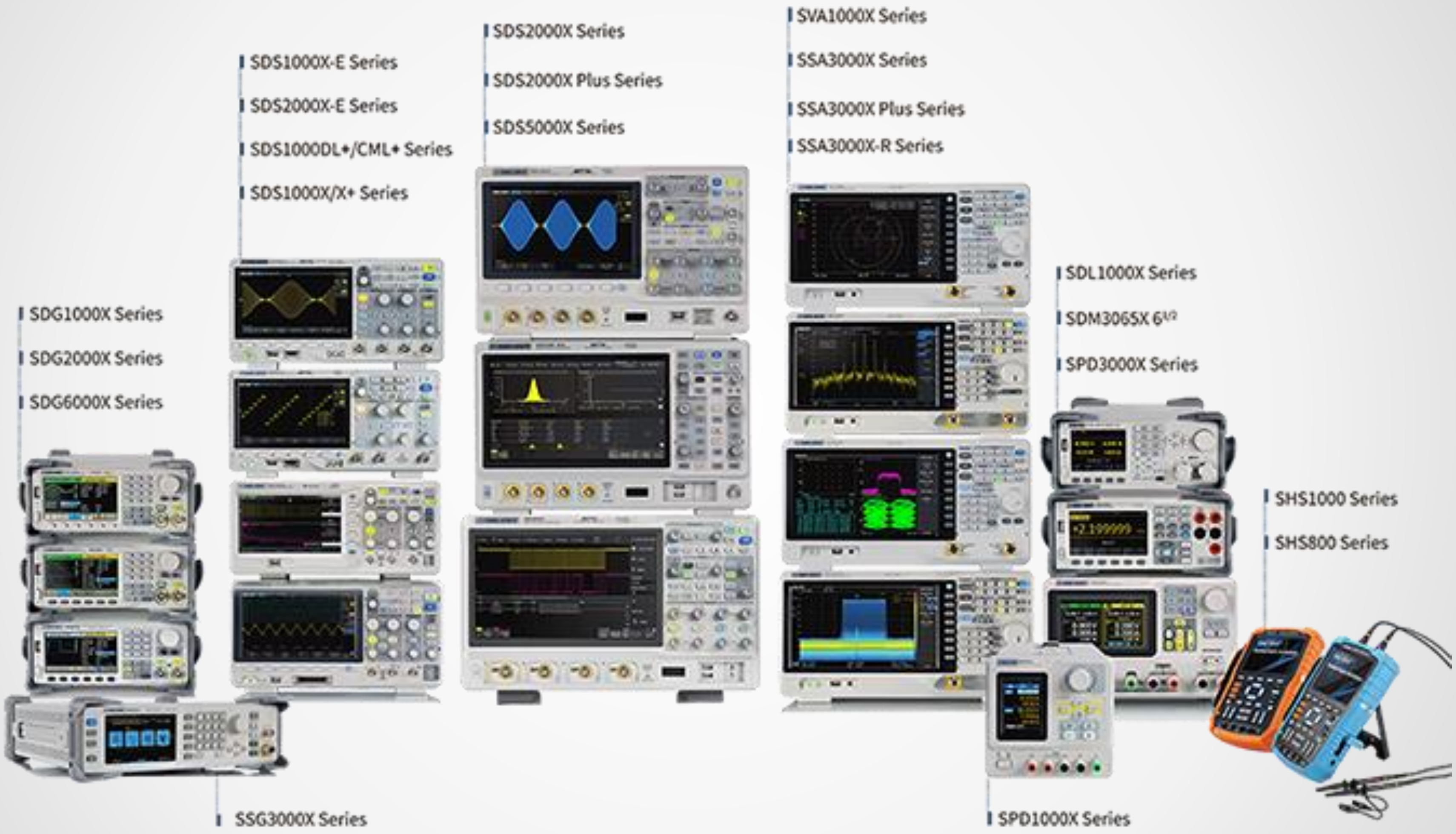
SIGLENT TECHNOLOGIES

The Best Value in Electronic Test & Measurement

SIGLENT®

New Product Introduction



Public May 15th, 2020

Content

- The SSG5000X Series at a Glance
- Specs and Datasheet explanation
- Features
- Applications
- Competition Analysis

The SSG5000X Series at a Glance

Models	SSG5040X	SSG5060X	SSG5040X-V	SSG5060X-V
Frequency Range	9 kHz - 4 GHz (CW Mode)	9 kHz - 6 GHz (CW Mode)	9 kHz - 4 GHz (CW Mode) 10 MHz - 4 GHz (IQ Mode)	9 kHz - 6 GHz (CW Mode) 10 MHz - 6 GHz (IQ Mode)
Level setting range	-140 dBm~+26 dBm (1 MHz≤f≤4 GHz)			
Level Accuracy	< 0.7 dB (typ)			
Phase Noise	-120 dBc/ Hz @ 1 GHz, 20 kHz offset (typ.)			

Specs and Datasheet explanation

- **Frequency Range**: When choosing a Signal Generator, it is necessary to consider all the tests. Not only the DUT operating frequency range. For example, when testing a radio receiver, it is necessary to test its susceptibility to out of band signals.
- **Frequency Accuracy**
  - Is affected by stability of the reference oscillator and the amount of time since last calibration
  - High Accuracy Frequency Reference Option: 10M_OCXO_L
  - Frequency accuracy = Output Frequency * Aging rate per year * Time since last calibration

    For example, SSG5060X one year after calibration, Accuracy = 6 GHz * 0.5ppm/first year * 1(year) = 3 kHz

	SSG5040X	SSG5060X	SSG5040X-V	SSG5060X-V
Frequency Range	9 kHz - 4 GHz (CW Mode)	9 kHz - 6 GHz (CW Mode)	9 kHz - 4 GHz (CW Mode) 10 MHz - 4 GHz (IQ Mode)	9 kHz - 6 GHz (CW Mode) 10 MHz - 6 GHz (IQ Mode)
Frequency Resolution	0.001 Hz			
	Frequency Accuracy			
Reference frequency	10.000000 MHz		Option 10M_OCXO_L	
Initial calibration accuracy	< 0.2 ppm		±100 ppb	
Temperature stability	< 1 ppm/year, 0℃ ~50℃		±1 ppb, 0℃ ~50℃	
Frequency aging rate	< 0.5 ppm/first year, 3.0 ppm/20 years		50 ppb/1 year	

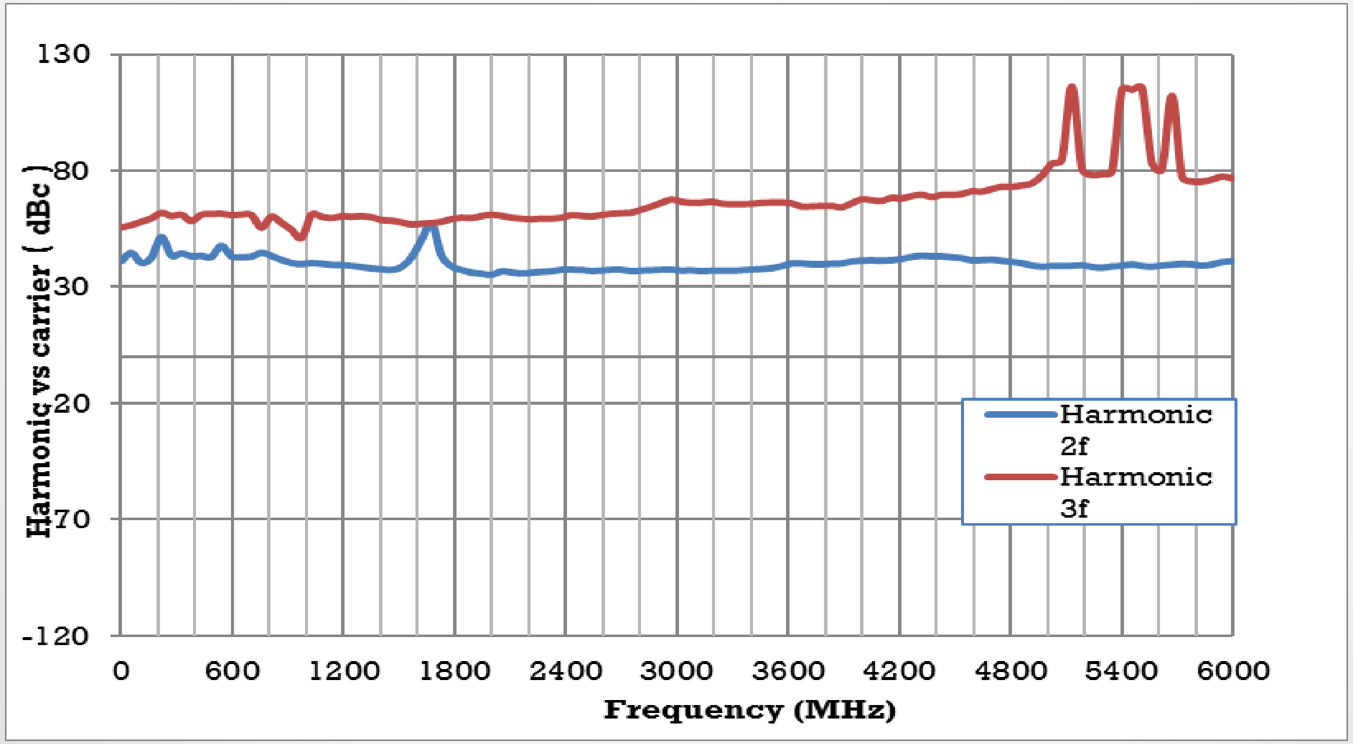
Specs and Datasheet explanation

- **Output power** (level): Defined in dBm, dB relative to one milliwatt.
  For example, 1 milliwatt expressed in dBm. $10 * \log_{10} 1 = 0$ dBm
- **Level Accuracy** describes how closely the actual output value matches the set value.
  - Good accuracy can save cost by improving yield. For example, receiver sensitivity testing.
  - Amplitude accuracy affects the sweeping frequency capability, which is often used in filters and amplifiers tests. The higher the amplitude accuracy, the flatter the output with respect to frequency.
  - Amplitude accuracy can be improved with the use of automatic leveling control (ALC).

