Utilizzo del Time Domain per misure EMI

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KEYSIGHT TECHNOLOGIES

Compliance EMI receiver requirements (CISPR 16-1-1)

range 9 kHz - 18 GHz:

•A normal +/- 2 dB absolute accuracy

•CISPR-specified resolution bandwidths (-6 dB)

•Peak, quasi-peak, EMI average, and RMS average detectors

•Specified input impedance with a nominal value of 50 ohms; deviations specified as VSWR

•Be able to pass product immunity in a 3 V/m field

•Be able to pass the CISPR pulse test (implies pre-selector below 1 GHz)

•Other specific harmonic and intermodulation requirements

Above 1GHz

•1 MHz bandwidth for measurements

•No quasi-peak detector

•No CISPR pulse test, meaning no additional pre-selector required

• excellent sensitivity

•According to current FCC regulations, the maximum test frequency is the fifth harmonic of the highest clock frequency for an “unintentional radiator” (for example, computers without wireless connectivity) and the tenth harmonic for an intentional radiator (such as a cellular phone or wireless LAN).

MIL STD 461F

Spectrum Analyzer use allowed (and commonly used)

- need to ensure measurement linearity (avoid overloads)
- need to have sufficient sensitivity (may need preamp)

Requires MIL Bandwidths

Requires Peak Detector

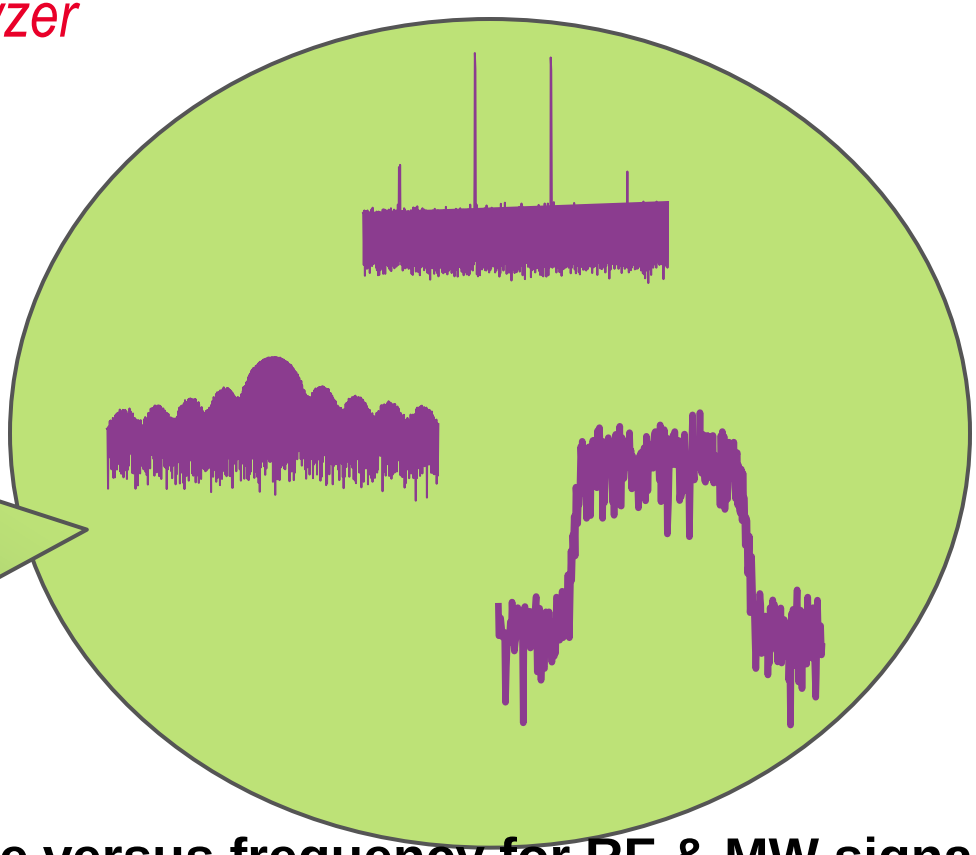
+/- 2dB amp accuracy, +/- 2% frequency accuracy

Dwell times specified in document

What is an EMI Receiver?

Let's begin with a spectrum analyzer

Spectrum Analysis



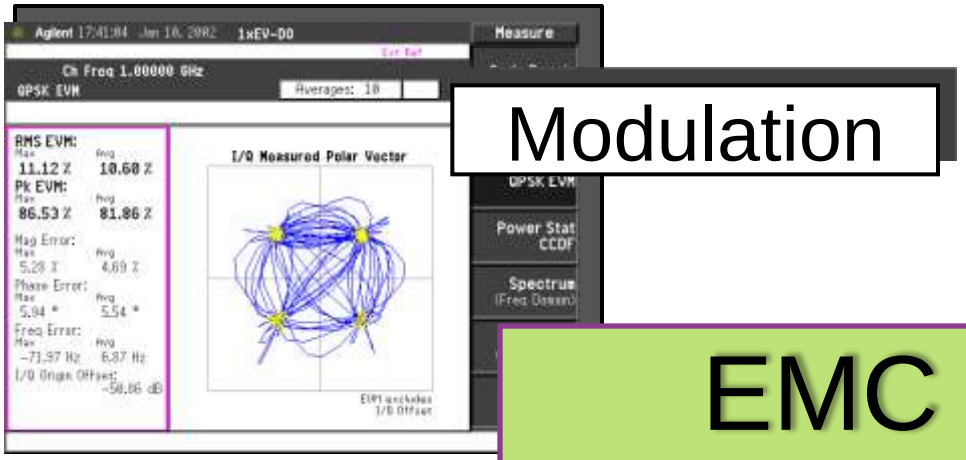
- **Display and measure amplitude versus frequency for RF & MW signals**
- **Separate or demodulate complex signals into their base components (sine waves)**

