DATA SHEET

M9336A PXIe I/Q Arbitrary Waveform Generator

3-channel, up to 1 GHz I/Q bandwidth

KEYSIGHT TECHNOLOGIES

Exceptional performance in a single-slot PXIe module

The Keysight Technologies, Inc. M9336A PXIe Arbitrary Waveform Generator (AWG) provides multiple independent or synchronized signal outputs with exceptional performance in a single-slot PXIe module. It is ideal for creating digitally modulated waveforms for wideband communication systems and high-resolution waveforms for radar and satellite test. Industry standard waveforms for the AWG can be easily generated using Keysight software applications tools such as Signal Studio or Waveform Creator. In addition to these tools, users can generate their own waveforms using MATLAB or custom tools. The AWG provides standard IVI compliant drivers for integration with multiple application development environments.

Applications

- Generation of wide-bandwidth baseband I/Q communication signals with synchronized envelope tracking signals
- High bandwidth, small sample size control signals used for quantum computing
- DOCSIS upstream signals
- Satellite and radar signals
- General purpose, multi-channel arbitrary waveform generation

Key Features

- Single PXIe slot
- Three differential or single-ended signal channels with SMB connectors
- 16-bit amplitude resolution
- Up to 540 MHz bandwidth per channel (1080 MHz I/Q modulation bandwidth)
- Per channel control of channel skew, gain, and offset
- Up to eight modules can be synchronized with option PCH
- Highly flexible waveform definition and sequencing with up to 4 GB of waveform sample and waveform sequencing memory
- Play large waveforms from external storage with option LW1
- Up to 8 marker signals per channel
- Front panel and PXIe backplane triggers and markers
- Keysight exclusive Trueform waveform generation
- Simple to use soft front panel

M9336A PXIe I/Q Arbitrary Waveform Generator

The M9336A AWG delivers exceptional performance for creation of complex wideband waveforms. Multiple, 540 MHz bandwidth channels with 16-bit resolution and up to a 1.28 GSa/s sampling rate are provided in a single-slot PXIe instrument. This enables the AWG to generate wide bandwidth signals with low Error Vector Magnitude (EVM), making it ideal for creating baseband waveforms for wireless communications, radar, and satellite. The AWG can also be combined with a wideband I/Q upconverter/modulator, resulting in modulation bandwidths of 1 GHz at RF frequencies for signal simulations employed in functional testing of chip sets designed for modern digital communications radios.

The AWG includes advanced sequencing and triggering modes which can be used to create complex waveforms and event-based signal simulations. In addition to the driver API provided with the instrument, the AWG provides a comprehensive soft front panel (SFP) which speeds test development and debug by enabling the user to interactively control the module.

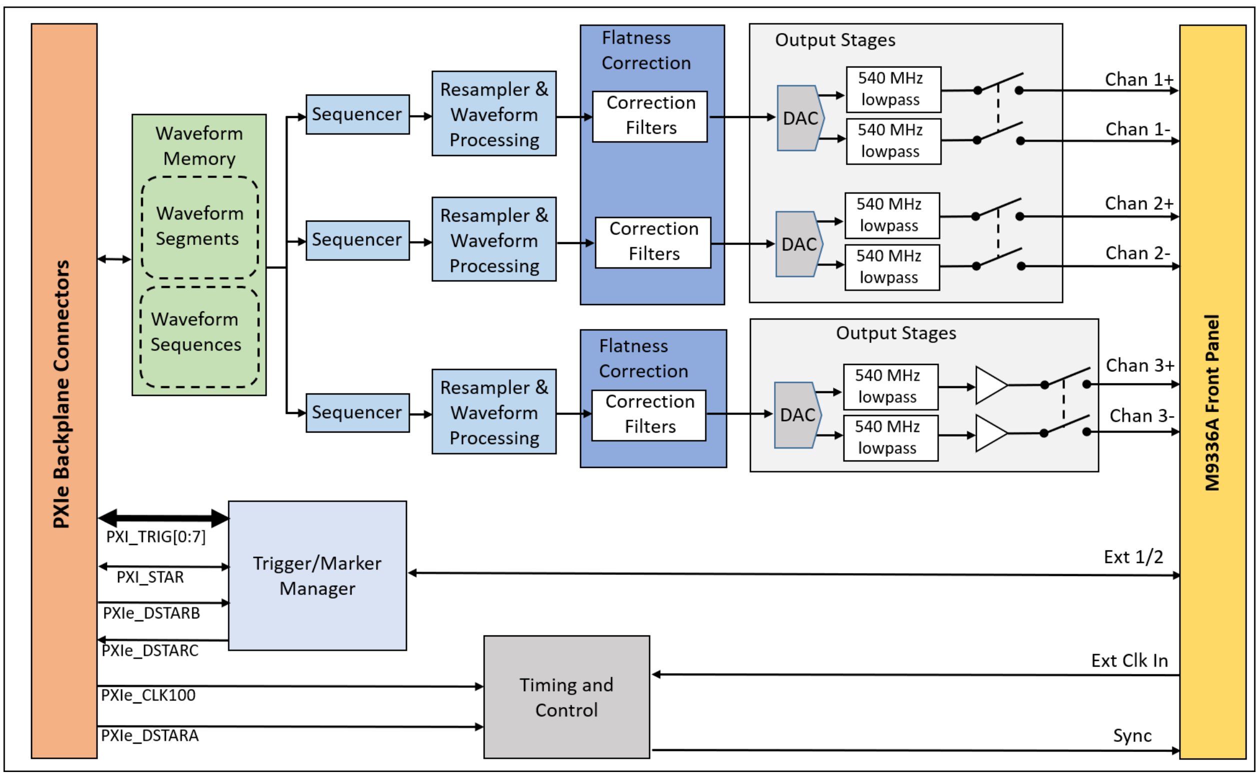


Figure 1. M9336A AWG block diagram.

Exceptional signal quality

The M9336A AWG provides exceptional signal quality which is essential for reliable and repeatable measurements on today's advanced wireless designs. With 16-bit resolution, it generates full bandwidth SFDR (without harmonics) of >67 dBc on differential channels. Selectable amplitude flatness correction can be used to achieve a DC to 540 MHz flatness of ±0.15 dB. Corrected phase flatness is ±1 degree, also from DC to 540 MHz. This results in an EVM as low as 75 m% RMS (20 MHz bandwidth LTE-A signal).

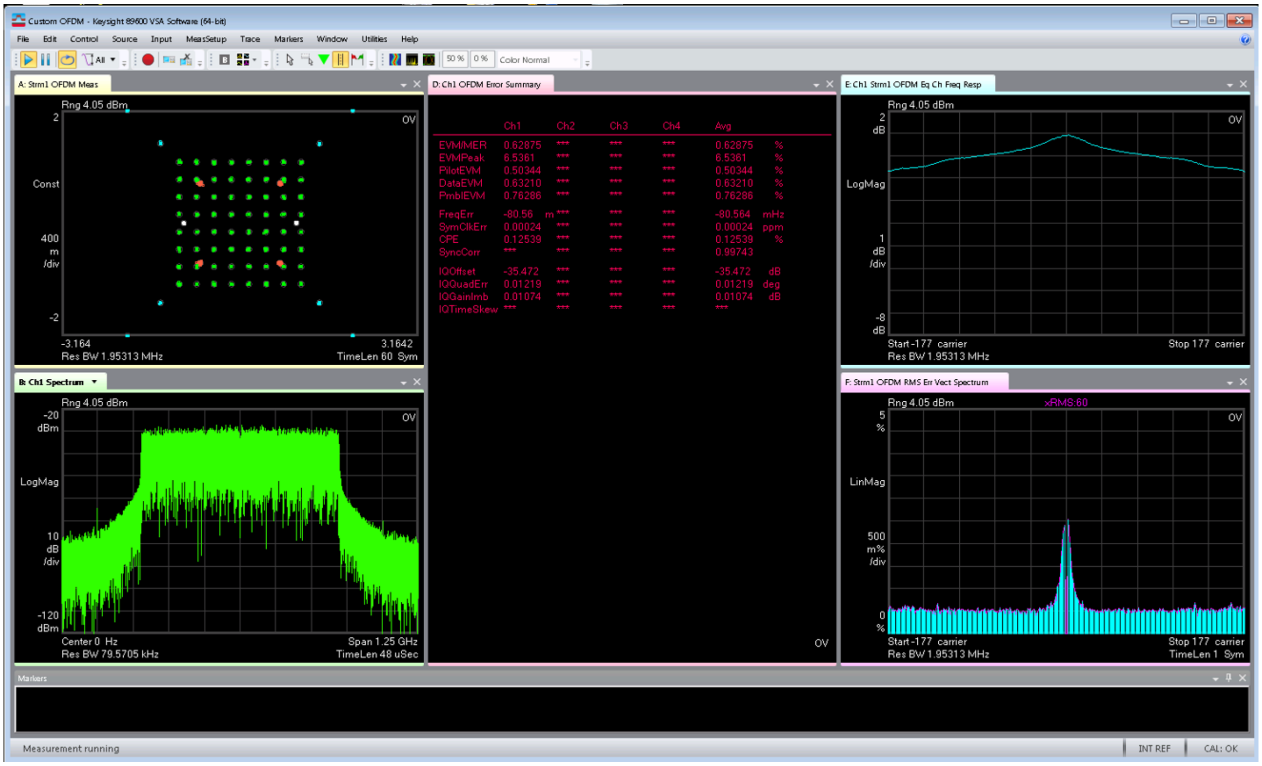


Figure 2. Generate complex, wide bandwidth signals with exceptional EVM performance.

Individual channel capability

The AWG provides three scalar channels with SMB connections and up to 540 MHz bandwidth. Each channel utilizes a high-resolution DAC and can drive both single-ended and balanced designs. The I/Q channels (channels 1 and 2) are not amplified and provide an output range of up to 2 Vp-p for differential signals (1 Vp-p for single-ended). Common mode offsets ranging from -0.3 to +0.8 V can be added to each channel. The third channel does include an amplifier and its output range is 3.4 Vp-p for differential signals (1.7 Vp-p for single-ended) with a common mode offsets of ±1.2 V. All single-ended channels have a nominal output impedance of 50 ohms (100 ohms differential).

Each channel has its own waveform sequencer and can operate independently. The channels can also be synchronized with a typical channel-to-channel alignment of <20 ps (channels 1 and 2) and individual channels can be adjusted with a resolution of .001 ps. When used in I/Q applications, the channel-to-channel delay can be used to compensate for modulator behavior which can improve channel matching resulting in a better EVM of the test signal. In addition, the third synchronized channel can be used as a very accurate marker output or as a third signal such as a synchronized envelope tracking signal.

Channel filtering and gain

The AWG has the capability to provide real-time correction filtering on each of the three analog output channels. This filter provides a flatter frequency response for each channel over the entire channel bandwidth. The user can bypass this filtering, if required. In addition to the digital correction filter, the instrument provides a high-performance reconstruction filter on each channel that is tuned to the DAC sample rate.

