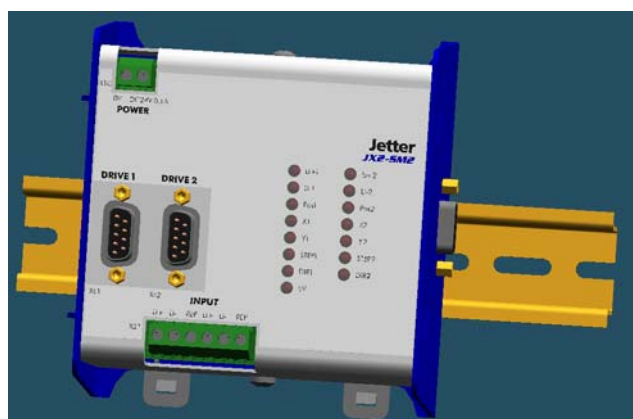


JetWeb

JX2-SM2

User Manual



Rev. 1.14.3

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This Manual is an Integral Part of the Module JX2-SM2:

Type: _____
Serial #: _____
Year of construction: _____
Order #: _____



To be entered by the customer:

Inventory #: _____
Place of operation: _____

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Significance of this User Manual

This manual is an integral part of the JX2-SM2 module, and

- must be kept in a way that it is always at hand until the JX2-SM2 module will be disposed of;
- If the JX2-SM2 module is sold, alienated or loaned, this manual must be handed over.

In any case you encounter difficulties to clearly understand this user manual, please contact the manufacturer.

We would appreciate any suggestions and contributions on your part and would ask you to contact us. This will help us to produce manuals that are more user-friendly and to address your wishes and requirements.

This manual contains important information on how to transport, erect, install, operate, maintain and repair the JX2-SM2 module.

Therefore, this person must carefully read, understand and observe this manual, and especially the safety instructions.

Missing or inadequate knowledge of the manual results in the loss of any claim of liability on part of Jetter AG. Therefore, the operating company is recommended to have the instruction of the persons concerned confirmed in writing.

History

Revision	Comment
1.00	Original issue
1.1	JetNode images replaced with JetControl images Chapter 3: Images of physical dimensions Chapter 5: Images showing LEDs
1.2	Chapter 1: Safety Instructions, Residual Dangers, Instructions on EMC Chapter 4: Operating parameters Chapter 5: Picture Chapter 6: Pin assignment of stepper motor Chapter 7.1: Section "Important!" Chapter 7.2: new Chapter 8: 2 sub-chapters have been deleted Chapter 9: Chapter numbering Chapter 11: Example "Referencing Cycle"
1.14.1	Introduction: History has been added Chapter 4: Technical Data Chapter 9: Various modifications Chapter 10: Various modifications Chapter 11: Program has been adapted to JetSym Appendix: "Recent Revisions" has been added
1.14.2	Chapter 9.2: Register 1xy69 Chapter 9.3: Register 1xy69
1.14.3	See "Recent Revisions" on page 108.

Description of Symbols



Warning

This sign is to indicate a possible impending danger of serious physical damage or death.



Caution

This sign is to indicate a possible impending danger of light physical damage. This sign is also to warn you of material damage.



Important

This sign is to indicate a possible impending situation which might bring damage to the product or to its surroundings. It also identifies requirements necessary to ensure faultless operation.



Note

You will be informed of various possible applications and will receive further useful suggestions. It also gives you words of advice on how to efficiently use hardware and software in order to avoid unnecessary efforts.



Enumerations are marked by full stops, strokes or scores.



Operating instructions are marked by this arrow.



Automatically running processes or results to be achieved are marked by this arrow.



PC and user interface keys.



This symbol informs you of additional references (data sheets, literature, etc.) associated with the given subject, product, etc. It also helps you to find your way around this manual.

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1 Safety Instructions

1.1 General Words of Advice

The JX2-SM2 module complies with the applicable safety regulations and standards. Special emphasis was given to the safety of the users.

Of course, the following regulations apply to the user:

- pertinent accident prevention regulations;
- accepted safety rules;
- EC guidelines and other country-specific regulations.

1.1.1 Usage as agreed upon

Usage as agreed upon includes operation in accordance with these operating instructions.

The JX2-SM2 module is used as drive module for a stepper motor amplifier for positioning a stepper motor. It is integrated into machinery, such as conveyors, production plants and handling machines. An axis consists of stepper motor controller, amplifier and motor.

The supply voltage of the JX2-SM2 module is DC 24 V.

This operating voltage is classified as SELV (Safety Extra Low Voltage). The JX2-SM2 module is therefore not subject to the EU Low Voltage Directive.

The JX2-SM2 module may only be operated within the limits of the stated characteristics. Do not apply a voltage to the JX2-SM2 module that is higher than the specified operating voltage.

1.1.2 Usage Other Than Agreed Upon

The JX2-SM2 module must not be used in technical systems which to a high degree have to be fail-safe, e.g. ropeways and aeroplanes.

If the JX2-SM2 module is to be run under ambient conditions, which differ from the conditions mentioned in chapter 4: "Technical Data", page 19, the manufacturer is to be contacted beforehand.

1.1.3 Who is Permitted to Operate the JX2-SM2 Module?

Only instructed, trained and authorised persons are permitted to operate the JX2-SM2 module.

Transport:	Only by personnel with knowledge in handling electrostatically sensitive components.
Installation:	Only by specialists with training in electrical engineering.
Commissioning:	Only by specialists with extensive knowledge of, and experience with, electrical engineering / drive technology.

1.1.4 Modifications and Alterations to the Module

Due to safety reasons, neither any alterations to the JX2-SM2 module nor any modifications of its functions are permitted. Any modifications to the JX2-SM2 module not expressly authorized by the manufacturer will result in a loss of any liability claims to Jetter AG.

The original parts are specially designed for the JX2-SM2 module. Parts and equipment of other manufacturers are not tested on our part, and are, therefore, not released by us. The installation of such parts may impair the safety and the proper functioning of the JX2-SM2 module.

Any liability on the part of Jetter AG for any damages resulting from the use of non original parts and equipment is excluded.

1.1.5 Repairing and Maintaining the JX2-SM2 Module

The JX2-SM2 module must not be repaired by the operator itself. The JX2-SM2 module does not contain any parts which can be repaired by the operator. If the JX2-SM2 module needs repairing, please send it to Jetter AG.

The JX2-SM2 module is maintenance-free. Therefore, absolutely no inspection or maintenance works are required for the operation of the module.

1.1.6 Decommissioning and Disposal of the JX2-SM2 Module

Decommissioning and disposal of the JX2-SM2 module are subject to the environmental legislation of the respective country in effect for the operator's premises.

1.2 Ensure Your Own Safety

- Disconnect the JX2-SM2 module from the mains to carry out maintenance work. By doing so, you will prevent accidents resulting from electric voltage and moving parts.
- Protection and safety components, such as guards, as well as terminal box covers must not be shunted or bypassed.
- Dismantled protective equipment must be reattached prior to commissioning and checked for proper functioning.

1.2.1 Malfunctions

- Malfunctions or other damages are to be reported to an authorised person at once.
- Safeguard the JX2-SM2 module against misuse or accidental use.

1.2.2 Information Signs and Labels

- Writings, information signs, and labels always have to be observed and kept readable.
- Damaged or unreadable information signs and labels are to be exchanged.

1.3 Residual Dangers

During Operation



Caution

Danger of injuries caused by mechanic force!

The stepper motor control serves for running a stepper motor, which is to move mechanic parts of parts with sharp edges. Deshalb können Versagen bzw. Therefore, failure or malfunctioning of the module JX2-SM2 may result in damages to persons or the manufacturing plant. This should be prevented by installing additional safety devices.

- One safety precaution is to install a second set of limit switches to interrupt the power supply of the motor.
- Another safety precaution would be installing a guard.

1.4 Instructions on EMI

The noise immunity of a system corresponds to the weakest component of the system. For this reason, correct wiring and shielding of the cables is important.



Important!

Measures for increasing immunity to interference:

- Follow the instructions given in Application Note 016 "EMC-Compatible Installation of the Electric Cabinet" published by Jetter AG.

The following instructions are excerpts from Application Note 016:

- On principle, physical separation should be maintained between signal and voltage lines. We recommend spacings greater than 20 cm. Cables and lines should cross each other at an angle of 90°.
- Shield cables on both ends.
- The entire shield must be drawn behind the isolation, and then be clamped under an earthed strain relief with the greatest possible surface area.

When male connectors are used:

- Only use metallised connectors, e.g. SUB-D with metallised housing. Make sure that the strain relief is directly connected with the housing here as well (see Fig. 1).

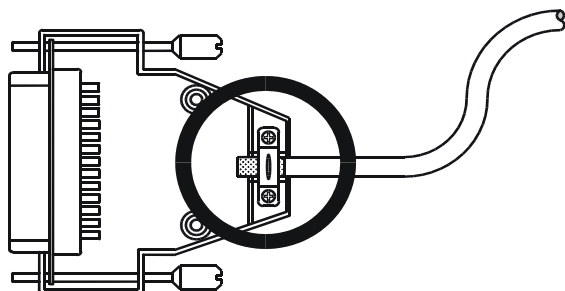


Fig. 1: Shielding of SUB-D connectors in conformity with the EMC standards

- The JX2-SM2 module must only be connected to the Jetter system bus by directly plugging it into a JX2 module (not through a cable). The system bus can be extended by means of a cable.

2 Word of Advice on this Manual

In this operator's manual, the possibilities offered by the JX2-SM2 module will be described.

For making use of the possibilities offered by the stepper motor and for accordingly design a drive, relatively precise knowledge of the stepper motor characteristics, above all the ones connected with controlling the stepper motor, will be needed. Thus, the running smoothness and the performance of a stepper motor is to a great extend dependent on its control, both regarding performance and creation of a stepping frequency.

Faulty design of a stepper motor drive will usually lead to an overdimensioned system which means it is too expensive, or the performance will not meet the requirements - in limiting cases, malfunctions can occur sporadically. In order to gain a reliable system, knowledge of the load to be driven and of other components involved is absolutely necessary.

Thanks to its characteristic features, the JX2-SM2 module can be applied in many ways.

The JX2-SM2 can be connected to the controller or other JX2 modules via Jetter system bus.

The advantages of the plain-text high-level languages JetSym, JetSymST and JstSymSTX, especially of the "POS" and "AXARR" instructions can be made use of. Positioning is exclusively controlled and monitored by module JX2-SM2. Thus, the controller is relieved and can carry out other tasks.

3 Physical Dimensions

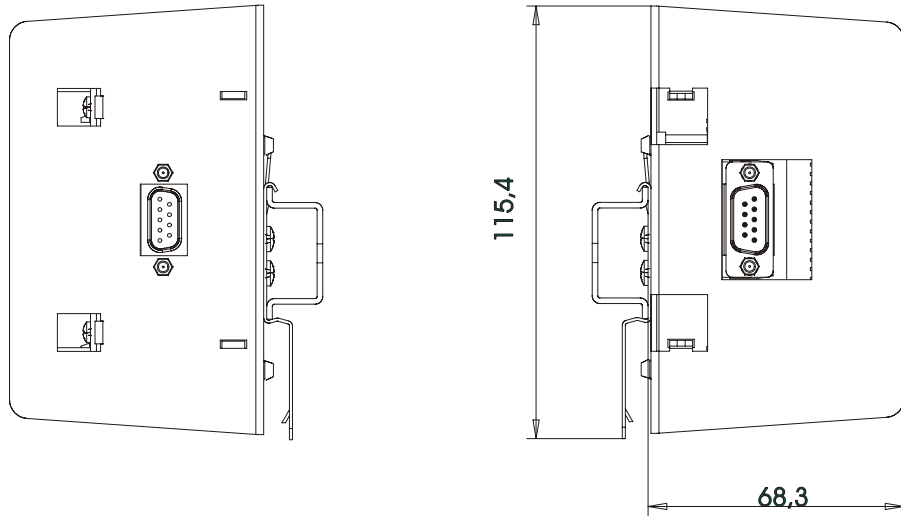


Fig. 2: Side View

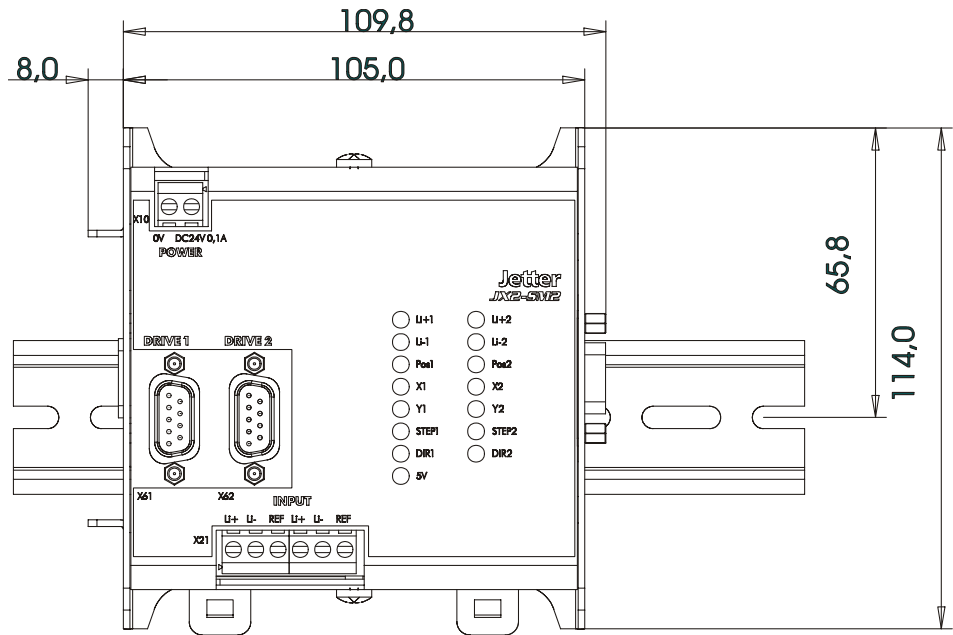


Fig. 3: Front View

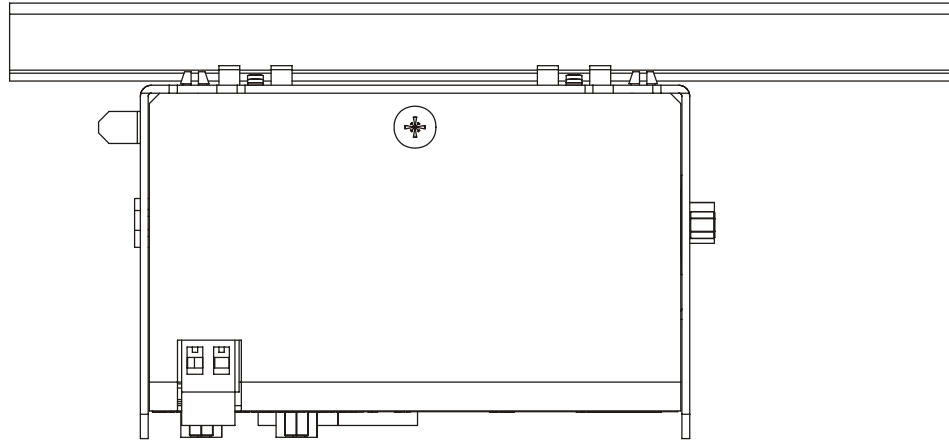


Fig. 4: Top View

Design	
Connection to the basic unit via Jetter system bus	Male connector SUB-D, 9 pins
Dimensions (HxWxD in mm)	114 x 105 x 69
Housing bottom Housing cover	Aluminium, powder coated Steel sheet metal coated with AlZn
Weight	470 g
Installation	DIN rail EN 50022-35 x 7.5

4 Technical Data

Technical Data	
Positioning range	-8,388,608 ...+8,388,607 steps
Stepping rate	max. 250 kHz
Maximum start / stop frequency.	5 kHz
Acceleration/deceleration ramp	linear, with programmable gradient (1 ... 32,767 (Hz / 4 ms)
Machine Referencing	max. stepping rate 1,000 Hz During the reference run, the reference switch is queried every 500 μ s. When referencing at stepping rates > 1,000 Hz, the resolution exceeds one step, i.e. the accuracy will reduce.
Supply Voltage	DC 24 V (20 .. 30 V, residual ripple < 5 % filtered)
Connection to the controller module	via system bus, SUB-D female connector, 9 pins
Terminals	Power supply, limit and reference switches: Screw terminals Interface between module and amplifier: Female connector, SUB-D, 9 pins
Interface between module and amplifier:	Open collector, RS422
Enclosure	Metal
Dimensions (HxWxD)	115 x 105 x 69 mm
Installation	DIN-rail EN 50022-35 x 7.5
Power dissipation of logic circuit (P_V)	2 Watt

