Report No. 58250SC10016301

Test Report

Client Name	:	Shenzhen Zk electric technology co., limited
Address	:	Room 617, Guanlida Building, NO. 269 of Qianjin Road, Wenhui community, Xin'an street, Bao'an District, Shenzhen city.
Product Name	:	Inverter
Date	:	Jun. 21, 2021

Anbotek (Guangzhou) Compliance Laboratory Limited

TEST REPORT

EN 61800-5-1

Adjustable speed electrical power drive systems–
Part 5-1: Safety requirements – Electrical, thermal and energy

Report	
Report reference No. ..... :	58250SC10016301
Tested by ..... :	Clearloveq Zheng
Approved by ..... :	Terry Tian
Date of issue ..... :	Jun. 21, 2021
Contents ..... :	68 pages
Testing laboratory	
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Testing location ..... :	As above
Client	
Name ..... :	Shenzhen Zk electric technology co., limited
Address ..... :	Room 617, Guanlida Building, NO. 269 of Qianjin Road, Wenhui community, Xin'an street, Bao'an District, Shenzhen city.
Test specification	
Standard ..... :	EN 61800-5-1: 2007+A1: 2017
Procedure deviation ..... :	N.A.
Non-standard test method ..... :	N.A.
Test item	
Description ..... :	Inverter
Trademark ..... :	ZK
Model and/or type reference ..... :	See attachment 1 on page 4
Manufacturer ..... :	Shenzhen Zk electric technology co., limited
Address ..... :	Room 617, Guanlida Building, NO. 269 of Qianjin Road, Wenhui community, Xin'an street, Bao'an District, Shenzhen city.
Factory ..... :	Same as manufacturer
Address ..... :	Same as manufacturer
Rating(s) ..... :	See attachment 1 on page 4

Particulars: test item vs. test requirements	
Equipment mobility ..... :	Stationary equipment
Tested for IT power systems ..... :	N.A.
IT testing, phase-phase voltage (V) ..... :	N.A.
Class of equipment..... :	Class I
Protection against ingress of water ..... :	IPX0
Rated ambient temperature Ta (℃) ..... :	-5℃~+40℃
Test case verdicts	
Test case does not apply to the test object……..:	N.A
Test item does meet the requirement..... :	P(Pass)
Test item does not meet the requirement..... :	F(Fail)
Testing	
Date of receipt of test item ..... :	May 29, 2021
Date(s) of performance of test..... :	May 29, 2021 to Jun. 07, 2021

General remarks

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

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

"(see appended table)" refers to a table appended to the report.

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

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According to the EU directives which have been aligned with EU NLF (new legislative framework), both of manufacturer and importer’s name and address shall be affixed on the product or, where that is not possible, on its packaging or in a document accompanying the product before the product is placed on the EU market.

Notes: All models are same except the rated power and appearance.

Copy of marking plate:

Inverter

Model: SU100-D3-004G-B

Rating: Input: AC380V/DC350-750V

Output: AC0-440V, 45A, 0-600Hz

Shenzhen Zk electric technology co., limited

Room 617, Guanlida Building, NO. 269 of Qianjin Road, Wenhui community, Xin'an street, Bao'an District, Shenzhen city.

Attachment 1

Model	Input voltage 1 (V.AC)	Input voltage 2 (V.DC)	Output current (A)	Output voltage (V.AC)	Output frequency (Hz)
SU10M-D1-R75G-B	110	90-400	7	0-110	0-600
SU10M-D1-1R5G-B	110	90-400	10	0-110	0-600
SU10M-D2-R75G-B	220	150-450	4	0-240	0-600
SU10M-D2-1R5G-B	220	150-450	7	0-240	0-600
SU10M-D2-2R2G-B	220	150-450	10	0-240	0-600
SU10M-D3-R75G-B	380	250-750	3	0-460	0-600
SU10M-D3-1R5G-B	380	250-750	4	0-460	0-600
SU10M-D3-2R2G-B	380	250-750	5	0-460	0-600
SU10M-D3-004G-B	380	250-750	9.5	0-460	0-600
SU10M-D3-5R5G-B	380	250-750	13	0-460	0-600
SU10M-D3-7R5G-B	380	250-750	17	0-460	0-600
SU100-D1-R75G-B	110	90-400	7	0-110	0-600
SU100-D1-1R5G-B	110	90-400	10	0-110	0-600
SU100-D2-R75G-B	220	150-450	4	0-240	0-600
SU100-D2-1R5G-B	220	150-450	7	0-240	0-600
SU100-D2-2R2G-B	220	150-450	10	0-240	0-600
SU100-D2-004G-B	220	150-450	16	0-240	0-600
SU100-D3-R75G-B	380	250-780	3	0-460	0-600
SU100-D3-1R5G-B	380	250-780	4	0-460	0-600
SU100-D3-2R2G-B	380	250-780	6	0-460	0-600
SU100-D3-004G-B	380	350-750	10	0-440	0-600
SU100-D3-5R5G-B	380	250-780	13	0-460	0-600
SU100-D3-7R5G-B	380	250-780	17	0-460	0-600
SU100-D3-011G-B	380	250-780	25	0-460	0-600
SU100-D3-015G-B	380	250-780	32	0-460	0-600
SU100-D3-018G-B	380	250-780	38	0-460	0-600
SU100-D3-022G-B	380	250-780	45	0-460	0-600
SU100-D3-030G	380	250-780	60	0-460	0-600
SU100-D3-037G	380	250-780	75	0-460	0-600

SU100-D3-045G	380	250-780	90	0-460	0-600
SU100-D3-055G	380	250-780	110	0-460	0-600
SU100-D3-075G	380	250-780	150	0-460	0-600
SU100-D3-093G	380	250-780	180	0-460	0-600
SU100-D3-110G	380	250-780	210	0-460	0-600
SU100-D3-132G	380	250-780	250	0-460	0-600
SU100-D3-160G	380	250-780	310	0-460	0-600
SU100-D3-185G	380	250-780	340	0-460	0-600
SU100-D3-200G	380	250-780	380	0-460	0-600
SU100-D3-220G	380	250-780	415	0-460	0-600
SU100-D3-250G	380	250-780	470	0-460	0-600
SU100-D3-280G	380	250-780	510	0-460	0-600
SU100-D3-315G	380	250-780	600	0-460	0-600
SU100-D3-355G	380	250-780	670	0-460	0-600
SU100-D3-400G	380	250-780	750	0-460	0-600
SU100-D3-450G	380	250-780	810	0-460	0-600
SU100-D3-500G	380	250-780	860	0-460	0-600
SU100-D3-560G	380	250-780	990	0-460	0-600
SU100-D3-630G	380	250-780	1100	0-460	0-600
SU100-D3-720G	380	250-780	1260	0-460	0-600
SU100-D3-800G	380	250-780	1450	0-460	0-600

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Clause	Requirement – Test	Result - Remark	Verdict
4	Protection against electric shock, thermal, and energy hazards		--
4.1	General	See below	--
	This clause 4 defines the minimum requirements for the design and construction of a PDS. to ensure its safety during installation, normal operating conditions and maintenance for the expected lifetime of the PDS. Consideration is also given to minimising hazards resulting from reasonably foreseeable misuse.		P
4.2	Fault conditions		--
	PDS 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.		P
4.3	Protection against electric shock	See below	--
4.3.1	Decisive voltage classification		P
4.3.1.1	Use of decisive voltage class (DVC)	Class C	P
	Protective measures against electric shock depend on the decisive voltage classification of the circuit according to Table 3, which correlates the limits of the working voltage within the circuit with the DVC. The DVC in turn determines the minimum required level of protection for the circuit.		P
4.3.1.2	Limits of DVC	DVC C	P
4.3.1.3	Requirements for protection		P
	Table 4 shows the requirements for the application of basic insulation or protective separation, dependent on the DVC of the circuit under consideration and of adjacent circuits.	Basic insulation for circuit of higher voltage.	P
4.3.1.4	Circuit evaluation		--
4.3.1.4.2	AC working voltage (see Figure 2)		P
	The working voltage has an r.m.s. value of UAC and a recurring peak value of UACP.		P
	The decisive voltage class is that of the lowest voltage row of Table 3 for which both of the following conditions are satisfied.		P
	- UAC < UACL		P
	- UACP < UACPL		P
4.3.1.4.3	D.C. working voltage (see Figure 3)		N
	The working voltage has a mean value of UDC and a recurring peak value of UDCP, caused by a ripple voltage of r.m.s. value not greater than 10% of UDC.		N

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Clause	Requirement – Test	Result - Remark	Verdict
	The decisive voltage class is that of the lowest voltage row of Table 1 for which both of the following conditions are satisfied.		N
	- UDC < UDCL		N
	$U_{DCP} \leq 1{,}17 \times U_{DCL}$		N
4.3.1.4.4	Pulsating working voltage (see Figure 4)		N
	The working voltage has a mean value of UDC and a recurring peak value of UACP, caused by a ripple voltage of r.m.s. value UAC greater than 10% of UDC.		N
	The decisive voltage class is that of the lowest voltage row of Table 1 for which both of the following conditions are satisfied.		N
	$U_{AC}/U_{ACL} + U_{DC}/U_{DCL} \leq 1$		N
	$U_{ACP}/U_{ACPL} + U_{DC}/(1{,}17 \times U_{DCL}) \leq 1$		N
4.3.2	Protective separation	See below	--
	Protective separation shall be achieved by application of materials resistant to degradation, as well as by special constructive measures; and		P
	by double or reinforced insulation,		N
	by protective screening, i.e. by a conductive screen connected to earth by protective bonding of the PDS, or connected to the protective earth conductor itself, whereby the screen is separated from live parts by at least basic insulation,		N
	by protective impedance according to 4.3.4.3 comprising limitation of discharge energy and of current, or by limitation of voltage according to 4.3.4.4.		P
	The protective separation shall be fully and effectively maintained under all conditions of intended use of the PDS.		P
4.3.3.3	Protection by means of enclosures and barriers	See below	--
	Live parts of DVC B, C or D shall be arranged in enclosures or located behind enclosures or barriers, which meet at least the requirements of the Protective Type IPXXB according to 15.1 of IEC 60529.		N
	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.		N

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Clause	Requirement – Test	Result - Remark	Verdict
	See 5.2.2.3 for test. It shall only be possible to open enclosures or remove barriers with the use of a tool or after de-energization of these live parts.		P
	Where the enclosure is required to be opened and the PDS energised during installation ormaintenance:		P
	a) Where the enclosure is required to be opened and the PDS energised during installation ormaintenance:		N
	b) live parts of DVC B, C or D that are likely to be touched when making adjustments shall be protected to at least IPXXB;		N
	c) it shall be ensured that persons are aware that live parts of DVC B, C or D are accessible.	DVC C	P
	Open type sub-assemblies and devices do not require protective measures against direct contact.		P
	Products containing circuits of DVC A, B or C, intended for installation in closed electrical operating areas, as defined in 3.5, need not have protective measures against direct contact.	DVC C	P
	Products containing circuits of DVC D, intended for installation within a closed electrical operating area, have additional requirements (see 4.3.12).		N
4.3.4	Protection in case of direct contact	See below	--
4.3.4.1	General		--
	Protection in case of direct contact is required to ensure that contact with live parts does not produce a shock hazard.		P
	The protection against direct contact according to 4.3.3 is not required if the circuit contacted is separated from all other circuits according to 4.3.1.3, and:		N
	is of DVC A and complies with 4.3.4.2,		N
	is current limited via a protective impedance according to 4.3.4.3,		P
	is limited in voltage according to 4.3.4.4		N
	NOTE The requirements of these subclauses apply to the entire circuit including power supplies and any associated peripheral devices.		P
	Compliance with protective separation requirements shall be verified according to 5.2.1, 5.2.2, and 5.2.3 as appropriate.		P
4.3.4.2	Protection using DVC A		N

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Clause	Requirement – Test	Result - Remark	Verdict
	Unearthed circuits of DVC A, and earthed circuits of DVC A used within a zone of equipotential bonding (see 3.44), do not require protection in case of direct contact.	DVC C	N
	Earthed circuits of DVC A that are not within a zone of equipotential bonding require additional protection in case of direct contact, by one of the measures given in 4.3.4.3 or 4.3.4.4, in order to provide protection in cases where the earth reference potentials of the DVC A circuits are not the same.		N
	The instruction manual shall provide information concerning the use of these circuits (see 6.3.6.5).		N
4.3.4.3	Protection by means of protective impedance		P
	The connection of accessible live parts to circuits of DVC B, C or D, or to earthed circuits of DVC A not used within a zone of equipotential bonding, shall only be made through protective impedances (unless 4.3.4.4 applies).		P
	The same constructional provisions as those for protective separation shall be applied for the construction and arrangement of a protective impedance.		P
	The current value stated below shall not be exceeded in the event of failure of a single component.		P
	The stored charge available between simultaneously accessible parts protected by the protective impedance shall not exceed 50 µC.		N
	The protective impedances shall be designed so that the current available through them to earth at the accessible live part does not exceed a value of 3,5 mA a.c. or 10 mA d.c. See 5.2.3.4 for test		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 5.2.3.1 and 5.2.3.2 for tests.		P
4.3.4.4	Protection by means of limited voltages		N
	This type of protection implies a voltage division technique from a circuit protected against direct contact, resulting in a voltage to earth not greater than that of DVC A.	DVC C	N
	the voltage across output terminals as well as the voltage to earth will not become greater than that of DVC A.		N
	The same constructional measures as in protective separation shall be employed in this case.		N

