ROHDE&SCHWARZ

Visualize, Localize and Troubleshoot EMI Signals with Real-time Spectral Analysis

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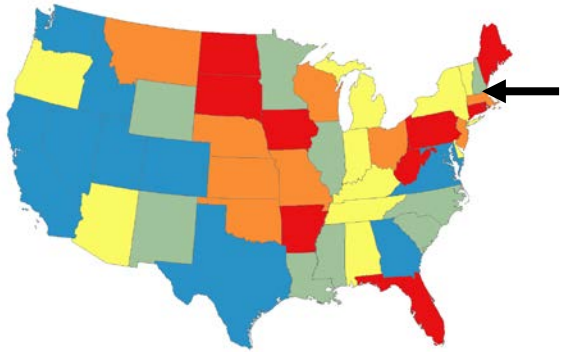
SILENT

Solutions for your noisy world.

- Lee is Founding Partner of SILENT Solutions LLC, an EMC and RF design firm he established in 1992. Lee is a member of adjunct faculty at Worcester Polytechnic Institute (WPI) where he teaches graduate-level classes in EMC. He is also an EMC instructor at University of Oxford (England), and for the IEEE EMC Society's annual Global University and EMC Fundamentals program.
  He earned his MSEE in electromagnetics from the Missouri University of Science and Technology EMC Laboratory under
  Dr.'s Tom Van Doren, Todd Hubing, and James Drewniak.



- SILENT employees are not Rohde & Schwarz employees, but we do have customers in common

- Contact Lee or his business partner Randal Vaughn for more information about SILENT Solutions EMC Design Reviews, Troubleshooting and Intensive Courses

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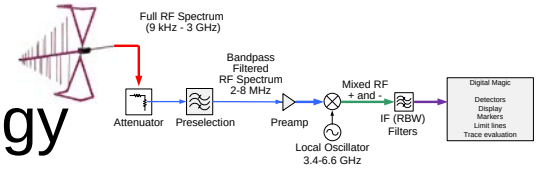
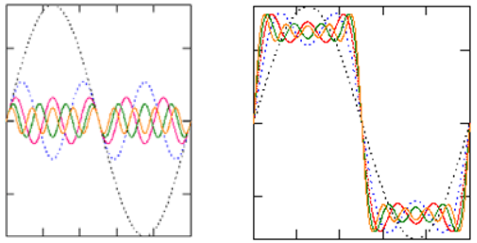
Outline

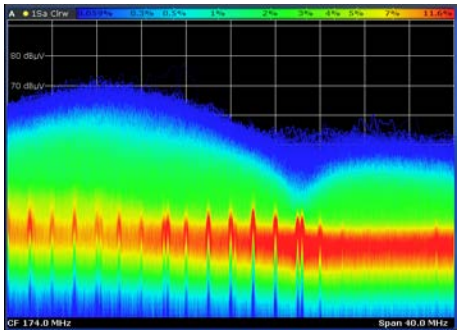
- Review of Old Measurement Technology



- Quick review of “EMI signals”



- Why I’m excited about
  “Real Time” spectral analysis &
  “Persistence Mode”

