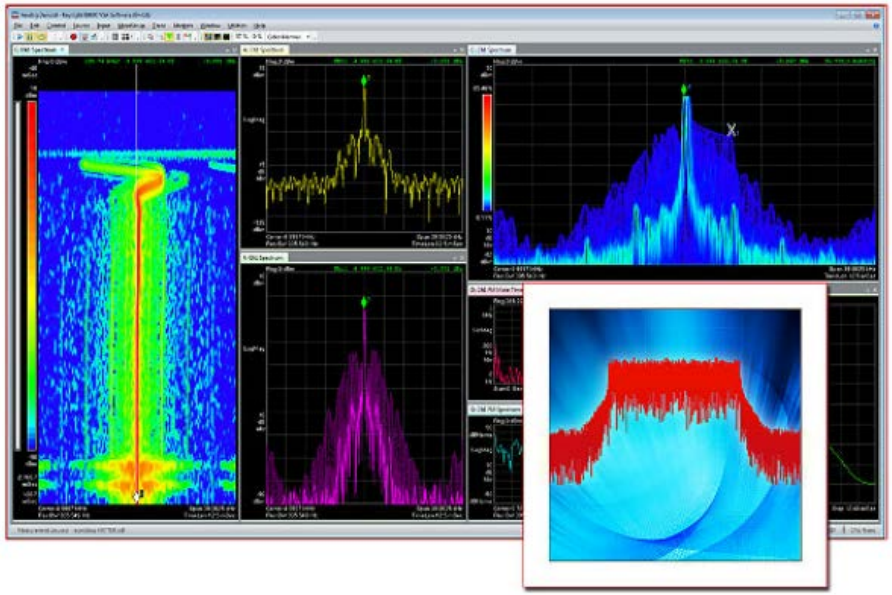
Vector Signal Analysis Basic

January 2017

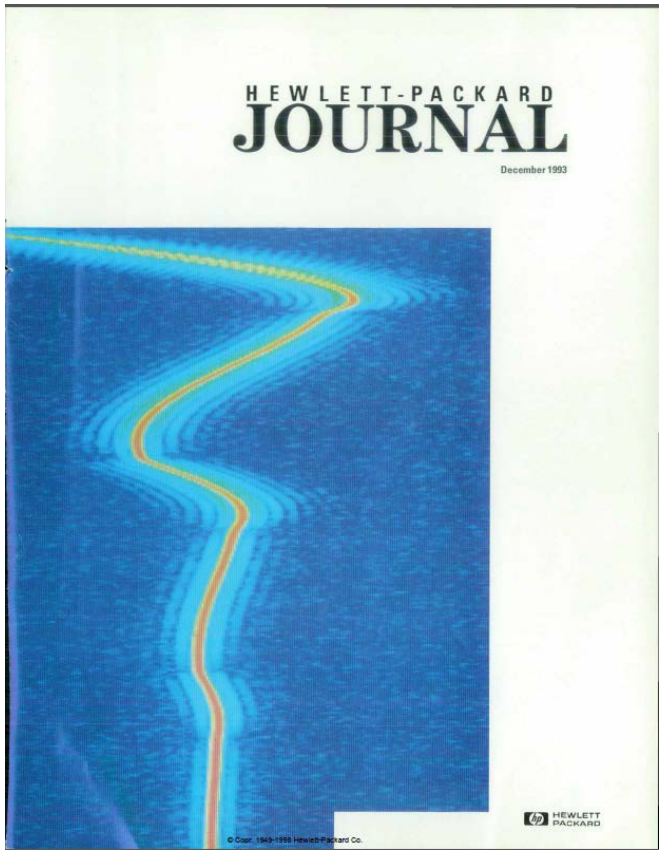


KEYSIGHT TECHNOLOGIES

KEYSIGHT HOTSPOTS
Where Technologies and Experts Meet

Hewlett-Packard Journal article December 1993 details 89400 Series Vector Signal Analyzer

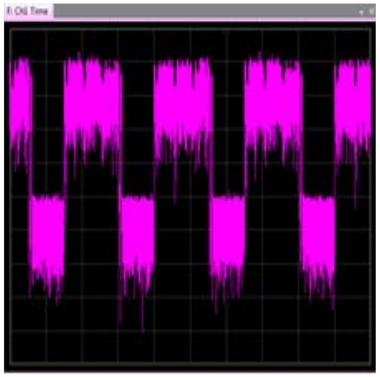
The Worlds First Vector Signal Analyzer (VSA)



89600 VSA Software

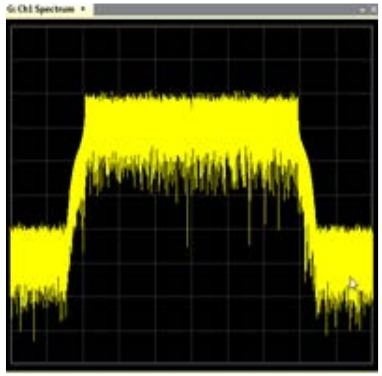
A comprehensive toolset for demodulation & vector signal analysis

Time



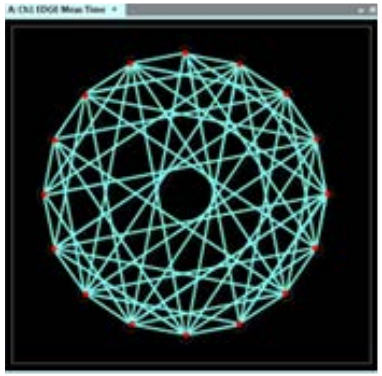
Magnitude and phase time domain data analysis

Frequency



High resolution, FFT-based spectrum analysis

Modulation



Demodulation & signal quality measurements

Explore virtually every facet of today's most complex signals

- Measure *your* signal: supports >75 standards and modulation types
- Leverage a first-to-market track record with support for emerging standards LTE-Advanced 3GPP Release 10 & WLAN 802.11ac
- Analyze proprietary signals with flexible tools for custom APSK, IQ & OFDM

Cellular Communications	Wireless Connectivity	Audio/Video Broadcasting	Detection, Positioning, Tracking & Navigation	General RF & MW
				
LTE-Advanced FDD/TDD LTE FDD/TDD W-CDMA/HSPA/HSPA+ TD-SCDMA/HSPA GSM/EDGE/EDGE Evo cdma2000/1xEV-DO	802.11ac WLAN 802.11n WLAN 802.11a/b/g/p/j WLAN 802.16 WiMAX *Bluetooth* ZigBee Wi-SUN	ATSC, ATSC-M/H DVB-C, DVB-S, DVB-S2/S2X J.83A/B/C DOCSIS, ISDB-C DAB, DVB-T/H/SH	SOQPSK Custom APSK Custom IQ RFID Pulse analysis FMCW radar analysis	AM/FM/PM demod Flexible digital demod Custom OFDM AM/AM, AM/PM, gain compression Channel quality meas

KEYSIG... TECHNOLOGIES

KEYSIGHT HOTSPOTS
Where Technologies and Experts Meet

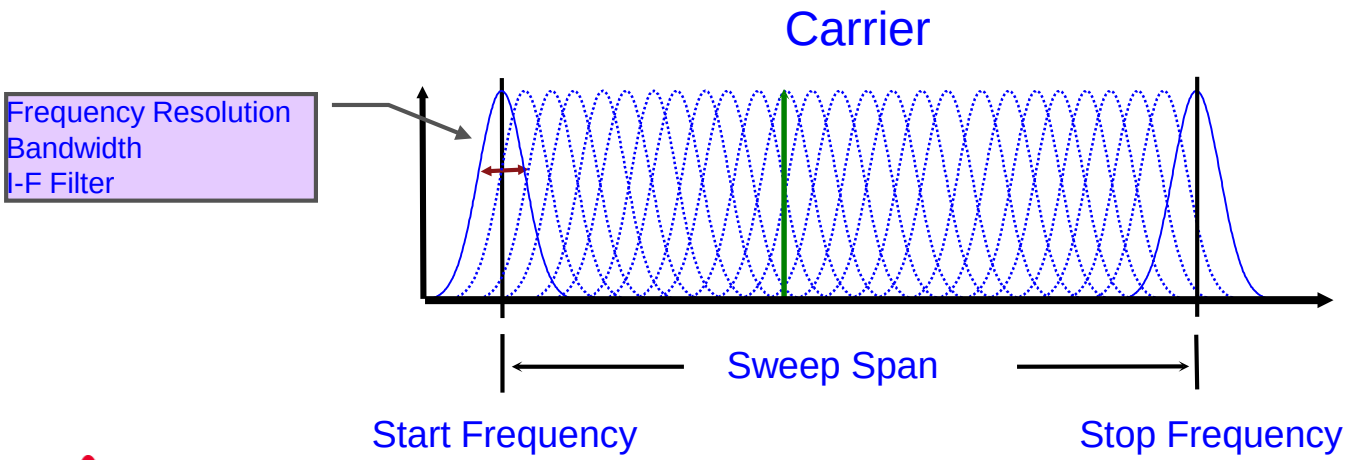
Agenda

- Introduction to Vector Signal Analysis
- Comparison between scalar SA/VSA
  - Capabilities
  - Block diagram
- Fundamental signal processing
- Windowing - Resolution Bandwidth
- Time Capture
- What about real time?
- Recordings
- Vector Modulation Measurements

Swept Spectrum Analyzer Compared to Vector Signal Analyzer

Key Characteristics

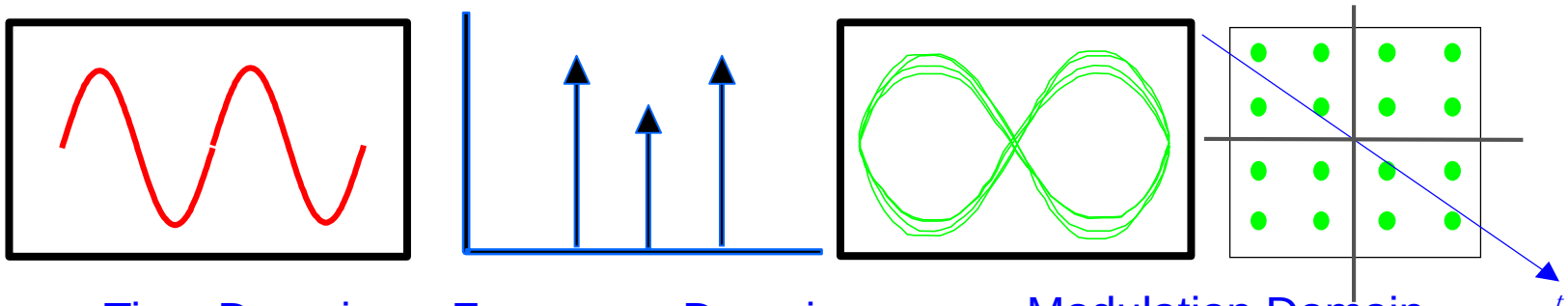
- Swept Analyzers do not measure all signal characteristics (i.e. no phase)
- Very long sweeps times required for narrow Resolution-Bandwidths
- Provides accurate amplitude vs. frequency for time stationary signals
- Gating provides accurate amplitude .v. freq. for repetitive burst signals
- Measures RF Spectrum by sweeping a signal past a fixed I-F filter



Vector Signal Analyzers

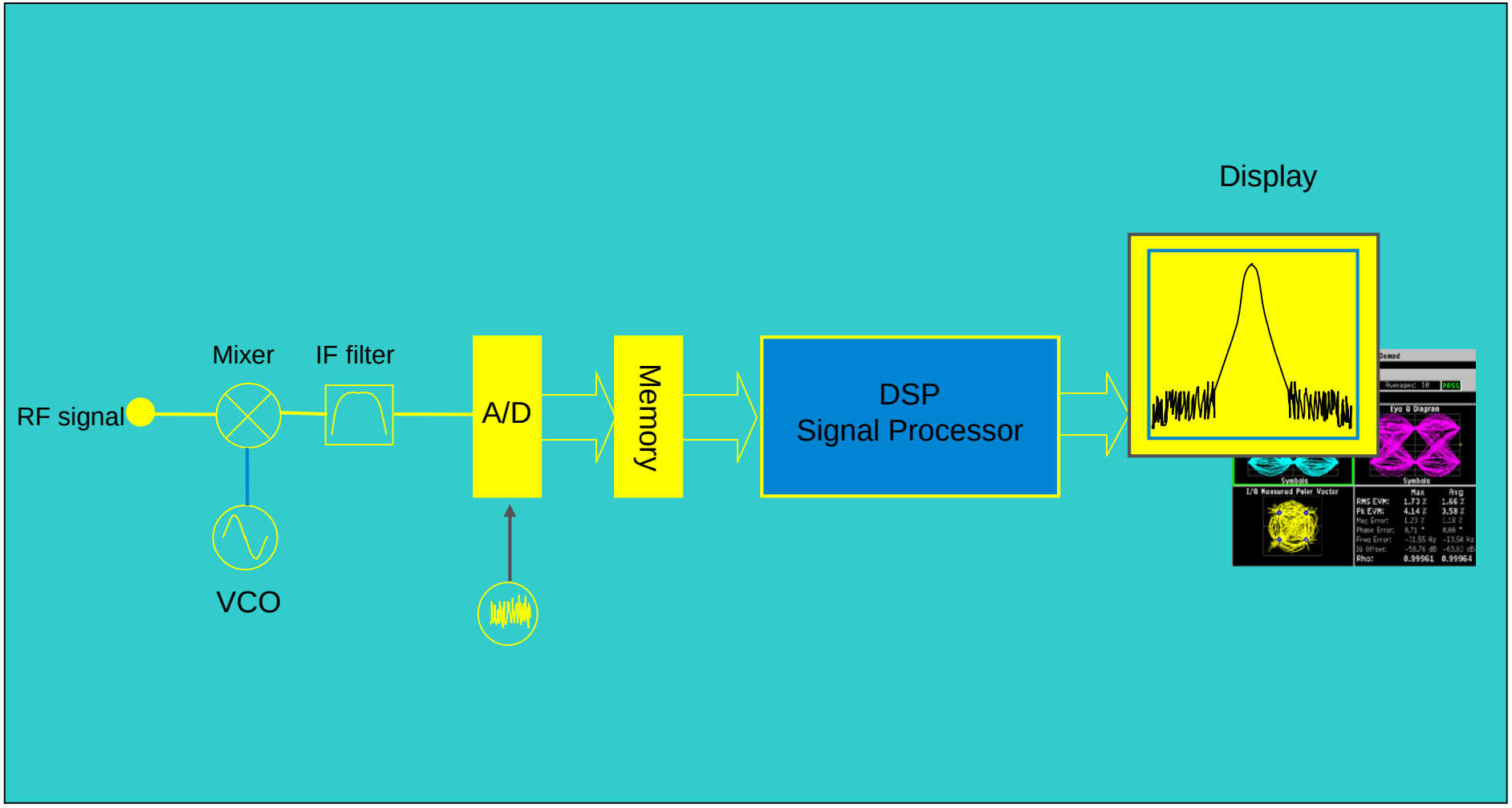
A new Class of Analyzer

- Digitizes complete signal, magnitude and phase
- Measures RF signals IF signals or baseband signals
- Measures Time Domain, Frequency Domain and Modulation Domain
- Accurately measures time varying signals
- Record and Playback functionality
- Transforms the digitized signal data into information via Digital Signal Processing
- Measures Vector Modulated signals
- General purpose user defined Digital demodulator



Time Domain Frequency Domain Modulation Domain

Modern Signal Analyzer Block Diagram



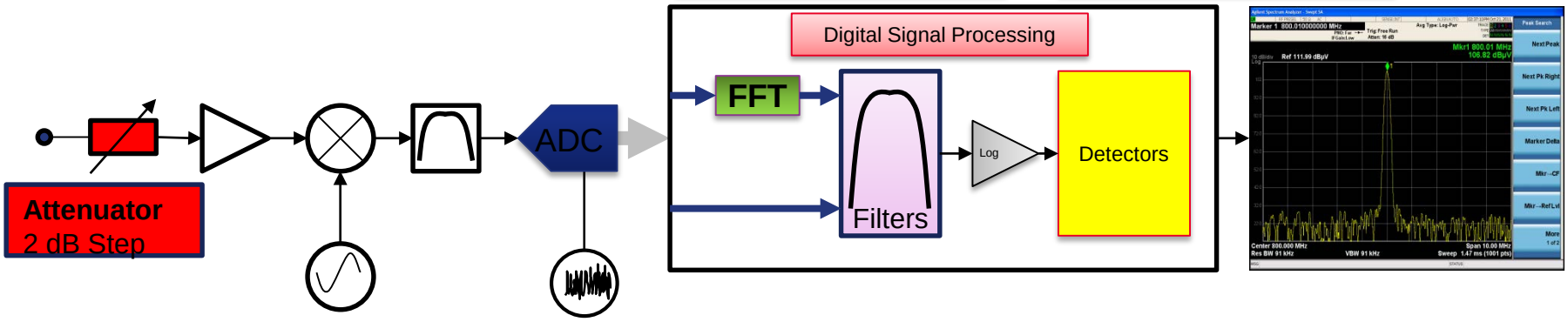
Modern Keysight Signal Analyzer Block Diagram

Wideband PreAmp
Improve 1GHz
DANL from –153 dBm to –167 dBm

Analog IF Filter
(Single Pole)

Digital IF Filter
- 160 Settings
- 1 Hz to 8 MHz RBW
- CISPR and MIL BW
- 1 Hz to 50 MHz VBW
- Min Switching Uncertainty

Digital Detectors
- Normal
- Peak
- Minimum Peak
- Sample
- RMS
- Quasi Peak
- CISPR RMS Average



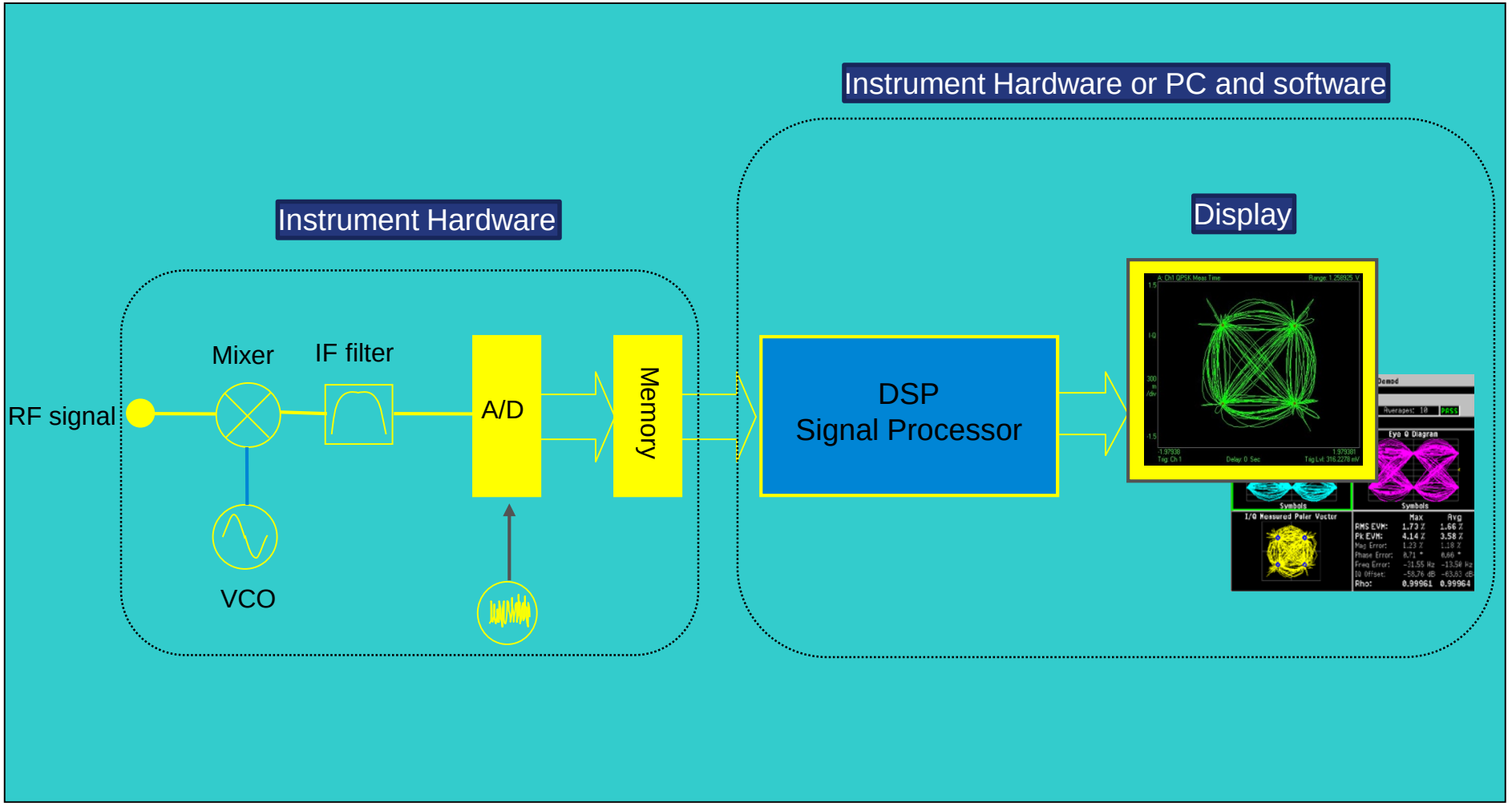
VCO
- Fast Tune
- Stepped for FFT
- Optimization for
  Close in PhaseNoise
  Far out Phase Noise