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Clause	Requirement – Test	Result - Remark	Verdict
	This type of protection shall not be used in case of protective class II, because it relies on protective earth being connected.		N
4.3.5	Protection against indirect contact	See below	--
4.3.5.1	General		--
4.3.5.2	Insulation between live parts and accessible conductive parts		P
	Accessible conductive parts of equipment shall be separated from live parts at least by basic insulation or by clearances as in 4.3.6.4.		P
4.3.5.3	Protective bonding circuit		--
4.3.5.3.1	General		--
	when accessible conductive parts are protected by one of the measures in 4.3.4.2 to 4.3.4.4; protective bonding shall be provided between accessible conductive parts of equipment and the means of connection for the protective earthing conductor:		P
	a) when accessible conductive parts are protected by one of the measures in 4.3.4.2 to 4.3.4.4;		P
	b) when accessible conductive parts are separated from live parts using double or reinforced insulation.		N
	The protective bonding circuit shall not incorporate a switching device, an overcurrent device (e.g. switch, fuse) or means of current detection for such devices.	No switching and overcurrent	P
4.3.5.3.2	Rating of protective bonding		P
	Protective bonding shall withstand the highest thermal and dynamic stresses that can occur to the PDS/CDM/BDM item(s) concerned when they are subjected to a fault connecting to accessible conductive parts.		P
	The protective bonding shall 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.		P
	These conditions will be satisfied if the cross-section of the protective bonding conductor is the same as that for the protective earthing conductor according to 4.3.5.4. For testing, see 5.2.3.9.		P
4.3.5.3.3	Protective bonding impedance		P

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Clause	Requirement – Test	Result - Remark	Verdict
	during normal operation, no voltage exceeding continuously 5 V a.c. or 12 V d.c. can persist between the accessible conductive parts and the means of connection for the protective earthing conductor,		P
	under fault conditions, no voltage exceeding AC-2 or DC-2 in Figure 7 can persist between accessible conductive parts and the means of connection for the protective earthing conductor until an upstream protective device removes power from the part.		P
	The upstream protective device considered for this requirement shall have the characteristics required by the installation manual according to 6.3.7.		P
4.3.5.4	Protective earthing conductor		--
	A protective earthing conductor shall be connected at all times when power is supplied to the PDS/CDM/BDM, unless the PDS/CDM/BDM complies with the requirements of protective class II (see 4.3.5.6). .	Class I	P
	Unless local wiring regulations state otherwise, the protective earthing conductor cross-sectional area shall be determined from Table 5 or by calculation according to 543.1 of IEC 60364-5-54		P
	If the protective earthing 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.	No such devices	N
	For special system topologies, such as 6-phase motors, the PDS designer shall verify the protective earthing conductor cross-section required.		N
4.3.5.5	Means of connection for the protective conductor	See below	--
4.3.5.5.1	General		--
	Every PDS or PDS element (motor, converter, transformer) requiring protective bonding shall have a means of connection for the external protective conductor, located near the terminals for the respective live conductors. The means of connection shall be corrosion-resistant and shall be suitable for the connection of cables according to Table 5 and of cables in accordance with the wiring rules applicable at the installation. The means of connection for the external protective conductor shall not be used as a part of the mechanical assembly of the equipment or for other connections. A separate means of connection shall be provided for each external protective conductor.		P

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Clause	Requirement – Test	Result - Remark	Verdict
	For special system topologies, such as 6-phase motors, the PDS designer shall verify the protective conductor cross-section required.		N
	For high-voltage products, the high voltage cables shall have provision for protective bonding in accordance with IEC 60204-11 and IEC 61800-4. The protective bonding concept shall be by agreement between the supplier and user and consistent with local requirements in the area of installation.	Low-voltage	N
	Connection and bonding points shall be so designed that their current-carrying capacity is not impaired by mechanical, chemical, or electrochemical influences. Where enclosures and/or conductors of aluminium or aluminium alloys are used, particular attention should be given to the problems of electrolytic corrosion.		P
	See 6.3.6.6 for marking requirements.		P
4.3.5.5.2	Connection under high leakage current		P
	If the leakage current (measured in accordance with 5.2.3.5) is higher than 3,5 mA a.c. or 10 mA d.c., a fixed connection is required and one or more of the following conditions shall be satisfied:		P
	a) a cross-section of the protective conductor of at least 10 mm^2 Cu or 16 mm^2 Al;	Great than 10 mm^2	P
	automatic disconnection of the supply in case of discontinuity of the protective conductor;	No such devices	N
	provision of an additional terminal for a protective conductor of the same cross-sectional area as the original protective conductor.	Only one	N
	b) connection with an industrial connector according to IEC 60309 and a minimum protective earthing conductor cross-section of 2,5 mm^2 as part of a multi-conductor power cable.	35 mm^2	P
	Adequate strain relief shall be provided.		N
	For marking requirements, see 6.3.6.7		N
4.3.5.6	Special features in equipment for protective class II	Class I this subclause is not applicable	N
	If equipment is designed to use double or reinforced insulation between live parts and accessible surfaces in accordance with 4.2.3.2, then the design is considered to meet protective class II, if the following also apply:		N

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Clause	Requirement – Test	Result - Remark	Verdict
	- equipment designed to protective class II shall not have means of connection for the protective conductor. However this does not apply if the protective conductor is passed through the equipment to equipment series-connected beyond it. In the latter event, the protective conductor and its means for connection shall be insulated with basic insulation from the accessible surface of the equipment and from circuits which employ protective separation, extra-low voltage, protective impedance and limited discharging energy, according to 4.2.4. This basic insulation shall correspond to the rated voltage of the series connected equipment;		N
	- metal-encased equipment of protective class II may have provision on its enclosure for the connection of an equipotential bonding conductor;		N
	- equipment of protective class II may have provision for the connection of an earthing conductor for functional reasons or for the damping of overvoltages; it shall, however, be insulated as though it is a live part;		N
	Equipment of protective class II shall be marked according to 6.3.6.6.		N
4.3.6	Insulation	See below	--
4.3.6.1	General		--
4.3.6.1.1	Influencing factors		P
	This subclause gives minimum requirements for insulation, based on the principles of IEC 60664 and IEC 60071.		P
	Manufacturing tolerances shall be taken into account during design and installation of the PDS.		P
	For integrated PDS the motor insulation system shall meet the requirements of the relevant part of IEC 60034. The CDM/BDM shall comply with the requirements of 4.3.6.		P
	Insulation shall be selected after consideration of the following influences:		P
	- pollution degree;	Pollution degree 2	P
	- overvoltage category;	Overvoltage category 3	P
	- supply earthing system;		P
	- insulation voltage;		P
	- location of insulation;	Live parts	P
	- type of insulation;	Class I	P
	Verification of insulation shall be made according to 5.2.2.1, 5.2.3.1, 5.2.3.2, and 5.2.3.3.		P
4.3.6.1.2	Pollution degree	Pollution degree 2	P

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Clause	Requirement – Test	Result - Remark	Verdict
	Insulation, especially when provided by clearances and creepage distances, is affected by pollution which occurs during the service life of the PDS. The micro-environmental conditions for insulation shall be applied according to Table 6.		P
	In accordance with IEC 61800-1, IEC 61800-2 and IEC 61800-4, a standard PDS is designed for pollution degree 2. This requires that one of the following apply:		P
	a) instructions are provided with the PDS indicating that it shall be installed in a pollution degree 2 environment; or		P
	b) the specific installation application of the PDS is known to be a pollution degree 2 environment; or		P
	c) the PDS enclosure provides adequate protection against what is expected in pollution degree 3 and 4 (conductive pollution and condensation)	Pollution degree 2	N
	If none of these requirements are met, pollution degree 3 shall be assumed in determining the insulation. Thereby the PDS is usable for pollution degree 1, 2 and 3 environments. If operation in pollution degree 4 is required, item c) shall be met.		N
4.3.6.1.3	Overvoltage category		P
	The concept of overvoltage categories (based on IEC 60664-1) is used for equipment energized from the supply mains. Four categories are considered:		P
	– category IV applies to equipment used at the origin of an installation. Examples are electricity meters and primary overcurrent protection equipment and other equipment connected directly to outdoor open lines;	Indoor used	N
	– category III applies to equipment in fixed installations. Examples are switchgear and equipment for permanent connection to an industrial installation;		P
	– category II applies to equipment powered from the fixed installation. Examples are appliances, portable tools and other plug-connected equipment;		N
	– category I applies to equipment connected to a circuit where measures have been taken to reduce transient overvoltages to a low level.		N
4.3.6.1.4	Supply earthing systems		P
	Three basic types of earthing system are described in IEC 60364-1. They are:		P

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Clause	Requirement – Test	Result - Remark	Verdict
	- TN system: has one point directly earthed, the exposed conductive parts of the installation being connected to that point by protective conductors. Three types of TN system, TN-C, TN-S and TN-C-S, are defined according to the arrangement of the neutral and protective conductors;	TN-C-S system	P
	- TT system: has one point directly earthed, the exposed conductive parts of the installation being connected to earth electrodes electrically independent of the earth electrodes of the power system;		N
	- IT system: has all live parts isolated from earth or one point connected to earth through an impedance, the exposed conductive parts of the installation being earthed independently or collectively to the earthing system.		N
4.3.6.1.5	Insulation voltages		--
	Table 7 and Table 8 use the system voltage of the circuit under consideration and overvoltage category to define the impulse voltage. The system voltage is also used to define the temporary overvoltage.		P
4.3.6.2	Insulation to the surroundings		--
4.3.6.2.1	General		--
	Insulation for basic, supplementary, and reinforced insulation between a circuit and its surroundings, shall be designed according to:	Basic insulation	P
	- the impulse voltage; or	Overvoltage category III	P
	- the temporary overvoltage; or	2550V	P
	- the working voltage of the circuit.	<600V	P
	For creepage distances, the r.m.s. value of the working voltage is used: for clearance distances and solid insulation, the recurring peak value is used, as described in 4.3.6.2.2 to 4.3.6.2.4.		P
	NOTE Examples of working voltage with the combination of a.c., d.c. and recurring peaks are on the d.c. link of an indirect voltage source converter, or the damped oscillation of a thyristor snubber, or internal voltages of a switch-mode power supply.		N
	The impulse voltage and temporary overvoltage depend on the system voltage of the circuit, and the impulse voltage also depends on the overvoltage category, as shown in Table 7 (for low-voltage PDS) and Table 8 (for high-voltage PDS).	Overvoltage category III	P
	The system voltage in column 1 of these tables is:	See below	--
	For Table 7:		--

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Clause	Requirement – Test	Result - Remark	Verdict
	– in TN and TT systems: the r.m.s. value of the rated voltage between a phase and earth;		P
	NOTE A corner-earthed system is a TN system with one phase earthed, in which the system voltage is the r.m.s. value of the rated voltage between a non-earthed phase and earth.		P
	– in three-phase IT systems: - for determination of impulse voltage, 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); - for determination of temporary overvoltage, the r.m.s. value of the rated voltage between phases;		N
	– in single-phase IT systems: the r.m.s. value of the rated voltage between phases.		N
	For Table 5: the r.m.s. value of the rated voltage between phases.		N
4.3.6.2.2	Circuits connected directly to the supply mains		--
	Insulation between the surroundings and circuits which are connected directly to the supply mains shall be designed according to the impulse voltage, temporary overvoltage, or recurring peak value of the working voltage, whichever gives the most severe requirement.		P
	This insulation is normally evaluated to withstand impulses of overvoltage category III, except that overvoltage category IV shall be used when the PDS is connected directly to the origin of the installation. Overvoltage category II may be used for plug-in equipment connected to a supply for non-industrial purposes without special requirements with regard to reliability.	Overvoltage category III	P
	If measures are provided which reduce transient overvoltages of category IV to values of category III, or values of category III to values of category II, basic or supplementary insulation may be designed for the reduced values. Devices used for such measures shall be approved by a suitable safety authority for use at the maximum intended supply voltage (including tolerances). Where appropriate, the measures shall be monitored.		N
	The requirements for double or reinforced insulation shall not be reduced.		P
	NOTE 1 Circuits which are connected to the supply mains via protective impedances, according to 4.3.4.3, or via means of voltage limitation, according to 4.3.4.4, are not regarded as connected directly to the supply mains.		P
4.3.6.2.3	Circuits not connected directly to the supply mains		N

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Clause	Requirement – Test	Result - Remark	Verdict
	Insulation between the surroundings and circuits not connected directly (that is, having no galvanic connection) to the supply mains shall be designed according to the impulse voltage or the working voltage, whichever gives the more severe requirement. This insulation is evaluated to withstand impulses of overvoltage category II.		N
	If measures are provided which reduce transient overvoltages of category III to values of category II, or values of category II to values of category I, basic or supplementary insulation may be designed for the reduced value. Devices used for such measures shall be approved by a suitable safety authority for use at the maximum intended supply voltage (including tolerances). Where appropriate, the measures shall be monitored.		N
	The requirements for double or reinforced insulation shall not be reduced.		N
4.3.6.2.4	Insulation between circuits		P
	Insulation between two circuits shall be designed according to the circuit having the more severe requirement.		P
4.3.6.3	Functional insulation		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
	For parts or circuits that are significantly affected by external transients, functional insulation shall be designed according to the impulse voltage of overvoltage category II, except that overvoltage category III shall be used when the PDS is connected at the origin of the installation.		N
	Where measures are provided which reduce transient overvoltages within the circuit from category III to values of category II, or values of category II to values of category I, functional insulation may be designed for the reduced values		N
	Where the circuit characteristics can be shown by testing (see 5.2.3.1) to reduce impulse voltages, functional insulation may be designed for the highest impulse voltage occurring in the circuit during the tests.		N
4.3.6.4	Clearance distances		P
4.3.6.4.1	Determination		P
	Table 9 defines the minimum clearance distances required to provide functional, basic, or supplementary insulation (see Annex C for examples of clearance distances).		P

