APEX WAVES PXI-5650 1.3 GHz RF Analog Signal Generator User Manual

Contents

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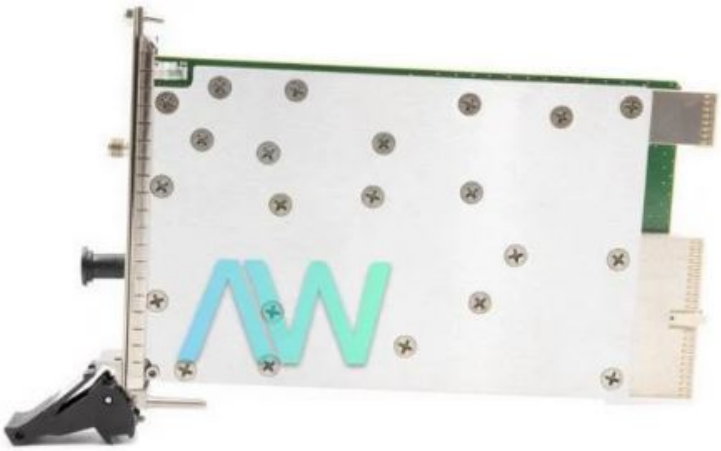


Product Information

The PXI-5650 is a high-performance RF analog signal generator designed to generate signals in the frequency range of 500 kHz to 1.3 GHz. It is equipped with advanced features and specifications to meet the needs of various applications.

Definitions
Warranted specifications describe the performance of a model under stated operating conditions and are covered by the model warranty. The following characteristic specifications describe values that are relevant to the use of the model under stated operating conditions but are not covered by the model warranty.

- Typical specifications describe the performance met by a majority of models.
- Nominal specifications describe an attribute that is based on design, conformance testing, or supplemental testing.

Specifications are Warranted unless otherwise noted.

Conditions
Minimum or maximum warranted specifications are valid under the following conditions unless otherwise noted.

- 30 minutes warm-up time
- Calibration cycle maintained
- Temperature of 0 °C to 55 °C

Typical specifications are valid under the following condition unless otherwise noted.

- Over ambient temperature ranges of 23 °C ± 5 °C

Frequency

- **Range1** 500 kHz to 1.3 GHz
- **Resolution** <3 Hz
- **Accuracy** Refer to the Reference Clock section.

Frequency Settling Time2

Table 1. Narrow Loop Bandwidth

Settling Time (ppm)	Median (ms)	Maximum (ms)
≤0.01	6.5	13
≤0.1	1.5	6.53

Table 2. Wide Loop Bandwidth

Settling Time (ppm)	Median (ms)	Maximum (ms)
0.01	1.0	5.0
0.1	0.3	1.0
1.0	0.2	0.7

Reference Clock

Internal Clock

- **Initial accuracy** ±3 ppm, maximum
- **Temperature (15 ºC to 35 ºC)** ±1 ppm, maximum
- **Aging** ±5 ppm per year, maximum

Internal Reference Output (REF IN/OUT connector)

- **Frequency** 10 MHz
- **Amplitude** 1 Vpk-pk into 50 Ω
- **Coupling** AC
- **Output impedance** 50 Ω

External Reference Input (REF IN/OUT connector)

- **Frequency** 10 MHz ±10 ppm
- **Amplitude** 0.2 Vpk-pk to 1.5 Vpk-pk into 50 Ω
- **Input impedance** 50 Ω
- **Lock time to external reference** <1 s

