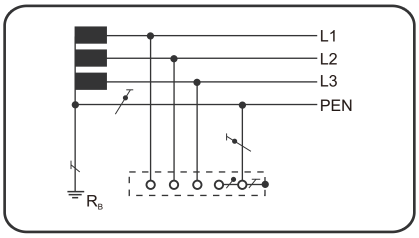
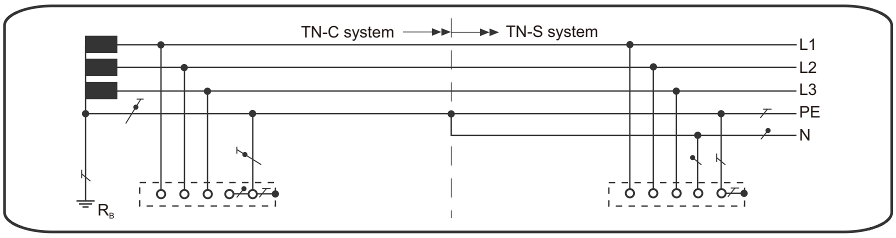
International Power Supply Systems

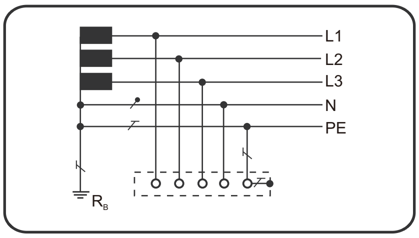
International system configurations* according to IEC 60364-1



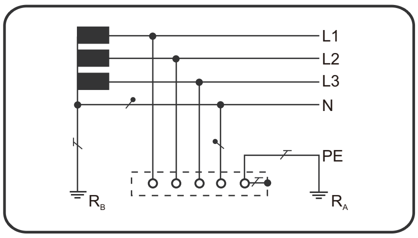
TN-C system 230 / 400 V



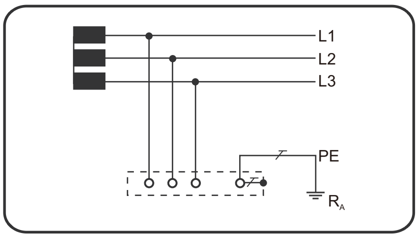
TN-C-S system 230 / 400 V



TN-S system 230 / 400 V

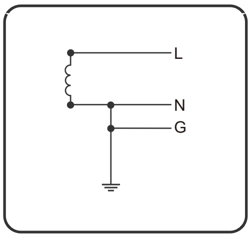


TT system 230 / 400 V



IT system 230 V, 400 V, 500 V, 690 V

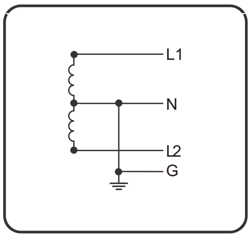
Further international system configurations*



single-phase; 3 conductors

(1 Ph, 2 W + G)

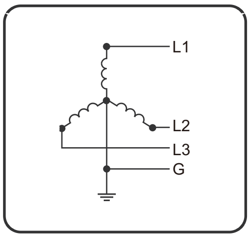
110 V
120 V
220 V
240 V



single-phase; 4 conductors
Split Phase or Edison

(1 Ph, 3 W + G)

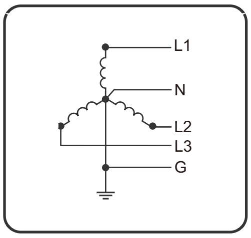
120 V / 240 V



three-phase; 4 conductors

(3 Ph Y, 3 W + G)

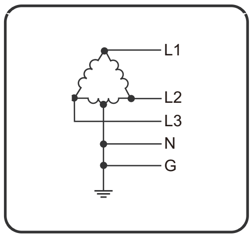
480 V



three-phase; 5 conductors

(3 Ph Y, 4 W + G)

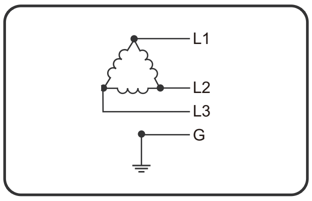
120 V / 208 V
277 V / 480 V



three-phase; 5 conductors
Delta “Highleg“

(3 Ph∆, 4 W + G)

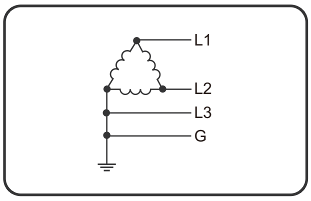
120 V / 240 V



three-phase; 4 conductors
Delta “Ungrounded“

(3 Ph∆, 3 W + G)

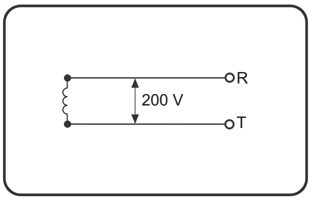
240 V
480 V



three-phase; 4 conductors
Delta “Grounded Corner”

(3 Ph∆, 3 W + G)

