1000BASE-T1

Slow Transient Noise Analysis based on ISO 7637-3

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Foreword

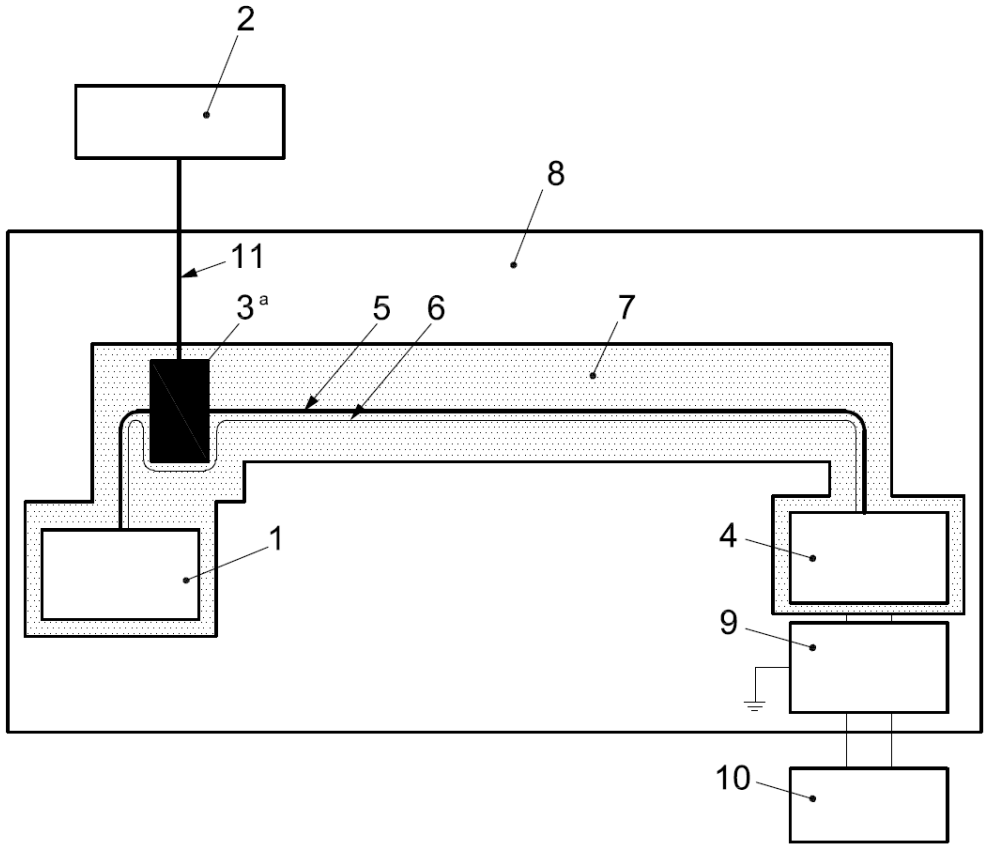
- ISO 7637-3 specifies transient noise tests on signal lines for road vehicles.
- The specification recommends cable harness of 2m and an inductive coupling clamp for slow transient noise tests.
- The differential noise induced on the 1000BASE-T1 receiver is estimated for single pair UTP cables using the suggested slow transient noise coupler and simulated noise pulses.

Test Setup per ISO 7637-3

Key

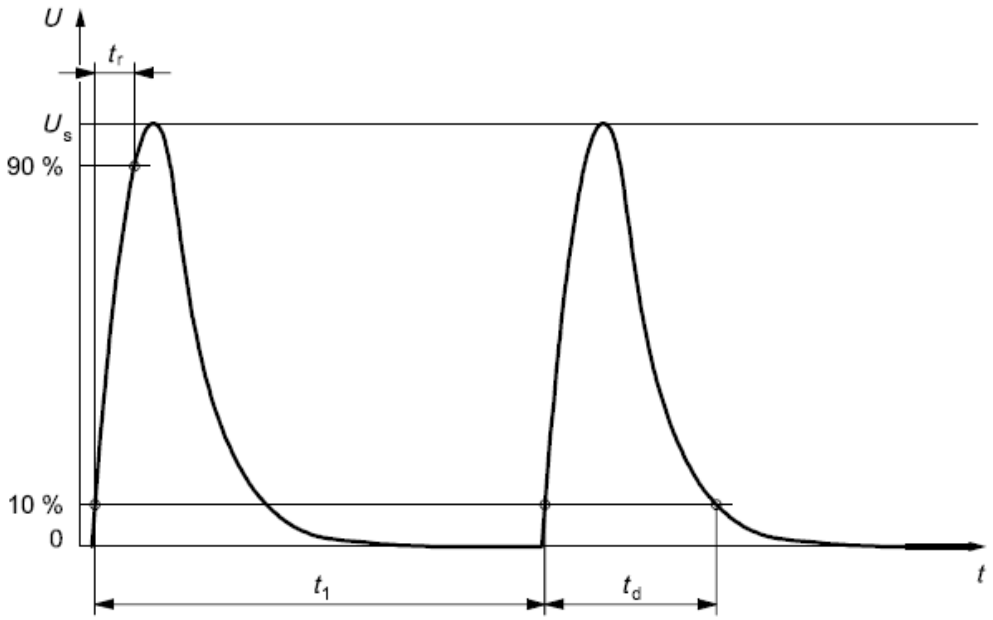
1 DUT
2 test pulse generator
3 ICC
4 peripheral
5 test harness (length ⩽ 2 m)
6 ground line
7 insulation [(50 ± 10) mm]
8 ground plane
9 battery
10 d.c. power supply
11 50 Ω coaxial cable (⩽ 0,5 m)