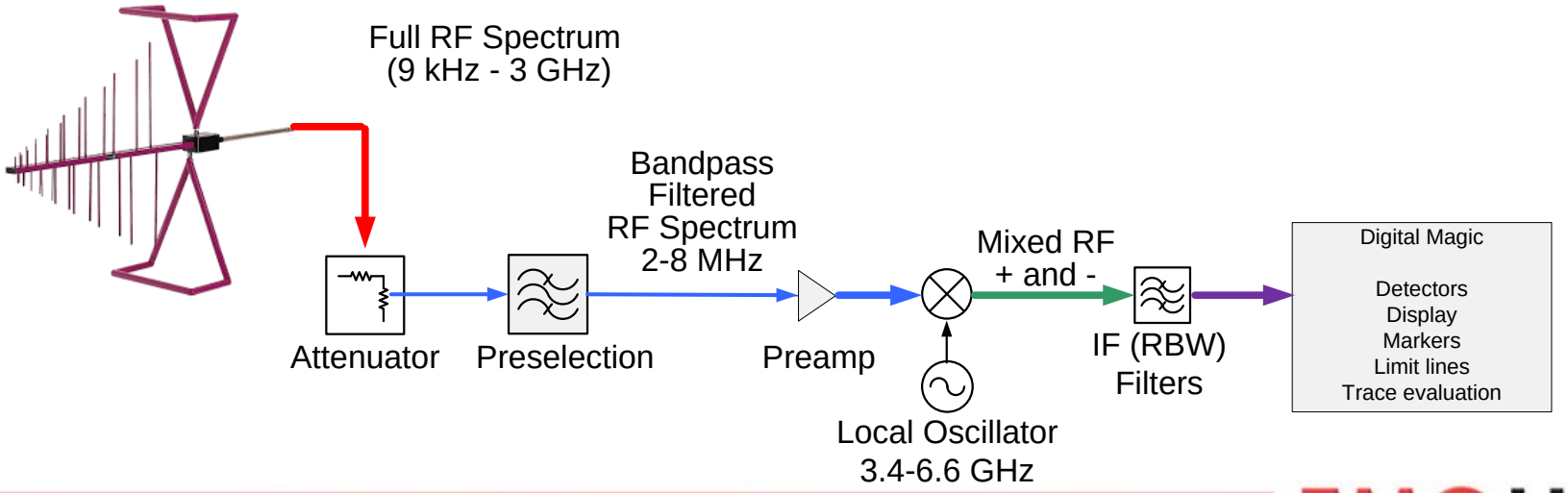


- Demonstration Videos

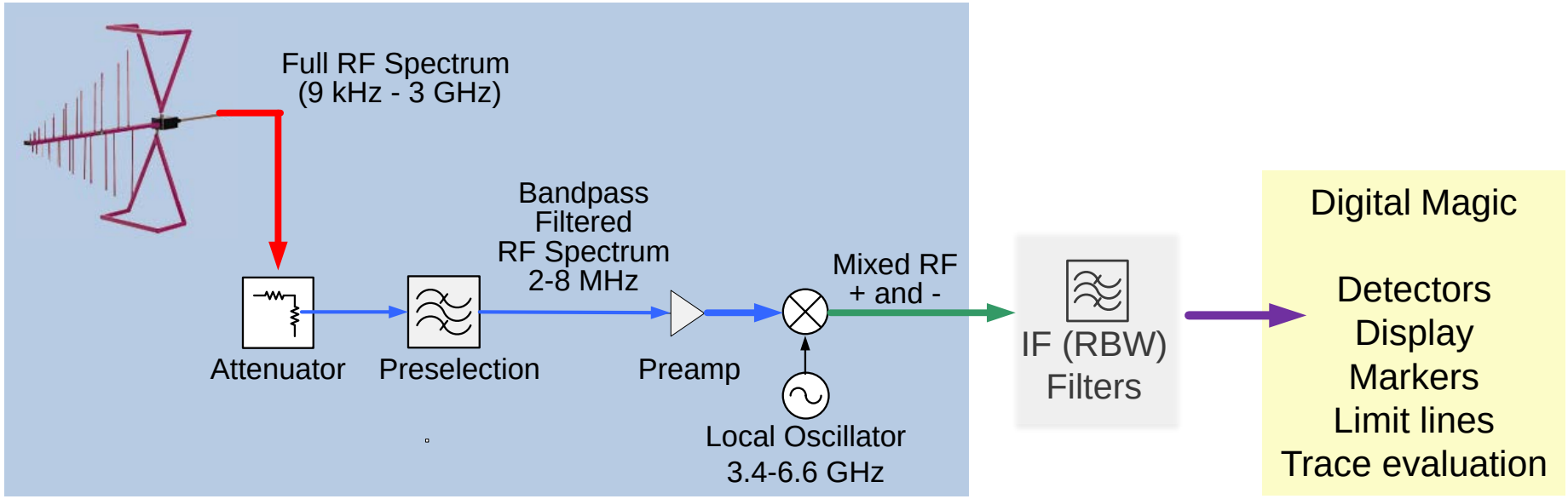
Old Style “Swept” Spectrum Analyzers or “Stepped-Tune” Receivers

The “old days”

- “Swept-tuned” Spectrum Analyzer
- “Step-tuned” Receiver
- Sequentially step or sweep a narrow window across the frequency axis
- Good “intercept” with “continuous wave”, periodic signal ONLY
- Significant “blind time” when sweeping or stepping



Old Style “Swept” Spectrum Analyzers or “Stepped-Tune” Receivers



ACQUIRE

RESPOND

DISPLAY

Old Style "Swept" Spectrum Analyzers or "Stepped-Tune" Receivers

The "old days"

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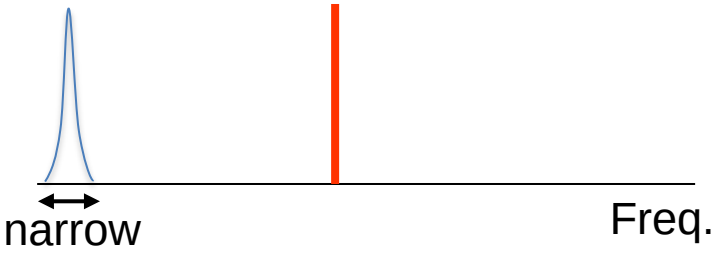
S L O W

