

INTERNATIONAL STANDARD

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**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

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

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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 11¹ 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.

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

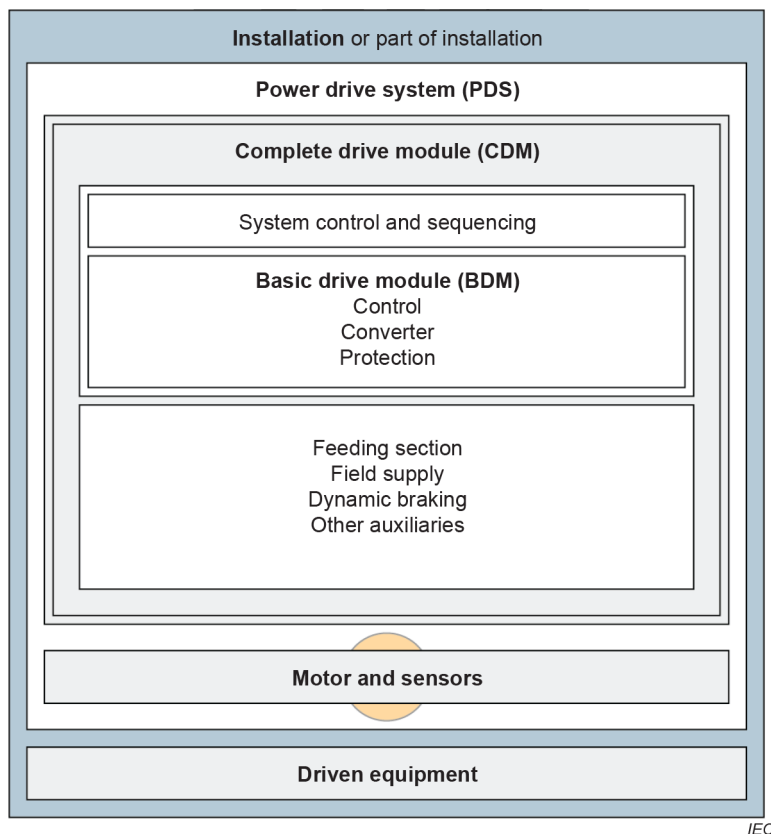
3.1.3

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.



IEC

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

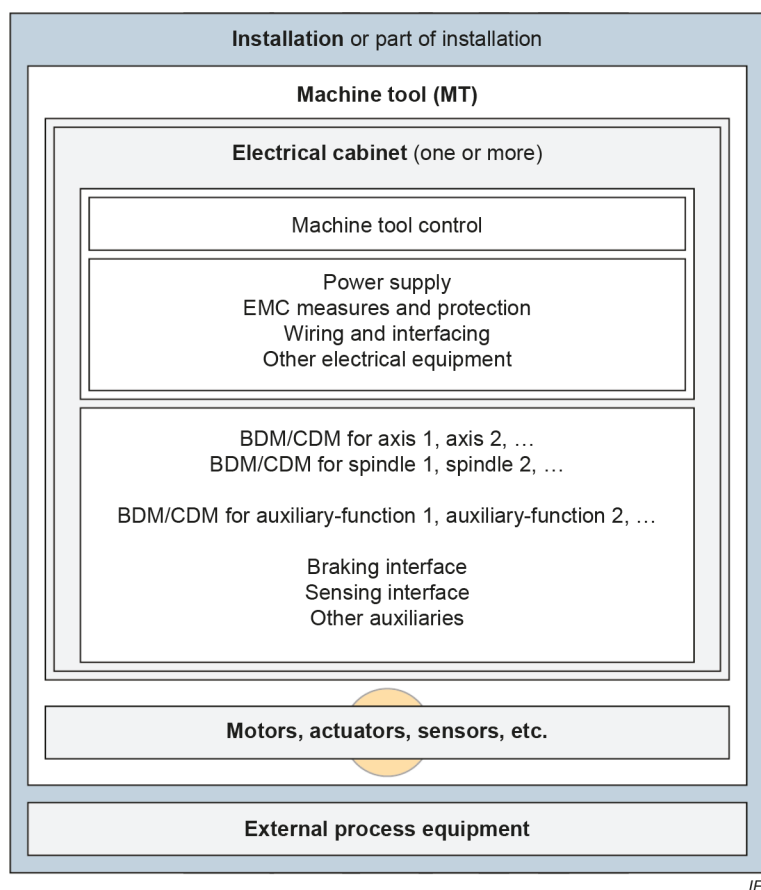
3.2 Content of the machine tool (MT) and its installation**3.2.1****machine tool****MT**

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.



IEC

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.

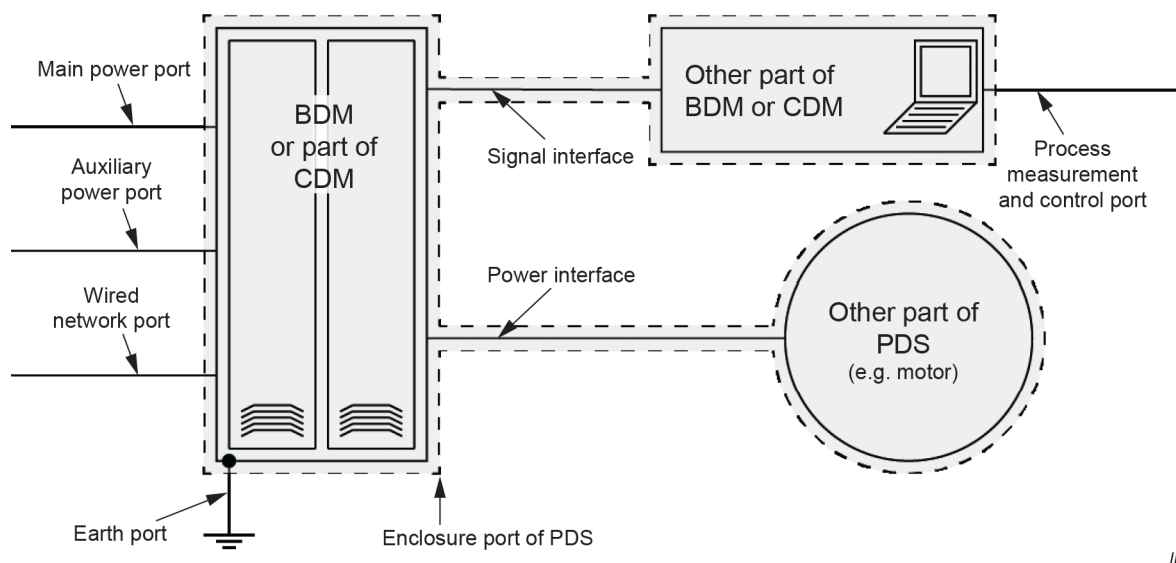
[SOURCE IEC 61000-6-3:2020, 3.1.3, modified – The word "communication" has been replaced with "a communication device/system" in the definition, and the words "in previous editions of this document and" has been deleted from Note 5 to entry.

