



Agilent RF/MW NPI Seminar

Stewart Forsyth

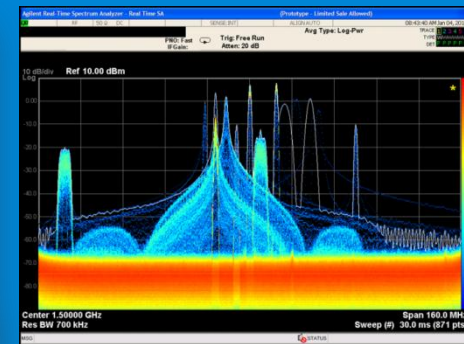
Microwave
Communications Division

Agenda

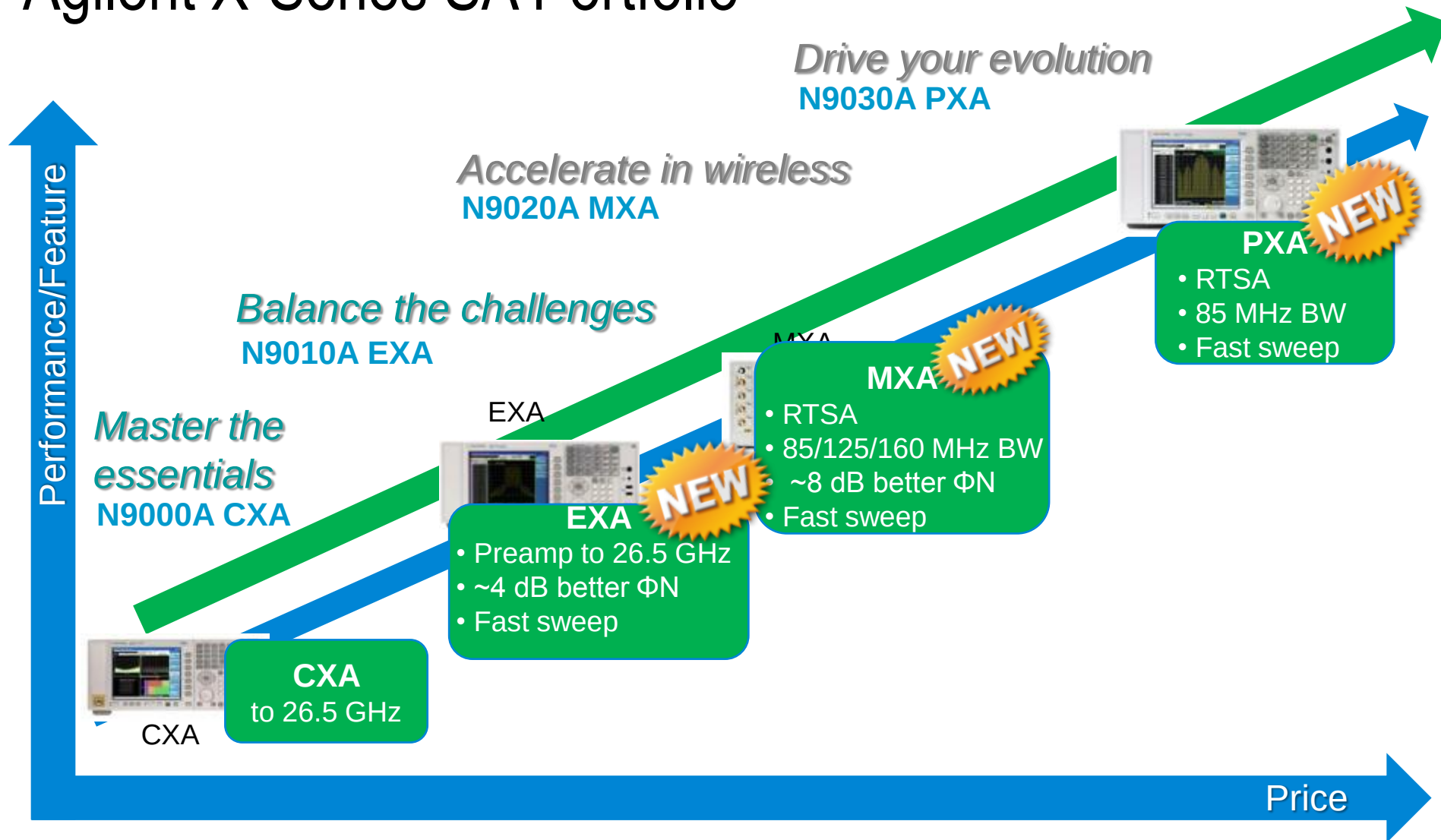
- Improvements to Mid Range Signal Analyzers
 - Phase Noise Improvements to EXA / MXA
 - Wider Bandwidth on MXA
 - Real Time Spectrum Analysis on MXA
 - Speed Improvements to EXA / MXA/ PXA
- Application Updates for Spectrum Analysis
 - N9079A Noise Figure Measurements
 - 89600B VSA Updates with version 17.0 & 17.2
- N9322C Basic Benchtop Spectrum Analyzer
- N9038A MXE EMI Receiver Enhancements
- mmWave Extensions for Signal Generation & Analysis to 1THz
- Update on GNSS solutions – GLONASS
- New Microwave N5173B / N5183B MXG Signal Analyzers



Improvements to Mid Range Signal Analyzers



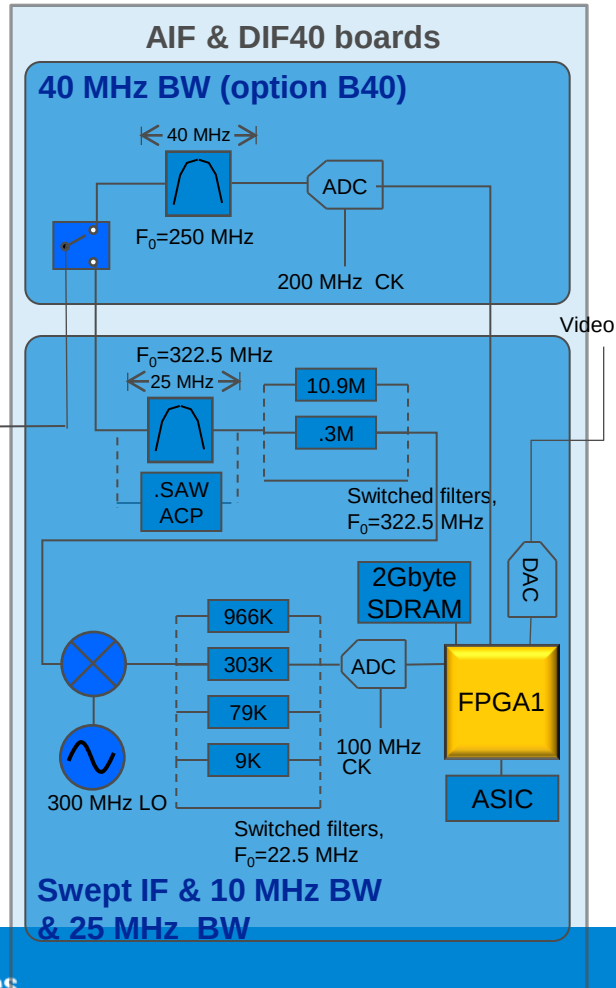
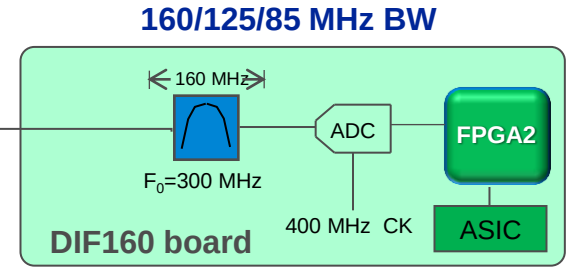
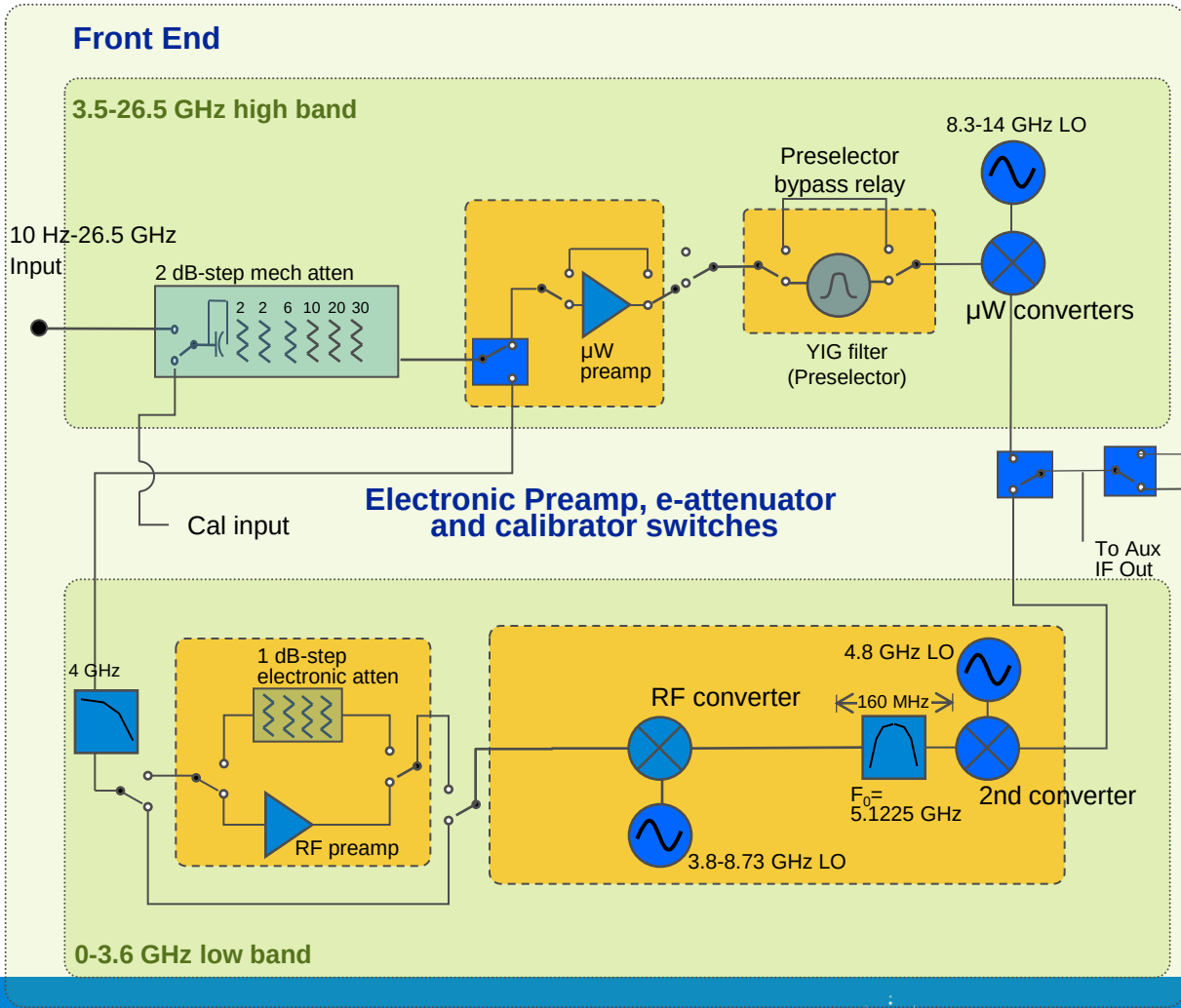
Agilent X-Series SA Portfolio



Simplified Block Diagram for MXA Front-End/BW



Option B85 (85 MHz), B1A (125 MHz), or B1X (160 MHz). The FPGA2 on the board is where the RTSA algorithm resides



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Customer challenges to increase data rates



N9020A



Industry trends

Increase complexity of transmission scheme

Solution example

From single carrier to multi-subcarriers (e.g., OFDM)

Customer challenges

Better PN to ensure the orthogonality

How the NEW MXA helps

Best-in-class PN performance to ensure best yield

Increase complexity of digital modulation

From lower order to higher order (e.g., 64-QAM to 256 QAM)

Lower EVM to minimize bit-error-rates

Best-in-class PN performance to ensure best yield

Increase channel bandwidth

From 20, 40 MHz to 85, 160 MHz

Requires instruments with wider BW

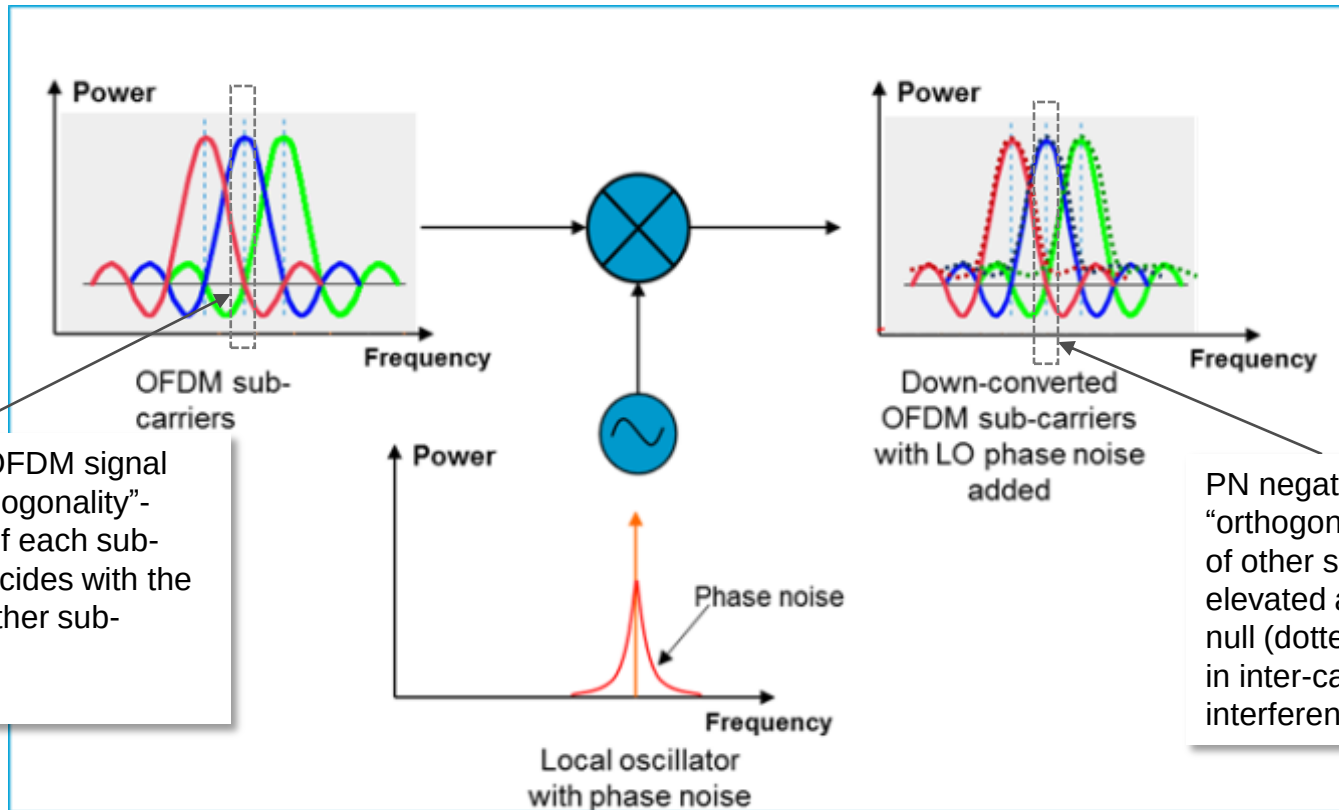
Best-in-class wide analysis BW covering up to 26.5GHz



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Why does phase noise (PN) matter?

Example for OFDM (Orthogonal Frequency Divisional Multiplexing)



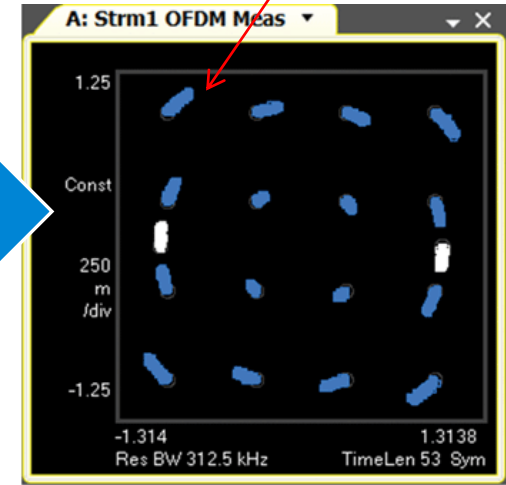
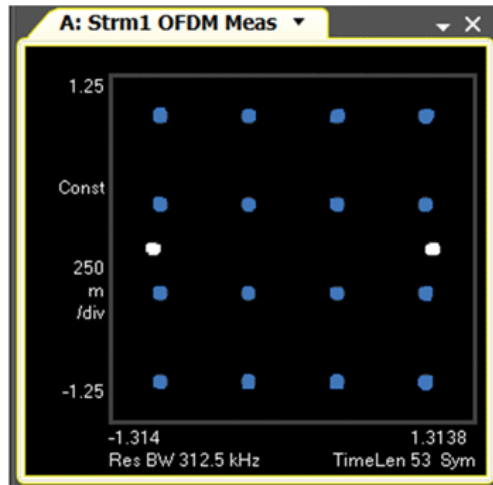
The ideal OFDM signal keeps “orthogonality”- The peak of each sub-carrier coincides with the trough of other sub-carriers

PN negatively affects the “orthogonality”: the trough of other sub-carriers is elevated and no longer at null (dotted line), resulting in inter-carrier interference.

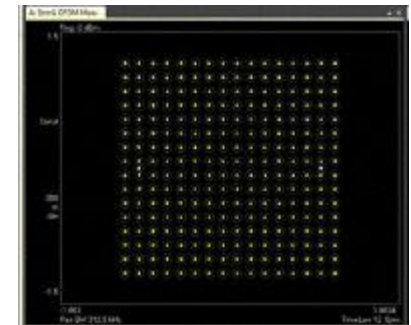


Better PN helps minimizing EVM

Example for 16-QAM modulation



- PN contributes to poor EVM
- Higher modulation order (e.g., 256 QAM) requires lower PN
- NEW MXA's enhanced PN performance helps designers to get the best EVM for their wireless devices



256 QAM modulation allows much smaller spacing for EVM degradation



NEW MXA's phase noise enhancement

N9020A MXA



- Modernized LO assembly (redesign)
- Most enhancements @ close-in/pedestal regions
 - Up to 11 dB improvement
- Identifier: **N9020A-EP2**
 - Ship standard on new products
 - FW rev. $\geq$ A.13 required
 - Not upgradable
 - Trade-in recommended

MXA PN specs comparison (NEW and Legacy)

Offset	NEW *	Legacy	Improve- ment
100 Hz	-91 dBc/Hz	-84 dBc/Hz	7 dB
1 kHz	-112 dBc/Hz (nom.)	-101 dBc/Hz (nom.)	11 dB
10 kHz	-113 dBc/Hz	-103 dBc/Hz	10 dB
100 kHz	-116 dBc/Hz	-115 dBc/Hz	1 dB
1 MHz	-135 dBc/Hz	-135 dBc/Hz	0 dB
10 MHz	-148 dBc/Hz (nom.)	-148 dBc/Hz (nom.)	0 dB



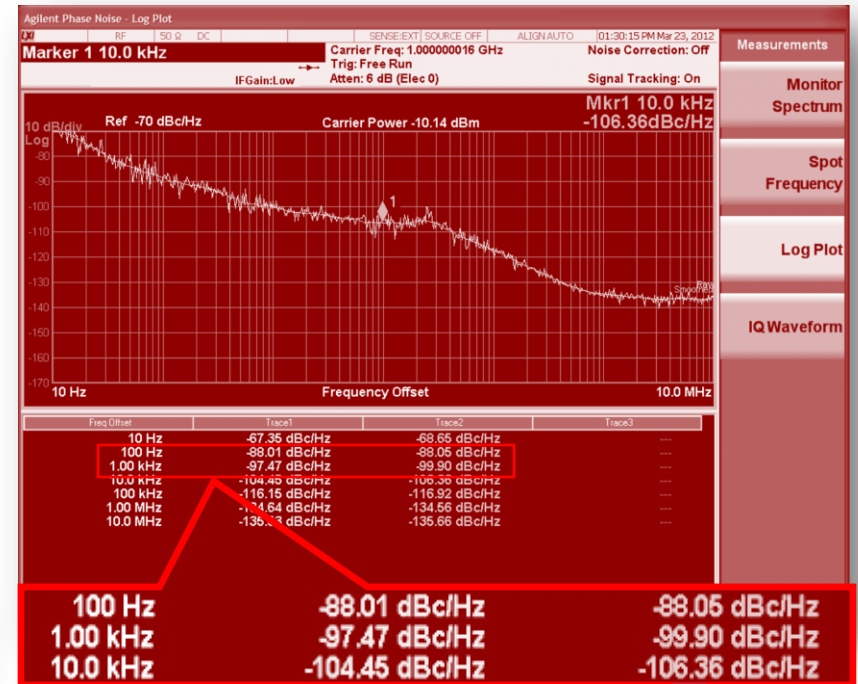
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How much better PN compared to legacy MXA?

