Cable Clamp Injection of Impulse Noise

Pete Cibula

Intel Corporation

Purpose

- Perform an initial assessment of the cable clamp as a method of injecting impulse noise
  - Neither comprehensive nor final
  - Informative as a feasibility study

Proposed Cable Clamp Setup

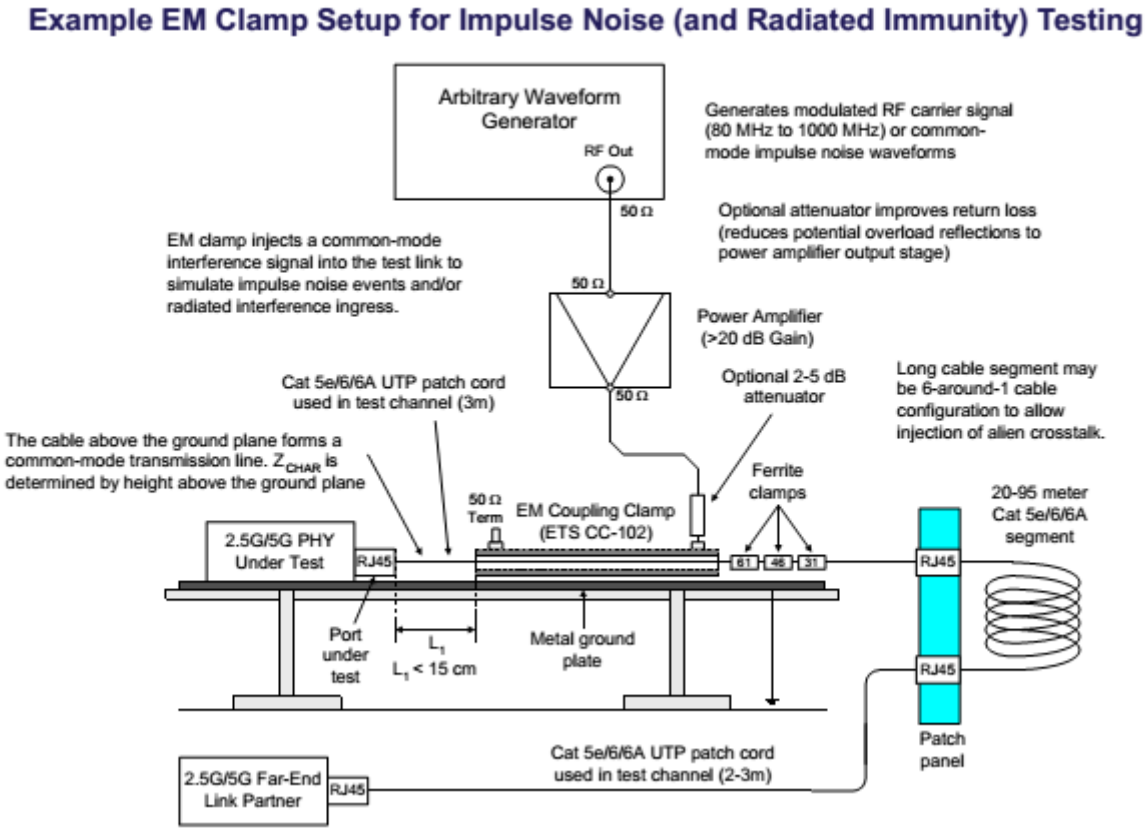
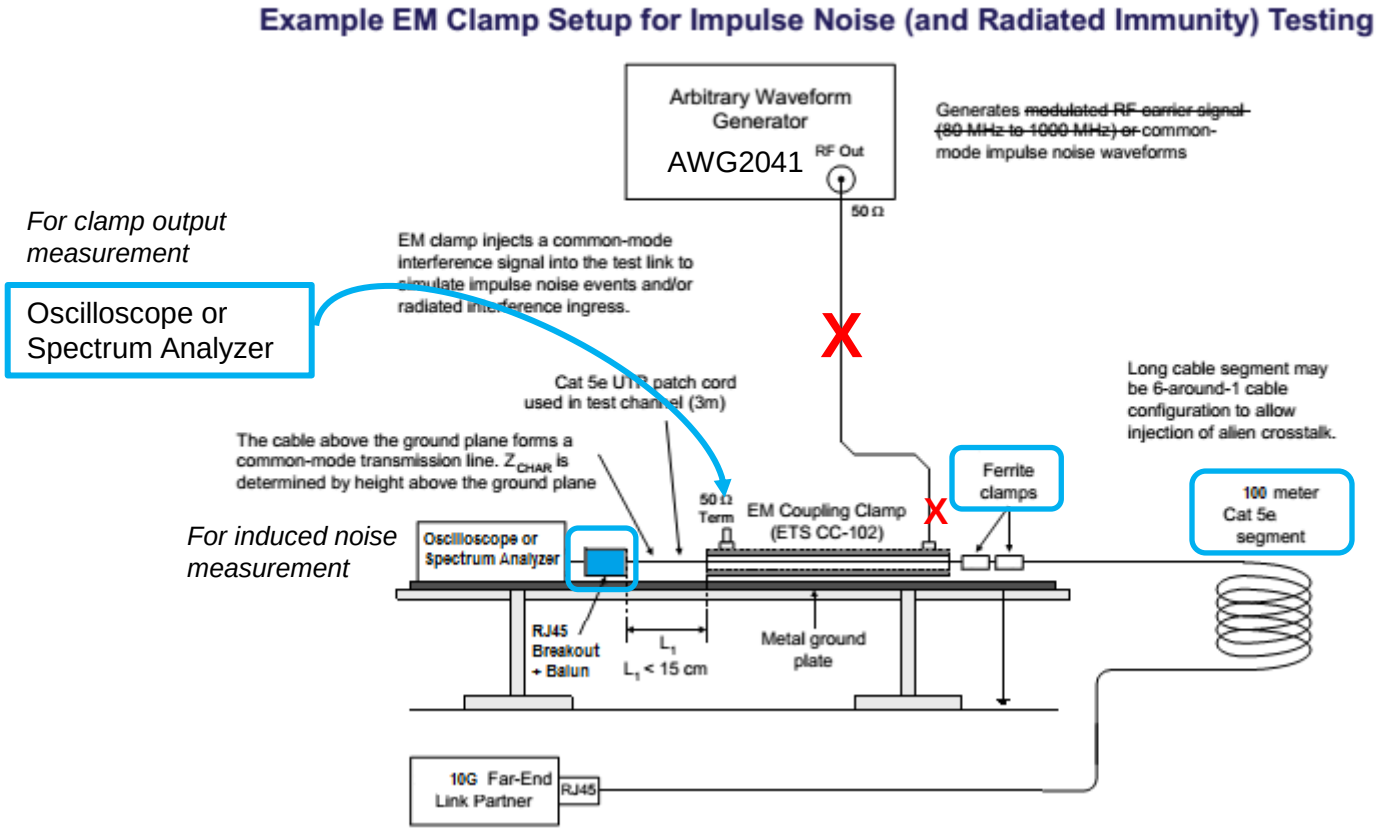


