CE

LVD TEST REPORT

For

Shenzhen Consnant Technology Co., Ltd.

Building B6, Junfeng Industrial Park, Yonghe Road, Fuhai Sub-District, Bao'an District, Shenzhen City, 518103 P.R.China.

Test Model: SVG-100kVar

Additional Model No.: SVG-75kVar, SVG-50kVar, SVG-35kVar, SVG-30kVar, SVG-20kVar

Equipment Under Test	:	Static Var Generator
Date of receipt of test sample	:	June 08, 2020
Test Date	:	June 08, 2020 - June 17, 2020
Issue Date	:	June 20, 2023
Compiled By	:	Jone Zhang
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TEST REPORT
EN 62477-1:2012+A1:2017
Safety requirements for power electronic converter systems and equipment Part 1:General

Part 1: General

Report No. .....:	BCT220715R-001SA
Date of issue.....:	June 20, 2023
Total number of pages ..... :	61
Applicant's name.....:	Shenzhen Consnant Technology Co., Ltd.
Address.....:	Building B6, Junfeng Industrial Park, Yonghe Road, Fuhai Sub-District, Bao'an District, Shenzhen City, 518103 P.R.China.
Manufacturer's name.....:	Shenzhen Consnant Technology Co., Ltd.
Address.....:	Building B6, Junfeng Industrial Park, Yonghe Road, Fuhai Sub-District, Bao'an District, Shenzhen City, 518103 P.R.China.
Name of Testing Laboratory preparing the Report ..... :	Shenzhen BCT Technology Co., Ltd.
Testing Laboratory.....:	CCIC Southern Electronic Product Testing (Shenzhen) Co., Ltd.
Testing location / address.....:	Electronic Testing Building, No.43 ShaHe Road, XiLi Street, Nanshan District, Shenzhen, GuangDong, China
Test specification.....:	
Standard.....:	EN 62477-1:2012+A1:2017, IEC 62477-1:2012+Amend 1:2016
Test procedure.....:	Type test
Non-standard test method……..:	N/A
Test Report Form No.....:	EN/IEC 62477D
Test Report Form(s) Originator.....:	Nemko AS
Master TRF.....:	Dated 2017-03
Test item description.....:	Static Var Generator
Trade Mark.....:	CONSNANT
Model/Type reference.....:	SVG-100kVar
Serial number .....:	SVG-75kVar, SVG-50kVar, SVG-35kVar, SVG-30kVar, SVG-20kV
Ratings.....:	Input: AC400V, 50Hz, 150A, 100kvar

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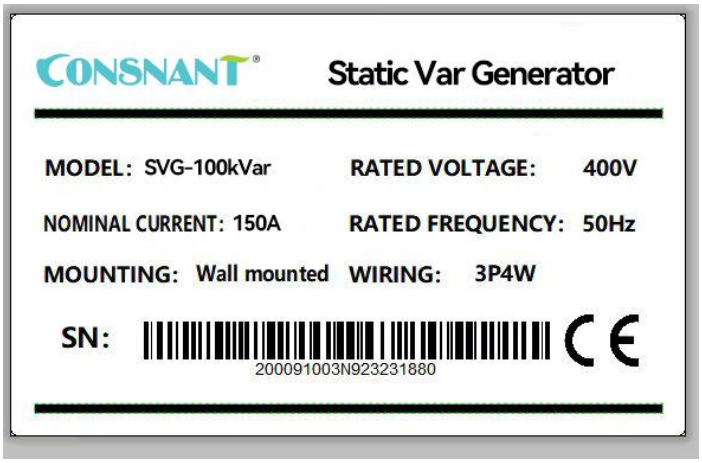
Copy of marking plate:

The artwork below may be only a draft.



Remark: The height dimension of CE mark should not less than 5mm, the height dimension of WEEE symbol should not less than 7mm.

Summary of testing:

The test object has been assessed for safety with respect to the above test specifications and found to comply with the requirements of EN 62477-1:2012+A1:2017, IEC 62477-1:2012+Amend 1:2016.

General remarks:

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The test results presented in this report relate only to the item(s) tested.

"(see remark #)" refers to a remark appended to the report.

"(see Annex #)" refers to an annex appended the report.

Throughout this report a point is used as the decimal separator.

General product information:

a)The model **SVG-100kVar** is widely used in kinds of industry fields.

b)Indoor use only.

Test item particulars.....:	
Classification of installation and use.....:	Fixing device
Supply Connection.....:	Directly connected to the mains

Possible test case verdicts:

- test case does not apply to the test object.....: N (N/A)
- test object does meet the requirement.....: P (Pass)
- test object does not meet the requirement..... : F (Fail)

*Note: This Report is based on report **BCT220715R-001S**, In addition to the applicant's name and address, no further test need.*

EN 62477-1:2012+A1:2017, IEC 62477-1:2012+Amend 1:2016			
Clause	**Requirement- Test**	**Result**	**Verdict**
4	**Protection against hazards**		**P**
4.1	General		P
	Clause 4 defines the minimum requirements for the design and construction of a PECS, to ensure its safety during installation, normal operating conditions and maintenance for the expected lifetime of the PECS. Consideration is also given to minimising hazards resulting from reasonably foreseeable misuse.		P
	Protection against hazards shall be maintained under normal and single fault conditions, as specified in this standard.		P
4.2	Fault and abnormal conditions		P
	The PECS shall be designed to avoid operating modes or sequences that can cause a fault condition or component failure leading to a hazard, unless other measures to prevent the hazard are provided by the installation and are described in the installation information provided with the PECS. The requirements in this clause also apply to abnormal operating conditions as applicable.		P
	This analysis shall include situations where a failure of the component or the insulation (functional, basic and supplementary) would result in:		P
	• an impact on the decisive voltage determination according to 4.4.2;		P
	• a risk of electric shock due to: – degradation of the basic protection according to 4.4.3, or – degradation of the fault protection according to 4.4.4;		P
	• a risk of energy hazard according to 4.5;		P
	• a risk of degradation due to emission of flame, burning particles or molten metal of the fire according to 4.6;		P
	• a risk of thermal hazard due to high temperature according to 4.6;		P
	• a risk of mechanical hazard according to 4.7.		P
	The analysis or testing shall include the effect of short circuit and open-circuit conditions of the		

	component. Testing is necessary unless analysis can conclusively show that no hazard will result from failure of the component. Compliance shall be checked by test of 5.2.4.6.		P
	The evaluation of components shall be based on the expected stress occurring in the expected lifetime of the PECS including, but not limited to:		P
	• specified climatic and mechanical conditions according to 4.9 (temperature, humidity, vibration, etc.);		P
	• electrical characteristics according to 4.4.7 (expected impulse voltage, working voltage, temporary overvoltage, etc.);		P
	• micro environment according to 4.4.7 (pollution degree, humidity, etc.).		P
4.3	Short circuit and overload protection		P
4.3.1	The PECS shall not present a hazard, under short circuit or overload conditions at any port,including phase to phase, phase to earth and phase to neutral. Adequate information shall be provided in the documentation to allow proper selection of external wiring and protective devices (see 6.3.7.6 and 6.3.7.7).		P
4.3.2	Specification of input short-circuit withstand strength and output short circuit current ability		P
4.3.2.1	General		P
	The interrupting capability of the overcurrent protective device shall be equal or greater than the prospective short circuit current of the mains supply.	Set value 130A, If the current exceeds the setting value, the device will stop running.	P
	For pluggable equipment type A, either the PECS shall be designed so that the building installation provides short circuit backup protection, or additional short circuit backup protection shall be provided as part of the equipment.		P
4.3.2.2	Input ports short-circuit withstand strength		P
	The input prospective short circuit current ratings apply to ports intended to be connected to battery circuits, external mains supply, non-mains a.c. or d.c. sources, and to other ports for which overcurrent protection is necessary.		P
	For co-ordination and selection of internal or external protective devices, the PECS manufacturer shall specify:		

	• a maximum allowable prospective short circuit current for each input port of the PECS; and • a minimum required prospective short circuit current in order to ensure proper operation of the protective device	Please refer to the user's manual and marking	P
4.3.2.3	Output short circuit current ability		P
	The output short circuit current ratings appliy to a.c. and d.c. power output ports and to other ports for which overcurrent protection is necessary.		P
	For all output ports, short circuit evaluation to determine the minimum and maximum output short circuit current shall be performed according to 5.2.4.4 and the output short circuit current available from the PECS shall be specified as in 5.2.4.4 and 6.2.		P
4.3.2.4	Combined input and output ports		P
4.3.3	Short-circuit coordination (backup protection)		P
	Protective devices provided or specified shall have adequate breaking capability to interrupt the maximum prospective short circuit current specified for the port to which they are connected.		P
4.3.4	Protection by several devices	Compliance	P
4.4	Protection against electric shock		P
	General		P
	Protection against electric shock depends on the decisive voltage class from 4.4.2 and insulation requirements from 4.4.2.3, and is to be provided by at least one of the following measures: • basic protection from 4.4.3 and fault protection from 4.4.4; • enhanced protection from 4.4.5		P
	Protection under normal conditions is provided by basic protection, and protection under single fault conditions is provided by fault protection.		P
4.4.2	Decisive voltage class		P
4.4.2.1	General		P
	The probability of electric shock increases with voltage level, surface area of the accessible conductive part or circuit in contact with the skin and the humidity condition of skin. To reduce the likelihood of electric shock, it is important to determine the safe decisive voltage class (DVC As).		P

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4.4.2.2	Determination of decisive voltage class		P
4.4.2.2.1	General		P
	If it is impossible to protect against the body reaction relevant to the DVC As, a basic protection against accessibility to hazardous live parts according to 4.4.3 is required		P
4.4.2.2.2	Selection tables for contact area and skin humidity condition	“Hand” or “Dry”	P
4.4.2.2.3	Limits of the working voltage for the DVC	DVC A3	P
4.4.2.3	Requirements for protection against electric shock	Protection to accessible Conductive parts connected to PE	P
4.4.3	Provision for basic protection		P
4.4.3.1	General		P
4.4.3.2	Protection by means of basic insulation of live parts		P
	Live parts shall be completely surrounded with insulation if their working voltage is greater than DVC As or if they do not have protective separation from adjacent circuits of DVC C.	completely surrounded with insulation	P
	Basic insulation may be provided by solid insulation or air clearance.		P
	The basic insulation shall be designed and tested to withstand the impulse voltages and temporary overvoltages for the circuits to which they are connected. See 5.2.3.2 and 5.2.3.4 for tests.		P
4.4.3.3	Protection by means of enclosures or barriers		P
	Live parts with voltage higher than DVC As shall be: • arranged in enclosures or located behind enclosures or barriers, which meet at least the requirements of the Protective Type IPXXB according to Clause 7 of IEC 60529:1989; • located at the top surfaces of enclosures or barriers which are accessible when the equipment is energized shall meet at least the requirements of the protective type IP3X with regard to vertical access only.	IP20	P
	Product committees using this document as reference document might consider less requirement for equipment having openings in the top of an enclosure with a height exceeding 1,8 m.		N
	It shall only be possible to open enclosures or		

	remove barriers: • with the use of a tool or key; or • after de-energization of these live parts.		N
	Open type sub-assemblies and equipment do not require protective measures for basic protection. The information provided with the PECS shall indicate that protection shall be provided in the end application.		P
	Products containing circuits of DVC A, B or C, intended for installation in restricted access areas as defined in 3.48, need not have protective measures for basic protection.		P
4.4.3.4	Protection by means of limitation of touch current and charge		P
	The limitation of touch current and discharge energy shall not exceed: • a value of 3,5 mA a.c. or 10 mA d.c. for the limitation of touch current; and • a value of 50 µC for the limitation of discharge energy.		P
4.4.3.5	Protection by means of limited voltages		P
	The voltage between simultaneously accessible parts shall not be greater than DVC As as determined in 4.4.2.2.		P
4.4.4	Provision for fault protection		P
4.4.4.1	General		P
	Fault protection is required to prevent shock currents which can result from contact with accessible conductive parts during and after an insulation failure.		P
	Fault protection shall be provided by one or more of the following measures: • Protective equipotential bonding in 4.4.4.2 in combinations with the PE conductor in 4.4.4.3; • Automatic disconnection of supply in 4.4.4.4; • Supplementary insulation in 4.4.4.5; • Simple separation between circuits in 4.4.4.6; • Electrically protective screening in 4.4.4.7.		P
	Fault protection shall be independent and additional to those for basic protection.		P
4.4.4.2	Protective equipotential bonding		P
4.4.4.2.1	General		P
	Protective equipotential bonding shall be provided between accessible conductive parts of the		

