EtherCAT® Implementation Directive for CiA402 Drive Profile

Directive for using IEC 61800-7-201 within EtherCAT-based servo drives

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DOCUMENT HISTORY

Version	Comment
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1 Scope

IEC 61800–7–201 and IEC 61800–7–301 specify the CiA402 drive profile which is mapped to EtherCAT. In the IEC Standard many objects and operation modes are defined as optional therefore this document intends to define a common behaviour of an EtherCAT servo drive supporting the CiA402 drive profile.

Scope of this guideline

- CiA402 Servo drives with EtherCAT interface

Frequency converter or stepper motors are intentionally not within the scope of this guideline.

The mapping of the SERCOS profile to EtherCAT described in IEC 61800-7-304 is not part of this guideline. The specific usage of this part of the standard is defined within the SERCOS International e.V.

NOTE Objects / functions / operation modes in bold letters throughout the text and the figures means that this feature is mandatory according to this guideline.

This guideline is not a substitute of the IEC 61800-7-201 specification! For the understanding and implementation of the drive profile the IEC specification is indispensable.

The guideline gives explanations and defines enhancements to the specification.

1.1 IEC 61800-7

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 61800-7-1 specifies a generic interface between power drive system(s) (PDS) and the application control program in a controller. The generic PDS interface is not specific to any particular communication network technology. Annexes of IEC 61800-7-1 specify the mapping of the different drive profiles onto the generic PDS interface.

IEC 61800-7-2xx specifies different profiles for power drive systems (PDS). The profiles of the PDS are not specific to any particular communication network technology. This guideline deals with subpart -201 that specifies the CiA402 DriveProfile.

IEC 61800-7-3xx specifies the mapping of different profiles to different network technologies.

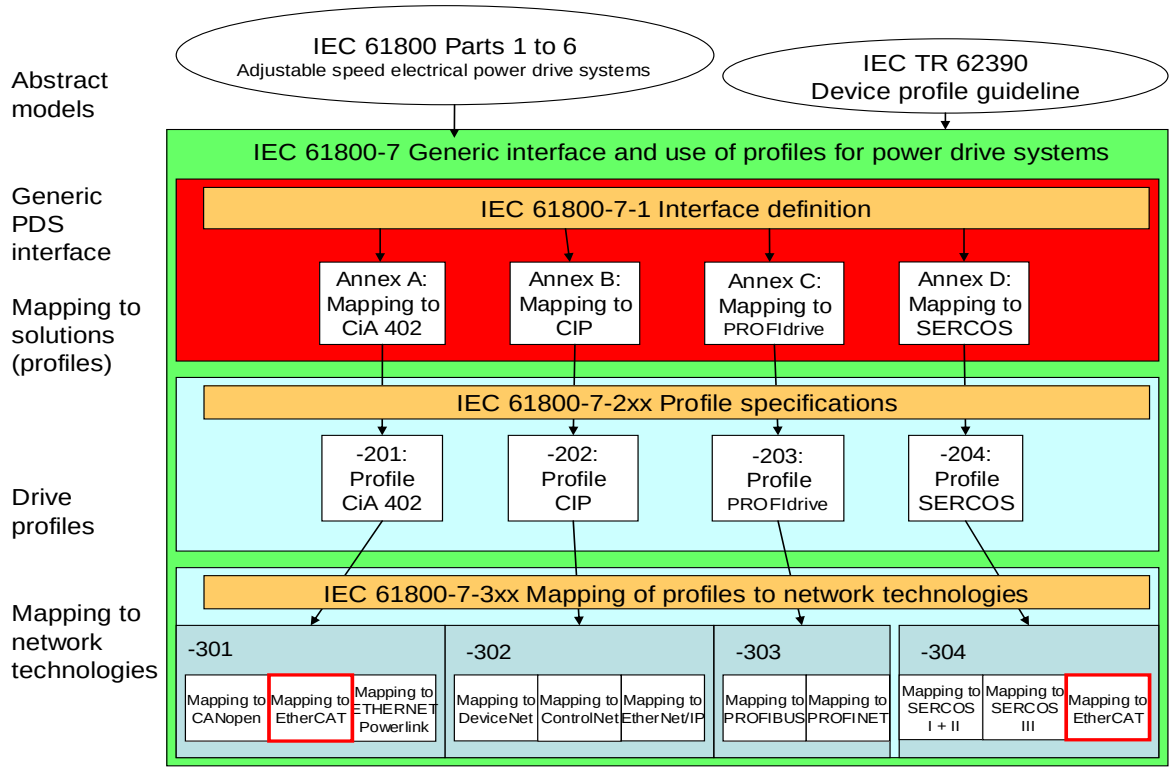


Figure 1: Structure of the IEC 61800 - 7

2 References

[1] IEC 61800 (all parts), Adjustable speed electrical power drive systems

[2] IEC 61800-7-1:—, Adjustable speed electrical power drive systems – Part 7-1 Generic interface and use of profiles for power drive systems – Interface definition

[3] IEC 61800-7-201:—, Adjustable speed electrical power drive systems – Part 7-2 Generic interface and use of profiles for power drive systems – Profile specification Type 1

[4] IEC 61800-7-3:—, Adjustable speed electrical power drive systems – Part 7-2 Generic interface and use of profiles for power drive systems – Mapping of profiles to network technologies

[5] IEC 61158-3-12, Digital data communications for measurement and control – Fieldbus for use in industrial control systems – Part 3-12: data-link layer service definition – Type 12 elements

[6] IEC 61158-4-12, Digital data communications for measurement and control – Fieldbus for use in industrial control systems – Part 4-12: Data-link layer protocol specification – Type 12 elements

[7] IEC 61158-5-12, Digital data communications for measurement and control – Fieldbus for use in industrial control systems – Part 5-12: Application layer service definition – Type 12 elements

[8] IEC 61158-6-12, Digital data communications for measurement and control – Fieldbus for use in industrial control systems – Part 6-12: Application layer protocol specification – Type 12 elements

[9] ETG.1020, EtherCAT Guidelines & Protocol Enhancements.doc, ETG guideline for synchronization

3 Terms and Definitions

(M) Mandatory
the object / feature shall be supported according to IEC 61800-7 or according to this guideline.

(C) Conditional
the object / feature parameter is conditional upon other parameters / features. I.e. it shall be supported if the other parameter / feature is supported.

(R) Recommended
the object / feature is highly recommended according to this guideline.
It is defined for a better quality of the corresponding function.

(O) Optional
the object / feature might be supported.
It is not recommended according to this guideline.

(FG) Function Group
combination of objects and features to support a specific function within the drive.

Low-level power
electrical power supply for the control section of the drive, e.g. 24 V.

High-level power
main electric power supply of the drive, e.g. 230 V or 380 V.

4 Error codes and error behavior

The following error option codes are supported:

Table 1: Supported Error option codes

Index	Name	Category	Remark
0x6007	Abort connection option code	O	
0x605A	Quick stop option code	O	
0x605B	Shutdown option code	O	if there is a transition from Operation Enabled state to Ready To Switch On state. The slow down ramp is the deceleration value of the used mode of operations.
0x605C	Disable operation option code	O	if there is a transition from Operation Enabled state to Switched on state. The slow down ramp is the deceleration value of the used mode of operations
0x605D	Halt option code	O	
0x605E	Fault reaction option code	O	when a fault is detected in the PDS. The slow down ramp is the deceleration value of the used mode of operations. Default: +2 (quick stop ramp)

The communication state machine (ESM) is independent of the drive State machine (FSA SM).

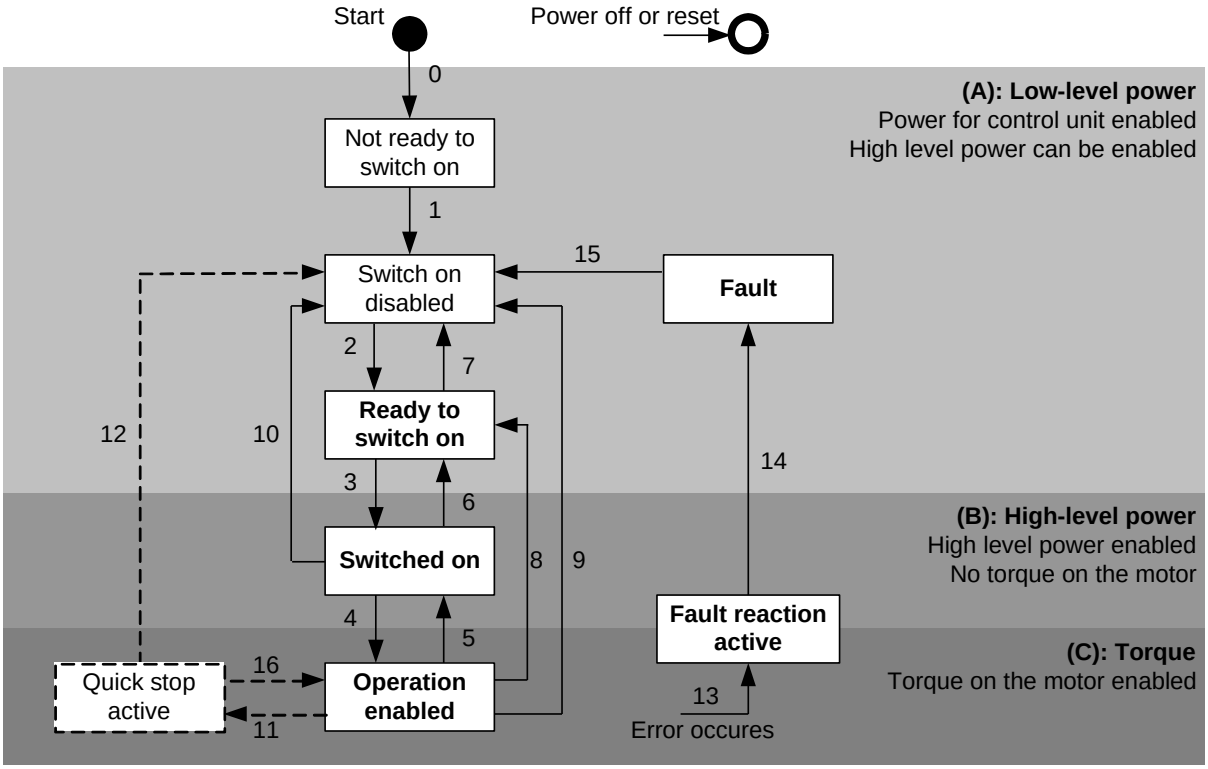
Object 0x6007 can be used to define the behaviour in case the slave ESM leaves the OP state.

A state change of the FSA SM does not affect the ESM.

NOTE: See also [9]: Error Handling, Object 0x10F1 Error Settings for multiple Synch Error behaviour.

5 Controlling the power drive system

5.1 State machine



state Optional state

state State can be changed manually by the slave

state State is checked by master

Figure 2: State Machine

The state *Quick stop active* is optional. Usually the control device will perform the quick stop function.

The state *Not ready to switch on* is performed automatically by the drive.

The state *Switch on disabled* can be passed through automatically by local signals of the drive. The control device has to compare during start-up which state is reached by the drive. Then the control device has to perform the transition *2* only if necessary.

The states in bold letters are stable states in the drive and will be checked by the control device. The transitions *3* and *4* can only be requested by the control device.

If the control device sets Bits 0, 1 and 3 simultaneous in the controlword the drive can pass from *Ready to Switch on* via *Switched on* to *Operation enabled* with one control device command.

In area (A) the Low-level power is enabled. The High-level power may be enabled, e.g. to supply the low-level power.

In area (B) the High-level power shall be switched on but there is no torque on the motor. Transition *3* shall be refused by the drive, if no high-level power is enabled. Target and set-point values shall be ignored.

In area (C) the drive is ready to operate and the torque is switched on to the motor. Target and set-point values shall be processed.

During transition *4* the torque can be set up and if necessary a brake can be opened. The statusword displays the state *Switched on* until the drive is ready to follow the target and set-point values.

Accordingly in transition 5 the drive can actively be decelerated and the brake can be closed. The statusword displays the state Operation enabled as long as torque on the motor is enabled.

The servo drive shall support the functions as shown in Table 2.

Table 2: State Machine - States

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**
	O	O	**M**	**M**	**M**	O	**M**	**M**
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

5.2 Controlword (Object 0x6040)

The servo drive shall support the following Bits in the *controlword*.

Table 3: Use of controlword

Bit	Meaning	Category
0	**Switch on**	**M**
1	**Enable voltage**	**M**
2	Quick stop	O
3	**Enable operation**	**M**
4 – 6	Operation mode specific	O
7	**Fault reset**	**M**
8	Halt	O
9	Operation mode specific	O
10	reserved	O
11 – 15	Manufacturer specific	O

Bit 2 *Quick stop* shall be set (= 1) by the control device to deactivate an optional quick stop. This bit shall be ignored by a drive that does not support the quick stop state.

5.3 Statusword (Object 0x6041)

The servo drive shall support the following Bits in the *statusword*.

Table 4: Use of statusword

Bit	Meaning	Category	
0	**Ready to switch on**	**M**	
1	**Switched on**	**M**	
2	**Operation enabled**	**M**	
3	**Fault**	**M**	
4	Voltage enabled	O	
5	Quick stop	O	
6	**Switch on disabled**	**M**	
7	Warning	O	
8	Manufacturer specific	O	
9	Remote	O	
10	Operation mode specific	O	
11	Internal limit active	O	
12	Operation mode specific	C	Mandatory for csp, csv, cst mode
13	Operation mode specific	O	
14 – 15	Manufacturer specific	O	

Bit 5 *Quick Stop* shall be set by the drive if the Quick Stop state is not supported or the Quick stop function is not active.

Bit 11 *Internal limit active* is set if internal limits are exceeded so that the target and set-point values can't be reached. E.g. for hardware position switches, current limiter or thermal overload.

6 Modes of Operation

The following operation modes for the servo drives are recommended:

Table 5: Operation Modes

Mode of operation	Abbr.	Code	Category	Remarks
Profile position mode	pp	1	O	
Velocity mode (frequency converter)	vl	2	O	
Profile velocity mode	pv	3	O	
Torque profile mode	tq	4	O	
Homing mode	hm	6	O	
Interpolated position mode	ip	7	O	
Cyclic synchronous position mode	**csp**	**8**	**C**	at least one of these modes shall be supported
Cyclic synchronous velocity mode	**csv**	**9**	**C**	
Cyclic synchronous torque mode	**cst**	**10**	**C**	
Cyclic synchronous torque mode with commutation angle	cstca	11	O	
Manufacturer specific mode		-128…-1	O	

At least one of the cyclic synchronous modes shall be supported.

