

Simulation of Transient Protectors and Their Co-ordinations

Ericsson AB
Applied Technology
Hong Tang
Hong.Tang@era.ericsson.se

One of the previous works in this field

Comprehensive Summaries of Uppsala Dissertations
from the Faculty of Science and Technology 297



Transient Control in Low-Voltage Power Installation Networks and Electronic Systems

BY
HONG TANG

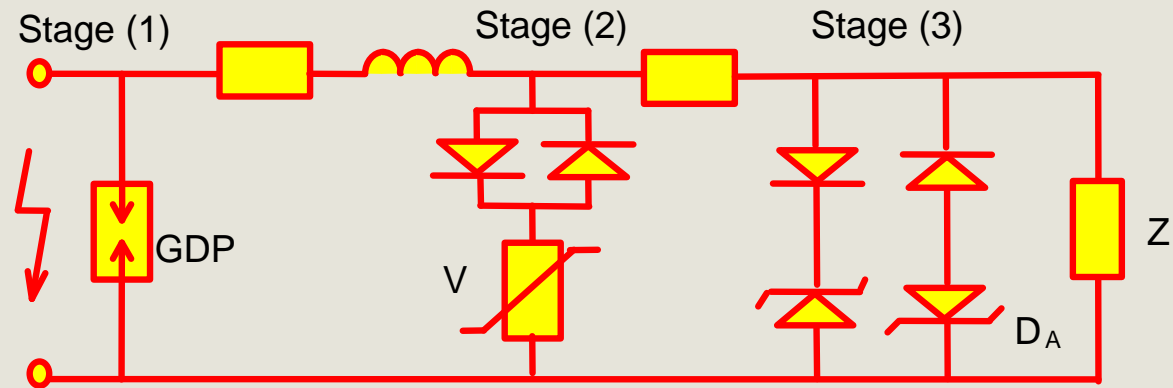


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Introduction

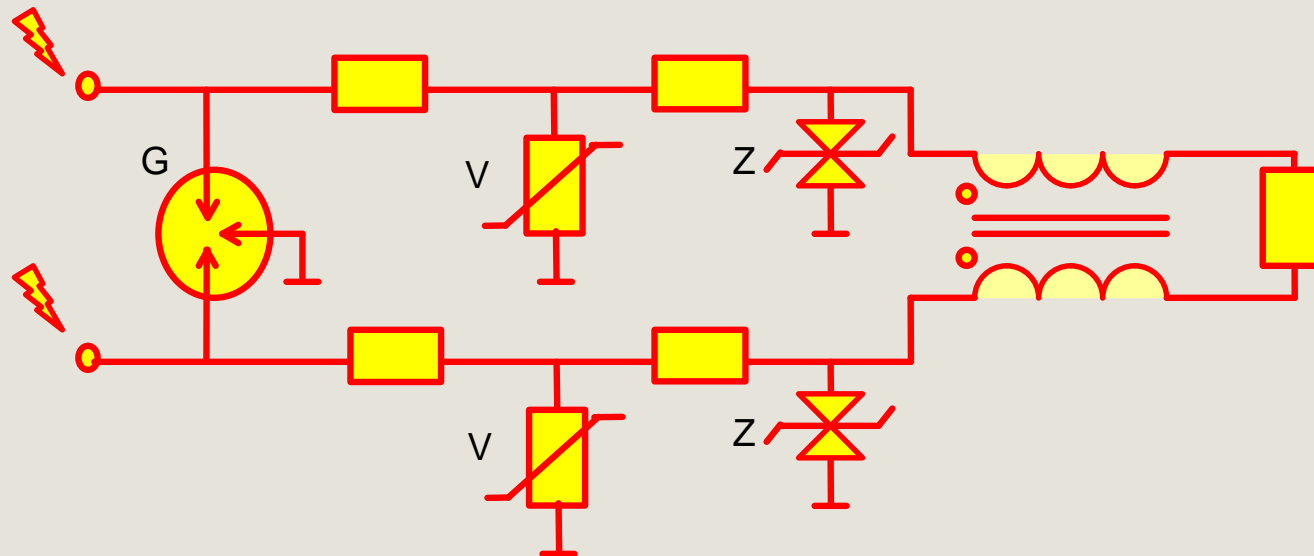
- Co-ordination of protection circuit – why simulation
- Model of protection component
- Circuit simulation tool – ATP-EMTP
- Examples
- Questions and comments

