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Calibration Executive for Traditional DAQ

2023-05-09



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June 2014, 374563A-01

This help file describes how to use National Instruments Calibration Executive for Traditional DAQ to calibrate National Instruments traditional DAQ hardware devices. Calibration Executive for Traditional DAQ supports devices that are not supported in Calibration Executive 4.x or later. For detailed information on calibration, visit ni.com/calibration.

Overview of Calibration Executive for Traditional DAQ

Intended primarily for metrology labs, Calibration Executive for Traditional DAQ provides an integrated software environment in which to verify and adjust NI measurement devices.

Features

Calibration Executive for Traditional DAQ has the following capabilities:

- Externally calibrates supported NI measurement devices
- Operates in automated or manual mode
- Configures and controls calibration instruments automatically
- Stores calibration reports in a central database
- Expands as new hardware calibration procedures are added

The Calibration Executive engine provides the core calibration, control, and reporting functionality. Each [device calibration procedure](#) provides the calibration routines and automation for a specific measurement device family.

Major Components

Calibration Executive for Traditional DAQ is designed using National Instruments LabVIEW, IVI, TestStand, and NI-VISA. A core component of Calibration Executive is the calibration engine. This engine, which includes the user interface, communicates with the following drivers and databases to control the calibration process:

- Interchangeable virtual Instruments (IVI)—A software standard for creating a common interface (API) to common test and measurement instruments. The IVI driver communicates with your standards during calibration, typically using GPIB.
- Report Database—A Microsoft Access database that stores the calibration results about assets you have calibrated, such as verification readings taken before and after calibration.
- TestStand—A test executive framework that manages the calibration procedures used to calibrate the asset.

System Requirements

For proper operation of the Calibration Executive software, your computer must meet the following minimum requirements:

- Pentium 4/M processor or equivalent
- 4 GB of RAM
- 1024 x 768 pixels screen resolution
- The user must have administrator privileges
- Windows XP (Sp2)/7 (32-bit)



Notes

Refer to [Windows Support](#) for information on Windows 7 support for specific devices.

Calibration Executive for Traditional DAQ is not compatible with operating systems that use wide characters (for example, Japanese or Chinese).

Calibration Executive only supports using periods (.) for decimal places. If your computer is configured to use commas as decimal places, you must change this setting.

Additional Requirements

To view calibration reports in all available formats, you must have the following components installed on your system:

- Java Runtime Environment
- Adobe Acrobat Reader
- Microsoft Word
- Microsoft Office Excel 2003 or later

Automated Mode Versus Manual Mode

For most devices, Calibration Executive calibrates in either automated or manual mode.

Automated Mode

If the IVI driver supports the calibration standard(s) you are using or if Calibration Executive provides a custom driver and you have a GPIB card, Calibration Executive automates verification and adjustment by communicating directly with the calibration standards.

Manual Mode

If you do not have supported standards, you must run the procedure in manual mode. In manual mode, Calibration Executive prompts you to manually control the standards. Calibration Executive then makes the necessary verification and/or adjustment to the device. To enter manual mode, select **Enter Unsupported Instrument** on the [Required Standards](#) dialog box when launching a calibration procedure.



Note Not all devices are supported in manual mode. Refer to the specific [device calibration procedure](#) to check if your device supports manual mode.

Uninstalling Calibration Executive

Each National Instruments software product has its own uninstall information. To remove any of these products from your system, use the Add/Remove Programs utility in your system control panel. Many of these programs update your Windows registry and place files in your system directory.

For Windows XP systems, perform the following procedure to uninstall Calibration Executive:

1. Open the Control Panel from **Start»Settings»Control Panel** and choose **Add or Remove Programs**.
2. Select **National Instruments Software**.
3. Click **Remove**.
4. Select **NI Calibration Executive** from the list of installed NI software.
5. Click **Uninstall**.



Caution Do **not** attempt to uninstall by deleting files, as some files may be shared with other programs.

Refer to [Calibration Reports Database](#) for information on saving a report database file (calibration reports.mdb) that is compatible with version 3.2 or prior.

Launching Calibration Executive and Logging In

To log in to Calibration Executive, complete the following steps:

1. Launch Calibration Executive by selecting **Start»Programs»National Instruments»Calibration Executive**.
2. In the Login dialog box, select either **administrator** or another user name from the User Name control.

- If you select a user name other than administrator, enter a valid password. If you select administrator, no password is necessary.

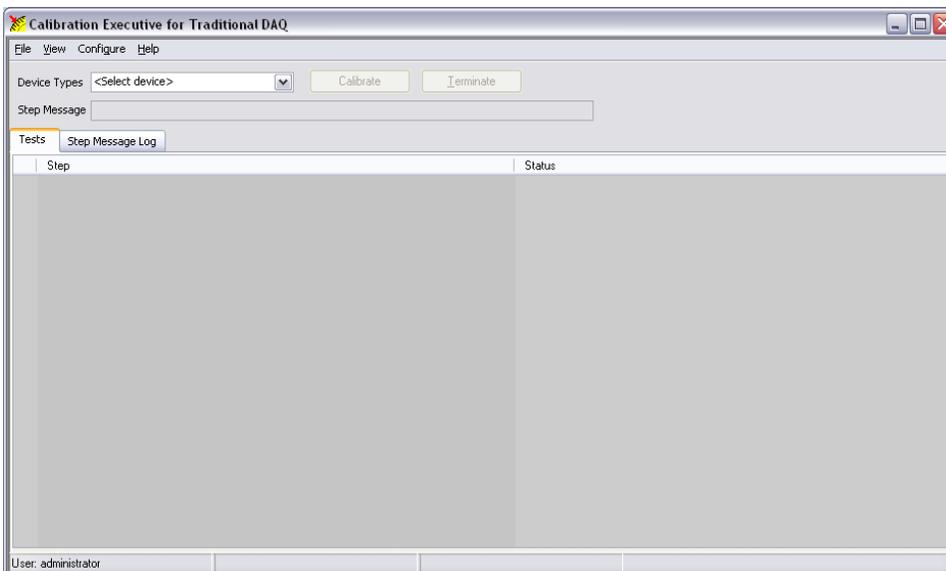


Note You should change the default administrator password after the initial login. Refer to [Editing a User Profile](#) for instructions on how to change the default password.

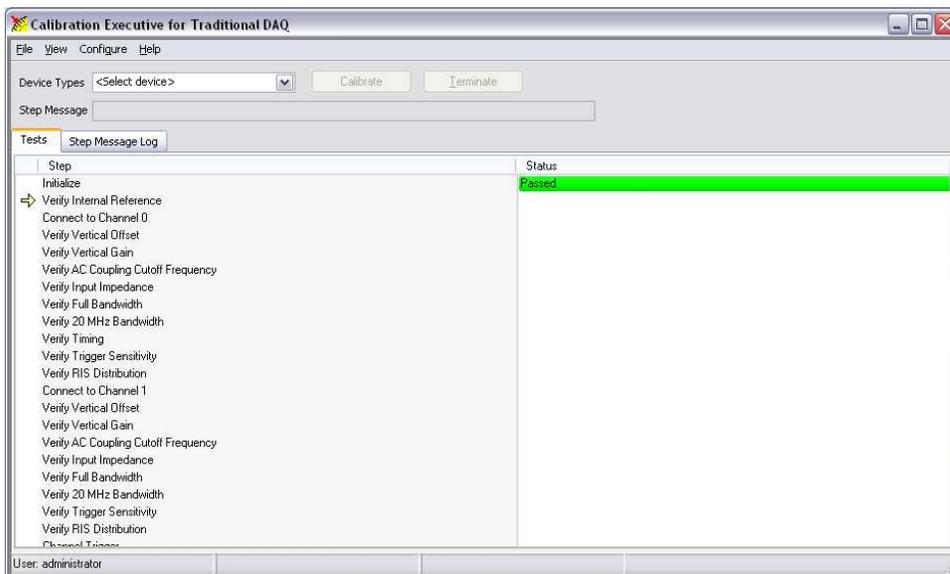
- Click **OK** to launch the user interface.

User Interface

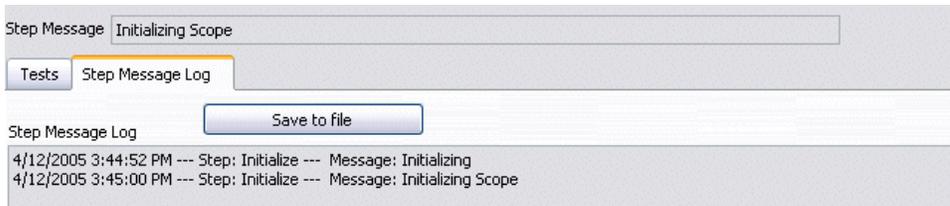
The following figure shows the main components of the Calibration Executive user interface. This interface provides access to run calibration procedures, configure users, databases, and calibration reports, and to view the documentation.



- **Menu bar**—Menu items control the main processes of Calibration Executive.
 - **Device Types selector**—Select the device name for the calibration procedure to run.
 - **Calibrate button**—Starts the calibration procedure.
 - **Terminate button**—Ends the calibration procedure before it completes.
 - **Step Message**—Displays status messages from the step that is currently executing.
 - **Tests tab**—Displays the step name that is currently running and the status of each step.
 - **Step**—Displays which values are currently being verified or adjusted.
 - **Status**—Indicates whether a step in the procedure passed or failed.
- The following figure shows the Step and Status window during a calibration procedure. The yellow arrow to the left of the step indicates which step is currently executing.



- **Step Message Log tab**—Displays a log of the history of verify test points and their results.



- **Save to file button**—Saves the Step Message Log results in a text file.

Menu Bar



The Calibration Executive for Traditional DAQ menu bar contains the following four menus:

File

The File menu contains the following options:

- **Logout**—Logs out the current user and enables the Login selection under the File menu.
- **Exit**—Closes Calibration Executive.



Note If a calibration procedure is currently running, closing Calibration Executive may cause errors. Make sure you click the **Terminate** button before you exit Calibration Executive.

- **Login**—Allows a new user to log in to the application.

View

The view menu contains the following option:

- **Calibration Reports**—Opens the Calibration Reports window. Use this window to [view or delete](#) a stored calibration report.

Configure

The Configure menu contains the following options:

- **Audio Notifications**—Selects a sound that notifies you when a dialog box requires user interaction.
- **Report Options**—Configures how Calibration Executive displays calibration reports.
- **Database Options**—Determines the database that stores calibration reports.
- **Report Database Backup Copy**—Saves a secondary copy of the current calibration reports database.
- **User**—Allows you to add new users, edit current user profiles, or delete users.

Help

The Help menu contains the following options:

- **Calibration Executive Help**—Launches this help file.
- **Calibration Procedure Help**—Provides procedure help for the device type selected.
- **About Procedure**—Provides specific information about the procedure used to calibrate the device selected.
- **About Calibration Executive**—Displays the version of Calibration Executive you are using.

Configuring Audio Notifications

Select **Configure»Audio Notifications** to configure your system to notify you when a test needs attention.



1. Select an audio notification type from the following:

- Disable Audio Notifications—does not generate a sound when a test needs user interaction.
- System Speaker—plays one of the three system sounds: Beep, Trill, or Chime, which you select from the Select a Sound list.
- External Speaker—allows you to choose from any of the wave files in the Select a Sound list, or you can install your own. To add your own wave file, do one of the following:
 - Install the new file in the following location: `C:\Program Files\National Instruments\calibrationExecutive\Source\vi.lib\AudioNotifications\SoundFiles`.
 - Browse to any file storage location. In the Select a Sound list, double-click **<Browse for a file>**.

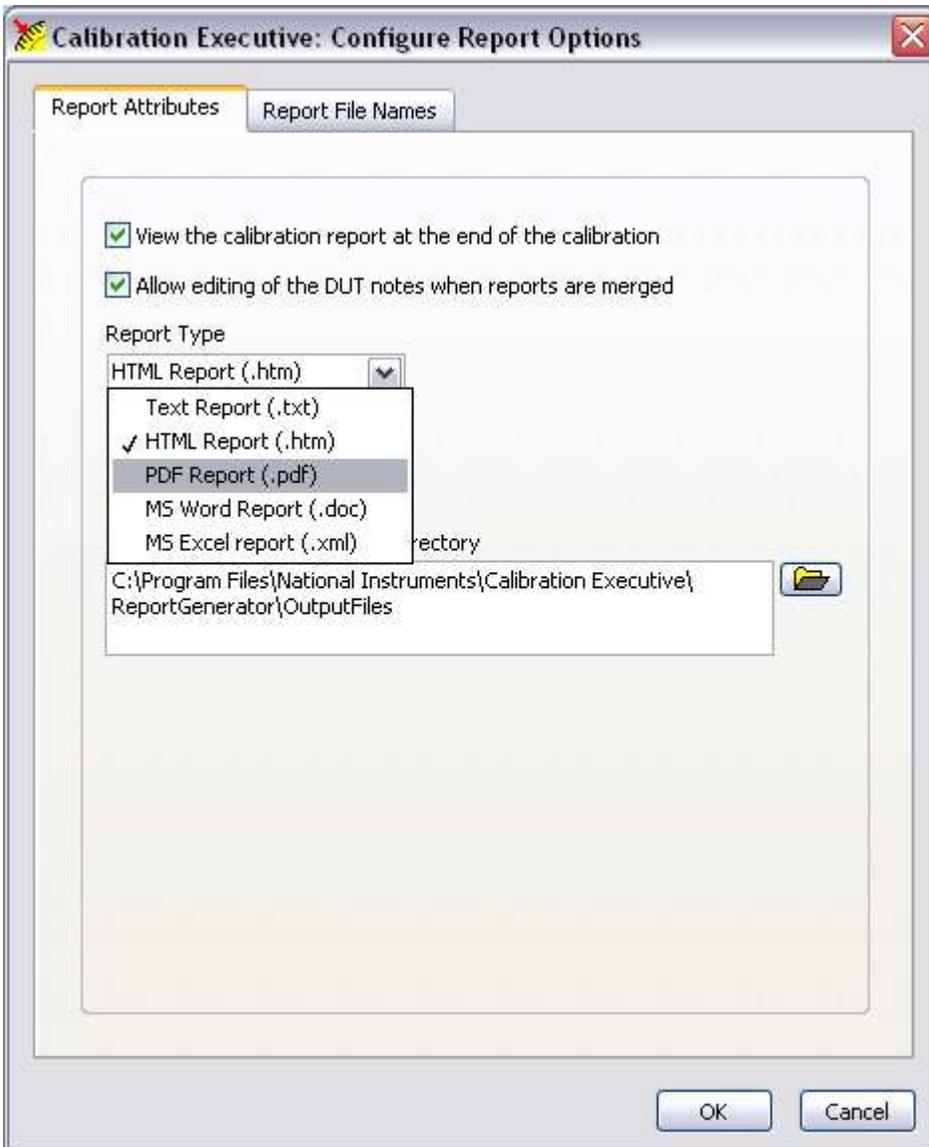
The new wave file appears in the Select a Sound list.

2. To test your audio notification, click the **Play Notification** button.

3. Click **OK** to save your settings.

Configuring Report Options

Select **Configure»Report Options** to specify the format of the calibration report, the location in which to store calibration reports, and customize the report name.



1. Select a format from the Report Type pull-down menu: Text, HTML, PDF, or MS Word.

2. Click the folder icon to the right of the Report Generator Output File Directory field to browse for the directory in which to store your calibration reports.
3. Highlight the name of the directory.
4. Click **Select Cur Dir**.
5. Click **OK**.

**Tips** Enable**View calibration report at the end of the calibration** if

you want the report to display automatically when the calibration completes.

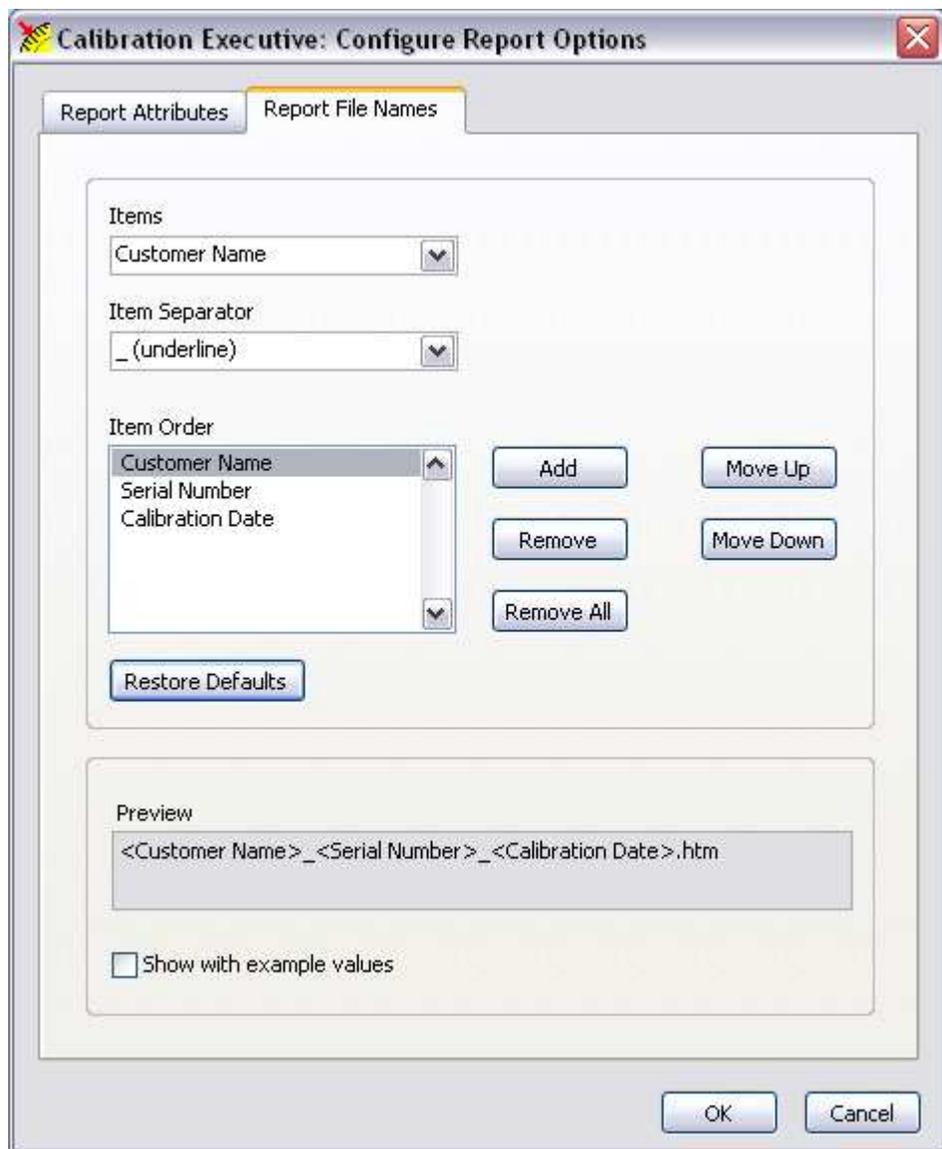
Enable

Allow editing of DUT notes when reports are merged

to edit the DUT notes when merging reports.

Flexible Report Names

Click the **Report File Names** tab to customize the report name.



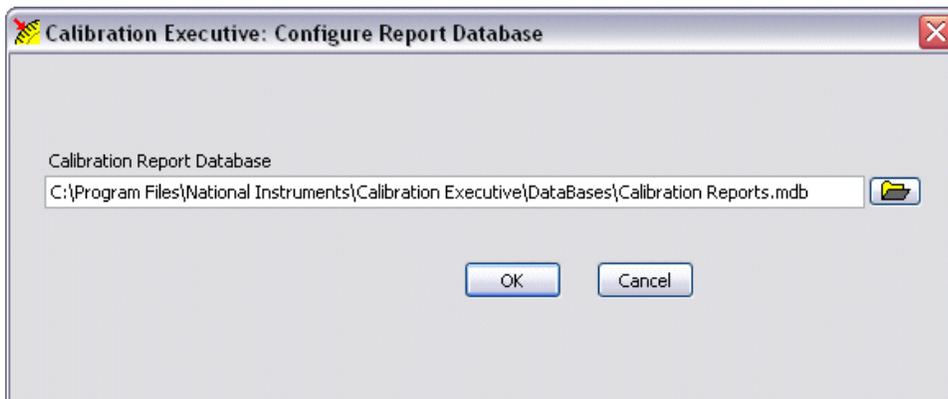
1. Select an item for the report name using the Items pull-down menu.
2. Click **Add** to add the selected item to the report name. Use the **Remove** and **Remove All** buttons to remove any selected items from the report name.
3. Repeat steps 1 and 2 for each item you want to add to the report name.
4. Select a separating character for the report name using the Item Separator pull-down menu.
5. Click **Move Up** and **Move Down** to arrange the items in the Item Order text box. The preview text box displays the customized report name.



Tip Click **Restore Defaults** to restore the default report name.

Configuring Database Options

Select **Configure»Database options** to specify the database that stores calibration reports. The Configure Report Database dialog box contains the path to the location where the database is stored.



To modify this path, complete the following steps:

1. Click the folder icon to the right of the path.
2. Search for the new file location.
3. Highlight the name of the file.
4. Click **Open**.
5. Click **OK**.

Configuring Users

Select **Configure»Users** to access the Configure Users dialog box, in which you can add new users and edit or delete current users.

Adding a New User

1. Click **Add** to display the New User dialog box, shown in the following figure.

2. Enter the User Name, Full Name, Comment, and Password.
3. Re-enter the Password in the Confirm Password field.
4. Select a profile in the User Profile control to define an initial set of privileges for a new user. The following table shows specific user privileges.

Feature	Non-Administrator Privilege	Administrator Privilege
Create/edit/delete users	No	Yes
Configure file locations	No	Yes
Delete calibration reports	No	Yes

5. Click **OK** to save your changes and close the dialog box.

Deleting a User

To delete a user name, complete the following steps:

1. Highlight the name of the user you want to remove.
2. Click **Delete**.
3. Click **OK** to save your changes and close the dialog box.



Note You cannot delete your own login information.

Editing a User Profile

To modify the login name, comments, or password associated with the selected user, complete the following steps:

1. Click **Edit** to display the Edit User dialog box.
2. Modify the information you want to change.
3. Click **OK** to save your changes and close the Edit User dialog box.



Note The Advanced button displays the Edit Flags dialog box, which contains TestStand property flags you can modify. You need to configure these property flags only when you are developing a relatively sophisticated custom type in TestStand. The Advanced button has no function in Calibration Executive.

Viewing a Calibration Report

You can view calibration reports in one of the following formats: text, HTML, PDF, or Microsoft Word.

1. Select **View»Calibration Reports** to display the Calibration Reports window, shown in the following figure.

Customer Name	Work Order	<Calibration Date>	Asset	Serial Number	As Found Status	As Left Status
National Instruments	327479	Wednesday, May 23, 2007 14:33:25	PXI-5124	E23DE7	Passed	Passed
GUIDANT CORPORATION	23021287	Wednesday, May 23, 2007 14:21:03	PCI-5112	DC442D	Passed	Passed
Goodrich Aerospace	2020090	Wednesday, May 23, 2007 10:52:03	SCXI-1102	11C2A24	Passed	Passed
Goodrich Aerospace	2020090	Wednesday, May 23, 2007 10:29:55	SCXI-1102	11C979A	Passed	Passed
National Instruments	327479	Wednesday, May 23, 2007 9:39:06	PXI-6052E	10C06D0	Passed	Passed
National Instruments	327479	Wednesday, May 23, 2007 9:19:10	PXI-5112	10F3818	Passed	Passed
National Instruments	327479	Wednesday, May 23, 2007 9:13:06	PXI-5112	10F3818	Passed	Passed
National Instruments	327479	Wednesday, May 23, 2007 8:48:51	PXI-4060	D2B53A	Passed	Passed
Dade Behring Inc.	DAN36846N	Tuesday, May 22, 2007 10:06:22	PCI-6036E	10E6649	Passed	Passed
Dade Behring Inc.	DAN36846N	Tuesday, May 22, 2007 9:56:07	PCI-6036E	10CSEFB	Passed	Passed
Advanced Bionics	53712	Tuesday, May 22, 2007 9:47:47	PCI-6251	1171C68	Passed	Passed
National Instruments	327479	Tuesday, May 22, 2007 9:27:24	PXI-6602	11146C0	Passed	Passed
National Instruments	327479	Tuesday, May 22, 2007 9:05:00	PXI-6031E	10B36A3	Passed	Passed

Search Column: Customer Name for [] # of Records found: 0

Report Type: HTML Report [v] [View] [Merge Reports] [Delete] [Close]

2. Highlight the report you want to view from the displayed list.

3. Use the Report Type field to select Text, PDF, HTML, or MS Word report type.
4. Click **View** to display the report or click **Delete** to remove the report from the database.
5. Click **Close** to close the Calibration Reports window and return to the main Calibration Executive user interface.



Tip The brackets around a column header indicate that the reports are sorted on this field. To sort on a different field, click on another column header.

Launching a Calibration Procedure

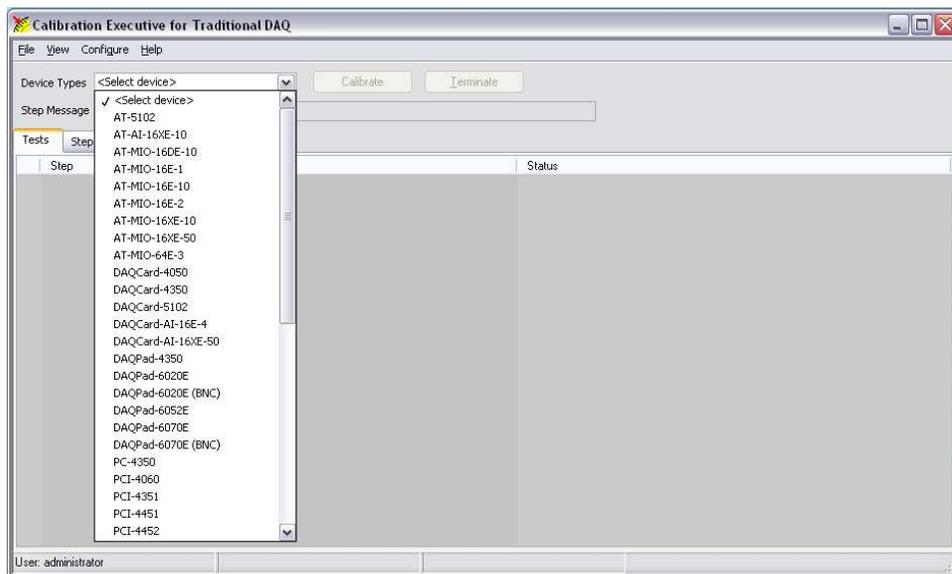
This tutorial teaches you how to launch a calibration procedure in NI Calibration Executive. In this tutorial, you will launch a calibration procedure by completing the following tasks:

1. Launching the Setup Wizard
2. Entering the Customer Information
3. Selecting the Required Standards
4. Entering Environmental Information and Selecting Options
5. Selecting a DUT
6. (Optional) Selecting Test Points
7. Run-time Dialog Boxes

1. Launching the Setup Wizard

Complete the following steps to launch the setup wizard.

