X67SM4320

Data sheet
2.70 (September 2024)

Translation of the original documentation

Publishing information

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Version history

B&R makes every effort to keep documents as current as possible. The most current versions are available for download on the B&R website (www.br-automation.com).

1 General information

1.1 Other applicable documents

For additional and supplementary information, see the following documents.

Other applicable documents

Document name	Title
MAX67	X67 System user's manual
MAEMV	Installations / EMV guide

1.2 Order data

Order number	Short description	Figure
	Motor modules	
X67SM4320	X67 stepper motor module, I/O power supply 24 VDC ±25%, 4 motor connections, 1 A continuous current, 1.5 A peak current, NetTime function	

Table 1: X67SM4320 - Order data

Required accessories
For a general overview, see section "Accessories - General overview" in the X67 System user's manual.

1.3 Module description

The stepper motor module is used to control up to 4 stepper motors with a nominal voltage of 24 VDC ±25% at a motor current up to 1 A (1.5 A peak).

Functions:

- Currents independently configurable
- Stall detection
- Homing
- Limitations
- Motion generator
- Counters
- Automatic shutdown
- NetTime Technology

Currents independently configurable

With individual adjustment of the coil currents, the motor is only operated with the current it actually needs. This prevents unnecessary heating of the motor. This lower heating has a positive effect on the energy consumption, thermal load and thus on the service life of the complete system.

Stall detection

Stall detection is integrated to analyze the motor load. Motor stall detection is defined by a configurable threshold. This allows an overload or motor stall to be detected sufficiently accurately in many applications.

Homing

A large selection of homing procedures allows a wide range of applications for the module. Both stop-controlled and immediate homing can be defined.

For end stop-controlled homing, a delay time can also be defined for stall detection. Homing is only performed after the delay time has elapsed. This prevents unwanted homing due to accidental, brief stoppage of the motor.

Limitations

Software limitations allow control of the maximum range of movement. This prevents limit transgressions that could result in damage to the machine.

Motion generator

Movements can be generated directly by the module. Homing or exact positioning procedures can be implemented with minimal application effort using a specified target position and acceleration as well as several other parameters.

Counter functions

The position of the motor is determined by internal calculations in the module. This allows a large number of motors to be used that are precisely adapted to the machine requirements.

Automatic shutdown

The voltage of the module power supply and the module temperature are monitored. If a value overshoots the predefined limit value, the module is automatically shut down. The outputs are automatically started up again as soon as the value is within the limit value again.

In addition, SDC life sign monitoring can be used to monitor the communication between the controller and module. An interruption of the communication triggers an automatic shutdown of the motor by the module.

The module current, the voltage of the module power supply and the module temperature are monitored. If a value overshoots the predefined limit value, the module is automatically shut down.

NetTime timestamp of the position and trigger time

It is not just the position value that is important for highly dynamic positioning tasks, but also the exact time the position is measured. The module is equipped with a NetTime function for this that supplies a timestamp for the recorded position and trigger time with microsecond accuracy.

2 Technical description

2.1 Technical data

Order number	X67SM4320
Short description	
I/O module	4 full bridges for controlling stepper motors
General information	
B&R ID code	0x1DCC
Status indicators	"Motor active" per channel, bus function
Diagnostics	
I/O power supply	Yes, using LED status indicator and software
Motor status	Yes, using LED status indicator and software
Connection type	
X2X Link	M12, B-coded
Outputs	4x M12, A-coded
I/O power supply	M8, 4-pin
Power consumption	
Internal I/O	2 W
X2X Link power supply	0.75 W
Certifications	
CE	Yes
UKCA	Yes
ATEX	Zone 2, II 3G Ex nA IIA T5 Gc IP67, Ta = 0 - Max. 60°C TÜV 05 ATEX 7201X
UL	cULus E115267 Industrial control equipment
HazLoc	cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5
KC	Yes
Motor bridge - Power unit	
Quantity	4
Type	2-phase bipolar stepper motor
Nominal voltage	24 VDC ±25% [1)]
Nominal current	1 A
Max. current/motor	1.5 A for 2 s (after a recovery time of at least 10 s at maximal 1 A)
Max. current/module	6 A
Controller frequency	38.5 kHz
DC bus capacitance	440 µF
Step resolution	256 microsteps per full step
I/O power supply	
Nominal voltage	24 VDC ±25%
Integrated protection	
Short-circuit/Overload protection	Yes
Reverse polarity protection	No
Electrical properties	
Electrical isolation	Channel isolated from bus Channel not isolated from channel
Operating conditions	
Mounting orientation	
Any	Yes
Installation elevation above sea level	
0 to 2000 m	No limitation
>2000 m	Reduction of ambient temperature by 0.5°C per 100 m
Degree of protection per EN 60529	IP67
Ambient conditions	
Temperature	
Operation	0 to 50°C
Derating	-
Storage	-40 to 85°C
Transport	-40 to 85°C

Table 2: X67SM4320 - Technical data

Order number	X67SM4320
Mechanical properties	
Dimensions	
Width	53 mm
Height	85 mm
Depth	42 mm
Weight	195 g
Torque for connections	
M8	Max. 0.4 Nm
M12	Max. 0.6 Nm

Table 2: X67SM4320 - Technical data

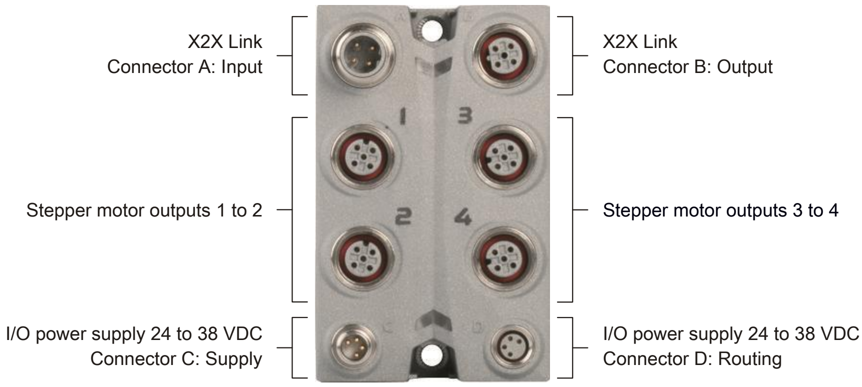
1) The tolerance value is composed of the voltage tolerances and permissible total AC voltage component with a peak value of 5% of the rated voltage.

2.2 LED status indicators

Figure	LED	Color/Status		Description
Status indicator 1: Left: Green, Right: Red  Status indicator 2: Left: Green, Right: Red	**Status indicator 1: Status indicator for X2X Link**			
	Left/Right	**Green (left)**	**Red (right)**	**Description**
		Off	Off	No power supply via X2X Link
		On	Off	X2X Link supplied, communication OK
		Off	On	X2X Link supplied but no X2X Link communication
		On	On	Preoperational: X2X Link supplied, module not initialized
	I/O LEDs: Status indicator			
	1 - 4	**Color**	**Status**	**Description**
		Yellow	On	Motors 1 to 4 are active.
	Status indicator 2: Status indicator for module functionality			
	Left	**Color**	**Status**	**Description**
		Green	Off	No power to module
			Single flash	Mode RESET
			Double flash	Mode BOOT (during firmware update)[1]
			Blinking	Mode PREOPERATIONAL
			On	Mode RUN
	Right	**Color**	**Status**	**Description**
		Red	Off	Module not supplied with power or everything OK
			On	Error or reset state
			Single flash	Warning/Error on an I/O channel. Overflow in analog inputs.
			Double flash	Supply voltage not within the valid range

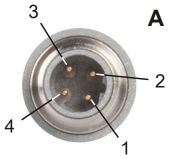
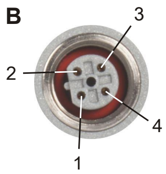
1) Depending on the configuration, a firmware update can take up to several minutes.

2.3 Connection elements

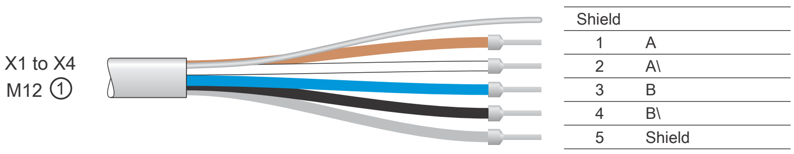


2.3.1 X2X Link

The module is connected to the X2X Link network using pre-assembled cables. The connection is made using M12 circular connectors.

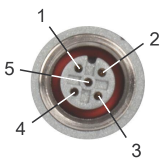
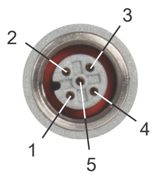
Connection	Pinout	
	Pin	Name
	1	X2X+
	2	X2X
	3	X2X⊥
	4	X2X\
	Shield connection made via threaded insert in the module. A → B-coded (male), input B → B-coded (female), output	

2.3.2 Pinout



①	X67CA0A41.xxxx:	M12 sensor cable, straight
	X67CA0A51.xxxx:	M12 sensor cable, angled

2.3.2.1 Connections X1 to X4

M12, 5-pin	Pinout	
Connection X1/X2	Pin	Name
	1	Stepper motor A
	2	Stepper motor A\
	3	Stepper motor B
	4	Stepper motor B\
	5	Shield
 Connection X3/X4	Shield connection made via threaded insert in the module	

Warning!

Circular connectors are not permitted to be connected or disconnected during operation.

Information:

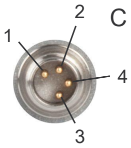
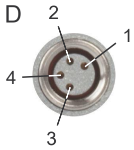
Shielded motor cables must be used in order to meet the limit values per standard EN 55011 (emissions).

2.3.3 24 VDC I/O power supply

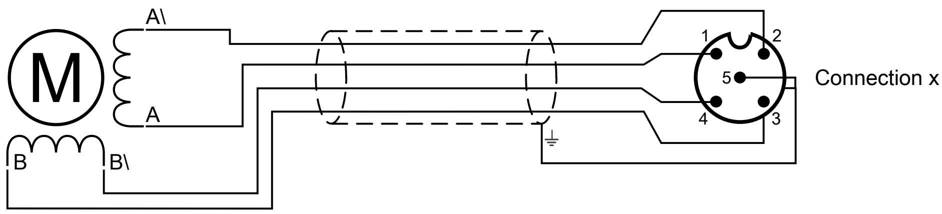
The I/O power supply is connected using circular connectors (M8, 4-pin). The power supply is fed via connector C (male). Connector D (female) is used to route the power supply to other modules.

Information:

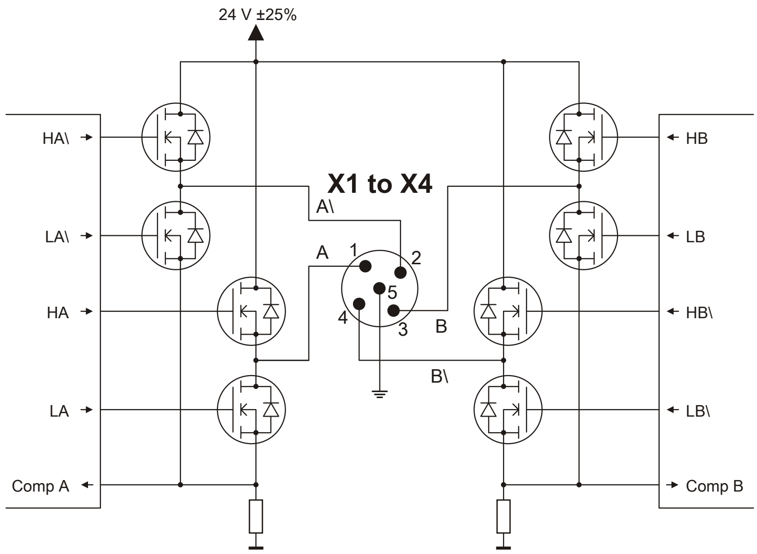
The maximum current per power supply is 4 A (8 A in summation)!

Connection	Pinout	
 	**Pin**	**Name**
	1	24 VDC ±25%
	2	24 VDC ±25%
	3	GND
	4	GND
	C → Connector (male) in module, supply D → Connector (female) in module, routing	

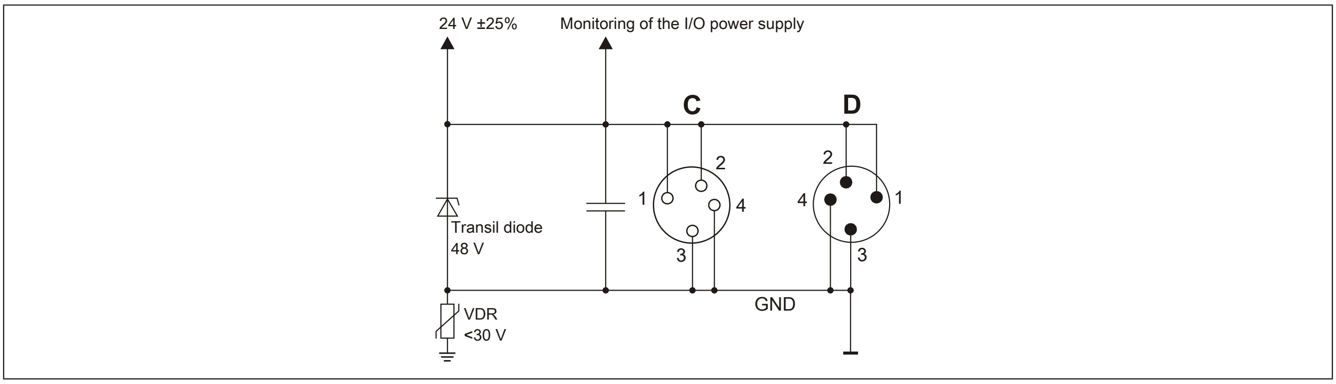
2.4 Connection example



2.5 Output circuit diagram



2.6 I/O power supply circuit diagram



2.7 Installation

Top-hat rail installation can only be recommended if the module is used for low power ratings.