For the real-time correction filter, the AWG uses a unique technique to match the filter response to the user-defined sample rate in order to maximize the available signal level for the specific signal bandwidth required. Each channel can be adjusted individually using the digital or analog gain controls. This is required in applications where each channel needs to be adjusted to meet the test system's requirements. Channel 3 also has an additional analog amplifier for higher signal levels than channel 1 and 2. This is provided for envelope tracking standards.

Waveform Sequencing

The AWG utilizes a very flexible and powerful waveform sequencer to play simple or complex waveforms which can be built from several common waveform segments. Each output channel has its own independent sequencer. Channel sequencers can be synchronized as required to create tightly aligned channels required for I/Q baseband signals.

The waveform sequencer gives the user the ability to create long, complex waveforms while using minimal sample memory. The sequencer operates as follows (see figure 3):

- Each waveform segment is composed of waveform samples.
- Waveform sequences are built by combining waveform segments.
- Segments and sequences can also be combined as needed to create desired signals.
- Repeat loops can be used to repeat individual segments or the entire waveform sequence itself. These repeat loops can be nested up to 8 deep.
- The sample rate for the waveform samples is based on the channel sample rate setting which can be different for each channel.
- Both hardware and software triggers can be used to control how to advance from one waveform segment to the next within a sequence.

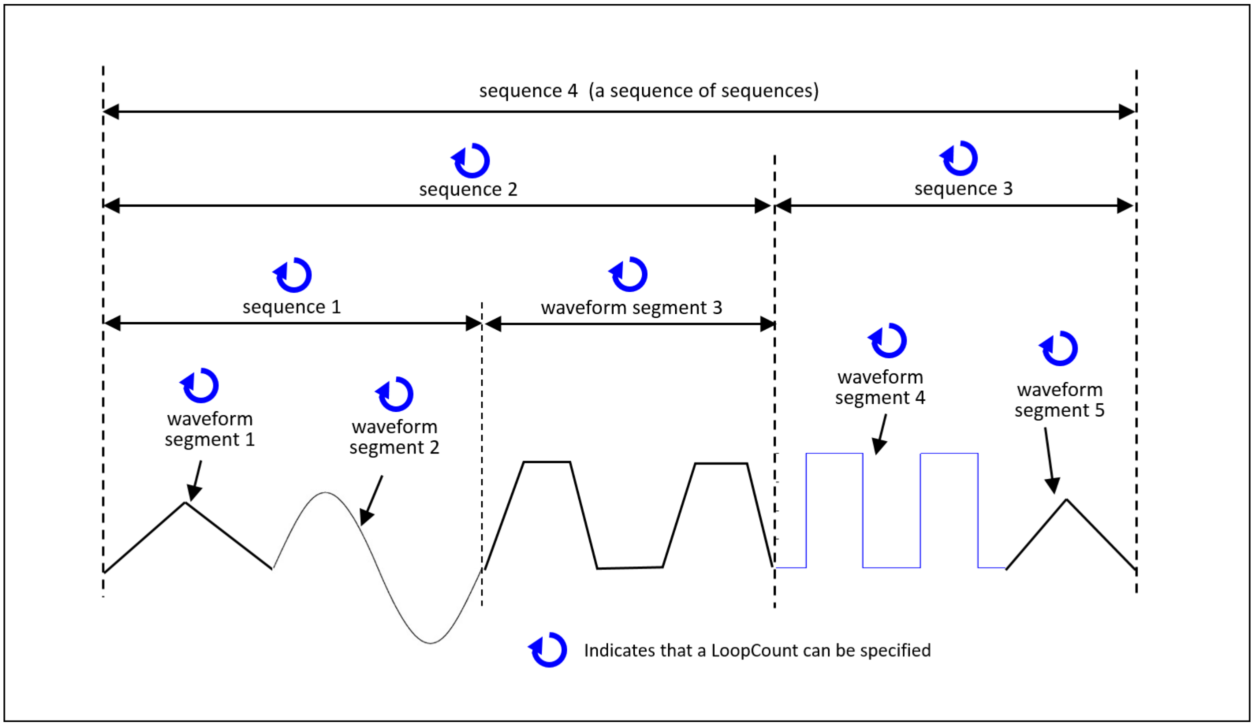


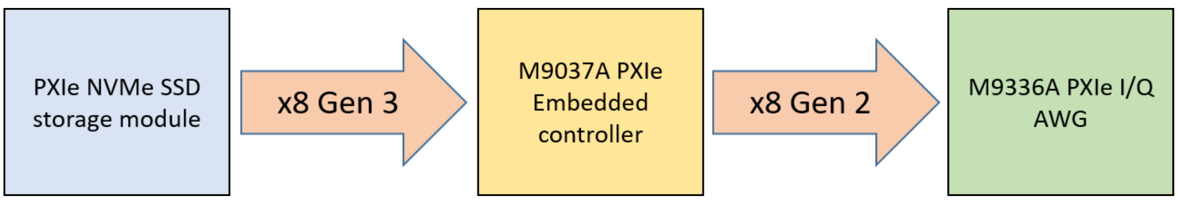
Figure 3. M9336A AWG waveform sequencing

Module memory

The AWG has up to 4 GB of memory which is managed as a single shared storage space for waveforms, markers, and sequencer programs. The memory segments for the data that shares this storage space are dynamically allocated. This generally results in >500 MSa of waveform storage per channel (depending on memory option).

Large waveform playback (option LW1)

Option LW1 enables the AWG to play a waveform from external memory that does not reside on the module (e.g. embedded controller or external PC with NVMe SSD). Large waveform files are loaded over the PXIe backplane and it is recommended the AWG is installed in a Gen 3 chassis. The waveform length is only limited by the size of this external memory allowing the AWG to playback very long, non-periodic waveforms. Applicable to I/Q waveforms only, with a Bandwidth of 400 MHz or less (500 MSa/s maximum sample rate).



Triggers and markers

The AWG can accept hardware or software triggers which are primarily used to:

- Control the starting of waveform segments/sequences
- Control internal operation of waveform sequences, e.g. loop until trigger and wait for trigger

Triggers sources include the front panel Ext 1/2 connectors and PXI backplane. Software triggers are also allowed.

Output markers are used to identify points in time that are correlated to a waveform as it is played. Each marker is typically aligned with a particular sample of the waveform. The marker can be output on:

- An analog channel. A marker being output on an analog channel goes through the same DSP signal chain as other channels and results in the most accurate place- ment relative to another analog channel.
- Through the front panel Ext 1/2 connectors
- Through the PXI trigger lines

Phase-coherent operation (option PCH)

Up to eight modules (each with option PCH) can be synchronized to provide phase-coherent operation. Modules are interconnected using the front panel Sync signal in a daisy-chain configuration. An SMB cable and tee are provided with each module (with option PCH) for this purpose. Out of the box, there is typically 500 ps of skew between modules. However, module-to-module alignment can be improved by using an oscilloscope to manually characterize delays and compensate for them with the channel delay feature. For more details, see Pub Number 5992-3787EN

Keysight Trueform signal generation

The AWG includes Keysight's exclusive Trueform technology that allows waveforms to be expressed with the same shape, regardless if the signal is 1 Sa/s or the maximum rate of 1.28 GSa/s. Waveforms are always anti-aliased for exceptional accuracy, and can be played at the selectable sample rate, without the chance of missing short-duration anomalies that are critical for testing device reliability. Digital waveforms with transients and pulses can be reproduced with the same characteristics every time.

Many arbitrary waveform generators store points in memory and then read those points out one after another and clock them into a DAC. This requires a low-noise variable-frequency clock which adds to complexity and cost. Trueform technology instead uses a patented virtual variable clock with advanced filtering techniques that track the sample rate of the arbitrary waveform. This exclusive digital sampling technique results in overall better signal integrity with more efficient memory use. It also enables the waveform segment to be scaled in time to produce different frequency shifted versions of the same waveform simply by changing the waveform sample rate.

M9336A AWG Software Toolset

Soft front panel interface

An easy-to-use soft front panel (SFP) interface for the AWG is a standard interface provided with the product (Figure 4). The SFP can be used to control the AWG and has the following functions:

- Provide an interactive soft front panel to allow the user to quickly learn how to use the instrument
- Configure individual channel physical connections: differential, single-ended
- Load waveform files
- Develop simple or complex waveform sequences created using waveform files
- Control the operation of the module and how to execute the waveforms: continuous, burst, immediate or triggered using software or hardware inputs, sample rate, synchronous or independent channel operation.
- Configure channel trigger and marker source and destination
- Monitor driver calls as the AWG is controlled via the SFP to allow the user to quickly integrate API calls into the test development environment
- Provides module utilities such as self-test and firmware upgrade

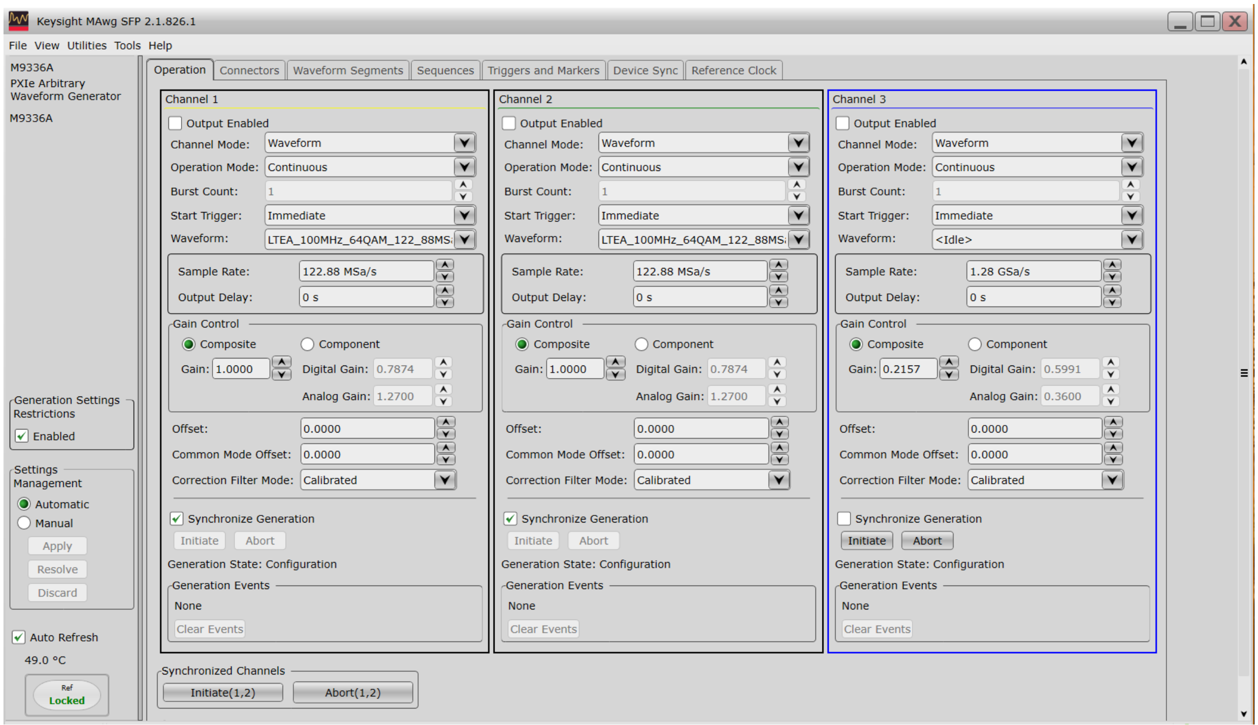


Figure 4. M9336A AWG soft front panel

IVI drivers

The AWG provides IVI.NET, IVI-C, and LabVIEW drivers to enable easy integration into common test development environments. These drivers are used with IDE and test development tools such as Command Expert, LabVIEW, MATLAB, and Visual Studio.

