NI PXI-5660 Help

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This help file contains hardware and software information for NI RF signal analyzers. This file contains an introduction to fundamental RF Signal Analyzer concepts, guidelines for accurate measurements, ni5660 VI reference information, and links to related documentation.

To navigate this help file, use the **Contents**, **Index**, and **Search** tabs to the left of this window.

For more information about this help file, refer to the following topics:

Conventions—formatting and typographical conventions in this help file

Important Information

Technical Support and Professional Services

To comment on the documentation, email techpubs@ni.com

Conventions

This help file uses the following conventions:

< >	Angle brackets that contain numbers separated by an ellipsis represent a range of values associated with a bit or signal name—for example, DBIO<3..0>.
[ ]	Square brackets enclose optional items—for example, [response].
»	The » symbol leads you through nested menu items and dialog box options to a final action. The sequence **File»Page Setup»Options** directs you to pull down the **File** menu, select the **Page Setup** item, and select **Options** from the last dialog box.
	This icon denotes a tip, which alerts you to advisory information.
	This icon denotes a note, which alerts you to important information.
bold	Bold text denotes items that you must select or click on in the software, such as menu items and dialog box options. Bold text also denotes parameter names, emphasis, or an introduction to a key concept.
green	Underlined text in this color denotes a link to a help topic, help file, or Web address.
italic	Italic text denotes variables or cross references. This font also denotes text that is a placeholder for a word or value that you must supply.
monospace	Text in this font denotes text or characters that you should enter from the keyboard, sections of code, programming examples, and syntax examples. This font is also used for the proper names of disk drives, paths, directories, programs, subprograms, subroutines, device names, functions, operations, variables, filenames, and extensions.
monospace italic	Italic text in this font denotes text that is a placeholder for a word or value that you must supply.

Key Terms

You may find the following definitions helpful as you use this document:

Digitizer

Downconverter

IF

Module

ni5660

PLL

RF

RF Vector Signal Analyzer

Digitizer A device that converts analog voltages into digital representations and stores the results in memory; refers to the NI 5620 IF digitizer hardware module.

Downconverter A device that frequency-translates RF signals to center around a specified IF frequency—refers to the NI 5600 3-slot RF downconverter hardware module.

IF Refers to the signal passed from the NI 5600 RF downconverter module front panel OUTPUT connector to the NI 5620 IF digitizer module front panel INPUT connector.

Module Refers to one of the hardware components of the RF Signal Analyzer: the NI 5620 IF digitizer or the NI 5600 RF downconverter.

ni5660 Refers to the set of LabVIEW virtual instruments (VIs) included with the RF Vector Signal Analyzer hardware. The ni5660 VIs operate both the NI 5620 IF digitizer module and the NI 5600 RF downconverter module as a single instrument for data acquisition.

PLL Phase-Locked Loop—an electronic circuit that controls an oscillator so that the circuit maintains a constant phase angle relative to a reference signal.

RF Radio Frequency—refers to the signal input to the INPUT connector on the NI 5600 RF downconverter module front panel.

RF Vector Signal Analyzer Refers to the NI PXI-5660 RF Vector Signal Analyzer device consisting of the NI 5620 IF digitizer module, the NI 5600 RF downconverter module, and software included on the *NI-RFSA* CD. There is no single physical device labeled NI PXI-5660 RF Vector Signal Analyzer.

ni5660 VI Fundamentals

This section provides an introduction to some basic concepts central to use of the NI 5660 RF Vector Signal Analyzer and the ni5660 VIs.

- ni5660 VI Programming Flow
- Small Span Signals and Sample Rates
- RF Attenuation and Signal Levels

- Add-On Software for Measurement and Analysis
- Programming Examples
- Guidelines for Making Accurate Measurements

Refer to the *Related Documentation* section for more information about setup of the RF Signal Analyzer hardware and software, and advanced use of the ni5660 VIs.

Small Span Signals and Sample Rates

DDC Considerations

The IF digitizer module contains an onboard DDC chip that is enabled when acquiring complex IQ data from signals less than 1.25 MHz in bandwidth. DDC span settings must be considered when acquiring signals using the DDC.

DDC Span Settings

The DDC hardware has eight discrete bandwidth settings. The DDC hardware bandwidth setting is automatically calculated based on the value of the **bandwidth** input parameter of the ni5660 Configure for IQ VI or the **span** input parameter of the ni5660 Configure for Spectrum VI. Each DDC bandwidth setting is associated with decimation and sample rates according to the following formula:

$$SampleRate = \frac{64MSamples/s}{Decimation}$$

You must always specify a ni5660 Configure for IQ VI **bandwidth** parameter wider than the bandwidth of your incoming modulated wave to avoid data loss.

Tip DDC bandwidth settings have a large effect on application speed because they determine the amount of IQ data acquired and processed. If you modify your test setup to use a VI **bandwidth** parameter narrow enough for the DDC hardware to use a smaller bandwidth setting, your application realizes a significant increase in speed.

The following table relates DDC span settings to decimation and sample rates:

DDC Hardware Bandwidth Setting	Associated Decimation Rate	Resulting Sample Rate
1.25 MHz	32	2 MS/s
800 kHz	64	1 MS/s
400 kHz	128	500 kS/s
200 kHz	256	250 kS/s
100 kHz	512	125 kS/s
50 kHz	1024	62,500 S/s
25 kHz	2048	31,250 S/s
12.5 kHz	4096	15,625 S/s

Bandwidth Coercion

If the **bandwidth** parameter specified in the ni5660 Configure for IQ VI or the ni5660 Configure for Spectrum VI does not match an available DDC bandwidth setting, the DDC bandwidth setting is coerced to the next graduation above the value specified in the **bandwidth** parameter. For example, a **bandwidth** input value of 801 kHz sets the DDC bandwidth to 1.25 MHz.

If the DDC bandwidth setting is coerced, the raw IQ data is acquired using a DDC bandwidth setting wider than the **bandwidth** parameter specified in the ni5660 Configure for IQ VI or the ni5660 Configure for Spectrum VI.

To find the sample rate of the IQ data returned from the DDC, use the reciprocal of the **dt** value output by the ni5660 Read IQ VI or the ni5660 Fetch IQ VI. You can also use the MT Get Attributes VI to query the value of the **receiver»IQ sample rate** attribute.

Note For more information on using the MT Get Attributes VI, refer to the *Modulation VIs Online Help*, accessible at **Start»Programs»National Instruments»Modulation»LabVIEW Support**, or run the VI and press <Ctrl-H>.

RF Attenuation and Signal Levels

This section describes how attenuation is handled by the ni5660 VIs. The user modifies attenuation through the **reference level** and **attenuation** parameters of the ni5660 Configure for Spectrum VI and the ni5660 Configure for IQ VI.

The **auto attenuation** option automatically selects an attenuation setting based on the user-specified **reference level**. Refer to the ni5660 Configure for Spectrum VI and the ni5660 Configure for IQ VI for details.

The Hardware

The RF downconverter module has five programmable attenuators: three RF attenuators at the beginning of its signal chain and two IF attenuators near the end of the signal chain. They are set up in the following sequence:

Attenuator Sequence	
Attenuator	**Asserted Value**
RF Attenuator 1	20 dB
RF Attenuator 2	20 dB
RF Attenuator 3	10 dB
IF Attenuator 1	20 dB
IF Attenuator 2	10 dB

Attenuators are either set/asserted or not set/asserted. This allows a dynamic range of RF attenuation from 0–50 dB and a dynamic range of IF attenuation from 0–30 dB. Overall attenuation within the signal chain is the sum of all the attenuators set, for a range of 0–80 dB.

Reference Level and Mixer Level

Understanding the parts played by the reference level and the mixer level is key to setting the individual attenuators. NI–RFSA sets the RF attenuators first.

Let *D* be the difference between the reference level and the mixer level, such that

$$D = referenceLevel - mixerLevel$$

This formula correlates directly with the range of possible RF attenuator settings. Recall that the RF attenuators have a range of 0 - 50 dB. The coercions described in the previous section ensure that

$$mixerLevel < referenceLevel$$

and that

$$referenceLevel - mixerLevel \leq 50 \text{ dBm.}$$

D is then directly proportional to the total RF attenuation, a value between 0-50 dB.

The attenuators are set as follows (refer to the Attenuator Sequence table above):

RF Attenuator Settings	
D	**Attenuators**
0	None are set
10	RF Attenuator 3
20	RF Attenuator 1
30	RF Attenuators 1 and 3
40	RF Attenuators 1 and 2
50	RF Attenuators 1, 2, and 3

Add-On Software for Measurement and Analysis

The ni5660 VIs perform data acquisition using the RF Signal Analyzer. NI provides add-on software toolkits, such as the Spectral Measurements Toolkit (included) and the Modulation Toolkit, which extend the capability of the RF Signal Analyzer to include frequency- and modulation-domain measurements and analysis of analog- and digitally-modulated IF signals.

> **Note** To enable proper operation of the RF Signal Analyzer, you must install the *Spectral Measurements Toolkit* CD after installing the *NI-RFSA* CD.