In order to improve heat dissipation, it is recommended to install the module on a cooler machine part or on a base plate of at least 1 dm². In addition, a distance of at least 1 cm to the next X67 module must be maintained.

2.8 Power supply unit dimensioning

The motor's current consumption depends on the defined motor currents, the available power and the actual motor being used. An increase in the motor load causes an increase in current consumption.

An increase in the motor load causes an increase in the effective current of the module power supply.

2.9 Fuse protection

Line protection must be provided in the power supply line via a circuit breaker or fuses. In general, dimensioning the supply line and overcurrent protection depends on the structure of the power supply (modules can be connected individually or in groups).

Information:

The effective current for the power supply depends on the load but is always less than the motor current. Make sure that the maximum nominal current of 8 A (4 A per pin) is not exceeded on the power supply terminals of the power unit.

When choosing a suitable fuse, the user must also account for characteristics such as aging effects, temperature derating, overcurrent capacity and the definition of the rated current, which can vary by manufacturer and type. In addition, the fuse that is selected must also be able to handle application-specific characteristics (e.g. overcurrent that occurs in acceleration cycles).

The cross section of the mains power input and the rated current of the used fuse are chosen according to the current-carrying capacity such that the permissible current-carrying capacity of the selected cable cross section (depending on wiring, see table) is greater than or equal to the current load in the mains power input. The rated current of the fuse protection must be less than or equal to the permissible current-carrying capacity of the selected cable cross section (depending on the how it is installed, see table):

$$I_{Mains} \leq I_b \leq I_Z$$

Mains ≤ Fuse ≤ Line/Cable

Line cross section [mm²]	Current-carrying capacity of cable cross section I_Z / rated current of fuse I_b [A] depending on the to type of wiring at an ambient air temperature of +40°C per EN 60204-1			
	B1	**B2**	**C**	**E**
1.5	13.5 / 13	13.1 / 10	15.2 / 13	16.1 / 16
2.5	18.3 / 16	16.5 / 16	21 / 20	22 / 20

Table 3: Cable cross section of the mains power input depending on the type of wiring

The tripping current of the fuse is not permitted to exceed the rated current of the fuse I_b.

Type of wiring	Description
B1	Wires in conduit or cable duct
B2	Cables in conduit or cable duct
C	Cables or lines on walls
E	Cables or lines on open-ended cable tray

Table 4: Type of wiring used for the mains power input

2.10 Energy regeneration from the voltage

If voltage is regenerated during generator operation of the motor, the built-in Transil diode may be overloaded and the module could be irreparably damaged as a result. The following recovery values are therefore not permitted to be exceeded:

- 6 W at more than 40 V

Notice!

Overshoot of the limit values must not be avoided by means of suitable technical measures or by disconnecting cables during maintenance tasks.

3 Function description

3.1 Currents independently configurable

Due to the individual adjustment of the coil currents, the motor is only operated with the current it actually needs. The required motor voltage is automatically set via the constant current control of the module and the provided winding resistance of one phase of the motor.

This simplifies the selection of the available motors and prevents unnecessary heating. Because this affects energy consumption and thermal load, the effects are positive on the service life of the complete system. Complete flexibility is achieved through the use of independently adjustable holding, maximum and nominal current values. The current for microsteps is automatically adjusted to the configured current values.

The holding current, nominal current and maximum current registers are used to configure the desired motor current. The nominal motor current is entered in the nominal current register according to the motor's data sheet.

Reasonable values:

- Holding current < Nominal current < Maximum current

Information:

The maximum current must always be configured greater than or equal to the nominal current.

Register	Description
Nominal current	Current during operation at constant speed
Maximum current	Current during short acceleration phases if a higher motor torque is required. In mode "Homing", the nominal current is always used instead of the maximum current, even in acceleration phases.
Holding current	Current consumption for phases in which less torque is required (e.g. at standstill). This reduces the amount of heat generated by the motor.

When the current changes to a weaker value (e.g. when transitioning from the acceleration phase to the constant speed mode), the stronger current is maintained for an additional 100 ms. The following priority applies regardless of the values actually set: Maximum current before nominal current before holding current.

Information:

The registers are described in "Configuring currents (function model 0)" on page 34 and "Configuring currents (function models 3 and 254)" on page 34.

3.2 Stall detection

The module is equipped with integrated sensorless load measurement for the motor axis. This functionality is particularly useful for detecting a "stall condition" (e.g. if the motor moves against the endpoint during a homing procedure). It is not suitable for torque monitoring during dynamic movements.

Stall threshold value

The threshold value valid for the motor must be determined individually since the result of the load measurement depends on various influences.

- Motor speed: A higher speed results in higher measured values.
- Speeds at which motor resonances occur that falsify the load measurement must be avoided.
- Motor accelerations that generate a dynamic load and thus also falsify the measurement must be avoided.
- In particular, it is important to note that mixed decay mode must be optimized for reliable stall detection (see "Mixed decay threshold" on page 35).

The higher the load measured value, the lower the load. This means that a stall condition is detected if the load measured value falls below the trigger threshold for stall detection.

Mixed decay threshold

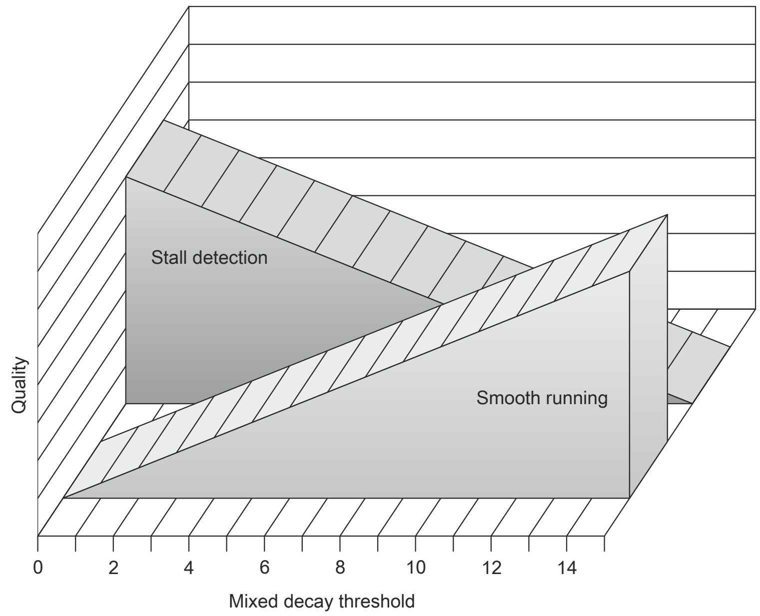
The mixed decay module ensures the best possible sinusoidal current curve in the individual phases of the stepper motor, particularly in the case of rapid current changes and low current values.

Mixed decay is disruptive for reliable stall detection, however. This is why the mixed decay threshold can be used to disable mixed decay mode at the time of stall detection (motor load measurement). The smaller the set mixed decay threshold, the larger the range regarding the time of the motor load measurement in which mixed decay is disabled.

Mixed decay mode is always enabled with a mixed decay threshold of 15.

Relationship between stall detection and mixed decay

Depending on the application and the motor used, satisfactory smooth running with simultaneous stall detection functionality can be achieved by setting the mixed decay threshold to a value between 1 and 14. This represents a compromise between smooth running and stall detection quality and must be determined during commissioning.



Information:

Registers are described in "Stall detection" on page 35.

3.3 Homing

Homing can be carried out in forward and reverse direction.

Before homing can be performed, the motor must be at a standstill.

If the homing condition occurs, the motor stops and the values of the position counter that are valid at the moment when the homing condition occurs are applied as the homed zero position.

Whether homing should take place via stall or unconditionally must be set in the homing configuration.

Homing during stall

Movement continues in the homing direction until a stall is detected. When a stall is detected, the value of the position counter is applied as the homed zero position within one millisecond. The motor is then stopped abruptly (not using the deceleration ramp). However, it can take up to 25 ms to stop the motor because the ramp generator runs with a configurable internal cycle of up to 25 ms.

In order to prevent unwanted homing due to brief stalling, an additional delay time can be defined for stall detection. Homing is only performed after the delay time has elapsed.

In this mode, the nominal current is always used instead of the maximum current, even in acceleration phases.

To test the responsiveness of this homing mode, the motor load value used for identifying a stall can be made visible in the status word.

Immediate homing

The current values of the position counter are immediately applied as the homed zero position (no motor movement).

Information:

Registers are described in "Homing" on page 38.

3.4 Limitations

Limitations can be implemented in software using software limits.

Monitoring software limits

This function is enabled if at least one of the two software limit registers is not equal to zero.

This limit monitoring is effective in all positioning modes. Position overflow is not possible when this function is enabled. Movement is always contained within the two limits.

If a position is specified that overshoots/undershoots the software limits or in the event of an invalid configuration (minimum > maximum), bit "Internal limit active" is set in the status word. The motor movement will be stopped until a position is specified within the limits.

Information:

Monitoring software limits works only when in connection with the following CANopen bus controllers:

- **X20BC0043-10**
- **X20BC0143-10**
- **X67BC4321-10**
- **X67BC4321.L08-10**
- **X67BC4321.L12-10**

Information:

The registers are described in "Limitations" on page 39.

3.5 Motion generator

Mode

The module can independently generate a number of different movements based on specified parameters:

- Position mode
- Velocity setpoint
- Homing

	Information
	No mode selected
Positioning	
	Velocity setpoint
	Position mode Depending on bit 0 in the general configuration, the position mode behaves as follows: • Without extended control word: Move to target position as soon as the target position is changed. • Position mode with extended control word: Move to the target position as described in "Extended control word".
Moving to absolute positions	
	Moving to a fixed position (first or second position)
Homing	
	Homing in the forward direction
	Homing in the reverse direction
Applying positions	
	Applying the actual position (homing or actual position)

Information:

For all modes: Bit "Target reached" is set in when the current action is ended (i.e. when the position or speed is reached, depending on the mode).

A new position or speed can be specified even before the current action is finished.

Velocity setpoint

The desired velocity setpoint is specified to the module (microsteps per cycle).

Observing the maximum permissible acceleration, the motor moves with a ramp to the desired speed setpoint and maintains this speed until a new speed setpoint is specified.

Position mode

A position setpoint is specified. The motor is then moved to this new position. This is done with a ramp function that accounts for the defined maximum speed and acceleration values.

The position setpoint can also be changed during an active positioning procedure.

The position setpoint is specified in microsteps (1/256 of a full step).

How the position is applied can be controlled in the configuration by bit 0:

- If bit 0 equals 0 (no extended control word), the position setpoint will be applied as soon as it is not equal to the current position. The new position is then used for the movement.
- If bit 0 equals 1, the position setpoint is accepted as described in "Extended control word".

Extended position mode

Position mode with extended control word behaves like the previously described position mode (without the extended control word), but the new position setpoint is applied according to the extended control word.

Extended control word

Additional commands can be sent depending on the state of the module:

- (Do not) Apply the new target position.
- Process or interrupt the current positioning and start the next positioning.
- Define the target position as an absolute or relative value.
- Stopping a movement

Relative position setting

If bit abs / rel in extended control word is set, then the target position is interpreted as a relative value. At each New setpoint trigger, the target position will be increased by this value (or decreased if the value is negative).

If the mode changes between the position settings, relative movement will then proceed starting at the last specified position. The position setpoint mode is initialized with 0 when the module is started.

Specifying the target position

The target position can be defined in 2 different ways:

Type of setpoint definition	Description
Single setpoint	After the target position is reached, bit Target reached is set in the status word. A new target position (setpoint) is then defined. The drive stops at each target position before starting the movement to the next target position.
Set of setpoints	After the target position has been reached, the movement to the next target position is started immediately without stopping the drive. It is therefore possible to initiate a new positioning by specifying another target position during active positioning.

The two options "Single setpoint" and "Set of setpoints" are controlled by the timing of bits New setpoint and Change set immediately in the extended control word and Setpoint acknowledge in the extended status word register.

These bits can be used to create a Request-Response mechanism. This makes it possible to specify a target position while a previous position specification is still being processed.

