CALIBRATION PROCEDURE

PXIe-5654 with PXIe-5696

250 kHz to 20 GHz RF Analog Signal Generator with Amplitude Extender

This document contains the verification and adjustment procedures for the PXIe-5654 RF Analog Signal Generator when used with the PXIe-5696 Amplitude Extender.

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

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**Required Software**

Calibrating the PXIe-5654 requires you to install the following package on the calibration system:

- NI-RFSG 14.5 or later

You can download all required software from [ni.com/downloads](http://ni.com/downloads).

The software supports programming the verification procedures in the LabVIEW, C, and LabWindows™/CVI™ application development environments (ADE) and programming the adjustment procedures in LabVIEW. When you install the software, you need to install support only for the ADE that you intend to use.

**Related Documentation**

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

- PXIe-5654 Getting Started Guide
- PXIe-5654 Calibration Procedure
- PXIe-5696 Getting Started Guide
- PXIe-5654 Specifications (includes specifications for the PXIe-5696)
- NI RF Signal Generators Help

Visit [ni.com/manuals](http://ni.com/manuals) for the latest versions of these documents.

**Test Equipment**

The following table lists the equipment NI recommends for the performance verification and adjustment procedures. If the recommended equipment is not available, select a substitute using the minimum requirements listed in the following table.
<table>
<thead>
<tr>
<th>Equipment</th>
<th>Recommended Model</th>
<th>Where Used</th>
<th>Minimum Requirements</th>
</tr>
</thead>
</table>
| Signal source analyzer  | Rhode & Schwarz (R&S) FSUP26 Signal Source Analyzer | Verifications:  
  • RF OUT frequency accuracy  
  • RF OUT phase noise  
  • RF OUT amplitude accuracy  
  • RF OUT maximum power  
  • PULSE IN operation  
Adjusted:  
  • Frequency reference accuracy | Frequency range: 0.25 MHz to 20 GHz  
Frequency counter resolution: 0.1 Hz  
Phase noise measurement using cross-correlation  
Frequency counter marker feature  
Spectrum analysis capabilities |
| Frequency reference     | Symmetricom 8040C Rubidium Frequency Standard | Verifications:  
  • RF OUT amplitude accuracy  
  • RF OUT maximum power  
  • PULSE IN operation  
Adjusted:  
  • Frequency reference accuracy | Frequency: 10 MHz  
Frequency accuracy: $\pm 1 \times 10^{-9}$ |
<table>
<thead>
<tr>
<th>Equipment</th>
<th>Recommended Model</th>
<th>Where Used</th>
<th>Minimum Requirements</th>
</tr>
</thead>
</table>
| Power meter | Anritsu ML2438A with a SC7413A Power Sensor | Verifications:  
  • RF OUT maximum power  
  • RF OUT amplitude accuracy  
Adjustments:  
  • RF OUT power  
  • RF attenuator accuracy  
  • Amplitude accuracy (low harmonic paths)  
  • Amplitude accuracy (high power paths)  
  • Automatic Level Control (ALC) | Range: -40 dBm to 20 dBm  
Frequency range: 250 kHz to 20 GHz  
Accuracy: <±4.0% |
| K(m)-to-K(m) cable, 36 in. (x2) | Florida RF Labs KMS-160-36.0-KMS | Verifications:  
  • RF OUT frequency accuracy  
  • RF OUT phase noise  
  • RF OUT amplitude accuracy  
Adjustments:  
  • Frequency reference accuracy | Length: 36 in.  
Loss: <0.7 dB/ft. (typical) at 20 GHz  
Impedance: 50 Ω |
| K(m)-to-K(m) cable, 12 in. (x2) | Florida RF Labs KMS-160-12.0-KMS | Verifications:  
  • RF OUT amplitude accuracy  
  • RF OUT maximum power  
Adjustments:  
  • RF attenuator path | Length: 12 in.  
Loss: <0.5 dB/ft. (typical) at 20 GHz  
Impedance: 50 Ω |
### Table 1. Recommended Equipment for PXIe-5654 Calibration (Continued)

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Recommended Model</th>
<th>Where Used</th>
<th>Minimum Requirements</th>
</tr>
</thead>
</table>
| K(m)-to-K(f) 20 dB attenuator | Anritsu 41KB-20 | Adjustments: • RF attenuator path | Frequency range: DC to 20 GHz  
Voltage standing wave ratio (VSWR): <1.18  
Accuracy: <±0.5 dB  
Impedance: 50 Ω |
| K(m)-to-K(f) 6 dB attenuator (x2) | Anritsu 41KB-6 | Test system characterization  
Verifications: • RF OUT amplitude accuracy  
• RF OUT maximum power | Frequency range: DC to 20 GHz  
VSWR: <1.18  
Accuracy: <±0.5 dB  
Impedance: 50 Ω |
| Power splitter | Aeroflex/Weinschel 1593 | Test system characterization  
Verifications: • RF OUT amplitude accuracy  
• RF OUT maximum power | Frequency range: DC to 20 GHz  
VSWR: <1.35  
Insertion loss: <8.5 dB  
Impedance: 50 Ω |
| K(m)-to-K(f) adapter¹ | Anritsu K224B | Test system characterization | Frequency range: DC to 20 GHz  
VSWR: ≤1.12  
Impedance: 50 Ω |

The following table lists the equipment NI recommends for optional performance verification procedures for non-warranted specifications. If the recommended equipment is not available, select a substitute using the minimum requirements listed in the table.

¹ The connector on the power sensor listed above may be difficult to access with a torque wrench when there is adjacent connected hardware. Use this adapter if you need to extend the capabilities of the power sensor to make it accessible by a torque wrench.
Table 2. Recommended Equipment for Optional PXIe-5654 Calibration

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Recommended Model</th>
<th>Where Used</th>
<th>Minimum Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>USB digital output</td>
<td>USB-6501 Digital I/O Device</td>
<td>Verifications:</td>
<td>Active drive capability</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• PULSE IN operation</td>
<td>Voltage: &lt;3.3 V CMOS</td>
</tr>
<tr>
<td>BNC(m)-to-SMB(f) cable</td>
<td>Radiall R284C0351028</td>
<td>Verifications:</td>
<td>Impedance: 50 Ω</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• PULSE IN operation</td>
<td></td>
</tr>
<tr>
<td>BNC(m)-to-screw terminal block adapter</td>
<td>Clever Little Box CLB-JL73</td>
<td>Verifications:</td>
<td>Impedance: 50 Ω</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• PULSE IN operation</td>
<td></td>
</tr>
<tr>
<td>BNC(m)-to-BNC(m) cable</td>
<td>Pasternack PE3087</td>
<td>Verifications:</td>
<td>Impedance: 50 Ω</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• PULSE IN operation</td>
<td></td>
</tr>
<tr>
<td>BNC Tee adapter (f-f-f)</td>
<td>Pasternack PE9003</td>
<td>Verifications:</td>
<td>Impedance: 50 Ω</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• PULSE IN operation</td>
<td></td>
</tr>
</tbody>
</table>

Test Conditions

The following setup and environmental conditions are required to ensure the PXIe-5654 and PXIe-5696 meet 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-5654 and PXIe-5696, 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. The warm-up time ensures that the PXIe-5654 and PXIe-5696 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.
Plug the chassis and the calibration instrument(s) into the same power strip to avoid ground loops.