MXA (NEW)



MXA (Legacy)



Most significant phase noise enhancements @ close-in & pedestal region

- Measured results: ~10 dB or more improvement
- Beneficial to LTE (OFDM) customers and radar/EW customers



EXA's enhanced phase noise

N9010A EXA



- HW change + FPGA code optimization
- Most enhancement @ pedestal regions and far-out
 - ~4 dB PN improvement
- Identifier: **N9010A-EP3**
 - Ship standard on new products
 - FW rev. $\geq$ A.13 required
 - Not upgradable
 - Trade-in recommended

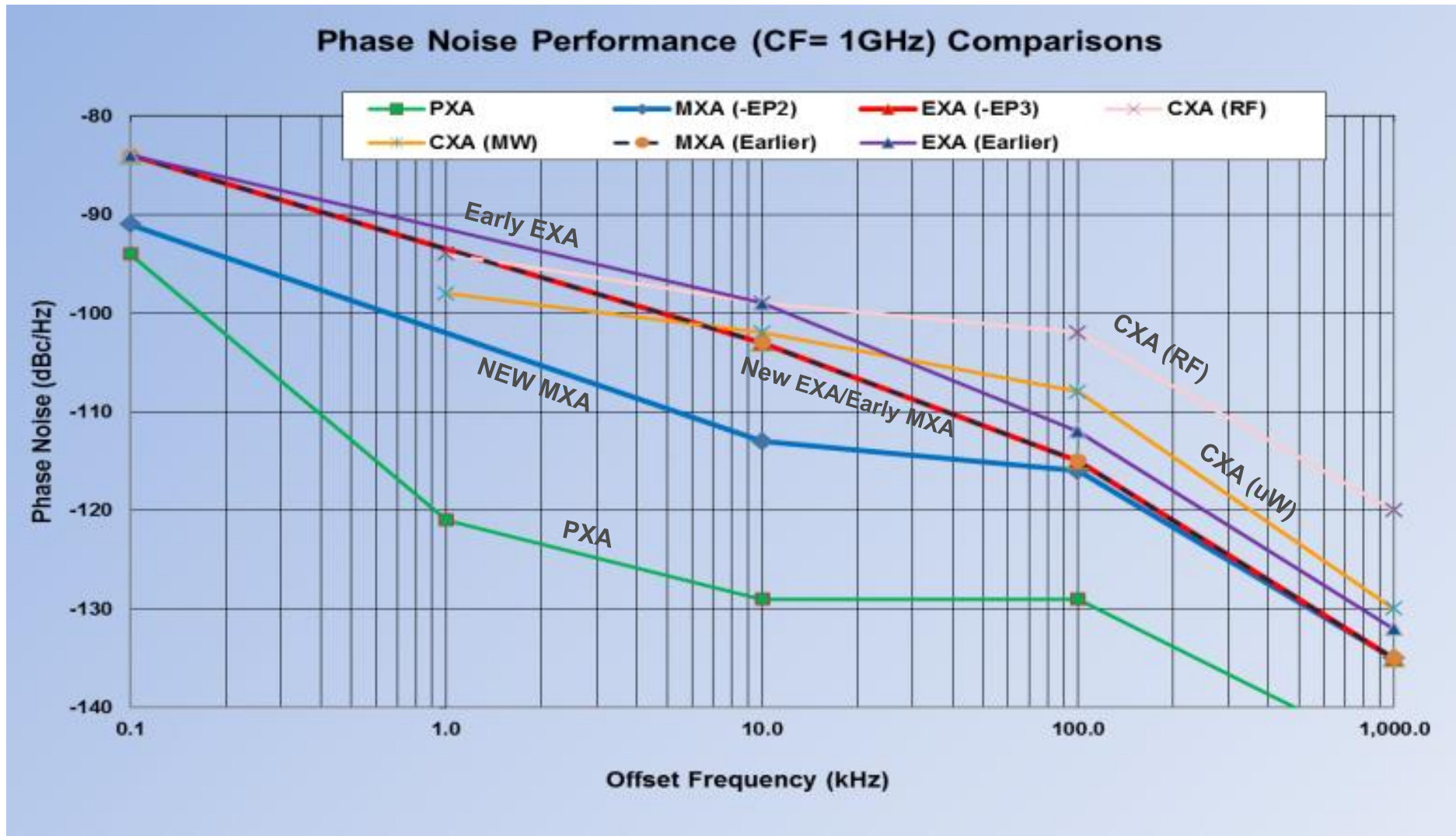
EXA PN specs comparison (NEW and Legacy)

Offset	New EXA (-EP3)*	Legacy (non -EP3)	Delta
100 Hz	-84 dBc/Hz	-84 dBc/Hz	0 dB
1 kHz	-98 dBc/Hz (nom.)	-98 dBc/Hz (nom.)	0 dB
10 kHz	-103 dBc/Hz	-99 dBc/Hz	4 dB
100 kHz	-115 dBc/Hz	-112 dBc/Hz	3 dB
1 MHz	-135 dBc/Hz	-132 dBc/Hz	3 dB
10 MHz	-148 dBc/Hz (nom.)	-143 dBc/Hz (nom.)	5 dB

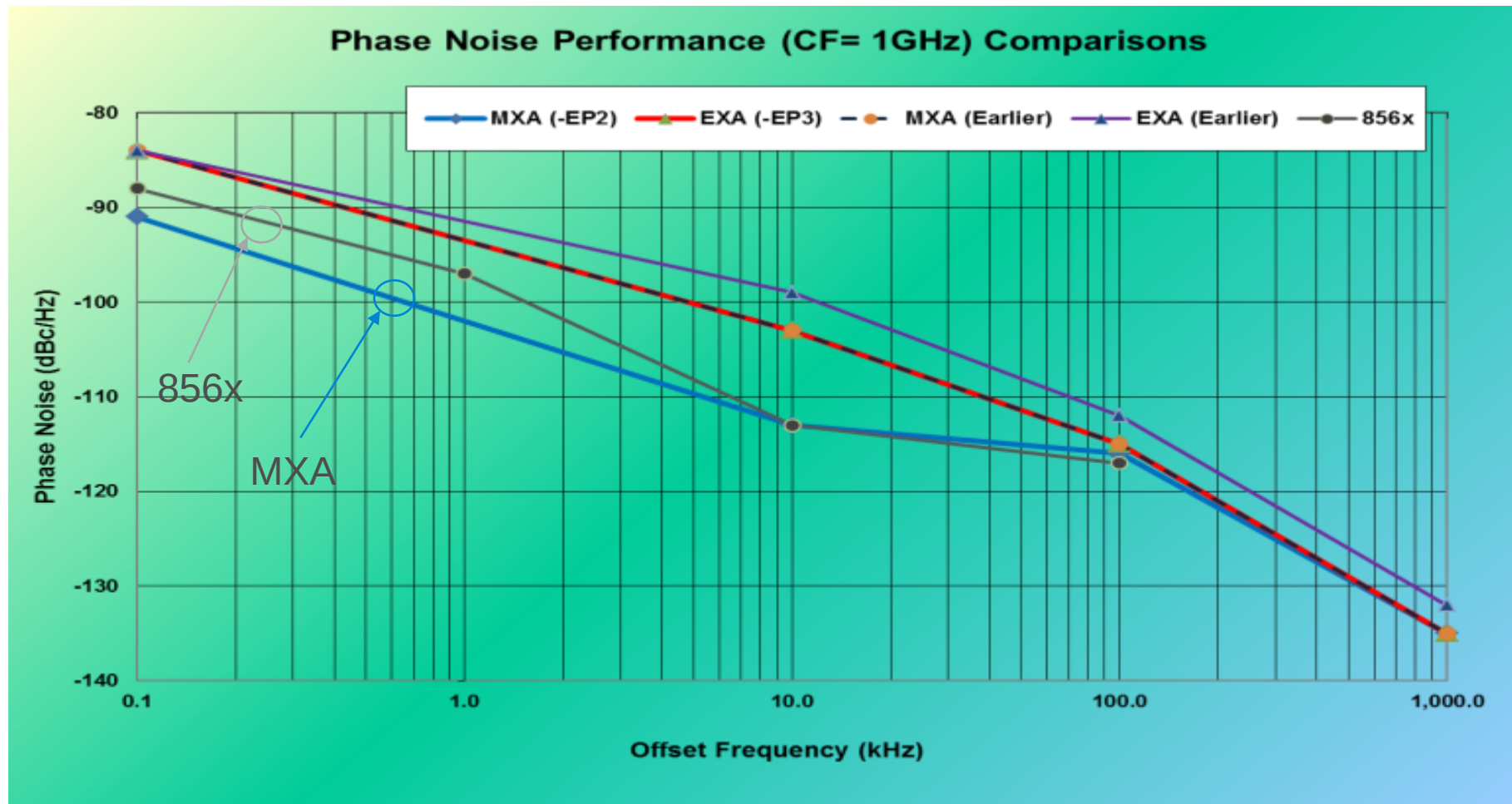


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X-Series PN comparisons



New MXA's PN exceeds 856x's!



856x (RF/uM):
Out of support
Sept 1, 2014)



Migrate



N9020A
MXA



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Maximize dynamic range on M/EXA

Improvement in TOI specifications

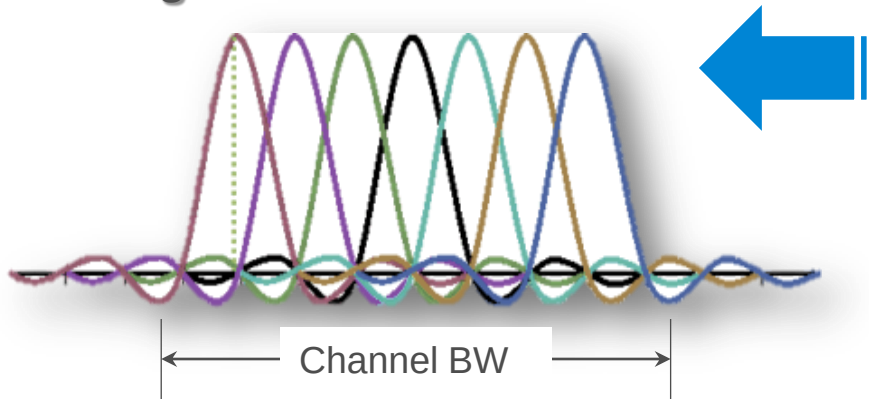
- Improved MXA high-band (13.6 to 26.5 GHz) TOI by ~5 dB
 - From +10 dBm (+14 dBm typ.) to +15 dBm (+18 dBm typ.)
- Improved EXA TOI across multiple bands
 - Coupled with N9010A Phase Noise Improvement
 - TOI comparisons between New EXA and legacy EXA:

Frequency	New EXA, typical TOI	Legacy, typical TOI	Delta
100 - 400 MHz	+17 dBm	+14 dBm	3 dB
0.4 - 1.7 GHz	+18 dBm	+15 dBm	3 dB
1.7 - 7.0 GHz	+18 dBm	+17 dBm	1 dB
7.0 - 13.6 GHz	+18 dBm	+15 dBm	3 dB
13.6 - 26.5 GHz	+16 dBm	+14 dBm	2 dB



Why wider analysis bandwidth?

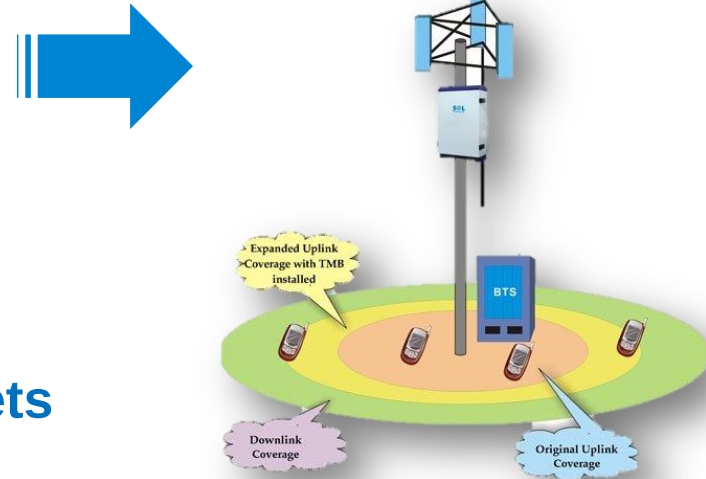
Get higher data rates!



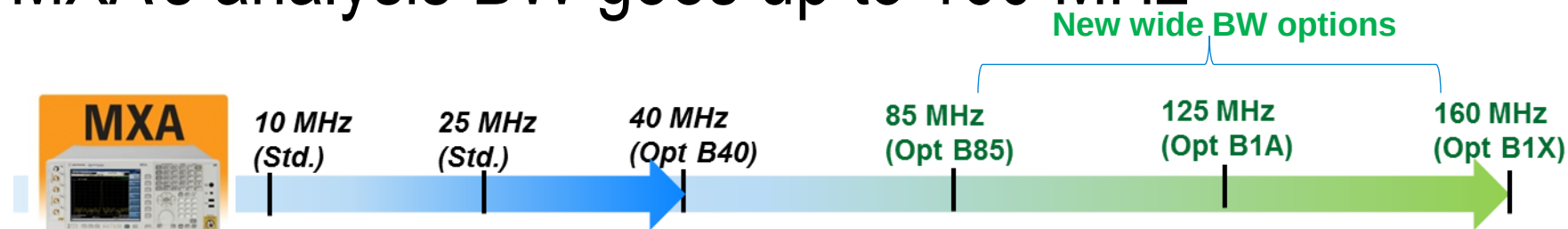
- Wider channel BW allows larger number of sub-carriers
- Channel BW options include:
 - 20 MHz
 - 40 MHz (or 20+20 MHz)
 - 80 MHz (or 40+40 MHz)
 - 160 MHz

- multi-channel power amplifier
- Larger channel number requires wider analysis BW

MXA w/ 160 MHz analysis BW meets increasing BW demands



MXA's analysis BW goes up to 160 MHz



Ready for the next-generation wireless standards such as 802.11ac, LTE-Advanced

Excellent IF performance all the way to 26.5 GHz frequency coverage

Supported by

- 89600 VSA and N9064A VXA measurement application
- Other wireless comms/connectivity apps, such as N9077A WLAN measurement application
- Real-time spectrum analyzer



Upgradable to existing MXA's

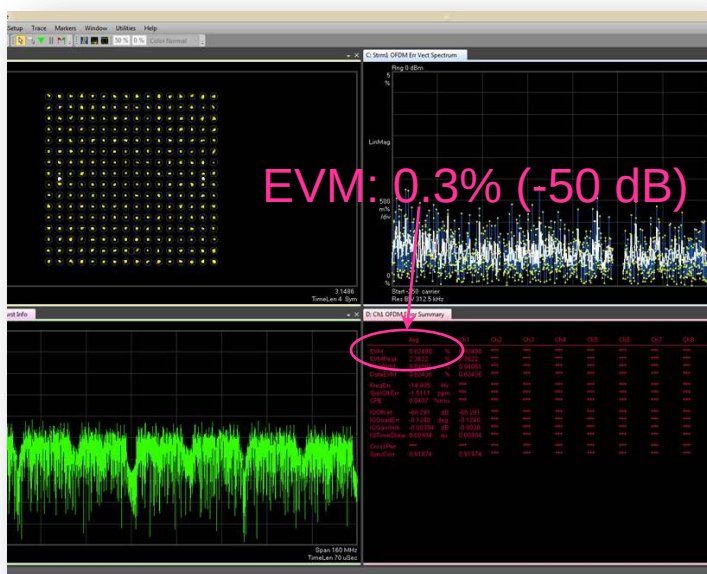
Not compatible with analog baseband IQ input (Opt BBA)



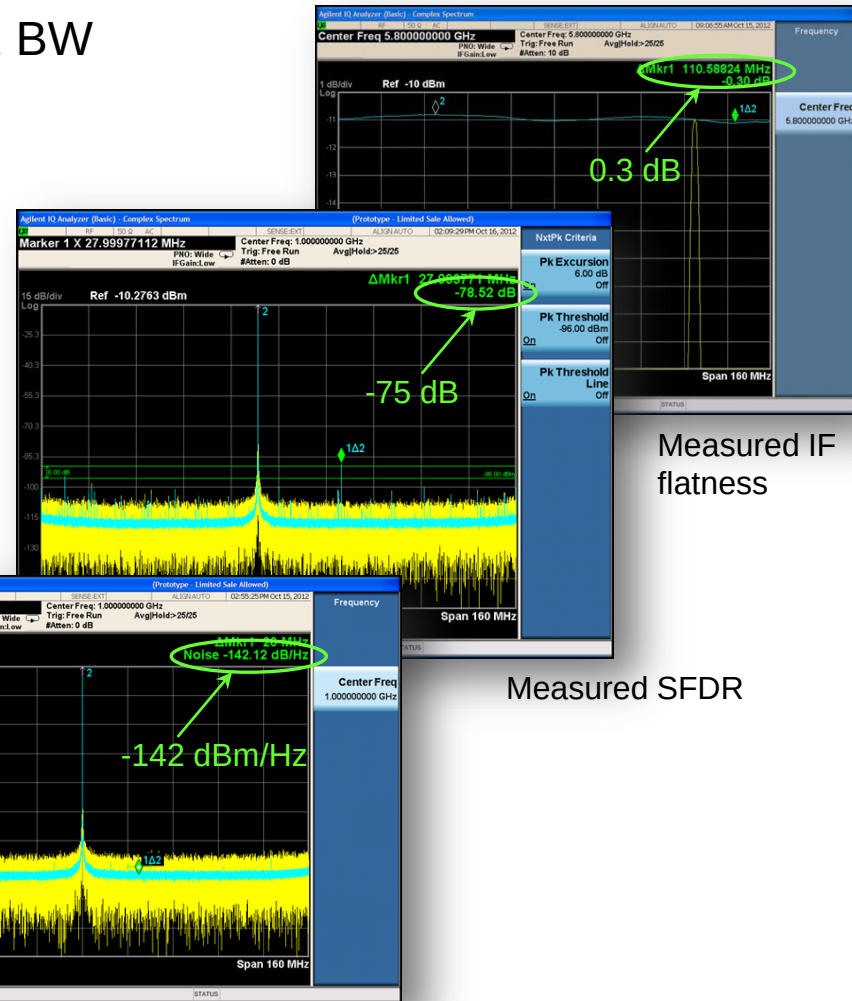
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Excellent wideband IF performance to 26.5 GHz

- Flat IF frequency response across 160 MHz BW
- Wide spurious-free dynamic range (SFDR)
- High signal-to-noise ratio (SNR)
- Exceptionally low EVM for 802.11ac demod



Measured EVM for 802.11ac demod: 0.3% (w/ equalizer training set to preamble + data)



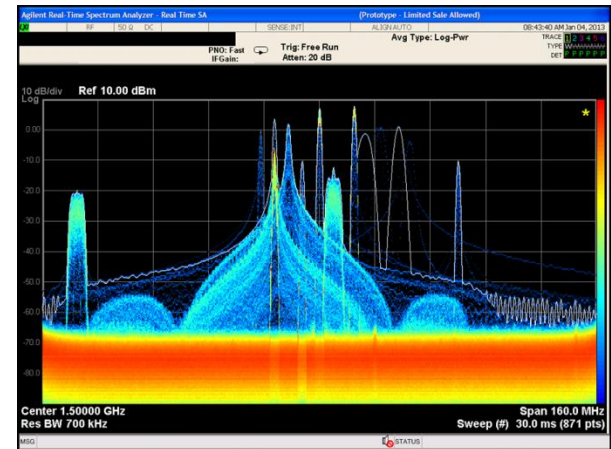
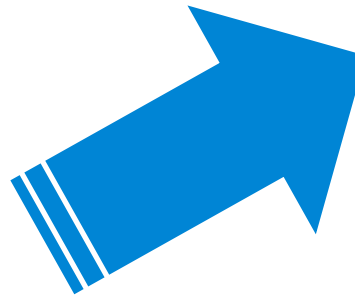
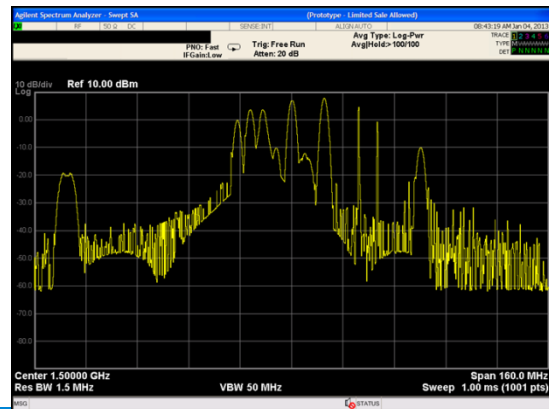
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Why “real-time spectrum analyzer (RTSA)”?



