



N9056EM0E Channel Quality/Group Delay Measurement Application

Key Features

- Characterize RF components with spectrum, waveform, amplitude, phase, gain amplitude, gain phase, and group delay etc. measurements
- User can flexibly define the number of tones and tone spacing for group delay measurement
- Tones phase can be defined with phase type as zero phase, random phase or parabolic phase. You can also import a tone table as txt or csv format.
- Support Keysight X-Series Signal Generators (MXG, EXG) and VXG Microwave Signal Generator for multi-tones signal generation
- Support Keysight X-Series Signal Analyzers (UXA, PXA, or MXA) for channel quality/group delay measurement
- Use multi-touch user interface and SCPI remote interface
- Extend test assets with transportable, USB Portal or floating licenses between X-Series signal analyzers with multi-touch UI

Group Delay

N9056EM0E Channel Quality/Group Delay measurement application provides a solution to make repeatable channel response measurements such as group delay and other characteristics of multi-channel signals targeting wideband components testing in 5G NR, WLAN etc. N9056EM0E is running inside Keysight X-series Signal Analyzers which can connect Keysight Signal Generators for multi-tone signal generation to make group delay measurements as the typical measurements shown in the right table.



Typical Measurements

- Group delay
- Spectrum
- Amplitude
- Phase
- Gain Amplitude
- Gain Phase

Instrument Connection

The instrument itself can introduce uncertainty in the measurement, including internal phase distortion and trigger delay. On the other hand, the initial phases for individual tones may be randomly generated to achieve better PAPR. To eliminate those uncertainties, a 2-step group delay measurement is recommended as the following diagram.

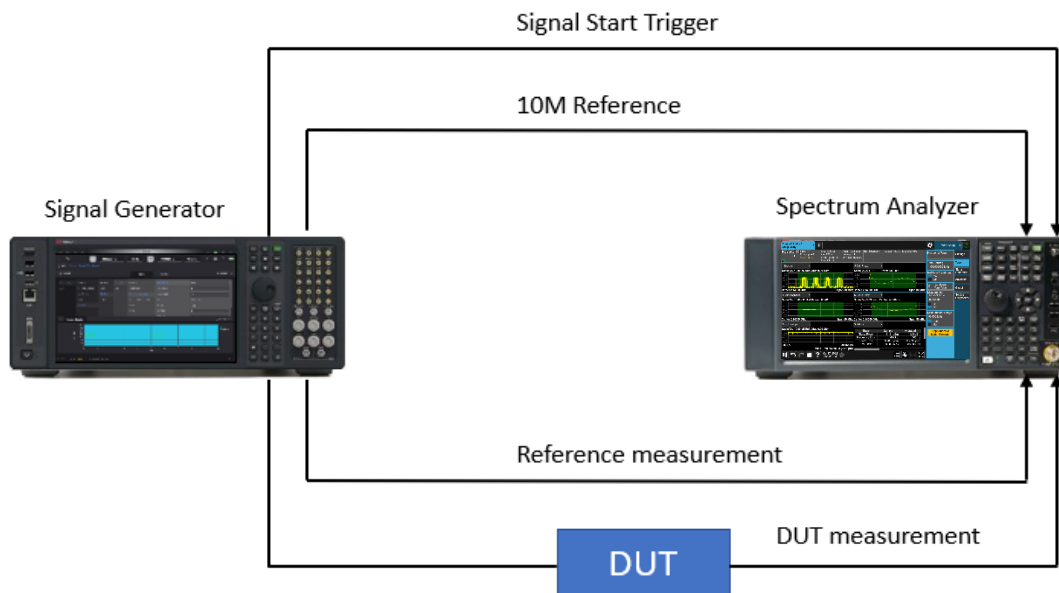


Figure 1. Group Delay Measurement Integrated System Connection Diagram

1. Connect signal generator to spectrum analyzer directly to perform a reference measurement to establish the reference data from the instruments, including phase distortion, trigger delay and initial tone phases.
2. Add DUT between signal generator and spectrum analyzer and perform the real measurement, the measured data will be then corrected with the reference data from step#1 to provide the group delay solely for DUT

Apply Your Signals in Real World Testing

To use N9056EM0E Channel Quality/Group Delay measurement application, you must have some properly configured instruments, as described here.

