BS EN 62305-4:2011 Part 4: Electrical and electronic systems
Danger / Damage due to Lightning Strikes

Source: *BLIDS, Siemens AG, evaluation from 2000 to 2010
Impact on electrical installations
Causes of transient surges

Direct lightning strikes (LEMP)
- Galvanic coupling
- Inductive / capacitive coupling

Indirect lightning strikes
- Conducted partial lightning currents
- Inductive / capacitive coupling

Surges (SEMP)
- Switching operations
- Earth faults / short-circuits
- Tripping of fuses
- Parallel installation of power and IT conductor systems

LEMP: Lightning Electromagnetic Pulse, SEMP: Switching Electromagnetic Pulse
Lightning strike into an adjoining building
Flashover to main building and living room
Surge damage to a telephone system
Damage to distribution board

Test eines elektronischen Elektrizitätszählers

50 kA (10/350 μs)
Impulse Current for Lightning Current Arresters
Impulse Current for Surge Arresters

<table>
<thead>
<tr>
<th>I (kA)</th>
<th>10 µs</th>
<th>200 µs</th>
<th>350 µs</th>
<th>600 µs</th>
<th>800 µs</th>
<th>1000 µs</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 kA</td>
<td></td>
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<tr>
<td>80 kA</td>
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<td></td>
<td></td>
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<tr>
<td>60 kA</td>
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<tr>
<td>50 kA</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>40 kA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20 kA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Wave form [µs] 10/350 8/20
i_max. [kA] 100 5
Q [As] 50 0.1
W/R [J/ · ] 2.5 · 10^6 0.4 · 10^3
Standard EN 62305 EN 62305

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## Comparison of test currents

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>wave form [µs]</td>
<td>10/350</td>
<td>8/20</td>
</tr>
<tr>
<td>(i_{\text{max}}) [kA]</td>
<td>40</td>
<td>40</td>
</tr>
</tbody>
</table>

Ref.: IEC 61643-11
Comparison of test currents
Video: Impact on the electrical installation

Wiring tested with an impulse current 40 kA (8/20 µs)
Standardisation of Surge Protective Devices

IEC 61643-1
Performance Requirements of Surge Protective Devices for Low-Voltage Power Supply Systems

**Type I**
Protection Against Direct Lightning Currents
(Lightning Current Arrester)
(10/350 µs)

**Type II**
Protection Against Indirect Lightning Effects
(Surge Arrester)
(8/20 µs)

**Type III**
Protection Against Switching Overvoltages
(Surge Arrester)
(1.2/50 µs, 8/20 µs)
Maximum values of lightning parameters according to LPL (lightning protection level)

<table>
<thead>
<tr>
<th>First short stroke Current parameters</th>
<th>Lightning protection level LPL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
</tr>
<tr>
<td>Peak current I (kA)</td>
<td>200</td>
</tr>
<tr>
<td>Spec. energy W/R (MJ/Ω)</td>
<td>10</td>
</tr>
<tr>
<td>Charge Q\text{} _\text{}\text{short} (C)</td>
<td>100</td>
</tr>
<tr>
<td>Time parameters T\text{}_1/T\text{}_2 (μs/μs)</td>
<td></td>
</tr>
</tbody>
</table>

Ref.: DIN EN 62305-1 (VDE 0185-305-1):2011-10, Tab. 3 (extract)
Laboratory tests
System tests

Laboratories in Neumarkt
- 200 kA (10/350)
- 100 kA (8/20)
- Follow current transformer (50 kA_{rms})
- d.c. laboratory (up to 5000 A)
- PV laboratory (up to 300 A)

- In-house tests of products in compliance with the latest product standards
- In-house approval tests under supervision of official authorities
- Complete system tests
Lightning Protection Zones (LPZ) Concept
Division of a structure into Lightning Protection Zones (LPZs). Outer Zones

Outer zones:

LPZ 0  LPZ 0 is subdivided into:

LPZ 0_A  Systems in unprotected external areas of structures. The internal systems may be subjected to full lightning surge currents.

