



BSI Standards Publication

Adjustable speed electrical power drive systems

Part 3: EMC requirements and specific test methods

National foreword

This British Standard is the UK implementation of EN IEC 61800-3:2018. It is identical to IEC 61800-3:2017. It supersedes BS EN 61800-3:2004+A1:2012, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PEL/22, Power electronics.

A list of organizations represented on this committee can be obtained on request to its secretary.

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English Version

**Adjustable speed electrical power drive systems - Part 3: EMC
requirements and specific test methods
(IEC 61800-3:2017)**

Entraînements électriques de puissance à vitesse variable -
Partie 3: Exigences de CEM et méthodes d'essais
spécifiques
(IEC 61800-3:2017)

Drehzahlveränderbare elektrische Antriebssysteme - Teil 3:
EMV-Anforderungen einschließlich spezieller Prüfverfahren
(IEC 61800-3:2017)

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European foreword

The text of document 22G/347/FDIS, future edition 3 of IEC 61800-3, prepared by SC 22G "Adjustable speed electric drive systems incorporating semiconductor power converters" of IEC/TC 22 "Power electronic systems and equipment" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 61800-3:2018.

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- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2021-07-09

This document supersedes EN 61800-3:2004 and EN 61800-3:2004/A1:2012.

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The text of the International Standard IEC 61800-3:2017 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 60038:2009	NOTE	Harmonized as EN 60038:2011 (modified).
IEC 60065	NOTE	Harmonized as EN 60065.
IEC 60146-1-3:1991	NOTE	Harmonized as EN 60146-1-3:1993 (not modified).
IEC 60146-2:1999	NOTE	Harmonized as EN 60146-2:2000 (not modified).
IEC 60364-1:2005	NOTE	Harmonized as HD 60364-1:2008 (modified).
IEC 60664-1:2007	NOTE	Harmonized as HD 60664-1:2007 (not modified).
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IEC 61000-6-2:2016	NOTE	Harmonized as EN 61000-6-2:2017 (not modified).
IEC 61000-6-4:2006	NOTE	Harmonized as EN 61000-6-4:2007 (not modified).

IEC 61000-6-5:2015	NOTE	Harmonized as EN 61000-6-5:2015 (not modified).
IEC 61400-21:2008	NOTE	Harmonized as EN 61400-21:2008 (not modified).
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IEC 61557-9	NOTE	Harmonized as EN 61557-9.
IEC 61800-1:1997	NOTE	Harmonized as EN 61800-1:1998 (not modified).
IEC 61800-2:2015	NOTE	Harmonized as EN 61800-2:2015 (not modified).
IEC 61800-4:2002	NOTE	Harmonized as EN 61800-4:2003 (not modified).
IEC 61800-5-1:2007	NOTE	Harmonized as EN 61800-5-1:2007 (not modified).
CISPR 14-1:2016	NOTE	Harmonized as EN 55014-1:2017 (not modified).
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CISPR 16-2-3:2016	NOTE	Harmonized as EN 55016-2-3:2017 (not modified).

Annex ZA

(normative)

Normative references to international publications with their corresponding European publications

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE 1 Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60146-1-1	2009	Semiconductor converters - General requirements and line commutated converters -- Part 1-1: Specification of basic requirements	EN 60146-1-1	2010
IEC 61000-2-2	2002	Electromagnetic compatibility (EMC) -- Part 2-2: Environment - Compatibility levels for low-frequency conducted disturbances and signalling in public low-voltage power supply systems	EN 61000-2-2	2002
IEC 61000-2-4	2002	Electromagnetic compatibility (EMC) -- Part 2-4: Environment - Compatibility levels in industrial plants for low-frequency conducted disturbances	EN 61000-2-4	2002
IEC 61000-3-2	2014	Electromagnetic compatibility (EMC) - Part 3-2: Limits - Limits for harmonic current emissions (equipment input current - 16 A per phase)	EN 61000-3-2	2014
IEC 61000-3-3	2013	Electromagnetic compatibility (EMC) - Part 3-3: Limits - Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current - 16 A per phase and not subject to conditional connection	EN 61000-3-3	2013
IEC 61000-3-11	2000	Electromagnetic compatibility (EMC) -- Part 3-11: Limits - Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems - Equipment with rated current ≤ 75 A and subject to conditional connection	EN 61000-3-11	2000

IEC 61000-3-12	2011	Electromagnetic compatibility (EMC) -- Part 3-12: Limits - Limits for harmonic currents produced by equipment connected to public low-voltage systems with input current > 16 A and ≤ 75 A per phase	EN 61000-3-12	2011
IEC 61000-4-2	2008	Electromagnetic compatibility (EMC) -- Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test	EN 61000-4-2	2009
IEC 61000-4-3	2006	Electromagnetic compatibility (EMC) -- Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test	EN 61000-4-3	2006
IEC 61000-4-4	2012	Electromagnetic compatibility (EMC) -- Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test	EN 61000-4-4	2012
IEC 61000-4-5	2014	Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques - Surge immunity test	EN 61000-4-5	2014
IEC 61000-4-6	2013	Electromagnetic compatibility (EMC) -- Part 4-6: Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields	EN 61000-4-6	2014
IEC 61000-4-8	2009	Electromagnetic compatibility (EMC) -- Part 4-8: Testing and measurement techniques - Power frequency magnetic field immunity test	EN 61000-4-8	2010
IEC 61000-4-11	2004	Electromagnetic compatibility (EMC) -- Part 4-11: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations immunity tests	EN 61000-4-11	2004
IEC 61000-4-13	2002	Electromagnetic compatibility (EMC) -- Part 4-13: Testing and measurement techniques - Harmonics and interharmonics including mains signaling at a.c. power port, low frequency immunity tests	EN 61000-4-13	2002
IEC 61000-4-34	2005	Electromagnetic compatibility (EMC) -- Part 4-34: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations immunity tests for equipment with input current more than 16 A per phase	EN 61000-4-34	2007
CISPR 11 (mod)	2015	Industrial, scientific and medical equipment - Radio-frequency disturbance characteristics - Limits and methods of measurement	EN 55011	2016
+ A1	2016		+ A1	2017

EN IEC 61800-3:2018 (E)

CISPR 16-1-2	2014	Specification for radio disturbance and immunity measuring apparatus and methods - Part 1-2: Radio disturbance and immunity measuring apparatus - Coupling devices for conducted disturbance measurements	EN 55016-1-2	2014
CISPR 16-1-4	2010	Specification for radio disturbance and immunity measuring apparatus and methods -- Part 1-4: Radio disturbance and immunity measuring apparatus - Antennas and test sites for radiated disturbance measurements	EN 55016-1-4	2010
CISPR 22	-	Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement	-	-
CISPR 32	2015	Electromagnetic compatibility of multimedia equipment - Emission requirements	EN 55032	2015

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**ADJUSTABLE SPEED ELECTRICAL POWER
DRIVE SYSTEMS –****Part 3: EMC requirements and specific test methods****FOREWORD**

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 61800-3 has been prepared by subcommittee 22G: Adjustable speed electric drive systems incorporating semiconductor power converters, of IEC technical committee 22: Power electronic systems and equipment.

This third edition cancels and replaces the second edition published in 2004 and Amendment 1:2011. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) clarification of requirements for the test report, particularly when a number of alternative test methods exist;
- b) introduction of a more detailed test setup for radiated emission measurements, along with the introduction of a 3 m measurement distance for small size equipment;
- c) general updates in the informative annexes.

The text of this standard is based on the following documents:

FDIS	Report on voting
22G/347/FDIS	22G/350/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2, and with IEC Guide 107.

A list of all parts in the IEC 61800 series, published under the general title *Adjustable speed electrical power drive systems*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

IMPORTANT – The "colour inside" logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this publication using a colour printer.

ADJUSTABLE SPEED ELECTRICAL POWER DRIVE SYSTEMS –

Part 3: EMC requirements and specific test methods

1 Scope

This part of IEC 61800 specifies electromagnetic compatibility (EMC) requirements for power drive systems (PDSs, defined in 3.1). These are adjustable speed AC or DC motor drives. Requirements are stated for PDSs with converter input and/or output voltages (line-to-line voltage), up to 35 kV AC RMS.

