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CALIBRATION PROCEDURE

NI 6738/6739

Analog Output Devices and Modules with NI-DAQmx

This document contains the verification and adjustment procedures for the National Instruments PCIe-6738 and PXIe-6738/6739 analog output devices and modules. For more information about calibration solutions, visit ni.com/calibration.

Contents

Software

Calibrating NI 6738/6739 devices and modules requires the installation of NI-DAQmx on the calibration system. You must use NI-DAQmx 17.6 or later. Refer to the *NI-DAQmx Readme* to ensure support for the device you want to calibrate. You can download NI-DAQmx from ni.com/downloads. NI-DAQmx supports many programming languages, including LabVIEW, LabWindows™/CVI™, C/C++, C#, and Visual Basic .NET. When you install NI-DAQmx, you need to only install support for the application software that you intend to use.

NATIONAL INSTRUMENTS

Documentation

Consult the following documents for information about your NI 6738/6739, NI-DAQmx, and your application software. All documents are available on ni.com, and help files install with the software.

The DAQ Getting Started Guide for your device or module

These guides provide instructions for installing the NI 6738/6739 with NI-DAQmx.

NI 6738/6739 User Manual

The user manual provides information about your NI 6738/6739 device.

Your 673x Device Specifications

The specifications document for your DAQ device provides detailed specifications, including the device calibration interval.

NI-DAQmx Readme

Operating system and application software support in NI-DAQmx.

NI-DAQmx Help

Information about creating applications that use the NI-DAQmx driver.

LabVIEW Help

LabVIEW programming concepts and reference information about NI-DAQmx VIs and functions.

NI-DAQmx C Reference Help

Reference information for NI-DAQmx C functions and NI-DAQmx C properties.

NI-DAQmx .NET Help Support for Visual Studio

Reference information for NI-DAQmx .NET methods and NI-DAQmx .NET properties, key concepts, and a C enum to .NET enum mapping table.

Password

The default password for password-protected operations is `NI`.

Test Equipment

Table 1 lists the equipment recommended for the performance verification and adjustment procedures. If the recommended equipment is not available, select a substitute using the requirements listed in Table 1.

Notice For compliance with Electromagnetic Compatibility (EMC) requirements, this product must be operated with shielded cables and accessories. If unshielded cables or accessories are used, the EMC specifications are no longer guaranteed unless all unshielded cables and/or accessories are installed in a shielded enclosure with properly designed and shielded input/output ports.

Table 1. Recommended Equipment

Equipment	Recommended Models	Where Used	Requirements
DMM	NI 4070*	*Analog Output Verification* and *Adjustment*	If this instrument is unavailable, use a multiranging 6 1/2-digit DMM with an accuracy of 40 ppm or better.
Counter	Agilent 53131A or Agilent 53220A	*Counter Verification*	Whether using the recommended instrument or another counter, you must ensure that it is configured to achieve an accuracy of 12.5 ppm (0.00125%) or better.
PXI Express chassis	NI PXIe-1062Q	—	Use with NI PXIe-6738/6739 modules.
Shielded DAQ cable	NI SHC68-68-A2	—	Use with NI 6738/6739 modules.
	NI SH68-C68-S	—	Use when connecting signals using the NI 6738 Adapter or NI 6739 Adapter.

Table 1. Recommended Equipment (Continued)

Equipment	Recommended Models	Where Used	Requirements
DAQ accessory	NI SCB-68, NI SCB-68A	—	Shielded I/O connector block with 68 screw terminals for easy signal connection to the NI 6738/6739.
	NI CB-68LP, NI CB-68LPR, NI TBX-68	—	Low-cost termination accessories with 68 screw terminals for easy connection of field I/O signals to the NI 6738/6739.
DAQ switch fixture†	NI PXI/PXIe-2529 (x2)	—	128-Crosspoint, 2-Wire PXI Matrix Switch Module
	NI TB-2636 terminal blocks (x2)	—	Configures the PXI/PXIe-2529 as a 4x32 (2-wire) matrix **Notice** Before using this unshielded accessory, determine if the documentation for the connected device requires shielded cables or accessories. Do not use this product unless it is installed in a shielded enclosure with properly designed and shielded input/output ports and is connected to the NI product using a shielded cable.
	NI SHC68-NT-S cables (x2)	—	Shielded Cable Assembly (Unterminated), 2 m

* If you are using the NI 4070, ensure that it is set to the 10 V range.

† Locally constructed fixture to facilitate calibration using Calibration Executive.

Switch Maintenance

To ensure proper operation of the switches used in this procedure, you must periodically test their performance.

NI PXI/PXIe-2529 Switch Performance Test

Use the following procedure to test the performance of the PXI/PXIe-2529 using Calibration Executive.

Table 2. Calibration Executive Procedure Features

Adjustment	Manual Mode	Selectable Test Points
Not supported	Supported	Not supported

Table 3. Approximate Test Time

Module	Performance Test
PXI/PXIe-2529	8 minutes

Test Equipment

The following table lists the test instruments required for testing the NI PXI/PXIe-2529.

Instrument	Recommended Model	Requirements
DMM	PXI-4071	Voltage Accuracy: 7.5 digits Resistance Accuracy: 6.5 digits
Terminal Block	PXI/PXIe-2529: TB-2636	—

The switch performance tests should be executed periodically to check if any switch paths have become damaged, or if the switches are approaching the end of their useful life. The frequency of execution of these tests will depend on many factors, including how often the switches are used.

Test Conditions

The following setup and environmental conditions are required to ensure the NI PXI/PXIe-2529 meets published specifications.

