 4072 before performing the verification procedure.

To verify the capacitance measurements of the NI 4072, complete the following steps:

1. Disconnect any fixtures or cables from the NI 4072.
2. Call `niDMM_reset` to reset the NI 4070/4072 to a known state.
3. Call `niDMM_ConfigureMeasurement` with the following parameters:
   - **Function** = `NIDMM_VAL_CAPACITANCE`
   - **Range** = `300e-12`
   - **Resolution** = `50e-15`
4. Set the number of averages of the NI 4072 to `20` by calling `niDMM_SetAttributeViInt32` with the following parameters:
   - **Attribute_ID** = `NIDMM_ATTR_LC_NUMBER_MEAS_TO_AVERAGE`
   - **Attribute_Value** = `20`

Note This measurement corresponds to a 0 pF capacitance.

5. Call `niDMM_Read`. Verify that this measurement falls between the tolerances listed in Table 22.
6. Plug in the insulated banana plug shorting bar across the *HI* and *LO* banana plug connectors of the NI 4072.
7. Call `niDMM_ConfigureMeasurement` with the following parameters:
   - **Function** = `NIDMM_VAL_INDUCTANCE`
   - **Range** = `10e-6`
   - **Resolution** = `1e-9`
8. Set the number of averages of the NI 4072 to `40` by calling `niDMM_SetAttributeViInt32` with the following parameters:
   - **Attribute_ID** = `NIDMM_ATTR_LC_NUMBER_MEAS_TO_AVERAGE`
   - **Attribute_Value** = `40`

Note This measurement corresponds to a 0 µH inductance.

9. Call `niDMM_Read`. Verify that this measurement falls between the tolerances listed in Table 22.
10. Remove the shorting bar and plug the 270 pF verification capacitor into the *HI* and *LO* banana plug connectors of the NI 4072. Remember to wait 30 seconds for the temperature to stabilize before performing the next step.

11. Call `niDMM_ConfigureMeasurement` with the following parameters:
    - **Function** = `NIDMM_VAL_CAPACITANCE`
    - **Range** = `300e-12`
    - **Resolution** = `50e-15`
12. Set the number of averages of the NI 4072 to `20` by calling `niDMM_SetAttributeViInt32` with the following parameters:
    - **Attribute_ID** = `NIDMM_ATTR_LC_NUMBER_MEAS_TO_AVERAGE`
    - **Attribute_Value** = `20`
13. Call `niDMM_Read`. Verify that this measurement falls between the tolerances listed in Table 22.

Note If you use capacitance verification values that differ from the values listed in Table 10, verify that each measurement falls between the tolerances listed in Table 22. The tolerances shown in Table 22 correspond to the NI 4072 accuracy specifications.

14. Remove the 270 pF verification capacitor, and plug the 1 nF verification capacitor into the *HI* and *LO* banana plug connectors of the NI 4072.
15. Call `niDMM_ConfigureMeasurement` with the following parameters:
    - **Function** = `NIDMM_VAL_CAPACITANCE`
    - **Range** = `1e-9`
    - **Resolution** = `100e-15`
16. Set the number of averages of the NI 4072 to `20` by calling `niDMM_SetAttributeViInt32` with the following parameters:
    - **Attribute_ID** = `NIDMM_ATTR_LC_NUMBER_MEAS_TO_AVERAGE`
    - **Attribute_Value** = `20`

Note If you use capacitance verification values that differ from the values listed in Table 10, verify that each measurement falls between the tolerances listed in Table 22. The tolerances shown in Table 22 correspond to the NI 4072 accuracy specifications.

17. Call `niDMM_Read`. Verify that this measurement falls between the tolerances listed in Table 22.
18. Call `niDMM_ConfigureMeasurement` with the following parameters:
    - **Function** = `NIDMM_VAL_CAPACITANCE`
    - **Range** = `10e-9`
    - **Resolution** = `1e-12`

19. Set the number of averages of the NI 4072 to `20` by calling `niDMM_SetAttributeViInt32` with the following parameters:
    - **Attribute_ID** = `NIDMM_ATTR_LC_NUMBER_MEAS_TO_AVERAGE`
    - **Attribute_Value** = `20`

Note If you use capacitance verification values that differ from the values listed in Table 10, verify that each measurement falls between the tolerances listed in Table 22. The tolerances shown in Table 22 correspond to the NI 4072 accuracy specifications.

20. Call `niDMM_Read`. Verify that this measurement falls between the tolerances listed in Table 22.
21. Remove the verification capacitor, and plug into the *HI* and *LO* banana plug connectors of the NI 4072 the next capacitor to be verified, according to Table 10.
22. Repeat steps 18 through 21, using the parameters shown in Table 10 for `niDMM_ConfigureMeasurement` and `NIDMM_ATTR_LC_NUMBER_MEAS_TO_AVERAGE` for all verification capacitors listed.

Note If you use capacitance verification values that differ from the values listed in Table 10, verify that each measurement falls between the tolerances listed in Table 22. The tolerances shown in Table 22 correspond to the NI 4072 accuracy specifications.

Table 10. niDMM_ConfigureMeasurement Parameters

Value of Verification Capacitor	niDMM Configure Measurement Parameters		Number of Averages
	Range	Resolution	
100 nF	100e-9	10e-12	20
	1e-6	100e-12	20
10 uF	10e-6	1e-9	20
	100e-6	10e-9	3
1000 uF	1e-3	100e-9	3
	10e-3	1e-6	3

You have completed verifying the capacitance and inductance of the NI 4072. Select one of the following options:

- If you are performing a pre-adjustment verification, call `niDMM_close` to close the session.
- If you are performing a post-adjustment verification, go to the *Completing the Adjustment Procedures* section.

Adjustment Procedures

This section explains how to adjust the NI 4070/4072. You can choose to perform these adjustment procedures with or without performing the verification procedures first.

The parameters **Range**, **Resolution**, **Expected Measurement**, and **Frequency** used in function calls in this section have floating point values. For example, if **Range** = `1`, the floating point value is `1.0`. Refer to the *NI Digital Multimeters Help* for more information about parameter values.

Note NI recommends repeating the verification procedures after you perform these adjustment procedures. Reverification ensures that the device you have calibrated is operating within specifications after adjustments.

Caution If you skip any of the steps within a section of the adjustment procedures, NI-DMM does *not* allow you to store your new calibration coefficients. Instead, NI-DMM restores the original coefficients to the EEPROM.

Setting Up the Test Equipment

If you have not already set up the test equipment, complete the following steps:

1. Remove all connections from the four input banana plug connectors on the NI 4070/4072.
2. Verify that the calibrator has been calibrated within the time limits specified in the *Required Test Equipment* section, and that DC zeros calibration has been performed within the last 30 days. Consult the Fluke 5700A/5720A user documentation for instructions on calibrating these devices.

Note Ensure that the calibrator is warmed up for at least 60 minutes before you begin this procedure.

3. Reset the calibrator.
4. If you have not already done so, allow the NI 4070/4072 to warm up for 60 minutes within a powered-on PXI chassis or PC.

Adjusting DC Voltage and Resistance

To adjust the DC voltage and resistance of the NI 4070/4072, complete the following steps:

1. Fasten the connectors on one end of the Fluke 5440 cable to the appropriate banana plug connectors on the NI 4070/4072, and fasten the connectors on the other end of the cable to the appropriate calibrator binding posts. Figure 1 shows the correct connections. Table 1 lists the cable connections.
2. Wait two minutes for the thermal EMF to stabilize if the cable was not previously connected in this configuration.
3. Call `niDMM_InitExtCal` with the resource descriptor of the NI 4070/4072 and your valid user password to output a calibration session (**Cal Session**) that you can use to perform NI-DMM calibration or regular measurement functions.

Note You will use **Cal Session** in all subsequent function calls.

Note The default user password for adjusting the NI 4070/4072 is `NI`. Use `niDMM_SetCalPassword` to change the password.

