

INTERNATIONAL STANDARD

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

**Entraînements électriques de puissance à vitesse variable –
Partie 7-1: Interface générique et utilisation de profils pour les entraînements
électriques de puissance – Définition de l'interface**



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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ADJUSTABLE SPEED ELECTRICAL POWER DRIVE SYSTEMS –**Part 7-1: Generic interface and use of profiles for
power drive systems – Interface definition**

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International Standard IEC 61800-7-1 has been prepared by subcommittee SC 22G: Adjustable speed electric drive systems incorporating semiconductor power converters, of IEC technical committee TC 22: Power electronic systems and equipment.

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

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

- a) mapping of drive profile type 1 onto additional network technologies;
- b) minor updates in the subclauses for profile types 1, 2 and 4, in relation with corresponding changes in the dedicated IEC 61800-7-20x parts.

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

FDIS	Report on voting
22G/306/FDIS	22G/321/RVD

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

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

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

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

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

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

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

IEC 61800-7 defines a set of common drive control functions, parameters, and state machines or description of sequences of operation to be mapped to the 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 adapt a solution to a drive profile and to manufacturer specific extensions may be unacceptable. This will reduce the degree of freedom to select a device best suited for this application to the selection of the unit which will be available for a specific physical interface and supported by the controller.

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

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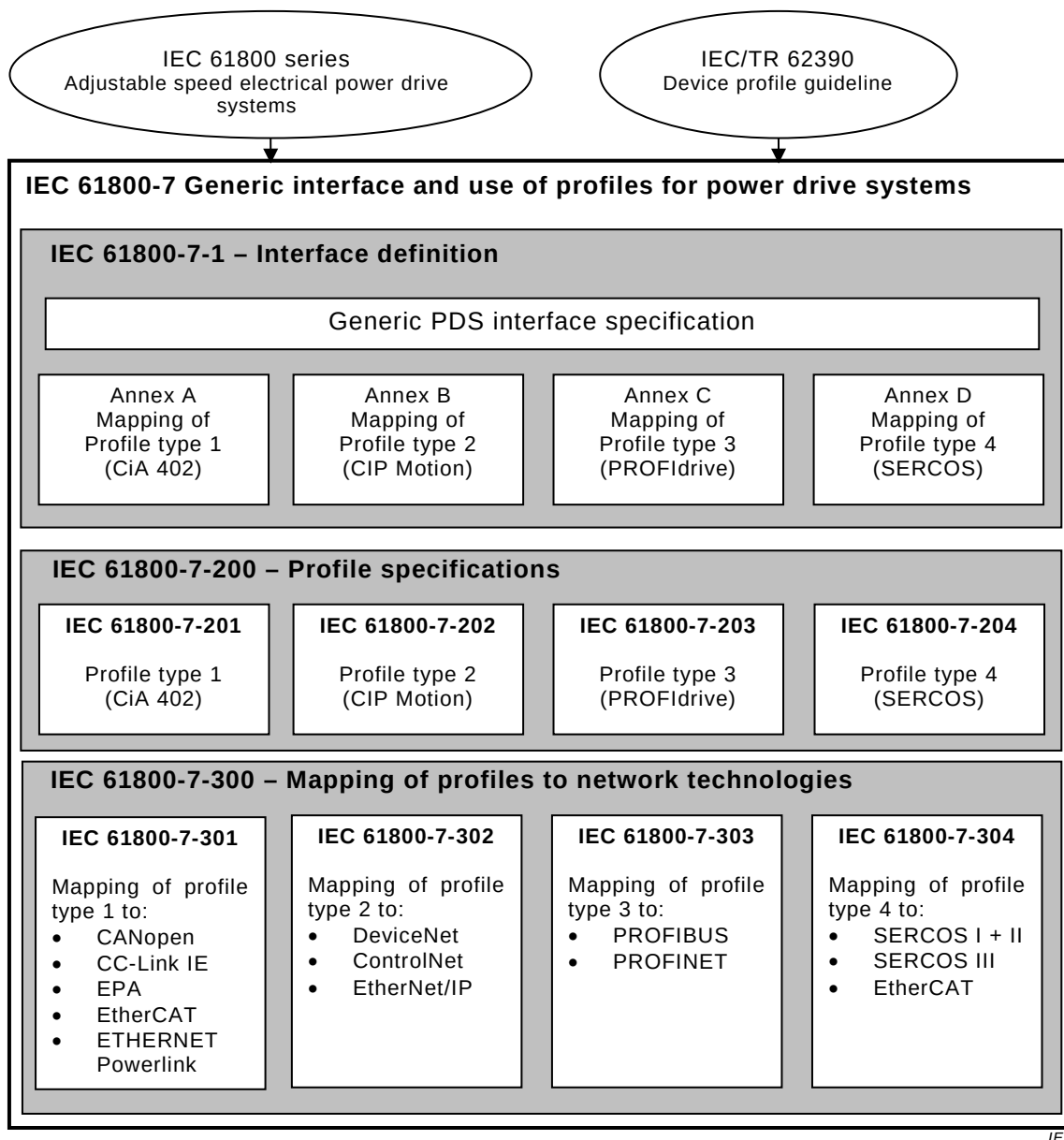
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IEC 61800-7-301, IEC 61800-7-302, IEC 61800-7-303 and IEC 61800-7-304 specify how the profile types 1, 2, 3 and 4 are mapped to different network technologies (such as CANopen®⁵, CC-Link IE® Field Network⁶, EPA™⁷, EtherCAT®⁸, Ethernet Powerlink™⁹,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

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Figure 1 – Structure of IEC 61800-7

ADJUSTABLE SPEED ELECTRICAL POWER DRIVE SYSTEMS –

Part 7-1: Generic interface and use of profiles for power drive systems – Interface definition

1 Scope

This part of IEC 61800 specifies a generic interface between power drive system(s) (PDS) and the application control program in a controller. The generic PDS interface is not specific to any particular communication network technology. Annexes of this part of IEC 61800 specify the mapping of the different drive profiles types onto the generic PDS interface.

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

2 Normative references

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

IEC 61158-5-2, *Industrial communication networks – Fieldbus specifications – Part 5-2: Application layer service definition – Type 2 elements*

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 61158-6-2, *Industrial communication networks – Fieldbus specifications – Part 6-2: Application layer protocol specification – Type 2 elements*

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

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

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

IEC 61800-7-201, *Adjustable speed electrical power drive systems – Part 7-201: Generic interface and use of profiles for power drive systems – Profile type 1 specification*

IEC 61800-7-202:2015, *Adjustable speed electrical power drive systems – Part 7-202: Generic interface and use of profiles for power drive systems – Profile type 2 specification*

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*

IEC 61800-7-204:2015, *Adjustable speed electrical power drive systems – Part 7-204: Generic interface and use of profiles for power drive systems – Profile type 4 specification*

IEC 61800-7-304, *Adjustable speed electrical power drive systems – Part 7-304: Generic interface and use of profiles for power drive systems – Mapping of profile type 4 to network technologies*

IEC TR 62390:2005, *Common automation device – Profile guideline*

EN 50325-4, *Industrial communications subsystem based on ISO 11898 (CAN) for controller-device interfaces – Part 4: CANopen*

3 Terms, definitions and abbreviated terms

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

3.1 System definitions

3.1.1

power drive system

PDS

combination of a motor and the Complete Drive Module (CDM)

Note 1 to entry: The complete drive module may include converter, control and self-protection functions and also some auxiliaries (for example ventilation). The PDS does not include the equipment driven by the motor.

Note 2 to entry: A logical power drive system consists of the PDS and an interface (e.g. communication network, fieldbus or software interface) and is accessed by an application control program over the generic PDS interface as described in Figure 3 to Figure 5.

Note 3 to entry: This definition is adapted from specifications in IEC 61800-1, IEC 61800-2, IEC 61800-3 and IEC 61800-4.

Note 4 to entry: The English abbreviation PDS is also used in French.

3.2 General definitions

3.2.1

algorithm

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

[SOURCE: IEC 60050-351:2013, 351-42-27, modified — The words "instructions" and "variables" are replaced by the words "operations" and "data" and the notes to entry are deleted.]

3.2.2

application

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

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

[SOURCE: IEC TR 62390:2005, 3.1.2, modified — The term "application program" has been replaced.]

3.2.3

attribute

property or characteristic of an entity

[SOURCE: IEC TR 62390:2005, 3.1.3]

3.2.4

axis

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

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

3.2.5

class

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

[SOURCE: ISO/IEC 19501:2005, 0000_121, modified — The second sentence is omitted.]

3.2.6

control

purposeful action on or in a process to meet specified objectives

[SOURCE: IEC 60050-351:2013, 351-42-19, modified — The notes to entry are omitted.]

3.2.7

control device

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

3.2.8

data type

set of values together with a set of permitted operations

[SOURCE: IEC 62390:2005, 3.1.6]

3.2.9

device

field device

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

[SOURCE: IEC 61499-1:2012, 3.29, modified — The note to entry is omitted, “networked” and “of an industrial automation system” are added.]

3.2.10

device

field device

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

[SOURCE: ISO 15745-1:2003, 3.11]

3.2.11

device profile

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

[SOURCE: IEC TR 62390:2005, 3.1.9, modified — The notes to entry are omitted.]

3.2.12**feedback variable**

variable quantity, which represents the controlled variable and is returned to the comparing element

[SOURCE: IEC 60050-351:2013, 351-48-03, modified — The figure is omitted.]

3.2.13**functional element**

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

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

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

[SOURCE: IEC TR 62390:2005, 3.1.12]

3.2.14**input data**

data transferred from an external source into a device, resource or functional element

[SOURCE: IEC TR 62390:2005, 3.1.14]

3.2.15**interface**

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

[SOURCE: IEC 60050-351:2013, 351-42-25, modified — The words "functional units" are replaced by "entities" and the notes to entry are omitted.]

3.2.16**logical power drive system**

model which includes PDS and communication network accessible through the generic PDS interface

3.2.17**model**

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

[SOURCE: IEC 60050-351:2013, 351-42-26]

3.2.18**operating mode**

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

[SOURCE: IEC 60050-351:2013, 351-55-01, modified – The figure is omitted.]

3.2.19**output data**

data originating in a device, resource or functional element and transferred from them to external systems

[SOURCE: IEC TR 62390:2005, 3.1.21]

3.2.20

parameter

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

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

[SOURCE: IEC TR 62390:2005, 3.1.22, modified – The note 1 to entry is omitted.]

3.2.21

profile

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

Note 1 to entry: Used in this part of IEC 61800 as a synonym for the specifications referenced in the annexes.