Table 6: Modes of operation – Object list

Index	Name	Category
0x6060	**Modes of operation**	**M**
0x6061	**Modes of operation display**	**M**
0x6502	Supported drive modes	M

6.1 Cyclic synchronous position mode (csp)

Figure 3 shows an overview of the *Cyclic synchronous position mode (csp)*.

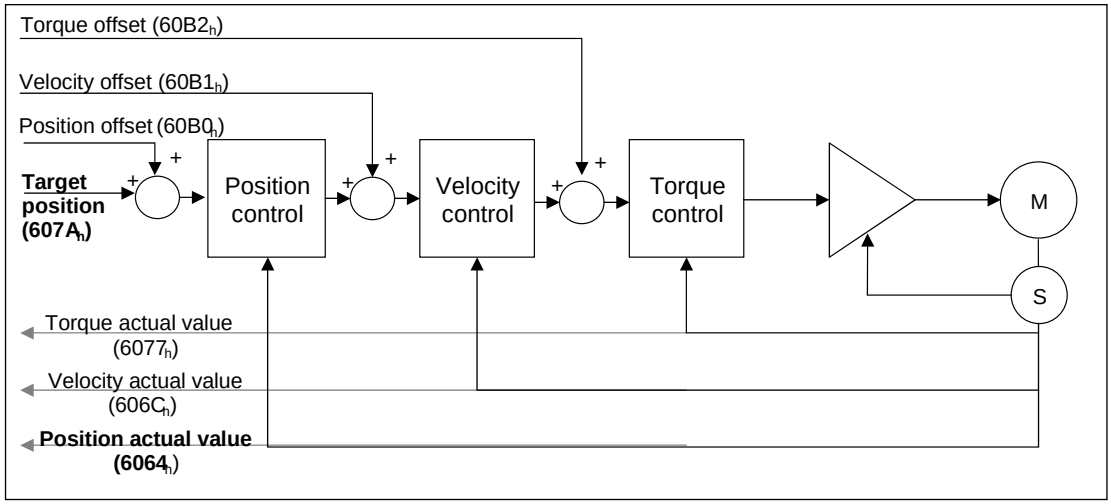


Figure 3: Cyclic synchronous position mode overview

The following (bold) objects are used for *csp* (see Figure 4).

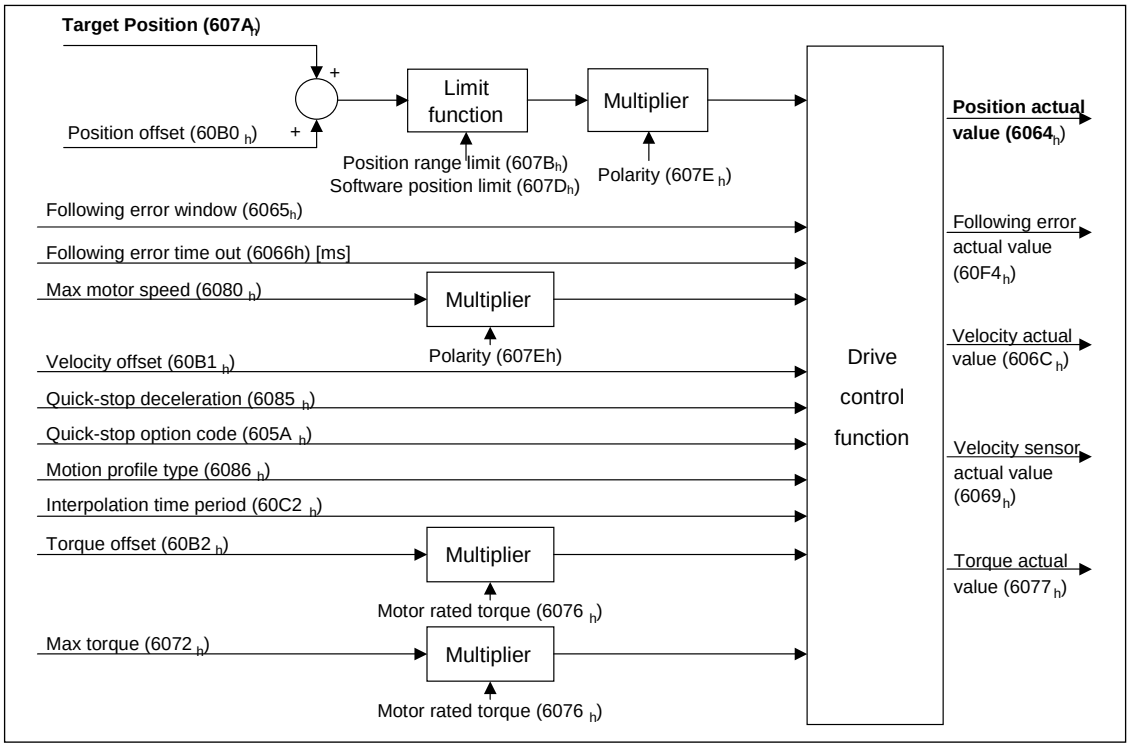


Figure 4: Cyclic synchronous position control function

Table 7: csp mode – Object list

Index	Name	Category
0x607A	**Target Position**	**M**
0x6064	**Position actual value**	**M**
0x6077	Torque actual value	R
0x607B	Position range limit	R
0x607D	Software position limit	R
0x60B1	Velocity offset	R
0x60B2	Torque offset	R

Index	Name	Category
0x60F4	Following error actual value	R
0x6065	Following error window	R
0x6066	Following error time out	R
0x60C2	Interpolation time period	R

If the following error is calculated in the control device it is afflicted with a dead-time. Therefore the calculation of the following error in the drive might have a better quality.

The following error value shall only be evaluated in state *Operation enabled*.

After a Reset the setpoint should be set to the actual value so that the following error is zero.

The operation mode specific Bits (bit 4…6, bit 9) and the Halt bit (bit 8) in the Controlword shall be ignored by the drive. In the *csp* mode the bit 8 shall be ignored because the halt function is controlled by the control device.

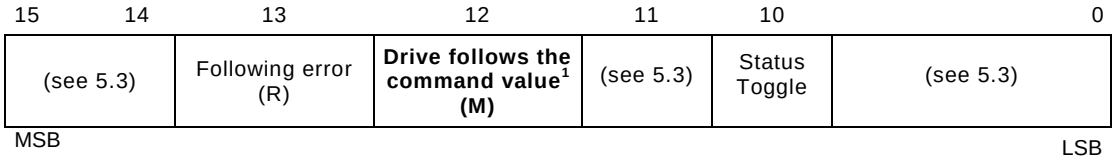


Figure 5: Statusword for *csp* mode

In the statusword Bit 12 is mandatory. The Bit 13 is recommended.

The bit 10 is used in Profile position mode as "target reached" information. In *csp* the new target position is given cyclically by the control device. This bit is used as *Status Toggle* information to indicate if the device provides updated input data. The bit shall be toggled with every update of the input process data. If object 0x60D9 is supported, the Status Toggle function can be enabled or disabled.

The Bit 12 *Drive follows the command value* shall be zero if the drive **does not** follow the target value (position, velocity or torque) because of local reasons (internal set-point settings). E.g. if a local Input is configured to a halt function or a safety function prevents the drive in Operational to follow the target setpoint. The control device shall evaluate the bit. The Bit 12 shall be set if the drive is in state *Operation enabled* and follows the target and set-point values of the control device. In all other cases it shall be zero. If the bit is not supported it shall be fix set to 1 in the statusword.

NOTE: If Bit 12 is not supported and is not set to 1, the control device will not run the drive, because it expects that the drive does not follow the command.

[1] In IEC 61800-7-200 this bit is called “Target position ignored”. Due to the logical definition the bit is renamed. This is agreed by CiA e.V. Working Group.

6.2 Cyclic synchronous velocity mode (csv)

Figure 6 shows an overview of the *Cyclic synchronous velocity mode (csv)*.

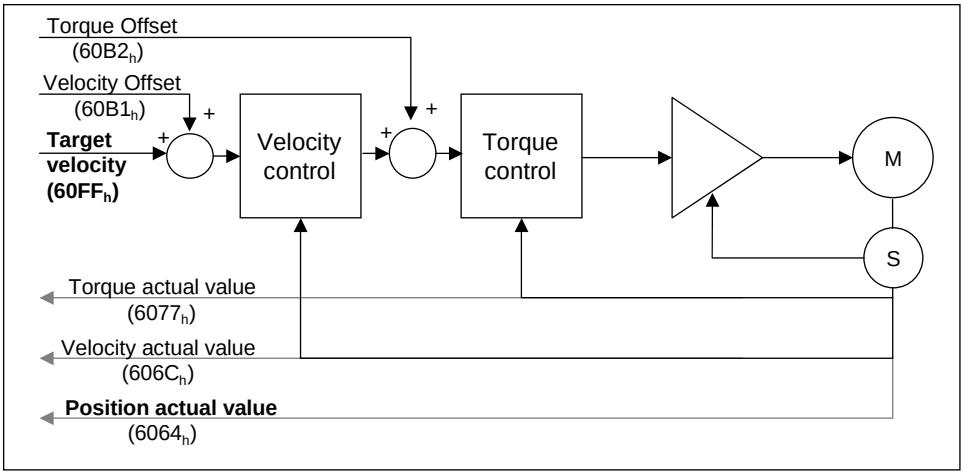


Figure 6: Cyclic synchronous velocity mode overview

The following (bold) objects are used for *csv* (see Figure 7).

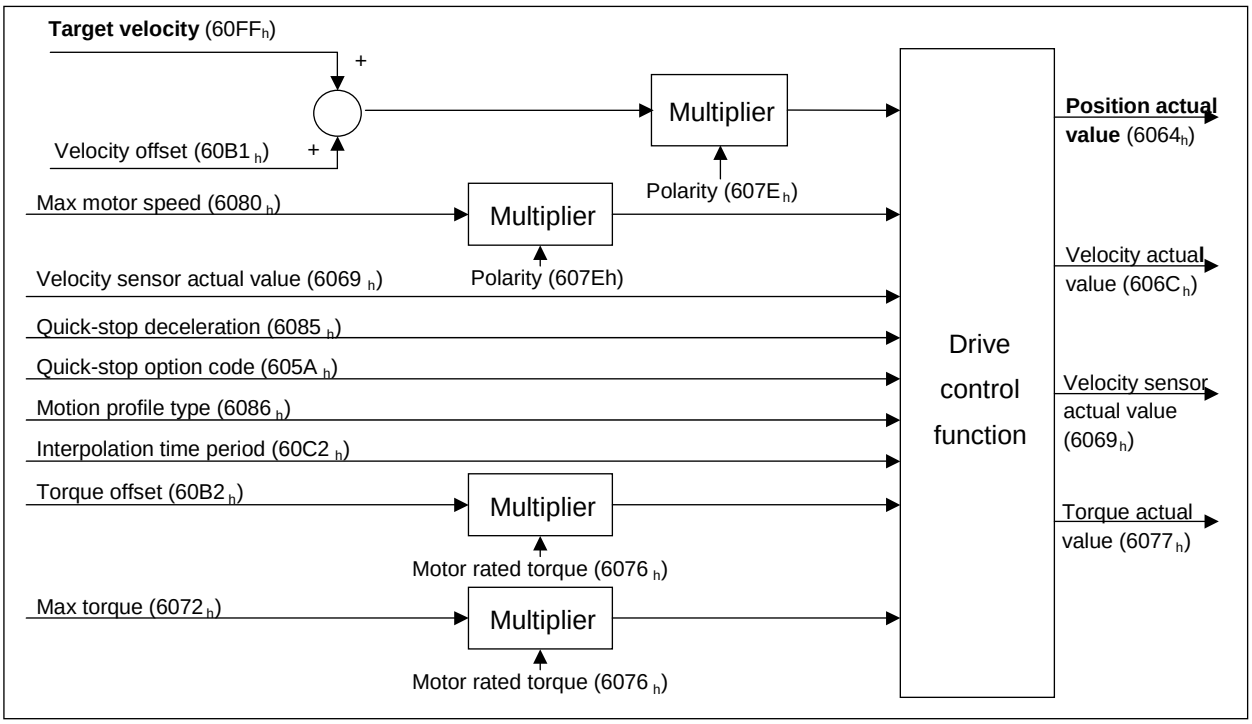


Figure 7: Cyclic synchronous velocity control function

Table 8: csv mode – Object list

Index	Name	Category
0x60FF	**Target Velocity**	**M**
0x6064	**Position actual value**	**M**
0x606C	Velocity actual value	R
0x6077	Torque actual value	R
0x60B2	Torque offset	R
0x60C2	Interpolation time period	R

The operation mode specific (bit 4…6, bit 9) and the Halt bit (bit 8) in the Controlword shall be ignored by the drive

In the csv mode the bit 8 shall be ignored because the halt function is controlled by the control device.

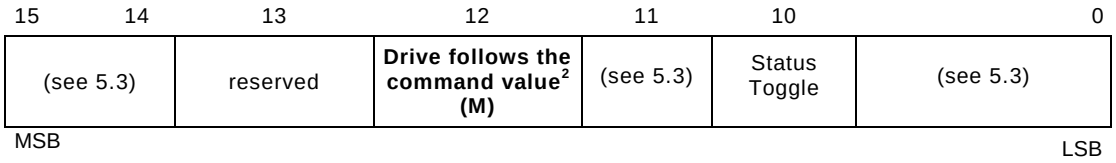


Figure 8: Statusword for *csv* mode

In the statusword Bit 12 is mandatory.

In *csv* mode Bit 10 is used as *Status Toggle* information to indicate if the device provides updated input data. The bit shall be toggled with every update of the input process data. If object 0x60D9 is supported, the Status Toggle function can be enabled or disabled.

The Bit 12 *Drive follows the command value* shall be zero if the drive **does not** follow the target value (position, velocity or torque) because of local reasons (internal set-point settings). E.g. if a local Input is configured to a halt function or if a safety function prevents the drive in Operational to follow the target setpoint. The control device shall evaluate the bit. The Bit 12 shall be set if the drive is in state *Operation enabled* and follows the target and set-point values of the control device. In all other cases it shall be zero. If the bit is not supported it shall be fix set to 1 in the statusword.

NOTE: If Bit 12 is not supported and is not set to 1, the control device will not run the drive, because it expects that the drive does not follow the command.

[2] In IEC 61800-7-200 this bit is called “Target position ignored”. Due to the logical definition the bit is renamed. This is agreed by CiA e.V. Working Group.

6.3 Cyclic synchronous torque mode (cst)

Figure 9 shows an overview of the *Cyclic synchronous torque mode (cst)*.