Signal Generator	Signal Analyzer
VXG M9384B	X-Series Signal Analyzer – UXA N9040B
X-Series Signal Generator – MXG/EXG	X-Series Signal Analyzer – PXA N9032B
	X-Series Signal Analyzer – PXA N9030B
	X-Series Signal Analyzer – PXA N9021B
	X-Series Signal Analyzer – PXA N9020B

What is Group Delay?

Group delay is a measure of the phase distortion with respect to frequency after passing through a device. From time domain perspective, it's also a measure of how long it takes for the signal to pass through a device. Here 'group' means a group of frequencies that is considered to have the constant delay after passing the device. Then, for a wider bandwidth, the delay values should be measured at many groups to form a complete group delay curve covering the whole bandwidth.

Mathematically, group delay is defined as:

$$\tau = -\frac{1}{2\pi} \frac{d\phi}{df}$$

Taking a look at the phase-to-frequency response, the linear phase is represented by the green line for the ideal case, and its slope represents the group delay for the overall frequency range. However, in a practical test with DUT, the phase response would be something like the red line, where deviations (called phase distortion) to the ideal slope could be observed. The phase distortion will result in a variable group delay for different frequency components in the signal, like a ripple.

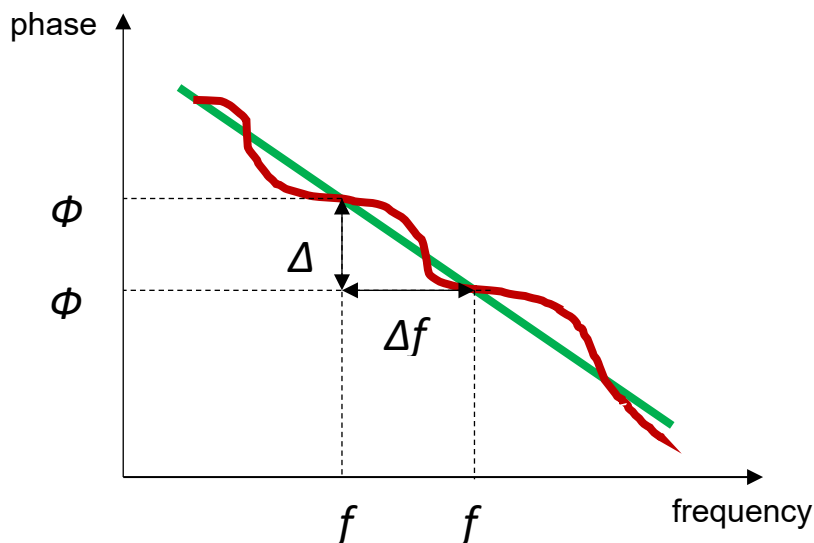


Figure 2. Group Delay Derived from phase vs. frequency

Connect to Signal Generator via LAN Connection.

If it is the first time to use a new generator, you'll need to input the IP address or Host name. Then you can add the configuration to the Signal Generator List, which will be stored even after instrument reboot. After connection is established between SA and SG, the SG Information is shown automatically in the information box and the button will be changed to "Disconnect". You can add more Signal Generators in the list, only the "Connected" SG is highlighted in green color.

