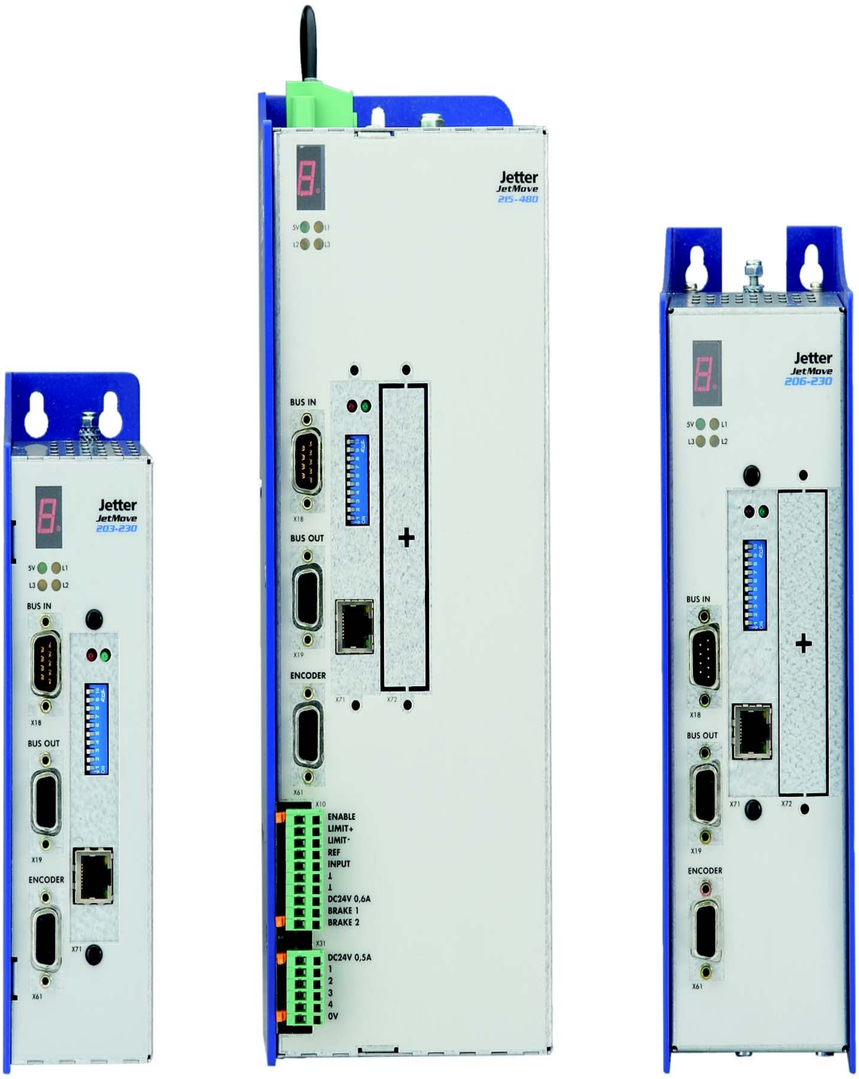
JetMove 1xx, 2xx, D203 at the JetControl

Drive



User Information

Jetter

60874950

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Significance of this User Information

This user information forms part of the JetMove 105, 2xx and D203 at the JetControl system bus

- and must be kept in a way that it is always at hand until the JetMove will be disposed of.
- Pass this user information on if the JetMove is sold or loaned/leased out.

In any case you encounter difficulties to clearly understand this user information, 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.

Missing or inadequate knowledge of the user information 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
23.1	Original issue
24.1	– Additional functions of software version 24.1 are described. – Various amendmends, renaming or additions of several chapters. – Extended register overviews.
24.2	For changes, please refer to revision 24.2, Appendix A
24.3	For changes please refer to revision 24.3, Appendix A
2.10.1	For changes please refer to revision 2.10.1, Appendix A
2.11.1	For changes please refer to revision 2.11.1, Appendix A
2.11.3	For changes please refer to revision 2.11.3, Appendix A
2.11.4	Refer to Appendix A: "Recent Revisions", page 413

Description of Symbols

Warning

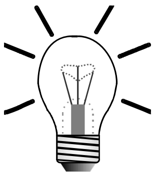
This sign is to indicate a possible impending danger of serious physical damage or death.

