



BSI Standards Publication

Adjustable speed electrical power drive systems

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

National foreword

This British Standard is the UK implementation of EN IEC 61800-1:2021. It is identical to IEC 61800-1:2021. It supersedes BS EN 61800-1:1998, which is withdrawn.

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

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

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

© The British Standards Institution 2021
Published by BSI Standards Limited 2021

ISBN 978 0 580 52366 3

ICS 29.160.30; 29.200

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 March 2021.

Amendments/corrigenda issued since publication

Date	Text affected
------	---------------

English Version

Adjustable speed electrical power drive systems - Part 1:
General requirements - Rating specifications for low voltage
adjustable speed DC power drive systems
(IEC 61800-1:2021)

Entraînements électriques de puissance à vitesse variable -
Partie 1: Exigences générales - Spécifications de
dimensionnement pour systèmes d'entraînement de
puissance à vitesse variable en courant continu et basse
tension
(IEC 61800-1:2021)

Drehzahlveränderbare elektrische Antriebe - Teil 1:
Allgemeine Anforderungen - Festlegungen für die
Bemessung von Niederspannungs-Gleichstrom-
Antriebssystemen
(IEC 61800-1:2021)

This European Standard was approved by CENELEC on 2021-02-23. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.



European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

European foreword

The text of document 22G/430(F)/FDIS, future edition 2 of IEC 61800-1, prepared by SC 22G "Adjustable speed electric power drive systems (PDS)" of IEC/TC 22 "Power electronic systems and equipment" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 61800-1:2021.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2021-11-23
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2024-02-23

This document supersedes EN 61800-1:1998 and all of its amendments and corrigenda (if any).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC shall not be held responsible for identifying any or all such patent rights.

Endorsement notice

The text of the International Standard IEC 61800-1:2021 was approved by CENELEC as a European Standard without any modification.

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

IEC 60027-3	NOTE Harmonized as EN 60027-3
IEC 60034-6	NOTE Harmonized as EN 60034-6
IEC 60204-1	NOTE Harmonized as EN 60204-1
IEC 60364-1	NOTE Harmonized as HD 60364-1
IEC 61131-2	NOTE Harmonized as EN 61131-2
IEC 61439-1	NOTE Harmonized as EN 61439-1
IEC 61800-9 series	NOTE Harmonized as EN 61800-9 series
IEC 61800-9-1	NOTE Harmonized as EN 61800-9-1
IEC 61800-9-2	NOTE Harmonized as EN 61800-9-2

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

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

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

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

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60034-1	2017	Rotating electrical machines - Part 1:- Rating and performance		-
IEC 60034	series	Rotating electrical machines	-	-
IEC 60034-9	-	Rotating electrical machines - Part 9: Noise limits	EN 60034-9	-
IEC/TS 60034-25	-	Rotating electrical machines – Part 25: AC-electrical machines used in power drive systems – Application guide		-
IEC 60038	-	IEC standard voltages	EN 60038	-
IEC 60068	series	Environmental testing	EN 60068	series
IEC 60068-2-27	2008	Environmental testing - Part 2-27: Tests Test Ea and guidance: Shock	EN 60068-2-27	2009
IEC 60076-1	-	Power transformers - Part 1: General	EN 60076-1	-
IEC 60076-6	-	Power transformers - Part 6: Reactors	EN 60076-6	-
IEC 60076	series	Power transformers	EN 60076	series
IEC 60079	series	Explosive atmospheres	EN 60079	series
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 requirements and line commutated converters - Part 1-1: Specification of basic requirements	EN 60146-1-1	2010
IEC 60364	series	Low-voltage electrical installations	HD 60364	series
IEC 60664-1	-	Insulation coordination for equipment within low-voltage supply systems - Part 1: Principles, requirements and tests	EN IEC 60664-1	-
IEC 60721-2-6	-	Classification of environmental conditions. Part 2: Environmental conditions appearing in nature. Earthquake vibration and shock	HD 478.2.6 S1	-
IEC 60721-3-1	1997	Classification of environmental conditions - Part 3: Classification of groups of environmental parameters and their severities -- Section 1: Storage	EN 60721-3-1	1997
IEC 60721-3-2	1997	Classification of environmental conditions - Part 3: Classification of groups of environmental parameters and their severities -- Section 2: Transportation	EN 60721-3-2	1997

EN IEC 61800-1:2021 (E)