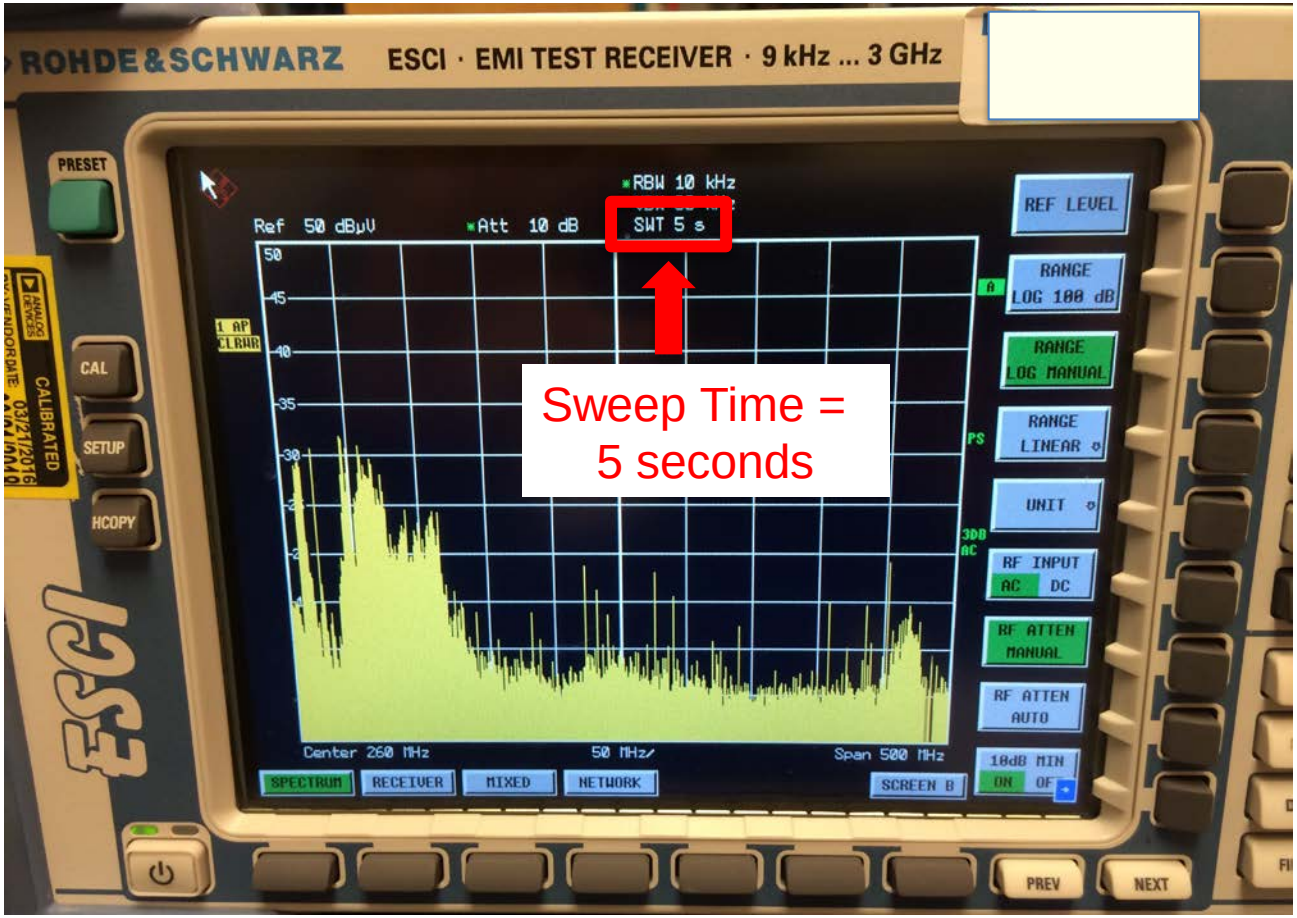


How “Slow” is “Slow”?
Swept-Tuned Spectrum Analyzer vs. FFT Spectrum Analyzer

- For weak signal measurements, e.g. interference @ vehicle antenna terminals, narrow RBW is needed for low noise floor
- Where wide span is desirable to visualize wide spectral signatures, narrow RBW forces very slow sweep times
- Slow sweep times make it difficult for the EMC engineer to observe cause-and-effect changes in emissions during troubleshooting