- Use an appropriate torque wrench to tighten all module RF connectors (SMA, 3.5 mm, or K). NI recommends a 0.565 N · m (5 lb · in) wrench for SMA connectors and a 0.90 N · m (8 lb · in) wrench for 3.5 mm or K connectors.

- Connect the frequency reference source to the signal source analyzer REF IN back panel connector using a BNC(m)-to-BNC(m) cable, and connect the signal source analyzer REF OUT connector to the PXIe-5654 REF IN connector using a BNC(m)-to-SMA(m) cable.

- 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.

- Frequencies less than and equal to 10 GHz apply to the 10 GHz and 20 GHz PXIe-5654; frequencies above 10 GHz apply only to the 20 GHz PXIe-5654.

- The PXIe-5654 must be verified as a stand-alone device using the PXIe-5654 Calibration Procedure before performing the procedures in this document.

**Initial Setup**

Refer to the PXIe-5654 Getting Started Guide and PXIe-5696 Getting Started Guide for information about how to install the software and the hardware and how to configure the devices in MAX.

**Test System Characterization**

The following procedures characterize the test equipment used during verification.

- **Note** Before starting characterization, unassociate the PXIe-5654 and PXIe-5696 in Measurement & Automation Explorer (MAX) by setting the PXIe-5696 connected to the PXIe-5654 to None.

**Zeroing and Calibrating the Power Sensor**

1. Connect channel A of the power meter to the power sensor.
2. Zero and calibrate the power sensor using the built-in functions in the power meter.

**Characterizing the Power Splitter**

Several procedures in this document require using a splitter that has been characterized to remove error from future measurements. Complete the following steps to characterize a splitter using a PXIe-5654, power meter, and signal source analyzer, as shown in the following figure.

1. Connect the frequency reference source to the signal source analyzer REF IN back panel connector using a BNC(m)-to-BNC(m) cable, and connect the signal source analyzer
REF OUT connector to the PXIe-5654 REF IN connector using a BNC(m)-to-SMA(m) cable.

2. Connect the power meter power sensor to the PXIe-5654 RF OUT front panel connector.

3. Create a new device session for the PXIe-5654.

4. Create a list of test frequencies using the values in the following table.

<table>
<thead>
<tr>
<th>Start Frequency (MHz)</th>
<th>Stop Frequency (MHz)</th>
<th>Frequency Step (MHz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.25</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>25</td>
<td>250</td>
<td>112.5</td>
</tr>
<tr>
<td>275</td>
<td>1,000</td>
<td>145</td>
</tr>
<tr>
<td>1,250</td>
<td>20,000</td>
<td>250</td>
</tr>
</tbody>
</table>

5. Configure the PXIe-5654 using the following settings:
   • Frequency: Frequency from the list in step 4.
   • Power Level: -10 dBm

6. Commit the settings to hardware if this is the first iteration of running this procedure; otherwise skip to step 9.

7. Initiate signal generation.

8. Enable the RF output.

9. Check the signal generation status and verify that there are no reported errors or warnings.

10. Use the power meter to measure the output power. Store this value as the Power Meter Reading.

11. Repeat steps 5 through 10 for each remaining test frequency in the list created in step 4.

12. Disconnect the power meter from the PXIe-5654 RF OUT front panel connector.

13. Connect the PXIe-5654 RF OUT front panel connector to the 6 dB attenuator.

14. Connect the open end of the attenuator to the input of the power splitter using a K(m)-to-K(m) 12 in. cable.

15. Connect an available output port of the power splitter to the power sensor.

16. Connect a 6 dB attenuator to the signal source analyzer RF input.

17. Connect the other available output port of the power splitter to the attenuator connected to the signal source analyzer RF input connector using a K(m)-to-K(m) 36 in. cable.

The hardware setup is shown in the following image, with the dotted line surrounding the equipment fixture.

Note After assembling the hardware and performing characterization, do not disassemble or alter the torque applied to the connectors of the fixture. If any hardware within the fixture is altered, you must characterize again.
18. Configure the reference level of the spectrum analyzer to -30 dBm.

The spectrum analyzer is used only for termination.

19. Configure the PXIe-5654 using the following settings:
   • Frequency: Frequency from the list in step 4.
   • Power Level: -10 dBm

20. Check the signal generation status and verify that there are no reported errors or warnings.

21. Use the power meter to measure the output power. Store this value as Splitter.

22. Calculate the splitter loss using the following formula:

   \[ \text{Splitter Loss} = \text{Power Meter Reading} - \text{Splitter} \]

23. Store the calculated values.

24. Repeat steps 19 through 23 for each remaining test frequency in the list created in step 4.

25. Close the device session.

As-Found and As-Left Limits

The as-found limits are the published specifications for the PXIe-5654 with PXIe-5696. NI uses these limits to determine whether the PXIe-5654 with PXIe-5696 meets the
specifications when it is received for calibration. Use the as-found limits during initial verification.

The as-left calibration limits are equal to the published NI specifications for the PXIe-5654 with PXIe-5696, less guard bands for measurement uncertainty, temperature drift, and drift over time. NI uses these limits to reduce the probability that the instrument will be outside the published specification limits at the end of the calibration cycle. Use the as-left limits when performing verification after adjustment.

Verification

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

Before starting verification, complete the following steps.

1. Complete the verification procedures for the PXIe-5654 as a stand-alone device.
2. Associate the PXIe-5654 and PXIe-5696 in MAX.
3. Make the following reference connections.
   a) Connect the frequency reference source to the signal source analyzer REF IN back panel connector using a BNC(m)-to-BNC(m) cable.
   b) Connect the signal source analyzer REF OUT connector to the PXIe-5654 REF IN connector using a BNC(m)-to-SMA(m) cable.

Related Information

For instructions on verifying the PXIe-5654 as a stand-alone device, refer to the PXIe-5654 Calibration Procedure.

Verifying RF OUT Frequency Accuracy

This procedure verifies that the internal signal generation circuitry is adjusted for correct frequency accuracy.

1. Connect the PXIe-5654 to the PXIe-5696.
2. Connect the PXIe-5696 RF OUT front panel connector to the signal source analyzer RF input connector using the K(m)-to-K(m) cable, as shown in the following figure.
1. PXIe-5654 RF Analog Signal Generator
2. PXIe-5696 Amplitude Extender
3. Signal Source Analyzer
4. K(m)-to-K(m) Cable

3. Create a new device session for the PXIe-5654 with PXIe-5696.
4. Create a list of test frequencies, including endpoints, containing 100 MHz and 1 GHz, according to the frequency range of your PXIe-5654 model, with 1 GHz increments.
5. Configure the PXIe-5654 with PXIe-5696 using the following settings:
   • Frequency: Frequency from the list in step 4
   • Power Level: 0 dBm
   • Reference Clock Source: Onboard Clock
6. Commit the settings to hardware if this is the first iteration of running this procedure; otherwise skip to step 9.
7. Initiate signal generation.
8. Enable the RF output.
9. Check the signal generation status and verify that there are no reported errors or warnings.
10. Configure the signal source analyzer using the following settings:
   - Center frequency: Frequency from the list in step 4
   - Reference level: 20 dBm
   - Frequency span: 1 MHz
   - Reference Clock source: External
   - Frequency counter resolution: 0.1 Hz
   - Sweep: Manual
   - Number of sweeps: 1
   - Auto Sweep Time

11. Measure the frequency of the peak that is returned by the signal source analyzer at approximately the corresponding point in the frequency list you created in step 4.

