LVD Test Report

Related to CE Directive: 2014/35/EU Low Voltage Directive
Report Number: H(18)080601LR
Date: Aug. 06, 2018

Applicant : Zhejiang H-WISE Technology Co., Ltd.

Address : No. 88 Yexin Road, Ganyao Industrial Park, Jiashan, Zhejiang, China(314107).

Trade mark : /

Product name: AC Drive/Inverters

Model(s): H300, H500, H600, H700, H900.

According to : EN 61800-5-1:2007

TEST REPORT FOR COMPLIANCE WITH

EN 61800-5-1:2007 Adjustable speed electrical power drive systems — Part 5-1: Safety requirements — Electrical, thermal and energy

Registered Number		
Applicant	Zhejiang H-WISE Technology Co., Ltd.	
Applicant Address	No. 88 Yexin Road, Ganyao Industrial Park, Jiashan, Zhejiang, China(314107).	
Trade mark :		
Machinery		
Product Name	AC Drive/Inverters	
Main Model	H300	
Series Model(s)	H300, H500, H600, H700, H900.	
File No.	H(18)080601LR	
Directive	2014/35/EU Low Voltage Directive	
Standards Compliance	EN 61800-5-1:2007	
Date of Testing	Aug. 06, 2018	
Testing Laboratory	Shanghai Biaotong Testing Technology Service Co., Ltd No.11, Lane 225, Jinxiang Road, Jinqiao Pudong, Shanghai, China.	
Tested by	Stone Lee	Stone Lee
Approved by	Jack Yang	Jack Yang

Test item particulars:
Type of item tested…….: LVD evaluation Description of equipment function……: AC Drive/Inverters Overall size of the equipment (L x W x H)…..: See general products information Mass of the equipment (kg)……..: See general products information
Accessories and detachable parts included in the evaluation……..: — Option…… …...: —
Test case verdicts:
Test case does not apply to the test object….: N(N/A) Test object does meet the requirement…….: P(Pass) Test object does not meet the requirement….: F(Fail)
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Copy of Marking Plate:

EN 61800-5-1:2007 test report

Clause	Requirements EN 61800-5-1:2007	Result-Remark	Verdict
	Adjustable speed electrical power drive systems —Part 5-1: Safety requirements – Electrical, thermal and energy		N
1	Scope		N
2	Normative references		N
3	Terms and definitions		N
4	Protection against electric shock, thermal, and energy hazards		P
4.1	General		N
	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		N
	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
	Protection against thermal hazards and electric shock shall be maintained in single fault conditions as well as under normal conditions. Circuit analysis shall be performed to identify components (including insulation systems) whose failure would result in a thermal or electric shock hazard. The analysis shall include the effect of short-circuit and open-circuit conditions of the component. The analysis need not include power semiconductor devices if equivalent		P

Clause	Requirements EN 61800-5-1:2007	Result-Remark	Verdict
	testing is accomplished during short-circuit tests, or components which have been determined to have an insignificant probability of failure during the expected lifetime of the PDS. See 5.2.3.6.4 for test.		
4.3	Protection against electric shock		N
4.3.1	Decisive voltage classification		N
4.3.1.1	Use of decisive voltage class (DVC) 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
4.3.1.3	Requirements for protection 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.		P
4.3.1.4	Circuit evaluation		N
4.3.1.4.1	General The DVC of a given circuit is evaluated by the method set out below, three cases of waveforms being considered		P
4.3.2	Protective separation		N
	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, or •by protective screening, i.e. by a conductive		P