16 Bit ADC
- Autoranging
- Dither on/off

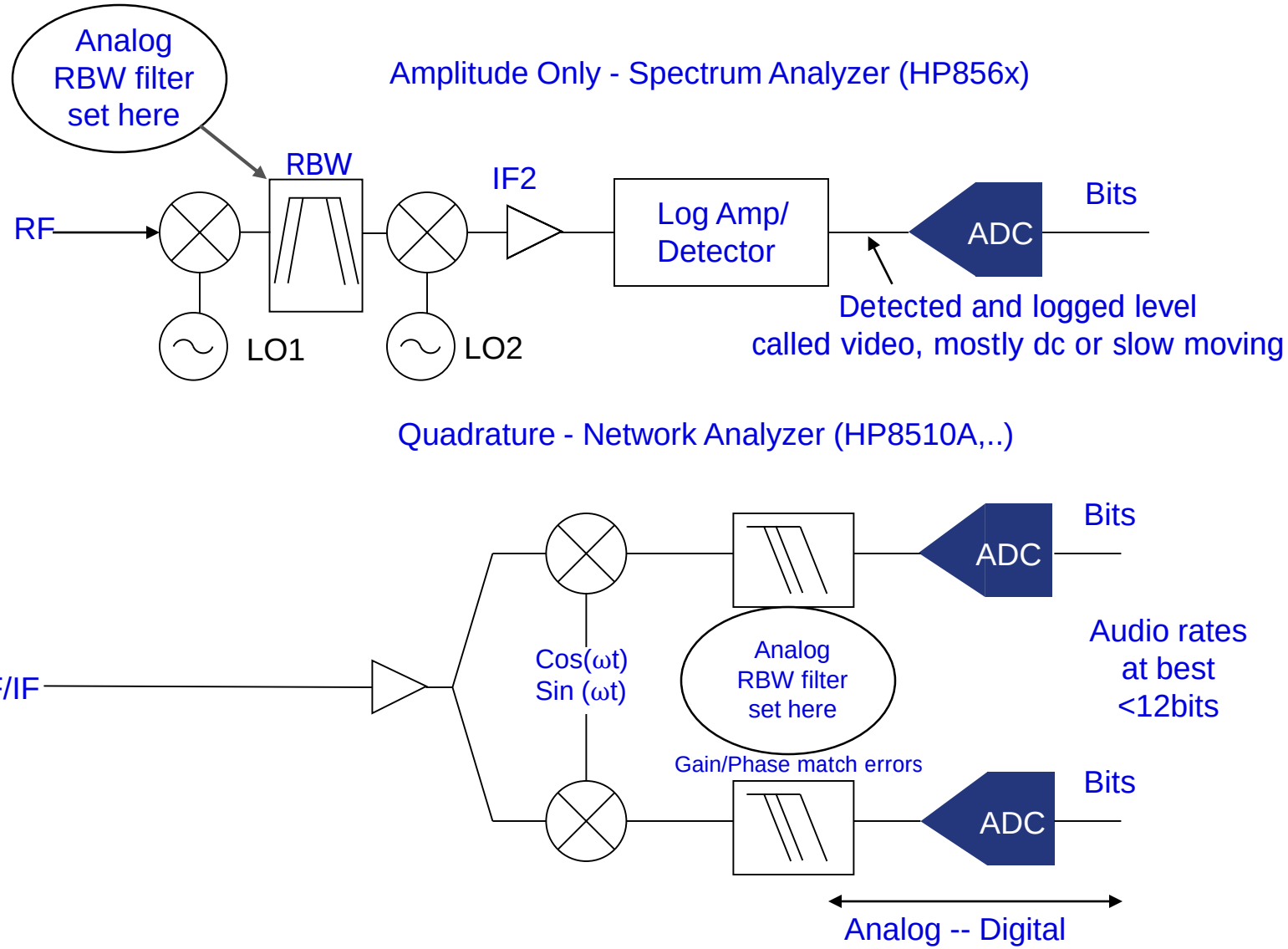
Sweep .v. FFT
- Fast Sweep
- Narrow BW
- High Selectivity

Digital Log Amp
- Min Linearity Contribution
- > 100 dB Dynamic Range

Vector Signal Analyzer Block Diagram

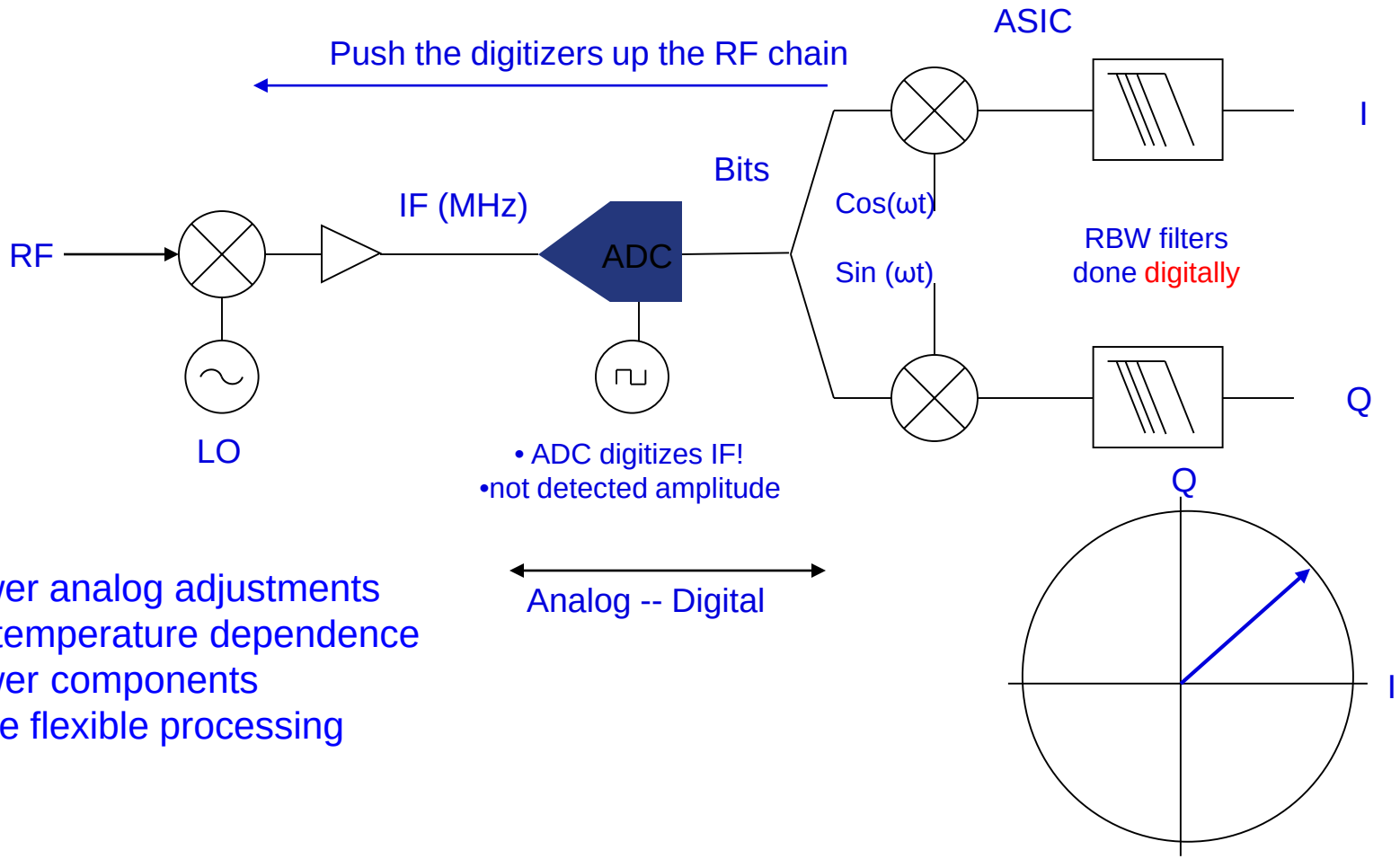


Background information - IF Processing Past



Background information – IF Processing Today

Amplitude or Vector Analyzer, X-series, PSA, 89600…



- Fewer analog adjustments
- No temperature dependence
- Fewer components
- More flexible processing

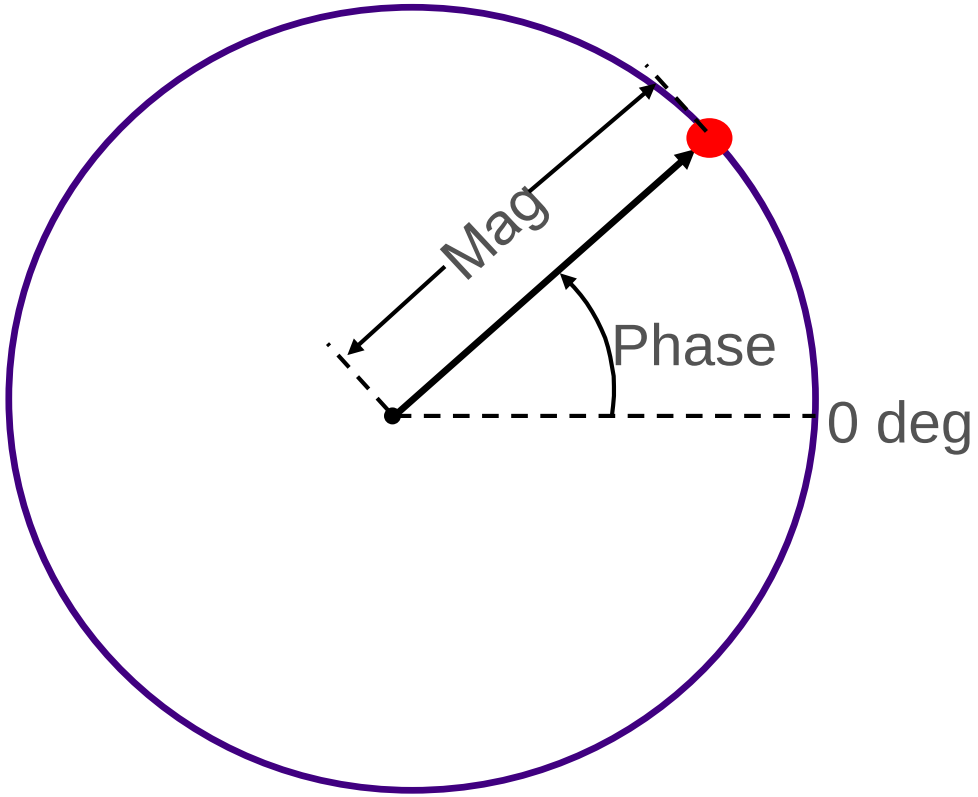
Vector Modulation Basics

The Advantages of Digital Transmission

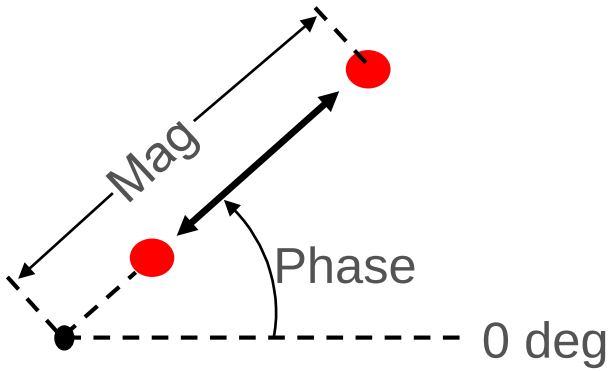
- One transmission system for all types of data
- Signal Processing applied to
  - Error correction
  - Data compression
  - Encryption
- Advanced switching and multiplexing
  - and many others

Polar Display - Magnitude and Phase Represented Together

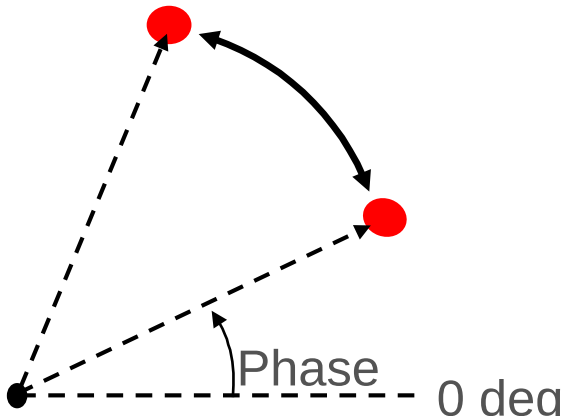
- Magnitude is an absolute value
- Phase is relative to a reference signal



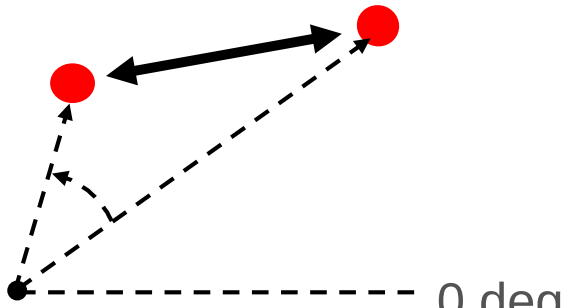
Phasors and Signal Space



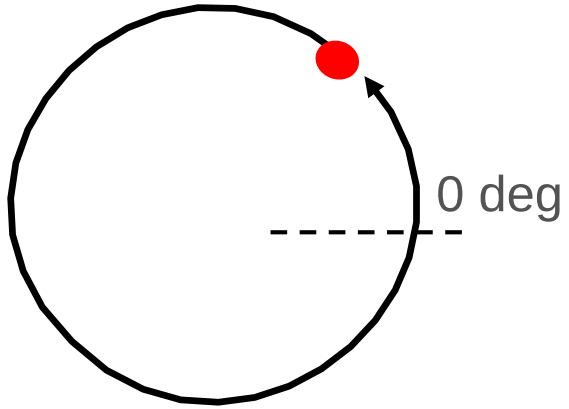
Magnitude Change



Phase Change



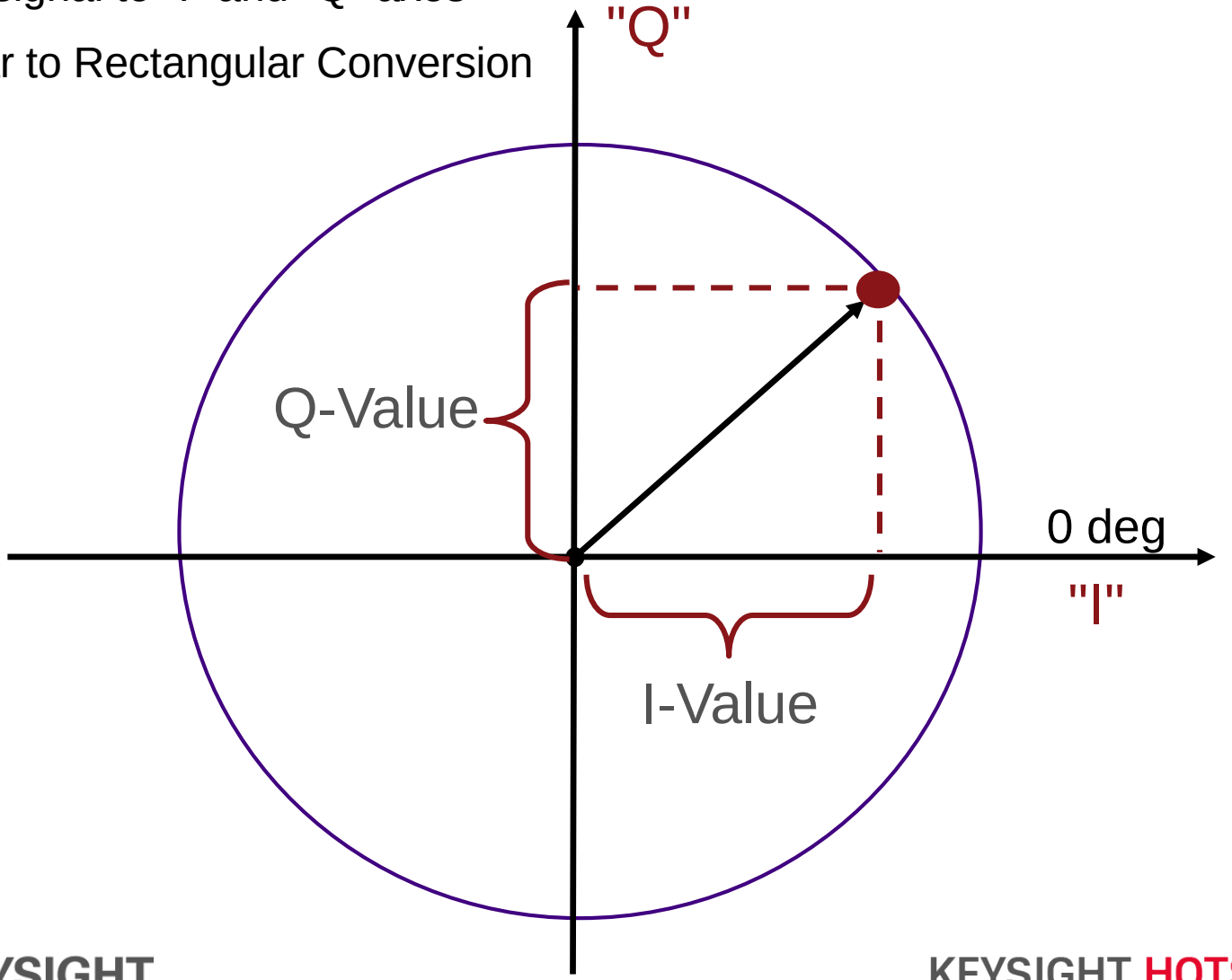
Both Change



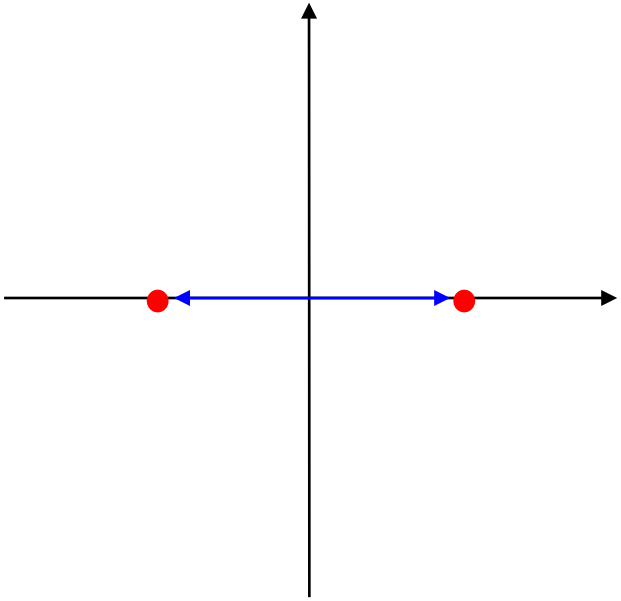
Frequency Change

Polar vs. "I-Q" Format

- Project signal to "I" and "Q" axes
  - Polar to Rectangular Conversion

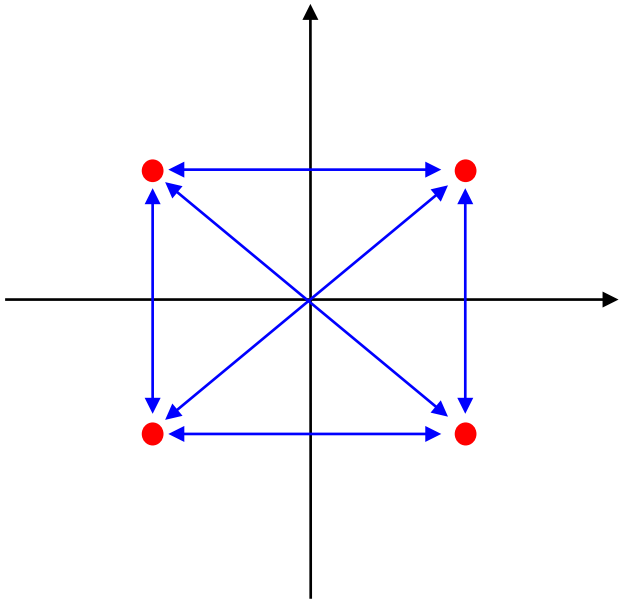


Vector Modulation Basics



BPSK

One Bit Per Symbol

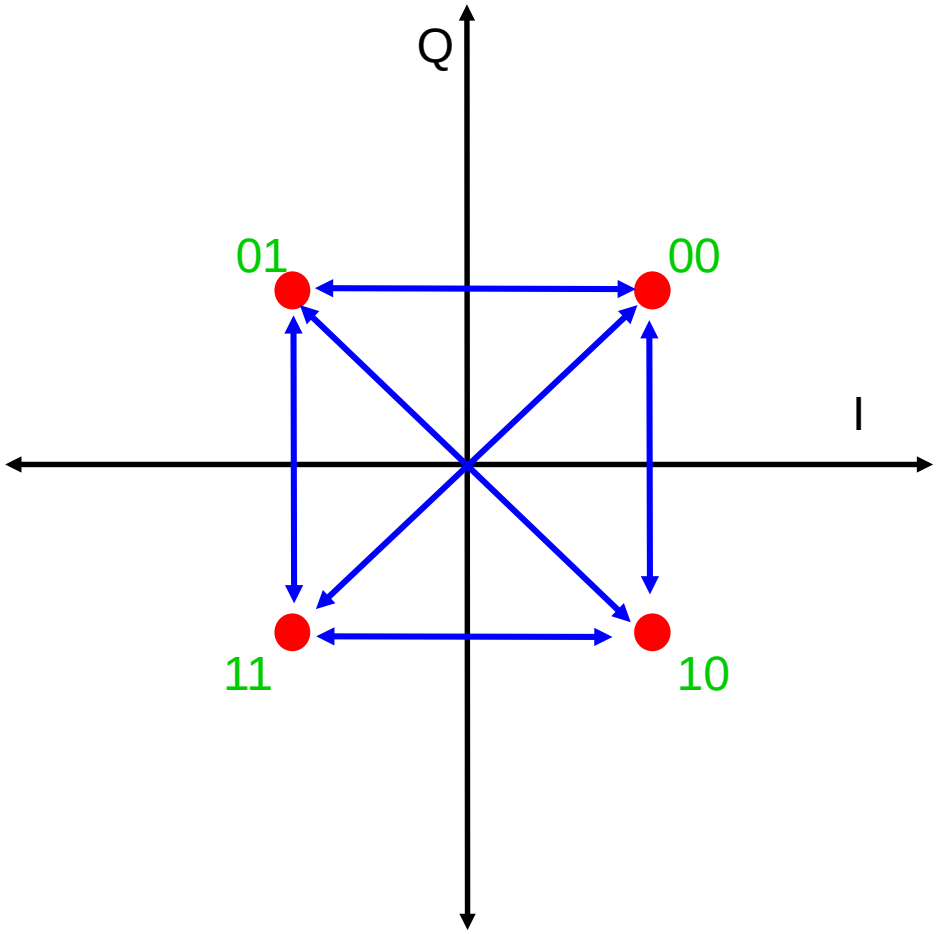


QPSK

Two Bits Per Symbol

Digital, or Vector, modulation- Getting bits on to a carrier.