12. Calculate the deviation using the following formula:

   \[ \Delta f = \left| \frac{f_{\text{Measured}}(\text{MHz}) - f_{\text{Expected}}(\text{MHz})}{f_{\text{Expected}}(\text{MHz})} \right| \text{ ppm} \]

13. Ensure that the deviation found in the previous step is less than the result of the following equations:

   As Left Calculation: Initial Accuracy + Temperature Stability

   As Found Calculation: Initial Accuracy + Aging + Temperature Stability

   where
   
   Initial Accuracy = ±0.1 ppm
   
   Temperature Stability (15 °C to 35 °C) = ±0.2 ppm
   
   Ten Year Aging = 1.25 ppm

14. Repeat steps 5 through 13 for the remaining frequencies in the list created in step 4.

15. Close the device session.

Verifying RF OUT Phase Noise

This procedure verifies that the internal frequency generation circuitry is adjusted for correct phase noise accuracy.

1. Connect the PXIe-5654 to the PXIe-5696.

2. Connect the PXIe-5696 RF OUT front panel connector to the signal source analyzer RF input connector using the K(m)-to-K(m) cable.

   The hardware setup is shown in the following figure.
3. Create a new device session for the PXIe-5654 with PXIe-5696.

4. Configure the signal source analyzer using the following settings:
   - Phase noise measurement using cross-correlation phase-locked loops (PLLs) and internal generators
   - Automatic device under test (DUT) detection
   - Spur suppression enabled
   - Fast Fourier transform (FFT) mode with Blackman-Harris window
   - Measurement span from 100 Hz to 1 MHz (offset frequencies)

5. Use the signal source analyzer to perform a manual frequency sweep at the settings listed in the following table.
Table 4. RF OUT Manual Sweep Settings

<table>
<thead>
<tr>
<th>Carrier Frequency Offset</th>
<th>Resolution Bandwidth</th>
<th>Cross Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 Hz to 300 Hz</td>
<td>10 Hz</td>
<td>100</td>
</tr>
<tr>
<td>300 Hz to 1 kHz</td>
<td>30 Hz</td>
<td>1,000</td>
</tr>
<tr>
<td>1 kHz to 3 kHz</td>
<td>100 Hz</td>
<td>10,000</td>
</tr>
<tr>
<td>3 kHz to 10 kHz</td>
<td>300 Hz</td>
<td>10,000</td>
</tr>
<tr>
<td>10 kHz to 30 kHz</td>
<td>1 kHz</td>
<td>10,000</td>
</tr>
<tr>
<td>30 kHz to 100 kHz</td>
<td>1 kHz</td>
<td>5,000</td>
</tr>
<tr>
<td>100 kHz to 300 kHz</td>
<td>3 kHz</td>
<td>1,000</td>
</tr>
<tr>
<td>300 kHz to 1 MHz</td>
<td>10 kHz</td>
<td>1,000</td>
</tr>
</tbody>
</table>

6. Configure the PXIe-5654 with PXIe-5696 using the following settings:
   - Frequency: 500 MHz
   - Power Level: +8 dBm

7. Commit the settings to hardware if this is the first iteration of running the procedure; otherwise skip to step 10.

8. Initiate signal generation.

9. Enable the RF output.

10. Set the signal source analyzer center frequency to 500 MHz if the signal source analyzer does not automatically center for phase noise measurements.

11. Check the signal generation status and verify that there are no reported errors or warnings.

12. Measure the phase noise using the signal source analyzer for every offset value in the following table. Record the measurements.

13. Ensure that the recorded measurements are within the limits set in the following tables.

Table 5. RF OUT Phase Noise (dBc/Hz), As-Found Limits

<table>
<thead>
<tr>
<th>Offset</th>
<th>500 MHz</th>
<th>1 GHz</th>
<th>5 GHz</th>
<th>10 GHz</th>
<th>20 GHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 Hz</td>
<td>≤-107</td>
<td>≤-101</td>
<td>≤-87</td>
<td>≤-81</td>
<td>≤-75</td>
</tr>
<tr>
<td>1 kHz</td>
<td>≤-126</td>
<td>≤-121</td>
<td>≤-109</td>
<td>≤-103</td>
<td>≤-97</td>
</tr>
<tr>
<td>10 kHz</td>
<td>≤-135</td>
<td>≤-130</td>
<td>≤-120</td>
<td>≤-114</td>
<td>≤-108</td>
</tr>
<tr>
<td>100 kHz</td>
<td>≤-137</td>
<td>≤-131</td>
<td>≤-122</td>
<td>≤-117</td>
<td>≤-111</td>
</tr>
<tr>
<td>1 MHz</td>
<td>≤-138</td>
<td>≤-132</td>
<td>≤-125</td>
<td>≤-119</td>
<td>≤-113</td>
</tr>
</tbody>
</table>
Table 6. RF OUT Phase Noise (dBc/Hz), As-Left Limits

<table>
<thead>
<tr>
<th>Offset</th>
<th>Carrier Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>500 MHz</td>
</tr>
<tr>
<td>100 Hz</td>
<td>≤-108.5</td>
</tr>
<tr>
<td>1 kHz</td>
<td>≤-127.5</td>
</tr>
<tr>
<td>10 kHz</td>
<td>≤-135.5</td>
</tr>
<tr>
<td>100 kHz</td>
<td>≤-138</td>
</tr>
<tr>
<td>1 MHz</td>
<td>≤-138.5</td>
</tr>
</tbody>
</table>

14. Repeat steps 6 through 13 for 1 GHz, 5 GHz, 10 GHz, and 20 GHz carrier frequencies.

15. Close the device session.

Verifying RF OUT Amplitude Accuracy
This procedure verifies that the PXIe-5654 with PXIe-5696 is adjusted for correct amplitude accuracy.

1. Connect the PXIe-5654 to the PXIe-5696.

2. Using the fixture that was previously characterized in Characterizing the Power Splitter, connect the input of the fixture to the PXIe-5696 RF OUT front panel connector.

3. Connect the outputs of the fixture to the power sensor and to the signal source analyzer RF input connector, as shown in the following image.

All other connections should not have changed since characterization.
Figure 4. RF OUT Amplitude Accuracy Verification Equipment Setup

1. PXIe-5654 RF Analog Signal Generator
2. PXIe-5696 Amplitude Extender
3. K(m)-to-K(f) 6 dB Attenuator
4. K(m)-to-K(m) Cable, 12 in.
5. Power Sensor
6. Power Meter
7. Power Splitter
8. K(m)-to-K(m) Cable, 36 in.
9. Signal Source Analyzer

4. Create a new device session for the PXIe-5654 with PXIe-5696.
5. Create a list of test frequencies from the following table based on your current power level under test.

