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RF and Microwave Signal Generators with Modulation Capability

NI PXI-565x

- 500 kHz to 6.6 GHz frequency range
- Less than 2 ms frequency sweep tuning speed typical
- Less than 1 ppb frequency resolution
- -110 dBc/Hz phase noise at 1 GHz, 10 kHz offset typical
- FM, 2-FSK, OOK modulation
- Modulating waveforms include sine, triangle, square, 31-order PRBS, user-defined 1020-bit
- Use as tunable local oscillator or clock source
- Use with NI PXI-5660 RF vector signal analyzer for stimulus response or tracking generator applications

Recommended Software

- LabVIEW
- LabWindows/CVI

Driver Software (included)

- NI-RFSG



Module	Frequency Range
PXI-5650	500 kHz to 1.3 GHz[1]
PXI-5651	500 kHz to 3.3 GHz[1]
PXI-5652	500 kHz to 6.6 GHz[1]

[1]Tunable down to 100 kHz with amplitude uncalibrated.

Table 1. NI PXI-565x Selection Guide

Overview

The National Instruments PXI-565x RF and microwave signal generators are continuous-wave with modulation capability. The new signal generators extend PXI waveform generation to 6.6 GHz. In a single 3U PXI slot, NI PXI-565x signal generators provide exceptional phase noise and signal jitter.

With the PXI-5652 6.6 GHz RF and microwave signal generator, the PXI-5651 3.3 GHz RF signal generator, and the PXI-5650 1.3 GHz RF signal generator, you can easily set up sophisticated stimulus response or tracking generator applications using the PXI-5660 RF vector signal analyzer and the National Instruments LabVIEW graphical development environment.

The new RF and microwave signal generators use direct digital synthesis (DDS) for high-resolution frequency hopping or phase-continuous sweeping for fixture and device characterization applications. They are ideal for clocking nonstandard sample rates, such as WCDMA signals at baseband or intermediate frequency (IF). With these versatile signal generators, you can perform analog and digital modulation through the onboard DDS circuit, which gives you frequency modulation and frequency-shift keying for applications such as bit-error rate testing, antenna testing, or even keyless entry. Amplitude modulation is also available through on-off keying.

You can seamlessly integrate PXI-565x signal generators, which follow industry-standard plug-and-play specifications for the PXI bus, with compliant systems.

RF and Microwave Signal Generator Hardware Operation

The PXI-565x system block diagram in Figure 1 illustrates how the system control unit manages the control signals and data transferred between the circuit blocks. The system control unit also contains the temperature monitor and modulation components.

The clocking circuitry, shown in the upper left-hand corner of the diagram, contains the system clock reference and the DDS. The system clock is a 200 MHz voltage-controlled crystal oscillator (VCXO) that you can program to phase-lock to an external 10 MHz clock signal at the REF IN/OUT connector.

The DDS clocked by the 200 MHz reference provides signals of up to 50 MHz, with very fine frequency steps. RF signals below 50 MHz come directly from the DDS.

Above 50 MHz, signal generation takes place inside the main synthesizer circuit. The synthesizer is phase-locked to the DDS output signal as a reference. This DDS reference signal delivers the necessary fine-tuning steps of the synthesizer; the synthesized RF frequency steps are typically 1 Hz or less.

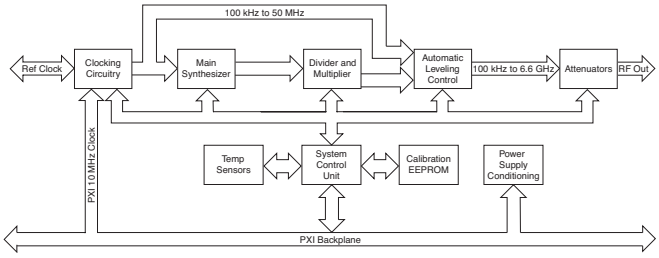


Figure 1. PXI-565x Block Diagram

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Following the main synthesizer are dividers and multipliers to scale the frequency over the range of 50 MHz to the upper frequency limit of PXI-565x signal generators.

The automatic leveling control (ALC) loop performs fine amplitude control. The ALC has a broad frequency response, typically from a few kilohertz to more than 6.6 GHz. A temperature-stable voltage digital-to-analog converter (DAC) sets the reference for the ALC. Additional temperature calibration performed during the manufacturing process makes the ALC very stable over the specified operating temperature. Attenuators (final block of the system) perform coarse amplitude control. These attenuators have a typical range of 100 dB.

The NI-RFSG instrument driver uses calibration data stored in the EEPROM to correctly set up the hardware for signal generation. The instrument driver uses calibration data to compensate for nonideal components and temperature variation. Refer to Understanding Factory Calibration in the NI RF Signal Sources Help for more information.