1. Select the device to calibrate from the Device Types control in the upper left corner of the user interface.



2. Click the **Calibrate** button to launch the setup wizard.

2. Entering the Customer Information

The Customer Information dialog box is shown in the following figure.

The screenshot shows a dialog box titled "PXI-5112" with a close button in the top right corner. The main title of the dialog is "Customer Information". It contains four input fields: "Customer Name" with the value "National Instruments", "Address" with the value "11500 N. MoPac Expwy Austin, TX 78759", "Work Order Number" with the value "NI987542", and "Notes" which is an empty text area with a vertical scrollbar. At the bottom of the dialog, there are three buttons: "Help", "Next", and "Cancel".

1. Enter the customer name and address. Calibration Executive stores this information and retrieves it the next time you begin to enter the customer name.

3. Selecting the Required Standards

The **Required Standards** dialog box is shown in the following figure.



Note Each calibration instrument required for your selected calibration procedure has its own dialog box. You must complete the required information for each instrument before proceeding to the next dialog box.

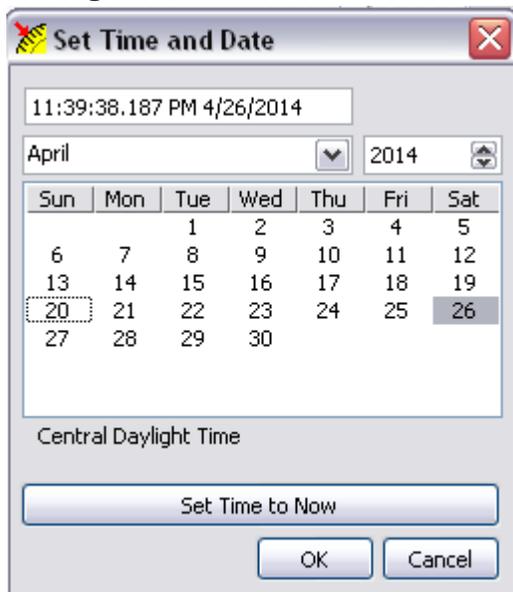
1. In the first field, select an instrument from the supplied list.



Note If you select an unsupported instrument, you are prompted to enter additional information about the instrument in the **Description** field.

2. Enter a tracking number for the instrument in the **Tracking No.** field.
3. Select a calibration interval for the instrument from the **Calibration Period** list box.

- Select the calibration due date for the selected instrument in the **Calibration Due Date** field. You can either enter the date from the keyboard or click the calendar icon  to launch the time and date dialog box, shown in the following figure.



- Enter any additional comments in the **Notes** field.
- Highlight the correct device address of the instrument in the **Address** field.

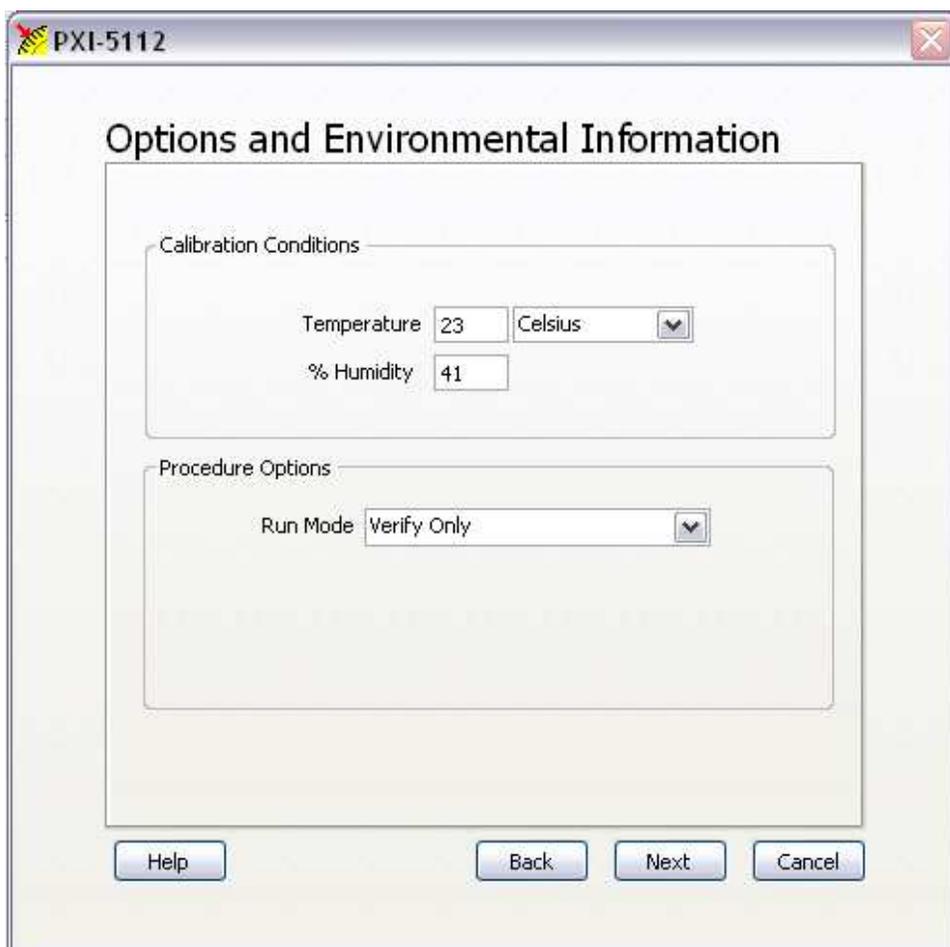


Note The **Address** field displays all of the GPIB instruments, along with supported NI devices, that are connected to your computer. If the address of your instrument is not displayed in the list, ensure that the instrument is connected and click **Refresh**. To run a calibration procedure in automated mode, you must select the instrument and its associated device address.

- Click **Next** to proceed to the next Required Standards dialog box.
- When you complete all required standards information, click **Next**.

4. Entering Environmental Information and Selecting Options

The Options and Environmental Information dialog box is shown in the following figure.



Calibration Conditions

1. Enter the ambient temperature.
2. Select the temperature scale (Celsius or Fahrenheit).
3. Enter the % Humidity.



Note The information you enter in the Calibration Conditions section is included on the calibration report.

Procedure Options

1. Select the Run Mode. The modes available vary depending on the device you are calibrating. Refer to the help page for your device for details on available run modes.
 1. **Verify Only** - This run mode will verify the device against the specifications. This mode does not adjust the performance of the device.
 2. **Verify & Adjust** - This run mode will verify the device against the as-found specifications. Then, the procedure will execute a series of steps to adjust the performance of the device. The device will then be re-verified against the as-left specifications.

Devices that support this run mode may also support the Optional Adjust feature. Optional Adjust is a feature that allows the user to terminate a procedure being executed in Verify & Adjust run mode after the initial verify. After the initial verify, a pop-up will be displayed showing the test results to the user, and allowing them to terminate the procedure without running adjust and generate a report with the initial verify results.

3. **Adjust Only** - This run mode will only adjust the device performance and will not generate any report. This run mode can be used if a Verify Only has already been performed.
2. Complete any additional fields as needed.

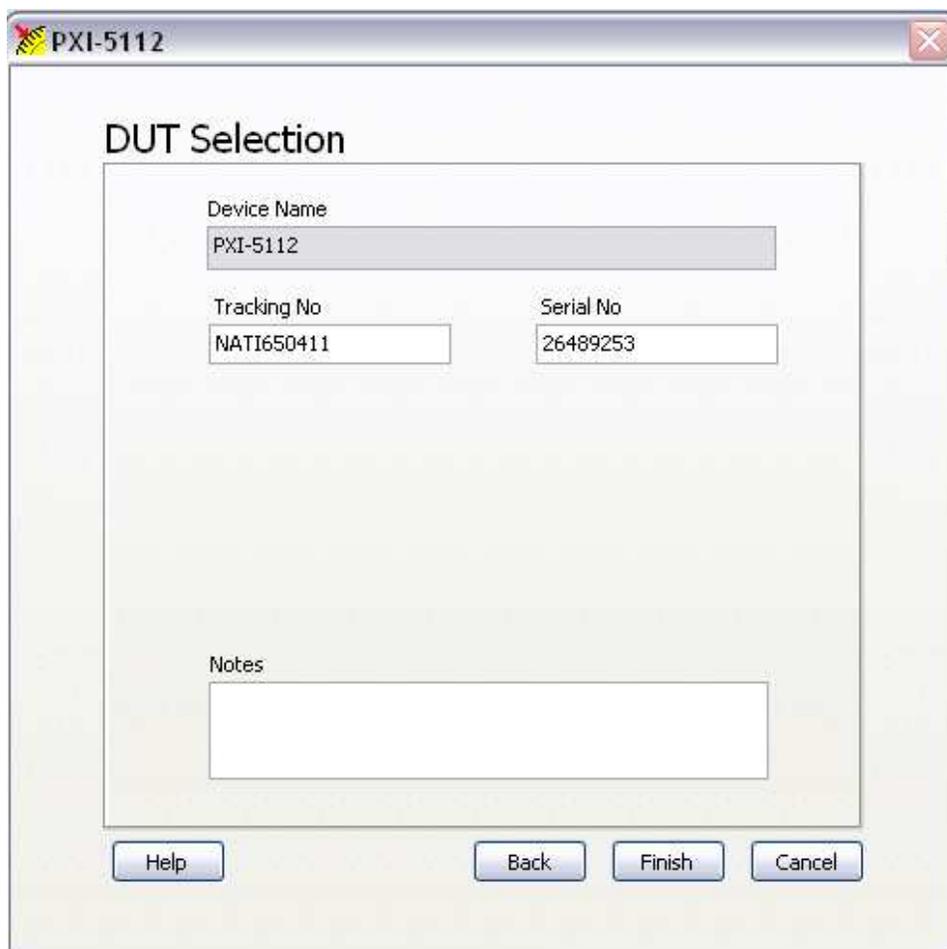


Note Not all device procedures present the same Procedure Options. Make sure you complete all required information before proceeding to the next step.

3. Click **Next**.

5. Selecting a DUT

The DUT Selection dialog box is shown in the following figure.



PXI-5112

DUT Selection

Device Name
PXI-5112

Tracking No
NATI650411

Serial No
26489253

Notes

Help Back Finish Cancel



Note The Device Name field populates automatically based on the calibration procedure you have selected.

1. In the DUT Selection dialog box, enter the following information:
 - Tracking Number
 - Serial Number
2. Complete any additional fields required by the procedure. The required information may vary depending on which device you are calibrating.
3. Click **Finish** to launch the calibration procedure.

Device Identifiers

After you launch the procedure, a dialog box appears in which you must enter a device identifier such as a device number, device name, or resource name. This dialog box varies depending on which device you are calibrating.

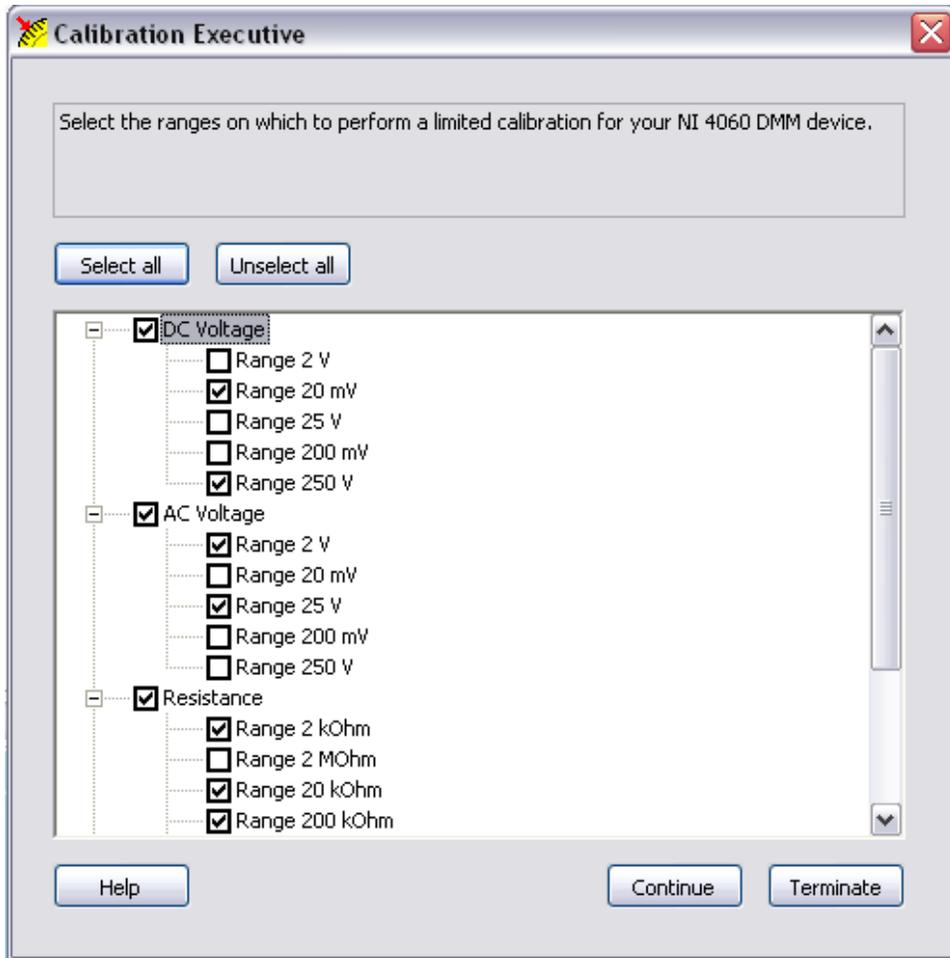


Note In some device procedures, the device identifier is required in the DUT Selection dialog box, rather than in a separate dialog box.

This device identifier is assigned by Measurement & Automation Explorer (MAX) when you configure the hardware in MAX. To find this information, launch MAX, expand **Devices and Interfaces**, and locate the device in the list.

6. (Optional) Selecting Test Points

The Selectable Test Points dialog box is shown in the following figure.



1. Select **Enable Limited Calibration** on the Options and Environmental Information dialog box.
2. Click **Next** to go to the DUT Selection dialog box.
3. Enter the appropriate information in the DUT Selection dialog box. Refer to [DUT Selection](#) for more information on the DUT Selection dialog box.
4. Click **Finish** to go to the Selectable Test Points dialog box.
5. Select the desired parameters in the Selectable Test Points dialog box. You must select one parameter for each test.
6. Click **Continue** to launch the calibration procedure. An entry in the DUT notes indicates that a limited calibration was performed that did not cover the entire capability of the device.



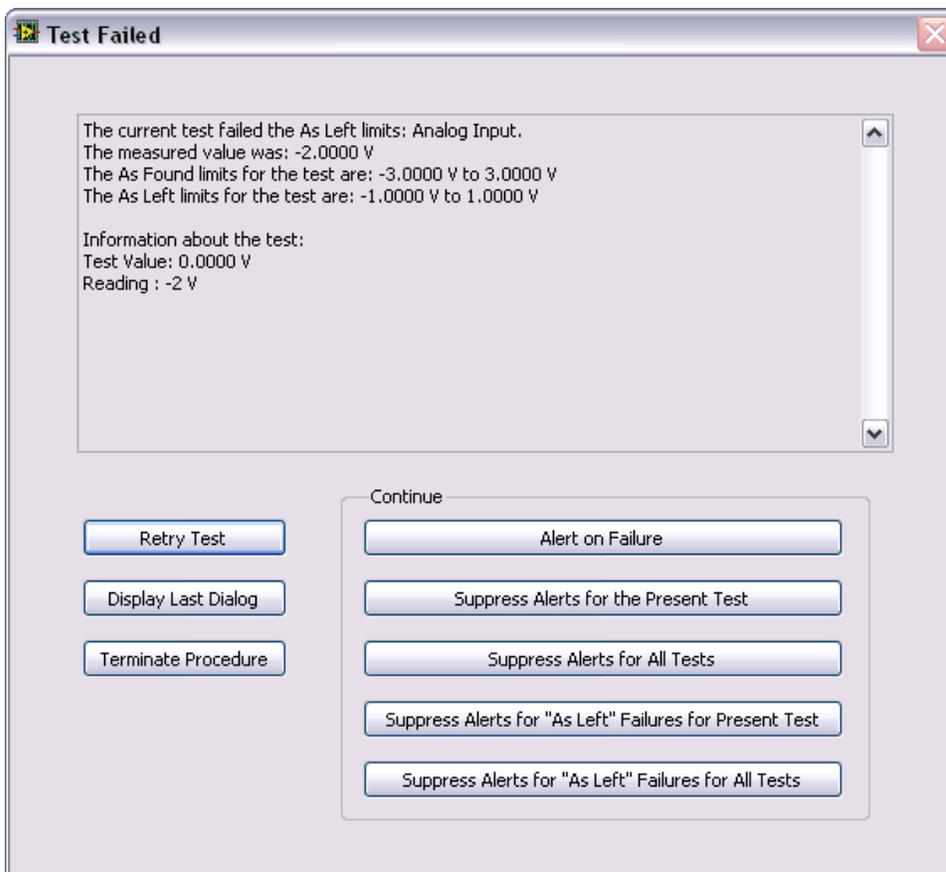
Note Not all devices support limited calibration. Refer to the specific [device calibration procedure](#) to check if your device supports limited calibration.

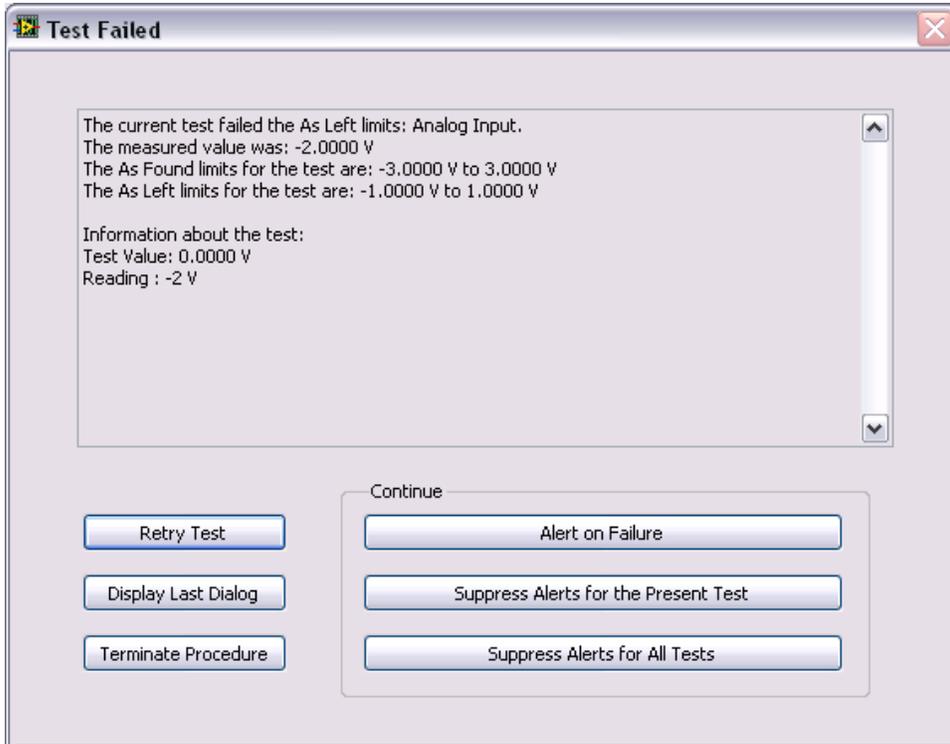
7. Run-Time Dialog Boxes

The Run-Time dialog boxes are shown and described below.

Test Failed Dialog Box

During the initial verify, the dialog boxes shown below will appear for As Found and As Left limit failures, respectively, and will describe the details of each failure. As-left limit failures will not result in an overall test failure during the initial verify, but allow the user to retry the test point if failures are result of setup issues.





Retry the existing test point or continue to the next test point by selecting one of the available buttons.

- **Retry Test:** Retries the current test point. Allows you to check your connections if you believe the failure to be a connection issue.
- **Display Last Dialog:** Displays the last dialog box to aid in checking your connections.
- **Terminate Procedure:** Terminates the procedure.

All of the **Continue** options will accept the current failure and continue to the next test point.

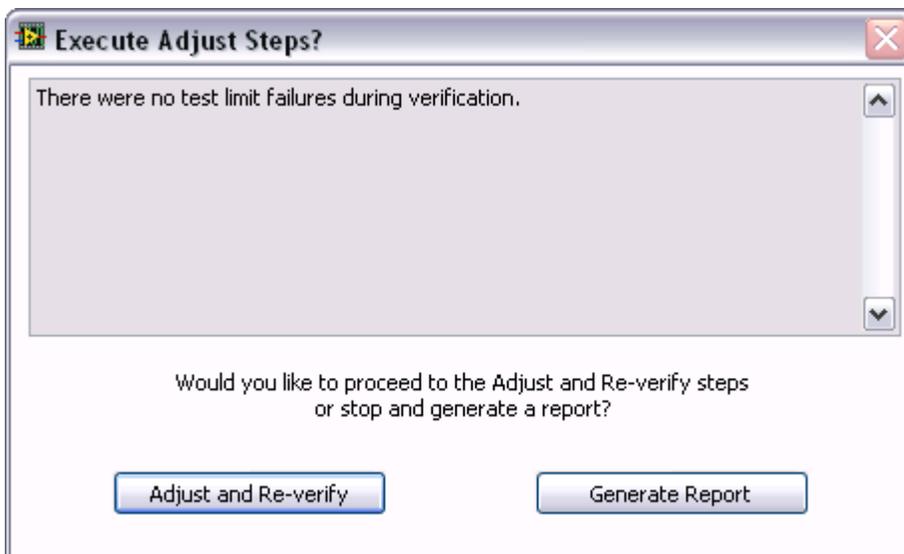
- **Alert on Failure:** Do not suppress future failures.
- **Suppress Alerts for the Present Test:** Suppress all failure only for the current test. The next tests will display this dialog box for any failures.
- **Suppress Alerts for All Tests:** This option will suppress all alerts.
- **Suppress Alerts for "As Left" Failures for Present Test:** This option will suppress alerts only for as-left test limit failures for the present test, but

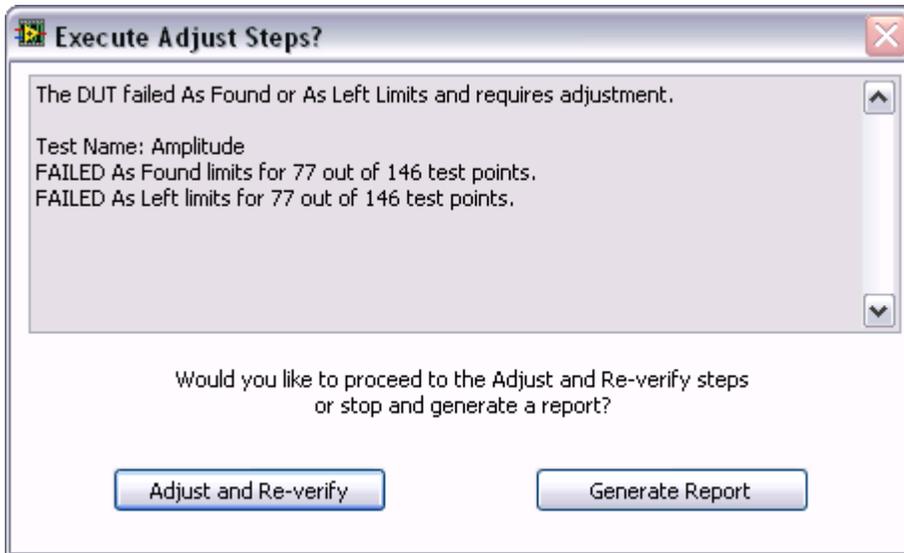
will continue to display failures for as-found test limits. This option is not available during re-verify.

- **Suppress Alerts for "As Left" Failures for All Tests:** This option will suppress only alerts for as-left test limit failures for all tests, but will continue to display failures for as-found test limits. This option is not available during re-verify.

Execute Adjust Steps? Dialog Box

The **Execute Adjust Steps?** dialog box will appear after verification and detail whether or not there were test point failures.





Either dialog box provides the following options:

- **Adjust and Re-verify**
- **Generate Report**



Note Not all devices support limited calibration. Refer to the specific [device calibration procedure](#) to check if your device supports limited calibration.

Calibration Reports

Calibration reports are stored in a central database. Calibration Executive retrieves the data from this database and displays the report in the format you have selected (text file, HTML, PDF, Microsoft Excel, or Microsoft Word). Each report includes the customer name and address, the purchase order number, calibration date, and DUT type (model) for the calibrated device, as well as similar information about the calibration standards used.



Note To view calibration reports with Microsoft Excel, you must have Microsoft Office Excel 2003 or later installed on your PC.

Reading the Calibration Report

The following terms are common to all of the calibration report tables.

- **Low Limit** is the lower limit of the reading allowable to meet specifications.
- **High Limit** is the upper limit allowable to meet specifications.
- **Reading** is the actual reading taken during the calibration procedure. For an ideal calibration, the reading value always lies between the upper and lower limits. If the reading is outside this range, the calibration fails.
- **As Found Status** details the response of the DUT prior to any adjustment, or as received at the calibration lab. Therefore, if the DUT is out of calibration, the As Found tests can fail.
- **As Left Status** represents the DUT performance after calibration, or as the DUT left the calibration lab. The DUT should pass the As Left tests.



Note The calibration report includes an error message if an error or a termination occurred that may have invalidated the calibration data.

Calibration Reports Database

The calibration reports database, a Microsoft Access database, contains all of the results for each calibration. By default, the database is named `Calibration Reports.mdb` and is stored in the Databases folder of Calibration Executive. If you installed Calibration Executive in the default location, this database is located in `C:\Program Files\National Instruments\Calibration Executive\DataBases`. The calibration reports database responds to standard structured query language (SQL) commands. Therefore, you can write your own report-handling routine to retrieve data from the database. You could write such a routine in LabVIEW, C, visual Basic, or any other language that supports SQL communication. The calibration reports database consists of the following seven tables:

- ASSET contains all of the information about the calibrated DUT.

- CALIBRATION_DATA contains all the data acquired during the calibration, as well as the uncertainty data, if applicable.
- CUSTOMER contains all of the customer information associated with the DUT.
- ENGINE contains information about the operator and the calibration date.
- ENVIRONMENT contains information about the environmental conditions during the calibration.
- STANDARD contains information about the standards, such as calibrators and DMMs, that were used during the calibration.
- REPORT keeps track of all of the relationships between the six other tables.

The REPORT table contains a search value for each of the other tables. The search value is a unique number that represents all of the data associated with a specific calibration report—all the customer information, calibration condition information, and so on. To locate data associated with a given calibration, you must first find the search value for that data in the REPORT table. When you know the search value number for a specific report, you can search for a match to that number in the other search value fields of the table.