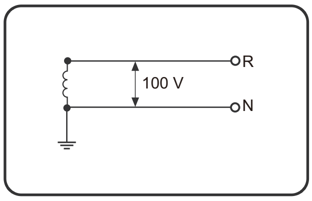
240 V
480 V



single-phase; 2 conductors

(1 Ph, 2 W)

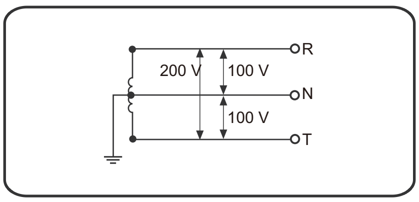
200 V



single-phase; 2 conductors

(1 Ph, 2 W)

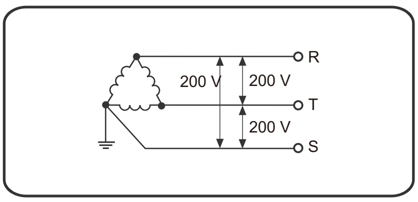
100 V



single-phase; 3 conductors

(1 Ph, 3 W)

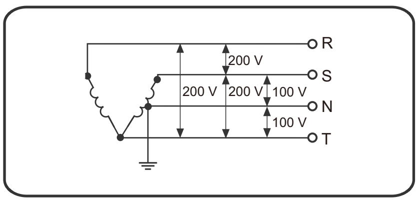
100 V / 200 V



three-phase; 3 conductors

(3 Ph, 3 W)

200 V



three-phase; 3 conductors + single-phase; 3 conductors

100 V / 200 V; 200 V

* System according to the earth connection (according to IEC 60364-1)

Terms

SPD = Surge Protection Device

Classification of surge arresters

1. Power lines
Class I, Type 1, Type 1
(lightning arrester)
Class II, Type 2, Type 2
(surge protection)
Class III, Type 3, Type 3
(surge protection for end devices)

2. Measurement/control cables
and data cables
Class D1 (lightning arrester)
Class C2 (surge protection)
Class C1 (surge protection for end devices)

Surge voltage category (EN 60664-1)
Rated impulse voltage
IV = 6 kV (before the meter)
III = 4 kV (after the meter, HV + UV, fixedinstallation)
II = 2.5 kV (outlet/end device)
I = 1.5 kV (in end device)

LPZ = Lightning Protection Zone
External lightning protection
LPZ 0 / 0_A / 0_B
Internal lightning protection LPZ 1, 2, 3

LPL = Lightning Protection Level
I= 200 kA
II= 150 kA
III + IV = 100 kA

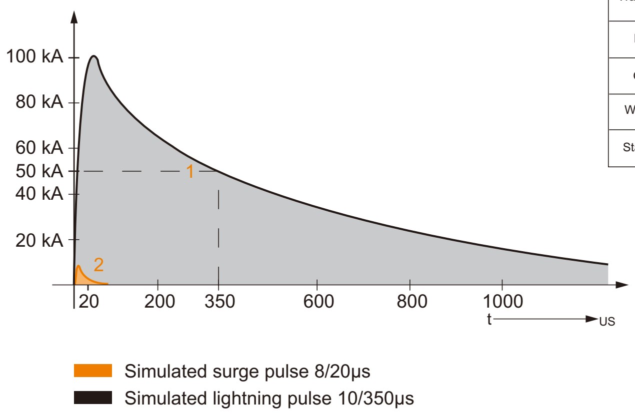
LPS = Lightning Protection System
Lightning protection system

SPM = Surge Protection Measures

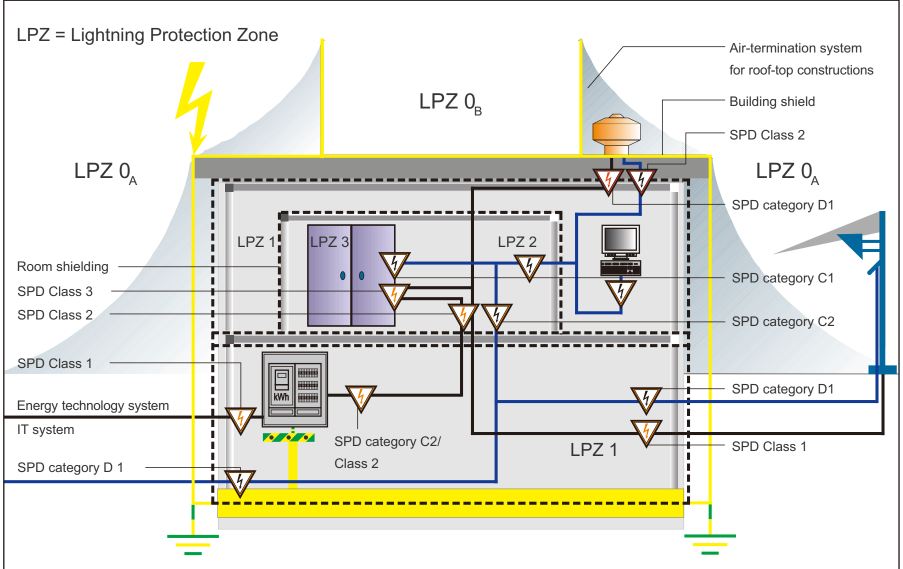
International standards
Application standard:
IEC 62305 – Application of lightning and surge protection with 4 chapters:
General overview, Risk analysis, Internal and external lightning protection
IEC 61643-12 – Usage for energy protection
IEC 61643-22 – Usage for measurement and control signals

