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STANDARDS
Australia



Adjustable speed electrical power drive systems

Part 1: General requirements — Rating specifications for low voltage adjustable speed DC power drive systems



AS IEC 61800.1:2024

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- Bureau of Steel Manufacturers of Australia
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- Energy Networks Australia
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- The University of Newcastle

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Part 1: General requirements — Rating specifications for low voltage adjustable speed DC power drive systems

Originated as AS 61800.1—2007.
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Preface

This Standard was prepared by the Standards Australia Committee EL-027, Power Electronics, to supersede AS 61800.1—2007.

The objective of this document is to specify requirements for adjustable speed electric DC power drive systems, which include semiconductor power conversion and the means for their control, protection, monitoring, measurement and the DC motors.

It applies to adjustable speed electric power drive systems intended to feed DC motors from a BDM/CDM connected to line-to-line voltages up to and including 1 kV AC 50 Hz or 60 Hz and/or voltages up to and including 1.5 kV DC input side.

NOTE 1 Adjustable speed electric AC power drive systems intended to feed AC motors are covered by AS IEC 61800.2:2024.

NOTE 2 This document can be used as a reference for adjustable speed electric power drive systems, intended to feed DC motors from a BDM/CDM connected to line-to-line voltages up to and including 1.5 kV AC, 50 Hz or 60 Hz and/or voltages up to and including 2.25 kV DC input side.

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- (b) A full point substitutes for a comma when referring to a decimal marker.

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FOREWORD

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International Standard IEC 61800-1 has been prepared by subcommittee 22G: Adjustable speed electric power drive systems (PDS), of IEC technical committee 22: Power electronic systems and equipment.

This second edition cancels and replaces the first edition published in 1997. This edition constitutes a technical revision.

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

- a) the clause structure has been harmonized with IEC 61800-2;
- b) [Clause 2](#) has been updated;

- c) [Clause 3](#) has been updated including fundamental definitions to be used across IEC 61800 (all parts);
- d) [Clause 4](#) has been updated with respect to:
 - 1) description of the basic topology for *BDM/CDM/PDS* ([4.2](#));
 - 2) ratings and performance ([4.3](#) and [4.4](#));
 - 3) reference to applicable standards within the IEC 61800 series with respect to EMC (IEC 61800-3), general safety (IEC 61800-5-1), functional safety (IEC 61800-5-2), load duty aspects (IEC TR 61800-6), communication profiles (IEC 61800-7 series), *power interface* voltage (IEC TS 61800-8), and ecodesign energy efficiency standards (IEC 61800-9) to avoid conflicting requirements ([4.5](#), [4.6](#), [4.7](#), [4.10](#), [4.11](#), [4.12](#));
 - 4) update of requirement for ecodesign ([4.8](#));
 - 5) update of requirement for environmental evaluation ([4.9](#));
 - 6) implementation of requirement for explosive atmosphere ([4.13](#));
- e) [Clause 5](#) has been updated with test requirement in order to provide a clear link between design requirement and test requirement;
- f) [Clause 6](#) has been updated to harmonize the marking and documentation requirement within IEC 61800 (all parts);
- g) the Annexes have been updated.

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

FDIS	Report on voting
22G/430/FDIS	22G/433/RVD

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

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

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.

In this document, the terms in *italics* are defined in [Clause 3](#).

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

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

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

INTRODUCTION

0.1 General

This document is part of the IEC 61800 series specifying requirements for adjustable *speed* electrical *power drive systems* (PDSs). Since the publication of the first edition of IEC 61800–1, several documents of the IEC 61800 series have been developed and maintained, which has resulted in outdated references and conflicting requirements across the IEC 61800 series.

This document contains general requirements for PDSs intended to feed DC *motors* and with rated *converter* input voltages (line-to-line voltage) up to and including 1 000 V AC.

0.2 Consistency of requirement

This document specifies requirements for PDSs under its scope for the identified topics not covered by any other of the standards in the IEC 61800 series.

The following requirements are covered by other standards in the IEC 61800 series:

- AC PDS requirements are covered by IEC 61800–2;
- EMC requirements are covered by IEC 61800–3;
- general safety requirements are covered by IEC 61800–5–1;
- functional safety requirements are covered by IEC 61800–5–2;
- type of load duty guidance is covered by IEC TR 61800–6;
- interface and use profiles requirements are covered by IEC 61800–7 (all parts);
- *power interface* voltage specification is covered by IEC TS 61800–8;
- ecodesign energy *efficiency* requirements of drive system are covered by IEC 61800–9 (all parts).

NOTE IEC 61800–9 series only provides requirements for AC PDS. Requirements for the Energy *Efficiency* classification, the set of power losses limits and measurement methods from IEC 61800–9–2 cannot be directly applicable to DC PDS. The Extended product approach (EPA) and Semi analytic Model (SMA) from IEC 61800–9–1 are in principle applicable to DC PDS.

Generally, this document provides a basic description of topics and refers to the relevant standard for specific requirement. This is done in order to ensure consistency and avoid conflicting requirement within IEC 61800 (all parts) as well as minimize future maintenance of the documents.

As a result of the development of the IEC 61800 series of standards, the need to reference documents outside the series has decreased.

0.3 Tool for agreement between customer and manufacturer

This document is intended to be used to create a comprehensive list of requirements to be used as a specification between *customer* and *manufacturer*. The requirement in this document is in itself not applicable for the *BDM/CDM/PDS*. Instead, each topic should be specified by the *customer* as a compliance requirement.

The document may be useful as a specification tool, when *BDM/CDM/PDSs* are built into a final *installation* or application applied as a component. The following applications are considered relevant: lift and hoist, machinery, conveyor, industrial switchgears applications, heating and ventilation, pump, excitation systems, tidal and marine applications.

In every application, an identification of the environmental conditions under which the product is stored, transported and operated is essential for the proper specification of the *BDM/CDM/PDSs*. The environmental conditions considered should include electrical, mechanical, thermal, pollution, explosive environmental conditions and humidity environmental condition.

NOTES

Australian Standard®

Adjustable speed electrical power drive systems

Part 1: General requirements — Rating specifications for low voltage adjustable speed DC power drive systems

1 Scope

This part of IEC 61800 applies to adjustable *speed* electric *DC power drive systems*, which include semiconductor power conversion and the means for their control, protection, monitoring, measurement and the *DC motors*.

It applies to adjustable *speed* electric *power drive systems* intended to feed *DC motors* from a *BDM/CDM* connected to line-to-line voltages up to and including 1 kV AC 50 Hz or 60 Hz and/or voltages up to and including 1,5 kV DC input side.

NOTE 1 Adjustable *speed* electric AC *power drive systems* intended to feed AC *motors* are covered by IEC 61800-2.

NOTE 2 This document can be used as a reference for adjustable speed electric *power drive systems*, intended to feed *DC motors* from a *BDM/CDM* connected to line-to-line voltages up to and including 1,5 kV AC, 50 Hz or 60 Hz and/or voltages up to and including 2,25 kV DC input side.

Traction applications and electric vehicles are excluded from the scope of this document.

This document is intended to define the following aspects of a *DC power drive system (PDS)*:

- principal parts of the *PDS*;
- ratings and performance;
- specifications for the environment in which the *PDS* is intended to be installed and operated;
- other specifications which might be applicable when specifying a complete *PDS*.

This document provides minimum requirements, which may be used for the development of a specification between *customer* and *manufacturer*.

Compliance with this document is possible only when each topic of this document is individually specified by the *customer* developing specifications or by product standard committees developing product standards.

For some aspects which are covered by specific *PDS* product standards in the IEC 61800 series, this document provides a short introduction and reference to detailed requirements in these product standards.

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 60034 (all parts), *Rotating electrical machines*

IEC 60034-1:2017, *Rotating electrical machines – Part 1: Rating and performance*

IEC 60034-9, *Rotating electrical machines – Part 9: Noise limits*

IEC TS 60034-25, *Rotating electrical machines – Part 25: AC electrical machines used in power drive systems – Application guide*

IEC 60038, *IEC standard voltages*

IEC 60068 (all parts), *Environmental testing*

IEC 60068-2-27:2008, *Environmental testing – Part 2-27: Tests – Test Ea and guidance: Shock*

IEC 60076 (all parts), *Power transformers*

IEC 60076-1, *Power transformers – Part 1: General*

IEC 60076-6, *Power transformers – Part 6: Reactors*

IEC 60079 (all parts), *Explosive atmospheres*

IEC TS 60079-42, *Explosive atmospheres – Part 42: Electrical safety devices for the control of potential ignition sources for Ex-Equipment*

IEC 60146-1-1:2009, *Semiconductor converters – General requirement and line commutated converters – Part 1-1: Specification of basic requirements*

IEC 60364 (all parts), *Low voltage electrical installations*

IEC 60664-1, *Insulation coordination for equipment within low-voltage supply systems – Part 1: Principles, requirements and tests*

IEC 60721-2-6, *Classification of environmental conditions – Part 2: Environmental conditions appearing in nature – Earthquake vibration and shock*

IEC 60721-3-1:1997, *Classification of environmental conditions – Part 3: Classification of groups of environmental parameters and their severities – [Section 1](#): Storage*

IEC 60721-3-2:1997, *Classification of environmental conditions – Part 3: Classification of groups of environmental parameters and their severities – [Section 2](#): Transportation*

IEC 60721-3-3:1994, *Classification of environmental conditions – Part 3: Classification of groups of environmental parameters and their severities – [Section 3](#): Stationary use at weatherprotected locations*