LPZ 0_B  Systems in external areas, but protected against direct lightning strikes. The internal systems may be subjected to partial lightning surge currents.
Division of a structure into Lightning Protection Zones (LPZs). Inner Zones

**Inner zones** (protected against direct lightning flashes):

**LPZ 1** Zone where the surge current is limited by current sharing and isolating interfaces and/or by SPDs at the boundary. Spatial shielding may attenuate the lightning electromagnetic field.

**LPZ 2 ..n** Further Zones where the surge current may be limited further by current sharing, additional SPDs and spatial shielding.
Implementation of LEMP protection measures (SPM = Surge Protection Measures)
Energy Co-ordination
Energy co-ordination with terminal devices and/or type 3 surge arresters

Initial interference
Lightning impulse current (10/350 µs)

Residual interference uncritical to terminal device?

230 / 400 V

alternative
230 / 400 V

type 1 combined arrester

cable length > 10m

max. cable length of 10m

type 3 arrester

typical input circuit of a terminal device with varistor ... K 275

terminal device
How to prove energy co-ordination?

The energy co-ordination should be proved by either:

- Co-ordination test (on a case-by-case basis)
- Calculation (approximation in simple cases; computer simulation in complex systems)
- Application of co-ordinated SPD families, the manufacturer has to prove that co-ordination is achieved; if so, manufacturer indicates SPD’s as member of product families in technical documentation
Application conflict spark gap – varistor
Co-ordination with the varistor of a terminal device

Co-ordination of a type 1 varistor with the varistor of a terminal device

Load:
12.5kA (10/350µs)

Result:
Overload / destruction of the terminal device
Co-ordination of a type 1 spark gap with the varistor of a terminal device

High-speed video

Load:
12.5kA (10/350µs)

Result:
No overload
Technologies for surge protective devices used in power supply systems

COMPARISON

spark gap

varistor
Technologies for surge protective devices used in power supply systems

**Spark gap**

- Sparkover voltage
- Residual voltage

**Varistor**

- I
- U
- t
Application conflict spark gap – varistor
Comparison of the coordination behaviour

Spark-gap-based type 1 SPD

Varistor-based type 1 SPD

Load: 1.25 kA (10/350 μs)

A reduced load value was used for this graphical comparison given that the varistor of the terminal device is destroyed if a varistor-based type 1 SPD is loaded with higher values and the current characteristics are thus no longer comparable.
Selection with regard to Voltage protection level
### IEC 60364-4-44, Table 44.B
### BS 7671 (17th Edition), Table 44.3

<table>
<thead>
<tr>
<th>Nominal voltage of the installation** [in V]</th>
<th>Required impulse withstand voltage [in kV*] for</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Equipment at the origin of the installation (overvoltage category IV)</td>
</tr>
<tr>
<td>230 / 400 277 / 480</td>
<td>6</td>
</tr>
<tr>
<td>400 / 690</td>
<td>8</td>
</tr>
<tr>
<td>1000</td>
<td>12</td>
</tr>
</tbody>
</table>

*) This impulse withstand voltage is applied between live conductors and PE.
**) According to IEC 60038
Overvoltage categories acc. to IEC 60364-5-53, BS 7671
Use of surge protective devices

rated impulse withstand voltage
6 kV

2 kV appliances
1.5 kV sensitive devices

voltage protection level ≤ 1.5 kV

230/400 V

SEB: service entrance box; M: meter; SDB: sub-distribution board

arrester
type 1
type 2
type 3
type 3
terminal device
Surge Protection – Mains power Applications

Main Distribution Level / Lightning Equipotential Bonding

Type I – Lightning Current Arrester
Lightning equipotential bonding for incoming lines

- Utility (e.g. TN-C)
- Telecommunication / DSL
- Broadband cable system
- Water
- Gas
- Heating system
- Cathodically protected tank pipe