Clause	Requirements EN 61800-5-1:2007	Result-Remark	Verdict
	screen connected to earth by protective bonding of thePDS, or connected to the protective earth conductor itself, whereby the screen is separated from liveparts by at least basic insulation, or •by protective impedance according to 4.3.4.3 comprising limitation of discharge energy and ofcurrent, or by limitation of voltage according to 4.3.4.4.		
	The protective separation shall be fully and effectively maintained under all conditions of intended use of the PDS.		P
4.3.3	Protection against direct contact		N
4.3.3.1	General Protection against direct contact is employed to prevent persons from touching live parts which do not meet the requirements of 4.3.4. It shall be provided by one or more of the measures given in 4.3.3.2 and 4.3.3.3. For integrated PDS the motor shall meet the requirements of IEC 60034-5. For the BDM the protection shall be provided by one or more of the measures given in 4.3.3.2 and 4.3.3.3.		P
4.3.3.2	Protection by means of insulation of live parts Live parts shall be completely surrounded with insulation if their working voltage is greater than the maximum limit of DVC A or if they do not have protective separation from adjacent circuits of DVC C or D. The insulation shall be rated according to the impulse voltage, temporary overvoltage or working voltage (see 4.3.6.2.1), whichever gives the most severe requirement. It		P

Clause	Requirements EN 61800-5-1:2007	Result-Remark	Verdict
	shall not be possible to remove the insulation without the use of a tool. Any conductive part which is not separated from the live parts by at least basic insulation is considered to be a live part. A metallic accessible part is considered to be conductive if its surface is bare or is covered by an insulating layer which does not comply with the requirements of basic insulation. As an alternative to solid or liquid insulation, a clearance according to 4.3.6.4, shown by L1 and L2 in Figure 5, may be provided.		
	The grade of insulation - basic, double or reinforced - depends on: the DVC of the live parts or adjacent circuits, and the connection of conductive parts to earth by protective bonding.		P
4.3.3.3	Protection by means of enclosures and barriers 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. 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. 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 or maintenance:		N

Clause	Requirements EN 61800-5-1:2007	Result-Remark	Verdict
	a)accessible live parts of DVC B, C or D shall be protected to at least IPXXA; b)live parts of DVC B, C or D that are likely to be touched when making adjustments shall be protectedto at least IPXXB; c)it shall be ensured that persons are aware that live parts of DVC B, C or D are accessible		P
	Open type sub-assemblies and devices do not require protective measures against direct contact. 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. Products containing circuits of DVC D, intended for installation within a closed electrical operating area, have additional requirements (see 4.3.12).		P
4.3.4	Protection in case of direct contact		N
4.3.4.1	General		N
	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:		P
	•is of DVC A and complies with 4.3.4.2, or •is current limited via a protective impedance according to 4.3.4.3, or is limited in voltage according to 4.3.4.4.		P

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4.3.4.2	Protection using DVC A 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. 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. The instruction manual shall provide information concerning the use of these circuits (see 6.3.6.5).		P
4.3.4.3	Protection by means of protective impedance		N
	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). The same constructional provisions as those for protective separation shall be applied for the construction and arrangement of a protective impedance. The current value stated below shall not be exceeded in the event of failure of a single component. The stored charge available between simultaneously accessible parts protected by the protective impedance shall not exceed 50 µC. 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

Clause	Requirements EN 61800-5-1:2007	Result-Remark	Verdict
	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.		
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. This circuit shall be designed so that, even in the event of failure of a single component in the voltage division circuit, the voltage across output terminals as well as the voltage to earth will not become greater than that of DVC A. The same constructional measures as in protective separation shall be employed in this case. This type of protection shall not be used in case of protective class II, because it relies on protective earth being connected.		P
4.3.5	Protection against indirect contact		N
4.3.5.1	General Protection against indirect contact is required to prevent shock currents which can result from accessible conductive parts during an insulation failure. This protection shall comply with the requirements for protective class I, class II or class III.		P
4.3.5.2	Insulation between live parts and accessible conductive parts 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

Clause	Requirements EN 61800-5-1:2007	Result-Remark	Verdict
4.3.5.3	Protective bonding circuit 4.3.5.3.1 General Other than in a) or b) below, protective bonding shall be provided between accessible conductive parts of equipment and the means of connection for the protective earthing conductor: a)when accessible conductive parts are protected by one of the measures in 4.3.4.2 to 4.3.4.4; b)when accessible conductive parts are separated from live parts using double or reinforced insulation. NOTE Some examples of such parts are magnetic cores, screws, rivets, nameplates and cable clamps		P
4.3.5.3.2	Rating of protective bonding 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. 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. NOTE In cases where the protective bonding is routed through conductors of low cross-section (for example, PWB tracks), particular care should be taken to ensure that no undetected damage to the bonding circuit can occur in the event of a fault.		P