3.4.8

signal interface

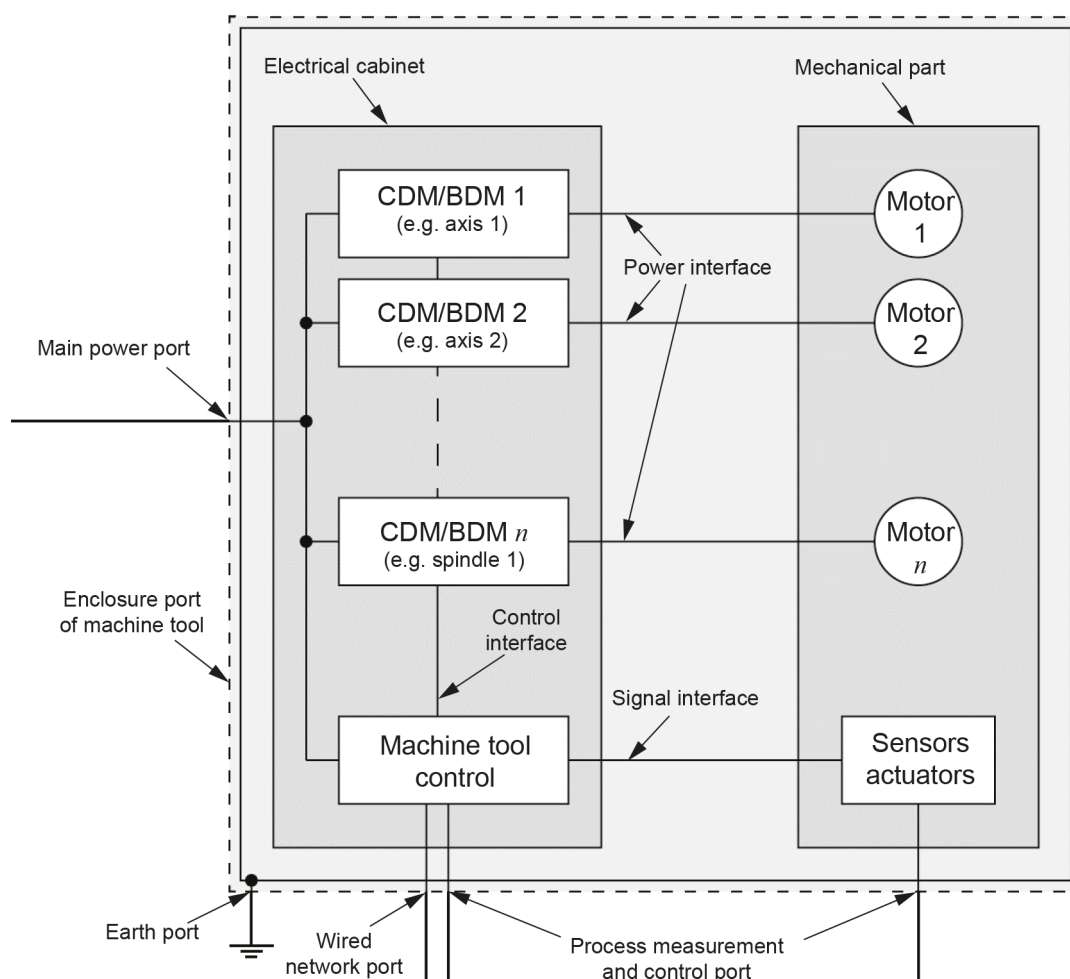
input/output (I/O) connection for a line connecting the basic drive module or complete drive module (BDM/CDM) to another part of the PDS or, in the case of an MT, for connecting the BDM/CDM to another part of the MT

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



IEC

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



IEC

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.

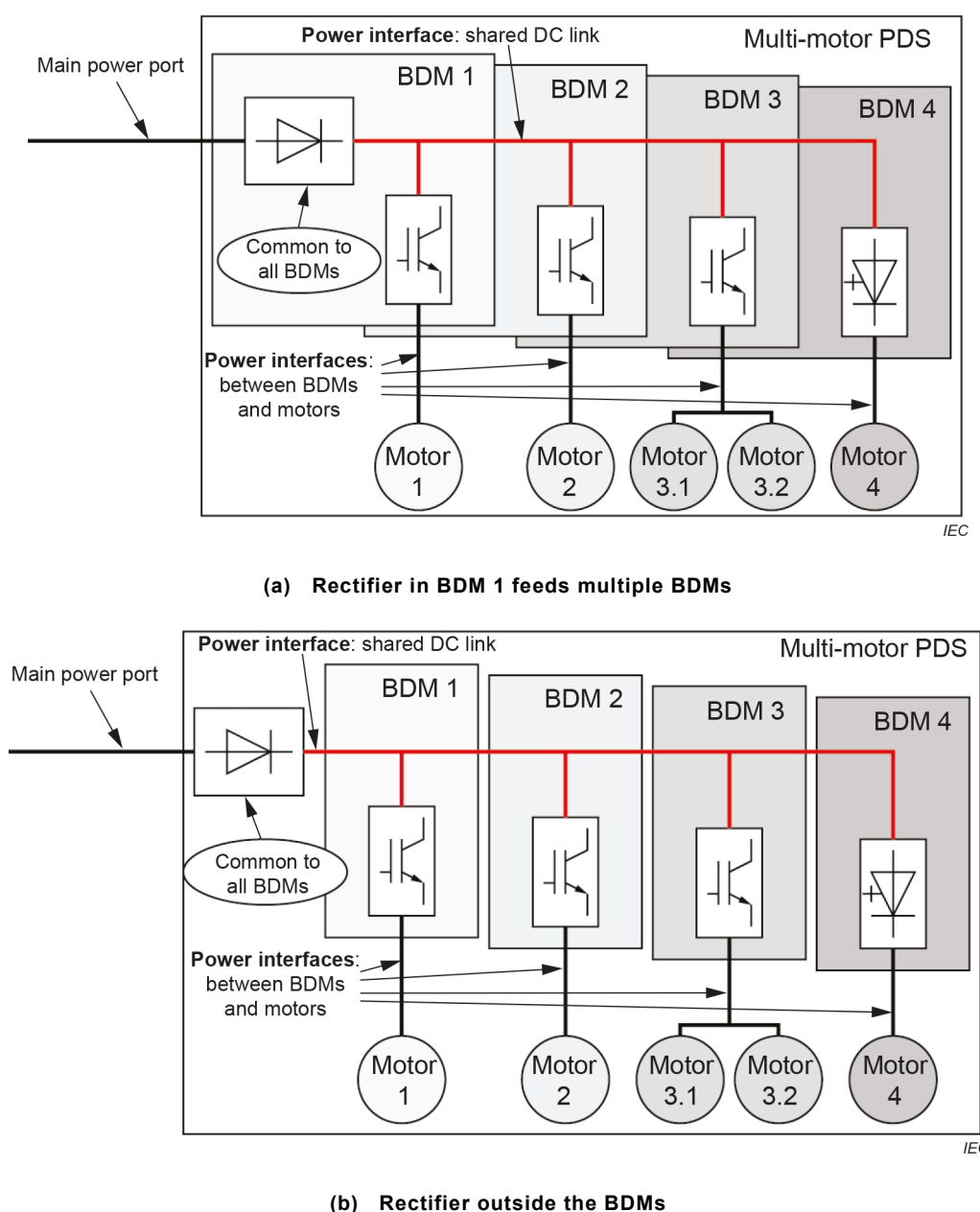


Figure 5 – Power interfaces of a PDS with common DC link

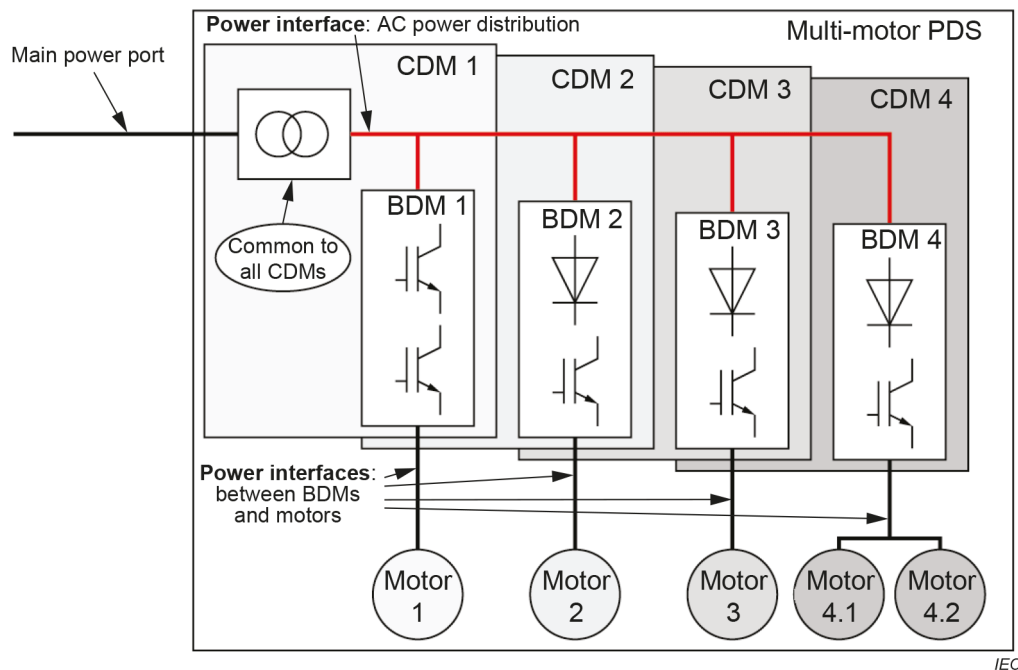


Figure 6 – Power interfaces with common input transformer

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

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

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.

For a realistic assessment of the EMC situation, a typical configuration shall be chosen based on a risk assessment by taking into account

- the worst-case steady state conditions, and
- all operating modes.

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

For further information, see Annex A.

4.2 Tests

4.2.1 Conditions

All the tests specified in this document are type tests only. The equipment shall meet the EMC requirements under all steady state 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.

For the tests of an EUT, the BDM or CDM shall be connected to a motor of a type permitted in the instructions for use. The motor shall be chosen based on a risk assessment by taking into account

- the worst-case steady state conditions, and
- all operating modes.

