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Elektrische Leistungsantriebssysteme mit einstellbarer Drehzahl – Teil 7-203: Generisches Interface und Nutzung von Profilen für Leistungsantriebssysteme (PDS) – Spezifikation von Profil-Typ 3 (IEC 61800-7-203:2007); Englische Fassung EN 61800-7-203:2008

Adjustable speed electrical power drive systems –
Part 7-203: Generic interface and use of profiles for power drive systems –
Profile type 3 specification (IEC 61800-7-203:2007);
English version EN 61800-7-203:2008

Entraînements électriques de puissance à vitesse variable –
Partie 7-203: Interface et utilisation génériques de profils pour les entraînements électriques de puissance –
Spécifications des profils de type 3 (CEI 61800-7-203:2007);
Version anglaise EN 61800-7-203:2008

Gesamtumfang 190 Seiten

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Beginn der Gültigkeit

Die von CENELEC am 2008-02-01 angenommene EN 61800-7-203 gilt als DIN-Norm ab 2008-11-01.

Nationales Vorwort

Vorausgegangener Norm-Entwurf: E DIN IEC 61800-7-2:2006-06.

Für diese Norm ist das nationale Arbeitsgremium K 226 „Ausrüstung von Starkstromgeräten und -anlagen mit elektronischen Betriebsmitteln“ der DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik im DIN und VDE (www.dke.de) zuständig.

Die enthaltene IEC-Publikation wurde vom SC 22G „Semiconductor power converters for adjustable speed electric drive systems“ erarbeitet.

Diese Norm erscheint ausschließlich in der englischsprachigen Originalfassung.

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Der Zusammenhang der zitierten Normen mit den entsprechenden Deutschen Normen ergibt sich, soweit ein Zusammenhang besteht, grundsätzlich über die Nummer der entsprechenden IEC-Publikation. Beispiel: IEC 60068 ist als EN 60068 als Europäische Norm durch CENELEC übernommen und als DIN EN 60068 ins Deutsche Normenwerk aufgenommen.

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 61800-7-203

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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 61800-7-203:2007)

Entraînements électriques de puissance à vitesse variable – Partie 7-203: Interface et utilisation génériques de profils pour les entraînements électriques de puissance – Spécifications des profils de type 3 (CEI 61800-7-203:2007)

Elektrische Leistungsantriebssysteme mit einstellbarer Drehzahl – Teil 7-203: Generisches Interface und Nutzung von Profilen für Leistungsantriebssysteme (PDS) – Spezifikation von Profil-Typ 3 (IEC 61800-7-203:2007)

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CENELEC

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

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Foreword

The text of document 22G/184/FDIS, future edition 1 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 was approved by CENELEC as EN 61800-7-203 on 2008-02-01.

The following dates were fixed:

– latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2008-11-01

– latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 2011-02-01

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

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

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[SI] Siemens AG
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Annex ZA has been added by CENELEC.

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Endorsement notice

The text of the International Standard IEC 61800-7-203:2007 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	NOTE	Harmonized in EN 61158 series (not modified).
IEC 61499-1	NOTE	Harmonized as EN 61499-1:2005 (not modified).
IEC 61784-1	NOTE	Harmonized as EN 61784-1:2008 (not modified).
IEC 61784-2	NOTE	Harmonized as EN 61784-2:2008 (not modified).
IEC 61800	NOTE	Harmonized in EN 61800 series (not modified).
IEC 61800-7-201	NOTE	Harmonized as EN 61800-7-201:2008 (not modified).
IEC 61800-7-202	NOTE	Harmonized as EN 61800-7-202:2008 (not modified).
IEC 61800-7-204	NOTE	Harmonized as EN 61800-7-204:2008 (not modified).
IEC 61800-7-301	NOTE	Harmonized as EN 61800-7-301:2008 (not modified).
IEC 61800-7-302	NOTE	Harmonized as EN 61800-7-302:2008 (not modified).
IEC 61800-7-304	NOTE	Harmonized as EN 61800-7-304:2008 (not modified).

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INTRODUCTION

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

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 systems 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 adopt 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.

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IEC 61800-7-1 is divided into a generic part and several annexes as shown in Figure 1. The drive profile types for CiA 402[1], CIP Motion™[2], PROFIdrive[3] and SERCOS Interface™[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 trademarks.

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.

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], EtherCAT™[6], Ethernet Powerlink™[7], DeviceNet™[8], ControlNet™[9], EtherNet/IP™[10], PROFIBUS[11], PROFINET[12] and SERCOS Interface).

_____

1 CiA 402 is a trade name of CAN in Automation, e.V. 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 CiA 402.

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

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4 SERCOS™ and SERCOS Interface™ are trade names of SERCOS International e.V. 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 SERCOS and SERCOS interface. Use of the trade name SERCOS and SERCOS interface requires permission of the trade name holder.

5 CANopen is an acronym for *C*ontroller *A*rea *N*etwork *open* and is used to refer to EN 50325-4.

6 EtherCAT™ is a trade name 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 trademark holder or any of its products. Compliance to this profile does not require use of the trade name EtherCAT™. Use of the trade name EtherCAT™ requires permission of the trade name holder.

7 Ethernet Powerlink™ is a trade name of B&R, control of trade name 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 trademark holder or any of its products. Compliance to this profile does not require use of the trade name Ethernet Powerlink™. Use of the trade name Ethernet Powerlink™ requires permission of the trade name holder.

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9 ControlNet™ is a trade name of ControlNet International, Ltd. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by IEC of the trademark holder or any of its products. Compliance to this profile does not require use of the trade name ControlNet™. Use of the trade name ControlNet™ requires permission of ControlNet International, Ltd.

10 EtherNet/IP™ is a trade name of ControlNet International, Ltd. and Open DeviceNet Vendor Association, Inc. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by IEC of the trademark holder or any of its products. Compliance to this profile does not require use of the trade name EtherNet/IP™. Use of the trade name EtherNet/IP™ requires permission of either ControlNet International, Ltd. or Open DeviceNet Vendor Association, Inc.

11 PROFIBUS is a trade name of PROFIBUS 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 International.

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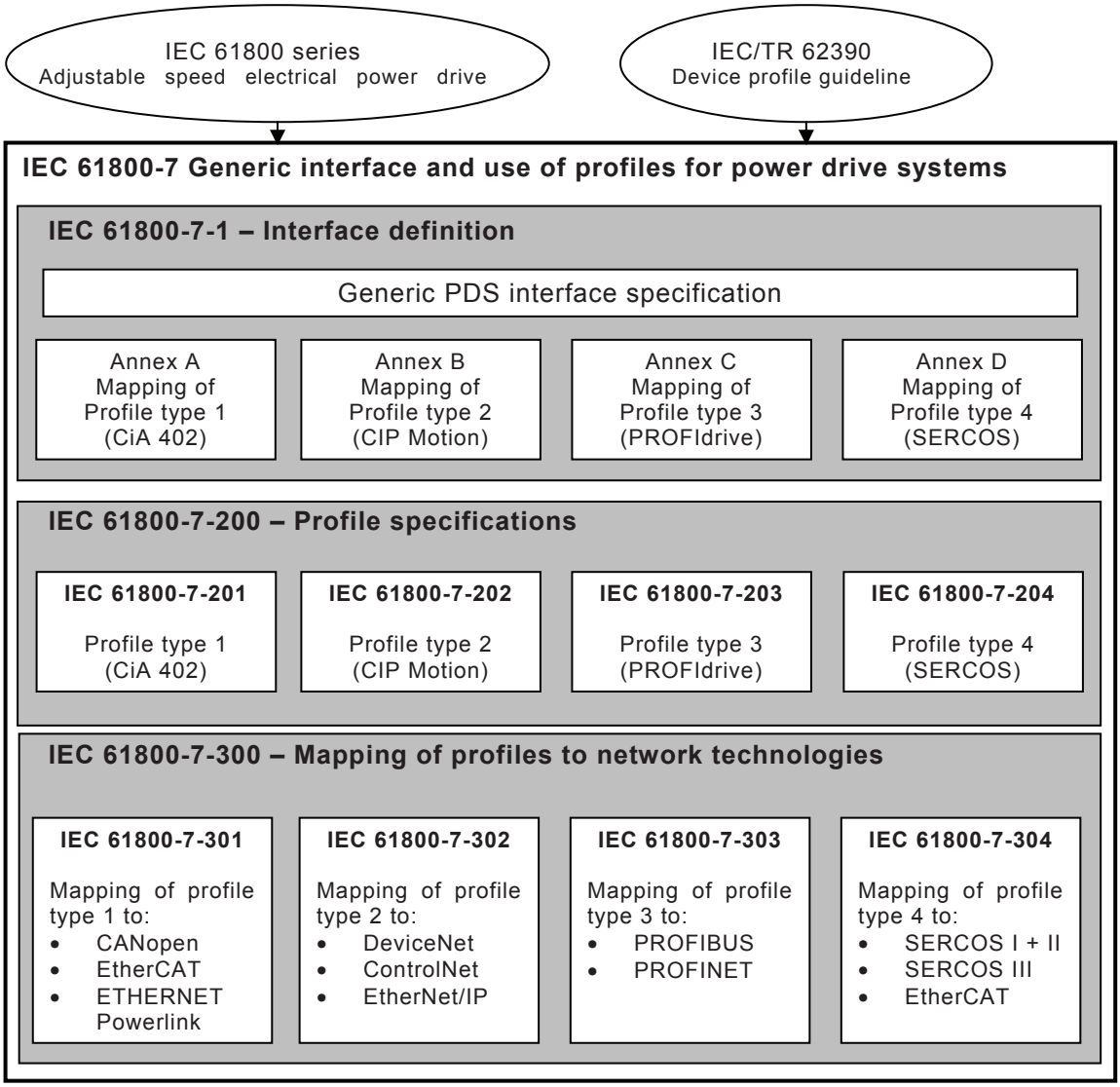

Figure 1 – Structure of IEC 61800-7

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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

1 Scope

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

The functions specified in this part of IEC 61800-7 are not intended to ensure functional safety. This requires additional measures according to the relevant standards, agreements and laws.

