



**SIRIM QAS International Sdn.Bhd.** (Company No.: 410334-X)  
No.1, Persiaran Dato' Menteri, P.O.BOX 7035, Section 2,  
40911 Shah Alam, Selangor Darul Ehsan, Malaysia  
Tel. no: 03-55446253 / 55446251 Fax. no: 03-55446272

## TEST REPORT

REPORT NO.: 2011EL0627

PAGE : 1 OF 77

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Applicant : Harapan Erat Sdn. Bhd.,  
D10-10-1, Blok D10,  
Pusat Perdagangan Dana 1,  
Jalan PJU 1A/U6, PJU 1A,  
47301 Petaling Jaya,  
Selangor, Malaysia.

Manufacturer : Ground Co., Ltd,  
# 209 SunTech City, 307-2 Sangdaewon-dong,  
Jungwon-gu, Seongnam-si, Kyenggi-do,  
South Korea.

Product : SURGE PROTECTIVE DEVICES WITH GROUNDING FOR LOW  
VOLTAGE SYSTEMS

Reference Standard /  
Method of test : MS IEC 61643-1: 2006

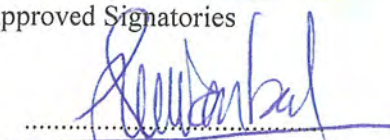
Description of sample: Brand Name : ECA3G  
Model / Type : LM-34-40-90M (Three Phase)  
Rating : I<sub>max</sub> : 65 kA  
In : 20 kA  
U<sub>c</sub> : 275 V (L – N); 255 V (N – G)  
Classification : Class II (see page 4)


Date received : 10-Jan-2011

Job No./Ref.No. : J20115020028

Issued date : **18 MAY 2011**

Approved Signatories

  
(SURIAN RASOL)  
Senior Technical Executive

  
(MOHD ISMAIL)  
Testing Specialist,  
Electrical & Electronic Section  
Testing Services Department

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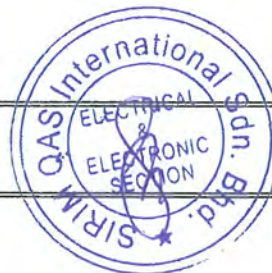
### SUMMARY OF TESTS:

1. This is a type test report.
2. The tests were carried out on fifteen (15) submitted samples as shown in table below;

Test clause(s)	Item	Location
7.2	Identification and marking	SIRIM QAS International
7.3	Terminals and connections	
7.4	Protections against direct contact	
7.7.5	Standby power consumption and residual current	
7.5	Measurement of limiting voltage	
7.6.4	Preconditioning	Korean Electrotechnical Research Institute
7.6.5	Operating duty test	Korean Electrotechnical Research Institute
7.7.2	Thermal stability test	Korean Electrotechnical Research Institute
7.7.3	Short-circuit withstand test	Korean Electrotechnical Research Institute
7.7.4	TOV test caused by faults in the high (medium) voltage system	Korean Electrotechnical Research Institute
7.7.6	TOV test caused by faults in the low voltage system	Korean Electrotechnical Research Institute
7.9	Additional test - Mechanical strength, heat resistance, resistance to abnormal heat and fire, clearances and creepage distances, tracking resistance, insulation resistance, dielectric strength, IP test	SIRIM QAS International

3. Since the component and structure used is identical for L – N and L – G, the tests were carried out on L – N mode only.
4. All the test conducted at Korean Electrotechnical Research Institute (KERI) had been witnessed by SIRIM's representative.
5. Unless otherwise specified, tests were conducted at ambient temperature of  $25 \pm 5$  ° C.
6. The abbreviation used in this test report denotes as follows;
  - P:** Complied with the requirement
  - N:** Not Applicable with the requirement
  - F:** Did Not Comply with the requirement

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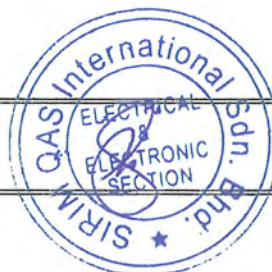


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**ADDITIONAL INFORMATION;**

1. Tested by : Kim, Young-Sun, Khairul Azmi
2. Witnessed and checked by: Surian Rasol
3. Date of test sample(s) received;
  - a) 1<sup>st</sup> submission: 24-Jan-2011
  - b) 2<sup>nd</sup> submission (if any): 17-Mar-2011
  - c) 3<sup>rd</sup> submission (if any): \_\_\_\_\_

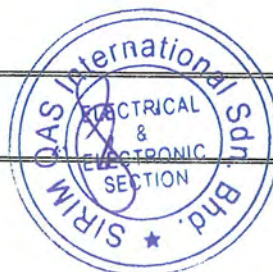
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<b>CLASSIFICATION</b>	
Number of ports:	One port
SPD design topology:	Voltage switching / Voltage limiting
SPD type (and test class):	Type 2 (II)
Location:	Outdoor, indoor
Accessibility:	Accessible, Inaccessible
Mounting method:	Fixed
SPD Disconnecter:	Internal
Protection functions:	Thermal
Overcurrent protection:	Not specified
Degree of protection (IP code)	Not specified
Temperature range:	Normal
Required SPD disconnecter	Not specified

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**TEST SEQUENCE 1**

Clause	Requirement - Test	Result	Verdict
6.1.1/6.1.2	<b>Identification and Marking</b>		
	<b><u>Markings on the body or permanently attached to</u></b>		
	a) Manufacturer/Trade mark/Model number	Ground/ECA3G/ LM-34-40-90M	-
	e) Maximum continuous operating voltage $U_c$ (for each mode) and rated frequency	275 V (L1-N, L2-N, L3-N), 255 V (N- GND)  50 ~ 60 Hz	-
	f) SPD test classification/type and discharge parameters for each mode of protection	No. of modes 7 (L1-N, L2-N, L3- N, L1-G, L2-G, L3- G, N-G)	-
	Class I test / Type 1 $I_{imp}$		-
	Class II test / Type 2 $I_{max}$	65 kA	-
	Class III test / Type 3 $U_{oc}$		-
	g) Nominal discharge current $I_n$ for test class I / Type 1 and test class II / Type 2 SPDs (for each mode)	20 kA	-
	h) Voltage protection level $U_p$	2.0 kV	-
	j) Degree of protection if > IP20	-	-
	l) Maximum overcurrent protection	- A	-
	o) Identification of terminals, if necessary	L1, L2, L3, N, GND	-
	q) Type of current	a.c	-
	<b><u>Information provided by the manufacturer</u></b>		
	b) Location category	Indoor & outdoor	-
	c) Number of ports	ONE port	-
	d) Method of mounting	fixed	-
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Clause	Requirement - Test	Result	Verdict
	i) Rated load current $I_L$ , if required	No	-
	k) Short circuit withstand	10 kA	-
	m) Indication of disconnector operation, if any	Indicator light	-
	n) position of normal use, if significant	No	-
	p) Installation instructions (type of LV systems: TN, TT, IT etc , connections to LV systems and rated system voltages for which the SPD is designed, mechanical dimensions, lead lengths, etc..)	TT, TN	-
	r) Specific energy W/R for Type 1 SPDs (class I test)		-
	s) Temperature range	normal	-
	t) Follow current interrupting rating (except in case of voltage limiting SPDs)	-	-
	u) External SPD disconnector requirements	-	-
	v) Residual current (optional)	-	-
	w) Temporary overvoltage characteristic at $U_T$	<i>withstand</i>	-
	x) Total discharge current /Total for multipole SPDs (if declared by the manufacturer)	-	-
	Markings indelible and legible, not placed on screws and removable washers		P
7.2.2	Test applied to markings not made by impressing, molding or engraving:  15s rubbing by hand with cotton soaked with - water - aliphatic solvent hexane	Sticker marking	P
	After test marking easily legible		P
6.2.1/7.3	<b>Terminals and Electrical connections</b>		

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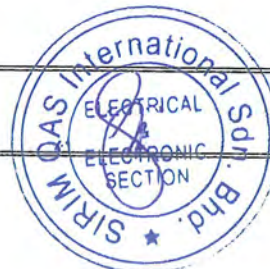


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**TEST SEQUENCE 1**

Clause	Requirement - Test	Result	Verdict
	Terminals designed for connection of cables with min. and max. cross section acc. to manufacturers declaration	min. 4 mm <sup>2</sup> max. 10 mm <sup>2</sup>	P
	Terminals allow connection by means of screws, nuts, plugs, sockets, screwless terminals, insulation piercing connections or equal effective means	Yes	P
7.3.1	SPD mounted according to the manufacturer's recommendation and protected against undue external heating or cooling	Yes	P
	SPD terminals wired with conductors according to: – table 6 for two-port devices and one-port devices with separate input/output terminals – the manufacturer's instruction for other one-port devices	4 to 10 mm <sup>2</sup>	P
	Sample fixed on a dull, black-painted wood board of about 20 mm thickness		P
	Method of fixing complies with any requirements relating to the means of mounting recommended by the manufacturer	Yes	P
	SPDs tested according to class I and one-port SPDs with a nominal discharge current $\geq 5$ kA tested according to class II shall be capable of clamping conductors up to a cross-section of at least 4 mm <sup>2</sup>		N
	During the test no maintenance or dismantling of the sample		P
7.3.2	<b>Terminals with screws</b>		
7.3.2.1	Test of reliability of screws, current-carrying parts and connections		P

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Clause	Requirement - Test	Result	Verdict
	Screws which are operated when connecting up the SPD are tightened and loosened: - ten times for screws in engagement with a thread of insulating material - five times in all other cases	5 times	N P
	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
	Test made by means of a suitable test screwdriver or spanner applying a torque as shown in table 5	3.88 mmØ 1.2 Nm	P
	The screws are not tightened in jerks, the conductor is moved each time the screw is loosened		P
	During the test, the screwed connections do not work loose and there is no damage, such as breakage of screws or damage to the head slots, threads, washers or stirrups, that impairs the further use of the SPD	No damage	P
	Enclosures and covers are not damaged - verification by visual inspection	No damage	P
7.3.2.2	<b>Test of reliability of terminals for external conductors</b>		
	Tests are made by means of a suitable screwdriver or spanner applying a torque as shown in table 5	3.88 mmØ 1.2 Nm	P
7.3.2.2.1	The terminals are fitted with copper conductors of the smallest or largest cross-sectional areas specified in 7.3.1, solid or stranded, whichever is most unfavourable	min. 4 mm <sup>2</sup> max. 10 mm <sup>2</sup>	P

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**TEST SEQUENCE 1**

Clause	Requirement - Test	Result	Verdict
	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 most likely to assist the wire to escape		P
	The clamping screws are tightened with a torque equal to two-thirds of that shown in the appropriate column of table 5	3.88 mm $\emptyset$ 0.8 Nm	P
	Each conductor is subjected to a pull of the value, in newtons, shown in table 7, the pull is applied without jerks, for 1 min, in the direction of the axes of the conductor space	60 N	P
	During the test, the conductor shall not move noticeably in the terminal		P
7.3.2.2.2	The terminals are fitted with copper conductors of the smallest or largest cross-sectional areas specified in 7.3.1 solid or stranded, whichever is the most unfavourable	min. 4 mm <sup>2</sup> max. 10 mm <sup>2</sup>	P
	The terminal screws are tightened with a torque equal to two-thirds of that shown in the appropriate column of table 5 - the terminal screws are then loosened and the part of the conductor which may have been affected by the terminal is inspected	3.88 mm $\emptyset$ 0.8 Nm	P
	The conductors shows neither undue damage nor severed wires - conductors show no deep or sharp indentations		P
	During the test, terminals do not work loose and there is no damage such as breakage of screws or damage to the head slots, threads, washers or stirrups, that impairs the further use of the terminal		P
7.3.2.2.3	The terminals are fitted with a rigid stranded copper conductor conforming to table 8, before insertion in the terminal, the wires of the conductors are suitably reshaped	10 mm <sup>2</sup>	P

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**TEST SEQUENCE 1**

Clause	Requirement - Test	Result	Verdict
	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		P
	The clamping screw or nut is tightened with a torque equal to two-thirds of that shown in the appropriate column of table 5	3.88 mm $\varnothing$ 0.8 Nm	P
	After the test, no wire of the conductor has escaped from the SPD terminal		P
7.3.3	<b>Screwless terminals</b>		
	The terminals are fitted with new conductors of the type and of the minimum and maximum cross-sectional areas specified under 7.3.1, solid or stranded whichever is the most unfavourable.	All terminals are screw-type	N
	Each conductor is subjected to a pull of the value shown in table 9, the pull is applied without jerks for 1 min in the direction of the axis of the conductor		N
	During the test there is no movement of the conductor in the terminal or any indication of damage		N
7.3.4	<b>Insulation pierced connections</b>		
7.3.4.1	Pull out test on SPD terminals designed for single core conductors:		N
	The terminals are fitted with new copper conductors of the smallest or largest cross-sectional area specified in 7.3.1. solid or stranded, whichever is most unfavourable		N
	Screws, if any, are tightened according to table 5		N
	The conductors are connected and disconnected five times, new conductors being used each time		N