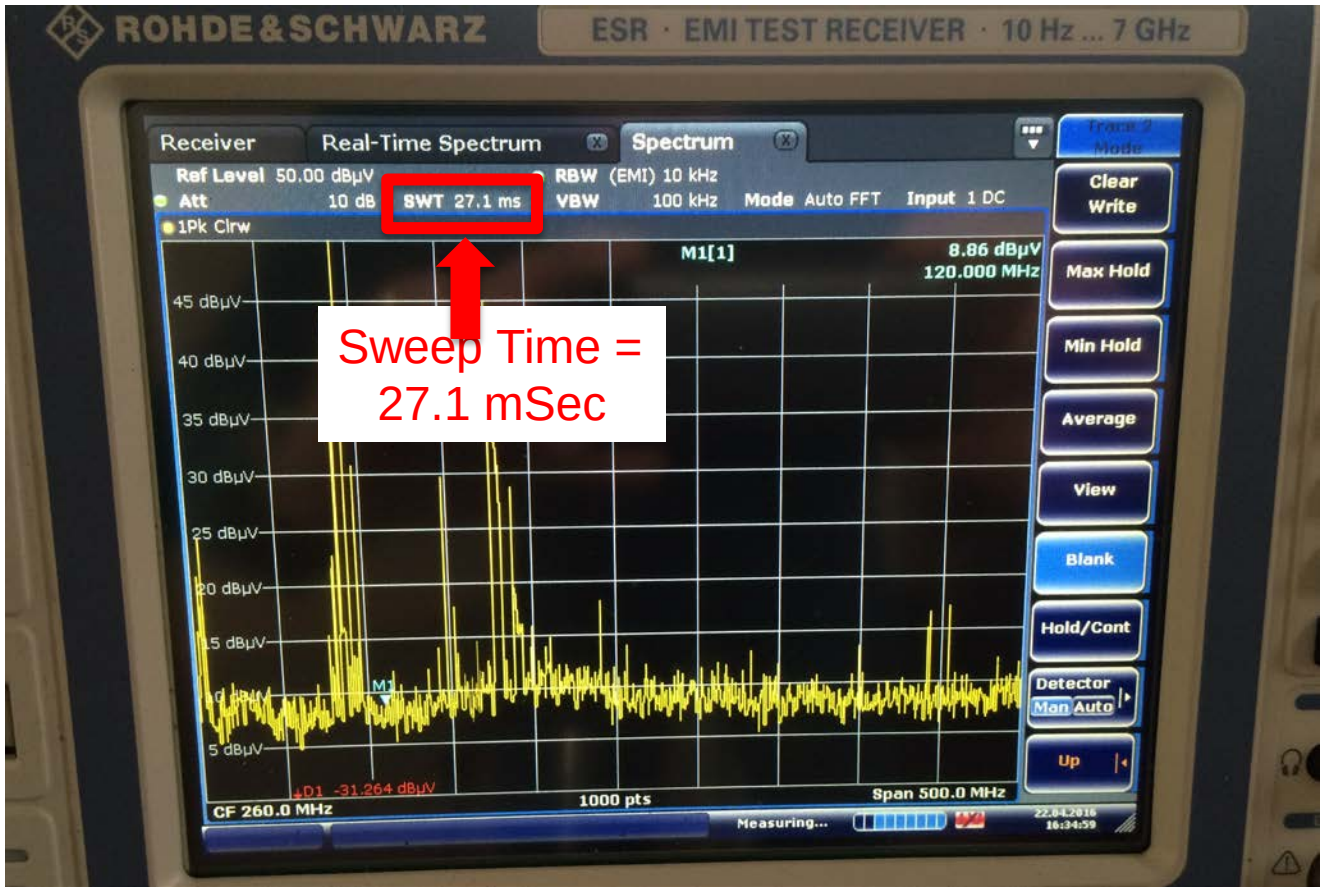
How “Slow” is “Slow”?
Swept-Tuned vs. FFT Spectrum Analyzer

Rohde & Schwarz ESCI SPAN = 500 MHz RBW = 10 kHz



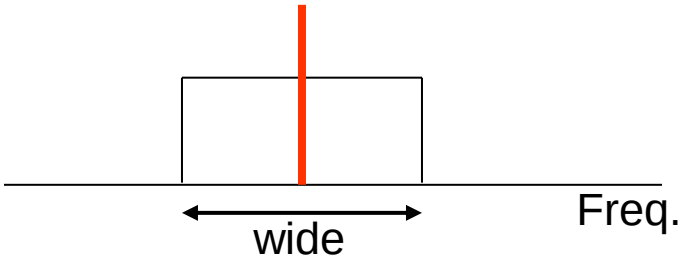
How “Slow” is “Slow”?
Swept-Tuned vs. FFT Spectrum Analyzer

Rohde & Schwarz ESR SPAN = 10 to 510 MHz RBW = 10 kHz



"FFT", "Fast Fourier Transform"
"Time Domain" Instruments

NOW, with FFT ("time domain")

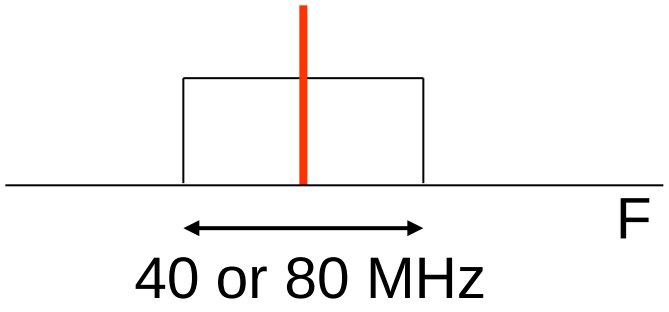


- Much FASTER
- Measure lots of signal frequencies simultaneously "in parallel", over a WIDE CHUNK of the frequency axis
- **Calculate** RBW instead of **waiting** for filter response
- Still some "blind time" to do processing (not "100% intercept")
- And only 1 measurement @ each frequency in each chunk

“Real Time” FFT

“Real – Time” FFT (“time domain”)

- FASTEST – dedicated measurement hardware for FFT
- WIDE (up to 40 or 80 MHz) chunk of spectrum
- **Calculate** RBW instead of **waiting** for filter response
- Zero “blind time” “100% intercept”
- Multiple measurements @ each frequency in each chunk
- Allows for generation and display of signal statistics, i.e., how often and how strong a signal is present at a given frequency