<table>
<tr><th></th><th colspan="2">SSG5040X</th><th>SSG5060X</th><th>SSG5040X-V</th><th>SSG5060X-V</th></tr>
<tr><td>Level setting range</td><td colspan="5">-140 dBm~+26 dBm (1 MHz≤f≤4 GHz)</td></tr>
<tr><td>Level of performance range</td><td colspan="5">-130 dBm~+20 dBm (1 MHz≤f≤4 GHz)</td></tr>
<tr><td rowspan="5">Level error,
when ALC State is on</td><th>Frequency Range</th><th colspan="4">Range of Output Power</th></tr>
<tr><td></td><td>+20 dBm to -40 dBm</td><td>-40 dBm to -90 dBm</td><td>-90 dBm to -110dBm</td><td>-110 dBm to -130 dBm</td></tr>
<tr><td>9 kHz ≤ f < 100 kHz</td><td>≤0.9 dB
≤0.7 dB (typ.)</td><td>≤0.9 dB
≤0.7 dB (typ.)</td><td>≤1.1 dB</td><td></td></tr>
<tr><td>100 kHz ≤ f ≤ 4 GHz</td><td>≤0.7 dB
≤0.5 dB (typ.)</td><td>≤0.7 dB
≤0.5 dB (typ.)</td><td>≤1.1 dB
≤0.7 dB (typ.)</td><td>≤1.1 dB (typ.)</td></tr>
<tr><td>4 GHz < f ≤ 6 GHz</td><td>≤0.7 dB
≤0.5 dB (typ.)</td><td>≤0.7 dB
≤0.5 dB (typ.)</td><td>≤1.1 dB
≤0.7 dB (typ.)</td><td>≤1.2 dB (typ.)</td></tr>
<tr><td>Level error,
when ALC off (S&H)</td><td colspan="5">Additional Level Error <0.2 dB</td></tr>
</table>

Specs and Datasheet explanation

- **Spectral Purity**
  - **Harmonics and Spurious Signals**: They are normally quoted in terms of decibels relative to the carrier.
  - Harmonics are integer multiples of the carrier frequency. Spurs are non-integer multiples of the carrier frequency.
  - High dynamic range generators are needed when measuring spurs and harmonics, or the ones detected may come from the generator and not the DUT.



Measured harmonics versus carrier frequency at level ≤ +13 dBm

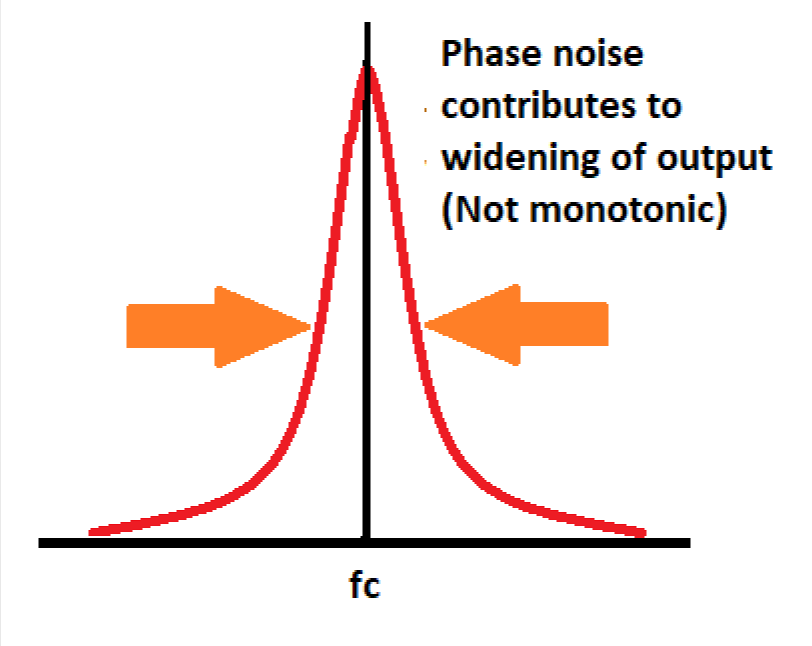
Specs and Datasheet explanation

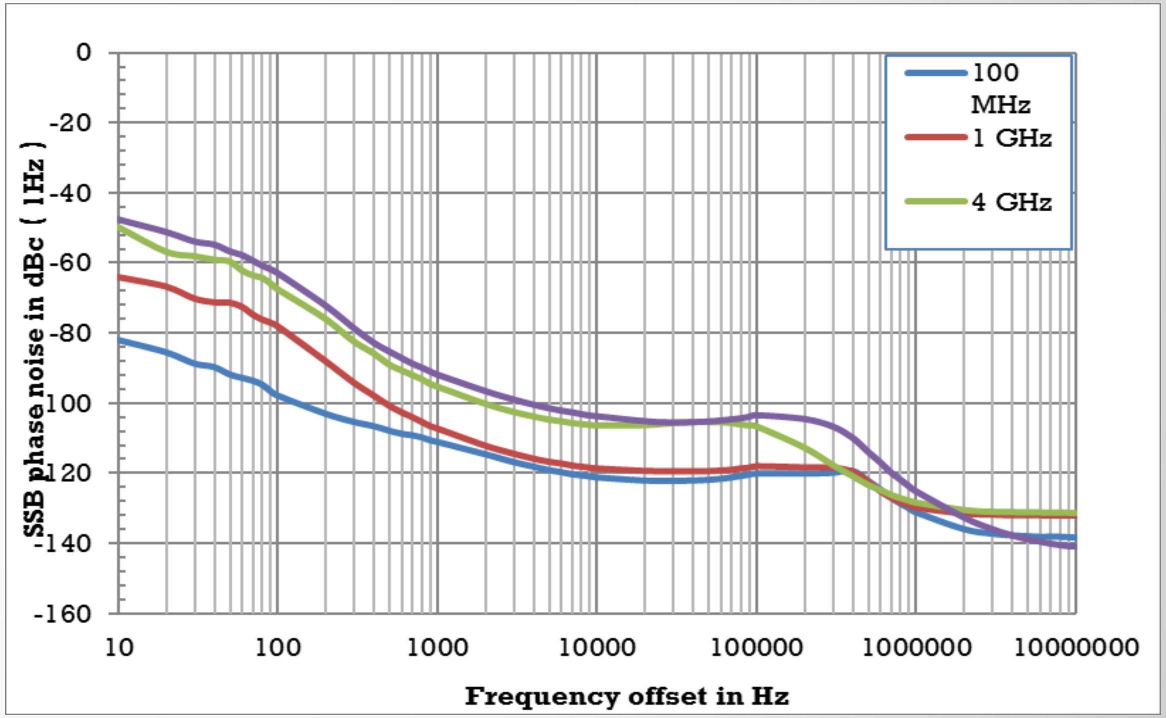
- **Distortion:**
  - Harmonic Distortion: Often caused by non-linear semiconductors, the frequency is integer multiples of a sine wave.
  - Intermodulation Distortion (IMD): Occurs when mixing two or more signals at different frequencies. Its frequency is the sum and difference of integer multiples of the input frequencies. For example, input F1 and F2, it could be 2*F1 – F2 or 2*F2 –F1.
- When it matters: Power amplifier tests require low distortion generators as do ACPR tests on receivers.

3GPP2 cdma 2000 distortion performance			
Offset	Configuration	Frequency	Power level ≤ 4 dBm
885 kHz to 1.98 MHz	9 channel forward link	800 to 900 MHz	-64 dBc(typ.)
> 1.98 to 4.0 MHz			-82 dBc(typ.)
> 4.0 to 10 MHz			-82 dBc(typ.)

Specs and Datasheet explanation

- **Phase Noise:** When measuring the noise of a system, the phase noise of the signal generator may affect the measurements. It is measured in terms of dBc/Hz. This is the noise measured in 1 Hz bandwidth relative to the level of the carrier. Noise is distributed over the frequency range but not only a frequency point.
- When it matters? Radar applications, orthogonal frequency-division multiplexing (OFDM)





Measured phase noise

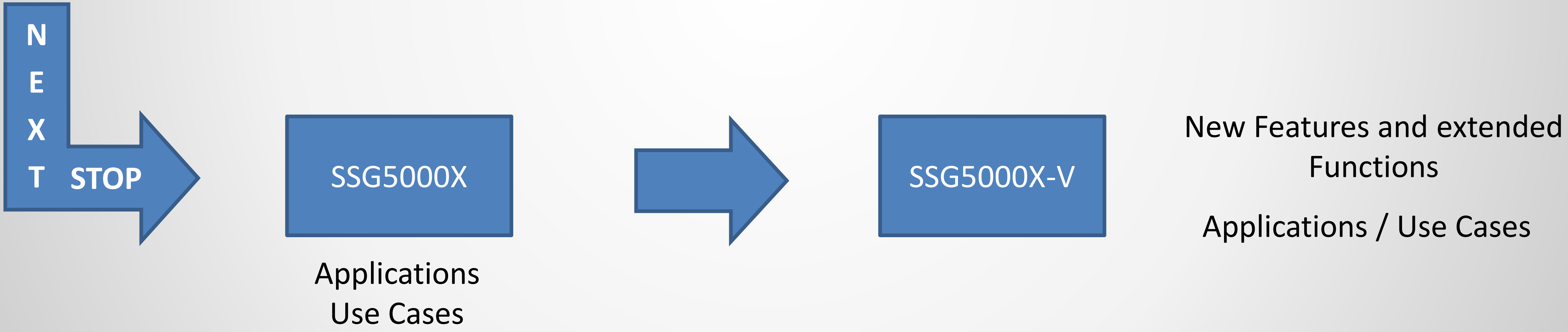
Specs and Datasheet explanation

- **Speed**
  - Time is money, faster generators shorten the test time thus save manufacture costs.
  - How fast does a generator change from one frequency/ amplitude/ waveform to another?
  - Main Factors: Type of change, source of commands (SCPI, List/Step Sweep mode)
  - When it matters: Tests which require fast change of frequency/amplitude/waveforms. For example, receiver sensitivity measurements and bit-error-rate (BER) measurements, verify amplifier functionality over variable waveforms, amplifier gain compression tests require various power levels.