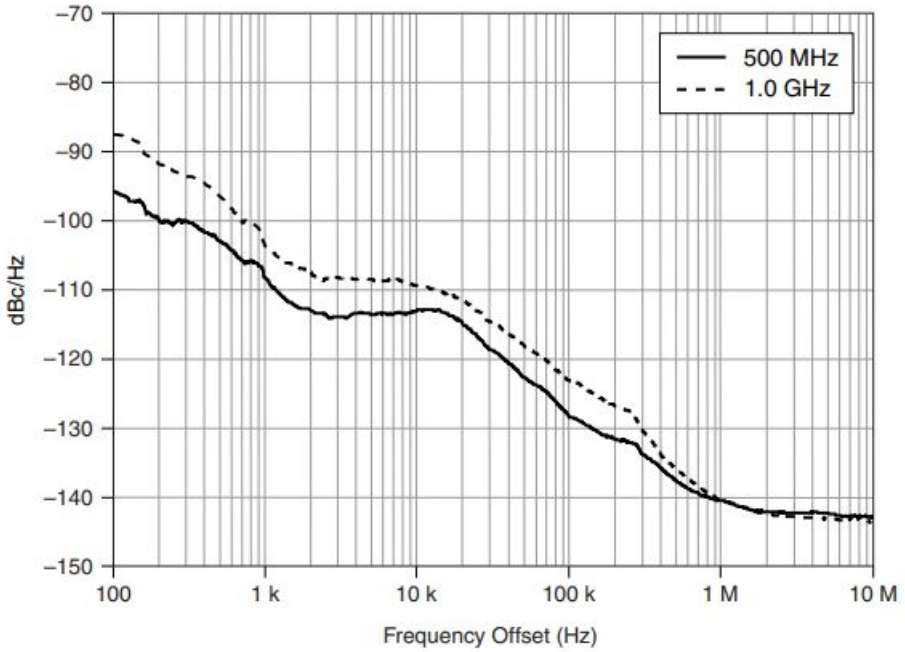
Spectral Purity

Table 3. Single Sideband (SSB) Phase Noise at 10 kHz Offset4

Frequency	Phase Noise (dBc/Hz)
100 MHz	<-125, typical
500 MHz	<-111
1 GHz	<-105

- **Residual FM, 1 GHz (300 Hz to 3 kHz, RMS)** <0.8 Hz RMS, typical
- **Jitter5 (seconds, RMS), 622 MHz with 1 kHz to 5 MHz jitter bandwidth** <200 fs, typical

Figure 1. Measured Phase Noise at 500 MHz and 1 GHz (0 dBm Output Power)