The cabling between the BDM/CDM and motor and the earthing rules shall be in accordance with the installation instructions of the BDM or CDM and the motor. If the EUT is a BDM or CDM, a passive test load (resistive, or resistive and inductive) may be applied as an alternative to a motor during immunity tests or low frequency emission tests, provided that passive test load represents the worst case.

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

For an MT, the EUT shall operate a programmed cycle that exercises the various functions of the MT during the test.

NOTE 3 The test can be performed without machining a workpiece, because cutting material will require cooling fluid, dust filters and fire extinguishers which cannot be applied on a test site.

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.

All terminals shall be connected and operated in normal operating conditions to ensure that all relevant types of termination are covered. The tests shall be carried out at the rated supply voltage.

NOTE 4 If a risk assessment shows that some terminals are not significant to the EMC performance of the EUT, those terminals can remain disconnected during the test, while ensuring that the remaining configuration still represents the worst case.

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 performance (acceptance) criteria shall be noted in the test report. Within the test report, the chosen test arrangements shall be justified. The test arrangement shall be described in detail in the test report. The test report shall also state whether the EUT is a BDM, a CDM, a PDS or a MT.

4.3 Documentation for the user

The installation instructions shall contain the information necessary for the correct installation of an EUT into a typical system or process in the intended location. This information includes any information on emissions required by 6.5.1.1 and 6.5.1.3 for EUT of category C1 and EUT of category C2, 6.5.2.1 for EUT of category C3 and 6.6.2 for EUT of category C4. It also includes the information required by 5.3.2 in the case where the immunity of an EUT is suitable for residential, commercial and light industrial locations only.

NOTE 1 From the emission point of view, an EUT 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 an EUT has emission category C1 does not imply that the immunity is only suitable for a residential location.

If special EMC measures are necessary to fulfil the required limits, these shall be clearly stated in the user documentation in sufficient detail to permit the installer to install the equipment correctly. Where relevant, these can include details of the following:

- maximum and minimum acceptable supply network impedance (or R_{SI} , R_{SC});
- use of shielded or special cables (power and/or control);
- cable shield connection requirements;
- maximum permissible cable length;
- cable segregation;
- use of external devices such as filters;
- correct bonding to functional earth.

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

5 Immunity requirements

5.1 General conditions

5.1.1 Performance (acceptance) criteria

The system performance relates to the functions of the EUT as a whole that are declared in the information for the user.

The performance (acceptance) criteria shall be used to check the performance of an EUT against external disturbances. From the EMC point of view, any installation according to Figure 1 or Figure 2 shall be running properly.

Table 1 classifies the effects of a given disturbance into three performance (acceptance) criteria: A, B and C for the BDM, CDM and PDS.

Table 2 classifies the effects of a given disturbance into three performance (acceptance) criteria: A, B and C for the MT.

The "general system performance" item from Table 1 and Table 2 is based on the performance criteria in the generic EMC immunity standards IEC 61000-6-1 and IEC 61000-6-2.

The other items in Table 1 and Table 2 describe in more detail the meaning of the general system performance (acceptance) criteria for individual features of the EUT.

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

Table 1 – Criteria to prove the acceptance of a BDM, CDM or PDS against electromagnetic disturbances

Item	Performance (acceptance) criterion ^a		
	A	B	C
General system performance	No noticeable changes of the operating characteristic Operating as intended, within specified tolerance False starts are not acceptable	Temporary noticeable changes (visible or audible) of the operating characteristic Self-recoverable False starts are not acceptable	Shutdown, changes in operating characteristics Triggering of protective devices ^b Not self-recoverable False starts are not acceptable
Torque ^c generating behaviour	Torque ^c deviation within specified tolerances	Temporary torque ^c deviation outside specified tolerances Self-recoverable	Loss of torque ^c Not self-recoverable
Operation of power electronics and driving circuits	No malfunction of a power semiconductor	Temporary malfunction which cannot cause unintended shut-down of the PDS	Shutdown, triggering of protective devices ^b No loss of stored program No loss of user program No loss of persistent settings Not self-recoverable
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 shutdown	Errors in communication, loss of data and information No loss of stored program, no loss of user program No loss of persistent settings Not self-recoverable
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 persistent settings
NOTE Performance (acceptance) criteria A describes continuously unchanged behaviour of the EUT, whereas criterion B refers to performance which can degrade transiently provided that the performance self-recovers. ^a Performance (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 Performance (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. ^c For BDM and CDM, the EUT output current shall be assessed instead of torque.			

Table 2 – Criteria to prove the acceptance of an MT against electromagnetic disturbances

Item	Performance (acceptance) criterion		
	A	B	C
General system performance	No noticeable changes of the operating characteristic Operating as intended, within specified tolerance	Temporary noticeable changes (visible or audible) of the operating characteristic Self-recoverable	Shutdown, changes in operating characteristics ^a Triggering of protective devices Not self-recoverable
Data loss behaviour	No loss of data Continuous running	No loss of data Programs, data and positions are kept	Loss of data Recoverable by restart or new set-up
Workpiece program execution	No changes in workpiece program execution Continuous running	Temporary changes in workpiece program execution Normal program execution resumes automatically	Shut down, changes in workpiece program execution, etc. Program execution restored by control operation or by any other operation specified in the instructions for use
Operation of the power electronics (axis and spindle drives etc.)	Control functions within limits No message(s) on the display of any unit about control limits being exceeded	Control function temporarily outside limits Message(s) on the displays of control or other units about control limits being exceeded Operation resumes automatically	Shut down of the unit by protective or safety devices Restart by operator is allowed
Information processing and sensing functions	No disturbances in sensing or communication functions between units	Communication or sensing temporarily interrupted Sensing/communication ability stays functioning; next required event is performed well	Loss of sensing function and/or communication control between units Restart by operator is allowed
Operation of display units and control panels	No changes in display information Maximum slight influences in Intensity, brightness or movements of characters	Temporary visible changes of display information Temporary undesired lamp and/or LED illumination	Permanent loss of display information or obviously wrong information Incorrect illumination of lamps, LEDs etc., not self-recoverable. Restart by operator is allowed
^a Examples: The monitor turns off, but the machine carries on operating properly; alarm indications turn on without reason; incoherent error messages, incompatible with the actual status of the machine, appear on the monitor (e.g. motor position error message with no movement).			

5.1.2 Conditions during the test

5.1.2.1 General

The immunity test requirements for equipment covered by this document are given on a port by port basis and listed in 5.2 and 5.3.

NOTE If several process measurement and control ports or signal interfaces have the same physical configuration (layout) demonstrated and recorded in the test report, it is common practice to test one port or interface of that type only. A risk assessment is helpful to justify any reduction of the number of ports tested.

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

5.1.2.2 BDM/CDM/PDS test conditions

The BDM/CDM/PDS load used for the tests shall be selected according to 4.2.1. 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 may only be used if the immunity of the test set-up can be proven by reference measurements.

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.

5.1.2.3 MT test conditions

The MT shall operate normally during measurement, but without processing workpieces, without using coolant liquid, without transporting raw and finished workpieces or chips etc. or machining a workpiece. Despite the MT not producing workpieces, all components for operating inside the (stand-alone) MT should be built in and operating.

During the tests concerning electromagnetic fields and conducted radio-frequency common mode, the MT shall run an automatic operation programme which exercises all equipment of the MT (with a typical cycle time), for example as is used for real production. The automatic programme shall be described in the test report.

If the MT or the sub-components can be connected to auxiliary equipment, then the MT or the sub-component shall be tested while connected to the minimum configuration of auxiliary equipment necessary to exercise all ports selected for testing.

5.2 Basic immunity requirements – Low-frequency (< 150 kHz) disturbances

5.2.1 Harmonics

5.2.1.1 Low voltage EUTs

The EUT shall sustain the immunity levels while meeting the performance criteria given in Table 3. The test shall be performed using the EUT with the motor connected. The test method of IEC 61000-4-13 shall be applied.

NOTE The scope of IEC 61000-4-13 is limited to 16 A. However, test generators can be available above 16 A as well. When such test equipment is available, an EUT with rated input current above 16 A can be tested according to IEC 61000-4-13 as well.

Table 3 – Minimum immunity requirements for individual harmonic orders on AC power ports of low voltage EUT

Phenomenon Harmonic order	Residential, commercial or light industrial environment		Industrial 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, C ^a
3		8 %		9 %	
4		1,5 %		2 %	
5		9 %		12 %	
Even orders 6 ≤ h ≤ 40		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 residential, commercial or light industrial locations, 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 industrial locations, levels are from class 3 in IEC 61000-4-13 (these are approximately 1,5 times the compatibility levels of IEC 61000-2-4).					
NOTE 3 High levels of harmonic voltage can cause excess power dissipation in passive filters in the input circuits of active infeed converters. This can cause tripping of the thermal protection of these filters, resulting in performance criterion C. If performance criterion A at these test levels is desired, an installation-specific filter can be required.					
^a Generally, the performance criterion is A. However, in the case of active infeed converters, the performance criterion C is accepted.					