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

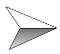
This sign is to indicate a possible impending situation which might bring damage to the product or to its surroundings.
It also identifies requirements necessary to ensure faultless operation.



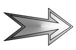
Note

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.

Table of Contents

Verzeichnis Anhang

1 Introduction

In this description, the following JetMoves are called JetMove 2xx or JetMove 200 series:
- JetMove 105
- JetMove 203
- JetMove 204
- JetMove 206
- JetMove 208
- JetMove 215
- JetMove D203

This user information describes the functions of the product JetMove 2xx of the operating system version V 2.11

In this manual, the operation of the JetMove 2xx at the system bus of Jetter AG will be described. Additional information on the contents of this document is given in the instructions for the specific sizes of the JetMove 200 series.

1.1 Product Description

The JetMove 200 series by Jetter offers modern servo amplifers for being applied with synchronized servo motors.

The servo amplifier JetMove D203 can address two synchronous servo motors.

1.2 System Requirements

The JetMove 200 amplifiers can be operated by JetControl 24x controllers and by the JX6-SB-I submodule.

The JetMove 2xx amplifiers can directly be connected to the Jetter system bus. It is still possible to simultaneously operate all non-intelligent JX2-IO and all intelligent JX2 slave expansion modules made by Jetter AG at the system bus.
The table shows the required software version of the controllers, which are prerequisite for the operation of the JM-2xx at the Jetter system bus according to these instructions.

Software Versions of Controllers and the Submodule JX6-SB-I	
Controller	**Minimum Software Version**
JC-241, JC-243, JC-246	No limitation
JM-D203-JC24x	1.10
JX6-SB-I	2.10

2 Numbering of Registers

2.1 JC-24x and JM-D203-JC24x

The following register numbering applies to the controllers of the JC-24x series:

The registers are addressed with the help of five-digit numbers. The first two digits are made up of the slot number of the JetMove 2xx module plus value 10. Below, the pattern of register numbering is illustrated.

REG 1xzzz

Only intelligent modules are counted.

X = max. permitted amount of intelligent modules to be connected to the CPU (CPU = position 1)

2.2 Submodule JX6-SB-I

The servo amplifier series JetMove 200 can also be operated at a JX6-SB-I submodule withouth changing its range of functions. JX6-SB-I is a submodule of JetControl 647. All intelligent and non-intelligent expansion modules to the Jetter system bus can be connected to the JX6-SB-I submodule. JetMove 2xx is an intelligent expansion module.

Description of the register pattern: 3m1xzzz

By way of example **REG 3m1xzzz**, the register numbering pattern is demonstrated below.

- The registers are addressed with the help of a 7-digit number.
- The first digit is always **3**.

- The second digit **m** specifies the **submodule socket** for the JX6-SB(-**I**) submodule on the controller:
  m = submodule socket (1 ... 3).

- The third digit is always **1**.

- The fourth digit **x** specifies the **number of the slave module** connected to the system bus:
  x = slave module number (2 ... 9).

The slave module number specifies the position among the intelligent expansion modules connected to the Jetter system bus. The smaller the number, the closer is the module to the controller.

- The digits five, six and seven **zzz** specify the core **register number**. One of the 100 possible registers is selected by using this register number.

