RTPGE TRANSIENT NOISE MEASUREMENTS AND MODELING BASED ON ISO 7637-3

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AGENDA

- Objectives & Methodology
- Set-up & Calibration Information
- Measurement and Analysis Results
- A Transient Noise Model for system analysis
- Summary

OBJECTIVES

1. Estimate transient (pulse) noise on the signal lines at the RTPGE receiver for single pair UTP cables.

2. Investigate the effect of test head grounding (floating) on the transient noise magnitude and duration.

3. Provide simple noise models for initial analysis of modulation and coding solutions for RTPGE.

METHODOLOGY

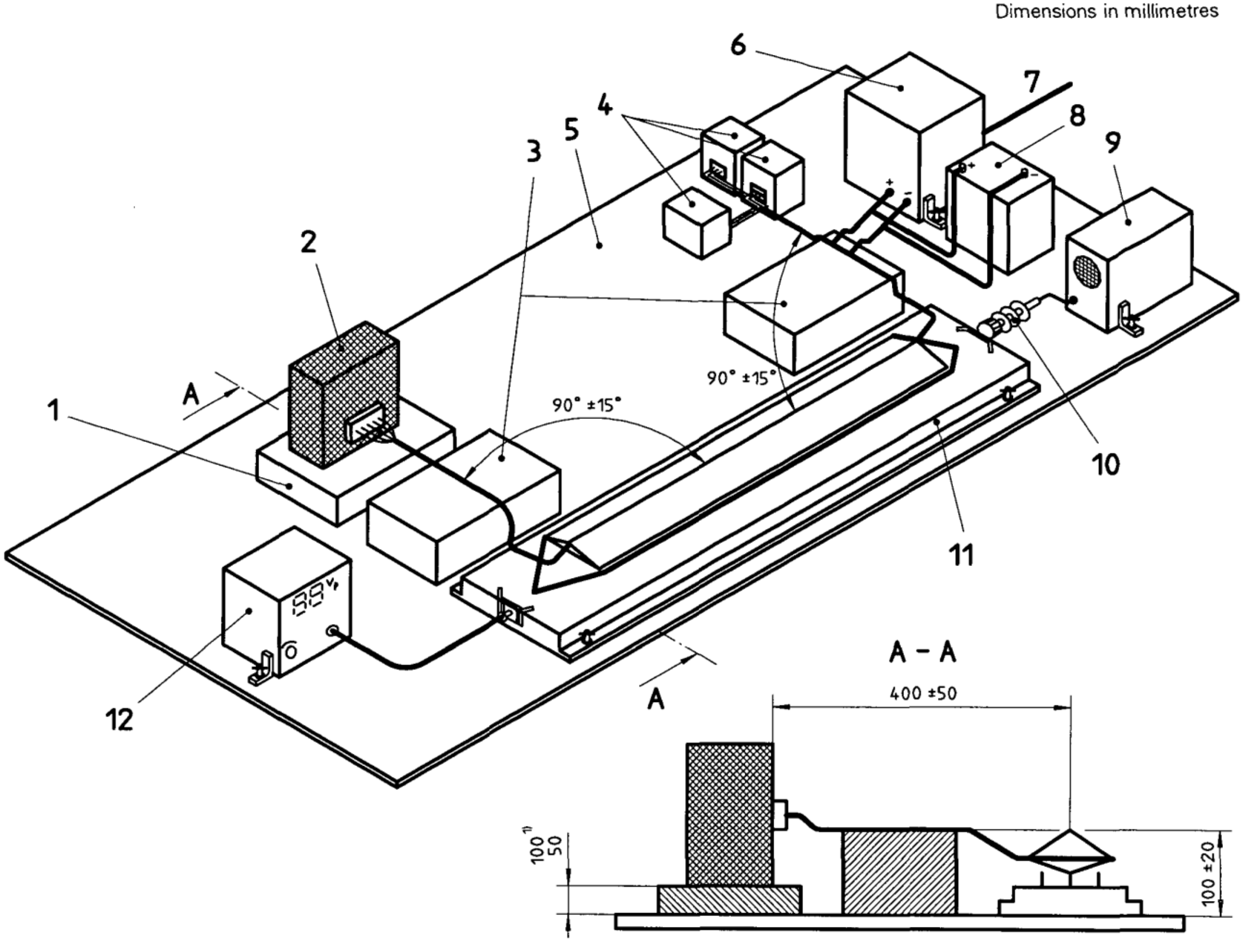
1. Used ISO 7637-3 specification for transient noise tests on signal lines for road vehicles.

2. Used 2m cables with TESEQ capacitive coupling clamp (1m long) as specified in ISO 7637-3.

3. Used Agilent VNA to obtain coupling transfer function and mathematical calculation to estimate noise from simulated test pulses.

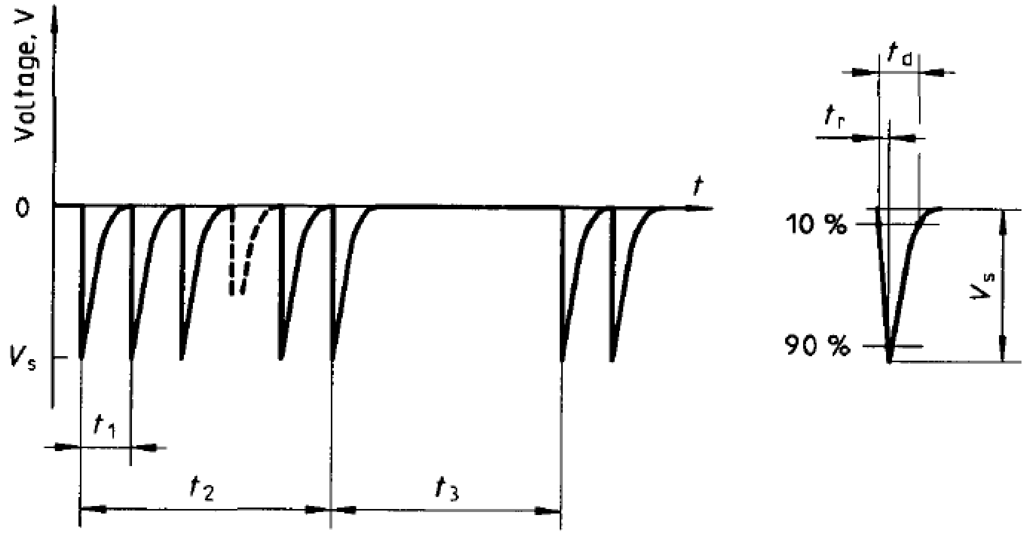
4. Used BMW suggested test levels to obtain differential noise levels at the receiver.

Transient test setup per ISO 7637-3



1) The selected dimension shall be specified in the test plan and documented in the test report.

