X67SM4320

1 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" of the X67 system user's manual.

2 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. As soon as the value is within the limit value again, the outputs are automatically started up again.

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

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.

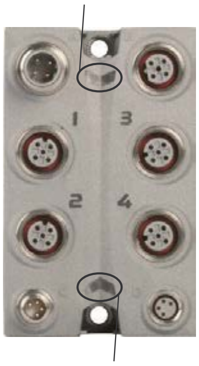
3 Technical data

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 status LED and software
Motor status	Yes, using status LED and software
Connection type	
X2X Link	M12, B-keyed
Outputs	4x M12, A-keyed
I/O power supply	M8, 4-pin
Power consumption	
Internal I/O	2 W
X2X Link power supply	0.75 W
Certifications	
CE	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
EAC	Yes
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 protection, 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 limitations
>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
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

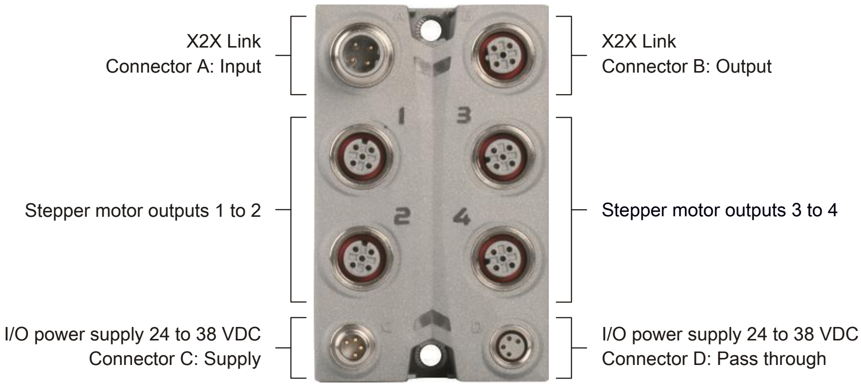
[1] The tolerance value is composed of the voltage tolerances and permissible total AC voltage component with a peak value of 5% of the rated voltage.

4 LED status indicators

Figure	LED	Color/Status		Description
 Status indicator 1: Left: Green, Right: Red 1 3 2 4 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 supply via X2X Link
		On	Off	X2X Link supplied, communication is functioning
		Off	On	X2X Link supplied, but X2X Link communication is not functioning
		On	On	Preoperational: X2X Link supplied, module not initialized
	I/O LEDs: Status display			
	1 - 4	**Color**	**Status**	**Description**
		Yellow	On	Motors 1 to 4 are active
	Status indicator 2: Status indicator for module function			
	Left arrow	**Color**	**Status**	**Description**
		Green	Off	No power to module
			Single flash	RESET mode
			Double flash	BOOT mode (during firmware update)[1]
			Blinking	PREOPERATIONAL mode
			On	RUN mode
	Right arrow	**Color**	**Status**	**Description**
		Red	Off	No power to module or everything OK
			On	Error or reset status
			Single flash	Warning/Error on an I/O channel. Overflow in analog inputs.
			Double flash	Supply voltage not in the valid range

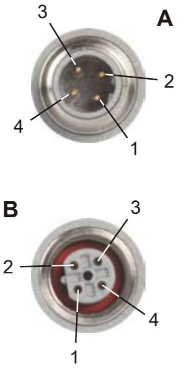
[1] Depending on the configuration, a firmware update can take up to several minutes.

5 Connection elements


X2X Link
Connector A: Input
X2X Link
Connector B: Output
1
3
2
4
Stepper motor outputs 1 to 2
Stepper motor outputs 3 to 4
I/O power supply 24 to 38 VDC
Connector C: Supply
I/O power supply 24 to 38 VDC
Connector D: Pass through

5.1 X2X Link

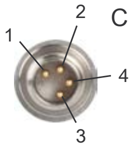
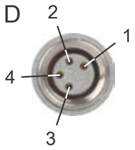
This module is connected to X2X Link using pre-assembled cables. The connection is made using M12 circular connectors.

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	

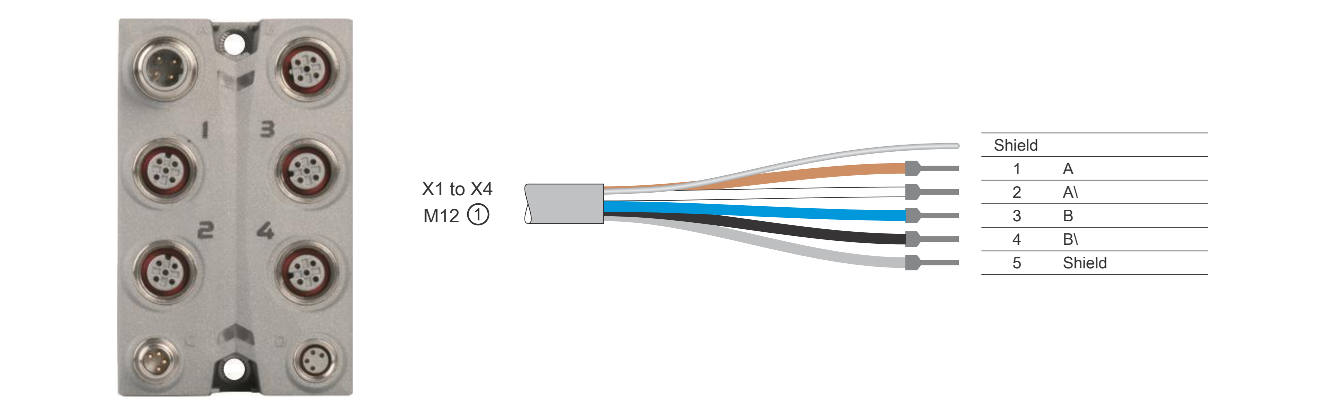
5.2 24 VDC I/O power supply

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

> ## Information:
>
> **The maximum current per supply is 4 A (in summation 8 A)!**

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	

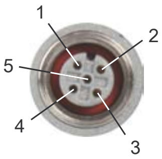
5.3 Pinout

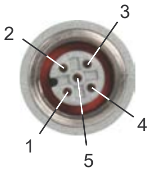


Shield	
1	A
2	A\
3	B
4	B\
5	Shield

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

5.3.1 Connections X1 to X4

<table>
<tr><th>M12, 5-pin</th><th colspan="2">Pinout</th></tr>
<tr><td rowspan="7">Connection X1/X2




Connection X3/X4</td><th>Pin</th><th>Name</th></tr>
<tr><td>1</td><td>Stepper motor A</td></tr>
<tr><td>2</td><td>Stepper motor A\</td></tr>
<tr><td>3</td><td>Stepper motor B</td></tr>
<tr><td>4</td><td>Stepper motor B\</td></tr>
<tr><td>5</td><td>Shield</td></tr>
<tr><td colspan="2">Shield connection made via threaded insert in the module</td></tr>
</table>

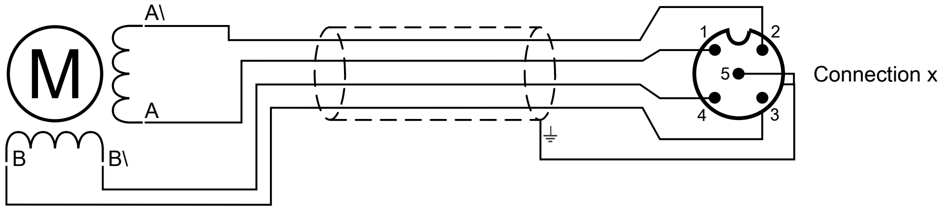
Warning!