	equipment and the means of connection for the PE conductor, except: a) accessible conductive parts that are protected by one of the measures in 4.4.6.4; or b) when accessible conductive parts are separated from live parts using double or reinforced insulation.	PE Used	P
	Electrical contact to the means of connection of the PE conductor shall be achieved by one or more of the following means: • through direct metallic contact; • through other accessible conductive parts or other metallic components which are not removed when the PECS is used as intended; • through a dedicated protective equipotential bonding conductor.	PE Used	P
	Where electrical equipment is mounted on lids, doors, or cover plates, continuity of the protective equipotential bonding circuit shall be ensured by a dedicated conductor or equivalent means complying with the requirements for protective equipotential bonding. If fasteners, hinges or sliding contacts do not provide and guarantee low enough impedance, sufficient parallel bonding is required		P
	Electrical connections of protective equipotential bonding circuit shall be designed so that contact pressure is not transmitted through insulating material, unless there is sufficient resilience in the metallic parts to compensate for any possible shrinkage or distortion of the insulating material.		P
	The protective equipotential bonding circuit shall not incorporate a component such as switch or overcurrent protective devices which may open the circuit.		P
4.4.4.2.2	Rating of protective equipotential bonding		P
	Protective equipotential bonding shall either be:		P
	a) sized in accordance with the requirements for the PE conductor in 4.4.4.3 and the means of connection for the PE conductor in 4.4.4.3.2 to ensure no voltage drop exceeding the values from 4.4.2.2.3 during a fault; or		P
	b) sized • to withstand the highest stresses that can occur to the PECS item(s) concerned when		

	they are subjected to a fault connecting to accessible conductive parts; and • to remain effective for as long as a fault to the accessible conductive parts persists or until an upstream protective device removes power from the part; and • to ensure no voltage drop exceeding the values from 4.4.2.2.3 during normal operation and during a fault.		P
	Compliance shall be checked with the type tests in 5.2.3.11.		P
4.4.4.3	PE conductor		P
4.4.4.3.1	General		P
	A PE conductor shall be connected at all times when power is supplied to the PECS, unless the PECS complies with the requirements of protective class II (see 4.4.6.3) or protective class III. Unless local wiring regulations state otherwise, the PE conductor cross-sectional area shall be determined from Table 7 or by calculation according to 543.1 of IEC 60364-5-54:2011.		P
	If the PE conductor is routed through a plug and socket, or similar means of disconnection, it shall not be possible to disconnect it unless power is simultaneously removed from the part to be protected.		P
	The cross-sectional area of every PE conductor that does not form part of the supply cable or cable enclosure shall, in any case, be not less than: • 2,5 mm^2 if mechanical protection is provided; or • 4 mm^2 if mechanical protection is not provided.	2,5 mm^2 Used	P
4.4.4.3.2	Means of connection for the PE conductor		P
	Where enclosures and/or conductors of aluminium or aluminium alloys are used, particular attention should be given to the problems of electrolytic corrosion.		P
	The marking shall not be placed on or fixed by screws, washers or other parts which might be removed when conductors are being connected.	PE Marking Used	P
4.4.4.3.3	Touch current in case of failure of PE conductor		P
	The requirements of this subclause shall be		P

	satisfied to prevent accessible conductive parts to become dangerous in case of damage to or disconnection of the PE conductor.		
	For pluggable type A equipment, the touch current shall not exceed the limits specified in 4.4.3.4	EUT is pluggable type A equipment	P
	Compliance is checked by inspection and by test of 5.2.3.7.		P
4.4.4.4	Automatic disconnection of supply		P
	For automatic disconnection of supply: • a protective equipotential bonding system shall be provided; and • a protective device operated by the fault current shall disconnect one or more of the line conductors supplying the equipment, system or installation, in case of a failure of basic insulation.		P
4.4.4.5	Supplementary insulation		P
	Supplementary insulation is an independent insulation applied in addition to basic insulation for fault protection and shall be dimensioned to withstand the same stresses as specified for basic insulation.		P
4.4.4.6	Simple separation between circuits		P
	Simple separation between a circuit and other circuits or earth shall be achieved by basic insulation throughout, rated for the highest voltage present.	insulation resistance≥100MΩ	P
	If any component is connected between the separated circuits, that component shall withstand the electric stresses specified for the insulation which it bridges.	insulation resistance≥100MΩ	P
	If any component is connected between a circuit and a circuit connected to earth, its impedance shall limit the current flow through the component to the steady-state touch current values indicated in 4.4.3.4.	insulation resistance≥100MΩ	P
4.4.4.7	Electrically protective screening		P
	The protective screen and the connection to the protective equipotential bonding system of the PECS and that interconnection shall comply with the requirements of 4.4.4.2.		P
4.4.5	Enhanced protection		P
4.4.5.1	General		P
	Enhanced protection shall provide both basic and		

	fault protection and can be achived by means of: • Reinforced insulation in 4.4.5.2; • Protective separation between circuits in 4.4.5.3; • Protection by means of in 4.4.5.4.		P
4.4.5.2	Reinforced insulation		P
	Reinforced insulation shall be so designed as to be able to withstand electric, thermal, mechanical and environmental stresses with the same reliability of protection as provided by double insulation (basic insulation and supplementary insulation, see 4.4.3.2 and 4.4.4.5).		P
4.4.5.3	Protective separation between circuits		P
	Protective separation between a circuit and other circuits shall be achieved by one of the following means: • double insulation (basic insulation and supplementary insulation in 4.4.3.2 and 4.4.4.5); • reinforced insulation in 4.4.5.2; • electrically protective screening in 4.4.4.7; • a combination of these provisions.		P
4.4.5.4	Protection by means of protective impedance		P
	Protective impedance shall be arranged so that under both normal and single fault conditions the current and discharge energy available shall be limited according to 4.4.3.4.		P
	The protective impedances shall be designed and tested to withstand the impulse voltages and temporary overvoltages for the circuits to which they are connected. See 5.2.3.2 and 5.2.3.4 for tests.		P
4.4.6	Protective measures		P
4.4.6.1	General		P
	Compliance shall be checked by satisfying the requirements for protective class I, class II or class III.	class I	P
4.4.6.2	Protective measures for protective class I equipment		P
	Protective class I equipment shall meet the requirements for: • basic protection in 4.4.3; and • fault protection in 4.4.4.2 and 4.4.4.3 with respect to equipotential bonding and PE conductor.		P

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4.4.7	Insulation		P
4.4.7.1	General		P
4.4.7.1.1	Influencing factors		P
	Insulation shall be selected after consideration of the following influences: • pollution degree; • overvoltage category; • supply system earthing; • impulse withstand voltage, temporary overvoltage and working voltage; • location of insulation; • type of insulation.		P
4.4.7.1.2	Pollution degree		P
	Insulation, especially when provided by clearances and creepage distances, is affected by pollution which occurs during the expected lifetime of the PECS.		P
	The PECS manufacturer shall state in the documentation the pollution degree for which the PECS has been designed.		P
4.4.7.1.3	Overvoltage category (OVC)		P
	The concept of overvoltage categories (based on IEC 60364-4-44 and IEC 60664-1) is used for equipment energized from the supply mains, and addresses the level of overvoltage protection expected. The OVC for non-mains supply is determined by taking into account whether control of overvoltages is provided or not, and whether the PECS is connected to outdoor lines or not, and if so, the length of the lines.		P
	Equipment of overvoltage category III (OVC III) is equipment in fixed installations and for cases where the reliability and the availability of the equipment are subject to special requirements.	Examples of such equipment are switches in the fixed installation and equipment for industrial use with permanent connection to the fixed installation.	P
4.4.7.1.4	Supply system earthing		P
	IT system: has all live parts isolated from earth or one point connected to earth through an impedance, the accessible conductive parts of the installation being earthed independently or collectively to the system earthing.		P
4.4.7.1.5	Determination of impulse withstand voltage and	2.5KV	P

	temporary overvoltage		
4.4.7.1.6	Determination of the system voltage		P
4.4.7.1.6.1	For mains supply		P
	in three-phase IT systems for determination of impulse voltage:		P
	– the r.m.s. value of the rated voltage between a phase and an artificial neutral point (an imaginary junction of equal impedances from each phase);		P
	– the r.m.s. value of the rated voltage between phases for PECS with increased reliability;		P
	– for determination of temporary overvoltage, the r.m.s. value of the rated voltage between phases;		P
4.4.7.1.6.2	For non-mains supply		P
	For PECS supplied by non-mains a.c. or d.c., the system voltage is the r.m.s. value of the supply voltage between phases.		P
4.4.7.1.7	Components bridging insulation		P
	Components bridging insulation shall comply with the requirements of the level of insulation (e.g. basic, reinforced, double) they are bridging.		P
4.4.7.2	Insulation to the surroundings		P
4.4.7.2.1	General		P
	Insulation for basic, supplementary, and reinforced insulation between a circuit and its surroundings shall be designed according to: • the impulse withstand voltage; or • the temporary overvoltage; or • the working voltage of the circuit.		P
	For creepage distances, the r.m.s. value of the working voltage is used, as described in 4.4.7.5.		P
	For clearance distances and solid insulation, the impulse withstand voltage, the temporary overvoltage or the recurring peak value of the working voltage is used, as described in 4.4.7.2.2 to 4.4.7.2.4.		P
4.4.7.2.2	Circuits connected to mains supply		P
	Insulation between the surroundings and circuits which are connected directly to the mains supply shall be designed according to the impulse		

	withstand voltage, temporary overvoltage, or working voltage, whichever gives the most severe requirement	Overvoltage category III	P
4.4.7.2.3	Circuits connected to non-mains supply		P
	Insulation between the surroundings and circuits supplied from a non-mains supply shall be designed according to: • the impulse withstand voltage determined from Table 9 using the system voltage; • the working voltage; • the temporary overvoltage if known to exist due to the nature of the supply;		P
4.4.7.2.4	Insulation between circuits		P
	Insulation between two circuits shall be designed according to the circuit having the more severe requirement.		P
	For the design of simple and protective separation between circuits the insulation shall be designed according to: • the circuit having the more severe requirement; or • the working voltage between the circuits;		P
4.4.7.3	Functional insulation		P
	If the failure of functional insulation does not produce a hazard (electrical, thermal, fire), no specific requirements apply for the dimensioning of functional insulation. In other cases the following requirements apply.		P
	For parts or circuits that are significantly affected by external transients, functional insulation shall be designed according to the impulse withstand voltage of overvoltage category II, except that overvoltage category III shall be used when the PECS is connected at the origin of the installation.		P
	Where the circuit characteristics can be shown by testing (see 5.2.3.2) to reduce impulse voltages, functional insulation may be designed for the highest impulse voltage occurring in the circuit during the tests.		P
	For parts or circuits that are not significantly affected by external transients, functional insulation shall be designed according to the working voltage across the insulation.		P
4.4.7.4	Clearance distances		P
4.4.7.4.1	Determination		P