IEC 60721-3-3	1994	Classification of environmental conditions -EN 60721-3-3	1995
		Part 3: Classification of groups of environmental parameters and their severities - Section 3: Stationary use at weatherprotected locations	
+ A1	1995	-	-
+ A2	1996	+ A2	1997
IEC 60721-3-4	1995	Classification of environmental conditions -EN 60721-3-4	1995
		Part 3: Classification of groups of environmental parameters and their severities - Section 4: Stationary use at non-weatherprotected locations	
+ A1	1996	+ A1	1997
IEC 61158	series	Industrial communication networks -EN IEC 61158	series
		Fieldbus specifications	
IEC 61378	series	Converter transformers	EN 61378
IEC 61800-2	-	Adjustable speed electrical power driveEN 61800-2	series
		systems - Part 2: General requirements - Rating specifications for low voltage adjustable speed a.c. power drive systems	-
IEC 61800-3	-	Adjustable speed electrical power driveEN IEC 61800-3	-
		systems - Part 3: EMC requirements and specific test methods	
IEC 61800-5-1	-	Adjustable speed electrical power driveEN 61800-5-1	-
		systems - Part 5-1: Safety requirements - Electrical, thermal and energy	
IEC 61800-5-2	-	Adjustable speed electrical power driveEN 61800-5-2	-
		systems – Part 5-2: Safety requirements – Functional	
IEC/TR 61800-6	-	Adjustable speed electrical power driveCLC/TR 61800-6	-
		systems - Part 6: Guide for determination of types of load duty and corresponding current ratings	
IEC 61800-7	series	Adjustable speed electrical power driveEN 61800-7	series
		systems - Part 7-1: Generic interface and use of profiles for power drive systems - Interface definition	
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	

CONTENTS

FOREWORD	8
INTRODUCTION	10
0.1 General	10
0.2 Consistency of requirement	10
0.3 Tool for agreement between <i>customer</i> and <i>manufacturer</i>	10
1 Scope	12
2 Normative references	12
3 Terms and definitions	14
3.1 System elements	14
3.2 Converters and circuit elements (see Table 2)	19
3.3 Drive system operating characteristics (see Table 3)	20
3.4 Input ratings of <i>BDM/CDM/PDS</i> (see Table 4)	23
3.5 Output ratings of <i>BDM/CDM</i> (see Table 5)	27
3.6 <i>Motor</i> ratings (see Table 6)	29
3.7 Control systems (see Table 7)	32
3.8 Tests (see Table 8)	33
4 Ratings and specifications for the act of installing, commissioning and operation	34
4.1 General	34
4.2 <i>BDM/CDM/PDS</i> characteristics and topology	34
4.2.1 General	34
4.2.2 <i>BDM/CDM/PDS</i> characteristics	35
4.2.3 Basic topology for <i>BDM/CDM/PDS</i> 's	35
4.3 Ratings	39
4.3.1 General	39
4.3.2 Input ratings	40
4.3.3 Output ratings	41
4.3.4 Operating quadrants	44
4.3.5 Ratings, properties and functionalities of the <i>BDM/CDM/PDS</i>	44
4.3.6 Special ratings related to <i>BDM/CDM/PDS</i> or <i>motor</i>	45
4.4 Performance	45
4.4.1 Operational	45
4.4.2 Fault supervision and protection	55
4.4.3 Minimum status indication required	56
4.4.4 I/O devices	57
4.5 General safety	59
4.6 Functional safety	59
4.7 EMC	59
4.8 Ecodesign	60
4.8.1 General	60
4.8.2 Energy <i>efficiency</i> and power losses	60
4.8.3 Environmental impact	60
4.9 Environmental condition for service, transport and storage	60
4.9.1 General	60
4.9.2 Operation	60
4.9.3 Storage and transport of equipment	65
4.9.4 Mechanical conditions	66

