IEC 61800-3

Edition 4.0 2022-11

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Adjustable speed electrical power drive systems – Part 3: EMC requirements and specific test methods for PDS and machine tools

Entraînements électriques de puissance à vitesse variable – Partie 3: Exigences de CEM et méthodes d'essai spécifiques pour les PDS et machines-outils



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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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ADJUSTABLE SPEED ELECTRICAL POWER DRIVE SYSTEMS –

Part 3: EMC requirements and specific test methods for PDS and machine tools

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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IEC 61800-3 has been prepared by subcommittee 22G: Adjustable speed electric power drive systems (PDS), of IEC technical committee 22: Power electronic systems and equipment. It is an International Standard.

It has the status of a product EMC standard in accordance with IEC Guide 107.

This fourth edition cancels and replaces the third edition published in 2017. This edition constitutes a technical revision.

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

a) extension of the scope to machine tools with one or more embedded PDS;
b) extension of the frequency range for radiated immunity tests to 6 GHz;
c) general updates in the normative part and the informative annexes.

The text of this International Standard is based on the following documents:

Draft	Report on voting
22G/461/FDIS	22G/466/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

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 https://webstore.iec.ch in the data related to the specific document. At this date, the document will be

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ADJUSTABLE SPEED ELECTRICAL POWER DRIVE SYSTEMS –

Part 3: EMC requirements and specific test methods for PDS and machine tools

1 Scope

This part of IEC 61800 specifies electromagnetic compatibility (EMC) requirements for adjustable speed power drive systems (PDSs) and machine tools (MTs). A PDS is an AC or DC motor drive including an electronic converter. Requirements are stated for AC and DC PDSs and MTs with input and/or output voltages (line-to-line voltage), up to 35 kV AC RMS. This document applies to equipment of all power ratings.

As a product EMC standard, this document can be used for the assessment of PDS and MT. It can also be used for the assessment of complete drive modules (CDM) or basic drive modules (BDM).

NOTE 1 BDMs and CDMs are parts of the PDS which are often marketed separately.

Traction applications and electric vehicles are excluded. Equipment which is defined as group 2 in CISPR 11:2015 is excluded.

NOTE 2 Examples of group 2 equipment are:

– welding equipment (arc welding, resistance welding, etc);

– electro-discharge machining equipment (EDM).

This document does not give requirements for the electrical machine which converts power between the electrical and mechanical forms within the PDS. Requirements for rotating electrical machines are covered by the IEC 60034 series. In this document, the term "motor" is used to describe the electrical machine, whether rotary or linear, and regardless of the direction of power flow.

This document is applicable to BDMs, CDMs, PDSs and MTs with or without radio function. However, this document does not specify any radio transmission and reception requirements.

NOTE 3 It is planned that the future edition 7 of CISPR 11[1] will contain a procedure how to address radio transmission and reception requirements, which is also applicable to products in the scope of this document.

This document defines the minimum requirements for emission and immunity in the frequency range from 0 Hz to 400 GHz. Tests are not required in frequency ranges where no requirements are specified.

BDMs, CDMs, PDSs and MTs covered by this document are those installed in residential, commercial and industrial locations. Requirements are given according to the environment classification.

BDMs, CDMs and PDSs are often included in a larger system. The system aspects are not covered by this document, but guidance is provided in the informative annexes.

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1 Under preparation. Stage at the time of publication: CISPR/NFDIS 11:2022.

This document is intended as a complete product EMC standard for the EMC conformity assessment of products. As a product EMC standard for BDMs, CDMs, PDSs and MTs, according to IEC Guide 107, this document takes precedence over all aspects of the generic standards.

NOTE 4 If a PDS or MT is included as part of equipment covered by a separate product EMC standard, the separate EMC standard applies to the complete equipment.

NOTE 5 The requirements have been selected to ensure EMC for PDSs and MTs at residential, commercial and industrial locations. Changes in the EMC behaviour of a PDS or an MT as a result of fault conditions are not considered.

NOTE 6 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.

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

IEC 61000-3-2:2018, *Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic current emissions (equipment input current ≤ 16 A per phase)*
IEC 61000-3-2:2018/AMD1:2020

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 61000-3-3:2013/AMD1:2017
IEC 61000-3-3:2013/AMD2:2021

IEC 61000-3-11:2017, *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 61000-3-12:2011/AMD1:2021

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

IEC 61000-4-3:2020, *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 61000-4-5:2014/AMD1:2017

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 61000-4-11:2020, *Electromagnetic compatibility (EMC) – Part 4-11: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests for equipment with input current up to 16 A per phase*

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 61000-4-13:2002/AMD1:2009
IEC 61000-4-13:2002/AMD2:2015

IEC 61000-4-28:1999, *Electromagnetic compatibility (EMC) – Part 4-28: Testing and measurement techniques – Variation of power frequency, immunity test for equipment with input current not exceeding 16 A per phase*
IEC 61000-4-28:1999/AMD1:2001
IEC 61000-4-28:1999/AMD2:2009

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*
IEC 61000-4-34:2005/AMD1:2009

CISPR 11:2015, *Industrial, scientific and medical equipment – Radio-frequency disturbance characteristics – Limits and methods of measurement*
CISPR 11:2015/AMD1:2016
CISPR 11:2015/AMD2:2019

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 16-1-2:2014/AMD1:2017

CISPR 16-1-4:2019, *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 16-1-4:2019/AMD1:2020

CISPR 32:2015, *Electromagnetic compatibility of multimedia equipment – Emission requirements*
CISPR 32:2015/AMD1:2019

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 https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

3.1 Content of the power drive system (PDS) and its installation

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 transmits power from the electric supply to the motor and power from the motor to the electric supply.