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Clause	Requirement – Test	Result - Remark	Verdict
	for low-voltage PDS, the value corresponding to the next higher impulse voltage, or 1,6 times the temporary overvoltage, or twice the working voltage shall be used;	Twice the working voltage 380*2=760	P
	for high-voltage PDS, the value corresponding to 1,6 times the impulse voltage, temporary overvoltage or working voltage shall be used.	Low-voltage PDS	N
	Clearances for reinforced insulation between circuits connected directly to the supply mains and other circuits shall not be reduced when measures to reduce transient overvoltages are provided.		P
	The compliance of clearances shall be verified by visual inspection (see 5.2.2.1) and if necessary by performing the impulse voltage test of 5.2.3.1 and the a.c. or d.c voltage test of 5.2.3.2.	Impulse voltage:6000V	P
	Figure E.1 and Table E.1 provide informative guidance for determination of clearances for frequencies above 30 kHz.	0-650Hz	N
4.3.6.4.2	Electric field homogeneity		P
	The dimensions in Table 9 correspond to the requirements of an inhomogeneous electric field distribution across the clearance, which are the conditions normally experienced in practice. If a homogeneous electric field distribution is known to exist, and the impulse voltage is equal to or greater than 6 000 V for a circuit connected directly to the supply mains or 4 000 V within a circuit, the clearance may be reduced (see Table 2 of IEC 60664-1). In this case, however, the impulse voltage test of 5.2.3.1 shall be performed on the clearance.		P
4.3.6.4.3	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 4.3.6.4.1 following the deformation tests of 5.2.2.5.		P
	If the design clearance is at least 12,7 mm and the clearance required by 4.3.6.4.1 does not exceed 8 mm, the deformation tests may be omitted.	Comply with requirement	P
4.3.6.5	Creepage distance		P
4.3.6.5.1	General		P
	Creepage distances shall be large enough to prevent long-term degradation of the surface of solid insulators, according to Table 10:		P
	For functional, basic and supplementary insulation, the values in Table 10 apply directly. For reinforced insulation, the distances in Table 10 shall be doubled.		P

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Clause	Requirement – Test	Result - Remark	Verdict
	When the creepage distance determined from Table 10 is less than the clearance required by 4.3.6.4.1, then it shall be increased to that clearance.		P
	Creepage distances shall be verified by measurement or inspection (see 5.2.2.1) (see Annex C for examples of creepage distances).		P
	Figure E.2 and Table E.2 provide informative guidance for determination of creepage distances for frequencies above 30 kHz.	0-650Hz	N
4.3.6.5.2	Materials		P
	Insulating materials are classified into four groups corresponding to their comparative tracking index (CTI) when tested according to 6.2 of IEC 60112:		P
	- 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.	Group IIIa/b	P
	Creepage distances on printed wiring boards (PWBs) exposed to pollution degree 3 environmental conditions shall be determined based on Table 10 Pollution degree 3 under “Other insulators”.		N
	If the creepage distance is ribbed, then the creepage distance of insulating material of group I may be applied using insulating material of group II and the creepage distance of insulating material of group II may be applied using insulating material of group III. Except at pollution degree 1 the ribs shall be 2 mm high at least.		N
	For inorganic insulating materials, for example glass or ceramic, which do not track, the creepage distance may equal the associated clearance, as determined from Table 6.	No such materials	N
4.3.6.6	Coating		--
	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 4.3.6.8.4.2 and 4.3.6.8.6).		N
4.3.6.7	PWB spacings for functional insulation		--
	Spacings for functional insulation on a PWB are not required to comply with 4.3.6.4 and 4.3.6.5 when all the following are satisfied:		P
	- the PWB has flammability rating of V-0 (see IEC 60707 and IEC 60695-11-10); and	V-0	P
	- the PWB base material has a minimum CTI of 100; and	400 > CTI > 175	P

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Clause	Requirement – Test	Result - Remark	Verdict
	- the equipment complies with the PWB abnormal operation test (see 5.2.2.2).		N
	On PWB creepage and clearance distances for functional insulation at working voltages less than 80 V (r.m.s.) or 110 V (recurring peak) are permitted to be evaluated according to pollution degree 1 if the tracks are covered with a suitable coating.		N
4.3.6.8	Solid insulation	See below	--
4.3.6.8.1	General		--
	Solid insulation shall be designed to withstand the stresses occurring. These include mechanical, electrical, thermal and climatic stresses which are to be expected in normal use. Insulation shall also be resistant to ageing during the projected life of the PDS.		P
4.3.6.8.2	Requirements for electrical withstand capability		P
4.3.6.8.2.1	Basic or supplementary insulation		P
	Test with impulse withstand voltage according to 5.2.3.1, column 2 or column 4 of Table 19, or Table 20, column 2 or 4, as appropriate;	Basic insulation: 1800V Supplementary insulation:3600V	P
	Test with a.c. or d.c. voltage according to 5.2.3.2, column 2 ofTable 21, Table 22, orTable 23, as appropriate.		P
4.3.6.8.2.2	Double and reinforced insulation:		P
	- Impulse withstand voltage according to 5.2.3.1 Table 19, column 3 or column 5, or Table 20, colum 3 or 5 as appropriate;		P
	- Test with a.c. or d.c. voltage according to 5.2.3.2, column 3 of Table 21, Table 22, or Table 23, as appropriate;		P
	partial discharge test according to 5.2.3.3, 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, subassemblies and PWB. In addition, a sample test shall be performed if the insulation consists of a single layer of material.		N
	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
4.3.6.8.2.3	Functional insulation		P
4.3.6.8.3	Thin sheet or tape material	See below	--
4.3.6.8.3.1	General		--

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Clause	Requirement – Test	Result - Remark	Verdict
	Subclause 4.3.6.8.3 applies to the use of thin sheet or tape materials in assemblies such as wound components and bus-bars.		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.		N
4.3.6.8.3.2	Material thickness not less than 0,2 mm		N
	- Basic or supplementary insulation comprises at least one layer of material, which will meet the requirements of 4.3.6.8.1 and 4.3.6.8.2.1.		N
	- Double insulation comprises at least two layers of material, each of which will meet the requirements of 4.3.6.8.1 and 4.3.6.8.2.1, and both layers together will meet the requirements of 4.3.6.8.1 and 4.3.6.8.2.2.		N
	- Reinforced insulation comprises a single layer of material, which will meet the requirements of 4.3.6.8.1 and 4.3.6.8.2.2.		N
4.3.6.8.3.3	Material thickness less than 0,2 mm	Comply with requirement	P
	Basic or supplementary insulation shall consist of at least one layer of material, which will meet the requirements of 4.3.6.8.1 and 4.3.6.8.2.1.	Least two layers insulation tape	P
	Double insulation shall consist of at least three layers of material. Each layer shall meet the requirements of 4.3.6.8.1 and 4.3.6.8.2.1, and any two layers together shall meet the requirements of 4.3.6.8.2.2.	Used three layers insulation tape	P
	Reinforced insulation consisting of a single layer of material is not permitted.	Used three layers insulation tape	P
4.3.6.8.3.4	Compliance	Comply with requirement	P
	When a component or sub-assembly makes use of thin sheet insulating materials, it is permitted to perform the tests on the component rather than on the material.		P
4.3.6.8.4	Printed wiring boards (PWBs)		P
	Insulation between conductor layers in double-sided single-layer PWBs, multi-layer PWBs and metal core PWBs, shall meet the requirements of 4.3.6.8.1. Basic, supplementary, double and reinforced insulation shall meet the appropriate requirements of 4.3.6.8.2.1 or 4.3.6.8.2.2. Functional insulation in PWBs shall meet the requirements of 4.3.6.8.2.3.		P
	For the inner layers of multi-layer PWBs, the insulation between adjacent tracks on the same layer shall be treated as either:		N

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Clause	Requirement – Test	Result - Remark	Verdict
	a creepage distance for pollution degree 1 and a clearance as in air (see Example C.14 of Annex C);		N
	solid insulation, in which case it shall meet the requirements of 4.3.6.8.1 and 4.3.6.8.2.		N
4.3.6.8.4.2	Use of coating materials		N
4.3.6.8.5	Wound components	Comply with requirement	P
	Varnish or enamel insulation of wires shall not be used for basic, supplementary, double or reinforced insulation.		P
	Wound components shall meet the requirements of 4.3.6.8.1 and 4.3.6.8.2.		P
	The component itself shall pass the requirements given in 4.3.6.8.1 and 4.3.6.8.2. If the component has reinforced or double insulation, the voltage test of 5.2.3.2 shall be performed as a routine test.		P
4.3.6.8.6	Potting materials, etc.	No such materials	N
	A potting material may be used to provide insulation or to act as a coating to protect against pollution. The insulation material shall comply with the requirements of 4.2.7.1 and 4.2.7.2.		N
4.3.6.9	Insulation requirements above 30 kHz	See below	N
	Where voltages across insulation have fundamental frequencies greater than 30 kHz, further considerations apply. For low-voltage circuits, guidance is provided in IEC 60664-4.	0-650Hz, this subclause is not applicable	N
	Annex E contains flow-charts for the determination of clearance and creepage distances under these circumstances. For information, Tables 1 and 2 of IEC 60664-4 are also included in Annex E.		N
4.3.7	Enclosures	Metal enclosure	--
4.3.7.1	General	See below	--
	Metal enclosures shall comply with the deflection test of 5.2.2.5.2 or have a thickness as specified in 4.3.7.2 or 4.3.7.3.		P
	Polymeric enclosures or polymeric parts, relied on to complete and maintain the integrity of an electrical enclosure, shall comply with the flammability requirements of 4.4.3 and the impact test in 5.2.2.5.3.		N
	For integrated PDS the CDM/BDM enclosure shall comply with the above requirements. The motor enclosure shall meet the requirements of the relevant parts of IEC 60034.	No motor	N
	The manufacturer shall specify the IP rating of the enclosure. See 5.2.2.4 for test.	Used indoor IPX0	P

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Clause	Requirement – Test	Result - Remark	Verdict
	For integrated PDS the combination of motor and CDM/BDM shall be tested according to their intended environment. For external fans and drain holes of the motor part the requirements of IEC 60034-5 apply.		P
4.3.7.2	Cast metal	See below	--
	Die-cast metal, except at threaded holes for conduit, where a minimum of 6,4 mm is required, shall be:		N
	- not less than 2,0 mm thick for an area larger than 155 cm2 or having any dimension larger than 150 mm;		N
	- not less than 1,2 mm thick for an area of 155cm2 or less and having no dimension larger than 150mm.		N
	Malleable iron or permanent-mould cast aluminium, brass, bronze, or zinc, except at threaded holes for conduit, where a minimum of 6,4 mm is required, shall be:	Aluminium heating sink	P
	- at least 2,4 mm thick for an area greater than 155 cm2 or having any dimension more than 150mm; and		N
	- at least 1,5 mm thick for an area of 155 cm2 or less having no dimension more than 150 mm.		P
	A sand-cast metal enclosure shall be a minimum of 3,0 mm thick except at locations for threaded holes for conduit, where a minimum of 6,4 mm is required.		N
4.3.7.3	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 1,2mm thick for non-ferrous metal.		P
	Enclosure thickness at points other than where a wiring system is to be connected shall be not less than that specified in Table 11 or Table 12.		P
	With reference to Table 11 and Table 12, a supporting frame is a structure of angle or channel or folded rigid section of sheet metal, which is rigidly attached to and has the same outside dimensions as the enclosure surface, and which has torsional rigidity to resist the bending moments that are applied by the enclosure surface when it is deflected.		P
	A structure which is as rigid as one built with a frame of angles or channels has equivalent reinforcing. Constructions without supporting frame include:		P

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Clause	Requirement – Test	Result - Remark	Verdict
	- a single sheet with single formed flanges – formed edges;		P
	- a single sheet which is corrugated or ribbed;		N
	- an enclosure surface loosely attached to a frame, for example, with spring clips; and		N
	- an enclosure surface having an unsupported edge.		P
4.3.8	Wiring and connections		--
4.3.8.1	General		--
	The wiring and connections between parts of the equipment and within each part shall be protected from mechanical damage during installation. The insulation and conductors of all wires of the equipment shall be suitable for electrical, mechanical, thermal and environmental conditions of use. Conductors which are able to contact each other shall be provided with insulation rated for the highest voltage present.		P
	NOTE Electrical reflections in a motor cable fed from a Pulse Width Modulated (PWM) source can cause high voltages to appear on the cable, which should be taken into consideration for PDS component selection.		N
4.3.8.2	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.	No such routing	N
	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 cold flow of the insulation does not occur. If a metal clamp is used for conductors having thermoplastic insulation less than 0,8 mm, non-conducting mechanical protection shall be provided.	No such clamps and guides	N
4.3.8.3	Colour coding		N

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Clause	Requirement – Test	Result - Remark	Verdict
	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 not be used for other than protective bonding.	Consider in system	N
	NOTE The choice of green or green/yellow for the protective bonding is covered by national regulations.		N
4.3.8.4	Splices and connections	No such connection	N
	All splices and connections shall be mechanically secure and shall provide electrical continuity.		N
	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.		N
	When stranded internal wiring is connected to a wire-binding screw, the construction shall be such that loose strands of wire do not contact:		N
	- other uninsulated live parts not always of the same potential as the wire; or		N
	- de-energized metal parts.		N
4.2.9.5	Accessible connections		P
	In addition to measures given in 4.3.4.1 to 4.3.4.3 it shall be ensured that neither error nor polarity reversal of connectors can lead to a higher voltage than the maximum decisive voltage class A. This applies for example to plug-in sub-assemblies or other plug-in devices which can be plugged in without the use of a tool (key) or which are accessible without the use of a tool. This does not apply to equipment intended to be installed in closed electrical operating areas.		P
	If required, testing of non-interchangeability and protection against polarity reversal of connectors, plugs and socket outlets shall be confirmed by inspection and trial insertion.		N
4.3.8.6	Interconnections between parts of the PDS	No such interconnections	N
	In addition to complying with the requirements given in 4.2.9.1 to 4.2.9.5, the means provided for the interconnection between parts of the PDS shall comply with the following requirements or those of 4.2.9.7.		N
	Cable assemblies and flexible cords provided for interconnection between sections of equipment or between units of a system shall be of a type which is evaluated for the service or use involved and shall be provided with bushings and strain relief.		N