Circular connectors are not permitted to be plugged in or unplugged during operation.

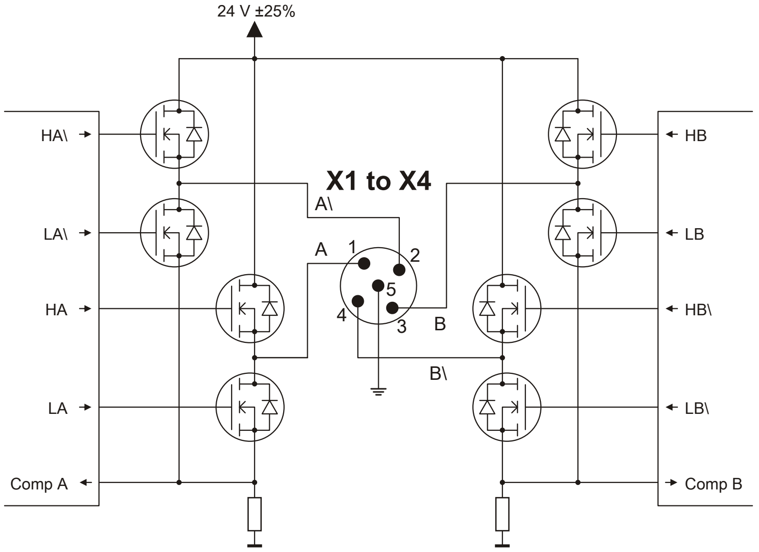
Information:

Shielded motor cables must be used in order to meet the limits according to the EN55011 standard (emissions).

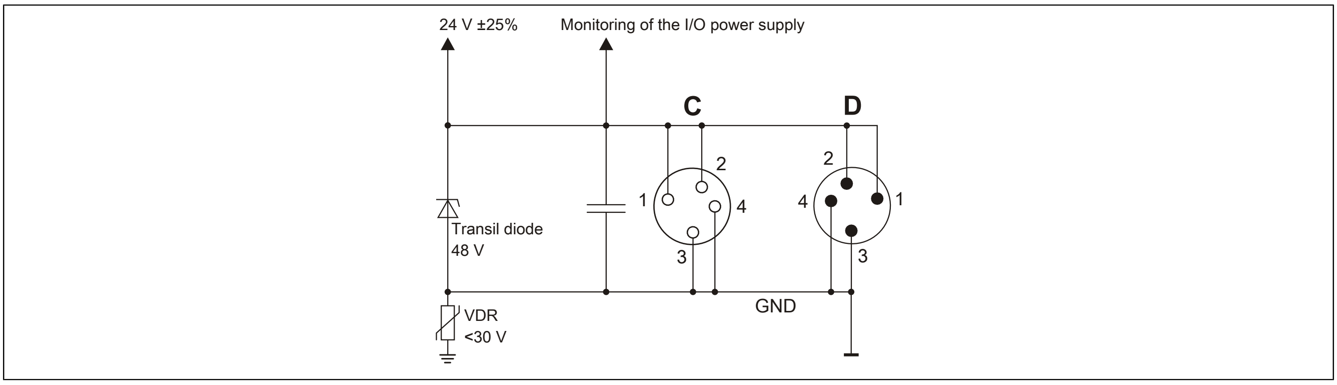
6 Connection example



7 Output circuit diagram



8 I/O power supply circuit diagram



9 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. A minimum distance of 1 cm must be maintained between X67 modules.

10 Power supply 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 the current consumption.

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

11 Protection

The power supply line should be protected by a circuit breaker or a fuse. 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 power mains and the rated current of the overcurrent protection used are chosen according to the current load so that the maximum current load for the cable cross section selected (based on the type of wiring, see table) is greater than or equal to the current load in the power mains. The rated current of the overcurrent protection must be less than or equal to the maximum current load for the cable cross section selected (based on the type of wiring, see table):

$$\begin{array}{ccccc} I_{Mains} & \leq & I_b & \leq & I_Z \\ \text{Mains} & \leq & \text{Fuse} & \leq & \text{Line/cable} \end{array}$$

Wire cross-section [mm²]	Current load of the cable cross section I_Z / rated current of the over current protection I_b [A] according to type of installation in an ambient air temperature of + 40°C in accordance to 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 cannot 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 wires on walls
E	Cables or wires on open-ended cable tray

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

12 Energy regeneration of 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 work.

13 Function description

13.1 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 motor's nominal current is entered in the nominal current register according to the motor's data sheet.

Reasonable values are:

- Holding current < Nominal current < Maximum current

Information:

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

Register	Description
Nominal current	Current during operation at constant speed
Maximum current	Current during short acceleration phases when 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	Power 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:

For a description of the registers, see "Configure currents (function model 0)" on page 31 and "Configure currents (function model 3 and 254)" on page 31.

13.2 Stall detection

The SM 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.

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 32).

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

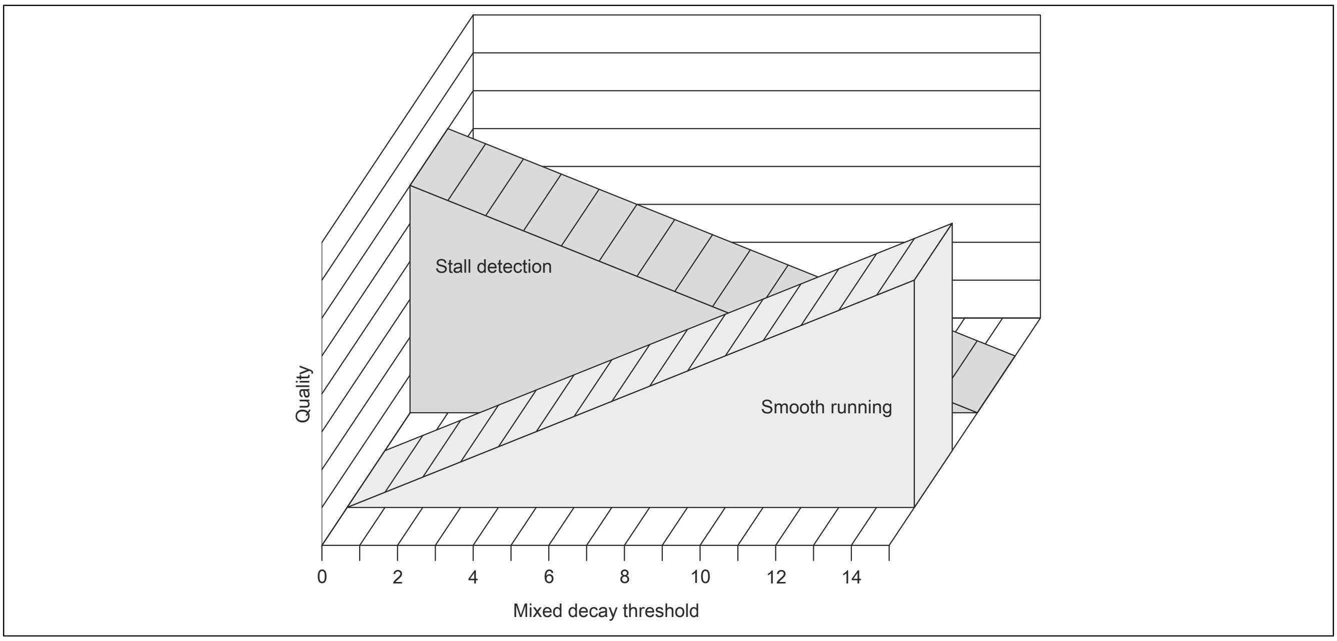
Mixed decay modules provide a greatly optimized sinusoidal current profile in the individual phases of the stepper motor, especially for fast current changes and low current values.

