TEST REPORT
EN 61643-11
DC SPD
Part 11: Surge-protective devices connected to low-voltage power systems- Requirements and test methods

Report Number.....:	24ZCTB0119018SP
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Testing location/ address.....:	3/F., Building 5, Hongsheng Industrial Zone, Bao'an Road, Xixiang Street, Bao'an District, Shenzhen, Guangdong, China.
Applicant's name.....:	**Wenzhou Yijie Electric Co., Ltd**
Address.....:	No. 83, Fengquan Road, Tianhe Street, Wenzhou Economic and Technological Development Zone, Wenzhou City, Zhejiang Province
Test specification:	
Standard.....:	EN 61643-11:2011
Test procedure.....:	CE report
Non-standard test method.....:	N/A
Test Report Form No.....:	IEC 61643_11B
Test Report Form(s) Originator.....:	OVE
Master TRF.....:	Dated 2012-12

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This report is not valid as a CB Test Report unless signed by an approved CB Testing Laboratory and appended to a CB Test Certificate issued by an NCB in accordance with IECEE 02.

Test item description.....:	DC SPD
Trade Mark.....:	/
Manufacturer.....:	**Wenzhou Yijie Electric Co., Ltd**
Address.....:	No. 83, Fengquan Road, Tianhe Street, Wenzhou Economic and Technological Development Zone, Wenzhou City, Zhejiang Province

Model/Type reference.....:	**JX6285** JX6275,JX6285,JX6276,JX6286,JX6375,JX6385,JX6376,JX6386,J120, JX5410,JX5210
Ratings..... :	Input:220V~, 50/60Hz

Test item particulars.....:	DC SPD
Number of ports..... :	1
SPD design topology..... :	Combination type SPD
SPD classified for test class..... :	II
Location..... :	Indoor
Accessibility.....:	Inaccessible
Mounting method.....:	Build in
SPD Disconnector..... :	Internal
Protection functions.....:	Thermal
Overcurrent protection.....:	Not specified
Degree of protection (IP code).....:	IP 20
Temperature range..... :	Extended
Required SPD-disconnectors..... :	N/A
SPD failure behaviour:.....:	Open circuit
Possible test case verdicts:	
- test case does not apply to the test object..... :	N/A
- test object does meet the requirement..... :	P (Pass)
- test object does not meet the requirement..... :	F (Fail)
Testing.....:	
Date of receipt of test item..... :	2024-01-19
Date (s) of performance of tests.....:	2024-01-19 to 2024-01-29

General remarks:

The test results presented in this report relate only to the object tested.
This report shall not be reproduced, except in full, without the written approval of the Issuing testing laboratory.
"(See Enclosure #)" refers to additional information appended to the report.
"(See appended table)" refers to a table appended to the report.
Throughout this report a ☒ comma / ☐ point is used as the decimal separator.

Manufacturer's Declaration per Sub-clause 4.2.5 of IECEE 02::

The application for obtaining a CB Test Certificate includes more than one factory location and a declaration from the Manufacturer stating that the sample(s) submitted for evaluation is (are) representative of the products from each factory has been provided……..:

☐ **Yes**
☒ **Not applicable**

When differences exist; they shall be identified in the General Product Information section.

List of Attachments (including a total number of pages in each attachment):

Attachment 1- European group differences and national differences(9 pages)

Attachment 2- Photo Document(3 page(s))

Copy of marking plate

The artwork below may be only a draft. The use of certification marks on a product must be authorized by the respective NCBs that own these marks.

DC SPD
Model:JX6285 Input:220V~ ;50/60Hz
Wenzhou Yijie Electric Co., Ltd
Made in china

Name and address of factory (ies).....:

Wenzhou Yijie Electric Co., Ltd

No. 83, Fengquan Road, Tianhe Street, Wenzhou Economic and Technological Development Zone, Wenzhou City, Zhejiang Province

General product information:

The product is a one port combination type SPD that built into end enclosure with the degree of protection of IP 20.
The protection of SPD, including protection against electric shock, mechanical strength and protection against ingress of solid objects and water, depending on the enclosure for installtion.

If not otherwise specified all tests have been carried out on three samples per test sequence.
Terminal tests have been carried out on three terminals of each construction used.

~~Impulse tests have been carried out according to chapters 8.1.1 to 8.1.4.~~

~~SPDs according test class I: Calculation of charge Q and specific energy W/R applied during additional duty test acc. to 8.3.4.4~~

~~I (kA)~~	~~Q (As) within 5 ms~~	~~W/R (kJ/Ω)~~
~~0,1* I_{imp} = _____~~		

~~0,25* I_{imp} = _____~~		
~~0,5* I_{imp} = _____~~		
~~0,75* I_{imp} = _____~~		
~~1,0* I_{imp} = _____~~		

If the SPD is an integral part of a product covered by another standard, the requirements of the other standard were applied to those parts of the product, which do not belong to the SPD section of the product. The SPD section was judged according to the general (7.1), the electrical (7.2), the environmental and material (7.4) requirements.

Unless otherwise specified, a.c. values given in this report are r.m.s. values.

If not otherwise specified the tests have been performed in free air and at an ambient temperature of (20 ± 15)°C.

If not otherwise specified, for all tests where a power supply at U_{REF} or U_C is required, the voltage tolerance for testing was $^{+0}/_{-5}$%.

If the SPD is supplied with integral cables, the full length of these cables forms part of the SPD under test, except for the determination of the measured limiting voltage 8.3.3, where a lead length of 150 mm was used.

SPD disconnectors have been selected according to the manufacturer's instructions and connected for testing according to Table 3.

For SPDs having more than one mode of protection, for which the manufacturer declares a voltage protection level, the tests have been performed on each mode, with the values chosen according to the manufacturer's declaration, using new samples each time. For three phase devices in which the protective component circuitry per given mode is identical, the testing may be performed on each of the three phases which fulfils the three sample requirement.

~~For SPDs with a designated N terminal which may be applied in systems without distributed neutral according to the manufacturer's instructions, separate testing has been performed for the L-PE mode of protection with the neutral being unconnected.~~

If the manufacturer sets different requirements for the external SPD disconnector(s) depending upon the prospective short-circuit current of the supply system, all relevant test sequences have been performed for every combination of required SPD disconnector(s) and corresponding prospective short-circuit currents.

Throughout the entire type testing procedure, the status shown by the indicator(s) give a clear sign of the status of the part to which it is linked. Where there is more than one method of status indication, for example local and remote indication, each type of indication was checked.

IEC/EN 61643-11 - TEST SEQUENCE 1			
Clause	Requirement - Test	Result - Remark	Verdict
7.1.1/7.1.2	**Identification and Marking**		P
	Markings on the body or permanently attached to		P
	a1) Manufacturer/Trade mark/Model number		N/A
	a2) Maximum continuous operating voltage U_C (one value for each mode of protection)		N/A
	a3) Type of current: a.c. or "~"and/or frequency	~	P
	a4) Test classification and discharge parameters shall be printed next to each other for each mode of protection declared by the manufacturer For test class I: either "test class I" and "I_{imp}" and the value in kA, and/or "T1" (T1 in a square) and "I_{imp}" and the value in kA		N/A
	For test class II: either "test class II" and "I_n" and the value in kA, and/or "T2" (T2 in a square) and "I_n" and the value in kA	T2 I_n: 20 kA	N/A
	For test class III: either "test class III" and "U_{OC}" and the value in kV, and/or "T3" (T3 in a square) and "U_{OC}" and the value in kV	T3 U_{oc}: _____ kV	N/A
	a5) Voltage protection level U_P (one value for each mode of protection)	1.5 kV	N/A
	a6) Degree of protection if > IP20	Depending on end enclosure	N/A
	a7) Identification of terminals or leads		P
	a8) Rated load current I_L		N/A
	Information provided with the products		P
	b1) Location	Indoor	P
	b2) Number of ports	One port	P
	b3) Method of mounting	Build in	P
	b4) Short circuit current rating I_{SCCR}		N/A
	b5) Ratings and characteristics for external disconnector		N/A

IEC/EN 61643-11 - TEST SEQUENCE 1			
Clause	Requirement - Test	Result - Remark	Verdict
	b6) Indication of disconnector operation	Color	P
	b7)Orientation for normal installation		P
	b8) Installation instructions - type of LV systems (TN-, TT-, IT-system) - intended connection - nominal a.c. system voltages and maximum allowed voltage regulation for which the SPD is designed, mechanical dimensions, lead lengths, etc.	TN	P
	b9) Temperature and humidity range	Extended or normal	P
	b10) Follow current interrupting rating I_{fi}		N/A
	b11) Residual current I_{PE}	<5μA	N/A
	b12) Transition surge current rating for short-circuiting type SPD I_{trans}		N/A
	b13) The minimum distance from any earthed conductive surface at which the SPD can be installed		N/A
	b14) I_{max} (optional)		N/A
	Information which shall be available in a datasheet		P
	c1) Temporary overvoltage rating U_T and/or the type(s) of power system(s) the SPD is designed for according to Annex B and corresponding connection details	$1.32U_{REF}$(U_{REF}=316.8 V)	P
	c2) Total discharge current ITOTAL for multipole SPDs (if declared by the manufacturer) and the corresponding test class		N/A
	c3) Voltage drop for two port SPDs		N/A
	c4) Load-side surge withstand capability for two-port SPDs		N/A
	c5) Information about replaceable parts (indicators, fuses, etc.)		N/A
	c6) Voltage rate of rise du/dt		N/A
	c7) Current factor k, if different from Table 20		N/A
	c8) Modes of protection (for SPDs with more than one mode of protection)		N/A
8.2	**Indelibility of markings**		P

IEC/EN 61643-11 - TEST SEQUENCE 1			
Clause	Requirement - Test	Result - Remark	Verdict
	This test shall be applied on markings of all types except those made by impressing, molding and engraving.		P
	The test is made by rubbing the marking by hand for 15s with a piece of cotton soaked with water and again for 15s with a piece of cotton soaked with aliphatic solvent hexane with a content of aromatics of maximum 0,1% volume, a kauributanol value of 29, initial boiling-point approximately 65 °C and a specific gravity of 0,68 g/cm³.		P
	After this test, the marking shall be easily legible**.**		P
7.3.1	**Mounting**		P
	SPDs shall be provided with appropriate means for mounting that will ensure mechanical stability. Mechanical coding/interlock shall be provided to prevent incorrect combinations of plug-in DC SPDs and sockets. Compliance is checked by visual inspection.		P
	Terminals and connections	Terminals	P
7.3.2	**Screws, current carrying parts and connections**		P
8.4.1	Reliability of screws, current-carrying parts and connections		N/A
	Screws operated when connecting the SPD:		N/A
	The screws are tightened and loosened: - ten times for screws in engagement with a thread of insulating material - five times in all other cases		N/A
	Screws or nuts in engagement with a thread of insulating material are completely removed and reinserted each time unless the construction of the screw prevents this.		N/A
	The test is made by means of a suitable test screwdriver or spanner applying a torque as shown in Table 10 or according to the manufacturer’s specification, whichever is greater.		N/A
	The screws shall not be tightened in jerks.		N/A
	The conductor is moved each time the screw is loosened.		N/A

IEC/EN 61643-11 - TEST SEQUENCE 1			
Clause	Requirement - Test	Result - Remark	Verdict
	During the test, the screwed connections shall not work loose and there shall be no damage, such as breakage of screws or damage to the head slots, threads, washers or stirrups, that will impair the further use of the SPD.		N/A
	Enclosures and covers shall not be damaged. This shall be verified by visual inspection.		N/A
7.3.3	**External connections**		P
8.4.2	Terminals for external conductors		P
	The SPD is mounted according to the manufacturer's recommendation on a dull, black-painted board of about 20mm thickness, and protected against undue external heating or cooling. SPD terminals wired with conductors according to: - table 11, for two-port devices and one port devices with separate input/output terminals, or - the manufacturer's instruction, for other one-port devices		P
	SPDs tested according to class I and one-port SPDs with a nominal discharge current ≥ 5 kA tested according to class II shall be capable of clamping conductors up to a cross-section of at least 4 mm^2		P
	Terminals shall be fastened to the SPD in such a way that they will not work loose if the clamping screws or the lock nuts are tightened or loosened. A tool shall be required to loosen the clamping screws or the lock nuts.		P
	Terminals for external conductors shall be such that the conductors may be connected so as to ensure that the necessary contact pressure is maintained permanently. The terminals shall be readily accessible under the intended conditions of use.		P
	The means for clamping the conductors in the terminals shall not serve to fix any other component, although they may hold the terminals in place or prevent them from turning.		P
	Terminals shall have adequate mechanical strength.		P
	Terminals shall be so designed that they clamp the conductor without undue damage to the conductor.		P

IEC/EN 61643-11 - TEST SEQUENCE 1			
Clause	Requirement - Test	Result - Remark	Verdict
	Terminals shall be so designed that they clamp the conductor reliably and between metal surfaces.		P
	Terminals shall be so designed or positioned that neither a rigid solid conductor nor a wire of a stranded conductor can slip out while the clamping screws or nuts are tightened.		P
7.3.3.1	**Terminals with screws**		P
	Screws and nuts for clamping the conductors shall have a metric ISO thread or a thread comparable in pitch and mechanical strength.		P
	Terminals shall be so fixed or located that, when the clamping screws or nuts are tightened or loosened, the terminals shall not work loose from their fixings to the SPDs.		P
	These requirements do not imply that the terminals shall be so designed that their rotation or displacement is prevented, but any movement shall be sufficiently limited so as to prevent non-compliance with the requirements of this standard.		P
	The use of sealing compound or resin id considered to be sufficient for preventing a terminal from working loose, provided that: • The sealing compound or resin is not subject to stress during normal use, and • The effectiveness of the sealing compound or resin is not impaired by temperatures attained by the terminal under the least favourable conditions specified in this standard.		N/A
	Clamping screws or nuts of terminals intended for the connection of protective conductors shall be adequately secured against accidental loosening.		N/A
	Screws shall not be made of metal that is soft or liable to creep, such as zinc or aluminium.		P
8.4.2.1.1	General		P
s	These tests are made by means of a suitable screwdriver or spanner applying a torque as shown in table 10.		P
	The terminals are fitted with cooper conductors of the smallest or largest cross-sectional areas specified in 8.4.2, solid or stranded, whichever is least favourable		P
	The conductor is inserted into the terminal for the minimum distance prescribed or, where no distance is prescribed, until it just projects from the far side, and in the position		P

IEC/EN 61643-11 - TEST SEQUENCE 1			
Clause	Requirement - Test	Result - Remark	Verdict
	most likely to assist the wire to escape		
	The clamping screws are then tightened with a torque to two-thirds of that shown in the appropriate column of table 10.		P
	Each conductor is then subjected to a pull of the value, in newtons, shown in table 12. The pull is applied without jerks, for 1 min, in the direction of the axes of the conductor space.		P
	During this test, the conductor shall not move noticeably in the terminal		P
8.4.2.1.2 a)	The terminals are fitted with cooper conductors (solid or stranded), of the smallest or largest-sectional areas as specified in 8.4.2, (whichever is the least favourable) and the terminal screws are tightened with a torque equal to two-thirds of the values shown in the appropriate column of table 10. The terminal screws are then loosened and the part of the conductor which may have been affected by the terminal is inspected.		P
	The conductors shall show neither undue damage nor severed wires		P
	Conductors are considered to be unduly damaged if they show deep or sharp indentations.		P
	During the test, terminals shall not work loose and there shall be no damage such as breakage of screws or damage to the head slots, threads, washers or stirrups, that will impair the further use of the terminal.		P
8.4.2.1.2 b)	The terminals are fitted with a rigid stranded cooper conductor according to table 13.		N/A
	Before insertion in the terminal, the wires of the conductors are suitably reshaped		N/A
	The conductor is inserted into the terminal until the conductor reaches the bottom of the terminal or just projects from the far side of the terminal and in the position most likely to assist a wire to escape. The clamping screw or nut is then tightened with a torque equal to two-thirds of that shown in the appropriate column of table 10		N/A
	After the test, no wire of the conductor shall have slipped out of the SPD terminal.		N/A
7.3.3.2	**Screwless terminals**		N/A

IEC/EN 61643-11 - TEST SEQUENCE 1			
Clause	Requirement - Test	Result - Remark	Verdict
	Terminals shall be so designed and constructed that: • each conductor is clamped individually. During the connection or disconnection the conductors can be connected or disconnected either at the same time or separately, • it is possible to clamp securely any number of conductors up to the maximum provided		N/A
8.4.2.2	The terminals are fitted with new cooper conductors (solid or stranded), of the smallest or largest cross-sectional areas as specified in 8.4.2		N/A
	Each conductor is then subjected to a pull of the value shown in table 14. The pull is applied without jerks for 1 min in the direction of the axis of the conductor.		N/A
8.4.2.3	**Insulation piercing connections**		N/A
8.4.2.3.1	Pull test on terminals designed for single core conductors		N/A
	The terminals are fitted with new cooper conductors (solid or stranded), of the smallest or largest cross-sectional areas as specified in 8.4.2, (whichever is the least favourable). Screws, if any, are tightened according to Table 10.		N/A
	The conductors are connected and disconnected five times, new conductors being used each time. After each connection the conductors are subjected to a pull, without jerks, for 1 min in the axis of the tapping conductor according to the value given in Table 14.		N/A
	During the test, there shall be no movement of the conductor in the terminal or any sign of damage.		N/A
8.4.2.3.2	**Pull test on terminals designed for multi-core cables or cords**		N/A
	The pull-out test on the SPD terminals designed for multi-core cables or cords is carried out as for single core conductors, except that the pull force is applied to the entire multi-core cable or cord instead of to the individual core.		N/A

IEC/EN 61643-11 - TEST SEQUENCE 1			
Clause	Requirement - Test	Result - Remark	Verdict
	The pull force is calculated according to the following formula: $F = F(x)\sqrt{n}$ *F* is the total force to apply *n* is the number of cores *F(x)* is the force for one core according to the cross-section of one conductor (see table 9)		N/A
	During the test, the cable or cord shall not slip out of the terminals.		N/A
8.4.2.4	**Flat quick connect terminations**		N/A
	Under consideration		N/A
8.4.2.5	**Pigtail connections (flying leads)**		P
8.4.2.5.1	Pull test on flying lead conductors		N/A
	A flying lead and anchorage shall withstand without damage or detachment a direct pull of 89N for one minute, applied to the lead from any angle which the construction or the device will allow.		N/A
	During the test, there shall be no movement of the conductor or any sign of damage.		N/A
7.2.1	**Protection against direct contact**	Assessment in the end enclosure	N/A
	Test applied to SPDs with U_C > 50V r.m.s.		N/A
	For protection against direct contact (inaccessibility of live parts), SPDs shall be so designed that, when they are wired and mounted as for normal use, live parts are not accessible, even after removal of parts which can be removed without the use of a tool.		N/A
8.3.1.1	**Insulated parts**		N/A
	The sample is mounted as for normal use and the test is conducted using conductors of the smallest cross-sectional area and then again using conductors of the largest cross-sectional area specified in 8.4.2.	Assessment in the end enclosure	N/A
	The standard test finger (in accordance with IEC 60529) is applied in every possible position.		N/A