IEC 60721-3-3:1994/AMD1:1995

IEC 60721-3-3:1994/AMD2:1996

IEC 60721-3-4:1995, *Classification of environmental conditions – Part 3-4: Classification of groups of environmental parameters and their severities – Stationary use at non-weatherprotected locations*

IEC 60721-3-4:1995/AMD1:1996

IEC 61158 (all parts), *Industrial communication networks – Fieldbus specifications*

IEC 61378 (all parts), *Converter transformers*

IEC 61800-2, *Adjustable speed electrical power drive systems – Part 2: General requirements – Rating specifications for low voltage adjustable speed a.c. power drive systems*

IEC 61800-3, *Adjustable speed electrical power drive systems – Part 3: EMC requirements and specific test methods*

IEC 61800-5-1, *Adjustable speed electrical power drive systems – Part 5-1: Safety requirements – Electrical, thermal and energy*

IEC 61800-5-2, *Adjustable speed electrical power drive systems – Part 5-2: Safety requirements – Functional*

IEC TR 61800-6, *Adjustable speed electrical power drive systems – Part 6: Guide for determination of types of load duty and corresponding current ratings*

IEC 61800–7 (all parts), *Adjustable speed electrical power drive systems – Part 7: Generic interface and use of profiles for power drive systems*

IEC TS 61800–8, *Adjustable speed electrical power drive systems – Part 8: Specification of voltage on the power interface*

IEC TS 62578, *Power electronics systems and equipment – Operation conditions and characteristics of active infeed converter (AIC) applications including design recommendations for their emission values below 150 kHz*

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:

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

3.1 System elements

[Table 1](#) lists the system elements.

Table 1 — System elements

No.	Terms	Acronym	Symbols	Mark	Unit
3.1.1	power drive system	PDS		b	
3.1.2	DC power drive system	DC PDS		b	
3.1.3	basic drive module	BDM		b	
3.1.4	complete drive module	CDM		b	
3.1.5	installation			a	
3.1.6	integrated PDS			b	
3.1.7	customer <BDM/CDM/PDS>			a	
3.1.8	<i>manufacturer</i> <BDM/CDM/PDS>			a	
3.1.9	end user			a	
3.1.10	system integrator			a	
3.1.11	original equipment <i>manufacturer</i>	OEM			
3.1.12	product packaging				
3.1.13	shipping packaging				
3.1.14	efficiency <CDM>			b	
3.1.15	efficiency <PDS>			b	
a Definitions used in several standards of the IEC 61800 series.					
b Fundamental definition across IEC 61800 (all parts).					

3.1.1

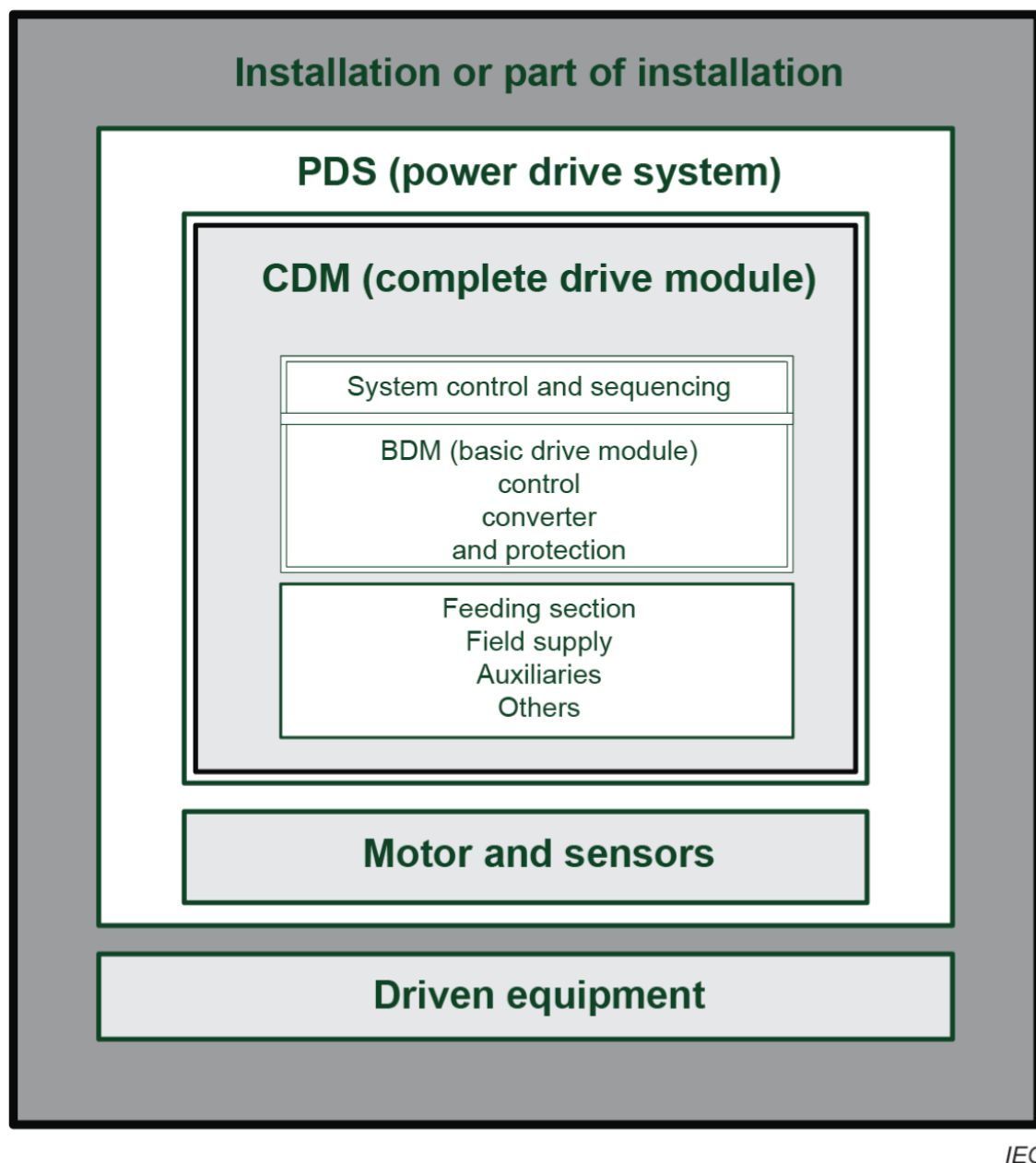
power drive system

PDS

system consisting of one or more *complete drive module(s)* (CDM) and a *motor* or *motors*, any sensors which are mechanically coupled to the *motor* shaft are also part of the *PDS*, however the driven equipment is not included

See [Figure 2](#).

Note 1 to entry: This note applies to the French language only.



IEC

Figure 1 — PDS hardware configuration within an *installation*

3.1.2

DC power drive system

DC PDS

system consisting of power equipment and control equipment

See [Figure 2](#).

Note 1 to entry: The power equipment is composed of the *converter* section, the *DC motor* and other equipment such as, but not limited to, the feeding section or the field supply; the control equipment is composed of the switching control – on/off for example –, the speed control, the current control, the firing system, the field control, the protection, the status monitoring, the communication, the tests, the diagnostics, the process interface/port, etc.

Note 2 to entry: This note applies to the French language only.

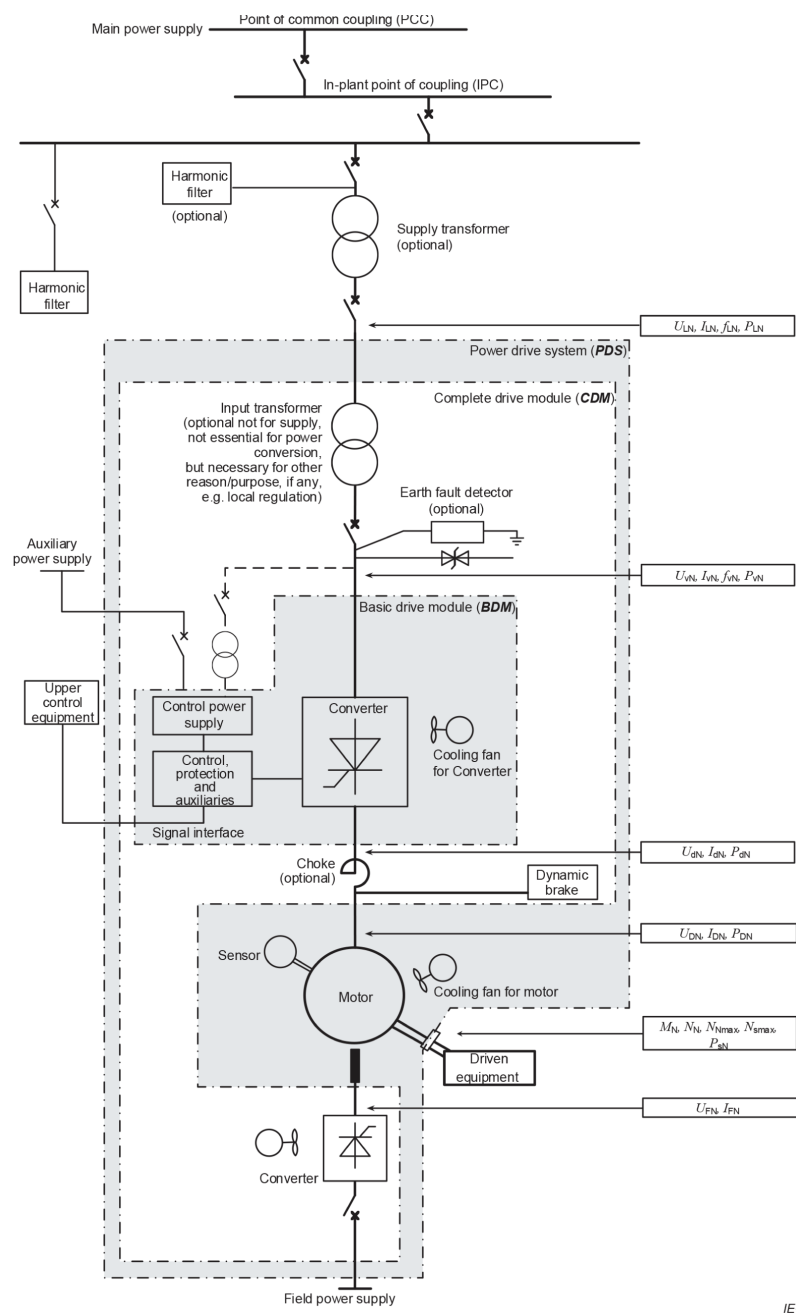


Figure 2 — Example of function diagram of a DC power drive system

3.1.3 basic drive module BDM

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

See [Figure 2](#).