- Keep connections to the device as short as possible. Long cables and wires act as antennae, picking up extra noise that can affect measurements.
- Verify that all connections to the device are secure.
- Use shielded copper wire for all cable connections to the device. Use twisted-pair wire to eliminate noise and thermal offsets.

- Maintain an ambient temperature of 23 °C ±5 °C. The device temperature will be greater than the ambient temperature.
- Keep relative humidity below 80%.

Device Setup

1. Configure the hardware using Measurement & Automation Explorer (MAX).
2. Launch the Calibration Executive procedure and complete the setup wizard. For information, refer to ni.com/r/loadcalpro.
3. Complete the following steps to create fixtures that will be used to connect the switches to the DMM.

Create the NI PXI/PXIe-2529 Fixture

1. On the TB-2636, connect the positive (+) and negative (-) terminals together for C0–C31.
2. Connect all + terminals together for R0 to R3, and wire them out using two separate wires to banana connectors labeled *DMM HI* and *DMM HI Sense*.
3. Connect all - terminals together for R0 to R3, and wire them out using two separate wires to banana connectors labeled *DMM LO* and *DMM LO Sense*.

To run the procedure, connect the TB-2636 to the PXI/PXIe-2529 switch, and connect the four banana connectors to the appropriate terminals on the DMM.

Test Limit Equations

These switch tests are not intended to be a validation of the full warranted performance of these devices. The parameters and limits used in these tests are based on the measurement requirements of this procedure.

Table 4. NI PXI-PXIe-2529 Test Limits

Thermal EMF	Path Resistance	Relay Count
±9 µV	<1 Ω	For all relays (0–127), <100,000 for each

Test Conditions

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

- Keep connections to the device as short as possible. Long cables and wires can act as antennae, which could pick up extra noise that would affect measurements.
- Verify that all connections to the NI 6738/6739 are secure.
- Use shielded copper wire for all cable connections to the device. Use twisted-pair wire to eliminate noise and thermal offsets.
- Maintain an ambient temperature of 23 °C ±5 °C throughout the *Analog Output Verification* procedure. The device temperature is greater than the ambient temperature. Refer to the *Calibration Procedure* section for more information about calibration temperatures and temperature drift.

- For valid test limits, maintain the device temperature within ±1 °C from the last self-calibration and ±10 °C from the last external calibration.
- Keep relative humidity below 80%.
- Allow adequate warm-up time of at least 15 minutes to ensure that the measurement circuitry is at a stable operating temperature.

Calibration Procedure

The calibration process has the following steps.

1. *Initial Setup*—Configure your device in NI-DAQmx, adjust the self-calibration constants of the device, and verify that the current device temperature does not cause you to incorrectly calibrate your device.
2. *Verification*—Verify the existing operation of the device. This step allows you to confirm that the device was operating within its specified range prior to calibration.
3. *Adjustment*—Perform an external calibration that adjusts the device calibration constants with respect to a known voltage source.
4. *EEPROM Update*—When an adjustment procedure is completed, the NI 6738/6739 internal calibration memory (EEPROM) is immediately updated. If you do not want to perform an adjustment, you can update the calibration date without making any adjustments.
5. *Reverification*—Perform another verification to ensure that the device is operating within its specifications after adjustment.

These steps are described in detail in the following sections.

Initial Setup

Refer to your device getting started guide for information about how to install the software and hardware and how to configure the device in Measurement & Automation Explorer (MAX).

Note When a device is configured in MAX, it is assigned a device name. Each function call uses this device name to determine which device to calibrate. This document uses `Dev_name` to refer to the device name. In the following procedures, use the device name as it appears in MAX.

Complete the following steps to set up the NI 6738/6739.

1. Install the application software (if applicable).
2. Install the NI-DAQmx driver software.
3. Power off the chassis that will contain the device and install the device.
4. Power on the chassis and launch MAX.
5. Select **My System»Devices and Interfaces»*your device***.
6. Configure the device identifier and select **Self-Test** to ensure that the device is working properly.

Self-Calibration

Complete the following steps to self-calibrate the device.

Note Disconnect all external signals before beginning self-calibration.

1. Wait for the device to warm-up for at least 15 minutes.
2. Launch MAX.
3. Select **My System»Devices and Interfaces»*your device***.
4. Click **Self-Calibrate**.

Checking Device Temperature Changes

Device temperature changes greater than those described in the *Test Conditions* section will require action to ensure that your calibration is successful. Complete the following steps to check for device temperature changes:

1. Self-calibrate your device as described in the *Self-Calibration* section.
2. Call `DAQmxGetCalDevTemp` with the following parameter:
   - **deviceName**: `Dev_name`
3. Call `DAQmxGetSelfCalLastTemp` with the following parameter:
   - **deviceName**: `Dev_name`

   If the current device temperature differs by more than 1 °C from the last self-calibration temperature, or you cannot maintain a device temperature within 1 °C of the last self-calibration temperature throughout the verification process, the calibration limits for the devices that support self-calibration are not valid.

   In order to successfully calibrate your device in this case:
   - Allow the device temperature to settle and self-calibrate your device again.
   - Change the test limits to include the additional error due to temperature drift. Refer to your device specifications document for more information.
4. Call `DAQmxGetExtCalLastTemp` with the following parameter:
   - **deviceName**: `Dev_name`

   If the current device temperature differs by more than 10 °C from the last external calibration temperature, or you cannot maintain a device temperature within 10 °C of the last external calibration temperature throughout the verification process, the calibration limits are not valid.

   In order to successfully calibrate your device in this case:
   - Change the system so that the temperature is within ±10 °C of the temperature recorded during the last external calibration.
   - Change the test limits to include the additional error due to temperature drift. Refer to your device specifications document for more information.