Mixed decay interferes with reliable stall detection, however. For this reason, mixed decay mode can be disabled during stall detection (motor load measurement) using the mixed decay threshold. The smaller the configured mixed decay threshold, the larger the range in which mixed decay is disabled while motor load measurement takes place.

Mixed decay mode is always enabled if the mixed decay threshold is set to 15.

Relationship between stall detection and mixed decay

Depending on the application and the motor used, satisfactorily smooth operation can be achieved while using stall detection by setting the mixed decay threshold to a value between 1 and 14. This is a compromise between smooth operation and stall detection quality and must be fine tuned during commissioning.



Information:

Registers are described in "Stall detection" on page 31.

13.3 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 35.

13.4 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.

These limit monitors are 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:
>
> **The software limits will only be monitored when using the following CANopen bus controllers:**
>
> - **X20BC0043-10**
> - **X20BC0143-10**
> - **X67BC4321-10**
> - **X67BC4321.L08-10**
> - **X67BC4321.L12-10**

> ### Information:
>
> **Registers are described in "Limitations" on page 35.**

13.5 Motion generator

Mode

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

- Position mode
- Speed setpoint
- Homing

	Information
	No mode selected
Positioning	
	Speed 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 (reference 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.

Speed setpoint

The module is given the desired speed setpoint (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 modus (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.
- Stop the 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

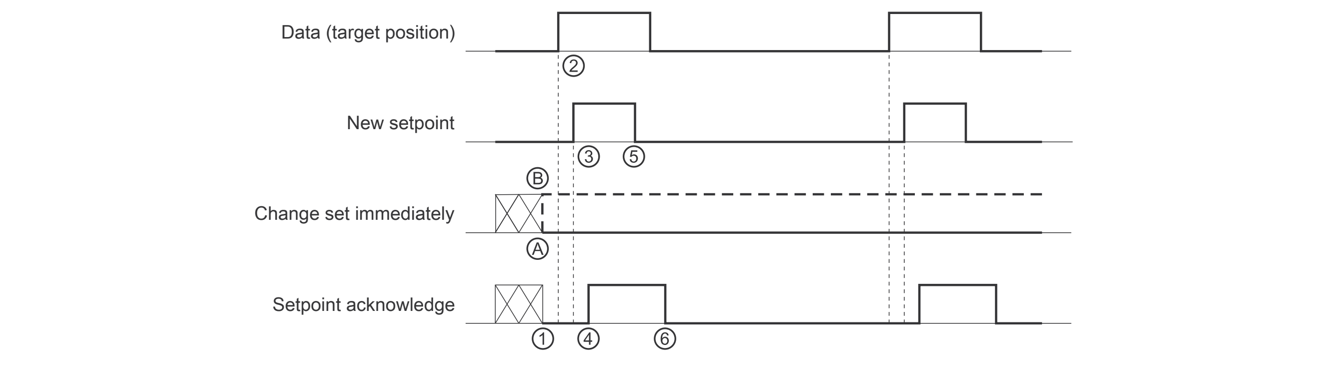


Figure 1: Principle for applying the setpoint

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.

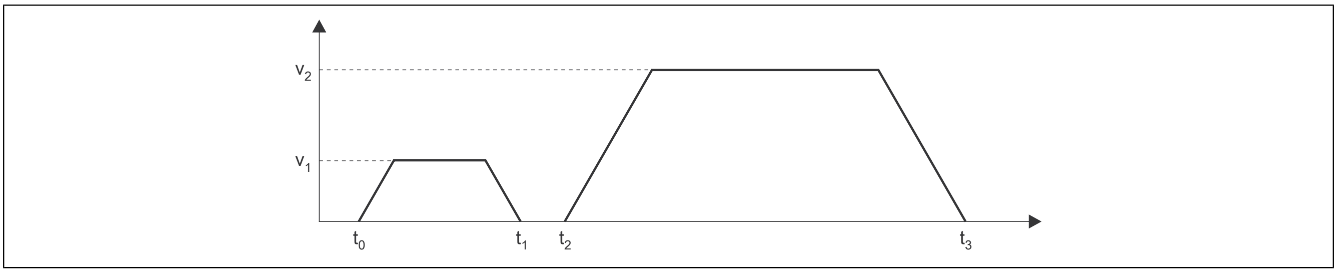


Figure 2: Ramp in *Single setpoint*

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.

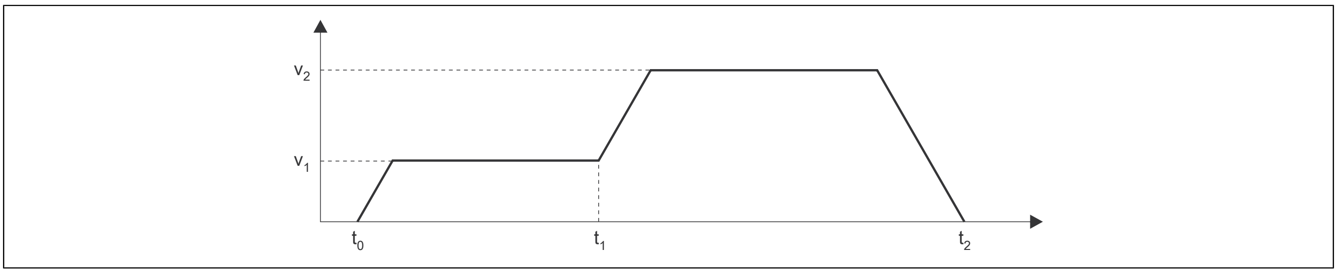


Figure 3: Ramp in *Set of setpoints*

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.

