CALIBRATION PROCEDURE

# PXIe-5840

## Reconfigurable 6 GHz RF Vector Signal Transceiver with 1 GHz Bandwidth

This document contains the verification procedures for the PXIe-5840 vector signal transceiver.

Refer to *ni.com/calibration* for more information about calibration solutions.

# Contents



# Required Software

Calibrating the PXIe-5840 requires you to install the following software on the calibration system:

- LabVIEW 2016 SP1 Base/Full/Pro or later
- NI-RFSA 16.0.3 or later
- NI-RFSG 16.0.3 or later

- Modulation Toolkit 4.3.3 or later
- Spectral Measurements Toolkit 2.6.3 or later

You can download all required software from *ni.com/downloads*.

# Related Documentation

For additional information, refer to the following documents as you perform the calibration procedure:

- *PXIe-5840 Getting Started Guide*
- *NI RF Vector Signal Transceivers Help*
- *PXIe-5840 Specifications*
- *NI RF Signal Generators Help*

Visit *ni.com/manuals* for the latest versions of these documents.

# Test Equipment

Table 1 lists the equipment NI recommends for the performance verification procedures.

If the recommended equipment is not available, select a substitute using the minimum requirements listed in the table.

**Table 1.** Required Equipment Specifications for PXIe-5840 Calibration

| Equipment | Recommended Model | Where Used | Minimum Requirements |
|---|---|---|---|
| Frequency reference | Symmetricom 8040 Rubidium Frequency Standard | Verifications:<br>• Internal frequency reference<br>• Spectral purity | Frequency: 10 MHz<br>Frequency accuracy: ≤±1E-9<br>Output mode: sinusoid |
| Power sensor | Rohde & Schwarz NRP-Z91 | Test system characterization<br>Verifications:<br>• Absolute amplitude accuracy<br>• Frequency response<br>• Output power level accuracy<br>• LO OUT (RF IN 0 and RF OUT 0) | Range: -60 dBm to +20 dBm<br>Frequency range: 10 MHz to 6 GHz<br>Absolute uncertainty: 0.15 dB<br>Power linearity: <0.17 dB<br>VSWR: <1.22:1 up to 6 GHz |
| Vector signal generator | PXIe-5673E | Test system characterization<br>Verifications:<br>Internal frequency reference | Frequency range: 50 MHz to 6.5 GHz<br>Frequency resolution: <5 Hz<br>Amplitude range: -50 dBm to 5 dBm<br>Instantaneous bandwidth: 50 MHz |

**Table 1.** Required Equipment Specifications for PXIe-5840 Calibration (Continued)

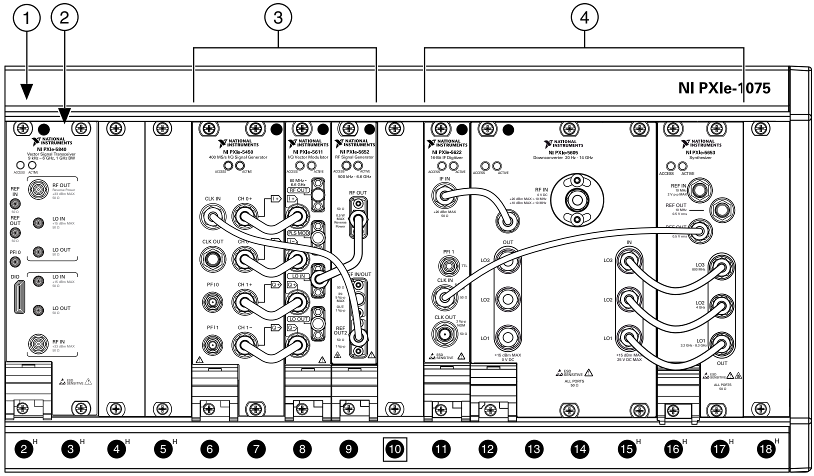
| Equipment | Recommended Model | Where Used | Minimum Requirements |
|---|---|---|---|
| Spectrum analyzer or vector signal analyzer | PXIe-5665 | Test system characterization<br>Verifications:<br>• Spectral purity<br>• Output power level accuracy<br>• Output frequency response | Frequency range: 10 MHz to 6.5 GHz<br>Instantaneous bandwidth: 50 MHz<br>Phase noise at 20 kHz offset: <-125 dBm/Hz |
| Power splitter | Aeroflex/Weinschel 1593 | Test system characterization<br>Verifications:<br>• Frequency response<br>• Absolute amplitude accuracy<br>• Output power level accuracy | VSWR: ≤1.25:1 up to 18 GHz<br>Amplitude tracking: <0.25 dB |
| 6 dB attenuator (x2) | Anritsu 41KB-6 or Mini-Circuits | Test system characterization<br>Verifications:<br>• Frequency response<br>• Absolute amplitude accuracy<br>• Output power level accuracy | Frequency range: DC to 6 GHz<br>VSWR: ≤1.1:1 |

**Table 1.** Required Equipment Specifications for PXIe-5840 Calibration (Continued)

| Equipment | Recommended Model | Where Used | Minimum Requirements |
|---|---|---|---|
| 50 Ω SMA terminator | — | Test system characterization<br>Average noise density verification | Frequency range: DC to 6 GHz<br>VSWR: ≤1.1:1 |
| SMA (m)-to-SMA (m) cable | — | All procedures | Frequency range: DC to 6 GHz<br>Impedance: 50 Ω |
| SMA (f)-to- N (f) adapter | Huber+Suhner 31_N-SMA-50-1/1-_UE | Test system characterization | Frequency range: DC to 6 GHz<br>Impedance: 50 Ω<br>Return loss: ≥23 dB |
| 3.5 mm (m)-to-3.5 mm (m) adapter | Huber+Suhner 32_PC35-50-0-2/199_NE | Test system characterization<br>Verifications:<br>• Frequency response<br>• Absolute amplitude accuracy<br>• Output power level accuracy | Frequency range: DC to 6 GHz<br>Impedance: 50 Ω<br>Return loss: ≥30 dB |
| 3.5 mm (f)-to-3.5 mm (f) adapter | Huber+Suhner 32_PC35-50-0-1/199_UE | Test system characterization | Frequency range: DC to 6 GHz<br>Impedance: 50 Ω<br>Return loss: ≥30 dB |

The following figure shows a recommended calibration system configuration for the PXIe-5840.

**Figure 1.** Recommended PXIe-5840 Calibration System




1. PXIe-1075 Chassis
2. Slot 2: PXIe-5840 (Device Under Test)
3. Slot 6: PXIe-5673E Vector Signal Generator
4. Slot 11: PXIe-5665 Vector Signal Analyzer

# Test Conditions

The following setup and environmental conditions are required to ensure the PXIe-5840 meets published specifications.

- Keep cabling as short as possible. Long cables act as antennas, picking up extra noise that can affect measurements.
- Verify that all connections to the PXIe-5840, including front panel connections and screws, are secure.
- Maintain an ambient temperature of 23 °C ± 5 °C.
- Keep relative humidity between 10% and 90%, noncondensing.
- Allow a warm-up time of at least 30 minutes after the chassis is powered on and the NI-RFSA/G Instrument Design Libraries is loaded and recognizes the PXIe-5840. The warm-up time ensures that the PXIe-5840 and test instrumentation are at a stable operating temperature.
- In each verification procedure, insert a delay between configuring all instruments and acquiring the measurement. This delay may need to be adjusted depending on the instruments used but should always be at least 1,000 ms for the first iteration, 1,000 ms when the power level changes, and 100 ms for each other iteration.
- Ensure that the PXI chassis fan speed is set to HIGH, that the fan filters, if present, are clean, and that the empty slots contain filler panels. For more information about cooling, refer to the *Maintain Forced-Air Cooling Note to Users* document available at *ni.com/manuals*.

# Initial Setup

Refer to the *PXIe-5840 Getting Started Guide* for information about how to install the software and the hardware and how to configure the device in Measurement & Automation Explorer (MAX).

# Test System Characterization

The following procedures characterize the test equipment used during verification.

**Caution** The connectors on the device under test (DUT) and test equipment are fragile. Perform the steps in these procedures with great care to prevent damaging any DUTs or test equipment.

## Zeroing the Power Sensor

1. Ensure that the power sensor is not connected to any signals.
2. Zero the power sensor using the built-in function, according to the power sensor documentation.

## Characterizing Power Splitter Balance

You must zero the power sensor as described in the *Zeroing the Power Sensor* section prior to starting this procedure.