SSG5000X Frequency and Level Setting Time	
Frequency Setting Time	<5 ms (typ.), ALC ON
	<10 ms (typ.), ALC OFF (S&H)
Frequency Sweep Dwell Time	10 ms~100 s
Level Setting Time	ALC state ON < 5 ms
	ALC state S&H < 10 ms

Intermediate Summary

- **All discussed Parameters are common to the CW-Version and the Vector Signal Version of the SSG5000X Series.**
- **The comparison to SSG3000X shows that the SSG5000X is superior**
    - **Higher max. Freq.**
    - **Higher output power**
    - **Better Phase Noise**
    - **IQ Modulation (internal, external) + Output differential Baseband I & Q signals**
    - **Higher Modulation Bandwidth**
    - **Etc.**

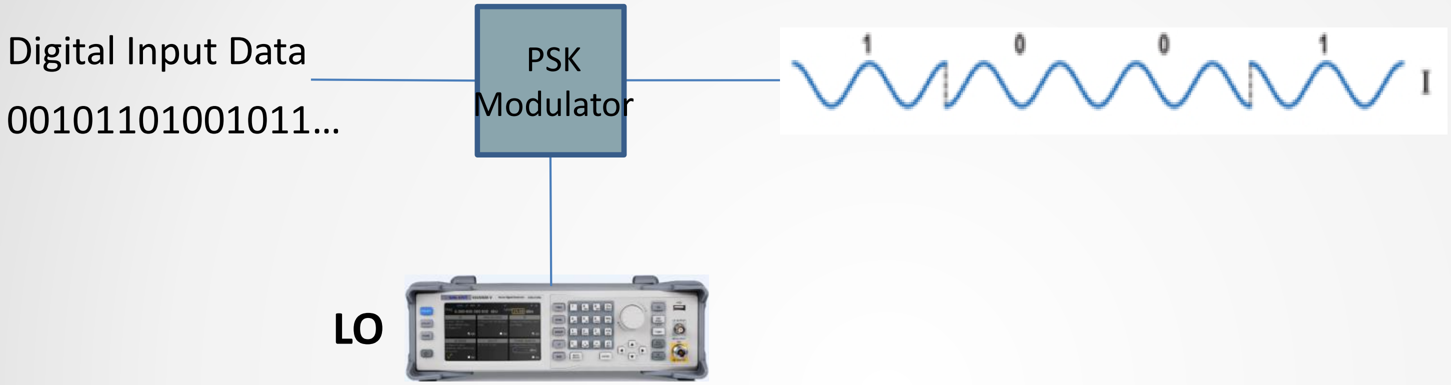


Contents

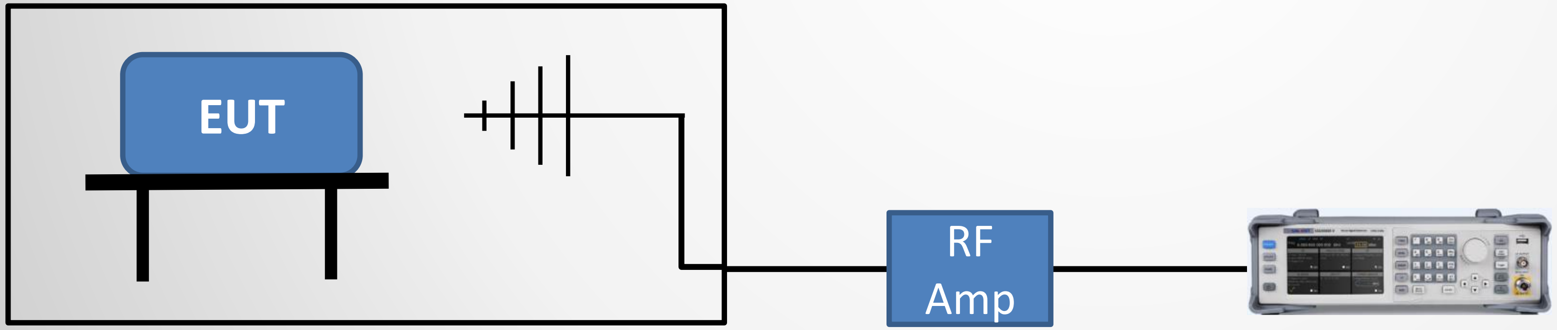
Application Areas for SSG5000X

Applications for CW-Source

- Stable Reference Source (e.g. Local Oscillator, Cal.Source, Reference Signal)

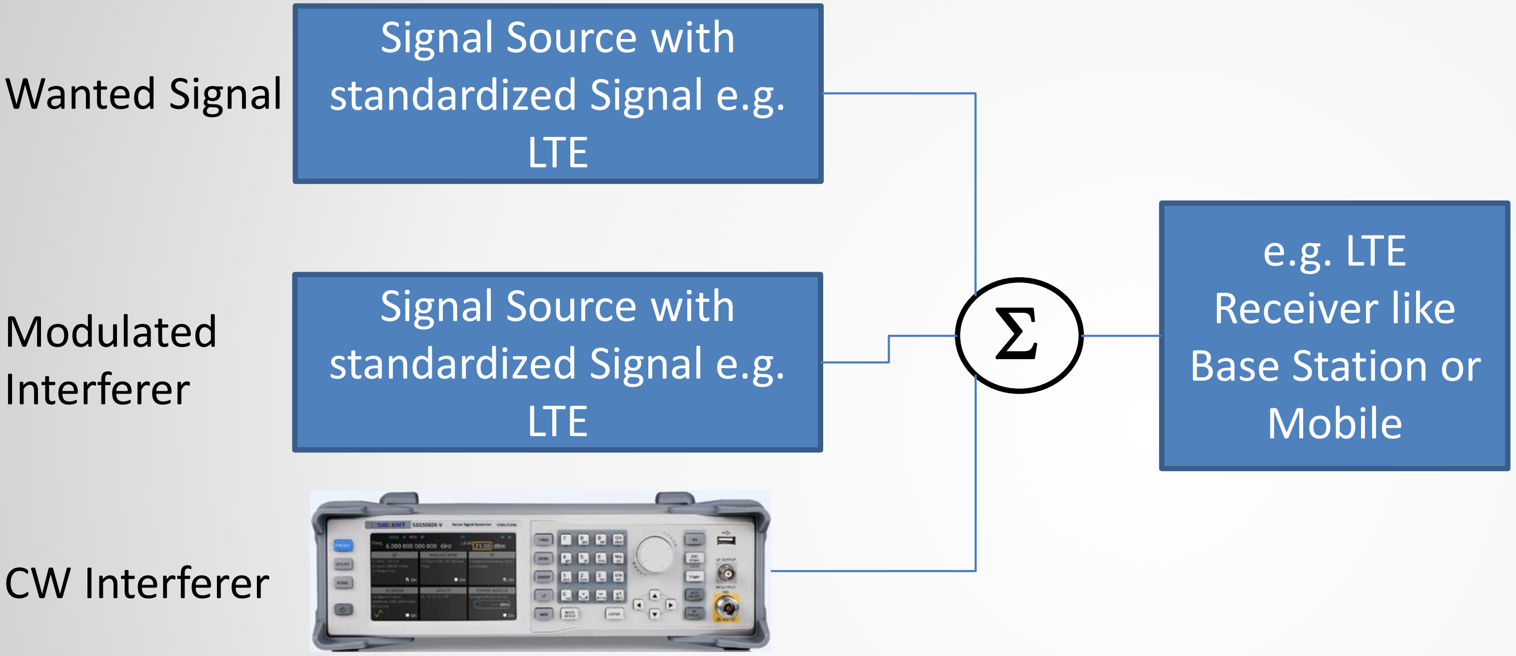


- Interference Source for electro-magnetic susceptibility (EMS) measurements



Applications for CW-Source

- **Receiver Testing (Interference Source for Blocking, Two-Tone tests)**



In-Band Blocking
Out-of-Band Blocking
Intermodulation

- **Universal Instrument for testing (Linearity e.g. with two-tone signal for Intermodulation Performance, Component testing)**
- **Radar-Testing (Pulse Modulated Signals)**
- **Military applications**
- **Avionic applications (VOR/ILS)**

Contents

New Features and extended Functions for SSG5000X-V

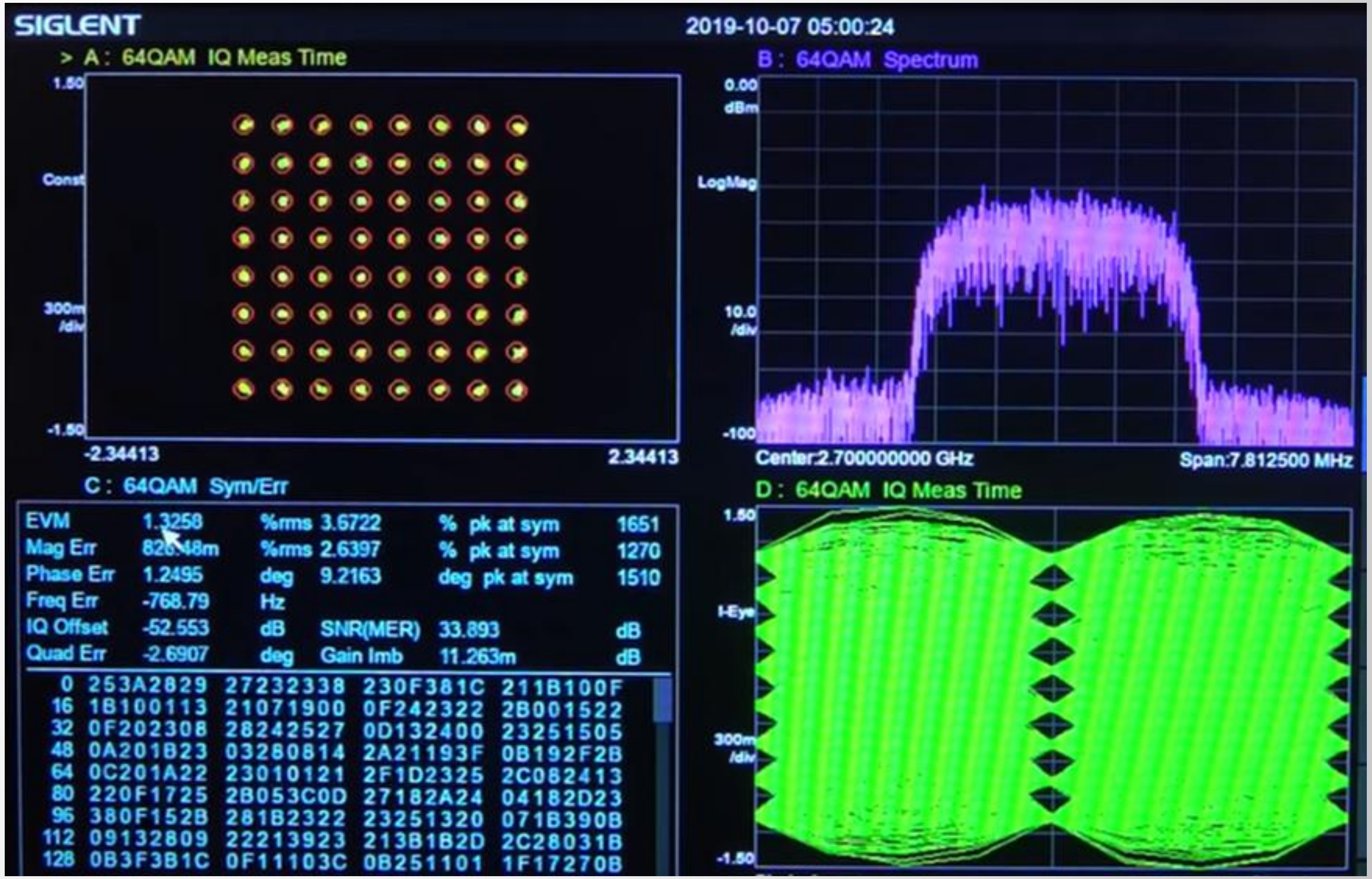
V stands for Vector Signal Source

What is a Vector Signal Source?