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Clause	Requirement – Test	Result - Remark	Verdict
	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 fire, electric shock, or injury to persons.		N
	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 exposed contacts of either the plug or receptacle when disconnected.		N
	NOTE An interlock circuit in the cable to de-energize the exposed contacts whenever an end of the cable is disconnected meets the intent of these requirements.		N
4.3.8.7	Supply connections		P
	A PDS intended for permanent connection to the power supply shall have provision for connection to the applicable wiring system in accordance with the requirements where it is being installed. 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
4.3.8.8	Terminals	See below	--
4.3.8.8.1	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.	Comply with requirement	P
	The requirements of this subclause are met by using terminals complying with IEC 60947-7-1 or IEC 60947-7-2, as appropriate.		P
4.3.8.8.2	Connecting capacity		P

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Clause	Requirement – Test	Result - Remark	Verdict
	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 5.2.3.8. The terminals shall also be suitable for conductors of the same type at least two sizes smaller, as given in the appropriate column of Table F.1.		P
	Standard values of cross-section of round copper conductors are shown in Annex F, which also gives the approximate relationship between ISO metric and AWG/MCM sizes.		P
4.3.8.8.3	Connection	See below	P
	Terminals for connection to external conductors shall be readily accessible during installation.	Comply with requirement	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
4.3.8.8.4	Wire bending space for wires 10 mm^2 and greater	Less than 10mm^2	N
	For low-voltage PDS, the distance between a terminal for connection to the main supply, or between major parts of the PDS (for example, motor, transformer, CDM/BDM), and an obstruction toward which the wire is directed upon leaving the terminal shall be at least that specified in Table 13.		N
4.3.9	Output short-circuit requirements		P
	The PDS shall not present a thermal hazard, electric shock or energy hazard under short-circuit conditions at any output that is capable of providing power. In some cases, short-circuit protection may be provided by external measures, the characteristics of which shall be specified by the manufacturer.	No hazards	P
	For co-ordination with upstream protection devices, the manufacturer shall specify a maximum prospective short-circuit current rating corresponding to each power output of the CDM/BDM. If protection devices with particular characteristics are necessary, these shall also be specified.		P
	Short-circuit evaluation shall be performed according to 5.2.3.6 on all power outputs.		P
4.3.10	Residual current-operated protective (RCD) or monitoring (RCM) device compatibility		P

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Clause	Requirement – Test	Result - Remark	Verdict
	An insulation fault or direct contact with certain types of PDS circuits can cause current with a d.c. component to flow in the protective conductor and thus reduce the sensitivity of an RCD of type A or AC (see IEC 60755 and IEC 62020).	Comply with requirement	P
	The PDS shall satisfy one of the following conditions.	See below	--
	A plug-connected single-phase PDS with rated input current less than or equal to 16 A, not using an industrial connector according to IEC 60309, shall be designed so that, under normal and fault conditions, it does not reduce the ability of RCD and RCM of type A to provide protection for other equipment in the installation.		N
	For plug-connected PDS other than a) with an industrial connector according to IEC 60309, and PDS having a fixed connection, if a d.c. current can be present in the protective earthing conductor, a caution notice and the symbol ISO 7000-0434 (2004-01) shall be provided in the user manual, and the symbol shall be placed on the PDS (see 6.3.6.7 and Annex H.		N
	NOTE For design and construction of electrical installations, care should be taken with RCDs of Type B. All the RCDs upstream from an RCD of Type B up to the supply transformer should be of Type B.		N
4.3.11	Capacitor discharge		P
	Capacitors within a *PDS* shall be discharged to a voltage less than 60 V, or to a residual charge less than 50 ⌈C, within 5 s after the removal of power from the *PDS*. If this requirement is not achievable for functional or other reasons, the information and marking requirements of 6.5.2 apply. See 5.2.3.7 for test.		P
	NOTE This requirement also applies to capacitors used for power factor correction, filtering, etc.		N
	In the case of plugs or similar devices that may be disconnected without the use of a tool, the withdrawal of which results in the exposure of conductors (e.g. pins), the discharge time shall not exceed 1 s. Otherwise such conductors shall be protected against direct contact to at least IP2X or IPXXB. If neither a discharge time of 1 s nor a protection of at least IP2X or IPXXB can be achieved, additional disconnecting devices or an appropriate warning device shall be applied.	No used plugs or similar devices	N
4.3.12	Access conditions for high-voltage PDS	Low-voltage	N

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Clause	Requirement – Test	Result - Remark	Verdict
	The high voltage sections (transformer, converter, motor, etc.) shall be protected by an appropriate housing enclosure according to IEC 60204-11 with respect to personnel safety.		N
	a) Operating conditions Interlocking doors shall prevent any access inside the enclosure of the high voltage converter section when main circuit breaker(s) providing the high voltage to the circuit are on, and if live parts have not been earthed (see b)).		N
	b) Access for maintenance – earthing instructions An earthing switch shall be provided for earthing major live parts of the PDS in accordance with subclause 16.1 of IEC 60204-11. The earthing contacts, or an indication that the contacts of the switches are closed, shall be visible by the maintenance personnel before they access the equipment.		N
	NOTE In particular cases, (for example, load-commutated Inverters), two earthing switches (one line side, one load side) can be required.		
	The earthing operation is performed after the normal discharge time stated by the converter manufacturer. Care shall be taken that this is a safe operation even in case of failure of the discharge circuit. Care shall also be taken that on the input and output side the stray capacitance of cables, motor and/or transformer shall be discharged before possible access to live parts. The requirements of 4.2.12 apply.		N
	For parts which are not directly earthed by an earthing switch the component manufacturers shall provide safe instructions to perform earthing (see 6.3.6.7).		N
4.4	Protection against thermal hazards		P
4.4.1	Minimizing the risk of ignition	No such devices	N
	The risk of ignition due to high temperature shall be minimized by the appropriate selection and use of components and by suitable construction.		N
	Electrical components shall be used in such a way that their maximum working temperature under normal load conditions is less than that necessary to cause ignition of the surrounding materials with which they are likely to come into contact. The limits Table 11 shall not be exceeded for the surrounding material.		N
	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 or better.		N

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Clause	Requirement – Test	Result - Remark	Verdict
4.4.2	Insulating materials	See below	--
4.4.2.1	General		--
	A material which is used for the direct support of an uninsulated live part shall comply with the following requirements.		P
	The insulating material shall be suitable for the maximum temperature it attains as determined by the temperature rise test of 5.2.3.8. 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
4.4.2.2	Material requirements		P
	The insulating material shall have a CTI of 100 or greater.	According to Table 14. Epoxy	P
	In other cases, the insulating material shall comply with the glow-wire test described in 5.2.5.2 at a test temperature of 850 °C. The alternative hot wire ignition test of 5.2.5.3 may be used.		N
	Where an insulating material is used in a device that incorporates switching contacts, and is within 12,7 mm of the contacts, it shall comply with the high current arcing ignition test of 5.2.5.1.	No such devices	N
	The manufacturer may provide data from the insulating material supplier to demonstrate compliance with the above requirements. In this case, no further testing is required.		N
4.4.3	Flammability of enclosure materials	Used metal enclosure	P
	Materials used for enclosures of PDS shall meet the test requirements of 5.2.5.4.		N
	Metals, ceramic materials, and glass which is heat-resistant tempered, wired or laminated, are considered to comply without test.		N
	Materials are considered to comply without test if, in the minimum thickness used, the material is of flammability class 5V, according to IEC 60695-11-20.		N
	Components which fill an opening in an enclosure, and which are intended to be mounted in this way, need not be evaluated for compliance with the flammability requirements of 5.2.5.5, provided that the components comply with the flammability aspects of the relevant IEC component standard.		N
	Compliance is checked by examination and, where necessary, by test.		N

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Clause	Requirement – Test	Result - Remark	Verdict
	The manufacturer may provide data from the insulating material supplier to demonstrate compliance with the above requirements. In this case, no further testing is required.		N
4.4.4	Temperature limits		P
4.4.4.1	Internal parts		P
	Equipment and its component parts shall not attain temperatures in excess of those in Table 15 when tested in accordance with the ratings of the equipment.		P
4.4.4.2	External parts of CDM	Comply with requirement	P
	The maximum temperature for accessible exterior parts of the PDS shall be in compliance with Table 16. It is permitted that parts have temperatures exceeding these values, but they shall then be marked with a warning statement as given in 6.4.3.4.		P
4.4.5	Specific requirements for liquid cooled PDS		N
4.4.5.1	Coolant	No coolant	N
4.4.5.2	Design requirements		N
4.4.5.2.1	Corrosion resistance		N
	All cooling system components shall be suitable for use with the specified coolant. They shall be corrosion resistant and shall not corrode as a result of electrolytic action or prolonged exposure to the coolant and/or air.		N
4.4.5.2.2	Tubing, joints and seals		N
4.4.5.2.3	Provision for condensation		N
	Where internal condensation occurs during normal operation or maintenance, measures shall be taken to prevent degradation of insulation.		N
4.4.5.2.4	Leakage of coolant		N
	Measures shall be taken to prevent leakage of coolant onto live parts as a result of normal operation, servicing, or loosening of hoses or other cooling system parts during the expected lifetime.		N
4.4.5.2.5	Loss of coolant		N
4.4.5.2.6	Conductivity of coolant		N
4.4.5.2.7	Insulation requirements for coolant hoses		N
	When the coolant is intentionally in contact with live parts (for example non-earthed heatsinks), the coolant hoses form a part of the insulation system. Depending on the location of the hoses, the requirements of 4.3.6 for functional or basic insulation or protective separation shall be applied where relevant.		N

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Clause	Requirement – Test	Result - Remark	Verdict
4.5	Protection against energy hazards		P
4.5.1	Electrical energy hazards		P
	Failure of any component within the PDS shall not release sufficient energy to lead to a hazard, for example, expulsion of material into an area occupied by personnel.	Comply with requirement	P
4.4.2	Mechanical energy hazards		--
4.4.2.1	General	See below	--
	Mechanical failure due to critical speed considerations or torsional problems can create a hazard to operating personnel. These considerations are applicable to all PDS, although they are increasingly significant with increased equipment size, such as with high-voltage product.		P
4.4.2.2	Critical torsional speed	No such hazards	N
	Communication shall be established between PDS supplier, driven equipment supplier, installer, and user with respect to any anticipated critical torsional speed considerations.		N
4.4.2.3	Transient torque analysis		P
	Transient torque analysis is an important design tool for PDS to check torsional stresses in the whole mechanical string. For example, the following operating conditions are areas of concern.		P
	- start-up;		P
	- single-phase or three-phase short-circuit at the terminals of an a.c. motor;		P
	- impact of possible commutation failure of an a.c. CDM;		P
	- impact of the harmonic components of an a.c. CDM;		P
	- field supply loss in a d.c. CDM;		N
	- short-circuit at the armature terminals of a d.c. motor.		N
	Where appropriate, communication shall be established with the driven equipment supplier and the information required by 6.3.5.4 provided.		N
4.4.3	Acoustic noise emission		N
	Under consideration.		N
4.6	Protection against environmental stresses	Used indoor	N

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Clause	Requirement – Test	Result - Remark	Verdict
	The PDS/CDM/BDM shall not present any hazards as a result of specified environmental stresses. As a minimum, the PDS/CDM/BDM shall satisfy the environmental endurance tests of 5.2.6. More demanding requirements may be specified by the manufacturer, in which case less demanding tests of this standard do not need to be performed.		N
5	Test requirements		--
5.1	General	See below	--
5.1.1	Test objectives and classification		P
	Testing, as defined in this clause 5, is required to demonstrate that PDS is fully in accordance with the requirements of this part of IEC 61800. 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 PDS. They describe:		P
	- type tests;		N
	- routine tests;		N
	- sample tests;		P
	- commissioning tests;		N
	- individual tests which, when combined in a sequence, form the above tests.		
	The manufacturer and/or test house shall ensure that the specified maximum and/or minimum environment (or test) values are imposed, when a test is applied, having already taken tolerances and measurement inaccuracies fully into account. This task shall be performed by the manufacturer or the test house by agreement with the user.	Max. environment: 40℃	P
	Warning ! These tests may result in hazardous situations. Suitable precautions must be taken to avoid injury.		P
5.1.2	Selection of test samples	See below	--
	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 adequately represent the entire range for that particular test.	Comply with requirement	P
5.1.3	Sequence of tests		--

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Clause	Requirement – Test	Result - Remark	Verdict
	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
5.1.2	Earthing conditions		P
	The manufacturer shall state the acceptable earthing systems for the PDS. Type tests sensitive to the earthing system shall be performed using the worst-case earthing system. Earthing systems may include:		P
	- neutral to earth;		P
	- line to earth;		N
	- neutral to earth through high impedance;		N
	- isolated (not earthed)		N
	The unacceptable systems shall be indicated as		N
	- forbidden;		N
	- with modification of values and/or safety levels which shall be quantified through type test		N
5.1.3	Compliance	See below	--
	Compliance with this part of IEC 61800 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 constructional requirements and information to be provided by the manufacturer shall be verified by suitable examination, visual inspection, and/or measurement.		P
	Significant modifications shall be indicated on the PDS through the use of suitable revision level indices and markings, and a new type test may be required to confirm compliance.		P
5.1.4	Test overview		--
	Table 13 provides an overview of the type, routine and special testing of electronic components, devices and PDS/CDM/BDM.		P
5.2	Test specifications	See below	--
5.2.1	Visual inspections (type and routine test)		P
	Before starting testing, a visual inspection shall be made to check features such as adequacy of labelling, warnings and other safety aspects. A check shall be made that the PDS delivered for type test is as expected with respect to supply voltage, input and output ranges, etc.	Comply with requirements	P

