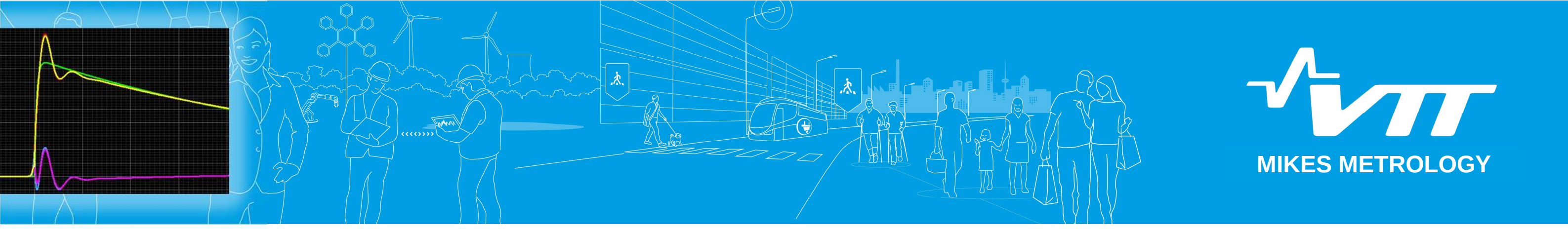

Correction of Non-Ideal Step Response of LI Measurement System Using Deconvolution

Jari Hällström • Jussi Havunen
VTT Technical Research Centre of Finland Ltd, Centre for Metrology MIKES

Introduction

Non-ideal step response of a digitizer or a voltage divider causes errors to voltage and time parameters when measuring lightning impulses (*LI*). Front time T_1 depends on instrument's ability to react to fast voltage changes i.e. how ideal the beginning of the step response is. Time to half value T_2 depends on instrument's ability to stabilize after fast voltage changes i.e. how fast the step response stabilizes.

Deconvolution is a mathematical process which is used to reverse the effects of convolution on recorded data. Convolution in this case means the non-ideal step response of an instrument. Deconvolution is widely used in signal processing and provides a solution for correcting the non-ideal step response. However, deconvolution has not yet been used in impulse voltage measurements.

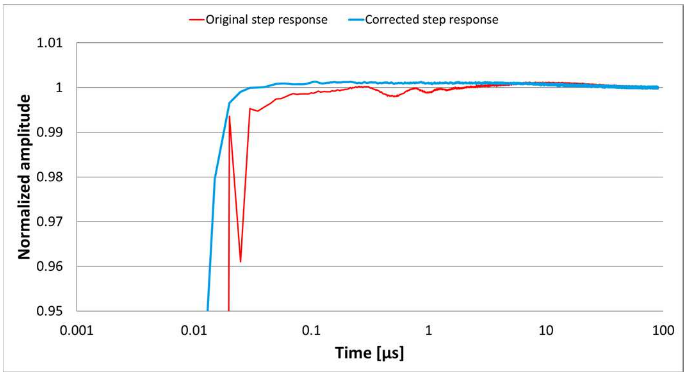

Figure 1. Step response of digitizer before and after correction.

Step response correction for a digitizer

Step response for a digitizer is determined by measuring steady DC voltage which is then shorted to ground by a mercury-wetted relay. Mercury-wetter relay is assumed to be almost an ideal switch. Average of 50 measured steps are then normalized to a rising step from 0 to 1. DC gain of the digitizer is also corrected to the step. Step response has to be measured for all the channels and all the ranges of the digitizer.

Step response correction is made in frequency domain by using deconvolution. Example of corrected step response is presented in Figure 1. Procedure for correction is explained in Figure 2.

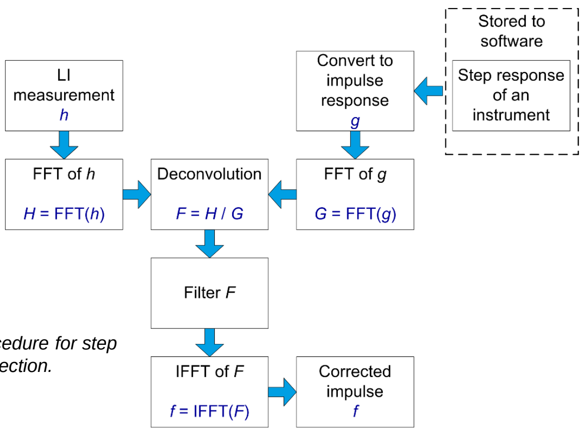

Figure 2. Procedure for step response correction.

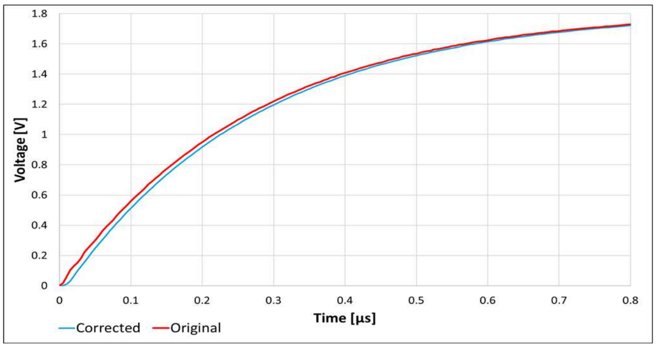

Figure 3. Front of a lightning impulse (0.84/60) before and after correction.

Results

Digitizer was calibrated using a calculable impulse voltage calibrator. Both original and corrected measurement data was used for LI calculations. Example of corrected and original impulse is presented in Figure 3. Results of the calibration are shown in Figure 4.

Results show improvement in U_t and T_2. T_1 has systematic negative error which can be a result of the non-ideality of the used relay or systematic error in the impulse voltage calibrator.

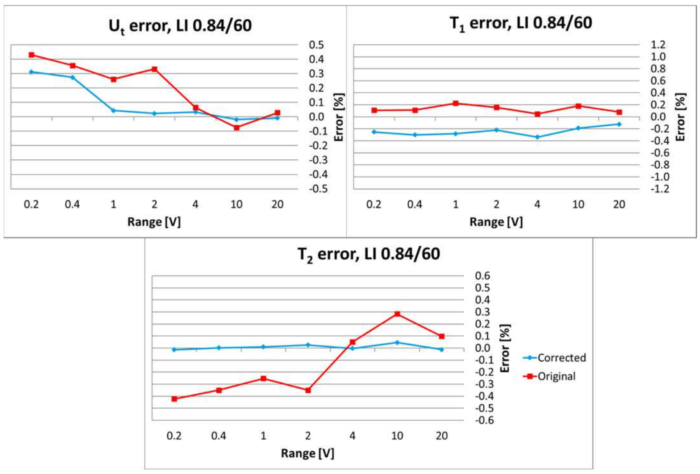

Figure 4. Impulse calibration results for the tested digitizer. Uncertainty is 0.1 % for U_t calibration, 1.0 % for T_1 and 0.5 % for T_2.

Conclusions

Non-ideal step response can be successfully corrected using deconvolution. Correction was done for a digitizer that is used in lightning impulse measurements. Step response correction made the step response smoother and reduced errors in voltage and time parameters.

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Contacts

Jari Hällström
Tel. +358 50 382 2127
jari.hallstrom@vtt.fi

Jussi Havunen
Tel. +358 50 590 6536
jussi.havunen@vtt.fi