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Siehe jedoch Beginn der
Gültigkeit

**Elektrische Leistungsantriebssysteme mit einstellbarer Drehzahl –
Teil 7-303: Generisches Interface und Nutzung von Profilen für
Leistungsantriebssysteme (PDS) –
Abbildung von Profil-Typ 3 auf Netzwerktechnologien
(IEC 61800-7-303:2007);
Englische Fassung EN 61800-7-303:2008**

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 (IEC 61800-7-303:2007);
English version EN 61800-7-303:2008

Entraînements électriques de puissance à vitesse variable –
Partie 7-303: Interface et utilisation génériques de profils pour les entraînements
électriques de puissance –
Mapping des profils de type 3 pour technologies réseaux (CEI 61800-7-303:2007);
Version anglaise EN 61800-7-303:2008

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Die von CENELEC am 2008-02-01 angenommene EN 61800-7-303 gilt als DIN-Norm ab 2008-11-01.

Nationales Vorwort

Vorausgegangener Norm-Entwurf: E DIN IEC 61800-7-3:2006-06.

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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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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mit einstellbarer Drehzahl –
Teil 7-303: Generisches Interface
und Nutzung von Profilen
für Leistungsantriebssysteme (PDS) –
Abbildung von Profil-Typ 3
auf Netzwerktechnologien
(IEC 61800-7-303:2007)

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CENELEC

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

Central Secretariat: rue de Stassart 35, B - 1050 Brussels

Foreword

The text of document 22G/185/FDIS, future edition 1 of IEC 61800-7-303, 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 61800-7-303 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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Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 61800-7-303:2007 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 61158-2	NOTE	Harmonized as EN 61158-2:2008 (not modified).
IEC 61158-3-3	NOTE	Harmonized as EN 61158-3-3:2008 (not modified).
IEC 61158-4-3	NOTE	Harmonized as EN 61158-4-3:2008 (not modified).
IEC 61499-1	NOTE	Harmonized as EN 61499-1:2005 (not modified).
IEC 61800	NOTE	Harmonized in EN 61800 series (not modified).
IEC 61800-7-1	NOTE	Harmonized as EN 61800-7-1:2008 (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 drive 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

- 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 often specified with incompatibilities. This requires the system integrator to write special interfaces for the application software and this 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.

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^{TM2}, PROFIdrive³ and SERCOS interface^{TM4} 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.

The different profile types 1, 2, 3 and 4 are specified in IEC 61800-7-201, IEC 61800-7-202, IEC 61800-7-203 and IEC 61800-7-204.

This part of IEC 61800-7 specifies how the profile type 3 (PROFIdrive) is mapped to the network technologies PROFIBUS⁵ and PROFINET⁶.

IEC 61800-7-301, IEC 61800-7-302 and IEC 61800-7-304 specify how the profile types 1, 2 and 4 are mapped to different network technologies (such as CANopen⁷, EtherCAT^{TM8}, Ethernet Powerlink^{TM9}, DeviceNet^{TM10}, ControlNet^{TM11}, EtherNet/IP^{TM12}, 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.
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 - ⁷ CANopen is an acronym for Controller Area Network *open* and is used to refer to EN 50325-4.
 - ⁸ EtherCATTM 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 EtherCATTM. Use of the trade name EtherCATTM requires permission of the trade name holder.
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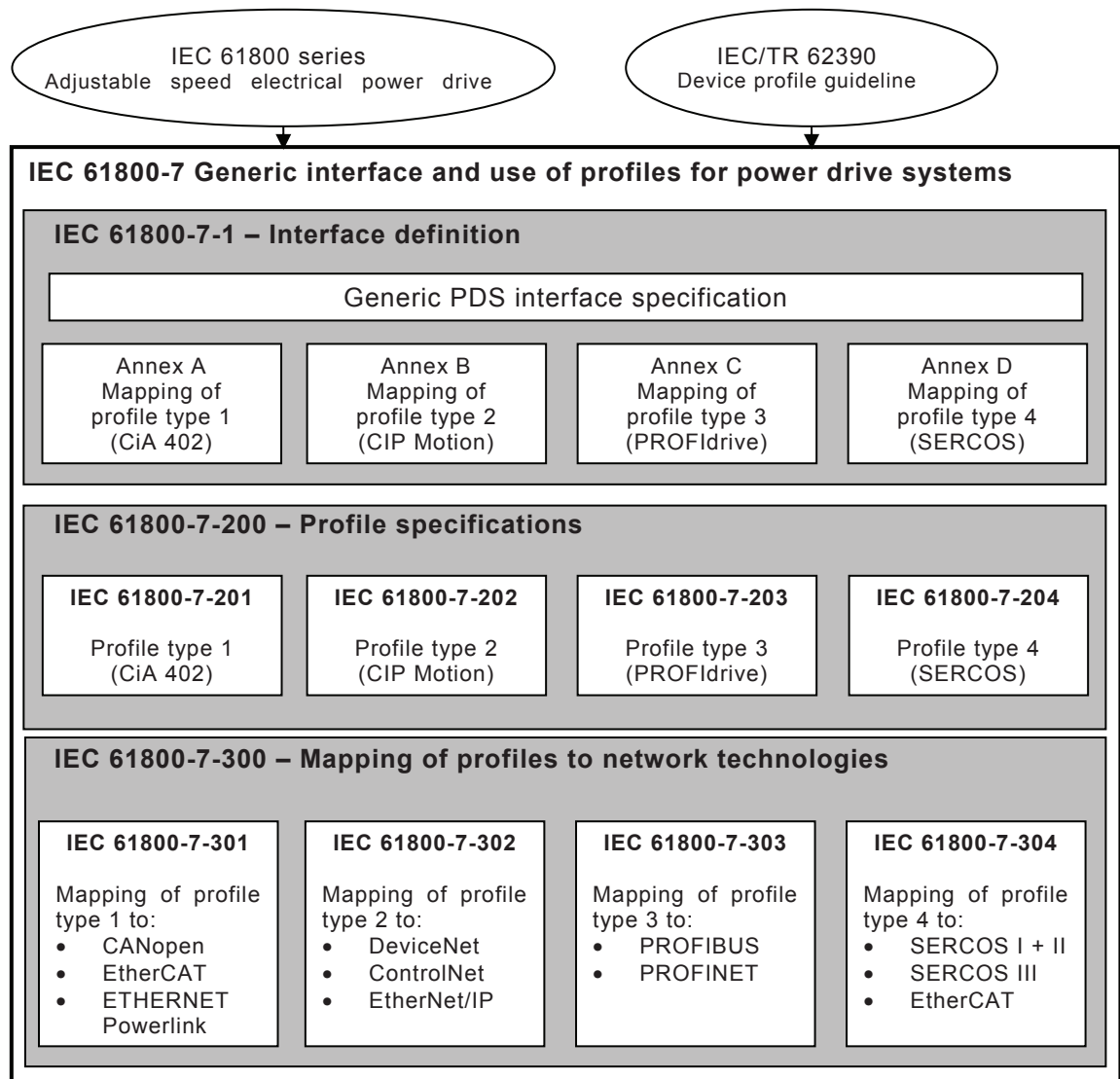


Figure 1 – Structure of IEC 61800-7

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

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 how the profile type 3 (PROFIdrive) specified in IEC 61800-7-203 onto different network technologies.