This part of IEC 61800-7 specifies profile type 3 for Power Drive Systems (PDS). Profile type 3 can be mapped onto different communication network technologies.

2 Normative references

The following referenced documents are indispensable for the application 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 61158-5-3, *Industrial communication networks – Fieldbus specifications – Part 5-3 (Ed.1.0): Application layer service definition – Type 3 elements*

IEC 61158-5-10, *Industrial communication networks – Fieldbus specifications – Part 5-10 (Ed.1.0): Application layer service definition – Type 10 elements*

IEC 61158-6-3, *Industrial communication networks – Fieldbus specifications – Part 6-3 (Ed.1.0): Application layer protocol specification – Type 3 elements*

IEC 61158-6-10, *Industrial communication networks – Fieldbus specifications – Part 6-10 (Ed.1.0): Application layer protocol specification – Type 10 elements*

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

IEC 61800-7-1, *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, *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*

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3 Terms, definitions and abbreviatiated 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 at a given instant

[IEV 351-21-02]

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

[IEV 351-21-37]

3.1.3
application
software functional element specific to the solution of a problem in industrial-process measurement and control

NOTE An application may be distributed among resources, and may communicate with other applications.

[IEC/TR 62390:2005, 3.1.2, modified]

3.1.4
application mode
type of application that can be requested from a PDS

NOTE The different application modes reflect the control loop for torque control, velocity control, position control or other applications like homing.

3.1.5
attribute
property or characteristic of an entity

[IEC/TR 62390:2005, 3.1.3]

3.1.6
class
description of a set of objects that share the same attributes, operations, methods, relationships, and semantics

[ISO/IEC 19501, modified]

3.1.7
clock cycle synchronous application
synchronisation of sampling and cycle times in the closed-loop control software in digital drives and control systems

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3.1.8
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 The behaviour is reflected by states or operating modes.

NOTE 2 The different commands may be represented by one bit each.

3.1.9
control
purposeful action on or in a process to meet specified objectives

[IEV 351-21-29]

3.1.10
control device
physical unit that contains – in a module/subassembly or device – an application program to control the PDS

3.1.11
data type
set of values together with a set of permitted operations

[ISO/IEC 2382-15:1999, 15.04.01, modified]

3.1.12
device
field device

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

[IEC 61499-1:2005, 3.30, modified]

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

[ISO 15745-1:2003, 3.11]

3.1.13
device profile
representation of a device in terms of its parameters, parameter assemblies and behaviour according to a device model that describes the device's data and behaviour as viewed through a network

NOTE This is a definition from IEC/TS 61915 which is extended by the addition of the device functional structure.

[IEC/TR 62390:2005, 3.19, modified]

3.1.14
DO IO Data
collection of all Input Data and Output Data (cyclic transmission) of a Drive Object (drive axis)

3.1.15
Drive Object
functional element of a Drive Unit

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3.1.16
Drive to Drive communication
communication (cyclic) between drives from the user's perspective

3.1.17
Drive Unit
logical device which comprises all functional elements related to one central processing unit

3.1.18
functional element
entity of software or software combined with hardware, capable of accomplishing a specified function of a device

NOTE 1 A functional element has an interface, associations to other functional elements and functions.

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

[IEC/TR 62390:2005, 3.1.12]

3.1.19
interface
shared boundary between two entities defined by functional characteristics, signal characteristics, or other characteristics as appropriate

[IEV 351-21-35, modified]

3.1.20
Input Data
data to be sent cyclically from the device to the controller

3.1.21
IO Data
Input Data and Output Data of a device

3.1.22
Isochronous Mode
communication system service for clock cycle synchronism which generates a constant (timing) bus cycle

3.1.23
model
mathematical or physical representation of a system or a process, based with sufficient precision upon known laws, identification or specified suppositions

[IEV 351-21-36]

3.1.24
operating mode
characterisation of the way and the extent to which the human operator intervenes in the control equipment

[IEV 351-31-01]

3.1.25
Output Data
data to be sent cyclically from the controller to the device

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3.1.26
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 Adapted from IEC/TS 61915.

NOTE 2 A parameter is typically characterised by a parameter name, data type and access direction.

[IEC/TR 62390:2005, 3.1.22, modified]

3.1.27
Process data
data related to the control process, for example gain factor and state vaiables, typically mapped on parameters

3.1.28
profile
representation of a PDS interface in terms of its parameters, parameter assemblies and behaviour according to a communication profile and a device profile

3.1.29
setpoint
value or variable used as Output Data of the application control program to control the PDS

3.1.30
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 The different status information may be coded with one bit each.

3.1.31
technological functions
closed-loop controls and sequence controls to automate application-specific processes

3.1.32
type
hardware or software element which specifies the common attributes shared by all instances of the type

[IEC/TR 62390:2005, 3.1.25]

3.1.33
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

[IEC/TR 62390:2005, 3.1.26]

3.1.34
variable
software entity that may take different values, one at a time

[IEC/TR 62390:2005, 3.1.27]

NOTE The values of a variable as well as of a parameter are usually restricted to a certain data type.

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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	Device Data File (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
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 international

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PLC	Programmable Logic Controller without a Motion Control command set
PLL	Phase Locked Loop (phase control loop)
PNO	PROFIBUS User Organization
PNU	Parameter Number
PROFIBUS	Process Field Bus
PROFINET	Process Field Bus
PWE	Parameter value
RFG	Ramp Function Generator
SN	Sign
STW	Control Word
T_a	Sampling time
T_{DP}	DP-Cycle-Time
T_{DX}	Data_Exchange-Time
T_M	Master-Time
T_{MAPC}	Master_Application_Cycle-Time
T_{MLS}	Master_Life_Sign-Time
T_O	Output-Time
T_{PC}	Position Controller Sampling Time
T_{SC}	Speed Controller Sampling Time
T_{SLS}	Slave_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 user organization PROFIBUS 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.

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The mapping to the generic interface is given in IEC 61800-7-1, 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 61158-5-3. For more details see IEC 61158-5-10, IEC 61158-6-3 and IEC 61158-6-10. 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.

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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	Coding (decimal)
Boolean	Boolean (see IEC 61158-5-3)	1
Integer8	Integer8 (see IEC 61158-5-3)	2
Integer16	Integer16 (see IEC 61158-5-3)	3
Integer32	Integer32 (see IEC 61158-5-3)	4
Integer64	Integer64 (see IEC 61158-5-3)	55
Unsigned8	Unsigned8 (see IEC 61158-5-3)	5
Unsigned16	Unsigned16 (see IEC 61158-5-3)	6
Unsigned32	Unsigned32 (see IEC 61158-5-3)	7
Unsigned64	Unsigned64 (see IEC 61158-5-3)	56
FloatingPoint	Float32 (see IEC 61158-5-3)	8
FloatingPoint64	Float64 (see IEC 61158-5-3)	15
VisibleString	VisibleString (see IEC 61158-5-3)	9
OctetString	OctetString (see IEC 61158-5-3)	10
TimeOfDay (with date indication)	TimeOfDay (see IEC 61158-5-3)	12
TimeDifference	TimeDifference (see IEC 61158-5-3)	13
Date	Date (see IEC 61158-5-3)	50
TimeOfDay without date indication	TimeOfDay (see IEC 61158-5-3)	52
TimeDifference with date indication	TimeDifference (see IEC 61158-5-3)	53
TimeDifference without date indication	TimeDifference (see IEC 61158-5-3)	54

The data types Unsigned8, Unsigned16 and Unsigned32 shall be implemented by every drive. All other standard data types may be implemented in addition (optional data types).

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	Coding (decimal)
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

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Data types used in Profile PROFIdrive	Reference to definition	Coding (decimal)
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

To allow 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	$-200\ \% \le i \le (200\text{-}2^{-14})\ \%$	$2^{-14} = 0{,}006\ 1\ \%$	2 Octet
114	N4	$-200\ \% \le i \le (200\text{-}2^{-30})\ \%$	$2^{-30} = 9{,}3 \times 10^{-8}\ \%$	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).