This procedure characterizes the balance between the two output terminals of the splitter, where the second terminal is terminated into an attenuator. The following procedures require the power splitter balance data:

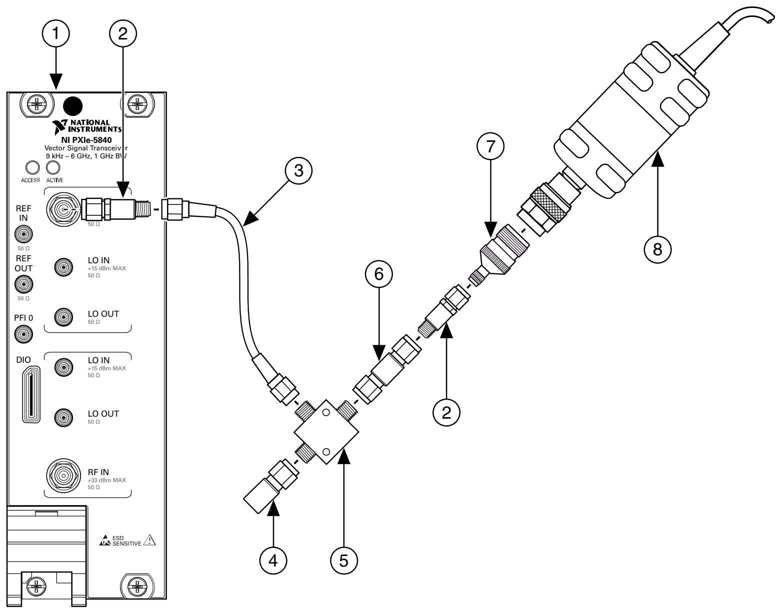
- *Verifying Input Absolute Amplitude Accuracy*
- *Verifying Input Frequency Response*

For characterization used in a verification procedure, use the test points in the *Characterization Test Points for Verification Procedures* table.

1. Connect the SMA (m) connector of the 6 dB attenuator to the RF OUT front panel connector of the PXIe-5840.
2. Connect the SMA (f) connector of the 6 dB attenuator to the input port of the power splitter using an SMA (m)-to-SMA (m) cable.
3. Connect the 50 Ω (m) terminator to one of the power splitter output ports. Refer to this port as *splitter output 1*.
4. Connect the other power splitter output to the SMA (f) connector of the second 6 dB attenuator using a 3.5 mm (m)-to-3.5 mm (m) adapter. Refer to the combined power splitter output and 6 dB attenuator as *splitter output 2*.
5. Connect the power sensor to splitter output 2 using the SMA (f)-to-N (f) adapter.

   The following figure illustrates the hardware setup.

**Figure 2.** Connection Diagram for Measuring at Splitter Output 2




1. PXIe-5840
2. 6 dB Attenuator
3. SMA (m)-to-SMA (m) Cable
4. 50 Ω Terminator
5. Power Splitter
6. 3.5 mm (m)-to-3.5 mm (m) Adapter
7. SMA (f)-to-N (f) Adapter
8. Power Sensor

6. Configure the PXIe-5840 to generate a tone using the following settings:
   - Center frequency: For characterization used in a verification procedure, use the first test point in the following *Characterization Test Points for Verification Procedures* table. Store as *frequency*.
   - Power level: 0 dBm

**Table 2.** Characterization Test Points for Verification Procedures

| **Test Points (MHz)** | **Step Size (MHz)** |
|---|---|
| 10 to 150 | 5 |
| 150 to 5,990 | 50 |

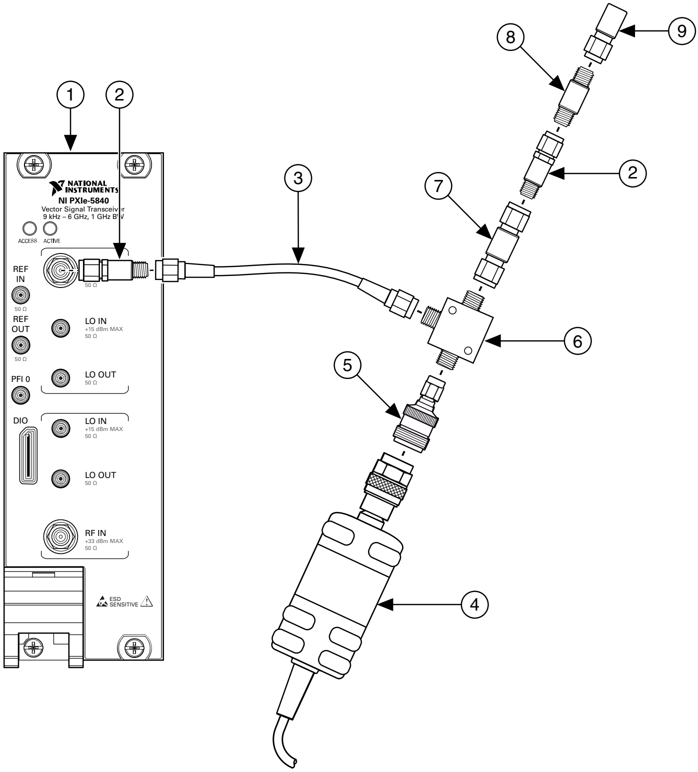
7. Configure the power sensor to correct for *frequency* using the power sensor frequency correction function.
8. Use the power sensor to measure the power at the *frequency* from step 6.
9. Repeat steps 6 through 8 by updating *frequency*. For characterization used in a verification procedure, use the test points in the *Characterization Test Points for Verification Procedures* table.

Record the resulting measurements as *splitter output 2 power*. Each frequency should have a corresponding value.

10. Disconnect the power sensor and 50 Ω terminator from the power splitter.
11. Connect the power sensor to splitter output 1 using an SMA (m)-to-N (f) adapter.
12. Connect the 50 Ω terminator to splitter output 2 using an SMA (f)-to-SMA (f) adapter.

The following figure illustrates the hardware setup.

**Figure 3.** Connection Diagram for Measuring at Splitter Output 1




1. PXIe-5840
2. 6 dB Attenuator
3. SMA (m)-to-SMA (m) Cable
4. Power Sensor
5. SMA (m)-to-N (f) Adapter
6. Power Splitter
7. 3.5 mm (m)-to-3.5 mm (m) Adapter
8. 3.5 mm (f)-to-3.5 mm (f) Adapter
9. 50 Ω Terminator

13. Configure the PXIe-5840 using the following settings:
    - Center frequency: For characterization used in a verification procedure, use the test points in the *Characterization Test Points for Verification Procedures* table. Store as *frequency*.
    - Power level: 0 dBm

14. Configure the power sensor to correct for *frequency* using the power sensor frequency correction function.
15. Use the power sensor to measure the power.
16. Repeat steps 13 through 15 by updating *frequency*. For characterization used in a verification procedure, use the test points in the *Characterization Test Points for Verification Procedures* table.

    Record the resulting measurements as *splitter output 1 power*. Each frequency should have a corresponding value.
17. Calculate the splitter balance for each frequency point using the following equation:

    *splitter balance = splitter output 2 power - splitter output 1 power*

# Characterizing Power Splitter Loss

This procedure characterizes the loss through the power splitter.

You must zero the power sensor as described in the *Zeroing the Power Sensor* section prior to starting this procedure.

The following procedures require the power splitter loss data:

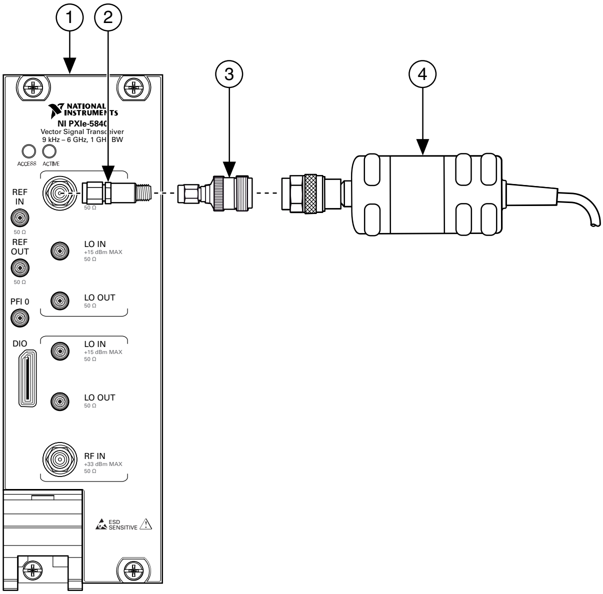
- *Verifying Output Power Level Accuracy*
- *Verifying Output Frequency Response*

For characterization used in a verification procedure, use the test points in the *Characterization Test Points for Verification Procedures* table.

