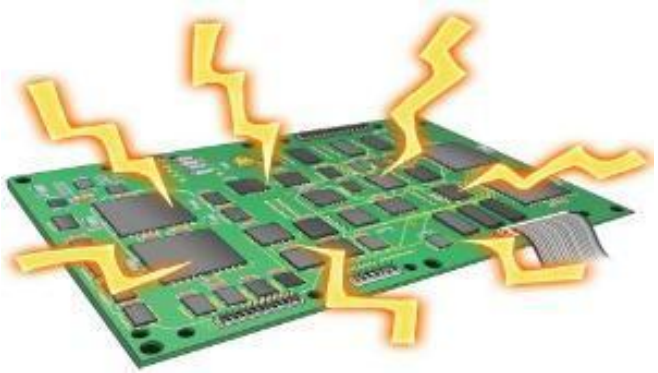
EMC-ESD In de Praktijk

Speeding your device through EMC compliance

EMI/EMC Definitions

- EMI/EMC
- Regulations
  - Country/Region
  - Industrial/Consumer
  - Military
- Conducted Emissions
  - Unwanted signals coupled to AC mains
- Radiated Emissions
  - Unwanted signals broadcast from DUT
- Intentional Radiator
  - Spectrum Emission Mask
  - Power Limits
  - Harmonic Content
- Susceptibility/Immunity
  - Region dependent



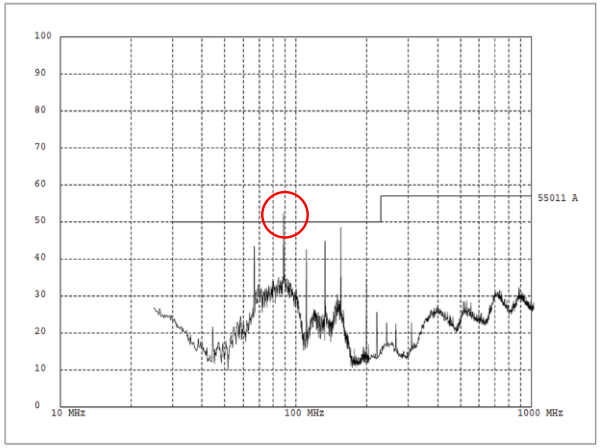
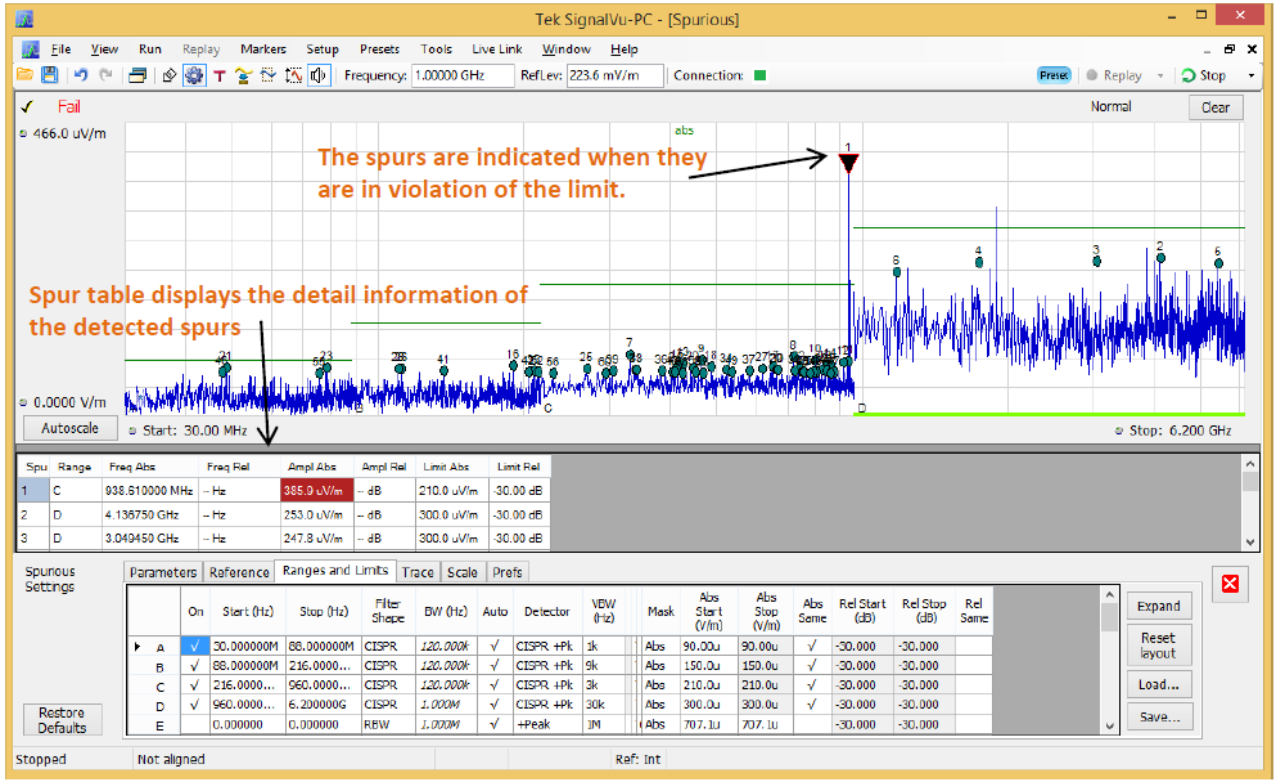


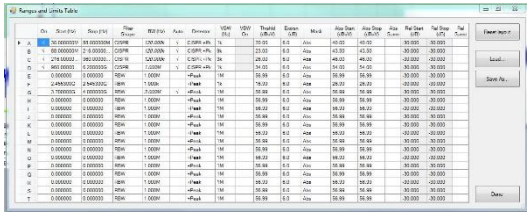
Figure 1. This EMI test report shows a failure at around 90 MHz.

