Lightning Protection Zones
and
Protection of Low Voltage Power Systems
According to IEC standards

Present Standards for Lightning
Protection of structures and low voltage installations

IEC 62305-1 // Part 1: (BS EN 62305 –)	General principles
IEC 62305-2 // Part 2: (BS EN 62305 – 2)	Risk management
IEC 62305-3 // Part 3: (BS EN 62305 – 3)	Physical damages and life hazard
IEC 62305-4 // Part 4: (BS EN 62305-4)	LEMP- General principles Protection of electrical and electronic systems
IEC 62305-5 // Part 5: (BS EN 62305 – 5)	Incoming Services Protection of supply lines

Introduction

Lightning protection installations

External lightning protection	Internal lightning protection	Surge protection
• Air Termination • Down Conductor • Earthing • Room shielding	• Equipotential bonding for lightning protection • Room shielding • Screenign • Cable routing	The measures taken to ensure surge protection are separate from the setting-up of a lightning protection installation. However, they must be coordinated with internal lightning protection.

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External Lightning Protection System

Lightning protection system (LPS)

External lightning protection

- **Air Termination**
- **Down Conductor**
- **Earth Termination**
- **Room shielding**

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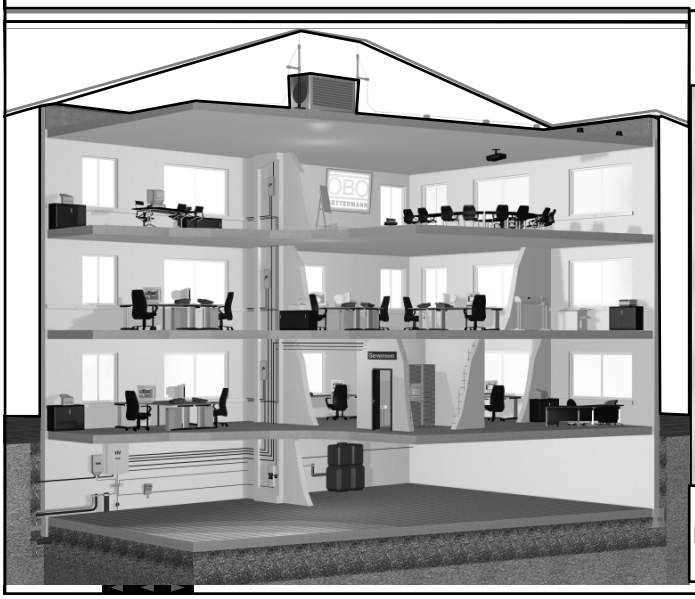
Defining lightning protection zones



Lightning protection zone concept

LPZ 0 A

LPZ 0 B

With External Lightning Protection, the structure is protected against a direct lightning hit.

LPZ = **L**ightning **P**rotection **Z**one

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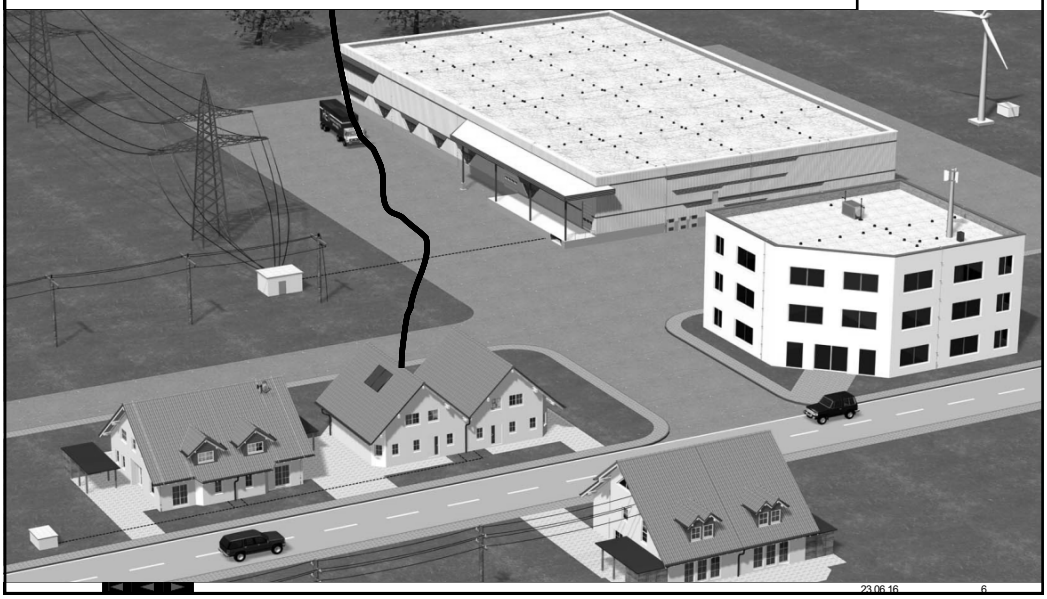
A direct strike on a building without an external lightning protection installation



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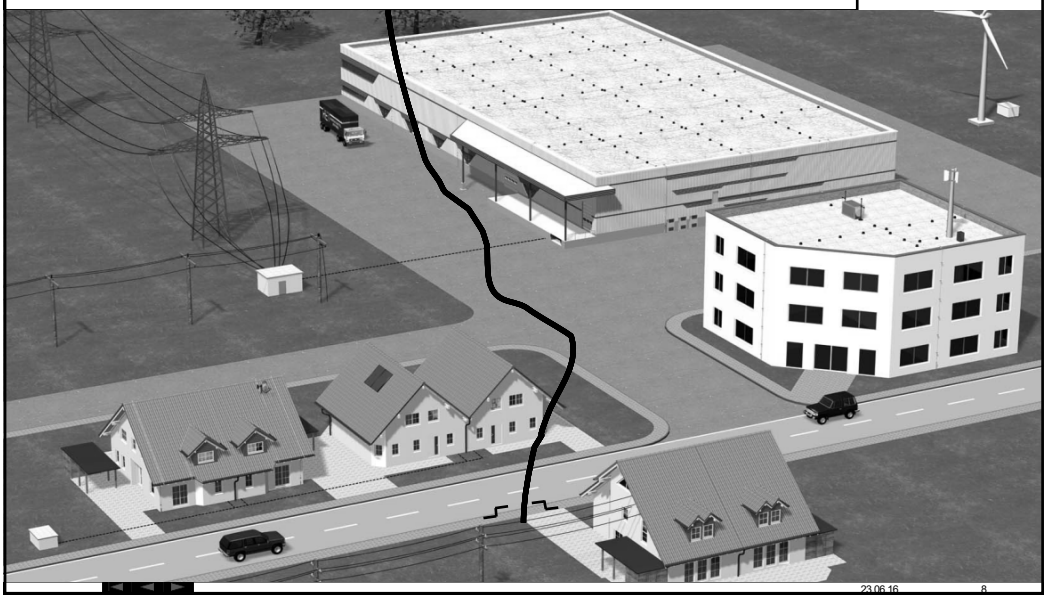
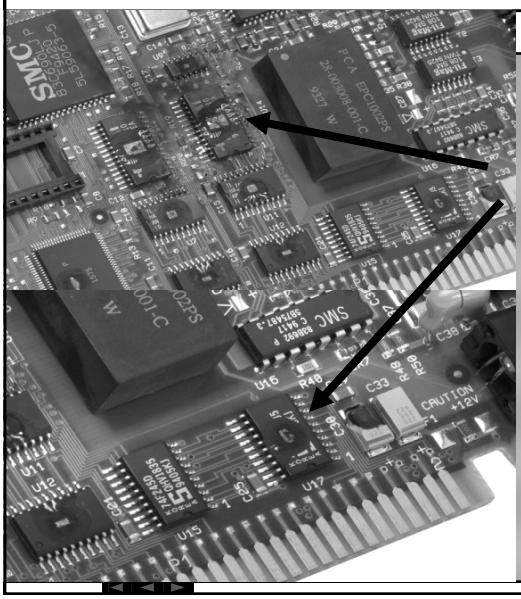
Direct strike on a high-voltage overhead line

Direct strike on a low-voltage overhead line



Direct strike on a low-voltage overhead line



Direct strike on a low-voltage overhead line

Effects: Partial lightning currents and voltage surges in the low-voltage network.
Cause: the amplitude of the lightning impulse current

The preconditions for a direct strike on a low-voltage overhead line are not the same as for direct strikes on high-voltage overhead lines.
The fundamental difference is in the proximity to the building, which permits the conduction of partial lightning currents.

Source: Lightning protection and EMC technology centre (BET)

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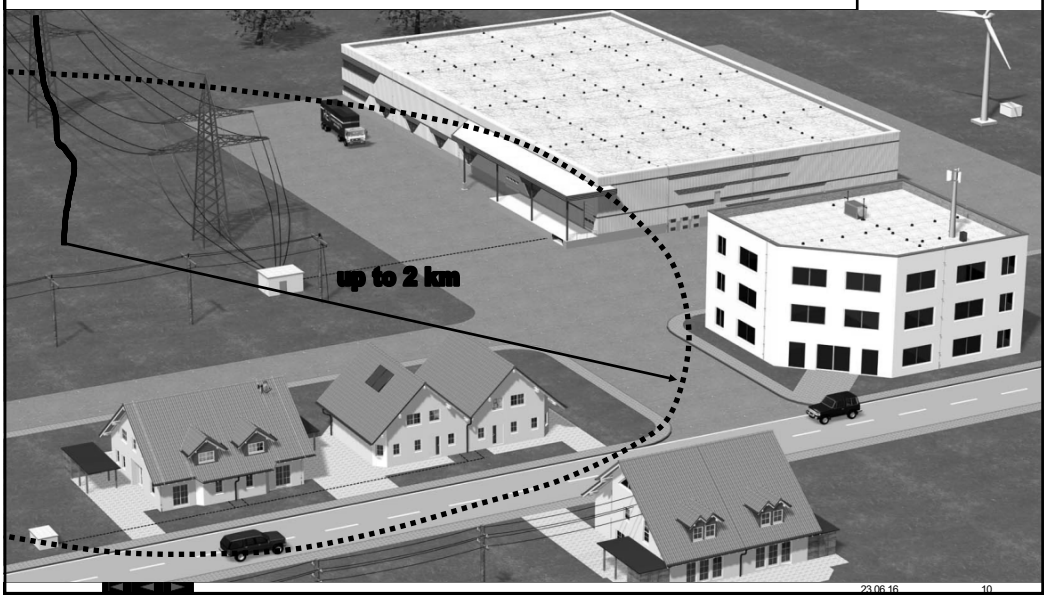
Coupling of voltage surges (distant lightning strike)