Negative Test Pulses per ISO 7637-3

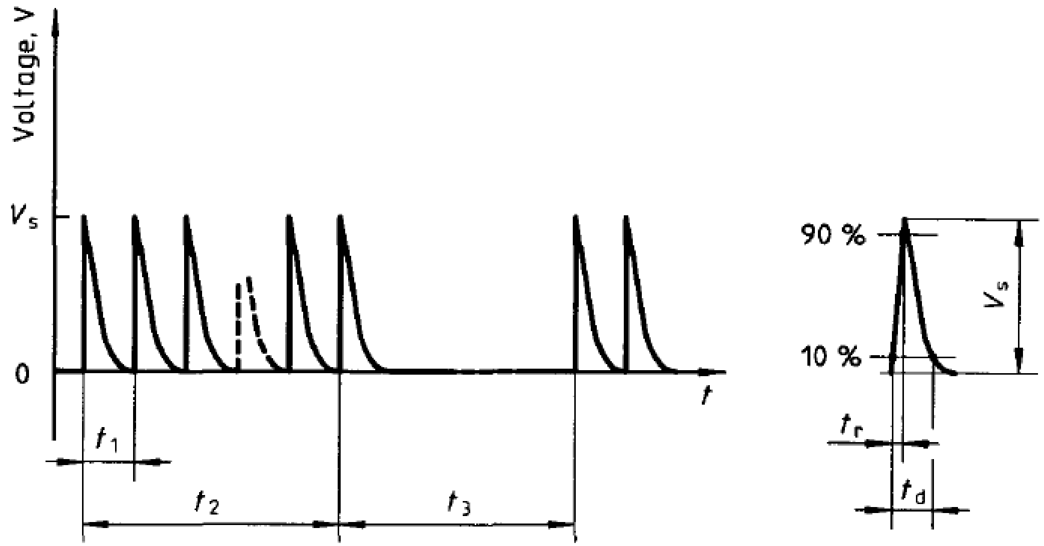


Parameters

V_s (see table A.1 for 12 V electrical systems or table A.2 for 24 V electrical systems)
R_i = 50 Ω
t_d = 0,1 µs
t_r = 5 ns ± 30 % at V_s = – 50 V, 50 Ω
t_1 = 100 µs
t_2 = 10 ms
t_3 = 90 ms

Figure 4 — Test pulse a

Positive Test Pulses per ISO 7637-3

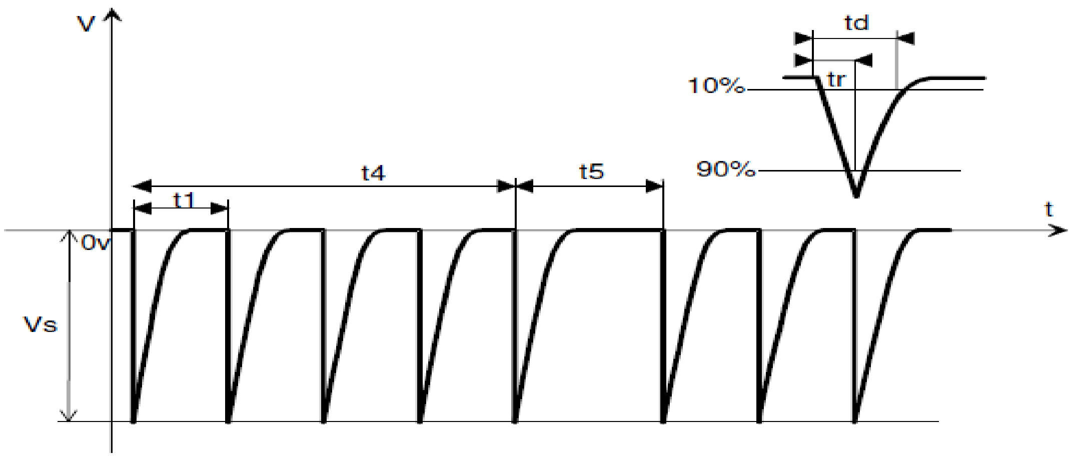
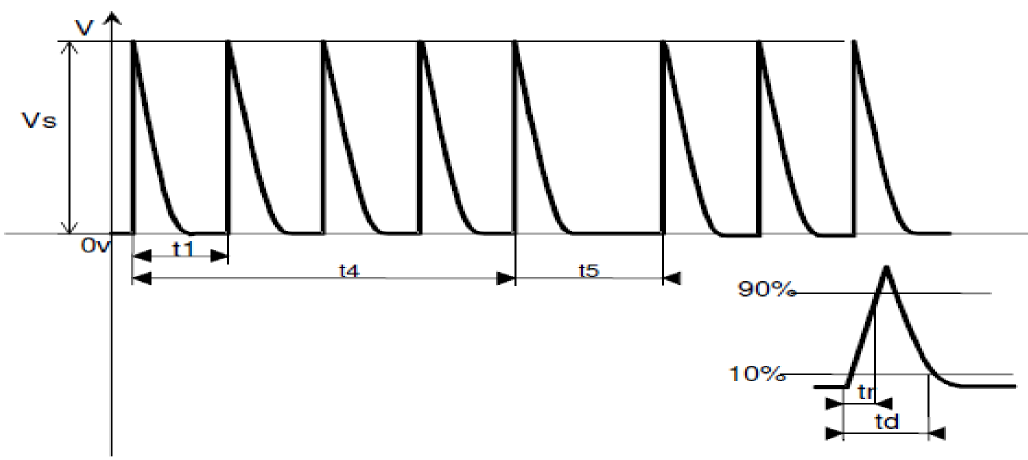


Parameters

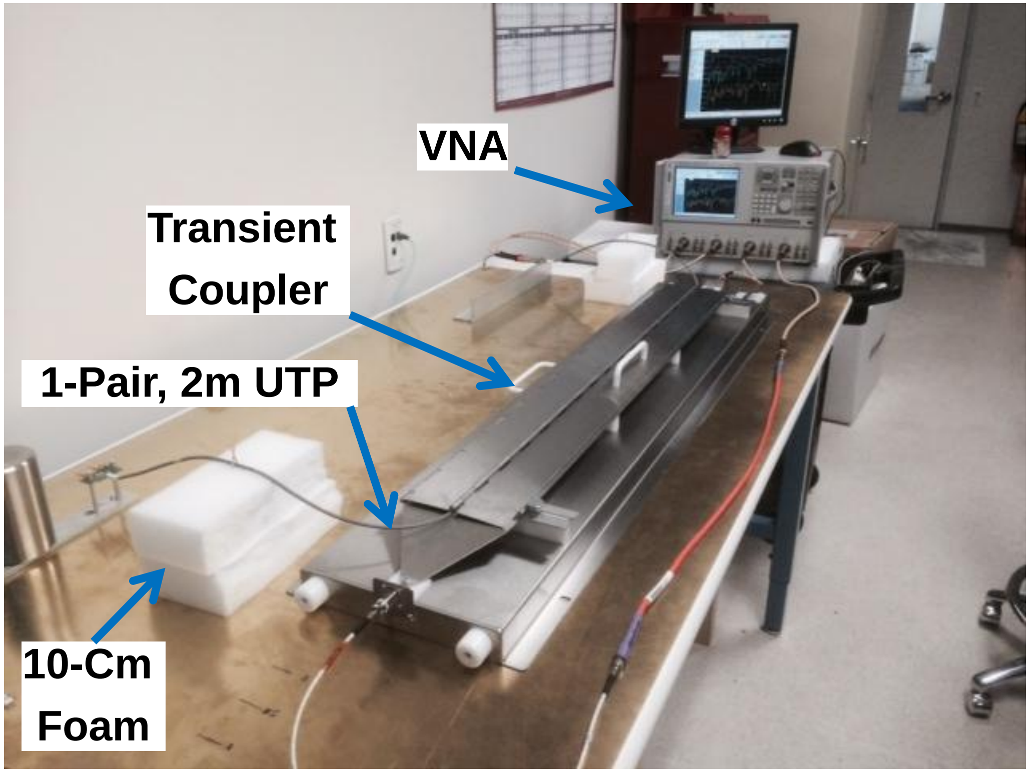
V_s (see table A.1 for 12 V electrical systems or table A.2 for 24 V electrical systems)
R_i = 50 Ω
t_d = 0,1 µs
t_r = 5 ns ± 30 % at V_s = + 50 V, 50 Ω
t_1 = 100 µs
t_2 = 10 ms
t_3 = 90 ms