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	Clearances for functional, basic and supplementary insulation shall be dimensioned according to Table 10 (see Annex D for examples of the evaluation of clearance distances). Interpolation is permitted, when clearance is determined from temporary overvoltage or working voltage.		P
	Clearances for reinforced insulation shall be dimensioned to withstand an impulse voltage one step higher than the impulse withstand voltage, or 1,6 times the peak temporary overvoltage or peak working voltage, required for basic insulation.		P
4.4.7.4.2	Electric field homogeneity		P
	If the withstand against steady state voltages, recurring peak or temporary overvoltages according to Table 10 is decisive for the dimensioning of clearance and if these clearances are smaller than the values of Table 10 then an a.c. or d.c. voltage test according to 5.2.3.4 is required. Clearance distances for reinforced insulation shall not be reduced for homogeneous fields.		P
4.4.7.4.3	Clearance to conductive enclosures		P
	The clearance between any non-insulated live part and the walls of a metal enclosure shall be in accordance with 4.4.7.4.1 during and following the deflection tests of 5.2.2.4.2.		P
	Compliance is checked by inspection and by test of 5.2.2.4.2.	≥12mm	P
4.4.7.5	Creepage distances		P
4.4.7.5.1	Insulating material groups		P
	Insulating materials are classified into four groups corresponding to their comparative tracking index (CTI) when tested according to 6.2 of IEC 60112:2003: • Insulating material group I: CTI ≥ 600; • Insulating material group II: 600 > CTI ≥ 400; • Insulating material group IIIa: 400 > CTI ≥ 175; • Insulating material group IIIb: 175 > CTI ≥ 100.		P
	Creepage distance requirements for PWBs exposed to pollution degree 3 environmental conditions shall be determined based on Table 11 pollution degree 3 under “Other insulators”.		P
4.4.7.5.2	Determination		P
	Creepage distances for functional, basic and	≥20mm	P

	supplementary insulation shall be dimensioned according to Table 11. Interpolation is permitted. Creepage distances for reinforced insulation shall be twice the distances required for basic insulation.		
4.4.7.6	Coating		P
	A coating may be used to provide insulation, to protect a surface against pollution, and to allow a reduction in creepage and clearance distances (see 4.4.7.8.4.2 and 4.4.7.8.6).		P
4.4.7.7	PWB spacings for functional insulation		P
	Spacings for functional insulation shall comply with the requirement of 4.4.7.4 and 4.4.7.5.		P
	Decreased spacings on PWB are permitted when all the following are satisfied: • the PWB has flammability rating of V-0 (see IEC 60695-11-10); • the PWB base material has a minimum CTI of 100; • the equipment complies with the PWB short circuit test (see 5.2.4.7).	UL94 V-0	P
4.4.7.8	Solid insulation		P
4.4.7.8.1	General		P
	Materials selected for solid insulation shall be able to withstand the stresses occurring. These include mechanical, electrical, thermal, climatic and chemical stresses which are to be expected in normal use. Insulation materials shall also be resistant to ageing during the expected lifetime of the PECS.		P
	Tests shall be performed on components and sub-assemblies using solid insulation, in order to ensure that the insulation performance has not been compromised by the design or manufacturing process.		P
4.4.7.8.2	Material requirements		P
	The insulating material shall have a CTI of 100 or greater.		P
	The insulating material shall be suitable for the maximum temperature it attains as determined by the temperature rise test of 5.2.3.10. Consideration shall be given as to whether or not the insulating material additionally provides mechanical strength and whether or not the part can be subject to impact during use.		P

4.4.7.8.3	Thin sheet or tape material		P
4.4.7.8.3.1	General		P
	Insulation consisting of thin (less than 0,75 mm) sheet or tape materials is permitted, provided that it is protected from damage and is not subject to mechanical stress under normal use.		P
	Where more than one layer of insulation is used, there is no requirement for all layers to be of the same material.		P
4.4.7.8.3.2	Material thickness equal to or more than 0,2 mm		P
	• Basic or supplementary insulation shall consist of at least one layer of material, which will meet the requirements of 4.4.7.8.1 and 4.4.7.10.1.		P
	• Double insulation shall consist of at least two layers of material, each of which will meet the requirements of 4.4.7.8.1, 4.4.7.10.1, and the partial discharge requirements of 4.4.7.10.2, and both layers together will meet the impulse and a.c. or d.c. voltage requirements of 4.4.7.10.2.		P
	• Reinforced insulation shall consist of a single layer of material, which will meet the requirements of 4.4.7.8.1 and 4.4.7.10.2.		P
4.4.7.8.3.3	Material thickness less than 0,2 mm		P
	Basic or supplementary insulation shall consist of at least two layers of material, which will meet the requirements of 4.4.7.8.1 and 4.4.7.10.1.		P
	Double insulation shall consist of at least three layers of material. Each layer shall meet the requirements of 4.4.7.8.1 and 4.4.7.10.1, and any two layers together shall meet the requirements of 4.4.7.10.2.		P
	Reinforced insulation consisting of a single layer of material is not permitted.		P
4.4.7.8.3.4	Compliance		P
	Compliance shall be checked by the tests described in 5.2.3.1 to 5.2.3.5.		P
	When a component or sub-assembly makes use of thin sheet insulating materials, it is permitted to perform the tests on the component		P

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	rather than on the material.		
4.4.7.8.4	Printed wiring boards (PWBs)	UL	P
4.4.7.8.5	Wound components		P
4.4.7.8.6	Potting materials		P
4.4.7.9	Connection of parts of solid insulation (cemented joints)		P
	The creepage and clearance path in the presence of a cemented joint between two insulating parts, are determined as follows. • Type 1 or type 2 protection as described in 4.4.7.8.4.2 apply. • A cemented joint that is not evaluated as providing protection of type 1 or type 2, is neither considered solid insulation nor to reduce pollution degree. The clearance and creepage distances of Table 10 and Table 11 apply for the pollution degree of the environment around the joint. See 5.2.5.7 for test.		P
4.4.7.10	Requirements for electrical withstand capability		P
4.4.7.10.1	Basic or supplementary insulation		P
	Basic or supplementary insulation shall be tested as follows: • Test with impulse withstand voltage according to 5.2.3.2; and • Test with a.c. or d.c. voltage according to 5.2.3.4.		P
4.4.7.10.2	Double or reinforced insulation		P
	Double or reinforced insulation shall be tested as follows: • Test with impulse withstand voltage according to 5.2.3.2; and • Test with a.c. or d.c. voltage according to 5.2.3.4.		P
	For solid insulation, the partial discharge test according to 5.2.3.5 shall be performed in addition to the above tests, if the recurring peak working voltage across the insulation is greater than 750 V and the voltage stress on the insulation is greater than 1 kV/mm.		P
	The partial discharge test shall be performed as a type test on all components, sub-assemblies and PWB. In addition, a sample test shall be performed if the insulation consists of a single layer of material.		P
	Double insulation shall be designed so that failure		

	of the basic insulation or of the supplementary insulation will not result in reduction of the insulation capability of the remaining part of the insulation.		P
4.4.7.11	Insulation requirements above 30 kHz		P
	Where voltages across insulation have fundamental frequencies greater than 30 kHz, further considerations apply.		P
4.4.8	Compatibility with residual current-operated protective devices (RCD)		P
	An insulation fault or direct contact with certain types of PECS circuits can cause failure current with a d.c. component to flow in the PE conductor and thus reduce the ability of an RCD of type A or AC (see IEC 60755) to provide this protection for other equipment in the installation.		P
	To ensure the intended work of an RCD provided by the installation PECS shall satisfy one of the following conditions.		P
	A Pluggable Type A single-phase PECS, shall be designed so that, under normal and fault conditions any resulting d.c. component of the current in the PE conductor does not exceed the d.c. current withstand requirements in IEC 60755 for RCD of type A.		P
4.4.9	Capacitor discharge		P
	For protection against shock hazard, capacitors within a PECS shall be discharged to a voltage less than DVC As, or to a residual charge less than 50 μC, after the removal of power from the PECS:		P
	• For pluggable PECS type A and B the discharge time shall not exceed 1 s or the hazardous live parts shall be protected against direct contact by at least IPXXB (see 4.4.3.3). • For permanently connected PECS the discharge time shall not exceed 5 s.		P
	For pluggable PECS type A and B and permanently connected PECS, which do not meet the above requirements, access shall only be possible by means of a tool or key and the information and marking requirements of 6.5.2 apply.		P
4.5	Protection against electrical energy hazards		P

4.5.1	Operator access areas		P
4.5.1.1	General		P
	Equipment shall be so designed that there is no risk of electrical energy hazard in operator access areas from accessible circuits by fulfilling requirement of 4.2.	Compliance	P
	A risk of injury due to an electrical energy hazard exists if it is likely that two or more bare parts (one of which may be earthed) between which a hazardous energy level exists, will be bridged by a metallic object.		P
	The likelihood of bridging the parts under consideration is determined by means of the test finger of Figure 1 of IEC 60529:1989, in a straight position. If it is possible to bridge the parts with this test finger, a hazardous energy level shall not exist.		P
	Barriers, guards, and similar means preventing unintentional contact may be provided as an alternative to limiting the energy.		P
4.5.1.2	Determination of hazardous electrical energy level		P
	A hazardous electrical energy level is considered to exist if: • the voltage is 2 V or more; and • power available exceeds 240 VA after 60 s; or • the energy exceeds 20 J.	Compliance	P
4.5.2	Service access areas		P
	Capacitors located behind panels that are removable for servicing, installation, or disconnection shall present no risk of electric energy hazard from charge stored on capacitors after disconnection of the PECS.	Please refer to the user's Manual	P
	Capacitors within a PECS shall be discharged to an energy level less than 20 J, as in 4.5.1.2, within 5 s after the removal of power from the PECS. If this requirement is not achievable for functional or other reasons, the information and marking requirements of 6.5.2 apply.		P
	Compliance is checked by inspection of the equipment and relevant circuit diagrams, taking into account the possibility of disconnection with any "ON"/"OFF" switch in either position and non-operation of periodic power consuming		P

	devices or components within the PECS. If the capacitor discharge time can not be accurately calculated, the discharge time shall be measured.		
4.6	Protection against fire and thermal hazards		P
4.6.1	Circuits representing a fire hazard		P
	The following types of circuits are considered a fire hazard: • circuits directly connected to the mains; • circuits that are not directly connected to the mains but exceed the limits for limited power sources in 4.6.5; • components having unenclosed arcing parts.		P
4.6.2	Components representing a fire hazard		P
4.6.2.1	General		P
	The risk of ignition due to high temperature shall be minimized by the appropriate selection and use of components and by suitable construction.		P
	Electrical components shall be used in such a way that their maximum working temperature under normal or single fault conditions is less than that necessary to cause ignition of the surrounding materials with which they are likely to come into contact. Under normal conditions the limits in Table 14 shall not be exceeded for components or their surrounding material.		P
	Where it is not practical to protect components against overheating under fault conditions, all materials in contact with such components shall be of flammability class V-1, according to IEC 60695-11-10, or better.		P
	Compliance with 4.6.2 and 4.6.3 shall be confirmed by inspection of component and material data sheets and, where necessary, by test.		P
4.6.2.2	Components within a circuit representing a fire hazard		P
	Inside fire enclosures, materials for components and other parts and all materials in contact with such parts shall comply with flammability class V-2 as classified in IEC 60695-11-10 or flammability class HF-2 as classified in ISO 9772 or better.		P
4.6.2.3	Components within a circuit not representing a fire hazard		P
4.6.3	Fire enclosures		P

