

# Introducing the X-Series Signal Generator N5166B CXG RF Vector Signal Generator

*Keysight Technologies*

*2019.8.1*
























This slide is in candidate  
release rev 1.0

# Keysight Signal Generator Portfolio

Microwave/mmW

RF

	Basic Performance	Mid-Performance	High-Performance					
Analog	 N9310A	 N5173B EXG	 N5183B MXG	 M9383A	 E8257D PSG	 OML & VDI		
		 N5171B EXG	 M9380A	 N5181B MXG	 E8663D PSG			
Vector	 N9310A	 N5172B EXG	 M9381A	 M9383A	 M9383B VXG-m	 M9384B VXG	 E8267D PSG	 N5194A UXG
		 N5166B CXG		 N5182B MXG	 N5182B + X07			

# Keysight X-Series RF Vector Signal Generator Position

Performance

## CXG RF Signal Generators

Perform system-level test with the value CXG



- Low-cost tool for **essential device tests**
  - Signal generation capabilities include CW, swept, analog, pulse and vector
  - Support offline signal studio waveform playback in 5/50-pack
- Harness the power of X-Series signal generators – proven efficiency

## EXG RF Signal Generators

Optimize manufacturing test with the cost-effective EXG



- Maximize **test margins** on the production line with industry-leading ACPR
- Maximize **throughput** with < 800  $\mu$ s simultaneous switching of frequency, power and waveform type
- Enable rapid, accurate tests using Signal Studio's predefined, **standards-based waveforms**

## MXG RF Signal Generators

Test your design within and beyond its limits with the MXG

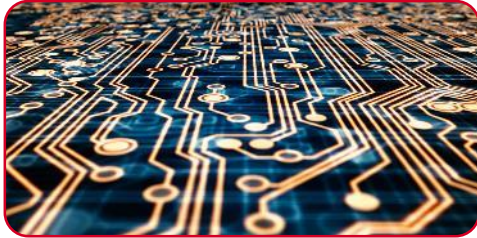


- Generate the signals you need with outstanding **hardware performance**
  - Industry-leading **phase noise** performance
  - industry-leading **ACPR** and **output power**
  - Best **EVM** and **frequency responses** performance
- Go beyond standard application requirements with sophisticated **real-time** and **waveform-based** Signal Studio software

Price

# Why Choose the N5166B CXG?

HARNESS THE POWER OF X-SERIES SIGNAL GENERATOR



## Trusted signal generation solution for your general purpose testing needs

- Consistent with the industry-proven MXG/EXG designs
- Just-enough performance and features for general purpose applications
- SCPI command compatible with Keysight signal generators



## Simplify signal creation with Signal Studio waveform playback

- Create performance-optimized reference signals
- Ensure designs meet latest standards
- Speed signal creation & reduce simulation time



## The lowest cost of ownership

- Calibration interval and warranty period: 3 years
- Maximize uptime: Target MTBF 116,000 hours (existing EXG's data)
- Minimize downtime: self service diagnostics and warranty parts direct

SSB phase noise (at 1 GHz, 20 kHz offset)	–146 dBc/Hz	–122 dBc/Hz	–119 dBc/Hz
Harmonics (at 1 GHz)	-35 dBc	-35 dBc	-35 dBc
Internal BBG RF bandwidth / external I/Q	160 MHz / 200MHz	160 MHz / 200MHz	120 MHz / 200MHz
Waveform playback memory	1024 Msa	512 Msa	512 Msa
Modulation EVM (LTE)	0.2%	0.2%	0.2%
ACPR (W-CDMA TM1 64 DPCH)	-73 dBc	-73 dBc	-73 dBc
Narrow pulse width	20 ns	20 ns	20 ns



# X-series Vector Signal Generators Comparison

## APPLICATIONS, CAPABILITIES



Embedded capabilities	MXG N5182B	EXG N5172B	CXG N5166B
USB power meter	•	•	•
AM, FM, PM, pulse	•	•	•
LF Multifunction Generator	•	•	•
Real-time baseband generation mode	•	•	
Phase noise impairments	•	•	
Multitone and two-tone	•	•	•
LO In/Out for phase coherency	•	•	
Digital input/out connectivity with N5102A	•	•	
Calibrated AWGN	•	•	•
Pulse Train	•	•	•
BERT	•	•	
Real-time fading	•	•	
Differential I/Q Outputs	•	•	