4. Call `niDMM_ConfigurePowerLineFrequency` with **PowerLine Frequency** set to `50` or `60`, depending on the power line frequency (in hertz) that your instruments are powered from; select `50` for 400 Hz power line frequencies.
5. Output 100 mV on the calibrator with the range locked to 2.2 V.
6. Call `niDMM_CalAdjustGain` with the following parameters:
   - **Mode** = `NIDMM_VAL_DC_VOLTS`
   - **Range** = `0.1`
   - **Input Resistance** = `NIDMM_VAL_10_MEGAOHM`
   - **Expected Measurement** = `0.1`
7. Output –100 mV on the calibrator.
8. Call `niDMM_CalAdjustGain` with the following parameters:
   - **Mode** = `NIDMM_VAL_DC_VOLTS`
   - **Range** = `0.1`
   - **Input Resistance** = `NIDMM_VAL_10_MEGAOHM`
   - **Expected Measurement** = `-0.1`
9. Output 10 V on the calibrator.

10. Call `niDMM_CalAdjustGain` with the following parameters:
    - **Mode** = `NIDMM_VAL_DC_VOLTS`
    - **Range** = `10`
    - **Input Resistance** = `NIDMM_VAL_GREATER_THAN_10_GIGAOHM`
    - **Expected Measurement** = `10`
11. Output –10 V on the calibrator.
12. Call `niDMM_CalAdjustGain` with the following parameters:
    - **Mode** = `NIDMM_VAL_DC_VOLTS`
    - **Range** = `10`
    - **Input Resistance** = `NIDMM_VAL_GREATER_THAN_10_GIGAOHM`
    - **Expected Measurement** = `-10`
13. Disconnect the Fluke 5440 cable from the NI 4070/4072 banana plug connectors, leaving the other end of the cable connected to the calibrator binding posts.
14. Plug in the insulated banana plug shorting bar across the *HI* and *LO* banana plug connectors of the NI 4070/4072.
15. Wait two minutes for the thermal EMF to stabilize.
16. Call `niDMM_CalAdjustOffset` with the following parameters:
    - **Mode** = `NIDMM_VAL_DC_VOLTS`
    - **Range** = `10`
    - **Input Resistance** = `NIDMM_VAL_GREATER_THAN_10_GIGAOHM`
17. Call `niDMM_CalAdjustMisc` with **Type** set to `NIDMM_EXTCAL_MISCCAL_VREF`.
18. Call `niDMM_CalAdjustOffset` with the following parameters:
    - **Mode** = `NIDMM_VAL_DC_VOLTS`
    - **Range** = `0.1`
    - **Input Resistance** = `NIDMM_VAL_10_MEGAOHM`
19. Remove the shorting bar, and plug the Fluke 5440 cable back into the NI 4070/4072 banana plug connectors, as shown in Figure 1.
20. Wait one minute for the thermal EMF to stabilize.
21. Output 10 MΩ from the calibrator without external sense.
22. Call `niDMM_CalAdjustGain` with the following parameters:
    - **Mode** = `NIDMM_VAL_2_WIRE_RES`
    - **Range** = `10e6`
    - **Input Resistance** = `NIDMM_VAL_RESISTANCE_NA`
    - **Expected Value** = *the display on the calibrator for 10 MΩ*

23. Output 0 Ω from the calibrator without external sense or 2-wire compensation.
24. Call `niDMM_CalAdjustGain` with the following parameters:
    - **Mode** = `NIDMM_VAL_2_WIRE_RES`
    - **Range** = `10e6`
    - **Input Resistance** = `NIDMM_VAL_RESISTANCE_NA`
    - **Expected Value** = *the display on the calibrator for 0* Ω
25. Call `niDMM_CalAdjustOffset` with the following parameters:
    - **Mode** = `NIDMM_VAL_2_WIRE_RES`
    - **Range** = `10e6`
    - **Input Resistance** = `NIDMM_VAL_RESISTANCE_NA`
26. Disconnect the Fluke 5440 cable from the NI 4070/4072.
27. Call `niDMM_CalAdjustMisc` with **Type** set to `NIDMM_EXTCAL_MISCCAL_ZINT`.
28. Call `niDMM_CalAdjustMisc` with **Type** set to `NIDMM_EXTCAL_MISCCAL_2WIRELEAKAGE`.
29. On the NI 4070/4072, plug a Pomona B-4 banana cable from the *HI* input to the *HI SENSE* input. Plug another Pomona B-4 banana cable from the *LO* input to the *LO SENSE* input.

Caution Make sure that the insulation of these cables does *not* touch.

30. Call `niDMM_CalAdjustMisc` with **Type** set to `NIDMM_EXTCAL_MISCCAL_4WIRELEAKAGE`.
31. Remove the banana cables, and plug the two sets of Fluke 5440 cables into the appropriate banana plug connectors on the NI 4070/4072, as shown in Figure 2 for 4-wire resistance.
32. Wait two minutes for the thermal EMF to stabilize.
33. Output 100 MΩ from the calibrator without external sense.
34. Call `niDMM_CalAdjustGain` with the following parameters:
    - **Mode** = `NIDMM_VAL_2_WIRE_RES`
    - **Range** = `100e6`
    - **Input Resistance** = `NIDMM_VAL_RESISTANCE_NA`
    - **Expected Value** = *the display on the calibrator for 100 M*Ω
35. Output 0 Ω from the calibrator without external sense or 2-wire compensation.

36. Call `niDMM_CalAdjustGain` with the following parameters:
    - **Mode** = `NIDMM_VAL_2_WIRE_RES`
    - **Range** = `100e6`
    - **Input Resistance** = `NIDMM_VAL_RESISTANCE_NA`
    - **Expected Value** = *the display on the calibrator for 0* Ω
37. Call `niDMM_CalAdjustOffset` with the following parameters:
    - **Mode** = `NIDMM_VAL_2_WIRE_RES`
    - **Range** = `100e6`
    - **Input Resistance** = `NIDMM_VAL_RESISTANCE_NA`
38. Output 100 kΩ on the calibrator with external sense turned on but without 2-wire compensation.
39. Call `niDMM_CalAdjustGain` with the following parameters:
    - **Mode** = `NIDMM_VAL_4_WIRE_RES`
    - **Range** = `100e3`
    - **Input Resistance** = `NIDMM_VAL_RESISTANCE_NA`
    - **Expected Value** = *the display on the calibrator for 100 k*Ω
40. Output 0 Ω on the calibrator with external sense turned on but without 2-wire compensation.
41. Call `niDMM_CalAdjustGain` with the following parameters:
    - **Mode** = `NIDMM_VAL_4_WIRE_RES`
    - **Range** = `100e3`
    - **Input Resistance** = `NIDMM_VAL_RESISTANCE_NA`
    - **Expected Value** = *the display on the calibrator for 0* Ω
42. Output 10 kΩ on the calibrator with external sense turned on but without 2-wire compensation.
43. Call `niDMM_CalAdjustGain` with the following parameters:
    - **Mode** = `NIDMM_VAL_4_WIRE_RES`
    - **Range** = `10e3`
    - **Input Resistance** = `NIDMM_VAL_RESISTANCE_NA`
    - **Expected Value** = *the display on the calibrator for 10 k*Ω
44. Output 0 Ω on the calibrator with external sense turned on but without 2-wire compensation.
45. Call `niDMM_CalAdjustOffset` with the following parameters:
    - **Mode** = `NIDMM_VAL_4_WIRE_RES`
    - **Range** = `100e3`
    - **Input Resistance** = `NIDMM_VAL_RESISTANCE_NA`