3.2.22

reference variable

input variable to a comparing element in a controlling system which sets the desired value of the controlled variable and is deducted from the command variable

[SOURCE: IEC 60050-351:2013, 351-48-02, modified — The figure is omitted.]

3.2.23

type

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

[SOURCE: IEC TR 62390:2005, 3.1.25]

3.2.24

use case

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

[SOURCE: IEC TR 62390:2005, 3.1.26]

3.2.25

variable

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

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

[SOURCE: IEC TR 62390:2005, 3.1.27, modified — Note 1 to entry is added.]

3.3 Specific definitions

3.3.1 Common definitions

NOTE The following terms and definitions are mapped by the different profiles to their specific terms.

3.3.1.1

actual value

value of a variable quantity at a given instant

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

[SOURCE: IEC 60050-351:2013, 351-41-02, modified – A note to entry is added.]

3.3.1.2**application mode**

type of application that can be requested from a PDS

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

3.3.1.3**commands**

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

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

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

3.3.1.4**I/O data**

input data and output data that would typically need to be updated on a regular basis (e.g. periodic change of state)

EXAMPLE Commands, set-points, status and actual values

3.3.1.5**set-point**

value or variable used as output data of the application control program to control the PDS

3.3.1.6**status**

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

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

3.3.2 Definitions for Annex A**3.3.2.1****CANopen**

application layer protocol as defined in EN 50325-4

3.3.2.2**object dictionary**

list of objects with unique 16-bit index and 8-bit sub-index as defined in EN 50325-4

3.3.2.3**process data object**

communication object with real-time capability

3.3.3 Definitions for Annex B

The terms and definitions given in IEC 61158-5-2 and IEC 61158-6-2 as well as the following also apply for Annex B.

3.3.3.1

CIP Motion™¹⁵

extensions to the CIP services and protocol to support motion control over CIP networks

3.3.3.2

CIP Motion™ controller

CIP compliant controller containing a Motion Control Axis Object that can interface to a CIP Motion device via a CIP Motion I/O Connection

Note 1 to entry: A description of the Motion Control Axis Object is beyond the scope of IEC 61800-7.

3.3.3.3

CIP Motion™ device

CIP compliant device containing one or more Motion Device Axis Object instances that can communicate to a CIP Motion controller via a CIP Motion I/O Connection

EXAMPLE: A CIP Motion drive is a particular case of a CIP Motion device.

3.3.3.4

CIP Motion™ I/O Connection

CIP Motion™ Connection

periodic bi-directional, class 1, CIP connection between a controller and a drive that is defined as part of the CIP Motion specification

3.3.3.5

CIP Sync™¹⁵

extensions to the CIP services and protocol to encapsulate IEC 61588:2009 time synchronization functionality over a CIP Network

Note 1 to entry: See Time Sync Object in IEC 61158-5-2 and IEC 61158-6-2.

3.3.3.6

cyclic data

high priority real-time data that is transferred by a CIP Motion Connection on a periodic basis

Note 1 to entry: This data would be considered I/O data as defined in IEC 61800-7.

3.3.3.7

event data

medium priority real-time data that is transferred by a CIP Motion Connection only after a specified event occurs

Note 1 to entry: Registration and marker input transitions are typical drive events.

3.3.3.8

motion

any aspect of the dynamics of an axis

Note 1 to entry: In the context of this part of IEC 61800-7, it is not limited to servo drives but encompasses all forms of drive based motor control.

3.3.3.9

Motion Device Axis Object

object that defines the attributes, services, and behavior of a motion device based axis according to the CIP Motion specification

¹⁵ CIP Motion™ and CIP Sync™ are trademarks of ODVA, Inc. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by IEC of the trade mark holder or any of its products. Compliance to this profile does not require use of the trade marks CIP Motion™ or CIP Sync™. Use of the trade marks CIP Motion™ or CIP Sync™ requires permission of ODVA, Inc.

Note 1 to entry: This object includes Communications, Device control, and Basic drive FE elements as defined in IEC 61800-7

3.3.3.10

service data

lower priority real-time data associated with a service message from the controller that is transferred by a CIP Motion Connection on a periodic basis

Note 1 to entry: Service data includes service request messages to access Motion Device Axis Object attributes or perform various drive diagnostics.

3.3.3.11

synchronized

condition where the local clock value on the drive is locked onto the master clock of the distributed System Time

Note 1 to entry: When synchronized, the drive and controller devices may utilise time stamps associated with CIP Motion Connection data.

3.3.3.12

System Time

absolute time value as defined in the CIP Sync specification in the context of a distributed time system where all devices have a local clock that is synchronized with a common master clock

Note 1 to entry: In the context of CIP Motion, System Time is a 64-bit integer value in units of nanoseconds with a value of 0 corresponding to the date 1970-01-01.

3.3.3.13

time stamp

System Time stamp value associated with the CIP Motion Connection data that conveys the absolute time when the associated data was captured, or that can also be used to determine when the associated data shall be applied

Note 1 to entry: CIP time stamps are always in the context of a distributed time system where all nodes on the CIP control network have clocks that are synchronized with a master clock source using CIP Sync.

3.3.4 Definitions for Annex C

3.3.4.1

Application Class

configuration of a Drive Object with a set of functional objects and supported by standard telegrams

3.3.4.2

Controller

controlling device which is associated with one or more drives (axes) a host for the overall automation

3.3.4.3

Drive Object

functional element of a Drive Unit

3.3.4.4

Drive Unit

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

3.3.4.5

host

device that covers the automation functionality of an automation device

3.3.4.6

P-Device

field device and the host for the Drive Objects

3.3.4.7

standard telegram

set of input data and output data for an application mode

3.3.4.8

Supervisor

engineering device which manages provisions of configuration data (parameter sets) and collections of diagnosis data from P-Devices and/or controllers

3.3.5 Definitions for Annex D

3.3.5.1

acknowledge telegram

AT

telegram, in which each slave inserts its data

Note 1 to entry: The English abbreviation AT is also used in French.

3.3.5.2

communication cycle

accumulation of all telegrams between two master synchronization telegrams

3.3.5.3

control unit

control device

3.3.5.4

control word

two adjacent bytes inside the master data telegram containing commands for the addressed drive

3.3.5.5

cycle time

time span between two consecutive cyclically recurring events

3.3.5.6

cyclic data

part of the message which does not change its meaning during cyclic operation of the interface

3.3.5.7

data exchange

demand dependent, non-cyclic transmission of information after request was sent by the master (service channel)

3.3.5.8

feed forward

command value used to compensate the lag in the control loop

3.3.5.9

identification number

IDN

designation of operating data under which a data block is preserved with its attribute, name, unit, minimum and maximum input values, and the data

Note 1 to entry: The English abbreviation IDN is also used in French.

3.3.5.10**master**

node, which assigns the other nodes the right to transmit

3.3.5.11**master data telegram****MDT**

telegram, in which the master inserts its data

Note 1 to entry: The English abbreviation MDT is also used in French.

3.3.5.12**operating cycle**

period of the control loop within the drive or the control unit

3.3.5.13**protocol**

convention about the data formats, time sequences, and error correction in the data exchange of communication systems

3.3.5.14**slave**

node, which is assigned the right to transmit by the master

3.3.5.15**status word**

two adjacent bytes inside the drive telegram containing status information

3.3.5.16**telegram**

message

dataset

3.3.5.17**topology**

physical network architecture with respect to the connection between the stations of the communication system

3.4 Abbreviated terms**3.4.1 Common abbreviations**

CDM	complete drive module
DCS	distributed control system
ERP	enterprise resource planning
FE	functional element
HMI	human machine interface
I/O	input/output
ID	identifier
MES	manufacturing execution system
NC	numerical control system with a numeric control command set
PDS	power drive system
PLC	programmable logic controller without a motion control command set

SCADA	supervisory control and data acquisition
URL	universal resource locator

3.4.2 Abbreviations for Annex A

CiA	CAN in Automation
FSA	finite state automaton
NMT	network management
PDO	process data object

3.4.3 Abbreviations for Annex B

Attr ID	attribute identifier
CIP™	Common Industrial Protocol (see IEC 61158 Type 2, IEC 61784-1 and IEC 61784-2 Communication Profile Family 2)

3.4.4 Abbreviations for Annex C

AC x	Application Class x, where x is the number of the AC
DO	Drive Object
DU	Drive Unit
I&M	identification and maintenance functions
P-Device	Peripheral Device
PROFIdrive	PROcess FIeldbus for drives
STW	control word
ZSW	status word

3.4.5 Abbreviations for Annex D

AT	acknowledge telegram
C1D	class 1 diagnostic
C2D	class 2 diagnostic
C3D	class 3 diagnostic
CP	communication phase (CP0 ... to CP6 – communication phases 0 ... 6)
IDN	identification number
MDT	master data telegram
SERCOS	SErial Real time COmmunication System
SVC	service channel

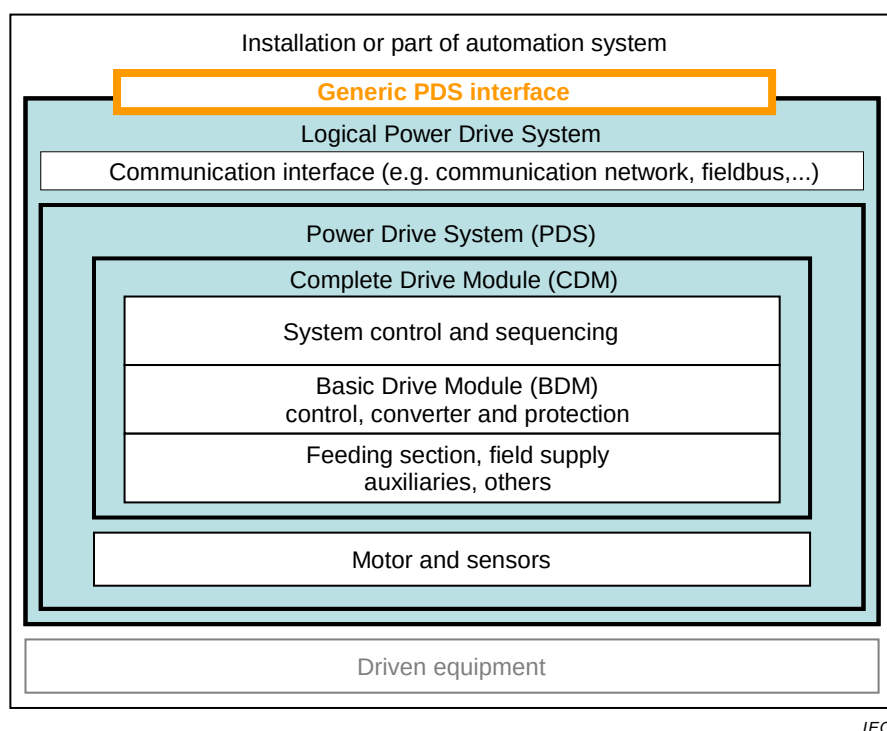
3.5 Conventions

Hexadecimal numbers shall be represented by 0xnn, nn_{hex} or nn_h.