IEC/EN 61643-11 - TEST SEQUENCE 1			
Clause	Requirement - Test	Result - Remark	Verdict
	For plug-in SPDs (which can be changed without a tool), the test finger is applied in every possible position, when the plug is partially inserted or completely inserted in a socket outlet.		N/A
	An electrical continuity indicator operating from a voltage of not less than 40V and not more than 50V, one side of which is connected to the test finger to check for the possibility of contact with any live part or the sample.		N/A
8.3.1.2	**Metal parts**		N/A
	Metal parts which are accessible when the SPD is wired and mounted as for normal use are connected to earth through a low resistance connection, except of small screws and the like, isolated from live parts, for fixing bases and covers or cover plates of socket-outlets.		N/A
	A current (derived from an a.c. source having a no-load voltage not exceeding 12 V) equal to 1,5 times the rated load current or 25 A, whichever is the greater, is passed between the earthing terminal and each of the accessible metal parts in turn.		N/A
	The voltage drop between the earthing terminal and the accessible metal part is measured and the resistance is calculated from the current and this voltage drop. The resistance shall not exceed 0,05 Ω.		N/A
7.4.1	**Environment, IP code**		P
	SPDs shall be provided with an enclosure for protection against ingress of solid objects and water in accordance with the IP code declared by the manufacturer.	Depending on end enclosure	P
8.5.1	Test carried out acc. to IEC 60529 to check IP code		P
7.2.2	**Residual current I_{PE}**		N/A
	For all SPDs with a terminal for the protective conductor, the residual current I_{PE} shall be measured when all SPD terminals are connected to a power supply at the reference test voltage (U_{REF}) according to the manufacturer's instructions.	I_{PE}<5μA	N/A
8.3.2	The SPD shall be connected as for normal use according to the manufacturer's instructions. The voltage shall be adjusted to the reference test voltage of U_{REF}. The residual current flowing through the PE terminal is measured.	U_{REF} =316.8V	P

IEC/EN 61643-11 - TEST SEQUENCE 1			
Clause	Requirement - Test	Result - Remark	Verdict
7.2.4/8.3.4	**Operating duty**		P
	The SPD shall be capable of withstanding specified discharge currents during application of the maximum continuous operating voltage U_C without unacceptable changes in its characteristics. The test setup shall comply with the circuit diagram given in Figure 7.	Uc:240VAC	P
	Determination of the measured limiting voltage:		P
	according to 8.3.3.1, but only at a crest value corresponding to I_{imp} for test class I		N/A
	according to 8.3.3.1, but only at I_n for test class II	20kA	N/A
	according to 8.3.3.3, but only at U_{OC} for test class III		N/A
	SPDs tested acc. to class I and II containing switching components: Front-of-wave sparkover voltage acc. to 8.3.3.2 All measured peak values (5 pos./5 neg.) below U_P		P
	Sample connected to power frequency source at U_C	240 V	P
8.3.4.2.1	SPDs with follow current < 500A: Voltage at SPD terminals does not fall below the peak value of U_C by more than 10% during flow of follow current		P
8.3.4.2.2	SPDs with follow current > 500A: Power frequency voltage U_C with a prospective short circuit current equal to the follow current interrupt rating I_{fi} declared by the manufacturer in accordance with Table 8, or 500A, whichever is greater. For SPDs connected between neutral and protective earth only, the prospective short-circuit current shall be at least 100A.		N/A
8.3.4.3	**Class I and II operating duty tests**		P
	Three groups of five impulses of 8/20 current impulses with positive polarity shall be applied. The test samples are connected to a power source according to 8.3.4.2. Each impulse shall be increased in steps of 30° with a tolerance of ± 5° for each synchronisation angle. time interval between the impulses 50s – 60s time interval between the groups 30 min – 35 min		P

IEC/EN 61643-11 - TEST SEQUENCE 1			
Clause	Requirement - Test	Result - Remark	Verdict
	The SPD shall be energized at U_C. The prospective short-circuit current of the power source shall comply with 8.3.4.2 during the application of groups of impulses. After the application of each group of impulses and after the interruption of the last follow current (if any) the SPD shall remain energized without interruption for at least 1 min to check for reignition. After the last group of impulses and the 1 min period the SPD either remains applied or is reapplied within less than 30s to U_C for another 15 min to check for stability. For that purpose, the short-circuit capability of the power source (at U_C) may be reduced to 5A.		P
	When testing SPDs to class I, 8/20 current impulses with a crest corresponding to I_{imp} shall be applied.		N/A
	When testing SPDs to class II, 8/20 current impulses with I_n shall be applied.		P
	Current records show no sign of puncture or flashover of the sample		P
8.3.4.5	**Class III operating duty tests**		N/A
	The SPD is tested with three groups of impulses corresponding to U_{OC} with: - five positive impulses initiated at crest value of positive half cycle (±5°) - five negative impulses initiated at crest value of positive half cycle (±5°) - five positive impulses initiated at crest value of positive half cycle (±5°)		N/A
8.3.4.4	**Additional duty test for test class I**		N/A
	This test is carried out with current impulses in steps up to I_{imp} passing through the SPD. SPD energized at U_C by a voltage source having a nominal current capability of 5A during the application of impulses.		N/A

IEC/EN 61643-11 - TEST SEQUENCE 1			
Clause	Requirement - Test	Result - Remark	Verdict
	Current impulses of positive polarity shall be initiated in the corresponding positive crest value of the power frequency voltage source to the energized test sample as follows: a) One current impulse at 0,1 I_{imp} b) One current impulse at 0,25 I_{imp} c) One current impulse at 0,5 I_{imp} d) One current impulse at 0,75 I_{imp} e) One current impulse at 1,0 I_{imp}		N/A
	After each impulse cool down to ambient temperature		N/A
8.3.4.6	**Pass criteria**		P
A	After the application of each impulse and after interruption of each follow current (if any) the SPD shall remain energized without interruption for at least 1 min to check for re-ignition. After that period the SPD either remains applied or is reapplied within less than 30s to U_C for another 15 min to check for stability. For that purpose the short-circuit capability of the power source shall also be 5A.		P
B	Voltage and current records and visual inspection show no sign of puncture or flashover.		P
C	No mechanical damage		P
D	Determination of the measured limiting voltage:	U_P ≤1.5K V	N/A
	according to 8.3.3.1, but only at a crest value corresponding to I_{imp} for test class I		N/A
	according to 8.3.3.1, but only at I_n for test class II		P
	according to 8.3.3.3, but only at U_{OC} for test class III		N/A
	SPDs tested acc. to class I and II containing switching components: Front-of-wave sparkover voltage acc. to 8.3.3.2 All measured peak values (5 pos./5 neg.) below U_P		P
E	No excessive leakage currents shall occur after the test		P
	If there is more than one possible connection arrangement for normal use, this check shall be performed for all arrangements		P

IEC/EN 61643-11 - TEST SEQUENCE 1			
Clause	Requirement - Test	Result - Remark	Verdict
	The SPD shall be connected as for normal use according to the manufacturer's instructions to a power supply at the reference test voltage (U_{REF}). The current that flows through each terminal is measured. Its resistive component (measured at the crest of the sine wave) • shall not exceed a value of 1 mA, or • the current shall not have changed by more than 20% compared to the initial value determined at the beginning of the test sequence	U_{REF}= 240V L&N: 0,32mA	P
	Any resettable or rearmable disconnector shall be switched off and dielectric withstand shall be checked by application of two times U_C or 1000V a.c. whichever is greater. During the test, no flashover, breakdown of insulation or any other manifestation of disruptive discharge shall occur.		N/A
	For SPD modes connected N-PE only, the current through the PE-terminal shall be measured, whereas the terminals are connected to a power supply at U_C. Its resistive component (measured at the crest of the sine wave) • shall not exceed a value of 1 mA, or • the current shall not have changed by more than 20% compared to the initial value determined at the beginning of the test sequence		N/A
F	External disconnectors shall not operate during the test and shall be in working order after the test.		N/A
G	Internal disconnectors shall not operate during the test and shall be in working order after the test.		P
M	There shall be no explosion or other hazard to either personnel or the facility.		P
7.2.5.2	**Thermal protection**		P
	SPDs shall be protected against overheating due to degradation or overstress		P
	This test is not performed on SPDs containing only switching components and/or ABD devices.		N/A
7.2.5.4	**Status indicator**		P
	The manufacturer shall provide information about the function of the indicator and the actions to be taken after change of status indication.		P

IEC/EN 61643-11 - TEST SEQUENCE 1			
Clause	Requirement - Test	Result - Remark	Verdict
	A status indicator may be composed of two parts (one of which is not replaced on replacement of the SPD), linked by a coupling mechanism which can be mechanical, optical, audio, electromagnetic, etc. The part of the status indicator which is not replaced shall be capable of operating at least 50 times.		P
	Where there is an appropriate standard for the type of indication used, this shall be met by the non-replaced part of the status indicator, with the exception that the indicator need only be tested for 50 operations.		P
8.3.5.2	**Thermal stability**		P
	If different non-linear components connected in parallel, this test has to be performed for every current path of the SPD by disconnecting/interrupting all the remaining current path. If components of the same type and parameters are connected in parallel, they shall be tested as one current path.		P
	Any voltage switching component within the current path under test, which is connected in series with a voltage limiting component shall be short-circuited by a cooper dummy with a diameter such that it does not melt during the test.		P
	Test for SPDs containing only voltage limiting components - procedure a)		N/A

IEC/EN 61643-11 - TEST SEQUENCE 1			
Clause	Requirement - Test	Result - Remark	Verdict
	Sample connected to power frequency source with a voltage high enough to drive a constant current, which is increased by the following steps – 2mA or 5% of the previously adjusted test current, whichever is greater – with a tolerance of ± 10%: 2 mA r.m.s. or corresponding crest value 4 mA r.m.s. or corresponding crest value 6 mA r.m.s. or corresponding crest value 8 mA r.m.s. or corresponding crest value 10 mA r.m.s. or corresponding crest value 12 mA r.m.s. or corresponding crest value 14 mA r.m.s. or corresponding crest value 16 mA r.m.s. or corresponding crest value 18 mA r.m.s. or corresponding crest value 20 mA r.m.s. or corresponding crest value 22 mA r.m.s. or corresponding crest value 24 mA r.m.s. or corresponding crest value 26 mA r.m.s. or corresponding crest value 28 mA r.m.s. or corresponding crest value		N/A
	Each step is maintained until thermal equilibrium is reached – temperature variation < 2K within 10 min		N/A
	Surface temperature of the hottest spot and current through the SPD are monitored continuously		N/A
	Test interrupted if all non-linear components under test are disconnected. The voltage is not increased further in order to avoid any malfunction of the disconnectors.		N/A
	For the other two samples the starting point shall be changed from 2 mA to a current corresponding to 5 steps below the current value at which the first sample disconnected		N/A
	If the voltage across the SPD falls below U_{REF} during the test, the current regulation is discontinued and the voltage is adjusted back to U_{REF} and maintained for a duration of 15 min. Continuous current monitoring is no longer required. Source short-circuit current capability does not limit the current before any disconnector operates. The maximum available current value does not exceed the short circuit withstand capability declared by the manufacturer.		N/A
	Test for SPDs having a voltage switching component in series with other components – procedure b)		P

IEC/EN 61643-11 - TEST SEQUENCE 1			
Clause	Requirement - Test	Result - Remark	Verdict
	SPD energized with a power frequency source at U_{REF} having a short-circuit current capability which will not limit the current before any disconnector operates. The maximum available current value does not exceed the short-circuit withstand capability declared by the manufacturer.	U_{REF} =240V	P
	If no significant current flows – test procedure a) shall be followed		P
	Pass criteria		P
C	No mechanical damage		P
H	Disconnection shall be provided by one or more internal or external disconnector(s). Their correct indication shall be checked.		P
I	SPDs having an IP degree ≥ IP 2X – no live parts accessible with standardised test finger applied with a force of 5N, except the ones which are accessible when the SPD is fitted as in normal use.		N/A
J	If disconnection occurs during the test, there shall be clear evidence of effective disconnection of the corresponding protective component(s). If internal disconnection occurs, the test sample is connected at U_C and rated frequency for 1 min. The current flow shall not exceed a value of 1 mA.	500/600 V 0 mA	N/A
	Currents through components connected in parallel to the relevant protective component(s), are disregarded for this measurement.		N/A
	Current through the PE-terminal shall not exceed 1mA If there is more than one possible connection arrangement for normal use, this check shall be performed for all arrangements.		N/A
M	There shall be no explosion or other hazard to either personnel or the facility		P
O	After completion of this test the samples shall be allowed to return to room temperature and be connected to a power source at U_C for 2 hours. The residual current shall be monitored and not exceed the value measured at the beginning of the test by more than 10%.		P
	In addition for indoor SPDs the surface temperature rise shall not exceed 120K during and after the test.	32,1K	P
	5 min. after disconnection of all non-linear components under test the surface temperature rise shall not exceed 80K.	45,9K	P
7.3.4/8.4.3	**Verification of air clearances and creepage distances**		P
	SPDs for domestic and similar applications shall be designed for pollution degree 2.		P

IEC/EN 61643-11 - TEST SEQUENCE 1			
Clause	Requirement - Test	Result - Remark	Verdict
	SPDs for more stringent environmental applications may require special precautions, e.g. an appropriate SPD housing or an additional enclosure, which will ensure pollution degree 2 for the SPD	SPD built in end enclosure	P
	For SPDs for outdoor and out of reach applications pollution degree 4 applies. This may be reduced to pollution degree 3 for internal distances, if they are covered by an adequate housing ensuring pollution degree 3 conditions.		N/A
	The electrode spacing of spark gaps shall not be considered for the determination of air clearances and creepage distances.		N/A
	The air clearances and creepage distances shall not be smaller than the values indicated in Table 15 and Table 16.		P
	Air clearances in millimetres 1) Between live parts of different polarity 2) Between live parts and – screws and other means to fasten a covering, having to be detached for mounting the SPD – fastening surfaces (note 2) – screws or other means for fastening the SPD (note 2) – bodies (notes 1 and 2) 3) Between the metal parts of the disconnector mechanism and – bodies (note 1) – screws or other means for fastening the SPD NOTE 1 – Definition see 8.3.6 a) NOTE 2 – If clearances between live parts of the device and the metallic screen or the surface on which the SPD is mounted are dependent on the design of the SPD only and cannot be reduced when the SPD is mounted in the least favourable position (even in a metallic enclosure), the values of lines 1 are sufficient. **Creepage distances in millimetres** – r.m.s. voltage – Material group	U_{max} 7000 V required / measured 7,8 / 8,5 / / / 8,6 / 11,6 / / 240 V IIIa	N/A P

IEC/EN 61643-11 - TEST SEQUENCE 1			
Clause	Requirement - Test	Result - Remark	Verdict
	– Pollution – distances required 1) Between live parts of different polarity 2) Between live parts and bodies 3) Between the metal parts of the disconnector mechanism and bodies **Printed wiring material** – r.m.s. voltage – Material group – Pollution – distances required	2 5,0 8,2 5,0/8,2 240 IIIa 2 5,0 /8,5	
7.4.2/8.5.3	**Ball pressure test**		P
	Outer parts of SPDs, consist of insulating material, are submitted to a ball pressure test by means of a tester as shown on Figure 20 and 21.		P
	Parts of insulating material necessary to retain current carrying parts and parts of the earthing circuit in position are tested in a heating cabinet at 125°C ± 2 K.	PCB, body	P
	Parts of insulating material not necessary to retain current carrying parts and parts of the earthing circuit in position, even though they are in contact with them, are tested at 70°C ± 2 K.		N/A
	The sample to be tested is fastened accordingly, its surface being positioned horizontally; a steel ball having a diameter of 5 mm is pressed against the surface with a force of 20 N.		P
	After 1 h, the steel ball is taken away from the sample; by dipping it into cold water, the temperature of the sample is reduced to ambient temperature within 10 s.		P
	Pass criteria		P
	The diameter of the ball indentation is measured and shall not exceed 2 mm.	PCB;0,78mm ; Body; 1,15mm	P
7.4.3/8.5.4	**Resistance to abnormal heat and fire**		P

IEC/EN 61643-11 - TEST SEQUENCE 1			
Clause	Requirement - Test	Result - Remark	Verdict
	Insulating parts of the housing shall be either non-flammable or self-extinguishing. The glow wire test is performed in accordance with Clauses 4 to 10 of IEC 60695-2-11 under the following conditions: • for external parts of SPDs made of insulating material necessary to reatain in position current-carrying parts and parts of the protective circuit, by the test made at a temperature of 850 °C ± 15 K. • for all other external parts made of insulating material, by the test made at a temperature of 650 °C ± 10 K.	PCB; 850°C; Body; 850°C	P
	The test is not made on parts of ceramic material and parts with lower size than defined in 3.1 of IEC 60695-2-11.		N/A
	If the insulating parts are made of the same material, the test is carried out only on one of these parts, according to the appropriate glow-wire test temperature.		P
	The test is made on one sample		P
	In case of doubt, the test is repeated on two additional samples.		N/A
	The test is made by applying the glow-wire once.		P
	The sample shall be positioned during the test in the least favourable position of its intended use (with the surface tested in a vertical position).		P
	The tip of the glow-wire shall be applied to the specified surface of the test sample taking into account the conditions of intended use under which a heated or glowing element may come into contact with the sample.		P
	Pass criteria		P
	The sample is regarded as having passed the glow-wire test if • there is no visible flame and no sustained glowing or if, • flames and glowing parts on the sample extinguish themselves within 30 s after the removal of the glow-wire.	No visible flame	P
	There shall be no ignition of the tissue paper or scorching		P

IEC/EN 61643-11 - TEST SEQUENCE 1			
Clause	Requirement - Test	Result - Remark	Verdict
	of the pinewood board.		
7.4.4/8.5.5	**Tracking resistance**		P
	The test is performed according to IEC 60112, solution A with a test voltage depending on the measured creepage distances and the required material group according to 8.3.4.	PCB	P