4.9.5	Specific storage hazards	67
4.9.6	Environmental service tests (type test)	67
4.10	Types of load duty profiles	68
4.11	Generic interface and use of profiles for <i>PDS</i>	68
4.12	Voltage on <i>power interface</i>	70
4.13	Explosive environment	70
5	Test	71
5.1	General	71
5.2	Performance of tests	71
5.2.1	General conditions	71
5.2.2	Supply system earthing conditions	71
5.3	Standard tests for <i>BDM/CDM/PDS</i>	71
5.3.1	General	71
5.3.2	Test for mass produced products	73
5.3.3	Test for one-off products	73
5.4	Test specifications	73
5.4.1	Visual inspections (<i>type test</i> , <i>sample test</i> and <i>routine test</i>)	73
5.4.2	Performance and rating test	74
5.4.3	General safety	82
5.4.4	Functional safety	82
5.4.5	EMC	82
5.4.6	Energy <i>efficiency</i> and power losses determination	82
5.4.7	Environmental condition tests	82
5.4.8	Communication profiles	84
5.4.9	Explosive atmosphere environment	85
6	Information and marking requirements	85
6.1	General	85
6.2	Marking on product	86
6.3	Information to be supplied with the PDS or BDM/CDM	87
6.4	Information to be supplied or made available	87
6.5	Safety and warning information	87
6.5.1	Warning labels	87
6.5.2	Additional safety considerations of a PDS	87
Annex A	(informative) <i>Motor</i> considerations	89
A.1	General	89
A.2	Cooling considerations	89
A.3	Waveform <i>ripple</i> considerations	90
A.3.1	General	90
A.3.2	<i>Converter</i> topologies	90
A.3.3	Potentials to earth	90
A.4	Torsional considerations	91
A.4.1	General	91
A.4.2	Torsional analysis	91
A.4.3	Remedies to torsional problems (rare with DC drives)	91
A.4.4	Torque pulsation	91
A.5	Operational modes	91
A.5.1	General	91
A.5.2	Torque/speed characteristics	92
A.5.3	Considerations of drive regeneration	93

A.6	Acoustic noise	93
A.7	Service life of the <i>motor</i> insulation system	93
A.8	Shaft voltages	94
A.9	New drive systems	94
Annex B	(informative) Line-side considerations	95
B.1	General	95
B.2	AC power source earthing	95
B.3	Introduction to harmonics and inter-harmonics	96
B.4	Results for typical <i>converters</i> phase control	98
B.4.1	General	98
B.4.2	Square wave line current	99
B.4.3	Trapezoidal line current	99
B.4.4	Current harmonic with <i>DC current ripple</i>	99
B.4.5	Diode <i>rectifiers</i>	101
B.4.6	Diode <i>rectifiers</i> without <i>DC link</i> inductance	102
B.4.7	General	104
B.5	Example of assessment of harmonic effect of a <i>PDS</i>	104
B.6	Attenuation of emission of harmonics	105
B.7	Commutation notches	106
B.8	Protection against voltage dips and short interruptions	108
Annex C	(informative) Auxiliary equipment	110
C.1	General	110
C.2	Transformers	110
C.2.1	General	110
C.2.2	Voltage	110
C.2.3	Codes	110
C.2.4	Provide continuity of service for installations prone to nuisance grounding	110
C.2.5	Line voltage unbalance	111
C.2.6	Reduction of <i>converter</i> input harmonic currents	111
C.2.7	Reduction of prospective short-circuit current at <i>converter</i> input	111
C.2.8	Pulse number	111
C.3	Reactors	111
C.4	Switchgear	112
Annex D	(informative) Control strategies	113
D.1	General	113
D.2	Control configurations	113
D.2.1	General	113
D.2.2	Basic structure	114
D.2.3	Optional facilities	114
D.2.4	Digital and analog control	116
D.3	Control modes	117
D.3.1	Operating modes	117
D.3.2	Loop control	117
D.3.3	Accuracy and performance	117
D.4	Steady state and transient performance	118
D.4.1	Time response	118
D.4.2	Response time	118
D.4.3	Performances of particular functions	118