Harmonics

500 kHz to <1.3 GHz (0 dBm to -40 dBm output power) -15 dBc, typical

Figure 2. Typical Spectrum at 1.3 GHz

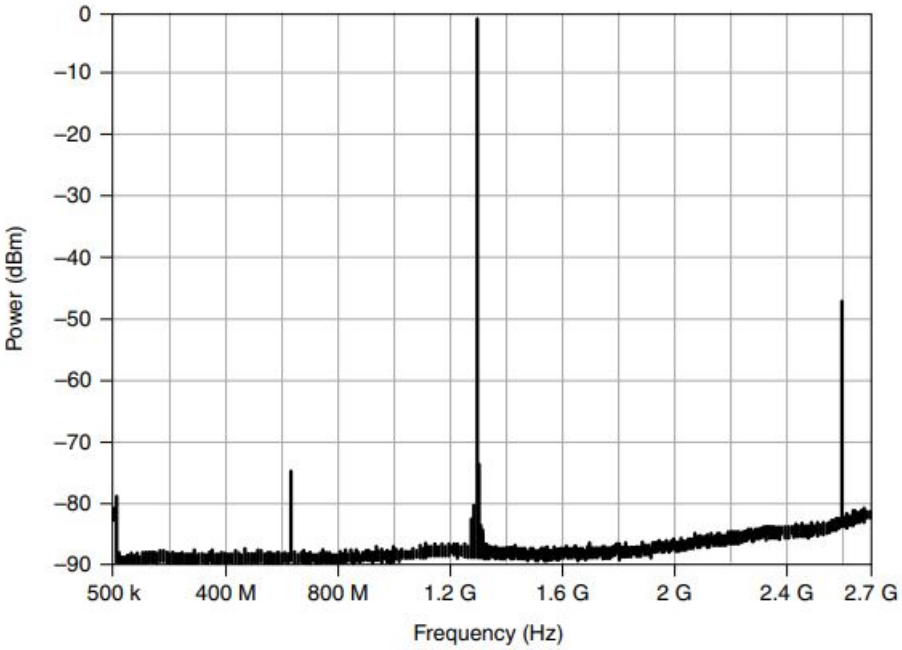
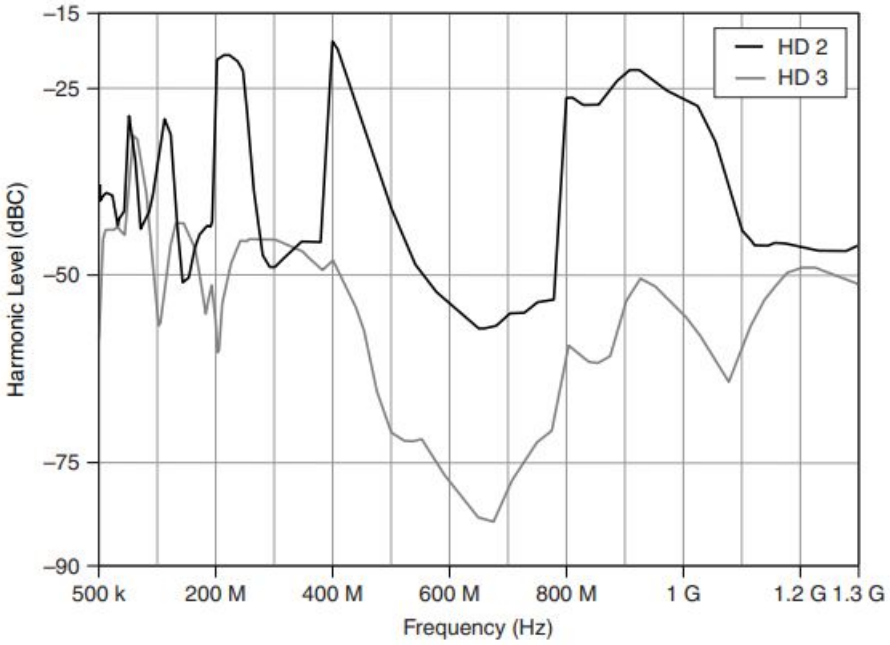


Figure 3. Typical Second Harmonic (HD 2) and Third Harmonic (HD 3) Levels (0 dBm Output Power)



Nonharmonics
Narrow Loop Bandwidth
Table 4. Nonharmonic Products at 0 dBm to -20 dBm Output Power

Frequency	<3 kHz Offset (dBc), Typical	>3 kHz Offset (dBc)	>100 kHz Offset (dBc)
500 kHz to <50 MHz	<-57	<-57	<-57
50 MHz to 1.3 GHz	<-65	<-65	<-70

Wide Loop Bandwidth
Table 5. Nonharmonic Products at 0 dBm to -20 dBm Output Power

Frequency	<3 MHz Offset (dBc), Typical	>3 MHz Offset (dBc), Typical
500 kHz to <50 MHz	<-57	<-57
50 MHz to 1.3 GHz	<-44	<-70