Modulation Modes

PXI-565x RF signal generators can generate three types of modulated signals, including:

- Frequency-shift keying signals
- On-off keying signals
- Frequency modulated signals

Frequency-Shift Keying (FSK)

PXI-565x signal generators are capable of producing a 2-FSK signal. You can control the following modulation parameters:

- Internal modulation waveform types – 1020-bit, user-defined bit stream, or pseudorandom bit sequence (PRBS)
- Symbol rate
- FSK deviation

NI-RFSG calculates the exact symbol rate and FSK deviation, which can differ slightly from the input parameters.

On-Off Keying (OOK)

OOK is a modulation scheme that varies the power level of the carrier signal between two discrete power levels. You can control the following modulation parameters:

- Internal modulation waveform type – PRBS
- Symbol rate

A bit value of 1 sets the carrier signal power to the configured power level. A bit value of 0 sets the carrier signal power to the lowest possible level for this frequency. Refer to your device specifications document for minimum and maximum power levels.

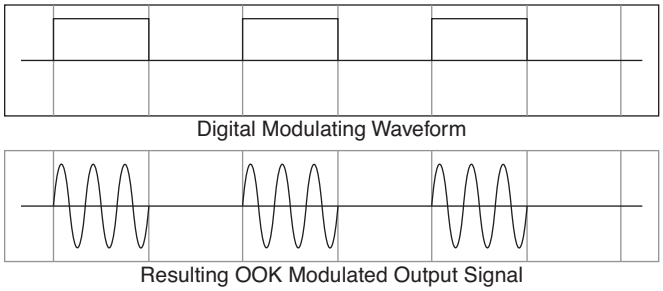


Figure 2. On-Off Keying Overview

Frequency Modulation (FM)

You can control the following modulation parameters:

- Internal modulation waveform types – square, sine, triangle
- Modulation waveform frequency
- FM deviation

Output Enable

You can disable signal output at the RF OUT connector using the Output Enabled property. In addition, you can change the output enable state at any time during waveform generation, and the generation continues on internally.

Calibration

PXI-565x signal generator calibration is relative to an NIST-traceable standard over the specified operating temperature range. Calibration consists of two major parts – frequency accuracy calibration and amplitude accuracy calibration. Calibration certificates are available on request.

Software

The NI PXI-565x is shipped with NI-RFSG, a fully functional instrument driver compatible with a variety of application software environments, such as NI LabVIEW, LabWindows/CVI, and C. Also included are a number of interactive, instructional examples and interactive online help guides that can assist you in jump-starting your application test development.

For more information, consult the NI RF Signal Sources Help.

Ordering Information

NI PXI-5652.....779670-02
NI PXI-5651.....779670-01
NI PXI-5650.....779670-00
Includes NI-RFSG instrument driver software.

BUY NOW!

For complete product specifications, pricing, and accessory information, call (800) 813 3693 (U.S.) or go to **ni.com/rf**.

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Specifications

See detailed specifications for more information.

NI PXI-565x RF Signal Generator

This document lists specifications for NI PXI-565x RF Signal Generators. Minimum or maximum specifications are warranteed under the following conditions:

- 30 minutes warm-up time at ambient temperature
- Calibration cycle maintained
- Temperature 0 to 55 °C unless otherwise noted.

Typical values are used to define an average unit measured at ambient temperatures of 15 to 35 °C. Specifications that do not list a tolerance are typical values unless otherwise specified. Tolerance values represent the maximum variation that will be observed.

Frequency

Range

PXI-5650 ..... 500 kHz[1] to 1.3 GHz
PXI-5651 ..... 500 kHz[1] to 3.3 GHz
PXI-5652 ..... 500 kHz[1] to 6.6 GHz

[1]Tunable down to 100 kHz with amplitude uncalibrated.

Resolution

Frequency	Step Size
500 kHz to 1.3 GHz	<1 Hz
1.3 to 3.3 GHz	<2 Hz
3.3 to 6.6 GHz	<4 Hz

Settling Time

0.1 ppm of final frequency..... <5 ms
0.01 ppm of final frequency..... <20 ms

Reference Clock

Internal Clock

Initial accuracy..... ±3 ppm max.
Temperature (15 to 35 °C) ..... ±1 ppm max.
Aging ..... ±5 ppm/year max.