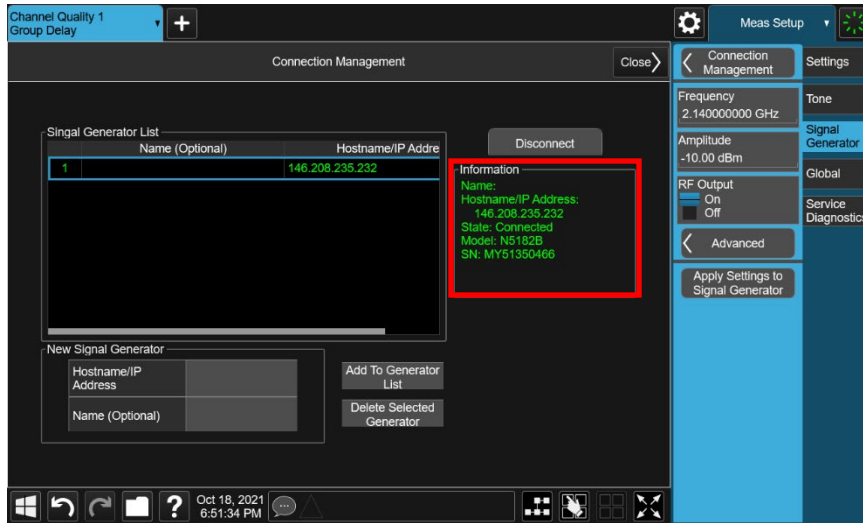


Figure 3. Signal Generator Connection Management

Multi-tone Configuration

You can create a multi-tone table inside the N9056EM0E measure application. You can specify the number of tones, tone spacing and define the tone phase type as zero phase, random phase with random seed of phase, parabolic phase with initial phase. Or you can also import a previously generated tone table with the format as txt or csv. Then you can apply the tones to signal generators.



Figure 4. Multi-tone Configuration Table

Group Delay Measurement

For wideband DUT, group delay measurement needs to be done at many frequency groups, so multi-tone signal method would be a good choice for group delay measurement. Signal generator is able to generate the multi-tone signal with defined number of tones, tone spacing and configurable phase and playback it repeatedly. Then you are recommended to make the group delay measurement with two steps as below.

1. Firstly, you can connect the signal generator and signal analyzer with a cable. Then go to [Meas Setup] and [Configure Tone Table] menu as Figure 4 and then press “**Do Calibration**” button. It will do the group delay reference measurement and the calibration data will be applied with the real measurement if you turn on the “**Reference Tone Adjustment**” which is turned on by default.
2. Secondly you can connect the signal passes through the DUT, signal analyzer can measure the phase difference for the adjacent tones to determine the group delay. The measured data will be corrected with the calibration data from step#1 to provide the group delay solely for DUT.

When trigger is not available, it adds an unknown time gap between the measure time and signal start time, so the result cannot reflect the absolute group delay of the DUT. In this case, the measured result is called relative group delay, which has exactly the same delay curve pattern with the absolute one, but it may shift up/down along the Y-axis. Relative group delay makes sense in the tests that focus on the group delay variation across frequencies which will impact the distortion of the signal quality.

The following Figure 5 is measured with a wideband filter (2110-2170 MHz). Here we create 80 tones with tone spacing 1 MHz. Phase type defined as random and seed type as random are used. Then we apply the tones to the specified signal generator with frequency as 2140 MHz and amplitude as -10 dBm. You can see the group delay measurement results as the picture below. Yellow color is the current measurement trace. Blue color is the averaged trace. Pink color is the Reference trace.

Top left is the spectrum of the multi-tone signal passing through this filter. Top right is the phase trace; Middle left is the magnitude trace; Middle right is the group delay trace; Bottom left is the RF envelope trace; Bottom right is the metrics results including signal power, frequency error, clock error, and group delay results with sample, average and max hold detectors.