LPS: Lightning Protection System; M: Meter; MEB: Main Earthing Busbar

Tour of System:
1. Utility (e.g. TN-C)
2. Telecommunication / DSL
3. Broadband cable system
4. Water
5. Gas
6. Heating system
7. Cathodically protected tank pipe
8. Foundation earth electrode
9. External LPS
DEHNventil® 3 phase TNS installation
TN-S system 230/400 V – 4-0 circuit
DEHNventil® M TNS 951405

≤ 315 A gL/gG

R_A

MEB
Surge Protection – Mains power

Sub Distribution Level

Type II – Surge Arrester
DEHNguard® 3 phase TNS installation
TN-S system 230/400 V – 4-0 circuit
DEHNguard® M TNS 952 405

≤ 125 A gL/gG
Surge Protection – Mains power

Sensitive Device Level

Type III – Surge Arrester
DEHNrail® single phase installation
TN-S system 230V circuit
DEHNrail® M 953 205
Application
Surge protection for power supply systems

power network

MDB main distribution board
SDB sub distribution board
Red/Line

Surge protection devices for power systems.
Type 1 + Type 2
Fully energy co-ordinated

Type 1 + Type 2 + Type 3
Fully energy co-ordinated if used within 5m with regard to the terminal equipment
General features of the Red/Line family design

- Dark grey buttons
- Overloaded modules can be replaced without removing the cover

Module replacement without tools

- Protection from vibration during transport or use
- Withstands considerable mechanical pulse loads during every discharge process

Vibration and shock-tested
General features of the Red/Line family design

- Checks all protective circuits (even NPE)
- Floating changeover contact
- Connection to e.g. building control system, controller, DEHNpanel, ...

Optional remote signalling contact

- Mechanical visual indication
- No operating currents
- Separately for every protective path
- Red/green

Operating state / fault indication
DEHNguard® modular Characteristics

- High-capacity varistor-based SPD
  - Nominal discharge current
    \[ I_n (20x) = 20 \text{ kA} (8/20 \mu\text{s}) \]
  - Maximum discharge current
    \[ I_{\text{max}} (1x) = 40 \text{ kA} (8/20 \mu\text{s}) \]
  - Low voltage protection level at
    \[ I_n = 1.25 \text{ kV} \]

- High safety due to Thermo Dynamic Control
  SPD controlling device

- Control of all protective circuits and central remote signalling by floating changeover contact
Approvals / certificates

A variety of approvals is available for the relevant products.
Yellow/Line

Surge protective devices for information technology systems and devices
Lightning protection zone concept in conformity with BSEN 62305-4:2011

Yellow/Line SPD classes (total load):
- **TYPE 1**: 2.5 kA (10/350)
- **TYPE 2**: 5 kA (8/20)
- **TYPE 3**: 0.5 kA (8/20)

Direct lightning current (10/350 μs)

ITE: Information Technology Equipment
Ref.: CLC/TS 61643-22 (VDE V 0845-3-2)
Surge protective devices for data and information technology systems are subdivided into:

- **TYPE 1**: arresters discharge partial lightning currents of 10/350 µs waveform without destruction (lightning current arresters)
- **TYPE 2**: and **TYPE 3**: arresters provide surge protection (surge arresters)
Yellow Line portfolio
TYPE 1 arresters

- lightning current arresters
- “fail-safe” feature
- combined arresters
- application-oriented designs
- condition monitoring
- variety of system voltages

DEHNrapid® LSA
DEHNbox
BLITZDUCTOR® XTU
BLITZDUCTOR® VT KKS
DEHNgate L4
DEHNgate TV
DEHNgate AG
DEHN equipotential bonding enclosure

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**Yellow Line portfolio**

**TYPE 2 arresters**

- DEHNconnect SD 2
- DEHNpatch
- DEHNlink
- FS / USD
- DEHNpipe
- DEHNrapid® LSA
- DEHNpatch M CAT6
- BUSector
- UGKF
- NET-Protector
- DGA G N
- ITAK Ex (i)
- DEHNgate

**varieties of system voltages**

**surge arresters**

for use in Ex i circuits

**application-oriented designs**

single-pole/multipole
Approvals and certificates
Thank you for your time and attention

Surge Protection

Lightning/Earthing Protection

Safety Equipment