Note 1 to entry: The *BDM* is capable of transmitting power from the electric supply to the *motor* and may be capable of transmitting 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, including current, voltage, speed, torque.

Note 3 to entry: This note applies to the French language only.

3.1.4 complete drive module CDM

drive module consisting of, but not limited to, the *BDM* and extensions such as field *converter*, protection devices, transformers and auxiliaries, but excluding the *motor* and the sensors which are mechanically coupled to the *motor* shaft

See [Figure 2](#).

Note 1 to entry: This note applies to the French language only.

3.1.5 installation

one apparatus or a set of devices and/or apparatuses associated in a given location to fulfil specified purposes, including all means for their satisfactory operation

See [Figure 1](#).

Note 1 to entry: The words "act of installing" are used in this document to denote the process of installing a *PDS*.

[SOURCE: IEC 60050–151:2001, 151.11.26, modified – The note to entry has been added]

3.1.6 integrated PDS

power drive system where *motor* and *BDM/CDM* are combined into a single unit

3.1.7 customer

⟨*BDM/CDM/PDS*⟩ *original equipment manufacturer (OEM)*, *system integrator* or *end user* specifying and purchasing a *BDM/CDM/PDS* from the *BDM/CDM/PDS manufacturer*

See [Figure 3](#).

3.1.8 manufacturer

⟨*BDM/CDM/PDS*⟩ entity which designs and builds all or part of a *BDM/CDM/PDS*

SEE [Figure 3](#).

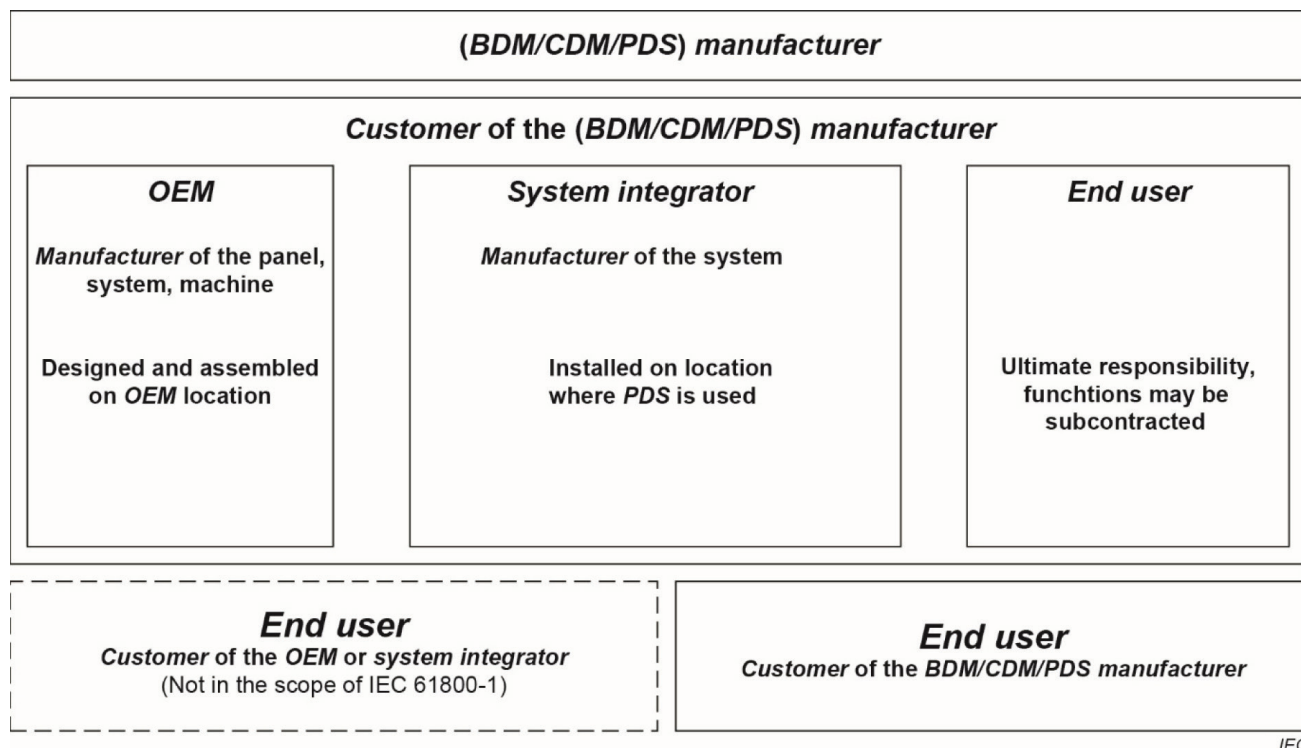


Figure 3 — BDM/CDM/PDS manufacturer/customer relationship

3.1.9

end user

entity who has ultimate responsibility for the installation, operation and maintenance of the PDS

See [Figure 3](#).

3.1.10

system integrator

entity with responsibility to design the complete system of the application incorporating one or more PDSs

See [Figure 3](#).

3.1.11

original equipment manufacturer

OEM

entity which designs and manufactures series of machines, panels or systems incorporating one or more PDSs

See [Figure 3](#).

Note 1 to entry: This note applies to the French language only.

3.1.12

product packaging

temporary protection of the BDM/CDM/PDS or part of it during storage and known in-house transport route

3.1.13**shipping packaging**

temporary protection to prevent damage during worldwide air, sea and land transportation

Note 1 to entry: *Shipping packaging* can be realized as product specific transport packaging or as a *product packaging* with additional transport packaging.

3.1.14**efficiency**

(CDM) ratio of the total electrical power at the *CDM power interface* at the *motor* terminals to the total electrical power at the *mains supply port*

Note 1 to entry: Power at the *motor* terminals includes armature, field, and auxiliaries (*motor* ventilation fan, etc.).

3.1.15**efficiency**

(PDS) ratio of the mechanical power at the *motor* shaft to the total electrical power at the *mains supply port*

Note 1 to entry: *Efficiency* is usually expressed as a percentage.

3.2 Converters and circuit elements (see [Table 2](#))**Table 2 — Converters and circuits elements**

No.	Terms	Acronym	Symbols	Mark	Unit
3.2.1	active infeed converter	AIC		a	
3.2.2	converter <BDM>			b	
3.2.3	rectifier <BDM>			a	
3.2.4	DC link			b	
3.2.5	power interface			a	
3.2.6	power port			a	
3.2.7	mains supply				
a Definitions used in several standards of the IEC 61800 series.					
b Fundamental definition across IEC 61800 (all parts).					

3.2.1**active infeed converter****AIC**

self-commutated electronic power *converter* which can convert electric power in both directions and which can control the reactive power or the *power factor*

Note 1 to entry: An active infeed converter can be of any technology, topology, voltage and size containing either current or voltage source DC side which work in generation and regeneration.

Note 2 to entry: Some of them can additionally control the harmonics to reduce the distortion of an applied voltage or current.

Note 3 to entry: Basic topologies may be realized as a Voltage Source *Converter* (VSC) or a Current Source *Converter* (CSC).

Note 4 to entry: In IEC 60050, these terms (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 5 to entry: In some literature *active infeed converters* are also known as active front end (AFE) converters.

[SOURCE: IEC TS 62578:2015, 3.5, modified – Some words in the definition have been moved to Note 1 to entry.]

3.2.2

converter

(BDM) unit which changes the form of electrical power supplied by the *mains supply* to the form required by the *motor(s)* by changing one or more of the following: voltage, current

(BDM) See [Figure 3](#).

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 or self-commutated and can consist for example of one or more *rectifiers*.

3.2.3

rectifier

(BDM) electric energy *converter* that changes single-phase or polyphase alternating electric currents to unidirectional current

[SOURCE: IEC 60050–151:2001, 151-13-45]

3.2.4

DC link

power DC circuit linking the input *converter* and the output *converter* of an indirect *converter*, consisting of capacitors and/or reactors to reduce DC voltage *ripple* or DC current *ripple*

3.2.5

power interface

connections needed for the distribution of electrical power within the *PDS*

3.2.6

power port

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

3.2.7

mains supply

low or high-voltage power distribution *system* for supplying power to a *BDM/CDM/PDS*

3.3 Drive system operating characteristics (see [Table 3](#))

Table 3 — Drive system operating characteristics

No.	Terms	Acronym	Symbols	Mark	Unit
3.3.1	one quadrant operation			b	
3.3.2	two quadrant operation			b	
3.3.3	four quadrant operation			b	
3.3.4	dynamic braking			a	
3.3.5	regeneration			b	
3.3.6	rectifying – rectification				
3.3.7	inverting – inversion				
a Definitions used in several standards of the IEC 61800 series.					
b Fundamental definition across IEC 61800 (all parts).					