Testing pulse for surge arrester

	1	2
Wave form [µs]	10/350	8/20
I_{max}[kA]	100	5
Q[As]	50	0.1
W/R[J/Ω]	$2.5\text{-}10^6$	$0.4\text{-}10^3$
Standard	DIN V VDE V 0185-1	DIN V VDE 0432 T.2



EMC lightning protection - zone concept in accordance with IEC 62305-4



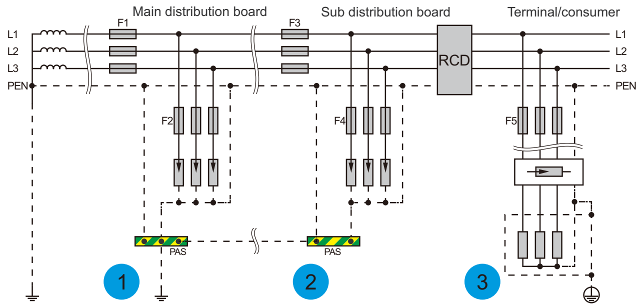
LPZ 0_A	Directimpactispossibleandfullelectromagneticfield
LPZ 0_B	Nodirectimpactispossiblebutfullelectromagneticfield
LPZ 1	Pulse currents are further limited by current distribution; the lightning fieldisattenuatedbyroomshielding
LPZ 2…n	Pulsecurrentsfurtherlimited;reductionofthefieldbyroomshielding

Examples of applications in 230/400 V systems

TN-C systems

Neutral conductor and protective earth conductor functions are combined throughout the network in a single conductor, the PEN conductor (4-conductor-system).

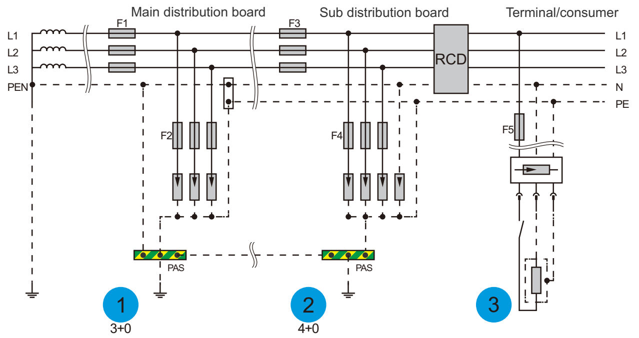
Position	LPL	Type	Order No.
1	I/II	FLP25-275/3S	2527532
	III/IV	FLP12.5-275/3S	1227532
2		SLP40-275/3S	4027532
3		TLP-255/2S	0325522



TN-C-S systems

Neutral conductor, PEN conductor and equipotential bonding system are connected once at the main distribution board or after the incoming supply to the building. Therefore, a TN-C system becomes a TN-S system (TN-C-S system) from this point onwards.

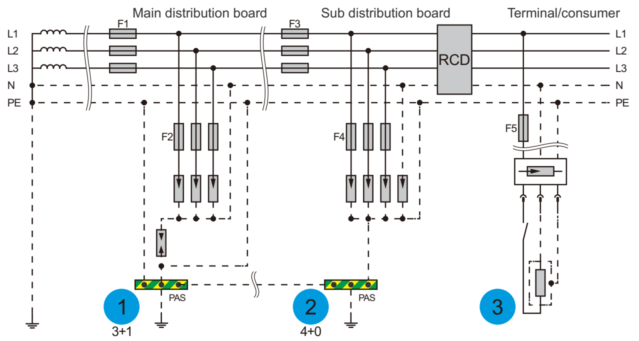
Position	LPL	Type	Order No.
1	I/II	FLP25-275/3S	2527532
	III/IV	FLP12.5-275/3S	1227532
2		SLP40-275/3S+1	4027534
		SLP40-275/4S	4027542
3		TLP-255/2S	0325522



TN-S systems

Neutral conductor and protective earth conductor are separated throughout the network.