- Evolving technologies in cellular communications and wireless connectivity bring new challenges to customers
- RTSA helps to see better in following signals
 - Time-varying spectral schemes
 - Multi-standard radio switching
 - Burst transmissions
 - Frequency hopping
 - Elusive interference
 - Transient signals

Traditional spectrum analysis



Real-time spectrum analysis
tells you much more!



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Real-Time Spectrum Analysis on MXA

See, capture and understand the most elusive signals

Key features

Detect signals with durations as short as **3.57 μ s** with 100% POI

- Use Frequency Mask Triggering (FMT) to identify or record culprit signals - *standard*

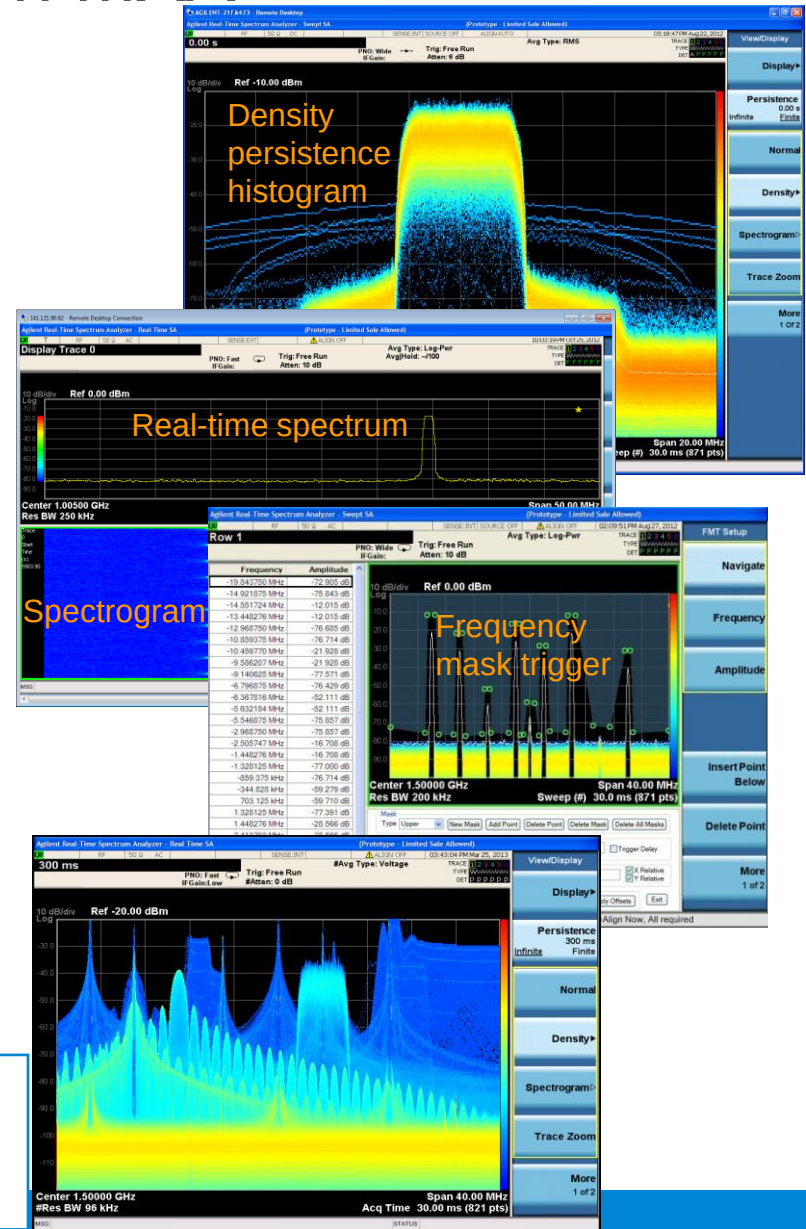
Scan wide spans of spectrum with up to **160-MHz real-time bandwidth**

- License-only upgradable RTSA on MXA with wide BW option (85 MHz or above)
- 30-day free trial license

Eliminate need for a specialized/dedicated instrument by adding real-time capabilities to the MXA

Requires wide analysis BW option (85 MHz or above)

A live environment with number of CW, pulses and W-CDMA signals



Fast sweep capability (Opt FS1) on PXA/MXA/EXA

Over 50x sweep speed improvement

- Wide frequency span – find spurs across all frequencies
- Narrow RBW – find spurs at low power level
- Fast sweep – find spurs within a reasonable time period



“Top 10 things in measurements are SPEED” – a customer quote

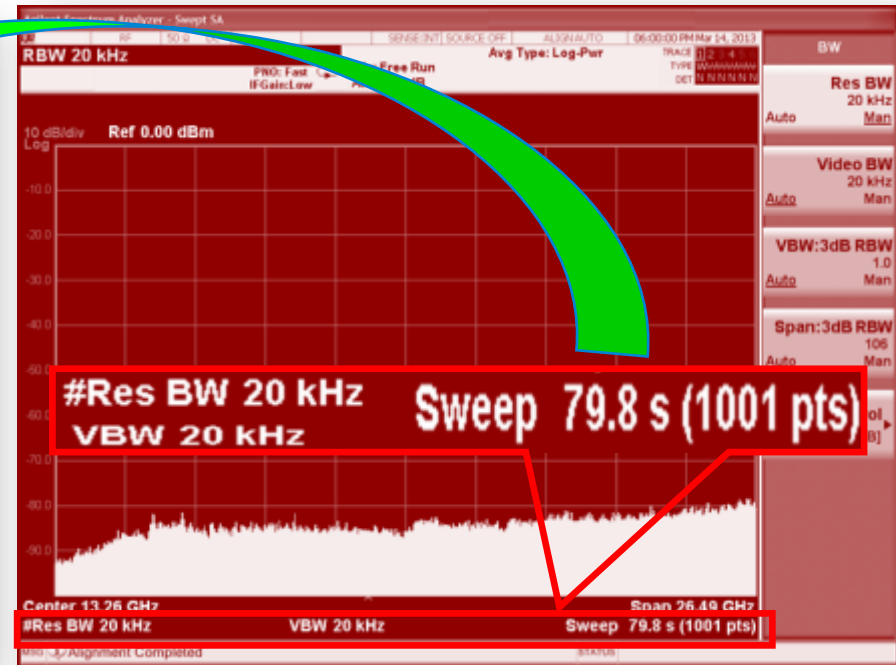
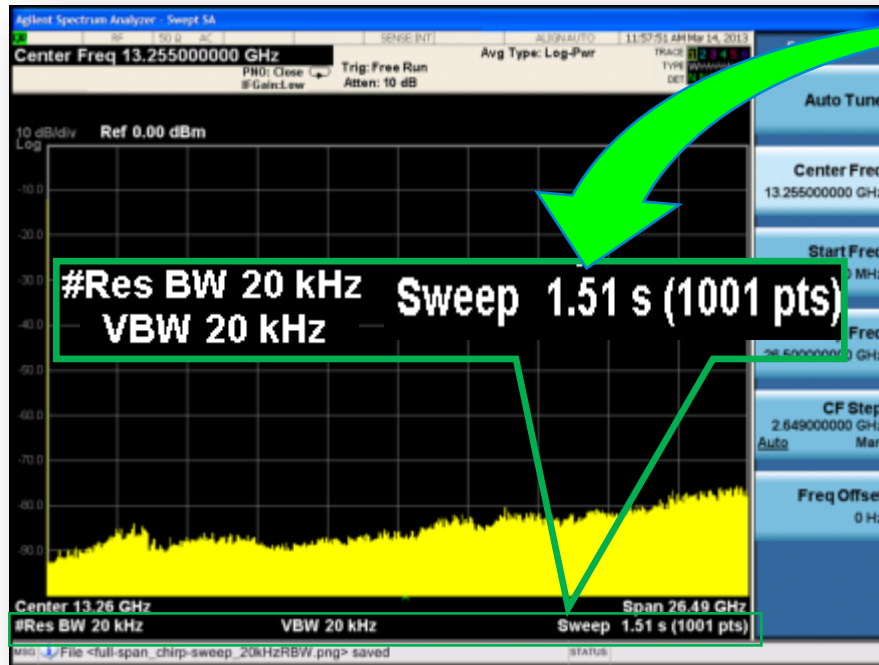
Now, we are ~5x faster than the competitor!



Over 50x faster compared to legacy P/M/EXA



P/M/EXA (w/ B40 or DP2, fw rev $\geq$ A.13) **Legacy P/M/EXA (fw rev $<$ A.13)**



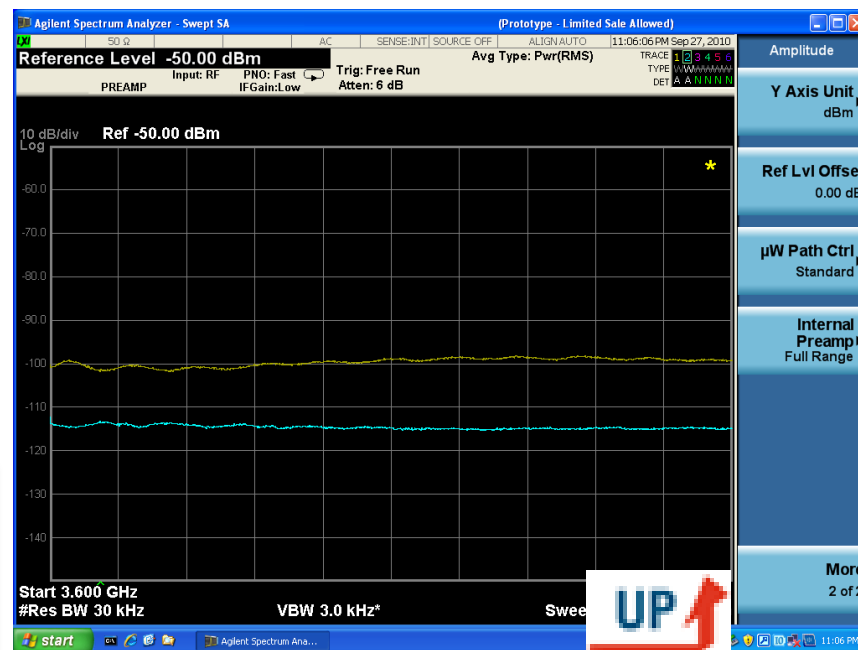
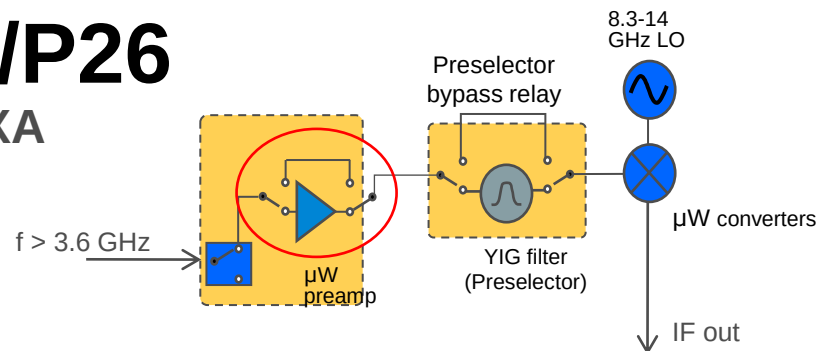
- Fast sweep capability shipped standard on P/M/EXA w/Opt B40 or DP2 & fw $\geq$ A.13
- Measured results shown 53x faster sweep (@26.5 GHz full span w/ 20 kHz RBW)
 - 1.5 seconds w/ fast sweep capability vs. 79.8 second without
- License key upgradable if the M/EXA has Option, B40, DP2, or MPB, or MXA w/ B85/B1A/B1X installed. All PXA units can be upgraded



EXA Option N9010A-P13/P26

13.6 and 26.5 GHz Preamplifier added on EXA

- Frequency range:
 - 100 kHz – 13.6 GHz
 - 100 kHz – 26.5 GHz
- License key upgradable
- Introduced: Jun 1, 2013



**UP
GRADE**

Option	Features
N9010A/AK-P13	Preamp, 13.6 GHz
N9010A/AK -P26	Preamp, 26.5 GHz



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New enhancements on MXA

Re-Defining the Mid-Range Signal Analyzers

- Best-in-class phase noise performance
- Widest analysis bandwidth, covering carriers up to 26.5 GHz
- Industry's only upgradable real-time spectrum analysis (RTSA) capability



New enhancements on EXA

Balance the Challenges

- Improved phase noise and TOI performance
- Enhanced microwave sensitivity by adding optional 13.6/26.6 GHz preamps
- Fast sweep capability with select options (B40, DP2, or MPB)

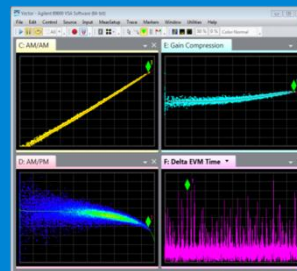




Application Updates for Signal Analyzers

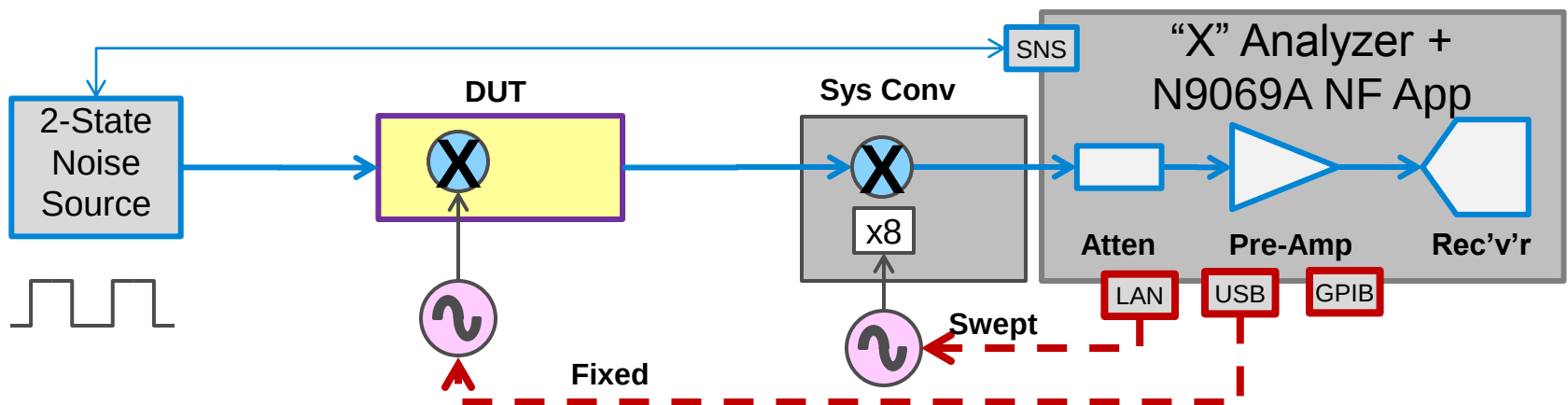
N9079A Noise Figure Application

89600B VSA Software



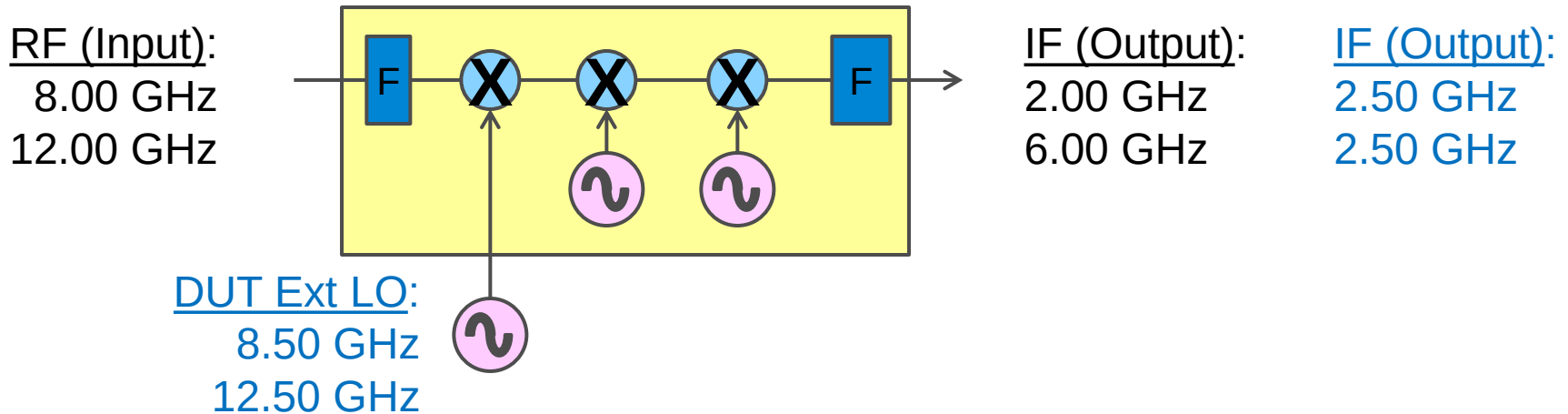
Enhanced LO Control in N9069A Noise Figure

- ✓Formally supports **all I/O types** (GPIB, LAN, USB, USB-GPIB).
- ✓Supports “smart” source discovery (e.g. can “scan” GPIB for a source).
- ✓Supports both **DUT** Ext LO **and** a **Sys Conv** Ext LO. Each can be Upper- or Lower-SideBand. Each can be Fixed or Swept (but not both Swept).



Generic “Converter” DUT in N9069A Noise Figure

✓New generic “**Converter**” DUT type (in addition to Amplifier, Up-Conv, & Down-Conv). Handles multi-stage converters with any “frequency plan”, suppresses error checking.



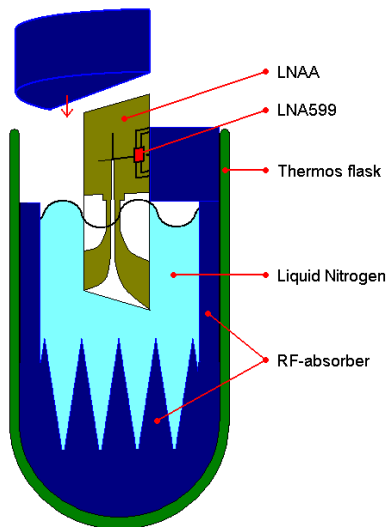
- User describes start-stop frequency pair for input and output only; user does not describe each stage's LO, up- or down-conv, USB vs LSB, etc.
- One DUT stage may have Ext LO controlled by app, and swept.
- Pre-existing Up-Conv and Down-Conv can still be used for 1-stage DUTs.



“Manual” Measurement in N9069A Noise Figure

✓“Manual” measurement algorithm, where the Noise Source state is not under control of app:

- Temperature control of noise source is **s-l-o-w** (mechanical, thermal).
- Hot and cold noise sources are **physically separate** and connected sequentially.
- Radio-telescope receivers are tested with antenna and LNA combined (G/T). Hot & cold standards are in *free space* (e.g. sun & empty sky), change by **antenna pointing** (slow).
- Custom noise sources** that won’t accept normal control signals.



Hot =
Room

Cold =
Liq N2

Normal Algorithm	Manual Algorithm
1: Cal 2: Meas	1: Cal 2: Meas
For Each Freq	Prompt User to Set NS to Hot , <u>Pause</u>
Switch NS to Hot	For Each Freq
Measure Power A	Measure Power A
Switch NS to Cold	Next Freq
Measure Power B	Prompt User to Set NS to Cold , <u>Pause</u>
Next Freq	For Each Freq
Display Results, Repeat if Cont	Measure Power B
	Next Freq
	Display Results, <u>Pause</u> (Single)

- “Manual” algorithm Pause for user to change temperature; and nests the **Freq** loops inside.



89600 VSA Software –Agilent's Industry-Leading Vector Signal Analysis Software

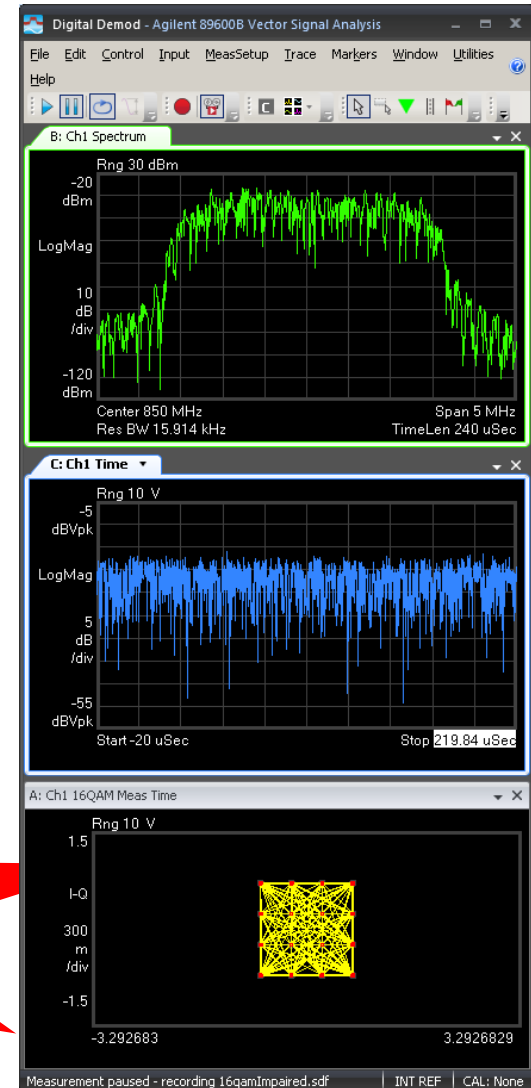
Definition: Vector signal analyzer (VSA) - Any software or instrument designed to test a signal's spectrum, and modulation, and time characteristics by analyzing both the signal's magnitude and phase.