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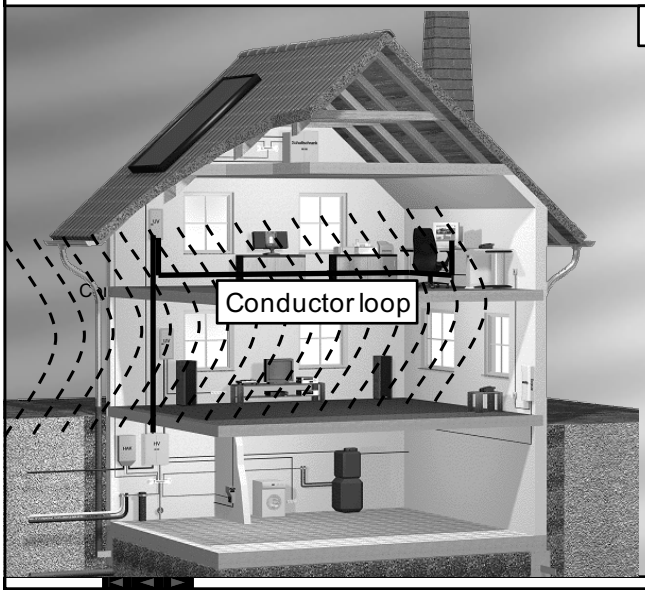
Coupling of voltage surges
(distant lightning strike)



(Distant lightning strike)

Effects: Inductive coupling
Caused by: maximum steepness of the lightning current

$$\left(\frac{di}{dt}\right)_{max}$$

A magnetic field forms around every conductor through which a current flows.
If conductor loops are located in the vicinity of a conductor in which lightning current is flowing, the law of induction states that a voltage will be induced.

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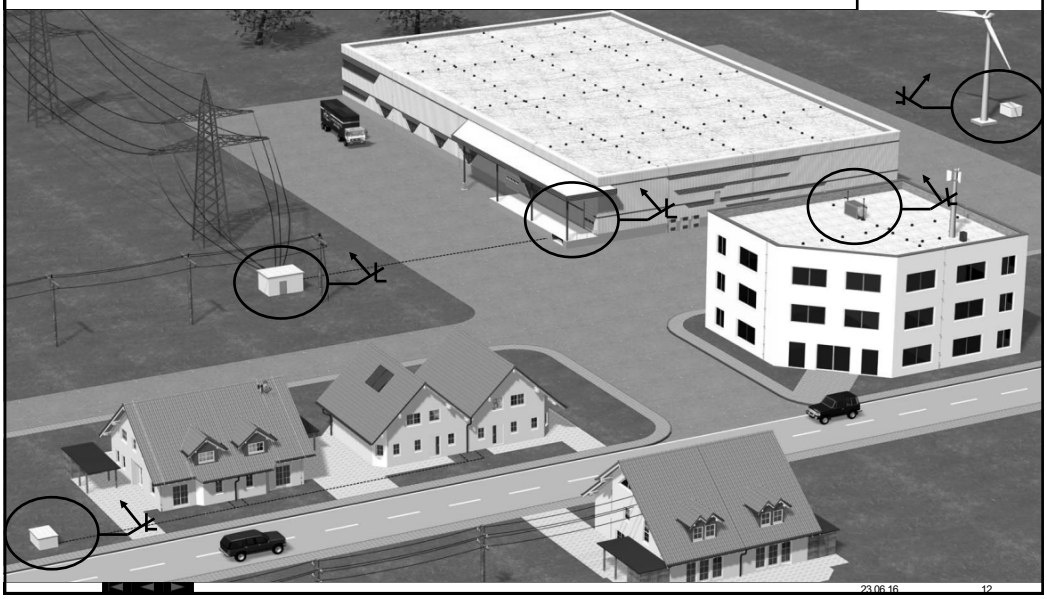
Switching actions



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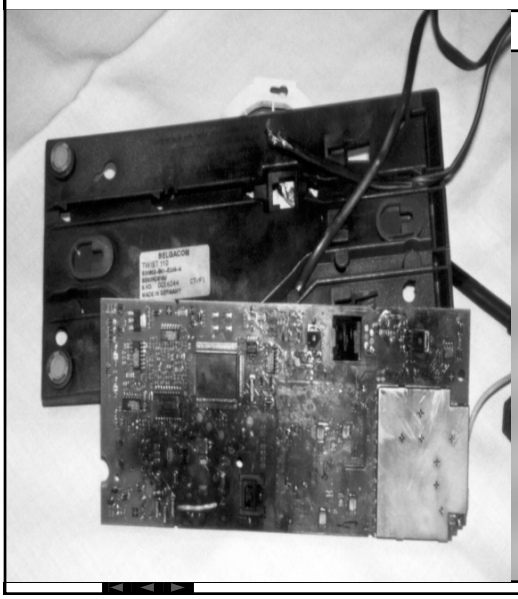
Effects



Switching actions

Effects: Overvoltages (surges) on network lines
Cause: High current steepnesses on switching actions lead to transient surges (overvoltages) on the mains wiring.

Switching actions occur almost everywhere where work is done with electrical energy. Especially vulnerable are areas in which large inductive loads are switched, for example:

- Motors
- Transformers
- Chokes
- Climate control installations
- Welding equipment
- Long light strings

Source: Kopecky/Aachen

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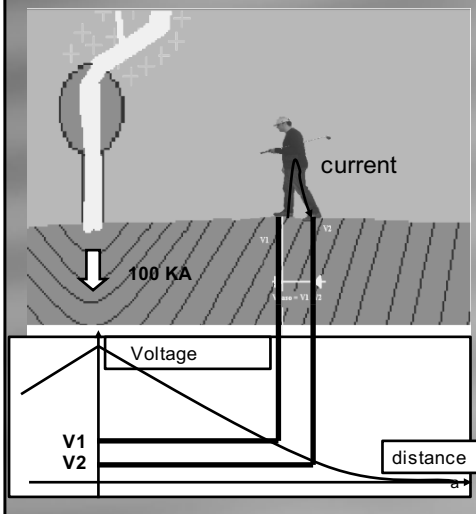
STEP VOLTAGE

STEP VOLTAGE Vs= V1-V2



Indirect Impact
People: High voltages on the ground
Structures: inductive and capacitive joining

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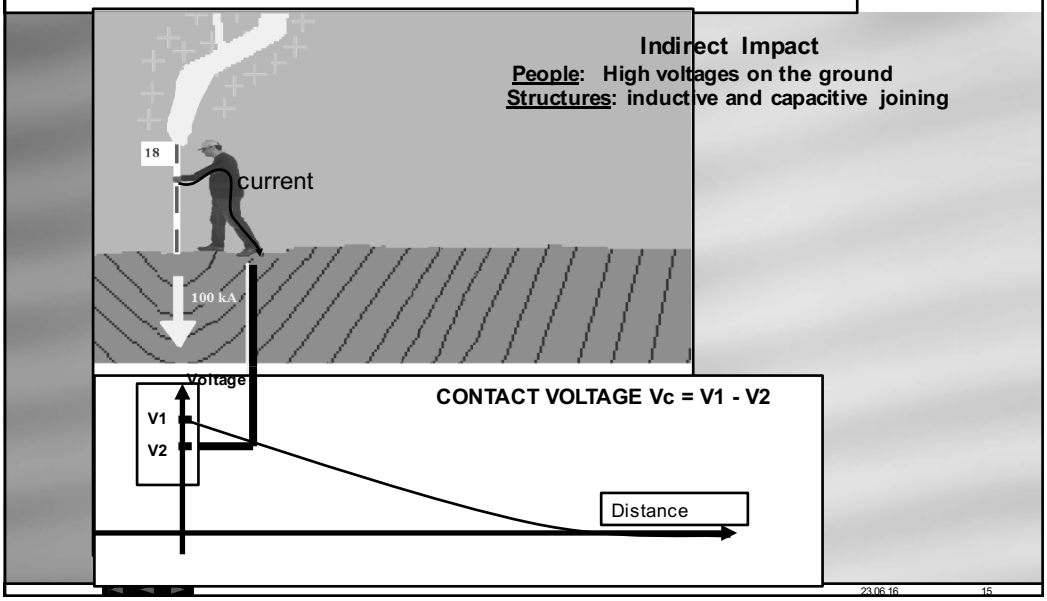
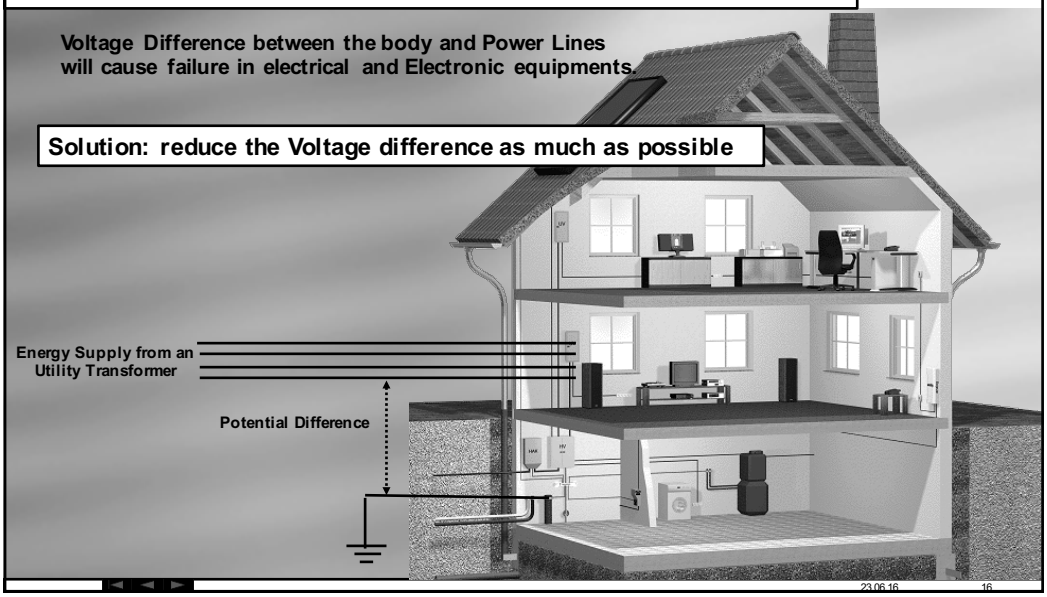
VOLTAGE CONTACT (Touch Voltage)