Note 2 to entry: 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.

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, but excluding the motor and the sensors which are mechanically coupled to the motor shaft

3.1.3
power drive system
PDS
system consisting of one or more complete drive module(s) (CDM) and a motor or motors, and any sensors which are mechanically coupled to the motor shaft, but not including the driven equipment

Note 1 to entry: Figure 1 illustrates the major items in the PDS. It also shows the relationship between the PDS and the installation.

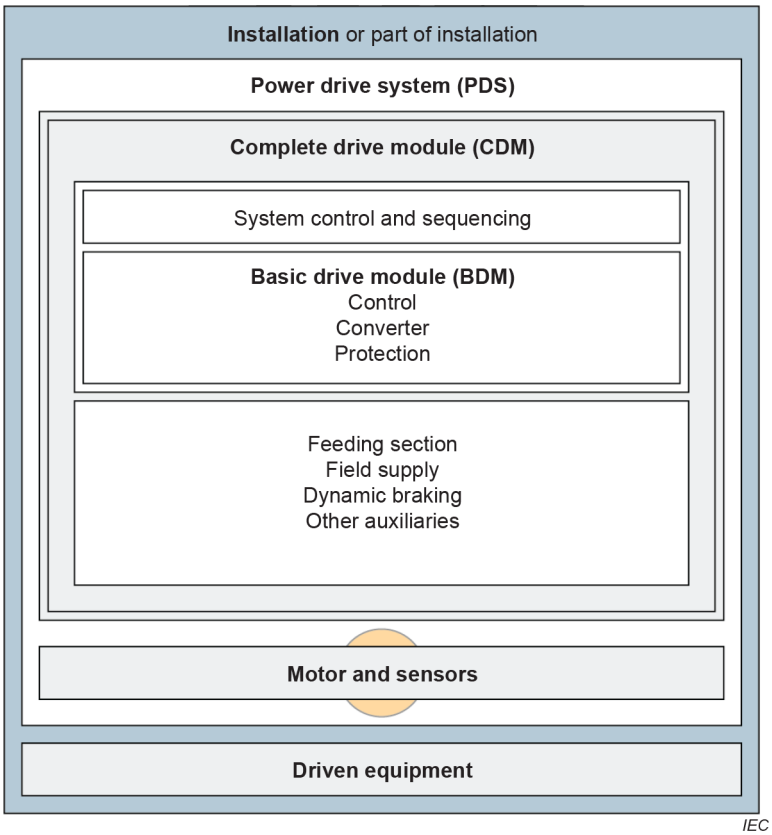


Figure 1 – Content of the PDS and its installation

3.1.4
installation
equipment (one or more) which includes at least both the PDS and the driven equipment

3.2 Content of the machine tool (MT) and its installation

3.2.1
machine tool
MT
mechanical device which is fixed (i.e. not mobile) and powered (typically by electricity and compressed air), used to process workpieces by selective removal/addition of material and/or by mechanical deformation

Note 1 to entry: Machine tool operation can be mechanical, controlled by humans or by computers. Machine tools can have a number of peripherals used for machine tool cooling/heating, process conditioning, workpiece and tool handling (workpiece feeding excluded), recyclables and waste handling and other tasks connected to their main activities.

Note 2 to entry: The machine tool is normally equipped with a power supply, an electrical and electronic assembly for power and control and one or more power drive systems for the movement of mobile elements or workpieces.

Note 3 to entry: Figure 2 illustrates the major parts of the machine tool. It also shows the position of the machine tool in the installation.

