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Edition 2.0 2015-11
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Adjustable speed electrical power drive systems –
Part 7-201: Generic interface and use of profiles for power drive systems –
Profile type 1 specification

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IEC 61800-7-201:2015-11 RLV(en)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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ADJUSTABLE SPEED ELECTRICAL POWER DRIVE SYSTEMS –

Part 7-201: Generic interface and use of profiles for power drive systems – Profile type 1 specification

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The International Standard IEC 61800-7-201 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 editon 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:

- Updates, clarifications and enhancements.

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

FDIS	Report on voting
22G/307/FDIS	22G/322/RVD

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

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

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

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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

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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 ~~(builds modules, machines, plants etc.)~~

– less integration effort for devices;
– only one understandable way of modeling;
– independent of bus technology,

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

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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~~ adapt a solution to a drive profile and to manufacturer-specific extensions may be unacceptable. This will reduce the degree of freedom to select a device best suited for this application to the selection of the unit which will be available for a specific physical interface and supported by the controller.

IEC 61800-7-1 is divided into a generic part and several annexes as shown in Figure 1. The drive profiles types for CiA® 402[1], CIP Motion™[2], PROFIdrive[3] and SERCOS® ~~Interface~~™[4] are mapped to the generic interface in the corresponding annex. The annexes have been submitted by open international network or fieldbus organizations which are responsible for the content of the related annex and use of the related trade marks.

This part of IEC 61800-7 specifies the profile type 1 (CiA® 402).

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

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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], ~~EtherCAT™~~, CC-Link IE® Field Network[6], EPA™[7], EtherCAT®[8], Ethernet Powerlink™[9], DeviceNet™[10], ControlNet™[11], EtherNet/IP™[12], PROFIBUS[13], PROFINET[14] and SERCOS® ~~Interface~~).

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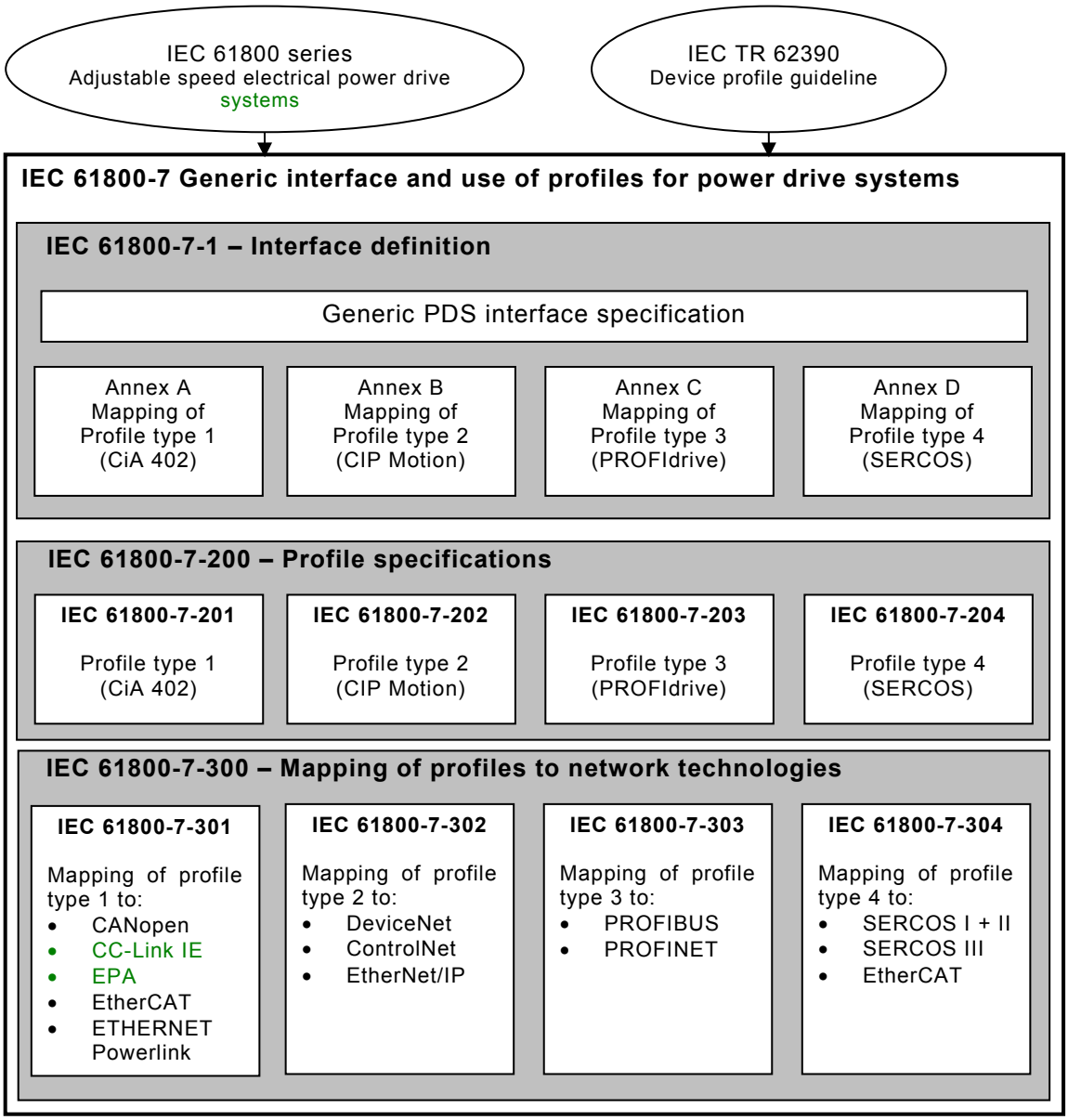


Figure 1 – Structure of IEC 61800-7

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ADJUSTABLE SPEED ELECTRICAL POWER DRIVE SYSTEMS –

Part 7-201: Generic interface and use of profiles for power drive systems – Profile type 1 specification

1 Scope

This part of IEC 61800 specifies profile type 1 for Power Drive Systems (PDS). Profile type 1 can be mapped onto different communication network technologies.