Electrical Data	
Power Supply Unit	DC 20 V ... 30 V / 5 W Residual ripple: < 5 % filtered
Reference switch (REF), limit switch positive (L+) and negative (L-)	DC 20 V ... 30 V / 2.8 k Ω internal reference to GND: Terminal X 10 / 0 V NCC or NOC is possible Delay time: approx. 3 ms

Operating Parameters (Power Supply)		
Parameter	Value	Reference
Power Rating	DC 20 V ... 30 V / 5 W Residual ripple: < 5 % filtered	
Voltage dips	Duration of voltage dips <= 10 ms Time interval between two voltage dips >= 1 s	DIN EN 61131-2

Operating Parameters (Environmental Data)		
Parameter	Value	Reference
Operating Temperature Range	0° C through 50° C	
Storage Temperature Range	-25° C through +70° C	DIN EN 61131-2 DIN EN 60068-2-1 DIN EN 60068-2-2
Air Humidity / Humidity Rating	10 % to 95 % No condensing	DIN EN 61131-2
Pollution Degree	2	DIN EN 61131-2
Corrosion Immunity/ Chemical Resistance	No special protection against corrosion. Ambient air must be free from higher concentrations of acids, alkaline solutions, corrosive agents, salts, metal vapours, or other corrosive or electroconductive contaminants.	General specification
Atmospheric pressure	max. 2000 m above sea level	DIN EN 61131-2

Operating Parameters (Mechanical Data)		
Parameter	Value	Reference
Free Falls Withstanding Test	Height of fall (units within packing): 1 m	DIN EN 61131-2 DIN EN 60068-2-32
Vibration Resistance	10 Hz .. 57 Hz with an amplitude of 0.0375 mm for continuous operation (peak amplitude of 0.075 mm) 57 Hz .. 150 Hz: 0.5 constant acceleration for continuous operation (1 g constant acceleration occasionally); 1 octave/min, 10 sinusoidal frequency sweeps, all 3 spatial axes	DIN EN 61131-2 DIN EN 60068-2-6
Shock Resistance	15 g occasionally, 11 ms, sinusoidal half-wave, 2 shocks in all three spatial axes	DIN EN 61131-2 DIN EN 60068-2-27
Class of protection	IP20, rear: IP10	DIN EN 60529
Mounting position	Any position, snapped on DIN rail	

Operating Parameters (Electrical Safety)		
Parameter	Value	Reference
Protection class	III	DIN EN 61131-2
Dielectric Test Voltage	Functional ground is connected to chassis ground internally.	DIN EN 61131-2
Overvoltage Category	II	DIN EN 61131-2

Operating Parameters (EMC) - Emitted Interference		
Parameter	Value	Reference
Enclosure	Frequency band 30 - 230 MHz, limit 30 dB ($\mu\text{V}/\text{m}$) at 10 m distance 230 - 1,000 MHz, limit 37 dB ($\mu\text{V}/\text{m}$) at 10 m distance (class B)	DIN EN 50081-1 DIN EN 50081-2 DIN EN 55011

Operating Parameters (EMC) - Enclosure		
Parameter	Value	Reference
Magnetic Field with Mains Frequency	50 Hz 30 A/m	DIN EN 61000-6-2 DIN EN 61000-4-8
RF Field, amplitude-modulated	Frequency band 26 - 1,000 MHz Test field strength 10 V/m AM 80% with 1 kHz Criterion A	DIN EN 61131-2 DIN EN 61000-6-2 DIN EN 61000-4-3
ESD	Discharge through air: Test peak voltage 8 kV Contact Discharge: Test peak voltage 4 kV Criterion A	DIN EN 50082-2 DIN EN 61131-2 DIN EN 61000-4-2

Operating Parameters (EMC) - Signal Ports		
Parameter	Value	Reference
Asymmetric RF, amplitude-modulated	Frequency band 0.15 - 80 MHz Test voltage 10 V AM 80% with 1 kHz Source impedance 150 Ohm Criterion A	DIN EN 61000-6-2 DIN EN 61000-4-6
Burst (fast transients)	Test voltage 1 kV tr/tn 5/50 ns Repetition frequency 5 kHz Criterion A	DIN EN 61131-2 DIN EN 61000-6-2 DIN EN 61000-4-4
Surge voltages, asymmetrical (line to earth)	tr/tn 1.2/50 μ s No-load voltage 1 kV	DIN EN 61000-6-2 DIN EN 61000-4-5

Operating Parameters (EMC) - Process, measuring and control lines,		
Parameter	Value	Reference
Asymmetric RF, amplitude-modulated	Frequency band 0.15 - 80 MHz Test voltage 10 V AM 80% with 1 kHz Source impedance 150 Ohm Criterion A	DIN EN 50082-2 DIN EN 61000-4-6
Burst (fast transients)	Test voltage 2 kV tr/tn 5/50 ns Repetition frequency 5 kHz Criterion A	DIN EN 50082-2 DIN EN 61131-2 DIN EN 61000-4-4

Operating Parameters (EMC) - DC Power Supply Inputs and Outputs		
Parameter	Value	Reference
Asymmetric RF	Frequency band 0.15 - 80 MHz Test voltage 10 V AM 80% with 1 kHz Source impedance 150 Ohm Criterion A	DIN EN 61000-6-2 DIN EN 61000-4-6
Bursts	Test voltage 2 kV tr/tn 5/50 ns Repetition frequency 5 kHz Criterion A	DIN EN 61000-6-2 DIN EN 61131-2 DIN EN 61000-4-4
Surge voltages, asymmetrical (line to earth), symmetrical (line to line)	tr/tn 1.2/50 μ s No-load voltage 0.5 kV	DIN EN 61000-6-2 DIN EN 61000-4-5

5 Meaning of LEDs

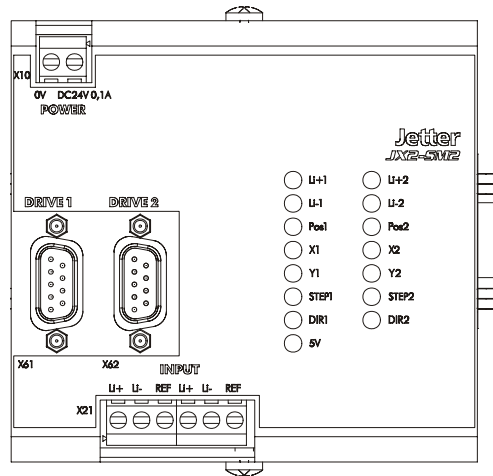


Fig. 5: LEDs of JX2-SM2 Module

LEDs of JX2-SM2 Module	
Software-related LEDs	
Designation	Function
Li +	<p>The positive limit switch is or was active</p> <p>ON:</p> <p>The axis stands on the limit switch</p> <p>flashing regularly:</p> <p>The axis has recognized the limit switch; yet, it does not stand on the limit switch any more</p> <p>flashing irregularly:</p> <p>The axis has recognized the software limit switch</p>

LEDs of JX2-SM2 Module	
Software-related LEDs	
Designation	Function
Li -	<p>The negative limit switch is or was active</p> <p>ON:</p> <p>The axis stands on the limit switch</p> <p>flashing regularly:</p> <p>The axis has recognized the limit switch; yet, it does not stand on the limit switch any more</p> <p>flashing irregularly:</p> <p>The axis has recognized the software limit switch</p>
POS	<p>AXARR status</p> <p>ON:</p> <p>The axis stands in position</p>
X1 (special function)	<p>Flashing:</p> <p>for example during operating system update.</p>

LEDs of JX2-SM2 Module	
Hardware-related LEDs	
Designation	Function
5 V	Power supply of the module is ok
STEP	<p>ON:</p> <p>Is lit as long as a step pulse is output (i.e. the higher the frequency, the more brightly the LED will be lit)</p>
DIR	Indicates the polarity of the DIR output (is lit when the open collector signal is low, or respectively, when the RS422 signal is high).

6 Description of Connections

6.1 Power supply of the module

Specification of the terminal

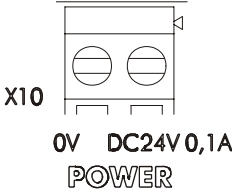
- 2-pin screw terminal (for PC board connection)
- Allowed conductor size 0.14 - 2.5 mm²
- Bladed screw-driver: 0.6 x 3.5 x 100 mm

Specification of the connecting cable

- Not needed

Cable Shielding

- Not needed

Contact assignment of the 2-pin screw terminal X10			
Terminal X10 (POWER LOGIC)	Pin	Signal	Comment
	0 V	GND	connected to the ground potential
	+24 V	24 V	



Important!

Please mind the correct connection of the power supply. This module is not protected against polarity reversal.

6.2 Control inputs

Specification of the terminal

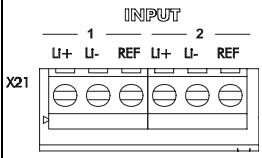
- 3-pin screw terminal (for PC board connection)
- Diameter of the cable apt for connecting: 0.14 - 2.5 mm²
- Bladed screw-driver: 0.6 x 3.5 x 3.94 in

Specification of the connecting cable

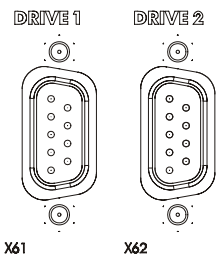
- Not needed

Cable Shielding

- Not needed

Contact assignment of the 6-pin screw terminal X21			
Terminal X21 (INPUT)	Pin	Signal	Comment
	Li+ 1	Positive limit switch - Axis # 1	Reference to GND: Terminal X10 / 0 V DC 24 V / 2.8 kΩ
	Li- 1	Negative limit switch - Axis # 1	Reference to GND: Terminal X10 / 0 V DC 24 V / 2.8 kΩ
	REF 1	Reference switch - Axis # 1	Reference to GND: Terminal X10 / 0 V DC 24 V / 2.8 kΩ
	Li+ 2	Positive limit switch - Axis # 2	Reference to GND: Terminal X10 / 0 V DC 24 V / 2.8 kΩ
	Li- 2	Negative limit switch - Axis # 2	Reference to GND: Terminal X10 / 0 V DC 24 V / 2.8 kΩ
	REF 2	Reference switch - Axis # 2	Reference to GND: Terminal X10 / 0 V DC 24 V / 2.8 kΩ

6.3 Outputs

Assignment of the 9-pin female SUB-D-connectors X61, X62			
Terminals X61, X62 (DRIVE1, DRIVE2)	Pin	Signal	Comment
 <p>DRIVE 1 DRIVE 2</p> <p>X61 X62</p>	Pin 1	Step + (RS422)	
	Pin 2	Dir + (RS422)	
	Pin 3	Step (Open Collector)	
	Pin 4	0 V	
	Pin 5	5V output (50 mA)	
	Pin 6	Step - (RS422)	
	Pin 7	Dir - (RS422)	
	Pin 8	Dir (Open Collector)	
	Pin 9	0 V	

7 Connection diagram

7.1 Open Collector

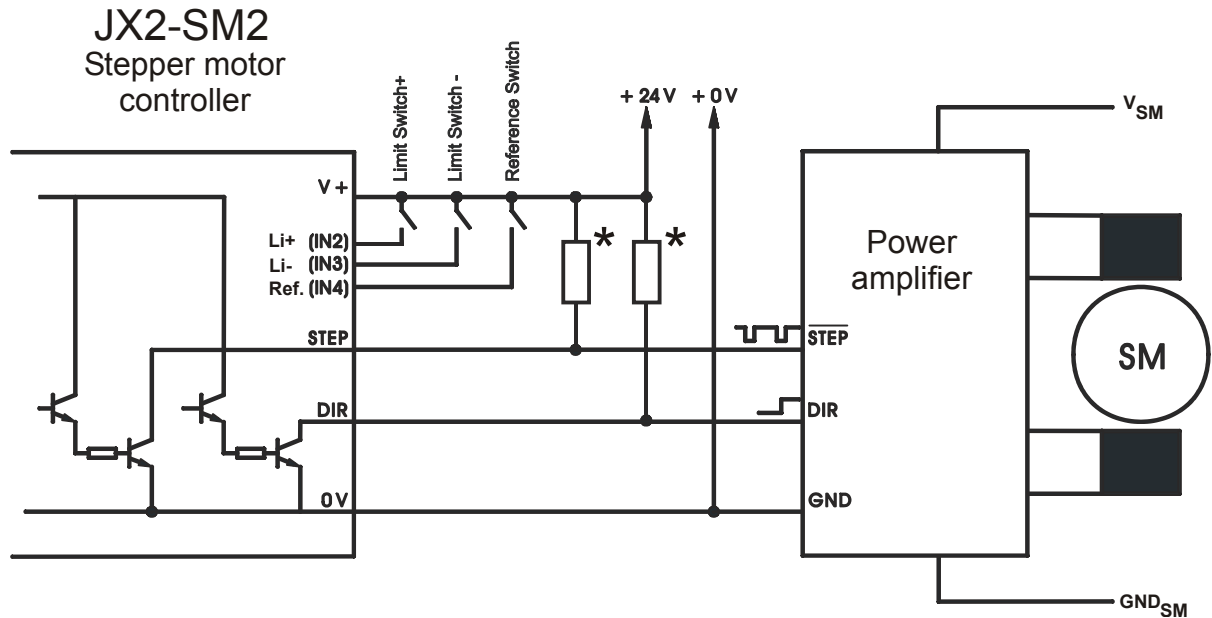


Fig. 6: Connection Diagram - Open Collector



Important!

Pull-up resistor rating of open collector signal lines STEP and DIR (in Fig. 6 marked with asterisk).

- At a voltage of +24 V the rating of the pull-up resistor must not fall below 1 k Ω
- At a voltage of +5 V the rating of the pull-up resistor must not fall below 220 k Ω
- The voltage must not exceed +30 V.

7.2 RS422

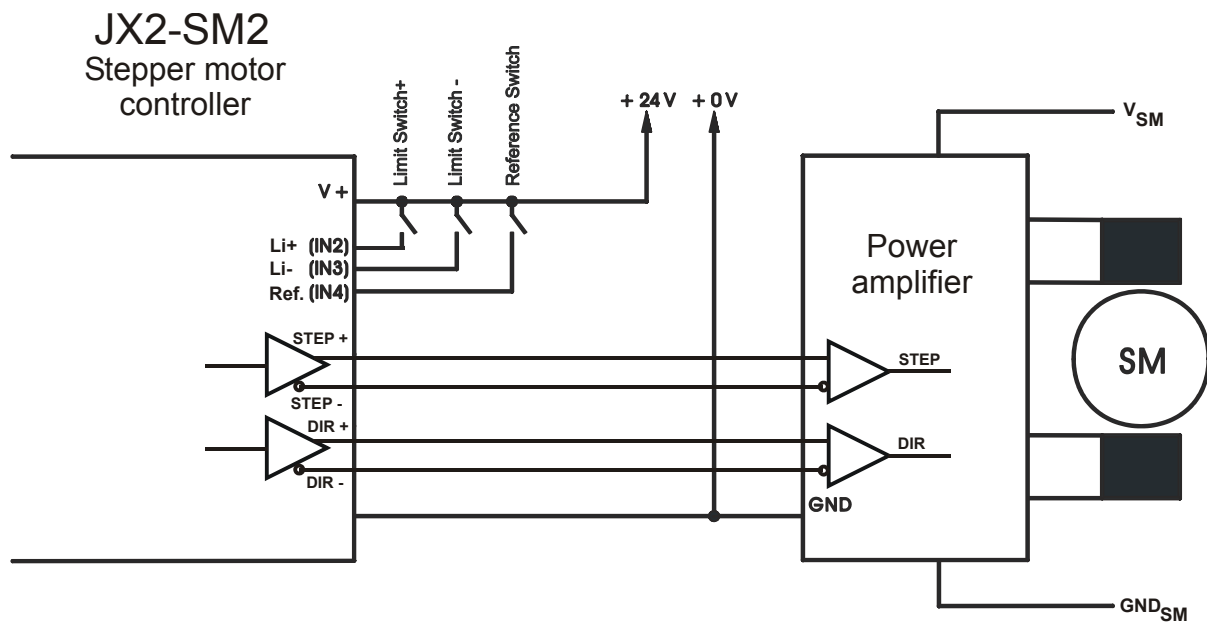


Fig. 7: Connection Diagram - RS422

8 Facts worth knowing about stepper motor controls

8.1 What is a stepper motor?

A stepper motor is an electric motor consisting - like most of the other electric motors - of a stator and a rotor.