46. Call `niDMM_CalAdjustOffset` with the following parameters:
    - **Mode** = `NIDMM_VAL_4_WIRE_RES`
    - **Range** = `10e3`
    - **Input Resistance** = `NIDMM_VAL_RESISTANCE_NA`
47. Call `niDMM_CalAdjustMisc` with **Type** set to `NIDMM_EXTCAL_MISCAL_RREF`.
48. Call `niDMM_SelfCal` to self-calibrate the NI 4070/4072.
49. Output 0 Ω on the calibrator with external sense turned on but with 2-wire compensation turned off.
50. Call `niDMM_CalAdjustOffset` with the following parameters:
    - **Mode** = `NIDMM_VAL_4_WIRE_RES`
    - **Range** = `10e6`
    - **Input Resistance** = `NIDMM_VAL_RESISTANCE_NA`
51. Call `niDMM_CalAdjustOffset` with the following parameters:
    - **Mode** = `NIDMM_VAL_4_WIRE_RES`
    - **Range** = `1e6`
    - **Input Resistance** = `NIDMM_VAL_RESISTANCE_NA`
52. Call `niDMM_CalAdjustOffset` with the following parameters:
    - **Mode** = `NIDMM_VAL_4_WIRE_RES`
    - **Range** = `1e3`
    - **Input Resistance** = `NIDMM_VAL_RESISTANCE_NA`
53. Call `niDMM_CalAdjustOffset` with the following parameters:
    - **Mode** = `NIDMM_VAL_4_WIRE_RES`
    - **Range** = `100`
    - **Input Resistance** = `NIDMM_VAL_RESISTANCE_NA`
54. Remove the Fluke 5440 cables from the NI 4070/4072, leaving the other end of the cables connected to the calibrator.
55. Plug in the insulated shorting bar across the *HI* and *LO* banana plug connectors of the NI 4070/4072.
56. Wait two minutes for the thermal EMF to stabilize.
57. Call `niDMM_CalAdjustOffset` with the following parameters:
    - **Mode** = `NIDMM_VAL_2_WIRE_RES`
    - **Range** = `10e6`
    - **Input Resistance** = `NIDMM_VAL_RESISTANCE_NA`

58. Call `niDMM_CalAdjustOffset` with the following parameters:
    - **Mode** = `NIDMM_VAL_2_WIRE_RES`
    - **Range** = `1e6`
    - **Input Resistance** = `NIDMM_VAL_RESISTANCE_NA`
59. Call `niDMM_CalAdjustOffset` with the following parameters:
    - **Mode** = `NIDMM_VAL_2_WIRE_RES`
    - **Range** = `100e3`
    - **Input Resistance** = `NIDMM_VAL_RESISTANCE_NA`
60. Call `niDMM_CalAdjustOffset` with the following parameters:
    - **Mode** = `NIDMM_VAL_2_WIRE_RES`
    - **Range** = `10e3`
    - **Input Resistance** = `NIDMM_VAL_RESISTANCE_NA`
61. Call `niDMM_CalAdjustOffset` with the following parameters:
    - **Mode** = `NIDMM_VAL_2_WIRE_RES`
    - **Range** = `1e3`
    - **Input Resistance** = `NIDMM_VAL_RESISTANCE_NA`
62. Call `niDMM_CalAdjustOffset` with the following parameters:
    - **Mode** = `NIDMM_VAL_2_WIRE_RES`
    - **Range** = `100`
    - **Input Resistance** = `NIDMM_VAL_RESISTANCE_NA`
63. Call `niDMM_CalAdjustMisc` with **Type** set to `NIDMM_EXTCAL_MISCCAL_SECTION`.

You have completed adjusting the DC voltage and resistance modes of the NI 4070/4072. Select one of the following options:

- If you are performing additional adjustments, refer to the following sections, as applicable:
    - *Adjusting AC Voltage (AC- and DC-Coupled) Modes*
    - *Adjusting Current Modes*
    - *Adjusting Capacitance and Inductance (NI 4072 Only)*

Caution For the NI 4072, adjusting the capacitance and inductance is required. Skipping this step causes an incorrect adjustment of the device.

- If you are *not* performing additional adjustments, refer to one of the following sections:
  - *Verification Procedures*—to verify your new calibration coefficients before saving them to the EEPROM
  - *Completing the Adjustment Procedures*—if you do *not* want to verify the adjustments you have just made

Adjusting AC Voltage (AC- and DC-Coupled) Modes

Note If you do not use the AC voltage modes for any measurements, or the accuracy of these modes is irrelevant, you can skip this section in the calibration procedure and go directly to the *Adjusting Current Modes* section.

To adjust the AC voltage of the NI 4070/4072, complete the following steps:

1. Reset the calibrator.
2. Fasten the connectors on one end of the Fluke 5440 cable into the appropriate banana plug connectors on the NI 4070/4072, and fasten the connectors on the other end of the cable to the appropriate calibrator binding posts. Figure 1 shows the correct connections. Table 1 lists the cable connections.
3. Refer to Table 11 for the appropriate calibrator output and parameter values as you complete the following steps:
   a. On the calibrator, output the value listed in the *Calibrator Output* column in Table 11 for the current iteration.
   b. Call `niDMM_CalAdjustGain` with **Mode** set to `NIDMM_VAL_AC_VOLTS`. Set the remaining parameters as shown in Table 11 for the current iteration.
   c. Call `niDMM_CalAdjustGain` again, changing **Mode** to `NIDMM_VAL_AC_VOLTS_DCCOUPLED`.
4. Repeat step 3 for each of the remaining iterations listed in Table 11.

Table 11. niDMM_CalAdjustGain Parameters

	Calibrator Output		niDMM_CalAdjustGain Parameters			
Iteration	**Amplitude**	**f (kHz)**	**Mode**	**Range (V)**	**Input Resistance**	**Expected Value**
1	50 mV	1	NIDMM_VAL_AC_VOLTS	0.05	NIDMM_VAL_1_MEGAOHM	0.05
	50 mV	1	NIDMM_VAL_AC_VOLTS_DCCOUPLED	0.05	NIDMM_VAL_1_MEGAOHM	0.05
2	500 mV	1	NIDMM_VAL_AC_VOLTS	0.5	NIDMM_VAL_1_MEGAOHM	0.5
	500 mV	1	NIDMM_VAL_AC_VOLTS_DCCOUPLED	0.5	NIDMM_VAL_1_MEGAOHM	0.5

Table 11. niDMM_CalAdjustGain Parameters (Continued)

Iteration	Calibrator Output		niDMM_CalAdjustGain Parameters			
	Amplitude	f (kHz)	Mode	Range (V)	Input Resistance	Expected Value
3	5 V	1	`NIDMM_VAL_AC_VOLTS`	5	`NIDMM_VAL_1_MEGAOHM`	5
	5 V	1	`NIDMM_VAL_AC_VOLTS_DCCOUPLED`	5	`NIDMM_VAL_1_MEGAOHM`	5
4	50 V	1	`NIDMM_VAL_AC_VOLTS`	50	`NIDMM_VAL_1_MEGAOHM`	50
	50 V	1	`NIDMM_VAL_AC_VOLTS_DCCOUPLED`	50	`NIDMM_VAL_1_MEGAOHM`	50
5	100 V	1	`NIDMM_VAL_AC_VOLTS`	300	`NIDMM_VAL_1_MEGAOHM`	100
	100 V	1	`NIDMM_VAL_AC_VOLTS_DCCOUPLED`	300	`NIDMM_VAL_1_MEGAOHM`	100

5. Refer to Table 12 for the appropriate parameter values as you complete the following steps:
   a. Output 0 V on the calibrator.
   b. Call `niDMM_CalAdjustOffset` with **Mode** set to `NIDMM_VAL_AC_VOLTS` and the remaining parameters as shown in Table 12 for the current iteration.
   c. Call `niDMM_CalAdjustOffset` again, changing **Mode** to `NIDMM_VAL_AC_VOLTS_DCCOUPLED`.
6. Repeat step 5 for each of the remaining iterations shown in Table 12.