Spectral Measurements Toolkit

Use the Spectral Measurements Toolkit (SMT) VIs and functions for frequency-domain analysis, measurement, and display of data acquired using the RF Vector Signal Analyzer. The SMT can perform several operations, including the following:

- Zoom FFT processing and spectrum averaging
- Spectral measurements such as band power, adjacent channel power, and peak frequency and magnitude Spectrogram display and analysis
- RF Vector Signal Analyzer hardware configuration for frequency-domain measurements

Refer to the Spectral Measurements Toolkit documentation, accessible from **Start»Programs»National Instruments»Spectral Measurements**, for complete information about SMT VIs and functions.

Modulation Toolkit

The Modulation Toolkit integrates with SMT and NI-RFSA for modulation/demodulation measurements and analysis. The Modulation Toolkit VIs and functions generate and analyze analog and digital modulated IF signals in FSK, MSK, PSK, QAM, AM, FM, and PM formats. The Modulation Toolkit is capable of measuring several aspects of signals generated by a unit under test, including the following:

- Modulation quality and modulation index
- Signal impairments, bit error rate, and phase noise
- Carrier frequency drift and complementary cumulative distribution functions (CCDF) values

Refer to the Modulation Toolkit documentation, accessible from **Start»Programs»National Instruments»Modulation**, for complete information about Modulation Toolkit VIs and functions.

Programming Examples

NI-RFSA includes several examples for LabVIEW. These examples are intended to serve as interactive tools, programming models, and building blocks in your own applications.

With LabVIEW running, select **Help»Find Examples** to launch the LabVIEW Example Finder. The Example Finder offers two ways to access all installed LabVIEW example VIs and their descriptions:

- Click the **Browse** tab to locate NI-RFSA examples by task at **Hardware Input and Output»Modular Instruments»NI-RFSA** or by directory structure at **instr»ni5660**.
- Click the **Search** tab to search all installed examples by keyword. Enter the keyword power, for instance, to locate an example that demonstrates making power in band measurements using the RF Signal Analyzer.

All installed NI-RFSA files are located in the <LabVIEW home>\examples\instr\ni5660 folder.

Spectral Measurements Toolkit Examples for the RF Signal Analyzer

The Spectral Measurements Toolkit includes LabVIEW examples for the RF Signal Analyzer. You can access the Spectral Measurements Toolkit examples at **Start»Programs»National Instruments»Spectral Measurements**.

Note Refer to the Spectral Measurements Toolkit documentation, accessible at **Start»Programs»National Instruments»Spectral Measurements**, for more information about the Spectral Measurements Toolkit software and examples.

Examples Available Online

Examples for the RF Signal Analyzer are also available online at ni.com/examples. Available examples demonstrate integration of the RF Signal Analyzer with the RF Signal Generator and NI toolkit software, including the Modulation Toolkit. Refer to the NI Developer Zone on the Web for more information.

Refer to the *Programming the NI 5660 in LabWindows/CVI* section in the *NI 5660 Getting Started Guide* for more information on the software subcomponents that install with the ni5660 VIs. The *NI 5660 Getting Started Guide* is accessible at **Start»Programs»National Instruments»NI-RFSA»Documentation**.

Guidelines for Making Accurate Measurements

This section provides guidelines for making accurate measurements with the RF Signal Analyzer hardware and software. Click one of the following measurements for more information:

- General Amplitude/Spectrum
- Harmonic Distortion
- Two-Tone Third-Order Intermodulation Distortion
- 1 dB Gain Compression
- Noise Figure

General Amplitude/Spectrum Measurement

Amplitude dynamic range is the difference between the maximum input level of a device and its minimum detectable signal level.

Dynamic range estimates the ability of the RF Signal Analyzer to distinguish and measure the amplitude difference of two signals. The RF Signal Analyzer can make signal measurements over a frequency range from 9 kHz to 2.7 GHz, and over an amplitude dynamic range of greater than 100 dB.

Signals of large amplitude can saturate the system and cause spurious effects. These "spurs" may be large enough to be mistaken for real signals. Avoid this effect by properly adjusting the amplitude of the incoming signal. Achieving proper signal levels may involve attenuating the signal before it gets to the first mixer, either by programming the internal attenuators or by using external attenuation.

The RF Signal Analyzer must be properly configured before making a measurement. A small signal can be buried in noise if the resolution bandwidth setting is too large. To measure a small signal, make sure that the input attenuators are switched off and lower the resolution bandwidth setting to reduce the noise content.

For signals below the noise floor of the RF Signal Analyzer, use an external low-noise amplifier (LNA) in front of the RF Signal Analyzer to raise the signal level. If the update speed is not fast enough to resolve a signal due to the processing demands imposed by a narrow resolution bandwidth, an LNA helps provided it does not significantly affect system linearity. For example, with a signal level of 100 dBm, set the resolution bandwidth to 1 kHz or less.

Harmonic Distortion Measurement

Harmonic distortion is a measure of the amount of power contained in the harmonics of a fundamental signal. Harmonic distortion is inherent to devices and systems that possess nonlinear characteristicsthe more nonlinear the device, the greater its harmonic distortion.

Harmonic distortion can be expressed as a power ratio or as a percentage ratio. Use the following formula to express it as a power ratio:

where P_{HD} is the power of the harmonic distortion in dBc, P_{fund} is the fundamental signal power in dB or dBm, and P_{harm} is the power of the harmonic of interest in dB or dBm.

Convert the powers to voltages to express harmonic distortion as a percentage ratio:

In some applications, the harmonic distortion is measured as a total percentage harmonic distortion (*THD*). This measurement involves the power summation of all the harmonics in the spectrum band, defined in the following equation:

A typical setup to perform a harmonic distortion measurement is shown in the figure below. A lowpass or bandpass filter passes the fundamental signal while suppressing its harmonics. This setup injects a very clean sinusoidal signal into the unit under test (UUT). Any harmonic content at the UUT output is assumed to be generated by the UUT instead of the source.

Typical Harmonic Distortion Measurement Setup

Understanding the RF Signal Analyzer Harmonic Distortion Limits

As with all analyzers, there are residual distortions inherent in the RF Signal Analyzer. It is important that these distortions do not corrupt your measurement.

The level of internal distortion is a function of the linearity of the system, which is primarily determined at the input mixer. Increasing input power at the mixer increases distortion, so if the input signal is too high, the internally generated harmonics overwhelm the harmonics of the original signal.

The specifications for the second- and third-order harmonic intercept points provide sufficient information about the linearity of the system. For example, to measure a second-order harmonic at –70 dBc, the fundamental power at the mixer input has to satisfy the following condition:

where IIP_2 is the second-order intercept point.

If the input signal power is greater than this value, the signal must be attenuated before the first mixer. There is an upper limit on the amount of attenuation you can switch in because the noise floor rises by the same amount as the attenuation. To lower the noise level decrease the resolution bandwidth, but keep in mind that there is also a practical lower limit on the resolution bandwidth. Decreasing the resolution bandwidth increases measurement time.

The harmonic distortion dynamic range (HDDR) indicates the minimum distortion the RF Signal Analyzer can measure, which is about 96 dBc/Hz for the RF Signal Analyzer.

Choosing an Optimal Setting for the RF Signal Analyzer

Because the level of harmonic distortion is often unknown, the optimal attenuation level can be difficult to determine. Complete the following steps to find the proper attenuation setting for the RF Signal Analyzer:

1. Set the attenuation so that the input power at the mixer is about 30 dBm. When using the RF Signal Analyzer Demo Panel,

   mixer level = reference level – attenuation.

2. Tune to the harmonic frequency of interest and then decrease the resolution bandwidth until the harmonic spur appears.
3. Increase the attenuation level. If the harmonic spur decreases, attenuate more.
4. Repeat step 3 until the harmonic level does not decrease any further. Attenuation does not lower the harmonics of the original signal; it only lowers the internally generated ones.
5. Decrease the resolution bandwidth to lower the noise floor.

This setting is the optimal attenuation setting.

Two-Tone Third-Order Intermodulation Distortion Measurement

Two-tone third-order intermodulation distortion (IMD_3) is the measure of the third-order distortion products produced by a nonlinear device when two tones closely spaced in frequency are fed into its input. This distortion product is usually so close to the carrier that it is almost impossible to filter out and can cause interference in multichannel communications equipment.

If F_1 and F_2 are the frequencies of the two tones, then the third-order distortion products occur on both sides of these tones at $2F_2 – F_1$ and $2F_1 – F_2$. Assuming that the power levels of the two tones are equal, IMD_3 is the difference between the power of the fundamental signals and the third-order products, as defined in the following equation:

where $_o$ refers to the output of the UUT, P_{o3} is the power level of one of the output third-order products, and P_o is the power level of one of the fundamental tones.