Figure 5 — Test pulse b

BMW Suggested Test Levels

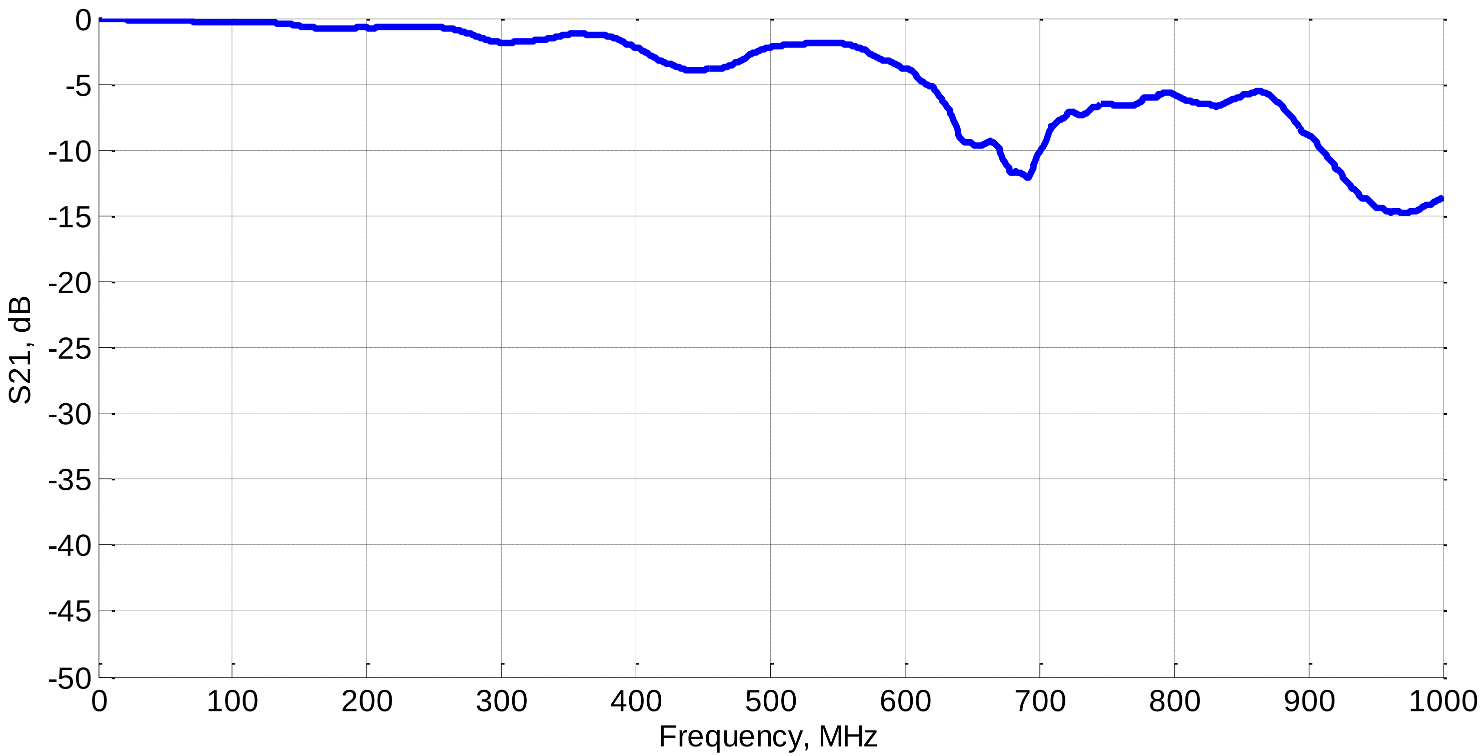
12 V Network	Pulse 3a
$V_s = -150$ V $R_i = 50\ \Omega$ $t_d = (0.1^{+0.1}{}_{0})\ \mu s$ $t_r = 5ns \pm 1.5$ ns $t_1 = 100\ \mu s$ $t_4 = 10$ ms $t_5 = 90$ ms	
12 V Network	**Pulse 3b**
$V_s = 100$ V $R_i = 50\ \Omega$ $t_d = (0.1^{+0.1}{}_{0})\ \mu s$ $t_r = 5ns \pm 1.5$ ns $t_1 = 100\ \mu s$ $t_4 = 10$ ms $t_5 = 90$ ms	