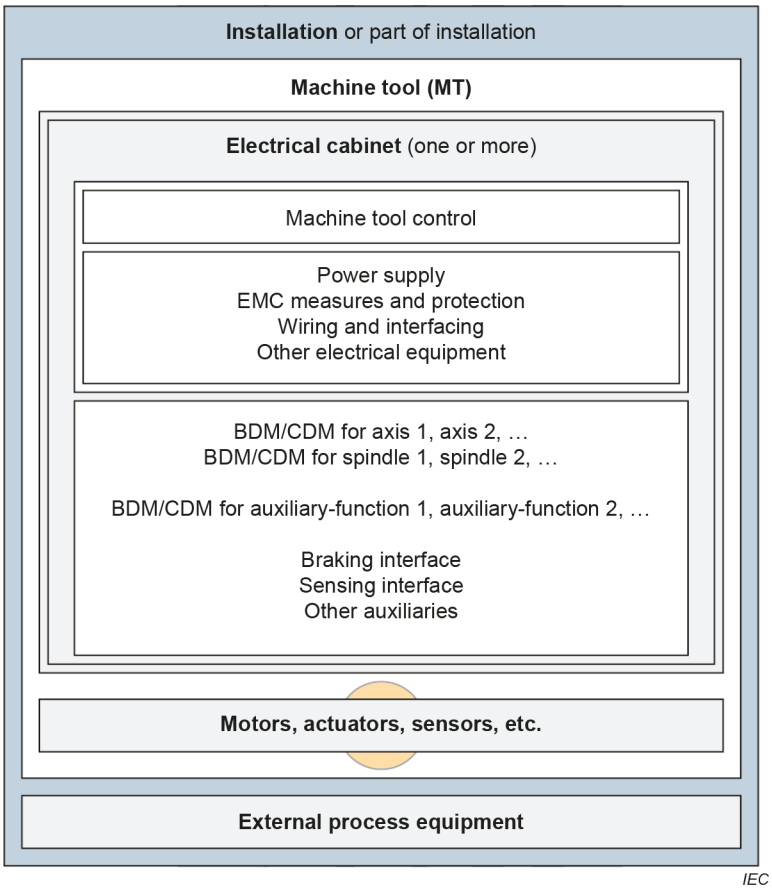


Figure 2 – Content of the MT and its installation

[SOURCE: ISO 14955-1:2017, 3.16, modified – Note 2 to entry and Note 3 to entry have been added with Figure 2.]

3.3 Locations and equipment categories

3.3.1
EMC plan
procedure for the EMC assessment when installing category C4 (see 3.3.8) equipment

3.3.2
residential location
area of land designated for domestic dwellings where the mains power within these locations is directly connected to the low-voltage public mains network

Note 1 to entry: Examples of residential locations are: houses, apartments, farm buildings housing people.

Note 2 to entry: A dwelling can be a single building, separate building or a separate section of a larger building.

Note 3 to entry: Within these locations it is expected to operate a radio receiver within a distance of 10 m from the equipment.

Note 4 to entry: Domestic dwellings are places for one or more people to live.

[SOURCE: IEC 61000-6-8:2020, 3.1.16]

3.3.3
commercial and light-industrial location
location which is not residential in accordance with 3.3.2, where the mains supply is directly connected to the low-voltage public network or connected to a dedicated DC source which is intended to interface between the equipment and the low-voltage public mains network

Note 1 to entry: Examples of commercial or light-industrial locations are:

– retail outlets,
– business premises,
– areas of public entertainment,
– places of worship,
– outdoor locations,
– general public locations,
– hospitals, educational institutions,
– public traffic area, railway stations, and public areas of an airport,
– specific common area of buildings, such as basements, control rooms, electrical service areas,
– workshops, laboratories, service centres.

Note 2 to entry: Within these locations it is expected to operate a radio receiver within a distance of 30 m from the equipment. The risk of interference will be minimized by following the instructions defined in Annex B.

[SOURCE: IEC 61000-6-8:2020, 3.1.3, modified – The references have been updated to the clauses in this document.]

3.3.4
industrial location
location characterized by a separate power network, supplied from a high- or medium-voltage transformer, dedicated for the supply of the installation

EXAMPLE Metalworking, pulp and paper, chemical plants, car production, farm building, high-voltage areas of airports

Note 1 to entry: Industrial locations can generally be described by the existence of an installation with one or more of the following characteristics:

– items of equipment installed and connected together and working simultaneously;
– significant amount of electrical power generated, transmitted and/or consumed;
– frequent switching of heavy inductive or capacitive loads;
– high currents and associated magnetic fields;
– presence of industrial, high power scientific and medical (ISM) equipment (for example, welding machines).

The electromagnetic environment at an industrial location is predominantly produced by the equipment and installation present at the location. There are types of industrial locations where some of the electromagnetic phenomena appear in a more severe degree than in other installations.

[SOURCE: IEC 61000-6-4:2018, 3.1.12, modified – Note 2 to entry has been deleted and examples in Note 1 to entry moved before Note 1 to entry.]

3.3.5
EUT of category C1
equipment under test of category C1
EUT of rated input voltage less than 1 000 V, intended for use in a residential, commercial or light industrial location

3.3.6
EUT of category C2
equipment under test of category C2
EUT of rated input voltage less than 1 000 V, which is neither a plug-in device nor a movable device and which is not intended for use in a residential location

Note 1 to entry: When used in a commercial or light industrial location, it is intended to be installed and commissioned only by a professional. A professional is a person or an organisation having necessary skills in installing and/or commissioning power drive systems or machine tools, including their EMC aspects (see IEC 61000-6-8:2020, 3.1.14).