Unparalleled in analysis flexibility, depth and breadth.

- Supports >70 signal standards and modulation types
- Advanced evaluation and troubleshooting tools
- Works with >30 models hardware (embedded or on external PC)

agilent.com/find/89600_trial

**FREE
30 DAY
TRIAL**



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What's New in 89600B Version 17 & 17.2

- Complex stimulus-response measurements
- Real-time signal analyzer support
- Enhanced WLA for LTE FDD
- New Wi-SUN Analysis



Agilent 89600B Vector Signal Analyzer Software

Premier Analysis software – See through the complexity

Mobile Communications



- LTE (FDD & TDD)
- W-CDMA / HSPA+
- TD-SCDMA
- GSM / EDGE Evo
- CDMA 2000/1xEV-DO
- Custom OFDM
- 4X4 MIMO

Wireless Connectivity



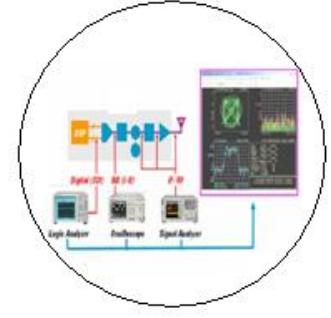
- WiMax
- WLAN (a/b/g/n/j)
- RFID
- UWB
- 4X4 MIMO

Aerospace Defense



- FSK, BPSK, QPSK
- QAM, StarQAM
- APSK
- AM, FM, PM
- Custom OFDM
- 4 channel

General Purpose



- Education (89600BSP-ED1/-ED2)
- System integrators

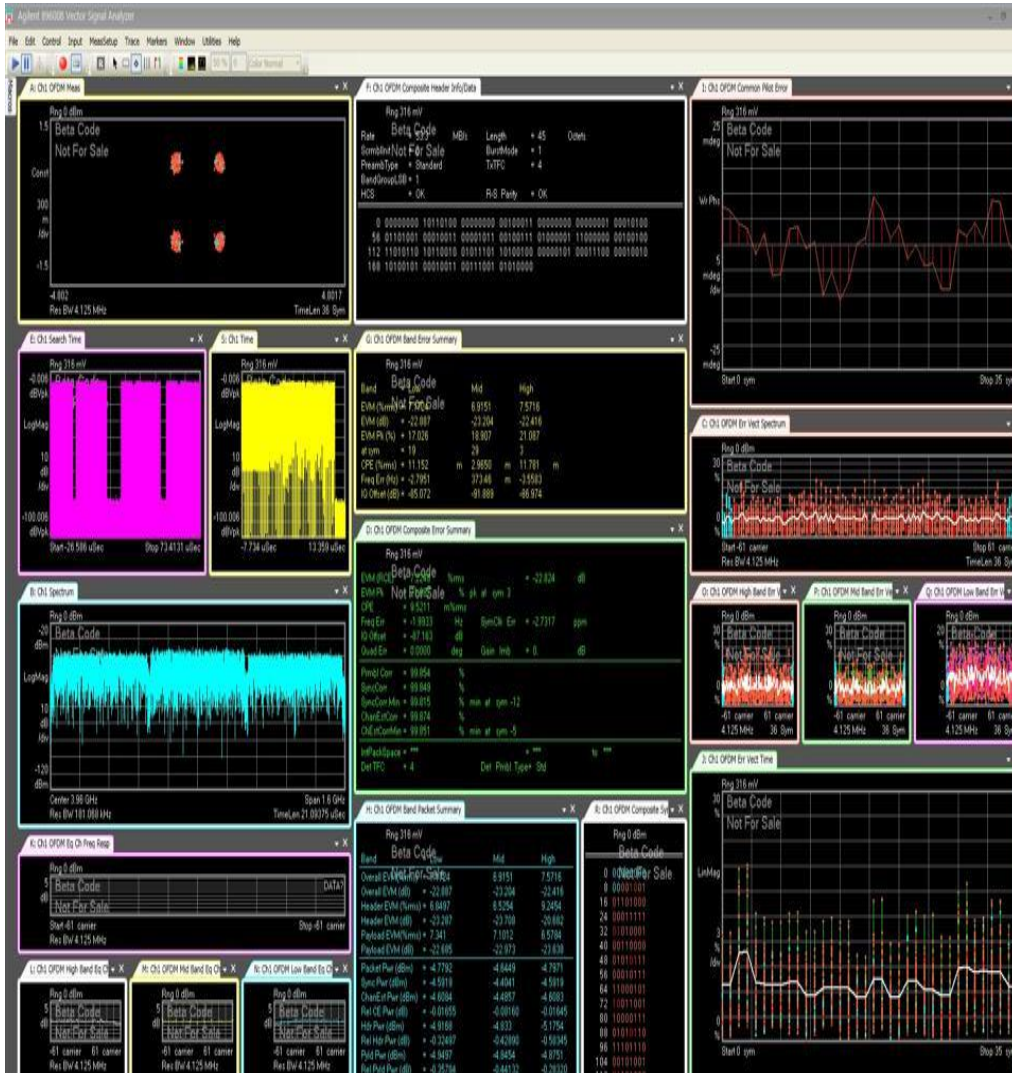


Signal formats: Supports >70 signal standards and modulation types

Cellular Communication Standards	
Opt BHG Opt BHH	LTE-Advanced TDD analysis LTE-Advanced FDD analysis
Opt BHE Opt BHD	LTE TDD analysis (MIMO) LTE FDD analysis (MIMO)
Opt B7T	cdma2000/1xEV-DV analysis
Opt B7U	WCDMA/HSPA+ analysis (MIMO)
Wireless Networking Standards	
Opt BHJ	802.11ac
Opt B7Z	802.11n WLAN MIMO
Opt B7R	802 a/b/g
Opt B7Y	WiMax mobile (MIMO)
Other Standards	
Opt BHB	MB-OFDM analysis
Opt BHC	RFID analysis
Opt BHA	TEDS
AND	AM/FM/PM analysis

Option AYA: Flexible modulation analysis	
Demodulators	Custom APSK,FSK: 2 to 16 & GFSK / CPM
	MSK (including GMSK) / BPSK
	QPSK , OQPSK, DQPSK, pi/4 DQPSK
	8PSK , D8PSK, 3pi/8 8PSK (EDGE), pi/8 D8PSK
	QAM: 16 to 1024, absolute encoding
	QAM: 16 to 256, differential encoding per DVB std
	Star QAM: 16, 32
	APSK: 16, 16w/DVB, 32, 32w/DVB
	VSB: 8, 16
Filter types	Raised cosine, sq rt cosine, IS-95 compatible, Gaussian, EDGE, low pass, rectangular
	User defined
	Adaptive equalizer
alpha/BT	Continuously adjustable: 0.05 to 10
Single button presets	
<i>Cell</i>	NADC, GSM, EDGE, EDGE E, CDMA (base), CDMA (mobile), CDPD, PDC, PHP(PHS)
<i>Wireless Net</i>	Bluetooth, HyperLan1(HBR & LBR), Zigbee (868MHz, 915MHz, 2450MHz)
<i>Digital Video</i>	DTV (8, 16)
	DVB (16, 32, 64)





UNLIMITED trace/marker capability
More flexible GUI

Unlimited traces

- Signals getting more complex, view every facet, today & tomorrow**

Unlimited markers/trace

- **Evaluate signal performance in detail**

Arbitrary arrangement

- **See *patterns, engineering insight***

Arbitrary sizing

- **Get more data from displays**

Arbitrary assignment

- ***“Any-trace-any-measurement”, today & tomorrow***

Complex Stimulus-Response Measurements

New Graph trace type plots one signal vs. another

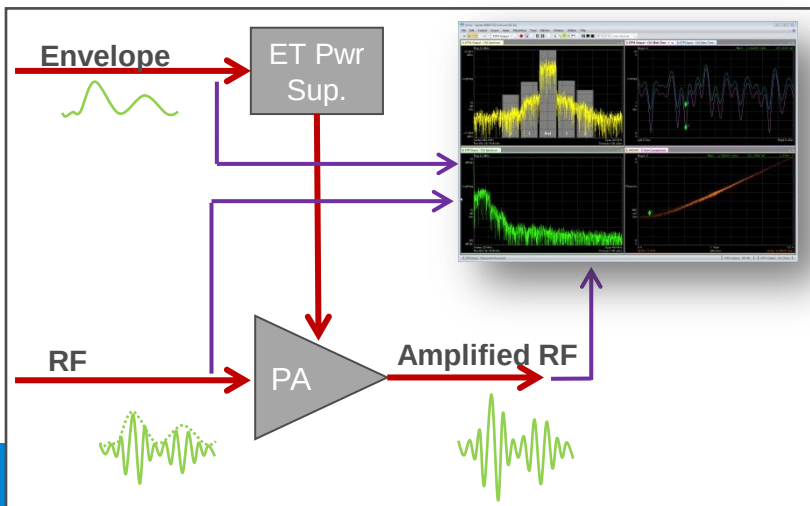
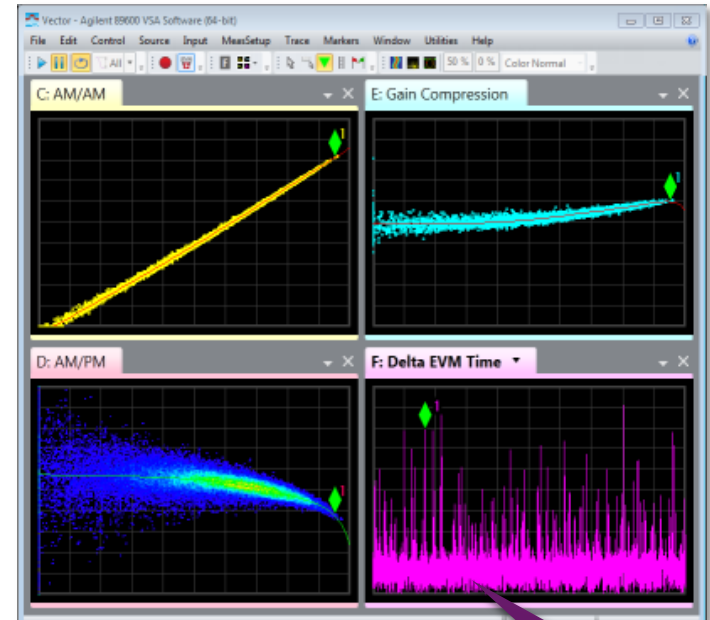
- Distortion measurements (AM/AM, AM/PM, gain compression) with realistic signals

Automatic compensation for timing, amplitude and phase, even between baseband & RF

- Easy setup and analysis, even for envelope tracking

Flexible hardware support for signal acquisition

- Hardware configuration to meet budget and performance requirements



Customer Applications

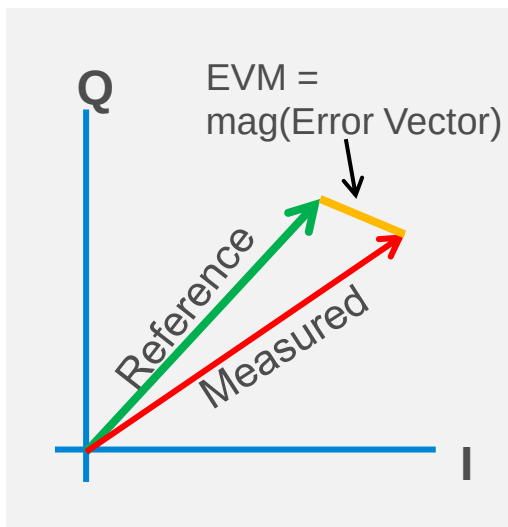
- PA distortion measurements
- Envelope tracking
- Comparing any 2 time-domain signals

Migrate
89604A

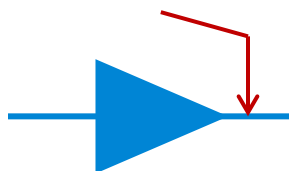


Complex Stimulus-Response Measurements

- **AM/AM** = $\text{mag}(\text{resp}(t))$ vs. $\text{mag}(\text{stim}(t))$
- **AM/PM** = $\text{phase}(\text{resp}(t))$ vs. $\text{mag}(\text{stim}(t))$
- **Gain Compression** = $\text{resp}(t)/\text{stim}(t)$ vs. $\text{mag}(\text{stim}(t))$
- **Differential (Δ , additive) EVM:**



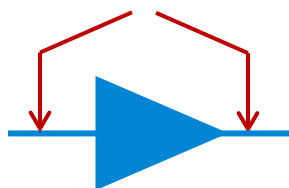
Standard EVM



One-port measurement, calculated:

- vs. ideal waveform
- at data symbols only
- after baseband filtering

Differential EVM



Two-port measurement, calculated:

- vs. input waveform
- at each waveform sample
- with no baseband filtering

Customers can characterize devices using complex modulated signals – especially important with wider bandwidth, high PAPR signals



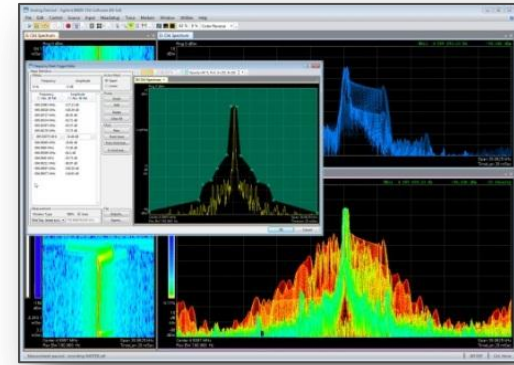
Support for Real-Time Signal Analyzers

Support for new MXA and PXA real-time signal analyzers

- Enables acquisition of signals from real-time hardware for in-depth analysis and demodulation

Frequency Mask Trigger (FMT) UI available directly within the software when connected to real-time MXA/PXA

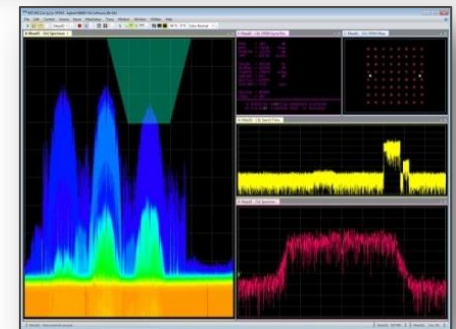
- Provides full configuration and execution of FMT to initiate single measurement or recording capture directly within the software



Applications

Fully analyze short-lived signals in dynamic spectral environment

- Demodulate & measure EVM in the presence of interfering signal
- Post-capture tune & zoom and adjustable overlap processing
- Download captured signal to signal generator for test stimulus



Enhanced WLA for LTE FDD

Simultaneous uplink and downlink analysis

- Enables full understanding of closed-loop UE/eNB interactions

Summary charts available directly within WLA software, dynamically linked to message log and VSA

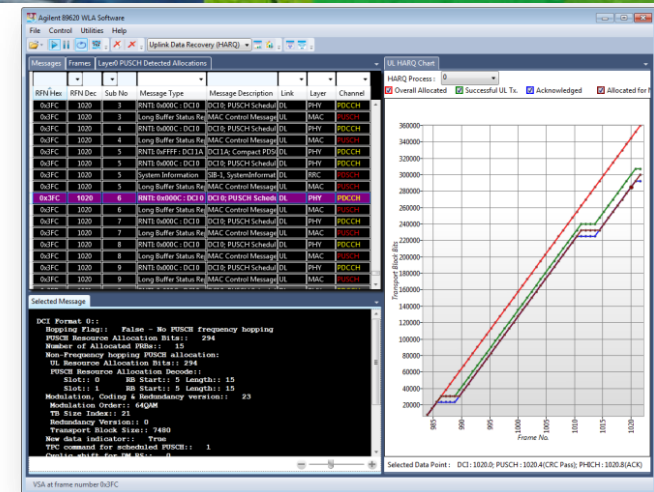
- Visualize key parameters like data throughput, UE power and timing loops and correlate to RF/PHY layer

Improved usability and built-in demo examples

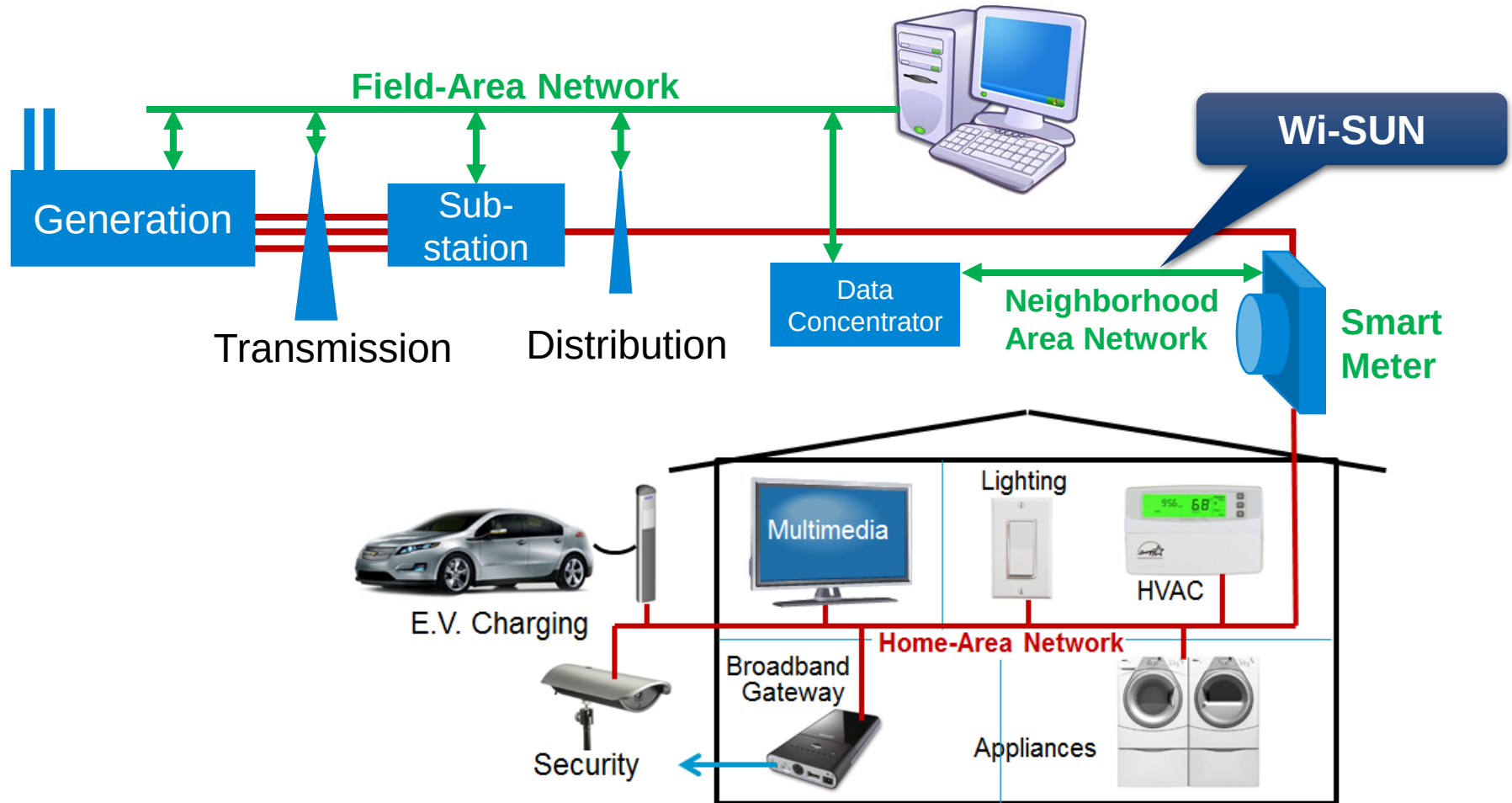
- Simplifies product demos and facilitates exploration and learning by customers

Applications

- Independent verification of “conversation” between UE/eNB/small cell
- Troubleshooting data throughput and connection issues
- Layer 2/3 message decoding & correlation to RF behavior