Transient Noise Test Setup



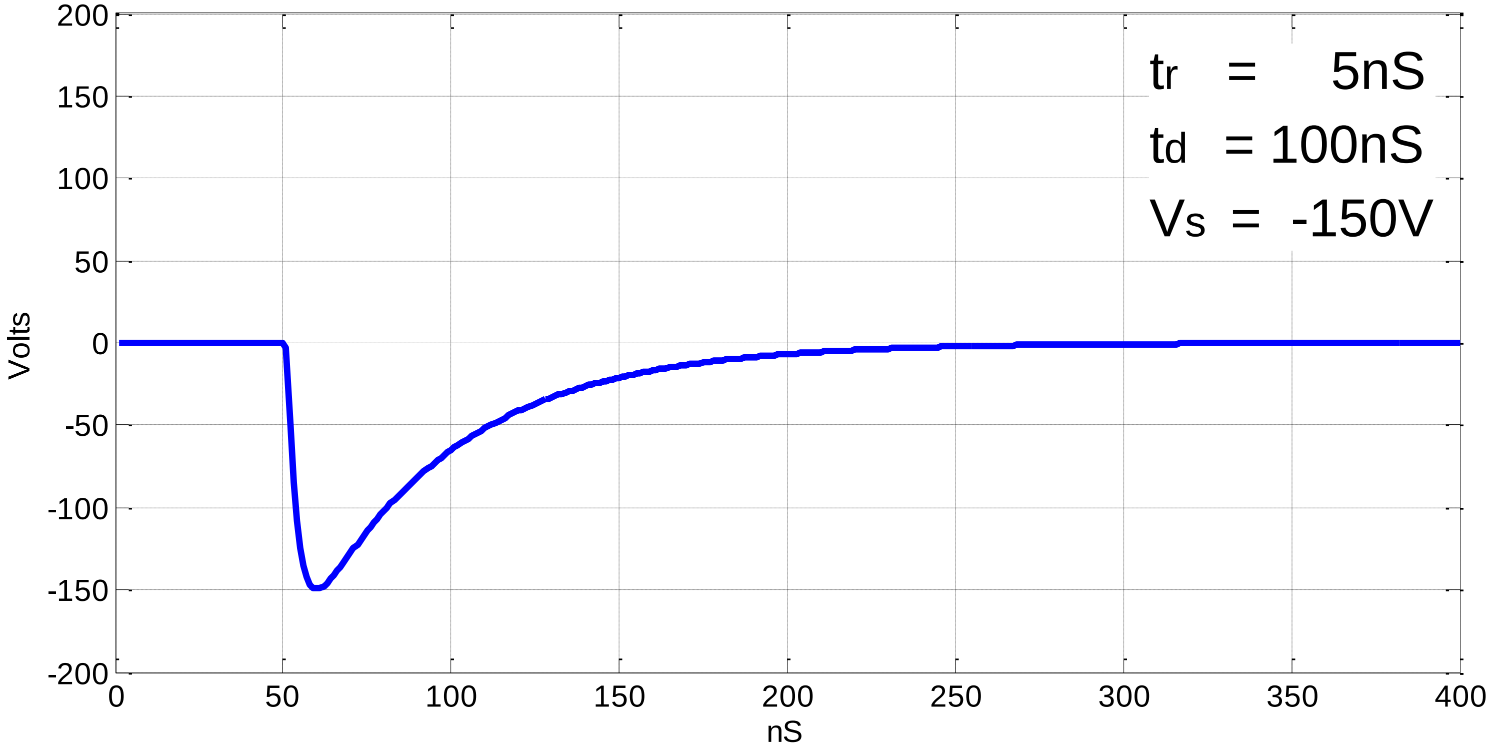
- Transient coupler (by TESEQ) designed per ISO 7637-3 was used to couple transient noise.
- Agilent VNA measured the coupling transfer function.
- One side of the cable connected to port 1 and 2 of VNA and other side terminated with 50Ω loads (100Ω differential).
- Test heads had optional grounding stands in order to study the effect of grounding or floating.

Transient Coupler Calibration

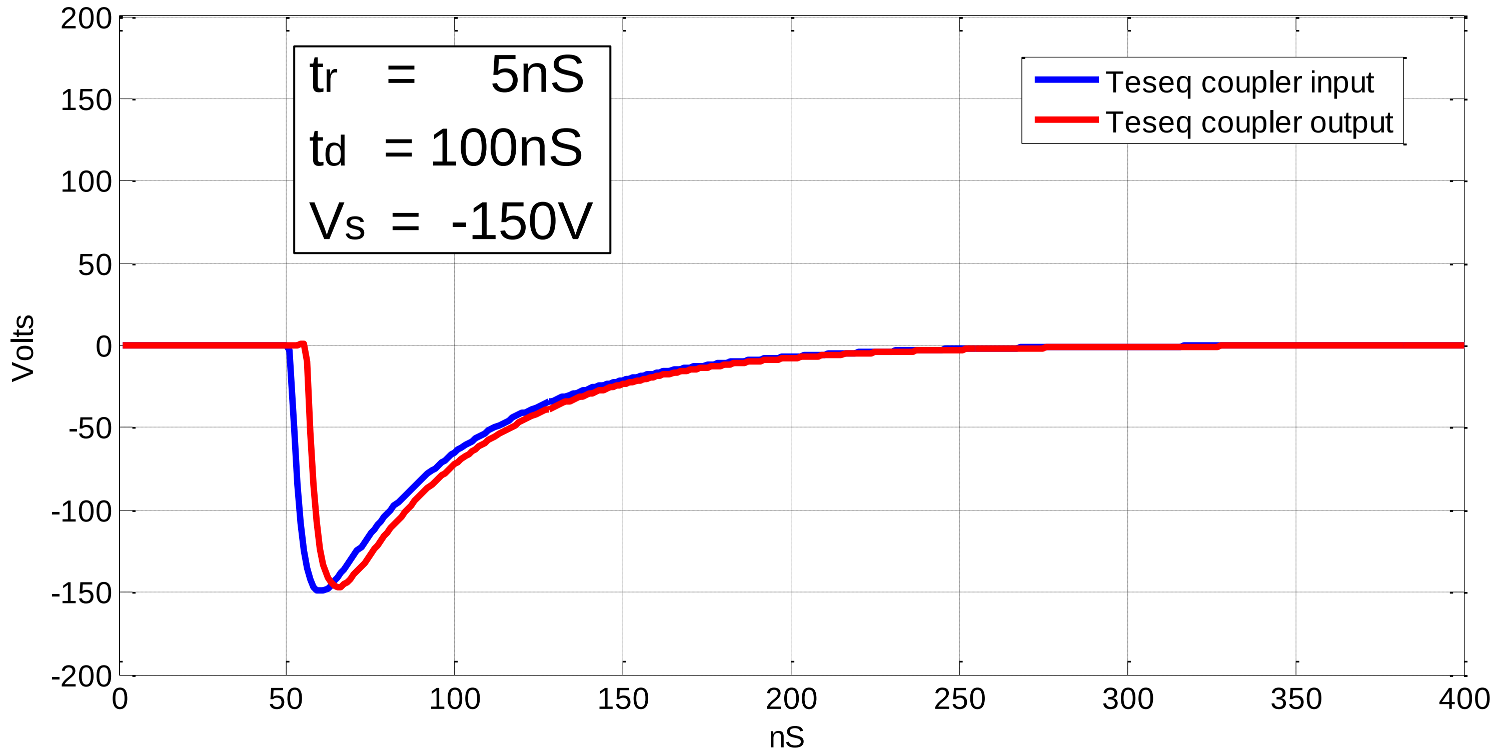


- Almost no insertion loss in the lower frequency band where test pulses have their most energy. Port 1 is noise injection port and port 2 is the measurement port for calibration.