Table 12. niDMM_CalAdjustOffset Parameters

Iteration	niDMM_CalAdjustOffset Parameters		
	Mode	Range (V)	Input Resistance (Ω)
1	`NIDMM_VAL_AC_VOLTS`	0.05	`NIDMM_VAL_1_MEGAOHM`
	`NIDMM_VAL_AC_VOLTS_DCCOUPLED`	0.05	`NIDMM_VAL_1_MEGAOHM`
2	`NIDMM_VAL_AC_VOLTS`	0.5	`NIDMM_VAL_1_MEGAOHM`
	`NIDMM_VAL_AC_VOLTS_DCCOUPLED`	0.5	`NIDMM_VAL_1_MEGAOHM`
3	`NIDMM_VAL_AC_VOLTS`	5	`NIDMM_VAL_1_MEGAOHM`
	`NIDMM_VAL_AC_VOLTS_DCCOUPLED`	5	`NIDMM_VAL_1_MEGAOHM`
4	`NIDMM_VAL_AC_VOLTS`	50	`NIDMM_VAL_1_MEGAOHM`
	`NIDMM_VAL_AC_VOLTS_DCCOUPLED`	50	`NIDMM_VAL_1_MEGAOHM`
5	`NIDMM_VAL_AC_VOLTS`	300	`NIDMM_VAL_1_MEGAOHM`
	`NIDMM_VAL_AC_VOLTS_DCCOUPLED`	300	`NIDMM_VAL_1_MEGAOHM`

7. Refer to Table 13 for the appropriate calibrator outputs and parameter values as you complete the following steps:
   a. On the calibrator, output the value listed in the *Calibrator Output* column in Table 13 for the current iteration.
   b. Call `niDMM_CalAdjustACFilter` with **Mode** set to `NIDMM_VAL_AC_VOLTS` and the remaining parameters as shown in Table 13 for the current iteration.

Note The **Session** parameter remains the same for all instances of this function.

   c. Call `niDMM_CalAdjustACFilter` again, changing **Mode** to `NIDMM_VAL_AC_VOLTS_DCCOUPLED`.
8. Repeat step 7 for each of the remaining iterations shown in Table 13.

Table 13. niDMM_CalAdjustACFilter Parameters

Iteration	Calibrator Output		niDMM_CalAdjustACFilter Parameters		
	Amplitude	Frequency (kHz)	Mode	Range (V)	Frequency (Hz)
1	50 mV	1	NIDMM_VAL_AC_VOLTS	0.05	1e3
	50 mV	1	NIDMM_VAL_AC_VOLTS_DCCOUPLED	0.05	1e3
2	50 mV	5	NIDMM_VAL_AC_VOLTS	0.05	5e3
	50 mV	5	NIDMM_VAL_AC_VOLTS_DCCOUPLED	0.05	5e3
3	50 mV	20	NIDMM_VAL_AC_VOLTS	0.05	20e3
	50 mV	20	NIDMM_VAL_AC_VOLTS_DCCOUPLED	0.05	20e3
4	50 mV	50	NIDMM_VAL_AC_VOLTS	0.05	50e3
	50 mV	50	NIDMM_VAL_AC_VOLTS_DCCOUPLED	0.05	50e3
5	50 mV	100	NIDMM_VAL_AC_VOLTS	0.05	100e3
	50 mV	100	NIDMM_VAL_AC_VOLTS_DCCOUPLED	0.05	100e3
6	50 mV	200	NIDMM_VAL_AC_VOLTS	0.05	200e3
	50 mV	200	NIDMM_VAL_AC_VOLTS_DCCOUPLED	0.05	200e3
7	50 mV	300	NIDMM_VAL_AC_VOLTS	0.05	300e3
	50 mV	300	NIDMM_VAL_AC_VOLTS_DCCOUPLED	0.05	300e3
8	50 mV	500	NIDMM_VAL_AC_VOLTS	0.05	500e3
	50 mV	500	NIDMM_VAL_AC_VOLTS_DCCOUPLED	0.05	500e3
9	500 mV	1	NIDMM_VAL_AC_VOLTS	0.5	1e3
	500 mV	1	NIDMM_VAL_AC_VOLTS_DCCOUPLED	0.5	1e3

Table 13. niDMM_CalAdjustACFilter Parameters (Continued)

Iteration	Calibrator Output		niDMM_CalAdjustACFilter Parameters		
	Amplitude	Frequency (kHz)	Mode	Range (V)	Frequency (Hz)
10	500 mV	5	NIDMM_VAL_AC_VOLTS	0.5	5e3
	500 mV	5	NIDMM_VAL_AC_VOLTS_DCCOUPLED	0.5	5e3
11	500 mV	20	NIDMM_VAL_AC_VOLTS	0.5	20e3
	500 mV	20	NIDMM_VAL_AC_VOLTS_DCCOUPLED	0.5	20e3
12	500 mV	50	NIDMM_VAL_AC_VOLTS	0.5	50e3
	500 mV	50	NIDMM_VAL_AC_VOLTS_DCCOUPLED	0.5	50e3
13	500 mV	100	NIDMM_VAL_AC_VOLTS	0.5	100e3
	500 mV	100	NIDMM_VAL_AC_VOLTS_DCCOUPLED	0.5	100e3
14	500 mV	200	NIDMM_VAL_AC_VOLTS	0.5	200e3
	500 mV	200	NIDMM_VAL_AC_VOLTS_DCCOUPLED	0.5	200e3
15	500 mV	300	NIDMM_VAL_AC_VOLTS	0.5	300e3
	500 mV	300	NIDMM_VAL_AC_VOLTS_DCCOUPLED	0.5	300e3
16	500 mV	500	NIDMM_VAL_AC_VOLTS	0.5	500e3
	500 mV	500	NIDMM_VAL_AC_VOLTS_DCCOUPLED	0.5	500e3
17	5 V	1	NIDMM_VAL_AC_VOLTS	5	1e3
	5 V	1	NIDMM_VAL_AC_VOLTS_DCCOUPLED	5	1e3
18	5 V	5	NIDMM_VAL_AC_VOLTS	5	5e3
	5 V	5	NIDMM_VAL_AC_VOLTS_DCCOUPLED	5	5e3
19	5 V	20	NIDMM_VAL_AC_VOLTS	5	20e3
	5 V	20	NIDMM_VAL_AC_VOLTS_DCCOUPLED	5	20e3
20	5 V	50	NIDMM_VAL_AC_VOLTS	5	50e3
	5 V	50	NIDMM_VAL_AC_VOLTS_DCCOUPLED	5	50e3
21	5 V	100	NIDMM_VAL_AC_VOLTS	5	100e3
	5 V	100	NIDMM_VAL_AC_VOLTS_DCCOUPLED	5	100e3
22	5 V	200	NIDMM_VAL_AC_VOLTS	5	200e3
	5 V	200	NIDMM_VAL_AC_VOLTS_DCCOUPLED	5	200e3
23	5 V	300	NIDMM_VAL_AC_VOLTS	5	300e3
	5 V	300	NIDMM_VAL_AC_VOLTS_DCCOUPLED	5	300e3

Table 13. niDMM_CalAdjustACFilter Parameters (Continued)

Iteration	Calibrator Output		niDMM_CalAdjustACFilter Parameters		
	Amplitude	Frequency (kHz)	Mode	Range (V)	Frequency (Hz)
24	5 V	500	NIDMM_VAL_AC_VOLTS	5	500e3
	5 V	500	NIDMM_VAL_AC_VOLTS_DCCOUPLED	5	500e3
25	50 V	1	NIDMM_VAL_AC_VOLTS	50	1e3
	50 V	1	NIDMM_VAL_AC_VOLTS_DCCOUPLED	50	1e3
26	50 V	5	NIDMM_VAL_AC_VOLTS	50	5e3
	50 V	5	NIDMM_VAL_AC_VOLTS_DCCOUPLED	50	5e3
27	50 V	20	NIDMM_VAL_AC_VOLTS	50	20e3
	50 V	20	NIDMM_VAL_AC_VOLTS_DCCOUPLED	50	20e3
28	50 V	50	NIDMM_VAL_AC_VOLTS	50	50e3
	50 V	50	NIDMM_VAL_AC_VOLTS_DCCOUPLED	50	50e3
29	50 V	100	NIDMM_VAL_AC_VOLTS	50	100e3
	50 V	100	NIDMM_VAL_AC_VOLTS_DCCOUPLED	50	100e3
30	50 V	200	NIDMM_VAL_AC_VOLTS	50	200e3
	50 V	200	NIDMM_VAL_AC_VOLTS_DCCOUPLED	50	200e3
31	50 V	300	NIDMM_VAL_AC_VOLTS	50	300e3
	50 V	300	NIDMM_VAL_AC_VOLTS_DCCOUPLED	50	300e3
32	10 V	500	NIDMM_VAL_AC_VOLTS	50	500e3
	10 V	500	NIDMM_VAL_AC_VOLTS_DCCOUPLED	50	500e3
33	100 V	1	NIDMM_VAL_AC_VOLTS	300	1e3
	100 V	1	NIDMM_VAL_AC_VOLTS_DCCOUPLED	300	1e3
34	100 V	5	NIDMM_VAL_AC_VOLTS	300	5e3
	100 V	5	NIDMM_VAL_AC_VOLTS_DCCOUPLED	300	5e3
35	100 V	20	NIDMM_VAL_AC_VOLTS	300	20e3
	100 V	20	NIDMM_VAL_AC_VOLTS_DCCOUPLED	300	20e3
36	100 V	50	NIDMM_VAL_AC_VOLTS	300	50e3
	100 V	50	NIDMM_VAL_AC_VOLTS_DCCOUPLED	300	50e3
37	100 V	100	NIDMM_VAL_AC_VOLTS	300	100e3
	100 V	100	NIDMM_VAL_AC_VOLTS_DCCOUPLED	300	100e3