# Why You Need a CXG

## REAL-TIME AND ARB MODE



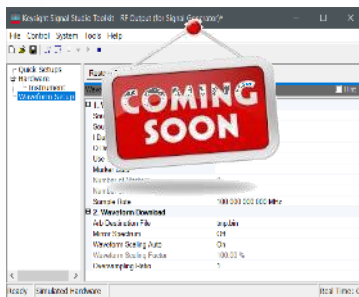
	Real-Time mode	ARB mode
<b>MXG &amp; EXG</b>	•	•
<b>CXG</b>		•
<b>Application</b>	Primarily used in receiver testing	Used for both component and receiver testing
<b>Feature</b>	<ul style="list-style-type: none"><li>• DSP-programmed for existing communication standards and common modulation schemes</li><li>• Fully coded and framed signal for a long amount of time. Great for BER testing.</li></ul>	<ul style="list-style-type: none"><li>• Unlimited signal creation flexibility</li><li>• Waveform files based</li><li>• Support no coding &amp; framing for component testing</li><li>• Fully coded and framed signal for a short amount of time. Good for packet PER or FER testing.</li></ul>
<b>Carrier(s)</b>	Single carrier	Support multi-carrier
<b>Limitation</b>	Limited signal creation flexibility	<ul style="list-style-type: none"><li>• Memory sizes</li><li>• Waveform phase discontinuity.</li><li>• Automatic leveling control (ALC) inappropriately works</li></ul>
<b>Signal creation tools</b>	Both embedded and external software	Software tools to generate waveform files

# Download I/Q Waveform into CXG

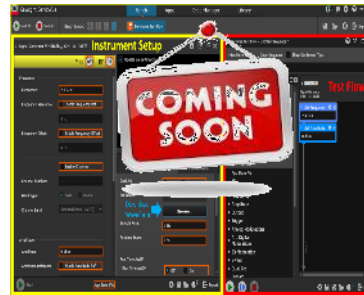
## Signal Studio Software\*

Offline waveform playback

## IQ Waveform Download Toolkit\*



## BenchVue\*\*



## Waveform Download Assistant



## Using FTP

1. Microsoft IE
2. PC/UNIX FTP
3. SG internal Web server

## Programing Environment

1. SCPI
2. API
3. FTP command

LAN/GPIB



\* Support offline playback at launch and direct download in next software release

\*\* Not support CXG at launch.



# Signal Studio Software

## SIMPLIFY SIGNAL CREATION

- Create Performance-Optimized Reference Signals
- Validate Component, Transmitter & Receiver Testing

Cellular communications		Wireless connectivity	
N7600C*	W-CDMA/HSPA+	N7606C	Bluetooth®
N7601C*	cdma2000®/1xEV-DO	N7607C	DFS Radar Profiles
N7602C*	GSM/EDGE/Evo		IoT: WiSUN, ZigBee, Z-

N7614C	Power amplifier test		
N7621B	Multitone distortion	N7609C*	Global Navigation Satellite Systems
N7622C	IQ Waveform Download Toolkit	N7620B	Pulse building

\* Support both Real-Time and ARB mode

# Playback the Waveforms You Need

REDUCE TOTAL COST OF TEST

## 5-Pack and 50-Pack Waveform Licensing

- 5/50 Signal Studio waveforms of any type to be permanently licensed to a specific instrument
- Maximum of 545 waveforms per instrument
- Each waveform comes with a 48 hour trial period
- Available as a post-purchase upgrade



- N5166B opt.221-229: 5-pack waveform playback
- N5166B opt.250-259: 50-pack waveform playback

# The Lowest Cost of Ownership

## LOWER OPERATING COSTS

### Calibration interval & Warranty period

- 36 months

### Maximize uptime

- Target mean time between failures (MTBF) of 116,000 hours

### Minimize downtime

- Self-service diagnostics and warranty parts
- Less than 2 hours to replace any part
- No post-repair calibration needed

