

BS EN 61800-7-203:2016



BSI Standards Publication

Adjustable speed electrical power drive systems

Part 7-203: Generic interface and use of profiles for power drive systems — Profile type 3 specification

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National foreword

This British Standard is the UK implementation of EN 61800-7-203:2016. It is identical to IEC 61800-7-203:2015. It supersedes BS EN 61800-7-203:2008, which will be withdrawn on 12 October 2018.

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

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

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Adjustable speed electrical power drive systems -
Part 7-203: Generic interface and use of profiles for power drive
systems - Profile type 3 specification
(IEC 61800-7-203:2015)

Entraînements électriques de puissance à vitesse variable -
Partie 7-203: Interface générique et utilisation de profils
pour les entraînements électriques de puissance -
Spécification de profil de type 3
(IEC 61800-7-203:2015)

Elektrische Leistungsantriebssysteme mit einstellbarer
Drehzahl - Teil 7-203: Generisches Interface und Nutzung
von Profilen für Leistungsantriebssysteme (PDS) -
Spezifikation von Profil-Typ 3
(IEC 61800-7-203:2015)

This European Standard was approved by CENELEC on 2015-12-25. 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.

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Europäisches Komitee für Elektrotechnische Normung

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European foreword

The text of document 22G/309/FDIS, future edition 2 of IEC 61800-7-203, prepared by SC 22G "Adjustable speed electric drive systems incorporating semiconductor power converters" of IEC/TC 22 "Power electronic systems and equipment" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 61800-7-203:2016.

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publication of an identical national
standard or by endorsement
- latest date by which the national (dow) 2018-12-25
standards conflicting with the
document have to be withdrawn

This document supersedes EN 61800-7-203:2008.

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The text of the International Standard IEC 61800-7-203:2015 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 61158:2014 Series	NOTE	Harmonized as EN 61158:2014 Series.
IEC 61499-1:2005	NOTE	Harmonized as EN 61499-1:2005 ¹⁾ (not modified).
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IEC 61784-2	NOTE	Harmonized as EN 61784-2.
IEC 61800 Series	NOTE	Harmonized as EN 61800 Series.
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IEC 61800-7-302	NOTE	Harmonized as EN 61800-7-302.
IEC 61800-7-304	NOTE	Harmonized as EN 61800-7-304.

¹⁾ Superseded by EN 61499-1:2013 (IEC 61499-1:2012).

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE 1 When 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 61158-5-3	-	Industrial communication networks - Fieldbus specifications - Part 5-3: Application layer service definition - Type 3 elements	EN 61158-5-3	-
IEC 61158-5-10	-	Industrial communication networks - Fieldbus specifications - Part 5-10: Application layer service definition - Type 10 elements	EN 61158-5-10	-
IEC 61158-6-3	-	Industrial communication networks - Fieldbus specifications - Part 6-3: Application layer protocol specification - Type 3 elements	EN 61158-6-3	-
IEC 61158-6-10	-	Industrial communication networks - Fieldbus specifications - Part 6-10: Application layer protocol specification - Type 10 elements	EN 61158-6-10	-
IEC 61800-7-1	2015	Adjustable speed electrical power drive systems - Part 7-1: Generic interface and use of profiles for power drive systems - Interface definition	EN 61800-7-1	2016
IEC 61800-7-303	2015	Adjustable speed electrical power drive systems - Part 7-303: Generic interface and use of profiles for power drive systems - Mapping of profile type 3 to network technologies	EN 61800-7-303	2016

CONTENTS

FOREWORD	10
INTRODUCTION	12
0.1 General	12
0.2 Patent declaration	15
1 Scope	17
2 Normative references	17
3 Terms, definitions and abbreviated terms	17
3.1 Terms and definitions	17
3.2 Abbreviated terms	22
4 General	23
4.1 Background	23
4.2 Requirements	23
4.3 Goals of the PROFIdrive Profile	24
5 Data types	24
5.1 Data types overview	24
5.2 Standard data types	24
5.3 Profile-specific data types	25
5.3.1 General	25
5.3.2 Normalised value: N2, N4	26
5.3.3 Normalised value (variable normalisation): X2, X4	27
5.3.4 Fixed point value: E2	27
5.3.5 Fixed point value: C4	28
5.3.6 Bit sequence: V2	28
5.3.7 Nibble: L2	29
5.3.8 Time constant: T2, T4	29
5.3.9 Time constant: D2	29
5.3.10 Reciprocal time constant: R2	30
6 Specifications	30
6.1 Integration of drives in automation systems	30
6.1.1 General	30
6.1.2 Base Model	30
6.1.3 Drive model	38
6.1.4 P-Device communication model	42
6.1.5 Application Model and Application Classes	43
6.2 Parameter model	49
6.2.1 Parameter definition	49
6.2.2 Global and local parameters	61
6.2.3 Base Mode Parameter Access	62
6.3 Drive control application process	87
6.3.1 General Axis type Drive Object architecture	87
6.3.2 Control and status words	90
6.3.3 Operating modes and State Machine	97
6.3.4 DO IO Data	113
6.3.5 Dynamic Servo Control (DSC)	125
6.3.6 Position feedback interface	130

6.3.7	Periphery	152
6.3.8	Diagnosis	152
6.3.9	Identification	162
6.3.10	Drive reset (power-on reset)	165
6.3.11	Operation priority of parameters and control priority	168
6.3.12	User data reliability	169
6.3.13	Specified DO functions for the Application Classes	174
6.4	Parameter definition	175
6.4.1	PROFIdrive Parameter listed by Function	175
6.4.2	PROFIdrive Parameter listed by number	180
6.5	Integration of Drives in Process Technology (VIK-NAMUR)	188
6.5.1	General	188
6.5.2	Commands and Checkback Signals	189
6.5.3	State diagrams	192
6.5.4	Inevitable line interruption	194
6.5.5	Forced inverter inhibit	195
6.5.6	External interlock	196
6.5.7	Standard telegram	196
	Bibliography	198
	Figure 1 – Structure of IEC 61800-7	15
	Figure 2 – PROFIdrive Devices and there relationship	31
	Figure 3 – General Communication Model of a PROFIdrive automation system	32
	Figure 4 – The PROFIdrive Device (consists of one or several Functional Objects)	33
	Figure 5 – Hierarchical order in the Object Model	34
	Figure 6 – PROFIdrive Base Model contains the Application Layer and Communication Layer	35
	Figure 7 – Typical use case for Clock Synchronous Operation	36
	Figure 8 – General model for Clock Synchronous Operation	37
	Figure 9 – Base Model State Machine	38
	Figure 10 – General Drive Unit model	39
	Figure 11 – General Drive Object architecture	40
	Figure 12 – Principle functional model of an Axis type Drive Object	41
	Figure 13 – Classes of PROFIdrive P-Devices	42
	Figure 14 – Classes of PROFIdrive Drive Units	42
	Figure 15 – Overview of the available communication services between the PROFIdrive Devices	43
	Figure 16 – Application Class 1	45
	Figure 17 – Application Class 2	46
	Figure 18 – Application Class 3	47
	Figure 19 – Application Class 4	48
	Figure 20 – Application Class 5	48
	Figure 21 – Application Class 6	49
	Figure 22 – Example overview of global and local parameters of a Multi-Axis/Modular Drive Unit	62
	Figure 23 – Byte order for Words and Double words	64

Figure 24 – Data flow for Base Mode Parameter Access	73
Figure 25 – General functional elements of the PROFIdrive Axis type DO	88
Figure 26 – Functional block diagram of the PROFIdrive Axis type DO	89
Figure 27 – General state diagram for all operating modes	99
Figure 28 – General functionality of a PROFIdrive Axis DO with Application Class 1 functionality	101
Figure 29 – Speed setpoint channel for use in Application Class 1 and 4	102
Figure 30 – General functionality of a PROFIdrive Axis DO with Application Class 4 functionality	103
Figure 31 – Reduced speed setpoint channel for use in Application Class 4 (optional)	104
Figure 32 – General functionality of a PROFIdrive Axis DO with Application Class 3 functionality	105
Figure 33 – Functionality of the Motion Controller in the Program submode	106
Figure 34 – Functionality of the Motion Controller in the MDI submode	107
Figure 35 – State diagram of the positioning mode	110
Figure 36 – Homing Procedure: Home Position Set	111
Figure 37 – Homing Procedure: Abortion by the controller	111
Figure 38 – Traversing Task active	112
Figure 39 – Change of the Traversing Tasks immediately	112
Figure 40 – Example for configuring a telegram	122
Figure 41 – Structure of the position control circuit based on the velocity setpoint interface without DSC	126
Figure 42 – Structure of the position control circuit based on the velocity setpoint interface with DSC	127
Figure 43 – Example of the sensor interface (Sensor-1: two actual values/Sensor-2: one actual value)	131
Figure 44 – Actual value format, Example 1	135
Figure 45 – Actual value format, Example 2	135
Figure 46 – Actual value format, Example 3	135
Figure 47 – Actual value format, Example 4	136
Figure 48 – Actual value format, Example 5	136
Figure 49 – Actual value format, Example 6	136
Figure 50 – Actual value format, Example 7	136
Figure 51 – Actual value format, Example 8	137
Figure 52 – State diagram of the position feedback interface with designations of the states and transitions	142
Figure 53 – Acknowledgement of acknowledgeable sensor error	147
Figure 54 – Acknowledgement of unacknowledgeable sensor error	148
Figure 55 – Timing diagram: Measurement on the fly – sequence 1	149
Figure 56 – Timing diagram: Measurement on the fly – sequence 2	150
Figure 57 – Timing diagram: Reference mark search	151
Figure 58 – Overview about the diagnostic mechanisms of PROFIdrive	153
Figure 59 – Working of the warning mechanism	154
Figure 60 – Overview about the fault buffer mechanism	155
Figure 61 – Fault acknowledgement for the fault buffer mechanism	156

Figure 62 – Processing of the fault messages in the fault buffer mechanism	157
Figure 63 – Fault buffer with fault sequence example	159
Figure 64 – Fault number list and fault code list with example.....	160
Figure 65 – Drive reset: Direct initiation (P972 = 1).....	167
Figure 66 – Example: Permanent failure of the controller LS	170
Figure 67 – Example: Temporary failure of the controller LS (negative deviation)	171
Figure 68 – Example: Temporary failure of the controller LS (positive deviation; double step)	171
Figure 69 – Example: Permanent failure of the DO LS	172
Figure 70 – Example: Temporary failure of the DO LS (negative deviation).....	172
Figure 71 – Example: Temporary failure of the DO LS (positive deviation; double step)	172
Figure 72 – Value of the DO Sign-Of-Life failure counter (axis-specific) with respect to the transferred controller Sign-Of-Life	173
Figure 73 – Functionality and Interfaces for drive integration according to VIK-NAMUR	188
Figure 74 – Principle structure of the drive interface according to VIK-NAMUR guideline.....	189
Figure 75 – Speed setpoint channel for VIK-NAMUR process technology operating mode	193
Figure 76 – Process technology operating mode, control word 1 bit 15 and status word 1 bit 10,11,13,14.....	194
Figure 77 – Process technology operating mode with inevitable line interruption.....	195
Figure 78 – Process technology operating mode with forced inverter inhibit.....	196
Table 1 – Standard data types	25
Table 2 – Profile specific data types	26
Table 3 – N2, N4-Range of values	26
Table 4 – N2, N4-Coding	27
Table 5 – X2, X4-Range of values.....	27
Table 6 – X2, X4-Coding (example x=12/28).....	27
Table 7 – E2-Range of values.....	28
Table 8 – E2-Coding	28
Table 9 – C4-Range of values.....	28
Table 10 – V2-Coding	28
Table 11 – L2-Coding	29
Table 12 – T2, T4-Range of values	29
Table 13 – D2-Range of values.....	29
Table 14 – R2-Range of values.....	30
Table 15 – Application Classes	44
Table 16 – Parameter definition	49
Table 17 – Parameter description elements	50
Table 18 – Parameter description element "Identifier (ID)"	51
Table 19 – Parameter description element "variable attribute"	51
Table 20 – Variable index and conversion index for SI units	53
Table 21 – Conversion values for the conversion index (SI units).....	56
Table 22 – Variable index and conversion index for US units	57

Table 23 – Conversion values for the conversion index (US units)	58
Table 24 – Parameter description elements “IO Data reference value/IO Data normalisation”	59
Table 25 – Text array for parameter description	60
Table 26 – Text array for the data type Boolean	60
Table 27 – Text array for data type V2 (bit sequence)	61
Table 28 – Base mode parameter request	64
Table 29 – Base mode parameter response	64
Table 30 – Permissible combinations consisting of attribute, number of elements and subindex	67
Table 31 – Coding of the fields in parameter request/parameter response of Base Mode Parameter Access	68
Table 32 – Error numbers in Base Mode parameter responses	70
Table 33 – General state machine for the parameter manager processing	73
Table 34 – Sequence 1: Parameter request	74
Table 35 – Sequence 1: Parameter response positive with data of data type Word	74
Table 36 – Sequence 1: Parameter response positive with data of data type Double word	74
Table 37 – Sequence 1: Parameter response, negative	75
Table 38 – Sequence 2: Parameter request	75
Table 39 – Sequence 2: Parameter response, positive	75
Table 40 – Sequence 2: Parameter response, negative	75
Table 41 – Sequence 3: Parameter request	76
Table 42 – Sequence 3: Parameter response, positive	76
Table 43 – Sequence 3: Parameter response, negative	76
Table 44 – Sequence 4: Parameter request	77
Table 45 – Sequence 4: Parameter response, positive	77
Table 46 – Sequence 4: Parameter response, negative	77
Table 47 – Sequence 5: Parameter request	78
Table 48 – Sequence 5: Parameter response, positive	78
Table 49 – Sequence 5: Parameter response, negative	78
Table 50 – Sequence 6: Parameter request	79
Table 51 – Sequence 6: Parameter response (+): all partial accesses OK	79
Table 52 – Sequence 6: Parameter response (-): first and third partial access OK, second partial access erroneous	80
Table 53 – Sequence 7: Parameter request	81
Table 54 – Sequence 7: Parameter response (+): all partial accesses OK	81
Table 55 – Sequence 7: Parameter response (-): first and third partial access OK, second partial access erroneous	82
Table 56 – Sequence 8: Parameter request	82
Table 57 – Sequence 8: Parameter response positive with data of the data type word (for example ID)	82
Table 58 – Sequence 8: Parameter response positive with text	83
Table 59 – Sequence 8: Parameter response, negative	83
Table 60 – Sequence 9: Parameter request	83

