

INTERNATIONAL STANDARD

NORME INTERNATIONALE



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

**Entraînements électriques de puissance à vitesse variable –
Partie 7-201: Interface générique et utilisation de profils pour les entraînements
électriques de puissance – Spécification de profil de type 1**



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CONTENTS

FOREWORD.....	17
INTRODUCTION.....	19
1 Scope.....	23
2 Normative references	23
3 Terms, definitions and abbreviated terms	23
3.1 Terms and definitions.....	23
3.2 Abbreviated terms.....	27
4 General	28
4.1 General considerations	28
4.2 Communication interface.....	28
4.3 Object dictionary	29
5 Data types	30
5.1 Standard data types.....	30
5.2 Record definitions	30
6 General object definitions	31
6.1 General.....	31
6.2 Communication parameter objects	31
6.3 Additional identification and information objects.....	32
6.3.1 Object 6402 _h : Motor type.....	32
6.3.2 Object 6403 _h : Motor catalogue number	33
6.3.3 Object 6404 _h : Motor manufacturer	34
6.3.4 Object 6405 _h : http motor catalogue address	35
6.3.5 Object 6406 _h : Motor calibration date	35
6.3.6 Object 6407 _h : Motor service period	36
6.3.7 Object 6503 _h : Drive catalogue number	36
6.3.8 Object 6505 _h : http drive catalogue address	37
7 Error codes and error behavior	37
7.1 Error codes	37
7.2 Error behavior	41
8 Controlling the power drive system	42
8.1 General.....	42
8.2 Finite state automaton	42
8.3 Modes of operation	45
8.4 Detailed object specifications	46
8.4.1 Object 6040 _h : Controlword	46
8.4.2 Object 6041 _h : Statusword.....	47
8.4.3 Object 603F _h : Error code.....	49
8.4.4 Object 6007 _h : Abort connection option code	50
8.4.5 Object 605A _h : Quick stop option code	51
8.4.6 Object 605B _h : Shutdown option code	51
8.4.7 Object 605C _h : Disable operation option code	52
8.4.8 Object 605D _h : Halt option code	53
8.4.9 Object 605E _h : Fault reaction option code	54
8.4.10 Object 6060 _h : Modes of operation	54
8.4.11 Object 6061 _h : Modes of operation display	56

8.4.12	Object 6502 _h : Supported drive modes	56
9	Factor group	57
9.1	General	57
9.2	Detailed object definitions	59
9.2.1	Object 608F _h : Position encoder resolution	59
9.2.2	Object 6090 _h : Velocity encoder resolution	60
9.2.3	Object 6091 _h : Gear ratio	61
9.2.4	Object 6092 _h : Feed constant	62
9.2.5	Object 6096 _h : Velocity factor	64
9.2.6	Object 6097 _h : Acceleration factor	64
9.2.7	Object 60A2 _h : Jerk factor	65
9.2.8	Object 607E _h : Polarity	66
9.2.9	Code table for device profile specific units	67
9.2.10	Object 60A8 _h : SI unit position	67
9.2.11	Object 60A9 _h : SI unit velocity	68
9.2.12	Object 60AA _h : SI unit acceleration	69
9.2.13	Object 60AB _h : SI unit jerk	70
10	Profile position mode	70
10.1	General information	70
10.2	Functional description	71
10.2.1	General	71
10.2.2	Single set-point	72
10.2.3	Set of set-points	73
10.2.4	Usage of halt bit in conjunction with new set-point bit	74
10.3	General definitions	75
10.4	Use of controlword and statusword	75
10.5	Detailed object definitions	76
10.5.1	Object 607A _h : Target position	76
10.5.2	Object 607B _h : Position range limit	77
10.5.3	Object 607D _h : Software position limit	78
10.5.4	Object 607F _h : Max profile velocity	80
10.5.5	Object 6080 _h : Max motor speed	81
10.5.6	Object 6081 _h : Profile velocity	81
10.5.7	Object 6082 _h : End velocity	82
10.5.8	Object 6083 _h : Profile acceleration	82
10.5.9	Object 6084 _h : Profile deceleration	83
10.5.10	Object 6085 _h : Quick stop deceleration	83
10.5.11	Object 6086 _h : Motion profile type	84
10.5.12	Object 60A3 _h : Profile jerk use	85
10.5.13	Object 60A4 _h : Profile jerk	85
10.5.14	Object 60C5 _h : Max acceleration	87
10.5.15	Object 60C6 _h : Max deceleration	88
11	Homing mode	89
11.1	General information	89
11.2	Functional description	89
11.3	General definitions	90
11.3.1	General	90
11.3.2	Method 1: Homing on negative limit switch and index pulse	90
11.3.3	Method 2: Homing on positive limit switch and index pulse	90

