SURUGA SEIKI

Stepper motor driver

DS1000A-EC

Instruction manual

EtherCAT drive profile supported

CE

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0. Abbreviations and terms

ESC	EtherCAT Slave Controller
SII	Slave Information Interface
CoE	CANopen over EtherCAT
FoE	File over EtherCAT
PP	Profile position mode
PV	Profile velocity mode
TQ	Torque profile mode
CSP	Cyclic synchronous position mode
CSV	Cyclic synchronous velocity mode
CST	Cyclic synchronous torque mode
IP	Interpolated position mode
HM	Homing mode:
FIFO	First In First Out
SM	Sync Manager
DC	Distributed Clock

Data sizes

BOOL	Boolean
U8	Unsigned integer 8
U16	Unsigned integer 16
U32	Unsigned integer 32
I8	Signed integer 8
I16	Signed integer 16
I32	Signed integer 32

1. Introduction

1.1. System overview

The DS1000A-EC is a motor driver designed for the Stages and actuator control, equipped with input ports for home and limit sensors, and general-purpose input / output ports.
The EtherCAT CiA402 drive profile is supported, and control of various axes, such as for linear and rotational motion, is possible by performing the settings for those control axes.

1.2. About EtherCAT

EtherCAT is a form of open network communication which performs master-slave communication using real-time Ethernet technology developed by Beckhoff Automation GmbH.
It is a network method that can synchronize and control multiple devices with high accuracy, and it is suitable for the coordination and control of the multiple axes of motion devices such as stages and actuators.

2. Safety precautions

The following precautions are the guidance for the correct and safe use of this product, thereby preventing harm to our customers or other persons in its vicinity, and physical damage to objects during said use. Persons should become thoroughly familiarized with them prior to using this product.

Precautionary notifications

⚠WARNING	Handling not in accordance with these instructions could result in light to moderate injury or, in certain cases, even serious injury or death. In addition, there is a risk of serious damage to physical objects.
⚠CAUTION	Handling not in accordance with these instructions may result in light to moderate injury, or the property damage.

Definitions of the symbols

	This symbol indicates “Prohibited.” Specific contents, either illustrated or written, or both, are followed by the symbol; 
	This symbol indicates “obligatory.” Contents must be followed.

⚠ WARNING	
	・Do not apply excessive stress to the cables; such as scratching, pulling, placing heavy objects on or pinching them. You are at the risk of electric shock, product malfunction, or fire. ・Do not use in explosive or flammable atmosphere, corrosive atmosphere, wet locations or in the vicinity of combustible materials. You are at the risk of causing fire. ・Do not disassemble or modify the product. You are at the risk of causing injury, malfunction or damage to the equipment.
	・Wiring must be proceeded after that the drivers and motors are firmly attached at the planned locations and orientation. You are at the risk of electric shock. ・Wiring must be completed before supplying the electrical power. You are the risk of electric shock. ・The input voltage must be within the input rating of the driver. You are at the risk of fire or electric shock.

⚠ CAUTION	
	・Do not insert fingers or objects into the product's openings. You are at the risk of breakage, electric shock or fire. ・Do not hung by the cable or motor shaft during transportation. You are at the risk of breakage or injury.
	・The operating environment must be the norm when installing the product. You are at the risk of breakage or malfunction. ・Connect the motor to the driver in the specified combination. You are at the risk of fire or injury. ・The applied direct current power supply for the driver must be that the primary and the secondary sides are electrically isolated. You are at the risk of electric shock. ・Be sure that the motor current is shut down when touching and holding the motor shaft by hand. You are at the risk of injury. ・Be aware of the all sharp edges, like the corners of the device. You are at the risk of injury.

3. Laws, regulations and standards

3.1. CE marking

This product is CE marked based on the EMC directive.

3.1.1. The EMC directive

This product was tested under following conditions. However, compatibility changes by condition of usage and combination of devices used with. It is necessary to retest final products which all components are combined for confirming a compatibility.

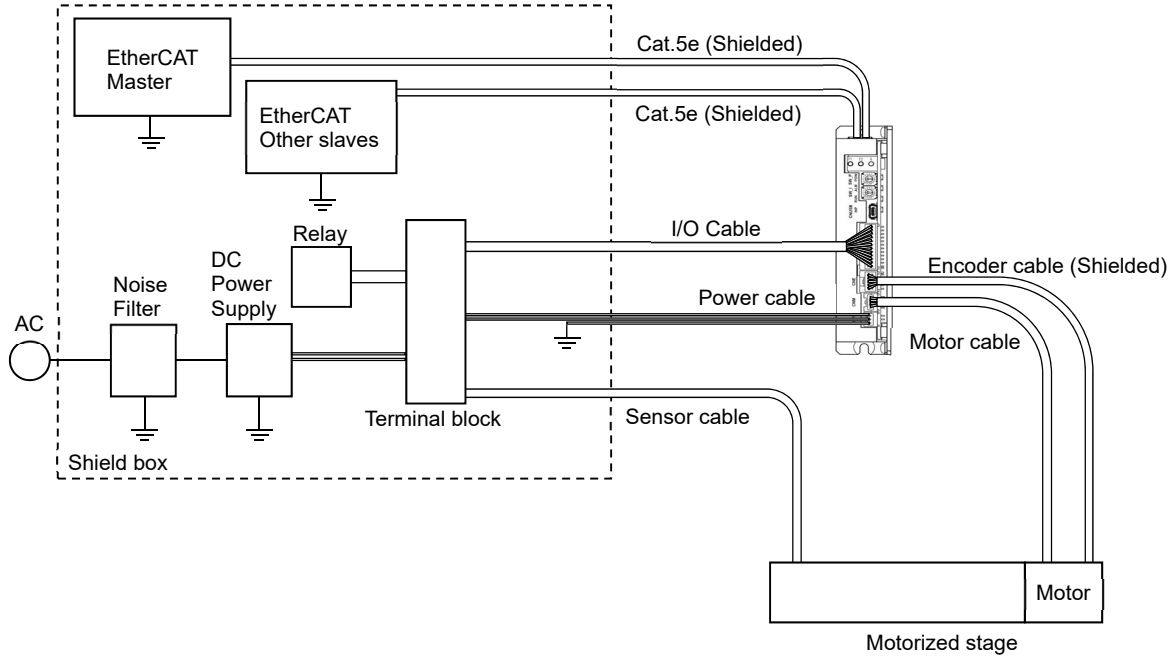
Applied standards

EMI	EN55011 Group1 Class A EN61000-6-4
EMS	EN61000-6-2

Caution

This product is not intended to use in a home environment. It may affect wireless devices around if this product is used in a home environment or it's connected to power supply for home usage.

Measurement condition of the EMC directive

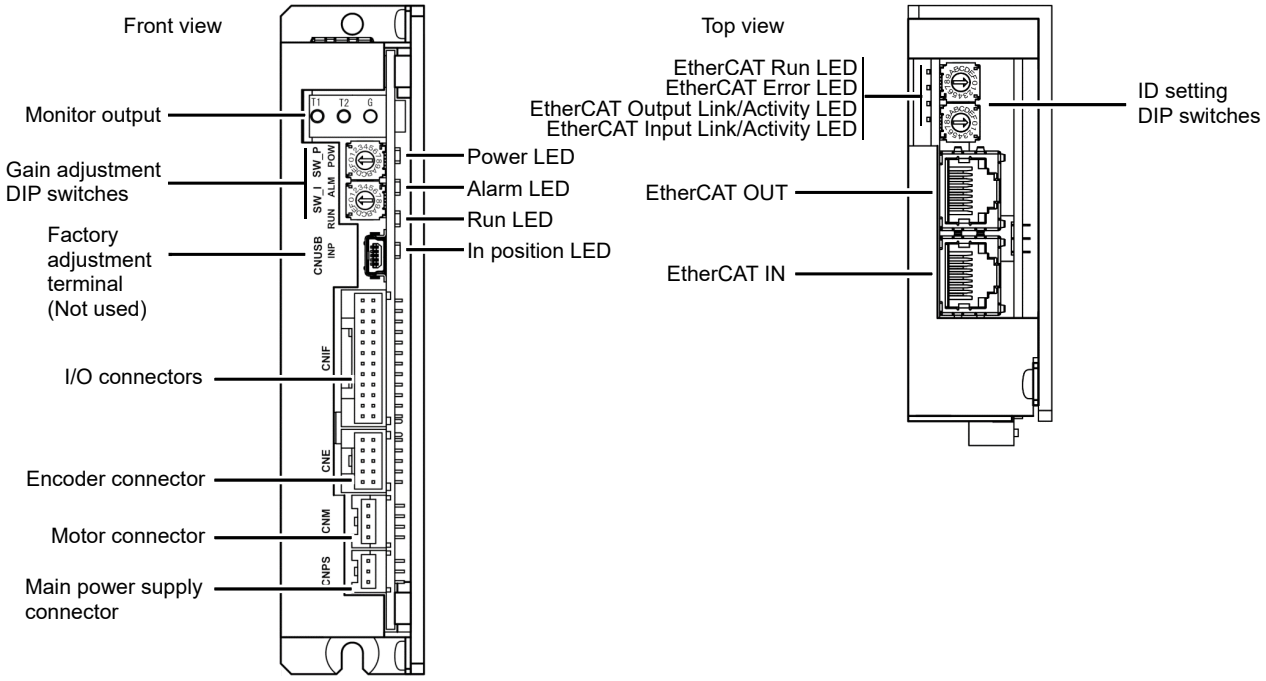


3.2. The RoHS directive

No materials exceeding mass ratio specified by the RoHS directive (EU/2015/863) are not included in this product.

4. Setup

4.1. Names and functions of parts



4.2. Method for installation

4.2.1. Operating environment

Use the driver in the environment as following;

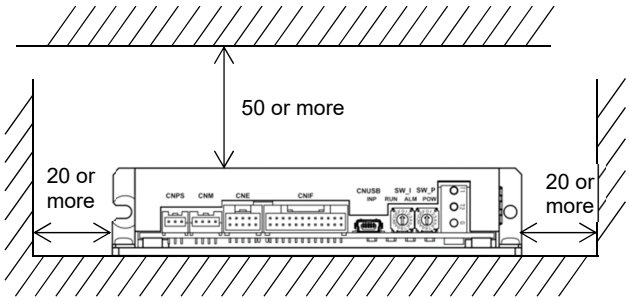
- An atmosphere at no less than 0°C and no more than 50°C with humidity of 85% RH or less
- A place with low vibration (0.5 G or less)
- A place without corrosive gases, flammable gases, abrasives, oil mists, iron powder, chippings, etc.
- A place with low pulse noise (if noise is unavoidable, add a noise filter to the power supply)

4.2.2. Mounting

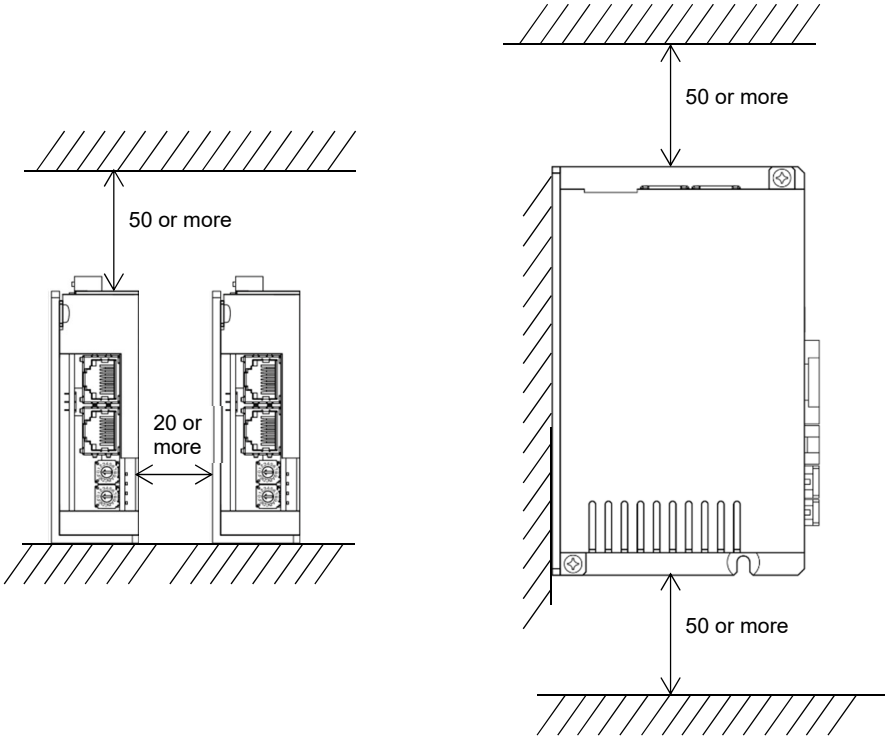
Two mounting surfaces are at your discretion; vertically or horizontally.

Two M3 screws are used for mounting the driver case. For the horizontal or the vertical mounting, it has two screw holes with un-anodized area, which establishes electrical grounds for the driver case, to its housing to protect the circuit. Additionally, be sure that the motor and housing frame ground are at the same electrical potential.

4.2.2.1. Horizontal mounting (mm)



4.2.2.2. Vertical mounting (mm)



4.2.3. Precautions when installing the motor

- Install the motor where the ambient temperature is within the range 0 to 40°C.
- Levels of heat radiation must be such as to maintain the motor surface temperature at 65°C or less.
- Do not install in where significant amounts of water, lubricant, or conductive metal powder are present.

4.2.3.1. Fixing the motor in place

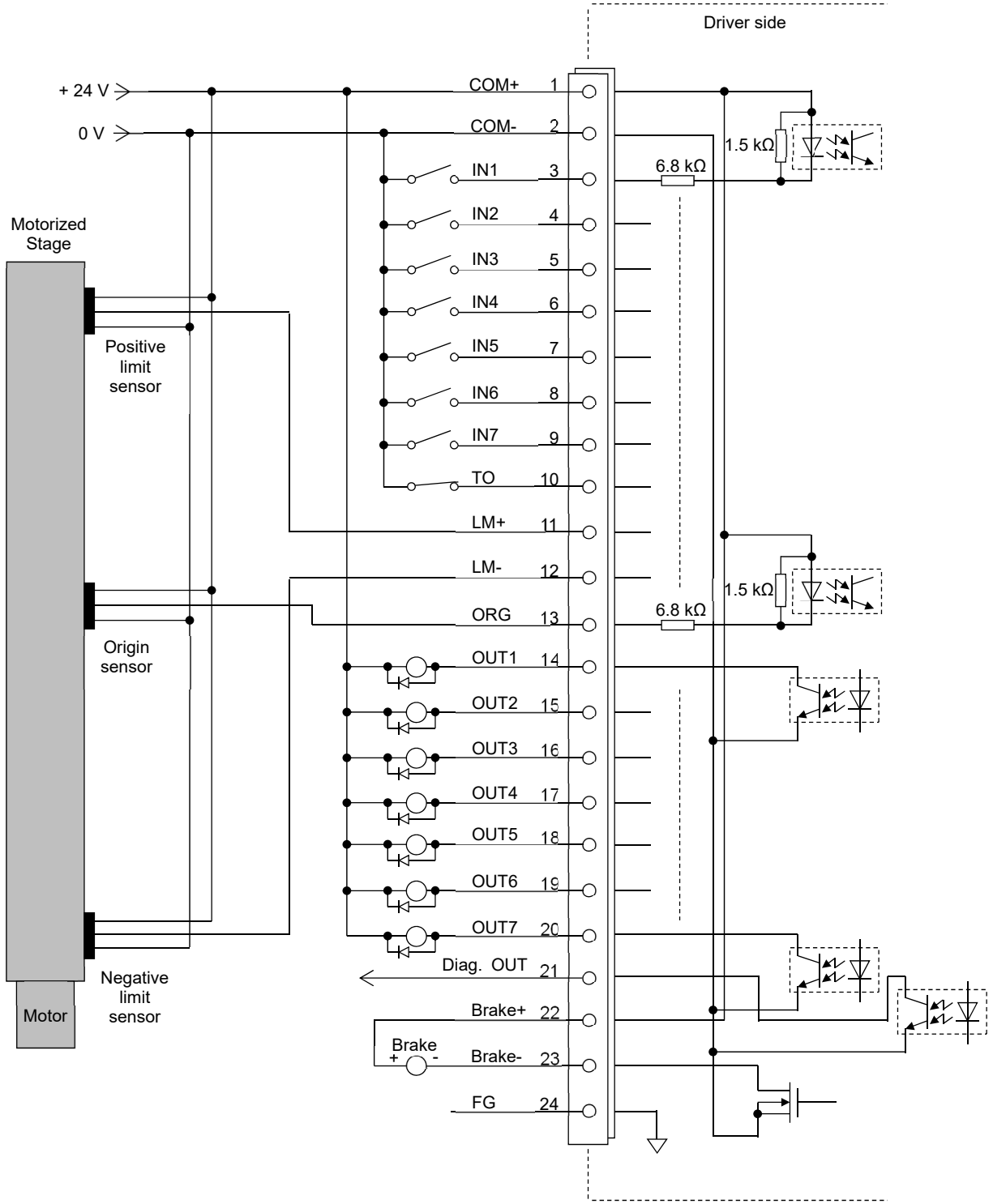
Motor type	Motor size	Screw	Tightening torque
STM28W100A	28 mm sq.	M2.5 × 4	0.4 Nm
STM42W100A	42 mm sq.	M3 × 4	0.6 Nm

4.2.4. Grounding

Ground the driver case to prevent malfunction by electrical noise.

It is one method to connect the driver's frame ground to the power supply connector (CNPS), and another is by connecting the un-anodized area on the driver case to other conductive point or area. The grounding must be single point grounding (SPG) with a ground wire sizing of AWG18 (0.75 mm^2) or higher. Refer to the outline drawing for the un-anodized areas.

4.3. Connection example



4.4. Connector pin arrangement

4.4.1. Power supply connector (CNPS)

No.	Signal name	Details	Remarks
1	+24 V or +48 V	Main power supply - positive	+24 V ± 10%, Rated 2 A, Peak 3 A +48 V ± 10%, Rated 1 A, Peak 2 A
2	0 V	Main power supply 0 V	I/O power supply input
3	FG	Frame ground	

4.4.2. Input / output connector (CNIF)

No.	Signal name	Details	Input / output	Remarks
1	COM+	+24 V	IN	I/O power supply input + 24 V ± 10%
2	COM-	0 V	IN	I/O power supply input
3	IN1	General-purpose input port 1	IN	Opto-isolated
4	IN2	General-purpose input port 2	IN	
5	IN3	General-purpose input port 3	IN	
6	IN4	General-purpose input port 4	IN	
7	IN5	General-purpose input port 5	IN	
8	IN6	General-purpose input port 6	IN	
9	IN7	General-purpose input port 7	IN	
10	TO	Torque Off	IN	Opto-isolated, torque-off by releasing the terminal
11	+LM	Positive direction limit sensor input	IN	Opto-isolated
12	-LM	Negative direction limit sensor input	IN	
13	ORG	Origin sensor input	IN	
14	OUT1	General-purpose output port 1	OUT	Opto-isolated
15	OUT2	General-purpose output port 2	OUT	
16	OUT3	General-purpose output port 3	OUT	
17	OUT4	General-purpose output port 4	OUT	
18	OUT5	General-purpose output port 5	OUT	
19	OUT6	General-purpose output port 6	OUT	
20	OUT7	General-purpose output port 7	OUT	
21	Diag OUT	Diagnostic output (Reserved)	OUT	
22	BRAKE+	Brake release output +	OUT	Same potential as pin 1 (+ 24 V)
23	BRAKE-	Brake release output -	OUT	500 mA or less
24	FG	Shield		

4.4.3. Motor connector (CNM)

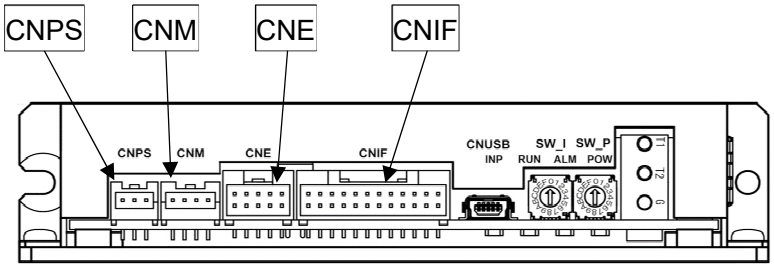
No.	Signal name	Details
1	A	Motor A phase
2	/A	Motor /A phase
3	B	Motor B phase
4	/B	Motor /B phase

4.4.4. Encoder connector

No.	Signal name	Details	Input / output
1	+5 V	Encoder power supply +5 V	OUT
2	GND	Encoder power supply GND	OUT
3	A+	A phase +	IN
4	A-	A phase -	IN
5	B+	B phase +	IN
6	B-	B phase -	IN
7	Z+	Z phase +	IN
8	Z-	Z phase -	IN
9	NC	No Connection	-
10	FG	Shield	-

4.5. Connector type

Code	Use	Type	Applicable wire size	Manufacturer
CNPS	For power supply	Housing: PAP-03V-S Contact: SPHD-001T-P0.5	AWG#26-22	JST
CNIF	For interface	Housing: PUDP-24V-S Contact: SPUD-002T-P0.5	AWG#28-24	JST
CNM	For motor	Housing: PAP-04V-S Contact: SPHD-001T-P0.5	AWG#26-22	JST
CNE	For encoder	Housing: PUDP-10V-S Contact: SPUD-002T-P0.5	AWG#28-24	JST



5. Communication specifications

5.1. EtherCAT communication specifications

Items	Specifications
Physical Layer	100BASE-TX (IEEE802.3)
Synchronization Mode / Communication Cycle	SM2 event synchronization mode: 1 ms or more, 1 ms unit * DC mode: 1 ms or more, 1 ms unit *
Sync Manager	SM0: Mailbox output SM1: Mailbox input SM2: Process data output SM3: Process data input
Mail Box (CoE)	Emergency Message SDO Request SDO Response SDO Information
Device Profile	IEC 61800-7 CiA402 Drive Profile

* For the synchronization cycle, the value should be sufficient for the intended operation. If the cycle is too long, drive errors may become too large to perform expected operations.
For the cycle, 10 ms or less is recommended.

5.2. Device profile

5.2.1. CoE

CiA402 drive profile

Mode of operation	Abbreviation	Support
Profile position mode	pp	supported
Velocity mode	vl	not supported
Profile velocity mode	pv	supported
Torque profile mode	tq	supported
Homing mode	hm	supported
Interpolated position mode	ip	supported
Cyclic synchronous position mode	csp	supported
Cyclic synchronous velocity mode	csv	supported
Cyclic synchronous torque mode	cst	supported
Cyclic synchronous torque mode with commutation angle	cstca	not supported

5.2.2. FoE

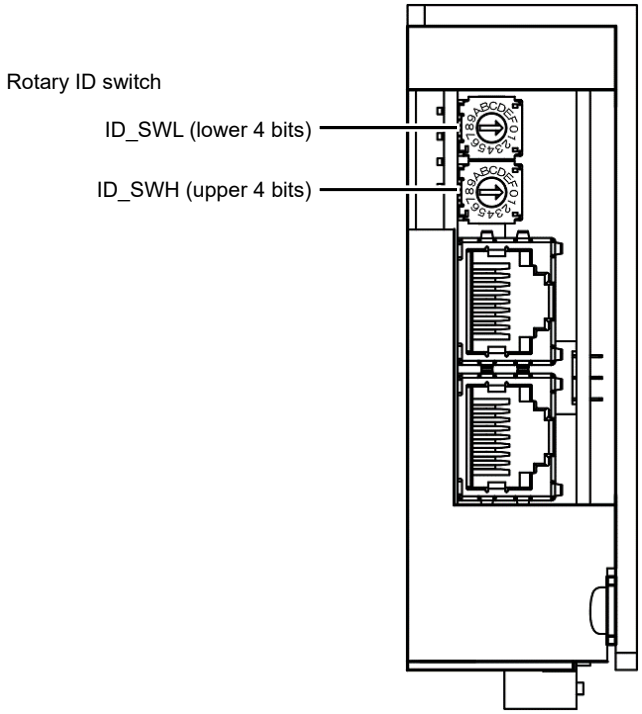
Firmware Download support

Refer to a master device manual for the download method.

5.3. Setting the node address

In addition to the method in which an address is automatically assigned from an EtherCAT master, the driver has three methods to set a fixed node ID (Station Alias) by the equipped rotary ID switches.

Please note that, by the standards, each method has own unique conditions to reflect and to read the ID. You may not combine a method with one and anther. Only one can be chosen out of the three.



5.3.1. Reading SII (EEPROM) settings via Configured Station Alias

This method reads a value at SII 0004_h (Configured Station Alias), which may be set by a slave configuration tool through 0012_h (Configured Station Alias) in the ESC register.

Be sure to set the rotary ID switches illustrated above to 0 when using this method. If the rotary ID switches point at rather than 0, the ESC register returns error because this setting clears 0000_h upon the device slave state transition from PreOP to SafeOP.