IEC/EN 61643-11 - TEST SEQUENCE 2			
Clause	Requirement - Test	Result - Remark	Verdict
7.2.3/8.3.3	**Voltage protection level**		P
	The measured limiting voltage of the SPDs shall not exceed the voltage protection level that is specified by the manufacturer.		P
	All one-port SPDs shall be tested unenergized.		P
	All two-port SPDs shall be tested energized for the tests according 8.3.3.1 and 8.3.3.3 by means of a voltage source having a nominal current of at least 5 A at U_C. Positive impulses are applied at the (90 ± 5)° point and negative impulses at (270 ± 5)° point on the sinusoidal voltage waveform.	One-port SPD	N/A
	For a one-port SPD having terminals, the test is performed without external disconnectors and the voltage is measured at the terminals. For a one-port SPD having connecting leads the voltage is measured with external lead lengths of 150mm. For a two-port SPD, and a one-port SPD having separate load terminals, the voltage for determining the measured limiting voltage is measured at the output/load port or load terminals of the SPD and the voltage for determining U_{max} is measured at the input/line port or terminals of the SPD.		P
8.3.3.1	**Residual voltage with 8/20 current impulses**		P
	Class I, 8/20 current impulses with a sequence of crest values of 0,1; 0,2; 0,5; 1,0 times the crest value of I_{imp} shall be applied. 0,1 times I_{imp} 0,2 times I_{imp} 0,5 times I_{imp} 1,0 times I_{imp} Class II, 8/20 current impulses with a sequence of crest values of 0,1; 0,2; 0,5; 1,0 times I_n shall be applied. 0,1 times I_n 0,2 times I_n 0,5 times I_n 1,0 times I_n If the SPD contains only voltage-limiting components, this test needs only to be performed at a crest values of I_{imp} for test class I or I_n for test class II.		P
	When I_{max} is declared by the manufacturer an additional 8/20 current impulse with a crest value of I_{max} shall be applied and the residual voltage shall be measured and recorded.		N/A

IEC/EN 61643-11 - TEST SEQUENCE 2			
Clause	Requirement - Test	Result - Remark	Verdict
	One sequence of positive polarity and one sequence of negative polarity are applied to the SPD		P
	The interval between individual impulses shall be long enough for the sample to cool down to ambient temperature.		P
	Current and voltage oscillogram		P
	Crest values – discharge current versus residual voltage diagram to I_n or I_{imp}		P
	The residual voltage used for determining the measured limiting voltage is the highest voltage value corresponding to the range of currents for: • class I: up to I_{imp} • class II: up to I_n		P
	The value for determining U_{max} is the highest residual voltage measured at I_n, I_{max} or I_{imp}, as applicable depending on the SPD test class.		P
8.3.3.2	**Front-of-wave sparkover voltage**		P
	The 1,2/50 voltage impulse is used. The generator is set to an open circuit output voltage of 6 kV.		P
	10 impulses are applied to the SPD, five of positive and five of negative polarity.		P
	The interval between individual impulses shall be long enough for the sample to cool down to ambient temperature.		P
	If sparkover is not observed during each of the 10 impulses on the front of wave, then the above procedure are repeated with the generator output voltage increased up to a maximum 10 kV.		P
	Voltage oscillograms		P
	The value for determining the measured limiting voltage and U_{max} is the maximum sparkover voltage recorded during this test.		P
8.3.3.3	**Limiting voltage with the combination wave**		N/A
	To perform this test a combination wave generator is used. The interval between the individual impulses shall be long enough for the sample to cool down to ambient temperature.		N/A

IEC/EN 61643-11 - TEST SEQUENCE 2			
Clause	Requirement - Test	Result - Remark	Verdict
	The voltage of the combination wave generator is set to provide an open-circuit voltage of 0,1; 0,2; 0,5; 1,0 times the U_{OC}. If the SPD only contains voltage-limiting components this test needs to be carried out at U_{OC} only. 0,1 times U_{OC} _____ kV 0,2 times U_{OC} _____ kV 0,5 times U_{OC} _____ kV 1,0 times U_{OC} 4,0 kV		N/A
	With these generator settings four surges will be applied to the SPD at each amplitude: two with positive and two with negative polarity.		N/A
	Current-voltage oscillograms; voltage at the output port of the SPD		N/A
	The value for determining the measured limiting voltage and U_{max} is the maximum voltage recorded during the test.		N/A
8.3.3.4	**Pass criteria for all measured limiting voltage tests**		P
B	Voltage and current records and visual inspection show no sign of puncture or flashover.		P
C	No mechanical damage		P
I	SPDs having an IP degree ≥ IP 2X – no live parts accessible with standardised test finger applied with a force of 5N, except the ones which are accessible when the SPD is fitted as in normal use.	IP 20	N/A
M	There shall be no explosion or other hazard to either personnel or the facility		P

IEC/EN 61643-11 - TEST SEQUENCE 2a Additional tests if declared by the manufacturer			
Clause	Requirement - Test	Result - Remark	Verdict
7.6.2.2/8.7.3	**Load-side surge withstand capability**		N/A
	For this test: • 15 current impulses 8/20, or • 15 combination wave impulses with an open-circuit voltage U_{OC} with a value equal to the load-side surge withstand capability declared by the manufacturer are applied in three groups of five impulses to the output port of the test sample. The SPD is energized at U_C by means of a voltage source having a nominal current of at least 5 A. Each impulse shall be synchronized to the power frequency. Starting from 0° the synchronization angle shall be increased in steps of (30 ± 5)°.		N/A
	The interval between the impulses is 50 s to 60 s and the internal between the groups is 30 min to 35 min.		N/A
	The test sample shall be energized during the whole test sequence. The voltage on the output terminals shall be recorded.		N/A
	Pass criteria		N/A
A	Thermal stability shall be achieved		N/A
B	Voltage and current records and visual inspection show no sign of puncture or flashover.		N/A
C	No mechanical damage		N/A
D	Determination of the measured limiting voltage:		N/A
	according to 8.3.3.1, but only at a crest value corresponding to I_{imp} for test class I		N/A
	according to 8.3.3.1, but only at I_n for test class II		N/A
	according to 8.3.3.3, but only at U_{OC} for test class III		N/A
	SPDs tested acc. to class I and II containing switching components: Front-of-wave sparkover voltage acc. to 8.3.3.2 All measured peak values (5 pos./5 neg.) below U_P		N/A
E	No excessive leakage currents shall occur after the test		N/A

IEC/EN 61643-11 - TEST SEQUENCE 2a Additional tests if declared by the manufacturer			
Clause	Requirement - Test	Result - Remark	Verdict
	If there is more than one possible connection arrangement for normal use, this check shall be performed for all arrangements		N/A
	The SPD shall be connected as for normal use according to the manufacturer's instructions to a power supply at the reference test voltage (U_{REF}). The current that flows through each terminal is measured. Its resistive component (measured at the crest of the sine wave) • shall not exceed a value of 1 mA, or • the current shall not have changed by more than 20% compared to the initial value determined at the beginning of the test sequence		N/A
	Any resettable or rearmable disconnector shall be switched off and dielectric withstand shall be checked by application of two times U_C or 1000V a.c. whichever is greater. During the test, no flashover, breakdown of insulation or any other manifestation of disruptive discharge shall occur.		N/A
	For SPD modes connected N-PE only, the current through the PE-terminal shall be measured, whereas the terminals are connected to a power supply at U_C. Its resistive component (measured at the crest of the sine wave) • shall not exceed a value of 1 mA, or • the current shall not have changed by more than 20% compared to the initial value determined at the beginning of the test sequence		N/A
F	External disconnectors shall not operate during the test and shall be in working order after the test.		N/A
G	Internal disconnectors shall not operate during the test and shall be in working order after the test.		N/A

IEC/EN 61643-11 - TEST SEQUENCE 2b Additional tests for two-port SPDs and one port-SPDs with separate input / output terminals			
Clause	Requirement - Test	Result - Remark	Verdict
7.5.1.3	**Load-side short-circuit current behaviour**		N/A
	The SPD shall be able to carry the currents caused by a power short-circuit on the load side until it is interrupted either by the SPD itself or by an internal or external disconnector.		N/A
8.6.1.3	This test applies to all SPDs, except those classified for outdoor use and mounted out of reach and those connected N-PE for use in TN and/or TT systems only.		N/A
	The test settings and the test procedure according to 8.3.5.3 (excluding 8.3.5.3.1) are repeated without short-circuiting any components, but with a short-circuit link connected to the following output terminals of the SPD as applicable: • short-circuit link across all phase terminals and the neutral terminal (if applicable) on the load side • short-circuit link across all terminals on the load side, with a conductors of the largest cross-section specified under 8.4.2 and with a length of 500 mm each.		N/A
	Pass criteria		N/A
C	No mechanical damage		N/A
E	No excessive leakage currents shall occur after the test		N/A
	If there is more than one possible connection arrangement for normal use, this check shall be performed for all arrangements		N/A
	The SPD shall be connected as for normal use according to the manufacturer's instructions to a power supply at the reference test voltage (U_{REF}). The current that flows through each terminal is measured. Its resistive component (measured at the crest of the sine wave) • shall not exceed a value of 1 mA or • the current shall not have changed by more than 20% compared to the initial value determined at the beginning of the test sequence		N/A

IEC/EN 61643-11 - TEST SEQUENCE 2b Additional tests for two-port SPDs and one port-SPDs with separate input / output terminals			
Clause	Requirement - Test	Result - Remark	Verdict
	Any resettable or rearmable disconnector shall be switched off and dielectric withstand shall be checked by application of two times U_C or 1000V a.c. whichever is greater. During the test, no flashover, breakdown of insulation or any other manifestation of disruptive discharge shall occur.		N/A
	For SPD modes connected N-PE only, the current through the PE-terminal shall be measured, whereas the terminals are connected to a power supply at U_C. Its resistive component (measured at the crest of the sine wave) • shall not exceed a value of 1 mA or • the current shall not have changed by more than 20% compared to the initial value determined at the beginning of the test sequence		N/A
H	Disconnection shall be provided by one or more internal or external disconnector(s). Their correct indication shall be checked.		N/A
I	SPDs having an IP degree ≥ IP 2X – no live parts accessible with standardised test finger applied with a force of 5N, except the ones which are accessible when the SPD is fitted as in normal use.		N/A
J	If disconnection occurs during the test, there shall be clear evidence of effective disconnection of the corresponding protective component(s). If internal disconnection occurs, the test sample is connected at U_C and rated frequency for 1 min. The current flow shall not exceed a value of 1 mA.		N/A
	Currents through components connected in parallel to the relevant protective component(s), are disregarded for this measurement.		N/A
	Current through the PE-terminal shall not exceed 1mA If there is more than one possible connection arrangement for normal use, this check shall be performed for all arrangements.		N/A
K	The short-circuit current from the power source, if any, shall be interrupted within 5 s by one or more internal and/or external disconnector(s).		N/A

IEC/EN 61643-11 - TEST SEQUENCE 2b Additional tests for two-port SPDs and one port-SPDs with separate input / output terminals			
Clause	Requirement - Test	Result - Remark	Verdict
M	There shall be no explosion or other hazard to either personnel or the facility.		N/A
N	There shall be no flashover to the metallic screen and the 6 A gL/gG fuse connecting the screen shall not operate during the test.		N/A
	a) Internal disconnector(s) have operated:		N/A
	After removing the short-circuit links from output terminals and with U_{REF} applied according to the circuit shown in Figure 22, there shall be no voltage on the output terminals.		N/A
	With a power frequency voltage equal to two times U_C applied between all corresponding input and output phase terminals for 1 min there shall be no current flow in excess of 0,5 mA.		N/A
	a) No internal disconnector has operated:		N/A
D	Determination of the measured limiting voltage:		N/A
	according to 8.3.3.1, but only at a crest value corresponding to I_{imp} for test class I		N/A
	according to 8.3.3.1, but only at I_n for test class II		N/A
	according to 8.3.3.3, but only at U_{OC} for test class III		N/A
	SPDs tested acc. to class I and II containing switching components: Front-of-wave sparkover voltage acc. to 8.3.3.2 All measured peak values (5 pos./5 neg.) below U_P		N/A

IEC/EN 61643-11 - TEST SEQUENCE 3			
Clause	Requirement - Test	Result - Remark	Verdict
7.2.6/8.3.6	**Insulation resistance**		P
	The insulation resistance of the SPD shall be sufficient with respect to leakage currents and protection against direct contact. This test is not applicable to SPDs having a metallic enclosure connected to protective earth.		N/A
	Additional entry holes for cables, if there are any, are left open. If there are any knockouts, one of them is opened. Coverings and other parts which are detachable without tools, are removed and undergo the same moisture treatment.		P
	The moisture treatment is carried out in a humidity cabinet at a relative humidity of 93% ± 3% RH. The air temperature is kept at all points, where the test sample can be positioned, within ± 2 K at a suitable temperature T between 20°C and 30°C. Before putting the test samples into the humidity cabinet, they shall have a temperature between T and (T+4) in °C.		P
	The samples shall be kept in the humidity cabinet for 2 days (48 h).		P
	After a delay of between 30 min and 60 min following the humidity treatment, the insulation resistance is measured 60 s after having applied a d.c. voltage of 500 V.		P
	This measurement is carried out in the humidity cabinet or in the room into which the specimens were brought to reach the determined temperature, after having refitted the parts which might have been detached. a) between all interconnected live parts and the SPDs body accessible to accidental contact. The express “body” in the sense of this test means • all touchable metal parts and a metal foil on surfaces of insulating material, which are touchable after installation as for normal use, • the surface on which the SPD is mounted, if necessary covered with metal foil, • screws and other facilities for fastening the SPD on its support Fore these measurements, the metal foil is put on in such a way, that perhaps existing casting mass is effectively tested. Protective components connected to PE may be disconnected for this test		P

IEC/EN 61643-11 - TEST SEQUENCE 3			
Clause	Requirement - Test	Result - Remark	Verdict
	b) between the live parts of the SPD main circuit and live parts of separate isolated circuits, if there are any.		N/A
	Pass criteria		P
	The insulation resistance shall not be lower than • 5 MΩ for the measurements according to a), • 2 MΩ for the measurements according to b).	>500 MΩ	P
7.2.7/8.3.7	**Dielectric withstand**		P
	The dielectric withstand of the SPD shall be sufficient with respect to insulation breakdown and protection against direct contact.		P
	SPDs classified for outdoor use are tested between the terminals with the internal parts removed. During this test, the SPD is subjected to sprinkling according to 9.1 of IEC 60060-1.		P
	SPDs classified for indoor are tested as indicated in a) and b) of 8.3.6.		P
	SPDs are tested with an a.c. voltage according to Table 9. Starting with not more than half the required a.c. voltage, this voltage is increased to the full value within 30 s which is maintained for 1 min. a) between all interconnected live parts and the SPDs body accessible to accidental contact. The express “body” in the sense of this test means • all touchable metal parts and a metal foil on surfaces of insulating material, which are touchable after installation as for normal use, • the surface on which the SPD is mounted, if necessary covered with metal foil, • screws and other facilities for fastening the SPD on its support Fore these measurements, the metal foil is put on in such a way, that perhaps existing casting mass is effectively tested. Protective components connected to PE may be disconnected for this test. b) between the live parts of the SPD main circuit and live parts of separate isolated circuits, if there are any.		P P
	Pass criteria		P

IEC/EN 61643-11 - TEST SEQUENCE 3			
Clause	Requirement - Test	Result - Remark	Verdict
	Arcing or puncturing shall not occur, however, partial discharges are accepted if the voltage change the discharge is less than 5%.		P
	The power transformer used for testing shall be designed in such a way that after having been adjusted to the test voltage at its open terminals it will generate a short-circuit current of at least 200 mA after short-circuiting the terminals. An overcurrent relay, if any, shall only react if the test circuit current exceeds 100 mA. The device for measuring the test voltage shall have a precision of ± 3 %.		P
7.3.5/8.4.4	**Mechanical strength**		P
	All parts of the SPD relating to the protection against direct contact shall have sufficient mechanical strength.		P
	The samples are subjected to strikes by means of an impact-test apparatus as shown in Figure 18 and Figure 19.		P
	Samples are mounted on a sheet of plywood, 8 mm thick and 175 mm square, secured at its top and bottom edges to a ridged bracket.		P
	Portable SPDs are tested as fixed SPDs, but they are fixed to the plywood sheet by auxiliary means.		N/A
	Flush-type SPDs are mounted in a recess provided in a block of hornbeam or material having similar mechanical characteristics, which is fixed to a sheet of plywood. (They are not tested in their relevant mounting boxes.)		P
	If wood is used for the block, the direction of the wood fibres shall be perpendicular to the direction of the impact.		N/A
	Flush-type screw fixing SPDs shall be fixed by means of screws to lugs recessed in the block.		N/A
	Flush-type claw fixing SPDs shall be fixed to the block by means of the claws.		N/A
	Before applying the strikes, fixing screw of bases and covers are tightened with a torque equal to two-thirds of that specified in Table 10.		N/A
	The samples are mounted so that the point of impact lies in the vertical plane through the axis of the pivot. The striking element is allowed to fall from a height which is specified in the following Table 18: parts A and B h = 100 mm		P

IEC/EN 61643-11 - TEST SEQUENCE 3			
Clause	Requirement - Test	Result - Remark	Verdict
	parts C h = 150 mm parts D h = 200 mm A: parts on the front surface, including parts which are recessed. B: Parts which do not project more than 15 mm from the mounting surface (distance from the wall) after mounting as in normal use, with the exception of the above parts A. C: Parts which project more than 15 mm and not more than 25 mm from the mounting surface (distance from the wall) after mounting as in normal use, with the exception of the above parts A. D: Parts which project more than 25 mm from the mounting surface (distance from the wall) after mounting as in normal use, with the exception of the above parts A.		P
	The heights of the fall determined by the part of the sample which projects most from the mounting surface is applied on all parts of the sample, with the exception of parts A		P
	The samples are subjected to strikes which are evenly distributed over the samples. The strikes are not applied to “knock-out” areas.		P
	The following blows are applied: • for parts A, five strikes: one in the centre. After the sample has been moved horizontally: one each on the unfavourable points between the centre and the edges; and then, after the sample has been turned 90° about its axis perpendicular to the plywood, one each on similar points; • for parts B (as far as applicable), C and D, four blows: – one on one side of the sample of the sample after the plywood sheet has been turned 60° and one blow on another side of the sample after it has been turned 90° about its axis perpendicular to the plywood sheet, keeping the position of the plywood sheet unchanged; – one blow on each of the other two sides of the sample, with the plywood sheet turned 60° in the opposite direction.		P
	Pass criteria		P

IEC/EN 61643-11 - TEST SEQUENCE 3			
Clause	Requirement - Test	Result - Remark	Verdict
	After the test, the sample shows no damage within the meaning of the standard. In particular, live parts have not become accessible with the standard test finger.		P
	Damage to the finish small dents which do not reduce creepage distances or clearances and small chips which do not adversely affect the protection against electric shock or harmful ingress of water are neglected		P
	Cracks not visible with the normal or corrected vision, without additional magnification, and surface cracks in fibre reinforced mouldings and the like are ignored.		P
7.2.5/8.3.5.1	**Temperature withstand**		P
	The SPD is kept in a heated cabinet at an ambient temperature of 80 °C ± 5 K for 24 h.		P
	Pass criteria		P
C	No mechanical damage		P
G	Internal disconnectors shall not operate during the test and shall be in working order after the test.		P
Remarks: /			