11.3.4	Method 3 and 4: Homing on positive home switch and index pulse	90
11.3.5	Method 5 and 6: Homing on negative home switch and index pulse	91
11.3.6	Method 7 to 14: Homing on home switch and index pulse	91
11.3.7	Method 15 and 16: Reserved	92
11.3.8	Method 17 to 30: Homing without index pulse	92
11.3.9	Method 31 and 32: Reserved	93
11.3.10	Method 33 and 34: Homing on index pulse	93
11.3.11	Method 35: Homing on current position (obsolete)	93
11.3.12	Method 36: Reserved for compatibility reasons	93
11.3.13	Method 37: Homing on current position	93
11.4	Use of controlword and statusword	94
11.5	Detailed object definitions	94
11.5.1	Object 607C _h : Home offset	94
11.5.2	Object 6098 _h : Homing method	95
11.5.3	Object 60E3 _h : Supported homing methods	96
11.5.4	Object 6099 _h : Homing speeds	97
11.5.5	Object 609A _h : Homing acceleration	98
12	Touch probe functionality	99
12.1	Object 60B8 _h : Touch probe function	99
12.2	Object 60B9 _h : Touch probe status	101
12.3	Object 60BA _h : Touch probe 1 positive edge	102
12.4	Object 60BB _h : Touch probe 1 negative edge	102
12.5	Object 60BC _h : Touch probe 2 positive edge	103
12.6	Object 60BD _h : Touch probe 2 negative edge	103
12.7	Object 60D0 _h : Touch probe source	104
12.8	Touch probe time stamp latch	105
12.8.1	General	105
12.8.2	Object 60D1 _h : Touch probe time stamp 1 positive value	106
12.8.3	Object 60D2 _h : Touch probe time stamp 1 negative value	106
12.8.4	Object 60D3 _h : Touch probe time stamp 2 positive value	107
12.8.5	Object 60D4 _h : Touch probe time stamp 2 negative value	107
12.9	Touch probe edge counter for continuous mode	108
12.9.1	General	108
12.9.2	Object 60D5 _h : Touch probe 1 positive edge counter	108
12.9.3	Object 60D6 _h : Touch probe 1 negative edge counter	108
12.9.4	Object 60D7 _h : Touch probe 2 positive edge counter	109
12.9.5	Object 60D8 _h : Touch probe 2 negative edge counter	110
12.10	Timing diagram for touch probe example	110
13	Position control function	112
13.1	General information	112
13.2	Functional description	112
13.3	Detailed object definitions	114
13.3.1	Object 6062 _h : Position demand value	114
13.3.2	Object 6063 _h : Position actual internal value	115
13.3.3	Object 6064 _h : Position actual value	115
13.3.4	Object 6065 _h : Following error window	116
13.3.5	Object 6066 _h : Following error time out	117
13.3.6	Object 6067 _h : Position window	117
13.3.7	Object 6068 _h : Position window time	118

13.3.8	Object 60F4 _h : Following error actual value	118
13.3.9	Object 60FA _h : Control effort	119
13.3.10	Object 60FC _h : Position demand internal value	119
13.3.11	Object 60F2 _h : Positioning option code	120
14	Interpolated position mode	123
14.1	General information	123
14.2	Functional description	125
14.2.1	General	125
14.2.2	Linear interpolated position mode with several axes	125
14.2.3	Buffer strategies for the interpolated position mode	127
14.2.4	Interpolated position mode FSA	128
14.3	General definitions	129
14.4	Use of controlword and statusword	129
14.5	Detailed object definitions	130
14.5.1	Object 60C0 _h : Interpolation sub mode select	130
14.5.2	Object 60C1 _h : Interpolation data record	131
14.5.3	Object 60C2 _h : Interpolation time period	132
14.5.4	Object 60C4 _h : Interpolation data configuration	133
15	Profile velocity mode	136
15.1	General information	136
15.2	Functional description	136
15.3	General definitions	137
15.4	Use of controlword and statusword	137
15.5	Detailed object definitions	138
15.5.1	Object 6069 _h : Velocity sensor actual value	138
15.5.2	Object 606A _h : Sensor selection code	139
15.5.3	Object 606B _h : Velocity demand value	139
15.5.4	Object 606C _h : Velocity actual value	140
15.5.5	Object 606D _h : Velocity window	140
15.5.6	Object 606E _h : Velocity window time	141
15.5.7	Object 606F _h : Velocity threshold	141
15.5.8	Object 6070 _h : Velocity threshold time	142
15.5.9	Object 60FF _h : Target velocity	142
15.5.10	Object 60F8 _h : Max slippage	143
16	Profile torque mode	144
16.1	General information	144
16.2	Functional description	144
16.3	General definitions	145
16.4	Use of controlword and statusword	145
16.5	Detailed object definitions	145
16.5.1	Object 6071 _h : Target torque	145
16.5.2	Object 6072 _h : Max torque	146
16.5.3	Object 60E0 _h : Positive torque limit value	146
16.5.4	Object 60E1 _h : Negative torque limit value	147
16.5.5	Object 6073 _h : Max current	148
16.5.6	Object 6074 _h : Torque demand	148
16.5.7	Object 6075 _h : Motor rated current	149
16.5.8	Object 6076 _h : Motor rated torque	149
16.5.9	Object 6077 _h : Torque actual value	150