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

IEC 61800-7-301[15], *Adjustable speed electrical power drive systems – Part 7-301: Generic interface and use of profiles for power drive systems – Mapping of profile type 1 to network technologies*

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

CiA 303-2:2012, *CANopen recommendation – Part 2: Representation of SI units and prefixes*[16]

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

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

3.1.1
actual value
value of a variable quantity at a given instant

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

---

[15] To be published.

[16] CiA 303-2 may be freely downloaded from www.can-cia.org. To avoid download misuse, the downloading person has to fill in a registration form, which does not arise some obligations to the specification user.

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[SOURCE: ~~[IEV 351-21-02]~~ IEC 61800-7-1:2015, 3.3.1.1]

3.1.2
algorithm
completely determined finite sequence of operations by which the values of the output data can be calculated from the values of the input data

[SOURCE: ~~IEV 351-21-37~~ IEC 61800-7-1:2015, 3.2.1]

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

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

[SOURCE: ~~IEC/TR 62390:2005, 3.1.2, modified~~ IEC 61800-7-1:2015, 3.2.2]

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

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

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

3.1.5
attribute
property or characteristic of an entity

[SOURCE: ~~IEC/TR 62390:2005, 3.1.3~~ IEC 61800-7-1:2015, 3.2.3]

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

[SOURCE: ~~ISO/IEC 19501, modified~~ IEC 61800-7-1:2015, 3.2.5]

3.1.7
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.

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

3.1.8
control
purposeful action on or in a process to meet specified objectives

[SOURCE: ~~IEV 351-21-29~~ IEC 61800-7-1:2015, 3.2.6]

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3.1.9
control device
physical unit that contains – in a module/subassembly or device – an application program to control the PDS

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

3.1.10
data type
set of values together with a set of permitted operations

[SOURCE: ~~ISO/IEC 2382-15:1999, 15.04.01, modified~~ IEC 61800-7-1:2015, 3.2.8]

3.1.11
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 61499-1:2005, 3.30, modified~~ IEC 61800-7-1:2015, 3.2.9]

~~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 data and behaviour of the device as viewed through a network, independent from any network technology

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

[SOURCE: ~~IEC/TR 62390:2005, 3.19, modified~~ IEC 61800-7-1:2015, 3.2.11]

3.1.13
feedback variable
variable quantity, which represents the controlled variable and is returned to the comparing element

~~[IEV 351-27-03]~~

[SOURCE: IEC 61800-7-1:2015, 3.2.12]

3.1.14
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~~ IEC 61800-7-1:2015, 3.2.13]

3.1.15
high-level power
main electric power supply of the drive device

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3.1.16
input data
data transferred from an external source into a device, resource or functional element

[SOURCE: ~~IEC/TR 62390:2005, 3.1.14~~ IEC 61800-7-1:2015,3.2.14]

3.1.17
interface
shared boundary between two entities defined by functional characteristics, signal characteristics, or other characteristics as appropriate

[SOURCE: ~~IEV 351-21-35, modified~~ IEC 61800-7-1:2015, 3.2.15]

3.1.18
logical power drive system
model which includes PDS and communication network accessible through the generic PDS interface

[SOURCE: IEC 61800-7-1:2015, 3.2.16]

3.1.19
low-level power
electrical power supply for the control section of the drive device

3.1.20
model
mathematical or physical representation of a system or a process, based with sufficient precision upon known laws, identification or specified suppositions

[SOURCE: ~~IEV 351-21-36~~ IEC 61800-7-1:2015, 3.2.17]

3.1.21
operating mode
characterization of the way and the extent to which the human operator intervenes in the control equipment

[SOURCE: ~~IEV 351-31-01~~ IEC 61800-7-1:2015, 3.2.18]

3.1.22
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~~ IEC 61800-7-1:2015, 3.2.19]

3.1.23
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 1 to entry: A parameter is typically characterised by a parameter name, data type and access direction.

[SOURCE: ~~IEC/TR 62390:2005, 3.1.22, modified~~ IEC 61800-7-1:2015, 3.2.20]

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3.1.24
profile
representation of a PDS interface in terms of its parameters, parameter assemblies and behavior according to a communication profile and a device profile

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

3.1.25
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: ~~IEV 351-27-02~~ IEC 61800-7-1:2015, 3.2.22]

3.1.26
set-point
value or variable used as output data of the application control program to control the PDS

[SOURCE: IEC 61800-7-1:2015, 3.3.1.5]

3.1.27
status
set of information from the PDS to the application control program reflecting the state or mode of the PDS or a functional element of the PDS

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

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

3.1.28
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~~ IEC 61800-7-1:2015, 3.2.23]

3.1.29
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~~ IEC 61800-7-1:2015, 3.2.24]

3.1.30
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~~ IEC 61800-7-1:2015, 3.2.25]

3.2 Abbreviated terms

AC	alternating current
BL	brush-less
c	constant
CiA	CAN in Automation
COB	communication object

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csp	cyclic synchronous profile mode
cst	cyclic synchronous torque mode
cstca	cyclic synchronous torque mode with commutation angle
csv	cyclic synchronous velocity mode
DC	direct current
DIV	divisor
FC	frequency converter
FE	functional element
FIFO	first In, first out
FSA	finite state automaton
hm	homing mode
HMI	human machine interface
I/O	input/output
ip	interpolated position mode
LSB	less significant bit/byte
MSB	most significant bit/byte
MUL	multiplication
NMT	network management
PDO	process data object
PDS	power drive system
PM	permanent magnet
pp	profile position mode
pv	profile velocity mode
r	reserved
r.m.s.	root mean square
ro	read-only
rw	read-write
tq	torque mode
vl	velocity mode

4 General

4.1 General considerations

This part of the IEC 61800-7 series specifies the bus-independent CiA 402 device profile for power drive systems such as frequency converters, servo controllers, or stepper motor controllers. It includes the definition of real-time control objects as well as of configuration, adjustment, identification and network management objects. The PDS finite state automaton (FSA) is also defined, which may be controlled externally by a control device communicating via a communication system to the drive device.