Multistage protection device



Reflection and dissipation

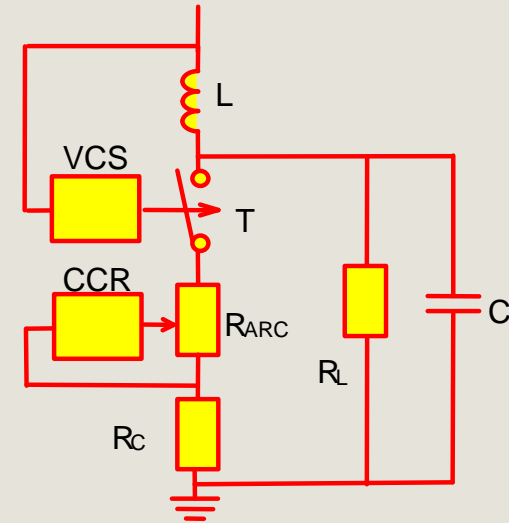
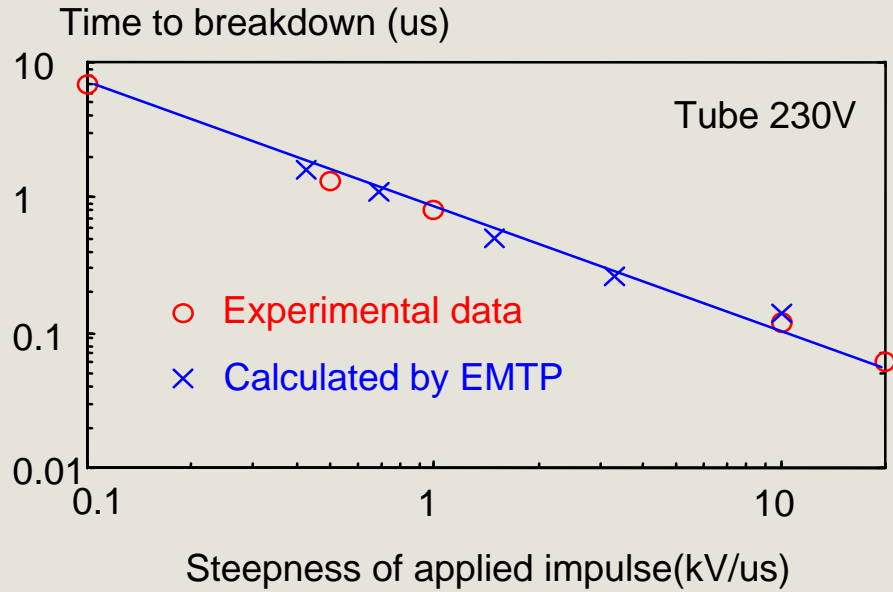
Balanced protection circuit



Efficient model for computer simulation

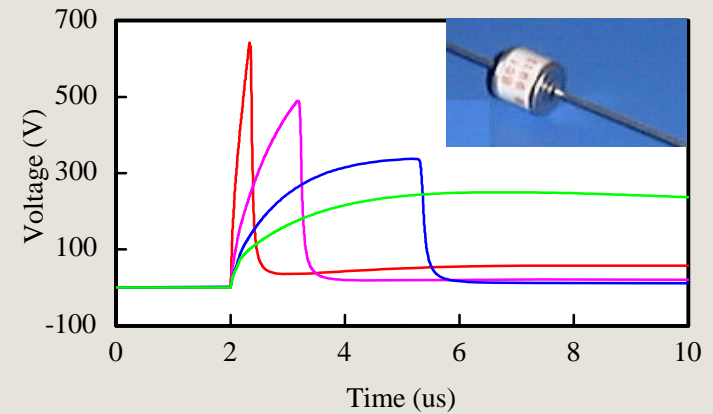
- Gas discharge protector
 - Two electrode version
 - Three electrode version
- Varistor
- Zener diode
- Common mode choke
- Cables with skin effect
- ...