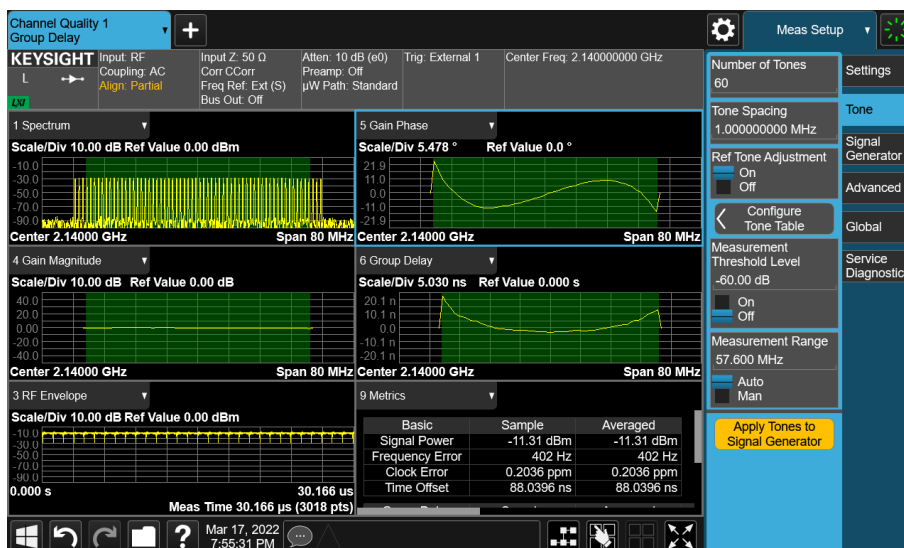


Figure 5. Group Delay measurement with a wideband filter as DUT

Channel Quality Measurement (Group Delay) Feature Summary

Feature	Parameter Setting
Group Delay Measurement	
General Settings	Average On/Off
	Average Mode: Exponential, Repeat
	Measurement Time (second)
Signal Generator	Frequency (Hz)
	Amplitude (dBm)
	RF Output: On (default)/Off
	DC Calibration: On (Default) /Off
	ALC: On (default) /Off
	Run-time Scaling: 70% (default)
	Apply Settings to Signal Generator
Connection Management	Signal Generator List (table)
	Connect (showing the connected Signal Generation Information)
	IP Address and Hostname (Optional)
	Add To Signal Generator List
	Delete Selected Generator
Tone	Number of Tones (max. 20,000)
	Tone Spacing (min. 0.1 Hz, max. 1 GHz)
	Tone span (coupled with tone spacing and number of tones)
	Ref Tone Adjustment: On (default)/Off
	◦ Measurement Threshold: -60 dB (default)
	◦ Measurement Threshold: On/Off (default)
	◦ Measurement Range: Auto (default)/Manual
	Measurement Range
◦ Auto (Default) /Manual	
Apply Tones to Signal Generator	
Configure Tone Table	Tone Phase Type: Zero phase, Random phase, Parabolic phase
	Random Seed Type: Fixed (default)/Random for random phase
	Initial Phase: 0.5% (default) or user input
	Do Calibration/Clear Calibration
	Import Tone Table/Export Tone Table/ Clear Tone Table
Trace	Spectrum Trace: On/Off; Average Trace: On/Off; Reference Trace: On/Off
	Aperture: 4.0% (default) or user input
Measurements	Spectrum trace
	Phase trace
	Magnitude trace
	Group Delay trace
	IQ Waveform
	RF Envelope

	Gain Magnitude
	Gain Phase
	Marker Table with marker position by tone index
	Metrics: Signal Power, Frequency Error, Clock Error, Time Offset, Group Delay as RMS, Pk+, PK-, (Pk-Pk)/2 (with Sample, Averaged, Max Hold detectors)

Power Stat CCDF Measurement

General Settings	Counts (points)
	Meas Intervals (seconds)
	IF Gain: Low Gain, High Gain
Measurement	Average Power
	Power Probability Table (10%, 1.0%, 0.1%, 0.01%, 0.001%, 0.0001%)
	Peak: power and peak-average power ratio
	CCDF Trace (with Gaussian as Reference)

Monitor Spectrum Measurement

General Settings	Average: On/Off; Average Number
	Average Mode: Exponential, Repeat
	Noise Floor Extension (if applicable)
	Span (Hz)
Measurement	Spectrum trace
	Gate trace