Table 61 – Sequence 9: Parameter response, positive	84
Table 62 – Sequence 9: Parameter response, negative	84
Table 63 – Sequence 10: Parameter request	84
Table 64 – Sequence 10: Parameter response, positive	85
Table 65 – Sequence 10: Parameter response, negative	85
Table 66 – Sequence 11: Request of values, description and text in one request.....	85
Table 67 – Sequence 11: Parameter response (+): all partial accesses OK.....	86
Table 68 – Sequence 12: Request of values, header with illegal Request ID	86
Table 69 – Sequence 12: Parameter response (-): service not supported.....	87
Table 70 – Overview on the assignment of the bits of control word 1	90
Table 71 – Detailed assignment of the common control word 1 bits (STW1) for speed control/positioning.....	91
Table 72 – Detailed assignment of the special control word 1 bits (STW1) for speed control mode.....	92
Table 73 – Detailed assignment of the special control word 1 bits (STW1) for the positioning mode.....	93
Table 74 – Overview on the assignment of the bits of control word 2	93
Table 75 – Overview on the assignment of the bits of Encoder control word 2	94
Table 76 – Overview on the assignment of the bits of status word 1	94
Table 77 – Detailed assignment of the common status word 1 bits (ZSW1) for the speed control /positioning mode.....	95
Table 78 – Detailed assignment of the special status word 1 bits (ZSW1) for the speed control mode.....	96
Table 79 – Detailed assignment of the special status word 1 bits (ZSW1) for the positioning mode.....	96
Table 80 – Overview on the assignment of the bits of status word 2.....	96
Table 81 – Overview on the assignment of the bits of Encoder status word 2.....	97
Table 82 – Structure of Parameter 924 “Status word bit Pulses Enabled”	97
Table 83 – Definition of signal SATZANW	108
Table 84 – Definition of signal AKTSATZ	108
Table 85 – Definition of signal MDI_MOD.....	109
Table 86 – Signal list – assignment.....	114
Table 87 – Definition of standard telegram 1	116
Table 88 – Definition of standard telegram 2.....	116
Table 89 – Definition of standard telegram 3.....	116
Table 90 – Definition of standard telegram 4.....	117
Table 91 – Definition of standard telegram 5.....	117
Table 92 – Definition of standard telegram 6.....	118
Table 93 – Definition of standard telegram 7.....	118
Table 94 – Definition of standard telegram 9.....	119
Table 95 – Definition of standard telegram 8.....	119
Table 96 – Parameters for configuring a telegram	120
Table 97 – Coding of P922	120
Table 98 – Example A/B for normalising DO IO Data, parameter values.....	123
Table 99 – Example A/B for normalising DO IO Data, parameter description elements	124

Table 100 – Example C for normalising DO IO Data, parameter values	124
Table 101 – Example C for normalising DO IO Data, parameter description elements	125
Table 102 – Structure of parameter 979 (sensor format)	132
Table 103 – Subindex 0 (header) of parameter 979	132
Table 104 – Subindex 1 (sensor type) of parameter 979	133
Table 105 – Subindex 2 (sensor resolution) of parameter 979	133
Table 106 – Assigning Gx_XIST2 (sensor-x position actual value-2)	137
Table 107 – Error codes in Gx_XIST2	138
Table 108 – Sensor control word	139
Table 109 – Sensor status word	141
Table 110 – States	143
Table 111 – Transitions	145
Table 112 – Prioritisation of Sensor Control Word	147
Table 113 – Example for standard telegram with additional peripheral control	152
Table 114 – Fault buffer parameters	158
Table 115 – Fault codes examples	159
Table 116 – Definition of the fault classes attribute	160
Table 117 – Definition of the PROFIdrive fault classes	161
Table 118 – Structure of parameter 964 (Drive Unit identification)	162
Table 119 – Definition of the Profile identification number	163
Table 120 – Structure of parameter 975 (DO identification)	163
Table 121 – Structure of P975.5	163
Table 122 – DO type class definition in P975.5	164
Table 123 – Assignment of the bits of DO sub class 1 identification in P975.6	164
Table 124 – Structure of parameter 974 (Base Mode Parameter Access identification)	165
Table 125 – PROFIdrive I&M parameter definition	165
Table 126 – PROFIdrive parameter value definition	166
Table 127 – PROFIdrive error code definition	166
Table 128 – Specified DO functions for the Application Classes	174
Table 129 – Parameter for “Life sign monitoring”	175
Table 130 – Parameter for “DO IO DATA-Telegram selection and configuration”	175
Table 131 – Parameter for “Sensor interface”	176
Table 132 – Parameter for “Fault buffer handling”	176
Table 133 – Parameter for “Warning mechanism”	176
Table 134 – Parameter for “Closed loop control operating mode”	176
Table 135 – Parameter for “Set and store of the local parameter set”	176
Table 136 – Parameter for “Set and store complete parameter set”	177
Table 137 – Parameter for “Drive reset”	177
Table 138 – Parameter for “Operation priority for write parameters”	177
Table 139 – Parameter for “DO identification and setup”	178
Table 140 – Parameter for “Parameter set identification”	178
Table 141 – Parameter for “Device identification”	178
Table 142 – Parameter for “Alternative Supervisor DO IO Data control channel”	179

Table 143 – PROFIdrive Parameter listed by number.....	180
Table 144 – Overview on the assignment of the bits of control word1 for the process technology operating mode	190
Table 145 – Overview on the assignment of the bits of status word1 for the process technology operating mode	191
Table 146 – Overview on the assignment of the bits of drive status/fault word for the process technology operating mode	192
Table 147 – Definition of standard telegram 20	197

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ADJUSTABLE SPEED ELECTRICAL POWER DRIVE SYSTEMS –**Part 7-203: Generic interface and use of profiles for
power drive systems – Profile type 3 specification**

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 61800-7-203 has been prepared by subcommittee SC 22G: Adjustable speed electric drive systems incorporating semiconductor power converters, of IEC technical committee TC 22: Power electronic systems and equipment.

This second edition cancels and replaces the first edition published in 2007. This edition constitutes a technical revision.

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

- a) minor updates in the Base Mode Parameter Access mechanism;
- b) minor updates and simplification in the Application Class 3 state machine definition.

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

FDIS	Report on voting
22G/309/FDIS	22G/324/RVD

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

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

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

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

The IEC 61800 series is intended to provide a common set of specifications for adjustable speed electrical power drive systems.

IEC 61800-7 specifies profiles for power drive systems (PDS) and their mapping to existing communication systems by use of a generic interface model.

IEC 61800-7 describes a generic interface between control systems and power drive systems. This interface can be embedded in the control system. The control system itself can also be located in the drive (sometimes known as "smart drive" or "intelligent drive").

A variety of physical interfaces is available (analogue and digital inputs and outputs, serial and parallel interfaces, fieldbuses and networks). Profiles based on specific physical interfaces are already defined for some application areas (e.g. motion control) and some device classes (e.g. standard drives, positioner). The implementations of the associated drivers and application programmers interfaces are proprietary and vary widely.

IEC 61800-7 defines a set of common drive control functions, parameters, and state machines or description of sequences of operation to be mapped to the profiles.

IEC 61800-7 provides a way to access functions and data of a drive that is independent of the used drive profile and communication interface. The objective is a common drive model with generic functions and objects suitable to be mapped on different communication interfaces. This makes it possible to provide common implementations of motion control (or velocity control or drive control applications) in controllers without any specific knowledge of the drive implementation.

There are several reasons to define a generic interface:

For a drive device manufacturer

- less effort to support system integrators;
- less effort to describe drive functions because of common terminology;
- the selection of drives does not depend on availability of specific support;

For a control device manufacturer

- no influence of bus technology;
- easy device integration;
- independent of a drive supplier;

For a system integrator (builds modules, machines, plants etc.)

- less integration effort for devices;
- only one understandable way of modeling;
- independent of bus technology.

Much effort is needed to design a motion control application with several different drives and a specific control system. The tasks to implement the system software and to understand the functional description of the individual components may exhaust the project resources. In some cases, the drives do not share the same physical interface. Some control devices just support a single interface which will not be supported by a specific drive. On the other hand, the functions and data structures are specified with incompatibilities. It is up to the system

integrator to write interfaces to the application software to handle that which should not be his responsibility.

Some applications need device exchangeability or integration of new devices in an existing configuration. They are faced with different incompatible solutions. The efforts to adapt a solution to a drive profile and to manufacturer specific extensions may be unacceptable. This will reduce the degree of freedom to select a device best suited for this application to the selection of the unit which will be available for a specific physical interface and supported by the controller.

IEC 61800-7-1 is divided into a generic part and several annexes as shown in Figure 1. The drive profile types for CiA® 402¹, CIP Motion™², PROFIdrive³ and SERCOS®⁴ are mapped to the generic interface in the corresponding annex. The annexes have been submitted by open international network or fieldbus organizations which are responsible for the content of the related annex and use of the related trade marks.

This part of IEC 61800-7 specifies the profile type 3 (PROFIdrive).

The profile types 1, 2 and 4 are specified in IEC 61800-7-201, IEC 61800-7-202 and IEC 61800-7-204.

¹ CiA® 402 is a registered trade mark of CAN in Automation e.V. (CiA). This information is given for the convenience of users of this International Standard and does not constitute an endorsement by IEC of the trade mark holder or any of its products. Compliance to this profile does not require use of the registered trade mark CiA® 402. Use of the registered trade mark CiA® 402 requires permission of CAN in Automation e.V. (CiA).

² CIP Motion™ is a trade mark of ODVA, Inc. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by IEC of the trade mark holder or any of its products. Compliance to this profile does not require use of the trade mark CIP Motion™. Use of the trade mark CIP Motion™ requires permission of ODVA, Inc.

³ PROFIdrive is a trade name of PROFIBUS & PROFINET International. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by IEC of the trade name holder or any of its products. Compliance to this profile does not require use of the trade name PROFIdrive. Use of the trade name PROFIdrive requires permission of PROFIBUS & PROFINET International.

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IEC 61800-7-301, IEC 61800-7-302, IEC 61800-7-303 and IEC 61800-7-304 specify how the profile types 1, 2, 3 and 4 are mapped to different network technologies (such as CANopen®⁵, CC-Link IE® Field Network⁶, EPA™⁷, EtherCAT®⁸, Ethernet Powerlink™⁹, DeviceNet™¹⁰, ControlNet™¹¹, EtherNet/IP™¹², PROFIBUS¹³, PROFINET¹⁴ and SERCOS®).

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- ⁵ CANopen® is a registered trade mark of CAN in Automation e.V. (CiA). This information is given for the convenience of users of this International Standard and does not constitute an endorsement by IEC of the trade mark holder or any of its products. Compliance to this profile does not require use of the registered trade mark CANopen®. Use of the registered trade mark CANopen® requires permission of CAN in Automation e.V. (CiA). CANopen® is an acronym for Controller Area Network *open* and is used to refer to EN 50325-4.
- ⁶ CC-Link IE® Field Network is a registered trade mark of Mitsubishi Electric Corporation. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by IEC of the trade mark holder or any of its products. Compliance to this profile does not require use of the registered trade mark CC-Link IE® Field Network. Use of the registered trade mark CC-Link IE® Field Network requires permission of Mitsubishi Electric Corporation.
- ⁷ EPA™ is a trade mark of SUPCON Group Co. Ltd. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by IEC of the trade mark holder or any of its products. Compliance to this profile does not require use of the trade mark EPA™. Use of the trade mark EPA™ requires permission of the trade mark holder.
- ⁸ EtherCAT® is a registered trade mark of Beckhoff, Verl. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by IEC of the trade mark holder or any of its products. Compliance to this profile does not require use of the registered trade mark EtherCAT®. Use of the registered trade mark EtherCAT® requires permission of the trade mark holder.
- ⁹ Ethernet Powerlink™ is a trade mark of Bernecker & Rainer Industrieelektronik Ges.m.b.H., control of trade mark use is given to the non profit organisation EPSG. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by IEC of the trade mark holder or any of its products. Compliance to this profile does not require use of the trade mark Ethernet Powerlink™. Use of the trade mark Ethernet Powerlink™ requires permission of the trade mark holder.
- ¹⁰ DeviceNet™ is a trade mark of ODVA, Inc. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by IEC of the trade mark holder or any of its products. Compliance to this profile does not require use of the trade mark DeviceNet™. Use of the trade mark DeviceNet™ requires permission of ODVA, Inc.
- ¹¹ ControlNet™ is a trade mark of ODVA, Inc. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by IEC of the trade mark holder or any of its products. Compliance to this profile does not require use of the trade mark ControlNet™. Use of the trade mark ControlNet™ requires permission of ODVA, Inc.
- ¹² EtherNet/IP™ is a trade mark of ODVA, Inc. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by IEC of the trade mark holder or any of its products. Compliance to this profile does not require use of the trade mark EtherNet/IP™. Use of the trade mark EtherNet/IP™ requires permission of ODVA, Inc.
- ¹³ PROFIBUS is a trade name of PROFIBUS & PROFINET International. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by IEC of the trade name holder or any of its products. Compliance to this profile does not require use of the trade name PROFIBUS. Use of the trade name PROFIBUS requires permission of PROFIBUS & PROFINET International.
- ¹⁴ PROFINET is a trade name of PROFIBUS & PROFINET International. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by IEC of the trade name holder or any of its products. Compliance to this profile does not require use of the trade name PROFIBUS. Use of the trade name PROFIBUS requires permission of PROFIBUS & PROFINET International.