Diagram from Cohen_NGEABT_01_0515.pdf
Presented in the May 6th P802.3bz ENUCA ad hoc

Measurement Setup for this Initial Assessment



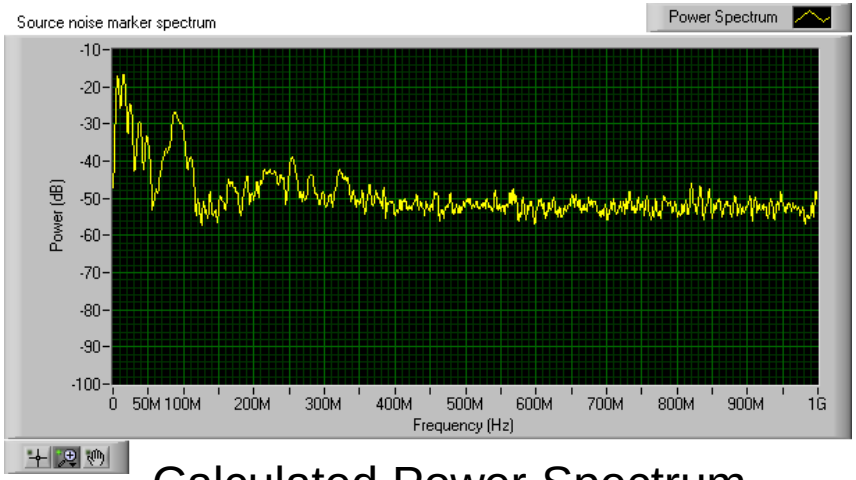
Modifications for this initial assessment

Initial Assessment Process

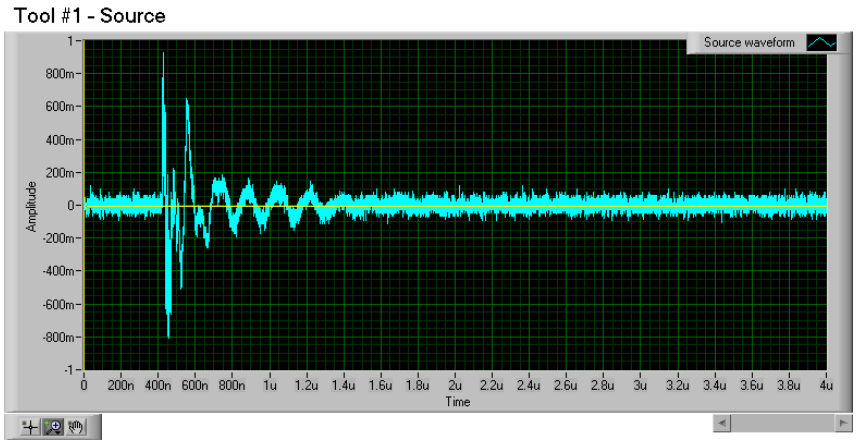
- #1 - Capture source impulse event
  - Oscilloscope traces provided by Larry Cohen/Aquantia (Thanks!)
- #2 - Get the event into an AWG and the clamp
  - Re-sample as needed for specific AWG
  - Compare source and re-sampled signals
    - Time and frequency domain
  - Inject signal and measure at clamp output
- #3 - See what gets into the cable
  - Measure common-mode and differential-mode signals (after breakout + balun fixture)