Example: Using the Calibration Reports Database

Suppose you want to find out all of the calibration-related information—the calibration conditions, DUT specifics, calibration data, and so on—about the devices you have calibrated for a customer. To find that information, start by opening the CUSTOMER table and locating the name of your client. In the same row that the customer name appears, there is a numeric search value. With that search value, you can open the REPORT table and use that value to search the other tables for that customer's asset information, calibration data, and so on. You could also use that search value to write your own asset-handling routine.

Saving a Calibration Reports Database Backup

This feature allows you to save a secondary copy of the current calibration reports database.

1. Select **Configure»Report Database Backup Copy**.

- Click the folder icon to the right of the Path to Report Database Backup field to browse for the directory in which to store your calibration reports database backup.



Note Do not select the same directory where the original report database is saved.

- Highlight the name of the directory.
- Click **Open**.
- Select the desired Calibration Executive version from the Select Version pull-down menu.



Note If you select Calibration Executive 3.2 or prior, the report files do not support the Driver Information section. So this information will not be in the source report database.

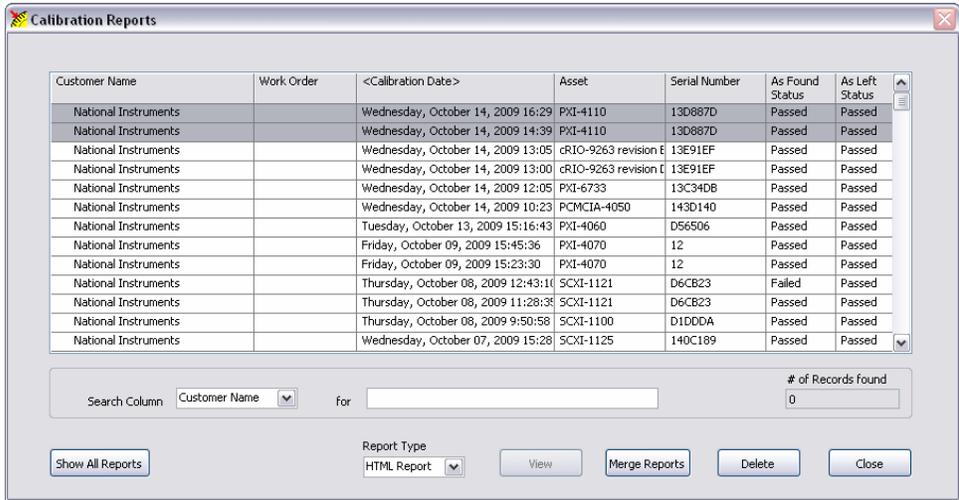
- Click **Save As**.

Merge Reports

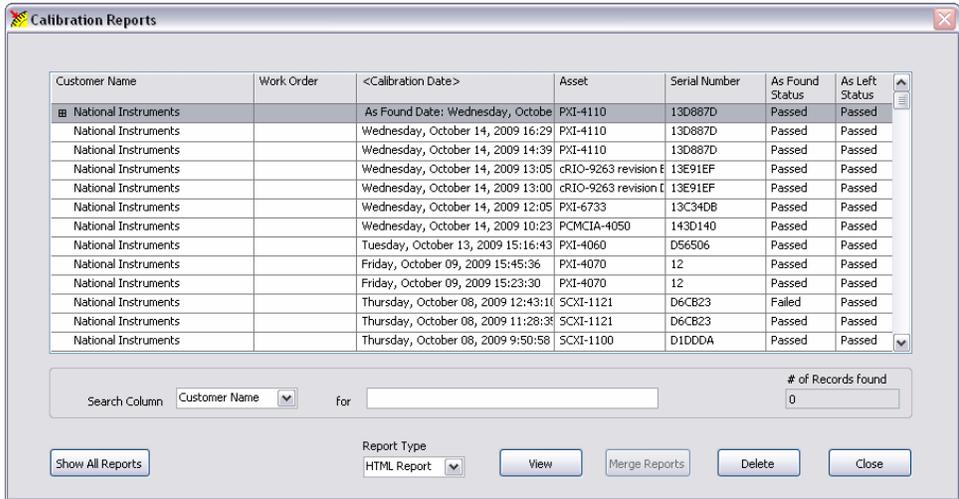
- Select **View»Calibration Reports** to display the Calibration Reports dialog box.
- Highlight the two reports you want to merge. If the two reports appear to be compatible, the Merge Report button enables as shown in the following figure.



Note The Merge Reports button enabling is only a pre-checking function and does not mean that two reports can be merged.



3. Select the report format using the Report Type pull-down menu.
4. Click **Merge Reports** to merge the two highlighted reports.
5. Edit the DUT notes if you enabled **Allow Editing of the DUT notes when reports are merged** on the [Configuring Report Options](#) dialog box.
6. If the two reports are compatible, the merged report appears at the top of the report list, as shown in the following figure. If the reports are not compatible an error appears.



Measurement Uncertainty

Measurement uncertainty is defined by NCSL Rp3-1988 as an estimate of the range of values about the measured value in which the accepted value is believed to lie. A

total uncertainty value represents the combination of a measure of the random error and estimated bounds of the systematic error, and considers all factors that contribute to the measurement uncertainty. For detailed information about measurement uncertainty, refer to **ANSI/NCSL Z540-2-1997, U.S. Guide to the Expression of Uncertainty in Measurement**. For some devices, Calibration Executive can calculate measurement uncertainties for you. When you run the procedure, the software prompts you to select whether to perform measurement uncertainty calculations. If you select Yes, the procedure prompts you for which uncertainty file you want to use.

How Does Calibration Executive Calculate Measurement Uncertainty?

Calibration Executive does not provide uncertainty calculations for all devices. Only the following devices support an option for uncertainty calculations:

AT-AI-16XE-10	AT-MIO-16DE-10
AT-MIO-16E-1	AT-MIO-16E-2
AT-MIO-16E-10	AT-MIO-16XE-10
AT-MIO-16XE-50	AT-MIO-64E-3
DAQCard-AI-16E-4	DAQCard-AI-16XE-50
DAQPad-6020E	DAQPad-6070E
DAQPad-6052E	

For devices that do not include automatic uncertainty calculations, you can calculate the uncertainty manually using the [template files](#) provided in Calibration Executive.

When calculating measurement uncertainty, Calibration Executive accounts for Type A uncertainty and Type B uncertainty. The following table explains the calculations for these uncertainty components.



Note Type B uncertainty consists of two parts: uncertainty of the reference standard and resolution uncertainty of the DUT.

Component	Description
Type A uncertainty	Defined as the standard deviation of the measurements divided by the square root of the number of measurements.

	<p>r of measurements. This calculation is based on different numbers of measurements for different products. The degrees of freedom value is taken into account in cases where the number of degrees of freedom is not considered infinite.</p>
<p>Type B uncertainty, part 1: uncertainty of the reference standard</p>	$= \frac{\text{Standard Deviation of Measurements Taken}}{\sqrt{N}} \times f$ <p>where N is the number of measurements taken and f accounts for the t-distribution. Including the t-distribution is only necessary in cases where the number of degrees of freedom is not considered infinite.</p>
<p>Type B uncertainty, part 2: resolution uncertainty of the device</p>	$= \frac{1}{2} \left(\frac{\text{Resolution of the Device}}{\sqrt{3}} \right)$ <p>where Resolution of the Device is the accuracy of the smallest meaningful displayed digit normalized using a rectangular distribution. The $\sqrt{3}$ term comes from assuming a rectangular distribution of probabilities of the values of measurements.</p>

After the standard uncertainty components are calculated, they are combined using the square root of the sum of the squares method to arrive at the combined standard uncertainty. The expanded uncertainty of measurement that Calibration Executive prints on the calibration report is this combined standard uncertainty of measurement multiplied by the coverage factor **k** = 1.96, which for a normal distribution corresponds to a coverage probability of approximately 95%.

Related Topics

[Uncertainty Files for Standards](#)

[Uncertainty Files for Commonly Used Standards](#)

Uncertainty Files for Standards

Calibration Executive stores uncertainty information for common standards, including calibrators and DMMs, in tab-delimited text files under the Calibration

Executive\Uncertainty directory. Calibration Executive prompts you to select whether to include uncertainty information when you run a procedure. The Calibrator Uncertainty Information dialog box, shown in the following figure, displays the list of calibrators for which Calibration Executive has uncertainty files. You can select a calibrator from the displayed list, or you can browse to select another uncertainty file.

The DMM Uncertainty Information dialog box displays the list of DMMs for which Calibration Executive has uncertainty files. You can select the DMM model you are using from the displayed list, or you can browse to select another uncertainty file.

Each uncertainty file contains a confidence level that corresponds to a coverage factor, as listed in the following table. These coverage factors assume an infinite number of degrees of freedom.

Confidence Levels and Corresponding Coverage Factors				
90%	95%	95.45%	99%	99.73%
1.645	1.960	2.000	2.576	3.000



Note For a more detailed table of confidence levels and coverage factors, refer to Annex G in **ANSI/NCSL Z540-2-1997, U.S. Guide to the Expression of Uncertainty in Measurement**.

Related Topics

[Uncertainty Files for Commonly Used Standards](#)

Uncertainty Files for Commonly Used Standards

The information in the uncertainty files is taken from the manufacturer's specifications for each particular instrument, at a confidence level shown in the specifications and at the top of the uncertainty file.



Note Uncertainty files contain specifications expressed in specific units. For example, calibrator uncertainty files generally contain **ppm output** and **mV offset**, whereas DMM uncertainty files generally contain **ppm reading** and **ppm range**. If the specifications for your

instrument are not in this format, you must convert them to the same units. For example, if the specifications of your calibrator are given in percent output and mV offset, you must convert them correctly to ppm output and mV offset, respectively. If the confidence level is not given in the instrument specifications, you can assume a 95% confidence level and set the coverage factor to 1.96. For more information, refer to Annex G in **ANSI/NCSL Z540-2-1997, U.S. Guide to the Expression of Uncertainty in Measurement**.

Template Files

If you use instruments that do not have uncertainty files provided by Calibration Executive, you can create your own uncertainty files by using the template files. Template files named `Calibrator Template.txt` and `DMM Template.txt` are provided in their respective directories under `Calibration Executive\Uncertainty`.



Tip Instead of using the template files, you can modify an existing DMM or calibrator uncertainty file by making a copy of the file and changing the appropriate information for the standard you are using.

Uncertainty Calculations of Reference Standards

The uncertainty of the calibrator depends on what range it is operating in and what output value it is returning. Calibration Executive calculates the uncertainty of a DC voltage Test Point for a calibrator as follows:

1. Searches in the proper uncertainty file for the row in which the Test Value is less than the range.
2. Retrieves the ppm output and mV offset from that row.
3. Calculates uncertainty using the formula

$$Uncertainty = \frac{ppm\ Output \times Test\ Value}{1,000,000} + \frac{\mu V\ Offset}{1,000,000}$$

4. Calculates standard uncertainty using the formula

$$\text{Standard Uncertainty} = \frac{\text{Uncertainty}}{1.96}$$

because a 95% confidence level corresponds to a coverage factor of 1.96.

The standard uncertainty is the value that Calibration Executive combines with the other standard uncertainties using the root-sum-square method to determine the combined standard uncertainty. The uncertainty of the DMM depends on what range it is operating in and the value that it is reading. Calibration Executive calculates the uncertainty of a DC voltage Test Point for a DMM as follows:

1. Searches in the proper uncertainty file for the row in which the Test Value is less than the Range.
2. Retrieves the Range, ppm Reading, and ppm Range from that row.
3. Calculates uncertainty using the formula

$$\text{Uncertainty} = \frac{\text{ppm Reading} \times \text{Reading}}{1,000,000} + \frac{\text{ppm Range} \times \text{Range}}{1,000,000}$$

4. Calculates standard uncertainty using the formula

$$\text{Standard Uncertainty} = \frac{\text{Uncertainty}}{1.96}$$

The standard uncertainty is the value Calibration Executive combines with the other standard uncertainties using the root-sum-square method to determine the combined standard uncertainty. The combined standard uncertainty is then multiplied by a coverage factor of 1.96, corresponding to a final expanded uncertainty with a 95% confidence level and a normal distribution.

Adding Uncertainty Components

If you want to add other uncertainty components, you can copy and modify an existing uncertainty file. For example, if you want to add an offset uncertainty component to all analog input tests, make a copy of the proper calibrator uncertainty file, rename it, and modify it by adding the offset to the mV offset column.

If the DMM you are using is operating outside of its normal temperature range and you want to account for the temperature difference, make a copy of the proper DMM

uncertainty file and add the temperature coefficients to the absolute uncertainty specifications. When you run the Calibration Executive procedure, a dialog box prompts you for information on which calibrator and DMM you are using. If you want to use your modified uncertainty files and they are not in the provided list, click **Browse** and select your modified uncertainty files.

Example: Calculating the Uncertainty for a Test Point

The following example is the uncertainty calculation for the PCI-MIO-16XE-10 at the 9.98 V analog input Test Point, 20 V range, bipolar mode (± 10 V), using a Fluke 5720A calibrator that was calibrated one year ago.

-

Calibrator uncertainty

The specification for the Fluke 5720A calibrator at 1 year, 95% confidence level ($k = 1.96$ for normal distribution) is 3.5 ppm + 2.5 μ V.

$$3.5 \text{ ppm} \times 9.98 \text{ V} + 2.5 \text{ } \mu\text{V} = 37.43 \text{ } \mu\text{V}$$

$$\text{Standard Uncertainty} = (37.43 \text{ } \mu\text{V}) / 1.96 = 19.1 \text{ } \mu\text{V}$$

-

Resolution of device

$$\text{Resolution} = \text{Range} / \text{Number of Levels of 16-bit ADC}$$

$$= 20 \text{ V} / 2^{16}$$

$$= 305.175 \text{ } \mu\text{V}$$

$$\text{Standard Uncertainty} = \frac{1}{2} \left(\frac{\text{Resolution}}{\sqrt{3}} \right) = 88.1 \text{ } \mu\text{V}$$

-

Noise and other Type A uncertainty

Standard deviation from 10,000 measurements was 207 μ V.

$$\begin{aligned} \text{Standard Uncertainty of Mean} &= \frac{\text{Standard Deviation}}{\sqrt{N}} \\ &= \frac{207 \mu\text{V}}{\sqrt{10,000}} \\ &= 2.07 \mu\text{V} \end{aligned}$$

■

Combined standard uncertainty

Use the square root of sum of squares method.

Combined Standard Uncertainty

$$\begin{aligned} &= \sqrt{19.1 \mu\text{V}^2 + 88.1 \mu\text{V}^2 + 2.07 \mu\text{V}^2} \\ &= 90.2 \mu\text{V} \text{ (1 sigma normal distribution)} \end{aligned}$$

■

Final expanded uncertainty

To convert into 95% confidence level, multiply the standard uncertainty by the coverage factor.

$$90.2 \mu\text{V} \times 1.96 = \pm 177 \mu\text{V}$$

$\pm 177 \mu\text{V}$ is the value printed on the calibration report.

Measurement Uncertainty for NI E Series Devices

The components of uncertainty vary depending on which test is running. The E Series device calibration procedure runs up to three main tests, depending on which device you are calibrating. Each test takes different uncertainty components into account. After Calibration Executive calculates all the components of uncertainty, the components are converted to a 1-sigma normal distribution, then combined using the root-sum-square method. The combined standard uncertainty is then multiplied by an appropriate coverage factor, taking degrees of freedom into

account, to arrive at the reported expanded uncertainty of measurement, which corresponds to a coverage probability of approximately 95%.

Counter Uncertainty

This section describes the components of counter uncertainty in the E Series device calibration procedure. You must manually calculate final expanded counter uncertainty at a 95% confidence level based on the manufacturer's specifications for the counter and your own Type A calculations. Enter this value when the procedure prompts you for it. A suggested final expanded uncertainty value is computed as follows:

$$\text{Counter Uncertainty} = \sqrt{(\text{Type A Uncertainty})^2 + (\text{Type B Uncertainty})^2}$$

where

$$\text{Type A Expanded Uncertainty} = 1.96 \times \frac{\text{Std. Dev. of Measurements Taken}}{\sqrt{10}}$$

where 10 is the number of measurements taken.

Type B uncertainty can be calculated as shown in the following example, which measures a 5 MHz square wave signal (which has negligible trigger error) with a one second gate time. This example is for an HP53132A counter with a high-stability oven that was calibrated three days ago.

$$\text{Type B Uncertainty} = \text{Systematic Uncertainty} \pm 1.96 \times \text{RMS Resolution} =$$

$$\left[\left(\pm \text{Time Base Error} \pm \frac{t_{\text{acc}}}{\text{Gate Time}} \right) \pm 1.96 \times \left(\frac{4 \times \sqrt{t_{\text{res}}^2 + (2 \times \text{Trigger Error}^2)}}{\text{Gate Time} \times \sqrt{\text{Number of Samples}}} + \frac{t_{\text{jitter}}}{\text{Gate Time}} \right) \right] \times \text{Frequency}$$

where

Number of Samples is 200,000 (because frequency > 200 kHz)

Gate Time is 1 second

Time Base Error is **Temp. Stability** × (3 Days × Daily Aging Rate)

t_{acc} is the timebase accuracy of the counter (from the hardware documentation)

t_{jitter} is the jitter specification of the counter (from the hardware documentation)

t_{res} is the rms resolution of the counter (from the hardware documentation)

$$= 2.5 \times 10^{-9} + 3 \times (5 \times 10^{-10})$$

$$= 4.0 \times 10^{-9}$$

$$= [\pm 4.0 \times 10^{-9} \pm 1.96 \times (2.01 \times 10^{-12} + 3 \times 10^{-12})] \times 5 \text{ MHz}$$

$$= (\pm 4.0 \times 10^{-9} \pm 9.8 \times 10^{-12}) \times 5 \text{ MHz}$$

$$= \pm 20.05 \text{ mHz}$$

Analog Input Uncertainty

The following table contains the names and descriptions of the components of analog input uncertainty in the E Series device calibration procedure.

Uncertainty Component	Description
Calibrator uncertainty	Retrieved from the calibrator uncertainty text file.
Resolution uncertainty of the E Series device	$= \frac{1}{2} \left(\frac{\text{Resolution of DUT}}{\sqrt{3}} \right)$ <p>where Resolution of DUT is the range of the E Series device divided by the number of levels in the ADC. The term in the denominator results from assuming a rectangular distribution of probabilities of the measurement values.</p>
Type A uncertainty	$= \frac{\text{Standard Deviation of Measurements Taken}}{\sqrt{10,000}}$ <p>where 10,000 is the number of measurements taken.</p>
Leads, wiring, and calibration fixture	Insignificant compared with other uncertainty components.

Analog Output Uncertainty

The following table contains the names and descriptions of the components of analog output uncertainty in the E Series device Calibration Executive procedure.

Uncertainty Component	Description
DMM uncertainty	Retrieved from the DMM uncertainty text file.
Resolution uncertainty of the E Series device	$= \frac{1}{2} \left(\frac{\text{Resolution of DUT}}{\sqrt{3}} \right)$ <p>where Resolution of DUT is the range of the E Series device divided by the number of levels in the digital-to-analog-converter (DAC). The term in the denominator results from assuming a rectangular distribution of probabilities of the measurement values.</p>
Type A uncertainty	$= \frac{\text{Standard Deviation of Measurements Taken}}{\sqrt{10}} \times 1.06$ <p>where 10 is the number of measurements taken and 1.06 accounts for the t-distribution.</p>
Leads, wiring, and calibration fixture	Insignificant compared with other uncertainty components.



Note If you use the recommended test equipment and follow the test conditions guidelines, the vast majority of the uncertainty for the analog input tests is due to the resolution uncertainty of the ADC on the E Series device. The majority of the uncertainty for the analog output tests is due to the resolution uncertainty of the DAC on the E Series device. Other uncertainty components are negligible compared to these components.

NI 6601/6602/6608 Calibration Procedure

This topic contains information for calibrating the National Instruments 6601/6602/6608 using Calibration Executive.

Calibration Executive Procedure Features:

Adjustment ✓	Manual Mode ✓	Selectable Test Points ✗
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Approximate Test Time: (NI 6601/6602) 1 minute, (NI 6608) 95 minutes

[Test
Equipment](#)

[Test
Conditions](#)

[Device
Setup](#)

[Troubleshoo
ting
Guidelines](#)

Test Equipment

The following table lists the test equipment required to calibrate NI 6601/6602/6608 devices.

Instrument	Recommended Model	Requirements
Highly Stable 10 MHz Clock Source	—	Make sure the clock source outputs a 10 MHz TTL square wave. For the 6601/6602 use a clock source that is accurate to within one ppm. For the NI 6608 use a clock source that is accurate to within 0.75 ppb.
Chassis	NI PXI-1042, NI PXI-1042Q	Use with PXI modules.
DAQ Accessory	NI SCB-68	Shielded I/O connector block with 68 screw terminals for easy signal connection to 68- or 100-pin DAQ devices.
Shielded DAQ Cable	NI Sh68-68-D1	You must use this cable for calibrating NI 660x devices.
CompactPCI-to-PCI Adapter	—	You must use this adapter in a PCI chassis to verify the onboard oscillator on the NI PXI-6602. If you verify the NI PXI-6602 in a PCI chassis, the measured frequency is that of the PXI backplane

	clock instead of the onboard oscillator.
--	--

Test Conditions

The following setup and environmental conditions are required to ensure the NI 6601/6602/6608 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.
- Use shielded coaxial wire for all cable connections to the device.
- Maintain a temperature of 25 °C.
- Keep the relative humidity below 80%.
- Allow a warm-up time of at least 15 minutes to ensure that the measurement circuitry of the NI 660x device and the clock source are at a stable operating temperature.
- (PXI) Ensure that the PXI chassis fan speed is set to HIGH, that the fan filters are clean, and that the empty slots contain filler panels.

Device Setup

Connecting 6601/6602 Devices to a Clock Source

1. Install the NI 6601/6602 device as described in the **DAQ Getting Started Guide**.
2. Use the NI Sh68-68-D1 cable to connect the NI 6601/6602 device to the NI SCB-68.
3. Using twisted-pair wires, connect the clock to source pins 7 and 41 on the NI SCB-68. Pin 7 corresponds to PFI_35, which is the SOURCE of counter 1 on all NI 6601/6602 devices. Pin 41 is the digital ground.
4. [Launch](#) the Calibration Executive procedure and complete the setup wizard.

Connecting NI 6608 Devices to a Clock Source

1. Install the NI 6608 device in as described in the **DAQ Quick Start Guide**.

2. The NI 6608 must be installed in slot 2 of the PXI chassis for calibration. Configure the NI 6608 in Measurement & Automation Explorer (MAX) to make sure MAX recognizes the device as being in slot 2:
 1. Launch MAX.
 2. Expand the **Devices and Interfaces** branch of the MAX configuration tree. PXI system controllers that have not yet been configured appear as **PXI System (Unidentified)**. Right-click **PXI System (Unidentified)**, and select the appropriate controller model from the **Identify As** menu. For MXI-3 and MXI-4 controllers, select **External PC**.
 3. Expand the **PXI System** controller to display a list of chassis.
 4. To identify each chassis, right-click the chassis name, and select the appropriate chassis model from the **Identify As** menu.
 5. Verify that MAX lists the NI 6608 as being in slot 2.
3. Use the NI Sh68-68-D1 cable to connect the NI 6608 to the NI SCB-68.
4. Connect the clock source to pin 2 (PFI_39). PFI_39 is the SOURCE of counter 0 on the NI 6608.
5. Connect the ground of the clock source to pin 36.
6. Launch the Calibration Executive procedure and complete the setup wizard.



Note If the NI 6601/6602/6608 fails after calibration, refer to the [Troubleshooting Guidelines](#). If the NI 6608 fails after troubleshooting, return it to NI for repair or replacement. NI 6601/6602 devices that fail verification cannot be adjusted and must be returned to National Instruments for repair or replacement.

Troubleshooting Guidelines

Use the following troubleshooting guidelines if the NI 6601/6602/6608 device fails after running the calibration procedure:

1. Verify that the clock source is a 10 MHz TTL signal.

2. Verify that the device is properly connected, and run the Calibration Executive procedure again.
3. If the calibration fails after running the Calibration Procedure again, open the test panel in MAX and configure as follows:
 - **Counter Mode:** Simple Event Counting
 - **Counter:** GPCTR0
 - **Event Source:** Counter Source Pin

An increasing Counter value indicates that the device is connected properly. A counter value that does not change indicates that the signal is not connected or is not working.

NI E Series Calibration Procedure

This topic contains information for calibrating the National Instruments E Series devices using Calibration Executive.

Calibration Executive Procedure Features:

Adjustment 	Manual Mode 	Selectable Test Points 
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Approximate Test Time: 5 minutes

Test Equipment	Test Conditions	Device Setup	Troubleshooting Guideline	Test Limits
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Test Equipment

The following table lists the test equipment required to calibrate E Series devices.

Instrument	Recommended Model	Calibration Procedure	Minimum Requirements
Calibrator	Fluke 5700A	Analog Input	If this instrument is unavailable, use a high-precision voltage source that is at least 50 ppm (0.

			005%) accurate for 12-bit devices, and 10 ppm (0.001%) accurate for 14-, 16-, and 18-bit devices.
DMM	NI 4070, Agilent 34401A	Analog Output	If these instruments are unavailable, use a multiranging 6 1/2 digit DMM with an accuracy of 40 ppm.
Counter	Agilent 53131A	Counter	If this instrument is unavailable, use a counter that is accurate to 0.01%.
DAQ Accessory	NI E Series calibration hardware adapter	Analog Input, Analog Output, Counter	Connects your calibration equipment to your 68-pin E Series device.
	NI SCC-68		I/O connector block with screw terminals, general breadboard area, bus terminals, and four expansion slots for SCC signal conditioning modules.
	NI SCB-68		Shielded I/O connector block with 68 screw terminals for easy signal connection to 68- or 100-pin DAQ devices.
	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 68-pin DAQ devices.
	NI BNC-2110		Desktop and DIN rail-mountable BNC adapter you can connect to DAQ devices.

	NI CB-37F-LP		Low-cost termination accessory with 37 screw terminals for easy connection of field I/O signals to 37-pin DAQ devices.
Low thermal Copper E MF Plug-in Cable (x2)	Fluke 5440A-7002	Analog Input, Analog Output	Do not use standard banana cables.
BNC Cable	—	Counter	Use a 50 Ω coaxial cable.
Shielded DAQ Cable	NI Sh68-68-EP	Analog Input, Analog Output, Counter	Use with E Series devices with a 68-pin SCSI II connector.
	NI Sh1006868		Use with E/S Series devices with a 100-pin connector. Connect the 68-pin cable labeled MIO-16 to the accessory. The 68-pin cable labeled Extended I/O remains unconnected.
Chassis	NI PXI-1042, NI PXI-1042Q	—	Use with PXI modules.



Note The Calibration Executive procedure runs in [automated mode](#) if you use IVI-supported instruments.