State or Constellation diagram



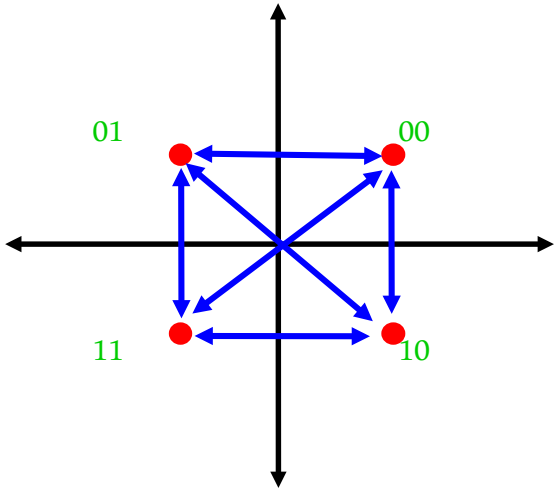
Example **QPSK**

Quadrature Phase Shift Keying

Two bits per symbol

Bit Rate = 2 x Symbol Rate

Digital, or Vector, Modulation.
States, Bit Rate & Symbol Rate



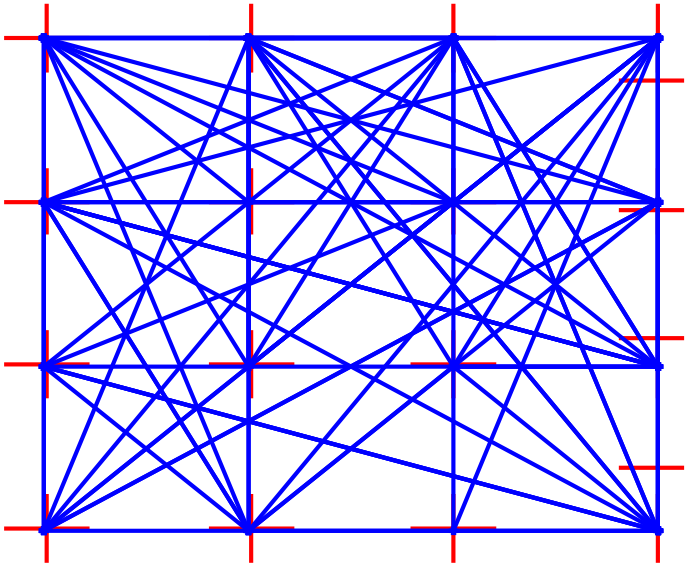
Bit Rate
is the number of bits transferred per second in the system

Symbol Rate = Bit Rate / No. of bits per symbol,
AKA Baud Rate

Symbol Rate
determines the minimum system bandwidth requirement

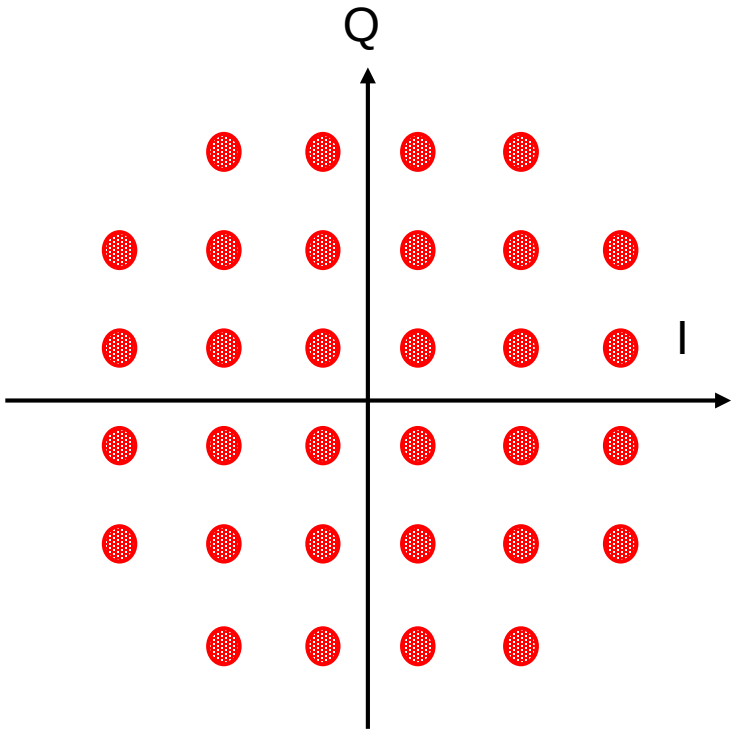
Quadrature Amplitude Modulation

16 QAM



4 Bits per Symbol
Symbol Rate = 1/4 of Bit Rate

32 QAM



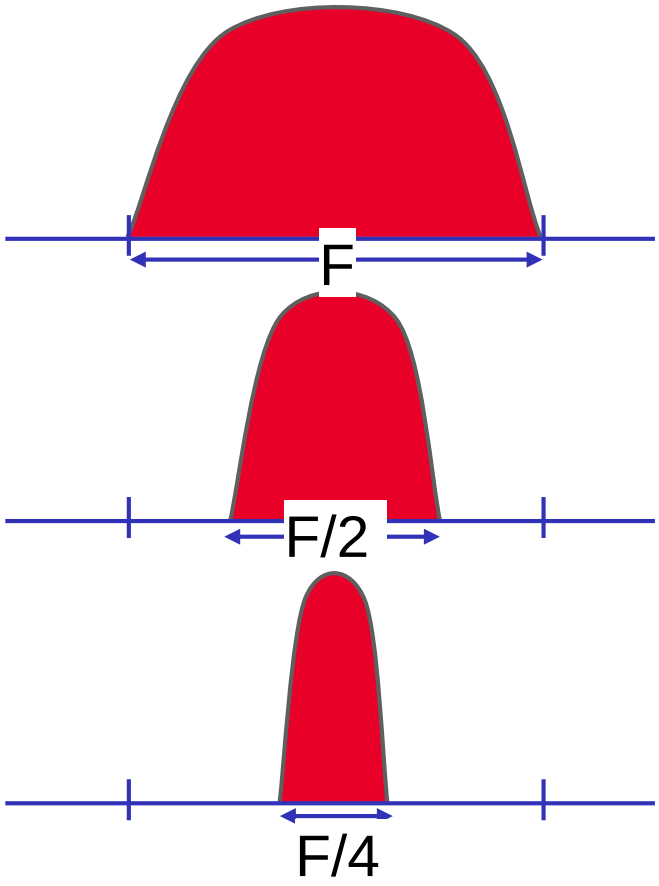
5 bits per Symbol
Symbol Rate = 1/5 of Bit Rate

Corner states are not used.

Using Less Bandwidth for the Same Data

Same Bits/sec

Modulation Format	Number of bits per symbol	Transmission Bandwidth
BPSK	1	
QPSK	2	
16QAM	4	



Major Modulation Goal: Spectral Efficiency

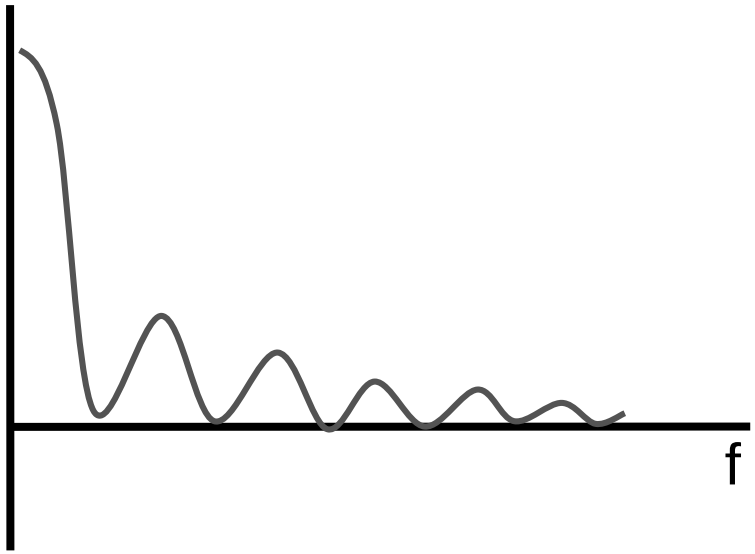
- Theoretical Bandwidth Efficiency Limits:

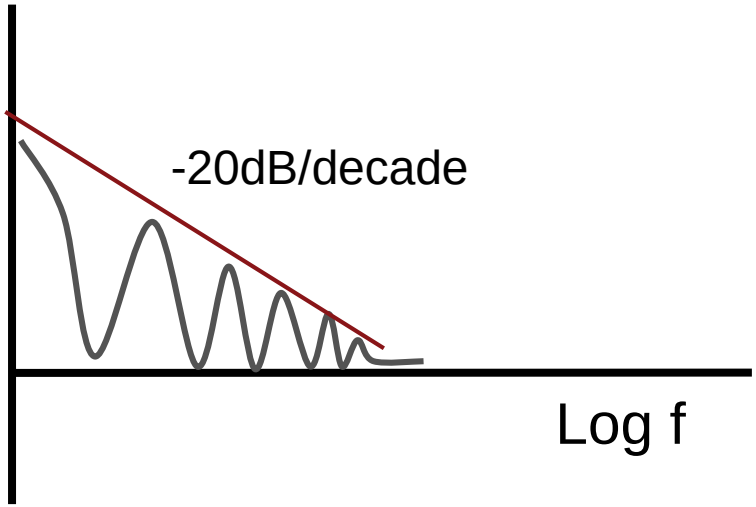
Modulation Format	Spectral Efficiency
BPSK	1 bit/second/Hz
QPSK	2 bits/second/Hz
8PSK	3 bits/second/Hz
16QAM	4 bits/second/Hz
32 QAM	5 bits/second/Hz
64 QAM	6 bits/second/Hz
128 QAM	7 bits/second/Hz
256 QAM	8 bits/second/Hz
512 QAM	9 bits/second/Hz
1024 QAM	10 bits/second/Hz
2048 QAM	11 bits/second/Hz
4096 QAM	12 bits/second/Hz
8192 QAM	13 bits/second/Hz
16384 QAM	14 bits/second/Hz

Note: The figures are theoretical limits and CAN NOT be achieved in practical radios

Transmission Bandwidth

- The spectrum of a digital signal is very wide.
- Theoretically infinite.

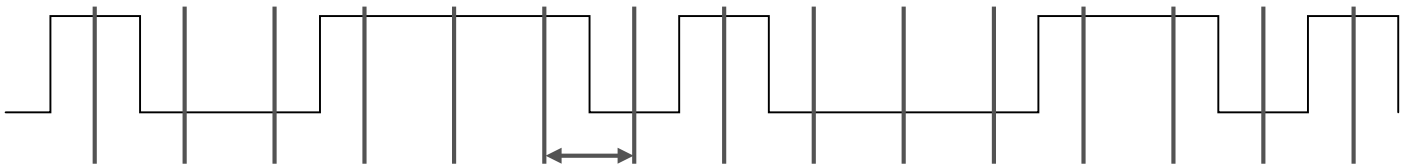




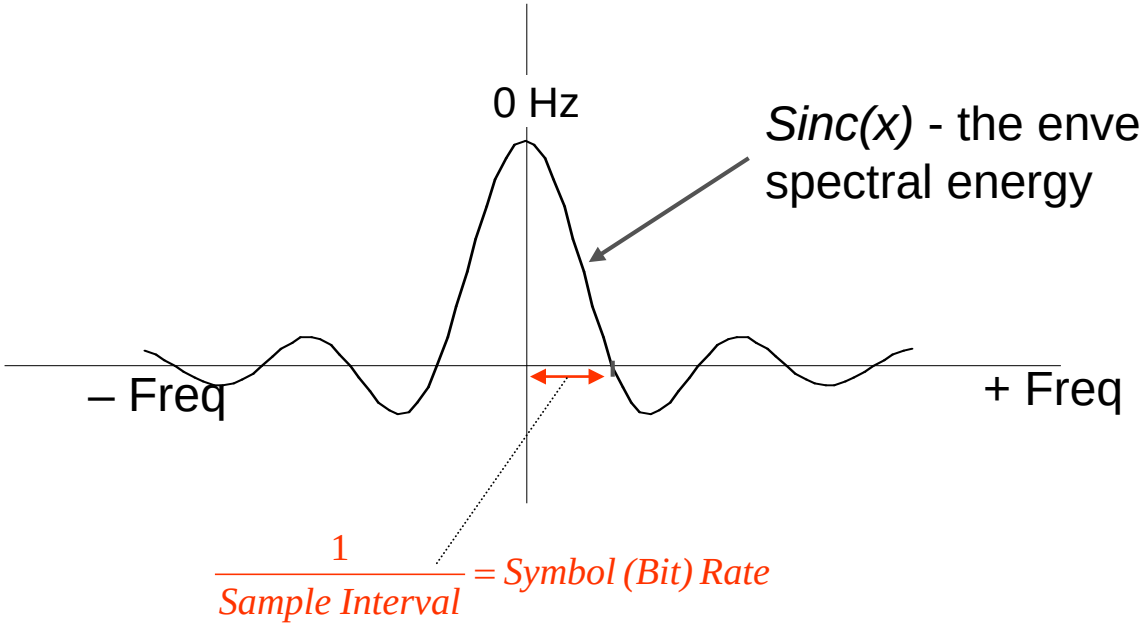
Roll Off rate is a function of pulse risetime, for 0 risetime pulses the power spectrum rolls off at –20dB/decade

Pulse Spectrum (baseband)

NRZ baseband signal



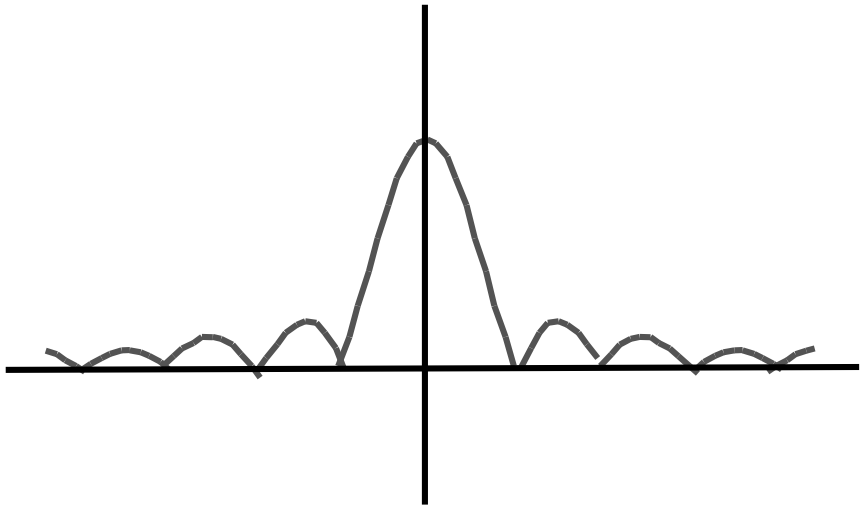
Sample Interval between symbols (bits shown here)



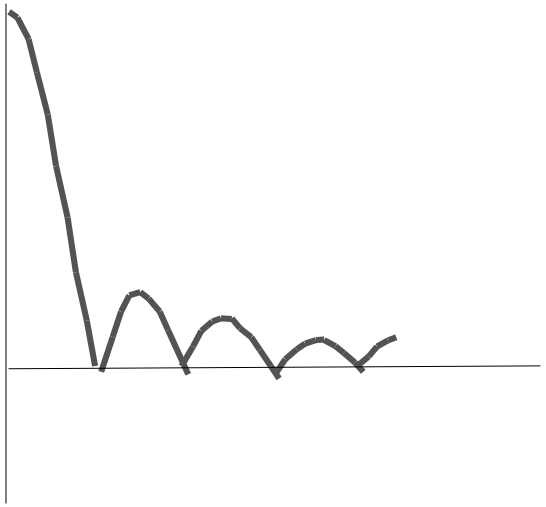
$$Sinc(x) = \frac{Sin(x)}{x}$$

The Spectrum Analyzer View

- Sinc(x) Magnitude



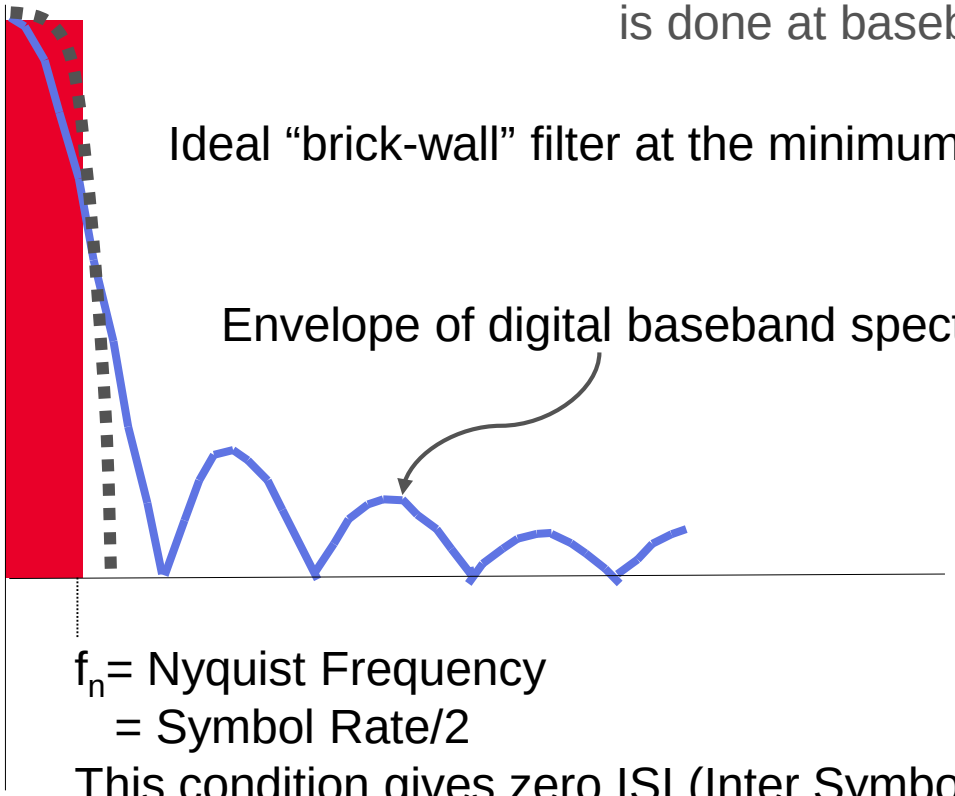
- Sinc(x) Magnitude One Sided



- Spectrum Analyzer View
- All voltages folded over and doubled, except the DC.

The Nyquist Bandwidth

In a radio transmitter the filtering is done at baseband.