4 General architecture

4.1 Generic PDS interface

This part of IEC 61800-7 specifies a generic interface between power drive systems (PDS) and the application control program in a controller. The generic PDS interface is not specific to any particular communication network technologies. The generic PDS interface supports only single axis control. Any functions for coordination of multiple axis are outside the scope of this part of IEC 61800-7. This might be a part of the logical controller.



NOTE In this part of IEC 61800-7, the drive device corresponds to the Complete Drive Module (CDM).

Figure 2 – Definition of power drive system

The PDS includes the drive device (or complete drive module) and the motor and sensors as shown in Figure 2.

The logical PDS is controlled by one or more logical controllers. The functions of the logical controller are performed by the application control program. The functionality of the logical PDS may be differentiated by position-control, velocity-control and torque-control applications. Figure 3 shows a subset of possible structures for position-control, Figure 4 shows a subset of possible structures for velocity-control and Figure 5 shows a subset of possible structures for torque-control applications.

NOTE 1 Possible velocity control types are listed in IEC 61800-4:2002, Annex B, and not covered by this part of IEC 61800-7.

NOTE 2 “Velocity” is used throughout this part of IEC 61800 to mean speed (e.g. movement of a motor) as well as velocity (e.g. movement of mechanical equipment). However “speed” is retained in the title to be consistent with common usage.

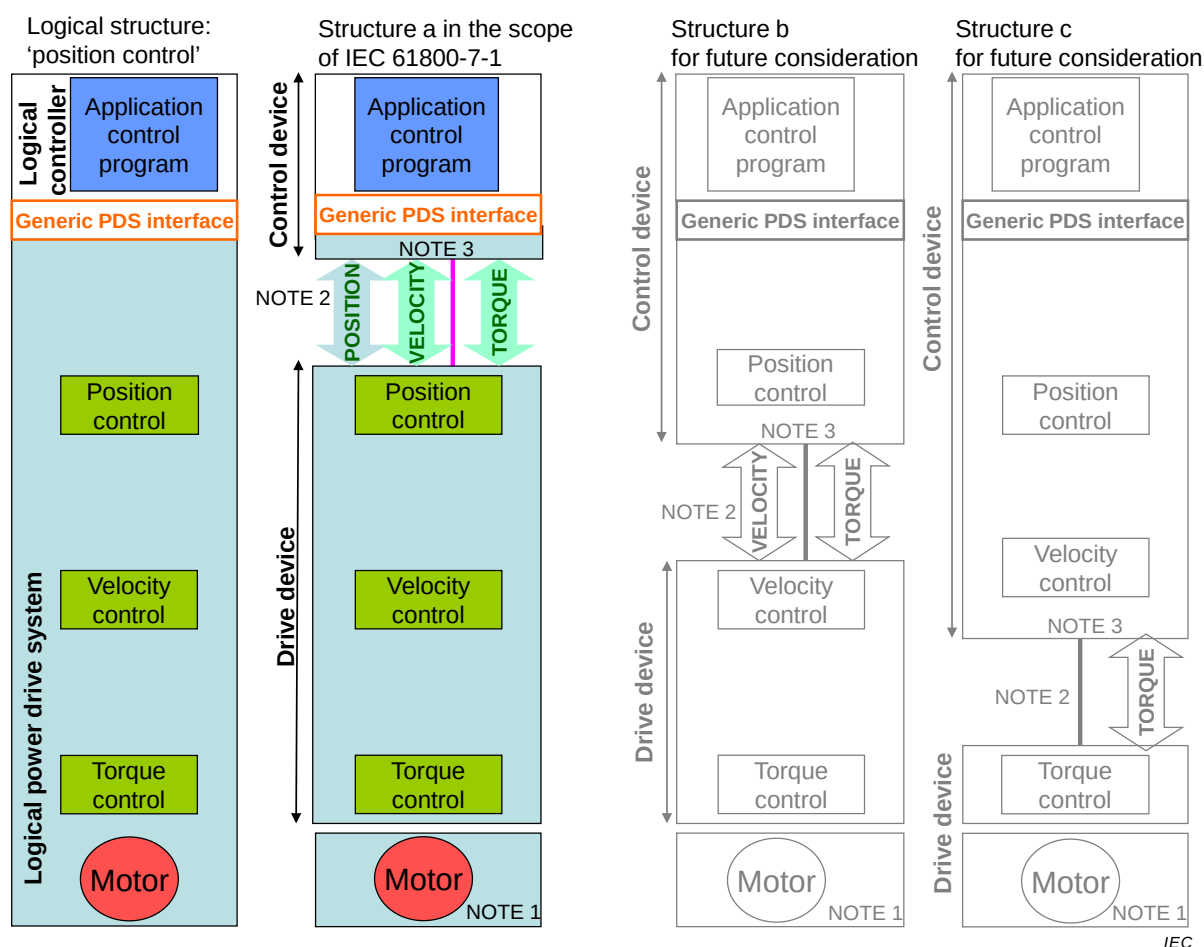
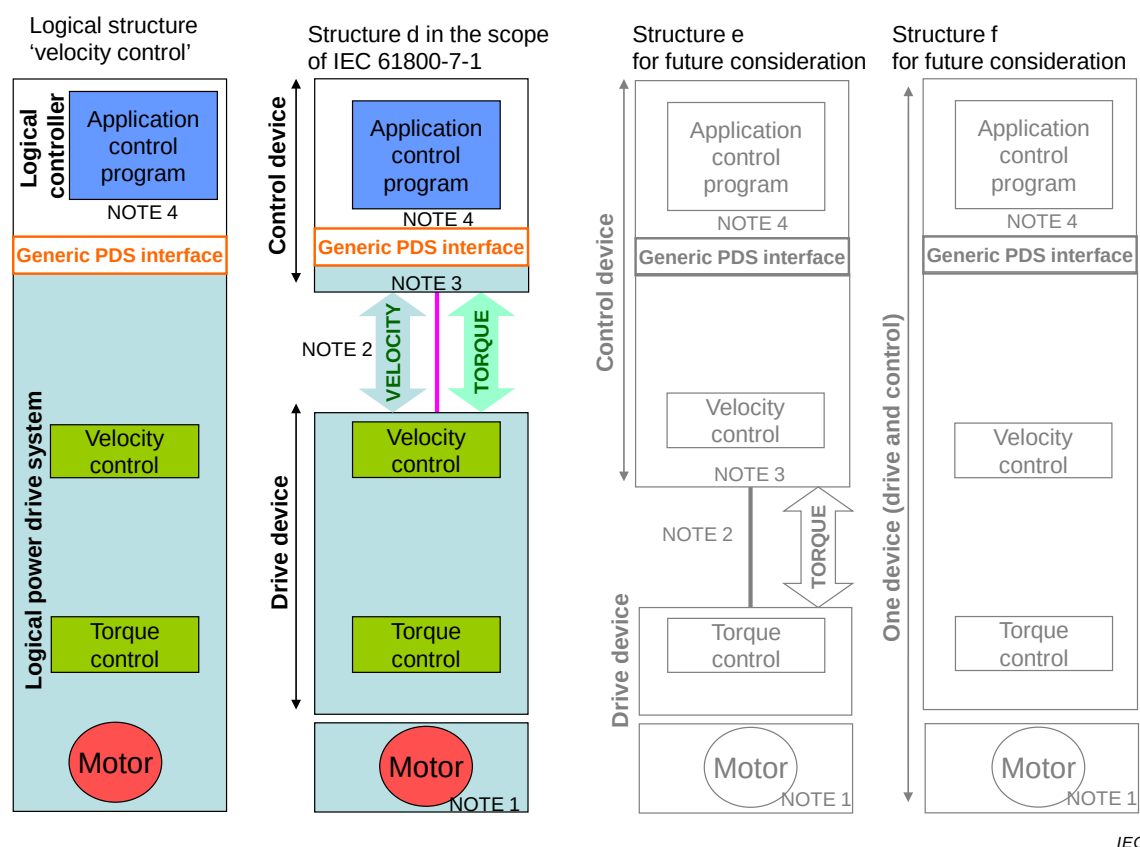


Figure 3 – Example of system structures for position-control applications

Structure a in Figure 3 shows a position-control application where all three control loops are implemented inside the drive device. In structure b, the velocity- and torque-control loops are inside the drive device and the position-control loop is in the control device. In structure c, only the torque-control is inside the drive device and the other control loops of the complete logical PDS are implemented inside the control device. In all three examples, the generic PDS interface is identical.



IEC

NOTE 1 In general, the PDS model includes the motor.

NOTE 2 Between the control device and the drive device is a network or fieldbus to transmit the data values like velocity and torque.