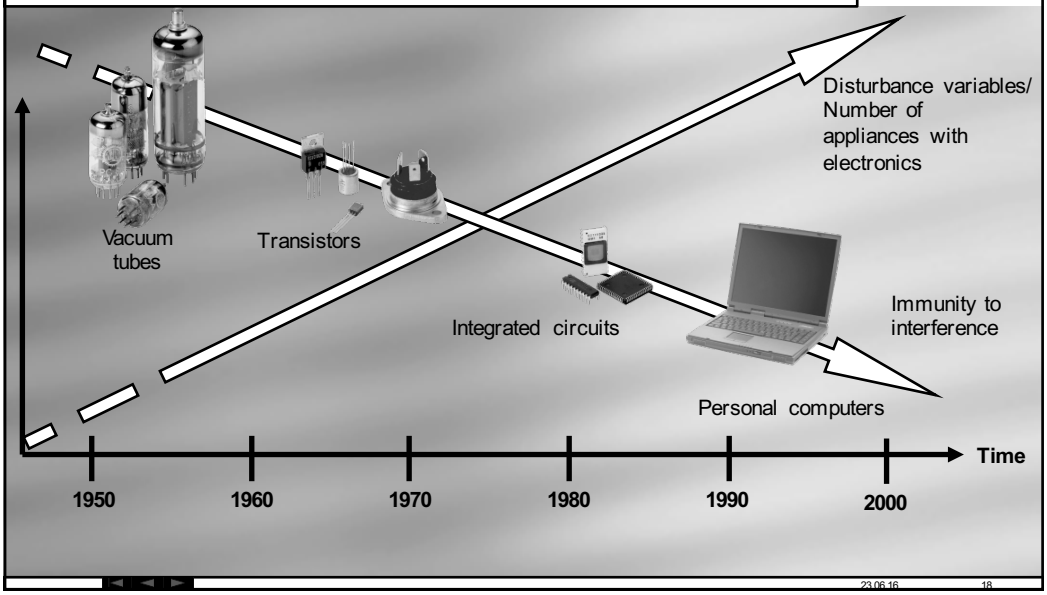


Failure of Electrical / Electronic Equipments



Electrical Systems in Building
Over Voltage Protection
Overview of Latest Standards

History of EMC: Why failures are more now ???



IEC Standards for Low Voltage Electrical Installations

- **IEC 60364-1 Low Voltage Electrical Installations, Fundamentals, Assessment of General Characteristics and Definitions**

- **IEC 60364-4-44 Electrical installations in Building Protection for Safety – Protection against Voltage Disturbances and Protection against Electro magnetic disturbances. Chapter 44 section 443 explains about Protection against Over Voltages of atmospheric origin or due to Switching**

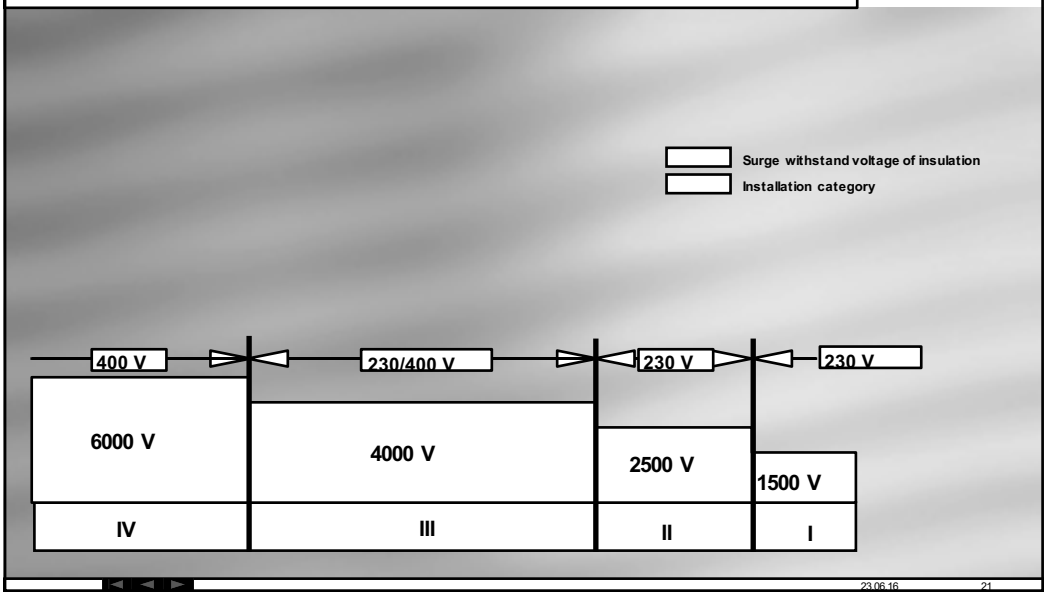
IEC 60364-4-443
Impulse Voltage Withstanding categories of Electrical Equipments

Nominal voltage of the supply system based on IEC 60038 1)		Voltage line to neutral derived from nominal voltages a.c. or d.c. up to and including V	Rated impulse voltage 2) Over voltage category			
Three phase	Single phase		I	II	III	IV
230/400 277/480 400/690 1000	120.240	50	330	500	800	1500
		100	500	800	1500	2500
		150	800	1500	2500	4000
		300	1500	2500	4000	6000
		600	2500	4000	6000	8000
		1000	4000	6000	8000	12000

1) The / mark indicates a four-wire three phase distribution system. The lower value is the voltage line-to-neutral, while the higher value is the voltage line-to-line. Where only one value is indicated, it refers to three-wire, three-phase systems and specifies the value line-to-line.
2) Equipment with these rated impulse voltages can be used in installations in accordance with IEC 60364 - 4 - 443.

Electrical Electronic Equipments in a Building

IEC 60364-4-443 Insulation Coordination of Electrical and Electronic Equipments:



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L.V Switchgear: Contactors

Voltage Impulse withstanding Capacity

A Contactors - A.C. Operated

Technical Data

Type		A 9	A 12	A 16	A 26	A 30	A 40	A 45	A 50	A 63
Number of poles		3 or 4	3	3 or 4	3 or 4	3	3	4	3 or 4	3
Insulation Characteristics										
Rated insulation voltage U_i according to IEC 947-4-1 and VDE 0110 (Gr. C)	V	1000								
according to UL/CSA	V	600								
Rated impulse withstand voltage $U_{imp.}$		8 kV								
Main Pole Utilization Characteristics										
Rated operational voltage U_e	V	690			690			1000		
Conventional free-air thermal current I_{th}										

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L.V Switchgear: Contactors

Voltage Impulse withstanding Capacity

Environment (IEC 947-4-1)				
Pollution Degree		3		
Impulse Voltage withstand	-	6kV		
Operating temperature (upto 300A)	-	-20°C to +55° C		
(above 300A)	-	-20°C to +45° C		
Operating altitude	-	2000m		
Vibration	-	5 to 100 Hz (0.7g in x,y,z, plane)		
Humidity	-	Max 50% RH at 60°C		
	-	Max 95% RH at 40°C		
Operating position	-	±30°		
Contactor			**D15CR**	**CE15BN**	**CE15C**
Nominal current rating at 380/415V 50Hz (A)			-	9.1	12
MECHANICAL DATA					
Frame size (mm)			45	45	45
Number of poles			4	4	4
Mechanical life		Million of Operations	20	20	20
Weight (kg.)			0.41	0.41	0.41
POWER CIRCUIT					
Operational voltage (V)			660	660	660

L.V Switchgear: Moulded Case Circuit Breaker

Voltage Impulse withstanding Capacity

SACE Isomax S circuit-breakers for power distribution

Electrical characteristics IEC 60947-2

			SACE Isomax
ed uninterrupted current, Iu		[A]	125
s		Nr.	3-4
ed service voltage, Ue	(AC) 50-60Hz	[V]	500
	(DC)	[V]	250
d impulse withstand voltage, Uimp		[kV]	6
d insulation voltage, Ui		[V]	500
voltage at industrial frequency for 1 min.		[V]	3000
d ultimate short-circuit breaking capacity, Icu			B

d impulse withstand voltage, Uimp	[kV]	6	6	8
d insulation voltage, Ui	[V]	500	690	800
voltage at industrial frequency for 1 min.	[V]	3000	3000	3000

Industrial Electronics

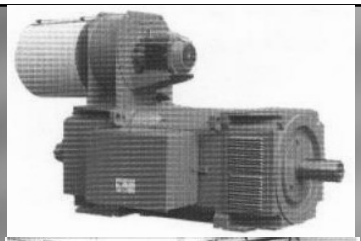
AC/DC drives Operating up to 500 volts

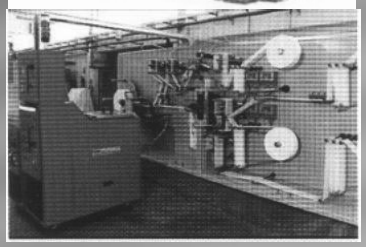
V_{imp} withstand capacity: 1500–1600 volts