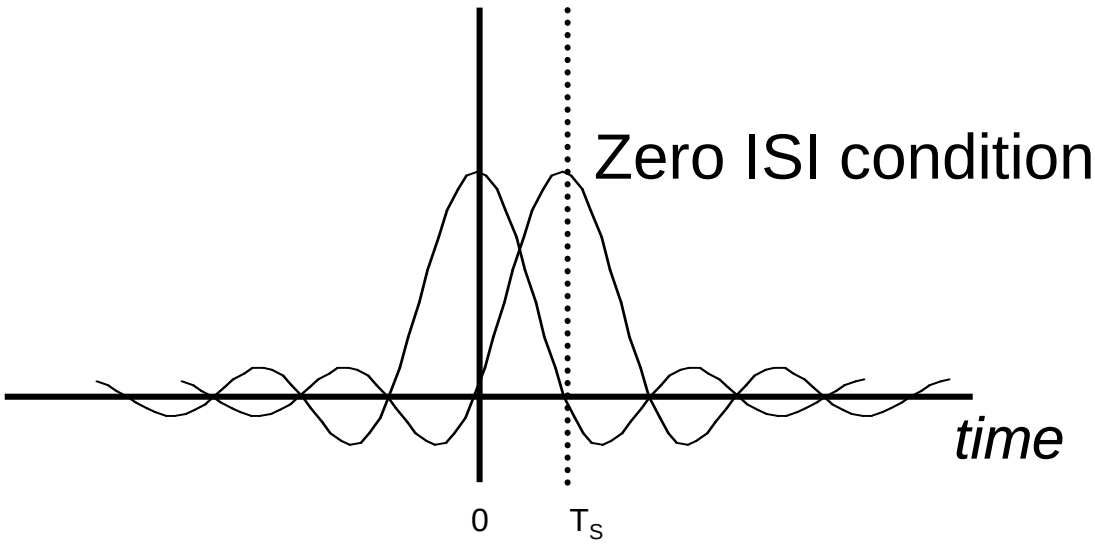


f_n= Nyquist Frequency
= Symbol Rate/2

This condition gives zero ISI (Inter Symbol Interference)

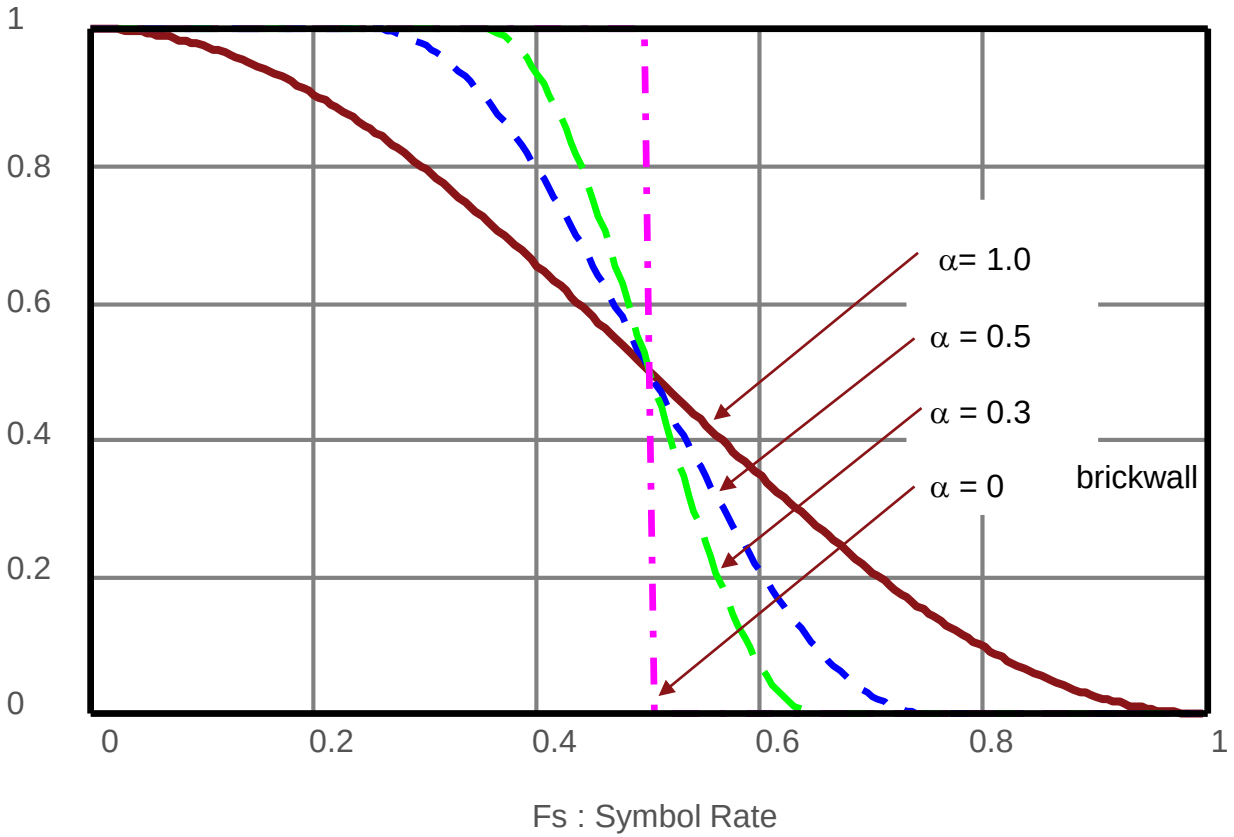
Inter Symbol Interference

Response of two successive impulses



Design a filter so that at sample times the response of the previous pulse is zero.

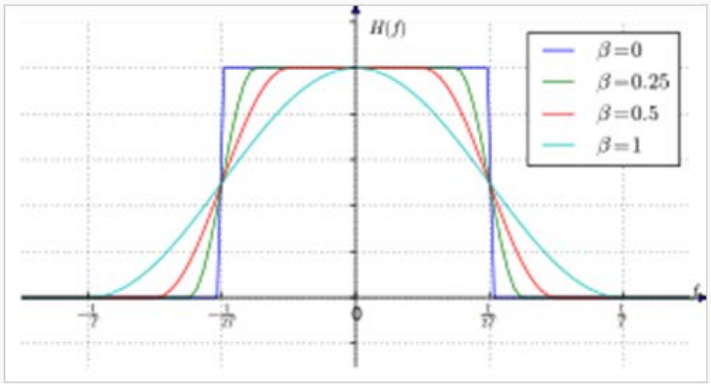
Filter Bandwidth Parameter "∝"
Practical Filter Shapes



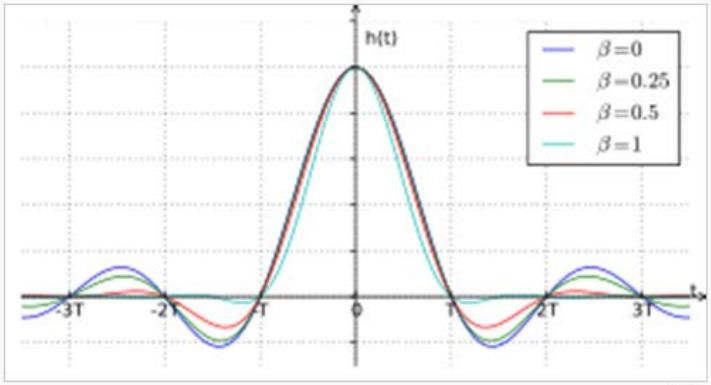
Alpha describes the "sharpness" of the filter.

Occupied bandwidth is approximately: Symbol rate X (1 + ∝)

Frequency and impulse response of raised cosine (RC) filters

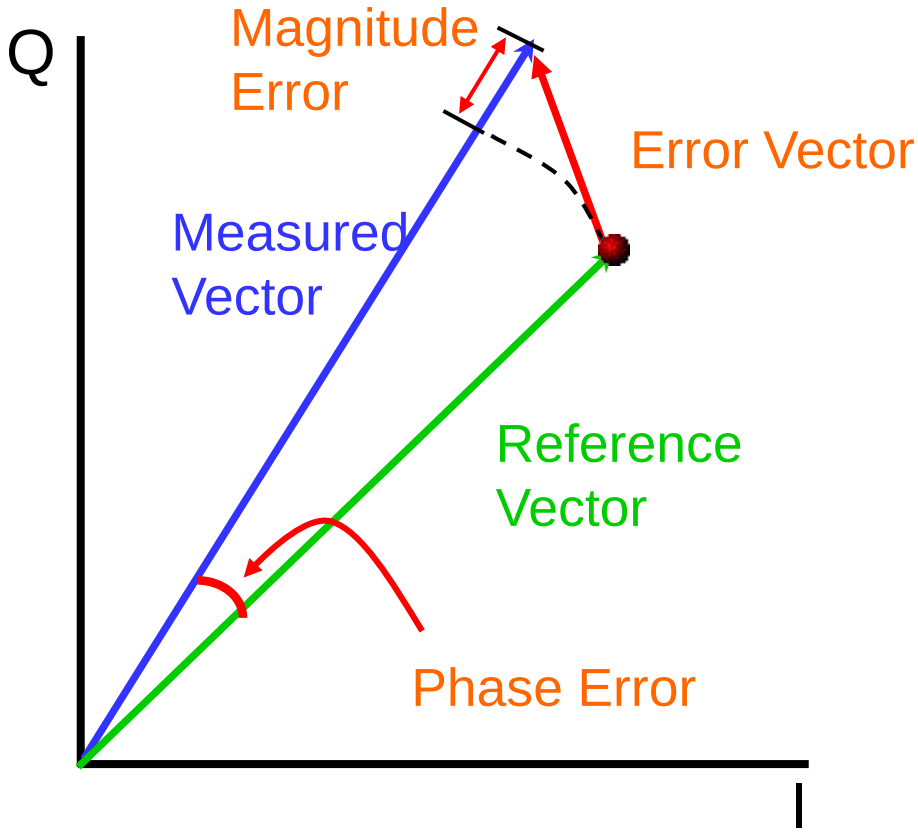


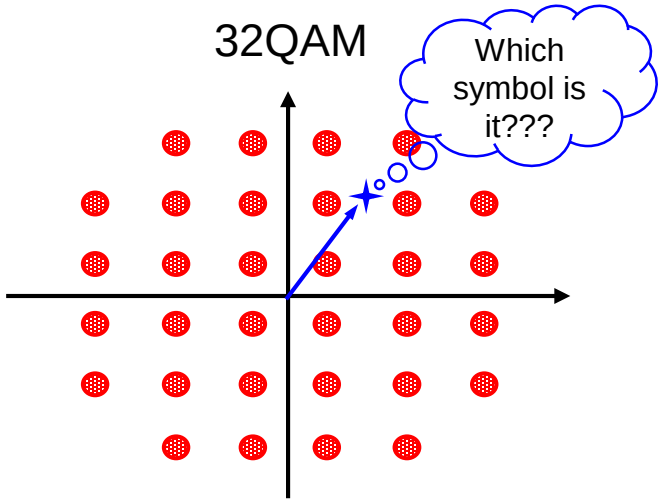
Frequency response of raised-cosine filter with various roll-off factors



Impulse response of raised-cosine filter with various roll-off factors

Modulation Quality Error Vector Magnitude (EVM)

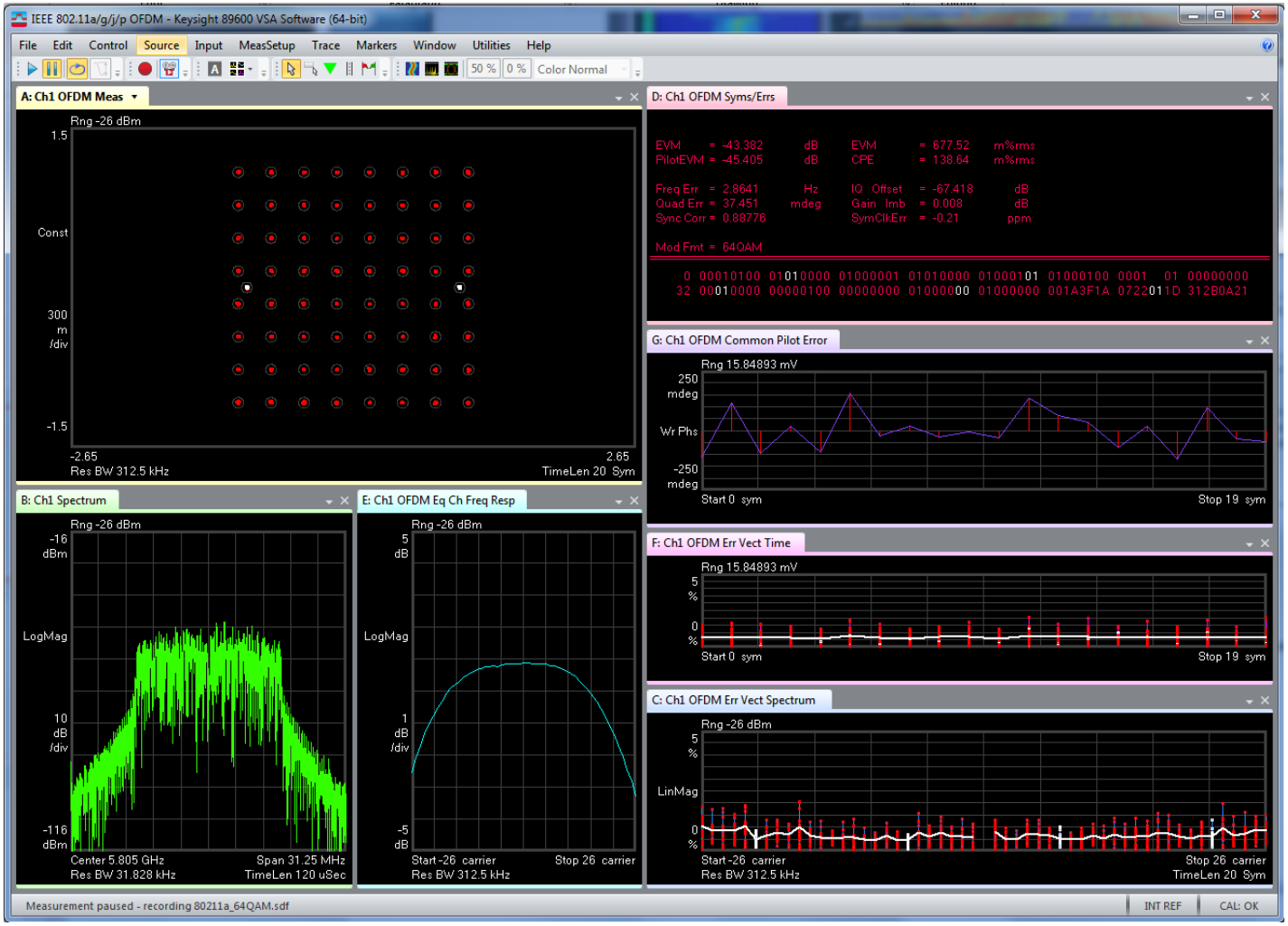




Q:
What if the signal doesn't land on a constellation point?

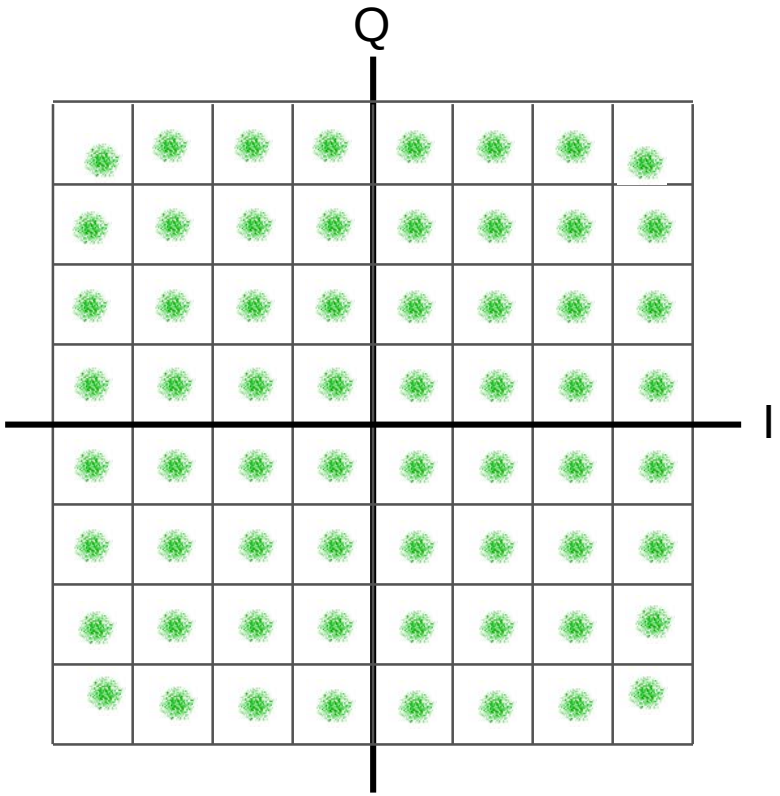
A:
Symbol error!

Demo!


IEEE 802.11a/g/j/p OFDM - Keysight 89600 VSA Software (64-bit)
File Edit Control Source Input MeasSetup Trace Markers Window Utilities Help
A: Ch1 OFDM Meas
Rng -26 dBm
Const
Res BW 312.5 kHz
TimeLen 20 Sym
D: Ch1 OFDM Syms/Errs
EVM = -43.382 dB
PilotEVM = -45.405 dB
EVM = 677.52 m%rms
CPE = 138.64 m%rms
Freq Err = 2.8641 Hz
Quad Err = 37.451 mdeg
Sync Corr = 0.88776
IQ Offset = -67.418 dB
Gain Imb = 0.008 dB
SymClkErr = -0.21 ppm
Mod Fmt = 64QAM
G: Ch1 OFDM Common Pilot Error
Rng 15.84893 mV
Wr Phs
Start 0 sym
Stop 19 sym
B: Ch1 Spectrum
Rng -26 dBm
LogMag
Center 5.805 GHz
Span 31.25 MHz
Res BW 31.828 kHz
TimeLen 120 uSec
E: Ch1 OFDM Eq Ch Freq Resp
Rng -26 dBm
LogMag
Start -26 carrier
Stop 26 carrier
Res BW 312.5 kHz
F: Ch1 OFDM Err Vect Time
Rng 15.84893 mV
Start 0 sym
Stop 19 sym
C: Ch1 OFDM Err Vect Spectrum
Rng -26 dBm
LinMag
Start -26 carrier
Stop 26 carrier
Res BW 312.5 kHz
TimeLen 20 Sym
Measurement paused - recording 80211a_64QAM.sdf
INT REF
CAL: OK

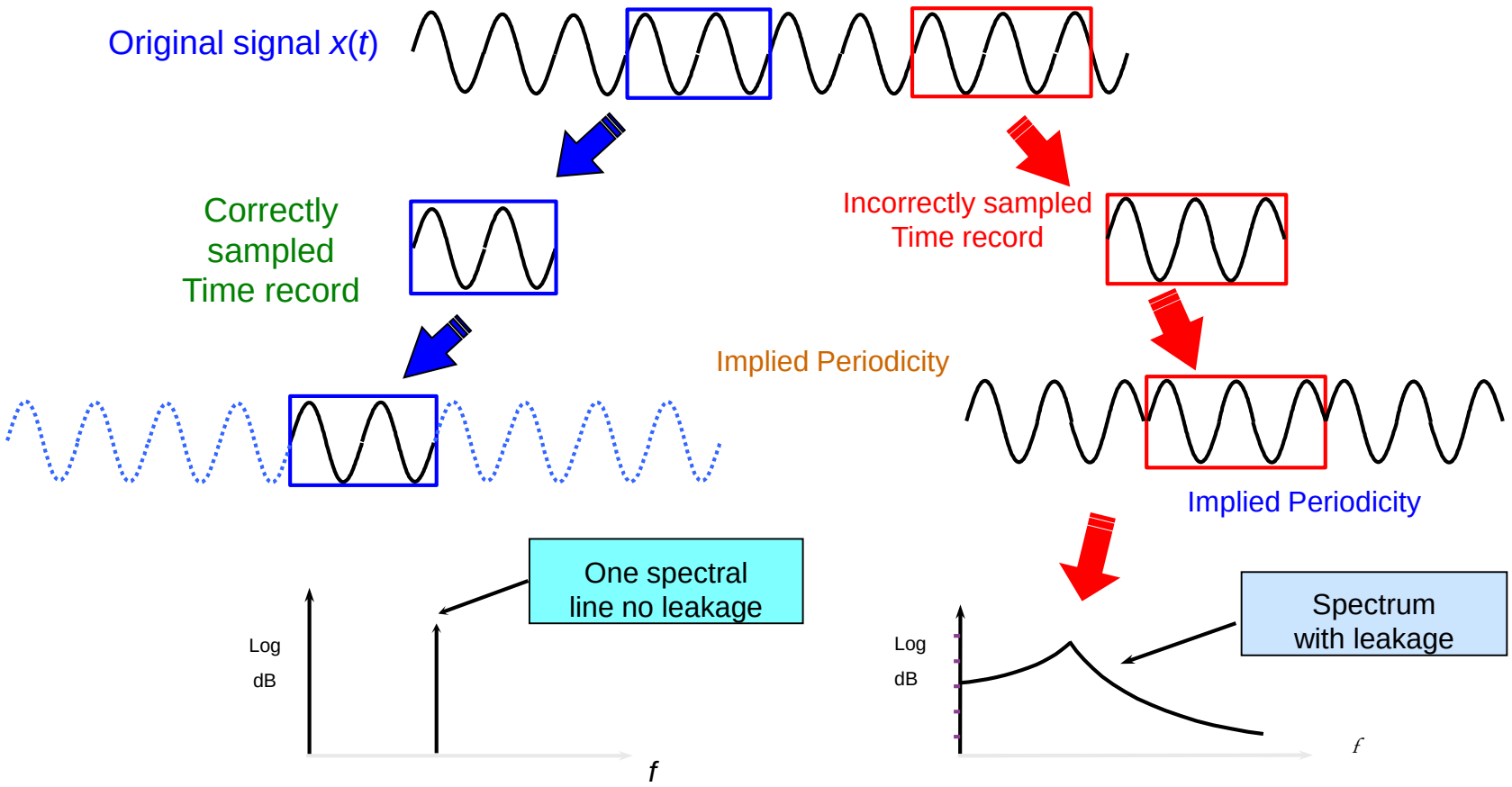
Error Vector Magnitude Measurements
Constellation Errors Signatures

- Ideal Symbol Point
- Random Noise
- Phase Noise
- AM/AM Distortion
- AM/PM Distortion
- Delay Distortion/ISI
- Spur / Interference

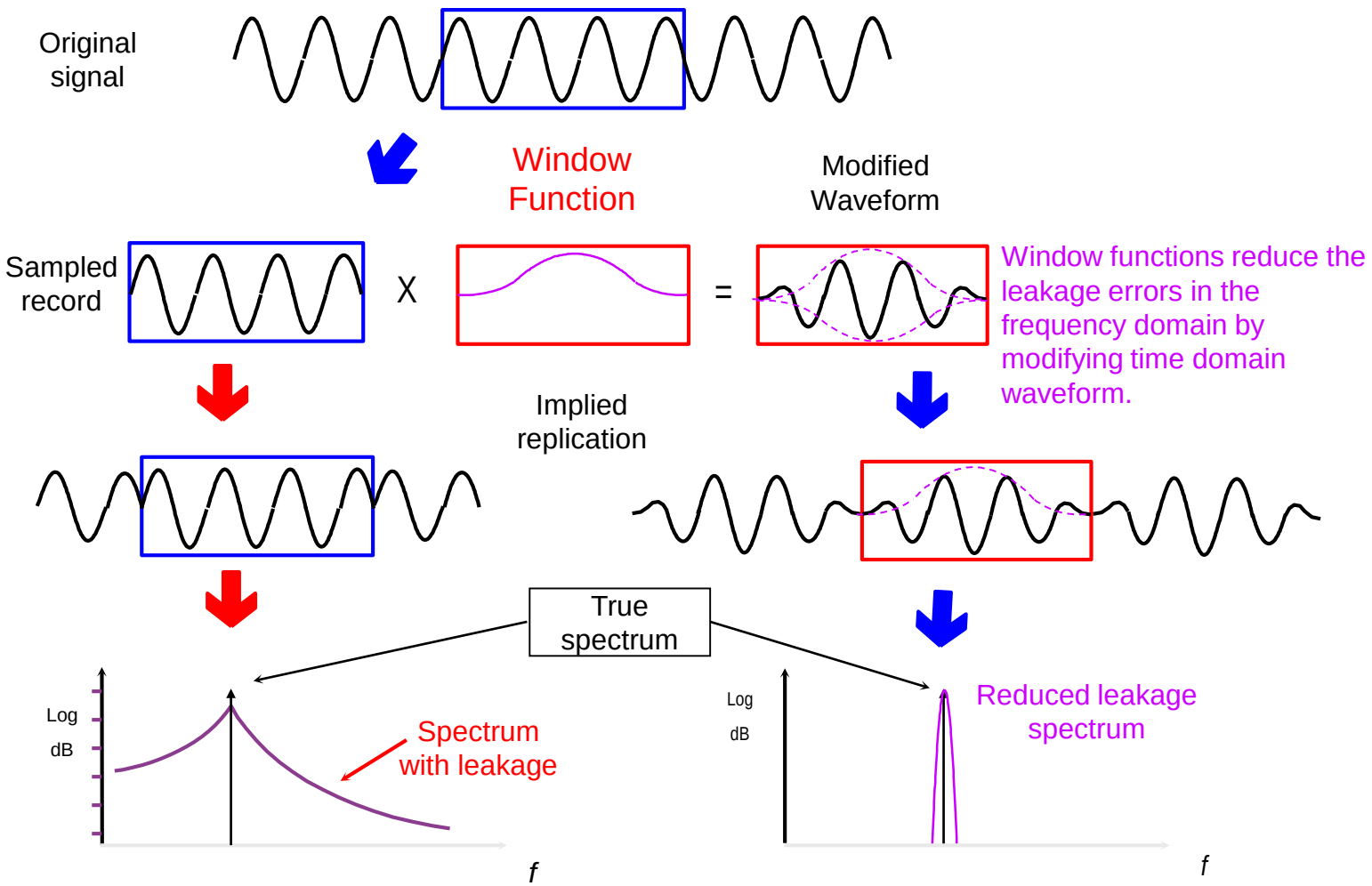


Why do you need a Window ?