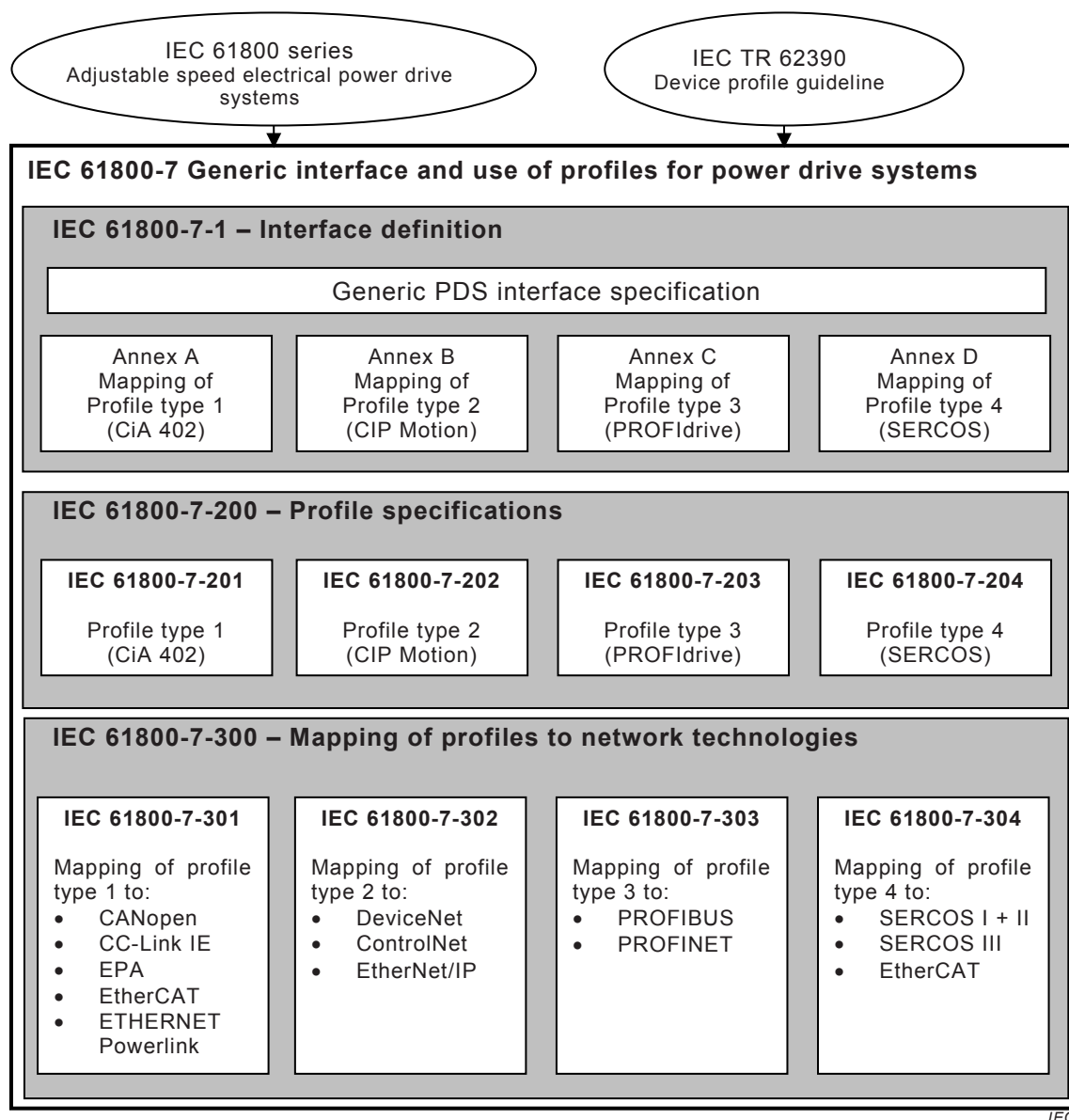


Figure 1 – Structure of IEC 61800-7

0.2 Patent declaration

The International Electrotechnical Commission (IEC) draws attention to the fact that it is claimed that compliance with this document may involve the use of a patent concerning the following:

Publication/ Application serial number	Holder	Title	Derwent accession Number	Derwent publication
EP844542	[SI]	Numerical control method and control structure for controlling of movement of objects whereby speed control is effected at a higher rate than position control	1998-274369	EP844542-A1 27.05.1998; DE59603496-G 02.12.1999; EP844542-B1 27.10.1999

The IEC takes no position concerning the evidence, validity and scope of this patent right.

The holder of this patent right has assured the IEC that he is willing to negotiate licences under reasonable and non-discriminatory terms and conditions with applicants throughout the world. In this respect, the statement of the holder of this patent right is registered with IEC. Information may be obtained from:

[SI]	Siemens AG Corporate Intellectual Property Licensing & Transactions Otto-Hahn-Ring 6 81730 Munich Germany
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Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights other than those identified above. IEC shall not be held responsible for identifying any or all such patent rights.

ISO (www.iso.org/patents) and IEC (<http://patents.iec.ch>) maintain on-line data bases of patents relevant to their standards. Users are encouraged to consult the data bases for the most up to date information concerning patents.

ADJUSTABLE SPEED ELECTRICAL POWER DRIVE SYSTEMS –

Part 7-203: Generic interface and use of profiles for power drive systems – Profile type 3 specification

1 Scope

This part of IEC 61800 specifies profile type 3 for power drive systems (PDS). Profile type 3 can be mapped onto different communication network technologies.

The functions specified in this part of IEC 61800 are not intended to ensure functional safety. This requires additional measures according to the relevant standards, agreements and laws.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 61158-5-3, *Industrial communication networks – Fieldbus specifications – Part 5-3: Application layer service definition – Type 3 elements*

IEC 61158-5-10, *Industrial communication networks – Fieldbus specifications – Part 5-10: Application layer service definition – Type 10 elements*

IEC 61158-6-3, *Industrial communication networks – Fieldbus specifications – Part 6-3: Application layer protocol specification – Type 3 elements*

IEC 61158-6-10, *Industrial communication networks – Fieldbus specifications – Part 6-10: Application layer protocol specification – Type 10 elements*

IEC 61800-7-1:2015, *Adjustable speed electrical power drive systems – Part 7-1: Generic interface and use of profiles for power drive systems – Interface definition*

IEC 61800-7-303:2015, *Adjustable speed electrical power drive systems – Part 7-303: Generic interface and use of profiles for power drive systems – Mapping of profile type 3 to network technologies*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

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

3.1.1

actual value

value of a variable quantity at a given instant

Note 1 to entry: Actual value is used in this document as input data of the application control program to monitor variables of the PDS (e.g. feedback variables).

[SOURCE: IEC 61800-7-1:2015, 3.3.1.1]

3.1.2**algorithm**

completely determined finite sequence of operations by which the values of the output data can be calculated from the values of the input data

[SOURCE: IEC 61800-7-1:2015, 3.2.1]

3.1.3**application**

software functional element specific to the solution of a problem in industrial-process measurement and control

Note 1 to entry: An application may be distributed among resources, and may communicate with other applications.

[SOURCE: IEC 61800-7-1:2015, 3.2.2]

3.1.4**application mode**

type of application that can be requested from a PDS

Note 1 to entry: The different application modes reflect the control loop for torque control, velocity control, position control or other applications like homing.

[SOURCE: IEC 61800-7-1:2015, 3.3.1.2]

3.1.5**attribute**

property or characteristic of an entity

[SOURCE: IEC 61800-7-1:2015, 3.2.3]

3.1.6**axis**

logical element inside an automation system (e.g. a motion control system) that represents some form of movement

Note 1 to entry: Axes can be rotary or linear, physical or virtual, controlled or simply observed.

Note 2 to entry: A physical *axis* may include one or more of the following components: a motion sensor, a motion control structure, a power amplifier, and a motion actuator.

[SOURCE: IEC 61800-7-1:2015, 3.2.4, modified – A note to entry is added]

3.1.7**class**

description of a set of objects that share the same attributes, operations, methods, relationships, and semantics

[SOURCE: IEC 61800-7-1:2015, 3.2.5]

3.1.8**clock cycle synchronous application**

synchronisation of sampling and cycle times in the closed-loop control software in digital drives and control systems

3.1.9**commands**

set of commands from the application control program to the PDS to control the behaviour of the PDS or functional elements of the PDS

Note 1 to entry: The behaviour is reflected by states or operating modes.

Note 2 to entry: The different commands may be represented by one bit each.

[SOURCE: IEC 61800-7-1:2015, 3.3.1.3]

3.1.10

control

purposeful action on or in a process to meet specified objectives

[SOURCE: IEC 61800-7-1:2015, 3.2.6]

3.1.11

control device

physical unit that contains – in a module/subassembly or device – an application program to control the PDS

[SOURCE: IEC 61800-7-1:2015, 3.2.7]

3.1.12

data type

set of values together with a set of permitted operations

[SOURCE: IEC 61800-7-1:2015, 3.2.8]

3.1.13

device

field device

<function blocks> networked independent physical entity of an industrial automation system capable of performing specified functions in a particular context and delimited by its interfaces

[SOURCE: IEC 61800-7-1:2015, 3.2.9]

3.1.14

device

field device

<system integration> entity that performs control, actuating and/or sensing functions and interfaces to other such entities within an automation system

[SOURCE: IEC 61800-7-1:2015, 3.2.10]

3.1.15

device profile

representation of a device in terms of its parameters, parameter assemblies and behaviour according to a device model that describes the data and behaviour of the device as viewed through a network, independent from any network technology

[SOURCE: IEC 61800-7-1:2015, 3.2.11]

3.1.16

DO IO Data

collection of all Input Data and Output Data (cyclic transmission) of a Drive Object (drive axis)

3.1.17

Drive Object

functional element of a Drive Unit

3.1.18**Drive to Drive communication**

communication (cyclic) between drives from the user's perspective

3.1.19**Drive Unit**

logical device which comprises all functional elements related to one central processing unit

3.1.20**functional element**

entity of software or software combined with hardware, capable of accomplishing a specified function of a device

Note 1 to entry: A functional element has an interface, associations to other functional elements and functions.

Note 2 to entry: A functional element can be made out of function block(s), object(s) or parameter list(s).

[SOURCE: IEC 61800-7-1:2015, 3.2.13]

3.1.21**Input Data**

data to be sent cyclically from the device to the controller

3.1.22**interface**

shared boundary between two entities defined by functional characteristics, signal characteristics, or other characteristics as appropriate

[SOURCE: IEC 61800-7-1:2015, 3.2.15]

3.1.23**IO Data**

Input Data and Output Data of a device

3.1.24**Isochronous Mode**

communication system service for clock cycle synchronism which generates a constant (timing) bus cycle with a clock cycle signal at the start of the cycle

3.1.25**model**

mathematical or physical representation of a system or a process, based with sufficient precision upon known laws, identification or specified suppositions

[SOURCE: IEC 61800-7-1:2015, 3.2.17]

3.1.26**operating mode**

characterisation of the way and the extent to which the human operator intervenes in the control equipment

[SOURCE: IEC 61800-7-1:2015, 3.2.18]

3.1.27**Output Data**

data to be sent cyclically from the controller to the device

3.1.28**parameter**

data element that represents device information that can be read from or written to a device, for example through the network or a local HMI

Note 1 to entry: A parameter is typically characterized by a parameter name, data type and access direction.

[SOURCE: IEC 61800-7-1:2015, 3.2.20]

3.1.29**Process data**

data related to the control process, for example gain factor and state variables, typically mapped to parameters

3.1.30**profile**

representation of a PDS interface in terms of its parameters, parameter assemblies and behaviour according to a communication profile and a device profile

[SOURCE: IEC 61800-7-1:2015, 3.2.21, modified – Note 1 to entry is deleted]

3.1.31**setpoint**

value or variable used as Output Data of the application control program to control the PDS

3.1.32**status**

set of information from the PDS to the application control program reflecting the state or mode of the PDS or a functional element of the PDS

Note 1 to entry: The different status information may be coded with one bit each.

[SOURCE: IEC 61800-7-1:2015, 3.3.1.6]

3.1.33**technological functions**

closed-loop controls and sequence controls for automation of application-specific processes

3.1.34**type**

hardware or software element which specifies the common attributes shared by all instances of the type

[SOURCE: IEC 61800-7-1:2015, 3.2.23]

3.1.35**use case**

class specification of a sequence of actions, including variants, that a system (or other entity) can perform, interacting with actors of the system

[SOURCE: IEC 61800-7-1:2015, 3.2.24]

3.1.36**variable**

software entity that may take different values, one at a time

Note 1 to entry: The values of a variable as well as of a parameter are usually restricted to a certain data type.