- PROFIBUS DP, see Clause 4,
- PROFINET IO, see Clause 5.

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

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 61784-1, *Industrial communication networks – Profiles – Part 1: Fieldbus profiles*

IEC 61784-2, *Industrial communication networks – Profiles – Part 2: Additional fieldbus profiles for real-time networks based on ISO/IEC 8802-3*

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

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

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 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

attribute

property or characteristic of an entity

[IEC/TR 62390:2005, 3.1.3]

3.1.5

class

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

[ISO/IEC 19501, modified]

3.1.6

clock cycle synchronous application

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

3.1.7

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.

3.1.8
control

purposeful action on or in a process to meet specified objectives

[IEV 351-21-29]

3.1.9
control device

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

3.1.10
data type

set of values together with a set of permitted operations

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

3.1.11
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]

3.1.12
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]

3.1.13
DO IO Data

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

3.1.14
Drive Object

functional element of a Drive Unit

3.1.15
Drive Unit

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

3.1.16

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]

3.1.17

Input Data

data to be sent cyclically from the device to the controller

3.1.18

interface

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

[IEV 351-21-35, modified]

3.1.19

IO Data

Input Data and Output Data of a device

3.1.20

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

3.1.21

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]

3.1.22

operating mode

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

[IEV 351-31-01]

3.1.23

Output Data

data to be sent cyclically from the controller to the device

3.1.24

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 characterized by a parameter name, data type and access direction.

[IEC/TR 62390:2005, 3.1.22modified]

3.1.25

Process data

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

3.1.26

profile

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

3.1.27

setpoint

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

3.1.28

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.

3.1.29

technological functions

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

3.1.30

type

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

[IEC/TR 62390:2005, 3.1.25]

3.1.31

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.

3.2 Abbreviated terms

AC x	Application Class x, where x is the number of the AC
AP	Application Process
API	Application Process Identifier
AR	Application Relationship
ASE	Application Service Element
CM	Context Management
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
DXB	Data-eXchange-Broadcast
f	frequency
FDL	Fieldbus Data Link (Layer 2)
GAP	Area between own station address and the next one (attempt to include new active stations)
GC	Global Control Telegram
GSD	Device Data File (device description, input for a bus configuring tool)
HW	Hardware
ID	Identifier
IO AR	IO Application Relationship
IOCS	IO Consumer Status
IOPS	IO Producer Status
IO Data	IO Data; is transmitted cyclically
IP	Internet Protocol
IRT	Isochronous Realtime Ethernet
I/O	Input/Output
LS	Sign-Of-Life
MAP	Module Access Point
MSG	Acyclic services (Message)
M CR	Multicast CR
MS0 AR	PROFIBUS MS0 AR (cyclic data exchange between master (class1) and slave)
MS1 AR	PROFIBUS MS1 AR (acyclic data exchange between master (class1) and slave)
MS2 AR	PROFIBUS MS2 AR (acyclic data exchange between master (class2) and slave)
NAMUR	Standards Working Group for Instrumentation and Control in the Chemical Industry
NC	Numerical control system with a numeric control command set
OP	Operator Panel
Pxxx	Parameter (identified by number xxx)
PAP	Parameter Access Point
PC	Personal Computer
PDS	Power Drive System
P-Device	Peripheral Device (PROFIdrive Base Model)
PDU	Protocol Data Unit
PG	Programming device
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 (see IEC 61158 Type 3 elements and IEC 61784-1)

PROFINET	Process Field Bus (see IEC 61158 Type 10 and IEC 61784-2)
RES	Reserve
RT	Realtime Ethernet
SAP	Service Access Point
SW	Software
SYNC	Synchronization
SYNCH	Synchronization Telegram (global control)
T _{BASE_DP}	Time base of TDP
T _{BASE_IO}	Time base of TI, TO
t _{BIT}	Bit-Time
TCA_Min	Lacktime for the Controller application process
TCA_Valid	Time for Input Data available
T _{DC} , T _{DC}	Data-Cycle-Time
T _{DP}	DP-Cycle-Time
T _{DP_MAX}	Maximum of TDP
T _{DP_MIN}	Minimum of TDP
T _{DX}	Data_Exchange-Time
T _J	Jitter-Time
T _I	Input-Time
T _{I_MIN}	Minimum of TI
T _{ID1}	Idle-Time 1
T _{ID2}	Idle-Time 2
T _{input_valid}	Lack time for the acquisition process
T _{IO_Input}	Time for <i>actual value</i> acquisition
T _{IO_InputMin}	Lack time for the acquisition process
T _{IO_Output}	Time for setpoint transfer
T _{IO_OutputMin}	Lack time for the setpoint transfer process
T _{IO_OutputValid}	Time for Output Data available
T _M	Master-Time
T _{MAPC}	Master_Application_Cycle-Time
T _{MLS}	Master_Life_Sign-Time
T _O	Output-Time
T _{O_MIN}	Minimum of (TO-TDX)
T _{PLL_D}	PLL-Delay
T _{PLL_W}	PLL-Window
T _{SAPC}	Slave_Application_Cycle-Time
T _{SC}	Speed Controller Sampling Time
T _{SDR}	Station_Delay_Responder Time
T _{TR}	Target_Rotation-Time
T _{WD}	Watchdog-Time
UUID	Universal Unique Identifier
TOK	Token passing

VIK Association of the Industrial Customers and Industrial Power Producers
ZSW Status Word

4 Mapping to PROFIBUS DP

4.1 General

This clause defines the mapping of the PROFIdrive Base Model on the PROFIBUS DP Communication System (see IEC 61158 Type 3 elements).

4.2 Mapping to PROFIBUS data types

Table 1 shows the mapping of the PROFIdrive standard data types to the PROFIBUS DP specific data types.

