When and Where should Which surge protection be used?

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*Answers to **WWW** for the user of surge protective devices connected to telecommunications and signalling networks are given in this article – and the most important parts of IEC 61643-22 [1] / CLC prTS 61643-22 [2] are explained.*

IEC 61643-22 [1] is a guide for the application of Surge Protective Devices (SPDs) to telecommunications and signalling lines. Because telecommunications and signalling systems depend on long lengths of wire, either buried or aerial, the exposure to over voltages from lightning, power line faults and power line or load switching, can be significant. If these lines are unprotected, the resultant risk to Information Technology Equipment (ITE) can also be significant. International Standard IEC 61643-22 [1] (prTS 61634-22 [2]) describes the principles for the selection, operation, location and coordination of SPDs connected to telecommunication and signalling networks.

When should a surge protection be used?

The need for protective measures for IT systems should be based on a risk assessment considering the probability of overvoltage and overcurrent. The decision to install protective measures shall be assessed based on:

- Risk of damage to the network outside or inside the structure
- Tolerable risk of damage

For the structure and network inside the structure, the customer shall analyse these two values. *Table 1* gives a general overview of the responsibility for protective measures. Annex C of IEC 61643-22 [1] provides additional information concerning Risk Management.

Table 1: Responsibility for protective measures.

Information Technology System	Responsibility
Installation inside the structure; private network	Customer
Installation outside the structure; operator's network	Network operator
Interconnection between operator's network and private network (NT)	Network operator or customer
Information technology equipment ITE	Customer (NOTE)
Additional protective measures based on risk assessment	Customer

NOTE: Resistibility requirements of telecommunications equipment are given by ITU-T K series and referenced by IEC 61663-2 [2]. They are implemented by the ITE-manufacturer.

Coupling mechanisms

When considering the application of SPDs to a telecommunications and signalling network, it is important to determine the probable overvoltage and overcurrent sources and how energy from these sources is coupled into the network. These are shown in *Figure 2*, as are the means for reducing the amount of energy coupled into the network.

To keep the energies of the couplings low or to avoid the couplings, the following measures are necessary: The metallic shield of the cable, if used, shall be continuous, i.e. it shall be connected across all splices, regenerators, etc, along the length of the cable. It shall also be connected to the EBB, preferably directly or through an SPD or a combination of an SPD and a capacitor (to avoid corrosion problems).