IQ Waveform Measurement

General Settings	Average: On/Off; Average Number
	Average Mode: Exponential, Repeat
	Time Avg Number
	Meas Time (second)
	Sample Rate (Hz)
	Digital IF BW (Hz)
	Phase Noise Optimization: Best Close-In Phase Noise, Best Wide-Offset Phase Noise, Fast Tuning
	ADC Dither: Off (Best Noise), On (Best Log Accuracy)
	IF Gain: Auto-range (Follow Signals), Low gain (Best for Large Signals), High Gain (Best Noise Level), Other IF Gain (Explicit)
	IF Gain Offset
Measurement	RF Envelope
	IQ Waveform
	Metrics: Mean Power, Pk-to-Mean Ratio, Max Point, Min Point

Ordering Information

Flexible Software Licensing and Configuration

- **Node-locked:** Allows you to use the license on one specified instrument/computer.
- **Transportable:** Allows you to use the license on one instrument/computer at a time. This license may be transferred to another instrument/computer using Keysight's online tool.
- **Floating:** Allows you to access the license on networked instruments/computers from a server, one at a time. For concurrent access, multiple licenses may be purchased. Floating support single site, single region and worldwide three different types.
- **USB portable:** Allows you to move the license from one instrument/computer to another by end-user only with certified USB dongle, purchased separately.
- **Subscription (time-based):** License is time limited to a defined period, such as 12-months



Try Before You Buy!

Evaluate a full-featured version of our X-Series measurement application with our FREE trial. Redeem one 30-day trial license of each measurement application online at www.keysight.com/find/X-Series_apps_trial

Channel Quality/Group Delay Measurement Application, Multi-touch (N9056EM0E)		
Software License Type	Software License	KeysightCare Subscription
Node-locked perpetual	R-Y5C-001-A	R-Y6C-001-y ²
Node-locked time-based	R-Y4C-001-z ¹	Included
Transportable perpetual	R-Y5C-004-D	R-Y6C-004-y ²
Transportable time-based	R-Y4C-004-z ¹	Included
Floating perpetual (single site)	R-Y5C-002-B	R-Y6C-002-y ²
Floating time-based (single site)	R-Y4C-002-z ¹	Included
Floating perpetual (worldwide)	R-Y5C-010-J	R-Y6C-010-y ²
Floating time-based (worldwide)	R-Y4C-010-z ¹	Included
USB portable perpetual	R-Y5C-005-E	R-Y6C-005-y ²
USB portable time-based	R-Y4C-005-z ¹	Included
One-month KeysightCare Support and Subscription		
Software License Type		
R-Y6B-501	1-month extension for node-locked perpetual license	
R-Y6B-504	1-month extension for transportable perpetual license	
R-Y6B-502	1-month extension for floating (single site) perpetual license	
R-Y6B-510	1-month extension for floating (worldwide) perpetual license	
R-Y6B-505	1-month extension for USB portable perpetual license	

1. z means different time-based license duration. F for 6 months, L for 12 months, X for 24 months, and Y for 36 months. All time-based licenses have included the support subscription same as the time-base duration.
y means different support subscription duration. L for 12 months (as default), X for 24 months, Y for 36 months, and Z for 60-months. Support subscription must be purchased for all perpetual licenses with 12-months as the default. All software upgrades and KeysightCare support are provided for software licenses with valid support subscription.
2. Support subscription for all perpetual licenses can be extended with monthly extensions.

Additional Information

Websites

- X-Series measurement applications: www.keysight.com/find/X-Series_apps
- Download X-Series measurement application: www.keysight.com/find/X-Series_apps_software
- Learn about compatible instruments: www.keysight.com/find/X-Series_apps_platforms
- 30-day trial license for X-Series measurement application: www.keysight.com/find/X-Series_apps_trial
- X-Series Signal Analyzers: www.keysight.com/find/X-Series
- M9384B VXG Microwave Signal Generator: www.keysight.com/find/VXG

Literatures

- X-Series Measurement Application, Brochure, [5989-8019EN](#)

Learn more at: www.keysight.com

For more information on Keysight Technologies' products, applications or services, please contact your local Keysight office. The complete list is available at: www.keysight.com/find/contactus