Generally, the rotor consists of two soft-magnetic toothed pole shoes with permanent magnets placed in between.

The stator also consists of soft magnetic toothed metal sheets. It accommodates the drive coils.

When power is fed to specific drive coils (phases) (see Fig. 8), the north and south poles will rotate in the stator, taking the rotor with them (see Fig. 9).

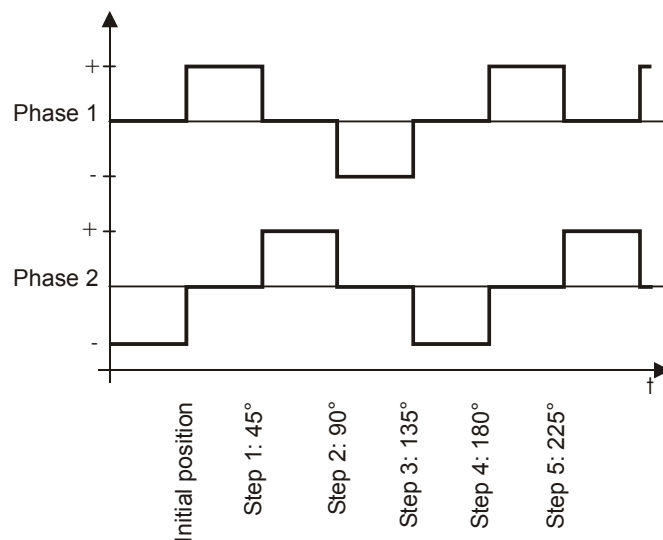


Fig. 8: Feeding power to the motor windings

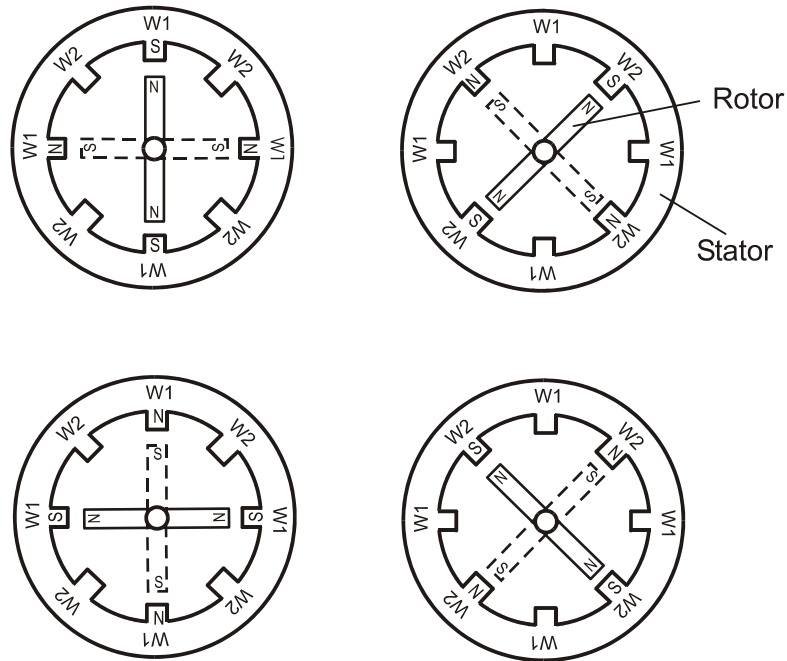


Fig. 9: Commutating the rotor

The rotating motion is not continuous, but the shaft is rotating step by step by a certain angle α .

After m steps, the shaft has carried out exactly one complete rotation. In that way, the motor can be turned a precise angle and have a definite and reproducible rotor position by counting the steps.

The step resolution m depends on the motor construction and on the characteristics of the electrical controller.

Classic stepper motors have got the following natural step resolutions:

2-phase motor

$m = 200$ Full step mode

$m = 400$ Half step mode

5-phase motor

$m = 500$ Full step mode

$m = 1,000$ Half step mode

More exact step resolutions can be realized by electronic means. This is called micro step function. With the help of a finer (mathematical) gradation, the 1/4 step, 1/8 step, 1/16 step, etc. can be realized.

If the number of steps per time unit is increased, the jerking motion of the motor shaft turns into a more and more regular continuous rotating motion.

The speed can be calculated as follows:

$$\text{Speed} = 60 * \text{stepping rate} / \text{step resolution}$$

Speed in revolutions per minute

Stepping rate in Hz

Step resolution in steps per revolution

The moments of inertia of rotor and load result in smoother motion.

The stepper motor can both move towards defined discrete positions and drive a load with a predefined speed.

It is an interesting fact, that the stepper motor exhibits torque even at standstill; this kind of torque is called holding torque. The mechanical system permitting, the holding torque can be decreased by "current reduction during standstill".

A typical motion profile normally consists of a starting phase with the start / stop frequency, an acceleration phase, a phase of constant speed, a deceleration phase and a stop at last.

8.2 Acceleration and deceleration

The stepper motor is a slow-acting device. It will just not be able to accelerate or decelerate too quickly.

Position inaccuracies will occur, or else, the stepper motor will just stop.

In order to prevent this, please mind:

For starting and stopping, the stepper motor must not be controlled at any higher step frequency than the start / stop frequency.

The start / stop frequency is the step frequency, at which the motor including its load will faultlessly start and stop.

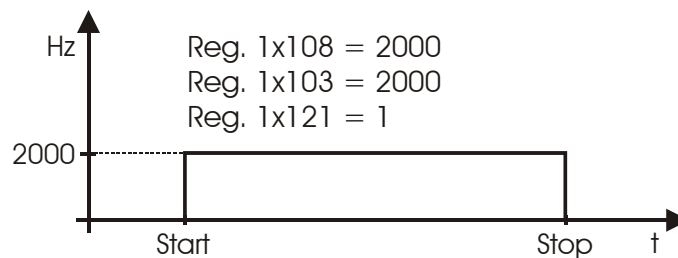


Fig. 10: Start-stop operation

Typically, though, higher operating speed is required, which means that the stepper motor must be accelerated at a rate exceeding the start / stop frequency until the "operating speed" has been reached.

Motor acceleration is accomplished by means of a linear acceleration ramp.

A linear ramp results in constant acceleration of motor and load. For this purpose, a constant motor torque is required. The degree of a possible acceleration depends on the available torque.

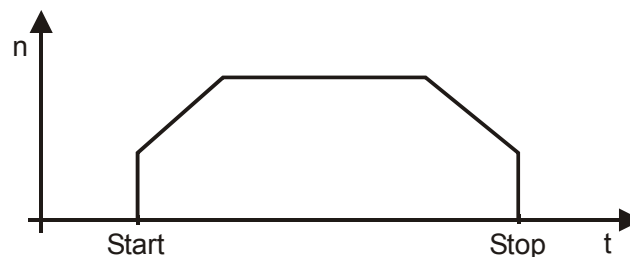


Fig. 11: Acceleration via linear ramp

With the help of the module JX2-SM2, the linear acceleration respectively deceleration ramp can be realized.

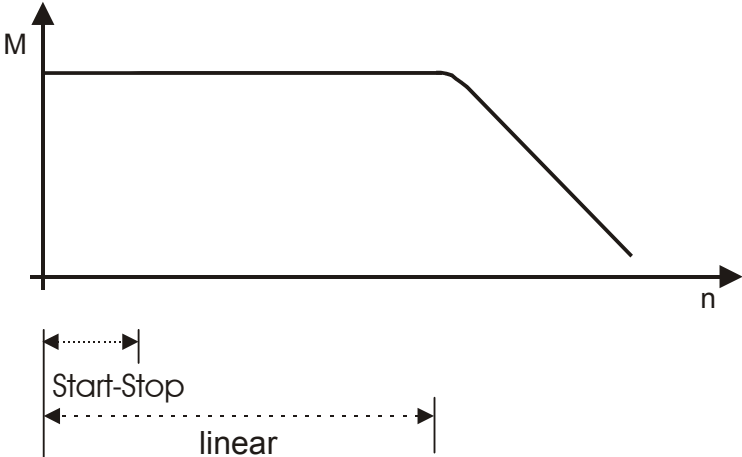


Fig. 12: Usage of the ramps in the speed range

9 Description of Software

9.1 Axis Numbering System

By way of example **Axis xy** will be demonstrated how axes are numbered.

- The first digit specifies the module number.
x = Module number
- The second digit specifies the number of the axis which is to be addressed by the module (1 or 2):
y = Axis number



Note!

The axis numbering system described here applies to the control systems NANO-B/C/D, and JC-24x.

In order to determine the module number, only intelligent modules are taken into account, but not digital and analog input and output modules or counter modules. An example is given in the following table:

Basic Controller	JX2-SM2	JX2-ID8 Input module	JX2-SM2
Module position # 1	Module position # 2	Module position # 3	Module position # 4
Input 101 ... 108	Axis 21 and 22	Input 201 ... 208	Axis 31 and 32

Register Number

By way of example **REG 1xyzz** will be demonstrated how the registers are numbered.

- The registers are addressed with the help of five-digit numbers.
- The first digit is always **1**.
- The second digit **x** specifies the **module number**.
- The third digit **y** is the **number of the axis** on the module (1 or 2).
- The digits four and five **zz** specify the actual **register number** with the letters **zz** corresponding to the register numbers from **0** to **99**.

Basic Controller	JX2-SM2	JX2-ID8 Input module	JX2-SM2
Module position # 1	Module position # 2	Module position # 3	Module position # 4
Input 101 ... 108	Register numbers 121zz, 122zz	Input 201 ... 208	Register numbers 131zz, 132zz



Note!

The register numbering system described here applies to the control systems NANO-B/C/D, and JC-24x.

9.2 Overview of Registers

*) R/W: Read/Write; Ro: Read only; Wo: Write only

Reg. #:	Type of register	R/W Ro Wo*)
1xy00	Status register -8,388,608 ... +8,388,607	R/W
1xy01	Instruction Register 0 ... 69	R/W
1xy02	Set Position -8,388,608 ... +8,388,607	R/W
1xy03	Set Speed (Stepping Rate) 1 ... 250.000	R/W
1xy04	Polarities 0 ... 7	R/W
1xy05	Acceleration ramp 0 ... 32,767	R/W
1xy06	Deceleration ramp 0 ... 32,767	R/W
1xy07	Destination window 0 ... +8,388,607	R/W
1xy08	Start-stop frequency 1 ... 5.000	R/W
1xy09	Actual position -8,388,608 ... +8,388,607	Ro
1xy11	Present stepping rate 0 ... 250.000	Ro
1xy14	Positive software limit switch -8,388,608 ... +8,388,607	R/W
1xy15	Negative software limit switch -8,388,608 ... +8,388,607	R/W
1xy21	Scaling Max. stepping rate 1 ... 255	R/W
1xy67	Relative positioning in the mode "Relative positioning with starting input" -8,388,608 ... +8,388,607	R/W
1xy68	Absolute positioning of the latest positioning in the mode "Relative positioning with start input" -8,388,608 ... +8,388,607	Ro
1xy69	Pulse length of STEP signal 8 ... 65,535	R/W
1xy85	Overflow position for endless and relative positioning 0 ... +8,388,607	R/W
1xy95	Actual position of master axis -8,388,608 ... +8,388,607	R/W
1xy96	Velocity Master Axis Modules JX2-DIMA, JX2-SV1, JX2-SM1D, JX2-SM2: Counter module JX2-CNT: -32,768 ... +32,767 rpm -8,388,608 ... +8,388,607 Hz	Ro
1x199	Software version 0 ... +8,388,607	Ro

Reg. #:	Type of register	R/W Ro Wo*)
	Follower Control	
1xy10	P-gain of the Position Controller 0 ... 32,767	R/W
1xy23	Resolution of drive system 0 ... 32,767	R/W
1xy43	Number of the master axis Module JX2-SM1D: 0, 21, 31, 41, 51, 61, 71 Modules JX2-DIMA, JX2-SV1, JX2-SM2: 0, 21, 22, 31, 32, 41, 42, 51, 52, 61, 62, 71, 72 Counter module JX2-CNT: 102 - 124	R/W
1xy44	Overflow position for endless positioning (the amount is taken from master register 1xy85) 0 ... 8,388,607	R/W
1xy52	Adjustment of the number of increments per revolution 0 ... 8,388,607	R/W
1xy53	Pointer to a table element 0 ... +7,499	R/W
1xy54	Value of the table element -8,388,608 ... +8,388,607	R/W
1xy55	Total number of table elements 0 ... +7,500	R/W
1xy56	Factor between master and slave 0 ... 32,767	R/W
1xy57	Divisor between master and slave 0 ... 32,767	R/W
1xy58	Maximum position in positive direction of the master axis -8,388,608 ... +8,388,607	R/W
1xy59	Maximum position in negative direction of the master axis -8,388,608 ... +8,388,607	R/W
1xy60	Limitation of acceleration 0 ... 65,535 (Hz/4 ms)	R/W
1xy78	Increasing the value of register 1xy95 by multiples of 0.5 ms 1 ... 65,535	R/W

Reg. #:	Type of register	R/W Ro Wo*)
	Winding mode	
1xy56	Travel distance of a traversing axis during one spindle revolution -32,768 ... +32,767	R/W
1xy57	Number of increments carried out by the spindle axis referring to one spindle revolution 1 ... 32,767	R/W
1xy79	Increased resolution of the winding gradient 0 ... 8,388,607	R/W
1xy88	Void increments 0 ... 8,388,607	R/W
1xy89	Changing the winding gradient at the edge of the coil 0 ... 8,388,607	Wo
1xy90	Counter of layers -8,388,608 ... +8,388,607	R/W
1xy91	Counter of windings -8,388,608 ... +8,388,607	R/W
1xy92	Number of windings to be carried out in relation to the last spindle position -8,388,608 ... +8,388,607	R/W
1xy93	Positive edge -8,388,608 ... +8,388,607	R/W
1xy94	Negative edge -8,388,608 ... +8,388,607	R/W
	Capture function	
1xy86	Enable of the Capture-function 0 ... 3	R/W
1xy87	Acquired position value -8,388,608 ... +8,388,607	Ro
	Automatic shift of the reference point	
1xy71	New position value after shifting the reference point -8,388,608 ... +8,388,607	R/W

9.3 Register Description

For each register, the following information will be given:

- Function of the register resulting from a "read access", i.e. an instruction of the following kind **REGISTER_LOAD (220, @1xyzz)**.
- Function of the register resulting from a "write access", i.e. an instruction of the following kind **REGISTER_LOAD (1xyzz with @220)**.
- Value range, i.e. valid numerical values for the registers.
- Value of the register shortly after the JetControl module has been switched on (or following reset).
- Example of the use of the register with a description of the effect resulting from the given instruction.

Register 1xy00: Status register	
Function	Description
Read	Feedback of the status of the module JX2-SM2
Write	It is possible to write bits 14 and 23.
Value range	-8,388,608 ... +8,388,607 (bit-coded)
Value after reset	Depending on the present state

Meaning of the individual status register bits:

Bit 0: Referenced?

1 = Reference has been set

The reference switch has been found *or* manual referencing has been carried out after giving command 3.

0 = Reference has been cleared

Automatic referencing is being carried out *or* the status has been reset either by giving command 4 *or* by giving the "reset" instruction.

Bit 1: AXARR?

1 = AXARR

The axis has reached the destination window *or else* it has been stopped by giving an AXARR instruction *or* by giving command 0.

Bit 2: Has the axis reached the destination window?

1 = Yes

Bit 4: Is the negative limit switch active?

1 = The negative limit switch is active

Meaning of the individual status register bits:

It is active, as long as the axis has triggered the limit switch.

Bit 5: Is the positive limit switch active?

1 = The positive limit switch is active

It is active, as long as the axis has triggered the limit switch.

Bit 6: Reference switch?

1 = The reference switch is active

It is active, as long as the axis has triggered the reference switch.

Bit 7: Is or was the software limit switch active?

1 = Yes

It will be active, until the next positioning is started.

Bit 8: Is or was the hardware limit switch active?

1 = Yes

It will be active, until the next positioning is started.

Bit 9: Not assigned

Bit 10: Not assigned

Bit 12: Reference run error?

1 = Reference run error

Bit 13: BUSY for commands 9 to 12, 42 and register 1xy43

1 = BUSY

A command is being processed.