PDSs covered by this document are those installed in residential, commercial and industrial locations with the exception of traction applications, and electric vehicles. PDSs can be connected to either industrial or public power distribution networks. Industrial networks are supplied by a dedicated distribution transformer, which is usually adjacent to or inside the industrial location, and supplies only industrial customers. Industrial networks can also be supplied by their own electric generating equipment. On the other hand, PDSs can be directly connected to low-voltage public mains networks which also supply residential premises, and in which the neutral is generally earthed (grounded).

The scope of this part of IEC 61800, related to EMC, includes a broad range of PDSs from a few hundred watts to hundreds of megawatts. PDSs are often included in a larger system. The system aspect is not covered by this document but guidance is provided in the informative annexes.

The requirements have been selected so as to ensure EMC for PDSs at residential, commercial and industrial locations. The requirements cannot, however, cover extreme cases which can occur with an extremely low probability. Changes in the EMC behaviour of a PDS, as a result of fault conditions, are not taken into account.

The object of this document is to define the limits and test methods for a PDS according to its intended use. This document includes immunity requirements and requirements for electromagnetic emissions.

NOTE 1 Emission can cause interference in other electronic equipment (for example radio receivers, measuring and computing devices). Immunity is meant to protect the equipment from continuous and transient conducted and radiated disturbances including electrostatic discharges. The emission and immunity requirements are balanced against each other and against the actual environment of the PDS.

This document defines the minimum EMC requirements for a PDS.

Immunity requirements are given according to the environment classification. Low-frequency emission requirements are given according to the nature of the supply network. High-frequency emission requirements are given according to four categories of intended use, which cover both environment and bringing into operation.

As a product standard, this document can be used for the assessment of PDS. It can also be used for the assessment of complete drive modules (CDM) or basic drive modules (BDM) (see 3.1), which can be marketed separately.

This document contains

- conformity assessment requirements for products to be placed on the market, and

- recommended engineering practice (see 6.5) for cases where high frequency emissions cannot be measured before the equipment is placed on the market (such PDSs are defined in 3.2.7 as category C4).

NOTE 2 The first edition of IEC 61800-3 identified that the intended use could require engineering for putting into service. This was done by the “restricted distribution mode”. Equipment formerly identified under “restricted distribution mode” is now covered by categories C2 and C4 (see 3.2).

This document is intended as a complete EMC product standard for the EMC conformity assessment of products of categories C1, C2 and C3, when placing them on the market (see definitions 3.2.4 to 3.2.6).

Radio frequency emission of equipment of category C4 is only assessed when it is installed in its intended location. It is therefore treated as a fixed installation, for which this document gives rules of engineering practice in 6.5 and Annex E, although it gives no defined emission limits (except in case of complaint).

This document does not specify any safety requirements for the equipment such as protection against electric shocks, insulation co-ordination and related dielectric tests, unsafe operation, or unsafe consequences of a failure. It also does not cover safety and functional safety implications of electromagnetic phenomena.

In special cases, when highly susceptible apparatus is being used in proximity, additional mitigation measures can have to be employed to reduce the electromagnetic emission further below the specified levels or additional countermeasures can have to be employed to increase the immunity of the highly susceptible apparatus.

As an EMC product standard for PDSs, this document takes precedence over all aspects of the generic standards, and no additional EMC tests are performed. If a PDS is included as part of equipment covered by a separate EMC product standard, the EMC standard of the complete equipment applies.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60146-1-1:2009, *Semiconductor convertors – General requirements and line commutated convertors – Part 1-1: Specifications of basic requirements*

IEC 61000-2-2:2002, *Electromagnetic compatibility (EMC) – Part 2-2: Environment – Compatibility levels for low-frequency conducted disturbances and signalling in public low-voltage power supply systems*

IEC 61000-2-4:2002, *Electromagnetic compatibility (EMC) – Part 2-4: Environment – Compatibility levels in industrial plants for low-frequency conducted disturbances*

IEC 61000-3-2:2014, *Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic current emissions (equipment input current ≤ 16 A per phase)*

IEC 61000-3-3:2013, *Electromagnetic compatibility (EMC) – Part 3-3: Limits – Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤ 16 A per phase and not subject to conditional connection*

IEC 61000-3-11:2000, *Electromagnetic compatibility (EMC) – Part 3-11: Limits – Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems – Equipment with rated current ≤ 75 A and subject to conditional connection*

IEC 61000-3-12: 2011, *Electromagnetic compatibility (EMC) – Part 3-12: Limits – Limits for harmonic currents produced by equipment connected to public low-voltage systems with input current > 16 A and ≤ 75 A per phase*

IEC 61000-4-2:2008, *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test*

IEC 61000-4-3:2006, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test*

IEC 61000-4-4:2012, *Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test*

IEC 61000-4-5:2014, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test*

IEC 61000-4-6:2013, *Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields*

IEC 61000-4-8:2009, *Electromagnetic compatibility (EMC) – Part 4-8: Testing and measurement techniques – Power frequency magnetic field immunity test*

IEC 61000-4-11:2004, *Electromagnetic compatibility (EMC) – Part 4-11: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests*

IEC 61000-4-13:2002, *Electromagnetic compatibility (EMC) – Part 4-13: Testing and measurement techniques – Harmonics and interharmonics including mains signalling at a.c. power port, low frequency immunity tests*

IEC 61000-4-34:2005, *Electromagnetic compatibility (EMC) – Part 4-34: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests for equipment with input current more than 16 A per phase*

CISPR 11:2015, *Industrial, scientific and medical equipment – Radio-frequency disturbance characteristics – Limits and methods of measurement*
CISPR 11:2015/AMD1:2016

CISPR 16-1-2:2014, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-2: Radio disturbance and immunity measuring apparatus – Coupling devices for conducted disturbance measurements*

CISPR 16-1-4:2010, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-4: Radio disturbance and immunity measuring apparatus – Antennas and test sites for radiated disturbance measurements*

CISPR 22, *Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement*

CISPR 32:2015, *Electromagnetic compatibility of multimedia equipment – Emission requirements*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1 Installation and its content

Figure 1 shows the major parts of the PDS as defined below and the rest of the installation.