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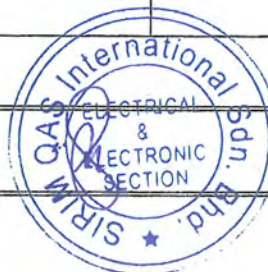


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Clause	Requirement - Test	Result	Verdict
	After each connection the conductors are subjected to a pull, without jerks, for 1 min in the axis of the tapping conductor according to the value given in table 9		N
	During the test, there is no movement of the conductor in the terminal or any sign of damage		N
7.3.4.2	Pull out test on SPD terminals designed for multi-core cables or cords:		N
	The pull-out test on the SPD terminals designed for multi-core cables or cords is carried out according to 7.3.4.1 except that the pull force is applied to the entire multicore cable or cord instead of to the individual core		N
	Screws, if any, are tightened according to table 5		N
	The pull force is calculated according to the following formula:  $F = F(x)\sqrt{n}$ <p><i>F</i> is the total force to apply  <i>n</i> is the number of cores  <i>F(x)</i> is the force for one core according to the cross-section of one conductor (see table 9)</p>		N
	During the test, the cable or cord does not slip out of the terminal		N
7.3.5	<b>Nuts, plug, socket</b>		
	Compliance is checked by inspection and trial mounting		P
6.3.2	<b>Mechanical connections</b>		
	Terminals are fastened to the SPD in such a way that they do not work loose if the clamping screws or the lock nuts are tightened or loosened. A tool is required to loosen the clamping screws or the lock nuts		P

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Clause	Requirement - Test	Result	Verdict
	1) Terminals for external conductors are such that the conductors may be connected so as to ensure that the necessary contact pressure is maintained permanently		P
	Arrangements either of the plug-in or of the bolt-on type		P
	Terminals are readily accessible under the intended conditions of use		P
	2) The means for clamping the conductors in the terminals do not serve to fix any other component, although they may hold the terminals in place or prevent them from turning		N
	3) Terminals have adequate mechanical strength, screws and nuts for clamping the conductors have a metric ISO thread or a thread comparable in pitch and mechanical strength		P
	Provisionally, SI, BA and UN threads may be used as they are virtually equivalent in pitch and mechanical strength to metric ISO threads		P
	4) Terminals shall be so designed that they clamp the conductor without undue damage to the conductor		P
	5) Terminals shall be so designed that they clamp the conductor reliably and between metal surfaces		P
	6) 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 - this requirement does not apply to lug terminals		P

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**TEST SEQUENCE 1**

Clause	Requirement - Test	Result	Verdict
	<p>7) Terminals are so fixed or located that, when the clamping screws or nuts are tightened or loosened, the terminals do not work loose from their fixings to the SPDs</p> <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>		P
	<p>The use of sealing compound or resin is considered to be sufficient for preventing a terminal from working loose, provided that:</p> <ul style="list-style-type: none"> <li>- the sealing compound or resin is not subject to stress during normal use, and</li> <li>- the effectiveness of the sealing compound or resin is not impaired by temperatures attained by the terminal under the most unfavourable conditions specified in this standard</li> </ul>		N
	8) Clamping screws or nuts of terminals intended for the connection of protective conductors are adequately secured against accidental loosening		P
<b>Screwless terminals for external conductors:</b>			
	<p>1) Terminals are so designed and constructed that</p> <ul style="list-style-type: none"> <li>- each conductor is clamped individually. During the connection or disconnection the conductors can be connected or disconnected either at the same time or separately</li> <li>- it is possible to clamp securely any number of conductors up to the maximum provided</li> </ul>		N
	2) Terminals shall be so designed and constructed that they clamp the conductor without undue damage to the conductor		N
<b>Insulation pierced connections for external conductors:</b>			

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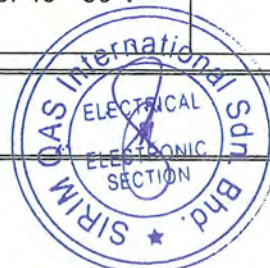


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**TEST SEQUENCE 1**

Clause	Requirement - Test	Result	Verdict
	1) The insulation pierced connections shall make a reliable mechanical connection		N
	2) Screws for making contact-pressure do not serve to fix any other component, although they may hold the SPD in place or prevent it from turning		N
	3) Screws are not be of metal which is soft or liable to creep		N
6.3.3	<b>Corrosive resistant metals</b>		
	Clamps, except clamping screws, lock nuts, binding clip thrust washers, wire, and similar, consist of corrosion resistant metal such as copper, brass, etc. (see IEC 60999)	_____	P
6.5.1	<b>Protection against direct contact</b>		
	Test applied to SPDs with $U_c > 50$ V r.m.s. a.c. or d.c.		P
	Live parts cannot be touched when installed for intended use - tested acc. to IEC 60529	_____	N
	Live parts of SPDs classified accessible are not accessible when wired and mounted for normal use, even after removal of parts which can be removed without the use of a tool		N
7.4.1	Sample mounted as for normal use and fitted with conductors of smallest cross section and largest cross section acc. to 7.3.1	min. 4 mm <sup>2</sup> max. 10 mm <sup>2</sup>	P
	Standard test finger applied in every possible position		P
	For plug in SPDs changeable without a tool the test finger is applied in every possible position when the plug is partially engaged or completely engaged with a socket		N
	Electrical indicator with test voltage of 40 - 50 V shows no contact		P

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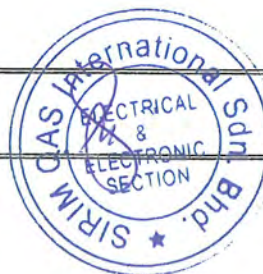




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<b>TEST SEQUENCE 1</b>			
Clause	Requirement - Test	Result	Verdict
7.4.2	Metal parts which are accessible when the SPD is wired and mounted as for normal use are connected to earth, except small screws and the like which are isolated from live parts		P
	Test of earth connections with 1,5 times rated load current or 25 A, whichever is greater, passed between the earthing terminal and each of the accessible metal parts in turn	25 A	P
	Resistance does not exceed 0,05 $\Omega$	0.006 $\Omega$	P
6.5.3/6.5.4/ 7.7.5	<b>Standby Power Consumption and Residual Current Test</b>		
	<p>The SPD is connected to a voltage source at its maximum continuous operating voltage (<math>U_c</math>) according the manufacturers instruction. The Apparent Power (Volt-Amperes) consumed by the SPD is measured. The current at the PE terminal is called the residual current..</p> <p>Notes</p> <p>1: If the manufacturer allows more than one configuration for the SPD installation, this test should be performed for every configuration.</p> <p>2: The true r.m.s. current value is measured.</p>	<p>275 V</p> <p>6.85 VA</p> <p><math>I_{PE}</math> 0.001 A</p>	P

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<b>TEST SEQUENCE 2</b>				
Clause	Requirement - Test	Result		Verdict
6.2.2	<b>Voltage protection level <math>U_p</math></b> <b>Measured limiting voltage</b>			
	Measured limiting voltage does not exceed the protection level specified by the manufacturer			P
7.5.	SPDs tested acc. to class I and II perform 7.5.2			P
	SPDs tested acc. to class I and II containing switching components perform 7.5.3 in addition			P
	SPDs tested acc. to class III perform 7.5.4 or 7.5.5			N
	One port SPDs are tested unenergized			P
	Two port SPDs are tested energized at $U_c$ with a source having a nominal current $\geq 5$ A			N
	For a one-port SPD having terminals, the test is performed without external disconnectors and the measured limiting voltage is measured at the terminals. For a one-port SPD having connecting leads, the measured limiting voltage is measured with an external lead length of 150 mm.			N
	For a two-port SPD, and a one-port SPD having separate load terminals, the measured limiting voltage is measured at the load port or load terminals of the SPD.			N
	Measured limiting voltage = highest value measured	1.59 kV (L1 – N) 1.06 kV (N – G)		P
7.5.2	<b>Residual voltage with 8/20 current impulse</b>			
	Test with current impulses of	L1 – N	N – G	P
	1,0 times $I_n = 10$ kA	1.59 kV	1.06 kV	
	With one sequence of positive and one sequence of negative polarity	+1ve, 1-ve		P

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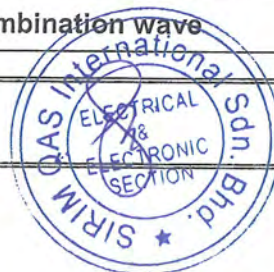


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**TEST SEQUENCE 2**

Clause	Requirement - Test	Result	Verdict
	Finally one impulse at $I_{max}$ or $I_{peak}$ if $I_{max}$ or $I_{peak} > I_n$ with polarity that showed higher residual voltages during previous tests	65 kA	P
	Time interval between impulses long enough for sample to cool down to ambient		P
	Current -voltage oscillograms		P
	Discharge current - residual voltage diagram showing peak values	see Annex 1	P
	Value for determination of the measured limiting voltage = highest voltage on the curve corresponding to: - $I_{peak}$ or $I_n$ whichever is greater for class I test - $I_n$ for class II test	1.59 kV (L1 – N) 1.06 kV (N – G)	P
7.5.3	<b>Front-of-wave sparkover voltage</b>		
	The 1,2/50 voltage impulse is used. The generator voltage is set to an open circuit output voltage of 6 kV	N - GND	P
	10 impulses applied to the SPD, five of positive and five of negative polarity	10 +ve, 10 –ve	P
	Time interval between impulses long enough for sample to cool down to ambient		P
	If sparkover is not observed during any of the 10 impulses on the front of the wave, then the above procedure is repeated, but with a generator open circuit output voltage of 10 kV.	Sparkover observed	N
	Voltage oscillograms	see Annex 2	P
	Value for determination of the Measured limiting voltage is the maximum value of the sparkover voltages recorded during the whole test sequence	1.15 kV	P
7.5.4	<b>Measured limiting voltage with combination wave</b>		

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**TEST SEQUENCE 2**

Clause	Requirement - Test	Result	Verdict
	Sample energised at $U_c$		N
	For a.c. rated SPDs positive impulses are applied at $90^\circ \pm 10^\circ$ el point and negative impulses at $270^\circ \pm 10^\circ$ el point of the sinusoidal voltage wave		N
	Time interval between impulses long enough for sample to cool down to ambient		N
	Test with voltage settings of: 0,1 times $U_{oc}$ _____ kV 0,2 times $U_{oc}$ _____ kV 0,5 times $U_{oc}$ _____ kV 1,0 times $U_{oc}$ _____ kV		N
	With four surges, two of positive and two of negative polarity, applied at each setting		N
	Current -voltage oscillograms	see Annex 1	N
	Value for determination of the Measured limiting voltage = maximum peak voltage recorded		N

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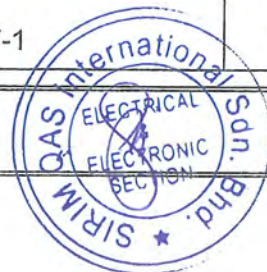


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**TEST SEQUENCE 3**

Clause	Requirement - Test	Result		Verdict
6.2.6/7.6	<b>Operating duty test</b>			
	Determination of the measured limiting voltage:			
	SPDs tested acc. to class I and II: Residual voltage acc. to 7.5.2 at $I_n$ only with one positive and one negative impulse applied	L - N 1.59 kV	N - G 1.06 kV	P
	SPDs tested acc. to class I and II containing switching components: Sparkover voltage acc. to 7.5.3 All measured peak values (5 pos./ 5 neg.) below $U_p$	N - GND 1.15 kV		P
	SPDs tested acc. to class III: Measured limiting voltage acc. to 7.5.4 or 7.5.5 at $U_{oc}$ only with four surges (2 pos./ 2 neg.)			N
7.6.3	<b>Power frequency source for preconditioning:</b>			P
	Sample connected to power frequency source at $U_c$	275 V; 255 V		P
	SPDs with follow current < 500 A: Voltage at the SPD terminals does not fall below the peak value of $U_c$ by more than 10% during flow of follow current			P
	SPDs with follow current > 500 A: 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 11, or 500 A, whichever is greater. For SPDs connected between neutral and protective earth only, the prospective short-circuit current shall be at least 100 A. Recovery voltage acc. to IEC 60947-1	$\gamma = \underline{\hspace{2cm}}$ $f_\gamma = \underline{\hspace{2cm}}$ Hz		N  N

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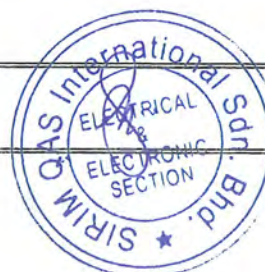