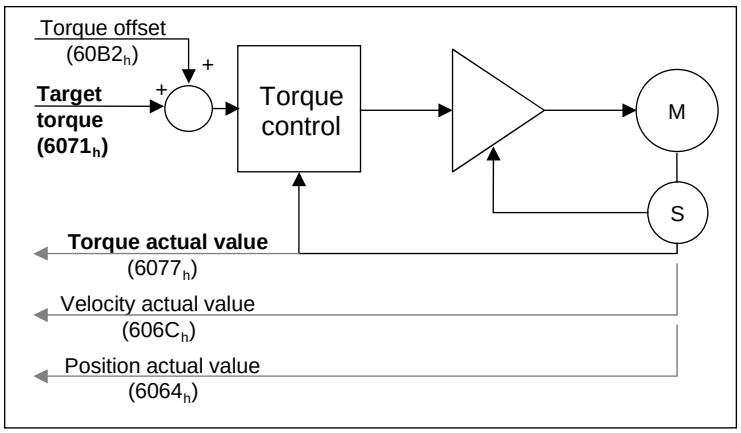


Figure 9: Cyclic synchronous torque mode overview

The following (bold) objects are used for *cst* (Figure 10).

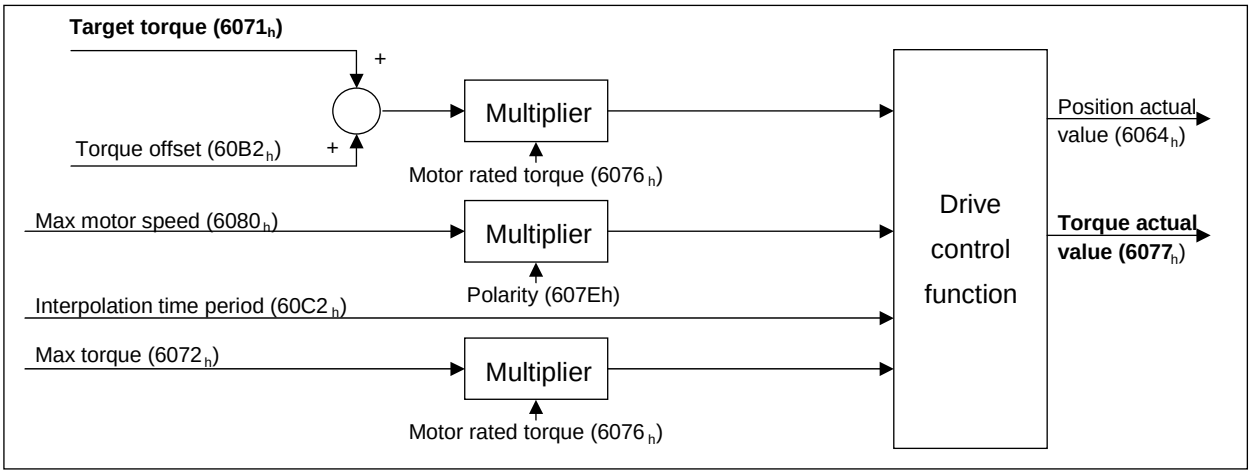


Figure 10: Cyclic synchronous torque control function

Table 9: cst mode – Object list

Index	Name	Category
0x6071	**Target Torque**	**M**
0x6077	**Torque actual value**	**M**
0x6064	Position actual value	R
0x60C2	Interpolation time period	R

The operation mode specific Bits (bit 4…6, bit 9) and the Halt bit (bit 8) in the Controlword shall be ignored by the drive

In the cst mode the bit 8 shall be ignored because the halt function is controlled by the control device.

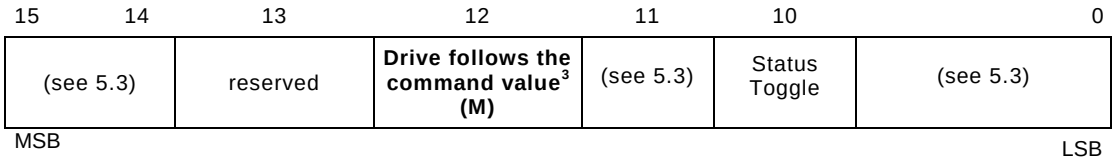


Figure 11: Statusword for *cst* mode

In the statusword Bit 12 is mandatory.

In *cst* mode Bit 10 is used as *Status Toggle* information to indicate if the device provides updated input data. The bit shall be toggled with every update of the input process data. If object 0x60D9 is supported, the Status Toggle function can be enabled or disabled.

The Bit 12 *Drive follows the command value* shall be zero if the drive **does not** follow the target value (position, velocity or torque) because of local reasons (internal set-point settings). E.g. if a local Input is configured to a halt function or if a safety function prevents the drive in Operational to follow the target setpoint. The control device shall evaluate the bit. The Bit 12 shall be set if the drive is in state *Operation enabled* and follows the target and set-point values of the control device. In all other cases it shall be zero. If the bit is not supported it shall be fix set to 1 in the statusword.

NOTE: If Bit 12 is not supported and is not set to 1, the control device will not run the drive, because it expects that the drive does not follow the command.

[3] In IEC 61800-7-200 this bit is called “Target position ignored”. Due to the logical definition the bit is renamed. This is agreed by CiA e.V. Working Group.

6.4 Cyclic synchronous torque mode with commutation angle (cstca)

6.4.1 General information

The overall structure for this mode is shown in Figure 12. With this mode, the trajectory generator is located in the control device, not in the drive device. In cyclic synchronous manner, it provides a commutation angle and a target torque to the drive device, which performs current control and space vector modulation. Optionally, an additive torque value can be provided by the control system in order to allow two instances to set up the torque. Measured by sensors, the drive device could provide actual values for position or may provide velocity and torque to the control device.

This mode can be used for example

- to find the commutation angle during commissioning
- to check the function (increments, zero signal) and direction of the sensor
- Use of external sensor interface to calculate commutation angle (in that case there might be no internal feedback to Torque control)

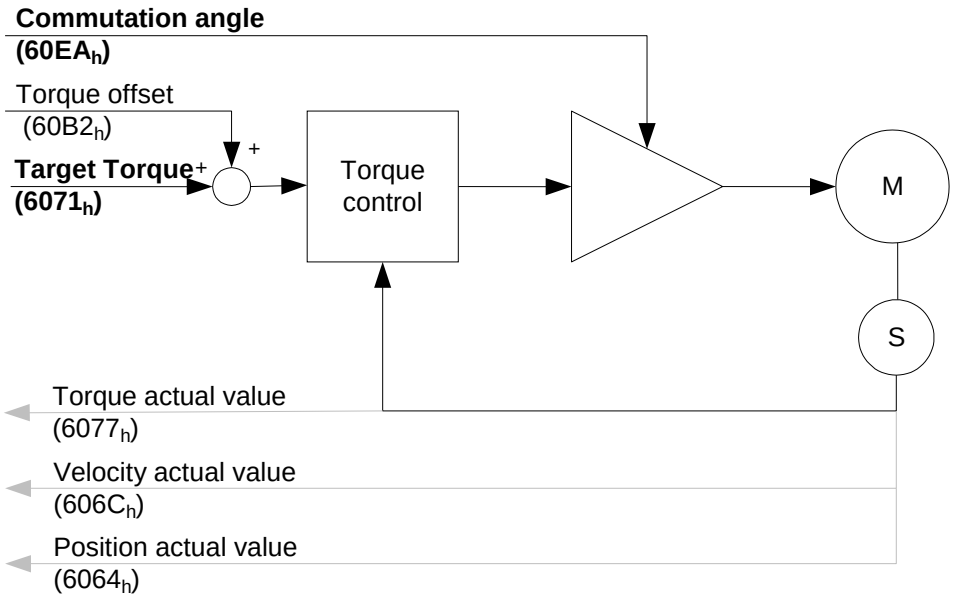


Figure 12: Cyclic synchronous torque mode with commutation angle overview

6.4.2 General definitions

The factors necessary for scaling have a linear relationship and therefore they are described in the factor group. The polarity is described in the factor group as well.

6.4.3 Functional description

Figure 13 shows the inputs and outputs of the torque control function with commutation angle. The inputs (from the control function point of view) are the commutation angle and the target torque and optionally a torque offset (to be added to the target torque to allow two instances to set up the torque).

The drive device can have features for limitation of motor speed. The torque can be limited as well.

The interpolation time period defines the time period between two updates of the target velocity and/or additive velocity and shall be used for intercycle interpolation.

The torque actual value can be used as output to the control device.

The following (bold) objects are used for *cstca* (Figure 13).

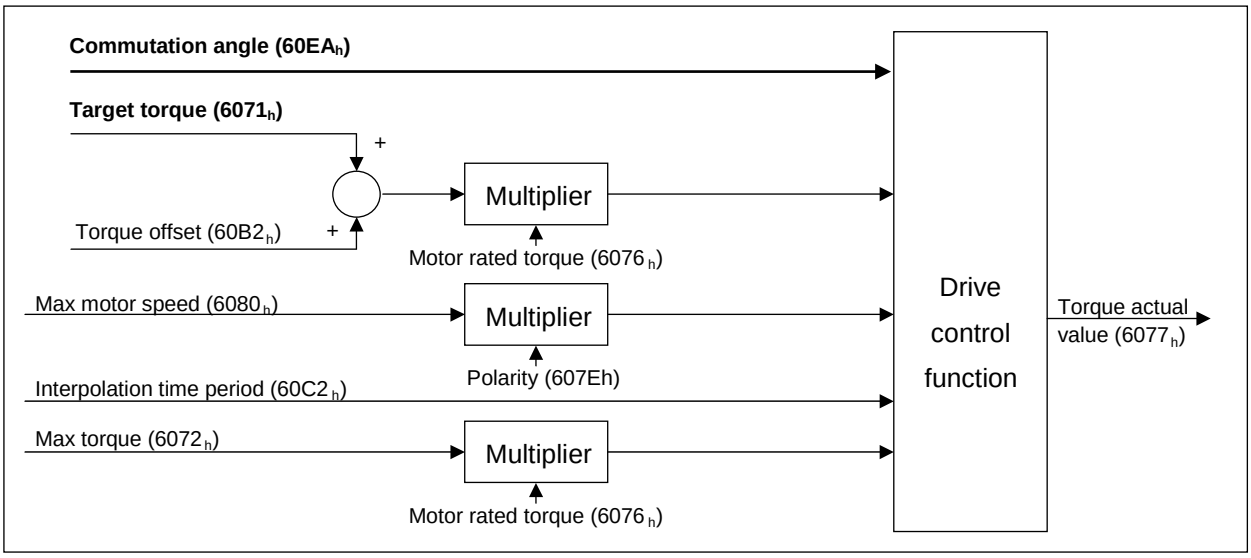


Figure 13: Cyclic synchronous torque with commutation angle control function

Table 10: cstca mode – Object list

Index	Name	Category
0x6071	**Target Torque**	**M**
0x60EA	**Commutation angle**	**M**
0x6077	Torque actual value	R
0x6064	Position actual value	R

The operation mode specific Bits (bit 4…6, bit 9) and the Halt bit (bit 8) in the Controlword shall be ignored by the drive.

In the *cstca* mode the bit 8 shall be ignored because the halt function is controlled by the control device.

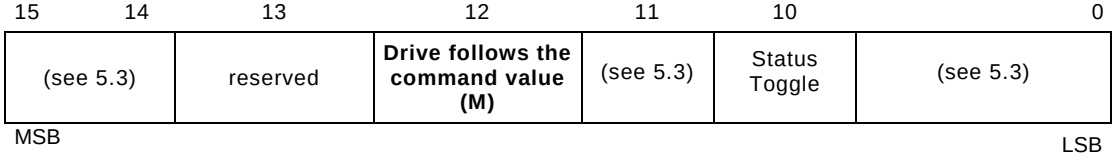


Figure 14: Statusword for *cstca* mode

In the statusword Bit 12 is mandatory.

In *cstca* mode Bit 10 is used as *Status Toggle* information to indicate if the device provides updated input data. The bit shall be toggled with every update of the input process data. If object 0x60D9 is supported, the Status Toggle function can be enabled or disabled.

The Bit 12 *Drive follows the command value* shall be zero if the drive **does not** follow the target value (position, velocity or torque) because of local reasons (internal set-point settings). E.g. if a local Input is configured to a halt function or if a safety function prevents the drive in Operational to follow the target setpoint. The control device shall evaluate the bit. The Bit 12 shall be set if the drive is in state *Operation enabled* and follows the target and set-point values of the control device. In all other cases it shall be zero. If the bit is not supported it shall be fix set to 1 in the statusword.

NOTE: If Bit 12 is not supported and is not set to 1, the control device will not run the drive, because it expects that the drive does not follow the command.

6.4.4 Object $60EA_h$: Commutation angle

This object shall indicate the electrical commutation angle for the space vector modulation. The value shall be given in $360°/2^{16}$, whereby the electrical angle is used. Table 11 specifies the object description, and Table 12 specifies the entry description.

Table 11: Object description

Attribute	Value
Index	$60EA_h$
Name	Commutation angle
Object Code	Variable
Data Type	Unsigned16
Category	Mandatory if *cstca* is supported

Table 12: Entry description

Attribute	Value
Sub-Index	00_h
Access	rw
PDO Mapping	optional
Value Range	Unsigned16
Default Value	0x0000

6.5 Object 6502_h: Supported drive modes

This object shall provide information on the supported drive modes. Figure 15 specifies the value definition, Table 13 specifies the object description, and Table 14 specifies the entry description.

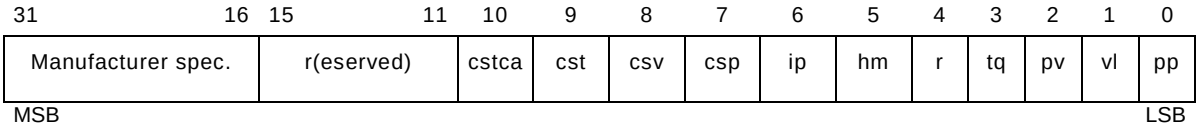


Figure 15: Value definition

Table 13: Object description

Attribute	Value
Index	6502_h
Name	Supported drive modes
Object Code	Variable
Data Type	Unsigned32
Category	Mandatory

Table 14: Entry description

Attribute	Value
Sub-Index	00_h
Access	ro
PDO Mapping	possible
Value Range	see Figure 15
Default Value	No

6.6 Object $60D9_h$: Supported functions

This object shall provide information on the supported functions in the device.