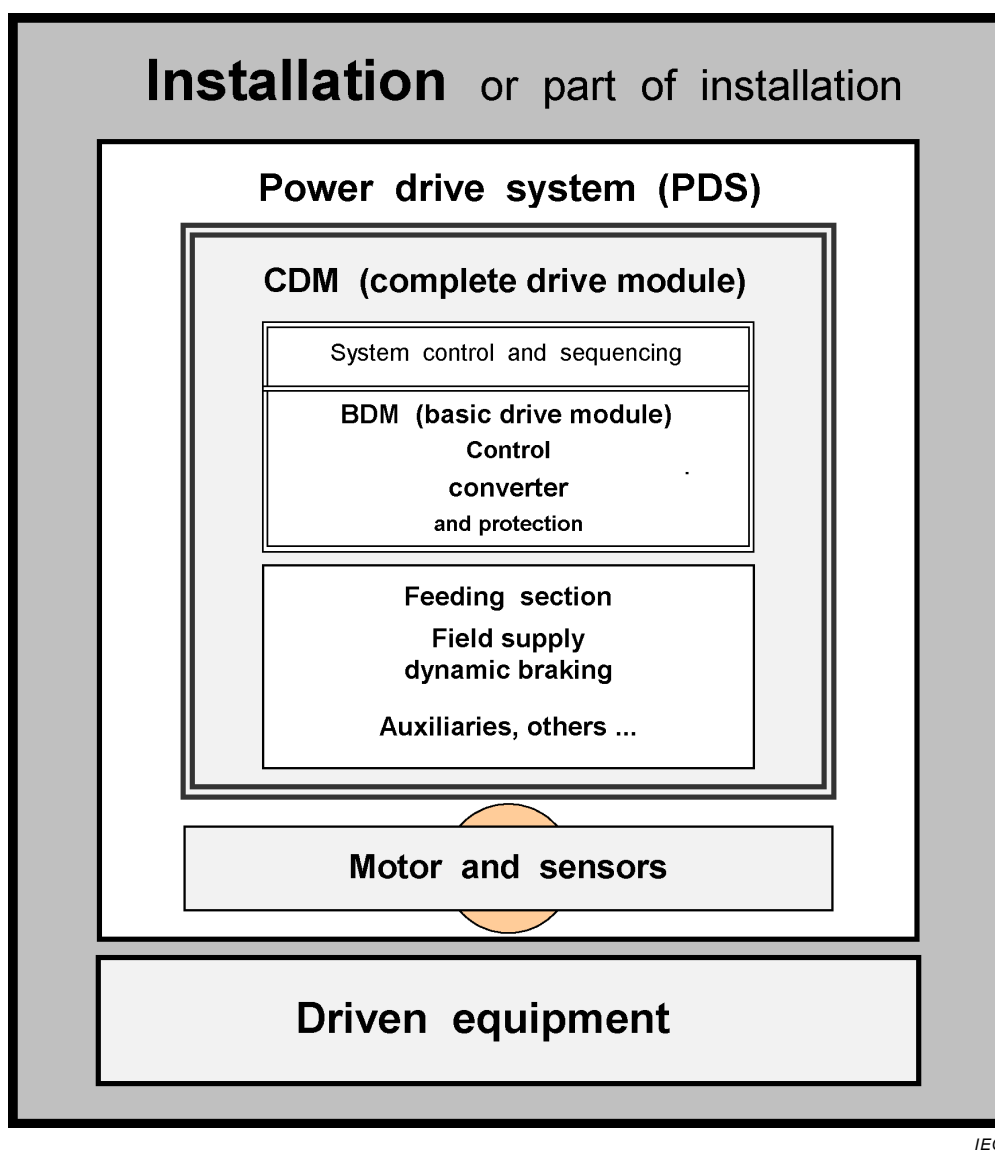


Figure 1 – Installation and its content

3.1.1

basic drive module

BDM

electronic power converter and related control, connected between an electric supply and a motor

Note 1 to entry: The BDM is capable of transmitting power from the electric supply to the motor and can be capable of transmitting power from the motor to the electric supply. The BDM controls some or all of the following aspects of power transmitted to the motor and motor output:

- current;
- frequency;
- voltage;
- speed;
- torque;
- force;
- position.

3.1.2

complete drive module

CDM

drive module consisting of, but not limited to, the BDM and extensions such as protection devices, transformers and auxiliaries

Note 1 to entry: The motor and the sensors which are mechanically coupled to the motor shaft are not included.

3.1.3

power drive system

PDS

system consisting of one or more complete drive module(s) (CDM) and a motor or motors

Note 1 to entry: Any sensors which are mechanically coupled to the motor shaft are also part of the PDS; however, the driven equipment is not included.

3.1.4

installation

equipment or equipments which include at least both the PDS and the driven equipment

3.1.5

small size equipment

equipment, either positioned on a table top, wall-mounted or standing on the floor which, including its cables and possible auxiliary equipment, fits in an imaginary cylindrical test volume of maximum 1,2 m in diameter and 1,5 m height (to ground plane)

Note 1 to entry: This definition has been modified to apply to measurement of radiated emissions from the enclosure port.

[SOURCE: CISPR 11:2015, 3.17, modified — The expression "wall-mounted" and "and possible auxiliary equipment" have been added, as well as the note to entry.]

3.1.6

wall-mounted equipment

CDM/BDM intended to be mounted on a vertical surface

3.2 Intended use

3.2.1

EMC plan

procedure for the EMC assessment when installing category C4 (see 3.2.7) equipment

3.2.2

first environment

environment that includes residential premises and establishments directly connected without intermediate transformers to a low-voltage power supply network which supplies buildings used for residential purposes

Note 1 to entry: Houses, apartments, commercial premises or offices in a residential building are examples of first environment locations.

3.2.3

second environment

environment that includes all establishments other than those directly connected to a low-voltage power supply network which supplies buildings used for residential purposes

Note 1 to entry: Industrial areas or technical areas of any building fed from a dedicated transformer are examples of second environment locations.

3.2.4

PDS of category C1

PDS of rated voltage less than 1 000 V, intended for use in the first environment

3.2.5

PDS of category C2

PDS of rated voltage less than 1 000 V, which is neither a plug in device nor a movable device and, when used in the first environment, is intended to be installed and commissioned only by a professional

Note 1 to entry: A professional is a person or an organisation having necessary skills in installing and/or commissioning power drive systems, including their EMC aspects.

3.2.6

PDS of category C3

PDS of rated voltage less than 1 000 V, intended for use in the second environment and not intended for use in the first environment

3.2.7

PDS of category C4

PDS of rated voltage equal to or above 1 000 V, or rated current equal to or above 400 A, or intended for use in complex systems in the second environment

3.3 Location, ports and interfaces

3.3.1

in situ

<test> location where the equipment is installed for its normal use by the end user

3.3.2

test site

<radiation> site meeting requirements necessary for correctly measuring, under defined conditions, electromagnetic fields emitted by a device under test

[SOURCE: IEC 60050-161:1990, 161-04-28]

3.3.3

port

access to a device or network where electromagnetic energy or signals may be supplied or received or where the device or network variables may be observed or measured

Note 1 to entry: Figure 2 illustrates the diversity of the ports of a PDS.

[SOURCE: IEC 60050-131:2002, 131-12-60, modified – The note to entry has been replaced by a new one.]

3.3.4 enclosure port

physical boundary of the PDS through which electromagnetic fields may radiate or impinge

Note 1 to entry: See Figure 2.

3.3.5 port for process measurement and control

input/output (I/O) port for a conductor or cable which connects the process to the PDS

3.3.6 power port

port which connects the PDS to the power supply, which also feeds other equipment

3.3.7 main power port

power port which feeds the PDS for only the power which, after electrical power conversion, is converted by the motor into mechanical power

3.3.8 auxiliary power port

power port which feeds only the auxiliaries of the PDS, including the field circuit, if any

3.3.9 signal interface

input/output (I/O) connection for a line connecting the basic drive module or complete drive module (BDM/CDM) to another part of the PDS

Note 1 to entry: See Figure 2.

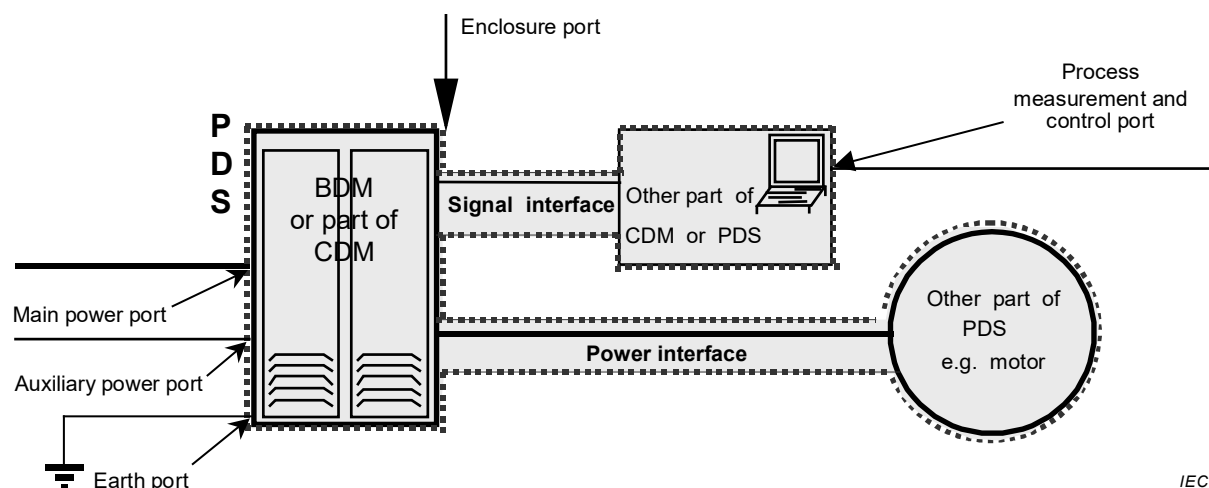


Figure 2 – Internal interfaces of the PDS and examples of ports

3.3.10 power interface

connections needed for the distribution of electrical power

Note 1 to entry: See Figure 3 for an example of power interface and Clause E.1 for an explanation.