Please refer to a tool manual applied at a master side how to rewrite the SII address.

5.3.2. Reading the rotary ID switch value via Configured Station Alias

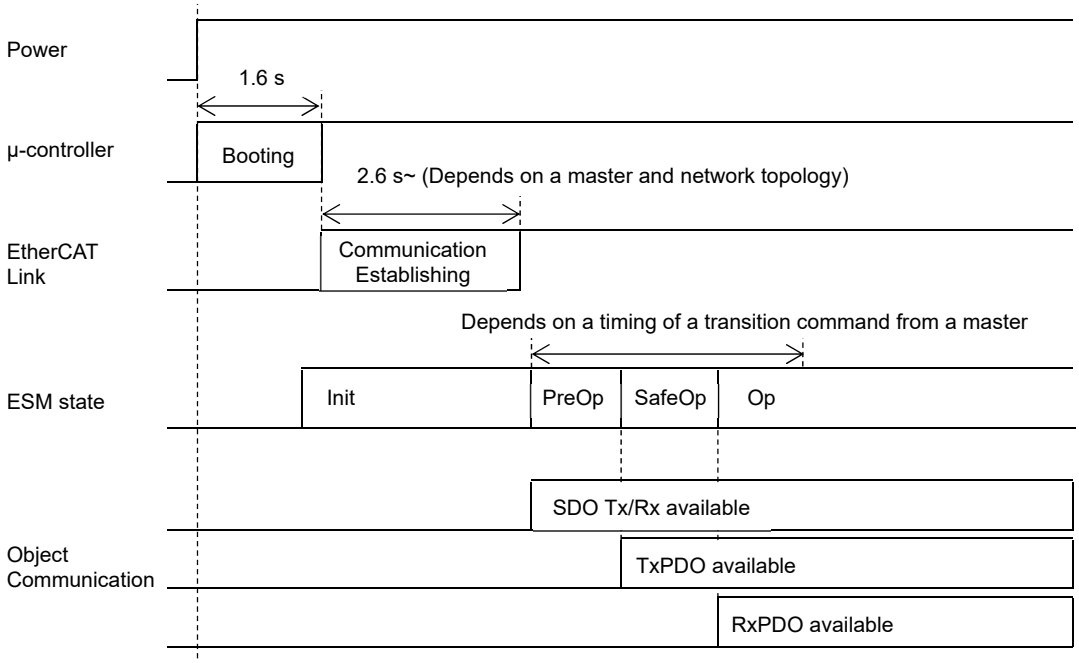
This method reads a value that is set by the rotary ID switches, at the 0012_h (Configured Station Alias) in the ESC register. By this method, a range of value can be from 0001_h to $00FF_h$ of 255 combinations.

5.3.3. Reading the rotary ID switch value via AL Status Code

This method reads a value set by the rotary ID switches, at the AL Status Code (0134_h). The range of a value can be from 0001_h to $00FF_h$ of 255 combinations.

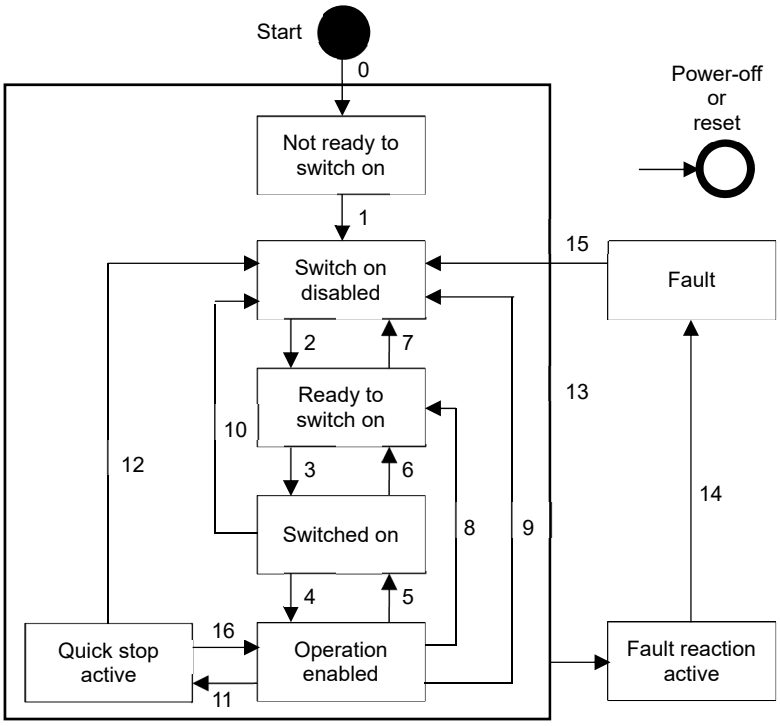
5.4. Sequence flow from power-on to establishment of communication

The figure below shows the sequence flow from turning on the driver power until communication is enabled.



6. CiA402 drive profile common specifications

6.1. State machine



State	Description	Motor energized	Parameter setting
Not ready to switch on	Executing initialization	OFF	Not possible
Switch on disabled	Initialization complete	OFF	Possible
Ready to switch on	Main power can be turned on	OFF	Possible
Switched on	Main power on	OFF	Possible
Operation enabled	Operation possible	ON	Possible
Quick stop active	Executing quick stop	ON	Possible
Fault reaction active	Stop processing due to occurrence of alarm	ON	Possible
Fault	Alarm operating	OFF	Possible

6.2. State machine state transitions

Controlword (6040_h) controls the state machine.

6.2.1. Controlword (6040_h)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
ms					r	oms	h	fr	oms			eo	qs	ev	so
MSB															LSB

ms manufacturer-specific: a vendor-specific fixed setting (not used in the driver)

r reserved: not used

oms operation mode specific: used in the various operation modes

h halt: by setting to 1, this halts the motor according to Halt option code ($605D_h$).

Setting to 0 resumes the operation, except it is in the hm mode.

fr fault reset: please refer to “Controlword state transition commands”

eo enable operation: please refer to “Controlword state transition commands”

qs quick stop: please refer to “Controlword state transition commands”

ev enable voltage: please refer to “Controlword state transition commands”

so switch on: please refer to “Controlword state transition commands”

6.2.1.1. Controlword state transition commands

Command	Bits of the Controlword					Transitions
	Bit7	Bit3	Bit2	Bit1	Bit0	
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
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	0→1	X	X	X	X	15

6.2.1.2. Table for operation mode specific

The oms bits usages at each operation mode are shown in the table below.

For specific behavior, refer to the details on each operation mode.

Op-mode	Bit9	Bit6	Bit5	Bit4
pp	change on set-point	absolute / relative	change set immediately	new set-point
pv	-	-	-	-
tq	-	-	-	-
hm	-	-	-	start homing
ip	-	-	-	enable interpolation
csp	-	-	-	-
csv	-	-	-	-
cst	-	-	-	-

6.2.2. Statusword (6041h)

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

ms manufacturer-specific: not used

oms operation mode specific: used in the various operation modes

ila internal limit active: restricted by the internal limit

tr target reached: target position reached

rm remote: command received

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

6.2.2.1. State coding

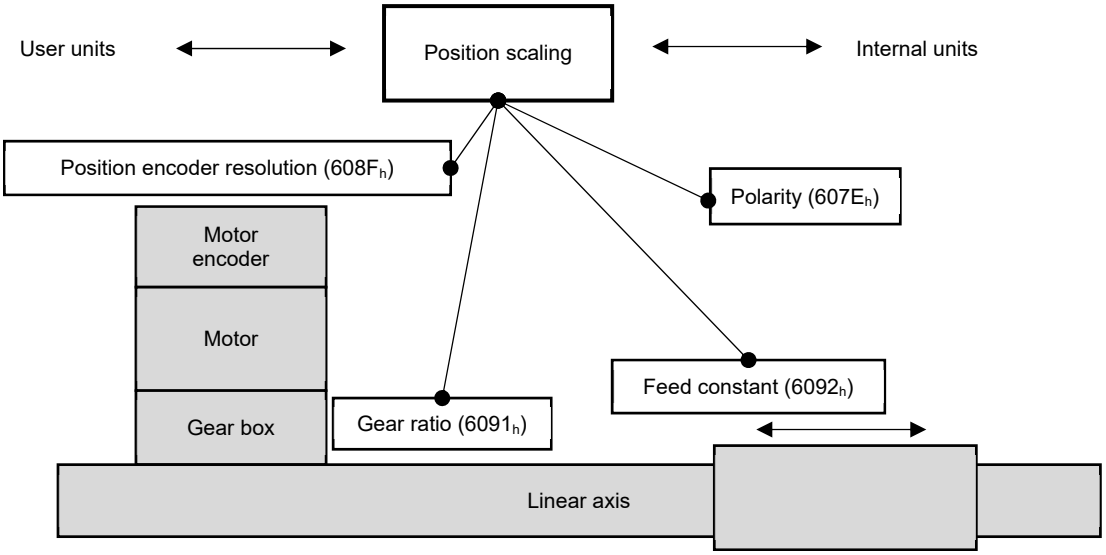
The table below shows the bit coding in the Statusword corresponds the each state in the State machine.

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

7. Basic parameters

7.1. Setting user units

This specifies coefficients to convert the device's "Internal units" (encoder pulse unit in the driver) to "User units". The position and speed are set or displayed based on the values set here. However, the unit for torque is in 0.1%.



Index	Sub-Index	Name	Units	Data Type	Range	Access	PDO
$607E_h$	00_h	Polarity	-	U8	0, 192	rw	No
6080_h	00_h	Max motor speed	rpm	U16	0 - 65535	rw	RxPDO
6081_h		Position encoder resolution					
	01_h	Encoder Increments	count	U32	0 - 4294967295	rw	No
	02_h	Shaft revolutions	rot	U32	0 - 4294967295	rw	No
6091_h		Gear ratio					
	01_h	Motor revolutions	rot	U32	1 - 4294967295	rw	No
	02_h	Shaft revolutions	rot	U32	1 - 4294967295	rw	No
6092_h		Feed constant	-	-	-	-	-
	01_h	Feed	User/rot	U32	1 - 4294967295	rw	No
	02_h	Shaft revolutions	rot	U32	1 - 4294967295	rw	No
$60C5_h$	00_h	Max acceleration	User/s^2	U32	0 - 4294967295	rw	RxPDO
$60C6_h$	00_h	Max deceleration	User/s^2	U32	0 - 4294967295	rw	RxPDO

7.1.1. Position encoder resolution ($608F_h$)

Sub-index	Name	Unit	Range	Description
01	Encoder increments	pulse	0 - 4294967295	The scale of the encoder increments relative to the number of motor revolutions.
02	Motor revolutions	rot	1 - 4294967295	The number of motor revolutions relative to the scale of the encoder increment.

This sets the scale of the encoder increment relative to the number of motor revolutions.

To set it at 0 reads 2^{32}.

The driver holds default values reflecting the preset motor configuration. The user may not need to modify the factory default.

7.1.2. Gear ratio (6091h)

Sub-index	Name	Unit	Range	Description
01	Motor shaft revolutions	rot	1 - 4294967295	The number of motor revolutions relative to the number of gear revolutions.
02	Driving shaft revolutions	rot	1 - 4294967295	The number of gear revolutions relative to the number of motor revolutions.

This sets the gear ratio for the external gearbox.

For example, if the drive shaft rotates once per 2 motor rotations, set the Motor shaft revolutions = 2 and the Driving shaft revolutions = 1.

7.1.3. Feed constant (6092h)

Sub-index	Name	Unit	Range	Description
01	Feed	User	1 - 4294967295	The feed amount per revolution.
02	Shaft revolutions	rot	1 - 4294967295	The number of revolutions of the rotating shaft relative to the feed amount.

This sets the resolution of the Feed amount per axis revolutions. For example, if a ball screw has a lead of 1 mm, set the Shaft revolution to 1 and the Feed to 1000, thus, 1 [mm/rot] ÷ 1000 × 1 [rot] = 1 [μm] as the user-specified unit If the resolution is 0.1 μm, the set Feed is 10000.

Note that although the calculated resolution can be freely set as described above, the physical resolution binds to the encoder resolution.

7.1.4. Polarity (607Eh)

7	6	5 - 0
Position polarity	Velocity Polarity	Reserved

MSB LSB

This sets the polarities of the position and of the velocity.

Position polarity: Sets the polarity of the position. Setting to 1 gives reverse polarity.

Velocity polarity: Sets the polarity of the velocity. Setting to 1 gives reverse polarity. The polarity of the torque is linked to the polarity of the velocity.

Basically, it is recommended to set the same value to the Position polarity and to the Velocity polarity.

7.2. Common objects

These are the objects that can be set and read in the all control modes.

Index	Sub-Index	Name	Units	Data Type	Range	Access	PDO
6064_h	00_h	Position actual value	User	I32	-2147483648 - 2147483647	ro	RxPDO
$606C_h$	00_h	Velocity actual value	User/s	I32	-2147483648 - 2147483647	ro	RxPDO
6077_h	00_h	Torque actual value	0.1%	I32	-32768 - 32767	ro	RxPDO
6080_h	00_h	Max motor speed	rpm	U32	0 - 4294967295	rw	No

7.2.1. Position actual value (6064h)

This indicates the current position. The unit is user-specified.

7.2.2. Velocity actual value (606Ch)

This indicates the current velocity. The unit is a user-specified/second.

7.2.3. Torque actual value (6077_h)

This indicates the current torque. The unit is in 0.1%.

7.2.4. Max motor speed (6080_h)

This sets the maximum rotational speed of the motor. The unit is in rpm.

This register limits the maximum speed in each control mode. In the torque control mode, the speed is limited either by this or 500 rpm; Whichever is lower.

7.3. Position control common settings

7.3.1. Related objects

Index	Sub-Index	Name	Units	Data Type	Range	Access	PDO
6062_h	00_h	Position demand value	User	I32	-2147483648 - 2147483647	ro	TxPDO
6065_h	00_h	Following error window	User	U32	0 - 4294967295	rw	RxPDO
6066_h	00_h	Following error time out	User	U16	0 - 65535	rw	RxPDO
$607A_h$	00_h	Target position	User	I32	-2147483648 - 2147483647	rw	RxPDO
$607B_h$		Position range limit					-
	01_h	Min position range limit	User	I32	-2147483648 - 2147483647	rw	RxPDO
	02_h	Max position range limit	User	I32	-2147483648 - 2147483647	rw	RxPDO
$607D_h$		Software position limit	-	-	-	-	-
	01_h	Min position limit	User	I32	-2147483648 - 2147483647	rw	RxPDO
	02_h	Max position limit	User	I32	-2147483648 - 2147483647	rw	RxPDO
$60F4_h$	00_h	Following error actual value	User	I32	-2147483648 - 2147483647	ro	TxPDO

7.3.2. Position demand value (6062_h)

This indicates current target position at the controlled positioning. The unit is user-specified.

7.3.3. Following error window (6065_h)

This sets a threshold value, at that it sets the Following error (bit 13) in the Statusword (6041_h) to 1, of the difference in the Position demand value (6062_h) and the Position actual value (6064_h). The unit is user-specified.

7.3.4. Following error time out (6066_h)

This sets the duration time, before it sets the Following error (bit 13) to 1, while the difference in the Position demand value (6062_h) and the Position actual value (6064_h) exceeds the value of the Following error window (6065_h), The unit is in millisecond.

7.3.5. Target position ($607A_h$)

This sets the target position. The unit is user-specified.

7.3.6. Position range limit ($607B_h$)

Sub-index	Name	Unit	Range	Description
01	Min position range limit	User	-2147483648 - 2147483647	The minimum value for cycling.
02	Max position range limit	User	-2147483648 - 2147483647	The maximum value for cycling.

This sets the range for the maximum and minimum values for the positioning. If position information exceeds values set in this register, the displayed position will automatically wrap around to that value opposite of the exceeded side. The unit is user-specified.

Setting Example

If a rotary stage has the range of 0° to 359.9°at the increments of 0.1°

Min position range limit = 0 and Max position range limit = 3599

*In order to operate with the unit of 0.1°, a user-specified unit must be set, separately.

7.3.7. Software position limit (607D$_h$)

Sub-index	Name	Unit	Range	Description
01	Min position limit	User	-2147483648 - 2147483647	The lower limit at the range of movement
02	Max position limit	User	-2147483648 - 2147483647	The upper limit at the range of movement

The software limits the range of movement.

If a set position goes beyond the set ranges, the positioning will be halt at the set range.

If the current position is outside of the set range, it operates only movement directed toward the inside of the range.

This function does not become effective before performing the homing operation.

Also, this function can be disabled to set the values equating to Min position limit > = Max position limit.

If using the Position range limit function, instead, the set values to the function should be the outside of the ranges of the Position range limit, or disable it.

The unit is user-specified.

7.3.8. Following error actual value (60F4$_h$)

This is the difference in the Position demand value (6062$_h$) and the Position actual value (6064$_h$). The unit is user-specified.

7.4. Velocity control common settings

Index	Sub-Index	Name	Units	Data Type	Range	Access	PDO
606D$_h$	00$_h$	Velocity window	User/s	U16	0 - 65535	rw	RxPDO
606E$_h$	00$_h$	Velocity window Time	1ms	U16	0 - 65535	rw	RxPDO
606F$_h$	00$_h$	Velocity threshold	User/s	U16	0 - 65535	rw	RxPDO
6070$_h$	00$_h$	Velocity threshold time	1ms	U16	0 - 65535	rw	RxPDO
60B1$_h$	00$_h$	Velocity offset	User/s	I32	-2147483648 - 2147483647	rw	RxPDO
60B2$_h$	00$_h$	Torque offset	0.1%	I16	-32768 - 32767	rw	RxPDO
60C5$_h$	00$_h$	Max acceleration	User/s^2	U32	0 - 4294967295	rw	RxPDO
60C6$_h$	00$_h$	Max deceleration	User/s^2	U32	0 - 4294967295	rw	RxPDO
60FF$_h$	00$_h$	Target velocity	User/s	I32	-2147483648 - 2147483647	rw	RxPDO

7.4.1. Velocity demand value (606B$_h$)

This is the control velocity over the current time. The unit is a user-specified unit/s.

7.4.2. Velocity window (606D$_h$)

This sets the difference in the velocities, at which judges that the current velocity (Velocity actual value reaches the current target velocity (Target velocity) + (Velocity offset).

7.4.3. Velocity window time (606E$_h$)

This sets the duration time waiting to set the bit 10 in the Statusword to 1, while the current velocity reaches the range set in the Velocity window (606D$_h$). The unit is in millisecond (ms).

7.4.4. Velocity threshold (606F$_h$)

This specifies the velocity threshold which is considered to be stopped.

7.4.5. Velocity threshold time (6070$_h$)

This sets the duration time waiting to set the bit 12 (speed) in the Statusword at 0, while the current velocity exceeds the Velocity threshold (606F$_h$). The unit is in millisecond (ms).

7.4.6. Velocity offset (60B1$_h$)

This sets the velocity offset for the target velocity. The unit is a user-specified/s.

7.4.7. Target velocity (60FF$_h$)

This sets the target velocity. The unit is a user-specified/second.

7.5. Torque control common settings

The Torque control function controls the torque maintained at the specified value.

For no-load, or for light loads, the acceleration will automatically be according to the set torque, but the maximum speed of the motor is limited to 500 rpm.

Index	Sub-Index	Name	Units	Data Type	Range	Access	PDO
6071$_h$	00$_h$	Target torque	0.1%	I16	-32768 - 32767	rw	RxPDO
6072$_h$	00$_h$	Max torque	0.1%	U16	0 - 65535	rw	RxPDO
60B2$_h$	00$_h$	Torque offset	0.1%	I16	-32768 - 32767	rw	RxPDO

7.5.1. Target torque (6071$_h$)

This sets the target torque. The unit is in 0.1%.

7.5.2. Max torque (6072$_h$)

This sets the maximum torque value. The unit is in 0.1%.

7.5.3. Torque offset (60B2$_h$)

This sets an offset for the target torque. The unit is in 0.1%.

8. Modes of operation

8.1. Supported operation modes

The driver supports the following operation modes.

Modes of the Position control

pp: profile position mode

ip: interpolated position mode

csp: cyclic synchronous position mode

hm: homing mode

Modes of the Velocity control system

pv: profile velocity mode

csv: cyclic synchronous velocity mode

Modes of the Torque control system

tq: torque profile mode

cst: cyclic synchronous torque mode

8.1.1. Supported drive modes (6502_h)

31 - 16	15 - 11	10	9	8	7	6	5	4	3	2	1	0
Manufacturer-specific	reserved	cstca	cst	csv	csp	ip	hm	r	tq	pv	vl	pp
MSB												LSB

The bits for the operation modes supported are displayed as 1.

The default value for this register is 000003EDh in the driver.

8.2. Switching operation modes

When switching operation modes, it is recommended to perform such switching at a state other than that at the Operation enabled. If a mode setting is performed at the Operation enabled, the servo may be temporarily turned off during the transition.

8.2.1. Modes of operation (6060_h)

This specifies which operation mode to switch.

If an unsupported mode number is specified the setting is ignored.

Value	Mode of operation
-128 to -1	Manufacturer-specific operation modes (not supported)
0	No mode change/no mode assigned
1	Profile position mode
2	Velocity mode (not supported)
3	Profile velocity mode
4	Torque profile mode
5	Reserved (Not used)
6	Homing mode

7	Interpolated position mode
8	Cyclic sync position mode
9	Cyclic sync velocity mode
10	Cyclic sync torque mode
11	Cyclic sync torque mode with commutation angle (not supported)
12 to 127	Reserved (Not used)

8.2.2. Modes of operation display (6061h)

This displays a currently active operation mode.

The definitions of the displayed values are the same in the 6060h.

8.3. Profile position mode (PP)

In the Profile position mode, the positioning to the specified position is performed according to the set velocity and the set acceleration / deceleration.

8.3.1. Related objects

Index	Sub-Index	Name	Units	Data Type	Range	Access	PDO
6040h	00h	Controlword	-	U16	0 - 65535	rw	RxPDO
6041h	00h	Statusword	-	U16	0 - 65535	ro	TxPDO
6062h	00h	Position demand value	User	I32	-2147483648 - 2147483647	ro	TxPDO
6064h	00h	Position actual value	User	I32	-2147483648 - 2147483647	ro	TxPDO
607Ah	00h	Target position	User	I32	-2147483648 - 2147483647	rw	RxPDO
607Bh		Position range limit					
	01h	Min position range	User	I32	-2147483648 - 2147483647	rw	RxPDO
	02h	Max position range	User	I32	-2147483648 - 2147483647	rw	RxPDO
607Dh		Software position limit	-	-	-	-	-
	01h	Min position limit	User	I32	-2147483648 - 2147483647	rw	RxPDO
	02h	Max position limit	User	I32	-2147483648 - 2147483647	rw	RxPDO
607Eh	00h	Polarity	-	U8	0, 192	rw	No
607Fh	00h	Max profile velocity	User	U32	0 - 4294967295	rw	RxPDO
6080h	00h	Max motor speed	rpm	U16	0 - 65535	rw	RxPDO
6081h	00h	Profile velocity	User/s	U32	0 - 4294967295	rw	RxPDO
6083h	00h	Profile acceleration	User/s^2	U32	0 - 4294967295	rw	RxPDO
6084h	00h	Profile deceleration	User/s^2	U32	0 - 4294967295	rw	RxPDO
6086h	00h	Motion profile type	-	U8	0 - 3	rw	No
60C5h	00h	Max acceleration	User/s^2	U32	0 - 4294967295	rw	RxPDO
60F2h	00h	Position option code	-	U16	0 - 32767	rw	RxPDO

8.3.2. Controlword (6040h)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
ms					r	oms	h	fr	oms			eo	qs	ev	so
MSB															LSB

8.3.2.1. Operational instructions

The bit 9, 5 and 4 instruct the operations in PP mode.

Bit 9	Bit 5	Bit 4	Description
0	0	0 → 1	After completing the current target positioning, it proceeds the next target positioning.
X	1	0 → 1	Transition to the next target positioning starts immediately.
1	0	0 → 1	The Current target positioning maintains the current profiled speed. After completing the current positioning, the new target positioning proceeds with a new set profiled speed.

8.3.2.2. Setting operation states

The Bit 8 and the Bit 6 configure the operation states.

Bit	Value	Description
6	0	The position of the target is absolute positioning.
	1	The position of the target is relative to positioning.
8	0	The target positioning proceeds on or will be processed.
	1	The operation stops according to the set Halt option code ($605D_h$).

8.3.3. Statusword (6041_h)

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

8.3.3.1. Display of operating state

In PP mode, the returned status is as following; Refer to 6.2.2 for other bits.

Bit	Value	Description
10	0	Halt = 0: Target position has not been reached. Halt = 1: Axis is decelerating.
	1	Halt = 0: Target position has been reached. Halt = 1: Axis has stopped.
12	0	It has completed the previous targeting and is ready for a next new target position input.
	1	The previous set target positioning is being processed and the next target position can be overwritten.
13	0	No Following error has occurred.
	1	Following error has occurred.