Simulated Transient Test Pulse a

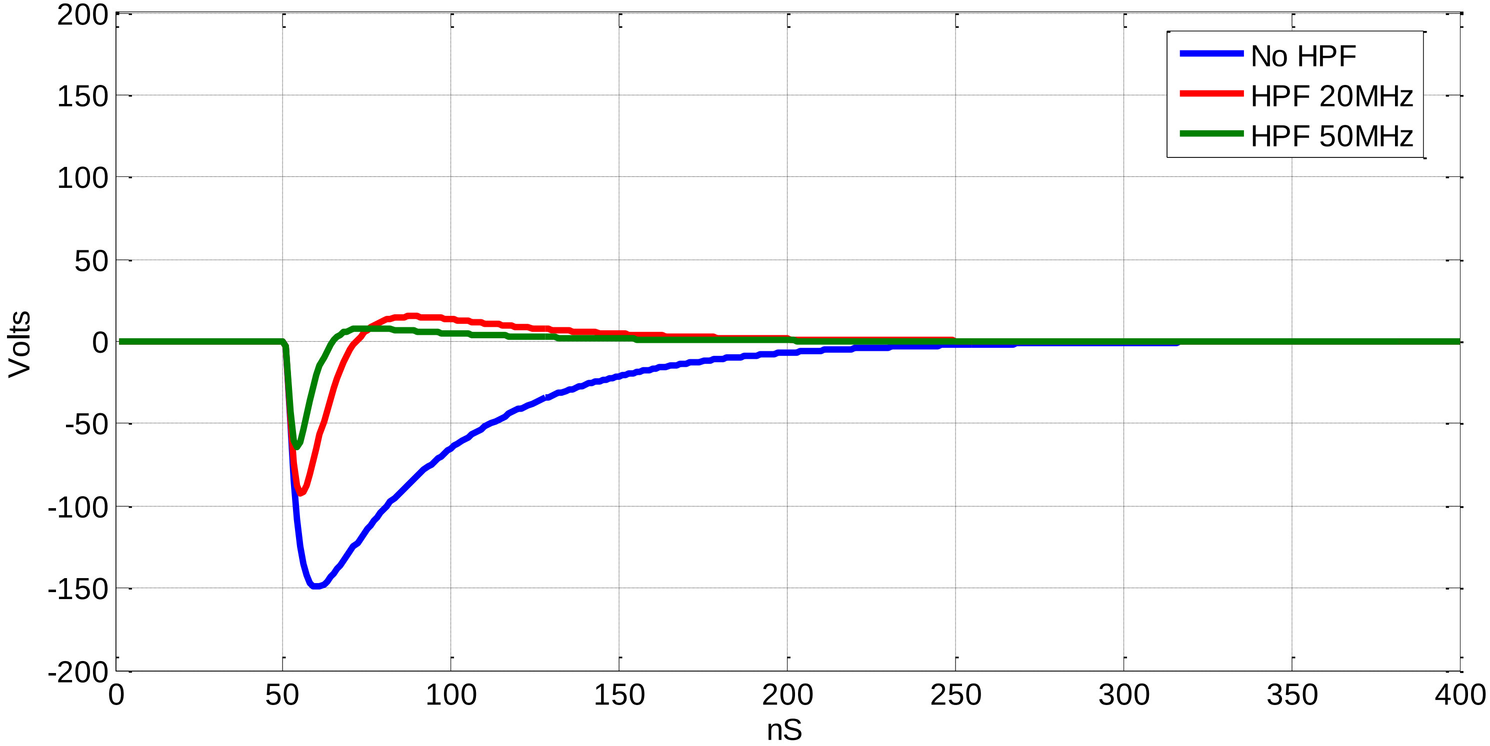


Simulated Transient Test Pulse and Calibration



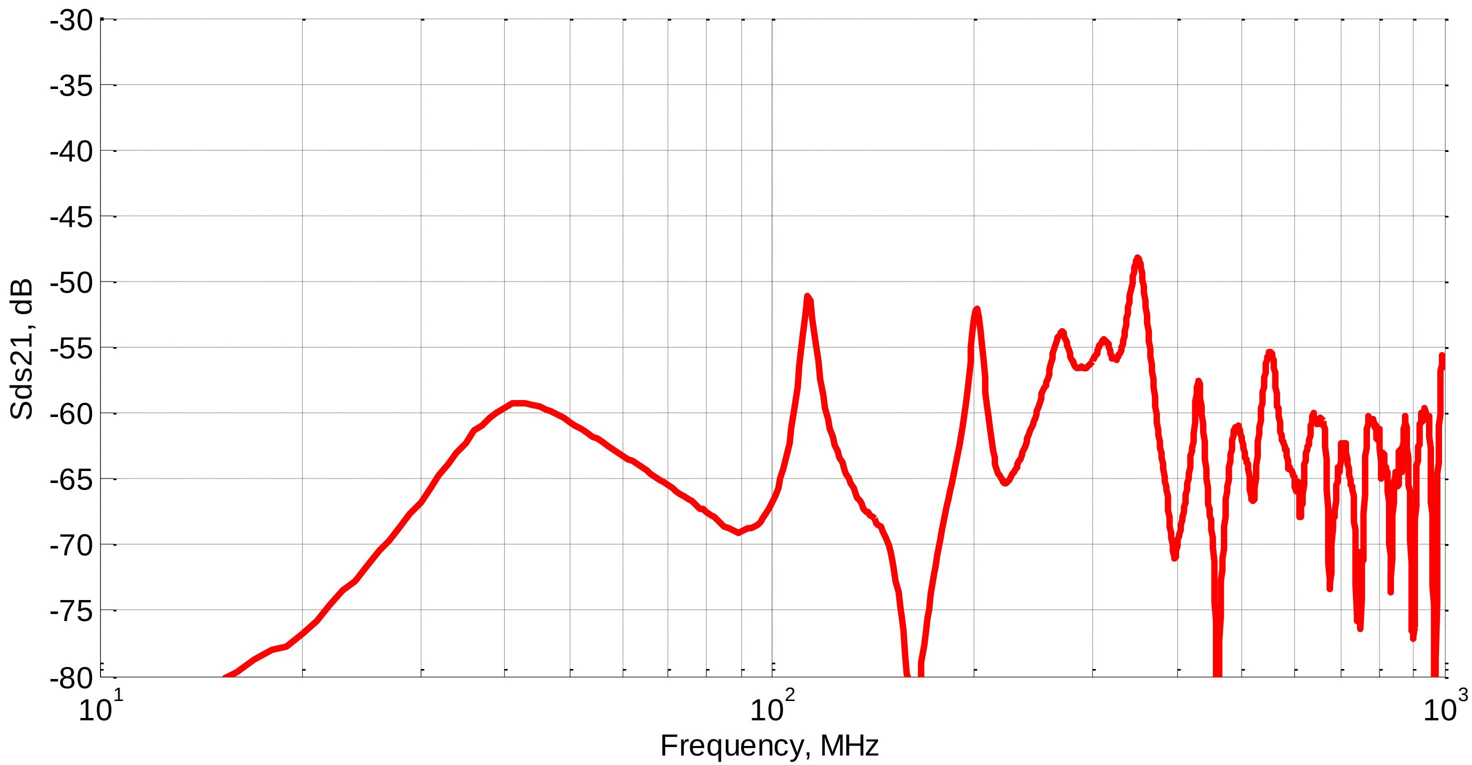
- No need for calibration, Input/output pulses are about the same magnitude. Input port is where noise is injected and output port is where noise level is measured for calibration.