Source Impulse Event

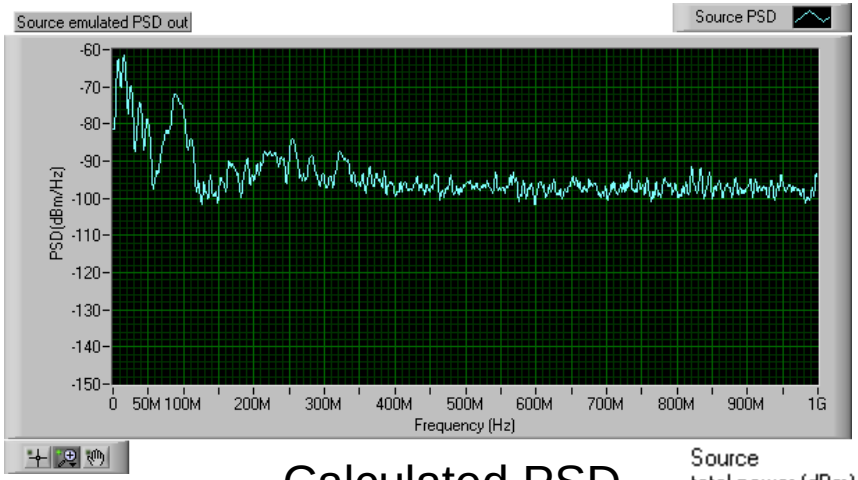
- Oscilloscope capture from Noise Event Capture Test Setup
  - cohen_feb-11-15_ImpulseNoiseMeasurement_InitialResults.pdf
- 10k points sampled at 2.5Gsps (400ps)



Calculated Power Spectrum



Time domain signal



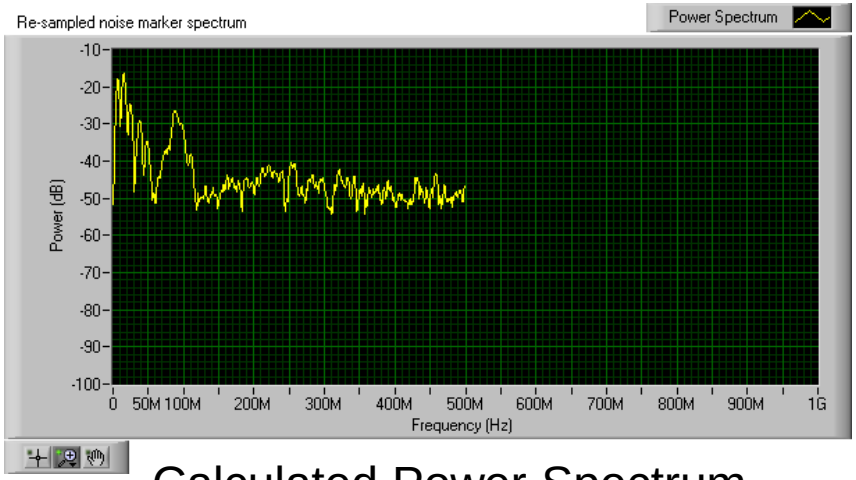
Calculated PSD

Source total power (dBm)