4.6.3.1	General		P
	Fire enclosures are used to reduce the risk of fire to the environment, independent of the location where they are installed.		P
	A fire enclosure shall be provided for all PECS unless: • the product committee specifies that a fire enclosure is not required; or • there is an agreement between the user and the manufacturer; or • the PECS is intended to be used only in areas without combustible materials and is marked according to 6.3.5.	not applicable	P
4.6.3.2	Flammability of enclosure materials	Metals	P
4.6.3.3	Openings in fire enclosures		P
4.6.3.3.1	General		P
	These requirements are in addition to requirements regarding openings, in other sections of this standard		P
4.6.3.3.2	Openings in the top and side of fire enclosures	side	P
4.6.3.3.3	Openings in the bottom of a fire enclosure		P
4.6.3.3.4	Doors or covers in fire enclosures		P
4.6.4	Temperature limits		P
4.6.4.1	Internal parts		P
	Equipment and its component parts shall not attain temperatures in excess of those in Table 14 when tested in accordance with the ratings of the equipment.	Compliance is checked by test of 5.2.3.10.	P
4.6.4.2	Accessible parts		P
	In order to limit the touch temperatures of accessible parts of PECS, and to protect against long-term degradation of building materials, the maximum temperature for accessible parts of the PECS shall be in compliance with Table 15.		P
	When surface temperatures of the PECS, close to mounting surfaces, exceed the limit of Table 15, a warning according to 6.3.5 shall be provided.	warning	P
	It is permitted that accessible parts that are required to get hot as part of their intended function (for example heatsinks) may have temperatures up to 100 °C, if the parts are not in contact with building materials upon installation, and are marked with the warning given in 6.4.3.4. For products only for use in a restricted access area, the temperature may exceed 100 °C.		P

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4.6.5	Limited power sources		P
	Where an overcurrent protective device is used, it shall be a fuse or a non-adjustable, non-autoreset, electromechanical device.	overcurrent protective device is used	P
4.7	Protection against mechanical hazards		P
4.7.1	General		P
	Failure of any component within the PECS shall not release sufficient energy to lead to a hazard, for example, expulsion of material into an area occupied by personnel.		P
4.7.2	Specific requirements for liquid cooled PECS		P
4.7.2.1	General		P
4.7.2.2	Coolant	Intelligent air cooling	P
4.7.2.3	Design requirements		P
4.7.2.3.1	General	not applicable	N
4.7.2.3.2	Corrosion resistance		N
4.7.2.3.3	Tubing, joints and seals		N
4.7.2.3.4	Provision for condensation		N
4.7.2.3.5	Leakage of coolant		N
4.7.2.3.6	Loss of coolant		N
4.7.2.3.7	Conductivity of coolant		N
4.7.2.3.8	Insulation requirements for coolant hoses		N
4.8	Equipment with multiple sources of supply	not applicable	N
4.9	Protection against environmental stresses		P
	The manufacturer has to specify the following service conditions for operation, storage and transportation:	Please refer to the user's Manual	P
	• coolant temperature (min/max);		N
	• ambient temperature (min/max);	-10℃-40℃	P
	• humidity (min/max);	<95%	P
	• pollution degree;		P
	• vibration;	<5.9m/s^2	P
	• UV resistance;		P
	• OVC (overvoltage category);		P
	• altitude for thermal consideration, if rated for operation above 1 000 m;	≤1500m	P
	• altitude for insulation coordination considerations, if rated for operation above 2 000 m.		N
4.10	Protection against sonic pressure hazards		P
4.10.1	General		P
	The equipment shall provide protection against the effects of sonic pressure. Compliance tests are carried out if the equipment is likely to cause such hazards.		P

4.10.2	Sonic pressure and sound level		P
	If equipment produces noise at a level which could cause a hazard, the noise shall be measured to determine the maximum sound pressure level which the equipment can produce (except that sounds from alarms are not included). If the measured sound pressure exceeds 70 dBA the documentation shall provide information regarding the sound level of the equipment.	64.8dB	P
4.11	Wiring and connections		P
4.11.1	General		P
	The wiring and connections between parts of the equipment and within each part shall be protected from mechanical damage during installation. The insulation, conductors and routing of all wires of the equipment shall be suitable for the electrical, mechanical, thermal and environmental conditions of use. Conductors which are able to contact each other shall be provided with insulation rated for the DVC requirements of the relevant circuits.		P
4.11.2	Routing		P
	A hole through which insulated wires pass in a sheet metal wall within the enclosure of the equipment shall be provided with a smooth, well-rounded bushing or grommet or shall have smooth, well-rounded surfaces upon which the wires bear to reduce the risk of abrasion of the insulation.		P
	Wires shall be routed away from sharp edges, screw threads, burrs, fins, moving parts, drawers, and similar parts, which abrade the wire insulation. The minimum bend radius specified by the wire manufacturer shall not be violated.		P
	Clamps and guides, either metallic or non-metallic, used for routing stationary internal wiring shall be provided with smooth, well-rounded edges. The clamping action and bearing surface shall be such that abrasion, or deformation of the insulation does not occur. If a metal clamp is used for conductors having thermoplastic insulation less than 0,8 mm thick, non-conducting mechanical protection shall be		P

	provided.		
4.11.3	Colour coding		P
	Insulated conductors, other than those which are integral to ribbon cable or multi-cord signal cable, identified by the colour green with or without one or more yellow stripes shall only be used for protective equipotential bonding.		P
4.11.4	Splices and connections		P
	All splices and connections shall be mechanically secured and shall provide electrical continuity.		P
	Electrical connections shall be soldered, welded, crimped, or otherwise securely connected. A soldered joint, other than a component on a PWB, shall additionally be mechanically secured.		P
	When stranded internal wiring is connected to a wire-binding screw, the construction shall be such that loose strands of wire do not contact: • other uninsulated live parts not always of the same potential as the wire; • de-energized metal parts.		P
	When screw terminal connections are used, the resulting connections may require routine maintenance (tightening). Appropriate reference shall be made in the maintenance manual (see 6.5.1).		P
4.11.5	Accessible connections		P
	If relevant, non-interchangeability and protection against polarity reversal of connectors, plugs and socket outlets shall be confirmed by inspection and trial insertion.		P
4.11.6	Interconnections between parts of the PECS		P
	In addition to complying with the requirements given in 4.11.1 to 4.11.5, the means provided for the interconnection between parts of the PECS shall comply with the following requirements or those of 4.11.7.		P
	Cable assemblies and flexible cords provided for interconnection between sections of equipment or between units of a system shall be suitable for the service or use involved. Cables shall be protected from physical damage as they leave the enclosure and shall be provided with mechanical strain relief.		P
	Misalignment of male and female connectors, insertion of a multipin male connector in a		

	female connector other than the one intended to receive it, and other manipulations of parts which are accessible to the operator shall not result in mechanical damage or a risk of thermal hazards, electric shock, or injury to persons.		P
	When external interconnecting cables terminate in a plug which mates with a receptacle on the external surface of an enclosure, no risk of electric shock shall exist at accessible contacts of either the plug or receptacle when disconnected.		P
4.11.7	Supply connections		P
	The connection points provided shall be of appropriate construction to preclude the possibility of loose strands reducing the spacing between conductors when careful attention is paid to installation.		P
4.11.8	Terminals		P
4.11.8.1	Construction requirements		P
	All parts of terminals which maintain contact and carry current shall be of metal having adequate mechanical strength.		P
	Terminal connections shall be such that the conductors can be connected by means of screws, springs or other equivalent means so as to ensure that the necessary contact pressure is maintained.		P
	Terminals shall be so constructed that the conductors can be clamped between suitable surfaces without any significant damage either to conductors or terminals.		P
	Terminals shall not allow the conductors to be displaced or be displaced themselves in a manner detrimental to the operation of equipment and the insulation shall not be reduced below the rated values.		P
4.11.8.2	Connecting capacity		P
	Terminals shall be provided which accommodate the conductors specified in the installation and maintenance manuals (see 6.3.6.4) and cables in accordance with the wiring rules applicable at the installation. The terminals shall meet the temperature rise test of 5.2.3.10.		P
	Information regarding the permitted wire sizes shall be given in the installation manual.		P
	Standard values of cross-section of round copper		

	conductors are shown in Annex G, which also gives the approximate relationship between ISO metric and AWG/MCM sizes.		P
4.11.8.3	Connection		P
	Terminals for connection to external conductors shall be readily accessible during installation.		P
	Sets of terminals for connection to the same input or output shall be grouped together and shall be located in proximity to each other and to the main protective earthing terminal, if any. If the installation instructions provide detail on the proper earthing of the system, the protective earthing terminal need not be placed in proximity to the terminals.		P
	Clamping screws and nuts shall not serve to fix any other component although they may hold the terminals in place or prevent them from turning.		P
4.11.8.4	Wire bending space for wires 10 mm^2 and greater		P
	The distance between a terminal for connection to the main supply, or between major parts of the PECS (for example a transformer), and an obstruction toward which the wire is directed upon leaving the terminal shall be at least that specified in Table 19.		P
4.12	Enclosures		P
4.12.1	General		P
	Enclosures shall be suitable for use in their intended environments. The manufacturer shall specify the intended environment (see 6.3.3) and the IP rating of the enclosure (see 5.2.2.3 for test).		P
	Equipment shall have adequate mechanical strength and shall be so constructed that no hazard occurs when subjected to handling as may be expected.		P
	Mechanical strength tests are not required on an internal barrier, screen or the like, provided to meet the requirements of 4.6.3, if the enclosure provides mechanical protection.		P
	An enclosure shall be sufficiently complete to contain or deflect parts which, because of failure or for other reasons, might become loose, separated or thrown from a moving part.		P
4.12.2	Handles and manual controls		P
	Handles, knobs, grips, levers and the like shall be		

	reliably fixed so that they will not work loose in normal use, if this could result in a hazard. Sealing compounds and the like, other than self-hardening resins, shall not be used to prevent loosening. If handles, knobs and the like are used to indicate the position of switches or similar components, it shall not be possible to fix them in a wrong position if this could result in a hazard.		P
4.12.3	Cast metal		N
4.12.4	Sheet metal		P
	The thickness of a sheet-metal enclosure at points to which a wiring system is to be connected shall be not less than 0,8 mm thick for uncoated steel, 0,9 mm thick for zinc-coated steel, and 1,2 mm thick for non-ferrous metal.		P
4.12.5	Stability test for enclosure		P
	Under conditions of normal use, units and equipment shall not become physically unstable to the degree that they could become a hazard to an operator or to a service person.		P
	During operations performed by a service person, the stabilizing means, if needed, shall either be automatic in operation, or a marking shall be provided to instruct the service person to deploy the stabilizing means.		P
5	**Test requirements**		**P**
5.1	General		P
5.1.1	Test objectives and classification		P
	Testing, as defined in this Clause 5, is required to demonstrate that PECS is fully in accordance with the requirements of this standard. Testing may be waived if permitted by the relevant requirements subclause of Clause 4.		P
	The subclauses in this Clause 5 describe the procedures to be adopted for the testing of PECS. The tests are classified as: • type tests; • routine tests; • sample tests.		P
5.1.2	Selection of test samples		P
	When testing a range or series of similar products, it may not be necessary to test all models in the range. Each test should be performed on a model or models having mechanical and electrical characteristics that	SVG-100kVar	P

	adequately represent the entire range for that particular test.		
5.1.3	Sequence of tests		P
	In general, there is no requirement for tests to be performed in a set sequence, nor is it required that they are all performed on the same sample of equipment. However, the pass criteria for some of the tests require that they are followed by one or more further tests.		P
5.1.4	Earthing conditions		P
	Test requirements shall be determined using the worst-case (most stressful) system earthing allowed by the manufacturer. Systems earthing may include: • neutral to earth; • line to earth; • neutral to earth through high impedance; • isolated (not earthed).	neutral to earth through high impedance	P
5.1.5	General conditions for tests		P
5.1.5.1	Application of tests		P
	Unless otherwise stated, upon conclusion of the tests, the equipment need not be operational.		P
5.1.5.2	Test samples		P
	Unless otherwise specified, the sample or samples under test shall be representative of the equipment the user would receive, or shall be the actual equipment ready for shipment to the user.		P
	As an alternative to carrying out tests on the complete equipment, tests may be conducted separately on circuits, components or sub-assemblies outside the equipment, provided that inspection of the equipment and circuit arrangements indicates that the results of such testing will be representative of the results of testing the assembled equipment. If any such test indicates a likelihood of non-conformance in the complete equipment, the test shall be repeated in the equipment.		P
	Where in this standard compliance of materials, components or sub-assemblies is checked by inspection or by testing of properties, it is permitted to confirm compliance by reviewing any relevant data or previous test results that are available instead of carrying out the specified type tests. See also 4.1		P