PLC's Operating at 24 volt DC

V_{imp} withstand capacity: 300 – 400 volts

Industrial Electronics





Electro Magnetic Equipments: 1.8 to 2.5 KV

Highly Sensitive Equipments: 0.5 to 1 KV

Home Entertainment System: 1.5 to 1.8 KV

Personal Computers: 1 to 1.5 KV

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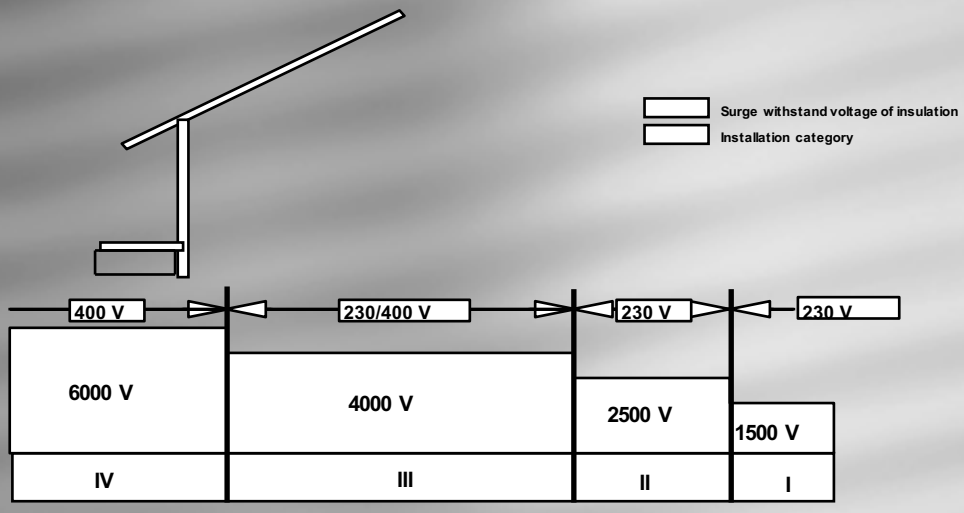
Electrical / Electronic Equipments in a Building

IEC 60364-4-443 Insulation Coordination of Electrical and Electronic Equipments:



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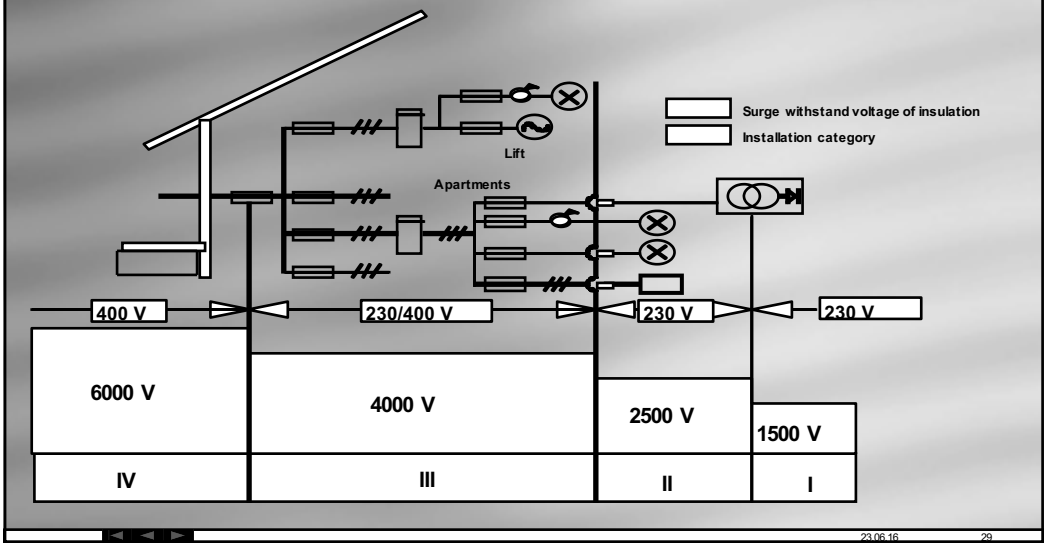
IEC 60364-4-443 Insulation Coordination of Electrical and Electronic Equipments:



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IEC 60364-5-53 Electrical Installations in a Building (Selection and Erection of Electrical Equipments for Isolation, Switching and Control)

Electrical Installations in a Building need

- Over Current Protection
  1. Over Load Protection
  2. Short Circuit Protection
- Residual Current Protection
- Over Voltage Protection
- Coordination of Various Protection Devices

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IEC 60364-5-53 Electrical Installations in a Building

Over Voltage Protection of LV Systems. Why?

- **Achieve Insulation coordination**
- **Surge Protective devices Should be installed in the line to obtain Limitation of Transient Over Voltages caused by Direct Lightning Strike in the building, Nearby Lightning strike in the building, Transmitted Surges through the incoming Power Lines, Switching Over Voltages.**

Over Voltage Protection of LV Systems. How?

- **Place of Use – At the origin of Installation and then according to IEC standard for protection against LEMP**
- **Connection of SPD's**
- **Selection of SPD's**

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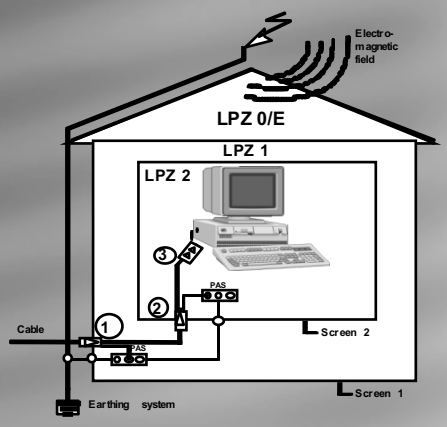
Place of Use
Lightning protection zone concept according to IEC 61312-1 & IEC 62305



- **LPZ = lightning protection zone**
  - PAS = equipotential bonding bar
  - Screen 1 = building screen
  - Screen 2 = room screen

1 Lightning arresters Class 1
to **IEC 61643** (also called as Class B)
Requirement class 1 (<4 kV)

2 Surge arresters Class 2
to **IEC 61643** (also called as Class C)
Requirement class 2 (<2.5 kV)

3 Surge arresters Class 3
to IEC 61643 (also called as Class D)
Requirement class 3 (<1.5 kV)

Computer, telecommunications and control system cables must also be covered by the **equipotential bonding** by surge protection devices at their zone interfaces.

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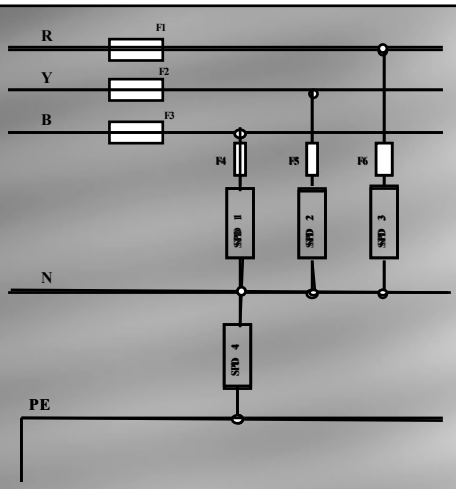
Connection diagram for SPD for 3 phase 4 wire network

Connection 3 + 1 Before RCCB



F1, F2, F3 - : Incoming ACB/MCCB/SFU
F4, F5, F6 -: Back up fuse for Surge Arrester
PE - : Panel Earth
For backup fuse rating refer manufacturers catalogue

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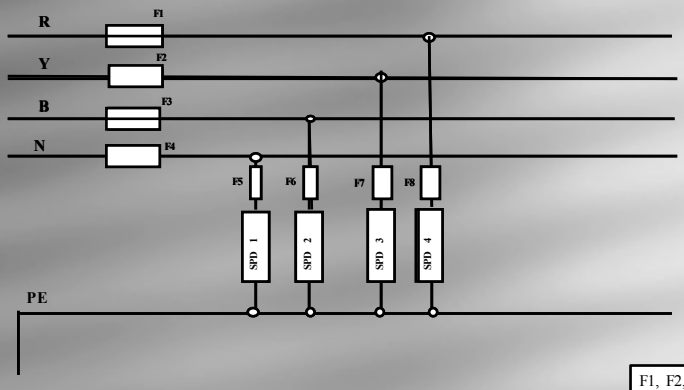
Connection diagram for SPD for 3 phase 4 wire network

Connection R,Y,B,N to PE After RCCB



F1, F2, F3,F4 - : Incoming ACB/MCCB/SFU
F5, F6,F6,F7 -: Back up fuse for Surge Arrester
PE - : Panel Earth
For backup fuse rating refer manufacturers catalogue

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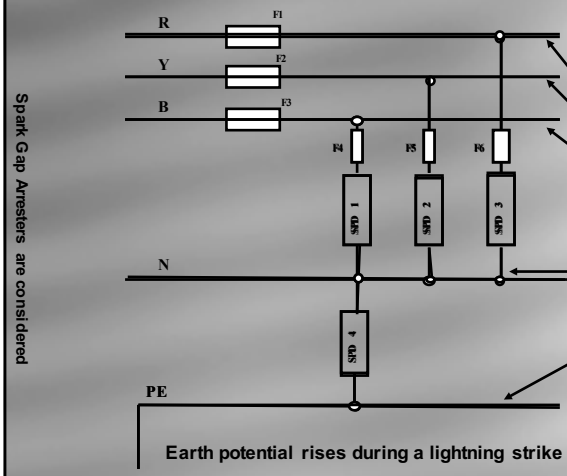
Connection diagram for SPD for 3 phase 4 wire network

Connection 3 + 1



Equipotentialisation achieved.

There is no potential difference between Earth line, Neutral and other phases. Electrical / Electronic Equipment is safe since there is no voltage between phases and neutral

SPD 1,2,3 operates because of Voltage difference between Neutral and other phases

Earth potential rises during a lightning strike

Voltage protection level of arrester = 1000 volts

F1, F2, F3	- : Incoming ACB/MCCB/SFU
F4, F5, F6	-: Back up fuse for Surge Arrester
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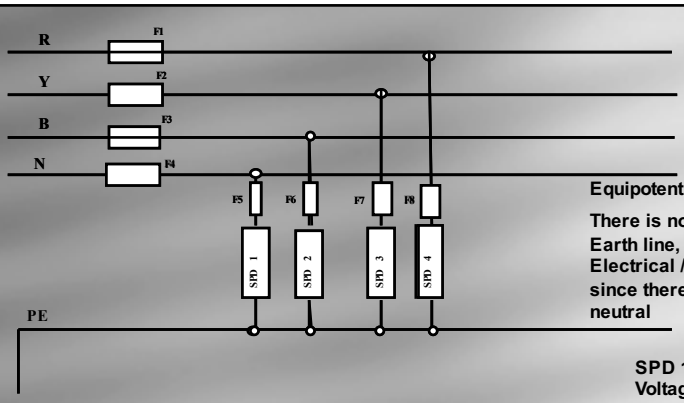
Connection diagram for SPD for 3 phase 4 wire network

Connection R,Y,B,N to PE



Equipotentialisation achieved.