Pre-Compliance Scan → Tektronix RSA306B



- 30 MHz – 6.2 GHz
- 128,004 Trace Points
- ~ 7s (CISPR Peak)
- Shaded area = limit
- Auto ID limit failures

Pre-Compliance Scan → Frequency Ranges



Spurious Settings

Parameters | Reference | Ranges and Limits | Trace | Scale | Prefs

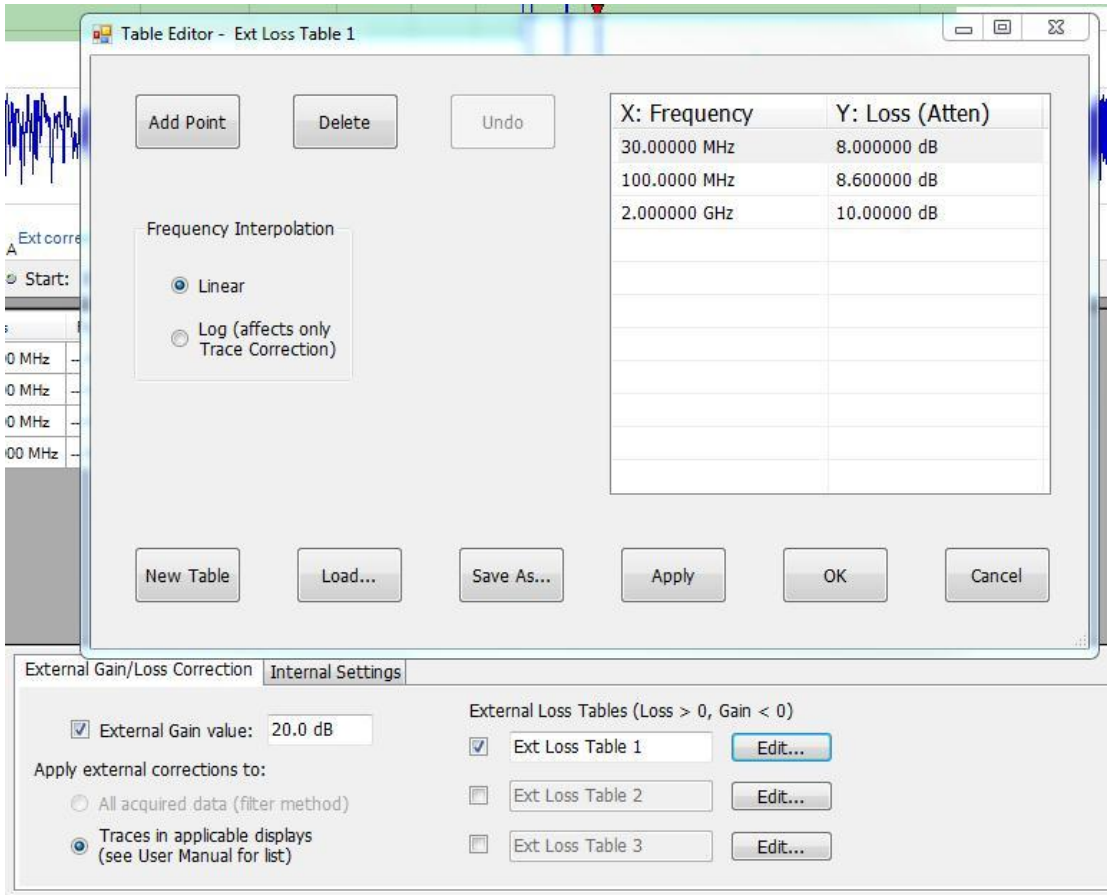
	On	Start (Hz)	Stop (Hz)	Filter Shape	BW (Hz)	Auto	Detector	VBW (Hz)	Mask	Abs Start (V/m)	Abs Stop (V/m)	Abs Same
A	√	30.000000M	88.000000M	CISPR	*120.000k*	√	CISPR +Pk	1k	Abs	90.00u	90.00u	√
B	√	88.000000M	216.0000...	CISPR	*120.000k*	√	CISPR +Pk	9k	Abs	150.0u	150.0u	√
C	√	216.0000...	960.0000...	CISPR	*120.000k*	√	CISPR +Pk	3k	Abs	210.0u	210.0u	√
D	√	960.0000...	6.200000G	CISPR	*1.000M*	√	CISPR +Pk	30k	Abs	300.0u	300.0u	√

Frequency bands | Scanning filter | Power limit

Expand | Reset layout | Load... | Save... | Restore Defaults

- Up to 20 ranges
- CISPR/MIL RBW
- Variable detection thresholds
- Absolute measurements
- Relative measurements
- Standards pre-defined