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**TEST SEQUENCE 3**

Clause	Requirement - Test	Result	Verdict
7.6.4	<b>Class I and II preconditioning test</b>		
	15 current impulses 8/20 of positive polarity in 3 groups of 5 impulses, peak value equal to $I_n$ or $I_{peak}$ , whichever is greater, each impulse synchronized to the power frequency, starting from $0^\circ$ el the sync. angle is increased in steps of $30^\circ \pm 5^\circ$ , time interval between the impulses 50s - 60s time interval between the groups 25min - 30min	L1 - N, N - GND 20 kA  sync. $0^\circ, 30^\circ, 60^\circ, 90^\circ, 120^\circ, 150^\circ, 180^\circ, 210^\circ, 240^\circ, 270^\circ, 300^\circ, 330^\circ, 0^\circ, 30^\circ, 60^\circ$ el	P
	Current records show no sign of puncture or flashover of the sample		P
7.6.7	<b>Class III preconditioning test</b>		
	Power frequency source according to 7.6.3, Combination wave generator adjusted to $U_{oc}$  15 impulses of positive polarity in 3 groups of 5 impulses, peak value equal to $U_{oc}$ , each impulse synchronized to the power frequency voltage at the corresponding positive peak value time interval between the impulses 50s - 60s time interval between the groups 25min - 30min		N
	Current records show no sign of puncture or flashover of the sample	see Annex 4	P
7.6.5	<b>Class I and II operating duty test</b>		
	SPD energized at $U_c$ by a voltage source having a nominal current capability of $\geq 5$ A	275 V  100 A	P
	Power frequency voltage remains applied for 30min after each impulse to prove thermal stability		P

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**TEST SEQUENCE 3**

Clause	Requirement - Test	Result	Verdict
	Test with current impulses of positive polarity initiated in the corresponding positive peak value of the power frequency voltage, one impulse for each value: 0,1 times $I_{max}$ for class II test 0,25 times $I_{max}$ for class II test 0,5 times $I_{max}$ for class II test 0,75 times $I_{max}$ for class II test 1,0 times $I_{max}$ for class II test	L1 – N, N - G 6.5 kA 16.25 kA 32.5 kA 48.75 kA 65 kA	P
	After each impulse cool down to ambient temperature		P
7.6.7	<b>Class III operating duty test</b>		
	SPD energized at $U_c$ by a voltage source having a nominal current capability of $\geq 5$ A		N
	Power frequency voltage remains applied for 30min after each impulse to prove thermal stability		N
	Test with impulses of positive polarity initiated in the corresponding positive peak value of the power frequency voltage: 0,1 times $U_{oc}$ 0,25 times $U_{oc}$ 0,5 times $U_{oc}$ 0,75 times $U_{oc}$ 1,0 times $U_{oc}$		N
	After each impulse cool down to ambient temperature		N
7.6.6	<b>Pass criteria</b>		
	After each impulse thermal stability		P

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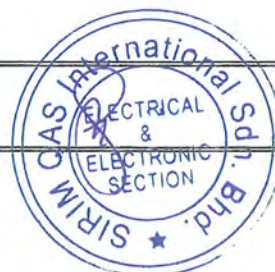


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**TEST SEQUENCE 3**

Clause	Requirement - Test	Result		Verdict
	Any follow current is self extinguished			P
	Voltage and current records and visual inspection show no indication of puncture or flashover and no mechanical damage of the sample	see Annex 3		P
	No mechanical damage			P
	One more impulse at $I_n$ or $U_{OC}$ shall be applied to the SPD whilst the SPD is energized at $U_C$ by means of a voltage source having a nominal current capability of at least 5 A. After this impulse, $U_C$ remains applied and thermal stability shall be achieved within 30 min.  Once thermal stability is achieved, either: <ul style="list-style-type: none"> <li>the current which flows through the test sample is measured. Its resistive component (measured at the crest of the sine wave) shall not exceed a value of 1 mA.</li> </ul> or <ul style="list-style-type: none"> <li>the stand-by power consumption shall not be greater than 20% above the value measured in 7.7.5</li> </ul> Following this complete test sequence and after the sample has cooled down to near ambient temperature, the measured limiting voltage test, which was made at the beginning of the test sequence, shall be repeated.	20 kA		P
			< 1 mA	P
				N
				P
	SPDs tested acc. to class I and II:	L1 - N	N - G	P
	Residual voltage acc. to 7.5.2 at $I_n$ only with one positive and one negative impulse applied	1.61	1.08	

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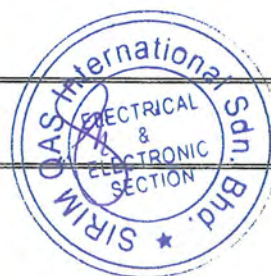


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**TEST SEQUENCE 3**

Clause	Requirement - Test	Result	Verdict
	SPDs tested acc. to class I and II containing switching components:  Sparkover voltage acc. to 7.5.3  All 10 measured peak values (5 pos./ 5 neg.) below $U_p$	N – G   1.16 kV	P
	SPDs tested acc. to class III:  Measured limiting voltage acc. to 7.5.4 or 7.5.5 at $U_{oc}$ only with four surges (2 pos./ 2 neg.)		N
7.7.1	No SPD disconnecter has operated during the test and they are in working order after the test.		P
	Values of measured limiting voltage test measured before and after the test are below or equal to $U_p$		P

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**TEST SEQUENCE 4**

Clause	Requirement - Test	Result	Verdict
7.9.10	<b>Class I and II total discharge current for multipole SPDs</b>		
	<p>One side of the test generator is connected to the PE or PEN terminal of the multipole SPD.</p> <p>Each of the remaining terminals is connected via typical series impedance consisting of a resistance of 30 mΩ and an inductance of 25 μH, to the other side of the generator.</p> <p>Smaller impedances may be used if the tolerances for the proportional surge currents according to Table 18 are met.</p>		N
	The multipole SPD is tested once with the total discharge current $I_{Total}$ declared by the manufacturer	_____ kA	N
	Pass criteria:		
	<p>Each mode of the test sample is connected to UC. The test transformer shall have a short-circuit current capability of at least 200 mA.</p> <p>The current, which flows through the test sample, is measured.</p> <p>Its resistive component (measured at the crest of the sine wave) shall not exceed a value of 1 mA</p> <p>or</p> <p>the stand-by power consumption shall not increase by more than 20 % of the value measured in 7.7.5.</p>		N
	<p>SPDs tested acc. to class I and II:</p> <p>Residual voltage acc. to 7.5.2 at <math>I_n</math> only with one positive and one negative impulse applied</p>	_____ kA / _____ V	N

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**TEST SEQUENCE 4**

Clause	Requirement - Test	Result	Verdict
	SPDs tested acc. to class I and II containing switching components: Sparkover voltage acc. to 7.5.3 Average of 10 measured peak values (5 pos./ 5 neg.)		N
	Values of measured limiting voltage test measured before and after the test are below or equal to $U_p$		N
	Auxiliary circuits, like status indicators, are in working order.		N
	Visual inspection of the test sample shows no evidence of any damage.		N

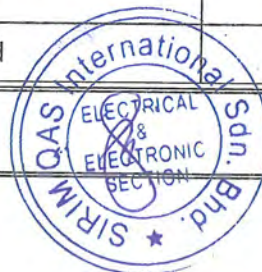
**For TEST SEQUENCES 5, 6 and 7**

Clause	Requirement - Test	Result	Verdict
6.2.7/7.7	<b>SPD disconnectors and safety performance of overstressed SPDs</b>		
	SPD disconnector operation is indicated		N
	SPD disconnectors tested with the SPD during the type tests of 7.7 and 7.8.3, except for RCDs which are not tested during operating duty test according to 7.7.1.		P

**TEST SEQUENCE 5**

Clause	Requirement - Test	Result	Verdict
7.7.2	<b>Test of thermal stability of SPDs</b>		
7.7.2.1	<b>Temperature withstand test</b>		
	SPD kept in a heating cabinet at an ambient temperature of $(80 \pm 5)^\circ\text{C}$ for 24 h		P
	No SPD disconnector has operated		P

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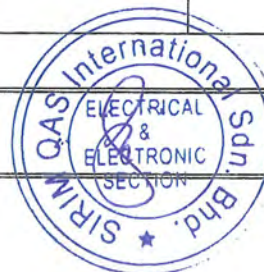


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**TEST SEQUENCE 5**

Clause	Requirement - Test	Result	Verdict
7.7.2.2	<b>Thermal stability test</b>		
	This test is not performed on SPDs containing only voltage switching components.		
	Any voltage switching component, which is connected in series with a voltage limiting component, is short-circuited by a copper wire with a diameter such that it does not melt during the test.		P
	For SPDs with different non-linear components connected in parallel, this test is performed for every current path of the SPD by disconnecting/interrupting all the remaining current paths.  If components of the same type and parameters are connected in parallel, they shall be tested as one current path.		P
	<b>Test for SPDs having no switching components in series with other components - Procedure a)</b>		
	Sample connected to a power frequency source with a voltage high enough to drive a constant current, which is increased by the following steps - 2 mA or 5 % of the previously adjusted test current, whichever is greater - with a tolerance of $\pm 10\%$ :  Start 24.9 mA r.m.s. or corresponding crest value End 123 mA r.m.s. or corresponding crest value	duration  10 min  15 min	P
	Each step is maintained until thermal equilibrium is reached - temperature variation $< 2$ K within 10 min		P
	Surface temperature of the hottest spot and current through the SPD are monitored continuously		P

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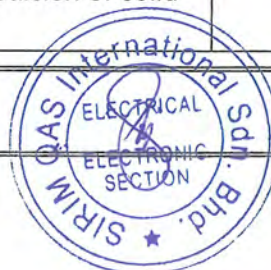


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**TEST SEQUENCE 5**

Clause	Requirement - Test	Result	Verdict
	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 disconnector(s).		P
	If the voltage across the SPD falls below $U_c$ during the test, the current regulation is discontinued and the voltage is adjusted back to $U_c$ (EN 61643-11 $\rightarrow U_{cs}$ ) 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.	275 V	P
<b>Test for SPDs having switching components in series with other components - Procedure b)</b>			
	SPD energized with a power frequency source at $U_C$ having a short-circuit current capability which 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
	If no significant current flows - further testing acc to Procedure a)		N
<b>Pass criteria</b>			
	Indoor SPDs:  Surface temperature always less than 120°K during test and less than 80°K, 5min after disconnector operation	max 22.3 K  $\leq 21.9$ K after 5min	P
	Outdoor SPDs:  No evidence of burning and no expulsion of solid material		P

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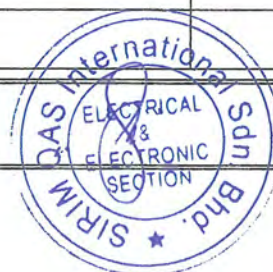
**TEST SEQUENCE 5**

Clause	Requirement - Test	Result	Verdict
	Accessible SPDs: SPDs having an IP degree $\geq$ 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		P
	For disconnectors having operated there is clear evidence of effective and permanent disconnection - checked with power frequency voltage equal to $U_C$ applied for 1min - current flow $\leq$ 0,5 mA r.m.s	275 V < 5 mA	P

**TEST SEQUENCE 6**

Clause	Requirement - Test	Result	Verdict
6.2.11/7.7.3	<b>Short circuit withstand capability</b>		
	This test is not applied to SPDs, which are either – classified for outdoor use and mounted out of reach, – for connection N-PE in TN- and/or TT-systems only		P
	Test sample mounted in accordance with the manufacturer's published recommendations and connected with conductors of the maximum cross section according to 7.3.1, keeping the cables inside the box to a maximum length of 0,5 m each		P
	SPD, disconnectors placed in a cube shaped wooden box whose sides are 50cm $\pm$ 5cm away from the SPD external surfaces		P
	The internal surface of the box covered with tissue paper or cheese cloth, one box side (not the bottom) remains open for connecting supply cables	front open	P
	Sample Preparations:		

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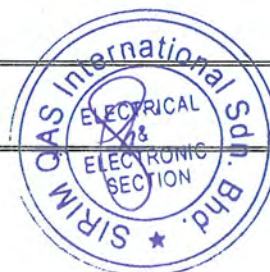


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**TEST SEQUENCE 6**

Clause	Requirement - Test	Result	Verdict
	For SPDs with non-linear components connected in parallel, separate sets of three samples are prepared in the manner described below for every current path of the SPD, which contains one or more non-linear components described in 3.4 and 3.5.	L - N	P
	Voltage limiting components and voltage switching components described in 3.4 and 3.5 are replaced by appropriate copper blocks, (dummies), ensuring that the internal connections and their cross-section and surrounding material (e.g. resins) and packaging are not changed.	Link with copper block	P
	Test procedure:		
	Test performed at two different test settings with a separate set of prepared test samples for each setting a) and b)		P
	<b>a) Test of the declared short circuit withstand capability</b> Power frequency source at <i>UC</i> , having a prospective shortcircuit current according to the declared short-circuit withstand capability and power factor according to Table 11	465 V 10 kA cos phi = 0.47	P
	Test carried out twice with the short-circuit initiated at 45 electrical degrees and at 90 electrical degrees after the zero crossing of the voltage. If a replaceable or resettable internal or external disconnecter operates, the relevant disconnecter shall be replaced or reset each time. If the disconnecter cannot be replaced or reset, the test is stopped.	45 °, 90 °	P