3.3.1

one quadrant operation

converter operation of a machine as a *motor* in one direction of machine rotation

See [Figure 4](#).

3.3.2

two quadrant operation

converter operation of a machine as a *motor* in one direction or a generator in another direction of machine rotation; it involves operation in quadrants I and II or quadrants I and IV

See [Figure 4](#).

3.3.3

four quadrant operation

converter operation of a machine as a *motor* or a generator in either direction of machine rotation

See [Figure 4](#).

Note 1 to entry: *Four quadrant operation* involves operation in quadrants I, II, III and IV as shown in [Figure 4](#).

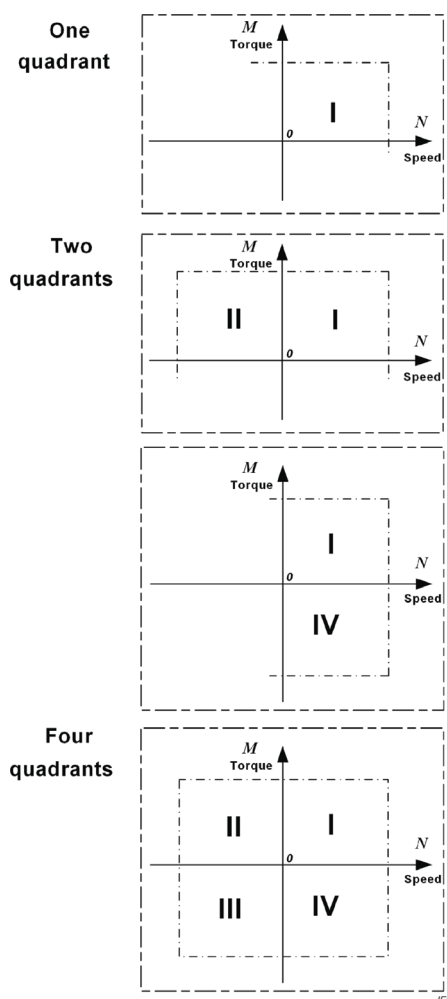


Figure 4 — Operating quadrants

3.3.4

dynamic braking

method used to transfer energy generated when the load controlled by a PDS is slowed or stopped

Note 1 to entry: *Dynamic braking* includes resistive braking, regenerative braking, etc.

3.3.5

regeneration

process of converting the mechanical energy at the *motor* shaft of the *PDS* to electrical energy

3.3.6 rectifying rectification

process of converting from AC to DC

Note 1 to entry: For the purpose of this document, the line-side *converter* normally operates as a *rectifier*.

3.3.7 inverting inversion

process of converting from DC to AC

3.4 Input ratings of BDM/CDM/PDS (see Table 4)

Table 4 — Input ratings of BDM/CDM/PDS

No.	Terms	Acronym	Symbols	Mark	Unit
3.4.1	power factor		λ	^a	
3.4.2	short circuit ratio		R_{SC}		
3.4.3	total harmonic distortion	<i>THD</i>		^a	
3.4.4	input active power <BDM>		P_v		W,kW
3.4.5	rated input active power <BDM>		P_{vN}		W,kW
3.4.6	input active power <CDM/PDS>		P_L		W,kW
3.4.7	rated input active power <CDM/PDS>		P_{LN}		W,kW
3.4.8	input apparent power <BDM>		S_v		VA,kVA
3.4.9	rated input apparent power <BDM>		S_{vN}		VA,kVA
3.4.10	input apparent power <CDM/PDS>		S_L		VA,kVA
3.4.11	rated input apparent power <CDM/PDS>		S_{LN}		VA,kVA
3.4.12	input current <BDM>		I_v, I_{dc}		A
3.4.13	rated input current <BDM>		I_{vN}, I_{dcN}		A
3.4.14	input current <CDM/PDS>		I_L, I_{dc}		A
3.4.15	rated input current <CDM/PDS>		I_{LN}, I_{dcN}		A
3.4.16	DC current		I_{DC}		A
3.4.17	input frequency <BDM>		f_v		Hz
3.4.18	rated input frequency <BDM>		f_{vN}		Hz
3.4.19	input frequency <CDM/PDS>		f_L		Hz
3.4.20	rated input frequency <CDM/PDS>		f_{LN}		Hz
3.4.21	input voltage <BDM>		U_v, U_{DC}		V
3.4.22	rated input voltage <BDM>		U_{vN}, U_{DCN}		V
3.4.23	input voltage <CDM/PDS>		U_L, U_{DC1}		V
3.4.24	rated input voltage <CDM/PDS>		U_{LN}, U_{DC1N}		V

NOTE Subscripts follow the concept of IEC 60146-1-1.

^a Definitions used in several standards of the IEC 61800 series.

^b Fundamental definition across IEC 61800 (all parts).

3.4.1**power factor** λ

under periodic conditions, ratio of the absolute value of the active power P to the apparent power S

$$\lambda = \frac{|P|}{S}$$

[SOURCE: IEC 60050–131:2002, 131-11-46, modified — The note to entry has been deleted.]

3.4.2**short circuit ratio** R_{sc}

ratio of the short-circuit power of the source at the point of common coupling (PCC) to the *rated apparent power* of the *BDM/CDM/PDS*

3.4.3**total harmonic distortion****THD**

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

[SOURCE: IEC 60050–551-20:2001, 551-20-13, modified – The definition has been rephrased and the notes to entry removed.]

3.4.4**input active power** P_v

⟨BDM⟩ power determined by the fundamental components of voltage and current at the supply terminals of the *BDM*

3.4.5**rated input active power** P_{vN}

⟨BDM⟩ rated power determined by the fundamental components of voltage and current at the supply terminals of the *BDM*

3.4.6**input active power** P_L

⟨CDM/PDS⟩ power determined by the fundamental components of voltage and current at the supply terminals of the *CDM/PDS*

3.4.7**rated input active power** P_{LN}

⟨CDM/PDS⟩ rated power determined by the fundamental components of voltage and current at the supply terminals of the *CDM/PDS*

3.4.8**input apparent power** S_v

⟨BDM⟩ power determined by the RMS values of voltage and current at the supply terminals of the *BDM*

3.4.9**rated input apparent power** S_{vN}

⟨BDM⟩ rated power determined by the RMS values of voltage and current at the supply terminals of the *BDM*

3.4.10**input apparent power** S_L

(CDM/PDS) power determined by the RMS values of voltage and current at the supply terminals of CDM/PDS

3.4.11**rated input apparent power** S_{LN}

(CDM/PDS) rated power determined by the RMS values of voltage and current at the supply terminals of the CDM/PDS

3.4.12**input current** I_v, I_{vdc}

(BDM) RMS value of AC current or average value of DC current at the supply terminals of the BDM

3.4.13**rated input current** I_{vN}, I_{vdcN}

(BDM) maximum RMS value of AC current or maximum average value of DC current at the supply terminals of the BDM under rated conditions

Note 1 to entry: It takes into account rated load and the most onerous combination of all other conditions within their specified ranges, e.g. line voltage and frequency deviations.

3.4.14**input current** I_L, I_{LDC}

(CDM/PDS) RMS value of AC current or average value of DC current at the supply terminals of the CDM/PDS

3.4.15**rated input current** I_{LN}, I_{LDCN}

(CDM/PDS) maximum RMS value of AC current or maximum average value of DC current at the supply terminals of the CDM/PDS under rated conditions

Note 1 to entry: It takes into account rated load and the most onerous combination of all other conditions within their specified ranges, e.g. line voltage and frequency deviations.

3.4.16**DC current** I_{dc}

value of the DC input current or average value of the current in the DC link over one full period of the input power system frequency

Note 1 to entry: DC current I_{dc} can also indicate the current of the intermediate DC link in the case of an indirect converter using a chopper.