Note 2 to entry: The power interfaces of the PDS may have different forms and extensions:

- Within the CDM/BDM

A power interface can be the connection for distribution of electrical power from one part of the BDM/CDM to another part of the BDM/CDM. One power interface can be common to different components of the PDS. For examples, see Figure 3 and Figure 4.

Figure 3 shows a power interface which distributes power from an input converter (where power is converted from the mains to another type, here DC power) to output inverters (where power is converted from an intermediate form (here DC) to another type (here AC) which can be directly applied to AC motors).

Figure 4 shows a power interface which distributes power from the secondary of a transformer (which is part of the CDM) to individual BDMs.

- Within the PDS

Note that the connection between the inverter and the motor or the motors is also a power interface. It is the last power interface before the conversion to mechanical power.

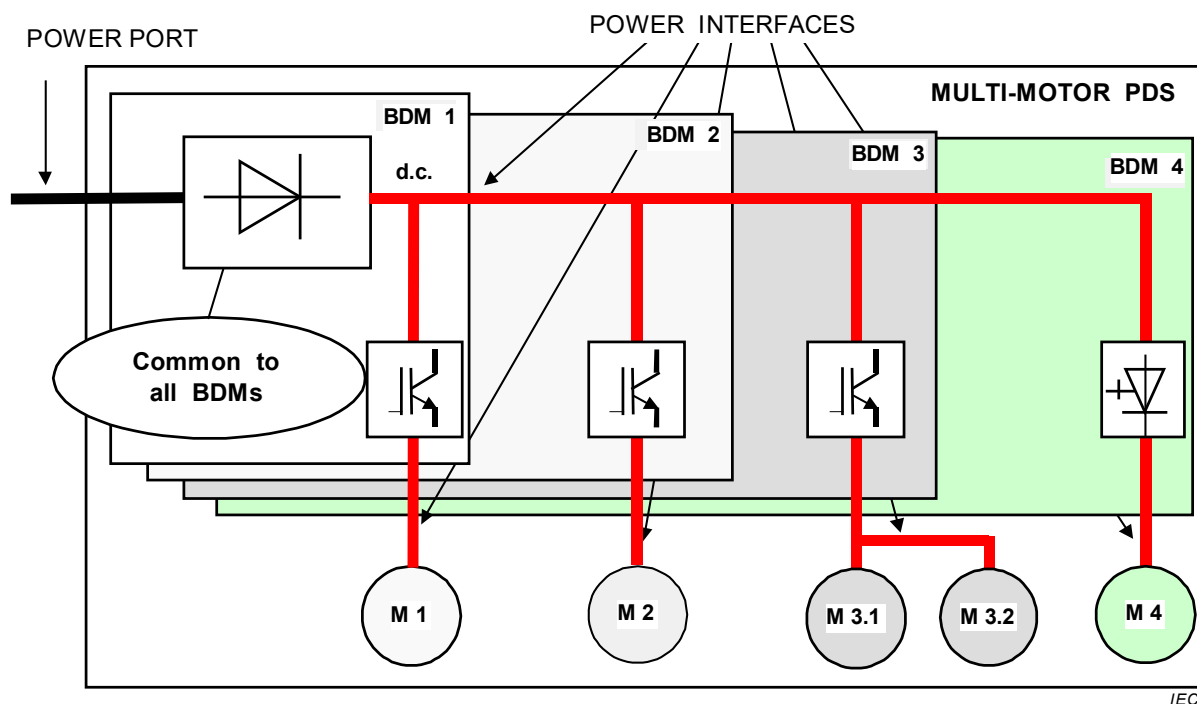


Figure 3 – Power interfaces of a PDS with common DC BUS

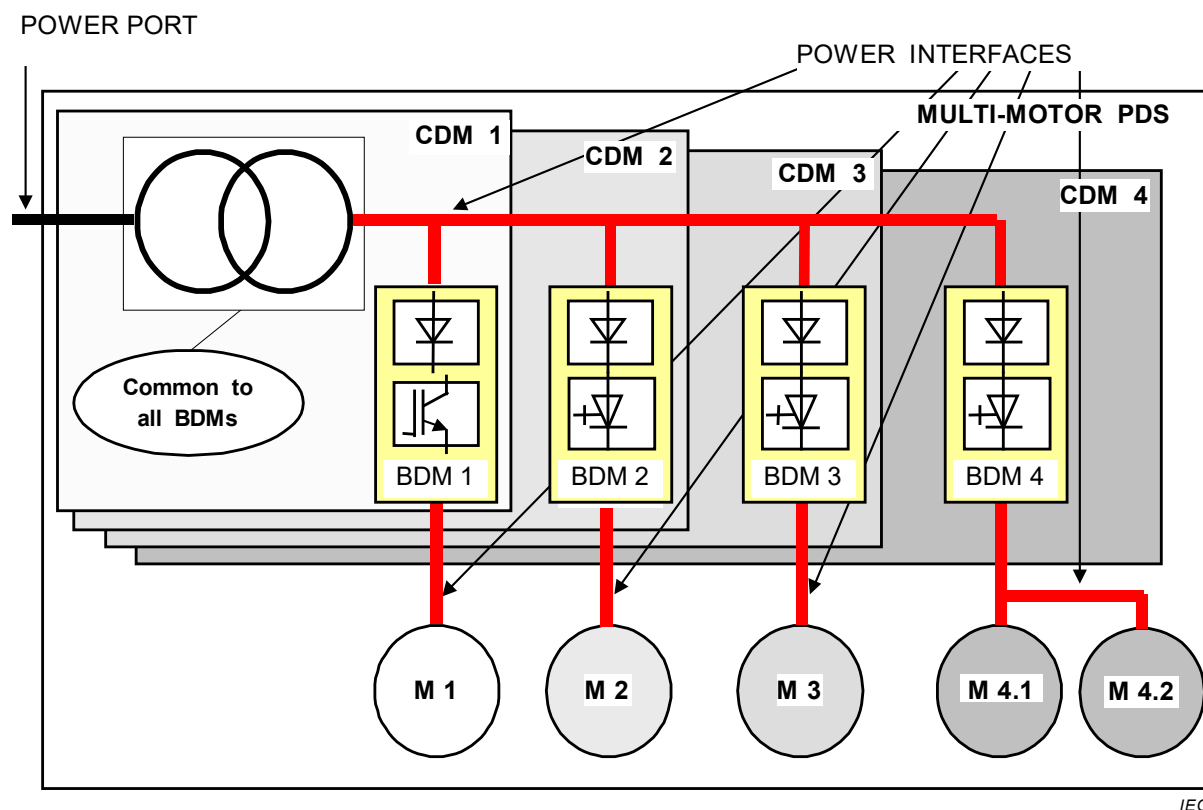


Figure 4 – Power interfaces with common input transformer

3.3.11

point of common coupling

PCC

point on a public power supply network, electrically nearest to a particular load, at which other loads are, or could be, connected

[SOURCE: IEC 61000-2-4:2002, 3.1.6]

3.3.12

in-plant point of coupling

IPC

point on a network inside a system or an installation, electrically nearest to a particular load, at which other loads are, or could be, connected

Note 1 to entry: The IPC is usually the point for which electromagnetic compatibility is to be considered.

