



HV-com² Stakeholder Workshop

25th April 2023, PTB Braunschweig, Germany

Towards a Traceable Step Calibration of High Voltage Impulse Digitizers

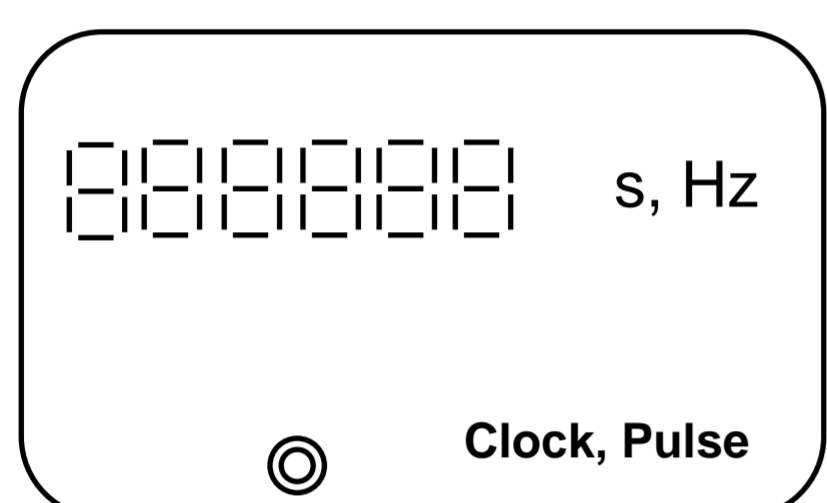
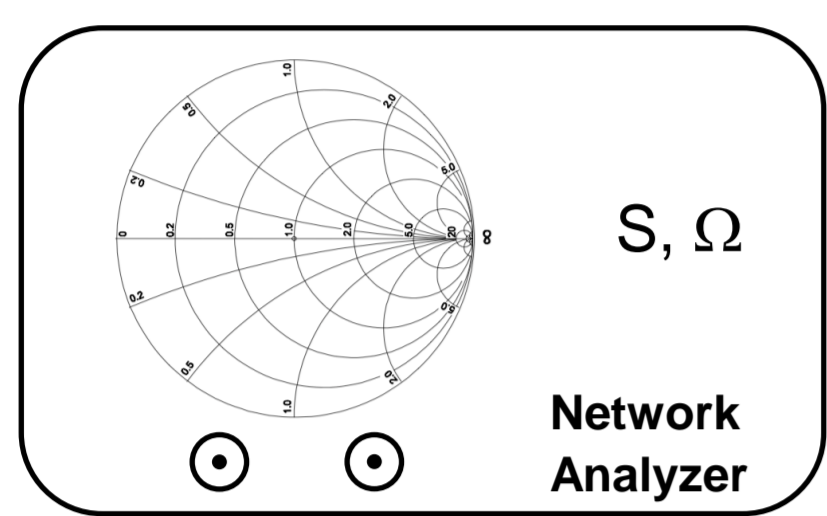
P. Treyer, U. Hammer