Note You also can read the current device temperature, the temperature during the last self-calibration, and the temperature during the last external calibration in MAX. Launch MAX, select **My System»Devices and Interfaces»*your device***, and then click the **Calibration** tab. Temperature information is displayed *Self-Calibration* and *External Calibration* sections of the **Settings** tab.

Verification

The following performance verification procedures describe the sequence of operation and provide test points required to verify the NI 6738/6739. The verification procedures assume that adequate traceable uncertainties are available for the calibration references.

The verification procedure is divided into the major functions of the device. Throughout the verification process, use the tables in the *Test Limits* section to determine if your device needs to be adjusted. These tables show all acceptable settings for the device.

Analog Output Verification

The NI 6738 has 32 analog outputs, AO <0..31>. The NI 6739 has 64 analog outputs, AO <0..63>.

Note Table 7, *NI 6738/6739 Analog Output Values*, is based upon the most recent edition of the specifications document for your device. Refer to the most recent specifications document online at `ni.com/manuals`.

Note The test limits used in this document assume a maximum temperature drift of ±10 °C from the last external calibration, and a maximum temperature drift of ±1 °C from the last self-calibration. Refer to the *Checking Device Temperature Changes* section for more information and instructions on reading your device temperature and comparing it against the device temperature during the last external calibration.

Notice Do not perform analog output verification and counter verification simultaneously, as the multiple signal connections will produce noise that can affect measurements.

Complete the following steps to check analog output measurements.

1. Connect your DMM to AO 0 as shown in Table 5, *Analog Output Connections*. If using the DAQ switch fixture, configure your connections as shown in Table 6, *Switch Fixture Connection Details*.

Note If you are using the NI 4070, ensure that it is set to the 10 V range.

Table 5. Analog Output Connections

Analog Output*	DMM	
	Positive Input	Negative Input
AO 0	Connector 0, AO 0 (pin 10)	Connector 0, AO GND 0/1 (pin 11)
AO 1	Connector 0, AO 1 (pin 44)	Connector 0, AO GND 0/1 (pin 11)
AO 2	Connector 0, AO 2 (pin 45)	Connector 0, AO GND 2/3 (pin 39)
AO 3	Connector 0, AO 3 (pin 12)	Connector 0, AO GND 2/3 (pin 39)
AO 4	Connector 0, AO 4 (pin 13)	Connector 0, AO GND 4/5 (pin 41)
AO 5	Connector 0, AO 5 (pin 47)	Connector 0, AO GND 4/5 (pin 41)
AO 6	Connector 0, AO 6 (pin 48)	Connector 0, AO GND 6/7 (pin 49)
AO 7	Connector 0, AO 7 (pin 15)	Connector 0, AO GND 6/7 (pin 49)
AO 8	Connector 0, AO 8 (pin 16)	Connector 0, AO GND 8/9/10 (pin 50)
AO 9	Connector 0, AO 9 (pin 17)	Connector 0, AO GND 8/9/10 (pin 50)
AO 10	Connector 0, AO 10 (pin 51)	Connector 0, AO GND 8/9/10 (pin 50)
AO 11	Connector 0, AO 11 (pin 52)	Connector 0, AO GND 11 (pin 18)
AO 12	Connector 0, AO 12 (pin 53)	Connector 0, AO GND 12/13 (pin 20)
AO 13	Connector 0, AO 13 (pin 54)	Connector 0, AO GND 12/13 (pin 20)
AO 14	Connector 0, AO 14 (pin 21)	Connector 0, AO GND 14/15 (pin 55)
AO 15	Connector 0, AO 15 (pin 22)	Connector 0, AO GND 14/15 (pin 55)
AO 16	Connector 0, AO 16 (pin 23)	Connector 0, AO GND 16/17 (pin 24)
AO 17	Connector 0, AO 17 (pin 57)	Connector 0, AO GND 16/17(pin 24)
AO 18	Connector 0, AO 18 (pin 58)	Connector 0, AO GND 18/19 (pin 59)
AO 19	Connector 0, AO 19 (pin 25)	Connector 0, AO GND 18/19 (pin 59)
AO 20	Connector 0, AO 20 (pin 26)	Connector 0, AO GND 20/21 (pin 27)
AO 21	Connector 0, AO 21 (pin 60)	Connector 0, AO GND 20/21 (pin 27)
AO 22	Connector 0, AO 22 (pin 61)	Connector 0, AO GND 22/23 (pin 62)
AO 23	Connector 0, AO 23 (pin 28)	Connector 0, AO GND 22/23 (pin 62)
AO 24	Connector 0, AO 24 (pin 29)	Connector 0, AO GND 24/25 (pin 30)

Table 5. Analog Output Connections (Continued)