8.3.4. Target position ($607A_h$)

This sets the target position. It reflects the target position by setting the new set-point (Bit 4) in the Controlword at 0 → 1 and the operation begins.The unit is user-specified.

8.3.5. Max profile velocity ($607F_h$)

This sets the maximum value for the profile velocity. The unit is a user-specified unit/second.

The profile velocity is limited either by this setting, or by the Max motor speed (6080_h); Whichever is smaller.

8.3.6. Profile velocity (6081_h)

This sets the profile velocity. The unit is a user-specified unit/s.

8.3.7. Profile acceleration (6083_h)

This sets the acceleration for the profile velocity. The unit is a user-specified unit/s^2.

8.3.8. Profile deceleration (6084_h)

This sets the deceleration for the profile velocity. The unit is a user-specified unit/s^2.

8.3.9. Motion profile type (6086_h)

This sets the acceleration / deceleration curve. To set it at 0 executes linear acceleration. To set it at 1 executes $\sin^2$ curve acceleration. This profile type does not support the setting at 2.

8.3.10. Max acceleration (60C5h)

This sets the maximum value for acceleration / deceleration. The unit is a user-specified unit/s^2.

8.3.11. Position option code (60F2h)

The Position option code enables more detailed operation settings for operation conditions specified by the Controlword.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
ms	reserved			ip option				rado		rro		cio		rop	
MSB															LSB

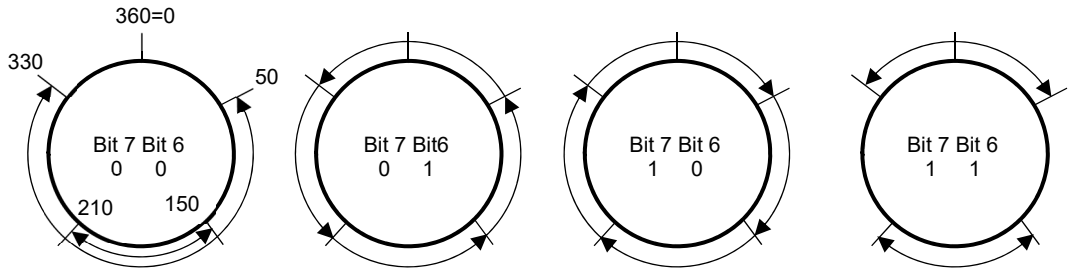
ms manufacturer specific: not used

ip option reserved for interpolation position mode: not used

8.3.11.1. Rotary axis direction option (rado)

These are the configuration of the Positioning mode and operating directions for the rotating shaft.

Bit 7	Bit 6	Description
0	0	This is the same Positioning mode as for a linear actuator. Use this setting when using a linear actuator. Only with this setting is it possible to set a value that exceeds the Position range limit.
0	1	In this mode, the rotation direction can only be CCW.
1	0	In this mode, the rotation direction can only be CW.
1	1	This mode performs positioning using the shortest path. If the distance is the same for either directions, it operates in the CW direction.



Rotating shaft positioning example

8.3.11.2. Request-response option (rro)

This sets the new set-point bit (bit4) in the Countrolword either to be controlled on a master side with a handshake executed as usual, or to automatically be released within the slave. If a normal handshake is not executed, the set-point acknowledge bit (Statusword bit12) on the slave side is immediately cleared to 0 under the specified conditions, regardless of the state of the new set-point bit.

Bit 5	Bit 4	Description
0	0	Performs the normal handshake operation.
0	1	Releases the new set-point bit upon the completion of a positioning.
1	0	Releases the new set-point bit as soon as being ready to accept the setting of a new target position.
1	1	Reserved

8.3.11.3. Change immediately option (cio)

This specifies the operation when the change immediately option bit (bit 5) in the Controlword is set to 1.

Note that this is not supported by the driver.

Bit 3	Bit 2	Description
0	0	The slave immediately starts a new positioning.
0	1	The slave continues with the current positioning and, upon reaching the position, starts to operate according to the new set speed and acceleration.
1	0	Reserved
1	1	Reserved

8.3.11.4. Relative option (rop)

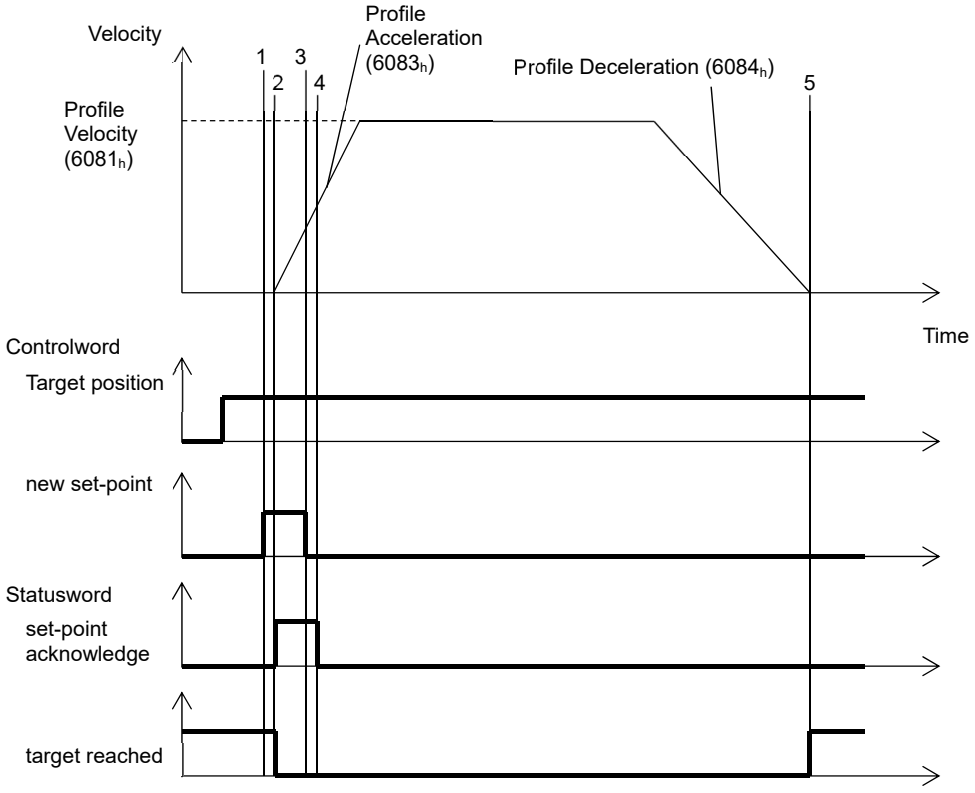
This specifies the operation when the abs/rel bit (bit 6) in the Controlword is set to 1.

Bit 1	Bit 0	Description
0	0	This performs relative movement with respect to the previous positioning target (Target position).
0	1	This performs relative movement with respect to the current movement target value (Actual position demand value).
1	0	This performs relative movement with respect to the current position (Position actual value).
1	1	Reserved

8.3.12. Control in PP mode

8.3.12.1. Basic control

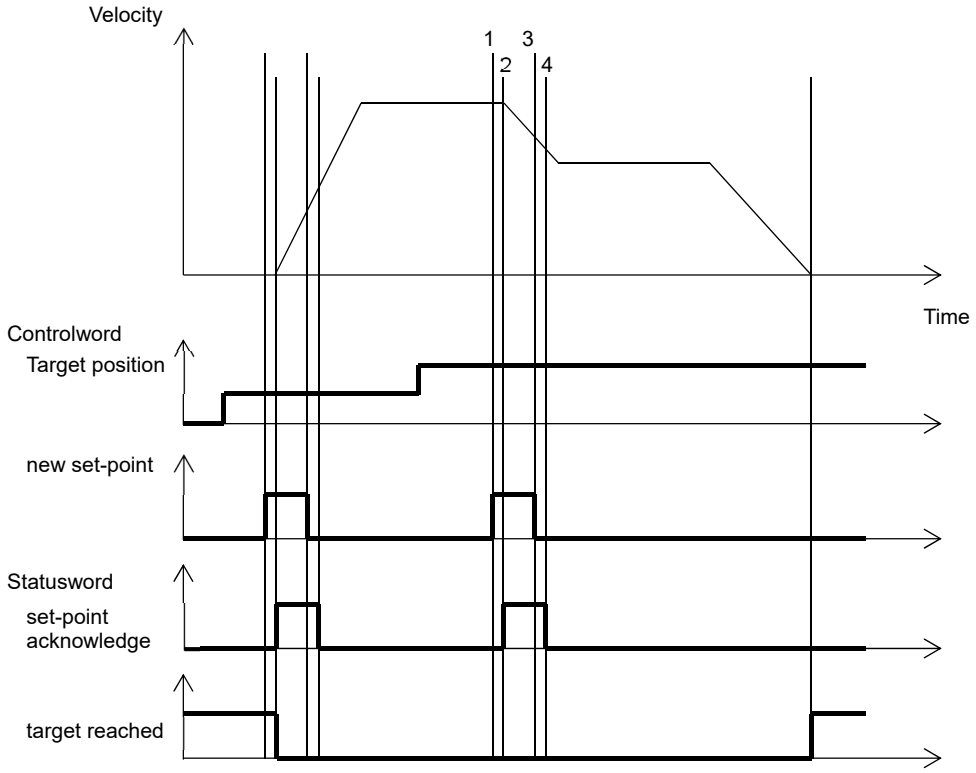
1. For motions, it sets maximum velocity in the Profile velocity (6081_h), acceleration / deceleration in the Profile Acceleration (6083_h) and the Profile Deceleration (6084_h), respectively, a target position to the Target position ($607A_h$) and, after at least one cycle apart, changes the new set-point (bit 4) in the Controlword (6040_h) from 0 to 1.
2. The driver changes the set-point acknowledge (bit 2) in the Statusword (6041_h) from 0 to 1 and then the driver receives a new position values to begin the operation.
3. The master re-sets the new set-point to 0 after confirming the change in the set-point acknowledge is 0.
4. The driver confirms that the new set-point is 0, and then re-sets the set-point acknowledge to 0.
5. The driver, after reaching a specified position, changes the target reached (bit 10) in theStatusword changes from 0 to 1. Thus, a positioning is completed.



8.3.12.2. Setting the target position during the operation by not using a buffer

If a target position is updated during the operation while the bit 5 (change set immediately) in the Controlword (6040_h) is 1, the driver interrupts a current positioning and starts a next positioning operation immediately.

1. After a master sets a new target position, it confirms that the set-point acknowledge (Statusword bit 12) is 0, and then changes the bit 4 (new set-point) in the Controlword from 0 → 1.
2. The driver confirms the transition of the bit 4 (new set-point) in the Controlword from 0 → 1, at which time, it starts a new operation based on the Target position ($607A_h$), Profile velocity (6081_h), Profile acceleration (6083_h) and Profile deceleration (6084_h). Thereafter, it sets the bit 12 (set-point acknowledge) in the Statusword (6041_h) to 1.
3. The master confirms the change of the bit 12 (set-point acknowledge) in the Statusword (6041_h) to 1, and then sets the bit 4 (new set-point) in the Controlword (6040_h) to 0.
4. The driver confirms that the bit 4 (new set-point) in the Controlword (6040_h) is 0, and then it re-sets the bit 12 (set-point acknowledge) in the Statusword (6041_h) to 0.

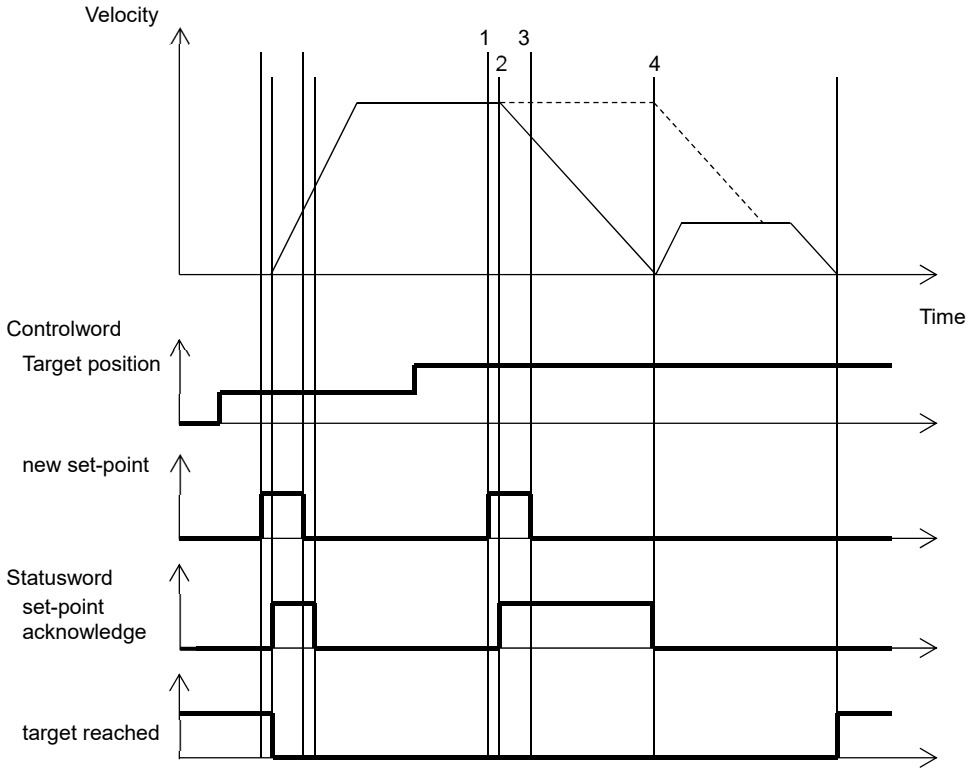


8.3.12.3. Setting the target position during operation byusing a buffer

If a target position is updated during operation while the bit 5 (change set immediately) in theControlword (6040_h) is 0, a driver starts a next positioning operation, immediately after, it completes the current positionin.

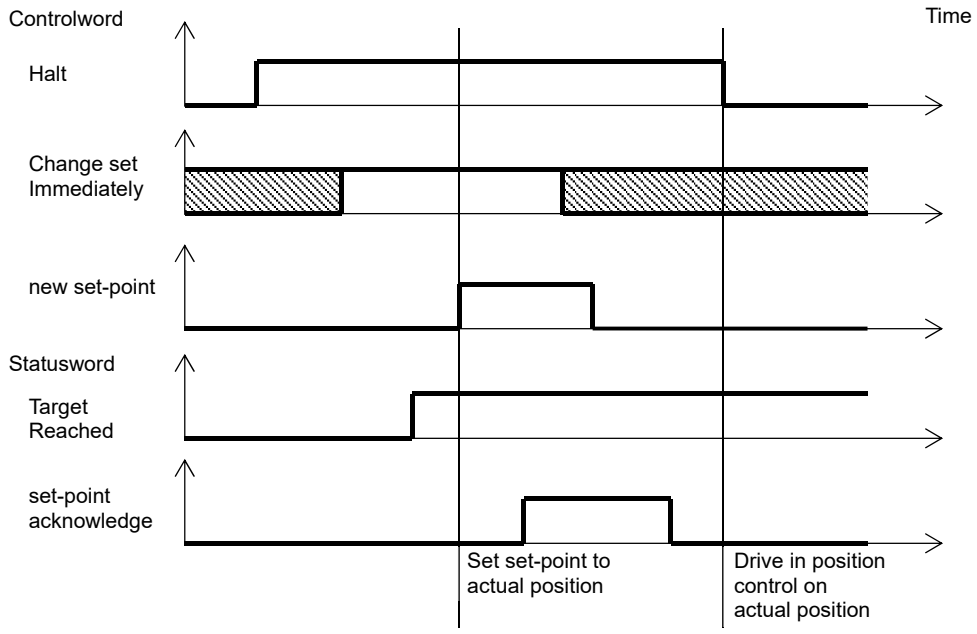
1. A master sets a new target position, then, confirms that the set-point acknowledge (Statusword bit 12) is 0, and then changes the bit 4 (new set-point) in the Controlword from 0 → 1.
2. The driver confirms the change of the bit 4 (new set-point) in the Controlword from 0 → 1, saves the current Target position ($607A_h$) to the buffer while continuing its operation. Thereafter, sets the bit 12 (set-point acknowledge) of Statusword (6041_h) to 1.
3. The master confirms the change of the bit 12 (set-point acknowledge) in the Statusword (6041_h) to 1, and sets the bit 4 (new set-point) in the Controlword (6040_h) to 0.
4. After the completion of the current operation, the driver reads the new target position from the buffer and starts the next operation. Simultaneously, the dirver confirms the buffer is emptied by being read the change of the bit 4 (new set-point) in the Controlword (6040_h) is 0, and then changes the bit 12 (set-point acknowledge) in the Statusword (6041_h) to 0.

During the operation described above, if the bit 9 (change on set-point) in the Controlword (6040_h) is 1, a sequenced operation will be performed without stopping, as the dotted line illustrated as below. However, if a direction of a movement reverses for a sequenced positioing, a stop will occur at the first target position prior to moving in the reverse direction.



8.3.12.4. Erasing a target position while in Halt.

While a master keeps the Halt (bit 8) in the Controlword (6040h) at 1, keeping an axis in halt, it sets the change set immediately (bit 5) to 1 and then executes the New set-point, the driver erases a previous target position and handles a current position as a target position, therefore, a driver stops at the current position even after the master re-sets the Halt to 0.



8.4. Cyclic synchronous position mode (CSP)

In the Cyclic synchronous position mode, a master side performes track generation to instruct position data periodically for a synchronous control of the slave device(s).

8.4.1. Related objects

Index	Sub-Index	Name	Units	Data Type	Range	Access	PDO
6040_h	00_h	Controlword	-	U16	0 - 65535	rw	RxPDO
6041_h	00_h	Statusword	-	U16	0 - 65535	ro	TxPDO
6062_h	00_h	Position demand value	User	I32	-2147483648 - 2147483647	ro	TxPDO
6064_h	00_h	Position actual value	User	I32	-2147483648 - 2147483647	ro	TxPDO
$606C_h$	00_h	Velocity actual value	User	I32	-2147483648 - 2147483647	ro	TxPDO
6077_h	00_h	Torque actual value	0.1%	I32	-1000 - 1000	ro	TxPDO
$607A_h$	00_h	Target position	User	I32	-2147483648 - 2147483647	rw	RxPDO
$607B_h$		Position range limit	-	-	-	-	-
	01_h	Min position range	User	I32	-2147483648 - 2147483647	rw	RxPDO
	02_h	Max position range	User	I32	-2147483648 - 2147483647	rw	RxPDO
$607D_h$		Software position limit	-	-	-	-	-
	01_h	Min position limit	User	I32	-2147483648 – 2147483647	rw	RxPDO
	02_h	Max position limit	User	I32	-2147483648 – 2147483647	rw	RxPDO
$607E_h$	00_h	Polarity	-	U8	0 or 192	rw	No
6080_h	00_h	Max motor speed	rpm	I16	0 - 4294967295	rw	RxPDO
$60C2_h$		Interpolation time period	-	-	-	-	-
	01_h	Interpolation time period value	ms	U8	1 - 255	rw	No
	02_h	Interpolation time index	-	I8	-3	rw	No

8.4.2. Controlword (6040_h)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
ms					r	oms	h	fr	oms			eo	qs	ev	so
MSB															LSB

Bit	Name	Value	Description
7, 3-0		-	Refer to “Controlword state transition commands”
8	Halt	0	Allow operation
		1	Stop operation
9, 6-4	Operation mode specific	-	Not used
10	Reserved	-	Not used
15-11	Manufacturer specific	-	Not used

8.4.3. Statusword (6041_h)

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

Bit	Name	Value	Description
12	Drive follows the command value	0	Target position command invalid
		1	Target position command valid
15-14, 8	Manufacturer specific	-	Not used

8.4.4. Target position ($607A_h$)

This sets a target position. The unit is user-specified.

It constantly follows a specified position in a PDO communication cycle.

The difference in set positions is values which speed and acceleration are with taking into account to a motor is able to follow.

If motion speed per cycle exceeds the Max motor speed (6080_h), the tracking position is limited to that position that can be reached at the Max motor speed.

8.4.5. Position Offset ($60B0_h$)

This specifies an offset for the target position. The unit is user-specified.

8.4.6. Interpolation time period ($60C2_h$)

Sub-index	Name	Unit	Range	Description
01	Interpolation time period value	ms	1 - 255	The mantissa part of the interpolation time period
02	Interpolation time index	-	-3	The exponent part of the interpolation time period

The interpolation time period is set automatically. For the driver, the exponent part is fixed at -3, and the mantissa shows ms.

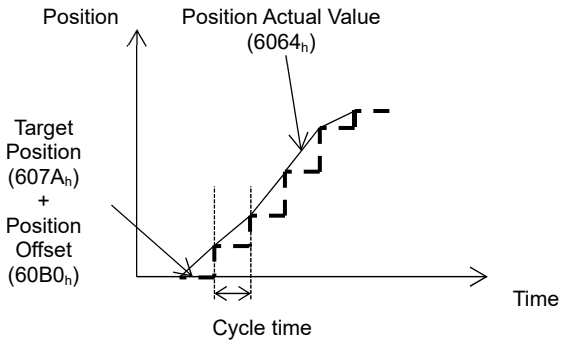
8.4.1. Control in CSP mode

8.4.1.1. Basic control

When setting the CSP mode in the Modes of operation and changing the Operation enable state, the driver operates by tracking target positions set by the addition of the Target position ($607A_h$) and Position offset ($60B0_h$).

A mater side updats target positions by a PDO communication cycle.

When the Max motor speed (6080_h) is set beyond a reachable position, the target position is limited to the reachable range to perform tracking operation.



8.5. Interpolated position mode (IP)

The Interpolated position mode is a positioning which interpolates intermediate positions based on position information set in advance. The calculation for the interpolat intermediate data is performed in 1 ms cycle. The two methods, FIFO or ring buffer, can be selected to storing and reading the interpolation data.

8.5.1. Related objects

Index	Sub-Index	Name	Units	Data Type	Range	Access	PDO
6040_h	00_h	Controlword	-	U16	0 - 65535	rw	RxPDO
6041_h	00_h	Statusword	-	U16	0 - 65535	ro	TxPDO
6062_h	00_h	Position demand value	User	I32	-2147483648 - 2147483647	ro	TxPDO
6064_h	00_h	Position actual value	User	I32	-2147483648 - 2147483647	ro	TxPDO
$606C_h$	00_h	Velocity actual value	User	I32	-2147483648 - 2147483647	ro	TxPDO
6077_h	00_h	Torque actual value	0.1%	I32	-1000 - 1000	ro	TxPDO
$607B_h$		Position range limit	-	-	-	-	-
	01_h	Min position range	User	I32	-2147483648 - 2147483647	rw	RxPDO
	02_h	Max position range	User	I32	-2147483648 - 2147483647	rw	RxPDO
$607D_h$		Software position limit	-	-	-	-	-
	01_h	Min position limit	User	I32	-2147483648 - 2147483647	rw	RxPDO
	02_h	Max position limit	User	I32	-2147483648 - 2147483647	rw	RxPDO
$607E_h$	00_h	Polarity	-	U8	0 or 192	rw	No
6080_h	00_h	Max motor speed	rpm	I16	0 - 4294967295	rw	RxPDO
$60C0_h$	00_h	Interpolation sub mode select	-	I16	-32768 - 32767	rw	No
$60C1_h$		Interpolation data record	-	-	-	-	-
	01_h	Interpolation target position	User	I32	-2147483648 - 2147483647	rw	RxPDO
$60C2_h$		Interpolation time period	-	-	-	-	-
	01_h	Interpolation time period value	ms	U8	1 – 255	rw	No
	02_h	Interpolation time index	-	I8	-3	rw	No
$60C4_h$		Interpolation data configuration	-	-	-	-	-
	01_h	Maximum buffer size	-	U32	256	ro	No
	02_h	Actual buffer size	-	U32	0 - 4294967295	rw	RxPDO
	03_h	Buffer organization	-	U8	0 - 1	rw	RxPDO
	04_h	Buffer position	-	U16	0 - 256	rw	RxPDO
	05_h	Size of data record	-	U8	4	rw	RxPDO
	06_h	Buffer clear	-	U8	0 - 1	rw	RxPDO

8.5.2. Controlword (6040_h)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
ms					r	oms	h	fr	oms			eo	qs	ev	so

MSB LSB

Bit	Name	Value	Description
4	Enable interpolation	0	Interpolation disabled
		1	Interpolation enabled
8	Halt	0	Allow operation
		1	Stop operation

8.5.3. Statusword (6041_h)

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

Bit	Name	Value	Description
10	Target reached	0	Halt = 0: Target position not reached Halt = 1: Decelerating
		1	Halt = 0: Target position reached Halt = 1: Stopped
12	Drive follows the command value	0	Target position command invalid

Bit	Name	Value	Description
		1	Target position command valid
13	Following error	0	No position deviation error
		1	Position deviation error occurrence
15-14, 8	Manufacturer specific	-	Not used

8.5.4. Interpolation sub mode select (60C0$_h$)

This specifies calculation algorithm for the interpolation. The driver supports only linear interpolation (= 0).