Subharmonic products 500 kHz to 1.3 GHz Not applicable6

Amplitude

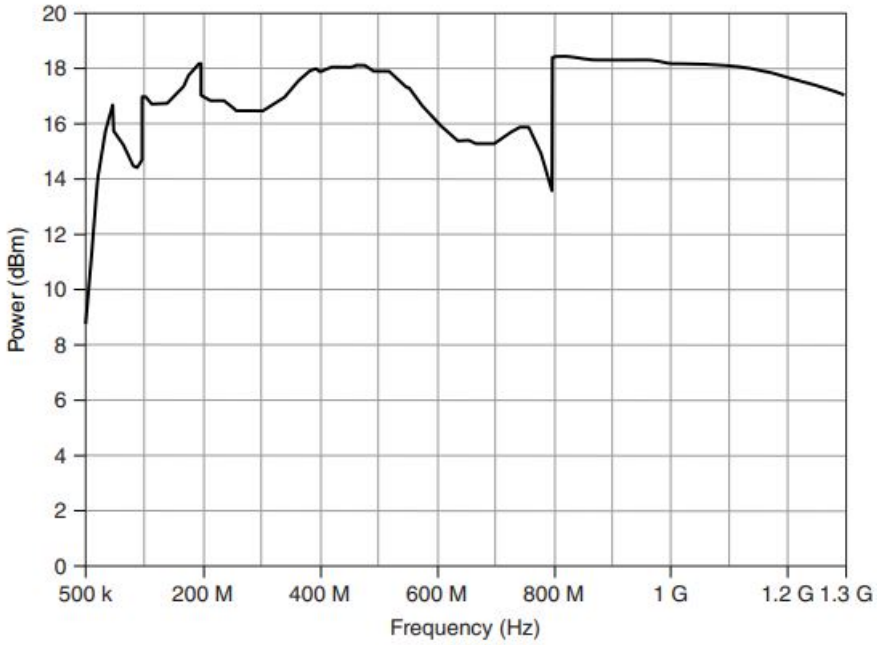
- **Resolution** <0.1 dB

Table 6. Amplitude Range

Frequency	Amplitude (dBm)
500 kHz to <10 MHz	-90 to 5
10 MHz to <50 MHz	-90 to 8
50 MHz to <500 MHz	-90 to 10
500 MHz to <1.3 GHz	-90 to 10

- **Maximum available power** 2 dB above maximum specified amplitude, typical
- **Minimum available power** 10 dB below minimum specified amplitude, typical

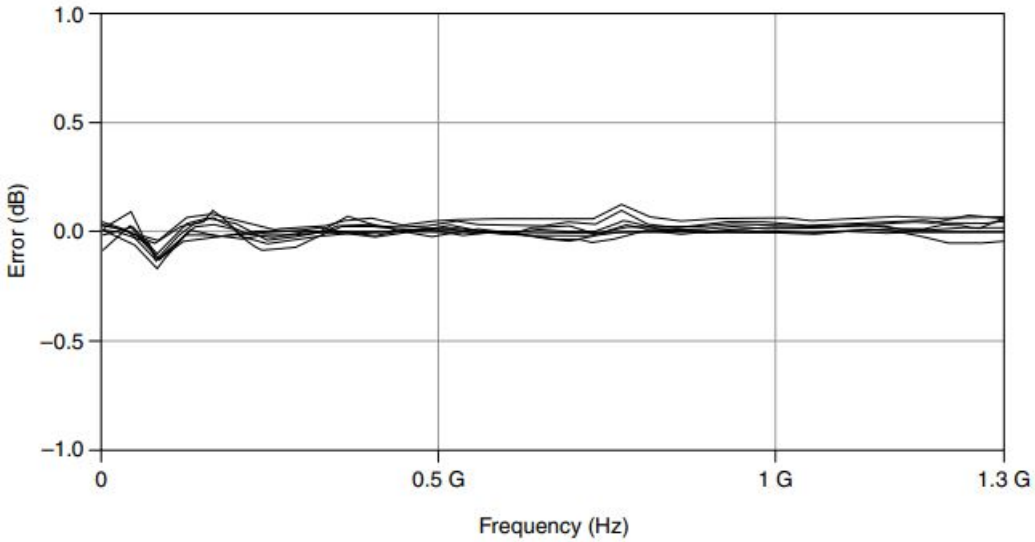
Figure 4. Measured Maximum Available Power



Power Level Accuracy
Table 7. Power Level Accuracy (15 °C to 35 °C)

Frequency	>-40 dBm Output Power (dB)	≤-40 dBm Output Power (dB)
500 kHz to <10 MHz	±1.6	±2.2
10 MHz to 1.3 GHz	±0.75	±1.8