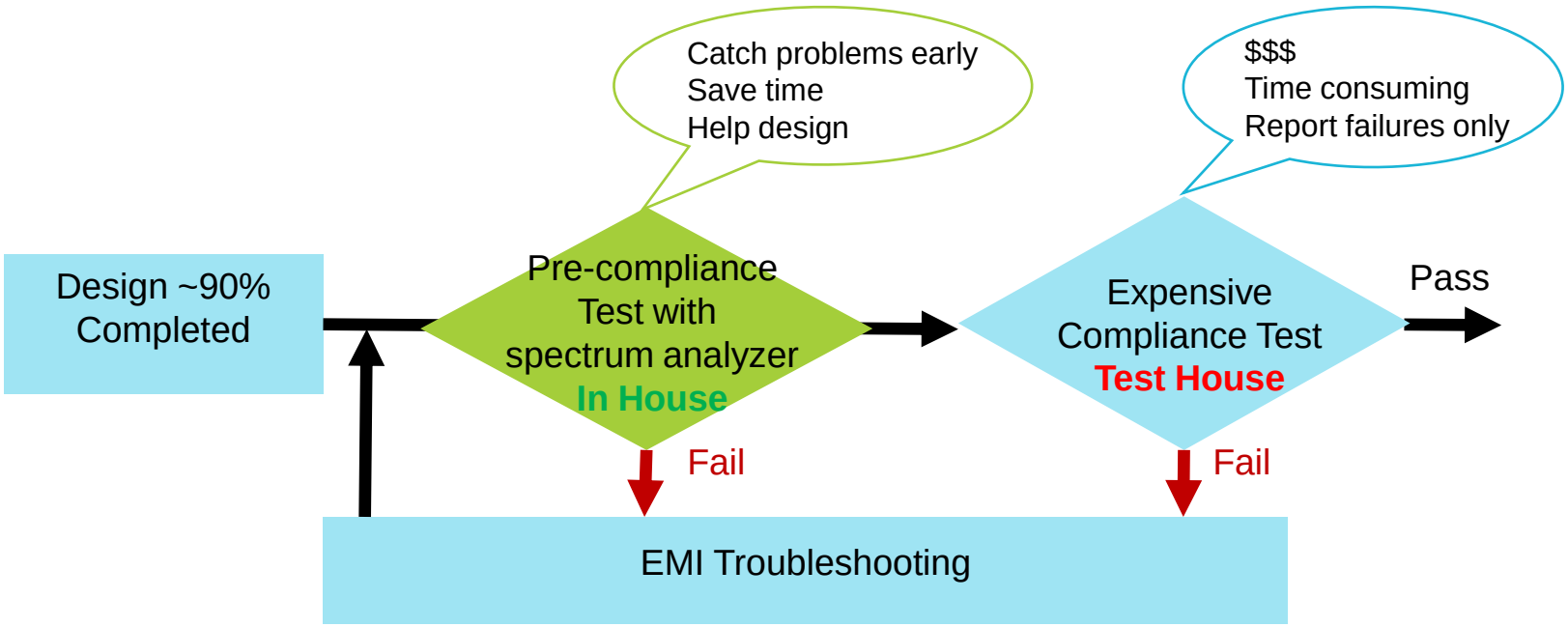
Pre-Compliance Scan → Path Loss/Gain



- Compensate for path gain/loss
- Be careful of antenna factor vs gain/loss
- Up to 3 different tables at one time

EMI Testing Work Flow

SCHEDULE TIME AT TESTING LAB



EMI Pre-Compliance testing will save time/money by identifying problem areas before they become expensive re-design issues

Do I Need An EMI Receiver ?

- EMI receiver are designed specifically for spectrum sweeping
  - RBW
    - Shape
    - Bandwidth
  - Detectors
    - Peak
    - Average
    - Quasi-Peak
- Pre-selected RF tuning stages
- User defined dwell time per step
- Detailed requirements in CISPR 16-1-1

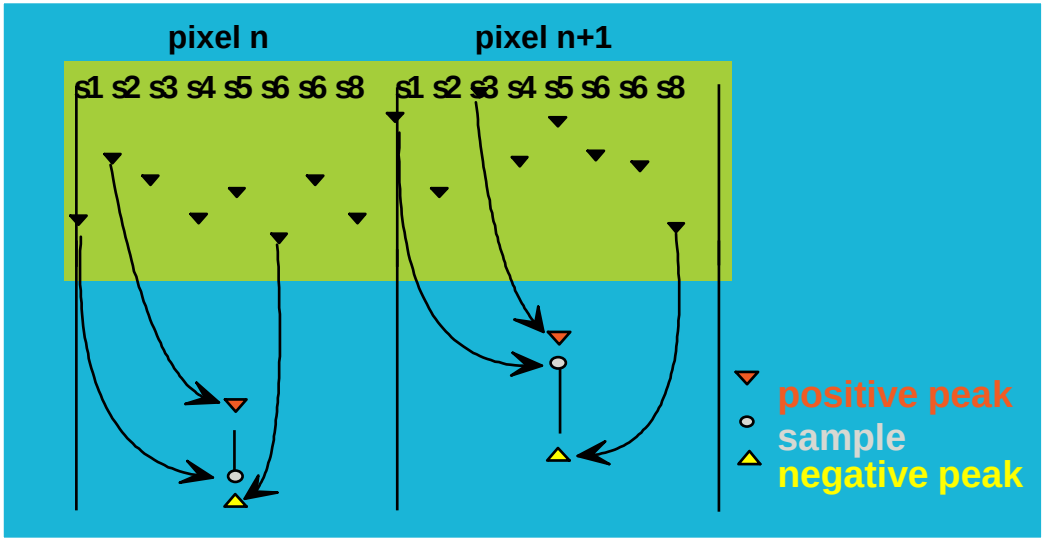
Frequency Range	Bandwidth (6 dB)	Reference BW
9 kHz to 150 kHz (Band A)	100 Hz to 300 Hz	200 Hz
0.15 MHz to 30 MHz (Band B)	8 kHz to 10 kHz	9 kHz
30 MHz to 1000 MHz (Bands C and D)	100 kHz to 500 kHz	120 kHz
1 GHz to 18 GHz (Band E)	300 kHz to 2 MHz	1 MHz

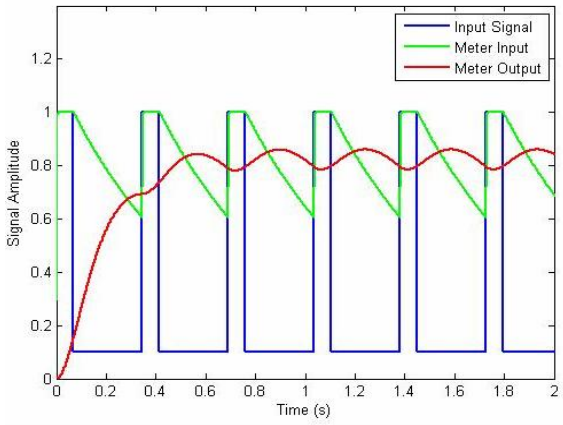
Table 1. Measurement Bandwidth versus Frequency specified by CISPR 16-1-1.