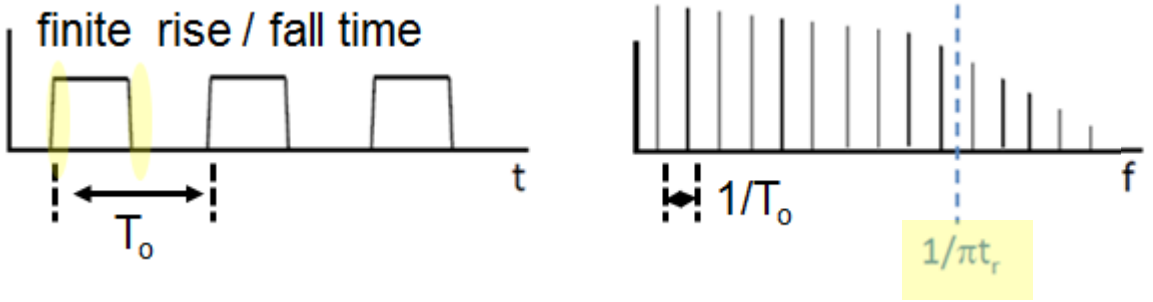


Review of Signals We're Going to See

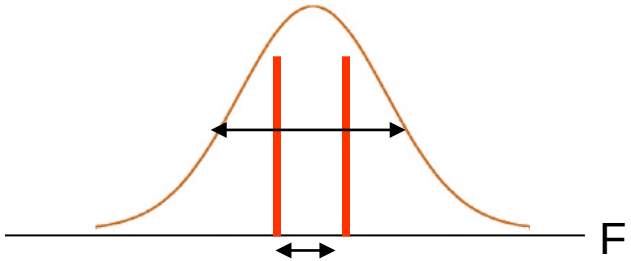
- Definitions and buzzwords that EMC engineers like to use when discussing different types of noise

EMI Signals – Funny Names

- Continuous (“CW”)
- Periodic
- “Power Signals”



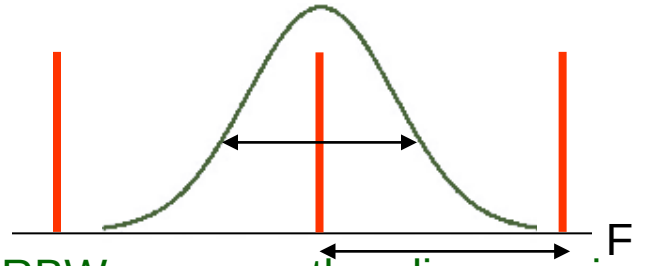
“Broadband” (SMPS, motor control, sparky)



RBW wider than line spacing

a) Measurement value increases with increased RBW
b) Cannot identify (resolve) individual lines

“Narrowband” (clocks, steady RF)