Table 7. RF OUT Amplitude Accuracy Test Settings

<table>
<thead>
<tr>
<th>Power Level (dBm)</th>
<th>Start Frequency (MHz)</th>
<th>Stop Frequency (MHz)</th>
<th>Frequency Step (MHz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-80</td>
<td>0.25</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>25</td>
<td>250</td>
<td>112.5</td>
<td></td>
</tr>
<tr>
<td>275</td>
<td>1,000</td>
<td>145</td>
<td></td>
</tr>
<tr>
<td>1,250</td>
<td>3,000</td>
<td>250</td>
<td></td>
</tr>
<tr>
<td>3,250</td>
<td>6,000</td>
<td>250</td>
<td></td>
</tr>
<tr>
<td>6,250</td>
<td>15,000</td>
<td>250</td>
<td></td>
</tr>
<tr>
<td>15,250</td>
<td>20,000</td>
<td>250</td>
<td></td>
</tr>
</tbody>
</table>
Table 7. RF OUT Amplitude Accuracy Test Settings (Continued)

<table>
<thead>
<tr>
<th>Power Level (dBm)</th>
<th>Start Frequency (MHz)</th>
<th>Stop Frequency (MHz)</th>
<th>Frequency Step (MHz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-40</td>
<td>0.25</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>25</td>
<td>250</td>
<td>112.5</td>
</tr>
<tr>
<td></td>
<td>275</td>
<td>1,000</td>
<td>145</td>
</tr>
<tr>
<td></td>
<td>1,250</td>
<td>3,000</td>
<td>250</td>
</tr>
<tr>
<td></td>
<td>3,250</td>
<td>6,000</td>
<td>250</td>
</tr>
<tr>
<td></td>
<td>6,250</td>
<td>15,000</td>
<td>250</td>
</tr>
<tr>
<td></td>
<td>15,250</td>
<td>20,000</td>
<td>250</td>
</tr>
<tr>
<td>-20</td>
<td>0.25</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>25</td>
<td>250</td>
<td>112.5</td>
</tr>
<tr>
<td></td>
<td>275</td>
<td>1,000</td>
<td>145</td>
</tr>
<tr>
<td></td>
<td>1,250</td>
<td>3,000</td>
<td>250</td>
</tr>
<tr>
<td></td>
<td>3,250</td>
<td>6,000</td>
<td>250</td>
</tr>
<tr>
<td></td>
<td>6,250</td>
<td>15,000</td>
<td>250</td>
</tr>
<tr>
<td></td>
<td>15,250</td>
<td>20,000</td>
<td>250</td>
</tr>
<tr>
<td>-10</td>
<td>0.25</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>25</td>
<td>250</td>
<td>112.5</td>
</tr>
<tr>
<td></td>
<td>275</td>
<td>1,000</td>
<td>145</td>
</tr>
<tr>
<td></td>
<td>1,250</td>
<td>3,000</td>
<td>250</td>
</tr>
<tr>
<td></td>
<td>3,250</td>
<td>6,000</td>
<td>250</td>
</tr>
<tr>
<td></td>
<td>6,250</td>
<td>15,000</td>
<td>250</td>
</tr>
<tr>
<td></td>
<td>15,250</td>
<td>20,000</td>
<td>250</td>
</tr>
</tbody>
</table>
Table 7. RF OUT Amplitude Accuracy Test Settings (Continued)

<table>
<thead>
<tr>
<th>Power Level (dBm)</th>
<th>Start Frequency (MHz)</th>
<th>Stop Frequency (MHz)</th>
<th>Frequency Step (MHz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-7</td>
<td>0.25</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>25</td>
<td>250</td>
<td>112.5</td>
</tr>
<tr>
<td></td>
<td>275</td>
<td>1,000</td>
<td>145</td>
</tr>
<tr>
<td></td>
<td>1,250</td>
<td>3,000</td>
<td>250</td>
</tr>
<tr>
<td></td>
<td>3,250</td>
<td>6,000</td>
<td>250</td>
</tr>
<tr>
<td></td>
<td>6,250</td>
<td>15,000</td>
<td>250</td>
</tr>
<tr>
<td></td>
<td>15,250</td>
<td>20,000</td>
<td>250</td>
</tr>
<tr>
<td>0</td>
<td>0.25</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>25</td>
<td>250</td>
<td>112.5</td>
</tr>
<tr>
<td></td>
<td>275</td>
<td>1,000</td>
<td>145</td>
</tr>
<tr>
<td></td>
<td>1,250</td>
<td>3,000</td>
<td>250</td>
</tr>
<tr>
<td></td>
<td>3,250</td>
<td>6,000</td>
<td>250</td>
</tr>
<tr>
<td></td>
<td>6,250</td>
<td>15,000</td>
<td>250</td>
</tr>
<tr>
<td></td>
<td>15,250</td>
<td>20,000</td>
<td>250</td>
</tr>
<tr>
<td>10</td>
<td>0.25</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>25</td>
<td>250</td>
<td>112.5</td>
</tr>
<tr>
<td>18</td>
<td>15,250</td>
<td>20,000</td>
<td>250</td>
</tr>
<tr>
<td>20</td>
<td>275</td>
<td>1,000</td>
<td>145</td>
</tr>
<tr>
<td></td>
<td>6,250</td>
<td>15,000</td>
<td>250</td>
</tr>
<tr>
<td>23</td>
<td>3,250</td>
<td>6,000</td>
<td>250</td>
</tr>
<tr>
<td>24</td>
<td>1,250</td>
<td>3,000</td>
<td>250</td>
</tr>
</tbody>
</table>

6. Configure the reference level of the spectrum analyzer to -30 dBm.

   The spectrum analyzer is used only for termination.

7. Configure the PXIe-5654 with PXIe-5696 using the following settings:
   - Frequency: Frequency from the list in step 5
   - Power Level: Current power level from the preceding table, which is the *Expected Power (dBm)*

8. Commit the settings to hardware if this is the first iteration of running the procedure; otherwise skip to step 11.

9. Initiate signal generation.
10. Enable the RF output.
11. Check the signal generation status and verify that there are no reported errors or warnings.
12. Measure the power using the power meter. Correct the power meter reading for the RF frequency.
   This measurement is the Power Meter Reading.
13. Correct the power meter reading with the characterization value from Characterizing the Power Splitter.
   \[
   \text{Measured Power (dBm)} = \text{Power Meter Reading} + \text{Splitter Loss}
   \]
14. Calculate the Power Deviation (dB) using the following formula:
   \[
   \text{Power Deviation (dB)} = \text{Measured Power (dBm)} - \text{Expected Power (dBm)}
   \]
15. Verify that the Power Deviation (dB) results in the previous step are within the limits listed in the following tables.