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	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. Alternatively, protective bonding may be designed to meet the impedance requirements of 4.3.5.3.3.		
4.3.5.3.3	Protective bonding impedance		N
	The impedance of the protective bonding shall be sufficiently low that:		N
	•during normal operation, no voltage exceeding continuously 5 V a.c. or 12 V d.c. can persist betweenthe accessible conductive parts and the means of connection for the protective earthing conductor, and •under fault conditions, no voltage exceeding AC-2 or DC-2 in Figure 7 can persist between accessibleconductive parts and the means of connection for the protective earthing conductor until an upstream protective device removes power from the part. The upstream protective device considered for thisrequirement shall have the characteristics required by the installation manual according to 6.3.7.		P
4.3.5.4	Protective earthing conductor		N
	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). Unless local wiring regulations state otherwise, the protective		P

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	earthing conductor cross-sectional area shall be determined from Table 5 or by calculation according to 543.1 of IEC 60364-5-54. 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.		
4.3.5.5	Means of connection for the protective earthing conductor		N
4.3.5.5.1	General Every PDS or PDS element (motor, converter, transformer) requiring connection to earth by protective bonding shall have a means of connection for the protective earthing 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 protective earthing 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 protective earthing conductor. For high-voltage PDS, protective shields of high voltage cables shall have provision for connection to earth by 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		P

Clause	Requirements EN 61800-5-1:2007	Result-Remark	Verdict
	installation		
4.3.5.5.2	Touch current in case of failure of protective earthing conductor The requirements of this subclause shall be satisfied to maintain safety in case of damage to or disconnection of the protective earthing conductor. For plug-connected single phase PDS/CDM/BDM, not using an industrial connector according to IEC 60309, the touch current (measured in accordance with 5.2.3.5) shall not exceed 3,5 mA a.c. or 10 mA d.c. For all other PDS/CDM/BDM, one or more of the following measures shall be applied, unless the touch current (measured in accordance with 5.2.3.5) can be shown to be less than 3,5 mA a.c. or 10 mA d.c.		P
	a)A fixed connection and: •a cross-section of the protective earthing conductor of at least 10 mm2 Cu or 16 mm2 Al, or •automatic disconnection of the supply in case of discontinuity of the protective earthingconductor; or •provision of an additional terminal for a second protective earthing conductor of the same cross-sectional area as the original protective earthing conductor,		P
	or		N

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	b)connection with an industrial connector according to IEC 60309 and a minimum protective earthingconductor cross-section of 2,5 mm2 as part of a multi-conductor power cable. Adequate strain reliefshall be provided. For marking requirements, see 6.3.6.7.		
4.3.5.6	Special features in equipment for protective class II		P
	If equipment is designed to use double or reinforced insulation between live parts and accessible surfaces in accordance with 4.3.3.2, then the design is considered to meet protective class II, if the following also apply.		P
	•Equipment designed to protective class II shall not have means of connection for the protectiveearthing conductor. However this does not apply if a protective earthing conductor is passed throughthe equipment to equipment series-connected beyond it. In the latter event, the protective earthingconductor and its means for connection shall be insulated with basic insulation from the accessiblesurface of the equipment and from circuits which employ protective separation, extra-low voltage,protective impedance and limited discharging energy, according to 4.3.4. This basic insulation shallcorrespond to the rated voltage of the series-connected equipment.		P
	•Metal-encased equipment of protective class II may have provision on its enclosure for the connectionof an equipotential bonding conductor. •Equipment of protective class II may have provision for the connection of an earthing		P