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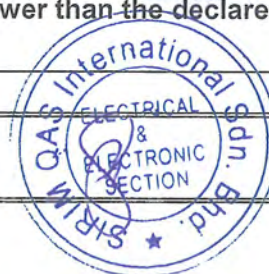


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**TEST SEQUENCE 6**

Clause	Requirement - Test	Result	Verdict
	<p><b>b) Test at low short-circuit current</b></p> <p>Power frequency source at <math>U_C</math>, 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 11, shall be applied for <math>5\text{ s} \pm 0,5\text{ s}</math>.</p> <p>If no external overcurrent protection is required by the manufacturer, a prospective short-circuit current of 300 A is used. The test is carried out once with the short-circuit initiated at 45 electrical degrees after the zero crossing of the voltage.</p>	<p>465 V</p> <p>5 times max. overc. Prot. = 1200 A</p> <p>cos phi = 0.9</p>	<p>P</p> <p>P</p>
	Pass criteria:		
	During the test for the short circuit withstand capability, the power short-circuit current shall be interrupted by one of the disconnectors (internal or external) required by the manufacturer		P
	<p><i>Internal and/or special disconnectors not covered by another IEC standard:</i></p> <p>There shall be clear evidence of effective and permanent disconnection. To check this power frequency voltage equal to <math>U_C</math> is applied for one minute to the disconnector(s) having operated. The current flow shall not exceed 0.5mA r.m.s.</p>	< 0.5 mA	P
	During the test the muslin paper or cheese cloth does not catch fire	No burn	P
	<p>Accessible SPDs:</p> <p>SPDs having an IP degree <math>\geq</math> 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</p>		N
7.7.3.1	<b>Additional test for SPDs with <math>I_{fi}</math> lower than the declared short-circuit withstand capability</b>		

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**TEST SEQUENCE 6**

Clause	Requirement - Test	Result	Verdict
	<p>Tests according to 7.7.3 repeated, but without voltage switching components being short-circuited.</p> <p>The short-circuit is initiated by triggering the SPD with a positive surge current (8/20 or other appropriate waveshape) at 30 to 40 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 <math>I_n</math>.</p>		N
	To ensure that no external disconnecter operates due to the trigger surge, all external disconnectors placed in series with the power frequency source as shown in Figure 6a.		N
	Test procedure:		
	Test performed at two different test settings with a separate set of new test samples for each setting a) and b)		N
	a) Power frequency source at $U_C$ , having a prospective shortcircuit current according to the declared short-circuit withstand capability and power factor according to Table 11		N
	Recovery voltage according to IEC 60947-1		N
	Test carried out twice with the short-circuit initiated at 45 electrical degrees and at 90 electrical degrees after the zero crossing of the voltage. If a replaceable or resettable internal or external disconnecter operates, the relevant disconnecter shall be replaced or reset each time. If the disconnecter cannot be replaced or reset, the test is stopped.		N

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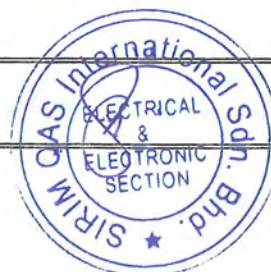


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**TEST SEQUENCE 6**

Clause	Requirement - Test	Result	Verdict
	b) Power frequency source at $U_C$ , 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 11, shall be applied for $5\text{ s} \pm 0,5\text{ s}$ .		N
	If no external overcurrent protection is required by the manufacturer, a prospective short-circuit current of 300 A is used. The test is carried out once with the short-circuit initiated at 45 electrical degrees after the zero crossing of the voltage.		N
	Pass criteria:		
	During the test for the short circuit withstand capability, the power short-circuit current shall be interrupted by one of the disconnectors (internal or external) required by the manufacturer		N
	<i>Internal and/or special disconnectors not covered by another IEC standard:</i>  There shall be clear evidence of effective and permanent disconnection. To check this power frequency voltage equal to $U_C$ is applied for one minute to the disconnector(s) having operated. The current flow shall not exceed 0.5mA r.m.s.		N
	During the test the muslin paper or cheese cloth does not catch fire		N
	Accessible SPDs:  SPDs having an IP degree $\geq$ 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

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<b>TEST SEQUENCE 7</b>			
Clause	Requirement - Test	Result	Verdict
7.7.6	<b>Test under TOVs caused by faults in the low voltage system</b>		
	If $U_C$ is greater or equal to $U_T$ there is no requirement for testing.	$U_C = 275V$	P
7.7.6.1	Test procedure:		
	New set of samples used and fitted as in normal use according to the manufacturer's instructions.		P
	The surge protective device is placed in a cuboid wooden box whose sides are $500\text{ mm} \pm 50\text{ mm}$ away from the SPD external surfaces. The internal surface of the box is covered with muslin paper or cheese cloth. One of the box sides (not the bottom) remains open in order that the supply cables can be connected according to the manufacturer's instructions.	front open	P
	The test sample is connected for a duration of $t_T = 5\text{ s}^{+5}/_{-0}\%$ to a power frequency voltage of $U_T^{+0}/_{-5}\%$ as given in Table B.1, or greater TOV-voltages which the manufacturer has declared in accordance with item w) of 6.6.1.  This voltage source shall be capable of delivering a current either high enough to ensure that the voltage at the SPD terminals does not fall below $U_T - 5\%$ during the test or at the declared short circuit withstand of the SPD, whichever is lower.	409 V (L1 – G) 348 V (L1 – N)	P
	Immediately following the application of $U_T$ a voltage equal to $U_{CS} +0,-5\%$ with the same current capability, is applied to the test sample for a period of 30 min. The time interval between the test periods shall be as short as possible and in any case not exceed 100ms.	264 V  < 100 ms	P
7.7.6.2	Pass criteria:		
	The muslin paper or cheese cloth did not catch fire during the test.		P

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**TEST SEQUENCE 7**

Clause	Requirement - Test	Result	Verdict
	SPDs having an IP degree equal or greater than IP20 do not have live parts accessible with the standardized test finger applied with a force of 5 N (see IEC 60529), except for those live parts which were already accessible before the test when the SPD is fitted as in normal use.		P
a)	TOV failure mode : If a disconnecter has operated, there shall be clear evidence of effective and permanent disconnection by the device. To check this, a power frequency voltage equal to <i>UC</i> is applied for 1 min without current flow in excess of 0,5 mA r.m.s.	_____ mA	N
b)	TOV withstand mode : -The SPD has maintained thermal stability during the application of <i>UCS</i> (following the application of <i>UT</i> ). The SPD is considered to be thermally stable if the current flowing through it or its power dissipation does not continue to increase during the total time of application of <i>UCS</i> . -The test sample is then connected to <i>UC</i> . The test transformer shall have a short circuit current capability of at least 200 mA. The current, which flows through the test sample, is measured. Its resistive component (measured at the crest of the sine wave) shall not exceed a value of 1 mA or the stand-by power consumption shall not increase by more than 20 % of the value measured in 7.7.5.	Withstand	P  P  N
	SPDs tested acc. to class I and II: Residual voltage acc. to 7.5.2 at $I_n$ only with one positive and one negative impulse applied	20 kA / 1.3 kV	P

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**TEST SEQUENCE 7**

Clause	Requirement - Test	Result	Verdict
	SPDs tested acc. to class I and II containing switching components:  Sparkover voltage acc. to 7.5.3  Average of 10 measured peak values (5 pos./ 5 neg.)	1.1 kV	P
	SPDs tested acc. to class III:  Measured limiting voltage acc. to 7.5.4 or 7.5.5 at $U_{oc}$ only with four surges (2 pos./ 2 neg.)		N
	Auxiliary circuits, like status indicators, are in working order.		P
	Visual inspection of the test sample shall reveal no evidence of any damage.		P
<b>7.7.4</b>	<b>Test under TOVs caused by faults in the high (medium) voltage system</b>		
	Applied to SPDs connected between live terminals and earth according to table B.1.		P
	New set of samples fitted as in normal use acc. to the manufacturers instructions and connected to a test circuit according to Figure 13 or equivalent.  Equivalent circuit shown in Annex		P
	SPD placed in a cuboid wooden box whose sides are $50\text{cm} \pm 5\text{cm}$ away from the SPD external surfaces		P
	The internal surface of the box covered with muslin paper or cheese cloth, one box side (not the bottom) remains open for connecting supply cables	front open	P

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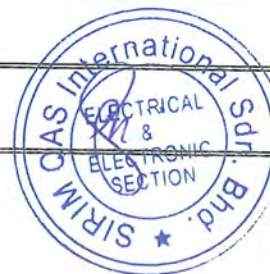


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**TEST SEQUENCE 7**

Clause	Requirement - Test	Result	Verdict
	<p><math>U_T +0/-5\%</math> is applied to the test sample at 90 electrical degrees of phase L1 by closing switch S1. After 200 ms <math>+0/-10\%</math> switch S2 is closed automatically.</p> <p>The prospective short circuit current of the power source for UCS is equal to five times the rated current of the maximum overcurrent protection declared by the manufacturer, or 300 A if no maximum overcurrent protection is declared. The tolerance for the current is <math>+0/-10\%</math>.</p> <p>The prospective short-circuit current delivered by the TOV transformer is adjusted to 300 A <math>+0/-10\%</math>.</p> <p>With the exception of SPDs connected neutral to ground only, UCS remains applied to the test sample for 15 min without interruption until switch S1 is reopened.</p>	<p><math>U_T = 1200\text{ V}</math></p> <p>300 A</p> <p>300 A</p>	P
	Pass criteria:		
	During test muslin paper or equivalent does not catch fire		P
	SPDs having an IP degree equal or greater than IP20 do not have live parts accessible with the standardized test finger applied with a force of 5 N (see IEC 60529), except for those live parts which were already accessible before the test when the SPD is fitted as in normal use.		P
	<p>a) TOV failure mode :</p> <p>If a disconnector has operated, there shall be clear evidence of effective and permanent disconnection by the device.</p> <p>To check this, a power frequency voltage equal to UC is applied for 1 min without current flow in excess of 0,5 mA r.m.s.</p>	_____ mA	N

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**TEST SEQUENCE 7**

Clause	Requirement - Test	Result	Verdict
	<p>b) TOV withstand mode:</p> <p>-The SPD has maintained thermal stability during the application of UCS (following the application of UT). The SPD is considered to be thermally stable if the current flowing through it or its power dissipation does not continue to increase during the total time of application of UCS.</p> <p>-The test sample is then connected to UC. The test transformer shall have a short circuit current capability of at least 200 mA. The current, which flows through the test sample, is measured. Its resistive component (measured at the crest of the sine wave) shall not exceed a value of 1 mA</p> <p>or</p> <p>the stand-by power consumption shall not increase by more than 20 % of the value measured in 7.7.5.</p>	withstand	P
	SPDs tested acc. to class I and II:		P
	Residual voltage acc. to 7.5.2 at $I_n$ only with one positive and one negative impulse applied	10 kA / 1.5 kV	
	SPDs tested acc. to class I and II containing switching components:		P
	Sparkover voltage acc. to 7.5.3		
	Average of 10 measured peak values (5 pos./ 5 neg.)	1.1 kV	
	SPDs tested acc. to class III:		N
	Measured limiting voltage acc. to 7.5.4 or 7.5.5 at $U_{oc}$ only with four surges (2 pos./ 2 neg.)		
	Auxiliary circuits, like status indicators, are in working order.		P
	Visual inspection of the test sample shall reveal no evidence of any damage.		P

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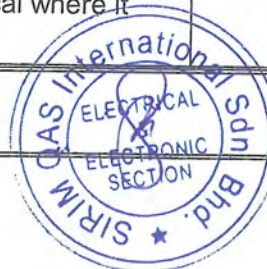