[SOURCE: IEC 61800-7-1:2015, 3.2.25]

3.2 Abbreviated terms

AC	PROFIdrive Application Class
BERO	proximity switch
CO	Communication Object
CR	communication relationship
C-LS	Controller's Sign-Of-Life
DO	Drive Object
DO-LS	Drive Object Sign-Of-Life
DP	Decentralised (distributed) Periphery
DSC	Dynamic Servo Control
DU	Drive Unit
DX	Data_Exchange
f	frequency
GSD	General Station Description (device description, input for a bus configuring tool)
HMI	human machine interface
ID	identifier
IO Data	IO Data; is transmitted cyclically
I/O	input/output
K_V	position closed loop control gain factor
k_{PC}	position closed loop control gain factor
LS	Sign-Of-Life
LSB	least significant bit
MSB	most significant bit
M CR	Multicast CR
MDI	Manual Data Input
NAMUR	Standards Working Group for Instrumentation and Control in the Chemical Industry
NC	numerical control system with a numeric control command set
Pxxx	parameter (identified by number xxx)
PAP	Parameter Access Point
PBE	parameter description
P-Device	peripheral device (PROFIdrive Base Model)
PDS	power drive system
PI	PROFIBUS & PROFINET International
PLC	programmable logic controller without a motion control command set
PLL	phase locked loop (phase control loop)
PNO	PROFIBUS user organisation
PNU	parameter number
PROFIBUS	process field bus as defined in IEC 61158-5-3 and IEC 61158-6-3
PROFINET	process field bus as defined in IEC 61158-5-10 and IEC 61158-6-10
PWE	parameter value

RFG	Ramp Function Generator
RMS	root mean square value (true root mean square value)
SN	sign
STW	control word
T _a	sampling time
T _{DC}	Data-Cycle-Time
T _{DX}	Data_Exchange-Time
T _M	Master-Time
T _{CAC}	Controller_Application_Cycle-Time
T _{CLS}	Contoller_Life_Sign-Time
T _O	Output-Time
T _{PC}	position controller sampling time
T _{SC}	speed controller sampling time
T _{DLS}	DO_Life_Sign-Time
VIK	Association of the Industrial Customers and Industrial Power Producers
x _{err}	closed loop control system deviation
ZSW	status word

4 General

4.1 Background

The PROFIdrive profile was generated by the PROFIBUS & PROFINET user organisation PROFIBUS & PROFINET international (PI). It defines a unified device behaviour and access technique to the drive data.

For the user, this means that engineering costs are reduced when planning and implementing plants and systems, as the various drives respond the same way to control instructions.

The programming costs are significantly reduced by using standardised program blocks in the open loop and closed loop control systems for controlling the drive. For drive manufacturers, as a result of the profile definition, development costs are reduced and the implementation of non-proprietary standardised interface improves the chances of being successful in the market.

The mapping to the generic interface is given in IEC 61800-7-1:2015, Annex C.

4.2 Requirements

Today, variable-speed electric drives from basic AC drive converters up to high-dynamic performance servo controllers are being increasingly connected to higher-level open loop and closed-loop control systems in automated plants and systems via digital interfaces.

In today's systems, the speed interface is mostly common. The speed setpoint is entered from a higher-level automation system which controls the drive. Generally, the speed actual value is signalled back to the automation system to monitor the drive.

In order that the digital field bus interface in distributed automation concepts may also be used in the area of motion control with several drive axes, today's standard field busses shall be expanded by specific features. This involves fulfilling the following requirements:

Clock cycle synchronism: If a central motion controller is being used which handles the interpolation and closed-loop position control, the control loop shall be closed via the bus. The speed setpoint is transferred to the drive in the setpoint direction. In the actual value direction, the drive provides a position actual value. In order to implement sufficiently high loop gains to fulfil the required dynamic performance, the delays shall be minimal and it is especially important that they be absolutely constant. If the motion control task requires the coordination of several axes, the position actual values shall be acquired precisely at the same time and evaluated in synchronism in the motion controller. Furthermore, the setpoints shall take effect precisely at the same time in the axes. The actual value acquisition, transfer and setpoint activation are in clock cycle synchronism with the closed-loop position controller.

Drive-to-Drive communication: State-of-the-art automation solutions with digital Drive Units also use distributed concepts where the open loop and closed-loop control tasks, which were previously implemented centrally, are shifted into intelligent drives. Examples are single-axis-positioning drives or drives with integrated software for winding functions or synchronous operating applications.

If automation functions are to be decentralised and distributed, then data shall be directly transferred between the drives, which, for example for an electronic shaft, shall be realised with precise angular synchronism and also with clock cycle synchronism.

Acyclic communication: The acyclic communication services are requested to transfer parameter requests for operator control and monitoring of drives in parallel to the Cyclic Data Exchange.

With modern automation profiles, it is a strong requirement that state of the art communication systems be supported.

4.3 Goals of the PROFIdrive Profile

To protect investments in engineering tools, automation program libraries and training of staff, it is important to have a stable generic application profile functionality which migrates to future enhanced field bus systems by keeping its application platform interface stable.

5 Data types

5.1 Data types overview

Profile-specific data types corresponding to the particular drive requirements are defined. The profile-specific data types are individually defined in 5.3. The standard types are defined in IEC 61158-5-10. An overview of all of the permissible data types (standard data types and profile-specific data types) is given in Table 1 and Table 2.

It is strongly recommended to use standard and profile specific data types out of Table 1 and Table 2 for all drive device parameters. In addition, because of compatibility to older systems, all Controller and Device implementations also shall support the basic data types Byte, Word, Double word as defined in Table 31. For further information about handling of data types in the PROFIdrive Base Mode Parameter Access, see 6.2.3.6.

5.2 Standard data types

Table 1 shows references of data types used in this profile and the related definitions.

Table 1 – Standard data types

Data types used in Profile PROFIdrive	Reference to definition	Data type numeric identifier
Boolean	Boolean (see IEC 61158-5-10)	1
Integer8	Integer8 (see IEC 61158-5-10)	2
Integer16	Integer16 (see IEC 61158-5-10)	3
Integer32	Integer32 (see IEC 61158-5-10)	4
Integer64	Integer64 (see IEC 61158-5-10)	55
Unsigned8	Unsigned8 (see IEC 61158-5-10)	5
Unsigned16	Unsigned16 (see IEC 61158-5-10)	6
Unsigned32	Unsigned32 (see IEC 61158-5-10)	7
Unsigned64	Unsigned64 (see IEC 61158-5-10)	56
FloatingPoint	Float32 (see IEC 61158-5-10)	8
FloatingPoint64	Float64 (see IEC 61158-5-10)	15
VisibleString	VisibleString (see IEC 61158-5-10)	9
OctetString	OctetString (see IEC 61158-5-10)	10
UNICODEString	UNICODEString (see IEC 61158-5-10)	39
TimeOfDay (with date indication)	TimeOfDay (see IEC 61158-5-10)	12
TimeDifference (do not use) ^a	TimeDifference (see IEC 61158-5-10)	13
Date	BinaryDate (see IEC 61158-5-10)	50
TimeOfDay without date indication	TimeOfDay (see IEC 61158-5-10)	52
TimeDifference with date indication	TimeDifference (see IEC 61158-5-10)	53
TimeDifference without date indication	TimeDifference (see IEC 61158-5-10)	54
^a Data type TimeDifference should not be used for new device implementations. For device implementation use data types TimeDifference with date indication and TimeDifference without date indication instead. For compatibility reasons all three data types of TimeDifference shall be supported by a controller implementation.		

5.3 Profile-specific data types

5.3.1 General

All profile-specific data types (see Table 2) may be implemented in the drive (optional data types).

Table 2 – Profile specific data types

Data types used in Profile PROFIdrive	Reference to definition	Data type numeric identifier
N2 Normalised value (16 bit)	5.3.2, Table 3 and Table 4	113
N4 Normalised value (32 bit)	5.3.2, Table 3 and Table 4	114
V2 Bit sequence	5.3.6 and Table 10	115
L2 Nibble	5.3.7 and Table 11	116
R2 Reciprocal time constant	5.3.10 and Table 14	117
T2 Time constant (16 bit)	5.3.8 and Table 12	118
T4 Time constant (32 bit)	5.3.8 and Table 12	119
D2 Time constant	5.3.9 and Table 13	120
E2 Fixed point value (16 bit)	5.3.4, Table 7 and Table 8	121
C4 Fixed point value (32 bit)	5.3.5 and Table 9	122
X2 Normalised value, variable (16 bit)	5.3.3, Table 5 and Table 6	123
X4 Normalised value, variable (32 bit)	5.3.3, Table 5 and Table 6	124

It is strongly recommended to use the profile specific data types for optimum matching to the application. For compatibility to older drive applications with none of the profile-specific data types:

- Instead of N2, N4 or X2, X4 use Integer16, Integer32 with optional normalisation.

5.3.2 Normalised value: N2, N4

Meaning

Linear normalised value. 0 % corresponds to 0 (0x0), 100 % corresponds to 2^{14} (0x4000) for N2 or 2^{30} (0x40000000) for N4.

Table 3 – N2, N4-Range of values

Coding	Data type	Range of values	Resolution	Length
113	N2	$-200 \% \leq i \leq (200-2^{-14}) \%$	$2^{-14} = 0,006 \text{ 1 } \%$	2 Octet
114	N4	$-200 \% \leq i \leq (200-2^{-30}) \%$	$2^{-30} = 9,3 \times 10^{-8} \%$	4 Octet

Coding

- Representation in twos complement, the MSB (Most significant bit) is the bit after the sign bit (SN) of the first octet.
- SN = 0: positive numbers including zero
- SN = 1: negative numbers

Table 4 – N2, N4-Coding

Octet	Bit							
	8	7	6	5	4	3	2	1
1	SN	2^0	2^{-1}	2^{-2}	2^{-3}	2^{-4}	2^{-5}	2^{-6}
2	2^{-7}	2^{-8}	2^{-9}	2^{-10}	2^{-11}	2^{-12}	2^{-13}	2^{-14}
3	2^{-15}	2^{-16}	2^{-17}	2^{-18}	2^{-19}	2^{-20}	2^{-21}	2^{-22}
4	2^{-23}	2^{-24}	2^{-25}	2^{-26}	2^{-27}	2^{-28}	2^{-29}	2^{-30}

5.3.3 Normalised value (variable normalisation): X2, X4

Meaning

Linear normalised value. 0 % corresponds to 0 (0x0), 100 % corresponds to 2^X . The structure is the same as for data types N2 and N4, but the normalisation (100 %) does not automatically refer to bit 14 or bit 30 respectively, but is variable. The normalisation bit is coded in the parameter description element “DO IO Data normalisation” (refer to 6.2.1.3).

Table 5 – X2, X4-Range of values

Coding	Data type	Range of values	Resolution	Length
123	X2 (e.g. with x = 12)	$-800 \% \leq i \leq (800 \cdot 2^{-12}) \%$	2^{-12}	2 Octet
124	X4 (e.g. with x = 28)	$-800 \% \leq i \leq (800 \cdot 2^{-28}) \%$	2^{-28}	4 Octet

Coding

- Twos complement representation, the MSB (Most Significant Bit) is the bit after the sign bit (SN) of the first octet.
- SN = 0: positive numbers including zero.
- SN = 1: negative numbers.

Table 6 – X2, X4-Coding (example x=12/28)

Octet	Bit							
	8	7	6	5	4	3	2	1
1	SN	2^2	2^1	2^0	2^{-1}	2^{-2}	2^{-3}	2^{-4}
2	2^{-5}	2^{-6}	2^{-7}	2^{-8}	2^{-9}	2^{-10}	2^{-11}	2^{-12}
3	2^{-13}	2^{-14}	2^{-15}	2^{-16}	2^{-17}	2^{-18}	2^{-19}	2^{-20}
4	2^{-21}	2^{-22}	2^{-23}	2^{-24}	2^{-25}	2^{-26}	2^{-27}	2^{-28}

5.3.4 Fixed point value: E2

Meaning

Linear fixed-point value with seven binary places after the decimal point. 0 corresponds to 0 (0x0), 128 corresponds to 2^{14} (0x4000).

Table 7 – E2-Range of values

Coding	Data type	Range of values	Resolution	Length
121	E2	$-256+2^{-7} \leq i \leq 256-2^{-7}$	$2^{-7} = 0,007\ 812\ 5$	2 Octet

Coding

- Twos complement representation, the MSB (Most significant bit) is the bit after the sign bit (SN) of the first octet.
- SN = 0: positive numbers including zero.
- SN = 1: negative numbers.

Table 8 – E2-Coding

Octet	Bit							
	8	7	6	5	4	3	2	1
1	SN	2^7	2^6	2^5	2^4	2^3	2^2	2^1
2	2^0	2^{-1}	2^{-2}	2^{-3}	2^{-4}	2^{-5}	2^{-6}	2^{-7}

5.3.5 Fixed point value: C4**Meaning**

Linear fixed point value with four decimal places. 0 corresponds to 0 (0x0), 0,0001 corresponds to 2^0 (0x0000 0001).

Table 9 – C4-Range of values

Coding	Data type	Range of values	Resolution	Length
122	C4	$-214\ 748,364\ 8 \leq i \leq 214\ 748,364\ 7$	$10^{-4} = 0,000\ 1$	4 Octet

Coding

As by Integer32, weighting of the bits has been reduced by a factor of 10 000.

5.3.6 Bit sequence: V2**Meaning**

Bit sequence to control and represent application functions. 16 Boolean variables are combined in two octets. (Coding: 115)

Table 10 – V2-Coding

Octet	Bit							
	8	7	6	5	4	3	2	1
1	15	14	13	12	11	10	9	8
2	7	6	5	4	3	2	1	0

5.3.7 Nibble: L2

Meaning

Four associated bits form a nibble. Four nibbles are represented in two octets.

The definition of the nibble is not specified. (Coding: 116)

Table 11 – L2-Coding

Octet	Bit							
	8	7	6	5	4	3	2	1
1	Nibble 3				Nibble 2			
2	Nibble 1				Nibble 0			

Comment regarding time parameters

The value of time parameters of types D2, T2, T4, R2 always refer to the specified constant sampling time T_a . The associated sampling time (value of profile parameter 962) is required in order to interpret the internal value.

5.3.8 Time constant: T2, T4

Meaning

Time data as a multiple of constant sampling time T_a .

Table 12 – T2, T4-Range of values

Coding	Data type	Range of values	Resolution	Length
118	T2	$0 \leq i \leq 32\,767 \times T_a$	T_a	2 Octet
119	T4	$0 \leq i \leq 4\,294\,967\,295 \times T_a$	T_a	4 Octet

Interpreted value = Internal value $\times T_a$

Coding of internal value

- T2: As by Unsigned16 with a restricted Range of values $0 \leq x \leq 32\,767$. When interpreted, internal values outside this range are set to 0.
- T4: As by Unsigned 32.

