Basics of Surge Protection

Ing. Jiří Prchal
Surges – What are we talking about?

- **Nominal voltage**
  - Duration: $\infty$
  - Voltage: $U_N = 230\, V$

- **Temporary Overvoltage**
  - Duration: $> 1\, \text{msec}$
  - Voltage: $U_{TOV} = 260\, V$

- **Transient Overvoltage**
  - Duration: $< 1\, \text{msec}$
  - Voltage: $U_{TR} = 20,000\, V$
Kinds of surges

- Nuclear Explosion (NEMP)
- Lightning (LEMP)
- Switching action (SEMP)
- Electrostatic Discharge (ESD)
Lightnings are not predictable

Lightning rod of the Space Shuttle launch pad
How does a lightning enter the building?

Energy supplier company

MDB

F₁

Main bonding busbar

50%

50%
How does a lightning enter the building?

Energy supplier company
Lightning Electromagnetic Pulse

A graph showing a lightning electromagnetic pulse with a 10/350 µs rise time.
Switching Electromagnetic Pulse (SEMP)
Switching 500 kV
Sources for SEMPs

- Switchgear
- Frequency converters
- Blowing fuses / Triggered MCBs
- Motor starters
- Relays
- Etc.
Switching electromagnetic pulse (SEMP)
Switching Electromagnetic Pulse

![Graph showing a 8/20 µs pulse with a peak current of 1.0 and a duration of 20 µs.](image)
Comparison of surge currents

- **8/20 µs**
- **10/350 µs**
Coupling mechanisms
Mechanisms of coupling

- **Galvanic**
  - High voltage drop due to the inductance of the wire

- **Induktive**
  - Voltage is imposed on adjacent wires by the electromagnetic field

- **Capacitive**
  - Influence is insignificant
Function principle of SPDs
Surge protection: Function principle

- Surge on a wire - unprotected

Surge is conducted to the device
Surge protection: Function principle

- Surge on a wire - protected

Surge is discharged by the SPD

SPD = Surge Protective Device
Surge protection: Function principle

- Surge coming from earth - unprotected

Surge is conducted to the device
Surge protection: Function principle

- Surge coming from earth - protected

Surge is discharged by the SPD

SPD = Surge Protective Device
Surge protection: Function principle

- Optimized protection

Surge is discharged by the SPD

SPD = Surge Protective Device
## Typical physical quantities of SPD

<table>
<thead>
<tr>
<th>Name</th>
<th>Designation</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal voltage</td>
<td>$U_N$</td>
<td>Nominal system voltage</td>
</tr>
<tr>
<td>Max. continuous operating voltage</td>
<td>$U_C$</td>
<td></td>
</tr>
<tr>
<td>Protection level</td>
<td>$U_p$</td>
<td>Highest voltage the SPD</td>
</tr>
<tr>
<td>Impulse discharge current</td>
<td>$I_{imp}$</td>
<td>• Lightning currents</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• 10/350 µs current impulse</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Only for SPD Type 1</td>
</tr>
<tr>
<td>Nominal discharge current</td>
<td>$I_n$</td>
<td>• Surge currents</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• 8/20 µs current impulse</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Only für SPD Type 2</td>
</tr>
<tr>
<td>Max. discharge current</td>
<td>$I_{max}$</td>
<td>• Surge current</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• 8/20 µs current impulse</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Only für SPD Type 2</td>
</tr>
<tr>
<td>Combination wave</td>
<td>$U_{OC}$</td>
<td>• Voltage peaks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• 1,2/50 µs voltage impulse</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Only for SPD Type 3</td>
</tr>
</tbody>
</table>
Does surge protection work?
Devices for surge protection

- Suppressor diode
- Varistor
- Gas Discharge Tube
- Spark gap

Response time: better
Discharge capability/Protection level

Graph: Response time vs. Discharge capability/Protection level
Types of connection

Stub line connection

V-shape connection

* Additional fuse (compulsory / optional)
Why fuses in front of SPDs?
Why fuses in front of SPDs?
Types of connection

* Additional fuse (compulsory / optional)  
Main equipotential Busbar / Ground Terminal

Max. availability of the installation  
Max. security of the installation
Trabtech Safe Energy Control
Surge Protection Reinvented