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Clause	Requirement – Test	Result - Remark	Verdict
5.2.2	Mechanical tests		P
5.2.2.1	Clearances and creepage distances (type test)		P
	It shall be verified by measurement or visual inspection that the clearance and creepage distances comply with Table 9 and Table 10. See Annex C for measurement examples. Where this verification is impossible to perform, the impulse voltage test shall be performed between the considered circuits. The test may be performed with or without components which do not reduce these distances.		P
5.2.2.2	PWB abnormal operation test (type test)	See below	--
	On PWBs, functional insulation provided by spacings which are less than those specified in Table 9 and Table 10 (see 4.3.6.7) shall be type tested as described below.	Comply with requirements	P
	A sample of the equipment containing the PWB assembly shall be connected as intended to an electrical supply circuit sized and protected to simulate end-use conditions. In the case of a PDS/CDM/BDM supplied without an enclosure, a wire mesh cage which is 1,5 times the individual linear dimensions of the part under study may be used to simulate the intended enclosure.		P
	Surgical cotton shall be placed at all openings, handles, flanges, joints and similar locations on the outside of the enclosure, and the wire mesh cage (if used), in a manner which will not significantly affect the cooling.		P
	The PDS/CDM/BDM is not required to be operational after testing and it is possible that the enclosure can become deformed. Overcurrent protection integral to the PDS/CDM/BDM, or required to be used with the PDS/CDM/BDM, is allowed to open.		P
5.2.2.3	Non-accessibility test (type test)	See below	--
	This test is intended to show that live parts, protected by means of enclosures and barriers in compliance with 4.3.3.3, are not accessible.		P
	This test shall be performed as a type test of the enclosure of a PDS as specified in IEC 60529 for the enclosure classification. Except as noted below:		N
	- the test probe for IP3X shall not penetrate the top surface of the enclosure when probed from the vertical direction ± 5° only.		N
5.2.2.4	Enclosure integrity test (type test)		N

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Clause	Requirement – Test	Result - Remark	Verdict
	The claimed IP rating of the enclosure shall be verified. This test shall be performed as a type test of the enclosure of a PDS as specified in IEC 60529 for the enclosure classification.		N
5.2.2.5	Deformation tests	See below	--
5.2.2.5.1	General		--
	The Deflection and Impact tests apply to PDS, and to enclosed CDM/BDM where they are intended for operation without a further enclosure to which access is restricted to trained maintenance staff. After completion of the Deflection test (see 5.2.2.5.2) for metallic enclosures and the Impact test (see 5.2.2.5.3) for polymeric enclosures, the PDS/CDM/BDM shall pass the tests of 5.2.3.1 and 5.2.3.2 and shall be inspected to check that:	This subclauses is not applicable	N
	live parts have not become accessible (see 4.3.3.3);		N
	- enclosures show no cracks which could cause a hazard;		N
	- clearances are not less than their permitted values and the insulation of internal wiring remains undamaged;		N
	- barriers have not been damaged or loosened;		N
	- no moving parts are exposed;		N
	The deflection and impact tests shall be performed at the worst case point on representative accessible face(s) of the enclosure.		N
	The PDS/CDM/BDM is not required to be operational after testing and the enclosure may be deformed to such an extent that its original IP classification is not maintained.		N
5.2.2.5.2	Deflection test (type test)	See below	--
	The enclosure is held firmly against a rigid support and subjected to a steady force of 250 N applied for 5 s through the end of a rod having a 12,7 mm by 12,7 mm square, flat steel face.		P
	Damage to the finish, small dents and small chips which do not adversely affect the protection against electric shock or moisture, are to be ignored.		N
5.2.2.5.3	Impact test (type test)	See below	--

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Clause	Requirement – Test	Result - Remark	Verdict
	A sample consisting of the enclosure or a portion thereof representing the largest nonreinforced area is to be supported in its normal position. A solid smooth steel sphere, approximately 50 mm in diameter and with a mass of 500 g ± 25 g, shall be permitted to fall freely from rest through a vertical distance of 1 300 mm onto the sample. (Vertical surfaces are exempt from this test.)		P
	In addition, the steel sphere is to be suspended by a cord and swung as a pendulum in order to apply a horizontal impact, dropping through a vertical distance of 1 300 mm. (Horizontal surfaces are exempt from this test.)		N
	If the pendulum test is inconvenient, it is permitted to simulate horizontal impacts on vertical or sloping surfaces by mounting the sample at 90° to its normal position and applying the vertical impact test instead of the pendulum test.		N
5.2.3	Electrical tests	See below	--
5.2.3.1	Impulse voltage test (type and sample test)	Sample test	P
	The purpose of this test is to verify that clearances and solid insulation will withstand specified transient overvoltages. It is performed with a voltage having a 1,2/50 µs waveform (see Figure 6 of IEC 60060-1) and is intended to simulate overvoltages of atmospheric origin. It also covers overvoltages due to switching of equipment. See Table 18 for conditions of the impulse voltage test.		P
	Tests on clearances smaller than required by Table 9 and on solid insulation are performed as type tests using appropriate voltages from Table 19 or Table 20.	Adequate clearances	N
	Tests on components and devices for protective separation are performed as a type test and a sample test before they are assembled into the PDS, using the impulse withstand voltages listed in column 3 or column 5 of Table 19 or Table 20, as appropriate.	Column 5 reinforced insulation:8000V	P
	To ensure that limiting devices (see 4.3.6.2.2, 4.3.6.2.3, 4.3.6.3) are able to reduce the overvoltage, the values of column 2 or column 4 in Table 19 or Table 20, as appropriate, are applied to the PDS as a type test, and reduced values corresponding to the next lower voltage of the same column of that Table are verified.	Column 4 basic insulation:6000V	P
	The impulse voltage test is successfully passed if no puncture, flashover, or sparkover occurs. In the case of components and devices for protective separation, a subsequent partial discharge test (see 5.2.3.3) shall also be passed.		P

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Clause	Requirement – Test	Result - Remark	Verdict
	Alternatively for high-voltage PDS the impulse test is successfully passed if	Low-voltage PDS	N
	a) three consecutive impulses for each polarity have been applied and:- no disruptive discharge occurs; or- one discharge occurs in the self-restoring part of insulation, and then nine additional impulses have been applied with no disruptive discharge occurring; or		P
	b) 15 consecutive impulses for each polarity have been applied and:- the number of disruptive discharges on self-restoring insulation does not exceed two for each series; and - no disruptive discharge on non-self-restoring insulation occurs.		N
5.2.3.2	AC or d.c. voltage test (type and routine test)	See below	--
5.2.3.2.1	Purpose of test		--
	The test is used to verify that the insulation of assembled PDS possesses adequate dielectric strength to resist long-term overvoltage conditions.		P
5.2.3.2.2	Value and type of test voltage	See below	--
	The values of the test voltage are determined from column 2 or 3 of Table 17, Table 18, or Table 19.		P
	The test voltage from column 2 is used for testing circuits with basic or supplementary insulation. Between circuits with protective separation (double or reinforced insulation), twice the test voltage (column 3) shall be applied for type tests. For routine tests the values from column 2 shall be applied to prevent damage to the solid insulation by partial discharge.	Basic insulation: 1800V Reinforced insulation: 3600V	P
	The values of column 3 refer to PDS with protection against direct contact according to 4.2.3. The test is performed between circuits and accessible surfaces of PDS, which are nonconductive or conductive but not connected to the protective conductor.	Class I, this subclauses is not applicable	N
	The voltage test shall be performed with a sinusoidal voltage at 50/60 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

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Clause	Requirement – Test	Result - Remark	Verdict
	Routine tests are performed to verify that clearances have not been jeopardized during the manufacturing operations. Protective devices designed to make a shunt over the clearances and belonging to monitoring or protection circuits, not designed to sustain the constraint for the duration of the test, shall be disconnected in order to avoid damage and to ensure that the test voltage can be applied without a false indication of failure.		N
5.2.3.2.3	Performing the voltage test	See below	--
	The test shall be applied as follows, according to Figure 8:		--
	a) Test (1) between exposed conductive part (connected to earth) and each circuit sequentially (except PELV or SELV decisive voltage class A circuits). Test voltage according to Table 22, Table 23, or Table 19, column 2, corresponding to voltage of considered circuit under test.		P
	Test (2) between accessible surface (non conductive or conductive but not connected to earth) and each circuit sequentially (except PELV or SELV decisive voltage class A circuits). Test voltage according to Table 21, Table 22, or Table 23, column 3 (for type test) or column 2 (for routine test), corresponding to voltage of considered circuit under test.		N
	b) Test between each considered circuit sequentially and the other adjacent circuits connected together. Test voltage according to Table 21, Table 22, or Table 23, column 2, corresponding to voltage of considered circuit under test.		P
	c) Test between PELV or SELV decisive voltage class A circuit and each adjacent circuit sequentially. Test voltage according to Table 17, Table 18, or Table 19, column 3 (for type test) or column 2 (for routine test), corresponding to the circuit with the higher voltage. It is not necessary to test functional insulation between adjacent PELV or adjacent SELV circuits.		N
	The tests shall be performed with the doors of the enclosure shut.		N
	When the circuit is electrically connected to exposed conductive parts, the voltage test is not relevant, and may be omitted.		P

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Clause	Requirement – Test	Result - Remark	Verdict
	To create a continuous circuit for the voltage test on the PDS, terminals, open contacts on switches and semiconductor switching devices, etc. shall be bridged where necessary. Before testing, semiconductors and other vulnerable components within a circuit may be disconnected and/or their terminals bridged to avoid damage occurring to them during the test.		N
	Individual components forming part of the insulation under test, for example interference suppression capacitors, shall not be disconnected or bridged before the test. In this case, it is recommended to use the d.c. test voltage according to 5.2.3.2.2.		P
	Where the PDS is covered totally or partly by a non-conductive accessible surface, a conductive foil to which the test voltage is applied shall be wrapped around this surface for testing. In this case, the insulation test between circuit and non-conductive accessible surface may be performed as a sample test instead of a routine test.		N
	Routine testing of the assembled PDS is not required if routine testing of all subassemblies related to the insulation system of the PDS is performed, it can be demonstrated that final assembly will not compromise the insulation system, and type testing of the fully-assembled PDS was performed successfully.		
	Protective impedances according to 4.3.4.3 shall either be included in the testing or the connection to the protectively separated part of the circuit shall be opened at the joints before testing. In the latter case, the connection shall be restored after the voltage test carefully in order to avoid any damage to the insulation. Protective screens according to 4.2.2 shall remain connected to exposed conductive parts during the voltage test.		P
	In the case of high-voltage products, the voltage shall be applied using a ramp of up to 5 s in duration. If the test is required or requested to be repeated, the voltage shall be de-rated to 80 % of the original test voltage.	Low-voltage	N
5.2.3.2.4	Duration of the a.c. or d.c. voltage test		--
	The duration of the test shall be at least 5 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 5 s and 1 s respectively for type and routine tests.		P
5.2.3.2.5	Verification of the a.c. or d.c. voltage test		--
	The test is successfully passed if no electrical breakdown occurs during the test.	No breakdown	P

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Clause	Requirement – Test	Result - Remark	Verdict
5.2.3.3	Partial discharge test (type, sample, or special test)	Manufacturer declaration of conformity	P
	The partial discharge test shall confirm that the solid insulation used within devices (see 4.3.6.8) applied for protective separation of electrical circuits remains partial-discharge-free within the specified voltage range (see Table 24).		N
	This test is to be performed as a type test and a sample test. It may be deleted for insulating materials which are free of partial discharge, for example ceramics.		N
	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.		N
5.2.3.4	Protective impedance (type test and routine test)	Type test	--
	A type test shall be performed to verify that the current through a protective impedance does not exceed the values given in 4.3.4.3. The test shall be performed using the circuit of IEC 60990, Figure 4.		P
	Type and routine tests shall be performed to verify the value of the protective impedance.		P
5.2.3.5	Leakage current measurement (type test)		--
	The touch current shall be measured to determine if the measures of protection need not be taken (see 4.3.5.5.2). The test may be used for a BDM, but in that case the BDM shall be connected to a motor. The motor may be unloaded, but the length and the type of the motor cable indicated by the manufacturer shall be used.		P
	The PDS 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 current shall be measured between the protective terminal and the protective conductor itself with the probe of Figure 4 of IEC 60990.		P
	– For a PDS to be connected to an earthed neutral system, the neutral of the mains of the test site shall be directly connected to the protective conductor.		P
	– For a PDS to be connected to an isolated system or impedance system, the neutral shall be connected through a resistance of 1 kΩ to the protective conductor which shall be connected to each input phase in turn. The highest value will be taken as the definitive result.		N