3.4.17**input frequency** f_v

(BDM) frequency of the power input to the BDM

3.4.18**rated input frequency** f_{vN}

(BDM) rated value of the frequency at the AC supply terminals of the BDM

3.4.19**input frequency** f_L

⟨CDM/PDS⟩ frequency of the power input to the *CDM/PDS*

3.4.20**rated input frequency** f_{LN}

⟨CDM/PDS⟩ rated value of the frequency at the AC supply terminals of the *CDM/PDS*

3.4.21**input voltage** U_v, U_{vdc}

⟨BDM⟩ RMS value of input AC line-to-line voltage or average value of DC voltage at the supply terminals of the *BDM*

3.4.22**rated input voltage** U_{vN}, U_{vdcN}

⟨BDM⟩ RMS value of the rated input AC line-to-line voltage or average value of the rated DC voltage at the supply terminals of the *BDM*

3.4.23**input voltage** U_L, U_{LDC}

⟨CDM/PDS⟩ RMS value of input AC line-to-line voltage or average value of DC voltage at the supply terminals of the *CDM/PDS*

3.4.24**rated input voltage** U_{LN}, U_{LDCN}

⟨CDM/PDS⟩ RMS value of the rated input AC line-to-line voltage or average value of the rated DC voltage at the supply terminals of the *CDM/PDS*

3.5 Output ratings of BDM/CDM (see Table 5)

Table 5 — Output ratings of *BDM/CDM*

No.	Terms	Acronym	Symbols	mark	unit
3.5.1	output current <BDM>		I_d		A
3.5.2	rated output current <BDM>		I_{dN}		A
3.5.3	output current <CDM>		I_D		A
3.5.4	rated output current <CDM>		I_{DN}		A
3.5.5	output voltage <BDM>		U_d		V
3.5.6	rated output voltage <BDM>		U_{dN}		V
3.5.7	output voltage <CDM>		U_D		V
3.5.8	rated output voltage <CDM>		U_{DN}		V
3.5.9	ripple <voltage>		U_{pp}		V
3.5.10	ripple <current>		I_{pp}		A
3.5.11	rated output power <BDM>		P_{dN}		W, kW
3.5.12	rated output power <CDM>		P_{DN}		W, kW
3.5.13	output overload capability <BDM/CDM>		I_{dM}		A
3.5.14	rated field supply voltage		U_{FN}		V
3.5.15	rated field current		I_{FN}		A

NOTE Subscripts follows the concept of IEC 60146-1-1.

3.5.1 output current

I_d

<BDM> average value of the current at the output terminals of the *BDM*

3.5.2 rated output current

I_{dN}

<BDM> average *output current* at the *motor* side of the *BDM* which can be supplied continuously without exceeding established limits, under prescribed operating condition

3.5.3 output current

I_D

<CDM> average value of the current at the *motor* side of the *CDM*

3.5.4 rated output current

I_{DN}

<CDM> average *output current* at the *motor* side of the *BDM* which can be supplied continuously without exceeding established limits, under prescribed operating conditions

3.5.5 output voltage

U_d

<BDM> average value of the voltage at the output terminals of the *BDM*

3.5.6 rated output voltage

U_{dN}
(BDM) average *output voltage* which can be supplied continuously without exceeding established limits, under prescribed operating condition

Note 1 to entry: This value is the available average value of the DC voltage under usual service conditions.

3.5.7 output voltage

U_D
(CDM) average value of the voltage at the *motor* side of the CDM

3.5.8 rated output voltage

U_{DN}
(CDM) average *output voltage* which can be supplied continuously without exceeding established limits, under prescribed operating condition

Note 1 to entry: This value is the available average value of the DC voltage under usual service conditions.

3.5.9 ripple

U_{pp}
(voltage) periodic AC voltage superimposed on steady direct voltage, usually expressed as peak-to-peak value

3.5.10 ripple

I_{pp}
(current) periodic AC current superimposed on steady direct current, usually expressed as peak-to-peak value

Note 1 to entry: If the *ripple* content of the current is given as peak-to-peak value in amperes measured or calculated at rated voltage of the *motor*, then the symbol is I_{ppN} .

3.5.11 rated output power

P_{dN}
(BDM) rated power determined by the average voltage and current at the motor side of the BDM

3.5.12 rated output power

P_{DN}
(CDM) rated power determined by the average voltage and current at the motor side of the CDM

3.5.13 output overload capability

maximum *output current* which can be supplied, for a specified period of time, without exceeding established limitations under prescribed operating conditions

3.5.14 rated field supply voltage

U_{FN}
rated average voltage of the motor field load to be connected to the field *converter*

3.5.15 rated field current

I_{FN}
(motor) value of the field current presented by the *motor manufacturer*, which is the excitation current the *motor* can operate at *rated speed* at *rated armature voltage* and *rated armature current*

3.6 Motor ratings (see [Table 6](#))

Table 6 — *Motor ratings*

No.	Terms	Acronym	Symbols	Mark	Unit
3.6.1	motor <electric>			^a	
3.6.2	DC motor				
3.6.3	speed <motor>		N		r/min (Note 1)
3.6.4	base speed		N_0		r/min (Note 1)
3.6.5	rated speed <motor>		N_N		r/min (Note 1)
3.6.6	maximum rated speed <motor>		N_{NMax}		r/min (Note 1)
3.6.7	maximum safe motor speed		N_{SMax}		r/min (Note 1)
3.6.8	torque <motor>		M		Nm
3.6.9	rated torque <motor>		M_N		Nm
3.6.10	output power <PDS>		P_s		kW
3.6.11	rated output power <PDS>		P_{sN}		kW
3.6.12	rated armature voltage		U_{AN}		V
3.6.13	rated armature current		I_{AN}		A
3.6.14	rated field current		I_{FR}		A
3.6.15	maximum rated safe speed <motor>		N_{SNMax}		r/min (Note 1)
NOTE 1 See also Figure 8 .					
NOTE 2 Subscripts follows the concept of IEC 60146-1-1.					
^a Definitions used in several standards of the IEC 61800 series.					

3.6.1

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.]

3.6.2

DC motor

motor where the rotor is supplied with *DC current* via a brushed collector

Note 1 to entry: *DC motors* are typically equipped with separate field (see [Figure 2](#)). This type of *motor* can be compensated or not. The purpose of compensation is to minimize the armature reaction and increase the *motor* commutating ability.

Note 2 to entry: Other types of *motors* are: permanent magnet *motor*, series field, combinations (shunt and series).

3.6.3

speed

N

<motor> rotational velocity of the *motor*

3.6.4

base speed

N_0

<motor> *speed* obtained with *rated armature voltage*, with rated field current, which is usually the breakpoint *speed* between constant torque and constant power operation

3.6.5 rated speed

N_N
<motor> maximum *speed*, at which the *motor* is able to continuously deliver *rated torque* at *rated armature voltage* and *rated armature current*

3.6.6 maximum rated speed

N_{NMax}
<motor> maximum *speed* specified by the *PDS manufacturer*

Note 1 to entry: This might include operation in the field weakening mode, at a *speed* higher than the *rated speed*, but with torque lower than *rated torque* (constant power region).

Note 2 to entry: When operating a *motor* at speeds above *rated speed*, the mechanical stress increases and the expected lifetime of the bearings may be reduced. Fine balance of the *motor* as well as service of the *motor* should be considered. See also IEC 60034-1.

Note 3 to entry: See also [Figure 8](#).

3.6.7 maximum safe motor speed

N_{SMax}
maximum designed *speed* of the *motor* under which no permanent abnormal mechanical deformation or weakness is introduced

Note 1 to entry: See IEC 60034-1.

Note 2 to entry: The maximum safe *speed* of the driven equipment may be more restrictive.

Note 3 to entry: This *speed* is not the safety function SSM or SLS as defined by IEC 61800-5-2.

3.6.8 torque

M
<motor> twisting moment of force with respect to the longitudinal axis of the *motor* shaft

3.6.9 rated torque

M_N
<motor> torque the *motor* develops at its shaft end at *rated output power* and *speed*

[SOURCE: IEC 60050-411:1996, 411-48-05, modified – The word "power" has been added to the definition.]

3.6.10 output power

P_s
<PDS> (mechanical) power of the *PDS* determined by the torque and *speed* at the motor shaft

3.6.11 rated output power

P_{sN}
<PDS> rated (mechanical) power of the *PDS* determined by the torque and *speed* at the motor shaft

3.6.12 rated armature voltage

U_{AN}
<motor> value of the armature voltage presented by the *motor manufacturer*, which is the maximum armature voltage the *motor* can operate continuously at rated conditions

3.6.13 rated armature current

I_{AN}

(motor) value of the armature current presented by the *motor manufacturer*, which is the maximum armature current the *motor* can operate continuously at rated conditions

3.6.14 rated field current

I_{FN}

(motor) value of the field current presented by the *motor manufacturer*, which is the excitation current the *motor* can operate at *rated speed* at *rated armature voltage* and *rated armature current*

3.6.15 maximum rated safe speed

N_{SNMax}

(motor) maximum *speed*, at which the *motor* may be operated continuously

Note 1 to entry: Operation above the *maximum rated safe speed* could lead to a hazard.

3.7 Control systems (see [Table 7](#))

Table 7 — Control system and variables

No.	Terms	Acronym	Symbols	Mark	Unit
3.7.1	controlled variable				
3.7.2	service variable				
3.7.3	operating variable				
3.7.4	stimulus				
3.7.5	torque pulsation				
3.7.6	port				
3.7.7	port for process measurement and control				
3.7.8	signal interface				

3.7.1 controlled variable

system variable in the feedback control of adjustable DC drives

Note 1 to entry: Some examples of controlled variables are speed, armature voltage, armature and field current.

3.7.2 service variable

specified variable, usually related to ambient conditions (e.g. temperature), for which the feedback control system is to correct in attempting to maintain the ideal value of the controlled variable

3.7.3 operating variable

specified variable (e.g. load torque for a speed controlled drive) other than those arising from service conditions and drift, for which the feedback control system is to correct in attempting to maintain the ideal value of the controlled variable

3.7.4 stimulus

change, variation or fluctuation of parameter which may cause deviation of performance or behavior of the *PDS*

Note 1 to entry: Examples of stimulus: change of speed reference, load of *PDS*, input voltage or temperature.

3.7.5**torque pulsation**

cyclic fluctuation of a steady-state *motor* torque measured as a peak-to-peak variation

3.7.6**port**

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

[SOURCE: IEC 60050–131:2002, 131-12-60, modified – The note to entry has been deleted.]