Specifying the target position

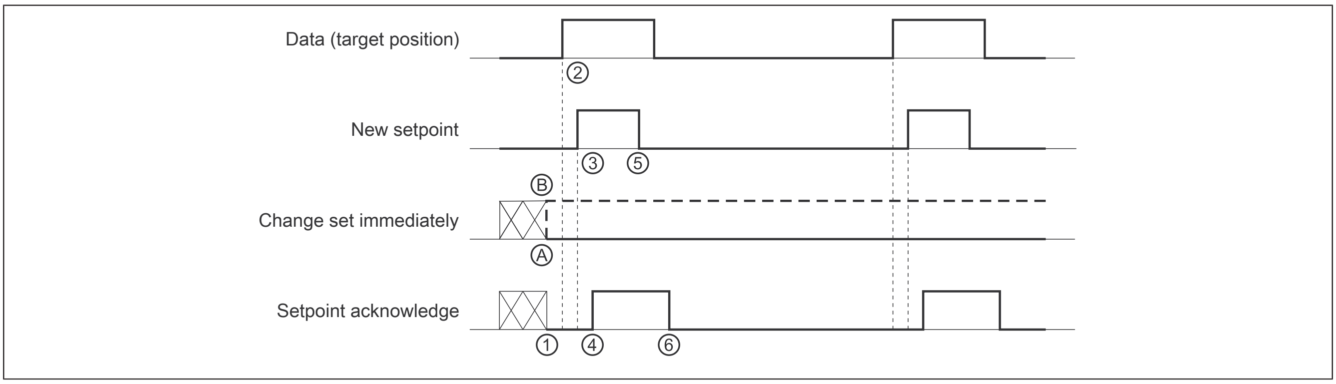


Figure 1: Principle for applying the setpoint

Transferring a new setpoint:

1) If bit Setpoint acknowledge in the extended status word is 0, the module will accept a new target position.
2) Specify the new target position.
3) A rising edge on bit New setpoint in the extended control word indicates that the new target position is valid and can be used for the next positioning movement.
4) After the module has received and saved the new target position, bit Setpoint acknowledge is set to 1 in register Status word.
5) Now the controller can reset the New setpoint bit to 0.
6) Then the module resets bit Setpoint acknowledge to 0 to signal when a new target position is accepted.

Position specification "Single setpoint"

If bit Change set immediately is set to 0 (Ⓐ in figure "Principle for applying the setpoint"), then the module is operating with position specification Single setpoint. This mechanism results in a speed of 0 when the motor reaches target position x_1 at time t_1. After the controller has been notified that the setpoint has been reached, the next target position x_2 will be processed at time t_2 and reached at t_3.

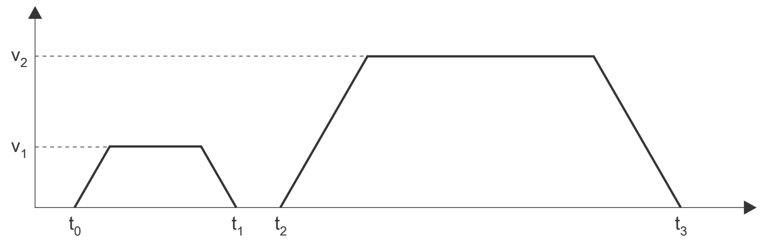


Figure 2: Ramp characteristics in mode Single setpoint

Position specification "Set of setpoints"

If bit Change set immediately is set to 1 (Ⓑ in figure "Principle for applying the setpoint"), then the module is operating with position specification Set of setpoints. This means that the module receives the first target position at t_0. A second target position is received at time t_1. The drive immediately adapts the current movement to the new target position.

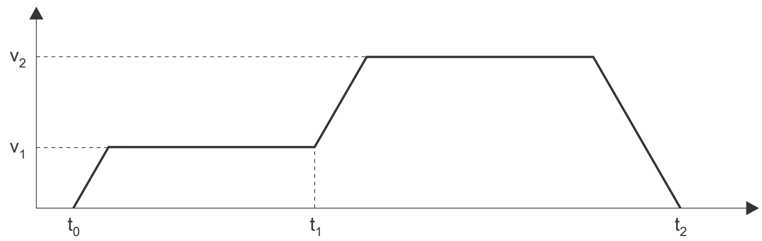


Figure 3: Ramp characteristics in mode Set of setpoints

Moving to the target position

A preset position setpoint is approached on a rising edge of digital input 3.

A changed position setpoint is only applied on a new rising edge of the associated digital input. This can also take place during the ongoing positioning process and is then immediately effective.

In addition, a reversing loop can be set.

Moving to a fixed position

2 fixed positions can be transferred acyclically to the module that are approached differently depending on the mode.

- Mode -125: Move to the first fixed position
- Mode -126: Move to the second fixed position

In addition, a reversing loop can be set.

Applying the actual position

Before a position can be applied, the motor must be at a standstill and physically located at the point for which the position being set should be applied. The new position is applied when the state machine is in state "Operation enable".

Depending on the mode, the following positions can be applied:

- The set target position is applied as the current actual position in the internal position counter.
- The current actual position is modified such that the specified position exists at the reference. If moved to this position, the motor is at the home position. The home position in the referenced position register is also set to this value. Before this mode is called, the motor must be at a standstill and the home position must have been determined using the positive/negative homing mode.

Reversing loop

This parameter is only available for absolute positioning.

A reversing loop can be used to avoid mechanical backlash and different movement tolerances.

If the value is not equal to 0, the target position is approached directly when coming from one direction; when coming from the other direction, the target position is initially overshot by the configured number of steps before finally moving to the target position. The target position is therefore always approached from the same direction. The sign of the defined value determines the direction in which the reversing loop runs.

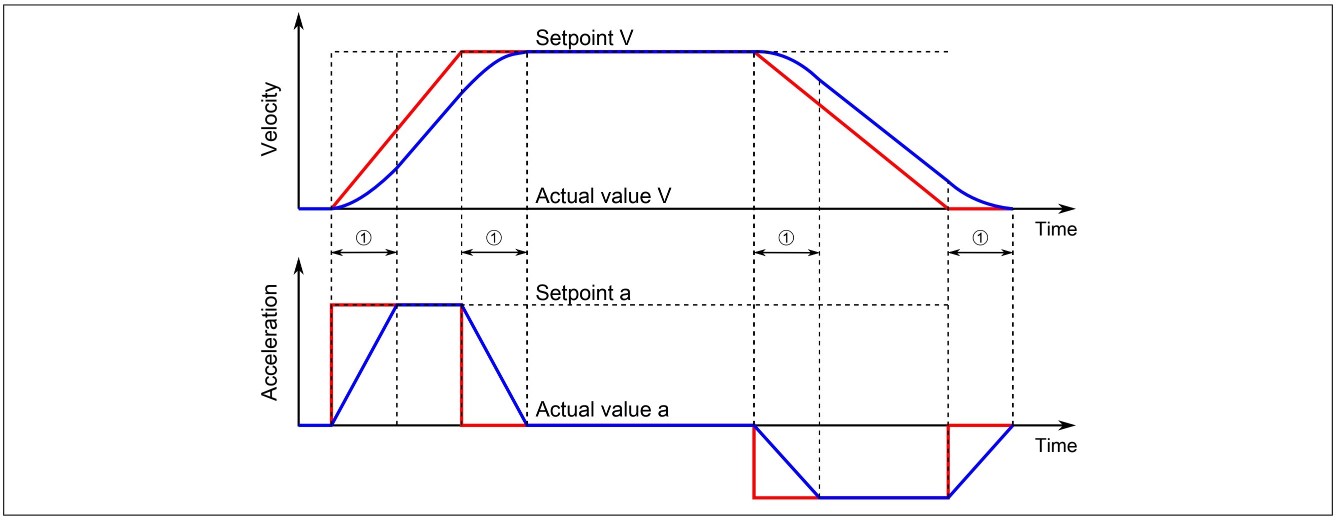
- Positive sign: Forward movement
- Negative sign: Backward movement

Jerk limitation

To avoid noticeable jumps when starting the motor or when the acceleration changes (e.g. from 1 m/s^2 to 3 m/s^2), a jerk time (①) can be defined. This indicates the number of cycles during which the acceleration is adapted to the new setpoint. If more than 80 cycles are entered, they are limited to 80.

Changes made to the jerk time while the motor is running are only applied when the preset position is reached or the next motor standstill.

The following diagram shows the change of acceleration and speed with (blue line) and without (red line) jerk limitation time.



① Set jerk time in cycles

3.6 Automatic shutdown

To prevent damage to the module or motor, both the voltage of the module power supply and the module temperature are monitored. In addition, the communication of the module with the PLC can be monitored.

3.6.1 Shutdown in the event of overvoltage/undervoltage

The module power supply voltage is monitored. Its status can be read. An error is reported in the event of a voltage greater or less than the limit values.

If the supply voltage in the module rises above the limit value, e.g. due to regenerative operation, or falls below the limit value, then the motor output is cut off. The motor output is reactivated as soon as the supply voltage is back within the valid range.

Limit values for the supply voltage

	Drive cut off	Drive switched back on
Lower limit	<18 V	>30 V

Information:

The error message is described under register "Module status" on page 41.

3.6.2 Shutdown in the event of overtemperature

If the module temperature reaches or overshoots the limit value, the module performs the following actions:

- Sets the "overtemperature" error bit
- The outputs are cut off.

As soon as the temperature falls below the module temperature limit value, the error bit is automatically cleared by the module and the outputs are put back into operation.

Module temperature limit value
85°C

Information:

The error message is described under register "Motor error" on page 42.

3.6.3 Monitoring the module communication

The communication between the module and controller can be monitored with SDC life sign monitoring.

After life sign monitoring is enabled, counter and timestamp information is exchanged and evaluated between the module and controller. If bit "SDC information" is additionally enabled, bit "EncOK01" is displayed in the Automation Studio I/O mapping. This bit is permanently linked to bit ModulOK and always indicates its value.

If the NetTime timestamp specified by the controller is in the past, then an error is triggered for the motor axis (only when the motor is switched on). The module performs the following steps:

1) The controller is informed of the error using the drive bit (DrvOk) = 0.

2) Braking at the configured nominal current with speed setpoint = 0

3) Wait for the configured switch-off delay to expire

4) Switch off the motor current

When the timestamp is back within the valid range, the motor can be started up again by a rising edge on bit DriveEnable.

Information:

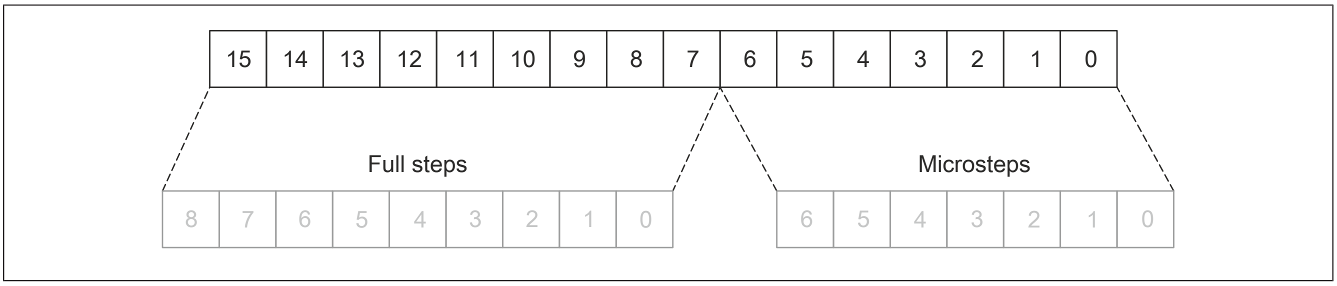
The registers are described in "SDC configuration" on page 33 and "Motor current" on page 40.

3.7 Counters

The internal position counter is the position calculated by the module (position setpoint). This is a cyclic 16-bit counter.

The lowest 5 to 8 bits represent microsteps, and the higher bits represent full steps. In function model Standard with SDC, this value is defined as "8-bit microstep" and cannot be changed.

Example for the format of the internal position counter with 7-bit microsteps:



Information:

The smallest physical full-step division of the module that is possible is 1/64 of a full step. Bits with a significance of 1/128 or 1/256 of a full step therefore remain 0. This must be taken into account if this position register is used for controller feedback.

Information:

The registers are described in "Module configuration" on page 33.

3.8 NetTime Technology

NetTime refers to the ability to precisely synchronize and transfer system times between individual components of the controller or network (controller, I/O modules, X2X Link, POWERLINK, etc.).

This allows the moment that events occur to be determined system-wide with microsecond precision. Upcoming events can also be executed precisely at a specified moment.

NetTime TECHNOLOGY

3.8.1 Time information

Various time information is available in the controller or on the network:

- System time (on the PLC, Automation PC, etc.)
- X2X Link time (for each X2X Link network)
- POWERLINK time (for each POWERLINK network)
- Time data points of I/O modules

The NetTime is based on 32-bit counters, which are increased with microsecond resolution. The sign of the time information changes after 35 min, 47 s, 483 ms and 648 µs; an overflow occurs after 71 min, 34 s, 967 ms and 296 µs.