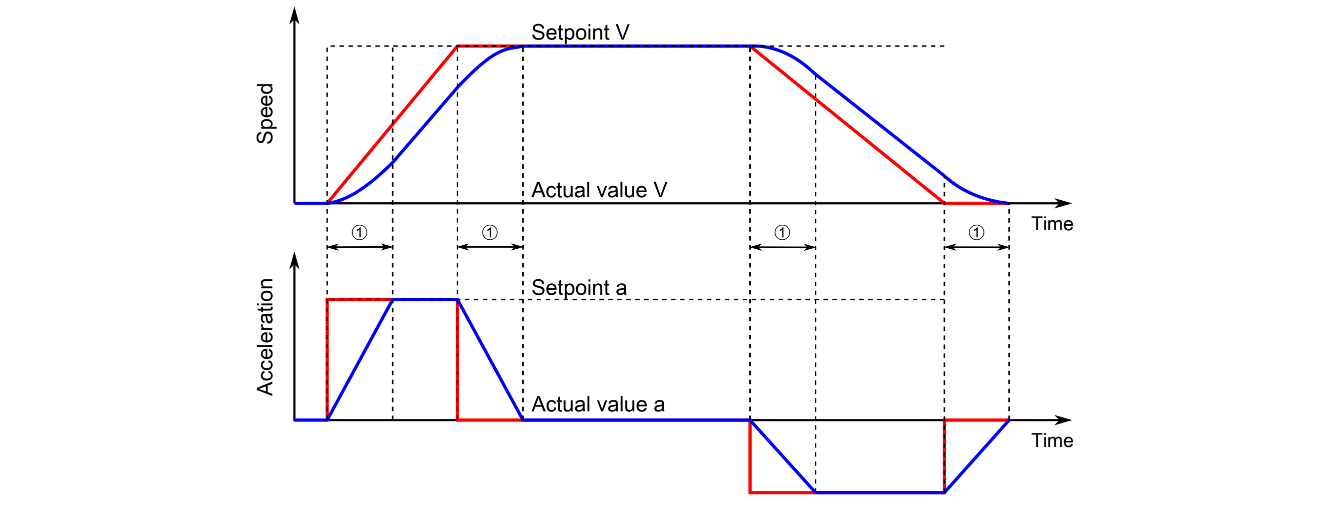
- Positive sign: Forward movement
- Negative sign: Backward movement

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

13.6 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.

13.6.1 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:**
>
> **For the error message, see register "Module status" on page 38.**

13.6.2 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:**
>
> **For the error message, see register "Motor error" on page 38.**

13.6.3 Monitoring the module communication

The communication between the module and PLC 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 PLC. 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 PLC 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 CPU 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.

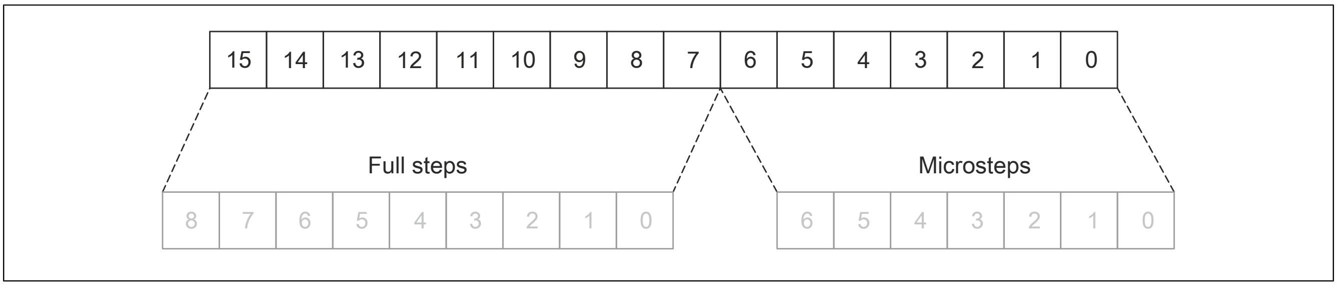
> **Information:**
>
> **For the configuration, see "SDC configuration" on page 30 and "Motor current" on page 36.**

13.7 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, while the highest 8 to 11 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 register setting is described in "Module configuration" on page 30.

13.8 NetTime Technology

NetTime refers to the ability to precisely synchronize and transfer system times between individual components of the controller or network (CPU, 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

13.8.1 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.

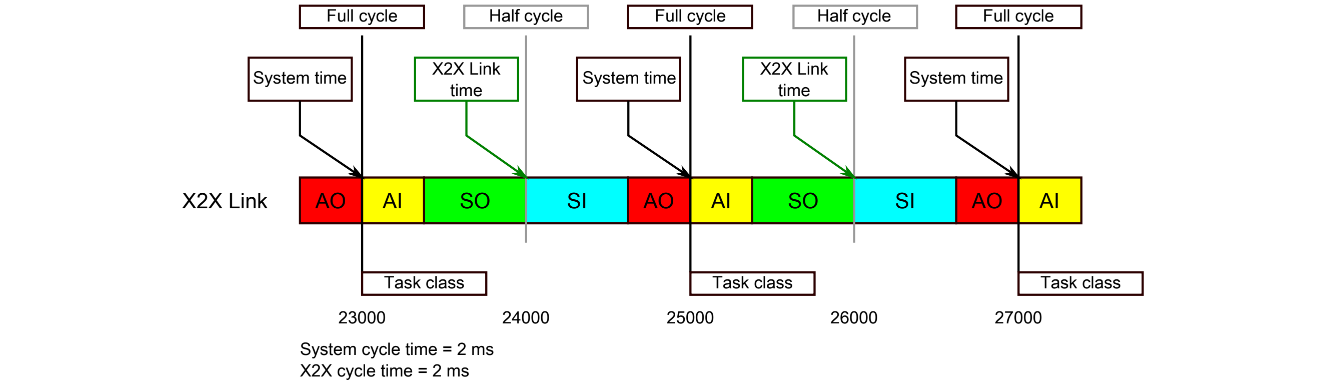
The initialization of the times is based on the system time during the startup of the X2X Link, the I/O modules or the POWERLINK interface.