16.5.10	Object 6078 _h : Current actual value	150
16.5.11	Object 6079 _h : DC link circuit voltage	151
16.5.12	Object 6087 _h : Torque slope	151
16.5.13	Object 6088 _h : Torque profile type	152
17	Velocity mode	152
17.1	General information	152
17.2	Functional description	153
17.2.1	Ramp function	153
17.2.2	Velocity control function	154
17.2.3	Factor function	154
17.3	General definitions	155
17.4	Use of controlword and statusword	155
17.5	Detailed object definitions	156
17.5.1	Object 6042 _h : vl target velocity	156
17.5.2	Object 6043 _h : vl velocity demand	156
17.5.3	Object 6044 _h : vl velocity actual value	157
17.5.4	Object 6046 _h : vl velocity min max amount	158
17.5.5	Object 6049 _h : vl velocity deceleration	159
17.5.6	Object 6048 _h : vl velocity acceleration	160
17.5.7	Object 604A _h : vl velocity quick stop	162
17.5.8	Object 604B _h : vl set-point factor	163
17.5.9	Object 604C _h : vl dimension factor	164
18	Cyclic synchronous position mode	166
18.1	General information	166
18.2	Functional description	166
18.3	Use of controlword and statusword	167
18.4	Detailed object definitions	168
18.4.1	Object 60B0 _h : Position offset	168
18.4.2	Object 60B1 _h : Velocity offset	168
18.4.3	Object 60B2 _h : Torque offset	169
19	Cyclic synchronous velocity mode	170
19.1	General information	170
19.2	General definitions	171
19.3	Functional description	171
19.4	Use of controlword and statusword	171
20	Cyclic synchronous torque mode	172
20.1	General information	172
20.2	General definitions	173
20.3	Functional description	173
20.4	Use of controlword and statusword	173
21	Cyclic synchronous torque mode with commutation angle (cstca)	174
21.1	General information	174
21.2	General definitions	175
21.3	Functional description	175
21.4	Use of controlword and statusword	175
21.5	Object 60EA _h : Commutation angle	176
22	Support of additional sensor interfaces	176
22.1	General	176

22.2	Object 60E4 _h : Additional position actual value	177
22.3	Object 60E5 _h : Additional velocity actual value	178
22.4	Object 60E6 _h : Additional position encoder resolution – encoder increments	179
22.5	Object 60EB _h : Additional position encoder resolution – motor revolutions	180
22.6	Object 60E7 _h : Additional velocity encoder resolution – encoder increments per second	182
22.7	Object 60EC _h : Additional velocity encoder resolution – motor revolutions per second	183
22.8	Object 60E8 _h : Additional gear ratio – motor shaft revolutions	185
22.9	Object 60ED _h : Additional gear ratio – driving shaft revolutions	186
22.10	Object 60E9 _h : Additional feed constant – feed	186
22.11	Object 60EE _h : Additional feed constant – driving shaft revolutions	188
23	Optional application FE	189
23.1	General	189
23.2	Object 60FD _h : Digital inputs	189
23.3	Object 60FE _h : Digital outputs	190
24	Device information	191
24.1	General	191
24.2	Object 67FE _h : Version number	191
	Bibliography	193
	Figure 1 – Structure of IEC 61800-7	22
	Figure 2 – Value definition	31
	Figure 3 – Remote and local control	42
	Figure 4 – Power drive system finite state automaton	43
	Figure 5 – Relation between different value parameters	46
	Figure 6 – Value definition	46
	Figure 7 – Value definition	48
	Figure 8 – Value definition	56
	Figure 9 – Position scaling concept	58
	Figure 10 – Value definition	67
	Figure 11 – Example for a position unit	68
	Figure 12 – Example for a velocity unit	69
	Figure 13 – Example for an acceleration unit	70
	Figure 14 – Example for a jerk unit	70
	Figure 15 – Trajectory generator and position control function	71
	Figure 16 – Trajectory generator for profile position mode	71
	Figure 17 – Set-point example	72
	Figure 18 – Handshaking procedure for the single set-point method	72
	Figure 19 – Handshaking procedure for the set of set-points method	73
	Figure 20 – Set-point handling for two set-points	74
	Figure 21 – Erase set-point	75
	Figure 22 – Controlword for profile position (pp) mode	75
	Figure 23 – Statusword for profile position (pp) mode	76
	Figure 24 – Software position limits	79
	Figure 25 – Velocity/time diagram with jerk positions	86