Figure 5. Typical Power Accuracy, -40 dBm to 0 dBm, 5 dB Steps



Amplitude Settling Time

- **0.05 dB of final value** <500 ms, typical
- **0.25 dB of final value** <10 ms, typical

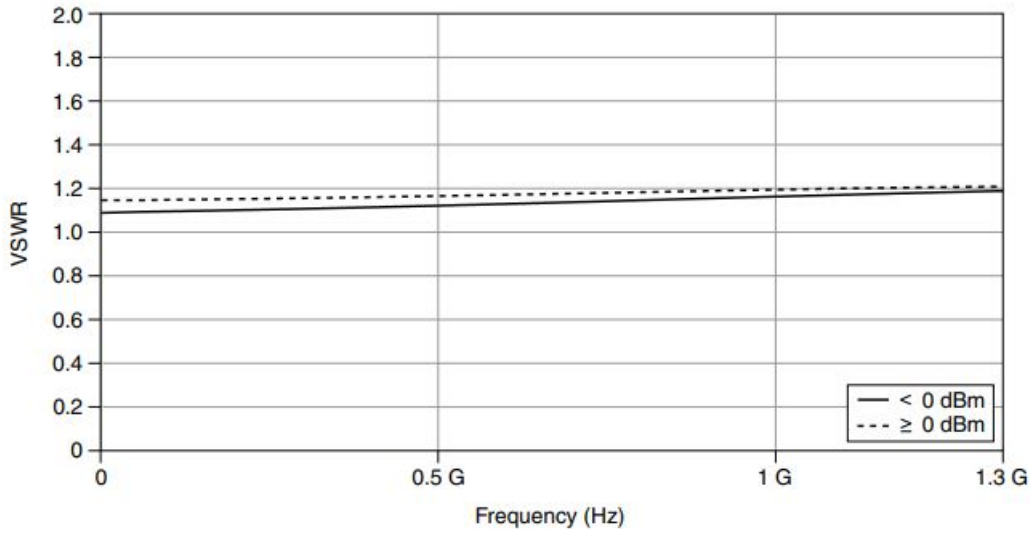
Signal-to-Noise Ratio

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

Voltage Standing Wave Ratio (VSWR)

- **500 kHz to 1.3 GHz** <1.8:1, typical
- **Output impedance** 50 Ω

Figure 6. Measured VSWR



Reverse Power Handling

- **RF** 0.5 watts, +27 dBm7

- **DC** 25 volts

Modulation

Frequency Modulation (FM)

- **Modulation waveform types** Sine, triangle, square
- **External modulation source** Not supported

Table 8. FM Typical Maximum Deviation

Frequency Range	Typical Maximum Deviation (Sine Wave)
500 kHz to <50 MHz	500 kHz
50 MHz to <100 MHz	125 kHz
100 MHz to <200 MHz	250 kHz
200 MHz to <400 MHz	500 kHz

Frequency Range	Typical Maximum Deviation (Sine Wave)
400 MHz to <800 MHz	1 MHz
800 MHz to 1.3 GHz	2 MHz

- **Modulation waveform frequency** 1 Hz to 100 kHz
- **Characteristic deviation accuracy8** <±3.5%
- **Typical distortion8** <0.1%
- **SINAD8** >65 dB

Frequency Shift Keying (FSK)

- **Modulation waveform types**
  - **PRBS** 5-order to 31-order
  - **User-defined** Up to 1,022 bit
  - **Modulation format** 2-FSK