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5.1.5.3	Operating parameters for tests		P
	Except where specific test conditions are stated elsewhere in the standard and where it is clear that there is a significant impact on the results of the test, the tests shall be conducted under the most unfavourable combination within the manufacturer's operating specifications of the following parameters:		P
	• supply voltage; • supply frequency; • operating temperature taking derating and cooling control characteristic into account; • physical location of equipment and position of movable parts; • operating mode; • load conditions; • adjustment of thermostats, regulating devices or similar controls in restricted access area, which are: – adjustable without the use of a tool or key; or – adjustable using a means, such as a key or a tool, deliberately provided for the operator.		P
5.1.6	Compliance		P
	Compliance with this standard shall be verified by carrying out the appropriate tests specified in this Clause 5		P
	Compliance may only be claimed if all relevant tests have been passed.		P
	Compliance with construction requirements and information to be provided by the manufacturer shall be verified by suitable examination, visual inspection, and/or measurement.		P
	Whenever design or component changes have potential impact upon compliance, new type testing shall be performed to confirm compliance. It is desirable that the modified product should be identified, for example by using a suitable date code or serial number as described in 6.2.		P
5.1.7	Test overview		P
	Table 22 provides an overview of the type, routine and sample testing of electronic components, equipment and PECS.		P
5.2	Test specifications		P
5.2.1	Visual inspections (type test, sample test and		P

	routine test)		
	Visual inspections shall be made: • as routine tests, to check features such as adequacy of labelling, warnings and other safety aspects; • as acceptance criteria of individual type tests, sample tests or routine tests, to verify that the requirements of this standard have been met.		P
	Routine inspections may be part of the production or assembly process.		P
	Before type testing, a check shall be made that the PECS delivered for the test is as expected with respect to supply voltage, input and output ranges, etc.		P
5.2.2	Mechanical tests		P
5.2.2.1	Clearances and creepage distances test (type test)		P
	It shall be verified by measurement or visual inspection that the clearance and creepage distances comply with 4.4.7.4 and 4.4.7.5. See Annex D for measurement examples. Where this verification is impossible to perform, an impulse voltage test (see 5.2.3.2) shall be performed between the considered circuits.		P
5.2.2.2	Non-accessibility test (type test)		P
	This test is intended to show that live parts, protected by means of enclosures or barriers in compliance with 4.4.3.3, are not accessible		P
5.2.2.3	Ingress protection test (IP rating) (type test)		P
	The claimed IP rating of the enclosure shall be verified. This test shall be performed as a type test of the enclosure of a PECS as specified in IEC 60529 for the enclosure classification.	IP20	P
5.2.2.4	Enclosure integrity test (type test)		P
5.2.2.4.1	General		P
	The integrity tests apply to PECS, and also where PECS are intended for operation without a further enclosure in restricted access areas. After completion of the integrity test, the PECS shall pass the tests of 5.2.3.2 and 5.2.3.4 and shall be inspected to confirm that:		P
	• no degradation of any safety-relevant component of the PECS has occured; • hazardous live parts have not become		

	accessible (see 4.4.3.3); • enclosures show no cracks or openings which could cause a hazard; • clearances are not less than their minimum permitted values and other insulation is undamaged; • barriers have not been damaged or loosened; • no moving parts which could cause a hazard are exposed.		P
	The integrity tests shall be performed at the worst case point on representative accessible face(s) of the enclosure.		P
	The PECS is not required to be operational after testing and the enclosure may be deformed to such an extent that its original IP rating is not maintained.		P
5.2.2.4.2	Deflection test (type test)		P
5.2.2.4.2.1	General		P
	If requested by 4.12.1 the test in 5.2.2.4.2.2 and 5.2.2.4.2.3 applies, for metallic enclosure, as applicable.		P
	The enclosure shall be held firmly against a rigid support.		P
	During the tests of 5.2.2.4.2.2 and 5.2.2.4.2.3, earthed or unearthed conductive enclosures shall not reduce clearance and creepage distances required for basic insulation or withstand the impulse voltage test in 5.2.3.2.		P
5.2.2.4.2.2	Steady force test, 30 N		P
	Parts of an enclosure located in an restricted access area, which are protected by a cover or door meeting the requirements of 5.2.2.4.2.3, are subjected to a steady force of 30 N ± 3 N for a period of 5 s, applied by means of a straight unjointed version of the test finger (Figure 2, test probe B of IEC 61032:1997), to the part on or within the equipment.		P
5.2.2.4.2.3	Steady force test, 250 N		P
	External enclosures are subjected to a steady force of 250 N ± 10 N for a period of 5 s, applied in turn to the top, bottom and sides of the enclosure fitted to the equipment, by means of a		P

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	suitable test tool providing contact over a circular plane surface 30 mm in diameter. However, this test is not applied to the bottom of an enclosure of equipment having a mass of more than 18 kg or to surfaces that are mounted to a wall.		
	For surfaces neither horizontal nor vertical, test shall be performed by tilting the equipment in a suitable way so that the surface is either horizontal or vertical.		P
5.2.2.4.3	Impact test (type test)		P
	A sample consisting of the complete enclosure, or a portion thereof representing the largest unreinforced area, is supported in its normal position. A solid smooth steel ball, approximately 50 mm in diameter and with a mass of 500 g ± 25 g, is permitted to fall freely from rest through a vertical distance (H) of 1,3 m (see Figure 9) onto the sample. Vertical surfaces are exempt from this test.		P
	In addition, the steel ball is suspended by a cord and swung as a pendulum in order to apply a horizontal impact, dropping through a vertical distance (H) of 1,3 m (see Figure 9) onto the sample. Horizontal surfaces are exempt from this test. Alternatively, the sample is rotated 90°about each of its horizontal axes and the ball dropped as in the vertical impact test.		P
5.2.2.4.4	Drop test	Not applicable, the weight of the equipment is 50KG	N
5.2.2.4.5	Stress relief test		P
	Enclosures of moulded or formed thermoplastic materials shall be so constructed that any shrinkage or distortion of the material due to release of internal stresses caused by the moulding or forming operation does not result in the exposure of hazardous parts or in the reduction of creepage distances or clearances below the minimum required.		P
	One sample consisting of the complete equipment, or of the complete enclosure together with any supporting framework, is placed in a circulating air oven (according to IEC 60216-4-1) at a temperature 10 K higher than the maximum temperature of the enclosure during the test of		P

	5.2.3.10, but not less than 70 °C, for a period of 7 h, then permitted to cool at room temperature.		
5.2.2.5	Stability test		P
	To prove the stability of the equipment the following tests shall be carried out, where relevant. Each test is carried out separately. During the tests, reservoirs are to contain the amount of liquid within their rated capacity producing the most disadvantageous condition. All castors and jacks, if used in normal operation, are placed in their most unfavourable position, with wheels and the like locked or blocked. However, if the castors are intended only to transport the unit, and if the installation instructions require jacks to be lowered after installation, then the jacks (and not the castors) are used in this test; the jacks are placed in their most unfavourable position, consistent with reasonable leveling of the unit.		P
	A unit having a mass of 7 kg or more shall not fall over when tilted to an angle of 10° from its normal upright position. Doors, drawers, etc., are closed during this test. A unit provided with multi-positional features shall be tested in the least favourable position permitted by the construction.		P
	A floor-standing unit having a mass of 25 kg or more shall not fall over when a force equal to 20 % of the weight of the unit, but not more than 250 N, is applied in any direction except upwards, at a height not exceeding 2 m from the floor. Doors, drawers, etc., which may be moved for servicing by the operator or by a service person, are placed in their most unfavourable position, consistent with the installation instructions.		P
	A floor-standing unit shall not fall over when a constant downward force of 800 N is applied at the point of maximum moment to any horizontal surface of at least 12,5 cm by at least 20 cm, at a height up to 1 m from the floor. Doors, drawers, etc., are closed during this test. The 800 N force is applied by means of a suitable test tool having a flat surface of approximately 12,5 cm by 20 cm.		P

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	The downward force is applied with the complete flat surface of the test tool in contact with the equipment under test; the test tool need not be in full contact with uneven surfaces (for example, corrugated or curved surfaces).		
5.2.2.6	Wall or ceiling mounted equipment test	Wall mounted	P
	The equipment is mounted in accordance with the manufacturer's instructions. A force in addition to the weight of the equipment is applied downwards through the geometric centre of the equipment, for 1 min. The additional force shall be equal to three times the weight of the equipment but not less than 50 N. The equipment and its associated mounting means shall remain secure during the test.	1min. 150Kg After the test, the equipment remains safe	P
5.2.2.7	Handles and manual controls securement test		N
	Handles and manual controls shall be tested by manual test and by trying to remove the handle, knob, grip or lever by applying for 1 min an axial force as shown in Table 23.		N
	Under the tests above the handles, knobs, grips levers and the like shall remain fixed to the equipment as intended.		N
5.2.3	Electrical tests		P
5.2.3.1	General		P
	The electrical tests described in 5.2.3.2 to 5.2.3.5 are applicable to basic, supplementary and reinforced insulation. Before performing these tests,preconditioning according to 5.2.6.3.1 and 5.2.6.3.2 is required.		P
	When performing electrical and preconditioning tests, the preferred procedure is to test the entire equipment; however it is acceptable to test the components or sub-assemblies providing the basic and reinforced insulation. When components or sub-assemblies are tested, test conditions shall simulate the least favourable conditions occurring inside the equipment at the place of installation.		P
5.2.3.2	Impulse voltage test (type test and sample test)		P
	The impulse voltage test is performed with a voltage having a 1,2/50 μs waveform (see 6.1 and 6.2 of IEC 61180-1:1992) and is intended to simulate overvoltages of atmospheric origin. It also covers overvoltages due to switching of		P

	equipment. See Table 24 for conditions of the impulse voltage test.		
	Tests on clearances smaller than required by 4.4.7.4 and test on solid insulation required by 4.4.7.8 are performed as type tests using appropriate voltages from Table 25.		P
	Tests on components and devices for protective separation are performed as a type test and a sample test before they are assembled into the PECS, using the impulse withstand voltages listed in column 3 or column 5 of Table 25.		P
	To ensure that surge protective devices (see 4.4.7.2.2, 4.4.7.2.3, 4.4.7.3) are able to reduce the overvoltage, the values of column 2 or column 4 in Table 25, are applied to the PECS as a type test. The measured peak voltage shall not exceed the next lower voltage value of the same column of that table.		P
	The impulse voltage test is successfully passed if no puncture of insulation, flashover, or sparkover occurs. In the case of components and devices which use solid insulation for protective separation, a subsequent partial discharge test (see 5.2.3.5) shall also be passed.	2.5KV	P
5.2.3.3	Alternative to impulse voltage test (type test and sample test)		P
	An a.c. or d.c. voltage test according to 5.2.3.4 may be used as an alternative method to the impulse voltage test of 5.2.3.2.		P
	For an a.c. voltage test the peak value of the a.c. test voltage shall be equal to the impulse test voltage of Table 25 and applied for three cycles of the a.c. test voltage.		P
5.2.3.4	AC or d.c. voltage test (type test and routine test)		P
5.2.3.4.1	Purpose of test		P
	The test is used to verify that the clearances and solid insulation of components and assembled PECS have adequate dielectric strength to resist temporary overvoltage conditions.		P
5.2.3.4.2	Value and type of test voltage		P
	The test voltage from column 2 is used for testing circuits with basic insulation.		P
	Between circuits with protective separation		