Clause	Requirements EN 61800-5-1:2007	Result-Remark	Verdict
	conductor forfunctional reasons or for the damping of overvoltages; it shall, however, be insulated as though it isa live part. •Equipment of protective class II shall be marked according to 6.3.6.6.		
4.3.6	Insulation		N
4.3.6.1	General 4.3.6.1.1 Influencing factors This subclause gives minimum requirements for insulation, based on the principles of IEC 60664 and IEC 60071. Manufacturing tolerances shall be taken into account during design and installation of the PDS. 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: •pollution degree; •overvoltage category; •supply earthing system; •insulation voltage; •location of insulation; •type of insulation;		P
4.3.6.2	Insulation to the surroundings		N
4.3.6.2.1	General Insulation for basic, supplementary, and		P

Clause	Requirements EN 61800-5-1:2007	Result-Remark	Verdict
	reinforced insulation between a circuit and its surroundings shall be designed according to: •the impulse voltage, or •the temporary overvoltage, or •the working voltage of the circuit.		
	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).		P
	The system voltage in column 1 of these tables is:		N
	For Table 7 — in TN and TT systems: the r.m.s. value of the rated voltage between a phase and earth; 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 (i.e. the phase-phase voltage).		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); NOTE For most systems, this is equivalent to		P

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	dividing the phase-to-phase voltage by √3. • for determination of temporary overvoltage, the r.m.s. value of the rated voltage between phases; — in single-phase IT systems: the r.m.s. value of the rated voltage between phases. • For Table 8: the r.m.s. value of the rated voltage between phases.		
4.3.6.2.2	Circuits connected directly to the supply mains		N
	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 working voltage, whichever gives the most severe requirement. 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 at 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. If measures are provided which reduce impulses of overvoltage 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. If the devices used for this purpose can be damaged by overvoltages or repeated impulses, thus decreasing their ability to reduce impulses, they		P

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	shall be monitored and an indication of their status provided. For low-voltage applications, IEC 61643-12 provides information on the selection and use of such devices.		
	The requirements for double or reinforced insulation shall not be reduced when measures to reduce impulses are provided.		P
4.3.6.3	Functional insulation		N
	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. 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. 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. 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.		P
4.3.6.4	Clearance distances		N
4.3.6.4.1	Determination Table 9 defines the minimum clearance distances required to provide functional, basic, or		P

Clause	Requirements EN 61800-5-1:2007	Result-Remark	Verdict
	supplementary insulation (see Annex C for examples of clearance distances).		
4.3.6.4.2	Electric field homogeneity 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 for basic or supplementary insulation may be reduced to not less than that required by Table 2 Case B 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 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. 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		P
4.3.6.5	Creepage distances 4.3.6.5.1 General Creepage distances shall be large enough to prevent long-term degradation of the surface of solid insulators, according to Table 10. For functional, basic and supplementary insulation, the values in Table 10 apply directly.		P

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	For reinforced insulation, the distances in Table 10 shall be doubled. When the creepage distance determined from Table 10 is less than the clearance required by 4.3.6.4.1 or the clearance determined by impulse testing (see 5.2.3.1), then it shall be increased to that clearance. Creepage distances shall be verified by measurement or inspection (see 5.2.2.1) (see Annex C for examples of creepage distances).		
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).		P
	4.3.6.7 PWB spacings for functional insulation		N
	Spacings for functional insulation on a PWB which do not comply with 4.3.6.4 and 4.3.6.5 are permitted when all the following are satisfied: • the PWB has a flammability rating of V-0 (see IEC 60695-11-10); • the PWB base material has a minimum CTI of 100; • the equipment complies with the PWB short-circuit test (see 5.2.2.2). 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.		P
4.3.6.8	Solid insulation		N

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4.3.6.8.1	General Materials selected for solid insulation shall be able to withstand the stresses occurring. These include mechanical, electrical, thermal and climatic stresses which are to be expected in normal use. Insulation materials shall also be resistant to ageing during the expected lifetime of the PDS. Tests shall be performed on components and subassemblies using solid insulation, in order to ensure that the insulation performance has not been compromised by the design or manufacturing process. Components that comply with a relevant product standard which provides equivalent requirements to those of this standard do not require separate evaluation. Assemblies containing such components shall be tested according to the requirements of this standard		P
4.3.7	Enclosures		N
4.3.7.1	General 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. 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. For integrated PDS the CDM/BDM enclosure shall comply with the above requirements. The motor enclosure shall meet the requirements of		P