### Low cost parts and labor

- Self-maintenance strategy

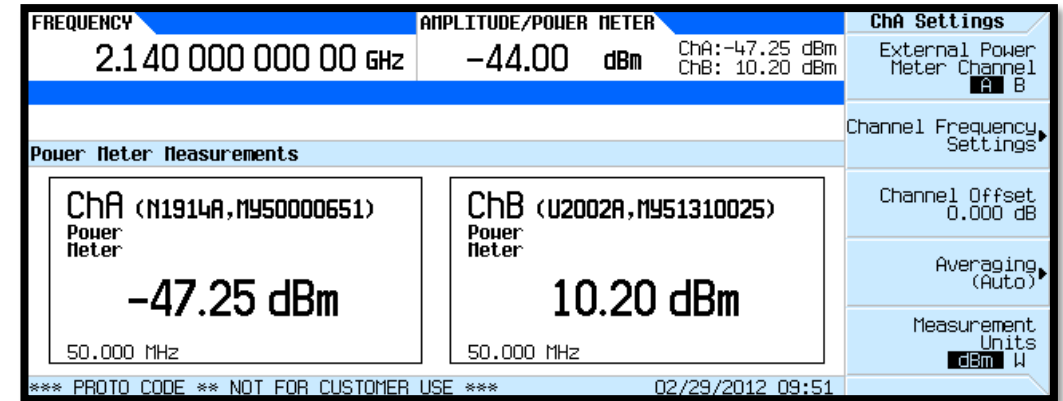
# USB Power Sensor Connectivity

Support all Keysight USB U2000 series

- Save rack space
- Use X-series SG as power meter display
- Automate via SCPI
- Dual channel

Applications:

- General power measurement
- Flatness correction (amplitude compensation)
- Channel correction (frequency response)



# Multifunction Generator – Option 303

CONSIST OF 7 WAVEFORM GENERATORS



Waveform	1. Function Generator 1	Sine, triangle, square, positive ramp, negative ramp, pulse
	2. Function Generator 2	Sine, triangle, square, positive ramp, negative ramp, pulse
	3. Dual Function Generator	Sine, triangle, square, positive ramp, negative ramp, phase offset, and amplitude ratio for Tone 2 relative to Tone 1
	4. Swept function Generator	Sine, triangle, square, positive ramp, negative ramp
Frequency Parameter		Trigger: free run, trigger key, bus, external, internal, timer trigger
	5. Noise Generator 1	Uniform, Gaussian
	6. Noise Generator 2	Uniform, Gaussian
	7. DC	Only for LF output –
	Sine wave	0.1 Hz to 10 MHz
	Triangle, Square, Ramp, pulse	0.1 Hz to 1 MHz
	Noise bandwidth	10 MHz
	Resolution	0.1 Hz



# CXG Use Cases

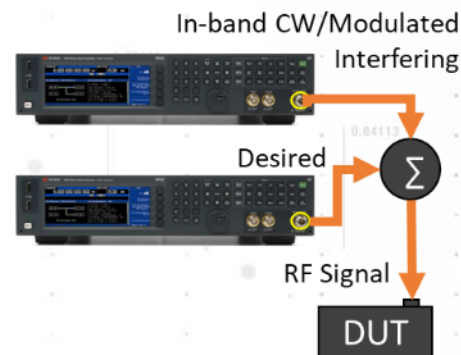
## RECEIVER TEST

- Wanted (desired) signal
- Modulated interfering
  - In-band
  - Out-of-band
- Blocking signal (CW)