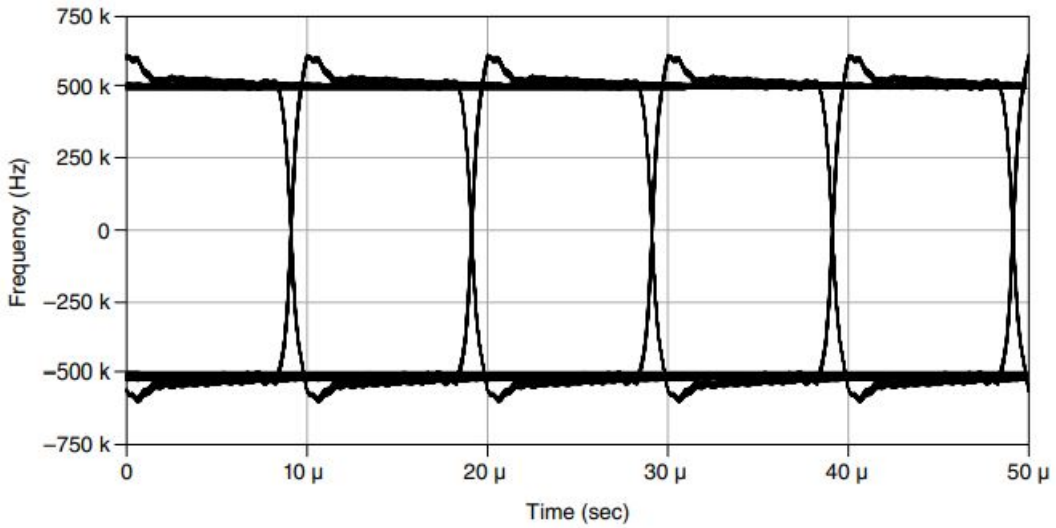
Table 9. FSK Typical Maximum Deviation

Frequency Range	Typical Maximum Deviation (kHz)
500 kHz to <50 MHz	250
50 MHz to <100 MHz	31.25
100 MHz to <200 MHz	62.5
200 MHz to <400 MHz	125

Frequency Range	Typical Maximum Deviation (kHz)
400 MHz to <800 MHz	250
800 MHz to 1.3 GHz	500

- **FSK characteristic deviation accuracy (100 kHz rate, 10% of maximum deviation)** <±10%
- **Symbol rate**
  - **PRBS** 763 Hz to 100 kHz
  - **User-defined** 763 Hz to 100 kHz
  - **Pulse shaping** Not supported

Figure 7. FSK Modulation Eye Diagram, 1.0 GHz Carrier, 100 kHz Symbol Rate, 500 kHz Deviation, Ninth-Order PRBS



On-Off Keying (OOK)

- **Modulation waveform types**
  - **PRBS** 5-order to 31-order
  - **User-defined** Up to 1,024 bit

Table 10. OOK Typical Amplitude

Frequency Range	Typical Amplitude (dBm)
500 kHz to <10 MHz	-3 to 5
10 MHz to <50 MHz	-3 to 8
50 MHz to 1.3 GHz	-3.5 to 10

- **Symbol rate**
  - **PRBS** 153 Hz to 100 kHz
  - **User-defined** 153 Hz to 100 kHz
  - **Pulse shaping** Not supported