a The ICC is placed 150 mm from the DUT.



ICC is an Inductive Coupling Clamp

Positive Test Pulses per ISO 7637-3



Key

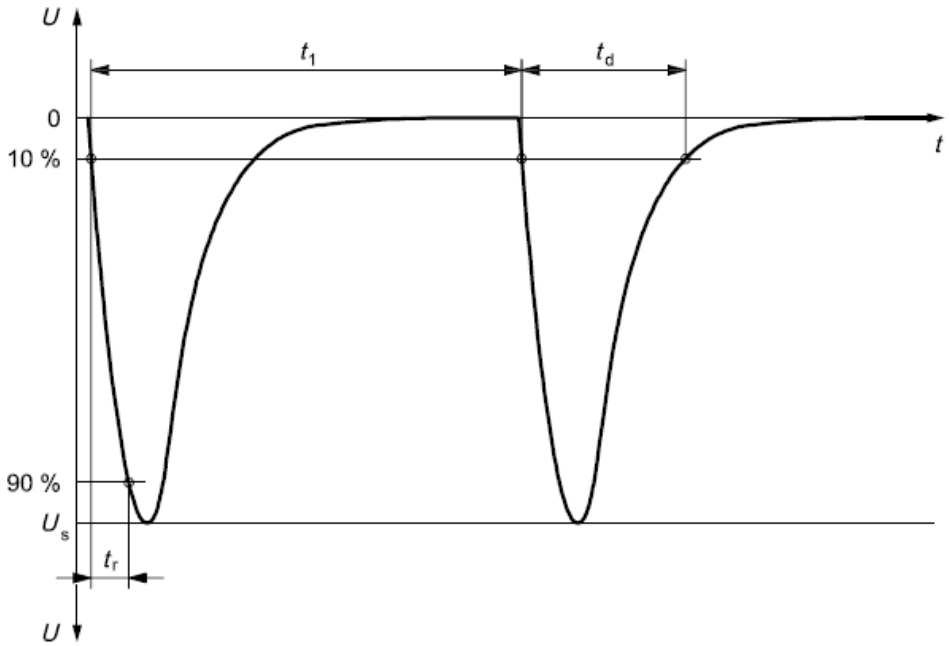
t time

U tension, in volts

Parameters	
U_s	To be defined in test plan
t_r	⩽1 µs
t_d	0,05 ms
t_1	0,5 s to 5 s
R_i	2 Ω

Figure 9 — Slow transient test pulse — Positive

Negative Test Pulses per ISO 7637-3



Key

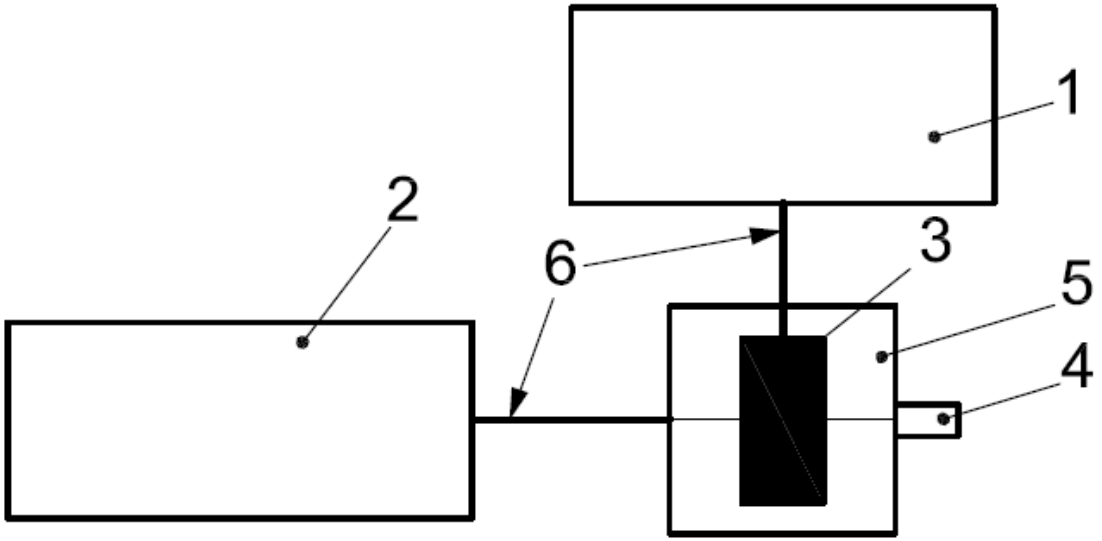
t time

U tension, in volts

Parameters	
U_s	To be defined in test plan
t_r	⩽1 µs
t_d	0,05 ms
t_1	0,5 s to 5 s
R_i	2 Ω