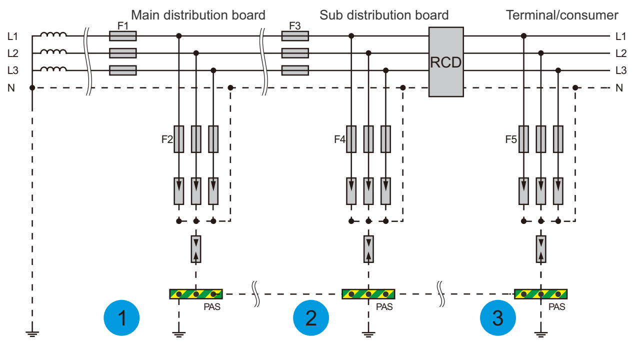
Position	LPL	Type	Order No.
1	I/II	FLP25-275/3S+1	2527534
	III/IV	FLP12.5-275/3S+1	1227534
2		SLP40-275/3S+1	4027534
		SLP40-275/4S	4027542
3		TLP-255/2S	0325522



TT systems

One point is earthed directly (operational earth). The exposed conductive parts of the electrical installation are connected to earth lines separate from the operational earth.

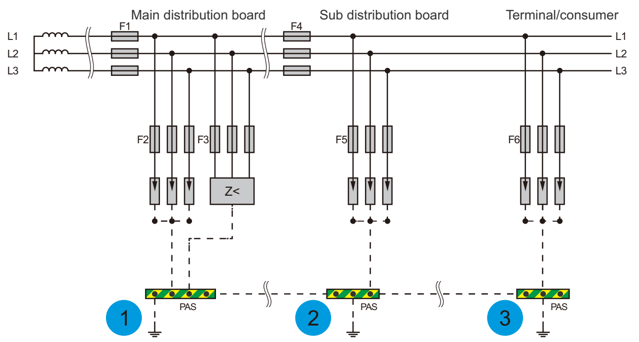
Position	LPL	Type	Order No.
1	I/II	FLP25-275/3S+1	2527534
	III/IV	FLP12.5-275/3S+1	1227534
2		SLP40-275/3S+1	4027534
3		SLP40-275/3S+1	4027534



IT systems

There is no direct connection between active conductors and earthed parts. The exposed conductive parts of the electrical installation are earthed.

Position	LPL	Type	Order No.
1	I/II	FLP25-275/3S	2527532
	III/IV	FLP12.5-275/3S	1227532
2		SLP40-275/3S	4027532
3		SLP40-275/3S	4027532



EMC lightning protection-zone concept in accordance with IEC 62305-4:2010

Lightning Protection Zone (LPZ)

Outer zones:

LPZ 0: Zone where the threat is due to the unattenuated lightning electomagnetic field and where the internal systems may be subjected to full or partal lightning sutge cuttent.

LPZ 0 is subdivided into:

LPZ 0_A: Zone where the threat is due to the direct lightning flash and the full lightning electromagnetic field. The internal systems may be subjected to full lightning surge current

LPZ 0_B: Zone protected against direct lightning flashes but where the threat is the full lightning electromagnetic field. The internal systems may be subjected to partial lightning surge currents.

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 electomagnetic field.

LPZ 2 ... n: Zone where the surge current may be further limited by current sharing and isolating interfaces and/or by additional SPDs at the boundary. Additional spatial shielding may be used to further attenuate the lightning electromagnetic field.

Terms and Definitions

Surge protective devices (SPDs)

Surge protective devices mainly consist of voltage-dependent resistors (varistors, suppressor diodes) and / or spark gaps (discharge paths) .Surge protective devices are used to protect other electrical equipment and installations against inadmissibly high surges and / or to establish equipotential bonding. Surge protective devices are categorised:

a) according to their use into:

- Surge protective devices for power supply installations and devices for nominal voltage ranges up to 1000 V

- according to EN 61643-11:2012 into type 1 / 2 / 3 SPDs
- according to IEC 61643-11:2011 into class I / II / III SPDs

LSP product family to the new EN 61643-11:2012 and IEC 61643-11:2011 standard will be completed in the course of the year 2014.

- Surge protective devices for information technology installations and devices

for protecting modern electronic equipment in telecommunications and signalling networks with nominal voltages up to 1000 Vac (effective value) and 1500 Vdc against the indirect and direct effects of lightning strikes and other transients.

- according to IEC 61643-21:2009 and EN 61643-21: 2010.

- Isolating spark gaps for earth-termination systems or equipotential bonding

Surge protective devices for use in photovoltaic systems

for nominal voltage ranges up to 1500 Vdc

- according to EN 61643-31:2019 (EN 50539-11:2013 will be substituted), IEC 61643-31:2018 into type 1+2, type 2 (Class I+II, Class II) SPDs

b) according to their impulse current discharge capacity and protective effect into:

- Lightning current arresters / coordinated lightning current arresters

for protecting installations and equipment against interference resulting from direct or nearby lightning strikes (installed at the boundaries between LPZ 0_A and 1).

- Surge arresters

for protecting installations, equipment and terminal devices against remote lightning strikes, switching overvoltages as well as electrostatic discharges (installed at the boundaries downstream of LPZ 0_B).