1. Connect the SMA (m) connector of the 6 dB attenuator to the RF OUT front panel connector of the vector signal generator.
2. Connect the SMA (f) connector of the 6 dB attenuator to the power sensor using an SMA (m)-to-N (f) adapter.

   The following figure illustrates the hardware setup.

**Figure 4.** Connection Diagram for Measuring Splitter Input Power




1. PXIe-5840
2. 6 dB Attenuator
3. SMA (m)-to-N (f) Adapter
4. Power Sensor

3. Configure the PXIe-5840 to generate a tone using the following settings:
   - Center frequency: For characterization used in a verification procedure, use the first test point in the *Characterization Test Points for Verification Procedures* table.
   - Power level: Configured output power from transfer function A in the following table.
   - Tone offset: 3.75 MHz

**Table 3.** Accuracy Transfer Definitions

| Transfer Function | Supported Output Power Level (dBm) | Configured Output Power (dBm) | Configured Reference Level (dBm) |
|---|---|---|---|
| A | +15 to 0 | 0 | 10 |
| B | <0 to -50 | -10 | -20 |

4. Configure the power sensor to correct for the center frequency from step 3 using the power sensor frequency correction function.
5. Use the power sensor to measure the output power.
6. Repeat steps 3 through 5 for the remaining frequencies. For characterization used in a verification procedure, use the test points in the *Characterization Test Points for Verification Procedures* table.

Record the resulting measurements as *splitter input power*. Each frequency should have a corresponding value.

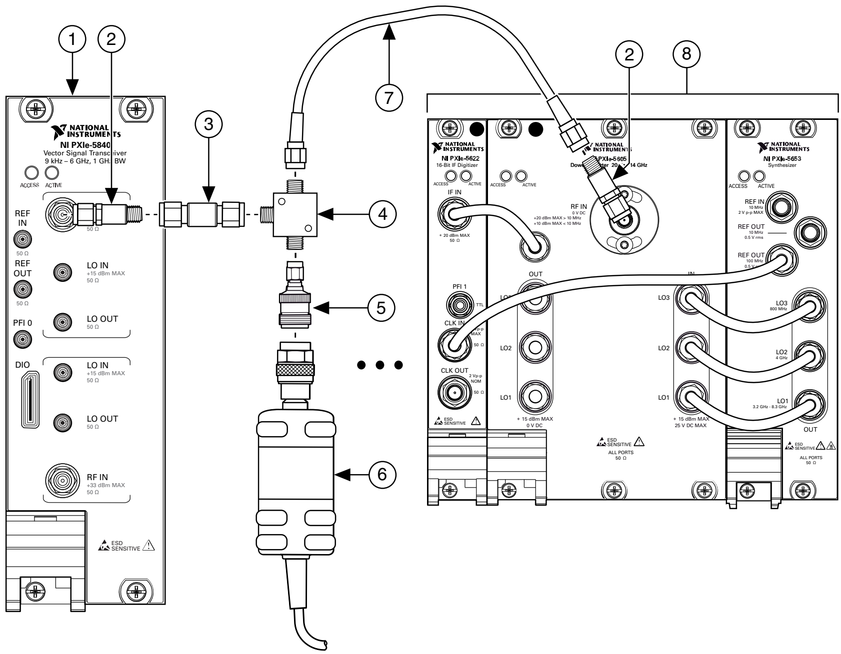
7. Disconnect the power sensor from the 6 dB attenuator.
8. Connect the power splitter input port to the SMA (f) port of the 6 dB attenuator using an SMA (m)-to-SMA (m) adapter.
9. Connect the power sensor to one of the splitter output ports using the SMA (m)-to-N (f) adapter.

   Refer to this port as *splitter output 1* for the remainder of this procedure and all tests that use the resulting characterization data.
10. Connect the other output of the power splitter to the SMA (f) connector of a second 6 dB attenuator using an SMA (m)-to-SMA (m) cable.
11. Connect the SMA (m) connector of the second 6 dB attenuator to the RF IN front panel port of the spectrum analyzer.

    Refer to this port as *splitter output 2* for the remainder of this procedure and all tests that use the resulting characterization data.

    The following figure illustrates the hardware setup.

**Figure 5.** Connection Diagram for Measuring Splitter Output 1 Power




| | |
|---|---|
| 1. PXIe-5840 | 5. SMA (m)-to-N (f) Adapter |
| 2. 6 dB Attenuator | 6. Power Sensor |
| 3. SMA (m)-to-SMA (m) Adapter | 7. SMA (m)-to-SMA (m) Cable |
| 4. Power Splitter | 8. Spectrum Analyzer |

**Note** If you use the PXIe-5665, as recommended, for the spectrum analyzer, disable the preamplifier and preselector options and set the FFT window type to Flat Top.

12. Configure the PXIe-5840 to generate a tone using the following settings:
    - Center frequency: *Center frequency* from step 3.
    - Power level: *Configured output power* from transfer function A in the *Accuracy Transfer Definitions* table.
13. Configure the spectrum analyzer using the following settings:
    - Center frequency: Center frequency of the PXIe-5840 from step 3 + *tone offset* from step 3.
    - Reference level: *Configured reference level* from transfer function A in the *Accuracy Transfer Definitions* table.
    - Span: 250 kHz
    - Resolution bandwidth: 4 kHz
    - Averaging mode: RMS
    - Number of averages: 10

14. Use the spectrum analyzer to acquire the signal.
15. Measure the peak output power present in the signal from step 14. Store this value as *splitter output 2 power*.
16. Configure the power sensor to correct for the frequency from step 12 using the power sensor frequency correction function.
17. Use the power sensor to measure the output power. Store this value as *splitter output 1 power*.
18. Repeat steps 12 through 17 for the remaining frequencies. For characterization used in a verification procedure, use the test points in the *Characterization Test Points for Verification Procedures* table.
19. Repeat steps 12 through 18 for transfer function B from the *Accuracy Transfer Definitions* table.
20. Repeat steps 12 through 18 for transfer function C from the *Accuracy Transfer Definitions* table.
21. Calculate a table of splitter loss values for each frequency of each transfer function using the following equation:

    *splitter loss = splitter output 1 power - splitter input power*

    Store the results in a *Splitter Loss* table.
22. Calculate the accuracy transfer result for each frequency of each transfer function using the following equation:

    *accuracy transfer result = splitter output 1 - splitter output 2*

    Store the results in an *RF Output Transfer Result* table.

# Self-Calibrating the PXIe-5840

Allow a 30-minute warm-up time before you begin self-calibration.

**Note** The warm-up time begins after the PXI Express chassis is powered on and the operating system completely loads.

The PXIe-5840 includes precise internal circuits and references used during self-calibration to adjust for any errors caused by short-term fluctuations in the environment. You must call the self-calibration function to validate the specifications in the *Verification* section.

1. Perform self-calibration using the NI-RFSA or NI-RFSG installed Self Calibrate VI. Open one of the following self-calibration tools:
    - Add the niRFSG Self Cal VI, located on the **Functions»Measurement I/O»NI-RFSG»Calibration»Self Calibration** palette, to a block diagram. You must call the niRFSG Initialize.VI before and niRFSG Close.VI after the niRFSG Self Cal VI.
    - Add the niRFSA Self Cal VI, located on the **Functions»Measurement I/O»NI-RFSA»Calibration** palette, to a block diagram. You must call the niRFSA Initialize.VI before and niRFSA Close.VI after the niRFSA Self Cal VI.
2. Run the self-calibration VI.

# As-Found and As-Left Limits

The as-found limits are the published specifications for the PXIe-5840. NI uses these limits to determine whether the PXIe-5840 meets the specifications when it is received for calibration.

The as-left calibration limits are equal to the published NI specifications for the PXIe-5840, less guard bands for measurement uncertainty, temperature drift, and drift over time. NI uses these limits to determine whether the PXIe-5840 meets the device specifications over its calibration interval.

# Verification

The performance verification procedures assume that adequate traceable uncertainties are available for the calibration references.