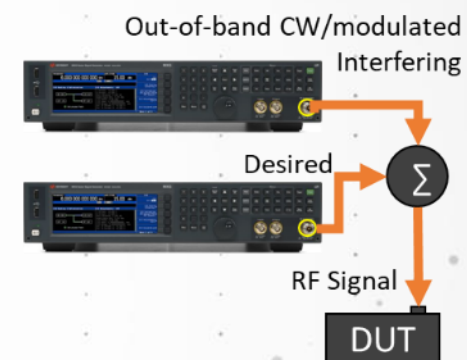
**Sensitivity Measurement**



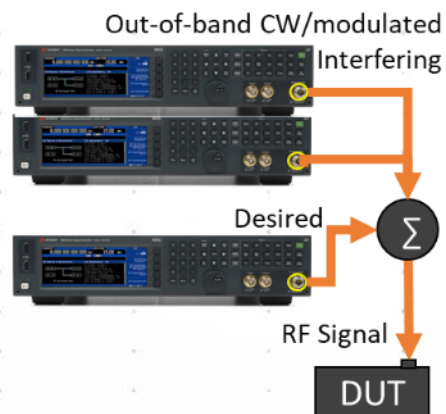
**Co-Channel Rejection Measurement**



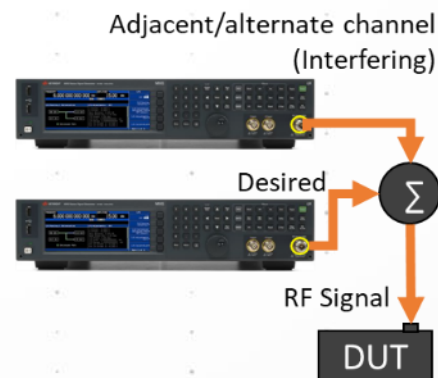
**Spurious Immunity Measurement**



**Intermodulation Immunity Measurement**



**Adjacent and Alternate Channel Selectivity**



**Fading Measurement**



# Wireless Connectivity for the Internet of Things

## Smart Home



- Security & alarm
- Light control
- HVAC control
- Remote control
- Door control
- Energy efficiency
- Entertainment
- Appliances

- Bluetooth
- WLAN
- ZigBee
- Z-Wave

## Wearables



- Health monitor
- Fitness trackers
- Smart watch
- Smart glasses
- Smart bands
- E-textiles
- Hearing-aid

- Bluetooth
- WLAN
- NFC
- EMV

## Smart City



- Traffic management
- Water distribution
- Waste management
- Security
- Lighting
- Environmental monitoring
- Infrastructure
- Parking sensor

- NB-IOT
- LTE Cat-M1
- LoRa

## Industry Automation



- Smart machine
- Surveillance camera
- Factory automation
- Asset tracking
- Logistics and optimization of supply chain

- NB-IOT
- LTE Cat-M1
- LoRa

## Smart Energy



- Generation & trading
- Transmission
- Distribution & metering
- Storage
- Services

- NB-IOT
- LTE Cat-M1
- ZigBee
- Wi-SUN

## Connected Car



- V2V, V2X, V2I communications
- eCall
- Infotainment
- Traffic control
- Navigation
- Autonomous vehicles
- Maintenance

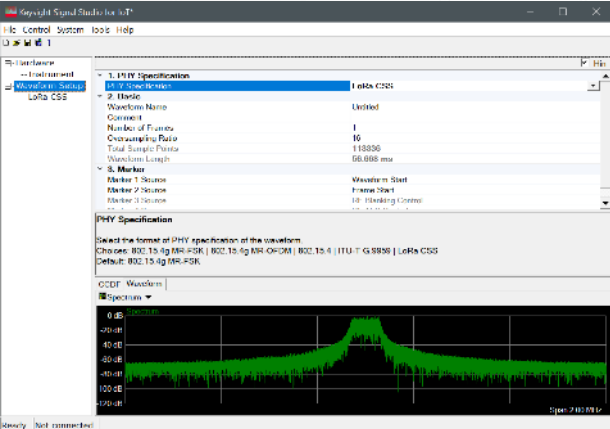
- C-V2X

# Signal Studio for Various IOT Wireless Standards

**SPEED SIGNAL CREATION & REDUCE SIMULATION TIME**

Specification	Name	Signal Studio
802.15.1	Bluetooth	N7606C Bluetooth Signal Creation
802.15.4	ZigBee	N7610C IOT Waveform Signal Creation
802.15.4g	WiSUN	
LoRa	LoRaWAN	
ITU-T G9959	Z-Wave	
802.11a,b,g,n,ac	WLAN	
802.11ax	WiFi 6	N7617C WLAN 802.11 Waveform Signal Creation
802.11ah	HaLow	
802.11p	DSRC/WAVE	
802.11af	White Space	
3GPP Rel-13	Cat-NB2 (NB-IOT)	N7624C/N7625C LTE and LTE-A TDD and FDD Signal Creation
3GPP Rel-13	Cat-M1 (eMTC)	
3GPP Rel-14/15/16	C-V2X	N7626C V2X Waveform Signal Creation