Table 13. niDMM_CalAdjustACFilter Parameters (Continued)

Iteration	Calibrator Output		niDMM_CalAdjustACFilter Parameters		
	Amplitude	Frequency (kHz)	Mode	Range (V)	Frequency (Hz)
38	100 V	200	`NIDMM_VAL_AC_VOLTS`	`300`	`200e3`
	100 V	200	`NIDMM_VAL_AC_VOLTS_DCCOUPLED`	`300`	`200e3`
39	50 V	300	`NIDMM_VAL_AC_VOLTS`	`300`	`300e3`
	50 V	300	`NIDMM_VAL_AC_VOLTS_DCCOUPLED`	`300`	`300e3`
40	10 V	500	`NIDMM_VAL_AC_VOLTS`	`300`	`500e3`
	10 V	500	`NIDMM_VAL_AC_VOLTS_DCCOUPLED`	`300`	`500e3`

9. Reset the calibrator for safety reasons.
10. Call `niDMM_CalAdjustMisc` with **Type** set to `NIDMM_EXTCAL_MISCCAL_SECTION`.

You have completed adjusting the AC voltage modes of the NI 4070/4072. Select one of the following options:

- If you are performing additional adjustments, refer to the following sections, as applicable:
  - *Adjusting Current Modes*
  - *Adjusting Capacitance and Inductance (NI 4072 Only)*

Caution For the NI 4072, adjusting the capacitance and inductance is required. Skipping this step causes an incorrect adjustment of the device.

- If you are *not* performing additional adjustments, refer to one of the following sections:
  - *Verification Procedures*—to verify your new calibration coefficients before saving them to the EEPROM
  - *Completing the Adjustment Procedures*—if you do *not* want to verify the adjustments you have just made

Adjusting Current Modes

If you do not use the current modes (DC and AC), or the accuracy is insignificant for your application, you can skip this section and select one of the following options:

- If you skip this section and you are calibrating an NI 4072, go to the *Adjusting Capacitance and Inductance (NI 4072 Only)* section.

- If you skip this section and you want to verify the new calibration coefficients before saving them to the EEPROM, repeat the *Verification Procedures* section (except for *Initial Setup*).
- If you skip this section and you do not want to verify the new calibration coefficients, go to the *Completing the Adjustment Procedures* section.

To adjust the current modes of the NI 4070/4072, complete the following steps:

1. Reset the calibrator.
2. Fasten the connectors on one end of the Fluke 5440 cable to the NI 4070/4072 *HI SENSE* and *LO* banana plug connectors, and fasten the connectors on the other end of the cable to the *HI* and *LO* calibrator binding posts. Figure 3 shows the correct connections. Table 9 lists the cable connections.
3. Call `niDMM_ConfigureMeasurement` with the following parameters:
    - **Function** = `NIDMM_VAL_DC_CURRENT`
    - **Range** = `0.02`
4. Call `niDMM_Read` to configure the NI 4070/4072 for a current mode before applying current.
5. Output 20 mA on the calibrator with the current output set to `NORM`.
6. Call `niDMM_CalAdjustGain` with the following parameters:
    - **Mode** = `NIDMM_VAL_DC_CURRENT`
    - **Range** = `0.02`
    - **Input Resistance** = `NIDMM_VAL_RESISTANCE_NA`
    - **Expected Value** = `0.02`
7. Output –20 mA on the calibrator with the current output set to `NORM`.
8. Call `niDMM_CalAdjustGain` with the following parameters:
    - **Mode** = `NIDMM_VAL_DC_CURRENT`
    - **Range** = `0.02`
    - **Input Resistance** = `NIDMM_VAL_RESISTANCE_NA`
    - **Expected Value** = `–0.02`
9. Output 0 A on the calibrator.
10. Call `niDMM_CalAdjustOffset` with the following parameters:
    - **Mode** = `NIDMM_VAL_DC_CURRENT`
    - **Range** = `0.02`
    - **Input Resistance** = `NIDMM_VAL_RESISTANCE_NA`

11. Call `niDMM_CalAdjustOffset` with the following parameters:
    - **Mode** = NIDMM_VAL_AC_CURRENT
    - **Range** = 0.01
    - **Input Resistance** = NIDMM_VAL_RESISTANCE_NA
12. Output 200 mA on the calibrator.
13. Call `niDMM_CalAdjustGain` with the following parameters:
    - **Mode** = NIDMM_VAL_DC_CURRENT
    - **Range** = 0.2
    - **Input Resistance** = NIDMM_VAL_RESISTANCE_NA
    - **Expected Value** = 0.2
14. Output –200 mA on the calibrator.
15. Call `niDMM_CalAdjustGain` with the following parameters:
    - **Mode** = NIDMM_VAL_DC_CURRENT
    - **Range** = 0.2
    - **Input Resistance** = NIDMM_VAL_RESISTANCE_NA
    - **Expected Value** = –0.2
16. Output 0 A on the calibrator.
17. Call `niDMM_CalAdjustOffset` with the following parameters:
    - **Mode** = NIDMM_VAL_DC_CURRENT
    - **Range** = 0.2
    - **Input Resistance** = NIDMM_VAL_RESISTANCE_NA
18. Call `niDMM_CalAdjustOffset` with the following parameters:
    - **Mode** = NIDMM_VAL_AC_CURRENT
    - **Range** = 0.1
    - **Input Resistance** = NIDMM_VAL_RESISTANCE_NA
19. Output 1 A on the calibrator.
20. Call `niDMM_CalAdjustGain` with the following parameters:
    - **Mode** = NIDMM_VAL_DC_CURRENT
    - **Range** = 1
    - **Input Resistance** = NIDMM_VAL_RESISTANCE_NA
    - **Expected Value** = 1
21. Output –1 A on the calibrator.

22. Call `niDMM_CalAdjustGain` with the following parameters:
    - **Mode** = `NIDMM_VAL_DC_CURRENT`
    - **Range** = `1`
    - **Input Resistance** = `NIDMM_VAL_RESISTANCE_NA`
    - **Expected Value** = `–1`
23. Output 0 A on the calibrator with the current output set to `NORM`.
24. Call `niDMM_CalAdjustOffset` with the following parameters:
    - **Mode** = `NIDMM_VAL_DC_CURRENT`
    - **Range** = `1`
    - **Input Resistance** = `NIDMM_VAL_RESISTANCE_NA`
25. Call `niDMM_CalAdjustOffset` with the following parameters:
    - **Mode** = `NIDMM_VAL_AC_CURRENT`
    - **Range** = `1`
    - **Input Resistance** = `NIDMM_VAL_RESISTANCE_NA`
26. Call `niDMM_CalAdjustMisc` with **Type** set to `NIDMM_EXTCAL_MISCCAL_SECTION`.

You have completed adjusting the current modes of the NI 4070/4072. Select one of the following options:

♦ If you are calibrating an NI 4070, refer to one of the following sections:
- *Verification Procedures*—to verify your new calibration coefficients before saving them to the EEPROM
- *Completing the Adjustment Procedures*—if you do *not* want to verify the adjustments you have just made

♦ If you are calibrating an NI 4072, refer to the *Adjusting Capacitance and Inductance (NI 4072 Only)* section.