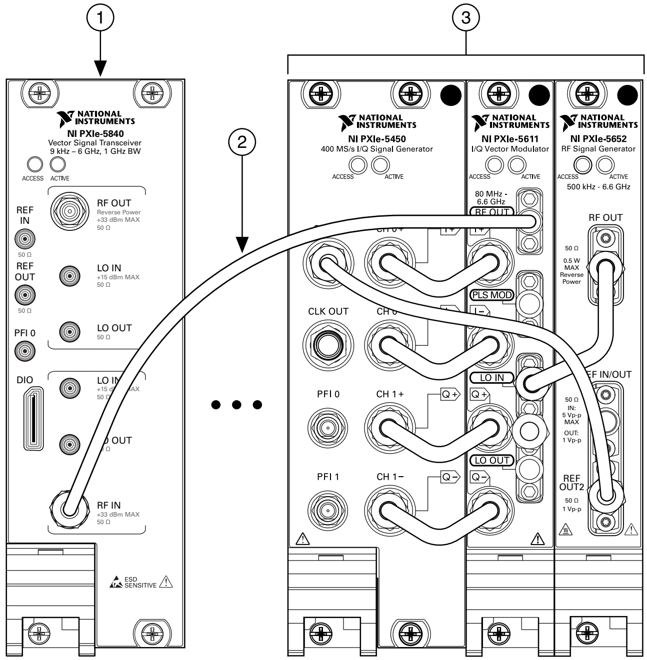
## Verifying Internal Frequency Reference

This procedure verifies the frequency accuracy of the PXIe-5840 onboard frequency reference using a vector signal generator.

1. Connect the vector signal generator RF OUT front panel connector to the PXIe-5840 RF IN front panel connector.

   The following figure illustrates the hardware setup.

**Figure 6.** Internal Frequency Reference Verification Cabling Diagram




1. PXIe-5840
2. SMA (m)-to-SMA (m) Cable
3. Vector Signal Generator

2. Connect an available 10 MHz rubidium frequency reference output to the vector signal generator REF IN front panel connector.
3. Configure the signal generator to generate a 2.22 GHz signal with a 0 dBm average output power, using the following settings:
   - Center frequency: 2.22 GHz
   - Output power: 0 dBm
   - Reference Clock source: External
4. Configure the PXIe-5840 to acquire and measure the signal generated in step 3, using the following settings:
   - Center frequency: 2.22 GHz
   - Reference level: +10 dBm
   - Resolution bandwidth: 100 Hz
   - Span: 100 kHz
   - FFT window: Hanning
   - Averaging type: RMS
   - Number of averages: 20
   - Reference Clock source: Onboard

5. Measure the frequency of the peak acquired tone.
6. Calculate the deviation using the following equation:

$$\Delta f = \left| \frac{f_{measured}\text{GHz} - 2.2\text{GHz}}{2.2\text{GHz}} \right|$$

7. The result in step 6 should be less than the result of the following equation:

   *initial accuracy* + *aging* + *temperature stability*
   where
   
   *initial accuracy* = ±200 * $10^{-9}$
   *aging* = ±1 * $10^{-6}$ */year* * *number of years since last adjustment*
   *temperature stability* = ±1 * $10^{-6}$

   **Note** You can determine number of years since last adjustment programmatically using the NI-RFSA or NI-RFSG driver APIs.

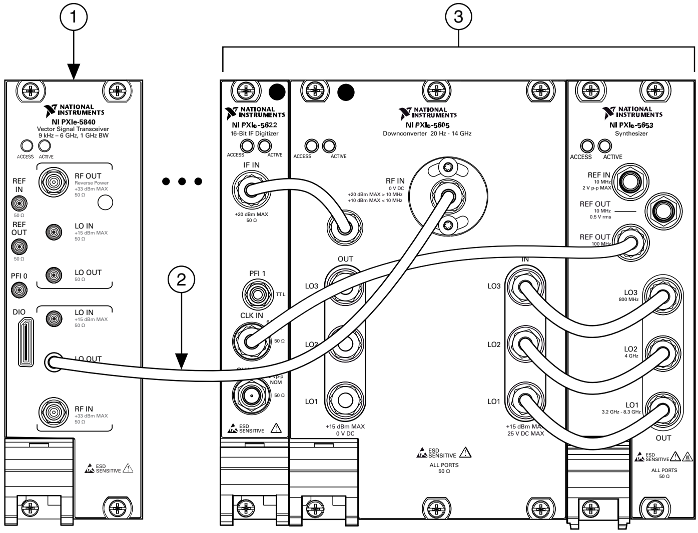
# Verifying RF Input Spectral Purity

This procedure verifies the RF input spectral purity of the PXIe-5840.

1. Connect the PXIe-5840 LO OUT (RF IN) front panel connector to the RF IN front panel connector of the spectrum analyzer.

   The following figure illustrates the hardware setup.

**Figure 7.** RF Input Spectral Purity Verification Cabling Diagram




1. PXIe-5840
2. MMPX (m)-to-SMA (m) Cable
3. Spectrum Analyzer

2. Connect an available 10 MHz rubidium frequency reference output to the PXIe-5840 REF IN front panel connector.
3. Connect the same 10 MHz rubidium frequency reference output to the spectrum analyzer REF IN front panel connector.
4. Configure the PXIe-5840 to export the LO using the following settings:
   - Center frequency: 900 MHz
   - LO OUT: Enabled
   - Reference Clock source: REF IN
5. Configure the spectrum analyzer to acquire a spectrum using the following settings:
   - Center frequency: 900 MHz
   - Reference level: 0 dBm
   - Span: 100 Hz
   - Resolution bandwidth: 10 Hz
   - Reference Clock source: External
   - Averaging type: RMS
   - Number of averages: 20
6. Measure the peak power at the center frequency.

   The measured value is the power, in dBm, of the generated tone.

7. Configure the spectrum analyzer to acquire a spectrum using the following settings:
   - Center frequency: *Center frequency* from step 4 + 20 kHz
   - Reference level: 0 dBm
   - Span: 100 Hz
   - Resolution bandwidth (RBW): 10 Hz
   - Reference Clock source: External
   - Averaging type: RMS
   - Number of averages: 20
8. Measure the power at a 20 kHz offset by averaging all measurements across the 100 Hz span.

   The result of this step is in dBm/Hz.
9. Calculate the relative difference between the signal and noise using the following equation:

   *SSB Phase Noise at 20 kHz* (dBc/Hz) = *step 8 measurement* (dBc/Hz) - *step 6 measurement* (dBm)

   The result of this step is in dBc/Hz.
10. Compare the results of step 9 to the specified limits in the following table.

**Table 4.** SSB Phase Noise at 20 kHz Offset

| Frequency | As-Found Limit (dBc/Hz) | As-Left Limit (dBc/Hz) |
|---|---|---|
| <3 GHz | -102 | -102 |
| 3 GHz to 4 GHz | -102 | -102 |
| >4 GHz to 6 GHz | -96 | -96 |

11. Repeat steps 4 through 10 for the center frequencies listed in the following table.

**Table 5.** Spectral Purity Test Points

| Center Frequency (MHz) | Step Size (MHz) |
|---|---|
| 900 | — |
| 2,400 | — |
| 3,300 to 3,500 | 100 |
| 4,100 to 4,300 | 100 |
| 4,700 to 4,900 | 100 |
| 5,700 to 5,900 | 100 |

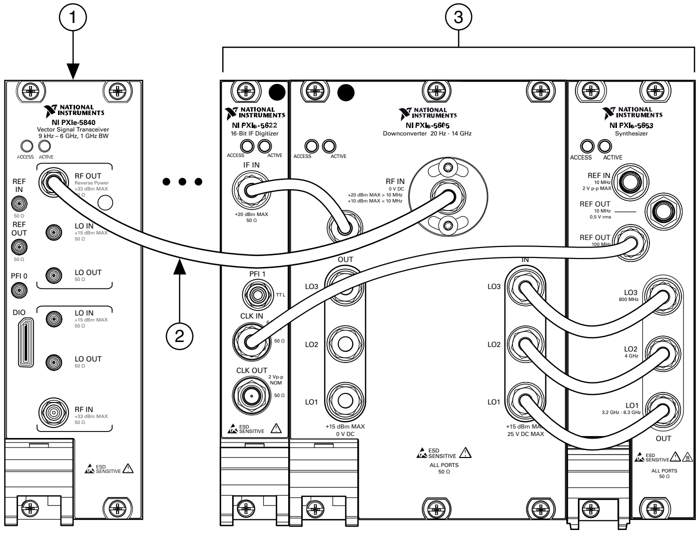
# Verifying RF Output Spectral Purity

This procedure verifies the RF output spectral purity of the PXIe-5840.

1. Connect the PXIe-5840 RF OUT front panel connector to the RF IN front panel connector of the spectrum analyzer.

The following figure illustrates the hardware setup.