5.3.9 Time constant: D2

Meaning

Time data as a fraction of the constant sampling time T_a .

Table 13 – D2-Range of values

Coding	Data type	Range of values	Resolution	Length
120	D2	$0 \leq i \leq (2 \cdot 2^{-14}) \times T_a$	$2^{-14} \times T_a$	2 Octet

Interpreted value = Internal value $\times T_a/16\,384$

Coding of internal value

As by Unsigned16 with a restricted Range of values $0 \leq x \leq 32\,767$.

When interpreted, internal values outside this range are set to 0.

5.3.10 Reciprocal time constant: R2

Meaning

Time data as a reciprocal multiple of a constant sampling time T_a .

Table 14 – R2-Range of values

Coding	Data type	Range of values	Resolution	Length
117	R2	$1 \times T_a \leq i \leq 16\,384 \times T_a$	T_a	2 Octet

Interpreted value = $16\,384 \times T_a/\text{internal value}$

Coding of internal value

As by Unsigned16 with a limited Range of values $1 \leq x \leq 16\,384$.

When interpreted, internal values outside this range are set to 16 384

6 Specifications

6.1 Integration of drives in automation systems

6.1.1 General

This clause specifies the abstract modelling and different variants for integration of PROFIdrive drive axis in automation systems. This PROFIdrive model is generally independent of the communication system used as network platform (PROFIBUS, PROFINET). Depending on the communication system, limitations to the general model and functionality may be possible.

6.1.2 Base Model

6.1.2.1 Communication devices

The PROFIdrive Base Model defines as basic elements the following three classes of devices:

Controller

The Controller is a controlling device which is associated with one or more drives (axes). Related to the automation system, the Controller is the host for the overall automation.

P-Device

The P-Device (peripheral device) is a field device and the host device for the drives (closed loop control, inverter). The P-Device typically is associated with one or more Controller devices.

Supervisor

The Supervisor typically is an engineering device which manages provisions of configuration data (parameter sets) and collections of diagnosis data from P-Devices and/or Controllers.

6.1.2.2 Communication relationship

The PROFIdrive Base Model defines the following types of communication relationships between the devices:

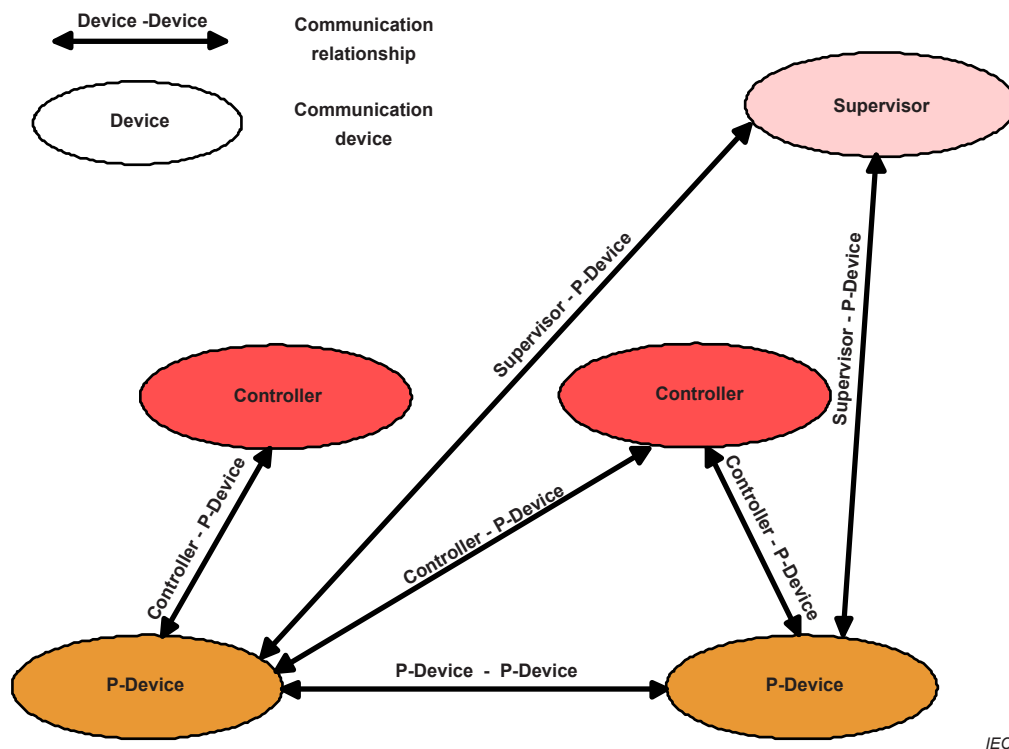


Figure 2 – PROFIdrive Devices and there relationship

Figure 2 shows the PROFIdrive Devices and the defined relationships between them in the context of the PROFIdrive Base Model.

6.1.2.3 Communication network

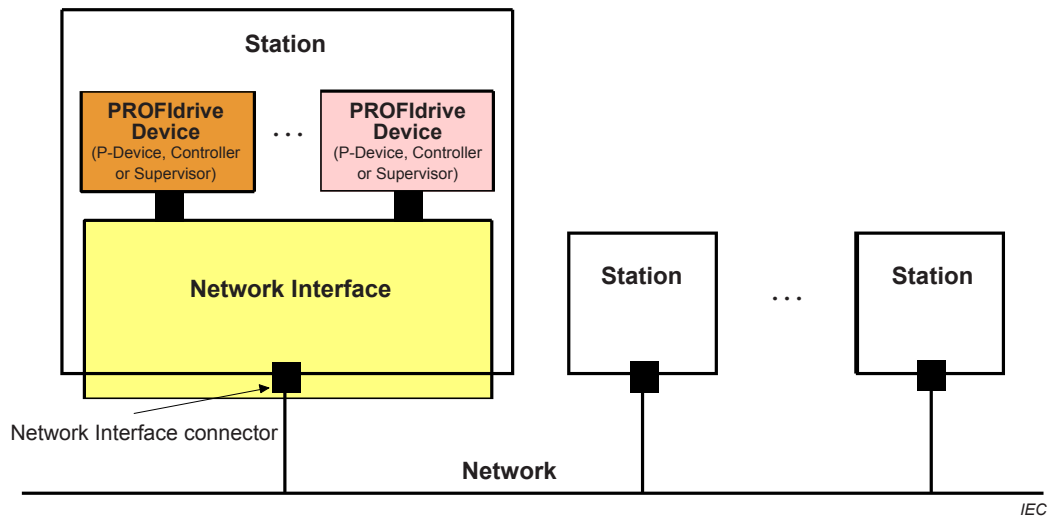


Figure 3 – General Communication Model of a PROFIdrive automation system

Figure 3 shows the general architecture of the automation system and the location of the PROFIdrive Devices as components of the Station. The physical model generally consists of physical Stations embedded in a communication network system. Though every Station comprises a Network Interface connector to physically connect the Station to the Network and a Network Interface functionality, which provides the communication service to the devices.

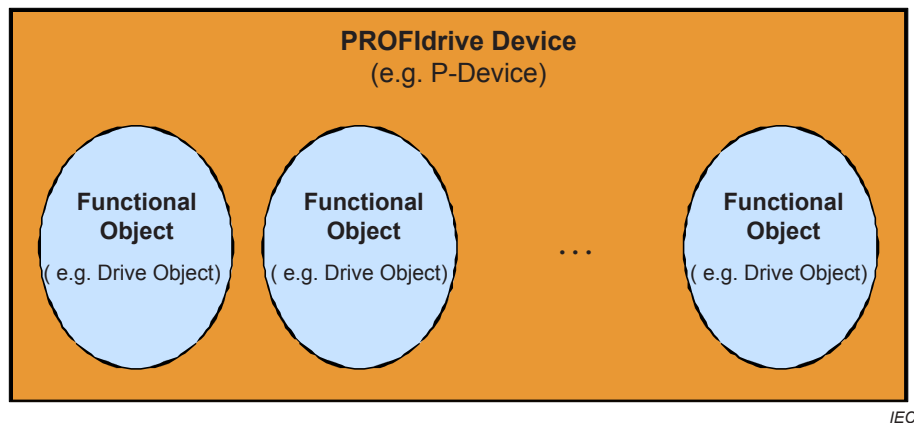
Therefore the PROFIdrive Device is precisely defined by the following address information:

- Network,
- Station (Identifier for Station inside the Network),
- Device (Identifier for Device inside the Station).

6.1.2.4 Functional Object

The PROFIdrive Device consists of one or more Functional Objects. The Functional Objects are logical Objects which represent a special functionality inside the automation system. Figure 4 shows the general architecture of the PROFIdrive Device containing Functional Objects.

If the Device is of P-Device type, the Functional Objects inside the P-Device are of Drive Object type (see Figure 4). The typical functionality of the Drive Object is the drive functionality itself (motor, inverter stage, closed loop current and speed control, input and output functionality). For example, one drive axis is related to a Drive Object.



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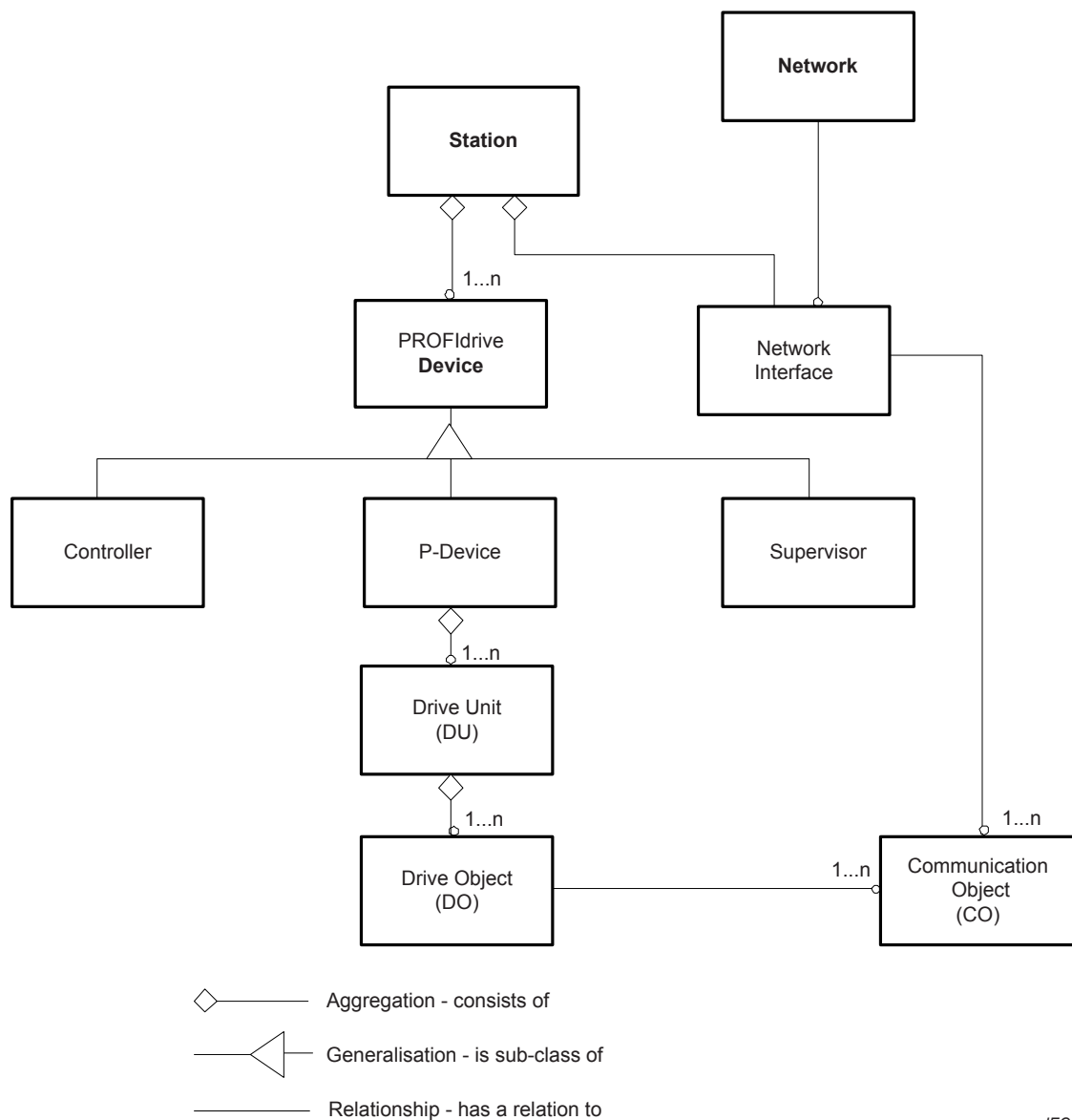
**Figure 4 – The PROFIdrive Device
(consists of one or several Functional Objects)**

6.1.2.5 Object Model

Based on the objects defined in the Base Model, the hierarchical order and dependencies between them are specified in the Object Model (see Figure 5).

Every Station consists of the Network Interface and one or more Devices. The Network Interface is related to the Network to which the Station is connected. The Devices are classified in three types, Controller, P-Device and Supervisor. If the Device is of P-Device type, the P-Device consists of one or more Drive Units (DU) which comprises one or more Drive Objects (DO). Clustering the Drive Objects in Drive Units (DU) may be used to define the affiliation of Drive Objects to one physical drive control unit (CPU) or physical cluster. The Drive Unit expresses definitely the area of validity of global parameters.

In addition, the Communication Object (CO), which has a relationship to the Network Interface and also to the Functional Object (e.g. Drive Object), is defined. The purpose of the Communication Object is to be a communication system addressable communication end point, which may be associated to a Functional Object.