- ***For Pre-Compliance You Don't Have To Use A Special Receiver***
  - We are making an accurate approximation
  - Understand the compromises in the measurements

Spectrum Analyzer Sweep Speed

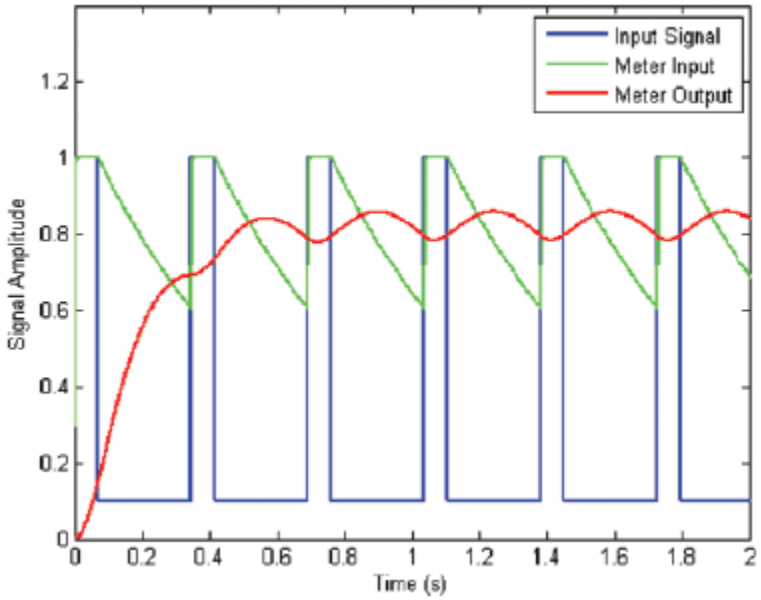
- EMI Detector types
  - EMI-Peak (or Peak)
    - Worst case
    - **Safest detector**
  - EMI-Average
    - Incorporates dwell
    - ~100ms common
  - EMI-Quasi-Peak
    - Incorporates dwell
    - ~1second
    - VERY long sweep times
- Filter Shape Factor
  - EMI RBW More selective
  - BW measured at -6dB points