D.4.4	Speed ratio control	118
D.5	List of relevant control parameters	120
D.5.1	<i>BDM/CDM</i> control parameters	120
D.5.2	<i>Motor</i> parameters	121
D.5.3	Mechanical parameters	121
D.5.4	Supply parameters	121
D.6	Structures	121
D.6.1	Functional structures	121
D.6.2	Hardware structures	123
D.6.3	Important drive performances issues	123
D.6.4	Effect of torsional elasticity	123
D.6.5	Effects of the backlash	125
Annex E (informative)	Protection	126
E.1	General	126
E.2	Equipment availability	126
E.2.1	General	126
E.2.2	Equipment protection circuits	126
E.2.3	Types of equipment alarms and faults	126
E.2.4	Alarm and fault listing	127
E.3	System protection (features and devices)	128
E.4	Protection of the drive system	128
E.4.1	Protection included in the <i>BDM/CDM</i>	128
E.4.2	Specific <i>motor</i> protection	129
E.4.3	Specific transformer protection	129
Annex F (informative)	Monitoring features	130
F.1	General	130
F.2	Technology	130
Bibliography		131
Figure 1	– <i>PDS</i> hardware configuration within an <i>installation</i>	15
Figure 2	– Example of function diagram of a <i>DC power drive system</i>	16
Figure 3	– <i>BDM/CDM/PDS manufacturer/customer</i> relationship	18
Figure 4	– Operating quadrants	22
Figure 5	– Main configurations for line-commutated <i>converters</i>	36
Figure 6	– Basic configurations of self-commutated <i>converters</i> (choppers)	37
Figure 7	– Overview of input and output ratings of the <i>BDM/CDM/PDS</i>	40
Figure 8	– Example of operating region of a <i>PDS</i>	42
Figure 9	– Overload cycle example	44
Figure 10	– Deviation band	47
Figure 11	– Time response following a step change of reference input, no change in operating variables	50
Figure 12	– Time response following a change in an operating variable – No reference change	51
Figure 13	– Time response following a reference change at specified rate	52
Figure 14	– Frequency response of the control – Reference value as <i>stimulus</i>	53
Figure 15	– Example of relationship of IEC 61800-7 (all parts) to control system software and the <i>BDM/CDM/PDS</i>	70

Figure 16 – Measuring circuit of <i>PDS</i>	76
Figure A.1 – Torque and power output of a <i>DC motor</i>	92
Figure B.1 – Thyristor <i>rectifier</i> with a large DC inductance	99
Figure B.2 – Square wave line current	99
Figure B.3 – Trapezoidal line current	99
Figure B.4 – Major harmonic components of supply current considering square wave line current with idealized DC <i>ripple</i>	100
Figure B.5 – Power <i>converter</i> with a diode <i>rectifier</i> on the line-side and a DC/DC <i>converter</i>	101
Figure B.6 – Input voltage and current waveforms of the diode <i>rectifier</i>	101
Figure B.7 – Line-side voltage and current distortion factors of a diode <i>rectifier</i>	102
Figure B.8 – Diode <i>rectifier</i> without <i>DC link</i> inductance	102
Figure B.9 – Input harmonic current (AC and DC)	103
Figure B.10 – <i>Input current</i> distortion	103
Figure B.11 – Example of simple structure	105
Figure B.12 – 3-phase, 6-pulse bridge <i>converter</i>	106
Figure B.13 – Commutation notches with a 3-phase, 6-pulse bridge <i>converter</i>	107
Figure B.14 – Equivalent circuit for assessment of commutation notch mitigation	108
Figure D.1 – Block diagram of feedback control system containing all basic elements	113
Figure D.2 – Functional block diagram	115
Figure D.3 – Master/follower drive system	119
Figure D.4 – Zero current inversion time	120
Figure D.5 – Structure of a drive system	122
Figure D.6 – Mechanical diagram	124
Figure D.7 – Simple stability criterion	125
Figure E.1 – Protection classification	127
Table 1 – System elements	14
Table 2 – Converters and circuits elements	19
Table 3 – Drive system operating characteristics	20
Table 4 – Input ratings of <i>BDM/CDM/PDS</i>	23
Table 5 – Output ratings of <i>BDM/CDM</i>	27
Table 6 – <i>Motor</i> ratings	29
Table 7 – Control system and variables	32
Table 8 – Type of tests	33
Table 9 – Standard rated voltages as specified in IEC 60038	40
Table 10 – Example of reduced maximum continuous load as a function of an overload	43
Table 11 – Maximum deviation bands (%)	47
Table 12 – <i>PDS</i> protection functions	55
Table 13 – Environmental service conditions	61
Table 14 – Limit of temperature of the cooling medium for indoor equipment	62
Table 15 – Definitions of pollution degree	62
Table 16 – Environmental vibration limits for fixed <i>installation</i>	63
Table 17 – Environmental shock limits for fixed <i>installation</i>	63

Table 18 – Storage and transport limits.....	65
Table 19 – Transportation vibration limits.....	66
Table 20 – Transportation limits of free fall	66
Table 21 – Environmental service tests.....	68
Table 22 – Tests overview	72
Table 23 – Classification of commutation made by visual observation.....	74
Table 24 – Shock test	84
Table 25 – Information requirements.....	86
Table B.1 – Minimum R_{SC} requirements for low voltage systems.....	97
Table B.2 – Harmonic current – 6-pulse conversion	98
Table B.3 – Harmonic results for the drive contribution	105
Table D.1 – Typical control configurations	114
Table D.2 – Composition of the typical control configurations	116
Table D.3 – Drive system control strategies	118

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ADJUSTABLE SPEED ELECTRICAL POWER DRIVE SYSTEMS –**Part 1: General requirements –
Rating specifications for low voltage
adjustable speed DC power drive systems**

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

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.

