New Technologies and Techniques for Wideband Analysis

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Anticipate Accelerate Achieve

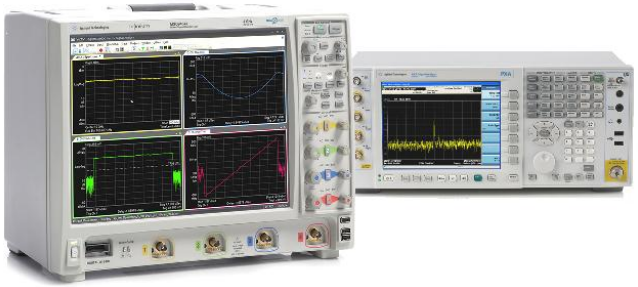
Agenda:

- Introduction of current bandwidth options for signal analysis
- Review feature and performance trade-offs as bandwidths expand
- A look at signal processing features for narrower or moderate bandwidths
  - Real-time analysis
  - Triggering, waveform capture and post analysis
    - Real-time analysis
    - Triggering, waveform capture and post analysis
- Wideband analysis options and techniques
  - “Analog” considerations
  - “Digital” considerations
    - Understanding performance
- Measurement techniques and results

Wideband High-Frequency Vector Measurement Options

MXA 160MHz
@ ~75 dBc

PXA 160MHz
@75 dBc



Wide Band VSA
(PXA + Infiniium)
~1.0 GHz @ ~55 dB*

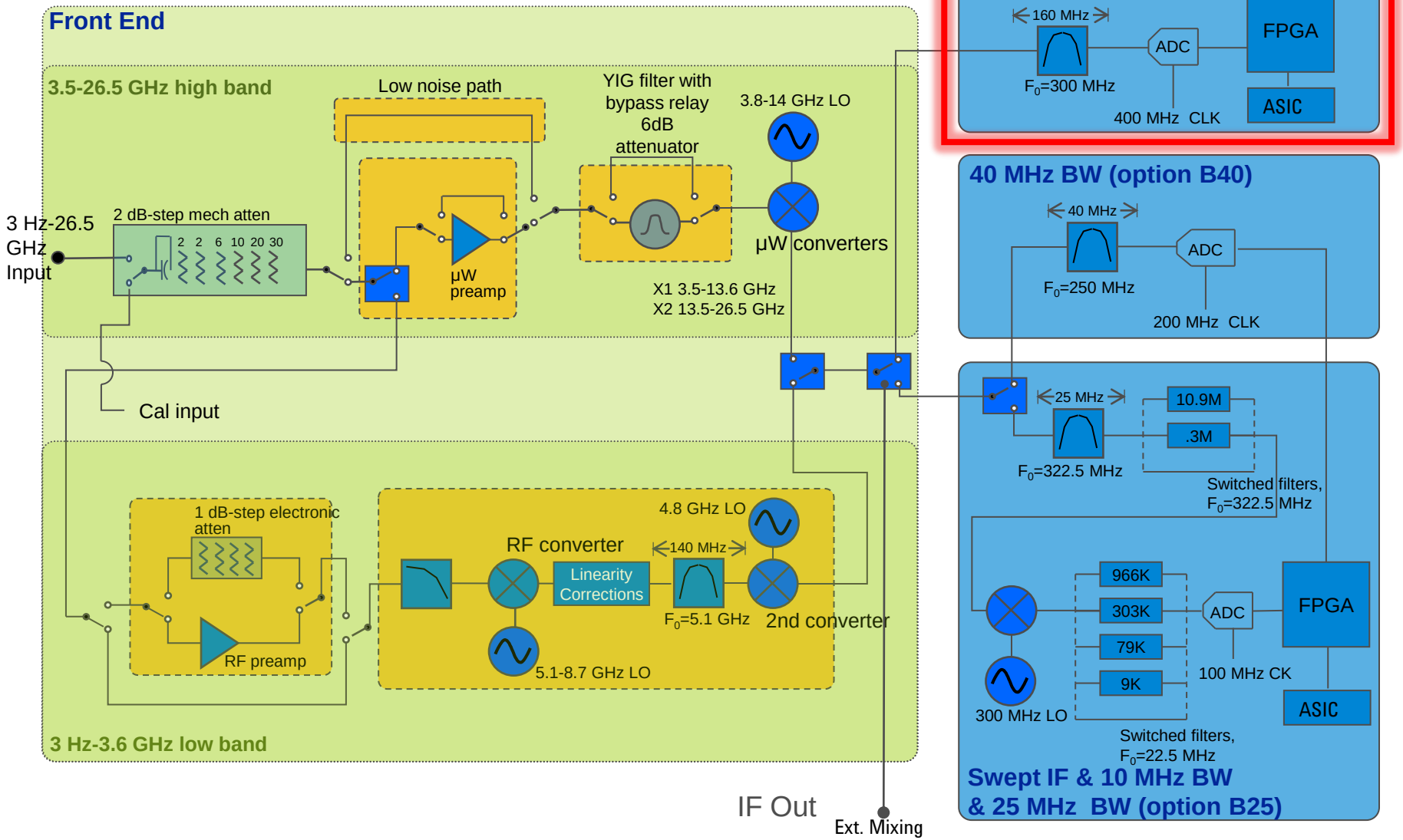
X93204A Infiniium scope
32 GHz @ ~50 dB

SF Dynamic Range @ max BW

Maximum Bandwidth

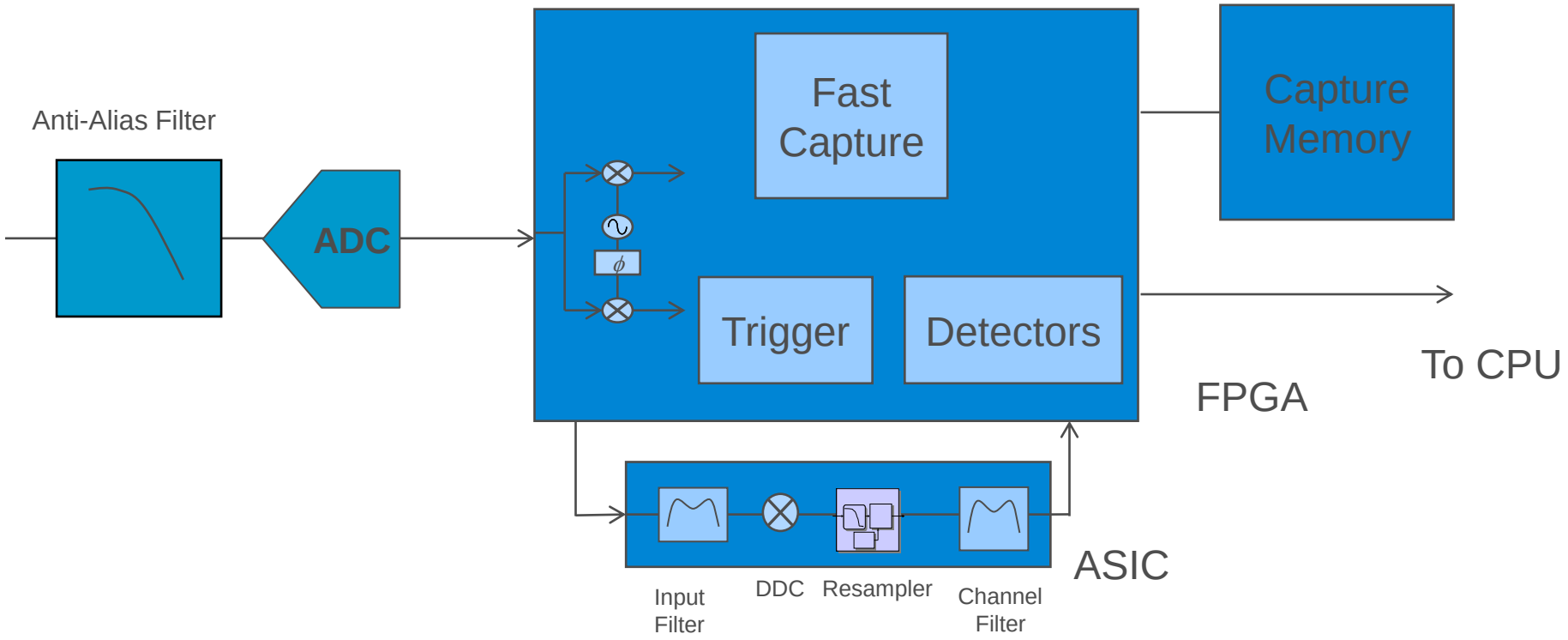
Simplified Block Diagram of PXA

26.5GHz model



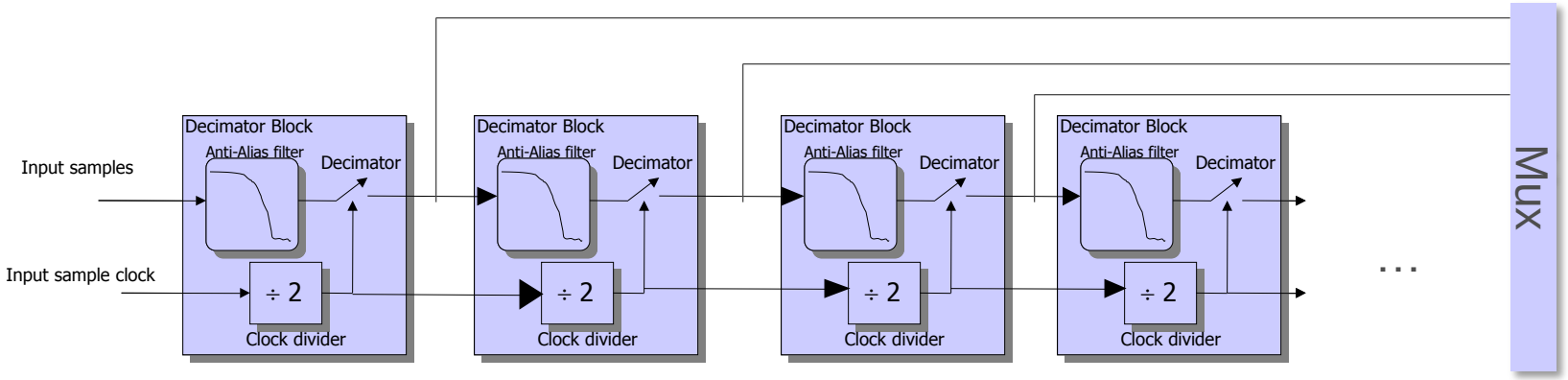
The Digital IF

- The pattern of using a combination of a FPGA with an ASIC has continued
- Both FPGAs and ASICs have become dramatically more capable

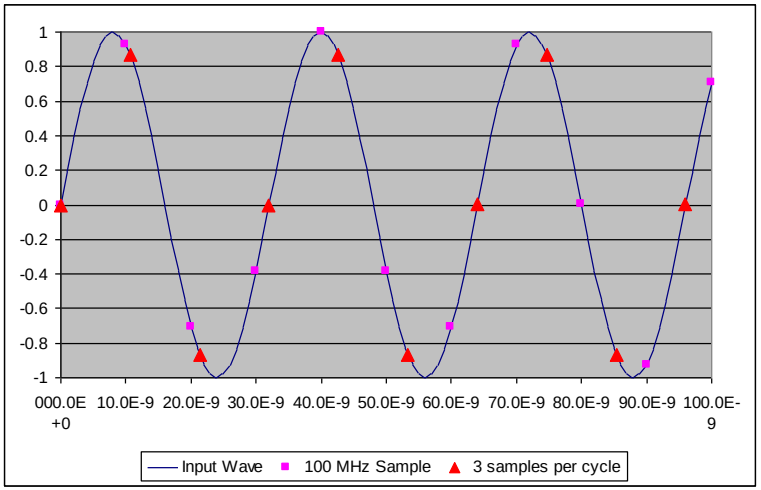


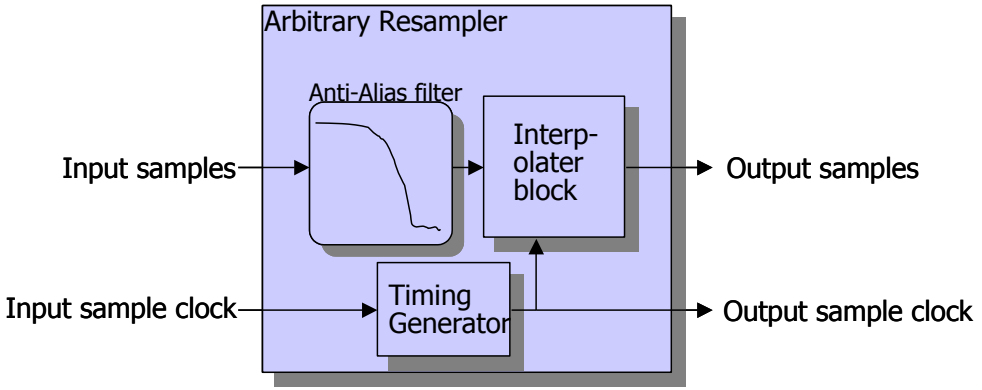
Arbitrary Resampling

- **Arbitrary Resampling is done with a combination of decimation and resampling**



Decimator Block

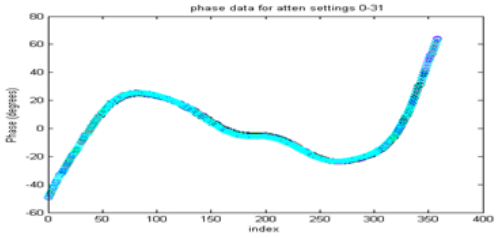


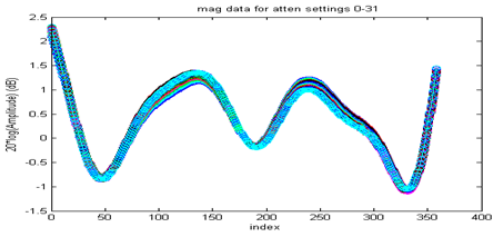


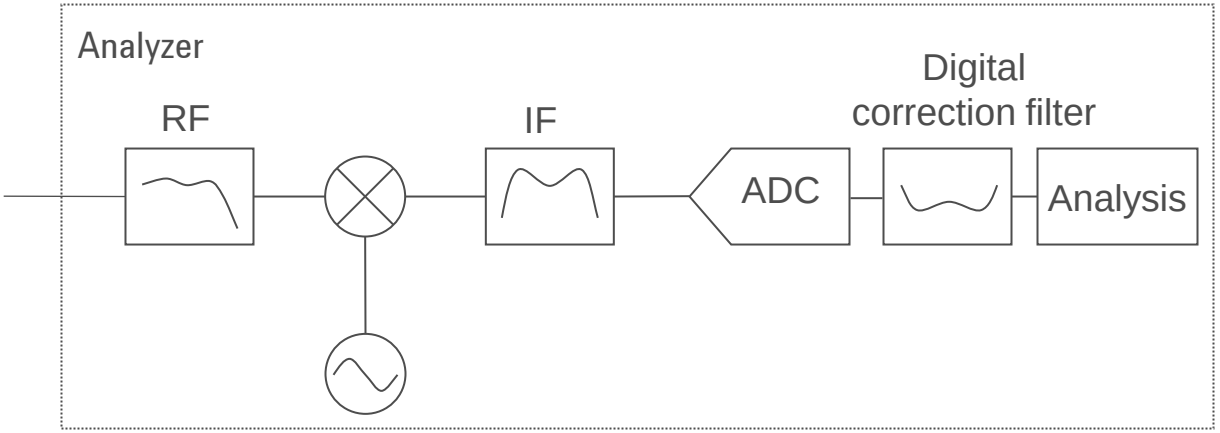
Resampler Block

Wideband Corrections

- **Both the RF front end and the IF are subject to errors**
  - Amplitude response is not constant with frequency
  - Phase response is not linear with frequency
- **Flatness corrections can be done in software but slow**
- **Custom ASIC used to correct data**