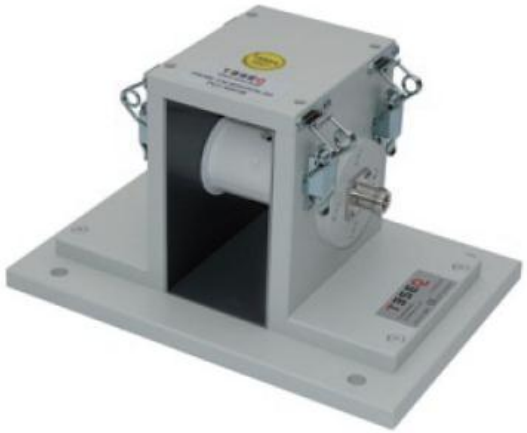
Figure 10 — Slow transient test pulse — Negative

Test Calibration per ISO 7637-3

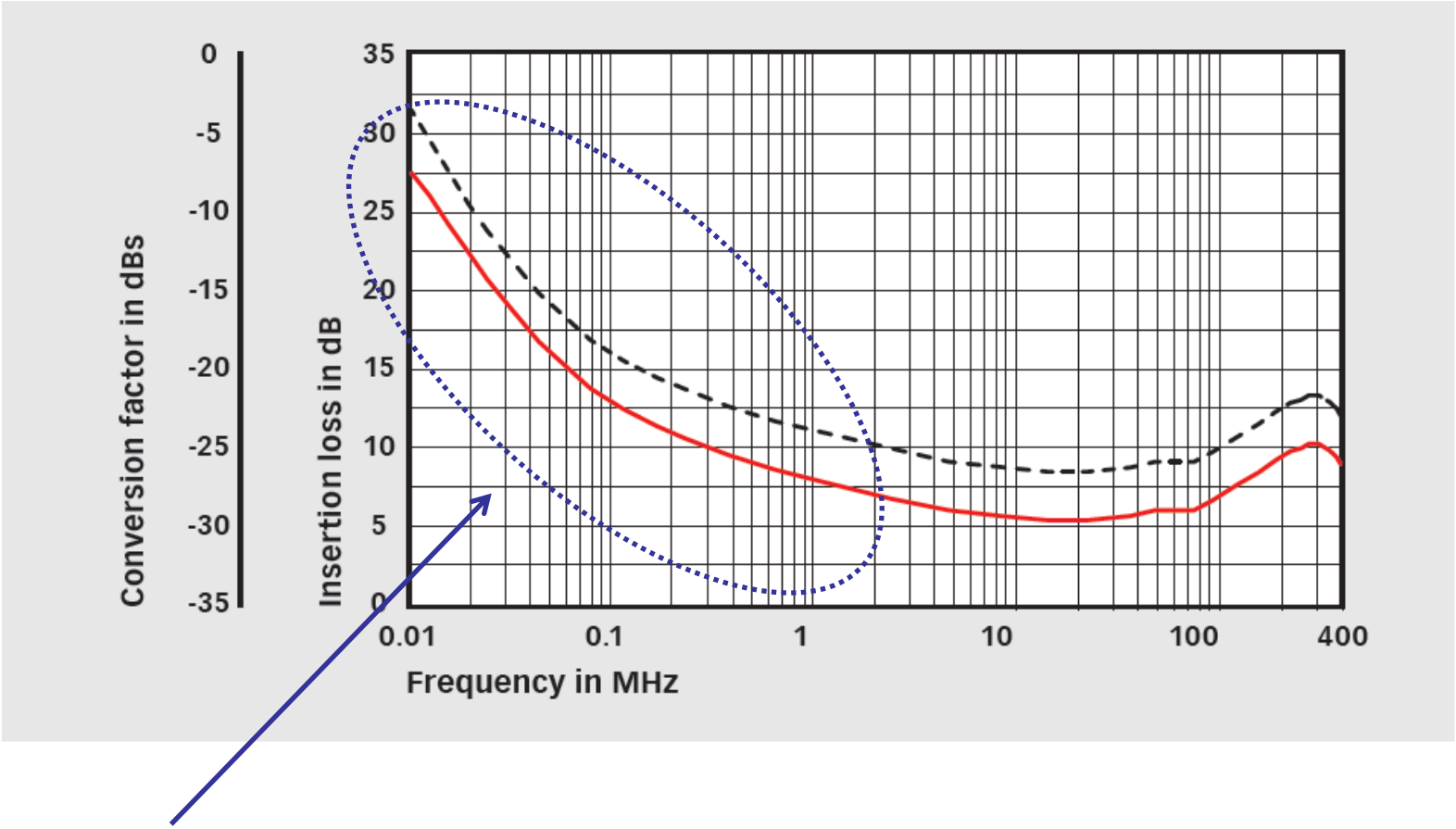


Key

1 test pulse generator
2 oscilloscope (1 MΩ input)
3 ICC
4 short circuit
5 calibration fixture
6 50 Ω coaxial cable