Bit 14: Software limit switch enable

1 = Software limit switch function is activated

Bit 15: Not assigned

Bit 16: The axis is in the deceleration ramp

1 = The axis is in the deceleration ramp

Bit 17: Not assigned

Bit 18: Not assigned

Bit 23: Speed pre-control during follower or winding mode

1 = Deactivate

**Note!**

The status bits can be queried, set or reset in a simple way by using the **BIT_SET** and **BIT_CLEAR** instructions.

Example with regard to the status register:

This program part waits until the BUSY bit is reset. This BUSY bit is reset once a previously started reference run is completed.

```
//...
CONST
  Busy = 13; // Declaring constants
END_CONST;
VAR
  AX_Status: INT AT %VL 12100; // Declaring variables
END_VAR;

//...
WHEN BIT_CLEAR (AX_Status, Busy) CONTINUE;
//...
```

Register 1xy01: Command Register	
Function	Description
Read	Instruction currently being executed or the last executed instruction
Write	Starts the execution of a new instruction
Value range	0 ... 57
Value after reset	0

The stepper motor controller JX2-SM2 is equipped with the following commands:

-
- 0 Stop with deceleration ramp:**
Slow down by the set deceleration ramp.
-
- 3 Set the reference:**
Is only useful during standstill of the axis!

The stepper motor controller JX2-SM2 is equipped with the following commands:

The actual and set position will be set to zero, while the status register bit 0 (register 1xy00) will be set to **1**.
This way, the reference point is set at the present axis position.

4 Clear the reference:

The reference is cleared. The status register bit 0 (register 1xy00) will be reset to **0**.

Only then the axis will set another reference after operating the reference switch.

Through referencing, actual and set position will be set to **0**.
Status register bit 0 is set to **1**.

If commands 9 to 12 are given, command 4 will not be needed.

5 Stop the axis:

The axis is stopped without deceleration ramp.

This is only possible without losing steps at stepping frequencies below the maximum start / stop frequency!

9 Automatic reference run, mode # 1:

The reference is cleared. The status register bit 0 (register 1xy00) will be reset to **0**.

Start referencing in positive direction up to the reference switch. If the positive limit switch operated before the reference switch, the axis movement will reverse to negative direction, until the reference switch is found. Referencing depends on whether command 22 or command 23 has been given last.

Command 22: (Default)

The axis will stop at the reference point. The actual and set position will be set to **0**, while the status register bit 0 (register 1xy00) will be set to **1**.

Command 23:

The axis actuates the reference switch. When actuating the reference switch, the actual position is set to 0, while the status register bit 0 (register 1xy00) is set to 1. The set position that has been loaded remains unchanged. The axis will travel on up to the negative limit switch.

- The negative limit switch is actuated. Then, referencing will be terminated by internally setting set position = actual position.

The reference run error will be reported in status register 1xy00 by setting bit 12.

Automatic referencing is carried out by the stepping rate loaded in register 1xy03.

For command 22 the value must not be greater than the maximum start/stop frequency.

Basically, the start/stop frequency should not be greater than 1 kHz, as otherwise referencing cannot be carried out in accurate steps.

The stepper motor controller JX2-SM2 is equipped with the following commands:

10 Automatic reference run, mode # 2:

The reference is cleared. The status register bit 0 (register 1xy00) will be reset to **0**.

Start referencing in negative direction up to the reference switch. If the negative limit switch is actuated before the reference switch, the axis reverses the direction of motion and continues to travel in negative direction until:

- The reference switch is actuated. Referencing depends on whether command 22 or command 23 has been given last.

Command 22: (Default)

The axis will stop at the reference point. The actual and set position will be set to 0, while the status register bit 0 (register 1xy00) will be set to 1.

Command 23:

The axis actuates the reference switch. When actuating the reference switch, the actual position is set to 0, while the status register bit 0 (register 1xy00) is set to 1. The set position that has been loaded remains unchanged. The axis will travel on up to the positive limit switch. The positive limit switch is operated. Then, referencing will be terminated by internally setting set position = actual position.

The reference run error will be reported in status register 1xy00 by setting bit 12.

Automatic referencing is carried out by the stepping rate loaded in register 1xy03. For command 22 the value must not be greater than the maximum start / stop frequency.

Basically, the start / stop frequency should not be greater than 1 kHz, as otherwise referencing cannot be carried out in accurate steps.

11 Automatic reference run, mode # 3:

The reference is cleared. The status register bit 0 (register 1xy00) will be reset to **0**.

Start referencing in positive direction up to the positive limit switch. The reference switch is ignored first. At the positive limit switch the axis reverses the direction of motion and travels in negative direction until:

- the reference switch is actuated. Referencing depends on whether command 22 or command 23 has been given last.

Command 22: (Default)

The axis will stop at the reference point. The actual and set position will be set to 0, while the status register bit 0 (register 1xy00) will be set to 1.

Command 23:

The axis actuates the reference switch. When actuating the reference switch, the actual position is set to 0, while the status register bit 0 (register 1xy00) is set to 1. The set position that has been loaded remains unchanged. The axis will travel on up to the negative limit switch.

The stepper motor controller JX2-SM2 is equipped with the following commands:

- The negative limit switch is actuated. Then, referencing will be terminated by internally setting set position = actual position. The reference run error will be reported in status register 1xy00 by setting bit 12.

Automatic referencing is carried out by the stepping rate loaded in register 1xy03 . If command 22 is to be given, the value must not be greater than the maximum start / stop frequency. Basically, the start / stop frequency should not be greater than 1 kHz, as otherwise referencing cannot be carried out in accurate steps.

12: Automatic reference run, mode # 4:

The reference is cleared. The status register bit 0 (register 1xy00) will be reset to 0.

Start referencing in negative direction up to the negative limit switch. The reference switch is ignored first. At the negative limit switch the axis reverses its direction and moves in positive direction, until the reference switch is actuated. Referencing depends on whether command 22 or command 23 has been given last.

Command 22: (Default)

The axis will stop at the reference point. The actual and set position will be set to 0, while the status register bit 0 (register 1xy00) will be set to 1.

Command 23:

The axis actuates the reference switch. When actuating the reference switch, the actual position is set to 0, while the status register bit 0 (register 1xy00) is set to 1. The set position that has been loaded remains unchanged. The axis will travel on up to the positive limit switch.

The positive limit switch is actuated. Then, referencing will be terminated by internally setting set position = actual position. The reference run error will be reported in status register 1xy00 by setting bit 12.

Automatic referencing is carried out by the stepping rate loaded in register 1xy03 . If command 22 is to be given, the value must not be greater than the maximum start / stop frequency. Basically, the start / stop frequency should not be greater than 1 kHz, as otherwise referencing cannot be carried out in accurate steps.

13-16 Reserved

17 Relative positioning - ON:

The value loaded into register 1xy02 as a set position refers to the latest set position - stored in register 1xy68 - not to the reference position.

The new position value results from the sum of values loaded in registers 1xy68 and 1xy02.

18 Absolute positioning - ON (Default):

The stepper motor controller JX2-SM2 is equipped with the following commands:

	The value loaded into register 1xy02 as set position refers to the reference position.
--	--

19	<p>Continuing the interrupted positioning run:</p> <p>The positioning run that has been interrupted by issuing command 0 or 5 (AXARR with or without deceleration ramp) is continued.</p> <p>Absolute positioning: The set position has been loaded into register 1xy02.</p> <p>Relative positioning: The new position value results from the sum of values loaded into registers 1xy68 and 1xy02.</p> <p>Relative positioning with start input: The new position value results from the sum of values loaded into registers 1xy68 and 1xy67.</p>
-----------	---

20	<p>Relative positioning with start input - ON:</p> <p>The start input is the "REF" input. If 24 V have been attached to this input, if the axis is at standstill, while status bit 1 = 1, relative positioning will be started. Before the target position is reached, 0 V must be attached to input "REF". Otherwise the axis will not stop; yet, another positioning run will be started.</p> <p>The relative positioning value has been loaded into register 1xy67.</p>
-----------	---

21	Relative positioning with start input - OFF (Default):
-----------	---

22	<p>Stop at the reference point - ON (Default):</p> <p>During referencing, the axis will stop at the reference point. The actual and set position will be set to 0, while the status register bit 0 (register 1xy00) will be set to 1.</p>
-----------	--

23	<p>Stop at the reference point - OFF:</p> <p>During referencing, the axis actuates the reference switch. When actuating the reference switch, the actual position is set to 0, while the status register bit 0 (register 1xy00) is set to 1. The set position that has been loaded remains unchanged.</p>
-----------	--

30	<p>Establishing of communication between 2 modules (not CPUs):</p> <p>The master, e.g. the module JX2-SM2 starts sending the position value to the slave via system bus. This command is issued to the master. In the follower and in winding mode it is necessary for the sake of saving time, that master and slave communicate directly, not via CPU. This command can be cancelled by issuing command 42. It applies to the modules JX2-SV1, JX2-DIMA, JX2-SM2 or JX2-SM1D.</p>
-----------	--

31 - 41	Reserved
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42	End of communication between 2 modules (not CPUs):
-----------	---

The stepper motor controller JX2-SM2 is equipped with the following commands:

The master, respectively the slave, terminate their individual part in communication. This command is to be given both to the master and the slave.
It applies to the modules JX2-SV1, JX2-DIMA, JX2-SM2 or JX2-SM1D.

43 Reserved

44 Follower ON:

The follower function is activated. A slave and a master are synchronized. Synchronisation is carried out in a fixed transmission ratio (see registers 1xy56 and 1xy57).
Function: Electric gearbox.
This command is issued to the slave and can be cancelled by issuing command 45.

45 Follower OFF:

The follower function by a fixed transmission ratio is deactivated. The axis is stopped by issuing command 5. This command is given to the slave.

46 Follower via table - ON:

The slave follows setpoints that have been stored in a table. The setpoints have been stored depending on the master position in the table. This command is given to the slave and can be cancelled by giving command 47.

47 Function "Follower via Table" - OFF

48 - 51 Reserved

52 Time table mode - ON:

The slave follows setpoints that have been stored in a table. The table is processed on a time base.
This command is given to the slave and can be cancelled by giving command 53.

53 Time-based table mode - OFF

54 At the end of the table the actual slave position is not set to the first table value:

When the end of the table has been reached, the actual slave position is not reset to the first table value (set position of the slave).
This command is to be used in operating mode "Follower via Table" if the setpoint values at the end of the table correspond to the values at its beginning.

55 Resetting the actual slave position to the first table value (default):

When the end of the table has been reached, the actual slave position is reset to the first table value (set position of the slave).
This command must be used in the operating mode "follower mode via table".

56 Start endless motion in positive direction:

The stepper motor controller JX2-SM2 is equipped with the following commands:

The axis will move in positive direction with the stepping rate written in register 1xy03; it will be stopped by issuing command 0 or 5 (AXARR). The movement will also be stopped when the positive limit switch is reached, the POS command is issued or a value is entered into register 1xy02.

57 Start endless motion in negative direction:

The axis will move in negative direction with the stepping rate written in register 1xy03; it will be stopped by issuing command 0 or 5 (AXARR). The movement will also be stopped when the negative limit switch is reached, the POS command is issued or a value is entered into register 1xy02.

66 Starting the winding mode:

The winding mode is activated. A slave and a master are synchronized. This command is given to the slave and can be cancelled by giving command 67.

67 Stopping the winding mode:

The winding mode is deactivated. The axis is stopped as with command 5. This command is given to the slave.

68 Layer traversing in winding mode:

After each single revolution of the spindle, the traversing axis will be moved on by the number of steps written in register 1xy56.

69 Continuous layering in the winding mode (default):

The traversing axis is moving continuously in a fixed ratio to the spindle.

Reg. 1xy02: Set Position	
Function	Description
Read	Set position of the axis
Write	Starts a new positioning process
Value range	-8,388,608 ... +8,388,607 (steps)
Value after reset	0 (steps)



Important!

A new value written into register 1xy02 will have an immediate effect on positioning. The target position will change immediately - positioning starts. If the maximum stepping rate is greater than the start / stop frequency, a change of direction or stopping of the axis suddenly caused by a new target position, will lead to a loss of steps.

Reg. 1xy03: Maximum stepping rate	
Function	Description
Read	Maximum stepping rate of the axis
Write	New maximum stepping rate of the axis The new value will be effective immediately.
Value range	<Reg. 1xy08>* ... 250,000 (in Hz)
Value after reset	10 Hz

*: The smallest value to be set can be read out of register 1xy08.

Effects of writing this value:

1. During standstill of the axis:
The new value will be saved for the next positioning run.
2. If positioning is being carried out at that moment:
The new value will be taken over as the new maximum set speed. In case the maximum value is greater than the start / stop frequency, the change of speed towards the peak value will not be carried out in jerks, but will increased or decreased through the acceleration ramp.



Important!

The actual set stepping rate (maximum value) results from the product of the values in registers 1xy103 and 1xy21.

$$\text{Actual set stepping rate} = \langle \text{Reg. 1xy03} \rangle * \langle \text{Reg. 1xy21} \rangle$$

The reason for this is that the speed value in the POS command can be entered only from 0 through 65,535.

A higher speed can also be achieved by entering a value directly into register 1xy03. In this case, values may exceed 65,535.

The command is: REGISTER_LOAD (12103, 100,000)

Reg. 1xy04: Polarities	
Function	Description
Read	Present setting of polarities
Write	New setting of reference and limit switch polarities
Value range	0 ... 7
Value after reset	7 (reference switch and limit switch: NO contact; DIR level)

This register is bit-coded:

- Bit 0: 0 = Reference switch 0 V - active (NCC)
 1 = Reference switch 24 V - active (NOC)
- Bit 1: 0 = Limit switch 0 V - active (NCC)
 1 = Limit switch 24 V - active (NOC)
- Bit 2: DIR level:
 0 = Low open collector output for positive direction
 High RS422 output for positive direction
 1 = High open collector output for positive direction
 Low RS422 output for positive direction

24 V - active If 24 V are applied to the "REF" input, referencing will be carried out at the present position.

0 V - active If 0 V are applied to the "REF" input, referencing will be carried out at the present position.

Reg. 1xy05: Acceleration ramp	
Function	Description
Read	Presently effective value of the parameter "acceleration ramp"
Write	New value for the parameter "acceleration ramp"
Value range	1 ... 32,767 (Hz / 4 ms)
Value after reset	10 (Hz / 4 ms)



Important!

Effects of writing this value:

1. During standstill of the axis:
The new value will be saved for the next positioning run.
2. If positioning is being carried out at that moment:

Attention!

The new value will have an effect on the present positioning process!

If the acceleration ramp is changed when the motor is accelerating through this ramp, high acceleration may result.

If this is the case, the motor may skip steps.



Do not enter values into register 1xy05 when positioning is in progress!

Meaning:

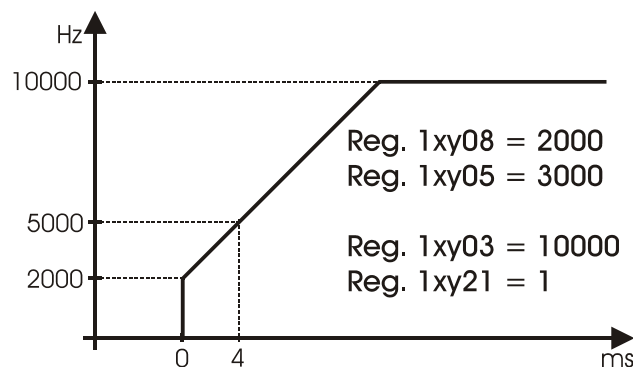


Fig. 13: Acceleration through an acceleration ramp

In the classical case, the stepper motor must be accelerated until the start / stop frequency has been exceeded and the "operating speed" has been reached.

Motor acceleration is accomplished by means of a linear acceleration ramp. The gradient of the ramp results from the change of the stepping rate over a set time. In the given case the time is 4 ms.



Important!

The parameter value to be set must be adjusted to the individual stepper motor drive.

If the acceleration ramp is too steep, position inaccuracies will occur because of a load angle shift, or else, the stepper motor will just stop.

Reg. 1xy06: Deceleration ramp	
Function	Description
Read	Presently effective value of the parameter "deceleration ramp"
Write	New value for the parameter "deceleration ramp"
Value range	1 ... 32,767 (Hz / 4 ms)
Value after reset	10 (Hz / 4 ms)



Important!

Effects of writing this value:

1. During standstill of the axis:
The new value will be saved for the next positioning run.
2. If positioning is being carried out at that moment:

Attention!

The new value will have an effect on the present positioning process!

If the deceleration ramp is changed when the motor is decelerating through this ramp, high deceleration may result.