**Figure 8.** RF Output Spectral Purity Verification Cabling Diagram




1. PXIe-5840
2. SMA (m)-to-SMA (m) Cable
3. Spectrum Analyzer

2. Connect an available 10 MHz rubidium frequency reference output to the PXIe-5840 REF IN front panel connector.
3. Connect the same 10 MHz rubidium frequency reference output to the spectrum analyzer REF IN front panel connector.
4. Configure the PXIe-5840 to generate an offset CW tone using the following settings:
   - Center frequency: 1 GHz
   - Output power: 0 dBm
   - Tone offset: 3.75 MHz
   - I/Q rate: 10 MS/s
   - Fractional mode: Enabled
   - Step size: 200 kHz
   - Reference Clock source: REF IN
5. Configure the spectrum analyzer to acquire a spectrum using the following settings:
   - Center frequency: 1 GHz + 3.75 MHz
   - Reference level: 0 dBm
   - Span: 100 Hz
   - Resolution bandwidth: 10 Hz
   - Reference Clock source: External

- Averaging type: RMS
- Number of averages: 20

6. Measure the peak power at the center frequency.

   The measured power should match the power, in dBm, of the generated tone.

7. Configure the spectrum analyzer to acquire a spectrum using the following settings:
   - Center frequency: *Center frequency* from step 5 + 20 kHz
   - Reference level: 0 dBm
   - Span: 100 Hz
   - Resolution bandwidth: 10 Hz
   - Reference Clock source: External
   - Averaging type: RMS
   - Number of averages: 20

8. Measure the power at a 20 kHz offset by averaging all measurements across the 100 Hz span. Normalize the result to 1 Hz bin width by subtracting 10 * log (RBW), where RBW is the setting specified in step 7.

   The result of this step is in dBm/Hz.

9. Calculate the relative difference between the signal and noise using the following equation:

   *SSB Phase Noise at 20 kHz* (dBm/Hz) = *step 8 measurement* (dBm/Hz) - *step 6 measurement* (dBm)

   The result of this step is in dBm/Hz.

10. Compare the results of step 9 to the specified limits in the following table.

**Table 6.** SSB Phase Noise at 20 kHz Offset

| Frequency | As-Found Limit (dBc/Hz) | As-Left Limit (dBc/Hz) |
|---|---|---|
| <3 GHz | -102 | -102 |
| 3 GHz to 4 GHz | -102 | -102 |
| >4 GHz to 6 GHz | -96 | -96 |

11. Repeat steps 4 through 10 for the following frequencies listed in the *Spectral Purity Test Points* table.

# Verifying Input Absolute Amplitude Accuracy

This procedure verifies the absolute amplitude accuracy of the PXIe-5840 input channels.

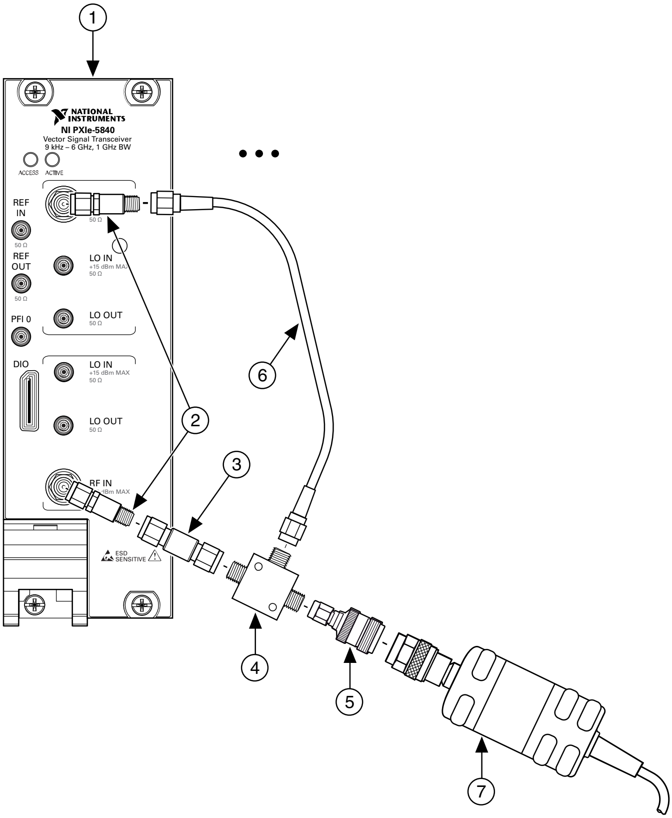
This procedure requires the same attenuator and splitter positioning as used during the *Test System Characterizations* procedures, as well as the data collected in the *Characterizing Power Splitter Balance* section. You must characterize the power splitter balance before running this procedure. Ensure you use the characterization data derived from test points in the *Characterization Test Points for Verification Procedures* table.

You must zero the power sensor as described in the *Zeroing the Power Sensor* section prior to starting this procedure.

1. Connect the vector signal generator RF OUT front panel connector to the input terminal of the power splitter using a 6 dB attenuator and a SMA (m)-to-SMA (m) cable.
2. Connect splitter output 1 directly to the power sensor input connector using the SMA (m)-to-N (f) adapter.
3. Connect splitter output 2 to the SMA (f) end of the 6 dB attenuator using a 3.5 mm (m)-to-3.5 mm (m) adapter.
4. Connect the remaining 6 dB attenuator SMA (m) connector directly to the PXIe-5840 RF IN front panel connector.

   The following figure illustrates the complete hardware setup.

**Figure 9.** Input Absolute Amplitude Accuracy Verification Cabling Diagram




1. PXIe-5840
2. 6 dB Attenuator
3. 3.5 mm (m)-to-3.5 mm (m) Adapter
4. Power Splitter
5. SMA (m)-to-N (f) Adapter
6. SMA (m)-to-SMA (m) Cable
7. Power Sensor

5. Configure the PXIe-5840 to acquire a signal at 500 MHz, using the following settings:
   - Center frequency: 500 MHz
   - Reference level: 30 dBm

   **Note** Steps 6 through 10 create correction factors that transfer the accuracy of the power sensor to the vector signal generator. Record the results from these steps in a lookup table called *Accuracy Transfer Results*.

6. Configure the PXIe-5840 to generate a 20 MHz tone, using the following settings:
   - Center frequency: 16.25 MHz
   - Tone offset: 3.75 MHz
   - I/Q rate: 10 MS/s
   - Output power: *Configured output power* from transfer row A in the following table.

**Table 7.** RF Input Accuracy Transfers

| Transfer | Supported Reference Levels (dBm) | Configured Output Power (dBm) | Start Frequency (MHz) | Stop Frequency (MHz) | Frequency Step Size (MHz) |
|---|---|---|---|---|---|
| A | 30 to -10 | 0 | 16.25 | 111.25 | 5 |
| | | | 146.25 | 946.25 | 50 |
| | | | 996.25 | 5,996.25 | 200 |
| B | <-10 to -30 | -20 | 16.25 | 111.25 | 5 |
| | | | 146.25 | 946.25 | 50 |
| | | | 996.25 | 5,996.25 | 200 |

7. Configure the power sensor to correct for the (*center frequency* + *tone offset*) from step 6 using the power sensor frequency correction function.
8. Measure the power of the signal present at the reference output of the power splitter using the power sensor.

   Record the results from this step as *accuracy transfer result*.
9. Repeat steps 6 through 8 for the remaining frequencies listed in transfer row A in the previous table.
10. Repeat steps 6 through 9 for transfer row B in the previous table. Create a table and include a value for each test point, *transfer* versus *frequency*.
11. Configure the PXIe-5840 to acquire a signal at 20 MHz, using the following settings:
    - Center frequency: 16.25 MHz
    - Preamp: Automatic
    - Reference level: 30 dBm
    - Span: 10 MHz
    - Resolution bandwidth: 1 kHz
    - Averaging type: RMS
    - Number of averages: 10
    - FFT window: Flat Top
12. Configure the PXIe-5840 to generate a signal at the *center frequency* specified in step 11, using the following settings:
    - Center frequency: *Center frequency* from step 11
    - Tone offset: 3.75 MHz
    - Power level: *Configured output power* from the transfer row in the previous table that supports the *reference level* from step 11.
    - I/Q rate: 10 MS/s
    - Prefilter gain: -3 dB
    - Digital gain: (*reference level* from step 11 - *power level* from step 12) or 0 dB, whichever is less.
13. Calculate the *transfer input power* using the following equation:

*transfer input power* = *accuracy transfer result* + *digital gain* from step 12

**Note** Determine the *accuracy transfer result* by interpolating between the data points in the *Accuracy Transfer Results* table.

14. Calculate the *corrected input power* using the following equation:

    *corrected input power* = *transferred input power* + *splitter balance*

    **Note** Determine the *splitter balance* by interpolating between data points derived using test points in the *Characterization Test Points for Verification Procedures* table.

15. Configure the PXIe-5840 using the settings from step 11, perform an acquisition, and measure the tone present at the offset of 3.75 MHz.

    Record this measurement as PXIe-5840 *input power*.