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SPD 1,2,3& 4 operates because of Voltage difference between Neutral and other phases

Earth potential rises during a lightning strike

Voltage protection level of arrester = 1000 volts

F1, F2, F3,F4	- : Incoming ACB/MCCB/SFU
F5, F6,F6,F7	-: Back up fuse for Surge Arrester
PE	- : Panel Earth

For backup fuse rating refer manufacturers catalogue

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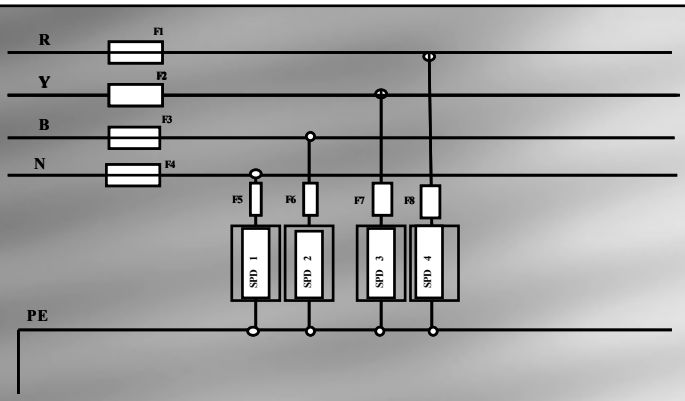
Connection diagram for SPD for 3 phase 4 wire network

Connection R,Y,B,N to PE



To Load which can withstand 2500 volts

Voltage protection level of arrester should be less than the equipment withstand level

Surge through Y phase

SPD 3 Operates because of difference in voltage

High Voltage reaches PE

SPD 1,2 & 4 Operates because of difference in voltage

F1, F2, F3,F4 - : Incoming ACB/MCCB/SFU

F5, F6,F6,F7 -: Back up fuse for Surge Arrester

PE - : Panel Earth

For backup fuse rating refer manufacturers catalogue

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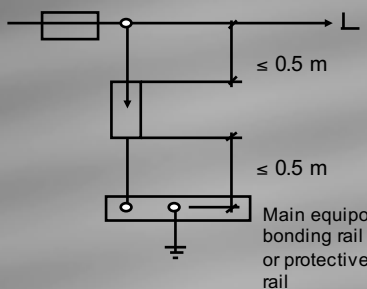
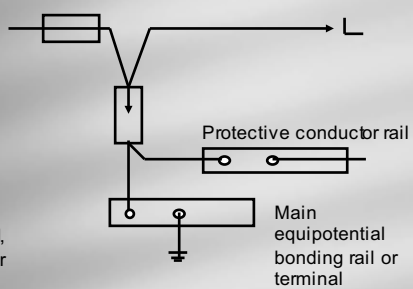
Connecting wires

If it is not possible to keep to the recommended line length of ≤ 0.5 m to the arrester and from the arrester to the earthing point, the surge protection devices should not be connected with a spur line, but in a V-shape.

Take care to run the outgoing and return lines as far apart as possible.





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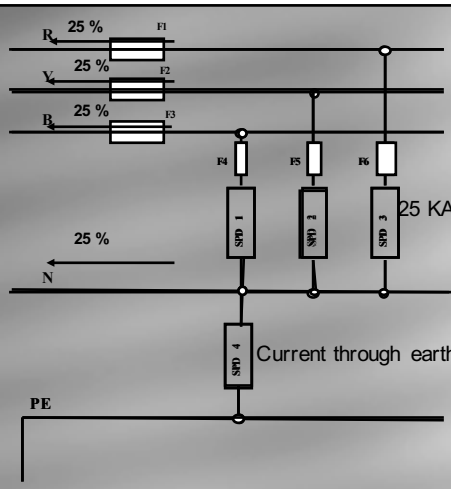
Selection of SPD's

- Voltage Protection Level between Line and PE should be less than 2.5 KV
- Maximum Continuous operating voltage of arrester should be 1.1 times the Line to Neutral Voltage of the system
- Temporary Over Voltages – Arresters should withstand Temporary Over Voltage
- Impulse Current I_{imp} (10/350 µS) and Discharge Current I_n (8/20 µS)
- Expected Short Circuit Current
- Arrester Coordination

Connection diagram for SPD for 3 phase 4 wire network

Connection 3 + 1 (Current Sharing)



25 KA current flows through each Line as well as through SPD 1,2 and 3

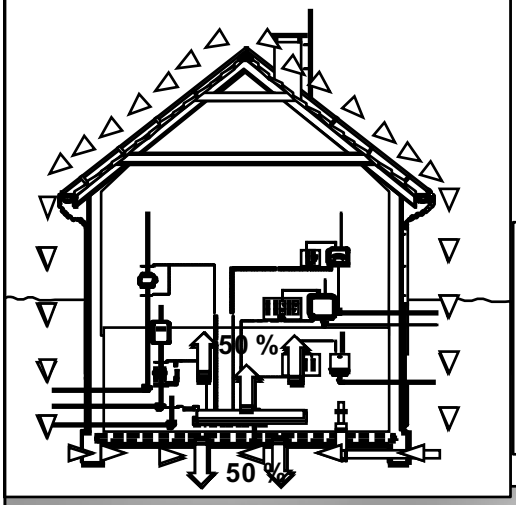
Current is shared at Neutral in 4 lines

Current through earth reaches Neutral (Say 100 KA)

F1, F2, F3	- :	Incoming ACB/MCCB/SFU
F4, F5, F6	-:	Back up fuse for Surge Arrester
PE	- :	Panel Earth

For backup fuse rating refer manufacturers catalogue

Equipotential bonding for lightning protection according IEC 61024-1 and IEC 61312-1; IEC62305



The 100% of lightning energy breaks down as follows:

a) **50% of the lightning current will flow through the ground**

b) **50% of the lightning current will flow over the connected metal parts out of the building:**

In India & Sri Lanka Only Chance is Power Line

Approximately 50 % of Total Lightning Current has to be diverted to Power lines

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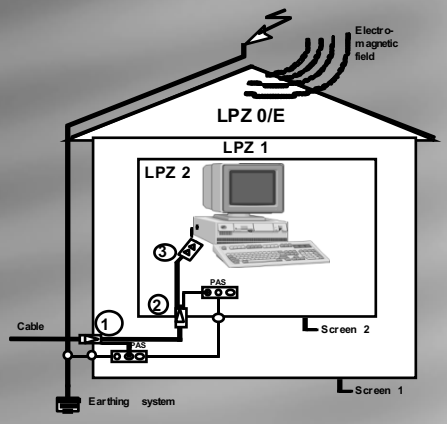
Lightning protection zone concept according to IEC 61312-1 & IEC 62305



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Requirement class 2 (<2.5 kV)

3 Surge arresters
to IEC 61643 (also called as Class D)
Requirement class 3 (<1.5 kV)

Computer, telecommunications and control system cables must also be covered by the **equipotential bonding** by surge protection devices at their zone interfaces.

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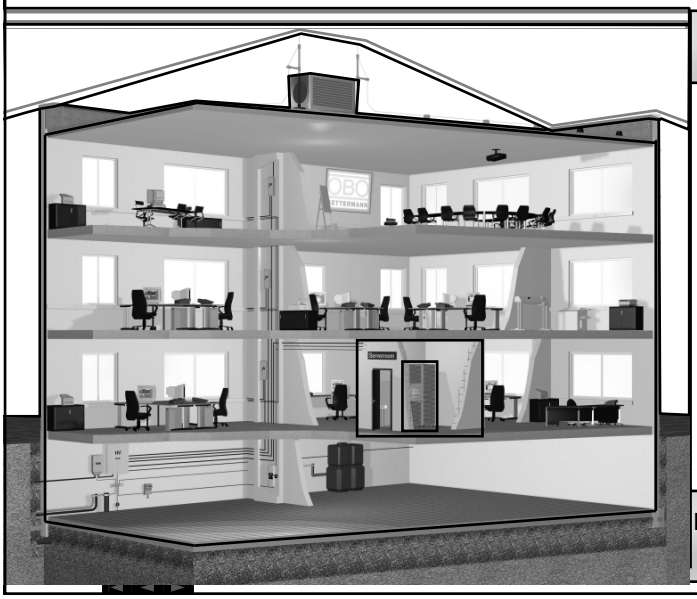
Lightning protection zone concept Practical Case



Lightning Protection Zone concept

- LPZ 0 A
- LPZ 0 B
- LPZ 1
- LPZ 2
- LPZ 3

LPZ = **L**ightning **P**rotection **Z**one

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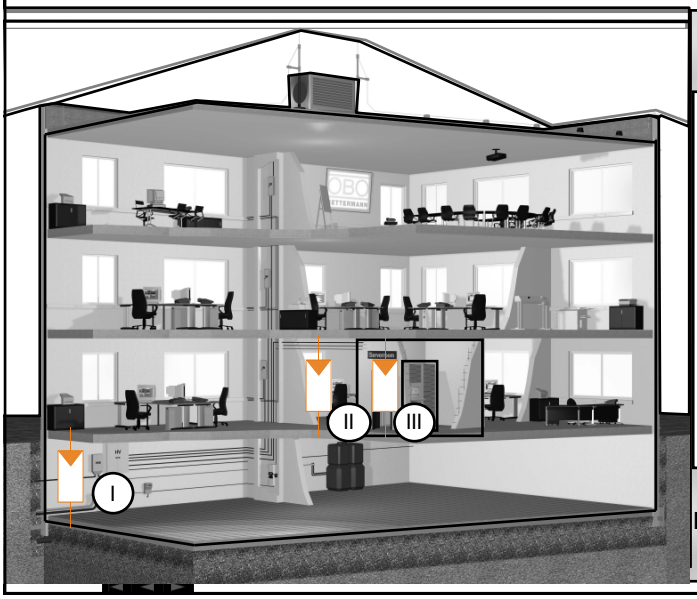
Incorporating the power and data lines into the equipotential bonding system for lightning protection



Lightning protection zone concept

- (I) LPZ 0→ LPZ 1 **Class 1 (Class B)**
- (II) LPZ 1 → LPZ 2 **Class 2 (Class C)**
- (III) LPZ 2 → LPZ 3 **Class 3 (Class D)**

LPZ = **L**ightning **P**rotection **Z**one

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Arrester Standardisation

IEC 61643-1:1998 / VDE 0675, P.6/A1/A2
Surge Protective Devices Connected to
Low-Voltage Power Systems

Class 1 / B	Class 2 / C	Class 3 / D
Arrester for lightning equipotential bonding.	Arrester for Over voltage surge protection.	Fine protectors for mobile use and for the top-hat rail.
Tested: I_{imp} (10/350) Charge Specific Energy	Tested: I_{max} (8/20) I_n (8/20)	Tested: U_{oc} (1,2/50)

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Arrester Standards & Technologies

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Standards

International

IEC 61643 – 1. SPD's connected to L.V Power Systems

IEC 61643 – 11 Selection and Erection of SPD's connected to L.V Power Systems

IEC 61643 – 12 SPD's for Telecom and Signal Lines

IEC 61643 - 22 Selection and Erection of SPD's for Telecom and Signal Lines

British (Equivalent to IEC)

BS EN 61643 – 1. SPD's connected to L.V Power Systems

BS EN 61643 – 11 Selection and Erection of SPD's connected to L.V Power Systems

BS EN 61643 – 12 SPD's for Telecom and Signal Lines

BS EN 61643 - 22 Selection and Erection of SPD's for Telecom and Signal Lines

ANSI / UL

UL 1449: 2006 (link)

TVSS is an old name – New Name SPD

UL 1449

ISBN 0-7629-1197-2

Surge Protective Devices

SEPTEMBER 29, 2006

UL 1449

Standard for Surge Protective Devices

First Edition – August, 1985
Second Edition – August, 1996

Third Edition

September 29, 2006

The most recent designation of ANSI/UL 1449 as an American National Standard (ANSI) occurred on September 27, 2006.