CIP9136A Insertion Loss from TESEQ data sheet



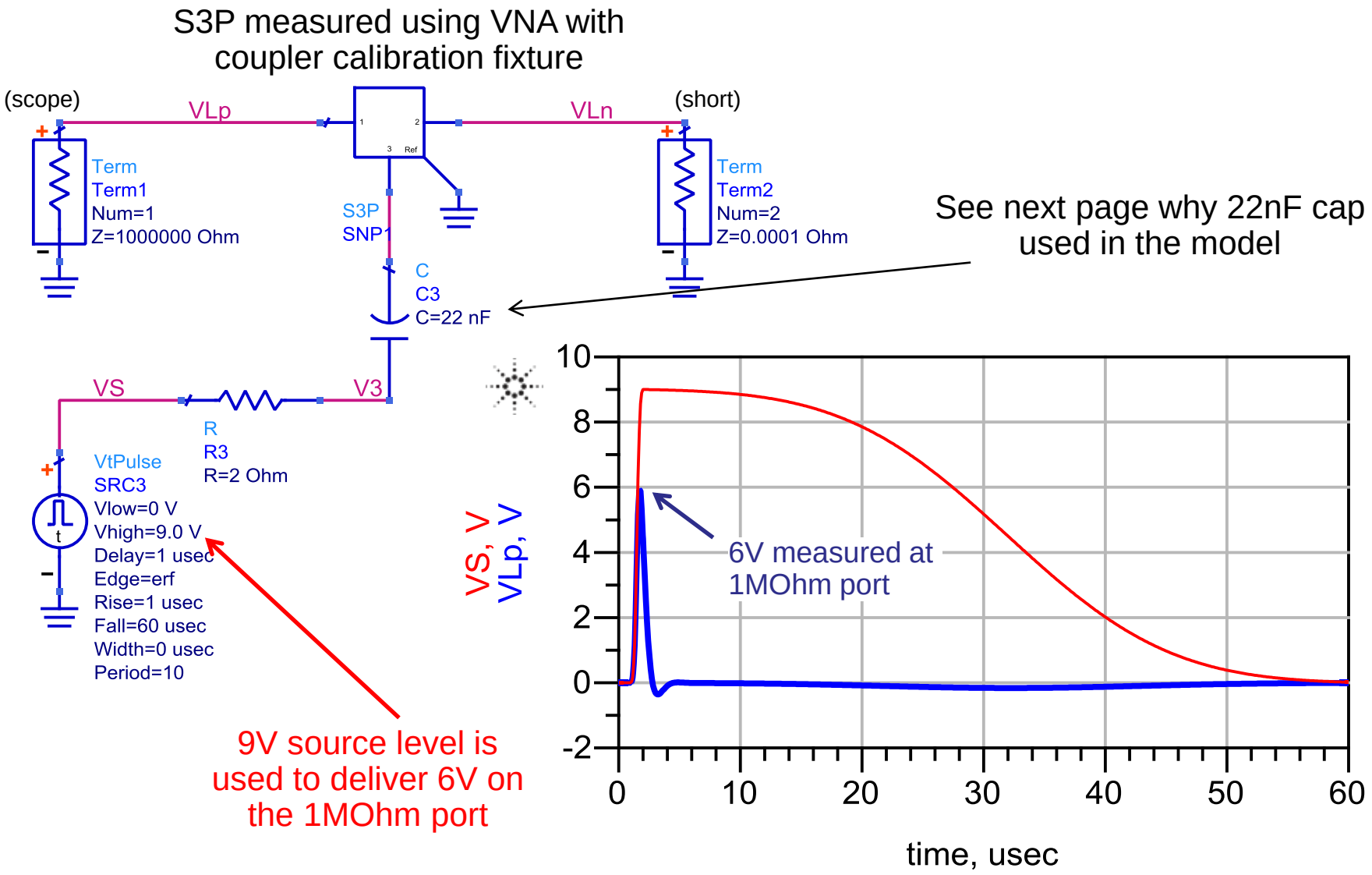
- Notice the lower band coupling of the test clamp shapes slow transient noise seen by DUT. The 3dB high pass corner of the clamp is however much lower than the expected HPF corner of the receiver.