8.5.5. Interpolation data record (60C1$_h$)

This specifies interpolation position data.

Position information for writing to Sub-index 01_h is set. In the case of SDO communication, data is added to the buffer when there is an entry written to this register. When mapping to PDO communication, writing is performed for each period in the communication cycle. The write position is always at the end in the case of FIFO, and in the case of the ring buffer, writing is to the position specified by Buffer position.

8.5.6. Interpolation time period (60C2$_h$)

Sub-index	Name	Unit	Range	Description
01	Interpolation time period value	ms	1	The mantissa part of the interpolation time period
02	Interpolation time index	-	-3	The exponent part of the interpolation time period

This specifies the period to interpolate the position data. This setting is 1 ms.

8.5.7. Interpolation data configuration (60C4$_h$)

Sub-index	Name	Unit	Range	Description
01	Maximum buffer size	-	256	The maximum size of the buffer
02	Actual buffer size	-	0 - 256	The actual size of the buffer
03	Buffer organization	-	0 - 1	0: FIFO, 1: Ring buffer
04	Buffer position	-	0 - 255	The next free buffer position
05	Size of data record	Byte	4	The record data size in bytes
06	Buffer clear	-	0 - 1	0: All buffer data is cleared, and access to the buffer is prohibited 1: Writing to the buffer is possible.

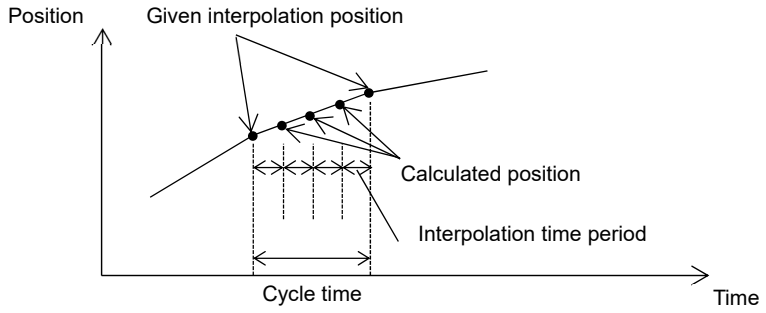
This makes settings for the interpolation position data buffer.

8.5.8. Control in IP mode

8.5.8.1. Basic control

This mode performs position control based on data stored in a buffer, while interpolating intermediate data. The buffer type can be selected as either FIFO (first-in first-out) or ring buffer.

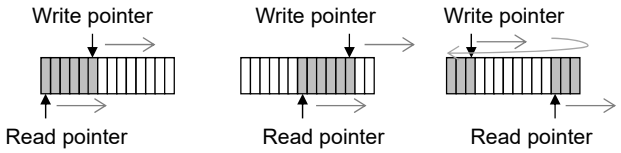
The Interpolation time period is fixed at 1 ms for this device.



8.5.8.2. FIFO mode

In FIFO mode, writing is always to the tail end of the buffer, and reading from the buffer is performed sequentially from the elements that were written first.

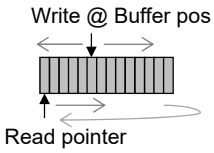
Operation ceases when the read data in the buffer catches up with the write data. For continuous operation without stopping, the read and write cycles must match (writing is with the PDO communication cycle).



8.5.8.3. Ring buffer mode

In Ring buffer mode, the interpolation operation is performed by sequentially reading over the specified buffer size range. For writing to the buffer, it is possible to specify some arbitrary position in the buffer to rewrite what is written there.

After reading up to the end, data will continue to be read from the beginning with continuous operation. This is used such as when repeating the same operations.



8.6. Homing mode (HM)

This mode sets the home position.

8.6.1. Related objects

Index	Sub-Index	Name	Units	Data Type	Range	Access	PDO
6040_h	00_h	Controlword	-	U16	0 – 65535	rw	RxPDO
6041_h	00_h	Statusword	-	U16	0 - 65535	ro	TxPDO
6062_h	00_h	Position demand value	User	I32	-2147483648 - 2147483647	ro	TxPDO
6064_h	00_h	Position actual value	User	I32	-2147483648 - 2147483647	ro	TxPDO
$607C_h$	00_h	Home offset	User	I32	-2147483648 - 2147483647	rw	RxPDO
6098_h	00_h	Homing method	-	I8	-128 - 127	rw	RxPDO
6099_h		Homing speeds		-	-	-	-
	01_h	Speed during search for switch	User/s	U32	0 - 4294967295	rw	RxPDO
	02_h	Speed during search for zero	User/s	U32	0 - 4294967295	rw	RxPDO
$609A_h$	00_h	Homing acceleration	$User/s^2$	U32	0 - 4294967295	rw	RxPDO

8.6.2. Controlword (6040_h)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
ms					r	oms	h	fr	oms			eo	qs	ev	so

MSB LSB

Bit	Name	Value	Description
4	start homing	0 → 1	Starts homing operation
8	Halt	0	Allow operation
		1	Stops homing operation

8.6.3. Statusword (6041_h)

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

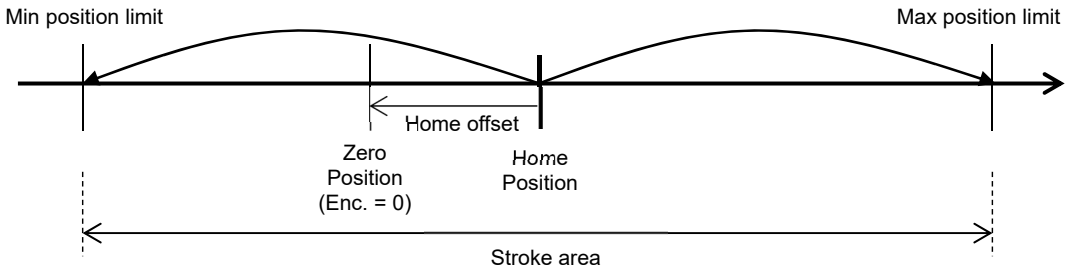
Bit	Name	Value	Description
10	Target reached	0	Operating
		1	Halted
12	Homing attained	0	Homing incomplete
		1	Homing completed
13	Homing error	0	No homing error
		1	Homing error occurrence

Bit 13	Bit 12	Bit 10	Description
0	0	0	Homing operating
0	0	1	Homing operation interrupted or not yet started
0	1	0	Homing operation completed but without reaching the target position
0	1	1	Homing operation completed successfully
1	0	0	Homing error occurred but operation is continuing
1	0	1	Homing error occurred and operation has halted

8.6.4. Home offset ($607C_h$)

This offsets the zero position with respect to a detected home position.

When performing homing operation, the Home offset sets a value reflected by the Position demand value (6062_h) and Position actual value (6064_h). Other changes do not affect a current position. Also, the Software position limit ($607D_h$) sets the value based on the original home position regardless of this setting. Thus, the value of the current position to which the software limits is applied to the value shifted by Home offset. Refer to the figure below for the relationship between the software limit range, homing position and Home offset.



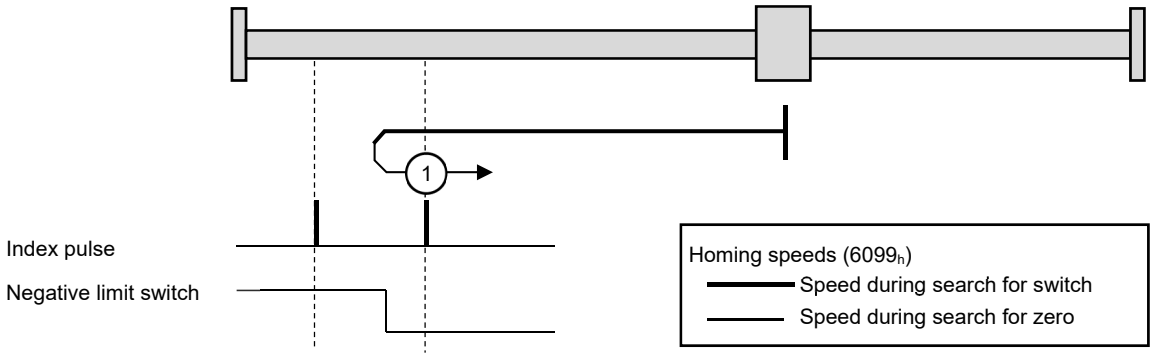
8.6.5. Homing method (6098_h)

This specifies the homing method.

The values that can be specified are -4--1, 1-14, 17-30, 33-35, and 37. If other values are set and homing is performed, a homing error occurs, and 1 is returned to Statusword bit 13: Homing error.

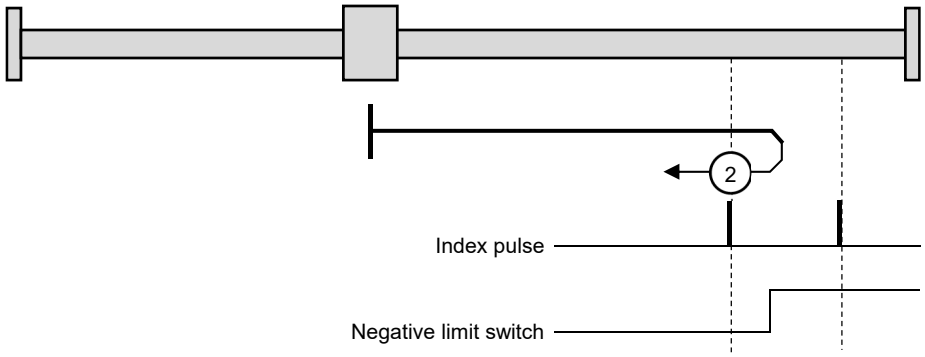
8.6.5.1. Method 1: Homing on negative limit switch and index pulse

In this method, the limit switch is detected in the negative direction, the direction reverses, and home is set at the closest index pulse (= encoder Z phase).



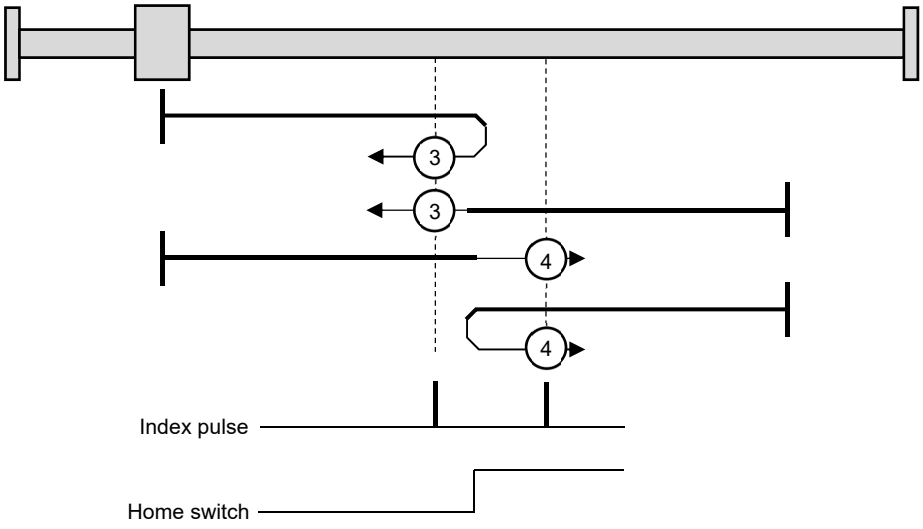
8.6.5.2. Method 2: Homing on positive limit switch and index pulse

In this method, the limit switch is detected in the positive direction, the direction reverses, and home is set at the closest index pulse.



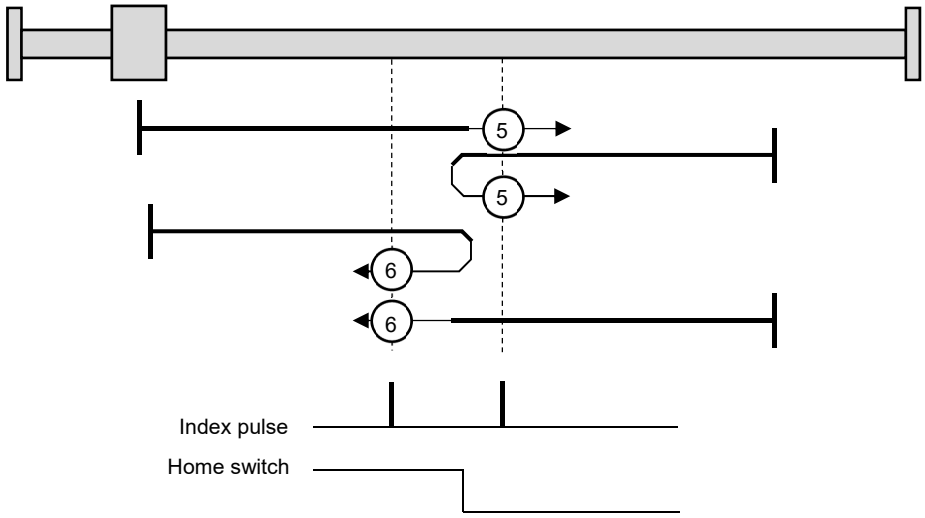
8.6.5.3. Method 3, 4: Homing on positive home switch and index pulse

In these methods, movement is in the positive direction if the home switch is not detected, and in the negative direction if it is detected, with 3 and 4 setting home at the nearest index pulses to the home switch respectively in the negative and positive directions.



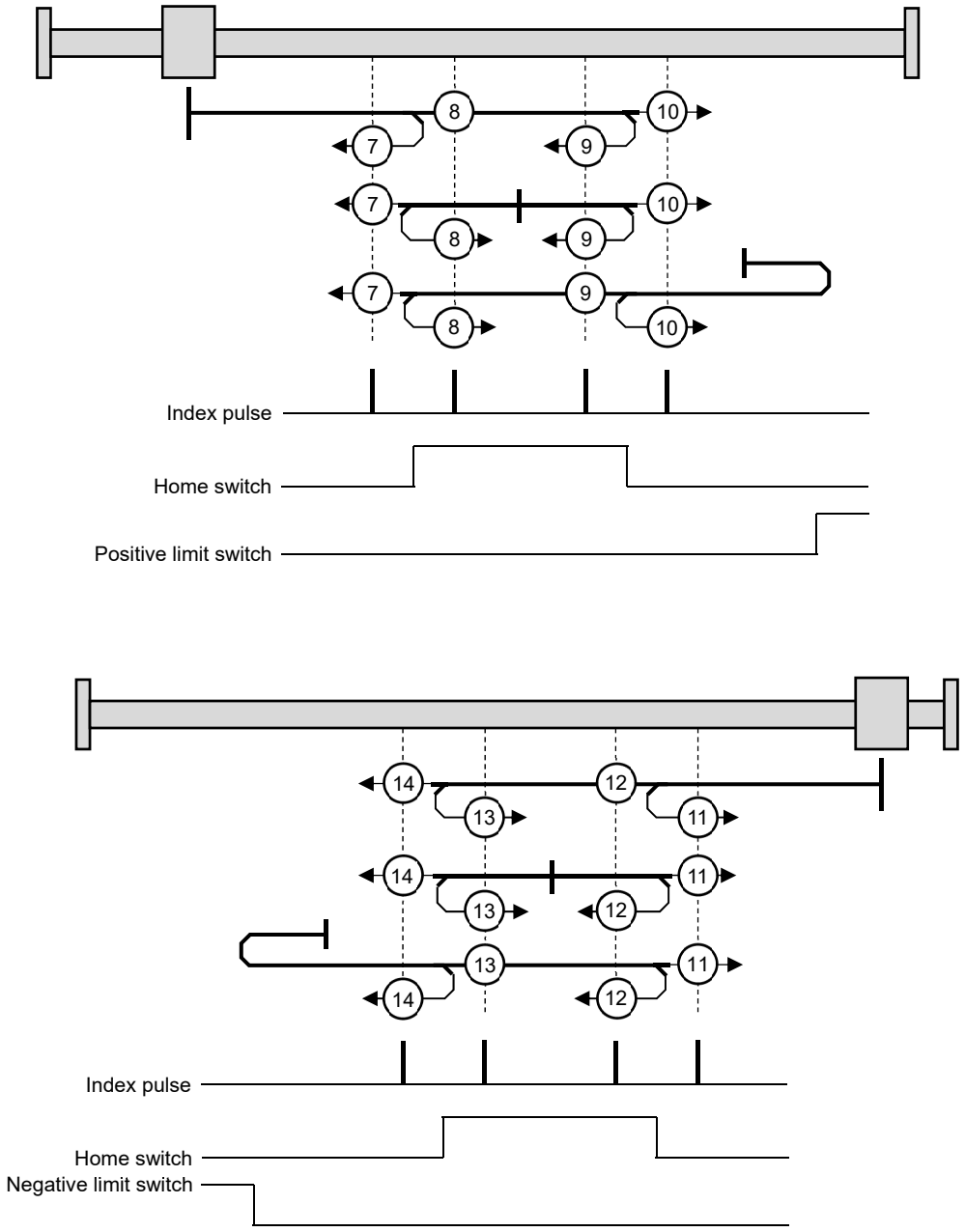
8.6.5.4. Method 5, 6: Homing on negative home switch and index pulse

In these methods, the movement will be toward negative direction if a home switch is not detected, and toward the positive direction if detected, with 5 and 6 setting home at the nearest index pulses to the home switch respectively toward the positive and negative directions.



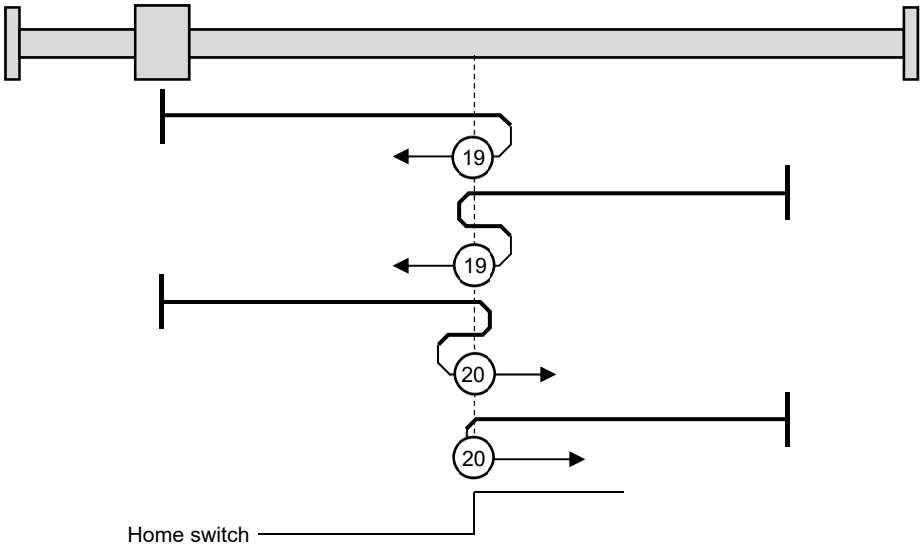
8.6.5.5. Method 7 to 14: Homing on home switch and index pulse

These methods set the nearest index pulse position to detection / non-detection as home for both detection ends of the home switch. If a limit switch is detected in an initial moving direction, the moving direction will be reversed. Refer to the illustration below for moving directions and home setting positions corresponding to each number.



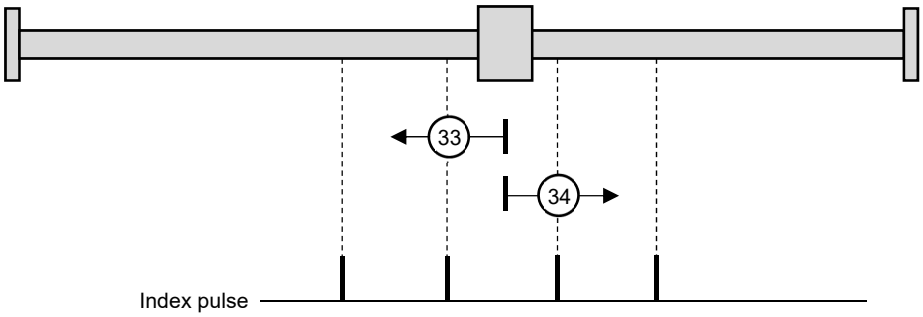
8.6.5.6. Method 17 to 30: Homing without index pulse

These methods respect each of the modes in Method 1 to 14, but take the edge of each switch as home, without using the index pulse. The following figure illustrates the movement for 19 and 20 as reference examples.



8.6.5.7. Method 33, 34: Homing on index pulse

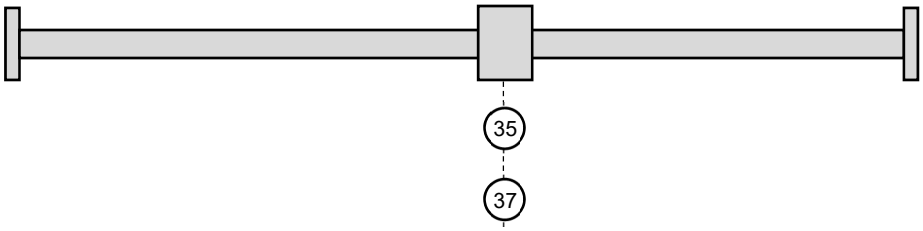
These methods set the nearest index pulse as home.



8.6.5.8. Method 35, 37: Homing on current position

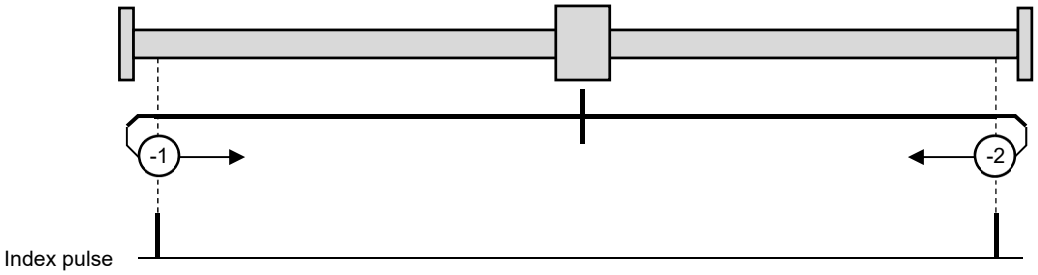
These methods set the current position as home.

Method 35 is now deprecated from the standard. Use Method 37 except, for instance, when compatibility with past designs is required.



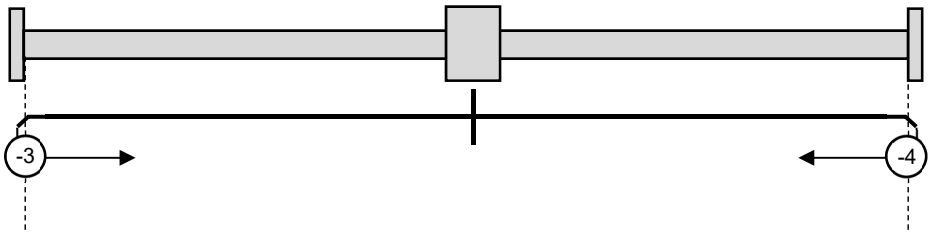
8.6.5.9. Method -1, -2: Homing on torque limit and index pulse

After detecting a fixed torque in the positive direction (Method -2) or the negative direction (Method -1), an index pulse in the opposite direction is detected and is set as home.



8.6.5.10. Method -3, -4: Homing on torque limit

The point at which a fixed torque in the positive direction (Method -4), or the negative direction (Method -3), is detected is set as home.



8.6.6. Homing speeds (6099h)

Sub-index	Name	Unit	Range	Description
01	Speed during search for switch	User	0 - 4294967295	This sets the speed prior to detection of the switch.
02	Speed during search for zero	User	0 - 4294967295	This sets the speed for moving to the home position.

8.6.7. Homing acceleration (609A$_h$)

This sets the acceleration for homing operation. The deceleration upon detection, by a sensor etc., will be as for a sudden stop regardless of this setting. The unit is a user-specified unit/s^2.

8.7. Profile velocity mode (PV)

In the Profile velocity mode, the acceleration or deceleration of a slave device toward a set target velocity is controlled by using a pre-specified acceleration.