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				



No.	Terms	Acronym	Symbols	Mark	Unit
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

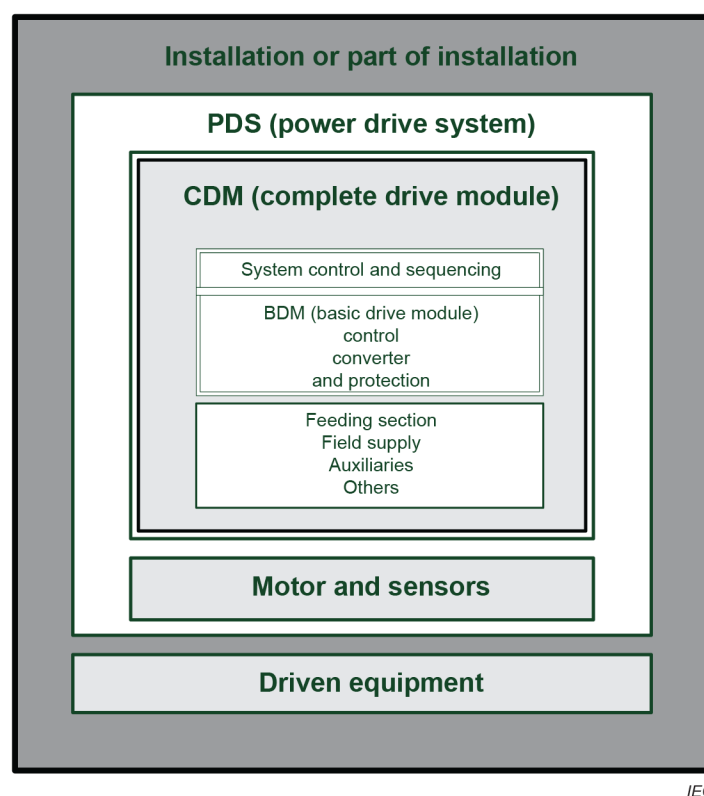
power drive system

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

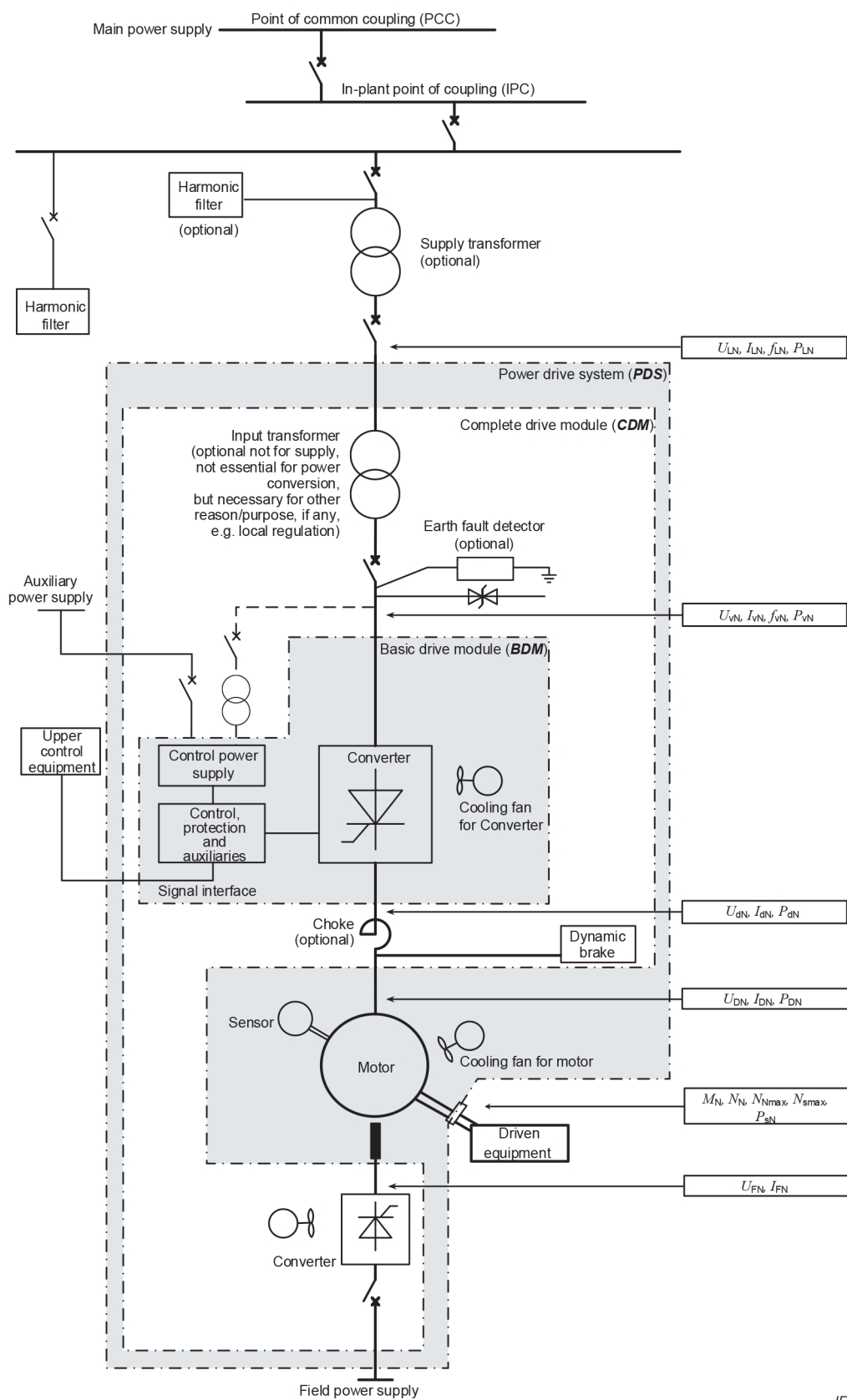
DC PDS