5.2.1.2 EUT of rated voltage above 1 000 V

5.2.1.2.1 AC main power port

The EUT shall sustain the immunity levels given in Table 4.

Table 4 – Minimum immunity requirements for harmonics on AC main power ports of EUTs of rated voltage above 1 000 V

Phenomenon	Reference document	Level	Performance (acceptance) criterion
Harmonics (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 compatibility level	A

5.2.1.2.2 AC auxiliary power port

The AC auxiliary power ports of EUTs shall sustain the immunity levels for industrial locations given in Table 3 while meeting the performance criteria in that table.

5.2.2 Voltage dips and short interruptions

5.2.2.1 Low voltage EUT

The EUT shall sustain the immunity levels given in Table 5.

For equipment rated up to 16 A per phase, the EUT shall be tested using the method of IEC 61000-4-11. For equipment rated above 16 A per phase, the EUT shall be tested using the method of IEC 61000-4-34.

Table 5 – Minimum immunity requirements for voltage dips and short interruptions on AC power ports of low voltage EUTs

Phenomenon	Residential, commercial or light industrial environment			Industrial environment			Performance (acceptance) criterion
	Reference document	Level		Reference document	Level		
Voltage dips	IEC 61000-4-11 class 2	Volts remaining	Cycles	IEC 61000-4-11 class 3	Volts remaining	Cycles	C ^b
		0 %	1		0 %	1	
	or IEC 61000-4-34 class 2 ^c	70 %	25/30 ^a	or IEC 61000-4-34 class 3 ^c	40 %	10/12 ^a	
					70 %	25/30 ^a	
					80 %	250/300 ^a	
Short interruptions	IEC 61000-4-11 class 2	Volts remaining	Cycles	IEC 61000-4-11 class 3	Volts remaining	Cycles	C ^b
	or	0 %	250/300 ^a	or	0 %	250/300 ^a	
	IEC 61000-4-34 class 2 ^c			IEC 61000-4-34 class 3 ^c			
^a "x/y cycles" means "x cycles for 50 Hz test" and "y cycles for 60 Hz test".							
^b Opening of fuses is allowed for line-commutated converters operating in inverting mode.							
^c 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.							

NOTE 1 A BDM/CDM/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 2 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 3 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 EUT is higher than the available power.

NOTE 4 Where it is possible and not dangerous, the behaviour of the EUT during short interruptions can be verified by switching off and on the mains supply during the standard operating conditions of the EUT (see B.6.1).

The degradation of performance resulting from voltage dips or short interruptions shall be stated in the documentation for the user.

NOTE 5 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 EUT and can reduce the efficiency or power factor. Operation such as automatic restart can have safety consequences, which are not covered by this document.

5.2.2.2 EUT of rated voltage above 1 000 V

5.2.2.2.1 AC main power port

AC main power ports of EUTs shall sustain the immunity levels given in Table 6.

The EUT shall be tested using the method of IEC 61000-4-34.

Table 6 – Minimum immunity requirements for dips and short interruptions on AC main power ports of rated voltage above 1 000 V of EUTs

Phenomenon	Reference document	Level		Performance (acceptance) criterion
Voltage dips	IEC 61000-4-34 ^a	Volts remaining	Cycles	C ^c
		0 %	1	
		40 %	10/12 ^b	
		70 %	25/30 ^b	
		80 %	250/300 ^b	
Short interruptions	IEC 61000-4-34 ^a	Volts remaining	Cycles	C ^c
		0 %	250/300 ^b	
^a Typical depths and durations of voltage dips are given in IEC TR 61000-2-8.				
^b "x/y cycles" means "x cycles for 50 Hz test" and "y cycles for 60 Hz test".				
^c Opening of fuses is allowed for line-commutated converters operating in inverting mode.				

The degradation of performance resulting from voltage dips or short interruptions shall be stated in the documentation for the user.

5.2.2.2.2 AC auxiliary power port

The low voltage AC auxiliary power ports of EUTs shall sustain the immunity levels given in Table 7.

Table 7 – Minimum immunity requirements for dips and short interruptions on low voltage AC auxiliary power ports of EUTs

Phenomenon	Reference document	Level		Performance (acceptance) criterion
Voltage dips	IEC 61000-4-11	Volts remaining	Cycles	C
	or IEC 61000-4-34 ^b	0 %	1	
		40 %	10/12 ^a	
		70 %	25/30 ^a	
		80 %	250/300 ^a	
Short interruptions	IEC 61000-4-11 class 3	Volts remaining	Cycles	C
	or	0 %	250/300 ^a	
	IEC 61000-4-34 class 3 ^b			
^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.				

5.2.3 Frequency variations

5.2.3.1 Low voltage EUTs

The EUT shall comply with the immunity levels given in Table 8. During testing, the rated load condition shall be used.

Table 8 – Minimum immunity requirements for frequency variations on AC power ports of low voltage EUTs

Phenomenon	Residential, commercial or light industrial environment		Industrial environment		Performance (acceptance) criterion
	Reference document	Level	Reference document	Level	
Frequency variation	IEC 61000-4-28	Frequency change: ±2 % Transition period between frequencies: 2 s	IEC 61000-4-28	Frequency change: ±2 % ±4 % where the supply is separated from public supply networks Transition period between frequencies: 2 s	A
NOTE The frequency rate of change is specified according to IEC 61000-4-28. For a transition period of 2 s, a frequency change of ±2 % corresponds to a frequency rate of change of ±1 %/s and a frequency change of ±4 % corresponds to a frequency rate of change of ±2 %/s.					

5.2.3.2 EUTs of rated voltage above 1 000 V

5.2.3.2.1 AC main power port

The EUT shall sustain the immunity levels given in Table 9. During verification, the rated load condition shall be used.

Table 9 – Minimum immunity requirements for frequency variations on AC main power ports of rated voltage above 1 000 V of EUTs

Phenomenon	Reference document	Level	Performance (acceptance) criterion
Frequency variation	IEC 61000-4-28	Frequency change: ±2 % ±4 % where the supply is separated from public supply networks Transition period between frequencies: 2 s	A
NOTE The frequency rate of change is specified according to IEC 61000-4-28. For a transition period of 2 s, a frequency change of ±2 % corresponds to a frequency rate of change of ±1 %/s and a frequency change of ±4 % corresponds to a frequency rate of change of ±2 %/s.			

5.2.3.2.2 AC auxiliary power port

The AC auxiliary power ports of EUTs shall sustain the immunity levels given in Table 10.

Table 10 – Minimum immunity requirements for frequency variations on auxiliary AC low voltage power ports of EUTs

Phenomenon	Reference document	Level	Performance (acceptance) criterion
Frequency variation	IEC 61000-4-28	Frequency change: ±2 % ±4 % where the supply is separated from public supply networks Transition period between frequencies: 2 s	A
NOTE The frequency rate of change is specified according to IEC 61000-4-28. For a transition period of 2 s, a frequency change of ±2 % corresponds to a frequency rate of change of ±1 %/s and a frequency change of ±4 % corresponds to a frequency rate of change of ±2 %/s.			

5.2.4 Supply influences – Magnetic fields

Immunity tests according to IEC 61000-4-8 are not required.

NOTE BDMs, CDMs, PDSs and MTs are inherently immune against external magnetic fields because the magnetic fields inside the EUT are orders of magnitude above the magnetic field test levels defined in IEC 61000-4-8 (see A.3.1 for explanation).

5.3 Basic immunity requirements – High-frequency (≥ 150 kHz) disturbances

5.3.1 Conditions

In the following Table 11 and Table 12, the minimum immunity requirements for high-frequency disturbance tests and performance (acceptance) criteria are stated. The performance (acceptance) criteria refer to 5.1.1.

5.3.2 Residential, commercial and light industrial environment

The levels in Table 11 shall be applied to EUTs which are intended to be used only in residential, commercial or light industrial locations.

If an EUT is designed to have immunity according to Table 11, it shall include a written caution in the instructions for use which indicates that it is not intended to be used in an industrial location.