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Table 5 – X2, X4-Range of values

Coding	Data type	Range of values	Resolution	Length
123	X2 (e.g. with x = 12)	$-800\ \% \le i \le (800\text{-}2^{-12})\ \%$	2^{-12}	2 Octet
124	X4 (e.g. with x = 28)	$-800\ \% \le i \le (800\text{-}2^{-28})\ \%$	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	$-256+2^{-7} \le i \le 256\text{-}2^{-7}$	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).

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Table 9 – C4-Range of values

Coding	Data type	Range of values	Resolution	Length
122	C4	-214 748,364 8 ≤ i ≤ 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	$0 \le i \le 32\,767 \times T_a$	T_a	2 Octet
119	T4	$0 \le i \le 4\,294\,967\,295 \times T_a$	T_a	4 Octet

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Interpreted value = Internal value × 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	$0 \leq i \leq (2\text{-}2^{-14}) \times T_a$	$2^{-14} \times T_a$	2 Octet

Interpreted value = Internal value × 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 × T_a/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:

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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:

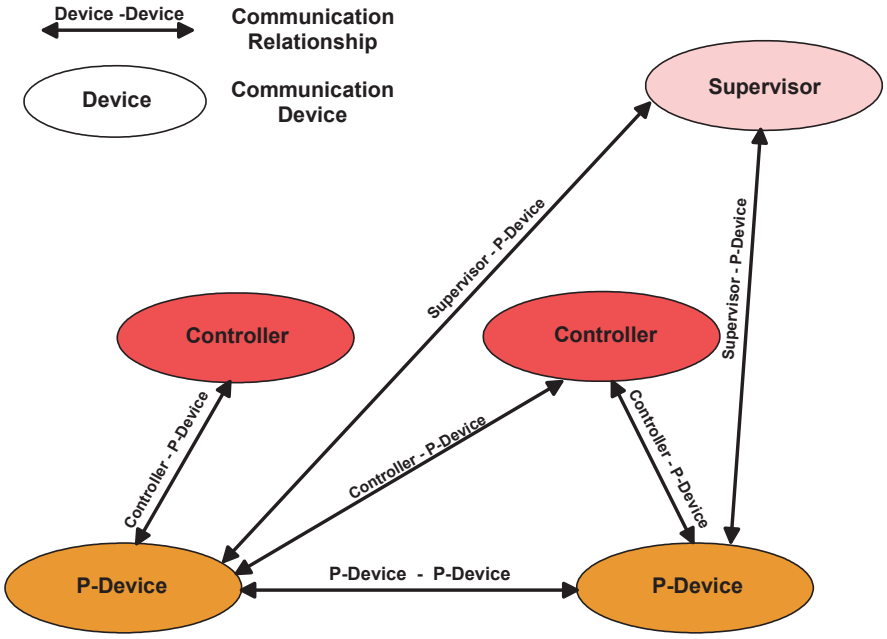

Figure 2 – PROFIdrive Devices and there relationship

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

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6.1.2.3 Communication Network

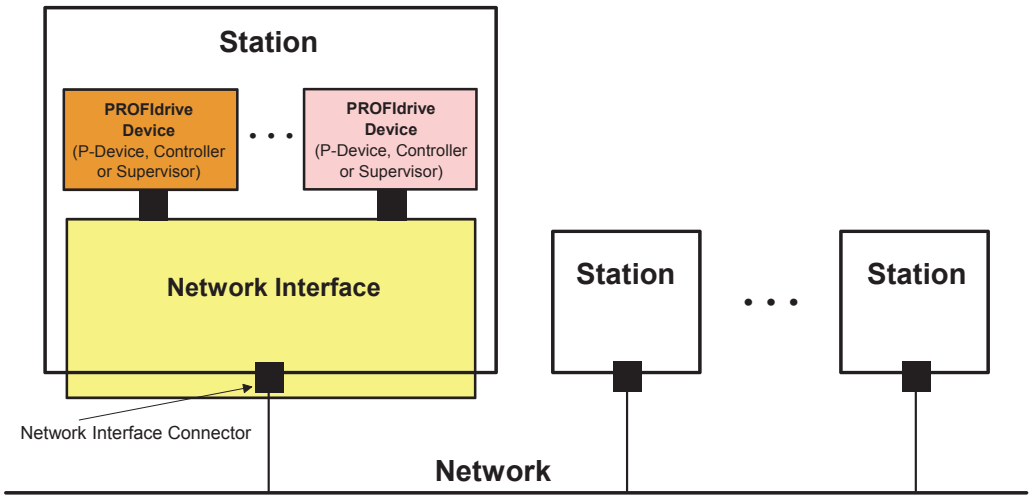

Figure 3 – General Communication Model of a PROFIdrive Automation System

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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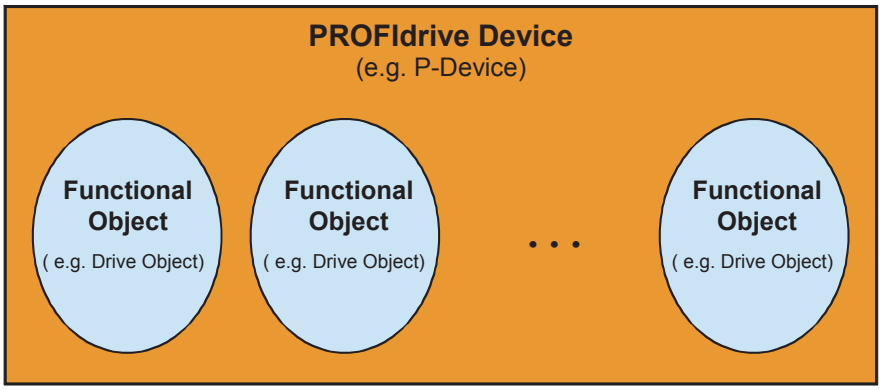

Figure 4 – The PROFIdrive Device (consists of one or several Functional Objects)

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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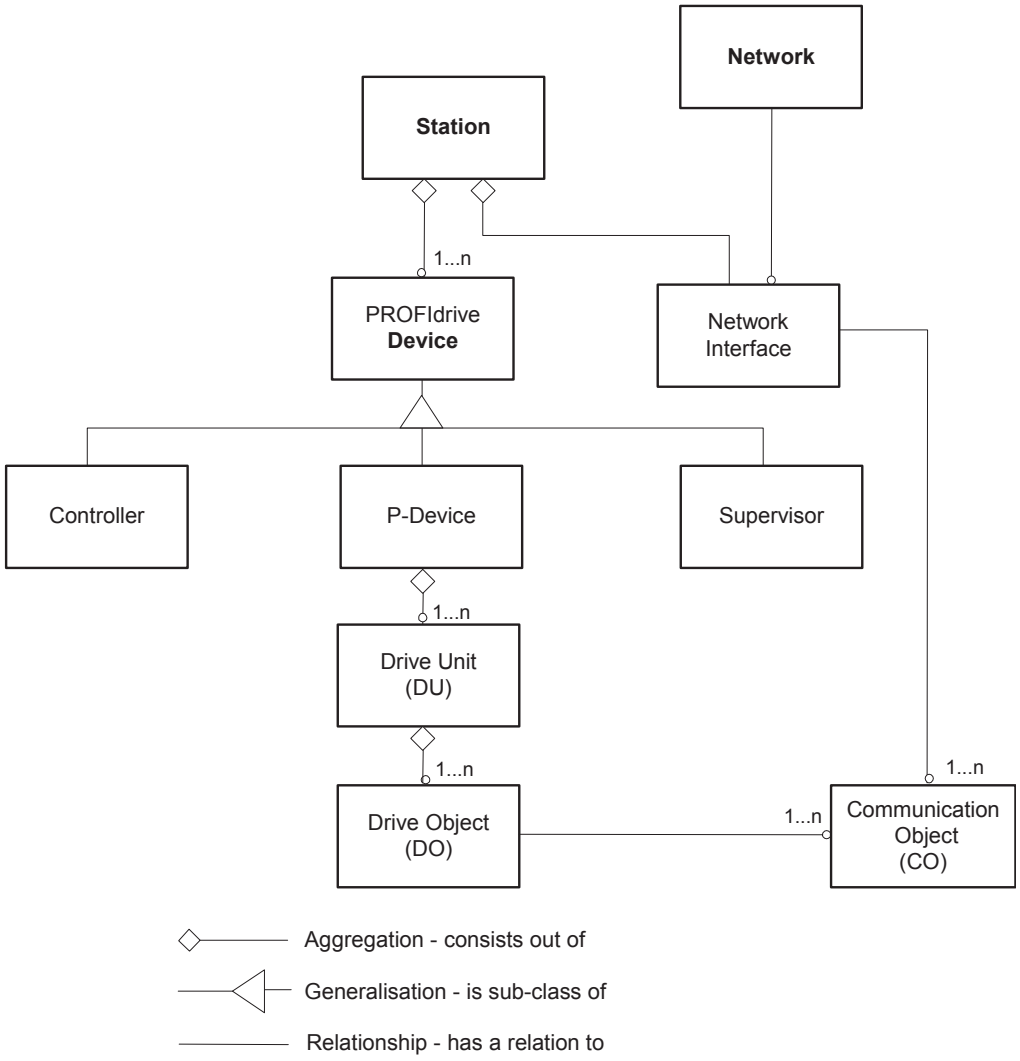