16. Repeat steps 11 through 16 for the remaining frequencies in the previous table.
17. Repeat steps 11 through 17 for the remaining reference levels from 30 dBm to -30 dBm in 10 dB increments.
18. Compare the *absolute amplitude accuracy* values measured to the verification test limits in the following table.

**Table 8.** Input Absolute Amplitude Accuracy Verification Test Limits

| Frequency | As-Found Limit (dB) | As-Left Limit (dB) |
|---|---|---|
| 10 MHz to <120 MHz | ±0.75 | ±0.55 |
| 120 MHz to 500 MHz | ±0.80 | ±0.65 |
| >500 MHz to 1.5 GHz | ±0.70 | ±0.55 |
| >1.5 GHz to 2.3 GHz | ±0.75 | ±0.60 |
| >2.3 GHz to 2.9 GHz | ±0.65 | ±0.50 |
| >2.9 GHz to 4.8 GHz | ±0.75 | ±0.55 |
| >4.8 GHz to 6 GHz | ±0.90 | ±0.60 |

# Verifying Input Frequency Response

This procedure verifies the frequency response of the PXIe-5840 input channels.

This procedure requires the same attenuator and splitter positioning as used during the *Test System Characterizations* procedures, as well as the data collected in the *Characterizing Power Splitter Balance* section. You must characterize the power splitter balance before running this procedure. Ensure you use the characterization data derived from test points in the *Characterization Test Points for Verification Procedures* table.

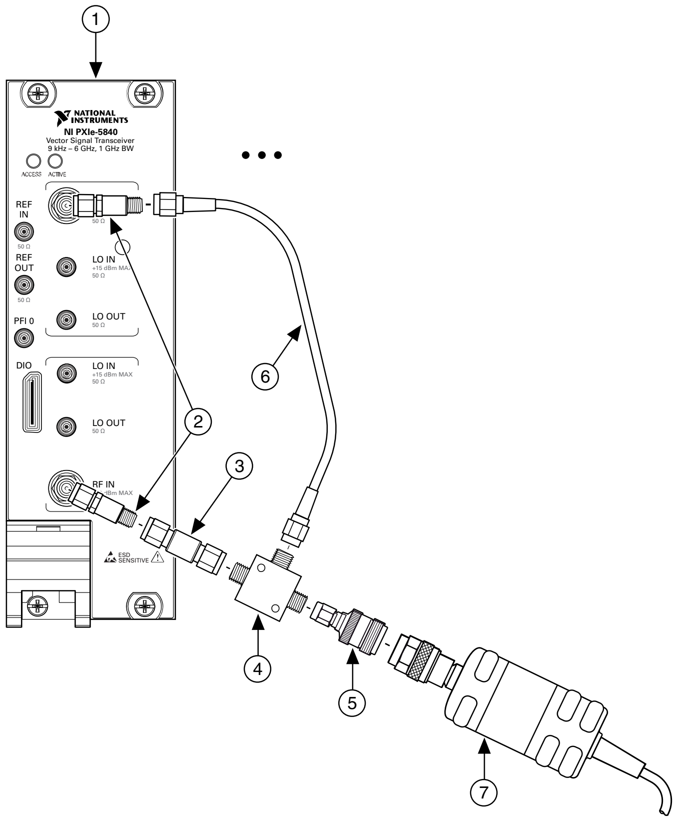
You must zero the power sensor as described in the *Zeroing the Power Sensor* section prior to starting this procedure.

1. Connect the vector signal generator RF OUT front panel connector to the input terminal of the power splitter using a 6 dB attenuator and an SMA (m)-to-SMA (m) cable.

2. Connect splitter output 1 directly to the power sensor input connector using the SMA (m)-to-N (f) adapter.
3. Connect splitter output 2 to the SMA (f) end of the 6 dB attenuator using a 3.5 mm (m)-to-3.5 mm (m) adapter.
4. Connect the remaining 6 dB attenuator SMA (m) connector directly to the PXIe-5840 RF IN front panel connector.

   The following figure illustrates the complete hardware setup.

**Figure 10.** Input Frequency Response Verification Cabling Diagram




1. PXIe-5840
2. 6 dB Attenuator
3. 3.5 mm (m)-to-3.5 mm (m) Adapter
4. Power Splitter
5. SMA (m)-to-N (f) Adapter
6. SMA (m)-to-SMA (m) Cable
7. Power Sensor

5. Configure the PXIe-5840 to acquire a signal using the following settings:
   - Center frequency: 500 MHz
   - Reference level: 30 dBm

**Note** Steps 6 through 11 create correction factors that transfer the accuracy of the power sensor to the vector signal generator. Record the results from these steps in a lookup table called *Accuracy Transfer Results*.

6. Configure the PXIe-5840 to generate a 235 MHz tone, using the following settings:
   - Center frequency: 260 MHz
   - Tone offset: -(*test bandwidth*/2) MHz, where *test bandwidth* is the value specified in the *Input Frequency Response Test Points* table.
   - I/Q rate: 10 MS/s
   - Output power: Configured output power from the transfer A row in the following table.

**Table 9.** Frequency Response Accuracy Transfers

| Transfer | Supported Reference Levels (dBm) | Configured Output Power (dBm) |
|---|---|---|
| A | 30 to -10 | 0 |
| B | <-10 to -30 | -20 |

7. Configure the power sensor to correct for the value of (*center frequency* + *tone offset*) from step 6 using the power sensor frequency correction function.
8. Measure the power of the signal present at splitter output 1 of the power splitter using the power sensor.
9. Repeat steps 6 through 8 by sweeping the signal generator tone around the test point from -(*test bandwidth*/2) to +(*test bandwidth*/2) in 10 MHz steps, where *test bandwidth* is the value specified in the following table.
10. Repeat steps 6 through 8 using a tone offset of 3.75 MHz from the Center frequency.

**Table 10.** Input Frequency Response Test Points

| Test Bandwidth (MHz) | Test Points (MHz) | | | | |
|---|---|---|---|---|---|
| 50 | 260 | 300 | 320 | 400 | — |
| 100 | 420 | 630 | — | — | — |
| 200 | 700 | 900 | 950 | 1,250 | 1,350 |
| | 1,550 | 1,650 | 2,150 | 2,250 | 2,650 |
| | 2,750 | 3,350 | 3,450 | 4,450 | 4,550 |
| | 5,250 | 5,350 | 5,950 | — | — |

11. Repeat steps 6 through 9 for the remaining test points listed in the previous table.
12. Repeat steps 6 through 10 for transfer B in the *Frequency Response Accuracy Transfers* table.

    Store results as *accuracy transfer result*.

13. Configure the PXIe-5840 to acquire a signal at 250 MHz, using the following settings:
    - Center frequency: 250 MHz
    - Reference level: 30 dBm
    - Span: *Test bandwidth* from the *Input Frequency Response Test Points* table
    - Resolution bandwidth: 10 kHz
    - Averaging type: RMS
    - Number of averages: 10
    - FFT window: Flat Top
14. Configure the PXIe-5840 to generate a signal at the *center frequency* specified in step 12 - (*test bandwidth*/2) MHz, where *test bandwidth* is the value specified in the previous table, using the following settings:
    - Center frequency: *Center frequency* from step 12
    - Tone offset: -(*test bandwidth*/2) MHz
    - Power level: *Configured output power* from the transfer row in the *Accuracy Transfer Definitions* table from the *Characterizing Power Splitter Loss* section that supports the *reference level* from step 12.
    - I/Q rate: 10 MS/s
    - Prefilter gain: -3 dB
    - Digital gain: (*reference level* from step 10 - *power level* from step 13 or 0 dB, whichever is less.
15. Calculate the *transfer input power* using the following equation:

    *transfer input power* = *accuracy transfer result* + *digital gain* from step 13

    **Note** Find the *accuracy transfer result* by interpolating between the data points in the *Accuracy Transfer Results* table.
16. Calculate the *corrected input power* using the following equation:

    *corrected input power* = *transferred input power* + *splitter balance*

    **Note** Determine the *splitter balance* by interpolating between data points derived using test points in the *Characterization Test Points for Verification Procedures* table.
17. Configure the PXIe-5840 using the settings from step 13, perform acquisition, and measure the tone present at the (*center frequency* + *tone offset*) from step 14.
18. Calculate the absolute amplitude accuracy using the following equation:

    *absolute amplitude accuracy* = PXIe-5840 *input power* - *corrected input power*
19. Repeat steps 14 through 18 by sweeping the vector signal generator tone around the test point from -(*test bandwidth*/2) to +(*test bandwidth*/2) in 10 MHz steps, where *test bandwidth* is the value specified in the *Input Frequency Response Test Points* table.
20. Repeat steps 14 through 18 and use a tone offset of 3.75 MHz. Record the result from step 18 as *reference point*.
21. Determine the positive and negative frequency response results for the center frequency from step 12 by completing the following steps.
    a) Subtract the *reference point* from the maximum *absolute power level accuracy* to determine the positive (+) *frequency response*.

b) Subtract the minimum *absolute power level accuracy* from *reference point* to determine the negative (-) *frequency response*.