Table 11 – Minimum immunity requirements for EUTs intended for use in a residential, commercial or light industrial location

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 ⁹	B
	Radio-frequency electromagnetic field, amplitude modulated	IEC 61000-4-3	80 MHz to 1 000 MHz 3 V/m 80 % AM (1 kHz)	A
	Radio-frequency electromagnetic field, amplitude modulated	IEC 61000-4-3	1,4 GHz to 6,0 GHz 3 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 or 100 kHz ^{a,b}	B
	Surge ^c 1,2/50 μ s, 8/20 μ s	IEC 61000-4-5	1 kV ^d 2 kV ^e	B
	Conducted radio-frequency common mode	IEC 61000-4-6	0,15 MHz to 80 MHz 3 V 80 % AM (1 kHz)	A
Power interfaces	Fast transient-burst ^f	IEC 61000-4-4	1 kV 5 kHz or 100 kHz ^b Capacitive clamp	B
Signal interfaces	Fast transient-burst ^f	IEC 61000-4-4	0,5 kV 5 kHz or 100 kHz ^b Capacitive clamp	B
	Conducted radio-frequency common mode ^f	IEC 61000-4-6	0,15 MHz to 80 MHz 3 V 80 % AM (1 kHz)	A
Ports for process measurement control lines and wired network ports	Fast transient-burst ^f	IEC 61000-4-4	0,5 kV 5 kHz or 100 kHz ^b Capacitive clamp	B



Port	Phenomenon	Basic standard for test method	Level	Performance (acceptance) criterion
Auxiliary DC power ports below 60 V	Surge ^g 1,2/50 µs, 8/20 µs	IEC 61000-4-5	1 kV ^e	B
	Conducted radio-frequency common mode ^f	IEC 61000-4-6	0,15 MHz to 80 MHz 3 V 80 % AM (1 kHz)	A
CD: contact discharge AD: air discharge AM: amplitude modulation				
^a Power ports with current rating < 100 A: direct coupling using the coupling and decoupling network. Power ports with current rating ≥ 100 A: if the EUT does not work properly with the coupling and decoupling network, the capacitive clamp without decoupling network shall be used instead. If the capacitive clamp is used, test level shall be 2 kV. The chosen test method shall be stated in the test report. ^b The test may be performed at one or both repetition frequencies. The use of 5 kHz is traditional; however, 100 kHz is closer to reality. The chosen test method shall be stated in the test report. ^c Applicable only to power ports with current consumption < 63 A during light load test conditions as specified in 4.2.1. ^d Coupling line-to-line. ^e Coupling line-to-earth. ^f Applicable only to ports or interfaces with cables whose total length, according to the instructions for use, is permitted to exceed 3 m. For justification, see A.3.2.1. ^g See the basic standard for applicability of contact and/or air discharge test, and for applicability of horizontal coupling planes (HCP) and vertical coupling planes (VCP).				

5.3.3 Industrial environment

The levels in Table 12 shall be applied to EUTs which are intended to be used in an industrial location. This also applies to the low voltage ports, or the low voltage interfaces (power, signal) of EUTs of rated voltage above 1 000 V.

NOTE 1 Examples of low voltage ports and interfaces of an EUT of rated voltage above 1 000 V are as follows:

- LV enclosure port enclosure of auxiliaries, control and protection;
- LV power ports LV power supply of the EUT;
- LV power interfaces auxiliary supply distribution within main components of the EUT;
- LV signal interfaces LV signal interfaces within main components of the EUT;
- LV process port signal port of the EUT.

Table 12 – Minimum immunity requirements for EUTs intended for use in an industrial location

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 ^h	B
	Radio-frequency electromagnetic field, amplitude modulated	IEC 61000-4-3	80 MHz to 1 000 MHz 10 V/m 80 % AM (1 kHz)	A
	Radio-frequency electromagnetic field, amplitude modulated	IEC 61000-4-3	1,4 GHz to 6,0 GHz 3 V/m 80 % AM (1 kHz)	A
Power ports (except auxiliary DC power ports below 60 V)	Fast transient-burst	IEC 61000-4-4	2 kV 5 kHz or 100 kHz ^{a,b}	B
	Surge ^c 1,2/50 µs, 8/20 µs	IEC 61000-4-5	1 kV ^d 2 kV ^e	B
	Conducted radio-frequency common mode ^f	IEC 61000-4-6	0,15 MHz to 80 MHz 10 V 80 % AM (1 kHz)	A
Power interfaces	Fast transient-burst ^f	IEC 61000-4-4	2 kV 5 kHz or 100 kHz ^b Capacitive clamp	B
Signal interfaces	Fast transient-burst ^f	IEC 61000-4-4	1 kV 5 kHz or 100 kHz ^b Capacitive clamp	B
	Conducted radio-frequency common mode ^f	IEC 61000-4-6	0,15 MHz to 80 MHz 10 V 80 % AM (1 kHz)	A
Ports for process measurement control lines and wired network ports Auxiliary DC power ports below 60 V	Fast transient-burst ^f	IEC 61000-4-4	2 kV 5 kHz or 100 kHz ^b Capacitive clamp	B
	Surge ^g 1,2/50 µs, 8/20 µs	IEC 61000-4-5	1 kV ^e	B
	Conducted radio-frequency common mode ^f	IEC 61000-4-6	0,15 MHz to 80 MHz 10 V 80 % AM (1 kHz)	A
CD: contact discharge AD: air discharge AM: amplitude modulation				

a	Power ports with current rating < 100 A: direct coupling using the coupling and decoupling network. Power ports with current rating ≥ 100 A: if the EUT does not work properly with the coupling and decoupling network, the capacitive clamp without decoupling network shall be used instead. If the capacitive clamp is used, the test level shall be 4 kV. The chosen test method shall be stated in the test report.
b	The test may be performed at one or both repetition frequencies. The use of 5 kHz is traditional; however, 100 kHz is closer to reality. The chosen test method shall be stated in the test report.
c	Applicable only to power ports with current consumption < 63 A during light load test conditions as specified in 4.2.1.
d	Coupling line-to-line.
e	Coupling line-to-earth.
f	Applicable only to ports or interfaces with cables whose total permitted length stated in the instructions for use is allowed to exceed 3 m. For justification, see A.3.2.1.
g	Applicable only to ports with cables whose total length, according to the instructions for use, is permitted to exceed 30 m. For justification, see A.3.2.2. In the case of a shielded cable, a direct coupling to the shield is applied. This immunity requirement does not apply to fieldbus or other signal interfaces where the use of surge protection devices is not practical for technical reasons. The test is not required where normal functioning cannot be achieved because of the impact of the coupling/decoupling network on the equipment under test (EUT).
h	See the basic standard for applicability of contact and/or air discharge test, and for applicability of horizontal coupling planes (HCP) and vertical coupling planes (VCP).

These phenomena are not relevant for application to the ports of rated insulation voltage above 1 000 V. For simplicity, such ports are named HV ports of EUTs of rated voltage above 1 000 V.

NOTE 2 Examples of HV ports and interfaces of an EUT of rated voltage above 1 000 V are as follows:

- HV enclosure port enclosure of transformer, converter section and motor;
- HV power port primary side of transformer;
- HV power interfaces HV distribution within main components of the EUT;
- HV signal interfaces HV signal interfaces within main components of the EUT.

5.4 Application of immunity requirements – Alternative verification methods

5.4.1 General

For some immunity phenomena, compliance may be demonstrated by sub-component testing.

For some low frequency immunity phenomena, another alternative is using either calculation or simulation instead of testing.

In these cases, the chosen verification method shall be stated in the test report. A risk assessment shall prove that the simulation and/or calculation model or the selected sub-components of the EUT include all effects relevant for the assessed EMC phenomenon. Unless otherwise stated, it is sufficient to demonstrate that the power circuit will comply with the required performance (acceptance) criterion in 5.2 and 5.3 and that the ratings of input circuits (filters, etc.) will not be exceeded.

NOTE 1 In some cases, simulation and calculation give a more effective assessment than tests of an EUT's low-frequency immunity or emission. Examples for such cases are as follows.

- The EUT is too large to be put into an EMC test chamber.
- The power of the EUT exceeds the power of available test generators.
- The network conditions (impedance, predistortion) cannot be realized with an available test generator.
- The generic or basic standards allow assessment by calculation or simulation.

NOTE 2 Testing on a representative model is a way to verify the simulation model.

5.4.2 Simulation and calculation of harmonics

Subclause 5.4.2 is particularly relevant for equipment with an input current exceeding 16 A. The EUT shall sustain the immunity levels while meeting the performance criteria given in Table 3 or Table 4, as applicable. It shall be verified that, if the harmonic is present for the time period defined in the test standard, the EUT will achieve the performance criterion given in the applicable table. In case of immunity simulation, the simulation model shall at least contain the following elements:

- the test generator according to IEC 61000-4-13;
- the main power circuit of the BDM part of the EUT and its control and monitoring signals;
- a load circuit.