Figure 5 – Hierarchical order in the Object Model

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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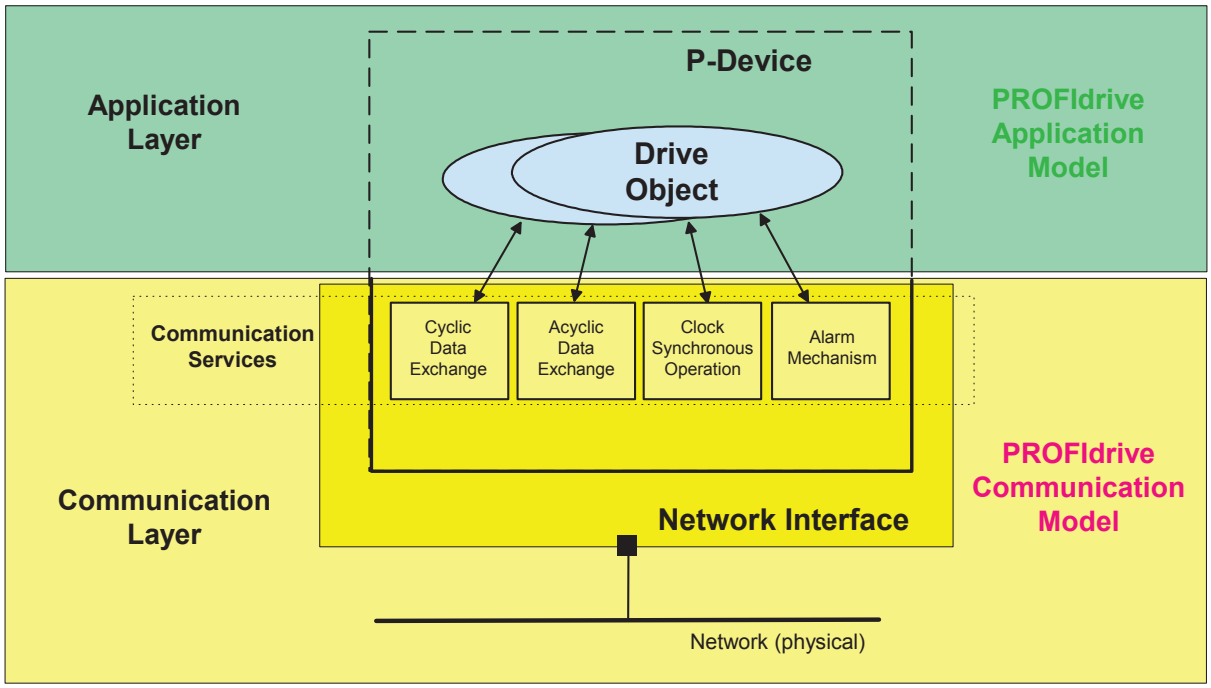

Figure 6 – PROFIdrive Base Model contains the "Application Layer" and "Communication Layer"

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.

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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. With this 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).

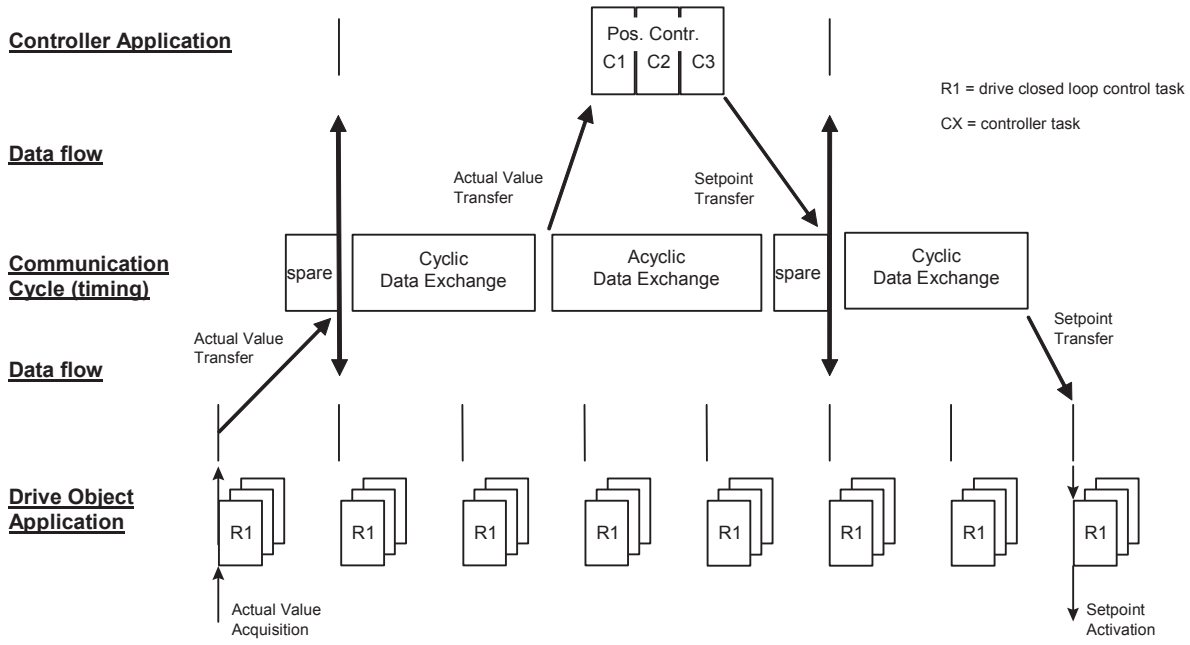

Figure 7 – Typical use case for Clock Synchronous Operation

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 µs. 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).

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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.

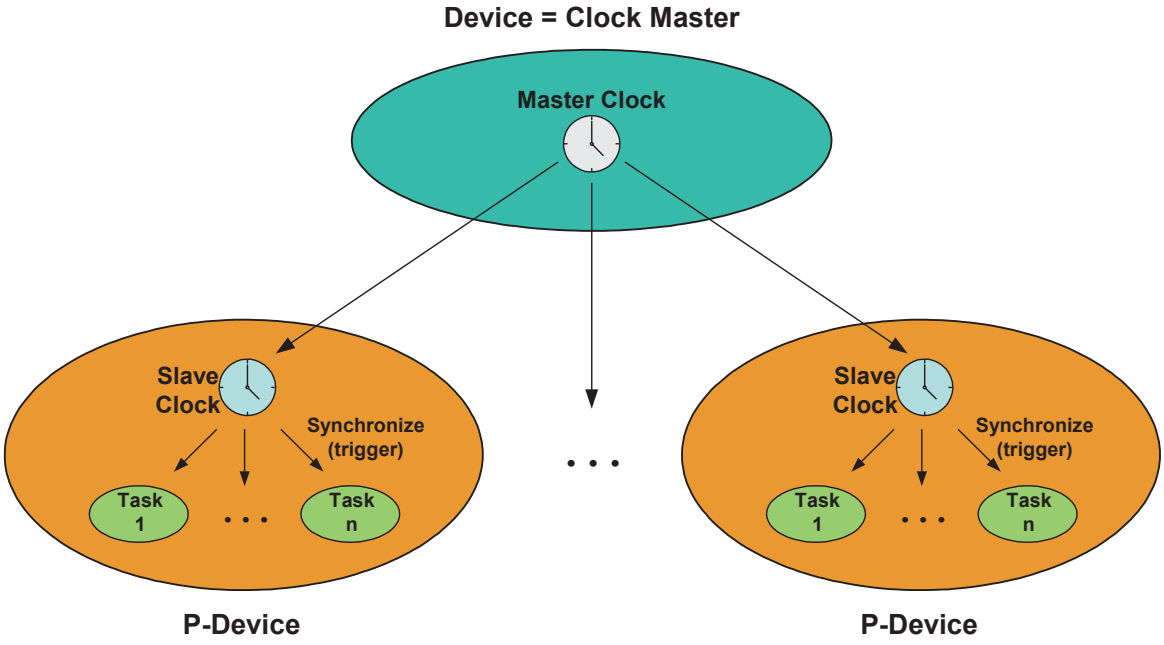

Figure 8 – General Model for Clock Synchronous Operation

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 is 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

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corresponding predecessor state, in order to proceed to switch forward to the next higher level again, if possible and allowed.