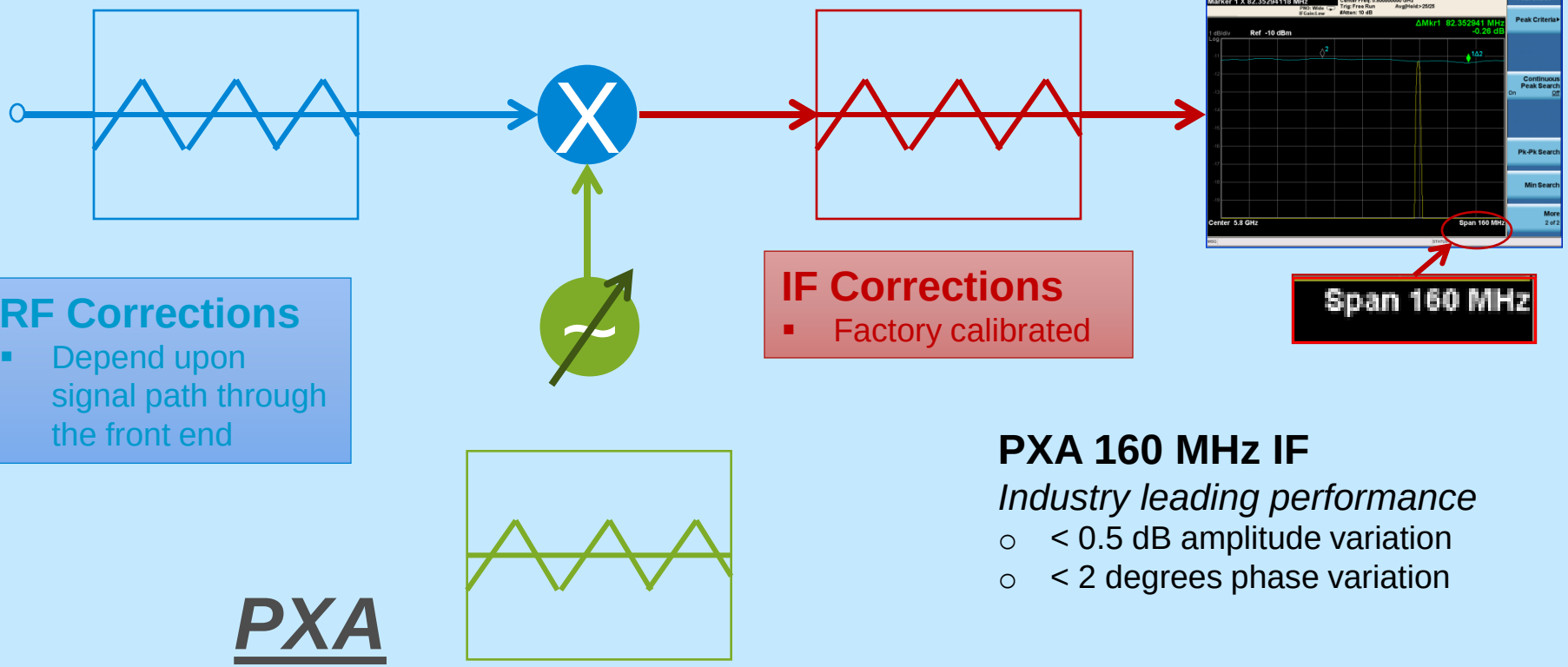






Internal Vector Analysis

The 160 MHz IF in the PXA currently utilizes **3** sets of corrections and other proprietary correction and alignment routines



PXA 160 MHz IF

Industry leading performance

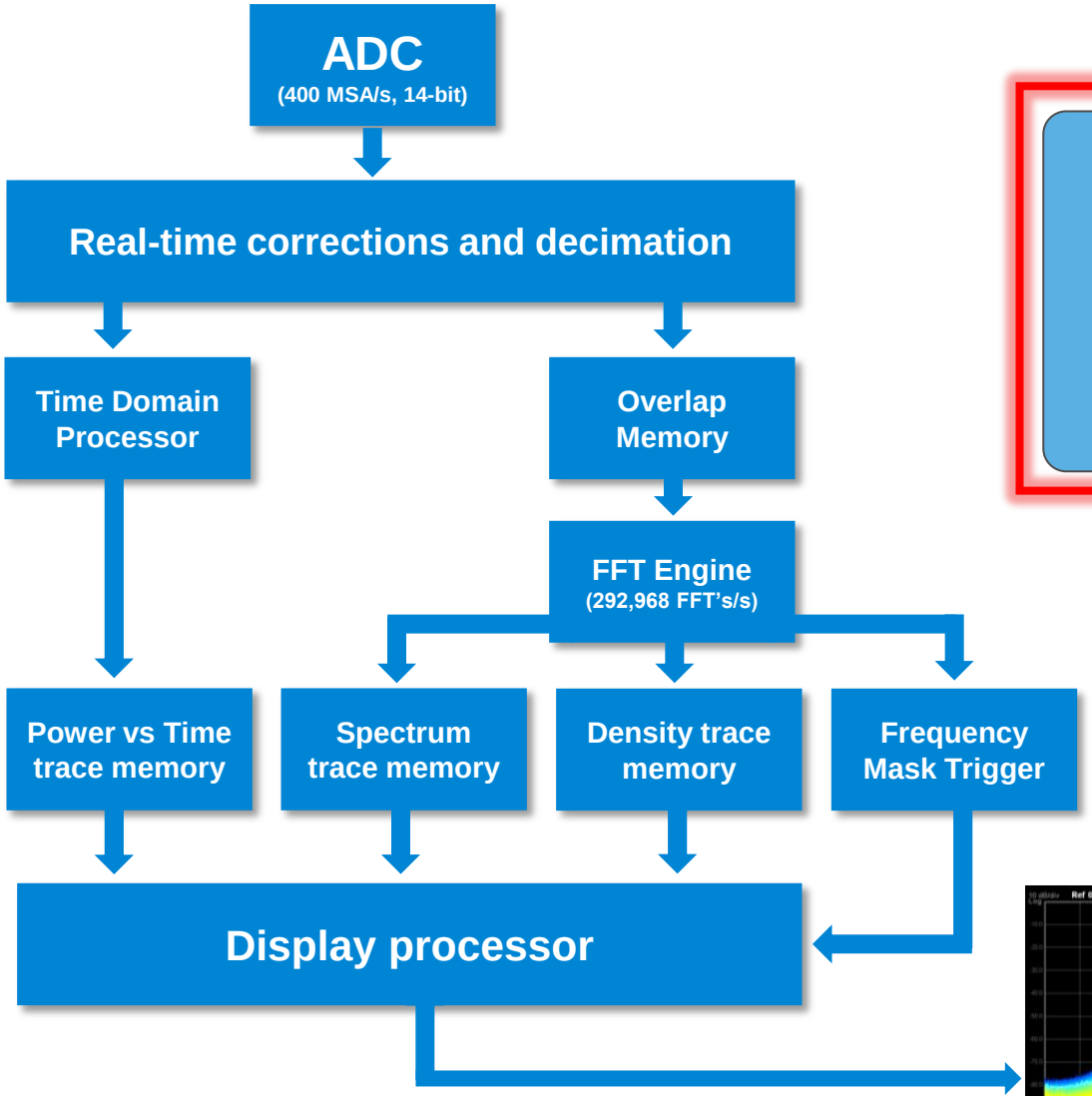
- < 0.5 dB amplitude variation
- < 2 degrees phase variation

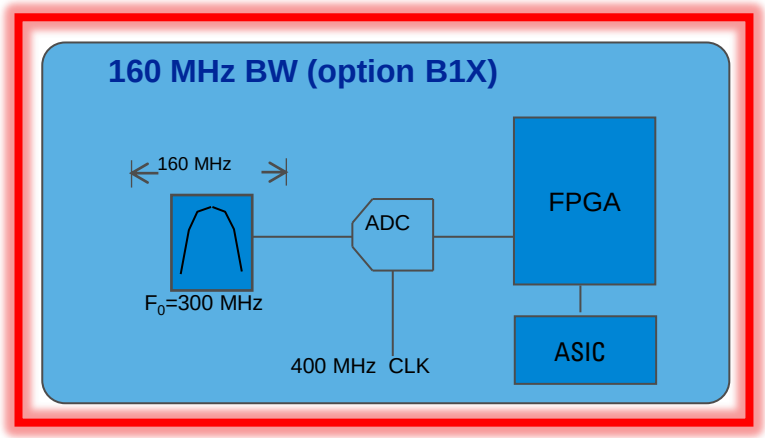
Comparison of Real Time IF performance at 1 GHz

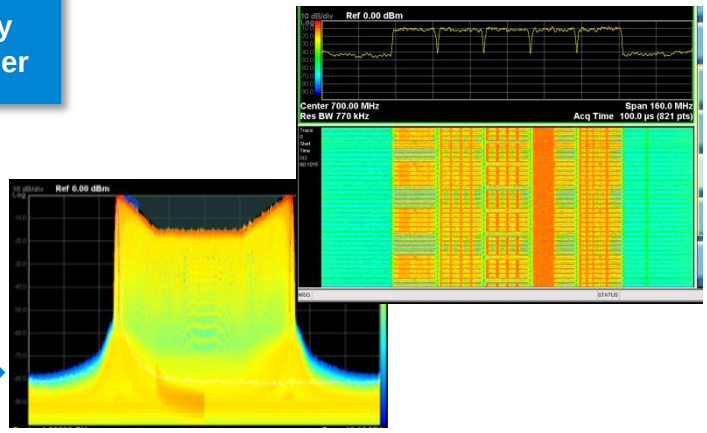
Analysis BW	IF Flatness (dB)			Phase Linearity *Nominal*		SFDR (dBc)	
	PXA	PXA	90000 Scope	PXA	90000 Scope	PXA	90000 Scope
Spec	Typical	Nom	Nom	Nom	Nom	Typical	Nom*
10 MHz	± 0.12	± 0.3	± 0.7	± 0.06º	TBD	-80	-65
25 MHz	± 0.12	± 0.3	± 0.7	± 0.48º	TBD	-80	-65
40 MHz	± 0.25	± 0.3	± 0.7	± 0.16º	TBD	-79	-65
80 MHz	± 0.17	± 0.3	± 0.7	± 0.9º	TBD	-74	-65
140 MHz	± 0.25	± 0.5	± 0.7	± 0.9º	TBD	-74	-65

* Depends upon sampling/carrier frequency

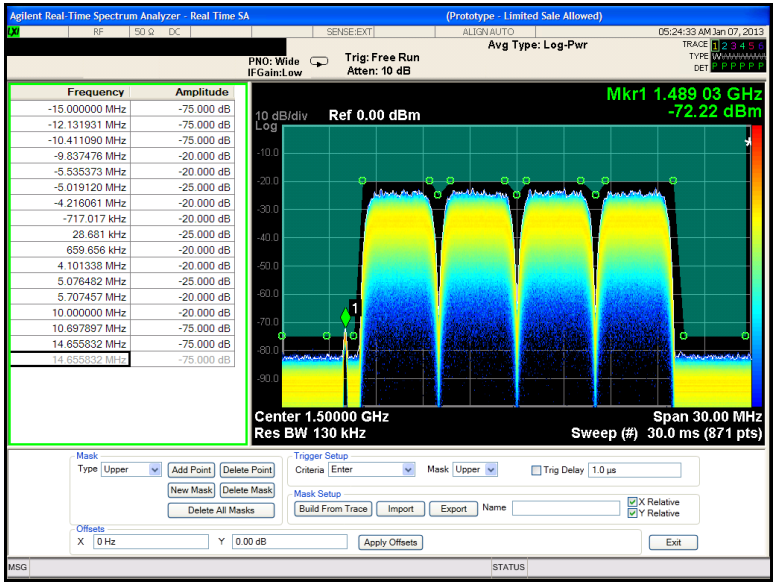
How Does a Real Time Spectrum Analyzer Work?