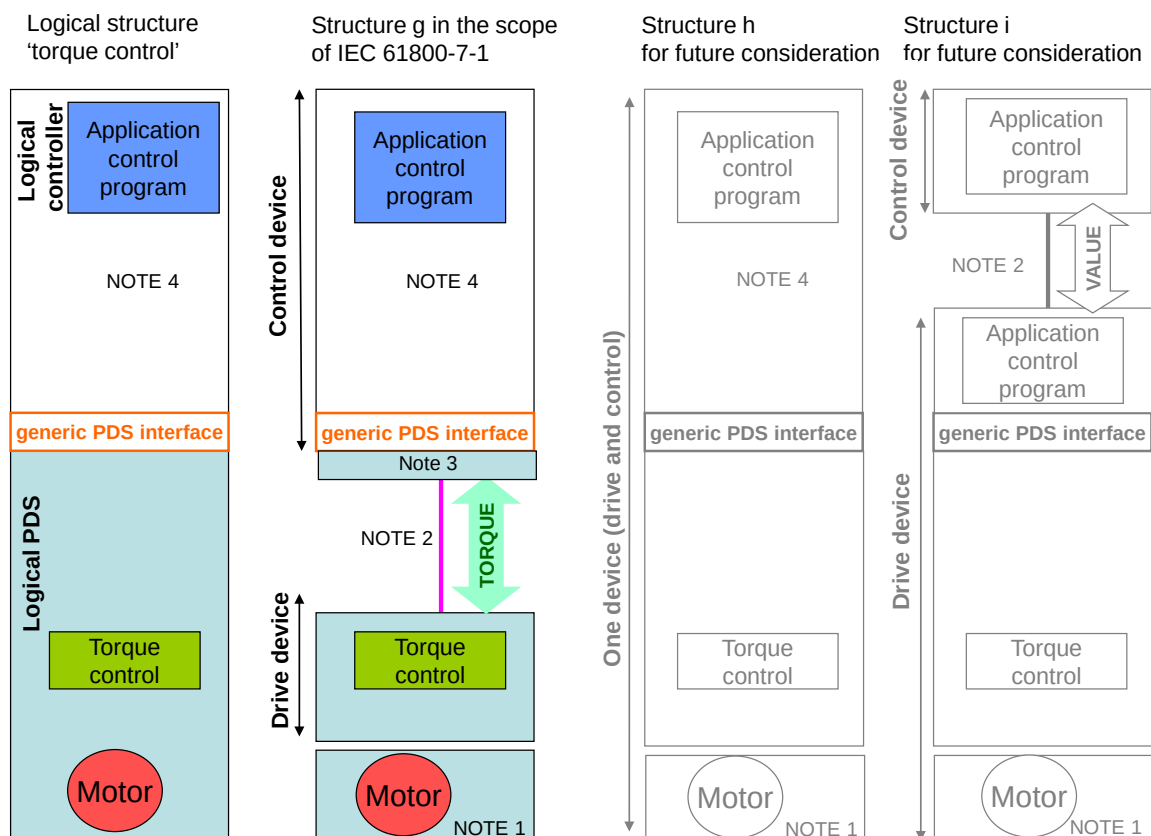
NOTE 3 Mapping or adaptation as needed for specific network or fieldbus technology.

NOTE 4 The application control program can also include position control.

Figure 4 – Examples of system structures for velocity-control applications

Structure d in Figure 4 shows a velocity-control application where all the control loops are implemented in the drive device. In structure e, the velocity-control loop is implemented in the control device and the torque-control in the drive device. Structure f shows an implementation where all the functionality is implemented in one single device. In fact, in structure f, the network or fieldbus is missing. In all three structures of Figure 4, the generic PDS interface is identical.

It is possible that the generic PDS interface be used in velocity-control and the application control program includes also position-control functionality.



IEC

NOTE 1 In general, the PDS model includes the motor.

NOTE 2 Between the control device and the drive device is a network or fieldbus to transmit the data values for torque.

NOTE 3 Mapping or adaptation as needed for specific network or fieldbus technology.

NOTE 4 The application control program can also include position control and velocity control functionality.

Figure 5 – Examples of system structures for torque-control applications

In Figure 5, possible implementations of torque-control applications are listed. The torque-control may be in the control device as in structure g. In structure h, all the functionality is in one device and the network or fieldbus is missing. It is always possible that the generic PDS interface be used for torque-control and the application program includes velocity-control and position-control functionality. In structure i, this generic interface is inside the “smart” drive device.

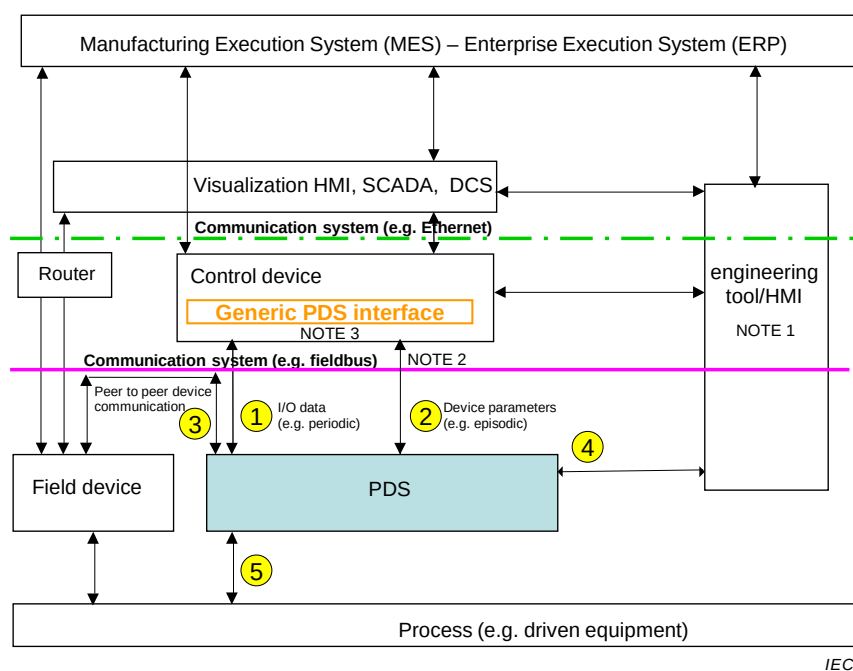
The specification of functionalities for the control device is beyond the scope of this part of IEC 61800-7. Table 1 lists the structures within the scope of this part of IEC 61800-7.

Table 1 – Structures within the scope of this part of IEC 61800-7

Structure	Application	In the scope of the document
a	Position control	Yes
b	Position control	No, for future consideration
c	Position control	No, for future consideration
d	Velocity control	Yes
e	Velocity control	No, for future consideration
f	Velocity control	No, for future consideration
g	Torque control	Yes
h	Torque control	No, for future consideration
i	Torque control	No, for future consideration

4.2 Typical structure of automation systems

The modelling of a device is done according to IEC device profile guideline (see IEC TR 62390). An automation system including PDS typically has the structure defined in Figure 6.



NOTE 1 The engineering tool can be one tool connected to one of the different communication networks or three different tools depending on the type of communication network connected to.

NOTE 2 Communication systems can be redundant as required; this has no influence to the generic PDS interface.

NOTE 3 Mapping or adaptation as needed for specific network or fieldbus technology.

Figure 6 – Typical structure of automation systems (adapted from IEC TR 62390)

The PDS has different logical interfaces to the outside world numbered 1) to 5) in Figure 6.

1) I/O data (generic PDS interface)

This interface is part of the generic PDS interface. It provides the control and monitoring interface between the control device and the PDS (see 3.3.1.4).

2) Device parameters (generic PDS interface)

This interface provides parameter access to the control device and remote engineering tools for identification, configuration, adjustment, monitoring or data logging. The device parameters are available for transfer via the communication system through the generic PDS interface.

3) Peer to peer device communication

The use of peer to peer communication service among other devices is a function of specific fieldbus technology and is not covered by the generic PDS interface.

4) Device parameters (local or other interface)

The local access and interface of an engineering tool or HMI to the PDS is not covered in this part of IEC 61800-7.

NOTE HMI or engineering tools can use the generic PDS interface or the fieldbus communication services which support the PDS interface. However, HMI sharing of the fieldbus could result in changes to performance of PDS data, this could be notified to the application.

5) Interface to the process

The interface to the process – the driven equipment – is not covered by this part of IEC 61800-7.

4.3 Structure of the logical PDS

A logical PDS is composed of different functional elements (FE) according to Figure 7.

Each FE has parameters and algorithms or functions to describe the behavior.

The parameters are used to define

- a unique name and identifier,
- state of operation,
- one or several inputs and output variables, and
- the behavior on algorithms and/or functions

of the FE.

The relation of the different states is described in a state-chart diagram.

Parameters may be structured in additional parameter lists depending on the operating mode of the FE or the application mode of the PDS.

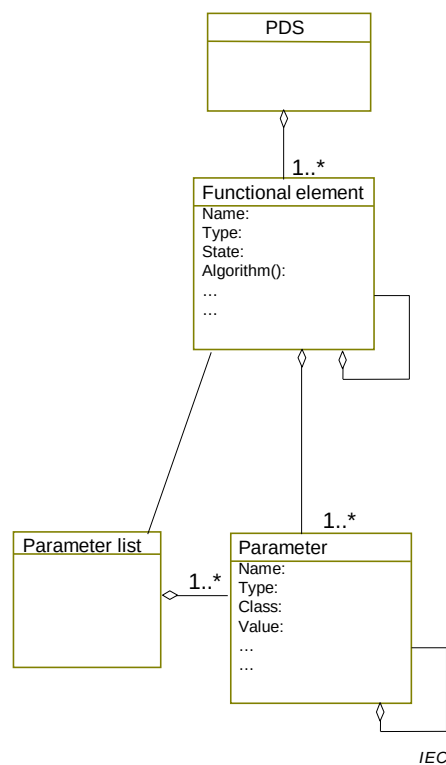


Figure 7 – Structure of the PDS with functional elements

For a logical PDS, the following FEs are recognized (see Figure 8):

Device identification FE

The Device identification FE contains the parameters needed to identify the physical device(s). Possible devices are drive device and control device according to Clause 1.

The Device identification FE is defined in 5.1.

Device control FE

The Device control FE includes the state machine for the control of the drive device.

The Device control FE is defined in 5.2.

Communication FE

The Communication FE of the logical PDS is composed of the communication specific parameters of the network between the control device and the drive device. It includes the communication state machine of the connected devices.

NOTE 1 Most of these parameters and states of the Communication FE are network or fieldbus specific.

NOTE 2 One profile can use different Communication FEs.

The generic Communication FE is defined in 5.3.

Basic drive FE

The different control loop functions like position-control, velocity-control and torque-control are the basic drive functions.

The Basic drive FE's are defined in 5.4.

Optional application FE

The possibility exists for the logical PDS to include additional – optional – application functions. A typical Optional application FE is the management of additional inputs or outputs for example the connections to a separated encoder device, brake control, limit switch etc. These functions are not further specified in this part of IEC 61800-7.

Other interface FE

The possibility exists for the logical PDS to have local interfaces or to support other protocols over the network to HMI or tools. These functions are not further specified in this part of IEC 61800-7.