- Combined arresters

for protecting installations, equipment and terminal devices against interference resulting from direct or nearby lightning strikes (installed at the boundaries between LPZ 0_A and 1 as well as 0_A and 2)

Technical data of surge protective devices

The technical data of surge protective devices include information on their conditions of use according to their:

- Application (e.g. installation, mains conditions, temperature)
- Performance in case of interference (e.g. impulse current discharge capacity, follow current extinguishing capability, voltage protection level, response time)
- Performance during operation (e.g. nominal current, attenuation, insulation resistance)
- Performance in case of failure (e.g. backup fuse, disconnector, failsafe, remote signalling option)

Nominal voltage U_N

The nominal voltage stands for the nominal voltage of the system to be protected. The value of the nominal voltage often serves as type designation for surge protective devices for information technology systems. It is indicated as an r.m.s. value for a.c. systems.

Maximum continuous operating voltage U_C

The maximum continuous operating voltage (maximum permissible operating voltage) is the r.m.s. value of th maximum voltage which may be connected to the corresponding terminals of the surge protective device during operation. This is the maximum voltage on the arrester in the defined non-conducting state, which reverts the arrester back to this state after it has tripped and discharged. The value of UC depends on the nominal voltage of the system to be protected and the installer's specifications (IEC 60364-5-534).

Nominal discharge current I_n

The nominal discharge current is the peak value of a 8/20 μs impulse current for which the surge protective device is rated in a certain test programme and which the surge protective device can discharge several times.

Maximum discharge current I_{max}

The maximum discharge current is the maximum peak value of the 8/20 μs impulse current which the device can safely discharge.

Lightning impulse current I_{imp}

The lightning impulse current is a standardised impulse current curve with a 10/350 μs wave form. Its parameters (peak value, charge, specific energy) simulate the load caused by natural lightning currents. Lightning current and combined arresters must be capable of discharging such lightning impulse currents several times without being destroyed.

Total discharge current I_{total}

Current which flows through the PE, PEN or earth connection of a multipole SPD during the total discharge current test. This test is used to determine the total load if current simultaneously flows through several protective paths of a multipole SPD. This parameter is decisive for the total discharge capacity which is reliably handled by the sum of the individual
paths of an SPD

Voltage protection level U_P

The voltage protection level of a surge protective device is the maximum instantaneous value of the voltage at the

terminals of a surge protective device, determined from the standardised individual tests:
- Lightning impulse sparkover voltage 1.2/50 µs (100%)
- Sparkover voltage with a rate of rise of 1kV/µs
- Measured limit voltage at a nominal discharge current In

The voltage protection level characterises the capability of a surge protective device to limit surges to a residual level. The voltage protection level defines the installation location with regard to the overvoltage category according to IEC 60664-1 in power supply systems. For surge protective devices to be used in information technology systems, the voltage protection level must be adapted to the immunity level of the equipment to be protected (IEC 61000-4-5: 2001).

Short-circuit current rating I_{SCCR}

Maximum prospective short-circuit current from the power system for which the SPD, in conjunction with the disconnector specified, is rated

Short-circuit withstand capability

The short-circuit withstand capability is the value of the prospective power-frequency short-circuit current handled by the surge protective device when the relevant maximum backup fuse is connected upstream.

Short-circuit rating I_{SCPV} of an SPD in a photovoltaic (PV) system

Maximum uninfluenced short-circuit current which the SPD, alone or in conjunction with its disconnection devices, is able to withstand.

Temporary overvoltage (TOV)

Temporary overvoltage may be present at the surge protective device for a short period of time due to a fault in the high-voltage system. This must be clearly distinguished from a transient caused by a lightning strike or a switching operation, which last no longer than about 1 ms. The amplitude UT and the duration of this temporary overvoltage are specified in EN 61643-11 (200 ms, 5 s or 120 min.) and are individually tested for the relevant SPDs according to the system configuration (TN, TT, etc.). The SPD can either a) reliably fail (TOV safety) or b) be TOV-resistant (TOV withstand), meaning that it is completely operational during and following temporary overvoltages.

Nominal load current (nominal current) I_L

The nominal load current is the maximum permissible operating current which may permanently flow through the orresponding terminals.

Protective conductor current I_{PE}

The protective conductor current is the current which flows through the PE connection when the surge protective device is connected to the maximum continuous operating voltage U_C, according to the installation instructions and without load-side consumers.

Mains-side overcurrent protection / arrester backup fuse

Overcurrent protective device (e.g. fuse or circuit breaker) located outside of the arrester on the infeed side to interrup the power-frequency follow current as soon as the breaking capacity of the surge protective device is exceeded. No additional backup fuse is required since the backup fuse is already integrated in the SPD (see relevant section).

Operating temperature range T_U

The operating temperature range indicates the range in which the devices can be used. For non-self-heating devices, it is equal to the ambient temperature range. The temperature rise for self-heating devices must not exceed the maximum value indicated.

Response time t_A

Response times mainly characterise the response performance of individual protection elements used in arresters. Depending on the rate of rise du/dt of the impulse voltage or di/dt of the impulse current, the response times may vary within certain limits.