[SOURCE: IEC 61000-2-4:2002, 3.1.7]

3.3.13

point of coupling

PC

point on a network which can be a public power supply network or a network inside a system or an installation

3.4 Components of the PDS

3.4.1

converter

<of the BDM> unit which changes the form of electrical power supplied by the mains to the form fed to the motor(s) by changing one or more of the voltage, current and/or frequency

Note 1 to entry: The converter comprises electronic commutating devices and their associated commutation circuits. It is controlled by transistors or thyristors or any other power switching semiconductor devices.

Note 2 to entry: The converter can be line-commutated, load-commutated or self-commutated and can consist, for example, of one or more rectifiers or inverters.

3.4.2

motor

electric motor

electric machine intended to transform electric energy into mechanical energy

Note 1 to entry: For the purposes of this document, the motor includes all sensors which are mounted on it and which are relevant for supporting the operating mode and interacting with a CDM.

[SOURCE: IEC 60050:2001, 151-13-41, modified — The note has been added.]

3.4.3

sub-component

physical piece of equipment which can be operated separately with an intrinsic function defined by the manufacturer

Note 1 to entry: For the purpose of this document, a component of the PDS can be divided into sub-components.

Note 2 to entry: As an example, the control unit of a CDM may be a sub-component.

3.5 Phenomena-related definitions

3.5.1

electromagnetic compatibility

EMC

ability of an equipment or system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to anything in that environment

[SOURCE: IEC 60050-161:1990, 161-01-07]

3.5.2

total harmonic current

THC

total RMS value of the harmonic current components of orders 2 to 40

$$THC = \sqrt{\sum_{h=2}^{40} I_h^2}$$

[SOURCE: IEC 61000-3-12:2011, 3.1]

3.5.3

total harmonic distortion

THD

ratio of the RMS value of the harmonic content to the RMS value of the fundamental component or the reference fundamental component of an alternating quantity

Note 1 to entry: The harmonic content depends on the choice of the fundamental component. If it is not clear from the context which one is used, an indication should be given.

Note 2 to entry: The total harmonic distortion can be restricted to a certain harmonic order (recommended notation "H"), which is 40 for the purpose of this document.

$$THD = \sqrt{\sum_{h=2}^{h=H} \left(\frac{Q_h}{Q_1} \right)^2}$$

where, in addition to the notes to entry of B.2.2.7,

Q_1 is the RMS value of the fundamental component.

[SOURCE: IEC 60050-551:2001, 551-20-13, modified — The term "total harmonic ratio" has been deleted, the formula has been added and Note 1 to entry has been rephrased. In Note 2 to entry, the sentence "This is to be stated" has been deleted and the part "(recommended notation "H"), which is 40 for the purpose of this document" has been added.]

3.5.4

voltage deviation

difference between the voltage at a given instant and the declared supply voltage

[SOURCE: IEC 60050-614:2016, 614-01-04]

3.5.5

voltage change

variation of the RMS or peak value of a voltage between two consecutive levels sustained for definite but unspecified durations

Note 1 to entry: Whether the RMS or peak value is chosen depends upon the application, and which is used should be specified.

[SOURCE: IEC 60050-161:1990, 161-08-01]

3.5.6

voltage fluctuation

series of voltage changes or a continuous variation of the RMS or peak value of the voltage

Note 1 to entry: Whether the RMS or peak value is chosen depends upon the application, and which is used should be specified.

[SOURCE: IEC 60050-161:1990, 161-08-05]

3.5.7

voltage dip

sudden reduction of the voltage at a point in an electrical system, followed by voltage recovery after a short period of time, from a few cycles to a few seconds

[SOURCE: IEC 60050-614:2016, 614-01-08, modified — The second preferred term "voltage sag" has been deleted. In the definition, the words "electric power system" has been replaced by "electrical system", and the words "from a few periods of the sinusoidal wave of the voltage to a few seconds" by "from a few cycles to a few seconds".]

4 Common requirements

4.1 General conditions

All phenomena, from the emission or immunity point of view, shall be considered individually. The limits are given for conditions which do not consider the cumulative effects of different phenomena.

For a realistic assessment of the EMC situation, a typical configuration shall be chosen.

The application of tests for evaluation of immunity depends on the particular PDS, its configuration, its ports, its technology and its operating conditions (see annexes).

4.2 Tests

4.2.1 Conditions

IEC 60146-1-1 and IEC 61800-2 distinguish between type test, routine test and special test. Unless otherwise stated, all the tests specified in this document are type tests only. The equipment shall meet the EMC requirements under all normal operating conditions as stated in the operating manual of the equipment when measured by the test methods specified in this document.

NOTE 1 Due to local radio transmission legislation, some immunity tests can be subject to conditions which restrict the choice of location where they can be performed.

If necessary, safeguards shall be taken against any unintended effects on the total process that may result from an equipment failure while an EMC test is being conducted.

For the tests, the CDM shall be connected to a motor recommended by the manufacturer with a cable and earthing rules defined by the manufacturer. Alternatively, a passive test load (resistive, or resistive and inductive) may be applied (for example, for evaluation of the low-frequency emissions), if permitted by the manufacturer.

NOTE 2 For high frequency emissions, passive test load can be unsuitable to simulate differential and common mode capacitances and couplings typically present.

The description of the tests, the test methods, the characteristics of the tests and the test set-ups are given in the referred standards and are not repeated here. If, however, modifications or additional requirements and information or specific test methods are needed for practical implementation and application of the tests, then they are given in this document.

A sufficient number of terminals shall be selected to simulate actual operating conditions and to ensure that all relevant types of termination are covered. The tests shall be carried out at the rated supply voltage and in a reproducible manner.

4.2.2 Test report

The test results shall be documented in a test report. The report shall clearly and unambiguously present all relevant information for reproducible testing. A functional description and detailed acceptance criteria provided by the manufacturer shall be noted in the test report.

Within the test report, the chosen test arrangements shall be justified. Whenever a subclause of this document offers alternative test methods, the chosen test method shall be stated in the test report. The information on test methods showed in Table 1 shall be given:

Table 1 – Subclauses containing alternative test methods

Subclause	Test methods
5.1.2	Type of test: – general system performance test; or – special system performance test; or – sub-component performance test.
5.2 and sub-clauses	Immunity verification by: – calculation; or – simulation; or – test.
5.3.2	Fast transient burst for equipment ≥ 100 A: – direct coupling; or – capacitive clamp.
5.3.3	Fast transient burst for equipment ≥ 100 A: – direct coupling; or – capacitive clamp.
5.3.4	Immunity against electromagnetic fields: – PDS test; or – sub-components test.
6.2.1	Emission verification by: – calculation; or – simulation; or – test.
6.3.1.1	Test on a test site or in situ
6.3.1.2	Conducted emission tests: – with CISPR artificial mains network; or – with high impedance voltage probe.
6.3.1.3.3	Radiated emissions: measurement distance

4.3 Documentation for the user

The setting of limits and the structure of this document are based on the understanding that the installer and user are responsible for following the EMC recommendations of the manufacturer.

The manufacturer shall supply the documentation necessary for the correct installation of a BDM, CDM or PDS into a typical system or process in the intended environment. This information includes any emission warnings required by 6.1 and Table 15. It also includes the warnings required by 5.3.2 in the case where the immunity of a BDM, CDM or PDS is not suitable for the second environment.

NOTE 1 From the emission point of view, a PDS (or BDM or CDM) with a lower emission category, such as C1, can always be used instead of one with a higher emission category, such as C3.

NOTE 2 Emission categories are independent of immunity. For example, a statement that a PDS has emission category C1 does not imply that the immunity is only suitable for the first environment.

If special EMC measures are necessary to fulfil the required limits, these shall be clearly stated in the user documentation. Where relevant, these can include the following:

- maximum and minimum acceptable supply network impedance;
- the use of shielded or special cables (power and/or control);
- cable shield connection requirements;

- maximum permissible cable length;
- cable segregation;
- the use of external devices such as filters;
- the correct bonding to functional earth.

If different devices or connection requirements apply in different environments, this shall also be stated.