Test levels used for ADS simulation

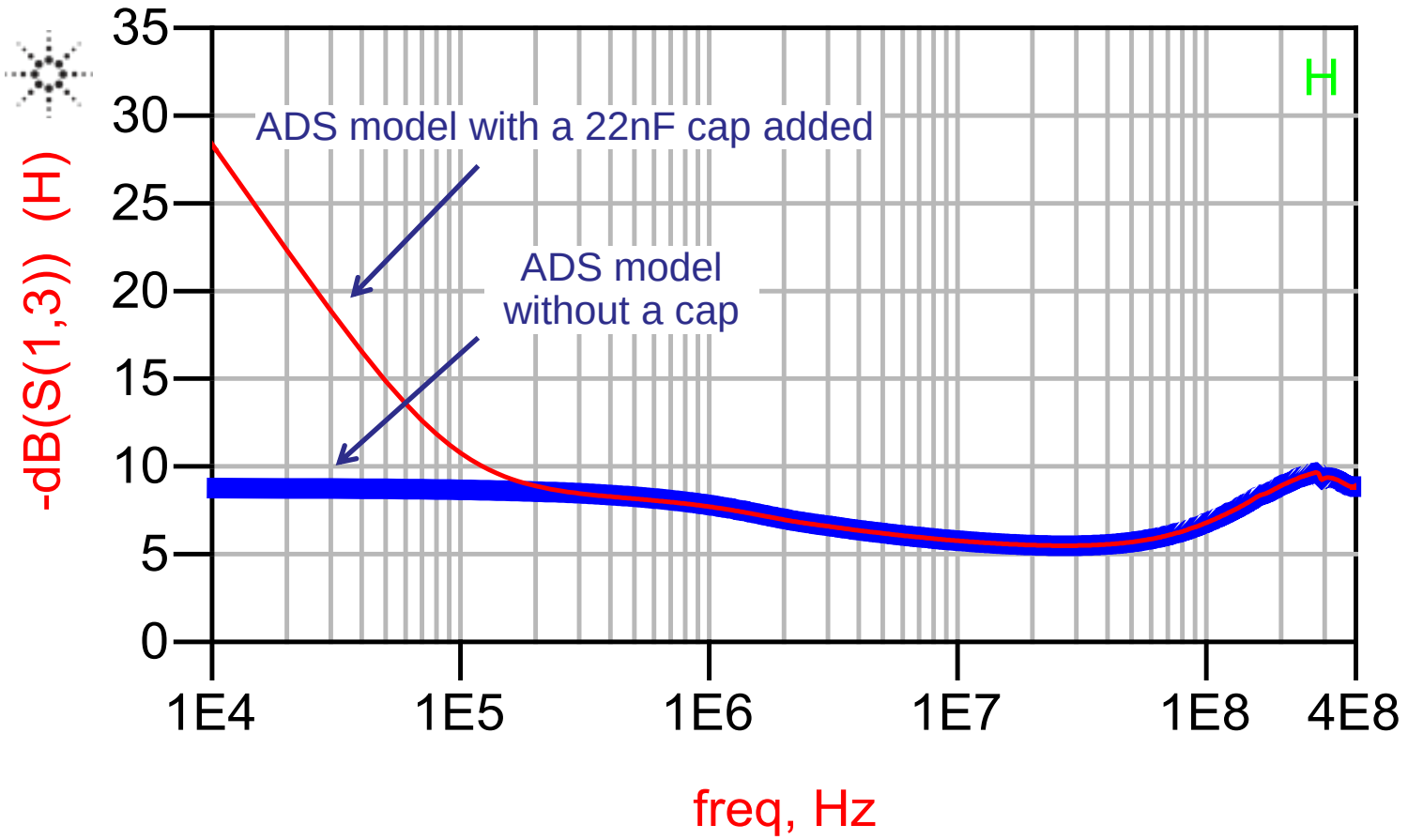
Pulse	tr rise time	td pulse duration (10%)	t1 pulse distance	Ri (ohms) source resistance
slow+	<1µs	0,05ms	0,5s	~2
slow-	<1µs	0,05ms	0,5s	~2