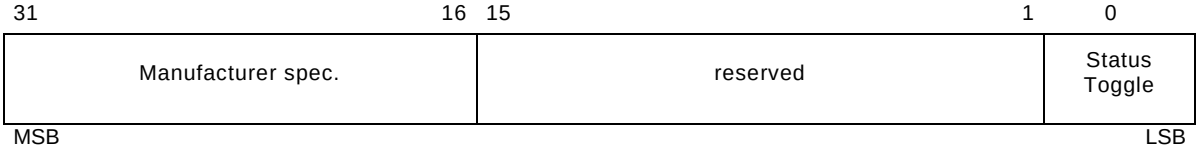


Figure 16: Value definition

1 = Function supported, 0 = Function not supported
Status Toggle: Status Toggle bit in csp, csv, cst and cstca mode supported

Figure 16 specifies the value definition, Figure 15 specifies the object description, and Figure 16 specifies the entry description.

Table 15: Object description

Attribute	Value
Index	$60D9_h$
Name	Supported functions
Object Code	Variable
Data Type	Unsigned32
Category	Optional

Table 16: Entry description

Attribute	Value
Sub-Index	00_h
Access	ro
PDO Mapping	no
Value Range	see Figure 16
Default Value	manufacturer specific

6.7 Object $60DA_h$: Function settings

This object shall enable/disable supported functions in the device.

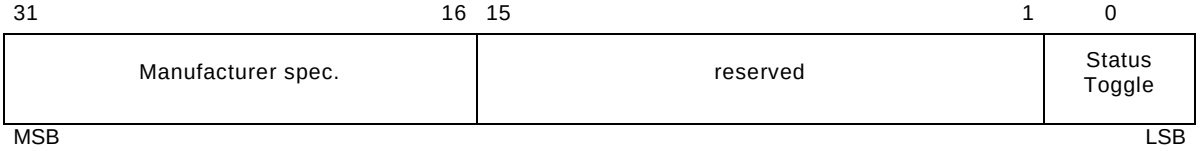


Figure 17: Value definition

If the device supports Status Toggle bit in csp, csv, cst and cstca mode:
Status Toggle bit:
1 = Status Toggle enabled, 0 = Status Toggle disabled

Figure 17 specifies the value definition, Table 17 specifies the object description, and Table 18 specifies the entry description.

Table 17: Object description

Attribute	Value
Index	$60DA_h$
Name	Function settings
Object Code	Variable
Data Type	Unsigned32
Category	Optional

Table 18: Entry description

Attribute	Value
Sub-Index	00_h
Access	rw
PDO Mapping	no
Value Range	see Figure 17
Default Value	manufacturer specific

6.8 Switching between Operation modes

The dynamic change of the operation mode in state operation is defined in this chapter. The Operation mode can be switched by writing the Object 0x6060 Modes of operation. This can be done via PDO communication or via SDO communication

6.8.1 Static setting of operation mode

Cyclic PDO communication and acyclic SDO communication are often implemented in different tasks, so there is no synchronization between an object access (e.g. SDO write-access to object “mode of operation”) and the cyclic process data processing in the drives. If the control device selects another operation mode via SDO, there might be the critical behaviour, that the update of the “new selected” process data objects is too late, so the drive works with older or undefined process data values (e.g. wrong target position) until a new PDO is received.

The selection of the operation mode via SDO (or local device configuration tool) can be done in state “pre-op”.

For the device parameterization the Index 0x6060 Modes of operation shall be part of the Start-up parameter. The list of possible operation modes can be described in the device description file (ESI) in form of several devices or in form of different modules with different start-up parameters. The user can select the operation mode in the configuration tool.

EXAMPLE:

A Drive supports the csp mode and the csv mode. In the ESI there are two modules defined:

Module A for csp mode: This module contains the PDO mapping for the csp mode (RxPDO: Controlword, Target Position; TxPDO: Statusword, Position actual Value). It contains the start-up parameter 0x06060 = 8 (csp)

Module B for csv mode: This module contains the PDO mapping for csv mode (RxPDO: Controlword, Target Velocity; TxPDO: Statusword, Velocity actual Value). It contains the start-up parameter 0x6060 = 9 (csv)

6.8.2 Dynamic change of operation mode in state operation

For a dynamic change of the operation mode in state operation, it is recommended to select the mode of operation via cyclic PDO communication.

The object 0x6060 Modes of operation shall be mapped in the RxPDO and the object 0x6061 Modes of operation display in the TxPDO. Additional the mode specific objects that are required for the dynamically selectable modes of operation shall be mapped in the Rx/TxPDO, too.

The control device has the responsibility to update all operation mode specific process data objects together with the selection of the operation mode at the same time. In this case there is no critical runtime behavior between the operation mode selection and the content of the process data objects.

If the control device selects a new operation mode, it depends on the drive implementation, if the drive switches during one process data cycle to the new operation mode. Mostly, the drives will answer with the process data information of the “old” operation mode, until the internal switching to the new operation mode is done. For the intermediate time, the control device shall transmit valid data in the PDO for the old and the new operation mode.

The mode specific bits in the Controlword shall always fit to the "Mode of operation" in the RxPDO, even in the intermediate time.

The mode specific bits in the Statusword shall always fit to the "Modes of operation display" in the TxPDO, even in the intermediate time.

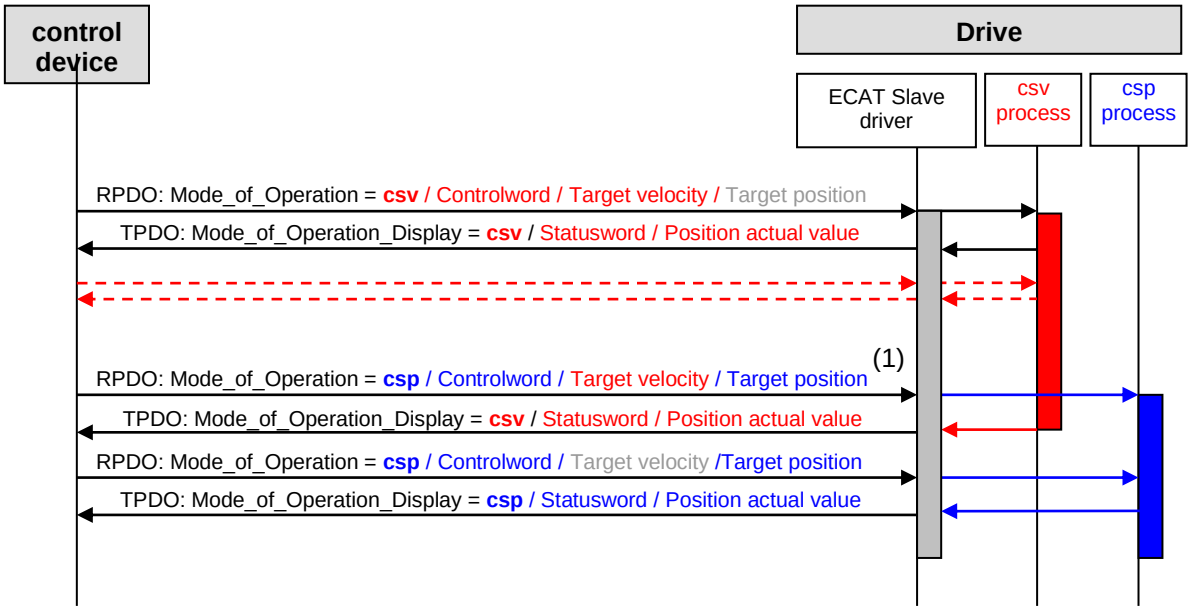


Figure 18: Dynamic change of operation mode

7 Function Groups

7.1 General

To describe the behavior of a servo drive, different function groups (FG) are defined in this guideline. The drive does not have to support all of these function groups, but if a group is supported it has to fulfill the specified objects and features.

The mandatory objects and features in the FGs are necessary for functionality and quality of the specified function.

7.2 Function Group "Torque Limiting"

The Function Group "Torque Limiting" defines

Table 19: FG Torque Limiting – Object list

Index	Name	Category	Remark
0x6072	Max torque	**M**	Mandatory if FG Torque Limiting is supported
0x60E0[4]	Positive torque limit value	**C**	Mandatory if FG Torque Limiting is supported
0x60E1[4]	Negative torque limit value	**C**	Mandatory if FG Torque Limiting is supported

The limiting of the torque will be stated in the bit 11 "internal limit active" in the statusword.

The Figure 19 shows the usage of the three limiting values

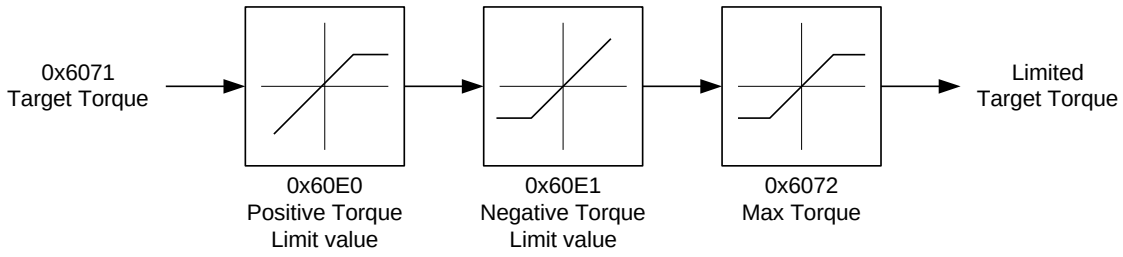


Figure 19: Usage of torque limiting objects

The lowest of the limiting values is effective.

7.2.1 Object $60E0_h$: Positive torque limit value

This object shall indicate the configured maximum positive torque in the motor. The value shall be given per thousand of rated torque. Table 20 specifies the object description, and Table 21 specifies the entry description.

Table 20: Object description object 0x60E0

Attribute	Value
Index	$60E0_h$
Name	Positive Torque Limit
Object Code	Variable
Data Type	Unsigned16
Category	Mandatory if FG "Torque Limiting" is supported

[4] These Index-numbers are new. This is agreed by CiA e.V. Working Group

Table 21: Entry description object 0x60E0

Attribute	Value
Sub-Index	00_h
Access	rw
PDO Mapping	possible
Value Range	Unsigned16
Default Value	Manufacturer-specific

Positive torque takes effect in the case of:

- motive operation is positive velocity
- regenerative operation is negative velocity

7.2.2 Object $60E1_h$: Negative torque limit value

This object shall indicate the configured maximum negative torque in the motor. The value shall be given per thousand of rated torque. Table 22specifies the object description, and Table 23 specifies the entry description.

Table 22: Object description object 0x60E1

Attribute	Value
Index	$60E1_h$
Name	Negative Torque Limit
Object Code	Variable
Data Type	Unsigned16
Category	Mandatory if FG "Torque Limiting" is supported

Table 23: Entry description object 0x60E1

Attribute	Value
Sub-Index	00_h
Access	rw
PDO Mapping	possible
Value Range	Unsigned16
Default Value	Manufacturer-specific

Negative torque takes effect in the case of:

- motive operation is negative velocity
- regenerative operation is positive velocity

7.3 Homing

The homing is generally leaded by the control device. Therefore all homing methods are optional.

Table 24: Homing methods

Method	Description	Category
1	Homing on negative limit switch and index pulse	O
2	Homing on positive limit switch and index pulse	O
3, 4	Homing on positive home switch and index pulse	O
5, 6	Homing on negative home switch and index pulse	O
7 …14	Homing on home switch and index pulse	O
15, 16	Reserved	O
17 …30	Homing without index pulse	O
31, 32	Reserved	O
33, 34	Homing on index pulse	O
35	Homing on current position – obsolete	--
~~36~~	~~Homing with touch-probe~~	~~R~~
37	Homing on current position	O

7.3.1 Homing Method 35: Homing on current position (obsolete) [5]

In this method, the current position shall be taken to be the home position. This method does not require the drive device to be in operational enabled state.

NOTE This method is obsolete because of compatibility reasons.

7.3.2 Homing Method 36: Homing with touch-probe – reserved for compatibility reasons[5]

This method was **not** used as a Homing Mode.

The control device leads the drive, e.g. in csp, csv or cst operation mode. For a high precise accuracy, the control device activates the touch probe inputs of the drive and use the touch probe information for detection of the homing position.

7.3.3 Homing Method 37: Homing on current position

In this method, the current position shall be taken to be the home position. This method does not require the drive device to be in operational enabled state.

At the Home position (i.e. after the homing process) the position actual value (0x6064) is calculated as follows:

Position actual value (0x6064) = Home Offset (0x607C)

EXAMPLE: Applications with no absolute sensor information.

EXAMPLE: The control device can set the operation mode csp, csv or cst and runs the drive to the home position. At the home position the control device switches the operation mode to Homing mode, Method 37. The drive takes the current position as the home position. Then the control device switches back to operation mode csp, csv or cst.

7.3.4 Calculation of position actual value by homing process

The current position is the unprocessed position sensor information (incremental, single or multi turn sensor) before homing.

For a single turn sensor the single turn information represents the position sensor information. For a multi turn sensor the multi turn information represents the position sensor information. For an incremental sensor (e.g. TTL encoder) the position sensor information is zero after initialization.

The Home Offset is configured with the machine specific value during commissioning.

During homing, the machine home position is found and once the homing is completed, the zero position is offset from the home position by adding the home offset to the home position.

[5] To define this method as obsolete/reserved was decided by CiA SIG. Use Homing Method 37 instead.

Zero position = home position + home offset

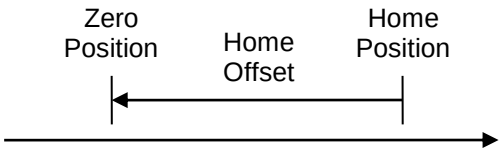


Figure 20: Home Offset definition[6]

The configured Home Offset (0x607C) is always used for the calculation of the Position actual value (0x6064) during Homing process!

The position actual value (0x6064) is the current software position in the drive. It is based on the unprocessed position sensor information and the Home Offset (after Homing process).

NOTE: The activation of a new value of the object home offset is manufacturer-specific. It is recommended to apply the new value only while the drive is in homing mode.

At the Home position (i.e. after the homing process) the position actual value (0x6064) is calculated according to the used Homing method.

7.3.5 Homing object list

Table 25: Homing – Object list

Index	Name	Category	Remark
0x607C	Home Offset	R	Recommended if Homing is supported
0x6098	Homing method	**M**	Mandatory if Homing is supported
0x6099	Homing speed	O	
0x609A	Homing acceleration	O	
0x60E3[7]	Supported homing methods	R	Recommended if Homing is supported

In the controlword the Bit 4 is used.