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**TEST SEQUENCE 8**

Clause	Requirement - Test	Result	Verdict
7.9	<b>Additional tests</b>		
7.9.1	<b>Portable SPDs with flexible cables and cords and their connection</b>		
7.9.1.1	Portable SPDs shall be provided with a cord anchorage such that the conductors are relieved from strain, including twisting, where they are connected to the terminals or terminations, and that their covering is protected from abrasion; The sheath, if any, of the cord shall be clamped within the cord anchorage  Compliance is checked by inspection		N
7.9.1.2	The effectiveness of the retention is checked by the following test by means of an apparatus as shown in figure 8		N
	Non-rewireable SPDs are tested as delivered; the test is made on new samples		N
	Rewireable SPDs are tested with the cable having the nominal cross-sectional area as declared by the manufacturer		N
	Conductors of the flexible cable or cord of rewireable accessories are introduced into the terminals, screws being tightened just sufficiently to prevent the position of the conductors from easily changing		N
	The cord anchorage is used in the normal way, clamping screws, if any, being tightened with a torque equal to two-thirds of that specified in table 12	0.8 Nm	N
	After reassembly of the sample, the component parts shall fit snugly and it shall not be possible to push the cable or cord into the sample to any appreciable extent		N
	The sample is placed in the test apparatus so that the axis of the cable or cord is vertical where it enters the sample		N

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**TEST SEQUENCE 8**

Clause	Requirement - Test	Result	Verdict
	<p>The cable or cord is subjected 100 times to a pull of</p> <ul style="list-style-type: none"> <li>- 60 N if the rated current is not more than 16 A and the rated voltage is up to and including 250 V;</li> <li>- 80 N if the rated current is not more than 16 A and the rated voltage is above 250 V;</li> <li>- 100 N if the rated current is more than 16 A.</li> </ul> <p>The pulls are applied practically without jerks each time for 1 s.</p> <p>Care shall be taken to exert the same pull on all parts (core, insulation and sheath) of the flexible cable simultaneously</p>		<p>N</p> <p>N</p> <p>N</p> <p>N</p> <p>N</p>
	<p>For measurement of the longitudinal displacement, a mark is made on the cable or cord while it is subjected to the pull, at a distance of approximately 20 mm from the end of the sample or the cord guard, before starting the tests. If, for non-rewireable accessories, there is no definite end to the sample or the cord guard, an additional mark is made on the body of the sample</p>		N
	<p>After these tests, the displacement of the mark on the cable or cord in relation to the sample or the cord guard is measured while the cable or cord is subjected to the pull</p>		N
	<p>The cable or cord shall not have been displaced by more than 2 mm;</p> <p>For rewireable accessories, the end of the conductors shall not have moved noticeably in the terminals; for non-rewireable accessories, there shall be no break in the electrical connections</p>	_____ mm	N

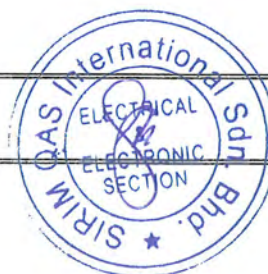
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**TEST SEQUENCE 8**

Clause	Requirement - Test	Result	Verdict
7.9.1.3	<p>Non-rewireable SPDs shall be provided with a flexible cable or cord complying with IEC 60227 and IEC 60245 with a cross-sectional area of the conductors suitable for the maximum rating of the SPD and associated equipment.</p> <p>Compliance is checked by inspection, by measurement, and by checking that the flexible cables or cords are in accordance with IEC 60227 or IEC 60245, as applicable</p>		N
7.9.1.4	<p>Non-rewireable SPDs shall be so designed that the flexible cable or cord is protected against excessive bending where it enters the accessory</p>		N
	<p>Guards provided for this purpose shall be of insulating material and shall be fixed in a reliable manner; Helical metal springs, whether bare or covered with insulating material, shall not be used as core guards</p>		N
	<p>Compliance is checked by inspection and by a flexing test made by means of an apparatus as shown in figure 8. The test is made on new samples.</p>		N

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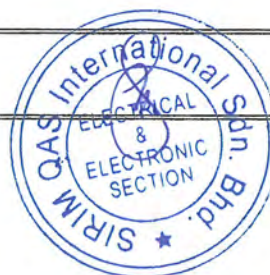


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**TEST SEQUENCE 8**

Clause	Requirement - Test	Result	Verdict
	<p>The sample is fixed to the oscillating mechanism of the apparatus. Therefore when it is in mid-position, the axis of the flexible cable or cord where it enters the sample is vertical; thus passing through the axis of oscillation.</p> <p>The accessory is, by variation of the distance between the fixed part of the oscillating mechanism and the axis of oscillation, so positioned that the cord makes the minimum lateral movement when the oscillating mechanism of the test apparatus is moved over its full length of travel.</p> <p>In order to have the possibility of finding easily by experiment the mounting position with the minimum lateral movement of the cord during the test, the flexing apparatus should be built in such a way that the different supports for the accessories mounted on the oscillating mechanism can be readily adjusted.</p>		N
	<p>Cable or cord is loaded with a mass such that the force applied is</p> <ul style="list-style-type: none"> <li>- 20 N for accessories with cables or cords having a nominal cross-sectional area exceeding 0,75 mm<sup>2</sup>;</li> <li>- 10 N for other accessories</li> </ul>	<p>_____</p> <p>_____</p>	N

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**TEST SEQUENCE 8**

Clause	Requirement - Test	Result	Verdict
	<p>A current equal to the rated current for the accessory or the following current, whichever is the lower, is passed through the conductors:</p> <ul style="list-style-type: none"> <li>- 16 A for accessories with cables or cords having a nominal cross-sectional area exceeding 0,75 mm<sup>2</sup>;</li> <li>- 10 A for accessories with cords having a nominal cross-sectional area of 0,75 mm<sup>2</sup>;</li> <li>- 2,5 A for accessories with cords having a nominal cross-sectional area less the 0,75 mm<sup>2</sup>.</li> </ul>	<p>_____</p> <p>_____</p> <p>_____</p>	N
	The voltage between the conductors is equal to the rated voltage of the sample	_____ V	N
	<p>The oscillating mechanism is moved through an angle of 90° (45° on either side of the vertical), the number of flexings being 10 000 and the rate of flexing 60 per minute.</p> <p>A flexing is one movement, either backwards or forwards.</p>		N
	Samples with circular section cables or cords are turned through 90° in the oscillating mechanism after 5 000 flexings, samples with flat cords are only bent in a direction perpendicular to the plane containing the axes of the conductors		N
	<p>the flexing test, there shall be</p> <ul style="list-style-type: none"> <li>- no interruption of the current,</li> <li>- no short-circuit between conductors.</li> </ul> <p>A short-circuit between the conductors of the flexible cable or cord is considered to occur if the current attains a value equal to twice the test current of the accessory.</p>	<p>_____</p> <p>_____</p>	N

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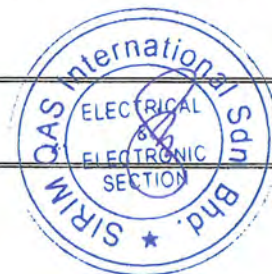


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**TEST SEQUENCE 8**

Clause	Requirement - Test	Result	Verdict
	The voltage drop between each contact and the corresponding conductor, with a test current flowing having a value of the rated current, shall not exceed 10 mV	_____ mV	N
	After the test the guard, if any, shall not have separated from the body and the insulation of the flexible cable or cord shall show no sign of abrasion or wear; broken strands of the conductor shall not have pierced the insulation so as to become accessible		N
6.5.1.1 7.9.2	<b>Mechanical strength</b>		
7.9.2.1	Samples subjected to strikes by means of an impact-test apparatus as shown in figure 9	Pendulum impact test	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 are fixed to the plywood sheet by auxiliary means		P
	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.)  If wood is used for the block, the direction of the wood fibres shall be perpendicular to the direction of the impact		N
	Flush-type screw fixing SPDs are fixed by means of screws to lugs recessed in the block		N
	Flush-type claw fixing SPDs are fixed to the block by means of the claws		N
	Before applying the strikes, fixing screws of bases and covers are tightened with a torque equal to two-thirds of that specified in table 12	0.8 Nm	P

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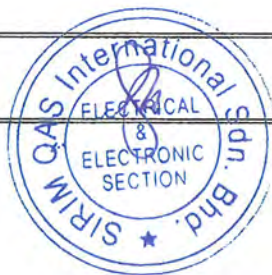


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**TEST SEQUENCE 8**

Clause	Requirement - Test	Result	Verdict
	<p>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 table 13:</p> <p>parts A and B                      h = 100 mm</p> <p>parts C                                      h = 150 mm</p> <p>parts D                                      h = 200 mm</p> <p>A: parts on the front surface, including parts which are recessed.</p> <p>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.</p> <p>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.</p> <p>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>	<p>Front body</p> <p>_____</p> <p>_____</p>	<p>P</p> <p>N</p> <p>N</p>
	<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>		<p>P</p>
	<p>The samples are subjected to strikes which are evenly distributed over the samples. The strikes are not applied to "knock-out" areas</p>		<p>P</p>

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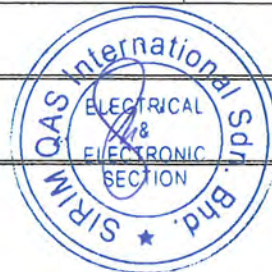


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**TEST SEQUENCE 8**

Clause	Requirement - Test	Result	Verdict
	<p>The following blows are applied:</p> <ul style="list-style-type: none"> <li>– 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;</li> <li>– for parts B (as far as applicable), C and D, four blows: <ul style="list-style-type: none"> <li>• one on one side 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;</li> <li>• one blow on each of the other two sides of the sample, with the plywood sheet turned 60° in the opposite direction.</li> </ul> </li> </ul>	<p>5 blows</p> <p>4 blows</p>	<p>P</p> <p>P</p> <p>P</p>
	<p>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> <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> <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>		P
7.9.2.2	Portable SPDs are tested in a tumbling barrel as shown in figure 10		N

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**TEST SEQUENCE 8**

Clause	Requirement - Test	Result	Verdict
	Rewireable SPDs are fitted with the flexible cable or cord specified by the manufacturer and a free length of approximately 100 mm		N
	Terminal screws and assembly screws are tightened with a torque equal to two-thirds of that specified in table 12	0.8 Nm	P
	Non-rewireable SPDs are tested as delivered, the flexible cable or cord being cut so that a free length of about 100 mm projects from the accessory		N
	The samples fall from a height of 500 mm onto a steel plate, 3 mm thick, the number of falls being the following: <ul style="list-style-type: none"> <li>– 1000 if the mass of the sample without cable or cord does not exceed 100 g;</li> <li>– 500 if the mass of the sample without cable or cord exceeds 100 g, but does not exceed 200 g;</li> <li>– 100 if the mass of the sample without cable or cord exceeds 200 g.</li> </ul>		N N N
	The barrel is turned at a rate of five revolutions per minute, ten falls per minute thus taking place, only one sample is tested in the barrel at a time		N
	After the test, the samples shall show no damage. In particular <ul style="list-style-type: none"> <li>– no part shall have become detached or loosened,</li> <li>– it should not be possible to touch any live parts, even if the standard test finger is applied with a force not exceeding 10 N.</li> </ul>		N N

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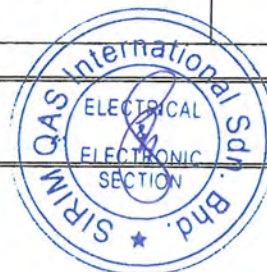


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**TEST SEQUENCE 8**

Clause	Requirement - Test	Result	Verdict
	During the examination after the test, special attention is paid to the connection of the flexible cable or cord; small pieces may be broken off without rejection, provided that the protection against electric shock is not affected		N
	Damage to the finish and small dents which do not reduce the creepage distances or clearances are neglected		N
	SPDs tested acc. to class I and II: Residual voltage acc. to 7.5.2 at $I_n$ only with one positive and one negative impulse applied		N
	SPDs tested acc. to class I and II containing switching components: Sparkover voltage acc. to 7.5.3 Maximum of 10 measured peak values (5 pos./ 5 neg.)		N
	SPDs tested acc. to class III: Measured limiting voltage acc. to 7.5.4 or 7.5.5 at $U_{oc}$ only with four surges (2 pos./ 2 neg.)		N
	The sample has passed the test if the measured limiting voltage is below or equal to $U_p$		N
	The test sample is then connected to $UC$ . The test transformer shall have a short-circuit current capability of at least 200 mA. The current, which flows through the test sample, is measured.  Its resistive component (measured at the crest of the sine wave) shall not exceed a value of 1 mA  or  the stand-by power consumption shall not increase by more than 20 % of the value measured in 7.7.5.		N

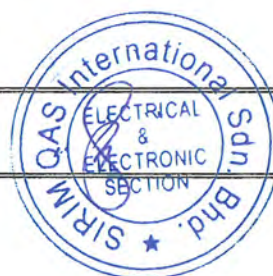
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<b>TEST SEQUENCE 8</b>			
Clause	Requirement - Test	Result	Verdict
6.5.1.3 7.9.7	<b>Insulation resistance</b>		
	This test is not applicable to SPDs having a metallic enclosure connected to protective earth.	All metal enclosure connected to earth	N
7.9.7.1	Additional entry holes for cables – if there are any – are left open; if there are any knock-outs, one of them is opened. Coverings and other parts, detachable without tools, are removed and – if necessary – undergo the same moisture treatment		N
	The moisture treatment is carried out in a humidity cabinet with a relative humidity between 91% and 95%. The air temperature is kept at all points, where the test sample can be positioned, within $\pm 1$ K at a suitable value $T$ between 20 C and 30 C. Before putting the test samples into the humidity cabinet, they have a temperature between $T$ and $(T+4)$ in C.  The test samples are kept in the humidity cabinet for 2 days (48 h).		N
7.9.7.2	After a delay period 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