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Maximum Leveled Power (dBm)</th>
<th>-80 dBm to &lt;-40 dBm</th>
<th>-40 dBm to &lt;-10 dBm</th>
<th>-10 dBm to 13 dBm</th>
<th>&gt;13 dBm to Maximum Leveled Power (dBm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.25 MHz to &lt;20 MHz</td>
<td>≥10</td>
<td>±1.75</td>
<td>±1.20</td>
<td>±0.80</td>
<td>—</td>
</tr>
<tr>
<td>20 MHz to ≤250 MHz</td>
<td>≥10</td>
<td>±1.50</td>
<td>±1.20</td>
<td>±0.80</td>
<td>—</td>
</tr>
<tr>
<td>&gt;250 MHz to ≤1,000 MHz</td>
<td>≥20</td>
<td>±1.50</td>
<td>±1.20</td>
<td>±0.80</td>
<td>±1.20</td>
</tr>
<tr>
<td>&gt;1,000 MHz to ≤3,000 MHz</td>
<td>≥24</td>
<td>±1.50</td>
<td>±1.20</td>
<td>±0.80</td>
<td>±1.20</td>
</tr>
<tr>
<td>&gt;3,000 MHz to ≤6,000 MHz</td>
<td>&gt;23</td>
<td>±1.50</td>
<td>±1.20</td>
<td>±0.80</td>
<td>±1.20</td>
</tr>
<tr>
<td>&gt;6,000 MHz to ≤8,000 MHz</td>
<td>&gt;20</td>
<td>±1.50</td>
<td>±1.20</td>
<td>±0.80</td>
<td>±1.20</td>
</tr>
<tr>
<td>&gt;8,000 MHz to ≤15,000 MHz</td>
<td>&gt;20</td>
<td>±1.50</td>
<td>±1.20</td>
<td>±0.80</td>
<td>±1.30</td>
</tr>
<tr>
<td>&gt;15,000 MHz to ≤20,000 MHz</td>
<td>&gt;18</td>
<td>±1.50</td>
<td>±1.20</td>
<td>±0.80</td>
<td>±1.30</td>
</tr>
</tbody>
</table>
### Table 9. Amplitude Accuracy, As-Left Limits (dB)

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Maximum Leveled Power (dBm)</th>
<th>-80 dBm to &lt; -40 dBm</th>
<th>-40 dBm to &lt; -10 dBm</th>
<th>-10 dBm to 13 dBm</th>
<th>&gt;13 dBm to Maximum Leveled Power (dBm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.25 MHz to ≤20 MHz</td>
<td>≥10</td>
<td>±1.00</td>
<td>±0.60</td>
<td>±0.35</td>
<td>—</td>
</tr>
<tr>
<td>&gt;20 MHz to ≤250 MHz</td>
<td>≥10</td>
<td>±0.70</td>
<td>±0.60</td>
<td>±0.35</td>
<td>—</td>
</tr>
<tr>
<td>&gt;250 MHz to ≤1,000 MHz</td>
<td>≥20</td>
<td>±0.70</td>
<td>±0.60</td>
<td>±0.35</td>
<td>±0.60</td>
</tr>
<tr>
<td>&gt;1,000 MHz to ≤3,000 MHz</td>
<td>≥24</td>
<td>±0.70</td>
<td>±0.60</td>
<td>±0.35</td>
<td>±0.60</td>
</tr>
<tr>
<td>&gt;3,000 MHz to ≤6,000 MHz</td>
<td>&gt;23</td>
<td>±0.60</td>
<td>±0.60</td>
<td>±0.35</td>
<td>±0.60</td>
</tr>
<tr>
<td>&gt;6,000 MHz to ≤8,000 MHz</td>
<td>&gt;20</td>
<td>±0.60</td>
<td>±0.60</td>
<td>±0.35</td>
<td>±0.60</td>
</tr>
<tr>
<td>&gt;8,000 MHz to ≤15,000 MHz</td>
<td>&gt;20</td>
<td>±0.60</td>
<td>±0.60</td>
<td>±0.35</td>
<td>±0.60</td>
</tr>
<tr>
<td>&gt;15,000 MHz to ≤20,000 MHz</td>
<td>&gt;18</td>
<td>±0.60</td>
<td>±0.60</td>
<td>±0.35</td>
<td>±0.60</td>
</tr>
</tbody>
</table>

16. Repeat steps 7 through 15 for each test frequency in the frequency list created in step 5.

17. Repeat steps 7 through 15 for all output powers greater than -20 dBm in the frequency list.

The following steps apply to using an output power of -20 dBm.

18. Create a list of test frequencies from Table 7 that apply to a power level of -20 dBm.

19. Configure the PXIe-5654 with PXIe-5696 using the following settings:
    • Frequency: Frequency from the list in step 18
    • Power Level: -20 dBm, which is the Expected Power (dBm)

20. Commit the settings to hardware if this is the first iteration of running this procedure; otherwise skip to step 21.

21. Check the signal generation status and verify that there are no reported errors or warnings.

22. Configure the signal source analyzer with the following settings:
    • Center frequency: Frequency in step 18
    • RF Input coupling: DC
    • Reference level: -30 dBm
    • Frequency span: 0 Hz
23. Measure the power using the power meter. Correct the power meter reading for the RF frequency.

This measurement is the **Power Meter Reading**.

24. Correct the power meter reading with the characterization value from *Characterizing the Power Splitter*.

\[
\text{Measured Power (dBm)} = \text{Power Meter Reading} + \text{Splitter Loss}
\]

25. Measure the power level with the signal source analyzer. Record the value as the **Signal Source Analyzer Reading**.

26. Calculate and store the characterization of the signal source analyzer.

\[
\text{Correction} = \text{Measured Power} - \text{Signal Source Analyzer Reading}
\]

27. Verify that the **Power Deviation (dB)** results in the preceding step are within the limits listed in Tables 8 and 9.

28. Repeat steps 19 through 27 for each test frequency in the frequency list created in step 18.

The following steps apply to using an output power of <-20 dBm.

29. Create a list of test frequencies from Table 7 that apply to a power level of -40 dBm.

30. Configure the PXIe-5654 with PXIe-5696 using the following settings:

- Frequency: Frequency from the list in step 29
- Power Level: -40 dBm, which is the *Expected Power (dBm)*

31. Commit the settings to hardware if this is the first iteration of running this procedure; otherwise skip to step 32.

32. Check the signal generation status and verify that there are no reported errors or warnings.

33. Configure the signal source analyzer with the following settings:

- Center frequency: Frequency in step 29
- RF Input coupling: DC
- Reference level: -30 dBm
- Frequency span: 0 Hz
- Resolution bandwidth: 100 Hz
- Sweep time: 20 ms
- Reference Clock source: External
- RF attenuation: 5 dB
- Preamplifier: On

34. Measure the power level with the signal source analyzer. Record the value as the **Signal Source Analyzer Reading**.

35. Correct the reading with previously stored characteristic values.

\[
\text{Power Deviation (dB)} = \text{Signal Source Analyzer Reading} + \text{Corrections stored in step 26}
\]
36. Verify that the *Power Deviation (dB)* results in the preceding step are within the limits listed in Tables 8 and 9.

37. Repeat steps 30 through 36 for each test frequency in the frequency list created in step 29. The following steps apply to using an output power of <-40 dBm.