Thermal disconnector

Surge protective devices for use in power supply systems equipped with voltage-controlled resistors (varistors) mostly feature an integrated thermal disconnector that disconnects the surge protective device from the mains in case of overload and indicates this operating state. The disconnector responds to the "current heat" generated by an overloaded varistor and disconnects the surge protective device from the mains if a certain temperature is exceeded. The disconnector is designed to disconnect the overloaded surge protective device in time to prevent a fire. It is not intended to ensure protection against indirect contact. The function of these thermal disconnectors can be tested by means of a simulated overload / ageing of the arresters.

Remote signalling contact

A remote signalling contact allows easy remote monitoring and indication of the operating state of the device. It features a three-pole terminal in the form of a floating changeover contact. This contact can be used as break and / or make contact and can thus be easily integrated in the building control system, controller of the switchgear cabinet, etc.

N-PE arrester

Surge protective devices exclusively designed for installation between the N and PE conductor.

Combination wave

A combination wave is generated by a hybrid generator (1.2/50 μs, 8/20 μs) with a fictitious impedance of 2 Ω. The open-circuit voltage of this generator is referred to as UOC. UOC is a preferred indicator for type 3 arresters since only these arresters may be tested with a combination wave (according to EN 61643-11).

Degree of protection

The IP degree of protection corresponds to the protection categories described in IEC 60529.

Frequency range

The frequency range represents the transmission range or cut-off frequency of an arrester depending on the described attenuation characteristics.

Protective circuit

Protective circuits are multi-stage, cascaded protective devices. The individual protection stages may consist of spark gaps, varistors, semiconductor elements and gas discharge tubes.

Return loss

In high-frequency applications, the return loss refers to how many parts of the "leading" wave are reflected at the protective device (surge point). This is a direct measure of how well a protective device is attuned to the characteristic impedance of the system.

Terms, definitions and abbreviations

3.1 Terms and definitions

3.1.1

surge protective device SPD

device that contains at least one nonlinear component that is intended to limit surge voltages and divert surge currents

NOTE: An SPD is a complete assembly, having appropriate connecting means.

3.1.2

one-port SPD

SPD having no intended series impedance

NOTE: A one port SPD may have separate input and output connections.

3.1.3

two-port SPD

SPD having a specific series impedance connected between separate input and output connections

3.1.4

voltage switching type SPD

SPD that has a high impedance when no surge is present, but can have a sudden change in impedance to a in response to a voltage surge

NOTE: Common examples of components used in voltage switching type SPDs are spark gaps, gas tubes and thyristors. These are sometimes called "crowbar type" components.

3.1.5

voltage limiting type SPD

SPD that has a high impedance when no surge is present, but will reduce it continuously with invreased surge current and voltage

NOTE: Common examples of components used in voltage limiting type SPDs are varistors and avalanche breakdown diodes. These are sometimes called "clamping type" components.

3.1.6

combination type SPD

SPD that incorporates both, voltage switching components and voltage limiting components. The SPD may exhibit voltage switching, limiting or both

3.1.7

short-circuiting type SPD

SPD tested according to Class II tests which changes its characteristic to an intentional internal short-circuit due to a surge current exceeding its nominal discharge current In

3.1.8

mode of protection of an SPD

an intended current path, between terminals that contains protective components, e.g. line- toline, line-to-earth, line-to-neutral, neutral-to-earth.

3.1.9

nominal discharge current for class II test I_n

crest value of the current through the SPD having a current waveshape of 8/20

3.1.10

impulse discharge current for class I test I_{imp}

crest value of a discharge current through the SPD with specified charge transfer Q and specified energy W/R in the specified time

3.1.11

maximum continuous operating voltage U_C

maximum r.m.s. voltage, which may be continuously applied to the SPD's mode of protection

NOTE: The UC value covered by this standard may exceed 1 000 V.

3.1.12

follow current I_f

peak current supplied by the electrical power system and flowing through the SPD after a discharge current impulse

3.1.13

rated load current I_L

that can be supplied to a resistive load connected to
the protected output of an SPD

3.1.14

voltage protection level U_P

maximum voltage to be expected at the SPD terminals due to an impulse stress with defined voltage steepness and an impulse stress with a discharge current with given amplitude and waveshape

NOTE: The voltage protection level is given by the manufacturer and may not be exceeded by:

- the measured limiting voltage, determined for front-of-wave sparkover (if applicable) and the measured limiting voltage, determined from the residual voltage measurements at amplitudes corresponding to I_n and/or I_{imp} respectively for test classes II and/or I;
- the measured limiting voltage at UOC, determined for the combination wave for test class III.

3.1.15

measured limiting voltage

highest value of voltage that is measured across the terminals of the SPD during the application of impulses of specified waveshape and amplitude

3.1.16

residual voltage U_{res}

crest value of voltage that appears between the terminals of an SPD due to the passage of discharge current

3.1.17

temporary overvoltage test value U_T

test voltage applied to the SPD for a specific duration tT, to simulate the stress under TOV conditions

3.1.18

load-side surge withstand capability for a two-port SPD

ability of a two-port SPD to withstand surges on the output terminals originating in circuitry downstream of the SPD

3.1.19

voltage rate-of-rise of a two-port SPD

rate of change of voltage with time measured at the output terminals of a two port SPD under specified test conditions

3.1.20

1,2/50 voltage impulse

voltage impulse with a nominal virtual front time of 1,2 μs and a nominal time to half-value of 50 μs

NOTE: The Clause 6 of IEC 60060-1 (1989) defines the voltage impulse definitions of front time, time to halfvalue and waveshape tolerance.