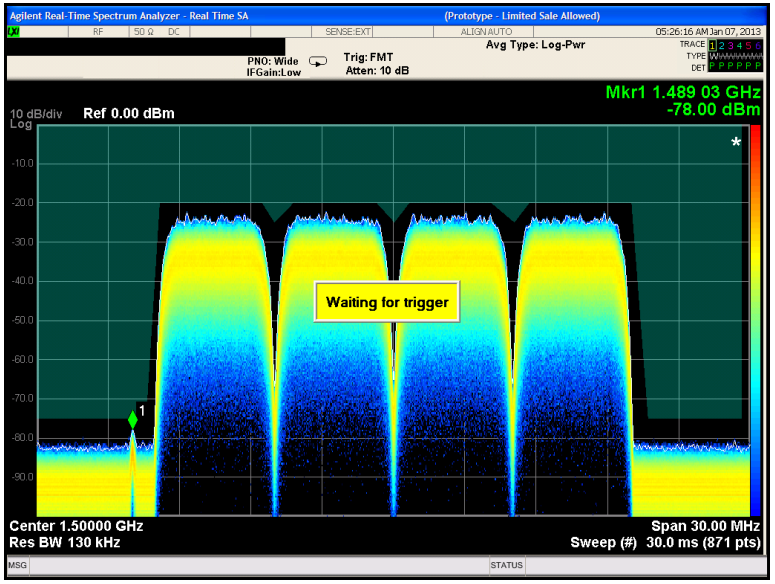






Frequency Mask Trigger (FMT)



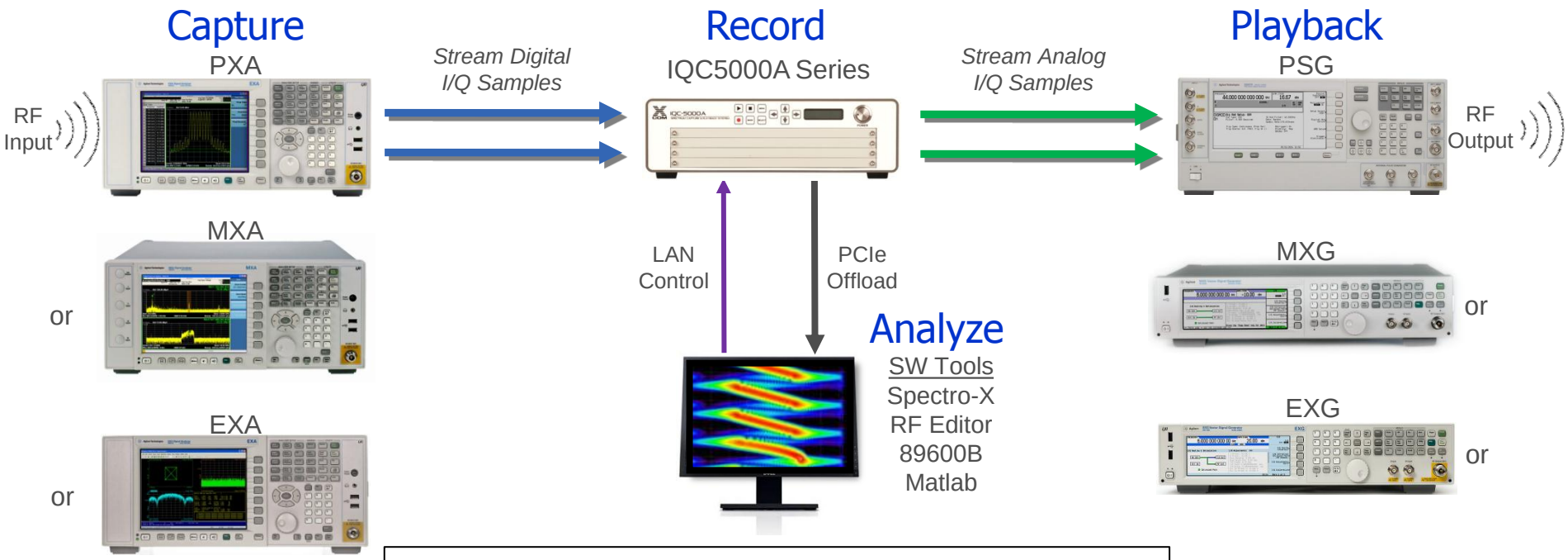


- Build Mask from trace and add offsets if required
- Edit table or use mouse to drag the mask points to the desired location
- Various criteria for Trigger: Enter, Leave, Inside, Outside, Enter → Leave, Leave → Enter
- Upper, Lower or Both masks available
- Import or Export masks as required
- FMT Combined with 89600B VSA software for further analysis

Video Example

Deep Recording

Using IQ Streaming



- Use high quality signal analyzer as RF front-end

- Continuously record 100% of RF spectrum
- No need for prior knowledge of signal characteristics
- Search and ID Signals of Interest
- Manipulate and re-transmit signals

- Agilent generator re-creates RF at any desired frequency

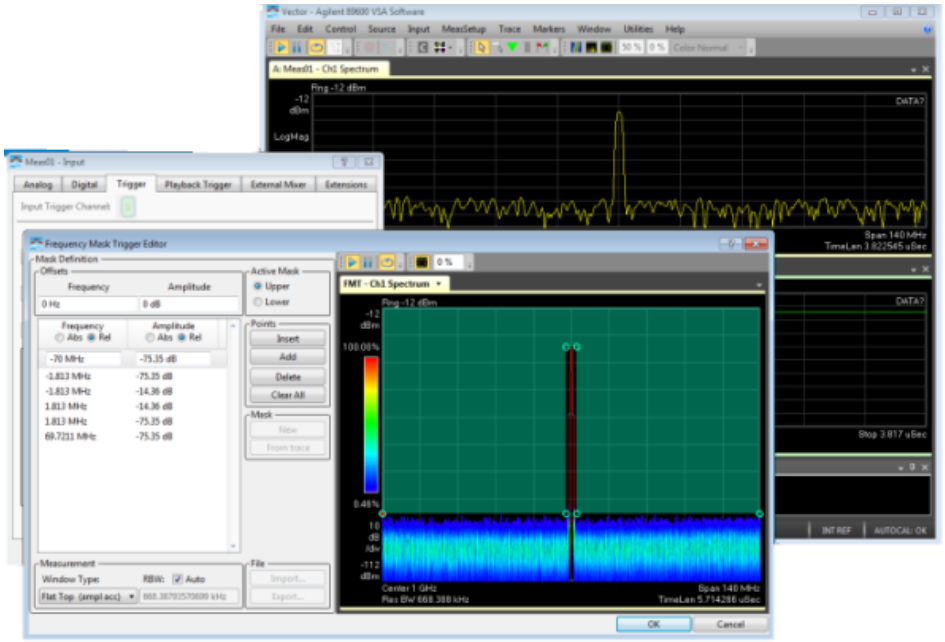
Capture and Playback with Exceptional Signal Fidelity

Using Post Processing for Deeper Analysis

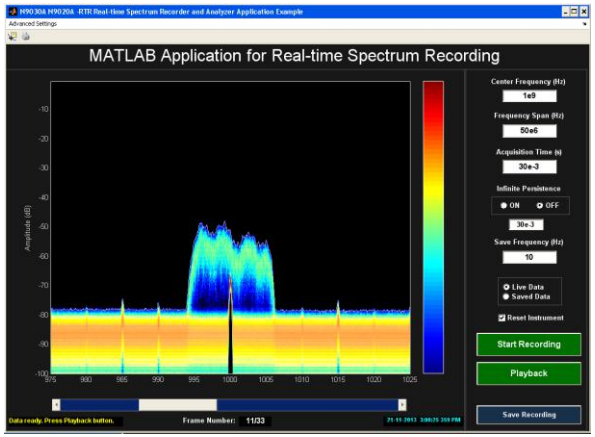
Advantages
- Mix and match FFT size and window size
- Use 99.99% overlap (view signal sample by sample)
- Correlation techniques are easier to accomplish
- Visualize data in multiple domains
- Typically more measurements
- Cataloged for reference

Trade-offs:
- Acquisition limited
- Longer analysis time

Using FMT
- More efficient capture
- Easier implementation



How about real-time export?

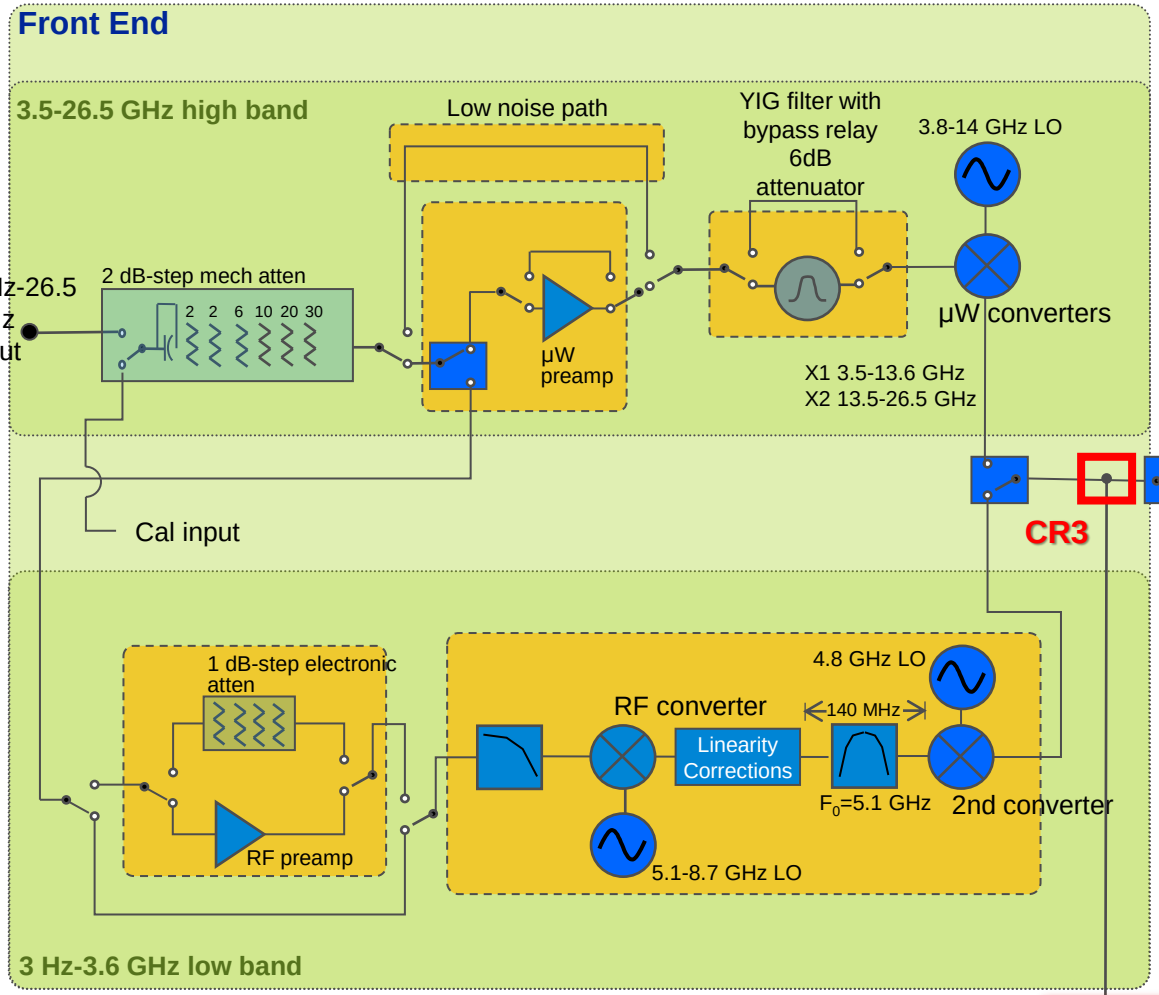


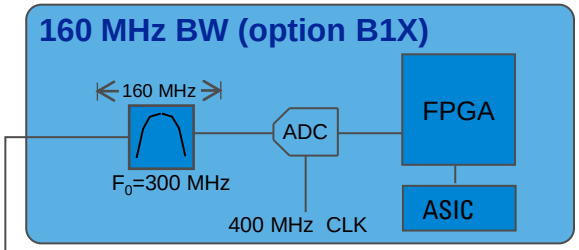
- **Record live spectrum signals - directly on the RTSA – for immediate or post signal analysis**

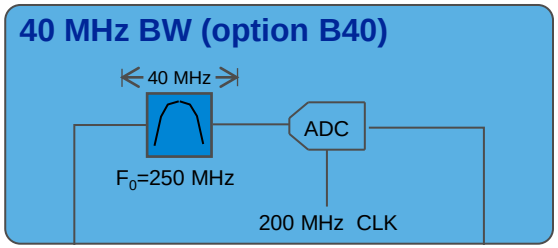
- Useful applications:
  1. Detecting and analyzing signal anomalies - often the edge cases customer need to find – but the hardest to detect.
  2. Identifying the highest power signal received during a period interest by you placing density and density envelope cursors.
  3. Studying a signal spectrum in which low-powered signals are followed by high-powered signals at the same frequency.
  4. Studying a spectrum in which multiple signal bursts occur at different frequencies at different times and the relative times and the number of occurrences of the signals at each frequency is important
  5. Complete future capability expansion by providing the application's source code and MATLAB software – automatically included with the option.