This ANSI/UL Standard for Safety, which consists of the Third edition is under continuous maintenance, whereby each revision is ANSI approved upon publication.

An effective date included as a note immediately following certain requirements is one established by Underwriters Laboratories Inc.

Revisions of this Standard will be made by issuing revised or additional pages bearing their date of issue. A UL Standard is current only if it incorporates the most recently adopted revisions, all of which are itemized on the transmittal notice that accompanies the latest set of revised requirements. Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at http://csds.ul.com.

ISBN 0-7629-1197-2

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3.33 SHORT CIRCUIT CURRENT RATING (SCCR) OF SPD – The suitability of an SPD for use on an AC power circuit that is capable of delivering not more than a declared rms symmetrical current at a declared voltage during a short circuit condition.

3.34 SUPPLEMENTARY PROTECTION DEVICE – A device intended for use as overcurrent, over- or under-voltage, or over-temperature protection within electrical equipment where branch circuit overcurrent protection is already provided, or is not required.

3.35 SURGE – A transient wave of current, potential or power in an electric circuit. For the purposes of this standard, surges do not include temporary overvoltages (TOV) consisting of an increase in the power frequency voltage for several cycles.

3.36 SURGE PROTECTIVE DEVICE (SPD) – A device composed of at least one non-linear component and intended for limiting surge voltages on equipment by diverting or limiting surge current and is capable of repeating these functions as specified. SPDs were previously known as Transient Voltage Surge Suppressors or secondary surge arresters.

3.37 TWO-PORT SPD – An SPD having provisions (terminals, leads, plug) for connection to the ac power circuit and provisions [terminals, leads, receptacles(s)] for supplying current to one or more ac power loads. SPDs provided with a minimum of two adjacent terminals for each circuit conductor may be considered and tested as a two-port SPD.

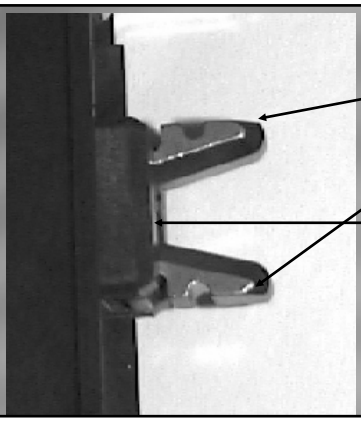
3.38 VOLTAGE AND CURRENT LIMITING TYPE SPD – An SPD that has a high impedance to surges at the input, such as a series connected inductor, followed by voltage limiting or voltage switching components.

3.39 VOLTAGE PROTECTION RATING (VPR) – A rating selected from a list of preferred values as given in Table 63.1 and assigned to each mode of protection. The value of VPR is determined as the nearest highest value taken from Table 63.1 to the measured limiting voltage determined during the transient-voltage surge suppression test using the combination wave generator at a setting of 6kV, 3kA.

3.40 VOLTAGE-LIMITING-TYPE SPD – An SPD that has a high impedance when no surge is present, but will reduce it continuously with increased surge current and voltage. Common examples of components used as nonlinear devices are varistors and suppressor diodes. These SPDs are sometimes called "clamping-type" SPDs.

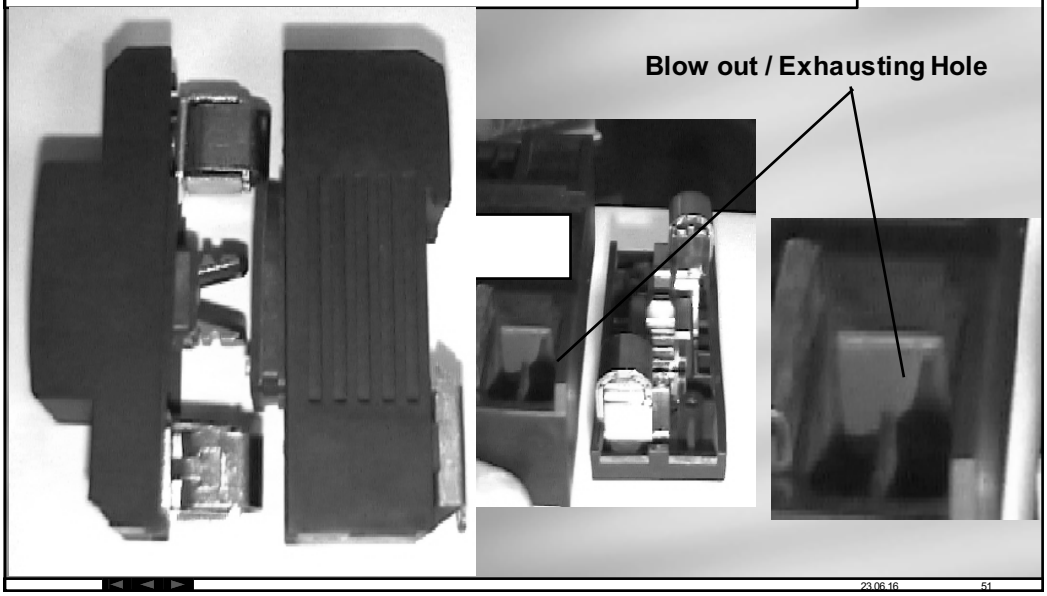
3.41 VOLTAGE-SWITCHING-TYPE SPD – An SPD that has a high impedance when no surge is present, but can have a sudden change in impedance to a low value in response to a voltage surge. Common examples of components used as nonlinear devices are spark gaps, gas tubes, and silicon-controlled rectifiers. These SPDs are sometimes called crowbar-type SPDs.

Spark gap technology

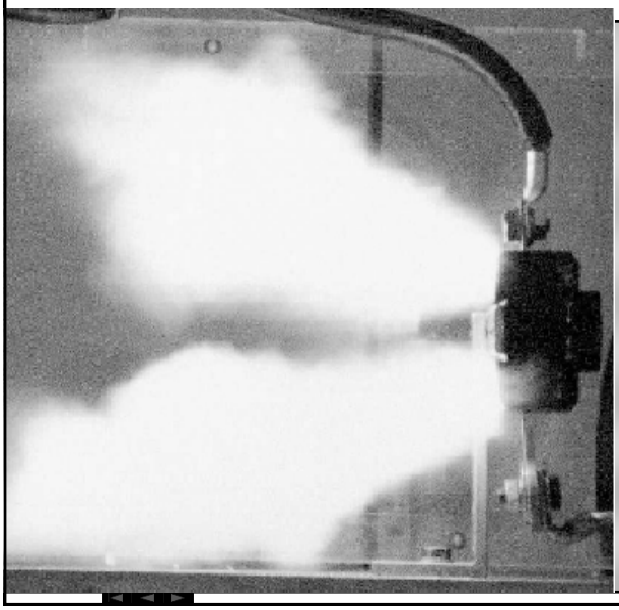


The operating voltage can be determined by the distances between the electrodes.
Spark gaps are arresters in which two or more electrodes in series are opposed to each other. The electrodes consist of incombustible material (metal, carbon, etc).
If a spark gap fires, the operating voltage collapses to the anode-cathode drop voltage.

Spark gap technology

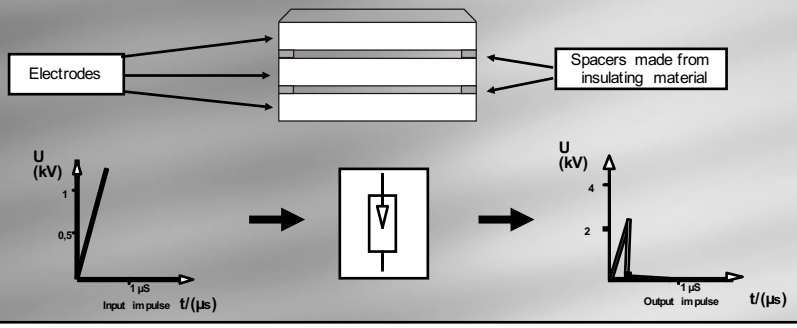


Spark gap technology



During a Lightning current admission, the spark gap blows hot ionized gases through the holes provided in the arrester. Ionized gases are good conductors of electricity. Hence Blow out type arresters should be connected away from live parts. These devices should be installed in pressure releasing type enclosures

Spark gap technology Encapsulated

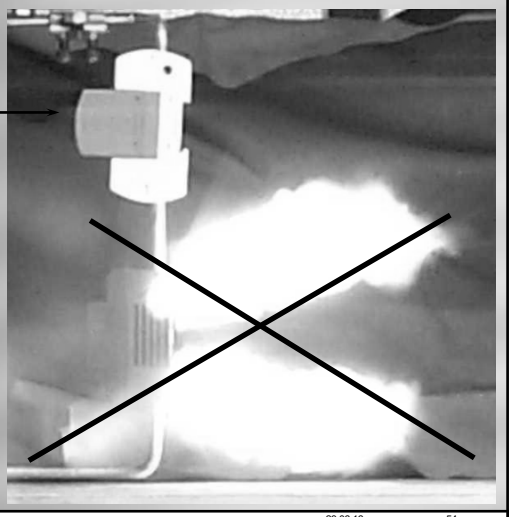


High Follow Current extinguishing capacity is achieved by connecting Spark Gaps in series, There by splitting the arc.