8.7.1. Related objects

Index	Sub-Index	Name	Units	Data Type	Range	Access	PDO
6040_h	00_h	Controlword	-	U16	0 - 65535	rw	RxPDO
6041_h	00_h	Statusword	-	U16	0 - 65535	ro	RxPDO
$606B_h$	00_h	Velocity demand value	User/s	I32	-2147483648 - 2147483647	ro	RxPDO
$606C_h$	00_h	Velocity actual value	User/s	I32	-2147483648 - 2147483647	ro	RxPDO
$606D_h$	00_h	Velocity window	User/s	U16	0 - 65535	rw	RxPDO
$606E_h$	00_h	Velocity window Time	1 ms	U16	0 - 65535	rw	RxPDO
$606F_h$	00_h	Velocity threshold	User/s	U16	0 - 65535	rw	RxPDO
6070_h	00_h	Velocity threshold time	1 ms	U16	0 - 65535	rw	RxPDO
$607F_h$	00_h	Max profile velocity	User/s	U32	0 - 4294967295	rw	RxPDO
6080_h	00_h	Max motor speed	rpm	U32	0 - 4294967295	rw	RxPDO
6083_h	00_h	Profile acceleration	User/s^2	U32	0 - 4294967295	rw	RxPDO
6084_h	00_h	Profile deceleration	User/s^2	U32	0 - 4294967295	rw	RxPDO
$60B1_h$	00_h	Velocity offset	User/s	I32	-2147483648 - 2147483647	rw	RxPDO
$60B2_h$	00_h	Torque offset	0.1%	I16	-32768 - 32767	rw	RxPDO
$60C5_h$	00_h	Max acceleration	User/s^2	U32	0 - 4294967295	rw	RxPDO
$60FF_h$	00_h	Target velocity	User/s	I32	-2147483648 - 2147483647	rw	RxPDO

8.7.2. Controlword (6040_h)

The Operation mode specific bit is not used in this mode.

8.7.3. Statusword (6041_h)

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

Bit	Name	Value	Description
10	Target reached	0	Halt = 0: Target speed has not been reached Halt = 1: Decelerating
		1	Halt = 0: Target speed has been reached Halt = 1: Stopped
12	Speed	0	Speed is not 0
		1	Speed is 0

8.7.4. Velocity demand value ($606B_h$)

This indicates a current velocity control value. The unit is a user-specified unit/second.

8.7.5. Velocity actual value ($606C_h$)

This indicates a current velocity value. The unit is a user-specified unit/second.

8.7.6. Velocity window ($606D_h$)

If the absolute value of the difference in the Velocity actual value ($606C_h$) and the sum of the Target velocity ($60FF_h$) and Velocity offset ($60B1_h$) is less than this setting, Target reached (bit 10) of Statusword (6041_h) is set to 1 when Velocity window time ($606E_h$) elapses. The unit is a user-specified unit/second.

8.7.7. Velocity window time (606E$_h$)

This sets the time interval from the instant that the absolute value of the difference between Velocity actual value (606C$_h$) and the sum of Target velocity (60FF$_h$) and Velocity offset (60B1$_h$) reaches Velocity window (606D$_h$) or below, until the instant at which Target reached (bit 10) of Statusword (6041$_h$) sets to 1. The unit is in milliseconds.

8.7.8. Velocity threshold (606F$_h$)

When Velocity actual value (606C$_h$) exceeds this setting, and the Velocity threshold time (6070$_h$) has elapsed, the Speed (bit 12) of Statusword (6041$_h$) is set to 1. The unit is a user-specified unit/second.

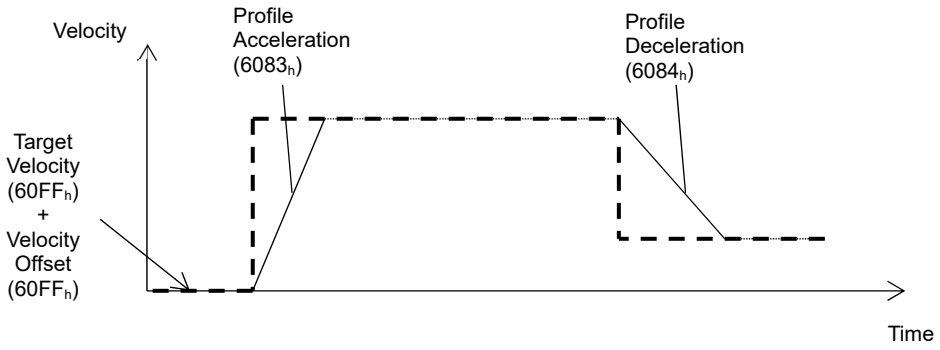
8.7.9. Velocity threshold time (6070$_h$)

This sets the time interval from the instant when Velocity actual value (606C$_h$) exceeds the Velocity threshold (606F$_h$), until the speed (bit 12) of Statusword (6041$_h$) sets to 1. The unit is in millisecond.

8.7.10. Control in PV mode

8.7.10.1. Basic control

In PV mode, the Target velocity (60FF$_h$) and Velocity offset (60B1$_h$) are used for target values to perform velocity tracking using a specified profile acceleration.



8.8. Cyclic synchronous velocity mode (CSV)

The Cyclic synchronous velocity mode controls a motor by periodically updating target velocities from a master side.

8.8.1. Related objects

Index	Sub-Index	Name	Units	Data Type	Range	Access	PDO
6040_h	00_h	Controlword	-	U16	0 - 65535	rw	RxPDO
6041_h	00_h	Statusword	-	U16	0 - 65535	ro	RxPDO
$606B_h$	00_h	Velocity demand value	User/s	I32	-2147483648 - 2147483647	ro	RxPDO
$606C_h$	00_h	Velocity actual value	User/s	I32	-2147483648 - 2147483647	ro	RxPDO
$606D_h$	00_h	Velocity window	User/s	U16	0 - 65535	rw	RxPDO
$606E_h$	00_h	Velocity window Time	1 ms	U16	0 - 65535	rw	RxPDO
$606F_h$	00_h	Velocity threshold	User/s	U16	0 - 65535	rw	RxPDO
6070_h	00_h	Velocity threshold time	1 ms	U16	0 - 65535	rw	RxPDO
$60B1_h$	00_h	Velocity offset	User/s	I32	-2147483648 - 2147483647	rw	RxPDO
$60FF_h$	00_h	Target velocity	User/s	I32	-2147483648 - 2147483647	rw	RxPDO

8.8.2. Controlword (6040_h)

The Operation mode specific bit is not used in this mode.

8.8.3. Statusword (6041_h)

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

Bit	Name	Value	Description
12	Drive follows the command value	0	Target velocity command invalid
		1	Target velocity command valid

8.8.4. Target velocity ($60FF_h$)

This sets the target velocity. The unit is a user-specified unit/s.

8.8.5. Velocity offset ($60B1_h$)

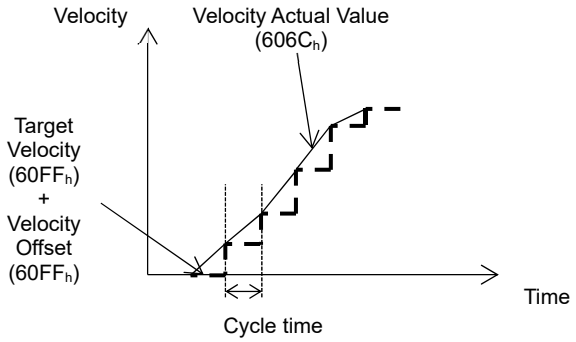
This sets an offset value to be added to the target velocity. The unit is a user-specified unit/s.

8.8.6. Control in CSV mode

8.8.6.1. Basic control

When CSV mode is set in Modes of operation, and the transition to the Operation enable state is made, the driver operates by following the velocity set in Target velocity ($60FF_h$). The target velocity is updated with the PDO communication cycle from a master side.

If the velocity set exceeds Max motor speed (6080_h), the operating velocity will be limited by that value.



8.9. Torque profile mode (TQ)

In torque profile mode, torque control is performed according to a preset torque profile for a specified torque value.

8.9.1. Related objects

Index	Sub-Index	Name	Units	Data Type	Range	Access	PDO
6040_h	00_h	Controlword	-	U16	0 - 65535	rw	RxPDO
6041_h	00_h	Statusword	-	U16	0 - 65535	ro	RxPDO
6071_h	00_h	Target torque	0.1%	I16	-32768 - 32767	rw	RxPDO
6087_h	00_h	Torque slope	0.1%/s	U32	0 - 4294967295	rw	RxPDO
$60B1_h$	00_h	Velocity offset	User/s	I32	-2147483648 - 2147483647	rw	RxPDO
$60B2_h$	00_h	Torque offset	0.1%	I16	-32768 - 32767	rw	RxPDO
$60C5_h$	00_h	Max acceleration	User/s^2	U32	0 - 4294967295	rw	RxPDO
$60FF_h$	00_h	Target velocity	User/s	I32	-2147483648 - 2147483647	rw	RxPDO

8.9.2. Target torque (6071_h)

This sets the target value for the torque. The unit is in 0.1%.

8.9.3. Torque offset ($60B2_h$)

This offsets the target value with respect to Target torque (6071_h). The Target torque value is the sum of Target torque and this setting. The unit is in 0.1%.

8.9.4. Torque slope (6087_h)

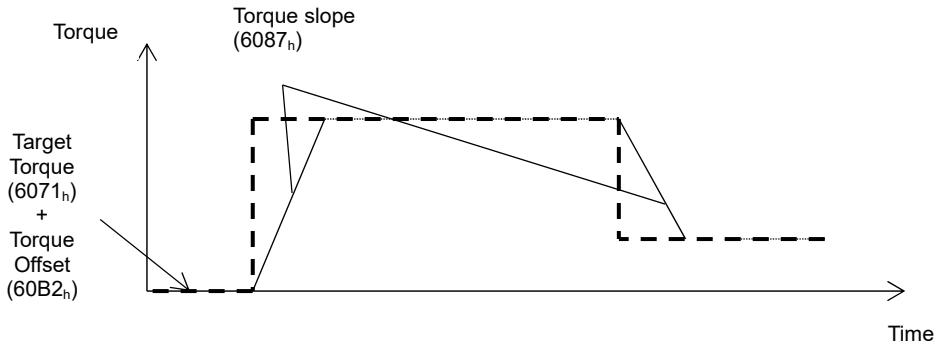
This sets the rate of change when making the torque transition to the target value. The unit is in 0.1%/s.

8.9.5. Control in TQ mode

8.9.5.1. Basic control

In TQ mode, torque tracking is performed at the torque change rate specified by Torque slope (6087_h), with the target value set as the sum of the Target torque (6071_h) and Torque offset ($60B2_h$).

If the sum of the Target torque and the Torque offset exceeds ± 100.0%, the control torque is limited to ± 100.0%.



Although the load is lighter in respect to the set torque the acceleration will be set in respect to the difference in the load and the set torque so that the driver can not stop it at the set torque. However the upper speed is limited at the value lower of either 500 rpm or Max motor speed (6080_h).

8.10. Cyclic synchronous torque mode (CST)

Cyclic synchronous torque mode (CST) is a control mode that periodically follows specified torques.

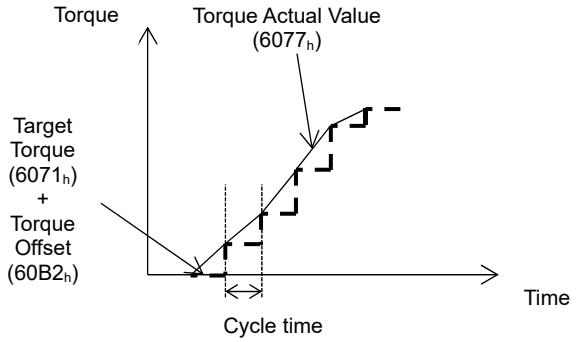
8.10.1. Related objects

Index	Sub-Index	Name	Units	Data Type	Range	Access	PDO
6071_h	00_h	Target torque	0.1%	I16	-32768 - 32767	rw	RxPDO
6072_h	00_h	Max torque	0.1%	U16	0 - 65535	rw	RxPDO
$60B2_h$	00_h	Torque offset	0.1%	I16	-32768 - 32767	rw	RxPDO

8.10.2. Control in CST mode

8.10.2.1. Basic control

When the CST mode is set in Modes of operation, and the transition made to the Operation enable state, this unit operates by following a torque target value set as the sum of Target torque (6071_h) and Torque offset ($60B2_h$). The target velocity is updated with the PDO communication cycle from a master side.



Although the load is lighter in respect to the set torque, the acceleration will be set in respect to the difference in the load and the set torque so that the driver can not stop it at the set torque. However, the upper speed is limited at the value lower of either 500 rpm or Max motor speed (6080_h).

9. Synchronization mode

The driver supports SM2 synchronization and DC synchronization.
The synchronization period can be specified from a minimum at 1 ms by 1 ms. Specifying a long period will cause a corresponding delay before actual operation, so it is recommended to use the shortest period within the range the system can handle.

9.1. SM2 synchronization

SM2 synchronization operates equipment with periodic communication acting as triggers from a master. Time accuracy is on the order of microseconds. In applications where multi-axis synchronization is required, it is recommended that the DC synchronization mode described below is used.

9.2. DC synchronization

The driver supports DC synchronization mode. Synchronization time accuracy is on the order of nanoseconds. Use of DC synchronous mode is recommended especially in the various cyclic modes.

10. Other features

10.1. Input / output ports

10.1.1. Related objects

Index	Sub-Index	Name	Units	Data Type	Range	Access	PDO
$60FD_h$	00_h	Digital inputs	-	U32	00000000_h - $007F000F_h$	ro	TxPDO
$60FE_h$		Digital outputs	-	-	-	-	-
	01_h	Physical Output	-	U32	00000000_h - $00FF0001_h$	rw	RxPDO
	02_h	Bit mask	-	U32	00000000_h - $FFFFFFFF_h$	rw	RxPDO

10.1.2. Digital inputs ($60FD_h$)

Digital inputs indicates the state of the input ports of the input / output interface.

31-23	22	-	16	15 - 4	3	2	1	0
reserved	IN7	…	IN1		interlock	home sw	positive limit sw	negative limit sw

MSB LSB

negative limit sw: indicates the status of the LM- sensor input. This returns 1 when a detection state.

positive limit sw: indicates the status of the LM+ sensor input. This returns 1 when a detection state.

home sw: indicates the status of the ORG sensor input. This returns 1 when a detection state.

interlock: returns 1 when the TO input is open.

IN1 to IN7: corresponding general-purpose input ports return 0 when open, and 1 when grounded.

10.1.3. Digital outputs ($60FE_h$)

Digital outputs controls the output ports of the input / output interface.

10.1.3.1. Physical Output (Sub-index 01_h)

This sets the state of the corresponding output ports.

31-24	22	-	16	15 - 1	0
reserved	OUT7	…	OUT1	reserved	set brake

MSB LSB

set brake: controls a brake output. A brake is enabled (output open) at 1, and released (energized) at 0. The initial value is 1: brake enabled.

OUT1 to OUT7: controls the corresponding general purpose output ports. The output is open at 0, and established at 1 (open collector output).

10.1.3.2. Bit mask (Sub-index 02_h)

This masks the Physical Output settings. When the Bit mask is 0, the current state is maintained regardless of the value of Digital outputs.

With the initial value of $00FF0000_h$, the brake control is masked. In a system that requires brake release, only release the mask for brake control after taking precautions to check that the setting value for Physical Output at the time of release is appropriate.

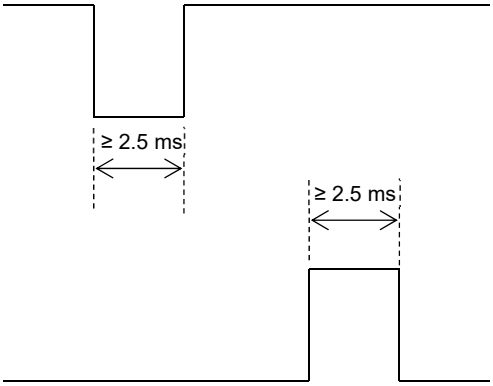
10.2. Touch probe function

This mode uses the various the Digital input ports and sensor inputs as triggers to capture the current position. Rising and falling edges of signals selected for Touch probe 1 and Touch probe 2 can variously be selected as triggers. However, when the software encoder zero (a softwer defined position of a Z-phase pulse) is selected as an input signal, latching is performed only at rising edges.

10.2.1. Input signal specifications

Use an input signal pulse width of 2.5 ms or more for each input.

As each input terminal implements negative logic, a rising edge means 24 V → 0 V and a falling edge means 0 V → 24 V.



10.2.2. Related objects

Index	Sub-Index	Name	Units	Data Type	Range	Access	PDO
$60B8_h$	00_h	Touch probe function	-	U16	0 - 65535	rw	RxPDO
$60B9_h$	00_h	Touch probe status	-	U16	0 - 65535	ro	TxPDO
$60BA_h$	00_h	Touch probe position 1 positive value	User	I32	-2147483648 - 2147483647	ro	TxPDO
$60BB_h$	00_h	Touch probe position 1 negative value	User	I32	-2147483648 - 2147483647	ro	TxPDO
$60BC_h$	00_h	Touch probe position 2 positive value	User	I32	-2147483648 - 2147483647	ro	TxPDO
$60BD_h$	00_h	Touch probe position 2 negative value	User	I32	-2147483648 - 2147483647	ro	TxPDO
$60D0_h$		Touch probe source	-	-	-	-	-
	01_h	Touch probe 1 source	-	I16	-32768 - 32767	rw	-
	02_h	Touch probe 2 source	-	I16	-32768 - 32767	rw	-
$60D1_h$	00_h	Touch probe time stamp 1 positive value	ns	U32	0 - 4294967295	ro	TxPDO
$60D2_h$	00_h	Touch probe time stamp 1 negative value	ns	U32	0 - 4294967295	ro	TxPDO
$60D3_h$	00_h	Touch probe time stamp 2 positive value	ns	U32	0 - 4294967295	ro	TxPDO
$60D4_h$	00_h	Touch probe time stamp 2 negative value	ns	U32	0 - 4294967295	ro	TxPDO
$60D5_h$	00_h	Touch probe 1 positive edge counter	-	U16	0 - 65535	ro	TxPDO
$60D6_h$	00_h	Touch probe 1 negative edge counter	-	U16	0 - 65535	ro	TxPDO
$60D7_h$	00_h	Touch probe 2 positive edge counter	-	U16	0 - 65535	ro	TxPDO
$60D8_h$	00_h	Touch probe 2 negative edge counter	-	U16	0 - 65535	ro	TxPDO

10.2.3. Touch probe function ($60B8_h$)

This performs touch probe function settings.

Bit	Value	Definition
0	0	Switch off touch probe 1
	1	Enable touch probe 1
1	0	Trigger first event
	1	Continuous
3, 2	00	Trigger with touch probe 1 input,
	01	Trigger with zero impulse signal or position encoder,
	10	Touch probe source defined by object $60D0_h$.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	-	Not used
8	0	Switch off touch probe 2
	1	Enable touch probe 2
9	0	Trigger first event
	1	Continuous
11, 10	00	Trigger with touch probe 2 input,
	01	Trigger with zero impulse signal or position encoder,
	10	Touch probe source defined by object $60D0_h$.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	-	Not used

10.2.4. Touch probe status ($60B9_h$)

This returns touch probe function status.

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	-	Reserved
6, 7		Not used
8	0	Touch probe 1 is switched off
	1	Touch probe 1 is enabled
9	0	Touch probe 1 no positive edge value stored
	1	Touch probe 1 positive edge position stored
10	0	Touch probe 1 no negative edge value stored
	1	Touch probe 1 negative edge position stored
11 – 13	-	Reserved
14, 15		Not used

10.2.5. Touch probe position 1 positive value ($60BA_h$)

This retains the latched value at a rising edge in the Touch probe input 1. The unit is user-specified.

10.2.6. Touch probe position 1 negative value ($60BB_h$)

This retains the latched value at a falling edge in the Touch probe input 1. The unit is user-specified.

10.2.7. Touch probe position 2 positive value ($60BC_h$)

This retains the latched value at a rising edge in the Touch probe input 2. The unit is user-specified.

10.2.8. Touch probe position 2 negative value (60BD$_h$)

This retains the latched value at a falling edge in the Touch probe input 2. The unit is user-specified.

10.2.9. Touch probe source (60D0$_h$)

Sub-index	Name	Unit	Range	Description
01	Touch probe 1 source	-	-32768 - 32767	Selecting touch probe 1 signal source
02	Touch probe 2 source	-	-32768 - 32767	Selecting touch probe 2 signal source

When 10_b is selected with bits 3 and 2 of Touch probe function (60B8$_h$) and when 10_b is selected with bits 11 and 10 of Touch probe function (60B8$_h$), the signal selected with this setting is used as each touch probe inputs. The table below provides details of the setting values.

Value	Definition
-32768 - -8	Manufacturer-specific (Not used)
-7	IN7
-6	IN6
-5	IN5
-4	Interlock
-3	ORG
-2	LM+
-1	LM-
0	Reserved
1	IN1
2	IN2
3	IN3
4	IN4
5	Hardware Zero impulse signal of position encoder (Not supported)
6	Software Zero impulse signal of position encoder
7 - 32767	Reserved

10.2.10. Touch probe time stamp 1 positive value (60D1$_h$)

This indicates the time of latching for a rising edge at the touch probe 1 input. The unit is in ns.

10.2.11. Touch probe time stamp 1 negative value (60D2$_h$)

This indicates the time of latching for a falling edge at the touch probe 1 input. The unit is in ns.

10.2.12. Touch probe time stamp 2 positive value (60D3$_h$)

This indicates the time of latching for a rising edge at the touch probe 2 input. The unit is in ns.

10.2.13. Touch probe time stamp 2 negative value (60D4$_h$)

This indicates the time of latching for a falling edge at the touch probe 2 input. The unit is in ns.

10.2.14. Touch probe 1 positive edge counter (60D5$_h$)

This counts the number of times that a rising latch occurs for the touch probe 1 input when Continuous is selected using bit 1 of Touch probe function (60B8h). If the count value exceeds 65,535, it will return to 0.

10.2.15. Touch probe 1 negative edge counter (60D6$_h$)

This counts the number of times that a falling latch occurs for the touch probe 1 input when Continuous is selected using bit 1 of Touch probe function (60B8h). If the count value exceeds 65,535, it will return to 0.

10.2.16. Touch probe 2 positive edge counter (60D7h)

This counts the number of times that a rising latch occurs for the touch probe 2 input when Continuous is selected using bit 1 of Touch probe function (60B8h). If the count value exceeds 65,535, it will return to 0.

10.2.17. Touch probe 2 negative edge counter (60D8h)

This counts the number of times that a falling latch occurs for the touch probe 2 input when Continuous is selected using bit 1 of Touch probe function (60B8h). If the count value exceeds 65,535, it will return to 0.

10.3. Push operation

In position and speed type modes, push operation can be performed by limiting the torque value.

10.3.1. Related objects

Index	Sub-Index	Name	Units	Data Type	Range	Access	PDO
$60E0_h$	00_h	Positive torque limit value	0.1%	U16	0 - 65535	rw	RxPDO
$60E1_h$	00_h	Negative torque limit value	0.1%	U16	0 - 65535	rw	RxPDO

10.3.2. Positive torque limit value (60E0h), Negative torque limit value (60E1h)

These set the torque value limits for the CW and CCW directions respectively. The unit is in 0.1%.
When the value of either setting is 100.0% or less, push operation is enabled. If one side is 100.0% or less, the other side is treated as 100.0% even if it exceeds 100.0%.
If push operation is not to be performed, set both values together to more than 100.0% (initial value 65535).
If both values exceed 100.0%, there is no operational difference arising from values set.

11. Manufacturer specific area

In the Manufacturer specific area for the driver, various settings related to motor control can be applied.