Analog Output*	DMM	
	Positive Input	Negative Input
AO 25	Connector 0, AO 25 (pin 63)	Connector 0, AO GND 24/25 (pin 30)
AO 26	Connector 0, AO 26 (pin 64)	Connector 0, AO GND 26/27 (pin 65)
AO 27	Connector 0, AO 27 (pin 31)	Connector 0, AO GND 26/27 (pin 65)
AO 28	Connector 0, AO 28 (pin 32)	Connector 0, AO GND 28/29 (pin 33)
AO 29	Connector 0, AO 29 (pin 66)	Connector 0, AO GND 28/29 (pin 33)
AO 30	Connector 0, AO 30 (pin 67)	Connector 0, AO GND 30/31 (pin 68)
AO 31	Connector 0, AO 31 (pin 34)	Connector 0, AO GND 30/31 (pin 68)
AO 32	Connector 1, AO 32 (pin 10)	Connector 1, AO GND 32/33 (pin 11)
AO 33	Connector 1, AO 33 (pin 44)	Connector 1, AO GND 32/33 (pin 11)
AO 34	Connector 1, AO 34 (pin 45)	Connector 1, AO GND 34/35 (pin 46)
AO 35	Connector 1, AO 35 (pin 12)	Connector 1, AO GND 34/35 (pin 46)
AO 36	Connector 1, AO 36 (pin 13)	Connector 1, AO GND 36/37 (pin 14)
AO 37	Connector 1, AO 37 (pin 47)	Connector 1, AO GND 36/37 (pin 14)
AO 38	Connector 1, AO 38 (pin 48)	Connector 1, AO GND 38/39 (pin 49)
AO 39	Connector 1, AO 39 (pin 15)	Connector 1, AO GND 38/39 (pin 49)
AO 40	Connector 1, AO 40 (pin 16)	Connector 1, AO GND 40/41/42 (pin 50)
AO 41	Connector 1, AO 41 (pin 17)	Connector 1, AO GND 40/41/42 (pin 50)
AO 42	Connector 1, AO 42 (pin 51)	Connector 1, AO GND 40/41/42 (pin 50)
AO 43	Connector 1, AO 43 (pin 52)	Connector 1, AO GND 43 (pin 18)
AO 44	Connector 1, AO 44 (pin 53)	Connector 1, AO GND 44/45 (pin 20)
AO 45	Connector 1, AO 45 (pin 54)	Connector 1, AO GND 44/45 (pin 20)
AO 46	Connector 1, AO 46 (pin 21)	Connector 1, AO GND 46/47 (pin 55)
AO 47	Connector 1, AO 47 (pin 22)	Connector 1, AO GND 46/47 (pin 55)
AO 48	Connector 1, AO 48 (pin 23)	Connector 1, AO GND 48/49 (pin 24)
AO 49	Connector 1, AO 49 (pin 57)	Connector 1, AO GND 48/49 (pin 24)
AO 50	Connector 1, AO 50 (pin 58)	Connector 1, AO GND 50/51 (pin 59)

Table 5. Analog Output Connections (Continued)

Analog Output*	DMM	
	Positive Input	Negative Input
AO 51	Connector 1, AO 51 (pin 25)	Connector 1, AO GND 50/51 (pin 59)
AO 52	Connector 1, AO 52 (pin 26)	Connector 1, AO GND 52/53 (pin 27)
AO 53	Connector 1, AO 53 (pin 60)	Connector 1, AO GND 52/53 (pin 27)
AO 54	Connector 1, AO 54 (pin 61)	Connector 1, AO GND 54/55 (pin 62)
AO 55	Connector 1, AO 55 (pin 28)	Connector 1, AO GND 54/55 (pin 62)
AO 56	Connector 1, AO 56 (pin 29)	Connector 1, AO GND 56/57 (pin 30)
AO 57	Connector 1, AO 57 (pin 63)	Connector 1, AO GND 56/57 (pin 30)
AO 58	Connector 1, AO 58 (pin 64)	Connector 1, AO GND 58/59 (pin 65)
AO 59	Connector 1, AO 59 (pin 31)	Connector 1, AO GND 58/59 (pin 65)
AO 60	Connector 1, AO 60 (pin 32)	Connector 1, AO GND 60/61 (pin 33)
AO 61	Connector 1, AO 61 (pin 66)	Connector 1, AO GND 60/61 (pin 33)
AO 62	Connector 1, AO 62 (pin 67)	Connector 1, AO GND 62/63 (pin 68)
AO 63	Connector 1, AO 63 (pin 34)	Connector 1, AO GND 62/63 (pin 68)

* Connector 1/AO <32..63> are on the PXIe-6739 only.

Table 6. Switch Fixture Connection Details

TB-2636 #1 Pin Number	TB-2636 #2 Pin Number	NI 6738/6739 Pin Number	NI 6738/6739 Pin Description	Banana/BNC Connector (if connected)
Analog Output				
r0+	r0+	—	—	Banana + (Red)*
r0-	r0-	—	—	Banana - (Black)*
c0+	N/A	AO 0 +	Connector 0, AO 0 (pin 10)	—
c0-	N/A	AO 0 -	Connector 0, AO GND 0/1 (pin 11)	—

Table 6. Switch Fixture Connection Details (Continued)

TB-2636 #1 Pin Number	TB-2636 #2 Pin Number	NI 6738/6739 Pin Number	NI 6738/6739 Pin Description	Banana/BNC Connector (if connected)
Analog Output				
c1+	N/A	AO 1 +	Connector 0, AO 1 (pin 44)	—
c1-	N/A	AO 1 -	Connector 0, AO GND 0/1 (pin 11)	—
c2+	N/A	AO 2 +	Connector 0, AO 2 (pin 45)	—
c2-	N/A	AO 2 -	Connector 0, AO GND 2/3 (pin 39)	—
c3+	N/A	AO 3 +	Connector 0, AO 3 (pin 12)	—
c3-	N/A	AO 3 -	Connector 0, AO GND 2/3 (pin 39)	—
c4+	N/A	AO 4 +	Connector 0, AO 4 (pin 13)	—
c4-	N/A	AO 4 -	Connector 0, AO GND 4/5 (pin 41)	—
c5+	N/A	AO 5 +	Connector 0, AO 5 (pin 47)	—
c5-	N/A	AO 5 -	Connector 0, AO GND 4/5 (pin 41)	—
c6+	N/A	AO 6 +	Connector 0, AO 6 (pin 48)	—
c6-	N/A	AO 6 -	Connector 0, AO GND 6/7 (pin 49)	—
c7+	N/A	AO 7 +	Connector 0, AO 7 (pin 15)	—
c7-	N/A	AO 7 -	Connector 0, AO GND 6/7 (pin 49)	—
c8+	N/A	AO 8 +	Connector 0, AO 8 (pin 16)	—