Clause	Requirements EN 61800-5-1:2007	Result-Remark	Verdict
	the relevant parts of IEC 60034. Enclosures shall be suitable for use in their intended environments. The manufacturer shall specify the intended environment (see 6.3.3) and the IP rating of the enclosure (see 5.2.2.4 for test). 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.		
5.2	Test specifications		N
5.2.1	Visual inspections (type test, sample test and routine test)		P
	Visual inspections shall be made: • as routine tests, to check features such as adequacy of labelling, warnings and other safety aspects. • as acceptance criteria of individual type tests, sample tests or routine tests, to verify that the requirements of this standard have been met; Routine inspections may be part of the production or assembly process. Before type testing, a check shall be made that the PDS delivered for the test is as expected with respect to supply voltage, input and output ranges, etc.		P
5.2.2	Mechanical tests		N
5.2.2.1	Clearances and creepage distances (type test)		N
	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		P

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	verification is impossible to perform, an impulse voltage test (see 5.2.3.1) shall be performed between the considered circuits.		
5.2.2.2	PWB short-circuit test (type test)		N
	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.		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. The decreased spacings shall be short-circuited one at a time, on representative samples, and the short-circuit shall be maintained until no further damage occurs.		P
	As a result of the PWB short-circuit test, the PDS/CDM/BDM shall comply with the following:		N
	• there shall be no emission of flame or molten metal; • the surgical cotton indicator shall not have ignited; • the earth connection shall not have opened; • the door or cover shall not have blown open;		P

Clause	Requirements EN 61800-5-1:2007	Result-Remark	Verdict
	• during and after the test, accessible SELV and PELV circuits shall not exhibit voltages greater than the time dependent voltages of Figure 7; • during and after the test, live parts at voltages greater than decisive voltage class A shall not become accessible.		
5.2.2.3	Non-accessibility test (type test) 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. This test shall be performed as a type test of the enclosure of a PDS as specified in IEC 60529 for the enclosure classification for protection against access to hazardous parts. Exception: • the test probe for IP3X shall not penetrate the top surface of the enclosure when probed from the vertical direction ± 5° only.		P
5.2.2.4	Enclosure integrity test (type test) 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		P
5.2.2.5	Deformation tests		N
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		P

Clause	Requirements EN 61800-5-1:2007	Result-Remark	Verdict
	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:		
	• live parts have not become accessible (see 4.3.3.3); • enclosures show no cracks or openings which could cause a hazard; • clearances are not less than their minimum permitted values and other insulation is undamaged; • barriers have not been damaged or loosened; • no moving parts which could cause a hazard are exposed. The Deflection and Impact tests shall be performed at the worst case point on representative accessible face(s) of the enclosure. The PDS/CDM/BDM is not		P
5.2.2.5.2	Deflection test (type test) The enclosure shall be 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. Damage to the finish, small dents and small chips which do not adversely affect the protection against electric shock or moisture, may be ignored.		P
5.2.2.5.3	Impact test (type test) A sample consisting of the enclosure or a portion thereof representing the largest non-reinforced area shall be supported in its normal position. A		P

Clause	Requirements EN 61800-5-1:2007	Result-Remark	Verdict
	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.) In addition, the steel sphere shall 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.)		
	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.		P
5.2.3	Electrical tests		N
5.2.3.1	Impulse voltage test (type test and sample test)		N
	The impulse voltage test 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. 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. 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. To ensure that limiting devices (see 4.3.6.2.2,		P