Model of gas discharge tube – time to breakdown



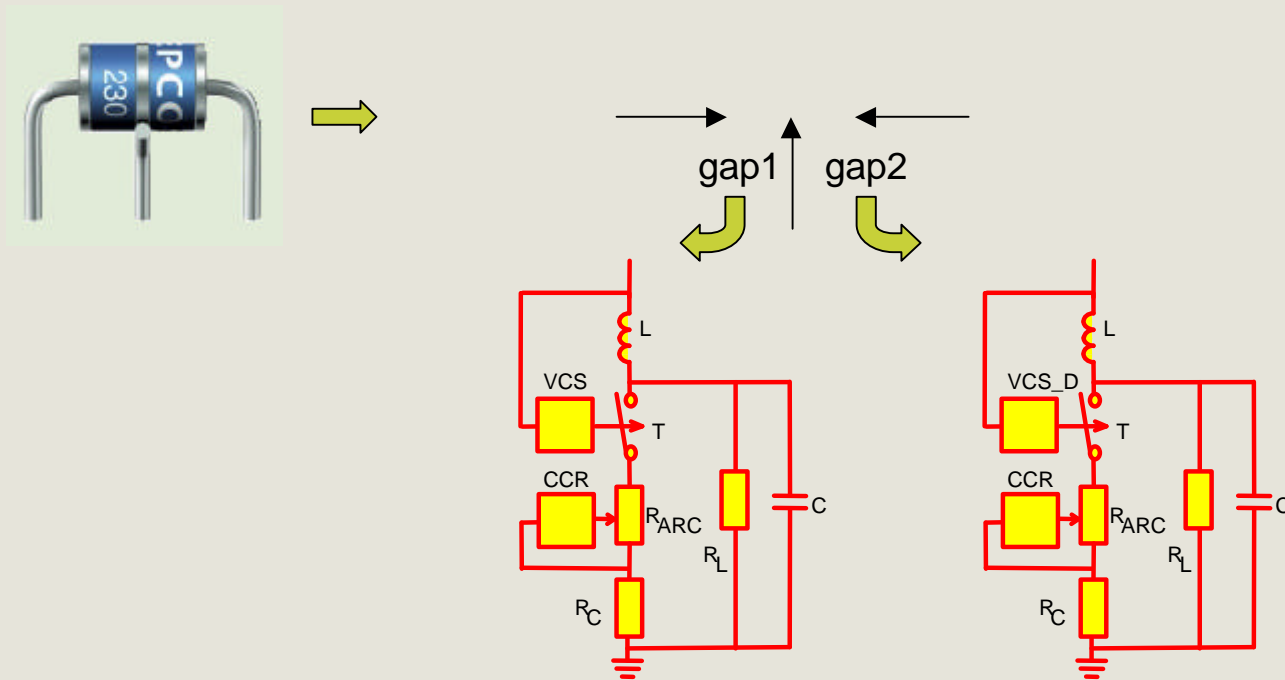
$$t_d = aS^{-b}$$

$$R_{arc} = \frac{k_T \cdot D}{\int_0^t i(t) \cdot dt}$$

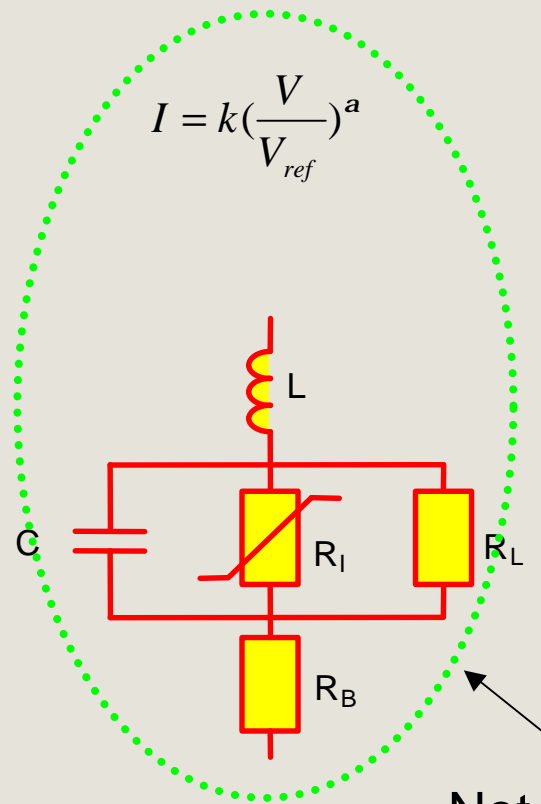


Model of gas discharge tube – three electrode