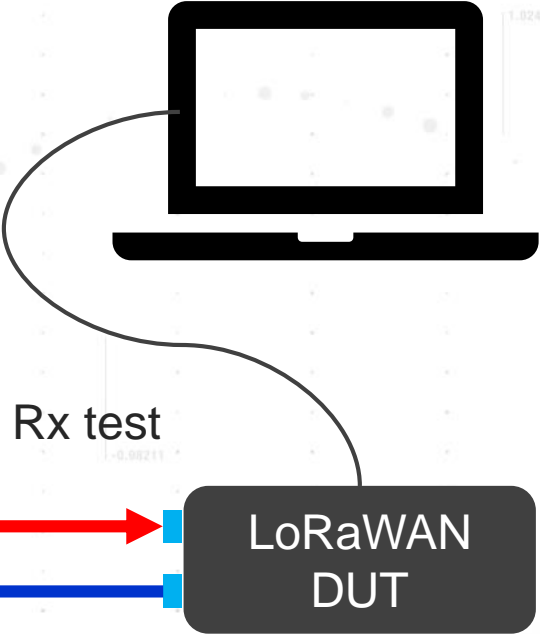
# LoRaWAN RF Tx/Rx Measurements



N7610C Signal Studio for IOT



N9063C Analog Demodulation Measurement Application

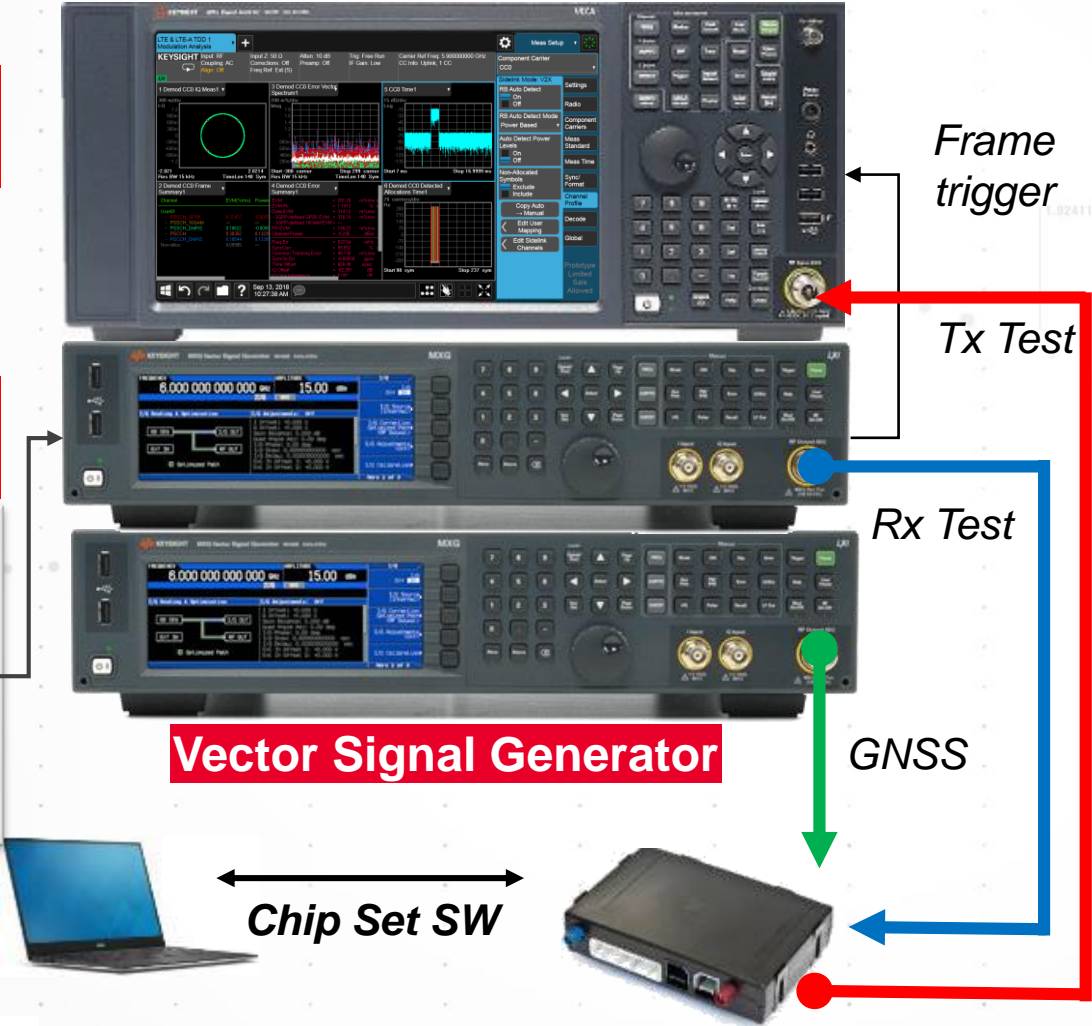
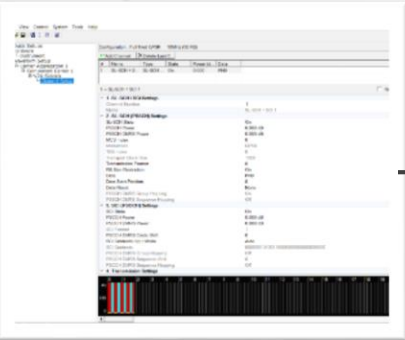