ABSTRACT

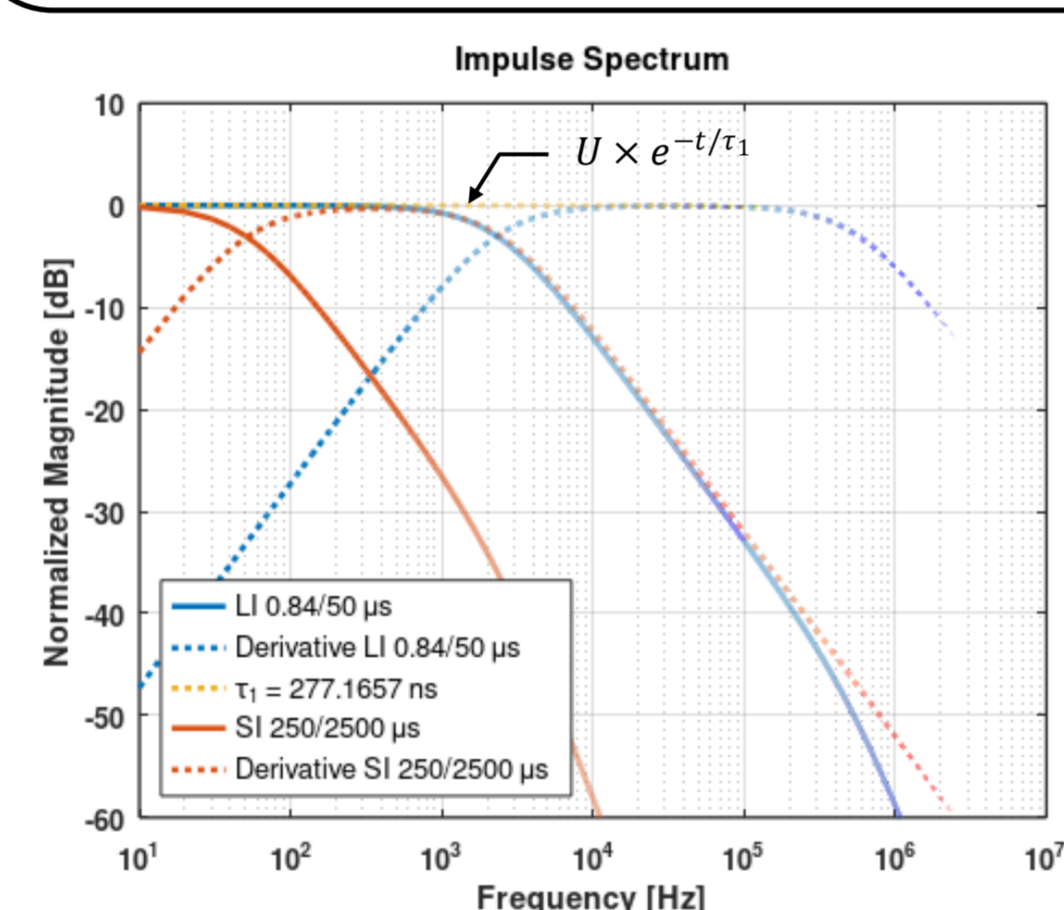
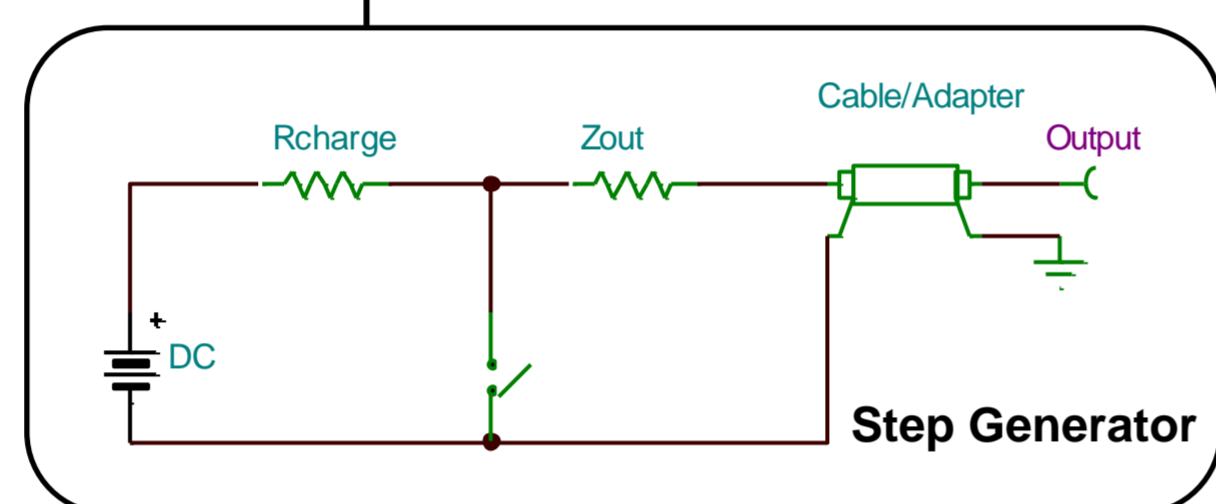
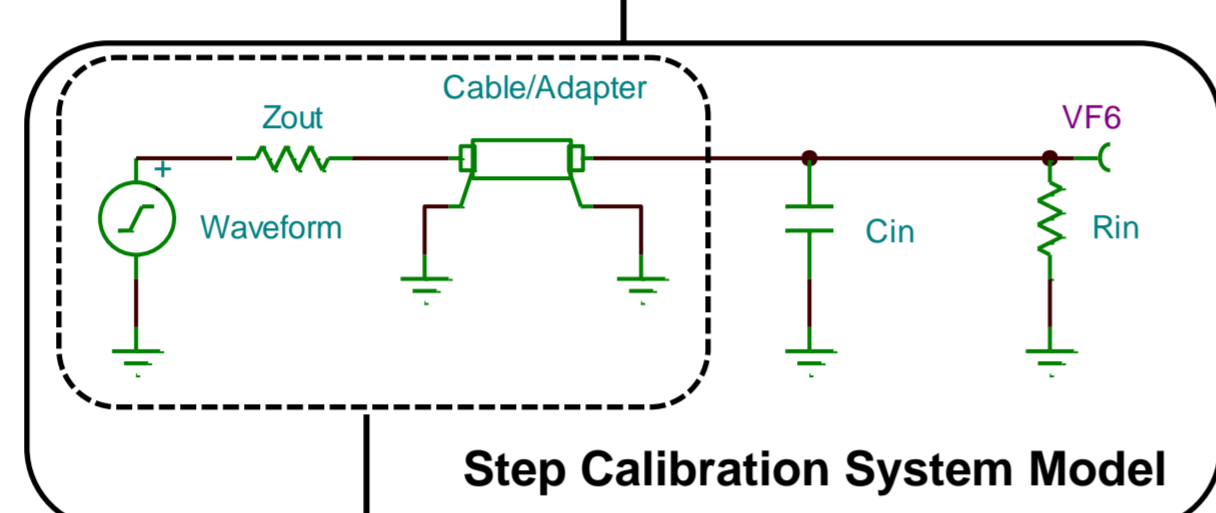
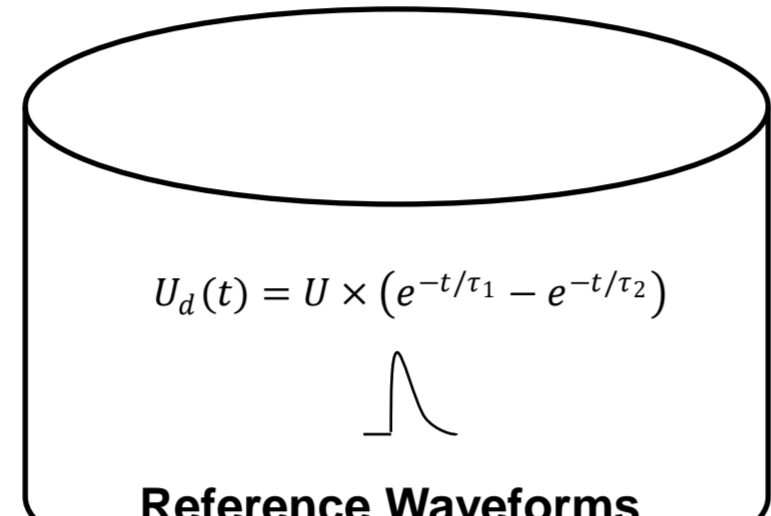
Covering all amplitude levels and polarities of all waveforms required for the calibration of impulse digitizers is very time consuming. A step generator extends to the full bandwidth and input amplitude range of the digitizer and provides the phase information which is missing in continuous wave frequency sweeps. The step response and convolution method enables a fast calibration.