Waveform development

There are different ways to develop waveforms for the M9336A AWG:

- M9099A Waveform Creator: supported via a .csv file
- MATLAB and Keysight IQtools Software: the AWG supports .NET driver access or through a .csv file format.
- SystemVue: the data for the waveform segment created by SystemVue can be exported to a .csv file compatible with the AWG
- File import: import a .csv or .bin (N5110) file
- Signal Studio: uses a waveform playback license that enables the M9336A to accept playback of Signal Studio waveforms (wfm format). Live connectivity with Signal Studio is not supported. The license supports four M9336A modules. Order the M9950A to support up to eight M9336A modules.

The following Signal Studio products are supported:

- N7600EMBC W-CDMA/HSPA+
- N7601EMBC CDMA2000®/1xEV-DO
- N7602EMBC GSM/Edge/Evo
- N7606EMBC Bluetooth (BR, EDR, LE 4.0, BT5)
- N7608EMBC Custom modulation
- N7610EMBC IoT (Internet of Things)
- N7612EMBC TD-SCDMA/HSPA
- N7617EMBC WLAN 802.11a/b/g/j/p/n/ac/ah/ax
- N7624EMBC LTE/LTE-Advanced FDD
- N7625EMBC LTE/LTE-Advanced TDD
- N7630EMBC Pre-5G
- N7631EMBC 5G NR

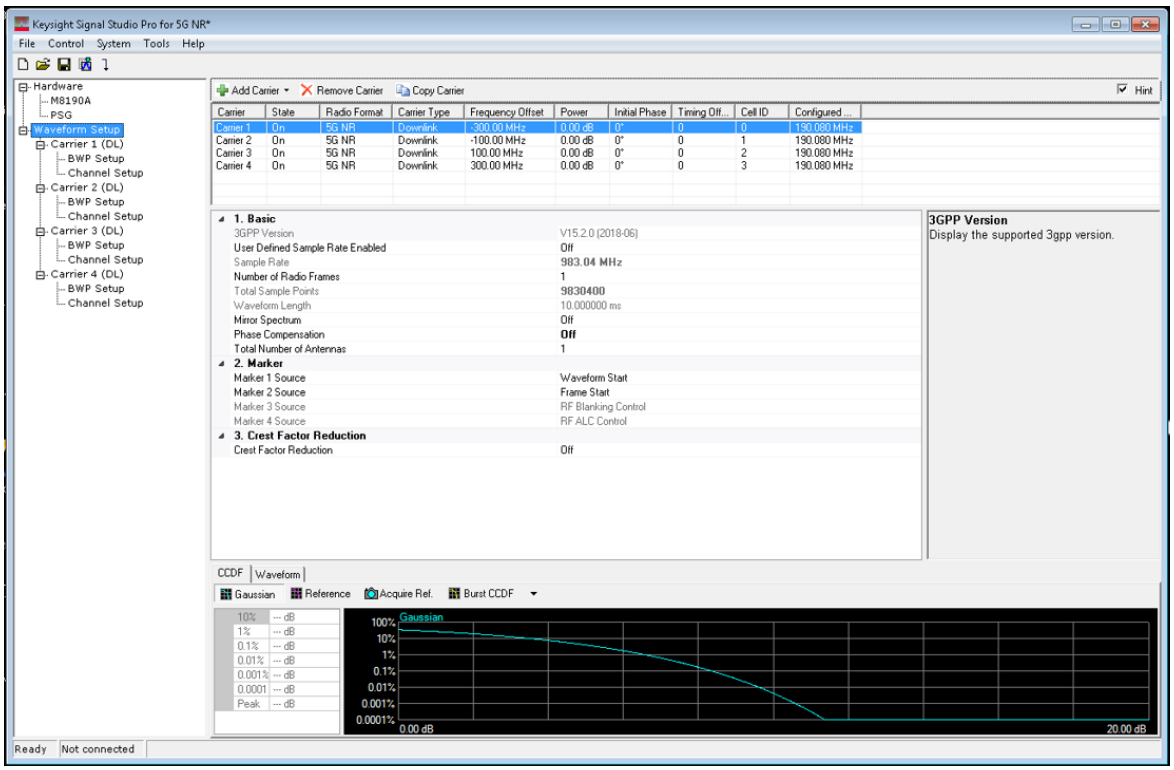


Figure 5. N7631C Keysight Signal Studio application for 5G NR

Technical Specifications and Characteristics

Definitions and Conditions

Specification (spec)
The warranted performance of a calibrated instrument that has been stored for a minimum of 1 hour within the operating temperature range of 0 to 50 °C and after a 30-minute warm up period. All specifications account for the effects of measurement and calibration-source uncertainties and were created in compliance with ISO-17025 methods. In addition, a driver session must be opened to initialize the power supplies. This can be done programmatically or by opening SFP and connecting to the instrument. Data published in this document are specifications (spec) only where specifically indicated.
Typical (typ)
The characteristic performance, which 80% or more of manufactured instruments will meet. This data is not warranted, does not include measurement uncertainty or calibration-source, and is valid only at room temperature (approximately 25°C).
Nominal (nom)
The mean or average characteristic performance, or the value of an attribute that is determined by design such as a connector type, physical dimension, or operating speed. This data is not warranted and is measured at room temperature (approximately 25°C).
Measured (meas)
An attribute measured during the design phase for purposes of communicating expected performance, such as amplitude drift vs. time. This data is not warranted and is measured at room temperature (approximately 25°C).
Additional Information
All data are measured from multiple units at room temperature and are representative of product performance within the operating temperature range unless otherwise noted. The data contained in this document is subject to change.

General Characteristics

Module characteristics	
Bus interface and compatibility	PXIe peripheral module (x8 Gen 2)
Number of slots	1
Module memory (option dependent)	2 or 4 GB
Maximum number of synchronized modules	8 (requires option PCH)
Supported waveform file formats	M9336A binary format (.bin), CSV, Signal Studio (.wfm), and N5110 (.bin)
Front panel connectors	
Ext1 and Ext2	SMB male
Channel 1+ and 1-	SMB male
Channel 2+ and 2-	SMB male
Channel 3+ and 3-	SMB male
Ext Clk In	SMB male
Sync	SMB male (enabled with M9336A-PCH option)
Aux port	Reserved for future use
Mechanical (nom)	
Size	3U/1-slot PXIe standard 130.1 x 21.7 x 210 mm; includes connectors and handle extensions
Weight	544 g (1.2 lbs)

DC Power Requirements

DC supply	Typical	Maximum
DC supply current		
+3.3V	2.7 A	3.0 A
+12V	3.3 A	3.8 A
Power dissipation		
Total power dissipated	48 W	54 W

Channel Characteristics

Characteristic	Value	Comments
Number of channels	3	
Resolution	16-bit	
Maximum channel bandwidth	540 MHz	Option dependent
Maximum modulation (I/Q) bandwidth	1080 MHz	Option dependent
Output coupling	DC	
Channel-to-channel alignment (meas)[3]		
Between channels 1 and 2	< 20 ps	
Between channels 3 and other channels	< 40 ps	
Between modules	< 500 ps	Requires option PCH
Channel delay (nom)		
Delay range	±0.5 x (sample period) or ±1.6 µs whichever is greater	Sample period = 1/sample rate
Delay resolution	0.1 ps for sample rates ≥ 2.5 KSa/s 250 ps @ 1 Sa/s	Delay resolution varies with sample rate below 2.5 KSa/s

Analog Output Characteristics and Specifications

Output Amplitude[1]	
Amplitude resolution	16-bit (nom)
Amplitude DC accuracy	±0.5% of setting ±5 mV (spec)
Jitter[2]	
Fc = 10 MHz	< 1 ps rms (meas)
Fc ≥ 50 MHz	< 0.25 ps rms (meas)
Rise/fall time (10% to 90%)	
Without corrections	< 1.2 ns, typical
With corrections	< 900 ps, typical

[1] Each output terminated with 50 ohms to ground.
[2] 1 kHz to 10 MHz integration bandwidth
[3] Module-to-module alignment can be improved by using an oscilloscope to manually characterize delays and compensate for them with the channel delay feature

Single-ended Output Characteristics (nom)[1]

Characteristic	Channels 1 & 2	Channel 3
Output impedance	50 Ω	50 Ω
Amplitude range[2,3]		
Without corrections	0 Vpp to 1 Vpp	0 Vpp to 1.65 Vpp
With corrections[4]	0 Vpp to 0.8 Vpp	0 Vpp to 1.26 Vpp
Offset		
Range	-0.3 to +0.81 V	±1.2 V
Adjustment resolution	100 uV	100 uV
Analog gain		
Range	15 dB (min=0.11, max=0.66)	15 dB (min=0.18, max=1.08)
Adjustment resolution	0.0001	0.0001
Digital gain		
Range	min=0, max=1	min=0, max=1
Adjustment resolution	0.0001	0.0001

Differential Output Characteristics (nom)[1]

Characteristic	Channels 1 & 2	Channel 3
Output impedance	100 Ω	100 Ω
Amplitude range[2,3]		
Without corrections	0 Vpp to 2 Vpp	0 Vpp to 3.6 Vpp
With corrections[4]	0 Vpp to 1.6 Vpp	0 Vpp to 2.5 Vpp
Differential offset		
Range	±0.35 V	±2.40 V
Adjustment resolution	100 uV	100 uV
Common mode offset		
Range	-0.3 to +0.81 V	±1.20 V
Adjustment resolution	100 uV	100 uV
Analog gain		
Range	15 dB (min=0.22, max=1.32)	15 dB (min=0.36, max=2.1)
Adjustment resolution	0.0001	0.0001
Digital gain		
Range	min=0, max=1	min=0, max=1
Adjustment resolution	0.0001	0.0001

[1] Each output terminated with 50 ohms to ground.
[2] With maximum analog and default digital gain settings. Higher levels of digital gain are possible depending on signal type. For example, channels 1 and 2 can output a with a 1.3 Vpp sinewave. Using maximum digital gain on complex waveforms with high crest factors may cause signal overload.
[3] For channel 3, it is recommended to keep (Vpp X Frequency) <2.5x108 and offsets = 0V to minimize harmonic distortion. If offsets are used, it is recommended to keep (Vp X Frequency) <4x107
[4] At maximum sample rate. Reducing sample rate will allow for higher amplitude settings.