Smart Energy Systems Overview



New Wi-SUN Analysis Wireless Smart Utility Network Standard

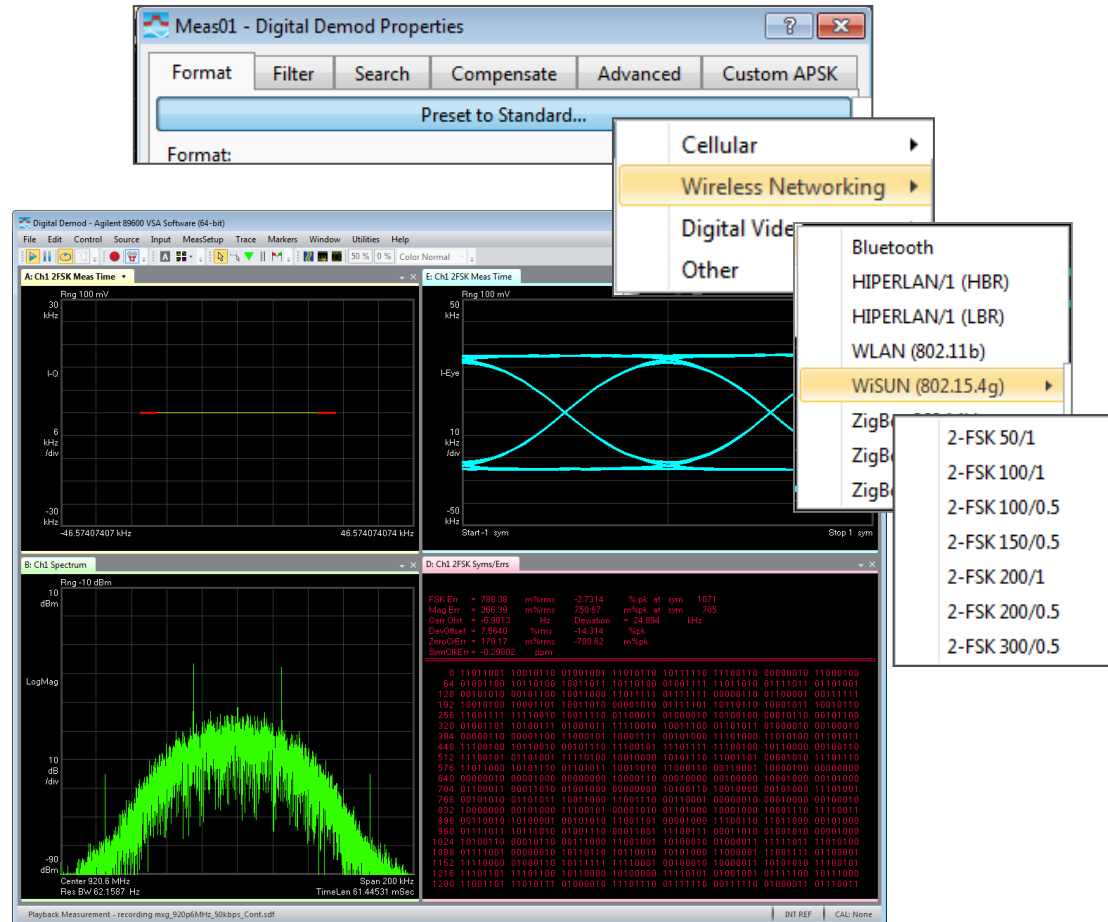
Based on IEEE
802.15.4g standard 2-
FSK mode

New standard presets for
Option AYA for Wi-SUN

Added results per the
standard for:

- Zero crossing error
- Deviation offset error
- Symbol clock error

Customer-validated





N9322C Benchtop Spectrum Analyzer 9kHz to 7GHz



Agilent Benchtop SA Portfolio Overview

Performance

Legacy

Price

X Platform

"P-Class"

PXA

"M-Class"

MXA

"E-Class"

EXA

CXA

"BSA family"

N9322C

N9320B

New

ESA-E

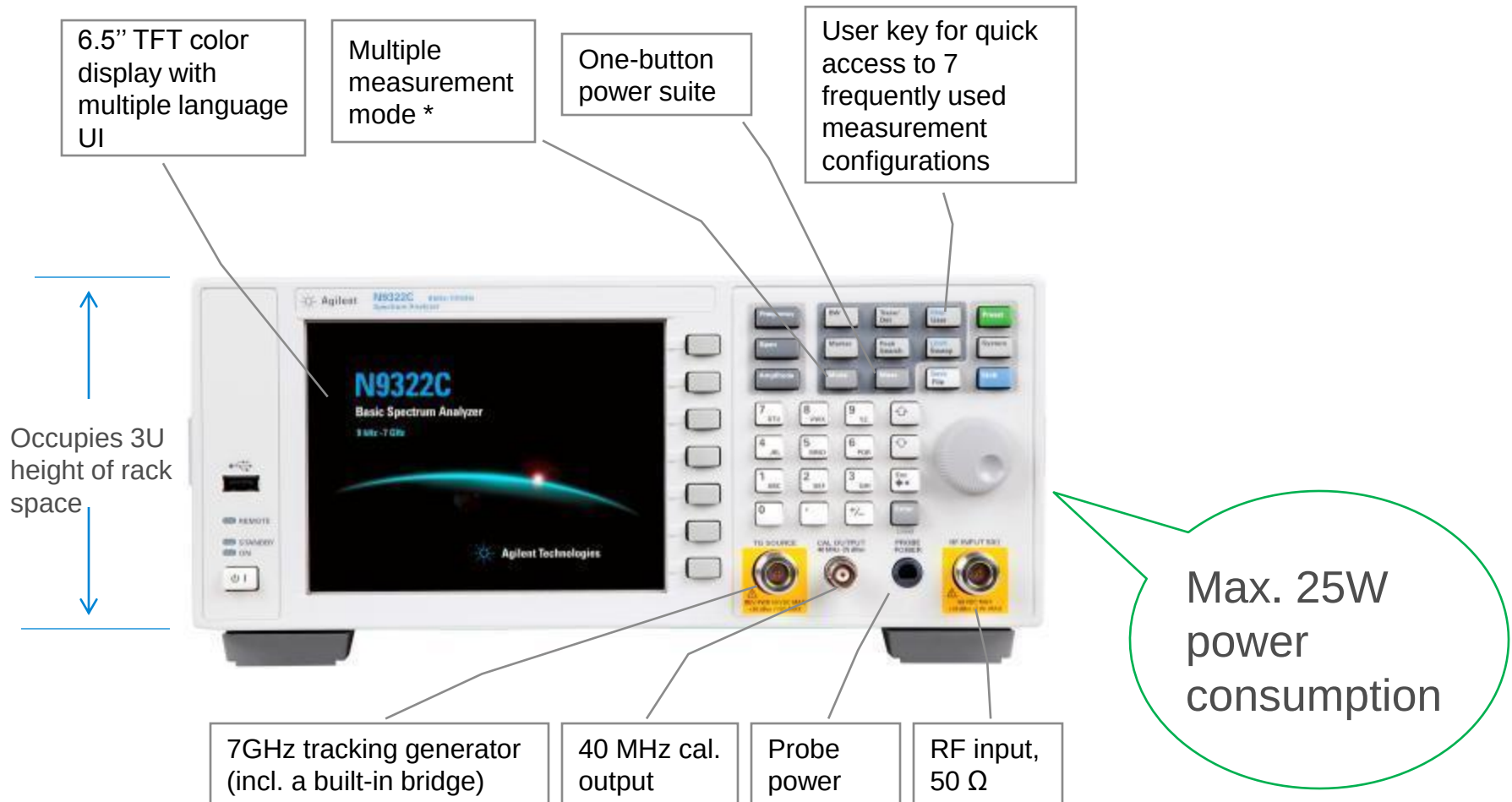
ESA-L

PSA

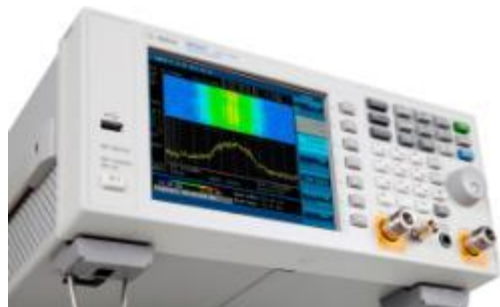


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Take a closer look...



Practical precision at a value price



Key Specifications

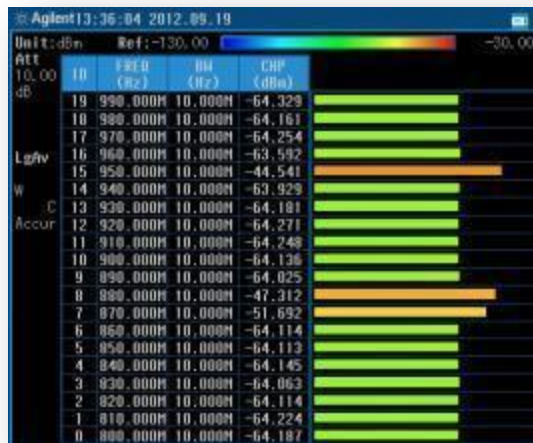
- Frequency range: 9 kHz to 7 GHz;
- Absolute amplitude accuracy: ± 0.3 dB (PA off); ± 0.4 dB (PA on)
- Frequency response (PA off): ± 0.7 dB ($F < 3$ GHz); 0.9 dB ($F > 3$ GHz)
- Displayed average noise level (PA on, 10 Hz RBW):
 - At 1 GHz: -152 dBm
 - At 4 GHz: -151 dBm
 - At 7 GHz: -144 dBm
- Resolution bandwidth: 10 Hz to 3 MHz
- Input attenuator: 50 dB range, in 1 dB steps
- TOI: +10 dBm
- Sweep speed: 2ms to 1000s (span > 100 Hz); 6 μ s to 1000s (span = 0 Hz)

General specifications:

- 5 ~ 45 °C operating temperature
- 25 W nominal power consumption
- 7.6 kg weight
- Dimension (H x W x D): 132.5 x 320 x 400 mm
- 1 year calibration cycle



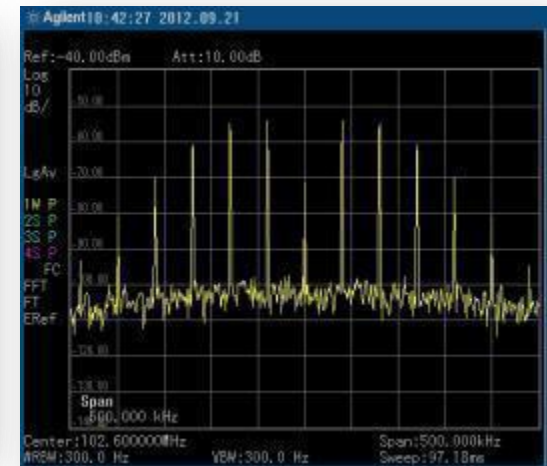
Value-added Measurement Features Inside



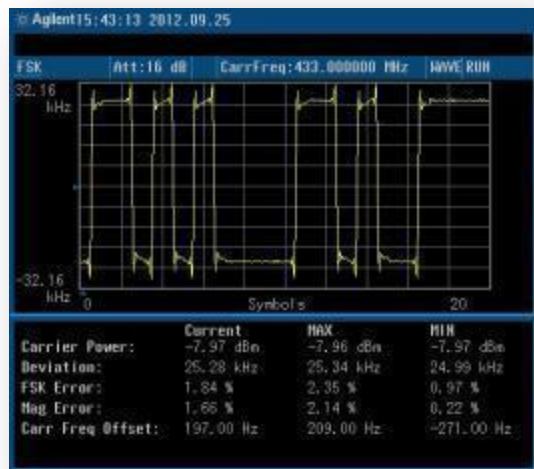
Channel scanner



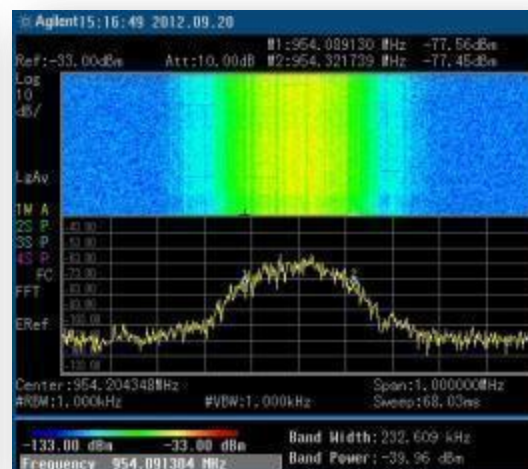
Task planner



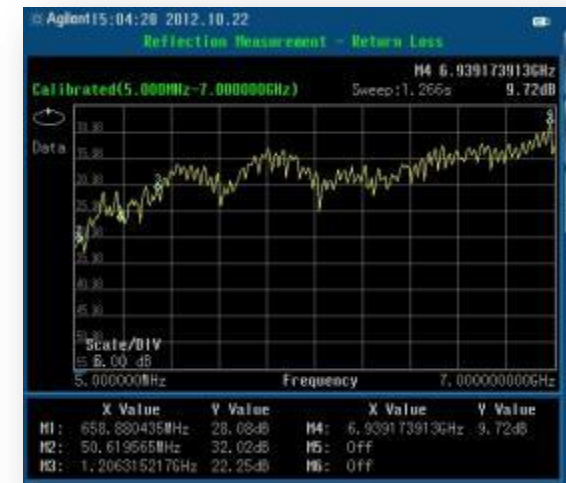
FM demodulation analysis



FSK demodulation analysis



Spectrogram



(1-port) Return loss measurement



N9322C BSA Spectrum Analyzer Enhancements



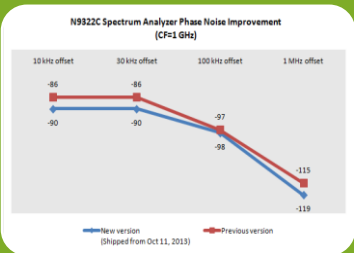
Trial License Available

- Apply from Agilent ASM website from Nov, 2013
- Available in option: AMA, DMA, SCN, RM7, MNT, TMG, TPN
- Supported by **F/W revision A.04.41** onward



User key extension

- Extended from 7 to 18 user definable softkeys
- Provides quick access to frequently-used measurement setups
- Available from **F/W revision A.04.41** onward



Phase noise Improvement

- 1 dB improvement at 10 kHz, 100 kHz offset, 4 dB improvement at 1 MHz offset
- Supported by **F/W revision A.04.41** onward



Latest Feature Updates for the N9038A MXE EMI Receiver



New MXE Capabilities

Extended frequency, enhanced speed, new standard features

- Expand testing with extended frequency to **44 GHz**
- Accelerate testing with new **Time Domain Scan**
- Simplify signal maximization with **Monitor Spectrum**
- Prepare for future CISPR 11 testing with **Amplitude Probability Density (APD)** function



Agilent Technologies

Performance



MXE 8GHz



MXE 26GHz



MXE 44GHz

Price



Agilent Technologies

Time Domain Scan (TDS)

What is “Time Domain Scan”

A new way to do Frequency scanning!

Swept scans, Stepped scans, now Time Domain scans

FFT-based scan

uses ~ 90% overlap (in time) to ensure amplitude accuracy for measurements of both CW and Impulsive signals

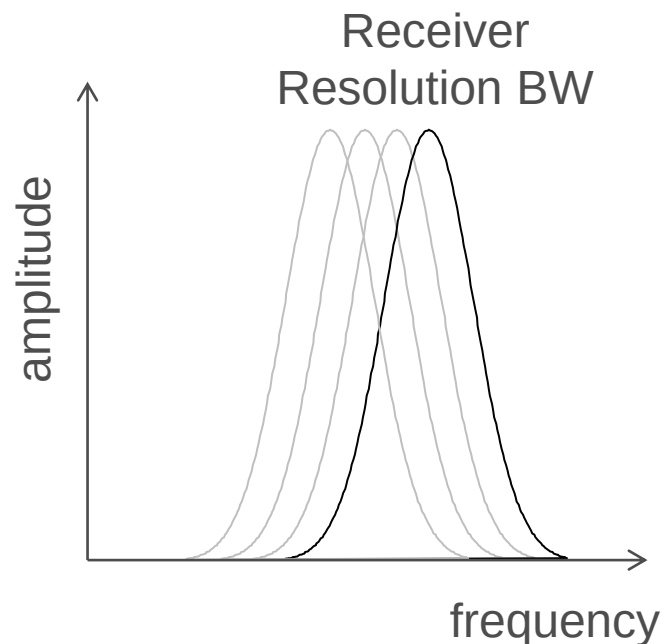
Allowed by CISPR 16, but not required.

Internal Automotive testing specifications require Time Domain



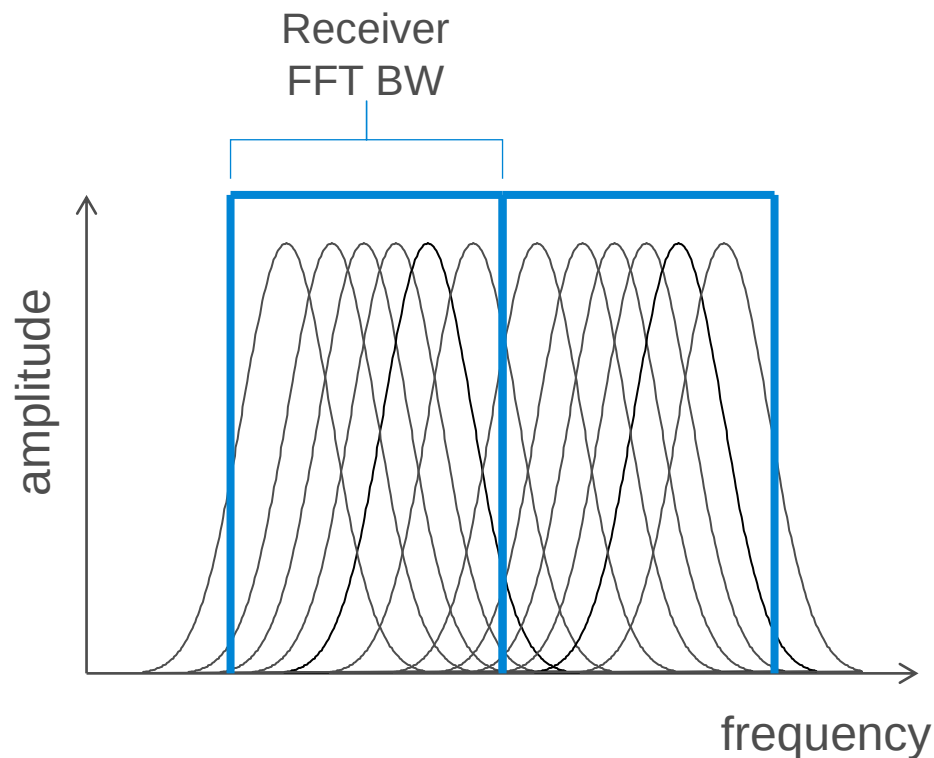
How Time Domain Sweep Saves Time

Have to dwell at each RBW



**Swept or Stepped
Frequency Scan**

Only have to dwell for each FFT BW (multiple RBWs)



**Time Domain
Frequency Scan**



Review: CISPR Radiated Measurement Methodology

1. Fast Prescan to collect all suspect emissions

- i. Scan speed limited by CISPR
- ii. Speed limit ensures you capture all emissions
- iii. Typically use Peak detector, but can use CISPR detector
- iv. **MXE: "Scan"**

TDS

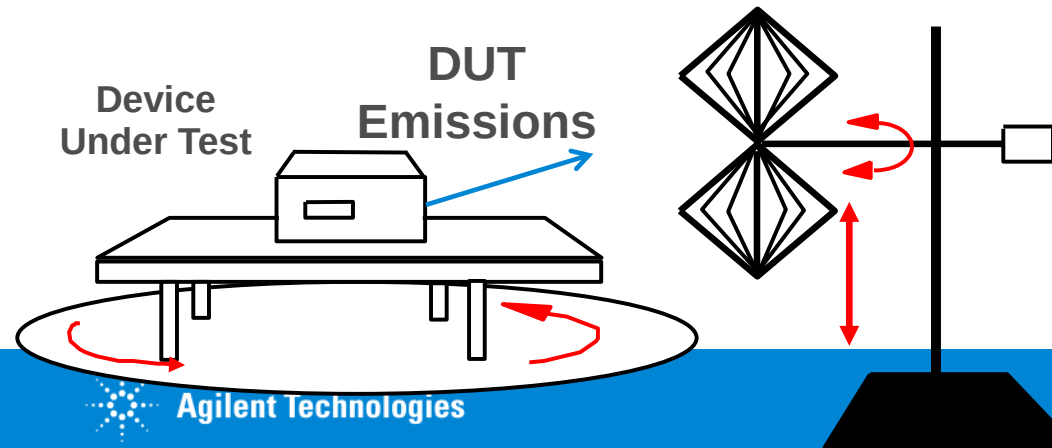
Helps Here

2. Identify all emissions above target limit line

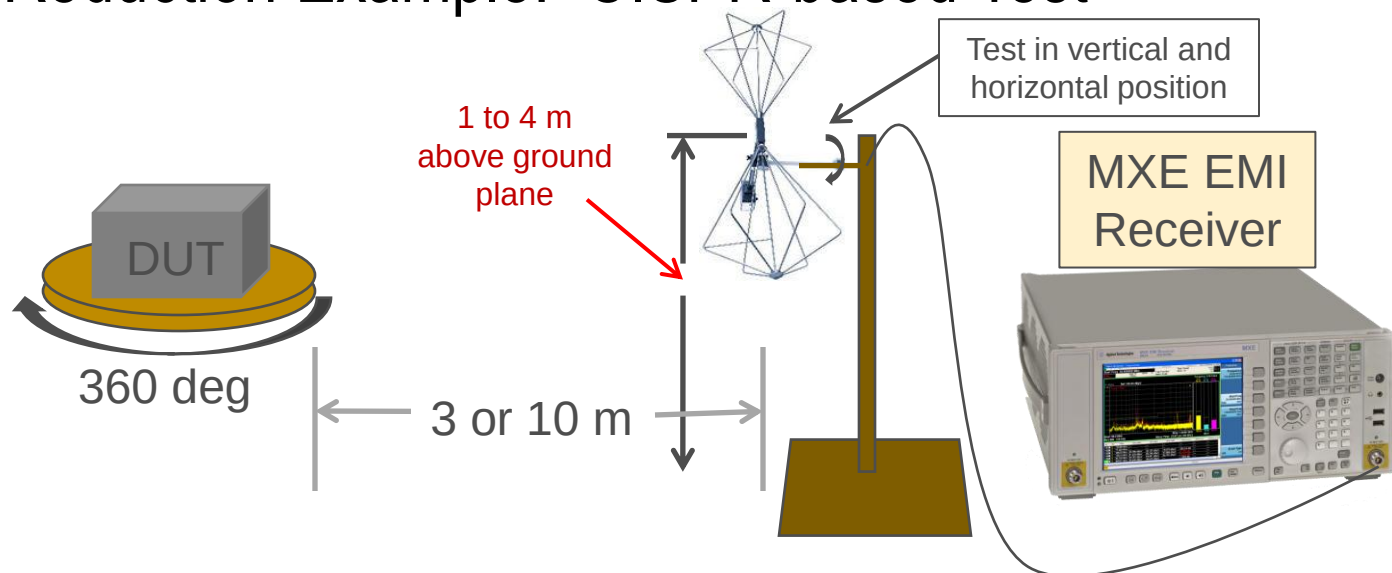
- i. **MXE: "Search"**

3. Perform final measurement on individual signals

- i. Find peak of signal, then make final measurement using appropriate CISPR detector: Quasi-Peak, EMI-Avg, RMS-Avg
- ii. **MXE: "Measure"**