The chosen verification method shall be stated in the test report. A risk assessment shall be performed according to 4.1.

5.4.3 Alternative verification methods for voltage dips and short interruptions

The EUT shall sustain the immunity levels given in the applicable Table 5, Table 6 and Table 7.

For equipment rated above 75 A per phase and equipment with rated voltage above 1000 V, the undervoltage ride-through test (UVRT) according to IEC 61400-21-1:2019, 8.5.2.2, may be used as an alternative to the test method of IEC 61000-4-34.

If, due to reasons of high power etc., suitable test equipment using any of the above methods is not available, immunity may be verified by calculation or simulation. In case of immunity simulation, the simulation model shall at least contain the following elements:

- the test generator according to IEC 61000-4-11 or IEC 61000-4-34;
- the main power circuit of the BDM part of the EUT and its control signals;
- a load circuit.

The chosen verification method shall be stated in the test report. A risk assessment shall be performed according to 4.1.

5.4.4 Frequency variations

The EUT shall comply with the immunity levels given in the applicable Table 8, Table 9 and Table 10. In case of immunity simulation, the simulation model shall at least contain the following elements:

- the test generator according to IEC 61000-4-28;
- the main power circuit of the BDM part of the EUT and its control signals;
- a load circuit.

The chosen verification method shall be stated in the test report. A risk assessment shall be performed according to 4.1.

5.4.5 Immunity against electromagnetic fields by subcomponents testing

Immunity against electromagnetic fields may be demonstrated by performing the tests of IEC 61000-4-3 and IEC 61000-4-6 on sensitive sub-components, if the EUT is

- of rated voltage more than 500 V,
- of rated current more than 200 A,
- of total mass more than 250 kg, or
- of height, width, and depth more than 1,9 m.

If the test is performed on sensitive sub-components, this shall be stated in the test report.

NOTE Sensitive sub-components are typically all electronic printed circuit boards.

If the motor is too large to be put into service on a test site, the motor may be replaced by one of smaller size, provided this does not adversely affect the operation of the BDM/CDM.

6 Emission

6.1 General emission requirements

The measurements shall be made in the operating mode producing the largest emission in the frequency band, while being consistent with the normal application.

6.2 General emission requirements for MT

The MT shall operate normally during measurement, but without cutting metal, without using coolant liquid, without transporting raw and finished workpieces or chips etc. or machining a real workpiece. Despite the MT not producing workpieces, all integrated components for operating the (stand-alone) MT in a real manner should be built in (e.g. chip conveyor, workpiece handling system or robot integrated inside working zone, etc.). All these integrated components shall run in an MT controlled mode but can be without load.

Table 13 lists the approaches that should be used when assessing the emissions from different configurations of MT.

Table 13 – Approach to type-test assessment of different MT configurations

Situation of machine tool	Action
MT manufactured in one or various configurations	Test representative configuration (EMC worst case configuration)
MT modified using only electromagnetically irrelevant components	MT is deemed to fulfil the relevant tests in all configurations without testing additional types
MT will be modified by using electromagnetically relevant components	Choose the EMC worst case configuration. Verify the validity of the representative MT configuration depending on upcoming new configurations. In case of non-validity, test of the new representative configuration shall be fulfilled.

In the case of an MT with an automatic cycling program, the test time can be started at random during the MT cycle time. In addition, it is necessary to take into account the size and dimensions of an MT. Therefore, distinctions shall be drawn between (type-) testable machines and machines which are not testable based on their physical dimensions.

6.3 Basic low-frequency (< 150 kHz) emission limits

6.3.1 Harmonics and interharmonics

6.3.1.1 Low-voltage public supply network – Equipment covered by IEC 61000-3-2 or IEC 61000-3-12

Equipment (e.g. MT) can contain one or several PDSs and also other loads.

When an EUT intended to be connected to a public low-voltage distribution system is within the scope of IEC 61000-3-2 (rated input current ≤ 16 A per phase), the requirements of that standard apply. However, when one or more BDM/CDM/PDSs are included in equipment within the scope of IEC 61000-3-2, the requirements of that standard apply to the complete equipment and not to the individual BDM/CDM/PDS.

When an EUT intended to be connected to a public low-voltage distribution system is within the scope of IEC 61000-3-12 (rated input current > 16 A and ≤ 75 A per phase), the requirements of that standard apply. However, when one or more BDM/CDM/PDSs are included in equipment (e.g. MT) within the scope of IEC 61000-3-12, the requirements of that standard apply to the complete equipment and not to the individual BDM/CDM/PDS.

If an equipment is in the scope of IEC 61000-3-2 or IEC 61000-3-12, the boundary of the system or sub-system to which that standard applies shall be stated in the test report of that equipment. The method used to demonstrate compliance shall also be stated in the test report of that equipment.

6.3.1.2 Low-voltage public supply network – Equipment not covered by IEC 61000-3-2 or IEC 61000-3-12

For equipment not covered by IEC 61000-3-2 or IEC 61000-3-12 (rated current above 75 A), recommendations can be found in Clause B.4.

6.3.1.3 Industrial networks

If equipment is to be used only in installations which are not directly supplied from a public low voltage network, it is outside the scope of IEC 61000-3-2 and IEC 61000-3-12. Therefore, a reasonable approach which considers the total installation should be used (see Clause B.4).

NOTE For network voltages above 1 000 V, the total installation can be subject to rules from the distribution network operator, usually based on IEC TR 61000-3-6. These rules apply to the installation as a whole, not to individual equipment. These rules usually take the existing harmonic currents and voltage distortion within the system into account. An efficient and simplified approach is provided by Table B.2.

In the case of an EUT of rated voltage above 1 000 V, harmonic emissions from the main power port and the auxiliary power ports shall be considered separately.

6.3.2 Voltage fluctuations and flicker

6.3.2.1 Conditions

Equipment can contain one or several BDM/CDM/PDSs and also other loads (e.g. MT) which are capable of causing voltage fluctuations and flicker.

NOTE 1 Voltage fluctuations can be caused, for instance, by frequently changing the load of a BDM/CDM/PDS, or by sub-harmonics of slip energy recovery of asynchronous motors. Voltage fluctuations can also be caused by interharmonics at frequencies slightly different from the fundamental or from predominant harmonics. The emission is typically generated by cyclo-converters or current source inverters. See B.4.3 and B.6.2. Interharmonics are covered by compatibility levels given in IEC 61000-2-4 or in IEC 61000-2-12.

NOTE 2 Voltage fluctuations are dependent on the impedance of the installation and the duty cycle of the load. In some applications, the user can reduce voltage fluctuations by adjusting the load duty cycle by changing speed ramp rate or using other techniques.

NOTE 3 Certain voltage fluctuations on networks that supply lighting loads can cause an impression of unsteadiness of visual sensation, known as flicker.

6.3.2.2 Low-voltage public supply network – Equipment in the scope of IEC 61000-3-3 or IEC 61000-3-11

When an EUT intended to be connected to a public low-voltage distribution system is within the scope of IEC 61000-3-3 (rated input current ≤ 16 A per phase), the requirements of that standard apply. However, when one or more BDM/CDM/PDSs are included in equipment within the scope of IEC 61000-3-3, the requirements of that standard apply to the complete equipment and not to the individual BDM/CDM/PDS.

When an EUT intended to be connected to a public low-voltage distribution system is within the scope of IEC 61000-3-11 (rated input current > 16 A and ≤ 75 A per phase), the requirements of that standard apply. However, when one or more BDM/CDM/PDSs are included in equipment (e.g. MT) within the scope of IEC 61000-3-11, the requirements of that standard apply to the complete equipment and not to the individual BDM/CDM/PDS.

NOTE Application of the voltage fluctuation limits of IEC 61000-3-3 and 61000-3-11 is only possible when the characteristics of the load provided by the driven equipment are known. For that reason, only the machine builder and/or end user are capable of characterizing compliance with regard to the voltage fluctuation limits.

6.3.2.3 EUTs not in the scope of IEC 61000-3-3 and IEC 61000-3-11

For equipment not in the scope of IEC 61000-3-3 and IEC 61000-3-11, emissions of voltage fluctuations are generally dependent on the loading conditions and this document cannot give requirements.

NOTE Local rules given by local authorities can apply to the complete installation. In some of these cases, guidance in IEC TS 61000-3-5 can be consulted.

6.3.3 Emissions in the frequency range from 2 kHz to 150 kHz

In the frequency range from 2 kHz to 150 kHz, limits are not specified.

NOTE 1 Horizontal EMC committees in IEC are working on limits in this frequency range.

NOTE 2 Until limits are specified in this frequency range, design recommendations for emission values can be found in IEC TS 62578:2015, Annex B.