Analog Output Characteristics (cont'd)

Output Frequency Response (meas)	
Ch 1 and Ch 2 corrected amplitude flatness	±0.1 dB DC - 400 MHz ±0.15 dB >400MHz - 540 MHz
Corrected phase flatness	±1 degree DC - 540 MHz
Analog reconstruction filter	540 MHz, 9th order elliptical, low pass

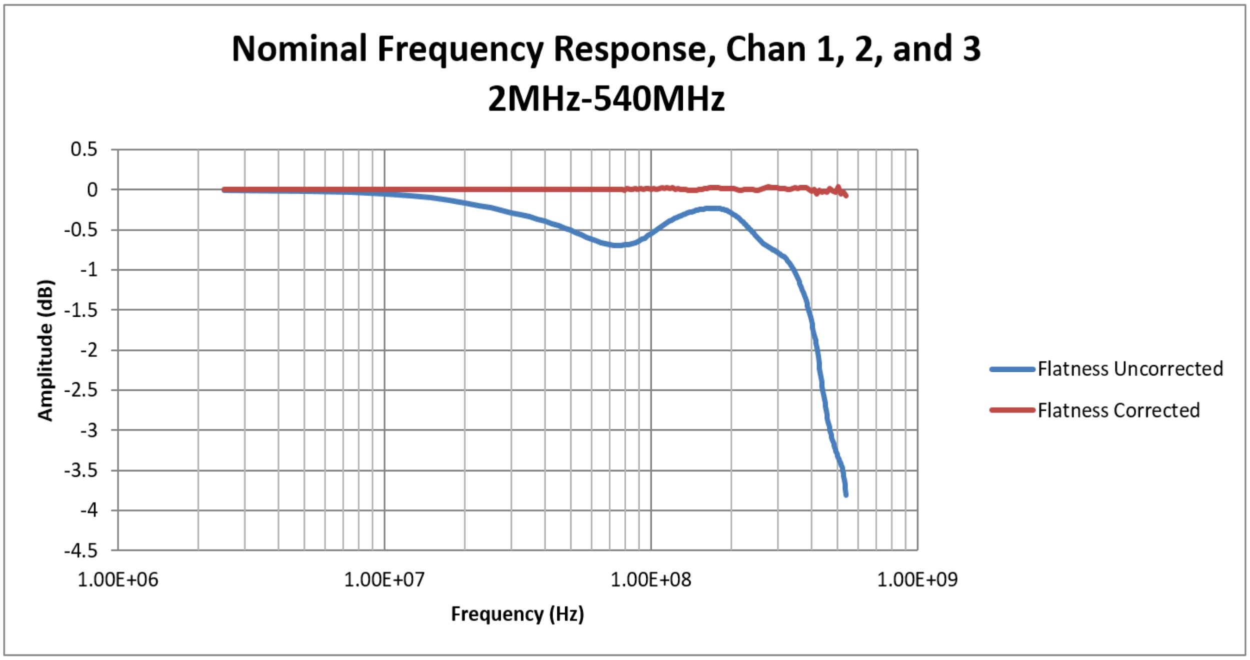


Figure 6. Nominal frequency response, channel 1-3

Spectral Characteristics (Channels 1 and 2)

Characteristic	Single-ended (typ)	Differential (typ)	Comments
Harmonic distortion			
Fc ≤ 200 MHz: 1 Vpp, 0.5 Voff (SE) or 2 Vpp, 0.8 Vcm (Diff)	≤ -44 dBc	≤ -47 dBc	
Fc ≤ 200 MHz: 1 Vpp, 0 Voff (SE) or 2 Vpp, 0 Vcm (Diff)	≤ -52 dBc	≤ -64 dBc	
Fc ≤ 200 MHz: 0.5 Vpp, 0 Voff (SE) or 1 Vpp, 0 Vcm (Diff)	≤ -54 dBc	≤ -69 dBc	
Fc ≤ 50 MHz: 1 Vpp, 0 Voff (SE) or 2 Vpp, 0 Vcm (Diff)	≤ -58 dBc	≤ -69 dBc	
SFDR without harmonics			
Fc = 500 MHz: 0.8 Vpp, 0 Voff (SE) or 1.6 Vpp, 0 Vcm (Diff)	≥ 37 dBc	≥ 58 dBc	Measured DC to 540 MHz
Fc = 200 MHz: 1 Vpp, 0 Voff (SE) or 2 Vpp, 0 Vcm (Diff)	≥ 58 dBc	≥ 67 dBc	Measured DC to 540 MHz
Fc = 50 MHz: 1 Vpp, 0 Voff (SE) or 2 Vpp, 0 Vcm (Diff)	≥ 52 dBc	≥ 67 dBc	Measured DC to 135 MHz
SFDR with harmonics			
Fc ≤ 200 MHz: 1 Vpp, 0.5 Voff (SE) or 2 Vpp, 0.8 Vcm (Diff)	≥ 44 dBc	≥ 47 dBc	Measured DC to 540 MHz
Fc ≤ 200 MHz: 1 Vpp, 0 Voff (SE) or 2 Vpp, 0 Vcm (Diff)	≥ 52 dBc	≥ 63 dBc	Measured DC to 540 MHz
Fc ≤ 200 MHz: 0.5 Vpp, 0 Voff (SE) or 1 Vpp, 0 Vcm (Diff)	≥ 53 dBc	≥ 67 dBc	Measured DC to 540 MHz
Fc ≤ 50 MHz: 1 Vpp, 0 Voff (SE) or 2 Vpp, 0 Vcm (Diff)	≥ 57 dBc	≥ 67 dBc	Measured DC to 135 MHz
Intermod distortion (IMD3)			
Fc = 100 MHz ± 500 KHz: 1 Vpp, 0.5 Voff (SE) or 2 Vpp, 0.8 Vcm	< -71 dBc	< -60 dBc	
Fc = 100 MHz ± 500 KHz: 1 Vpp, 0 Voff (SE) or 2 Vpp, 0 Vcm (Diff)	< -73 dBc	< -75 dBc	
Fc = 10 MHz ± 500 KHz: 1 Vpp, 0.5 Voff (SE) or 2 Vpp, 0.8 Vcm (Diff)	< -84 dBc	< -73 dBc	
Fc = 10 MHz ± 500 KHz: 1 Vpp, 0 Voff (SE) or 2 Vpp, 0 Vcm (Diff)	< -87 dBc	< -85 dBc	
Third order intercept (TOI)			
Fc = 100 MHz ± 500 KHz: 1 Vpp, 0.5 Voff (SE) or 2 Vpp, 0.8 Vcm	> 34 dBm	> 28 dBm	
Fc = 100 MHz ± 500 KHz: 1 Vpp, 0 Voff (SE) or 2 Vpp, 0 Vcm (Diff)	> 35 dBm	> 36 dBm	
Fc = 10 MHz ± 500 KHz: 1 Vpp, 0.5 Voff (SE) or 2 Vpp, 0.8 Vcm (Diff)	> 40 dBm	> 35 dBm	
Fc = 10 MHz ± 500 KHz: 1 Vpp, 0 Voff (SE) or 2 Vpp, 0 Vcm (Diff)	> 42 dBm	> 41 dBm	
Output phase noise (100 MHz output)			
1 kHz offset	-130 dBc/Hz	-130 dBc/Hz	
10 kHz offset	-135 dBc/Hz	-135 dBc/Hz	
100 kHz offset	-137 dBc/Hz	-137 dBc/Hz	
1 MHz offset	-152 dBc/Hz	-152 dBc/Hz	
10 MHz offset	-162 dBc/Hz	-162 dBc/Hz	
Noise floor			
	≤ -159 dBm/Hz	≤ -159 dBm/Hz	100 MHz tone, spot noise measured at 133 MHz

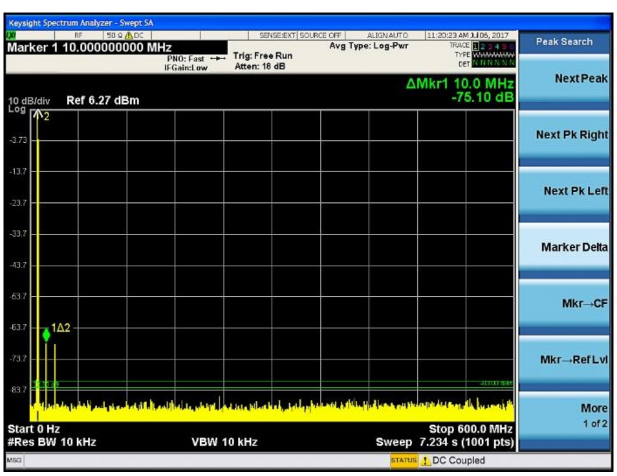


Figure 7. Typical Channel 1-2, 10 MHz tone spectrum

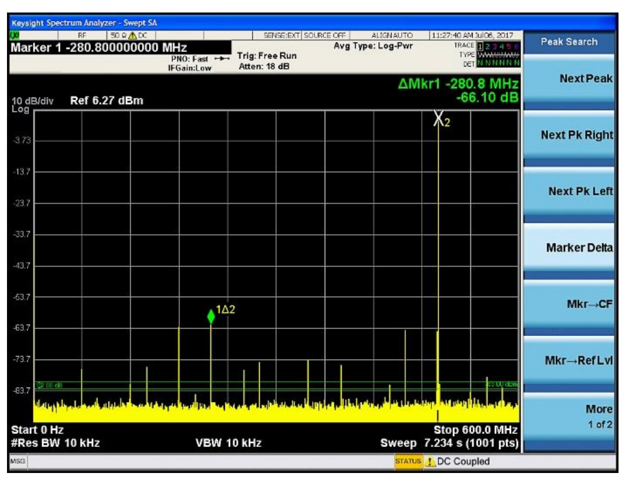


Figure 8. Typical Channel 1-2, 500 MHz tone spectrum

Spectral Characteristics (Channels 1 and 2) (cont'd)