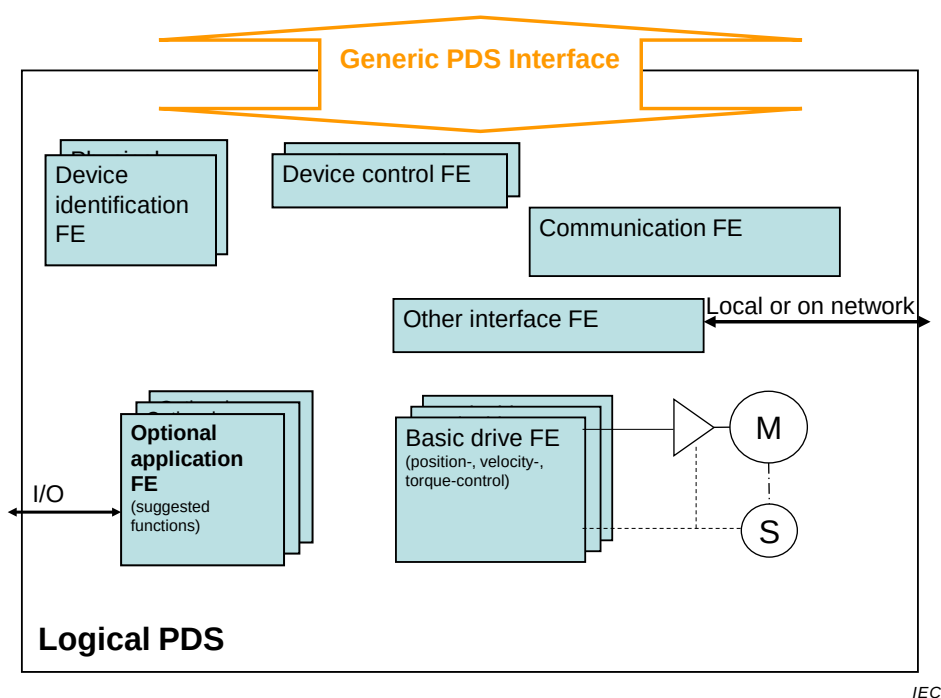


Figure 8 – Functional elements (FE) in the logical PDS

The detailed characteristics of the parameters in the different FE's in the PDS should be described according to IEC TR 62390:2005, Annex B.

Data flow and timing

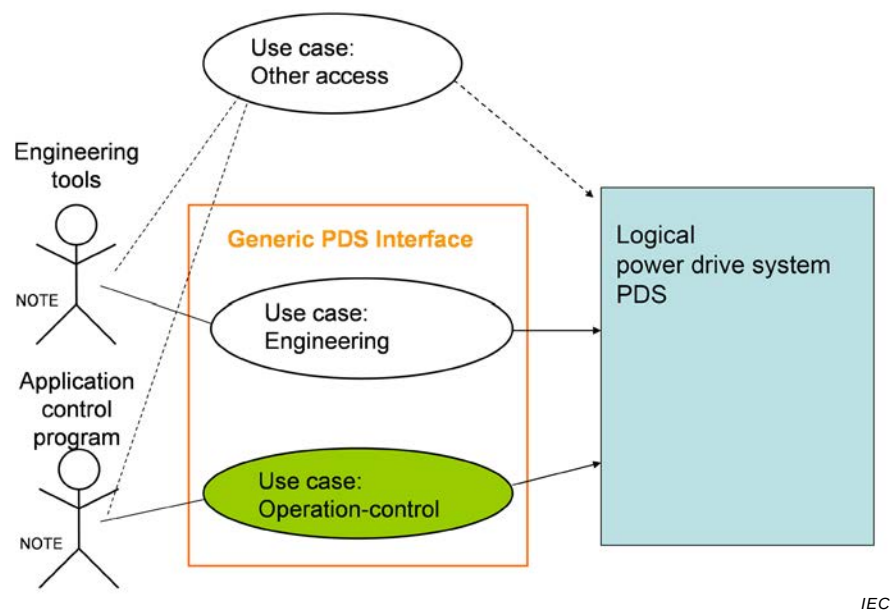
Commands and set-points are outputs from an application program and inputs to a logical PDS. Status information and actual values are outputs from a logical PDS and inputs to an application program.

One of the characteristics of a parameter or a parameters list is the access timing (see IEC TR 62390:2005, Annex B). This access timing depends on the need of the application program and the capabilities of the technology solutions.

4.4 Use cases of the PDS

4.4.1 General

The generic PDS interface is used by two different actors: the access by an application control program and the access by an engineering tool. The application control program uses the PDS for control-operation and the engineering tool uses the PDS for engineering. Local or other access methods to the PDS are beyond the scope of this part of IEC 61800-7. This relation is shown in Figure 9.



NOTE This symbol represents an “actor”. It can be an operator or a device.

Figure 9 – Use case for the generic PDS interface

4.4.2 Use case Engineering

The use case Engineering occurs in different phases of the life cycle of the system:

- commissioning;
- maintenance.

In this use case, different types of operation are needed:

- identification;
- configuration;
- adjustment;
- command;
- give set-point(s);
- monitoring;
- read data logging.

4.4.3 Use case Operation-control

In the use case Operation-control, the generic PDS interface for I/O data is used as follows.

- The application control program issues the commands (see 3.3.1.3) to the PDS.
- The application control program sets the set-point(s) (see 3.3.1.5) to the PDS.
- The PDS signals its status (see 3.3.1.6) to the application control program.
- The PDS may signal actual values (see 3.3.1.1) to the application control program.

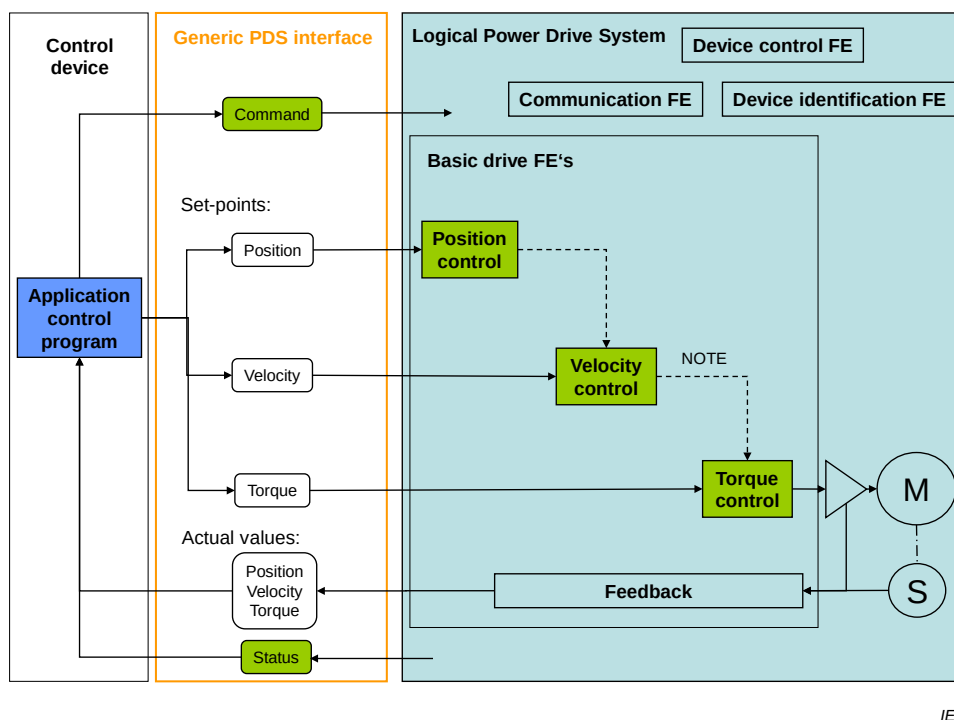
The commands, the set-points, the status and the actual values form the I/O data of the PDS.

The use case Operation-control may also use the generic PDS interface for device parameters for monitoring or modification of parameters (see 3.2.20).

The use case Operation-control can be in different application modes. Depending on the PDS Basic drive FE used inside the PDS and the possible set-point values, the application mode may be torque control, velocity control, position control or others for example homing.

Instead of set-point values, it is also possible to have one or several set-point values preset inside the PDS in a data array. The set-point is, in this case, a pointer to an element of the array. The pointer itself may be an index into the array or a bit pattern in a command word.

Depending on the application mode, different possible interfaces, parameters and state machines exist to describe the behavior of the PDS. Possible set-point values and actual values for all application modes are presented in a schematic way in Figure 10.



NOTE Additional relations between the different FE's can exist in the logical power drive system.

Figure 10 – The generic interface in the use case Operation

5 Functional elements

5.1 Device identification FE

5.1.1 General

In the Device identification FE are the parameters defined to identify the PDS, the versions of hardware and software and its manufacturer. An indication may be given about the identification and location of the PDS in a plant or installation.

5.1.2 Parameters

Possible parameters are listed in Table 2.

Table 2 – Parameters in the Device identification FE

Name	Meaning
Profile ID	Identification of the profile.
Manufacturer ID	Identification of the manufacturer or vendor of the device.
Product ID	Identification of the device type and model.
Serial number	A serial number is a unique production number of the device manufacturer even for devices with the same hardware, software or firmware version.
Hardware revision	The content of this parameter characterizes the edition of the hardware only.
Software revision	The content of this parameter characterizes the edition of the software or firmware of the device.
Tag	For each device within a plant, a unique label is necessary for the identification of its function. This label is set by the user but stored in the device.
Location	For each device within a plant, a unique label is necessary for the identification of its location.
Profile defined	Additional profile specific parameters.
This table is given for reference purposes. It is not necessary for all the parameters of this table to be implemented. Additional parameters not listed in this table may also be implemented.	

The type and size of these parameters are network dependent.

5.2 Device control FE

5.2.1 General

In the Device control FE, the state machine of the PDS is defined.

In this generic PDS interface, only a simple state machine to control the fault handling is defined. If the PDS is not able to provide the required services, it stays in the *faulted* state. A reset command from the controller device or a local interface is required to go to the *no fault* state. In the *no fault* state, the PDS is able to provide the required services.

The PDS may also signal a warning message to signal an error, which does not influence the services that the PDS is able to provide. These warnings may not require an acknowledgement and may therefore not be part of the state machine.

In a profile, more states may be provided, which means that one state defined in this generic PDS profile may be represented by several states in a PDS.

This state machine of the Device control FE is related to the other state machines in the other FEs of the PDS.

NOTE In the general architecture of the logical PDS system, the controller device can also have state machines. These state machines are not in the scope of this part of IEC 61800-7.

5.2.2 I/O data

With the status values listed in Table 3, the PDS signals the actual state of the Device control FE.

Table 3 – Status values for the Device control FE

Name	Meaning
Faulted	Set if the PDS is in the <i>faulted</i> state
Warning	Set if a warning condition is available
NOTE 1 Warning conditions do not necessarily need a reset action from the control device.	
NOTE 2 Additional information on the type of fault or warning can be provided in parameters.	