Test Conditions

The following setup and environmental conditions are required to ensure the E Series device meets published specifications.

- Keep connections to the device short. Long cables and wires act as antennae, picking up extra noise that can affect measurements.

- Use shielded copper wire for all cable connections to the device. Use twisted-pair wire to eliminate noise and thermal offsets.
- Maintain a temperature between 18 °C and 28 °C.
- Keep relative humidity below 80%.
- Allow adequate warm-up time (generally between 15 and 30 minutes for most DAQ devices) to ensure that the measurement circuitry is at a stable operating temperature. Refer to your DAQ device specifications document for the recommended warm-up time for your device.
- Temperature change affects the measurement characteristics of a device. To account for these changes, the tested specifications include the effects of temperature drift. For the E Series devices, valid temperature drift is ± 10 °C from the last external calibration temperature.
- (PXI) Ensure that the PXI chassis fan speed is set to HIGH, that the fan filters are clean, and that the empty slots contain filler panels.

Device Setup

1. Install the device in the host computer or chassis.
2. Configure the device with MAX. Refer to the **Measurement & Automation Explorer Help for NI-DAQmx** for more configuration information.



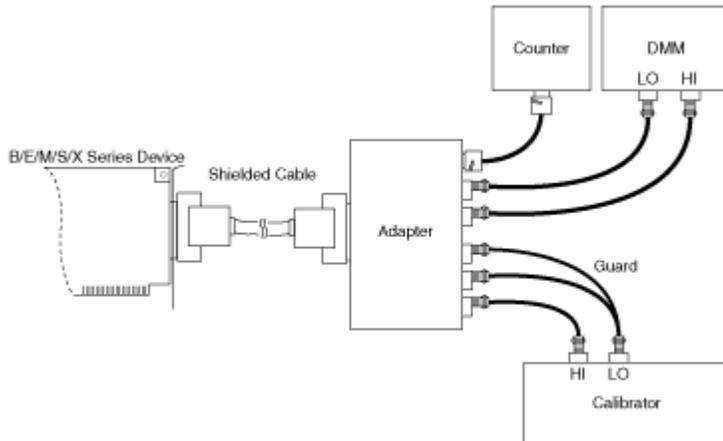
Note Measurement & Automation

Explorer Help for NI-DAQmx is located in the **MAX Help** under **Installed Products»NI-DAQ**.

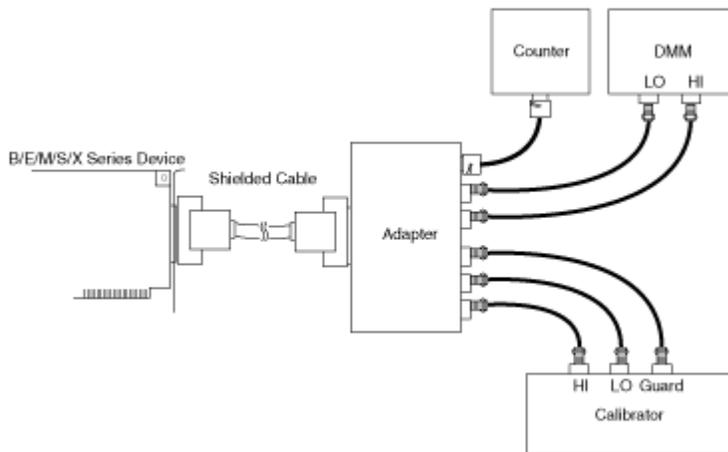
3. Connect the appropriate shielded cables between the E Series device, the DAQ accessory, and the test instruments, as shown in the two following figures.



Note Fluke 55xxA calibrators do not have GUARD connectors. You must connect the LO cable with the GUARD cable, then connect the GUARD cable into the LO terminal on the calibrator, as shown in the following figure.



Calibrators other than the Fluke 55xxA have GUARD connectors. Make the connections to these calibrators as shown in the following figure.



4. Launch the Calibration Executive procedure and complete the setup wizard.
5. If the Calibration procedure asks you whether to calculate measurement uncertainty, select Yes or No. If you select Yes, you are prompted to select the appropriate uncertainty files based on the standards you are using and the date the standards were last calibrated.

6. The following information about the installed hardware is required.

Item	Description
Traditional NI-DAQ (Legacy) Device Number	Enter the number assigned to the B/E/S Series device by MAX when you configured the hardware.
Supported Products	Select the model from the menu that lists all of the devices supported by the calibration procedure.

Troubleshooting Guidelines

This section describes common problems you might encounter when calibrating an E Series device and explains how to correct the problem. If the E Series device is not recognized by MAX, verify that you followed the configuration guidelines. If MAX fails to recognize the E Series device after you reconfigure and refresh (<F5>), contact [National Instruments](#) technical support. If the E Series device fails after calibration, complete the following steps:

1. Check the connections and run the Calibration Executive procedure again.
2. Verify that you do not have an SCXI chassis configured in MAX. Remove the configuration if it is present and run the Calibration Executive procedure again.
3. If the calibration still fails after you complete steps 1 and 2, try inputting or outputting the failed Test Points using the test panel in MAX. For example, if the analog input (AI) failed at 0.98 V, input that value from the calibrator, as follows:
 1. Launch the test panel in MAX.
 2. Click the **Analog Input** tab.
 3. Set the High Limit to 1.00 V and set the Low Limit to -1.00 V for bipolar readings.
 4. Check the Average Reading indicator.

If the Average Reading still fails after you complete steps 1–3, contact [National Instruments](#) for repair or replacement. If the Average Reading passes, you can change the calibration report to indicate the passing value.

Test Limit Equations

The following test limits are derived from the published specifications.

NI E Series

Analog Input

TestLimits = TestValue ± [(Input Voltage * Percentage of Reading) + Offset Volts + Noise]

Analog Output

TestLimits = TestValue ± [(Input Voltage * Percentage of Reading) + Offset Volts + Noise]

Base Clock

TestLimits = TestValue ±0.01% of Actual Clock Frequency

NI 4451/4452/4551/4552 Calibration Procedure

This topic contains information for calibrating the National Instruments PCI-4451/4452/4551/4552 using Calibration Executive.

Calibration Executive Procedure Features:

Adjustment ✓	Manual Mode ✓	Selectable Test Points ✗
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Approximate Test Time: 50 minutes

[Test Equipment](#)

[Test Conditions](#)

[Device Setup](#)

[Troubleshooting Guidelines](#)

Test Equipment

The following table lists the test equipment required to calibrate NI 4451/4452/4551/4552 devices.

Instrument	Recommended Model	Requirements
Calibrator	Fluke 5700A	<p>If this instrument is unavailable, use a calibrator that meets the following specifications:</p> <ul style="list-style-type: none"> ▪ Frequency Range: 20 Hz to 95 kHz ▪ Voltage Range: 5 mV_{rms} to 15 V_{rms} ▪ AC Accuracy: $\pm 0.1\%$*, 20 Hz to 95 kHz ▪ DC Accuracy: ± 115 ppm[†] at 5 V
Function Generator	Agilent 33250A	<p>If this instrument is unavailable, use a function generator that meets the following specifications:</p> <ul style="list-style-type: none"> ▪ Frequency range: 20 Hz to 95 kHz ▪ Frequency accuracy: ± 6 ppm** ▪ Voltage range: 3 V_{rms}
DMM	Agilent 3458A	<p>If this instrument is unavailable, use a DMM that meets the following specifications:</p> <ul style="list-style-type: none"> ▪ Voltage range: 5 mV_{rms} to 5 V_{rms} ▪ AC accuracy: $\pm 0.2\%$*, 20 Hz to 95 kHz

		<ul style="list-style-type: none"> DC accuracy: $\pm 500 \mu\text{V}^\dagger$ at 0 V
Frequency Counter	Agilent 53131A	<p>If this instrument is unavailable, use a frequency counter that meets the following specifications:</p> <ul style="list-style-type: none"> Frequency Range: 20 Hz to 5 MHz Frequency Accuracy: $\pm 6 \text{ ppm}^{**}$ 20 Hz to 20 kHz Frequency Accuracy: $\pm 25 \text{ ppm}^{**}$ 20 Hz to 5 MHz Input voltage: $3 V_{\text{rms}}$
Connection Accessory	NI BNC-2140	Use for analog input and analog output verification.
	NI SCB-68	Use for counter verification.
Analog Cable	NI SHC68-C68-A1	—
Shielded DAQ Cable	NI SHC50-68	—
T-connectors	—	<p>Use 1 T-connector for NI 4451 and NI 4551 devices.</p> <p>Use 3 T-connectors for NI 4452 and NI 4552 devices.</p>
<p>* AC accuracy is the sum of all errors including percent of reading error and temperature error but excluding percent of range error.</p> <p>† DC accuracy is the sum of all errors including percent of reading error, percent of range error, and temperature error.</p> <p>** Frequency accuracy is the sum of all errors including initial accuracy and stability errors.</p>		



Note The Calibration Executive procedure runs in automated mode if you use IVI-supported instruments.

Test Conditions

The following setup and environmental conditions are required to ensure the NI 4451/4452/4551/4552 meets published specifications.

- Keep connections to the device as short as possible. Long cables and wires can act as antennae, which could pick up extra noise and affect measurements.
- Use shielded copper wire for all cable connections to the device. Use twisted-pair wire to eliminate noise and thermal offsets.
- Maintain a temperature between 18 and 28 °C.
- Keep relative humidity below 80%.
- Allow a warm-up time of at least 15 minutes to ensure that the measurement circuitry is at a stable operating temperature.

Device Setup

To set up and configure NI 445x and NI 455x devices for calibration, complete the following steps:

1. Install the device in the host computer as described in the **PCI-4451/4452/4453/4454 User Manual**.
2. Configure the device with the Measurement & Automation Explorer (MAX).



Note Refer to the **PCI 4451/4452/4453/4454 User Manual** or the **NI 4551/4552 User Manual** for more information about configuration.

3. [Launch](#) the Calibration Executive procedure and complete the setup wizard.
4. While the calibration procedure is running, Calibration Executive prompts you for the appropriate connections. Follow the on-screen instructions at each prompt.

Troubleshooting Guidelines

If the NI 4451/4452/4551/4552 device fails after calibration, check the connections and run the Calibration Executive procedure again.

If the Average Reading still fails, contact [National Instruments](#) for repair or replacement. If the Average Reading passes, you can change the calibration report to indicate the passing value.



Note If you have Microsoft Access 2000 or later, you can also modify the database containing the test results. By default, this database is located in \Calibration Executive\Databases\Calibration Reports.mdb.

NI 4350/4351 Calibration Procedure

This topic contains information for calibrating the National Instruments 4350/4351 using Calibration Executive.

Calibration Executive Procedure Features:

Adjustment	Manual Mode	Selectable Test Points
⊘	✓	⊘

Approximate Test Time: 10 minutes

[Test Equipment](#) |

[Test Conditions](#) |

[Device Setup](#)

Test Equipment

The following table lists the test equipment required to calibrate NI 4350/4351 devices.

Instrument	Recommended Model	Requirements
Calibrator	Fluke 5700A	If this instrument is unavailable, use a calibrator that is more accurate than the A/D converter on the NI 4350/4351 (at least 10 ppm accurate).
DMM	Agilent 3458A	If this instrument is unavailable, use a multiranging 5 1/2 digit DMM with an accuracy of 15 ppm.

Chassis	NI PXI-1042, NI PXI-1042Q	Use with PXI modules.
Connection Accessory	NI 4350/4351 calibration adapter	—
Shielded DAQ Cable	NI Sh68-68-EP	Use with NI USB/ISA-4350 or NI PXI/PCI-4351.
	NI PSH32-30F	Use with NI PCMCIA-4350.



Note The Calibration Executive procedure runs in automated mode if you use IVI-supported instruments.

Test Conditions

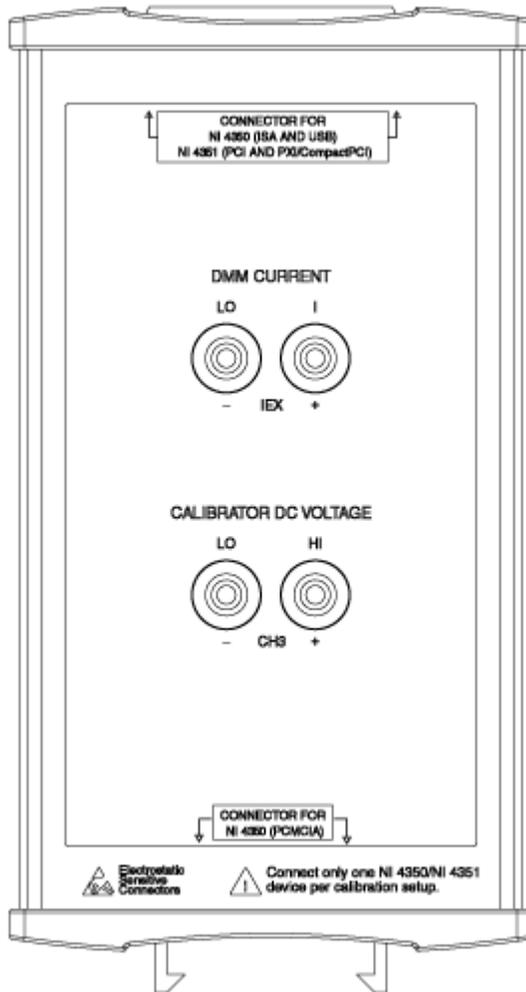
The following setup and environmental conditions are required to ensure the NI 4350/4351 meets published specifications.

- Keep connections to the NI 4350/4351 device as short as possible. Long cables and wires act as antennae, picking up extra noise that can affect measurements.
- Use shielded copper wire for all cable connections to the device. Use twisted-pair wire to eliminate noise and thermal offsets.
- Maintain a temperature of 18 to 28 °C.
- Keep relative humidity below 80%.
- Allow a warm-up time of at least 30 minutes for the device to ensure that the measurement circuitry is at a stable operating temperature.
- Temperature change affects the measurement characteristics of an instrument. To take these changes into account, the tested specifications include the effects of temperature drift. For the NI 4350/4351, valid temperature drift is ± 10 °C.
- (PXI) Ensure that the PXI chassis fan speed is set to HIGH, that the fan filters are clean, and that the empty slots contain filler panels.

Device Setup

To set up the NI 4350/4351 for calibration, complete the following steps:

1. Install the NI 4350/4351 device in the host computer or chassis.
2. Connect the device to the NI 4350/4351 calibration adapter, shown in the following figure, with an Sh68-68 shielded cable or a PSH32-30F cable.



3. Configure the NI 4350/4351 with Measurement & Automation Explorer (MAX). Refer to the **Measurement & Automation Explorer Help** for more configuration information.
4. [Launch](#) the Calibration Executive procedure and complete the setup wizard.

Calibration Executive prompts you for any additional connections.

Test Limit Equations

The following test limit is derived from published specifications.

DC Voltage

$$\text{TestLimits} = \text{TestValue} \pm (\text{TestValue} * \% \text{ of Reading} + \text{Offset error } \mu\text{V})$$

15 °C to 35 °C

NI 4050/4060 Calibration Procedure

This topic contains information for calibrating the National Instruments NI 4050/4060 using Calibration Executive.

Calibration Executive Procedure Features:

Adjustment ✓	Manual Mode ✓	Selectable Test Points ✗
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Approximate Test Time: 100 minutes

Test Equipment	Test Conditions	Device Setup	Troubleshooting Guidelines	Test Limit Equations
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Test Equipment

The following table lists the test equipment required to calibrate the NI 4050/4060.

Instrument	Recommended Model	Requirements
Calibrator	Fluke 5700A	If this instrument is unavailable, use a high-precision voltage source that is four times as accurate as the analog-to-digital converter (ADC) on the device being calibrated—at least 10 ppm (0.001%) accuracy for DC voltage specifications.

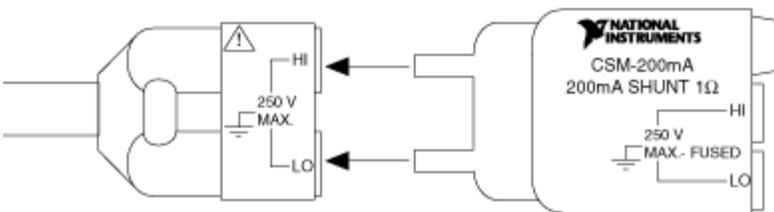
		Do not calibrate these devices using a Fluke 55xxA calibrator. The AC voltage test requires an output of 219 V at 30 Hz, and the Fluke 55xxA calibrators cannot output this value. You must use only a Fluke 5700A/5720A.
Chassis	NI PXI-1042, NI PXI-1042Q	Use with PXI modules.



Note The Calibration Executive procedure runs in automated mode if you use IVI-supported instruments.

Connectors

For current measurements on the NI 4050, use an NI 4050 cable adapter and CSM-200 mA current shunt module, shown in the following figure.



Note Current verification is optional.

Test Conditions

The following setup and environmental conditions are required to ensure the NI 4050/4060 meets published specifications.

- Keep connections to the NI 4050/4060 short. Long cables and wires act as antennae, picking up extra noise that can affect measurements.
- Keep relative humidity between 10% and 90%, noncondensing, or consult the DMM documentation for the optimum relative humidity.
- Maintain the temperature between 18 and 28 °C.
- Allow a warm-up time of at least 30 minutes to ensure that the measurement circuitry of the DMM is at a stable operating temperature.
- (PXI) Ensure that the PXI chassis fan speed is set to HIGH, that the fan filters are clean, and that the empty slots contain filler panels.

Calibration Temperatures

To account for temperature changes, the tested specifications include the effects of temperature drift. For NI 4050/4060 DMMs, the following temperature drifts are valid:

- 24-hour range—calibration temperature ± 1 °C
- 1-year range—calibration temperature ± 10 °C

Device Setup

To set up the NI 4050/4060 for calibration, complete the following steps:

1. Install the NI 4050/4060 in the host computer according to the instructions in the **NI Digital Multimeters Getting Started Guide**.
2. Configure the hardware using Measurement & Automation Explorer (MAX).
3. [Launch](#) the Calibration Executive procedure and complete the setup wizard.
4. Follow any further instructions you receive from Calibration Executive.



Note If the NI 4050/4060 fails after calibration, refer to the [Troubleshooting Guidelines](#) section. If the device still fails after you complete the troubleshooting procedures, return it to NI for repair or replacement.

Troubleshooting Guidelines

This section describes common problems you might encounter when calibrating an NI 4050/4060.

If the NI 4050/4060 is not recognized in MAX, make sure that you followed the configuration guidelines. If MAX fails to recognize the NI 4050/4060 after you reconfigure, contact [National Instruments](#) technical support.

If the NI 4050/4060 fails after calibration, try the following:

1. Check the connections and run the Calibration Executive procedure again.
2. If the calibration still fails after trying step 1, try inputting or outputting the failed Test Points using the test panel in MAX or the DMM Soft Front Panel, which is located at **Start»All Programs»National Instruments»NI-DMM»NI-DMM Soft Front Panel**. For example, if the analog input (AI) failed at 1.99 VDC, input that value from the calibrator.
 1. Launch the test panel in MAX.
 2. Set the **Input Limits** to ± 2.00 V and set the **Data Mode** to DC voltage.
 3. Check the Average Reading indicator.

If the Average Reading falls outside the range of limits shown in the calibration report after you complete steps 1 and 2, contact [National Instruments](#) for repair or replacement. If the Average Reading falls within the limits, you can change the calibration report to indicate the passing value.



Note If you have Microsoft Access 2000 or later installed on the computer, you can also modify the database containing the test results. By default, this database is located in Program Files\National Instruments\Calibration Executive\Databases\Calibration Reports.mdb.

Test Limit Equations

The following test limits are derived from the published specifications.

DC Voltage

TestLimits = TestValue \pm (TestValue * % of Reading + Offset μ V)

DC Current

TestLimits = TestValue \pm (TestValue * % of Reading + Offset μ A)

AC Voltage

TestLimits = TestValue \pm [TestValue * (% of Reading + Frequency dependent Error) + Offset mV]

AC Current

TestLimits = TestValue \pm [TestValue * (% of Reading + Frequency dependent Error) + Offset mA]

Resistance

TestLimits = TestValue \pm (TestValue * % of Reading + Offset Ω)

NI 5102 Calibration Procedure

This topic contains information for calibrating the National Instruments 5102 using Calibration Executive.

Calibration Executive Procedure Features:

Adjustment 	Manual Mode 	Selectable Test Points 
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Approximate Test Time: 8 minutes

[Test Equipment](#) |

[Test Conditions](#) |

[Device Setup](#)



Caution This procedure may crash Calibration Executive if you terminate execution while the procedure is running.

Test Equipment

The following table lists the test equipment required to calibrate the NI 5102.

Instrument	Recommended Model	Parameter Measured	Minimum Requirements
Scope Calibrator	Fluke 9500B with Fluke 9510 Test Head	Vertical Offset	0 VDC \pm 0.1 mV
		Vertical Gain	DC \pm 40 mV to \pm 4.5 V, \pm 0.1% into 1 M Ω
		AC Coupling	sine wave 9 Hz to 13 Hz \pm 100 ppm, 1.8 Vpp \pm 2% into 1 M Ω
		Bandwidth	1.5% amplitude flatness for leveled sine wave 100 kHz to 15 MHz \pm 50 ppm, 0.2 to 1.9 Vpp \pm 2% into 1 M Ω
		Input Impedance	2-wire resistance accuracy of 0.25% for 1 M Ω measurement
PXI Chassis	NI PXI-1042, NI PXI-1042Q	—	Use with PXI modules
BNC Cable	—	—	50 Ω coaxial cable

Alternative Test Equipment

The following table contains a list of alternative equipment you can use to calibrate the NI 5102 with Calibration Executive.



Note Although these alternative instruments are acceptable, National Instruments recommends that you use the instruments from the previous table.

Instrument	Recommended Model	Parameter Measured	Minimum Requirements
Calibrator	Fluke 5700A	Vertical Offset	0 VDC \pm 0.1 mV
		Vertical Gain	DC \pm 40 mV to \pm 4.5 V, \pm 0.1% into 1 M Ω

		AC Coupling	sine wave 9 Hz to 13 Hz ± 100 ppm, 1.8 Vpp $\pm 2\%$ into 1 M Ω
High-Speed Signal Generator	Tektronix Sg503	Bandwidth	1.5% amplitude flatness for leveled sine wave 100 kHz to 15 MHz ± 50 ppm, 0.2 to 1.9 Vpp $\pm 2\%$ into 1 M Ω
DMM	NI 4070	Input Impedance	2-wire resistance accuracy of 0.25% for 1 M Ω measurement
BNC Cable	—	—	50 Ω
BNC T-connector	—	—	—
BNC Terminator	—	Vertical Offset Sensitivity	0 VDC ± 0.025 mV

Test Conditions

The following setup and environmental conditions are required to ensure the NI 5102 meets published specifications.

- Keep connections to the NI 5102 short. Long cables and wires act as antennae, picking up extra noise that can affect measurements.
- Keep relative humidity between 10% and 90%, noncondensing, or consult the device documentation for the optimum relative humidity.
- Maintain the temperature at 25 °C.
- Allow a warm-up time of at least 15 minutes after the NI-SCOPE driver is loaded. Unless manually disabled, the NI-SCOPE driver automatically loads with the operating system and enables the device. The warm-up time ensures that the measurement circuitry of the NI 5102 is at a stable operating temperature.
- Plug the PXI chassis or PC and the calibrator into the same power strip to avoid ground loops.
- (PXI) Ensure that the PXI chassis fan speed is set to HIGH, that the fan filters are clean, and that the empty slots contain filler panels.

Device Setup

1. Install the NI 5102 in the PXI chassis or PC according to the instructions in the **NI High-Speed Digitizers Getting Started Guide**.
2. Configure the hardware using Measurement & Automation Explorer (MAX).
3. [Launch](#) the Calibration Executive procedure.
4. Connect the scope calibrator, sine wave generator, DMM, and the NI 5102 as prompted by the Calibration Executive procedure.



Note If you do not have a scope calibrator, use the alternative instruments listed in [Alternative Test Equipment](#) section and run the calibration procedure in manual mode. You can add information about the alternative instruments in the Notes sections of each dialog box. NI recommends that when prompted for the Scope Calibrator information, you include a list of all three alternative instruments, along with their associated tracking numbers and calibration due dates, in the Notes section. When the calibration report is generated, this information appears in the section labeled Scope Calibrator.



Note If the NI 5102 fails after calibration, return it to NI for repair or replacement.

NI 5112 Calibration Procedure

This topic contains information for calibrating the National Instruments 5112 using Calibration Executive.

Calibration Executive Procedure Features:

Adjustment 	Manual Mode 	Selectable Test Points 
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Approximate Test Time: 18 minutes

Test EquipmentTest ConditionsDevice Setup

Caution This procedure may crash Calibration Executive if you terminate execution while the procedure is running.

Test Equipment

The following table lists the test equipment required to calibrate the NI 5112.

Instrument	Recommended Model	Parameter Measured	Minimum Requirements
Scope Calibrator	Fluke 9500B with Fluke 9510 Test Head	Vertical Offset	0 VDC \pm 0.1 mV
		Vertical Gain	DC \pm 25 mV to \pm 22.5 V, \pm 0.25% into 1 M Ω
		AC Coupling	sine wave 9 Hz to 13 Hz \pm 100 ppm, 1.8 Vpp \pm 2% into 1 M Ω
		Bandwidth	\pm 2% amplitude flatness for leveled sine wave 100 kHz to 100 MHz \pm 50 ppm, 1.5 Vpp \pm 2% into 50 Ω
		Input Impedance	2-wire resistance accuracy of 0.25% for 50 Ω and 1 M Ω measurements
		Timing/RIS	sine wave 10 kHz to 10 MHz \pm 15 ppm, 1.8 Vpp \pm 2% into 1 M Ω
		Trigger Sensitivity	sine wave 100 kHz to 10 MHz \pm 100 ppm, 300 mVpp \pm 2% into 1 M Ω
DMM	NI 4070	Internal Reference	DC voltage accuracy of \pm 0.25% (\pm 12.5 mV) when measuring \pm 5 V
PXI Chassis	NI PXI-1042, NI PXI-1042Q	—	Use with PXI modules

Alternative Test Equipment

The following table contains a list of alternative equipment you can use to calibrate the NI 5112 with Calibration Executive.



Note Although these alternative instruments are acceptable, National Instruments recommends that you use the instruments from the previous table.