Agenda

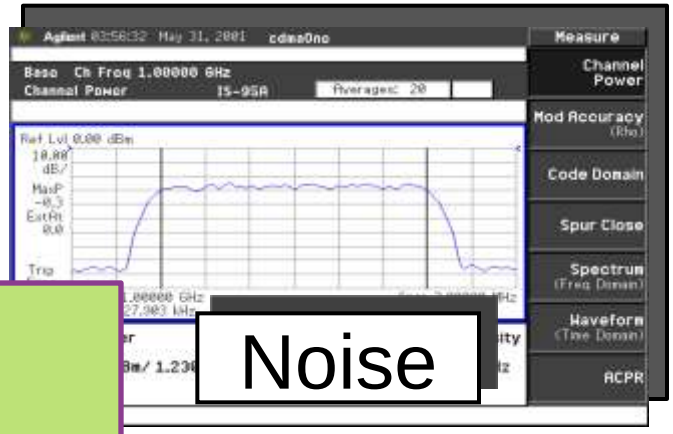
- Introduzione al ricevitore EMI
- Schema a blocchi e principio di funzionamento
- L’utilizzo della FFT per le misure EMI

Overview

Types of Tests Made



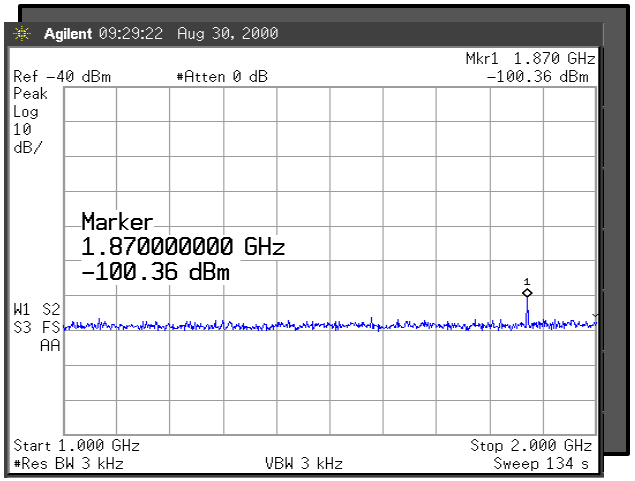
Modulation



EMC

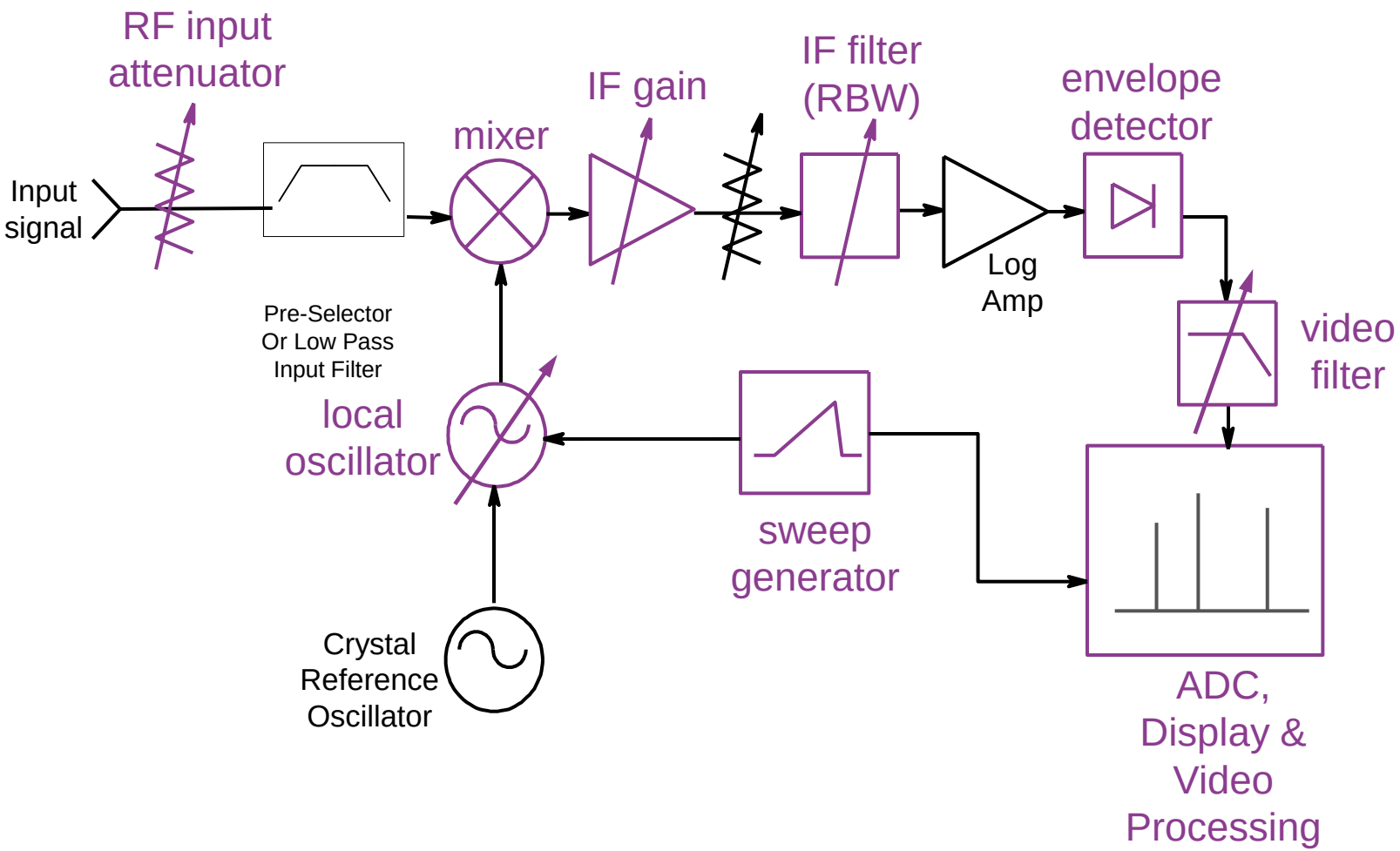
Noise