Receiver HPF Effect



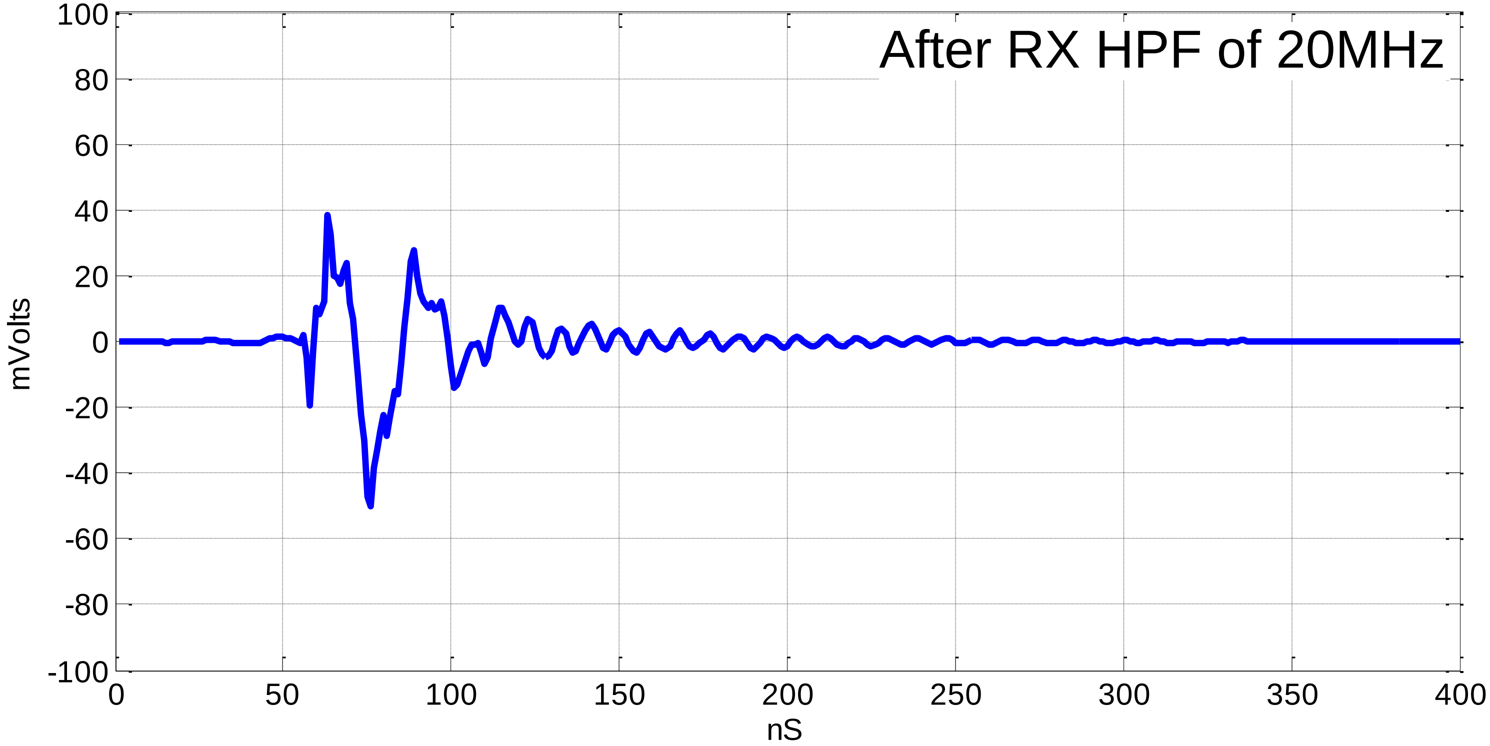
- Receiver HPF reduces the intensity and duration of the transient test pulses and needs to be considered in analysis of transient noises.

Example Measured Transient Transfer Function



- Port 1 is noise injection port and port 2 is the differential port at DUT Test Head.