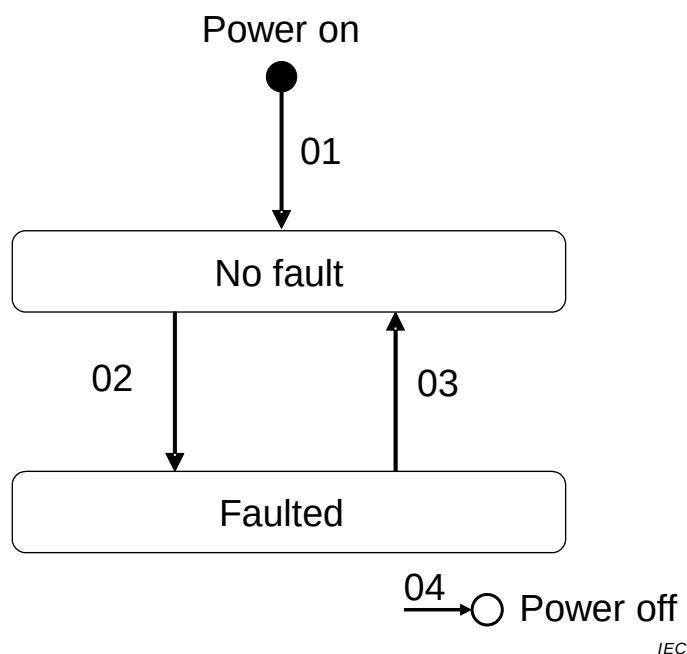
To control the state machine in the Device control FE, one message or command is used (see Table 4). Additional commands may be defined in the profile.

Table 4 – Command values for the Device control FE

Name	Meaning
Reset Fault	If the fault condition is eliminated, the PDS is requested to change state to <i>no fault</i> .

5.2.3 States

The Device control FE may be in the states described in Figure 11 and Figure 12. After the power on initialization, the Device control FE goes to the *no fault* state. If there exists a fault condition in the drive, a change to the *faulted* state shall be executed. A fault reaction may be performed before transiting to the *faulted* state.



NOTE The TRANSITION number corresponds to the number next to the arrow in the state-chart diagram.

Figure 11 – Device control FE state-chart diagram

STATE NAME		STATE DESCRIPTION	
No fault		The PDS is able to provide the required services	
Faulted		The PDS is not able to provide the required services and needs a reset	
TRANSITION	SOURCE STATE	TARGET STATE	EVENT / ACTION
01	Power on	No fault	Automatic transition / Initialization of the PDS.
02	No fault	Faulted	Fault condition in the drive / Signal new state. This is typically an event which is generated by the internal, device dependent functions of the PDS.
03	Faulted	No fault	The <i>reset fault</i> command is issued / Signal new state. This event may be generated by a command from the control device or from a local interface depending on the state of the Communication FE.
04	Any state	Power off	Power off / Shut down the PDS.

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Figure 12 – Device control FE state transition table

5.2.4 Parameters

In addition to the I/O data, the parameters in Table 5 are part of the Device control FE.

Table 5 – Parameters in the Device control FE

Name	Meaning
Fault	Identification of the fault which caused the <i>faulted</i> state
Warning	Identification of the condition which caused the warning status
Profile defined	Additional profile specific parameters
NOTE The exact coding and representation of this information is profile specific.	

5.3 Communication FE

5.3.1 General

The Communication FE includes all the state machines and parameters for the network or fieldbus interface. Multiple instances of the Communication FE are possible if a profile supports different networks or fieldbus interfaces.

The PDS may be in the *limited communication* or *normal communication* state.

Typically in the *limited communication* state the connection or functions of the network or fieldbus interface may be available in a read only mode, but the PDS does not accept commands and does not execute the set-points from the control device. In the *limited communication* state, the commands to the PDS are accepted only through the local interface.

In the *normal communication* state, the PDS is controlled by the control device over the network or fieldbus.

There is the possibility that different levels of access exist, which means that local or remote access may be separated for I/O data, reading of parameters and read/write of parameters. This may be represented by additional sub-states in the profiles.

There may be an additional state machine in the Communication FE reflecting the state of the network or fieldbus connection. This additional state machine is only needed, if a synchronous communication is required by the control application. In this case, the Communication FE may be in one of the states *synchronized* or *not synchronized*. The profiles may define additional sub-states for this state machine.

Synchronized operation means that the control device and the PDS use the same time base. This may be achieved for example by a local timer synchronization mechanism distributed via the network or external global time resources. These mechanisms allow synchronizing of application cycles in the control device and the PDS.

These state machines of the Communication FE are related to the other state machines in the other FEs of the PDS.

5.3.2 I/O data

With the status values listed in Table 6, the PDS signals the actual state of the Communication FE.

Table 6 – Status values for the Communication FE (see Figure 13)

Name	Meaning
Normal communication	Set if the PDS accepts commands and set-points over the communication interface

To control the state machine in the Communication FE the following messages or commands are used (see Table 7). In the profile additional commands may be defined.

Table 7 – Command values for the Communication FE (see Figure 13)

Name	Meaning
Stop communication	The control device requests the PDS to go to <i>limited communication</i> state
Run communication	The control device requests the PDS to go to the <i>normal communication</i> state

One optional communication function is the possibility to execute the PDS control loop in synchronous mode with the communication network or fieldbus. If this optional communication function is used, it is recommended to signal this status (see Table 8) and use the commands of Table 9.

Table 8 – Status values for the optional Communication FE (see Figure 15)

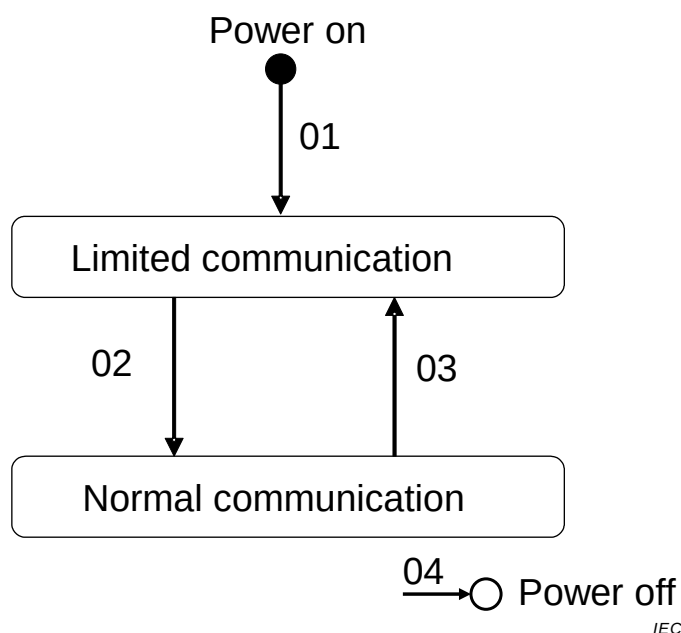
Name	Meaning
Synchronized	The local time of the PDS runs synchronous with the network and the control device

Table 9 – Command values for the optional Communication FE (see Figure 15)

Name	Meaning
Synchronize	Synchronization is requested to be switched on
Do not synchronize	Synchronization is requested to be switched off

5.3.3 States

The Communication FE may be in the states described in Figure 13 and Figure 14.



NOTE The TRANSITION number corresponds to the number next to the arrow in the state-chart diagram.

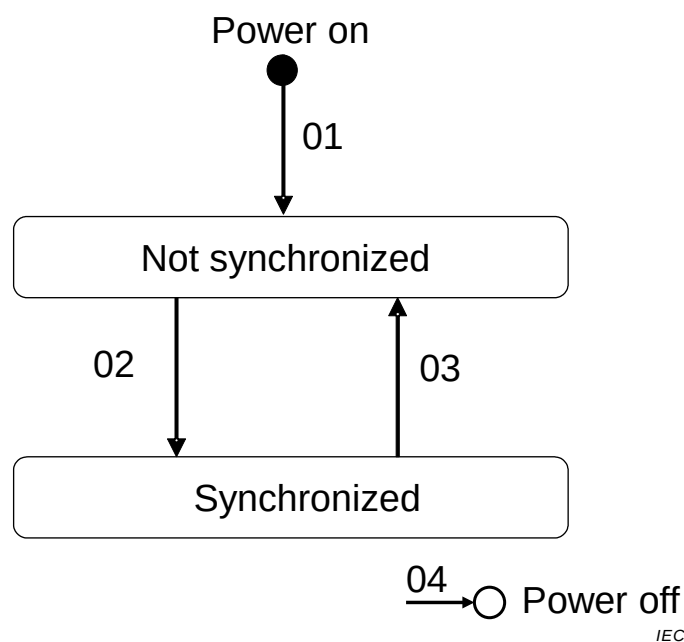
Figure 13 – Communication FE state-chart diagram

STATE NAME		STATE DESCRIPTION	
Normal communication		The PDS communicates over the communication interface	
Limited communication		The PDS does not communicate over the communication interface	
TRANSITION	SOURCE STATE	TARGET STATE	EVENT / ACTION
01	Power on	Limited communication	Automatic transition / the network interface is initialized
02	Limited communication	Normal communication	The <i>run communication</i> command is set by the control device or a local command to start communication is invoked / signal new state
03	Normal communication	Limited communication	The <i>stop communication</i> command is set by the control device or a local command is invoked / signal new state
04	Any	Power off	Power off / shut down the PDS
NOTE Possible conflicts of <i>run communication</i> and <i>stop communication</i> commands are handled by the profiles.			

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Figure 14 – Communication FE state transition table

In addition, the Communication FE can be in the states described in Figure 15 and Figure 16.



NOTE The TRANSITION number corresponds to the number next to the arrow in the state-chart diagram.

Figure 15 – Optional Communication FE state-chart diagram

STATE NAME		STATE DESCRIPTION	
Synchronized		The local time of the PDS is synchronous with the communication network and the control device	
Not synchronized		The local time of the PDS is not synchronous with the communication network and the control device	
TRANSITION	SOURCE STATE	TARGET STATE	EVENT / ACTION
01	Power on	Not synchronized	Automatic transition / initialization of the FE
02	Not synchronized	Synchronized	The command <i>synchronize</i> is requested by the control device and achieved by the PDS / signal state
03	Synchronized	Not synchronized	The synchronization is lost or the command <i>do not synchronize</i> is requested / signal state
04	All	Power off	Power off / shut down the PDS
NOTE In most implementations, there are additional states defined and used to implement the synchronization mechanism.			

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Figure 16 – Optional Communication FE state transition table

5.3.4 Parameters

In the Communication FE, there are the parameters defined to identify the communication interface and network type. These parameters are profile-dependent.

5.4 Basic drive FE

5.4.1 General

In the Basic drive FE, there are defined the state machines and the parameters to provide the basic drive functions.

In the generic interface, simple state machines with the states *operating* and *not operating* and *local control* and *remote control* are defined. Depending on the application mode, additional states and state machines may be defined by the profiles.