22. Repeat steps 13 through 21 for the remaining frequencies in the *Input Frequency Response Test Points* table.
23. Repeat steps 13 through 21 for the remaining reference levels between 20 dBm and -30 dBm in 10 dB steps.
24. Compare the ± *frequency response* values measured to the verification test limits in the following table.

**Table 11.** Input Frequency Response Test Limits

| Frequency | Equalized Bandwidth (MHz) | As-Found Limit (dB) | As-Left Limit (dB) |
|---|---|---|---|
| >250 MHz to 410 MHz | 50 | ±0.9 | ±0.9 |
| >410 MHz to 650 MHz | 100 | ±0.75 | ±0.75 |
| >650 MHz to 1.5 GHz | 200 | ±1.0 | ±1.0 |
| >1.5 GHz to 2.2 GHz | 200 | ±1.3 | ±1.3 |
| >2.2 GHz to 6 GHz | 200 | ±1.0 | ±1.0 |

# Verifying Output Power Level Accuracy

This procedure verifies the power level accuracy of the PXIe-5840 RF output channel.

This procedure requires the test setup and data collected in the *Characterizing Power Splitter Loss* section. You must characterize the power splitter loss before running this procedure. Ensure you use the characterization data derived from test points in the *Characterization Test Points for Verification Procedures* table.

You must zero the power sensor as described in the *Zeroing the Power Sensor* section prior to starting this procedure.

This procedure references the following tables you created when you characterized the power splitter loss:

- *Splitter Loss*
- *RF Output Transfer Result*

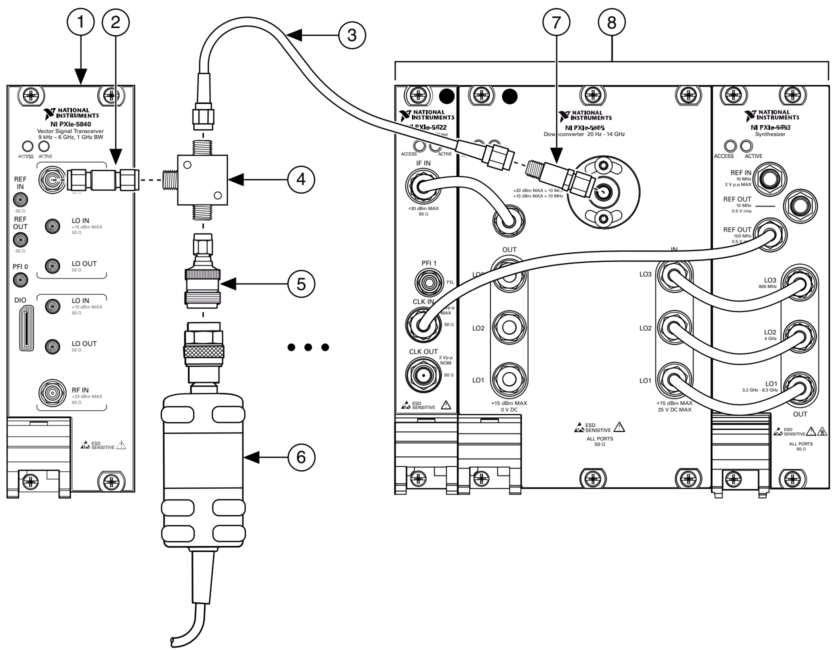
**Note** If you use the PXIe-5665, as recommended, for the spectrum analyzer, disable the preamplifier and preselector options and set the FFT window type to Flat Top.

1. Connect the PXIe-5840 RF OUT front panel connector to the input terminal of the power splitter using a 3.5 mm (m)-to-3.5 mm (m) adapter.
2. Connect splitter output 1 directly to the power sensor using the SMA (m)-to-N(f) adapter.
3. Connect the remaining power splitter output to one end of the 6 dB attenuator using an SMA (m)-to-SMA (m) cable.

4. Connect the other port of the 6 dB attenuator directly to the spectrum analyzer RF IN front panel connector.

   The following figure illustrates the complete hardware setup.

**Figure 11.** Output Power Level Accuracy Verification Cabling Diagram




1. PXIe-5840
2. 3.5 mm (m)-to-3.5 mm (m) Adapter
3. SMA (m)-to-SMA (m) Cable
4. Power Splitter
5. SMA (m)-to-N (f) Adapter
6. Power Sensor
7. 6 dB Attenuator
8. Spectrum Analyzer

5. Configure the PXIe-5840 to generate a tone using the following settings:
   - Center frequency: 246.25 MHz
   - Output power: 10 dBm
   - Tone offset: 3.75 MHz
   - I/Q rate: 10 MS/s

   **Note** For Center Frequencies greater than 2.3 GHz, configure the bandwidth to 200 MHz.

6. Configure the spectrum analyzer to acquire a signal at the *center frequency* specified in step 5 using the following settings:
   - Center frequency: (*Center frequency* + *tone offset*) from step 5
   - Reference level: *Configured reference level* from the transfer row in the *RF Output Accuracy Transfer Result* table from the Characterizing Power Splitter Loss section that supports the *output power* from step 5.

- Span: *Span* from the following table
- Resolution bandwidth: *RBW* from the following table
- Averaging type: RMS
- Number of averages: *Number of averages* from the following table

**Table 12.** Advanced Spectrum Analyzer Settings

| Supported Output Power Levels | Span (kHz) | RBW | Number of Averages |
|---|---|---|---|
| $x$ > -70 dBm | 250 | 4 kHz | 10 |
| -70 dBm ≥ $x$ > -100 dBm | 250 | 900 Hz | 20 |
| $x$ ≤ -100 dBm | 250 | 900 Hz | 100 |

7. Acquire the signal with the spectrum analyzer and measure the tone power located at the value of (*center frequency* + *tone offset*) from step 5. This value is the *measured tone power*.
8. Calculate the *transferred output power* using the following equation:

   *transferred output power* = *RF output accuracy transfer result* + *measured tone power*

   **Note** Determine the *accuracy transfer result* by interpolating between the data points in the *RF Output Transfer Result* table you created in step 22 of the *Characterizing Power Splitter Balance*section. Ensure you use the characterization data derived from test points in the *Characterization Test Points for Verification Procedures* table.
9. Calculate the *corrected output power* using the following equation:

   *corrected output power* = *transferred output power* + *splitter loss*

   **Note** Determine the *splitter loss* by interpolating between the data points in the *Splitter Loss* table you created in step 21 of the *Characterizing Power Splitter Loss* section. Ensure you use the characterization data derived from test points in the *Characterization Test Points for Verification Procedures* table. Choose the appropriate value based on the transfer function used from the *Accuracy Transfer Definitions* table.
10. Calculate the *absolute power level accuracy* using the following equation:

    *absolute power level accuracy* = *device output power* - *corrected output power*
    Where *device output power* is the configured output power of the PXIe-5840 RF output path.
11. Repeat steps 5 through 10 for the remaining frequencies listed in the following table.

**Table 13.** Output Power Level Accuracy Test Points

| Start Frequency (MHz) | Stop Frequency (MHz) | Frequency Step Size (MHz) |
|---|---|---|
| 246.25 | 946.25 | 50 |
| 996.25 | 5,996.25 | 200 |

12. Repeat steps 5 through 11 for the remaining power levels in the following table.

**Table 14.** Output Power Level Test Points

| Frequency Range | Start Power Level (dBm) | Stop Power Level (dBm) | Power Level Step Size (dB) |
|---|---|---|---|
| >200 MHz to 2.3 GHz | +15 | 0 | 5 |
| | -10 | -30 | 10 |
| >2.3 GHz to 6 GHz | +15 | 0 | 5 |
| | -10 | -50 | 10 |

13. Compare the *absolute power level accuracy* values measured to the test limits in the following table.

**Table 15.** Output Power Level Accuracy Test Limits

| Frequency | As-Found Limit (dB) | As-Left Limit (dB) |
|---|---|---|
| >200 MHz to 500 MHz | ±0.80 | ±0.60 |
| >500 MHz to 1.5 GHz | ±0.70 | ±0.60 |
| >1.5 GHz to 2.3 GHz | ±0.70 | ±0.60 |
| >2.3 GHz to 2.9 GHz | ±0.70 | ±0.60 |
| >2.9 GHz to 4.8 GHz | ±0.85 | ±0.65 |
| >4.8 GHz to 6 GHz | ±0.90 | ±0.70 |

**Note** The as-left limits are not listed in the published specifications for the PXIe-5840. These limits are based on published *PXIe-5840 Specifications*, less guard bands for measurement uncertainty, temperature drift, and drift over time.