Figure 8. OOK Diagram, 1.0 GHz Carrier, 100 kHz Symbol Rate, Ninth-Order PRBS

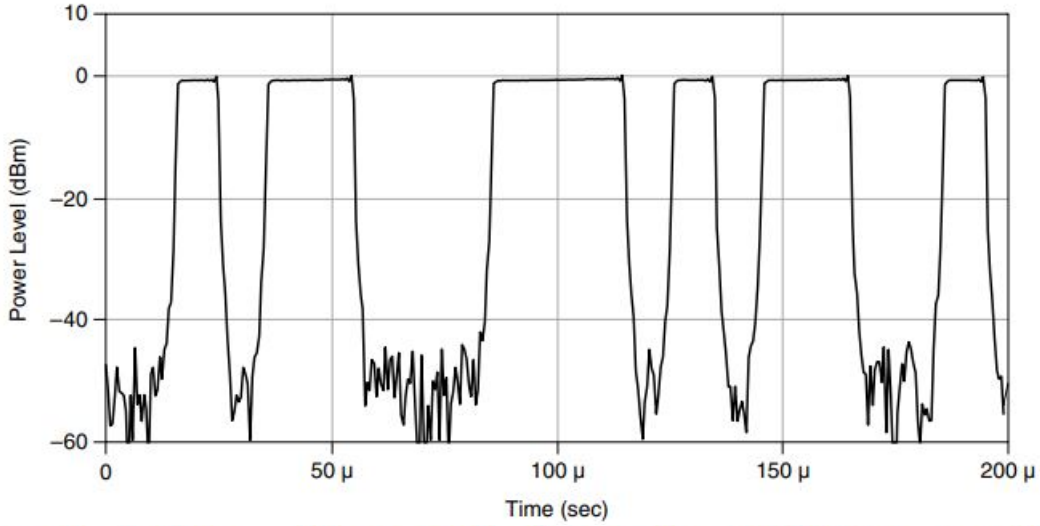
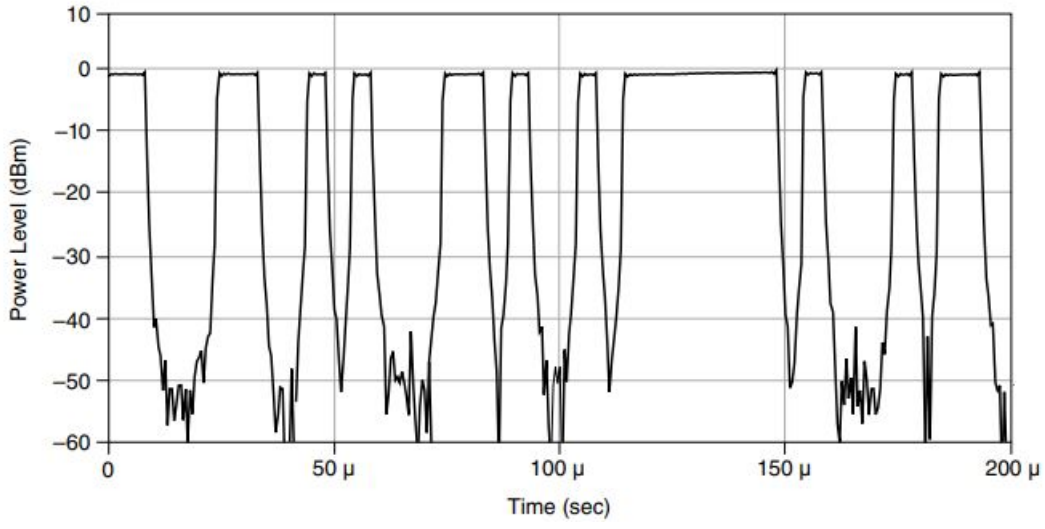


Figure 9. OOK Diagram, 1.0 GHz Carrier, 200 kHz Symbol Rate, Ninth-Order PRBS



DC Power Requirements

Table 11. DC Power Requirements

Voltage (V_{DC})	Maximum Current (A)	Typical Current (A)
+3.3	1.00	0.90
+12	1.00	0.80

Calibration

- **Interval** 1 year

Physical Dimensions

- **PXI-5650 module** 3U, one slot, PXI module 2.0 cm × 13.0 cm × 21.6 cm (0.8 in. × 5.1 in. × 8.5 in.)
- **Weight** 415 g (14.6 oz)

Environment

- **Maximum altitude** 2,000 m (800 mbar) (at 25 °C ambient temperature)
- **Pollution Degree** 2

Indoor use only.

Operating Environment

- **Ambient temperature range** 0 °C to 55 °C (Tested in accordance with IEC 60068-2-1 and IEC 60068-2-2. Meets MIL-PRF-28800F Class 3 low temperature limit and MIL-PRF-28800F Class 2 high temperature limit.)
- **Relative humidity range** 10% to 90%, noncondensing (Tested in accordance with IEC 60068-2-56.)