Pulse	Coupling Method	Test Level [V]
slow+	ICC	+6
slow-	ICC	-6

Calibration model in ADS



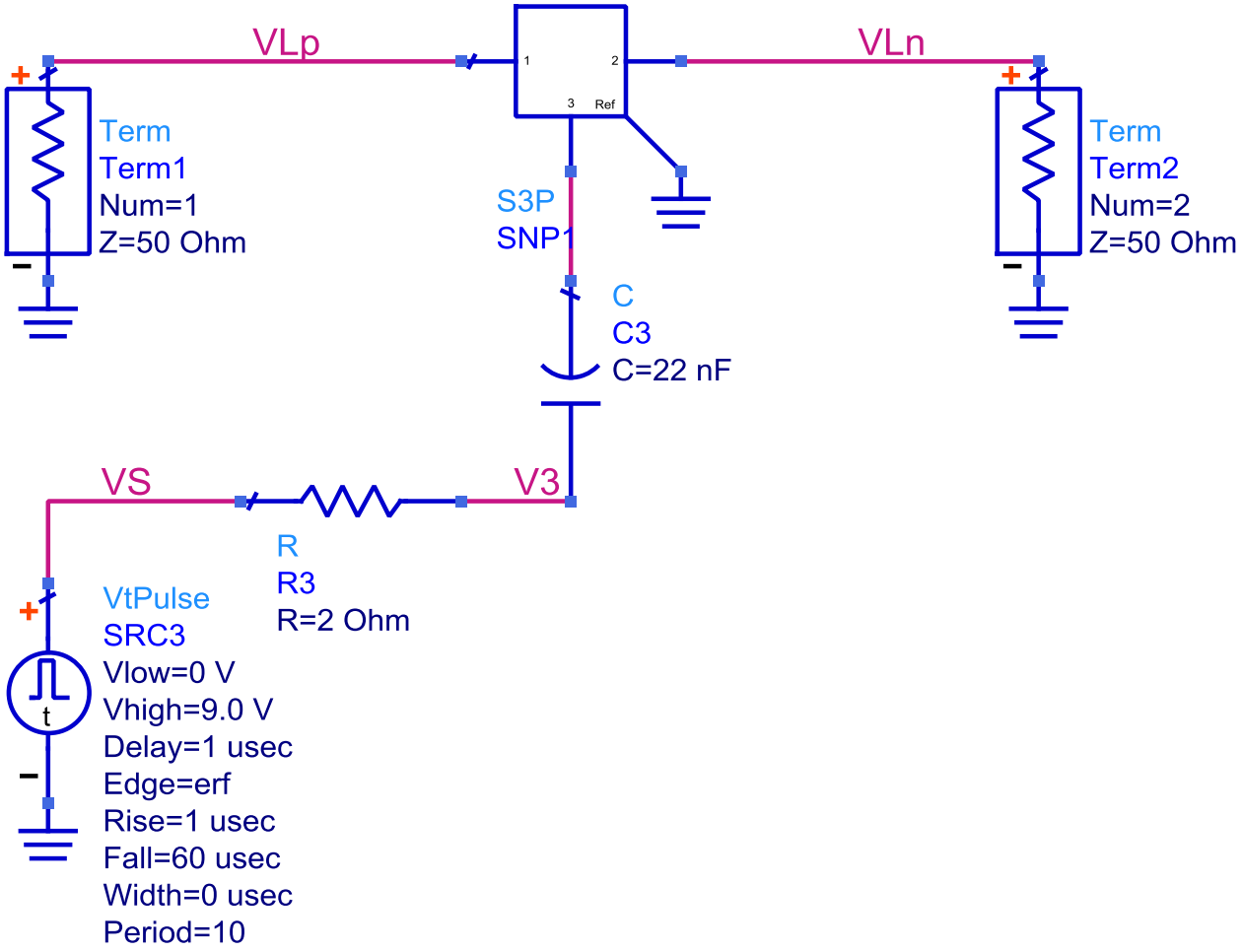
Calibration model in ADS, why adding a cap?