Distortion

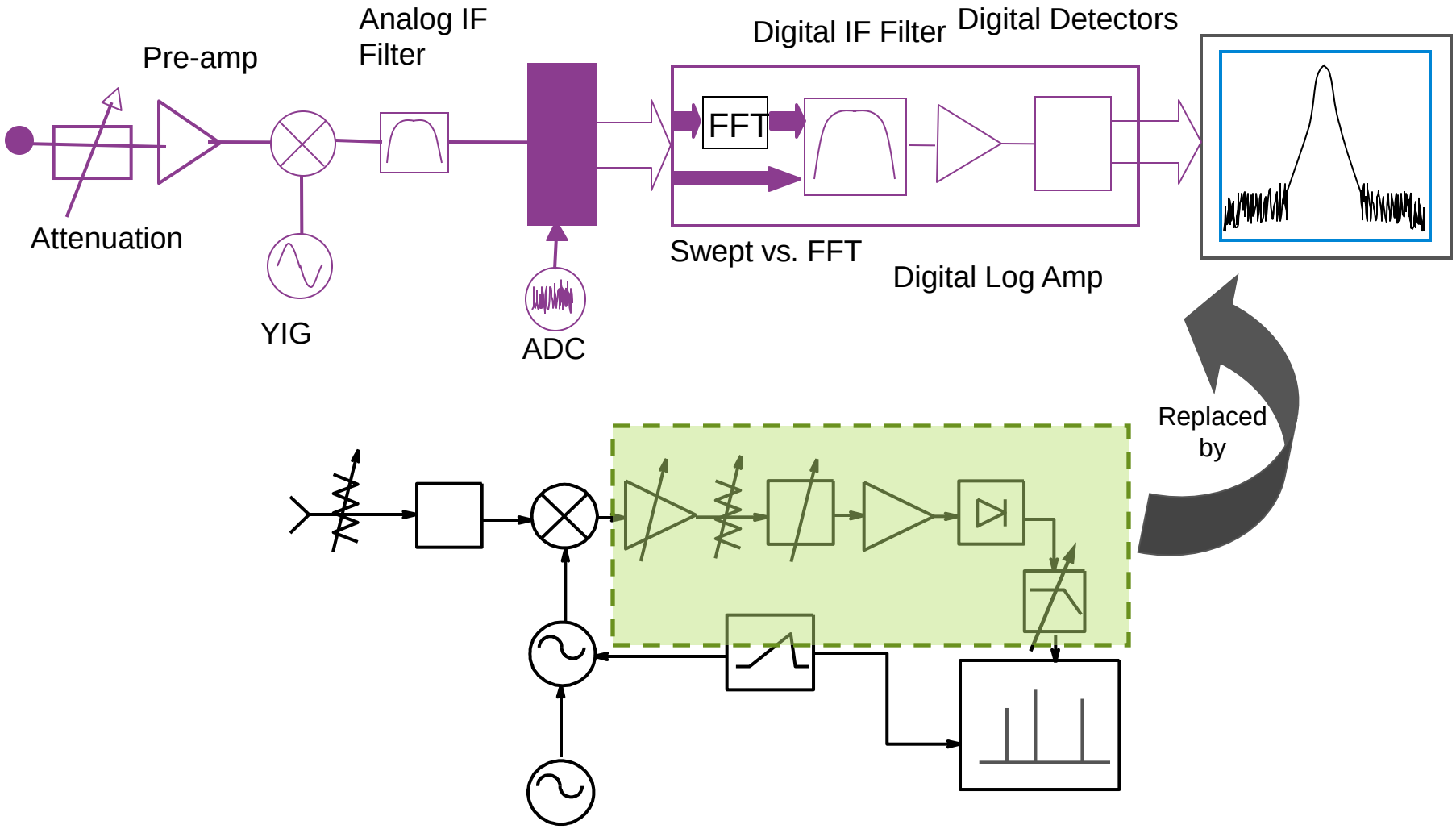


Theory of Operation

Swept Spectrum Analyzer Block Diagram

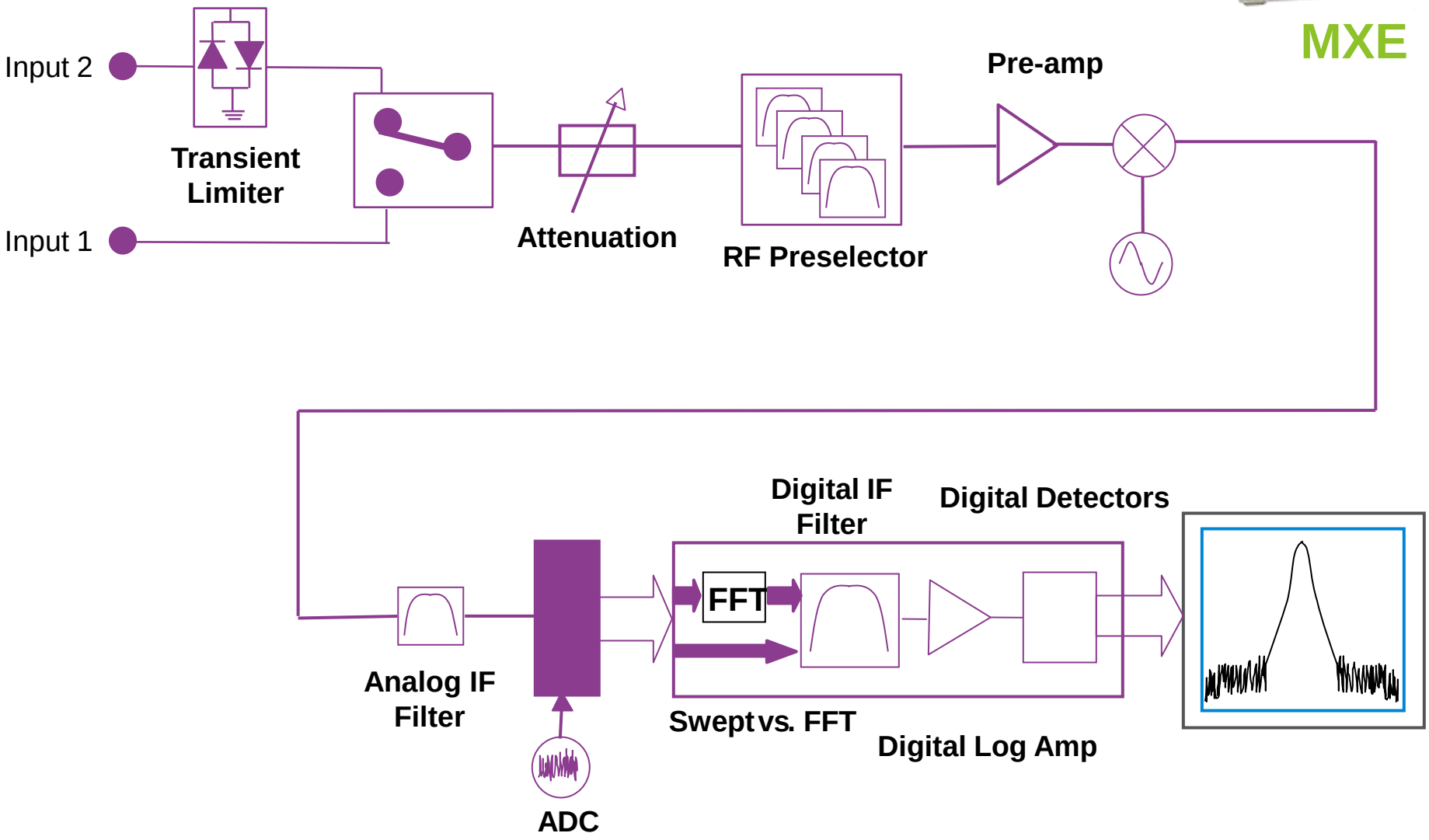


Modern Spectrum Analyzer Block Diagram

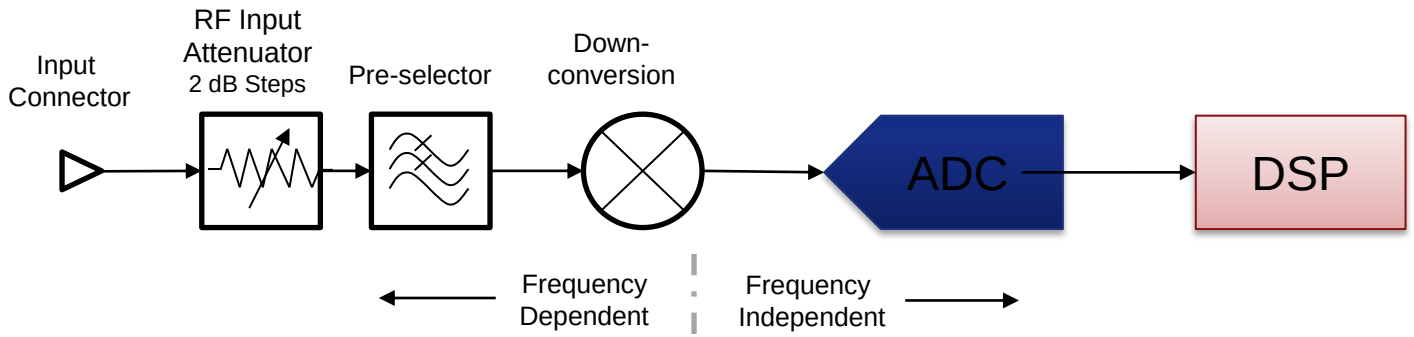


EMI Receiver Block Diagram

MXE



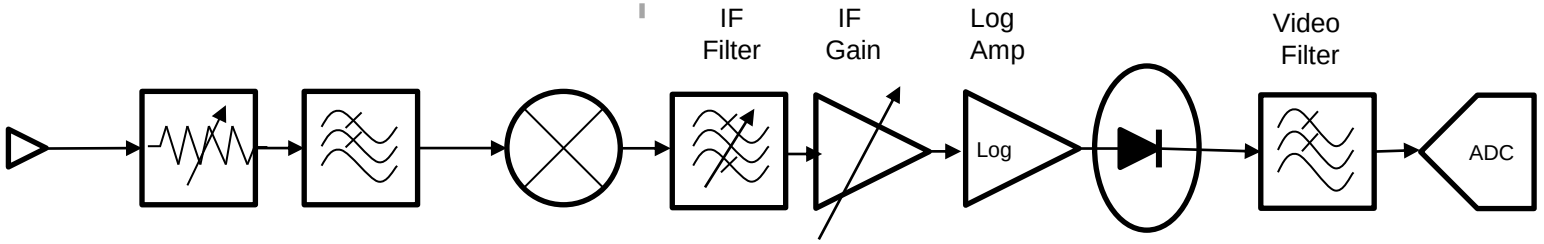