Clause	Requirements EN 61800-5-1:2007	Result-Remark	Verdict
	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.		
	If it is necessary to test a clearance that has been designed for altitudes between 2 000 m and 20 000 m (using Table A.2 of IEC 60664-1), the appropriate test voltage may be determined from the clearance distance, using Table 9 in reverse.		P
5.2.3.2	A.C. or d.c. voltage test (type test and routine test)		N
5.2.3.2.1	Purpose of test The test is used to verify that the clearances and solid insulation of components and of assembled PDS/CDM/BDM has adequate dielectric strength to resist overvoltage conditions.		P
5.2.3.2.2	Value and type of test voltage The values of the test voltage are determined from column 2 or 3 of Table 21, Table 22, or Table 23, depending upon whether the circuit under test is connected to low voltage mains, high voltage mains, or not mains connected. The test voltage from column 2 is used for testing circuits with basic insulation. Between circuits with protective separation (double or reinforced insulation), the test voltage of column 3 shall be applied for type tests. For routine tests between circuits with protective separation the values from column 2 shall be applied to prevent damage to the solid insulation by partial discharge		P

Clause	Requirements EN 61800-5-1:2007	Result-Remark	Verdict
	The values of column 3 shall apply to PDS with protection against direct contact according to 4.3.3. The test is performed between circuits and accessible surfaces of PDS, which are non-conductive or conductive but not connected to the protective earthing conductor.		P
	The voltage test shall be performed with a sinusoidal voltage at 50 Hz or 60 Hz. If the circuit contains capacitors the test may be performed with a d.c. voltage of a value equal to the peak value of the specified a.c. voltage.		P
	Routine tests are performed to verify that clearances have not been reduced during the manufacturing operations. Protective devices designed to reduce impulse voltages on the circuits under test (see 4.3.6.2.2 and 4.3.6.2.3), and circuits belonging to monitoring or protection circuits, not designed to sustain the test overvoltage 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.		P
5.2.3.2.3	Performing the voltage test		N
	The test shall be applied as follows, according to Figure 8.		P
	a) Test (1) between accessible conductive part (connected to earth) and each circuit sequentially (except DVC A circuits). Test voltage according to, Table 22, or Table 23, column 2, corresponding to voltage of considered circuit under test. Test (2) between accessible surface (non conductive or conductive but not connected to earth) and each circuit sequentially (except DVC		P

Clause	Requirements EN 61800-5-1:2007	Result-Remark	Verdict
	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.		
	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 DVC A circuit and each adjacent circuit sequentially. Test voltage according to Table 21, Table 22, or Table 23, column 3 (for type test) or column 2 (for routine test), corresponding to the circuit with the higher voltage. Either the adjacent circuit or the DVC A circuit may be earthed for this test. It is necessary to test basic insulation between PELV and SELV circuits, but it is not necessary to test functional insulation between adjacent PELV or adjacent SELV circuits.		P
	Because PELV / SELV circuits and circuits of DVC C and D are typically separated from chassis (earth) by basic insulation, it is typically impossible to test double or reinforced insulation separating low-voltage circuits from high-voltage circuits in a fully-assembled PDS without overstressing the basic insulation. Because of this, it may be necessary to disassemble the PDS, or it may not be possible to perform type tests of protective insulation at voltages according to column 3 of Table 21 to Table 23. In these cases the type test of insulation used for protective separation shall be performed at voltages according to column 2 of the appropriate table.		P

Clause	Requirements EN 61800-5-1:2007	Result-Remark	Verdict
	When the circuit is electrically connected to accessible conductive parts, the voltage test is not relevant, and may be omitted. 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. Wherever practicable, individual components forming part of the insulation under test, for example interference suppression capacitors, should 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. 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 a circuit and non-conductive accessible surface may be performed as a sample test instead of a routine test		P
	Routine testing of the assembled PDS is not required if:		N
	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		P

Clause	Requirements EN 61800-5-1:2007	Result-Remark	Verdict
	performed successfully.		
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.		P
5.2.3.3	Partial discharge test (type test, sample test) The partial discharge test (see Table 24) shall confirm that the solid insulation (see 4.3.6.8) used in components and subassemblies for protective separation of electrical circuits remains partial-discharge-free within the specified voltage range (see Table 24). This test shall be performed as a type test and a sample test. It may be deleted for insulating materials which are not degraded by partial discharge, for example ceramics. The partial discharge inception and extinction voltage are influenced by climatic factors (e.g. temperature and moisture), equipment self heating, and manufacturing tolerance. These influencing variables can be significant under certain conditions and shall therefore be taken into account during type testing.		P
5.2.3.4	Protective impedance (type test and routine test) A type test shall be performed to verify that the current through a protective impedance under normal operating conditions does not exceed the		P