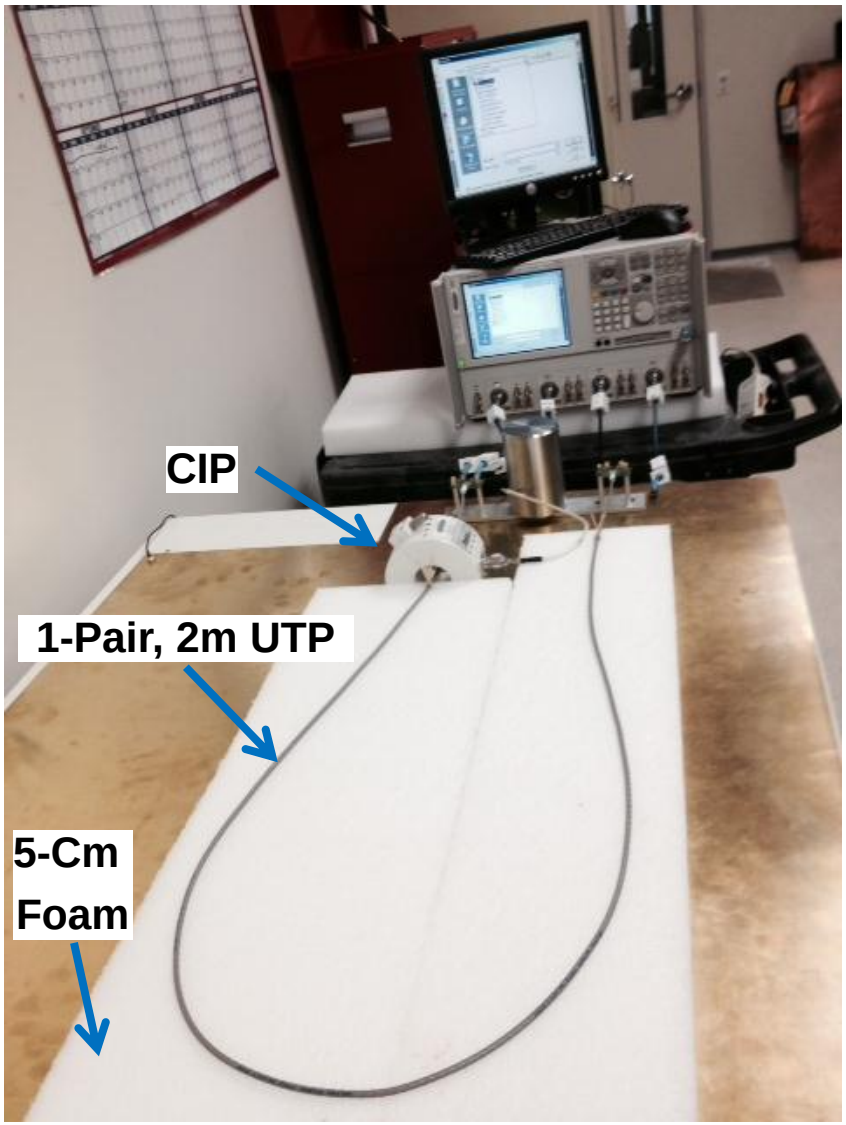
- VNA measurements extrapolated to lower frequencies. A 22nF cap was added to the ADS model to correct for lower frequency performance missing in VNA measurement to match clamp data sheet.