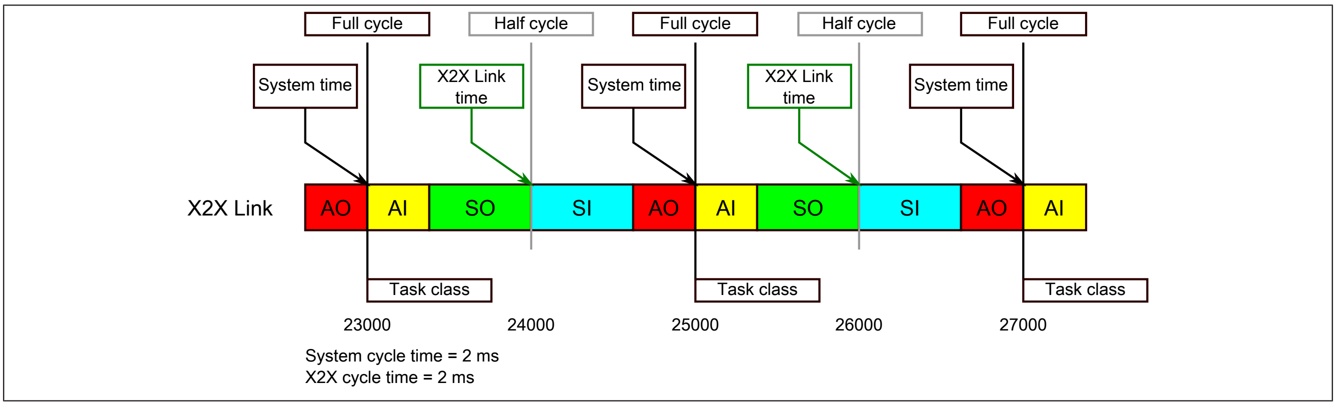
The initialization of the times is based on the system time during the startup of the X2X Link, the I/O modules or the POWERLINK interface.

Current time information in the application can also be determined via library AsIOTime.

3.8.1.1 Controller data points

The NetTime I/O data points of the controller are latched to each system clock and made available.

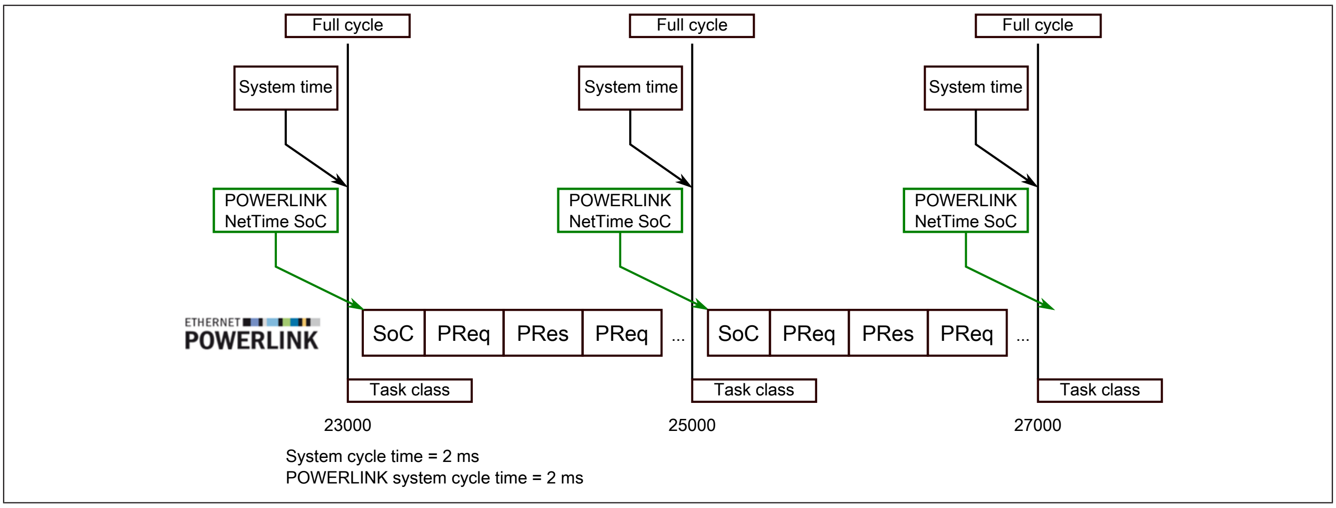
3.8.1.2 X2X Link - Reference time point



The reference time point on the X2X Link network is always calculated at the half cycle of the X2X Link cycle. This results in a difference between the system time and the X2X Link reference time point when the reference time is read out.

In the example above, this results in a difference of 1 ms, i.e. if the system time and X2X Link reference time are compared at time 25000 in the task, then the system time returns the value 25000 and the X2X Link reference time returns the value 24000.

3.8.1.3 POWERLINK - Reference time point

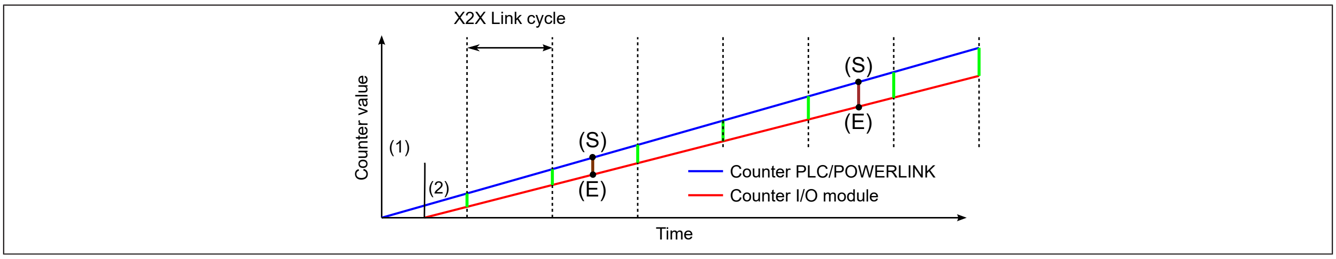


The POWERLINK reference time point is always calculated at the start of cycle (SoC) of the POWERLINK network. The SoC starts 20 µs after the system clock due to the system. This results in the following difference between the system time and the POWERLINK reference time:

POWERLINK reference time = System time - POWERLINK cycle time + 20 µs

In the example above, this means a difference of 1980 µs, i.e. if the system time and POWERLINK reference time are compared at time 25000 in the task, then the system time returns the value 25000 and the POWERLINK reference time returns the value 23020.

3.8.1.4 Synchronization of system time/POWERLINK time and I/O module



At startup, the internal counters for the controller/POWERLINK (1) and the I/O module (2) start at different times and increase the values with microsecond resolution.

At the beginning of each X2X Link cycle, the controller or POWERLINK network sends time information to the I/O module. The I/O module compares this time information with the module's internal time and forms a difference (green line) between the two times and stores it.

When a NetTime event (E) occurs, the internal module time is read out and corrected with the stored difference value (brown line). This means that the exact system moment (S) of an event can always be determined, even if the counters are not absolutely synchronous.

Note

The deviation from the clock signal is strongly exaggerated in the picture as a red line.

3.8.2 Timestamp functions

NetTime-capable modules provide various timestamp functions depending on the scope of functions. If a timestamp event occurs, the module immediately saves the current NetTime. After the respective data is transferred to the controller, including this precise moment, the controller can then evaluate the data using its own NetTime (or system time), if necessary.

3.8.2.1 Time-based inputs

NetTime Technology can be used to determine the exact moment of a rising edge at an input. The rising and falling edges can also be detected and the duration between 2 events can be determined.

Information:

The determined moment always lies in the past.

3.8.2.2 Time-based outputs

NetTime Technology can be used to specify the exact moment of a rising edge on an output. The rising and falling edges can also be specified and a pulse pattern generated from them.

Information:

The specified time must always be in the future, and the set X2X Link cycle time must be taken into account for the definition of the moment.

3.8.2.3 Time-based measurements

NetTime Technology can be used to determine the exact moment of a measurement that has taken place. Both the starting and end moment of the measurement can be transmitted.

4 Commissioning

4.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see section "Additional information - Using I/O modules on the bus controller" in the X67 user's manual (version 3.30 or later).

4.1.1 CAN I/O bus controller

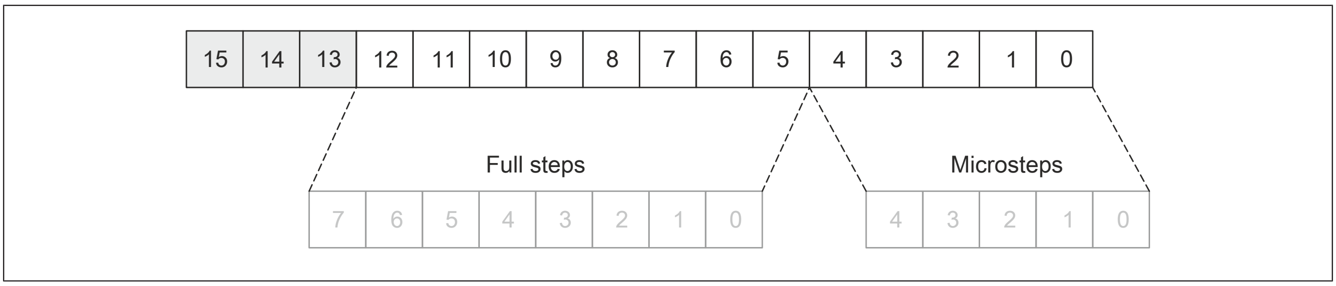
The module occupies 4 analog logical slots on CAN I/O.

4.2 Setting full step limit values

Setting the microsteps

Depending on the required resolution and maximum configurable speed, bits 5 and 6 of the module configuration can be used to set the bit position at which the 1s position of the full steps starts.

Example for 5-bit microsteps, i.e. bits 5 and 6 of the module configuration are set to binary 00:



(For the meaning of bits 13 to 15, see "Motor setting" on page 40.)

4.3 Operating function model "Ramp"

Commands for controlling the module are written to the "Control word" on page 47. The current state of the module is reported in register "Status word" on page 47. The function mode (absolute position, constant speed, homing, etc.) is set in the "mode register" on page 44.

4.3.1 Structure of the control word

Control word bits and their state for the commands of the state machine:

Command	Stall detection	Reserved	Current error detection	Warning reset	Reserved	Reserved	Reserved	Stop	Fault reset	Mode-specific	Mode-specific	Mode-specific	Enable operation	Quick stop	Enable voltage	Switch on
Bit[1]	**15**	**14**	**13**	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Shutdown	x	0	x	x	x	0	0	x	0	x	x	x	x	1	1	0
Switch on	x	0	x	x	x	0	0	x	0	x	x	x	0	1	1	1
Disable voltage	x	0	x	x	x	0	0	x	0	x	x	x	x	x	0	x
Quick stop	x	0	x	x	x	0	0	x	0	x	x	x	x	0	1	x
Disable operation	x	0	x	x	x	0	0	x	0	x	x	x	0	1	1	1
Enable operation	x	0	x	x	x	0	0	x	0	x	x	x	1	1	1	1
Fault reset	x	0	x	x	x	0	0	x	↑	x	x	x	x	x	x	x

1) x ... Any, ↑ ... Rising edge

Bits 0, 1, 2, 3 and 7 (light gray in the previous table)	These bits control the state of the "State machine" on page 26 according to the commands in the table above.
Fault reset	A rising edge resets errors and warnings (see "State machine" on page 26).
Stop	0 ... Perform motor movement 1 ... Stop axis with deceleration This bit is only evaluated if the extended control word is enabled in register "General configuration" on page 36.
Warning reset	A rising edge resets warnings (no effect on errors, which are reset using Fault reset; the state machine is not affected by this bit).
Current error detection	0 ... Current error detection disabled 1 ... Current error detection enabled
Stall detection warning	0 ... Stall detection warning disabled. 1 ... Stall detection warning enabled

4.3.2 Structure of the status word

The individual bits of this register and its states depend on the current state of the state machine:

Status	Reserved / MotorLoadBit 2 1)	Reserved / MotorLoadBit 1 1)	Reserved / MotorLoadBit 0 1)	Reserved	Int. limit active	Target reached	Remote	Reserved	Warning	Switch on disabled	Quick stop	Voltage enabled	Fault	Operation enabled	Switched on	Ready to switch on
Bit	**15**	**14**	**13**	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Not ready to switch on	x	x	x	x	x	x	1	0	x	0	x	0	0	0	0	0
Switch on disabled	x	x	x	x	x	x	1	0	x	1	x	0	0	0	0	0
Ready to switch on	x	x	x	x	x	x	1	0	x	0	1	0	0	0	0	1
Switched on	x	x	x	x	x	x	1	0	x	0	1	1	0	0	1	1
Operation enable	x	x	x	x	x	x	1	0	x	0	1	1	0	1	1	1
Quick stop active	x	x	x	x	x	x	1	0	x	0	0	1	0	1	1	1
Fault reaction active	x	x	x	x	x	x	1	0	x	0	x	0	1	1	1	1
Fault	x	x	x	x	x	x	1	0	x	0	x	0	1	0	0	0

1) If bit 7 in register "Stall detection configuration / Mixed decay" on page 38 configuration is set to 1, then the motor load value is returned in bits 13-15 of the status word. Otherwise, these bits are always 0.