MEASUREMENT ASSURANCE PROGRAM

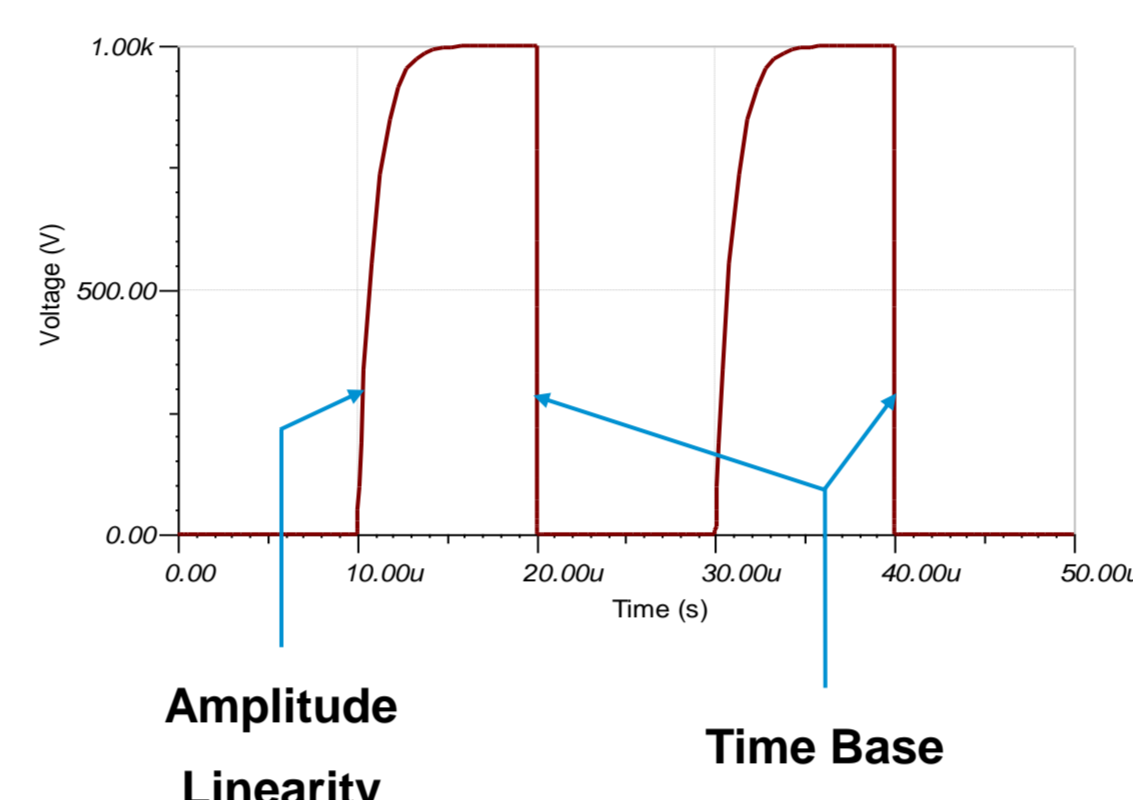
TRANSFER INSTRUMENTS



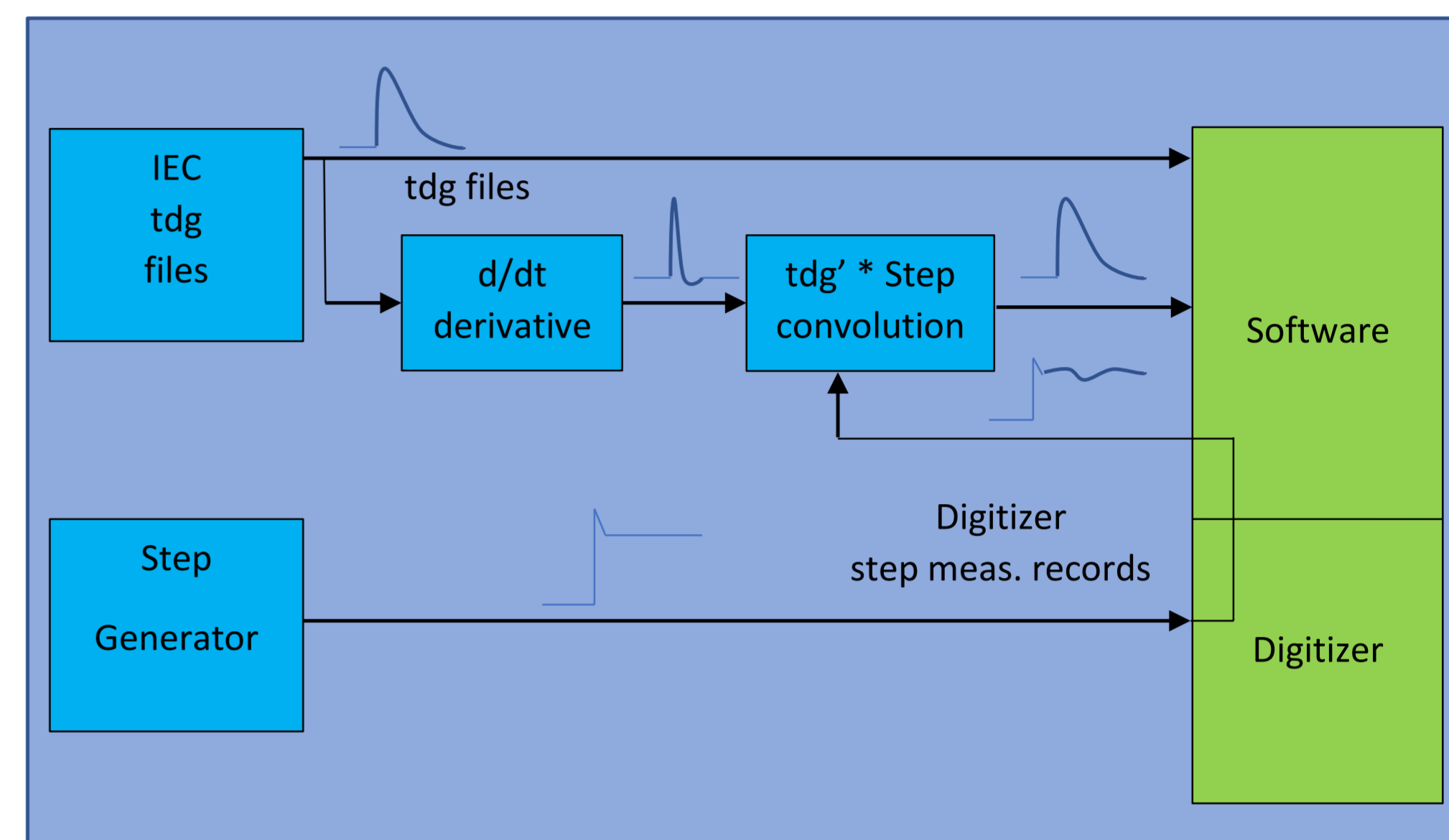
STEP CALIBRATION