Table 6. Switch Fixture Connection Details (Continued)

TB-2636 #1 Pin Number	TB-2636 #2 Pin Number	NI 6738/6739 Pin Number	NI 6738/6739 Pin Description	Banana/BNC Connector (if connected)
Analog Output				
c8-	N/A	AO 8 -	Connector 0, AO GND 8/9/10 (pin 50)	—
c9+	N/A	AO 9 +	Connector 0, AO 9 (pin 17)	—
c9-	N/A	AO 9 -	Connector 0, AO GND 8/9/10 (pin 50)	—
c10+	N/A	AO 10 +	Connector 0, AO 10 (pin 51)	—
c10-	N/A	AO 10 -	Connector 0, AO GND 8/9/10 (pin 50)	—
c11+	N/A	AO 11 +	Connector 0, AO 11 (pin 52)	—
c11-	N/A	AO 11 -	Connector 0, AO GND 11 (pin 18)	—
c12+	N/A	AO 12 +	Connector 0, AO 12 (pin 53)	—
c12-	N/A	AO 12 -	Connector 0, AO GND 12/13 (pin 20)	—
c13+	N/A	AO 13 +	Connector 0, AO 13 (pin 54)	—
c13-	N/A	AO 13 -	Connector 0, AO GND 12/13 (pin 20)	—
c14+	N/A	AO 14 +	Connector 0, AO 14 (pin 21)	—
c14-	N/A	AO 14 -	Connector 0, AO GND 14/15 (pin 55)	—
c15+	N/A	AO 15 +	Connector 0, AO 15 (pin 22)	—
c15-	N/A	AO 15 -	Connector 0, AO GND 14/15 (pin 55)	—

Table 6. Switch Fixture Connection Details (Continued)

TB-2636 #1 Pin Number	TB-2636 #2 Pin Number	NI 6738/6739 Pin Number	NI 6738/6739 Pin Description	Banana/BNC Connector (if connected)
Analog Output				
c16+	N/A	AO 16 +	Connector 0, AO 16 (pin 23)	—
c16-	N/A	AO 16 -	Connector 0, AO GND 16/17 (pin 24)	—
c17+	N/A	AO 17 +	Connector 0, AO 17 (pin 57)	—
c17-	N/A	AO 17 -	Connector 0, AO GND 16/17(pin 24)	—
c18+	N/A	AO 18 +	Connector 0, AO 18 (pin 58)	—
c18-	N/A	AO 18 -	Connector 0, AO GND 18/19 (pin 59)	—
c19+	N/A	AO 19 +	Connector 0, AO 19 (pin 25)	—
c19-	N/A	AO 19 -	Connector 0, AO GND 18/19 (pin 59)	—
c20+	N/A	AO 20 +	Connector 0, AO 20 (pin 26)	—
c20-	N/A	AO 20 -	Connector 0, AO GND 20/21 (pin 27)	—
c21+	N/A	AO 21 +	Connector 0, AO 21 (pin 60)	—
c21-	N/A	AO 21 -	Connector 0, AO GND 20/21 (pin 27)	—
c22+	N/A	AO 22 +	Connector 0, AO 22 (pin 61)	—
c22-	N/A	AO 22 -	Connector 0, AO GND 22/23 (pin 62)	—
c23+	N/A	AO 23 +	Connector 0, AO 23 (pin 28)	—

Table 6. Switch Fixture Connection Details (Continued)

TB-2636 #1 Pin Number	TB-2636 #2 Pin Number	NI 6738/6739 Pin Number	NI 6738/6739 Pin Description	Banana/BNC Connector (if connected)
Analog Output				
c23-	N/A	AO 23 -	Connector 0, AO GND 22/23 (pin 62)	—
c24+	N/A	AO 24 +	Connector 0, AO 24 (pin 29)	—
c24-	N/A	AO 24 -	Connector 0, AO GND 24/25 (pin 30)	—
c25+	N/A	AO 25 +	Connector 0, AO 25 (pin 63)	—
c25-	N/A	AO 25 -	Connector 0, AO GND 24/25 (pin 30)	—
c26+	N/A	AO 26 +	Connector 0, AO 26 (pin 64)	—
c26-	N/A	AO 26 -	Connector 0, AO GND 26/27 (pin 65)	—
c27+	N/A	AO 27 +	Connector 0, AO 27 (pin 31)	—
c27-	N/A	AO 27 -	Connector 0, AO GND 26/27 (pin 65)	—
c28+	N/A	AO 28 +	Connector 0, AO 28 (pin 32)	—
c28-	N/A	AO 28 -	Connector 0, AO GND 28/29 (pin 33)	—
c29+	N/A	AO 29 +	Connector 0, AO 29 (pin 66)	—
c29-	N/A	AO 29 -	Connector 0, AO GND 28/29 (pin 33)	—
c30+	N/A	AO 30 +	Connector 0, AO 30 (pin 67)	—
c30-	N/A	AO 30 -	Connector 0, AO GND 30/31 (pin 68)	—

Table 6. Switch Fixture Connection Details (Continued)