- **The answer is:**

A Vector Signal Source is capable to generate Complex Modulated Signals

A Vector Source utilize the IQ-Modulation Technique to generate e.g. 16, 64 QAM or higher modulated signals.



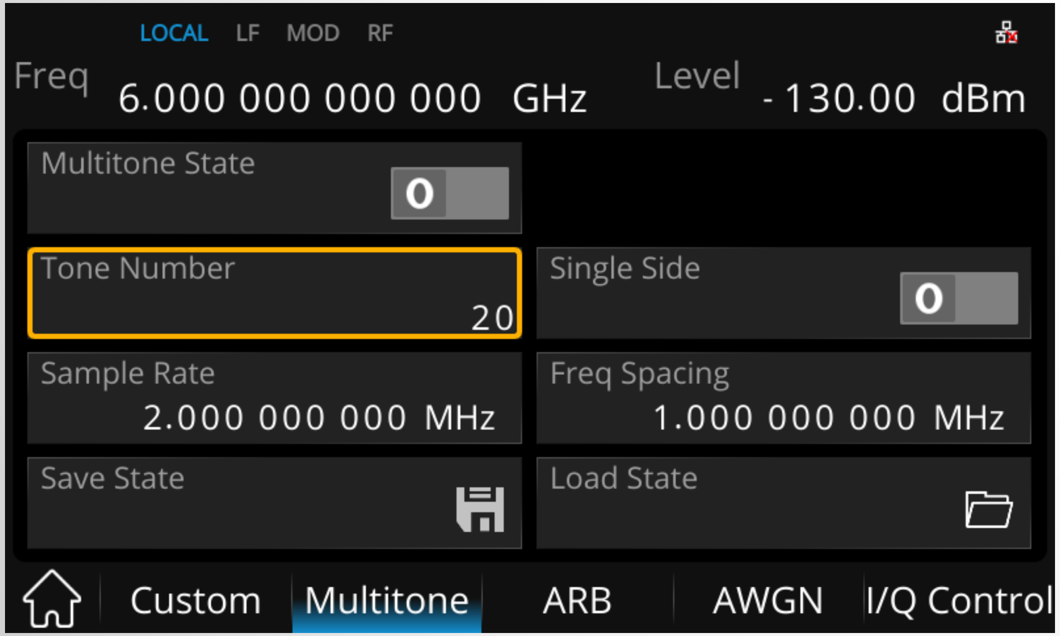
SSG5000X(-V)/3000X(-IQE) Features

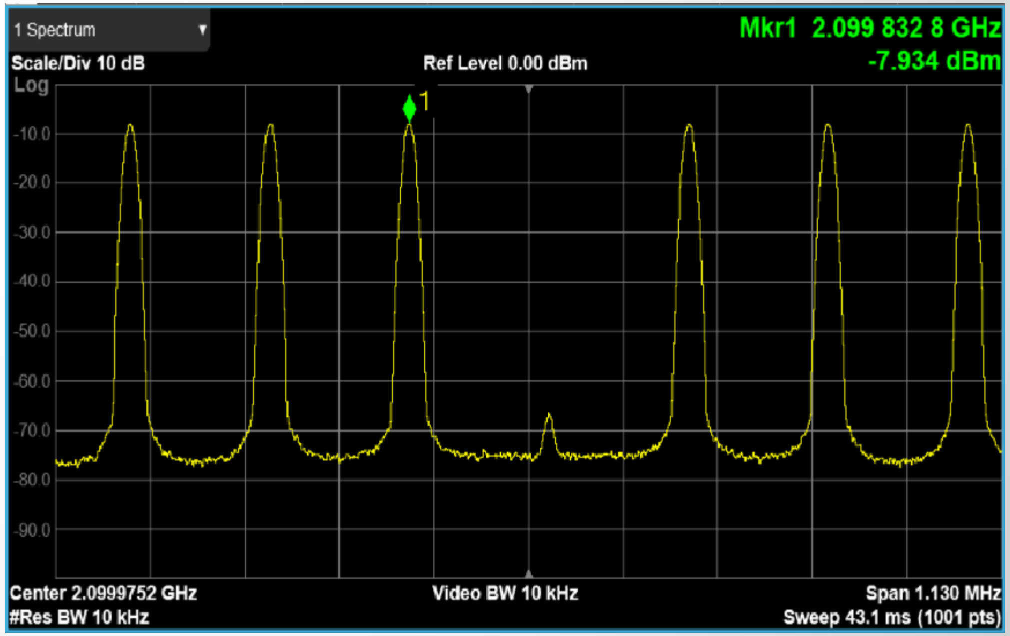
- **Cable loss compensation**
  - The longer the transmission line, the larger the cable loss. In order to ensure good flatness before the signal arrives at the DUT, a flatness correction is needed to compensate for the loss caused by the transmission line and switch impedance.
  - SSG5000X supports flatness correction with an external power sensor (not included).
  - Supported Power sensors currently include R&S USB-type Z series, Keysight U series.

Power Sensor Connection

SSG5000X-V Features

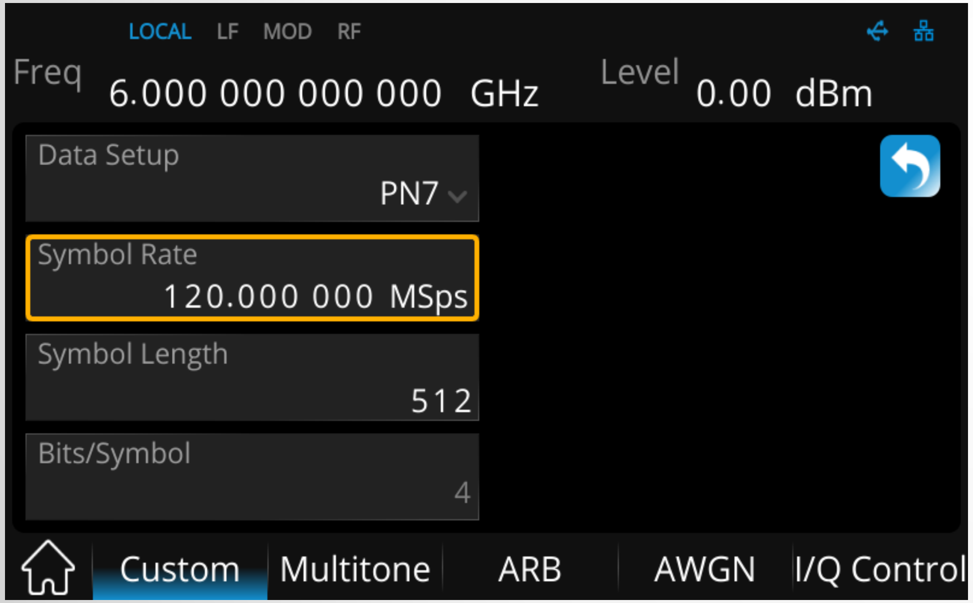
- **Multi-tone mode**
  - Multi-tone signal consists of several sine waves. SSG5000X supports up to 20 tones.
  - Audio Measurements
  - Amplifier and receiver non-linear distortion tests
  - Ground and satellite communications

