

# Grounding systems frequency response

Grounding system characteristic during lightning strike isn't constant. It depends on grounding resistivity, surge current value, earthing network etc. In this paper simple grounding systems was analyzed. Typical MV/LV distribution system was used in calculations. Fig. 1a presents first analyzed case – simple configuration more often than not used for IT, TT systems. Fig. 1b presents second analyzed case – configuration more often than not used for TN systems.

First configuration consists of simple grounding grid (ring around building), isolated power supply. Second one consists of ring around building, overhead transmission line and MV/LV substation.

The MV/LV substation earth grid is used as an electrical connection to earth at zero potential reference. This connection, however, is not ideal due to the resistivity of the soil within which the earth grid is buried. During typical earth fault conditions, the flow of current via the grid to earth will therefore result in the grid rising in potential relative to remote earth to which other system neutrals are also connected. This produces potential gradients within and around the substation ground area. This is defined as ground potential rise or GPR.

The GPR of a substation under earth fault conditions must be limited so that step and touch potential limits are not exceeded, and is controlled by keeping the earthing grid resistance as low as possible.

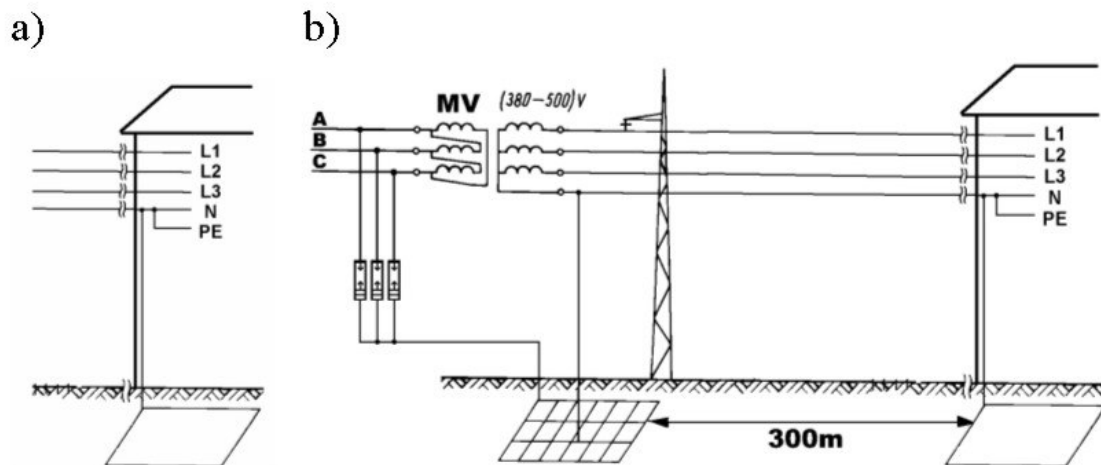
Knowledge of grounding behavior is crucial to safety standards and to overvoltage protection systems. GPR in carry out to the final user instalation comes by neutral wire, by the phase wire, by voltage difference between them. GPR with reference to the true earth can be very high and directly depend on grounding systems.

Presented calculation allows to provide behaviour of GPR in time domain. During lighting or short circuit GPR can rise high values. Indirectly can be estimate required real protection level. Real measurments are very expensive, so it's economical reason for computer simulations.

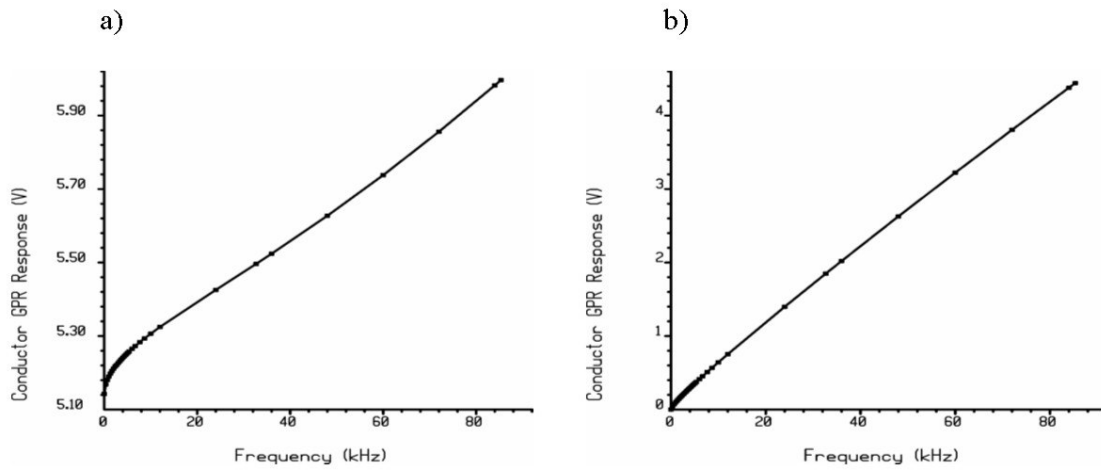
The engineering program CDEGS was used to compute frequency response to the lightning surge. It was made for wide range of the frequencies – up to 100kHz. Presented computation results describe GPR in frequency domain for two cases.

In theoretical model implemented into CDEGS the following assumptions were made:

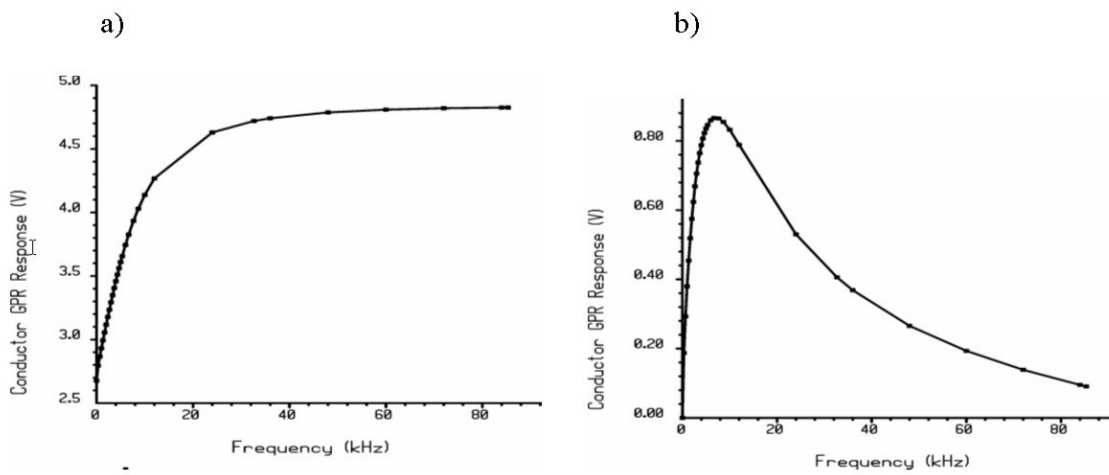
- ground resistivity  $\rho=100 \text{ Om}\cdot\text{m}$ ,
- excitation 1A for whole range of the analyzed frequencies.



**Fig. 1.** Grounding system view – first case (a), second one (b).



**Fig. 2.** Ground potential rise frequency response (first case) – real part (a), imagine part (b).



**Fig. 3.** Ground potential rise frequency response (second case) – real part (a), imagine part (b).