TB-2636 #1 Pin Number	TB-2636 #2 Pin Number	NI 6738/6739 Pin Number	NI 6738/6739 Pin Description	Banana/BNC Connector (if connected)
Analog Output				
c31+	N/A	AO 31 +	Connector 0, AO 31 (pin 34)	—
c31-	N/A	AO 31 -	Connector 0, AO GND 30/31 (pin 68)	—
N/A	c0+	AO 32 +	Connector 1, AO 32 (pin 10)	—
N/A	c0-	AO 32 -	Connector 1, AO GND 32/33 (pin 11)	—
N/A	c1+	AO 33 +	Connector 1, AO 33 (pin 44)	—
N/A	c1-	AO 33 -	Connector 1, AO GND 32/33 (pin 11)	—
N/A	c2+	AO 34 +	Connector 1, AO 34 (pin 45)	—
N/A	c2-	AO 34 -	Connector 1, AO GND 34/35 (pin 46)	—
N/A	c3+	AO 35 +	Connector 1, AO 35 (pin 12)	—
N/A	c3-	AO 35 -	Connector 1, AO GND 34/35 (pin 46)	—
N/A	c4+	AO 36 +	Connector 1, AO 36 (pin 13)	—
N/A	c4-	AO 36 -	Connector 1, AO GND 36/37 (pin 14)	—
N/A	c5+	AO 37 +	Connector 1, AO 37 (pin 47)	—
N/A	c5-	AO 37 -	Connector 1, AO GND 36/37 (pin 14)	—
N/A	c6+	AO 38 +	Connector 1, AO 38 (pin 48)	—

Table 6. Switch Fixture Connection Details (Continued)

TB-2636 #1 Pin Number	TB-2636 #2 Pin Number	NI 6738/6739 Pin Number	NI 6738/6739 Pin Description	Banana/BNC Connector (if connected)
Analog Output				
N/A	c6-	AO 38 -	Connector 1, AO GND 38/39 (pin 49)	—
N/A	c7+	AO 39 +	Connector 1, AO 39 (pin 15)	—
N/A	c7-	AO 39 -	Connector 1, AO GND 38/39 (pin 49)	—
N/A	c8+	AO 40 +	Connector 1, AO 40 (pin 16)	—
N/A	c8-	AO 40 -	Connector 1, AO GND 40/41/42 (pin 50)	—
N/A	c9+	AO 41 +	Connector 1, AO 41 (pin 17)	—
N/A	c9-	AO 41 -	Connector 1, AO GND 40/41/42 (pin 50)	—
N/A	c10+	AO 42 +	Connector 1, AO 42 (pin 51)	—
N/A	c10-	AO 42 -	Connector 1, AO GND 40/41/42 (pin 50)	—
N/A	c11+	AO 43 +	Connector 1, AO 43 (pin 52)	—
N/A	c11-	AO 43 -	Connector 1, AO GND 43 (pin 18)	—
N/A	c12+	AO 44 +	Connector 1, AO 44 (pin 53)	—
N/A	c12-	AO 44 -	Connector 1, AO GND 44/45 (pin 20)	—
N/A	c13+	AO 45 +	Connector 1, AO 45 (pin 54)	—
N/A	c13-	AO 45 -	Connector 1, AO GND 44/45 (pin 20)	—

Table 6. Switch Fixture Connection Details (Continued)

TB-2636 #1 Pin Number	TB-2636 #2 Pin Number	NI 6738/6739 Pin Number	NI 6738/6739 Pin Description	Banana/BNC Connector (if connected)
Analog Output				
N/A	c14+	AO 46 +	Connector 1, AO 46 (pin 21)	—
N/A	c14-	AO 46 -	Connector 1, AO GND 46/47 (pin 55)	—
N/A	c15+	AO 47 +	Connector 1, AO 47 (pin 22)	—
N/A	c15-	AO 47 -	Connector 1, AO GND 46/47 (pin 55)	—
N/A	c16+	AO 48 +	Connector 1, AO 48 (pin 23)	—
N/A	c16-	AO 48 -	Connector 1, AO GND 48/49 (pin 24)	—
N/A	c17+	AO 49 +	Connector 1, AO 49 (pin 57)	—
N/A	c17-	AO 49 -	Connector 1, AO GND 48/49 (pin 24)	—
N/A	c18+	AO 50 +	Connector 1, AO 50 (pin 58)	—
N/A	c18-	AO 50 -	Connector 1, AO GND 50/51 (pin 59)	—
N/A	c19+	AO 51 +	Connector 1, AO 51 (pin 25)	—
N/A	c19-	AO 51 -	Connector 1, AO GND 50/51 (pin 59)	—
N/A	c20+	AO 52 +	Connector 1, AO 52 (pin 26)	—
N/A	c20-	AO 52 -	Connector 1, AO GND 52/53 (pin 27)	—
N/A	c21+	AO 53 +	Connector 1, AO 53 (pin 60)	—

Table 6. Switch Fixture Connection Details (Continued)

TB-2636 #1 Pin Number	TB-2636 #2 Pin Number	NI 6738/6739 Pin Number	NI 6738/6739 Pin Description	Banana/BNC Connector (if connected)
Analog Output				
N/A	c21-	AO 53 -	Connector 1, AO GND 52/53 (pin 27)	—
N/A	c22+	AO 54 +	Connector 1, AO 54 (pin 61)	—
N/A	c22-	AO 54 -	Connector 1, AO GND 54/55 (pin 62)	—
N/A	c23+	AO 55 +	Connector 1, AO 55 (pin 28)	—
N/A	c23-	AO 55 -	Connector 1, AO GND 54/55 (pin 62)	—
N/A	c24+	AO 56 +	Connector 1, AO 56 (pin 29)	—
N/A	c24-	AO 56 -	Connector 1, AO GND 56/57 (pin 30)	—
N/A	c25+	AO 57 +	Connector 1, AO 57 (pin 63)	—
N/A	c25-	AO 57 -	Connector 1, AO GND 56/57 (pin 30)	—
N/A	c26+	AO 58 +	Connector 1, AO 58 (pin 64)	—
N/A	c26-	AO 58 -	Connector 1, AO GND 58/59 (pin 65)	—
N/A	c27+	AO 59 +	Connector 1, AO 59 (pin 31)	—
N/A	c27-	AO 59 -	Connector 1, AO GND 58/59 (pin 65)	—
N/A	c28+	AO 60 +	Connector 1, AO 60 (pin 32)	—
N/A	c28-	AO 60 -	Connector 1, AO GND 60/61 (pin 33)	—