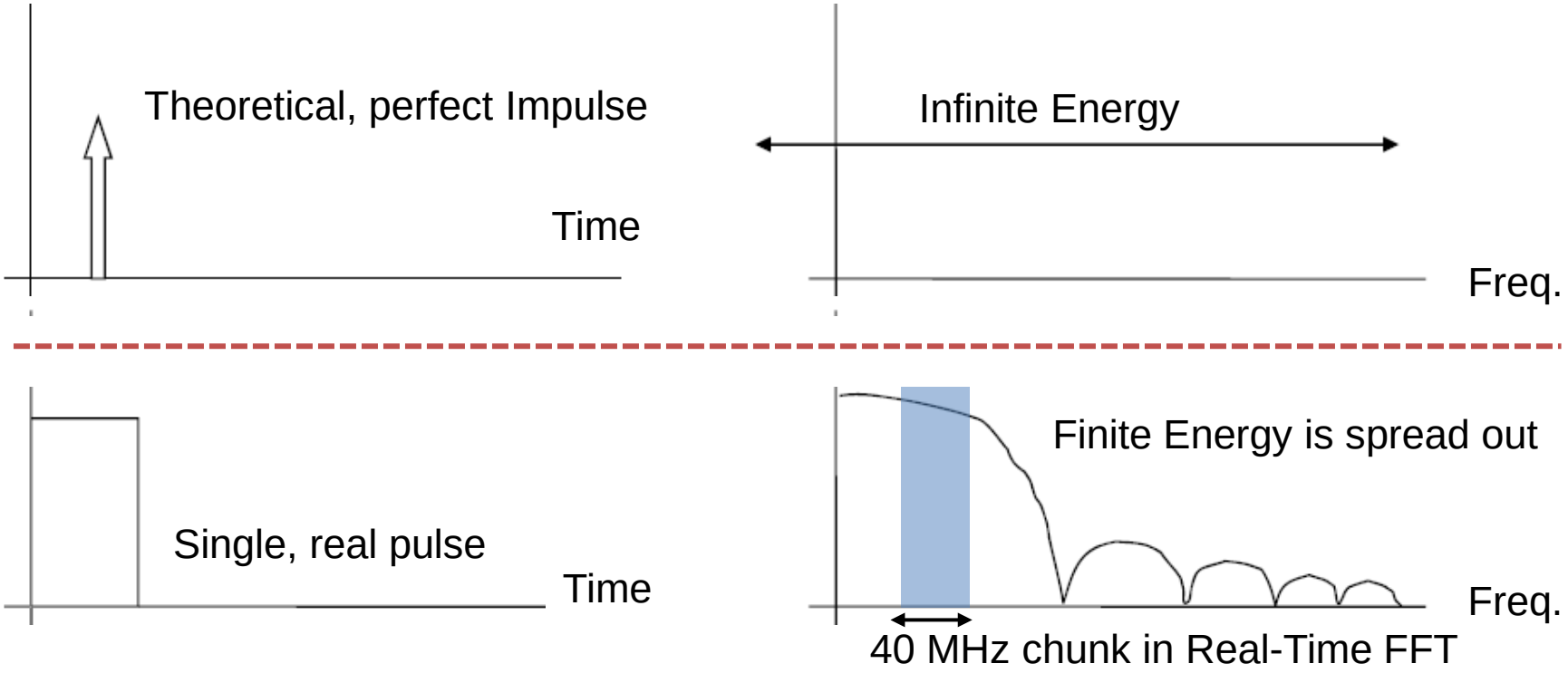
RBW narrower than line spacing

a) Measurement value does not change with RBW
b) Can identify (resolve) individual spectral lines

EMI Signals – Funny Names

A Single Real Pulse "Broadband Discontinuous" (Ex. ESD)

- Measurement value increases with increased RBW
- Finite Energy, Average power = 0
- Represent with Fourier Transform → Energy Spectrum



A Single Pulse

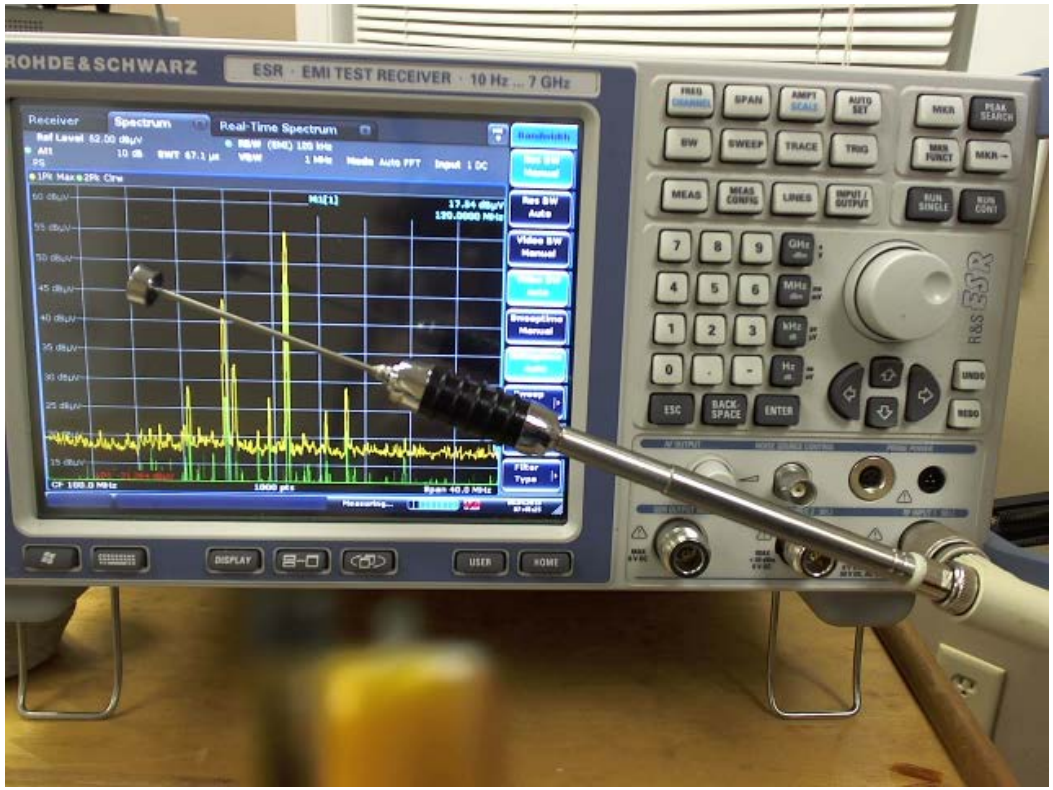
Let's try to watch a single pulse on the spectrum analyzer. Add pic of spark generator. YOU will be able to see it.
Can the spectrum analyzer see it?