The device profile defines several modes of operation. They include profile position mode, homing mode, interpolated position mode, profile velocity mode, profile torque mode, velocity mode, cyclic synchronous position mode, cyclic synchronous velocity mode, and cyclic synchronous torque mode.

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4.2 Communication interface

The communication system connects the drive device to the control device and other field devices. Via the communication system the control device uses communication services to exchange with the drive device:

- non real-time data (configuration, identification, adjustement, diagnostic, etc.);
- process data such as target values and actual values.

These services are defined in the IEC 61800-7-301. The process data are exchanged by real-time data messages. These messages may be configured by means of configuration services provided by the communication system.

The communication system shall provide services to transmit and receive communication objects (COB). The following COBs shall be supported:

- COB for real-time data transmission;
- COB for emergency information transmission;
- COB for network management purposes.

Additionally, the communication system may provide the following COBs:

- COB for configuration data transmission;
- COB for synchronization purposes;
- COB for system time distribution.

The COBs are defined in detail in IEC 61800-7-301.

4.3 Object dictionary

All objects in this part of the IEC 61800-7 series are grouped in the object dictionary, and defined by attributes as defined in EN 50325-4. All objects shall be accessible via the network in an ordered pre-defined fashion by means of COB for configuration data transmission. Each object within the dictionary shall be addressed uniquely by using a 16-bit index and an 8-bit sub-index. The communication-related objects are defined in detail in EN 50325-4 and IEC 61800-7-301.

The standardized device profile area at indices 6000_h through $9FFF_h$ shall contain all application objects common to this device profile specification. The following object indices shall be reserved for compatibility reasons: 6045_h, 6047_h, $604D_h$, $604E_h$, $604F_h$, 6052_h, 6053_h, 6054_h, 6055_h, 6056_h, 6057_h, 6058_h, 6059_h, 6089_h, $608A_h$, $608B_h$, $608C_h$, $608D_h$, $608E_h$, 6093_h, 6094_h, 6095_h, 6096_h, 6097_h, $60A0_h$, $60A1_h$, $60A2_h$, $60F6_h$, $60F7_h$, $60F9_h$, $60FB_h$, 6410_h, 6504_h, and 6510_h. The following object indices range shall be reserved for compatibility reasons with other standards: from 6200_h to $62FF_h$ and from 6600_h to $67EF_h$.

The objects may be read respectively written via the network. Within this range of objects, up to 8 axes may be realized. Additionally, it is possible to implement other device profiles (e. g. generic I/O module or encoder) within the drive device. These other device profiles may be implemented instead of one or several axes.

For multi axes devices, the object range 6000_h to $67FF_h$ shall be shifted as follows:

– 6000_h to $67FF_h$: axis 0
– 6800_h to $6FFF_h$: axis 1
– 7000_h to $77FF_h$: axis 2
– 7800_h to $7FFF_h$: axis 3
– 8000_h to $87FF_h$: axis 4

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– 8800_h to $8FFF_h$: axis 5
– 9000_h to $97FF_h$: axis 6
– 9800_h to $9FFF_h$: axis 7

The category and entry category attributes of an object indicate if the object shall be implemented (mandatory) or may be implemented (optional).

The object code and data type attributes are defined in detail in EN 50325-4 or in other network technology specifications. The used data type attributes are given in Clause 5. In the entry description, the access attribute indicating if an application object is read only (ro), read/write (rw) or write only (wo) or constant (c) is defined. Read only indicates that this shall not be written via the bus; read/write allows to read and to write this object; and write only means that this application object shall be not read via the bus.

The PDO mapping attribute shall indicate if this object shall be or may be or shall not be mapped into COB for real-time data transmission. The detailed definition of these attributes is given in IEC 61800-7-301.

The default value attribute defines the value of an object with access attribute of the value ‘rw’ and ‘c’ after power-on or application reset.

5 Data types

5.1 Standard data types

The data types used in this profile are listed in Table 1.

Table 1 – List of used data types

Data type	Reference
Unsigned8	EN 50325-4
Unsigned16	EN 50325-4
Unsigned32	EN 50325-4
Integer8	EN 50325-4
Integer16	EN 50325-4
Integer32	EN 50325-4
Visible string	EN 50325-4
Time of day	EN 50325-4
~~Interpolated~~ Interpolation time period	See Table 2
~~Interpolated~~ Interpolation data configuration	See Table 3
vl velocity acceleration/deceleration	See Table 4

5.2 Record definitions

Table 2, Table 3, and Table 4 define the records used in this part of the IEC 61800-7 series.

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Table 2 – ~~Interpolated~~ Interpolation time period

Index	Sub-index	Description	Data type
0080_h	00_h	Highest sub-index supported	Unsigned8
	01_h	Interpolation time units	Unsigned8
	02_h	Interpolation time index	Integer8

Table 3 – ~~Interpolated~~ Interpolation data configuration

Index	Sub-index	Description	Data type
0081_h	00_h	Highest sub-index supported	Unsigned8
	01_h	Maximum buffer size	Unsigned32
	02_h	Actual buffer size	Unsigned32
	03_h	Buffer organisation	Unsigned8
	04_h	Buffer position	Unsigned16
	05_h	Size of data record	Unsigned8
	06_h	Buffer clear	Unsigned8

Table 4 – vl velocity acceleration/deceleration

Index	Sub-index	Description	Data type
0082_h	00_h	Highest sub-index supported	Unsigned8
	01_h	Delta speed	Unsigned32
	02_h	Delta time	Integer16

6 General object definitions

6.1 General

In the following subclauses, the communication parameter objects, the additional identification and the information objects are defined.

6.2 Communication parameter objects

There are three communication parameter objects that shall be implemented:

– Device type object 1000_h
– Error register object 1001_h
– Identity object 1018_h

They are defined in EN 50325-4 and the following definitions shall also apply.

The device type object shall define the device type, the device's functionality, and the mapping variant.