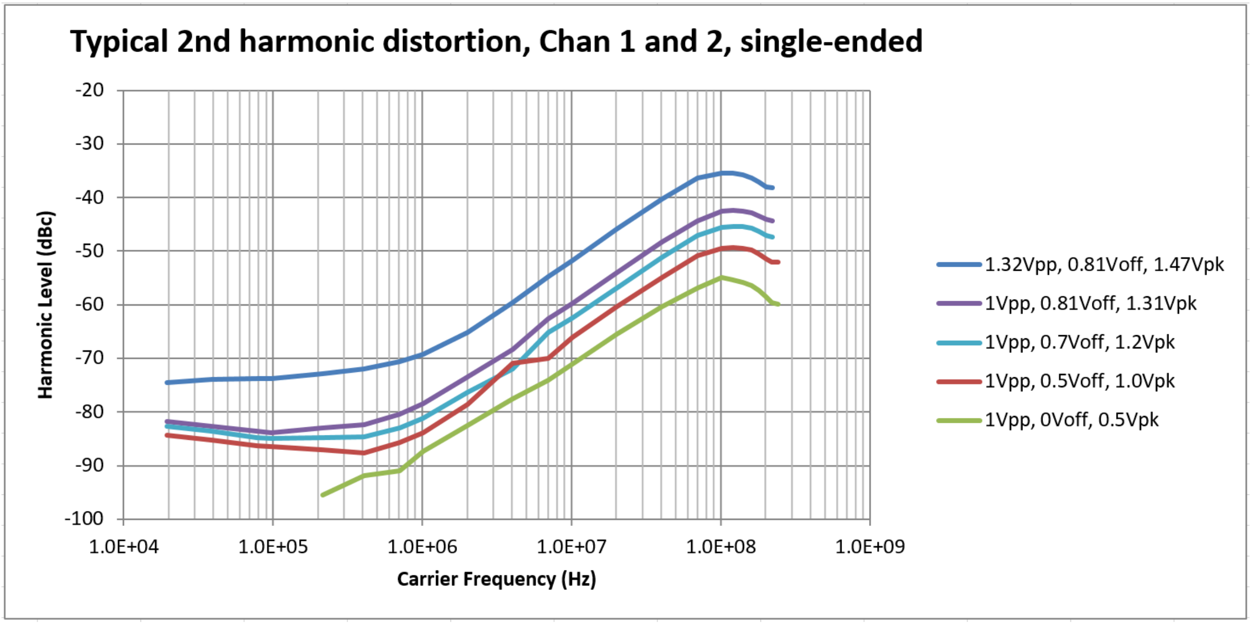


Figure 9. Typical 2nd harmonic distortion, channel 1 and 2, single-ended

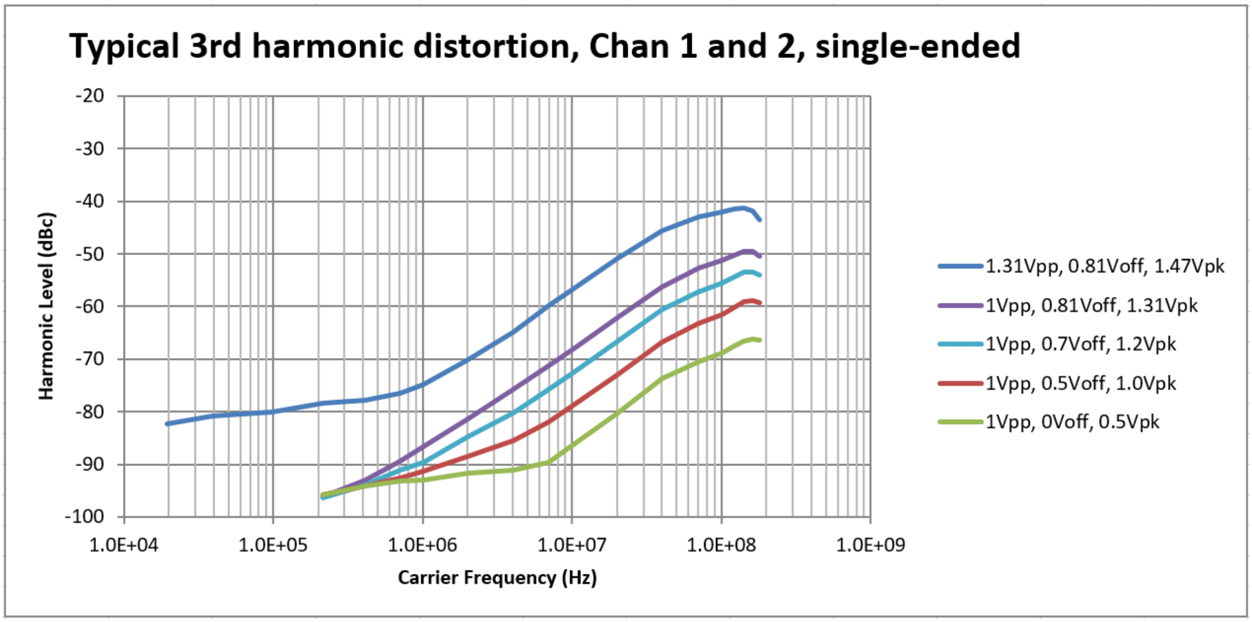


Figure 10. Typical 3rd harmonic distortion, channel 1 and 2, single-ended

Spectral Characteristics (Channels 1 and 2) (cont'd)

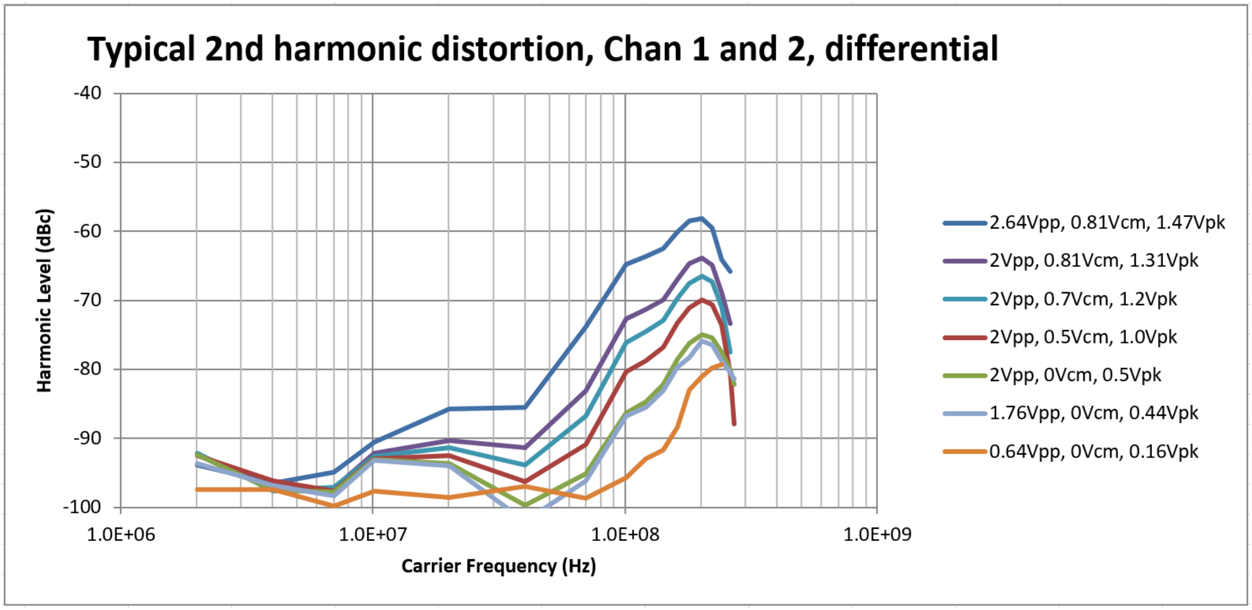


Figure 11. Typical 2nd harmonic distortion, channel 1 and 2, differential

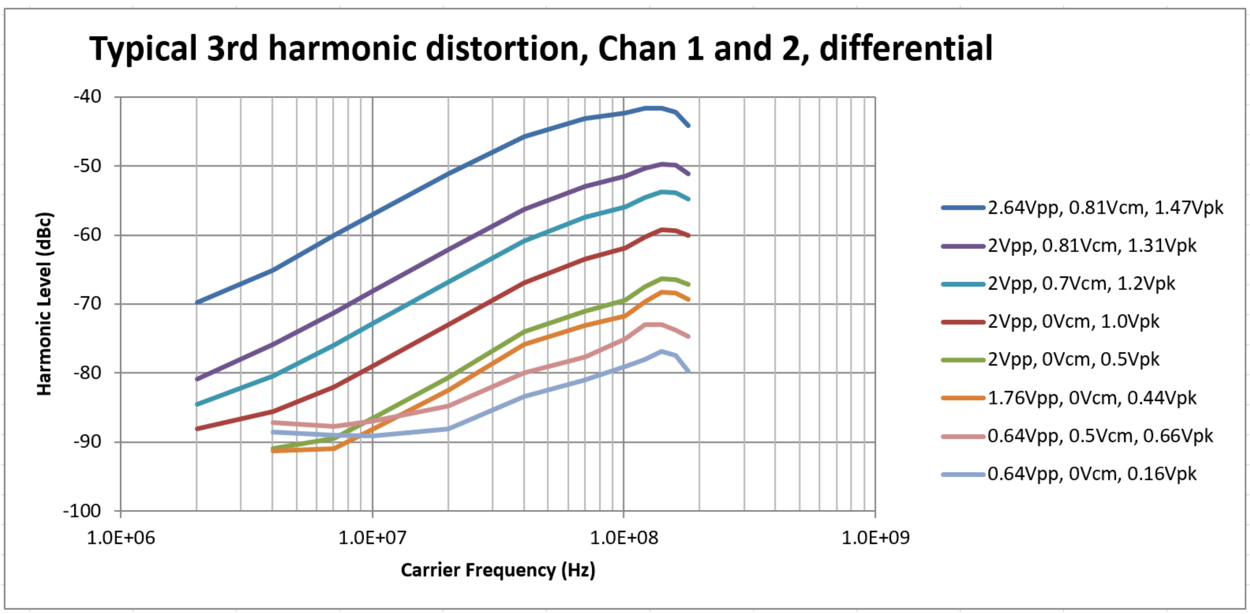


Figure 12. Typical 3rd harmonic distortion, channel 1 and 2, differential

Spectral Characteristics (Channels 1 and 2) (cont'd)