11.1. Object list

Index	Sub-Index	Name	Units	Data Type	Range	Access	PDO
2100_h	00_h	PKp	-	U16	0 - 65535	rw	No
2101_h	00_h	PKv	-	U16	0 - 65535	rw	No
2102_h	00_h	PTv	-	U16	0 - 65535	rw	No
2103_h	00_h	PKd	-	U16	0 - 65535	rw	No
2104_h	00_h	PDv	-	U16	0 - 20	rw	No
2105_h	00_h	PKvp	-	U16	0 - 65535	rw	No
2106_h	00_h	Ff	%	U16	0 - 100	rw	No
2108_h	00_h	FullCountValue	pulse	U32	1 - 2147483647	rw	No
$210D_h$	00_h	OpenModeSwitch	-	U16	0 - 2	rw	No
$210E_h$	00_h	CloseToOpenSpeed	rpm	U16	0 - 3000	rw	No
$210F_h$	00_h	AutoCrntDwnEnable	-	BOOL	0 - 1	rw	No
2110_h	00_h	AutoCrntDwnRate	0.1%	U16	0 - 1000	rw	No
2111_h	00_h	AutoCrntDwnTime	ms	U16	50 - 5000	rw	No
2112_h	00_h	OpenModeCrntRate	0.1%	U16	0 - 1000	rw	No
2113_h	00_h	CloseToOpenTime	ms	U16	10 - 5000	rw	No
2117_h	00_h	HoldAccuratePos	-	BOOL	0 - 1	rw	No
2118_h	00_h	CorrectSpeed	pps	U16	10 - 500	rw	No
2119_h	00_h	PosTolerance	pulse	U16	0 - 100	rw	No
$211A_h$	00_h	CorrectHightSpeed	pps	U32	10 - 300000	rw	No
$211C_h$	00_h	CrntBoostRate	%	U16	100 - 150	rw	No
$211D_h$	00_h	NumOfCorrectPos	-	U16	1 - 10000	rw	No
2120_h	00_h	VKv	-	U16	0 - 65535	rw	No
2121_h	00_h	VTv	-	U16	0 - 65535	rw	No
2122_h	00_h	VKvp	-	U16	0 - 65535	rw	No
2142_h	00_h	TrqLmtTime	ms	U16	0 - 10000	rw	No
2143_h	00_h	TrqUpEnable	-	BOOL	0 - 1	rw	No
2144_h	00_h	TrqUpTime	ms	U16	0 - 10000	rw	No
2151_h	00_h	FullTrqTime	ms	U16	1 - 10000	rw	No
2154_h	00_h	ProContSwitch	-	U16	0 - 1	rw	No
2158_h	00_h	SelMon1	-	U16	0 - 2	rw	No
2159_h	00_h	SelMon2	-	U16	0 - 2	rw	No
$215A_h$	00_h	SelLed	-	U16	0 - 1	rw	No
$215B_h$	00_h	DrvLogicLmtP	-	U16	0 - 1	rw	No
$215C_h$	00_h	DrvLogicLmtM	-	U16	0 - 1	rw	No
$215D_h$	00_h	DrvLogicLmtCond	-	U16	0 - 2	rw	No
$215E_h$	00_h	SelRegBrake	-	U16	0 - 1	rw	No
$215F_h$	00_h	SelHighSpeed	-	U16	0 - 1	rw	No
2162_h	00_h	DrvLogicOrg	-	U16	0 - 1	rw	No
2163_h	00_h	LpfSpeed	-	U16	0 - 3	rw	No
2187_h	00_h	TrqLimitPress	pulse	U32	0 - 4294967295	rw	No
$218A_h$	00_h	MoveSttSet	-	U16	0 - 1	rw	No
2224_h	00_h	Proportion gain dip switch	-	U16	0 - 15	ro	No
2225_h	00_h	Integral gain dip switch	-	U16	0 - 15	ro	No

11.1.1. Position control system parameters

11.1.1.1. Position loop gain / PKp (2100_h)

The higher the gain, the better the trackability, and the higher the positioning speed. It causes overshooting or hunching if it is set too high.

11.1.1.2. Base proportional gain / PKv (2101_h)

This is the base proportional gain when the rotary switch is “0”. Increase the gain according to the degree of load inertia. Be sure to set a value equal to the factory setting or higher.

11.1.1.3. Base integration time constant / PTv (2102_h)

This is the base integration time constant when the rotary switch is “0”. Increase the load stiffness if it is low. Also, when the inertia is large, there is an effect of suppressing hunting, but the positioning settling time will become longer.

11.1.1.4. Velocity feedback gain / PKd (2103_h)

A high setting increases the damping effect and shortens the positioning settling time, but an excessively high setting may result in vibration.

11.1.1.5. Differential compensation gain / PDv (2104_h)

It is recommended that this parameter is not changed. Higher levels may cause vibration.

11.1.1.6. Proportional gain / PKvp (2105_h)

A higher value reduces positional deviation upon stopping, but the motor may vibrate.

11.1.1.7. Feed-forward / Ff (2106_h)

Although increasing this setting can reduce positional deviation during rotation, hunting may occur with rapid acceleration and deceleration. Positional deviation during operation becomes zero at 100%.

11.1.1.8. Positioning operating mode / OpenModeSwitch ($210D_h$)

This sets the operating mode when in the Positioning mode.

0: Always closed loop

1: Open loop at or below set velocity

2: Always open loop

11.1.1.9. Positioning operating mode switching speed ($210E_h$)

Sets the switching speed between closed loop and open loop when the setting for the Positioning operating mode is 1. The unit is in motor speed (rpm).

11.1.1.10. Automatic current-down setting ($210F_h$)

This sets whether to perform current-down automatically at open loop transition.

0: disabled

1: enabled

11.1.1.11. Automatic current-down current value (2110_h)

This sets the electric current value during automatic current-down operation. The setting is in the unit of 0.1%, and the electric current value set is that for performing current-down over the range of 0 to 100% for the electric current value under normal circumstances.

11.1.1.12. Automatic current-down transition time (2111_h)

This is the time elapsed from transitioning to open mode until current-down is performed. The unit is in millisecond (ms).

11.1.1.13. Electric Current when in open mode (2112_h)

This sets the electric current value during open mode drive. The unit is in 0.1% and the value is set over the range of 0 to 100%.

11.1.1.14. Open mode transition time on motor stop (2113_h)

When the setting for positioning operating mode ($210D_h$) is 1, and the positioning operating mode switching speed (210Eh) is set to 0, this sets the time from when the motor stops until switching to open loop. The unit is at milliseconds (ms) and it can be set in the range of 10 to 5000 ms.

11.1.1.15. Position correction when in open control (2117_h)

This sets whether to perform position correction when in open loop control.

0: Position correction not performed

1: Position correction performed

11.1.1.16. Position correction velocity (2118_h)

This sets the velocity when performing position correction. The unit is in pps and it can be set in the range of 10 to 500 pps.

11.1.1.17. Position correction allowance when in open loop control (2119_h)

This sets the tolerance for position correction at open loop. Position correction operation is performed if this setting is exceeded. The unit is in pulse and it is set in the range of 0 to 100 pulses.

11.1.1.18. Position correction speed when in full-time open mode ($211A_h$)

This sets the position correction speed when the motor angle deviates by 1.8 ° or more in full-time open mode. The unit is in pps and it is set in the range of 10 to 300000 pps.

11.1.1.19. Acceleration / deceleration electric current increase ratio when in full-time open mode ($211C_h$)

This sets the ratio for increasing the current when accelerating / decelerating in full-time open mode. The unit is in % and it is set in the range of 100 to 150%.

11.1.1.20. Position correction limit count ($211D_h$)

This sets the limit count for position correction operation. If the limit count is exceeded, a position correction error alarm will occur. It is set in the range of 1 to 10000 counts.

11.1.2. Velocity control system parameters

11.1.2.1. Base proportional gain (2120_h)

This is the base proportional gain when the rotary switch is “0”. Increase the gain according to the degree of load inertia. Be sure to set a value equal to the factory setting or higher.

11.1.2.2. Base integration time constant (2121_h)

This is the base integration time constant when the rotary switch is “0”. Increase the load stiffness if it is low. This also has the effect of suppressing hunting even when the inertia is large.

11.1.2.3. Proportional gain (2122_h)

When raised the motor may vibrate.

11.1.2.4. Torque limit detection time (2142_h)

This sets the torque limit detection time. The unit is in millisecond (ms) and it can be set in the range of 0 to 10000 ms.

11.1.2.5. Torque-up setting (2143_h)

This sets whether to enable the torque-up function.

0: Torque-up disabled

1: Torque-up enabled

11.1.2.6. Torque-up time (2144_h)

This sets the torque-up time. The unit is in millisecond (ms) and it can be set in the range of 0 to 10000 ms.

11.1.2.7. Torque loop error detection time (2151_h)

This sets the loop error detection time for the torque value. The unit is in millisecond (ms) and it is set in the range of 500 to 10000 ms.

11.1.2.8. Monitor output terminal 1 setting (2156_h)

This selects the signal to be output to monitor output terminal 1.

0: Command speed

1: Motor speed

2: Command torque

11.1.2.9. Monitor output terminal 2 setting (2157_h)

This selects the signal to be output to monitor output terminal 2.

0: Motor speed

1: Motor torque

2: Position deviation

3: In-position

11.1.2.10. LED (INP) display selection ($215A_h$)

This selects the in-position LED display content.

When in position control

0: In-position

1: Push limit

When in velocity control

0: Velocity reached

1: No display

Torque control

0, 1: Torque matched

11.1.2.11. Positive direction limit switch logic setting ($215B_h$)

This sets the active level of the positive direction limit switch signal.

0: Active H

1: Active L

Negative direction limit switch logic setting ($215C_h$)

This sets the active level of the negative direction limit switch signal.

0: Active H

1: Active L

Limit input signal stop condition setting ($215D_h$)

This sets the limit stop function for the positive and negative limit switches.

0: Limit switch stop function disabled

1: Deceleration stop after detecting limit switch

2: Sudden stop after detecting limit switch

Regenerative brake setting ($215E_h$)

This sets the regenerative braking operation when the servo is off.

0: Brake off

1: Brake on

Low heat generation / high speed mode selection ($215F_h$)

This switches between the low heat generation mode and high speed mode.

0: Low heat generation mode

1: High speed mode

11.1.2.12. Home switch logic setting (2162_h)

This sets the active level for a home switch signal.

0: Active H

1: Active L

11.1.2.13. Velocity feedback signal LPF setting (2163_h)

This sets the Velocity feedback signal low pass filter setting. Filter OFF for 0, range is 0 to 3.

12. Alarms / errors

Error Code	Description	Cause	Countermeasures
5530_h	EEPROM errors	Error has occurred in EEPROM data	Repair measures necessary
7500_h	Internal communication error	An error has occurred with communication within the device	Repair measures necessary
8312_h	Initialization error	Load exceeds motor maximum rating	Reduce the load
$ff01_h$	Loop error	Overload	Reduce the load
		During position control, the motor speed does not track the command pulse	Set the maximum frequency of the command pulse at or below the maximum motor rotation frequency
$ff02_h$	Full count	Overload	Reduce the load to the continuous rated torque or below
		During position control, the motor speed does not track the command pulse	Set the maximum frequency of the command pulse at or below the maximum motor rotation frequency Reduce the acceleration and deceleration
$ff03_h$	Overspeed	Motor speed error	Set the command pulse to the maximum rotation speed of the motor or below.
$ff04_h$	Gain adjustment fault	Motor vibrates abnormally due to improper adjustment This also occurs when a command is input without acceleration or deceleration	Re-adjust proportional gain Perform command pulse acceleration / deceleration
$ff05_h$	Overvoltage	The voltage of the internal power supply increased abnormally due to regeneration	Add a regenerative unit (option)
$ff08_h$	Position correction error	Position correction not complete	If settling takes time due to the load conditions, increase the number of position corrections
$ff80_h$	ESM error	Transited any other ESM state from OP state while in operation enabled.	Keep OP state while in operation enabled.

13. Object dictionary list

13.1. Object dictionary structure

Index	Object	Description
0000_h to $0FFF_h$	Data Type Area	
1000_h to $1FFF_h$	CoE Communication Area	CoE Communication Area
2000_h to $23FF_h$	Manufacturer Specific Area	Various motor parameters (axis 0)
2400_h to $5FFF_h$		Not used
6000_h to $6FFF_h$	Profile Area (Axis 0)	Drive profile (axis 0)
6800_h to $9FFF_h$	Profile Area (Axis 1 to 7)	Not used

13.2. Object list

13.2.1. CoE communication area

Index	Sub-Index	Name	Units	Data Type	Initial value	Range	Access	PDO
1000_h	00_h	Device type	-	U16	00040192_h	-	ro	No
1001_h	00_h	Error register	-	U8	0	0 - FF_h	ro	No
1008_h	00_h	Manufacturer device name	-	STR	DS1000A-EC	-	ro	No
1009_h	00_h	Manufacturer hardware version	-	STR	V1.00	-	ro	No
100A	00_h	Manufacturer software version	-	STR	Vn.nn/m.mm	-	ro	No
1018_h		Identity object	-	-		-	-	-
	01_h	Vendor ID	-	U32	00000973_h	-	ro	No
	02_h	Product code	-	U32	$00004A39_h$	-	ro	No
	03_h	Revision number	-	U32	00000001		ro	No
	04_h	Serial number	-	U32	00000000		ro	No
1600_h	-	Receive PDO mapping	-	-	-	-	-	-
	00_h	Number of entries	-	U8	5	0 - 10	rw	No
	01_h	1st output object to be mapped	-	U32	60400010_h	00000000 - $FFFFFFFF_h$	rw	No
	02_h	2nd output object to be mapped	-	U32	60600008_h	00000000 - $FFFFFFFF_h$	rw	No
	03_h	3rd output object to be mapped	-	U32	$607A0020_h$	00000000 - $FFFFFFFF_h$	rw	No
	04_h	4th output object to be mapped	-	U32	60810020_h	00000000 - $FFFFFFFF_h$	rw	No
	05_h	5th output object to be mapped	-	U32	$60FE0120_h$	00000000 - $FFFFFFFF_h$	rw	No
	06_h	6th output object to be mapped	-	U32	00000000_h	00000000 - $FFFFFFFF_h$	rw	No
	07_h	7th output object to be mapped	-	U32	00000000_h	00000000 - $FFFFFFFF_h$	rw	No
	08_h	8th output object to be mapped	-	U32	00000000_h	00000000 - $FFFFFFFF_h$	rw	No
	09_h	9th output object to be mapped	-	U32	00000000_h	00000000 - $FFFFFFFF_h$	rw	No
	$0A_h$	10th output object to be mapped	-	U32	00000000_h	00000000 - $FFFFFFFF_h$	rw	No
1601_h	-	Receive PDO mapping	-	-	-	-	-	-
	00_h	Number of entries	-	U8	4	0 - 10	rw	No
	01_h	1st output object to be mapped	-	U32	60400010_h	00000000 - $FFFFFFFF_h$	rw	No
	02_h	2nd output object to be mapped	-	U32	60600008_h	00000000 - $FFFFFFFF_h$	rw	No
	03_h	3rd output object to be mapped	-	U32	$60FF0020_h$	00000000 - $FFFFFFFF_h$	rw	No
	04_h	4th output object to be mapped	-	U32	$60FE0120_h$	00000000 - $FFFFFFFF_h$	rw	No
	05_h	5th output object to be mapped	-	U32	00000000_h	00000000 - $FFFFFFFF_h$	rw	No
	06_h	6th output object to be mapped	-	U32	00000000_h	00000000 - $FFFFFFFF_h$	rw	No
	07_h	7th output object to be mapped	-	U32	00000000_h	00000000 - $FFFFFFFF_h$	rw	No
	08_h	8th output object to be mapped	-	U32	00000000_h	00000000 - $FFFFFFFF_h$	rw	No
	09_h	9th output object to be mapped	-	U32	00000000_h	00000000 - $FFFFFFFF_h$	rw	No
	$0A_h$	10th output object to be mapped	-	U32	00000000_h	00000000 - $FFFFFFFF_h$	rw	No
1602_h	-	Receive PDO mapping	-	-	-	-	-	-
	00_h	Number of entries	-	U8	5	0 - 10	rw	No
	01_h	1st output object to be mapped	-	U32	60400010_h	00000000 - $FFFFFFFF_h$	rw	No
	02_h	2nd output object to be mapped	-	U32	60600008_h	00000000 - $FFFFFFFF_h$	rw	No
	03_h	3rd output object to be mapped	-	U32	$60FF0020_h$	00000000 - $FFFFFFFF_h$	rw	No
	04_h	4th output object to be mapped	-	U32	60710010_h	00000000 - $FFFFFFFF_h$	rw	No
	05_h	5th output object to be mapped	-	U32	$60FE0120_h$	00000000 - $FFFFFFFF_h$	rw	No
	06_h	6th output object to be mapped	-	U32	00000000_h	00000000 - $FFFFFFFF_h$	rw	No
	07_h	7th output object to be mapped	-	U32	00000000_h	00000000 - $FFFFFFFF_h$	rw	No
	08_h	8th output object to be mapped	-	U32	00000000_h	00000000 - $FFFFFFFF_h$	rw	No
	09_h	9th output object to be mapped	-	U32	00000000_h	00000000 - $FFFFFFFF_h$	rw	No
	$0A_h$	10th output object to be mapped	-	U32	00000000_h	00000000 - $FFFFFFFF_h$	rw	No
1603_h	-	Receive PDO mapping	-	-	-	-	-	-
	00_h	Number of entries	-	U8	6	0 - 10	rw	No
	01_h	1st output object to be mapped	-	U32	60400010_h	00000000 - $FFFFFFFF_h$	rw	No
	02_h	2nd output object to be mapped	-	U32	60600008_h	00000000 - $FFFFFFFF_h$	rw	No

Index	Sub-Index	Name	Units	Data Type	Initial value	Range	Access	PDO
	03_h	3rd output object to be mapped	-	U32	$607A0020_h$	00000000 - FFFFFFFF$_h$	rw	No
	04_h	4th output object to be mapped	-	U32	$60FF0020_h$	00000000 - FFFFFFFF$_h$	rw	No
	05_h	5th output object to be mapped	-	U32	60710010_h	00000000 - FFFFFFFF$_h$	rw	No
	06_h	6th output object to be mapped	-	U32	$60FE0120_h$	00000000 - FFFFFFFF$_h$	rw	No
	07_h	7th output object to be mapped	-	U32	00000000_h	00000000 - FFFFFFFF$_h$	rw	No
	08_h	8th output object to be mapped	-	U32	00000000_h	00000000 - FFFFFFFF$_h$	rw	No
	09_h	9th output object to be mapped	-	U32	00000000_h	00000000 - FFFFFFFF$_h$	rw	No
	$0A_h$	10th output object to be mapped	-	U32	00000000_h	00000000 - FFFFFFFF$_h$	rw	No
$1A00_h$	-	Transmit PDO mapping	-	-	-	-	-	-
	00_h	Number of entries	-	U8	6	0 - 10	rw	No
	01_h	1st input object to be mapped	-	U32	$603F0010_h$	00000000 - FFFFFFFF$_h$	rw	No
	02_h	2nd input object to be mapped	-	U32	60410010_h	00000000 - FFFFFFFF$_h$	rw	No
	03_h	3rd input object to be mapped	-	U32	60610008_h	00000000 - FFFFFFFF$_h$	rw	No
	04_h	4th input object to be mapped	-	U32	60640020_h	00000000 - FFFFFFFF$_h$	rw	No
	05_h	5th input object to be mapped	-	U32	$606C0020_h$	00000000 - FFFFFFFF$_h$	rw	No
	06_h	6th input object to be mapped	-	U32	$60FD0020_h$	00000000 - FFFFFFFF$_h$	rw	No
	07_h	7th input object to be mapped	-	U32	00000000_h	00000000 - FFFFFFFF$_h$	rw	No
	08_h	8th input object to be mapped	-	U32	00000000_h	00000000 - FFFFFFFF$_h$	rw	No
	09_h	9th input object to be mapped	-	U32	00000000_h	00000000 - FFFFFFFF$_h$	rw	No
	$0A_h$	10th input object to be mapped	-	U32	00000000_h	00000000 - FFFFFFFF$_h$	rw	No
$1A01_h$	-	Transmit PDO mapping	-	-	-	-	-	-
	00_h	Number of entries	-	U8	5	0 - 10	rw	No
	01_h	1st input object to be mapped	-	U32	$603F0010_h$	00000000 - FFFFFFFF$_h$	rw	No
	02_h	2nd input object to be mapped	-	U32	60410010_h	00000000 - FFFFFFFF$_h$	rw	No
	03_h	3rd input object to be mapped	-	U32	60610008_h	00000000 - FFFFFFFF$_h$	rw	No
	04_h	4th input object to be mapped	-	U32	$606C0020_h$	00000000 - FFFFFFFF$_h$	rw	No
	05_h	5th input object to be mapped	-	U32	$60FD0020_h$	00000000 - FFFFFFFF$_h$	rw	No
	06_h	6th input object to be mapped	-	U32	00000000_h	00000000 - FFFFFFFF$_h$	rw	No
	07_h	7th input object to be mapped	-	U32	00000000_h	00000000 - FFFFFFFF$_h$	rw	No
	08_h	8th input object to be mapped	-	U32	00000000_h	00000000 - FFFFFFFF$_h$	rw	No
	09_h	9th input object to be mapped	-	U32	00000000_h	00000000 - FFFFFFFF$_h$	rw	No
	$0A_h$	10th input object to be mapped	-	U32	00000000_h	00000000 - FFFFFFFF$_h$	rw	No
$1A02_h$	-	Transmit PDO mapping	-	-	-	-	-	-
	00_h	Number of entries	-	U8	6	0 - 10	rw	No
	01_h	1st input object to be mapped	-	U32	$603F0010_h$	00000000 - FFFFFFFF$_h$	rw	No
	02_h	2nd input object to be mapped	-	U32	60410010_h	00000000 - FFFFFFFF$_h$	rw	No
	03_h	3rd input object to be mapped	-	U32	60610008_h	00000000 - FFFFFFFF$_h$	rw	No
	04_h	4th input object to be mapped	-	U32	60640020_h	00000000 - FFFFFFFF$_h$	rw	No
	05_h	5th input object to be mapped	-	U32	60770010_h	00000000 - FFFFFFFF$_h$	rw	No
	06_h	6th input object to be mapped	-	U32	$60FD0020_h$	00000000 - FFFFFFFF$_h$	rw	No
	07_h	7th input object to be mapped	-	U32	00000000_h	00000000 - FFFFFFFF$_h$	rw	No
	08_h	8th input object to be mapped	-	U32	00000000_h	00000000 - FFFFFFFF$_h$	rw	No
	09_h	9th input object to be mapped	-	U32	00000000_h	00000000 - FFFFFFFF$_h$	rw	No
	$0A_h$	10th input object to be mapped	-	U32	00000000_h	00000000 - FFFFFFFF$_h$	rw	No
$1A03_h$	-	Transmit PDO mapping	-	-	-	-	-	-
	00_h	Number of entries	-	U8	7	0 - 10	rw	No
	01_h	1st input object to be mapped	-	U32	$603F0010_h$	00000000 - FFFFFFFF$_h$	rw	No
	02_h	2nd input object to be mapped	-	U32	60410010_h	00000000 - FFFFFFFF$_h$	rw	No
	03_h	3rd input object to be mapped	-	U32	60610008_h	00000000 - FFFFFFFF$_h$	rw	No
	04_h	4th input object to be mapped	-	U32	60640020_h	00000000 - FFFFFFFF$_h$	rw	No
	05_h	5th input object to be mapped	-	U32	$606C0020_h$	00000000 - FFFFFFFF$_h$	rw	No
	06_h	6th input object to be mapped	-	U32	60770010_h	00000000 - FFFFFFFF$_h$	rw	No
	07_h	7th input object to be mapped	-	U32	$60FD0020_h$	00000000 - FFFFFFFF$_h$	rw	No
	08_h	8th input object to be mapped	-	U32	00000000_h	00000000 - FFFFFFFF$_h$	rw	No
	09_h	9th input object to be mapped	-	U32	00000000_h	00000000 - FFFFFFFF$_h$	rw	No
	$0A_h$	10th input object to be mapped	-	U32	00000000_h	00000000 - FFFFFFFF$_h$	rw	No
$1C12_h$	-	Sync manager 2 PDO assignment	-	-	-	-	-	-
	00_h	Number of assigned PDOs	-	U8	1	0 - 1	rw	No
	01_h	PDO mapping object Index assigned RxPDO	-	U16	1600_h	1600_h - 1603_h	rw	No
$1C13_h$	-	Sync manager 3 PDO assignment	-	-	-	-	-	-
	00_h	Number of assigned PDOs	-	-	-	-	-	-
	01_h	PDO mapping object index assigned TxPDO	-	U16	$1A00_h$	$1A00_h$ - $1A03_h$	rw	No
$1C32_h$		Sync manager 2 synchronization	-	-	-	-	-	-
	01_h	Synchronization type	-	U16	0	0 - 65535	rw	No
	02_h	Cycle time	ns	U32	0	0 - 4294967295	ro	No
	03_h	Shift time	ns	U32	0	0 - 4294967295	ro	No
	04_h	Synchronization types supported	-	U16	0	0 - 65535	ro	No