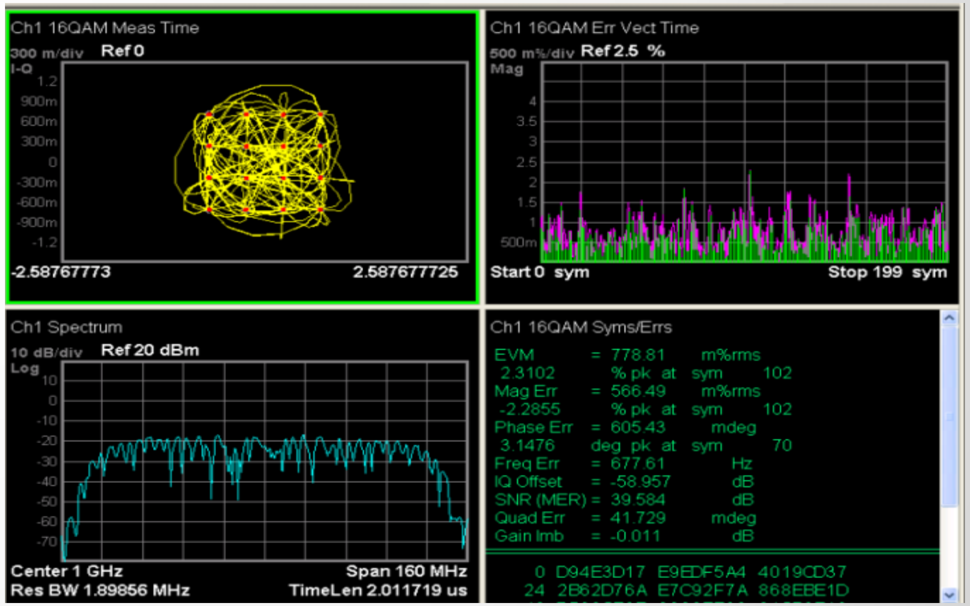




SSG5000X-V Features

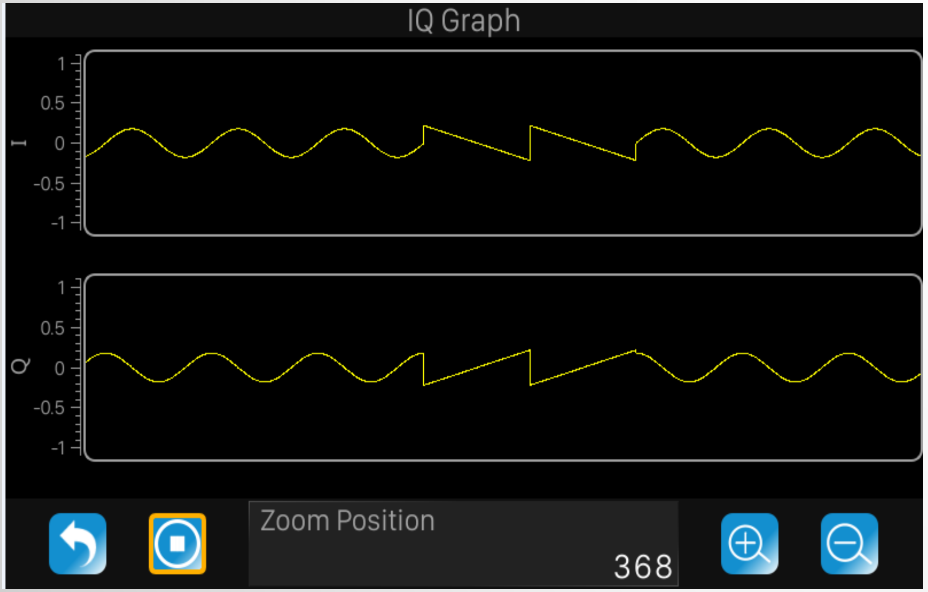
- **CUSTOM mode**
  - Create waveforms that meet requirements quickly.
  - IQ modulation is a very effective way to transmit information. SSG5000X can output common modulation signals like QAM, PSK, ASK, FSK.
  - The symbol rate can be set to as high as 120 Msps



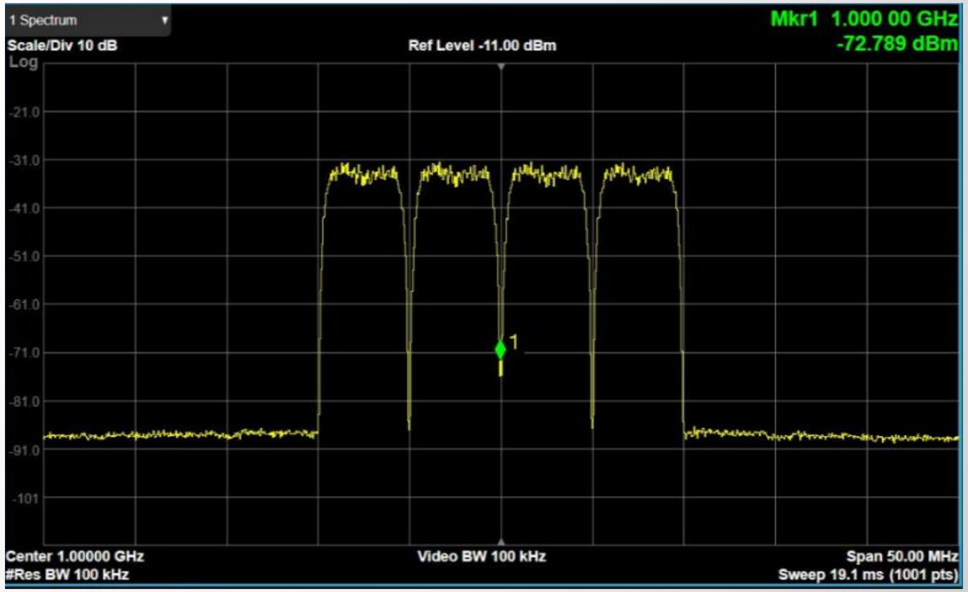


SSG5000X-V Features

- **Powerful ARB mode**
  - Build and replay waveform sequences. There are two types of waveform files.
    - Segment: Created by pre-defined ARB formats
    - Sequence: Several segments strung together
  - Generate multi-carrier signals
    - Usually narrowly spaced carriers, which is spectrally efficient and resilient to interference.
    - Widely used with the introduction of OFDM (Orthogonal Frequency Division Multiplexing), which is used for systems such as wireless/ cellular telecommunications and networking standards such as WiMAX, Wi-Fi 802.11, LTE.



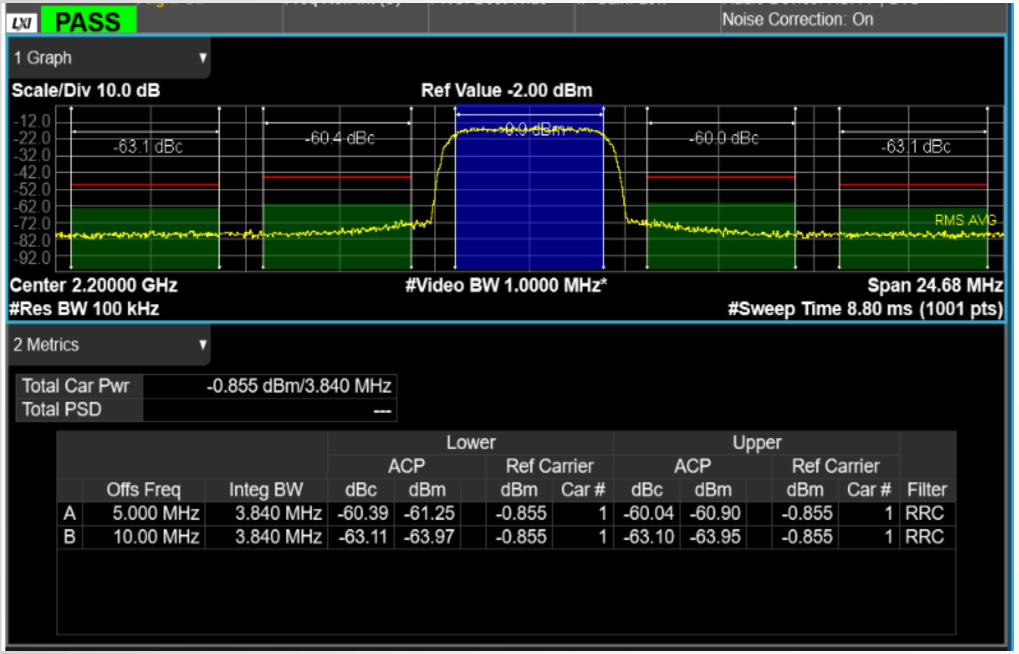
Build and Replay Waveform Sequences



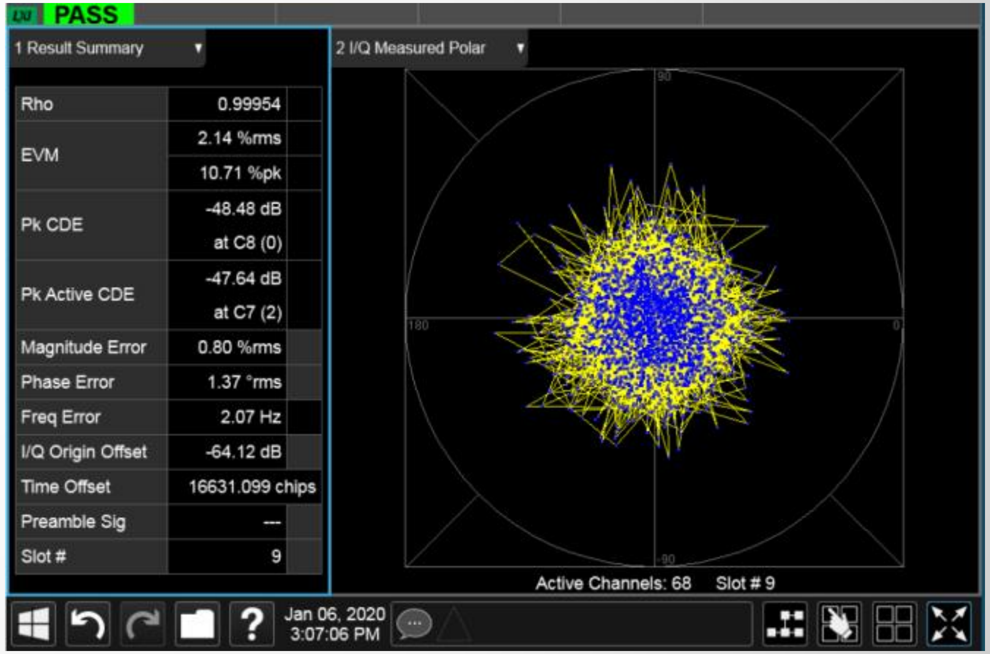
Generate Multi-Carrier Signals

SSG5000X-V Features

- **Powerful ARB mode**
  - Rapid developments in consumer electronics require a variety of communication protocols to verify wireless products.
  - SSG5000X series has built-in common protocol files: 5G NR, LTE, WLAN, WCDMA, GSM, BLUETOOTH.
  - Built-in or build-your-own..