Table 1 – Mapping of data types

Data types used in Profile PROFIdrive	Equivalent data types in PROFIBUS DP	Reference to the definition
Boolean	Boolean	IEC 61158-5-3
Integer8	Integer8	IEC 61158-5-3
Integer16	Integer16	IEC 61158-5-3
Integer32	Integer32	IEC 61158-5-3
Unsigned8	Unsigned8	IEC 61158-5-3
Unsigned16	Unsigned16	IEC 61158-5-3
Unsigned32	Unsigned32	IEC 61158-5-3
FloatingPoint	FloatingPoint	IEC 61158-5-3
VisibleString	VisibleString	IEC 61158-5-3
OctetString	OctetString	IEC 61158-5-3
TimeOfDay (with date indication)	TimeOfDay (with date indication)	IEC 61158-5-3
TimeDifference	TimeDifference	IEC 61158-5-3
Date	Date	IEC 61158-5-3
TimeOfDay without date indication	TimeOfDay without date indication	IEC 61158-5-3
TimeDifference with date indication	TimeDifference with date indication	IEC 61158-5-3
TimeDifference without date indication	TimeDifference without date indication	IEC 61158-5-3

4.3 Base Model at PROFIBUS DP

4.3.1 Communication Devices

When using PROFIBUS DP as Communication Network, the PROFIdrive Devices are mapped to the following PROFIBUS DP objects:

Controller

The PROFIdrive Controller is represented by the PROFIBUS **DP-master (class 1)**. For example, this may be a PLC, NC or PC.

P-Device

The PROFIdrive P-Device is represented by the PROFIBUS **DP-slave**. The P-Device is related to one or more Axis of the automation system.

Supervisor

The PROFIdrive Supervisor is represented by the PROFIBUS **DP-master (class 2)**. For example this may be a PG or OP.

Figure 2 shows the topology of a typical PROFIdrive drive system using PROFIBUS DP as Communication Network.

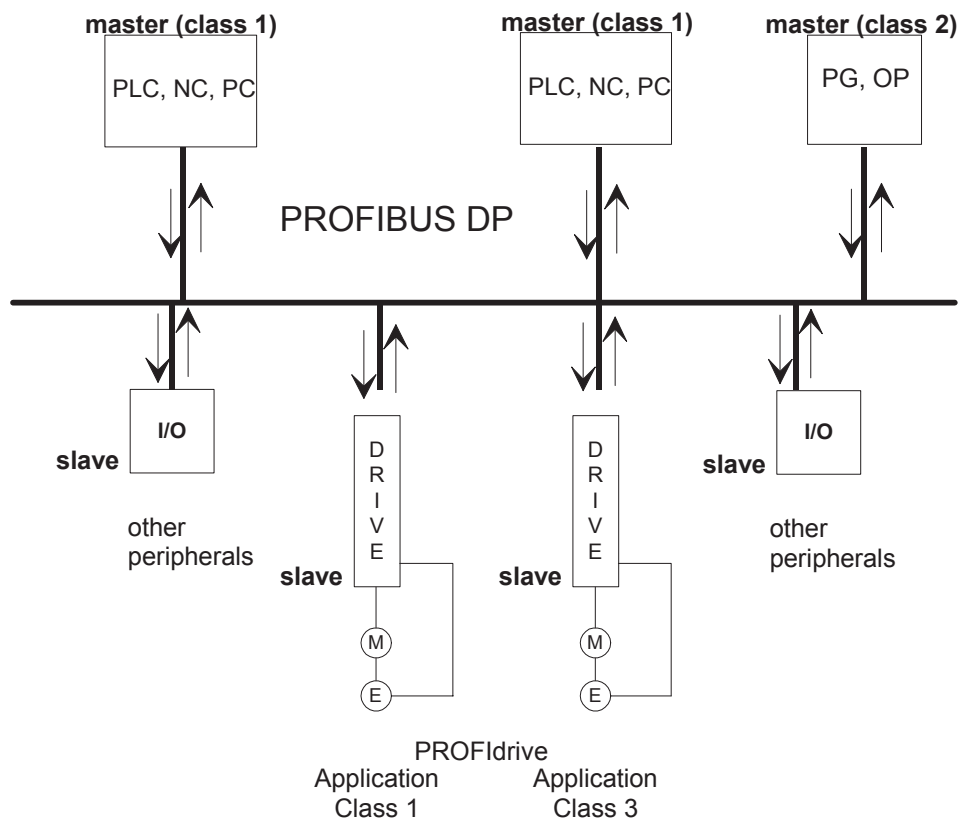


Figure 2 – PROFIBUS DP Devices in a PROFIdrive drive system

4.3.2 Communication Relationship

The PROFIdrive Communication Relationships between the Devices are mapped to PROFIBUS DP in the following way:

Controller – P-Device

Relationship is represented by **MS0 AR plus MS1 AR**

Supervisor – P-Device

Relationship is represented by **MS2 AR**

P-Device – P-Device

Relationship is represented by **cyclic data exchange between DP-slaves (DXB)**

Figure 3 shows the PROFIdrive Devices and their relationships on PROFIBUS DP.

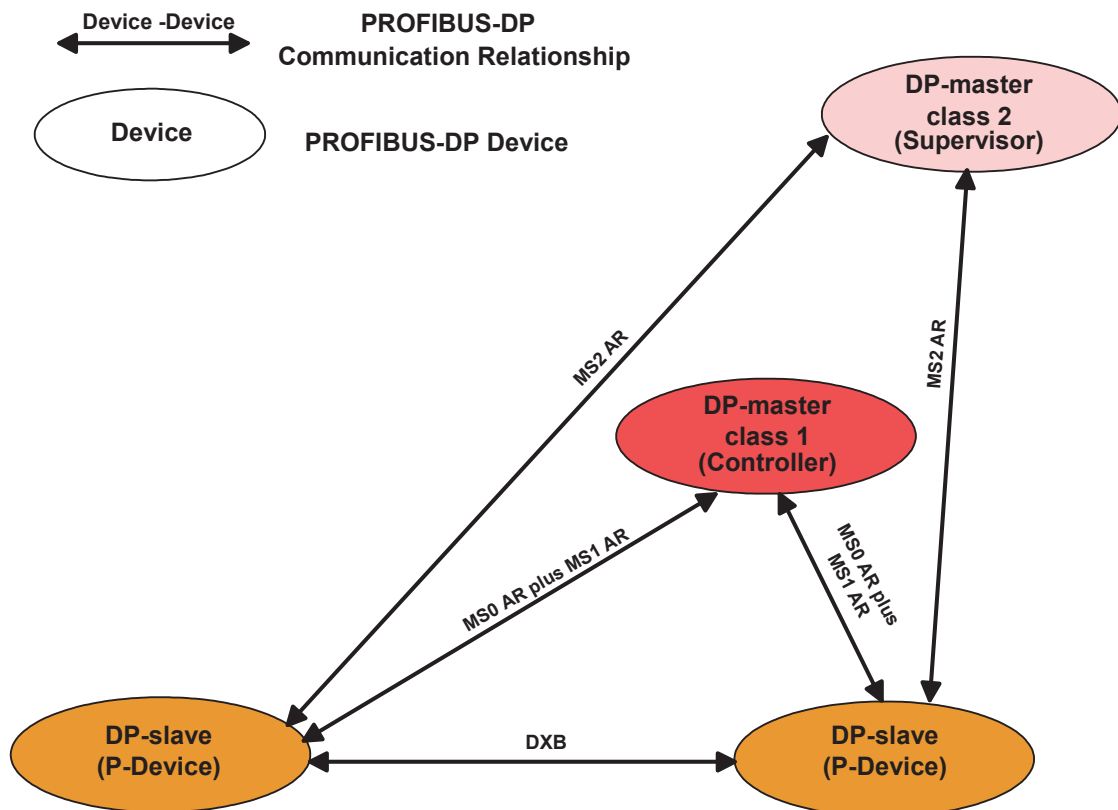


Figure 3 – PROFIdrive Devices and their Relationship for PROFIBUS DP

4.3.3 Communication Network

For PROFIBUS DP as Communication System for PROFIdrive, the PROFIdrive General Communication Model is shown in Figure 4. With PROFIBUS DP, having different Network Interfaces (master- or slave-Interface) means also having different Stations. Therefore, the Station and Device Objects in the General Communication Model are the same.