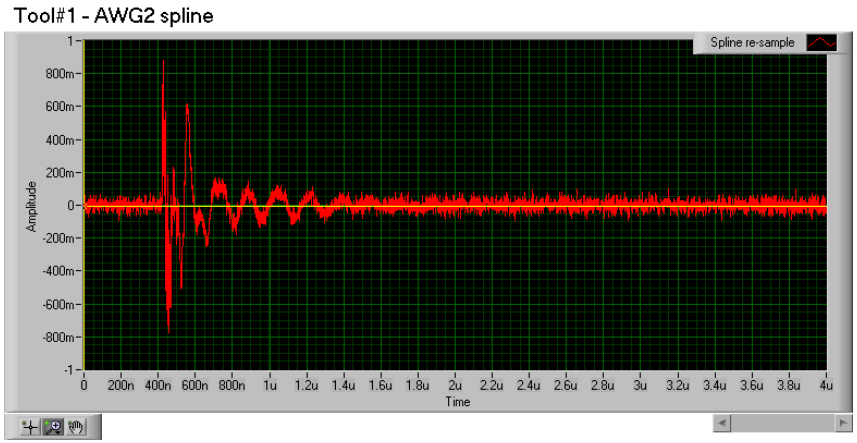
8.69109

Re-Sampled Impulse

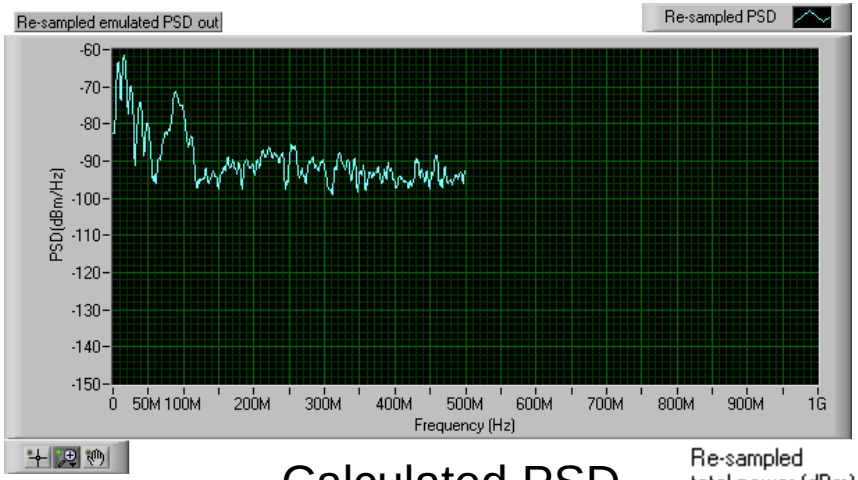
- 10k points re-sampled at 1Gsps (1000ps), spline interpolation
- Re-sampling is reflected in the calculated power spectrum, PSD and total power
- Lower total power probably reflects the loss of some high-frequency content



Calculated Power Spectrum



Time domain signal



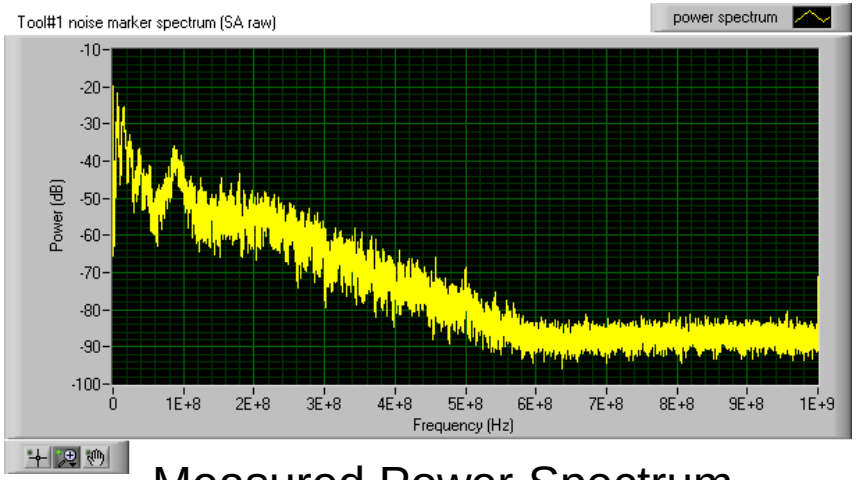
Calculated PSD

Re-sampled total power (dBm)

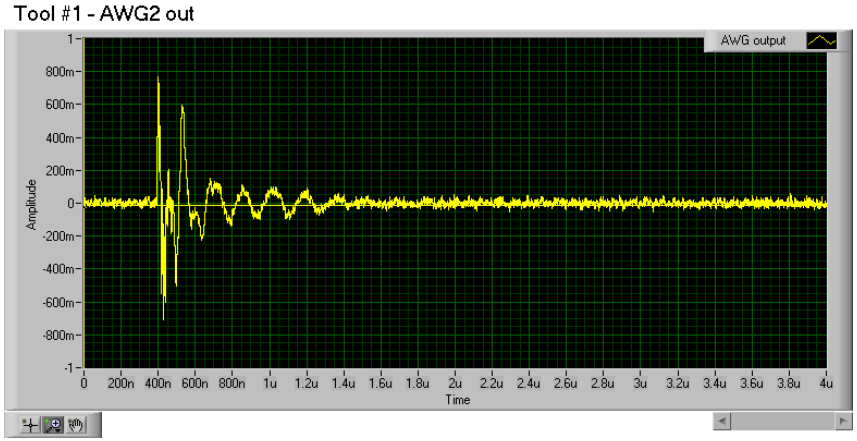
8.44804

AWG output

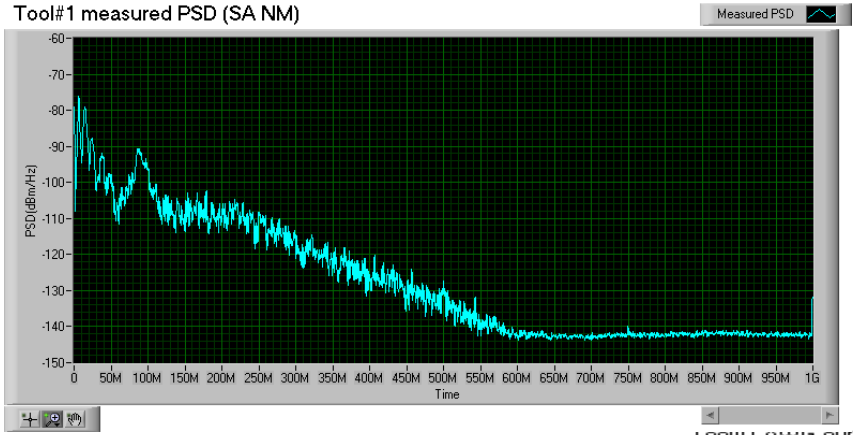
- 4k points output at 1GHz clock
- Time domain signal measured with oscilloscope
- Frequency domain signal and PSD measured with spectrum analyzer