Adjusting Capacitance and Inductance (NI 4072 Only)

♦ If you are calibrating an NI 4070, skip this section and select one of the following options:
- If you want to verify the new calibration coefficients before saving them to the EEPROM, repeat the *Verification Procedures* section (except for the *Initial Setup* section).
- If you do *not* want to verify the new calibration coefficients, go to the *Completing the Adjustment Procedures* section.

- ♦ If you are calibrating an NI 4072, you *must* complete this section to attain a valid calibration.

Caution It is necessary to adjust DC voltage and resistance before running these adjustment steps. During this procedure, be sure to keep hands and any other moving objects away from the fixture after calling every function.

To adjust the capacitance and inductance of the NI 4072, complete the following steps:

1. Disconnect any fixtures or cables from the NI 4072.
2. Call `niDMM_CalAdjustLC` with **Type** set to `NIDMM_EXTCAL_LC_OPEN`.
3. Plug in the insulated banana plug shorting bar across the *HI* and *LO* banana plug connectors of the NI 4072.
4. Call `niDMM_CalAdjustLC` with **Type** set to `NIDMM_EXTCAL_LC_SHORT`.
5. Remove the shorting bar and plug the 25 Ω resistor across the *HI* and *LO* banana plug connectors of the NI 4072. The leads between the resistor and the NI 4072 terminals should be ≤1 in.
6. Wait 30 seconds for the thermal EMF to stabilize.
7. Call `niDMM_CalAdjustLC` with **Type** set to `NIDMM_EXTCAL_LC_25OHM`.
8. Remove the resistor, and plug in across the *HI* and *LO* banana plug connectors of the NI 4072 the next adjustment resistor, according to Table 14.
9. Repeat steps 6 through 8 using the parameters shown in Table 14 for `niDMM_CalAdjustLC`.

Table 14. niDMM_CalAdjustLC Parameters

Value of Resistor	niDMM_CalAdjustLC Parameters
	Type
125 Ω	`NIDMM_EXTCAL_LC_1KOHM`
5 kΩ	`NIDMM_EXTCAL_LC_5KOHM`
100 kΩ	`NIDMM_EXTCAL_LC_100KOHM`

You have completed adjusting the capacitance and inductance modes of the NI 4072. Select one of the following options:

- To verify that the NI 4072 is now operating within its specifications, go to the *Verification Procedures* section and complete the appropriate procedures.

- To finish the calibration and close the session, go to the *Completing the Adjustment Procedures* section.

Completing the Adjustment Procedures

To complete the adjustment procedure for the NI 4070/4072 and close the session, call `niDMM_CloseExtCal` with the following parameter:

- **Action** = `NIDMM_EXTCAL_ACTION_SAVE` if the results of the calibration were satisfactory and you want to save the new calibration coefficients to the EEPROM.

  Otherwise,

- **Action** = `NIDMM_EXTCAL_ACTION_ABORT` if the results of the calibration were unsatisfactory and you want to restore the original calibration coefficients to the EEPROM.

Verification Limits

This section includes the verification limits for DC voltage, AC voltage, 4-wire resistance, 2-wire resistance, DC current, AC current, and frequency for the NI 4070/4072*,* and the verification tolerances for capacitance on the NI 4072. Compare these limits to the results you obtain in the *Verification Procedures* section.

Note Use the values in the *24-Hour Limits* column for a post-adjustment verification *only*. Otherwise, use the values in the *2-Year Limits* column.

Limits in the following tables are based upon the February 2007 edition of the *NI 4070/4072 Specifications*. Refer to the most recent NI 4070/4072 specifications online at `ni.com/manuals`. If a more recent edition of the specifications is available, recalculate the limits based upon the latest specifications.

DC Voltage

Table 15. NI 4070/4072 DC Voltage Verification Limits

Calibrator Amplitude	Range	Input Resistance	2-Year Limits		24-Hour Limits	
			Lower	Upper	Lower	Upper
0 V	1 V	>10 GΩ/10 MΩ	–6 µV	6 µV	–2 µV	2 µV
0 V	10 V	>10 GΩ/10 MΩ	–60 µV	60 µV	–20 µV	20 µV
0 V	100 V	10 MΩ	–600 µV	600 µV	–200 µV	200 µV
0 V	300 V	10 MΩ	–6 mV	6 mV	–1.8 mV	1.8 mV
100 mV	100 mV	>10 GΩ/10 MΩ	0.099994 V	0.100006 V	0.099998 V	0.100002 V

Table 15. NI 4070/4072 DC Voltage Verification Limits (Continued)

Calibrator Amplitude	Range	Input Resistance	2-Year Limits		24-Hour Limits	
			Lower	Upper	Lower	Upper
–100 mV	100 mV	>10 GΩ/10 MΩ	–0.100006 V	–0.099994 V	–0.100002 V	–0.099998 V
1 V	1 V	>10 GΩ/10 MΩ	0.999969 V	1.000031 V	0.999992 V	1.000008 V
–1 V	1 V	>10 GΩ/10 MΩ	–1.000031 V	–0.999969 V	–1.000008 V	–0.999992 V
10 V	10 V	>10 GΩ/10 MΩ	9.99969 V	10.00031 V	9.99994 V	10.00006 V
–10 V	10 V	>10 GΩ/10 MΩ	–10.00031 V	–9.99969 V	–10.00006 V	–9.99994 V
100 V	100 V	10 MΩ	99.9959 V	100.0041 V	99.9992 V	100.0008 V
–100 V	100 V	10 MΩ	–100.0041 V	–99.9959 V	–100.0008 V	–99.9992 V
300 V	300 V	10 MΩ	299.9835 V	300.0165 V	299.9964 V	300.0036 V
–300 V	300 V	10 MΩ	–300.0165 V	–299.9835 V	–300.0036 V	–299.9964 V

AC Voltage

Table 16. NI 4070/4072 AC Voltage Verification Limits

Calibrator Output		Range	Coupling	2-Year Limits	
Amplitude	Frequency			Lower	Upper
5 mV	1 kHz	50 mV	AC/DC	0.0049775 V	0.0050225 V
50 mV	30 Hz	50 mV	DC	0.04993 V	0.05007 V
50 mV	50 Hz	50 mV	AC/DC	0.049955 V	0.050045 V
50 mV	1 kHz	50 mV	AC/DC	0.049955 V	0.050045 V
50 mV	1 kHz	500 mV	AC/DC	0.049875 V	0.050125 V
50 mV	20 kHz	50 mV	AC/DC	0.049955 V	0.050045 V
50 mV	50 kHz	50 mV	AC/DC	0.049935 V	0.050065 V
50 mV	100 kHz	50 mV	AC/DC	0.04971 V	0.05029 V
50 mV	300 kHz	50 mV	AC/DC	0.04845 V	0.05155 V
500 mV	30 Hz	500 mV	DC	0.49945 V	0.50055 V
500 mV	50 Hz	500 mV	AC/DC	0.49965 V	0.50035 V
500 mV	1 kHz	500 mV	AC/DC	0.49965 V	0.50035 V
500 mV	1 kHz	5 V	AC/DC	0.49875 V	0.50125 V
500 mV	20 kHz	500 mV	AC/DC	0.49965 V	0.50035 V
500 mV	50 kHz	500 mV	AC/DC	0.49945 V	0.50055 V

Table 16. NI 4070/4072 AC Voltage Verification Limits (Continued)