38. Create a list of test frequencies from Table 7 that apply to a power level of -80 dBm.

39. Configure the PXIe-5654 with PXIe-5696 using the following settings:
   - Frequency: Frequency from the list in step 38
   - Power Level: -80 dBm, which is the *Expected Power (dBm)*

40. Commit the settings to hardware if this is the first iteration of running this procedure; otherwise skip to step 41.

41. Check the signal generation status and verify that there are no reported errors or warnings.

42. Configure the signal source analyzer with the following settings:
   - Center frequency: Frequency in step 38
   - RF Input coupling: DC
   - Reference level: -30 dBm
   - Frequency span: 0 Hz
   - Resolution bandwidth: 500 Hz
   - Sweep time: 200 ms
   - Reference Clock source: External
   - RF attenuation: 5 dB
   - Preamplifier: On

43. Measure the power level with the signal source analyzer. Record the value as the *Signal Source Analyzer Reading*.

44. Correct the reading with previously stored characteristic values.

   \[ \text{Power Deviation (dB)} = \text{Signal Source Analyzer Reading} + \text{Corrections} \text{ stored in step 26} \]

45. Verify that the *Power Deviation (dB)* results in the preceding step are within the limits listed in Tables 8 and 9.

46. Repeat steps 39 through 45 for each test frequency in the frequency list created in step 38.

47. Stop signal generation.

48. Close the device session.

### Verifying RF OUT Maximum Power

This procedure verifies that the PXIe-5654 with PXIe-5696 produces the correct maximum output power.

1. Connect the PXIe-5654 to the PXIe-5696.
2. Using the fixture that was previously characterized in *Characterizing the Power Splitter*, connect the input of the fixture to the PXIe-5696 RF OUT front panel connector.
3. Connect the outputs of the fixture to the power sensor and to the signal source analyzer RF input connector, as shown in the following image.

   All other connections should not have changed since characterization.
Figure 5. RF OUT Maximum Power Verification Equipment Setup

1. PXie-5654 RF Analog Signal Generator
2. PXie-5696 Amplitude Extender
3. K(m)-to-K(f) 6 dB Attenuator
4. K(m)-to-K(m) Cable, 12 in.
5. Power Sensor
6. Power Meter
7. Power Splitter
8. K(m)-to-K(m) Cable, 36 in.
9. Signal Source Analyzer

4. Configure the reference level of the spectrum analyzer to -30 dBm.
   The spectrum analyzer is used only for termination.
5. Create a new device session for the PXie-5654 with PXie-5696.
6. Create a list of test frequencies using the values in the following table.

<table>
<thead>
<tr>
<th>Power Level (dBm)</th>
<th>Start Frequency (MHz)</th>
<th>Stop Frequency (MHz)</th>
<th>Frequency Step (MHz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>0.25</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>12</td>
<td>25</td>
<td>250</td>
<td>112.5</td>
</tr>
<tr>
<td>22</td>
<td>275</td>
<td>1,000</td>
<td>145</td>
</tr>
<tr>
<td>26</td>
<td>1,250</td>
<td>3,000</td>
<td>250</td>
</tr>
<tr>
<td>25</td>
<td>3,250</td>
<td>6,000</td>
<td>250</td>
</tr>
<tr>
<td>22</td>
<td>6,250</td>
<td>15,000</td>
<td>250</td>
</tr>
<tr>
<td>20</td>
<td>15,250</td>
<td>20,000</td>
<td>250</td>
</tr>
</tbody>
</table>
7. Configure the PXIe-5654 with PXIe-5696 using the following settings:
   • Frequency: Start frequency from the list in step 6
   • Power Level: Power level from the list in step 6

8. Initiate signal generation if this is the first iteration of running the procedure; otherwise skip to step 11.

9. Enable the RF output.

10. Measure the PXIe-5696 RF OUT front panel connector power using the power meter and the fixture created in *Characterizing the Power Splitter*. Correct the power meter reading for the RF frequency and previously characterized power splitter loss.

11. Verify that the power output measured in step 10 meets the limits in the following table.

<table>
<thead>
<tr>
<th>Frequency (MHz)</th>
<th>As-Found Limit (dBm)</th>
<th>As-Left Limit (dBm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.25 to ≤250</td>
<td>≥10</td>
<td>≥11</td>
</tr>
<tr>
<td>&gt;250 to ≤1,000</td>
<td>≥20</td>
<td>≥21</td>
</tr>
<tr>
<td>&gt;1,000 to ≤3,000</td>
<td>≥24</td>
<td>≥25</td>
</tr>
<tr>
<td>&gt;3,000 to ≤6,000</td>
<td>≥23</td>
<td>≥24</td>
</tr>
<tr>
<td>&gt;6,000 to ≤15,000</td>
<td>≥20</td>
<td>≥21</td>
</tr>
<tr>
<td>&gt;15,000 to ≤20,000</td>
<td>≥18</td>
<td>≥19</td>
</tr>
</tbody>
</table>

12. Repeat steps 7 through 11 for each frequency from the list created in step 6.

13. Close the device session.

### Optional Verification

Use the following procedures to verify nonwarranted specifications for the PXIe-5654 with PXIe-5696.

#### Verifying PULSE IN Operation

This procedure verifies that the PXIe-5654 PULSE IN connection is functioning.

1. Connect the PXIe-5654 to the PXIe-5696.

2. Connect the signal source analyzer RF input to the PXIe-5696 RF OUT front panel connector using the K(m)-to-K(m) cable.

3. Connect the Port 0, Line 0 (P0.0) output of the USB digital output device to two separate connectors using a BNC Tee connector and a BNC(m)-to-terminal block adapter.
   a) Connect the P0.0 output of the USB digital output device to the signal source analyzer EXT TRIG/GATE IN back panel connector using a BNC(m)-to-BNC(m) cable. (Not pictured.)
   b) Connect the P0.0 output of the USB digital output device to the PXIe-5654 front panel PULSE IN connector using BNC(m)-to-SMB(f) cable.
The hardware setup is shown in the following figure.

**Figure 6. PULSE IN Operation Verification Equipment Setup**

1. USB-6501 Digital I/O Device
2. BNC(m)-to-SMB(f) Cable
3. PXIe-5654 RF Analog Signal Generator
4. PXIe-5696 Amplitude Extender
5. K(m)-to-K(m) Cable
6. Signal Source Analyzer

4. Create a new device session for the PXIe-5654 with PXIe-5696.

5. Configure the signal source analyzer using the following settings:
   - Reference level: 5 dBm
   - Start frequency: 0.25 MHz
   - Stop frequency: 10,000 MHz
   - Span (kHz): 2 KHz
   - Resolution bandwidth: 30 Hz
   - Video bandwidth: 100 Hz
   - RF attenuation: 30 dB

6. Configure the PXIe-5654 with PXIe-5696 using the following settings:
   - Pulse Modulation Enabled: TRUE
   - Frequency: 5 GHz
   - Power Level: 10 dBm
7. Commit the settings to hardware.
8. Initiate signal generation.
9. Enable the RF output.
10. Create a USB digital output channel for the Port 0, Line 0 of the USB digital output device.
11. Configure the channel to be Active Drive.
12. Enable the output on the channel created in step 10.
13. Start the USB digital output task for the channel.
14. Sweep the signal source analyzer and read the marker. This value is the OnPower.
15. Stop the USB digital output task.
16. Clear the USB digital output task.
17. Repeat steps 10 and 11, disabling the output of the USB digital output channel.
18. Sweep the signal source analyzer and read the marker. This value is the OffPower.
19. Verify that the following equation is true.
   \[ \text{OnPower} - \text{OffPower} \geq 80 \text{ dB} \]
20. Close the device sessions.