Simplified Block Diagram of PXA

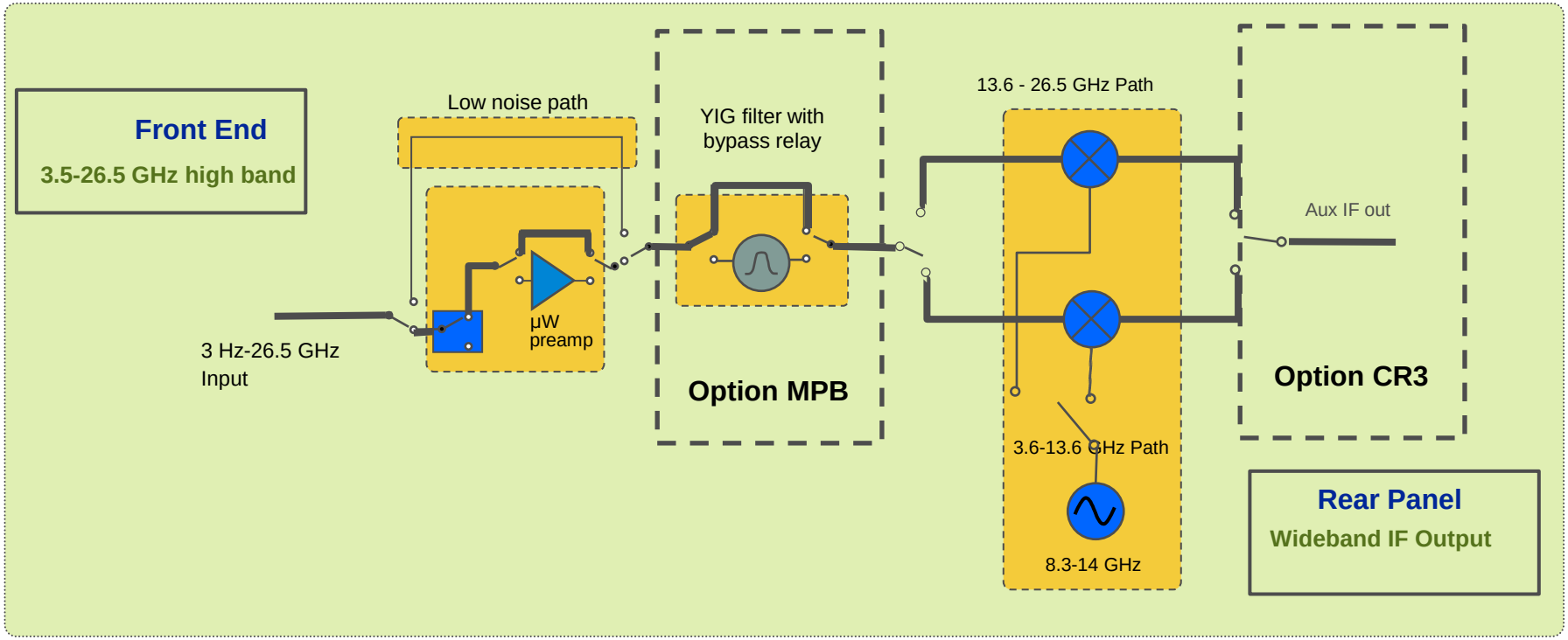
26.5GHz model



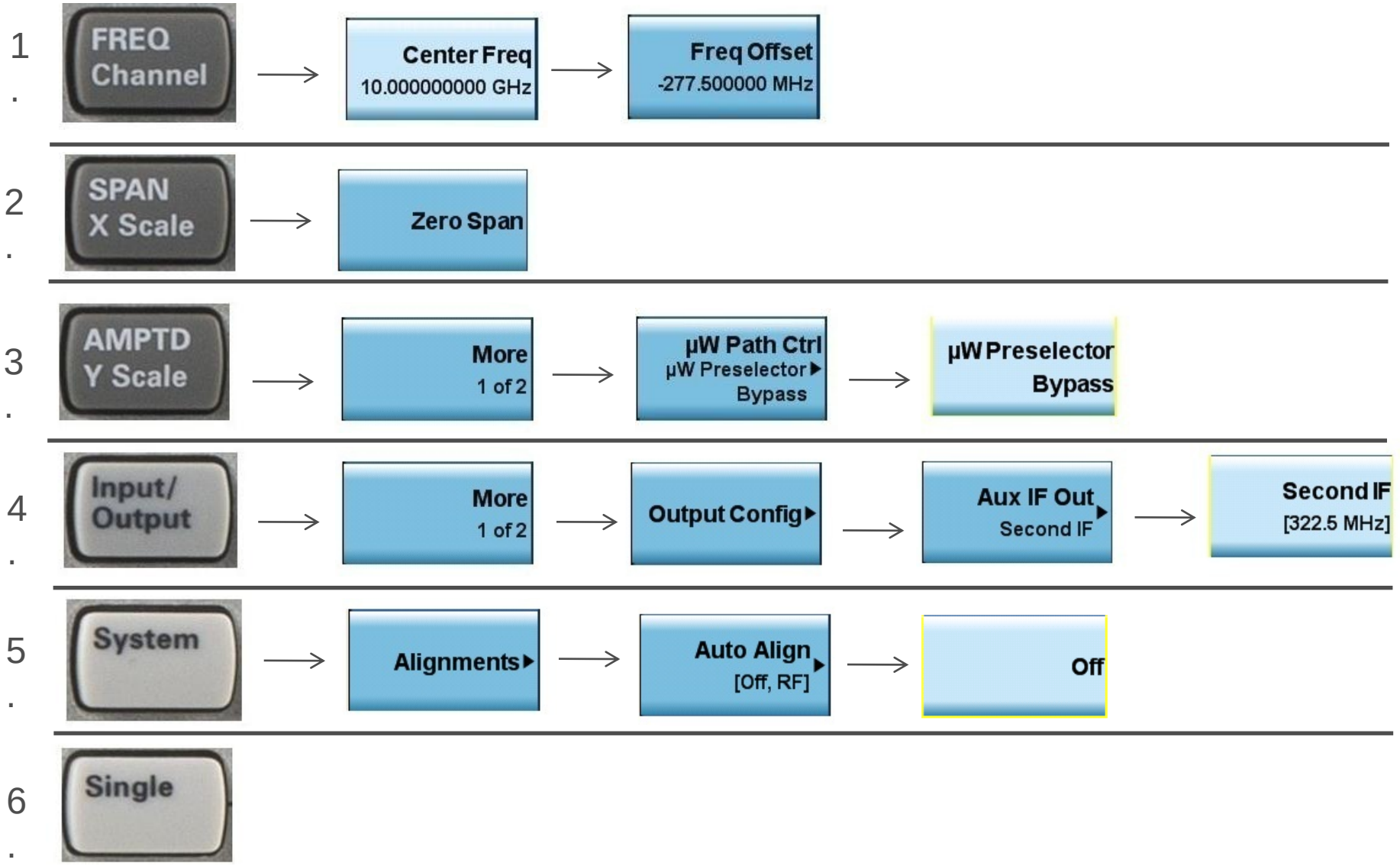




PXA Simplified Block Diagram (Option CR3)

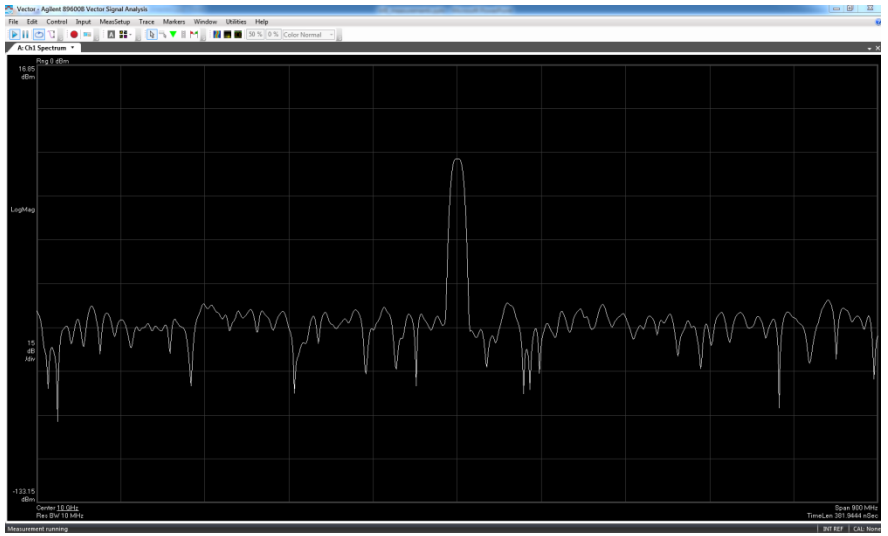


Traditional Method for Calibrations – PXA set-up

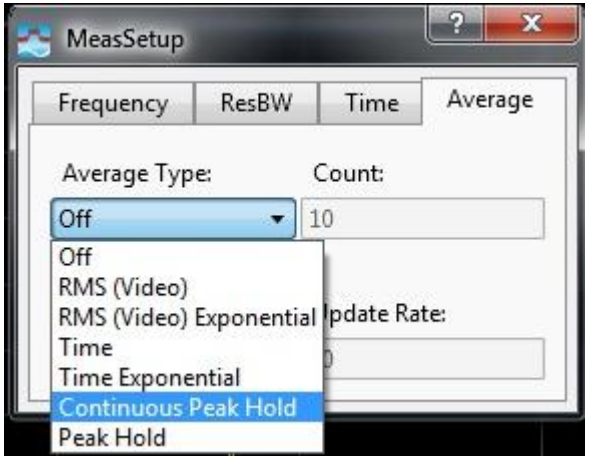


Traditional Method - Correcting Downconverter Frequency Response

1. Configure your source for a 0 dBm CW at the desired carrier

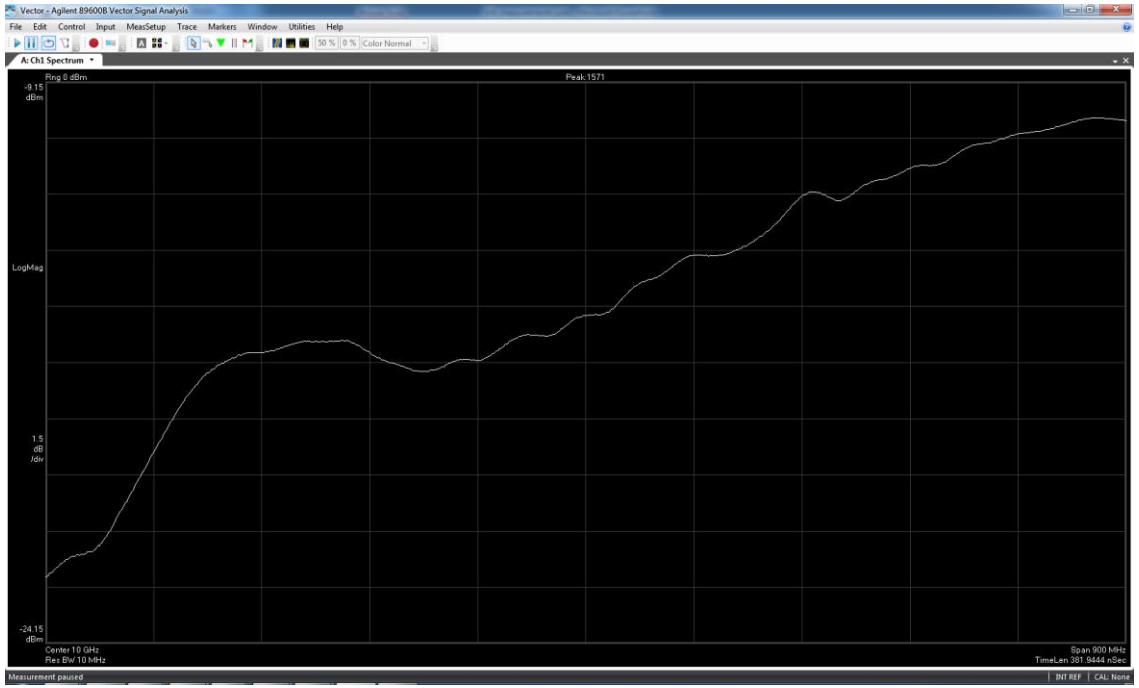


2. Set VSA averaging to “continuous peak hold”



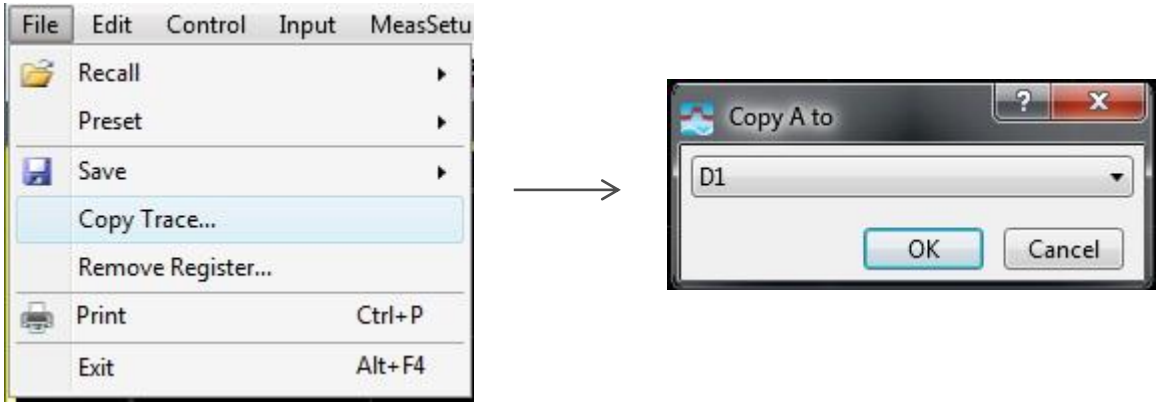
Traditional Method - Correcting Downconverter Frequency Response

1. Program your source to slowly sweep across the desired band
2. Be sure that the ADC is not being overdriven during the sweep.
3. Use an external leveling loop if necessary

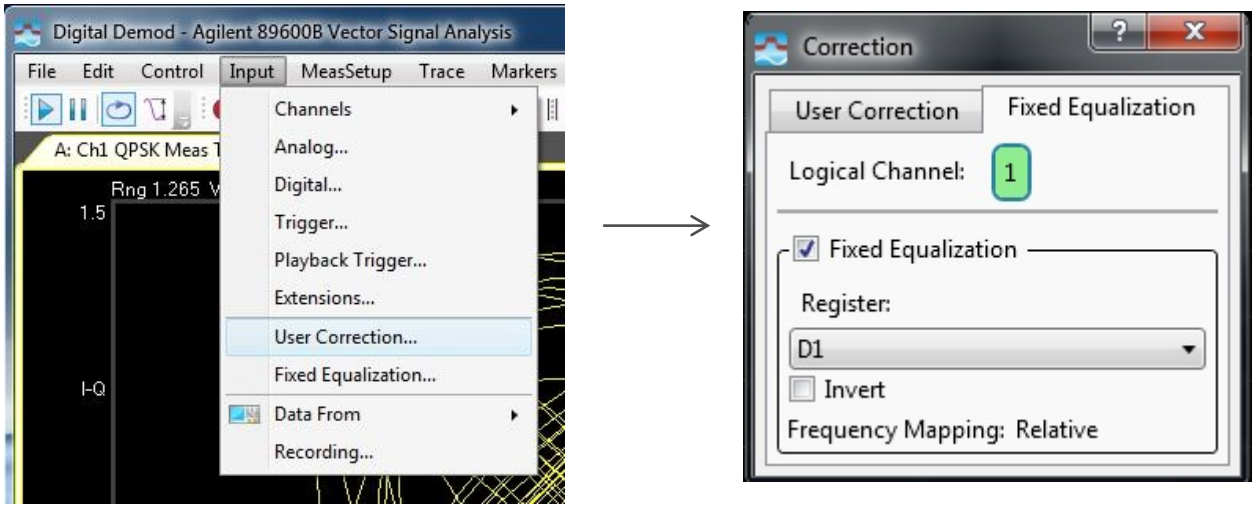


Alternative Method - Applying Frequency Response Corrections

1.