IEC/EN 61643-11 - TEST SEQUENCE 3a Additional tests for SPDs with separate isolated circuits			
Clause	Requirement - Test	Result - Remark	Verdict
7.5.3	Where a SPD includes a circuit that is electrically isolated from the main circuit, the manufacturer shall provide information about the isolation and dielectric withstand voltages between the circuits as well as the relevant standards that the manufacturer is claiming conformity with.		N/A
	Where there are more than two circuits, declarations shall be made with regard to each combination of circuits.		N/A
8.3.6	**Insulation resistance**		N/A
	The moisture treatment is carried out in a humidity cabinet at a relative humidity of 93% ± 3% RH. The air temperature is kept at all points, where the test sample can be positioned, within ± 2 K at a suitable temperature T between 20°C and 30°C. Before putting the test samples into the humidity cabinet, they shall have a temperature between T and (T+4) in °C.		N/A
	The samples shall be kept in the humidity cabinet for 2 days (48 h).		N/A
	After a delay of between 30 min and 60 min following the humidity treatment, the insulation resistance is measured 60 s after having applied a d.c. voltage of 500 V.		N/A
	This measurement is carried out in the humidity cabinet or in the room into which the specimens were brought to reach the determined temperature, after having refitted the parts which might have been detached. a) between all interconnected live parts of the separate circuits and the SPDs body accessible to accidental contact. The express “body” in the sense of this test means • all touchable metal parts and a metal foil on surfaces of insulating material, which are touchable after installation as for normal use, • the surface on which the SPD is mounted, if necessary covered with metal foil, • screws and other facilities for fastening the SPD on its support Fore these measurements, the metal foil is put on in such a way, that perhaps existing casting mass is effectively tested. Protective components connected to PE may be disconnected for this test		N/A

IEC/EN 61643-11 - TEST SEQUENCE 3a Additional tests for SPDs with separate isolated circuits			
Clause	Requirement - Test	Result - Remark	Verdict
	b) between each combination of separate isolated circuits of the SPD, if there is more than one.		N/A
	Pass criteria		N/A
	The insulation resistance shall not be lower than • 5 MΩ for the measurements according to a), • 2 MΩ for the measurements according to b).		N/A
8.3.7	**Dielectric withstand**		N/A
	SPDs classified for outdoor use are tested between the terminals with the internal parts removed. During this test, the SPD is subjected to sprinkling according to 9.1 of IEC 60060-1.		N/A
	SPDs classified for indoor are tested as indicated in a) and b) of 8.3.6.		N/A
	SPDs are tested with an a.c. voltage according to Table 9. Starting with not more than half the required a.c. voltage, this voltage is increased to the full value within 30 s which is maintained for 1 min. a) between all interconnected live parts of the separate circuits and the SPDs body accessible to accidental contact. The express “body” in the sense of this test means • all touchable metal parts and a metal foil on surfaces of insulating material, which are touchable after installation as for normal use, • the surface on which the SPD is mounted, if necessary covered with metal foil, • screws and other facilities for fastening the SPD on its support Fore these measurements, the metal foil is put on in such a way, that perhaps existing casting mass is effectively tested. Protective components connected to PE may be disconnected for this test. b) between each combination of separate isolated circuits of the SPD, if there is more than one.		N/A N/A

IEC/EN 61643-11 - TEST SEQUENCE 3a Additional tests for SPDs with separate isolated circuits			
Clause	Requirement - Test	Result - Remark	Verdict
	Pass criteria		N/A
	Arcing or puncturing shall not occur, however, partial discharges are accepted if the voltage change the discharge is less than 5%.		N/A
	The power transformer used for testing shall be designed in such a way that after having been adjusted to the test voltage at its open terminals it will generate a short-circuit current of at least 200 mA after short-circuiting the terminals. An overcurrent relay, if any, shall only react if the test circuit current exceeds 100 mA. The device for measuring the test voltage shall have a precision of ± 3 %.		N/A

IEC/EN 61643-11 - TEST SEQUENCE 3b Additional tests if declared by the manufacturer			
Clause	Requirement - Test	Result - Remark	Verdict
7.6.2.1/8.7.2	**Test to determine the voltage drop** (two port SPDs)	One port SPD	N/A
	U_C supplied at the input port SPD loaded with rated load current into a resistive load Input and output voltage measured simultaneously to determine the percentage voltage regulation $\Delta U\% = ((U_{in} - U_{out}) / U_{in})*100\%$		N/A
	Pass criteria		N/A
C	No mechanical damage		N/A

IEC/EN 61643-11 - TEST SEQUENCE 3c Additional tests for two-port SPDs with separate input / output terminals			
Clause	Requirement - Test	Result - Remark	Verdict
7.5.1.1/ 8.6.1.1	**Rated load current (I_L)**		N/A

IEC/EN 61643-11 - TEST SEQUENCE 3c Additional tests for two-port SPDs with separate input / output terminals			
Clause	Requirement - Test	Result - Remark	Verdict
	The SPD shall be powered at a voltage U_C $^{+0}/_{-5}$% at ambient temperature, using a cable with a nominal cross-section as specified in Table 19. The test shall be conducted with rated load current into a resistive load until thermal stability is reached. Additional cooling of the SPD is not permitted.		N/A
	Pass criteria		N/A
	Value complies with the manufacturers		N/A
	External disconnectors shall not operate during the test and shall be in working order after the test.		N/A
	Internal disconnectors shall not operate during the test and shall be in working order after the test.		N/A
	The temperature rise of surfaces which are accessible in normal use shall not exceed the values described in Annex G during the test. Parts of SPD: • Built-in components • Terminals for external insulated conductors • Busbars and conductors, plug-in contacts of removable or withdrawable parts which connect to busbars • Manual operating means of metal • Manual operating means of insulating material • Accessible external enclosures and covers – metal surfaces – insulating surfaces • Discrete arrangements of plug and socket-type connections		N/A
7.5.1.2	**Overload behaviour**		N/A
	The SPD shall be damaged or altered by overloads, which may occur in normal use.		N/A
8.6.1.2	The test is carried out at ambient temperature and the sample shall be protected against abnormal external heating or cooling.		N/A
	The test is carried out at ambient temperature and the sample shall be protected against abnormal external heating or cooling.		N/A

IEC/EN 61643-11 - TEST SEQUENCE 3c Additional tests for two-port SPDs with separate input / output terminals			
Clause	Requirement - Test	Result - Remark	Verdict
	The test circuit and procedure shall be as described in 8.6.1.1, except that circuits other than the main circuit are disregarded for this test.		N/A
	The test is performed without any external disconnectors being connected (internal removable overcurrent protective devices are replaced by a link of negligible impedance).		N/A
	If a maximum overcurrent protection is specified by the manufacturer, the SPD shall be loaded for 1 h with a current equal to k times that maximum overcurrent protection. The factor k shall be selected from Table 20.		N/A
	If no maximum overcurrent protection is specified by the manufacturer, the SPD shall be loaded with 1,1 times the rated load current for 1 h or until an internal disconnector operates. If no disconnector operates within 1 h, the test is continued by increasing the previous value of test current by a factor of 1,1 every hour, until an internal disconnector operates.		N/A
	Pass criteria		N/A
	The temperature rise of surfaces which are accessible in normal use shall not exceed the values described in ANNEX G during the test. Parts of SPD: • Built-in SPD: • Terminals for external insulated conductors • Busbars and conductors, plug-in contacts of removable or withdrawable parts which connect to busbars • Manual operating means of metal • Manual operating means of insulating material • Accessible external enclosures and covers – metal surfaces – insulating surfaces • Discrete arrangements of plug and socket-type connections		N/A
	a) Any internal disconnector has operated:		N/A
C	No mechanical damage		N/A
H	Disconnection shall be provided by one or more internal or external disconnector(s). Their correct indication shall be		N/A

IEC/EN 61643-11 - TEST SEQUENCE 3c Additional tests for two-port SPDs with separate input / output terminals			
Clause	Requirement - Test	Result - Remark	Verdict
	checked.		
I	SPDs having an IP degree ≥ IP 2X – no live parts accessible with standardised test finger applied with a force of 5N, except the ones which are accessible when the SPD is fitted as in normal use.		N/A
J	If disconnection occurs during the test, there shall be clear evidence of effective disconnection of the corresponding protective component(s). If internal disconnection occurs, the test sample is connected at U_C and rated frequency for 1 min. The current flow shall not exceed a value of 1 mA.		N/A
	Currents through components connected in parallel to the relevant protective component(s), are disregarded for this measurement.		N/A
	Current through the PE-terminal shall not exceed 1mA If there is more than one possible connection arrangement for normal use, this check shall be performed for all arrangements.		N/A
M	There shall be no explosion or other hazard to either personnel or the facility.		N/A
	b) No internal disconnector has operated:		N/A
C	No mechanical damage		N/A
D	Determination of the measured limiting voltage:		N/A
	according to 8.3.3.1, but only at a crest value corresponding to I_{imp} for test class I		N/A
	according to 8.3.3.1, but only at I_n for test class II		N/A
	according to 8.3.3.3, but only at U_{OC} for test class III		N/A
	SPDs tested acc. to class I and II containing switching components: Front-of-wave sparkover voltage acc. to 8.3.3.2 All measured peak values (5 pos./5 neg.) below U_P		N/A
E	No excessive leakage currents shall occur after the test		N/A
	If there is more than one possible connection arrangement for normal use, this check shall be performed for all arrangements		N/A

IEC/EN 61643-11 - TEST SEQUENCE 3c Additional tests for two-port SPDs with separate input / output terminals			
Clause	Requirement - Test	Result - Remark	Verdict
	The SPD shall be connected as for normal use according to the manufacturer's instructions to a power supply at the reference test voltage (U_{REF}). The current that flows through each terminal is measured. Its resistive component (measured at the crest of the sine wave) • shall not exceed a value of 1 mA, or • the current shall not have changed by more than 20% compared to the initial value determined at the beginning of the test sequence		N/A
	Any resettable or rearmable disconnector shall be switched off and dielectric withstand shall be checked by application of two times U_C or 1000V a.c. whichever is greater. During the test, no flashover, breakdown of insulation or any other manifestation of disruptive discharge shall occur.		N/A
	For SPD modes connected N-PE only, the current through the PE-terminal shall be measured, whereas the terminals are connected to a power supply at U_C. Its resistive component (measured at the crest of the sine wave) • shall not exceed a value of 1 mA, or • the current shall not have changed by more than 20% compared to the initial value determined at the beginning of the test sequence		N/A
I	SPDs having an IP degree ≥ IP 2X – no live parts accessible with standardised test finger applied with a force of 5N, except the ones which are accessible when the SPD is fitted as in normal use.		N/A

IEC/EN 61643-11 - TEST SEQUENCE 4			
Clause	Requirement - Test	Result - Remark	Verdict
7.4.2/8.5.2	**Heat resistance**		P
	The SPD is kept in a heated cabinet at a temperature of 100 °C ± 2 K for the duration of 1 h.		P
	Pass criteria		P
C	No mechanical damage		P
I	SPDs having an IP degree ≥ IP 2X – no live parts accessible with standardised test finger applied with a force of 5 N, except the ones which are accessible when the SPD is fitted as in normal use.		N/A
	Any sealing compound (including potting) used in the internal assembly shall not move to such an extent as to create a problem for the functionality of the SPD.	No such part	N/A
	The SPD is deemed to have passed the test even if a disconnector has opened.		N/A
7.2.8	**Behaviour under temporary overvoltages**		P
	SPDs for TT-systems between neutral and PE upstream the main RCD shall pass the TOV withstand mode criteria given 8.3.8.2.		N/A
7.2.8.1/ 8.3.8.1	**TOVs caused by faults or disturbances in the low voltage system**		P
	For SPDs with a U_C greater than or equal to U_T there is no need to perform this test		N/A
	SPDs shall be tested using either the • TOV voltages U_T given in the relevant tables of Annex B, or • TOV voltages stated by the manufacturer according to 7.1.1 c1), whichever values are higher.	$U_T = 1{,}32U_{REF}$ =316,8V	P
	Table B.1 shall be applied to all SPDs Depending on the information given by the manufacturer on 7.1.1 c1), the additional tables according to Clause B.1 of Annex B shall also be applied. For North American systems – Table B.2 For Japanese systems – Table B.3	Table B.1 applied Under consideration	P

IEC/EN 61643-11 - TEST SEQUENCE 4			
Clause	Requirement - Test	Result - Remark	Verdict
	New samples shall be used and fitted as in normal use, according to the manufacturer's instructions		P
	The test sample shall be connected to a power frequency voltage of U_T $^{+0}/_{-5}$ % for a duration t_T $^{+5}/_{-0}$ %.		P
	Except for loss of neutral tests, this power source for U_T, shall be capable of delivering a current high enough to ensure that the voltage at the SPD terminals does not fall below U_T by more than 5 % during the test. For loss of neutral tests this voltage source shall be capable of delivering a prospective short-circuit current of 10A.		N/A
	Immediately following the application of U_T, a voltage equal to U_{REF} $^{+0}/_{-5}$ % with the same current capability, shall be applied to the test sample for a period of 15 min $^{+5}/_{-0}$ %.	U_T = 240V U_{REF} = 316.8V	P
	For loss of neutral tests, this power source for U_{REF} shall be capable of delivering a prospective short-circuit current equal to the declared short-circuit current rating of the SPD.		P
	The time interval between the test periods shall be as short as possible and shell in any case not exceed 100 ms.	< 100 ms	P
a)	**Pass criteria TOV failure mode**		P
C	No mechanical damage		P
H	Disconnection shall be provided by one or more internal or external disconnector(s). Their correct indication shall be checked.		P
I	SPDs having an IP degree ≥ IP 2X – no live parts accessible with standardised test finger applied with a force of 5N, except the ones which are accessible when the SPD is fitted as in normal use.		N/A
J	If disconnection occurs during the test, there shall be clear evidence of effective disconnection of the corresponding protective component(s). If internal disconnection occurs, the test sample is connected at U_C and rated frequency for 1 min. The current flow shall not exceed a value of 1 mA.	0,38mA	P
	Currents through components connected in parallel to the relevant protective component(s), are disregarded for this measurement.		N/A

IEC/EN 61643-11 - TEST SEQUENCE 4			
Clause	Requirement - Test	Result - Remark	Verdict
	Current through the PE-terminal shall not exceed 1mA If there is more than one possible connection arrangement for normal use, this check shall be performed for all arrangements.	0,35mA	P
K	The short-circuit current from the power source, if any, shall be interrupted within 5 s by one or more internal and/or external disconnector(s).		N/A
L	The tissue paper shall not catch fire.		P
M	There shall be no explosion or other hazard to either personnel or the facility		P
b)	**Pass criteria TOV withstand mode**		P
A	Thermal stability shall be achieved		P
B	Voltage and current records and visual inspection show no sign of puncture or flashover.		P
C	No mechanical damage		P
D	Determination of the measured limiting voltage:	$U_P \leq 1{,}5kV$	N/A
	according to 8.3.3.1, but only at a crest value corresponding to I_{imp} for test class I		N/A
	according to 8.3.3.1, but only at I_n for test class II		P
	according to 8.3.3.3, but only at U_{OC} for test class III		N/A
	SPDs tested acc. to class I and II containing switching components: Front-of-wave sparkover voltage acc. to 8.3.3.2 All measured peak values (5 pos./5 neg.) below U_P		N/A
E	No excessive leakage currents shall occur after the test		P
	If there is more than one possible connection arrangement for normal use, this check shall be performed for all arrangements		N/A

IEC/EN 61643-11 - TEST SEQUENCE 4			
Clause	Requirement - Test	Result - Remark	Verdict
	The SPD shall be connected as for normal use according to the manufacturer's instructions to a power supply at the reference test voltage (U_{REF}). The current that flows through each terminal is measured. Its resistive component (measured at the crest of the sine wave) • shall not exceed a value of 1 mA, or • the current shall not have changed by more than 20% compared to the initial value determined at the beginning of the test sequence	U_{REF}= 316.8V 0,56mA	P
	Any resettable or rearmable disconnector shall be switched off and dielectric withstand shall be checked by application of two times U_C or 1000V a.c. whichever is greater. During the test, no flashover, breakdown of insulation or any other manifestation of disruptive discharge shall occur.		N/A
	For SPD modes connected N-PE only, the current through the PE-terminal shall be measured, whereas the terminals are connected to a power supply at U_C. Its resistive component (measured at the crest of the sine wave) • shall not exceed a value of 1 mA, or • the current shall not have changed by more than 20% compared to the initial value determined at the beginning of the test sequence		P
F	External disconnectors shall not operate during the test and shall be in working order after the test.		N/A
G	Internal disconnectors shall not operate during the test and shall be in working order after the test.		P
I	SPDs having an IP degree ≥ IP 2X – no live parts accessible with standardised test finger applied with a force of 5 N, except the ones which are accessible when the SPD is fitted as in normal use.		N/A
L	The tissue paper shall not catch fire.		P
M	There shall be no explosion or other hazard to either personnel or the facility		P
7.2.8.2/ 8.3.8.2	**TOVs caused by faults in the high (medium) voltage system**		N/A

IEC/EN 61643-11 - TEST SEQUENCE 4			
Clause	Requirement - Test	Result - Remark	Verdict
	SPDs connected to PE and for use on power distribution systems • TOV voltages U_T given in Annex B, or • TOV voltages stated by the manufacturer according to 7.1.1 c1) whichever values are higher.		N/A
	Table B.1 shall be applied to all SPDs Depending on the information given by the manufacturer on 7.1.1 c1), the additional tables according to Clause B.1 of Annex B shall also be applied. For North American systems – Table B.2 For Japanese systems – Table B.3		N/A
	New samples shall be used and fitted as in normal use, according to the manufacturer's instructions, and connected to a test circuit according to Figure 16 or equivalent		N/A
	The test voltage U_T $^{+0}/_{-5}$ % is applied to the test sample at 90 electrical degrees of phase L1 by closing switch S1.		N/A
	After the TOV application time t_T $^{+0}/_{-5}$ % switch S2 is closed automatically. This connects the SPD's PE-terminal to the neutral.		N/A
	Test circuit according to Figure 16 and Figure 17, or alternative test circuit given in Annex E. Other test circuits are permitted as long as they ensure the same stress to the SPD.		N/A
	The prospective short-circuit current of the power source for U_{REF} shall be equal to five times the rated current of the maximum overcurrent protection is declared. The tolerance for the current is $^{+10}/_{-0}$%.		N/A
	The prospective short-circuit current delivered by the TOV transformer shall be adjusted to 300A $^{+10}/_{-0}$% by R2.		N/A
	With the exception of SPDs connected neutral to ground, U_{REF} remains applied to the test sample for 15 min without interruption until switch S1 is reopened.		N/A
a)	**Pass criteria TOV failure mode**		N/A
C	No mechanical damage		N/A
H	Disconnection shall be provided by one or more internal or external disconnector(s). Their correct indication shall be checked.		N/A