Standard	LoRaWAN
Frequency Band	Sub GHz
Max BW	125 kHz
Data Rate	0.3 ~ 50 kbps
Modulation	Chirp spread spectrum
Range	32 km
Applications	Critical infrastructure and agriculture.

# C-V2X RF Tx/Rx Measurements

N9080C LTE/LTE-Advanced FDD

N7626C Signal Studio for V2X



Standard	CAT-M1	CAT-NB1
Frequency Band	LTE band	GSM/LTE bands
Max BW	1.4 MHz	180 kHz
Data Rate	200 kbps ~1Mbps	Up to 250 kbps
Modulation	OFDM	BPSK, QPSK, opt 16QAM
Range	1000 m	
Applications	Lower speed and power versions of the LTE standard defined in Rel12/13	Critical infrastructure and agriculture.



# N5166B CXG Option and List Price

Description	Options	
Frequency from 9 kHz to 3 GHz	503	
Frequency from 9 kHz to 6 GHz	506	
ARB baseband generator, RF BW 60MHz, 32MSa	653	
Upgrade BBG RF BW from 60 to 120 MHz	655	
Upgrade BBG memory from 32 to 512 MSa	022	
AM, FM, Phase modulation	UNT	
Narrow pulse modulation	UNW	
Multifunction generator	303	
Waveform license 5-pack	221-229	
Waveform license 50-pack	250-259	
Internal solid-state drive	009	
Flexible reference input (1-50MHz)	1ER	
Commercial calibration certificate with test data	UK6	
Pulse train	N5180320B	
Calibrated AWGN	N5180403B	
Multitone and two-tone	N5180430B	
Custom digital modulation	N5180431B	

# Resource

## Literature

- CXG X-series Signal generator N5166B Data Sheet
- CXG X-Series Signal Generator N5166B Configuration guide
- [X-Series Signal Generators MXG/EXG/CXG –Technical Overview \(TBU\)](#)
- [Signal Studio Software Simplify Signal Creation – Brochure](#)
- [Signal Generator Selection Guide \(TBU\)](#)

## Web pages

CXG: (TBU)

Signal Studio: <http://www.keysight.com/find/signalstudio>

IOT: <https://www.keysight.com/find/iot>

## Social Media

- Keysight Blog [RF + Microwave](#)
- Facebook [Keysight RF Test & Measurement](#)
- LinkedIn [RF & Microwave Instruments & Measurements](#)

## Application Note / White Paper

- [How to Minimize Measurement Uncertainty in RF Signal Generators](#)
- [9 Best Practices for Optimizing Your Signal Generator – Part 1](#)
- [9 Best Practices for Optimizing Your Signal Generator – Part 2](#)
- [Receiver Test: Overcoming Five Fundamental Challenges](#)
- [8 Hints for Making Better Measurements Using RF Signal Generators](#)
- [Improving Amplitude Accuracy with Next-Generation Signal Generators](#)
- [Making Noise in RF Receivers](#)
- [Tactics for Improving Distortion Measurements](#)
- [The Essential Signal Generator Guide: Building a Solid Foundation in RF – Part 1](#)
- [The Essential Signal Generator Guide: Building a Solid Foundation in RF – Part 2](#)

**Backup**



品勛科技股份有限公司

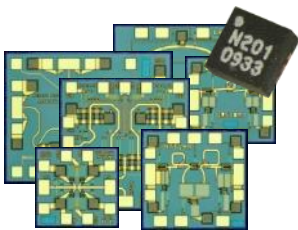
[www.pinsyun.com.tw](http://www.pinsyun.com.tw)