A list of auxiliary equipment (for example, options or enhancements) that can be added to the PDS, and which complies with the immunity and/or emission requirements shall be made available.

This information may also be covered in some part of the test report to clarify the final recommended arrangement.

5 Immunity requirements

5.1 General conditions

5.1.1 Acceptance criteria (performance criteria)

The system performance relates to the functions of the BDM, or of the CDM, or of the PDS as a whole that are declared by the manufacturer.

The sub-component performance relates to the functions of the sub-components of the BDM, or of the CDM, or of the PDS that are declared by the manufacturer.

The sub-component performance may be tested as an alternative instead of the system performance to show immunity (see 5.1.2). In the test report, it shall be stated which test has been applied.

Although this document allows tests on sub-components (components of CDM/BDM), it is not intended to be used for the separate conformity assessment of sub-components.

The acceptance criteria shall be used to check the performance of a PDS against external disturbances. From the EMC point of view, any installation according to Figure 1 shall be running properly. Since a PDS is part of the functional sequence of a larger process than the PDS itself, the effect on this process caused by changes in the performance of the PDS is hard to forecast. However, this important aspect for large systems should be covered by an EMC plan (see Annex E).

The main functions of a PDS are energy conversion between the electrical form and the mechanical form, and the information processing necessary to perform this.

Table 2 classifies the effects of a given disturbance into three acceptance (performance) criteria: A, B and C, both for the PDS and for its sub-components.

Subclauses 5.2 and 5.3 state the acceptance criterion required for each phenomenon.

5.1.2 Selection of performance type

5.1.2.1 General or special system performance

The “general system performance” item from Table 2 shall be defined in accordance with the special application and typical configuration of the PDS. It is the responsibility of the manufacturer to select these items.

The special system performance, torque-generating behaviour, shall be tested only in cases where it is explicitly defined in the product specification. In this case, the torque generating performance can be directly or indirectly tested. The direct test uses an EMC immune torque meter to measure torque disturbances.

Torque performance can be defined through the ability to keep current or speed constant, within specified tolerances, when a disturbance is applied (see also 5.1.3). Therefore, a test of current performance can be used as an indirect test of torque-generating performance. For EMC assessment, and unless otherwise agreed, the output current of the power converter is deemed to represent torque with sufficient accuracy. As an alternative, the indirect test can use speed performance provided the total inertia is specified.

5.1.2.2 Sub-component performance

Testing of sub-components with sub-component performance should be used in cases when a PDS cannot be put into service on a test site because of limitation on the physical size of the PDS, on the current or rated supply capability or load conditions. In any case, the test set-up shall be immune to the highest level of disturbance applied to the PDS or to the sub-component under test.

Testing of information processing and sensing functions, including optional accessories if any, shall be performed only in cases where the relevant ports or interfaces are available at the PDS. Testing of the sub-component performance, according to Table 2, where the functions exist, is sufficient to determine the compliance with this document.

Table 2 – Criteria to prove the acceptance of a PDS against electromagnetic disturbances

Item	Acceptance (performance) criterion ^a		
	A	B	C
General system performance	No noticeable changes of the operating characteristic Operating as intended, within specified tolerance	Noticeable changes (visible or audible) of the operating characteristic Self-recoverable	Shutdown, changes in operating characteristics Triggering of protective devices ^b Not self-recoverable
Special system performance Torque generating behaviour	Torque deviation within specified tolerances	Temporary torque deviation outside specified tolerances Self-recoverable	Loss of torque Not self-recoverable
Sub-component performance Operation of power electronics and driving circuits	No malfunction of a power semiconductor	Temporary malfunction which cannot cause unintended shut-down of the PDS	Shut-down, triggering of protective devices ^b No loss of stored program No loss of user program No loss of settings Not self-recoverable
Sub-component performance Information processing and sensing functions	Undisturbed communication and data exchange to external devices	Temporarily disturbed communication, but no error reports of the internal or external devices which could cause shut-down	Errors in communication, loss of data and information No loss of stored program, no loss of user program No loss of settings. Not self-recoverable
Sub-component performance Operation of displays and control panels	No changes of visible display information, only slight light intensity fluctuation of LEDs, or slight movement of characters	Visible temporary changes of information, undesired LED illumination	Shut down, permanent loss of information, or unpermitted operating mode, obviously wrong display information No loss of stored program, no loss of user program No loss of settings
^a Acceptance criteria A, B, C – False starts are not acceptable. A false start is an unintended change from the logical state "STOPPED" which can make the motor run. ^b Acceptance criterion C – The function can be restored by operator intervention (manual reset). Opening of fuses is allowed for line-commutated converters operating in inverting mode.			

5.1.3 Conditions during the test

The load shall be within the manufacturer's specification and the actual load shall be noted in the test report.

Testing the torque generating behaviour as well as the information processing and sensing functions requires special test equipment with adapted immunity against the parasitic coupling of the test disturbance. It can only be used if the immunity of the test set-up can be proven by reference measurements. The evaluation of the torque disturbance can be performed by a torque transducer or by measurement or calculation of the torque generating current or other indirect techniques; an adapted and immune load shall be available at the test-site.

For testing the performance of the information processing or sensing function, suitable equipment shall be available to simulate the data communication or data evaluation. This equipment shall have sufficient immunity to operate correctly during the test.

Since the motor has been tested by its manufacturer according to the relevant standards, the motor component of the PDS, with exception of the sensors, does not need any additional EMC immunity test. Therefore, while the motor is connected to the BDM/CDM for the duration of the test, EMC immunity tests on the motor itself are not required.

The tests shall be applied to the relevant ports where they exist, including those of optional accessories if any. They shall be conducted in a well-defined and reproducible manner on a port-by-port basis. However, if several process measurement and control ports or signal interfaces have the same physical configuration (layout) it is sufficient to test one port or interface of that type.

In 5.2 and 5.3 the minimum requirements, tests and acceptance criteria are stated. The acceptance criteria refer to 5.1.1.

5.2 Basic immunity requirements – low-frequency disturbances

5.2.1 Common principle

The requirements in this subclause shall be used for designing the immunity of a PDS against low-frequency disturbances.

For the immunity requirements, the manufacturer may demonstrate compliance using either testing, calculation or simulation, and shall state the chosen verification method in the test report. Unless otherwise stated, it is sufficient to demonstrate that the power circuit will comply with the required acceptance criterion and that the ratings of input circuits (filters, etc.) will not be exceeded.

NOTE 1 A number of these phenomena are not required by the generic standards, but are important for the dimensioning of the power circuit of the PDS. It is difficult to test immunity against many of these phenomena, particularly when the input current exceeds 16 A or the supply voltage exceeds 400 V. However, experience of many years shows that, provided the power circuit operates correctly, the control part and the auxiliaries are generally immune. This is due to natural decoupling that exists in the PDS. Examples of such decoupling are that provided by power supplies and the time constants of auxiliary processes such as fans.

The compliance with the requirements of this document shall be stated in the user documentation. Where compliance is demonstrated by tests, the relevant basic standards in the IEC 61000-4 series may be considered (see Clause B.7).

NOTE 2 The electrical service conditions for the main and the auxiliary supply if any, are already defined in the PDS service conditions in the relevant standard IEC 61800-1 or IEC 61800-2 or IEC 61800-4. These service conditions include frequency variations, frequency rate of change, voltage variations, voltage fluctuations, voltage unbalance, harmonics and commutation notches.

5.2.2 Harmonics and commutation notches/voltage distortion

5.2.2.1 Low voltage PDSs (voltage distortion)

The BDM, CDM or PDS shall sustain the immunity levels while meeting the performance criteria given in Table 3, Table 4 and Table 5. It shall be verified that these levels will not cause the ratings for the input circuits (filters, etc.) to be exceeded. Analysis of commutation notches shall be in the time domain. The manufacturer may verify immunity by calculation, simulation, or test, according to 5.2.1, and shall state the chosen verification method in the test report. If the chosen verification method is by test, it shall be performed using the PDS with the motor connected. For equipment rated below 16 A per phase, the test method of IEC 61000-4-13 can be applied.