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**TEST SEQUENCE 8**


Clause	Requirement - Test	Result	Verdict
	<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 fixed again the parts which might have been detached</p> <p>a) between all interconnected live parts and the SPDs body accessible to accidental contact</p> <p>The expression "body" in the sense of this test means</p> <ul style="list-style-type: none"> <li>– all touchable metal parts and a metal foil on surfaces of insulating material, which are touchable after installation as for normal use,</li> <li>– the surface on which the SPD is mounted, if necessary, covered with metal foil,</li> <li>– screws and other facilities for fastening the SPD on its support.</li> </ul> <p>For 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> <p>b) between the live parts of the SPD main circuit and live parts of auxiliary circuits, if there are any.</p>		N
	<p>The insulation resistance being not lower than</p> <p>5 MΩ for the measurements according to a),</p> <p>2 MΩ for the measurements according to b).</p>	<p>_____ MΩ</p> <p>_____ MΩ</p>	N N
6.2.10/7.9.8	<b>Dielectric withstand</b>		
	<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>		P

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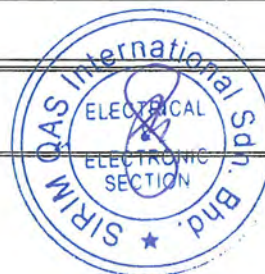
**TEST SEQUENCE 8**

Clause	Requirement - Test	Result	Verdict
	SPDs category indoor are tested as indicated in a) and b) of 7.9.7.2		P
	<p>SPDs are tested with an a.c. voltage according to table 16, starting with not more than half the required a.c. voltage, this voltage is increased to the full value within 30 s which is then held for 1 min</p> <p>a) between all interconnected live parts and the SPDs body accessible to accidental contact</p> <p>The expression "body" in the sense of this test means</p> <ul style="list-style-type: none"> <li>- all touchable metal parts and a metal foil on surfaces of insulating material, which are touchable after installation as for normal use,</li> <li>- the surface on which the SPD is mounted, if necessary, covered with metal foil,</li> <li>- screws and other facilities for fastening the SPD on its support.</li> </ul> <p>For these measurements, the metal foil is put on in such a way, that perhaps existing casting mass is effectively tested.</p> <p>b) between the live parts of the SPD main circuit and live parts of auxiliary circuits, if there are any.</p>	<p>test voltage</p> <p>2200 V</p> <p>_____ V</p>	<p>P</p> <p>N</p>
	Arcing or puncturing do not occur, however, partial discharges are accepted if the voltage change during the discharge is less than 5%		P
	Auxiliary circuits are tested according to IEC 60947-5-1	_____	N
7.9.9	<b>Resistance to ingress of solid objects and to harmful ingress of water</b>		
	Test carried out acc. to IEC 60529 to check the IP code (for IP more than 20)	IP _____	N
6.5.1.2 7.9.3	<b>Heat resistance</b>		
7.9.3.1	For 1 h the SPD is kept in a heating cabinet at a temperature of (100 ± 2)°C		P
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<b>TEST SEQUENCE 8</b>			
Clause	Requirement - Test	Result	Verdict
	Any sealing compound used in the internal assembly does not flow out to any significant extent		P
	After cooling, it is not possible to touch any live parts when the test sample is mounted as for normal use even if the standard test finger is applied with a force not exceeding 5 N  The SPD is deemed to have passed the test even if the SPD disconnector is open.		P
7.9.3.2	Outer parts of SPDs, consisting of insulating material, are submitted to a ball thrust test by means of a tester as shown on figure 11		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 $(125 \pm 2)^{\circ}\text{C}$	Terminal block	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 $(70 \pm 2)^{\circ}\text{C}$		N
	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. 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.		N
	The diameter of the ball indentation is measured and does not exceed 2 mm	< 2 mm	P
6.2.8/7.9.5	<b>Verification of air clearances and creepage distances</b>		
	The electrode spacing of spark gaps is not considered for the determination of air clearances and creepage distances		P
7.9.5.1	<b>SPDs category outdoor</b>		

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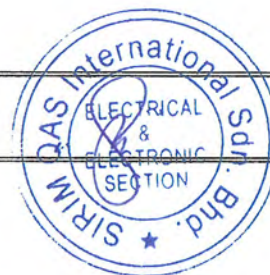


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**TEST SEQUENCE 8**

Clause	Requirement - Test	Result	Verdict
	Between live parts and earth, the air clearances and creepage distances are not smaller than the values indicated in table 14	$U_c = 275 \text{ V}$ $400 \leq \text{CTI} \leq 600$ Required:3.0mm Measured:14.98mm	P
7.9.5.2	<b>SPDs category indoor</b>		

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**TEST SEQUENCE 8**

Clause	Requirement - Test	Result	Verdict
	Air clearances and creepage distances are not smaller than the values indicated in table 15:	required/measured	
	<b>Air clearances in millimetres</b>		
	1) Between live parts of different polarity	3.0 / 12.65	P
	2) Between live parts and		
	–screws and other means to fasten a covering, having to be detached for mounting the SPD	3.0 / 33.14	P
	–fastening surfaces (note 2)		N
	–screws or other means for fastening the SPD (note 2)		N
	–bodies (notes 1 and 2)	3.0 / 21.67	P
	3) Between the metal parts of the disconnector mechanism and		
	–bodies (note 1)		N
	–screws or other means for fastening the SPD		N
	<b>Creepage distances in millimetres</b>		
	4) Between live parts of different polarity	3.0 / 20.9	P
	5) Between live parts and		
	– screws and other means to fasten a covering, having to be detached for mounting the SPD		N
	– screws or other means for fastening the SPD (note 2)		N
	– bodies (note 1)		P
	NOTE 1 – Definition see 7.9.7.2.	3.0 / 23.14	
	NOTE 2 – If clearances and creepage distances between live parts of the device and the metallic screen or the surface on which the SPD is mounted are dependant on the design of the SPD only, they cannot be reduced when the SPD is mounted in the most unfavourable position (even in a metallic enclosure), the values of lines 1 and 2 are sufficient.		
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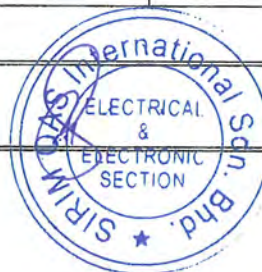


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**TEST SEQUENCE 8**

Clause	Requirement - Test	Result	Verdict
7.9.5.2.1	The measurements are carried out without conductors as well as with conductors of the greatest cross-sectional area indicated by the manufacturer. Nuts and screws with out-of-round heads are assumed to be in the most unfavourable tightening position.		P
	If metal parts are covered with self-hardening resin of a least 2 mm thickness, or if they are covered with an insulation, withstanding a test voltage according to 7.9.8, creepage distances and air clearances are not necessary		N
7.9.5.2.2	Casting does not come over the rim of the deepening, it sticks strongly to the walls of the cavity and the metal parts in it		N
	By examination and trial no possibility to detach the casting mass without a tool		N
6.2.9/7.9.6	<b>Tracking resistance</b>		
	Test done on insulating materials necessary to retain live parts in their position	Terminal block	P
	Testing is not applicable in case of insulating materials made out of ceramic, or if the creepage distances are at least equal to double the values indicated in 7.9.5		N
	Testing according to IEC 60112, solution A with a test voltage of 175 V		P
6.5.2/7.9.4	<b>Resistance to abnormal heat and fire</b>		
	The glow wire test is performed in accordance with clauses 4 to 10 of IEC 60695-2-1/1		P
	- for external parts of SPDs made of insulating material necessary to retain in position current-carrying parts and parts of the protective circuit, by the test made at a temperature of $(850 \pm 15)^{\circ}\text{C}$	terminal block	P

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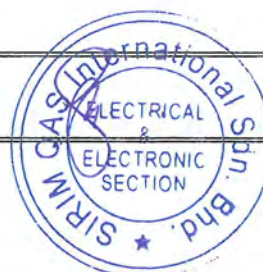


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**TEST SEQUENCE 8**

Clause	Requirement - Test	Result	Verdict
	<p>- for all other external parts made of insulating material, by the test made at a temperature of 650 °C ± 10 °C</p> <p>For the purpose of this test, bases of surface-type SPDs are considered as external parts.</p> <p>The test is not made on parts of ceramic material.</p> <p>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>		N
	The sample is positioned during the test in the most unfavourable position of its intended use (with the surface tested in a vertical position).		P
	The tip of the glow-wire is 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
	<p>The sample is regarded as having passed the glow-wire test if</p> <ul style="list-style-type: none"> <li>- there is no visible flame and no sustained glowing, or if</li> <li>- flames and glowing parts on the sample extinguish themselves within 30 s after the removal of the glow-wire.</li> </ul>	<p>YES</p> <p>0 s</p>	<p>P</p> <p>P</p>
	There is no ignition of the tissue paper or scorching of the pinewood board		P
6.4	<b>Environmental requirements</b>		
	Outdoor SPDs contained in a weather shield of glass, glazed ceramic or other acceptable material that is resistant to UV radiation, corrosion, erosion and tracking		N

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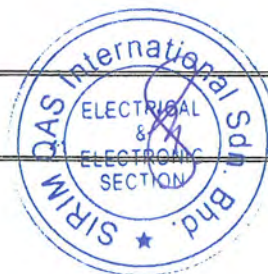


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**TEST SEQUENCE 9**

Clause	Requirement - Test	Result	Verdict
6.6/7.8	<b>Test for two-port SPDs and one-port SPDs with separate input/output terminals</b>		
6.6.1/7.8.1	<b>Percentage voltage regulation</b>		
	U <sub>c</sub> 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
	Value complies with the manufacturers declaration		N
6.6.3/7.8.4	<b>Load-Side Surge Withstand Capability</b>		
	Only applied to two-port SPDs, if declared by the manufacturer.		N

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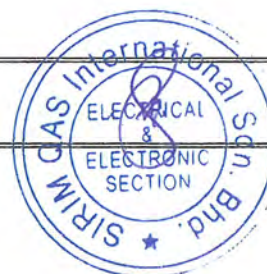


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**TEST SEQUENCE 9**

Clause	Requirement - Test	Result	Verdict
	<p>- 15 current impulses 8/20<math>\mu</math>sec</p> <p>- or 15 combination wave impulses with an open circuit voltage <math>U_{oc}</math></p> <p>with a value equal to the load-side surge withstand capability declared by the manufacturer are applied in 3 groups of 5 impulses to the output port of the test sample.</p> <p>The SPD is energized at <math>U_c</math> by means of a voltage source having a nominal current of at least 5A.</p> <p>Each impulse shall be synchronized to the power frequency. Starting from 0° the synchronization angle shall be increased in steps of 30<math>\pm</math>5 degrees.</p> <p>The interval between the impulses is 50-60 seconds and the interval between the groups are 25-30 minutes.</p> <p>The test sample shall be energized during the whole test sequence. The voltage on the output terminals shall be recorded.</p>		N
7.6.6	<b>Pass criteria</b>		
	After each impulse thermal stability		N
	Any follow current is self extinguished		N
	Voltage and current records and visual inspection show no indication of puncture or flashover of the sample	see Annex	N
	No mechanical damage		N

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**TEST SEQUENCE 9**

Clause	Requirement - Test	Result	Verdict
	<p>One more impulse at <math>I_n</math> or <math>U_{OC}</math> shall be applied to the SPD whilst the SPD is energized at <math>U_C</math> by means of a voltage source having a nominal current capability of at least 5 A. After this impulse, <math>U_C</math> remains applied and thermal stability shall be achieved within 30 min.</p> <p>Once thermal stability is achieved, either:</p> <ul style="list-style-type: none"> <li>the current which flows through the test sample is measured. Its resistive component (measured at the crest of the sine wave) shall not exceed a value of 1 mA.</li> </ul> <p>or</p> <ul style="list-style-type: none"> <li>the stand-by power consumption shall not be greater than 20% above the value measured in 7.7.5</li> </ul> <p>Following this complete test sequence and after the sample has cooled down to near ambient temperature, the measured limiting voltage test, which was made at the beginning of the test sequence, shall be repeated.</p>		N
	<p>SPDs tested acc. to class I and II:</p> <p>Residual voltage acc. to 7.5.2 at <math>I_n</math> only with one positive and one negative impulse applied</p>	___ kA / ___ V	N
	<p>SPDs tested acc. to class I and II containing switching components:</p> <p>Sparkover voltage acc. to 7.5.3</p> <p>Average of 10 measured peak values (5 pos./ 5 neg.)</p>		N
	<p>SPDs tested acc. to class III:</p> <p>Measured limiting voltage acc. to 7.5.4 or 7.5.5 at <math>U_{OC}</math> only with four surges (2 pos./ 2 neg.)</p>		N