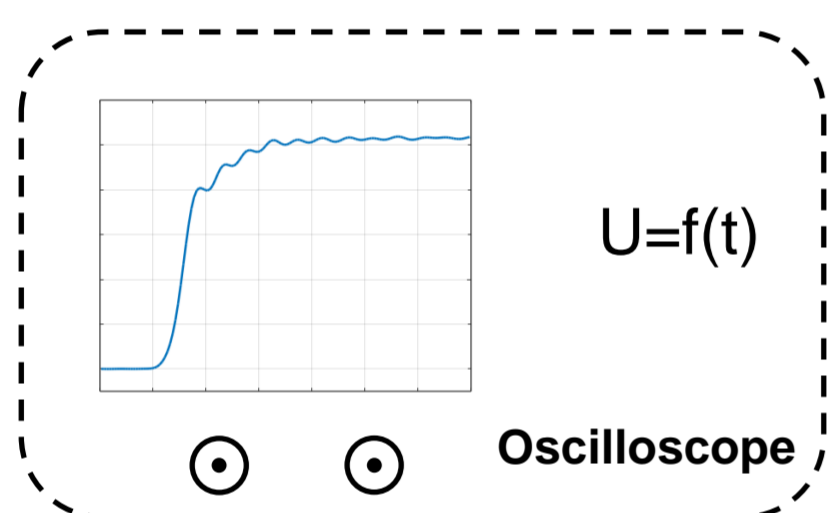
TIME BASE AND AMPLITUDE LINEARITY MODE



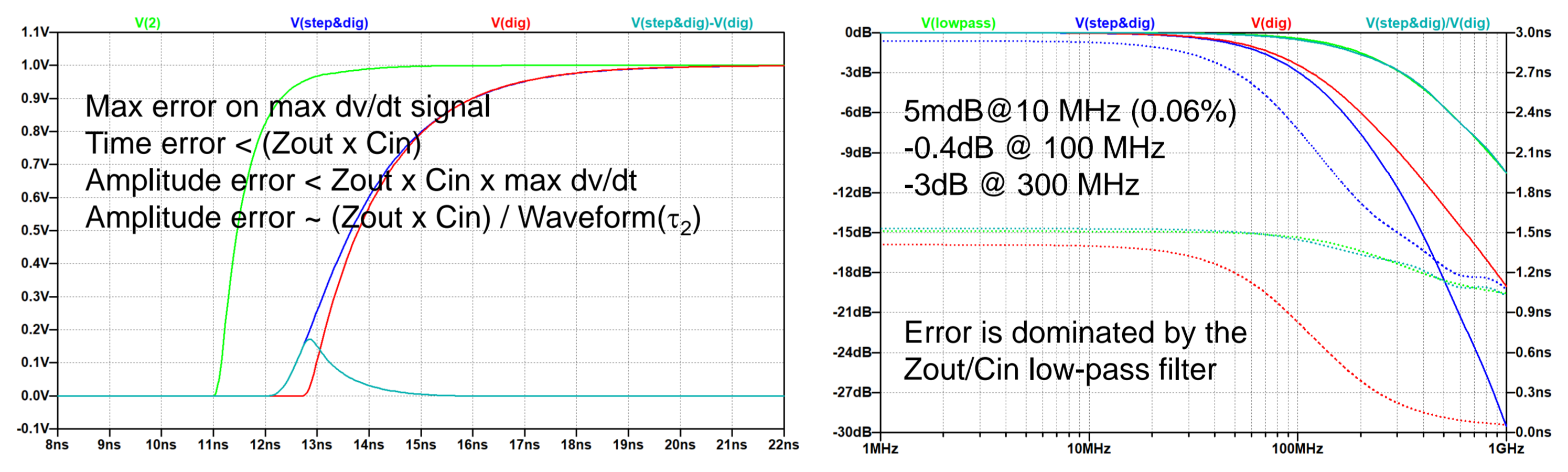