With PROFIBUS, a maximum of 126 devices – that is, masters or slaves – may be connected to one bus in single- or multi-master operation. Thus, PROFIdrive P-Devices with different Drive Objects as well as other peripherals (such as I/O) may be operated on one bus.

Therefore, the PROFIdrive Device at PROFIBUS DP is precisely defined by the following address information:

- Network (PROFIBUS bus/**domain**)
- Device (PROFIBUS **node address**)

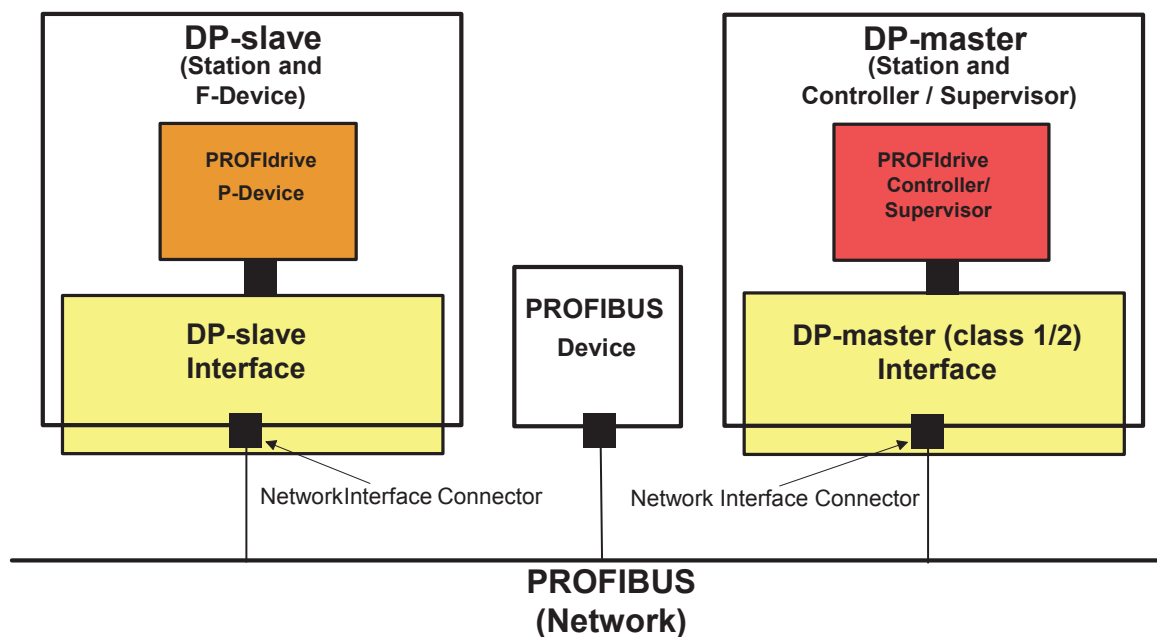


Figure 4 – General Communication Model for PROFIdrive at PROFIBUS DP

4.3.4 Communication Services

4.3.4.1 General

The PROFIdrive Base Model Communication Services are provided by the following PROFIBUS DP mechanisms:

4.3.4.2 Cyclic Data Exchange

The Cyclic Data Exchange service for PROFIBUS DP is realised by two different PROFIBUS DP communication mechanisms, depending on the communication relationship.

- For the master/slave (Controller/P-Device) relationship, the Cyclic Data Exchange is realised by use of simple transfer of user data via the Data_Exchange telegram (DX).
- For the slave/slave (P-Device/P-Device) relationship, the Cyclic Data Exchange is realised by use of the cyclic data exchange between DP-slaves (DXB) mechanism. The so-called Publisher-Subscriber-Model is based on a publisher (passive station) which provides its actual values not only to the DP master but also to all other stations (subscribers), so that the other slaves may access and process this data. Therefore, by the configuration of the PROFIBUS DP system, the DXB relationships between the DP slaves are configured and contain the information on which subscriber accesses to which publisher data. The DXB communication is coupled to the cyclic user data exchange of DP. Figure 5 shows the mechanism of the DXB communication.

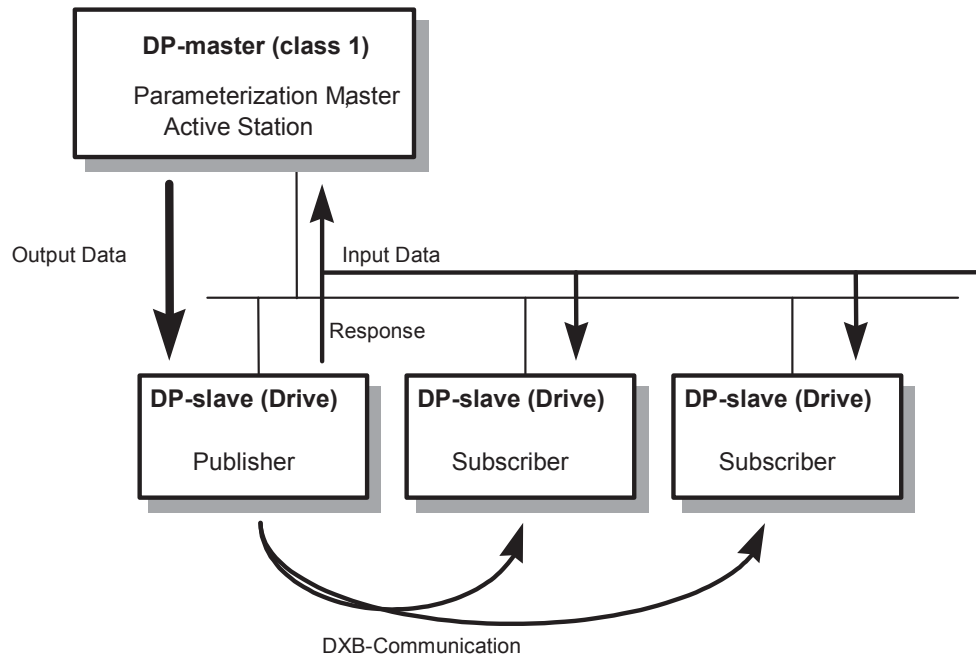


Figure 5 – PROFIBUS DP DXB communication designations

4.3.4.3 Acyclic Data Exchange

The Acyclic Data Exchange service is realised by the MS1 AR or MS2 AR of PROFIBUS DP.