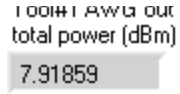
Measured Power Spectrum



Time domain signal

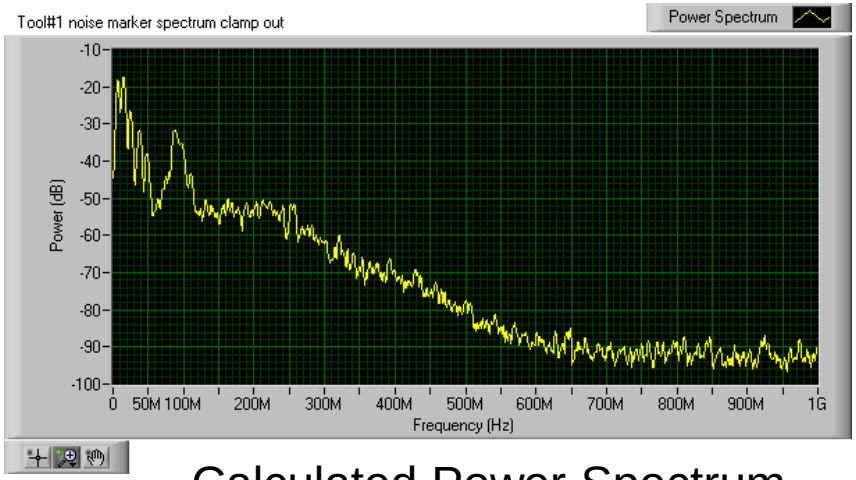


Measured PSD

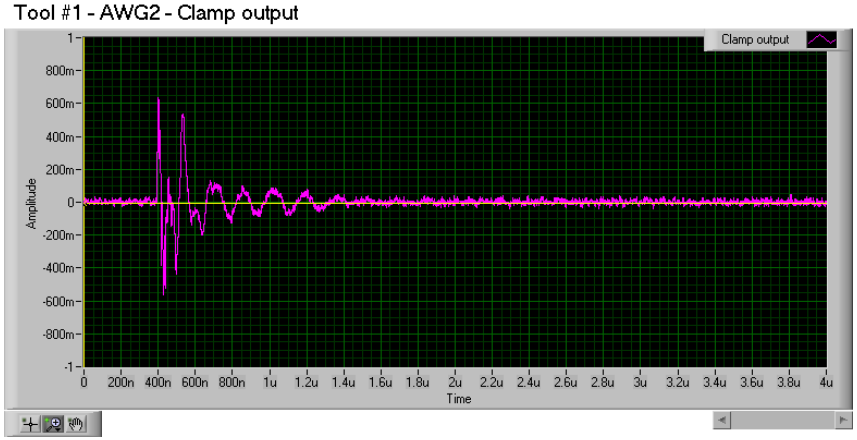


Cable Clamp output

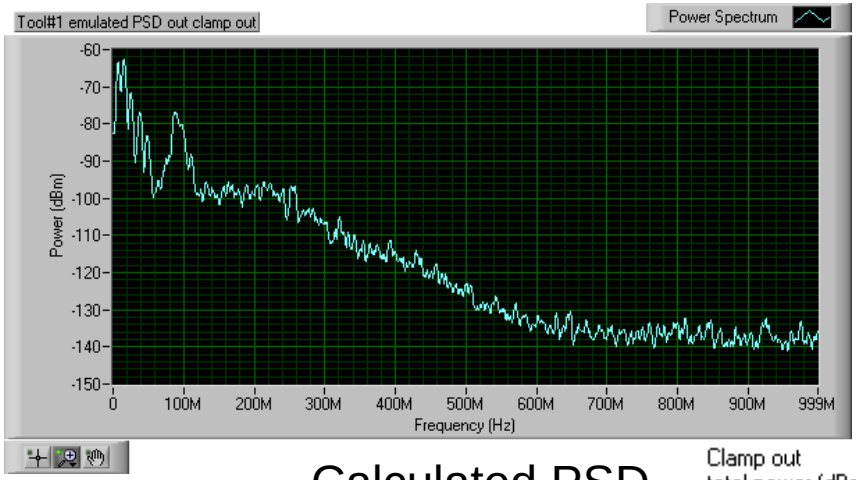
- 4k points output at 1GHz clock
- CC109 3/8” aperture clamp Loaded with cable
- 100m Cat5e cable, two Annex40B ferrites, common-mode termination at far end, 10GBASE-T device at “DUT end”