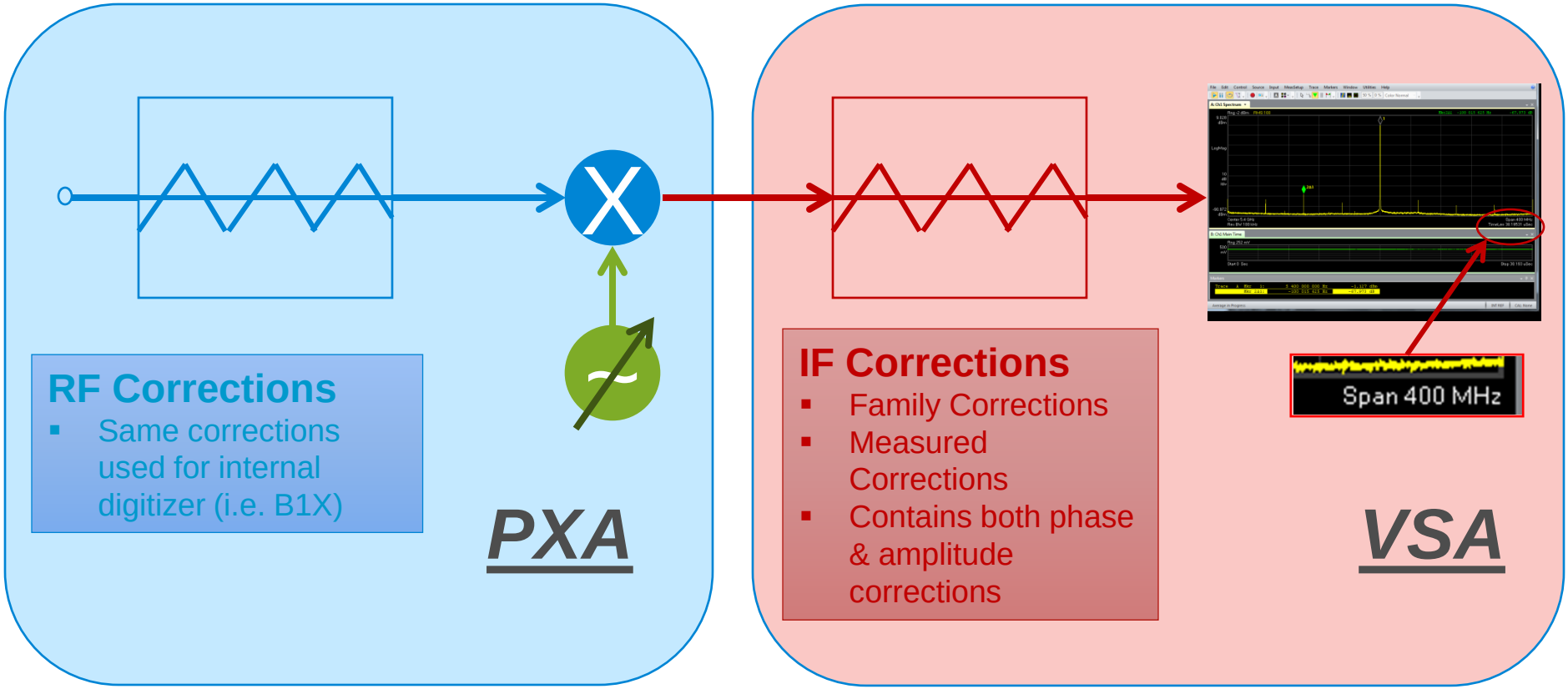


2.



A New Approach: "Auto" Calibration for Wideband Analysis

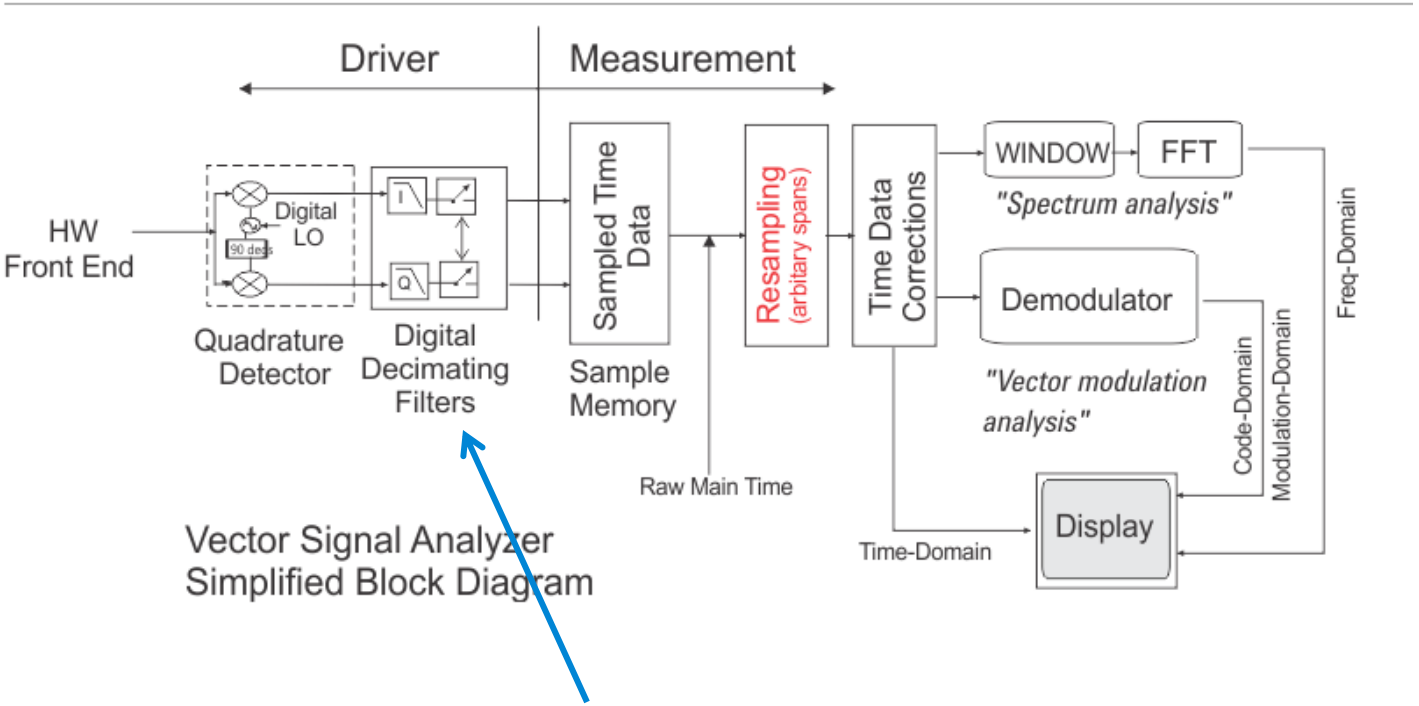
The new PXA/Scope currently utilizes **2** sets of corrections



N9070A – PXA/Scope

- < 2 dB amplitude variation*
- < 5 degrees phase variation*

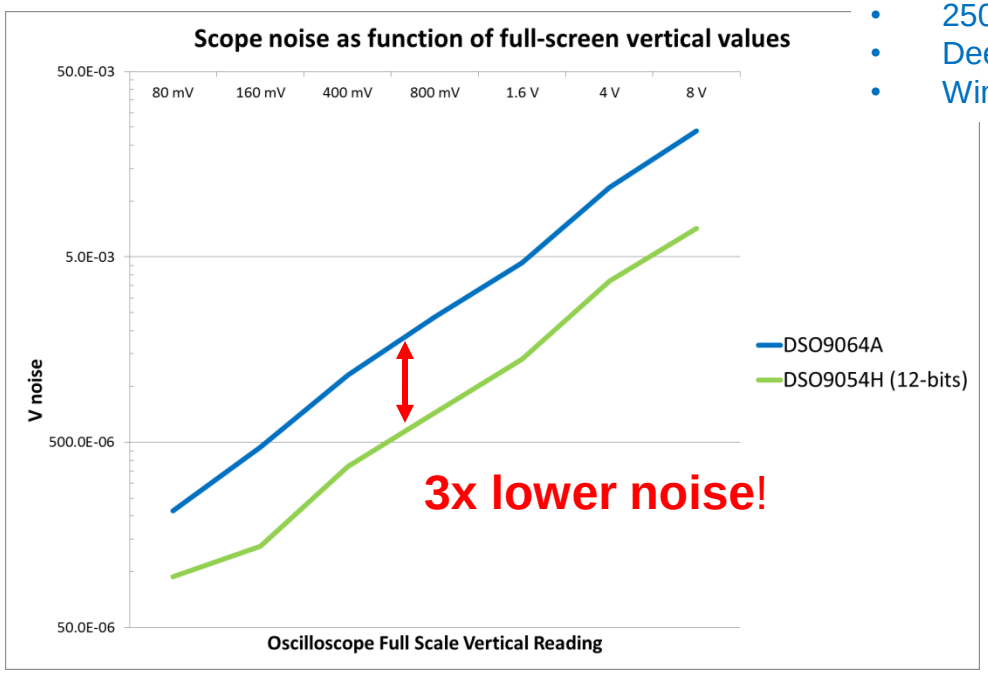
The 89600 VSA with an Oscilloscope



By default, the VSA controls the scope in driver mode, which performs digital decimation within the VSA Infiniium driver.

What is an HD Oscilloscope?

1. > 8 bits of vertical resolution (up to 12)
2. Significantly lower noise than traditional scopes



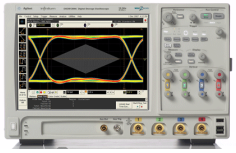
Infiniium

- 250 MHz to 63 GHz
- Deep memory debug & analysis
- Win7 OS


DCA-X Sampling


90000 Q-Series


90000 X-Series


90000A Series


9000A Series

9000H Series

Hypersampling and Linear Noise Reduction

Signal (DUT)

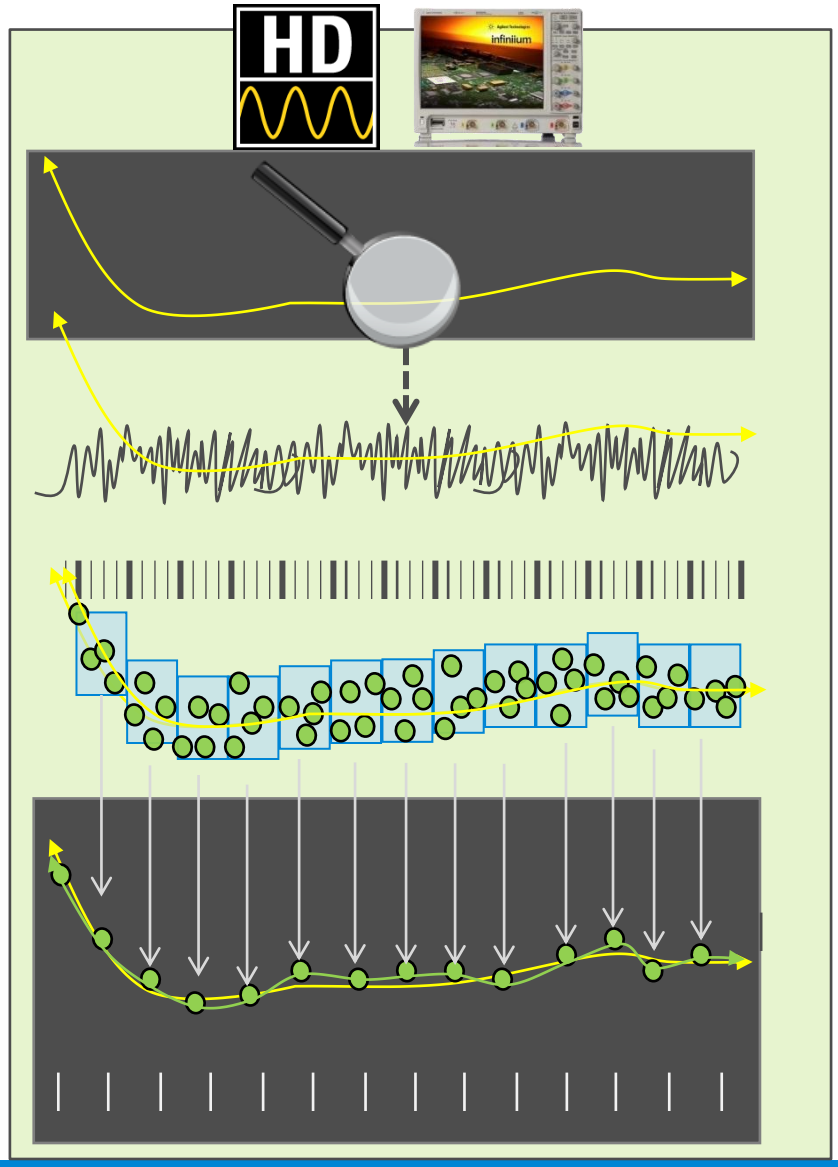
Front-end Noise

"Hypersamples" (up to 16X per group)

HW-based linear averaging of each group

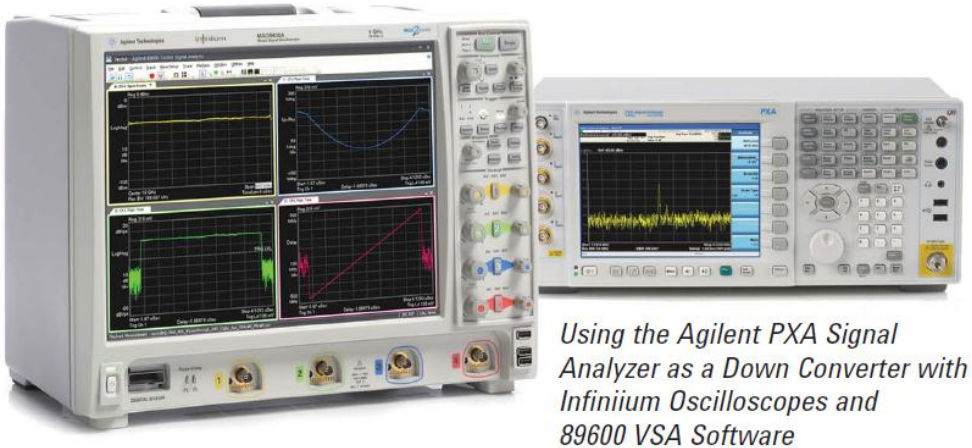
Scope stores group average to memory

Scope display →



Store to acquisition memory→

9000H Specs



Using the Agilent PXA Signal Analyzer as a Down Converter with Infiniium Oscilloscopes and 89600 VSA Software

	DSO9024H	DSO9054H	DSO9104H	DSO9204H
Scope channels	4	4	4	4
Bandwidth	250 MHz	500 MHz	1 GHz	2 GHz[1]
Max sample rate	1.25 GSa/s	2.5 GSa/s	5 GSa/s	10 GSa/s
Standard memory (2-ch)	100 Mpts	100 Mpts	100 Mpts	100 Mpts
Bits of resolution	12	12	12 at < 500 MHz	12 at < 500 MHz
			10 at 1 GHz	10 at 1 GHz
				10 at 2 GHz
Noise (at 100 mV/div)	700 uV	720 uV	1.1 mV	1.5 mV
MSO and app upgrades	√	√	√	√

1. 2 GHz bandwidth in 2-channel mode, and 1 GHz bandwidth when all 4 channels are enabled.

M9703A performance:
Great for multi-channel and improved DR

DC-2GHz input frequency range; 3.2 Gsa/sec

Figure 21. One Agilent M9703A AXIe 12-bit digitizers and one M9536A embedded AXIe controller installed in the Agilent M9502A 2-slot AXIe chassis.