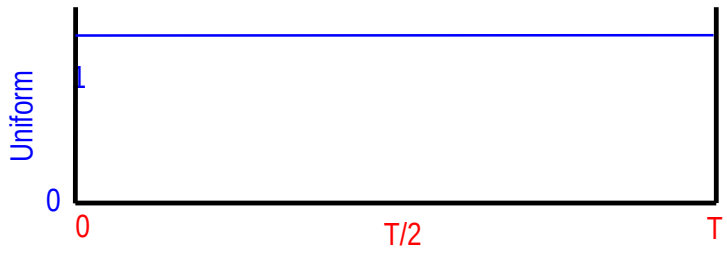
Implied Periodicity of the Fourier Transform assumes *x*(*t*) is periodic in T.

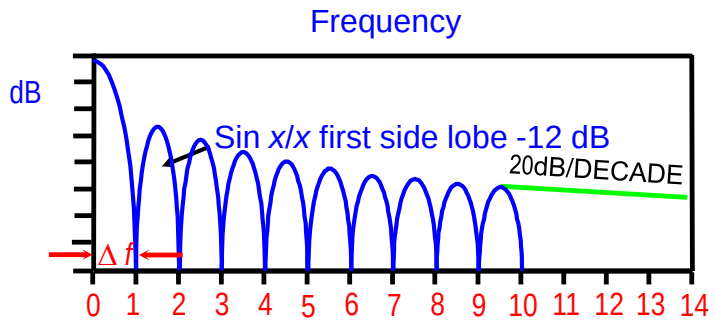


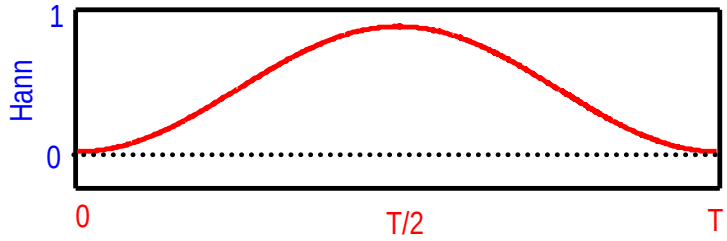
Windows Reduce Leakage

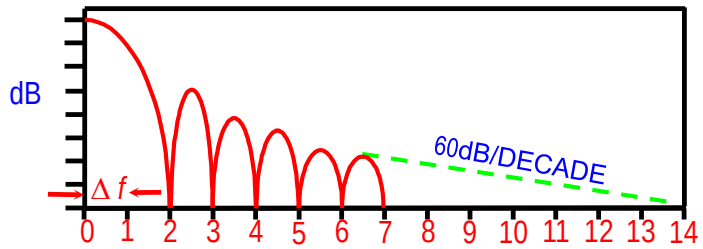


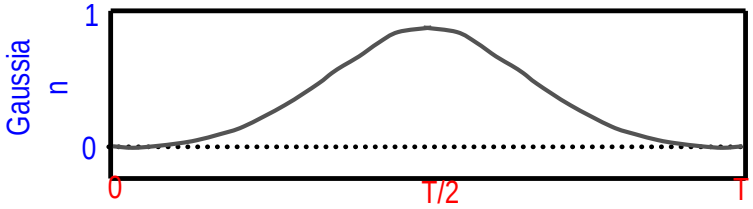
Window Functions

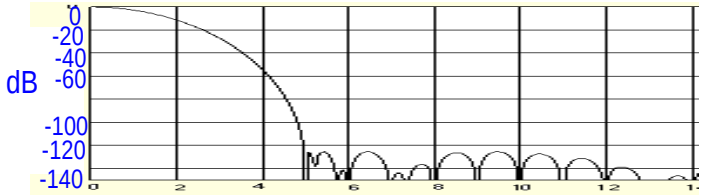


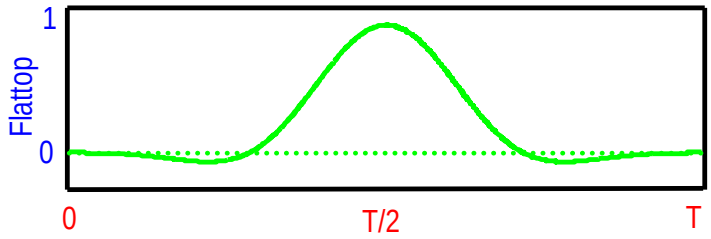


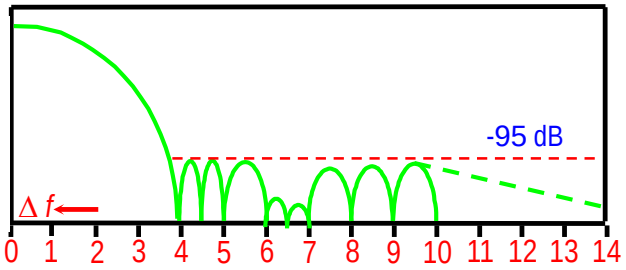






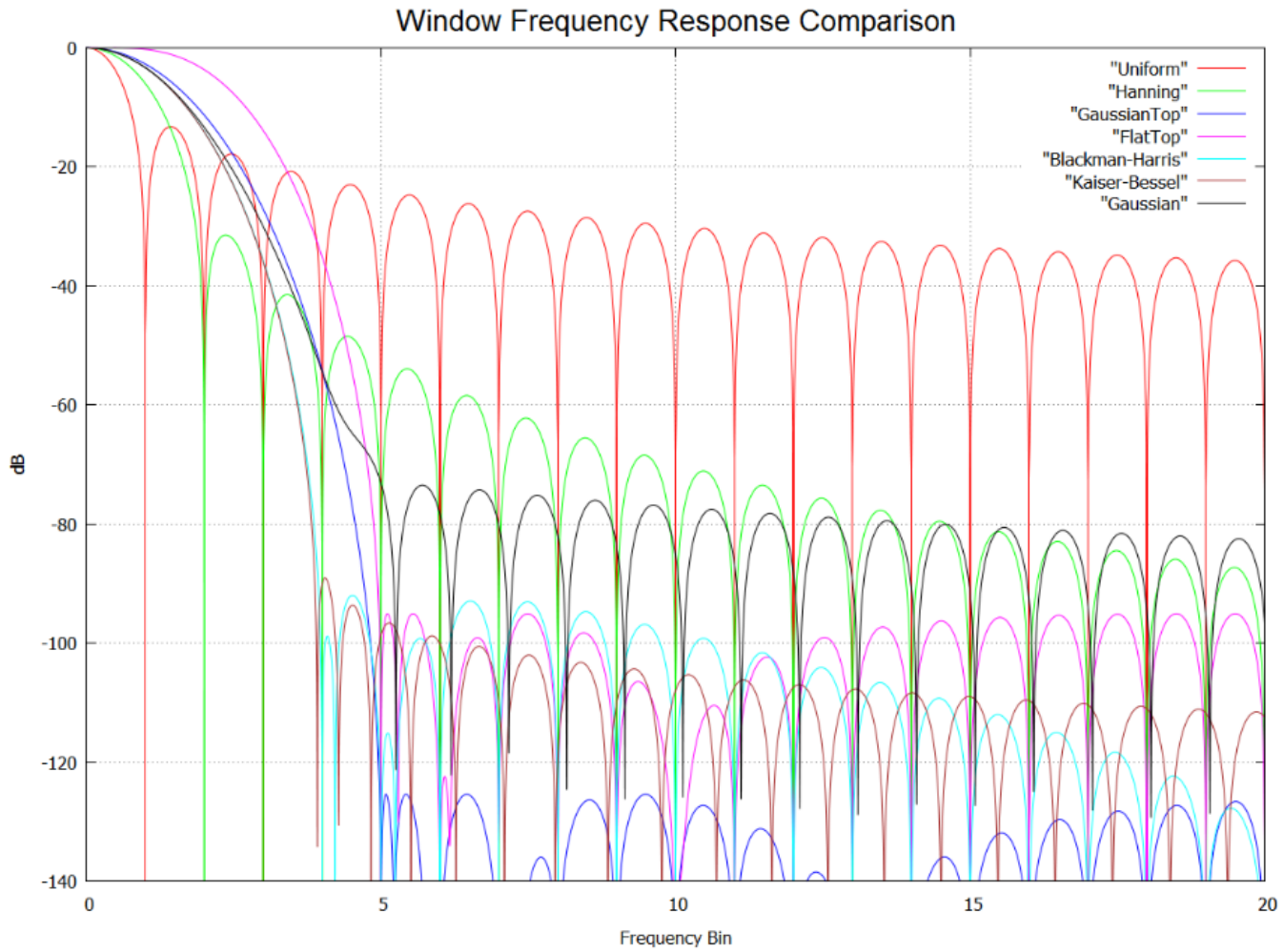






Window Comparison

Window Comparison (for the same time-record length)



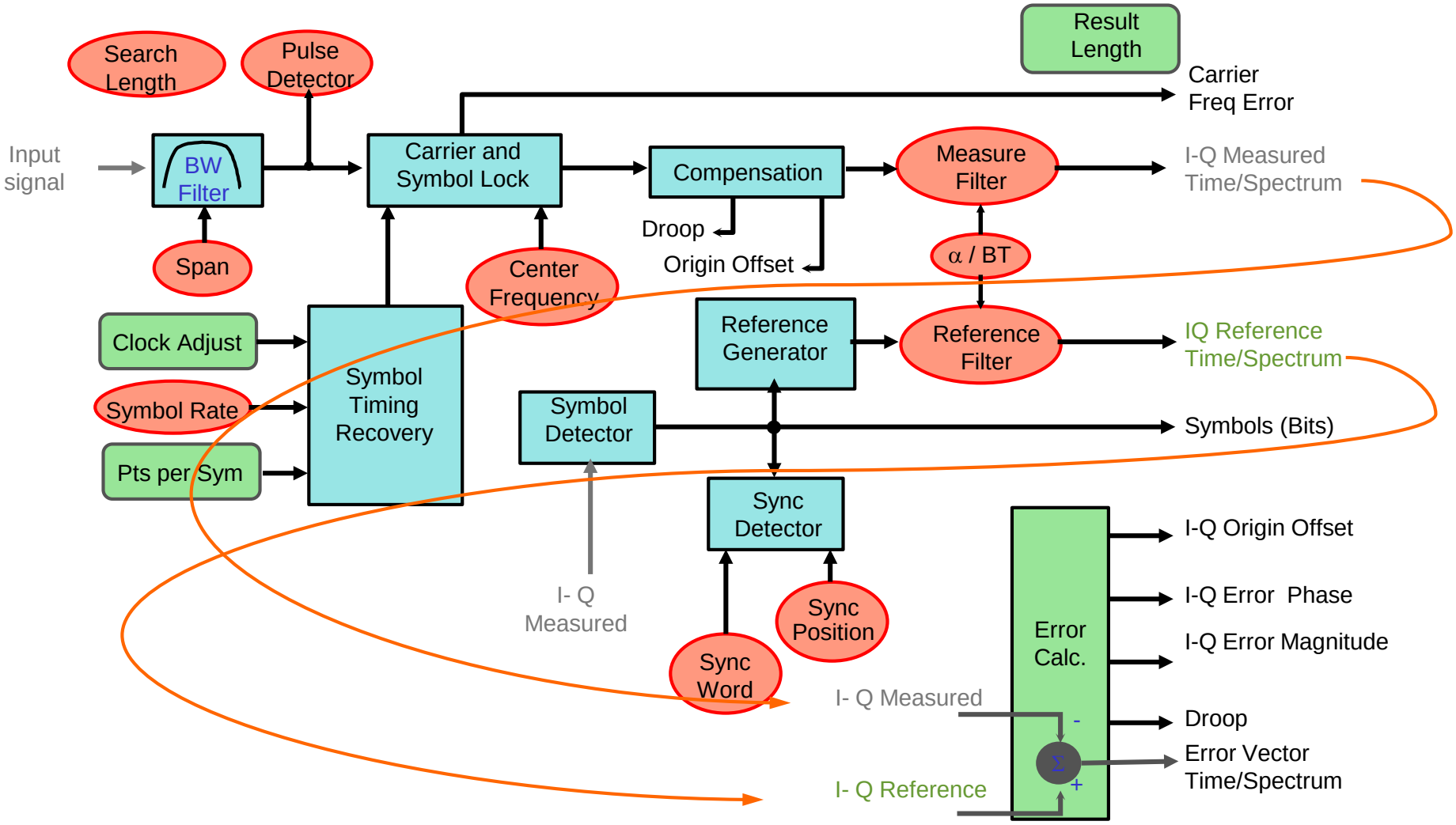
Window Characteristics Comparison

	Time Domain Shape		Freq. Domain Shape	
WINDOW SUMMARY				
Parameter	Uniform	Hanning	Gaussian	Flat Top (Default)
Leakage Performance:	Poor	Relatively Good	Best	Good
Frequency Resolution main length fixed :	Poor**	Relatively Good	Best	Better
Frequency Resolution: RBW fixed	Good	Good	Best	Better**
Normalized Equivalent Noise BW:	1.00 Hz-sec	1.50 Hz-sec	2.215 Hz-sec	3.8194 Hz- sec
3 dB BW	0.8844 Hz-sec	1.438 Hz-sec	2.091 Hz-sec	3.767 Hz-sec
Window Shape Factor	716:1	9.1:1	4.0:1	2.45:1
Maximum Amp. Error*	3.92 (dB)	1.42 (dB)	0.68 (dB)	< 0.01 (dB)
Highest Side lobe	-13 (dB)	-31 (dB)	-125 (dB)	-95 (dB)
Side lobe Fall Off	-20 dB /dec.	-60 dB /dec.	-20 dB /dec.	-20 dB /dec.

*** The maximum amplitude error occurs when a signal is halfway between frequency bins.**
**** Frequency resolution is best for equal amplitude signals (e.g. two closely spaced sine waves), Flat Top window side lobes are well below the dynamic range & noise floor of the VSA.**

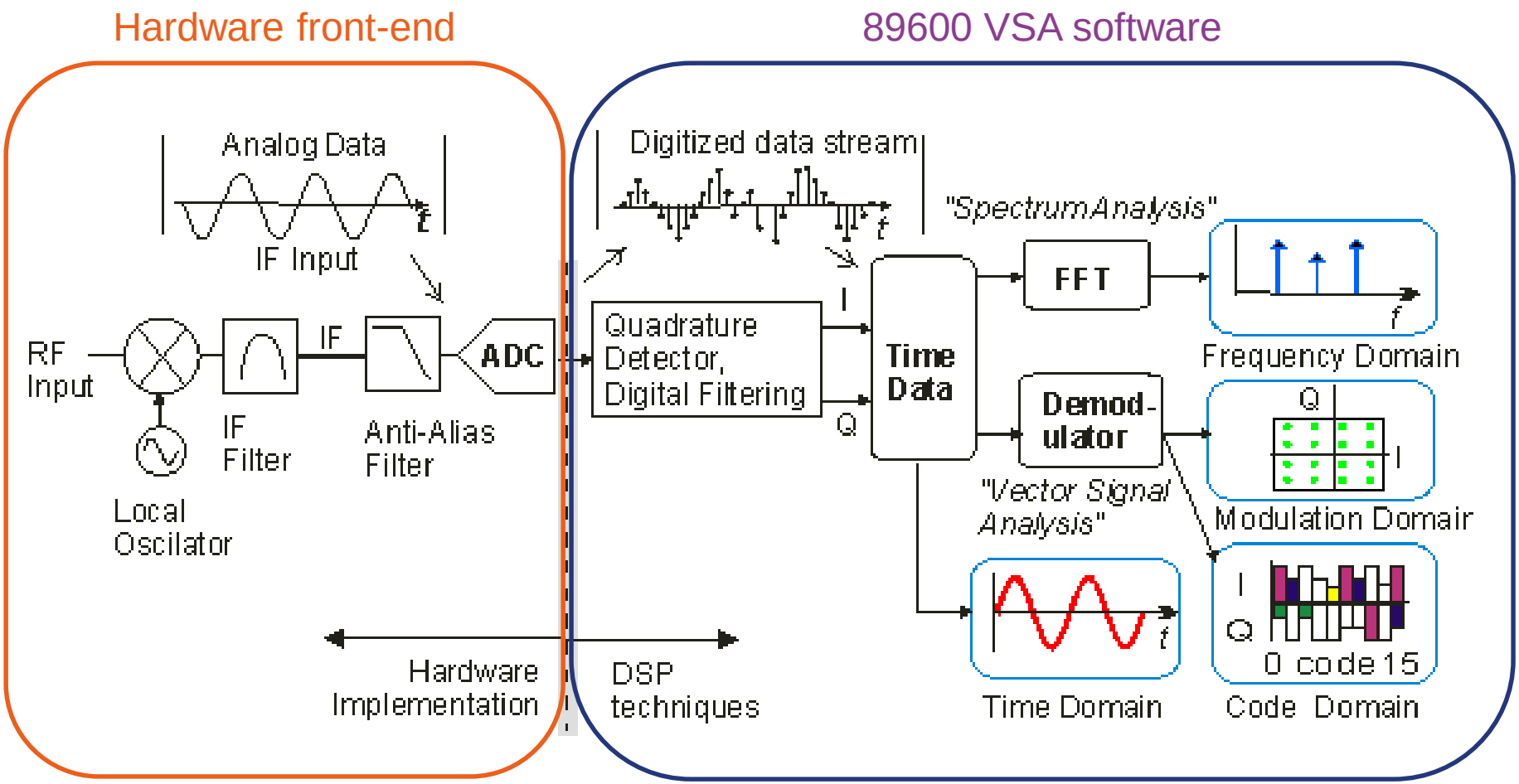
Vector Modulation Measurements

VSA Digital Demodulation Block Diagram



Theory of Operation

Block diagram

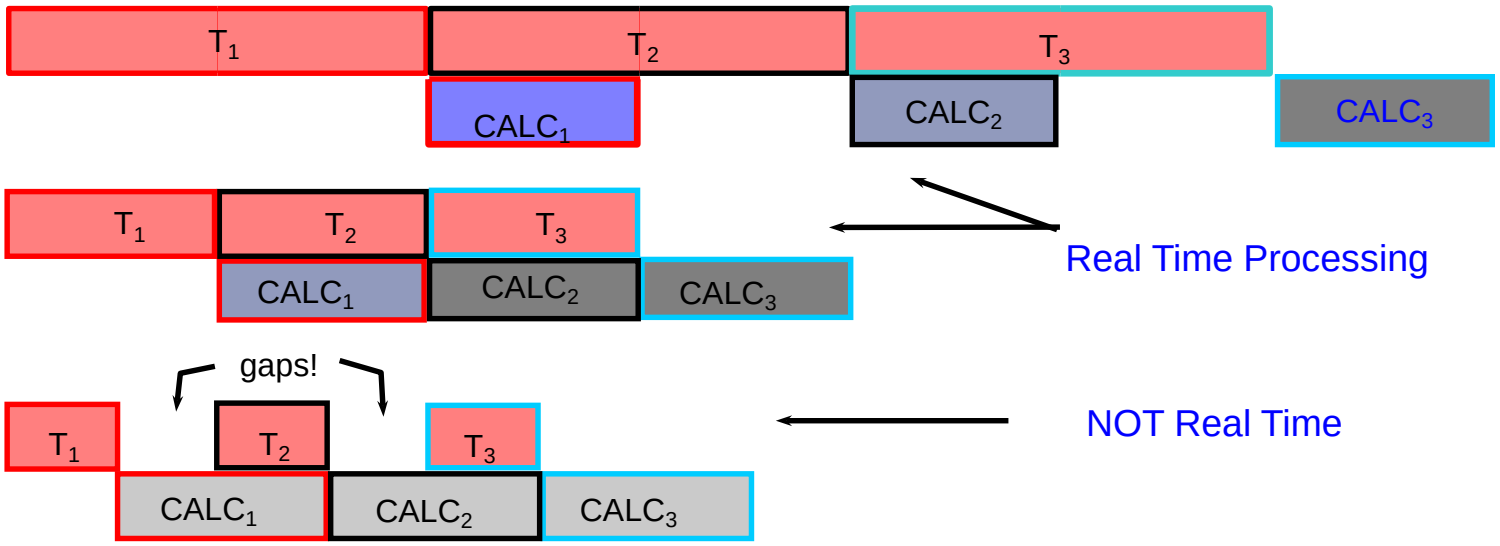


What about real-time?