# Discover X-Series Signal Generators

INNOVATION IN SIGNAL GENERATION



**IQ modulator**



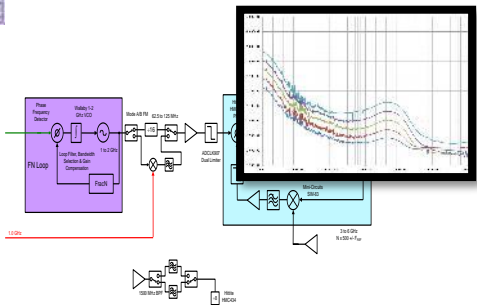
**Pin diode  
electronic  
attenuators**



**Software  
defined  
baseband**



**Baseband  
processing  
accelerator**



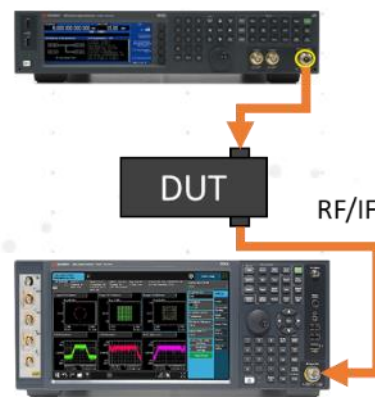
Innovation Design	
IQ Modulator	ACPR
Low Loss Attenuator	High output power
Baseband Accelerator	
Software Defined Baseband	Real-time applications
Triple-Loop Synthesizer	Phase noise & spurs

# More Use Cases

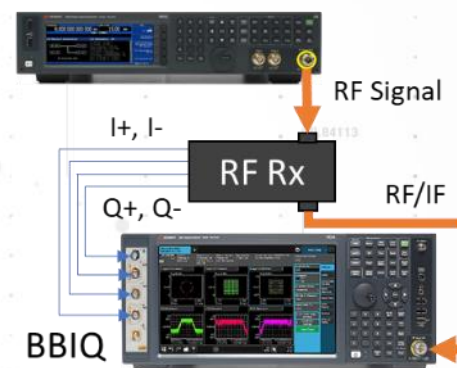
## COMPONENT TEST AND SYSTEM COMPONENT SUBSTITUTION

- Modulation RF/IF signal
- CW signal
- 2-tone or multi-tone
- Baseband I/Q signals
- As an I/Q modulator (external I/Q required)

**Component Measurement  
(Stimulus-Response test)**



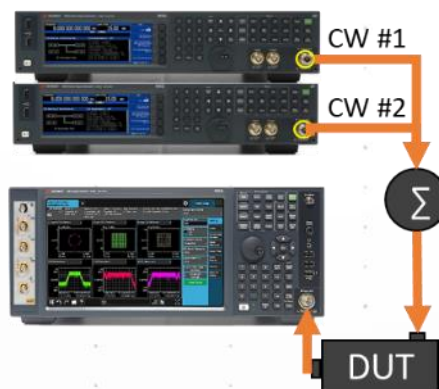
**RF Receiver Component  
Measurement**



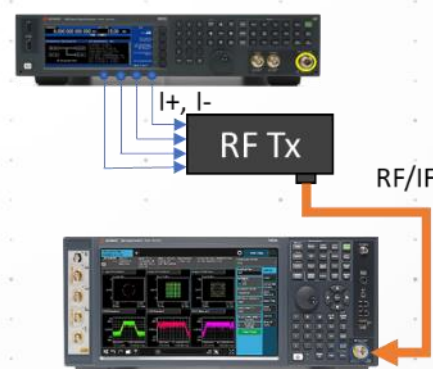
**System Component  
Modulator**



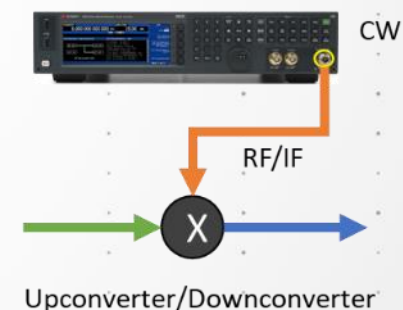
**Intermodulation  
(2-tone) Measurement**