Figure 26 – Homing mode function.....	89
Figure 27 – Homing on negative limit switch and index pulse	90
Figure 28 – Homing on positive limit switch and index pulse	90
Figure 29 – Homing on positive home switch and index pulse	91
Figure 30 – Homing on negative home switch and index pulse	91
Figure 31 – Homing on home switch and index pulse – positive initial motion	92
Figure 32 – Homing on home switch and index pulse – negative initial motion	92
Figure 33 – Homing on positive home switch	93
Figure 34 – Homing on index pulse	93
Figure 35 – Controlword for homing mode.....	94
Figure 36 – Statusword for homing mode	94
Figure 37 – Home offset definition	95
Figure 38 – Timing diagram for touch probe example.....	111
Figure 39 – Position control function	112
Figure 40 – Following error (functional overview)	113
Figure 41 – Position reached (functional overview)	113
Figure 42 – Position reached (definitions)	114
Figure 43 – Following error (definitions)	114
Figure 44 – Object structure.....	120
Figure 45 – Rotary axis positioning example	122
Figure 46 – Example for absolute movement greater than modulo value	122
Figure 47 – Example for relative movement greater than modulo value	123
Figure 48 – Interpolation controller	125
Figure 49 – Interpolated position mode for two axes	126
Figure 50 – Linear interpolation for one axis	127
Figure 51 – Input buffer organization	128
Figure 52 – Input buffer examples.....	128
Figure 53 – Interpolated position mode FSA	129
Figure 54 – Controlword for interpolated position mode	129
Figure 55 – Statusword for interpolated position mode	130
Figure 56 – Profile velocity mode	137
Figure 57 – Controlword for profile velocity mode	137
Figure 58 – Statusword for profile velocity mode	138
Figure 59 – Structure of the profile torque mode	144
Figure 60 – Controlword for profile torque mode	145
Figure 61 – Statusword for profile torque mode.....	145
Figure 62 – Velocity mode with all objects	153
Figure 63 – Velocity mode with mandatory objects only	153
Figure 64 – Velocity profile	154
Figure 65 – Factor function	154
Figure 66 – Reverse factor function	154
Figure 67 – Controlword for profile velocity mode	155
Figure 68 – Usage of controlword bits in velocity mode.....	155

Figure 69 – Statusword for profile velocity mode	156
Figure 70 – Transfer characteristic of vl velocity min max amount	158
Figure 71 – Transfer characteristic of the velocity deceleration	159
Figure 72 – Transfer characteristic of the velocity acceleration	161
Figure 73 – Transfer characteristic of the quick stop deceleration	162
Figure 74 – Cyclic synchronous position mode overview	166
Figure 75 – Cyclic synchronous position control function	167
Figure 76 – Statusword for profile cyclic synchronous position mode	167
Figure 77 – Cyclic synchronous velocity mode overview	170
Figure 78 – Cyclic synchronous velocity control function	171
Figure 79 – Statusword for profile cyclic synchronous velocity mode	172
Figure 80 – Cyclic synchronous torque mode overview	173
Figure 81 – Cyclic synchronous torque control function	173
Figure 82 – Statusword for profile cyclic synchronous torque mode	174
Figure 83 – Cyclic synchronous torque mode with commutation angle overview	174
Figure 84 – Cyclic synchronous torque with commutation angle control function	175
Figure 85 – Statusword for cstca mode	175
Figure 86 – Object structure	189
Figure 87 – Object structure	190
Figure 88 – Structure of the standard version parameter	191
Table 1 – List of used data types	30
Table 2 – Interpolation time period	30
Table 3 – Interpolation data configuration	31
Table 4 – vl velocity acceleration/deceleration	31
Table 5 – Object description	32
Table 6 – Entry description	32
Table 7 – Value definition	33
Table 8 – Object description	33
Table 9 – Entry description	33
Table 10 – Object description	34
Table 11 – Entry description	34
Table 12 – Object description	34
Table 13 – Entry description	34
Table 14 – Object description	35
Table 15 – Entry description	35
Table 16 – Object description	35
Table 17 – Entry description	35
Table 18 – Object description	36
Table 19 – Entry description	36
Table 20 – Object description	36
Table 21 – Entry description	36
Table 22 – Object description	37

Table 23 – Entry description	37
Table 24 – Error codes	38
Table 25 – FSA states and supported functions	43
Table 26 – Transition events and actions	44
Table 27 – Command coding	47
Table 28 – Object description	47
Table 29 – Entry description	47
Table 30 – State coding	48
Table 31 – Object description	49
Table 32 – Entry description	49
Table 33 – Object description	49
Table 34 – Entry description	50
Table 35 – Value definition	50
Table 36 – Object description	50
Table 37 – Entry description	50
Table 38 – Value definition	51
Table 39 – Object description	51
Table 40 – Entry description	51
Table 41 – Value definition	52
Table 42 – Object description	52
Table 43 – Entry description	52
Table 44 – Value definition	52
Table 45 – Object description	53
Table 46 – Entry description	53
Table 47 – Value definition	53
Table 48 – Object description	53
Table 49 – Entry description	54
Table 50 – Value definition	54
Table 51 – Object description	54
Table 52 – Entry description	54
Table 53 – Value definition	55
Table 54 – Object description	55
Table 55 – Entry description	55
Table 56 – Object description	56
Table 57 – Entry description	56
Table 58 – Object description	57
Table 59 – Entry description	57
Table 60 – Object description	60
Table 61 – Entry description	60
Table 62 – Object description	61
Table 63 – Entry description	61
Table 64 – Object description	62
Table 65 – Entry description	62