The math becomes more involved if the powers of the two tones are different. Once the IMD_3 is measured, calculate the UUT output third-order intercept point (OIP_3) using the following equation:

The input third-order intercept point (IIP_3) is defined as:

where G is the gain of the device. The IIP_3 number quantifies the third-order linearity of a device. Use the IIP_3 specification of the RF Signal Analyzer as a guide to optimize its settings when measuring the IMD_3 of an external device.

The two tones injected into the UUT must be free from any third-order products. These two tones are combined, or summed, at or before the UUT input. If they are not well isolated, they intermodulate with each other and cause distortion. A signal combiner with good input-to-input isolation is recommended to minimize distortion of the input tones.

Measurement Setup

A typical IMD_3 measurement setup is shown in the figure below. Lowpass filters are employed at the source outputs to suppress harmonics.

Typical IMD_3 Measurement Setup

Understanding Two-Tone Third-Order Intermodulation Distortion Limits of the RF Signal Analyzer

The RF Signal Analyzer generates its own distortion spurs, which are capable of swamping the P_{o3} of the UUT and giving rise to an erroneous measurement. Too much power at the signal input of the RF Signal Analyzer may drive the system into a nonlinear region of operation and produce very large distortion products. Choosing an appropriate attenuation setting for the RF Signal Analyzer minimizes its IMD_3 contribution to the measurement. The IMD_3 improves by 2 dB for every 1 dB of input power decrement.

To measure the IMD_3 of a UUT, input power to the RF Signal Analyzer mixer must satisfy the following condition:

where IIP_{3rfsa} is the input third-order intercept point of the RF Signal Analyzer (about 10 dBm). For example, to accurately measure an IMD_3 of 80 dBc the input power to the mixer must be less than 31.5 dBm.

If the powers of two-tone signals are larger than this optimal level, they must be attenuated, either with the attenuators internal to the RF Signal Analyzer or with external attenuators. However, as attenuation raises the noise floor of the RF Signal Analyzer, there is a limit to how much attenuation can be used before noise overwhelms the distortion spurs. Its spurious-free dynamic range (SFDR) specification indicates the largest IMD_3 value the RF Signal Analyzer can accurately measure, assuming 0 dB attenuation and input signals whose powers satisfy the above equation.

Choosing an Optimal Setting for the RF Signal Analyzer

Complete the following steps to set optimal attenuation levels for an IMD3 measurement when the level of the third-order distortion spur (P_{o3}) is unknown:

1. Set the attenuation so that the input power at the mixer is about 30 dBm. When using the RF Signal Analyzer Demo Panel,

   mixer level = reference level – attenuation.
2. Tune to the third-order distortion product frequency of interest, either $2F_2 - F_1$ or $2F_1 - F_2$. Then decrease the resolution bandwidth until a distortion spur appears.
3. Increase the attenuation level.
4. If the harmonic spur decreases, repeat step 3.
5. Repeat step 4 until the harmonic level does not decrease any further. Attenuation does not lower the distortion products of the signal; it only lowers the distortion products generated internally to the RF Signal Analyzer. Decrease the resolution bandwidth to lower the noise floor.

This setting is the optimal attenuation setting.

Noise Figure Measurement

All devices have inherent noise. When noise is quantified, it is usually referred to the device input. In other words, all noise power a UUT inherits is assumed to come from its input. The noise figure of a UUT is the ratio in dB of its noise power to the noise power that a matched resistive load would deliver at room temperature. If you terminate a UUT input with a matched resistive load (typically 50 Ω) and measure the noise power density at its output (N_o), the noise figure (*NF*) is given by the following equation:

$$NF = 10\log\left(\frac{N_o/G}{kT_0}\right)$$

where G is the power gain of the UUT, $k \approx 1.38 \times 10^{-23}$ is Boltzmanns constant, and $T_0 \approx 290°$ K is the room temperature.

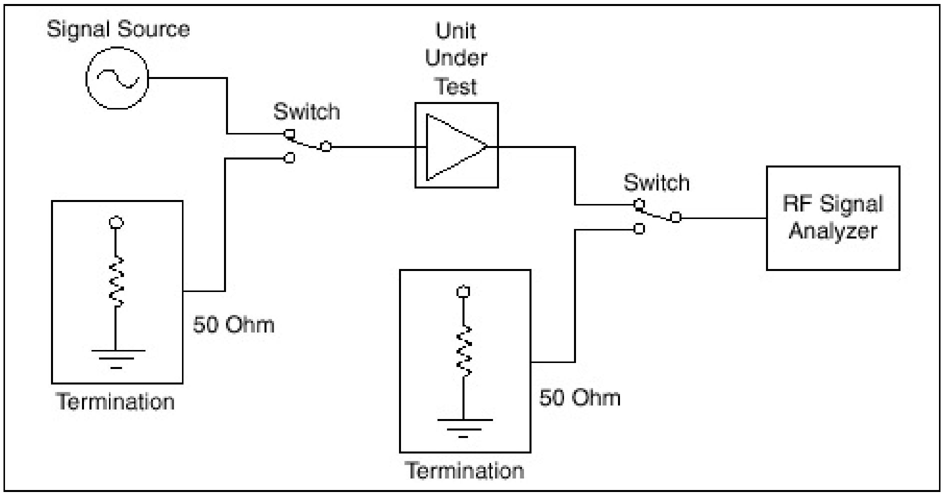
If you use the RF Signal Analyzer to measure the output noise of a UUT, the result of the measurement contains not only UUT noise but also noise intrinsic to the RF Signal Analyzer. If the UUT gain (G) is known, compute the noise figure of the UUT with the following equation:

$$NF = 10\log\left(\frac{N_m - N_{rfsa}}{kT_o} + 1\right) - 10\log G$$

where N_{rfsa} is the noise measured by the RF Signal Analyzer when its input is terminated with a matched resistive load and N_m is the measured noise with UUT attached. Both N_{rfsa} and N_m are given in Watts; G is a linear power gain.

Measurement Setup

A typical noise figure measurement setup is shown in the figure below:



Typical Noise Figure Measurement Setup

Measuring Noise Figure with the RF Signal Analyzer

To measure the noise figure, perform the following steps:

1. Turn on the RF Signal Analyzer and let it warm up for 20 minutes.
2. Turn on the UUT if it is active.
3. Set the RF Signal Analyzer to the frequency of interest, and decrease the resolution bandwidth to about 1 kHz.
4. Terminate the RF Signal Analyzer input with a broadband resistive load.
5. Obtain an average reading of the noise level. Make sure to take enough readings to obtain a good average.
6. Convert a reading taken in dBm to watts and normalize it to 1 Hz by dividing by the resolution bandwidth. This value is the noise floor of the RF Signal Analyzer at that frequency, which is N_{rfsa} in this document.
7. Remove the load termination from the RF Signal Analyzer input.
8. Attach the output of the UUT to the RF Signal Analyzer input.
9. Input a known small signal into the UUT input. This signal level should be less then 10 dB below the 1 dB compression point of the UUT.
10. Measure the output signal level on the RF Signal Analyzer to determine the gain (G) of the UUT.
11. Remove the signal source and terminate the UUT input with a broadband resistive load.
12. Make another averaged reading of the noise with the UUT attached by repeating steps 5 and 6. This average is the noise value for the UUT and the RF Signal Analyzer (N_{m}).
13. Substitute your values into the equation:

$$NF = 10\log\left(\frac{N_m - N_{rfsa}}{kT_o} + 1\right) - 10\log G$$

as follows to determine the UUT noise figure:

- The value from step 6 is N_{rfsa}
- The value from step 10 is G
- The value from step 12 is N_{m}

ni5660 VI Programming Reference

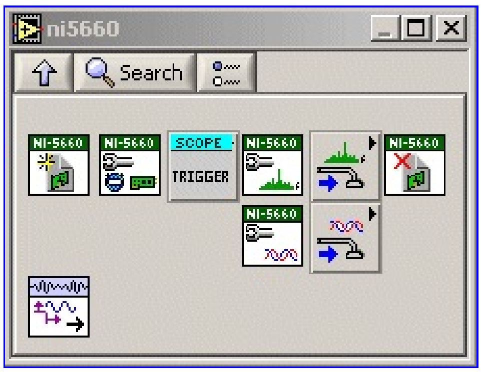
This section provides reference and programming information regarding the ni5660 VIs and installed examples.

Refer to the *Fundamentals* section for an introduction to basic concepts of the ni5660 VIs. For in-depth information on programming, refer to the *ni5660 LabVIEW VI Reference* for more information about using specific LabVIEW VIs. Refer to the *Related Documentation* section for more information about advanced use of the ni5660 VIs, and setup of the RF Signal Analyzer hardware and software.

ni5660 LabVIEW VI Reference Help

Use the ni5660 VIs on the **ni5660** palette to build the block diagram.

Click the icons for VI descriptions.

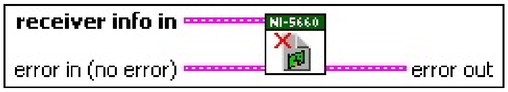


ni5660 Close

This VI performs the following actions:

- Aborts any signal acquisition in progress.
- Terminates the instrument I/O session.
- Destroys the instrument driver session and any attributes.