- The real-time bandwidth is the frequency span at which the FFT processing time equals the time record length-this means all input data is included in the average (in other words, there is no gap between the end of one time record and the beginning of the next).

REAL-TIME Bandwidth

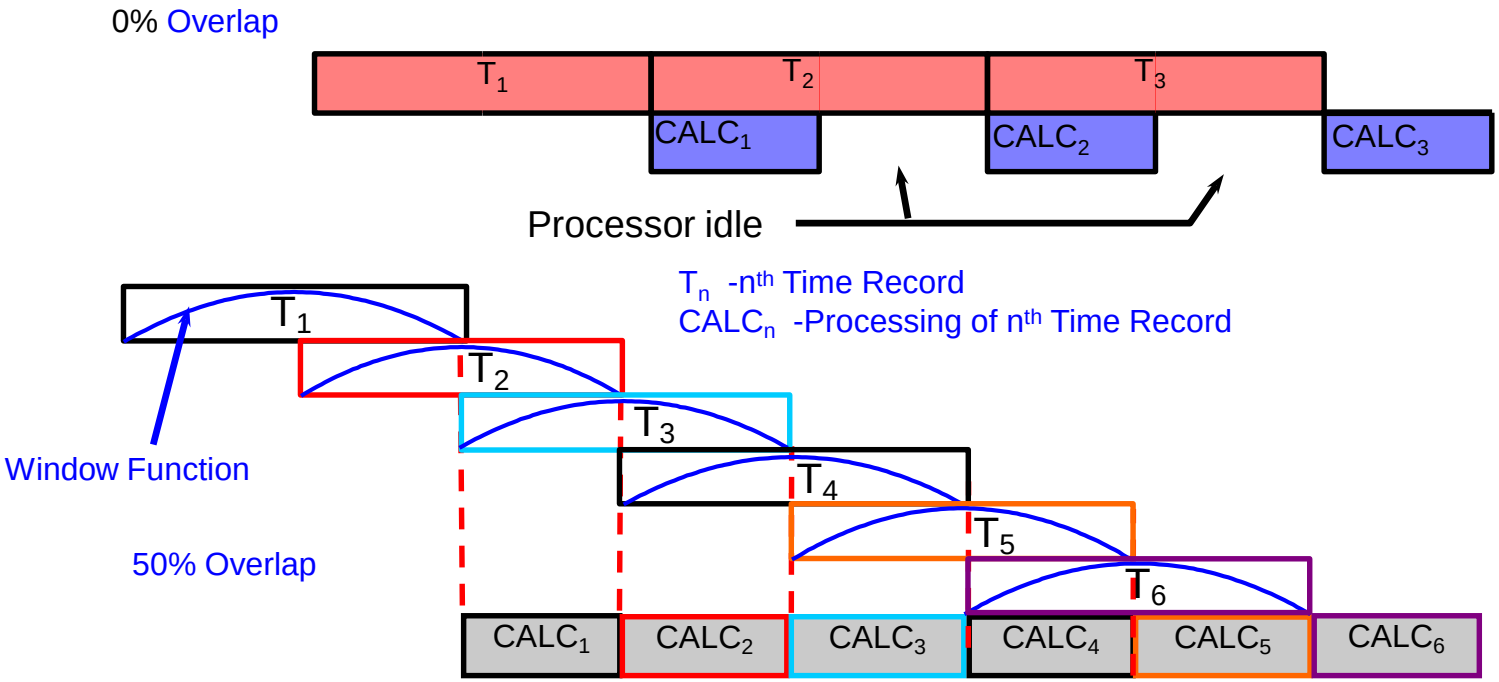
- The widest bandwidth (span) that can be selected such that every sample from the digital filter is used in the Spectrum.
- Real Time Bandwidth is also referred to as the "gap free" rate.
- Double Buffering allows Calculations on previous data record while collecting next data record.



Calculation time includes windowing, FFT, power spectrum, Linear to Log conversion, and averaging calculation plus display update!

Overlap Processing

- When in real time operation the analyzer can do additional signal processing.



- More averages/unit time
- Quicker variance reduction
- Recovers data lost due to window function

Recording signals

Why record signals

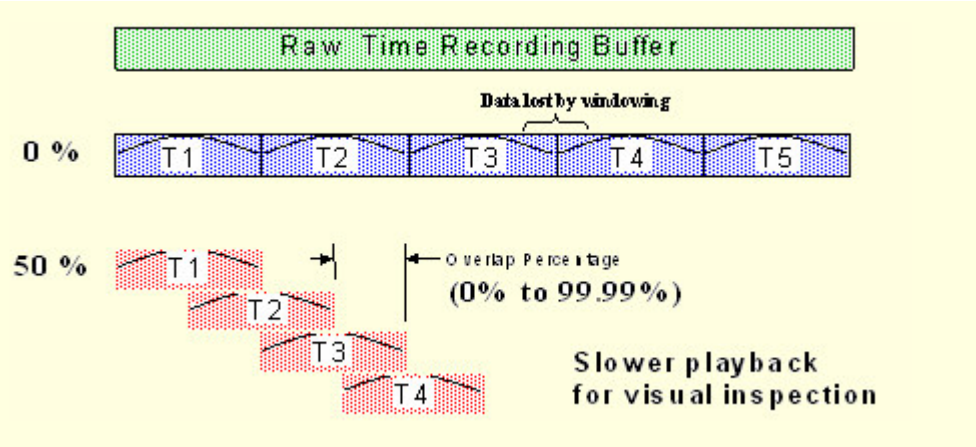
- No gaps! Continuous time record at full bandwidth.
- Long records. Up to 512 mega samples (Keysight XSA Family).
- Powerful post processing. More control over the analysis.
- Analyze in the frequency, time, analog or digital demodulation domains.
- Slow playback with overlap processing.
- Porting of simulations back to design software.
- Archiving. Save signal records for future analysis.

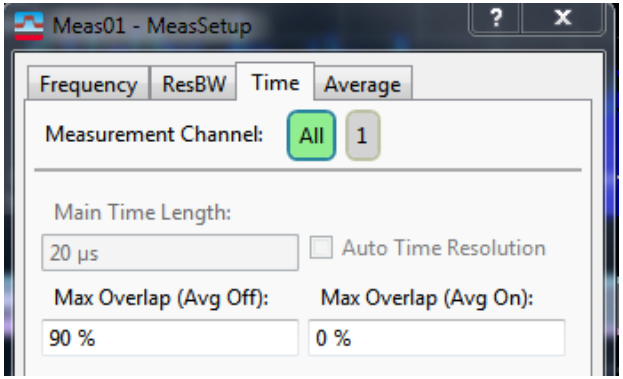
Gap free analysis

- Overlap Processing

- Recording playback requires that the recording buffer be broken into time records for processing and display. Shown in blue below, is the normal way to do that. This method results in the fastest playback speed.

- Overlap processing advances through the recording buffer by "sliding" the time record window through the buffer. You controls the rate at which data is replayed (0% to 99.99%). The result is a slower playback. Data lost by the FFT windowing process is now analyzed as well.





Recording signals

To record a signal

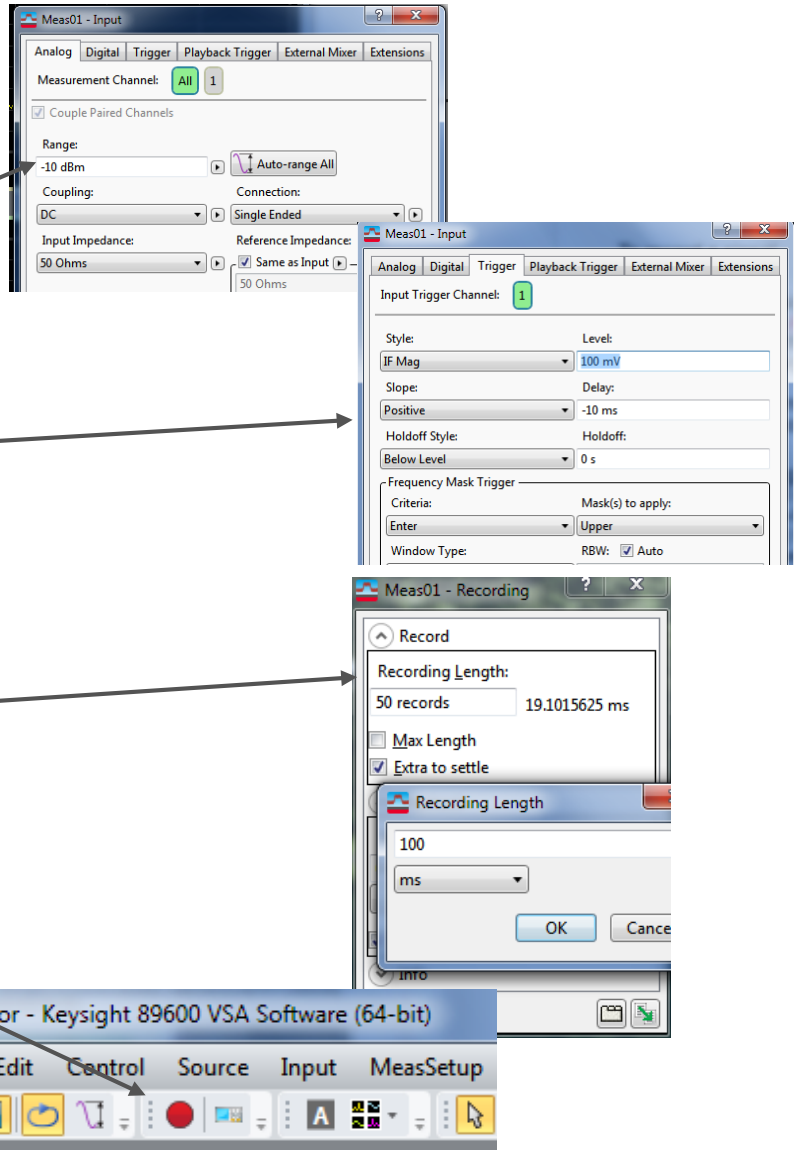
1. Acquire the signal in the normal fashion. See Acquiring a signal.
   Be sure that the Span chosen will contain the signal characteristics of interest.
   Choose the most sensitive Range without the possibility of overload.

2. Use triggering to ensure when the recording will start.
   Consider pre-triggering (negative trigger delay) to start recording before the event of interest occurs.

3. Set up recording length. Click Input > Recording > Length.
   This can be specified in points, records, or seconds.

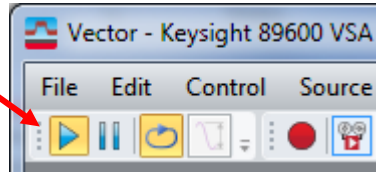
4. Click Control > Record or click the record button.

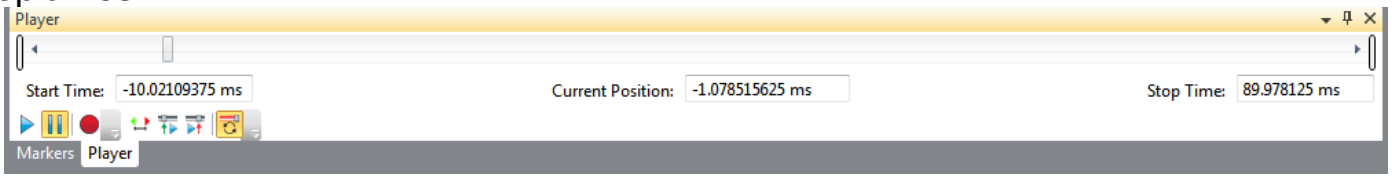
5. When a qualified trigger occurs the recording will begin.
   Recording is immediate when no triggering is specified.



Playback recordings

- Recording playback can be started by clicking the Play key or Control > Restart.
- Or
- Click Window > Player.
- The player lets you:
- Start and pause the playback
- Drag the bar to any position in the record
- Back up and rewind
- Loop the recording
- Set start and stop times
- Re-record

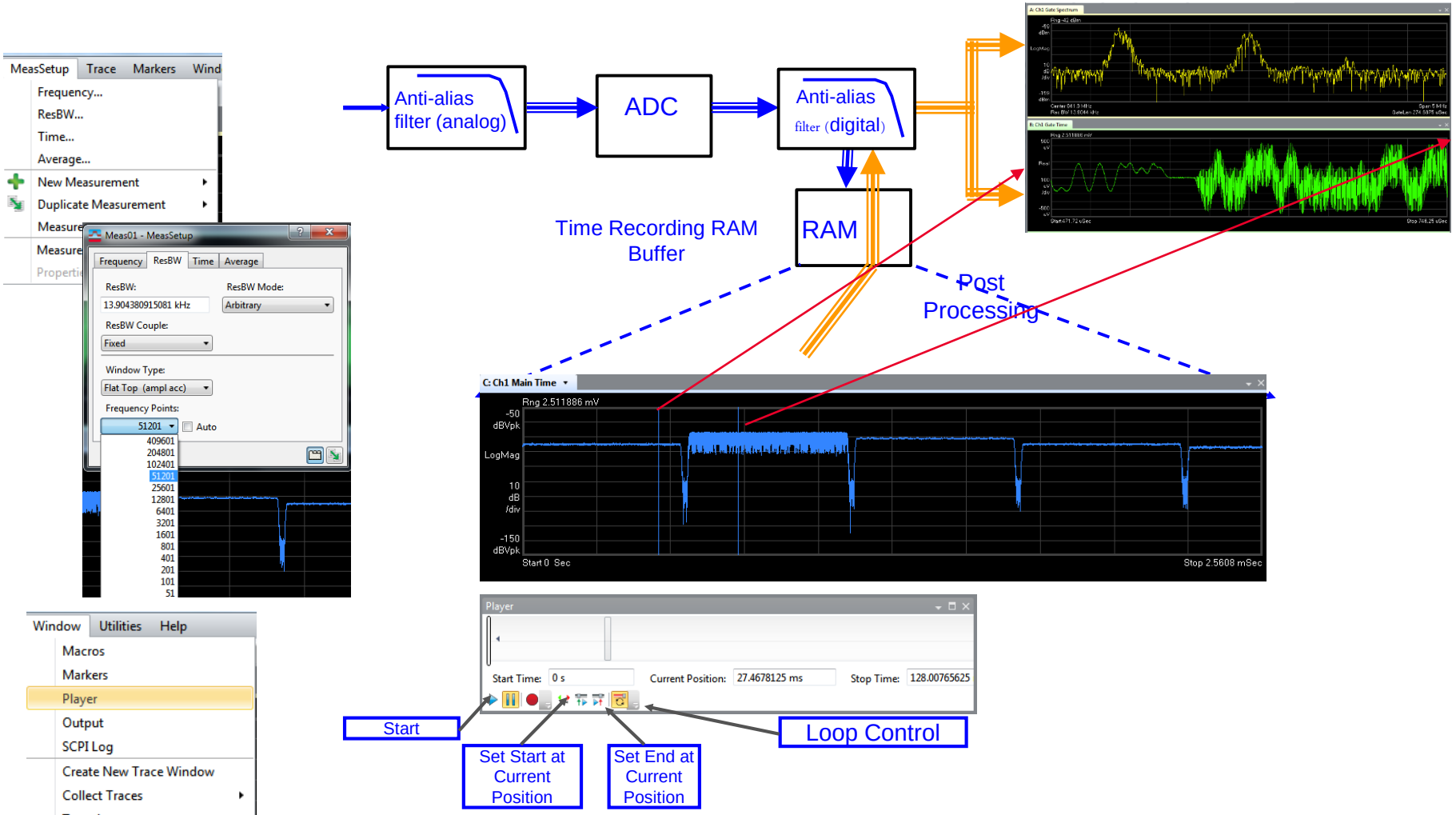




Playback Control

To view all or a large portion of the Recording Buffer, increase the number of Frequency Points..

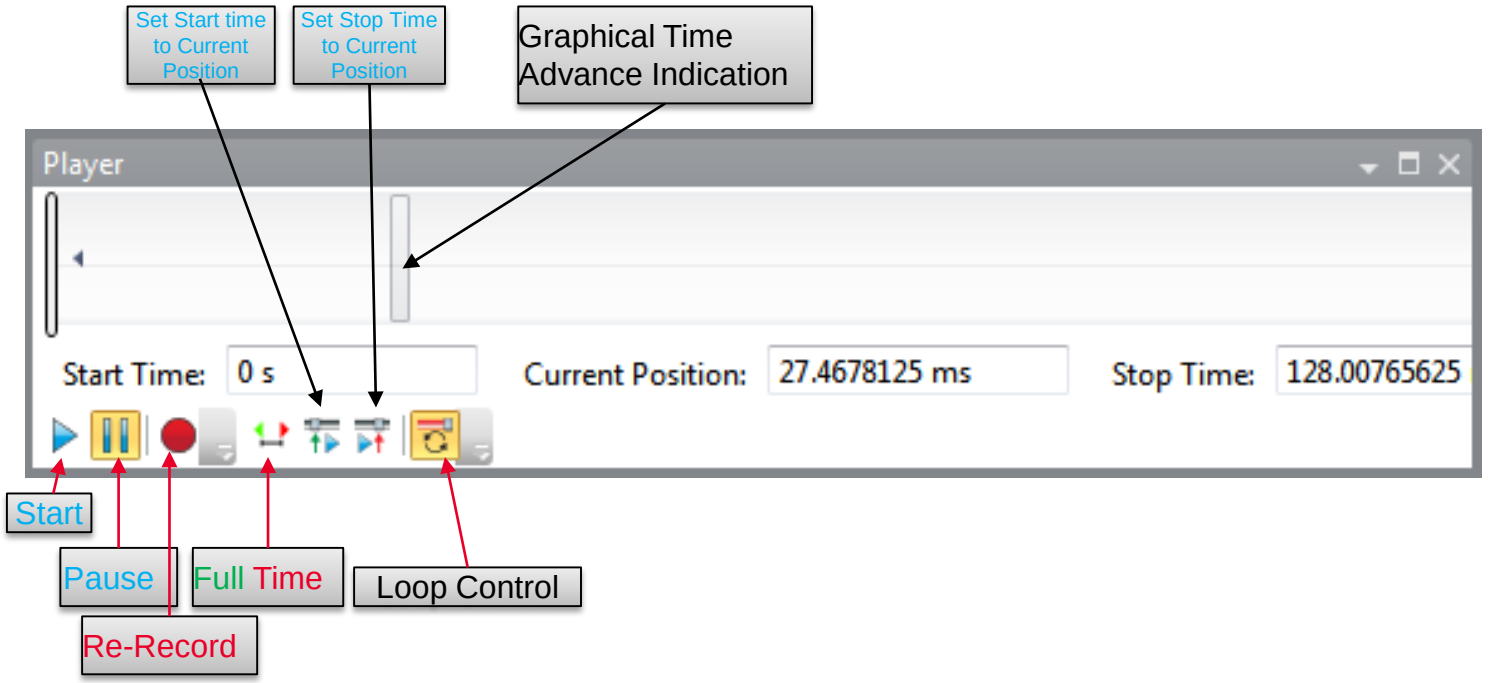
Expanded view of Time Gated Signal



– The Start Time for Analysis can be set by typing in a Time in the Player dialog box or click and dragging the slide bar of the time Record buffer data to be used for a measurement.

Keysight 89601B Player Control Window Detail

Control Icons and Indicators on Player Window Interface



Summary Recording Post-processing Changes in Measurement Parameters

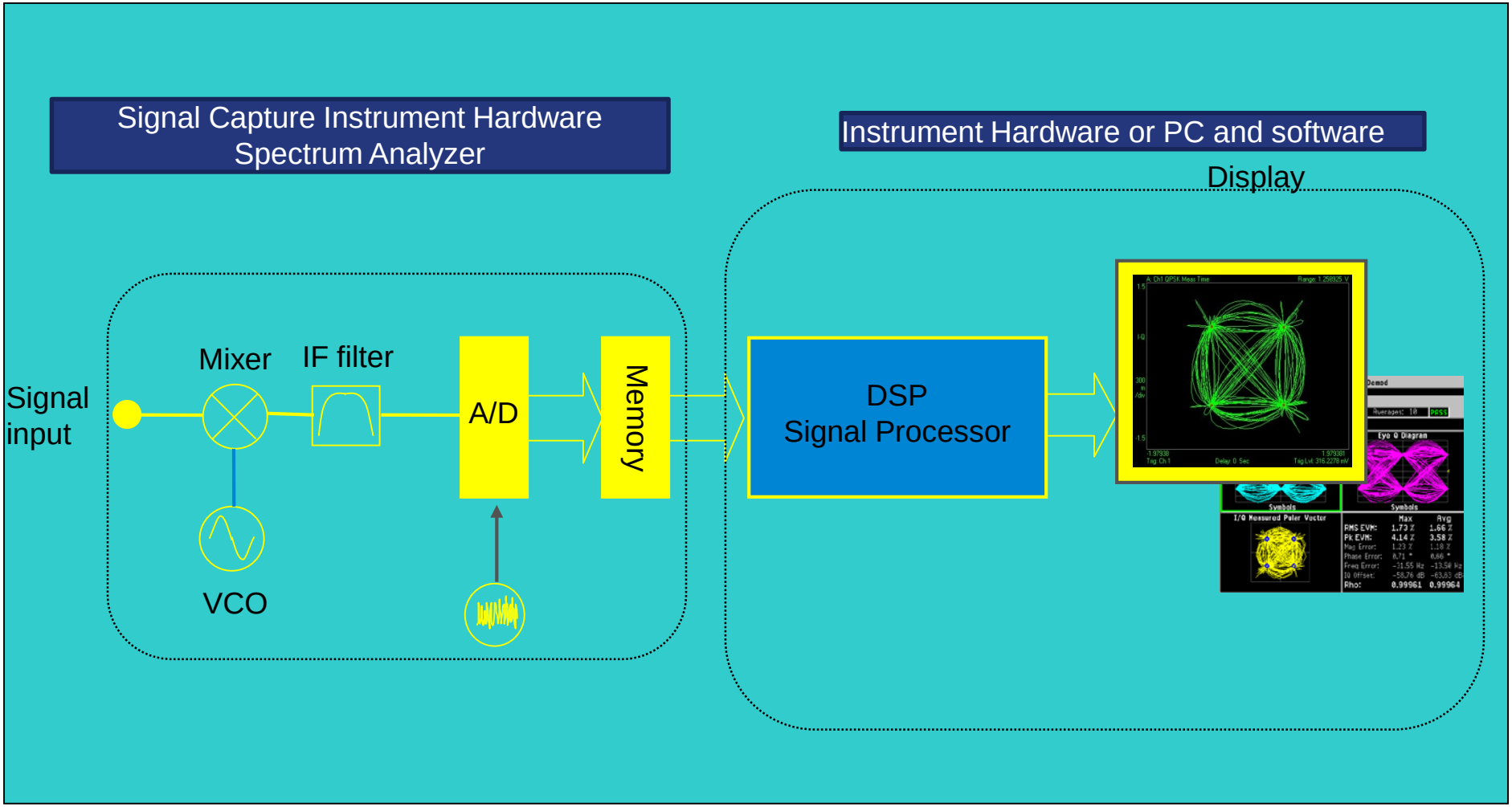
- After data has been Recorded, many measurement parameters can be changed, for each pass through the Recording.