Calibrator Output		Range	Coupling	2-Year Limits	
Amplitude	Frequency			Lower	Upper
500 mV	100 kHz	500 mV	AC/DC	0.4974 V	0.5026 V
500 mV	300 kHz	500 mV	AC/DC	0.48475 V	0.51525 V
5 V	30 Hz	5 V	DC	4.9945 V	5.0055 V
5 V	50 Hz	5 V	AC/DC	4.9965 V	5.0035 V
5 V	1 kHz	5 V	AC/DC	4.9965 V	5.0035 V
5 V	1 kHz	50 V	AC/DC	4.9875 V	5.0125 V
5 V	1 kHz	300 V	AC/DC	4.9375 V	5.0625 V
5 V	20 kHz	5 V	AC/DC	4.9965 V	5.0035 V
5 V	50 kHz	5 V	AC/DC	4.9945 V	5.0055 V
5 V	100 kHz	5 V	AC/DC	4.974 V	5.026 V
5 V	300 kHz	5 V	AC/DC	4.8475 V	5.1525 V
50 V	30 Hz	50 V	DC	49.945 V	50.055 V
50 V	50 Hz	50 V	AC/DC	49.965 V	50.035 V
50 V	1 kHz	50 V	AC/DC	49.965 V	50.035 V
50 V	20 kHz	50 V	AC/DC	49.965 V	50.035 V
50 V	50 kHz	50 V	AC/DC	49.945 V	50.055 V
50 V	100 kHz	50 V	AC/DC	49.74 V	50.26 V
50 V	300 kHz	50 V	AC/DC	48.475 V	51.525 V
219 V	30 Hz	300 V	DC	218.751 V	219.249 V
219 V	50 Hz	300 V	AC/DC	218.8305 V	219.1695 V
219 V	1 kHz	300 V	AC/DC	218.8305 V	219.1695 V
219 V	20 kHz	300 V	AC/DC	218.8305 V	219.1695 V
219 V	50 kHz	300 V	AC/DC	218.7429 V	219.2571 V
219 V	100 kHz	300 V	AC/DC	217.845 V	220.155 V
70 V	300 kHz	300 V	AC/DC	67.75 V	72.25 V

4-Wire Resistance

Note Tolerances are provided for 4-wire resistance instead of absolute limits because the limits depend on the actual resistance value output by your calibrator.

Table 17. NI 4070/4072 4-Wire Resistance Verification Tolerances

Calibrator Resistance	Range	2-Year Tolerance (ppm of Range)	24-Hour Tolerance (ppm of Range)
10 MΩ	10 MΩ	±410 ppm	±102 ppm
1 MΩ	1 MΩ	±100 ppm	±22 ppm
100 kΩ	100 kΩ	±86 ppm	±17 ppm
10 kΩ	10 kΩ	±83 ppm	±14 ppm
1 kΩ	1 kΩ	±83 ppm	±14 ppm
100 Ω	100 Ω	±90 ppm	±25 ppm
0 Ω	10 MΩ	±10 ppm	±2 ppm
0 Ω	1 MΩ	±10 ppm	±2 ppm
0 Ω	100 kΩ	±6 ppm	±2 ppm
0 Ω	10 kΩ	±3 ppm	±2 ppm
0 Ω	1 kΩ	±3 ppm	±2 ppm
0 Ω	100 Ω	±10 ppm	±10 ppm

2-Wire Resistance

Note Tolerances are provided for 2-wire resistance instead of absolute limits because the limits depend on the actual resistance value output by your calibrator.

Table 18. NI 4070/4072 2-Wire Resistance Verification Tolerances

Calibrator Resistance	Range	2-Year Tolerance (ppm of Range)	24-Hour Tolerance (ppm of Range)
0 Ω	10 kΩ	±40 ppm	±20 ppm
0 Ω	1 kΩ	±400 ppm	±200 ppm
0 Ω	100 Ω	±4000 ppm	±2000 ppm
100 MΩ	100 MΩ	±6040 ppm	±920 ppm
10 MΩ	10 MΩ	±410 ppm	±102 ppm
1 MΩ	1 MΩ	±100 ppm	±22 ppm

Table 18. NI 4070/4072 2-Wire Resistance Verification Tolerances (Continued)

Calibrator Resistance	Range	2-Year Tolerance (ppm of Range)	24-Hour Tolerance (ppm of Range)
100 kΩ	100 kΩ	±86 ppm	±17 ppm
10 kΩ	10 kΩ	±83 ppm	±14 ppm
1 kΩ	1 kΩ	±83 ppm	±14 ppm
100 Ω	100 Ω	±90 ppm	±25 ppm

DC Current

Table 19. NI 4070/4072 DC Current Verification Limits

Calibrator Amplitude	Range	2-Year Limits	
		Lower	Upper
0 A	20 mA	–1.5 µA	1.5 µA
0 A	200 mA	–4 µA	4 µA
0 A	1 A	–20 µA	20 µA
20 mA	20 mA	19.989 mA	20.011 mA
–20 mA	20 mA	–20.011 mA	–19.989 mA
200 mA	200 mA	199.916 mA	200.084 mA
–200 mA	200 mA	–200.084 mA	–199.916 mA
1 A	1 A	0.99945 A	1.00055 A
–1 A	1 A	–1.00055 A	–0.99945 A

AC Current

Table 20. NI 4070/4072 AC Current Verification Limits

Calibrator Output		Range	2-Year Limits	
Amplitude	Frequency		Lower	Upper
1 mA	1 kHz	10 mA	0.9976 mA	1.0024 mA
10 mA	1 kHz	10 mA	9.994 mA	10.006 mA
10 mA	1 kHz	100 mA	9.976 mA	10.024 mA
100 mA	1 kHz	100 mA	99.94 mA	100.06 mA
100 mA	1 kHz	1 A	99.7 mA	100.3 mA
1 A	1 kHz	1 A	0.9988 A	1.0012 A

Frequency

Table 21. Frequency Limits

NI 6608 Output Frequency	2-Year Limits	
	Lower	Upper
1 Hz	0.9999 Hz	1.0001 Hz
20 kHz	19.998 kHz	20.002 kHz
500 kHz	499.95 kHz	500.05 kHz

Capacitance and Inductance

Note Because the actual capacitance verification values can differ from the following values, Table 22 provides tolerances that correspond to the NI 4072 accuracy specifications

Table 22. NI 4072 Capacitance and Inductance Verification Tolerances

Verification Values	Range	2-Year Tolerances	
		% of Reading	% of Range
0 pF	300 pF	0	±0.5
0 uH	10 uH	0	±1
270 pF	300 pF	±0.15	±0.1
1 nF	1 nF	±0.15	±0.1
1 nF	10 nF	±0.15	±0.1
100 nF	100 nF	±0.15	±0.1
100 nF	1 uF	±0.18	±0.1
10 uF	10 uF	±0.18	±0.1
10 uF	100 uF	±0.18	±0.1
1,000 uF	1,000 uF	±0.18	±0.1
1,000 uF	10,000 uF	±0.18	±0.1

Appendix A: Calibration Options

The complete calibration process for the NI 4070/4072 consists of verifying, adjusting, and reverifying a device. During verification, you compare the measured performance to an external standard of known measurement uncertainty to confirm that the product meets or exceeds specifications. Figure 4 shows the procedural flow for verification.

During adjustment, you correct the measurement error of the device by adjusting the calibration constants and storing the new calibration constants in the EEPROM. Frequency is the only mode that does not require adjustment. Figure 5 shows the procedural flow for adjustment. Reverifying all modes after adjustments ensures that the adjustment procedures were performed correctly.

Normally, the calibration sequence is as follows:

1. Verify the operation of the NI 4070/4072 using the 2-year accuracy limits (or the 90-day accuracy limits if it has been externally calibrated within that time).
2. Adjust the NI 4070/4072.
3. Reverify the NI 4070/4072 using the 24-hour accuracy limits (or the 2-year accuracy limits when the 24-hour limits are not specified).