	(double or reinforced insulation), the test voltage of column 3 shall be applied for type tests. For routine tests between circuits with protective separation the values from column 2 shall be applied to prevent damage to the solid insulation by partial discharge.		P
	The values of column 3 shall apply to PECS with enhanced protection according to 4.4.3.		P
	The test is performed between circuits and accessible surfaces of PECS, which are non-conductive or which are conductive but not connected to the PE conductor.		P
	The voltage test shall be performed with a sinusoidal voltage at 50 Hz or 60 Hz. If the circuit contains capacitors the test may be performed with a d.c. voltage of a value equal to the peak value of the specified a.c. voltage.		P
5.2.3.4.3	Performing the voltage test		P
	The test shall be applied as follows, according to Figure 10:		P
	a) Test (1) between accessible conductive part (connected to earth) and each circuit sequentially (except DVC As circuits). Test voltage according to Table 26, or Table 27, column 2, corresponding to voltage of considered circuit under test. Test (2) between accessible surface (non conductive or conductive but not connected to earth) and each circuit sequentially (except DVC As circuits). Test voltage according to Table 26 or Table 27, column 3 (for type test) or column 2 (for routine test), corresponding to voltage of considered circuit under test.		P
	b) Test between each considered circuit sequentially and the other adjacent circuits connected together. Test voltage according to Table 26 or Table 27, column 2, corresponding to voltage of considered circuit under test.		P
	c) Test between DVC As circuit and each adjacent circuit sequentially. Test voltage according to Table 26 or Table 27, column 3 (for type test) or column 2 (for routine test), corresponding to the circuit with the higher voltage. Either the adjacent circuit or the DVC As circuit may be earthed for this test. It is		P

	necessary to test basic insulation between PELV and SELV circuits, but it is not necessary to test functional insulation between adjacent PELV or adjacent SELV circuits.		
5.2.3.4.4	Duration of the a.c. or d.c. voltage test		P
	The duration of the test shall be at least 60 s for the type test and 1 s for the routine test. The test voltage may be applied with increasing and/or decreasing ramp voltage but the full voltage shall be maintained for 60 s and 1 s respectively for type and routine tests.		P
5.2.3.4.5	Verification of the a.c. or d.c. voltage test		P
	The test is successfully passed if no electrical breakdown occurs during the test.		P
5.2.3.5	Partial discharge test (type test, sample test)		P
	The partial discharge test shall confirm that the solid insulation (see 4.4.7.8) used in components and sub-assemblies for protective separation of electrical circuits remains partial-discharge-free within the specified voltage range (see Table 28).		P
	This test shall be performed as a type test and a sample test. It may be omitted for insulating materials which are not degraded by partial discharge, for example ceramics.		P
	The partial discharge inception and extinction voltage are influenced by climatic factors (e.g. temperature and moisture), equipment self heating, and manufacturing tolerance. These influencing variables can be significant under certain conditions and shall therefore be taken into account during type testing.		P
5.2.3.6	Protective impedance test (type test and routine test)		P
	A type test shall be performed to verify that the current through a protective impedance under normal operating or single-fault conditions does not exceed the values given in 4.4.3.4. The test shall be performed using the circuit of IEC 60990:1999, Figure 4.		P
	The value of the protective impedance shall be verified as a routine test.		P
5.2.3.7	Touch current measurement test (type test)		P
	The touch current shall be measured to determine if the measures of protection need not be taken		

	(see 4.4.4.3.3). The PECS shall be set up in an insulated state without any connection to the earth and shall be operated at rated voltage. Under these conditions, the touch current shall be measured between the means of connection for the PE conductor and the PE conductor itself with the test circuit of Figure 4 of IEC 60990:1999.		P
	• For a PECS to be connected to an earthed neutral system, the neutral of the mains of the test site shall be directly connected to the PE conductor. • For a PECS to be connected to an isolated system or impedance system, the neutral shall be connected through a resistance of 1 kΩ to the PE conductor which shall be connected to each input phase in turn. The highest value will be taken as the definitive result. • For a PECS to be connected to a corner earthed system, the PE conductor shall be connected to each input phase in turn. The highest value will be taken as the definitive result. • For a PECS with a particular system earthing, this system shall operate as intended during the test. • If a PECS is intended to be connected to more than one system network, each of these different system networks (or the worst-case, if that can be determined) shall be used to make the touch current measurement.		P
5.2.3.8	Capacitor discharge test (type test)		P
	The capacitor discharge time as required by 4.4.3.4 may be verified by a type test and/or by calculation taking into account the relevant tolerances.		P
5.2.3.9	Limited power source test (type test)		P
	When required by 4.6.5 a limited power circuit shall be tested as below, with the equipment operating under normal operating conditions.		P
	In case the limited power source requirement depends on overcurrent protective device(s), the device(s) shall be short-circuited.		P
5.2.3.10	Temperature rise test (type test)		P
	The test is intended to ensure that parts and accessible surfaces of the PECS do not exceed		P

	the temperature limits specified in 4.6.4 and the manufacturer's temperature limits of safety-relevant parts.		
	Where possible, the PECS shall be tested at worst-case conditions of rated power and PECS output current, taking derating and cooling control characteristic into account.		P
	For equipment where the amount of heating or cooling is designed to be dependent on temperature (for example, the equipment contains a fan that has a higher speed at a higher temperature), the temperature measurement shall be performed at the worst case ambient temperature condition within the manufacturer's specified operating range.		P
	If this is not possible, it is permitted to simulate the temperature rise, if the validity of the simulation can be demonstrated by tests at lower power levels.		P
	The PECS shall be tested with at least 1,2 m of wire attached to each field wiring terminal. The wire shall be of the smallest size intended to be connected to the PECS as specified by the manufacturer for installation. When there is only provision for the connection of bus-bars to the PECS, they shall be of the minimum size intended to be connected to the PECS as specified by the manufacturer, and they shall be at least 1,2 m in length.		P
	The test shall be maintained until thermal stabilization has been reached. That is, when three successive readings, taken at intervals of 10 % of the previously elapsed duration of the test and not less than 10 min intervals, indicate no change in temperature, defined as ±1 °C between any of the three successive readings, with respect to the ambient temperature.		P
	The temperature of an electrical insulation (other than that of windings) is measured on the surface of the insulation at a point close to the heat source, if a failure of this insulation could cause a hazard. If temperatures of windings are measured by the thermocouple method, the thermocouple shall be located on the surface of the winding assuming the hottest part due to surrounding heat		P

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	emitting components. See also notes in Table 14.		
	The maximum temperature attained shall be corrected to the rated ambient temperature of the PECS by adding the difference between the ambient temperature during the test and the equipment's maximum rated ambient temperature.		P
	No corrected temperature shall exceed the rated temperature of the material or component measured.		P
	During the test, thermal cutout, overload detection functions and devices shall not operate.		P
5.2.3.11	Protective equipotential bonding tests (type tests and routine test)		P
5.2.3.11.1	General		P
	Each conductive accessible part under consideration shall be tested separately, to determine if the protective equipotential bonding path for that part is adequate to withstand the test current that the bonding path may be subjected to under fault conditions.		P
	The circuit under consideration shall be selected from amongst those circuits adjacent to the accessible part under consideration and separated from it by only basic or functional insulation.		P
	All of these selected circuits have to be analyzed regarding prospective short circuit current and the associated protective element(s):		P
	For pluggable equipment type A only the the protective equipotential bonding impedance test of 5.2.3.11.2 have to be performed.		P
	The testing shall include an individual test of the protective equipotential bonding path for each conductive accessible part unless analysis shows that the short circuit withstand capability of the path is adequate, or that the results of one combination are representative of the anticipated results of another combination.		P
5.2.3.11.2	Protective equipotential bonding impedance test		P
5.2.3.11.2.1	Test conditions		P
	Where required by 4.4.4.2.2 and 5.2.3.11.2.1, the impedance of protective equipotential bonding means shall be checked by passing a		P

	test current through the bond for a period of time. The test current is based on the rating of the overcurrent protection for the equipment or part of the equipment under consideration, as follows:		
	for pluggable equipment type A, the overcurrent protective device is that provided external to the equipment (for example, in the building wiring, in the mains plug or in an equipment rack);		P
	for pluggable equipment type B and permanently connected equipment, the maximum rating of the overcurrent protective device specified in the equipment installation instructions to be provided external to the equipment;		N
	the rating of the provided overcurrent device for a circuit or part of the equipment for which an overcurrent protective device is provided as part of the equipment.		P
	Voltages are measured from the protective earthing terminal to all the parts whose protective equipotential bonding means are being considered. The impedance of the PE conductor is not included in the measurement. However, if the PE conductor is supplied with the equipment, it is permitted to include the conductor in the test circuit, but the measurement of the voltage drop is made only from the main protective earthing terminal to the accessible part required to be earthed.		P
5.2.3.11.2.2	Test current, duration and acceptance criteria		P
	The test current is 200 % of the overcurrent protective device rating and the duration of the test is as shown in Table 29. The voltage drop in the protective equipotential bonding means,during and at the end of the test, shall not exceed DVC As, as determined from Table 2 and Table 5 with respect to the accessible surface of the enclosure.		P
	After the tests, visual inspection shall show no damage to the protective equipotential bonding means.		P
5.2.3.11.3	Protective equipotential bonding short circuit		P

	withstand test (type test)		
	As required by 5.2.3.11.2.1 the short circuit test in 5.2.4.3 shall be performed to ensure that protective equipotential bonding has the ability to withstand the prospective short circuit current that it may be subjected to under fault conditions		P
	The testing shall include an individual test of the protective equipotential bonding path for each conductive accessible part unless analysis shows that the short circuit withstand capability of the path is adequate, or that the results of one combination are representative of the anticipated results of another combination.		P
5.2.3.11.4	Protective equipotential bonding continuity test (routine test)		P
	The protective equipotential bonding continuity routine test shall be conducted when: • the continuity of the protective equipotential bonding is achieved by a single means only(for example a single conductor or a single fastener); or • the PECS is assembled at the installation location; or • if required by 5.2.3.11.2.2 c).		P
	The test current may be any convenient value sufficient to allow measurement or calculation of the resistance of the protective equipotential bonding means.		P
	The expected value of the resistance is the result of calculation or simulation according to 5.2.3.11.2.2 considering the length, the cross sectional area and the material of the related protective bonding conductor(s).		P
	Acceptance criteria: the resistance measured shall be within 90 % upto 110 % of the expected value.		P
5.2.4	Abnormal operation and simulated faults tests		P
5.2.4.1	General		P
	Protection against risk of thermal, electric shock and energy hazards in case of abnormal operating condition of a PECS in combination with its installation shall be evaluated by:		P
	a) tests defined in this section; or b) calculation or simulation based on tests as defined in 5.2.4.4 and 5.2.4.6 on a		P