Index	Sub-Index	Name	Units	Data Type	Initial value	Range	Access	PDO
	05_h	Minimum cycle time	ns	U32	1000000	0 - 4294967295	ro	No
	06_h	Calc and copy time	ns	U32	125000	0 - 4294967295	ro	No
	07_h	Minimum delay time	ns	U32	0	0 - 4294967295	ro	No
	08_h	Get cycle time	-	U16	0	0 - 1	rw	No
	09_h	Delay time	ns	U32	0	0 - 4294967295	ro	No
	$0A_h$	Sync0 cycle time	ns	U32	0	0 - 4294967295	rw	No
	$0B_h$	SM-event missed	-	U16	0	0 - 65535	ro	No
	$0C_h$	Cycle time too small	-	U16	0	0 - 65535	ro	No
	$0D_h$	Shift time too short	-	U16	0	0 - 65535	ro	No
	$0E_h$ -$1F_h$	Reserved	-	-	-	-	-	-
	20_h	Sync Error	-	BOOL		0 - 65535	ro	No
		Sync manager 2 synchronization	-	-	-	-	-	-
	01_h	Synchronization type	-	U16	0	0 - 65535	rw	No
	02_h	Cycle time	ns	U32	0	0 - 4294967295	ro	No
	03_h	Shift time	ns	U32	0	0 - 4294967295	ro	No
	04_h	Synchronization Types supported	-	U16	0	0 - 65535	ro	No
	05_h	Minimum cycle Time	ns	U32	1000000	0 - 4294967295	ro	No
	06_h	Calc and copy Time	ns	U32	125000	0 - 4294967295	ro	No
	07_h	Minimum delay Time	ns	U32	0	0 - 4294967295	ro	No
$1C33_h$	08_h	Get cycle Time	-	U16	0	0 - 1	rw	No
	09_h	Delay time	ns	U32	0	0 - 4294967295	ro	No
	$0A_h$	Sync0 cycle time	ns	U32	0	0 - 4294967295	rw	No
	$0B_h$	SM-event missed	-	U16	0	0 - 65535	ro	No
	$0C_h$	Cycle time too small	-	U16	0	0 - 65535	ro	No
	$0D_h$	Shift time too short	-	U16	0	0 - 65535	ro	No
	$0E_h$ -$1F_h$	Reserved	-	-	-	-	-	-
	20_h	Sync error	-	Bool		0 - 65535	ro	No
2100_h	00_h	PKp	-	U16	*	0 - 65535	rw	No
2101_h	00_h	PKv	-	U16	*	0 - 65535	rw	No
2102_h	00_h	PTv	-	U16	*	0 - 65535	rw	No
2103_h	00_h	PKd	-	U16	*	0 - 65535	rw	No
2104_h	00_h	PDv	-	U16	*	0 - 20	rw	No
2105_h	00_h	PKvp	-	U16	*	0 - 65535	rw	No
2106_h	00_h	Ff	%	U16	0	0 - 100	rw	No
2108_h	00_h	FullCountValue	pulse	I32	2147483647	1 - 2147483647	rw	No
$210D_h$	00_h	OpenModeSwitch	-	U8	0	0 - 2	rw	No
$210E_h$	00_h	CloseToOpenSpeed	rpm	U16	0	0 - 5000	rw	No
$210F_h$	00_h	AutoCrntDwnEnable	-	U8	0	0 - 2	rw	No
2110_h	00_h	AutoCrntDwnRate	0.1%	U16	500	0 - 1000	rw	No
2111_h	00_h	AutoCrntDwnTime	ms	U16	50	50 - 5000	rw	No
2112_h	00_h	OpenModeCrntRate	0.1%	U16	100	0 - 1000	rw	No
2113_h	00_h	CloseToOpenTime	ms	U16	100	10 - 5000	rw	No
2117_h	00_h	HoldAccuratePos	-	U8	1	0 - 1	rw	No
2118_h	00_h	CorrectSpeed	pps	U16	75	10 - 500	rw	No
2119_h	00_h	PosTolerance	pulse	U8	0	0 - 100	rw	No
$211A_h$	00_h	CorrectHighSpeed	pps	U32	10000	10 - 300000	rw	No
$211C_h$	00_h	CrntBoostRate	%	U8	100	100 - 150	rw	No
$211D_h$	00_h	NumOfCorrectPos	-	U16	100	1 - 10000	rw	No
2120_h	00_h	VKv	-	U16	*	0 - 65535	rw	No
2121_h	00_h	VTv	-	U16	*	0 - 65535	rw	No
2122_h	00_h	VKvp	-	U16	*	0 - 65535	rw	No
2142_h	00_h	TrqLmtTime	ms	U16	100	0 - 10000	rw	No
2143_h	00_h	TrqUpEnable	-	U16	0	0 - 1	rw	No
2144_h	00_h	TrqUpTime	ms	U16	100	0 - 10000	rw	No
2151_h	00_h	FullTrqTime	ms	U16	1000	500 - 10000	rw	No
2154_h	00_h	ProContSwitch	-	U8	0	0 - 1	rw	No
2158_h	00_h	SelMon1	-	U8	0	0 - 2	rw	No
2159_h	00_h	SelMon2	-	U8	0	0 - 2	rw	No
$215A_h$	00_h	SelLed	-	U8	0	0 - 1	rw	No
$215B_h$	00_h	DrvLogicLmtP	-	U8	1	0 - 1	rw	No
$215C_h$	00_h	DrvLogicLmtM	-	U8	1	0 - 1	rw	No
$215D_h$	00_h	DrvLogicLmtCond	-	U8	2	0 - 2	rw	No
$215E_h$	00_h	SelRegBrake	-	U8	0	0 - 1	rw	No
$215F_h$	00_h	SelHighSpeed	-	U8	1	0 - 1	rw	No
2162_h	00_h	DrvLogicOrg	-	U8	1	0 - 1	rw	No
2163_h	00_h	LpfSpeed	-	U8	0	0 - 3	rw	No
2224_h	00_h	Proportion gain dip switch	-	U16	-	0 - 15	ro	No

Index	Sub-Index	Name	Units	Data Type	Initial value	Range	Access	PDO
2225_h	00_h	Integral gain dip switch	-	U16	-	0 - 15	ro	No
$603F_h$	00_h	Error Code	-	U16	0	0 - 65535	ro	TxPDO
6040_h	00_h	Controlword	-	U16	0	0 - 65535	rw	RxPDO
6041_h	00_h	Statusword	-	U16	0	0 - 65535	ro	TxPDO
$605A_h$	00_h	Quick stop option code	-	I16	2	-2 - 7	rw	No
$605B_h$	00_h	Shutdown option code	-	I16	0	0 - 1	rw	No
$605C_h$	00_h	Disable operation option code	-	I16	0	0 - 1	rw	No
$605D_h$	00_h	Halt option code	-	I16	1	1 - 3	rw	No
$605E_h$	00_h	Fault reaction option code	-	I16	0	0 - 2	rw	No
6060_h	00_h	Modes of operation	-	I8	0	-128 - 127	rw	RxPDO
6061_h	00_h	Modes of operation display	-	I8	0	-128 - 127	ro	TxPDO
6062_h	00_h	Position demand value	User	I32	0	-2147483648 - 2147483647	ro	TxPDO
6063_h	00_h	Position actual internal value	pulse	I32	0	-2147483648 - 2147483647	ro	TxPDO
6064_h	00_h	Position actual value	User	I32	0	-2147483648 - 2147483647	ro	TxPDO
6065_h	00_h	Following error window	User	U32	1000	0 - 4294967295	rw	RxPDO
6066_h	00_h	Following error time out	ms	U16	40	0 - 65535	rw	RxPDO
6067_h	00_h	Position window	User	U32	4	0 - 4294967295	rw	RxPDO
6068_h	00_h	Position window time	ms	U16	26	0 - 65535	rw	RxPDO
$606B_h$	00_h	Velocity demand value	User/s	I32	0	-2147483648 - 2147483647	ro	TxPDO
$606C_h$	00_h	Velocity actual value	User/s	I32	0	-2147483648 - 2147483647	ro	TxPDO
$606D_h$	00_h	Velocity window	User/s	U16	0	0 - 65535	rw	RxPDO
$606E_h$	00_h	Velocity window time	ms	U16	0	0 - 65535	rw	RxPDO
$606F_h$	00_h	Velocity threshold	User/s	U16	0	0 - 65535	rw	RxPDO
6070_h	00_h	Velocity threshold time	ms	U16	0	0 - 65535	rw	RxPDO
6071_h	00_h	Target torque	0.1%	I16	0	-32768 - 32767	rw	RxPDO
6072_h	00_h	Max torque	0.1%	U16	1000	0 - 65535	rw	RxPDO
6074_h	00_h	Torque demand	0.1%	I16	0	-32768 - 32767	ro	TxPDO
6077_h	00_h	Torque actual value	0.1%	I16	0	-32768 - 32767	ro	TxPDO
$607A_h$	00_h	Target position	User	I32	0	-2147483648 - 2147483647	rw	RxPDO
$607B_h$		Position range limit	-	-	-	-	-	-
	01_h	Min position range	User	I32	0	-2147483648 - 2147483647	rw	RxPDO
	02_h	Max position range	User	I32	0	-2147483648 - 2147483647	rw	RxPDO
$607C_h$	00_h	Home offset	-	I32	0	-2147483648 - 2147483647	rw	RxPDO
$607D_h$		Software position limit	-	-	-	-	-	-
	01_h	Min position limit	User	I32	0	-2147483648 - 2147483647	rw	RxPDO
	02_h	Max position limit	User	I32	0	-2147483648 - 2147483647	rw	RxPDO
$607E_h$	00_h	Polarity	-	U8	0	0 - 192	rw	No
$607F_h$	00_h	Max profile velocity	User/s	U32	50000	0 - 4294967295	rw	RxPDO
6080_h	00_h	Max motor speed	rpm	U32	3000	0 - 4294967295	rw	RxPDO
6081_h	00_h	Profile velocity	User/s	U32	2000	0 - 4294967295	rw	RxPDO
6082_h	00_h	End velocity	User/s	U32	0	0 - 4294967295	rw	RxPDO
6083_h	00_h	Profile acceleration	User/s^2	U32	20000	0 - 4294967295	rw	RxPDO
6084_h	00_h	Profile deceleration	User/s^2	U32	20000	0 - 4294967295	rw	RxPDO
6085_h	00_h	Quick stop deceleration	User/s^2	U32	10000000	0 - 4294967295	rw	RxPDO
6086_h	00_h	Motion profile type	-	I16	0	-32768 - 32767	rw	RxPDO
6087_h	00_h	Torque slope	0.1%	U32	1000	0 - 4294967295	rw	RxPDO
6088_h	00_h	Torque profile type	-	I16	0	-32768 - 32767	rw	RxPDO
$608F_h$		Position encoder resolution	-	-	-	-	-	-
	01_h	Encoder increments	pulse	U32	*	0 - 4294967295	rw	No
	02_h	Motor revolutions	rot	U32	1	0 - 4294967295	rw	No
6091_h		Gear ration	-	-	-	-	-	-
	01_h	Motor revolutions	rot	U32	1	0 - 4294967295	rw	No
	02_h	Shaft revolutions	rot	U32	1	0 - 4294967295	rw	No
6092_h		Feed constant	-	-	-	-	-	-
	01_h	Feed	User/rot	U32	1000	0 - 4294967295	rw	No
	02_h	Shaft revolutions	rot	U32	1	0 - 4294967295	rw	No
6098_h	00_h	Homing method	-	I8	0	-128 - 127	rw	RxPDO
6099_h		Homing speed	-	-	-	-	-	-
	01_h	Speed during search for switch	User/s	U32	2000	0 - 4294967295	rw	RxPDO
	02_h	Speed during search for zero	User/s	U32	200	0 - 4294967295	rw	RxPDO
$609A_h$	00_h	Homing acceleration	User/s^2	U32	20000	0 - 4294967295	rw	RxPDO
$60B0_h$	00_h	Position offset	User	I32	0	-2147483648 - 2147483647	rw	RxPDO
$60B1_h$	00_h	Velocity offset	User/s	I32	0	-2147483648 - 2147483647	rw	RxPDO
$60B2_h$	00_h	Torque offset	0.1%	I16	0	-32768 - 32767	rw	RxPDO
$60B8_h$	00_h	Touch probe function	-	U16	0	0 - 65535	rw	RxPDO
$60B9_h$	00_h	Touch probe status	-	U16	0	0 - 65535	ro	TxPDO
$60BA_h$	00_h	Touch probe position 1 positive value	User	I32	0	-2147483648 - 2147483647	ro	TxPDO
$60BB_h$	00_h	Touch probe position 1 negative value	User	I32	0	-2147483648 - 2147483647	ro	TxPDO
$60BC_h$	00_h	Touch probe position 2 positive value	User	I32	0	-2147483648 - 2147483647	ro	TxPDO

Index	Sub-Index	Name	Units	Data Type	Initial value	Range	Access	PDO
$60BC_h$	00_h	Touch probe position 2 negative value	User	I32	0	-2147483648 - 2147483647	ro	TxPDO
$60C0_h$	00_h	Interpolation sub mode select	-	I16	0	-32768 - 32767	rw	No
$60C1_h$		Interpolation data record	-	-	-	-	-	-
	01_h	Interpolation target position	User	I32	0	-2147483648 - 2147483647	rw	RxPDO
$60C2_h$		Interpolation time period	-	-	-	-	-	-
	01_h	Interpolation time period value	ms	U8	1	1 - 255	rw	No
	02_h	Interpolation time index	-	I8	-3	-3	rw	No
$60C4_h$		Interpolation data configuration	-	-	-	-	-	-
	01_h	Maximum buffer size	-	U32	256	-	ro	No
	02_h	Actual buffer size	-	U32	0	0 - 256	rw	RxPDO
	03_h	Buffer organization	-	U8	0	0 - 1	rw	RxPDO
	04_h	Buffer position	-	U16	0	0 - 256	rw	RxPDO
	05_h	Size of data record	-	U8	4	4	rw	RxPDO
	06_h	Buffer clear	-	U8	0	0 - 1	rw	RxPDO
$60C5_h$	00_h	Max acceleration	User/s^2	U32	4294967295	0 - 4294967295	rw	RxPDO
$60C6_h$	00_h	Max deceleration	User/s^2	U32	4294967295	0 - 4294967295	rw	RxPDO
$60D0_h$		Touch probe source	-	-	-	-	-	-
	01_h	Touch probe 1 source	-	I16	1	-32768 - 32767	rw	-
	02_h	Touch probe 2 source	-	I16	2	-32768 - 32767	rw	-
$60D1_h$	00_h	Touch probe time stamp 1 positive value	ns	U32	0	0 - 4294967295	ro	TxPDO
$60D2_h$	00_h	Touch probe time stamp 1 negative value	ns	U32	0	0 - 4294967295	ro	TxPDO
$60D3_h$	00_h	Touch probe time stamp 2 positive value	ns	U32	0	0 - 4294967295	ro	TxPDO
$60D4_h$	00_h	Touch probe time stamp 2 negative value	ns	U32	0	0 - 4294967295	ro	TxPDO
$60D5_h$	00_h	Touch probe 1 positive edge counter	-	U16	0	0 - 65535	ro	TxPDO
$60D6_h$	00_h	Touch probe 1 negative edge counter	-	U16	0	0 - 65535	ro	TxPDO
$60D7_h$	00_h	Touch probe 2 positive edge counter	-	U16	0	0 - 65535	ro	TxPDO
$60D8_h$	00_h	Touch probe 2 negative edge counter	-	U16	0	0 - 65535	ro	TxPDO
$60E0_h$	00_h	Positive torque limit value	-	U16	65535	0 - 65535	rw	RxPDO
$60E1_h$	00_h	Negative torque limit value	-	U16	65535	0 - 65535	rw	RxPDO
$60E3_h$		Supported homing methods	-	-	-	-	-	-
	01_h	Supported homing method 1	-	I8	1	-	ro	No
	02_h	Supported homing method 2	-	I8	2	-	ro	No
	03_h	Supported homing method 3	-	I8	3	-	ro	No
	04_h	Supported homing method 4	-	I8	4	-	ro	No
	05_h	Supported homing method 5	-	I8	5	-	ro	No
	06_h	Supported homing method 6	-	I8	6	-	ro	No
	07_h	Supported homing method 7	-	I8	7	-	ro	No
	08_h	Supported homing method 8	-	I8	8	-	ro	No
	09_h	Supported homing method 9	-	I8	9	-	ro	No
	$0A_h$	Supported homing method 10	-	I8	10	-	ro	No
	$0B_h$	Supported homing method 11	-	I8	11	-	ro	No
	$0C_h$	Supported homing method 12	-	I8	12	-	ro	No
	$0D_h$	Supported homing method 13	-	I8	13	-	ro	No
	$0E_h$	Supported homing method 14	-	I8	14	-	ro	No
	$0F_h$	Supported homing method 15	-	I8	17	-	ro	No
	10_h	Supported homing method 16	-	I8	18	-	ro	No
	11_h	Supported homing method 17	-	I8	19	-	ro	No
	12_h	Supported homing method 18	-	I8	20	-	ro	No
	13_h	Supported homing method 19	-	I8	21	-	ro	No
	14_h	Supported homing method 20	-	I8	22	-	ro	No
	15_h	Supported homing method 21	-	I8	23	-	ro	No
	16_h	Supported homing method 22	-	I8	24	-	ro	No
	17_h	Supported homing method 23	-	I8	25	-	ro	No
	18_h	Supported homing method 24	-	I8	26	-	ro	No
	19_h	Supported homing method 25	-	I8	27	-	ro	No
	$1A_h$	Supported homing method 26	-	I8	28	-	ro	No
	$1B_h$	Supported homing method 27	-	I8	29	-	ro	No
	$1C_h$	Supported homing method 28	-	I8	30	-	ro	No
	$1D_h$	Supported homing method 29	-	I8	33	-	ro	No
	$1E_h$	Supported homing method 30	-	I8	34	-	ro	No
	$1F_h$	Supported homing method 31	-	I8	35	-	ro	No
	20_h	Supported homing method 32	-	I8	37	-	ro	No
	21_h	Supported homing method 33	-	I8	-1	-	ro	No
	22_h	Supported homing method 34	-	I8	-2	-	ro	No
	23_h	Supported homing method 35	-	I8	-3	-	ro	No
	24_h	Supported homing method 36	-	I8	-4	-	ro	No
$60F2_h$	00_h	Position option code	-	U16	0	0 - 65535	rw	RxPDO
$60F4_h$	00_h	Following error actual value	User	I32	0	-2147483648 - 2147483647	ro	TxPDO
$60FA_h$	00_h	Control effort	-	I32	0	-2147483648 - 2147483647	ro	TxPDO

Index	Sub-Index	Name	Units	Data Type	Initial value	Range	Access	PDO
$60FC_h$	00_h	Position demand internal value	-	I32	0	-2147483648 - 2147483647	ro	TxPDO
$60FD_h$	00_h	Digital inputs	-	U32	0	00000000_h - $007F000F_h$	ro	TxPDO
$60FE_h$		Digital outputs	-	-	-	-	-	-
	01_h	Physical output	-	U32	0	00000000_h - $00FF0001_h$	rw	RxPDO
	02_h	Bit mask	-	U32	$00FF0001_h$	00000000_h - $FFFFFFFF_h$	rw	RxPDO
$60FF_h$	00_h	Target velocity	User/s	I32	0	-2147483648 - 2147483647	rw	RxPDO
6502_h	00_h	Supported drive modes	-	U32	$00003ED_h$	00000000_h - $FFFFFFFF_h$	ro	TxPDO

* Initial value depends on the motor type

13.2.2. Supported objects

The table below shows that the driver supports the object list defined with the ETG6020.

Index	Name	Category	Supported	Remarks
1000_h	Device type	M	Yes	
1001_h	Error register	M	Yes	
1018_h	Identity object	M	Yes	
6007_h	Abort connection option code	O	No	No independent main power
$603F_h$	Error code	O	Yes	
6040_h	Controlword	M	Yes	
6041_h	Statusword	M	Yes	
6042_h	vl target velocity	C	No	VL mode is not supported.
6043_h	vl velocity demand	C	No	VL mode is not supported.
6044_h	vl velocity actual value	C	No	VL mode is not supported.
6046_h	vl velocity min max amount	C	No	VL mode is not supported.
6048_h	vl velocity acceleration	C	No	VL mode is not supported.
6049_h	vl velocity deceleration	O	No	VL mode is not supported.
$604A_h$	vl velocity quick stop	O	No	VL mode is not supported.
$604B_h$	vl set-point factor	O	No	VL mode is not supported.
$604C_h$	vl dimension factor	O	No	VL mode is not supported.
$605A_h$	Quick stop option code	O	Yes	
$605B_h$	Shutdown option code	O	Yes	
$605C_h$	Disable operation option code	O	Yes	
$605D_h$	Halt option code	O	Yes	
$605E_h$	Fault reaction option code	O	Yes	
6060_h	Modes of operation	M	Yes	
6061_h	Modes of operation display	M	Yes	
6062_h	Position demand value	O	Yes	
6063_h	Position actual internal value	O	Yes	
6064_h	Position actual value	C	Yes	
6065_h	Following error window	C	Yes	
6066_h	Following error time out	C	Yes	
6067_h	Position window	O	Yes	
6068_h	Position window time	O	Yes	
6069_h	Velocity sensor actual value	O	No	No velocity sensor
$606A_h$	Sensor selection code	O	No	No velocity sensor
$606B_h$	Velocity demand value	O	Yes	
$606C_h$	Velocity actual value	O	Yes	
$606D_h$	Velocity window	O	Yes	
$606E_h$	Velocity window time	O	Yes	
$606F_h$	Velocity threshold	O	Yes	
6070_h	Velocity threshold time	O	Yes	
6071_h	Target Torque	C	Yes	
6072_h	Max torque	C	Yes	
6073_h	Max current	O	No	Not servo motor
6074_h	Torque demand	O	Yes	
6075_h	Motor rated current	O	No	Not servo motor
6076_h	Motor rated torque	O	No	Absolute torque value control is not supported.
6077_h	Torque actual value	C	Yes	
6078_h	Current actual value	O	No	Not servo motor
6079_h	DC link circuit voltage	O	No	Not servo motor
$607A_h$	Target position	C	Yes	
$607B_h$	Position range limit	C	Yes	
$607C_h$	Home offset	R	Yes	
$607D_h$	Software position limit	C	Yes	
$607E_h$	Polarity	O	Yes	
$607F_h$	Max profile velocity	O	Yes	
6080_h	Max motor speed	O	Yes	
6081_h	Profile velocity	C	Yes	
6082_h	End velocity	O	Yes	
6083_h	Profile acceleration	C	Yes	
6084_h	Profile deceleration	O	Yes	
6085_h	Quick stop deceleration	O	Yes	
6086_h	Motion profile type	O	Yes	
6087_h	Torque slope	C	Yes	
6088_h	Torque profile type	O	Yes	
$608F_h$	Position encoder resolution	O	Yes	
6090_h	Velocity encoder resolution	O	No	No velocity encoder
6091_h	Gear ration	O	Yes	

Index	Name	Category	Supported	Remarks
6092_h	Feed constant	O	Yes	
6098_h	Homing method	C	Yes	
6099_h	Homing speed	O	Yes	
$609A_h$	Homing acceleration	O	Yes	
$60A3_h$	Profile jerk use	O	No	Jerk control is not supported.
$60A4_h$	Profile jerk	O	No	Jerk control is not supported.
$60B0_h$	Position offset	O	Yes	
$60B1_h$	Velocity offset	O	Yes	
$60B2_h$	Torque offset	O	Yes	
$60B8_h$	Touch probe function	C	Yes	
$60B9_h$	Touch probe status	C	Yes	
$60BA_h$	Touch probe position 1 positive value	C	Yes	
$60BB_h$	Touch probe position 1 negative value	C	Yes	
$60BC_h$	Touch probe position 2 positive value	O	Yes	
$60BD_h$	Touch probe position 2 negative value	O	Yes	
$60C0_h$	Interpolation sub mode select	O	Yes	
$60C1_h$	Interpolation data record	O	Yes	
$60C2_h$	Interpolation time period	O	Yes	
$60C4_h$	Interpolation data configuration	O	Yes	
$60C5_h$	Max acceleration	O	Yes	
$60C6_h$	Max deceleration	O	Yes	
$60D0_h$	Touch probe source	C	Yes	
$60D1_h$	Touch probe time stamp 1 positive value	O	Yes	
$60D2_h$	Touch probe time stamp 1 negative value	O	Yes	
$60D3_h$	Touch probe time stamp 2 positive value	O	Yes	
$60D4_h$	Touch probe time stamp 2 negative value	O	Yes	
$60D5_h$	Touch probe 1 positive edge counter	O	Yes	
$60D6_h$	Touch probe 1 negative edge counter	O	Yes	
$60D7_h$	Touch probe 2 positive edge counter	O	Yes	
$60D8_h$	Touch probe 2 negative edge counter	O	Yes	
$60D9_h$	Supported synchronization functions	O	Yes	
$60DA_h$	Synchronization Function settings	O	Yes	
$60E0_h$	Positive torque limit value	C	Yes	
$60E1_h$	Negative torque limit value	C	Yes	
$60E3_h$	Supported homing methods	C	Yes	
$60E4_h$	Additional position actual value	O	No	No additional sensor
$60E5_h$	Additional velocity actual value	O	No	No additional sensor
$60E6_h$	Additional position encoder resolution - encoder increments	O	No	No additional sensor
$60E7_h$	Additional velocity encoder resolution - Encoder increments per second	O	No	No additional sensor
$60E8_h$	Additional gear ratio	O	No	No additional sensor
$60E9_h$	Additional feed constant - Feed	O	No	No additional sensor
$60EA_h$	Commutation angle	C	No	CSTCA mode is not supported.
$60EB_h$	Additional position encoder resolution - motor revolutions	O	No	No additional sensor
$60EC_h$	Additional velocity encoder resolution	O	No	No additional sensor
$60ED_h$	Additional gear ratio - Shaft revolutions	O	No	No additional sensor
$60EE_h$	Additional feed constant - Shaft revolutions	O	No	No additional sensor
$60EF_h$	Motor resolution	O	No	Controlled by encoder resolution.
$60F2_h$	Position option code	O	Yes	
$60F4_h$	Following error actual value	C	Yes	
$60F8_h$	Max slippage	O	No	Not induction motor
$60FA_h$	Control effort	O	No	
$60FC_h$	Position demand internal value	O	Yes	
$60FD_h$	Digital inputs	O	Yes	
$60FE_h$	Digital outputs	O	Yes	
$60FF_h$	Target velocity	C	Yes	
6200_h …$62FF_h$	Profile 452 PLCopen motion control	O	No	Unsupported profile
6402_h	Motor Type	O	No	Designated motor used.
6403_h	Motor catalogue number	O	No	Designated motor used.
6404_h	Motor manufacturer	O	No	Designated motor used.
6405_h	http motor catalogue address	O	No	Designated motor used.
6502_h	Supported drive modes	M	Yes	
6503_h	Drive catalogue number	O	No	Designated motor used.
6600_h …$67EF_h$	Safety drive profile	O	No	Not FSoE device

Index	Name	Category	Supported	Remarks
$67FF_h$	Device profile number (for multiple device module)	O	No	Non multiple device

Category M: Essential

Category O: Option

Category R: Recommended

Category C: Required according to supported features

14. Torque-off function

14.1. Overview

This machine is equipped with a torque-off input (TO input) as a function to enable stopping without losing the current position when some stop, such as due to an emergency stop switch, is performed.