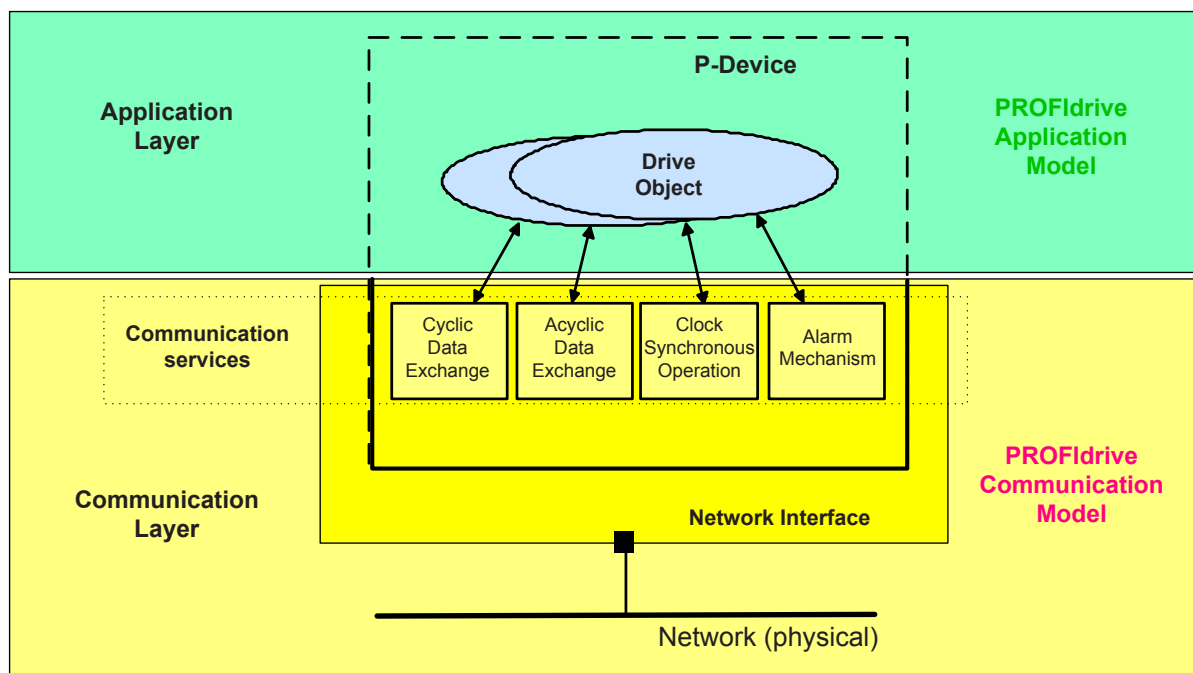


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Figure 5 – Hierarchical order in the Object Model

6.1.2.6 Layer Model

Separation of the objects in the Base Model according to the aspects of application and communication leads to the Layer Model according to Figure 6. Here, the Application Layer only contains the functional aspects of the automation system, independent of the distribution of the functional elements among physical stations and devices. The distribution aspect is represented by the Communication Layer, which specifies the physical network components and the allocation of the Functional Objects to them.



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Figure 6 – PROFIdrive Base Model contains the Application Layer and Communication Layer

6.1.2.7 Communication services

6.1.2.7.1 General

The PROFIdrive Base Model defines the following communication services. The communication services are provided from the device and are used from the Functional Object.

The representation of data shall be in big-endian format.

6.1.2.7.2 Cyclic Data Exchange

Cyclic communication means the simple transfer of IO data of predefined size in a reserved time slot. With cyclic communication, the IO data that is critical with respect to time is exchanged between the controller and device or between devices. Typical such data contains setpoint values and actual values, control- and status information. The Cyclic Data Exchange service is assigned to the “Controller – P-Device” and the “P-Device – P-Device” relationship. A Cyclic Data Exchange channel is related to a Communication Object at its end points.

6.1.2.7.3 Acyclic Data Exchange

Compared to cyclic communication, data is exchanged acyclically only if necessary. Via acyclic communication, non time critical data is transferred, for example the download of firmware or parameter data. The Acyclic Data Exchange service is assigned to the “Controller – P-Device” and the “Supervisor – P-Device” relationship. An Acyclic Data Exchange channel is related to a Communication Object at its end points.

6.1.2.7.4 Alarm Mechanism

With the Alarm Mechanism service, alarm information and exception situations are signalled to the controlling device in a real time manner. The service works demand-oriented to keep the exception status image of the Functional Object in the Controller up to date.

service, the controller is able to respond on an occurring event in the drive as fast as possible without polling the drive status information permanently. The Alarm Mechanism service is assigned to the “Controller – P-Device” relationship.

6.1.2.7.5 Clock Synchronous Operation

The Clock Synchronous Operation service guaranties that tasks on different communication devices or Functional Objects start at the same time with minimum (specified) jitter (e.g. the sampling and output processes). This service also implies, that dedicated cyclic data packages are definitely transmitted until a certain moment in the communication cycle.

For drive technology, clock cycle synchronous communication is the basis for drive synchronisation. Not only message interchange on the bus system is implemented in an isochronous time base, but also the internal control algorithms – such as closed loop speed and current controllers in the drive, or the controller in the higher level automation system – are synchronised (see Figure 7).

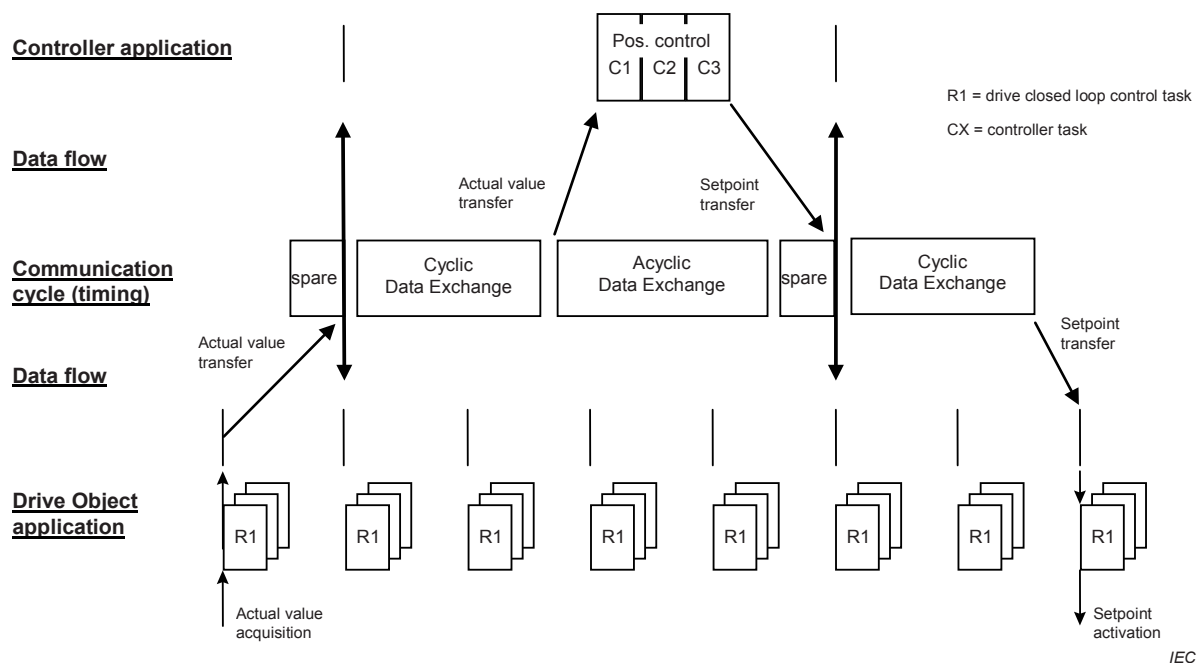


Figure 7 – Typical use case for Clock Synchronous Operation

The general model for the Clock Synchronous Operation service is defined according to Figure 8. The model is based on local clocks which are related to every Device supporting the Clock Synchronous Operation service. These local clocks are synchronised to one dedicated Master Clock. After the Clock Synchronous Operation mechanism is started, all Slave Clocks are synchronous to the Master Clock with a defined maximum Jitter of 1 μ s. The mechanism of start up and synchronisation of the Slave Clocks to the Master Clock are related to the communication system (part of the Communication Layer).

The device which comprises the Master Clock is defined as Clock Master. According to the application, application tasks may be triggered by the Slave Clock of the device. For example concerning an axis controller, the sampling of input values and the output of the motor current are triggered out of the Slave Clock and are therefore synchronous to all other processes related to the Clock Master.

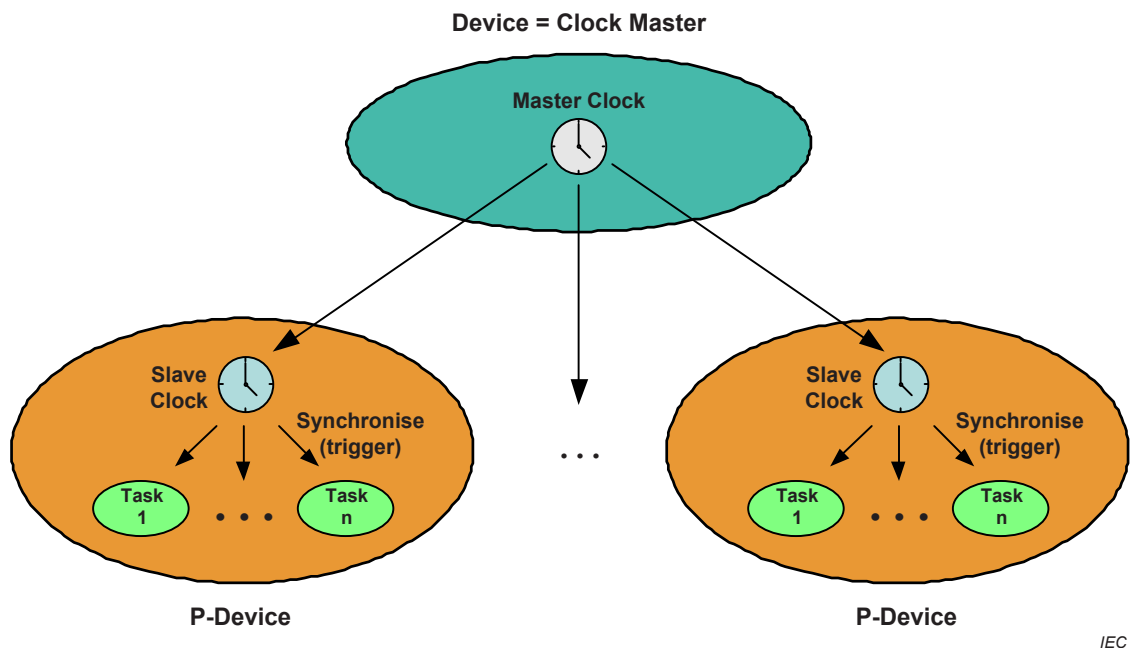


Figure 8 – General model for Clock Synchronous Operation

6.1.2.7.6 Base Model State Machine

For the Base Model (see Figure 9) the following states, related to the communication and application run up process, are defined:

Offline

There is generally no communication service working.

Preparation

In this state, the Acyclic Data Exchange service and the Alarm Mechanism are working. This means that configuration information may be passed from the Controller to the Drive Unit and that parameter access is possible. In addition, alarms will be forwarded. There may be no Cyclic Data Exchange service or the transmitted data is not valid. The communication system tries to synchronise all Slave Clocks to the Clock Master.

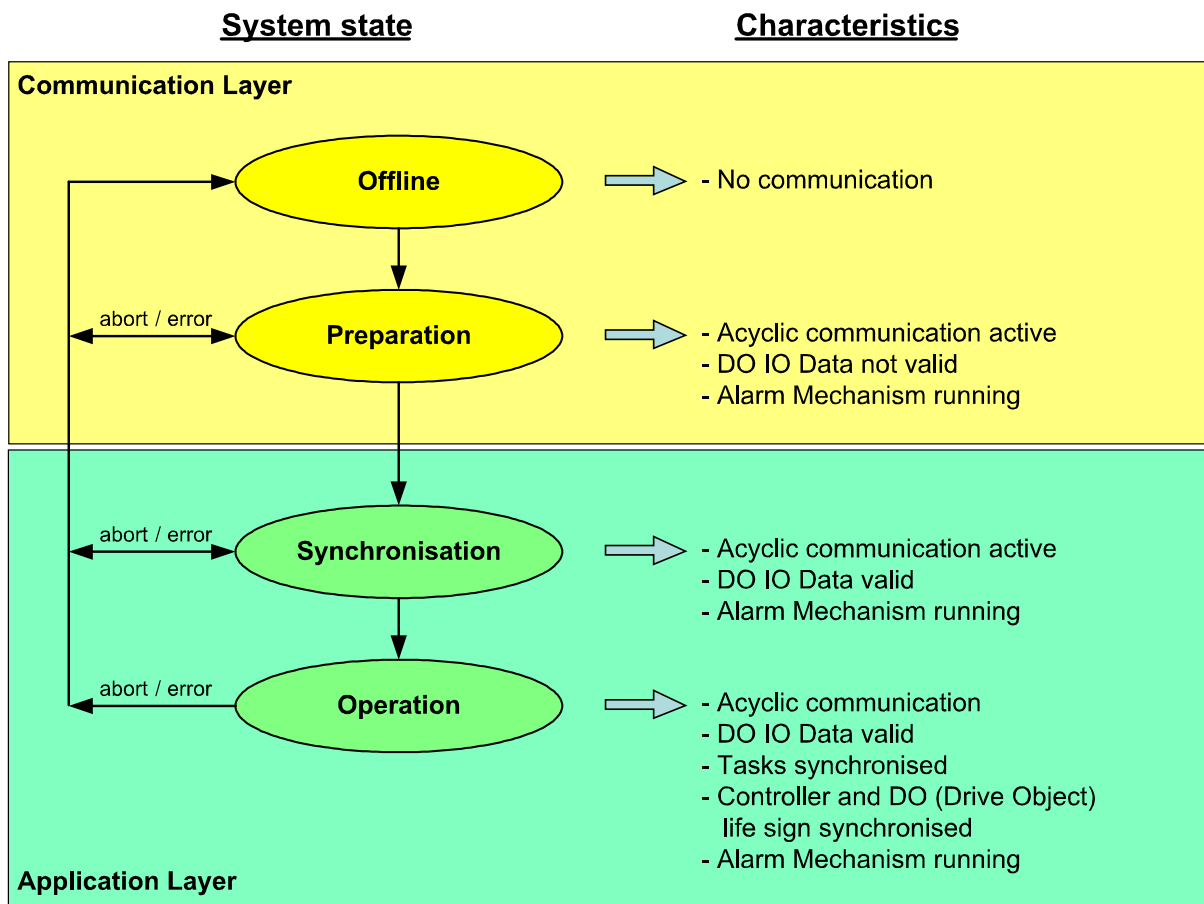
Synchronisation

In this state, the Acyclic Data Exchange, the Cyclic Data Exchange and the Alarm Mechanism are working and the transmitted cyclic data is valid. The application processes try to synchronise their tasks to each other (synchronise to the local Slave Clock and synchronise the data streams via the cyclic communication channels).