3.7.7**port for process measurement and control**

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

3.7.8**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*

3.8 Tests (see [Table 8](#))**Table 8 — Type of tests**

No.	Terms	Acronym	Symbols	Mark	Unit
3.8.1	acceptance test			a	
3.8.2	commissioning test			a	
3.8.3	routine test			a	
3.8.4	sample test			a	
3.8.5	special test			a	
3.8.6	type test			a	
3.8.7	witness test			a	
^a Definitions used in several standards of the IEC 61800 series.					

3.8.1**acceptance test**

contractual test to prove to the *customer* that the device meets certain conditions of its specification

[SOURCE: IEC 60050–151:2001, 151-16-23, modified – The word "item" has been replaced by the word "device".]

3.8.2**commissioning test**

test on a device or equipment carried out on site, to prove the correctness of *installation* and operation

[SOURCE: IEC 60050–151:2001, 151.16.24 and IEC 60050–411:1996, 411.53.06, modified – Both the definitions have been combined here.]

3.8.3**routine test**

test to which each individual device is subjected during or after manufacture to ascertain whether it complies with certain criteria

[SOURCE: IEC 60050–411:1996, 411-53-02, modified – The word "machine" has been replaced by "device".]

3.8.4

sample test

test on a number of devices taken at random from a batch

[SOURCE: IEC 60050-411:1996, 411-53-05, modified — In the term, the word "sampling" has been replaced by "sample". In the definition, the word "machines" has been replaced by "devices".]

3.8.5

special test

test in addition to *type test* and *routine test*, made either at the discretion of the *manufacturer* or according to an agreement between the *manufacturer* and the *customer* or customer representative

3.8.6

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".]

3.8.7

witness test

test performed in the presence of the *customer* or the representative of the *customer*

4 Ratings and specifications for the act of installing, commissioning and operation

4.1 General

[Subclauses 4.3](#) to [4.13](#) provide a list of requirements relevant for the specification of a *BDM/CDM/PDS*. More severe requirements might be specified if considered relevant for the considered application.

A *BDM/CDM/PDS* is typically used for a specific application in a specific environment under specific conditions, in which the product has to operate, be transported or stored. These conditions include, but are not limited to, the electrical, electro-magnetic, mechanical, thermal, and chemical environment as well as requirements on the functionality, general safety and functional safety. These conditions are known by the *customer* or product standard committees using this document as a reference document and will need to be specified.

The *manufacturer* of the *BDM/CDM/PDS* shall specify which requirements of this document apply to its equipment.

In order to ensure consistency and avoid conflicting requirements across IEC 61800 (all parts), some of the subclauses in [4.3](#) to [4.13](#) refer directly to other parts of the IEC 61800 series.

NOTE A visual inspection can be done as a part of the production to ensure the assembly and installing process.

4.2 BDM/CDM/PDS characteristics and topology

4.2.1 General

[Subclauses 4.2.2](#) and [4.2.3](#) are intended to be informative regarding common characteristics and topology for *DC PDS*'s. The information in these clauses shall not be construed as requirements.

4.2.2 BDM/CDM/PDS characteristics

BDM/CDM/PDSs are a type of electronic power conversion equipment, which provide *speed*, *current/torque*, or position control for electric *motors*. Some significant characteristics of *DC PDSs* include the following:

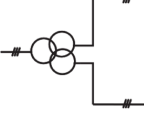
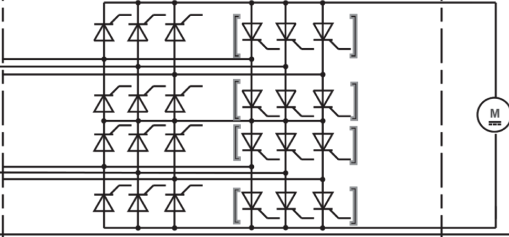
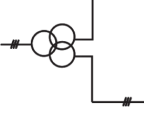
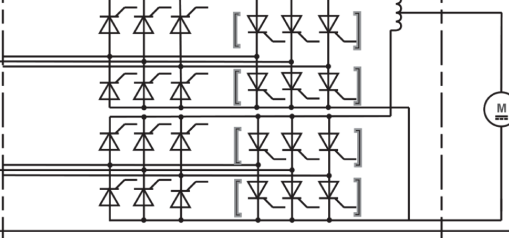
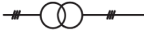
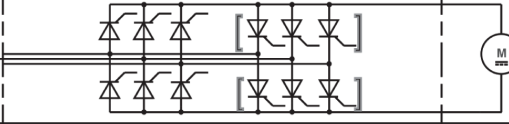
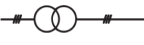
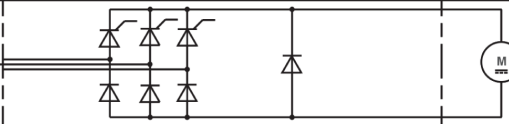
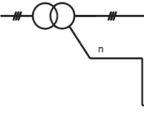
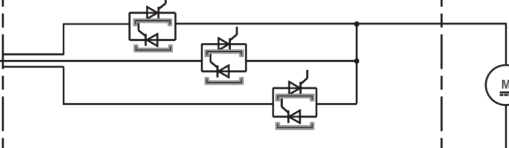
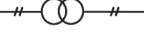
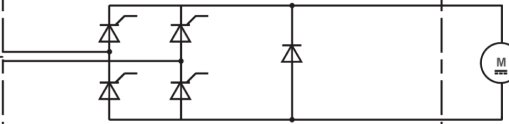
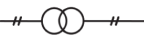
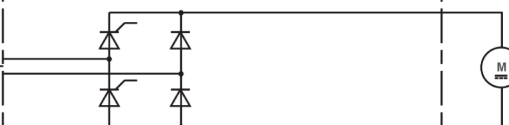
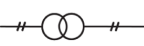
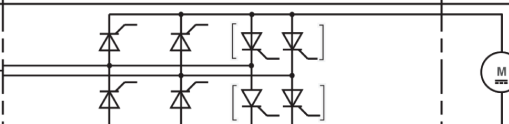
- *BDM/CDM/PD's* are commonly available with *output power* ranging from 0,2 kW to several thousand kW.
- Most industrial *BDM/CDM/PDS's* are designed to be powered from a three phase AC supply.
- Some *BDM/CDM/PDS's* are designed to be powered from single phase AC supply or DC supply.
- *BDM/CDM/PDS's* vary the *speed* of a *DC motor* by controlling the armature voltage and/or field current provided to the *motor*.
- Many *BDM/CDM's* are designed for use with permanent magnet *DC motors*.
- Energy *efficiency* of the typical DC *BDM/CDM* is typically very high. In general, it is beneficial to reduce energy lost in order to minimize size and operating cost.
- Regenerative *PDS's* are designed to operate in two or four quadrants and could return power from the *motor* of the *PDS's* to the feeding line.
- *BDM/CDM's* for use with *DC motors* are available with different control algorithms and speed/torque regulation methods for different applications. Control mode includes:
 - a) From the point of view of parameter under control:
 - i) torque control mode;
 - ii) speed control mode;
 - iii) position control mode.
 - b) From the point of view of control loop property:
 - i) open loop control, without feedback;
 - ii) closed loop control, with indirect (calculated) feedback;
 - iii) closed loop control, with direct (sensor) feedback.

4.2.3 Basic topology for *BDM/CDM/PDS's*

4.2.3.1 General

The commonly-used topologies for *BDM/CDM/PDS's* have two configurations. Main configurations are for line commutated *converters* and the other configurations are for self-commutated *converters* (choppers).

[Figure 5](#) shows eight topologies related to line-commutated *converters*. With these topologies, the *speed* regulation is adjusted by thyristor phase control and the semiconductor devices should be thyristors. [Subclauses 4.2.3.2](#) to [4.2.3.9](#) give the explanation of [Figure 5](#).

Transformer configuration examples	Converter	Motor	Ripple information	
			Number of pulses	Subclauses
 Dd0y11(as example)			12	4. 2. 3. 2
 Dd0y11(as example)			12	4. 2. 3. 3
 Dy11(as example)			6	4. 2. 3. 4
 Dy11(as example)			6	4. 2. 3. 5
 Dyn11(as example)			3	4. 2. 3. 6
			2	4. 2. 3. 7
			2	4. 2. 3. 8
			2	4. 2. 3. 9
NOTE [] Reversal of current direction				

IEC

Figure 5 — Main configurations for line-commutated converters

Figure 6 shows some topologies of self-commutated converters and their operation quadrants. In these topologies, the speed regulation is adjusted by chopping the input voltage and the semiconductor switching devices may be MOSFETs, IGBTs or IGCTs. Subclauses 4.2.3.10 to 4.2.3.12 give the explanation of Figure 6.