In the state *operating*, the PDS reacts on the commands and the set-point(s) provided by the remote or local interface and provides the status values and required actual values.

In the state *not operating*, the PDS does not react on the set-point(s) provided by the local or remote interface. The commands however are still valid and handled by the PDS.

In the state *local control*, the PDS reacts on the commands and the set-point(s) provided by local interface and provides the status values and required actual values.

In the state *remote control*, the PDS reacts on the commands and the set-point(s) provided by the remote interface and provides the status values and required actual values.

These state machines of the Basic drive FE may be related to the state machines in the other FE's of the PDS.

5.4.2 I/O data

With the status values listed in Table 10, the PDS signals the actual state of the Basic drive FE. Additional commands may be defined by the profiles. These commands may also be dependent on the application mode.

Table 10 – Status values of the Basic drive FE

Name	Meaning
Operating	The PDS is attempting to follow the set-point values

One optional basic drive function is the possibility to execute the PDS control loop in remote or local control mode. If this optional basic drive function is used, it is recommended to signal this status (see Table 11 and Figure 15).

Table 11 – Optional status values for the Basic drive FE

Name	Meaning
Remote control	Set if the PDS accepts commands and set-points over the communication interface

To control the state machine of the Basic drive FE, at least the command defined in Table 12 shall be defined. Depending on the additional states defined by the application mode, the profile may define additional commands.

Table 12 – Command values for Basic drive FE

Name	Meaning
Operate	The PDS should start action on the provided set point data

Depending on the application mode, the set-point and actual values are defined to control the PDS. These possible values are defined in Clause 6.

To control the optional state machine in the Basic drive FE, one message or command is used (see Table 13). In the profile, additional commands may be defined.

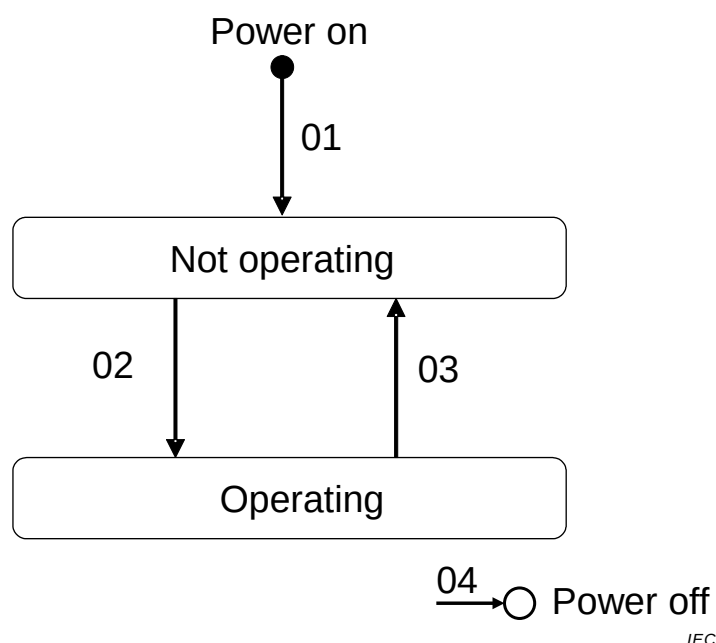
Table 13 – Optional command values for the Basic drive FE

Name	Meaning
Local	The control device releases the control over the PDS
Remote	The control device requests the control over the PDS

5.4.3 States

The PDS basic drive functions may be in the states as described in Figure 17 and Figure 18.

The different states may be split in sub-states by the profiles.



NOTE The TRANSITION number corresponds to the number next to the arrow in the state-chart diagram.

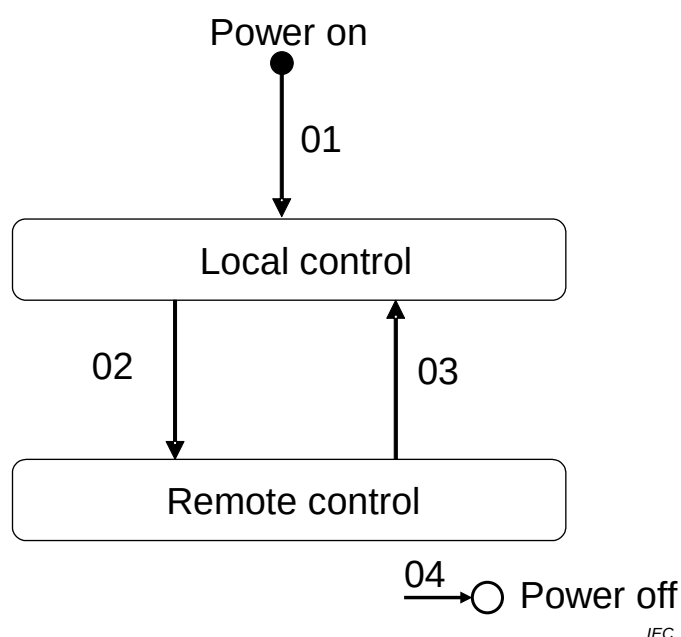
Figure 17 – Basic drive FE state-chart diagram

STATE NAME		STATE DESCRIPTION	
Operating		The PDS reacts on the requested set-points and commands	
Not operating		The PDS does not deal with the set-point values – but reacts on the commands	
TRANSITION	SOURCE STATE	TARGET STATE	EVENT / ACTION
01	Power on	Not operate	Automatic transition / initialization of the Basic drive FE
02	Not operating	Operating	The <i>operate</i> command from a local or remote interface is invoked / signal state
03	Operating	Not operating	The <i>operate</i> command is removed / signal state
04	All	Power off	Power off / shut down

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Figure 18 – Basic drive FE state transition table

In addition, the Basic drive FE may be in the states described in Figure 19 and Figure 20.



NOTE The TRANSITION number corresponds to the number next to the arrow in the state-chart diagram.

Figure 19 – Optional Basic drive FE state-chart diagram

STATE NAME		STATE DESCRIPTION	
Remote control		The PDS accepts commands and set-points over the communication interface	
Local control		The PDS does not accept set-points and accepts only reduced set of commands over the communication interface	
TRANSITION	SOURCE STATE	TARGET STATE	EVENT / ACTION
01	Power on	Local control	Automatic transition / the function is initialized
02	Local control	Remote control	The <i>remote</i> command is set by the control device or a local command to permit remote control is invoked / signal the state
03	Remote control	Local control	The <i>local</i> command is set by the control device or a local command to take local control is invoked / signal the state
04	All	Power off	Power off / shut down
NOTE Possible conflicts of <i>local</i> and <i>remote</i> commands are handled by the profiles.			

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Figure 20 – Optional Basic drive FE state transition table

5.4.4 Parameters

In the Basic drive FE, the parameters “mode command” and “mode status” are defined to

- define the actual application mode used,
- to define the set of I/O data, and
- to specify the behavior of the FE depending on the application mode.

These parameters are profile and application mode dependent.

5.5 Optional application FE

In the PDS, additional functionality may be introduced. This could be for example additional I/O connections for limit switches or additional sensors to measure the values of for example velocity or position.

These optional application FEs are not further specified in this generic PDS interface.

The profiles may use other profile specifications for these application FEs.

6 Application modes

6.1 General

The logical PDS can be in different application modes depending on the hardware and software functions available on the PDS. Table 14 shows the possible control loops and extensions.

Table 14 – Possible generic application modes

Control loop	Set-points		
	Torque control (see 6.2)	Velocity control (see 6.3)	Position control (see 6.4)
Preset	Normally not used	See Figure 23	See Figure 26
Control	See Figure 21	See Figure 24	See Figure 27
Control with mandatory feedback of the next control level	See Figure 22	See Figure 25	Higher control level such as multi-axis are not in the scope of this part of IEC 61800

In Table 15, the possible set-point values for the reference variables for these generic application modes are listed.

Table 15 – Set-point values for generic application modes

Application mode	Set-point	Functions in the PDS	Related figure
Torque preset	Torque-index or just On/Off	Open loop torque control.	Normally not used
Torque control	Torque	Open torque control loop. Additionally, a measured or estimated feedback value(s) is (are) provided.	Figure 21
Torque control with velocity feedback	Torque	Closed Torque control loop. Additionally, a measured or estimated feedback value(s) is (are) provided.	Figure 22
Velocity preset	Velocity-index or just On/Off	Drive can run on one or several fixed velocities with internal control of torque and velocity.	Figure 23
Velocity control	Velocity	Open velocity and torque control loop. Additionally, a measured or estimated feedback value is provided.	Figure 24
Velocity control with position feedback	Velocity	Closed velocity and torque control loop. Additionally, a measured or estimated feedback value is provided.	Figure 25
Position preset	Position-index or just On/Off	Drive can go to fixed positions with closed loop control with (or without) sensor feedback, using (optionally) defined trajectories.	Figure 26
Position control	Position	Open or closed torque, velocity and position control loop in the drive with (or without) sensor feedback.	Figure 27

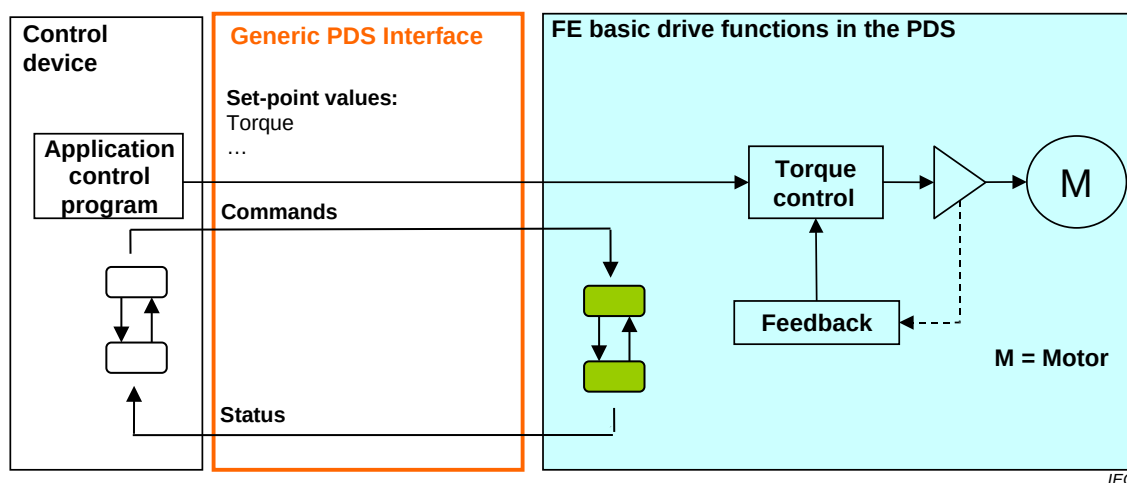
NOTE 1 Speed, velocity and frequency are considered as similar functionalities. In fact they are not the same, but there is a constant factor in the relation between the different meanings of the variables.