15…9	9	8…7	6	5	4	3…0
(see 5.2)	reserved	(see 5.2)	reserved	**Homing operation start (M)**		(see 5.2)

MSB LSB

7.3.6 Object $60E3_h$: Supported Homing Methods

This object defines the supported homing methods of the drive. Table 26 specifies the object description, and Table 27 specifies the entry description.

Table 26: Object description object 0x60E3

Attribute	Value
Index	$60E3_h$
Name	Supported Homing Methods
Object Code	ARRAY
Data Type	Integer16
Category	Conditional, Recommended if FG Homing is supported

[6] This is opposite to figure 30 of IEC 61800-7. This is agreed by CiA e.V. Working Group.
[7] This Index-number is new. This is agreed by CiA e.V. Working Group

Table 27: Entry description object 0x60E3

Attribute	Value
Sub-Index	00_h
Description	Highest sub-index supported
Entry category	Mandatory
Access	ro
PDO Mapping	no
Value Range	1 to 254
Default Value	Manufacturer-specific
Sub-Index	01_h
Description	1^{st} supported homing method
Entry category	Mandatory
Access	ro
PDO Mapping	no
Value Range	see Figure 21
Default Value	Manufacturer-specific
Sub-Index	02_h
Description	2^{nd} supported homing method
Entry category	Optional
Access	ro
PDO Mapping	no
Value Range	see Figure 21
Default Value	Manufacturer-specific
	to
Sub-Index	FE_h
Description	254^{th} supported homing method
Entry category	Optional
Access	ro
PDO Mapping	no
Value Range	see Figure 21
Default Value	Manufacturer-specific

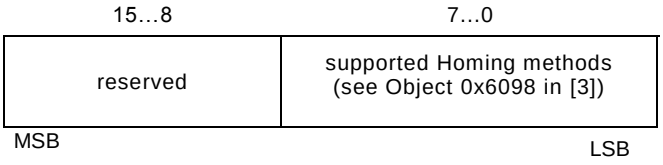


Figure 21: Object 0x60E3 Supported Homing Methods – Value definition

7.4 Function Group "Touch Probe"

For the Function Group "Touch Probe" at minimum one local digital input at the servo drive shall have a touch probe capability. The following objects are mandatory.

Table 28: FG Touch probe – Object list

Index	Name	Category
0x60B8	**Touch probe function**	**M**
0x60B9	**Touch probe status**	**M**
0x60BA	**Touch probe position 1 positive value**	**M**
0x60BB	**Touch probe position 1 negative value**	**M**
0x60D0[8]	Touch probe source	R
0x60D1	Touch probe time stamp 1 positive value	O
0x60D2[8]	Touch probe time stamp 1 negative value	O
0x60D5[8]	Touch probe 1 positive edge counter	O
0x60D6[8]	Touch probe 1 negative edge counter	O

If a second Touch Probe input is supported the following objects are used

Table 29: Touch Probe objects for optional Input 2

Index	Name	Category
0x60BC	Touch probe position 2 positive value	O
0x60BD	Touch probe position 2 negative value	O
0x60D3[8]	Touch probe time stamp 2 positive value	O
0x60D4[8]	Touch probe time stamp 2 negative value	O
0x60D7[8]	Touch probe 2 positive edge counter	O
0x60D8[8]	Touch probe 2 negative edge counter	O

The source of the touch probe inputs can differ. E.g. it could be a digital input or a signal from the encoder or something else. This is defined manufacturer specific.

Optional more than two touch probe inputs can be implemented in the drive. The manufacturer specific objects used for these additional inputs shall correspond to the standard touch probe objects.

[8] This Index-number is new. This is agreed by CiA e.V. Working Group

7.4.1 Object 60B8 $_h$: Touch probe function

This object shall indicate the configured function of the touch probe. Table 30 specifies the value definition.

The definition of bit 3 is extended according to the IEC 61800-7 to configure additional touch probe sources.

Table 30: Value definition object 0x60B8

Bit	Value	Definition
0	0	Switch off touch probe 1
	1	Enable touch probe 1
1	0	Trigger first event
	1	continuous
3,2[9]	00	Trigger with touch probe 1 input,
	01	Trigger with zero impulse signal or position encoder,
	10	Touch probe source defined by object 0x60D0.1
	11	reserved
4	0	Switch off sampling at positive edge of touch probe 1
	1	Enable sampling at positive edge of touch probe 1
5	0	Switch off sampling at negative edge of touch probe 1
	1	Enable sampling at negative edge of touch probe 1
6, 7	-	User defined (e.g. for testing)
8	0	Switch off touch probe 2
	1	Enable touch probe 2
9	0	Trigger first event
	1	continuous
11,10[9]	00	Trigger with touch probe 2 input
	01	Trigger with zero impulse signal or position encoder
	10	Touch probe source defined by object 0x60D0.2
	11	reserved
12	0	Switch off sampling at positive edge of touch probe 2
	1	Enable sampling at positive edge of touch probe 2
13	0	Switch off sampling at negative edge of touch probe 2
	1	Enable sampling at negative edge of touch probe 2
14, 15	-	User defined (e.g. for testing)

7.4.2 Object 60D0$_h$: Touch probe source

This object defines the source of the touch probe functions. Table 31 lists the value definition of the object.

Table 31: Value definition

Value	Definition
-32 768 … -1	Manufacturer-specific
0	reserved
+1	Digital Input 1 (Touch probe input)
+2	Digital Input 2 (Touch probe input)

[9] This is agreed by CiA e.V. Working Group

Value	Definition
+3	Digital Input 3 (Touch probe input)
+4	Digital Input 4 (Touch probe input)
+5	Hardware Zero impulse signal of position encoder
+6	Software Zero impulse signal of position encoder
+7 … +32 767	reserved

Table 32 specifies the object description, and Table 33 specifies the entry description.

Table 32: Object description

Attribute	Value
Index	$60D0_h$
Name	Touch probe source
Object Code	ARRAY
Data Type	Integer16
Category	Conditional, Recommended if FG Touch probe is supported

Table 33: Entry description

Attribute	Value
Sub-Index	00_h
Description	Highest sub-index supported
Entry category	Mandatory
Access	ro
PDO Mapping	no
Value Range	1 to 254
Default Value	Manufacturer-specific
Sub-Index	01_h
Description	Touch probe 1 source
Entry category	Mandatory
Access	ro
PDO Mapping	no
Value Range	see Table 31
Default Value	Manufacturer-specific
Sub-Index	02_h
Description	Touch probe 2 source
Entry category	Optional
Access	ro
PDO Mapping	no
Value Range	see Table 31
Default Value	Manufacturer-specific
	to
Sub-Index	FE_h
Description	Touch probe 254 source

Attribute	Value
Entry category	Optional
Access	ro
PDO Mapping	no
Value Range	see Table 31
Default Value	Manufacturer-specific

7.4.3 Object 60B9$_h$: Touch probe status

This object shall provide the status of the touch probe. Table 34 specifies the value definition[10].

Table 34: Value definition object 0x60B9

Bit	Value	Definition
0	0	Touch probe 1 is switched off
	1	Touch probe 1 is enabled
1	0	Touch probe 1 no positive edge value stored
	1	Touch probe 1 positive edge position stored
2	0	Touch probe 1 no negative edge value stored
	1	Touch probe 1 negative edge position stored
3 – 5	0	Reserved
6, 7	-	User defined (e.g. for testing)
8	0	Touch probe 2 is switched off
	1	Touch probe 2 is enabled
9	0	Touch probe 2 no positive edge value stored
	1	Touch probe 2 positive edge position stored
10	0	Touch probe 2 no negative edge value stored
	1	Touch probe 2 negative edge position stored
11 – 13	0	Reserved
14, 15	-	User defined (e.g. for testing)

The Touch probe status information shall be evaluated first by the control device, to check if the stored Touch probe values (0x60BA ... 0x60BD) are valid.

NOTE: Bit 1 and bit 2 are set to 0_b when touch probe 1 is switched off (object $60B8_h$ bit 0 is 0_b). Bit 9 and 10 are set to 0_b when touch probe 2 is switched off (object $60B8_h$ bit 8 is 0_b).

Figure 22 shows a timing diagram for a touch probe configuration and the corresponding behaviour.

[10] The value definition is added in this guideline since there is an error in the IEC 61800-7-200 Ed.1.0 definition. This is agreed by CiA e.V. Working Group and will be fixed in the next release of the IEC specification.

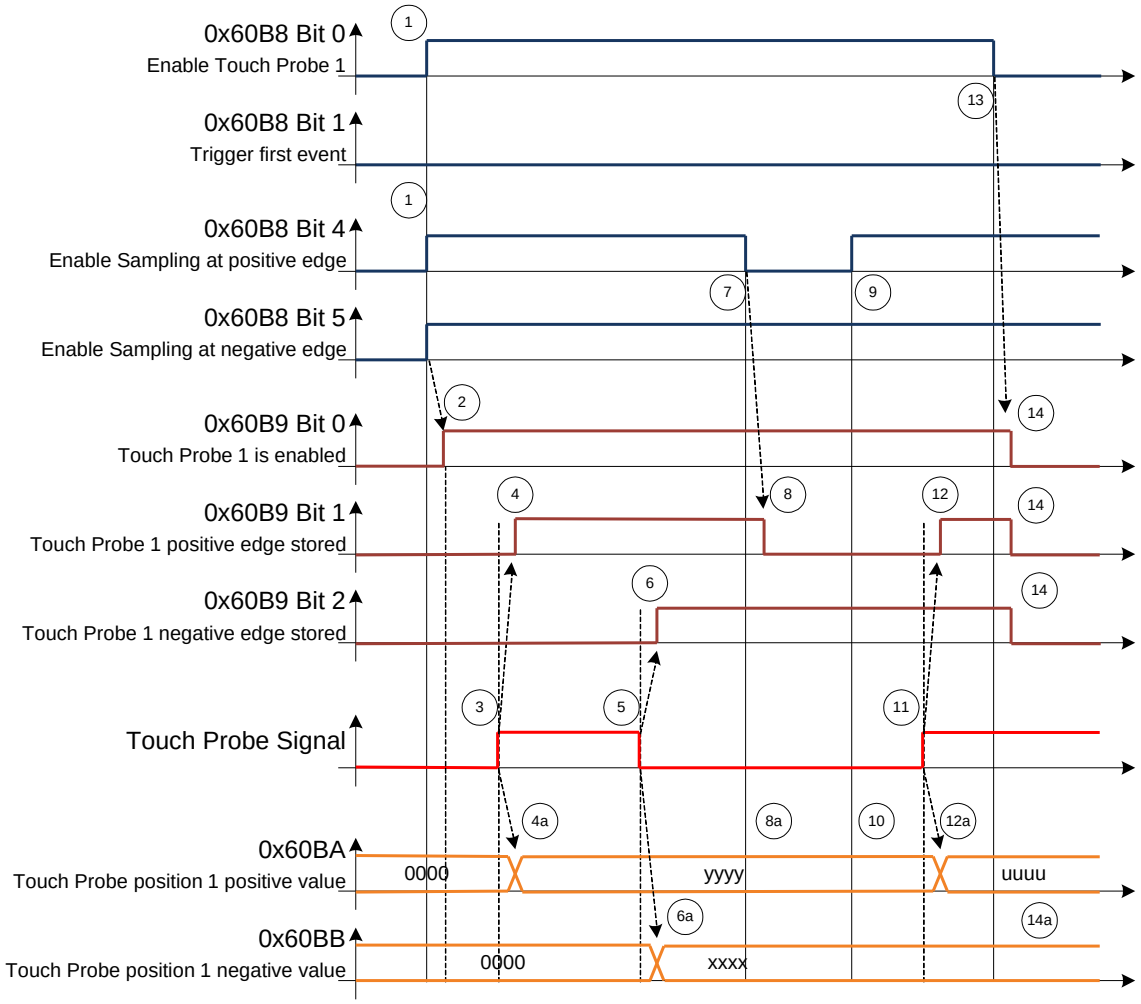


Figure 22: Timing diagram for Touch probe example

Table 35: Touch Probe Timing example

Number	Touch probe behaviour	
(1)	0x60B8, Bit 0 = 1 0x60B8 Bit 1, 4, 5	Enable Touch Probe 1, Configure and Enable Touch Probe 1 positive and negative edge
(2)	→ 0x60B9 Bit 0 = 1	Status “Touch Probe 1 enabled” is set
(3)	External touch probe signal has positive edge	
(4)	→ 0x60B9 Bit 1 = 1	Status “Touch Probe 1 positve edge stored” is set
(4a)	→ 0x60BA	Touch probe position 1 positive value is stored
(5)	External touch probe signal has negative edge	
(6)	→ 0x60B9 Bit 2 = 1	Status “Touch Probe 1 negative edge stored” is set
(6a)	→ 0x60BB	Touch probe position 1 negative value is stored
(7)	0x60B8:4	Sample positive edge is disabled
(8)	→ 0x60B9 Bit 0 = 0	Status “Touch Probe 1 positve edge stored” is reset
(8a)	→ 0x60BA	Touch probe position 1 positive value is not changed
(9)	0x60B8 Bit 4 = 1	Sample positive edge is enabled
(10)	→ 0x60BA	Touch probe position 1 positive value is not changed
(11)	External touch probe signal has positive edge	
(12)	→ 0x60B9 Bit 1 = 1	Status “Touch Probe 1 positve edge stored” is set
(12a)	→ 0x60BA	Touch probe position 1 positive value is stored
(13)	0x60B8 Bit 0 = 0	Touch Probe 1 is disabled
(14)	→ 0x60B9 Bit 0, 1, 2 = 0	Status Bits are reset
(14a)	→ 0x60BA, 0x60BB	Touch probe position 1 positive/negative value are not changed

7.4.4 Touch probe time stamp latch

In addition to the position (0x60BA, 0x60BB, 0x60BC, 0x60BD) the current time stamp can be latched by the device.

The objects 0x60D1, 0x60D2, 0x60D3, 0x60D4 should capture the corresponding time stamp for Touch probe 1 and 2.

NOTE: If the device supports Distributed Clocks (DC) and the DC is activated, the lower 32 Bits of the DC Unit shall be used as time stamp values

The control device can use several process values with the same time stamp to calculate new set points.

7.4.4.1 Object $60D1_h$: Touch probe time stamp 1 positive value

This object shall provide the time stamp value of the touch probe 1 at positive edge. The value shall be given in nanoseconds. Table 36 specifies the object description, and Table 37 specifies the entry description.