Clause	Requirements EN 61800-5-1:2007	Result-Remark	Verdict
	values given in 4.3.4.3. The test shall be performed using the circuit of IEC 60990, Figure 4. NOTE IEC 60990 states that the use of a single network for the measurement of a.c. combined with d.c. has not been investigated, but no suggestion is made for measurement in such cases. The value of the protective impedance shall be verified as a routine test.		
5.2.3.5	Touch 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
5.2.3.6	Short-circuit test and Breakdown of components test (type tests)		N
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 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,		P

Clause	Requirements EN 61800-5-1:2007	Result-Remark	Verdict
	where no damage other than opening of fuses or tripping of circuit breakers has occurred to the test sample, NOTE A representative model means a PDS/CDM/BDM with similar power elements (for example, power semiconductors, fuses, circuit breakers, capacitors, short circuit detection and output inductances) and circuit topologies as the PDS/CDM/BDM under consideration. or 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,		
	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		N
	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 PDS/CDM/BDM part under study shall be used to simulate the intended enclosure		P

Clause	Requirements EN 61800-5-1:2007	Result-Remark	Verdict
5.2.3.7	Capacitor discharge (type test) Verification of the capacitor discharge time as required by 4.3.11 may be done by a type test and/or by calculation		P
5.2.3.8	Temperature rise test (type test)		N
	The test is intended to ensure that parts and accessible surfaces of the PDS do not exceed the temperature limits specified in 4.4 and that the manufacturer's temperature limits of safety-relevant parts are not exceeded. Where possible, the PDS shall be tested at worst-case conditions of rated power and CDM/BDM output current. For integrated PDS where the motor speed might affect the thermal condition in the CDM/BDM the test shall be conducted at worst case operating speed and load according to the manufacturer's specification. If this is not possible, it is permitted to simulate the temperature rise, if the validity of the simulation can be demonstrated by tests at lower power levels. The PDS shall be tested with at least 1,2 m of wire		P
5.2.3.9	Protective bonding (type test and routine test)		N
	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.		P
5.2.4	Abnormal operation tests		N

Clause	Requirements EN 61800-5-1:2007	Result-Remark	Verdict
5.2.4.1	General Before all operation tests, the test sample shall be mounted, connected, and operated as described in the temperature rise test. 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. The PDS, and the wire mesh cage (if used), shall be earthed according to the requirements of 4.3.5.3.2. 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
5.2.4.5	Cooling failure tests (type tests)		N
5.2.4.5.1	General For PDS having a combination of cooling mechanisms, all relevant tests shall be performed. It is not necessary to perform the tests simultaneously.		P
5.2.5	Material tests		N
5.2.5.1	High current arcing ignition test (type test) 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 shall be free from burrs, fins, etc.		P

Clause	Requirements EN 61800-5-1:2007	Result-Remark	Verdict
	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 9).		
5.2.6	Environmental tests (type tests		N
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. 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.		P
5.2.7	Hydrostatic pressure (type test and routine test)		N
	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. For routine tests, the pressure shall be increased to its operating value. The pressure shall be maintained for at least 1 min. 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.		P
6	Information and marking requirements		N

Clause	Requirements EN 61800-5-1:2007	Result-Remark	Verdict
6.1	General		N
	The purpose of this Clause 6 is to define the information necessary for the safe selection, installation and commissioning, operation, and maintenance of PDS/CDM/BDM. It is presented as Table 28, showing where the information shall be provided, followed by explanatory subclauses. The requirements of this Clause 6 apply to all PDS/CDM/BDM, unless otherwise stated. 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. 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		N
	Each part of a PDS that is supplied as a separate product shall be provided with information relating to its function, electrical characteristics, and intended environment, so that its fitness for purpose and compatibility with other parts of the		P