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Clause	Requirement – Test	Result - Remark	Verdict
	– For a PDS to be connected to a corner earthed system, the protective conductor shall be connected to each input phase in turn. The highest value will be taken as the definitive result.		N
	– For a PDS with a particular earthing system, this system shall operate as intended during the test.		N
	This is performed as a type test		P
5.2.3.6	Short-circuit tests and Breakdown of components test (type tests)	See below	--
5.2.3.6.1	General		--
	Protection against risk of thermal, electric shock and energy hazards in case of short circuit or breakdown of a component for a CDM/BDM or for a PDS in combination with its installation shall be evaluated by:		P
	a) tests defined in 5.2.3.6.3 and 5.2.3.6.4, or		P
	b) calculation or simulation based on tests as defined in 5.2.3.6.3 and 5.2.3.6.4 on a representative model of PDS/CDM/BDM, where no damage other than opening of fuses or tripping of circuit breakers has occurred to the test sample,		P
	c) for high-voltage PDS: calculation or simulation based on tests of elements that adequately represent those used in the PDS. The elements, tests and test conditions shall be selected so that there is sufficient confidence in the test results for them to be transferred (for example, by scaling from lower to higher power) to the PDS/CDM/BDM under consideration,	Low-voltage	N
	d) for custom PDS: risk and hazard analysis of the intended application, and analysis of the construction characteristics. See 6.3.9 for commissioning information requirements.		P
5.2.3.6.2	Test configuration		--
5.2.3.6.2.1	Supply voltage and current		P
	PDS rated for d.c. input shall be tested using a d.c. source. PDS rated for a.c input shall be tested at their rated input frequency.		P
	The open-circuit voltage of the supply shall be 100 % - 105 % of the rated input voltage. The open-circuit voltage may exceed 105 % of the rated input voltage at the request of the manufacturer.	90%-110% of the input voltage at the request of the manufacturer.	P

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Clause	Requirement – Test	Result - Remark	Verdict
	For the Short-circuit test, the supply shall be capable of delivering the specified prospective short-circuit current (see 4.3.9) at the connection to the PDS, unless circuit analysis demonstrates that a lesser value may be used.		P
	For the Breakdown of components test, the supply shall be capable of delivering a prospective short-circuit current of between 1 kA and 5 kA, unless the analysis of 4.2 shows that a different value is required.		P
5.2.3.6.3	Short-circuit test		--
5.2.3.6.3.1	Load conditions		P
	The short circuit test shall be performed with the CDM/BDM at full load or light load whichever creates the more severe condition.		P
5.2.3.6.3.2	Location of short-circuit		P
	Power outputs shall be provided with cable of a cross-section appropriate to the rated current available at the output. The length of each loop shall be approximately 2 m, unless the size of the PDS requires a greater length, in which case the length shall be as short as practical to perform the test.		P
	All output terminals of each power output tested shall be simultaneously connected together, using an appropriate switching device.		P
	Each sample shall be subjected to only one short-circuit test.		P
5.2.3.6.4	Breakdown of components test (type test)		--
5.2.3.6.4.1	Load conditions		P
	The breakdown of a component, identified as a result of the circuit analysis of 4.2, shall be tested with the CDM/BDM at full load or light load whichever creates the more severe condition.		P
5.2.3.6.4.2	Application of short-circuit or open-circuit		P
	The short circuit or open circuit shall be applied with cable of a cross-section of minimum 2,5 mm2 and an appropriate switching device. The length of the loop shall be as short as practical to perform the test.	Comply with requirement	P
	Each identified component shall be subjected to only one Breakdown of components test.		P
5.2.3.6.5	Test sequence		P
	The PDS shall be powered, with its output(s) operating.	See below	--
	For the Short-circuit test, a short-circuit shall be introduced at the output under test.		P

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Clause	Requirement – Test	Result - Remark	Verdict
	For the Breakdown of components test, identified components shall be short-circuited or open-circuited, whichever creates the worse hazard, one at a time.		P
	The PDS shall be operated until one or more of the following ultimate results are obtained:	See below	--
	the operation of electronic short-circuit protection circuitry, or	Protection circuitry	P
	the opening of a short-circuit protection device, or		N
	a steady state temperature is attained after a minimum of 10 min		N
5.2.3.6.6	Pass criteria		--
	As a result of the Short-circuit test and the Breakdown of components test, the PDS/CDM/BDM shall comply with the following:	See below	--
	there shall be no emission of flame or molten metal;		P
	the surgical cotton indicator shall not have ignited;	No used surgical cotton	N
	the earth connection shall not have opened;		P
	the door or cover shall not have blown open;		P
	during and after the test, accessible SELV and PELV circuits shall not exhibit voltages greater than the time dependent voltages of Figure 7;		P
	during and after the test, live parts at voltages greater than decisive voltage class A shall not become accessible.		P
	The PDS/CDM/BDM is not required to be operational after testing and it is possible that the enclosure can become deformed.	Comply with requirement	P
5.2.3.7	Capacitor discharge (type test)		--
	Verification of the capacitor discharge time as required by 4.2.11 may be done by a type test and/or by calculation.	Voltage less that 60V within 5 s after the removal of power form the PDS	P
5.2.3.8	Temperature rise test (type test)		--
	The PDS shall be tested at rated power with the highest specified continuous rated BDM/CDM output current.		P
	It is permitted to test components and other parts independently provided that the test conditions applicable to the equipment are adhered to.		P

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Clause	Requirement – Test	Result - Remark	Verdict
	The PDS is to be tested with at least 1,2 m of wire attached to each user terminal. The wire is to be of the smallest size intended to be connected to the PDS as specified by the manufacturer for installation. When there is only provision for the connection of bus bars to the PDS, they shall be of the minimum size intended to be connected to the PDS as specified by the manufacturer.		P
	The maximum temperature of electrical insulation (other than that of windings), the failure of which could cause a hazard, is measured on the surface of the insulation at a point close to the heat source.		P
	The maximum temperature attained shall be corrected to the rated ambient temperature of the PDS by adding the difference between the ambient temperature during the test and the maximum rated ambient temperature.	Maximum rated ambient temperature 40℃	P
	No corrected temperature shall exceed the rated temperature of the material or component measured.		P
	During the test, thermal cut-out, overload detection functions and devices shall not operate.		P
5.2.3.9	Protective bonding (type test and routine test)		
	The impedance of each protective bonding circuit between the PE terminal and relevant points that are part of each protective bonding circuit shall be measured with a current of at least 10 A derived from a supply source, the output of which is not earthed, having a maximum no-load voltage of 24 V.	Measured current: 40A	P
	When the protective bonding has been designed using the cross-section rules of 4.3.5.4, the impedance shall not exceed 0,02 Ω.	0.0002Ω	P
	When the protective bonding has been designed using the rules of 4.3.5.3.3, the impedance shall not exceed the value required to meet the time dependent voltage limits of Figure 7.		P
	This test shall be performed as a routine test if the continuity of the protective bonding is achieved at any point by means of a single fastener.		N
5.2.4	Abnormal operation tests		--
5.2.4.1	General		P
	Before all operation tests, the test sample is to be mounted, connected, and operated as described in the temperature rise test.		P

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Clause	Requirement – Test	Result - Remark	Verdict
	In the case of a CDM/BDM supplied without an enclosure, a wire mesh cage which is 1,5 times the individual linear dimensions of the CDM/BDM part under study shall be used to simulate the intended enclosure.		N
	The PDS, and the wire mesh cage (if used), shall be earthed according to the requirements of 4.3.5.3.2.		P
	Surgical cotton shall be placed at all openings, handles, flanges, joints and similar locations on the outside of the enclosure, and the wire mesh cage (if used), in a manner which will not significantly affect the cooling.	No used surgical cotton	N
5.2.4.2	Test duration		--
	The individual tests shall be performed until terminated by a protective device or mechanism (internal or external), a component failure occurs, or the temperature stabilizes		P
5.2.4.3	Pass criteria	See below	--
	there shall be no emission of flame or molten metal;		P
	the surgical cotton indicator shall not have ignited;	No used surgical cotton	N
	the earth connection shall not have opened;		P
	the door or cover shall not have blown open;		P
	during and after the test, accessible SELV and PELV circuits shall not exhibit voltages greater than the time dependent voltages of Figure 7;		P
	during and after the test, live parts at voltages greater than decisive voltage class A shall not become accessible.		P
	The PDS/CDM/BDM is not required to be operational after testing and it is possible that the enclosure can become deformed.		P
5.2.4.4	Loss of phase (type test)		--
	A multi-phase PDS 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 (this particular requirement does not apply to high-voltage PDS and may be simulated for low-voltage PDS with rated input current greater than 500 A) and shall be repeated by initially energizing the device with one lead disconnected.		N
5.2.4.5	Cooling failure tests (type tests)		N
5.2.4.5.1	General		N
5.2.4.5.2	Inoperative blower motor		--

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Clause	Requirement – Test	Result - Remark	Verdict
	A PDS having forced ventilation shall be operated at rated load with blower motor or motors made inoperative, singly or in combination from a single fault, by physically preventing their rotation.		P
5.2.4.5.3	Clogged filter		--
	Enclosed PDS/CDM/BDM having filtered ventilation openings shall be operated with the openings blocked to represent clogged filters. The test shall be performed initially with the ventilation openings blocked 50 %. The test shall be repeated under a full blocked condition.	No hazards	P
5.2.4.5.4	Loss of coolant		--
	A liquid cooled PDS shall be operated at rated load. Loss of coolant shall be simulated by blocking the flow or disabling the system coolant pump. The a.c. or d.c. voltage test 5.2.3.2 shall be performed after termination of the Loss of coolant test.	No liquid	N
5.2.5	Material tests		--
5.2.5.1	High current arcing ignition test (type test)		N
	Five samples of each insulating material (see 4.4.2) to be tested are used. The samples are 130 mm long minimum by 13 mm wide and of uniform thickness representing the thinnest section of the part. Edges are to be free from burrs, fins, etc.	The insulating material used has been approved by UL, this test is not requirement	N
	Each test is made with a pair of test electrodes and a variable inductive impedance load connected in series to a source of 220 V to 240 V a.c., 50 Hz or 60 Hz (see Figure 7).		N
	It is permitted to use an equivalent circuit.		--
	One electrode is stationary and the second movable. The stationary electrode consists of a 3,5 mm diameter solid copper conductor having a 30° chisel point. The movable electrode is a 3 mm diameter stainless steel rod with a symmetrical conical point having a total angle of 60° and is capable of being moved along its own axis. The radius of curvature for the electrode tips does not exceed 0,1 mm at the start of a given test. The electrodes are located opposing each other, in the same plane, at an angle of 45° to the horizontal. With the electrodes short circuited, the variable inductive impedance load is adjusted until the current is 33 A at a power factor of 0,5.		N

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Clause	Requirement – Test	Result - Remark	Verdict
	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.		N
	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.		N
	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.		N
5.2.5.2	Glow-wire test (type test)		--
	The glow-wire test shall be made according to clauses 4 to 10 of IEC 60695-2-10 to IEC 60695-2-13 under the conditions specified in 4.3.2.	The insulating material used has been approved by UL	N
	NOTE If the test has to be made at more than one place on the same sample, care should be taken to ensure that any deformation caused by previous tests does not affect the test to be made.		N
5.2.5.3	Hot wire ignition test (type test – alternative to glow-wire test)		--
	Five samples of each insulating material (see 4.4.2) are tested. The samples are 130 mm long minimum by 13 mm wide and of a uniform thickness representing the thinnest section of the part. Edges are to be free from burrs, fins, etc.		N
	A 250 mm ± 5 mm length of nichrome wire (nominal composition 80 % nickel, 20 % chromium, iron-free) approximately 0,5 mm diameter and having a cold resistance of approximately 5 Ω/m is used. The wire is connected in a straight length to a variable source of power which is adjusted to cause a power dissipation of 0,25 W/mm ± 0,01 W/mm in the wire for a period of 8 s to 12 s. After cooling, the wire is wrapped around a sample to form five complete turns spaced 6 mm apart.		N
	The wrapped sample is supported in a horizontal position and the ends of the wire connected to the variable power source, which is again adjusted to dissipate 0,25 W/mm ± 0,01 W/mm in the wire (see Figure 8).		N

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Clause	Requirement – Test	Result - Remark	Verdict
	At the start of the test, the circuit is energized so that a current is passed through the heater wire yielding a linear power density of 0,25 W/mm ± 0,01 W/mm. The test is continued until the test specimen ignites or until 120 s have passed. When ignition occurs or 120 s have passed, the test is discontinued and the test time recorded. For specimens which melt through the wire without ignition, the test is discontinued when the specimen is no longer in intimate contact with all five turns of the heater wire.		N
	The test is repeated on the remaining samples.		N
	The average ignition time of the specimens tested shall not be less than 15 s.		N
5.2.5.4	Flammability test (type test)		--
	Three samples of the complete equipment or three test specimens of the enclosure thereof (see 4.3.3) shall be subjected to this test. Consideration is to be given to leaving in place components and other parts that might influence the performance. The test samples are to be conditioned in a full draft circulating air oven for seven days at 10 °C greater than the maximum use temperature but not less than 70 °C in any case. Prior to testing, the samples are to 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.		N
	The three test samples are to result in the acceptable performance described below. If one sample does not comply, the test is to be repeated on a set of three new samples with the flame applied under the same conditions as for the unsuccessful sample. If all the new specimens comply with the requirements described below the material is acceptable.		N
	The laboratory burner, adjustment and calibration are to be identical to that described in IEC 60707 and IEC 60695-11-20:		N