Digital IF Improves Amplitude Accuracy



Amplitude Uncertainty	N9038A Receiver	Analog IF (older receivers)
Ref Level Switching	0dB	<= +/- 1dB
RBW Switching	+/- .05dB	<= +/- .5dB
Display Scale Fidelity	+/- .15dB	<= +/- .85dB

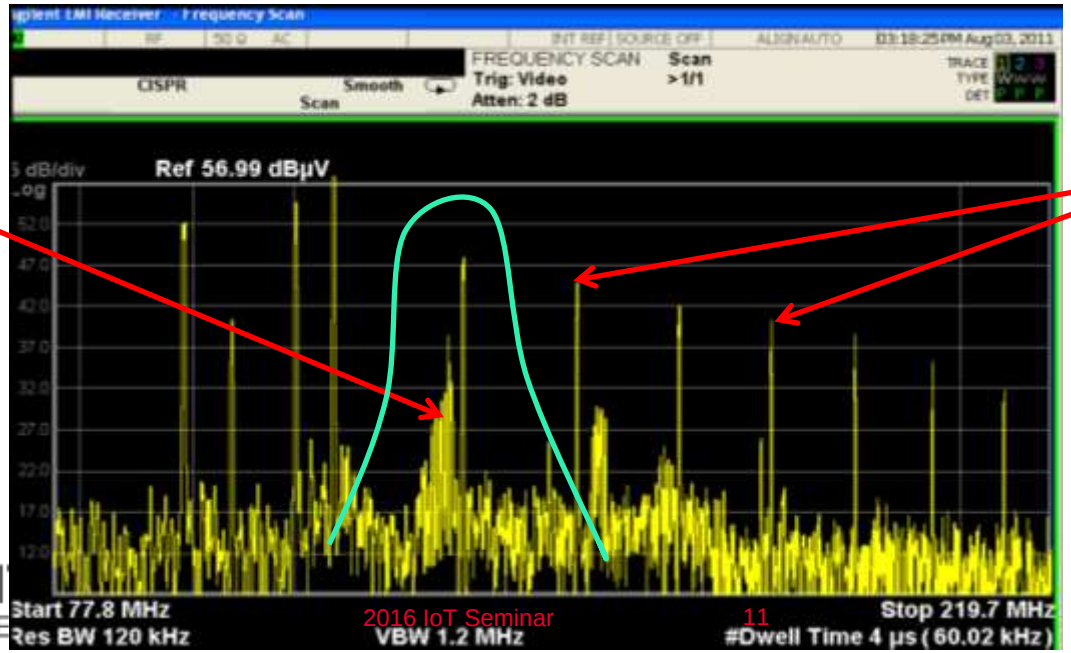
Digital IF improves Amplitude Accuracy:

- Ref Level switching uncertainty (IF gain)
  - Level correction digitally synthesized
- RBW filter switching uncertainty
  - RBWs all digitally synthesized
- Display scale fidelity (Log Amp)
  - Log response & display scaling digitally synthesized



RF Pre-selection (RF input filtering)

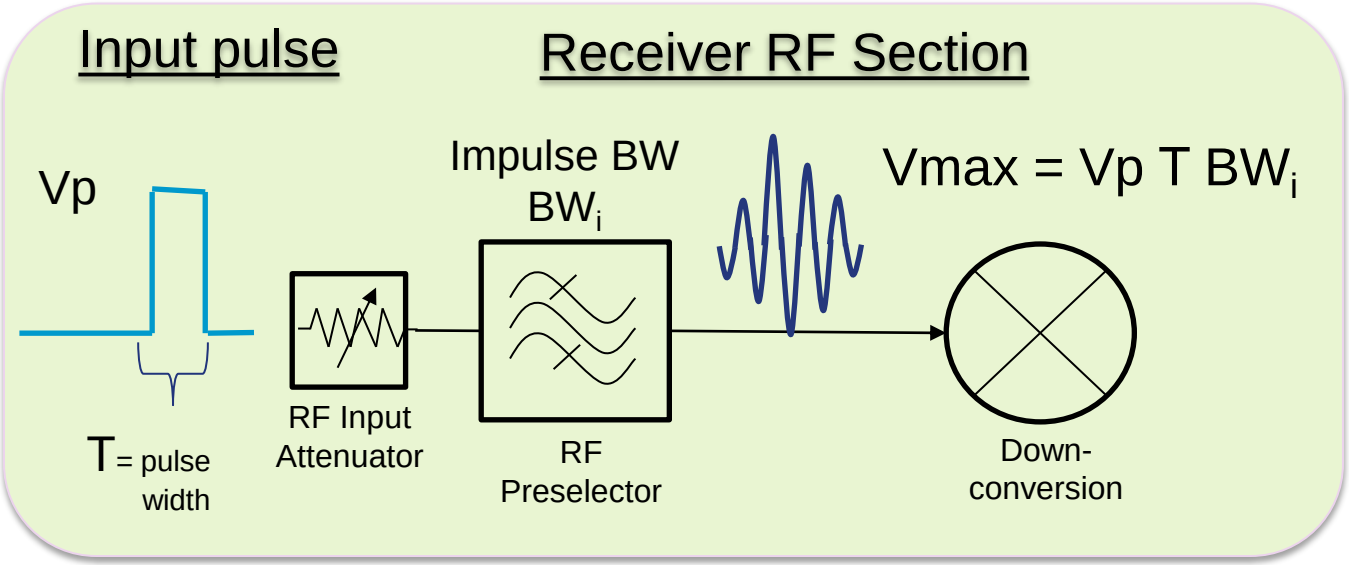
- **Purpose of RF pre-selection**
  - Help to prevent overload by reducing total energy at input mixer
  - RF preselector tracks the center frequency of the EMI receiver
  - The bandwidth of the RF preselector is wider than the widest RBW used
- **Useful in measuring broadband signals**
- **Types of filters used in RF pre-selectors**
  - Low-pass, Band-pass and High-pass
  - Fixed and Tracking



RF Preselector Bands

Description	Specifications	Supplemental Information
RF Preselector Filters		
Filter Band	Filter Type	6 dB Bandwidth (Nominal)
20 Hz to 150 kHz	Fixed lowpass	310 kHz
150 kHz to 1 MHz	Fixed bandpass	1.7 MHz
1 to 2 MHz	Fixed bandpass	2.4 MHz
2 to 5 MHz	Fixed bandpass	7.5 MHz
5 to 8 MHz	Fixed bandpass	10 MHz
8 to 11 MHz	Fixed bandpass	9.5 MHz
11 to 14 MHz	Fixed bandpass	9.5 MHz
14 to 17 MHz	Fixed bandpass	10 MHz
17 to 20 MHz	Fixed bandpass	9.5 MHz
20 to 24 MHz	Fixed bandpass	9.5 MHz
24 to 30 MHz	Fixed bandpass	9.0 MHz
30 to 70 MHz	Tracking bandpass	10 MHz
70 to 150 MHz	Tracking bandpass	24 MHz
150 to 300 MHz	Tracking bandpass	28 MHz
300 to 600 MHz	Tracking bandpass	50 MHz
600 MHz to 1 GHz	Tracking bandpass	60 MHz
1 to 2 GHz	Tracking bandpass	180 MHz
2 to 3.6 GHz	Fixed highpass	1.89 GHz (–3 dB corner frequency)

Wider RF Pre-selector Filter BW = Reduced Impulse Overload Protection



Max Pulse voltage into mixer is proportional to RFPS filter impulse BW (BW_i)

- Examples* : @10MHz: 20 log (35MHz/9.5MHz) = 11.3dB

  @ 500MHz: 20 log (200MHz/ 50MHz) = 12dB

- *Note: Above calculations using 6dB BW ratios, not impulse BW ratios
- Results provide approximate values of required input attenuation