Instrument	Recommended Model	Parameter Measured	Minimum Requirements
Calibrator	Fluke 5700A	Vertical Offset	0 VDC \pm 0.1 mV
		Vertical Gain	DC \pm 25 mV to \pm 22.5 V, \pm 0.25% into 1 M Ω
		AC Coupling	sine wave 9 Hz to 13 Hz \pm 100 ppm, 1.8 Vpp \pm 2% into 1 M Ω
Sine Wave Generator	Tegam SG 5030	Bandwidth	\pm 2% amplitude flatness for leveled sine wave 100 kHz to 100 MHz \pm 50 ppm, 1.5 Vpp \pm 2% into 50 Ω
		Timing/RIS	sine wave 10 kHz to 10 MHz \pm 15 ppm, 1.8 Vpp \pm 2% into 1 M Ω
		Trigger Sensitivity	sine wave 100 kHz to 10 MHz \pm 100 ppm, 300 mVpp \pm 2% into 1 M Ω
DMM	NI 4070	Input Impedance	2-wire resistance accuracy of 0.25% for 50 Ω and 1 M Ω measurements
		Internal Reference	DC voltage accuracy of \pm 0.25% (\pm 12.5 mV) when measuring \pm 5 V
BNC Cable	—	—	50 Ω
BNC Terminator	—	—	50 Ω
BNC T-Connector	—	—	—

Test Conditions

The following setup and environmental conditions are required to ensure the NI 5112 meets published specifications.

- Keep connections to the NI 5112 short. Long cables and wires act as antennae, picking up extra noise that can affect measurements.
- Keep relative humidity between 10 and 90%, noncondensing, or consult the digitizer documentation for the optimum relative humidity.
- Maintain the temperature between 5 and 40 °C.
- Allow a warm-up time of at least 15 minutes to ensure that the measurement circuitry of the NI 5112 is at a stable operating temperature.
- Plug the PXI chassis or PC and the calibrator into the same power strip to avoid ground loops.
- (PXI) Ensure that the PXI chassis fan speed is set to HIGH, that the fan filters are clean, and that the empty slots contain filler panels.

Device Setup

1. Install the NI 5112 in the PXI chassis or PC according to the instructions in the **NI High-Speed Digitizers Getting Started Guide**.
2. Configure the hardware using Measurement & Automation Explorer (MAX).
3. [Launch](#) the Calibration Executive procedure.
4. Connect the scope calibrator, DMM, and the NI 5112 as prompted by the Calibration Executive procedure.



Note If you do not have a scope calibrator, use the alternative instruments listed in [Alternative Test Equipment](#) section and run the calibration procedure in manual mode. You can add information about the alternative instruments in the Notes sections of each dialog box. NI recommends that when prompted for the Scope Calibrator information, you include a list of all three alternative instruments, along with their associated tracking numbers and calibration due dates, in the Notes section. When the

calibration report is generated, this information appears in the section labeled Scope Calibrator.



Note If the NI 5112 fails after calibration, return it to NI for repair or replacement.

NI 5620 Calibration Procedure

This topic contains information for calibrating the National Instruments 5620 using Calibration Executive.

Calibration Executive Procedure Features:

Adjustment ✓	Manual Mode ✓	Selectable Test Points ✗
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Approximate Test Time: 20 minutes

[Test Equipment](#) |

[Test Conditions](#) |

[Device Setup](#)

Test Equipment

The following table lists the test instruments required for calibrating the NI 5620.

Instrument	Recommended Model	Requirements
RF Signal Generator	Agilent ESG-4422B (with option UNB, high-output power, lockable to external frequency reference), Agilent 8340A, Agilent ESG-4433B (with option UNB, high-output power, lockable to external frequency reference)	If this instrument is unavailable, use a signal generator that meets the following specifications: <ul style="list-style-type: none"> Maximum power output: +10 dBm Frequency range: 100 kHz to 32 MHz Timebase accuracy: $\leq \pm 2$ ppm under calibration conditions Level accuracy: $\leq \pm 1$ dB
Power Meter with Sensor	Anritsu ML2438A with Anritsu MA2421A Thermal Sensor,	If one of these instruments is unavailable, use a power meter a

	Agilent E4419B with Agilent E9304A Power Sensor	<p>and sensor that meet the following specifications:</p> <ul style="list-style-type: none"> ▪ Frequency range: 100 kHz to 32 MHz ▪ Standard uncertainty (including mismatch)*: $\leq \pm 0.1$ dB at 0 dBm, source voltage standing wave ratio (VSWR) $\leq 1.4:1$
Broadband Precision Power Splitter	Weinschel 1507R	<p>If this instrument is unavailable, use a power splitter that meets the following requirements:</p> <ul style="list-style-type: none"> ▪ Frequency range: DC to 32 MHz ▪ Output maximum VSWR: 1.15 ▪ Amplitude tracking: 0.1 dB[†]
Chassis	NI PXI-1042, NI PXI-1042Q	—
SMA Torque Wrench	NI SMA Torque Wrench	Use a 1 NM (or 100 N-cm) torque wrench.
SMA Cable	—	Use a male–male, instrument-grade, 50 Ω coaxial cable that is <1 meter in length.
N-type to SMA Cable	—	Use a male–male, instrument-grade, 50 Ω coaxial cable that is ≤ 1 meter in length.
SMA Adapter	—	Use a male–male, instrument-grade, 50 Ω adapter with a VSWR ≤ 1.1 .
N-type to SMA Adapter	—	Use a N-type female–SMA male, 50 Ω adapter with a VSWR ≤ 1.12
<p>* With adapter SWR ≤ 1.12, and NI 5620 input SWR ≤ 1.2; source VSWR $\leq 1.4:1$</p> <p>[†] Screened for <0.1 dB tracking (Weinschel 1507R specification <0.2 dB)</p>		



Note National Instruments strongly recommends using the instruments specified above when calibrating the NI 5620 digitizer module. Substitution of instruments is permitted by Calibration Executive software, but National Instruments cannot guarantee that unsupported instruments meet the specifications required for calibration.

Test Conditions

The following setup and environmental conditions are required to ensure the NI 5620 meets published specifications.

- Always connect the calibrator test head directly to the input SMA of the digitizer, or use a short 50 Ω SMA coaxial cable if necessary. Long cables and wires act as antennae, picking up extra noise that can affect measurements.
- Allow a warm-up time of at least 15 minutes after the NI-SCOPE driver is loaded. Unless manually disabled, the NI-SCOPE driver automatically loads with the operating system and enables the device. The warm-up time ensures that the measurement circuitry of the NI 5620 is at a stable operating temperature.
- Ensure that the power meter and sensors are properly zeroed before starting the Calibration Executive procedure. Refer to your power meter documentation for zeroing instructions.
- Maintain an ambient temperature of 20 to 30 °C.
- Keep relative humidity between 10 and 90% non-condensing, or consult the digitizer hardware documentation for the optimum relative humidity.
- Ensure that the PXI chassis fan speed is set to HIGH, that the fan filters are clean, and that the empty slots contain filler panels.
- Plug the PXI chassis and the calibrator into the same power strip to avoid ground loops.

Device Setup

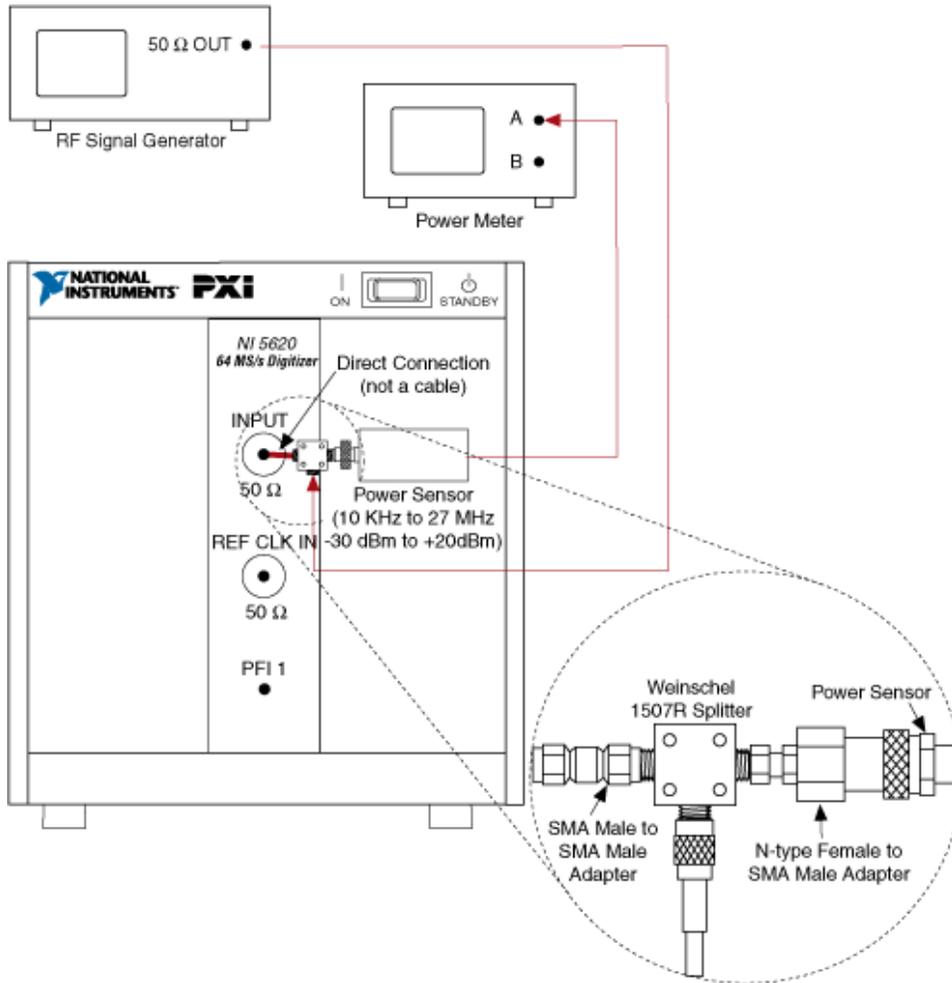
Refer to the [NI 5620 Connection Diagram](#) as you complete the following steps:

1. Connect the SMA-to-SMA adapter to the NI 5620 module front panel INPUT connector.
2. Connect one of the outputs of the Weinschel 1507R splitter to the SMA-SMA adapter.
3. Connect the other output of the Weinschel 1507R splitter to the Anritsu Ma2421 power sensor, using the N-type-to-SMA adapter.
4. Connect the input connector of the Weinschel 1507R splitter to the output of the signal generator, using the N-SMA cable.
5. Tighten all connections to 100 N-cm using an SMA torque wrench.
6. Launch the Calibration Executive procedure.



Note At the DUT Selection dialog box, enter information about the NI 5620 you are calibrating. You can find the Device Name and NI-DAQ device number in Measurement & Automation Explorer (MAX) under **Devices and Interfaces»Traditional NI-DAQ Devices**

NI 5620 Connection Diagram



NI 5911 Calibration Procedure

This topic contains information for calibrating the National Instruments PCI-5911 using Calibration Executive.

Calibration Executive Procedure Features:

Adjustment	Manual Mode	Selectable Test Points
✓	✓	✗

Approximate Test Time: 30 minutes

Test EquipmentTest ConditionsDevice Setup

Caution This procedure may crash Calibration Executive if you terminate execution while the procedure is running.

Test Equipment

The following table lists the test equipment required to calibrate the NI 5911.

Instrument	Recommended Model	Requirements
Oscilloscope Calibrator/Ohmmeter	Fluke 9500B	<p>If this instrument is unavailable, use a scope calibrator that meets the following specifications:</p> <ul style="list-style-type: none"> ▪ AC Coupling: sine wave 10 Hz \pm100 ppm, 1.8 Vpp \pm2% into 1 MΩ ▪ Bandwidth: 2% amplitude flatness for leveled sine wave 100 kHz to 100 MHz \pm50 ppm, 1.5 Vpp \pm2% into 50 Ω ▪ Input Impedance: 2-wire resistance accuracy of 0.25% for 1 MΩ measurements ▪ Timing/RIS: sine wave 10 kHz to 10 MHz \pm15 ppm, 1.8 Vpp \pm2% into 1 MΩ ▪ Trigger Sensitivity: sine wave 100 kHz to 10 MHz \pm100 ppm, 450 mVpp \pm2% into 1 MΩ
Active Head	Fluke 9510	—
Calibrator	Fluke 5700A	<p>If this instrument is unavailable, use a calibrator that meets the following requirement:</p>

		<ul style="list-style-type: none"> ▪ External Calibration/Gain: DC ± 90 mV to ± 9 V, $\pm 0.005\%$ into $1\text{ M}\Omega$ ▪ External Calibration: sine wave $1\text{ kHz} \pm 100\text{ ppm}$, $8\text{ Vpp} \pm 1\%$
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Alternative Test Equipment

The following table contains a list of alternative equipment you can use to calibrate the NI 5911 with Calibration Executive.

Instrument	Recommended Model	Requirements
Calibrator	Fluke 5700A	<p>If this instrument is unavailable, use a calibrator that meets the following specifications:</p> <ul style="list-style-type: none"> ▪ External Calibration/Gain: DC ± 90 mV to ± 9 V, $\pm 0.005\%$ into $1\text{ M}\Omega$ ▪ External Calibration: sine wave $1\text{ kHz} \pm 100\text{ ppm}$, $8\text{ Vpp} \pm 1\%$ into $1\text{ }\Omega$
Sine Wave Generator	Tegam SG 5030	<p>If this instrument is unavailable, use a sine wave generator that meets the following specifications:</p> <ul style="list-style-type: none"> ▪ AC Coupling: sine wave $10\text{ Hz} \pm 100\text{ ppm}$, $1.8\text{ Vpp} \pm 2\%$ into $1\text{ M}\Omega$ ▪ Bandwidth: 2% amplitude flatness for leveled sine wave 100 kHz to $100\text{ MHz} \pm 50\text{ ppm}$, $1.5\text{ Vpp} \pm 2\%$ into $1\text{ M}\Omega$ ▪ Timing/RIS: sine wave 10 kHz to $10\text{ MHz} \pm 15\text{ ppm}$, $1.8\text{ Vpp} \pm 2\%$ into $1\text{ M}\Omega$

		<ul style="list-style-type: none"> Trigger Sensitivity: sine wave 100 kHz to 10 MHz \pm 100 ppm, 450 mVpp \pm2% into 1 MΩ
DMM	NI 4070	If this instrument is unavailable, use a DMM that has a 2-wire resistance accuracy of 0.25% for 1 M Ω measurement.
BNC Cable	—	Use a 50 Ω BNC coaxial cable for all connections to the device.
BNC T-connector	—	—
BNC Terminator	—	Use a BNC terminator that has a vertical offset sensitivity of 0 V DC \pm 0.025 mV

Test Conditions

The following setup and environmental conditions are required to ensure the NI 5911 meets published specifications.

- Keep connections to the NI 5911 short. Long cables and wires act as antennae, picking up extra noise that can affect measurements.
- Use a 50 Ω BNC coaxial cable for all connections to the digitizer if you are not using a Fluke 9500 calibrator.
- Keep relative humidity between 10% and 90%, noncondensing, or consult the digitizer documentation for the optimum relative humidity.
- Maintain the temperature between 25 $^{\circ}$ C and 35 $^{\circ}$ C.
- Allow a warm-up time of at least 15 minutes to ensure that the measurement circuitry of the NI 5911 is at a stable operating temperature.



Caution To prevent overheating, do **not** place another NI 5911 or other heat-producing device near the digitizer you are calibrating.

Device Setup

1. Install the NI 5911 in the PC according to the instructions in the **NI High-Speed Digitizers Getting Started Guide**.

2. Configure the hardware using Measurement & Automation Explorer (MAX).
3. [Launch](#) the Calibration Executive procedure.
4. Connect the scope calibrator, sine wave generator, DMM, and the NI 5911 as prompted by the Calibration Executive procedure.



Note If you do not have a scope calibrator, use the alternative instruments listed in [Alternative Test Equipment](#) section and run the calibration procedure in manual mode. You can add information about the alternative instruments in the Notes sections of each dialog box. NI recommends that when prompted for the Scope Calibrator information, you include a list of all three alternative instruments, along with their associated tracking numbers and calibration due dates, in the Notes section. When the calibration report is generated, this information appears in the section labeled Scope Calibrator.



Note If the NI 5911 fails after calibration, return it to NI for repair or replacement.

NI 5600 Calibration Procedure

This topic contains information for calibrating the National Instruments PXI-5600 using Calibration Executive.

Calibration Executive Procedure Features:

Adjustment	Manual Mode	Selectable Test Points
✓	<ul style="list-style-type: none"> • RF Signal Generator ✗ • Power Meter ✗ • Frequency Counter ✓ 	✗

Approximate Test Time: 180 minutes

[Test Equipment](#) |

[Test Conditions](#) |

[Device Setup](#)



Note The NI PXI-5600 downconverter module and the [NI PXI-5620 digitizer module](#) comprise the NI PXI-5660 RF signal analyzer. The digitizer and downconverter modules must be calibrated individually.

Test Equipment

This section lists the test equipment required for calibrating the NI 5600 downconverter module.

Instrument	Recommended Model	Requirements
Frequency Counter	Agilent 53131A (lockable to external frequency reference)	Frequency range: 10 MHz Frequency resolution: >.5 Hz at 10 MHz
Rubidium Frequency Standard	Symmetricom 8040	Frequency: 10 MHz Frequency accuracy: 1 ppb (typically $\pm 6E-10$ within 1 year) Amplitude range: >5 dBm
Broadband Precision Power Splitter	Weinschel 1507R	Frequency range: DC to 3.0 GHz Output maximum VSWR: 1.15 Input maximum VSWR: 1.25 Amplitude tracking: <0.1 dB* Phase tracking: <4 Degrees Insertion loss: 6 dB, nominal
10 MHz Distribution Unit	Symmetricom 6502B	If this instrument is unavailable, use a 10 MHz distribution unit that meets the following specifications: RF input: One, 10 MHz RF outputs: Three or more, 10 MHz Nominal output: 1 Vrms
Chassis	NI PXI-1042, NI PXI-1042Q	—
Chassis Controller	NI MXI-4 kit	—
SMA Torque Wrench	NI RF Torque Wrench	1 N · m
SMA Cable	—	Use a male–male, instrument-grade, 50 Ω coaxial cable that is <1 meter in length.

N-type to SMA Cable	—	Use a male–male, instrument-grade, 50 Ω coaxial cable that is ≤1 meter in length.
SMA Adapter	—	Use a male–male, instrument-grade, 50 Ω adapter with a VSWR ≤1.1.
N-type to SMA Adapter	—	Use a N-type female–SMA male, 50 Ω adapter with a VSWR ≤1.12
* Screened for <0.1 dB tracking (Weinschel 1507R specification <0.2 dB).		



Note The following table lists specific instrument models that **must** be used when calibrating the NI 5600. National Instruments cannot guarantee that unsupported instruments meet the requirements for NI 5600 calibration.

Instrument	Required Model	Requirements
RF Signal Generator	Agilent ESG-4422B (with option UNB, high-output power, lockable to external frequency reference), Agilent ESG-4433B (with option UNB, high-output power, lockable to external frequency reference), Rhode & Schwarz SMA 100A	Frequency range: 20 MHz to 2.8 GHz Amplitude range: –30 to +16 dBm Phase noise/Spectral purity: <–95 dBc/Hz at 1 kHz
Power Meter	Anritsu ML2438A, Agilent E4419B	Frequency range: 10 kHz to 110 GHz, sensor-dependent Power measurement range: –70 to +47 dBm (0.1 nW to 50 W), sensor-dependent Voltage measurement range: 0.00 to 20.00 V, nominal 1.00 mW power reference: 50 MHz nominal, ±1.2% within 1 year, VSWR <1.04

(2) Power Meter Sensors	Anritsu MA2421A Thermal Sensor, Agilent E9304A Power Sensor	Range of IF output power sensor on CH-A: -30 to +20 dBm Range of frequency of power sensor on CH-A: 3 to 27 MHz Standard uncertainty (including mismatch)*: 0.07 dB
	Anritsu MA2473A Power Sensor, Agilent E4412A Power Sensor	Range of RF input power sensor on CH-B: -70 to +20 dBm Range of frequency of power sensor on CH-B: 20 MHz to 2.8 GHz Standard uncertainty (including mismatch)†: 0.11 dB

* With adapter standing wave ratio (SWR) ≤ 1.12 and NI 5600 IF output SWR ≤ 1.2 .

† Including splitter and adapter uncertainty: 0.11 dB standard uncertainty when device under test (DUT) on other side of the splitter has SWR ≤ 2.5 .

Test Conditions

The following setup and environmental conditions are required to ensure the NI 5600 meets published specifications.

- Use a National Instruments MXI controller (MXI-3 or MXI-4) to operate the PXI chassis. MXI controllers allow fast setup times, thus avoiding excessive warm-up of the NI 5600 downconverter module before calibration starts.
- Allow the counter, RF signal generator, and power meter to run for at least 30 minutes before starting the Calibration Executive procedure. This allows temperatures in these instruments to stabilize.
- Ensure that the power meter and sensors are properly zeroed before starting the Calibration Executive procedure. Refer to your power meter documentation for zeroing instructions.
- Maintain an ambient temperature of 23 ± 5 °C.
- Keep relative humidity between 10 and 90% non-condensing, or consult the downconverter hardware specifications for the optimum relative humidity.
- Ensure that the PXI chassis fan speed is set to HIGH, that the fan filters are clean, and that the empty slots contain filler panels.

- Plug the PXI chassis and the calibrator into the same power strip to avoid ground loops.
- All stages of the Calibration Executive procedure must be run using the same host computer (when using a MXI controller) or PXI controller.



Cautions Ensure that all of the conditions specified in the Test Conditions section are met before starting this procedure. Improper test conditions may cause errors or require repetition of the Calibration Executive procedure.

Incorrect torque at SMA connections can degrade signal fidelity, PLL performance, and insertion loss. Use an SMA torque wrench or torque screwdriver to ensure all SMA connections are properly torqued to 1 N · m.

Device Setup

1. Install the NI 5600 module in the PXI chassis as described in the **NI PXI-5660 Getting Started Guide**.
2. Using a 10 MHz distribution unit, connect the 10 MHz rubidium source to the spectrum analyzer, RF signal generator, and the NI 5600 FREQ REF IN front panel connector, as shown in [NI 5600 Connection Diagram 1](#).
3. Configure the hardware in Measurement & Automation Explorer (MAX).

Verification

1. Connect the power sensor to the NI 5600 OUTPUT front panel connector and to the power meter as shown in [NI 5600 Connection Diagram 2](#). Connections new to this step are shown as hashed lines.
2. Connect the RF signal generator output to the power sensor and the NI 5600 INPUT front panel connector using the splitter, as shown in [NI 5600 Connection Diagram 3](#). Connections new to this step are shown as hashed lines.

3. Connect the upper NI 5600 10 MHz OUT front panel connector to the frequency counter input. This connection is shown in [NI 5600 Connection Diagram 4](#) as a hashed line.
4. Ensure that all connections depicted in connection diagrams 1–4 are set up and tightened to 100 N-cm using a standard SMA torque wrench.
5. [Launch](#) the Calibration Executive procedure and complete the setup wizard.
6. When the verification stage completes, click **OK** at the Verification Complete dialog box.

Cooldown



Note Prior to the adjustment/reverification stage, the NI 5600 downconverter module must be cooled to 23 ± 5 °C.

If you are performing calibration at room temperature, perform the following procedure to cool the NI 5600 downconverter module between the verification and adjustment/reverification stages:

1. Shut down the MXI controller system (if applicable).
2. Shut down the PXI chassis.
3. Cool the NI 5600 module to 23 ± 5 °C. At room temperature, this may take up to one hour. Use of fans or a temperature chamber may shorten the time required to cool the module to 23 ± 5 °C.



Caution If you are performing calibration at room temperature, do not attempt to cool the NI 5600 by exposing the module to very low temperatures. Sudden placement in a refrigerated environment could result in damage to the downconverter module.

Adjustment/Reverification



Tip Set up and tighten all connections before starting the PXI chassis and controller. Connecting while the system is running may cause the NI 5600 to warm beyond allowed calibration start temperatures.

1. Restart the PXI chassis.
2. Restart the MXI controller system (if applicable).
3. Relaunch the Calibration Executive procedure and repeat the setup wizard. Upon restarting, Calibration Executive automatically resumes calibration at the appropriate stage.



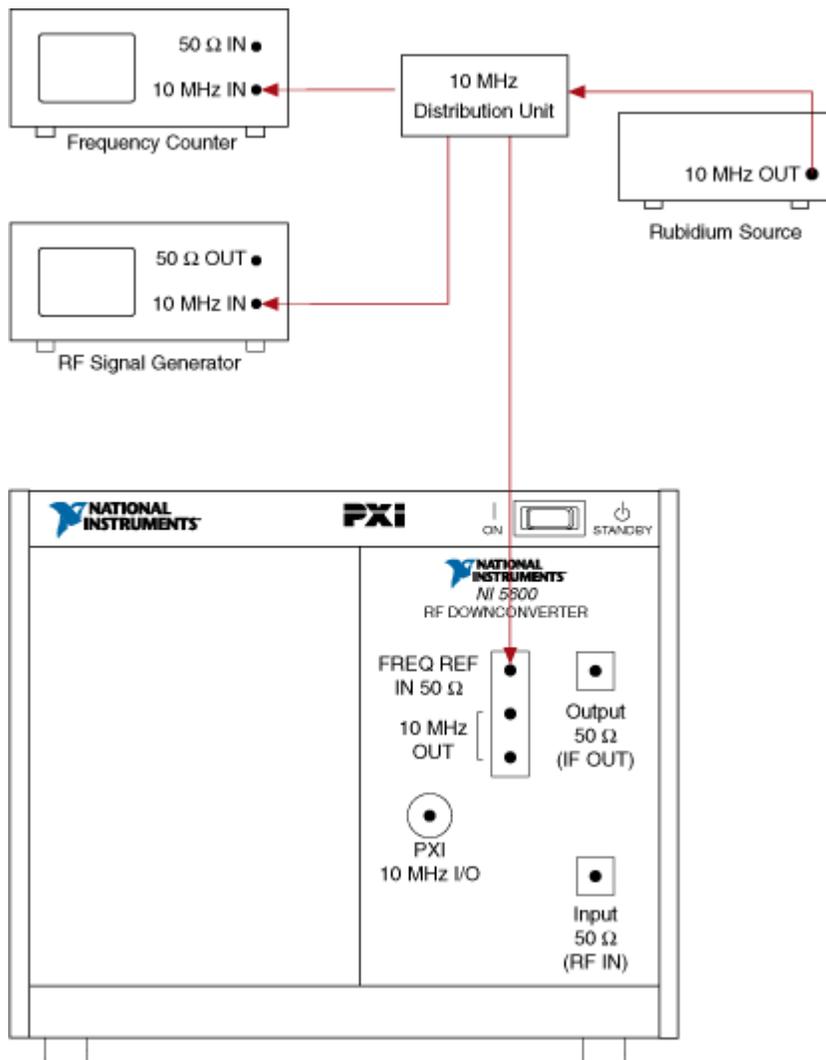
Note You **must** enter the serial number of the DUT exactly as you entered it the first time through the setup wizard. Otherwise, Calibration Executive restarts at the verification procedure.

4. Continue making connection changes when prompted by Calibration Executive.
5. When the adjustment/reverification stage is complete, click **OK** at the Calibration Complete dialog box.