Storage Environment

- **Ambient temperature range** -40 °C to 70 °C (Tested in accordance with IEC 60062-2-1 and IEC 60068-2-2.)
- **Relative humidity range** 5% to 95%, noncondensing (Tested in accordance with IEC 60068-2-56.)

Shock and Vibration

- **Nonoperational shock** 30 g peak, half-sine, 11 ms pulse (Tested in accordance with IEC 60068-2-27. Test profile developed in accordance with MIL-PRF-28800F.)
- **Random vibration nonoperating** 5 Hz to 500 Hz, 2.4 grms (Tested in accordance with IEC 60068-2-64. Nonoperating test profile exceeds the requirements of MIL-PRF-28800F, Class 3.)

Compliance and Certifications

Safety
This product is designed to meet the requirements of the following electrical equipment safety standards for measurement, control, and laboratory use:

- IEC 61010-1, EN 61010-1
- UL 61010-1, CSA C22.2 No. 61010-1

Note For UL and other safety certifications, refer to the product label or the Online Product Certification section.

Electromagnetic Compatibility
This product meets the requirements of the following EMC standards for electrical equipment for measurement, control, and laboratory use:

- **EN 61326-1 (IEC 61326-1):** Class A emissions; Basic immunity
- **EN 55011 (CISPR 11):** Group 1, Class A emissions
- **EN 55022 (CISPR 22):** Class A emissions
- **EN 55024 (CISPR 24):** Immunity
- **AS/NZS CISPR 11:** Group 1, Class A emissions
- **AS/NZS CISPR 22:** Class A emissions
- **FCC 47 CFR Part 15B:** Class A emissions
- **ICES-001:** Class A emissions

Note In the United States (per FCC 47 CFR), Class A equipment is intended for use in commercial, light-industrial, and heavy-industrial locations. In Europe, Canada, Australia, and New Zealand (per CISPR 11), Class A equipment is intended for use only in heavy-industrial locations.
Note Group 1 equipment (per CISPR 11) is any industrial, scientific, or medical equipment that does not intentionally generate radio frequency energy for the treatment of material or inspection/analysis purposes.
Note For EMC declarations, certifications, and additional information, refer to the Online Product Certification section.

CE Compliance
This product meets the essential requirements of applicable European Directives, as follows:

- **2014/35/EU;** Low-Voltage Directive (safety)
- **2014/30/EU;** Electromagnetic Compatibility Directive (EMC)

Online Product Certification
Refer to the product Declaration of Conformity (DoC) for additional regulatory compliance information. To obtain product certifications and the DoC for this product, visit **ni.com/certification**, search by model number or product line, and click the appropriate link in the Certification column.

Environmental Management
NI is committed to designing and manufacturing products in an environmentally responsible manner. NI recognizes that eliminating certain hazardous substances from our products is beneficial to the environment and to NI customers. For additional environmental information, refer to the Minimize Our Environmental Impact web page at **ni.com/environment**. This page contains the environmental regulations and directives with which NI complies, as well as other environmental information not included in this document.

Waste Electrical and Electronic Equipment (WEEE)
EU Customers At the end of the product life cycle, all NI products must be disposed of according to local laws and regulations. For more information about how to recycle NI products in your region, visit **ni.com/environment/weee**.

Documents / Resources

	APEX WAVES PXI-5650 1.3 GHz RF Analog Signal Generator [pdf] User Manual PXI-5650 1.3 GHz RF Analog Signal Generator, PXI-5650, 1.3 GHz RF Analog Signal Generator, Analog Signal Generator, Signal Generator, Generator

References

- Engineer Ambitiously - NI
- Engineer Ambitiously - NI
- Engineering a Healthy Planet - NI
- Managing Critical Substances - NI
- Product Take-Back Program and Recycling - NI
- Trade Compliance - NI
- National Instruments Patents - NI

- NI Trademarks and Logo Guidelines - NI
- Product Certifications - NI
- Product Take-Back Program and Recycling - NI
- Engineering a Healthy Planet - NI
- PXI-5650 National Instruments Analog Signal Generator | Apex Waves