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

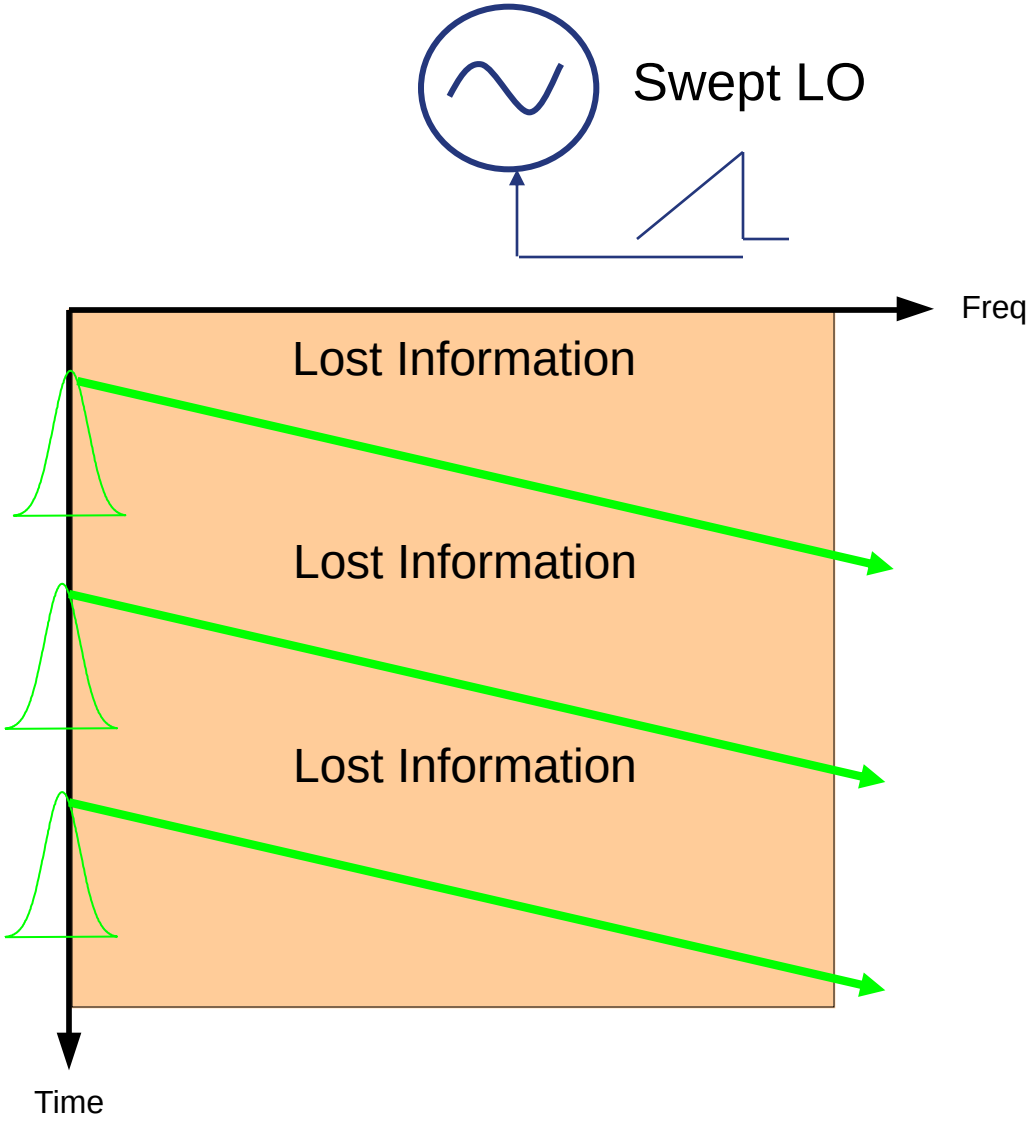
- uses ~ 90% overlap (in time) to ensure amplitude accuracy for measurements of both CW and Impulsive signals

–*Allowed* by CISPR 16, but not required.

- Internal Automotive industry testing specifications require Time Domain

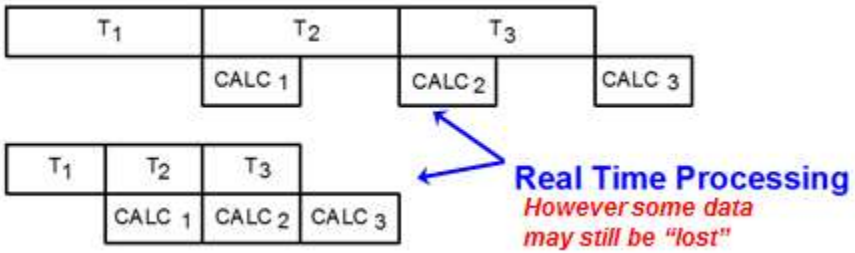
The Swept Analysis Mode

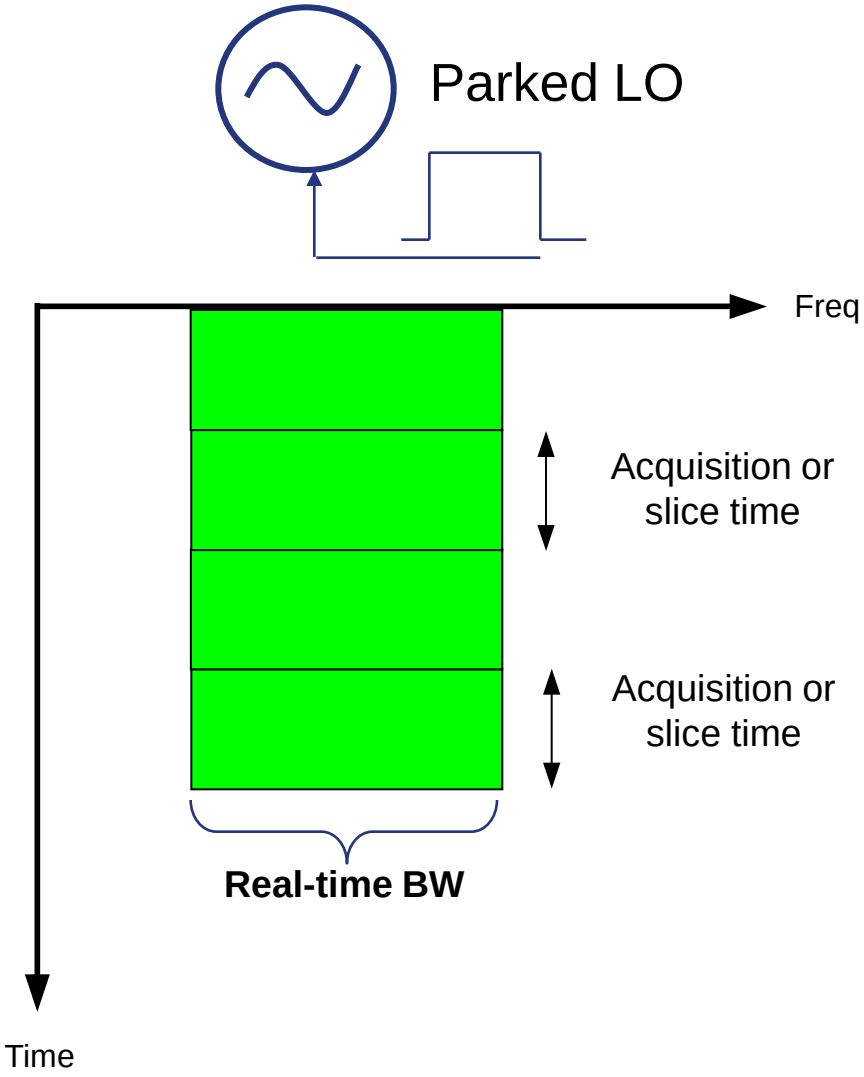
- A swept LO w/ an assigned RBW.
- Covers much wider span.
- Good for events that are stable in the freq domain.
- Magnitude ONLY, no phase information (scalar info).
- Captures only events that occur at right time and right frequency point.
- Data (info) loss when LO is “not there”.