Simulated DM Transient Noise Example

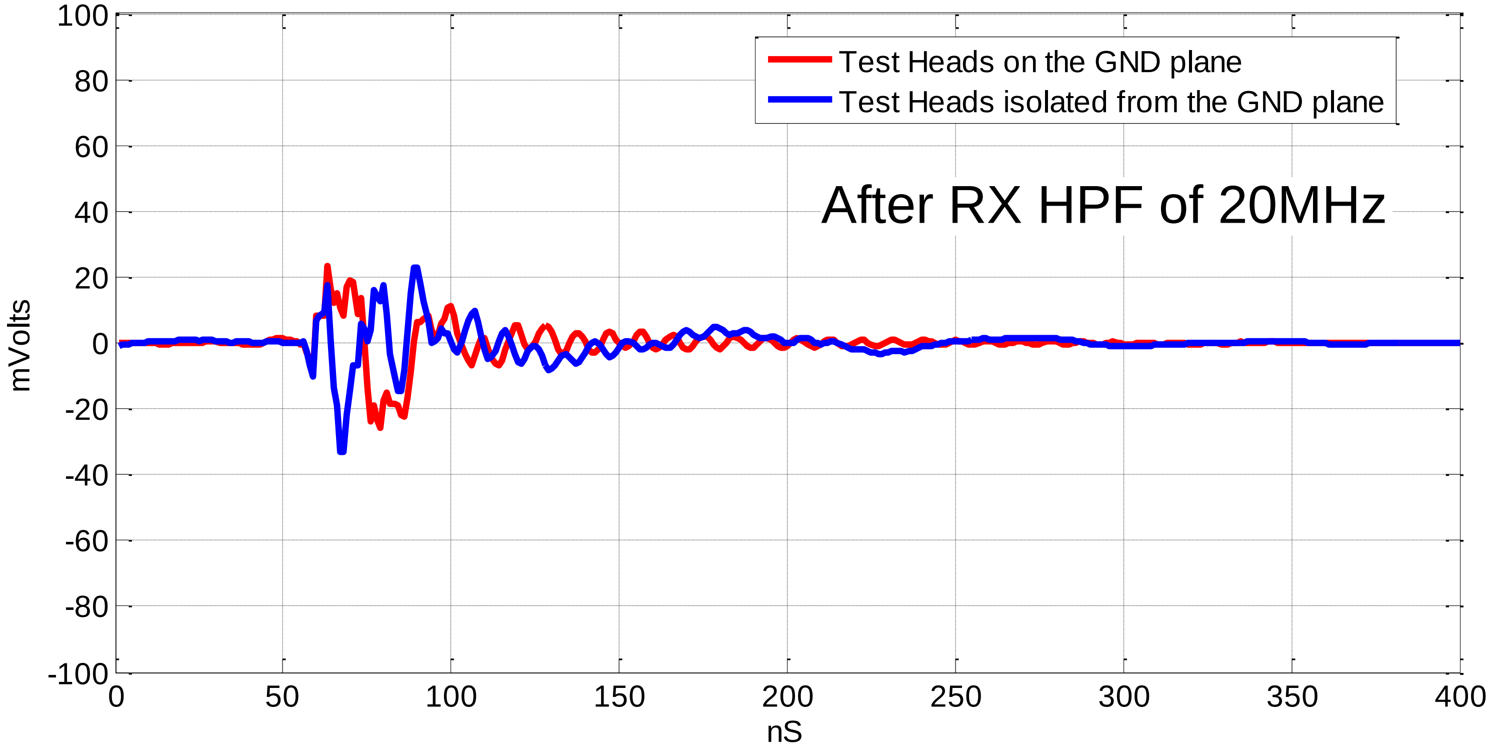


The received noise $n(t)$ is Fourier inverse of $N(f)$ where

$$N(f) = \sqrt{2}\, P(f)\, Sds21(f)\, H(f)$$

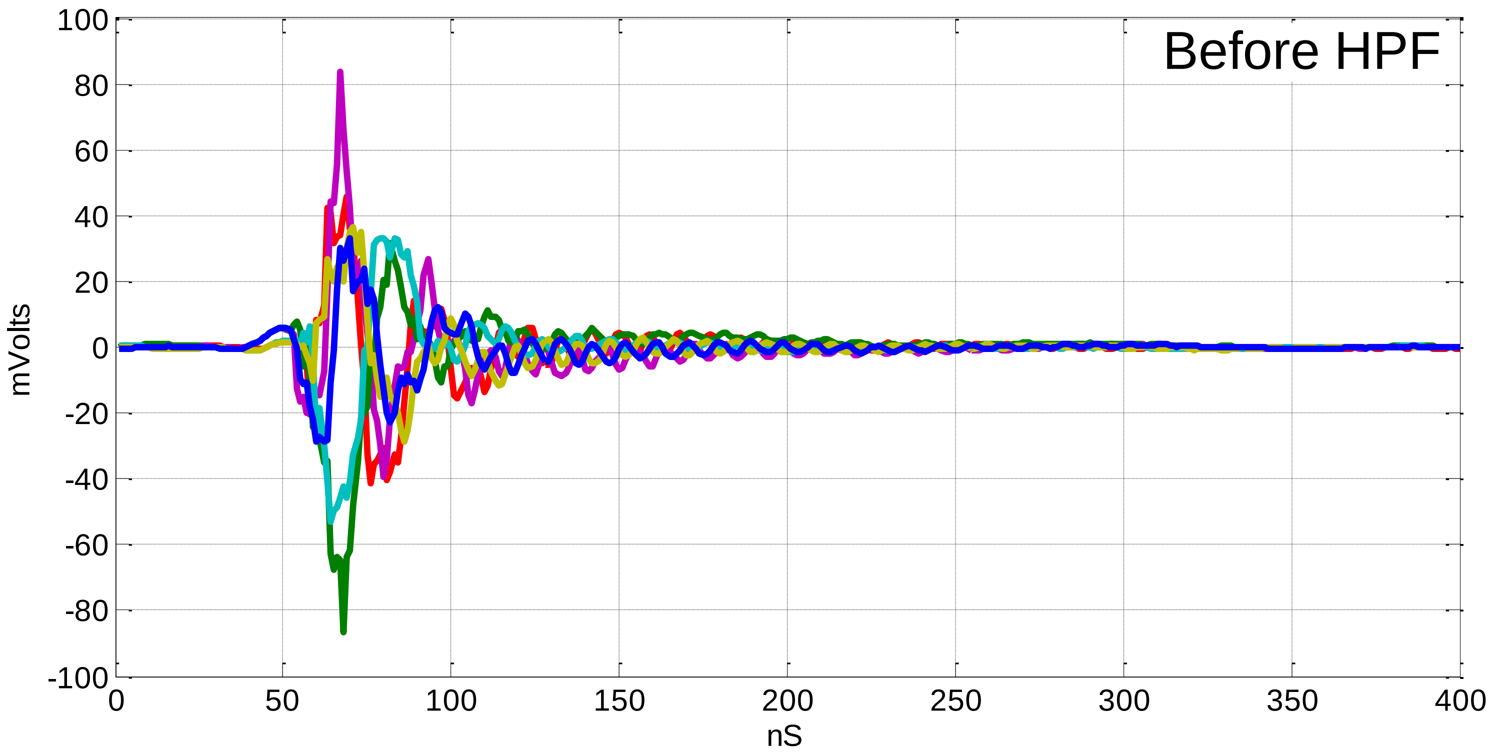
and $P(f)$ is frequency response of the injected pulse noise
and $Sds21(f)$ is the transient noise transfer function
and $H(f)$ is receiver highpass filter

Test Heads Grounding/Isolating Effect



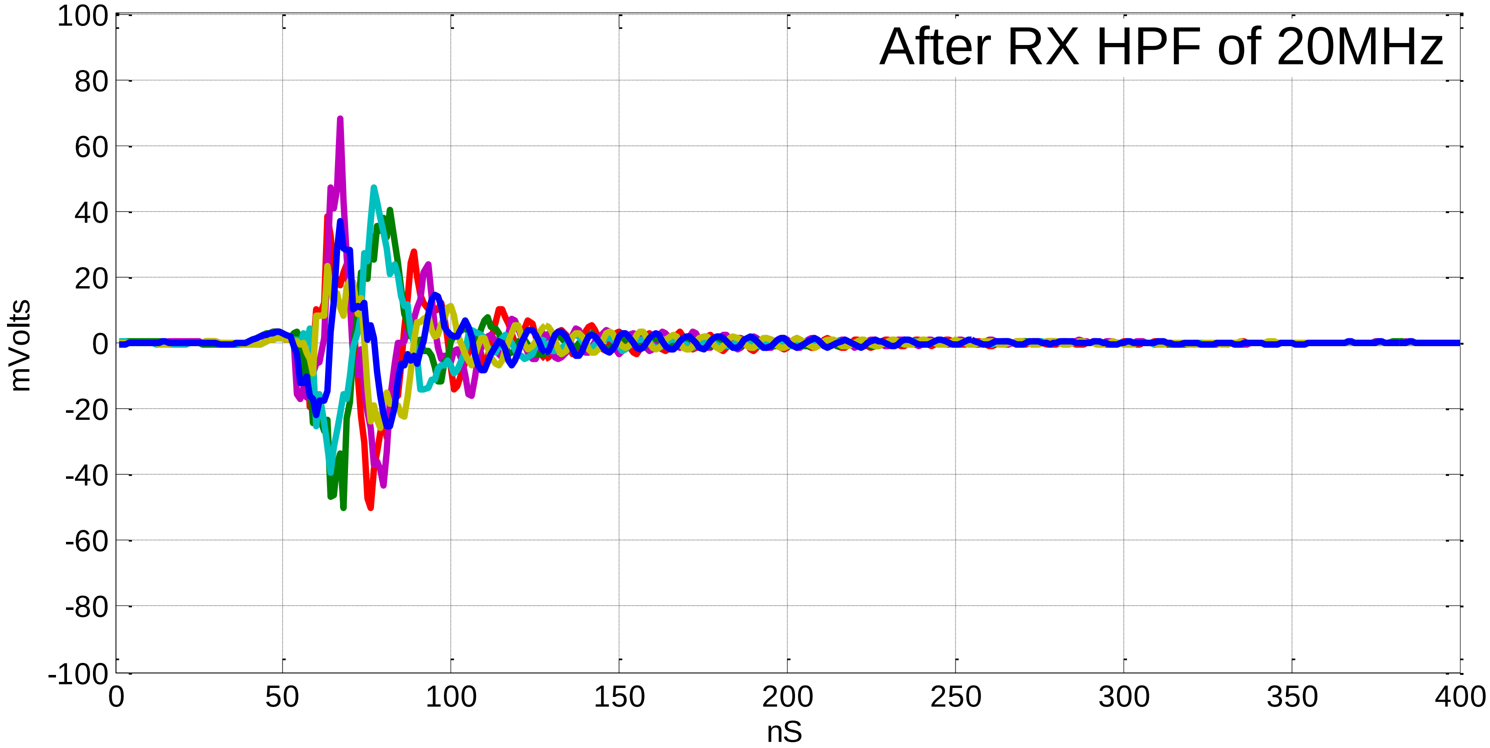
- Grounding/ Isolating the test heads does not affect the noise magnitude or duration significantly.