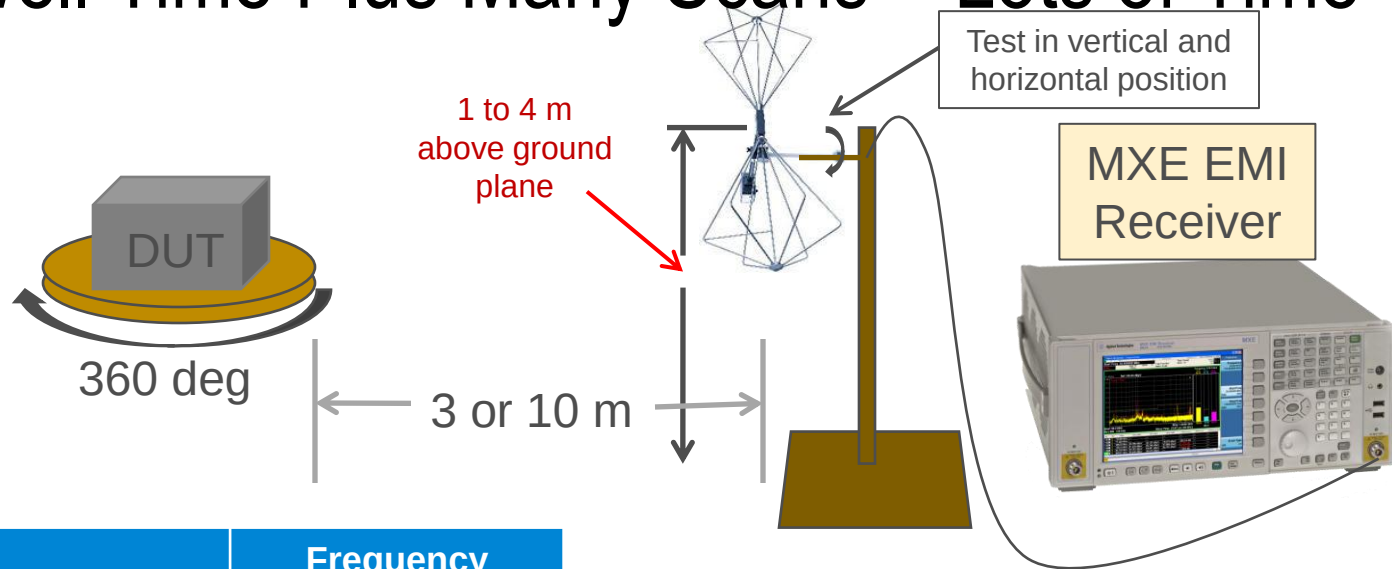
Test Time Reduction Example: CISPR-based Test



1. rotate DUT through 360°, scanning every 15° = **24 scans**
 2. test at 3 antenna heights (from 1– 4 meters) **x 3**
 3. both vertical and horizontal orientation **x 2**
- 144 scans**

Purpose: identify peak emissions
collect a list of suspect emissions for final measurement

Long Dwell Time Plus Many Scans = Lots of Time



	Frequency Domain Scan
CISPR Band	<u>MXE</u>
30MHz–1GHz Peak det. 10ms. dwell RBW =120kHz 3 pts/RBW	242 sec smooth scan
150kHz–30 MHz Peak det 100ms. dwell RBW = 9kHz 2 pts/RBW	664 sec smooth scan

144 scans

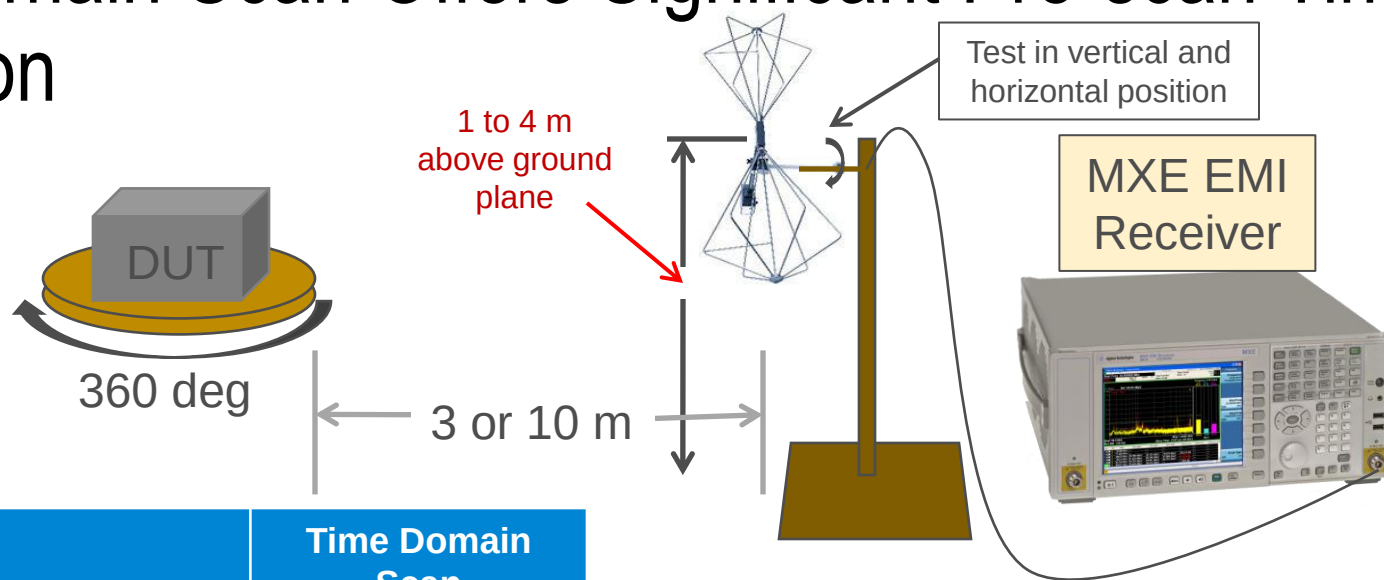
x ~250 sec/scan

10 hours

*Not counting antenna
and turntable positioning time*



Time Domain Scan Offers Significant Pre-scan Time Reduction



	Time Domain Scan
CISPR Band	<u>MXE</u>
30MHz–1GHz Peak det. 10ms. dwell RBW =120kHz 4 pts/RBW	~12 sec
150kHz–30 MHz Peak det 100ms. dwell RBW = 9kHz 2 pts/RBW	~13 sec

144 scans
~~12~~
~~x ~250 sec/scan~~

~~10 hours~~
29 minutes

Not counting antenna
and turntable positioning time



Monitor Spectrum – What is it?

- **Simultaneous** displays of **spectrum** and **meters**

- **Meters** are **tuned** to **center frequency**
- Spectrum measurement is **FFT** (Fixed BWs)
- Spectrum is **limited** to **span** around the CF

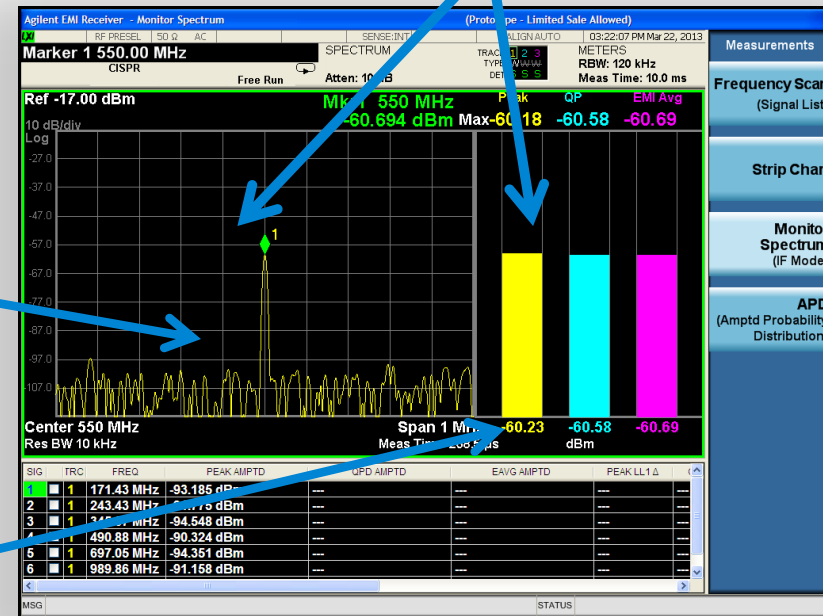
- **Diagnostic tool only**

- **NOT required** by any standards

Simultaneously
Updated

Spectrum View

Meters



Amplitude Probability Distribution

What is it?

- New **statistical measurement** to be released in CISPR 11
- Measures the **probability** of an emission **exceeding** a specified **level**
- Very similar to complementary cumulative distribution function (**CCDF**)

Included Standard
in MXE

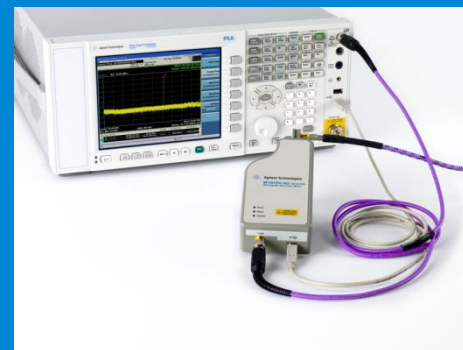
Y-axis -
probability

X-axis –
emission
level





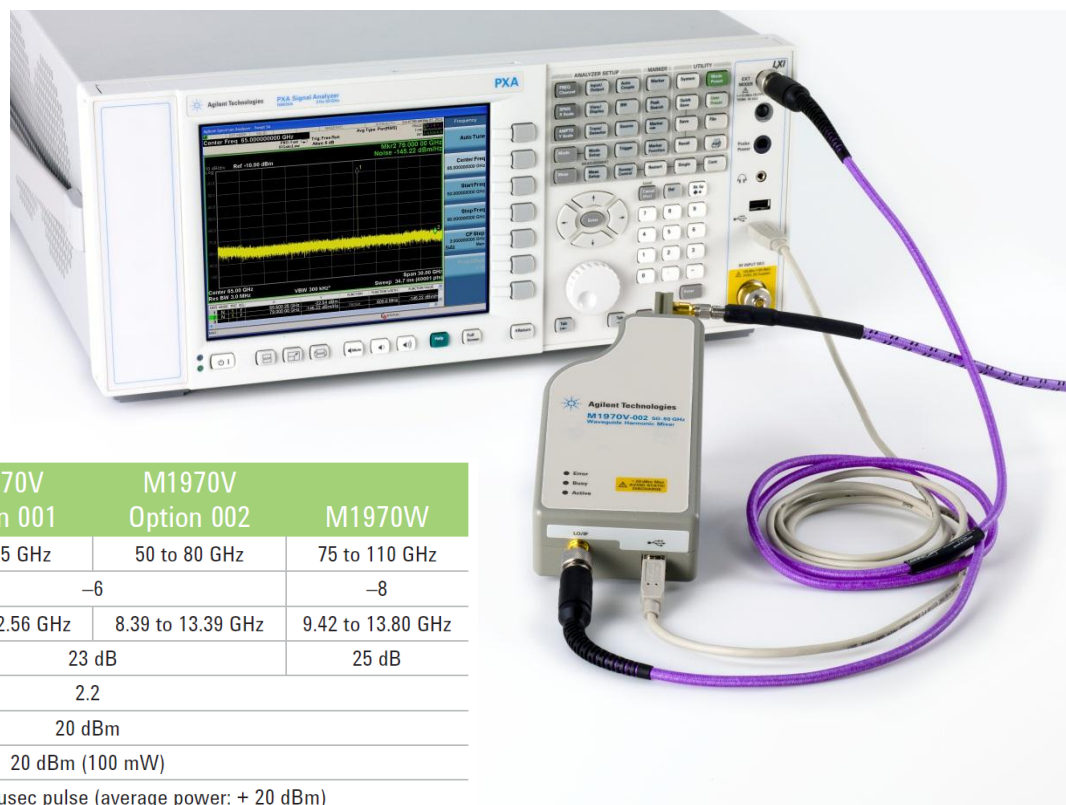
mmWave Extensions for Signal Generation & Analysis to 1THz



Agilent M1970-Series Smart Mixers

USB connection provides:

- Automatic ID
- Harmonic number
- Conversion loss data
- LO path loss



Specification	M1970E	M1970V Option 001	M1970V Option 002	M1970W
Frequency range	60 to 90 GHz	50 to 75 GHz	50 to 80 GHz	75 to 110 GHz
LO harmonic number ¹	−6/−8	−6		−8
LO input frequency range ²	9.42 to 12.56 GHz	8.39 to 12.56 GHz	8.39 to 13.39 GHz	9.42 to 13.80 GHz
Maximum conversion loss ³	27 dB	23 dB		25 dB
Calibration accuracy (<i>nominal</i>) ⁴	2.2			
Maximum LO power	20 dBm			
Maximum CW RF input level	20 dBm (100 mW)			
Maximum RF peak pulse power	24 dBm with < 1 μsec pulse (average power: + 20 dBm)			
Odd order mixing product suppression (<i>nominal</i>)	15 dB			
Gain compression level (< 1dB) (<i>nominal</i>)	−1 dBm			
Input SWR (<i>nominal</i>)	2.6			
Noise figure (<i>nominal</i>) ⁵	40 dB	36 dB		38 dB
System displayed average noise level (DANL) at 1 Hz resolution bandwidth (<i>nominal</i>) ⁶	−136 dBm	−140 dBm		−138 dBm



Positioning VDI and OML products

Signal Generation:



E8257DVxx VDI Frequency Extenders

VDI Strengths	Higher output power (e.g. WR-05, 140 – 220 GHz: +4 dBm)	Higher frequency models to 1.1 THz
VDI Weaknesses	External power supply required	

E8257DSxx OML source modules

OML Strengths	Power is supplied by connector on rear of PSG	Some models have optional attenuation available
OML Weaknesses	Lower output power (e.g. WR-05, 140 – 220 GHz: -15 dBm)	500 GHz max freq.



Positioning VDI and OML products



Signal Analysis:

N9029AVxx VDI Frequency Extenders			
VDI Strengths	Better conversion loss -> better DANL (e.g. WR-05 DANL, 140-220 GHz: -151 dBm/Hz)	Higher frequency models to 1.1 THz	Dual mode – Standard and block downconverter
VDI Weaknesses	External power supply required		
N9029AExx OML external mixers			
OML Strengths	No external power supply needed	Much smaller package	Lower price
OML Weaknesses	Higher conversion loss (e.g. WR-05 DANL, 140-220 GHz: -95 dBm/Hz)	325 GHz max freq.	





Update on GNSS solutions - GLONASS

Global Navigation Satellite Systems

Global Positioning System (GPS)



- Operated by United States
- Fully operational since 1994
- New Block IIF and Block III satellites being launched will provide additional signals and services

GLOBAL NAVIGATION Satellite System (GLONASS)



- Russian system first launched by Soviet Union in 1982
- Became fully operational in October 2011
- New GLONASS-K satellites being launched will provide additional signals

Galileo



- Joint project of the European Community and European Space Agency
- Experimental satellites launched in 2005 and 2008
- 4 In-Orbit Validation satellites launched in 2011 and 2012
- Initial open service planned by 2015
- Completion of full system (30 satellites) planned for 2020

BeiDou (Compass)

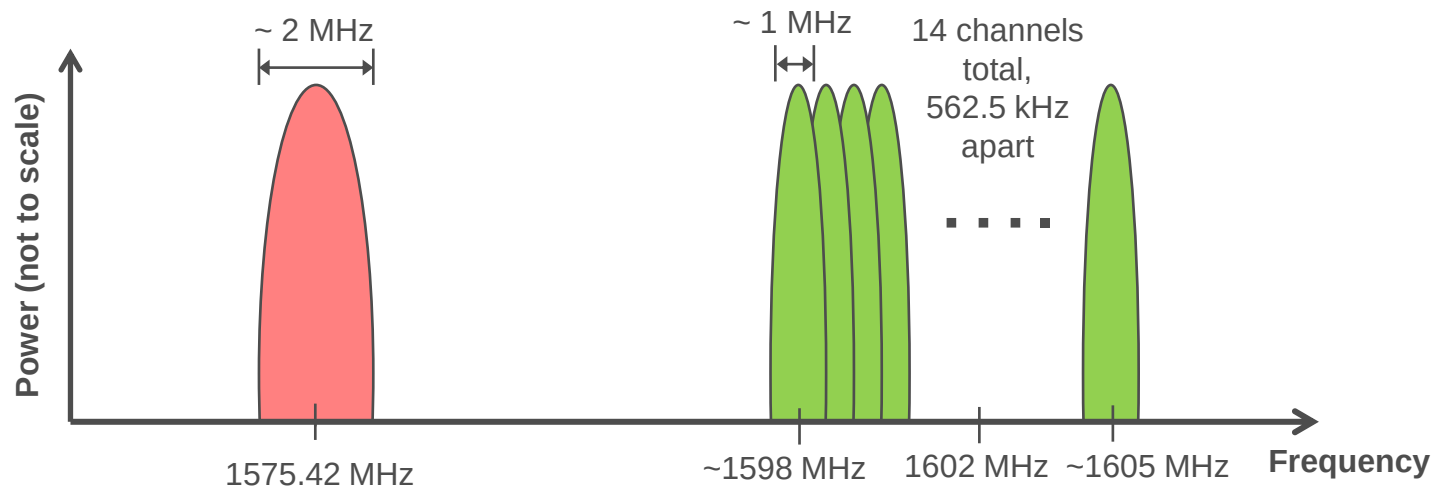


- Developed by China
- 16 satellites launched, 14 in service following last launch in October 2012
- Began service for Asia-Pacific region in December 2012
- Completion of full system planned for 2020
- Interface Control Document (ICD) for open service signal published in December 2012



GLONASS Technology

- Current GLONASS-M satellites transmit both standard and high precision signals on one of 14 frequencies, all with the same PRN code: frequency domain multiple access or FDMA system
 - L1 signals transmitted around 1602 MHz, 562.5 kHz apart (~1598-1605 MHz)
 - L2 signals transmitted around 1246 MHz, 437.5 kHz apart (~1242-1252 MHz)
- New GLONASS-K satellites will also transmit code domain multiple access (CDMA) signals similar to GPS and Galileo: same frequency, different PRN codes per satellite. Initial signal will be in L3 band at 1202.025MHz. CDMA signals also being developed for L1 and L2.