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	representative model of PECS, where no damage other than opening of overcurrent protective devices has occurred to the test sample.		
	Before all abnormal tests, the test sample shall be mounted, connected, and operated as described in the temperature rise test.		P
	Simulated faults or abnormal operating conditions shall be applied one at a time. Faults that are the direct consequence of a simulated fault or abnormal operating conditions are considered to be part of that simulated fault or abnormal operating condition.		P
	The individual tests shall be performed until terminated by activation of a protective device or mechanism (internal or external), a component failure occurs that interrupts the fault condition, or the temperatures stabilize.		P
5.2.4.2	Pass criteria		P
	As a result of the abnormal operation tests, the PECS shall comply with the following:		P
	• there shall be no emission of flame, burning particles or molten metal; • the cheese cloth or surgical cotton indicator shall not have ignited; • the earth connection and protective equipotential bonding of the PECS shall not have opened; • doors and covers shall remain in place; • during and after the test, accessible DVC As, SELV and PELV circuits and accessible conductive parts shall not exhibit voltages greater than the time dependent voltages of Figure 1, Figure 2 or Figure 3, as appropriate and shall be separated from live parts at voltages greater than DVC As with at least basic insulation. Compliance shall be checked by the a.c. or d.c. insulation test of 5.2.3.4 for basic insulation; • during and after the test, live parts at voltages greater than DVC As shall not become accessible.		P
	The PECS is not required to be operational after testing and it is possible that the enclosure can become deformed. Overcurrent protection		P

	integral to the PECS, or required to be used with the PECS, is allowed to open.		
5.2.4.3	Protective equipotential bonding short circuit withstand test (type test)		P
5.2.4.3.1	General		P
	When required by 5.2.3.11.2.1, a protective equipotential bonding path shall be subjected to the following short circuit withstand test.		P
5.2.4.3.2	Test conditions		P
	The equipment under test shall be supplied with power and the output port shall be operating as intended in 5.2.4.1 prior to closing the switching means that applies the short circuit, unless energizing the equipment with the short circuit already applied will be more severe.		P
	The protective equipotential bonding short circuit test shall be performed with the PECS working with light load, unless analysis shows that higher short circuit currents are available under higher loading conditions.		P
	A new sample may be used for each short circuit test.		P
5.2.4.3.3	Protective equipotential bonding short circuit test method		P
	The test current is applied by connecting the accessible part under consideration to one of the conductors of the the test source circuit through a switching means that will not limit the short circuit current. The switch shall be located such that the source is short circuited through the accessible part and its protective equipotential bonding path back to the protective earthing terminal for the source circuit under consideration. The connections to the shorting switch shall be through cables having the same cross-section as specified for the PE conductor in the installation and the length of the cables shall be limited to 2 m. If the size of the PECS requires a greater length, the length shall be as short as practical to perform the test and the short circuit current shall be calibrated at the entrance of the product.		P
5.2.4.3.4	Pass criteria		P
	During and after the test, accessible DVC As, SELV and PELV circuits and accessible		P

	conductive parts shall not exhibit voltages greater than the time dependent voltages of Figure 1, Figure 2 or Figure 3 of 4.4.2.2.3, and shall remain separated from live parts at voltages greater than DVC As by at least basic insulation. Compliance shall be checked by the a.c.or d.c. voltage test of 5.2.3.4 for basic insulation.		
	At the conclusion of the test, there shall be no damage to the protective equipotential bonding means under test. Compliance shall be checked by inspection, and if necessary, by the protective equipotential bonding continuity test (routine test) of 5.2.3.11.4.		P
5.2.4.4	Output short-circuit test (type test)		P
5.2.4.4.1	Load conditions		P
	The short-circuit test shall be performed with the PECS at full load or light load whichever creates the more severe condition.		P
5.2.4.4.2	Short-circuit test method		P
	Power output port terminals shall be provided with cable of a cross-section as specified for the installation connected to an appropriate switching means that will not limit the short circuit current. The complete length of the cable (forth and back) shall be approximately 2 m, unless the size of the PECS requires a greater length, in which case the length shall be as short as practical to perform the test.		P
	The equipment under test shall be supplied with power and the output port shall be operating as intended prior to closing the switching means that applies to the short circuit, unless energizing the equipment with the short circuit already applied will be more severe.		P
	The testing shall include individual tests of each output port where combinations of two or more terminals, including earth, on each individual port are subjected to short circuit tests on those terminals. Analysis may be used to reduce the number of tests if it is shown that the results of one combination are representative of the anticipated results of another combination.		P
	A new sample may be used for each short circuit test.		P

	In addition to determining compliance with the criteria of 5.2.4.2, this test is used to determine the output short circuit current rating of the port under consideration, in accordance with 4.3.2.3. An oscilloscope or other suitable instrument shall be used to measure the peak current during the test, and to measure or calculate the r.m.s. value of the current.		P
5.2.4.5	Output overload test (type test)		P
	The overload test shall be performed after operating the PECS at full load until normal operating temperatures are attained. Each output of the PECS, and each section of a tapped output, shall be overloaded in turn, one at a time. The other outputs and windings are loaded or not loaded whichever load condition of normal use is less favorable.		P
	Overloading is carried out by connecting a variable load across the output or winding. The load is adjusted as quickly as possible and readjusted, if necessary, after 1 min to maintain the applicable overload. No further readjustments are then permitted.		P
	If overcurrent protection is provided by a current-sensitive device or circuit, the overload test current is the maximum current which the overcurrent protection device is just capable of passing for 1 h. Before the test, the overcurrent protection device is made inoperative or replaced by a link with negligible impedance.		P
	For equipment in which the output voltage is designed to collapse when a specified overload current is reached, the overload is slowly increased to the point of maximum output power before the point which causes the output voltage to collapse.		P
	In all other cases, the loading is the maximum power output obtainable from the output.		P
5.2.4.6	Breakdown of components test (type test)		P
5.2.4.6.1	Load conditions		P
	The breakdown of a component, identified as a result of the circuit analysis of 4.2, shall be tested with the PECS at full load or light load whichever creates the more severe condition.		P
5.2.4.6.2	Application of short circuit or open-circuit		P

	The short circuit shall be applied with cable of a cross-section appropriate for the current that normally flows through the component, but not less than 2,5 mm 2 . The length of the loop shall be as short as practical to perform the test. Short circuits and open circuits are applied using an appropriate switching device.		P
	Each identified component shall be subjected to only one breakdown of components test unless both open- and short circuit failure modes are likely in that component.		P
5.2.4.6.3	Test sequence		P
	For the breakdown of components test, identified components shall be short circuited or open-circuited, whichever creates the worst hazard, one at a time.		P
5.2.4.7	PWB short circuit test (type test)		P
	On PWBs, functional insulation provided by spacings which are less than those specified in Table 10 and Table 11 (see 4.4.7.7) shall be type tested as described below		P
	The decreased spacings shall be short circuited one at a time, on representative samples, and the short circuit shall be maintained until no further damage occurs.		P
5.2.4.8	Loss of phase test (type test)		P
	A multi-phase PECS shall be operated with each line (including neutral, if used) disconnected in turn at the input. The test shall be performed by disconnecting one line with the power conversion equipment operating at its maximum normal load and shall be repeated by initially energizing the PECS with one lead disconnected.		P
	The test shall continue until terminated by a protective mechanism, a component failure occurs, or the temperature stabilizes.		P
	For PECS with rated input current greater than 500 A, compliance can be shown through simulation.		N
5.2.4.9	Cooling failure tests (type tests)	not applicable	N
5.2.5	Material tests		P
5.2.5.1	General		P
	When requested by 4.4.7.8.2, the manufacturer shall test the flammability properties of the materials used for insulating purposes, as defined		P

	in 5.2.5.2, 5.2.5.3 and 5.2.5.4.		
	When requested by 4.6.3.2 the manufacturer shall test the flammability properties of the materials used for fire enclosure, as defined in 5.2.5.5.		P
5.2.5.2	High current arcing ignition test (type test)		P
	Five samples of each insulating material (Figure 13) to be tested are used. The samples shall have minimum 130 mm length and 13 mm width and of uniform thickness representing the thinnest section of the part. Edges shall be free from burrs, fins, etc.		P
	The sample under test is supported horizontally in air or on a non-conductive surface so that the electrodes, when touching each other, are in contact with the surface of the sample. The movable electrode is manually or otherwise controlled so that it can be withdrawn from contact with the stationary electrode to break the circuit and lowered to remake the circuit, so as to produce a series of arcs at a rate of approximately 40 arcs/min, with a separation speed of 250 mm/s ± 25 mm/s.		P
	The test is continued until ignition of the sample occurs, a hole is burned through the sample or a total of 200 arcs have elapsed.		P
	The average number of arcs to ignition of the specimens tested shall be not less than 15 for V-0 class materials and not less than 30 for other materials.	UL94 V-0	P
5.2.5.3	Glow-wire test (type test)		P
	The glow-wire test shall be made under the conditions specified in 4.4.7.8.2 according to IEC 60695-2-10 and IEC 60695-2-13.		P
5.2.5.4	Hot wire ignition test (type test – alternative to glow-wire test)		N
5.2.5.5	Flammability test (type test)		P
	Three samples of the complete equipment or three test specimens of the enclosure thereof (see 4.6.3) shall be subjected to this test. Consideration shall be given to leaving in place components and other parts that might influence the performance. The test samples shall be conditioned in a full draft circulating air oven for seven days at 10 °C greater than the maximum		P

	use temperature, as determined by the temperature rise test 5.2.3.10, but not less than 70 °C in any case. Prior to testing, the samples shall be conditioned for a minimum of 4 h at 23 °C ± 2 °C and 50 % ± 5 % relative humidity. The flame shall be applied to an inside surface of the sample at a location judged to be likely to become ignited because of its proximity to a source of ignition including surfaces provided with ventilation holes. If more than one part is near a source of ignition, each sample shall be tested with the flame applied to a different location.		
	The following conditions shall be met as a result of this test: • the material shall not continue to burn for more than 1 min after the fifth 5 s application of the test flame, with an interval of 5 s between applications of the flame; and • flaming drops or flaming or glowing particles that ignite surgical cotton 305 mm below the test specimen shall not be emitted by the test sample at any time during the test.		P
	After the test, equipment shall meet the requirements for basic protection by means of enclosures or barriers in 4.4.3.3.		P
5.2.5.6	Flaming oil test (type test)		N
5.2.5.7	Cemented joints test (type test)		P
	The samples shall be subjected to the conditioning procedure specified in 5.7 of IEC 60664-3:2003, using the following parameters: for the cold test (5.7.1), a temperature of -25 °C shall be used, and for the rapid change of temperature test (5.7.3): –25 °C to +125 °C.		P
	After the conditioning the samples shall pass the following tests in the prescribed order: a) The mechanical strength of the joint shall be evaluated by loading the joint using the forces anticipated to be present under normal conditions. There shall be no separation of the parts. b) The insulation resistance between the conductive parts separated by the joint shall be measured according to 5.8.3 of IEC		P

	60664-3:2003. c) Cemented joints shall be treated as to be thin sheet material and shall be tested according 4.4.7.8.3. d) The sectioning of the joint shall not show any cracks, voids or separation.		
5.2.6	Environmental tests (type tests)		P
5.2.6.1	General		P
	Environmental testing is required to establish the safety of the PECS at the extremes of the environmental classification to which it will be subjected.		P
	If size or power considerations prevent the performance of these tests on the complete PECS, it is permitted to test individual parts that are considered to be relevant to the safety of the PECS.		P
	When testing components or sub-assemblies separately, the temperature during the dry-heat test shall be chosen as to simulate actual use in the end-product. The component or sub-assembly shall be energized simulating the same conditions as in the end-product.		P
5.2.6.2	Acceptance criteria		P
	The following acceptance criteria shall be satisfied: • no degradation of any safety-relevant component of the PECS; • no potentially hazardous behaviour of the PECS during the test; • no sign of component overheating; • no hazardous live part greater than As shall become accessible; • no cracks in the enclosure and no damaged or loose insulators; • pass routine a.c. or d.c. voltage test 5.2.3.4; • pass protective equipotential bonding impedance test 5.2.3.11.2; • no potentially hazardous behaviour when the PECS is operated following the test.		P
5.2.6.3	Climatic tests		P
5.2.6.3.1	Dry heat test (steady state)		P
5.2.6.3.2	Damp heat test (steady state)		P
5.2.6.4	Vibration test (type test)		P
5.2.6.5	Salt mist test (type test)		P