NOTE Frequency domain analysis of the contribution from notches to the total harmonic distortion will not fully account for harmful effects (see Clause B.1).

Table 3 – Minimum immunity requirements for total harmonic distortion on power ports of low voltage PDSs

Phenomenon	First environment		Second environment		Performance (acceptance) criterion
	Reference document	Level	Reference document	Level	
Harmonics – THD	IEC 61000-2-2	8 %	IEC 61000-2-4 class 3	12 %	A

Table 4 – Minimum immunity requirements for individual harmonic orders on power ports of low voltage PDSs

Phenomenon Harmonic order	First environment		Second environment		Performance (acceptance) criterion
	Reference document	Level	Reference document	Level	
2	IEC 61000-4-13 class 2	3 %	IEC 61000-4-13 class 3	5 %	A
3		8 %		9 %	
4		1,5 %		2 %	
5		9 %		12 %	
Even orders $6 \leq h \leq 50$		No requirement		1,5 %	
7		7,5 %		10 %	
9		2,5 %		4 %	
11		5 %		7 %	
13		4,5 %		7 %	
15		No requirement		3 %	
17		3 %		6 %	
19		2 %		6 %	
21		No requirement		2 %	
23		2 %		6 %	
25		2 %		6 %	
27		No requirement		2 %	
29		1,5 %		5 %	
31		1,5 %		3 %	
33		No requirement		2 %	
35		1,5 %		3 %	
37		1,5 %		3 %	
39		No requirement		2 %	

NOTE 1 For individual harmonic orders in the first environment, levels are from Class 2 in IEC 61000-4-13 (these are approximately 1,5 times the compatibility levels of IEC 61000-2-4).

NOTE 2 For individual harmonic orders in the second environment, levels are from Class 3 in IEC 61000-4-13 (these are approximately 1,5 times the compatibility levels of IEC 61000-2-4).

Table 5 – Minimum immunity requirements for commutation notches on power ports of low voltage PDSs

Phenomenon	First environment		Second environment		Performance (acceptance) criterion
	Reference document	Level	Reference document	Level	
Commutation notches	(None)	No requirement	IEC 60146-1-1 Class B	Depth = 40 %, total area = 250 in % degrees	A

5.2.2.2 PDSs of rated voltage above 1 000 V (voltage distortion)

5.2.2.2.1 Main power port

The PDS or BDM/CDM shall sustain the immunity levels given in Table 6. It shall be verified that these levels will not cause the ratings for the input circuits (filters, etc.) to be exceeded. Analysis of commutation notches shall be in the time domain. The manufacturer may verify immunity by calculation, simulation, or test, according to 5.2.1, and shall state the chosen verification method in the test report.

NOTE Frequency domain analysis of notches' contribution to total harmonic distortion will not obviously reveal certain types of harmful effects (see Clause B.1).

Table 6 – Minimum immunity requirements for harmonics and commutation notches/ voltage distortion on main power ports of PDSs of rated voltage above 1 000 V

Phenomenon	Reference document	Level	Performance (acceptance) criterion
Harmonics (<i>THD</i> and individual harmonic orders)	IEC 61000-2-4 Class 3	Value of the compatibility level	A
Harmonics short term (< 15 s)	IEC 61000-2-4 Class 2	1,5 times the value of the permanent compatibility levels	A
Commutation notches	IEC 60146-1-1	Depth = 40% U_{LWM} (class B) Area ^a = 125 in per cent degrees (class C)	A
^a Class C of IEC 60146-1-1 is appropriate for the primary side of the transformer.			

5.2.2.2.2 Auxiliary power port

The auxiliary power ports of PDSs shall sustain the immunity levels for the second environment given in Table 3, Table 4 and Table 5 while meeting the performance criteria in those tables. It shall be verified that these levels will not cause the ratings for the input circuits (filters, etc.) to be exceeded. Analysis of commutation notches shall be in the time domain. The manufacturer may verify immunity by calculation, simulation, or test, according to 5.2.1, and shall state the chosen verification method in the test report.

NOTE Frequency domain analysis of notches' contribution to total harmonic distortion will not obviously reveal certain types of harmful effects (see Clause B.1).

5.2.3 Voltage deviations, dips and short interruptions

5.2.3.1 Low voltage PDSs (voltage deviations)

The PDS or BDM/CDM shall sustain the immunity levels given in Table 7. The manufacturer may verify immunity by calculation, simulation, or test, according to 5.2.1, and shall state the chosen verification method in the test report.

Table 7 – Minimum immunity requirements for voltage deviations, dips and short interruptions on power ports of low voltage PDSs

Phenomenon	First environment			Second environment			Performance (acceptance) criterion
	Reference document	Level		Reference document	Level		
Voltage deviations (> 60 s)	IEC 61000-2-2	±10 % ^a		IEC 61000-2-4 Class 2	±10 % ^a		A ^b
Voltage dips ^e	IEC 61000-4-11 Class 2 or IEC 61000-4-34 Class 2 ^f	Volts remaining 0 % 70 %	Cycles 1 25/30 ^c	IEC 61000-4-11 Class 3 or IEC 61000-4-34 Class 3 ^f	Volts remaining 0 % 40 % 70 % 80 %	Cycles 1 10/12 ^c 25/30 ^c 250/300 ^c	C ^d
Short interruptions	IEC 61000-4-11 Class 2 or IEC 61000-4-34 Class 2 ^f	Volts remaining 0 %	Cycles 250/300 ^c	IEC 61000-4-11 Class 3 or IEC 61000-4-34 Class 3 ^f	Volts remaining 0 %	Cycles 250/300 ^c	C ^d

^a "Voltage deviation" is a supply voltage variation from the nominal supply voltage. Testing of voltage deviations for three phase PDS requires increasing or reducing the voltage of all three phases simultaneously.

^b When the voltage is below nominal, the maximum output power ratings – speed and/or torque – may be reduced, because they are voltage dependent.

^c "x/y cycles" means "x cycles for 50 Hz test" and "y cycles for 60 Hz test".

^d Opening of fuses is allowed for line-commutated converters operating in inverting mode.

^e Power ports with current rating ≥75 A: the method of the voltage drop test according to 7.5 of IEC 61400-21:2008 may be used.

^f IEC 61000-4-11 applies to equipment rated less than or equal to 16 A and IEC 61000-4-34 to equipment rated above 16 A.

A PDS is used for energy conversion, and a voltage dip represents a loss of available energy. It can be necessary to trip for safety reasons, even during a voltage dip of 30 % to 50 % amplitude and 0,3 s duration.

NOTE 1 A decreasing input voltage, even with few milliseconds duration, can result in blowing of fuses when applied to a line commutated thyristor converter operating under regeneration mode.

NOTE 2 The effect of a voltage dip (energy reduction) on the process cannot be defined without detailed knowledge of the process itself. This effect is a system and rating aspect, and will generally be greatest when the power demand (including losses) on the PDS is higher than the available power.

Where it is possible and not dangerous, the behaviour of the PDS during short interruptions may be verified by switching off and on the mains supply during the standard operating conditions of the PDS (see B.6.1).

The manufacturer shall state in the user documentation the degradation of performance resulting from voltage dips or short interruptions.

NOTE 3 Improvements to the immunity (use of UPS, stand-by generator, derating, etc.) can result in a considerable increase in the size and cost of the PDS and can reduce the efficiency or power factor. Operation such as automatic restart can have safety consequences, and are not covered by this document.

5.2.3.2 PDSs of rated voltage above 1 000 V (voltage deviations)

5.2.3.2.1 Main power port

Main power ports of PDSs shall sustain the immunity levels given in Table 8. The manufacturer may verify immunity by calculation, simulation, or test, according to 5.2.1, and shall state the chosen verification method in the test report.