Acyclic communication uses the MS1 AR and MS2 AR mechanism READ and WRITE of data block.

This allows start-up tools to be connected as DP-master (class 2) on PROFIBUS DP and a series of functions, for example reading out the DO IO Data normalisation through the control.

4.3.4.4 Alarm Mechanism

With PROFIdrive on PROFIBUS DP, the Alarm Mechanism is not used. Diagnosis and Fault management is done by use of PROFIdrive mechanism based on standard Parameter Access and the cyclic PROFIdrive control and status words.

4.3.4.5 Clock Synchronous Operation

Clock Synchronous Operation at PROFIBUS DP is done by using the PROFIBUS DP-V2 Isochronous Mode. Clock cycle synchronous operation in the PROFIBUS DP Isochronous Mode is implemented by using an isochronous clock signal. This cyclic, isochronous clock signal is transmitted as Global Control telegram from the DP-master (class 1) to all PROFIBUS slaves. Thus, the slaves supporting isochronous operation may synchronise their applications (internal/Slave Clock) with the Master Clock (see IEC 61158 Type 3 elements).

Special error mechanisms in each station make sTable communication possible, even if there is a sporadic failure of the Master Clock.

For PROFIdrive, the PROFIBUS Isochronous Mode is the basis for drive synchronization. Not only message interchange on the bus system is implemented in an isochronous time frame, 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 6).

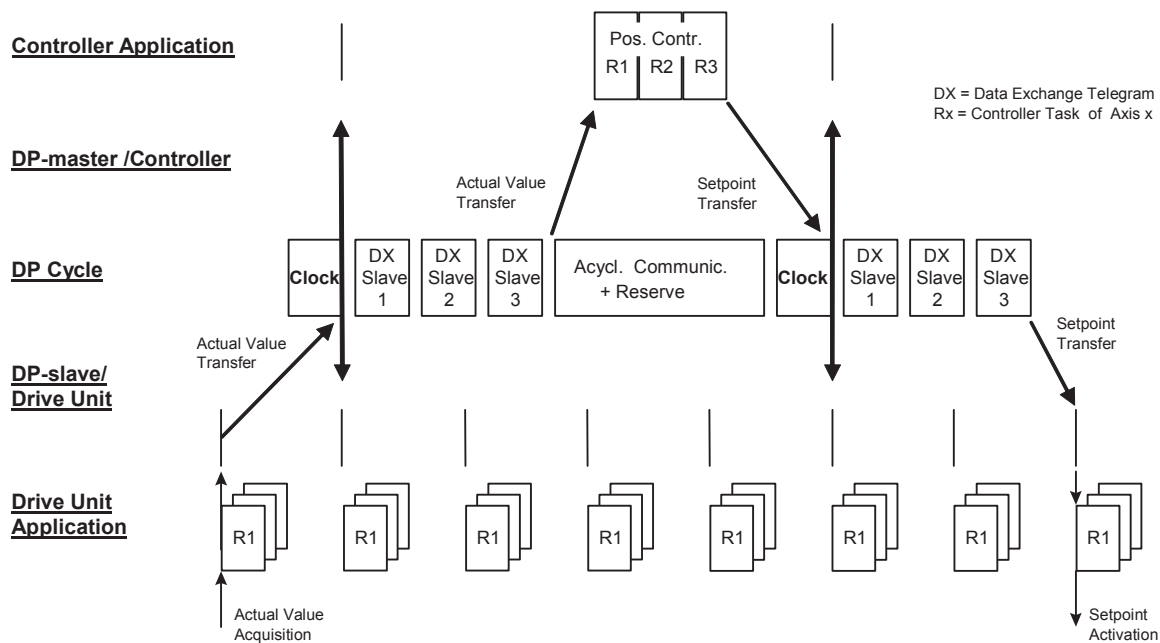


Figure 6 – Synchronous communication for PROFIdrive at PROFIBUS DP

4.3.5 P-Device Communication Model

Figure 7 shows the P-Device Communication Model when PROFIBUS DP is used as Communication System.

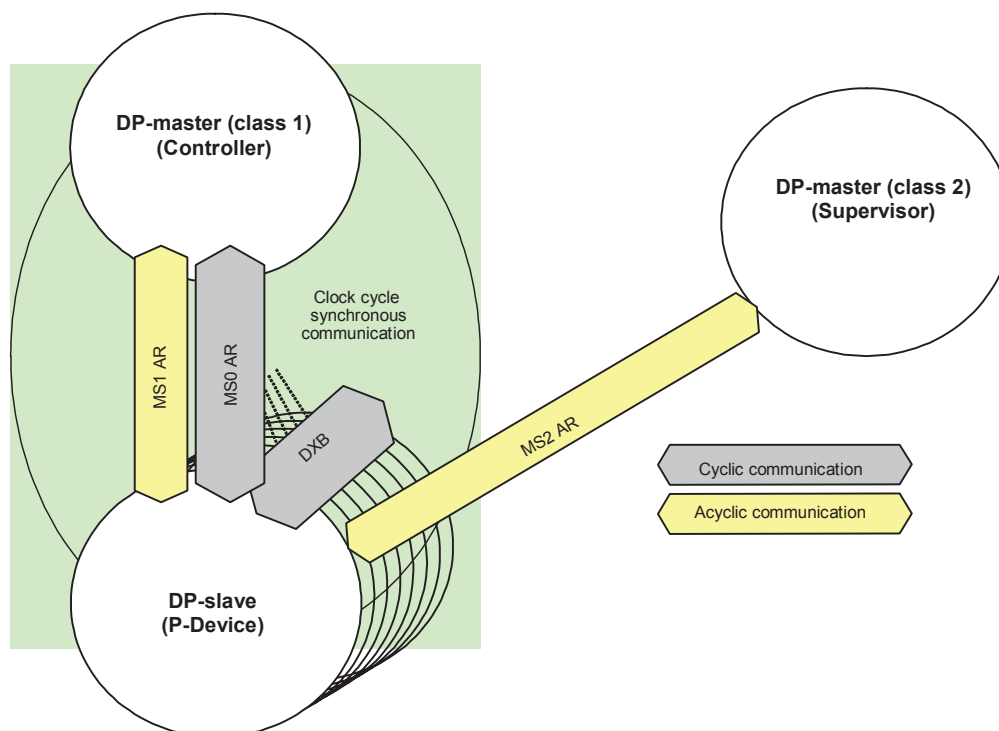


Figure 7 – Overview about the P-Device Communication Model on PROFIBUS

The type of PROFIBUS DP clock pulse generation (refer to 4.9.5) permits only one synchronous DP-master (class 1) on the bus. Additional masters on this bus may only be non synchronous DP-masters (class 1 or class 2). DP-masters class 2 are subordinated to the DP-master (class 1) with respect to the distribution of the cycle time, and thus increase the minimal DP cycle time T_{DP} (refer to 4.9).