Changes can be made to:

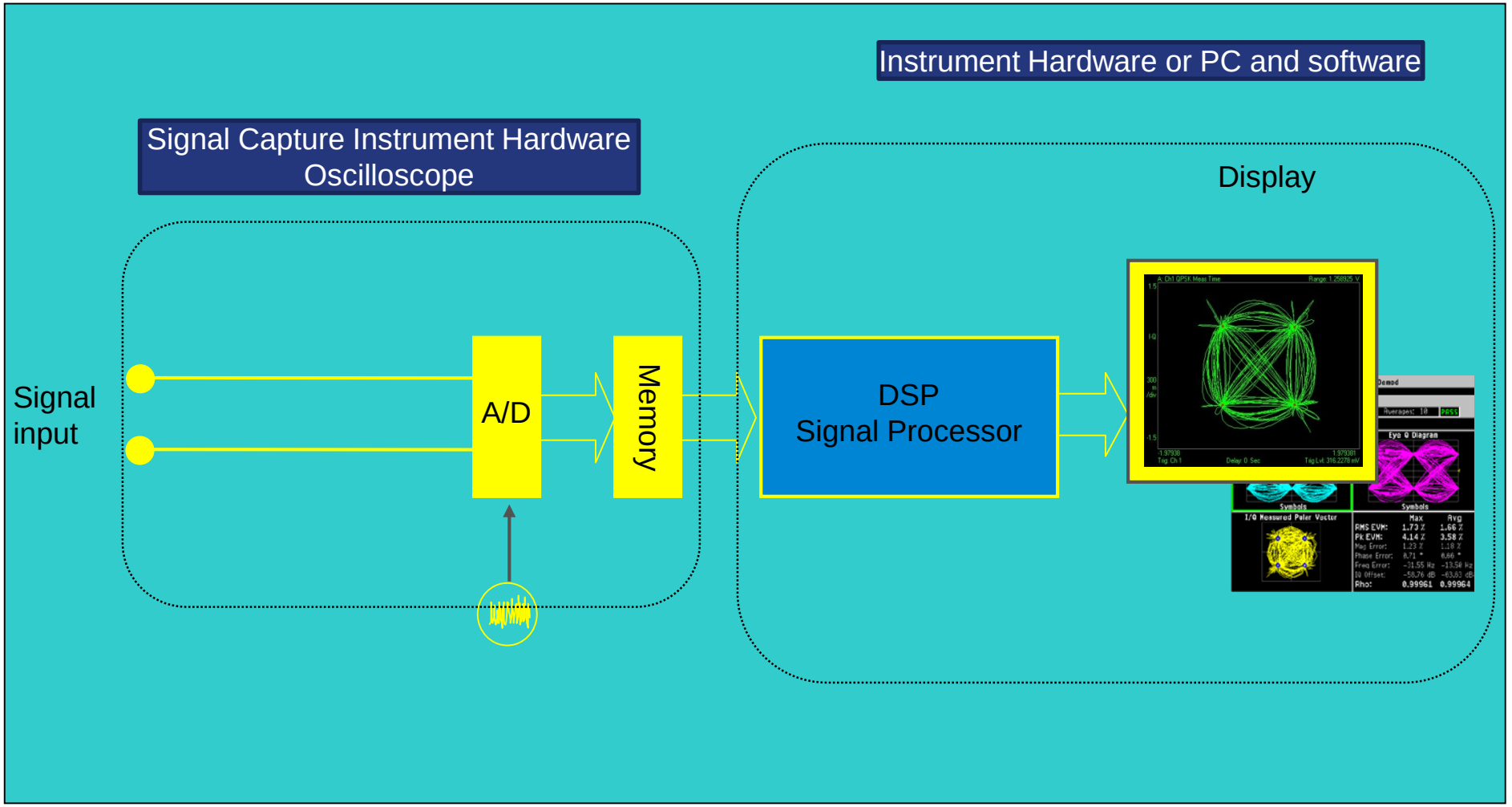
- Center Frequency & Span
- Resolution BandWidth
- Number of Frequency Points
- Window - ResBW
- Time length
- Gate Delay & length
- Average types, overlap processing
- Sweep mode, Single or Continuous
- Demodulation type
  - Analog - Demodulation
  - Digital - Demodulation

Keysight Vector Signal Analyzers

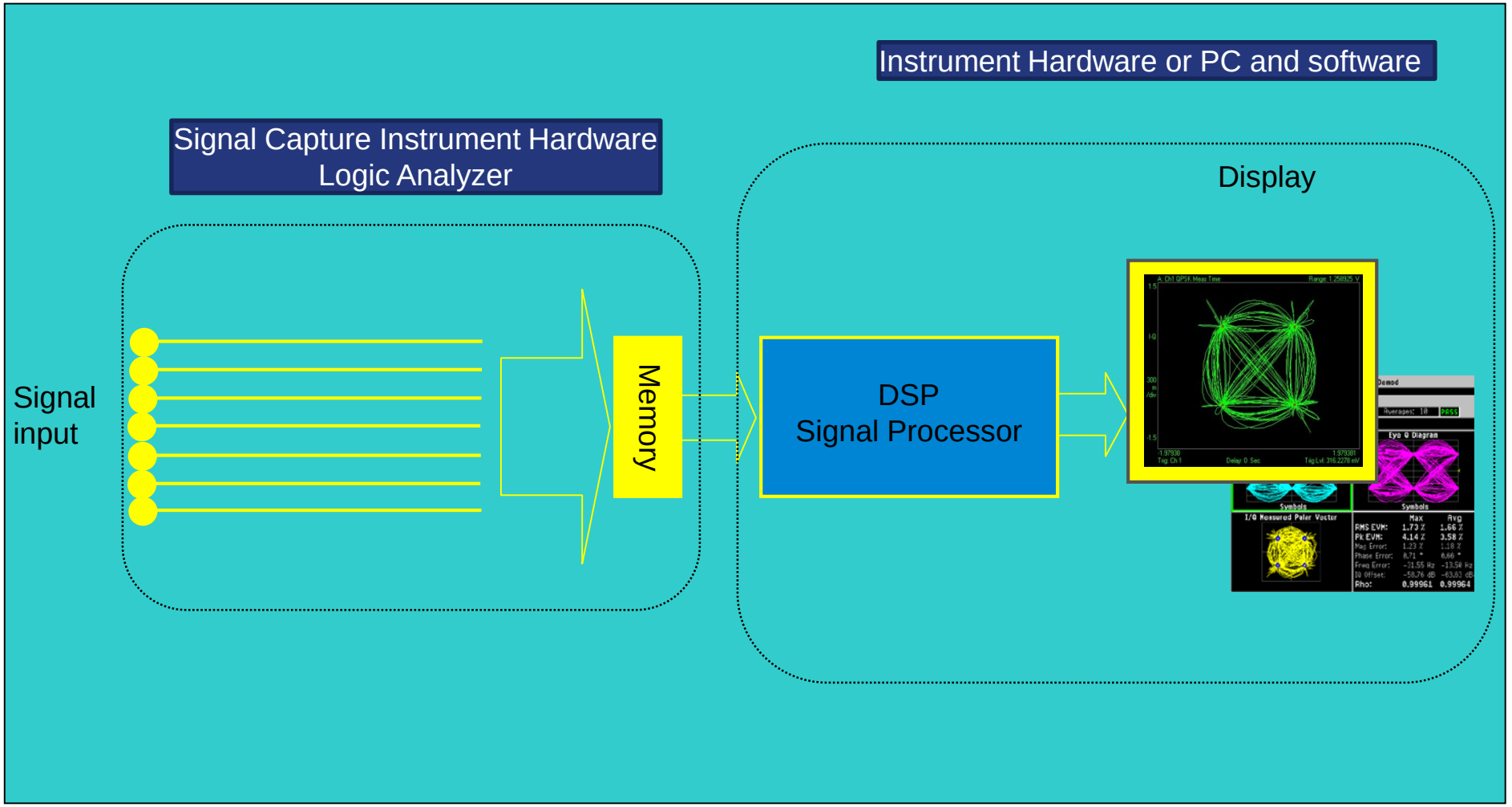
Vector Signal Analysis Block Diagram Analog RF



Vector Signal Analysis Block Diagram
Analog IF or IQ baseband



Vector Signal Analysis Block Diagram
Digital IF or IQ baseband



Keysight Vector Signal Analyzers

16900 Series Logic Analyzer

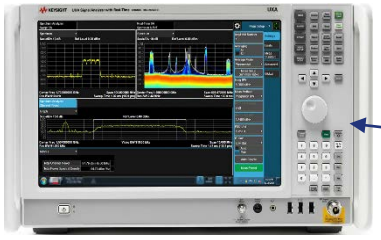
M9391 PXI VSA

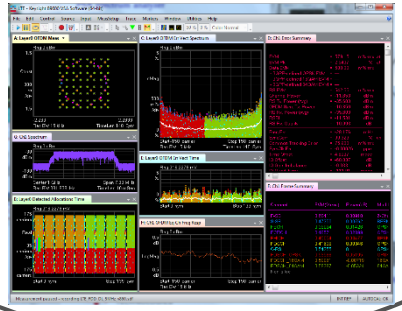
M9703 Series High Speed digitizer

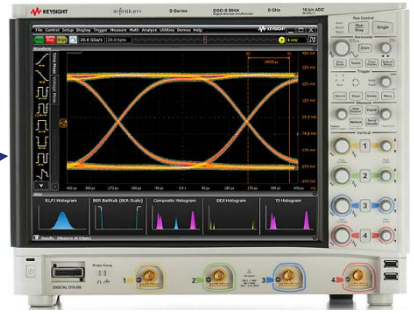
X-Series Signal Analyzers

89601B
VSA Software

Infiniium Series Oscilloscopes

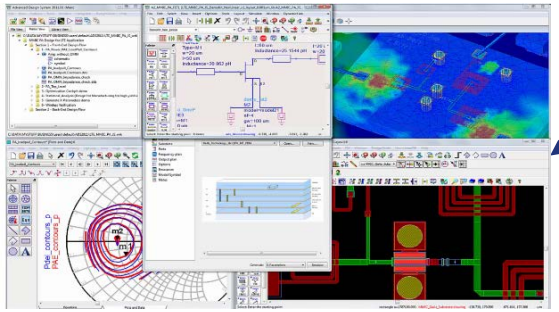






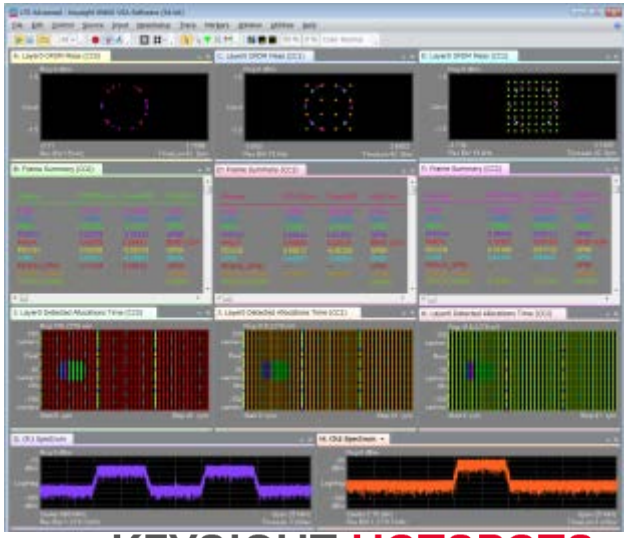
Keysight ADS or SystemVue

N4010A Bluetooth and WLAN Tester

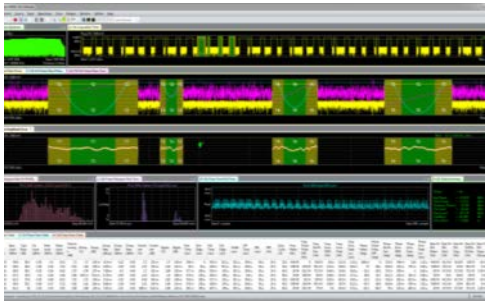


First-to-Market in Wireless

- **IEEE 802.11ac WLAN**
  - All signal BWs: 20, 40, 80, 80+80, 160 MHz
  - All modulation formats: BPSK to 256QAM
  - Up to 8x8 MIMO & multi-user MIMO
- **LTE-Advanced 3GPP Release 10**
  - Carrier aggregation
    - Contiguous and non-contiguous spectrum allocations
    - Uplink & downlink signals
    - Analyze up to 5 CCs simultaneously
  - Enhanced uplink
    - Clustered SC-FDMA
    - Simultaneous control and data channel support

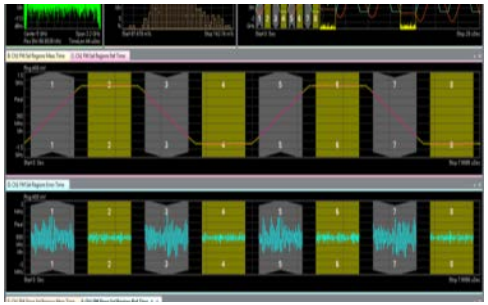


Robust Analysis in A/D, Automotive & Satellite



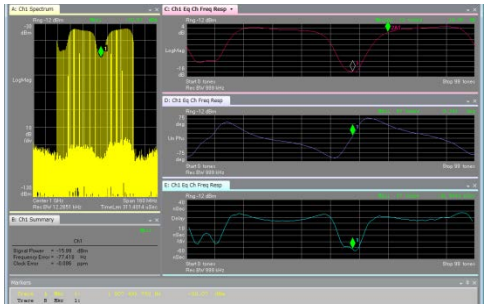
Pulse Analysis

- A/D Radar and EW
- General Radar



FMCW Radar Analysis

- Linear FM Chirp Analysis
- Automotive Radar



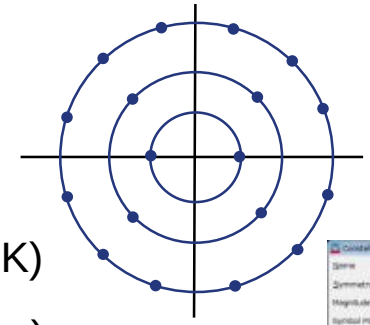
Channel Quality Measurements

- Multi-tone group delay for satellite systems

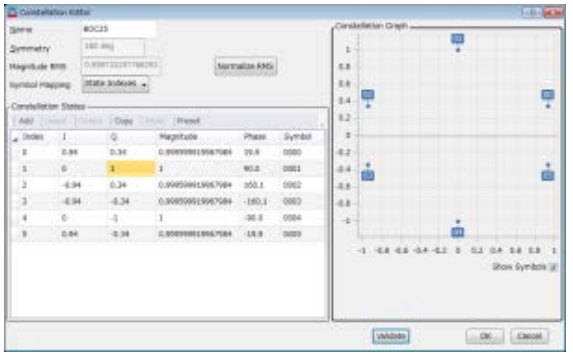
Supports new UXA signal analyzer, up to 1 GHz bandwidth

Industry-Standard Tools for Proprietary Signals

– **Custom APSK**

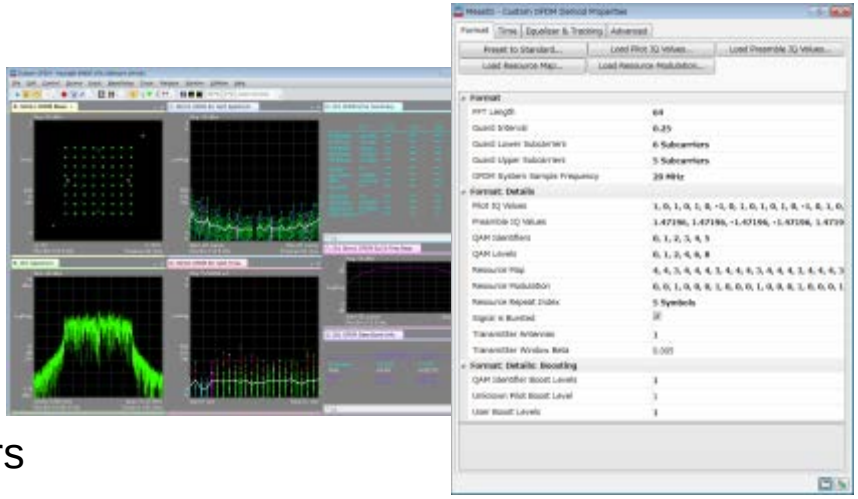


- APSK constellations, staggered
- High-order PSK (e.g. 16PSK, 32PSK)
- Amplitude Shift Keying (on-off keying)



– **Custom IQ**

- IQ constellation editor for custom, proprietary, non-standard, unique, asymmetric signals
- Longer symbol length with synchronization robustness

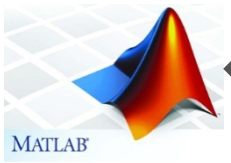


– **Custom OFDM**

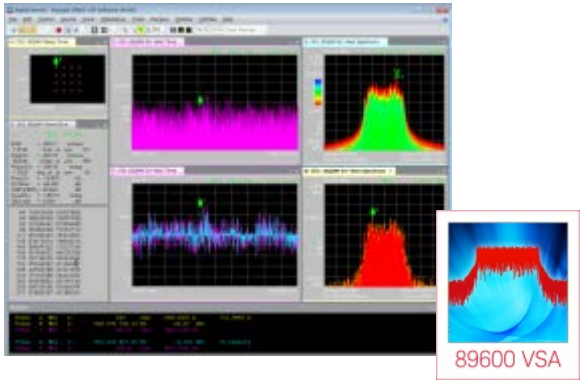
- Demodulation of custom, proprietary OFDM-based signals
- Support for multiple streams and users

Apply Vector Signal Analysis Across the Lifecycle

Produce consistent, comparable results from simulation to production



Compatible file formats



Supports >45 Keysight measurement platforms

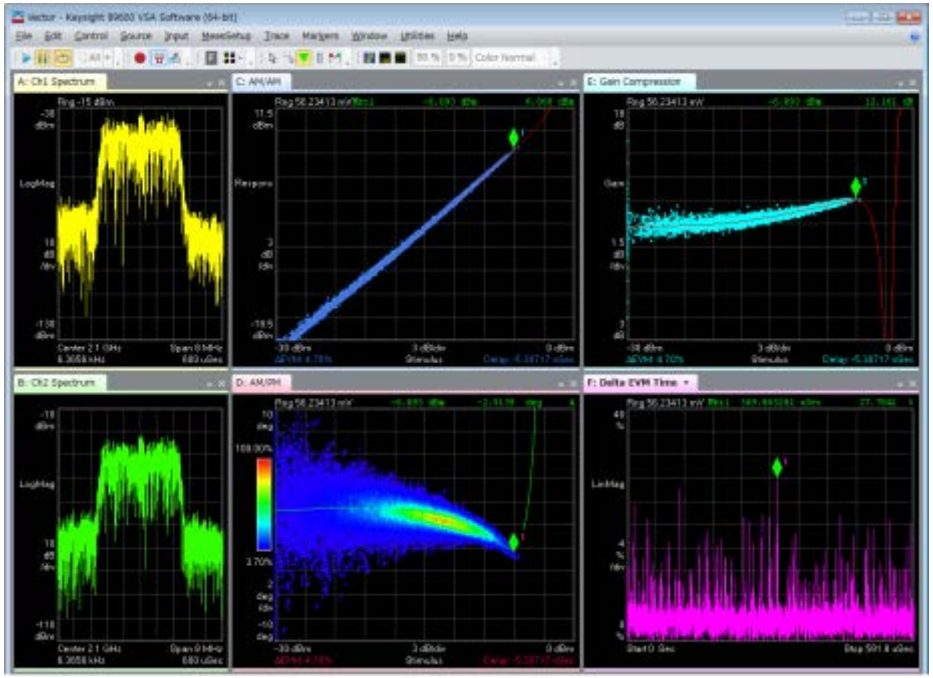
Simulation	Baseband Design	IF, RF, uW Design	System Verification	Quality Assurance	Production
• ADS • SystemVue	• Logic analyzer • Oscilloscope • Modular digitizer	• Signal analyzers – benchtop & modular • Oscilloscope	• Signal analyzers – benchtop & modular	• Signal analyzers – benchtop & modular	• Signal analyzers – benchtop and modular

Thoroughly Characterize Designs

Complex stimulus-response measurements

– Measure device distortion with the signals it will see during real-world operation
  - Wide bandwidth, high PAPR signals, like OFDM, stress devices much more than CW tones.