## Adjustment

This section describes the steps needed to adjust the PXIe-5654 with PXIe-5696 to meet published specifications. The PXIe-5696 is adjusted while connected to the PXIe-5654.

**Note** Adjusting the PXIe-5696 requires a calibrated 20 GHz PXIe-5654. If you performed verification using a 10 GHz PXIe-5654, power off the system and replace the 10 GHz PXIe-5654 with a 20 GHz PXIe-5654 prior to starting adjustment.

**Note** Before starting this adjustment on the PXIe-5654 with PXIe-5696, unassociate the PXIe-5654 and PXIe-5696 in MAX, then complete the adjustment procedures for the PXIe-5654 as a stand-alone device.

### Related Information

*For instructions on adjusting the PXIe-5654 as a stand-alone device, refer to the PXIe-5654 Calibration Procedure.*

## Measuring RF Attenuator Path Input Power

This procedure measures the input power used for PXIe-5696 attenuator path adjustments. Using the measured input power yields a more accurate adjustment for the PXIe-5696 attenuator paths.

1. Connect the PXIe-5654 RF OUT front panel connector to the power meter through the 20 dB attenuator as shown in the following figure.
1. PXIe-5654 RF Analog Signal Generator
2. PXIe-5696 Amplitude Extender
3. Power Meter
4. Power Sensor
5. SMA(f)-to-SMA(f) Adapter
6. 20 dB Attenuator

2. Initialize the power meter.
3. Initialize a new external calibration session for the PXIe-5696.
4. Call the niRFSG Initialize External Calibration VI using the appropriate password.

   **Note** The default password for password-protected operations is NI.

5. Call the niRFSG 5696 Attenuator Path Cal Initialize VI with the following inputs:
   - NI 5654 resource name
   - measurement port: Input Power
   - input power file: Specify a fully qualified path to the Atten_Zero_Loss.bin file

   **Note** The VI creates this file. Specify a path to a writeable location for the file.

6. Call the niRFSG 5696 Attenuator Path Cal Configure VI.
7. Measure the PXIe-5654 output power through the 20 dB attenuator with the power meter. Ensure that the power meter is settled within 0.1% before taking a measurement.
8. Correct the power meter reading for the RF frequency using the frequency to measure output of the niRFSG 5696 Attenuator Path Cal Configure VI.
9. Use the corrected reading from step 8 as the value of the **measured power** input of the niRFSG 5696 Attenuator Path Cal Adjust VI.

10. Repeat steps 6 through 9 until the **attenuator calibration complete** output of the niRFSG 5696 Attenuator Path Cal Adjust VI returns a value of TRUE.

11. Call the niRFSG Close External Calibration VI to close the session. Set the **write calibration to hardware?** parameter to TRUE.

### Adjusting RF Attenuator Path

This procedure characterizes the RF attenuator path in the PXIe-5696 and updates the values stored in the PXIe-5696 EE PROM. This adjustment yields a more accurate output power for the PXIe-5696 RF OUT.

1. Connect the PXIe-5654 RF OUT to the PXIe-5696 ATTN IN front panel connector through the 20 dB attenuator.

2. Connect the PXIe-5696 ATTN OUT front panel connector to the power meter as shown in the following figure.

   **Figure 8. PXIe-5696 RF Attenuator Path Adjustment Equipment Setup**

   ![Equipment Setup Diagram]

   1. PXIe-5654 RF Analog Signal Generator
   2. PXIe-5696 Amplitude Extender
   3. Power Meter
   4. Power Sensor
   5. 20 dB Attenuator

3. Initialize a new external calibration session for the PXIe-5696.
4. Call the niRFSG Initialize External Calibration VI using the appropriate password.

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

5. Call the niRFSG 5696 Attenuator Path Cal Initialize VI with the following inputs:
   • NI 5654 resource name
   • measurement port: Output Power

6. Select the file created during Measuring RF Attenuator Path Input Power on page 26 as the input power file of the niRFSG Attenuator Path Cal Initialize VI.

7. Call the niRFSG 5696 Attenuator Path Cal Configure VI.

8. Measure the PXIe-5696 output power with the power meter. Correct the measurement using the frequency to measure output of the niRFSG 5696 Attenuator Path Cal Configure VI. Ensure that the power meter is settled within 0.1% before taking a measurement.

9. Use the corrected measurement from step 8 as the value of the measured power input of the niRFSG 5696 Attenuator Path Cal Adjust VI.

10. Repeat steps 7 through 9 until the attenuator calibration complete output of the niRFSG 5696 Attenuator Path Cal Adjust VI returns a value of TRUE.

11. Call the niRFSG Close External Calibration VI to close the session. Set the write calibration to hardware? parameter to TRUE to store the results to the EEPROM on the PXIe-5696.

Adjusting RF Attenuator Accuracy

This procedure characterizes the RF attenuator in the PXIe-5696 and updates the values stored in the PXIe-5696 EEPROM. This adjustment yields a more accurate output power for the PXIe-5696 RF OUT.

1. Connect the power sensor directly to the PXIe-5696 RF OUT front panel connector as shown in the following figure.
1. PXIe-5654 RF Analog Signal Generator
2. PXIe-5696 Amplitude Extender
3. Power Meter
4. Power Sensor

1. PXIe-5654 RF Analog Signal Generator
2. PXIe-5696 Amplitude Extender
3. Power Meter
4. Power Sensor

2. Initialize a new external calibration session for the PXIe-5696.
3. Call the niRFSG Initialize External Calibration VI using the appropriate password.

**Note** The default password for password-protected operations is **NI**.

4. Call the niRFSG 5696 Attenuator Cal Initialize VI with the NI 5654 resource name as input.
5. Call the niRFSG 5696 Attenuator Cal Configure VI.
6. Measure the PXIe-5696 output power with the power meter. Correct the measurement using the **frequency to measure** output of the niRFSG 5696 Attenuator Cal Configure VI. Ensure that the power meter is settled within 0.1% before taking a reading.
7. Use the reading from step 6 as the value of the **measured power** input of the to niRFSG 5696 Attenuator Cal Adjust VI.
8. Repeat steps 6 and 7 until the **attenuator calibration complete** output of the niRFSG 5696 Attenuator Cal Adjust VI returns a value of TRUE.
9. Call the niRFSG Close External Calibration VI to close the session. Set the **write calibration to hardware?** parameter to TRUE to store the results to the EEPROM on the PXIe-5696.
Measuring Amplifier Path Input Power

This procedure measures the input power used for PXIe-5696 RF amplifier path adjustments. Using the measured input power yields a more accurate adjustment.

1. Connect the PXIe-5654 RF OUT front panel connector directly to the power meter as shown in the following figure.

**Figure 10. PXIe-5696 Amplifier Path Input Power Measurement Equipment Setup**

2. Initialize the power meter.
3. Initialize a new external calibration session for the PXIe-5696.
4. Call the niRFSG Initialize External Calibration VI using the appropriate password.