WAVEFORM CALIBRATION OF IMPULSE DIGITIZERS



MODEL SIMULATION AND VERIFICATION

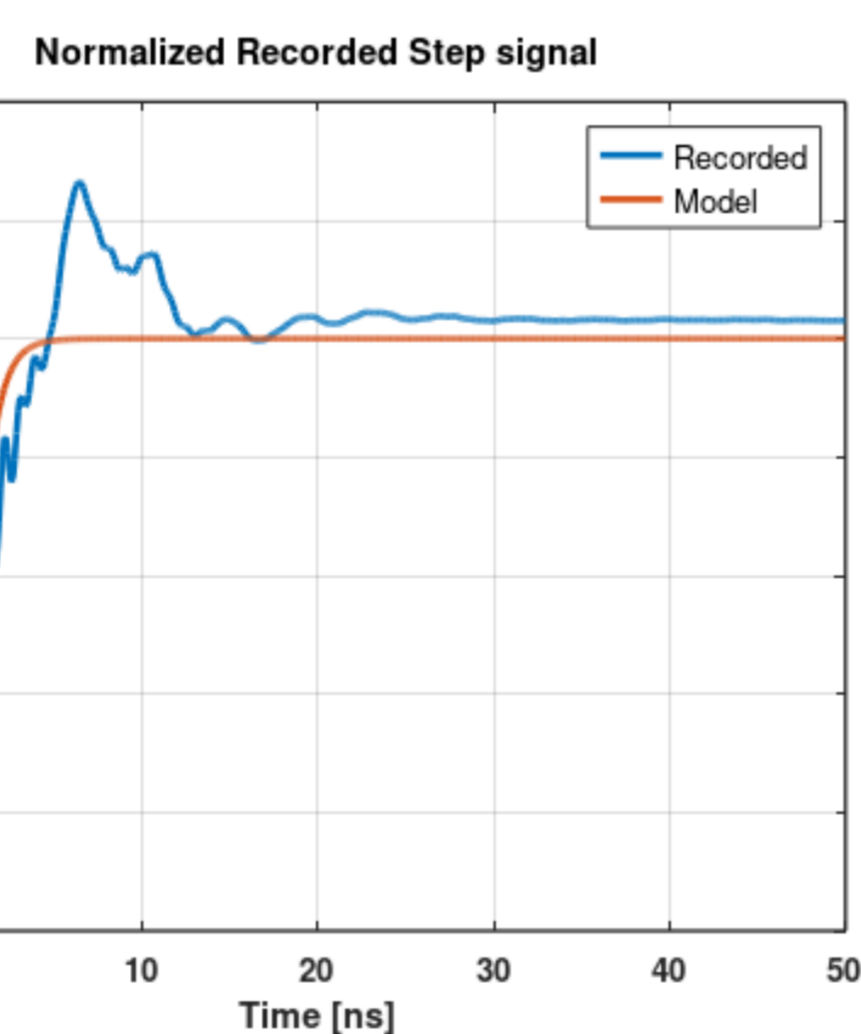
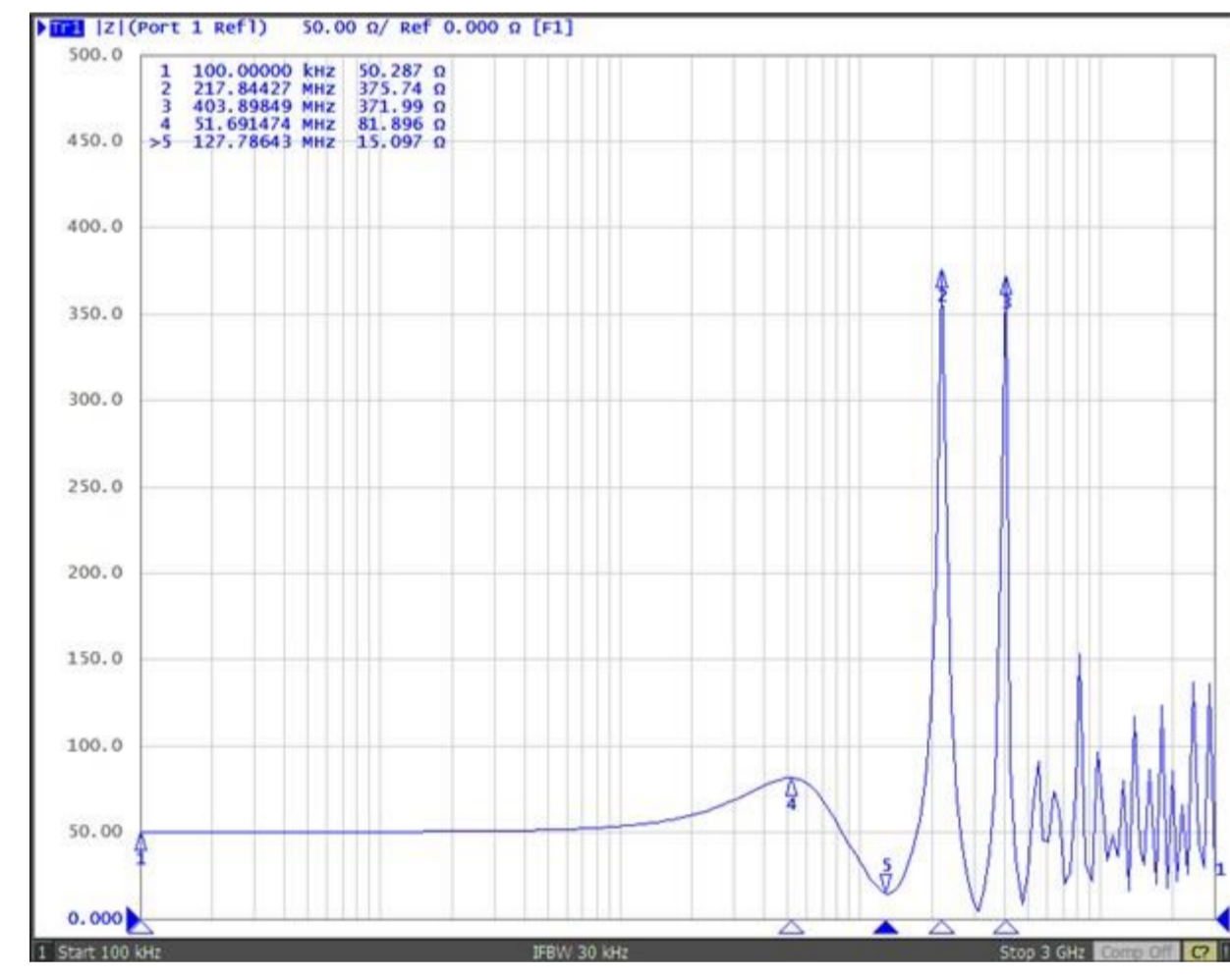