If this is the case, the motor may skip steps.



Do not enter values into register 1xy06 when positioning is in progress!

Meaning:

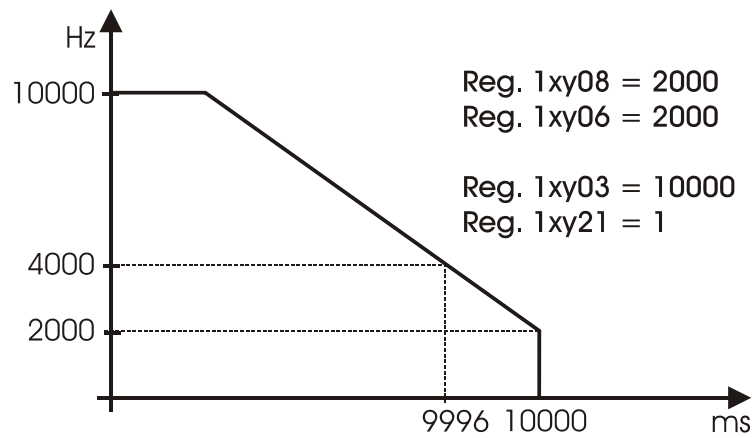


Fig. 14: Deceleration through a deceleration ramp

In the classical case, the stepper motor must be decelerated from its "operating speed", until the start / stop frequency has been reached.

The motor decelerates through a linear deceleration ramp. The gradient of the ramp results from the change of the stepping rate over a set time. In the given case the time is 4 ms.



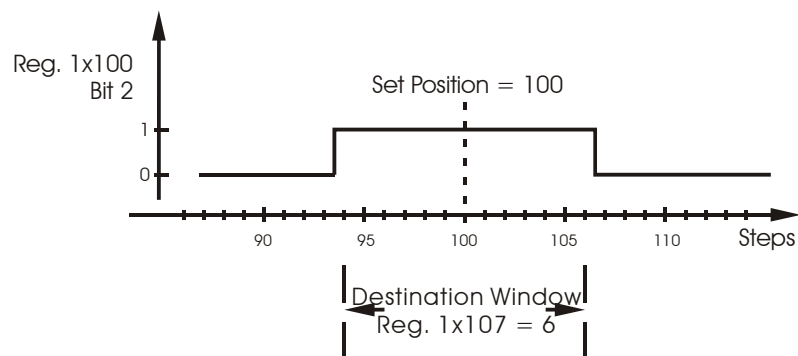
Important!

The parameter value to be set must be adjusted to the individual stepper motor drive. If the deceleration ramp is too steep, position inaccuracies will occur, or else, the stepper motor will just stop.

Reg. 1xy07: Destination window	
Function	Description
Read	Presently effective value of the parameter "destination window range"
Write	New value for the parameter "destination window range"
Value range	0 ... 8,388,607 (steps)
Value after reset	0 (steps)

Effects of writing this value:

1. During standstill of the axis:
The new value will be saved for the next positioning process.
2. If positioning is being carried out at that moment:
The new value will be taken over immediately. If the axis has not been in the destination window yet, the new value will be made use of. If the axis has reached the destination window already, the new value has practically not got any effect to the present positioning run.

Meaning:**Fig. 15: Presentation of the destination window**

The AXARR bit in the status register is already set once the destination window has been reached, and not only when the exact set position has been reached.

```
//...
CONST
    X_Achse = 21;                // Declaring constants
END_CONST;

//...
    WHEN AXARR(X_Achse) CONTINUE;
//...
```

Once the axis has reached the destination window, the AXARR bit in the status register is set. However, the axis continues to move until the destination will be reached.

If this can be tolerated, faster program processing can be achieved that way.

Reg. 1xy08: Start / Stop frequency	
Function	Description
Read	Presently effective value of the parameter "Start / Stop frequency"
Write	New value for the parameter "Start / Stop frequency"
Value range	1 ... 5,000 (Hz)
Value after reset	10 (Hz)



Important!

Effects of writing this value:

1. During standstill of the axis:
The new value will be saved for the next positioning run.
2. If positioning is being carried out at that moment:

Attention!

The new value will have an effect on the present positioning process!

Changes in the start / stop frequency may result in high acceleration or deceleration.

If this is the case, the motor may skip steps.



Do not enter values into register 1xy08 when positioning is in progress!

Meaning:

For starting and stopping, the stepper motor must not be fed at any higher step frequency than the start / stop frequency.

The start / stop frequency is the stepping rate, at which the motor will faultlessly start and stop. A start / stop frequency that has been set too low will impair the starting behaviour (long delays).

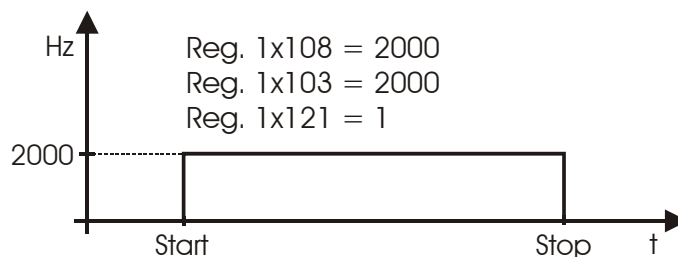


Fig. 16: Start-stop frequency



Important!

The parameter value to be set must be adjusted to the individual stepper motor drive. If the start / stop frequency is too high, position inaccuracies will occur, or else, the stepper motor will just stop.

It is necessary to optimize the settings with the help of practical tests. This test should be carried out using the maximum load, the steepest ramps and highest speeds which occur later during operation. The start / stop frequency will be increased gradually; after this, the stepper motor will be checked on fault-free positioning.

The value range must not be exceeded. Value 0 cannot be set for the start/stop frequency. The axis has come to a standstill, when the set position is equal to the actual position.

Reg. 1xy09: Present actual position	
Function	Description
Read	Actual position of the axis
Write	Illegal
Value range	-8,388,608 ... +8,388,607 (steps)
Value after reset	0 (steps)

Meaning:

R 1xy09 contains the present actual position as its value.



Important!

The present actual position reflects the "internal" count of the axis, as no feedback will be given by the motor. The stepper motor drive has been properly designed, if the present axis position corresponds to the value of this variable.

After power-up of the stepper motor drive and before the first positioning run, parameter initialisation and referencing will generally be needed.

After successful referencing, the value of register 1xy09 will be set to zero. This will be done after executing commands 3, 9, 10, 11 and 12.

Register 1xy11: Present stepping rate	
Function	Description
Read	Present stepping rate
Write	Read only
Value range	0 ... 250,000 (Hz)
Value after reset	0 (Hz)

Meaning:

Register 1xy11 contains as its value the present step frequency in Hz, by which the stepper motor is being controlled at that moment.

The present step frequency serves for measuring the present speed of the motor.

Register 1xy14: Position of the positive software limit switch	
Function	Description
Read	Present position of the positive software limit switch
Write	A new value is defined
Value range	-8,388,608 ... +8,388,607 (steps)
Value after reset	+8,388,607 (steps)

Meaning:

Register 1xy14 contains as its value the final position in positive direction. With the help of setting bit 14 of status register 1xy00, the function "software limit switch" is enabled. If now the value written in register 1xy14 is exceeded by the actual axis position, the software limit switch function will be activated. The hardware limit switch function will remain uninfluenced by this.

The status of the two software limit switches can be queried out of status register 1xy00:

- Bit 7 = 1: The positive *or* negative software limit switch is active
- Bit 7 = 1 *and* Bit 5 = 1: The positive software limit switch is active
- Bit 7 = 1 *and* Bit 4 = 1: The negative software limit switch is active

Register 1xy15: Position of the negative software limit switch	
Function	Description
Read	Present position of the negative software limit switch
Write	A new value is defined
Value range	-8,388,608 ... +8,388,607 (steps)
Value after reset	-8,388,608 (steps)

Meaning:

Register 1xy15 contains as its value the final position in negative direction. With the help of setting bit 14 of status register 1xy00, the function "software limit switch" is enabled. If the actual axis position now falls below the value in register 1xy14, the software limit switch function will be activated. The hardware limit switch function will remain uninfluenced by this.

The status of the two software limit switches can be queried from of status register 1xy00:

- Bit 7 = 1: The positive *or* negative software limit switch is active
- Bit 7 = 1 *and* Bit 5 = 1: The positive software limit switch is active
- Bit 7 = 1 *and* Bit 4 = 1: The negative software limit switch is active

Register 1xy21: Scaling of the maximum step frequency	
Function	Description
Read	Presently valid scaling for the maximum step frequency
Write	A new scaling is defined.
Value range	1 ... 255
Value after reset	1

Meaning:

The set speed (maximum stepping rate) results from the product of the values in registers 1xy103 and 1xy21.

$$\text{Actual set speed} = \langle 1xy03 \rangle * \langle 1xy21 \rangle$$

Select the value for register 1xy21 (scaling) in a way that the speed that is necessary for the application can be set. A compromise must be made between resolution and maximum value.

**Note!**

With the help of the makro instruction "POS" of the controller, a value of 65,535 max. can be loaded into speed register 1xy03.

Register 1xy69: Pulse length of STEP signal	
Function	Description
Read	Currently valid pulse length of STEP signal
Write	A new pulse length is defined.
Value range	8 ... 65,535
Value after reset	64 (8 μ s)

Meaning:

The pulse length of the STEP signal can be changed in this register. The minimum pulse length is determined through the input circuitry of the stepper motor drive. In this register the pulse length is specified in multiples of 0.125 μ s.

Register 1x199: Version number: Operating system of JX2-SM2 module	
Function	Description
Read	Software version
Write	Illegal
Value range	0 ...+8,388,607
Value after reset	Present version * 100

Meaning:

The version number of the operating system of the JX2-SM2 module (software) can be read from this register.

Example:

Version 1.02 of the operating system is loaded.
 <Reg. 1x199> = 102

**Note!**

When submitting technical support queries the version number must be specified.

10 Further Functions

10.1 Follower

10.1.1 General Information

The functioning principle of the follower is based on the slave axis directly following the master axis. One or more slave axes can follow a master axis. This following behaviour can be defined in two different ways:

- in a fixed transmission ratio (electric gearbox);
- by values defined in a table (dynamic transmission ratio).



Note!

The slower axis should be run as a slave, in order to avoid control problems in the follower controller.

In order to determine the position of the master axis, the modules JX2-DIMA, JX2-SV1, JX2-SM2 or JX2-SM1D can be used. In such a case, these modules will even drive the master axis by themselves.

For a separately driven axis, counter module JX2-CNT can be used as well. In this case, an incremental encoder or an absolute encoder (SSI) is placed on the master axis. The output signal of the rotary encoder will be recorded by a counter module JX2-CNT. The present position value is stored to a counting register within the JX2-CNT module.

The register description applies to the individual case that the slave axis is driven by module JX2-SM2.

Master and slave communicate via system bus. Both position and speed of the master axis are transmitted to the slave in cyclic mode via system bus.



Note!

If counter module JX2-CNT is the master, the following exception will apply: Instead of the speed, the time that has elapsed between the position value transmitted last and the position value being transmitted at the moment will be transferred to the slave. The slave calculates its speed values by generating the quotient of the difference of the two position values and the time value.

When does the master start communicating with the slave?

Module JX2-DIMA, JX2-SV1, JX2-SM2 or JX2-SM1D is master:

The master will receive **command 30** (command variable). From this moment, the position value will be transmitted by the master via system bus to the slave.

Module JX2-CNT is master:

Output x03 must be set: x stands for the module number of the module JX2-CNT. From this moment, module JX2-CNT will transmit the position value and the time value via system bus to the slave.

When the number of the master axis has been entered into slave register 1xy43, the slave will receive the position value of the master axis.

The slave will enter the position value into register 1xy95 and the speed value into register 1xy96.

After this, the slave will reset bit 13 in its status register.

After writing into register 1xy43, an enquiry must be made, whether status bit 13 has been reset. Then it is guaranteed that both the present position and the speed of the master axis have been read at least once each.

Slave register 1xy43: Number of the master axis	
Function	Description
Read	Present number of the master axis
Write	Definition of a new master axis
Value range:	
For JX2-SM1D, JX2-DIMA, JX2-SV1 as master axis:	0, 21, 31, 41, 51* , 61* , 71*
For JX2-SM2 as master axis:	0, 21, 22, 31, 32, 41, 42, 51* , 52* , 61* , 62* , 71* , 72*
For JX2-CNT as master axis:	102 - 124**
Value after reset	0

*: This is only possible for NANO-C and JetControl 246.

** : The last two figures denote the module number of JX2-CNT, e.g. 105 = module number 05.

Slave register 1xy95: Actual position of the master axis	
Function	Description
Read	Present position of the master axis
Write	Illegal
Value range	-8,388,608 ... +8,388,607
Value after reset	0

Example:

Starting communication between master and slave:

```
// Master is axis # 1 of module JX2-SM2 located in slot # 2
// Slave is axis # 2 of module JX2-SM2 located in slot #
CONST
    Send_Actpos = 30; // Declaring constants
    Master_AxisNo = 21;
    Busy = 13;
END_CONST;
VAR
    ri_Position: INT AT %VL 200; // Declaring variables
    ri_Speed: INT AT %VL 201;
    AX_Master_Instruction: INT AT %VL 12101;
    AX_Slave_Status: INT AT %VL 12200;
    AX_Slave_MasterNo: INT AT %VL 12243;
    AX_Slave_MasterPos: INT AT %VL 12295;
    AX_Slave_MasterSpeed: INT AT %VL 12296;
END_VAR;

//...
// Issuing instruction 30 to master
AX_Master_Instruction := Send_Actpos;
// From now on, the master is sending

// Entering master axis into slave register 1xy43
AX_Slave_MasterNo := Master_AchsNo;
// The slave is now in standby

// Entering the master axis into slave register 1xy43

// Has the slave received the position and speed value from the master?
WHEN BIT_CLEAR (AX_Slave_Status, Busy) CONTINUE;
// Reading the slave position and speed by the master
ri_Position := AX_Slave_MasterPos;
ri_Speed := AX_Slave_MasterSpeed;
//...
```

Slave register 1xy96: Speed of the master axis	
Function	Description
Read	Present speed of the master axis
Write	Illegal
Value range: JX2-DIMA, JX2-SV1, JX2-SM2 or JX2-SM1D is master:	-32,768 ... +32,767 rpm
JX2-CNT is the master:	-8,388,608 ... +8,388,607 Hz
Value after reset	0

Limitation of acceleration

When the axis is running in the operating mode "follower" or "winding mode", it will be adjusted to a master axis. Jerking motions of the master axis may require an amount of acceleration, which the slave as a stepper motor cannot perform. In this case, the motor may skip steps, or else the motor will just come to a standstill. In order to avoid this, an acceleration limitation can be set. In consequence, the change of step frequency will never go beyond this value.

Slave register 1xy60: Limitation of acceleration	
Function	Description
Read	Present limitation of acceleration
Write	New value for the accelerating ability of the motor-load combination
Value range	0 ... 65,535 (Hz / 4 ms)
Value after reset	65,535 (Hz / 4 ms) (no limitation)

10.1.2 Speed pre-control

The speed pre-control, that can be activated and deactivated by setting bit 23 in the status register of the slave, serves for the adjustment of the follower controller.

Deactivating the pre-control: Status bit 23 = 1

The pre-control is active: Status bit 23 = 0

It is the objective of programming, that the slave axis follows the master axis fast and directly. For this purpose, a position feedback controller (proportional controller) has been implemented into the slave.

The set frequency (set speed) for the slave is combined of the following constituents:

$$\text{Set frequ.} = \frac{(\text{Set pos} - \text{Actpos}) \times \text{Reg 1xy10}}{128} + \text{Reg 1xy96} \times \frac{1.000.000}{\text{Reg 1xy52}} \times \frac{\text{Reg 1xy56}}{\text{Reg 1xy57}}$$

$$\text{Set pos} = \text{Masterpos} \times \frac{1xy56}{1xy57}$$

Register 1xy10: P-gain of the Position Controller

Register 1xy96: Master speed

Register 1xy52: Adjustment of the PPR count

Register 1xy56: Factor of the transmission ratio between master and slave

Register 1xy57: Divisor of the transmission ratio between master and slave

The speed control component is to determine for the slave the best speed possible when following the master. If now a deviation from the ideal value has occurred, the speed will be increased or decreased accordingly.