3.3.7
EUT of category C3
equipment under test of category C3
EUT of rated input voltage less than 1 000 V, intended for use in an industrial location and not intended for use in a residential, commercial or light industrial location

Note 1 to entry: An EUT of category C3 with a rated input current above 100 A is an example of high-power electronic systems and equipment (HPESE), as defined in CISPR 11:2015.

3.3.8
EUT of category C4
equipment of category C4
EUT of rated input 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 an industrial location

3.4 Ports and interfaces

3.4.1
port
particular interface of an equipment which couples this equipment with the external electromagnetic environment and through which the equipment is influenced by this environment

Note 1 to entry: Figure 3 illustrates the diversity of the ports of a PDS.

[SOURCE: IEC 60050-161:2014, 161-01-27, modified – The example and figure have been deleted and the note to entry has been replaced by a new one.]

3.4.2
enclosure port
physical boundary of the EUT through which electromagnetic fields can radiate or impinge

SEE: Figure 3 and Figure 4.

3.4.3
process measurement and control port
input/output (I/O) port for a conductor or cable which connects the process to the EUT

3.4.4
power port
port which connects the EUT to the power supply, which also feeds other equipment

3.4.5
main power port
power port which feeds the EUT for only the power which, after electrical power conversion, is converted by the motor into mechanical power

3.4.6
auxiliary power port
power port which feeds only the auxiliaries of the EUT, including (where it exists) the circuit that feeds the motor's field winding

3.4.7
wired network port
port for the connection of a communication device/system intended to be interconnected to widely dispersed systems by direct connection to a single-user or multi-user network

Note 1 to entry: Examples of communication through the network include voice, data and signalling transfers.

Note 2 to entry: Examples of these networks include CATV, PSTN, ISDN, xDSL, LAN and similar.

Note 3 to entry: Wired network ports may support screened or unscreened cables and may also carry AC or DC power where this is an integral part of the telecommunication specification.

Note 4 to entry: A port generally intended for interconnection of components of a system under test (e.g. RS-232, RS-485, field buses in the scope of the IEC 61158 series, IEEE Standard 1284 (parallel printer), Universal Serial Bus (USB), IEEE Standard 1394 ("Fire Wire"), etc.) and used in accordance with its functional specifications (e.g. for the maximum length of cable connected to it), is not considered to be a wired network port.

Note 5 to entry: In many product standards, this port was defined as a telecommunications or network port.

[SOURCE IEC 61000-6-3:2020, 3.1.3, modified – The word "communication" has been replaced with "a communication device/system" in the definition, and the words "in previous editions of this document and" has been deleted from Note 5 to entry.

3.4.8
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 or, in the case of an MT, for connecting the BDM/CDM to another part of the MT

Note 1 to entry: See Figure 3 and Figure 4.