Table 66 – Object description	63
Table 67 – Entry description	63
Table 68 – Object description	64
Table 69 – Entry description	64
Table 70 – Object description	65
Table 71 – Entry description	65
Table 72 – Object description	66
Table 73 – Entry description	66
Table 74 – Object description	67
Table 75 – Entry description	67
Table 76 – Device profile specific units	67
Table 77 – Object description	68
Table 78 – Entry description	68
Table 79 – Object description	68
Table 80 – Entry description	69
Table 81 – Object description	69
Table 82 – Entry description	69
Table 83 – Object description	70
Table 84 – Entry description	70
Table 85 – Definition of bit 4, bit 5, and bit 9.....	76
Table 86 – Definition of bit 6 and bit 8.....	76
Table 87 – Definition of bit 10, bit 12, and bit 13	76
Table 88 – Object description	77
Table 89 – Entry description	77
Table 90 – Object description	77
Table 91 – Entry description	78
Table 92 – Object description	79
Table 93 – Entry description	80
Table 94 – Object description	80
Table 95 – Entry description	81
Table 96 – Object description	81
Table 97 – Entry description	81
Table 98 – Object description	82
Table 99 – Entry description	82
Table 100 – Object description.....	82
Table 101 – Entry description	82
Table 102 – Object description.....	83
Table 103 – Entry description	83
Table 104 – Object description.....	83
Table 105 – Entry description	83
Table 106 – Object description.....	84
Table 107 – Entry description	84
Table 108 – Value definition.....	84

Table 109 – Object description.....	84
Table 110 – Entry description	85
Table 111 – Object description.....	85
Table 112 – Entry description	85
Table 113 – Value assignments	86
Table 114 – Object description.....	86
Table 115 – Entry description	87
Table 116 – Object description.....	88
Table 117 – Entry description	88
Table 118 – Object description.....	88
Table 119 – Entry description	88
Table 120 – Definition of bit 4 and bit 8.....	94
Table 121 – Definition of bit 10, bit 12, and bit 13	94
Table 122 – Object description.....	95
Table 123 – Entry description	95
Table 124 – Value definition.....	96
Table 125 – Object description.....	96
Table 126 – Entry description	96
Table 127 – Object description.....	96
Table 128 – Entry description	97
Table 129 – Object description.....	98
Table 130 – Entry description	98
Table 131 – Object description.....	99
Table 132 – Entry description	99
Table 133 – Value definition.....	100
Table 134 – Object description.....	100
Table 135 – Entry description	101
Table 136 – Value definition.....	101
Table 137 – Object description.....	101
Table 138 – Entry description	102
Table 139 – Object description.....	102
Table 140 – Entry description	102
Table 141 – Object description.....	102
Table 142 – Entry description	103
Table 143 – Object description.....	103
Table 144 – Entry description	103
Table 145 – Object description.....	103
Table 146 – Entry description	104
Table 147 – Value definition.....	104
Table 148 – Object description.....	104
Table 149 – Entry description	105
Table 150 – Object description.....	106
Table 151 – Entry description	106

Table 152 – Object description.....	106
Table 153 – Entry description	106
Table 154 – Object description.....	107
Table 155 – Entry description	107
Table 156 – Object description.....	107
Table 157 – Entry description	107
Table 158 – Object description.....	108
Table 159 – Entry description	108
Table 160 – Object description.....	109
Table 161 – Entry description	109
Table 162 – Object description.....	109
Table 163 – Entry description	109
Table 164 – Object description.....	110
Table 165 – Entry description	110
Table 166 – Explanation of the timing diagram.....	112
Table 167 – Object description.....	115
Table 168 – Entry description	115
Table 169 – Object description.....	115
Table 170 – Entry description	115
Table 171 – Object description.....	116
Table 172 – Entry description	116
Table 173 – Object description.....	116
Table 174 – Entry description	116
Table 175 – Object description.....	117
Table 176 – Entry description	117
Table 177 – Object description.....	117
Table 178 – Entry description	118
Table 179 – Object description.....	118
Table 180 – Entry description	118
Table 181 – Object description.....	118
Table 182 – Entry description	119
Table 183 – Object description.....	119
Table 184 – Entry description	119
Table 185 – Object description.....	120
Table 186 – Entry description	120
Table 187 – Value definition for bit 0 and bit 1	120
Table 188 – Value definition for bit 2 and bit 3	121
Table 189 – Value definition for bit 4 and bit 5	121
Table 190 – Value definition for bit 6 and bit 7	121
Table 191 – Object description.....	123
Table 192 – Entry description	123
Table 193 – Position calculation in interpolated position mode for several axes	126
Table 194 – FSA states and supported functions	129