Table 6. Switch Fixture Connection Details (Continued)

TB-2636 #1 Pin Number	TB-2636 #2 Pin Number	NI 6738/6739 Pin Number	NI 6738/6739 Pin Description	Banana/BNC Connector (if connected)
Analog Output				
N/A	c29+	AO 61 +	Connector 1, AO 61 (pin 66)	—
N/A	c29-	AO 61 -	Connector 1, AO GND 60/61 (pin 33)	—
N/A	c30+	AO 62 +	Connector 1, AO 62 (pin 67)	—
N/A	c30-	AO 62 -	Connector 1, AO GND 62/63 (pin 68)	—
N/A	c31+	AO 63 +	Connector 1, AO 63 (pin 34)	—
N/A	c31-	AO 63 -	Connector 1, AO GND 62/63 (pin 68)	—
Counter				
—	—	Counter 0 +	CTR 0 OUT/PFI 7/P1.7 (Connector 0, pin 9)	BNC+†
—	—	Counter 0 -	D GND PFI 6/7 (Connector 0, pin 42)	BNC-†

* Connects to DMM. Use twisted pair wires.

† Connects to Counter. Use twisted pair wires and a Pomona 1296 BNC Male Plug to Double Binding Post Adapter.

2. Measure the internal device temperature and perform self-calibration if necessary. Refer to the *Checking Device Temperature Changes* section for more information.
3. Call `DAQmxCreateTask` with the following parameters:
   - **taskName**: *`MyAOVoltageTask`*
   - **taskHandle**: `&taskHandle`
4. Call `DAQmxCreateAOVoltageChan` with the following parameters.
   - **taskHandle**: `taskHandle`
   - **physicalChannel**: `Dev_name/ao0`
   - **nameToAssignToChannel**: `AOVoltageChannel`
   - **minVal**: *`-10.0`*

- **maxVal**: `10.0`
- **units**: `DAQmx_Val_Volts`
- **customScaleName**: `NULL`

5. Call `DAQmxStartTask` with the following parameter:
   - **taskHandle**: `taskHandle`
6. Call `DAQmxWriteAnalogF64` with the following parameters, using a *Test Point* from Table 7, *NI 6738/6739 Analog Output Values*.
   - **taskHandle**: `taskHandle`
   - **numSampsPerChan**: `1`
   - **autoStart**: `1`
   - **timeout**: `10.0`
   - **dataLayout**: `DAQmx_Val_GroupByChannel`
   - **writeArray**: `&data`
   - **sampsPerChanWritten**: `&samplesWritten`
   - **reserved**: `NULL`
7. Compare the resulting value shown by the DMM to the upper and lower limits in Table 7, *NI 6738/6739 Analog Output Values*. If the value is between these limits, the device passes the test.
8. Repeat steps 6 and 7 until all of the Test Point values in Table 7, *NI 6738/6739 Analog Output Values*, have been tested.
9. Call `DAQmxClearTask` with the following parameter:
   - **taskHandle**: `taskHandle`
10. Disconnect the DMM from AO 0, and reconnect it to AO 1, making the connections shown in Table 5, *Analog Output Connections*.
11. Repeat steps 3 through 10 for all AO channels on the device.
12. Disconnect your DMM from the device.

You have finished verifying the analog output levels on your device.

Counter Verification

NI 6738/6739 devices have only one timebase to verify, so only Counter 0 needs to be checked. It is not possible to adjust this timebase, so only verification can be performed.

Note Table 8, *NI 6738/6739 Counter Values*, is based upon the most recent edition of the specifications document for your device. Refer to the most recent specifications document online at `ni.com/manuals`.

Notice Do not perform analog output verification and counter verification simultaneously, as the multiple signal connections will produce noise that can affect measurements.

Complete the following steps to perform checks on the counter of your device.

1. Connect your counter positive input to CTR 0 OUT/PFI 7/P1.7 (Connector 0, pin 9) and your counter negative input to D GND PFI 6/7 (Connector 0, pin 42).
2. Create a task using `DAQmxCreateTask`.
3. To verify the Counter 0, call `DAQmxCreateCOPulseChanFreq` with the following parameters:

Note Throughout the procedure, refer to the NI-DAQmx function call parameters for the LabVIEW input values.

   - **taskHandle**: `taskHandle`
   - **counter**: `Dev_name/ctr0`
   - **nameToAssignToChannel**: `CounterOutputChannel`
   - **units**: `DAQmx_Val_Hz`
   - **idleState**: `DAQmx_Val_Low`
   - **initialDelay**: `0.0`
   - **freq**: `5000000.0`
   - **dutyCycle**: `0.5`
4. Call `DAQmxCfgImplicitTiming` with the following parameters:
   - **taskHandle**: `taskHandle`
   - **sampleMode**: `DAQmx_Val_ContSamps`
   - **sampsPerChan**: `10000`
5. Call `DAQmxStartTask` with the following parameter:
   - **taskHandle**: `taskHandle`

   The DAQ device generates a 5 MHz square wave.
6. Configure the external counter to measure frequency, 1 MΩ impedance, and gate time to achieve the minimum accuracy requirements from Table 1.
7. Take a measurement of the square wave using the external counter.
8. Compare the value read by your counter to the test limits shown on the device table in the *Test Limits* section. If the value falls between these limits, the device passes the test.
9. Call `DAQmxStopTask` with the following parameter:
   - **taskHandle**: `taskHandle`
10. Call `DAQmxClearTask` with the following parameter:
   - **taskHandle**: `taskHandle`
11. Disconnect the external counter from your device.