Operation

In this state, the application processes are also synchronised and the whole application is ready to operate (productive work).

If, in one of these states, exceptions occur which cause the system to lose one or more of the characteristics related to the actual state, the related devices will be forced to go back to a corresponding predecessor state, in order to proceed to switch forward to the next higher level again, if possible and allowed.



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Figure 9 – Base Model State Machine

6.1.3 Drive model

6.1.3.1 General

Based on the P-Device device type, defined in the Base Model previously, this subclause defines the architecture of the P-Device in more detail.

6.1.3.2 P-Device

This profile of drive engineering defines a PROFIdrive Device of P-Device type according to Figure 10 as a P-Device containing exactly one or multiple Drive Units (DU). The P-Device may also contain other objects which are not Drive Units. See also Figure 5.

6.1.3.3 Drive Unit

This profile of drive engineering defines a PROFIdrive Drive Unit (DU) according to Figure 10 as part of a P-Device containing exactly one or multiple Drive Objects (DO). The unambiguous identification of a Drive Object within a Drive Unit is done by the Drive Object ID (DO-ID) which is assigned to every DO of a DU. The Drive Unit contains only Drive Objects. See also Figure 5.

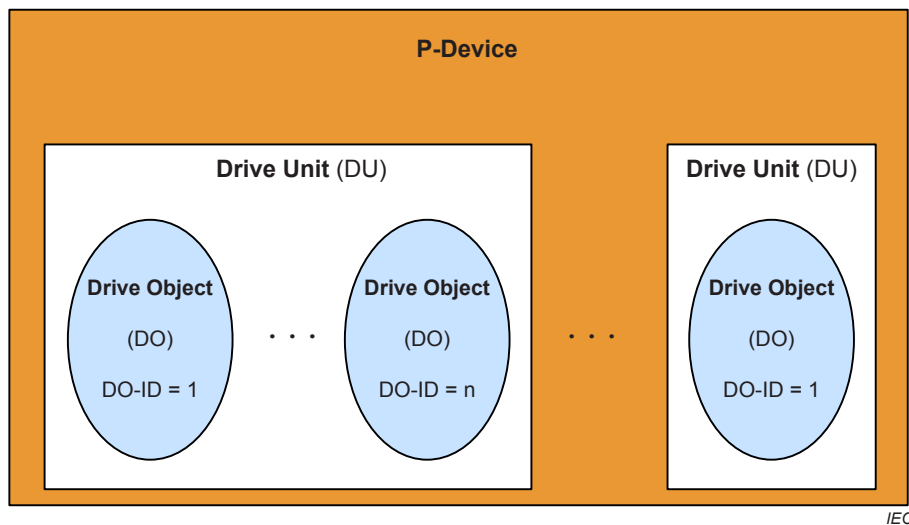


Figure 10 – General Drive Unit model

6.1.3.4 Drive Object

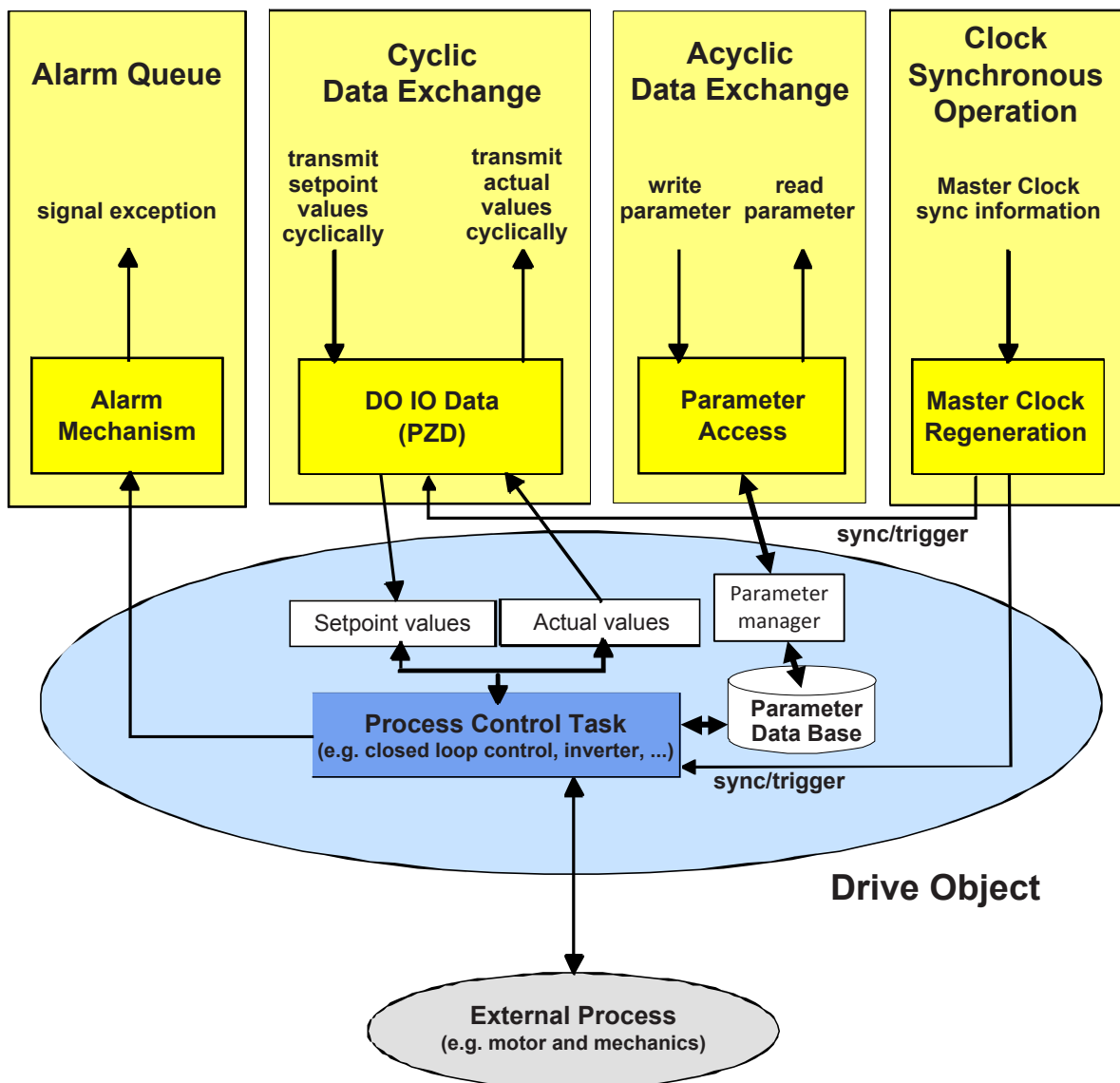
Figure 11 shows the general Drive Object (DO) architecture. The central element of the DO is the Process Control Task which is responsible for the automation functionality of the DO. Properties of the DO and the Process Control Task are represented and controlled by parameters. The parameters are administered in the Parameter Data Base. To access DO parameter, Acyclic Data Exchange service is used. For periodic transportation of setpoint values to the DO and actual values from the DO, the Cyclic Data Exchange service is used. If the DO is of Axis type (refer to 6.1.3.5), the DO comprises a General State Machine, which controls and represents the states of the Drive Process Control Task. Exceptions from the standard behaviour may occur in the Process Control Task or in the General State Machine. These exceptions may be signalled by the Alarm Mechanism to the controlling device.

The DO shall comprise as a minimum mandatory functionality:

- parameters

The DO may comprise as an optional functionality:

- Process Control Task,
- DO IO Data (setpoint value, actual values),
- General State Machine (for Axis type DO mandatory),
- support for Alarm Mechanism.



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Figure 11 – General Drive Object architecture

6.1.3.5 Axis type Drive Object

The DOs may be of different type. One dedicated type, which is of general importance in this drive profile is the Axis type, which is typically related to a motor (Drive Axis) and is specified in detail in 6.3.

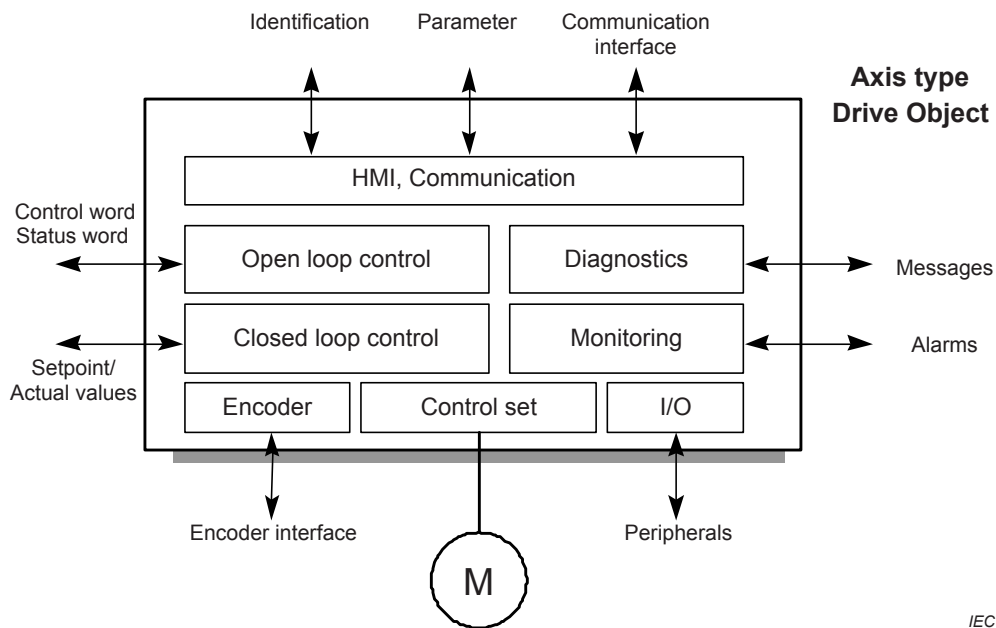


Figure 12 – Principle functional model of an Axis type Drive Object

Figure 12 shows the principle functionality of an Axis type DO. The Axis DO consists of numerous function modules that work together internally, and therefore portray the intelligence of the Axis type DO.

The following logical objects are included in an Axis DO:

- objects for DO identification;
- parameters for accessing information and settings of the individual function modules;
- objects for setting the communication interface (for example, PROFIdrive Interface);
- objects for drive control (for example, control words and status words);
- objects for setpoint processing (for example, setpoint values and actual values);
- objects for diagnostics and monitoring (for example, messages, alarms, faults);
- objects for integrated sensor interface(s);
- objects for integrated peripheral functions (integrated I/O).

6.1.3.6 P-Device classification

Figure 13 shows the two classes of PROFIdrive P-Devices. While the Homogeneous type is a P-Device containing only one PROFIdrive Drive Unit (and nothing else), the Heterogeneous P-Device contains at least one PROFIdrive Drive Unit and other objects of this abstraction layer which are not specified within PROFIdrive (they may belong to other application profiles).

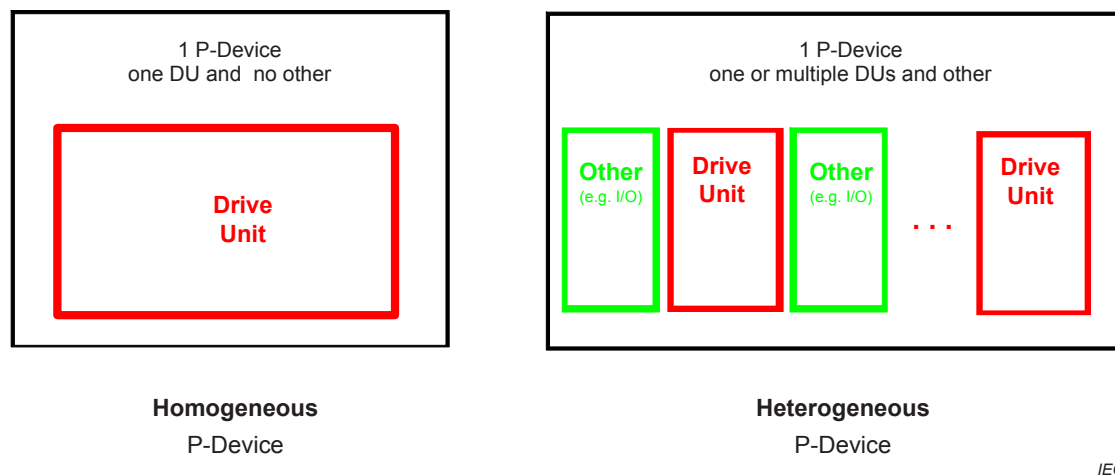


Figure 13 – Classes of PROFIdrive P-Devices

6.1.3.7 Drive Unit classification

Figure 14 shows the three principle classes of PROFIdrive Drive Units. While the Single-Axis type is one physical device with only one Axis type DO, the Multi-Axis type consists of several similar Axis type DOs. The modular type provides the greatest flexibility and comprises one or more DOs, which may be of a different type.