Lightning current and surge arrester type 1 + type 2

Lightning current arrester type 1 with integrated back-up fuse

Surge arrester type 2

Device protection type 3

Lightning current arrester type 1
## Safe Energy Control Family

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FLASHTRAB SEC PLUS</td>
<td>Line follow current free spark gap</td>
</tr>
<tr>
<td>FLASHTRAB SEC PLUS 440</td>
<td>Pluggable spark gap for 440V systems</td>
</tr>
<tr>
<td>FLASHTRAB SEC HYBRID</td>
<td>Pluggable T1 arrester + back-up fuse</td>
</tr>
</tbody>
</table>
### Safe Energy Control Family

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Function Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FLASHTRAB SEC [T1 + T2]</td>
<td>Combination of T1 and T2 arrester on 35 mm per pole</td>
</tr>
<tr>
<td>VALVETRAB SEC [T2]</td>
<td>Smallest type 2 arrester for DIN-rail</td>
</tr>
<tr>
<td></td>
<td>→ $I_{SCCR}$ up to 50 kA, max. fuse 315 A gG</td>
</tr>
<tr>
<td>PLUGTRAB SEC [T3]</td>
<td>Device protection with integrated fuse for AC and DC systems</td>
</tr>
</tbody>
</table>
Design
Highlights

- Good handling
- Identical appearance
- Eye-catching signaling
- Individual marking space
- All mounting orientation
- Turn, code, plug
- Screwdriver lever

PHOENIX CONTACT
INSPIRING INNOVATIONS
Name: FLT-SEC-T1+T2-3S-350/25-FM

Explanation:

- Remote: Function Monitoring
- \( I_{imp} \): 25 kA
- \( U_C \): 350 V
- Model: 3+1
- Class: Type 1 + Type 2
- Family: Safe Energy Control
- Product: FLASHTRAB
Surge protection concept with Safe Energy Control
Surge protection concept with Safe Energy Control

Type 1 arrester at building entrance:
e.g. FLT-SEC-P-3C-350/25-FM
Surge protection concept with Safe Energy Control

Type 2 arrester in the sub-distribution: e.g. VAL-SEC-3S-350-FM
Surge protection concept with Safe Energy Control

Type 3 arrester in front of the device: e.g. PLT-SEC-T3-230-FM
Safe Energy Control – key features

Safe Energy Control means:

- Impact-free and durable
- Back-up fuse free solution for every application
- Compact and pluggable
- High performance and quality
Impact-free and durable

- **Line follow current free spark gap:** The smooth way to discharge lightning currents.
  
  Minimum of energy is led through the SPD and the electrical installation.

- **High durability:**
  Less stress for the SPD and the electrical installation.
  Minimal maintenance costs.
Backup-fuse free solution for every application

<table>
<thead>
<tr>
<th>F1 current rating</th>
<th>16 A</th>
<th>26 A</th>
<th>63 A</th>
<th>160 A</th>
<th>315 A</th>
<th>&gt;315 A</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>FLT-SEC-P-T1...</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T2</td>
<td>VAL-SEC-T2...</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T3</td>
<td>PLT-SEC-T3...</td>
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</table>

Maximum back-up fuse rating

Max. short circuit current 1.5 kA
Compact and pluggable

- All arresters are pluggable
- All arresters are space-saving and easy to install
- Smallest T1+T2, T2 and T3 arrester
High performance and quality

- SPDs with Safe Energy Control Technology are extremely powerful and durable – for greater availability and less stress for the system
- We provide free replacement plugs for the first five years
- All SEC products showing a red status will be replaced for free
Infrastructure

Building

Cornerstone for each reliable lightning protection

- High performance
- Best protection
- Durable

FLT-SEC-PLUS

FLT-SEC-HYBRID
Even for 440 V & IT-Systems

- Compact
- Pluggable
- Certified

FLT-SEC-PLUS 440

PHOENIX CONTACT
INSPIRING INNOVATIONS
Universal protection

- Lightning protection for sensitive devices
- Space-saving and easy installation

T1 + T2

FLT-SEC-T1+T2

Telecom
VAL-SEC

- 30% less space needed
- High max. back-up fuse rating

Most compact

Cabinet Builders

Certified protection

- Save the space of a separate fuse
- Pluggable
Děkuji za pozornost