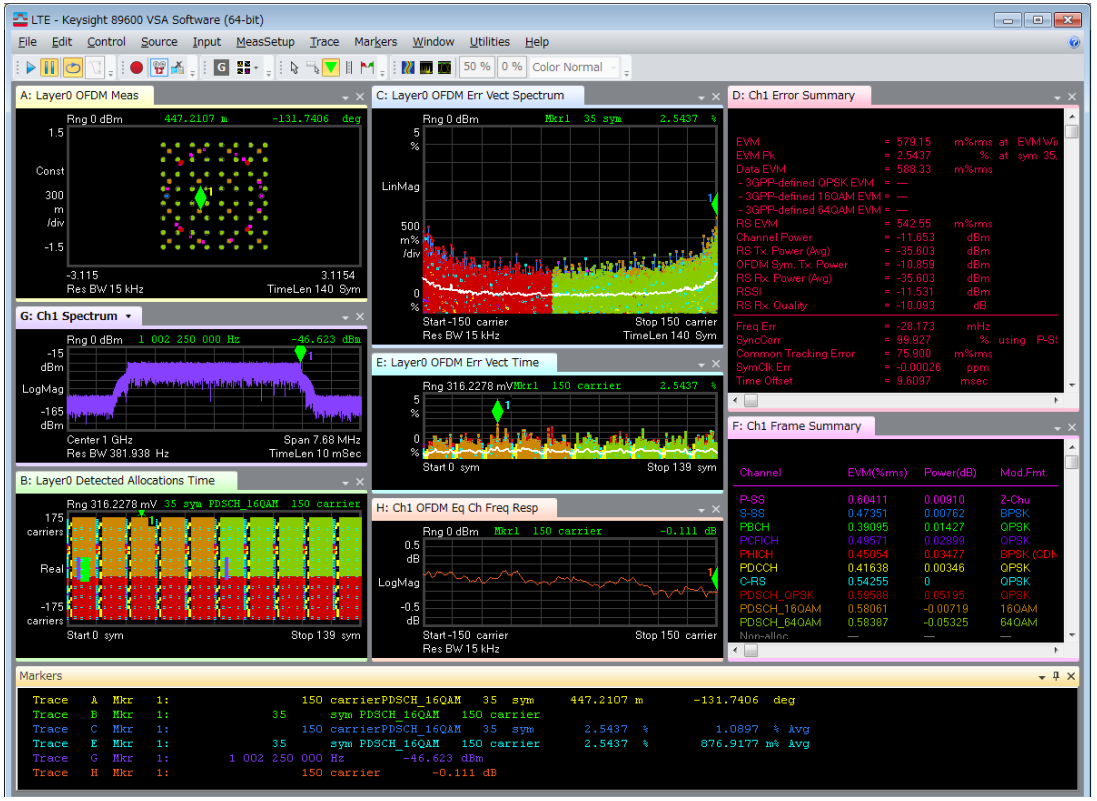
– Measurement results include
  - AM/AM
  - AM/PM
  - Gain Compression
  - Differential (Δ) EVM
  - Δ EVM vs. Time
  - Propagation delay
  - Best fit curve



Verify Signal Problems Quickly

Powerful display increases clarity

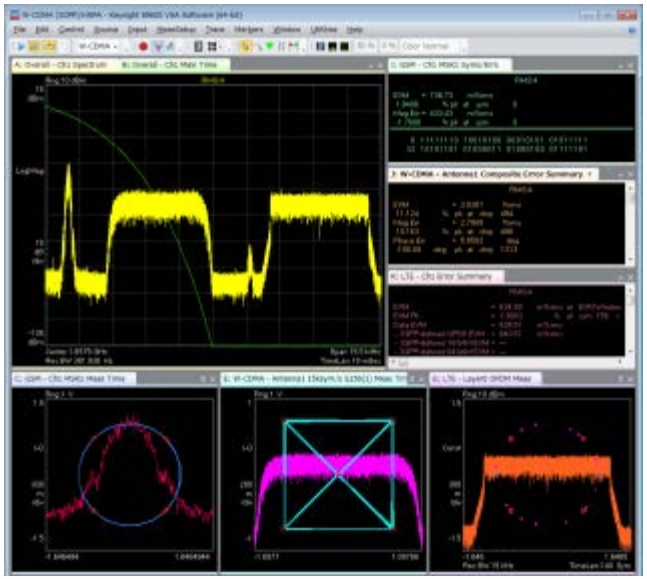
- Isolate unexpected behavior with unlimited markers and marker coupling between traces
- Intuitively analyze today's most complex signals with color-coded results by channel and user

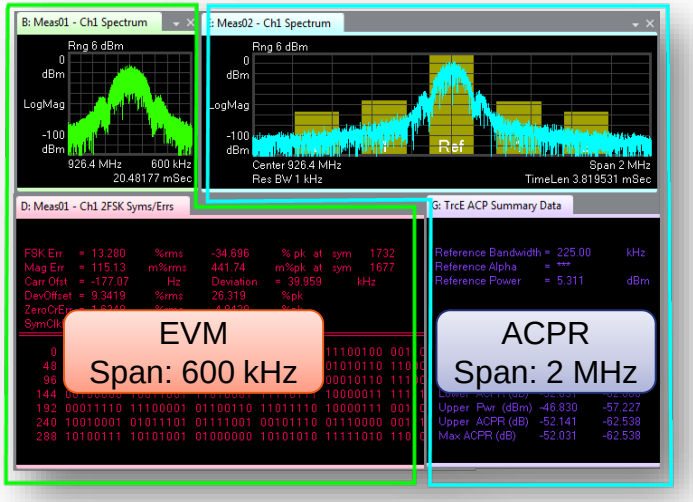


Analyze & Display Multiple Signals—Simultaneously

Multi-measurements

- Perform multiple measurements at once; display all results together
- Control multiple instruments to obtain wider frequency coverage
- Use multi-measurements to simultaneously:
  - Demodulate different signal types
  - Analyze signals at varying frequencies
  - Check for interactions between signals
  - Measure signals at different physical test points
  - Analyze both uplink & downlink signals
  - Use different analysis parameters (span, demod properties, etc.)

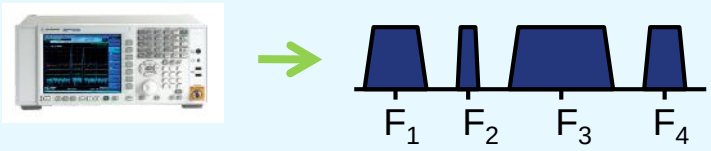




Multi-Measurements

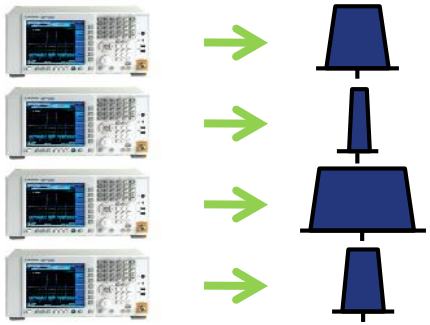
Signal acquisition styles

Simultaneous



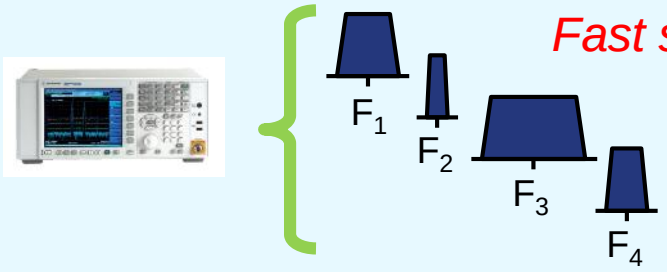
Shared: Acquire once, then perform multiple, truly simultaneous meas. within the max span width.

Unlimited BW



Independent, multi-box: Synchronized measurements at same/different freqs, spans, formats, etc. using multiple HW front ends and triggering.

Fast switching

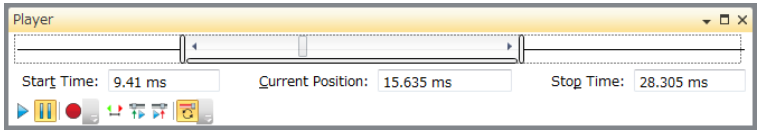


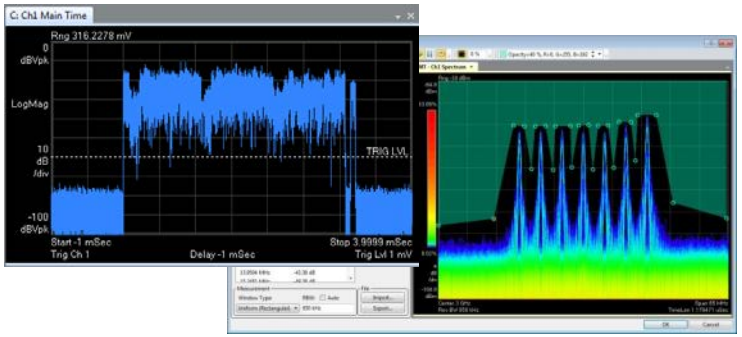
Independent, same-box: Non-simultaneous measurements at various freq's, spans, formats, etc. using a single HW front end.

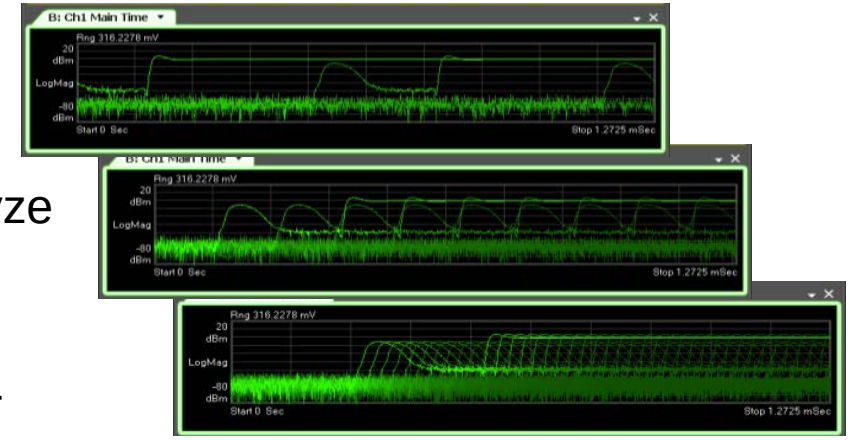
Pinpoint the Answers to Signal Problems

Advanced troubleshooting tools for capture & playback

- Easily record signals with familiar controls
- Catch elusive signals with flexible triggering
  - Trigger acquisition based on magnitude, frequency or external
- Play back gap-free recorded signals for detailed analysis
  - Modify parameters like overlap processing during playback
  - Utilize persistence displays to analyze behavior over time
  - Download recorded signal files into Keysight vector signal generator for playback



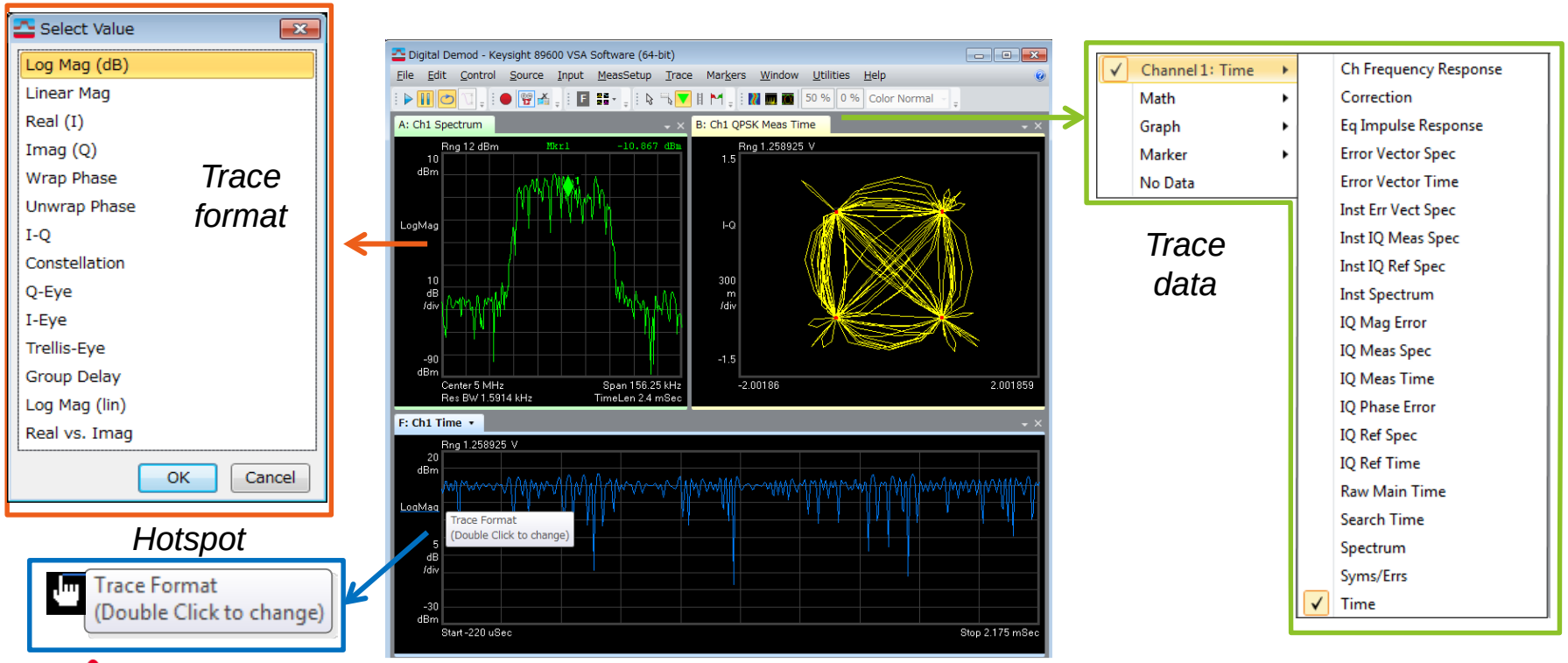




View & Organize Your Results

Flexible GUI enables greater insight

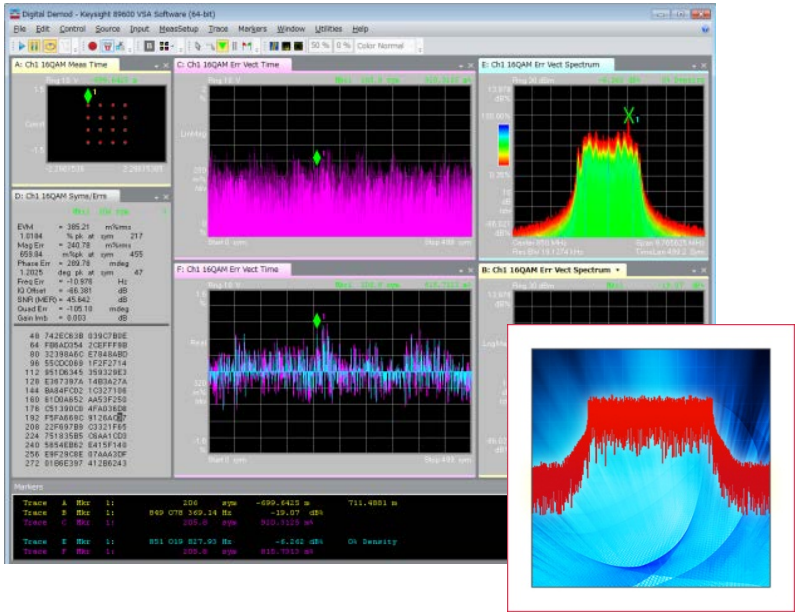
- View unlimited traces with unlimited markers
- Optimize trace arrangement to see signal patterns & interactions
- Adjust trace shape to extend event observation time or increase viewable



89600 VSA Software

See through the complexity

- Measure signals in cellular, wireless connectivity, aerospace, defense, and general-purpose applications
- Multiple simultaneous views
- Advanced troubleshooting tools
- Works across your design process: supports >45 measurement platforms



Subscription service keeps you up-to-date

89600 VSA Ordering Information

89601B (transportable), 89601BN (floating)

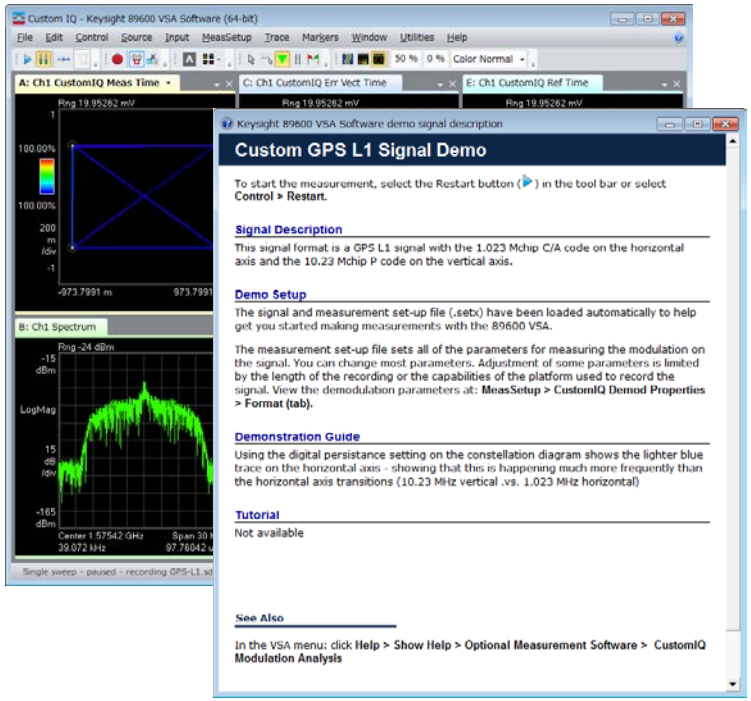
Description	Option	Notes
General purpose		
Vector modulation analysis	AYA	Analysis of > 30 digital modulation formats, including custom APSK and presets for communication formats like ZigBee, *Bluetooth*®, APCO 25 and SOQPSK
Custom OFDM modulation analysis	BHF	Proprietary and pre-standard OFDM formats including DOCSIS 3.1 upstream
Custom IQ modulation analysis	BHK	Proprietary and pre-standard, customized IQ constellation signals. Requires Option AYA.
Channel quality measurements	BHL	Channel response measurements such as phase/magnitude response and multi-tone group delay
Spectrum analysis	SSA	For M9391A and M9393A PXI VSA only
Cellular communications		
LTE-Advanced FDD modulation analysis	BHG	Release 10. Requires Option BHD
LTE-Advanced TDD modulation analysis	BHH	Release 10. Requires Option BHE
LTE-FDD modulation analysis	BHD	Release 8/9
LTE-TDD modulation analysis	BHE	Release 8/9
cdma2000®/1xEV-DV modulation analysis	B7T	
W-CDMA/HSPA+ modulation analysis	B7U	
1xEV-DO modulation analysis	B7W	
TD-SCDMA/HSPA modulation analysis	B7X	
3G modulation analysis bundle	B7N	Includes -B7T, -B7U, -B7W, and -B7X
TEDS modulation analysis	BHA	Includes TETRA2 signals
Wireless connectivity		
WLAN 802.11ac modulation analysis	BHJ	Requires Option B7Z
WLAN 802.11n modulation analysis	B7Z	
WLAN 802.11a/b/g modulation analysis	B7R	Includes WLAN 802.11j/p
WiMAX™ 802.16 modulation analysis	B7Y	Mobile and Fixed
RFID modulation analysis	BHC	Includes NFC formats
Radar analysis		
FMCW radar analysis	BHP	For multi-chirp linear FM modulated signals or automotive radar
Pulse analysis	BHQ	For single-emitter pulse analysis
Other standard format		
DOCSIS 3.1 downstream modulation analysis	BHM	

Description	Model-Option		Notes
	Transportable license	Floating license	
12 month software update and subscription service	89601BU-012	89601BNU-012	Immediately updates software to current version and provides 1 year of updates

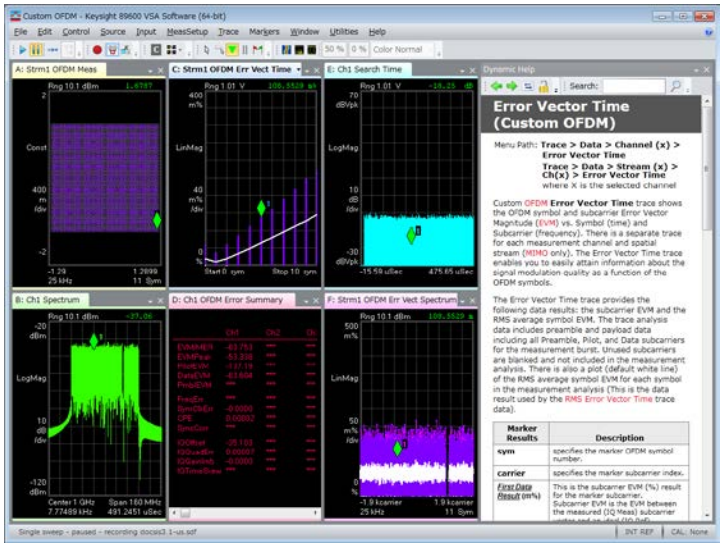
Try 89600 VSA Software Today

Free 30-day trial

– Play recorded demo signals
  - >110 signals available
  - File > Recall > Recall Demo



– Learn more with Dynamic Help
  - Click any feature to view text
  - Help > Dynamic help



www.keysight.com/find/vsa_trial

Additional Resources

- Web Page: www.keysight.com/find/89601B
- Literature
  - Vector Signal Analysis Basics, application note, literature number 5990-7451EN
  - Brochure, literature number 5990-6553EN
  - Configuration guide, literature number 5990-6386EN

Thank You