Clause	Requirements EN 61800-5-1:2007	Result-Remark	Verdict
	PDS can be determined. For CDM/BDM, this information includes, but is not limited to:		
	• the name or trademark of the manufacturer, supplier or importer; • catalogue number or equivalent; • input and output voltage range, current, and power rating information, including: — number of phases; — frequency range; • protective class; • the type of electrical supply system (e.g. TN, IT, etc.) to which the PDS/CDM/BDM may be connected; • prospective short-circuit current rating(s) and protective device characteristics • field supply requirements (if any); • coolant type and design pressure for liquid cooled product; • IP rating; • operating and storage environment; • reference(s) to relevant international standard(s) for manufacture, test, or use; • date code, or serial number from which the date of manufacture can be determined; • 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		P

Clause	Requirements EN 61800-5-1:2007	Result-Remark	Verdict
	covers a number of product variants, it shall be readily possible to distinguish between them.		
6.3	Information for installation and commissioning		N
6.3.1	General 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 information to support this task. 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		P
6.3.3	Environment The following environmental conditions shall be specified, for operation, transportation and storage: • climatic (temperature, humidity, altitude, pollution, ultra-violet light, etc.); • mechanical; • electrical.		P
6.3.4	Handling and mounting		N
	which can be experienced during installation. Where necessary, instructions shall be provided for:		P

Clause	Requirements EN 61800-5-1:2007	Result-Remark	Verdict
	• packing and unpacking; • moving; • lifting; • strength and rigidity of mounting surface; • fastening; • provision of adequate access for operation, adjustment and maintenance. When PDS surfaces at temperatures exceeding 90 °C are close to mounting surfaces, the installation manual shall contain a warning to consider the combustibility of the mounting surface		
6.3.5	Motor and driven equipment		N
6.3.5.1	Motor selection 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
6.3.6	Connections 6.3.6.1 General Information shall be provided to enable the installer to make safe electrical connection to the PDS. This shall include information for protection against hazards (for example, electric shock or availability of energy) that may be encountered		P

Clause	Requirements EN 61800-5-1:2007	Result-Remark	Verdict
	during installation, operation or maintenance.		
6.3.7	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). When the CDM/BDM complies with the requirement of 4.3.9, the manufacturer shall state that the electronic power output short-circuit protection circuitry meets the requirements of IEC 60364-4-41:2005/AMD1:—, Clause 411. In addition, the manufacturer shall specify under which conditions the electronic power output short-circuit protection circuitry can be applied (e.g. limit of cable length, wire size, shielded or not shielded, protective earth impedance, supply earthing system).		P
6.3.8	Motor overload protection and overtemperature protection		N
6.3.8.1	CDM/BDM not incorporating internal electronic motor overload and overtemperature protection If the CDM/BDM does not incorporate electronic motor overload or motor overtemperature protection, the installation manual shall indicate that these motor protection features are not provided.		P
6.3.9	Commissioning		N
	If commissioning tests are necessary to ensure the electrical and thermal safety of a PDS, information to support these tests shall be		N

Clause	Requirements EN 61800-5-1:2007	Result-Remark	Verdict
	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. Commissioning information shall include references to hazards that might be encountered during commissioning, for example those mentioned in 6.4 and 6.5.		
6.4	Information for use		N
6.4.1	General The user's manual shall include all information regarding the safe operation of the PDS/CDM/BDM. In particular, it shall identify any hazardous materials and risks of electrical shock, overheating, explosion, excessive acoustic noise, etc.		P
6.5	Information for maintenance		N
6.5.1	General Safety information shall be provided in the maintenance manual including, as appropriate, the following:		P
	• preventive maintenance procedures and schedules; • safety precautions during maintenance (for example, the use of earthing switches for high-voltage PDS) • location of live parts that can be accessible during maintenance (for example, when covers are removed); • adjustment procedures; • subassembly and component repair and		P

Clause	Requirements EN 61800-5-1:2007	Result-Remark	Verdict
	replacement procedures; • any other relevant information. NOTE 1 These may best be presented as diagrams. NOTE 2 A list of special tools should be provided, when appropriate		


PRG
RUN
MF.K
ENTER
STOP
R S T
DANGER
5 min
U V W P+ PB

======END======