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Clause	Requirement – Test	Result - Remark	Verdict
	When a complete enclosure is used to conduct the flame test, the sample is to be mounted as intended in service, if it does not impair the flame testing, in a draft-free test chamber, enclosure, or laboratory hood. A layer of absorbent 100 % cotton is to be located 305 mm below the point of application of the test flame. The 127 mm flame is to be applied to any portion of the interior of the part judged as likely to be ignited (by its proximity to live or arcing parts, coils, wiring, and the like) at an angle of approximately 20° insofar as possible from the vertical so that the tip of the blue cone touches the specimen. The test flame is to be applied to three different locations on each of the three samples tested. A supply of technical-grade methane gas is to be used with a regulator and meter for uniform gas flow. Natural gas having a heat content of approximately 37 MJ/m3 at 23 °C has been found to provide similar results and may be used.		N
	The flame is to be applied for 5 s and removed for 5 s. The operation is to be repeated until the specimen has been subjected to five applications of the test flame.		N
	All of the following conditions shall be met as a result of this test:		N
	- the material shall not continue to burn for more than one minute after the fifth 5 s application of the test flame, with an interval of 5 s between applications of the flame;		N
	- 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; and		N
	- the material shall not be destroyed in the area of the test flame to such an extent that the integrity of the part is affected with regard to containment of fire.		N
5.2.6	Environmental tests (type tests)		--
5.2.6.1	General		--
	Environmental testing is required to establish the safety of the PDS 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 PDS, it is permitted to test individual parts that are considered to be relevant to the safety of the PDS.		N
5.2.6.2	Acceptance criteria		--

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Clause	Requirement – Test	Result - Remark	Verdict
	no degradation of any safety-relevant component of the PDSICDMIBDM;		P
	no potentially hazardous behaviour of the PDSICDMIBDM during the test;		P
	no sign of component overheating;		P
	no live part shall become accessible;		P
	no cracks in the enclosure and no damaged or loose insulators;		P
	pass routine a.c. or d.c. voltage test 5.2.3.2;		P
	pass Protective bonding test 5.2.3.9;		P
	no potentially hazardous behaviour when the PDSICDMIBDM is operated following the test.		P
5.2.6.3	Climatic tests		N
5.2.6.3.1	Dry heat test (steady state)		--
	The Dry heat (steady state) test shall be performed according to Table 25.		N
5.2.6.3.2	Damp heat test (steady state)		--
	To prove the resistance to humidity, the CDM shall be subjected to a Damp heat test (steady state) according to Table 26.		N
5.2.6.4	Vibration test (type test)		--
	To verify the mechanical strength, a vibration test shall be performed according to Table 27 as a type test using a sliding frequency.		N
5.2.7	Hydrostatic pressure (type test and routine test)		--
	For type tests, the pressure inside the cooling system of a liquid cooled PDS (see 4.4.5.2.2) shall be increased at a gradual rate until a pressure relief mechanism (if provided) operates, or until a pressure of twice the operating value or 1,5 times the maximum pressure rating of the system is achieved, whichever is the greater.		N
	For routine tests, the pressure shall be increased to its operating value.		N
	The pressure shall be maintained for at least 1 min.		N
	There shall be no thermal, shock, or other hazard resulting from the test. There shall be no significant leakage of coolant or loss of pressure during the test, other than from a pressure relief mechanism during a type test.		N
6	Information and marking requirements		--
6.1	General		P

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Clause	Requirement – Test	Result - Remark	Verdict
	The purpose of this Clause 6 is to define the information necessary for the safe selection, installation and commissioning, operation, and maintenance of PDS. It is presented as Table 28, showing where the information shall be provided, followed by explanatory subclauses.		P
	Since any electrical equipment can be installed or operated in such a manner that hazardous conditions can occur, compliance with the design requirements of this part of IEC 61800 does not by itself assure a safe installation. However, when equipment complying with those requirements is properly selected and correctly installed and operated, the hazards will be minimized.		P
	All information shall be in an appropriate language, and documents shall have identification references. Drawing symbols shall conform to IEC 60417 or IEC 60617 as appropriate. Symbols not shown in IEC 60417 or IEC 60617 shall be identified where used.		P
	NOTE Further guidance for the preparation of documentation is provided in IEC 61082, and for the preparation of instructions and manuals in IEC 62079.		P
6.2	Information for selection		--
	Each part of a PDS 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 PDS can be determined. For BDM/CDM, this information includes, but is not limited to:		P
	- the name or trademark of the manufacturer, supplier or importer;	SINOVO	P
	- catalogue number or equivalent;		P
	input and output voltage range, current, and power rating information, including:	See below	--
	- number of phases;	See marking label	P
	- frequency range;	See marking label	P
	- protective class;	Class I	P
	the type of electrical supply system (e.g. TN, IT, etc.) to which the PDS/CDM/BDM may be connected;	TN system	P
	field supply requirements (if any);		N
	- coolant type and design pressure for liquid cooled product;	No used coolant	N
	- IP rating		N
	- operating and storage environment;	See manual	P

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Clause	Requirement – Test	Result - Remark	Verdict
	- reference(s) to relevant International Standard(s) for manufacture, test, or use;	EN 61800-5-1	P
	- date code, or serial number from which the date of manufacture can be determined;	See marking label	P
	- reference to instructions for installation, use and maintenance.		P
	The information shall be limited to that which is essential for correct selection to be made, and should relate to specific equipment. If information covers a number of product variants, it shall be readily possible to distinguish between them.		P
6.3	Information for installation and commissioning		--
6.3.1	General	See below	--
	Safe and reliable installation is the responsibility of the installer, machine builder, and/or user. The manufacturer of any part of the PDS shall provide sufficient information to enable this task to be performed. This information shall be unambiguous, and may be in diagrammatic form.		P
6.3.2	Mechanical considerations		--
	The following drawings shall be prepared by the manufacturer: - dimensional drawing, including mass information; - mounting drawing; Dimensions, mass, etc., shall be in SI units.	See manual	P
6.3.3	Environment		--
	The following environmental conditions shall be specified, for operation, transportation and storage:	See manual	P
	- climatic (temperature, humidity, altitude, pollution);		P
	- mechanical;		P
	- electrical.		P
6.3.4	Handling and mounting		--
	In order to prevent injury or damage, the installation documents shall include warnings of any hazards which can be experienced during installation. In particular, instructions shall be provided for:	See manual	P
	- packing and unpacking;		P
	- moving;		P
	- lifting;		P
	- fastening;		P

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Clause	Requirement – Test	Result - Remark	Verdict
	- provision of adequate access for operation, adjustment and maintenance.		P
6.3.5	Motor and driven equipment		--
6.3.5.1	Motor selection	See manual	P
	Where necessary for CDM/BDM, information on suitable motor specifications (for example, based on IEC 60034-1) shall be provided. The possible influence on motor insulation of reflections of the PWM output waveform shall be taken into consideration.		P
6.3.5.2	Motor integrated sensors		--
	Insulation requirements shall be identified (see 4.3.5 and 4.3.6).		P
6.3.5.3	Critical torsional speeds		--
	When required, the PDS supplier shall provide all relevant motor information to enable critical torsional speeds to be identified (see 4.5.2.2)		P
6.3.5.4	Transient torque analysis		--
	When required, the PDS supplier shall provide all relevant electrical and mechanical information to enable transient torque analysis to be performed (see 4.5.2.3).		P
6.3.6	Connections		--
6.3.6.1	General		--
	Information shall be provided to enable the installer to make proper electrical connection to the PDS.		P
6.3.6.2	Interconnection and wiring diagrams		--
	The Installation and maintenance manuals shall include details of all necessary connections, together with a suggested interconnection diagram. The wiring diagram for each installation shall either be attached to the installation or its location shall be indicated on the installation.		P
6.3.6.3	Conductor (cable) selection		--
	The Installation manual shall define the voltage and current levels for all connections to the PDS. These shall be worst-case values, taking into account overcurrent and overload conditions and the possible effects of non-sinusoidal currents.		P
6.3.6.4	Terminal capacity and identification		--

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Clause	Requirement – Test	Result - Remark	Verdict
	The installation and maintenance manuals shall indicate the range of acceptable conductor sizes and types (solid or stranded) for all terminals, and also the maximum number of conductors which can simultaneously be connected. For user terminals, the manual shall specify the requirements for tightening torque values and also the insulation temperature rating requirements for the conductor or cable.		P
6.3.6.5	Protection requirements		--
	The installation, users and maintenance manuals shall identify any parts at voltages greater than ELV, and shall describe the insulation and separation provisions required for protection of these connections.		P
	The manuals shall also indicate the type of electrical supply system (e.g. TN, IT, etc.) on which the PDS may be used.	TN system	P
6.3.6.6	Earthing		--
	Earthing in PDS is required for reasons of personnel safety and electromagnetic compatibility (EMC). Where there is any conflict between these two requirements, personnel safety shall always take precedence.		N
	The installation manual shall specify the type of earth connection required for safety, and shall identify any additional functional or EMC requirements. The manual shall also state the limitation of one external conductor for each means of connection.		P
6.3.6.7	Protective earthing conductor current		--
	Where the touch current in the protective earthing conductor (see 4.3.5.5.2) exceeds 3,5 mA a.c. or 10 mA d.c., this shall be stated in the installation and maintenance manuals.		P
	The installation and maintenance manuals shall indicate compatibility with RCDs		P
6.3.6.8	Special requirements		--
	Any particular cable and connection requirements, for example shielding or armouring, shall be identified in the installation and maintenance manuals.		P
6.3.7	Supply overcurrent or short-circuit protection		--
	Where external devices are necessary to protect against overcurrent or short-circuit, the installation manual shall specify the required characteristics (see also 5.2.2.2, 5.2.3.6.2, 5.2.4.2).		P
6.3.8	Motor overload protection		--

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Clause	Requirement – Test	Result - Remark	Verdict
	The installation and maintenance manuals of BDM/CDM incorporating internal overload protection for the motor shall indicate the overload protection provided in percent of full-load current and duration. If the protection is adjustable, the manuals shall include instructions for adjustment.		P
	The manuals for BDM/CDM not incorporating internal overload protection for the motor and intended to be used with external or remote overload protection shall indicate that such protection shall be provided.		P
	The manuals for BDM/CDM intended to be used with motors which have thermal protectors in or on the motors shall indicate that the motors shall have such protection. The manuals shall also identify the proper connection and rating, in volts and volt-amperes, a.c. or d.c., of the load imposed by the equipment on the protector.		P
6.3.9	Commissioning		--
	General		--
	If commissioning tests are necessary to ensure the electrical and thermal safety of a PDS, information to support these tests shall be provided for each part of the PDS. This information can depend on the specific installation, and close cooperation between manufacturer, installer, and user can be required.		P
	Commissioning information shall include references to hazards that might be encountered during commissioning, for example those mentioned in 6.4 and 6.5.		P
6.4	Information for use	See below	--
6.4.1	General		--
	The user's manual shall include all information regarding the safe operation of the PDS. In particular, it shall identify any hazardous materials and risks of overheating, explosion, excessive acoustic noise, etc. where unexpected danger could exist.	See manual	P
	The manual should also indicate any hazards which can result from reasonably foreseeable misuse of the PDS.		P
6.4.2	Adjustment		--
	The user's manual shall give details of all adjustments available to the user. The identification or function of each control or indicating device and fuse 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

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Clause	Requirement – Test	Result - Remark	Verdict
	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
6.4.3	Labels, signs and signals		--
6.4.3.1	General		--
	Labelling shall be in accordance with good ergonomic principles so that notices, controls, indications, test facilities, fuses, etc., are sensibly placed and logically grouped to facilitate correct and unambiguous identification.	Comply with requirement	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
	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.		N
	Labels shall:		--
	-wherever possible, use international symbols as given by ISO 3864, ISO 7000 or IEC 60417;		P
	- if no international symbol is available, be worded in an appropriate language or in a language associated with a particular technical field;		P
	- be conspicuous, legible and durable;		P
	- be concise and unambiguous;		P
	- state the hazards involved and give ways in which risks can be reduced.		P
	When instructing the person(s) concerned as to	See below	--
	- what to avoid: the wording should include “no”, “do not”, or “prohibited”;		P
	- what to do: the wording should include “shall”, or “must”;		P
	- the nature of the hazard: the wording should include “caution”, “warning”, or “danger”, as appropriate;		P
	- the nature of safe conditions: the wording should include the noun appropriate to the safety device.		P
	- Safety signs shall comply with ISO 3864.		P
	The signal words indicated hereinafter shall be used and the following hierarchy respected:		P
	- DANGER to call attention to a high risk, for example: “High voltage”		P
	- WARNING to call attention to a medium risk, for example: “This surface can be hot.”		P

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Clause	Requirement – Test	Result - Remark	Verdict
	-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.”		P
	Danger, warning and caution markings on the PDS shall be prefixed with the word “DANGER”, “WARNING”, or “CAUTION” as appropriate in letters not less than 3,2 mm high. The remaining letters of such markings shall be not less than 1,6 mm high.		P
6.4.3.2	Isolators		--
	Where the isolating device is not intended to interrupt load current, a warning shall state:		N
	DO NOT OPEN UNDER LOAD.		N
	The following requirements apply to any isolating device which does not disconnect all sources of power to the PDS.		--
	- 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 PDS.		N
	- 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 PDS.		N
6.4.3.3	Visual and audible signals		--
	Visual signals such as flashing lights, and audible signals such as sirens, may be used to warn of an impending hazardous event such as the driven equipment start-up and shall be identified.	Comply with requirement	P
	It is essential that these signals:		--
	- are unambiguous;		P
	- can be clearly perceived and differentiated from all other signals used;		P
	- can be clearly recognized by the user;		P
	- are emitted before the occurrence of the hazardous event.		P
	It is recommended that higher frequency flashing lights be used for higher priority information.		P
	NOTE IEC 60073 provides guidance on recommended flashing rates and on/off ratios.		P
6.4.3.4	Hot surfaces	See below	--