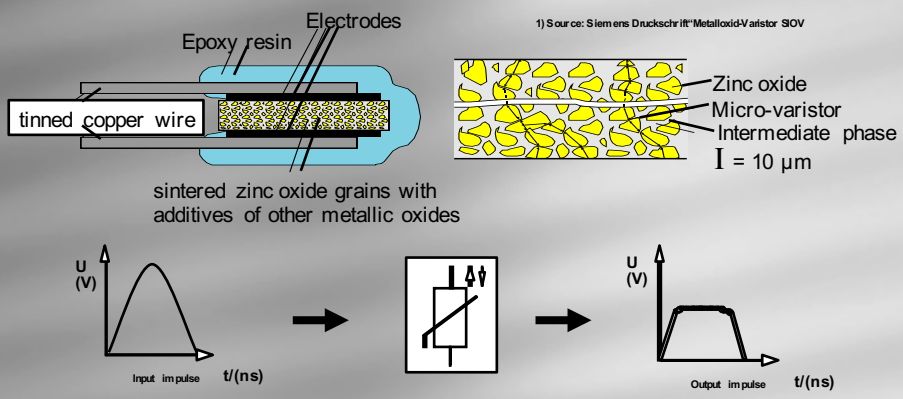
Application advantage / Encapsulated Arrester

Advantage for the installer by using Encapsulated Arresters

- **No minimum distances through other electrical installations!**
- **No special housing necessary!**

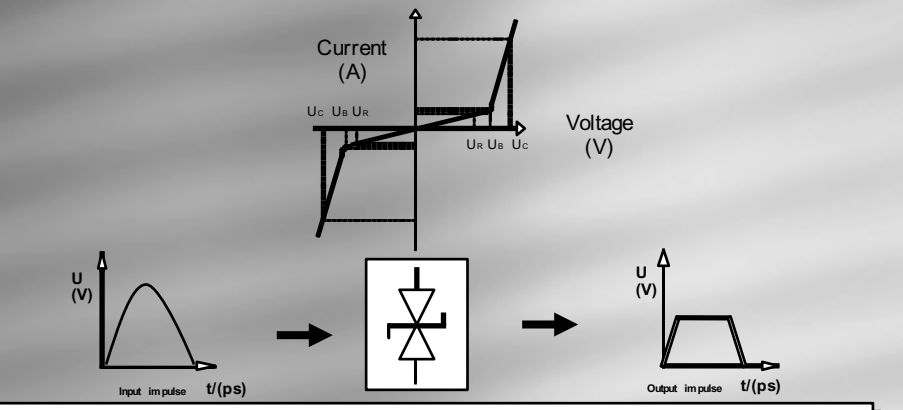


Varistor technology



Varistors are voltage-dependent resistors with a highly non-linear U/I characteristic.
The electrical properties arise from a large number of micro-varistors connected in parallel and in series.
The transitions between the micro-varistors age under the influence of overvoltages.

Diode technology



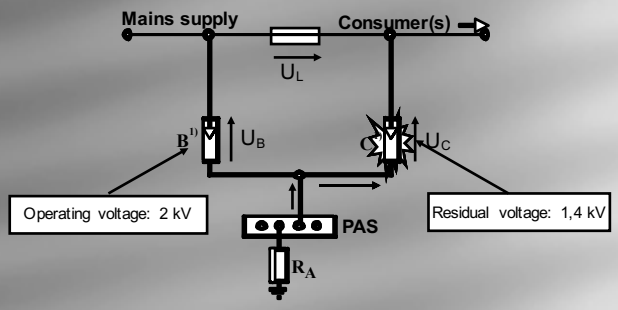
Transzorb diodes (also known as suppresser diodes) are diodes that limit both positive and negative voltage.
They switch in the picosecond region and are especially well suited for use in data line protection devices.

Arrester technologies

How to limit big lightning currents and surge overvoltages!

Spark gaps	Varistors	Diodes
High-performance spark gaps have a very high discharge capacity, which is why they are used as lightning arresters.	Varistors are used in surge arrestersand fine protection devices. Unlike other types of arrester, their ability to carry lightning current is limited.	Transzorb diodes, also known as suppresser diodes, are used as diode arresters only in fine protection devices. They are characterised by a fast response, but their discharge capacity is limited.

Installation guidance / arrester coordination
Interaction of B and C arresters



Coupling-in of a partial lightning current

Because it starts conducting quicker the C-arrester responds first.

The C-arrester may be destroyed by high partial lightning currents.

[1)] Arresters of requirement class

Inclusion of a decoupling impedance

$U_L = -L \times \frac{di}{dt}$

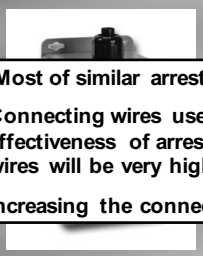
$U_L + U_C = U_B$

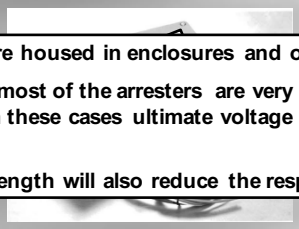
One metre of line length corresponds to about 1 µH, so five metres of line length are sufficient.

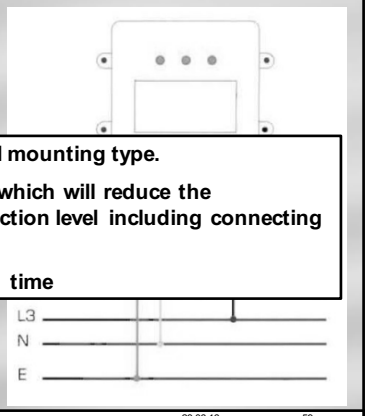
Type of connection (OLD)

Lint to Neutral
Line to Earth
Neutral to Earth
Line to Line

→ These are also called as 7 mode protection, 10 mode protection etc







Most of similar arresters are housed in enclosures and of Wall mounting type.

Connecting wires used for most of the arresters are very long which will reduce the effectiveness of arrester (In these cases ultimate voltage protection level including connecting wires will be very high)

Increasing the connecting length will also reduce the response time

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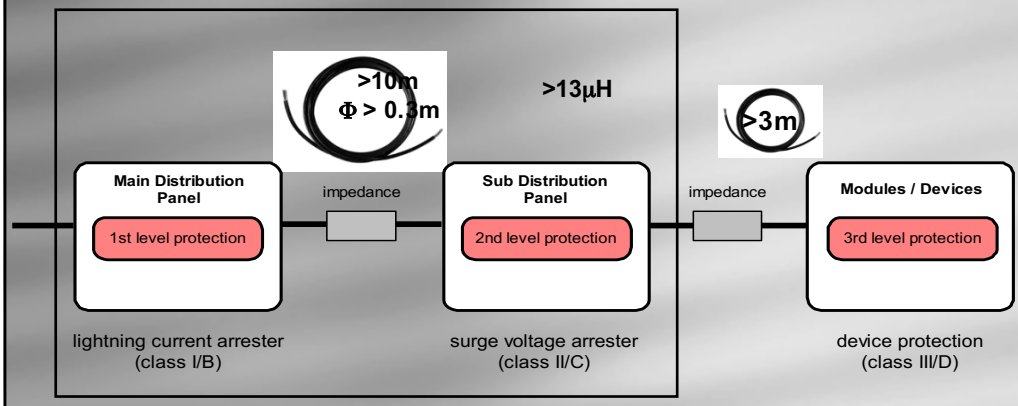
Earlier Concept

(Discontinued by most of the reputed Manufacturers more than 5 years)



Combination of 2 set of arresters with a coordination cable were also called as Surge Filters by few manufacturers creating an impression that customer gets an SPD and a Filter !!!!!!!

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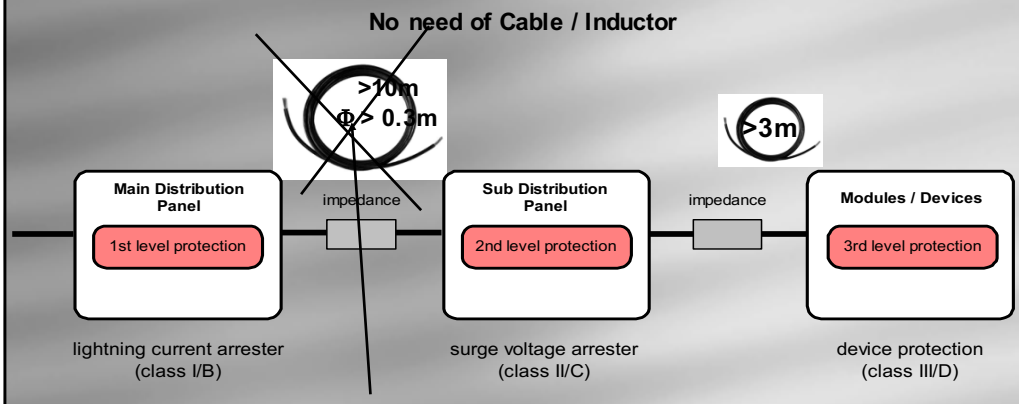
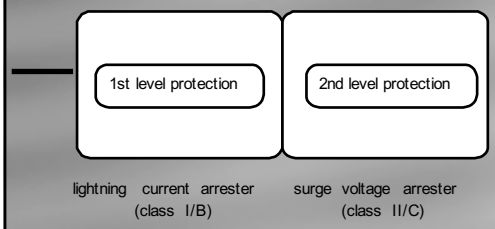
Latest Concept