There is one mandatory set-point and one or a set of actual values specified for each application mode. Additional set-points and additional actual values are possible.

NOTE 2 In all cases, the state of the FE basic drive functions in the PDS is controlled with the commands and monitored with the status.

6.2 Torque control

In the torque control application mode, the application control program gives a set-point value for the torque to the PDS. The PDS may provide the calculated or measured (estimated) actual torque value in the feedback variable.

**Figure 21 – Torque control application mode**

In the torque control with velocity feedback application mode, the application control program gives a set-point value for the torque to the PDS as input data. The actual velocity can be estimated or measured by the PDS depending on the hardware possibilities of the PDS.

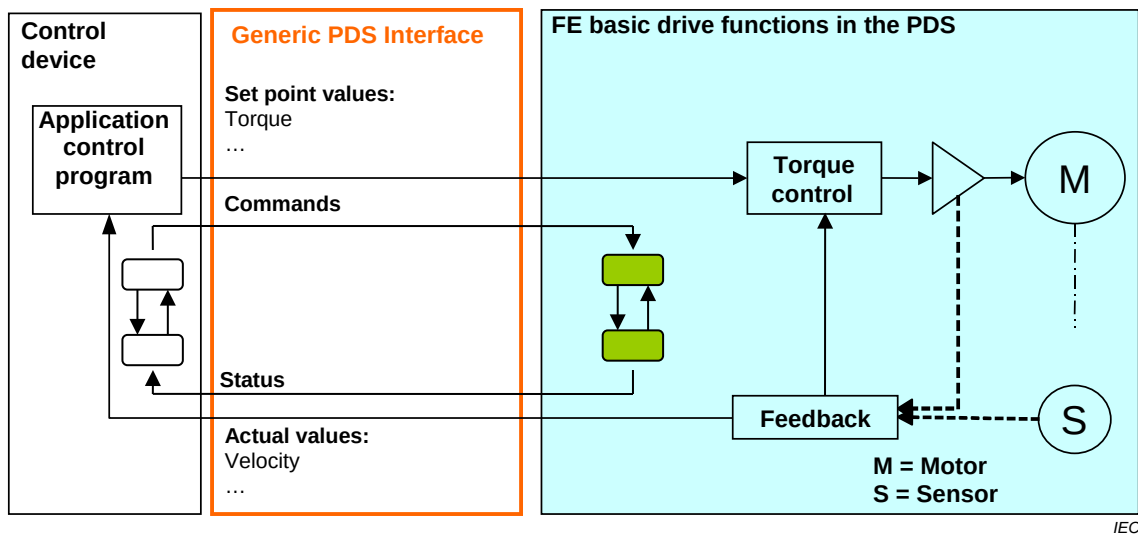


Figure 22 – Torque control with velocity feedback application mode

6.3 Velocity control

In the velocity preset application mode the velocity data holds the possible velocity values of the PDS. In the simplest case, this has two values: ON/OFF. In a more sophisticated PDS, there is the possibility of a selection of two or more different – fixed – velocities.

NOTE 1 The set-point data is only an index into the list of possible velocity values stored in the velocity data record inside the PDS.

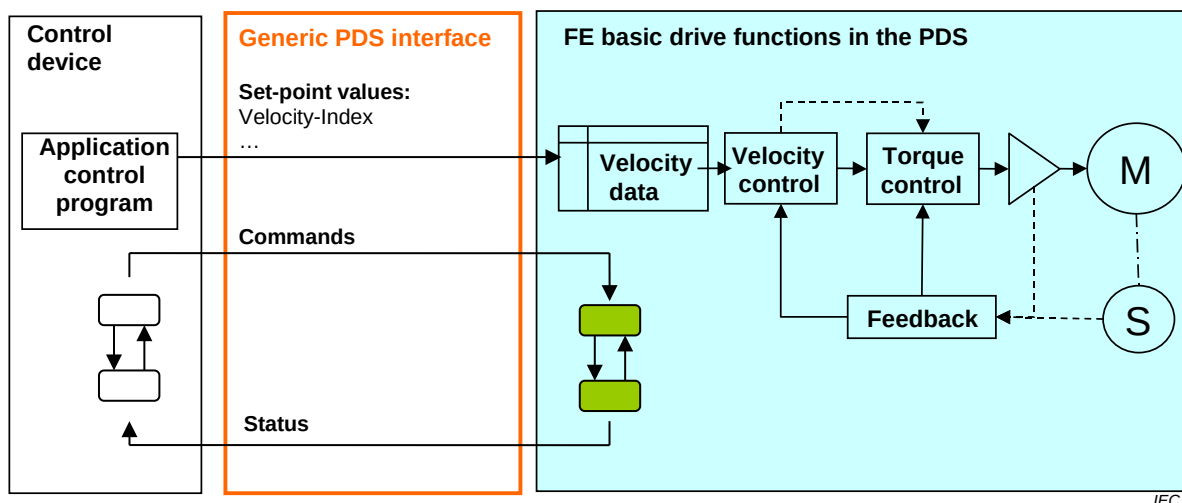


Figure 23 – Velocity preset application mode

The velocity control application mode is probably the most used application mode. The application control program gives the set-point value for velocity, and optionally the torque if forward control is also used. The PDS may optionally return the actual velocity and also the actual torque value. The feedback values may be calculated (estimated) or measured.

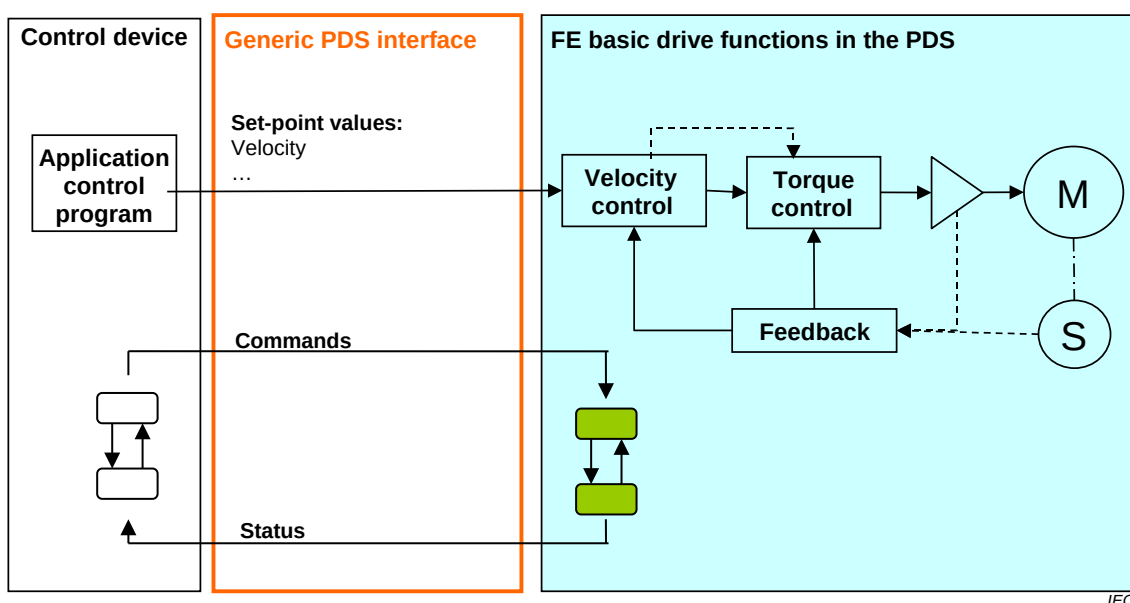


Figure 24 – Velocity control application mode

If the measurement possibilities exist, it may make sense to also feedback the actual position from the PDS. This allows the construction of a simple position control in the control device.

NOTE 2 In most implementations today, this position feedback is realized independently from the PDS in an additional device.

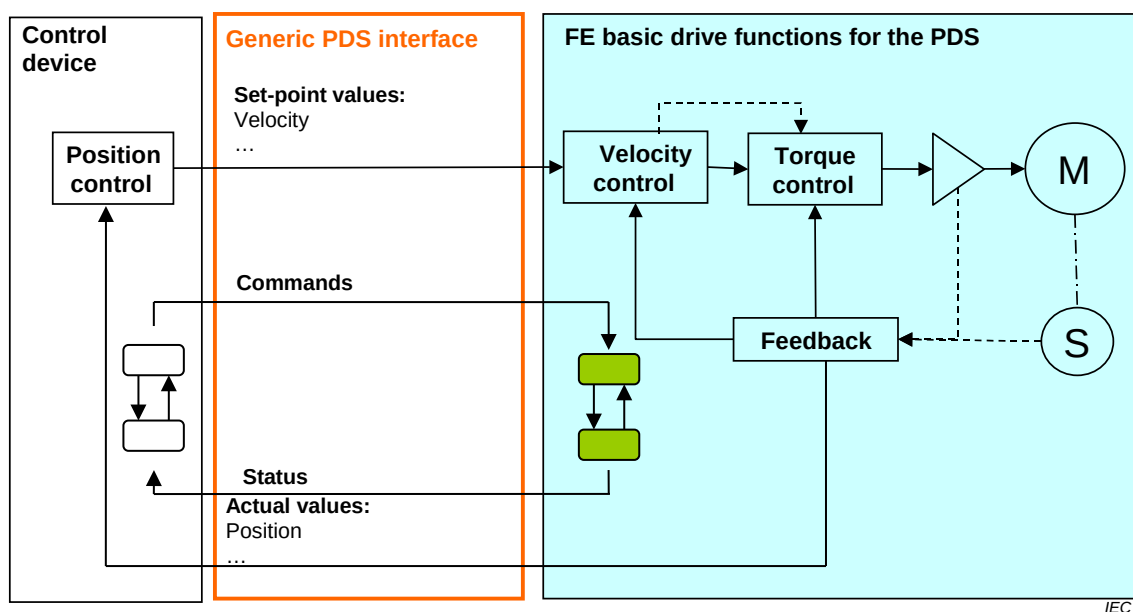


Figure 25 – Velocity control with position feedback application mode

6.4 Position control

In position data, a set of possible positions is stored in the PDS. Options may exist to define the trajectory to be followed between these positions.

NOTE The set-point data is only an index to the list of possible position values stored in the position data record inside the PDS.