For multi device modules, the additional information parameter shall contain $0FFF_h$ and the device profile number referenced by object 1000_h is the device profile of the first device in the object dictionary. All other devices of a multiple device module shall identify their profiles at object $67FF_h + x \times 800_h$ with x = internal number of the device (0 to 7). For details, see EN 50325-4. Figure 2 specifies the structure and the values of the device type object, Table 5 specifies the object description, and Table 6 specifies the entry desciption.

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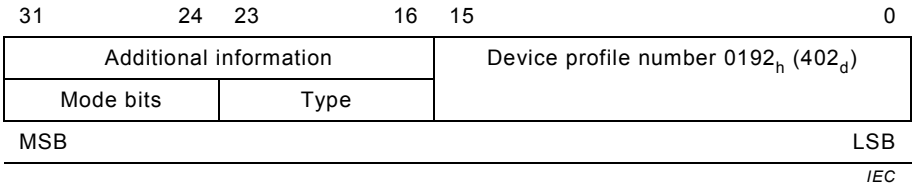


Figure 2 – Value definition

Mode bits and type in the additional information are defined in IEC 61800-7-301.

Table 5 – Object description

Attribute	Value
Index	1000_h
Name	Device type
Object code	See EN 50325-4
Data type	See EN 50325-4
Category	Mandatory

Table 6 – Entry description

Attribute	Value
Sub-index	00_h
Access	c
PDO mapping	See IEC 61800-7-301
Value range	See value definition
Default value	Manufacturer-specific

The device-profile specific bit in the error register object (1001_h) shall be used to indicate that the error code in the Emergency message is defined in this part of the IEC 61800-7 series.

~~NOTE~~ The corresponding error code ~~may be read~~ is readable in object 1003_h (see EN 50325-4) or object $603F_h$.

6.3 Additional identification and information objects

6.3.1 Object 6402_h: Motor type

This object shall indicate the type of motor attached to and driven by the drive device. Table 7 specifies the value definition, Table 8 specifies the object description, and Table 9 specifies the entry description.

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Table 7 – Value definition

Value	CANopen name	Other names
0000_h	Non-standard motor	–
0001_h	Phase modulated DC motor	–
0002_h	Frequency controlled DC motor	–
0003_h	PM synchronous motor	–
0004_h	FC synchronous motor	AC synchronous sinewave wound field
0005_h	Switched reluctance motor	AC synchronous reluctance switched
0006_h	Wound rotor induction motor	AC asynchronous induction polyphase wound rotor
0007_h	Squirrel cage induction motor	AC asynchronous induction squirrel cage
0008_h	Stepper motor	AC synchronous step
0009_h	Micro-step stepper motor	–
$000A_h$	Sinusoidal PM BL motor	AC synchronous sinusoidal PM
$000B_h$	Trapezoidal PM BL motor	AC synchronous brushless PM trapezoidal
$000C_h$	AC synchronous reluctance sync	–
$000D_h$	DC commutator PM	–
$000E_h$	DC commutator wound field series	–
$000F_h$	DC commutator wound field shunt	–
0010_h	DC commutator wound field compound	–
0011_h to $7FFE_h$	Reserved	–
$7FFF_h$	No motor type assigned	–
8000_h to $FFFF_h$	Manufacturer-specific	–

Table 8 – Object description

Attribute	Value
Index	6402_h
Name	Motor type
Object code	Variable
Data type	Unsigned16
Category	Optional

Table 9 – Entry description

Attribute	Value
Sub-index	00_h
Access	rw
PDO mapping	See IEC 61800-7-301
Value range	See Table 7
Default value	Manufacturer-specific

6.3.2 Object 6403_h: Motor catalogue number

This object shall indicate the motor catalogue number (nameplate number) provided by the motor manufacturer. If the number is not assigned yet, this object shall indicate this by /0

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(empty string). Table 10 specifies the object description, and Table 11 specifies the entry description.

Table 10 – Object description

Attribute	Value
Index	6403_h
Name	Motor catalogue number
Object code	Variable
Data type	Visible string
Category	Optional

Table 11 – Entry description

Attribute	Value
Sub-index	00_h
Access	rw
PDO mapping	See IEC 61800-7-301
Value range	Visible string
Default value	Manufacturer-specific

6.3.3 Object 6404_h: Motor manufacturer

This object shall indicate the name of the motor manufacturer. If the name is not assigned yet, this object shall indicate this by /0 (empty string). Table 12 specifies the object description, and Table 13 specifies the entry description.

Table 12 – Object description

Attribute	Value
Index	6404_h
Name	Motor manufacturer
Object code	Variable
Data type	Visible string
Category	Optional

Table 13 – Entry description

Attribute	Value
Sub-index	00_h
Access	rw
PDO mapping	See IEC 61800-7-301
Value range	Visible string
Default value	Manufacturer-specific

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6.3.4 Object 6405_h: http motor catalogue address

This object shall indicate the assigned web-address of the motor catalogue. If the address is not assigned yet, this object shall indicate this by /0 (empty string). Table 14 specifies the object description, and Table 15 specifies the entry description.

Table 14 – Object description

Attribute	Value
Index	6405_h
Name	http motor catalogue address
Object code	Variable
Data type	Visible string
Category	Optional

Table 15 – Entry description

Attribute	Value
Sub-index	00_h
Access	rw
PDO mapping	See IEC 61800-7-301
Value range	Visible string
Default value	Manufacturer-specific

6.3.5 Object 6406_h: Motor calibration date

This object shall indicate the assigned date of the last motor inspection. If the date is not assigned yet, this object shall indicate this by a value of 0. Table 16 specifies the object description, and Table 17 specifies the entry description.

Table 16 – Object description

Attribute	Value
Index	6406_h
Name	Motor calibration date
Object code	Variable
Data type	Time of day
Category	Optional

Table 17 – Entry description

Attribute	Value
Sub-index	00_h
Access	rw
PDO mapping	See IEC 61800-7-301
Value range	0_d or Time of day
Default value	Manufacturer-specific

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6.3.6 Object 6407_h: Motor service period

This object shall indicate the assigned motor service period. If the period is not assigned yet, this object shall indicate this by $0000\ 0000_h$. The value shall be given in multiples of hours. Table 18 specifies the object description, and Table 19 specifies the entry description.