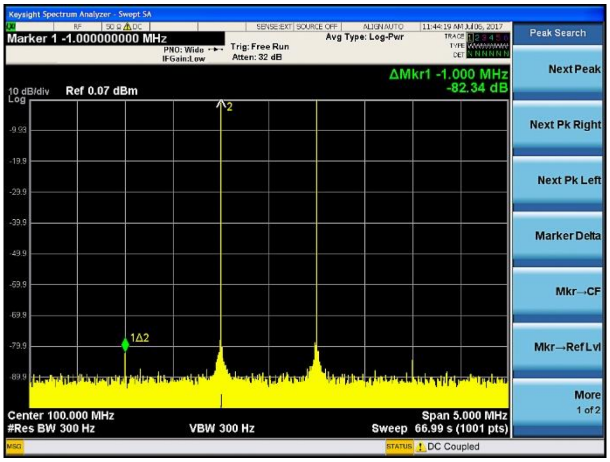


Figure 13. Typical Channel 1-2, 100 MHz two tone Intermod

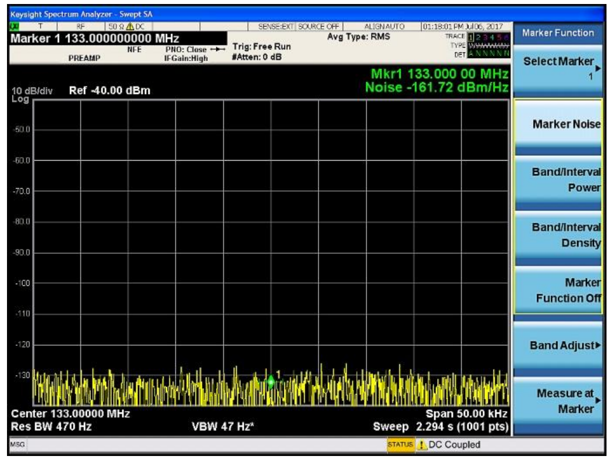


Figure 14. Typical Channel 1-2 noise floor

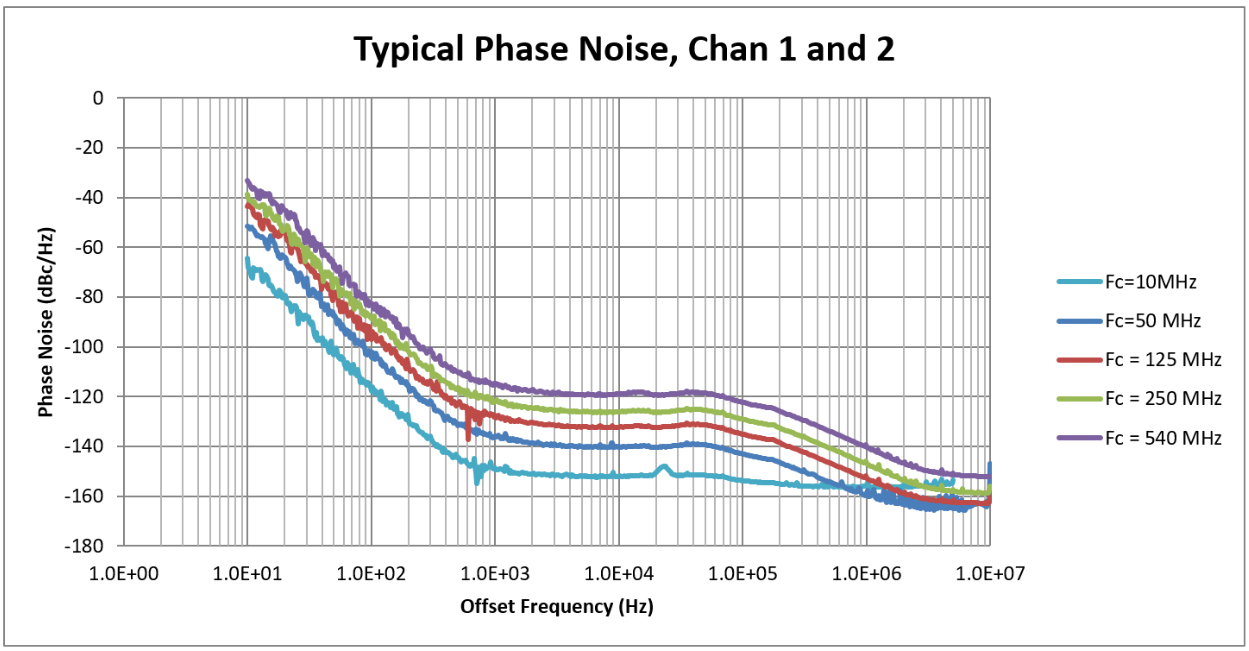


Figure 15. Typical phase noise, channel 1 and 2

Spectral Characteristics (Channel 3) (cont'd)

Characteristic	Single-ended (typ)	Differential (typ)	Comments
Harmonic distortion			
Fc ≤ 200 MHz: 0.5 Vpp, 0.5 Voff (SE) or 1.0 Vpp, 0.5 Vcm (Diff)	≤ -31 dBc	≤ -38 dBc	
Fc ≤ 200 MHz: 1.0 Vpp, 0 Voff (SE) or 2.0 Vpp, 0 Vcm (Diff)	≤ -41 dBc	≤ -47 dBc	
Fc ≤ 200 MHz: 0.5 Vpp, 0 Voff (SE) or 1.0 Vpp, 0 Vcm (Diff)	≤ -48 dBc	≤ -60 dBc	
Fc ≤ 50 MHz: 1.5 Vpp, 0 Voff (SE) or 3.0 Vpp, 0 Vcm (Diff)	≤ -66 dBc	≤ -64 dBc	
SFDR without harmonics			
Fc = 500 MHz: 0.25 Vpp, 0 Voff (SE) or 0.5 Vpp, 0 Vcm (Diff)	≥ 59 dBc	≥ 54 dBc	Measured DC to 540 MHz
Fc = 200 MHz: 0.5 Vpp, 0 Voff (SE) or 1.0 Vpp, 0 Vcm (Diff)	≥ 66 dBc	≥ 71 dBc	Measured DC to 540 MHz
Fc = 50 MHz: 1.5 Vpp, 0 Voff (SE) or 3.0 Vpp, 0 Vcm (\Diff)	≥ 64 dBc	≥ 69 dBc	Measured DC to 135 MHz
SFDR with harmonics			
Fc ≤ 200 MHz: 0.5 Vpp, 0.5 Voff (SE) or 1.0 Vpp, 0.5 Vcm (Diff)	≥ 32 dBc	≥ 39 dBc	Measured DC to 540 MHz
Fc ≤ 200 MHz: 1.0 Vpp, 0 Voff (SE) or 2.0 Vpp, 0 Vcm (Diff)	≥ 41 dBc	≥ 47 dBc	Measured DC to 540 MHz
Fc ≤ 200 MHz: 0.5 Vpp, 0 Voff (SE) or 1.0 Vpp, 0 Vcm (Diff)	≥ 48 dBc	≥ 58 dBc	Measured DC to 540 MHz
Fc ≤ 50 MHz: 1.5 Vpp, 0 Voff (SE) or 3.0 Vpp, 0 Vcm (Diff)	≥ 60 dBc	≥ 64 dBc	Measured DC to 135 MHz
Intermod distortion (IMD3)			
Fc = 100 MHz ± 500 KHz: 1.0 Vpp, 0.5 Voff (SE) or 2.0 Vpp, 0.5 Vcm	< -56 dBc	< -59 dBc	
Fc = 100 MHz ± 500 KHz: 1.0 Vpp, 0 Voff (SE) or 2.0 Vpp, 0 Vcm (Diff)	< -71 dBc	< -72 dBc	
Fc = 10 MHz ± 500 KHz: 1.0 Vpp, 0.5 Voff (SE) or 2.0 Vpp, 0.5 Vcm	< -76 dBc	< -78 dBc	
Fc = 10 MHz ± 500 KHz: 1.0 Vpp, 0 Voff (SE) or 2.0 Vpp, 0 Vcm (Diff)	< -79 dBc	<-81 dBc	
Third order intercept (TOI)			
Fc = 100 MHz ± 500 KHz: 1.0 Vpp, 0.5 Voff (SE) or 2.0 Vpp, 0.5 Vcm	> 27 dBm	> 27 dBm	
Fc = 100 MHz ± 500 KHz: 1.0 Vpp, 0 Voff (SE) or 2.0 Vpp, 0 Vcm (Diff)	> 34 dBm	> 34 dBm	
Fc = 10 MHz ± 500 KHz: 1.0 Vpp, 0.5 Voff (SE) or 2.0 Vpp, 0.5 Vcm	> 37 dBm	> 37 dBm	
Fc = 10 MHz ± 500 KHz: 1.0 Vpp, 0 Voff (SE) or 2.0 Vpp, 0 Vcm (Diff)	> 38 dBm	> 39 dBm	
Output phase noise (100 MHz output)			
1 kHz offset	-130 dBc/Hz	-130 dBc/Hz	
10 kHz offset	-135 dBc/Hz	-135 dBc/Hz	
100 kHz offset	-137 dBc/Hz	-137 dBc/Hz	
1 MHz offset	-152 dBc/Hz	-152 dBc/Hz	
10 MHz offset	-162 dBc/Hz	-162 dBc/Hz	
Noise floor			
	≤ -151 dBm/Hz	≤ -151 dBm/Hz	100 MHz tone, spot noise measured at 133 MHz

Figure 16. Typical Channel 3, 10 MHz tone spectrum

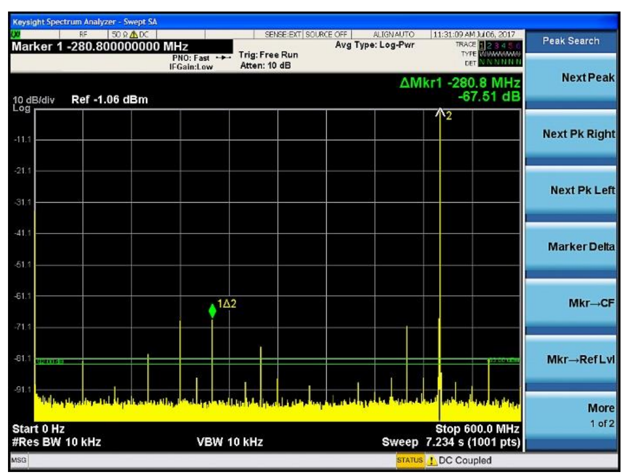


Figure 17. Typical Channel 3, 500 MHz tone spectrum

Spectral Characteristics (Channel 3) (cont'd)