IEC/EN 61643-11 - TEST SEQUENCE 4			
Clause	Requirement - Test	Result - Remark	Verdict
I	SPDs having an IP degree ≥ IP 2X – no live parts accessible with standardised test finger applied with a force of 5N, except the ones which are accessible when the SPD is fitted as in normal use.		N/A
J	If disconnection occurs during the test, there shall be clear evidence of effective disconnection of the corresponding protective component(s). If internal disconnection occurs, the test sample is connected at U_C and rated frequency for 1 min. The current flow shall not exceed a value of 1 mA.		N/A
	Currents through components connected in parallel to the relevant protective component(s), are disregarded for this measurement.		N/A
	Current through the PE-terminal shall not exceed 1mA If there is more than one possible connection arrangement for normal use, this check shall be performed for all arrangements.		N/A
K	The short-circuit current from the power source, if any, shall be interrupted within 5 s by one or more internal and/or external disconnector(s).		N/A
L	The tissue paper shall not catch fire.		N/A
M	There shall be no explosion or other hazard to either personnel or the facility		N/A
b)	**Pass criteria TOV withstand mode**		N/A
A	Thermal stability shall be achieved		N/A
B	Voltage and current records and visual inspection show no sign of puncture or flashover.		N/A
C	No mechanical damage		N/A
D	Determination of the measured limiting voltage:		N/A
	according to 8.3.3.1, but only at a crest value corresponding to I_{imp} for test class I		N/A
	according to 8.3.3.1, but only at I_n for test class II		N/A
	according to 8.3.3.3, but only at U_{OC} for test class III		N/A
	SPDs tested acc. to class I and II containing switching components:		N/A

IEC/EN 61643-11 - TEST SEQUENCE 4			
Clause	Requirement - Test	Result - Remark	Verdict
	Front-of-wave sparkover voltage acc. to 8.3.3.2 All measured peak values (5 pos./5 neg.) below U_P		
E	No excessive leakage currents shall occur after the test		N/A
	If there is more than one possible connection arrangement for normal use, this check shall be performed for all arrangements		N/A
	The SPD shall be connected as for normal use according to the manufacturer's instructions to a power supply at the reference test voltage (U_{REF}). The current that flows through each terminal is measured. Its resistive component (measured at the crest of the sine wave) • shall not exceed a value of 1 mA, or • the current shall not have changed by more than 20% compared to the initial value determined at the beginning of the test sequence		N/A
	Any resettable or rearmable disconnector shall be switched off and dielectric withstand shall be checked by application of two times U_C or 1000V a.c. whichever is greater. During the test, no flashover, breakdown of insulation or any other manifestation of disruptive discharge shall occur.		N/A
	For SPD modes connected N-PE only, the current through the PE-terminal shall be measured, whereas the terminals are connected to a power supply at U_C. Its resistive component (measured at the crest of the sine wave) • shall not exceed a value of 1 mA, or • the current shall not have changed by more than 20% compared to the initial value determined at the beginning of the test sequence		N/A
G	Internal disconnectors shall not operate during the test and shall be in working order after the test.		N/A
I	SPDs having an IP degree ≥ IP 2X – no live parts accessible with standardised test finger applied with a force of 5N, except the ones which are accessible when the SPD is fitted as in normal use.		N/A

IEC/EN 61643-11 - TEST SEQUENCE 4			
Clause	Requirement - Test	Result - Remark	Verdict
K	The short-circuit current from the power source, if any, shall be interrupted within 5 s by one or more internal and/or external disconnector(s).		N/A
L	The tissue paper shall not catch fire.		N/A
M	There shall be no explosion or other hazard to either personnel or the facility		N/A

IEC/EN 61643-11 - TEST SEQUENCE 5			
Clause	Requirement - Test	Result - Remark	Verdict
7.2.5.3	**Short-circuit current behaviour**		P
8.3.5.3	This test is not applied to SPDs which are either • classified for outdoor use and for mounting out of reach, • for connection N-PE in TN and/or TT systems only		P
	The test sample shall be mounted in accordance with the manufacturer's published recommendations and connected with conductors of the maximum cross section according to 8.4.2, keeping the cables connecting the sample to a maximum length of 0,5 m each.		P
	Sample preparation		P
	For SPDs with non-linear components connected in parallel, separate sets of three samples shall be prepared in the manner below for every current path of the SPD which contains one or more non-linear component in 3.1.4 and 3.1.5.		N/A
	Current paths containing voltage switching components with combined disconnector function, having an impulse withstand voltage equal or greater than 6 kV and a dielectric withstand equal or greater than 2500 V/50 Hz for 1 min in normal operating condition, are tested without any preparation and only in conjunction with other current paths prepared in the manner described below.		N/A
	Voltage limiting components and voltage switching components described in 3.1.4 and 3.1.5 shall be replaced by appropriate cooper blocks (dummies) ensuring that the internal connections and their cross-section and surrounding material (e.g. resins) and packaging are not changed.		P
	a) Test at the declared short-circuit current rating		P
	The sample is connected to a power frequency source at U_{REF}. The prospective short-circuit current as declared by the manufacturer and with the corresponding power factor as given in Table 8 are adjusted at the SPD terminals.	240 V / kA cos φ= 0,88	P
	The test is carried out twice with U_{REF} applied at (45 ± 5) electrical degrees and at (90 ± 5) electrical degrees after the zero crossing of the voltage.		P
	If a replaceable or resettable internal or external disconnector operates, the relevant disconnector shall be replaced or reset each time. If the disconnector cannot be replaced or reset, the test is stopped.	No such part	N/A

IEC/EN 61643-11 - TEST SEQUENCE 5			
Clause	Requirement - Test	Result - Remark	Verdict
	Pass criteria		P
C	No mechanical damage		P
H	Disconnection shall be provided by one or more internal or external disconnector(s). Their correct indication shall be checked.		P
I	SPDs having an IP degree ≥ IP 2X – no live parts accessible with standardised test finger applied with a force of 5N, except the ones which are accessible when the SPD is fitted as in normal use.		N/A
J	If disconnection occurs during the test, there shall be clear evidence of effective disconnection of the corresponding protective component(s). If internal disconnection occurs, the test sample is connected at U_C and rated frequency for 1 min. The current flow shall not exceed a value of 1 mA.	240V 0 mA	P
	Currents through components connected in parallel to the relevant protective component(s), are disregarded for this measurement.		N/A
	Current through the PE-terminal shall not exceed 1mA If there is more than one possible connection arrangement for normal use, this check shall be performed for all arrangements.		N/A
K	The short-circuit current from the power source, if any, shall be interrupted within 5 s by one or more internal and/or external disconnector(s).		P
M	There shall be no explosion or other hazard to either personnel or the facility		P
N	There shall be no flashover to the metallic screen and the 6 A gL/gG fuse connecting the screen shall not operate during the test.		N/A
	b) Test at low short-circuit current		N/A
	A power frequency source at U_{REF}, having a prospective short-circuit current of five times the rated current of the maximum overcurrent protection (if declared by the manufacturer), and a power factor according to Table 8, shall be applied for 5 s ± 0,5 s. If no external overcurrent protection is required by the manufacturer, a prospective short-circuit current of 300 A is used.	255 V 20 kA cos φ= 0,8	N/A

IEC/EN 61643-11 - TEST SEQUENCE 5			
Clause	Requirement - Test	Result - Remark	Verdict
	The test is carried out once with U_{REF} applied at (45 ± 5) electrical degrees after the zero crossing of the voltage.		P
	Pass criteria		P
C	No mechanical damage		P
I	SPDs having an IP degree ≥ IP 2X – no live parts accessible with standardised test finger applied with a force of 5 N, except the ones which are accessible when the SPD is fitted as in normal use.		N/A
M	There shall be no explosion or other hazard to either personnel or the facility.		P
N	There shall be no flashover to the metallic screen and the 6 A gL/gG fuse connecting the screen shall not operate during the test.		P
	If disconnection occurs during the test:		P
H	Disconnection shall be provided by one or more internal or external disconnector(s). Their correct indication shall be checked.		P
J	If disconnection occurs during the test, there shall be clear evidence of effective disconnection of the corresponding protective component(s). If internal disconnection occurs, the test sample is connected at U_C and rated frequency for 1 min. The current flow shall not exceed a value of 1 mA.	 250 V 0 mA	N/A
	Currents through components connected in parallel to the relevant protective component(s), are disregarded for this measurement.		N/A
	Current through the PE-terminal shall not exceed 1mA If there is more than one possible connection arrangement for normal use, this check shall be performed for all arrangements.		N/A
K	The short-circuit current from the power source, if any, shall be interrupted within 5 s by one or more internal and/or external disconnector(s).		N/A
8.3.5.3.1	**Additional test for SPDs with I_{fi} lower than the declared short-circuit current rating (I_{SCCR})**		N/A
	This test is only performed if the declared follow current interrupt rating I_{fi} is smaller than the test current.		N/A

IEC/EN 61643-11 - TEST SEQUENCE 5			
Clause	Requirement - Test	Result - Remark	Verdict
	The sample is connected to a power frequency source at U_{REF}. The prospective short-circuit current as declared by the manufacturer and with the corresponding power factor as given in Table 8 are adjusted at the SPD terminals.		N/A
	The voltage switching component(s) of the SPD is triggered with a positive surge current (8/20 or other appropriate waveshape) at (35 ± 5) electrical degrees after the zero crossing of the voltage on the positive half wave. The surge current shall be high enough to initiate a follow current but shall in no case exceed I_n. The test is carried out twice.		N/A
	To ensure that no external disconnector operates due to the trigger surge, all external disconnectors shall be placed in series with the power frequency source as shown in Figure 11.		N/A
	If a replaceable or resettable internal disconnector operates, the relevant disconnector shall be replaced or reset each time. If the disconnector cannot be replaced or reset, the test is stopped.		N/A
	Pass criteria		N/A
C	No mechanical damage		N/A
H	Disconnection shall be provided by one or more internal or external disconnector(s). Their correct indication shall be checked.		N/A
I	SPDs having an IP degree ≥ IP 2X – no live parts accessible with standardised test finger applied with a force of 5 N, except the ones which are accessible when the SPD is fitted as in normal use.		N/A
J	If disconnection occurs during the test, there shall be clear evidence of effective disconnection of the corresponding protective component(s). If internal disconnection occurs, the test sample is connected at U_C and rated frequency for 1 min. The current flow shall not exceed a value of 1 mA.		N/A
	Currents through components connected in parallel to the relevant protective component(s), are disregarded for this measurement.		N/A
	Current through the PE-terminal shall not exceed 1mA If there is more than one possible connection arrangement for normal use, this check shall be performed for all		N/A

IEC/EN 61643-11 - TEST SEQUENCE 5			
Clause	Requirement - Test	Result - Remark	Verdict
	arrangements.		
K	The short-circuit current from the power source, if any, shall be interrupted within 5 s by one or more internal and/or external disconnector(s).		N/A
M	There shall be no explosion or other hazard to either personnel or the facility		N/A
N	There shall be no flashover to the metallic screen and the 6 A gL/gG fuse connecting the screen shall not operate during the test.		N/A
8.3.5.3.2	**Additional test for SPD's failure mode simulation**		P
	For this test any electronic indicator circuitry may be disconnected.		P
	New samples shall be used and fitted as in normal use, acc. to the manufacturer's instructions and connected with conductors of the maximum cross section acc. to 8.4.2. The maximum length of the cables connection the sample shall be of 0,5 m each.		P
	External disconnectors, if recommended by the manufacturer, shall be used.		N/A
	The test sample shall be connected to a power frequency voltage source at the following conditioning voltages: • SPDs rated U_C up to 440V, apply a voltage equal to 1200 V_{rms} $^{+5}/_{-0}$% • SPDs with U_C rated above 440V, apply a voltage equal to 3 times U_C $^{+5}/_{-0}$%	U_C =240V	P
	The conditioning voltage is applied for a duration of 5 s $^{+5}/_{-0}$%. The prospective short-circuit current of this power source for conditioning shall be adjusted to a value between 1 A and 20 A_{rms} $^{+5}/_{-0}$%, as provided by the manufacturer according to 7.1.1 d5).		P
	Following the application of the conditioning voltage equal to U_{REF} $^{+0}/_{-5}$% with a short-circuit current capability as given below, shall be applied to the sample for a period of 5 min $^{+5}/_{-0}$% or for at least 0,5 s after interruption of the current by an internal or external disconnector.		P
	The transition from conditioning voltage application to U_{REF} application shall be performed without interruption. The current flow through the SPD shall be monitored. An appropriate test circuit and timing diagram is shown in Figure 12 and Figure 13.		P

IEC/EN 61643-11 - TEST SEQUENCE 5			
Clause	Requirement - Test	Result - Remark	Verdict
	The prospective short-circuit current of the power source at U_{REF} shall have a tolerance of $^{+5}/_{-0}$% at the location where the SPD is connected. The power factor of the power source shall comply with Table 8.		P
	Each of the following tests shall be performed on a new set of three preconditioned samples as above at U_{REF} with a short-circuit current of 100A, 500A and 1000A, respectively, unless these values exceed the declared short-circuit rating of the SPD.		N/A
	A further test shall be performed on three preconditioned samples as above and at U_{REF} with a prospective short-circuit current equal to the manufacturer's declared short-circuit current rating. For this test, the time internal between the completion of the conditioning test and the application of U_{REF} shall be as short as possible and shall not exceed 100 ms.		P
	If all oscillograms of the tests on the first set of samples (100 A test set up) show a disconnection within 5 s during the application of the conditioning voltage, no further test is performed.		P
	Pass criteria		P
	For this test any damage to electronic indicator circuitry during the conditioning test is not regarded as a failure.		P
C	No mechanical damage		P
I	SPDs having an IP degree ≥ IP 2X – no live parts accessible with standardised test finger applied with a force of 5 N, except the ones which are accessible when the SPD is fitted as in normal use.		N/A
M	There shall be no explosion or other hazard to either personnel or the facility		P
N	There shall be no flashover to the metallic screen and the 6 A gL/gG fuse connecting the screen shall not operate during the test.		P
	Additional pass criteria except for: • short circuiting type SPDs • SPDs where the current is interrupted during the application of U_{REF} where no disconnection occurs.		N/A
H	Disconnection shall be provided by one or more internal or external disconnector(s). Their correct indication shall be		N/A

IEC/EN 61643-11 - TEST SEQUENCE 5			
Clause	Requirement - Test	Result - Remark	Verdict
	checked.		
J	If disconnection occurs during the test, there shall be clear evidence of effective disconnection of the corresponding protective component(s). If internal disconnection occurs, the test sample is connected at U_C and rated frequency for 1 min. The current flow shall not exceed a value of 1 mA.	 250 V 0 mA	N/A
	Currents through components connected in parallel to the relevant protective component(s), are disregarded for this measurement.		N/A
	Current through the PE-terminal shall not exceed 1mA If there is more than one possible connection arrangement for normal use, this check shall be performed for all arrangements.		N/A

IEC/EN 61643-11 - TEST SEQUENCE 6 Additional tests if declared by the manufacturer			
Clause	Requirement - Test	Result - Remark	Verdict
7.6.1.1/8.7.1	**Total discharge current test for multipole SPDs**		N/A
	One side of the test generator is connected to the PE or PEN terminal of the multipole SPD. Each of the remaining SPD terminals is connected via a typical series impedance consisting of a resistance of 30 mΩ and an inductance of 25 µH, to the other side of the generator. Smaller impedances may be used if the tolerances for the proportional surge currents according to Table 21 are met.	One port SPD	N/A
	The multipole SPD shall be tested once with the total discharge current I_{Total} declared by the manufacturer.		N/A
	Pass criteria		N/A
B	Voltage and current records and visual inspection show no sign of puncture or flashover.		N/A
C	No mechanical damage		N/A
D	Determination of the measured limiting voltage:		N/A
	according to 8.3.3.1, but only at a crest value corresponding to I_{imp} for test class I		N/A
	according to 8.3.3.1, but only at I_n for test class II		N/A
	according to 8.3.3.3, but only at U_{OC} for test class III		N/A
	SPDs tested acc. to class I and II containing switching components: Front-of-wave sparkover voltage acc. to 8.3.3.2 All measured peak values (5 pos./5 neg.) below U_P		N/A
E	No excessive leakage currents shall occur after the test		N/A
	If there is more than one possible connection arrangement for normal use, this check shall be performed for all arrangements		N/A

IEC/EN 61643-11 - TEST SEQUENCE 6 Additional tests if declared by the manufacturer			
Clause	Requirement - Test	Result - Remark	Verdict
	The SPD shall be connected as for normal use according to the manufacturer's instructions to a power supply at the reference test voltage (U_{REF}). The current that flows through each terminal is measured. Its resistive component (measured at the crest of the sine wave) • shall not exceed a value of 1 mA or • the current shall not have changed by more than 20% compared to the initial value determined at the beginning of the test sequence		N/A
	Any resettable or rearmable disconnector shall be switched off and dielectric withstand shall be checked by application of two times U_C or 1000V a.c. whichever is greater. During the test, no flashover, breakdown of insulation or any other manifestation of disruptive discharge shall occur.		N/A
	For SPD modes connected N-PE only, the current through the PE-terminal shall be measured, whereas the terminals are connected to a power supply at U_C. Its resistive component (measured at the crest of the sine wave) • shall not exceed a value of 1 mA or • the current shall not have changed by more than 20% compared to the initial value determined at the beginning of the test sequence		N/A
G	Internal disconnectors shall not operate during the test and shall be in working order after the test.		N/A
I	SPDs having an IP degree ≥ IP 2X – no live parts accessible with standardised test finger applied with a force of 5N, except the ones which are accessible when the SPD is fitted as in normal use.		N/A
M	There shall be no explosion or other hazard to either personnel or the facility		N/A

IEC/EN 61643-11 - TEST SEQUENCE 7 Additional tests for outdoor use SPDs			
Clause	Requirement - Test	Result - Remark	Verdict
7.5.2/8.6.2	**Environmental tests for outdoor SPDs (informative)**	Indoor used only	N/A
F.1	Accelerated aging test with UV radiation		N/A
	Expose three complete SPDs, as to be installed for outdoor use, to 1000 h of UV radiation (UV-B) and water spray as follows: 500 cycles of 120 min each, consisting of 102 min of UV light at 60 °C, 18 min of UV light and water spray at 65 °C and 65 % RH. The UV radiation shall be according to ISO 4892-2, method A. ISO 4892-1 and ASTM 151 are to be used for general guidance for the test.		N/A
	The samples shall be connected to a power source at U_C during the test and residual current shall be monitored at 120 min intervals. After completion of this test, the samples shall be tested according to F.2.		N/A
	Pass criteria		N/A
	During and after the test the samples shall be visually inspected for voids, cracks, tracking and surface erosion. The residual currents shall not increase by more than 10%. The degree of tracking, surface erosion and cracking shall be assessed to determine if this will compromise the enclosure of the product to meet the other electrical and mechanical performance requirements of this standard.		N/A
F.2	**Water immersion test**		N/A
	The test is performed in accordance with Figure 8 of IEC 60099-4. The test samples shall kept immersed in a vessel, in boiling de-ionized water with 1 kg/m³ of NaCl, for 42 h.		N/A
	At the end of boiling, the SPD shall remain in the vessel until the water has cooled down to approximately 20 °C (± 15 °C) and shall be maintained in the water till the verification tests are performed. After the water immersion test the samples shall be subjected the dielectric test (see F.3).		N/A
F.3	**Dielectric test**		N/A