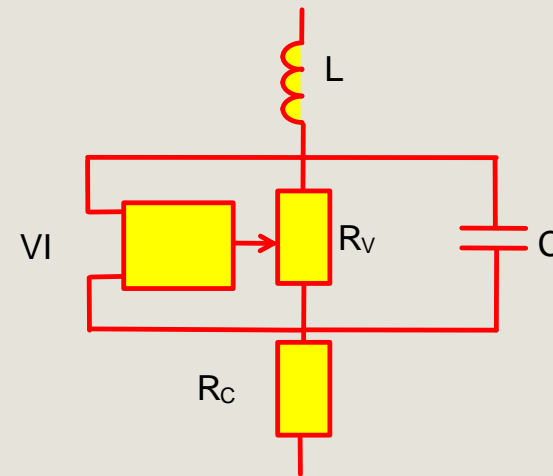
Time delay between gap1 and gap2



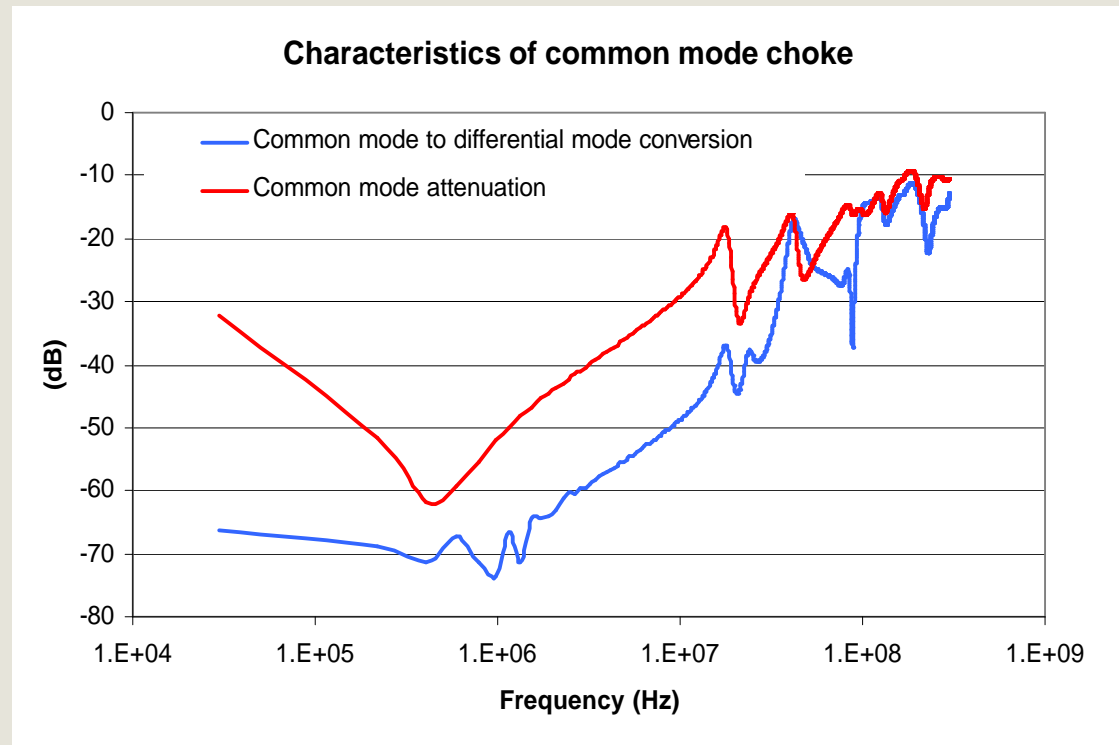
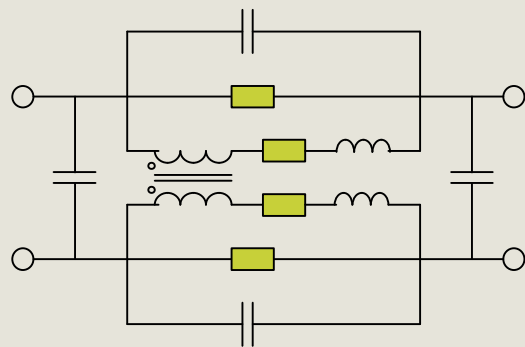
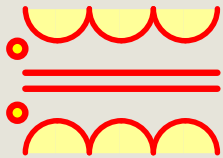
Model of varistor and zener diode