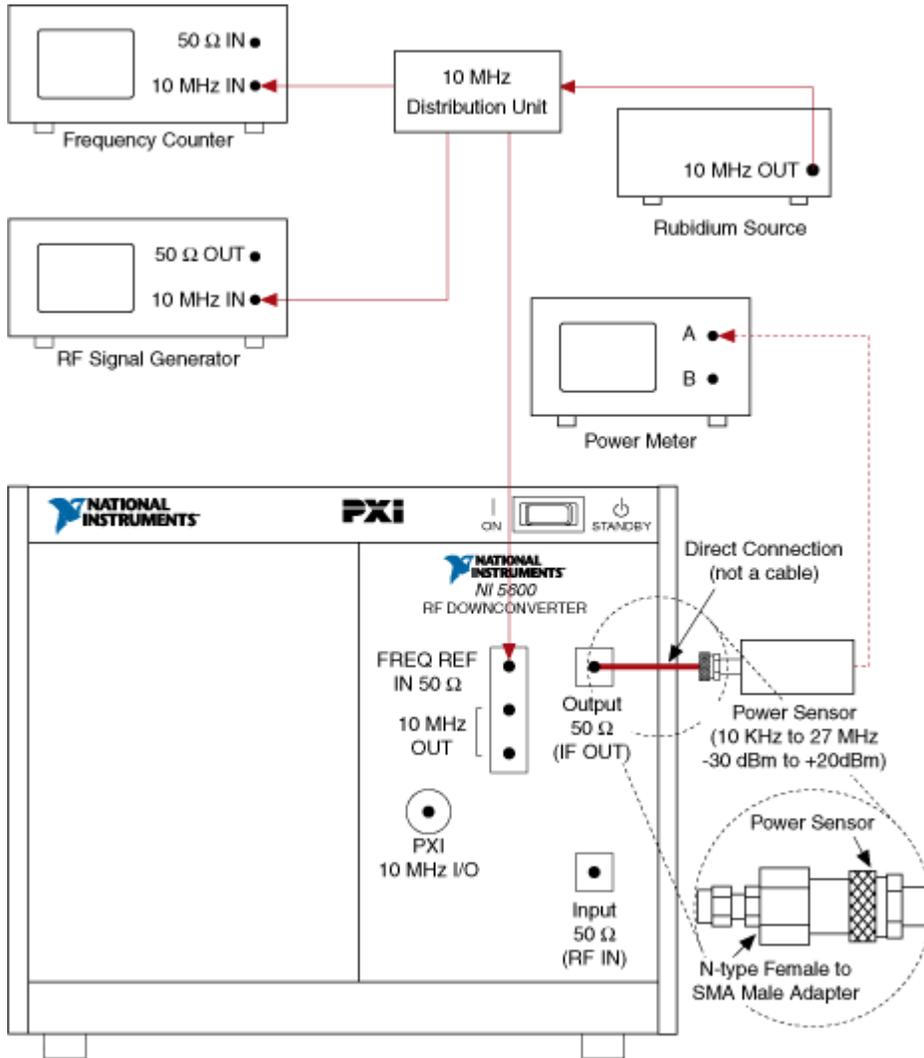


Note If the NI 5600 fails reverification, return it to NI for repair or replacement.

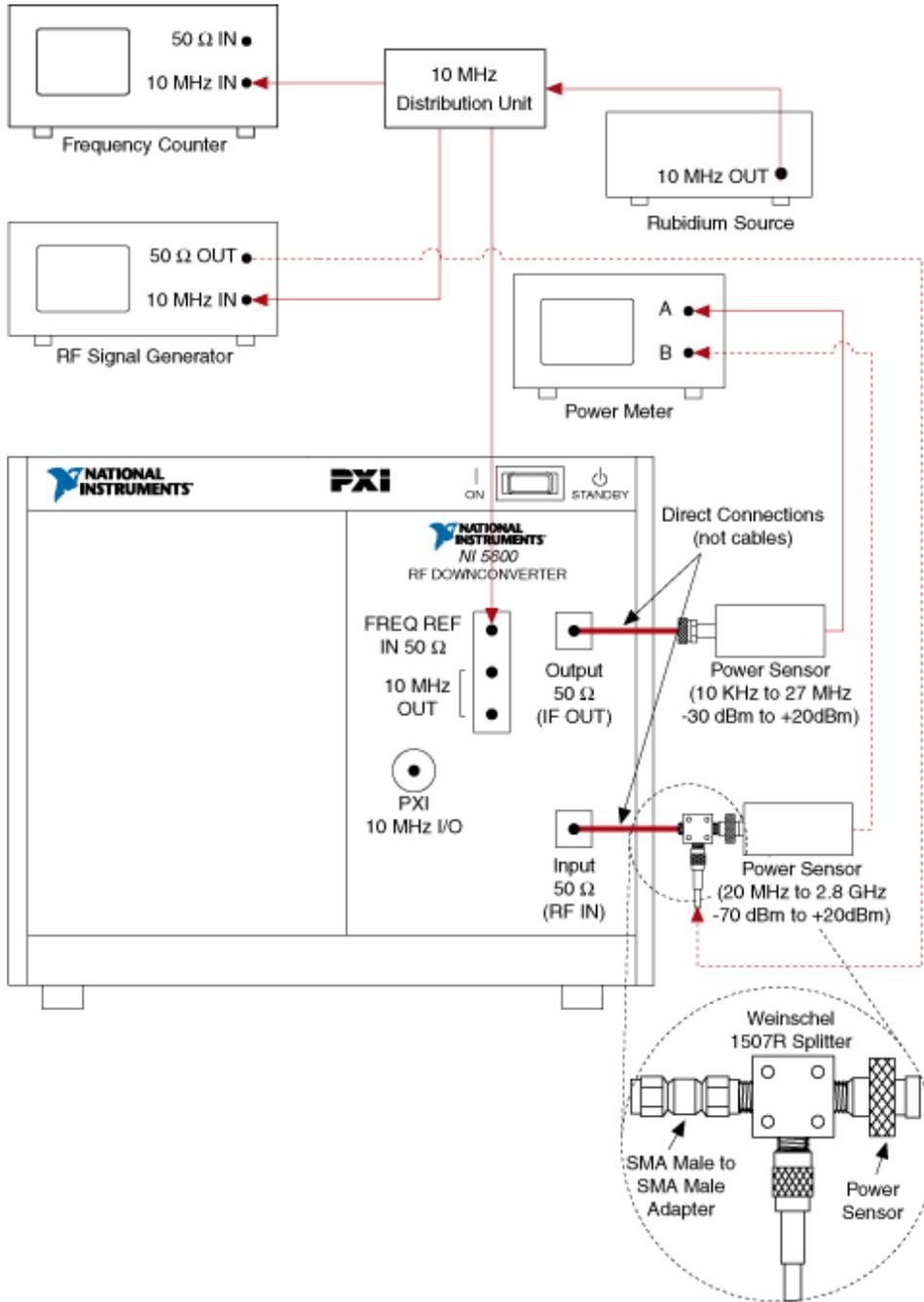
NI 5600 Connection Diagram 1



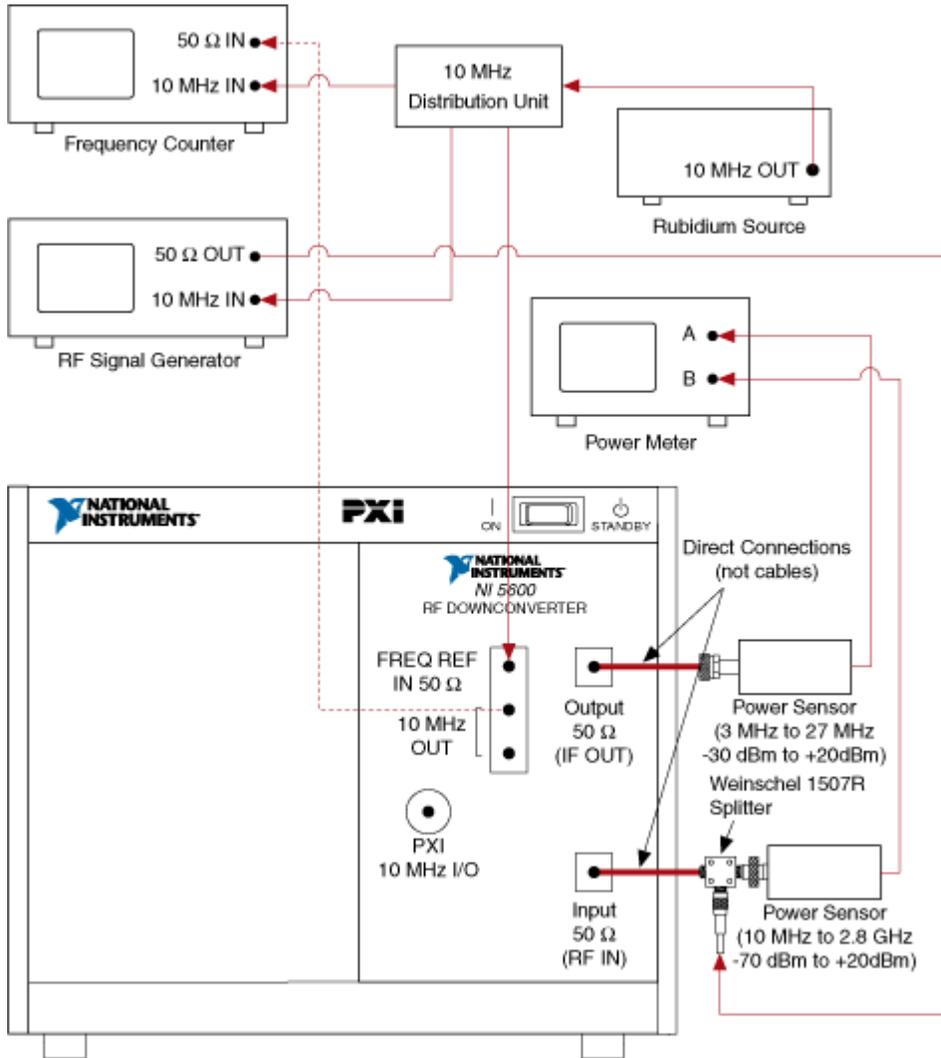
NI 5600 Connection Diagram 2



NI 5600 Connection Diagram 3



NI 5600 Connection Diagram 4



NI SCXI-1100 Calibration Procedure

This topic contains information for calibrating the National Instruments SCXI-1100 using Calibration Executive.

Calibration Executive Procedure Features:

Adjustment	Manual Mode	Selectable Test Points
⊘	✓	⊘

Approximate Test Time: 30 minutes

<u>Test Equipment</u>	<u>Test Conditions</u>	<u>Device Setup</u>	<u>Troubleshooting Guidelines</u>	<u>Test Limits</u>
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Note The NI SCXI-1100 calibration procedure does not support multiplexed mode.

Test Equipment

The following table lists the test equipment required to calibrate NI SCXI-1100 modules.

Instrument	Recommended Model	Requirements
Calibrator	Fluke 5700A	If this instrument is unavailable, use a high-precision voltage source that is accurate to at least 50 ppm.
NI E Series DAQ Device	NI 6030E, NI 6031E, NI 6032E, NI 6033E	—
SCXI Adapter	NI SCXI-1349	Adapter to connect SCXI systems to plug-in data acquisition devices.
Shielded DAQ Cable	NI Sh68-68-EP	Use with E Series DAQ devices.
Terminal Block	NI SCXI-1300	—



Note The Calibration Executive procedure runs in automated mode if you use IVI-supported instruments.

Test Conditions

The following setup and environmental conditions are required to ensure the NI SCXI-1100 meets published specifications.

- Keep connections to the SCXI module as short as possible. Long cables and wires act as antennae, which conduct noise that can affect measurements.
- Use shielded copper wire for all cable connections to the module. Use twisted-pair wire to eliminate noise and thermal offsets.
- Maintain a temperature between 18 °C and 28 °C.
- Keep relative humidity below 80%.
- Allow a warm-up time of at least 30 minutes for the SCXI module and the E Series DAQ device to ensure that the measurement circuitry is at a stable operating temperature.

Device Setup

To set up the SCXI module for the verification procedure, refer to [SCXI Module Installation](#) and [NI SCXI-1100 Calibration Setup](#) as you perform the following steps:

1. Remove the side plate of the SCXI chassis.
2. Remove the cover of the NI SCXI-1100 to access the filter jumpers.
3. Install the NI SCXI-1100 in slot 4 of the SCXI chassis.
4. Install the E Series DAQ device in the host computer.
5. Connect the NI Sh68-68-EP cable between the SCXI module and the E Series DAQ device installed in your host computer using the SCXI adapter.



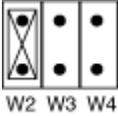
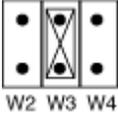
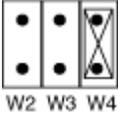
Caution The SCXI module **must** be cabled to the E Series DAQ device as described in this step. Otherwise, the calibration will fail.

6. Configure the chassis and SCXI module hardware with Measurement & Automation Explorer (MAX) under Traditional NI-DAQ.

Configuring Filter Settings

The SCXI-1100 module has jumpers that you use to change the filter settings, as shown in the following table. During the verification procedure, you must change

the filter settings to verify both the 4 Hz and 10 kHz measurement accuracies. You can change the filter settings without powering down the SCXI chassis. Refer to the [SCXI-1100 Jumper Locator Diagram](#) to locate each jumper.

Jumper	Description	Configuration
W2	Factory setting is full bandwidth (FBW) and no filtering	
W3	10 kHz lowpass filter	
W4	4 Hz lowpass filter	

The following table shows the jumpers that you must set to the specified (factory-default) settings.

Jumper	Description	Configuration
W1	Factory setting; parking position (used for ground-referenced sources)	
W5	Factory setting; connects MISO to SERDATOUT	
W6	Factory setting; do not remove this jumper	
W7	Factory setting; parking position. Disconnects the front connector from the module output	
W8	Factory setting; parking position	
W9	Factory setting; connects pullup to SERDATOUT	

	(revision C and higher modules only)	
W10	Factory setting; parking position (used with MIO boards in differential mode)	
W11	Factory setting; (Revision A and Revision B only)	

The Calibration Executive verification procedure guides you through the connections between the calibrator and the SCXI module. The first connections are as follows:

1. Connect the calibrator positive output to Ch0+ of the NI SCXI-1300 terminal block.
2. Connect the calibrator negative output to Ch0- of the NI SCXI-1300 terminal block.
3. Connect the calibrator GUARD and ground together, then connect these to the Ch0- of the terminal block.
4. Connect the terminal block to the front of the NI SCXI-1100.



Note If a terminal block is not available, you can connect to the pins on the front panel using a 96-pin Euro-style connector. Refer to [NI SCXI-1100 Front Connector](#) for the NI SCXI-1100 pin assignments.

5. [Launch](#) the Calibration Executive procedure and complete the setup wizard.

Hardware Information

Calibration Executive displays the following dialog box, which prompts you to enter information about the installed hardware.



Item	Description
MIO Device Number	The E Series DAQ device number assigned by MAX for the DAQ device
MIO Channel	The analog input channel that the E Series DAQ device uses to communicate with the SCXI module; this value is typically left at 0
MIO Resolution	The resolution of the E Series DAQ device
SCXI Module Slot	The SCXI slot where the NI SCXI-1100 is installed
SCXI Chassis ID	The ID number that MAX assigns for the SCXI chassis



Note The NI SCXI-1100 module is not user-adjustable. If your module fails the verification procedure, contact [National Instruments](#) for repair or replacement.

Troubleshooting Guidelines

The NI SCXI-1100 calibration procedure may return an IVI interface error, (-1074135039). This error occurs if you have reconfigured the SCXI module to measure current rather than voltage by installing current shunt resistors. Calibration Executive can only calibrate this module when it is configured to measure voltage.

The SCXI chassis power supply may be injecting noise into your measurement if the NI SCXI-1100 is installed in Slot 1 or 2 of the chassis.

Test Limit Equations

The following test limits are derived from published specifications.

DC Voltage

4 Hz

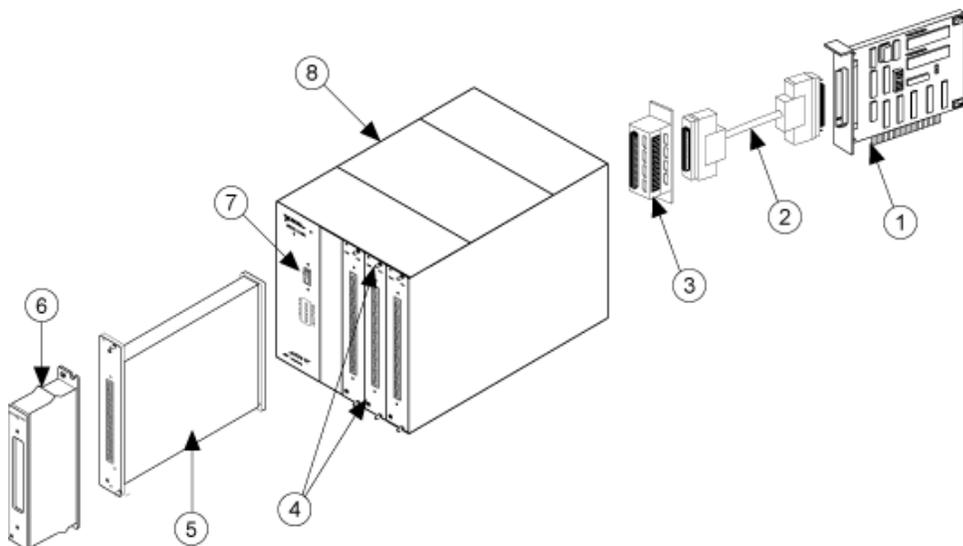
TestLimits = TestValue \pm [abs(TestValue) * % of reading + (Offset + Average system noise for 4 Hz)]

10 kHz

TestLimits = TestValue \pm [abs(TestValue) * % of reading + (Offset + Average system noise for 10 kHz)]

NI SCXI-1100 Calibration Setup

The following figure shows how to set up the SCXI-1100 for calibration.



1 E Series DAQ Device

2 Sh68-68 Cable

3 SCXI-1349 Cable Adapter

4 Thumbscrews

5 SCXI Module

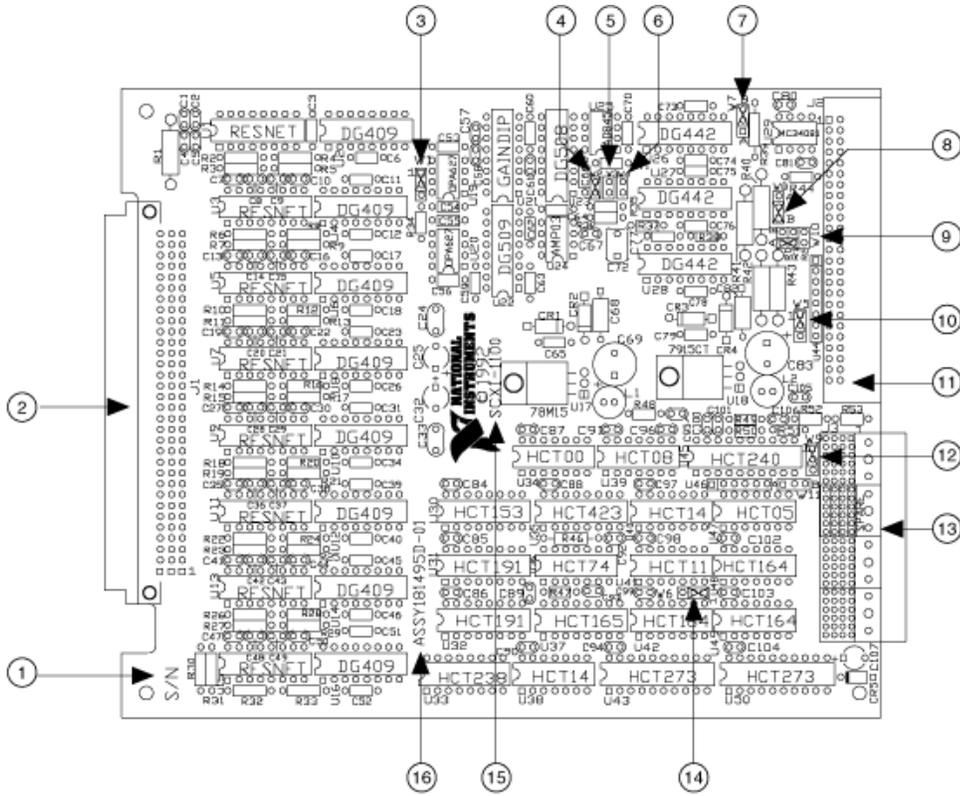
6 SCXI Terminal Block

7 SCXI Chassis Power Switch

8 SCXI Chassis

NI SCXI-1100 Jumper Locator Diagram

The following figure shows the locations of the jumpers on the SCXI-1100 module.

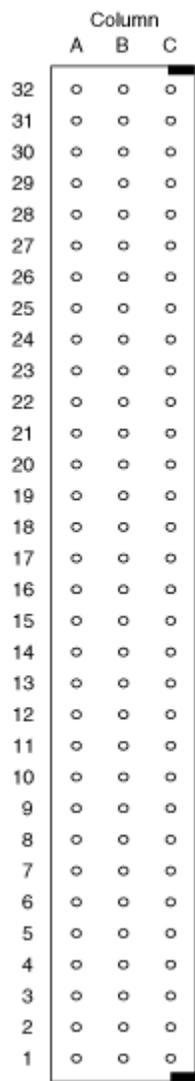


- | | | | |
|-------------------|-------------|--------------------------|---------------------------------|
| 1 Serial Number | 5 Jumper W3 | 9 Jumper W10 | 13 SCXIBus Connector |
| 2 Front Connector | 6 Jumper W4 | 10 Jumper W5 | 14 Jumper W6 |
| 3 Jumper W1 | 7 Jumper W7 | 11 Rear Signal Connector | 15 Module Name |
| 4 Jumper W2 | 8 Jumper W8 | 12 Jumper W9 | 16 Assembly Number and Revision |

NI SCXI-1100 Front Connector

The following figure shows the SCXI-1100 front connector pinout.

Front Connector Diagram	Pin Number	Column A	Column B	Column C
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32	C GND	CH 0 -	CH 0 +
31	NC	CH 1 -	CH 1 +
30	NC	CH 2 -	CH 2 +
29	NC	CH 3 -	CH 3 +
28	NC	CH 4 -	CH 4 +
27	NC	CH 5 -	CH 5 +
26	NC	CH 6 -	CH 6 +
25	NC	CH 7 -	CH 7 +
24	C GND	CH 8 -	CH 8 +
23	NC	CH 9 -	CH 9 +
22	NC	CH 10 -	CH 10 +
21	NC	CH 11 -	CH 11 +
20	NC	CH 12 -	CH 12 +
19	NC	CH 13 -	CH 13 +
18	NC	CH 14 -	CH 14 +
17	NC	CH 15 -	CH 15 +
16	C GND	CH 16 -	CH 16 +
15	NC	CH 17 -	CH 17 +
14	NC	CH 18 -	CH 18 +
13	NC	CH 19 -	CH 19 +
12	NC	CH 20 -	CH 20 +
11	NC	CH 21 -	CH 21 +
10	NC	CH 22 -	CH 22 +
9	NC	CH 23 -	CH 23 +
8	OUTPUT	CH 24 -	CH 24 +
7	AO REF	CH 25 -	CH 26 +
6	GUARD	CH 26 -	CH 26 +
5	C GND	CH 27 -	CH 27 +
4	D TEMP	CH 28 -	CH 28 +
3	M TEMP	CH 29 -	CH 29 +
2	C GND	CH 30 -	CH 30 +

NC means no connection	1	+5V	CH 31 –	CH 31 +
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NI SCXI-1120/D Calibration Procedure

This topic contains information for calibrating the National Instruments SCXI-1120/D using Calibration Executive.

Calibration Executive Procedure Features:

Adjustment ✓	Manual Mode ✓	Selectable Test Points ✗
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Approximate Test Time: 100 minutes

Test Equipment	Test Conditions	Device Setup	Troubleshooting Guideline	Test Limit Equations
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Note The NI SCXI-1120/D calibration procedure does not support multiplexed mode.

Test Equipment

The following table lists the test equipment required to calibrate NI SCXI-1120/D modules.

Instrument	Recommended Model	Requirements
Calibrator	Fluke 5700A	If this instrument is unavailable, use a high-precision voltage source that is accurate to at least 50 ppm.
DMM	NI 4070, Agilent 34401A	If one of these instruments is unavailable, use a multiranging 6 1/2 digit DMM that is accurate to at least 500 ppm.
NI E Series DAQ Device	NI 6030E, NI 6031E,	—

	NI 6032E, NI 6033E	
SCXI Adapter	NI SCXI-1349	Adapter to connect SCXI systems to plug-in data acquisition devices.
Shielded DAQ Cable	NI Sh68-68-EP	Use with E Series DAQ devices.
Ribbon Cable	—	Use a 50-pin ribbon cable.
Connector Block	NI CB-50	—
Terminal Block	NI SCXI-1320, NI SCXI-1327, NI SCXI-1328	—

Test Conditions

The following setup and environmental conditions are required to ensure the NI SCXI-1120/D meets published specifications.

- Keep connections to the SCXI module as short as possible. Long cables and wires act as antennae, which conduct noise that can affect measurements.
- Use shielded copper wire for all cable connections to the module. Use twisted-pair wire to eliminate noise and thermal offsets.
- Maintain a temperature between 18 °C and 28 °C.
- Keep relative humidity below 80%.
- Allow a warm-up time of at least 30 minutes for the SCXI module and the E Series DAQ device to ensure that the measurement circuitry is at a stable operating temperature.

Device Setup

Before you begin the calibration procedure, you must configure the digital jumper settings, gain jumper settings, and the filter jumper settings of the NI SCXI-1120/D module. Refer to the [NI SCXI-1120/D Parts Locator Diagram](#) to locate the jumpers on the module.



Note If you move any jumpers, be sure to restore them to their original positions after calibration.

Configuring Digital Jumpers

Configure jumpers W41 through W46 as shown in the following table.

Jumper	Description	Configuration
W41	Position 1—Temperature sensor accessed in MTS mode (factory-default setting).	
W42	Position 1—Connects pullup to SERDATOUT (factory-default setting). Applies only to NI SCXI-1120 Revisions C or later and all NI SCXI-1120D modules.	
W43	Position 1—Connects MISO to SERDATOUT (factory-default setting).	
W44	Connects SLOT0SEL* to the SCXibus INTR* line after buffering (factory-default setting). Applies to Revision A and B of the NI SCXI-1120 only.	
W45	Factory-default setting.	
W46	B-R0R1—Factory-default setting in parking position.	

Configuring Gain Jumpers

Each input channel has two user-configurable gain stages. The first-stage gain provides gains of 1, 10, 50, and 100. The second-stage gain provides gains of 1, 2, 5, 10, and 20.

The following table shows the jumpers for gain selection associated with each channel.