**RF Transmitter Component  
Measurement**



**System Component  
LO**

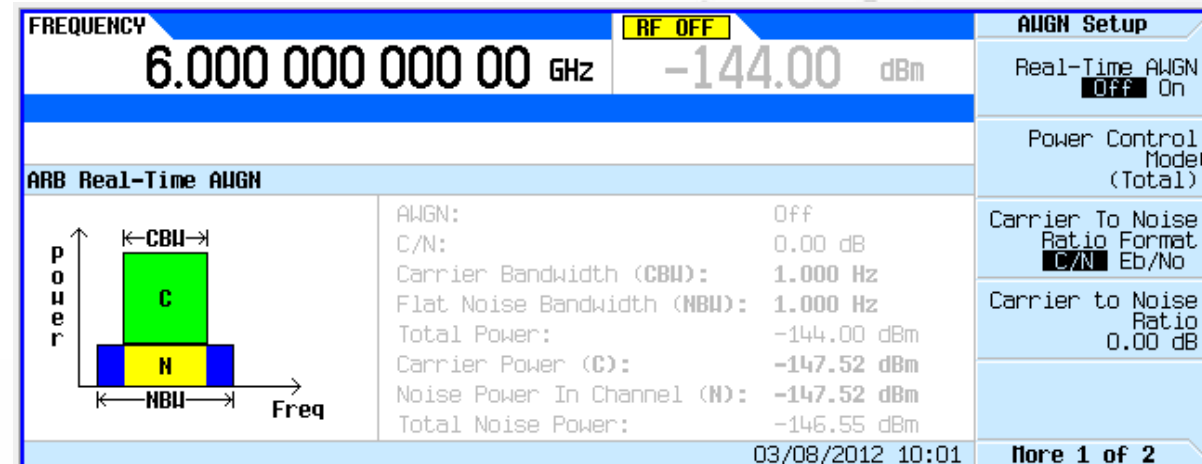
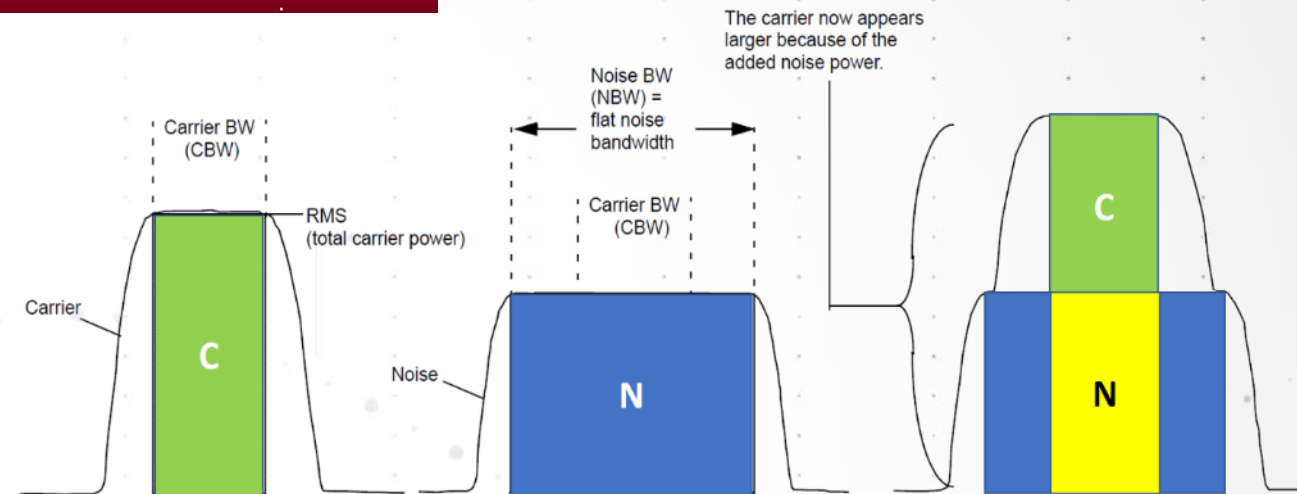




# Calibrated Noise (AWGN)

## FAST SETUP AND ACCURATE SIGNAL GENERATION

- Add real-time noise AWGN to the baseband waveforms digitally
- Provides an accurate amplitude level for both the carrier and noise signal without additional measurements.
- Select either C/N or  $E_b/N_0$  as the variable controlling the ratio of the carrier power to noise power in the carrier bandwidth



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