Speed pre-control is generated as follows:

$$\text{SpeedPre - control} = \text{Reg. 1xy96} \times \frac{1.000.000}{\text{Reg. 1xy52}} \times \frac{\text{Reg. 1xy56}}{\text{Reg. 1xy57}}$$

Register 1xy96: Master speed

Register 1xy52: Adjustment of the PPR count

Register 1xy56: Factor of the transmission ratio between master and slave

Register 1xy57: Divisor of the transmission ratio between master and slave

Slave register 1xy52: Adjustment of the PPR count	
Function	Description
Read	Present parameter value
Write	New value for the calculation of the encoder adjustment
Value range	0 ... 8,388,607
Value after reset	1.000.000

If the master axis is driven by module JX2-SV1, JX2-DIMA, JX2-SM1D or JX2--SM2, encoder adjustment must be carried out in register 1xy52 according to the following formula:

$$\text{Slave-Register } 1xy52 = \frac{60,000,000}{\text{NumberOfMasterIncrementsPerRotation}}$$

If JX2-CNT is used as master, register 1xy52 must not be used.

Slave register 1xy10: P-gain of the Position Controller	
Function	Description
Read	Present parameter value
Write	New value for the P-amplification of the position feedback controller The new value will be valid immediately, which means, even during a positioning run.
Value range	0 ... 32,767
Value after reset	750



Note!

Normally, the value chosen for the p-gain for stepper motors can be much higher than 750.

If the value is too high, the axis will not run smoothly any more, or it will oscillate.

Master register 1xy23: Resolution of drive system	
Function	Description
Read	Present parameter value
Write	Resolution of drive system
Value range	0 ... 32,767
Value after reset	0

Meaning:

If the JX2-SM2 module is master, it must be informed of the drive resolution in order to forward the correct speed value to the slave.

To do so, the following formula is used:

$$\text{Set position Slave} = \frac{\text{Factor}}{\text{Divisor}} \times \text{ActpositionMaster}$$

10.1.3 Follower with a fixed transmission ratio

$$\text{Set position Slave} = \frac{\text{Factor}}{\text{Divisor}} \times \text{ActpositionMaster}$$

Slave register 1xy56: Factor between master and slave	
Function	Description
Read	Present factor
Write	A new factor is defined
Value range	0 ... 32,767
Value after reset	1

Slave register 1xy57: Divisor between master and slave	
Function	Description
Read	Present divisor
Write	A new divisor is defined
Value range	0 ... 32,767
Value after reset	1

First, communication between master and slave must be set up (see chapter 10.1.1 "General Information", page 65).

When the slave has received the first position value from the master, it will calculate the corresponding set position of the slave axis with the help of the defined transmission ratio.

Then, the speed, by which the axis will move towards this position, will be calculated by the slave.

In order to carry out these steps, command 44, written into command register 1xy01, must be given to the slave. Then, synchronization between master and slave will be started.

```
// Slave is axis # 2 of module JX2-SM2 located in slot # 2
CONST
  Start_Sync = 44; // Declaring constants
  Busy = 13;
END_CONST;
VAR
  AX_Slave_Status: INT AT %VL 12200; // Declaring variables
  AX_Slave_Command: INT AT %VL 12201;
END_VAR;
```



```
//...
// Issueing command 44 to the Slave JX2-SM2
  AX_Slave_Kommando := Start_Sync;
// Waiting until command has been executed
  WHEN BIT_CLEAR (AX_Slave_Status, Busy) CONTINUE;
//...
```

Command 45 with the slave will terminate synchronization. At the same time, the AXARR instruction (command 5) is carried out. The slave axis is internally given a set position which equals its actual position, which causes the slave axis to stand still.

```
// Slave is axis # 2 of module JX2-SM2 located in slot # 2
CONST
  Stop_Sync = 45;           // Declaring constants
  Busy = 13;
END_CONST;
VAR
  AX_Slave_Status:      INT AT %VL 12200; // Declaring variables
  AX_Slave_Command:    INT AT %VL 12201;
END_VAR;

//...
// Issueing command 45 to the slave JX2-SM2
  AX_Slave_Command := Stop_Sync;
// Waiting until command 45 has been executed
  WHEN BIT_CLEAR (AX_Slave_Status, Busy) CONTINUE;
//...
```

If command 42 is given to either master or slave, they will terminate their respective part of communication between master and slave. After giving this command, status bit 13 (BUSY) must be queried. The waiting period lasts until the value of the status bit is zero.

If module JX2-CNT is used as a master, output xx03 must be set to zero. In this case, status bit 13 (BUSY) of the slave must be queried, too.



Important!

Before start-up, set and actual slave position should be adjusted to the present master position. Please mind the transmission ratio as well.



Important!

It is not advisable to change the transmission ratio during motion. The reason is that in the follower mode, the axis is controlled towards the position value of the master.

A change in the transmission ratio leads to a sudden setpoint change of the slave axis. The stepper motor will get out of step.

Endless Positioning

If two axes are to be driven by the follower controller in the same direction in endless mode, the following configuration must be carried out in addition:

For positive sense of direction, the maximum positive position of the master axis must be written into slave register 1xy58.

Slave register 1xy58: Maximum position in positive direction of the master axis	
Function	Description
Read	Present parameter value
Write	New positive maximum position of the master axis
Value range	-8,388,608 ... +8,388,607
Value after reset	+8,388,607

For negative sense of direction, the maximum negative position of the master axis must be written into slave register 1xy59.

Slave register 1xy59: Maximum position in negative direction of the master axis	
Function	Description
Read	Present parameter value
Write	New negative maximum position of the master axis
Value range	-8,388,608 ... +8,388,607
Value after reset	-8,388,608

If the actual position of the master axis exceeds one of the two variable values, the actual position will be decreased by the value of register 1xy58 or 1xy59 (in most cases, it will be set to zero).

The set axis position will also change in relation to the transmission ratio. A new cycle will be started.

The application of print-marks in certain distances to a product that is transported by an conveyor may serve as a practical example. The conveyor is driven by the master axis. The position of the conveyor is evaluated by an encoder. A wheel for applying print marks is turned by the slave axis (see Fig. 17).

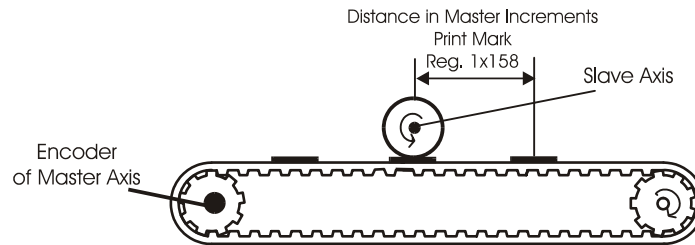


Fig. 17: Application of print marks

When a certain distance has been covered, the overflow position of the master axis counter will be reached.

If the master axis is driven by module JX2-SV1, JX2-DIMA, JX2-SM1D or JX2--SM2, the overflow position must be entered into register1xy85 of the master.

If the counter module JX2-CNT is the master, there will be a fixed overflow position between -8,388,608 and +8,388,607 increments (incremental encoder).

Master register 1xy85: Overflow position for endless and relative positioning	
Function	Description
Read	Present overflow position
Write	Value of the new overflow position
Value range	0 ... +8,388,607
Value after reset	+7,490,000

For endless positioning, the value of master register 1xy85 will be written into slave register 1xy44.

Slave register 1xy44: Overflow position for endlesspositioning (the value is taken out of master register 1xy85)	
Function	Description
Read	Present overflow position
Write	Value of the new overflow position
Value range	0 ... +8,388,607 (value from master register 1xy85)
Value after reset	+7,490,000

Module JX2-CNT, with an incremental encoder connected to it, is the master:
Entry in slave register 1xy44: 8,388,607

10.1.4 "Follower" Function in Table Mode

If one axis is to follow another in a variable transmission ratio, a table must be defined. The follower will follow the values written in the table.

Slave register 1xy53: Pointer to a table element	
Function	Description
Read	Table line that is presently referred to
Write	New table line to be referred to
Value range	0 ... +7,499
Value after reset	0

Slave register 1xy54: Value of the table element	
Function	Description
Read	Present value of the table element
Write	New value of the table element
Value range	-8,388,608 ... +8,388,607
Value after reset	0

Slave register 1xy55: Total number of table elements	
Function	Description
Read	Present total number of table elements
Write	New total number of table elements
Value range	1 ... +7,500
Value after reset	0

Slave register 1xy58: Maximum position in positive direction of the master axis	
Function	Description
Read	Present positive maximum position of the master axis
Write	New positive maximum position of the master axis
Value range	-8,388,608 ... +8,388,607
Value after reset	+8,388,607



Important!

Before the follower function in table mode is started by calling up command 46, values must already be written into the table then.

The table is cleared of its contents, when the power supply of the module is switched off.

First, communication between master and slave must be set up (see chapter 10.1.1 "General Information", page 65).

The function "Follower in table mode" is activated by giving command 46 in the slave. The function "Follower in table mode" is terminated by giving command 47 in the slave. At the same time, the AXARR instruction (command 5) is carried out. The slave axis is internally given a set position which equals its actual position, which causes the slave axis to stand still.

If command 42 is given to either master or slave, they will terminate their respective part of communication between master and slave. After giving this command, status bit 13 (BUSY) must be queried. The waiting period lasts until the value of the status bit is zero.

If module JX2-CNT is used as a master, output xx03 must be set to zero. In this case, status bit 13 (BUSY) of the slave must be queried, too.

Example of setting up a table

Slave table, register 1xy55 = 20		Present master position, Register 1xy58 = 1,000
Register 1xy53 = 0	Register 1xy54 = 0	-25 ... 25
Register 1xy53 = 1	Register 1xy54 = 10	26 ... 75
Register 1xy53 = 2	Register 1xy54 = 20	76 ... 125
Register 1xy53 = 3	Register 1xy54 = 30	126 ... 175
Register 1xy53 = 4	Register 1xy54 = 40	176 ... 225
Register 1xy53 = 5	Register 1xy54 = 50	226 ... 275
Register 1xy53 = 6	Register 1xy54 = 60	276 ... 325
Register 1xy53 = 7	Register 1xy54 = 70	326 ... 375
Register 1xy53 = 8	Register 1xy54 = 80	376 ... 425
Register 1xy53 = 9	Register 1xy54 = 90	426 ... 475
Register 1xy53 = 10	Register 1xy54 = 100	476 ... 525
Register 1xy53 = 11	Register 1xy54 = 90	526 ... 575
Register 1xy53 = 12	Register 1xy54 = 80	576 ... 625
Register 1xy53 = 13	Register 1xy54 = 70	626 ... 675
Register 1xy53 = 14	Register 1xy54 = 60	676 ... 725
Register 1xy53 = 15	Register 1xy54 = 50	726 ... 775
Register 1xy53 = 16	Register 1xy54 = 40	776 ... 825
Register 1xy53 = 17	Register 1xy54 = 30	826 ... 875
Register 1xy53 = 18	Register 1xy54 = 20	876 ... 925
Register 1xy53 = 19	Register 1xy54 = 10	926 ... 975

Entering table values:

```
// Slave is axis # 2 of module JX2-SM2 located in slot 3
CONST
    Tab_Number = 20;                // Declaring constants
    Master_MaxPos = 1000;
END_CONST;
VAR                                // Variablen deklarieren
    AX_Slave_TabIndex:             INT AT %VL 13253;
    AX_Slave_TabValue:             INT AT %VL 13254;
    AX_Slave_TabElementNumber:    INT AT %VL 13255;
    AX_Slave_TabMaxPosMaster:     INT AT %VL 13258;
END_VAR;

//...
// Total number of table elements
    AX_Slave_TabElementNumber := Tab_Number;

// Setting the pointer to the first table element
    AX_Slave_TabIndex := 0;
// Value of the first table element
    AX_Slave_Value := 0;
```



```
// Setting the pointer to the second table element
  AX_Slave_TabIndex := 1;
// Value of the second table element
  AX_Slave_Value := 10;

// Setting the pointer to the third table element
  AX_Slave_TabIndex := 2;
// Value of the third table element
  AX_Slave_Value := 20;
//... etc.
```

This way, a value can be assigned to every table element. After assigning, the highest position value of the master axis, which is 1000 in this example, is written into register 1xy58.

The step size of the master axis is calculated as follows:

$$\text{StepSize} = \frac{\text{MaximumPositionValue}}{\text{TotalNumberOfTableElements}} = \frac{\text{Reg 1xy58}}{\text{Reg 1xy55}}$$

In our example, the step size is 50. When the master axis is at position 0 ± 25 (step size divided by 2), the slave axis will move towards position zero.

The position of the master axis has been written into the right column of the table, while the respective set position of the slave axis has been written into the middle column of the table.



Note!

If there is no endless positioning:

The highest positive position value of the master axis must be smaller than the value written in slave register 1xy58.

The reason is as follows: Otherwise the range of the table will be exceeded, if positions vary around zero or the maximum value of the table.



Note!

Basically, the master may only be run in the positive range of positions. The sense of rotation of the master axis may be both positive or negative.

Endless Positioning

If two axes are to be driven in the same direction in endless mode via table, the following configuration must be carried out in addition.

The maximum positive position of the master axis must be written into slave register 1xy58.

Slave register 1xy58: Maximum position in positive direction of the master axis	
Function	Description
Read	Present parameter value
Write	New positive maximum position of the master axis
Value range	-8,388,608 ... +8,388,607
Value after reset	+8,388,607

As during "Follower in table mode" operation the master axis may only be run in the positive positioning range, slave register 1xy59 will not be needed.

There are 2 additional commands available:

– Command 54:

Resetting the actual slave position is not carried out here. Please mind that the value at the beginning and at the end of the table are approximately the same.

– Command 55:

When the end of the table has been reached, the actual slave position is reset to the first table value (set position of the slave).

The function of master register 1xy85 and slave register 1xy44 is the same here as in chapter 10.1.3 "Follower with a fixed transmission ratio", page 72.

Setting a position by a clock generator (time-table mode)

Setting a position need not always be based on the actual value of a motor axis. It can also be set by a clock generator.

In multiples of 0.5 ms, register 1xy95 will be incremented by one. The time will be set in register 1xy78.

Slave register 1xy78: Increasing the value of register 1xy95 by multiples of 0.5 ms	
Function	Description
Read	Present parameter value
Write	New setting of time
Value range	1 ... 65,535 (multiple of 0.5 ms)
Value after reset	4 = 2 ms

The time-table mode is started by issuing command 52. At the same time, command 46 (starting the follower function via table) and command 54 (when the end of the table has been reached, the actual slave position will be set back to the first table value) will be issued.

The time-table mode is deactivated by command 53. The speed pre-control will also be de-activated.

10.2 The Winding Mode

10.2.1 Function

The spindle of a winding machine is driven by a motor.

The position will be registered by the following means:

- Module JX2-DIMA, JX2-SV1, JX2-SM2 or JX2-SM1D. The motor is directly driven by these modules.
- An encoder system, e.g. incremental encoder, absolute encoder. The output signal of the rotary encoder will be recorded by a counter module JX2-CNT.

The traversing axis is driven by a stepper motor, the phase current of which is set by module JX2-SM2.

The module that acquires the spindle position is the master. The module by which the traversing motor is driven, is the slave. Here, the same principles as in chapter 10.1.1 "General Information", page 65 apply.

Master and slave communicate via system bus. Both the position of the master axis and a time signal that will be needed for calculating the speed of the master axis are transmitted to the slave in cyclic mode via system bus.

When the master has received command 30, it will immediately send the data mentioned above to the slave.

Everything else will be carried out by the slave. The slave will read the data of the master (spindle); it will evaluate the speed of the spindle and execute the traversing process.

In the traversing mode, the axis will drive in proportion to the spindle position (transmission ratio, no table), until the spindle will have reached the first position at the edge. Starting from this position, the axis will go on in the inverted transmission ratio. This will cause a change into the opposite sense of rotation, while the speed remains the same.

This way, the second position at the edge will be reached, where the sense of rotation will be changed again.

The sense of rotation will be changed without a ramp, in order to avoid gathering too much material at the edges. Therefore, the maximum traversing speed must not be greater than the maximum start / stop frequency of the motor. The start / stop frequency is the step frequency, by which the motor will start and stop faultlessly and without a ramp.

Switching between layered and continuous winding by command is possible.

10.2.2 Realisation

Step 1: Establish data connection between master (spindle) and slave (traversing axis)

The master is to transfer both position and speed of the spindle to the slave in cyclic mode.

Module JX2-DIMA, JX2-SV1, JX2-SM2 or JX2-SM1D is master:

The master will receive command 30 (command register).

Module JX2-CNT is master:

Output xx03 must be set. xx stands for the number of the module position for module JX2-CNT.