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.



IEC

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.

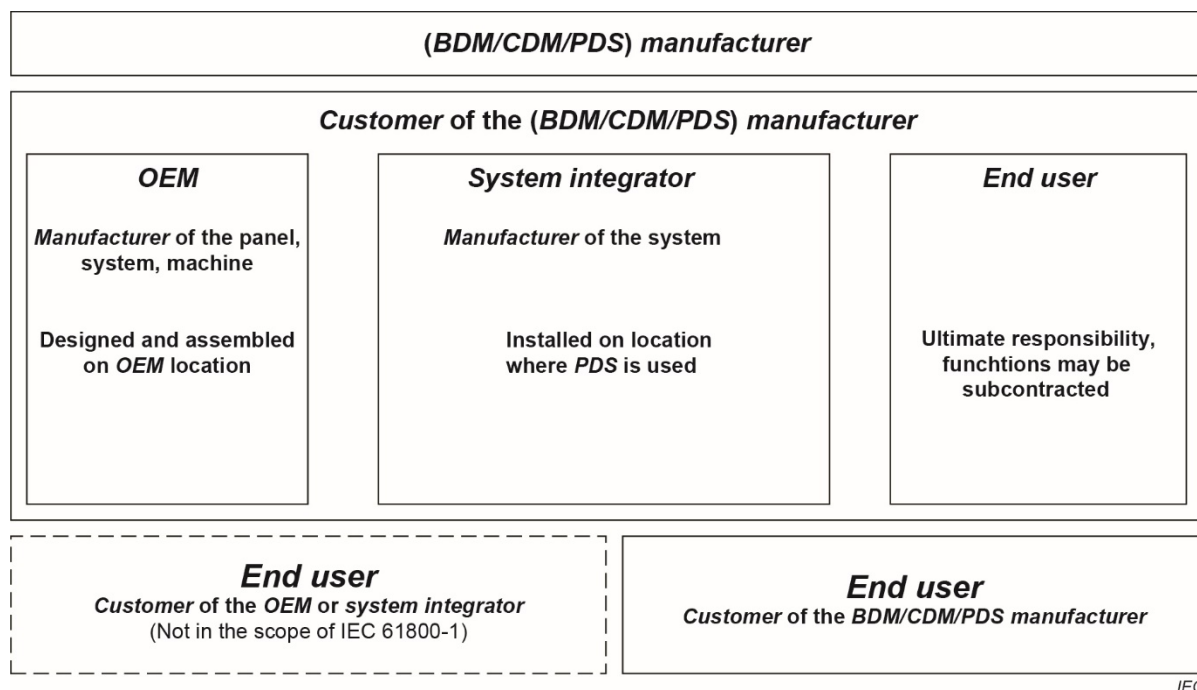


Figure 3 – BDM/CDM/PDS manufacturer/customer relationship

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

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.