GPS L1 C/A Signal:

All satellites transmit at same frequency using different PRN codes

GLONASS L1 C/A Signal (FDMA):

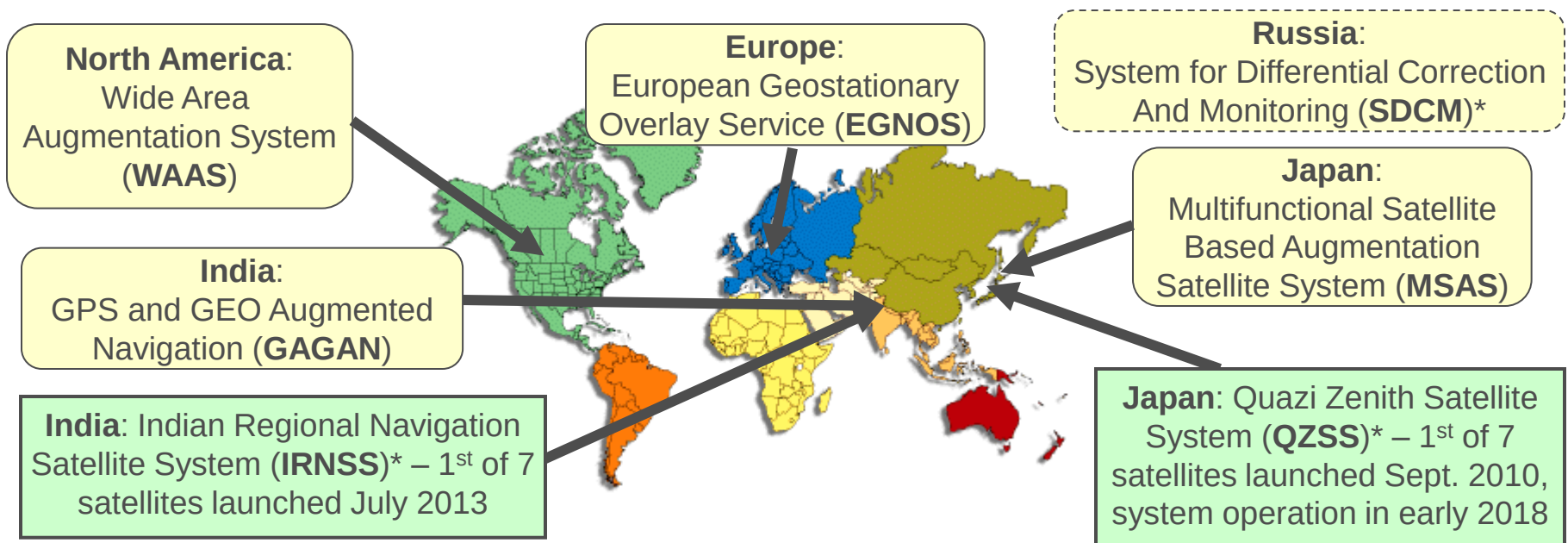
Satellites transmit at different frequencies around 1602 MHz using same PRN code



Augmentation and Regional Systems

Satellite Based Augmentation Systems (SBAS)

Geostationary satellites transmit ionosphere, clock, and ephemeris correction and integrity data for GNSS systems. Provide increased positioning accuracy.



Regional Navigation Satellite Systems (RNSS)

Provide improved GNSS signal availability/coverage and positioning accuracy over limited geographical areas.

**System is still in deployment phase*



Agilent Technologies

GNSS System Comparison

	GPS L1 C/A	GLONASS L1	Galileo E1 OS	Beidou 2 (Compass)	QZSS	SBAS
Satellites	24 minimum, 32 current	24 minimum, 31 current	24 minimum, 4 current	35 total: 5 GEO, 27 MEO, 3 IGSO	7 planned, 1 operational	2 of 5 WAAS operational, 4 EGNOS, 2 MSAS
Organization	USA	Russia	Europe	China	Japan (Augmentation system)	USA, Europe, Japan, India. (Augmentation systems)
Orbit	20,200 km	19,100 km	23,222 km	21,500 km, 36,000 km	35,786 km	35,786 km
Orbital Period	~ 12 Hours	~ 11.2 Hours	~ 14 Hours	~ 12 Hours	~ 24 Hrs	~ 24 Hrs
Frequency	L1: 1575.42 MHz L2: 1227.60 MHz	L1: 1602.00 MHz +- 7 channels of 0.5625 MHz	E1: 1575.42 MHz	B1: 1561.098 MHz	L1: 1575.42 MHz	L1: 1575.42 MHz
Signal Format	CDMA, BPSK	FDMA, BPSK	CDMA, MBOC	CDMA, BPSK	CDMA, BPSK	CDMA, BPSK
Initial Operating Capability	1994	Soviet Union system in 1995, current system in Oct. 2011	Initial limited service 2014, full operation 2020	Regional service Dec. 2011, full system in 2020. 16 satellites launched.	1 satellite transmitting, full system available early 2018	WAAS – 2003 EGNOS – 2009 MSAS – 2007 GAGAN - 2014
Design Accuracy	10-20 meters	20-30 meters	8-17 meters	7-16 meters	10-20 meters	1-3 meters
Data Rate	50 bits/s	50 bits/s	250 bits/s	50 bits/s, 500 bits/s	50 bits/s, 25 bits/s	250 bits/s
PRN Code Length (bits)	1023	511	4092	2046	1023	1023
Chip Rate	1.023 MHz	0.511 MHz	1.023 MHz	2.046 MHz	1.023 MHz	1.023 MHz
Navigation Message Structure	Frames, subframes, check bits	Superframes, frames, strings, Check bits	R2 Convolutional FEC	Not publicly disclosed	Frames, subframes, Check bits	CNAV, R2 Convolutional FEC



Alternatives for Multi-satellite Signal Simulation

Record and Playback

- + Capture all real-world RF signals including complex impairments
- + Can be less expensive than other solutions

- Only test with signals available today
- Hard to know what's included in signal
- No control of individual satellites
- Can't modify signal contents
- Limited length

Arbitrary Waveform Files

- + More control of simulation
- + Can simulate future satellites/signals
- + Less expensive than real-time

- Simulation length limited by baseband memory
- Multi-GNSS signals require more BW and memory
- Waveforms have finite length: receivers lose lock at end of file
- Can't modify simulation without creating new file

Real-time Simulator

- + Real-time control of satellite signals
- + Very flexible; most control over simulation parameters
- + Can simulate future satellites/signals
- + Not limited by baseband memory

- Solutions generally more expensive than alternatives



N7609B Signal Studio for GNSS: Real-time Multi-satellite GNSS Simulation

Real-time simulation of satellite signals from the U.S. Global Position System (GPS), Russian GLONASS system, European Galileo system, or Chinese Beidou system for receiver verification

Simulate up to 15 line-of-sight satellites for each constellation, with 40 channels now available for line-of-sight satellite and multipath signals combined for GPS, GLONASS, and/or Beidou

16 more channels available for Galileo satellite and multipath signals

Real-time changes to satellite visibility, power, pseudorange error, and multipath

Supports static scenarios for stationary receivers or dynamic scenarios for moving receivers

Up to 24 hours of signal simulation using saved scenario files, or use continuous scenario generation mode for longer simulations up to 7 days

Add calibrated AWGN (requires AWGN option in instrument)

Two Available Configurations for N7609B

For **Real-time** Signal Generation

Configure signal parameters and generate scenario data in N7609B Signal Studio running on external PC



Download data to X-series signal generator to configure FPGA and start real-time signal generation

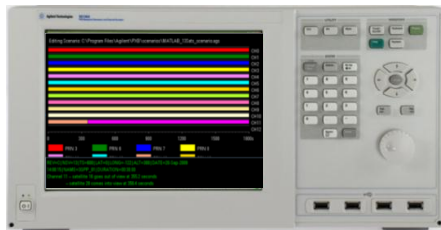


N5172B EXG or N5182B MXG

PC not required to play back scenarios that have been downloaded into EXG/MXG



N7609B Signal Studio runs in the PXB to generate scenario data and PXB creates real-time baseband GNSS signals



N5106A PXB Baseband Generator and Channel Emulator

Vector EXG, MXG or ESG used as RF upconverter

No baseband generator required for EXG/MXG



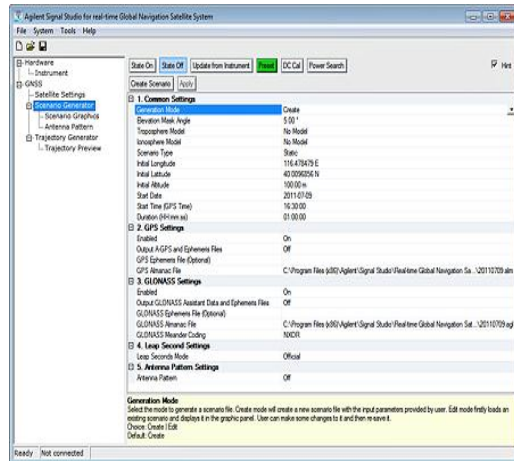
N5172B EXG, N5182A/B MXG, or E4438C ESG



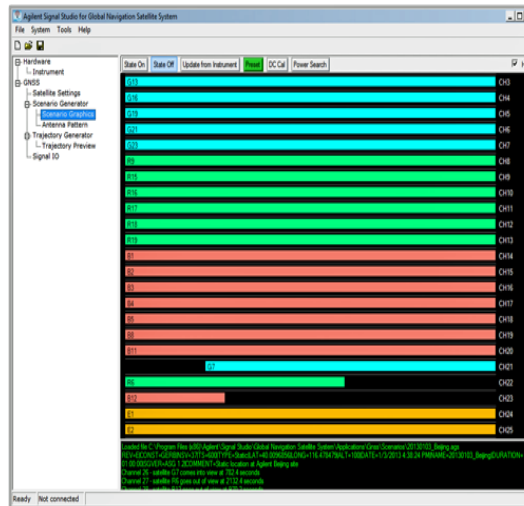
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Custom Scenario Generation

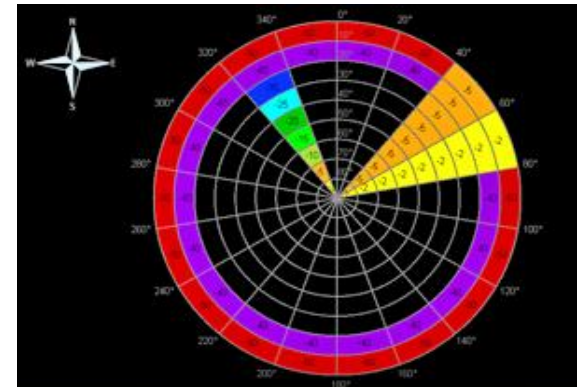
Create custom scenarios for any location, date, and time to model stationary or moving receivers.



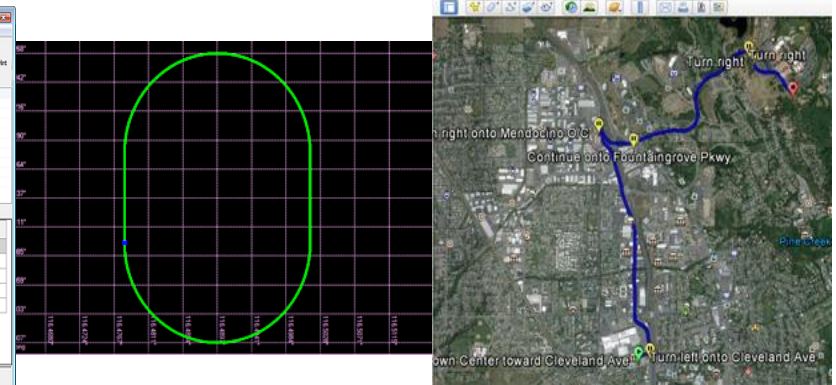
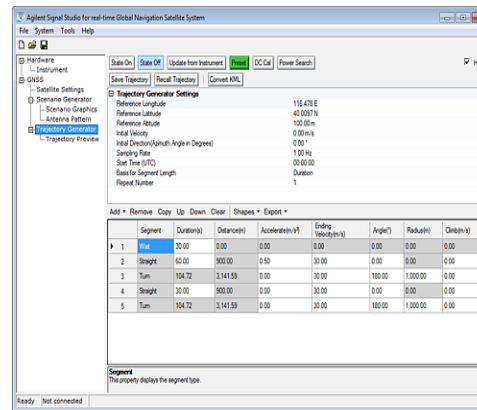
Scenario Graphics display shows each channel during the scenario.



Configure and apply an antenna model to the satellite signals



Trajectory generator creates NMEA GGA message files describing receiver's path for moving receiver scenarios from user description, or imports Google Maps KML file



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N7609B Signal Studio for GNSS: Single Satellite Waveform Files



- Basic mode **option EFP** for simple receiver verification tests such as receiver sensitivity, acquisition and tracking (no location fix)
- Creates waveform files simulating single satellite for GPS, GLONASS, Galileo, Beidou, satellite-based augmentation systems (SBAS), or Japan's Quasi-Zenith Satellite System (QZSS)
- User selects SV ID (or frequency channel for GLONASS) and Doppler frequency
- Waveform files may be used with multiple instrument platforms:
 - Vector signal generators:
 - E4438C ESG
 - N5172B EXG
 - N5182A/B MXG
 - E8267D PSG
 - E6607 EXT and E6630A wireless test sets
 - N5106A PXB.





New Microwave N5173B/N5183B MXG Signal Generators



N5183B UW ANALOG



N5173B UW ANALOG

The NEW Microwave Signal Generator Series

13 / 20 / 32 / 40 GHz

DECEMBER
2013!



the new E8257D/E8267D PSG
E8257D/E8267D



the Pure and Precise MXG
N5183B

Performance

Price

BEST IN CLASS
PERFORMANCE

FLEXIBLE INTEGRATED
FUNCTIONALITY

LOWEST COST OF OWNERSHIP



Agilent Technologies

Delivering a Range of Performance - Three models available

PSG *METROLOGY-GRADE*



E8257D UW ANALOG

MXG *PURE & COMPACT*



N5183B UW ANALOG

EXG *COST EFFECTIVE*



N5173B UW ANALOG

PSG vs. MXG vs. EXG ()=TYPICAL

	PSG	MXG	EXG
PHASE NOISE@ 10 GHZ , 20 KHZ OFFSET	-120 dBc/Hz	-119 dBc/Hz	-97 dBc/Hz
PHASE NOISE@ 10 GHZ , 10 HZ OFFSET	-72 dBc/Hz	-63 dBc/Hz	(-57) dBc/Hz
HARMONICS @ 10 GHZ/1 GHZ	-55 /-55 dBc	-55/-33 dBc	-55/-33 dBc
POWER @ 20 GHZ	+23 dBm	+19 dBm	+19 dBm
FREQUENCY SWITCHING SPEED	(9 ms)	900 us	900 us
RAMP SWEEP	Yes	No	No

COMMON X-SERIES CAPABILITIES

- Best in class performance
- Flexible Integrated functionality
- Low cost of ownership



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Key Specifications Comparison

Specification	MXG-B N5183B	PSG E8257D	EXG N5173B	MXG-A N5183A
Frequency range ^{1,2}	9 kHz to 40 GHz	100 kHz to 67 (70) GHz	9 kHz to 40 GHz	100 kHz to 40 GHz
Freq Stability (ppm/day)	+/- 5 x 10 ⁻¹⁰ nom	+/- 2.5 x 10 ⁻¹⁰ nom	+/- 5 x 10 ⁻¹⁰ nom	1 ppm/year nom
Pedestal Phase noise (dBc/Hz) 10GHz@20k/10k offset	STD: -113 (-117) UNY: -119 (-126)	STD: -110 (-113) UNX: -110 (-114) UNY: -120 (-126)	-97 (-101)	-95 (-98)
Close In Phase noise (dBc/Hz) 10GHz@10Hz offset	STD: (-80) UNY: -63	STD: (-74) UNX: -65 UNY: -72	(-57)	(-37)
Phase noise <250 MHz (dBc/Hz) 100 MHz@20k offset	STD: -129 (-134) UNY: -138 (-142)	STD: -130 (-134) UNX: -140 (-145) UNY: -150 (-157)	-115 (-120)	-113 (-116)
Non-harmonics (dBc) 10 GHz >10KHz offset	STD: -69 UNY: -74 (-80)	STD/UNX: -62 (-70) UNY: -70	- 60	-41 (-57)
Harmonics (dBc) 10 GHz	-55 dBc	-55 dB	-55 dBc	-54 dBc
Broadband noise 10 GHz @10MHz offset (dBc/Hz)	-149	-160	-149	-147
Max Power @ 20 GHz (dBm) with step attenuator	STD: +15 1EA: +19 dBm	STD: +15 (+19) 1EA: +19 (+22) 521: +23 (+26)	STD: +15 1EA: +19	STD: +11 1EA: +19
FM Deviation @ 20GHz	64 MHz	32 MHz	160 MHz	160 MHz
Max AM depth (exp)	50 dB	60 dB	50 dB	20 dB
Min Pulse width	20 ns	20 ns	20 ns	20 ns
Freq. Switch (list mode)	<900 us	9 ms to 24 ms	<900 us	<900 us
Ramp Sweep	No	Yes	No	No

() = Typical or measured data

1) MXG and EXG include 13, 20, 31.8 and 40 GHz frequency options.

2) PSG E8257D includes 20, 31.8, 40, 50 and 67 GHz options



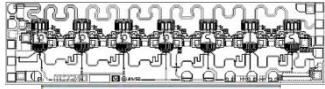
Agilent Technologies



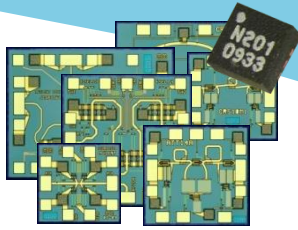
= best performance vs.
PSG or MXG-A

Innovation in Signal Generation

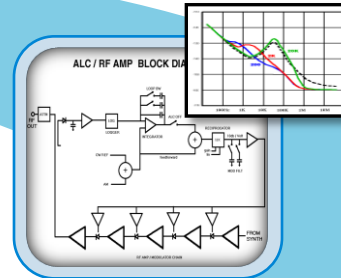
Proprietary Agilent Technology



**Micro circuit
amp & filter
module**

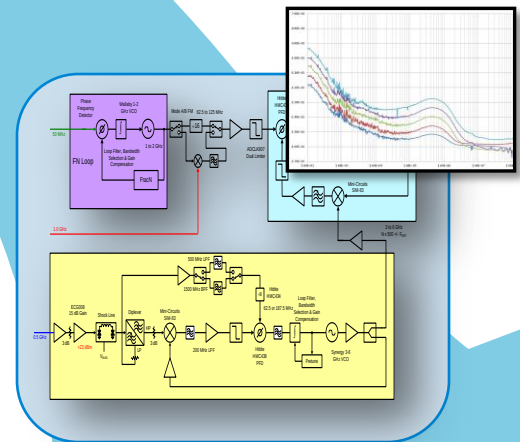


Low noise VCO



**Low noise
ALC**

**Triple-loop
synthesizer**



- Microcircuit Amp + filters → Power & harmonics
- Low noise VCO → Low phase noise & fast switching
- Low noise ALC → low AM noise
- Triple-Loop Synthesizer → low Phase noise & spurs



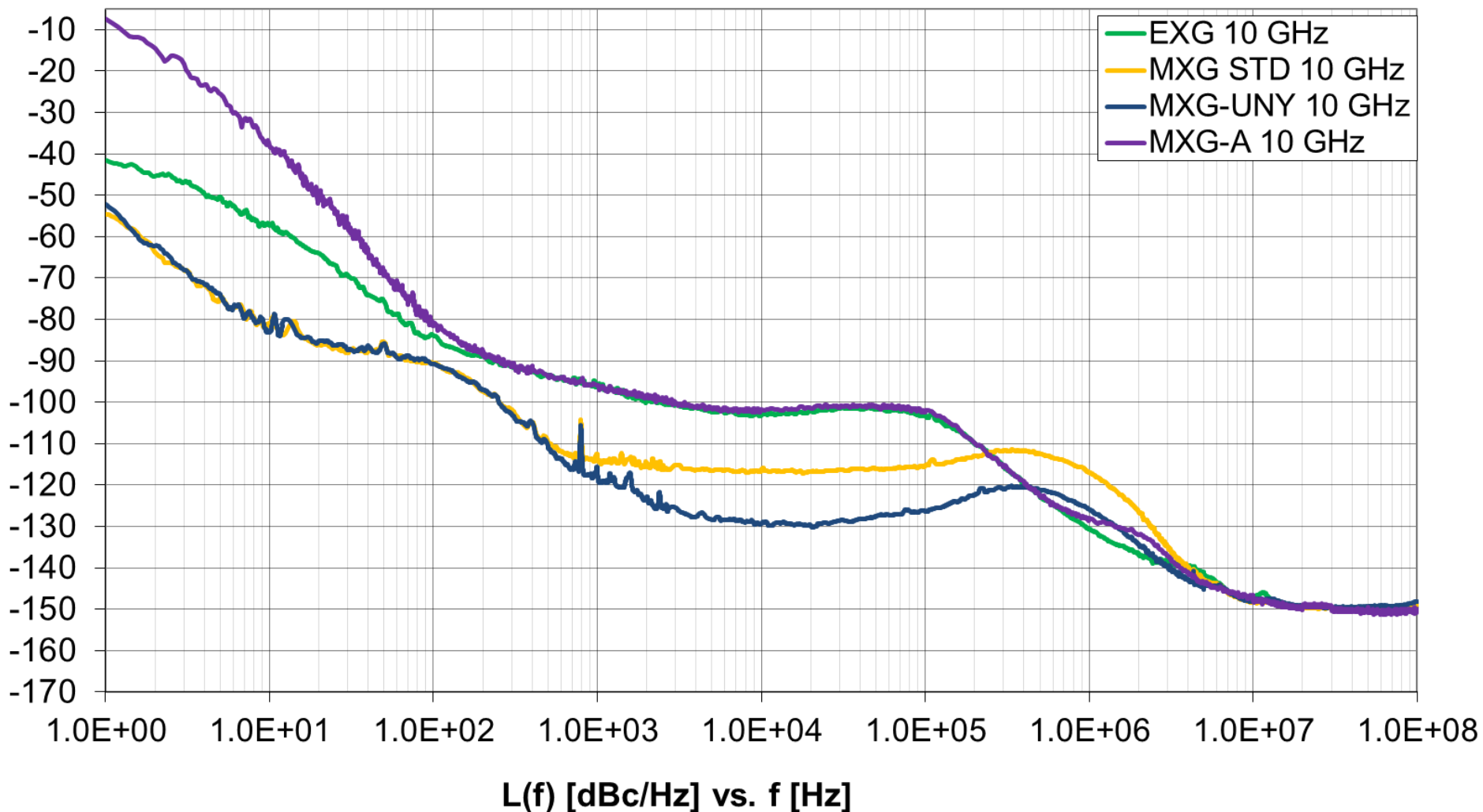
Agilent uW signal generators



Agilent Technologies

Phase Noise 10GHz

MXG-B vs EXG vs MXG-A



Flexible Signal Simulation

Simulate signals

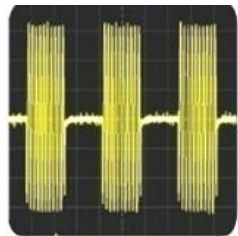
- **Radar pulse patterns**
- **Analog communications**
- **Moving antenna beams**
- **Mixed modulations**