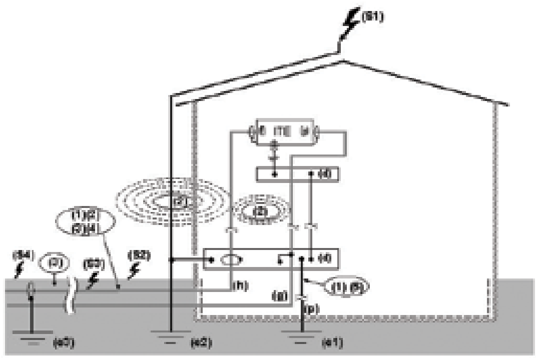
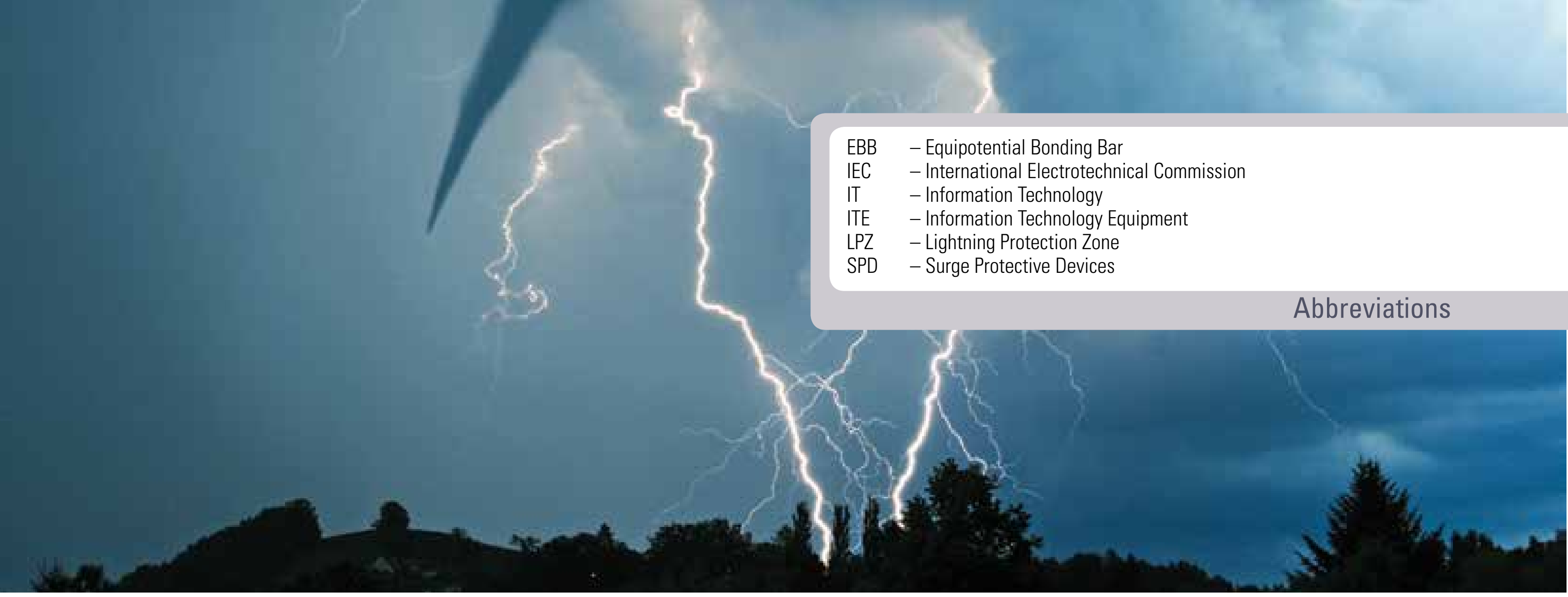


Figure 1: Coupling mechanisms.

Key

(d)	*EBB (see EN 61312 [4] for earthing and bonding services entering the structure in different locations)*
(e1)	*Building earth*
(e2)	*Lightning protection system earth*
(e3)	*Cable shield earth*
(f)	*IT/telecommunication port*
(g)	*Power supply port*
(h)	*IT/telecommunication line or network*
(p)	*Earthing electrode*
(S1)	*Direct lightning to the structure*
(S2)	*Lightning near to the structure*
(S3)	*Direct lightning to the telecommunication/power line*
(S4)	*Lightning near to the telecommunication/power line*
(1) - (5)	*Coupling mechanisms, see Table 2*



EBB – Equipotential Bonding Bar
IEC – International Electrotechnical Commission
IT – Information Technology
ITE – Information Technology Equipment
LPZ – Lightning Protection Zone
SPD – Surge Protective Devices

Abbreviations

Table 2: Coupling mechanisms.

Source of transients	**Direct lightning to the structure (S1)**		**Lightning to earth near the structure (S2)**	**Direct lightning to the line (S3)**	**Lightning to earth near the line (S4)[b]**	**Ac influence**
Coupling	Resistive (1)	Induction (2)	Induction[a] (2)	Resistive (1, 5)	Induction (3)	Resistive (4)
Voltage wave-shape (μs)	–	1,2/50	1,2/50	–	10/700	50/60 Hz
Current wave-shape (μs)	10/350	8/20	8/20	10/350[d]	5/300	–
Preferred test category[c]	D1	C2	C2	D1	B2	A2
NOTE: (1) – (5) see *Figure 1*, coupling mechanisms.						
a Also applies for capacitive/inductive couplings of switching in adjoining power supply networks. b Due to the significant reduction of fields with increased distance coupling effects from afar, lightning strike may be negligible. c See *Table 3* of EN 61643-21 [4]. d The simulated direct lightning strike test impulse is described by IEC/TC81 as a peak current value and total charge. A typical wave shape that can achieve these parameters is a double exponential impulse, 10/350 being used in this example.						