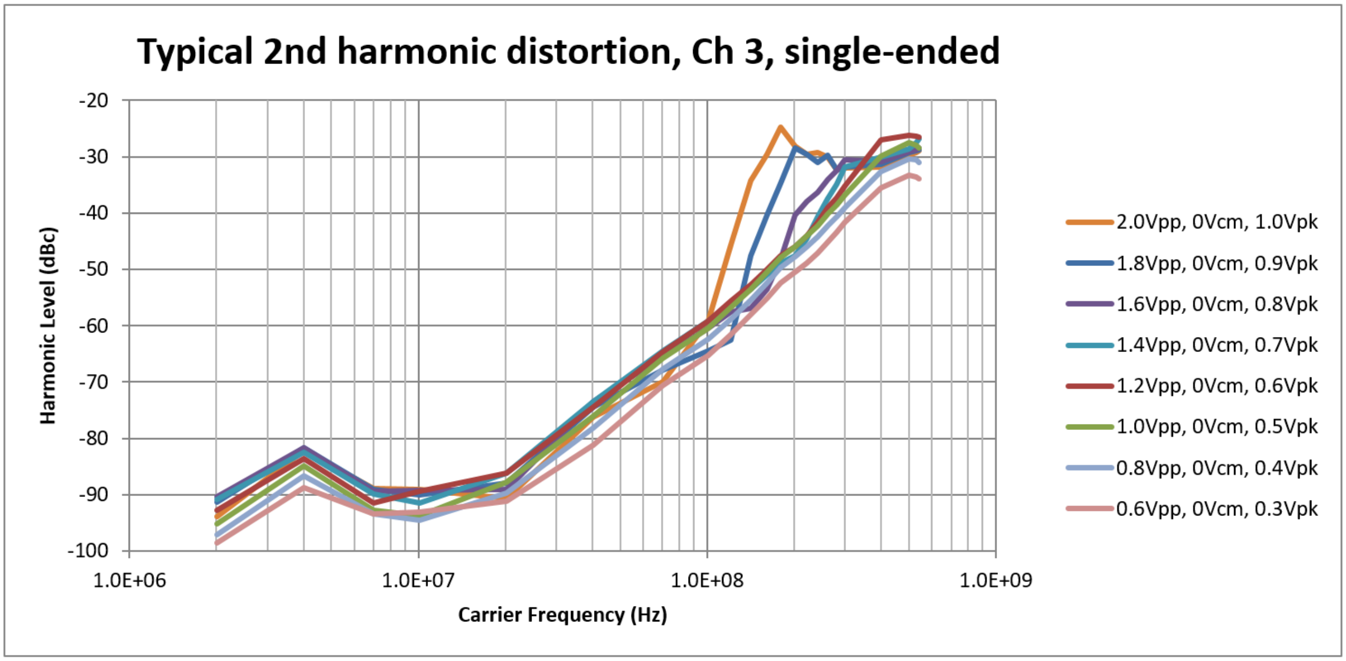


Figure 18. Typical 2nd harmonic distortion, channel 3, single-ended

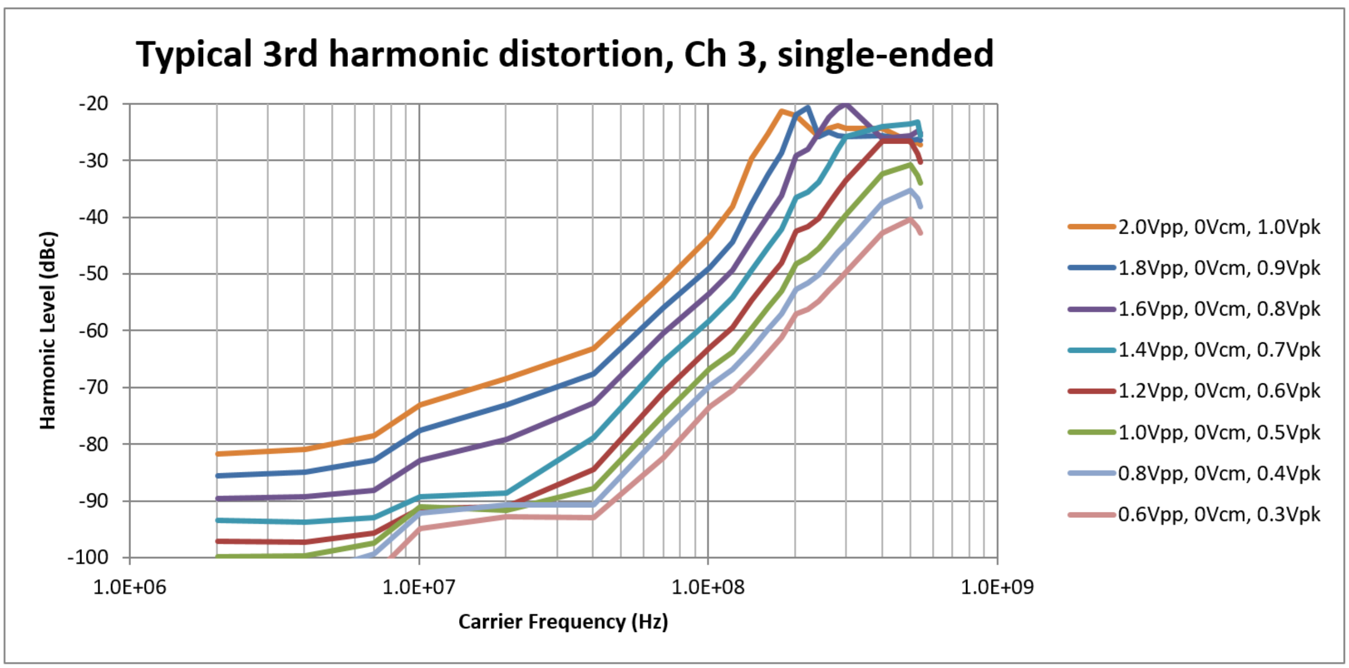


Figure 19. Typical 3rd harmonic distortion, channel 3, single-ended

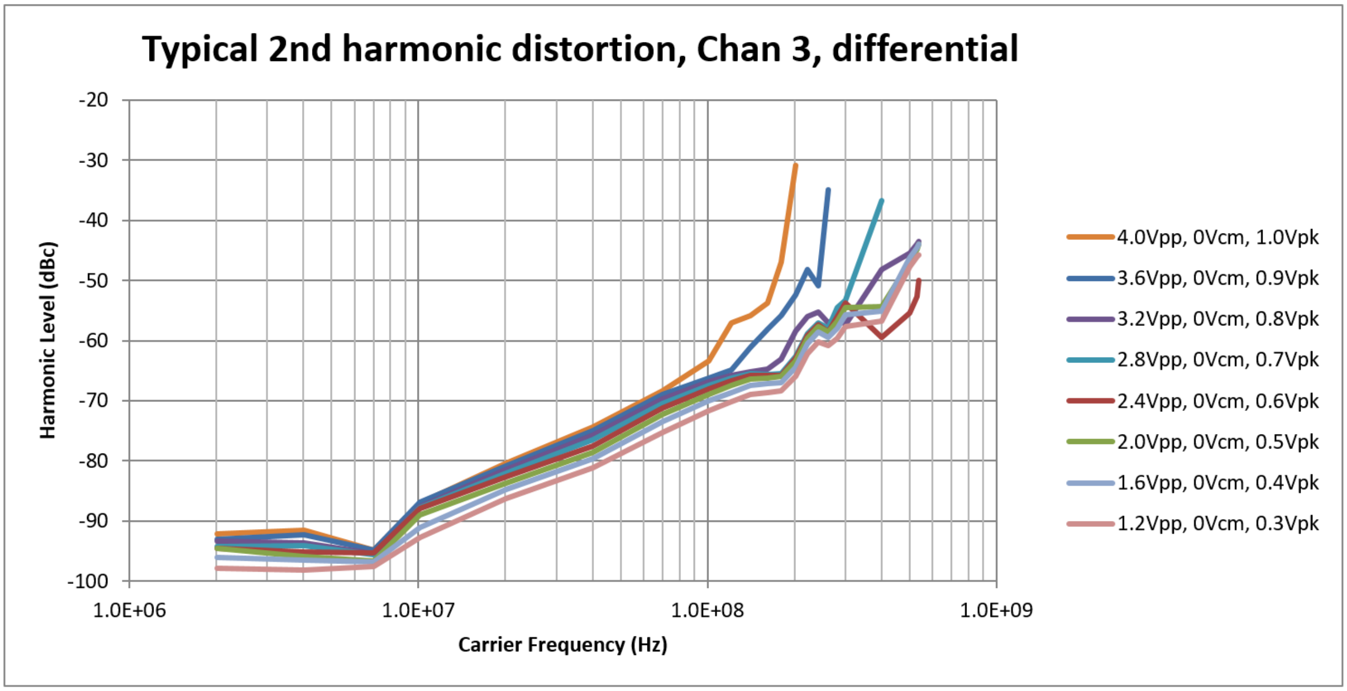


Figure 20. Typical 2nd harmonic distortion, channel 3, differential

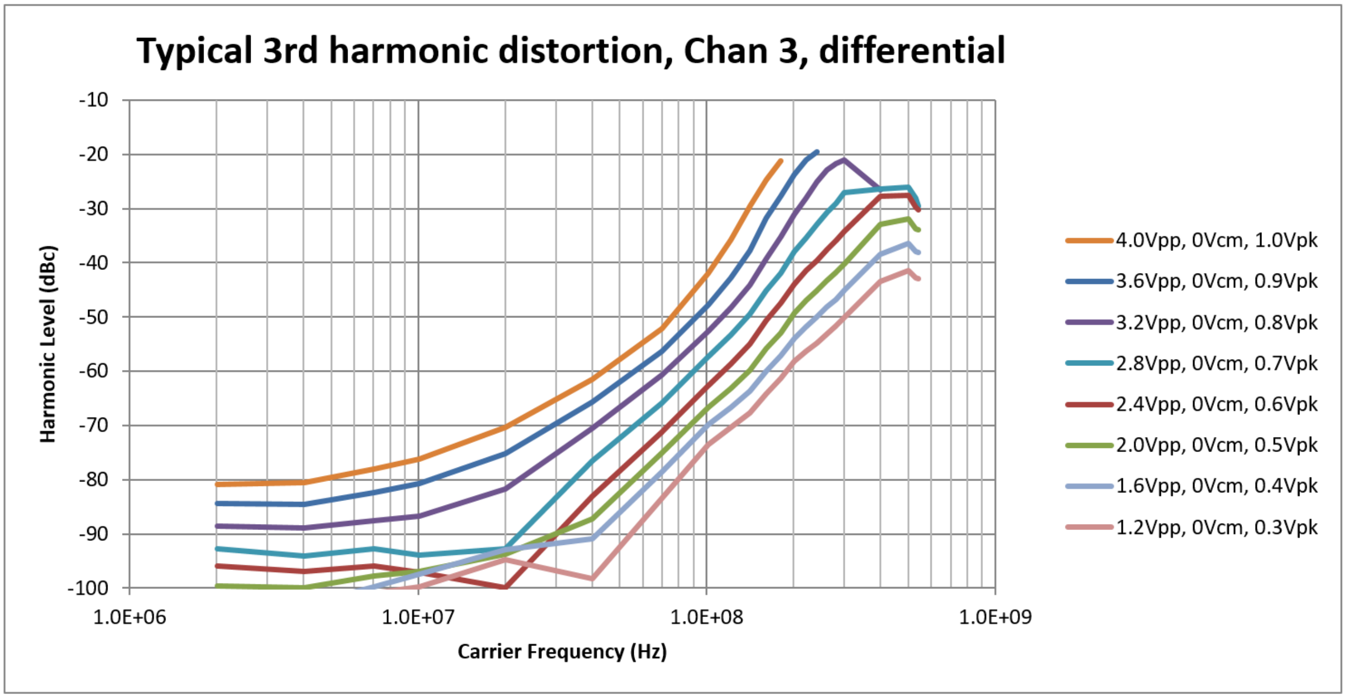


Figure 21. Typical 3rd harmonic distortion, channel 3, differential

Spectral Characteristics (Channel 3) (cont'd)