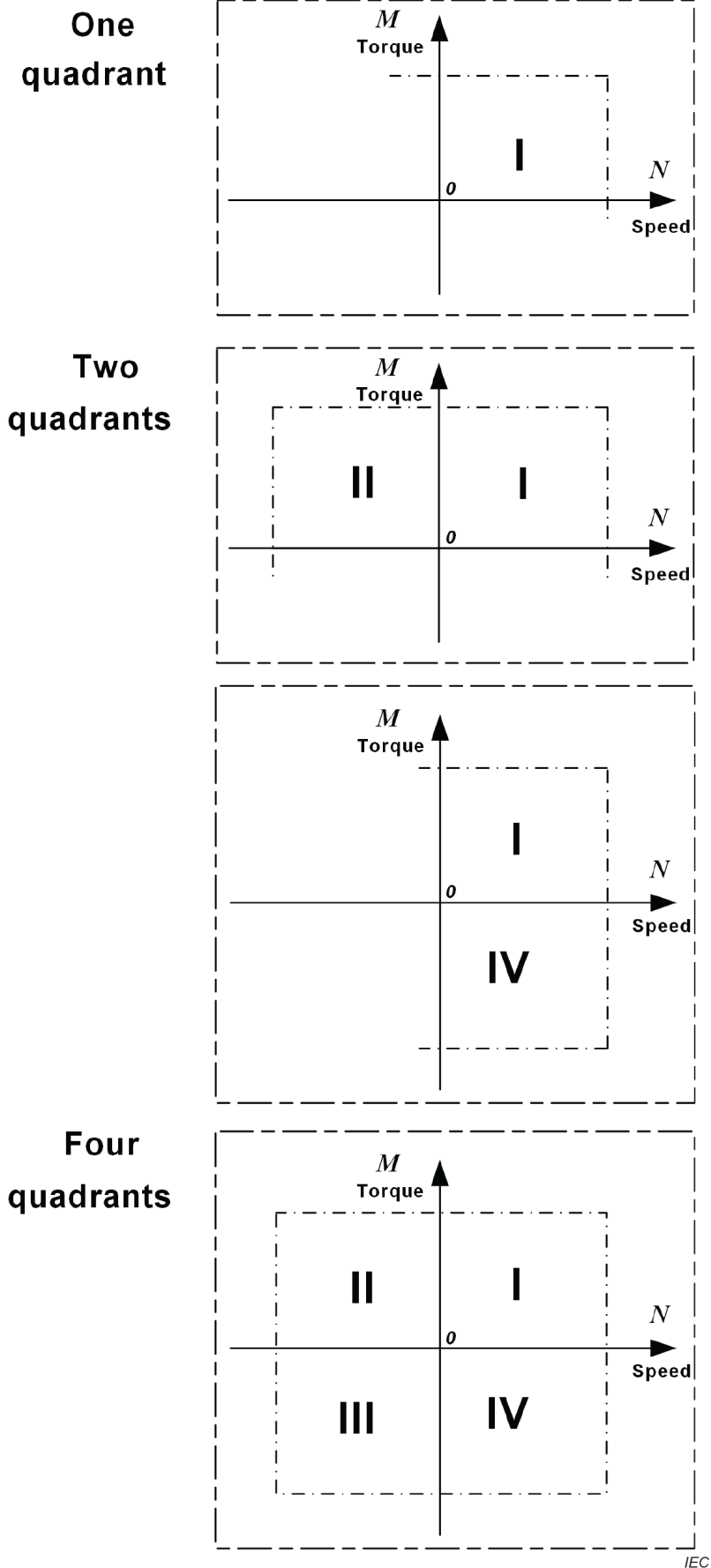


Figure 4 – Operating quadrants

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

No.	Terms	Acronym	Symbols	Mark	Unit
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
<p>NOTE Subscripts follow the concept of IEC 60146-1-1.</p> <p>^a Definitions used in several standards of the IEC 61800 series.</p> <p>^b Fundamental definition across IEC 61800 (all parts).</p>					

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).