Slow Transient test model in ADS

S3P measured using VNA with set up shown in the next page

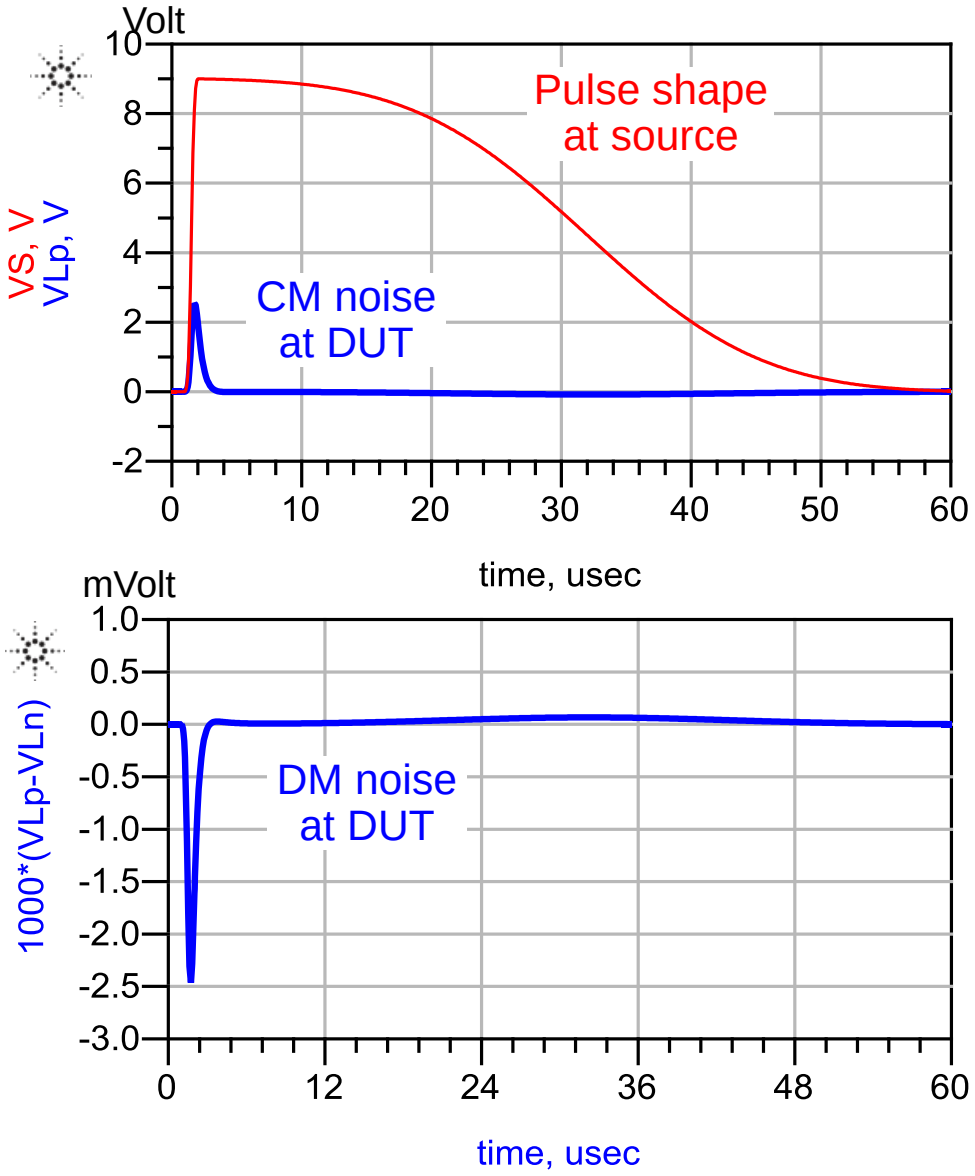


Transfer function measurement with BCI clamp



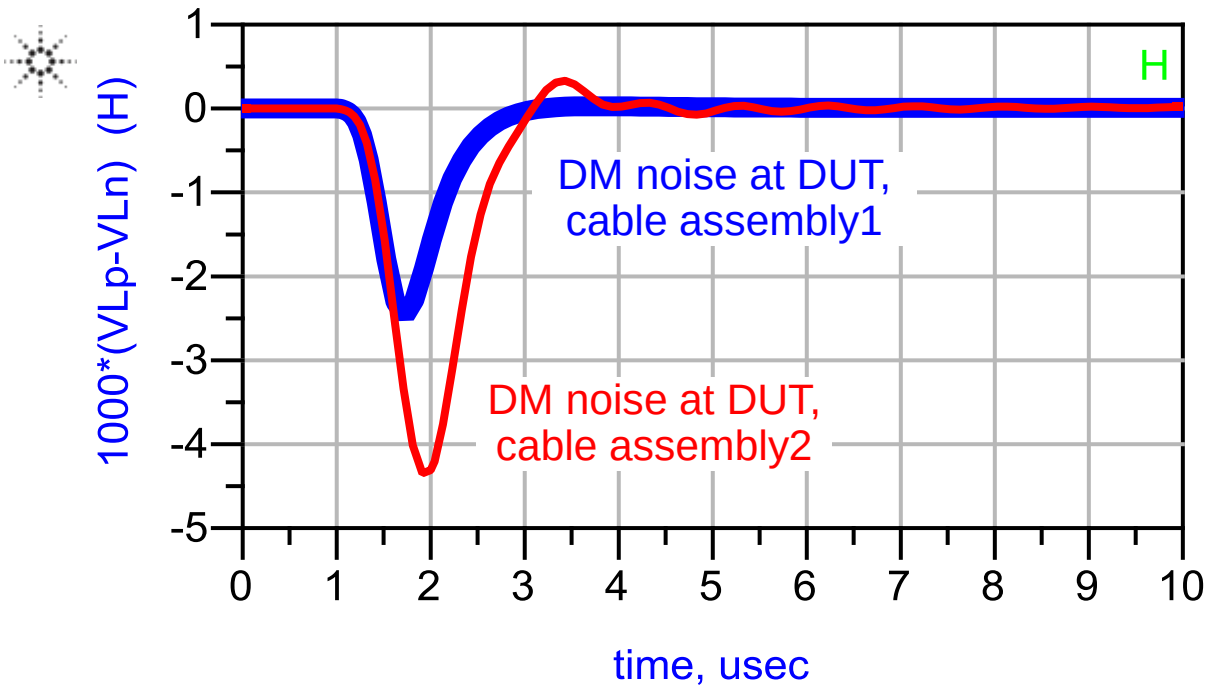
- VNA measured S3P for slow transient transfer function.
- BCI Clamp [TESEQ CIP9136A] was used to couple slow transient noise.
- When measuring 3-port S parameters (2 cable ports and one clamp port), the other side of the cable was terminated with 50Ω load (100Ω differential).
- Test heads had optional grounding stands.

Example simulation results for slow transient noise test



- The analysis is for DM noise converted in the cable alone (not considering for CMC mode conversion).
- The noise pulse seen at DUT is narrower than the injected noise because of clamp high pass behavior.
- The DM noise seen at DUT will be further reduced once going through receiver HPF.

DM noise for multiple cables and multiple set-ups



- With grounded test heads used in VNA measurements, the DM noise seen at DUT is below 10mV tested with various cable assemblies and test heads (only two are shown here).

- When test heads floating (not connected to GND plane), noise is seen lower in the analysis (not shown here).

Conclusion

- Slow transient noise analysis test was set up according ISO 7637-3 and 3-port transfer function (S3P) was captured using the VNA.
- A 3-port ADS model was generated in order to compute the differential noise at the PHY input.
- The DM noise at the PHY input is expected to be less than 10mV for slow transient noise.
- Slow transient noise estimated based on ISO 7637-3 is not expected to be a significant noise source for 1000BASE-T1.