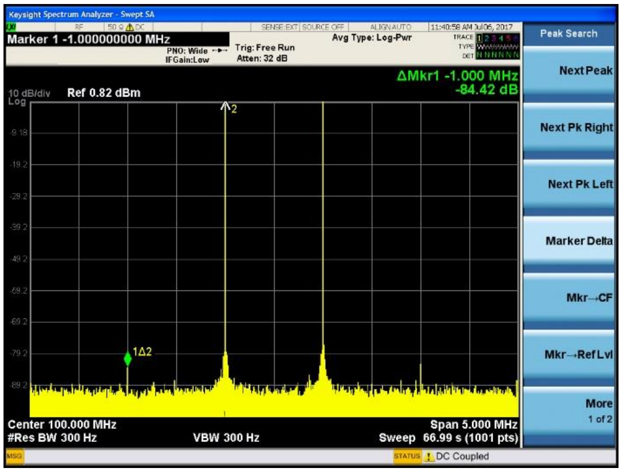


Figure 22. Typical Channel 3, 100 MHz two tone intermod

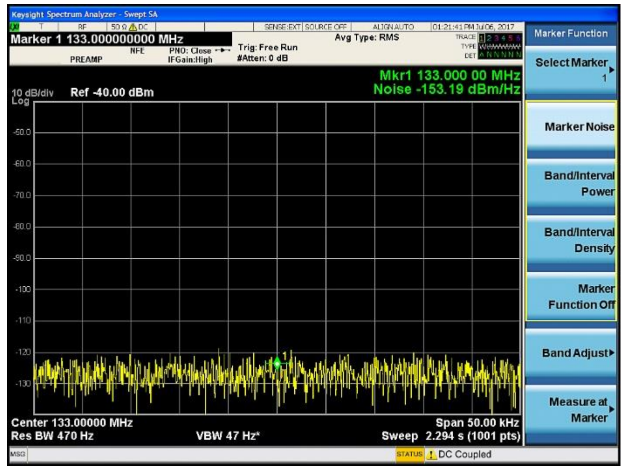


Figure 23. Typical Channel 3 noise floor

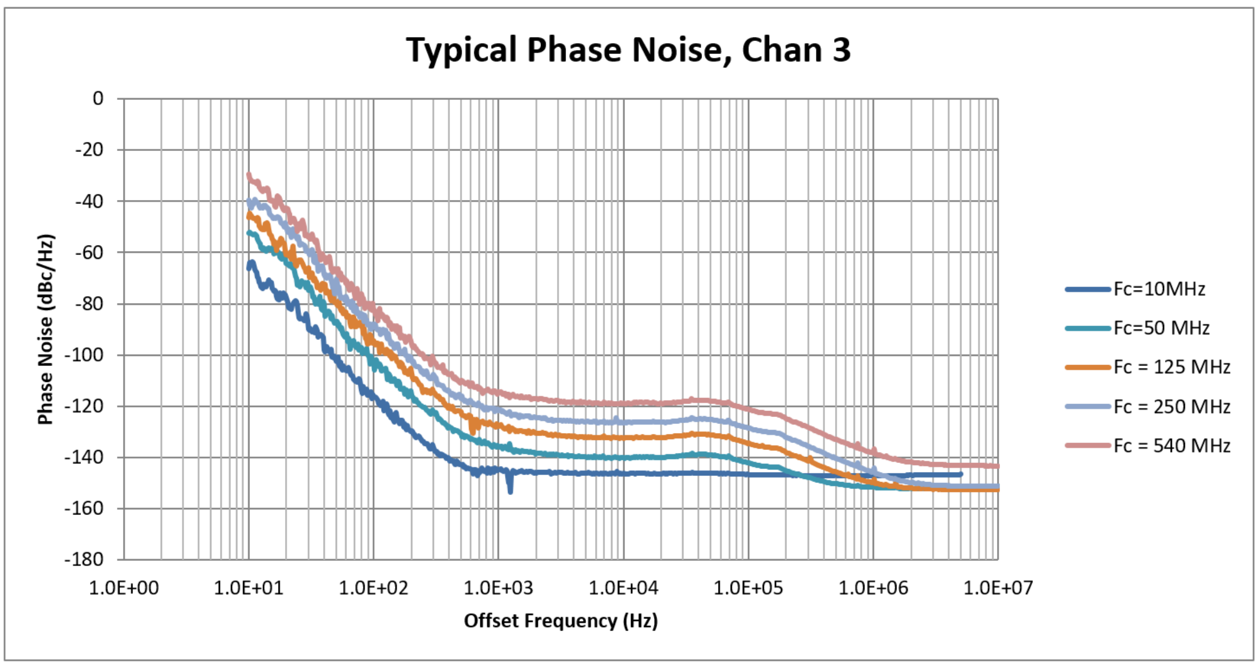


Figure 24. Typical phase noise, channel 3

Clocks

DAC Sample Clock	
DAC sample rate	1.28 GSa/s
Sample Clock	
User sample rate (F_S) - option B12	1 Sa/s to 320 MSa/s, 1µSa/s resolution
User sample rate (F_S) - option B50	1 Sa/s to 1.28 GSa/s, 1µSa/s resolution
100 MHz Reference Clock	
Clock sources	PXIe_CLK100 and ExtClk In[1]
Clock lock range	±25 ppm (nom)
Ext Clk In Characteristics (nom)[1]	
Frequency Input	100 MHz ±25 ppm
Input level	100 mV_{PP} to 5 V_{PP} (square-wave or sine-wave)

Sequencer, Triggers

Sequencer	
Waveform memory (option dependent)	Up to 500 MSa/ch
Waveform granularity (quantum)	4 samples
Maximum segments per sequence	2^{27}
Maximum number of sequences	2^{25}
Waveform segment length	
Minimum - burst	12 samples
Minimum - looped	512 samples
Maximum	2,145,300,000 samples (unlimited with option LW1)

Input Triggers	
Number of triggers	12 hardware and 12 software
Trigger sources	Software, PXI_TRIG, PXI_STAR, DSTARB, Ext 1, Ext 2, and immediate
Trigger types	Start and sequence
Trigger polarity	Positive or negative
Trigger timing resolution	3.125 ns
Minimum trigger width	20 ns
Trigger Jitter	±3.125 ns (typ)
Trigger latency (nom)	
Single module, correction filter off	322 ns + (24 x User sample period in ns)
Single module, correction filter on	2960 ns + (24 x User sample period in ns)
Multiple modules (opt PCH)	3.25 µs ± 50 ns
Programmable delay	
Range	10 s
Resolution	3.125 ns

[1] Supported on Serial Number MY56450309 and above

Markers

Data Markers	
Maximum number of markers	8 per channel
Marker destinations	PXI_TRIG, PXI_STAR, DSTARC, Ext1, and Ext2
Marker type	Sample (data marker)
Marker polarity	Positive or negative
Marker placement accuracy	3.125 ns
Minimum trigger width	20 ns
Marker to waveform jitter	Up to 3.125 ns, depending on waveform sample rate
Programmable delay	
Range	20 ms
Resolution	3.125 ns

Channel Markers	
Maximum number of markers	Up to 3 depending on number of available channels
Marker destinations	Analog output channels not being used for waveform output
Marker type	Precise data marker (timed precisely with waveform characteristics of another output channel)
Marker polarity	Positive or negative
Marker to waveform jitter	25 ps
Marker placement accuracy	
Marker on channels 1 and 2	20 ps
Marker on channel 3	40 ps
Programmable delay	
Range	±0.5 x (user sample period)
Resolution	.001 ps
Marker width	4 user samples

Ext1 and Ext2 Characteristics (nom)	
Direction Control	Input or output (configurable)
Output level	0 to 3.3 V
Output impedance (output mode)	50 Ω
Maximum input level	±5.5 V
Input impedance (input mode)	10 kΩ
Minimum input swing	100 mV
Minimum input pulse width	10 ns
Programmable trigger input threshold	
Range	-4 to 4V
Programming resolution	10 mV
Accuracy	±100 mV

Modulation Format Specific Data

Typical EVM performance (meas)[1]	
802.11ax	
EVM (80MHz, 1024 QAM)	0.2%
LTE/LTE advanced	
EVM (20MHz, 64 QAM)	0.075%
EVM (100MHz, 64 QAM)	0.3%
OFDM	
EVM (700MHz, 64 QAM)	0.7%

Environmental Characteristics[2,3]

Operating and Storage Conditions	Operating	Storage
Temperature[4]	0˚C to 50˚C	-40˚C to 70˚C
Altitude	Up to 10,000 ft (3048 m)	Up to 15,000 ft (4572 m)
Humidity	Type-tested at 95%, +40˚C (non-condensing)	
Calibration		
Calibration interval	1 year	
Warm-up time	30 minutes	
Vibration		
Operating random vibration: type-tested at 5 to 500 Hz, 0.21 g rms		
Survival random vibration: type-tested at 5 to 500 Hz, 2.09 g rms		

[1] With differential outputs and matched cables. Individual channel adjustments for gain and delay may be required to achieve best EVM performance

[2] Samples of this product have been type tested in accordance with the Keysight Environmental Test Manual and verified to be robust against the environ- mental stresses of Storage, Transportation and End-use; those stresses include but are not limited to temperature, humidity, shock, vibration, altitude and power line conditions.

[3] Test methods are aligned with IEC 60068-2 and levels are similar to MIL-PRF-28800F Class 3

[4] De-rate max temperature by 5°C above 2000 m.

Regulatory Characteristics

Safety
Complies with the essential requirements of the European Low Voltage Directive as well as the current versions of the following standards (dates and editions are cited in the Declaration of Conformity): – IEC/EN 61010-1 – Canada: CSA C22.2 No. 61010-1 – USA: UL std no. 61010-1
EMC
Complies with the essential requirements of the European EMC Directive as well as the current editions of the following standards (dates and editions are cited in the Declaration of Conformity): – IEC/EN 61326-1 – CISPR Pub 11 Group 1, class A – AS/NZS CISPR 11 – ICES/NMB-001 This ISM device complies with Canadian ICES-001. Cet appareil ISM est conformea la norme NMB-001 du Canada
South Korean Class A EMC declaration
Information to the user: This equipment has been conformity assessed for use in business environments. In a residential environment this equipment may cause radio interference. – This EMC statement applies to the equipment only for use in business environment.
사 용 자 안 내 문
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Ordering Information

Software

Supported Software Components		
Operating systems	Microsoft Windows 7 and 10 (64-bit only)	
Standard compliant drivers	IVI.NET, IVI-C, and LabVIEW	
Application development environments (ADE)	LabVIEW, MATLAB, Visual Studio.NET (C/C++, C#, VB.NET), Command Expert	
Keysight IO libraries	Version 2018 update 1 (or greater)	
Signal Studio Software		
Playback on up to four modules per license): • N76xxEMBC-1FP node-locked perpetual license • N76xxEMBC-1FL node-locked 12-month license	N7600EMBC W-CDMA/HSPA+ N7601EMBC CDMA2000®/1xEV-DO N7602EMBC GSM/Edge/Evo N7606EMBC Bluetooth (BR, EDR, LE 4.0, BT5) N7608EMBC Custom 5G modulation N7610EMBC IoT (Internet of Things)	N7612EMBC TD-SCDMA/HSPA N7617EMBC WLAN 802.11a/b/g/j/p/n/ac/ah/ax N7624EMBC LTE/LTE-Advanced FDD N7625EMBC LTE/LTE-Advanced TDD N7630EMBC Pre-5G N7631EMBC 5G NR

Hardware

Model	Description
M9336A	PXIe I/Q arbitrary waveform generator: 500 MHz BW, 16-bit, 3 scalar channels
M9336A-001	Enable I/Q channels (all 3 channels)
M9336A-B12	Channel Bandwidth, 135 MHz
M9336A-B50	Channel Bandwidth, 540 MHz
M9336A-LW1	Large waveform playback (up to 400 MHz I/Q)
M9336A-M02	Memory, 2 GB
M9336A-M04	Memory, 4 GB
M9336A-PCH	Phase Coherent Operation
Related Products	
M9037A	PXIe embedded controller: Intel i7, 4 GB RAM, 240 GB SSD
M9010A	PXIe chassis: 10-slot, 3U, 24GB/s
M9018B	PXIe chassis: 18-slot, 3U, 8GB/s
M9019A	PXIe chassis: 18-slot, 3U, 24GB/s

Learn more at: www.keysight.com

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