Call this VI to end every session with the ni5660 VIs.



receiver info in is the instrument handle that you obtain from the ni5660 Initialize VI. The handle identifies a particular RF Signal Analyzer session.

error in accepts error information wired from previously called VIs.

The pop-up option **Explain Error** (or Explain Warning) gives more information about the error displayed.

- **status** boolean is either TRUE (X) for an error, or FALSE (checkmark) for no error or a warning. The pop-up option **Explain Error** (or Explain Warning) gives more information about the error displayed.
- **code** input identifies the error or warning. The pop-up option **Explain Error** (or Explain Warning) gives more information about the error displayed.
- **source** string describes the origin of the error or warning. The pop-up option **Explain Error** (or Explain Warning) gives more information about the error displayed.

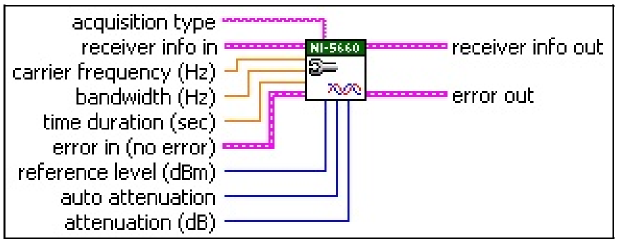
error out passes error or warning information out of a VI to be used by other VIs. The pop-up option **Explain Error** (or Explain Warning) gives more information about the error displayed.

- **status** is TRUE (X) if an error occurred, or FALSE (checkmark) for no error or a warning. The pop-up option **Explain Error** (or Explain Warning) gives more information about the error displayed.
- **code** identifies the error or warning. The pop-up option **Explain Error** (or Explain Warning) gives more information about the error displayed.
- **source** describes the origin of the error or warning. The pop-up option **Explain Error** (or Explain Warning) gives more information about the error displayed.

ni5660 Configure for IQ

This VI configures the RF Signal Analyzer hardware to acquire a time-domain signal with IQ settings you specify. **Carrier frequency**, **bandwidth**, and **acquisition time** settings define the IQ data. You can configure the acquisition to be finite or continuous.

This VI configures the **reference level** and **attenuation** settings used by the RF downconverter module, and the horizontal settings and **acquisition type** used by the IF digitizer module.



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acquisition type specifies whether the acquisition is finite or continuous.
Default Value: FINITE

receiver info in is the instrument handle that you obtain from the ni5660 Initialize VI. The handle identifies a particular RF Signal Analyzer session.

carrier frequency (Hz) specifies the expected carrier frequency of the incoming signal for demodulation. The RF Signal Analyzer tunes to this frequency. This value may be coerced based on hardware settings and downconversion specifications.
Default Value: 100 MHz

bandwidth (Hz) specifies the 0.01 dB down filter bandwidth of the software filter that is used in the downconversion process. Set this value equal to the bandwidth in Hz of the modulated wave. This value may be coerced based on hardware settings and downconversion specifications.
Default Value: 1 MHz

time duration (sec) specifies the time duration/interval in seconds over which to acquire IQ data. This control is ignored if **acquisition type** is set to CONTINUOUS.
Default Value: 10 µseconds

error in accepts error information wired from previously called VIs.

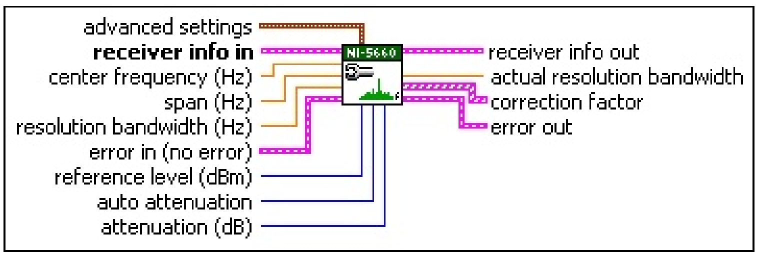
The pop-up option **Explain Error** (or Explain Warning) gives more information about the error displayed.

- **status** boolean is either TRUE (X) for an error, or FALSE (checkmark) for no error or a warning. The pop-up option **Explain Error** (or Explain Warning) gives more information about the error displayed.
- **code** input identifies the error or warning. The pop-up option **Explain Error** (or Explain Warning) gives more information about the error displayed.
- **source** string describes the origin of the error or warning. The pop-up option **Explain Error** (or Explain Warning) gives more information about the error displayed.

ni5660 Configure for Spectrum

This VI configures the RF Signal Analyzer hardware to acquire a frequency-domain spectrum with spectral settings you specify. **Center frequency**, **span**, and **resolution bandwidth** parameter settings define the spectrum. You can also specify **window type**, number of **spectral lines**, and **resolution bandwidth (RBW) definition**.

This VI configures the **reference level** and **attenuation** settings used by the RF downconverter module, and the horizontal settings and **acquisition type** used by the IF digitizer module. It returns a **correction factor** array. Wire this output to the **correction factor** input parameter of the ni5660 Read Averaged Power Spectrum VI or ni5660 Read FFT Spectrum VI.



receiver info in is the instrument handle that you obtain from the ni5660 Initialize VI. The handle identifies a particular RF Signal Analyzer session.

advanced settings parameters specify additional spectrum characteristics. These optional inputs are necessary only if you want to use a specific **window**, define the exact number of **spectral lines**, or change the **RBW definition**.

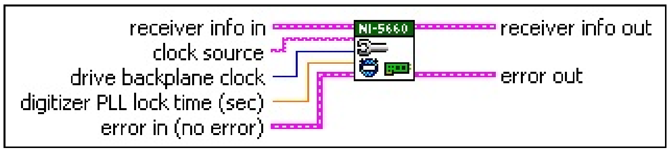
window specifies the time-domain window the VI uses. The VI handles the scaling effects of the window. You can select one of the following values for **window**:

0:	Uniform (no window)
1:	Hanning
2:	Hamming
3:	Blackman-Harris
4:	Exact Blackman
5:	Blackman
6:	Flat Top
7:	4-term Blackman-Harris
8:	7-term Blackman-Harris
9:	Low side lobe

Default Value: 7-term Blackman-Harris

ni5660 Configure Reference Clock

Use this function to configure the reference clock source for the RF Signal Analyzer. Reference clock source options include the high-stability oven-controlled crystal oscillator (OCXO) onboard the RF downconverter module (**On Board Clock**), a 10 MHz reference clock from an external source (**Ref In**), or the PXI backplane (**PXI Clock 10**). You can optionally use this VI to drive the PXI backplane using the specified reference clock source.



receiver info in is the instrument handle that you obtain from the ni5660 Initialize VI. The handle identifies a particular RF Signal Analyzer session.

clock source specifies the RF Signal Analyzer reference clock source. Select one of the following options:

- **Ref In** — Locks the RF downconverter module reference to an external reference signal connected to the FREQ REF IN connector on the RF downconverter module front panel.
- **On Board Clock** — Sets the RF downconverter module internal reference clock as the RF downconverter module timebase.
- **PXI Clock 10** — Locks the RF downconverter module internal reference to the PXI backplane. This option is useful only when the onboard PXI clock is locked to a more accurate reference (such as a PXI-6608 or another RF downconverter module) installed in PXI Slot 2. To use this option, connect the PXI 10 MHz I/O connector to the FREQ REF IN connector on the RF downconverter module front panel.

Default Value: On Board Clock

drive backplane clock specifies whether the reference clock specified in the **clock source** parameter is propagated to the PXI backplane. When **drive backplane clock** is FALSE (default), the PXI backplane is independent of the RF Signal Analyzer timebase. When **drive backplane clock** is TRUE, the PXI backplane is driven by the specified RF Signal Analyzer **clock source**.
Default Value: FALSE

Note This option is only available when the RF downconverter module is installed in PXI Slot 2, and the PXI 10 MHz I/O connector is wired to the 10 MHz OUT connector on the NI 5600 RF downconverter module front panel as shown in Overview.

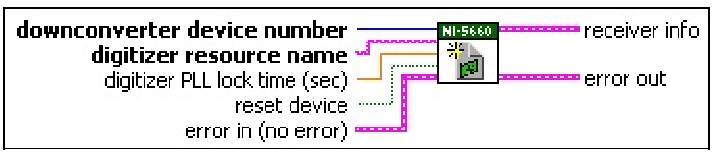
digitizer PLL lock time (sec) specifies time in seconds for which the digitizer module reference clock must be phase-locked to the 10 MHz reference of the downconverter module before execution. For most measurements, the PLL may be considered stable after 1 second, but NI recommends a **digitizer**

ni5660 Initialize

Purpose

This VI performs the following initialization actions:

- Creates a new instrument driver session to the RF signal analyzer, using the **downconverter device number** and the **digitizer resource name** you specify
- Sends initialization commands to reset both hardware modules to a known state necessary for NI-RFSA operation
- Sets the RF downconverter module onboard clock as the RF Signal Analyzer reference clock source. When all the PLLs lock correctly, the STATUS light on the RF downconverter module is activated.