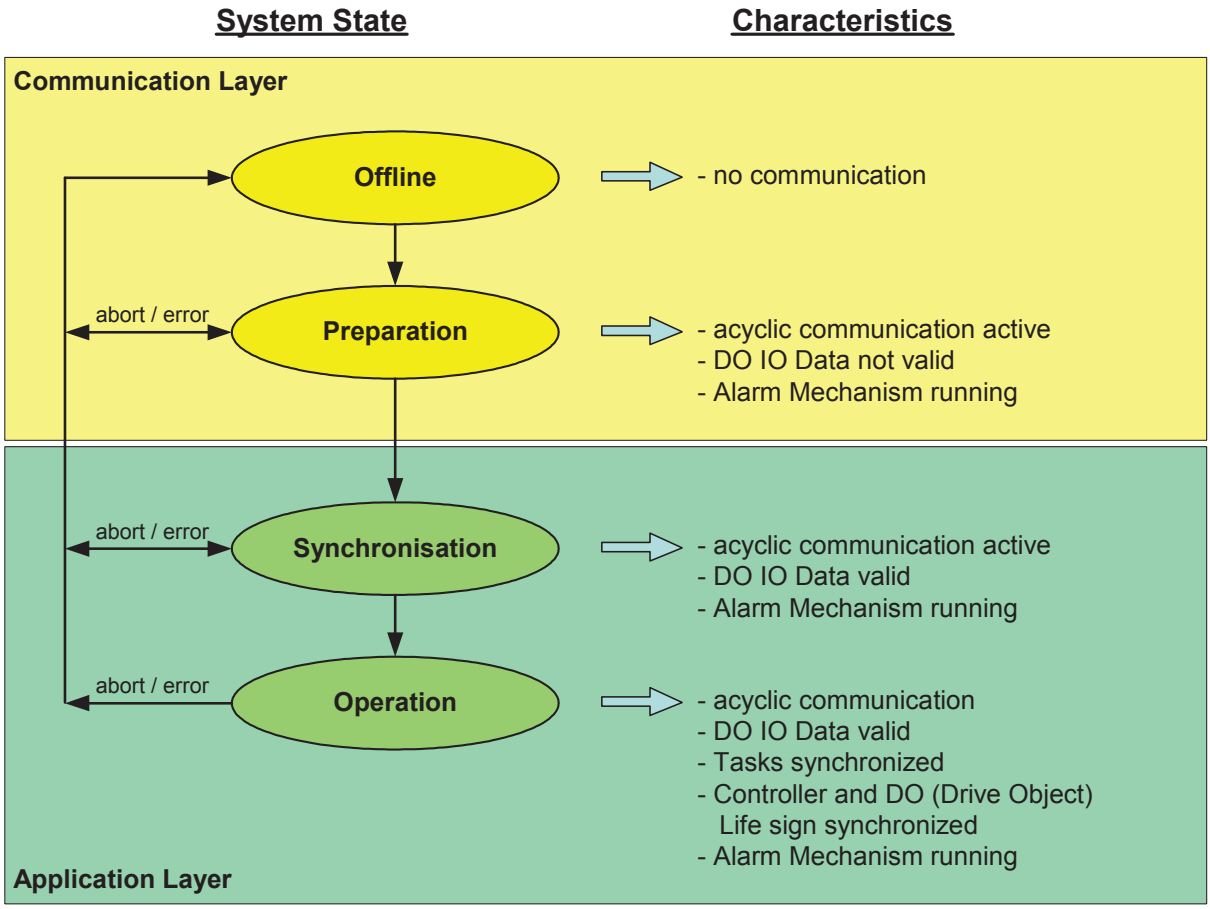

Figure 9 – Base Model State Machine

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.

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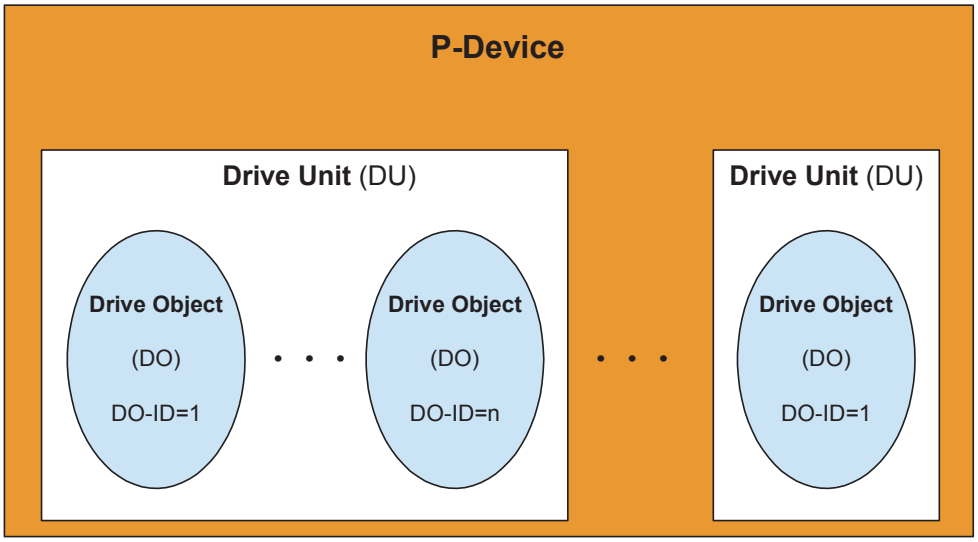

Figure 10 – General Drive Unit model

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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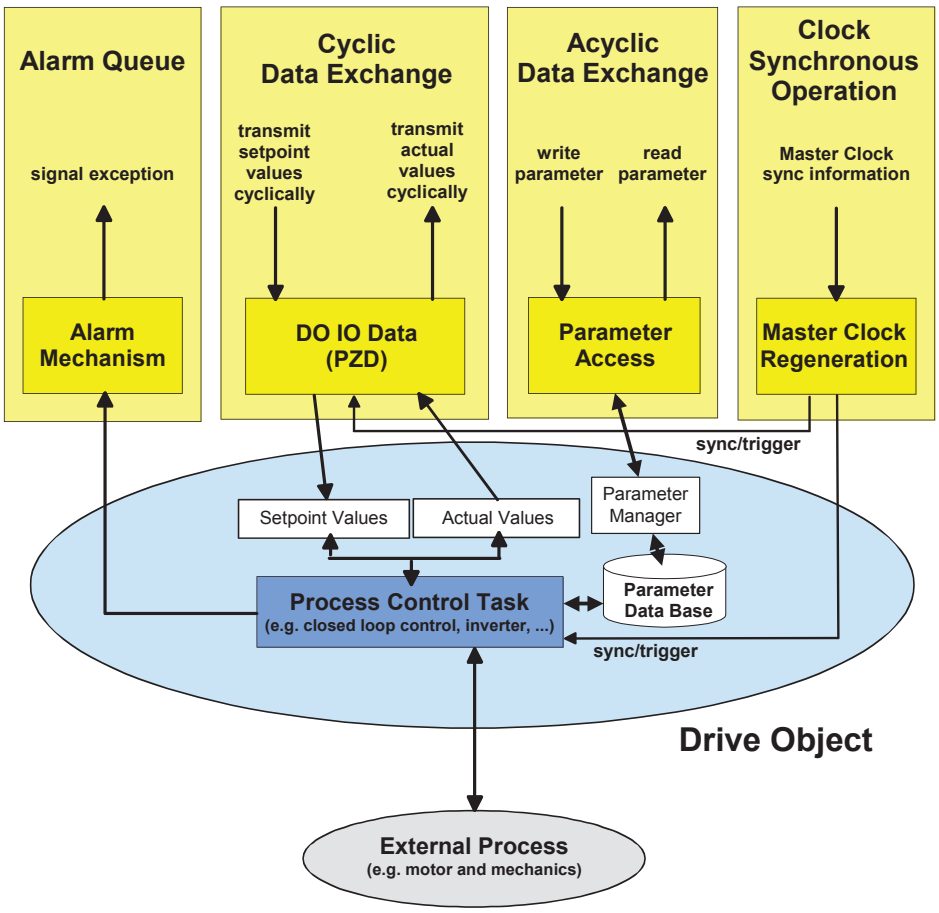

Figure 11 – General Drive Object architecture

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.

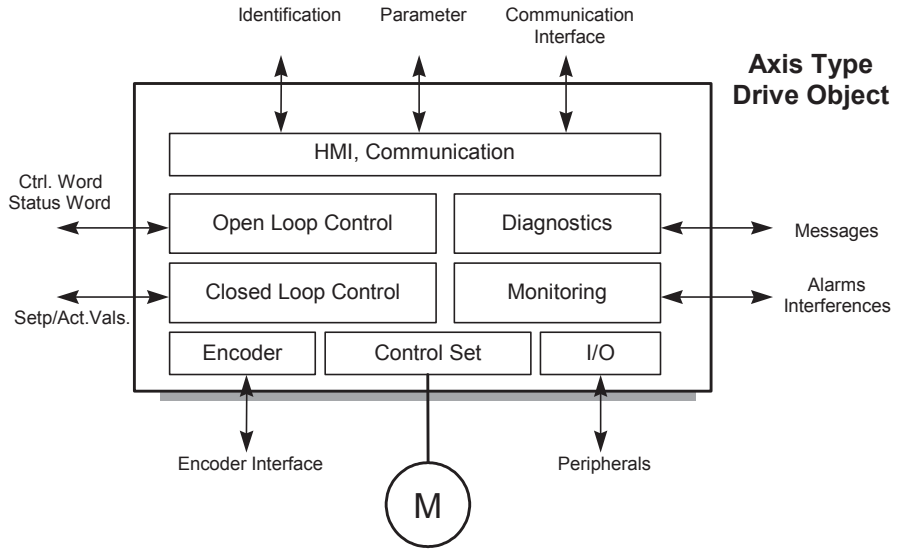

Figure 12 – Principle functional model of an Axis type Drive Object

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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).