Spectral Purity

SSB Phase Noise at 10 kHz Offset

Frequency	Phase Noise
100 MHz	<-125 dBc/Hz
500 MHz	<-112 dBc/Hz
1 GHz	<-105 dBc/Hz
3 GHz	<-95 dBc/Hz
6.6 GHz	<-90 dBc/Hz

Jitter (seconds, rms) at 0 dBm Output Power

622 MHz with 1 kHz to
5 MHz jitter BW..... <200 fs typical

2.488 GHz with 5 kHz to
15 MHz jitter BW..... <50 fs typical

Residual FM (300 Hz to 3 kHz, CCITT, rms)

Frequency	Residual FM
1.0 GHz	<0.8 Hz rms
2.4 GHz	<1.5 Hz rms

Harmonics at ≤0 dBm Output Power

Frequency	Harmonic (Typical)
500 kHz to 1.3 GHz	-15 dBc
1.3 to 3.3 GHz	-25 dBc
3.3 to 6.6 GHz	-20 dBc

Nonharmonics at ≤0 dBm Output Power

Nonharmonic Products

Frequency	>1 kHz Offset	>100 kHz Offset
500 kHz to 50 MHz	<-65 dBc	<-75 dBc
50 MHz to 3.3 GHz	<-65 dBc	<-70 dBc
3.3 to 6.6 GHz	<-50 dBc	<-65 dBc

Subharmonic Products

Frequency	Subharmonic Products
500 kHz to 3.3 GHz	Not applicable[2]
3.3 to 4 GHz	<-30 dBc
4 to 6.6 GHz	<-25 dBc

[2]No harmonic multiplication in this band.

Amplitude

Resolution ..... <0.1 dB
Range[3]..... -100 to 10 dBm

[3]See detailed specifications for frequency specific amplitude ranges.

Power Level Accuracy (15 °C to 35 °C)

Less than 3.3 GHz
>-40 dBm..... ±0.75 dB
<-40 dBm..... ±1.8 dB
Greater than 3.3GHz
>-40 dBm..... ±1.0 dB
<-40 dBm..... ±2.0 dB

Amplitude Settling Time

0.25 dB of final value..... <10 ms typical
0.05 dB of final value..... <500 ms typical

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Signal to Noise Ratio

≥0 dBm output power ..... <-140 dBc/Hz typical

VSWR

500 kHz to 3.3 GHz ..... <1.8:1 typical
3.3 to 6.6 GHz ..... <2.0:1 typical
Output impedance ..... 50 Ω

Modulation

Frequency Modulation (FM)

Modulation waveform types ..... Sine, triangle, square

Frequency Range	Maximum Deviation (Sine Wave)
500 kHz to <50 MHz	500 kHz
≥50 to <100 MHz	125 kHz
≥100 to <200 MHz	250 kHz
≥200 to <400 MHz	500 kHz
≥400 to <800 MHz	1 MHz
≥800 MHz to <1.6 GHz	2 MHz
≥1.6 to <3.3 GHz	4 MHz
≥3.3 to <6.6 GHz	8 MHz

Modulation waveform frequency[4] ..... 1 Hz to 100 kHz
Deviation accuracy[5] ..... <±3.5%
Distortion[5] ..... <0.1%
SINAD[5] ..... >65 dB

[4]Settable frequencies are given by 50 MHz/k, where k is an even integer up to 2^{26}

[5]1 kHz sine wave, 10% of maximum deviation; noise bandwidth of 10 kHz

Frequency Shift Keying (FSK)

Modulation waveform types
PRBS ..... 5 to 31-order
User defined ..... up to 1020 bit
Modulation format 2-FSK

Frequency Range	Maximum Deviation
500 kHz to <50 MHz	250 kHz
≥50 to <100 MHz	31.25 kHz
≥100 to <200 MHz	62.5 kHz
≥200 to <400 MHz	125 kHz
≥400 to <800 MHz	250 kHz
≥800 MHz to <1.6 GHz	500 kHz
≥1.6 to <3.3 GHz	1 MHz
≥3.3 to <6.6 GHz	2 MHz

FSK deviation accuracy (100 kHz rate, 10% of maximum deviation) ..... <±10%

Symbol rate ..... 763 Hz to 100 kHz

On-Off Keying (OOK)

Modulation waveform types ..... 5 to 31-order PRBS

Power level
<10 MHz ..... typically 7 dBm below maximum specified amplitude
>10 MHz ..... typically 10 dBm below maximum specified amplitude

Symbol rate ..... 153 Hz to 100 kHz

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Hardware Services

NI Factory Installation Services

NI Factory Installation Services (FIS) is the fastest and easiest way to use your PXI or PXI/SCXI combination systems right out of the box. Trained NI technicians install the software and hardware and configure the system to your specifications. NI extends the standard warranty by one year on hardware components (controllers, chassis, modules) purchased with FIS. To use FIS, simply configure your system online with **ni.com/pxiadvisor**.

Calibration Services

NI recognizes the need to maintain properly calibrated devices for high-accuracy measurements. We provide manual calibration procedures, services to recalibrate your products, and automated calibration software specifically designed for use by metrology laboratories. Visit **ni.com/calibration**.

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