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downconverter device number specifies the number of the RF downconverter module to initialize. This number is obtained from Measurement & Automation Explorer (MAX). Specify the downconverter device number without modifiers.
Default Value: 1

digitizer resource name specifies specifies the resource name of the IF digitizer module to initialize. This number is obtained from Measurement & Automation Explorer (MAX). Specify the digitizer resource name using the following syntax:
DAQ::*DeviceNumber*.
Default Value: DAQ::2

digitizer PLL lock time (sec) specifies time in seconds for which the digitizer module reference clock must be phase-locked to the 10 MHz reference of the downconverter module before execution. For most measurements, the PLL may be considered stable after 1 second, but NI recommends a **digitizer PLL lock time** of 4 seconds to ensure complete settling and utmost accuracy for phase measurements.
Default Value: 1 second

Tip Setting **PLL lock time** to 0 means that the VI does not wait for the PLL to settle before returning. Use this option when it is acceptable for your program to continue executing while the digitizer module PLL settles in the background, or when you intend to change the reference clock configuration using the ni5660 Configure Reference Clock VI.

reset device specifies whether the RF Signal Analyzer is reset at each call to this VI. When **reset device** is TRUE, the digitizer module is reconfigured with each call to this VI. When **reset device** is FALSE, this VI employs internal state caching that resets the digitizer module only on the initial call, even if this VI is called repetitively in your program.
Default Value: TRUE

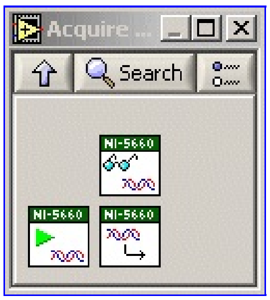
error in accepts error information wired from previously called VIs.

The pop-up option **Explain Error** (or Explain Warning) gives more information about the error displayed.

ni5660 Acquire IQ Palette

Use the VIs on the **ni5660»Acquire IQ** subpalette to acquire continuous and finite IQ data.

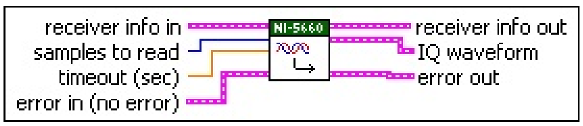
Click the icons for VI descriptions.



ni5660 Fetch IQ

This VI returns the IQ waveform acquired by the RF Signal Analyzer during a previously initiated acquisition. This VI returns IQ data computed through a process of filtering, decimation, and downconversion. Use this VI with the ni5660 Initiate VI when continuously acquiring data.

Note Continous IQ acquisition is only possible for bandwidths smaller than 1.25 MHz. Refer to Small Span Signals and Sample Rates for more information.



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receiver info in is the instrument handle that you obtain from the ni5660 Initialize VI. The handle identifies a particular RF Signal Analyzer session.

samples to read specifies the number of samples to fetch. A value of –1 fetches the actual record length.
Default Value: –1

timeout (sec) specifies the maximum amount of time in seconds to wait for the acquisition to finish. After this amount of time, the VI returns an error if the acquisition is not complete. If this parameter is set to 0, it returns immediately without checking the acquisition status. If this parameter is set to –1, the function waits forever.
Default Value: 5 seconds

error in accepts error information wired from previously called VIs.

The pop-up option **Explain Error** (or Explain Warning) gives more information about the error displayed.

status boolean is either TRUE (X) for an error, or FALSE (checkmark) for no error or a warning. The pop-up option **Explain Error** (or Explain Warning) gives more information about the error displayed.

code input identifies the error or warning. The pop-up option **Explain Error** (or Explain Warning) gives more information about the error displayed.

source string describes the origin of the error or warning. The pop-up option **Explain Error** (or Explain Warning) gives more information about the error displayed.

receiver info out passes a reference to your instrument session to the next VI. **receiver info** was obtained from the ni5660 Initialize VI.

Note Do not modify the contents of this wire manually.

IQ waveform contains the baseband (downconverted) time-domain waveform for demodulation. This cluster contains the following elements:

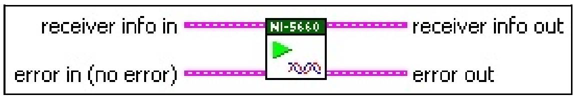
t0 returns the trigger (start) time of the acquired signal.

dt returns the time interval between data points in the acquired signal. The IQ data sampling rate is the reciprocal of this value

ni5660 Initiate IQ

This VI initiates an IQ waveform acquisition. Use this VI with ni5660 Fetch IQ VI when performing finite or continuous acquisition.

Note Continous IQ acquisition is only possible for bandwidths smaller than 1.25 MHz. Refer to Small Span Signals and Sample Rates for more information.



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receiver info in is the instrument handle that you obtain from the ni5660 Initialize VI. The handle identifies a particular RF Signal Analyzer session.

error in accepts error information wired from previously called VIs.

The pop-up option **Explain Error** (or Explain Warning) gives more information about the error displayed.

- **status** boolean is either TRUE (X) for an error, or FALSE (checkmark) for no error or a warning. The pop-up option **Explain Error** (or Explain Warning) gives more information about the error displayed.
- **code** input identifies the error or warning. The pop-up option **Explain Error** (or Explain Warning) gives more information about the error displayed.
- **source** string describes the origin of the error or warning. The pop-up option **Explain Error** (or Explain Warning) gives more information about the error displayed.

receiver info out passes a reference to your instrument session to the next VI. **receiver info** was obtained from the ni5660 Initialize VI.

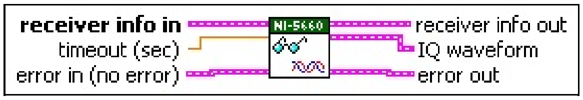
Note Do not modify the contents of this wire manually.

error out passes error or warning information out of a VI to be used by other VIs. The pop-up option **Explain Error** (or Explain Warning) gives more information about the error displayed.

- **status** is TRUE (X) if an error occurred, or FALSE (checkmark) for no error or a warning. The pop-up option **Explain Error** (or Explain Warning) gives more information about the error displayed.
- **code** identifies the error or warning. The pop-up option **Explain Error** (or Explain Warning) gives more information about the error displayed.
- **source** describes the origin of the error or warning. The pop-up option **Explain Error** (or Explain Warning) gives more information about the error displayed.

ni5660 Read IQ

This VI returns the waveform acquired by the RF Signal Analyzer. This VI initiates an acquisition and returns both a scaled voltage waveform with timing information, and IQ data computed through a process of filtering, decimation, and downconversion.



receiver info in is the instrument handle that you obtain from the ni5660 Initialize VI. The handle identifies a particular RF Signal Analyzer session.

timeout (sec) specifies the maximum amount of time in seconds to wait for the acquisition to finish. After this amount of time, the VI returns an error if the acquisition is not complete. If this parameter is set to 0, it returns immediately without checking the acquisition status. If this parameter is set to –1, the VI waits forever.
Default Value: 5 seconds

error in accepts error information wired from previously called VIs.

The pop-up option **Explain Error** (or Explain Warning) gives more information about the error displayed.

- **status** boolean is either TRUE (X) for an error, or FALSE (checkmark) for no error or a warning. The pop-up option **Explain Error** (or Explain Warning) gives more information about the error displayed.
- **code** input identifies the error or warning. The pop-up option **Explain Error** (or Explain Warning) gives more information about the error displayed.
- **source** string describes the origin of the error or warning. The pop-up option **Explain Error** (or Explain Warning) gives more information about the error displayed.

receiver info out passes a reference to your instrument session to the next VI. **receiver info** was obtained from the ni5660 Initialize VI.

Note Do not modify the contents of this wire manually.

IQ waveform returns the baseband (downconverted) time-domain data for demodulation. This cluster contains the following elements:

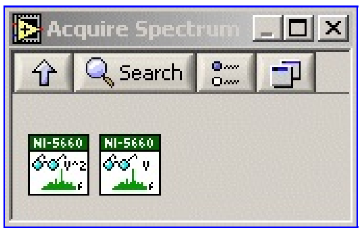
- **t0** returns the trigger (start) time of the acquired signal.
- **dt** returns the time interval between data points in the acquired signal. The IQ data sampling rate is the reciprocal of this value.
- **Y** returns the complex-valued time domain data array. The real and imaginary parts of this complex data array correspond to the in-phase (I) and quadrature-phase (Q) data, respectively.

  Note To calculate the instantaneous power of a sampled

ni5660 Acquire Spectrum Palette

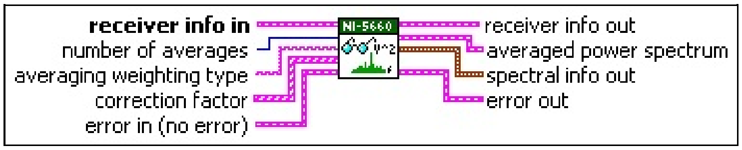
Use the VIs on the **ni5660»Acquire Spectrum** subpalette to acquire averaged power and FFT spectrum data.