14.1.1. Basic operation

The torque-off input is assigned to the pin No. 10 of the input / output connector (CNIF).
The driver operates normally if the input is connected at 0 V.
When this input is open or no I/O supply voltage is supplied, a torque-off condition is detected and the motor current will be shut off.
If the torque-off function is not to be used, connect the input to 0 V at the I/O power supply.

14.1.2. Torque-off behavior in the CiA402

When a torque off signal is detected, the Interlock (bit 3) of the Digital Input ($60FD_h$) changes from 0 to 1.
Simultaneously, the state of the CiA402 shifts to Switch on disabled.

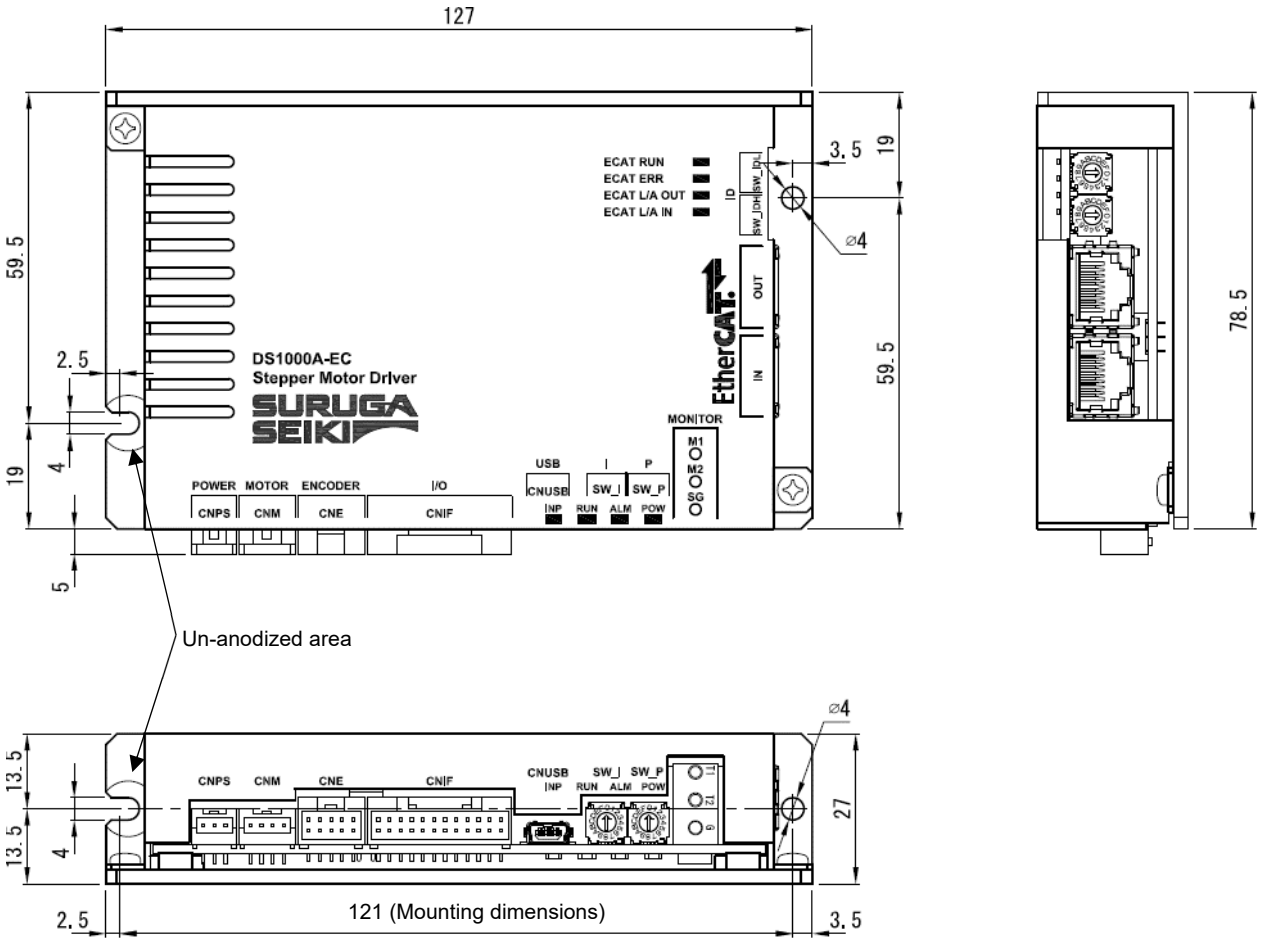
14.1.3. Return to the normal condition following torque-off signal detection

Perform the following steps to recover from a state in which the torque-off signal has been detected.

1. Release the torque-off signal (connect CNIF pin No. 10 to 0 V)
2. Use Controlword (6040_h) to transition from Switch on disabled to Operation enabled sequentially via Ready to switch on and Switched on (see 6.2.1)

15. Specifications

15.1. Dimensions



15.2. Electrical specifications

15.2.1. Main Specifications

Item	Details	Remarks
Main power supply voltage	DC24 V	Rated 2 A, Peak 3 A
	DC48 V	Rated 1 A, Peak 2 A
Drive system	PWM	
PWM frequency	20 kHz	
PWM ripple frequency	40 kHz	
Control method	Position control	
Adaptive load inertia	Within 20 times the motor inertia	

15.2.2. Position control

Item	Details	Remarks
Position mode	1) Always closed 2) Open at set speed or below, closed at set speed or above 3) Always open	When set to open, micro step drive is used, so position accuracy at encoder resolution is not guaranteed
Encoder resolution	28 mm sq. Motor: 9600 ppr 42 mm sq. Motor: 16000 ppr	
Position accuracy	Encoder resolution ±1 pulse	

Maximum frequency for internal commands	880 kpps	The maximum frequency at which actual operation is possible depends on the motor pairing
Feed-forward	0 to 100%	
Positioning completion range	0 to ±1000 pulses	
Full count error	1 to ±2147483647	

15.2.3. Speed control

Item	Details	Remarks
Maximum speed	3000 rpm	There are additional restrictions depending on the motor rating
Velocity control ratio	500: 1 or more	Minimum speed: 6 rpm

15.2.4. Torque control

Item	Details	Remarks
Torque resolution	0 to 100.0%, 0.1% unit	Ratio to rated torque
Speed limit	Max 500 rpm	

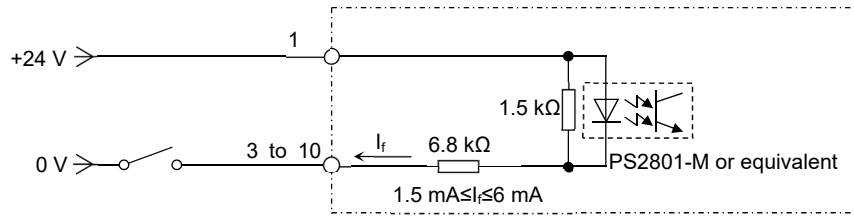
15.2.5. Input / output ports

Item	Details	Remarks
Input / output power supply voltage	DC 24 V ± 10%	
Digital input signal	7 points of input	Opto-isolated
Digital output signal	7 points of output	Opto-isolated
TO	1 point of input	Opto-isolated
Diag. out (Reserved)	1 point of output	Opto-isolated
Sensor input signal	1) +LM: CW side limit signal 2) -LM: CCW side limit signal 3) ORG: Origin sensor signal	Opto-isolated
Brake release output	MOSFET 500 mA_{max}	
Monitor terminal	Motor speed, command speed, command torque, motor torque, position deviation, in-position	Analog 5 V standard

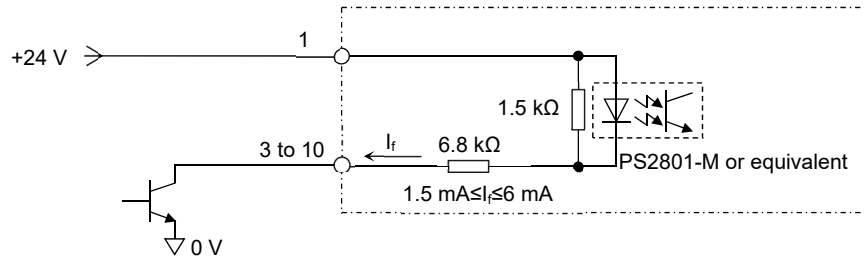
15.2.6. Input / output circuit

15.2.6.1. Input circuit diagram

For relay contacts

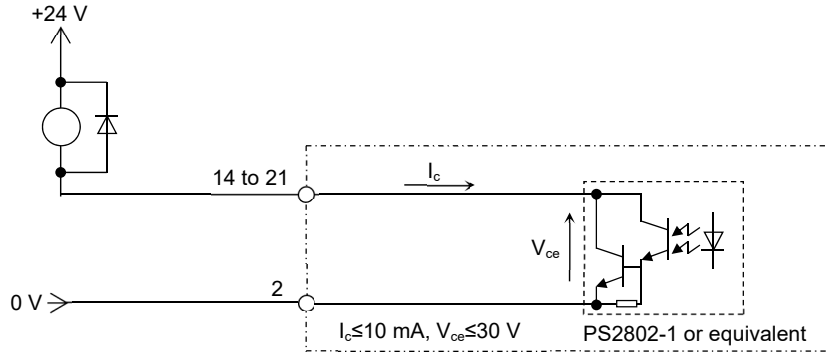


For open collector output

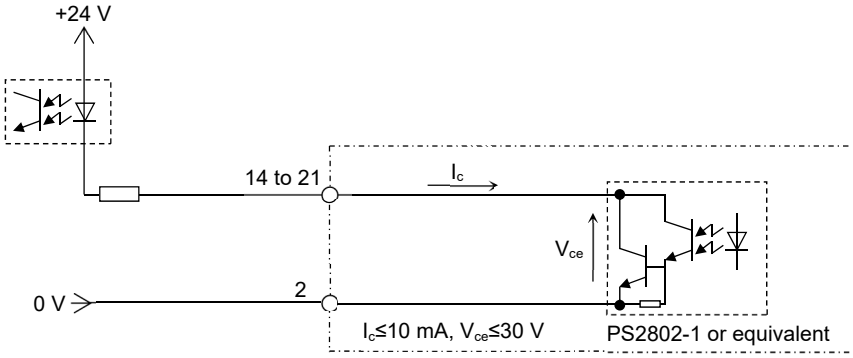


15.2.6.2. Output circuit diagram

For relay connection



For photocoupler connections

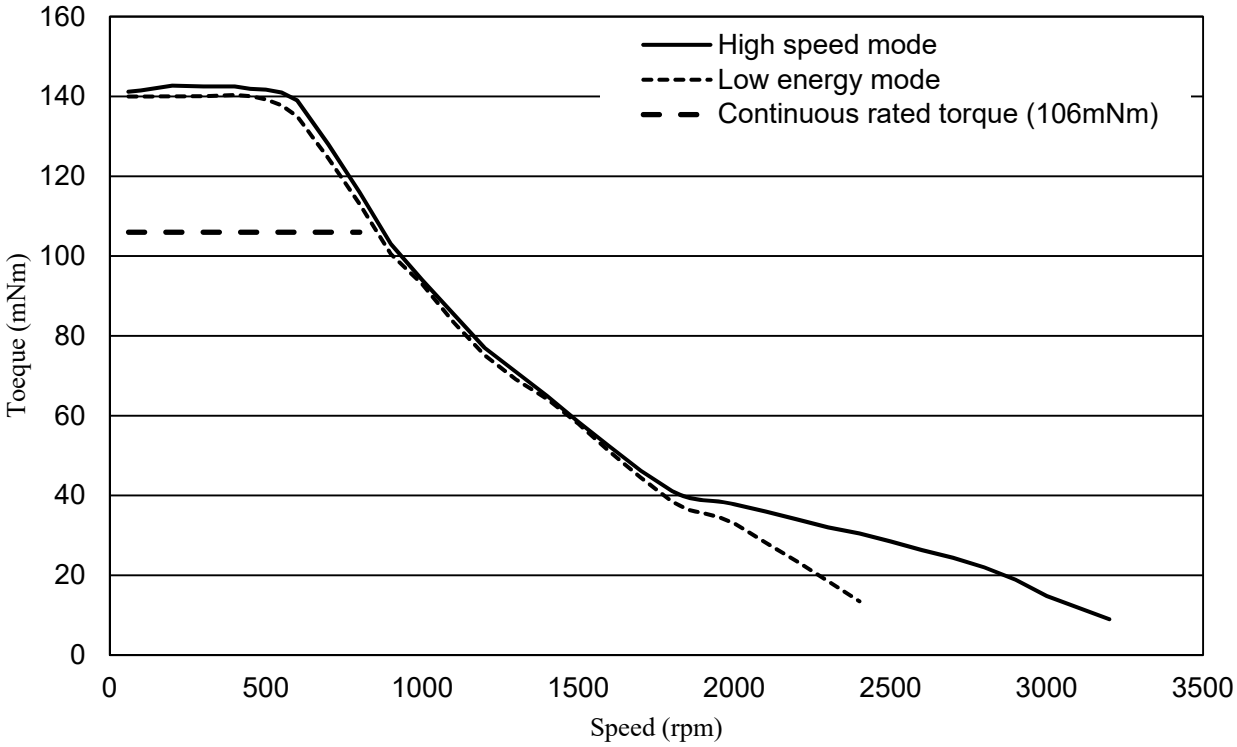


Note) Determine the limiting resistance value in consideration of the saturation voltage (1 V_{typ}, I_c = 10 mA) for the output photocoupler.

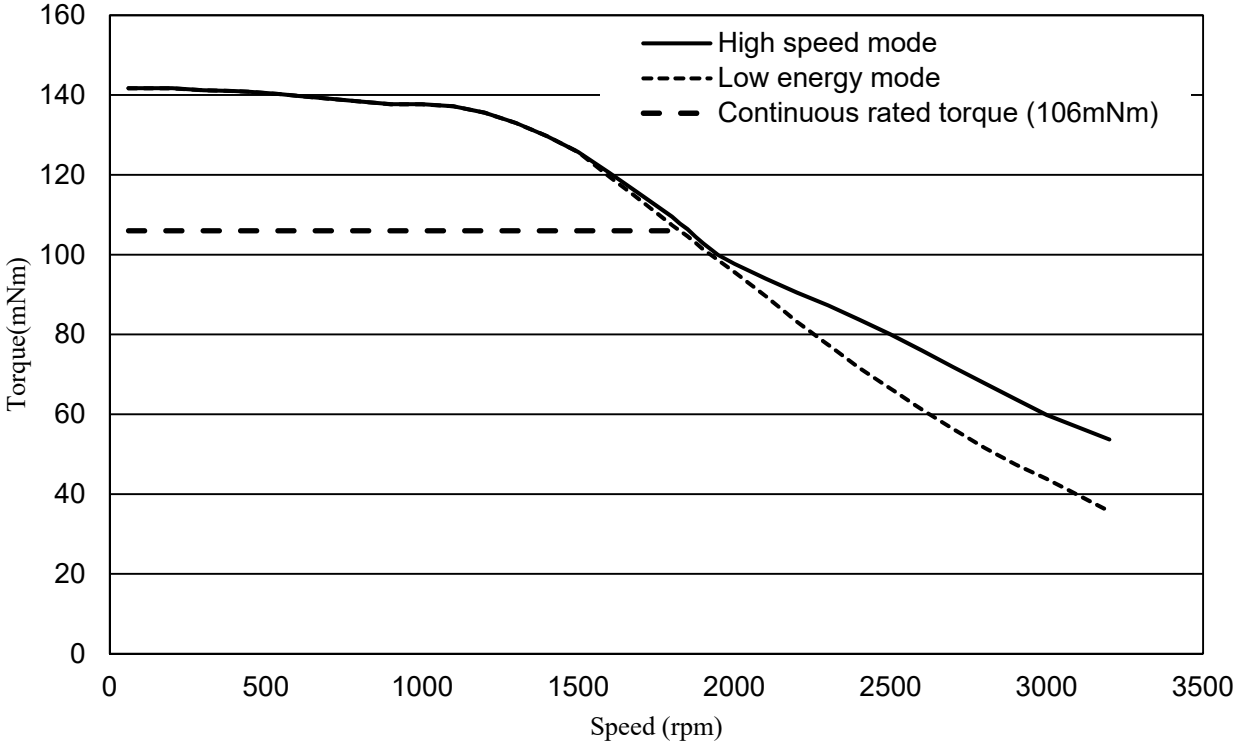
15.2.7. Motor torque characteristics

15.2.7.1. Motor type STM28W100A

Torque characteristics for power supply voltage of 24 V

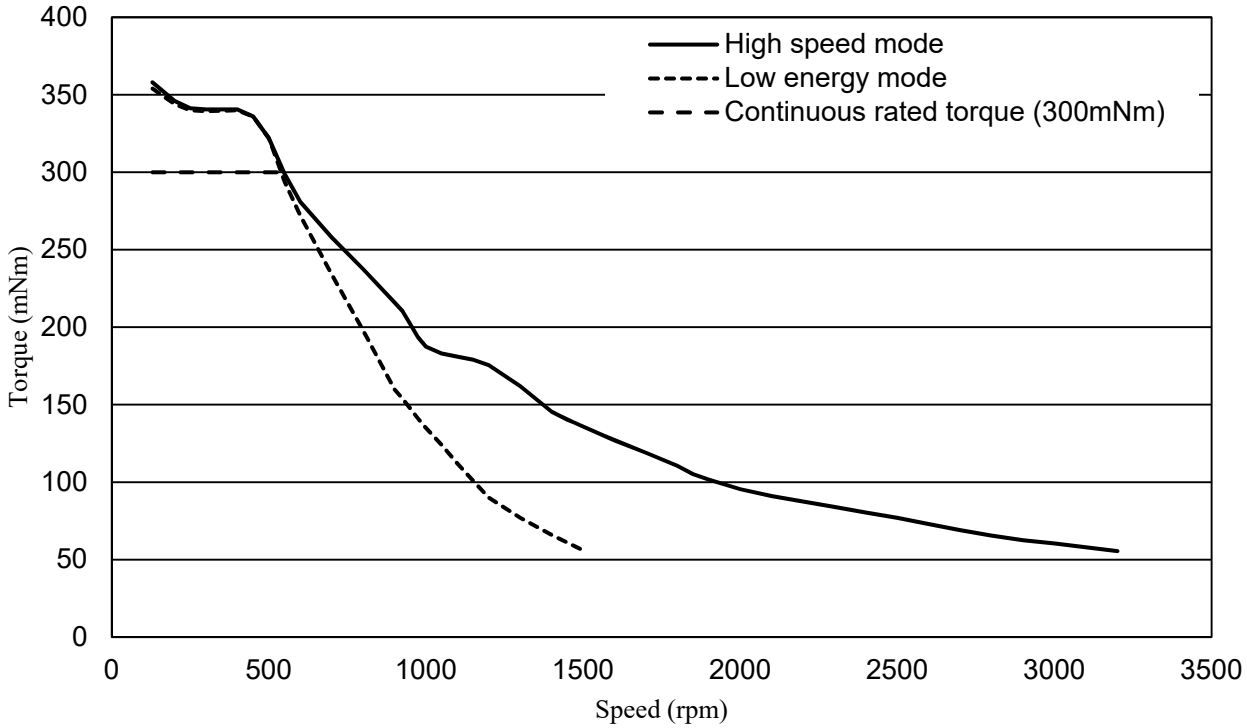


Torque characteristics for power supply voltage of 48 V

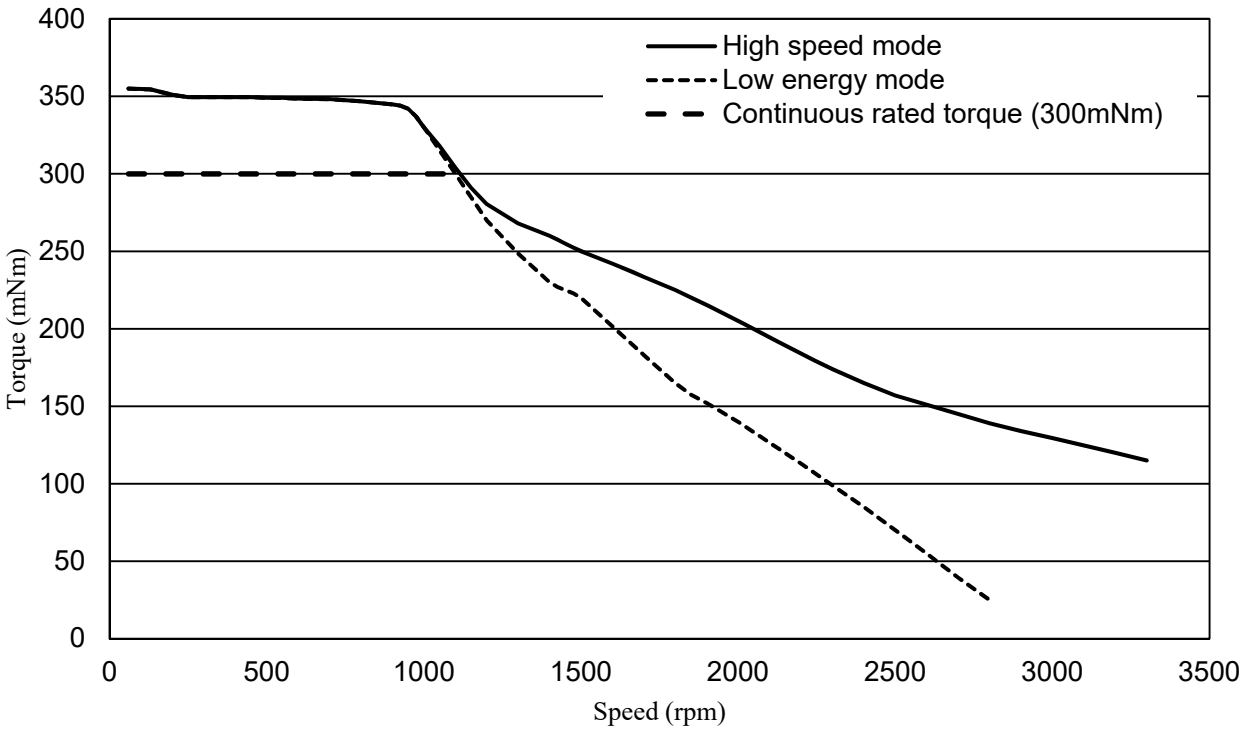


15.2.7.2. Motor type STM42W100A

Torque characteristics for power supply voltage of 24 V



Torque characteristics for power supply voltage of 48 V



15.2.8. Motor rating

15.2.8.1. High-speed mode (standard)

Motor type	Continuous rated torque	Rated speed	Maximum rotation speed	Encoder pulse
STM28W100A	106 mNm	800 rpm (24 V) 1800 rpm (48 V)	3000 rpm	9600 ppr
STM42W100A	300 mNm	500 rpm (24 V) 1100 rpm (48 V)	3000 rpm	16000 ppr

Note) the rated speed is the speed at which continuous rated torque is guaranteed.

15.2.8.2. Low heat generation mode

Motor type	Continuous rated torque	Rated speed	Maximum rotation speed	Encoder pulse
STM28W100A	106 mNm	800 rpm (24 V) 1800 rpm (48 V)	2400 rpm (24 V) 3000 rpm (48 V)	9600 ppr
STM42W100A	300 mNm	500 rpm (24 V) 1100 rpm (48 V)	1500 rpm (24 V) 2800 rpm (48 V)	16000 ppr

Note) the rated speed is the speed at which continuous rated torque is guaranteed.

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