For further information, see Annex D.

6.3.4 Common mode harmonic emission (low-frequency common mode voltage)

The switching frequency of the converter of the EUT is often in the audible frequency range and, in particular, the frequency range commonly used by telephone and data systems. To avoid the risk of crosstalk to signal cables, the installation instructions shall either recommend that the power interface cable be segregated from signal cables or state alternative mitigation methods.

6.4 Conditions related to high-frequency (≥ 150 kHz) emission measurement

6.4.1 General requirements for measurements on a test site

6.4.1.1 Common conditions

The tests shall be applied to the relevant ports where they exist and shall be performed in a well-defined and reproducible manner on a port-by-port basis.

The test method shall comply with CISPR 11:2015, CISPR 11:2015/AMD1:2016 and CISPR 11:2015/AMD2:2019, 7.3 to 7.4 and Clause 8. The requirements for configuration of test setup for the EUT considering cables arrangement are derived from CISPR 11:2015 and CISPR 11:2015/AMD1:2016, 7.5, paying particular attention to earth connections. An example for a PDS test setup and cable arrangement for measurements of radiated disturbances in 3 m separation distance is described in 6.4.1.3 below. The load and cable lengths shall be within the manufacturer's specification and the actual load and power interface cable length shall be noted in the test report.

6.4.1.2 Conducted emissions

The measurement equipment for evaluation of high-frequency mains terminal (power port) disturbance voltage emission is the artificial mains network (50 Ω /50 μ H, see CISPR 16-1-2 and CISPR 11:2015).

NOTE 1 Alternatively, an AMN can be connected in parallel as a voltage probe as described in CISPR 16-2-1:2014, Clause A.5.

NOTE 2 If the artificial mains network cannot be applied, the high impedance voltage probe according to CISPR 16-1-2:2014, 5.2.1, can be used. The reason why the artificial mains network cannot be used can be given in the test report. The chosen test method can be stated in the test report.

NOTE 3 EUTs in the scope of this document typically do not contain DC ports, but only AC ports and DC interfaces. If DC ports exist, applicable limits and test methods can be found in CISPR 11:2015.

Common-mode absorption devices (CMAD) shall not be used as part of the test setup for conducted emission measurement.

NOTE 4 A CMAD is a piece of test equipment intended to be placed on cables leaving the test volume. However, high common mode currents from EUTs can cause saturation of CMADs, leading to inconsistent results.

6.4.1.3 Radiated emissions of a BDM/CDM/PDS

6.4.1.3.1 Type of test site

EUT of category C1, category C2 and category C3 shall be measured on a test site compliant with requirements of CISPR 16-1-4. The measurement distance shall be stated in the test report.

This document allows test sites that are either an open-area test site (OATS) or a semi-anechoic chamber (SAC).

6.4.1.3.2 Test volume

The measurement distance is considered between the reference point (RP) of the antenna calibration and the boundary of the BDM/CDM/PDS's test volume (see Figure 7 to Figure 9).

The selection of measurement distances for tests up to 1 GHz shall comply with the requirements of CISPR 11:2015, 6.2.2.3 and 8.3.4..

The boundary of the BDM/CDM/PDS's test volume is the imaginary cylinder around the complete configuration of the BDM/CDM/PDS. This boundary is shown as item H in Figure 7 and Figure 8. All cables between different parts of the BDM/CDM/PDS shall be inside the imaginary cylinder. However, see 6.4.1.3.5 for information on the location of the motor. The height of the imaginary cylinder is measured from the floor, regardless of whether the BDM/CDM/PDS is table-top, wall-mounted equipment or standing on the floor.

The BDM/CDM/PDS is considered as small size equipment if the boundary of the BDM/CDM/PDS's test volume complies with the definition of 3.6.4. The maximum boundary for small size equipment is shown as item K in Figure 7 to Figure 9. The dimensions of the test volume should be measured with an accuracy of $\pm 0,1$ m.

6.4.1.3.3 Selection of measurement distance

Subclauses 6.5.1.3 and 6.5.2.4 give emission limits for tests at 10 m and 3 m distance.

Small size equipment meeting the size criterion defined in 3.6.4 may be tested at either 10 m or 3 m. Equipment not meeting this size criterion shall be tested at 10 m.

Special requirements relating to the test setup are specified in 6.4.1.3.4 to 6.4.1.3.6 for better reproducibility of measurement at 3 m. In cases where these requirements are practical for measurement at 10 m distance, they will also improve reproducibility at that distance.

As far as the applicability of common-mode absorption devices (CMAD) is concerned, see CISPR 11:2015.

NOTE 1 See CISPR 16-2-3.

NOTE 2 A measurement distance of 10 m is often used for large equipment with long motor cables. Long motor cables can cause saturation of CMADs, which leads to unreproducible test results.

6.4.1.3.4 Auxiliaries and peripherals

When auxiliaries or peripheral equipment are not part of the BDM/CDM/PDS (see EUT 2 in Figure 7 and Figure 8 and item E in Figure 7 to Figure 9), they may be placed outside the test volume. However, if they cannot be excluded from the maximum test volume because the interconnecting cables are too short or for other reasons, these auxiliaries or peripheral equipment are put on the positioning table or on the insulated plane.

6.4.1.3.5 Motor

For radiated emission, load conditions shall be selected to cause worst case emissions (see A.2.1 for information on load conditions).

NOTE 1 Emissions typically increase with common mode voltage and shorter rise time of the voltage. These conditions are achieved at light load and low motor speed.

The power rating of the motor shall be selected according to 4.2.1.

The power interface cable between the BDM/CDM and the motor shall be exposed to the antenna with at least 0,8 m length inside the test volume, unless the maximum cable length stated in the information for the user is shorter.

NOTE 2 The motor can be put inside or outside the test volume.

The position of the motor and the cable arrangement shall be stated in the test report.

The motor shall be directly connected to earth (i.e. to the ground plane), according to the recommendations for motor earthing given in the EUT's installation instructions. In the absence of such instructions, the motor shall be connected to the ground plane with a lead as short as possible, shown as item F in Figure 7 to Figure 9.

6.4.1.3.6 Layout of setup for radiated emission tests

Examples of typical layouts for radiated emission tests are given in Figure 7 to Figure 9 below.

If a special earthing conductor is used for the BDM/CDM/PDS, when put on the table this BDM/CDM/PDS shall be connected to earth (e.g. be bonded to the ground plane) with a length that shall be at least 1 m, as shown in item C of Figure 8. When the BDM/CDM/PDS is floor-standing, the earthing conductor shall be bonded to the ground plane with a lead as short as possible as shown in item C of Figure 9.

NOTE 1 An example of a special earthing conductor is a second protective earthing conductor, which could be used for compliance with IEC 61800-5-1:2007, 4.3.5.5.2.

NOTE 2 If the motor is placed far from the turntable, the motor cable can be passed through the floor of the turntable (see dotted line path "A" in Figure 9). If the motor is placed beside the turntable (see "F" in Figure 9) and prevents the turntable from moving, A.4.2 provides additional information for performing radiated emission measurements.

An artificial mains network (AMN) shall be used in radiated emission tests.

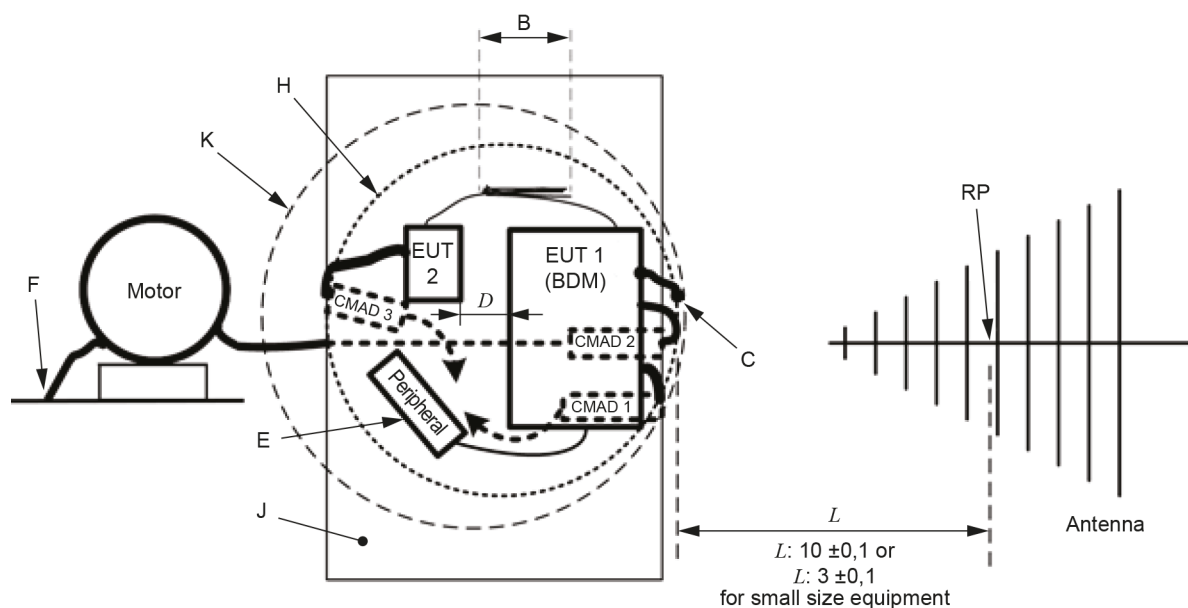
NOTE 3 Auxiliaries and peripheral equipment that are not part of the EUT can be located outside the test volume. However, if the connecting cables between them and the EUT cannot be extended to run outside the test volume, these auxiliaries and peripherals can be placed inside the test volume (see Figure 7 and Figure 8) or on the turntable (see Figure 9).