Table 18 – Object description

Attribute	Value
Index	6407_h
Name	Motor service period
Object code	Variable
Data type	Unsigned32
Category	Optional

Table 19 – Entry description

Attribute	Value
Sub-index	00_h
Access	rw
PDO mapping	See IEC 61800-7-301
Value range	Unsigned32
Default value	Manufacturer-specific

6.3.7 Object 6503_h: Drive catalogue number

This object shall indicate the assigned manufacturer's drive catalogue number (nameplate number). Table 20 specifies the object description, and Table 21 specifies the entry description.

Table 20 – Object description

Attribute	Value
Index	6503_h
Name	Drive catalogue number
Object code	Variable
Data type	Visible string
Category	Optional

Table 21 – Entry description

Attribute	Value
Sub-index	00_h
Access	rw
PDO mapping	See IEC 61800-7-301
Value range	No
Default value	~~/0 (empty string)~~ Manufacturer-specific

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6.3.8 Object 6505_h: http drive catalogue address

This object shall indicate the assigned web address of the drive manufacturer. If the address is not assigned yet, this object shall indicate this by /0 (empty string). Table 22 specifies the object description, and Table 23 specifies the entry description.

Table 22 – Object description

Attribute	Value
Index	6505_h
Name	http drive catalogue address
Object code	Variable
Data type	Visible string
Category	Optional

Table 23 – Entry description

Attribute	Value
Sub-index	00_h
Access	rw
PDO mapping	See IEC 61800-7-301
Value range	No
Default value	Manufacturer-specific

7 Error codes and error behavior

7.1 Error codes

Emergency messages are triggered by internal errors and severe warnings detected within the drive device. They are defined in detail in the IEC 61800-7-301. They shall contain the 16-bit error code. Error codes from $xx00_h$ to $xx7F_h$ are defined in EN 50325-4 or in Table 24. Error codes between $xx80_h$ and $xxFF_h$ are used manufacturer-specific.

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Table 24 – Error codes

Error code	Meaning
2110_h	Short circuit/earth leakage (input)
2120_h	Earth leakage (input)
2121_h	Earth leakage phase L1
2122_h	Earth leakage phase L2
2123_h	Earth leakage phase L3
2130_h	Short circuit (input)
2131_h	Short circuit phases L1-L2
2132_h	Short circuit phases L2-L3
2133_h	Short circuit phases L3-L1
2211_h	Internal current no.1
2212_h	Internal current no.2
2213_h	Over-current in ramp function
2214_h	Over-current in the sequence
2220_h	Continuous over current (device internal)
2221_h	Continuous over current no.1
2222_h	Continuous over current no.2
2230_h	Short circuit/earth leakage (device internal)
2240_h	Earth leakage (device internal)
2250_h	Short circuit (device internal)
2310_h	Continuous over current (device output side)
2311_h	Continuous over current no.1
2312_h	Continuous over current no.2
2320_h	Short circuit/earth leakage (motor-side)
2330_h	Earth leakage (motor-side)
2331_h	Earth leakage phase U
2332_h	Earth leakage phase V
2333_h	Earth leakage phase W
2340_h	Short circuit (motor-side)
2341_h	Short circuit phases U-V
2342_h	Earth leakage phase V-W
2343_h	Earth leakage phase W-U
2350_h	Load level fault (I^2t, thermal state)
2351_h	Load level warning (I^2t, thermal state)
3110_h	Mains over-voltage
3111_h	Mains over-voltage phase L1
3112_h	Mains over-voltage phase L2
3113_h	Mains over-voltage phase L3
3120_h	Mains under-voltage
3121_h	Mains under-voltage phase L1
3122_h	Mains under-voltage phase L2
3123_h	Mains under-voltage phase L3
3130_h	Phase failure
3131_h	Phase failure L1

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Error code	Meaning
3132_h	Phase failure L2
3133_h	Phase failure L3
3134_h	Phase sequence
3140_h	Mains frequency
3141_h	Mains frequency too great
3142_h	Mains frequency too small
3210_h	DC link over-voltage
3211_h	Over-voltage no. 1
3212_h	Over voltage no. 2
3220_h	DC link under-voltage
3221_h	Under-voltage no. 1
3222_h	Under-voltage no. 2
3230_h	Load error
3310_h	Output over-voltage
3311_h	Output over-voltage phase U
3312_h	Output over-voltage phase V
3313_h	Output over-voltage phase W
3320_h	Armature circuit
3321_h	Armature circuit interrupted
3330_h	Field circuit
3331_h	Field circuit interrupted
4110_h	Excess ambient temperature
4120_h	Too low ambient temperature
4130_h	Temperature supply air
4140_h	Temperature air outlet
4210_h	Excess temperature device
4220_h	Too low temperature device
4300_h	Temperature drive
4310_h	Excess temperature drive
4320_h	Too low temperature drive
4400_h	Temperature supply
4410_h	Excess temperature supply
4420_h	Too low temperature supply
5100_h	Supply device hardware
5110_h	Supply low voltage
5111_h	U1 = supply ±15V
5112_h	U2 = supply +24 V
5113_h	U3 = supply +5 V
5114_h	U4 = manufacturer-specific
5115_h	U5 = manufacturer-specific
5116_h	U6 = manufacturer-specific
5117_h	U7 = manufacturer-specific
5118_h	U8 = manufacturer-specific
5119_h	U9 = manufacturer-specific