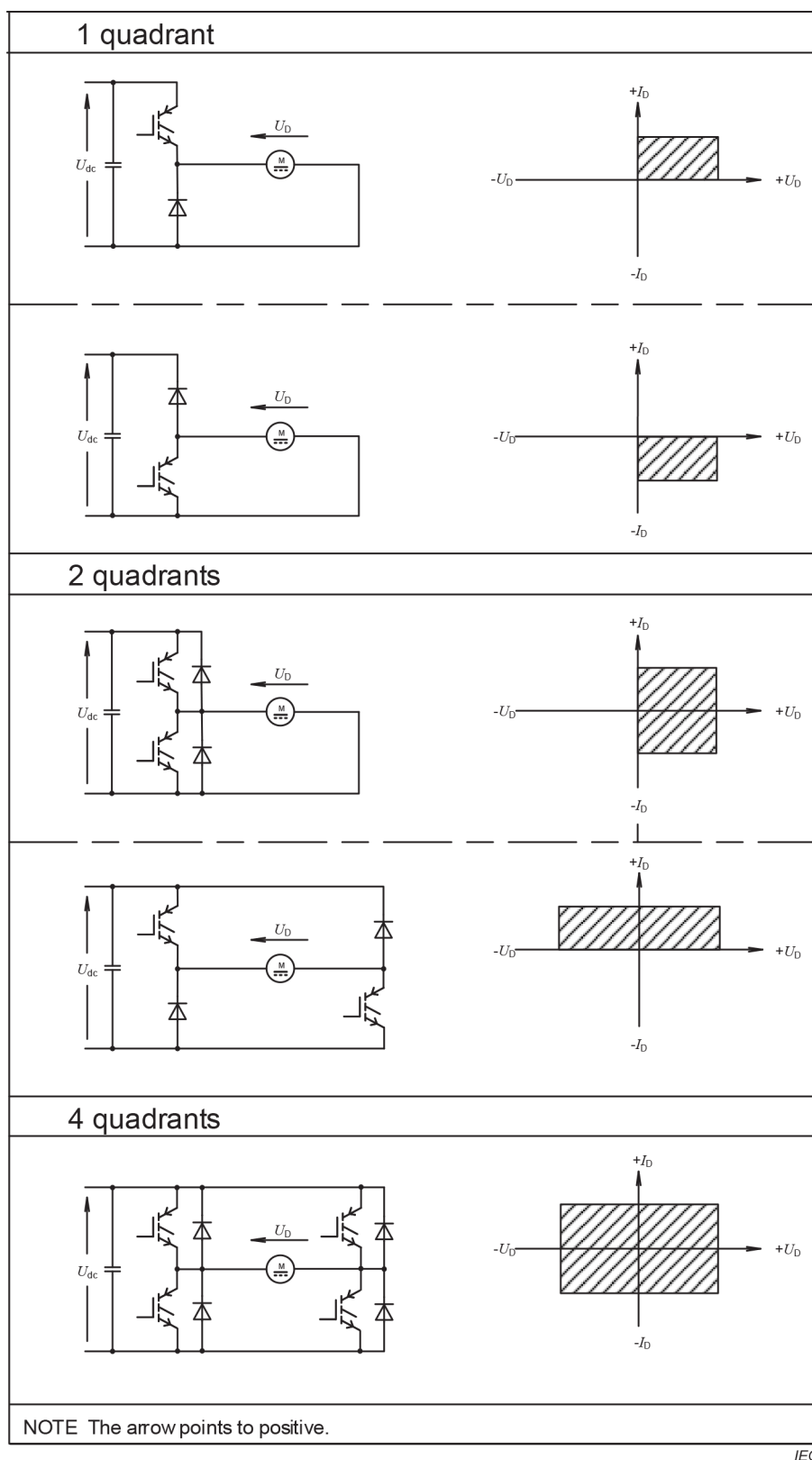
Figure 5 shows eight topologies related to line-commutated *converters*. With these topologies, the *speed* regulation is adjusted by thyristor phase control and the semiconductor devices should be thyristors. Subclauses 4.2.3.2 to 4.2.3.9 give the explanation of Figure 5.

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
Dy11(as example)			2	4. 2. 3. 7
Dy11(as example)			2	4. 2. 3. 8
Dy11(as example)			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.



IEC

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