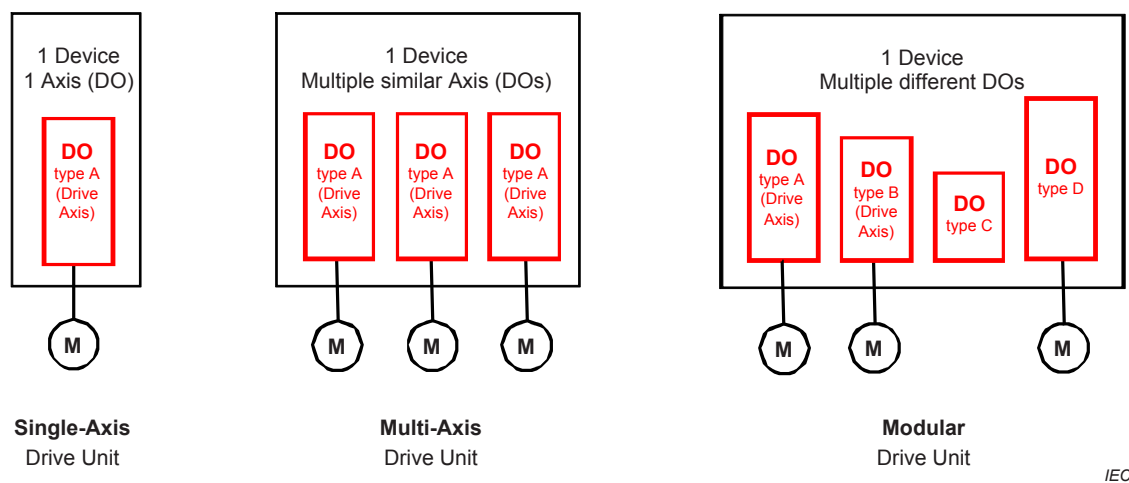
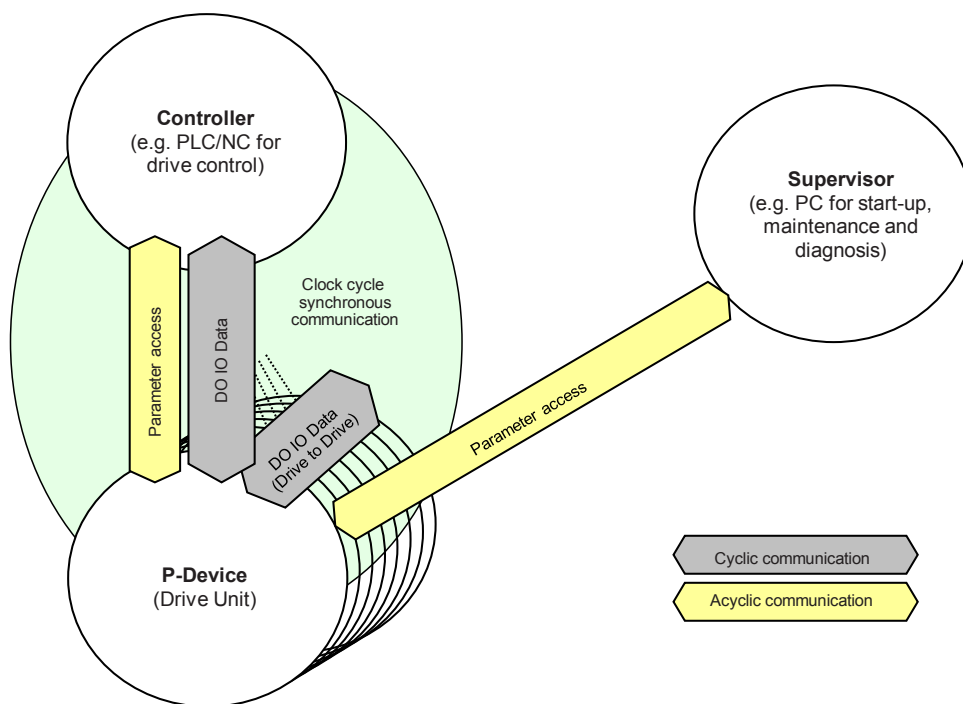


Figure 14 – Classes of PROFIdrive Drive Units

6.1.4 P-Device communication model

Figure 15 shows the different communication channels which are available between the P-Device and the other Devices. The color shows the communication service related to this communication channel.

The Clock Synchronous Operation as well as DO IO Data transfer is available between P-Device and Controller and between P-Devices itself (Drive to Drive communication). Parameter access to the P-Device is available from all other Controller and Supervisor devices.



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Figure 15 – Overview of the available communication services between the PROFIdrive Devices

6.1.5 Application Model and Application Classes

6.1.5.1 General

At present, drive applications are realised in multiple ways. Table 15 defines the different Application Classes where the drives are used. The Application Classes (AC) are typical examples from the entire spectrum of electrical drive engineering. The Application Classes include the functionality given by the application modes in IEC 61800-7-1.

The Application Model is part of the Application Layer and therefore only related to functional aspects (Functional Objects), independent on the distribution of Functional Objects among devices. Therefore the type of Application Class predefines the contents of the Functional Objects and the type of data (information) to be transported between the Functional Objects (interface). The Application Classes defined in Table 15 are assigned Profile functions in 6.3.13, which a drive manufacturer shall implement if he wishes to be compliant with the particular Application Class.

Table 15 – Application Classes

No.	Application Class	Interface	Functions ^b
1	Standard Drive	n-setpoint, torque-setpoint, current-setpoint	Cyclic IO Data interface ^a
2	Standard drive with distributed technology controller (continuous process)	Technological setpoint-actual values (command variables)	Cyclic IO Data interface with Drive to Drive communication ^a
3	Single Axis positioning drive, with local Motion Control	pos-setpoint, run requests	Cyclic IO Data interface ^a
4	Motion Control with central interpolation and speed setpoint interface Optional: DSC (Dynamic Servo Control)	n-setpoint x-actual additionally, for DSC: Δx (x_{err}), K_V (k_{PC})	Cyclic IO Data interface, Clock Synchronous Operation, DSC (refer to 6.3.5)
5	Motion Control with central interpolation and position setpoint interface	x-setpoint	Cyclic IO Data interface, Clock Synchronous Operation ^c
6	Motion control for clocked processes, or distributed angular synchronism	Command variables, motion instructions	Cyclic IO Data interface, Clock Synchronous Operation, Drive to Drive communication
^a The cyclic interface may also be operated clock-synchronously if, for example, it is a question of synchrony of the actions in the case of several drives.			
^b For all Application Classes: acyclic interface for parameters, diagnostics, identification.			
^c This Application Class is not described in this edition of the Profile. The dynamic characteristics of Application Class 5 are reached with Application Class 4 with DSC.			

6.1.5.2 AC 1: Standard Drive

In the simplest case, the drive is controlled via a primary setpoint (for example, speed setpoint) (see Figure 16). The speed control is governed completely in the drive controller. The PLC includes all technological functions for the automation process. The field bus is merely the transmission medium between the automation system and the drive controller. The Cyclic Data Exchange communication service is used. This type of application is used primarily in the field of classical drive engineering (for example, conveyor systems). A PLC is usually used as the automation system. Clock Synchronous Operation may be used, but is typically not necessary for this Application Class.

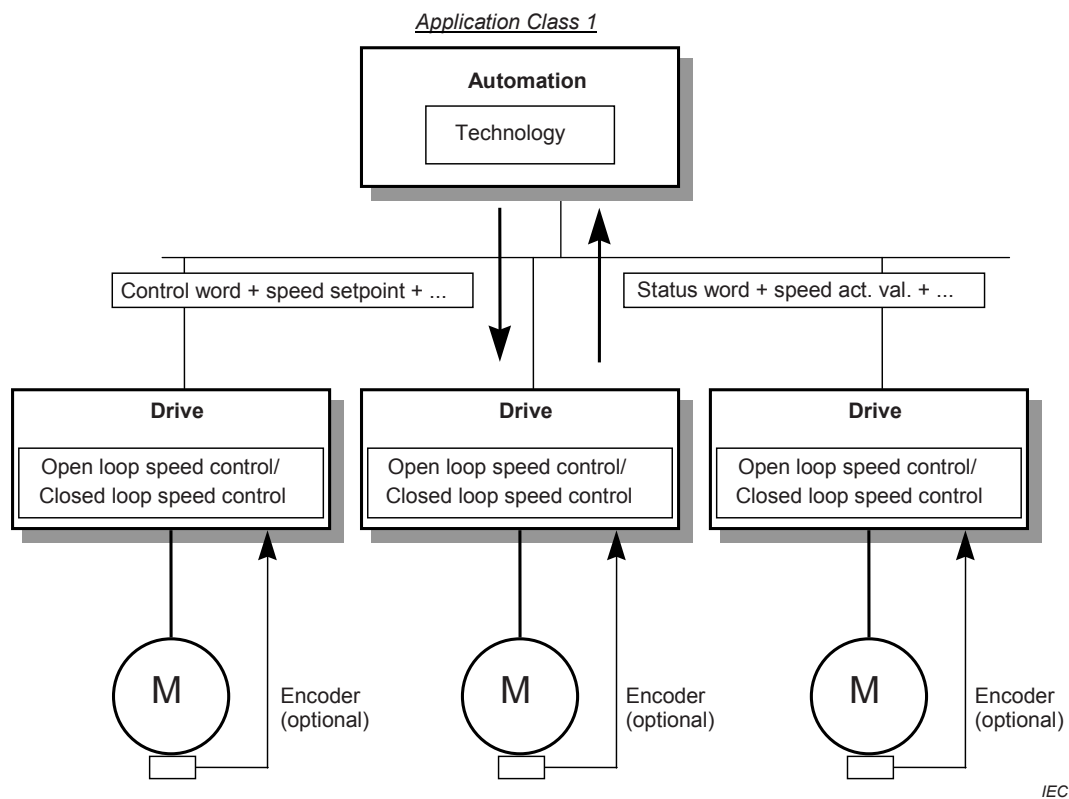


Figure 16 – Application Class 1

6.1.5.3 AC 2: Standard drive with distributed technology controller

Application Class 2 represents a very flexible version for implementing drive applications (see Figure 17). In this version, the automation process is broken down into many small sub-processes.

The technology functions are no longer exclusively in the central PLC, but are also distributed in the drives. The communication interface serves as the technology interface. The data that is exchanged via the bus system between the individual automation components and drive controllers may be individually defined. This variant assumes, however, that communication is guaranteed in all directions; that is, DO IO Data transfer should be possible also between Drive Objects (Axis). To realise applications like setpoint cascades, winders, and speed synchronism Clock Synchronous Operation should be possible. The technology functions are realised in the drive.

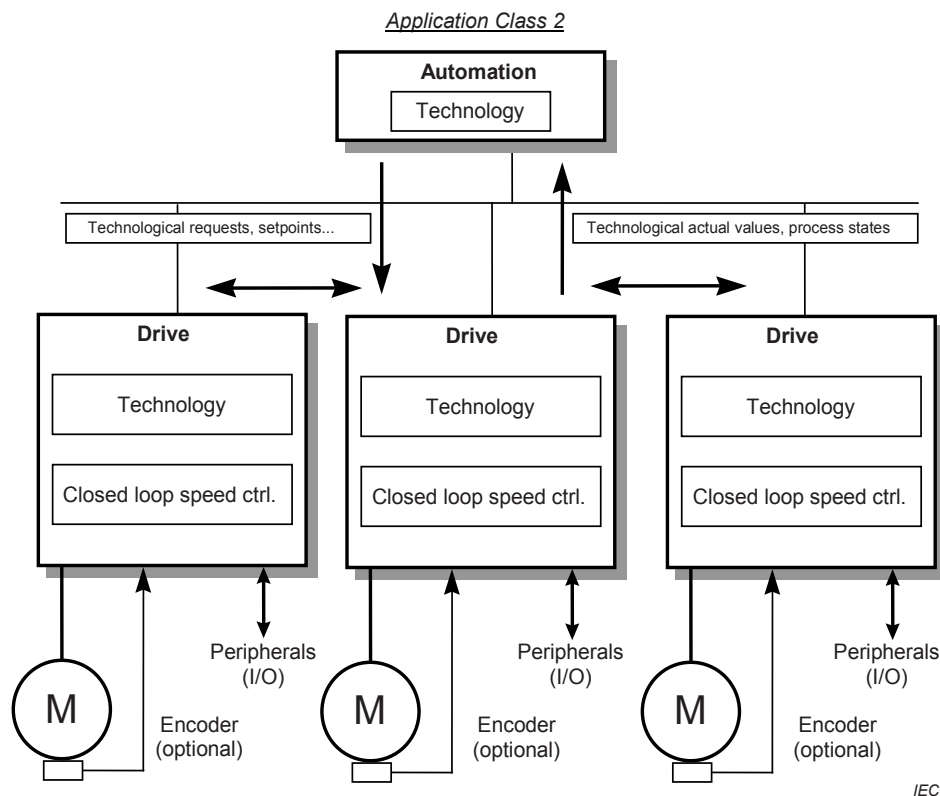


Figure 17 – Application Class 2

6.1.5.4 AC 3: Single Axis positioning drive with local Motion Control

In Application Class 3 (see Figure 18), only the technology functions for the automation process are still in the PLC. Positioning requests are stored in the Drive. A single positioning request is started via a command from the Controller (e.g. PLC). Interpolation and position control as well as speed control are implemented directly in the drive. Since in this variant, all time-critical control algorithms are hidden in the drive controller, Clock Synchronous Operation is only necessary if complex tracking for multiple axes shall be coordinated.