Click the icons for VI descriptions.



ni5660 Read Averaged Power Spectrum

This VI computes the averaged power spectrum that corresponds to the spectral settings specified in the ni5660 Configure for Spectrum VI. The VI returns a cluster that contains the averaged power spectrum in V^2rms, starting at frequency *f0* and frequency interval *df*. You can perform RMS averaging with linear, exponential, or peak-hold weighting.



receiver info in is the instrument handle that you obtain from the ni5660 Initialize VI. The handle identifies a particular RF Signal Analyzer session.

number of averages specifies either the number of averages to complete for linear weighting, or the time constant for exponential weighting. The VI stops the averaging process and returns the final result after **number of averages** is complete.
Default Value: 10 averages

averaging weighting type specifies the type of weighting used by the VI:

- **Linear** weighting specifies that each measurement has equal weighting during the averaging process.
- **Exponential** weighting specifies that each new measurement has less weighting than old measurements and that the averaging is continuous. The averaging process computes the exponentially weighted average for measurement *i* as

  $$\text{Avg}[i] = 1/N * X + (N - 1)/N * \text{Avg}[i - 1]$$

  where *X* is the new measurement, Avg[*i* - 1] is the previous average and *N* is the number of averages.
- **Peak hold** weighting specifies that the VI calculates and retains the maximum rms levels for each frequency bin across FFT records. The peak rms value for each bin is returned.

Default Value: linear

correction factor specifies the array of correction factors previously computed by the ni5660 Configure for Spectrum VI. Wire the **correction factor** output of the ni5660 Configure for Spectrum VI directly to this input. Do not modify the values.

error in accepts error information wired from previously called VIs.

The pop-up option **Explain Error** (or Explain Warning) gives more information about the error displayed.

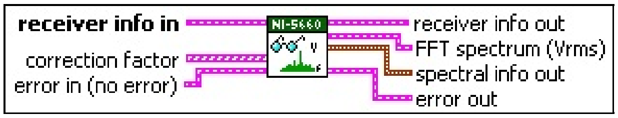
status boolean is either TRUE (X) for an error, or FALSE (checkmark) for no error or a warning. The pop-up option **Explain Error** (or Explain Warning) gives more information about the error displayed.

code input identifies the error or warning. The pop-up option **Explain Error** (or Explain Warning) gives more information about the error displayed.

source string describes the origin of the error or warning. The pop-up option **Explain Error** (or Explain Warning) gives more

ni5660 Read FFT Spectrum

This VI computes the FFT spectrum that corresponds to the spectral settings specified in the ni5660 Configure for Spectrum VI. The VI returns a cluster that contains the FFT spectrum in Vrms, starting at frequency *f0* and frequency interval *df*. Wire the **FFT spectrum** output to averaging and/or measurement VIs in the Spectral Measurements Toolkit.



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receiver info in is the instrument handle that you obtain from the ni5660 Initialize VI. The handle identifies a particular RF Signal Analyzer session.

correction factor specifies the correction factor previously computed by the ni5660 Configure for Spectrum VI. Wire the **correction factor** output of the ni5660 Configure for Spectrum VI directly to this input. Do not modify the values.

error in accepts error information wired from previously called VIs.

The pop-up option **Explain Error** (or Explain Warning) gives more information about the error displayed.

- **status** boolean is either TRUE (X) for an error, or FALSE (checkmark) for no error or a warning. The pop-up option **Explain Error** (or Explain Warning) gives more information about the error displayed.
- **code** input identifies the error or warning. The pop-up option **Explain Error** (or Explain Warning) gives more information about the error displayed.
- **source** string describes the origin of the error or warning. The pop-up option **Explain Error** (or Explain Warning) gives more information about the error displayed.

receiver info out passes a reference to your instrument session to the next VI. **receiver info** was obtained from the ni5660 Initialize VI.

Note Do not modify the contents of this wire manually.

FFT spectrum (Vrms) returns the averaged FFT spectrum in Vrms scaling, starting at frequency **f0** with frequency interval **df**.

- **f0** returns the start frequency of the spectrum, expressed in Hz.
- **df** returns the frequency interval between data points in the spectrum, expressed in Hz.
- **spectrum** returns the averaged FFT spectrum.

spectral info out returns properties of the computed spectrum such as spectrum type, spectrum scale (linear or dB), the window type used by the VI to compute the spectrum, window size, and FFT size. Connect this parameter to subsequent VIs that contain the **spectral info** input parameter. Do not modify the values.

NI 5660 RF Vector Signal Analyzer

Hardware Reference

This section includes information useful to the advanced user of the NI 5660 hardware, including module front panels, signal paths, block diagrams, and calibration information.

- NI 5660 Overview
- Theory of Operation
- Hardware Front Panels
- Signal Paths
- NI 5600 RF Downconverter Module Block Diagram
- NI 5620 IF Digitizer Module Block Diagram
- Calibration

Note Refer to the *NI 5660 RF Vector Signal Analyzer Specifications* document included in the RF Signal Analyzer kit for complete hardware specifications.

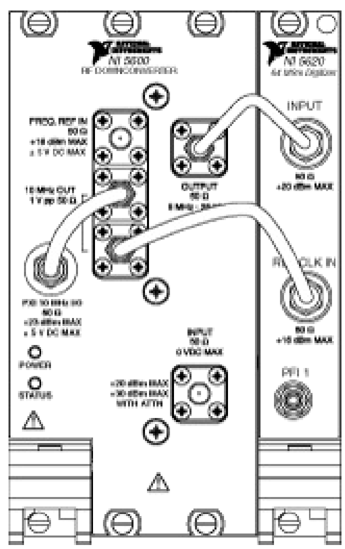
NI 5660 Overview

The NI 5660 is a modular RF vector signal analyzer consisting of two PXI hardware modules:

- NI 5620 — 14 bit, 64 megasample-per-second (MS/s) IF digitizer module
- NI 5600 — wideband RF downconverter module with input frequencies between 9 kHz and 2.7 GHz.

The hardware modules interconnect using the included SMA-SMA coaxial cables as shown below.

Note There is no physical device labeled the "NI PXI-5660." The NI 5660 RF Vector Signal Analyzer is the instrument comprised of the two hardware modules (NI 5600 and NI 5620) and the software included in the kit.



Interconnected NI 5660 Front Panels

The NI 5660 has the following characteristics and features:

- 9 kHz to 2.7 GHz frequency range
- 20 MHz real-time bandwidth
- 10 MHz oven-controlled crystal oscillator (OCXO) timebase
    - ±20 ppb frequency stability
    - ±50 ppb frequency accuracy
- >80 dB spurious-free dynamic range
- +30 dBm full signal input range
- Up to 64 MS of onboard waveform memory

- Software for performing frequency-domain and IQ measurements
- Four slots wide PXI/3U Compact PCI form factor

The NI 5660 follows industry-standard Plug and Play specifications for the PXI bus and seamlessly integrates with compliant systems.

NI 5660 Theory of Operation

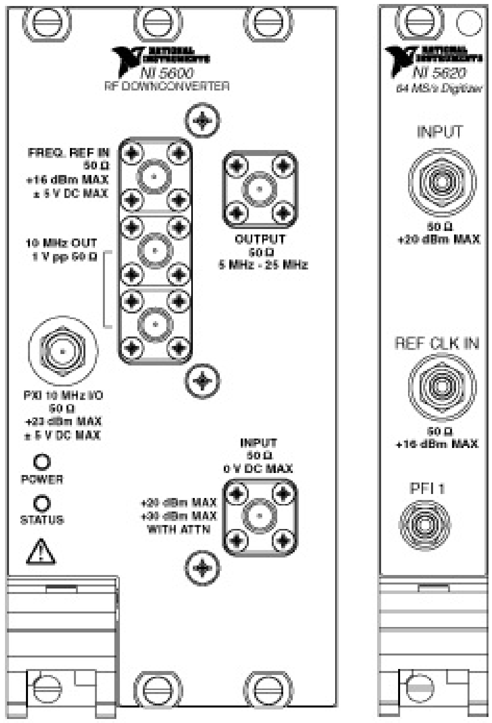
The NI 5600 downconverter module (block diagram) performs two primary functions: frequency shifting, or downconversion, and input signal conditioning. Frequency shifting is performed using a tunable oscillator in the superheterodyne signal chain.

Input signal conditioning is accomplished using three stages of mixer conversion and two sets of gain attenuators whose levels are programmable. The first set of attenuators can be set to minimize distortion and other spurious signals when input levels are high and to minimize noise when input levels are low. Attenuator levels are set using the ni5660 Configure for Spectrum VI and the ni5660 Configure for IQ VI.

The second set of attenuators is in the second intermediate frequency (IF) path before the third mixer and ensures an appropriate output signal level even if the first mixer is intentionally driven into compression. These attenuators are also set when performing linearity measurements. For more information on proper attenuation levels, refer to Guidelines for Making Accurate Measurements.