Table 195 – Transition events and actions	129
Table 196 – Definition of bit 4 and bit 8.....	130
Table 197 – Definition of bit 10 and bit 12.....	130
Table 198 – Value definition.....	130
Table 199 – Object description.....	131
Table 200 – Entry description	131
Table 201 – Object description.....	131
Table 202 – Entry description	132
Table 203 – Object description.....	133
Table 204 – Entry description	133
Table 205 – Object description.....	134
Table 206 – Entry description	135
Table 207 – Definition of bit 8	138
Table 208 – Definition of bit 10, bit 12, and bit 13	138
Table 209 – Object description.....	138
Table 210 – Entry description	139
Table 211 – Value definition.....	139
Table 212 – Object description.....	139
Table 213 – Entry description	139
Table 214 – Object description.....	140
Table 215 – Entry description	140
Table 216 – Object description.....	140
Table 217 – Entry description	140
Table 218 – Object description.....	141
Table 219 – Entry description	141
Table 220 – Object description.....	141
Table 221 – Entry description	141
Table 222 – Object description.....	142
Table 223 – Entry description	142
Table 224 – Object description.....	142
Table 225 – Entry description	142
Table 226 – Object description.....	143
Table 227 – Entry description	143
Table 228 – Object description.....	143
Table 229 – Entry description	143
Table 230 – Definition of bit 8	145
Table 231 – Definition of bit 10	145
Table 232 – Object description.....	146
Table 233 – Entry description	146
Table 234 – Object description.....	146
Table 235 – Entry description	146
Table 236 – Object description.....	147
Table 237 – Entry description	147

Table 238 – Object description.....	147
Table 239 – Entry description	147
Table 240 – Object description.....	148
Table 241 – Entry description	148
Table 242 – Object description.....	148
Table 243 – Entry description	148
Table 244 – Object description.....	149
Table 245 – Entry description	149
Table 246 – Object description.....	149
Table 247 – Entry description	150
Table 248 – Object description.....	150
Table 249 – Entry description	150
Table 250 – Object description.....	150
Table 251 – Entry description	151
Table 252 – Object description.....	151
Table 253 – Entry description	151
Table 254 – Object description.....	151
Table 255 – Entry description	152
Table 256 – Value definition.....	152
Table 257 – Object description.....	152
Table 258 – Entry description	152
Table 259 – Definition of bit 4, bit 5, bit 6, and bit 8	155
Table 260 – Object description.....	156
Table 261 – Entry description	156
Table 262 – Object description.....	157
Table 263 – Entry description	157
Table 264 – Object description.....	157
Table 265 – Entry description	157
Table 266 – Object description.....	158
Table 267 – Entry description	159
Table 268 – Object description.....	160
Table 269 – Entry description	160
Table 270 – Object description.....	161
Table 271 – Entry description	162
Table 272 – Object description.....	163
Table 273 – Entry description	163
Table 274 – Object description.....	164
Table 275 – Entry description	164
Table 276 – Object description.....	165
Table 277 – Entry description	165
Table 278 – Definition of bit 10, bit 12, and bit 13	168
Table 279 – Object description.....	168
Table 280 – Entry description	168

Table 281 – Object description.....	169
Table 282 – Entry description	169
Table 283 – Object description.....	169
Table 284 – Entry description	170
Table 285 – Definition of bit 10, bit 12, and bit 13	172
Table 286 – Definition of bit 10, bit 12, and bit 13	174
Table 287 – Definition of bit 10, bit 12, and bit 13	176
Table 288 – Object description.....	176
Table 289 – Entry description	176
Table 290 – Object description.....	177
Table 291 – Entry description	178
Table 292 – Object description.....	179
Table 293 – Entry description	179
Table 294 – Object description.....	180
Table 295 – Entry description	180
Table 296 – Object description.....	181
Table 297 – Entry description	181
Table 298 – Object description.....	182
Table 299 – Entry description	183
Table 300 – Object description.....	184
Table 301 – Entry description	184
Table 302 – Object description.....	185
Table 303 – Entry description	185
Table 304 – Object description.....	186
Table 305 – Entry description	186
Table 306 – Object description.....	187
Table 307 – Entry description	187
Table 308 – Object description.....	188
Table 309 – Entry description	188
Table 310 – Value definition.....	189
Table 311 – Object description.....	189
Table 312 – Entry description	190
Table 313 – Value definition.....	190
Table 314 – Object description.....	190
Table 315 – Entry description	191
Table 316 – Object description.....	192
Table 317 – Entry description	192

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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 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:

- 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.

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.