# Verifying Output Frequency Response

This procedure verifies the frequency response of the PXIe-5840 outputs.

This procedure requires the test setup and data collected in the *Characterizing Power Splitter Loss* section. You must characterize the power splitter loss before running this procedure. Ensure you use the characterization data derived from test points in the *Characterization Test Points for Verification Procedures* table.

You must zero the power sensor as described in the *Zeroing the Power Sensor* section prior to starting this procedure.

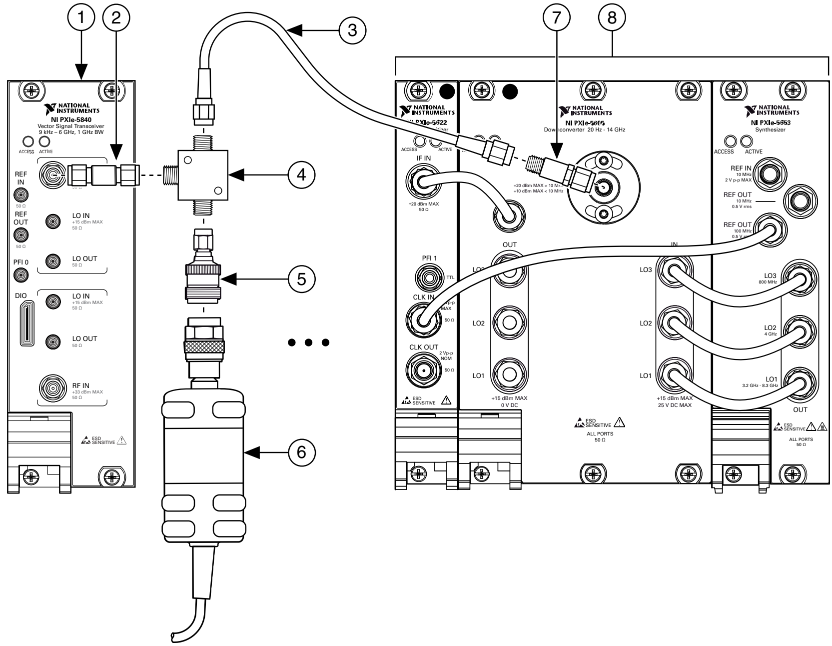
**Note** If you use the PXIe-5665, as recommended, for the spectrum analyzer, disable the preamplifier and preselector options and set the FFT window type to Flat Top.

1. Connect the PXIe-5840 RF OUT front panel connector to the input terminal of the power splitter using a 3.5 mm (m)-to-3.5 mm (m) adapter.

2. Connect splitter output 1 directly to the power sensor using the SMA (m)-to-N (f) adapter.
3. Connect the remaining power splitter output to one end of the 6 dB attenuator using an SMA (m)-to-SMA (m) cable.
4. Connect the other port of the 6 dB attenuator directly to the spectrum analyzer RF IN front panel connector.

   The following figure illustrates the complete hardware setup.

**Figure 12.** Output Frequency Response Verification Cabling Diagram




1. PXIe-5840
2. 3.5 mm (m)-to-3.5 mm (m) Adapter
3. SMA (m)-to-SMA (m) Cable
4. Power Splitter
5. SMA (m)-to-N (f) Adapter
6. Power Sensor
7. 6 dB Attenuator
8. Spectrum Analyzer

5. Configure the PXIe-5840 to generate a signal at 250 MHz with a tone at -(*test bandwidth*/2) MHz offset, where *test bandwidth* is the value specified in the following table, using the following settings:
   - Center frequency: 250 MHz
   - Tone offset: -(*test bandwidth*/2) MHz
   - I/Q rate: 250 MS/s
   - Output power: 10 dBm

**Table 16.** Output Frequency Response Test Points

| Test Bandwidth (MHz) | Test Points (MHz) | | | | |
|---|---|---|---|---|---|
| 50 | 250 | 300 | 320 | 400 | — |
| 100 | 420 | 630 | — | — | — |
| 200 | 700 | 900 | 950 | 1,250 | 1,350 |
| | 1,550 | 1,650 | 2,150 | 2,250 | 2,650 |
| | 2,750 | 3,350 | 3,450 | 4,450 | 4,550 |
| | 5,250 | 5,350 | 5,950 | — | — |

6. Configure the spectrum analyzer to acquire a signal at the tone frequency of step 5, using the following settings:
   - Center frequency: (*Center frequency* + *tone offset*) from step 5, in MHz
   - Reference level: Configured reference level (dBm) from the transfer row in the *Accuracy Transfer Definitions* table that supports the *output power* from step 5.
   - Span: *Span* from the following table
   - Resolution bandwidth: *RBW* from the following table
   - Averaging type: RMS
   - Number of averages: *Number of averages* from the following table

**Table 17.** Advanced Spectrum Analyzer Settings

| Supported Output Power Levels | Span (kHz) | RBW | Number of Averages |
|---|---|---|---|
| $x > -70$ dBm | 250 | 4 kHz | 10 |
| -70 dBm $\geq x >$ -100 dBm | 250 | 900 Hz | 20 |
| $x \leq$ -100 dBm | 250 | 900 Hz | 100 |

7. Acquire the signal with the spectrum analyzer and measure the tone power located at the value of (*center frequency* + *tone offset*) from step 5. This value is the *measured tone power*.
8. Calculate the *transferred output power* using the following equation:

   *transferred output power* = *accuracy transfer result* + *measured tone power*

   **Note** Find the *accuracy transfer result* by interpolating between the data points in the *RF Output Transfer Result* table you created in step 22 of the *Characterizing Power Splitter Loss* section. Ensure you use the characterization data derived from test points in the *Characterization Test Points for Verification Procedures* table.
9. Calculate the *corrected output power* using the following equation:

*corrected output power* = *transferred output power* + *splitter loss*

**Note** Find the *splitter loss* by interpolating between the data points in the *Splitter Loss* table you created in step 21 of the *Characterizing Power Splitter Loss* section. Ensure you use the characterization data derived from test points in the *Characterization Test Points for Verification Procedures* table. Choose the appropriate value based on the transfer function used from the *Accuracy Transfer Definitions* table.

10. Calculate the *absolute power level accuracy* using the following equation:

    *absolute power level accuracy* = *device output power* - *corrected output power*
    Where *device output power* is the configured output power of the PXIe-5840 RF output path.
11. Repeat steps 5 through 10 by sweeping the tone offset from -(*test bandwidth*/2) to +(*test bandwidth*/2) in 5 MHz steps, where *test bandwidth* is the value specified in the *Output Frequency Response Test Points* table.
12. Repeat steps 5 through 10 by using a tone offset of 3.75 MHz. Record the result from step 10 as *reference point*.
13. Determine the positive and negative frequency response results for the *center frequency* from step 5 by completing the following steps.
    a) positive (+) *frequency response* = maximum *absolute power level accuracy* - *reference point*
    b) negative (-) *frequency response* = *reference point* - minimum *absolute power level accuracy*
14. Repeat steps 5 through 12 for the remaining center frequencies listed in the *Output Frequency Response Test Points* table.
15. Repeat steps 5 through 13 for power levels 0 dBm to -30 dBm in 10 dB steps.
16. Compare the ± *frequency response* values measured to the test limits in the following table.

**Table 18.** Output Frequency Response Test Limits

| Frequency | Equalized Bandwidth (MHz) | As-Found Limit (dB) | As-Left Limit (dB) |
|---|---|---|---|
| >250 MHz to 410 MHz | 50 | ±0.9 | ±0.9 |
| >410 MHz to 650 MHz | 100 | ±1.1 | ±1.1 |
| >650 MHz to 1.5 GHz | 200 | ±2.0 | ±2.0 |
| >1.5 GHz to 2.9 GHz | 200 | ±1.4 | ±1.4 |
| >2.9 GHz to 6 GHz | 200 | ±2.2 | ±2.2 |

# Updating Calibration Date and Time

This procedure updates the date and time of the last calibration of the PXIe-5840.

Prior to updating the calibration date and time on the PXIe-5840, you must successfully complete all required verifications.

1. Call the Update External Calibration Last Date and Time VI.
2. Call the Update External Calibration Temp VI.

# Worldwide Support and Services

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Visit *ni.com/services* for information about the services NI offers.

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

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