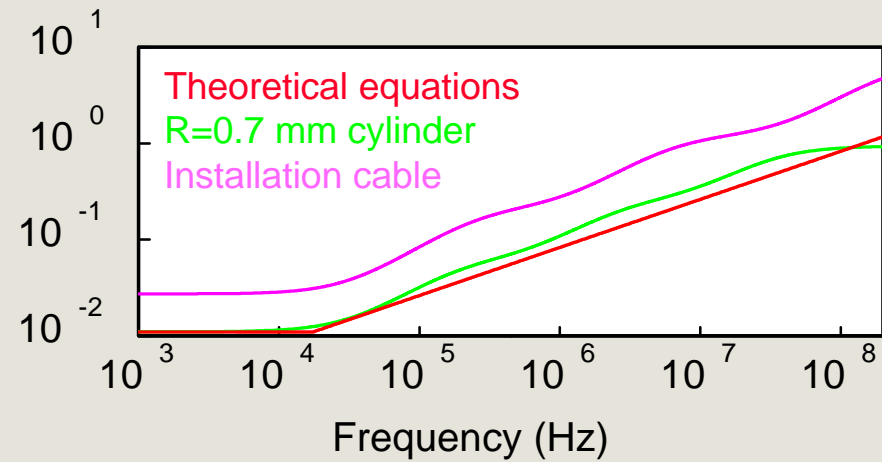
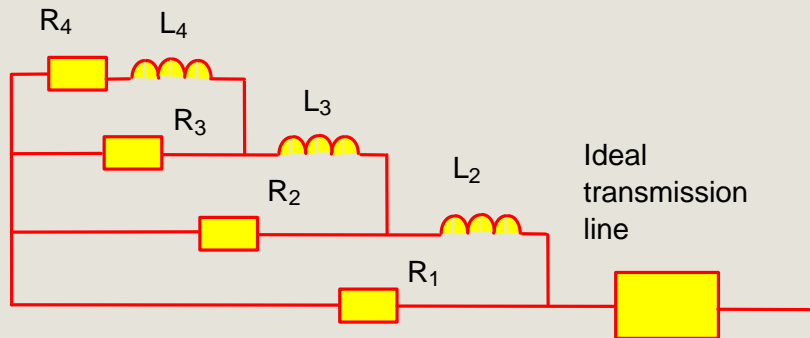
$$\log(u) = B_1 + B_2 \cdot \log(i) + B_3 \cdot e^{-\log(i)} + B_4 \cdot e^{\log(i)}$$