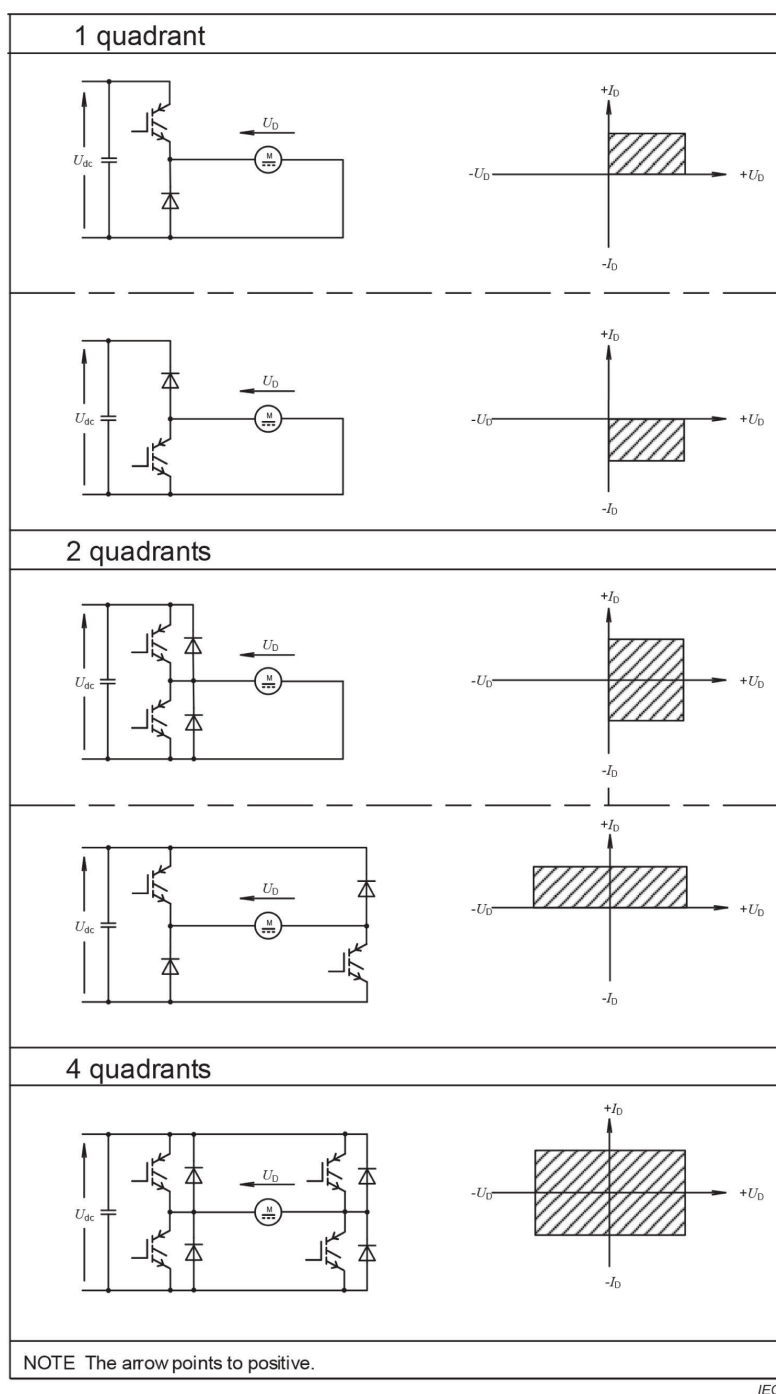


Figure 6 — Basic configurations of self-commutated converters (choppers)

4.2.3.2 12-pulse thyristor rectifier with double three-phase bridges in series

Two three-phase 6-pulse thyristor *rectifier* bridges are fully controlled and connected in series. The *motor speed* is controlled by thyristor phase angle control. This topology allows operation in quadrants I and II. For generator operation, two of additional thyristors bridges are used, which are inverse parallel connected with the original bridges. The inputs of three-phase bridges are connected to the two secondary windings of the three-phase transformer (for example Dd0y11). Double three-phase 12-pulse *rectifiers* greatly reduce the *THD* of *input current* of *input transformer*.

4.2.3.3 12-pulse thyristor rectifier with double three-phase bridges in parallel

Two three-phase 6-pulse thyristor *rectifier* bridges are fully controlled and connected in parallel. The *motor speed* is controlled by thyristor phase angle control. This topology allows operation in quadrants I and II. For generator operation, two of additional thyristor bridges are used, which are inverse parallel connected with the original bridges. The inputs of three-phase bridges are connected to the two secondary windings of the three phase transformer (for example Dd0y11). Double three-phase 12-pulse *rectifiers* greatly reduce the *THD* of *input current* of *input transformer*.

4.2.3.4 Three-phase 6-pulse fully controlled thyristor rectifier

Three-phase 6-pulse fully controlled thyristor *rectifier* is the most commonly used topology. The *motor speed* is regulated by thyristor phase angle control. This topology allows operation in quadrants I and II. For generator operation, an additional thyristor bridge is used, which is inverse parallel connection with the original bridge. The inputs of three-phase bridges are connected to the secondary winding of the three-phase transformer (for example Dy11). Three-phase 6-pulse *rectifier* can cause high *THD* of *input current* of *input transformer*.

4.2.3.5 Three-phase 6-pulse half controlled thyristor/diode rectifier with freewheel diode

The *motor speed* is regulated by thyristor phase angle control. This topology allows operation in quadrant I. The inputs of three-phase bridges are connected to the secondary winding of the three-phase transformer (for example Dy11). Three-phase 6-pulse *rectifier* can cause high *THD* of *input current* of *input transformer*.

4.2.3.6 Three-phase 3-pulse half-wave fully controlled rectifier

The *motor speed* is controlled by thyristor phase angle control. This topology allows operation in quadrant I and II. For generator operation, three additional thyristors are used, which are inverse parallel connection with the original thyristors. The inputs of three-phase half-wave fully controlled *rectifier* are connected to the secondary winding of the three-phase transformer (for example Dyn11) with neutral. A 3-pulse *rectifier* causes higher *THD* of *input transformer*.

4.2.3.7 Single-phase 2-pulse half controlled thyristor/diode rectifier with freewheel diode

The *motor speed* is regulated by thyristor phase angle control. This topology allows operation in quadrant I. The inputs of single-phase bridge are connected to the secondary of a transformer. The *THD* of *input current* of *input transformer* shall not be neglected.

4.2.3.8 Single-phase 2-pulse half controlled thyristor/diode rectifier

The *motor speed* is controlled by thyristor phase angle control. This topology allows operation in quadrant I. The inputs of single-phase bridge are connected to the secondary of a transformer. The *THD* of *input current* of *input transformer* shall not be neglected.

4.2.3.9 Single-phase 2-pulse fully controlled thyristor rectifier bridges

The *motor speed* is controlled by thyristor phase angle control. This topology allows operation in quadrants I and II. For generation, one additional thyristor bridge are used, which are inverse parallel connection with the original bridge. The inputs of single-phase bridge are connected to the secondary of a transformer. The *THD* of *input current* of *input transformer* shall not be neglected.

4.2.3.10 DC/DC converter with one quadrant

In the upper topology of "1 Quadrant" in [Figure 6](#), energy flow is unidirectional from DC power source into the *motor*; the converter operates in quadrant I.

In the lower topology of "1 Quadrant" in [Figure 6](#), energy flow is unidirectional from the *motor* into DC power source, the *converter* operates in quadrant IV.

4.2.3.11 DC/DC converter with two quadrants

In the upper topology of "2 Quadrants" in [Figure 6](#), the *converter* may operate in quadrant I or IV. Energy flow either from DC power source into the *motor* in quadrant I or from the *motor* into DC power source in quadrant IV.

In the lower topology of "2 Quadrants" in [Figure 6](#), the *converter* may operate in quadrant I or II. Energy flow either from DC power source into the *motor* in quadrant I or from the *motor* into DC power source in quadrant II.

4.2.3.12 DC/DC converter with four quadrants

This is the most commonly used topology. In the topology of "4 Quadrants" in [Figure 6](#), the *converter* can operate in four quadrants.

4.3 Ratings

4.3.1 General

The input and output ratings shall be specified by the *manufacturer* according to the requirements in [4.3.2](#) to [4.3.6](#) as shown in [Figure 7](#).

For EMC related items, see IEC 61800-3.

For general safety related items, see IEC 61800-5-1.

For functional safety related items, see IEC 61800-5-2.