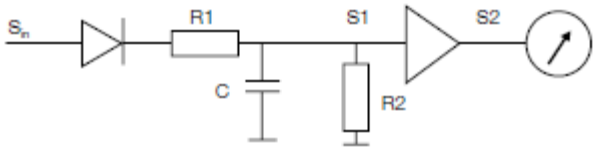


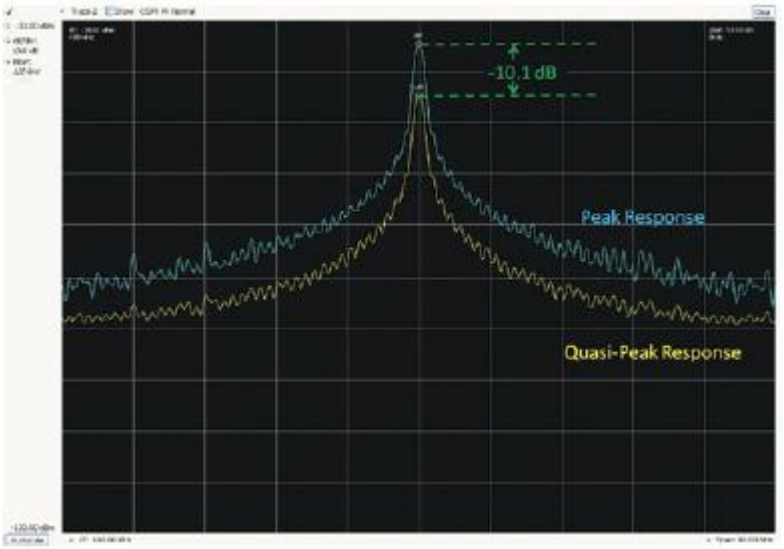


Calculated response of the QP detector and meter to pulse stimulus

Quasi Peak Detector example





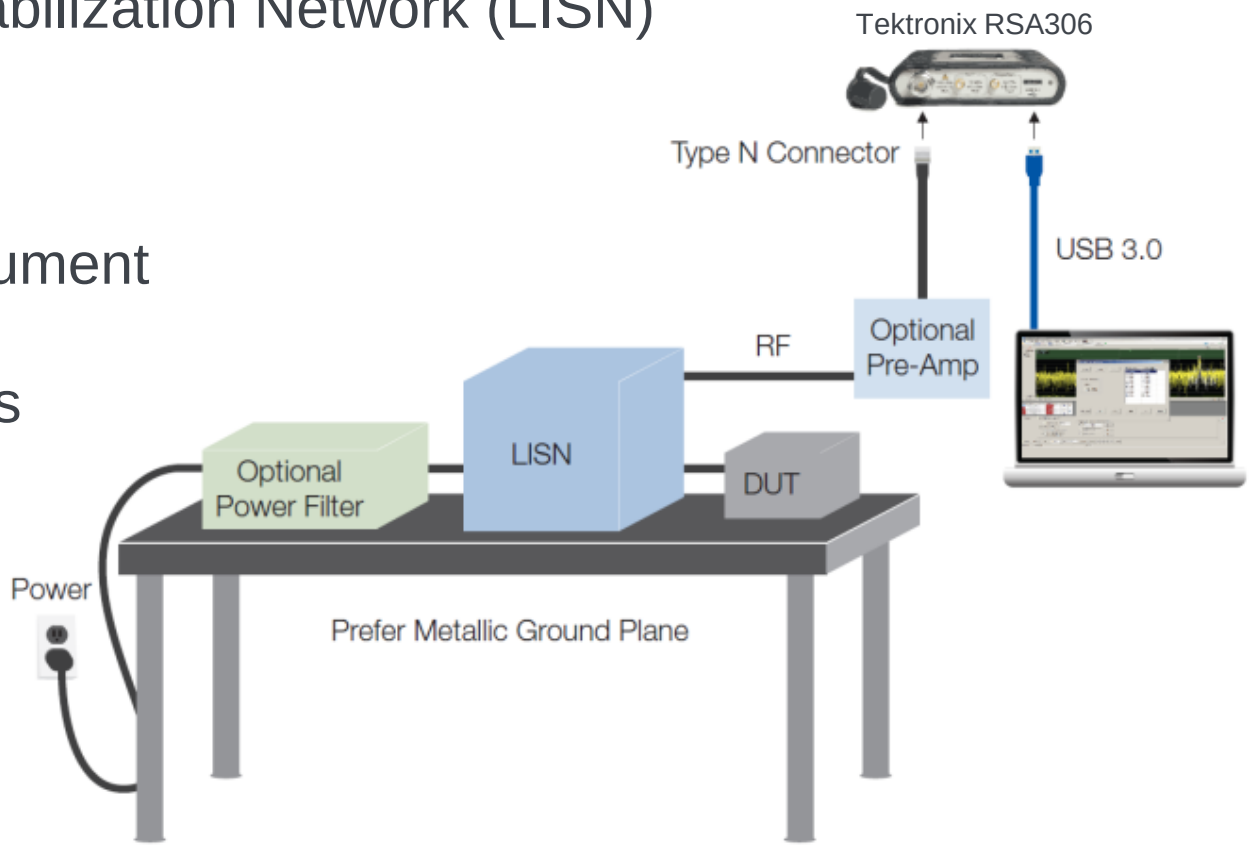


10dB differenz between Peak and QP,
8us Pulse width 10ms repetition rate

Setting Up A Pre-Compliance Test

CONDUCTED EMISSIONS <30 MHZ

- Utilize a metallic surface which can be grounded
- Line Impedance Stabilization Network (LISN)
- Pre-amp (Optional)
- Limiter (Optional)
- Make sure the instrument can accommodate gain/loss corrections

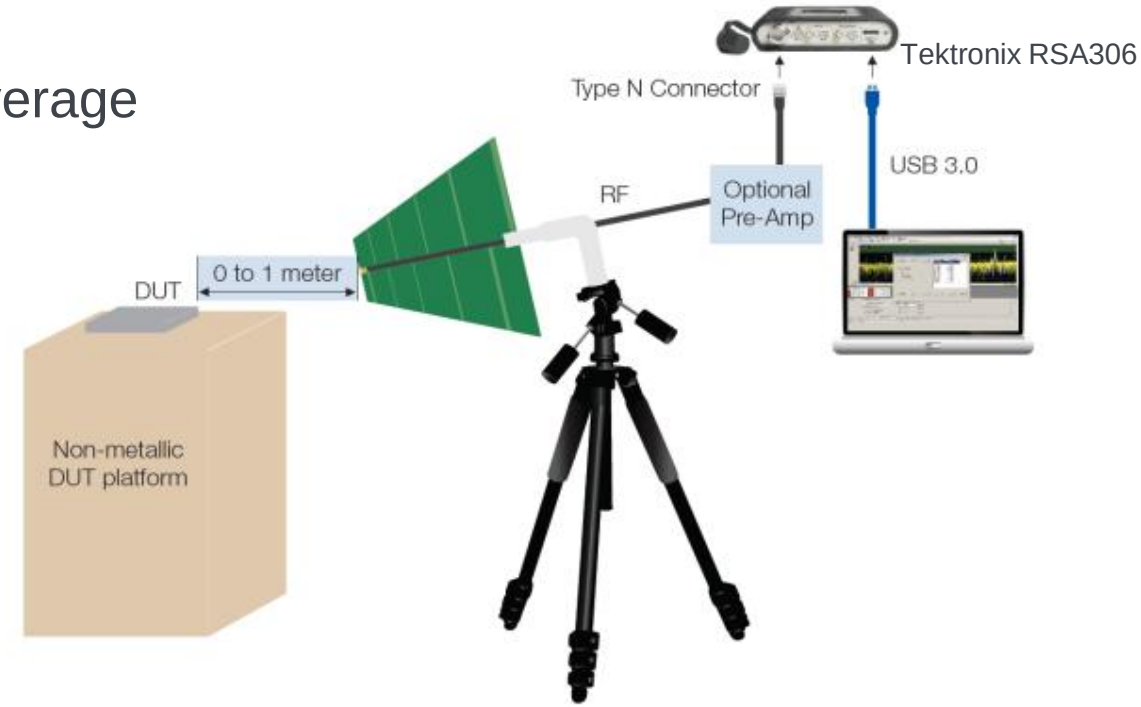


Setting Up A Pre-Compliance Test

RADIATED EMISSIONS >30 MHZ

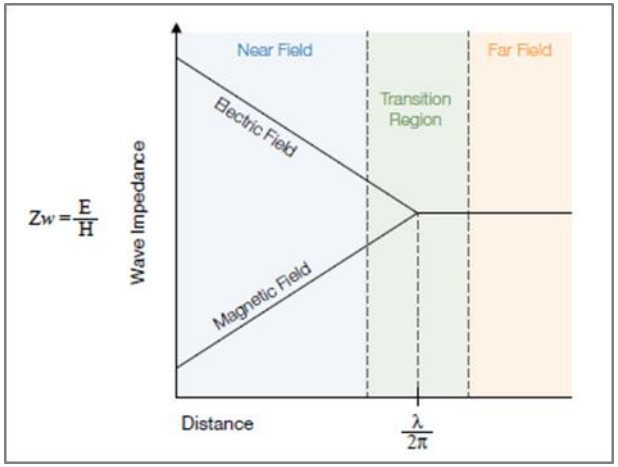
- Identify an area with natural RF shielding
  - Basements
  - Parking garages
- Watch out for DAS
  - Used to help cellular coverage

- Non metallic platform for DUT
- We need to look at 360 around DUT
- Tripod/pre-amp optional but recommended



Pre-Compliance Test

WHERE TO MEASURE ?