Note If the counter verification procedure determines that the device is outside of the limits, refer to the *Worldwide Support and Services* section for assistance in returning the device to NI.

Adjustment

The following procedure adjusts the analog output of your NI 6738/6739.

At the end of each calibration procedure, these new constants are stored in the external calibration area of the EEPROM. These values are password-protected, which prevents the accidental access or modification of any calibration constants adjusted by the metrology laboratory. The default password is `NI`.

Complete the following steps to perform device analog adjustment with a DMM.

Note If your DMM has a self-calibration routine, self-calibrate the device before performing AO adjustment.

1. Connect the DMM to AO 0 as shown in Table 5, *Analog Output Connections*.

Note If you are using the NI 4070, ensure that it is set to the 10 V range.

2. Call `DAQmxCreateAOVoltageChan` with the following parameters:
   - **taskHandle**: `taskHandle`
   - **physicalChannel**: `Dev_name/ao0`
   - **nameToAssignToChannel**: `AOVoltageChannel`
   - **minVal**: *`-10.0`*
   - **maxVal**: *`10.0`*
   - **units**: `DAQmx_Val_Volts`
   - **customScaleName**: `NULL`

Note Throughout the procedure, refer to the NI-DAQmx function call parameters for the LabVIEW input values.

3. Call `DAQmxStartTask` with the following parameter using Table 7, *NI 6738/6739 Analog Output Values*:
   - **taskHandle**: `taskHandle`
4. Call `DAQmxWriteAnalogF64` with the following parameters, using **`7.5`** for `data`:
   - **taskHandle**: `taskHandle`
   - **numSampsPerChan**: `1`
   - **autoStart**: `1`
   - **timeout**: `10.0`
   - **dataLayout**: `DAQmx_Val_GroupByChannel`
   - **writeArray**: `&data`
   - **sampsPerChanWritten**: `&samplesWritten`
   - **reserved**: `NULL`

5. Use the DMM to read the value of AO 0.
6. Call `DAQmxClearTask` with the following parameter:
   - **taskHandle**: `taskHandle`
7. Call `DAQmxInitExtCal` with the following parameters:
   - **deviceName**: `Dev_name`
   - **password**: `NI`
   - **calHandle**: `&calHandle`
8. Call `DAQmxAOSeriesCalAdjust` with the following parameters:
   - **calHandle**: `calHandle`
   - **referenceVoltage**: Value read from DMM
9. Call `DAQmxCloseExtCal` with the following parameters:
   - **calHandle**: `calHandle`
   - **action**: `DAQmx_Val_Action_Commit`

   This function also saves the date, time, and temperature of the adjustment to the onboard memory.

Note If an error occurs during adjustment, no constants are written to the EEPROM.

10. Disconnect the DMM from the device.

EEPROM Update

When an adjustment procedure is completed, the NI 6738/6739 internal calibration memory (EEPROM) is immediately updated.

If you do not want to perform an adjustment, you can update the calibration date without making any adjustments by initializing an external calibration (using the `DAQmxInitExtCal` function call) and closing the external calibration (using the `DAQmxCloseExtCal` function call).

Reverification

Repeat the *Verification* section to determine the as-left status of the device.

Note If any test fails reverification after performing an adjustment, verify that you successfully self-calibrated the device, as described in the *Self-Calibration* section, before returning your device to NI. Refer to *Worldwide Support and Services* for assistance in returning the device to NI.

Test Limits

The tables in this section list the specifications for PCIe/PXIe-6738 and PXIe-6739. The specifications are divided into analog output and counter/timer tables of values. Refer to the tables and specifications document for your device.

Table 7. NI 6738/6739 Analog Output Values

Range (V)		Test Point		24-Hour Limits		2-Year Limits	
Minimum	Maximum	Location	Value (V)	Lower Limit (V)	Upper Limit (V)	Lower Limit (V)	Upper Limit (V)
-10	10	Pos FS	9.980000	9.977392	9.982608	9.977063	9.982937
-10	10	0.000000	0.000000	-0.001630	0.001630	-0.001630	0.001630
-10	10	Neg FS	-9.980000	-9.982608	-9.977392	-9.982937	-9.977063

Table 8. NI 6738/6739 Counter Values

Set Point (MHz)	Lower Limit (MHz)	Upper Limit (MHz)
5	4.99975	5.00025

Worldwide Support and Services

The NI website 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.

Visit ni.com/services for NI Factory Installation Services, repairs, extended warranty, and other services.

Visit ni.com/register to register your NI product. Product registration facilitates technical support and ensures that you receive important information updates from NI.

NI corporate headquarters is located at 11500 North Mopac Expressway, Austin, Texas, 78759-3504. NI also has offices located around the world. For telephone support in the United States, create your service request at ni.com/support or dial 1 866 ASK MYNI (275 6964). For telephone support outside the United States, visit the Worldwide Offices section of ni.com/niglobal to access the branch office websites, which provide up-to-date contact information, support phone numbers, email addresses, and current events.

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