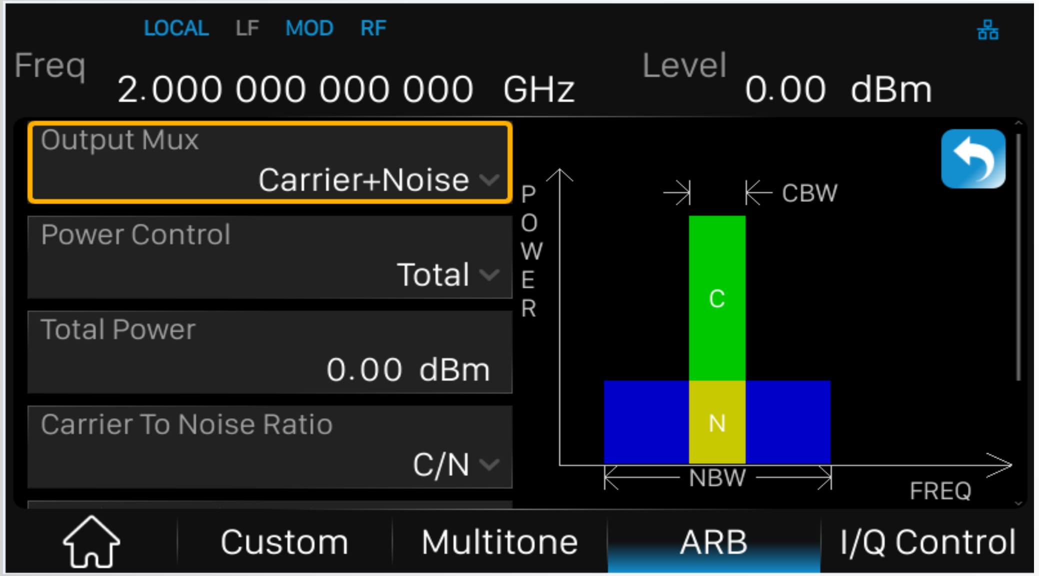
3GPP WCDMA TM1-64DPCH ACPR

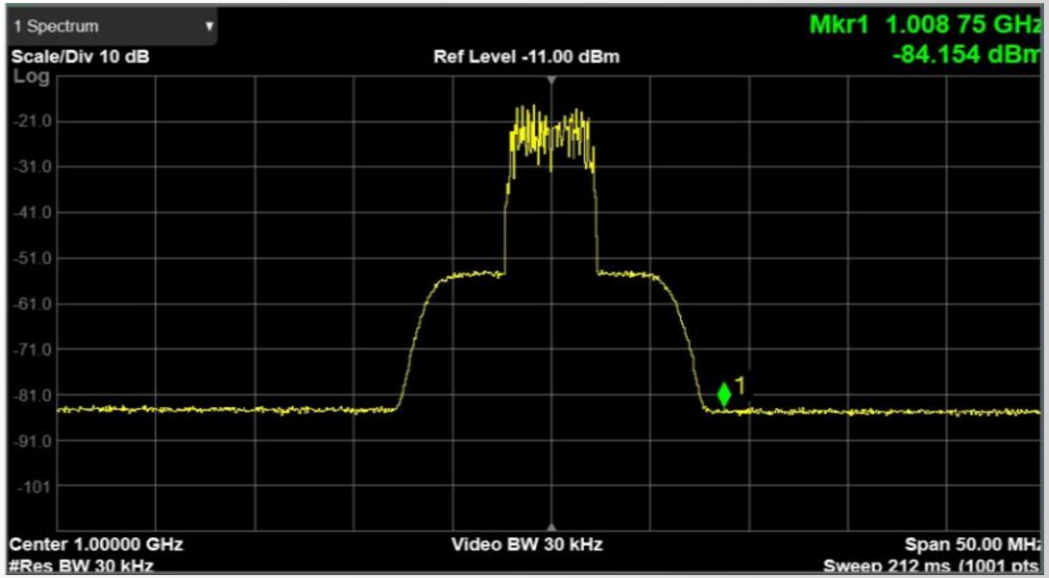


3GPP WCDMA TM1-64DPCH EVM

SSG5000X-V Features

- **Powerful ARB mode**
  - Add Real-Time AWGN (Additive White Gaussian Noise) to signals. AWGN is a basic noise model used in information theory to mimic the effect of many random processes that occur in nature, like thermal noise.
  - Add AWGN to the test signal when testing receiver performance to simulate various environments.



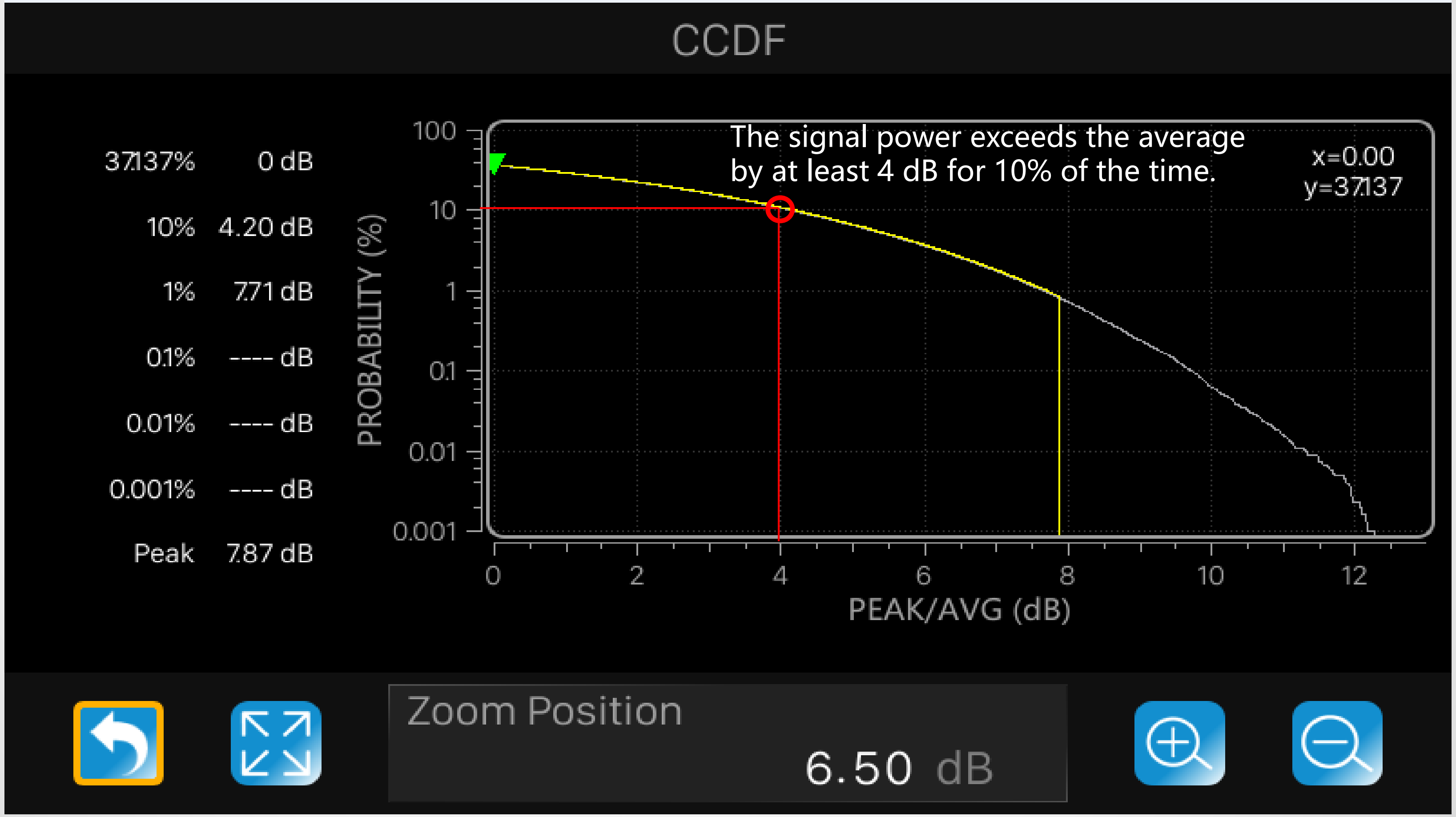


Add real time AWGN to digital IQ signals for receiver performance tests

SSG5000X-V Features

- **Powerful ARB mode**
  - Clip the peak power of the signal and display CCDF (Complementary Cumulative Distribution Function) curve.

Y axis is the percent of time the signal is at or above the power specified by the X axis.