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Error code	Meaning
5120_h	Supply intermediate circuit
5200_h	Control
5210_h	Measurement circuit
5220_h	Computing circuit
5300_h	Operating unit
5400_h	Power section
5410_h	Output stages
5420_h	Chopper
5430_h	Input stages
5440_h	Contacts
5441_h	Contact 1 = manufacturer-specific
5442_h	Contact 2 = manufacturer-specific
5443_h	Contact 3 = manufacturer-specific
5444_h	Contact 4 = manufacturer-specific
5445_h	Contact 5 = manufacturer-specific
5450_h	Fuses
5451_h	S1 = I1
5452_h	S2 = I2
5453_h	S3 = I3
5454_h	S4 = manufacturer-specific
5455_h	S5 = manufacturer-specific
5456_h	S6 = manufacturer-specific
5457_h	S7 = manufacturer-specific
5458_h	S8 = manufacturer-specific
5459_h	S9 = manufacturer-specific
5500_h	Hardware memory
5510_h	RAM
5520_h	ROM/EPROM
5530_h	EEPROM
6010_h	Software reset (watchdog)
6301_h to $630F_h$	Data record no. 1 to no. 15
6310_h	Loss of parameters
6320_h	Parameter error
7100_h	Power additional modules
7110_h	Brake chopper
7111_h	Failure brake chopper
7112_h	Over current brake chopper
7113_h	Protective circuit brake chopper
7120_h	Motor
7121_h	Motor blocked
7122_h	Motor error or commutation malfunc.
7123_h	Motor tilted
7200_h	Measurement circuit
7300_h	Sensor

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Error code	Meaning
7301_h	Tacho fault
7302_h	Tacho wrong polarity
7303_h	Resolver 1 fault
7304_h	Resolver 2 fault
7305_h	Incremental sensor 1 fault
7306_h	Incremental sensor 2 fault
7307_h	Incremental sensor 3 fault
7310_h	Speed
7320_h	Position
7400_h	Computation circuit
7500_h	Communication
7510_h	Serial interface no. 1
7520_h	Serial interface no. 2
7600_h	Data storage (external)
8300_h	Torque control
8311_h	Excess torque
8312_h	Difficult start up
8313_h	Standstill torque
8321_h	Insufficient torque
8331_h	Torque fault
8400_h	Velocity speed controller
8500_h	Position controller
8600_h	Positioning controller
8611_h	Following error
8612_h	Reference limit
8613_h	Homing Error
8700_h	Sync controller
8800_h	Winding controller
8900_h	Process data monitoring
$8A00_h$	Control monitoring
$F001_h$	Deceleration
$F002_h$	Sub-synchronous run
$F003_h$	Stroke operation
$F004_h$	Control additional functions
$FF00_h$ to $FFFF_h$	Manufacturer-specific

7.2 Error behavior

The communication system may support an object specifying to which network management state the drive device shall transit, when a communication error or a severe device-internal error is detected. When the PDS FSA transits into error (fault or fault reaction active) state, this shall be regarded as a severe device-internal failure.

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8 Controlling the power drive system

8.1 General

The PDS FSA is an abstraction to define the behavior of a black box as a control device experiences the PDS. It defines the application behavior of the PDS. Due to the requirement that a PDS provides local control even when the communication network is not working properly, the communication FSA as defined in the communication system mapping specifications and the PDS FSA are only loosely coupled.

Figure 3 specifies how the PDS may be operated locally or via the network remotely. The PDS is operated by local signals (not in the scope of this part of IEC 61800) and by the controlword sent by the control device via the network. The state of the PDS is reported by the statusword produced by the drive device. The FSA is also controlled by error detection signals.

The PDS FSA defines the PDS status and the possible control sequence of the PDS. A single state represents a special internal or external behavior. The state of the PDS also determines which commands are accepted. For example, it is only possible to start a point-to-point move when the drive is in the operation enabled state.

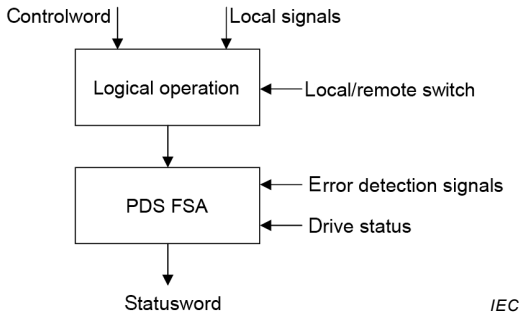


Figure 3 – Remote and local control

8.2 Finite state automaton

Figure 4 specifies the PDS FSA with respect to control of the power electronics as a result of user commands and internal drive faults.

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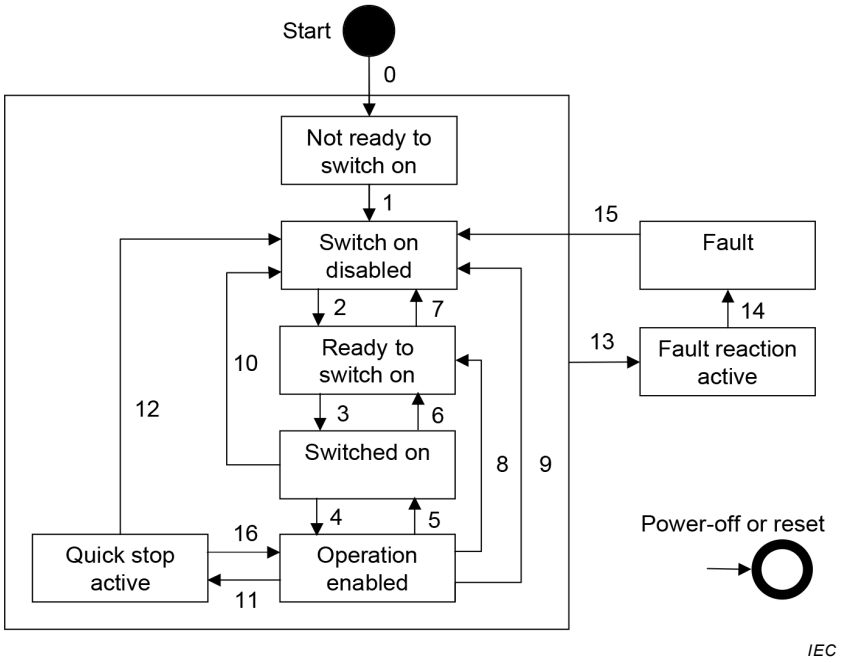


Figure 4 – Power drive system finite state automaton

The FSA states shall support the functions as shown in Table 25. The start state shall be a pseudo state indicating the start when the FSA is activated during the start-up sequence of the device drive's application software.