Real–Time Spectrum Analysis

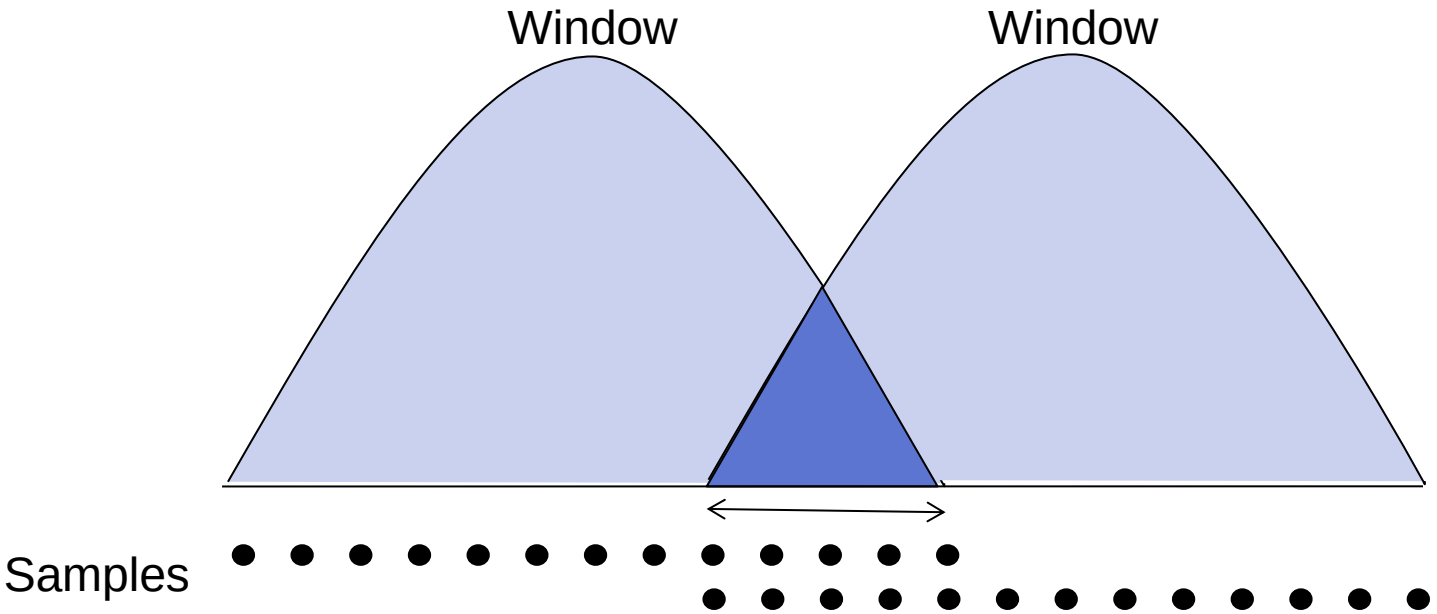
- A parked LO w/ a given IF BW
- Collects IQ data over an interval of time.
- Data is corrected and FFT'd in parallel
- Vector information is lost
- Advanced displays for large amounts of FFT's