Hardware Front Panel Connectors and Indicators

These sections describe the connectors and LED indicators on the front panels of the NI 5660 hardware modules. All inputs and outputs are AC-coupled.



Click a Module Front Panel for Description

NI 5600 Front Panel

This sections describe the connectors and LED indicators on the hardware front panel of the NI 5600 RF downconverter module. All inputs and outputs are AC-coupled.

Connector	Use
FREQ REF IN	Routes an external frequency reference signal to which the NI 5600 can lock. This signal can be propagated to the PXI backplane when the NI 5600 is installed in PXI Slot 2.
10 MHz OUT	Connect the lower 10 MHz OUT connector to the REF CLK IN connector on the NI 5620 module front panel. Both connectors output replications of the downconverter 10 MHz frequency reference signal, useful for driving other devices. Each replication is 180 degrees out-of-phase with the other. The signal output at these connectors is always on and cannot be disabled.
10 MHz OUT	
PXI 10 MHz I/O	Bidirectional connection to the PXI 10 MHz backplane clock. This connector can be used to drive the PXI 10 MHz backplane clock *only* when the NI 5600 downconverter module is installed in PXI Slot 2. To drive the PXI backplane with the NI 5600 onboard frequency reference, connect the PXI 10 MHz I/O connector to the 10 MHz OUT connector on the NI 5600 RF downconverter module front panel as shown in Interconnected NI 5600 Front Panels. Refer to the ni5660 Configure Reference Clock VI for more information. This connector can be used to export the PXI 10 MHz backplane clock when the NI 5600 downconverter is installed in any PXI slot.
OUTPUT	Connect to the INPUT connector on the NI 5620 digitizer module front panel. Outputs the frequency-translated IF signal for digitization.
INPUT	Connect to the analog RF input signal to be measured by the RF Vector Signal Analyzer.

The following table provides LED and indications information for the NI 5600 RF upconverter module front panel LEDs:

LED	Indications
POWER	Indicates the basic hardware power status of the NI 5600 downconverter module. This LED functions identically to the ACCESS LED on the digitizer module front panel. • OFFThe module is not yet functional, or has detected a problem with a PXI power rail. • GREENThe module is functional and receiving power.
STATUS	Indicates the status of the NI 5600 downconverter module PLLs. • OFFThe module is in an uninitialized state, or the module PLLs are attempting to lock. • GREENThe module is in a ready state; applicable PLLs are locked.

Note Refer to the *NI 5660 RF Vector Signal Analyzer Specifications* document included in the NI 5660 RF Signal Analyzer kit for more information on NI 5600 connectors.

NI 5620 Front Panel

This section describes the connectors on the hardware front panel of the NI 5620 IF digitizer module. All inputs and outputs are AC-coupled.

Connector	Use
INPUT	Inputs a frequency-translated IF waveform from the NI 5600 downconverter for digitization and measurement. Connect to the OUTPUT connector on the NI 5600 downconverter module front panel.
REF CLK IN	Inputs the NI 5600 internal reference clock signal. Connect to the lower 10 MHz OUT connector on the NI 5600 downconverter module front panel.
PFI 1	Inputs a digital trigger from an external source. Refer to the NI-SCOPE Help, located at **Start»Programs»National Instruments»NI-SCOPE»Documentation**, for more information about triggering.

Note Refer to the *NI 5620 Digitizer Specifications*, available at **Start»Programs»National Instruments»NI-SCOPE**, for more information on NI 5620 connectors.

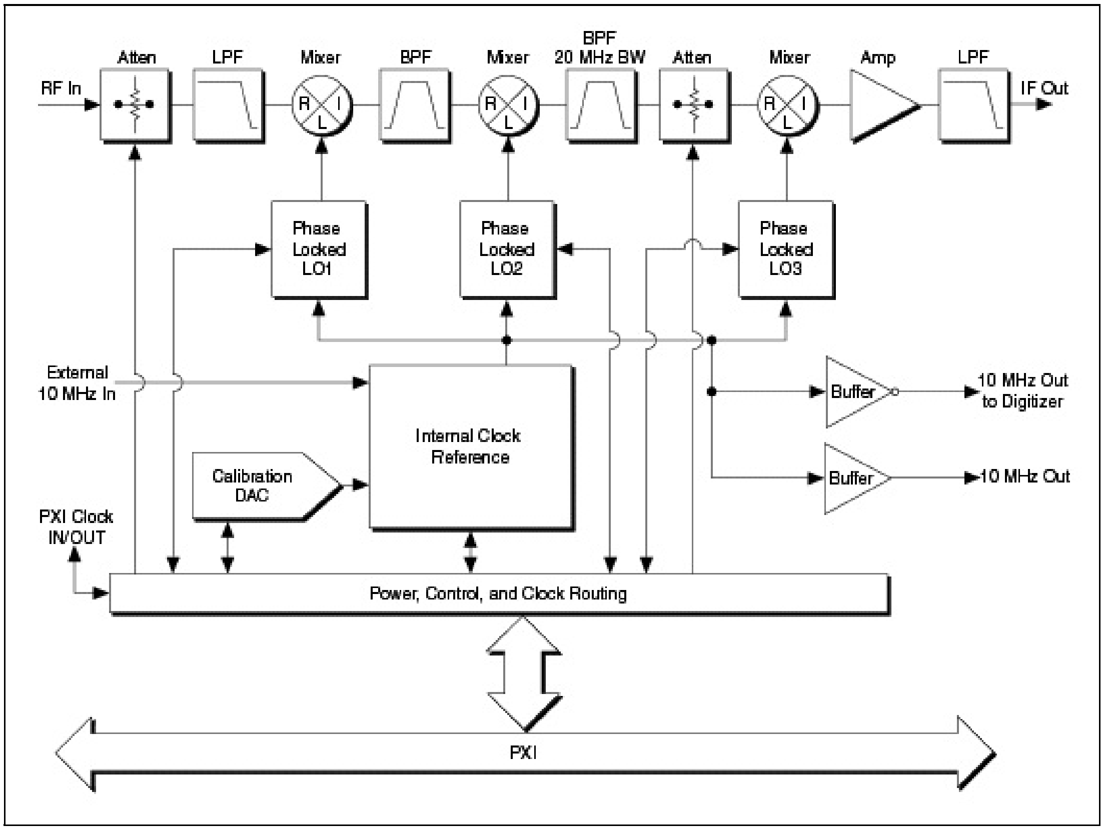
NI 5660 Signal Paths

A signal takes the following path through the RF Signal Analyzer to the PXI controller:

1. A signal enters the RF Signal Analyzer through the INPUT front panel connector of the NI 5600 RF downconverter module.
2. The NI 5600 RF downconverter module zooms in on a 20 MHz block of spectrum and frequency-translates it to center around 15 MHz. The translated IF signal is sent to the NI 5600 downconverter module OUTPUT connector.
3. The IF signal is passed from the NI 5600 RF downconverter module front panel OUTPUT connector to the NI 5620 IF digitizer module front panel INPUT connector.
4. The NI 5620 IF digitizer module filters and conditions the signal and applies gain and dither.
5. The Analog-to-Digital Converter (ADC) converts the signal from analog to digital.
6. The data is sent to onboard memory (the buffer).
7. The data is transferred to the host computer.

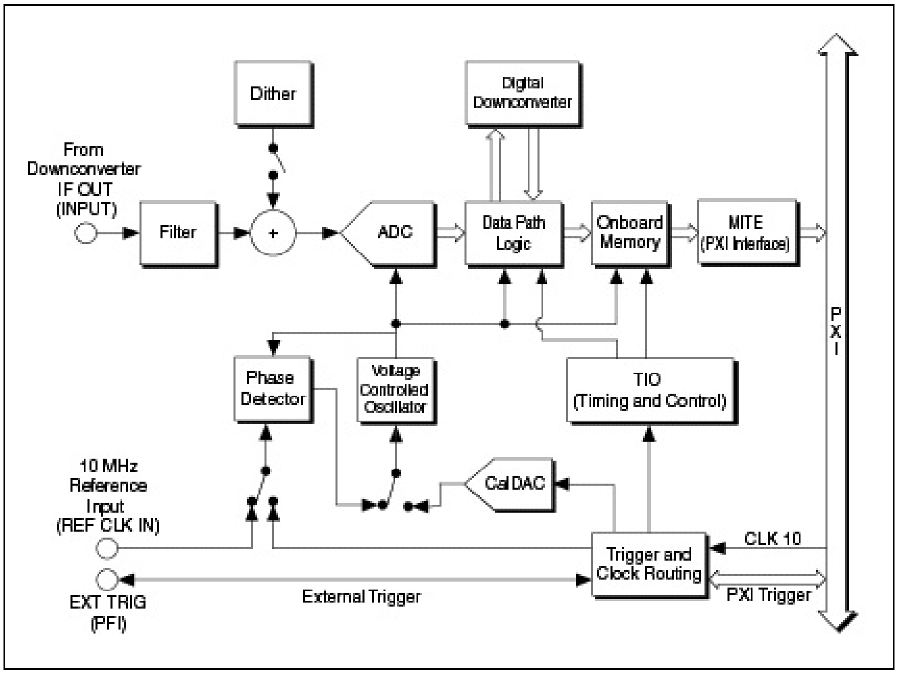
NI 5600 RF Downconverter Module Block Diagram

The NI 5600 RF downconverter module translates any 20 MHz-wide band of incoming signal to center at 15 MHz. Thus the downconverter module converts any block of spectrum, up to 20 MHz wide and centered anywhere between 9 kHz and 2.7 GHz, to an IF band between 5–25 MHz. The NI 5600 hardware always downconverts a 20 MHz band. This IF band is then passed to the NI 5620 digitizer module (block diagram), for further processing.