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

13.8.1.1 PLC/Controller data points

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

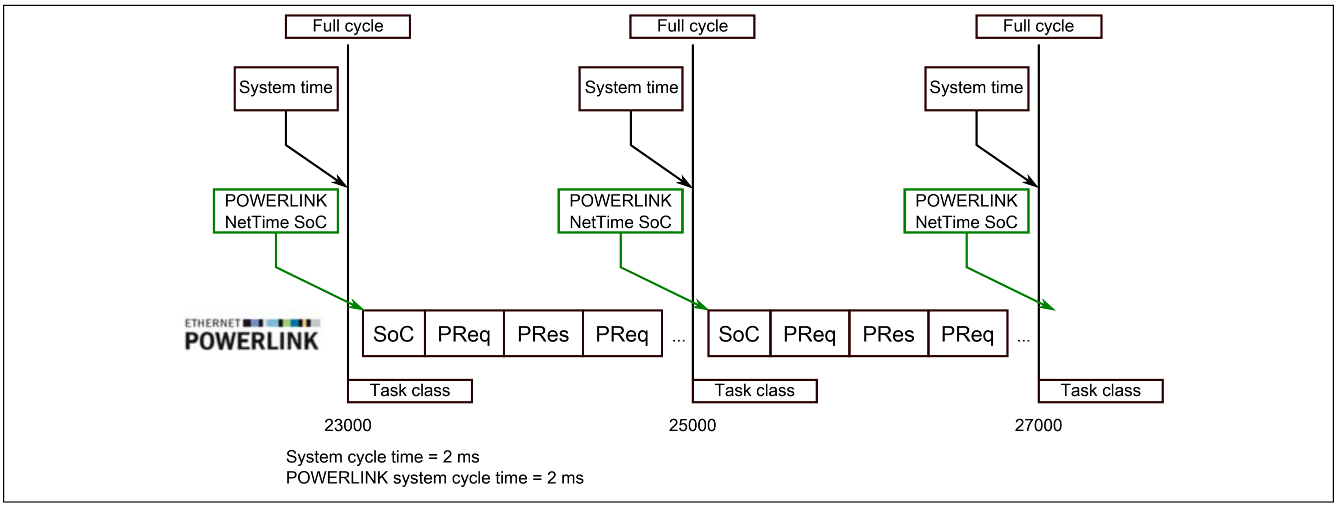
13.8.1.2 X2X Link reference moment



The reference moment 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 moment 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 moment are compared at time 25000 in the task, then the system time returns the value 25000 and the X2X Link reference moment returns the value 24000.

13.8.1.3 POWERLINK reference moment

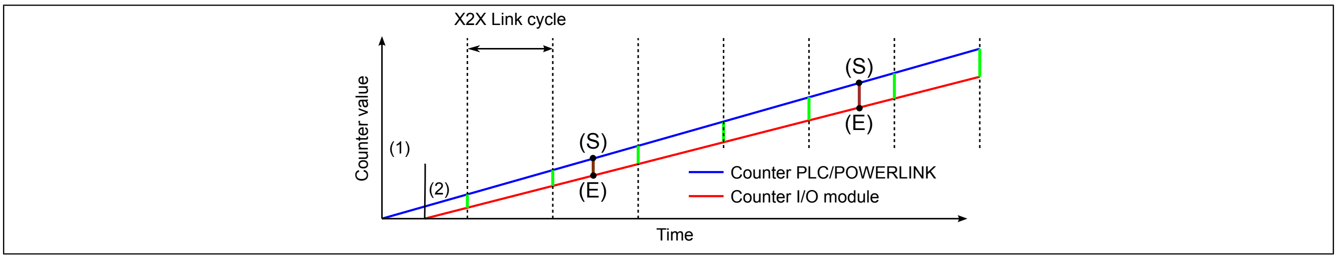


The reference moment on the POWERLINK network is always calculated at the start of cycle (SoC) of the POWERLINK network. The SoC starts 20 µs after the system tick. This results in the following difference between the system time and the POWERLINK reference time:

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 moment are compared at time 25000 in the task, then the system time returns the value 25000 and the POWERLINK reference moment returns the value 23020.

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



At startup, the internal counters for the PLC/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 PLC or the 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.

13.8.2 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 CPU, including this precise moment, the CPU can then evaluate the data using its own NetTime (or system time), if necessary.

13.8.2.1 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.**

13.8.2.2 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.**

13.8.2.3 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.

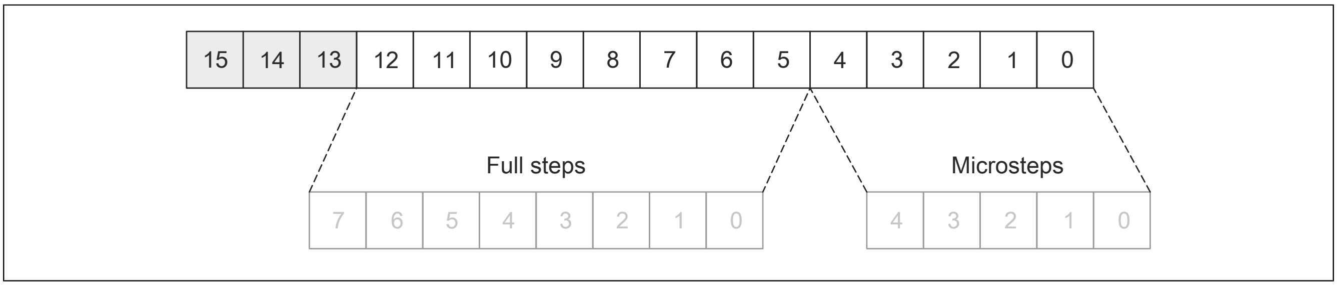
14 Commissioning

14.1 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 step starts.

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



14.2 Ramp function model operation

Commands for controlling the modules are written to the "Control word" on page 43. The current module state is returned in register "Status word" on page 43. The function mode (absolute position, constant speed, homing, etc.) is set in the "mode register" on page 40.

14.2.1 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 23 according to the commands in the table above.
Fault reset	A rising edge resets errors and warnings (see "State machine" on page 23)
Stop	0 ... Perform motor movement 1 ... Stop axis with deceleration This bit is only evaluated when the extended control word is activated in the "General configuration" on page 33 register.
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

14.2.2 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 is set to 1 in the "Mixed Decay / Stall Detection" on page 34 register, 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:

Bits 0, 1, 2, 3, 5 and 6 (light gray in the previous table)	These bits are set according to the current state of the "State machine" on page 23.	
Voltage enabled	Becomes 1 as soon as the motor is powered	
Warning	Becomes 1 if a warning is detected ("Overcurrent", "Undercurrent"). The type of warning is indicated in the "Error code" on page 44 register. 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 the "Warning reset" bit in the control word.	
Remote	Always 1	
Target reached[1], depends on bit 8 (Stop) in Structure of the control word	**If stop = 0**	**If stop = 1**
	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.	**In all modes:** 0...Axis decelerating 1...Axis speed = 0
Internal limit active	0 ... No limit violation 1 ... Internal limit is active (upper/lower software limit violated)	

[1] If the extended control word in register "General configuration" on page 33 was not enabled, "Target reached" behaves the same as if "Stop = 0".