   **Note** The default password for password-protected operations is NI.

5. Call the niRFSG 5696 Amplifier Cal Initialize VI with the following inputs:
   - NI 5654 resource name
   - path to calibrate: High Power
measurement port: Input Power
input power file: Specify a fully qualified path to the High_Power_Path_Input_Power.bin file

Note: The VI creates this file. Specify a path to a writeable location for the file.

6. Call the niRFSG 5696 Amplifier Cal Configure VI.
7. Measure the PXIe-5654 output power with the power meter. Ensure that the power meter is settled within 0.1% before taking a measurement.
8. Correct the measurement from step 7 using the frequency to measure output of the niRFSG 5696 Amplifier Cal Configure VI.
9. Use the corrected reading from step 8 as the value of the measured power input of the niRFSG 5696 Amplifier Cal Adjust VI.
10. Repeat steps 6 through 9 until the amp calibration complete output of the niRFSG 5696 Amplifier Cal Adjust VI returns a value of TRUE.
11. Call the niRFSG Close External Calibration VI to close the session. Set the write calibration to hardware? parameter to TRUE.
12. Repeat steps 5 through 10 with the following inputs:
   - path to calibrate: Low Harmonic
   - measurement port: Input Power
   - input power file: Specify a fully qualified path to the Low_Harmonic_Path_Input_Power.bin file
     Note: The VI creates this file. Specify a path to a writeable location for the file.
13. Call the niRFSG Close External Calibration VI to close the session. Set the write calibration to hardware? parameter to TRUE.

Adjusting Amplitude Accuracy (Low Harmonic Paths)

This procedure characterizes the low harmonic paths in the PXIe-5696 and updates the values stored in the PXIe-5696 EEPROM. This adjustment yields a more accurate output power for the PXIe-5696 RF OUT.

1. Connect the power sensor directly to the PXIe-5696 RF OUT front panel connector as shown in the following figure.
Figure 11. PXIe-5696 Amplitude Accuracy (Low Harmonic Paths) Adjustment

Equipment Setup

1. PXIe-5654 RF Analog Signal Generator
2. PXIe-5696 Amplitude Extender
3. Power Meter
4. Power Sensor

2. Initialize a new external calibration session for the PXIe-5696.
3. Call the niRFSG Initialize External Calibration VI using the appropriate password.
   
   **Note** The default password for password-protected operations is NI.

4. Call the niRFSG 5696 Amplifier Cal Initialize VI with the following inputs:
   - **path to calibrate**: Low Harmonic
   - **measurement port**: Output Power

5. Select the file created during Measuring Amplifier Path Input Power on page 31 for the Low Harmonic path as the input power file of the niRFSG Amplifier Cal Initialize VI.

6. Call the niRFSG 5696 Amplifier Cal Configure VI.

7. Measure the PXIe-5696 output power with the power meter. Correct the measurement using the frequency to measure output of the niRFSG 5696 Amplifier Cal Configure VI. Ensure that the power meter is settled within 0.1% before taking a reading.

8. Use the reading from step 7 as the value of the measured power input of the niRFSG 5696 Amplifier Cal Adjust VI.
9. Repeat steps 7 and 8 until the **amp calibration complete** output from the niRFSG 5696 Amplifier Cal Adjust VI returns a value of TRUE.

10. Call the niRFSG Close External Calibration VI to close the session. Set the **write calibration to hardware?** parameter to TRUE to store the results to the EEPROM on the PXIe-5696.

**Related Information**

*Measuring Amplifier Path Input Power* on page 31

**Adjusting Amplitude Accuracy (High Power Paths)**

This procedure characterizes the high power paths in the PXIe-5696 and updates the values stored in the PXIe-5696 EEPROM. This adjustment yields a more accurate output power for the PXIe-5696 RF OUT.

1. Connect the power sensor directly to the PXIe-5696 RF OUT front panel connector as shown in the following figure.

**Figure 12. PXIe-5696 Amplitude Accuracy (High Power Paths) Adjustment Equipment Setup**

![Diagram of equipment setup](image-url)
2. Initialize a new external calibration session for the PXIe-5696.
3. Call the niRFSG Initialize External Calibration VI using the appropriate password.
   
   Note  The default password for password-protected operations is NI.

4. Call the niRFSG 5696 Amplifier Cal Initialize VI with the following input parameters:
   - path to calibrate: High Power
   - measurement port: Output Power

5. Select the file created during Measuring Amplifier Path Input Power on page 31 for the High Power path as the input power file of the niRFSG Amplifier Cal Initialize VI.

6. Call the niRFSG 5696 Amplifier Cal Configure VI.

7. Measure the PXIe-5696 output power with the power meter. Correct the measurement using the frequency to measure output of the niRFSG 5696 Amplifier Cal Configure VI. Ensure that the power meter is settled within 0.1% before taking a reading.

8. Use the reading from step 7 as the value of the measured power input of the niRFSG 5696 Amplifier Cal Adjust VI.

9. Repeat steps 7 and 8 until the amp calibration complete output from the niRFSG 5696 Amplifier Cal Adjust VI returns a value of TRUE.

10. Call the niRFSG Close External Calibration VI to close the session. Set the write calibration to hardware? parameter to TRUE to store the results to the EEPROM on the PXIe-5696.

Related Information
Measuring Amplifier Path Input Power on page 31

Adjusting ALC

This procedure characterizes the ALC path in the PXIe-5654 with PXIe-5696 and updates the values stored in the PXIe-5696 EEPROM. This adjustment yields a more accurate output power for the PXIe-5696 RF OUT.

1. Connect the power sensor directly to the PXIe-5696 RF OUT front panel connector as shown in the following figure.
2. Initialize a new external calibration session for the PXIe-5696.
3. Call the niRFSG Initialize External Calibration VI using the appropriate password.

   **Note**  The default password for password-protected operations is **NI**.

4. Call the niRFSG 5696 ALC Cal Initialize VI.
5. Call the niRFSG 5696 ALC Cal Configure VI
6. Measure the PXIe-5696 output power with the power meter. Correct the measurement using the **frequency to measure** output of the niRFSG 5696 ALC Cal Configure VI. Ensure that the power meter is settled within 0.1% before taking a reading.
7. Use the reading from step 6 as the **measured power** input of the niRFSG 5696 ALC Cal Adjust VI.
8. Repeat steps 6 and 7 until **ALC calibration complete** output of the niRFSG 5696 ALC Cal Adjust VI returns a value of TRUE.
9. Call the niRFSG Close External Calibration VI to close the session. Set the **write calibration to hardware?** parameter to TRUE to store the results to the EEPROM on the PXIe-5696.
Reverification

Repeat the Verification section to determine the as-left status of the PXIe-5654 or the PXIe-5696.

Note If any test fails reverification after performing an adjustment, verify that you have met the test conditions before returning your PXIe-5654 or PXIe-5696 to NI. Refer to the Worldwide Support and Services section for information about support resources or service requests.

Updating Calibration Date and Time

This procedure updates the date and time of the last calibration of the PXIe-5696.

1. Call the niRFSG Initialize External Calibration VI.
2. Call the niRFSG Update External Calibration Date and Time VI.
3. Call the niRFSG Close External Calibration VI to close the session. Set the write calibration to hardware? parameter to TRUE to store the results to the EEPROM on the PXIe-5696.

Worldwide Support and Services

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

Visit ni.com/services for 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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