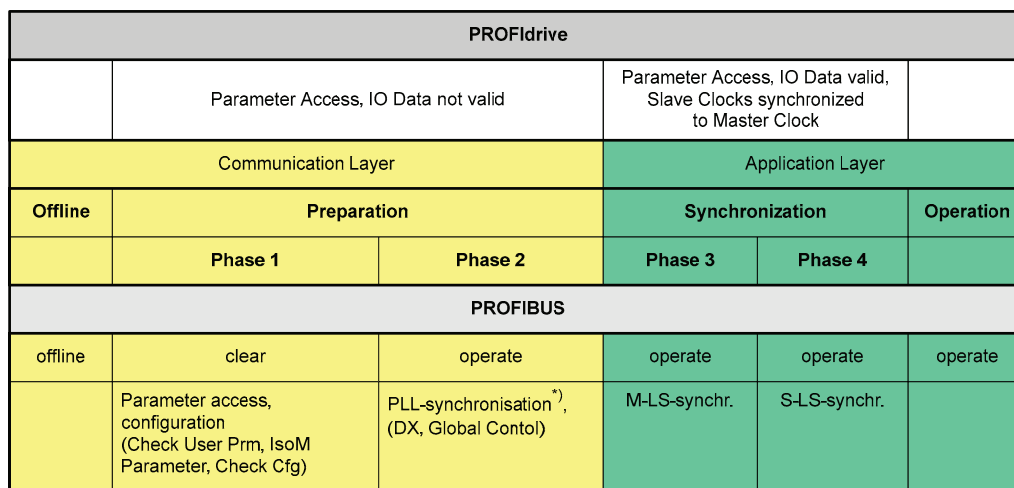
The following restrictions to bus topology are recommended when using the synchronous operation:

- A Class 1 Master may use all the available services without restrictions; other communication partners on the bus should be limited to maximum two MS2 AR channels (Services: Initiate, Read, Write, Data transport).
- A DP-master (class 2) has to be certified for the cycle synchronous applications (Token Hold Time).

4.3.6 Base Model State Machine

For PROFIdrive at PROFIBUS, the States of the PROFIdrive Base Model State Machine are mapped to the PROFIBUS states according to Figure 8. The actions to be carried out in the different phases and the corresponding PROFIBUS states are described in the following list:

- Offline: In the Offline state, no Communication Service is available. No data passes between the Devices.
- Phase1: This state is the PROFIBUS Clear state and part 1 of the PROFIdrive Preparation state. In Phase 1, the acyclic data transfer is working. Therefore Controller and Supervisor may perform a Parameter Access to the P-Device. The P-Device may also signal exceptions via the Alarm Mechanism to the Controller.
Typically in this mode, the Controller tries to parameterise the P-Devices (slaves) assigned to it, to conFigure them, and to prepare for start of IO Data exchange. In this state, Input and Output Data (DO IO Data) are not valid.
- Phase2: This state is part 2 of the PROFIdrive Preparation state, where the PROFIBUS is already in the operate state and the P-Devices (slaves) try to synchronise their local clocks to the Master Clock according to the specification of the Isochronous Mode. In this Phase, the Cyclic Data Exchange is active and the Global Control Telegram is sent by the DP-master (class 1). Also, the other Communication System services (MS1 AR, MS2 AR, Alarm Mechanism) are active and running.
- Phase3: This state is part 1 of the PROFIdrive Synchronization state, where the PROFIBUS is already in the operate state (Input and Output Data are valid), all Slave Clocks are synchronised to the Master Clock and the PROFIdrive Application Layer tries to synchronise their Tasks by use of the Life Sign mechanism. In this first part, the Master Life Sign (M-LS) is synchronised (see also IEC 61800-7-203, 6.3.12).
- Phase4: This state is part 2 of the PROFIdrive Synchronization state, where the PROFIBUS is already in the operate state (Input and Output Data are valid), all Slave Clocks are synchronised to the Master Clock and the PROFIdrive Application Layer tries to synchronise their Tasks by use of the Life Sign mechanism. In this second part the Slave Life Sign (S-LS) is synchronised while the Master Life Sign is already synchronised (see also IEC 61800-7-203, 6.3.12).
- Operation: In the Operation state, all Communication Services are available and active, also the Functional Objects on the Application Layer are synchronised and the whole PROFIdrive application is ready to operate.



^{*)} if clock synchronous operation is required

Figure 8 – Mapping of the Base Model State Machine at PROFIBUS DP

4.3.7 Definition of the CO

For PROFIdrive, the PROFIBUS Slot is defined as common CO. The CO/Slot should be used as Communication Object for IO Data, Parameter Access.

4.4 Drive Model at PROFIBUS DP

4.4.1 P-Device

Figure 9 shows the PROFIdrive P-Device mapped on a PROFIBUS slave device. The logical address elements for the Drive Object in the PROFIBUS system are:

- PROFIBUS domain
- Node-Address
- Drive Unit
- DO-ID

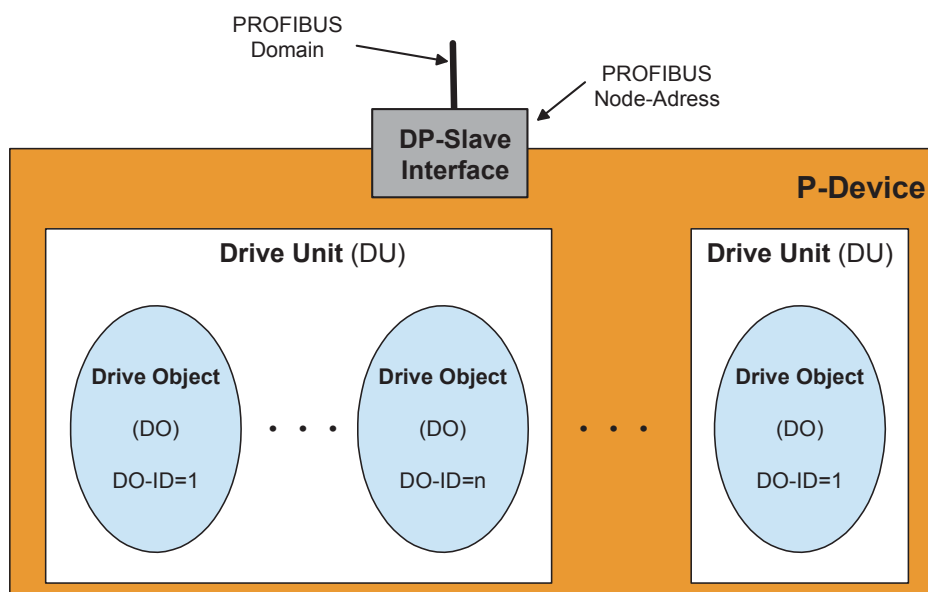


Figure 9 – PROFIBUS DP specific Logical P-Device model (multi axis drive)

4.4.2 Drive Unit

Figure 9 shows the PROFIdrive DOs inside a P-Device clustered in Drive Units (DU). The affiliation of the DOs to the DUs is relevant for the determination of the validity range of global PROFIdrive parameters. Here, the PROFIBUS slots belonging to one DU are merged to one block of consecutive slotnumbers. Mixing of slots of different DUs is not allowed.