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**TEST SEQUENCE 9**

Clause	Requirement - Test	Result	Verdict
	Values of measured limiting voltage test measured before and after the test are below or equal to $U_p$		N
6.6.2/7.8.2	<b>Rated load current</b>		
	$U_C$ supplied at the input port SPD loaded with rated load current into a resistive load, using cables with the minimum cross sectional area acc. to 7.3.1		N
	After thermal stability is reached the temperature rise of parts which are accessible in normal use does not exceed 40 K		N
7.8.5	<b>Overload behaviour</b>		
	Test performed on all two-port SPDs, but only performed on one-port SPDs if the internal connections between input and output terminals have a smaller cross-section than the conductors specified to perform the test.		N
	Test carried out at ambient temperature and the sample protected against abnormal external heating or cooling.		N
	Test circuit and procedure as described in 7.8.2, except that circuits other than the main circuit are disregarded for this test.		N
	Test performed without any external overcurrent protective devices being connected (internal removable overcurrent protective devices are replaced by a link of negligible impedance).		N
	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 11x, depending on national installation rules.		N

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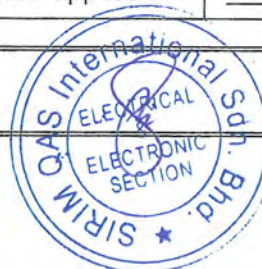


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**TEST SEQUENCE 9**

Clause	Requirement - Test	Result	Verdict
	<p>If no maximum overcurrent protection is specified by the manufacturer, the SPD is loaded with 1,1 times the rated load current for 1 h or until an internal disconnecter operates.</p> <p>If no disconnecter 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 disconnecter operates.</p>		N
	Pass criteria:		
	For touchable surfaces, the temperature rise is always be less than 60 K during the test.		N
	<p>a) No internal disconnecter has operated:</p> <ul style="list-style-type: none"> <li>• Visual inspection of the test sample shall reveal no evidence of any damage.</li> <li>• SPDs having an IP degree equal 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 for those live parts which were already accessible before the test when the SPD is fitted as in normal use.</li> <li>• The test sample is then connected to UC. The test transformer shall have a short-circuit current capability of at least 200 mA. The current, which flows through the test sample, is measured.</li> </ul> <p>Its resistive component (measured at the crest of the sine wave) shall not exceed a value of 1 mA</p> <p>or</p> <p>the stand-by power consumption shall not increase by more than 20 % of the value measured in 7.7.5.</p>		N N N
	<p>SPDs tested acc. to class I and II:</p> <p>Residual voltage acc. to 7.5.2 at <math>I_n</math> only with one positive and one negative impulse applied</p>	___ kA / ___ V	N

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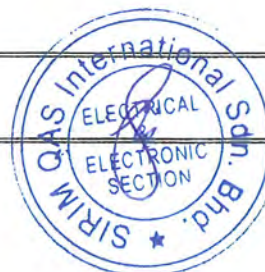


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**TEST SEQUENCE 9**

Clause	Requirement - Test	Result	Verdict
	SPDs tested acc. to class I and II containing switching components:  Sparkover voltage acc. to 7.5.3  Maximum of 10 measured peak values (5 pos./ 5 neg.)		N
	SPDs tested acc. to class III:  Measured limiting voltage acc. to 7.5.4 or 7.5.5 at $U_{oc}$ only with four surges (2 pos./ 2 neg.)		N
	The sample has passed the test if the measured limiting voltage is below or equal to $U_p$		N
	Auxiliary circuits, such as status indicators, shall be in working order		N
	b) Any internal disconnecter has operated:  • SPDs having an IP degree equal 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 for those live parts which were already accessible before the test when the SPD is fitted as in normal use.  • There shall be clear evidence of effective and permanent disconnection by the device. To check this, a power frequency voltage equal to $U_C$ shall be applied for 1 min without current flow in excess of 0,5 mA r.m.s.  • There shall be no evidence of burning and there shall be no expulsion of solid material during and after the test.		N  N  N
7.8.3	<b>Load-side short circuit withstand capability test</b>		

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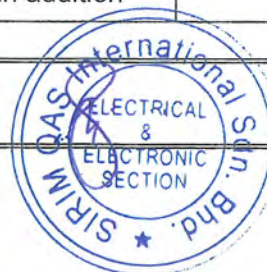


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**TEST SEQUENCE 9**

Clause	Requirement - Test	Result	Verdict
	The test according to 7.7.3 is repeated without short-circuiting of any component but with short-circuiting all load terminals with a conductor of the largest cross section specified under 7.3.1 and of length 0,5m.	_____ mm <sup>2</sup>	N
	<b>Pass Criteria</b>		
	During the test the power short-circuit current is interrupted within 5s. During the test the muslin paper, or cheesecloth does not catch fire. In addition, there is no explosion or hazard for either personnel or facility.	_____	N
	<b>For accessible SPDs:</b>		
	After the test for SPDs having an IP degree equal or greater than IP 2X shall not have live parts accessible with the standardized test finger applied with a force of 5N (IEC 60529).		N
	<b>If no internal disconnecter has operated</b> , the SPD shall fulfil the requirements according to 7.4.1 and 7.5		N
7.4.1	Sample mounted as for normal use and fitted with conductors of smallest cross section and largest cross section acc. to 7.3.1		N
	Standard test finger applied in every possible position		N
	For plug in SPDs changeable without a tool the test finger is applied in every possible position when the plug is partially engaged or completely engaged with a socket		N
	Electrical indicator with test voltage of 40 - 50 V shows no contact		N
7.5.	SPDs tested acc. to class I and II perform 7.5.2		N
	SPDs tested acc. to class I and II containing switching components perform 7.5.3 in addition		N

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**TEST SEQUENCE 9**

Clause	Requirement - Test	Result	Verdict
	SPDs tested acc. to class III perform 7.5.4 or 7.5.5		N
	One port SPDs are tested unenergized		N
	Two port SPDs are tested energised at $U_C$ with a source having a nominal current $\geq 5$ A	____ V ____ A	N
	For a one port SPD not having separate load terminals, the test is performed without external disconnectors and the measured limiting voltage is measured at the SPD terminals including cables forming a part of the SPD as offered by the manufacturer.		N
	For two port SPDs and one port SPDs having separate load terminals the voltage is measured at the load terminals		N
	The test includes all ancillary parts declared by the manufacturer	_____	N
	Measured limiting voltage = highest value measured	_____ V	N
7.5.2	Residual voltage with 8/20 current impulse		
IEC	Test with current impulses of 0,1 times $I_n$ 0,2 times $I_n$ 0,5 times $I_n$ 1,0 times $I_n$ 2,0 times $I_n$ ....or 1,2 times $I_n$ (if 2 times $I_n$ exceeds $I_{max}$ )		N
	With one sequence of positive and one sequence of negative polarity		N

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**TEST SEQUENCE 9**

Clause	Requirement - Test	Result	Verdict
	Finally one impulse at $I_{max}$ or $I_{peak}$ if $I_{max}$ or $I_{peak} > I_n$ with polarity that showed higher residual voltages during previous tests		N
	Time interval between impulses long enough for sample to cool down to ambient		N
	Current -voltage oscillograms		N
	Discharge current - residual voltage diagram showing peak values		N
	Value for determination of the Measured limiting voltage = highest voltage on the curve corresponding to: - $I_{peak}$ or $I_n$ whichever is greater for class I test - $I_n$ for class II test		N N
7.5.3	Sparkover voltage with 1,2/50 voltage impulse		
	Preliminary test:		
	Generator output voltage increased in steps of about 10% until sparkover is observed		N
	Restarting from last setting where no sparkover occurred increasing output voltage in steps of 5% until sparkover is observed and then applying 5 positive and 5 negative impulses for each setting until all of the 10 impulses applied lead to sparkover		N
	Voltage oscillograms		N
	Value for determination of the Measured limiting voltage = average of 10 peak values		N
7.5.4	Measured limiting voltage with combination wave		
	Sample energised at $U_c$		N

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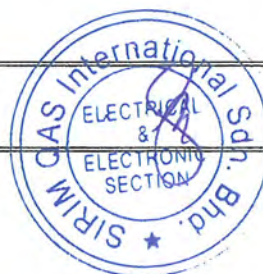


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**TEST SEQUENCE 9**

Clause	Requirement - Test	Result	Verdict
	For a.c. rated SPDs positive impulses are applied at $90^{\circ} \pm 10^{\circ}$ el point and negative impulses at $270^{\circ} \pm 10^{\circ}$ el point of the sinusoidal voltage wave		N
	Time interval between impulses long enough for sample to cool down to ambient		N
	Test with voltage settings of: 0,1 times $U_{oc}$ _____ kV 0,2 times $U_{oc}$ _____ kV 0,5 times $U_{oc}$ _____ kV 1,0 times $U_{oc}$ _____ kV		N
	With four surges, two of positive and two of negative polarity, applied at each setting		N
	Current -voltage oscillograms		N
	Value for determination of the Measured limiting voltage = maximum peak voltage recorded		N
	<b>If an SPD internal disconnecter has operated,</b> there shall be clear evidence of effective and permanent disconnection.  Check for disconnection:  a) confirm that there is no voltage on the output terminals  b) apply a power frequency voltage equal to 2 times $U_c$ between the corresponding input and output terminals for 1 minute without current flow in excess of 0,5mA r.m.s.		N
	The test includes all the auxiliary parts in series with the SPD as declared by the manufacturer		N

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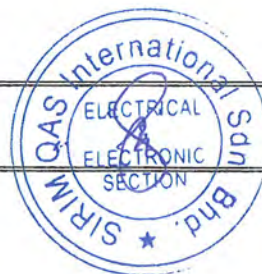


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**TEST SEQUENCE 10**

Clause	Requirement - Test	Result	Verdict
6.2.12	<b>Status Indicator Operation</b>		
	Throughout the entire Type Testing procedure, the status shown by the indicator(s) shall give a clear indication of the status of the part to which it is linked. For SPD with a stated intermediate status indication, the intermediate status is not considered as a failure of the indicator. Where there is more than one method of status indication, for example local and remote indication, each type of indication shall be checked. 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 on replacement of the SPD) linked by a coupling mechanism which can be mechanical, optical, audio electromagnetic, etc.  In this situation, the part of the status indicator with the replaced part of the SPD will be tested as above. The part of the status indicator which is not replaced shall be capable of operating at least 50 times.		N
	The action of the coupling mechanism which operates the non-replaced part of the status indicator may be simulated by means other than operation of the section within the replaced part of the SPD; e.g., a separate electromagnet or a spring.		N
	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.		N
6.2.13	<b>Isolation between separate circuits</b>		

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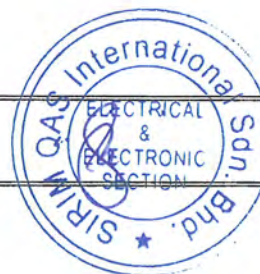


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**TEST SEQUENCE 10**

Clause	Requirement - Test	Result	Verdict
	Where a SPD includes a circuit which is electrically isolated from the main circuit, the manufacturer shall provide information about the isolation and dielectric withstand voltages between the circuits and relevant standards with which the manufacturer is claiming conformity.	No information	N
	Where there are more than two circuits, declarations shall be made with regard to each combination of circuits.		N
	The isolation and dielectric withstand of the separate circuits shall be tested according to the manufacturer's declaration.		N

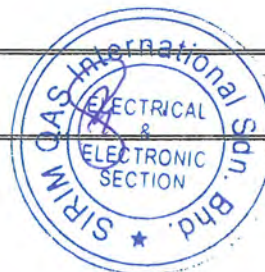
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<b>EMC TEST SEQUENCE</b>			
Clause	Requirement - Test	Result	Verdict
<b>APPENDIX</b>			
7.10	<b>Electromagnetic compatibility</b>		
7.10.1	<b>Electromagnetic immunity</b>		
	SPDs either incorporating no electronic circuits or incorporating electronic circuits in which all components are passive (for example diodes, resistors, capacitors, inductors, varistors and other surge protective components) are not sensitive to normal electromagnetic disturbances and therefore no immunity tests are required.		N
	The requirements for SPDs containing electronic circuits are under consideration.		N
7.10.2	<b>Electromagnetic emission</b>		
	For SPDs not incorporating electronic circuits, or incorporating electronic circuits that do not generate fundamental frequencies greater than 9 kHz in normal operation, electromagnetic disturbances can only be generated during protective operations. The duration of these disturbances is in the order of microseconds to milliseconds.  The frequency, level and the consequences of these emissions are considered as part of the normal electromagnetic environment of low-voltage installations. Therefore, the requirements for electromagnetic emissions are deemed to be satisfied and no verification is necessary.		N
	The requirements for SPDs containing electronic circuits generating fundamental frequencies greater than 9 kHz are under consideration.		N