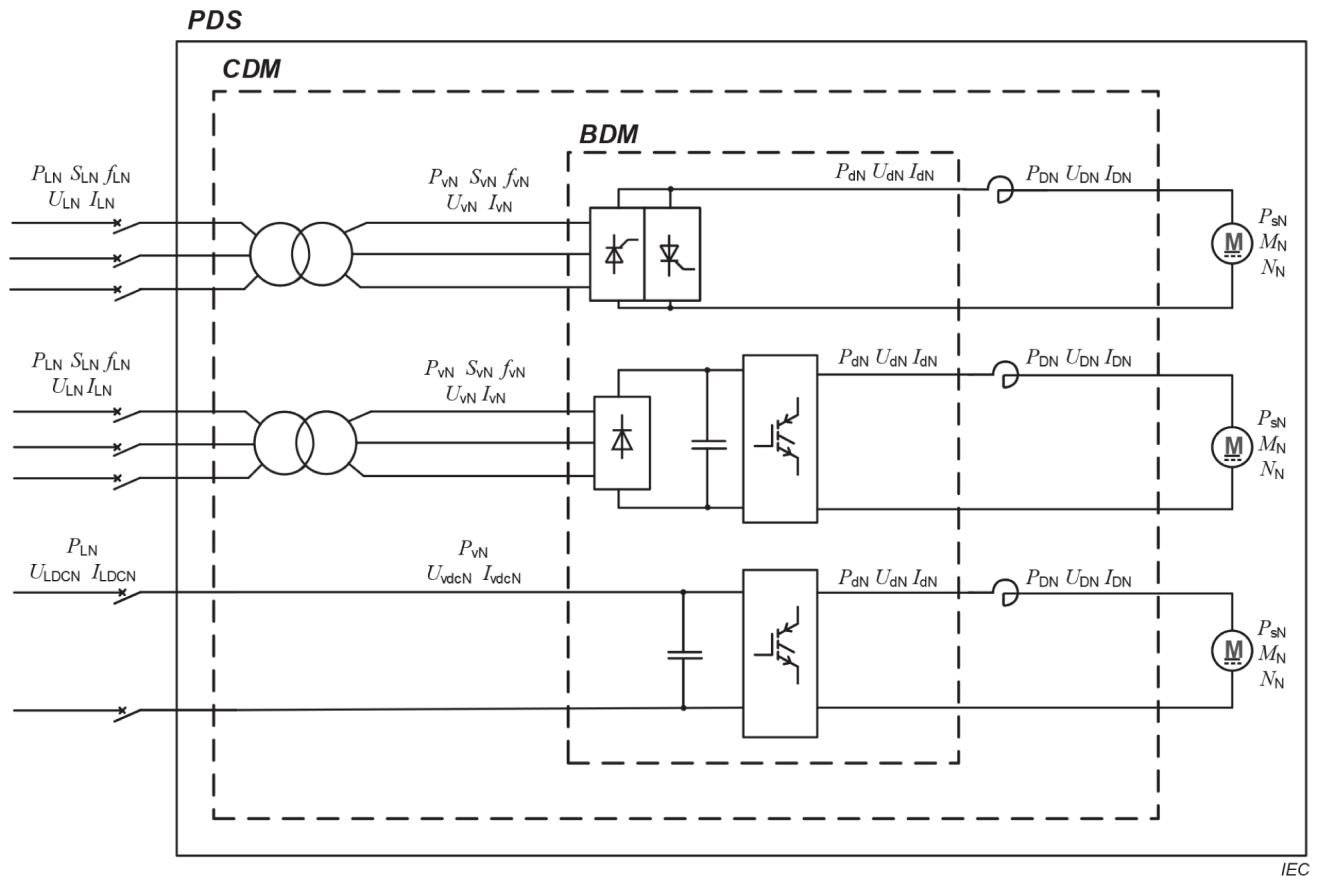


Figure 7 — Overview of input and output ratings of the BDM/CDM/PDS

NOTE 1 In case no transformer or other optional device such a filter is installed between *mains supply* input (i.e. CDM/PDS input) and BDM input, the ratings of CDM/PDS input and those of BDM input are same values, i.e. $U_{VN} = U_{LN}$ and so on.

NOTE 2 In case no optional device such a filter is installed between BDM output and *motor* input (i.e. CDM output), the ratings of CDM output and those of BDM output are same values, i.e. $U_{dN} = U_{DN}$ and so on.

NOTE 3 The BDM/CDM/PDS current, voltage and field ratings can be provided within a range of values.

NOTE 4 In the middle topology in [Figure 7](#), the *rectifier* in the can be any kinds of *rectifier*, such as AIC or diode *rectifier*.

4.3.2 Input ratings

4.3.2.1 Input voltage and input frequency

The BDM/CDM/PDS input voltage and frequency (in case of AC input) ratings/range shall be specified by the *manufacturer*.

Preferred rated values are listed in [Table 9](#).

Table 9 — Standard rated voltages as specified in IEC 60038

At 50 Hz V	At 60 Hz V
100	100
---	120

Table 9 (continued)

At 50 Hz V	At 60 Hz V
200	200
---	208
220	220
230	230
240	240
380	---
400	400
415	---
---	480
---	600
660	---
690	---
NOTE 1 Voltage tolerances are provided in IEC 61800-3.	
NOTE 2 Standard voltages as specified in IEC 60038.	

Non-standard voltage values may be specified for system optimization or special application needs.

For compliance, see [5.4.2.4.2](#).

4.3.2.2 Input current

The *BDM/CDM/PDS input current* rating shall be specified by the *manufacturer*.

The specified *input current* includes the current required by the auxiliaries if they are supplied from the same supply of the *BDM/CDM/PDS*.

These values shall be stated by *the manufacturer*.

For compliance, see [5.4.2.4.3](#).

4.3.3 Output ratings

4.3.3.1 BDM/CDM continuous output ratings

Continuous output ratings shall be stated by the *manufacturer* and shall be in terms of the output of the *BDM/CDM*:

- voltage U_{dN} / U_{dN} ;
- current I_{dN} / I_{dN} ;
- power P_{dN} / P_{dN} ;
- field current I_{FN} ;
- field voltage U_{FN} .

For compliance, see [5.4.2.5.3](#) and [5.4.2.5.4](#).

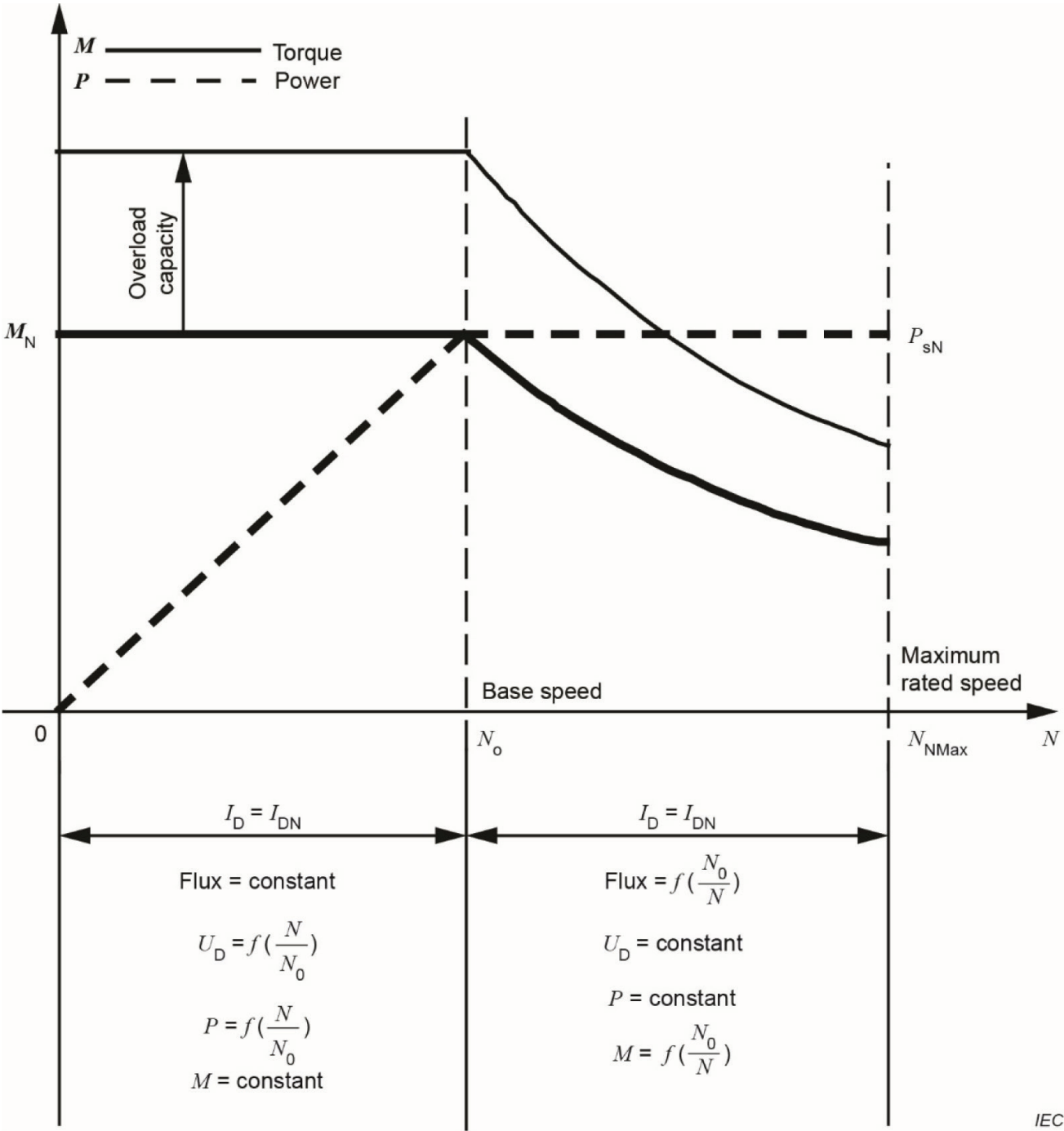
NOTE When *CDM* and *motor* are not provided by the same *manufacturer/supplier*, information can be exchanged to define proper performance and compatibility of *CDM* and *motor*.

4.3.3.2 PDS continuous output ratings

Continuous output ratings shall be stated by the *manufacturer* and shall be in terms of the *motor* shaft of the *PDS*:

- *rated torque* (M_N) [N·m];
- *rated speed* (N_N) [r/min];
- *maximum rated speed* (N_{Nmax}) [r/min];
- *rated output power* (P_{sN}) [kW].

Example of operating region of a PDS see [Figure 8](#).



- NOTE 1 In the example, the rated voltage and current of the *motor* are equal to those of the *CDM*.
- NOTE 2 Reducing overload capacity can be necessary for *speed* range over the *base speed*.
- NOTE 3 Operation below the *base speed* can necessitate the use of a blower for correct cooling of the *motor*.
- NOTE 4 This figure can be extended to four quadrant operation.
- NOTE 5 Reducing load capacity can be necessary for operation above *base speed*.
- NOTE 6 In the example, $N_0=N_N$.

Figure 8 — Example of operating region of a PDS

For compliance see [5.4.2.5.3](#), [5.4.2.5.4](#).