3.1.21

8/20 current impulse

current impulse with a nominal virtual front time of 8 μs and a nominal time to half-value of 20 μs

NOTE: The Clause 8 of IEC 60060-1 (1989) defines the current impulse definitions of front time, time to half-value and waveshape tolerance.

3.1.22

combination wave

a wave characterized by defined voltage amplitude (U_{OC}) and waveshape under open-circuit conditions and a defined current amplitude (I_{CW}) and waveshape under short-circuit conditions

NOTE: The voltage amplitude, current amplitude and waveform that is delivered to the SPD are determined by the combination wave generator (CWG) impedance Z_f and the impedance of the DUT.

3.1.23

open circuit voltage U_{OC}

open circuit voltage of the combination wave generator at the point of connection of the device under test

3.1.24

combination wave generator short-circuit current I_{CW}

prospective short-circuit current of the combination wave generator, at the point of connection of the device under test

NOTE: When the SPD is connected to the combination wave generator, the current that flows through the device is generally less than I_{CW}.

3.1.25

thermal stability

SPD is thermally stable if, after heating up during the operating duty test, its temperature decreases with time while energized at specified maximum continuous operating voltage and at specified ambient temperature conditions

3.1.26
degradation (of performance)
undesired permanent departure in the operational performance of equipment or a system from its intended performance

3.1.27
short-circuit current rating ISCCR
maximum prospective short-circuit current from the power system for which the SPD, in conjunction with the disconnector specified, is rated Copyright International Electrotechnical Commission

3.1.28
SPD disconnector (disconnector)
device for disconnecting an SPD, or part of an SPD, from the power system
NOTE: This disconnecting device is not required to have isolating capability for safety purposes. It is to prevent a persistent fault on the system and is used to give an indication of an SPD's failure. Disconnectors can be internal (built in) or external (required by the manufacturer). There may be more than one disconnector function, for example an over-current protection function and a thermal protection function. These functions may be in separate units.

3.1.29
degree of protection of enclosure IP
classification preceded by the symbol IP indicating the extent of protection provided by an enclosure against access to hazardous parts, against ingress of solid foreign objects and possibly harmful ingress of water

3.1.30
type test
conformity test made on one or more items representative of the production
[IEC 60050-151:2001, 151-16-16]

3.1.31
routine test
test made on each SPD or on parts and materials as required to ensure that the product meets the design specifications
[IEC 60050-151:2001, 151-16-17, modified]

3.1.32
acceptance tests
contractual test to prove to the customer that the item meets certain conditions of its specification
[IEC 60050-151:2001, 151-16-23]

3.1.33
decoupling network
an electrical circuit intended to prevent surge energy from being propagated to the power network during energized testing of SPDs
NOTE: This electrical circuit is sometimes called a "back filter".

3.1.34

Impulse test classification

3.1.34.1
class I tests
tests carried out with the impulse discharge current I_{imp}, with an 8/20 current impulse with a crest value equal to the the crest value of I_{imp}, and with a 1,2/50 voltage impulse

3.1.34.2
class II tests
tests carried out with the nominal discharge current In, and the 1,2/50 voltage impulse

3.1.34.3
class III tests
tests carried out with the 1,2/50 voltage - 8/20 current combination wave generator

3.1.35
residual current device RCD
switching device or associated devices intended to cause the opening of the power circuit when the residual or unbalance current attains a given value under specified conditions

3.1.36
sparkover voltage of a voltage switching SPD
trigger voltage of a voltage switching SPD
maximum voltage value at which the sudden change from high to low impedance starts for a voltage switching SPD

3.1.37
specific energy for class I test W/R
energy dissipated by a unit resistance of 1 Ω with the impulse discharge current I_{imp}
NOTE: This is equal to the time integral of the square of the current (W / R = ∫ i 2d t).

3.1.38
prospective short-circuit current of a power supply I_P
current which would flow at a given location in a circuit if it were short-circuited at that location by a link of negligible impedance
NOTE: This prospective symmetrical current is expressed by its r.m.s. value.

3.1.39
follow current interrupt rating I_{fi}
prospective short-circuit current that an SPD is able to interrupt without operation of a disconnector

3.1.40
residual current I_{PE}
current flowing through the PE terminal of the SPD while energized at the reference test voltage (UREF) when connected according to the manufacturer's instructions

3.1.41
status indicator

device that indicates the operational status of an SPD, or a part of an SPD.
NOTE: Such indicators may be local with visual and/or audible alarms and/or may have remote signalling and/or output contact capability.