Calculated Power Spectrum



Time domain signal

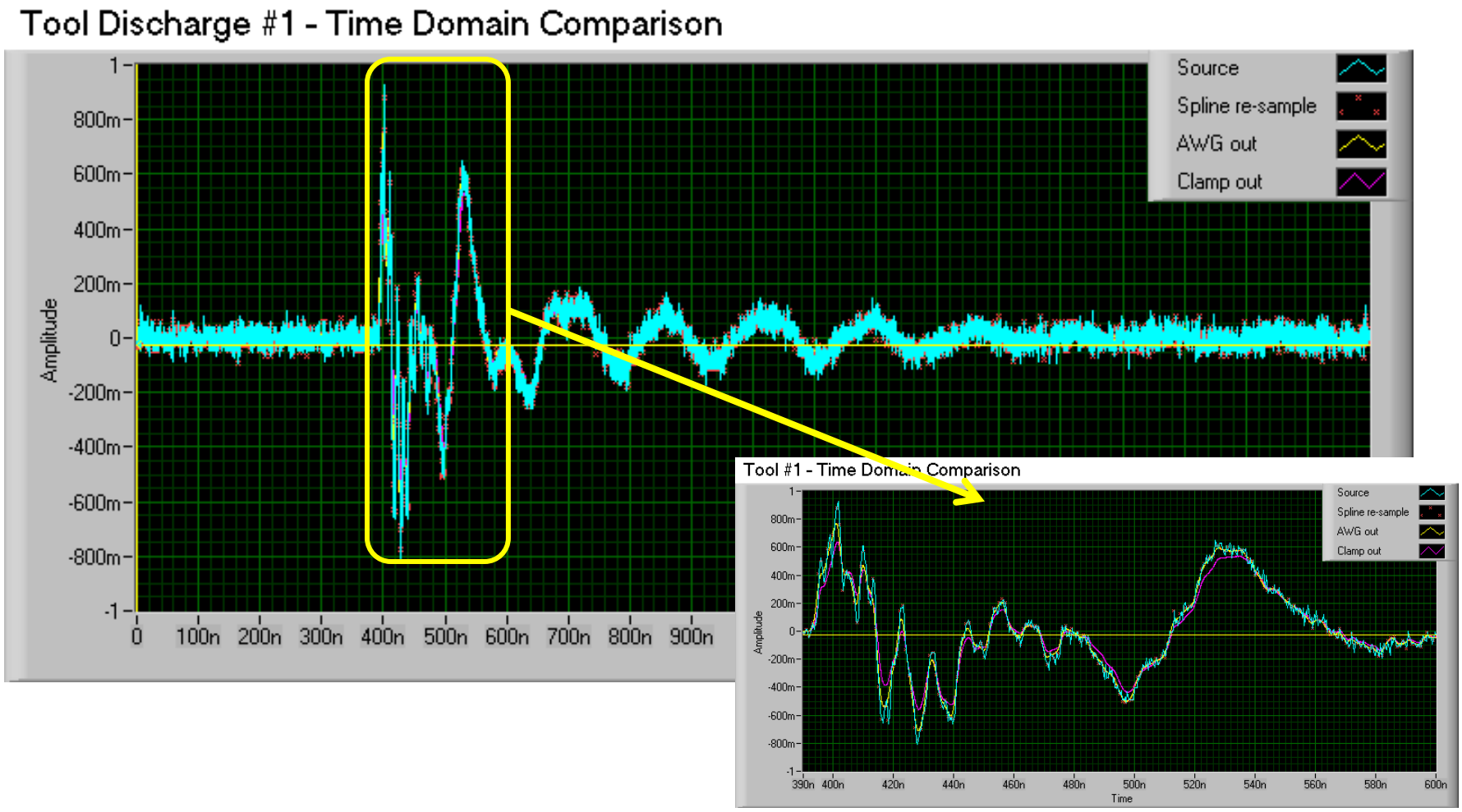


Calculated PSD

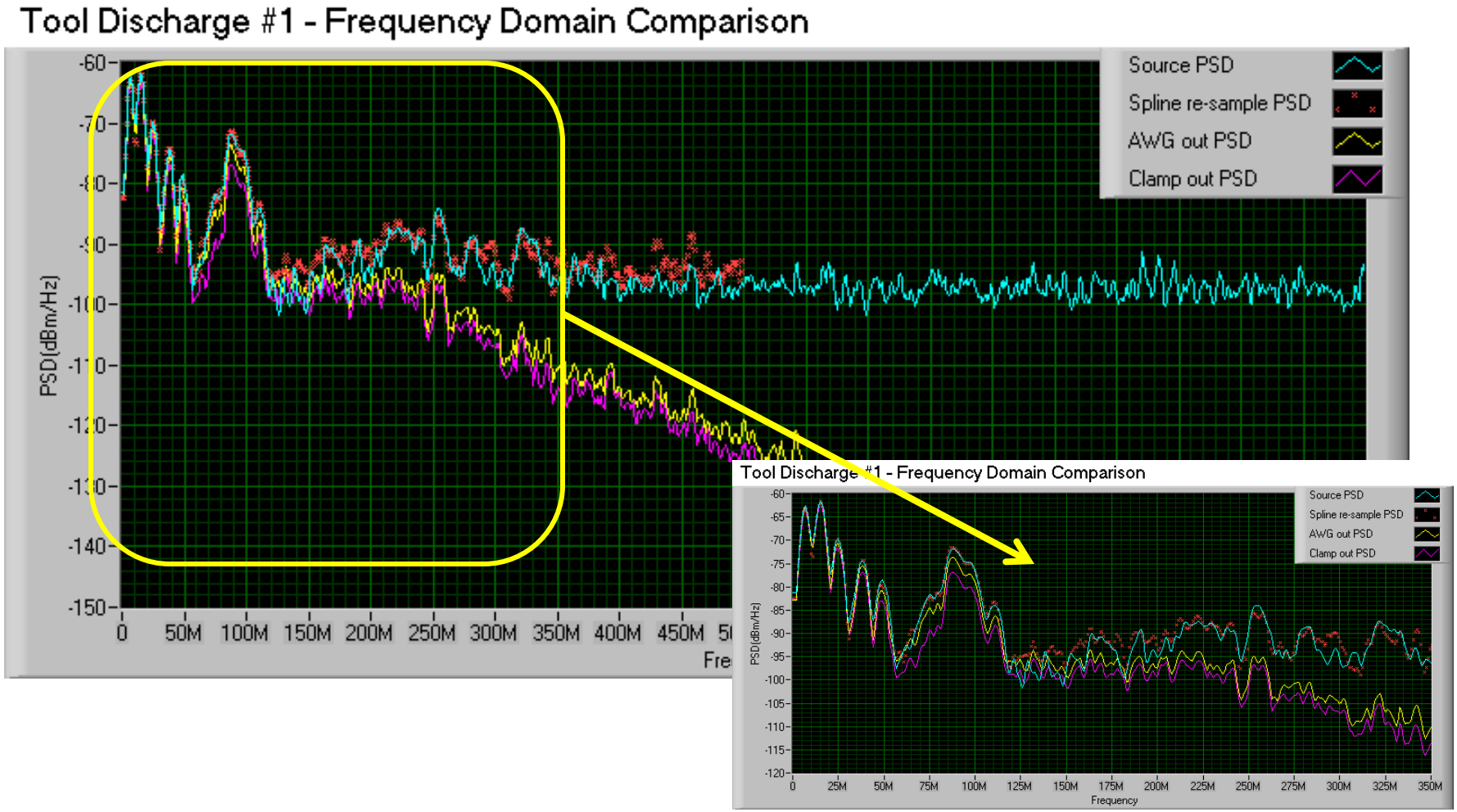
Clamp out total power (dBm)