SIMULATED AMPLITUDE, TIME AND GROUP DELAY ERRORS FOR THE SIMPLIFIED CALIBRATION MODEL



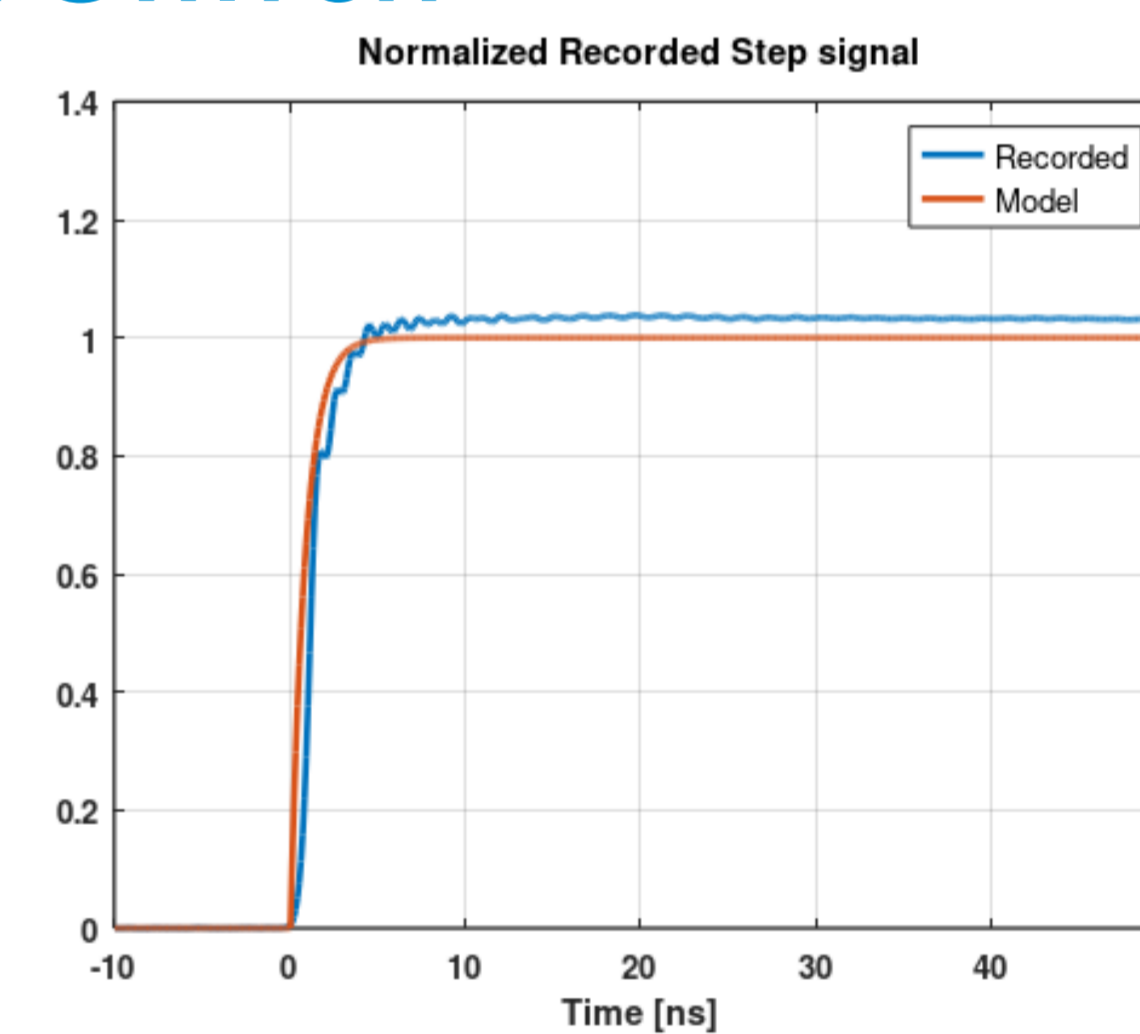
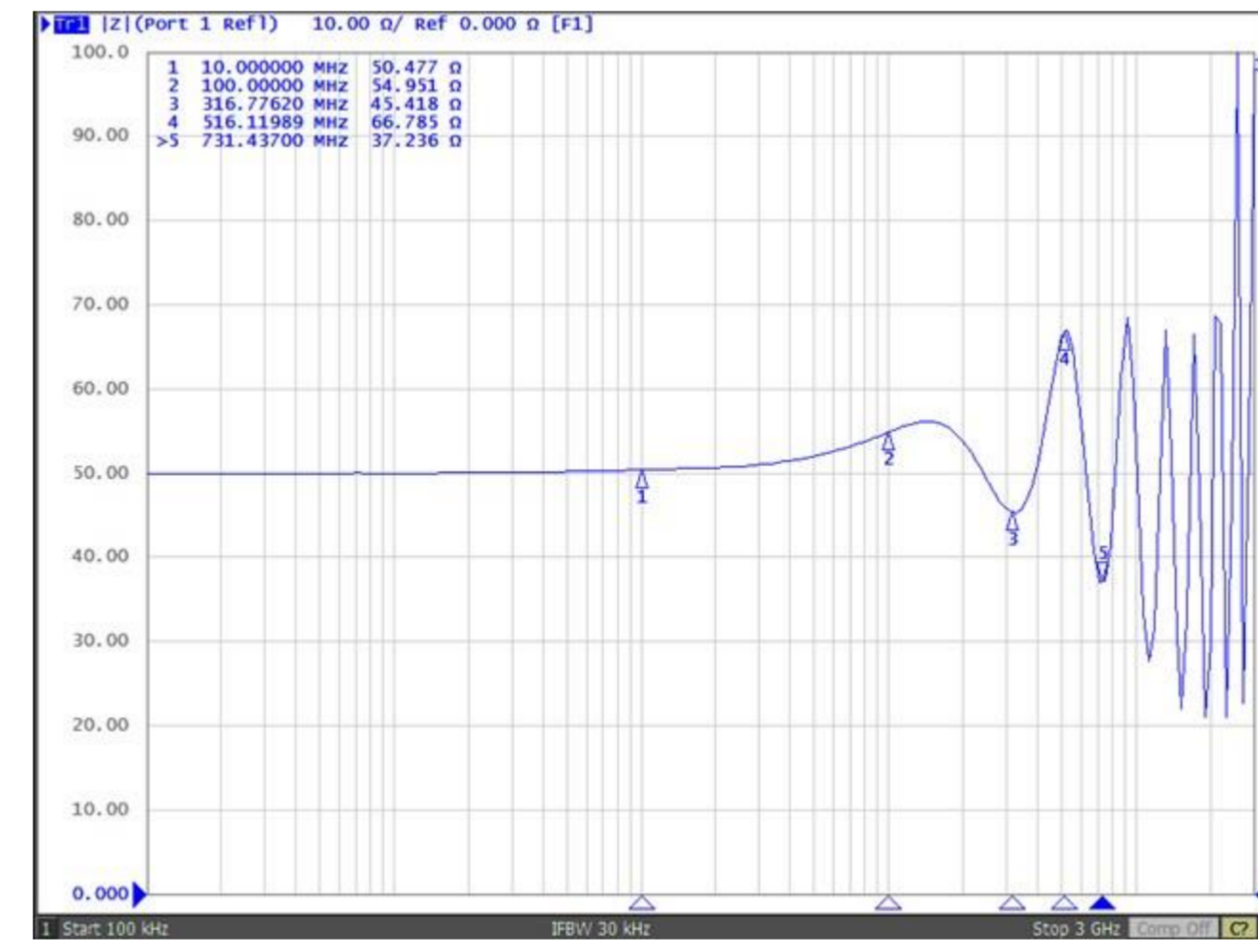
Output Impedance Z_{out}