From this moment, module JX2-CNT will transmit the position value and the time that has elapsed between two position values transmitted.

Register 3yy5* of the module JX2-CNT: Time interval for transmitting the position	
Function	Description
Read	Present parameter value
Write	New time interval
Value range	0 ... 5 (multiple of 300 µs)
Value after reset	0

*: yy = Module number - 2

Register value	Time interval
0	300 µs
1	600 µs
2	900 µs
3	1,200 µs
4	1,500 µs
5	1,800 µs

From this register the JX2-CNT module will be informed on the time intervals, by which the position of the master axis is to be transmitted via the bus. The higher the value, the smaller will be the bus load. Besides that, the resolution of the speed value will be the finer. The slave will calculate this speed value by the change in position during this interval of time.

When the set time interval is too long, new position values for precise value adjustment will not be transmitted to the slave often enough. For this reason, values between 300 μ s and 1.800 μ s are useful.

When the number of the spindle axis (master axis) is written into slave register, the slave (traversing axis) will receive the value of the spindle position. The slave will then be informed of which master to communicate with.

After writing into register 1xy43, an enquiry must be made, whether status bit 13 has been reset. Then it is guaranteed that both the present position and the speed of the master axis have been read at least once each.

Slave register 1xy43: Number of the master axis	
Function	Description
Read	Present number of the master axis
Write	Definition of a new master axis
Value range For the master axis module JX2-SM1D: For the master axis modules JX2-DIMA, JX2-SV1, JX2-SM2: For counter module JX2-CNT:	0, 21, 31, 41, 51* , 61** , 71** 0, 21, 22, 31, 32, 41, 42, 51* , 52* , 61** , 62** , 71** , 72** 102 - 124 ^{***}
Value after reset	0

* This is only possible with NANO-D and JetControl 246.

** Possible only with JetControl 246.

*** The last two figures denote the module number of JX2-CNT, e.g. 105 = module number 05.

Addresses 117 through 124 are possible only with NANO-D and JetControl 246.

When communication has been established, the spindle position can be read out of register 1xy95, while the speed of the spindle can be read out of register 1xy96.

Slave register 1xy95: Actual position of the master axis	
Function	Description
Read	Present actual position of the master axis
Write	Illegal
Value range	-8,388,608 ... +8,388,607
Value after reset	0

Slave register 1xy96: Speed of the master axis	
Function	Description
Read	Present speed of the master axis
Write	Illegal
Value range	-32,768 ... +32,767 rpm
Value after reset	0

Step 2: Configuring of the winding process (concerning the traversing axis)

Slave register 1xy93: Positive edge	
Function	Description
Read	Present positive edge
Write	Definition of a new edge
Value range	-8,388,608 ... +8,388,607
Value after reset	+8.388607

If the following set position of the traversing axis is greater than, or equal to the value written in register 1xy93, the sense of rotation of the traversing axis will be changed.

Slave register 1xy94: Negative edge	
Function	Description
Read	Present positive edge
Write	Definition of a new edge
Value range	-8,388,608 ... +8,388,607
Value after reset	-8.388608

If the following set position of the traversing axis is less than, or equal to the value written in register 1xy94, the sense of rotation of the traversing axis will be reversed.

**Note!**

Recognition of the edge is dependent on the direction.

If the traversing axis is moving in positive direction, only the positive edge will be recognized. The same applies to the negative edge.

This way it is possible to start the winding process from a position, for example, which is in an even further negative spot than the negative edge.

It will be of no effect, when the axis, while moving towards the positive edge, passes the position of the negative edge. The negative edge will not be considered before the sense of rotation is reversed at the positive edge.

Slave register 1xy56: Travel distance of a traversing axis during one spindle revolution	
Function	Description
Read	Present travel distance
Write	Definition of a new travel distance
Value range	-32,768 ... +32,767 (steps)
Value after reset	1

In continuous winding mode, the traversing axis will travel by the number of steps written here during one spindle revolution.

The speed corresponds to the ratio of the distance covered by the traversing axis and one spindle revolution. Yet, the speed will never be greater than the value of the maximum step frequency written in register 1xy03.

Module JX2-DIMA, JX2-SV1, JX2-SM2 or JX2-SM1D is master:

Value in register 1xy56	Latest sense of spindle revolution	Applying the first layer
positive	positive	in positive direction
negative	positive	in negative direction
positive	negative	in negative direction
negative	negative	in positive direction

Module JX2-CNT is master:

Value in register 1xy56	Sense of spindle revolution	Applying the first layer
positive	positive	in counting direction of the spindle motion
negative	positive	in opposite direction to counting direction of the spindle motion
positive	negative	in opposite direction to counting direction of the spindle motion
negative	negative	in counting direction of the spindle motion

It is also possible to change the laying width (register 1xy56) in one layer. In order to change the laying width, a positive value must be written into register 1xy56. The laying direction will be kept in spite of the positive sign. This will also apply to negative laying direction.



Note!

Before the winding mode is activated, the sign must be considered for setting the laying width.

Reason:

When the laying width is set the first time, the sense of rotation is evaluated by the controller.

Register 1xy57: Number of spindle axis increments referred to one spindle revolution	
Function	Description
Read	Number of set increments
Write	New setting of the number of set increments
Value range	1 ... 32,767 (increments)
Value after reset	1

By writing into this variable, the two axes are informed of how many increments are being covered during one spindle revolution. Register 1xy57 must be written into both in master and slave.

Slave register 1xy90: Counter of layers	
Function	Description
Read	Number of layers applied
Write	Initial value of the counter of layers
Value range	-8,388,608 ... +8,388,607
Value after reset	0

The value written in this register is incremented at each change of layers. Yet, it will not be reset by the operating system (except for reset).

The register may, respectively must be pre-occupied by the user.

Slave register 1xy91: Counter of windings	
Function	Description
Read	Number of windings applied
Write	Initial value of the counter of windings
Value range	-8,388,608 ... +8,388,607
Value after reset	0

This variable is incremented at each further winding.

It must be pre-occupied after activation of the winding mode.

Slave register 1xy89: Changing the winding gradient at the edge of the coil	
Function	Description
Read	Latest set value, respectively zero, if the value has been taken over
Write	New winding gradient to be taken over at the next edge
Value range	0 ... 8,388,607
Value after reset	0

If during a winding process a value that is greater than zero is written into this register, it will be taken over into register 1xy56 at the next edge of the coil. The travel distance of the traversing axis changes accordingly during one spindle revolution. Calculation of the traversing direction will be carried out automatically.

The value written in register 1xy89 will be reset to zero after being taken over. Only positive values may be written into the variable.

Slave register 1xy79: Increased resolution of the winding gradient	
Function	Description
Read	Presently set resolution
Write	New resolution of the winding gradient
Value range	0 ... 8,388,607
Value after reset	1

The gradient in a higher resolution is defined in register 1xy79 that belongs to the traversing axis.

The values of 1xy56 respectively 1xy89 can now be multiplied by the value of register 1xy79. This way, a non-integer gradient value can also be defined.

$$\text{Gradient} = \frac{1xy56 \text{ (resp. } 1xy89)}{1xy57 \times 1xy79}$$

Example 1:

Value in register 1xy79: 1

Value in register 1xy56: 56 steps

Actual travel distance during one spindle revolution: 56 steps

Example 2:

Value in register 1xy79: 10

Value in register 1xy56: 56 steps

Actual travel distance during one spindle revolution: 5.6 steps

Slave register 1xy88: Void increments	
Function	Description
Read	Present number of void increments
Write	New number of void increments
Value range	0 ... 8,388,607
Value after reset	0

"Void increments" can be applied to the edge. The traversing axis will stand still at the edge, until the spindle has covered this number of increments as defined in register 1xy88, which are calculated as starting from the edge.

If the traversing axis is not to delay at the start, register 1xy88 must not be written into before start-up. The spindle must already have covered the number of increments that is to be written into register 1xy88.

Step 3: Commands

Starting the winding mode by issuing command 66:

The winding mode is started by issuing this command. If the spindle is in motion, the traversing axis will follow the motion according to the configuration of the winding process.

Terminating the winding mode by issuing command 67: (active after reset)

The winding mode is terminated by issuing this command. At the same time, the AXARR instruction (command 5) is carried out. The slave axis is internally given a set position which equals its actual position, which causes the slave axis to stand still. Then, spindle and traversing axis can be operated independently of each other again.

Terminating the communication between master and slave by issuing command 42:

Master:

If command 42 is issued to the master, it will terminate its respective part of communication between master and slave.

After issuing this command, status bit 13 (BUSY) must be queried. The waiting period lasts until the value of the status bit is zero.

If module JX2-CNT is used as a master, output x03 must be set to zero. In this case, status bit 13 (BUSY) of the slave must be queried, too.

Slave:

If command 42 is issued to the slave, it will terminate its respective part of communication between master and slave.

In the slave, the value of register 1xy43 will be set to zero. At the same time, the AXARR instruction (command 5) is carried out. The slave axis is internally given a set position which equals its actual position, which causes the slave axis to stand still. After issuing this command, status bit 13 (BUSY) must be queried. The waiting period lasts until the value of the status bit is zero. Only then can the axis be moved to a new position.

Layered winding after issuing command 68:

The traversing axis will only move once and for a short time on one spot at the beginning of the spindle. When the spindle has rotated once, the traversing axis will be moved on by the number of steps, which has been written into register 1xy56. This is carried out by the step frequency set in register 1xy03. Then the traversing axis will delay its motion, until the spindle has made another rotation.

This function must be selected before the winding mode is activated, that is, before command 66 is issued.

Continuous winding after issuing command 69: (active after reset)

The traversing axis is moving continuously in a fixed ratio to the spindle. The ratio is determined by the value written in register 1xy56.

Step 4: New set position of the spindle

Master register 1xy92: Number of windings to be carried out in relation to the last spindle position	
Function	Description
Read	Present number of windings to be applied
Write	New number of windings to be applied
Value range	-8,388,608 ... 8,388,607
Value after reset	0

The winding mode is started by writing into master register 1xy92. The spindle will start rotating.

The value written in register 1xy92 is related to the position reached to last.

The following relation must apply to the maximum value:

$$1xy92 \text{ (Spindle)} \times 1xy57 + \text{latest set pos} < \pm 2,147,483,647$$

If the spindle is to be positioned via register 1xy92, the value of register 1xy57 of the spindle axis must be equal to the value of register 1xy57.

After writing the set acceleration ramp into master register 1xy92, the spindle axis will change its direction. Then it will continue travelling by the step frequency defined in register 1xy03 and stop after reaching the set number of windings by the set deceleration ramp.

Yet, the spindle can also be moved by giving another positioning instruction (e.g. the POS instruction, writing into register 1xy02).



Note!

For pre-positioning, please be careful to only turn the spindle in winding direction.

Reason:

When the edge is to be recognized, the former sense of rotation of the spindle axis is decisive.

If consequently a wrong sense of rotation is recognized, an edge will be recognized at the wrong point of time as well. This will in consequence lead to wrong positioning of the traversing axis.

10.2.3 Special Functions

Limit Switch Function

The limit switch function (software and hardware limit switch in the traversing axis) is also active in the winding mode.

If a limit switch has been actuated, the winding mode will automatically switch to the normal position control mode. This limit switch recognition will not be recognized by the spindle axis, though.

Tracking Error Correction

In winding mode, follower control between spindle and traversing axis will be carried out with the help of a proportional controller. In principle, the tracking error will be decreased, when the P gain (slave register 1xy10) of the controller is increased.

If the selected value is too high, though, the traversing axis will start chattering. Especially for a stepper motor this is a disadvantage.

Further, a tracking error correction in the shape of a speed precontrol is active (see chapter 10.1.2 "Speed pre-control", page 69).

It is possible that by deactivating the speed pre-control (status bit 23 of slave register 1xy00 has been set) the traversing axis can follow the spindle more easily. This can be the case, if the encoder resolution of the spindle is low, or if the time interval during transmission is too short.

When the sense of rotation is reversed at the edge, the tracking error must be cleared and built up again.

If the spindle position is read by module JX2-DIMA, JX2-SV1, JX2-SM1D or JX2-SM2. If the speed pre-control is active (status bit 23 in slave register 1xy00 has been reset), it might be possible that register 1xy52 of the traversing axis must be written in order to adjust the speed values.

The value is calculated by the following formula:

$$\text{SlaveRegister } 1xy52 = \frac{60,000,000}{\text{IncrementsPerSpindleRotation}}$$

If an incremental encoder on the spindle axis has, for example, got 500 encoder lines, and if values are read out of module JX2-SV1 with quadruple evaluation, value 30,000 must be written into slave register 1xy52.

If the spindle axis is driven by module JX2-DIMA (the resolver resolution is 4,096), value 14,648 must be entered into slave register 1xy52.



Note!

For layered winding, the tracking error correction must be deactivated.

Overflow of the Spindle Position

The spindle axis is driven by the module JX2-SV1, JX2-DIMA, JX2-SM2 oder JX2-SM1D. The spindle position is read-in as well:

It is possible that a value of $\pm 7,490,000$ is exceeded. For this reason, the following conditions must be considered:

– *Absolute positioning of the spindle*

There are no conditions to be considered.

– *Relative positioning and endless positioning of the spindle*

– *The value in register 1xy85 has not been changed.*

There are no conditions to be considered.

– *The value in register 1xy85 has been changed.*

The value of master register 1xy85 must be written into slave register 1xy44. This way, the slave will be informed of when the overflow takes place. Only then the overflow data can be acquired correctly.

The spindle position is read by module JX2-CNT:

The spindle position can exceed respectively fall below value $\pm 8,388,607$.

Entry in slave register 1xy44: 8,388,607

10.3 Relative Positioning with Start Input

Starting relative positioning using command 20:

When this command is issued, relative positioning with start input is started.

Terminating relative positioning using command 21:

When this command is issued, relative positioning with start input is terminated.

Register 1xy67: Relative Positioning with Start Input	
Function	Description
Read	Present relative position for the mode "Relative positioning with start input"
Write	A new value is defined
Value range	-8,388,608 ...+8,388,607 (Schritte)
Value after reset	0 (steps)

Meaning:

The start input is the "REF" input. While 24 V are applied to this input and the axis is in the AXARR condition, relative positioning will be started.

Before the target position is reached, 0 V must be applied to input "REF". Otherwise the axis will not stop; yet, another positioning process will be started.

The relative positioning value has been loaded into register 1xy67.

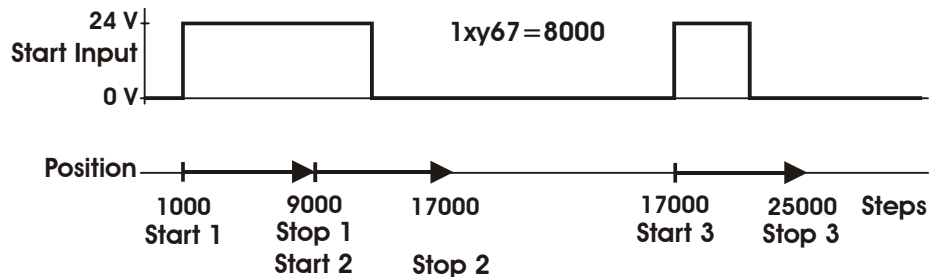


Fig. 18: The timing of positioning with start input

Example:

With the help of the start input, relative positioning is to be started. This is quite useful for applications where fast reaction to irregular signals is necessary, e.g. there are parcels to be transported from one assembly line to another.

```
// Transfer of command 20 (relative positioning with sStart input)
// to module JX2-SM2:
//...
CONST
    RelposWithoStartinput = 20;           // Declaring constants
END_CONST;
VAR
    AX_Kommando: INT AT %VL 12101;       // Declaring variables
    AX_RelSetPosition: INT AT %VL 12167;
END_VAR;

//...
// Enabling relative positioning with start input
    AX_Kommando := RelposWithoStartinput;
//...
// Transferring the relative set position to module JX2-SM2
    AX_RelSetPosition := 8000;
// Now the axis will move 8000 steps in positive direction,
// once the start input has been activated.
//...
```

Each time 24 V are applied to the start input *and* if the axis is not moving, positioning by 8,000 steps will be started independently of the CPU.

Register 1xy68: Absolute position of the latest positioning cycle	
Function	Description
Read	Absolute position of the latest positioning cycle
Write	Makes no sense
Value range	-8,388,608 ...+8,388,607 (steps)
Value after reset	0 (steps)

Meaning:

Register xy168 serves as an internal auxiliary register for carrying out relative positioning. In this register, the absolute set position of the latest positioning cycle has been stored. The JX2-SM2 stepper motor control adds this value to the value of the relative position defined by the user (registers 1xy02 or 1xy67) in order to get the new target position.