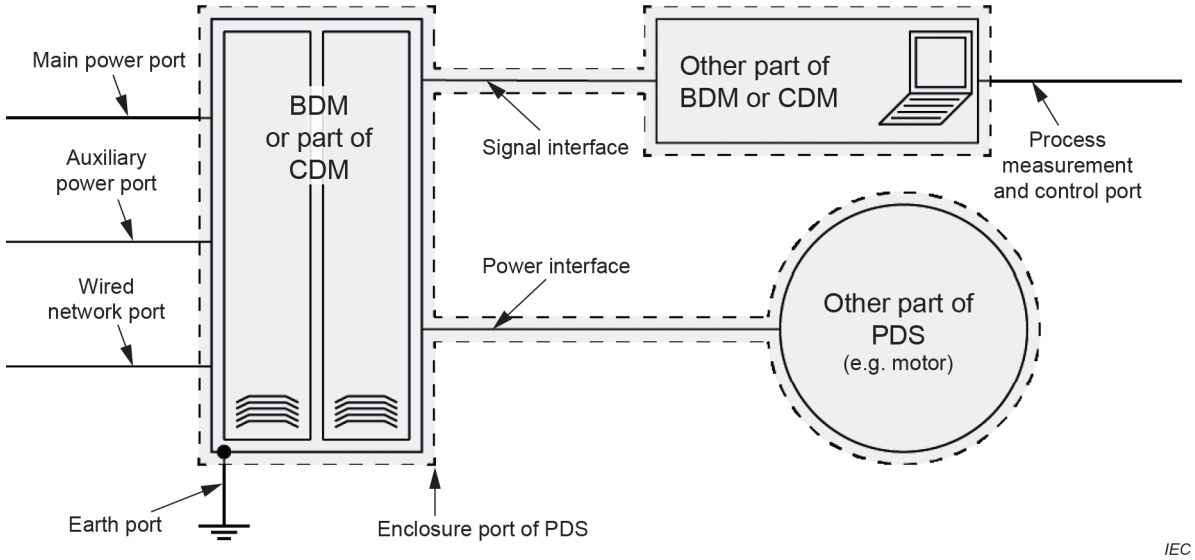


Figure 3 – Internal interfaces of the PDS and examples of ports

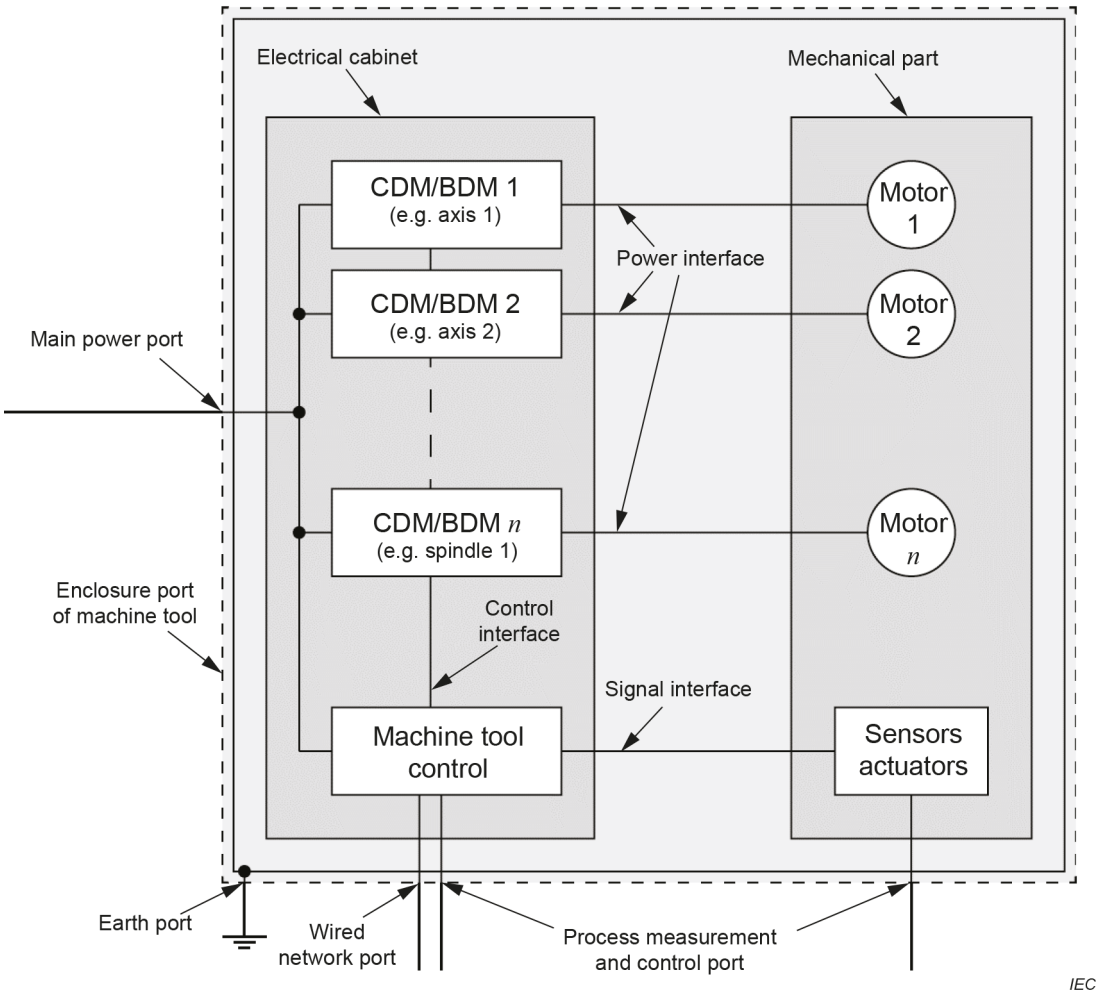


Figure 4 – Internal interfaces of the MT and examples for ports

3.4.9
power interface
connection needed for the distribution of electrical power within the PDS or MT

Note 1 to entry: See Figure 5 for an example of power interface and Clause E.1 for an explanation.

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

– Within the BDM/CDM

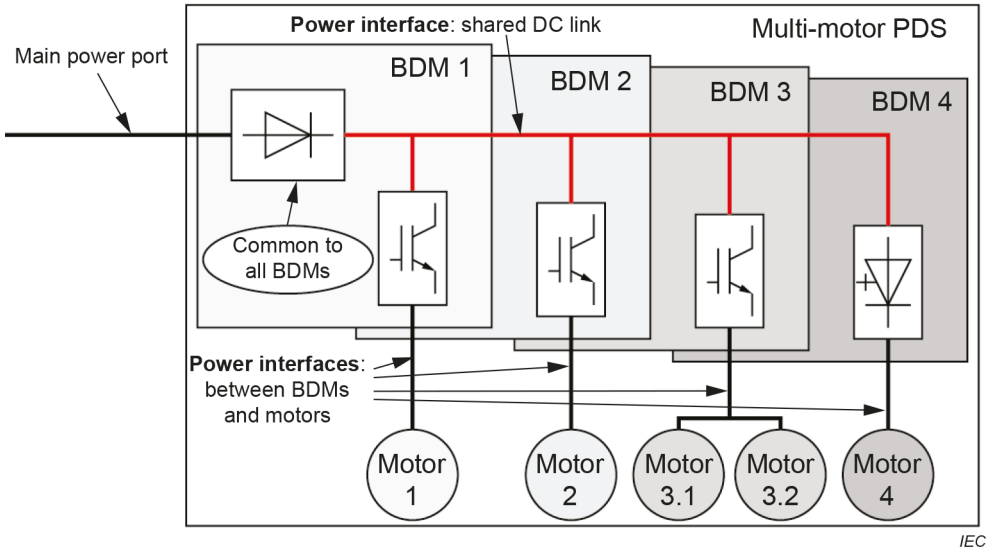
A power interface can be the connection for distribution of electrical power from one part of the BDM/CDM to another part of the BDM/CDM. One power interface can be common to different components of the PDS. For examples, see Figure 5 and Figure 6.