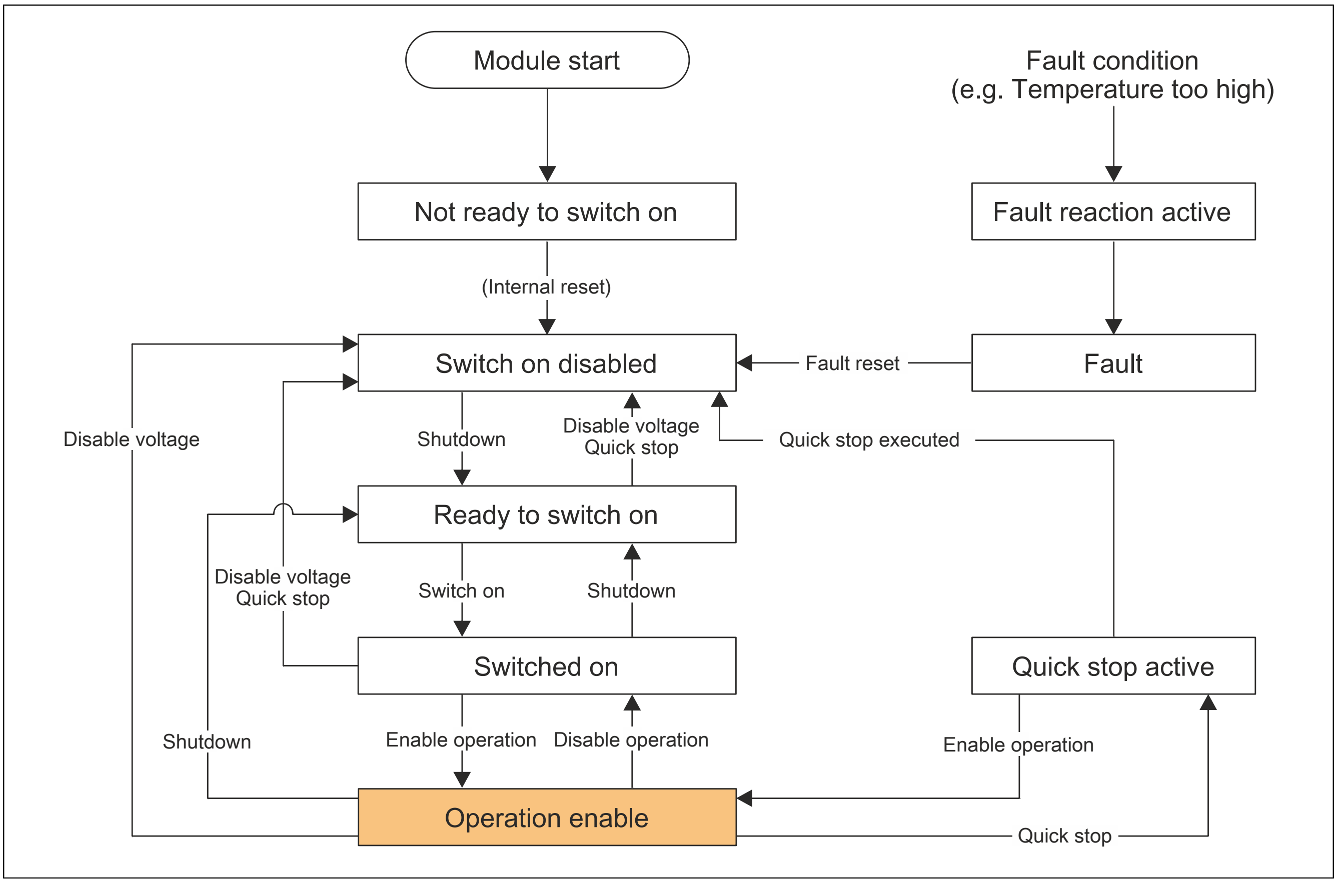
14.2.3 State machine

The motor is controlled 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 43.

The state machine successively reaches the 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 40 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 brought on by the *Shutdown* command. No others actions are performed.
Ready to switch on → Switch on disabled	This state change is brought on by the command *Disable voltage* or *Quick stop*. No others actions are performed.
Switched on → Switch on disabled	This state change is brought on by the command *Disable voltage* or *Quick stop*. The motor voltage is switched off immediately.
Ready to switch on → Switched on	This state change is brought on by the *Switch on* command. 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 the *Switched on* state is achieved. This can take approximately 1 second.
Switched on → Ready to switch on	This state change is brought on by the *Shutdown* command. The motor voltage is switched off immediately.
Switched on → Operation enable	This state change is brought on by the *Enable operation* command. Motor movements are now performed depending on the defined mode.
Operation enable → Switched on	This state change is brought on by the *Disable operation* command. If in motion, the motor is decelerated with the configured deceleration. Motor voltage remains on in the *Switched on* state.
Operation enable → Ready to switch on	This state change is brought on by the *Shutdown* command. The motor voltage is switched off immediately.
Operation enable → Switch on disabled	This state change is brought on by the *Disable voltage* command. 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 brought on by the *Quick stop* command. If in motion, the motor is decelerated with the configured deceleration. During the deceleration, the state machine remains in the *Quick stop active* state. Once the motor is at standstill, the state automatically changes to the *Switch on disabled* state. While the state machine is in the *Quick stop active* state, the *Enable operation* command can be used to switch it back to the *Operation enable* state.
→ 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 44). (Other error types listed as "Warning" only cause the "Warning" bit 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 44). 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 brought on by the *Fault reset* command. 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.

15 Register description

15.1 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

15.2 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.

15.3 Function model 0 - default

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				●
Configure 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				
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				

Register	Name	Data type	Read		Write	
			Cyclic	Acyclic	Cyclic	Acyclic
70	Error acknowledgment	USINT			●	
	ErrorReset01	Bit 0				
	...	...				
	ErrorReset04	Bit 3				
Positions						
0	Position1Sync	INT	●			
2	Position2Sync	INT	●			
4	Position3Sync	INT	●			
6	Position4Sync	INT	●			

15.4 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				●
Configure 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	●			
Error handling						
10	Module status	USINT	●			
	DrvOk01	Bit 0				
	...	...				
	DrvOk04	Bit 3				
	ModulePowerSupplyError	Bit 7				

Register	Name	Data type	Read		Write	
			Cyclic	Acyclic	Cyclic	Acyclic
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	●			

15.5 Function model 254 - Bus controller and function model 3 - Ramp

Register	Offset[1]	Name	Data type	Read		Write	
				Cyclic	Acyclic	Cyclic	Acyclic
Configuration							
Configure 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				●
260	-	RefSpeed04	UINT				●
70	-	RefConfig01	SINT				●
134	-	RefConfig02	SINT				●
198	-	RefConfig03	SINT				●
262	-	RefConfig04	SINT				●

Register	Offset[1]	Name	Data type	Read		Write	
				Cyclic	Acyclic	Cyclic	Acyclic
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.

15.5.1 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).

15.5.2 CAN I/O bus controller

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

15.6 Configuration registers - Function model 0 and function model MotionConfiguration

15.6.1 Module configuration

15.6.1.1 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 37)	**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 37 • "Current position" on page 39	00	Resolution: 5 bits (bit 0 - 4) microsteps; 8 bits (bit 5 - 12) full steps
		01	Resolution: 6 bits (bit 0 - 5) microsteps; 7 bits (bit 6 - 12) full steps
		10	Resolution: 7 bits (bit 0 - 6) microsteps; 6 bits (bit 7 - 12) full steps
		11	Resolution: 8 bits (bit 0 - 7) microsteps; 5 bits (bit 8 - 12) full steps
7 - 10	Reserved	0	
11	Operating mode	0	Normal mode (default)
		1	Enhanced mode
12 - 15	Reserved	0	

15.6.1.2 SDC configuration

Name:
SdcConfig01

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

Enabling/disabling the SDC information shows or hides additional cyclic registers. 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

Note:

Neither SDC information nor SDC life sign monitoring is permitted to be changed at runtime.

