Task 2: Dynamic Parameters Measurement of Impulse Voltage Dividers

(Laboratory F1-13, main lab)

Verify basic response parameters of impulse high voltage dividers by a unit step voltage (experimental response time T_N, partial response time T_α, settling time t_S and overshoot of the unit response β).

A) Measurement and determination of these parameters should be carried out for two separate impulse dividers. The comparison should be performed between them in conclusion.
B) The same measurement and parameters evaluation should be carried out for the chosen divider with the connected measurement path (with coaxial cable and attenuator). The comparison should be performed between divider with and without measurement c in conclusion.

Measurement circuit:

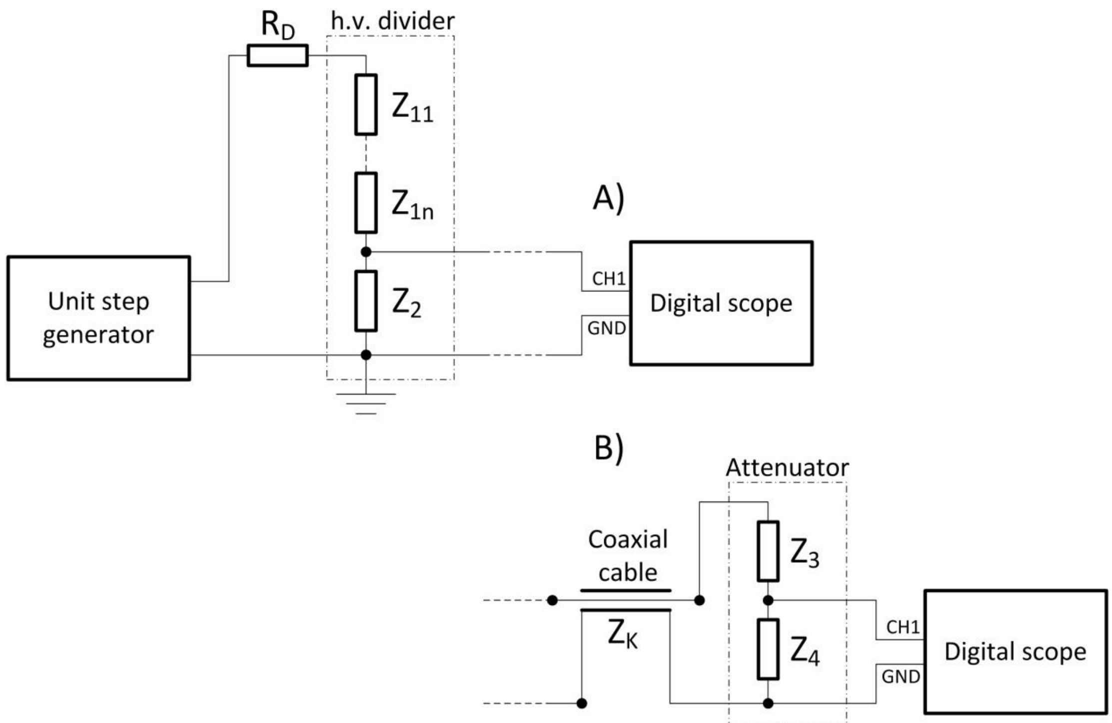

Fig. 1: Test circuit for unit step response measurement of voltage divider: A) separate divider B) divider with measurement path (with coaxial cable and attenuator)

Z_1 – h. v. part of the divider
Z_2 – sensing part of the divider
R_D – input damping resistor
Z_K – impedance of the coaxial cable
Z_3 – damping impedance of the attenuator
Z_4 – sensing impedance of the attenuator

Setup for measurement and evaluation:

Apply the unit step (about value 1 kV) to impulse dividers and measure their response by digital scope. Further, determine basic parameters of dividers by numerical integration method of the measured data (this setup is given by standard IEC 60060-2, and it is also described in lectures on this subject). Some numerical software is necessary to use for the evaluation of these measurements, e.g., MATLAB, Mathematica, Excel, etc.

- First, the approximation of oscillating response to determine measured impulse value (U_N) is needed. The measured impulse value (U_N) is given as an average of measured voltage response in the range from 0.4 μs to 3.6 μs from the impulse origin. The measured voltage response is then normalized ($g(t) = u(t)/U_N$). The percentual value of overshoot of the unit response β is given by the relationship:

$$\beta = (g_{max} - 1) \cdot 100 \ \ (\%)$$

- Experimental response time T_N is given by relationship:

$$T_N = \int_{t_0}^{t_n} \left(1 - g(t)\right) dt \, ,$$

  where t_o is a time of the impulse origin (not the start of data measurement!), t_n is given by standard as 3.6 μs from the origin of impulse.

- Partial response time $T\alpha$ is given by relationship:

$$T_\alpha = \int_{t_0}^{t_1} \left(1 - g(t)\right) dt \, ,$$

  where t_o is a time of impulse origin (not the start of data measurement!), t_1 is a time when the normalized step response g(t) first reach 1 or the time when the step response integral reach its maximal value.

- The settling time t_S. is the shortest time (from the origin of the impulse), where the step response time integral T(t) becomes and remains lower than 2 % of time t:

$$|T_N - T(t)| < 0.02 \cdot t$$