Figure 5 shows two examples of a power interface (DC link) which distributes power from a rectifier to the output inverters of four BDMs. The input converter converts AC power from the mains to another type, here DC power. The output inverters convert power from an intermediate form (here DC) to another type (here AC), which can be directly applied to AC motors.

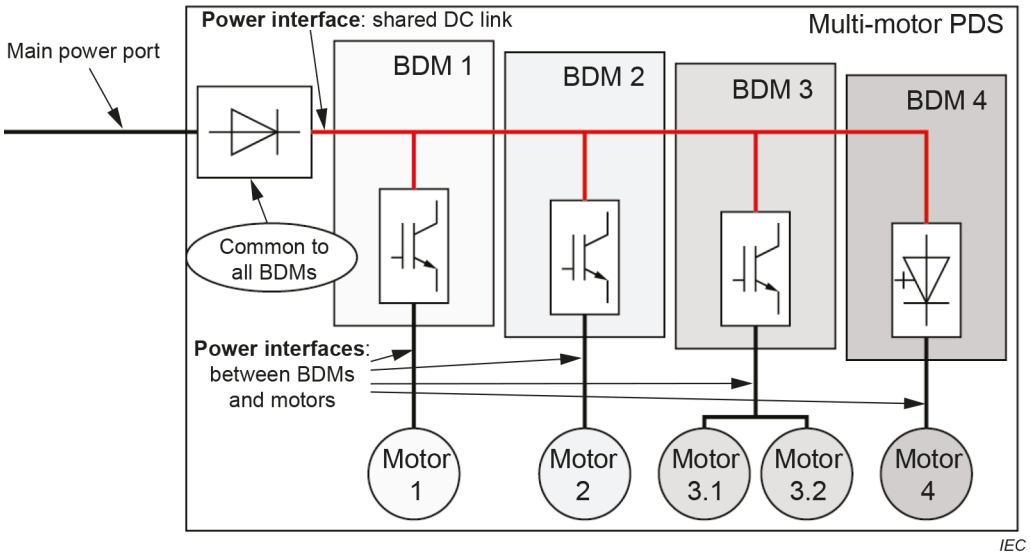
Figure 6 shows a power interface which distributes power from the secondary of a transformer (which is part of the CDM) to individual BDMs.

– Within the PDS

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. This power interface is shown in Figure 5 and Figure 6.



(a) Rectifier in BDM 1 feeds multiple BDMs



(b) Rectifier outside the BDMs

Figure 5 – Power interfaces of a PDS with common DC link

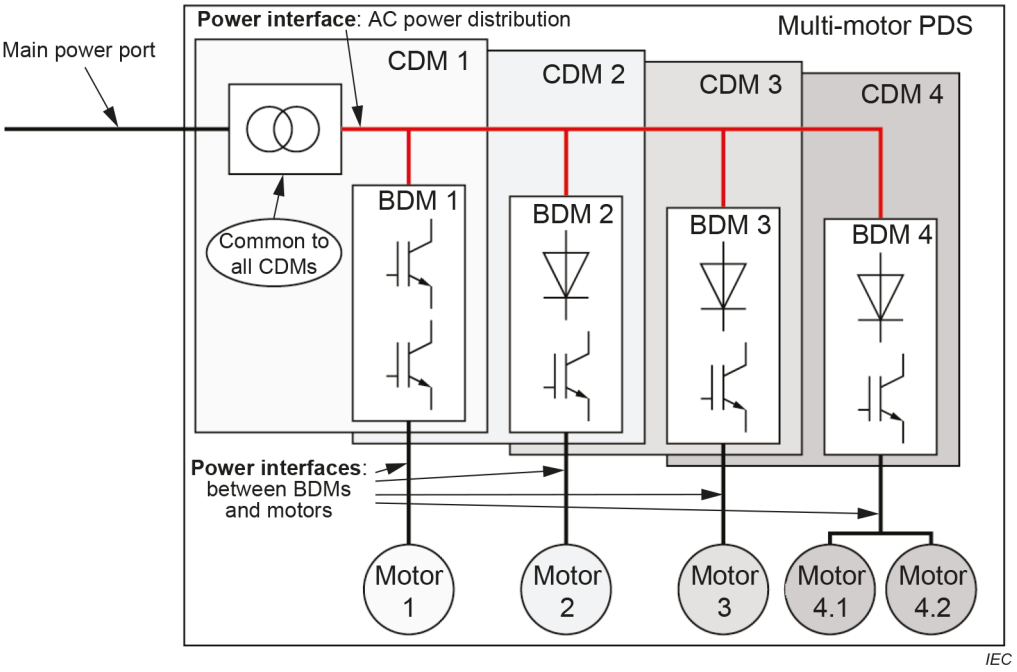


Figure 6 – Power interfaces with common input transformer

3.4.10
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]