Table 36: Object description

Attribute	Value
Index	$60D1_h$
Name	Touch probe time stamp 1 positive value
Object Code	VAR
Data Type	Unsigned32
Category	Optional

Table 37: Entry description

Attribute	Value
Sub-Index	00_h
Access	ro
PDO Mapping	TxPDO
Value Range	Unsigned 32
Default Value	no

7.4.4.2 Object $60D2_h$: Touch probe time stamp 1 negative value

This object shall provide the time stamp value of the touch probe 1 at negative edge. The value shall be given in nanoseconds. Table 38 specifies the object description, and Table 39 specifies the entry description.

Table 38: Object description

Attribute	Value
Index	$60D2_h$
Name	Touch probe time stamp 1 negative value
Object Code	VAR
Data Type	Unsigned32
Category	Optional

Table 39: Entry description

Attribute	Value
Sub-Index	00_h
Access	ro
PDO Mapping	TxPDO
Value Range	Unsigned 32

Attribute	Value
Default Value	no

7.4.4.3 Object 60D3$_h$: Touch probe time stamp 2 positive value

This object shall provide the time stamp value of the touch probe 2 at positive edge. The value shall be given nanoseconds. Table 40 specifies the object description, and Table 41 specifies the entry description.

Table 40: Object description

Attribute	Value
Index	60D3$_h$
Name	Touch probe time stamp 2 positive value
Object Code	VAR
Data Type	Unsigned32
Category	Optional

Table 41: Entry description

Attribute	Value
Sub-Index	00$_h$
Access	ro
PDO Mapping	TxPDO
Value Range	Unsigned 32
Default Value	no

7.4.4.4 Object 60D4$_h$: Touch probe time stamp 2 negative value

This object shall provide the time stamp value of the touch probe 2 at negative edge. The value shall be given nanoseconds. Table 42 specifies the object description, and Table 43 specifies the entry description.

Table 42: Object description

Attribute	Value
Index	60D4$_h$
Name	Touch probe time stamp 2 negative value
Object Code	VAR
Data Type	Unsigned32
Category	Optional

Table 43: Entry description

Attribute	Value
Sub-Index	00$_h$
Access	ro
PDO Mapping	TxPDO
Value Range	Unsigned 32
Default Value	no

7.4.5 Touch probe edge counter for continuous mode

For continuous touch probe mode (0x60B8 Bit 1 = 1 or 0x60B8 Bit 9 = 1) a counter per touch probe channel is incremented with each touch probe event. The control unit can check how many touch probe events happens between the control cycles.

Per touch probe and per edge a counter object is defined.

0x60D5 Touch probe 1 positive edge counter
0x60D6 Touch probe 1 negative edge counter
0x60D7 Touch probe 2 positive edge counter
0x60D8 Touch probe 2 negative edge counter

NOTE The counters are continuous counters. Counter overrun has to be taken into account

The according Touch probe counter is only valid if Touch probe input is enabled (0x60B8: Bit 0 / Bit 8). The value shall be interpreted depending on the mode:

- Single event measuring
  Only Bit 0 is valid,
- Continuous measuring
  This is a 16 Bit value with overflow

7.4.5.1 Object $60D5_h$: Touch probe 1 positive edge counter

This object shall provide a continuous counter that is incremented with each positive edge at touch probe 1. The counter is only valid if Touch probe input is enabled (0x60B8: Bit 0 = 1). Table 44 specifies the object description, and Table 45 specifies the entry description.

Table 44: Object description

Attribute	Value
Index	$60D5_h$
Name	Touch probe 1 positive edge counter
Object Code	VAR
Data Type	Unsigned16
Category	Optional

Table 45: Entry description

Attribute	Value
Sub-Index	00_h
Access	ro
PDO Mapping	TxPDO
Value Range	Unsigned 16
Default Value	no

7.4.5.2 Object $60D6_h$: Touch probe 1 negative edge counter

This object shall provide a continuous counter that is incremented with each negative edge at touch probe 1. The counter is only valid if Touch probe input is enabled (0x60B8: Bit 0 = 1). Table 67 specifies the object description, and Table 68 specifies the entry description.

Table 46: Object description

Attribute	Value
Index	$60D6_h$
Name	Touch probe 1 negative edge counter
Object Code	VAR
Data Type	Unsigned16

Attribute	Value
Category	Optional

Table 47: Entry description

Attribute	Value
Sub-Index	00_h
Access	ro
PDO Mapping	TxPDO
Value Range	Unsigned 16
Default Value	no

7.4.5.3 Object $60D7_h$: Touch probe 2 positive edge counter

This object shall provide a continuous counter that is incremented with each positive edge at touch probe 2. The counter is only valid if Touch probe input is enabled (0x60B8: Bit 8 = 1). Table 48 specifies the object description, and Table 49 specifies the entry description.

Table 48: Object description

Attribute	Value
Index	$60D7_h$
Name	Touch probe 2 positive edge counter
Object Code	VAR
Data Type	Unsigned16
Category	Optional

Table 49: Entry description

Attribute	Value
Sub-Index	00_h
Access	ro
PDO Mapping	TxPDO
Value Range	Unsigned 16
Default Value	no

7.4.5.4 Object $60D8_h$: Touch probe 2 negative edge counter

This object shall provide a continuous counter that is incremented with each negative edge at touch probe 2. The counter is only valid if Touch probe input is enabled (0x60B8: Bit 8 = 1). Table 50 specifies the object description, and Table 51 specifies the entry description.

Table 50: Object description

Attribute	Value
Index	$60D8_h$
Name	Touch probe 2 negative edge counter
Object Code	VAR
Data Type	Unsigned16
Category	Optional

Table 51: Entry description

Attribute	Value
Sub-Index	00_h

Attribute	Value
Access	ro
PDO Mapping	TxPDO
Value Range	Unsigned 16
Default Value	no

7.4.6 Application Example: Controller based “homing” with touch probe

Figure 23 shows an example for the usage of the touch probe function.

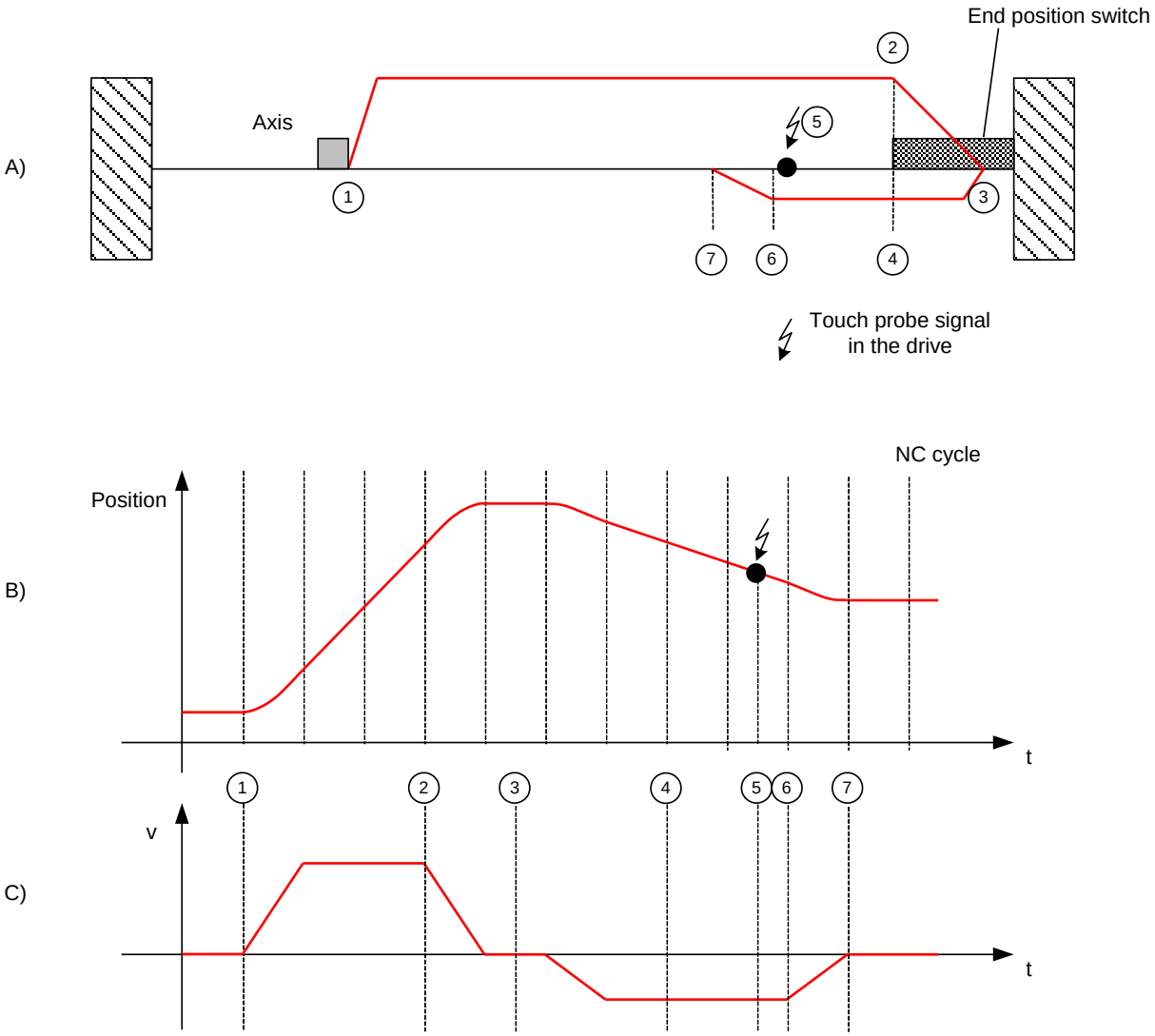


Figure 23: Control device based homing with touch probe

Part A) shows the way of the Axis within the machine. The red line denotes the velocity. In part B) the timing diagram of the position and in the part C) the timing diagram of the velocity is shown.

Table 52: Steps for control device based homing

Number	Controller action	Drive action
(1)	Accelerate the axis	
(2)	The end position switch is reached and signaled to the control device. The control device decelerates the axis to zero	

Number	Controller action	Drive action
(3)	The axis is stopped within the end position switch. The direction of the axis is changed.	
(4)	The end position switch is left. The control device enables the Touch probe function in the slave (0x60B8.0 = 1 for touch probe 1 or 0x60B8.8 = 1 for touch probe 2)	Touch probe enabled
(5)	Read touch probe status (0x60B9) continuously	The touch probe event occurs. The slave captures the current position.
(6)	With the next cycle the control device decelerates the axis.	
(7)	The axis is stopped. The control device calculates the reference position with the captured position from the slave and the current position of the axis.	

The touch probe event is sampled locally in the drive. So it is independent of the controller (NC) cycle time and can be captured more precisely.

The detection of the end position switch doesn't need to be very accurate. It is used for changing the direction and to activate the touch probe function in the drive. A digital Input of the drive (0x60FD) which is mapped to the PDOs or a standard input of the control device can be used.

The touch probe position (0x60BA or 0x60BB or 0x60BC or 0x60BD) should be mapped to the PDO (see clause 10).

8 Factor Group

The Factor Group shall be used according to [3].

If the Factor Group objects are not supported by the drive the default values given in Table 53 shall be used:

Table 53: Default values for Units

Parameter	Default Unit
Position Unit	inc
Velocity Unit	inc/s
Acceleration Unit	inc/s^2
Pos Encoder resolution	2^{16} inc/rev
Torque Unit	as given in 0x6071: 0,1%

For following objects/entries the value 0 equals 2^{32}.

- 0x608F:SI1 (Position Encoder resolution – encoder increments),
- 0x6090:SI1 (Velocity Encoder resolution – encoder increments per seconds),
- 0x60E6:SI1-SI254 (Additional Position Encoder resolution – encoder increments)
- 0x60E7:SI1-SI254 (Additional Velocity Encoder resolution – encoder increments per seconds)

NOTE This is defined to allow full resolution of 2^{32} (up to now only 2^{32} - 1 was possible).

Support of additional sensor interfaces

A drive may support several sensor interfaces. The information coming from this/these additional sensors should be given in the objects listed in Table 54.

Table 54: Additional sensor information – Object list

Index	Name	Category	Remark
0x60E4[11]	Additional position actual value	O	According to 0x6064 *Position actual value*
0x60E5[11]	Additional velocity actual value	O	According to 0x606C *Velocity actual value*
0x60E6[11]	Additional position encoder resolution - encoder increments	O	According to 0x608F *Position encoder resolution*
0x60EB[11]	Additional position encoder resolution - motor revolutions	O	
0x60E7[11]	Additional velocity encoder resolution - Encoder increments per second	O	According to 0x6090 *Velocity encoder resolution*
0x60EC[11]	Additional velocity encoder resolution - Motor revolutions per second	O	
0x60E8[11]	Additional gear ratio - Motor revolutions	O	According to 0x6091 *Gear ratio*
0c60ED[11]	Additional gear ratio - Shaft revolutions	O	
0x60E9[11]	Additional feed constant - Feed	O	According to 0x6092 *Feed constant*
0c60EE[11]	Additional feed constant - Shaft revolutions	O	

[11] This Index-number is new. This is agreed by CiA e.V. Working Group

8.1.1 Object $60E4_h$: Additional position actual value

This object defines one or more additional position actual values. Table 55 specifies the object description, and Table 56 specifies the entry description.

Table 55: Object description object 0x60E4

Attribute	Value
Index	$60E4_h$
Name	Additional position actual value
Object Code	ARRAY
Data Type	Integer32
Category	Optional

Table 56: Entry description object 0x60E4

Attribute	Value
Sub-Index	00_h
Description	Highest sub-index supported
Entry category	Mandatory
Access	constant
PDO Mapping	no
Value Range	1 to 254
Default Value	Manufacturer-specific
Sub-Index	01_h
Description	1^{st} additional position actual value
Entry category	Mandatory
Access	ro
PDO Mapping	yes
Value Range	Integer32
Default Value	No
Sub-Index	02_h
Description	2^{nd} additional position actual value
Entry category	Optional
Access	ro
PDO Mapping	yes
Value Range	Integer32
Default Value	No
to	
Sub-Index	FE_h
Description	254^{th} additional position actual value
Entry category	Optional
Access	ro
PDO Mapping	yes
Value Range	Integer32
Default Value	No

8.1.2 Object $60E5_h$: Additional velocity actual value

This object defines one or more additional velocity actual values. Table 57 specifies the object description, and Table 58 specifies the entry description.