The Identification of the DUs inside a P-Device can be done by evaluation of the global PROFIdrive parameter PNU 964.5 (number of DO) for all slots of the P-Device. The presence of PNU964 identifies the slot as a slot belonging to a PROFIdrive DO (important within heterogeneous P-Devices). Evaluation of the number of axis and correlation with the axis separator slots shows the start and the end slot of every DU.

4.5 DO IO Data

4.5.1 COs for DO IO Data configuration

Within PROFIBUS, the Slot consists of Input and/or Output Data. With PROFIdrive, the IO Data of one or more PROFIBUS Slots is mapped to setpoint values and actual values of the DO.

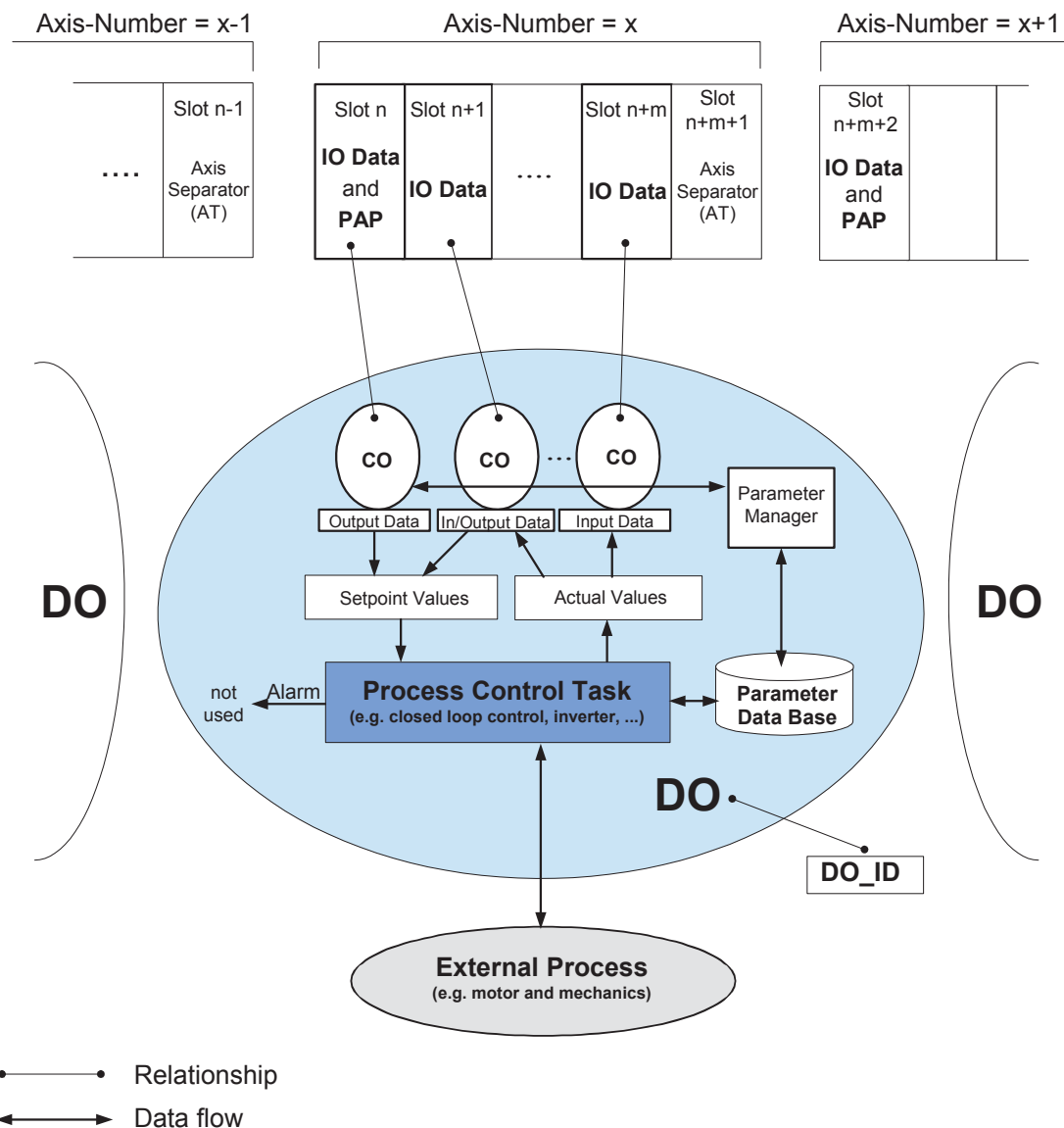


Figure 10 – Mapping of PROFIBUS Slot to the PROFIdrive DO

The mapping for a typical DO in a Multi-Axis or Modular Drive Unit is shown in Figure 10. A single axis DU consists at least out of one Slot/CO (Input/Output IO Data). In a Multi-Axis or Modular Drive Unit, the slots related to one DO are separated to the slots of the next DO by a special "Axis Separator" slot. The Axis Separator slot is empty and therefore does not comprise any IO Data.

For PROFIdrive at PROFIBUS, the following Slot types are defined:

- Standard DP-Slot (standard configuration identifier/DP ID):
 - Used for Input IO Data or Output IO Data
- Profile-specific Slots (special configuration identifier/PROFIdrive ID):
 - Axis Separator (empty/ no IO Data)
 - PROFIdrive Standard telegram (Input plus Output IO Data)
 - DXB (DXB Output IO Data)

A group of Slots belonging to one DO are identified by the Axis-Number. The Axis-Number starts with the number 1 and comprises at least one Slot. Note that the Drive Unit may consist of more DOs than the highest Axis-Number because of additional DOs without IO Data.

4.5.2 Standard telegram configuration

Every telegram type supported by the Drive Object shall be described by associated IDs. Telegrams which the master sends to the slave are interpreted as Output Data, and those telegrams which the master receives from the slave are interpreted as Input Data.

Recommendations for the DP IDs and the PROFIdrive IDs to transfer the PROFIdrive standard telegrams (defined in IEC 61800-7-203, 6.3.4.3) are shown in Table 2. The recommendations of the DP ID are given for data transfer with consistency over the complete length.