If an interrupted relative positioning is to be resumed, the original target can be calculated again this way (command 19).

If the axis reaches the position written into register 1xy85, the set and actual value will be reset to zero in the relative positioning mode.

Register 1xy85: Overflow position for endless and relative positioning	
Function	Description
Read	Present overflow position
Write	Value of the new overflow position
Value range	0 ... +8,388,607
Value after reset	+7,490,000

10.4 Capture Function

This function grants fast storing of the present axis position in a register, when a hardware signal has been given.

The positions are stored during a time of 500 μ s max.

Once a positive 24 V signal is applied to input "REF1", the position of axis 1 is stored to register 1x187 or position of axis 2 to register 1x287 irrespective of value in register 1x186.

Accordingly, once a positive 24 V signal is applied to input "REF2", the position of axis 1 is stored to register 1x187 or position of axis 2 to register 1x287 irrespective of value in register 1x286.

Once an input signal has been detected and the given positions have been saved, the register 1xy86 assigned to the corresponding input is set to zero. Thus, the function is deleted until it is again called-up.

Register 1x186: Enable of the capture function	
Function	Description
Read	Present register value
Write	Enable and disable of the capture function
Value range	0 ... 3 (bit-coded)
Value after reset	0

Meaning:

The significance of individual bits in register 1x186:

Bit 0: Once a signal is applied to REF1, the actual position of axis 1 is stored to register 1x187.

1 = enable
0 = disable

Bit 1: Once a signal is applied to REF1, the actual position of axis 2 is stored to register 1x287.

1 = enable
0 = disable

Register 1x286: Enable of the capture function	
Function	Description
Read	Present register value
Write	Enable and disable of the capture function
Value range	0 ... 3 (bit-coded)
Value after reset	0

Meaning:**The significance of individual bits in register 1x286:**

Bit 0: Once a signal is applied to REF2, the actual position of axis 2 is stored to register 1x287.

1 = enable
0 = disable

Bit 1: Once a signal is applied to REF2, the actual position of axis 1 is stored to register 1x187.

1 = enable
0 = disable

Register 1xy87: Acquired position value	
Function	Description
Read	Position value acquired last
Write	It can be pre-occupied by any value
Value range	-8,388,608 ... +8,388,607
Value after reset	0

10.5 Automatic shift of the reference point

It is possible to get a jerk-free shift of the reference point of the axis by accessing this register.

Example:

The axis is in a certain actual position, e.g. 2,000 steps distant from the zero position (reference point).

The entry in register 1xy71 is to determine the following:

The present actual axis position is not to be 2,000 steps, for example, but 3,000 steps distant from the zero position (reference point).

To do so, enter the following value into register 1xy71: 3.000

What will be the results?

- In this example, the reference point has been shifted by 1,000 steps in negative direction.
- The axis has not moved.
- Any further movements refer to the newly defined reference point.

Register 1xy71: New position value after shift of the reference point	
Function	Description
Read	Position value entered last
Write	Definition of a new position value
Value range	-8,388,608 ... +8,388,607
Value after reset	0



Important!

Only apply this function, if the axis is in AXARR position and if it is not in an interpolation mode.

11 Machine Referencing

If positioning is carried out with the help of stepper motors, there is no actual position feedback from the motor. For this reason, a reference run must be carried out after power-up of the plant, in order to report the present axis position to the controller.

There are several possibilities of carrying out a referencing cycle:

- 4 different modes have been stored as stepper motor control commands for automatic referencing cycles. The referencing cycle is started by uploading the respective command into command register 1xy01.
- It is also possible, with the help of the programming instructions, to write an individual program for carrying out referencing cycle.



Important!

As there is no feedback from the motor, module JX2-SM2 will calculate the total number of steps transmitted to the motor. The amount is stored in register 1xy09.

After powering-up the module JX2-SM2, the value in register 1xy09 will be zero. If the axis is not in the reference position by chance, there is no defined axis position at all at that moment.

Machine referencing must be carried out prior to the first positioning cycle. After this, the axis will be in reference position.

The stepping rate of the reference cycle must be smaller than, or equal to, the maximum start / stop frequency, if the axis is meant to stop at the reference point.

During referencing, the reference switch is scanned every 500 μ s. This will result in a reference point that will always remain the same, if the referencing cycle is carried out by a frequency that is smaller than, or equal to, 1 kHz *and* if the reference switch is always approached to from the same direction *and* always at the same stepping rate. Fig. 19 demonstrates this.

In this case, only modes 3 (command 11) and 4 (command 12) are useful for an automatic referencing cycle, except for the case that a defined position has been approached before switching off.

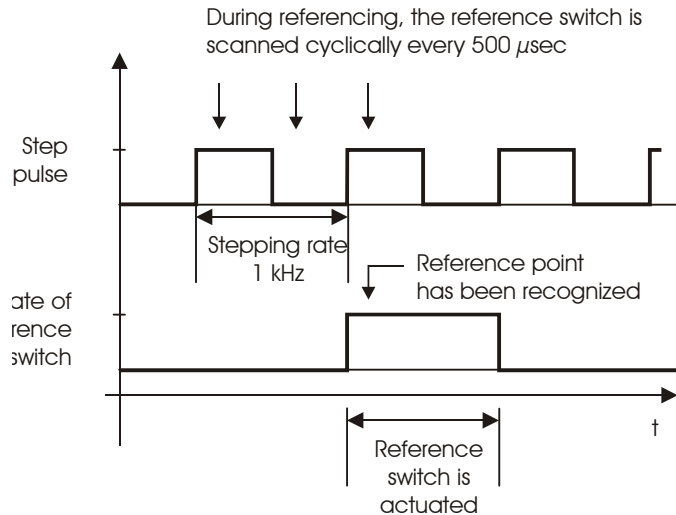


Fig. 19: Cyclic scan of the reference switch

The reference switch is placed on the positioning range between the two limit switches - normally it is close to a limit switch. Sometimes, a limit switch is used as a reference switch. For this purpose, a limit switch input must be bridged with the reference switch input. The polarities of the limit and reference switch that are to be set are different from each other. Immediately after leaving the limit switch position, referencing is carried out. In this case, half of the positioning range is available.



Note!

Below, the programming instructions needed for referencing will be described.

In example 1, individually designed programming of a referencing cycle will be shown. In example 2, the mode of an automatic referencing offered by the operating system of module JX2- SM2 will be used.

These two examples take as a basis a positioning range, where the reference switch is placed very close to the negative limit switch (see Fig. 20).

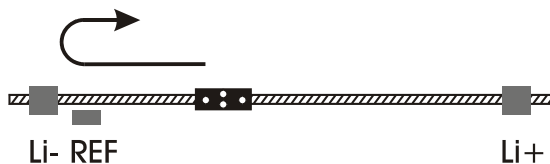


Fig. 20: Positioning range for the referencing cycle

- In both examples, referencing is carried out as follows:
- Approaching the limit switch in negative direction. Passing the reference switch.
 - Approaching the reference switch in positive direction.
 - Stop at the reference switch.

Example 1: Starting an individually programmed referencing cycle

```

// ...
// Approaching the negative limit switch and stopping.
// Destination is a negative position which will not be reached
// before the limit switch has been approached.
// The controller automatically stops the axis once the
// negative limit switch has been reached.
CONST
    X_Axis = 21;                // Declaring constants
    ReferenceOK = 0;
    NegLimitSwitch = 4;
    ClearReference = 4;
END_CONST;
VAR
    AX_Status:                INT AT %VL 12100; // Declaring variables
    AX_Command:              INT AT %VL 12101;
END_VAR;

SUB su_ERROR = 1 FORWARD;      // FORWARD Declaration UP

TASK 0;
//...
    POS(X_Achse, -8380000, 1000);
// Once the axis has reached the negative limit switch position:
    WHEN
        BIT_SET(AX_Status, NegLimitSwitch)
    CONTINUE;
    AX_Command := ClearReference;
// When the reference switch is actuated again, the reference point
// of the axis will be set by the module. For this purpose, the axis
// moves in positive direction.
    POS(X_Axis, 8380000, 1000);
// If command 22 (Reg. 1x101) - default - has been set,
// the axis stops at the reference switch.

// Waiting until referencing is completed. Then, status bit 0 will
// be set.
    WHEN_MAX(100,su_ERROR) BIT_SET(AX_Status, ReferenceOK)
    CONTINUE;
//...
END_TASK;

SUB su_ERROR = 1;              // In case of timeout
    DISPLAY_TEXT(0,1,'ReferencingError!');
END_SUB;

```

Example 2: Starting an Automatic Referencing Cycle

```
// ...  
  
CONST  
  
    X_Axis = 21;  
    RefError = 12;  
    Busy = 13;  
    ReferencingStartNeg = 12;  
  
END_CONST;  
  
VAR  
  
    AX_Status:          INT AT %VL 12100;    // Declaring variables  
    AX_Command:        INT AT %VL 12101;  
    AX_Speed:          INT AT %VL 12103;  
  
END_VAR;  
  
TASK 0;  
  
//...  
// Setting speed used for referencing  
// Stepping rate 1 kHz  
  
    AX_Speed := 1000;  
  
// Starting automatic referencing with command 12  
  
    AX_Command := ReferencingStartNeg;  
  
// Waiting until referencing has been completed.  
// For this purpose, status register 13 is scanned  
  
    WHEN BIT_CLEAR(AX_Status, Busy) CONTINUE;  
    IF BIT_SET(AX_Status, RefError) THEN  
        DISPLAY_TEXT(0, 1, 'Referencing Error!');  
    ELSE  
        DISPLAY_TEXT(0, 1, 'Referencing OK!');  
    END_IF;  
  
//...  
  
END_TASK;
```

Appendix

Appendix A:Recent Revisions

Chapter	Comment	Revised	Added	Deleted
Introduction	Revision history	✓		
Chapter	Headings	✓		
Chapter 1.2	Ensure your own safety	✓		
Chapter 1.2.2	Information signs		✓	
Chapter 2	Words of advice	✓		
Chapter 3	Side view	✓		
Chapter 4	Specifications modified to reflect UL conformity	✓		
Chapter 9	Value ranges of register 1xy01, 1xy43, 1xy85 and 1xy86 revised	✓		
	Description of register 1xy07 „Destination window“	✓		
Chapter 9/10	„Variable“ changed to „register“	✓		
	Sample programs in JetSymST	✓	✓	
Chapter 11	Sample programs in JetSymST	✓		
Appendix C	Abbreviations	✓		

Appendix B: Glossary

Absolute positioning	Reference point: Position of the reference switch
Amplifier	Power supply for the motor.
Analog	A parameter, e.g. voltage, which is steplessly adjustable. In contrast to digital.
Bipolar winding	The part-windings are internally connected in the motor. Other than in unipolar windings, only two connections per phase will be needed. For triggering, a bridge circuit will be needed.
Bus loading	In case of high bus loading, a great amount of information will be exchanged among the bus participants.
Clock generator	A clock generator creates impulses with an adjustable frequency.
Counter	A counter acquires the changes of state (edge) of a digital signal. At each change of state, the counter will increment (increase) or decrement (decrease) a variable value, which then will be evaluated by the controller.
Digital	Binary presentation of a parameter, e.g. time. This parameter in digital representation can be changed in given steps only, that is in binary mode. Contrast to analog.
Drive	A stepper motor is an electric motor. An electric motor belongs to the line of the drives.
EC Low Voltage Directive	To be considered when using electric devices of a rated voltage between 50 and 1000 V AC and between 75 and 1500 V DC.
Electrical isolation	With potential separation, the sensor mat is electrically isolated from the internal ground (GND) of the controller.
Electro-Magnetic Compatibility	Definition according to EMC regulations: "EMC is the ability of a device to function in a satisfactory way in an electro-magnetic environment without causing electromagnetic disturbances itself, which would be unbearable for other devices in this environment."
Encoder	A rotary encoder, which senses a rotation. It converts the rotating motion into a digital signal (by impulses), which can be acquired by a counter. Changes of position can be identified this way.

JETTER System Bus	The Jetter system bus allows a cable length of max. 30 m, and a high data transfer rate of 1 Mbit/s. In addition to this, the Jetter system bus is highly immune to interferences. Therefore, the Jetter system bus is an excellent choice for field bus applications. JX2 module are interconnected through this system bus.
Low Voltage Directive	To be considered when using electric devices of a rated voltage between AC 50 and 1000 V and between DC 75 and 1500 V.
Open collector (open collector)	As shown in Fig. 6, the output stage of this circuit arrangement has only an npn transistor with the emitter connected to ground. Such outputs can easily be connected in parallel and be provided with a common collector resistor (pull-up resistor). The pull-up resistor is located between the transistor collector and the positive voltage source. The voltage may range between +5 V and +30 V.
Overflow position	The change in the counter value at this position is greater than 1.
Phase	See "Bipolar winding". For a stepper motor control, a phase corresponds to a motor winding. Another definition: Phase of a supply voltage L1, L2, L3.
Position controller	The position controller tries to keep the axis in a certain set position.
Proportional-action controller	The proportional-action controller possesses a constant amplification factor (P-amplification). There will always remain a difference between set value and actual value.
Pull-up resistor	Refer to "open collector"
Relative Positioning	Reference point: Value of the latest set position.
Ripple - Smoothing - Filtering	Ripple: Superimposed AC of a direct voltage. Filtering: Circuit configuration with a RC or LC component in order to achieve more smoothness or a lower ripple of the DC voltage.
RS422	Type of a serial interface. The signal and the inverted signal are transferred via separate lines. This symmetrical transmission method is for detecting interferences during transmission.
Stepping rate	The stepping rate ist inversly proportional to the time interval between two subsequent steps. The steps are applied to a stepper motor with a certain stepping rate. The stepper is turning.
TASK	An individual application or sub-program which can be executed as an independent unit.

Tracking error	In case of a low tracking error, the slave axis will follow the master axis fast and precisely.
Vibration resistance	The device can permanently or shockwise be exposed to a vibration defined in the standard.

Appendix C: List of Abbreviations

Ω	Ohm (electric resistance)
M	Torque (symbol used in formulas)
%	per cent
°C	degrees centigrade (temperature unit)
μF	Microfarad ($1 \mu\text{F} = 10^{-6} \text{F}$)
μs	microsecond ($1 \mu\text{s} = 10^{-6} \text{s}$)
A	Ampere (electric current)
AC	A lternating C urrent
approx.	approximately
betw.	between
CE	C ommunautés E uropéennes = European Union
cf.	compare
Cl.	Class
cor.	correspondingly
dB	Dezibel (logarithmic unit for damping resp. amplification)
DC	D irect C urrent
e.g.	[lat. <i>exempli gratia</i>] for example
EMC	E lectro M agnetic C ompatibility
EN	E uropäische N orm, that is: European Standard
EU	E uropean U nion
F	Farad (electric capacity)
Fig.	Figure
g	gram
GND	G round
Gr.	Group
HxWxD	Height x Width x Depth
Hz	Hertz
I	Electric Current (symbol used in formulas)
i.e.	[Latin: <i>id est</i>] that is
IEC	I nternational E lectrotechnical C ommission

IP	I nternational P rotection
J	Moment of inertia (symbol used in formulas)
kΩ	a thousand ohms (1 kΩ = 10 ³ Ω)
kHz	Kilohertz (1 kHz = 10 ³ Hz)
L1	Outer conductor; conductor between current source and consumer
LED	L ight- E mitting D iode
m	Meter
max.	maximum
MHz	Megahertz (1 MHz = 10 ⁶ Hz)
min.	minimum
mm	Millimeter (1 mm = 10 ⁻³ m)
mm ²	square millimeter
ms	millisecond (1 ms = 10 ⁻³ s)
N	Neutral conductor
neg.	negative
NN	N ormal N ull = Sea Level
PE	P rotective E arth
pos.	positive
respectively	respectively
RPM	revolutions per minute
s	second
SELV	S afe E xtra L ow V oltage: Voltage, which, under all operating conditions will not exceed a peak or DC voltage of 42.4 V. This voltage is either measured between two conductors or between one conductor and earth. The circuit, in which this voltage occurs, must be separated from the mains power supply by a safety isolating transformer or some equivalent.
SetPos	Set Position
Speed	Speed
SUB-D	Type name of a plug-in connector
t _h	Half-life period
T _n	Total duration of burst
t _r	Rise time of burst

Units:

V	Volt (electric voltage)
Var.	Variable
W	Watt (electric active power)

Appendix C: List of Illustrations

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