Table 25 – FSA states and supported functions

Function	FSA states							
	Not ready to switch on	Switch on disabled	Ready to switch on	Switched on	Operation enabled	Quick stop active	Fault reaction active	Fault
Brake applied, if present	Yes	Yes	Yes	Yes	Yes/No	Yes/No	Yes/No	Yes
Low-level power applied	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
High-level power applied	Yes/No	Yes/No	Yes/No	Yes	Yes	Yes	Yes	Yes/No
Drive function enabled	No	No	No	No	Yes	Yes	Yes	No
Configuration allowed	Yes	Yes	Yes	Yes	Yes/No	Yes/No	Yes/No	Yes

If in the quick stop active state the quick stop option code is set to 5, 6, 7 or 8, the drive device shall not leave this state, but it may transit to the operation enabled state with the enable operation command.

The drive device shall support the transitions and actions as given in Table 26. The events shall initiate the transition. The transition shall be terminated after the action has been performed.

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Table 26 – Transition events and actions

Transition	Event(s)	Action(s)
0	Automatic transition after power-on or reset application	Drive device self-test and/or self initialization shall be performed.
1	Automatic transition	Communication shall be activated.
2	Shutdown command from control device or local signal	None
3	Switch on command received from control device or local signal	The high-level power shall be switched on, if possible.
4	Enable operation command received from control device or local signal	The drive function shall be enabled and all internal set-points cleared.
5	Disable operation command received from control device or local signal	The drive function shall be disabled.
6	Shutdown command received from control device or local signal	The high-level power shall be switched off, if possible.
7	Quick stop or disable voltage command from control device or local signal	None
8	Shutdown command from control device or local signal	The drive function shall be disabled, and the high-level power shall be switched off, if possible.
9	Disable voltage command from control device or local signal	The drive function shall be disabled, and the high-level power shall be switched off, if possible.
10	Disable voltage or quick stop command from control device or local signal	The high-level power shall be switched off, if possible.
11	Quick stop command from control device or local signal	The quick stop function shall be started.
12	Automatic transition when the quick stop function is completed and quick stop option code is 1, 2, 3 or 4, or disable voltage command received from control device (depends on the quick stop option code)	The drive function shall be disabled, and the high-level power shall be switched off, if possible.
13	Fault signal (see also IEC 61800-7-301)	The configured fault reaction function shall be executed.
14	Automatic transition	The drive function shall be disabled; the high-level power shall be switched off, if possible.
15	Fault reset command from control device or local signal	A reset of the fault condition is carried out, if no fault exists currently on the drive device; after leaving the fault state, the fault reset bit in the controlword shall be cleared by the control device.
16	Enable operation command from control device, if the quick stop option code is 5, 6, 7, or 8	The drive function shall be enabled.
~~NOTE~~ It is not recommended to support transition 16.		

If a state transition is requested, the related actions shall be processed completely before transitioning to the new state. Example: In operation enabled state, when the disable operation command is received, the drive device shall stay in the operation enabled state until the disable operation function (see object $605C_h$) is completed.

Drive devices able to control the contactor for the mains may switch the high-level power. If the high-level power is switched-off, the motor shall be free to rotate if not braked.

Drive function is disabled implies no energy shall be supplied to the motor. Target or set-point values (e.g. torque, velocity, position) shall be not processed.

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Drive function is enabled implies that energy may be supplied to the motor. Target or set-point values shall be processed.

If a fault is detected in the drive device, there shall be a transition to the fault reaction active state. In this state, the PDS shall execute a special fault reaction. After the execution of this fault reaction, the drive device shall switch automatically to the fault state. This state shall only be left by the fault reset command, but only if the fault is not active any more.

In case of fatal error, the drive device is not longer able to control the motor, so that an immediate switch-off of the drive device is necessary.

The behavior of drive disabling, quick stop, halt, and fault reaction functions is configurable by means of configuration objects defined in 8.4.

NOTE If a brake is present, the high-level power is switched off after a delay time in order to apply the brake.

8.3 Modes of operation

The PDS behavior depends on the activated mode of operation. The PDS may implement several modes of operation. Since it is not possible to operate the modes in parallel, the user is able to activate the required function by selecting a mode of operation.

The control device writes to the modes of operation object in order to select the operation mode. The drive device provides the modes of operation display object to indicate the actual activated operation mode. Controlword, statusword, and set-points are used mode-specific. This implies the responsibility of the control device to avoid inconsistencies and erroneous behavior. The switching between the modes of operation implies no automatic reconfiguration of COBs for real-time data transmission.

Therefore, the PDS may limit mode switching in one or some PDS FSA state(s). Mode switching may also be limited to the 'local control' function; this means it is not possible to select the operation mode via the network.

The following modes of operation are described in this part of the IEC 61800-7 series:

- profile position mode;
- homing mode;
- interpolated position mode;
- profile velocity mode (e.g. servo drives);
- torque profile mode;
- velocity mode (e.g. frequency converter);
- cyclic sync position mode;
- cyclic sync velocity mode;
- cyclic sync torque mode.

With the exception of the homing mode, the listed modes of operation deal with set-points. In addition to this, manufacturer-specific modes of operation may also be implemented. These are not limited to set-points.

Figure 5 shows the general relations between target, reference, effort, and actual values.