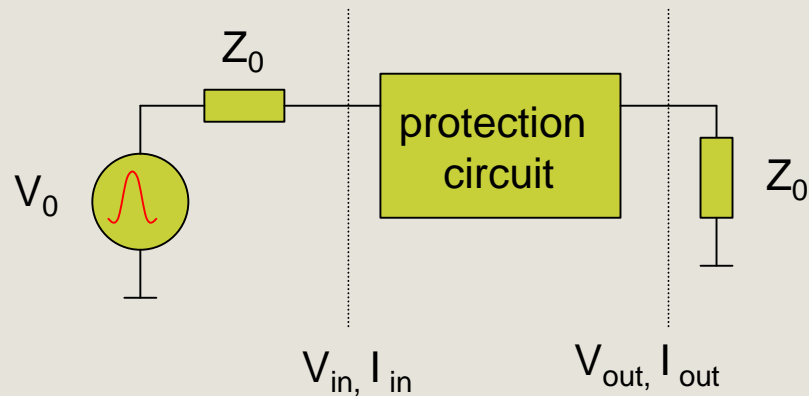
Model of common mode choke



Model of cables with skin effect

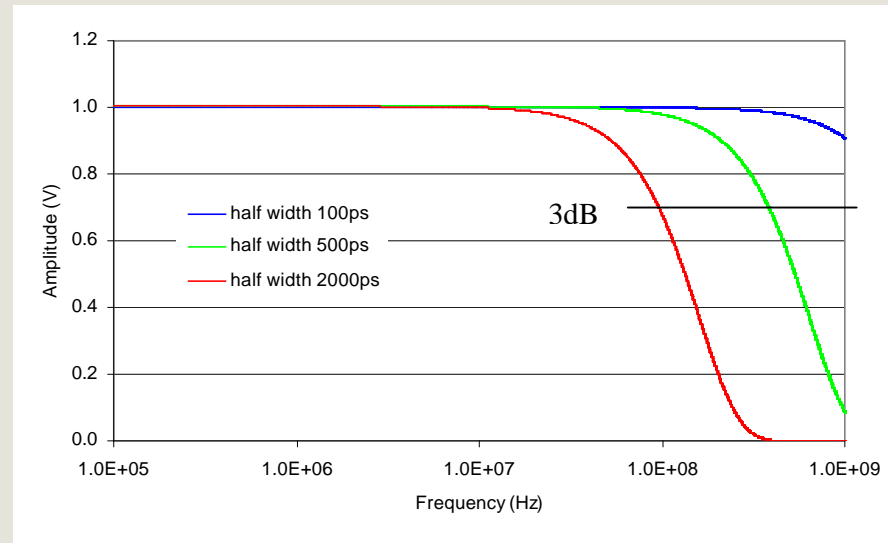
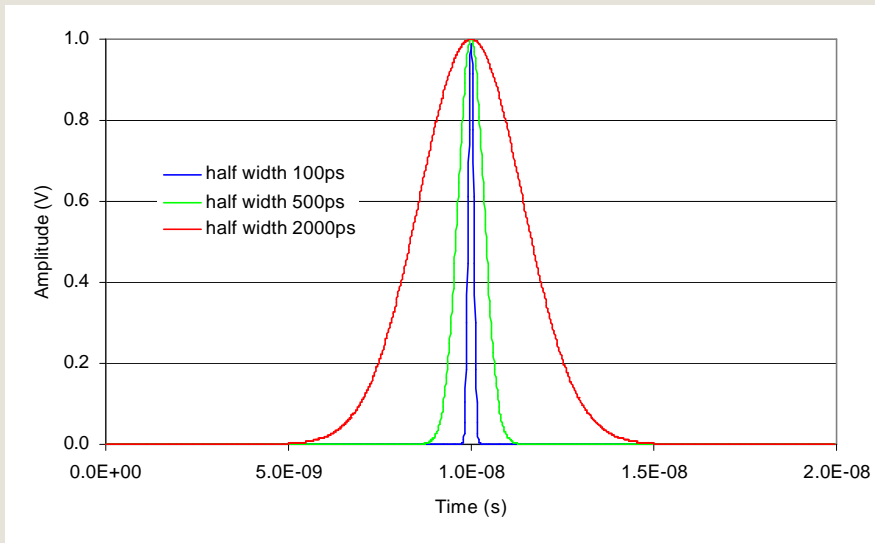