Table 57: Object description object 0x60E5

Attribute	Value
Index	$60E5_h$
Name	Additional velocity actual value
Object Code	ARRAY
Data Type	Integer32
Category	Optional

Table 58: Entry description object 0x60E5

Attribute	Value
Sub-Index	00_h
Description	Highest sub-index supported
Entry category	Mandatory
Access	constant
PDO Mapping	no
Value Range	1 to 254
Default Value	Manufacturer-specific
Sub-Index	01_h
Description	1^{st} additional velocity actual value
Entry category	Mandatory
Access	ro
PDO Mapping	yes
Value Range	Integer32
Default Value	No
Sub-Index	02_h
Description	2^{nd} additional velocity actual value
Entry category	Optional
Access	ro
PDO Mapping	yes
Value Range	Integer32
Default Value	No
to	
Sub-Index	FE_h
Description	254^{th} additional velocity actual value
Entry category	Optional
Access	ro
PDO Mapping	yes
Value Range	Integer32
Default Value	No

8.1.3 Object $60E6_h$: Additional position encoder resolution – encoder increments

This object defines one or more additional position encoder resolution - encoder increments.

Table 59 specifies the object description, and Table 60 specifies the entry description.

Table 59: Object description object 0x60E6

Attribute	Value
Index	$60E6_h$
Name	Additional position encoder resolution – encoder increments
Object Code	ARRAY
Data Type	Unsigned32
Category	Optional

Table 60: Entry description

Attribute	Value
Sub-Index	00_h
Description	Highest sub-index supported
Entry category	Mandatory
Access	constant
PDO Mapping	no
Value Range	1 to 254
Default Value	Manufacturer-specific
Sub-Index	01_h
Description	1st additional position encoder resolution – encoder increments
Entry category	Mandatory
Access	rw
PDO Mapping	yes
Value Range	Unsigned32 (0 equals 2^{32})
Default Value	No
Sub-Index	02_h
Description	2nd additional position encoder resolution – encoder increments
Entry category	Optional
Access	rw
PDO Mapping	yes
Value Range	Unsigned32 (0 equals 2^{32})
Default Value	No
	to
Sub-Index	FE_h
Description	254th additional position encoder resolution– encoder increments
Entry category	Optional
Access	rw
PDO Mapping	yes
Value Range	Unsigned32 (0 equals 2^{32})
Default Value	No

The calculation of the additional position encoder resolution is defined in combination with corresponding entry of object 0x60EB according to the definition given in object 0x608F *Position encoder resolution*.

8.1.4 Object $60EB_h$: Additional position encoder resolution – Motor revolutions

This object defines one or more additional position encoder resolution – Motor revolutions.

Table 61 specifies the object description, and Table 62 specifies the entry description.

Table 61: Object description object 0x60EB

Attribute	Value
Index	$60E6_h$
Name	Additional position encoder resolution – Motor revolutions
Object Code	ARRAY
Data Type	Unsigned32
Category	Optional

Table 62: Entry description

Attribute	Value
Sub-Index	00_h
Description	Highest sub-index supported
Entry category	Mandatory
Access	constant
PDO Mapping	no
Value Range	1 to 254
Default Value	Manufacturer-specific
Sub-Index	01_h
Description	1st additional position encoder resolution – Motor revolutions
Entry category	Mandatory
Access	rw
PDO Mapping	yes
Default Value	No
Sub-Index	02_h
Description	2nd additional position encoder resolution – Motor revolutions
Entry category	Optional
Access	rw
PDO Mapping	yes
Default Value	No
	to
Sub-Index	FE_h
Description	254th additional position encoder resolution– Motor revolutions
Entry category	Optional
Access	rw
PDO Mapping	yes
Default Value	No

The calculation of the additional position encoder resolution is defined in combination with corresponding entry of object 0x60E6 according to the definition given in object 0x608F *Position encoder resolution*.

8.1.5 Object $60E7_h$: Additional velocity encoder resolution - Encoder increments per second

This object defines one or more additional velocity encoder resolution - Encoder increments per second. Table 63 specifies the object description, and Table 64 specifies the entry description.

Table 63: Object description object 0x60E7

Attribute	Value
Index	$60E7_h$
Name	Additional velocity encoder resolution - Encoder increments per second
Object Code	ARRAY
Data Type	Unsigned32
Category	Optional

Table 64: Entry description

Attribute	Value
Sub-Index	00_h
Description	Highest sub-index supported
Entry category	Mandatory
Access	constant
PDO Mapping	no
Value Range	1 to 254
Default Value	Manufacturer-specific
Sub-Index	01_h
Description	1st additional velocity encoder resolution - Encoder increments per second
Entry category	Mandatory
Access	rw
PDO Mapping	yes
Value Range	Unsigned32 (0 equals 2^{32})
Default Value	No
Sub-Index	02_h
Description	2nd additional velocity encoder resolution - Encoder increments per second
Entry category	Optional
Access	rw
PDO Mapping	yes
Value Range	Unsigned32 (0 equals 2^{32})
Default Value	No
	to
Sub-Index	FE_h
Description	254th additional velocity encoder resolution - Encoder increments per second
Entry category	Optional
Access	rw
PDO Mapping	yes
Value Range	Unsigned32 (0 equals 2^{32})

Attribute	Value
Default Value	No

The calculation of the additional velocity encoder resolution is defined in combination with corresponding entry of object 0x60EC according to the definition given in object 0x6090 *Velocity encoder resolution*.

8.1.6 Object $60EC_h$: Additional velocity encoder resolution – Motor revolutions per second

This object defines one or more additional velocity encoder resolution - Motor revolutions per second. Table 65 specifies the object description, and Table 66 specifies the entry description.

Table 65: Object description object 0x60EC

Attribute	Value
Index	$60E7_h$
Name	Additional velocity encoder resolution - Motor revolutions per second
Object Code	ARRAY
Data Type	Unsigned32
Category	Optional

Table 66: Entry description

Attribute	Value
Sub-Index	00_h
Description	Highest sub-index supported
Entry category	Mandatory
Access	constant
PDO Mapping	no
Value Range	1 to 254
Default Value	Manufacturer-specific
Sub-Index	01_h
Description	1^{st} additional velocity encoder resolution - Motor revolutions per second
Entry category	Mandatory
Access	rw
PDO Mapping	yes
Default Value	No
Sub-Index	02_h
Description	2^{nd} additional velocity encoder resolution - Motor revolutions per second
Entry category	Optional
Access	rw
PDO Mapping	yes
Default Value	No
	to
Sub-Index	FE_h
Description	254^{th} additional velocity encoder resolution - Motor revolutions per second
Entry category	Optional
Access	rw

Attribute	Value
PDO Mapping	yes
Default Value	No

The calculation of the additional velocity encoder resolution is defined in combination with corresponding entry of object 0x60E7 according to the definition given in object 0x6090 *Velocity encoder resolution*.

8.1.7 Object $60E8_h$: Additional gear ratio – Motor revolutions

This object defines one or more additional gear ration – Motor revolutions. Table 67 specifies the object description, and Table 68 specifies the entry description.

Table 67: Object description object 0x60E8

Attribute	Value
Index	$60E8_h$
Name	Additional gear ratio – Motor revolutions
Object Code	ARRAY
Data Type	Unsigned32
Category	Optional

Table 68: Entry description

Attribute	Value
Sub-Index	00_h
Description	Highest sub-index supported
Entry category	Mandatory
Access	constant
PDO Mapping	no
Value Range	1 to 254
Default Value	Manufacturer-specific
Sub-Index	01_h
Description	1^{st} additional gear ratio – Motor revolutions
Entry category	Mandatory
Access	rw
PDO Mapping	yes
Default Value	No
Sub-Index	02_h
Description	2^{nd} additional gear ratio – Motor revolutions
Entry category	Optional
Access	rw
PDO Mapping	yes
Default Value	No
to	
Sub-Index	FE_h
Description	254^{th} additional gear ratio – Motor revolutions
Entry category	Optional
Access	rw

Attribute	Value
PDO Mapping	yes
Default Value	No

The calculation of the additional gear ratio is defined in combination with corresponding entry of object 0x60ED according to the definition given in object 0x6091 *Gear ratio*.

8.1.8 Object $60ED_h$: Additional gear ratio – Shaft revolutions

This object defines one or more additional gear ration – Shaft revolutions. Table 69 specifies the object description, and Table 70 specifies the entry description.

Table 69: Object description object 0x60ED

Attribute	Value
Index	$60E8_h$
Name	Additional gear ratio – Shaft revolutions
Object Code	ARRAY
Data Type	Unsigned32
Category	Optional

Table 70: Entry description

Attribute	Value
Sub-Index	00_h
Description	Highest sub-index supported
Entry category	Mandatory
Access	constant
PDO Mapping	no
Value Range	1 to 254
Default Value	Manufacturer-specific
Sub-Index	01_h
Description	1st additional gear ratio – Shaft revolutions
Entry category	Mandatory
Access	rw
PDO Mapping	yes
Default Value	No
Sub-Index	02_h
Description	2nd additional gear ratio – Shaft revolutions
Entry category	Optional
Access	rw
PDO Mapping	yes
Default Value	No
to	
Sub-Index	FE_h
Description	254th additional gear ratio – Shaft revolutions
Entry category	Optional
Access	rw
PDO Mapping	yes
Default Value	No

The calculation of the additional gear ratio is defined in combination with corresponding entry of object 0x60E8 according to the definition given in object 0x6091 *Gear ratio*.

8.1.9 Object $60E9_h$: Additional feed constant – Feed

This object defines one or more additional feed constant values – Feed. Table 71 specifies the object description, and Table 72 specifies the entry description.

Table 71: Object description object 0x60E9

Attribute	Value
Index	$60E9_h$
Name	Additional feed constant – Feed
Object Code	ARRAY
Data Type	Unsigned32
Category	Optional

Table 72: Entry description

Attribute	Value
Sub-Index	00_h
Description	Highest sub-index supported
Entry category	Mandatory
Access	constant
PDO Mapping	no
Value Range	1 to 254
Default Value	Manufacturer-specific
Sub-Index	01_h
Description	1^{st} additional feed constant – Feed
Entry category	Mandatory
Access	rw
PDO Mapping	yes
Default Value	No
Sub-Index	02_h
Description	2^{nd} additional feed constant – Feed
Entry category	Optional
Access	rw
PDO Mapping	yes
Default Value	No
to	
Sub-Index	FE_h
Description	254^{th} additional feed constant – Feed
Entry category	Optional
Access	rw
PDO Mapping	yes
Default Value	No

The calculation of the additional feed constant is defined in combination with corresponding entry of object 0x60EE according to the definition given in object 0x6092 *Feed constant*.

8.1.10 Object 60EE$_h$: Additional feed constant – Shaft revolutions

This object defines one or more additional feed constant values – Shaft revolutions. Table 73 specifies the object description, and Table 74 specifies the entry description.

Table 73: Object description object 0x60EE

Attribute	Value
Index	60E9$_h$
Name	Additional feed constant – Shaft revolutions
Object Code	ARRAY
Data Type	Unsigned32
Category	Optional

Table 74: Entry description

Attribute	Value
Sub-Index	00$_h$
Description	Highest sub-index supported
Entry category	Mandatory
Access	constant
PDO Mapping	no
Value Range	1 to 254
Default Value	Manufacturer-specific
Sub-Index	01$_h$
Description	1st additional feed constant – Shaft revolutions
Entry category	Mandatory
Access	rw
PDO Mapping	yes
Default Value	No
Sub-Index	02$_h$
Description	2nd additional feed constant – Shaft revolutions
Entry category	Optional
Access	rw
PDO Mapping	yes
Default Value	No
to	
Sub-Index	FE$_h$
Description	254^{tn} additional feed constant – Shaft revolutions
Entry category	Optional
Access	rw
PDO Mapping	yes
Default Value	No

The calculation of the additional feed constant is defined in combination with corresponding entry of object 0x60E9 according to the definition given in object 0x6092 *Feed constant*.

9 Endless positioning

The position data range (0x607A Target position, 0x6064 Position actual value) and the machine relevant absolute position data of the axis' sensor may differ. If the position data of an axis with infinite travel range (e.g. rotary axis, spindle etc.) were processed in absolute format, the axis would risk moving beyond the value range of the position data. This would lead to invalid position data; operating modes with position control would not be safe to operate.

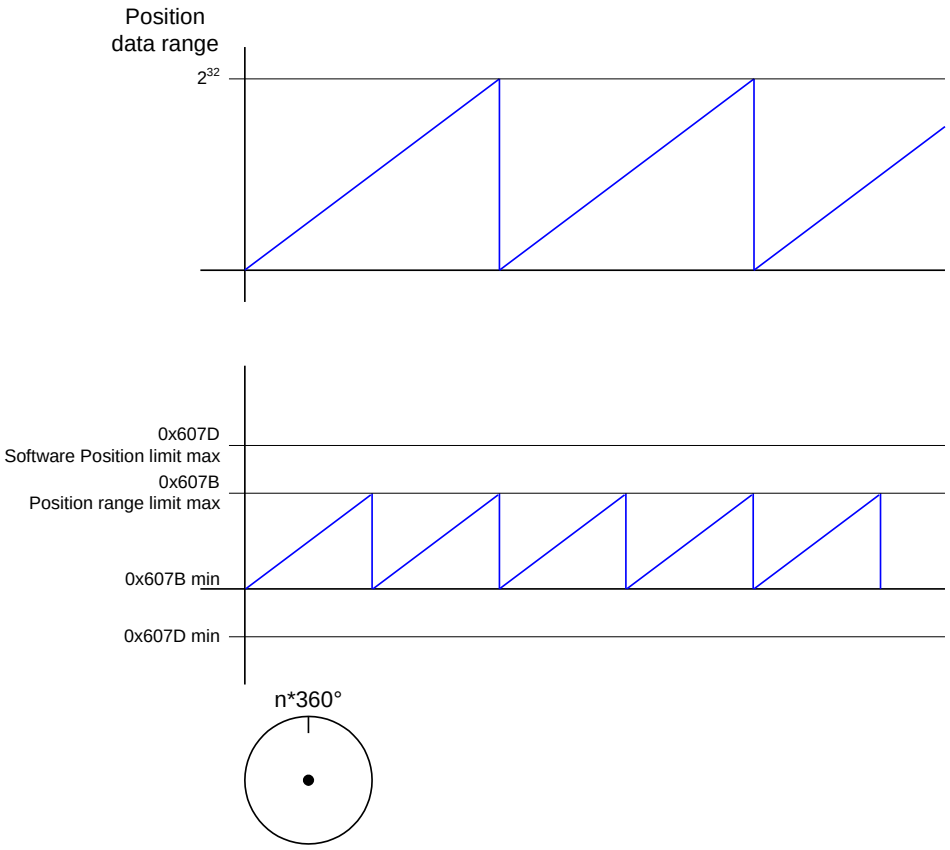


Figure 24: Position actual value in modulo format

The object 0x607B Position range limit indicates the maximum and minimum position range limits. It shall limit the range of the input value. On reaching or exceeding these limits, the input value shall wrap automatically to the other end of range. The Software position limit 0x607D shall be out of the range of the position range limits.