1) Standard FFT, spectrum view

2) Real-Time FFT, spectrum view

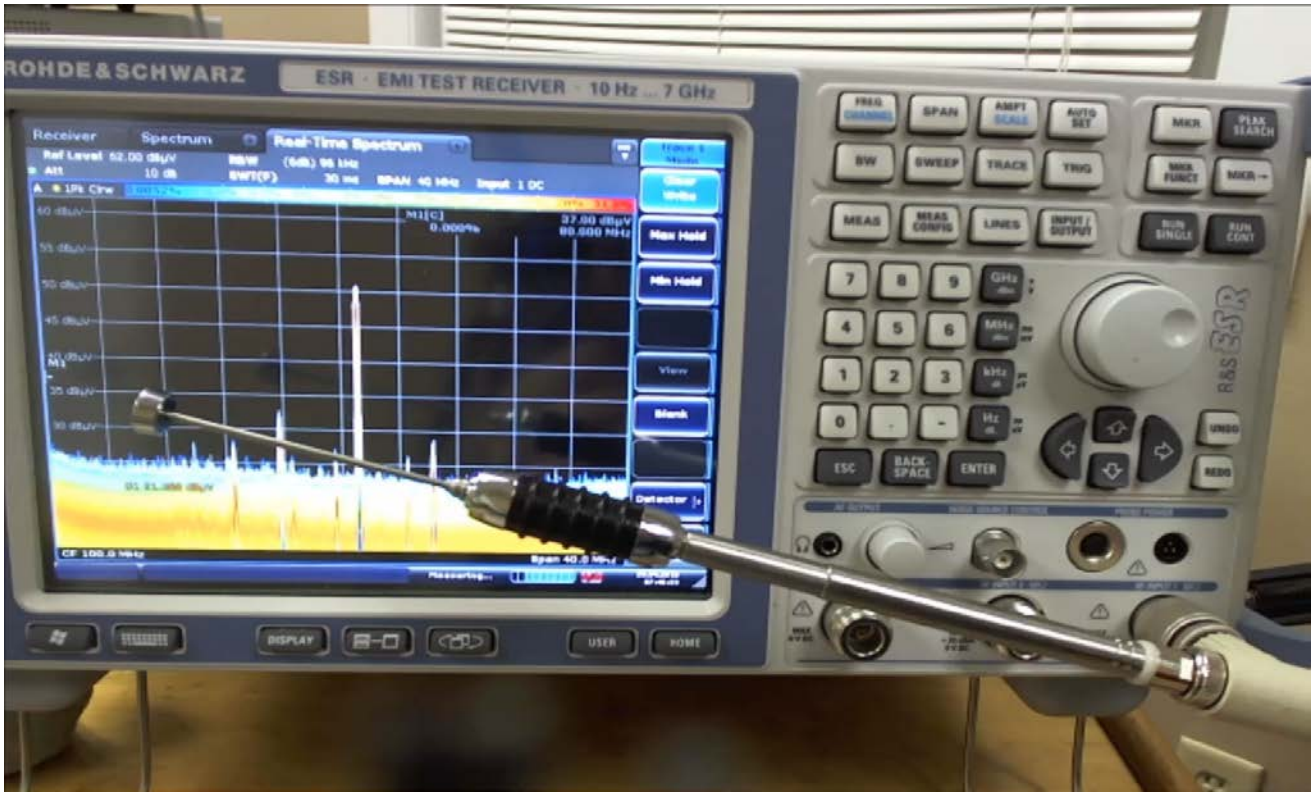
Standard FFT

1) Standard FFT, 40 MHz span, 100 kHz RBW



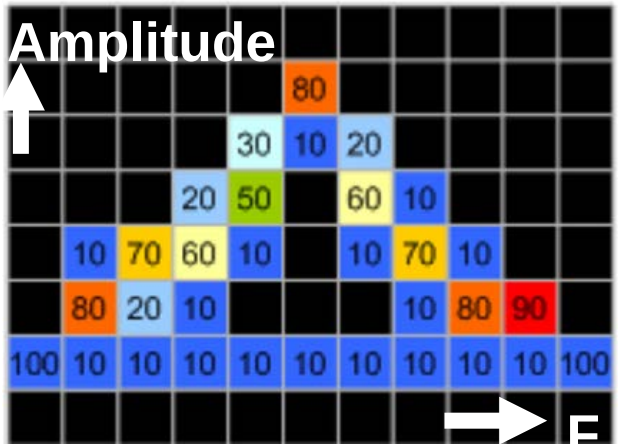
Let's Watch 100% Signal Intercept That's Possible w/ "Real Time" FFT

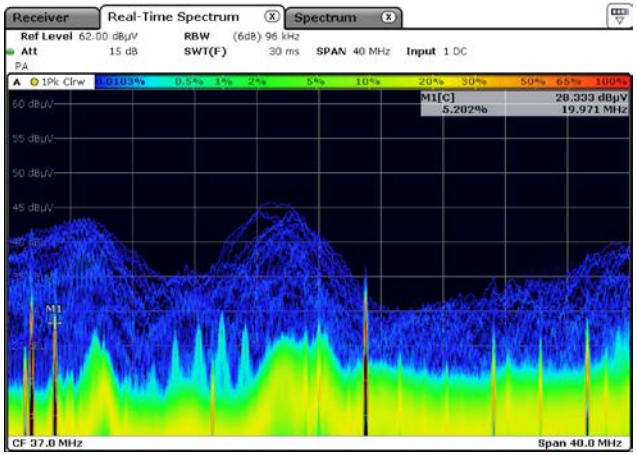
2) Real-Time FFT, "100% signal intercept" 40 MHz span, ~100 kHz RBW