Information about the status word:

<table>
<tr><td>Bits 0, 1, 2, 3, 5 and 6
(light gray in the preceding table)</td><td colspan="2">These bits are set according to the currently active state of the "State machine" on page 26.</td></tr>
<tr><td>Voltage enabled</td><td colspan="2">Becomes 1 as soon as the motor is energized.</td></tr>
<tr><td>Warning</td><td colspan="2">Becomes 1 if a warning is detected ("Overcurrent", "Undercurrent"). The type of warning is indicated in register "Error code" on page 48. The highest priority error / warning is shown in each case, with the priority corresponding to the order in the respective table. Warnings can be reset with a rising edge on bit "Warning reset" in the control word.</td></tr>
<tr><td>Remote</td><td colspan="2">Always 1</td></tr>
<tr><td rowspan="2">Target reached[1], depends on bit 8 (Stop) in Structure of the control word</td><td>If Stop = 0</td><td>If Stop = 1</td></tr>
<tr><td>In modes 1, -125, -126 (absolute positioning):
0...Positioning begins
1...Target has been reached
In mode 2 (constant speed):
0...Motor accelerates/brakes
1...Speed setpoint reached
In modes -127 and -128 (homing):
0...Homing started
1...Homing ended
In mode -122 (set actual position):
The bit briefly becomes 0 and immediately becomes 1 again as soon as the position is set.</td><td>In all modes:
0...Axis decelerating
1...Axis speed = 0</td></tr>
<tr><td>Internal limit active</td><td colspan="2">0 ... No limit violation
1 ... Internal limit is active (upper/lower software limit violated)</td></tr>
</table>

1) If the extended control word in register "General configuration" on page 36 was not enabled, Target reached behaves the same as if Stop = 0.

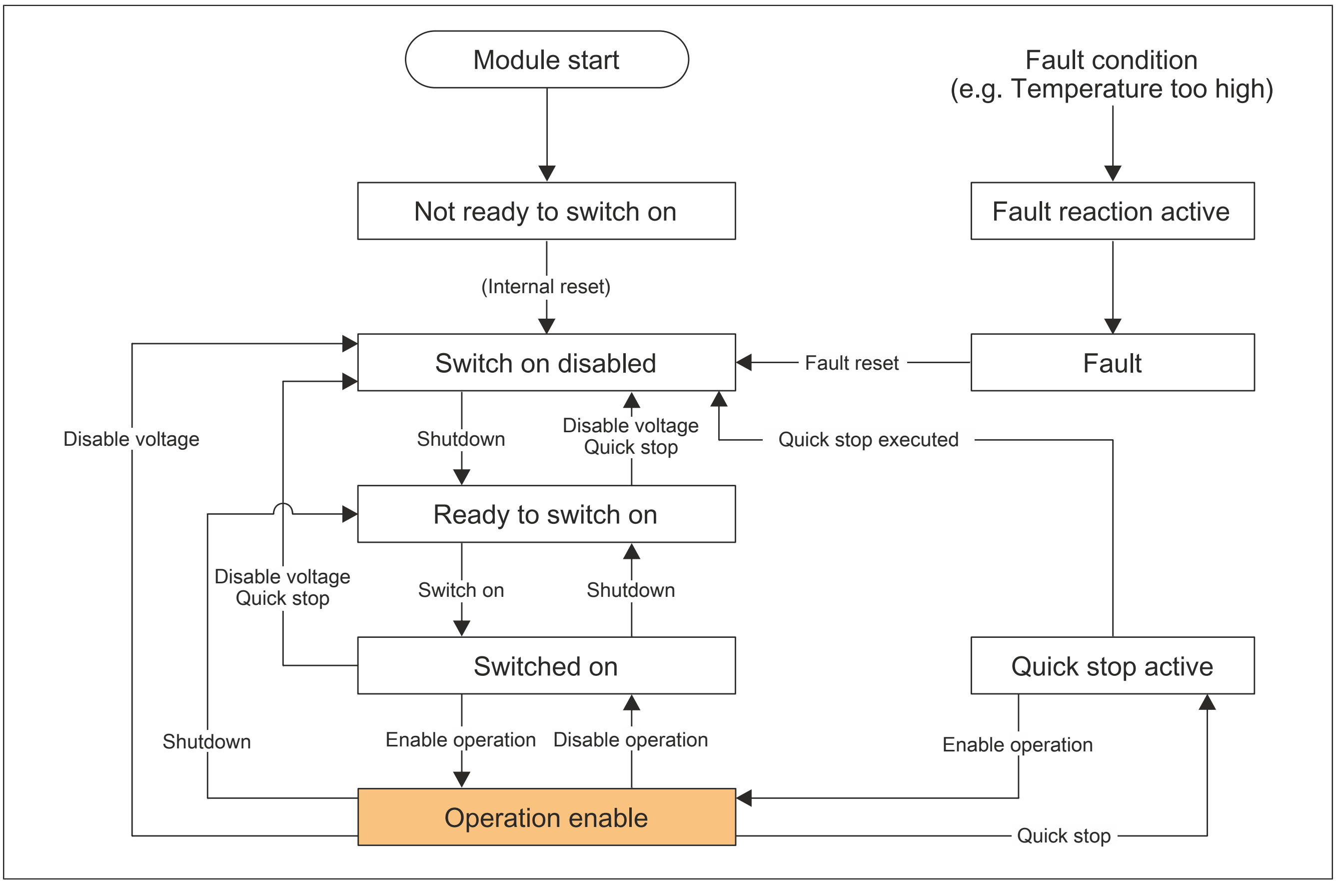
4.3.3 State machine

Control of the motor takes place according to the state machine illustrated below. After the module is started, the state machine automatically changes to state "Not ready to switch on". The application then operates the state machine by writing commands to the "Control word" on page 47.

The state machine successively reaches states "Ready to switch on", "Switched on" and "Operation enable" by writing the consecutive commands "Shutdown", "Switch on" and "Enable operation".

Information:

Motor movements are performed according to the setting in register "Mode" on page 44 only in state "Operation enable**".**



State change	Description
Not ready to switch on → Switch on disabled	This state change occurs automatically after starting the module and internal initialization has taken place.
Switch on disabled → Ready to switch on	This state change is initiated by command Shutdown. No others actions are performed.
Ready to switch on → Switch on disabled	This state change is initiated by command Disable voltage or Quick stop. No others actions are performed.
Switched on → Switch on disabled	This state change is initiated by command Disable voltage or Quick stop. The motor voltage is switched off immediately.
Ready to switch on → Switched on	This state change is initiated by command Switch on. The motor voltage is switched on. When this state change occurs for the first time since the module is started, the motor ID measurement is performed before state Switched on is achieved. This can take approximately 1 second.
Switched on → Ready to switch on	This state change is initiated by command Shutdown. The motor voltage is switched off immediately.
Switched on → Operation enable	This state change is initiated by command Enable operation. Motor movements are now performed depending on the defined mode.
Operation enable → Switched on	This state change is initiated by command Disable operation. If in motion, the motor is decelerated with the configured deceleration. Motor voltage remains on in state Switched on.
Operation enable → Ready to switch on	This state change is initiated by command Shutdown. The motor voltage is switched off immediately.
Operation enable → Switch on disabled	This state change is initiated by command Disable voltage. Motor voltage switched off. It is strongly recommended to only make this state change on a stopped motor since regeneration on a motor running at no load can cause an overvoltage error on the DC bus (0x3210).
Operation enable → Quick stop active	This state change is initiated by command Quick stop. If in motion, the motor is decelerated with the configured deceleration. During the deceleration, the state machine remains in state Quick stop active. If the motor comes to standstill, the switch to state Switch on disabled takes place automatically. While the state machine is in state Quick stop active, command Enable operation can be used to switch back to state Operation enable.
→ Fault reaction active	This state change is brought on when an error occurs and cannot be triggered by a command from the user. It can be triggered by an error type classified as "Error" (see "Error code" on page 48). (Other error types listed as a "warning" only cause bit "Warning" to be set in the status word and do not cause a state change in the state machine.) The motor voltage is cut off, and the state machine then changes immediately to state Fault. The error type is listed in the error code register (see table in "Error code" on page 48). The highest priority error is shown. The priority corresponds to the order in the error code table.
Fault → Switch on disabled	This state change is initiated by command Fault reset. However, the state only changes if no more errors are present when the command is written. All errors and warnings are reset. The error code register contains 0 or the warning code if a warning is still present.

5 Register description

5.1 mapp Motion system requirements

This module can be operated with mapp Motion function blocks. The following minimum versions are required for this:

- Automation Studio: 4.7.2
- Automation Runtime: 4.72
- mapp Technology Package: mapp Motion 5.9
- Hardware module upgrade: 2.2.0.0

5.2 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "Additional information - General data points" in the X67 System user's manual.

5.3 Function model 0 - Standard

Register	Name	Data type	Read		Write	
			Cyclic	Acyclic	Cyclic	Acyclic
Configuration						
Motor / Module configuration						
66	ConfigOutput02 (module configuration)	UINT				•
102	SdcConfig01	USINT				•
102 + N	MotorSettlingTime0N (index N = 1 to 4)	USINT				•
106 + N	DelayedCurrentSwitchOff0N (index N = 1 to 4)	USINT				•
Configuring currents						
52	ConfigOutput03 (holding current of channel 1)	USINT				•
53	ConfigOutput04 (nominal current of channel 1)	USINT				•
54	ConfigOutput05 (maximum current of channel 1)	USINT				•
55	ConfigOutput06 (holding current of channel 2)	USINT				•
56	ConfigOutput07 (nominal current of channel 2)	USINT				•
57	ConfigOutput08 (maximum current of channel 2)	USINT				•
58	ConfigOutput09 (holding current of channel 3)	USINT				•
59	ConfigOutput10 (nominal current of channel 3)	USINT				•
60	ConfigOutput11 (maximum current of channel 3)	USINT				•
61	ConfigOutput12 (holding current of channel 4)	USINT				•
62	ConfigOutput13 (nominal current of channel 4)	USINT				•
63	ConfigOutput14 (maximum current of channel 4)	USINT				•
Stall detection						
64	ConfigOutput01 (stall threshold)	UINT				•
68	ConfigOutput16 (mixed decay threshold)	UINT				•
90 + (N*2)	StallDetectMinSpeed0N (index N = 1 to 4)	UINT				•
Communication						
Motor detection						
74	MotorLoad	UINT	•			
Motor control						
20	Motor1Step1	UINT			•	
22	Motor1Step2	UINT			•	
28	Motor2Step1	UINT			•	
30	Motor2Step2	UINT			•	
36	Motor3Step1	UINT			•	
38	Motor3Step2	UINT			•	
44	Motor4Step1	UINT			•	
46	Motor4Step2	UINT			•	
Error handling						
10	Module status	USINT	•			
	ModulePowerSupplyError	Bit 7				

Register	Name	Data type	Read		Write	
			Cyclic	Acyclic	Cyclic	Acyclic
8	Motor error	UINT	•			
	StallError01	Bit 0				
	OvertemperaturError01	Bit 1				
	OpenLoadError01	Bit 2				
	OvercurrentError01	Bit 3				
	...	...				
	StallError04	Bit 12				
	OvertemperaturError04	Bit 13				
	OpenLoadError04	Bit 14				
	OvercurrentError04	Bit 15				
70	Error acknowledgment	USINT			•	
	ErrorReset01	Bit 0				
	...	...				
	ErrorReset04	Bit 3				
Positions						
0	Position1Sync	INT	•			
2	Position2Sync	INT	•			
4	Position3Sync	INT	•			
6	Position4Sync	INT	•			

5.4 Function model 0 - "Standard" with SDC

Register	Name	Data type	Read		Write	
			Cyclic	Acyclic	Cyclic	Acyclic
Configuration						
Motor / Module configuration						
66	ConfigOutput02 (module configuration)	UINT				•
102	SdcConfig01	USINT				•
102 + N	MotorSettlingTime0N (index N = 1 to 4)	USINT				•
106 + N	DelayedCurrentSwitchOff0N (index N = 1 to 4)	USINT				•
Configuring currents						
52	ConfigOutput03 (holding current of channel 1)	USINT				•
53	ConfigOutput04 (nominal current of channel 1)	USINT				•
54	ConfigOutput05 (maximum current of channel 1)	USINT				•
55	ConfigOutput06 (holding current of channel 2)	USINT				•
56	ConfigOutput07 (nominal current of channel 2)	USINT				•
57	ConfigOutput08 (maximum current of channel 2)	USINT				•
58	ConfigOutput09 (holding current of channel 3)	USINT				•
59	ConfigOutput10 (nominal current of channel 3)	USINT				•
60	ConfigOutput11 (maximum current of channel 3)	USINT				•
61	ConfigOutput12 (holding current of channel 4)	USINT				•
62	ConfigOutput13 (nominal current of channel 4)	USINT				•
63	ConfigOutput14 (maximum current of channel 4)	USINT				•
Stall detection						
64	ConfigOutput01 (stall threshold)	UINT				•
68	ConfigOutput16 (mixed decay threshold)	UINT				•
90 + (N*2)	StallDetectMinSpeed0N (index N = 1 to 4)	UINT				•
Communication						
Motor detection						
74	MotorLoad	UINT	•			
Motor control						
100	Motor current	UINT			•	
	DriveEnable01	Bit 0				
	BoostCurrent01	Bit 1				
	StandstillCurrent01	Bit 3				
	...	...				
	DriveEnable04	Bit 12				
	BoostCurrent04	Bit 13				
	StandstillCurrent04	Bit 14				
20	Motor1Step0	UINT			•	
28	Motor2Step0	UINT			•	
36	Motor3Step0	UINT			•	
44	Motor4Step0	UINT			•	
SDC life sign monitoring						
112	SetTime01	INT			•	
114	SetTime02	INT			•	
116	SetTime03	INT			•	
118	SetTime04	INT			•	
73	LifeCnt	SINT	•			