X axis is dB above average power

Appearance of SSG5000X-V Back

Various Control In-/Outputs

Differential I and Q Baseband Outputs

Ext I and Q Baseband Inputs

High Stability Oven Controlled Ref. Oscillator

USB Device
Remote Control

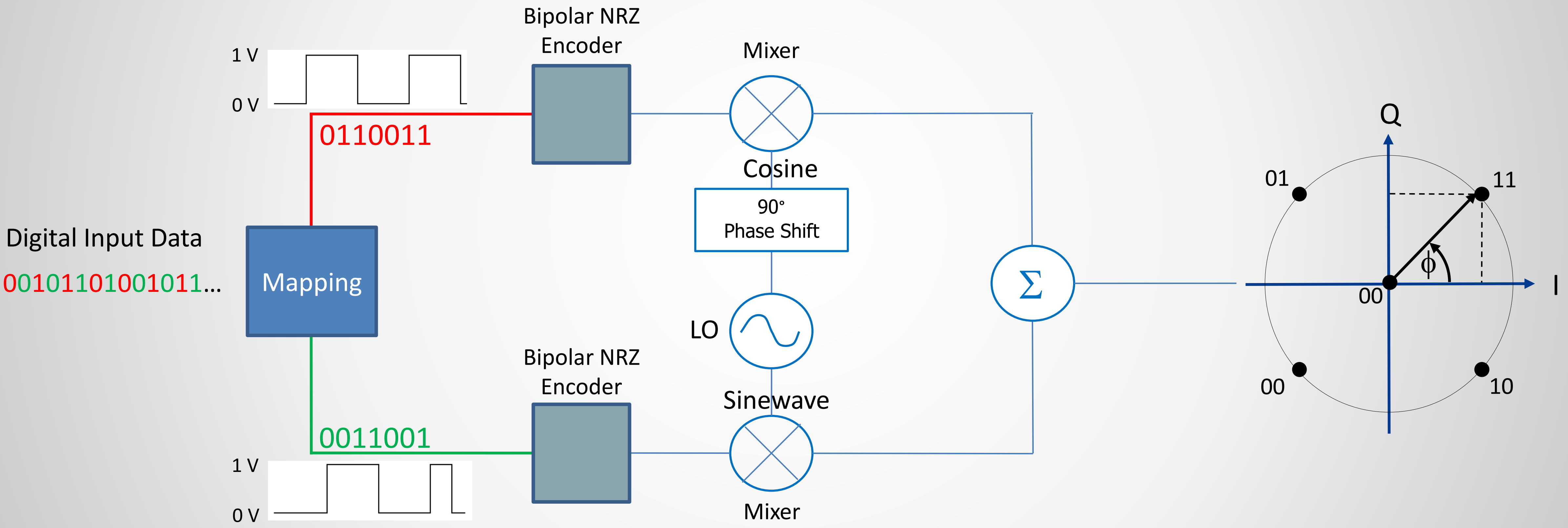
LAN
Web Server

Contents

Application Areas for SSG5000X-V

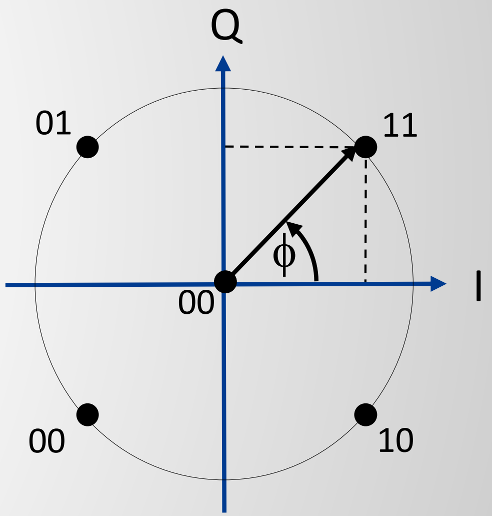
Applications

- **General overview on possibilities**



Applications

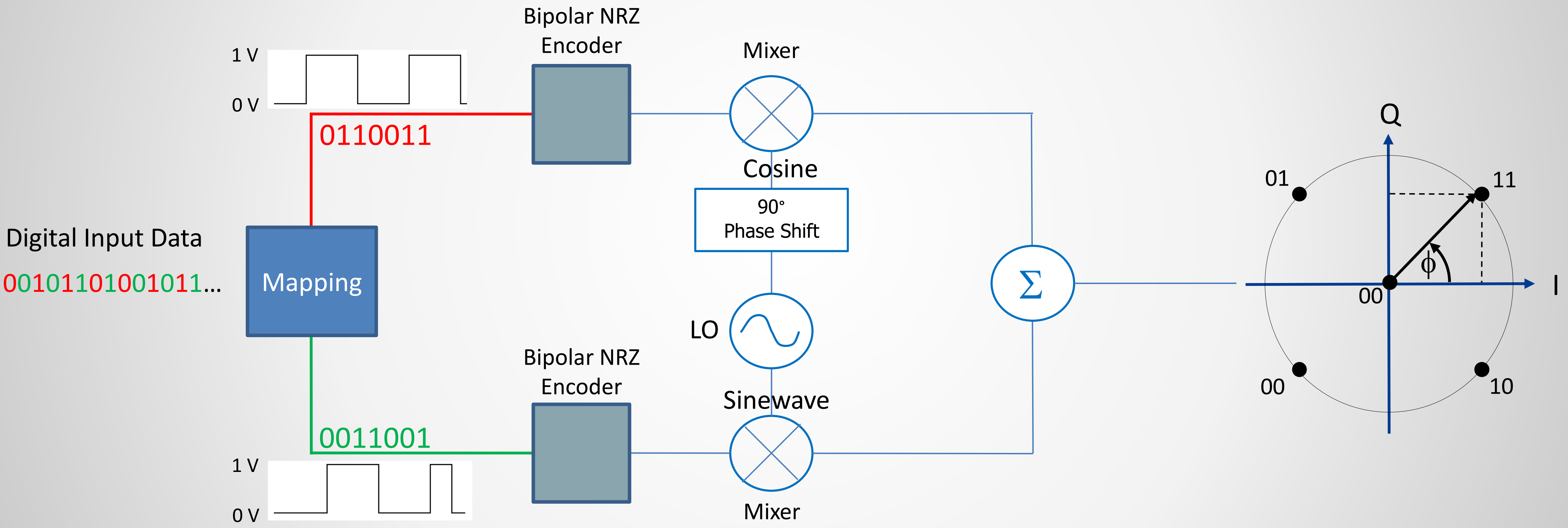
- **General overview on possibilities**



Generate the various complex modulations up to 6 GHz all in one Box

Applications

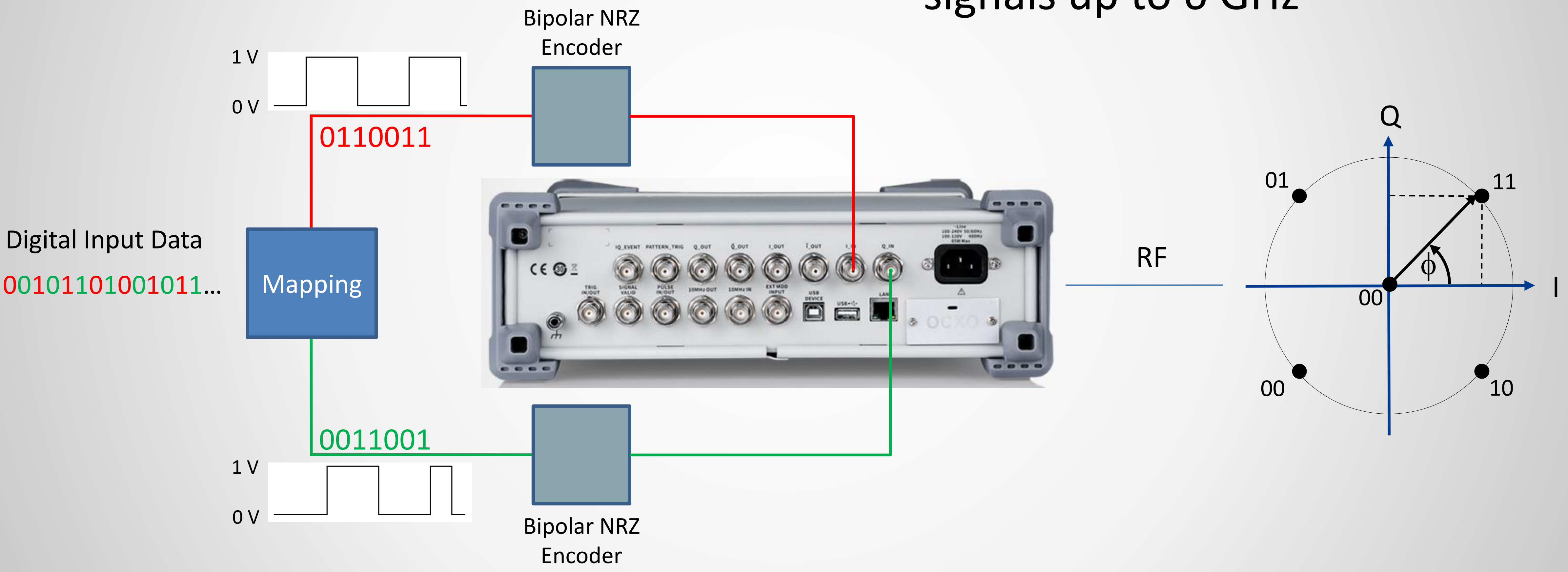
- **General overview on possibilities**



Applications

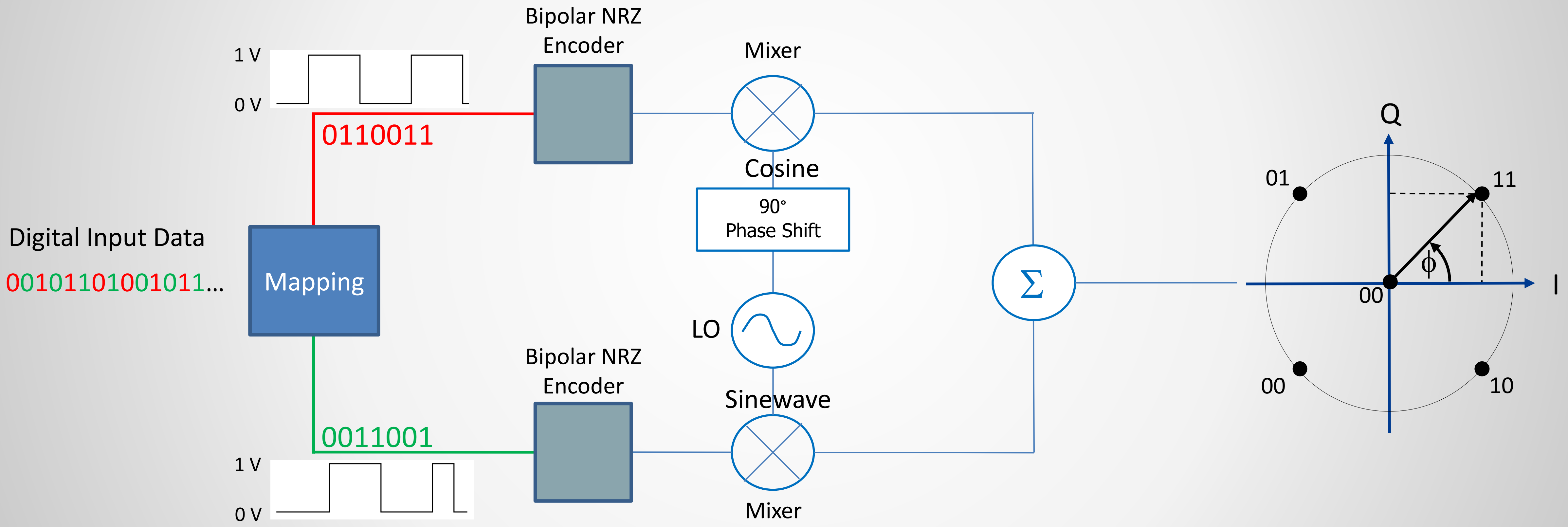
- **General overview on possibilities**

Up-modulate external IQ Baseband signals up to 6 GHz



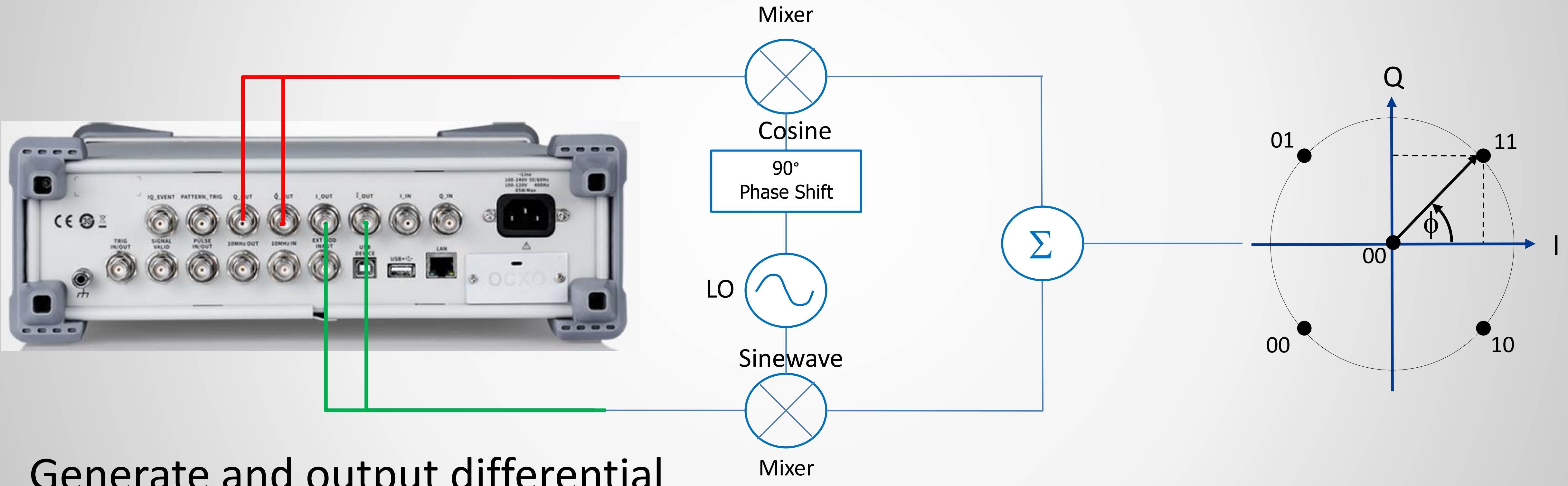
Applications

- **General overview on possibilities**



Applications