RF characteristics		
Nominal EVM using Agilent 89600B VSA software		
GSM BTS signal	@ 900 MHz @ 1.8 GHz	–51 dB (*nominal*) –48 dB (*nominal*)
DVB-T signal	10 MHz BW @ 850 MHz	–53 dB (*nominal*)
Spurious-free dynamic range (SFDR) nominal performance measured with Agilent 89600B VSA software [2]		
SFDR	30 MHz BW @ 900 MHz	–92 dBc (*nominal*)
	80 MHz BW @ 900 MHz	–90 dBc (*nominal*)
	100 MHz BW @ 400 MHz	–92 dBc (*nominal*)
	400 MHz BW @ 400 MHz	–87 dBc (*nominal*)
	625 MHz BW @ 400 MHz	–83 dBc (*nominal*)

~60 dBc SFDR at 410 MHz, 800 MHz span

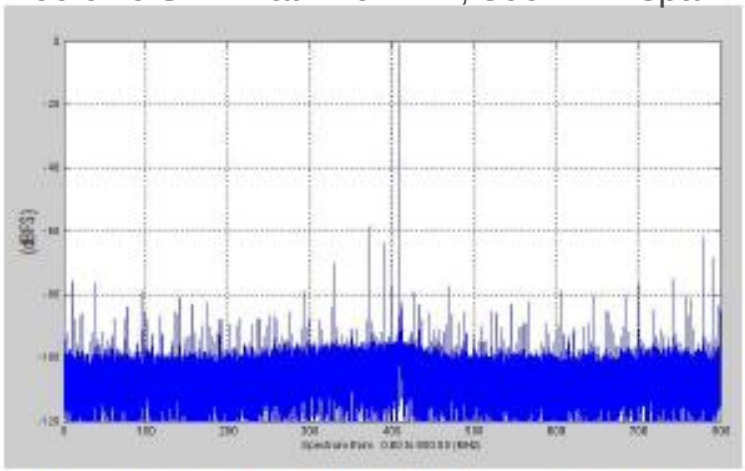


Figure 13. M9703A nominal dynamic performance in 1 V FSR for a –1 dBFS input signal at 410 MHz. Note how the dynamic range is still excellent for high frequency signals.

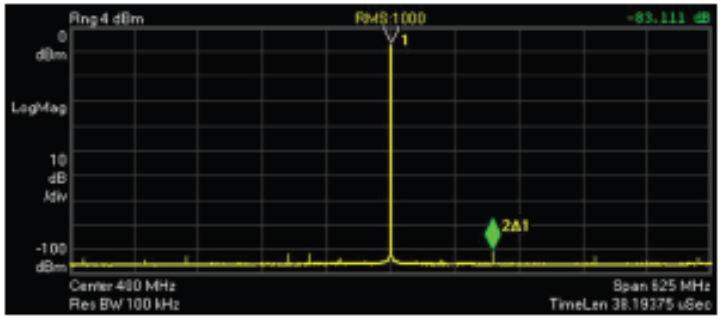
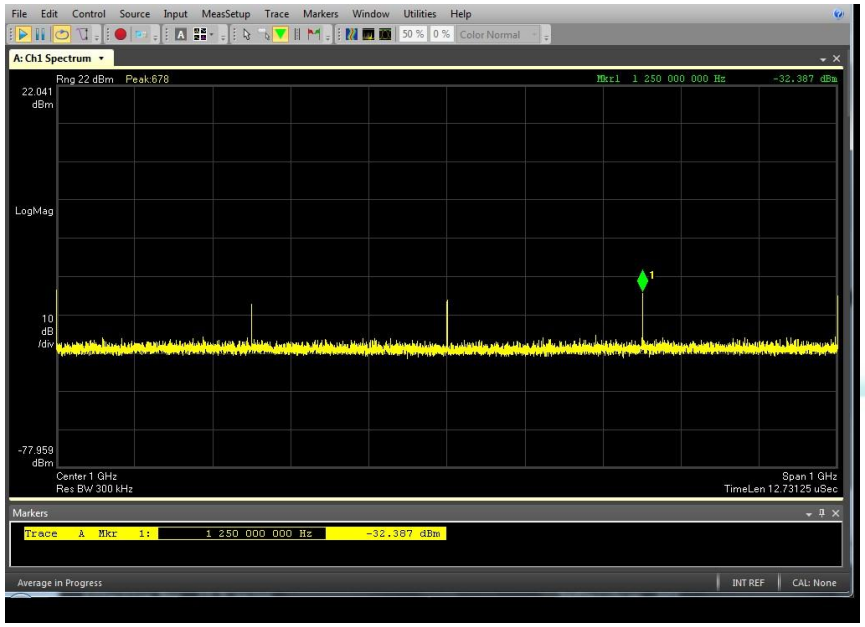


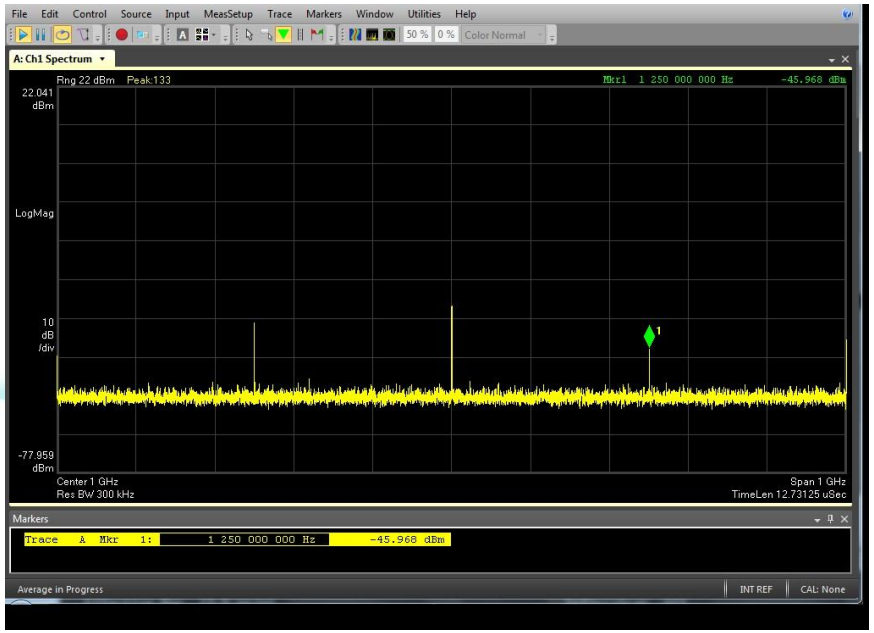
Figure 16. The M9703A has excellent dynamic range over a very wide bandwidth. In this example, the spectrum of a 400 MHz single tone signal, using the 89600 VSA software DDC, with 625 MHz frequency span centered at 400 MHz, showing -83 dBc SFDR.

~83 dBc SFDR with signal at CF in 625 MHz span

Oversampling and Digitizer Performance

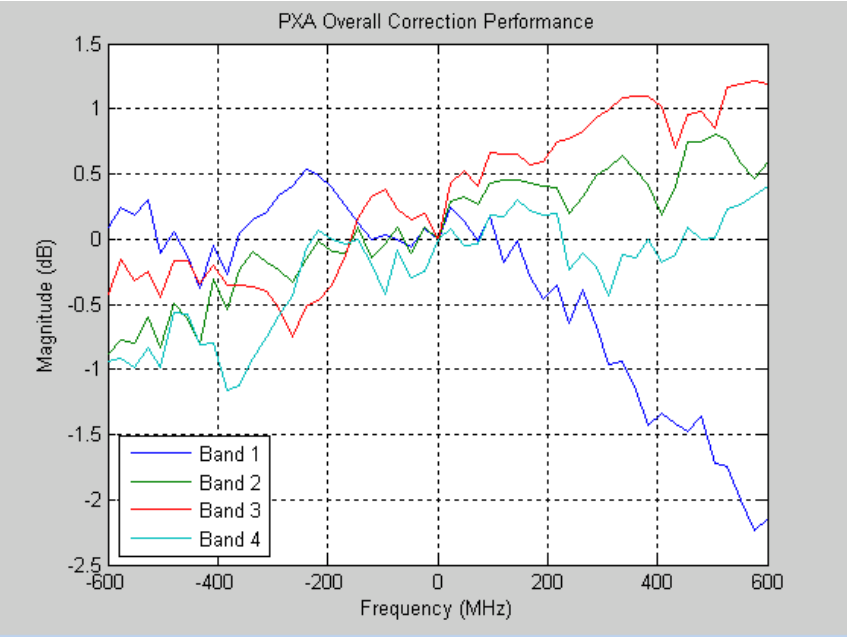
- Noise
- Spurious



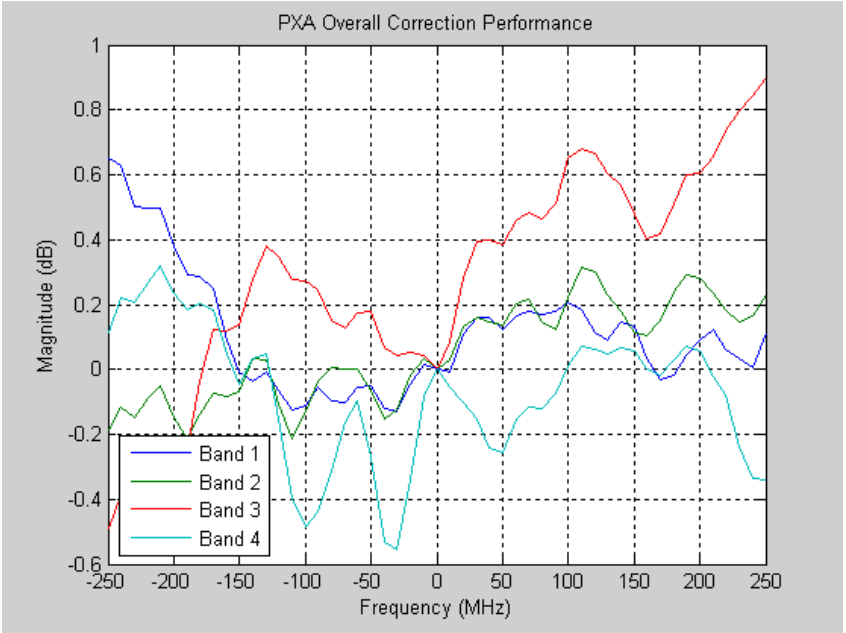


Measurement Results

Preliminary Flatness (using box specific IF corrections)



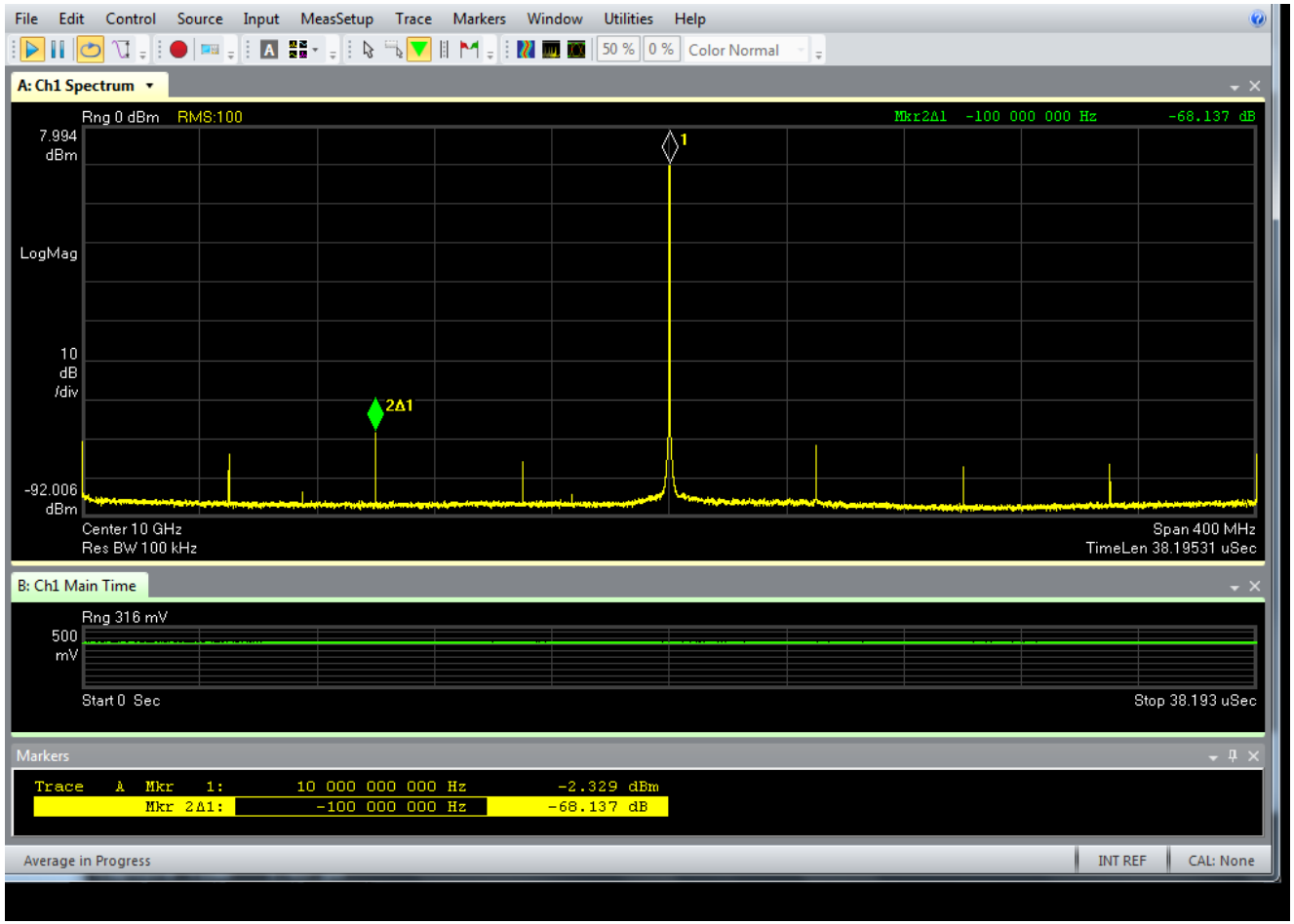
Across 1 GHz Bandwidth
(Higher IF required)



Across 500 MHz Bandwidth
(Lower IF required)