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Clause	Requirement – Test	Result - Remark	Verdict
	Surfaces which may exceed the temperature limits of Table 12 shall be marked with the warning symbol 5041 of IEC 60417 (see Annex B). The user's manual shall also contain this information.	Not exceed temperature limits	N
6.4.3.5	Equipment marking		--
	The identification of each control or indicating device and fuse shall be marked adjacent to the item. Replaceable fuses shall be marked with their rating and time characteristics. Where it is not possible to do this on the product, the information shall be provided pictorially in the manual.		P
	Appropriate identification shall be marked on or adjacent to each movable connector.		P
	Test points shall be individually marked with the circuit diagram reference.		P
	The polarity of any polarized devices shall be marked adjacent to the device.		P
	The diagram reference and if possible the function shall be marked adjacent to each pre-set control in a position where it is clearly visible while the adjustment is being made.		P
6.5	Information for maintenance		--
6.5.1	General		--
	Safety information shall be provided in the maintenance manual including, as appropriate, the following:		P
	preventive maintenance procedures and schedules;		P
	safety precautions during maintenance (for example, the use of earthing switches for high-voltage PDS);		N
	location of live parts that can be accessible during maintenance (for example, when covers are removed);		P
	adjustment procedures;		P
	subassembly and component repair and replacement procedures;		P
	any other relevant information.		P
	NOTE 1 These may best be presented as diagrams.		P
	NOTE 2 A list of special tools should be provided, when appropriate.		P
6.5.2	Capacitor discharge		--

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Clause	Requirement – Test	Result - Remark	Verdict
	When the warning symbol according to 4.3.11 is required, the symbol shall be explained in the installation and maintenance manuals together with the capacitor discharge time.		P
6.5.3	Auto restart/bypass connection		--
	A PDS which is configured to provide automatic restart or bypass connection after the removal of power shall be clearly identified. The installation, user and maintenance manuals shall contain appropriate warning statements.	No automatic restart	N
6.5.4	PT/CT connection		--
	A PDS which uses a Potential Transformer (PT) supplied from high voltage, or a Current Transformer (CT) supplied from a high current connection, shall be clearly marked to show the possible hazards of voltage transients upon disconnection of the secondary circuit. The hazards shall also be described in the installation and maintenance manuals.	No such PT/CT	N
6.5.5	Other hazards		--
	The manufacturer shall identify all components and materials of a PDS which require special procedures to prevent hazards.		P
Annex A	(informative) – Examples of protection in case of direct contact		P
A.1	General		P
	Figures A.1 to A.3 show examples of the methods used for protection in case of direct contact (see 4.3.4)		P
	Protection against direct contact		P
	Protective separation from circuits requiring protection against direct contact		N
A.2	Protection by means of DVC A		N
A.3	Protection by means of protective impedance		N
A.4	Protection by using limited voltages		N
Annex B	(informative) –Examples of overvoltage category reduction		P
B.1	General		P
	The following Figures B.1 to B.13 are intended as illustrations of the requirements in Table 4, 4.3.6.2 and 4.3.6.3. They are not intended as indications of good design practice.		P
	Protection against direct contact		P
	Conductive accessible parts		N

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Clause	Requirement – Test	Result - Remark	Verdict
	Protective separation		N
B.2	Insulation to the surroundings (see 4.3.6.2)		P
B.2.1	Circuits connected directly to the supply mains (see 4.3.6.2.2)	Overvoltage category III	P
B.2.2	Circuits not connected directly to the supply mains (see 4.3.6.2.3)		N
Annex C	(normative) – Measurement of clearance and creepage distances		P
C.1	Measurement		P
C.2	Relationship of measurement to pollution degree	Pollution degree II	P
Annex D	(informative) –Altitude correction for clearances	2000m	P
Annex E	(informative) –Clearance and creepage distance determination for frequencies greater than 30 kHz	Less than 30KHz	N
Annex F	(informative) –Cross-sections of round conductors		N
Annex G	(informative) –Guidelines for RCD compatibility		N
G.1	Selection of RCD type		N
G.2	Fault current waveforms		N
Annex H	(informative) –Symbols referred to in this part of IEC 61800	Comply with requirement	P

5.2.3.6.2.1	TABLE: Electrical data (in normal- and overload conditions)					P
fuse #	I rated (A)	U (V)	P (W)	I (A)	I fuse (A)	condition/status
--	5.0	380	--	5.0	--	Normally working
Remark:						

5.2.3.8	Temperature rise test (type test)		P
	test voltage (V) .....:	380V~	—
	t1 (°C) .....:	40.0℃	—
	t2 (°C) .....:	40.0℃	—

temperature rise dT of part/at:	dT (℃)	permitted dT (℃)
Input connector	74.2	125
Button	52.8	70
Internal wire	54.8	105
Y Capacitor	55.3	85
Winding of transformer	81.1	110
Core of transformer	80.2	110
Relay RLY1	53.7	85
PCB under transformer	78.3	130
Outside enclosure	53.1	70

Temperature rise dT of winding:	R_1 (Ω)	R_2 (Ω)	dT (K)	permitted dT (K)	insulation class
--	--	--	--	--	--
Remark:					

4.3.6.8	TABLE: distance through insulation measurements				P
distance through insulation di at/of:	U r.m.s. (V)	test voltage (V)	required di (mm)	di (mm)	
Transformer bobbin	380	3000	0.4	0.6	
Remark:					

4.3.6.4 and 4.3.6.5	TABLE: clearance and creepage distance measurements					P
clearance cl and creepage distance dcr at/of:	Up (V)	U r.m.s. (V)	required cl (mm)	cl (mm)	required dcr (mm)	dcr (mm)
R to S	538	380	5.5	13.8	5.5	13.9
S to T	538	380	5.5	14.0	5.5	14.0
T to "-"	538	380	5.5	14.2	5.5	14.0
U to V	538	380	5.5	13.5	5.5	13.6
V to W	538	380	5.5	13.8	5.5	13.9
W to PE terminal	538	380	5.5	15.2	5.5	15.0
Remark:						

4.3.6.8 4.3.8.7 4.4	**TABLE: list of critical components**	P

object/part No.	manufacturer/ trademark	type/model	technical data	standard	mark(s) of conformity[1])
Radiatior	shenzhen YIHE co., LTD	AB7152M0051 AB9040M0005		EN 61800-5-1	Test with appliance
ALL PWB	Bondcircuit (shenzhen)Co., LTD	E5217-01-01 E5812-01-01	UL94V-0, 130°C,	UL 94V-0 E348757	UL
Mosfets IGBT Rectifier	Infineon Technologies Ag	FP75R12KT4	Tvj=175°C, Vces=1200V, I_C nom =200A, I_{CRM}=400A	UL 1557	UL
DC FAN	Shenzhen Huaxia Hengtai Electronic Co.,Ltd	SP-F112-01 DZ08038B24UA	24VDC 12000rpm	UL、CE、TUV	UL、CE、TUV
Surge suppression varistor	CeNtRa Science (holdings) Ltd.	CNR-14D821K	MAX Allowable Voktage 460DC 105°C	UL 1499 IEC/EN 61051-1 IEC/EN 61051-2 IEC/EN 61051-2-2	VDE UL
Y-capacitor	CNJU ELECTRONICS CO.,LTD	Y2-472M/250VAC-Y5V	4700pF ±20% 85℃	UL1414, IEC 60384-14	UL VDE
Optical Isolator	AVAGO Co.,LTD	APCL-350-500E	2.5A output current 105℃	EN 60747-5-1 / -5-2 / -5-3 UL 1577	VDE UL
Transformer	ShenZhen XieXingELECTRONICS CO.,LTD	SFT-088	Class B	EN 61800-5-1	Test with appliance
Bobbin	ChangChun Plastics CO.,LTD	Type-EE-33	V-0, 150 °C,	UL 94	UL
Tiple Insulated Wire	ShenZhenChengWei IndustryCO LTD	2UEW-F	155°C	E227475	UL
（Alternate）	ShantouShengangElectricalIndustrial Co.,LTD	2UEW	155°C	E239508	UL
Insulating Tape	SuZhouMailaduonaElectric Material Co.,LTD	JY312	130°C	E188295	UL
-Tube	ShenZhenHangXuan S&Tco.LTD	HX-TFL,150V	200°C	E361862	UL
-Varnish	ZhuHaiChangXian New Materials Technology Co.,LTD	E926	130°C	E335405	UL
Mosfet（TR1）	ST	STFW3N150	1500V，2.5A	EN 61800-5-1	Test with appliance
Electrolyte Capacitor	Shen zhen CECTN TECHNOLOGY co.,LTD	PE20400102M2H707	1000uF/400V 85°φ30*70	EN 61800-5-1	Test with appliance

[1]) an asterisk indicates a mark which assures the agreed level of surveillance

5.2.3.6	Short-circuit test and Breakdown of components test (type tests)						P
	ambient temperature (°C) .....:			40℃			—
No.	compo-nent No.	fault	test voltage (V)	test time	fuse No.	fuse current (A)	result
1	Output	Short circuit	380	2hours	--	--	Unit shutdown immediately, no damage, no hazards.
2	Optocoupler PC1 Pin1- Pin2	Short circuit	380	30min	--	--	After SC, unit shut down immediately and recoverable after the fault condition removed. No damaged, no hazard.
3	Optocoupler PC1 Pin3- Pin4	Short circuit	380	30min	--	--	After SC, unit shut down immediately and recoverable after the fault condition removed. No damaged, no hazard.
supplementary information							
See technical documentation.							

PHOTO DOCUMENTATION

Photo 1 [√] front [ ] rear [ ] right side [ ] left side [√] top [ ] bottom [ ] internal	

Photo 2 [ ] front [√] rear [ ] right side [ ] left side [ ] top [ ] bottom [ ] internal	

PHOTO DOCUMENTATION

Photo 3

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[ ] rear
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[√] left side
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Photo 4

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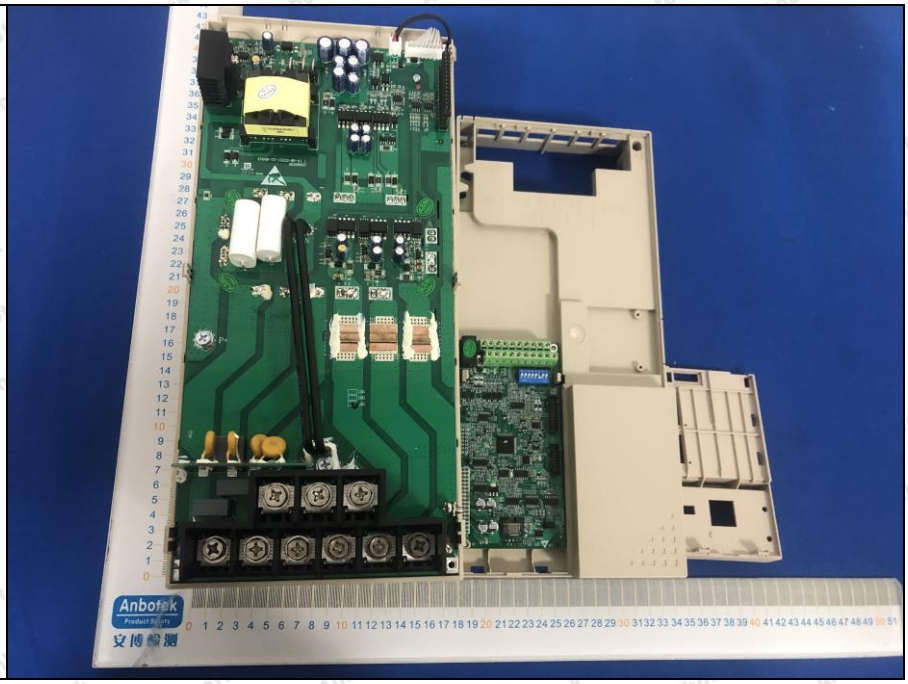

PHOTO DOCUMENTATION

Photo 5

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Photo 6

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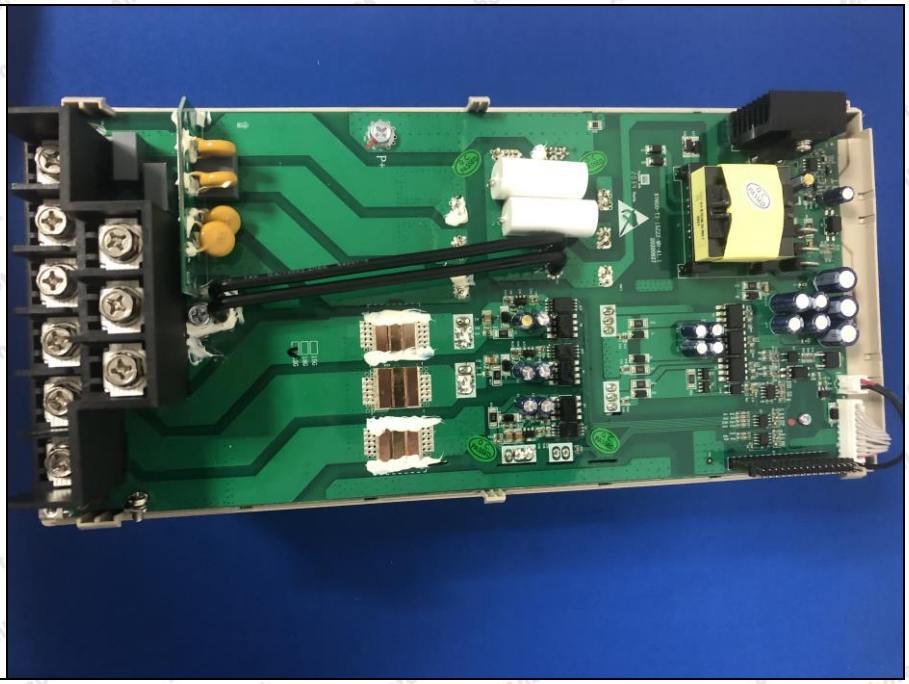

PHOTO DOCUMENTATION

Photo 7

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***** End of Report *****