IEC/EN 61643-11 - TEST SEQUENCE 7 Additional tests for outdoor use SPDs			
Clause	Requirement - Test	Result - Remark	Verdict
	The test samples shall be subjected to a dielectric test at a power frequency sinusoidal voltage of 1000 V plus twice the reference test voltage U_{REF} for 1 min and the leakage current shall be measured. The test voltage shall be applied as follows: a) **SPD with metallic housing with or without mounting bracket** The voltage shall be applied between all terminals or external leads which are not internally connected to the housing, neither directly nor through surge protective components, connected together, and the metallic housing. If all terminals and external leads are connected directly or through components to the conductive housing, this test is not performed. b) **SPD with non-conductive housing with non-conductive or without mounting bracket** The non-conductive housing shall be tightly wrapped in conductive foil to within 15 mm of any non-insulated lead or terminal. The voltage shall be applied between the conductive foil and all terminals or external leads connected together. c) **SPD with non-conductive housing with metallic mounting bracket** The non-conductive housing shall be tightly wrapped in conductive foil to within 15 mm of any non-insulated lead, terminal and the metallic mounting bracket. The voltage shall be applied between the conductive foil and all terminals, external leads and mounting bracket connected together.		N/A
	Pass criteria		N/A
	The leakage current measured during this test shall not exceed 25 mA.		N/A
F.4	**Temperature cycle test**		N/A
	The test shall be performed according to IEC 60068-2-14 with 5 cycles with a lower temperature of -40 °C and with an upper temperature of +100 °C. The time duration for each half cycle is 3 h and the temperature change shall occur within 30 s.		N/A
	Pass criteria		N/A

IEC/EN 61643-11 - TEST SEQUENCE 7 Additional tests for outdoor use SPDs			
Clause	Requirement - Test	Result - Remark	Verdict
	During and after the test, the samples shall be visually inspected for voids, cracks, tracking and surface erosion. The residual currents shall not increase by more than 10 %. The degree of tracking, surface erosion and cracking shall be assessed to determine if this will compromise the enclosure of the product to meet the other electrical and mechanical performance requirements of this standard.		N/A
F.5	**Verification of resistance to corrosion**		N/A
	SPDs with exposed metal parts shall be subjected to the test and shall be mounted as for normal use according to the manufacturer's instructions. The enclosure or samples shall be new and in a clean condition. The samples shall be subjected to the following test: • 12 cycles of 24 h, damp heat cycling test according to test Db of IEC 60068-2-30 at 40 °C and relative humidity of 95 %; • 14 cycles of 24 h, salt mist test according to test Ka of IEC 60068-2-11 at a temperature of (35 ± 2) °C. After the test, the samples shall be washed in running tap water for 5 min, rinsed in distilled or demineralized water then shaken or subjected to air blast to remove water droplets. The specimen under test shall then be stored under normal service conditions for 2 h.		N/A
	Pass criteria		N/A
	Compliance is checked by visual inspection to ensure that: • there is no evidence of rust, cracking or other deterioration. However, surface deterioration of any protective coating is allowed. In case of doubt, reference shall be made to ISO 4628-3 to verify that the samples conform to the specimen Ri1; • seals are not damaged; • any moving parts (disconnectors) work without abnormal effort.		N/A

IEC/EN 61643-11 - TEST SEQUENCE 8 Additional tests for short-circuiting type SPDs			
Clause	Requirement - Test	Result - Remark	Verdict
7.5.4/8.6.4	**Short-circuiting type SPDs**		N/A
	These SPDs shall be capable of withstanding a short-circuit current test at their declared short-circuit current rating after having been overstressed by a surge current according to their transition rating I_{trans}. For such SPD's a conditioning into an intentional short-circuit according 8.6.4.1 is carried out, followed by a surge withstand test according 8.6.4.2 and a short-circuit current behaviour test according 8.6.4.3.		N/A
8.6.4.1	**Change of characteristic procedure (conditioning test)**		N/A
	One impulse of I_{trans} with positive polarity is applied to the de-energised SPD to change of characteristic of the SPD into an internal short-circuit. To check for the internal short-circuit an appropriate measurement shall be performed after this test.		N/A
8.6.4.2	**Surge withstand test (in short-circuited condition)**		N/A
	One impulse of I_{trans} with positive polarity is applied to the de-energised SPD.		N/A
	Pass criteria		N/A
C	No mechanical damage		N/A
I	SPDs having an IP degree ≥ IP 2X – no live parts accessible with standardised test finger applied with a force of 5N, except the ones which are accessible when the SPD is fitted as in normal use.		N/A
M	There shall be no explosion or other hazard to either personnel or the facility		N/A
8.6.4.3	**Short-circuit current behaviour test (in short-circuited condition)**		N/A
	The test is performed according to 8.3.5.3 excluding 8.3.5.1 and 8.3.5.3.2, but without any sample preparation.		N/A
8.3.5.3	This test is not applied to SPDs which are either • classified for outdoor use and for mounting out of reach, • for connection N-PE in TN and/or TT systems only		N/A

IEC/EN 61643-11 - TEST SEQUENCE 8 Additional tests for short-circuiting type SPDs			
Clause	Requirement - Test	Result - Remark	Verdict
	The test sample shall be mounted in accordance with the manufacturer's published recommendations and connected with conductors of the maximum cross section according to 8.4.2, keeping the cables connecting the sample to a maximum length of 0,5 m each.		N/A
	a) Test at the declared short-circuit current rating		N/A
	The sample is connected to a power frequency source at U_{REF}. The prospective short-circuit current as declared by the manufacturer and with the corresponding power factor as given in Table 8 are adjusted at the SPD terminals.		N/A
	The test is carried out twice with U_{REF} applied at (45 ± 5) electrical degrees and at (90 ± 5) electrical degrees after the zero crossing of the voltage.		N/A
	If a replaceable or resettable internal or external disconnector operates, the relevant disconnector shall be replaced or reset each time. If the disconnector cannot be replaced or reset, the test is stopped.		N/A
	b) Test at low short-circuit current		N/A
	A power frequency source at U_{REF}, having a prospective short-circuit current of five times the rated current of the maximum overcurrent protection (if declared by the manufacturer), and a power factor according to Table 8, shall be applied for 5 s ± 0,5 s. If no external overcurrent protection is required by the manufacturer, a prospective short-circuit current of 300 A is used.		N/A
	The test is carried out twice with U_{REF} applied at (45 ± 5) electrical degrees after the zero crossing of the voltage.		N/A
	Pass criteria		N/A
C	No mechanical damage		N/A
H	Disconnection shall be provided by one or more internal or external disconnector(s). Their correct indication shall be checked.		N/A
I	SPDs having an IP degree ≥ IP 2X – no live parts accessible with standardised test finger applied with a force of 5N, except the ones which are accessible when the SPD is fitted as in normal use.		N/A

IEC/EN 61643-11 - TEST SEQUENCE 8 Additional tests for short-circuiting type SPDs			
Clause	Requirement - Test	Result - Remark	Verdict
J	If disconnection occurs during the test, there shall be clear evidence of effective disconnection of the corresponding protective component(s). If internal disconnection occurs, the test sample is connected at U_C and rated frequency for 1 min. The current flow shall not exceed a value of 1 mA.		N/A
	Currents through components connected in parallel to the relevant protective component(s), are disregarded for this measurement.		N/A
	Current through the PE-terminal shall not exceed 1mA If there is more than one possible connection arrangement for normal use, this check shall be performed for all arrangements.		N/A
K	The short-circuit current from the power source, if any, shall be interrupted within 5 s by one or more internal and/or external disconnector(s).		N/A
M	There shall be no explosion or other hazard to either personnel or the facility		N/A
N	There shall be no flashover to the metallic screen and the 6 A gL/gG fuse connecting the screen shall not operate during the test.		N/A

Table 3 – Type test requirements for SPDs

Test sequence	Test description	Subclause requirement/test	External disconnectors connected [a]	Tissue paper used	Metallic screen used	Test class I	Test class II	Test class III
1	Identification and marking	7.1.1/7.1.2/8.2	-	-	-	A	A	A
	Mounting	7.3.1	-	-	-	A	A	A
	Terminals and connections	7.3.2/7.3.3/8.4.2	-	-	-	A	A	A
	Testing for protection against direct contact	7.2.1/8.3.1	-	-	-	A	A	A
	Environment, IP code	7.4.1 / 8.5.1	-	-	-	A	A	A
	Residual current	7.2.2 / 8.3.2	-	-	-	A	A	A
	Operating duty test	7.2.4/8.3.4 [b]						
	Operating duty test for test classes I, II or III	8.3.4.2 / 8.3.4.3/ 8.3.4.5	A	-	-	A	A	A
	Additional duty test for test class I	8.3.4.4	A	-	-	A	–	–
	Thermal stability	7.2.5.2 / 8.3.5.2	A	-	-	A	A	A
	Air clearances and creepage distances	7.3.4 / 8.4.3	-	-	-	A	A	A
	Ball pressure test	7.4.2 / 8.5.3	-	-	-	A	A	A
	Resistance to abnormal heat and fire	7.4.3 / 8.5.4	-	-	-	A	A	A
	Tracking resistance	7.4.4 / 8.5.5	-	-	-	A	A	A
2	Voltage protection level	7.2.3/8.3.3						
	Residual voltage	8.3.3.1	-	-	-	A	A	–
	Front of wave sparkover voltage	8.3.3.2	-	-	-	A	A	–
	Limiting voltage with combination wave	8.3.3.3	-	-	-	–	–	A
2a	See below - only if applicable							
2b	See below - only if applicable							
3	Insulation resistance	7.2.6 / 8.3.6	-	-	-	A	A	A
	Dielectric withstand	7.2.7 / 8.3.7	-	-	-	A	A	A
3a	See below - only if applicable							
	Mechanical strength	7.3.5 / 8.4.4	-	-	-	A	A	A
	Temperature withstand	7.2.5 / 8.3.5.1 [b]	-	-	-	A	A	A
3b [c]	See below - only if applicable							
3c	See below - only if applicable							
4 [c]	Heat resistance	7.4.2 / 8.5.2	-	-	-	A	A	A
	TOV tests	7.2.8 / 8.3.8						
	TOVs caused by faults or disturbances in the low voltage system	7.2.8.1/8.3.8.1 [b]	A	A	-	A	A	A
	TOVs caused by faults in the high (medium) voltage system	7.2.8.2/8.3.8.2 [b]	A	A	-	A	A	A
5 [c]	Short-circuit current behaviour	7.2.5.3 / 8.3.5.3	A	-	A	A	A	A

Table 3 – Type test requirements for SPDs *(continued)*

Test sequence	Test description	Subclause requirement/test	External disconnectors connected [a]	Tissue paper used	Metallic screen used	Test class I	Test class II	Test class III
Additional tests for specific SPD designs								
Additional tests for two-port SPDs and one port-SPDs with separate input / output terminals								
3c [c]	Rated load current	7.5.1.1 / 8.6.1.1	A	-	-	A	A	A
	Overload behaviour	7.5.1.2 / 8.6.1.2[b]	-	-	-	A	A	A
2b	Load side short-circuit current behaviour	7.5.1.3 / 8.6.1.3[b]	A	-	A	A	A	A
Additional tests if declared by the manufacturer								
3b	Voltage drop	7.6.2.1 / 8.7.2	-	-	-	A	A	A
2a [c]	Load side surge withstand	7.6.2.2 / 8.7.3[b]	A	-	-	A	A	A
6	Total discharge current test for multipole SPDs	7.6.1.1 / 8.7.1[b]		-	-	A	A	-
Additional tests for outdoor use SPDs								
7	For SPDs classified "outdoor"	7.5.2 / 8.6.2	-	O	-	A	A	-
Additional tests for SPDs with separate isolated circuits								
3a	Isolation between separate circuits	7.5.3/ 8.3.6 / 8.3.7	-	-	-	A	A	A
Additional tests for short-circuiting type SPDs								
8	Change of characteristic procedure (preconditioning to short-circuited condition)	7.5.4 / 8.6.4	-	–	-	–	A	-
	Surge withstand test (in short-circuited condition)	7.5.4 / 8.6.4	-	–	-	–	A	-
	Short-circuit current behaviour (in short-circuited condition)	7.5.4 / 8.6.4	A	–	A	–	A	-

A = applicable

- = not applicable

O = optional

[a] external disconnecors connected means that all disconnectors as specified by the manufacturer shall be tested with the SPD during the type tests, except for RCDs, which are not tested during the operating duty test according to 8.3.4.

[b] For these tests initial measurements of leakage currents according to Table 4, pass criterion E may be necessary.

[c] For this test sequence more than one set of samples may be needed.

Table 4 – Common pass criteria for type tests

A	Thermal stability shall be achieved. The SPD is considered to be thermally stable if the crest of the resistive component of the current flowing into the SPD or the power dissipation shows either a decreasing tendency or does not increase during 15 min of U_c voltage application immediately after the application of U_C. If the test itself is performed with the SPD energized at U_c, then U_c either remains applied for these 15 min without interruption or is reapplied within less than 30 s.
B	Voltage and current records and visual inspection shall show no indication of puncture or flashover.
C	No visible damage shall occur during the test. After the test, small indents and cracks not impairing the protection against direct contact are disregarded during this check, unless the degree of protection (IP-code) given for the SPD is no longer provided. There shall be no visual evidence of burning of the sample after the test.
D	Values for measured limiting voltage after the test shall be below or equal to U_P. The measured limiting voltage shall be determined, using the tests described in 8.3.3, but the test of 8.3.3.1 is performed only with a 8/20-surge current with a crest value of I_{imp} for Test Class I or with I_n for Test Class II or with the test of 8.3.3.3 but only at U_{OC} for Test class III.
E	No excessive leakage currents shall occur after the test. The SPD shall be connected as for normal use according to the manufacturer's instructions to a power supply at the reference test voltage (U_{REF}). The current that flows through each terminal is measured. Its resistive component (measured at the crest of the sine wave) shall not exceed a value of 1 mA, or the current shall not have changed by more than 20 % compared to the initial value determined at the beginning of the relevant test sequence. Any resettable or rearmable disconnector shall be switched off manually, if applicable, and the dielectric withstand shall be checked by application of two times U_C or 1 000 V a.c., whichever is greater. During the test, no flashover, breakdown of insulation either internally (puncture) or externally (tracking) or any other manifestation of disruptive discharge shall occur. In addition for SPD modes connected N-PE only the current through the PE-terminal shall be measured, whereas the terminals are connected to a power supply at the maximum continuous operating voltage (U_C). Its resistive component (measured at the crest of the sine wave) shall not exceed a value of 1 mA, or the current shall not have changed by more than 20 % compared to the initial value determined at the beginning of the relevant test sequence. If there is more than one possible connection arrangement for normal use, this check shall be performed for all arrangements.
F	External disconnectors as specified by the manufacturer shall not operate during the test and shall be in working order after the test. For the purpose of this clause, working order means that there is no damage to the disconnector and that it is still operational. Operation can be checked either manually (where possible) or by a simple electrical test agreed between the manufacturer and the laboratory.
G	Internal disconnectors as specified by the manufacturer shall not operate during the test and shall be in working order after the test. For the purpose of this clause, working order means that there is no damage of the disconnector and that it is still operational. Operation can be checked either manually (where possible) or by a simple electrical test agreed between the manufacturer and the laboratory.
H	Disconnection shall be provided by one or more internal and/or external disconnector(s). Their correct indication shall be checked.
I	SPDs with an IP degree equal to, or greater than, IP20 shall not have live parts accessible with the standardized test finger applied with a force of 5 N (see IEC 60529), except the live parts which were already accessible before the test when the SPD is fitted as in normal use.
J	If disconnection (internal or external) occurs during the test, there shall be clear evidence of effective disconnection of the corresponding protective component(s). If internal disconnection occurs, the test sample is connected as for normal use at the maximum continuous operating voltage U_c and at rated frequency for 1 min. The test source shall have a short-circuit current capability equal or greater than 200 mA. The current that flows through the relevant protective components shall not exceed a value of 1 mA. Currents through components connected in parallel to the relevant protective component(s), or otherwise connected (e.g. indicator circuits), are disregarded for this measurement, as long as they cannot cause a current through the relevant protective component(s). In addition the current through the PE-terminal, including parallel circuits and other circuits (e.g. indicator circuits), if any, shall not exceed 1 mA. If there is more than one possible connection arrangement for normal use, this check shall be performed for all arrangements.
K	The short-circuit current from the power source, if any, shall be interrupted within 5 s by one or more internal and/or external disconnector(s).
L	The tissue paper shall not catch fire.
M	There shall be no explosion or other hazard to either personnel or the facility.
N	There shall be no flashover to the metallic screen and the 6 A gL/gG fuse connecting the screen shall not operate during the test.
O	After completion of this test the samples shall be allowed to return to room temperature and be connected to a power source at U_C for 2 h. The residual current shall be monitored and not exceed the value measured at the beginning of the test by more than 10 %.

Table 8 – Prospective short-circuit current and power factor

I_p (kA) $^{+5}_{0}$ %	cos φ ($^{0}_{-0,05}$)
$I_p \leq 1,5$	0,95
$1,5 < I_p \leq 3,0$	0,9
$3,0 < I_p \leq 4,5$	0,8
$4,5 < I_p \leq 6,0$	0,7
$6,0 < I_p \leq 10,0$	0,5
$10,0 < I_p \leq 20,0$	0,3
$20,0 < I_p \leq 50,0$	0,25
$50,0 < I_p$	0,2
NOTE Recovery voltage according to IEC 60947-1.	

Table 10 – Screw thread diameters and applied torques

Nominal diameter of thread mm	Torque Nm		
	I	II	III
Up to and including 2,8	0,2	0,4	0,4
Over 2,8 up to and including 3,0	0,25	0,5	0,5
Over 3,0 up to and including 3,2	0,3	0,6	0,6
Over 3,2 up to and including 3,6	0,4	0,8	0,8
Over 3,6 up to and including 4,1	0,7	1,2	1,2
Over 4,1 up to and including 4,7	0,8	1,8	1,8
Over 4,7 up to and including 5,3	0,8	2,0	2,0
Over 5,3 up to and including 6,0	1,2	2,5	3,0
Over 6,0 up to and including 8,0	2,5	3,5	6,0
Over 8,0 up to and including 10,0	–	4,0	10,0

Table 11 – Cross-sections of copper conductors for screw-type or screwless terminals

Maximum continuous load current for two-port SPDs or one-port SPDs with separate input/output terminals [a] A		Range of nominal cross-sections to be clamped (single conductor)	
		mm^2	American Wire Gauge
Up to and including 13		1 to 2,5	18 to 14
Above 13	up to and including 16	1 to 4	18 to 12
Above 16	up to and including 25	1,5 to 6	16 to 10
Above 25	up to and including 32	2,5 to 10	14 to 8
Above 32	up to and including 50	4 to 16	12 to 6
Above 50	up to and including 80	10 to 25	8 to 3
Above 80	up to and including 100	16 to 35	6 to 2
Above 100	up to and including 125	25 to 50	4 to 1

[a] It is required that, for current ratings up to and including 50 A, terminals be designed to clamp solid conductors as well as rigid stranded conductors; the use of flexible conductors is permitted.