NI 5620 IF Digitizer Module Block Diagram

The NI 5620 is an IF high-speed digitizer module featuring a 14-bit analog-to-digital converter (ADC) with deep onboard sample memory. Offering sample rates of 1 kS to 64 MS/s and distortion-free performance, it has been designed to complement the NI 5600 downconverter module (block diagram) in FFT analysis applications.



Calibration

Every NI 5660 RF Vector Signal Analyzer is individually calibrated for accurate frequency response at the factory and ships with a calibration certificate verifying NIST-traceable accuracy levels.

During frequency-response calibration, the RF Signal Analyzer is used to measure a NIST-certified high-precision signal. Any error in the returned data is quantified as a set of calibration constants. These calibration constants are used by the software to calculate and apply correction to your analysis based upon the spectrum of interest. For more information on applying calibration correction, refer to the example programs installed with the RF Signal Analyzer.

To preserve specified accuracy and NIST traceability, NI recommends returning both modules of the RF Signal Analyzer to the factory for annual recalibration. The RF downconverter module and the IF digitizer module are calibrated independently of one another, not as a combined system. At this time, recalibration of both modules can only be performed by NI. For more information on calibration, contact NI or visit ni.com/calibration.

Important Information

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Technical Support and Professional Services

Visit the following sections of the National Instruments Web site at ni.com for technical support and professional services:

- **Support**—Online technical support resources at ni.com/support include the following:
  - **Self-Help Resources**—For immediate answers and solutions, visit the award-winning National Instruments Web site for software drivers and updates, a searchable KnowledgeBase, product manuals, step-by-step troubleshooting wizards, thousands of example programs, tutorials, application notes, instrument drivers, and so on.
  - **Free Technical Support**—All registered users receive free Basic Service, which includes access to hundreds of Applications Engineers worldwide in the NI Developer Exchange at ni.com/exchange. National Instruments Applications Engineers make sure every question receives an answer.
- **Training and Certification**—Visit ni.com/training for self-paced training, eLearning virtual classrooms, interactive CDs, and Certification program information. You also can register for instructor-led, hands-on courses at locations around the world.
- **System Integration**—If you have time constraints, limited in-house technical resources, or other project challenges, NI Alliance Program members can help. To learn more, call your local NI office or visit ni.com/alliance.
- **Declaration of Conformity (DoC)**—A DoC is our claim of compliance with the Council of the European Communities using the manufacturers declaration of conformity. This system affords the user protection for electronic compatibility (EMC) and product safety. You can obtain the DoC for your product by visiting ni.com/hardref.nsf.
- **Calibration Certificate**—If your product supports calibration, you can obtain the calibration certificate for your product at ni.com/calibration.

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Warranty

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Related Documentation

These documents may contain information that you might find helpful as you use the NI-RFSA VIs and the RF Signal Analyzer. Refer to this document for basic information on setup, configuration, and operation of the RF Signal Analyzer hardware and software.

- *NI 5660 RF Vector Signal Analyzer Getting Started Guide*, printed and included in your NI 5660 RF Signal Analyzer kit. This document is also available in PDF format at **Start»Programs»National Instruments»NI-RFSA»Documentation**.
- *NI 5660 RF Vector Signal Analyzer Specifications*, printed and included in your NI 5660 RF Signal Analyzer kit. This document is also available in PDF format online by searching www.ni.com/manuals.
- *NI 5620 IF Digitizer Module Specifications*, printed and included in your NI 5660 RF Signal Analyzer kit. This document is also available in PDF format at **Start»Programs»National Instruments»NI-SCOPE**.
- For the latest NI-RFSA development information, visit the NI Developer Zone at ni.com/instruments. Search for the latest NI-RFSA examples at ni.com/examples. These links require an internet connection.
- *Spectral Measurements Toolkit Help*, accessible at **Start»Programs»National Instruments»Spectral Measurements»Documentation**. Refer to this file for information about measurements and examples available for the RF Signal Analyzer.
- *Spectral Measurements Toolkit User Guide*, accessible in PDF format at **Start»Programs»National Instruments»Spectral Measurements»Documentation**.
- *Modulation Toolkit Help*, accessible from **Start»Programs»National Instruments»Modulation»LabVIEW Support**. The Modulation Toolkit integrates with SMT and NI-RFSA for modulation/demodulation measurements and analysis.
- *NI High-Speed Digitizers Help*, available at **Start»Programs»National Instruments»NI-SCOPE»Documentation**. Refer to this file for information on implementing trigging for the RF Signal Analyzer.
- *NI-TUNER Help*, available at **Start»Programs»National Instruments»NI-TUNER»Documentation**. Refer to this file for

information on low-level control and examples for the RF Signal Analyzer.

Visit ni.com/manuals for the most current revisions of documentation and for newly released documentation.

ni5660 VI Programming Flow

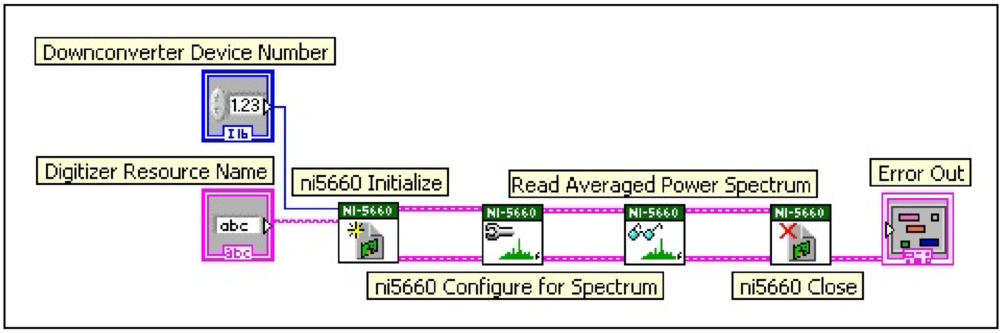
To programmatically configure the RF Vector Signal Analyzer hardware for data acquisition in LabVIEW, use the ni5660 VIs. These VIs control both the NI 5600 RF downconverter module and the NI 5620 IF digitizer module as a single instrument for frequency-domain and IQ data acquisitions. The ni5660 VIs are located on the LabVIEW function palette at **Instrument I/O»Instrument Drivers»ni5660**.

Two programming flows are used with the ni5660 VIs: a frequency-domain acquisition programming flow, and an IQ acquisition programming flow. Every application built using the ni5660 VIs must call the ni5660 Initialize and ni5660 Close VIs.

Note When programming the RF Vector Signal Analyzer, specify the NI 5620 IF digitizer module with the DAQ Resource Name using the following syntax: DAQ::*DeviceNumber*. Specify the NI 5600 RF downconverter module using the MAX device number without modifiers. Device numbers are obtained from Measurement & Automation Explorer (MAX).

Frequency-Domain Measurements Programming Flow

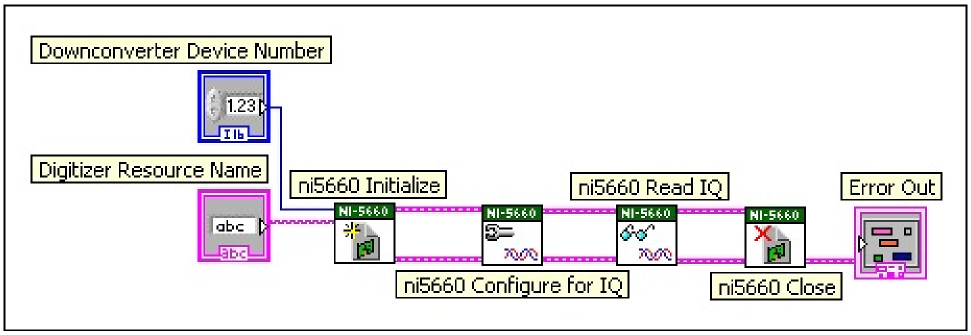
Use the programming flow shown in below to acquire data and perform frequency-domain measurements using the ni5660 VIs:



IQ Acquisition Programming Flow

Use the programming flows shown below to acquire IQ data in finite or continuous modes, respectively:

Finite IQ Acquisition



Continuous IQ Acquisition

Note NI provides add-on software toolkits, such as the Spectral Measurements Toolkit (included) and the Modulation Toolkit, to extend the measurement and analysis capability of the RF Signal Analyzer.

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