Measurement in Far Field with adequate distance to DUT

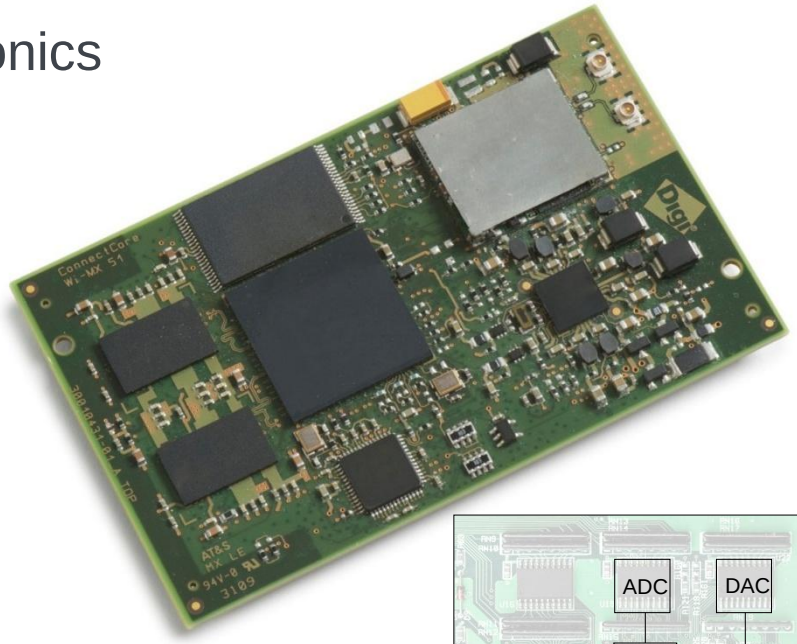
Open Area Test Site

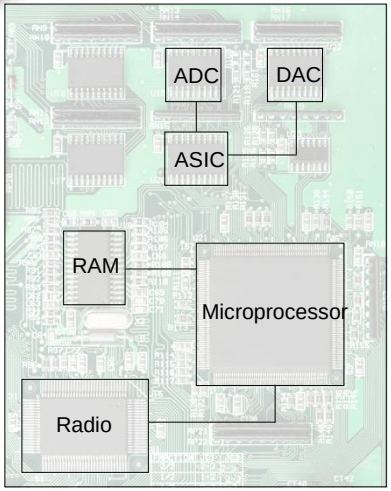
Anechoic Chamber

- Shield from external signals, RF quiet area
- Avoid reflections

De-Bugging EMI Issues

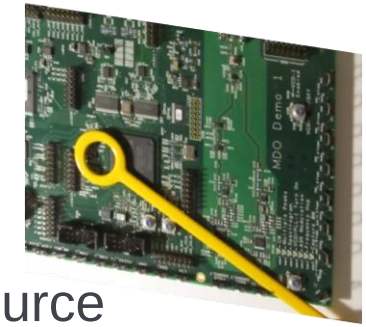
- Switching Power Supplies
  - Switching frequencies and harmonics
  - Load-dependent emissions
- Clock and Data
  - High speed clocks, data, edges
  - High speed interfaces
  - Switching controls
- Resonances
  - Board and conductor geometries
  - Wiring lengths, routing, termination
  - Shielding and mechanical connections
- **Radiated EMI problems are defined by**
  - **Sources**
  - **Antenna's**