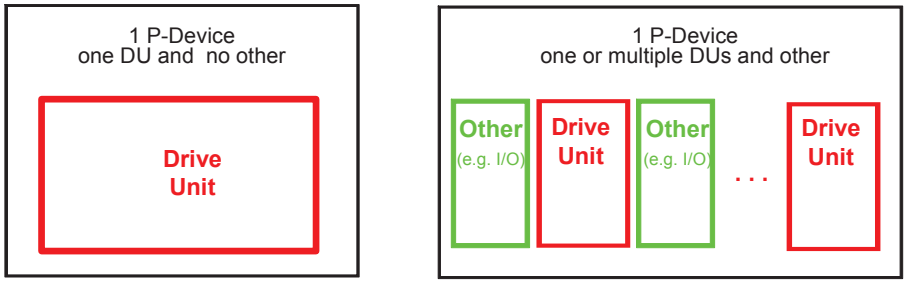

Figure 13 – Classes of PROFIdrive P-Devices

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.

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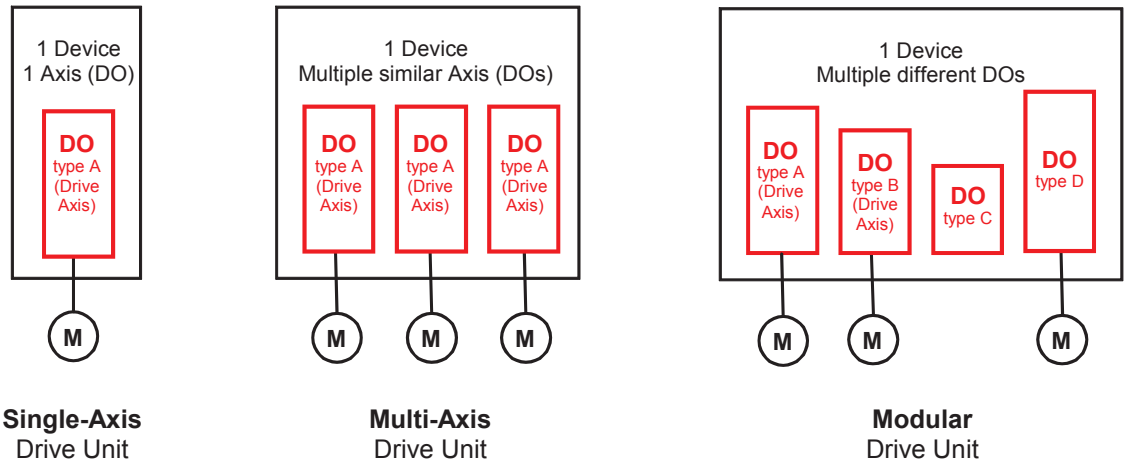

Figure 14 – Classes of PROFIdrive Drive Units

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.

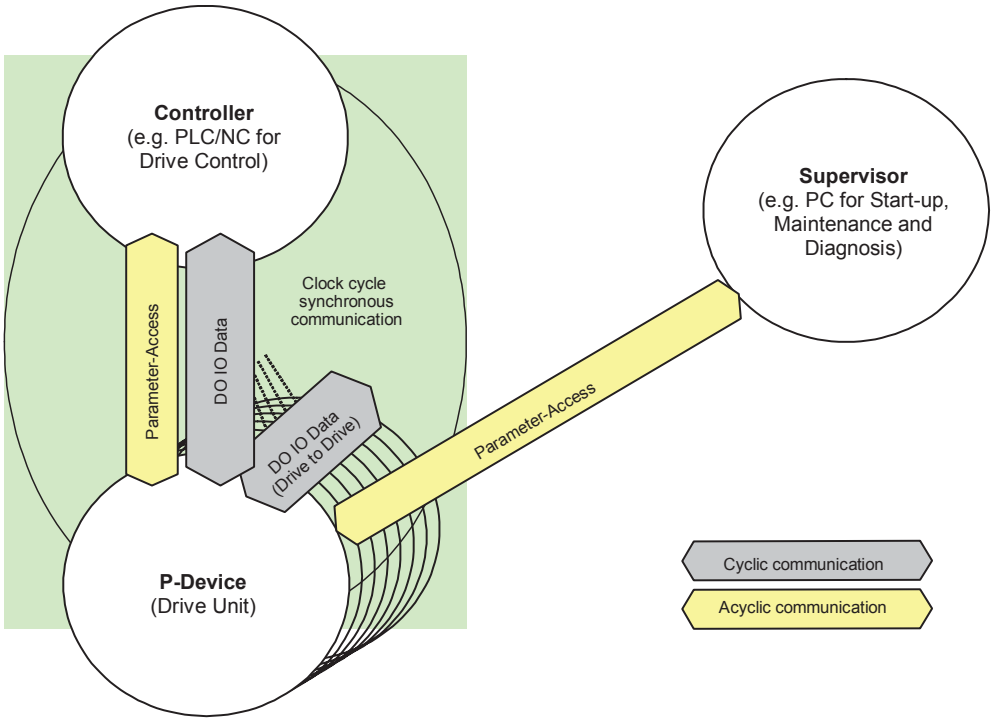

Figure 15 – Overview about the available Communication Services between the PROFIdrive Devices

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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).

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

NOTE The Application Classes described here 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.

[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.

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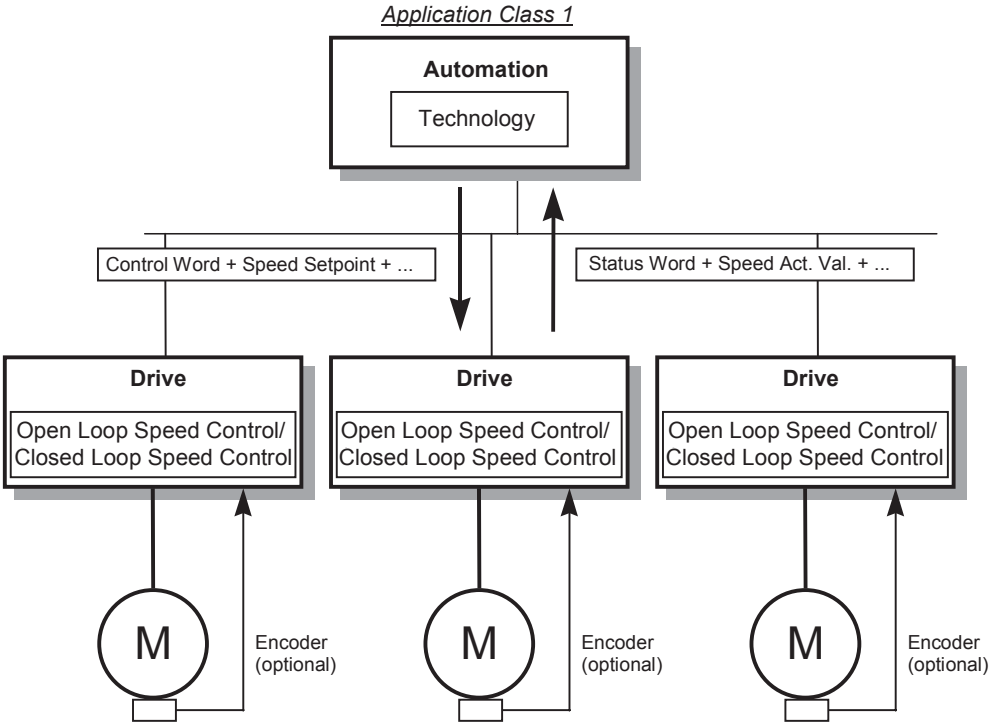

Figure 16 – Application Class 1

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.