Input Channel	First-Stage Gain Jumper	Second-Stage Gain Jumper

0	W1	W9
1	W2	W10
2	W3	W11
3	W4	W12
4	W5	W13
5	W6	W14
6	W7	W15
7	W8	W16

The following table shows how to position each jumper to select the desired gain for each channel.

Gain	Setting	Jumper Position
First-Stage	1	D
	10	C
	50	B
	100	A
Second-Stage	1	A
	2	B
	5	C
	10	D
	20	E

To change the gain setting of a specified channel on the module, move the appropriate jumper on the module to the position indicated in the previous table.



Note The NI SCXI-1120D has an additional fixed pre-stage gain of 0.5.

The order of the settings for the first- and second-stage does not matter as long as the first stage gain multiplied by the second stage gain—multiplied by 0.5 when using the NI SCXI-1120D—equals the desired final gain value.

- NI SCXI-1120—To determine the overall gain of a given channel on the NI SCXI-1120, multiply the gain selection of the first stage by the gain selection of the second stage.

- NI SCXI-1120D—To determine the overall gain of a given channel on the NI SCXI-1120D, multiply the gain selection of the first stage by the gain selection of the second stage and then multiply that product by 0.5.

Configuring NI SCXI-1120 Filter Jumpers

This section describes how to configure the filter jumpers on the NI SCXI-1120. During the Calibration Executive procedure, keep this information available for reference.

The NI SCXI-1120 module also has two-stage filtering. The first stage is located in the isolated section of the input channel. The second stage is located in the non-isolated section of the input channel. Two-stage filtering eliminates the noise generated by the isolation amplifier, producing a higher signal-to-noise ratio. Two filter bandwidths are available on the NI SCXI-1120: 4 Hz and 10 kHz. The following table shows the filter jumper allocations for the NI SCXI-1120.

Input Channel	First-Stage Filter Jumper		Second-Stage Filter Jumper	
	4 Hz (Factory Default)	10 kHz	4 Hz (Factory Default)	10 kHz
0	W17-A	W17-B	W25	W26
1	W18-A	W18-B	W27	W28
2	W19-A	W19-B	W29	W30
3	W20-A	W20-B	W31	W32
4	W21-A	W21-B	W33	W34
5	W22-A	W22-B	W35	W36
6	W23-A	W23-B	W37	W38
7	W24-A	W24-B	W39	W40

Verify that both filtering stages of the NI SCXI-1120 are set to the same bandwidth to ensure that the required bandwidth is achieved. One jumper block is available for each filter stage.

Configuring NI SCXI-1120D Filter Jumpers

This section describes how to configure the filter jumpers on the NI SCXI-1120D. During the Calibration Executive procedure, keep this information available for reference.

The NI SCXI-1120D module also has two-stage filtering. The first stage is located in the isolated section of the input channel. The second stage is located in the non-isolated section of the input channel. Two-stage filtering eliminates the noise generated by the isolation amplifier, producing a higher signal-to-noise ratio. Two filter bandwidths are available on the NI SCXI-1120D: 4.5 kHz and 22.5 kHz. The following table shows the filter jumper allocations for the NI SCXI-1120D.

Input Channel	First-Stage Filter Jumper		Second-Stage Filter Jumper	
	4.5 kHz (Factory Default)	22.5 kHz	4.5 kHz (Factory Default)	22.5 kHz
0	W17-A	W17-B	W26	W25
1	W18-A	W18-B	W28	W27
2	W19-A	W19-B	W30	W29
3	W20-A	W20-B	W32	W31
4	W21-A	W21-B	W34	W33
5	W22-A	W22-B	W36	W35
6	W23-A	W23-B	W38	W37
7	W24-A	W24-B	W40	W39

Verify that both filtering stages of the NI SCXI-1120D are set to the same bandwidth to ensure that the required bandwidth is achieved. One jumper block is available for each filter stage.

Configuring Potentiometers

Refer to the [NI SCXI-1120/D Parts Locator Diagram](#) to locate the potentiometers on the NI SCXI-1120/D module. The Calibration Executive procedure prompts you to adjust these potentiometers as shown in the following table.

Channel Number	Output Null Potentiometer	Input Null Potentiometer
0	R24	R08
1	R25	R10
2	R26	R12
3	R27	R14
4	R28	R16
5	R29	R18
6	R30	R20
7	R31	R21

Setting up the SCXI Module and Test Equipment

Refer to [SCXI Module Installation](#) and [NI SCXI-1120/D Setup](#) as you complete the following steps:

1. Remove the side plate of the SCXI chassis and the cover of the NI SCXI-1120/D module to access the potentiometers and jumpers.
2. Install the NI SCXI-1120/D module in slot 4 of the SCXI chassis.
3. Install the E Series DAQ device in the host computer.
4. Connect a Sh68-68-EP cable between the SCXI module and the E Series DAQ device installed in the host computer using the SCXI-1349 cable adapter.



Caution The SCXI module **must** be cabled to the E Series DAQ device as described in this step. Otherwise, the calibration will fail.

5. Connect the 50-pin connector to the 50-pin breakout on the adapter device.
6. Configure the hardware with Measurement & Automation Explorer (MAX) under Traditional NI-DAQ.

The calibration procedure guides you through the connections between the calibrator, DMM, and the SCXI module. The first connections are as follows:

1. Connect all negative inputs of each NI SCXI-1120/D channel together on the SCXI-1320, SCXI-1327, or SCXI-1328 terminal block.
2. Connect all positive inputs of each channel together on the terminal block.

3. Connect the calibrator positive output to Ch0+ of the terminal block.
4. Connect the calibrator negative output, GUARD, and ground to Ch0- of the terminal block.
5. Connect the calibrator GUARD and ground together, then connect these to the Ch0- of the terminal block.
6. Connect the terminal block to the front of the NI SCXI-1120/D module.
7. Connect the DMM HI voltage input to pin 3 of the 50-pin connector block.
8. Connect the DMM LO voltage input to pin 4 of the 50-pin connector block.
9. Launch the Calibration Executive procedure and complete the setup wizard.

Calibration Executive displays the following dialog box, which prompts you to enter information about the installed hardware.

Item	Description
MIO Device Number	The Traditional NI-DAQ device number assigned by MAX for the E Series DAQ device
MIO Channel	The analog input channel that the E Series DAQ device uses to communicate with the SCXI module; you can leave this value at 0
SCXI Chassis ID	The ID number that MAX assigns for the SCXI chassis
SCXI Module Slot	The SCXI slot where the NI SCXI-1120/D module has been installed
Terminal Block	The SCXI terminal block you are using

SCXI Module	A list of all 1120/D modules supported by the calibration procedure; select the module type that you are calibrating
Channels to verify and Adjust	The NI SCXI-1120/D channels to verify and adjust (or verify only)

Troubleshooting Guidelines

If the SCXI module is not recognized in MAX, make sure that you followed the configuration guidelines. If MAX fails to recognize the SCXI module after you reconfigure and refresh (<F5>), contact NI technical support.

The SCXI chassis power supply may be injecting noise into your measurement if the NI SCXI-1120/D is installed in Slot 1 or 2 of the chassis.

If the NI SCXI-1120/D module fails after calibration, try the following:

1. Check the connections and run the Calibration Executive procedure again.
2. If the calibration still fails after trying step 1, try inputting or outputting the failed Test Points using the Test Panel of the E Series DAQ device in MAX. For example, if the analog input (AI) failed at 0.98 V, input that value from the calibrator.
 1. Launch the test panel in MAX.
 2. Click the **Analog Input** tab.
 3. Set the **High Limit** to 1.00 V and set the **Low Limit** to -1.00 V for bipolar readings.
 4. Enter SC!MDX!y in the channel string field, where x is the slot in the SCXI chassis where the NI SCXI-1120/D is installed, and y is the channel you are testing on the module.
 5. Check the Average Reading indicator.

If the Average Reading still fails after you complete steps 1 and 2, contact National Instruments for repair or replacement. If the Average Reading passes, you can change the calibration report to indicate the passing value.



Note If you have Microsoft Access 2000 or later, you can also modify the database containing the test results. By default, this database is located in `\Calibration Executive\Databases\Calibration Reports.mdb`.

Test Limit Equations

The following test limits are derived from published specifications.

NI SCXI-1120

DC Voltage

4 Hz

TestLimits = TestValue \pm [abs(TestValue) * % of reading + (Offset + Average system noise for 4 Hz)]

10 kHz

TestLimits = TestValue \pm [abs(TestValue) * % of reading + (Offset + Average system noise for 10 kHz)]

NI SCXI-1120D

DC Voltage

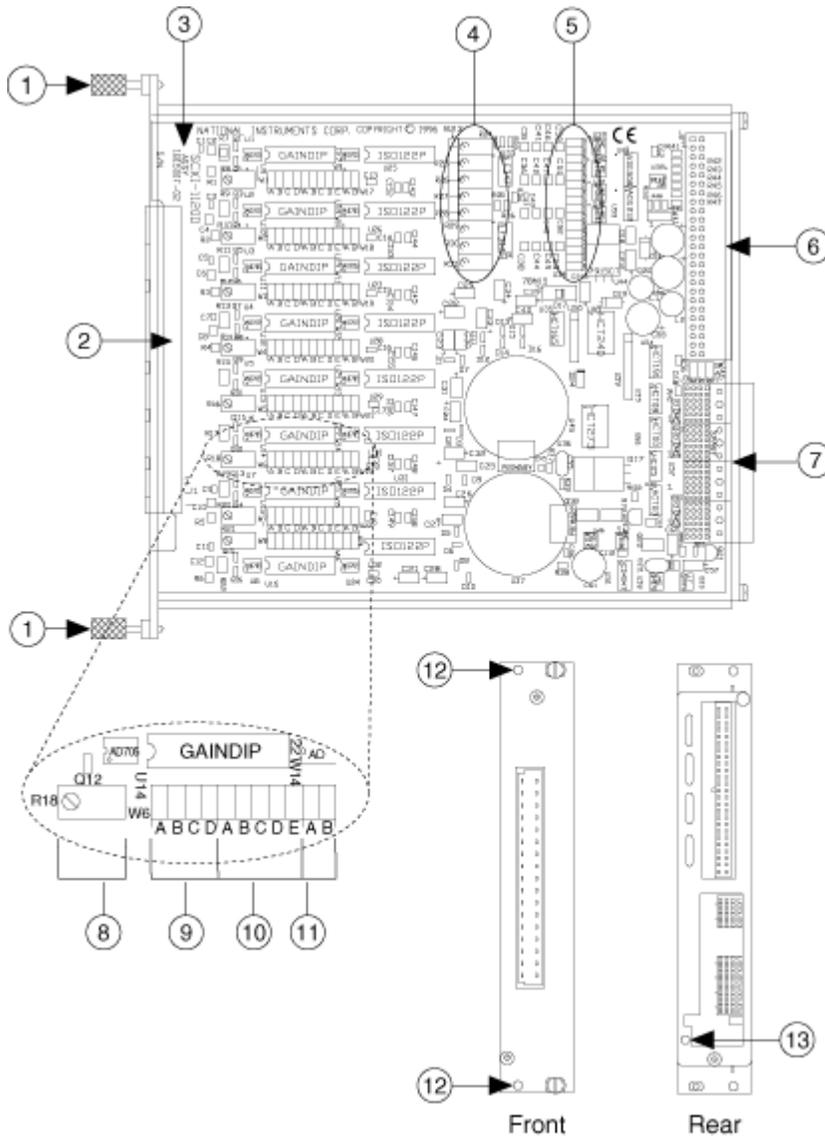
4.5 kHz

TestLimits = TestValue \pm [abs(TestValue) * % of reading + (Offset + Average system noise for 4.5 kHz)]

22.5 kHz

TestLimits = TestValue \pm [abs(TestValue) * % of reading + (Offset + Average system noise for 22.5 kHz)]

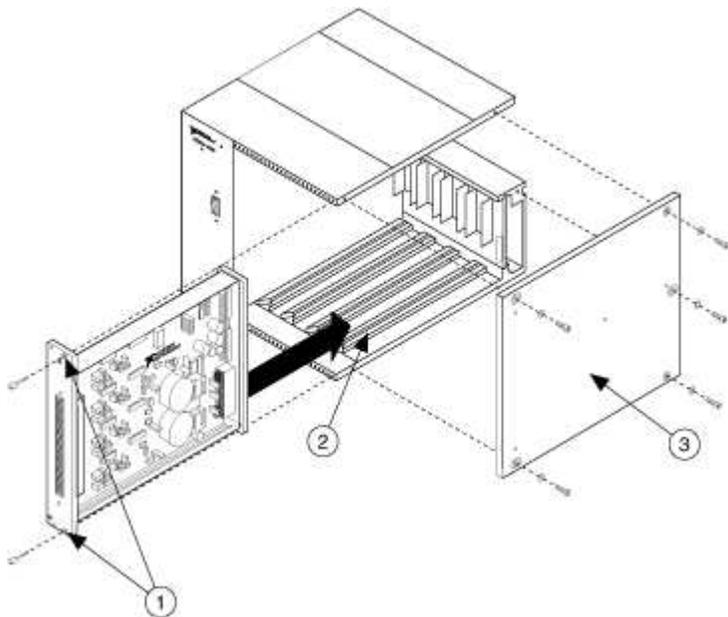
NI SCXI-1120/D Parts Locator Diagram



- | | |
|--|------------------------------------|
| 1 Thumbscrews | 7 SCXIbus Connector |
| 2 Front Connector | 8 Input Null Adjust Potentiometers |
| 3 Product Name, Assembly Number, and Serial Number | 9 First-Stage Gain Jumpers |
| 4 Output Null Adjust Potentiometers | 10 Second-Stage Gain Jumpers |
| 5 Second-Stage Filter Jumpers | 11 First-Stage Filter Jumpers |
| 6 Rear Signal Connector | 12 Terminal Block Mounting Hole |
| | 13 Grounding Screw |

SCXI Module Installation

The following figure shows how to remove the side plate of the SCXI chassis and install an SCXI module in the chassis.



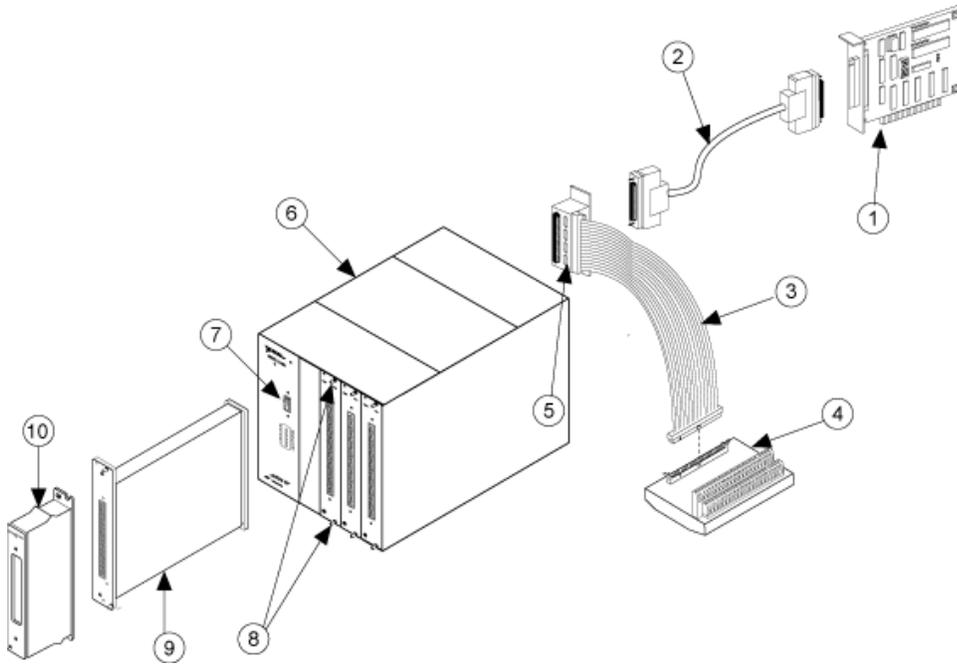
1 Thumbscrews

2 Slot 4

3 Side Plate

NI SCXI-1120/D Calibration Setup

The following figure shows how to set up the SCXI-1120/D for calibration.



- 1 E/M Series DAQ Device
- 2 Sh68-68-EP Shielded Cable
- 3 50-Pin Ribbon Cable
- 4 Connector Block
- 5 SCXI-1349 Cable Adapter

- 6 SCXI Chassis
- 7 SCXI Chassis Power Switch
- 8 Thumbscrews
- 9 SCXI Module (DUT)
- 10 SCXI Terminal Block

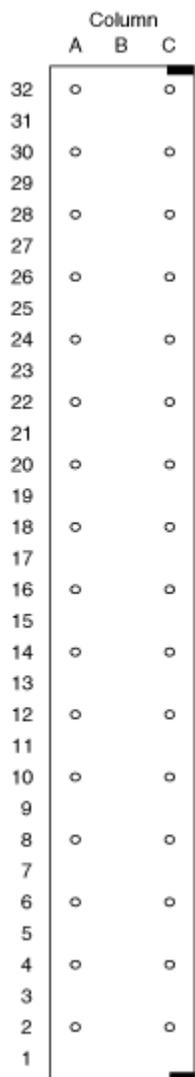


Note The E Series DAQ device, the shielded cable, and the cable adapter **must** be connected to the SCXI module being calibrated.

NI SCXI-1120/D Front Connector

The following figure shows the SCXI-1120/D front connector pinout.

Front Connector Diagram	Pin Number	Column A	Column B	Column C



32	CH 0+	—	CH 0-
31	—	—	—
30	CH 1+	—	CH 1-
29	—	—	—
28	NC	—	NC
27	—	—	—
26	CH 2+	—	CH 2-
25	—	—	—
24	CH 3+	—	CH 3-
23	—	—	—
22	NC	—	NC
21	—	—	—
20	CH 4+	—	CH 4-
19	—	—	—
18	CH 5+	—	CH 5-
17	—	—	—
16	NC	—	NC
15	—	—	—
14	CH 6+	—	CH 6-
13	—	—	—
12	CH 7+	—	CH 7-
11	—	—	—
10	NC	—	NC
9	—	—	—
8	NC	—	RSVD
7	—	—	—
6	RSVD	—	RSVD
5	—	—	—
4	+5V	—	M TEMP
3	—	—	—
2	CHS GND	—	D TEMP

NC means no connection

— means no physical pin	1	—	—	—
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NI SCXI-1121 Calibration Procedure

This topic contains information for calibrating the National Instruments SCXI-1121 using Calibration Executive.

Calibration Executive Procedure Features:

Adjustment ✓	Manual Mode ✓	Selectable Test Points ✗
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Approximate Test Time: 90 minutes

Test Equipment	Test Conditions	Device Setup	Troubleshooting Guideline	Test Limit Equations
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Note The NI SCXI-1121 calibration procedure does not support multiplexed mode.

Test Equipment

The following table lists the test equipment required to calibrate NI SCXI-1121 modules.

Instrument	Recommended Model	Requirements
Calibrator	Fluke 5700A	If this instrument is unavailable, use a high-precision voltage source that is accurate to at least 50 ppm.
DMM	NI 4070	If this instrument is unavailable, use a multiranging 6 1/2 digit DMM.
NI E Series DAQ Device	NI 6030E, NI 6031E, NI 6032E, NI 6033E	—

SCXI Adapter	NI SCXI-1349	Adapter to connect SCXI systems to plug-in data acquisition devices.
Shielded DAQ Cable	NI Sh68-68-EP	Use with E Series devices.
Ribbon Cable	—	Use a 50-pin ribbon cable.
Connector Block	NI CB-50	—
Terminal Block	NI SCXI-1320, NI SCXI-1327, NI SCXI-1328	—
Precision Resistors	—	Use an 800 Ω \pm 10% precision resistor.
		Use a 120 Ω \pm 10% precision resistor.



Note The Calibration Executive procedure runs in [automated mode](#) if you use IVI-supported instruments.

Test Conditions

The following setup and environmental conditions are required to ensure the NI SCXI-1121 meets published specifications.

- Keep connections to the SCXI module as short as possible. Long cables and wires act as antennae, which conduct extra noise that can affect measurements.
- Use shielded copper wire for all cable connections to the module. Use twisted-pair wire to eliminate noise and thermal offsets.
- Maintain a temperature between 18 and 28 °C.
- Keep relative humidity below 80%.

- Allow a warm-up time of at least 30 minutes for the SCXI module and the E Series DAQ device to ensure that the measurement circuitry is at a stable operating temperature.

Device Setup

This section describes the analog input jumpers, gain jumpers, filter jumpers, and excitation jumpers on the NI SCXI-1121 module and explains how to configure these jumpers for calibration. Refer to the [NI SCXI-1121 Jumper Locator Diagram](#) and the [NI SCXI-1121 Parts Locator Diagram](#) to locate the jumpers on the NI SCXI-1121 module.



Note If you move any jumpers, be sure to restore them to their original positions after calibration.

The NI SCXI-1121 has five digital signal connection jumpers and 45 analog configuration jumpers. The jumper configurations for each input channel and each excitation channel are similar—only the jumper numbers are different. Therefore, when you learn how to set up one channel pair, you can set up the other channel pairs as well. The following sections describe how to configure the digital signal connection jumpers, the gain and filter jumpers, and the excitation jumpers. Refer to the [NI SCXI-1121 Jumper Locator Diagram](#) and [NI SCXI-1121 Parts Locator Diagram](#) to locate the jumpers on the NI SCXI-1121.

Configuring the Digital Signal Connection Jumpers

Configure the digital signal connection jumpers on the module as shown in the following table.

Jumper	Description	Configuration
W38	Factory setting; connects MISO to SERDATOUT	
W38	Parking position	
W45	Factory setting	

W44	Factory setting (Revision A and B modules)	
W32	Factory-default setting; connects pull-up to SERDATOU T (Revision C and later)	
W32	Parking position (not connected on Revision A or B modules)	

Disable the Bridge Completion Network

Record the settings of jumpers W1, W2, W17, W18, W27, W28, W39, and W40 so that you can restore them after calibration. Disable the bridge completion network by setting these jumpers to the settings listed in the following table. After you complete the calibration, restore the jumpers to the settings you recorded previously.

Channel	Jumpers	Enable Completion	Disable Network (Factory Setting)
0	W1 and W2	 	 
1	W17 and W18	 	 
2	W27 and W28	 	 
3	W39 and W40	 	 

Configuring the Gain Jumpers

Each input channel has two user-configurable gain stages. The first-stage gain provides gains of 1, 10, 50, and 100, and the second-stage gain provides gains of 1, 2, 5, 10, and 20. To change the gain setting of a specified channel on the module, move

the appropriate jumper on the module to the position indicated in the following table.

Gain	Setting	Jumper Position
First-Stage	1	D
	10	C
	50	B
	100	A (factory setting)
Second-Stage	1	A
	2	B
	5	C
	10	D (factory setting)
	20	E

The following table shows the gain jumper allocation for the NI SCXI-1121.

Input Channel	First-Stage Gain Jumper	Second-Stage Gain Jumper
0	W3	W4
1	W19	W20
2	W29	W30
3	W41	W42

To determine the overall gain of a given channel, use the following formula:

$$\text{overall gain} = \text{first-stage gain} \times \text{second-stage gain}$$

The order of the settings for the first and second stages does not matter as long as the first-stage gain multiplied by the second-stage gain equals the desired final gain value.

Configuring the Filter Jumpers

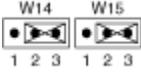
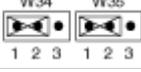
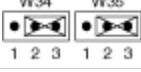
The following table shows the filter jumper allocation on the NI SCXI-1121. Two filter bandwidths are available—4 Hz and 10 kHz. Always make sure to set both stages to the same bandwidth to ensure that you achieve the required bandwidth.

Input Channel	First Filter Jumper	Second Filter Jumper
---------------	---------------------	----------------------

	4 Hz (Factory Setting)	10 kHz	4 Hz (Factory Setting)	10 kHz
0	W5-A	W5-B	W6	W7
1	W21-A	W21-B	W8	W9
2	W31-A	W31-B	W10	W11
3	W43-A	W43-B	W12	W13

Configure the Excitation Jumpers

Configure each excitation channel of the NI SCXI-1121 for both voltage and current excitation modes. Each channel has two jumpers for this purpose. Set both jumpers in the same mode for correct operation of the excitation channel. During the calibration procedure, the program prompts you to set up the module. The following table shows the correct jumper setup for both voltage mode and current mode.

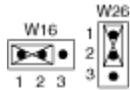
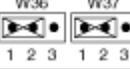
Excitation Channel	Jumpers	Voltage Mode (Factory Setting)	Current Mode
0	W14 and W15		
1	W22 and W23		
2	W34 and W35		
3	W46 and W47		

Each excitation channel of the NI SCXI-1121 has two different current or voltage levels. Set a given channel to the following level modes:

- Current mode—0.150 or 0.4501 mA
- Voltage mode—3.333 or 10 V

After selecting the excitation mode of operation you want—voltage or current—use the following table to set the level of operation of the NI SCXI-1121.

Excitation Channel	Jumpers	3.333 V or 0.150 mA (Factory Setting)	10 V or 0.450 mA

0	W16 and W26		
1	W24 and W25		
2	W36 and W37		
3	W48 and W49		

Setting up the SCXI Module and Test Equipment

Refer to [SCXI Module Installation](#) and [NI SCXI-1121 Setup](#) as you complete the following steps:

1. Install the NI SCXI-1121 module in the SCXI chassis. Remove the side plate of the chassis and the cover of the NI SCXI-1121 module to access the potentiometers and jumpers.
2. Install the E Series DAQ device in the host computer.
3. Connect a 68-to-68-pin cable between the SCXI module and the E Series DAQ device installed in the host computer using the SCXI-1349 cable adapter.



Caution The SCXI module **must** be cabled to the E Series DAQ device as described in this step. Otherwise, the calibration will fail.

4. Connect the terminal block to the 50-pin breakout on the adapter device.
5. Configure the hardware with Measurement & Automation Explorer (MAX) under Traditional NI-DAQ.
6. [Launch](#) the Calibration Executive procedure and complete the setup wizard.

Calibration Executive guides you through the connections between the calibrator, DMM, and NI SCXI-1121 module. The first connections are as follows:

1. Connect all negative inputs of each NI SCXI-1121 channel together on the SCXI-1320, SCXI-1327, or SCXI-1328 terminal block.
2. Connect all positive inputs of each channel together on the terminal block. Refer to the [NI SCXI-1121 Front Connector](#) for the correct signal connections.
3. Connect the calibrator positive output to Ch0+ of the same terminal block.

4. Connect the calibrator negative output to Ch0- of the same terminal block.
5. Connect the terminal block to the front of the NI SCXI-1121.
6. Connect the DMM HI voltage input to pin 3 of the 50-pin connector block.
7. Connect the DMM LO voltage input to pin 4 of the 50-pin connector block.