Register description

Register	Name	Data type	Read		Write	
			Cyclic	Acyclic	Cyclic	Acyclic
Error handling						
10	Module status	USINT	•			
	DrvOk01	Bit 0				
	...	...				
	DrvOk04	Bit 3				
	ModulePowerSupplyError	Bit 7				
8	Motor error	UINT	•			
	StallError01	Bit 0				
	OvertemperatureError01	Bit 1				
	OpenLoadError01	Bit 2				
	OvercurrentError01	Bit 3				
	...	...				
	StallError04	Bit 12				
	OvertemperatureError04	Bit 13				
	OpenLoadError04	Bit 14				
	OvercurrentError04	Bit 15				
70	Error acknowledgment	USINT			•	
	ClearError01	Bit 0				
	...	...				
	ClearError04	Bit 3				
Positions						
0	ActPos01	INT	•			
2	ActPos02	INT	•			
4	ActPos03	INT	•			
6	ActPos04	INT	•			
220	ActTime01	INT	•			
220	ActTime02	INT	•			
220	ActTime03	INT	•			
220	ActTime04	INT	•			

5.5 Function model 254 - "Bus controller" and function model 3 - "Ramp"

Register	Offset[1]	Name	Data type	Read		Write	
				Cyclic	Acyclic	Cyclic	Acyclic
Configuration							
Configuring currents							
48	-	ConfigOutput03a (holding current of channel 1)	USINT				•
49	-	ConfigOutput04a (nominal current of channel 1)	USINT				•
50	-	ConfigOutput05a (maximum current of channel 1)	USINT				•
112	-	ConfigOutput06a (holding current of channel 2)	USINT				•
113	-	ConfigOutput07a (nominal current of channel 2)	USINT				•
114	-	ConfigOutput08a (maximum current of channel 2)	USINT				•
176	-	ConfigOutput09a (holding current of channel 3)	USINT				•
177	-	ConfigOutput10a (nominal current of channel 3)	USINT				•
178	-	ConfigOutput11a (maximum current of channel 3)	USINT				•
240	-	ConfigOutput12a (holding current of channel 4)	USINT				•
241	-	ConfigOutput13a (nominal current of channel 4)	USINT				•
242	-	ConfigOutput14a (maximum current of channel 4)	USINT				•
Motion generator							
308	-	GeneralConfig01	USINT				•
52	-	MaxSpeed01	UINT				•
116	-	MaxSpeed02	UINT				•
180	-	MaxSpeed03	UINT				•
244	-	MaxSpeed04	UINT				•
54	-	MaxAcc01	UINT				•
118	-	MaxAcc02	UINT				•
182	-	MaxAcc03	UINT				•
246	-	MaxAcc04	UINT				•
56	-	MaxDec01	UINT				•
120	-	MaxDec02	UINT				•
184	-	MaxDec03	UINT				•
248	-	MaxiDec04	UINT				•
58	-	RevLoop01	INT				•
122	-	RevLoop02	INT				•
186	-	RevLoop03	INT				•
250	-	RevLoop04	INT				•
75	-	JoltTime01	USINT				•
139	-	JoltTime02	USINT				•
203	-	JoltTime03	USINT				•
267	-	JoltTime04	USINT				•
60	-	FixedPos01a	DINT				•
124	-	FixedPos02a	DINT				•
188	-	FixedPos03a	DINT				•
250	-	FixedPos04a	DINT				•
64	-	FixedPos01b	DINT				•
128	-	FixedPos02b	DINT				•
192	-	FixedPos03b	DINT				•
252	-	FixedPos04b	DINT				•
Stall detection							
51	-	StallDetectConfig01	USINT				•
115	-	StallDetectConfig02	USINT				•
179	-	StallDetectConfig03	USINT				•
243	-	StallDetectConfig04	USINT				•
74	-	StallRecognitionDelay01	USINT				•
138	-	StallRecognitionDelay02	USINT				•
202	-	StallRecognitionDelay03	USINT				•
266	-	StallRecognitionDelay04	USINT				•
78	-	StallDetectMinSpeed01	UINT				•
142	-	StallDetectMinSpeed02	UINT				•
206	-	StallDetectMinSpeed03	UINT				•
270	-	StallDetectMinSpeed04	UINT				•
Homing							
68	-	RefSpeed01	UINT				•
132	-	RefSpeed02	UINT				•
196	-	RefSpeed03	UINT				•

Register description

Register	Offset[1]	Name	Data type	Read		Write	
				Cyclic	Acyclic	Cyclic	Acyclic
260	-	RefSpeed04	UINT				•
70	-	RefConfig01	SINT				•
134	-	RefConfig02	SINT				•
198	-	RefConfig03	SINT				•
262	-	RefConfig04	SINT				•
Limitations							
448	-	PositionLimitMin01	DINT				•
456	-	PositionLimitMin02	DINT				•
464	-	PositionLimitMin03	DINT				•
472	-	PositionLimitMin04	DINT				•
452	-	PositionLimitMax01	DINT				•
460	-	PositionLimitMax02	DINT				•
468	-	PositionLimitMax03	DINT				•
476	-	PositionLimitMax04	DINT				•
Communication							
Motor control							
6	6	MpGenMode01	SINT			•	
14	14	MpGenMode02	SINT			•	
22	22	MpGenMode03	SINT			•	
30	30	MpGenMode04	SINT			•	
82	-	ModeReadback01	SINT		•		
146	-	ModeReadback02	SINT		•		
210	-	ModeReadback03	SINT		•		
274	-	ModeReadback04	SINT		•		
4	4	MpGenControl01	UINT			•	
12	12	MpGenControl02	UINT			•	
20	20	MpGenControl03	UINT			•	
28	28	MpGenControl04	UINT			•	
80	-	ControlReadback01	UINT		•		
144	-	ControlReadback02	UINT		•		
208	-	ControlReadback03	UINT		•		
272	-	ControlReadback04	UINT		•		
4	4	MpGenStatus01	UINT	•			
12	12	MpGenStatus02	UINT	•			
28	28	MpGenStatus04	UINT	•			
20	20	MpGenStatus03	UINT	•			
Error handling							
98	-	ErrorCode01	UINT		•		
162	-	ErrorCode02	UINT		•		
226	-	ErrorCode03	UINT		•		
290	-	ErrorCode04	UINT		•		
Homing							
86	-	RefPos01CyclicCounter	DINT		•		
150	-	RefPos02CyclicCounter	DINT		•		
214	-	RefPos03CyclicCounter	DINT		•		
278	-	RefPos04CyclicCounter	DINT		•		
Positioning and speed							
0	0	AbsPos01	DINT			•	
8	8	AbsPos02	DINT			•	
16	16	AbsPos03	DINT			•	
24	24	AbsPos04	DINT			•	
0	0	AbsPos01ActVal	DINT	•			
8	8	AbsPos02ActVal	DINT	•			
16	16	AbsPos03Val	DINT	•			
24	24	AbsPos04Val	DINT	•			

1) The offset specifies the position of the register within the CAN object.

5.6 Configuration registers - Function model 0 and function model MotionConfiguration

5.6.1 Module configuration

5.6.1.1 Module configuration

Name:
ConfigOutput02

The number of transfer values and the resolution of microsteps for the drive can be configured in this register.

Data type	Values
UINT	See the bit structure.

Bit structure:

Bit	Description	Value	Information
0 - 2	Reserved	0	
3 - 4	Number of transfer values per X2X Link cycle (see "Motor setting" on page 40)	**This setting applies to all 4 channels.**	
		00	1x Δs / Δt (transfer values: MotorXStep1)
		01	2x Δs / Δt (transfer values: MotorXStep1 - MotorXStep2)
		10	Reserved
		11	Reserved
5 - 6	Resolution of microsteps for the following registers: • "Motor setting" on page 40 • "Current position" on page 43	00	Resolution: 5 bits (bits 0 to 4) microsteps, 8 bits (bits 5 to 12) full steps
		01	Resolution: 6 bits (bits 0 to 5) microsteps, 7 bits (bits 6 to 12) full steps
		10	Resolution: 7 bits (bits 0 to 6) microsteps, 6 bits (bits 7 to 12) full steps
		11	Resolution: 8 bits (bits 0 to 7) microsteps, 5 bits (bits 8 to 12) full steps
7 - 10	Reserved	0	
11	Operating mode	0	Normal mode (standard setting)
		1	Enhanced mode
12 - 15	Reserved	0	

5.6.1.2 SDC configuration

Name:
SdcConfig01

This register can be used to enable or disable additional SDC information.

Enabling/Disabling the SDC information causes the additional cyclic registers to be shown or hidden. It is possible here to compare the two variants of the standard function model, i.e. with and without enabled SDC information.

Data type	Values
USINT	See the bit structure.

Bit structure:

Bit	Description	Value	Information
0 - 5	Reserved	0	
6	SDC life sign monitoring	0	Disabled
		1	Enabled
7	SDC information	0	Disabled
		1	Enabled

Information:

SDC information and SDC life monitoring are not permitted to be adjusted at runtime.

5.6.1.3 Motor settling time

Name:
MotorSettlingTime01 to MotorSettlingTime04

The motor settling time determines the minimum time from the time the motor is energized until the drive bit (DrvOk) is set (see section "Motor error" on page 42). The setting is made in steps of 10 ms.

Data type	Values	Information
USINT	1 to 255	10 ms to 2.55 s, default: 10 ms

5.6.1.4 Switch-off delay

Name:
DelayedCurrentSwitchOff01 to DelayedCurrentSwitchOff04

If the "SDC life sign monitoring" on page 41 is triggered (i.e. the NetTime timestamp is in the past), the motor is decelerated at nominal current with speed setpoint = 0.

Then the motor is switched off after the delay configured with this register.

Data type	Values	Information
USINT	0 to 255	0 to 25.5 s in steps of 100 ms (default: 100 ms)

5.6.2 Configuring currents

5.6.2.1 Holding current, nominal current and maximum current

Name:
ConfigOutput03 to ConfigOutput14

The holding current, nominal current and maximum current registers are used to configure the desired motor current.

Register	Description
Nominal current	Current during operation at constant speed
Maximum current	Current during acceleration phases
Holding current	Current when motor at standstill

Switching between preset current values (holding current, nominal current, maximum current):

Function model	Switching between preset current values at runtime
Standard	Using bits 14 and 15 in registers "Motor setting" on page 40
Standard with enabled SDC information	Using register "Motor current" on page 40

Data type	Values	Unit
USINT	0 to 150	Percentage of the nominal motor current • 100% corresponds to the nominal current of the motor bridge power unit in the technical data. • 150% corresponds to the maximum current of the motor bridge power unit in the technical data.

5.6.3 Stall detection

5.6.3.1 Stall threshold

Name:
ConfigOutput01

This register can be used to define a threshold for the motor load above which the module detects a stall condition (see "Motor error" on page 42).

Data type	Values
UINT	See the bit structure.

Bit structure:

Bit	Description	Value	Information
0 - 2	Stall detection trigger threshold for motor 1	0	Stall detection is disabled.
		1	Minimum sensitivity for stall detection
		2 to 6	Sets the sensitivity for stall detection
		7	Maximum sensitivity for stall detection
3	Reserved	0	
4 - 6	Stall detection trigger threshold for motor 2	0	Stall detection is disabled.
		1	Minimum sensitivity for stall detection
		2 to 6	Sets the sensitivity for stall detection
		7	Maximum sensitivity for stall detection
7	Reserved	0	
8 - 10	Stall detection trigger threshold for motor 3	0	Stall detection is disabled.
		1	Minimum sensitivity for stall detection
		2 to 6	Sets the sensitivity for stall detection
		7	Maximum sensitivity for stall detection
11	Reserved	0	
12 - 14	Stall detection trigger threshold for motor 4	0	Stall detection is disabled.
		1	Minimum sensitivity for stall detection
		2 to 6	Sets the sensitivity for stall detection
		7	Maximum sensitivity for stall detection
15	Reserved	0	

5.6.3.2 Mixed decay threshold

Name:
ConfigOutput16

The mixed decay threshold can be configured in this register. This value must be adjusted according to the motor being used, current and voltage when using "stall detection" on page 35. Otherwise, the default value 15 will be used.