Frequency characteristics of protection circuit



$$S_{11} = \frac{V_{in}(\omega) - Z_0 I_{in}(\omega)}{V_{in}(\omega) + Z_0 I_{in}(\omega)}$$

$$S_{21} = \frac{2V_{out}(\omega)}{V_0(\omega)}$$

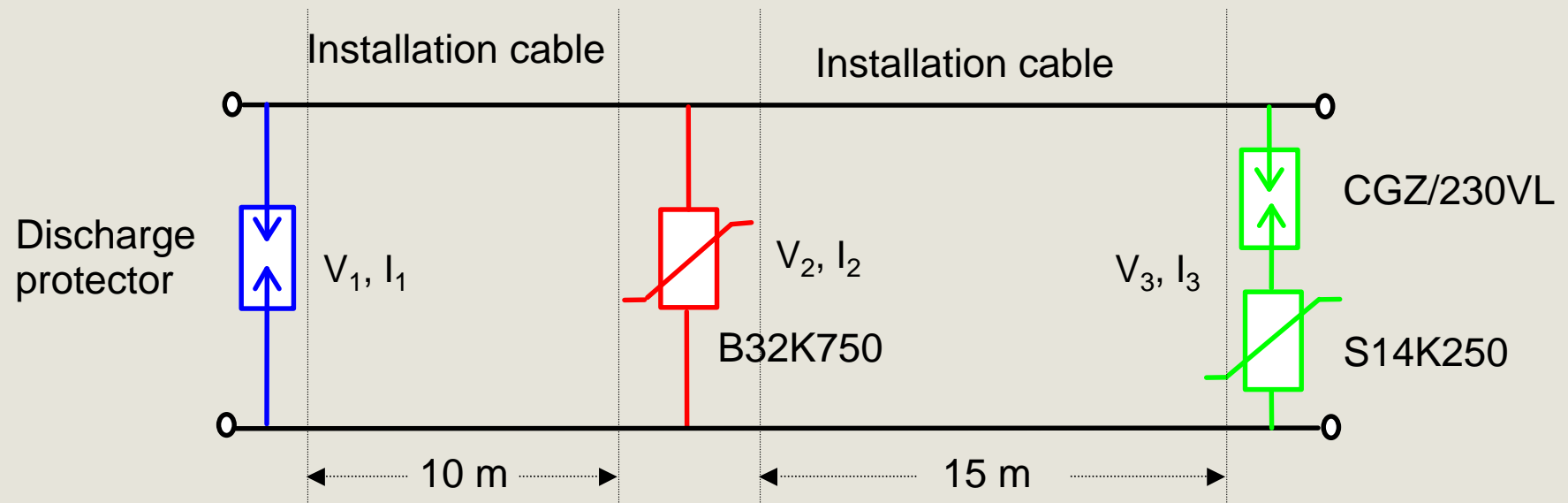


Advantage for simulation of co-ordination on protection circuit

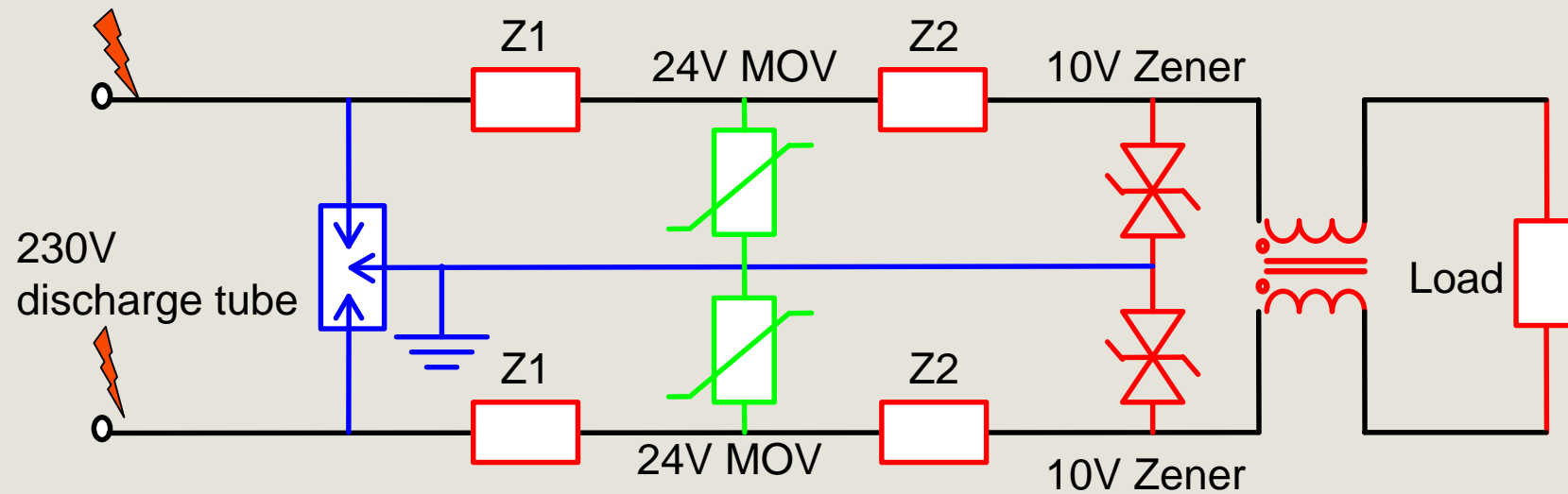
- Evaluation of the circuit with different voltage level