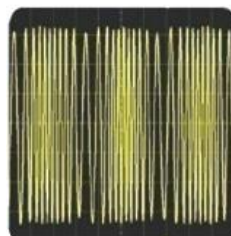
MXG and EXG

- **Option UNW: Narrow Pulse**
- **Option UNT: Analog Mod (AM, FM, Φ M)**
- **Option 303: Multifunction Generator**

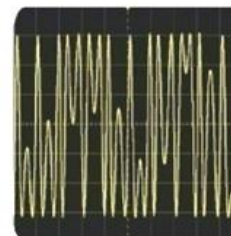
Modulation



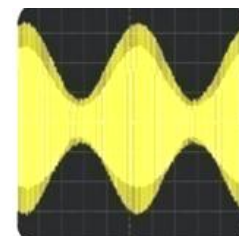
Pulse



FM



Φ M



AM

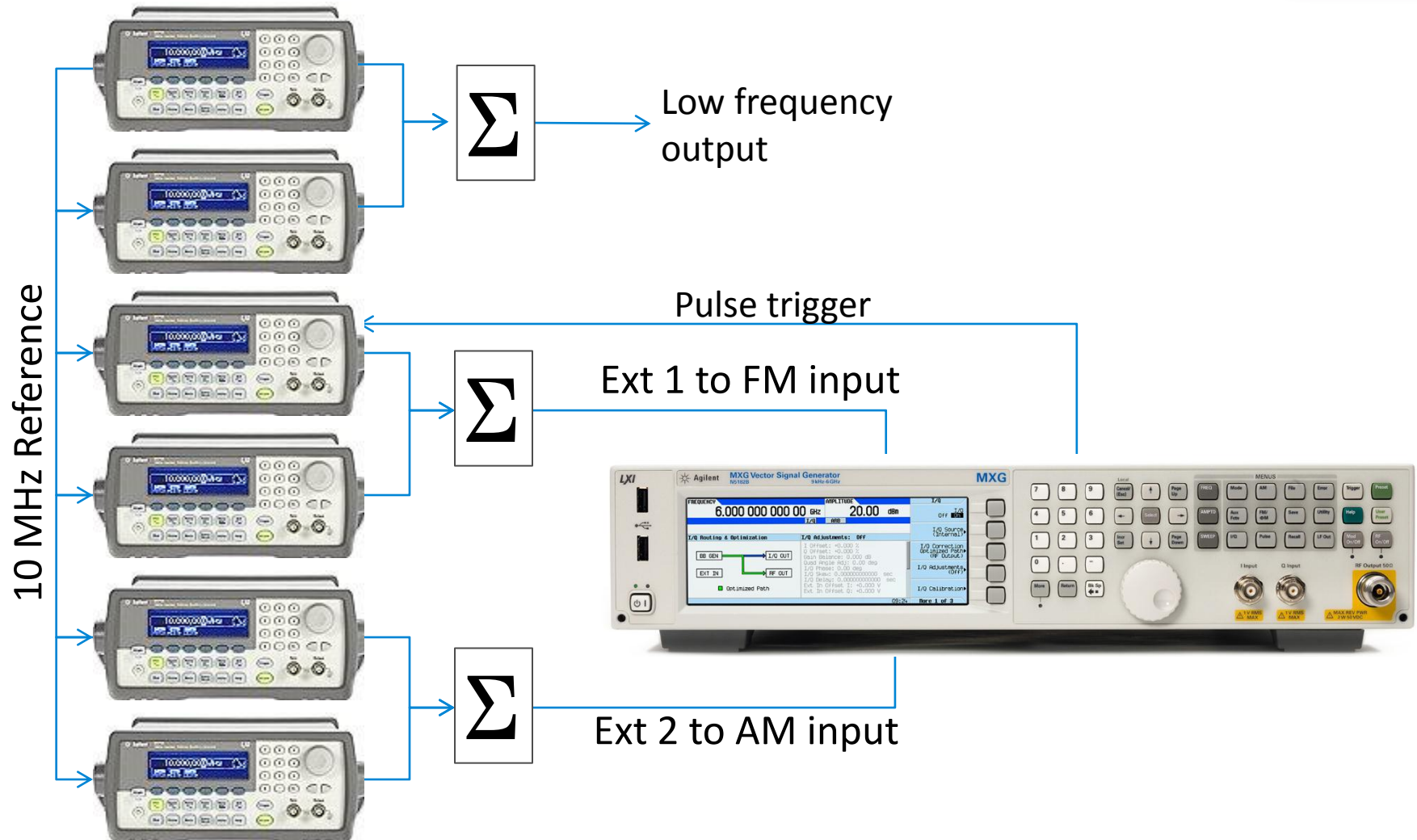
Max. Rate:		DC to 7MHz	1 / 10 MHz	100 kHz (Useable to 1 MHz)
Max Deviation / Depth:		120MHz (MXG) 320 MHz(EXG)	64 rad (MXG) 160 rad (EXG)	100% > 50 dB
Pulse Min Width:	20 ns (UNW)			
Pulse Rise/Fall:	6 ns (typ)			
Pulse Max. Repetition Frequency:	10 MHz			
Pulse On/Off:	> 80 dB			



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New Multifunction Generator – Option 303

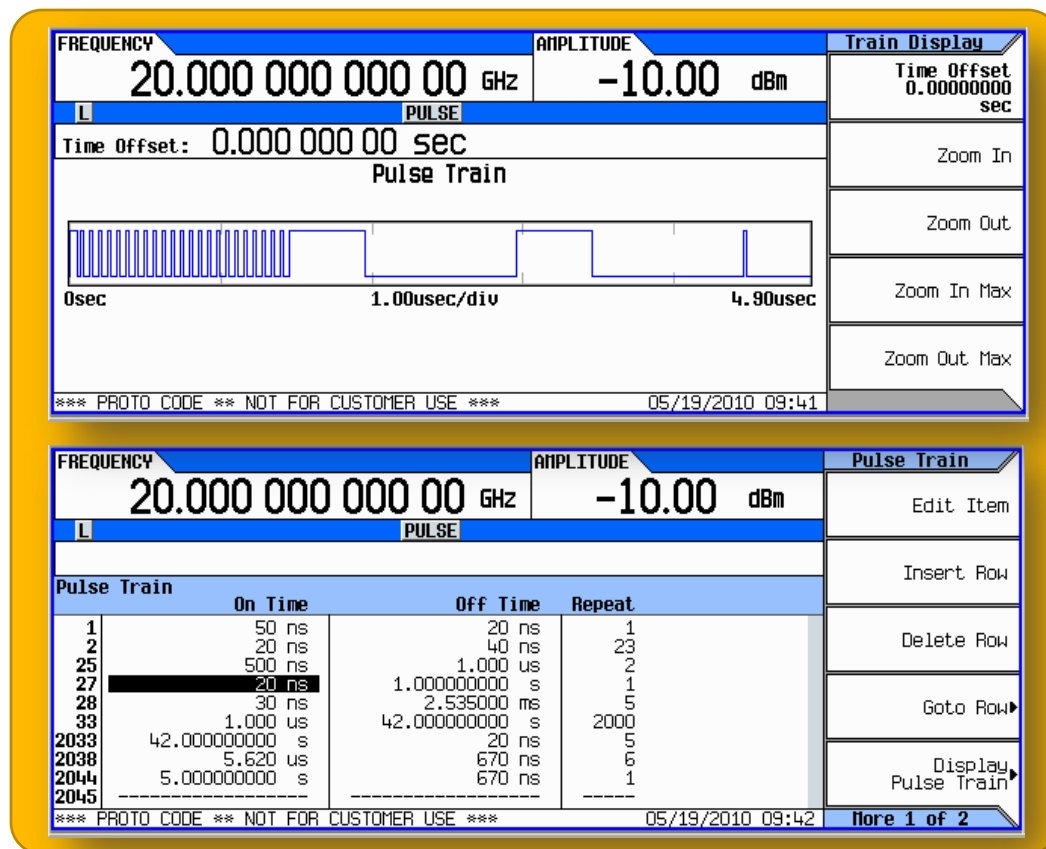
New!



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Pulse Train Option 320

- ✓ Define “On Time”, “Off Time”, and “Repeat” for up to 2047 pulses from the front panel.
- ✓ View pulse train pattern on front panel display
- ✓ Import CSV/ASCII files. Export Comma, Semicolon, Space, or Tab separated text files

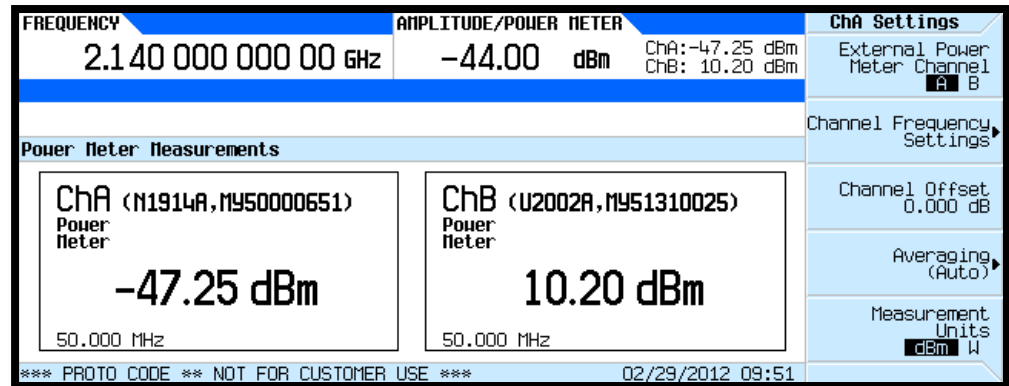


USB Power Sensor Connectivity

Support all Agilent USB U2000 series

- Save rack space
- Use X-series as power meter display
- Automate via SCPI
- Up to 4 Agilent USB power sensors can be connected. (two on display at one time)

USB power sensor connectivity & display



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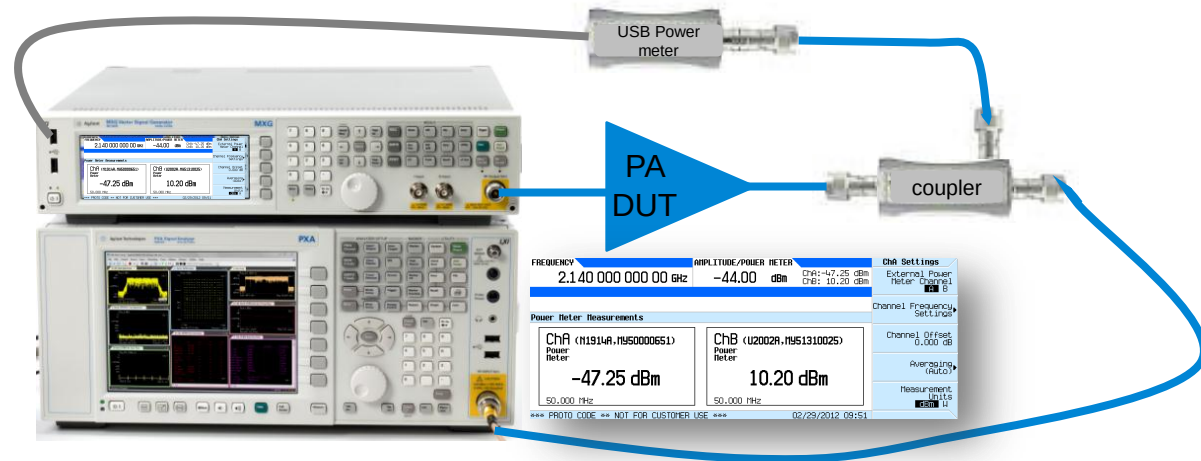
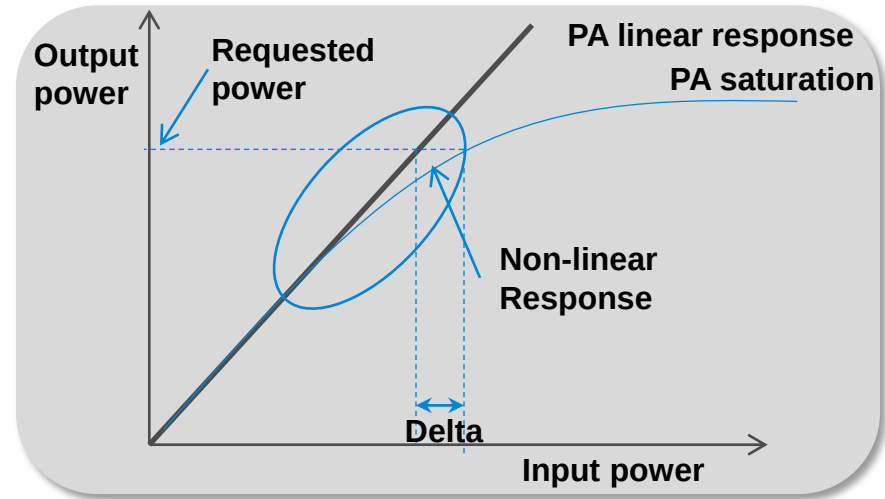
Power Servo (External Levelling)

What?:

- External USB power sensor leveling of DUT output.

What is the value?:

- Convenient bench top feature saves time and effort by enabling source to auto tune non-linear amplifier gain with power meter accuracy before making power sensitive measurements.



The Lowest Cost of Ownership

COST SAVINGS	DESCRIPTION
CALIBRATION INTERVAL	• 3 YEARS
MAXIMIZE UPTIME	• TARGET MTBF OF MXG-A
MINIMIZE DOWNTIME	• SELF SERVICE DIAGNOSTICS & WARRANTY PARTS DIRECT • LESS THAN 3 HOURS TO REPLACE ANY PART • LESS THAN 6 HOURS FOR POST-REPAIR CALIBRATION
LOW COST PARTS & LABOR	• REFURBISHED EXCHANGE PROGRAM • FAST POST-REPAIR CALIBRATION • STANDARD 3 YEAR WARRANTY



Thank you!



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X-Series Key Specifications Comparison

Specifications	PXA N9030A	MXA N9020A	EXA N9010A	CXA N9000A	MXE N9038A
Frequency range (min-max)	3 Hz – 50 GHz	10 Hz – 26.5 GHz	10 Hz – 44 GHz	9 kHz – 26.5 GHz	20 Hz – 26.5 GHz
Analysis bandwidth Standard RF Optional RF Optional baseband	10 MHz 25, 40, 85, 160 MHz 25, 40 MHz	25 MHz 40, 85, 125, 160 MHz 40 MHz	25 MHz 40 MHz	10 MHz 25 MHz	10 MHz 25 MHz
Overall amplitude accuracy (95%)	±0.19 dB	±0.23 dB	±0.27 dB	±0.50 dB	±0.75 dB
Displayed average noise level (DANL) @ 1 GHz @ 4 GHz	-172 dBm -172 dBm	-166 dBm -164 dBm	-163 dBm -165 dBm ¹ -162 dBm	-163 dBm -147 dBm ² -159 dBm	-167 dBm -172 dBm
Third order intercept (TOI) @ 1 GHz	22 dBm	20 dBm	18 dBm / 19 dBm ¹	17 dBm / 15 dBm ²	15 dBm
Phase noise @ 1 GHz 10 kHz offset 1 MHz offset	-132 dBc/Hz -146 dBc/Hz	-114 dBc/Hz -136 dBc/Hz	-105 dBc/Hz -106 dBc/Hz ¹ -137 dBc/Hz	-102 dBc/Hz -121 dBc/Hz	-106 dBc/Hz -137 dBc/Hz
Dynamic range, max third order at 1 GHz	119 dB	116 dB	112 dB 116 dB ¹	111 dB	112 dB
Standard attenuator range/step	70 dB / 2 dB	70 dB / 2 dB	60 dB / 10 dB	50 dB / 10 dB	70 dB / 2 dB

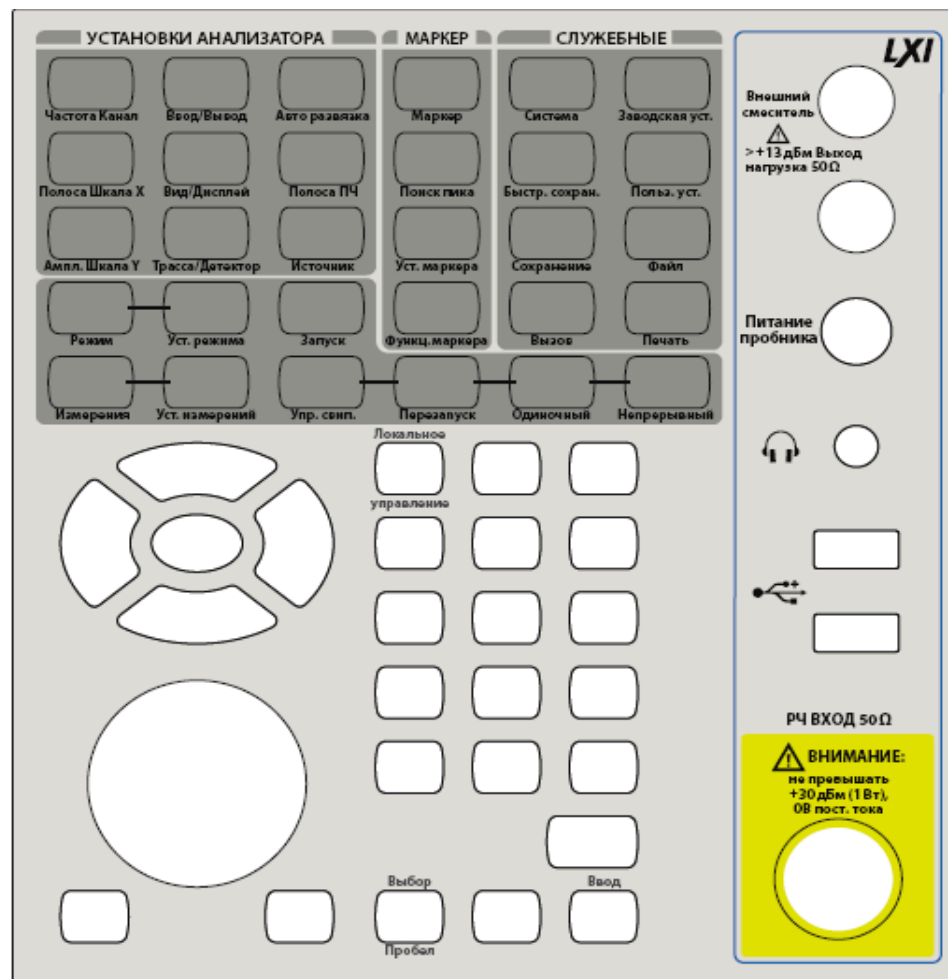
1) For N9010A EXA Option 532 or 544 frequencies only.

2) For N9000A CXA Option 513 or 526 frequencies only.

How to get Russian UI localization?

- With new P/MXA
 - Order Option N90x0A-AKT (no extra charge) including
 - A “Get Started Guide” Russian localization
 - An overlay for front panel (see right, user to put on)
 - Russian UI localization (for softkeys) license key enabled
- With existing P/MXA
 - Order Option N90x0AK-AKT (nominal charge: ~\$160) to get the above items
 - User to enable the license for Russian UI localization

FW rev ≥A.13.00 required



A Russian overlay to stick on the front panel