MERCURY RELAY

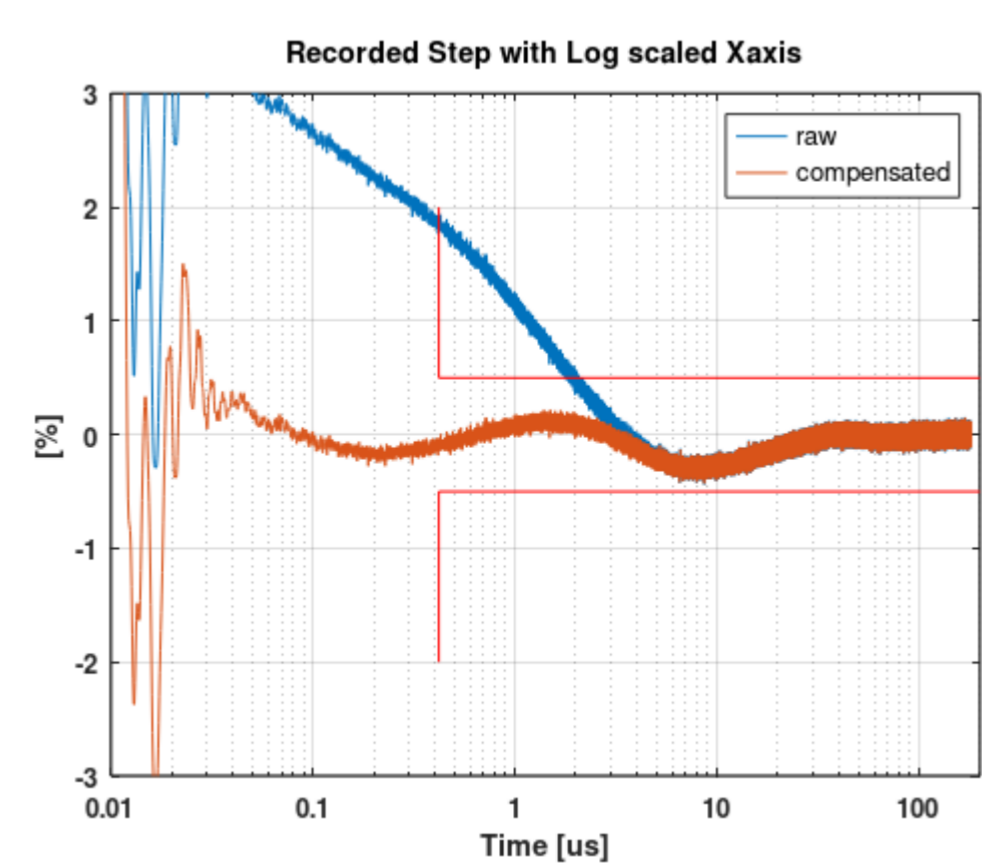
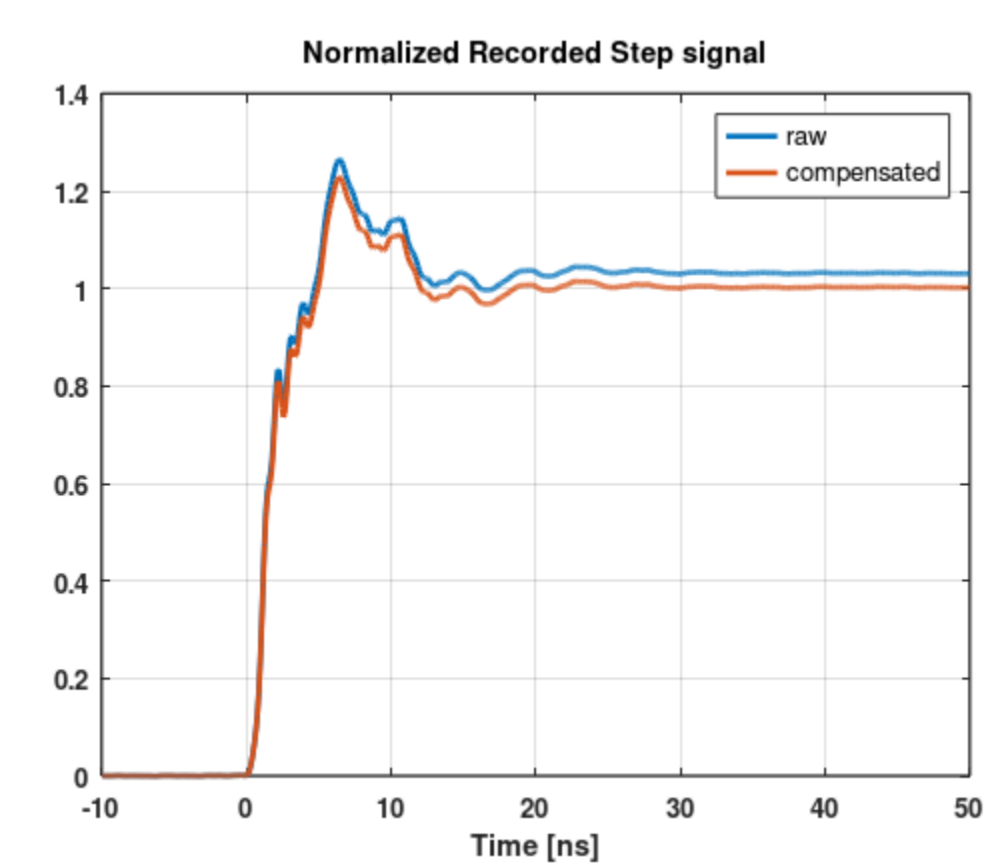
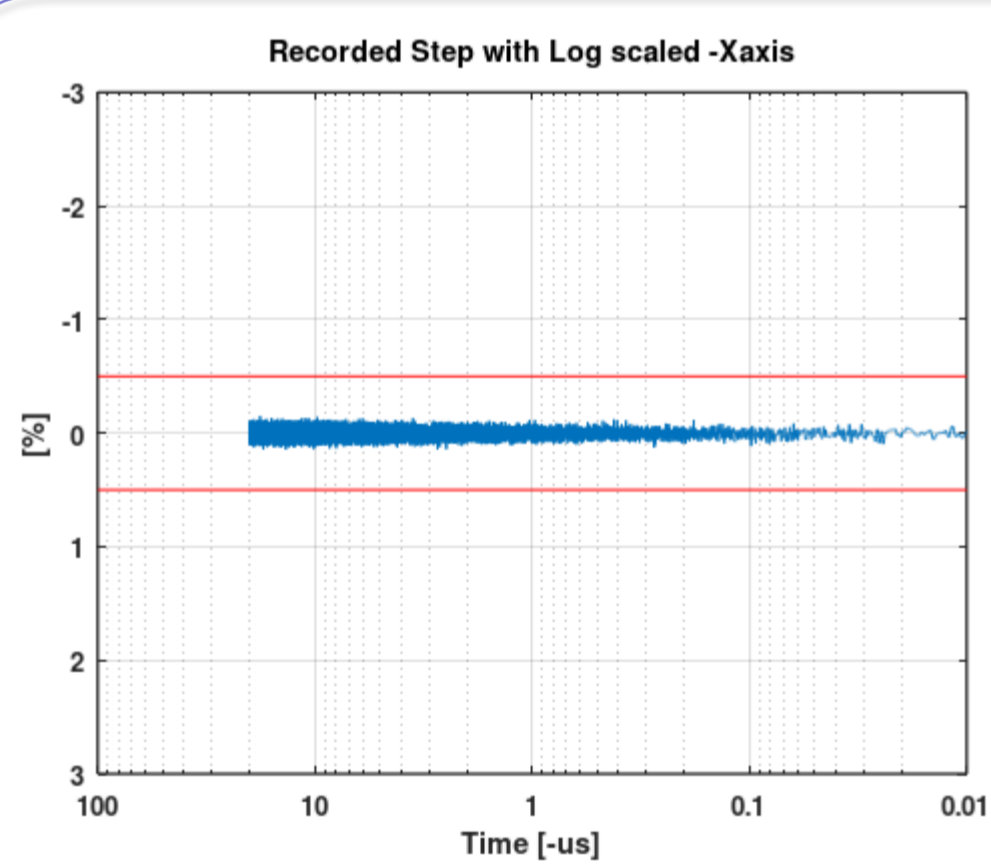