3.4.11
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]

3.4.12
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

3.5 Components of the PDS

3.5.1
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.

3.5.2
active infeed converter
AIC
self-commutated electronic power converters of all technologies, topologies, voltages and sizes which are connected between the AC power supply system (lines) and usually a stiff DC-side (current source or voltage source) and which can convert electric power in both directions (from AC to DC, and from DC to AC) and which can control the reactive power or the power factor

Note 1 to entry: Some of the AICs can additionally control the harmonics to reduce the distortion of an applied voltage or current.

Note 2 to entry: Basic topologies can be realized as a voltage source converter (VSC) or a current source converter (CSC).

Note 3 to entry: In the IEC 60050 series, VSC and CSC are defined as voltage stiff AC/DC converter [551-12-03] and current stiff AC/DC converter [551-12-04]. Most of the AICs are bi-directional converters and have sources on the DC side.

Note 4 to entry: In some literature, active infeed converters are also known as active front end (AFE).

[SOURCE: IEC TS 62578:2015, 3.5, modified – The words "(generative or regenerative)" were replaced by "(from AC to DC, and from DC to AC)", the last sentence of Note 3 to entry was deleted, and the existing Note 4 to entry was replaced with a new one.]

3.5.3
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 60050-151:2001, 151-13-41, modified – The note to entry has been added.]

3.6 Test-related definitions

3.6.1
type test
test of one or more devices made to a certain design to show that the design meets certain specifications

[SOURCE: IEC 60050-411:1996, 411-53-01, modified – The word "machines" has been replaced by "devices".]

3.6.2
in situ
<test> location where the equipment is installed for its normal use by the end user

3.6.3
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]

3.6.4
small size equipment
equipment, either positioned on a tabletop, 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 words "wall-mounted" and "and possible auxiliary equipment" have been added, as well as the note to entry.]

3.6.5
wall-mounted equipment
device intended to be mounted on a vertical surface

3.6.6
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 EUT can be divided into sub-components.

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

3.6.7
highest internal frequency
F_x
highest fundamental frequency generated or used within the EUT or highest frequency at which it operates

Note 1 to entry: The highest internal frequency includes frequencies which are solely used within an integrated circuit.

3.7 Phenomena-related definitions

3.7.1
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 60050-161:2018, 161-01-07]

3.7.2
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]

3.7.3
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

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

where

h is the harmonic order;

Q_1 is the RMS value of the fundamental component;

Q_h is the RMS value of the component of harmonic order h

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.

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

3.7.4
voltage variation
increase or decrease in voltage normally due to variation of the total load in an electricity supply system or a part of it

[SOURCE: IEC 60050-811:2017, 811-36-20, modified – The words "electric traction system" have been replaced by "electricity supply system".]

3.7.5
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]

3.7.6
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]

3.7.7
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" have been replaced by "electrical system", and the words "from a few periods of the sinusoidal wave of the voltage to a few seconds" have been replaced by "from a few cycles to a few seconds".]

3.7.8
fundamental frequency
frequency, in the spectrum obtained from a Fourier transform of a time function, to which all the frequencies of the spectrum are referred

Note 1 to entry: For the purposes of the IEC 61800 series, the fundamental frequency is the same as the power frequency supplying the converter or supplied by the converter according to the case which is considered.

Note 2 to entry: IEC 60050-551:2001, 551-20-01, and IEC 60050-551:2001, 551-20-02, define the components as a result of the Fourier analysis; frequencies are therefore a consequence. In 3.7, the definitions follow the approach of IEC 61000-4-7:2002 defining first the frequencies, the components being a consequence. There is no contradiction between the two different approaches.

Note 3 to entry: In the case of a periodic function, the fundamental frequency is generally equal to the frequency of the function itself (see IEC 60050-551:2001, 551-20-03, and IEC 60050-551:2001, 551-20-01). The above definition corresponds to the genuine definition of "reference fundamental frequency" according to IEC 60050-551:2001, 551-20-04, and IEC 60050-551:2001, 551-20-02, for which the term "reference" may be omitted where there is no risk of ambiguity.

Note 4 to entry: In case of any remaining risk of ambiguity, the power supply frequency should be referred to the polarity and speed of rotation of the synchronous generator(s) feeding the system.

Note 5 to entry: This definition may be applied to any industrial power supply network, without regard to the load it supplies (a single load or a combination of loads, rotating machines or other load), and even if the generator feeding the network is a static converter.