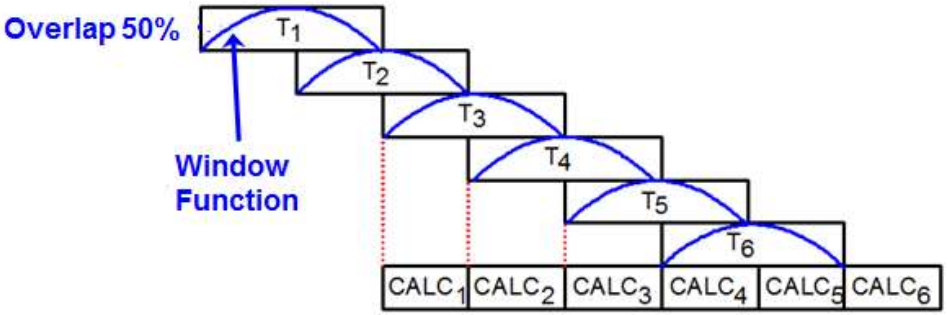




The FFT

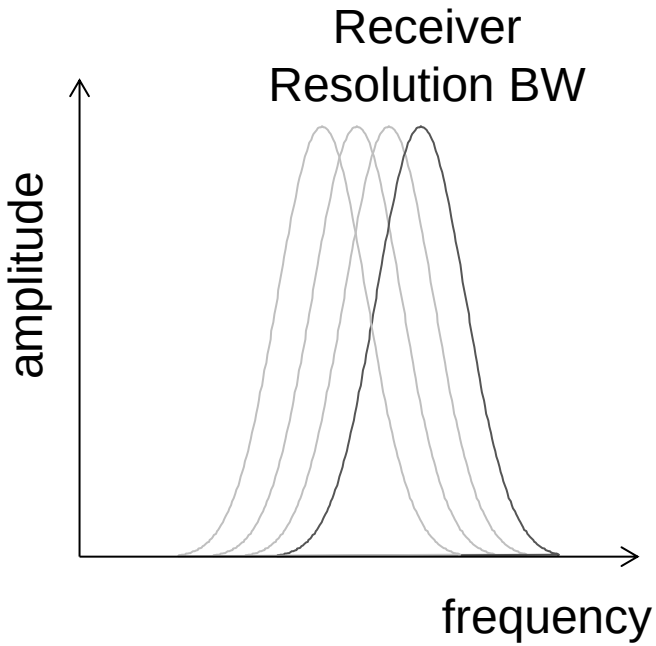
At first glance





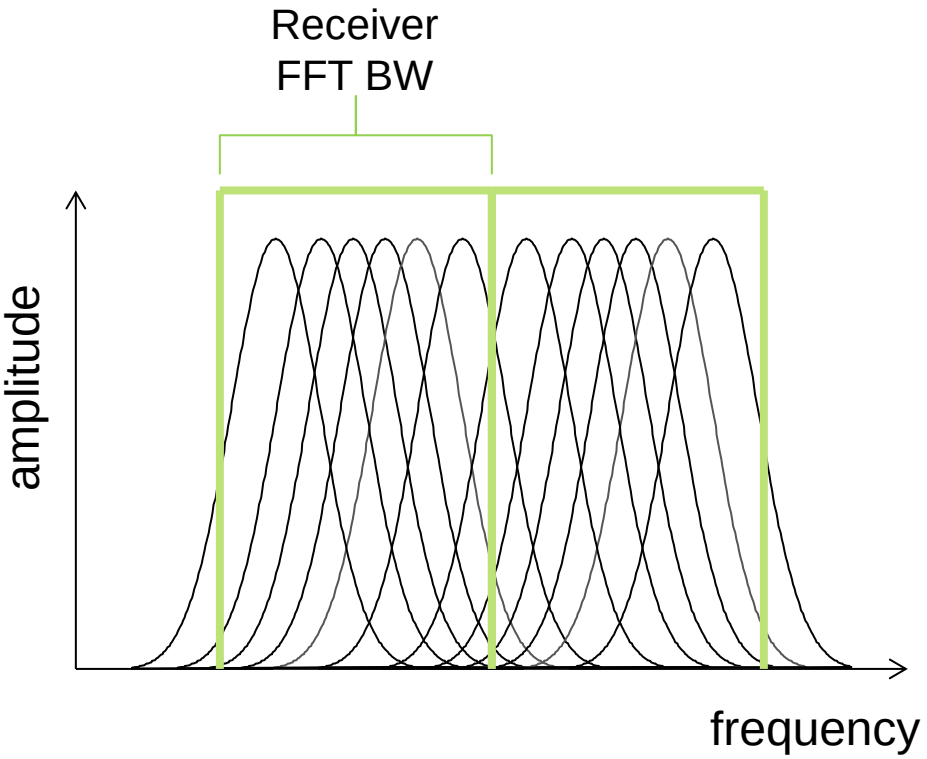
How Time Domain Sweep Saves Time

Have to dwell at each RBW



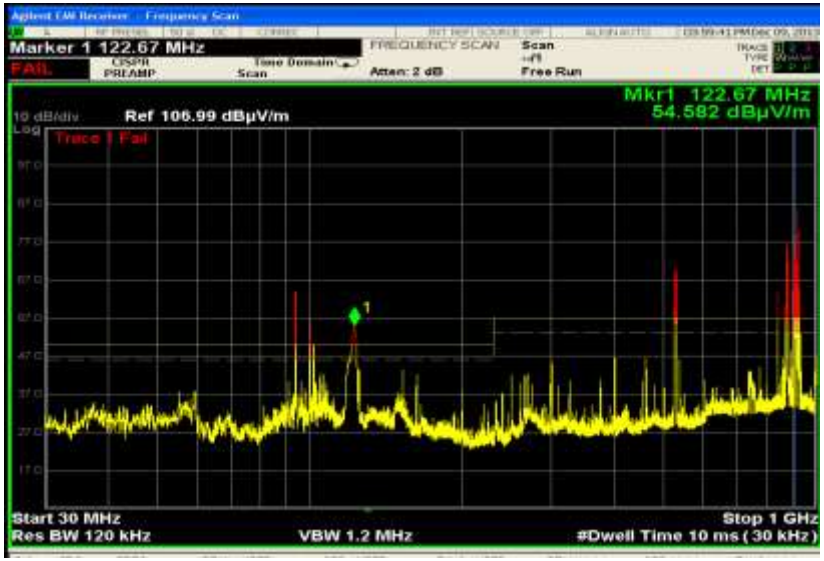
Swept or **Stepped**
Frequency Scan

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



Time Domain
Frequency Scan

Time Domain Scan is Not Real Time Spectrum Analysis



Time Domain Scan

FFT technology to speed frequency scanning

High overlap to ensure capture and accuracy

Provides CISPR-required amplitude accuracy

Accepted by CISPR for Compliance meas.

Real Time Spectrum Analysis

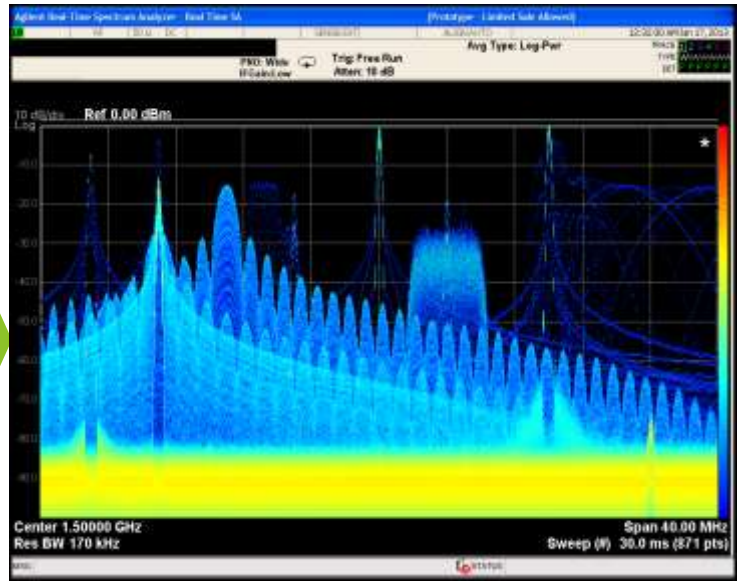
FFT technology to enhance signal analysis

Very wide bandwidth signal capture

Provides unique insights into high-speed signals

Very focused diagnostic tool

No direct application to EMC Compliance



N9038A MXE EMI Receiver Provides World-Class EMI Measurement Capability

- **Commercial and Military Compliance**
  - CISPR 16-1-1: 2010, MIL-STD-461F
  - all required detectors, bandwidths
- **Broad Frequency Coverage**
  - 20 Hz to 3.6, 8.4, 26.5 and 44 GHz
  - tunable to <10 Hz
- **Excellent accuracy**
  - ±0.5 dB @ 1 GHz
- **Excellent sensitivity**
  - DANL = -166 dBm @ 1 GHz w/ NFE
  - Built-in standard preamplifier

Now with 3.6 GHz!

Now with Frequency Upgrades!

Thank you!!!