5.2.6.6	Dust and sand test (type test)		P
5.2.7	Hydrostatic pressure test (type test and routine test)		N
6	**Information and marking requirements**		**P**
6.1	General		P
	The purpose of this Clause 6 is to define the information necessary for the safe selection, installation and commissioning, operation, and maintenance of PECS. It is presented as Table 36, showing where the information shall be provided, followed by explanatory subclauses.	Table 36 – Information requirements	P
6.2	Information for selection		P
	Each part of a PECS that is supplied as a separate product shall be provided with information relating to its function, electrical characteristics, and intended environment, so that its fitness for purpose and compatibility with other parts of the PECS can be determined. This information includes, but is not limited to:		P
	• the name or trademark of the manufacturer, supplier or importer; • catalogue number or equivalent; • electrical ratings for each power port: – maximum nominal input voltage; – maximum nominal output voltage; – maximum nominal output current or nominal output power rating; – maximum nominal input current rms for dimensioning overload protective elements and wiring; – number of phases (e.g. 3 a.c.); – nominal frequency range; (e.g. 50-60Hz) protective class (I, II, III); • the type of electrical supply system (e.g. TN, IT, etc.) to which the PECS may be connected; • prospective short circuit current rating(s) in accordance with 4.3.2.2 and 5.2.4.4; • output short circuit current accordance with 4.3.2.3; • protective device characteristics, in accordance with 4.3.2 and 5.2.4.4; • supply requirements of the load (if applicable); • liquid coolant type and design pressure for	Please refer to the user's manual and the marking	P

	liquid cooled PECS; • IP rating for enclosure; • operating and storage environment; • reference(s) to relevant standard(s) for manufacture, test, or use; • reference to instructions for installation, use and maintenance.		
6.3	Information for installation and commissioning		P
6.3.1	General		P
	Safe and reliable installation is the responsibility of the installer, machine builder, and/or user. The manufacturer of any part of the PECS shall provide information to support this task. This information shall be unambiguous, and may be in diagrammatic form.		P
6.3.2	Mechanical considerations		P
	The following drawings shall be prepared by the manufacturer: • dimensional drawing, including mass information; • mounting drawing.	Please refer to the user's manual	P
6.3.3	Environment		P
	In accordance with 4.9 the following environmental conditions shall be specified, for operation, transportation and storage: • climatic (temperature, humidity, altitude, pollution, ultra-violet light, etc.); • mechanical (vibration, shock, drop, topple, etc.); • electrical (overvoltage category).	Please refer to the user's manual	P
6.3.4	Handling and mounting		P
	In order to prevent injury or damage, the installation documents shall include warnings of any hazards which can be experienced during installation. Where necessary, instructions shall be provided for: • packing and unpacking; • moving; • lifting; • strength and rigidity of mounting surface; • fastening; • provision of adequate access for operation, adjustment and maintenance.	Please refer to the user's manual	P
6.3.5	Enclosure temperature		P
	When surface temperatures of the PECS, close to		

	mounting surfaces, exceed the limit of 4.6.4.2 , the installation manual shall contain a warning to consider the combustibility of the mounting surface		P
6.3.6	Connections	Please refer to the user's manual	P
6.3.7	Protection requirements		P
6.3.7.1	Accessible parts and circuits		P
	The installation and maintenance manuals shall identify any accessible parts at voltages greater than DVC As, and shall describe the insulation and separation provisions required for protection	Please refer to the user's manual	P
	The manuals shall also indicate the precautions to be taken to ensure that the safety of DVC As connections is maintained during installation.		P
	Where a hazard is present after the removal of a cover, a warning label shall be placed on the equipment. The label shall be visible before the cover is removed.		P
	The manual of a PECS shall state the maximum voltage allowed to be connected to each port.		P
	The manuals shall provide instructions for the use of PELV circuits within a zone of equipotential bonding.		P
6.3.7.2	Type of electrical supply system		P
	The installation manual of the PECS shall specify requirements for safe earthing including the permitted earthing system of the installation (see 4.4.7.1.4).		P
	The unacceptable earthing systems shall be indicated as: • not permitted; or • with modification of values and/or safety levels which shall be quantified through type test.		P
6.3.7.3	Protective class		P
6.3.7.3.1	General		P
	The installation manual of the PECS shall declare the protective class specified for the PECS and the product shall be marked according to the requirement of 6.3.7.3.2, 6.3.7.3.3, and 6.3.7.3.4.		P
6.3.7.3.2	Protective class I equipment		P
	Terminals for connection of the PE conductor shall be clearly and indelibly marked with one or		

	more of the following: • the symbol IEC 60417-5019 (2011-01) (see Annex C); or • with the letters PE; or • the colour coding green or green-yellow.		P
6.3.7.3.3	Protective class II equipment		N
6.3.7.3.4	Protective class III equipment		N
6.3.7.4	Touch current marking		P
	Where the touch current in the PE conductor exceeds the limits given in 4.4.4.3.3., this shall be stated in the installation and maintenance manuals. In addition, a warning symbol ISO 7010-W001 (2011-06) (see Annex C) shall be placed on the product, and a notice shall be provided in the installation manual to instruct the user that the minimum size of the PE conductor shall comply with the local safety regulations for high PE conductor current equipment.		P
6.3.7.5	Compatibility with RCD marking		P
6.3.7.6	Cable and connection		P
6.3.7.7	External protection devices		P
6.3.8	Commissioning		P
6.4	Information for use		P
6.4.1	General		P
	The user's manual shall include all information regarding the safe operation of the PECS. In particular, it shall identify any hazardous materials and risks of electric shock, overheating, explosion, excessive acoustic noise, etc.	Please refer to the user's manual	P
6.4.2	Adjustment		P
	The user's manual shall give details of all safety-relevant adjustments intended for the user. The identification or function of each control or indicating device and overcurrent protective devices shall be marked adjacent to the item. Where it is not possible to do this on the product, the information shall be provided pictorially in the manual.		P
	Maintenance adjustments may also be described in this manual, but it shall be made clear that they should only be made by qualified personnel.		P
	Clear warnings shall be provided where excessive adjustment could lead to a hazardous state of the PECS.		P
6.4.3	Labels, signs and signals		P

6.4.3.1	General		P
	Labelling shall be in accordance with good ergonomic principles so that notices, controls, indications, test facilities, overcurrent protective devices, etc., are sensibly placed and logically grouped to facilitate correct and unambiguous identification.		P
	All safety related equipment labels shall be located so as to be visible after installation or readily visible by opening a door or removing a cover.		P
	The signal words indicated hereinafter shall be used and the following hierarchy respected: • DANGER to call attention to a high risk, for example: “High voltage”. • WARNING to call attention to a medium risk, for example: “This surface can be hot.” • CAUTION to call attention to a low risk, for example: “Some of the tests specified in this standard involve the use of processes imposing risks on persons concerned.”	Please refer to the user's manual	P
6.4.3.2	Isolators		P
	Where an isolating device is not intended to interrupt load current, a warning shall state: DO NOT OPEN UNDER LOAD.		P
	The following requirements apply to any supply isolating device which does not disconnect all sources of power to the PECS.		P
	• If the isolating device is mounted in an equipment enclosure with the operating handle externally operable, a warning label shall be provided adjacent to the operating handle stating that it does not disconnect all power to the PECS. • Where a control circuit disconnector can be confused with power circuit disconnectors due to size or location, a warning label shall be provided adjacent to the operating handle of the control circuit disconnector stating that it does not disconnect all power to the PECS.		P
6.4.3.3	Visual and audible signals		P
6.4.3.4	Hot surfaces		P
6.4.3.5	Control and device marking		P
6.5	Information for maintenance		P
6.5.1	General		P

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	The PECS shall be marked with the date code, or serial number from which the date of manufacture can be determined.		P
	Safety information shall be provided in the installation and maintenance manuals including, as appropriate, the following: • preventive maintenance procedures and schedules; • safety precautions during maintenance; • location of live parts that can be accessible during maintenance (for example, when covers are removed); • adjustment procedures; • sub-assembly and component repair and replacement procedures; • any other relevant information.	Please refer to the user's manual	P
6.5.2	Capacitor discharge		P
	When the requirements in 4.4.3.4 are not met, the warning symbol ISO 7010-W012 (2011-06) (see Annex C) and an indication of the minimum discharge time required for discharge under worst conditions (for example, discharge time 5 min) shall be placed in a clearly visible position on the enclosure, the capacitor protective barrier, or at a point close to the capacitor(s) concerned (depending on the construction). The symbol shall be explained and the time required for the capacitors to discharge after the removal of power from the PECS shall be stated in the installation and maintenance manuals.	Please refer to the user's manual	P
6.5.3	Auto restart/bypass connection		P
6.5.4	Other hazards		P
	The manufacturer shall identify, on the product, in the installation and maintenance manuals, as applicable, any components and materials of a PECS which require special procedures to prevent hazards on the product.	Please refer to the user's manual	P
6.5.5	Equipment with multiple sources of supply		N
	In accordance with 4.8, where there is more than one source of supply energizing the PECS,information shall be provided to indicate which disconnect device or devices are required to be operated in order to completely isolate the equipment.		N

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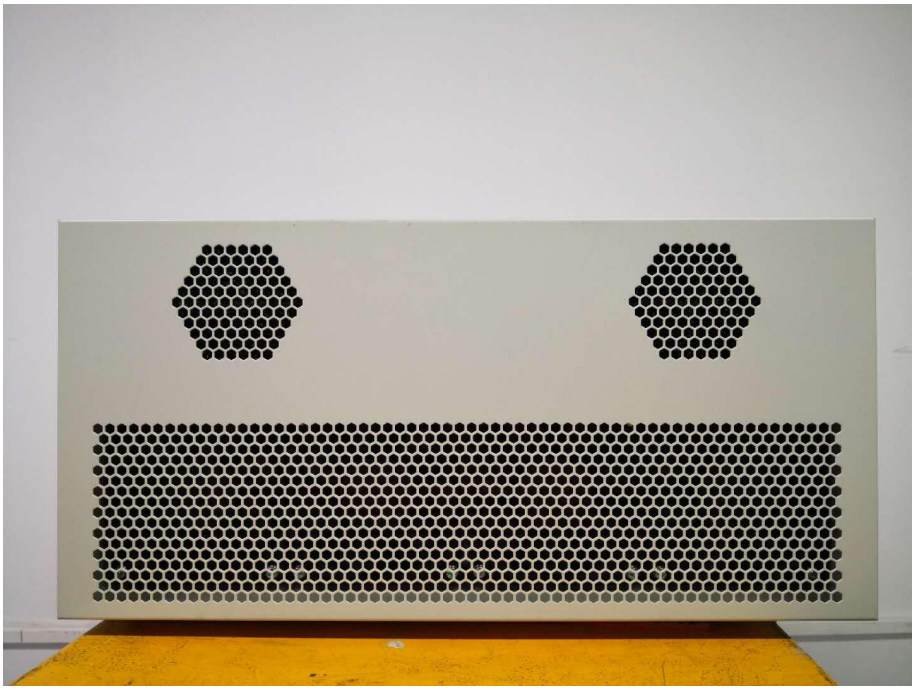

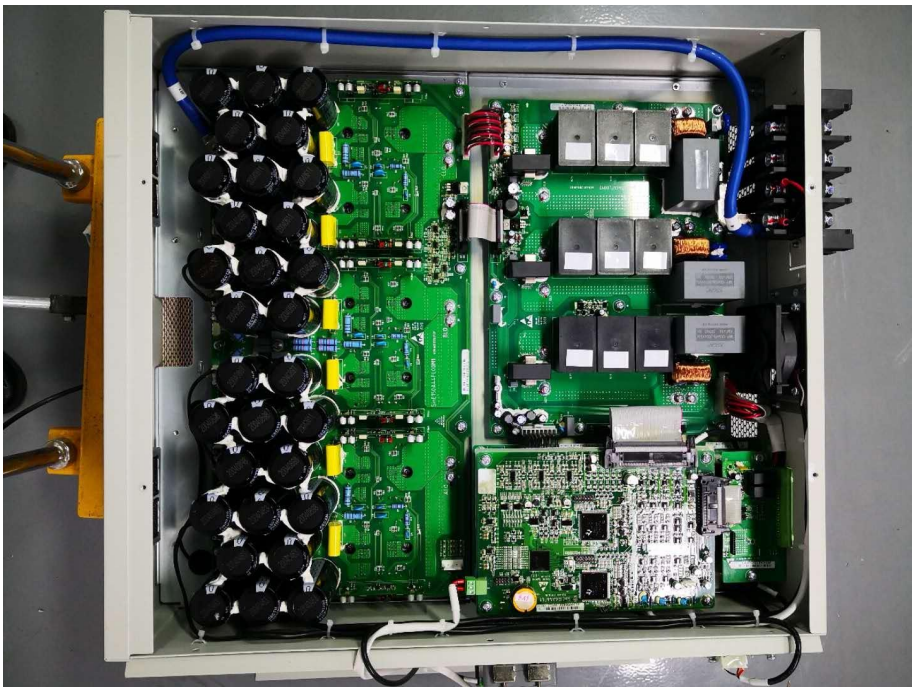

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