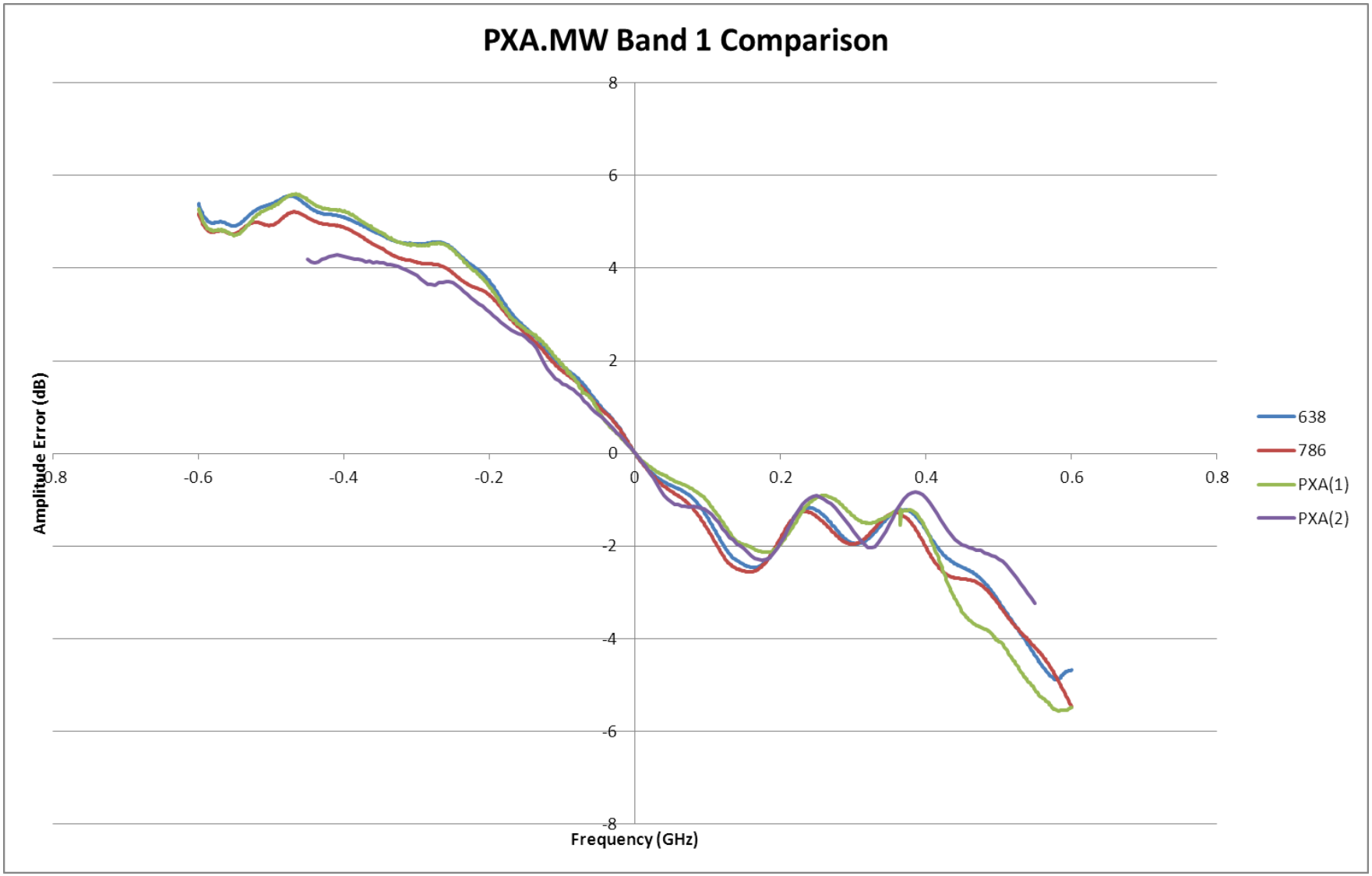
Measurement Results

Band 2

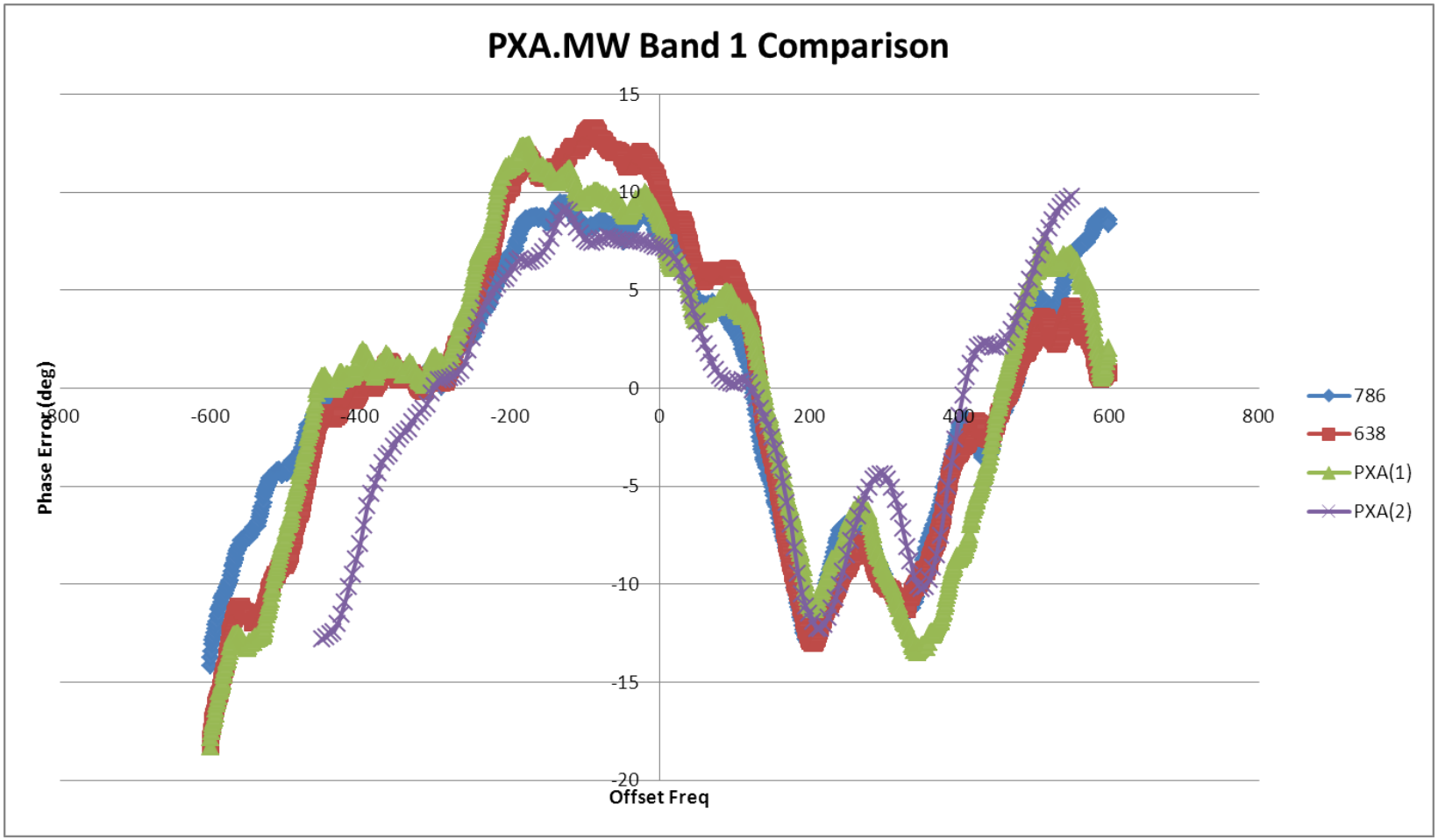


SFDR:~ -68 dBc (center span) **SNR: ~-86dB (RBW 100 kHz)**

IF Output Measurements -Flatness



IF Output Measurements - Phase

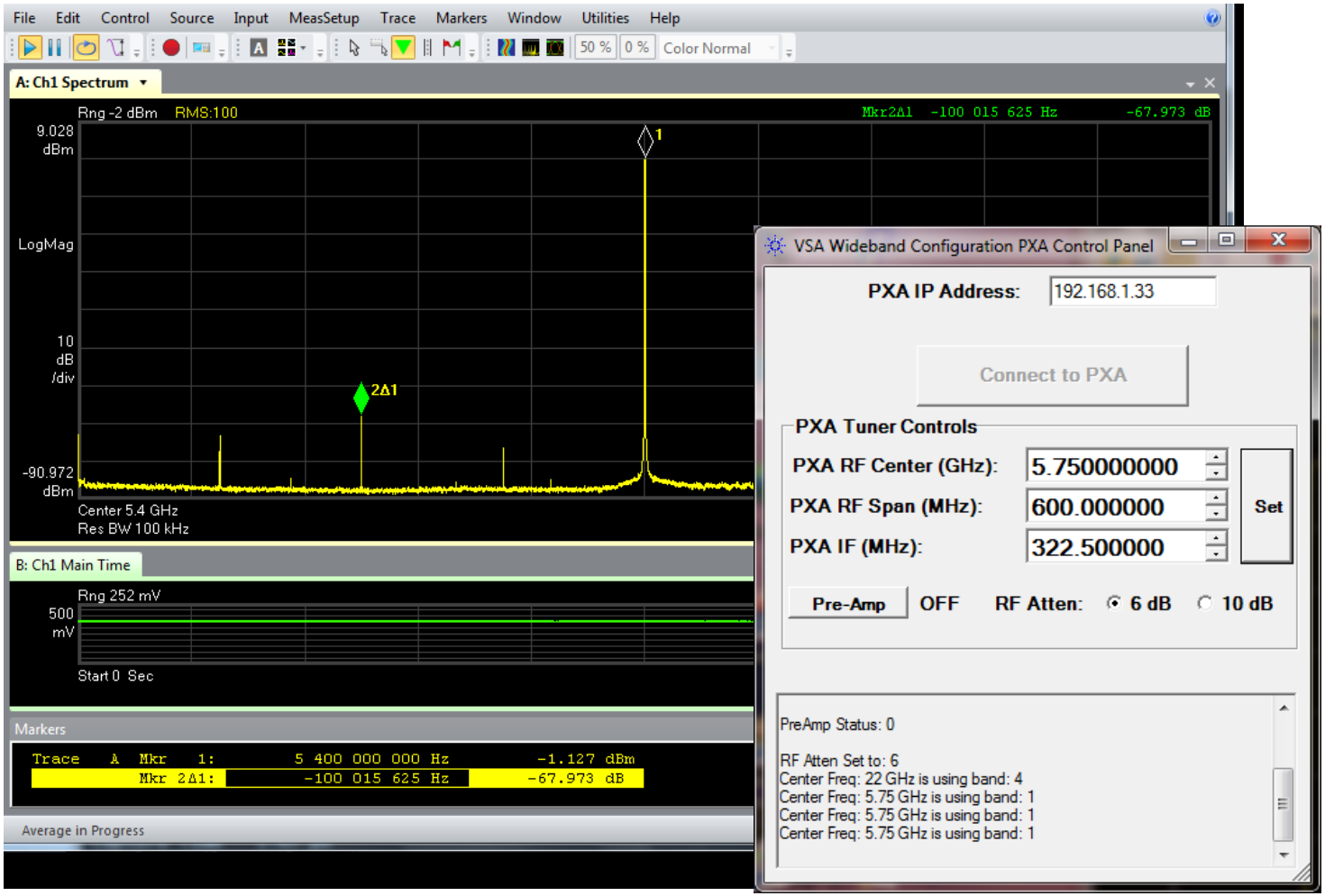


Analog and Digital Considerations

- Temperature
- Absolute amplitude accuracy
- Gain and attn. stages
- Spurs and residuals
- Correction range
- Higher end scopes can provide a better results
- Aliasing
- Processing time

Measurement Results

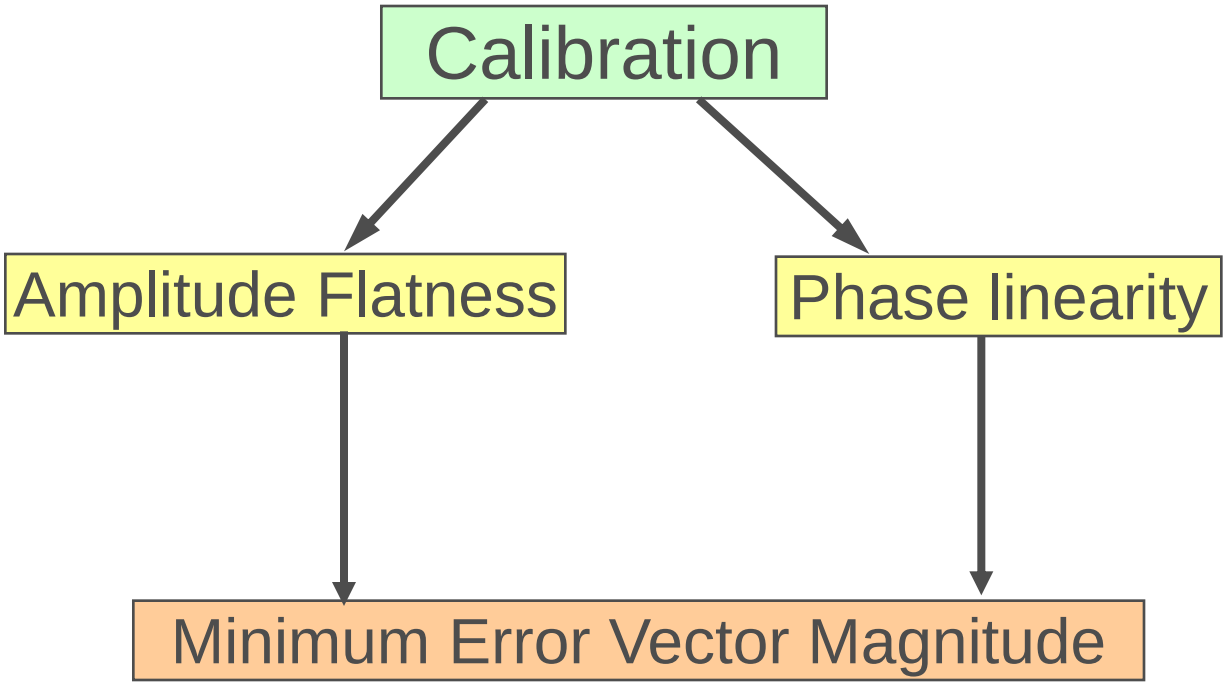
Band 1

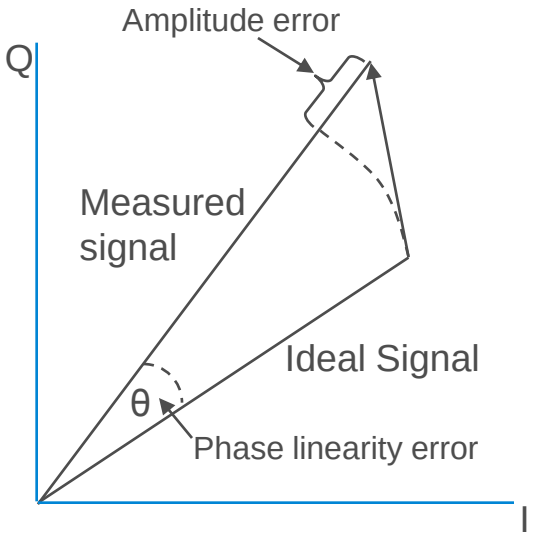


SFDR: ~ -68 dBc (center span)