Data type	Values
UINT	See the bit structure.

Bit structure:

Bit	Description	Value	Information
0 - 3	Mixed decay threshold of motor 1	0	Mixed decay disabled
		1 to 14	Setting for mixed decay threshold
		15	Mixed decay always enabled
4 - 7	Mixed decay threshold of motor 2	0 to 15	See motor 1.
8 - 11	Mixed decay threshold of motor 3	0 to 15	See motor 1.
12 - 15	Mixed decay threshold of motor 4	0 to 15	See motor 1.

5.6.3.3 Minimum speed for stall detection

Name:
StallDetectMinSpeed01 to StallDetectMinSpeed04

If the motor speed exceeds the value set in this register, then stall detection is enabled and the configured "mixed decay threshold" on page 35 is used. Value 15 is always used for the mixed decay threshold below this threshold value, and no stall error is reported. This means that mixed decay mode is always enabled at low speeds where stall detection principally does not work.

Data type	Values	Information
UINT	0 to 65535	Minimum speed in steps per second.

5.7 Function models 3 and 254 - Configuration registers

5.7.1 Configuring currents

5.7.1.1 Holding current, nominal current and maximum current

Name:
ConfigOutput03a to ConfigOutput14a

The holding current, nominal current and maximum current registers are used to configure the desired motor current.

Register	Description
Nominal current	Current during operation at constant speed
Maximum current	Current during acceleration phases
Holding current	Current when motor at standstill

Data type	Values	Unit
USINT	0 to 150	Percentage of the nominal motor current • 100% corresponds to the nominal current of the motor bridge power unit in the technical data. • 150% corresponds to the maximum current of the motor bridge power unit in the technical data. Bus controller default setting: 0

5.7.2 Motion generator

5.7.2.1 General configuration

Name:
GeneralConfig01

This register is used to switch the positioning mode and configure the cycle time of the movement profile generator.

Data type	Values	Bus controller default setting
USINT	See the bit structure.	0

Bit structure:

Bit	Description	Value	Information
0	Position mode	0	"Mode 1: Position mode without extended control word" on page 44 (bus controller default setting)
		1	"Mode 1: Position mode with extended control word" on page 44
1 - 2	Cycle time of the motion profile generator[1)]	00	25 ms (bus controller default setting)
		01	10 ms
		10	5 ms
		11	Reserved
3 - 7	Reserved	0	

1) This parameter is supported starting with upgrade 1.3.1.1 (firmware version 100).

The cycle time for the motion profile generator is configured with this cycle. This cycle time affects the unit for specifying the speed and acceleration:

- Unit for speed: Microsteps/Cycle
- Unit for acceleration: Microsteps/Cycle^2

5.7.2.2 Maximum speed

Name:
MaxSpeed01 to MaxSpeed04

This register defines the maximum speed for the absolute positioning modes (1, -125, -126).

Information:

The setting does not apply to the speed and homing modes (2, -127, -128).

Data type	Values	Information
UNIT	0 to 65535	Speed in microsteps/cycle. Bus controller default setting: 0

5.7.2.3 Maximum acceleration

Name:
MaxAcc01 to MaxAcc04

This register defines the maximum acceleration (also applies to homing modes).

Data type	Values	Information
UINT	0 to 65535	Acceleration in microsteps/cycle^2. Bus controller default setting: 0

5.7.2.4 Maximum deceleration

Name:
MaxDec01 to MaxDec04

This register defines the maximum deceleration (also applies to homing modes).

Data type	Values	Information
UINT	0 to 65535	Brake deceleration in microsteps/cycle^2. Bus controller default setting: 0

5.7.2.5 Reversing loop

Name:
RevLoop01 to RevLoop04

This register defines the steps for the reverse loop.

This parameter is only used in modes 1, -125, -126 (absolute positioning modes).

Data type	Values	Information
INT	-32768 to 32767	Bus controller default setting: 0

5.7.2.6 Jerk time

Name:
JoltTime01 to JoltTime04

This register is used to specify the number of cycles for the jerk limitation time. If more than 80 cycles are entered, they are limited to 80.

Data type	Values	Information
USINT	0	No jerk limitation time. Bus controller default setting
	1 to 80[1]	Number of cycles

1) Starting with upgrade 1.3.1.1 (firmware version 100), for older versions: 16

5.7.2.7 Fixed position A

Name:
FixedPos01a to FixedPos04a

This register can be used to define the position that should be approached in mode -125.

Data type	Values	Information
DINT	-2,147,483,648 to 2,147,483,647	Bus controller default setting: 0

5.7.2.8 Fixed position B

Name:
FixedPos01b to FixedPos04b

This register can be used to define the position that should be approached in mode -126.

Data type	Values	Information
DINT	-2,147,483,648 to 2,147,483,647	Bus controller default setting: 0

5.7.3 Stall detection

5.7.3.1 Stall detection configuration / Mixed decay

Name:
StallDetectConfig01 to StallDetectConfig04

The mixed decay threshold and stall detection sensitivity can be configured in this register.

Data type	Values	Bus controller default setting
USINT	See the bit structure.	0

Bit structure:

Bit	Description	Value	Information
0 - 3	Mixed decay threshold	0	Mixed decay disabled (bus controller default setting)
		1 to 14	Setting for mixed decay threshold
		15	Mixed decay always enabled
4 - 6	Stall threshold	0	Stall detection is disabled (bus controller default setting).
		1 to 6	Steps involved in setting stall detection sensitivity
		7	Maximum sensitivity for stall detection
7	Motor load	0	The motor load value is not displayed (bus controller default setting).
		1	Show value in register "Status word" on page 47[1)]

1) If this bit is 1, then the motor load value is indicated in bits 13 to 15 of the status word register (otherwise, these bits are 0). This value can help when testing stall detection and "Homing during stall" on page 46 mode.

5.7.3.2 Minimum speed for stall detection

Name:
StallDetectMinSpeed01 to StallDetectMinSpeed04

If the motor speed exceeds the value set in this register, then stall detection is enabled and the configured "mixed decay threshold" on page 35 is used. Value 15 is always used for the mixed decay threshold below this threshold value, and no stall error is reported. This means that mixed decay mode is always enabled at low speeds where stall detection principally does not work.

Data type	Values	Information
UINT	0 to 65535	Minimum speed in microsteps per cycle. Bus controller default setting: 0

5.7.3.3 Stall recognition delay

Name:
StallRecognitionDelay01 to StallRecognitionDelay04

The value in this register is only relevant for mode "Homing during stall" on page 13.

A stall is only detected after the time specified here has expired and after the homing procedure has started.

For example, a setting of 4 (and a cycle time of 25 ms) means that a stall will not be detected until 100 ms after the motor starts moving (start of the homing procedure).

Data type	Values	Information
USINT	0	No delay (bus controller default setting)
	1 to 255	Delay time in cycles, see "General configuration" on page 36.

5.7.4 Homing

5.7.4.1 Homing speed

Name:
RefSpeed01 to RefSpeed04

This register sets the speed for homing modes -127 and -128.

Data type	Values	Information
UINT	0 to 65535	Speed in microsteps/cycle. Bus controller default setting: 0

5.7.4.2 Homing configuration

Name:
RefConfig01 to RefConfig04

The homing mode can be set with this register.

Data type	Values	Information
SINT	-120	Set home position
	-127	Homing during stall detection[1]. Bus controller default setting
	-128	Immediate homing
	All others	No effect

1) Stall detection is automatically enabled when this mode is selected.

5.7.5 Limitations

5.7.5.1 Software limit

Name:
PositionLimitMin01 to PositionLimitMin04
PositionLimitMax01 to PositionLimitMax04

This register configures software limits. The function is enabled if at least one of the registers is not equal to zero.

Data type	Values	Information
DINT	-2,147,483,648 to 2,147,483,647	Bus controller default setting: 0

5.8 Communication registers - Function model 0 and function model Motion-Configuration

5.8.1 Motor detection

5.8.1.1 Measuring the motor load

Name:
MotorLoad

This register contains the current measured load value for stall detection. This can be used to tune stall detection.

Data type	Values
UINT	See the bit structure.

Bit structure:

Bit	Description	Value	Information
0 - 2	Motor 1	0 to 7	Motor load value
3	Reserved	-	
4 - 6	Motor 2	0 to 7	Motor load value
7	Reserved	-	
8 - 10	Motor 3	0 to 7	Motor load value
11	Reserved	-	
12 - 14	Motor 4	0 to 7	Motor load value
15	Reserved	-	

5.8.2 Motor control

5.8.2.1 Motor current

Name:
DriveEnable01 to DriveEnable04
BoostCurrent01 to BoostCurrent04
StandstillCurrent01 to StandstillCurrent04

Bits 0 to 14 of this register control the current feed of the motors.

Data type	Values
USINT	See the bit structure.

Bit structure:

Bit				Description	Value	Information
Motor 1	Motor 2	Motor 3	Motor 4			
0	4	8	12	DriveEnable01-04	x	Motor powered
1	5	9	13	BoostCurrent01-04	x	Maximum current
2	6	10	14	StandstillCurrent01-04	x	Holding current
3	7	11	15	Reserved	0	

The possible status of bits 0 to 14

StandstillCurrent0x	BoostCurrent0x	DriveEnable0x	Description
x	x	0	Motor not supplied with current
0	0	1	Nominal current supplied to motor
0	1	1	Maximum current supplied to motor
1	0	1	Holding current supplied to motor
1	1	1	Holding current supplied to motor

5.8.2.2 Motor setting

Name:
Motor1Step1 to Motor4Step1
Motor1Step2 to Motor4Step2

These registers are used to specify the number and direction of steps that must be carried out by the module during the next X2X Link cycle, and to select the motor current (see also "Holding current, nominal current and maximum current" on page 34).

Data type	Values
UINT	See the bit structure.

Bit structure:

Bit	Description	Value	Information
0 - 12	Number of steps the module should move during the next X2X Link cycle.	x	
13	Direction of movement	0	Positive
		1	Negative
14 - 15	Selection of motor current	00	Motor not powered
		01	Holding current
		10	Nominal current
		11	Maximum current

The number of transfer values per X2X Link cycle is specified by bits 3 and 4 in the module configuration (see "Module configuration" on page 33). If only one transfer value (bits 3 and 4 = 00) is specified, then the motor is advanced by MotorXStepX until the next X2X Link cycle. If 2 or 4 transfer values are specified, then the X2X Link is subdivided accordingly.

Example: X2X Link cycle = 1 ms (1000 µs)

Time	Number of transfer values (see "Module configuration" on page 33)	
	1 (bits 3 - 4 = 00)	2 (bits 3 - 4 = 01)
0 - 500 µs	MotorXStep1	MotorXStep1
500 - 1000 µs		MotorXStep2

5.8.2.3 Step specification

Name:
Motor1Step0 to Motor4Step0

This registers is used to specify the number and direction of steps that should be carried out by the module during the next X2X cycle.

The value is specified with a resolution of 1/256 of a full step (corresponds to 8-bit microsteps).

The direction of movement is derived from the value's sign:

Data type	Values	Information
INT	>0	Movement in the positive direction in 1/256 full steps
	<0	Movement in the negative direction in 1/256 full steps

5.8.3 Life sign monitoring

5.8.3.1 SDC life sign monitoring

Name:
SetTime01 to SetTime04

The module uses SDC life sign monitoring to check whether valid values have been received for the speed setpoint. SDC life sign monitoring is enabled in register "SDC configuration" on page 33 by setting bit 6 (SDCSetTime = On).

Data type	Values
INT	-32768 to 32767

5.8.3.2 Lifecycle counter

Name:
LifeCnt

This register is incremented by one with each X2X Link cycle.

Data type	Values
SINT	-128 to 127

5.8.4 Error handling

5.8.4.1 Module status

Name:
DrvOk01 to DrvOk04 (only for function model Standard with SDC)
ModulePowerSupplyError

This register contains the state of the drive.

Data type	Values
USINT	See the bit structure.

Bit structure:

Bit				Description	Value	Information
Motor 1	Motor 2	Motor 3	Motor 4			
0	1	2	3	DrvOk01-04[1]	0	An error was triggered for the motor axis
					1	The drive is running error-free.
4 - 6				Reserved	0	
7				ModulePowerSupplyError	0	I/O supply voltage within the valid range
					1	I/O supply voltage outside the valid range

1) Only with function model "Standard with SDC"

Status of the drive

The status of the drive is only displayed in function model "Standard" with enabled SDC information. Bit DrvOk is 1 if the following conditions are met:

- The motor has been switched on (see "Motor current" on page 40).
- The motor is energized.
- The motor settling time has expired.
- The supply voltage is within the valid range.
- No overtemperature error
- The preset position value is valid (see "SDC life sign monitoring" on page 41).

5.8.4.2 Motor error

Name:
StallError01 to StallError04
OvertemperatureError01 to OvertemperatureError04
OpenLoadError01 to OpenLoadError04
OvercurrentError01 to OvercurrentError04

This register contains the error state of the drive. Each bit indicates a certain error. If an error is registered in bits 0 to 15, then the corresponding bit remains set until the error has been acknowledged (see "Error acknowledgment" on page 43).