15.6.1.3 Motor settling time

Name:
MotorSettlingTime01 to MotorSettlingTime04

The motor settling time determines the minimum time from powering on the motor up to setting the drive bit (DrvOk) (see section "Motor error" on page 38). 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

15.6.1.4 Turn-off delay

Name:
DelayedCurrentSwitchOff01 to DelayedCurrentSwitchOff04

If the "SDC life sign monitoring" on page 37 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	Value	Information
USINT	0 to 255	0 to 25.5 ms in steps of 100 ms (default: 100 ms)

15.6.2 Configure currents

15.6.2.1 Holding current, rated 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, rated current, maximum current):

Function model	Switching between preset current values at runtime
Standard	Using bits 14 and 15 in the registers "Motor setting" on page 37
Standard with enabled SDC information	Using the register "Motor current" on page 36

Data type	Value	Unit
USINT	0 to 150	Percent of the module's rated current • 100% corresponds to the rated current of the motor bridge power unit listed in the technical data • 150% corresponds to the maximum current of the motor bridge power unit listed in the technical data

15.6.3 Stall detection

15.6.3.1 Stall threshold

Name:
ConfigOutput01

Register "Stall threshold" can be used to define a threshold above which the module defines a stall condition (see "Motor error" on page 38).

Data type	Values
UINT	See the bit structure.

Bit structure:

Bit	Description	Value	Information
0 - 2	Trigger threshold stall detection for Motor 1	0	Stall detection is disabled
		1	Minimum sensitivity for stall detection
		2 to 6	Setting the sensitivity of stall detection
		7	Maximum sensitivity for stall detection
3	Reserved	0	
4 - 6	Trigger threshold stall detection for Motor 2	0	Stall detection is disabled
		1	Minimum sensitivity for stall detection
		2 to 6	Setting the sensitivity of stall detection
		7	Maximum sensitivity for stall detection
7	Reserved	0	
8 - 10	Trigger threshold stall detection for Motor 3	0	Stall detection is disabled
		1	Minimum sensitivity for stall detection
		2 to 6	Setting the sensitivity of stall detection
		7	Maximum sensitivity for stall detection
11	Reserved	0	
12 - 14	Trigger threshold stall detection for Motor 4	0	Stall detection is disabled
		1	Minimum sensitivity for stall detection
		2 to 6	Setting the sensitivity of stall detection
		7	Maximum sensitivity for stall detection
15	Reserved	0	

15.6.3.2 Mixed decay threshold

Name:
ConfigOutput16

The mixed decay threshold is configured in this register. This value must be adjusted according to the motor being used, current and voltage when using "stall detection" on page 31. 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 Motor 1	0	Mixed decay disabled
		1 to 14	Setting for mixed decay threshold
		15	Mixed decay always enabled
4 - 7	Mixed Decay Threshold Motor 2	0 to 15	See motor 1
8 - 11	Mixed Decay Threshold Motor 3	0 to 15	See motor 1
12 - 15	Mixed Decay Threshold Motor 4	0 to 15	See motor 1

15.6.3.3 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 32 is used. The 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	Value	Information
UINT	0 to 65535	Minimum speed in steps per second.

15.7 Function models 3 and 254 - Configuration registers

15.7.1 Configure currents

15.7.1.1 Holding current, rated 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	Value	Unit
USINT	0 to 150	Percent of the module's rated current • 100% corresponds to the rated current of the motor bridge power unit listed in the technical data • 150% corresponds to the maximum current of the motor bridge power unit listed in the technical data Bus controller default setting: 0

15.7.2 Motion generator

15.7.2.1 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 40 (bus controller default setting)
		1	"Mode 1: Position mode with extended control word" on page 40
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

15.7.2.2 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	Value	Information
UNIT	0 to 65,535	Speed in microsteps/cycle. Bus controller default setting: 0

15.7.2.3 Maximum acceleration

Name:
MaxAcc01 to MaxAcc04

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

Data type	Value	Information
UINT	0 to 65,535	Acceleration in microsteps/cycle². Bus controller default setting: 0

15.7.2.4 Maximum deceleration

Name:
MaxDec01 to MaxDec04

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

Data type	Value	Information
UINT	0 to 65,535	Brake deceleration in microsteps/cycle². Bus controller default setting: 0

15.7.2.5 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

15.7.2.6 Jolt 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	Value	Information
USINT	0	No jerk time limitation. 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

15.7.2.7 Fixed position A

Name:
FixedPos01a to FixedPos04a

This register defines the position to move to in mode -125.

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

15.7.2.8 Fixed position B

Name:
FixedPos01b to FixedPos04b

This register defines the position to move to in mode -126.

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

15.7.3 Stall detection

15.7.3.1 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 shown (bus controller default setting).
		1	Show value in register "Status word" on page 43[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 "Home during stall" on page 42 mode.

15.7.3.2 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 32 is used. The 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	Value	Information
UINT	0 to 65535	Minimum speed in microsteps per cycle. Bus controller default setting: 0

15.7.3.3 Stall recognition delay

Name:
StallRecognitionDelay01 to StallRecognitionDelay04

The value in this register is only relevant for mode "Homing during stall" on page 10.

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	Value	Information
USINT	0	No delay (bus controller default setting)
	1 to 255	Delay time in cycles, see "General configuration" on page 33.

15.7.4 Homing

15.7.4.1 Homing speed

Name:
RefSpeed01 to RefSpeed04

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

Data type	Value	Information
UINT	0 to 65,535	Speed in microsteps/cycle. Bus controller default setting: 0

15.7.4.2 Homing configuration

Name:
RefConfig01 to RefConfig04

The homing mode can be set with this register.

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

[1] Stall detection is enabled automatically when this mode is selected.

15.7.5 Limitations

15.7.5.1 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

15.8 Communication registers - Function model 0 and function model MotionConfiguration

15.8.1 Motor detection

15.8.1.1 Measuring 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	-	

15.8.2 Motor control

15.8.2.1 Motor current

Name:
DriveEnable01 to DriveEnable04
BoostCurrent01 to BoostCurrent04
StandstillCurrent01 to StandstillCurrent04

Bits 0 to 14 of this register can be used to control the motors' current supply.

Data type	Values
USINT	See the bit structure.

Bit structure:

Bit						
Motor 1	Motor 2	Motor 3	Motor 4	Description	Value	Information
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

15.8.2.2 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, rated current and maximum current" on page 31).

Data type	Values
UINT	See the bit structure.

Bit structure:

Bit	Description	Value	Information
0 - 12	Number of steps for the module to 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 30). 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 30)	
	1 (bits 3 - 4 = 00)	2 (bits 3 - 4 = 01)
0 - 500 µs	MotorXStep1	MotorXStep1
500 - 1000 µs		MotorXStep2

15.8.2.3 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

15.8.3 Life sign monitoring

15.8.3.1 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 activated in register "SDC configuration" on page 30 by setting bit 6 (SDCSetTime = on).