Output Impedance Z_{out}

SOLID-STATE SWITCH



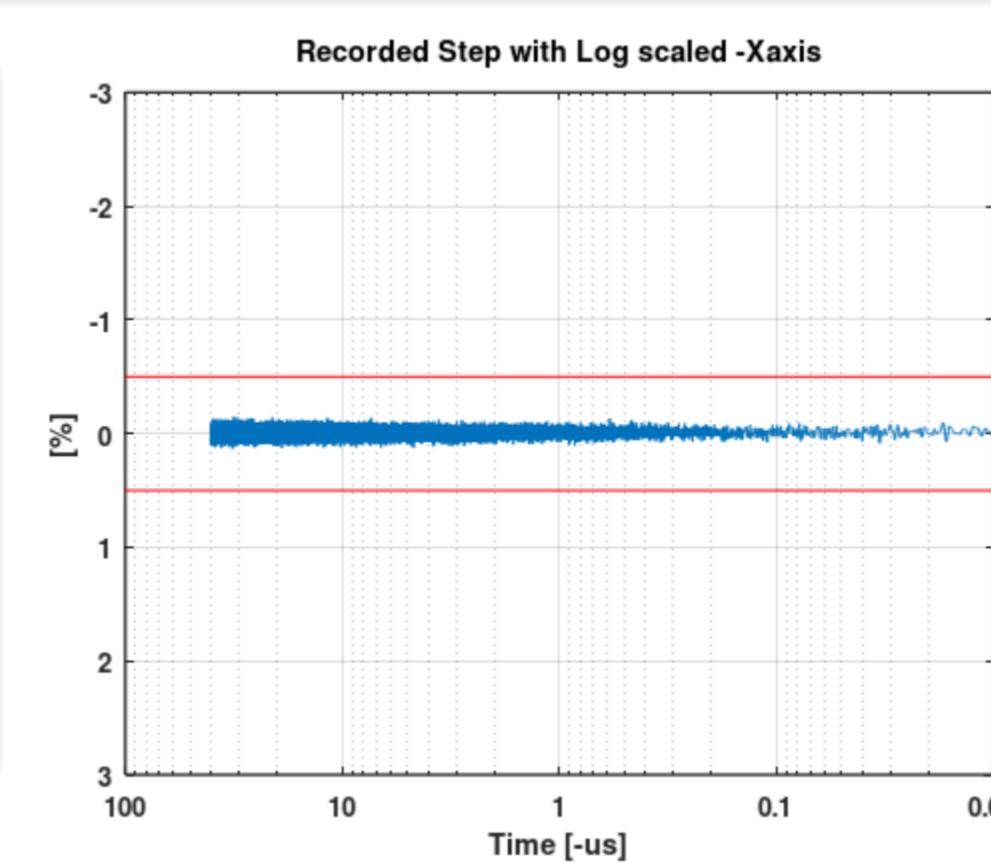
TEST RESULTS STEP & CONVOLUTION



IMPULSE CALIBRATION ↔ STEP & CONVOLUTION

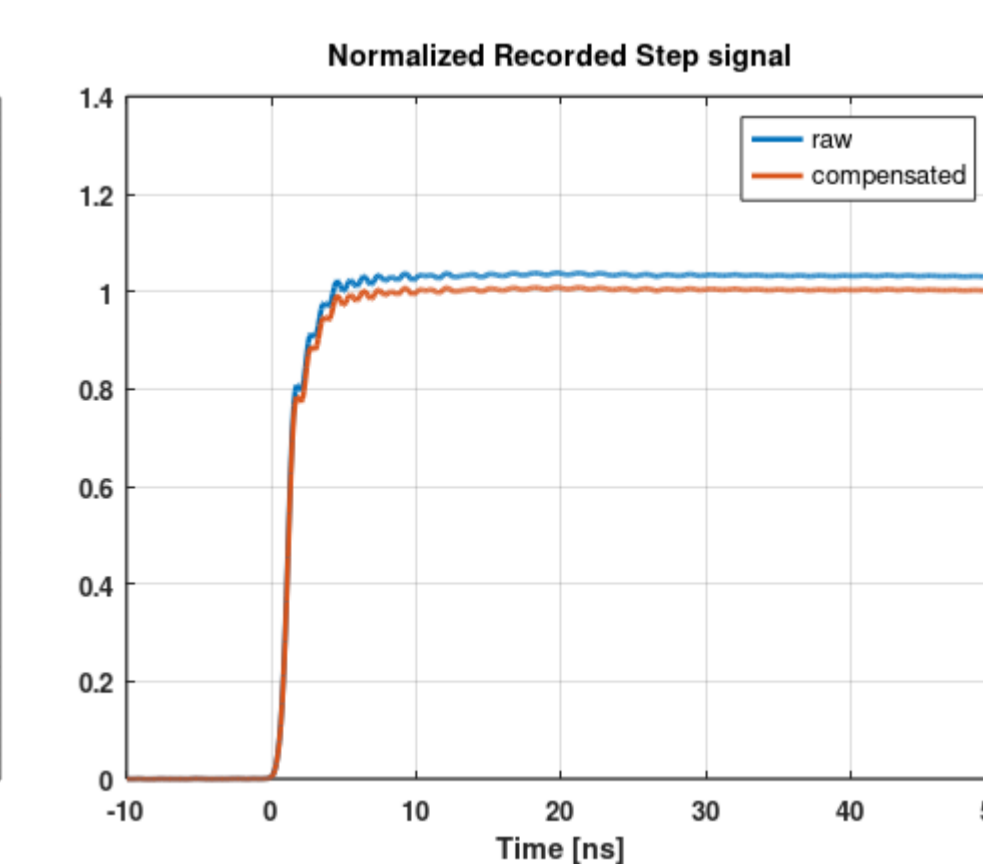
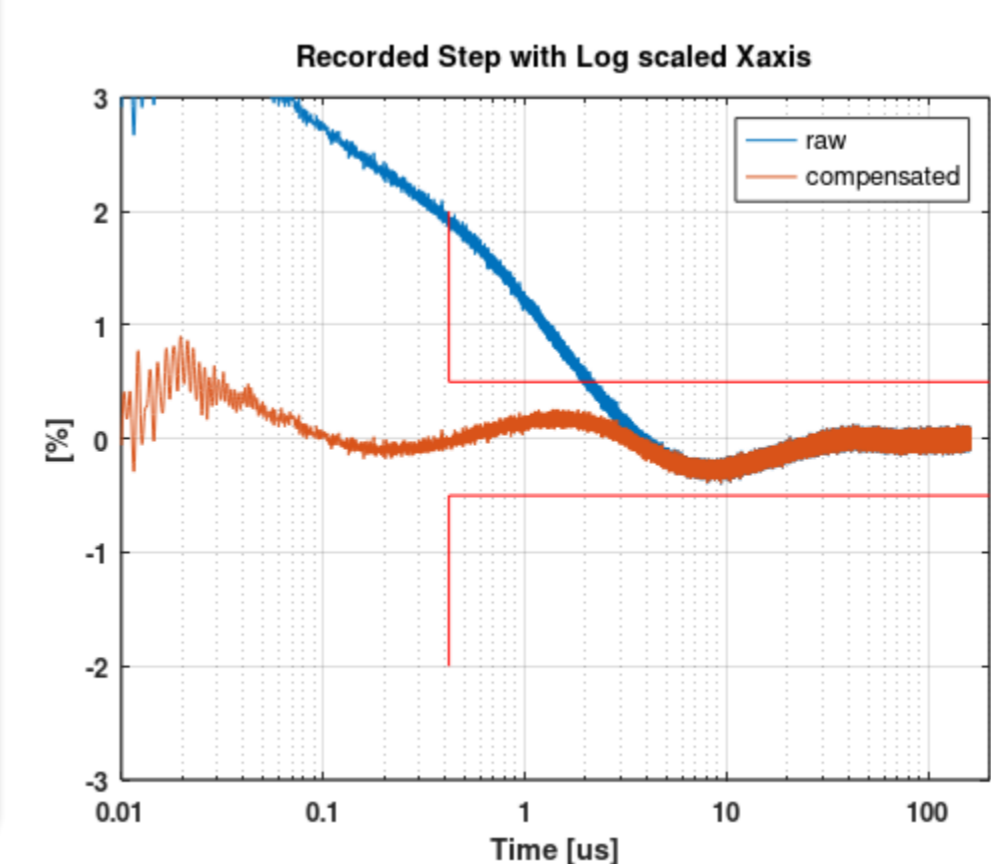
Arbitrary Waveform Generator
LI 0.84/60 μs

Channel	ΔT1 [ppm]	ΔT2 [ppm]
REF (CH1)	0	0
CH2	4	375
CH3	146	386
CH4	189	342
CH5	137	196



MERCURY RELAY ↔ SOLID-STATE SWITCH

Waveform	Compensated			Raw		
	ΔUp [%]	ΔT1 [%]	ΔT2 [%]	ΔUp [%]	ΔT1 [%]	ΔT2 [%]
LI 0.84/50 μs	-0.06	0.07	0.08	-0.06	0.06	0.08
LI 0.84/60 μs	-0.06	0.09	0.08	-0.06	0.06	0.10
LI 1.2/50 μs	-0.05	0.08	0.08	-0.06	0.09	0.07
LI 1.5/50 μs	-0.06	0.07	0.08	-0.05	0.07	0.07
LI 1.56/60 μs	-0.06	0.06	0.09	-0.06	0.07	0.10
TDG LIC A1	-0.05	0.10	0.04	-0.05	0.11	0.04



CONCLUSION

Step generators using different switch technologies, cables and adapters lead to very similar results. The bandwidth of the 1MΩ input is much lower than for the 50Ω input. Even though both considered step generators still show impedance mismatch and reflections, their performance is adequate to characterize the 10GS/s oscilloscope for impulse measurement. Any waveform can be calibrated with the convolution method. DC scaling, amplitude linearity and time base calibration can be covered with an integrated HV source and repetitive pulse mode measurements.