Table 2 shows the relationship between the type of disturbance/coupling mechanism (i.e. direct strike resistive coupling). The voltage and current wave-shapes and test categories are selected from IEC 61643-21 *Table 3*.

> *Depending on the over-voltage/over-current threat levels and SPDs characteristics, a single SPD can be used to protect the equipment within a building.*

Which and where surge protection should be used

Protection devices should be applied in a cascade arrangement at the zone interfaces. The zone concept is especially relevant when a physical LPS exists. For example, the first protection level (j, m), located at the entrance of the building, mainly serves to protect the installation against destruction. This protection should be designed and rated for such a threat. The output of this protection has a reduced disturbance energy that becomes the input disturbance level for subsequent downstream protection. The following protection levels (k, l and n, o) further reduce the surge level to a value that is acceptable for subsequent downstream protection or equipment. Depending on the over-voltage/over-current threat levels and SPDs characteristics, a single SPD can be used to protect the equipment within a building. Several protection levels can be determined by means of a combination protection circuit in one SPD. In this case simply one SPD can be used.

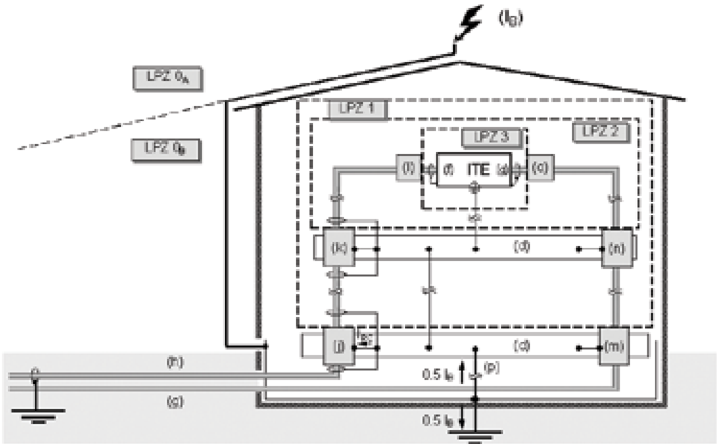


Figure 2: Example of a configuration of the lightning protection concept.

Key
(d) EBB at the lightning protection zone (LPZ) boundary
(f) IT / telecommunication port
(g) Power supply port/line
(h) IT- / telecommunication line or network
I_{PC} Partial surge current of a lightning current
I_B Direct lightning current according to IEC 61312-1 [4], which causes lightning partial currents iPC within buildings via different coupling paths
(j, k, l) SPD according to Table 3 (also see Table 3 of IEC 61643-21)
(m, n, o) SPD according to test classes I, II, III of IEC 61643-11 [5]
(p) Earthing conductor
LPZ 0_A…3 Lightning protection zone 0_A … 3 according to IEC 61312-1 [4]

When cascading SPDs exist, the coordination conditions (s clause 5) should be considered. The corresponding performance parameters with respect to the lightning protected zones (LPZ) are listed in *Table 3*.

Table 3: Selection aid for rating SPDs for the use in (zone) interfaces according to IEC61312-1 [5] / IEC61000-4-5 [6].

Lightning protection zone IEC 61312-1		LPZ 0/1	LPZ 1/2	LPZ 2/3
Range of surge values	10/350	0,5 – 2,5 kA	---	---
	1,2/50 8/20	---	0,5 – 10 kV 0,25 – 5 kA	0,5 – 1 kV 0,25 – 0,5 kA
	10/700 5/300	4 kV 100 A	0,5 – 4 kV 25 – 100 A	---
Require-ments to SPDs (Category from Table 3, EN 61643 21)	SPD (j) a)	D1 or B2	---	No resistive connection to the out-side of the building
	SPD (k) a)	---	C2 or B2	---
	SPD (l) a)	---	---	C1

[a] SPD (j, k, l), see Figure 3
NOTE: The range of surge values indicated under LPZ 2/3 includes typical minimum resistibility requirements and might be implemented into the equipment.