Data type	Values
INT	-32768 to 32767

15.8.3.2 Lifecycle counter

Name:
LifeCnt

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

Data type	Values
SINT	-128 to 127

15.8.4 Error handling

15.8.4.1 Module status

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

The status of the drive is indicated in this register.

Data type	Values
USINT	See the bit structure.

Bit structure:

Bit						
Motor 1	**Motor 2**	**Motor 3**	**Motor 4**	**Description**	**Value**	**Information**
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 power supply voltage within the valid range
					1	I/O power supply voltage outside the valid range

[1] Only for standard function model with SDC

Status of the drive

The status of the drive is only shown in the standard function model when SDC information is enabled. Bit DrvOk is 1 if the following conditions are met:

- Motor turned on (see "Motor current" on page 36)
- Motor is supplied with current
- Motor settling time has passed
- Supply voltage is in the valid range
- No overtemperature fault
- Preset position value is valid (see "SDC life sign monitoring" on page 37)

15.8.4.2 Motor error

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

The error status of the drive is indicated in this register. 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 39).

Data type	Values
UINT	See the bit structure.

Bit structure:

Bit						
Motor 1	**Motor 2**	**Motor 3**	**Motor 4**	**Description**	**Value**	**Information**
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

The "Overtemperature" error bit can be set for 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).

15.8.4.3 Error acknowledgment

Name:

Standard functional model without SDC	**Standard functional model 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 "Motor error" on page 38.

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	

15.8.5 Positioning

15.8.5.1 Current position

Name:

Standard functional model without SDC	**Standard functional model with SDC**
Position1Sync	ActPos01
Position2Sync	ActPos02
Position3Sync	ActPos03
Position4Sync	ActPos04

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

Data type	Values
INT	-32768 to 32767

15.8.5.2 NetTime of the position value

Name:
ActTime01 to ActTime04

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

For more information about NetTime and timestamps, see "NetTime Technology" on page 18.

Data type	Values
INT	-32768 to 32767

15.9 Function models 3 and 254 - Communication registers

15.9.1 Motor control

15.9.1.1 Mode

Name:
MpGenMode01 to MpGenMode04

Data type	Value	Information
SINT	0	No mode selected
	1	Depending on bit 0 in the "General configuration" on page 33 register, the position mode will behave as follows: • Position mode without extended control word: Move to target position as soon as the target position changes • Position mode with extended control word: Move to position setpoint as described in "Mode 1: Position mode with extended control word" on page 40
	2	Speed mode: Constant speed
	-120	Set reference 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 35)
	-128	Negative homing (see also "Homing configuration" on page 35)

Information:

For all modes: The "Target reached" bit is set in the "Status word" on page 43 register 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.

15.9.1.1.1 Mode 1: Position mode

The position setpoint is specified in register "Setting target position/speed" on page 44. 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 40.

15.9.1.1.2 Mode 1: Position mode with extended control word

Position mode with extended control word behaves like "Position mode 1" on page 40 as described previously (without the extended control word), but the new position setpoint ("Position/Speed" on page 44 register) is applied according to the "extended control word" on page 41.

Extended control word

This register can be used to issue commands based on the module's state (see "Ramp function model operation" on page 21).

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	Position setpoint is an absolute value
		1	Position setpoint 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.

Extended status word

The bits in the status word reflect the status of the state machine (for a detailed description, see "Structure of the status word" on page 22 and "State machine" on page 23).

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 43		**If stop = 0**
		0	Position setpoint not reached
		1	End 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	

Position setting

The position setpoint can be defined in 2 different ways:

Type of setpoint definition	Description
Single setpoint	Once the position setpoint is reached, the *Target reached* bit in the "Status word" on page 43 register is set. Then a new position setpoint is defined. The drive stops at each position setpoint before starting the movement to the next position setpoint.
Set of setpoints	Once a setpoint has been reached, the movement to the next setpoint is started immediately without stopping the drive. It is therefore not possible to initiate a new positioning movement by transferring a new position setpoint during an active positioning movement.

The two modes "Single setpoint" and "Set of setpoints" are controlled by the timing of the bits *New setpoint* and *Change set immediately* in the *"extended control word" on page 41* and *Setpoint acknowledge* in the *"Extended control word" on page 41* register.

Relative position setting

When the *abs / rel* bit in the Extended control word register is set, then the position setpoint is interpreted as a relative value. At each *New setpoint* trigger, the position setpoint 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.

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

The value in the "Position/Speed" on page 44 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.

15.9.1.1.4 Mode -120: Set home position

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

The current value for the actual position is modified so that the position specified by the "Position/Speed" on page 44 register is the home position. If you subsequently move to this position, the motor is at the home position.

The home position in the "Home position" on page 44 register is also set to this value.

15.9.1.1.5 Mode -122: Set the actual position

The target position set in register "Position/Speed" on page 44 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.

15.9.1.1.6 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 34
- Mode -126: "Fixed position B" on page 34

15.9.1.1.7 Mode -127/-128: Homing (positive/negative)

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 35.

If the referencing condition occurs, then the motor stops and the values of the position counter valid at the moment when the referencing condition occurs are written to the "Referenced zero position" on page 44 register.

15.9.1.2 Read back mode

Name:
ModeReadback01 to ModeReadback04

This register can be used to read the content of the "Mode" on page 40 register.

Data type	Values
SINT	-128 to 127

15.9.1.3 Control word

Name:
MpGenControl01 to MpGenControl04

This register can be used to issue commands based on the module's state.

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 33).

15.9.1.4 Read back control word

Name:
ControlReadback01 to ControlReadback04

This register can be used to read the content of the "Control word" on page 43 register.

Data type	Values
UINT	0 to 65,535

15.9.1.5 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 22 and "State machine" on page 23.

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 / Motor load value	0	Always 0 if bit 7 in register "Stall detection configuration / Mixed decay" on page 34 is set to 0.
		x	Returned motor load value

15.9.2 Error handling

15.9.2.1 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	Errors	Portrait ↓ ↓ ↓ ↓ Low	Voltage
	0x4200	Errors		Overtemperature
	0x2300	Warning		Overcurrent
	0xFF00	Warning		Current error[1]
	0xFF01	Warning		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 43 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 43 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.

15.9.3 Homing

15.9.3.1 Homing the zero position for cyclic counter

Name:
RefPos01CyclicCounter to RefPos04CyclicCounter

After a referencing procedure, the reference position of the position counter can be read with these registers.

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

15.9.4 Positioning and speed

15.9.4.1 Setting 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 40): Cyclic setting of the position setpoint in microsteps. In this mode, one micro-step is always 1/256 full-step.
- Speed mode (see "Mode" on page 40): In this mode, this register is considered a signed speed setpoint.

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

15.9.4.2 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

15.10 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	
Standard function model	400 µs
Ramp function model	400 µs

15.11 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	
Standard function model	400 µs
Ramp function model Inputs Outputs[1]	 400 µs 25 ms

[1] Depends on the configuration of the ."General configuration" on page 33