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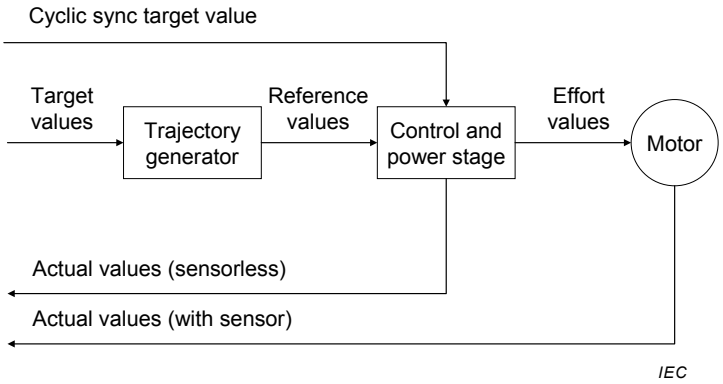


Figure 5 – Relation between different value parameters

8.4 Detailed object specifications

8.4.1 Object 6040_h: Controlword

This object shall indicate the received command controlling the PDS FSA. It shall be structured as defined in Figure 6. The bits 7, 3, 2, 1, and 0 shall be supported. The ~~other~~ bits 0 to 9 ~~may~~ shall be supported according to the mode of operation. If the related functionality is not available, an appropriate emergency message shall be generated. The manufacturer-specific (ms) bits may be supported. The commands shall be coded as given in Table 27. All implemented bits of the controlword are valid independent of the PDS FSA state. Starting of any movement is operation mode specific and is described in the related clause.

15 … 11	10	9	8	7	6 … 4	3	2	1	0
ms	r	oms	h	fr	oms	eo	qs	ev	so
MSB									LSB

IEC

Key

ms	manufacturer-specific
r	reserved
oms	operation mode specific
h	halt
fr	fault reset
eo	enable operation
qs	quick stop
ev	enable voltage
so	switch on

Figure 6 – Value definition

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Table 27 – Command coding

Command	Bits of the controlword					Transitions
	Bit 7	Bit 3	Bit 2	Bit 1	Bit 0	
Shutdown	0	X	1	1	0	2,6,8
Switch on	0	0	1	1	1	3
Switch on + enable operation	0	1	1	1	1	3 + 4 (NOTE)
Disable voltage	0	X	X	0	X	7,9,10,12
Quick stop	0	X	0	1	X	7,10,11
Disable operation	0	0	1	1	1	5
Enable operation	0	1	1	1	1	4,16
Fault reset	↑	X	X	X	X	15
NOTE Automatic transition to enable operation state after executing switched on state functionality.						

Bits 9, 6, 5, and 4 of the controlword are operation mode specific. The halt function (bit 8) behavior is operation mode specific. If the bit is 1, the commanded motion shall be interrupted, the PDS shall behave as defined in the halt option code. After releasing the halt function, the commanded motion shall be continued if possible.

The bit 10 is reserved for further use; it shall be set to 0. The bits 11, 12, 13, 14, and 15 are manufacturer-specific.

Table 28 specifies the object description, and Table 29 specifies the entry description.

Table 28 – Object description

Attribute	Value
Index	6040_h
Name	Controlword
Object code	Variable
Data type	Unsigned16
Category	Mandatory

Table 29 – Entry description

Attribute	Value
Sub-index	00_h
Access	rw
PDO mapping	See IEC 61800-7-301
Value range	See Table 27
Default value	Device and operation mode specific

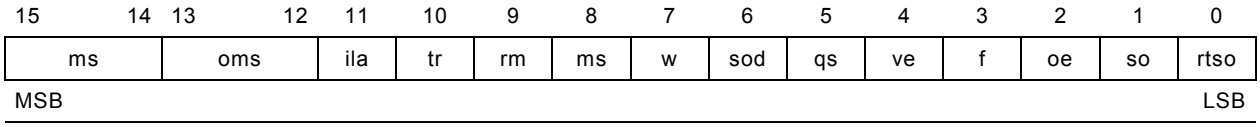
8.4.2 Object 6041_h: Statusword

This object shall provide the status of the PDS FSA. The object shall be structured as defined in Figure 7. The bits 10, 9, and 6 to 0 shall be supported. The ~~other~~ oms bits ~~may~~ shall be supported if the mode of operation is supported. If the related functionality of the oms bits

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not available, the corresponding bit shall be 0_b. The manufacturer-specific (ms) bits may be supported. The bit combinations defined in Table 30 shall code the PDS FSA states. All implemented bits of the status word are valid independent of the PDS FSA state.



Key:

ms	manufacturer-specific
oms	operation mode specific
ila	internal limit active
tr	target reached
rm	remote
w	warning
sod	switch on disabled
qs	quick stop
ve	voltage enabled
f	fault
oe	operation enabled
so	switched on
rtso	ready to switch on

Figure 7 – Value definition

Table 30 – State coding

Statusword	PDS FSA state
xxxx xxxx x0xx 0000_b	Not ready to switch on
xxxx xxxx x1xx 0000_b	Switch on disabled
xxxx xxxx x01x 0001_b	Ready to switch on
xxxx xxxx x01x 0011_b	Switched on
xxxx xxxx x01x 0111_b	Operation enabled
xxxx xxxx x00x 0111_b	Quick stop active
xxxx xxxx x0xx 1111_b	Fault reaction active
xxxx xxxx x0xx 1000_b	Fault

If bit 4 (voltage enabled) of the statusword is 1, this shall indicate that high voltage is applied to the PDS.

If bit 5 (quick stop) of the statusword is 0, this shall indicate that the PDS is reacting on a quick stop request.

If bit 7 (warning) of the statusword is 1, this shall indicate the presence of a warning condition. Warning is not an error or fault (examples: temperature limit exceeded, job refused). The status of the PDS FSA shall not be changed. The cause of the warning may be given in the fault code parameter object ($603F_h$).

If bit 9 (remote) of the statusword is 1, this shall indicate that the controlword is processed. If it is 0 (local), this shall indicate that the controlword is not processed. Nevertheless, the PDS may provide actual values, and the PDS may accept COB for configuration data transmission for other parameter objects.

If bit 10 (target reached) of the statusword is 1, this shall indicate that the PDS has reached the set-point. The set-point is operation mode specific and is defined in detail in the corresponding clauses of this part of the IEC 61800-7 series. Bit 10 shall also be set to 1, if the operation mode has been changed. The change of a target value by software shall alter this bit. If quick stop option code is 5, 6, 7 or 8, bit 10 shall be set to 1, when the quick stop

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