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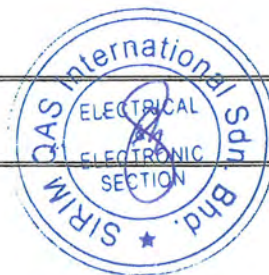


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Components Lists for SPD Portion of LM Series

Components (please state if any)	Technical data/Material
Housing body	Steel Sheet / 1.5mm thickness
Terminal screws for Line Conductor	M6, Nickel plated Steel with spring and flat washers
Earth bonding bar / plate	80 * 125 * 5 mm, Copper plate
Varistor (Ln-N, Ln-PE)	TVT34681, Internally thermally fused MOV
Gas Discharge Arrester (N-PE)	V17-A800XNTP
Conductor bus bar	2mm thickness x 15mm width, Copper
Mounting screws on bus bar	M5 and/or M4 , Zinc Plated Steel with spring and flat washer
(Subsidiary Parts of SPD )	
Varistor Case (SED Housing)	Plastic , ABS Molded
Printed circuit board	Glass wool, Epoxy, FR-4
Resistor Carbone film	100kΩ, 1/4 Watt
Photo Coupler	K814A
LED	5mm Diameter, Red Color

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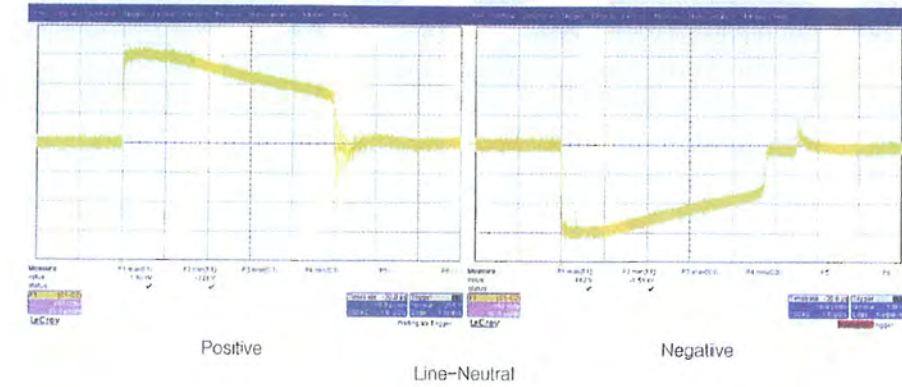


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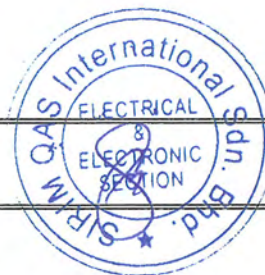
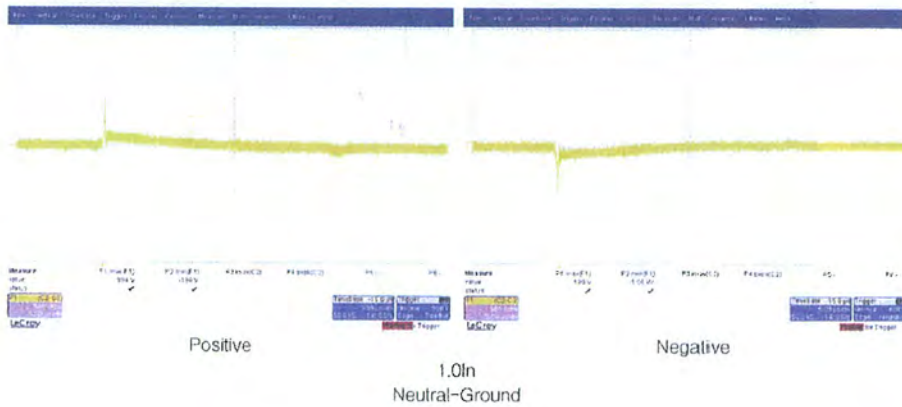
ANNEX 1

Measurement of residual voltage test

voltage graph



Neutral-Ground



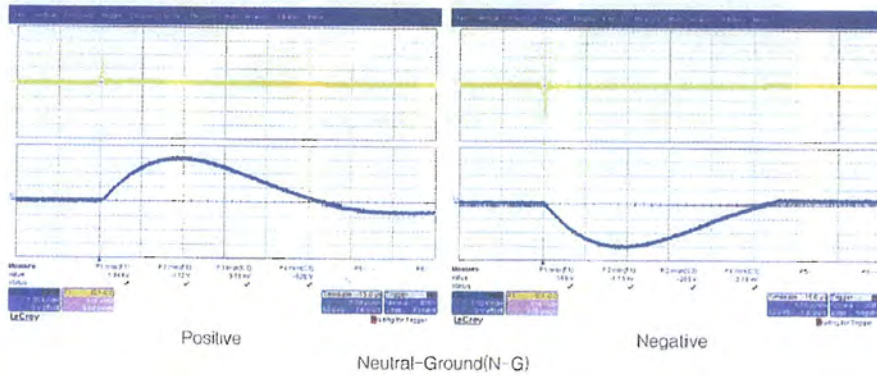
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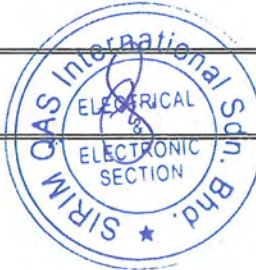


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ANNEX 2

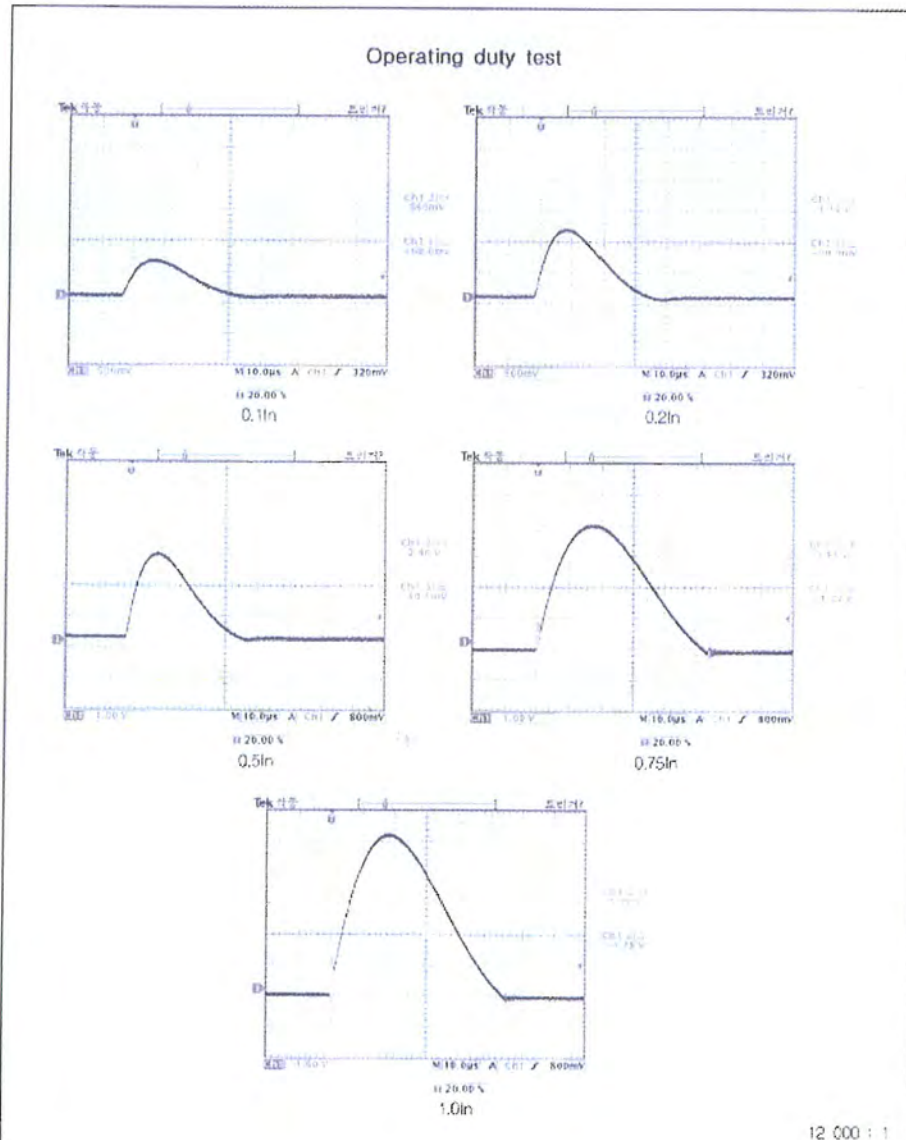
Measurement of the front of wave sparkover voltage test



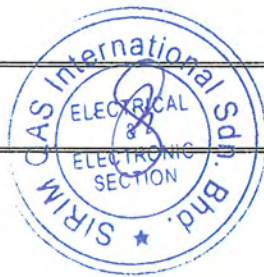
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ANNEX 3



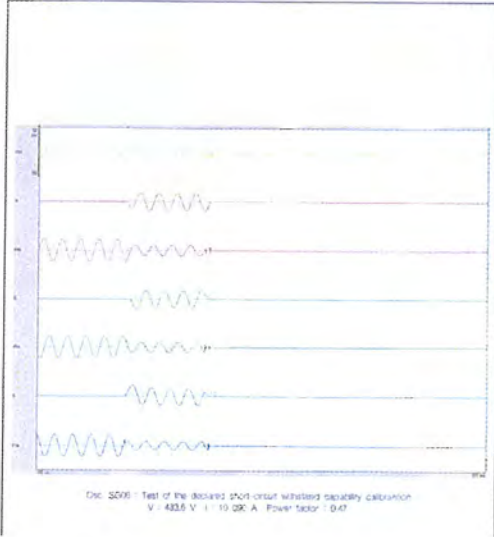
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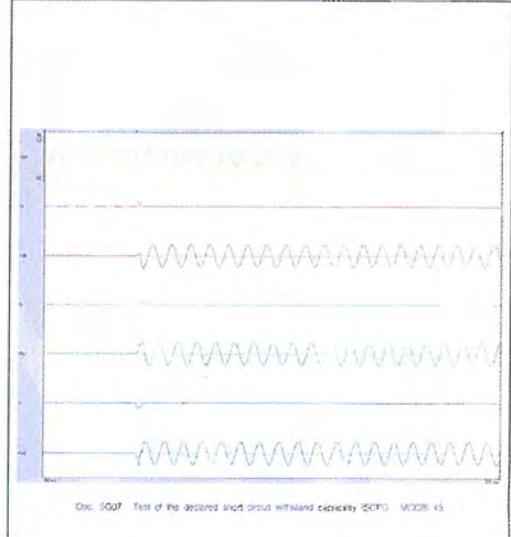
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### SHORT-CIRCUIT TEST AT 10 KA

Oscillograms :



Oscillograms :



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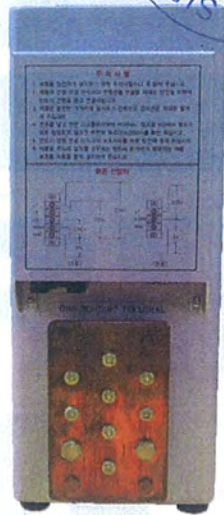
PHOTOGRAPH(S) OF TEST SAMPLE(S)



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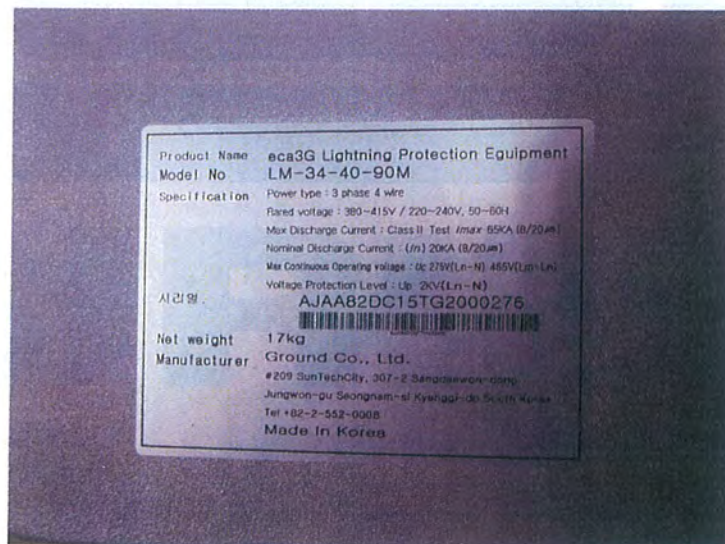
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