IEC 61800-7-1 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 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, 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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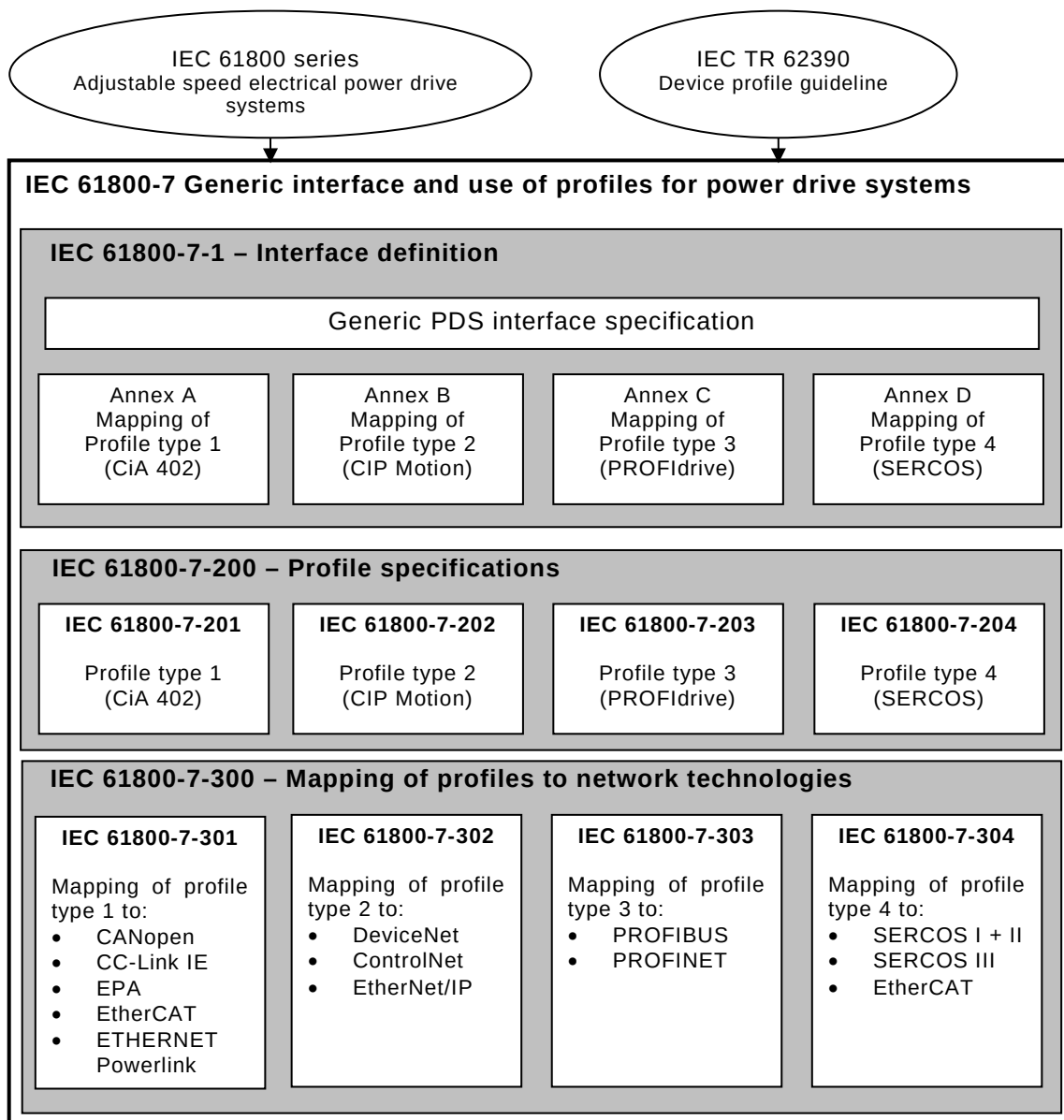


Figure 1 – Structure of IEC 61800-7

IEC

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.

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 61800-7-301¹⁵, *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 is used in this document as input data of the application control program to monitor variables of the PDS (e.g. feedback variables).

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

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.

3.1.2

algorithm

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

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

3.1.3

application

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

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

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

3.1.4

application mode

type of application that can be requested from a PDS

Note 1 to entry: The different application modes reflect the control loop for torque control, velocity control, position control or other applications 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 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: 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: IEC 61800-7-1:2015, 3.2.6]

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: 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 61800-7-1:2015, 3.2.9]

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

[SOURCE: 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

[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 61800-7-1:2015, 3.2.13]

3.1.15**high-level power**

main electric power supply of the drive device

3.1.16**input data**

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

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

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

**3.1.24
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: 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 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 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 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
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.

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, adjustment, 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
- 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
Interpolation time period	See Table 2
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.

Table 2 – 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 – 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 – vI 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

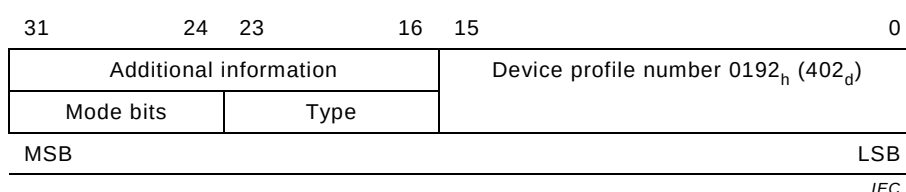
There are three communication parameter objects that shall be implemented:

- 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 × 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 description.