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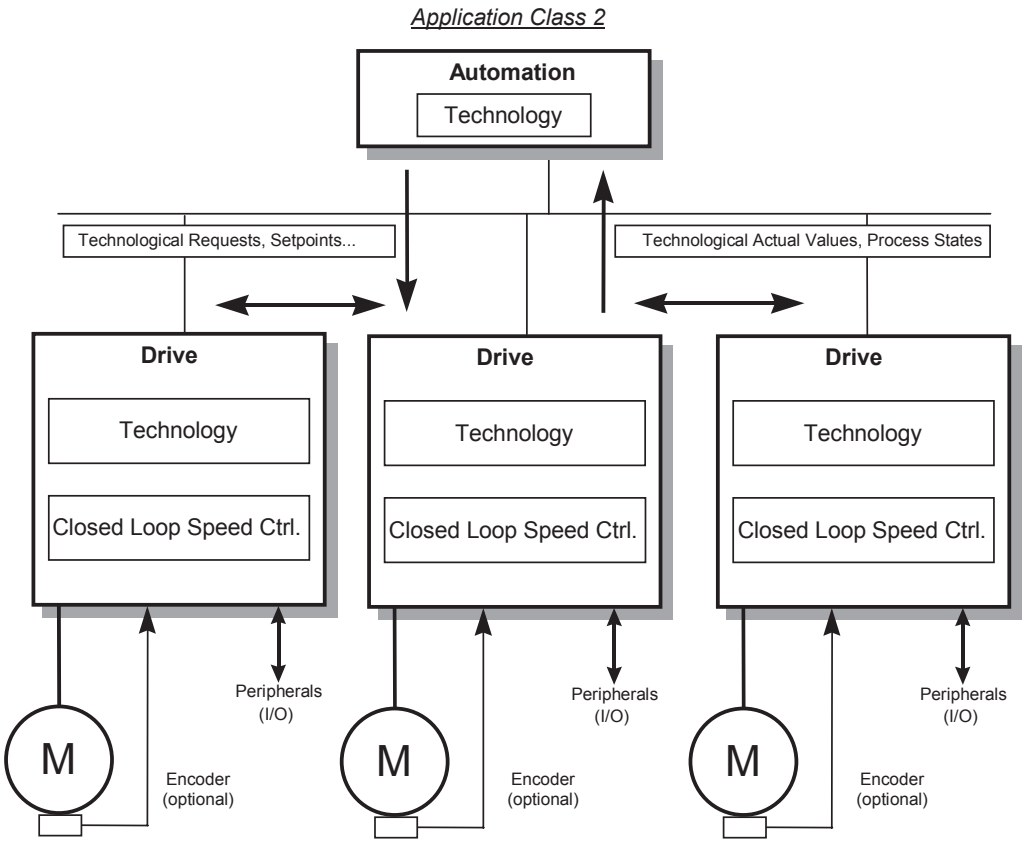

Figure 17 – Application Class 2

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.

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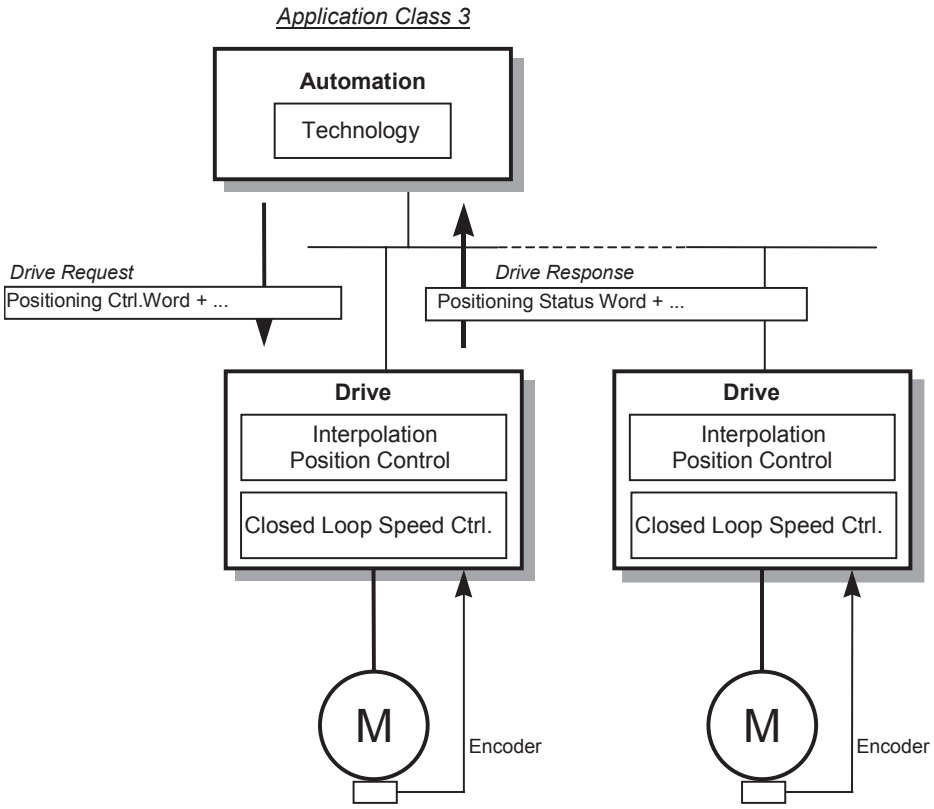

Figure 18 – Application Class 3

6.1.5.5 AC 4: Motion Control with central interpolation and speed setpoint interface

Application Class 4 (see Figure 19) shows the position closed loop control closed via the Communication System. Drives for manipulator and robotic applications often require a coordinated motion sequence of several drive systems. Motion control is primarily implemented via a central automation unit (NC). For each drive, these controllers calculate special setpoint profiles. By coordinating several drives (for example, for the XYZ axis), certain trajectories may be implemented. In addition to the required technology functions for the automation process, the automation system also includes the functions for interpolation and position control of the drive. Speed setpoint values and actual values as well as the position actual value are transferred via Cyclic Data Exchange. The drive controller essentially only includes the algorithms for closed loop speed control and actual position acquisition. Since the position is controlled via the bus system, Clock Synchronous Operation is necessary and shall be very precise. Additionally, the DSC-functionality may be used to increase the rigidity and dynamic response of the control loop.

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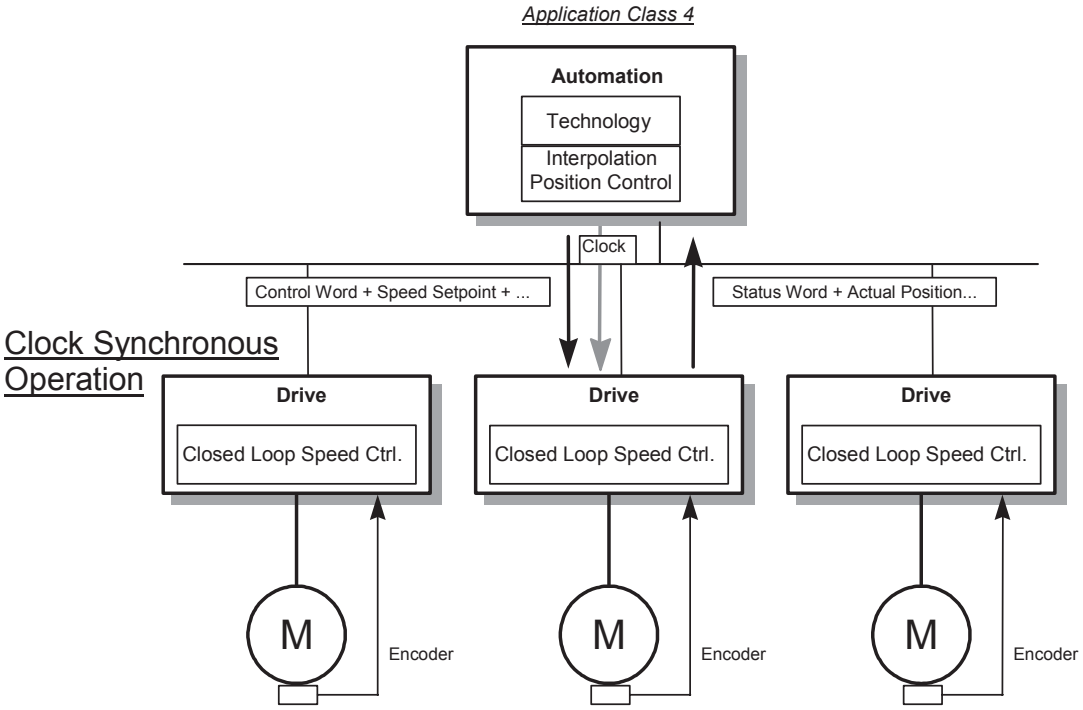

Figure 19 – Application Class 4

6.1.5.6 AC 5: Motion Control with central interpolation and position setpoint interface

Application Class 5 (see Figure 20) is not dealt with in this PROFIdrive Profile Version. The dynamic features of Application Class 5 may be achieved with Application Class 4 and DSC.