When you verify the operation of the excitation channels, connect the 120 Ω (3.333 V level) and the 800 Ω (10 V level) resistors to the output of the excitation channel you are testing. If you have a terminal block such as the SCXI-1320, the excitation channel connections are labeled on the terminal block.

When you adjust the analog inputs of the NI SCXI-1121, refer to the following table for the potentiometer reference designators.

Input Channel	Input Null	Output Null
0	R02	R03
1	R16	R04
2	R26	R05
3	R36	R06

When you adjust the excitation levels of the NI SCXI-1121, refer to the following table for the potentiometer reference designators.

Input Channel	Excitation Channel	
	Voltage Mode	Current Mode
0	R10	R7
1	R20	R17
2	R30	R27
3	R40	R37

Hardware Information

Calibration Executive displays the following dialog box, which prompts you to enter information about the installed hardware.

Obtain SCXI Information

SCXI Configuration

MIO Device Number: 1 MIO Channel: 0

SCXI Chassis ID: 1 SCXI Module Slot: 1

Terminal Block

- SCXI-1320
- SCXI-1321
- SCXI-1327
- SCXI-1328

Channels to Verify and Adjust

Analog Input Channels

0 1 2 3

Excitation Channels

0 1 2 3

Continue

Item	Description
MIO Device Number	The Traditional NI-DAQ device number assigned by MAX for the E Series DAQ device
MIO Channel	The analog input channel that the E Series DAQ device uses to communicate with the SCXI module; you can typically leave this at channel 0
SCXI Chassis ID	The ID number that MAX assigns for the SCXI chassis
SCXI Module Slot	The SCXI slot where the NI SCXI-1121 is installed
Terminal Block	The SCXI terminal block that you are using
Channels to verify and Adjust	The NI SCXI-1121 channels to calibrate

Troubleshooting Guidelines



Note For tests involving gain, the results in the calibration report are calculated so that gain is transparent to the user. The report appears as if there was no gain to the measurement, but the full resolution of the instrument was applied over the Gain multiplied range.

If the SCXI module is not recognized in MAX, make sure that you followed the configuration guidelines. If MAX fails to recognize the SCXI module after you reconfigure and refresh (<F5>), contact NI technical support.

The SCXI chassis power supply may be injecting noise into your measurement if the NI SCXI-1121 is installed in Slot 1 or 2 of the chassis.

If the NI SCXI-1121 module fails after calibration, try the following:

1. Check the connections and run the Calibration Executive procedure again.
2. If the calibration still fails after trying step 1, try inputting or outputting the failed Test Points using the Test Panel of the E Series DAQ device in MAX. For example, if the analog input (AI) failed at 0.98 V, input that value from the calibrator.
 1. Launch the test panel in MAX.
 2. Click the **Analog Input** tab.
 3. Set the **High Limit** to 1.00 V and set the **Low Limit** to -1.00 V for bipolar readings.
 4. Enter SC!MDX!y in the channel string field, where x is the slot in the SCXI chassis where the NI SCXI-1121 is installed, and y is the channel you are testing on the module.
 5. Check the Average Reading indicator.

If the Average Reading still fails after you complete steps 1 and 2, contact National Instruments for repair or replacement. If the Average Reading passes, you can change the calibration report to indicate the passing value.



Note If you have Microsoft Access 2000 or later, you can also modify the database containing

the test results. By default, this database is located in \Calibration Executive\Data bases\Calibration Reports.mdb.

Test Limit Equations

The following test limits are derived from published specifications.

DC Voltage

4 Hz

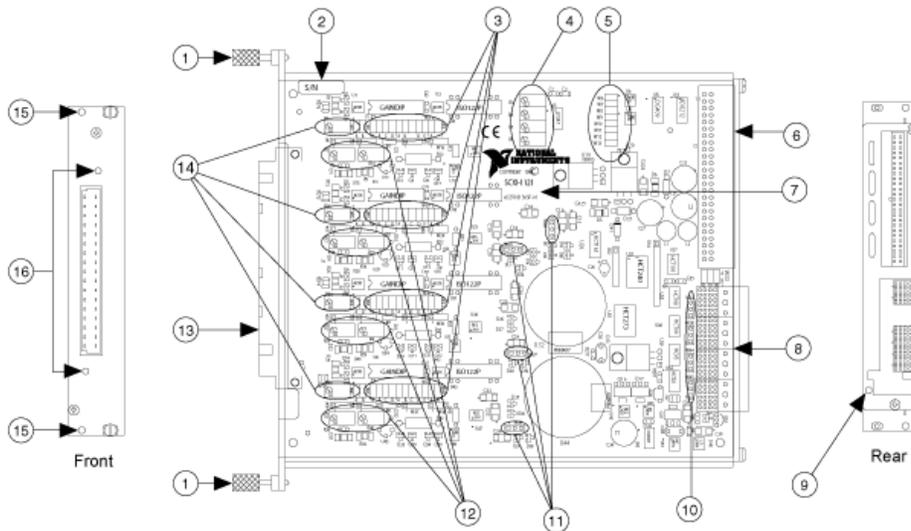
TestLimits = TestValue ± [abs(TestValue) * % of reading + (Offset + Average system noise for 4 Hz)]

10 kHz

TestLimits = TestValue ± [abs(TestValue) * % of reading + (Offset + Average system noise for 10 kHz)]

NI SCXI-1121 Parts Locator Diagram

The following figure shows the locations of the jumpers on the SCXI-1121.



1 Thumbscrew

2 Serial Number

3 Amplifier Gain, Filter, and Excitation Jumpers

9 Grounding Screw

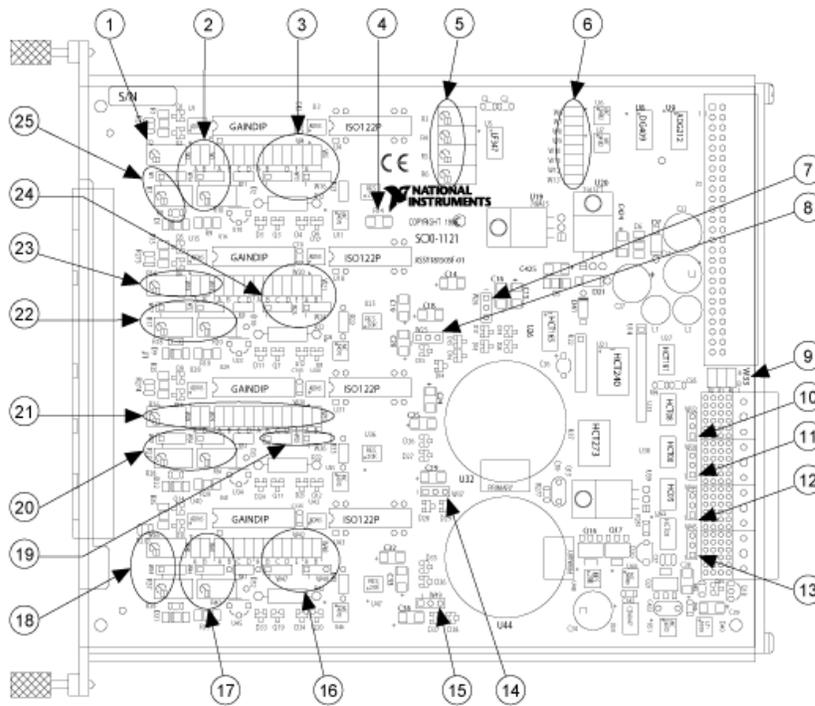
10 Digital Jumpers

11 Excitation Level Jumpers

- 4 Output Null Adjust Potentiometers
- 5 Second-Stage Filter Jumpers
- 6 Rear Signal Connector
- 7 Product Name, Assembly Number, and Revision Letter
- 8 SCXIbus Connector
- 12 Voltage and Current Adjust
- 13 Front Connector
- 14 Input Null Adjust Potentiometers
- 15 Terminal Block Mounting Hole
- 16 Connector and Shell Mounting Holes

NI SCXI-1121 Jumper Locator Diagram

The following figure shows detailed locations of the jumpers on the SCXI-1121.



- 1 R2
- 2 W2, W3, W14, R10
- 3 W4, W5, W15, W16
- 4 R14
- 5 R3-R6
- 6 W6-W13
- 7 W26
- 14 W37
- 15 W49
- 16 W42, W43, W47, W48
- 17 W40, W41, W46, R40
- 18 R36, W39, R37
- 19 W35, W36
- 20 W27, W34, R27, R30

8 W25	21 R26, W28-W31
9 W33	22 W17, W22, R17, R20
10 W32	23 R16, W18, W19
11 W38	24 W20, W22, W23, W3
12 W44 (not loaded)	25 W17, W22, R17, R20
13 W4	

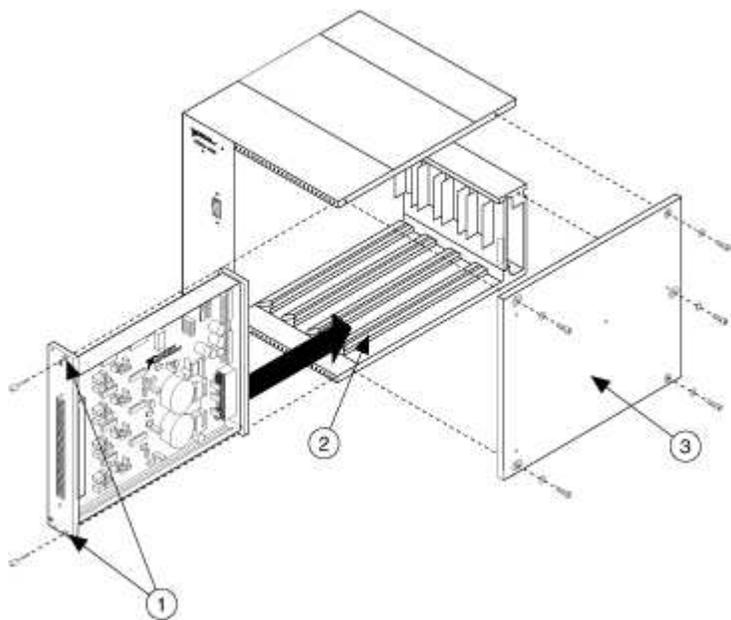
Jumper Functions

The jumpers on the SCXI-1121 are used as follows:

- Jumpers W3, W19, W29, and W41 configure the first-stage gain of input channels 0 through 3, respectively.
- Jumpers W4, W20, W30, and W42 configure the second-stage gain of input channels 0 through 3, respectively.
- Jumpers W5, W21, W31, and W43 configure the first-stage filtering of input channels 0 through 3, respectively.
- Jumpers W6 and W7, W8 and W9, W10 and W11, and W12 and W13 configure the second-stage filtering of input channels 0 through 3, respectively.
- Jumpers W14 and W15, W22 and W23, W34 and W35, and W46 and W47 configure the voltage or current mode of operation for excitation channels 0 through 3, respectively.
- Jumpers W16 and W26, W24 and W25, W36 and W37, and W48 and W49 configure the level of excitation for excitation channels 0 through 3, respectively.
- Jumpers W1 and W2, W17 and W18, W27 and W28, and W39 and W40 configure the half-bridge completion network for channels 0 through 3, respectively.

SCXI Module Installation

The following figure shows how to remove the side plate of the SCXI chassis and install an SCXI module in the chassis.



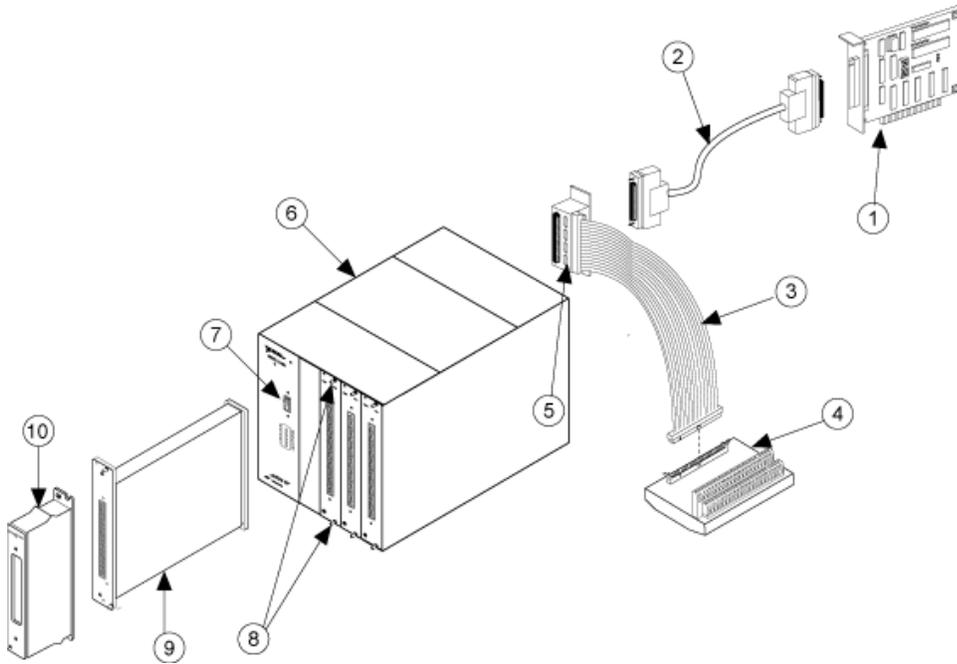
1 Thumbscrews

2 Slot 4

3 Side Plate

NI SCXI-1121 Calibration Setup

Calibration Setup The following figure shows how to set up the SCXI-1121 for calibration.



- 1 E Series DAQ Device
- 2 Sh68-68-EP Shielded Cable
- 3 50-Pin Ribbon Cable
- 4 Connector Block
- 5 SCXI-1349 Cable Adapter

- 6 SCXI Chassis
- 7 SCXI Chassis Power Switch
- 8 Thumbscrews
- 9 SCXI Module (DUT)
- 10 SCXI Terminal Block



Note The E Series DAQ device, the shielded cable, and the cable adapter **must** be connected to the SCXI module being calibrated.

NI SCXI-1121 Front Connector

The following figure shows the SCXI-1121 front connector pinout.

Front Connector Diagram	Pin Number	Column A	Column B	Column C

		Column						
		A	B	C				
32	○			○	32	CH 0 +	—	CH 0 -
31					31	—	—	—
30	○			○	30	EX 0 +	—	EX 0 +
29					29	—	—	—
28	○			○	28	E GND 0	—	NC
27					27	—	—	—
26	○			○	26	CH 1 +	—	CH 1 -
25					25	—	—	—
24	○			○	24	EX 1 +	—	EX 1 -
23					23	—	—	—
22	○			○	22	E GND 1	—	NC
21					21	—	—	—
20	○			○	20	CH 2 +	—	CH 2 -
19					19	—	—	—
18	○			○	18	EX 2 +	—	EX 2 -
17					17	—	—	—
16	○			○	16	E GND 2	—	NC
15					15	—	—	—
14	○			○	14	CH 3 +	—	CH 3 -
13					13	—	—	—
12	○			○	12	EX 3 +	—	EX 3 -
11					11	—	—	—
10	○			○	10	E GND 3	—	NC
9					9	—	—	—
8	○			○	8	NC	—	RSVD
7					7	—	—	—
6	○			○	6	SCAL	—	RSVD
5					5	—	—	—
4	○			○	4	+5V	—	M TEMP
3					3	—	—	—
2	○			○	2	C GND	—	D TEMP
1								

NC means no connection	2	C GND	—	D TEMP
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— means no physical pin	1	—	—	—
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NI SCXI-1124 Calibration Procedure

This topic contains information for calibrating the National Instruments SCXI-1124 using Calibration Executive.

Calibration Executive Procedure Features:

Adjustment ✓	Manual Mode ✓	Selectable Test Points ✗
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Approximate Test Time: 20 minutes

Test Equipment	Test Conditions	Device Setup	Troubleshooting Guidelines	Test Limit Equations
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Test Equipment

The following table lists the test equipment required to calibrate NI SCXI-1124 modules.

Instrument	Recommended Model	Requirements
DMM	NI 4070, Agilent 34401A	If one of these instruments is unavailable, use a multiranging 6 1/2 digit DMM that is accurate to at least 15 ppm.
NI E Series DAQ Device	NI 6030E, NI 6031E, NI 6032E, NI 6033E	—
SCXI Adapter	NI SCXI-1349	Adapter to connect SCXI systems to plug-in data acquisition devices.
Shielded DAQ Cable	NI Sh68-68-EP	Use with E Series devices.
Terminal Block	NI SCXI-1325	—

Resistor	—	Use an 290 Ω resistor that is accurate to $\pm 5\%$.
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Note The Calibration Executive procedure runs in [automated mode](#) if you use IVI-supported calibration standards.

Test Conditions

The following setup and environmental conditions are required to ensure the NI SCXI-1124 meets published specifications.

- Keep connections to the SCXI module as short as possible. Long cables and wires can act as antennae, which could pick up extra noise that would affect measurements.
- Use shielded copper wire for all cable connections to the module. Use twisted-pair wire to eliminate noise and thermal offsets.
- Maintain a temperature of 18 to 28 °C.
- Keep relative humidity below 80%.
- Allow a warm-up time of at least 30 minutes for the SCXI module and E Series DAQ device to ensure that the measurement circuitry is at a stable operating temperature.

Calibration Temperature Considerations

Temperature change affects an instrument's measurement characteristics. To take these changes into account, the tested specifications include the effects of temperature drift. For the NI SCXI-1124, valid temperature drift is ± 5 °C.

Device Setup

To set up the module for calibration, refer to [SCXI Module Installation](#) and [NI SCXI-1124 Calibration Setup](#) as you perform the following steps:

1. Install the NI SCXI-1124 in slot 4 of the SCXI chassis.
2. Install the E Series DAQ device in the host computer.

3. Connect a 68-to-68-pin cable between the SCXI module and the E Series DAQ device installed in the host computer through the SCXI-1349 cable adapter.



Caution The SCXI module **must** be cabled to the E Series DAQ device as described in this step. Otherwise, the calibration will fail.

4. Configure the hardware with Measurement & Automation Explorer (MAX) under Traditional NI-DAQ.

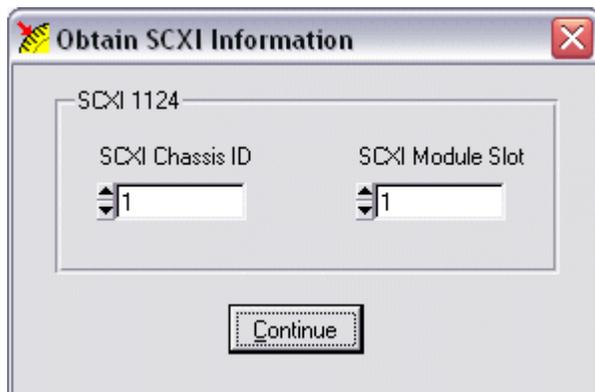
Connecting the DMM to the SCXI Module

Calibration Executive guides you through connections between the DMM and the SCXI module. However, the first steps are as follows:

1. Connect all GND inputs on each channel together.
2. Connect the LO voltage input of the DMM to any GND channel.
3. Connect the HI voltage input of the DMM to v_{OUT} on channel 0.
4. [Launch](#) the Calibration Executive procedure and complete the setup wizard.

Hardware Information

Calibration Executive displays the following dialog box, which prompts you to enter information about the installed hardware.



Item	Description
SCXI Chassis ID	The ID number that MAX assigns for the SCXI chassis
SCXI Module Slot	The SCXI slot where the NI SCXI-1124 is installed

Troubleshooting Guidelines

If the SCXI module is not recognized in MAX, make sure that you followed the configuration guidelines. If MAX fails to recognize the SCXI module after you reconfigure and refresh (<F5>), contact NI technical support.

The SCXI chassis power supply may be injecting noise into your measurement if the NI SCXI-1124 is installed in Slot 1 or 2 of the chassis.

If the NI SCXI-1124 module fails after calibration, try the following:

1. Check the connections and run the Calibration Executive procedure again.
2. If the calibration still fails after trying step 1, try inputting or outputting the failed Test Points using the Test Panel of the E Series DAQ device in MAX. For example, if the analog input (AI) failed at 0.98 V, input that value from the calibrator.
 1. Launch the test panel in MAX.
 2. Click the **Analog Input** tab.
 3. Set the **High Limit** to 1.00 V and set the **Low Limit** to -1.00 V for bipolar readings.
 4. Enter SC!MDx!y in the channel string field, where x is the slot in the SCXI chassis where the NI SCXI-1124 is installed, and y is the channel you are testing on the module.
 5. Check the Average Reading indicator.

If the Average Reading still fails after you complete steps 1 and 2, contact National Instruments for repair or replacement. If the Average Reading passes, you can change the calibration report to indicate the passing value.



Note If you have Microsoft Access 2000 or later, you can also modify the database containing the test results. By default, this database is located in \Calibration Executive\Dat abases\Calibration Reports.mdb.



Note If the NI SCXI-1124 module fails after calibration, return it to National Instruments for repair or replacement.

Test Limit Equations

The following test limits are derived from published specifications.

DC Voltage

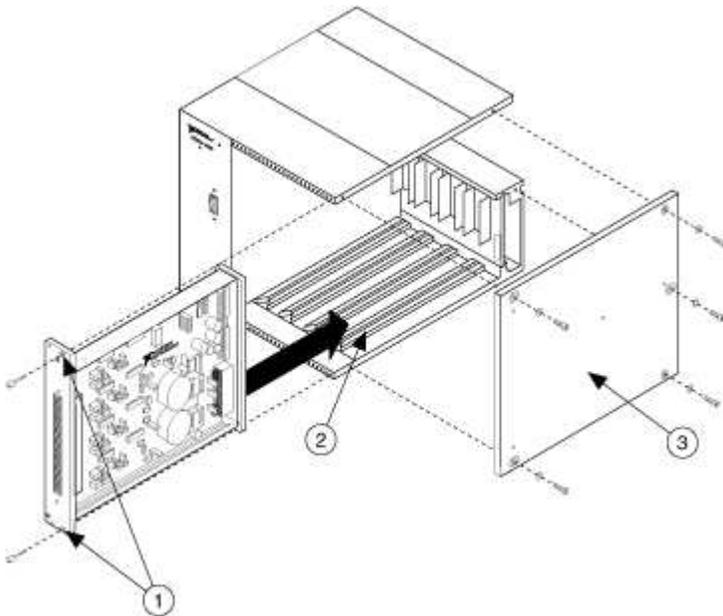
TestLimits = TestValue \pm [abs(TestValue) * 0.05% of full scale range]

DC Current

TestLimits = TestValue \pm [abs(TestValue) * 0.1% of full scale range]

SCXI Module Installation

The following figure shows how to remove the side plate of the SCXI chassis and install an SCXI module in the chassis.



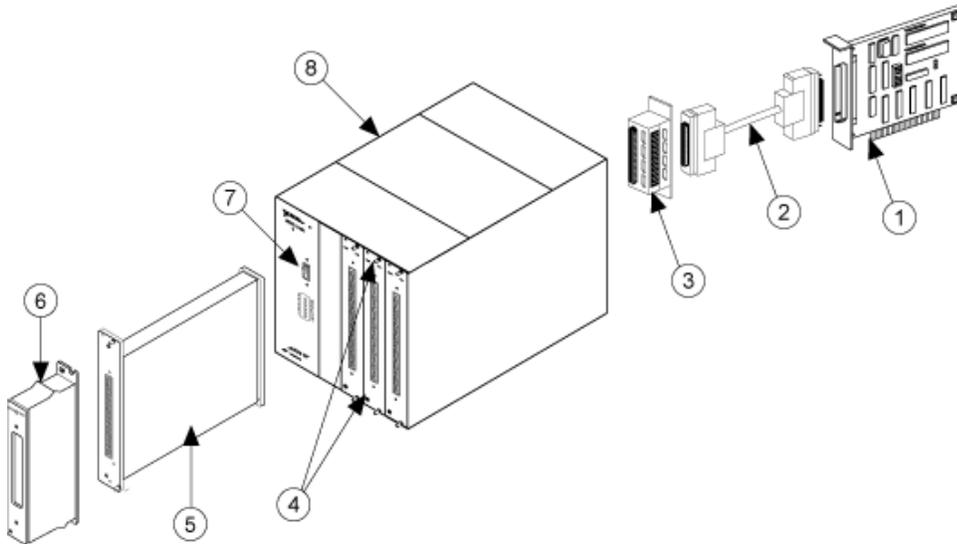
1 Thumbscrews

2 Slot 4

3 Side Plate

NI SCXI-1124 Calibration Setup

The following figure shows how to set up the SCXI-1124 for calibration.



1 E Series DAQ Device

2 Sh68-68-EP Shielded Cable

3 SCXI-1349 Cable Adapter

4 Thumbscrews

5 SCXI Module (DUT)

6 SCXI Terminal Block

7 SCXI Chassis Power Switch

8 SCXI Chassis

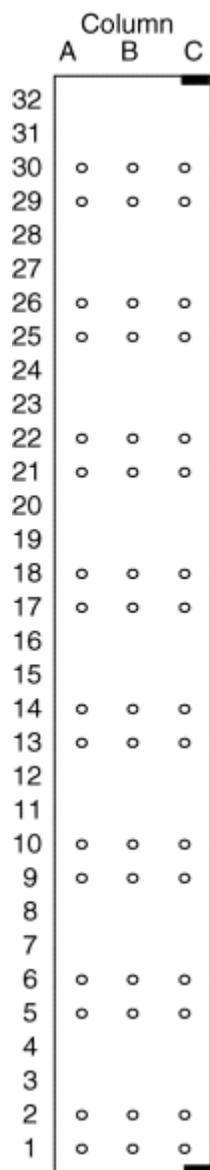


Note The E Series DAQ device, the shielded cable, and the cable adapter **must** be connected to the SCXI module being calibrated.

NI SCXI-1124 Front Connector

The following figure shows the SCXI-1124 front connector pinout.

Front Connector Diagram	Pin Number	Column A	Column B	Column C



32	NP	NP	NP
31	NP	NP	NP
30	SUPPLY 0	I SINK 0	NC
29	V OUT 0	GND 0	NC
28	NP	NP	NP
27	NP	NP	NP
26	SUPPLY 1	I SINK 1	NC
25	V OUT 1	GND 1	NC
24	NP	NP	NP
23	NP	NP	NP
22	SUPPLY 2	I SINK 2	NC
21	V OUT 2	GND 2	NC-
20	NP	NP	NP
19	NP	NP	NP
18	SUPPLY 3	I SINK 3	NC
17	V OUT 3	GND 3	NC
16	NP	NP	NP
15	NP	NP	NP
14	SUPPLY 4	I SINK 4	NC
13	V OUT 4	GND 4	NC
12	NP	NP	NP
11	NP	NP	NP
10	SUPPLY 5	I SINK 5	NC
9	V OUT 5	GND 5	NC
8	NP	NP	NP
7	NP	NP	NP
6	NC	NC	NC
5	NC	NC	NC
4	NP	NP	NP
3	NP	NP	NP
2	NC	NC	NC
1	NC	NC	NC

NC means no connection

NP means no physical pin	1	NC	NC	CHS GND
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