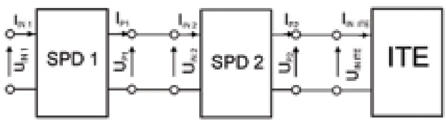


Figure 3: Coordination of two SPDs.

Key

U_{IN2}: UIN ITE - open circuit voltage of the generator used for resistibility verification

I_{IN2}: IIN ITE - short circuit current of the generator used for resistibility verification

U_P - voltage protection level

I_P - let through current

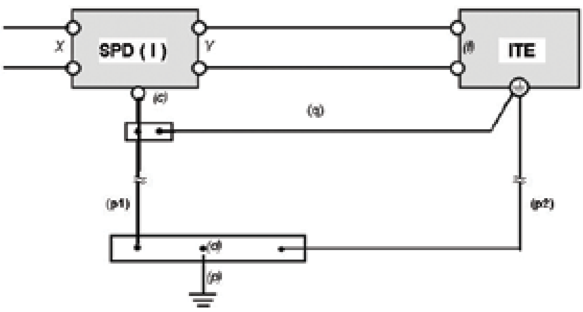


Figure 4: Necessary installation conditions of a 3, 5 or multi-terminal SPD with an ITE for minimising the interference influences on the protection level.

Coordination of SPDs respectively SPD-ITE

To ensure that two cascaded SPDs or an SPD and an ITE to be protected are coordinated during overvoltage conditions, the output protective levels from the SPD 1 should not exceed the input resistibility levels of SPD 2 or the ITE for all known and rated conditions.

Equipotential bonding between the surge protection and the to be protected device

An effective voltage-limiting outcome requires a system-specific observation which has to consider various conditions between the protective device and the ITE.

Additional measures:

- Do not run the cable to the protected port together with the cable to the unprotected port
- Do not run the cable to the protected port together with the earth conductor (p)
- The connection of the protected side of the SPDs to the ITE to be protected should be made as short as possible, or shielded

Bibliography

[1] IEC 61643-22. 2004. Low-voltage Surge Protective Devices: Part 22 - surge protective services connected to telecommunications and signalling networks – selection and application principles.

[2] CLC prTS 61643-22. 2006. Low-voltage surge protective devices: Part 22 - Surge protective devices connected to telecommunications and signalling networks – selection and application principles.

[3] IEC 61663-2. 2001. Lightning protection. Telecommunication lines; lines using metallic conductors.

[4] IEC 61312-1. 1995. Protection against lightning electromagnetic impulse: Part 1 - general principles.

[5] IEC 61643-21. 2000. Low-voltage Surge Protective Devices: Part 21 - Surge protective devices connected to telecommunications and signalling networks – performance requirements and testing methods. Part 11:

[6] IEC 61000-4-5. 1995. Electromagnetic compatibility for industrial process measuremetn and control equipment: Part 4 – surge immunity test.

After his apprenticeship at Deutsche Telekom Dipl Ing Ralf Hausmann studied Information Technology at a University of Applied Sciences. After qualifying as a Dipl Engineer he joined Phoenix Contact in 1987. As a team leader he was responsible for the protective devices used in data, MCR and antenna systems. Eight years later, he moved to overvoltage protection and today his responsibility is that of marketing the protective devices used in Data, Telekom, and antenna systems. He officiates as a chairman of the international standardisation committee IEC SC37A WG4 and the European standardization committee CLC TC37A WG2. The standards IEC/EN 61643-21 and -22 were substantially shaped by Ralf. Enquiries: Email rhausmann@phoenixcontact.com or tonyr@phoenixcontact.co.za