- Evaluation of the circuit with different transient shape
- Modification of the circuit easily
- Check the energy absorption of varistor and zener diode
- Localisation of the fault

- Established model and simulation tool is an efficient and convenient for the protection circuit co-ordination

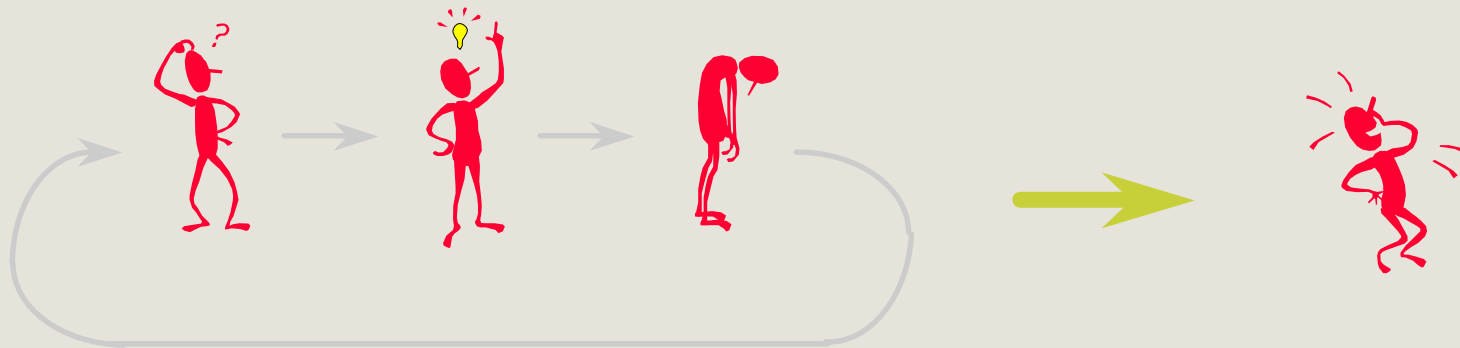
Example one



Example two



Advantage of simulation



Questions and Comments