Simulated DM Transient Noises, Various Cables



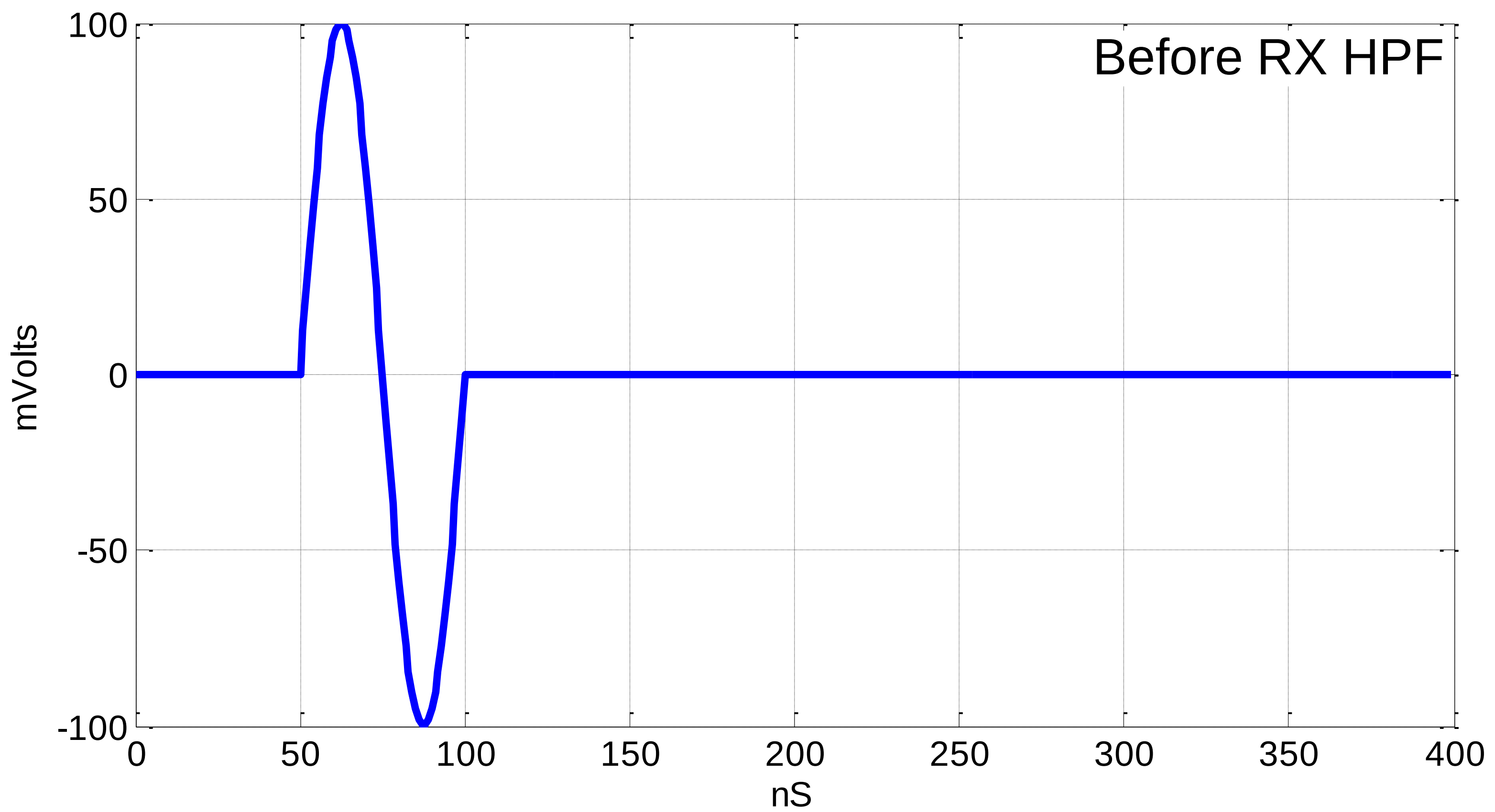
- Cables are from 3 different manufacturers, results shown are collected at both ends of coupler. Test heads are grounded.
- At the receiver and before HPF, the noise intensity is below 100mV and noise duration is less than 50nS.

Simulated DM Transient Noises, Various Cables



- Cables are from 3 different manufacturers, results shown are collected at both ends of coupler. Test heads are grounded.
- Note that intensity of transient noise pulses are reduced using the HPF at the receiver.

Transient Noise Model at Receiver



- One cycle of a 20MHz sinusoidal signal with magnitude of 100mV is suggested for system analysis of transient noises.

Summary

- **Suggested a method for estimation of DM transient noises based on ISO 7637-3**
  - Used a transient noise coupler and VNA to measure transfer function.
  - Used simulated pulse noises and mathematical calculation to estimate noise at the receiver.
  - Provided results for multiple cables from various manufacturers.

- **Grounding Effects for the Test Heads**
  - Comparing noise results for grounded and floating test heads, show no significant change in magnitude or duration of noise.

- **Transient Noise Model**
  - One cycle of a 20MHz sinusoidal signal with magnitude of 100mV is suggested for system analysis of transient noises. Effect of receiver HPF on the noise pulses should be considered in analysis.