Depending on your measurement and accuracy requirements, a complete calibration of the NI 4070/4072 may not be necessary. A number of options are available that can shorten the calibration time. The following adjustment options are available:

- Complete calibration—Performing the entire calibration procedure from beginning to end; guarantees that the NI 4070/4072 performs at or above the published specifications for all modes and ranges
- Complete calibration with exceptions:
  – Omitting AC voltage mode steps if you do not use the AC voltage modes or if the AC voltage accuracy is irrelevant
  – Omitting DC/AC current mode steps if you do not use the current modes or if the DC/AC current accuracy is irrelevant
  – Omitting both AC voltage and DC/AC current mode steps if you do not use those modes or if the accuracy of those measurements is irrelevant

Table 23. Summary of Adjustment Options

Adjustment	Optional	Required
DC Voltage	—	Y
Resistance	—	Y
AC Voltage	Y	—
AC/DC Current	Y	—
Inductance and Capacitance (NI 4072 only)	—	Y

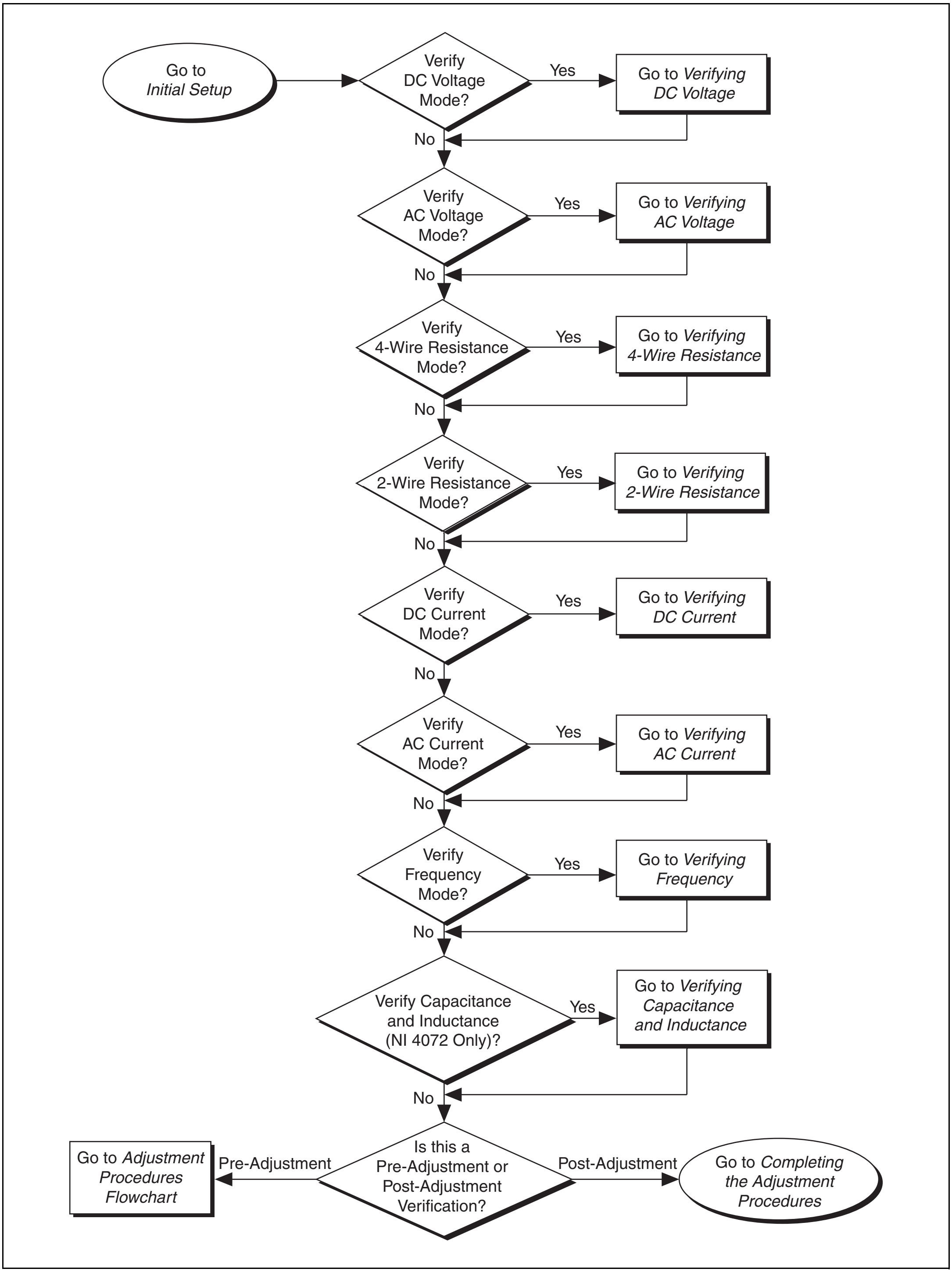


Figure 4. Verification Procedures Flowchart

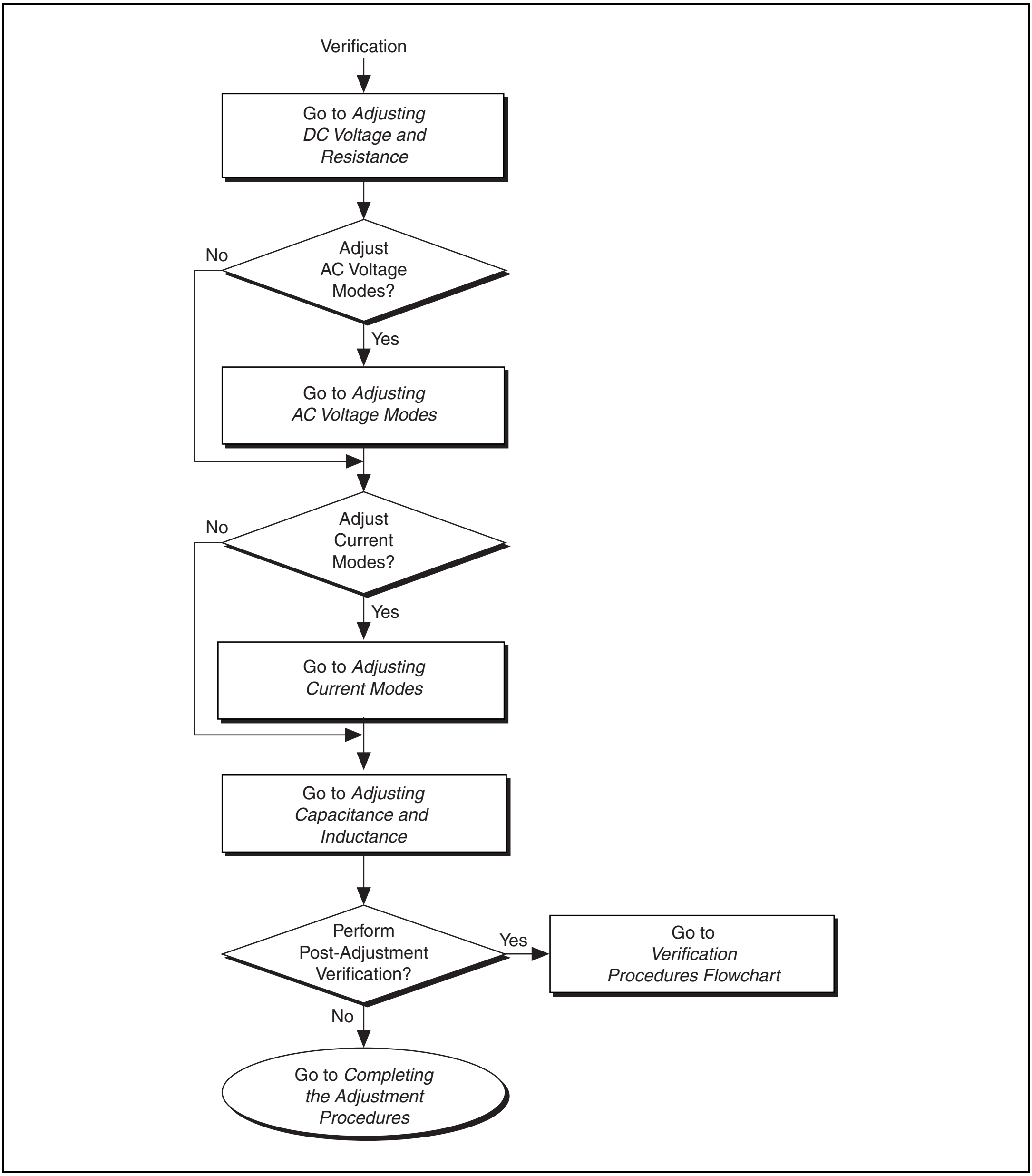


Figure 5. Adjustment Procedures Flowchart

Where to Go for Support

The National Instruments Web site is your complete resource for technical support. At `ni.com/support` you have access to everything from troubleshooting and application development self-help resources to email and phone assistance from NI Application Engineers.

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