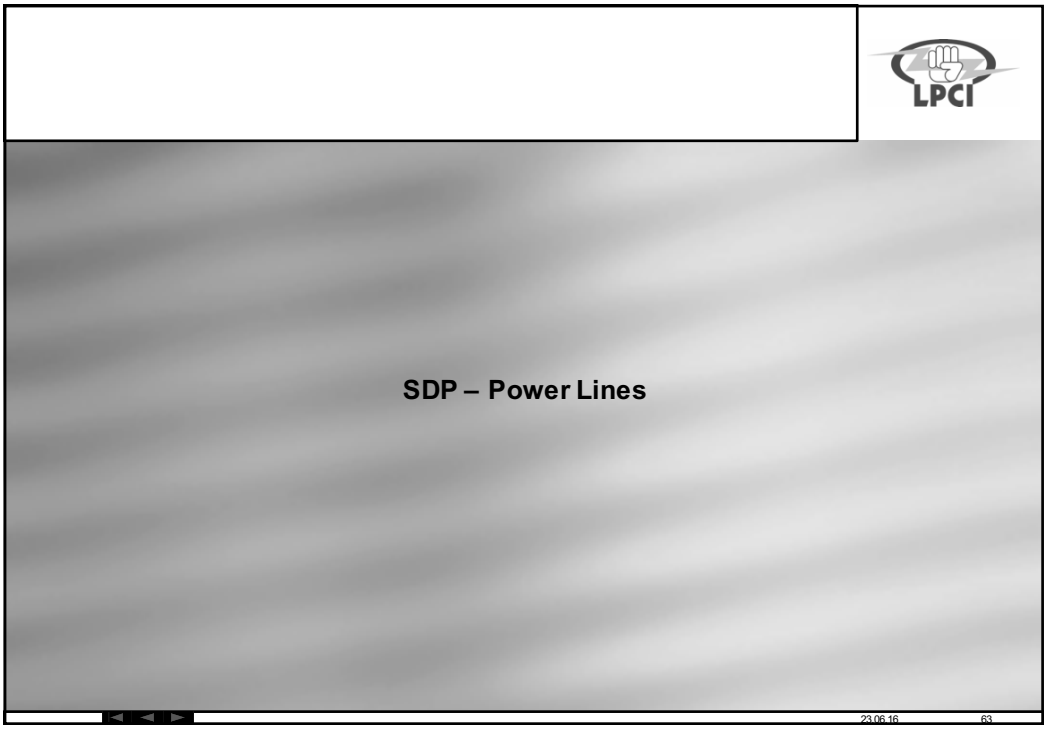
This concept is discontinued almost 8 years back

Latest Concept

Class B and Class C devices can be connected together with out a coordination cable / Inductor. These special Class B arresters are called as Coordinated class B arrester, with a voltage protection level less than 1300 volts



This is for Special Applications Like Mobile Telecom Shelters These are also called B+C arresters or Type 1+2 arresters


SDP – Power Lines
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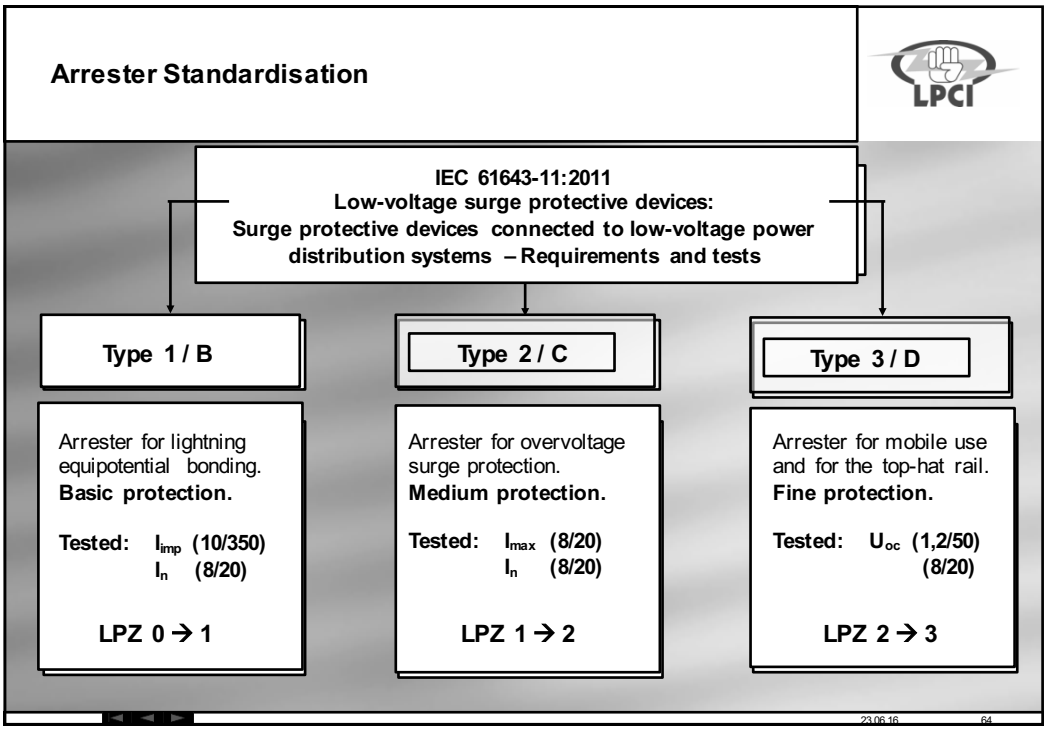
Arrester Standardisation
IEC 61643-11:2011
Low-voltage surge protective devices:
Surge protective devices connected to low-voltage power distribution systems – Requirements and tests
Type 1 / B
Arrester for lightning equipotential bonding.
Basic protection.
Tested: I_{imp} (10/350)
I_n (8/20)
LPZ 0 → 1
Type 2 / C
Arrester for overvoltage surge protection.
Medium protection.
Tested: I_{max} (8/20)
I_n (8/20)
LPZ 1 → 2
Type 3 / D
Arrester for mobile use and for the top-hat rail.
Fine protection.
Tested: U_{oc} (1,2/50)
(8/20)
LPZ 2 → 3
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3. Arrester Standardisation

IEC 61643-1:2005-03 / EN 61643-11 / VDE 0675, P. 6-11:2002
VDE 0675, P.6/A1/A2
Low-voltage surge protective devices – Part 1:
Surge protective devices connected to low-voltage power distribution systems – Requirements and tests

Type 1 / B	Type 2 / C	Type 3 / D
Arrester for lightning equipotential bonding. **Basic protection.**	Arrester for overvoltage surge protection. **Medium protection.**	Arrester for mobile use and for the top-hat rail. **Fine protection.**
Tested: I_{imp} (10/350) I_n (8/20)	**Tested:** I_{max} (8/20) I_n (8/20)	**Tested:** U_{oc} (1,2/50) (8/20)
LPZ 0 → 1	**LPZ 1 → 2**	**LPZ 2 → 3**

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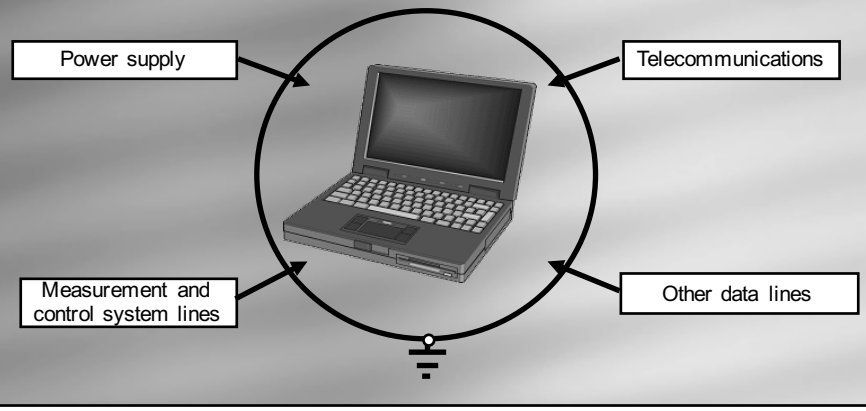
Surge protection concept



The best lightning and surge protection concept will be ineffective unless it embraces every incoming electrical and metal service line entering the building!

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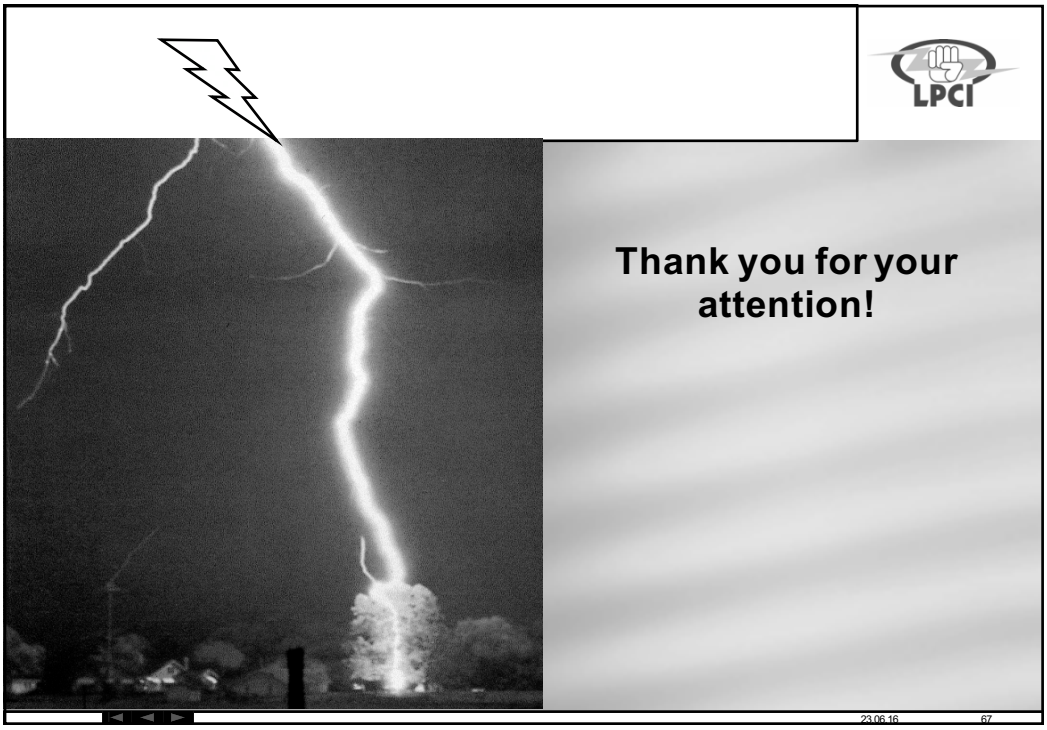
LPCI
Thank you for your attention!
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