[SOURCE: IEC 61000-2-2:2002, 3.2.1, modified – In the definition, the sentence starting with "For the purposes of this standard" has been moved to a note, replacing "this standard" with "the IEC 61800". The notes have been rephrased, and new notes have been added.]

3.7.9
fundamental component
fundamental
component whose frequency is the fundamental frequency

3.7.10
harmonic frequency
frequency which is an integer multiple greater than one of the fundamental frequency or of the reference fundamental frequency

[SOURCE: IEC 60050-551:2001, 551-20-05]

3.7.11
harmonic component
sinusoidal component of a periodic quantity having a harmonic frequency

Note 1 to entry: For brevity, such a component may be referred to simply as a harmonic.

Note 2 to entry: The value of a harmonic component is normally expressed as an RMS value.

[SOURCE: IEC 60050-551:2001, 551-20-07, modified – The note to entry has been replaced with Notes 1 and 2 to entry.]

3.7.12
harmonic order
ratio of the frequency of any sinusoidal component to the fundamental frequency or the reference fundamental frequency

Note 1 to entry: The harmonic order of the fundamental component or the reference fundamental component is one.

Note 2 to entry: The recommended notation is "h".

[SOURCE: IEC 60050-551:2001, 551-20-09, modified – Note 2 to entry has been added.]

3.7.13
interharmonic frequency
frequency which is a non-integer multiple of the reference fundamental frequency

Note 1 to entry: By extension of the harmonic order, the interharmonic order is the ratio of interharmonic frequency to the fundamental frequency. This ratio is not an integer (recommended notation "m").

Note 2 to entry: In the case where $m < 1$, the term of sub-harmonic frequency may also be used (see IEC 60050-551:2001, 551-20-10).

[SOURCE: IEC 60050-551:2001, 551-20-06, modified – The notes to entry have been added.]

3.7.14
interharmonic component
sinusoidal component of a periodic quantity having an interharmonic frequency

Note 1 to entry: For brevity, such a component may be referred to simply as an interharmonic.

Note 2 to entry: For the purposes of the IEC 61800 series, and as stated in IEC 61000-4-7, the time window has a width of 10 fundamental periods (50 Hz systems) or 12 fundamental periods (60 Hz systems), i.e. approximately 200 ms. The difference in frequency between two consecutive interharmonic components is, therefore, approximately 5 Hz. In case of other fundamental frequencies, the time window should be selected between 6 fundamental periods (approximately 1 000 ms at 6 Hz) and 18 fundamental periods (approximately 100 ms at 180 Hz).

[SOURCE: IEC 60050-551:2001, 551-20-08, modified – The note to entry has been replaced with Notes 1 and 2 to entry.]

3.7.15
harmonic content
HC
sum of the harmonic components of a periodic quantity

Note 1 to entry: The harmonic content is a time function.

Note 2 to entry: For practical analysis, an approximation of the periodicity may be necessary.

Note 3 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 4 to entry: The RMS value of the harmonic content is

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

where

Q represents either the current or the voltage;

h is the harmonic order (according to 3.7.12);

H is 40 for the purposes of this document.

[SOURCE: IEC 60050-551:2001, 551-20-12, modified – Note 4 to entry has been added.]

3.7.16
total distortion content
DC
quantity obtained by subtracting from an alternating quantity its fundamental component or its reference fundamental component

Note 1 to entry: The total distortion content includes harmonic components and interharmonic components if any.

Note 2 to entry: The total distortion content depends on the choice of the fundamental component. If it is not clear from the context which one is subtracted, an indication should be given.

Note 3 to entry: The total distortion content is a time function.

Note 4 to entry: An alternating quantity (abbreviated as Q) is a periodic quantity with zero DC component.

Note 5 to entry: The RMS value of the total distortion content is:

$$DC = \sqrt{Q^2 - Q_1^2}$$

where

Q comes from 3.7.15. See also IEC 60050-161:1990, 161-02-21, and IEC 60050-551:2001, 551-20-06.

[SOURCE: IEC 60050-551:2001, 551-20-11, modified – The text between brackets in Note 4 to entry have been added, as well as Note 5 to entry.]

3.7.17
total distortion ratio
TDR
ratio of the RMS value of the total distortion content to the RMS value of the fundamental component or the reference fundamental component of an alternating quantity

$$TDR = \frac{DC}{Q_1} = \frac{\sqrt{Q^2 - Q_1^2}}{Q_1}$$

Note 1 to entry: The total distortion ratio 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.

[SOURCE: IEC 60050-551:2001, 551-20-14, modified – The abbreviated term TDR and the formula have been added. Note 2 to entry has been deleted.]

3.7.18
individual distortion ratio
IDR
ratio of any harmonic component to the fundamental:

$$IDR = \frac{Q_h}{Q_1}$$

Note 1 to entry: In IEC 60050-161:1990, 161-02-20, this term is named "n^{th} harmonic ratio".

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.