Data type	Values
UINT	See the bit structure.

Bit structure:

Bit				Description	Value	Information
Motor 1	Motor 2	Motor 3	Motor 4			
0	4	8	12	StallError01-04	0	No stall
					1	Stall
1	5	9	13	OvertemperatureError01-04	0	No overtemperature
					1	Overtemperature
2	6	10	14	OpenLoadError01-04	0	No current error
					1	Current error
3	7	11	15	OvercurrentError01-04	0	No overcurrent
					1	Overcurrent

Stall error

The stall error bit is set if the load measurement value is below the stall threshold.

Overtemperature error

Error bit "Overtemperature" is set for one of the following reasons:

- The temperature of the output stage of a motor output exceeds the maximum permissible temperature.
- The module temperature exceeds 85°C.

Current error

This error bit occurs whenever the required current cannot be supplied to the motor windings. This can be triggered by an open circuit, for example. At higher speeds, this error can also occur without an open circuit depending on the motor. Due to the back EMF of the motor, this error already occurs at somewhat lower speeds if the engine is idling.

Overcurrent error

An overcurrent occurs if 2 times the motor current is measured in the motor windings (e.g. short circuit).

5.8.4.3 Error acknowledgment

Name:

Function model - "Standard" without SDC	Function model "Standard" with SDC
ErrorReset01	ClearError01
ErrorReset02	ClearError02
ErrorReset03	ClearError03
ErrorReset04	ClearError04

This register can be used to acknowledge errors that have occurred on the motor.

For more info, see register "Motor error" on page 42.

Data type	Values
USINT	See the bit structure.

Bit structure:

Bit	Description	Value	Information
0	ClearError01 or ErrorReset01	0	No effect
		1	Error acknowledgment for motor 1
1	ClearError02 or ErrorReset02	0	No effect
		1	Error acknowledgment for Motor 2
2	ClearError03 or ErrorReset03	0	No effect
		1	Error acknowledgment for Motor 3
3	ClearError04 or ErrorReset04	0	No effect
		1	Error acknowledgment for Motor 4
4 - 7	Reserved	0	

5.8.5 Positioning

5.8.5.1 Current position

Name:

Function model - "Standard" without SDC	Function model "Standard" with SDC
Position1Sync	ActPos01
Position2Sync	ActPos02
Position3Sync	ActPos03
Position4Sync	ActPos04

This register is the position (position setpoint) of the motor calculated by the module. Each of these is a cyclic 16-bit counter for each channel.

Data type	Values
INT	-32768 to 32767

5.8.5.2 NetTime of the position value

Name:
ActTime01 to ActTime04

This register contains the NetTime of the most recent valid position value.

For additional information about NetTime and timestamps, see "NetTime Technology" on page 20.

Data type	Values
INT	-32768 to 32767

5.9 Function models 3 and 254 - Communication registers

5.9.1 Motor control

5.9.1.1 Mode

Name:
MpGenMode01 to MpGenMode04

Data type	Values	Information
SINT	0	No mode selected
	1	Depending on bit 0 in the "General configuration" on page 36 register, the position mode will behave as follows: • Position mode without extended control word: Move to target position as soon as the target position is changed. • Position mode with extended control word: Move to the target position as described in "Mode 1: Position mode with extended control word" on page 44.
	2	Speed mode: Constant speed
	-120	Set home position
	-122	Set actual position
	-125	Move to fixed position A (position set acyclically)
	-126	Move to fixed position B (position set acyclically)
	-127	Positive homing (see also "Homing configuration" on page 39)
	-128	Negative homing (see also "Homing configuration" on page 39)

Information:

For all modes: Bit "Target reached" is set in register "Status word" on page 47 when the current action is finished (i.e. when the position or speed is reached, depending on the mode).

A new position or speed can be specified even before the current action is finished.

5.9.1.1.1 Mode 1: Position mode

The position setpoint is specified in register "Setting the target position / speed" on page 48. The motor is then moved to this new position.

- If bit 0 equals 0 (no extended control word), the position setpoint will be applied as soon as it is not equal to the current position. The new position is then used for the movement.
- If bit 0 equals 1, the position setpoint is applied as described in "Mode 1: Position mode with extended control word" on page 44.

5.9.1.1.2 Mode 1: Position mode with extended control word

The position mode with extended control word behaves like previously described "position mode 1" on page 44 (without extended control word); the difference is that the new position setpoint ("position/speed" on page 48 register) is applied by the "extended control word" on page 45.

5.9.1.1.2.1 Extended control word

Commands can be issued using this register depending on the state of the module (see "Operating function model "Ramp"" on page 24).

Data type	Values
UINT	See the bit structure.

Bit structure:

Bit	Description	Value	Information
0 - 3	Corresponds to the default control word	x	
4	New setpoint	0	Do not apply target position.
		1	Apply target position.
5	Change set immediately	0	Complete current positioning movement and then start next positioning movement
		1	Interrupt current positioning movement and then start next positioning movement
6	abs / rel	0	Target position is an absolute value.
		1	Target position is a relative value.
7	Corresponds to the default control word	x	
8	Stop [1]	0	Execute positioning
		1	Stop axis with deceleration
9 - 15	Corresponds to the default control word	x	

1) This bit applies to all modes.

5.9.1.1.2.2 Extended status word

The bits in the status word reflect the state of the state machine (for a detailed description, see "Structure of the status word" on page 25 and "State machine" on page 26).

Data type	Values
UINT	See the bit structure.

Bit structure:

Bit	Description	Value	Information
0 - 9	Corresponds to the default status word	x	
10	Target reached, depends on bit 8 (Stop) in register "Control word" on page 47		**If Stop = 0**
		0	Target position not reached.
		1	Target position reached
			If Stop = 1
		0	Axis decelerating
		1	Axis speed = 0
11	Corresponds to the default status word	x	
12	Setpoint acknowledge	0	Ramp generator did not apply the position value
		1	Ramp generator applied the position value
13 - 15	Corresponds to the default status word	x	

5.9.1.1.2.3 Position setting

The target position can be defined in 2 different ways:

Type of setpoint definition	Description
Single setpoint	After the target position is reached, bit Target reached in register "Status word" on page 47 is set. A new target position (setpoint) is then defined. The drive stops at each target position before starting the movement to the next target position.
Set of setpoints	After the target position has been reached, the movement to the next target position is started immediately without stopping the drive. It is therefore possible to initiate a new positioning by specifying another target position during active positioning.

The two options "Single setpoint" and "Set of setpoints" are controlled by the timing of bits New setpoint and Change set immediately in the "extended control word" on page 45 and Setpoint acknowledge in the "extended status word" on page 45 register.

5.9.1.1.2.4 Relative position setting

If bit abs / rel in Extended control word is set, then the target position is interpreted as a relative value. At each New setpoint trigger, the target position will be increased by this value (or decreased if the value is negative).

If the mode changes between the position settings, relative movement will then proceed starting at the last specified position. The position setpoint mode is initialized with 0 when the module is started.

5.9.1.1.3 Mode 2: Speed mode - Constant speed (pos./neg.)

The value in the "position/speed" on page 48 register is now interpreted as the speed setpoint (microsteps / cycle).

Observing the maximum permissible acceleration, the motor moves with a ramp to the desired speed setpoint and maintains this speed until a new speed setpoint is specified.

Values are allowed within the range -65535 to 65535. When a value is entered outside of this range, it is readjusted to these limits.

5.9.1.1.4 Mode -120: Set home position

This mode is supported starting with upgrade 1.3.1.1 (firmware version 100).

The current actual position is modified such that the position specified in the "position/speed" on page 48 register is the home position. If moved to this position, the motor is at the home position.

The home position in the "homed position" on page 48 register is also set to this value.

5.9.1.1.5 Mode -122: Set actual position

The target position set in register "Position/Speed" on page 48 is applied as the current actual position in the internal position counter.

Before this mode is started, the motor must be at a standstill and physically located at the point for which the position being set should be applied.

5.9.1.1.6 Mode -125/-126: Move to fixed position X

These modes can be used to move to specified fixed positions.

- Mode -125: "Fixed position A" on page 37
- Mode -126: "Fixed position B" on page 37

5.9.1.1.7 Mode -127/-128: Positive/Negative homing

Mode -127 or -128 is used to select the direction used for homing. Whether homing should occur during a stall or unconditionally must be set in the "homing configuration" on page 39.

If the homing condition occurs, then the motor stops and the values of the position counter valid at the moment when the homing condition occurs are written to the "homed zero position" on page 48 register.

5.9.1.2 Read back mode

Name:
ModeReadback01 to ModeReadback04

The contents of register "Mode" on page 44 can be read back with this register.

Data type	Values
SINT	-128 to 127

5.9.1.3 Control word

Name:
MpGenControl01 to MpGenControl04

Using this register, commands can be sent depending on the state of the module.

Data type	Values
UINT	See the bit structure.

Bit structure:

Bit	Description	Value	Information
0	Switch on	x	
1	Enable voltage	x	
2	Quick stop	x	
3	Enable operation	x	
4 - 6	Mode-specific	x	
7	Fault reset	x	
8	Stop [1]	x	
9 - 11	Reserved	0	
12	Warning reset	0	No effect
		1	Rising edge: Reset warnings
13	Undercurrent detection	0	Disable current fault detection
		1	Enable current error detection
14	Reserved	0	
15	Stall detection warning	0	Disable stall detection warning
		1	Enable stall detection warning

1) Bit "Stop" is only evaluated if the extended control word is enabled (see "General configuration" on page 36).

5.9.1.4 Reading back the control word

Name:
ControlReadback01 to ControlReadback04

The contents of register "Control word" on page 47 can be read back with this register.

Data type	Values
UINT	0 to 65535

5.9.1.5 Status word

Name:
MpGenStatus01 to MpGenStatus04

The bits in this register reflect the state of the state machine. For a more detailed description, see "Structure of the status word" on page 25 and "State machine" on page 26.

Bit structure:

Bit	Description	Value	Information
0	Ready to switch on	x	
1	Switched on	x	
2	Operation enabled	x	
3	Fault (error bit)	x	
4	Voltage enabled	x	
5	Quick stop	x	
6	Switch on disabled	x	
7	Warning	x	
8	Reserved	0	
9	Remote	1	Always 1
10	Target reached	x	
11	Internal limit active	0	No limit violation
		1	Internal limit is active (upper or lower software limit violated)
12	Mode-specific	x	
13 - 15	Reserved / MotorLoadBit	0	Always 0 if bit 7 in register "Stall detection configuration / Mixed decay" on page 38 is set to 0.
		x	Returned motor load value

5.9.2 Error handling

5.9.2.1 Error code

Name:
ErrorCode01 to ErrorCode04

The cause of an error or warning can be read in this register:

Data type	Error code	Error type	Priority	Description
UINT	0x0000	-	-	No error
	0x3000	Error	High	Voltage
	0x4200	Error	↓	Overtemperature
	0x2300	Warning	↓	Overcurrent
	0xFF00	Warning	↓	Current error[1]
	0xFF01	Warning	↓ Low	Stall [2]

1) A current error is only detected if bit 13 = 1 in the control word (current error detection enabled).
2) Stall is only detected if bit 15 = 1 in the control word (stall detection warning enabled).

Information regarding the handling of errors and warnings:

- Bit 3 (Fault) and bit 7 (Warning) in the "status word" on page 47 can be used to query whether an error or a warning was reported in the error code register.
- Bit 7 (Fault reset) and bit 12 (Warning reset) in the "control word" on page 47 are used to acknowledge pending errors and warnings.
- If two or more errors/warnings are pending, the one with the highest priority (the order in the table above) will be displayed in the error code register.

5.9.3 Homing

5.9.3.1 Homed zero position of the cyclic counter

Name:
RefPos01CyclicCounter to RefPos04CyclicCounter

These registers can be used to read out the home position of the position counter after a homing procedure.

Data type	Values
DINT	-2,147,483,648 to 2,147,483,647

5.9.4 Positioning and speed

5.9.4.1 Setting the target position / speed

Name:
AbsPos01 to AbsPos04

This register is used to set position or speed, depending on the operating mode.

- Position mode (see "Mode" on page 44): Cyclic setting of the position setpoint in microsteps. One microstep is always 1/256 of a full step in this mode.
- Speed mode (see "Mode" on page 44): In this mode, this register is considered a signed speed setpoint.

Data type	Values
DINT	-2,147,483,648 to 2,147,483,647

5.9.4.2 Current position - Cyclic

Name:
AbsPos01ActVal to AbsPos04ActVal

This cyclic register contains the current position.

Default: Value of the internal step counter

Data type	Values
DINT	-2,147,483,648 to 2,147,483,647

5.10 Minimum cycle time

The minimum cycle time specifies how far the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

Minimum cycle time	
Function model "Standard"	400 µs
Function model "Ramp"	400 µs

5.11 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

Minimum I/O update time	
Function model "Standard"	400 µs
Function model "Ramp" Inputs Outputs[1]	 400 µs 25 ms

1) Depends on the configuration of the "movement profile generator" on page 36