Table 8 – Minimum immunity requirements for voltage deviations, dips and short interruptions on main power ports of rated voltage above 1 000 V of PDSs

Phenomenon	Reference document	Level		Performance (acceptance) criterion
Voltage deviations exceeding 1 min	IEC 61000-2-4 Class 3	±10 %		A ^a
Voltage deviations not exceeding 1 min	IEC 61000-2-4 Class 3	+10 % to –15 %		A ^a
Voltage dips	IEC 61000-4-34 ^b	Volts remaining	Cycles	C ^d
		0 %	1	
		40 %	10/12 ^c	
		70 %	25/30 ^c	
		80 %	250/300 ^c	
Short interruptions	IEC 61000-4-34 ^b	Volts remaining	Cycles	C ^d
		0 %	250/300 ^c	

^a “Voltage deviation” is a supply voltage variation from the nominal supply voltage. Testing of voltage deviations for three phase PDSs requires increasing or reducing the voltage of all three phases simultaneously.

When considering voltage deviations, any voltage steps shall not exceed ±12 % of nominal voltage and the time between steps shall not be less than 2 s.

When the voltage is below nominal, the maximum output power ratings – speed and/or torque – may be reduced, because they are voltage dependent.

^b Typical depths and durations of voltage dips are given in IEC TR 61000-2-8.

^c “x/y cycles” means “x cycles for 50 Hz test” and “y cycles for 60 Hz test”.

^d Opening of fuses is allowed for line-commutated converters operating in inverting mode.

The manufacturer shall state in the user documentation the degradation of performance resulting from voltage dips or short interruptions.

5.2.3.2.2 Auxiliary power port

The auxiliary power ports of PDSs shall sustain the immunity levels given in Table 9. The manufacturer may verify immunity by calculation, simulation, or test, and shall state the chosen verification method in the test report.

Table 9 – Minimum immunity requirements for voltage deviations, dips and short interruptions on auxiliary low voltage power ports of PDSs

Phenomenon	Reference document	Level		Performance (acceptance) criterion
Voltage deviations exceeding 1 min	IEC 61000-2-4 Class 3	± 10 %		A
Voltage deviations not exceeding 1 min	IEC 61000-2-4 Class 3	+10 % to –15 %		A
Voltage dips	IEC 61000-4-11 or IEC 61000-4-34 ^b	Volts remaining	Cycles	C
		0 %	1	
		40 %	10/12 ^a	
		70 %	25/30 ^a	
		80 %	250/300 ^a	
Short interruptions	IEC 61000-4-11 Class 3 or IEC 61000-4-34 Class 3 ^b	Volts remaining	Cycles	C
		0 %	250/300 ^a	

^a "x/y cycles" means "x cycles for 50 Hz test" and "y cycles for 60 Hz test".

^b IEC 61000-4-11 applies to equipment less or equal to 16 A and IEC 61000-4-34 applies to equipment above 16 A.

5.2.4 Voltage unbalance and frequency variations

5.2.4.1 Low voltage PDSs

Definition and assessment of voltage unbalance are explained in B.5.2.

The PDS or BDM/CDM shall comply with the immunity levels given in Table 10. The manufacturer may verify immunity by calculation, simulation, or test, and shall state the chosen verification method in the test report. During verification, the rated load condition shall be used.

Table 10 – Minimum immunity requirements for voltage unbalance and frequency variations on power ports of low voltage PDSs

Phenomenon	First environment		Second environment		Performance (acceptance) criterion
	Reference document	Level	Reference document	Level	
Voltage unbalance ^a	IEC 61000-2-2	2 % negative sequence component	IEC 61000-2-4 Class 3	3 % negative sequence component	A ^b
Frequency variations	IEC 61000-2-2	± 2 %	IEC 61000-2-4	± 2 % ± 4 % where the supply is separated from public supply networks	A
Frequency rate of change		1 %/second		± 1 %/s 2 %/s where the supply is separated from public supply network	A

^a Not relevant for single phase PDSs.

^b In case of test, use test time of 30 s $\pm$ 5 s.

5.2.4.2 PDSs of rated voltage above 1 000 V

5.2.4.2.1 Main power port

Definition and assessment of voltage unbalance are explained in B.5.2.

The PDS or BDM/CDM shall sustain the immunity levels given in Table 11. The manufacturer may verify immunity by calculation, simulation, or test, and shall state the chosen verification method in the test report. During verification, the rated load condition shall be used.

Table 11 – Minimum immunity requirements for voltage unbalance and frequency variations on main power ports of rated voltage above 1 000 V of PDSs

Phenomenon	Reference document	Level	Performance (acceptance) criterion
Voltage unbalance	IEC 61000-2-4 Class 2	2 % negative sequence component	A
Frequency variations	IEC 61000-2-4	±2 % ±4 % where the supply is separated from public supply networks	A A
Frequency rate of change		±1 %/s 2 %/s where the supply is separated from public supply networks	A A

5.2.4.2.2 Auxiliary power port

Definition and assessment of voltage unbalance are explained in B.5.2.

The auxiliary power ports of PDSs shall sustain the immunity levels given in Table 12. The manufacturer may verify immunity by calculation, simulation, or test, and shall state the chosen verification method in the test report.

Table 12 – Minimum immunity requirements for voltage unbalance and frequency variations on auxiliary low voltage power ports of PDSs

Phenomenon	Reference document	Level	Performance (acceptance) criterion
Voltage unbalance	IEC 61000-2-4 Class 3	3 % negative sequence component	A
Frequency variations	IEC 61000-2-4	±2 % ±4 % where the supply is separated from public supply networks	A A

5.2.5 Supply influences – Magnetic fields

Immunity tests according to IEC 61000-4-8 are not required (see Clause A.3 for explanation).

5.3 Basic immunity requirements – High-frequency disturbances

5.3.1 Conditions

In the following Table 13 and Table 14, the minimum immunity requirements for high-frequency disturbance tests and acceptance criteria are stated. The acceptance criteria refer to 5.1.1. Explanations are given in Clause A.3.

5.3.2 First environment

The levels in Table 13 shall be applied to PDSs which are intended to be used in the first environment.

If a CDM/BDM is designed to have immunity according to Table 13, it shall include a written warning in the instructions for use which indicates that it is not intended to be used in an industrial installation.

Table 13 – Minimum immunity requirements for PDSs intended for use in the first environment

Port	Phenomenon	Basic standard for test method	Level	Performance (acceptance) criterion
Enclosure port	ESD (electrostatic discharge)	IEC 61000-4-2	4 kV CD or 8 kV AD if CD impossible	B
	Radio-frequency electromagnetic field, amplitude modulated	IEC 61000-4-3 see also 5.3.4	80 MHz to 1 000 MHz 3 V/m 80 % AM (1 kHz)	A
	Radio-frequency electromagnetic field, amplitude modulated	IEC 61000-4-3 See also 5.3.4	1,4 GHz to 2,0 GHz 3 V/m 80 % AM (1 kHz)	A
	Radio-frequency electromagnetic field, amplitude modulated	IEC 61000-4-3 See also 5.3.4	2,0 GHz to 2,7 GHz 1 V/m 80 % AM (1 kHz)	A
Power ports (except auxiliary DC power ports below 60 V)	Fast transient-burst	IEC 61000-4-4	1 kV/5 kHz ^a	B
	Surge ^b 1,2/50 µs, 8/20 µs	IEC 61000-4-5	1 kV ^c 2 kV ^d	B
	Conducted radio-frequency common mode	IEC 61000-4-6 see also 5.3.4	0,15 MHz to 80 MHz 3 V 80 % AM (1 kHz)	A
Power interfaces	Fast transient-burst ^e	IEC 61000-4-4	1 kV/5 kHz Capacitive clamp	B
Ports for process measurement control lines and signal interfaces Auxiliary DC power ports below 60 V	Fast transient-burst ^e	IEC 61000-4-4	0,5 kV/5 kHz Capacitive clamp	B
	Conducted radio-frequency common mode ^e	IEC 61000-4-6 see also 5.3.4	0,15 MHz to 80 MHz 3 V 80 % AM (1 kHz)	A
CD: contact discharge AD: air discharge AM: amplitude modulation				