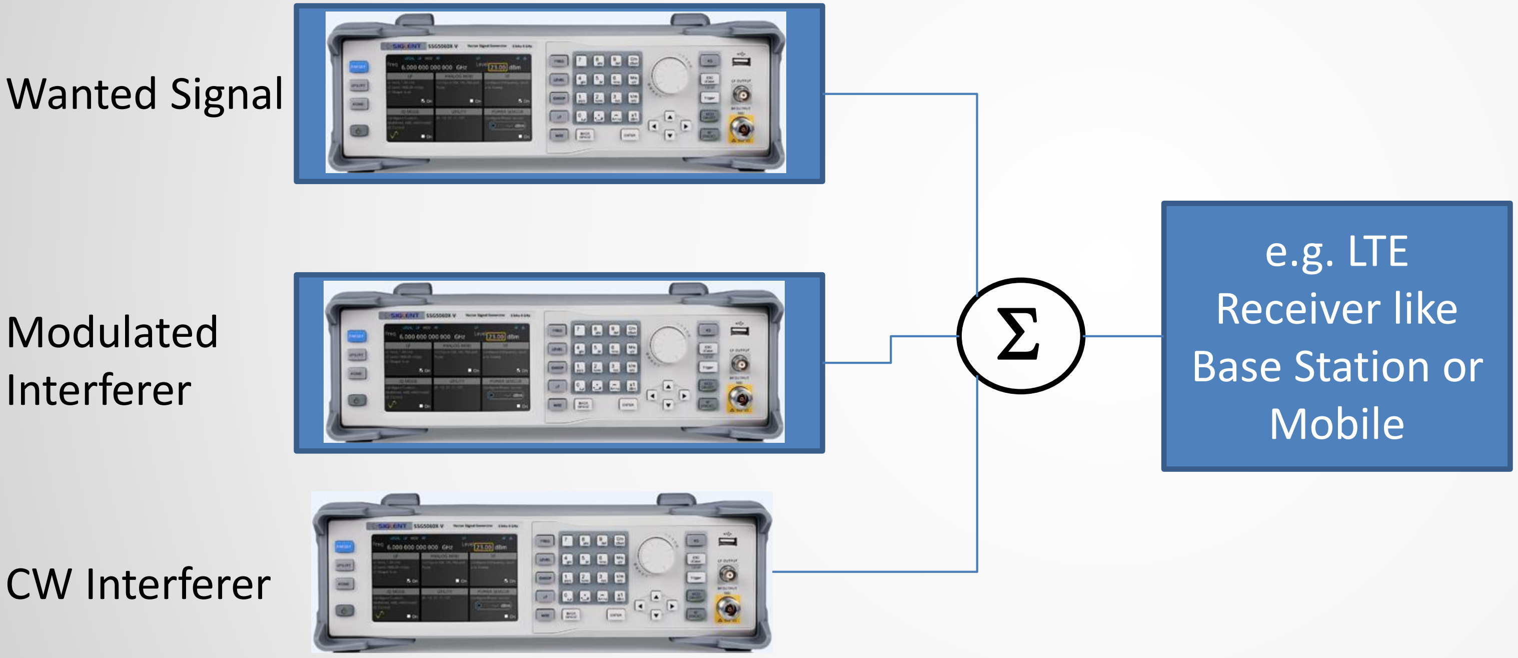
- **General overview on possibilities**



Generate and output differential
IQ Baseband signals

Applications

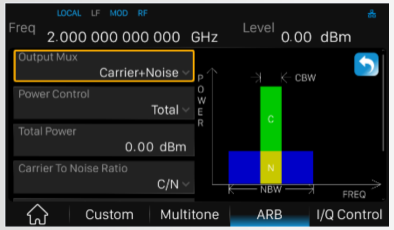
- **Receiver tests – Adjacent channel selectivity tests, Bit-error-rate (BER) measurement**



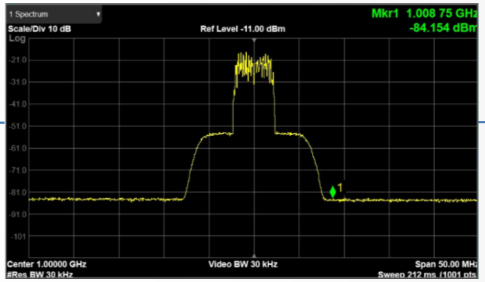
In-Band Blocking
Out-of-Band Blocking
Intermodulation

Applications

- **Receiver tests – Performance test**
- Add disturbances like Noise, Fading, Clipping or Bit Errors and determine how the receiver handles the changes…



Add Noise to Sender Signal



e.g. LTE Receiver like Base Station or Mobile

Multi-Channel Fading

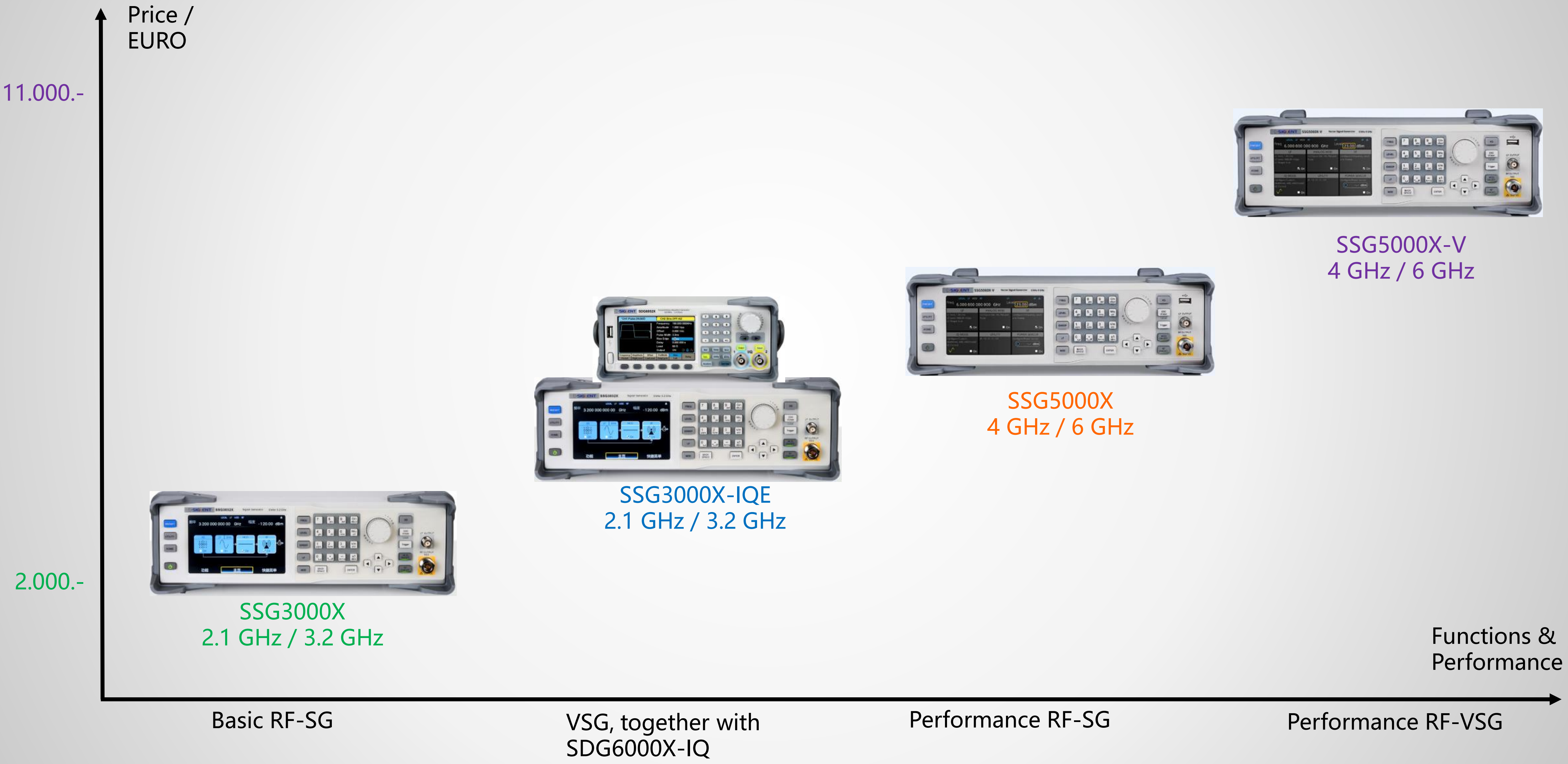
Add multi-channel signal propagation and reflections

e.g. LTE Receiver like Base Station or Mobile

Contents

Positioning / Pricing / Competitive Analysis

RF Signal Generator Positioning



Thank You

The Best Value in Electronic Test & Measurement

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