Real-Time FFT, Persistence Mode

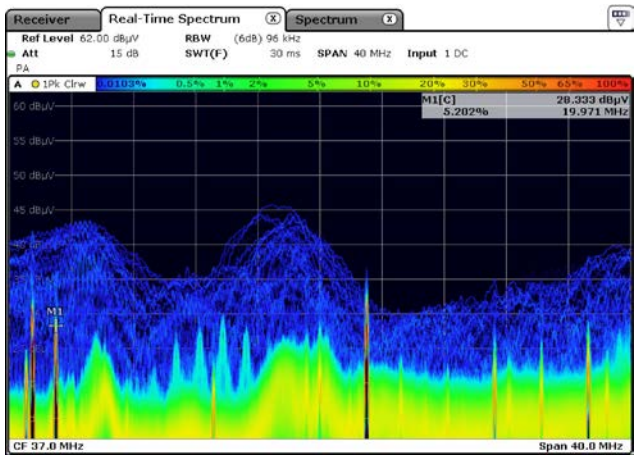
A Totally Different Way
to View, Measure, Identify EMI Sources





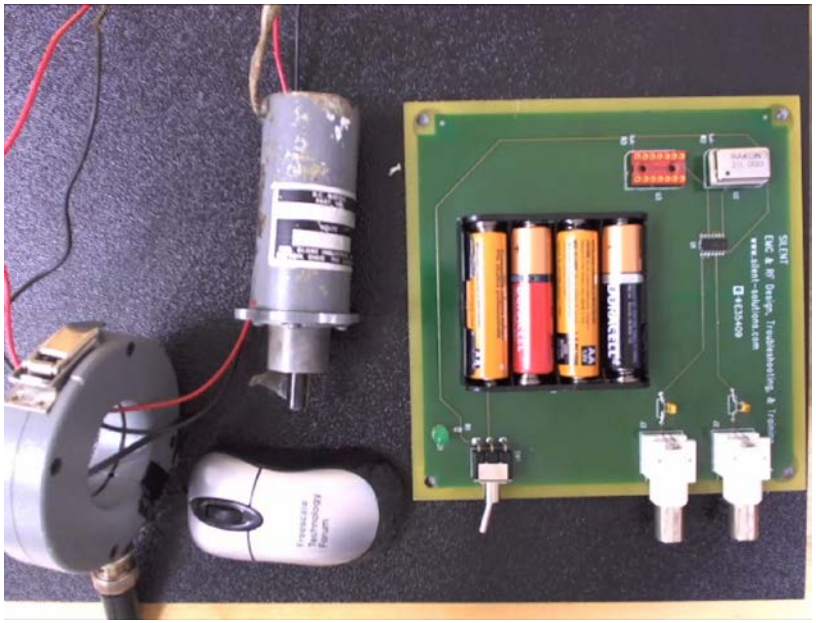
Real-Time FFT, Persistence Mode

- With Real Time, many measurements / frequency, can generate statistics
- The trace color shows how often a signal occurs at a specific frequency and amplitude
- Color = “Hit Rate” = how often signal occurs at particular frequency
  Height = amplitude of signal at particular frequency
- A signal histogram versus frequency
- Descriptive terms: % occupancy, amplitude, frequency



Next, We Are Going Watch Multiple Signals From These Sources

- at the SAME TIME, as they occupy the SAME FREQUENCY



Demonstration of Real Time FFT
Persistence Mode
Displaying “Signal under Signal”

Multiple signals occupying the same frequency, but

- different amplitude
- different % occupancy

Signal #1: DC motor + PWM controller	(broadband)
Signal #2: USB mouse	(broadband + narrowband)
Signal #3: 20 MHz digital clock on PCB	(narrowband)

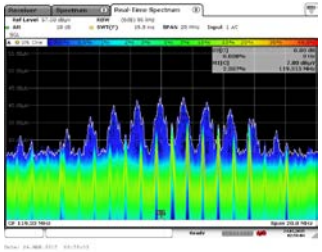
Demonstration of Real Time FFT Displaying “Signal under Signal”

Center Freq. = 37.5 MHz Span = 40 MHz RBW = 100 kHz

Summary – Old Technology

- Previous generation spectrum analyzers and test receivers use “swept tuned” or “stepped tuned” architecture.
- OK for measuring continuous (i.e., not intermittent) periodic signals in narrow spans.
  - When you ALWAYS know WHEN (time) and WHERE (frequency) the signal is.
- Cannot
  - reliably display pulse spectrums, or
  - visually distinguish between two or more broadband signals in a single piece of spectrum, or
  - display narrowband EMI signals “under” a larger broadband signal
- “Blind” during large parts of sweep or step & dwell time
- Challenging to use for EMI debug expect for “trivial” signals like narrowband clocks that have 100% occupancy

Summary: Real-Time FFT



- 100% signal intercept over a 40 or 80 MH\z frequency span
  - FFT machines without real-time hardware will “miss” signals
- “Real Time” FFT with **persistence mode** gives us a new, powerful way to visualize EMI signals that were previously tough or just impossible to display
  - Especially non-periodic, “blinky” and broadband signals (e.g., SMPS, motor control, & sparky signals - different from digital clocks)
- The ability to clearly display “signal under signal” situations
- The “visualization” that is possible with Real-Time FFT is difficult to describe in words, you have to see it

Thanks for attending!

Don’t miss our Test Bootcamp!
November 16, 2016
www.emclive2016.com

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