SNR: ~-86 dB (RBW 100 kHz)

Instrument and System Calibration



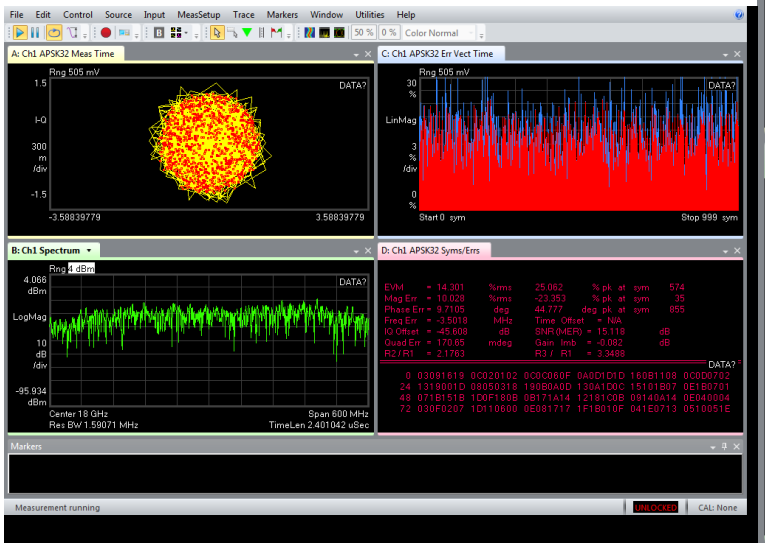


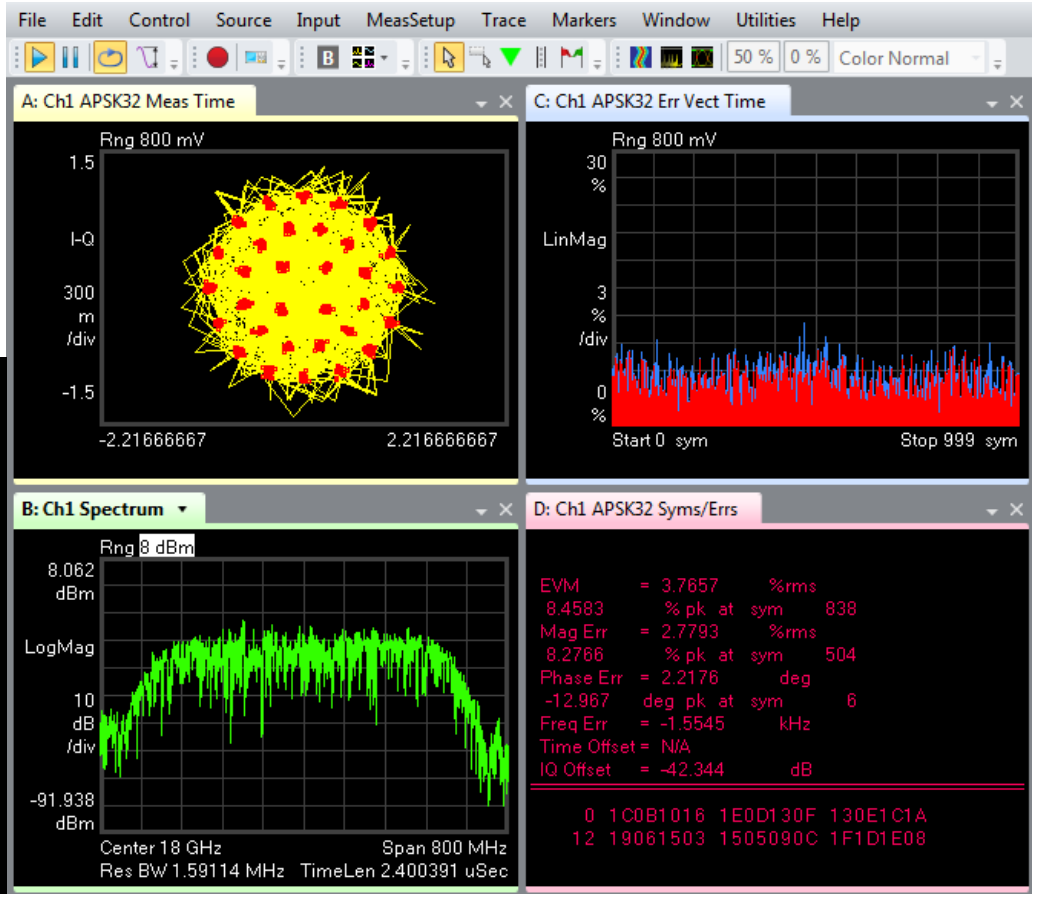
EVM

The goal is to measure the EVM of the DUT not the EVM introduced by the measuring system

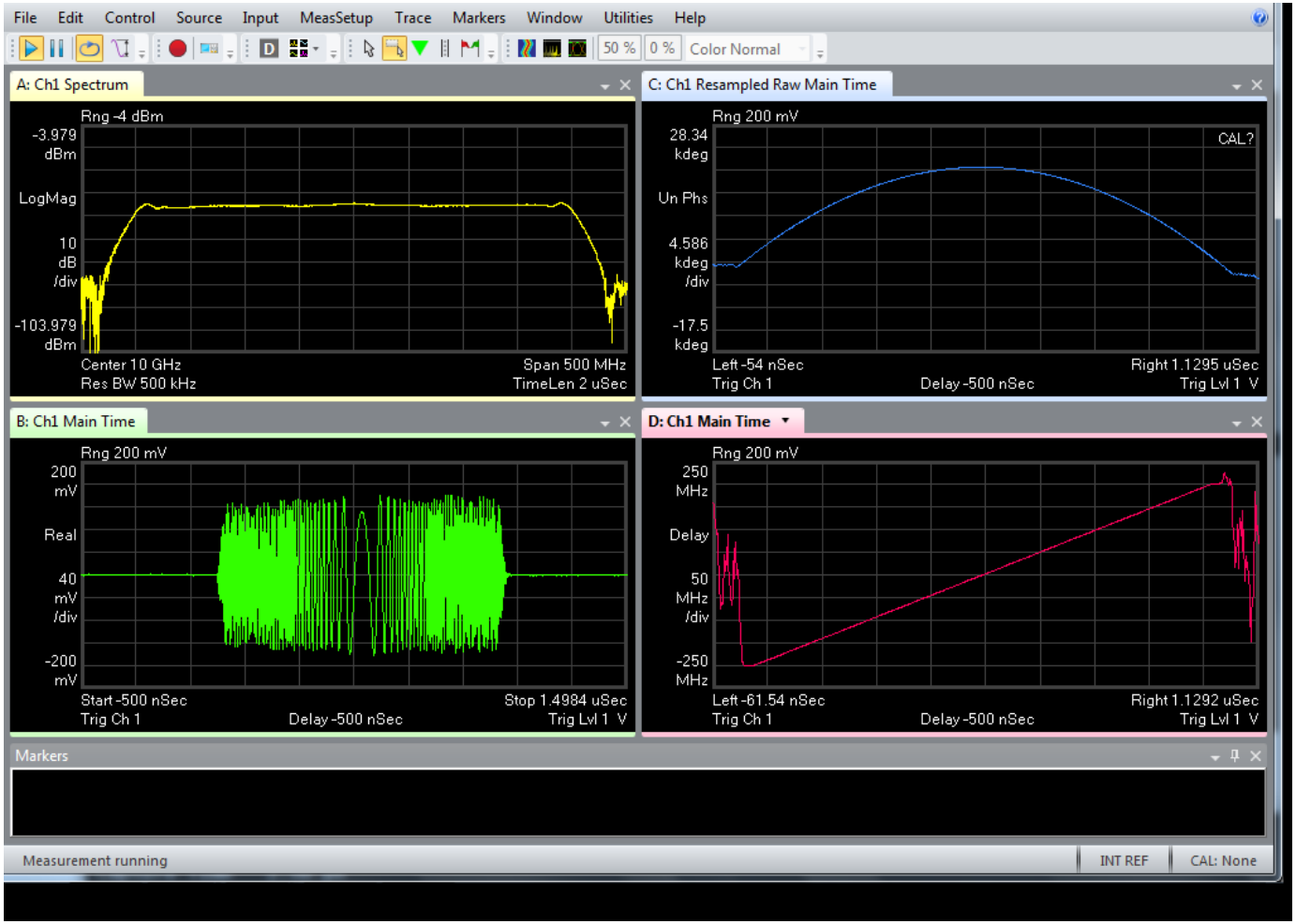
Satellite Test Example

- 500 MHz Signal Analysis



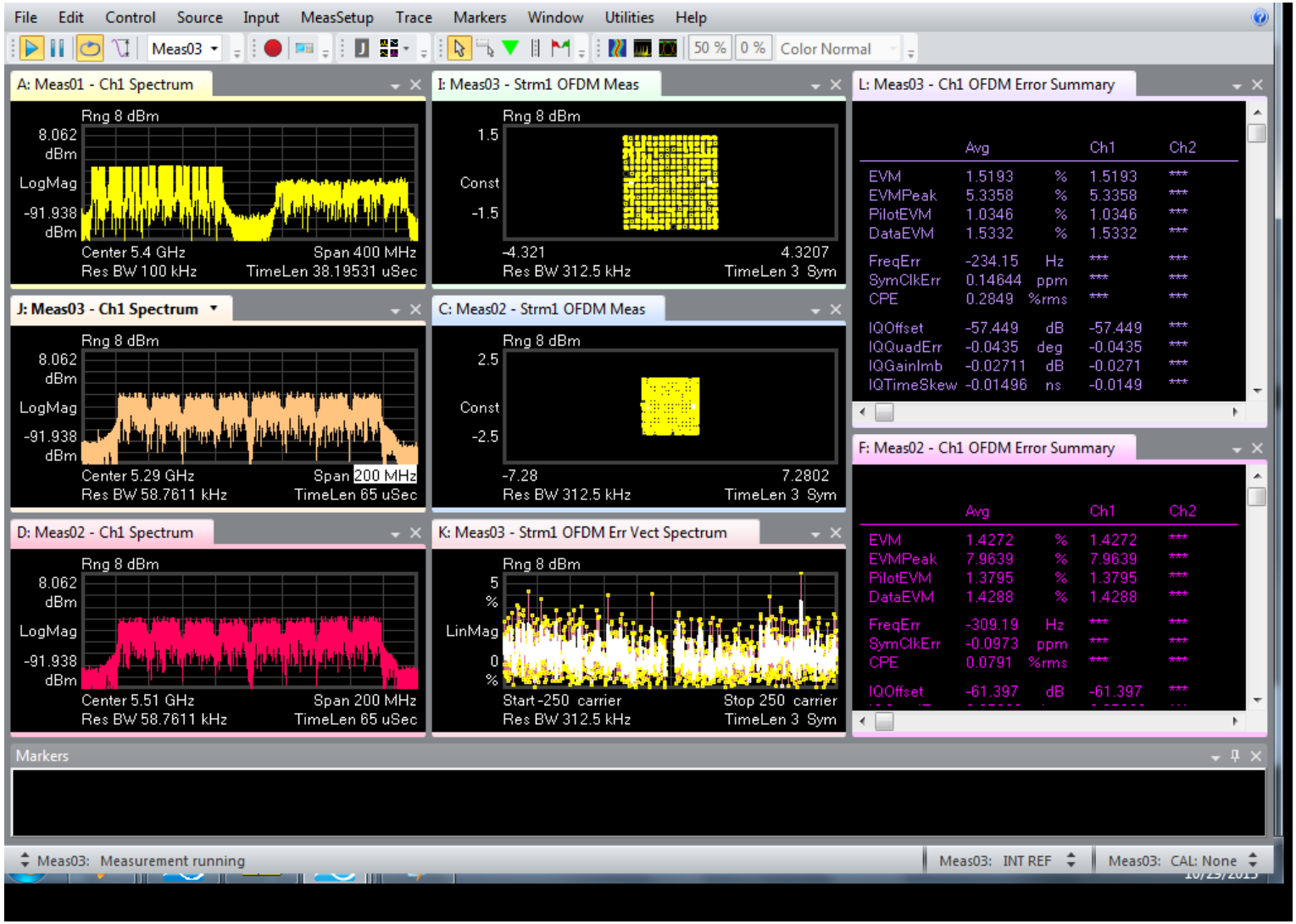


Chirp Analysis



Dual 802.11ac Analysis

Using Multi-measurements



N9070A – PXA with Scope for Ultra Wideband Analysis

Ordering

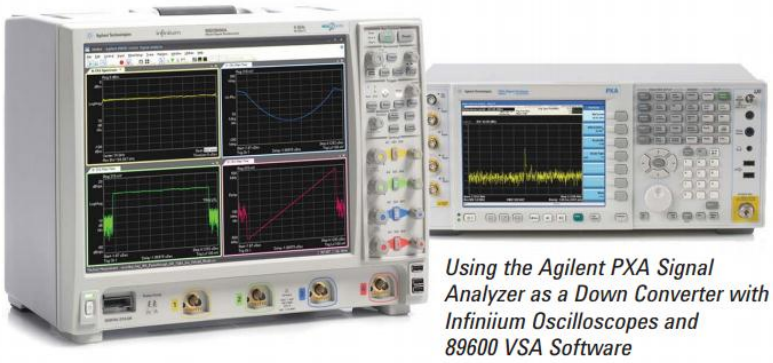
Included: PXA + DSO9204H Scope + VSA (200/300)

- The PXA, and the high dynamic range scope - DSO9204H, and a VSA license (200/300) will be provided.
- Very cost competitive
- Can be ordered by package or by individual products

- ***Order: N9070A-001***

What is does

1. Gives the ability to do vector signal analysis up-to 900 MHz of bandwidth
2. Accurate corrections to help performance
3. “12 bit” performance comparable to other in-the-box solutions
4. Integrated signal analysis with the largest set of measurement capabilities
5. Automatic configurations for user based on span and frequency – no need for user to generate and wait for calibrations



Using the Agilent PXA Signal Analyzer as a Down Converter with Infiniium Oscilloscopes and 89600 VSA Software

Questions?