7.00748

Time Domain Comparison



Frequency Domain Comparison



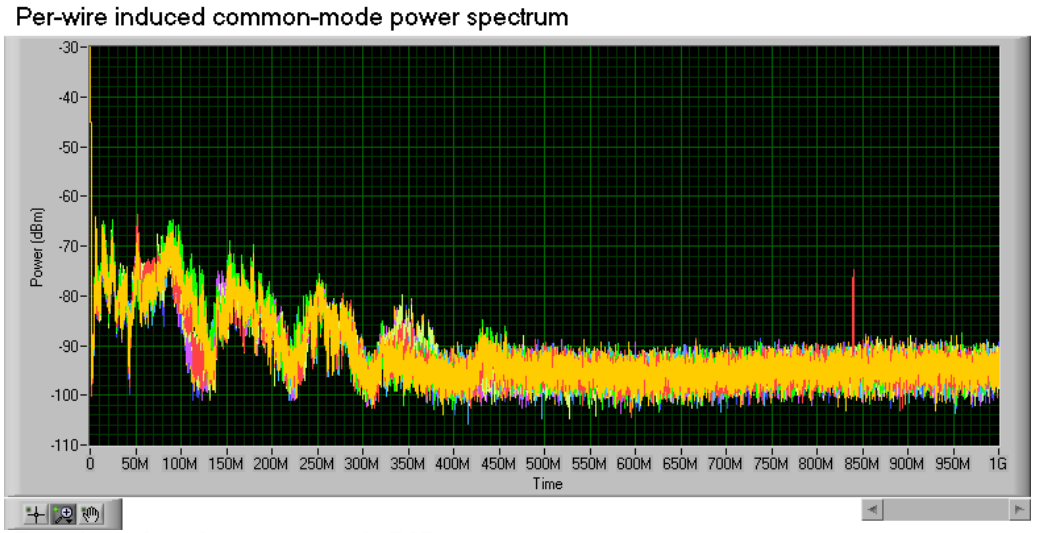
Induced Noise Measurement

- Setup is similar to that used for P802.3bq receiver common-mode noise characterization
  - 100m Cat5e cable with 2x Annex 40B ferrites
  - RJ45-to-SMA breakout fixture
  - 300kHz – 3GHz instrumentation balun (ETS PI102)
  - Spectrum analyzer
- Measure frequency domain induced noise
  - Common- and differential-mode noise