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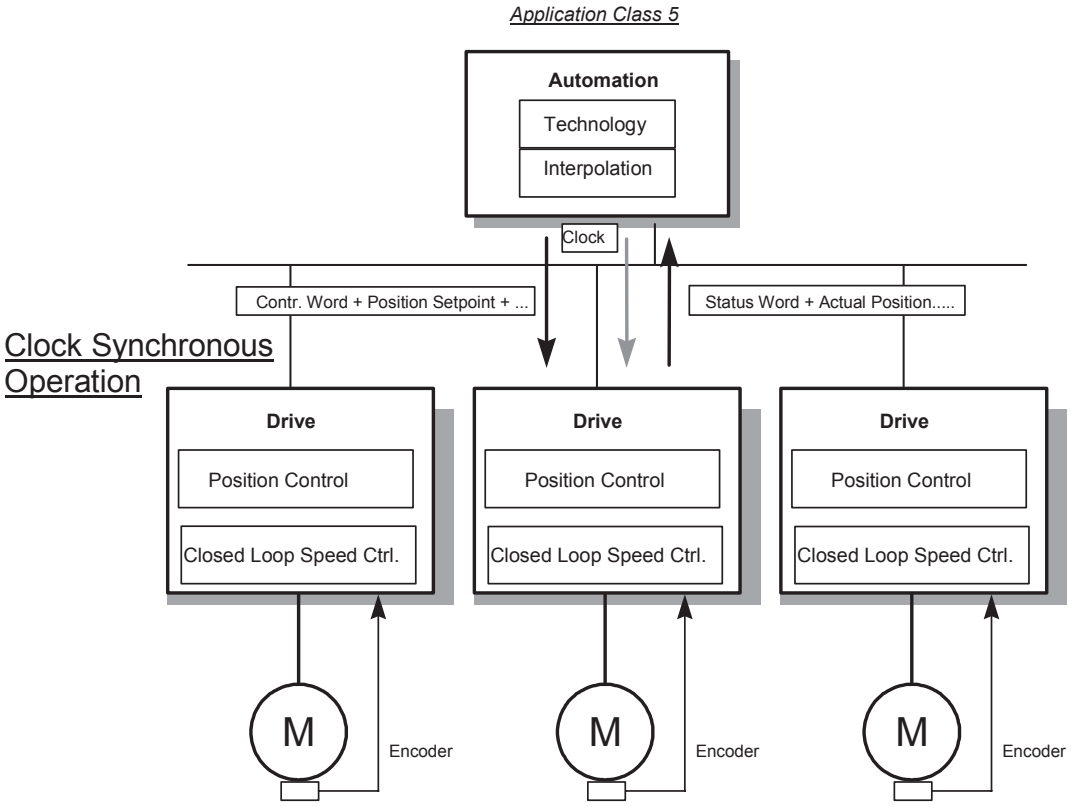

Figure 20 – Application Class 5

6.1.5.7 AC 6: Motion Control for clocked processes, or distributed angular synchronism

To realise applications like electric gearing, cam disc, angular synchronous operation, flying saw, Cyclic Data Exchange and Clock Synchronous Operation between Devices are necessary. These applications are normally realised with one master drive and several slave drives (see Figure 21). The term master drive in this context means that one drive axis provides process information (for example position actual value) to the other drives. Thereupon, the slave drives coordinate their own motion process with the process information of the master drive.

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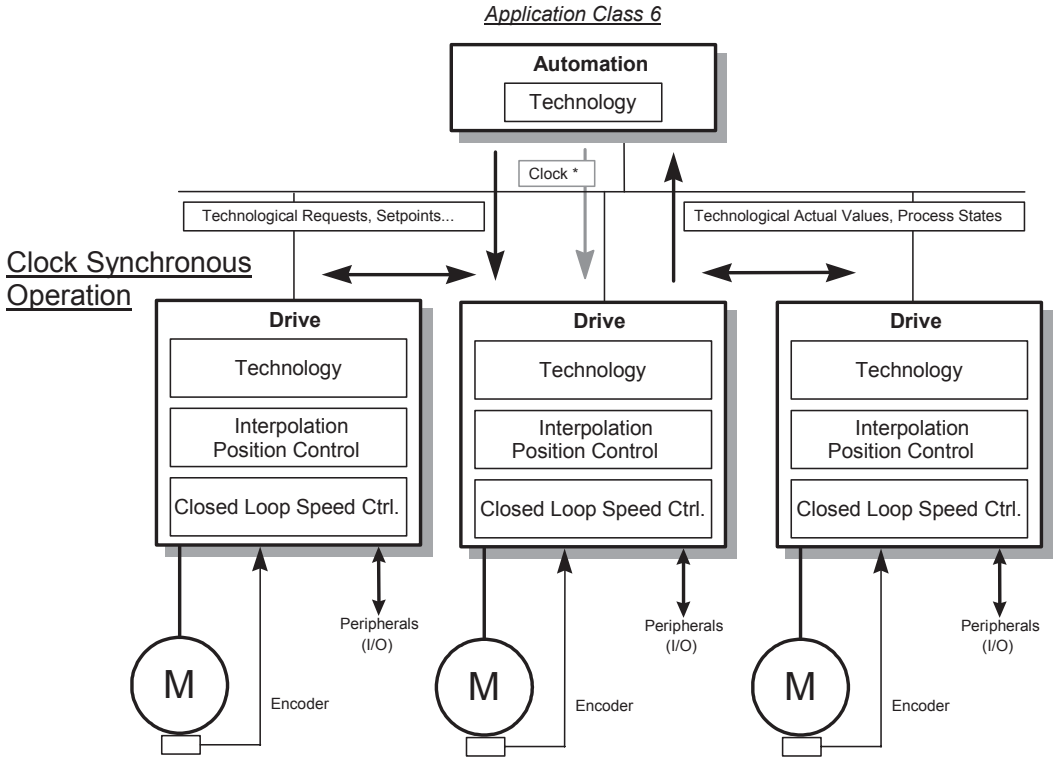

Figure 21 – Application Class 6

6.2 Parameter model

6.2.1 Parameter definition

6.2.1.1 General

A parameter represents an information memory that consists of the elements defined in Table 16:

Table 16 – Parameter definition

Element	Meaning
Parameter value (PWE) (refer to 6.2.1.2)	Includes the information variable(s)
Parameter description (PBE) (refer to 6.2.1.3)	Specifies a parameter
Text (refer to 6.2.1.4)	Is used to support visualisation and contains a general description on the parameter function or on the parameter value

The total of all parameters of a drive uniquely describes its behaviour or characteristics.

A parameter number is assigned to each parameter. The number range of the parameters is specified for decimal 1 to 65 535. The parameter 0 is not permitted. Profile-specific parameters are specified or reserved for the ranges decimal 900 to 999 and decimal 60 000 to 65 535 (refer to 6.4). The Profile-specific parameters shall be implemented exactly according to the definition in 6.4, even if a parameter description is implemented in the drive.

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Access to the parameters (parameter value, parameter description or text) is explained in 6.2.3.

6.2.1.2 Parameter value

The parameter value contains a single (simple variable) or several similar (array) information variables.

An array consists of n elements of the same data type which may be individually addressed with sub-indices from 0 to n-1.

6.2.1.3 Parameter description

The parameter description contains relevant information about the respective parameter. Table 17 shows the structure of the parameter description which will be discussed in the course of this clause.

Table 17 – Parameter description elements

Subindex	Meaning	Data type (refer to Clause 5)
1	Identifier (ID)	V2
2	Number of array elements or length of string	Unsigned 16
3	Standardisation factor	Floating Point
4	Variable attribute	OctetString 2
5	Reserved	OctetString 4
6	Name	VisibleString 16
7	Low limit	OctetString 4
8	High limit	OctetString 4
9	Reserved	OctetString 2
10	ID extension	V2
11	DO IO DATA reference parameter	Unsigned 16
12	DO IO DATA normalisation	V2
0	Complete description	OctetString 46

Identifier (ID)

Additional characteristics of the parameter are stored in the ID (see Table 18).

Bit value = “0” means: “parameter does not possess this attribute”.

Bit value = “1” means: “parameter possesses this attribute ".

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Table 18 – Parameter description element "Identifier (ID)"

Bit	Meaning	Explanation
0 to 7	Data type of the parameter value (see Table 1 and Table 2)	
8	Standardisation factor and variable attribute not relevant	This bit is set if parameters have data types to which physical values may not be calculated, for example the data type string.
9	Parameter not writeable	
10	Additional text array available	
11	Reserved	
12	Parameter was changed with respect to the factory setting	This bit is set if the parameter value is unequal to the factory setting. It is reset if the parameter value is equal to the factory setting.
13	Parameter value may be reset only	If this bit is set, the associated parameter value is increased exclusively by internal processing, while externally, it may only be set to “0” (for example, “time differences“).
14	Array	
15	Reserved	

Number of array elements or string length (subindex 2)

In the case of array parameters, the number of elements is entered here. In the case of parameters of the data type “String”, the length of the string is entered here. The data types OctetString or VisibleString correspond to an array of bytes. It is not possible to form an array of the data type “String”.

Standardisation factor (subindex 3)

Factor that converts the (internal) value into an (external) standardised variable which, together with the unit, corresponds to the physical representation of the parameter. The standardisation factor is of the data type Floating Point.

Variable attribute (subindex 4)

A variable index (see Table 20 and Table 22) and a conversion index (see Table 21 and Table 23) are indicated in the variable attribute (see Table 19).

Table 19 – Parameter description element "variable attribute“

Octet 1	Octet 2
variable index	conversion index (Factor A, Offset B)

The variable index represents the fixed coding of the physical variable (and therefore the base unit) of the parameter value. The variable index is of the data type Unsigned 8.

The conversion index represents the fixed coding of the conversion factor (A) and the offset (B) for a parameter value. With the conversion index, the unit may be converted into the base unit. The conversion index is of the data type Integer 8. See the following example 1.

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