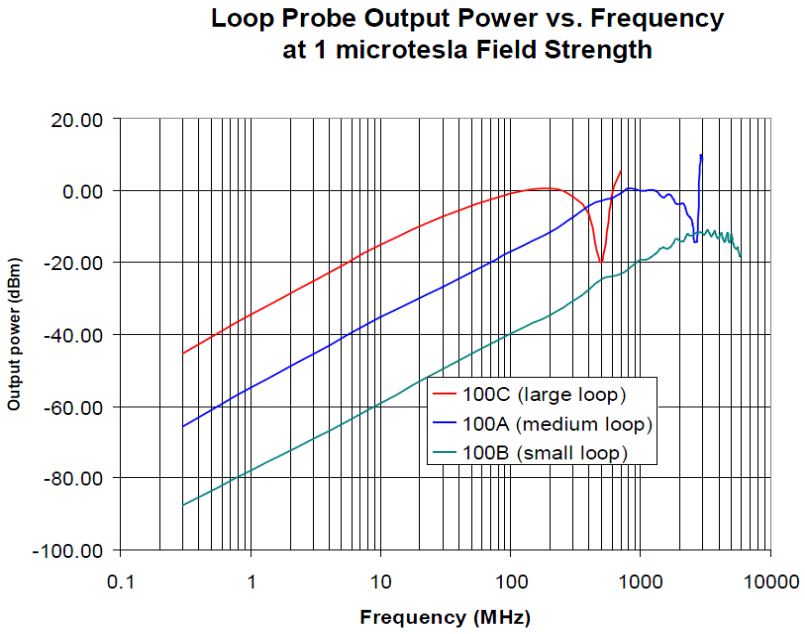


De-Bugging EMI Issues

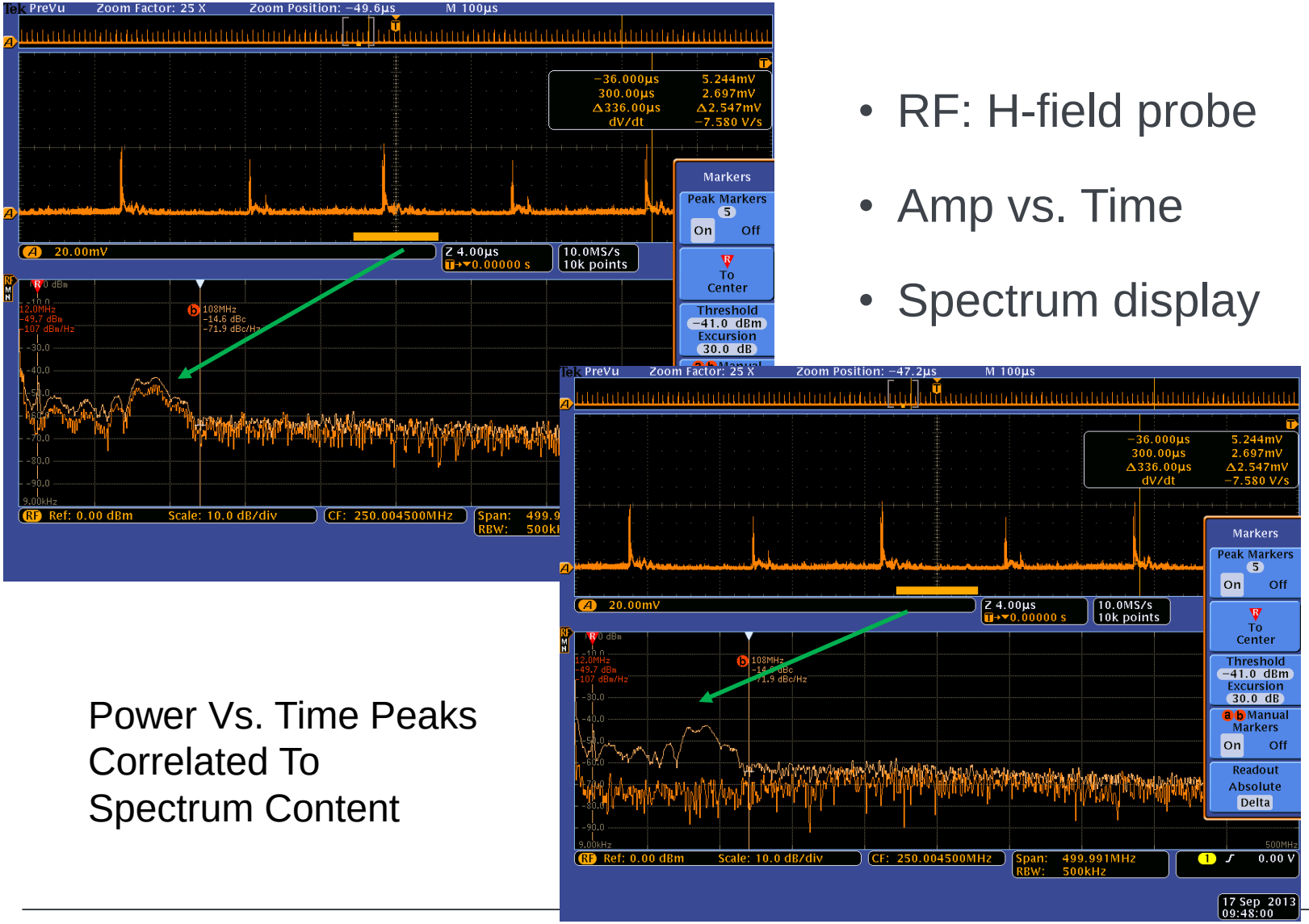
NEAR FIELD PROBING



- E-Field
  - Stub
  - High voltage, low current source
  - Max sensitivity perpendicular to source
- H-Field
  - Loop
  - Low voltage, high current source
  - Max sensitivity parallel to source
- Isolate sources of energy
- Measure relative changes
- Be Careful