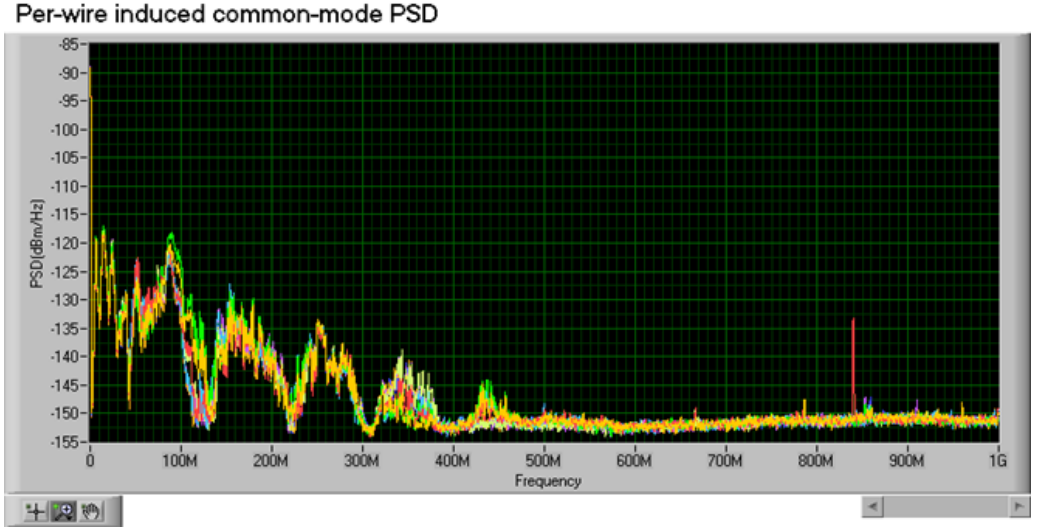
Induced common-mode noise

- Measurements on 8 individual wires

Measured Power Spectrum



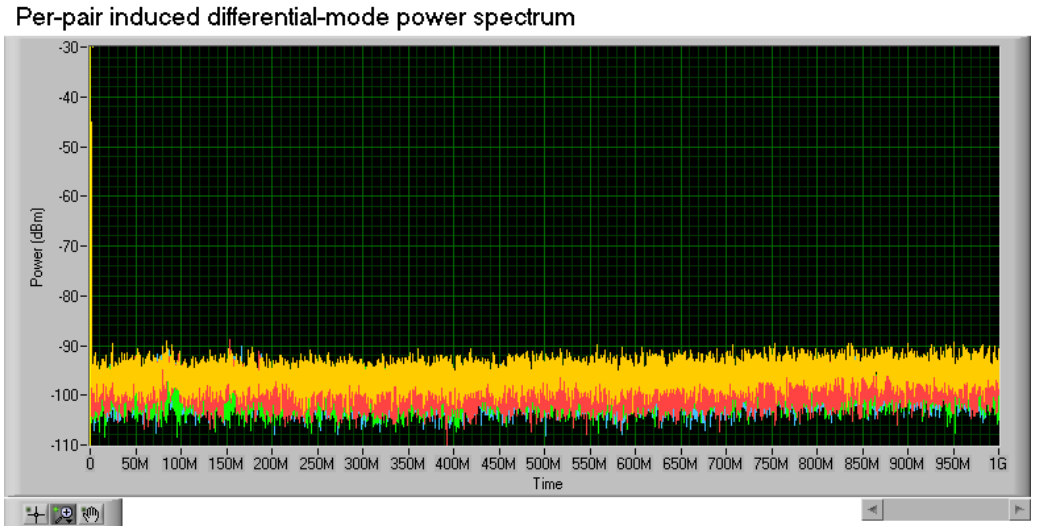
Measured PSD



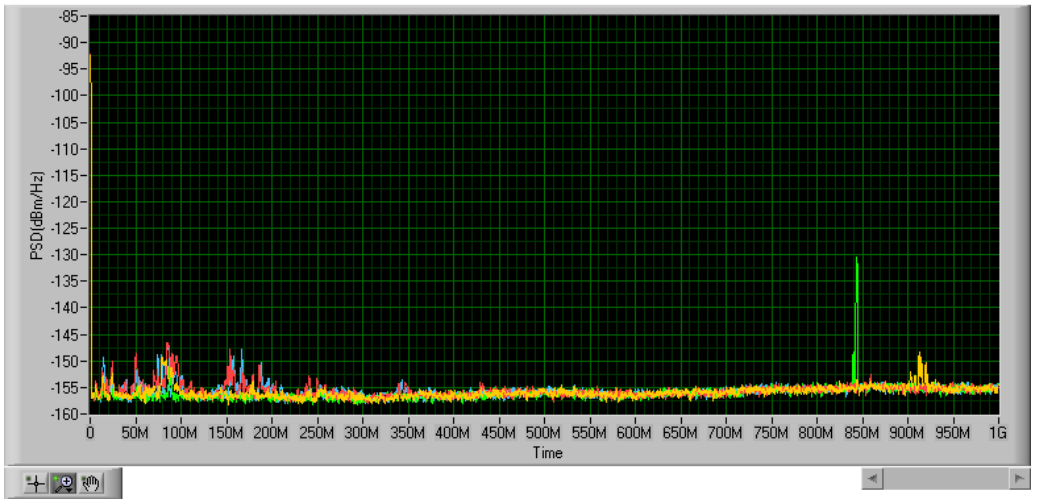
Induced differential-mode noise

- Measurements on 4 pairs

Measured Power Spectrum



Measured PSD



Summary & Next Steps

Summary

- The EM clamp setup described in Cohen_NGEABT_01_0515.pdf appears to be a valid method for introducing impulse impairments to twisted-pair cabling
  - Signals can be replayed using standard test equipment
  - Measured time- and frequency-domain characteristics from the test equipment are comparable to the actual impulse event

Next Steps

- Repeat with ¼” diameter clamps (ETS CC101, “homebrew), different cables, power amplifier, and signal compensation for amplifier/cable clamp response
- Further work to follow as refinements are defined in the ENUCA ad hoc

Thank You!

Questions?