Nevertheless, it is permitted that terminals for conductors having cross-sections from 1 mm^2 up to 6 mm^2 be designed to clamp solid conductors only.

Table 12 – Pulling forces (screw terminals)

Cross-section of conductor accepted by the terminal mm^2	Up to 4	Up to 6	Up to 10	Up to 16	Up to 50
Pull N	50	60	80	90	100

Table 13 – Conductor dimensions

Range of nominal cross-sections to be clamped mm^2	Stranded conductor Number of wires
1 to 2,5 [a]	7
1 to 4 [a]	7
1,5 to 6 [a]	7
2,5 to 10	7
4 to 16	7
10 to 25	7
16 to 35	19
25 to 50	Under consideration

[a] If the terminal is intended to clamp solid conductors only (see table footnote of Table 11), the test is not performed.

Table 14 – Pulling forces (screwless terminals)

Cross-sectional area mm²	0,5	0,75	1,0	1,25 1,5	2,0 2,5	3,5 4	5,5 6	8,0 10	14 16	22 25	35 38
Pull force N	30	30	35	40	50	60	80	90	100	135	190

Table 15 – Air clearances for SPDs

U_{max} [a]	≤2 000 V	≤4 000 V	>4 000 V up to 6 000 V	>6 000 V up to 8 000 V
	Air clearances in millimetres			
1) Between live parts of different polarity	1,5	3	5,5	8
2) Between live parts and				
– screws and other means to fasten a covering, having to be detached for mounting the SPD	1,5	3	5,5	8
– fastening surfaces (NOTE 2)	3	6	11	16
– screws or other means for fastening the SPD (NOTE 2)	3	6	11	16
– bodies (NOTES 1 and 2)	1,5	3	5,5	8
3) Between the metal parts of the disconnector mechanism and				
– bodies (NOTE 1)	1,5	3	5,5	8
– screws or other means for fastening the SPD	1,5	3	5,5	8

[a] This column is only applicable for SPDs with U_C lower or equal to 180 V.

NOTE 1 For definition, see 8.3.6 a)

NOTE 2 If clearances between live parts of the device and the metallic screen or the surface on which the SPD is mounted are dependent on the design of the SPD only and cannot be reduced when the SPD is mounted in the least favourable position (even in a metallic enclosure), the values of line 1) are sufficient.

Table 16 – Creepage distances for SPDs

r.m.s. voltage [b, c] V	Minimum creepage distances in millimetres								
	Printed wiring material		Pollution degree						
	Pollution degree								
	1	2	1	2			3		
	All material groups	All material groups, except IIIb	All material groups	Material group [a]			Material group [a]		
				I	II	III	I	II	III [d]
10	0,025	0,04	0,08	0,4	0,4	0,4	1	1	1
12,5	0,025	0,04	0,09	0,42	4,42	4,42	1,0	1,05	1,05
16	0,025	0,04	0,1	0,45	0,45	0,45	1,1	1,1	1,1
20	0,025	0,04	0,11	0,48	0,48	0,48	1,2	1,2	1,2
25	0,025	0,04	0,125	0,5	0,5	0,5	1,2	1,25	1,25
32	0,025	0,04	0,14	0,53	0,53	0,53	1,3	1,3	1,3
40	0,025	0,04	0,16	0,56	0,8	1,1	1,4	1,6	1,8
50	0,025	0,04	0,18	0,6	0,85	1,2	1,5	1,7	1,9
63	0,04	0,063	0,2	0,63	0,9	1,25	1,6	1,8	2
80	0,063	0,1	0,22	0,67	0,95	1,3	1,7	1,9	2,1
100	0,1	0,16	0,25	0,71	1	1,4	1,8	2	2,2
125	0,16	0,25	0,28	0,75	1,05	1,5	1,9	2,1	2,4
160	0,25	0,4	0,32	0,8	1,1	1,6	2	2,2	2,5
200	0,4	0,63	0,42	1	1,4	2	2,5	2,8	3,2
250	0,56	1	0,56	1,25	1,8	2,5	3,2	3,6	4
320	0,75	1,6	0,75	1,6	2,2	3,2	4	4,5	5
400	1	2	1	2	2,8	4	5	5,6	6,3
500	1,3	2,5	1,3	2,5	3,6	5	6,3	7,1	8
630	1,8	3,2	1,8	3,2	4,5	6,3	8	9	10
800	2,4	4	2,4	4	5,6	8	10	11	12,5
1 000	3,2	5	3,2	5	7,1	10	12,5	14	16

[a] For further information on material groups refer to Table 17.

[b] This voltage is
for functional insulation, the working voltage;
for basic and supplementary insulation of the circuit energized directly from the supply mains, the voltage rationalized through Table F.3a or Table F.3b of IEC 60664-1, based on the rated voltage of the equipment, or the rated insulation voltage;
for basic and supplementary insulation of systems, equipment and internal circuits not energized directly from the mains, the highest r.m.s. voltage which can occur in the system, equipment or internal circuit when supplied at rated voltage and under the most onerous combination of conditions of operation within equipment rating.

[c] For the main protection circuit, this column refers to U_C.

[d] Material IIIb shall not be used for application in pollution degree 3 above 630 V.

NOTE If the actual voltage differs from the values given in the table, it is allowed to interpolate values for intermediate voltages. When interpolating, linear interpolation should be used and values should be rounded to the same number of digits than the values picked from the table.

Table 17 – Relationship between material groups and classifications

Material group I	**600 ≤ CTI**
Material group II	**400 ≤ CTI < 600**
Material group IIIa	**175 ≤ CTI < 400**
Material group IIIb	**100 ≤ CTI < 175**
Relationship between material groups and classifications are according to IEC 60112 (CTI values, using solution A).	

Table 18 – Fall distances for impact requirements

Height of fall mm	**Parts of enclosures to be subjected to the impacts**	
	Ordinary accessory	**Other accessories**
100	A and B	A and B
150	C	C
200	D	D

A: parts on the front surface, including parts which are recessed.

B: parts which do not project more than 15 mm from the mounting surface (distance from the wall) after mounting as in normal use, with the exception of the above parts A.

C: parts which project more than 15 mm and not more than 25 mm from the mounting surface (distance from the wall) after mounting as in normal use, with the exception of the above parts A.

D: parts which project more than 25 mm from the mounting surface (distance from the wall) after mounting as in normal use, with the exception of the above parts A.

Table 19 – Test conductors for rated load current test

Test current [A]		Cross section	
Greater than	Less or equal	[mm²]	AWG/MCM
0	8	1,0	18
8	12	1,5	16
12	15	2,5	14
15	20	2,5	12
20	25	4,0	10
25	32	6,0	10
32	50	10	8
50	65	16	6
65	85	25	4
85	100	35	3
100	115	35	2
115	130	50	1
130	150	50	0
150	175	70	00
175	200	95	000
200	225	95	0000
225	250	120	250
250	275	150	300
275	300	185	350
300	350	185	400
350	400	240	500

NOTE If other standardized cross-sections are used in specific countries, the next closest cross-section should be used for testing.

Table 20 – Current factor *k* for overload behaviour

Protective device	Trip current factor *k*
Circuit breaker	1,45
Fuse	1,6

NOTE 1 If the type of protective device (breaker or fuse) is not specified by the manufacturer, the test is performed with the higher *k* factor.

NOTE 2 For countries using other values, these values should be declared on the SPD's data sheet according to 7.1.1 c7).

NOTE 3 National condition for Japan: *k* is 1,25 for circuit-breaker and 1,5 for fuse.

NOTE 4 National condition for North America: *k* is under consideration.

Table 21 – Tolerances for proportional surge currents

Test classification	Proportional currents and tolerances		
Test class I	$I_{imp(1)} = I_{imp(2)} =$ $Q_{(1)} = Q_{(2)} =$ $W/R_{(1)} = W/R_{(2)} =$	$I_{imp(N)} = I_{Total(Iimp)} / N$ $Q_{(N)} = Q_{Total} / N$ $W/R_{(N)} = W/R_{Total} / N^2$	10 % -10/+20 % -10/+45 %
Test class II	$I_{8/20(1)} = I_{8/20(2)} =$	$I_{8/20\ (N)} = I_{Total(8/20)} / N$	± 10%

Table B.1 – TOV test values for systems complying with IEC 60364 series

Application	TOV test parameters		
SPDs connected to:	For t_T=5 s (LV-system faults in consumer installation) (requirement to 7.2.8.1 and test 8.3.8.1)	For t_T=120 min (LV-system faults in distribution system and loss of neutral (requirement to 7.2.8.1 and test 8.3.8.1)	For t_T=200 ms (HV-system faults) (requirement to 7.2.8.2 and test 8.3.8.2)
	Withstand mode required	Withstand or safe failure mode acceptable	Withstand or safe failure mode acceptable
	TOV test values U_T (V)		
TN-systems			
Connected L-(PE)N or L-N	1,32 × U_{REF}	√3 x U_{REF}	
Connected N-PE			
Connected L-L			
TT-systems			
Connected L-PE	√3 × U_{REF}	1,32 × U_{REF}	1 200 + U_{REF}
Connected L-N	1,32 × U_{REF}	√3 x U_{REF}	
Connected N-PE			1 200
Connected L-L			
IT-systems			
Connected L-PE			1 200 + U_{REF}
Connected L-N	1,32 × U_{REF}	√3 x U_{REF}	
Connected N-PE			1 200 + U_{REF}
Connected L-L			

U_{REF}	reference test voltage used for testing and taking into account the maximum voltage regulation of the power system (see Annex A).
U_o	in TN- and TT-systems: nominal a.c. r.m.s. line voltage to earth; in IT-systems: nominal a.c. voltage between line conductor and neutral conductor or midpoint conductor, as appropriate (see 442.1.2 of IEC 60364-4-44:2007).
1,32 x	U_{REF} equals 1,45 x U_o in case the voltage regulation does not exceed +10 % (see 442.5 of IEC 60364-4-44:2007).

NOTE As voltage regulation exceeds 10 % in some countries, only U_{REF} is used in this standard for general applicability. Further information on voltage regulation can be found in IEC 60038.

Table B.3 – TOV test parameters for Japanese systems

Application	TOV test parameters			
	LV system faults	HV system faults		
SPDs connected to:	for t_T=120 min	Not specified duration	for t_T=2 s	for t_T=1 s
	(LV-system faults in distribution system and loss of neutral (requirement to 7.2.8.1 and test 8.3.8.1)	Withstand or safe failure mode acceptable		
	TOV test values U_T [V]			
TN systems				
Connected L-N(PE) or L-N	$\sqrt{3} \times U_{REF}$			
Connected N-PE				
Connected L-L				
TT systems				
Connected L-PE	$\sqrt{3} \times U_{REF}$	150+ U_{REF}	300+ U_{REF}	600+ U_{REF}
Connected L-N	$\sqrt{3} \times U_{REF}$			
Connected N-PE		150	300	600
Connected L-L				
IT systems				
Connected L-PE				1 200+ U_{REF}
Connected L-N	$\sqrt{3} \times U_{REF}$			
Connected N-PE				1 200+ U_{REF}
Connected L-L				

U_{REF} reference test voltage used for testing and taking into account the maximum voltage regulation of the power system (see Annex A).

NOTE 1 These values are required by ministerial ordinance of technical standards for electrical facilities.

NOTE 2 As voltage regulation exceeds 10 % in some countries, U_{REF} is used in this standard only for general applicability. Further information on voltage regulation can be found in IEC 60038.

Table G.1 – Temperature-rise limits

Parts of SPD	Temperature rise K
Built-in components [a]	In accordance with the relevant product standard requirements for the individual components or, in accordance with the component manufacturer's instructions [f], taking into consideration the temperature in the SPD
Terminals for external insulated conductors	70 [b]
Busbars and conductors, plug-in contacts of removable or withdrawable parts which connect to busbars	Limited by: – mechanical strength of conducting material [g]; – possible effect on adjacent equipment; – permissible temperature limit of the insulating materials in contact with the conductor; – effect of the temperature of the conductor on the apparatus connected to it; – for plug-in contacts, nature and surface treatment of the contact material.
Manual operating means: – of metal – of insulating material	 15 [c] 25 [c]
Accessible external enclosures and covers: – metal surfaces – insulating surfaces	 30 [d] 40 [d]
Discrete arrangements of plug and socket-type connections	Determined by the limit for those components of the related equipment of which they form part [e]

[a] The term "built-in components" means:
– conventional switchgear and controlgear;
– electronic sub-assemblies (e.g. rectifier bridge, printed circuit);
– parts of the equipment (e.g. regulator, stabilized power supply unit, operational amplifier).

[b] An SPD used or tested under installation conditions may have connections, the type, nature and disposition of which will not be the same as those adopted for the test, and a different temperature rise of terminals may result. Where the terminals of the built-in component are also the terminals for external insulated conductors, the lower of the corresponding temperature-rise limits shall be applied.

[c] Manual operating means within SPDs which are only accessible after the SPD has been opened, for example draw-out handles which are operated infrequently, are allowed to assume a 25 K increase on these temperature-rise limits.

[d] Unless otherwise specified, in the case of covers and enclosures, which are accessible but need not be touched during normal operation, a 10 K increase on these temperature-rise limits is permissible.

[e] This allows a degree of flexibility in respect of equipment (e.g. electronic devices) which is subject to temperature-rise limits different from those normally associated with switchgear and controlgear.

[f] For temperature-rise tests according to 8.6.1.1, the temperature-rise limits shall be specified by the manufacturer of the SPD.

[g] Assuming all other criteria listed are met, a maximum temperature rise of 105 K for bare copper busbars and conductors shall not be exceeded. The 105 K relates to the temperature above which annealing of copper is likely to occur.

IEC/EN 61643-11B - ATTACHMENT			
Clause	Requirement + Test	Result - Remark	Verdict

Attachment 1- European group differences and national differences

ATTACHMENT TO TEST REPORT IEC 61643_11B
EUROPEAN GROUP DIFFERENCES AND NATIONAL DIFFERENCES
(DC SPD-
Part 11: Surge protective devices connected to low-voltage power systems –
Requirements and test methods)

Differences according to.....:	IEC/EN 61643-11:2012
Attachment Form No..... :	EU_GD_EN 61643-11B
Attachment Originator.....:	OVE
Master Attachment ..:	Date (2012-12)

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	CENELEC COMMON MODIFICATIONS (EN)		
	EN 61643-11 - *TEST SEQUENCE 1*		
Clause	Requirement - Test	Result - Remark	Verdict
7.1.1/7.1.2	**Identification and Marking**		P
	Markings on the body or permanently attached to		P
	a4) The SPD type and discharge parameters for each mode of protection declared by the manufacturer and printed next to each other: For Type 1: "Type 1" and "I_{imp}" and the value in kA,and/or "T1" (T1 in a square) and "I_{imp}" and the value in kA For Type 2: "Type 2" and "I_n" and the value in kA,and/or "T2" (T2 in a square) and "I_n" and the value in kA For Type 3: "Type 3" and "U_{OC}" and the value in kV,and/or "T3" (T3 in a square) and "U_{OC}" and the value in kV	_____ kA 20 kA _____ kA	_____ P _____
	b14) I_{max} (if declared by the manufacturer)	_____	N/A

IEC/EN 61643-11B - ATTACHMENT			
Clause	Requirement + Test	Result - Remark	Verdict
7.2.2	**Residual current I_{PE}**	<5μA	P
	This test is not performed on SPDs for connection N-PE only		P
	For all SPDs with a terminal for the protective conductor, the residual current I_{PE} shall be measured when all SPD terminals are connected to a power supply at the reference test voltage (U_{REF}) according to the manufacturer's instructions.		P
8.3.2	All modes of protection of the SPD shall be connected as for normal use according to the manufacturer's instructions. The line to PE voltage of the supply system shall be adjusted to the reference test voltage U_{REF}.	U_{REF} 316.8 I_{PE} <5μA	P
7.2.4/8.3.4	**Operating duty**		P
	The SPD shall be capable of withstanding specified discharge currents during application of the maximum continuous operating voltage U_C without unacceptable changes in its characteristics. In addition voltage switching type SPDs or combination type SPDs shall be able to interrupt any follow current up to the short-circuit current rating (I_{sccr}) The test setup shall comply with the circuit diagram given in Figure 7.		N/A
8.3.4.2.2	SPDs with follow current > 500A: The test sample shall be connected to a power frequency voltage at Uc with a prospective short-circuit current equal to the short circuit current rating Isccr declared by the manufacturer and with a power factor in accordance with Table 8, except for SPDs which are only connected between neutral and protective earth in TT- and/or TN-systems, for which the prospective short-circuit current shall be at least 100A.	_____ kA cos φ = _____	N/A
7.3.4/8.4.3	**Verification of air clearances and creepage distances**		P
	The air clearances and creepage distances shall not be smaller than the values indicated in Table 15 and Table 16, whereby Table 16 shall be applied to items 1), 2) and 3) according to Table 15.		P

	Creepage distances in millimetres		

IEC/EN 61643-11B - ATTACHMENT			
Clause	Requirement + Test	Result - Remark	Verdict
	– r.m.s. voltage	240	P
	– Material group	IIIa	
	– Pollution	2	
		required / measured	
	1) Between live parts of different polarity	5,0 /8,2	
	2) Between live parts and		
	– screws and other means to fasten a covering, having to be detached for mounting the SPD	_____ / _____	
	– fastening surfaces (note 2)	_____ / _____	
	– screws or other means for fastening the SPD (note 2)	_____ / _____	
	– bodies (notes 1 and 2)	5,0 / 12,0	
	3) Between the metal parts of the disconnector mechanism and		
	– bodies (note 1)	_____ / _____	
	– screws or other means for fastening the SPD	_____ / _____	
	Printed wiring material		
	– r.m.s. voltage	240	
	– Material group	IIIa	
	– Pollution	2	
		required / measured	
	1) Between live parts of different polarity	5,0 / 8,5	
	2) Between live parts and		
	– screws and other means to fasten a covering, having to be detached for mounting the SPD	_____ / _____	
	– fastening surfaces (note 2)	_____ / _____	
	– screws or other means for fastening the SPD (note 2)	_____ / _____	
	– bodies (notes 1 and 2)	_____ / _____	
	3) Between the metal parts of the disconnector mechanism and		
	– bodies (note 1)	_____ / _____	
	– screws or other means for fastening the SPD	_____ / _____	
	NOTE 1 – Definition see 8.3.6 a)		
	NOTE 2 – If clearances between live parts of the device		