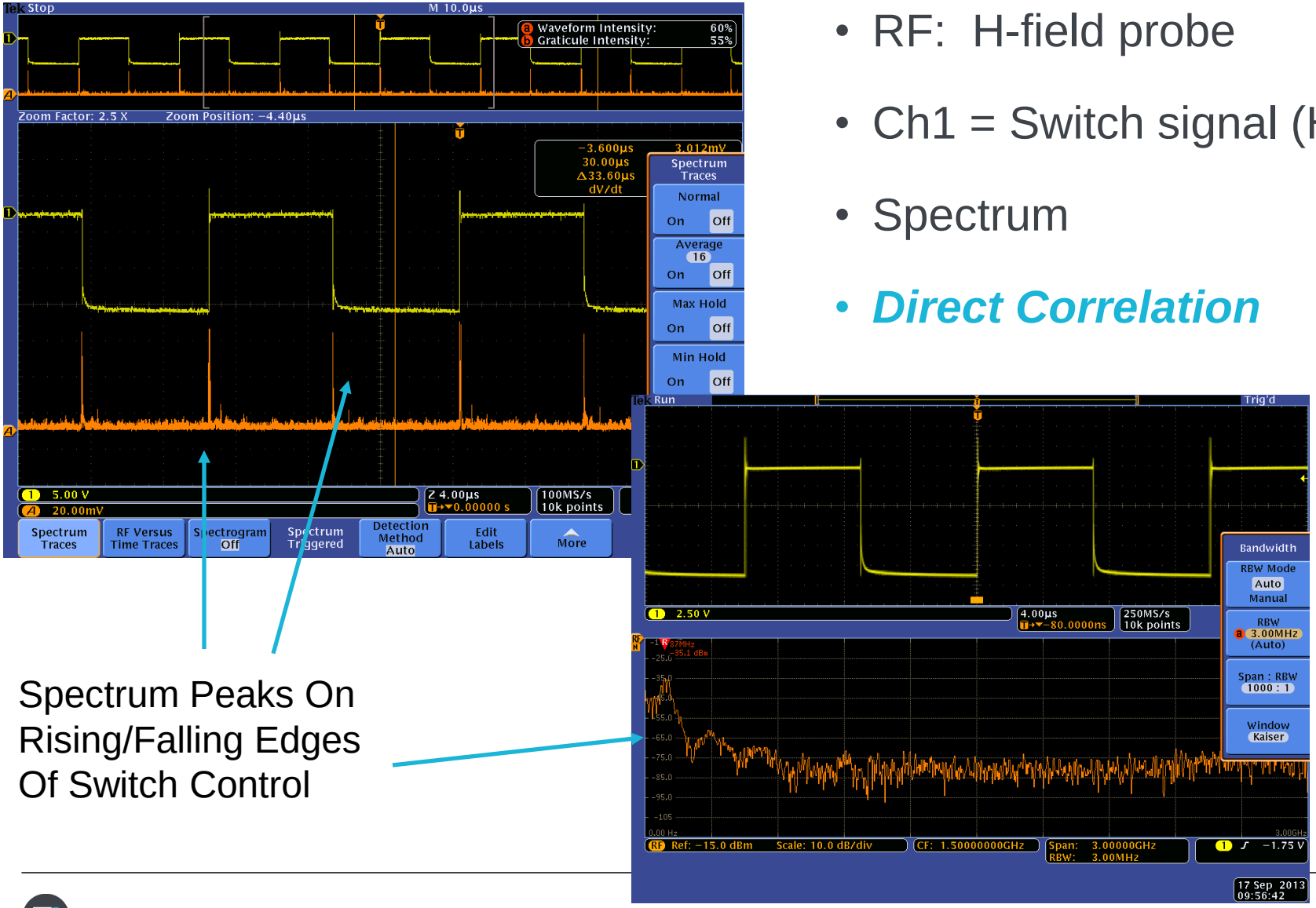
Example: Switched Class D Amp



- RF: H-field probe
- Amp vs. Time
- Spectrum display

Power Vs. Time Peaks Correlated To Spectrum Content

Example: Switched Class D Amp

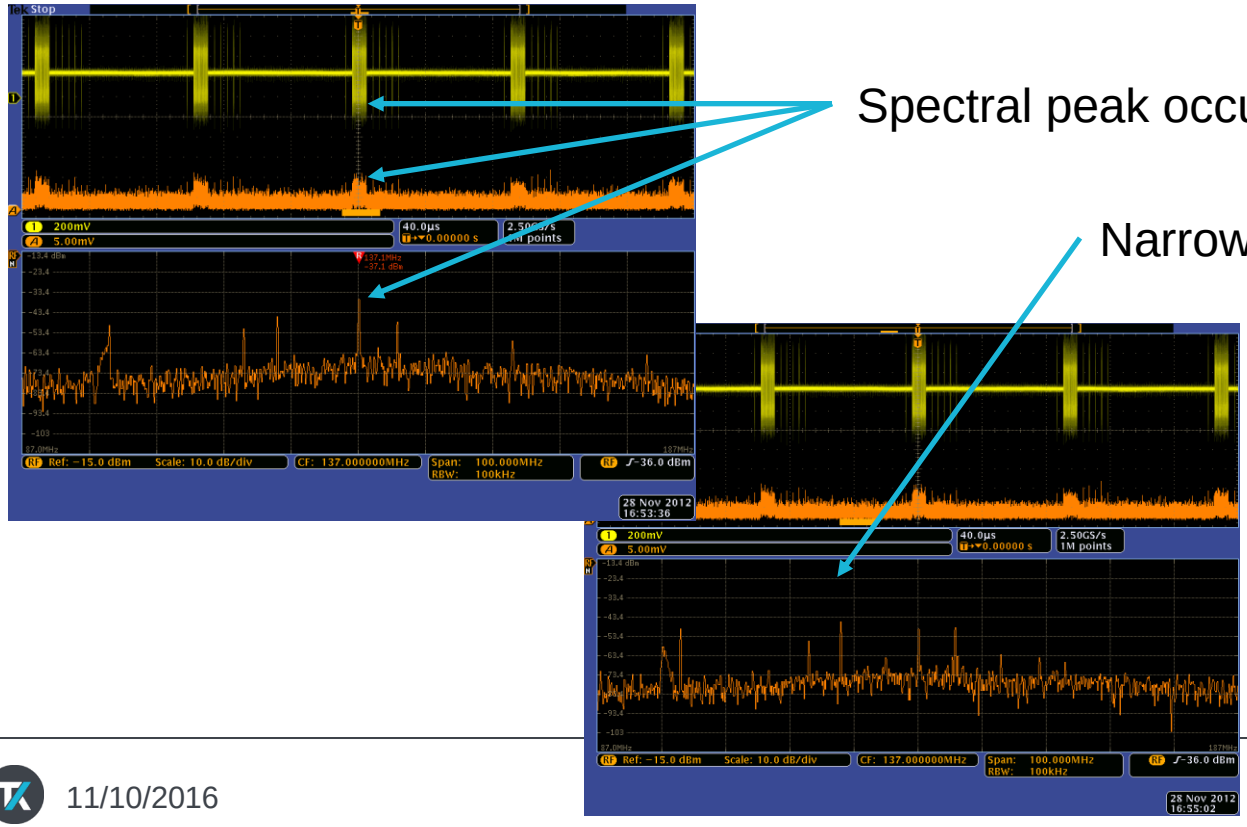


- RF: H-field probe
- Ch1 = Switch signal (HR)
- Spectrum
- ***Direct Correlation***

Spectrum Peaks On Rising/Falling Edges Of Switch Control

Example: USB Interference

- RF: H-field probe (USB cable interface)
- CH1: USB HS line
- ***Direct Correlation***



Spectral peak occurs during burst

Narrow & Broad level changes