**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.

The corresponding error code 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.

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

(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

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

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	Manufacturer-specific

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.

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 ² t, thermal state)
2351 _h	Load level warning (I ² t, 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

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

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

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.

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.

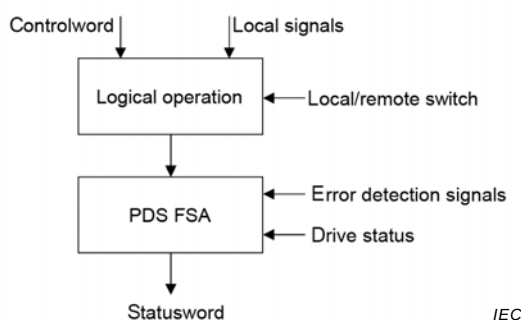


Figure 3 – Remote and local control

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.

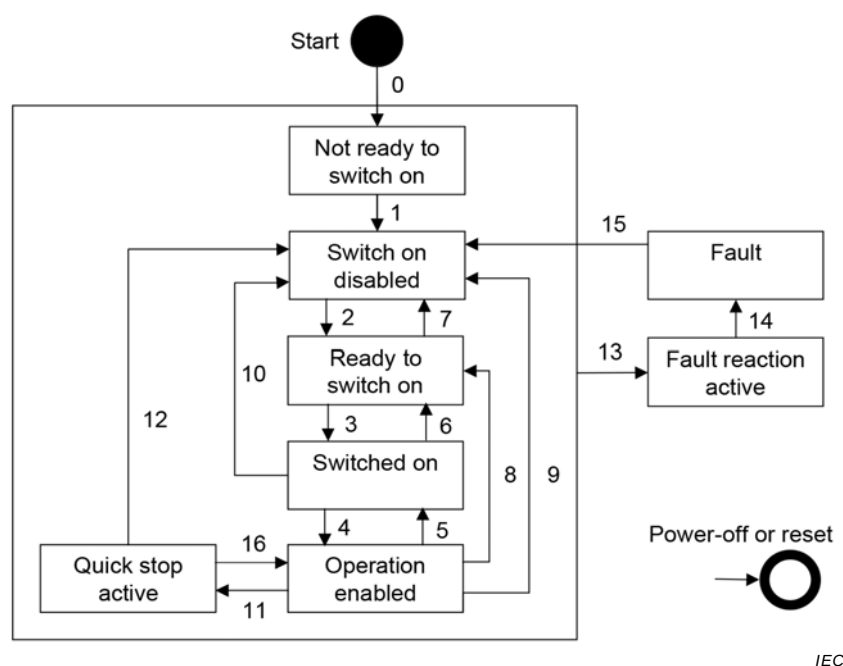


Figure 4 – Power drive system finite state automaton

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.

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.
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.

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.

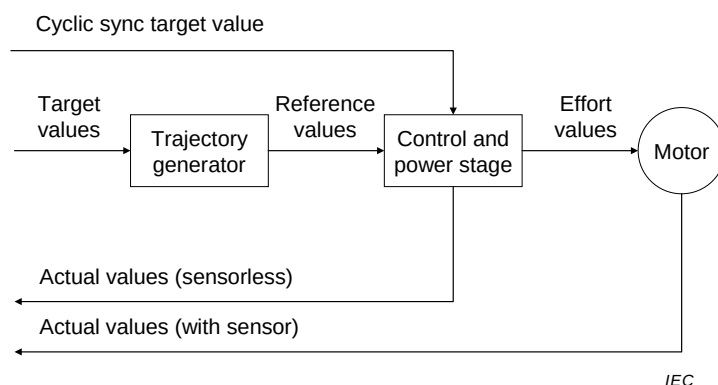
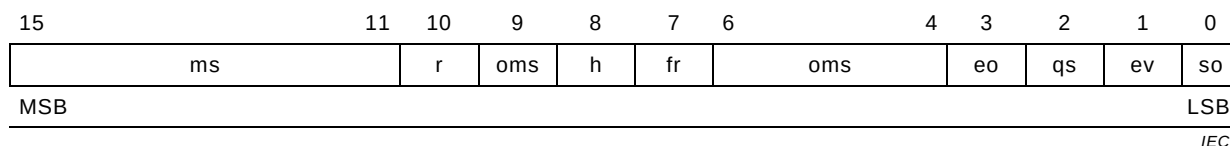


Figure 5 – Relation between different value parameters

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 bits 0 to 9 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.



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

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 oms bits shall be supported if the mode of operation is supported. If the related functionality of the oms bits is 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.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
ms	oms		ila	tr	rm	ms	w	sod	qs	ve	f	oe	so	rtso	
MSB														LSB	
IEC															

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