IEC/EN 61643-11B - ATTACHMENT			
Clause	Requirement + Test	Result - Remark	Verdict
	and the metallic screen or the surface on which the SPD is mounted are dependent on the design of the SPD only and cannot be reduced when the SPD is mounted in the least favourable position (even in a metallic enclosure), the values of lines 1 are sufficient.		P
7.2.5.4	**Status indicator**		P
	The manufacturer shall provide information about the function of the indicator and the actions to be taken after change of status indication.		P
	A status indicator may be composed of two parts (one of which is not replaced when e.g. a plug module is changed), linked by a coupling mechanism which can be mechanical, optical, audio, electromagnetic, etc. The part of the status indicator which is not replaced (e.g. base part of socket) shall be capable of operating at least 50 times.		P
	Where there is an appropriate standard for the type of indication used, this shall be met by the non-replaced part of the status indicator, with the exception that the indicator need only be tested for 50 operations.		P
8.3.3.1	**Residual voltage with 8/20 current impulses**		P
	Class I, 8/20 current impulses with a sequence of crest values of 0,1; 0,2; 0,5; 1,0 times the crest value of I_{imp} shall be applied. 0,1 times I_{imp} 0,2 times I_{imp} 0,5 times I_{imp} 1,0 times I_{imp} Class II, 8/20 current impulses with a sequence of crest values of 0,1; 0,2; 0,5; 1,0 times I_n shall be applied. 0,1 times I_n 0,2 times I_n 0,5 times I_n 1,0 times I_n If the SPD contains only voltage-limiting components, this test needs only to be performed at a crest values of I_{imp} for test class I or I_n for test class II.		P
	One sequence of positive polarity and one sequence of negative polarity are applied to the SPD		P

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Clause	Requirement + Test	Result - Remark	Verdict
	When I_{max} is declared by the manufacturer an additional 8/20 current impulse with a crest value of I_{max} shall be applied and the polarity that showed higher residual voltages in the previous tests.	_____ kA / _____ V	N/A
	The interval between individual impulses shall be long enough for the sample to cool down to ambient temperature.		N/A
	Current and voltage oscillogram		N/A
	Crest values – discharge current versus residual voltage diagram to I_n or I_{imp}		N/A
	The residual voltage used for determining the measured limiting voltage is the highest voltage value corresponding to the range of currents for: • class I: up to I_{imp} • class II: up to I_n	 _____ V _____ V	N/A
	The value for determining U_{max} is the highest residual voltage measured at surge currents up to I_n, I_{max} or I_{imp}, as applicable depending on the SPD test class.	_____ V	N/A
7.5.1.2	**Overload behaviour**		N/A
	If an external maximum overcurrent protection is specified by the manufacturer, the SPD shall be loaded for 1 h with a current equal to 1,6 times the rated current of that maximum overcurrent protection.	I = _____ A	N/A
8.3.5.3	**a) Test at the declared short-circuit current rating**		N/A
	The test is carried out twice with U_{REF} applied once at (45 ± 5) electrical degrees and once at (90 ± 5) electrical degrees after the zero crossing of the voltage.		N/A
8.3.5.3.2	**Additional test for SPD's failure mode simulation**		N/A
	For this test any electronic indicator circuitry may be disconnected.		N/A
	New samples shall be used and fitted as in normal use, acc. to the manufacturer's instructions and connected with conductors of the maximum cross section acc. to 8.4.2. The maximum length of the cables connection the sample shall be of 0,5 m each.		N/A
	External disconnectors, if recommended by the manufacturer, shall be used.	_____	N/A

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Clause	Requirement + Test	Result - Remark	Verdict
	The test sample shall be connected to a power frequency voltage source at the following conditioning voltages: • SPDs rated U_C up to 440V, apply a voltage equal to 1200 V_{rms} $^{+5}/_{-0}$% • SPDs with U_C rated above 440V, apply a voltage equal to 3 times U_C $^{+5}/_{-0}$%	_____ V	N/A
	For all types of SPDs with Uc up to 180V, the conditioning voltage may be reduced to 600V if for voltage switching type SPDs and for combination type SPDs, any voltage switching components operate at this voltage.		N/A
	The conditioning voltage is applied for a duration of 5 s $^{+5}/_{-0}$%. The prospective short-circuit current of this power source for conditioning shall be adjusted to a value between 1 A and 20 A_{rms} $^{+5}/_{-0}$%, as provided by the manufacturer according to 7.1.1 d5).	_____ A	N/A
	Following the application of the conditioning voltage equal to U_{REF} $^{+0}/_{-5}$% with a short-circuit current capability as given below, shall be applied to the sample for a period of 5 min $^{+5}/_{-0}$% or for at least 0,5 s after interruption of the current by an internal or external disconnector.		N/A
	The transition from conditioning voltage application to U_{REF} application shall be performed without interruption. The current flow through the SPD shall be monitored. An appropriate test circuit and timing diagram is shown in Figure 12 and Figure 13.		N/A
	The prospective short-circuit current of the power source at U_{REF} shall have a tolerance of $^{+5}/_{-0}$% at the location where the SPD is connected. The power factor of the power source shall comply with Table 8.		N/A
	Each of the following tests shall be performed on a new set of three preconditioned samples as above at U_{REF} with a short-circuit current of 100A, 500A and 1000A, respectively, unless these values exceed the declared short-circuit rating of the SPD.		N/A
	A further test shall be performed on three preconditioned samples as above and at U_{REF} with a prospective short-circuit current equal to the manufacturer's declared short-circuit current rating. For this test, the time internal between the completion of the conditioning test and the application of U_{REF} shall be as short as possible and shall not exceed 100 ms.		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
	If all measurements of the test on the first set of samples (100A test set up): • either show a disconnection within 5s during the application of the conditioning voltage or • the current through the sample during the application of U_{REF} after conditioning does not exceed a value of 1mA or • the current through the sample during the application or UREF after conditioning does not exceed the initial value determined at U_{REF} before the test by more than 20% no further test is performed		N/A
	Pass criteria		N/A
	For this test any damage to electronic indicator circuitry during the conditioning test is not regarded as a failure.		N/A
C	No mechanical damage		N/A
I	SPDs having an IP degree ≥ IP 2X – no live parts accessible with standardised test finger applied with a force of 5 N, except the ones which are accessible when the SPD is fitted as in normal use.		N/A
M	There shall be no explosion or other hazard to either personnel or the facility		N/A
N	There shall be no flashover to the metallic screen and the 6 A gL/gG fuse connecting the screen shall not operate during the test.		N/A
	Additional pass criteria except for: • short circuiting type SPDs • SPDs where the current is interrupted or no significant current flows during the application of U_{REF}. where no disconnection occurs.		N/A
H	Disconnection shall be provided by one or more internal or external disconnector(s). Their correct indication shall be checked.		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
J	If disconnection occurs during the test, there shall be clear evidence of effective disconnection of the corresponding protective component(s). If internal disconnection occurs, the test sample is connected at U_C and rated frequency for 1 min. The current flow shall not exceed a value of 1 mA.	_____ V _____ mA	N/A _____
	Currents through components connected in parallel to the relevant protective component(s), are disregarded for this measurement.		N/A _____
	Current through the PE-terminal shall not exceed 1mA If there is more than one possible connection arrangement for normal use, this check shall be performed for all arrangements.	_____ mA	_____ N/A _____
7.6.1.3	Vibration and shock (informative)		N/A
	Vibration and shock tests shall be performed according to • EN 60068-2-6 for sinusoidal vibration test • EN 60068-2-64 for broadband random vibration test • EN 60068-2-27 for shock test		N/A _____ _____ _____
ZB-2.2	**Transportation**		P
	Usually SPDs within their packaging are subjected to mechanical stress due to transportation. This should be checked by a vibration and shock test in accordance with EN 60721-3-2		P _____
ZB.2.3	**Special applications**		N/A
	Special applications of SPDs may require additional vibration and shock tests, on the device itself. Typical values can be found in EN 60721-3-3 and can be as shown in Table ZB.1.	_____	N/A _____
	Furthermore other applications like railway may require different parameters that are given in corresponding standards or directly from application. For instance required parameters for railway vibration and shock tests are given in EN 61373.	_____	N/A _____
	During the sinusoidal and random vibration tests (if requested), the sample should be powered under U_C with a short circuit capability of at least 5A.		N/A _____
ZB.3	**Pass criteria**		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
C	No mechanical damage		N/A
D	Determination of the measured limiting voltage:	U_P ≤ _____ V	N/A
	according to 8.3.3.1, but only at a crest value corresponding to I_{imp} for test class I	_____ kA / _____ V	N/A
	according to 8.3.3.1, but only at I_n for test class II	_____ kA / _____ V	N/A
	according to 8.3.3.3, but only at U_{OC} for test class III	_____ kA / _____ V	N/A
	SPDs tested acc. to class I and II containing switching components: Front-of-wave sparkover voltage acc. to 8.3.3.2 All measured peak values (5 pos./5 neg.) below U_P	_____ kV	N/A
E	No excessive leakage currents shall occur after the test		N/A
	If there is more than one possible connection arrangement for normal use, this check shall be performed for all arrangements		N/A
	The SPD shall be connected as for normal use according to the manufacturer's instructions to a power supply at the reference test voltage (U_{REF}). The current that flows through each terminal is measured. Its resistive component (measured at the crest of the sine wave) • shall not exceed a value of 1 mA or • the current shall not have changed by more than 20% compared to the initial value determined at the beginning of the test sequence	U_{REF}= _____ V	N/A
	Any resettable or rearmable disconnector shall be switched off and dielectric withstand shall be checked by application of two times U_C or 1000V a.c. whichever is greater. During the test, no flashover, breakdown of insulation or any other manifestation of disruptive discharge shall occur.	U_C= _____ V test voltage _____ V	N/A

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Clause	Requirement + Test	Result - Remark	Verdict
	For SPD modes connected N-PE only, the current through the PE-terminal shall be measured, whereas the terminals are connected to a power supply at U_C. Its resistive component (measured at the crest of the sine wave) • shall not exceed a value of 1 mA or • the current shall not have changed by more than 20% compared to the initial value determined at the beginning of the test sequence	U_C= _____ V I_{PE} = _____ mA	N/A
G	Internal disconnectors shall not operate during the test and shall be in working order after the test.		N/A
I	SPDs having an IP degree ≥ IP 2X – no live parts accessible with standardised test finger applied with a force of 5 N, except the ones which are accessible when the SPD is fitted as in normal use.		N/A

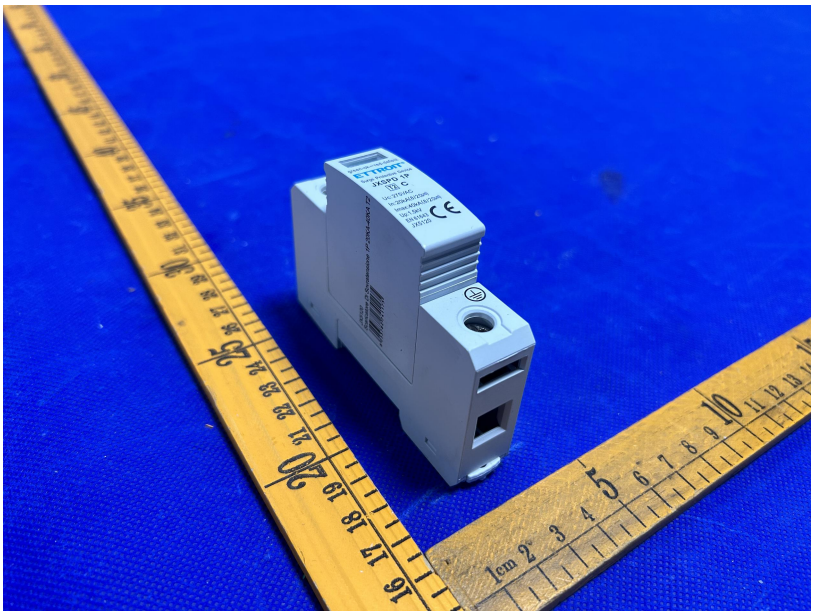


Photo 1

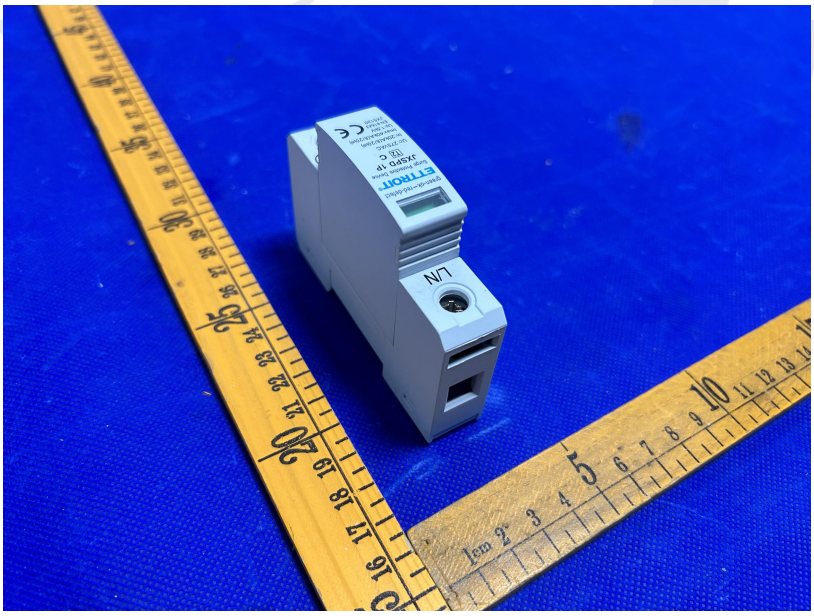


Photo 2

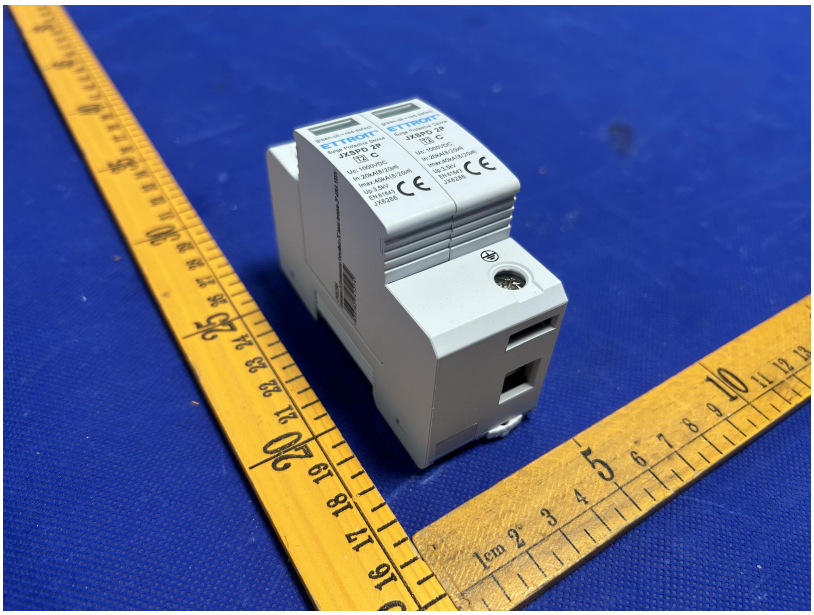


Photo 3

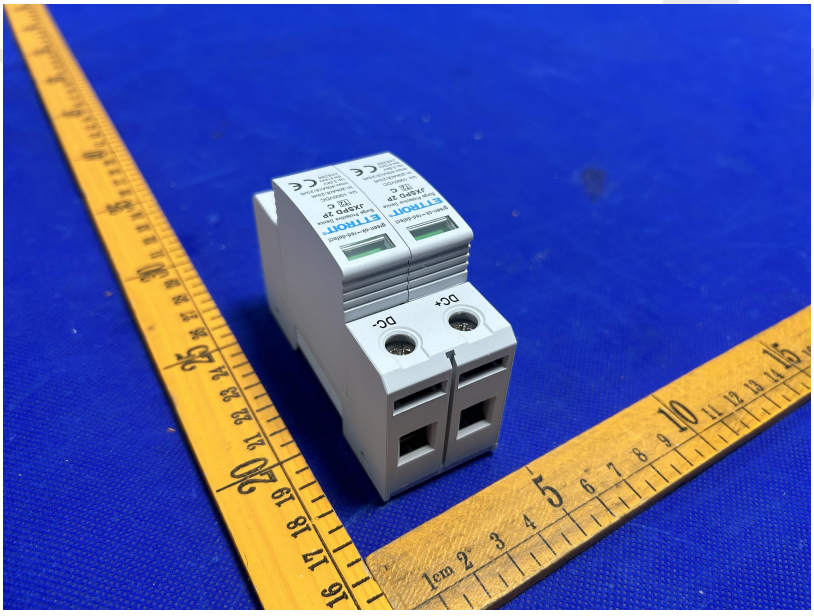


Photo 4



Photo 5

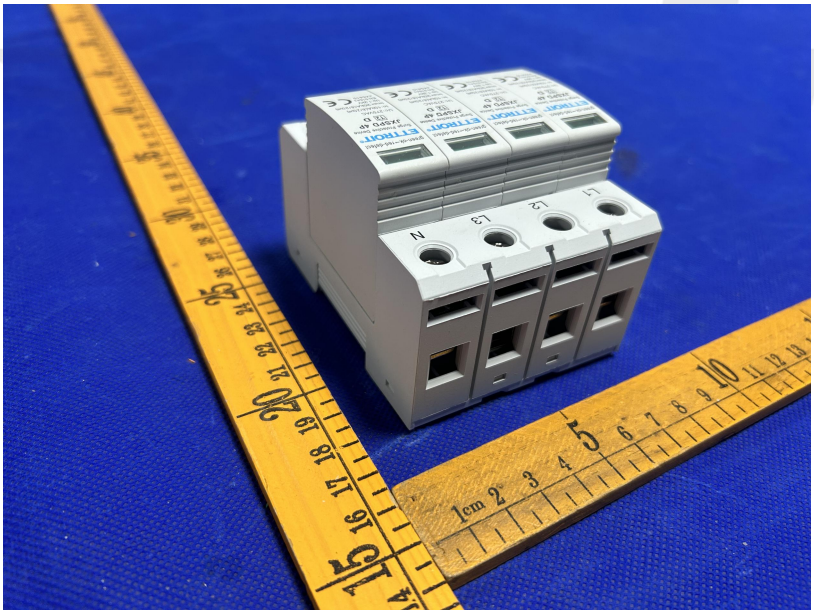


Photo 6

====== End of Report ======