To disable the position range limits for any reason the min position range limit (0x 607B:01) and max position range limit (0x607B:02) shall be set to 0.

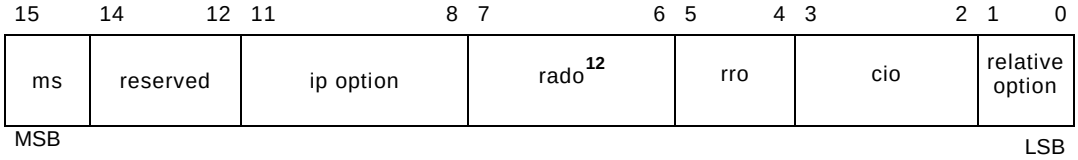
The drive shall always use the shortest way to the next Target position. Therefore the position command difference between two consecutive cycles may not exceed half the range:

Maximum position command difference = Position range / 2

Different movements are defined in object Positioning option code 60F2h in the bits 6 and 7.

Possible movements:

- normal positioning
- positioning only in negative direction
- positioning only in positive direction
- positioning with the shortest way
- movement greater than a modulo value



ms: manufacturer-specific
rado: rotary axis direction option
rro: request response option
cio: change immediately option

Figure 25: Object structure 0x60F2

Table 75 shows the bit value definition of bit 6 and 7.

Table 75: Value definition for bit 6 and 7 of object 0x60F2

Bit 7	Bit 6	Definition
0	0	Normal positioning similar to linear axis If reaching or exceeding the position range limits (607B) the input value shall wrap automatically to the other end of the range
0	1	Positioning only in negative direction; if target position is higher than actual position, axis moves over “Min position limit“ to target position
1	0	Positioning only in positive direction; if target position is lower than actual position, axis moves over “Max position limit“ to target position
1	1	Positioning with the shortest way to the target position. Special condition: If the difference between actual value and target position in a 360° system is 180°, the axis will move in positive direction.

Figure 26 depicts the movements depending on the settings of the rotary axis direction option bits. In this example min position range limit is 0 and max position range limit is 360.

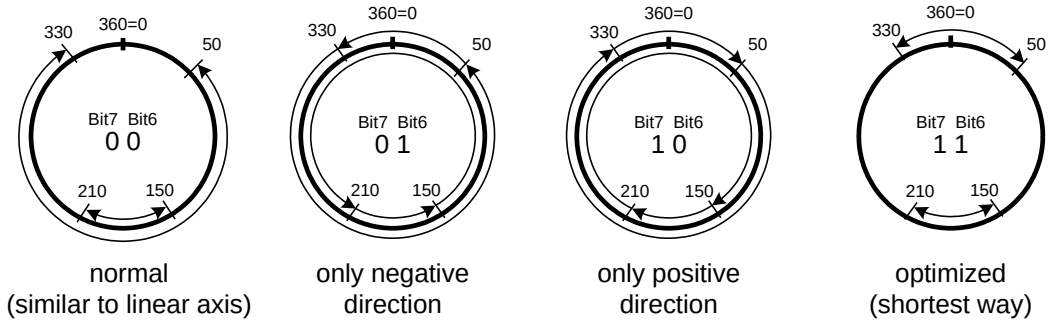


Figure 26: Rotary axis positioning

[12] The definition of bits 6 and 7 is defined by CiA e.V. Working Group and will be added in the next release of the IEC 61800-7-200 specification.

10 Process data objects (PDO)

The mapping of the process data is not fixed by this guideline, but defined by the device description of the drive.

The following PDO mappings are recommended.

Table 76: Default PDOs

Direction	Description
FG Position	
RPDO	Controlword (0x6040), Target position (0x607A)
TPDO	Statusword (0x6041), Position actual value (0x6064)
FG Velocity	
RPDO	Controlword (0x6040), Target velocity (0x60FF)
TPDO	Statusword (0x6041), Position actual value (0x6064)
FG Torque	
RPDO	Controlword (0x6040), Target torque (0x6071)
TPDO	Statusword (0x6041), Position actual value (0x6064), Torque actual value (0x6077)
FGs Position, Velocity, Torque, Touch Probe	
RPDO	Controlword (0x6040), Target position (0x607A), Target velocity (0x60FF), Target torque (0x6071), Max Torque (0x6072), Modes of operation (0x6060), Touch probe function (0x60B8)
TPDO	Statusword (0x6041), Position actual value (0x6064), Torque actual value (0x6077), Following error actual value (0x60F4), Modes of operation display (0x6061), Touch probe status (0x60B9), Touch probe value*

* NOTE: The object of the touch probe value depends on the configured touch probe input. It can be 0x60BA, 0x60BB, 0x60BC or 0x60BD

It is optional to add more objects to the proposed PDOs and a mixture of the PDOs can be configured without repeating same objects like Controlword or Statusword.

The default mapping for a drive is defined in the device description file.

10.1 Device Type

For the EtherCAT CiA402 servo drive the Device Type in object 0x1000 is set to 0xyy020192.

Table 77: Object 0x1000 Device Type for EtherCAT servo drive

Object 0x1000	Additional Information		Device Profile Number
	31 24	23 16	15 0
	Mode Bits	Type	Device Profile Number
EtherCAT servo drive	*	0x02 (Servo Drive)	0x0192 (402_d)

* means manufacturer specific

The Type = 0x02 is defined in [7] for generic servo drive devices.

Even though the standard defines a PDO set for generic servo drives this not adopted for an EtherCAT servo.

11 Synchronization

There are no further specifications in this guideline regarding synchronization.

Synchronization and error handling are described in [9].

For the Drive

- DC synchronous mode is very useful for csp, csv and cst mode. It is recommended to support this synchronization mode.
- Specific values for synchronization (e.g. shift time, internal delay times) are specified in [11].

For the control device

- control device shall provide new setpoints each bus cycle.

12 Object list

For multi axis devices the object range 0x6000 to 0x67FF shall be shifted by 0x800 per axis as described in the IEC 61800-7-201. The range is extended from 0x6000 to 0xDFFF so that up to 16 axes can be supported.

Table 78: Object dictionary – object list (numerical order)

Index	Name	Category	Remark
0x1000	Device Type	M	supporting generic PDO mapping = $xx020192_h$
0x1001	Error Register	M	
0x1018	Identity object	M	
0x6007	Abort connection option code	O	
0x603F	Error Code	O	
0x6040	Controlword	M	
0x6041	Statusword	M	
0x6042	vl target velocity	C	Mandatory if vl is supported
0x6043	vl velocity demand	C	Mandatory if vl is supported
0x6044	vl velocity actual value	C	Mandatory if vl is supported
0x6045	reserved	-	reserved for compatibility reasons
0x6046	vl velocity min max amount	C	Mandatory if vl is supported
0x6047	reserved	-	reserved for compatibility reasons
0x6048	vl velocity acceleration	C	Mandatory if vl is supported
0x6049	vl velocity deceleration	O	
0x604A	vl velocity quick stop	O	
0x604B	vl set-point factor	O	
0x604C	vl dimension factor	O	
0x604D	reserved	-	reserved for compatibility reasons
0x604E	reserved	-	reserved for compatibility reasons
0x604F	reserved	-	reserved for compatibility reasons
0x6052 … 0x6059	reserved	-	reserved for compatibility reasons
0x605A	Quick stop option code	O	
0x605B	Shutdown option code	O	
0x605C	Disable operation option code	O	
0x605D	Halt option code	O	
0x605E	Fault reaction option code	O	
0x6060	Modes of operation	M	Mandatory
0x6061	Modes of operation display	M	Mandatory
0x6062	Position demand value	O	
0x6063	Position actual internal value	O	
0x6064	Position actual value	C	Mandatory, if csp or csv is supported Recommended, if cst is supported
0x6065	Following error window	C	Recommended, if csp is supported
0x6066	Following error time out	C	Recommended, if csp is supported
0x6067	Position window	O	
0x6068	Position window time	O	
0x6069	Velocity sensor actual value	O	
0x606A	Sensor selection code	O	
0x606B	Velocity demand value	O	
0x606C	Velocity actual value	C	Mandatory if pv supported Recommended if csv is supported

Index	Name	Category	Remark
0x606D	Velocity window	O	
0x606E	Velocity window time	O	
0x606F	Velocity threshold	O	
0x6070	Velocity threshold time	O	
0x6071	Target Torque	C	Mandatory if tq or cst is supported
0x6072	Max torque	C	Mandatory if FG Torque Limiting is supported
0x6073	Max current	O	
0x6074	Torque demand	O	
0x6075	Motor rated current	O	
0x6076	Motor rated torque	O	
0x6077	Torque actual value	C	Mandatory if cst is supported Recommended if csp or csv is supported
0x6078	Current actual value	O	
0x6079	DC link circuit voltage	O	
0x607A	Target position	C	Mandatory if csp is supported
0x607B	Position range limit	C	Recommended if csp is supported
0x607C	Home offset	R	Recommended if Homing is supported
0x607D	Software position limit	C	Recommended if csp is supported
0x607E	Polarity	O	
0x607F	Max profile velocity	O	
0x6080	Max motor speed	O	
0x6081	Profile velocity	C	Mandatory if pp is supported
0x6082	End velocity	O	
0x6083	Profile acceleration	C	Mandatory if pp or pv is supported
0x6084	Profile deceleration	O	
0x6085	Quick stop deceleration	O	
0x6086	Motion profile type	O	
0x6087	Torque slope	C	Mandatory if tq is supported
0x6088	Torque profile type	O	
0x6089 …0x608E	reserved	-	reserved for compatibility reasons
0x608F	Position encoder resolution	O	
0x6090	Velocity encoder resolution	O	
0x6091	Gear ratio	O	
0x6092	Feed constant	O	
0x6093 …0x6097	reserved	-	reserved for compatibility reasons
0x6098	Homing method	C	Mandatory if Homing is supported
0x6099	Homing speed	O	
0x609A	Homing acceleration	O	
0x60A0	reserved	-	reserved for compatibility reasons
0x60A1	reserved	-	reserved for compatibility reasons
0x60A3	Profile jerk use	O	
0x60A4	Profile jerk	O	
0x60B0	Position offset	O	
0x60B1	Velocity offset	O	Recommended if csp is supported
0x60B2	Torque offset	O	Recommended if csp or csv is supported

Index	Name	Category	Remark
0x60B8	Touch probe function	C	Mandatory if FG Touch Probe is supported
0x60B9	Touch probe status	C	Mandatory if FG Touch Probe is supported
0x60BA	Touch probe position 1 positive value	C	Mandatory if FG Touch Probe is supported
0x60BB	Touch probe position 1 negative value	C	Mandatory if FG Touch Probe is supported
0x60BC	Touch probe position 2 positive value	O	Optional if FG Touch Probe and Touch probe input 2 is supported
0x60BD	Touch probe position 2 negative value	O	Optional if FG Touch Probe and Touch probe input 2 is supported
0x60C0	Interpolation sub mode select	O	
0x60C1	Interpolation data record	O	
0x60C2	Interpolation time period	C	Mandatory if ip mode is supported Recommended if csp, csv or cst is supported
0x60C4	Interpolation data configuration	O	
0x60C5	Max acceleration	O	
0x60C6	Max deceleration	O	
0x60D0[13]	Touch probe source	C	Recommended if FG Touch probe is supported
0x60D1[13]	Touch probe time stamp 1 positive value	O	
0x60D2[13]	Touch probe time stamp 1 negative value	O	
0x60D3[13]	Touch probe time stamp 2 positive value	O	
0x60D4[13]	Touch probe time stamp 2 negative value	O	
0x60D5[13]	Touch probe 1 positive edge counter	O	
0x60D6[13]	Touch probe 1 negative edge counter	O	
0x60D7[13]	Touch probe 2 positive edge counter	O	
0x60D8[13]	Touch probe 2 negative edge counter	O	
0x60D9	Supported functions	O	
0x60DA	Function Settings	O	
0x60E0[13]	Positive torque limit value	C	Mandatory if FG Torque Limiting is supported
0x60E1[13]	Negative torque limit value	C	Mandatory if FG Torque Limiting is supported
0x60E3[13]	Supported homing methods	C	Recommended if Homing is supported
0x60E4[13]	Additional position actual value	O	
0x60E5[13]	Additional velocity actual value	O	
0x60E6[13]	Additional position encoder resolution – encoder increments	O	
0x60E7[13]	Additional velocity encoder resolution - Encoder increments per second	O	

[13] These Index-numbers are new. They may be subjects to change, because they will be adjusted with the CiA e.V.

Index	Name	Category	Remark
0x60E8[13]	Additional gear ratio – Motor revolutions	O	
0x60E9[13]	Additional feed constant - Feed	O	
0x60EA[13]	Commutation angle	C	Mandatory if *cstca* mode supported
0x60EB[13]	Additional position encoder resolution – motor revolutions	O	
0x60EC[13]	Additional velocity encoder resolution – Motor revolutions per second	O	
0x60ED[13]	Additional gear ratio – Shaft revolutions	O	
0x60EE[13]	Additional feed constant – Shaft revolutions	O	
0x60F2	Position option code	O	
0x60F4	Following error actual value	C	Recommended if csp is supported
0x60F6	reserved	-	reserved for compatibility reasons
0x60F7	reserved	-	reserved for compatibility reasons
0x60F8	Max slippage	O	
0x60F9	reserved	-	reserved for compatibility reasons
0x60FA	Control effort	O	
0x60FB	reserved	-	reserved for compatibility reasons
0x60FC	Position demand internal value	O	
0x60FD	Digital inputs	O	
0x60FE	Digital outputs	O	
0x60FF	Target velocity	C	Mandatory if pv or csv is supported
0x6200 … 0x62FF	Profile 452 PLCopen Motion Control	O	
0x6402	Motor Type	O	
0x6403	Motor catalogue number	O	
0x6404	Motor manufacturer	O	
0x6405	http motor catalogue address	O	
0x6406	Motor calibration date	O	
0x6407	Motor service period	O	
0x6410	reserved	-	reserved for compatibility reasons
0x6502	Supported drive modes	R	
0x6503	Drive catalogue number	O	
0x6504	reserved	-	reserved for compatibility reasons
0x6505	http drive catalogue address	O	
0x6510	reserved	-	reserved for compatibility reasons
0x6600 … 0x67EF	Safety Drive Profile	O	
0x67F0 … 0x67FE	reserved		
0x67FF	Device profile number (for multiple device module)	O	