3.1.42
output contact
contact included in a circuit separate from the main circuit of an SPD, and linked to a disconnector or status indicator

3.1.43
multipole SPD
type of SPD with more than one mode of protection, or a combination of electrically interconnected SPDs offered as a

3.1.44
total discharge current I_{Total}
current which flows through the PE or PEN conductor of a multipole SPD during the total discharge current test
NOTE 1: The aim is to take into account cumulative effects that occur when multiple modes of protection of a multipole SPD conduct at the same time.
NOTE 2: I_{Total} is particularly relevant for SPDs tested according to test class I, and is used for the purpose of lightning protection equipotential bonding according to IEC 62305 series.

3.1.45
reference test voltage U_{REF}
r.m.s. value of voltage used for testing which depends on the mode of protection of the SPD, the nominal system voltage, the system configuration and the voltage regulation within the system
NOTE: The reference test voltage is selected from Annex A based on the information given by the manufacturer according to 7.1.1 b8).

3.1.46
transition surge current rating for short-circuiting type SPD I_{trans}
8/20 impulse current value exceeding the nominal discharge current In, that will cause a shortcircuiting type SPD to short-circuit

3.1.47
Voltage for clearance determination U_{max}
highest measured voltage during surge applications according 8.3.3 for clearance determination

3.1.48
maximum discharge current I_{max}
crest value of a current through the SPD having an 8/20 waveshape and magnitude according to the manufacturers specification. Imax is equal to or greater than I_n

3.2 Abbreviations

Table 1 – List of Abbreviations

Abbreviation	Description	Definition/clause
General abbreviations		
ABD	avalanche breakdown device	7.2.5.2

CWG	combination wave generator	3.1.22
RCD	residual current device	3.1.35
DUT	device under test	General
IP	degree of protection of enclosure	3.1.29
TOV	temporary overvoltage	General
SPD	surge protective device	3.1.1
k	trip current factor for overload behaviour	Table 20
Z_f	fictive impedance (of combination wave generator)	8.1.4 c)
W/R	specific energy for class I test	3.1.37
T1,T2, and/or T3	product marking for test classes I, II and/or III	7.1.1
t_T	TOV application time for testing	3.1.17
Abbreviations related to voltage		
U_C	maximum continuous operating voltage	3.1.11
U_{REF}	Reference test voltage	3.1.45
U_{OC}	open circuit voltage of the combination wave generator	3.1.22, 3.1.23
U_P	voltage protection level	3.1.14
U_{res}	residual voltage	3.1.16
U_{max}	voltage for clearance determination	3.1.47
U_T	temporary overvoltage test value	3.1.17
Abbreviations related to current		
I_{imp}	impulse discharge current for class I test	3.1.10
I_{max}	maximum discharge current	3.1.48
I_n	nominal discharge current for class II test	3.1.9
I_f	follow current	3.1.12
I_{fi}	follow current interrupt rating	3.1.39
I_L	rated load current	3.1.13
I_{CW}	short-circuit current of the combination wave generator	3.1.24
I_{SCCR}	short-circuit current rating	3.1.27
I_P	prospective short-circuit current of the power supply	3.1.38
I_{PE}	residual current at U_{REF}	3.1.40
I_{total}	total discharge current for multipole SPD	3.1.44
I_{trans}	transition surge current rating for short-circuiting type SPD	3.1.46

4 Service conditions

4.1 Frequency

Frequency range is from 47 Hz to 63 Hz a.c.

4.2 Voltage

The voltage applied continuously between the terminals of the surge protective device (SPD) must not exceed its maximum continuous operating voltage U_C.

4.3 Air pressure and altitude

Air pressure is 80 kPa to 106 kPa. These values represent an altitude of +2 000 m to -500 m, respectively.

4.4 Temperatures

- Inormal range: –5 °C to +40 °C

NOTE: This range addresses SPDs for indoor use in weather-protected locations having neither temperature nor humidity control and corresponds to the characteristics of external influences code AB4 in IEC 60364-5-51.

- Iextended range:–40 °C to +70 °C

NOTE: This range addresses SPDs for outdoor use in non weather protected locations.

4.5 Humidity

- normal range: 5 % to 95 %

NOTE This range addresses SPDs for indoor use in weather-protected locations having neither temperature nor humidity control and corresponds to the characteristics of external influences code AB4 in IEC 60364-5-51.

- Iextended range: 5 % to 100 %

NOTE This range addresses SPDs for outdoor use in non weather protected locations.

5 Classification

The manufacture shall classify the SPDs in accordance with the following parameters

5.1 Number of ports

5.1.1 One

5.1.2 Two

5.2 SPD design

5.2.1 Voltage switching

5.2.2 Voltage limiting

5.2.3 Combination

5.3 Class I, II and III tests

Information required for class I, class II and class III tests is given in Table 2.

Table 2 – Class I, II and III tests

Tests	Required information	Test procedures (see subclauses)
Class I	I_{imp}	8.1.1; 8.1.2; 8.1.3
Class II	I_n	8.1.2; 8.1.3
Class III	U_{OC}	8.1.4; 8.1.4.1