Table 2 – DP IDs and PROFIdrive IDs of the standard telegrams

Standard telegram	brief description of the standard telegrams	DP IDs		PROFIdrive IDs It is recommended to use the special configuration identifiers
		Setpoint direction	Actual value direction	
1	Speed setpoint (16 bit), no sensor, no Sign-Of-Life	IO Data component Output module 2 words 1110 0001 = 0xE1	IO Data component Input module 2 words 1101 0001 = 0xD1	2 words output, 2 word input 0xC3 0xC1 0xC1 0xFD 0x00 0x01
2	Speed setpoint (32 bit), no sensor, additional control word	IO Data component Output module 4 words 1110 0011 = 0xE3	IO Data component Input module 4 words 1101 0011 = 0xD3	4 words output, 4 words input 0xC3 0xC3 0xC3 0xFD 0x00 0x02
3	Speed setpoint (32 bit), additional control word, with one sensor	IO Data component Output module 5 words 1110 0100 = 0xE4	IO Data component Input module 9 words 1101 1000 = 0xD8	5 words output, 9 words input 0xC3 0xC4 0xC8 0xFD 0x00 0x03
4	Speed setpoint (32 bit), additional control word, with two sensors	IO Data component Output module 6 words 1110 0101 = 0xE5	IO Data component Input module 14 words 1101 1101 = 0xDD	6 word output, 14 word input 0xC3 0xC5 0xCD 0xFD 0x00 0x04

Standard telegram	brief description of the standard telegrams	DP IDs		PROFIdrive IDs It is recommended to use the special configuration identifiers
		Setpoint direction	Actual value direction	
5	Speed setpoint (32 bit), additional control word, with one sensor, DSC	IO Data component Output module 9 words 1110 1000 = 0xE8	IO Data component Input module 9 words 1101 1000 = 0xD8	9 words output, 9 words input 0xC3 0xC8 0xC8 0xFD 0x00 0x05
6	Speed setpoint (32 bit), additional control word, with two sensors, DSC	IO Data component Output module 10 words 1110 1001 = 0xE9	IO Data component Input module 14 words 1101 1101 = 0xDD	10 words output, 14 word input 0xC3 0xC9 0xCD 0xFD 0x00 0x06
7	Positioning interface (transferring traversing blocks)	IO Data component Output module 2 words 1110 0001 = 0xE1	IO Data component Input module 2 words 1101 0001 = 0xD1	2 words output, 2 words input 0xC3 0xC1 0xC1 0xFD 0x00 0x07
8	Position setpoint, speed setpoint, additional control word	IO Data component Output module 5 words 1110 0100 = 0xE4	IO Data component Input module 5 words 1101 0100 = 0xD4	5 words output, 5 words input 0xC3 0xC4 0xC4 0xFD 0x00 0x08
9	Positioning interface (with target position and velocity)	IO Data component Output module 6 words 1110 0101 = 0xE5	IO Data component Input module 5 words 1101 0100 = 0xD4	6 words output, 5 words input 0xC3 0xC5 0xC4 0xFD 0x00 0x09
20	Speed setpoint (16bit) n _{set} interface for the process technology See also IEC 61800-7-203, 6.5.5	IO Data component Output module 2 words 1110 0001 = 0xE1	IO Data component Input module 6 words 1101 0101 = 0xD5	2 words output, 6 words input 0xC3 0xC1 0xC5 0xFD 0x00 0x14
NOTE 1 For coding of the DP IDs, see IEC 61158-6-3.				
NOTE 2 The IO Data may be distributed over several modules in the master configuration for the IO Data component.				
NOTE 3 PROFIdrive IDs: The telegrams which are actually configured may be looked up in parameter P922 "telegram selection".				

Examples of configuration telegrams using DP IDs or PROFIdrive IDs for standard telegram 3 with one axis, two axis, and DXB communication are given in Table 3, Table 4 and Table 5.

Table 3 – 1 Drive Axis, standard telegram 3

Slot	1	2
DP ID	0xE4 (output)	0xD8 (input)
PROFIdrive ID	0xC3 0xC4 0xC8 0xFD 0x00 0x03	

Table 4 – 2 Drive Axes, standard telegram 3

Drive Axis	1			2		
Slot	1	2	3	4	5	6
DP ID	0xE4 (output)	0xD8 (input)	0x01 0xFE (axis separator)	0xE4 (output)	0xD8 (input)	0x01 0xFE (axis separator)
Slot	1		2	3		4
PROFIdrive ID	0xC3 0xC4 0xC8 0xFD 0x00 0x03		0x01 0xFE (axis separator)	0xC3 0xC4 0xC8 0xFD 0x00 0x03		0x01 0xFE (axis separator)

Table 5 – 2 Drive Axes, standard telegram 3, per axis one DXB link each with 2 words

Drive Axis	1				2			
Slot	1	2	3	4	5	6	7	8
DP ID	0xE4 (output)	0xD8 (input)	0x81 0xC1 0xF9 (1 DXB Link)	0x01 0xFE (axis separa- tor)	0xE4 (output)	0xD8 (input)	0x81 0xC1 0xF9 (1 DXB Link)	0x01 0xFE (axis separa- tor)
Slot	1		2	3	4		5	6
PROFIdrive ID	0xC3 0xC4 0xC8 0xFD 0x00 0x03		0x81 0xC1 0xF9 (1 DXB Link)	0x01 0xFE (axis separator)	0xC3 0xC4 0xC8 0xFD 0x00 0x03		0x81 0xC1 0xF9 (1 DXB Link)	0x01 0xFE (axis separator)

NOTE The coding of an empty slot (0x01 0x00 0xF9) instead of the coding of a DXB-slot (0x81 0xC1 0xF9) in the configuration telegram is also valid.

An example of the configuration telegram using DP IDs or PROFIdrive IDs for standard telegram 20 with one axis is given in Table 6.

Table 6 – 1 Drive Axis, standard telegram 20

Slot	1	2
DP ID	0xE1 (output)	0xD5 (input)
PROFIdrive ID	0xC3 0xC1 0xC5 0xFD 0x00 0x14	

4.5.3 Cyclic Data exchange between DP-Slaves (DXB)

NOTE In the subsequent text, only DXB communication will be referred to. Cyclic data exchange between DP-slaves and Data-eXchange Broadcast (DXB) are synonymous. The service used for cyclic data exchange between DP-slaves of PROFIBUS DP is Data-eXchange Broadcast.

4.5.3.1 Overview

Cyclic data exchange between DP-slaves (DXB) allows DP nodes to also read the Input Data (actual values) of DP slaves either completely or in part, and use them as Output Data (setpoint values). Thus, the possible uses of PROFIBUS are expanded, particularly in the area of distributed applications in drive engineering.

Via DXB, signals may be transmitted from drive to drive; for example:

- Speed setpoint values for setting up a setpoint cascade in paper, foil, wire-drawing machines and as well as fiber stretching plants.