The spacing between all enclosures (EUT, peripheral etc.) should be $\geq 0,1$ m. This is shown by item D in Figure 7 to Figure 9.

Where an interconnecting cable has an excess length, this excess length shall be bundled in the middle of the cable length, as required by CISPR 11:2015, 7.5.2. This bundle is shown as item B in Figure 7 and Figure 9.

NOTE 5 The reference point of the antenna calibration is considered for the measuring distance as shown by item RP in Figure 7 to Figure 9.

The measuring distance, shown as L in Figure 7 to Figure 9, is measured between the test volume and the reference point of the antenna calibration, shown as RP in Figure 7 to Figure 9.

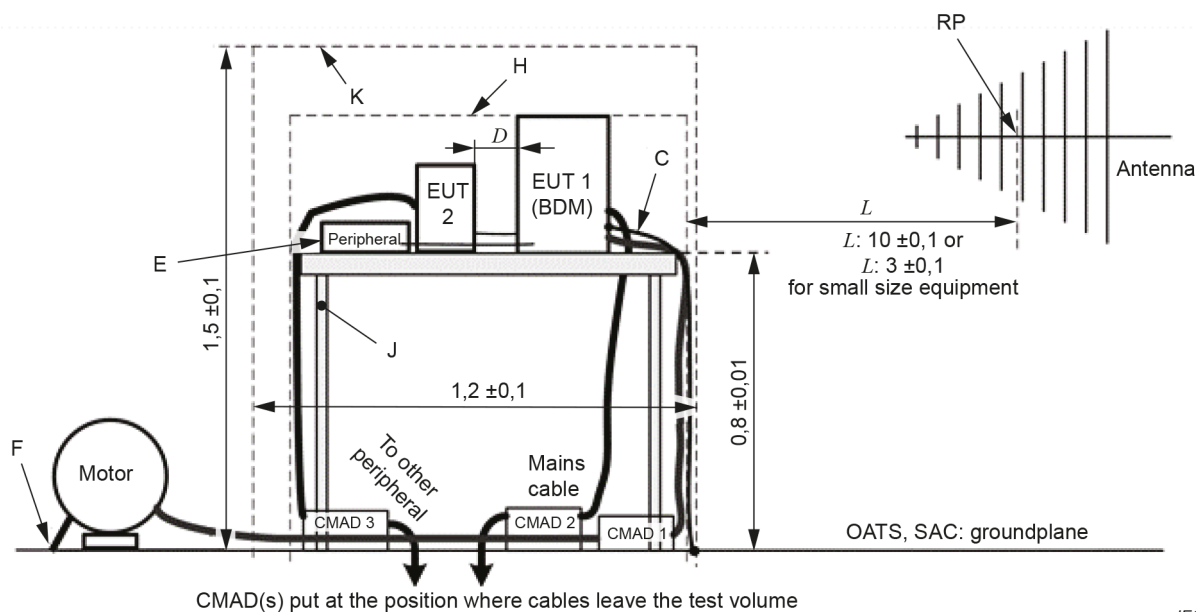


IEC

Key

- B excess cable, which is in a bundle of between 0,3 m and 0,4 m in the middle of the cable length
- C special earthing connection, only if specified in the user documentation
- D spacing between enclosures, which should be $\geq 0,1$ m
- E peripheral or auxiliary device, see 6.4.1.3.4
- F earthing of the motor, see 6.4.1.3.5
- H test volume, see 6.4.1.3.2
- J positioning table of insulating material, with height $0,8 \text{ m} \pm 0,01 \text{ m}$ above the ground plane
- K boundary of maximum test volume for small size equipment as defined in 3.6.4
- L measuring distance
- RP reference point of the antenna calibration

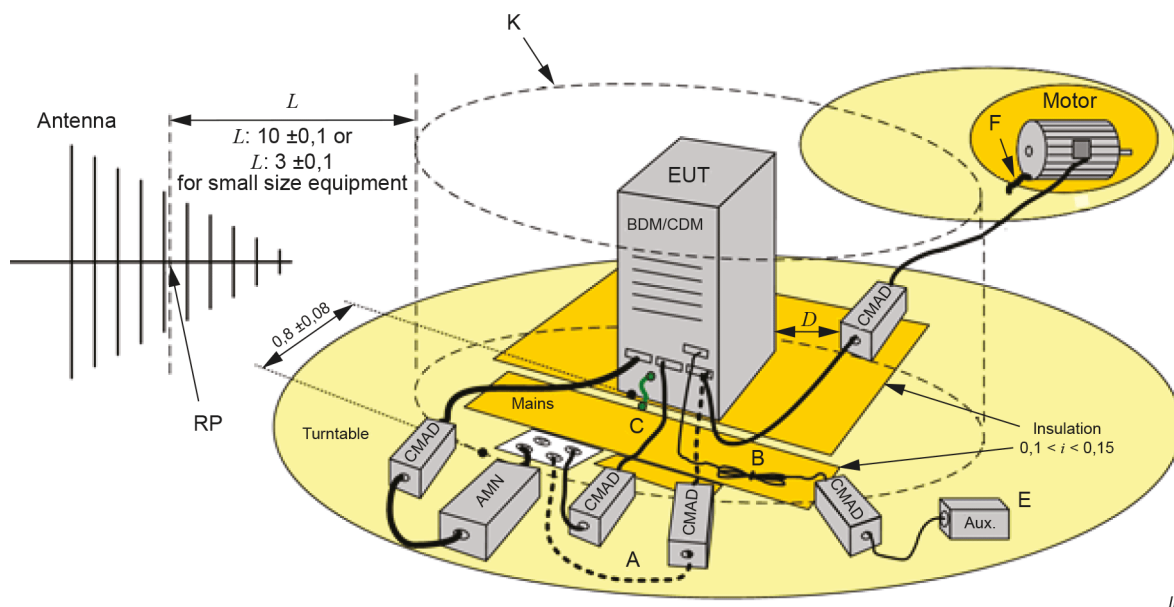
Figure 7 – Example for a typical cable arrangement for measurements in 3 m separation distance, for a table-top or wall-mounted equipment, top view



Key

- C special earthing connection, only if specified in the user documentation
- D spacing between enclosures, which should be $\geq 0,1$ m
- E peripheral or auxiliary device, see 6.4.1.3.4
- F earthing of the motor, see 6.4.1.3.5
- H test volume, see 6.4.1.3.2
- J positioning table of insulating material, with height $0,8 \text{ m} \pm 0,01 \text{ m}$ above the ground plane
- K boundary of maximum test volume for small size equipment as defined in 3.6.4
- L measuring distance
- RP reference point of the antenna calibration.

Figure 8 – Example for a typical cable arrangement for measurements in 3 m separation distance for a table-top or wall-mounted equipment, side view



IEC

Key

- A route of the motor cable when the motor is placed far from the turntable
- B excess cable, which is in a bundle of between 0,3 m and 0,4 m in the middle of the cable length
- C special earthing connection, only if specified in the user documentation
- D spacing between enclosures, which should be $\geq 0,1$ m
- E peripheral or auxiliary device, see 6.4.1.3.4
- F earthing of the motor, see 6.4.1.3.5
- K boundary of maximum test volume for small size equipment as defined in 3.6.4
- L measuring distance
- RP reference point of the antenna calibration

Figure 9 – Example for a typical test set up for measurement of conducted and/or radiated disturbances from a floor-standing PDS, 3D view

6.4.1.4 Radiated emissions of an MT

The general arrangement for testing radiated emissions from an MT is shown in Figure 10.