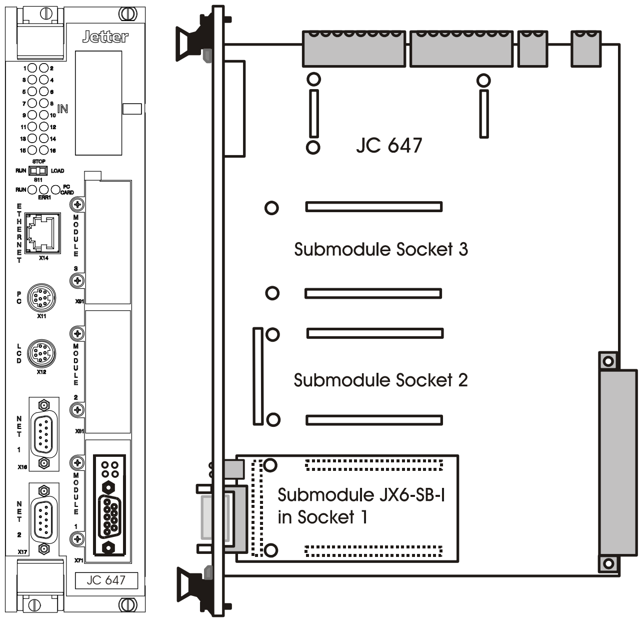


Fig. 1: Submodule sockets of the controller JC-647

3 Axis Definitions

3.1 Procedure

The basic properties of an axis have to be set beforehand.
Based on the respective axis definition, some registers of the JetMove are assigned validity or other units. Normally, the axis is defined in JetSym under Project Settings and loaded into JetMove by the instruction *MotionLoadParameter.* The following description refers to manual axis definition.

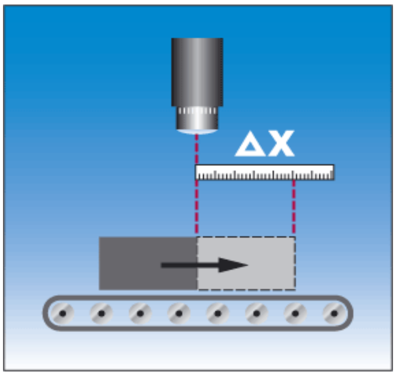
Setting the axis type

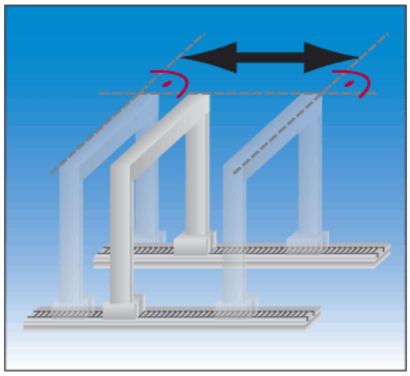
The axis type has to be set via “Register 191: Axis Type” on page 20. Usually, a machine consists of two kinds of axes:

- Linear axes
- Rotatory axes

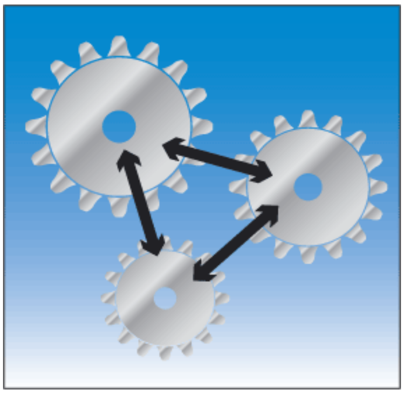
In case of a linear axis, the load is moved in linear direction; all positioning parameters have been specified in the [mm] unit. In case of a rotatory axis, the load will be moved on a circular path; for this reason, all positioning parameters have been specified in the [°] unit.
It is not relevant for defining the axis type, whether the motor is rotatory. The axis type defines the mechanic design of the load.
A rotatory motor, for example, can move a linear axis via a spindle.

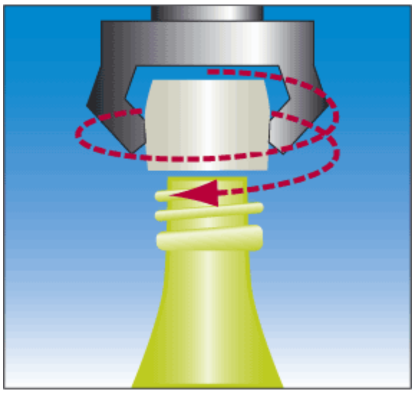
Sample applications for linear axes:





Sample applications of rotatory axes:





Setting the motion mode

In the motion mode, it is defined whether the axis is to run in modulo mode or not. In modulo mode, one axis absolutely exceeds the travel range, which has been defined in registers 182 and 183. This means that there will be a position overflow. Modulo operation will result in the as-is position of register 109 to jump to the maximum, respectively minimum limit defined in R182 respectively 183 at reaching the travel range limits. It is configured by means of register 192.

The modulo mode is configured for an axis, for example, which is to be run in endless positioning.

3.2 Register Description

Register 191: Axis Type	
Function	**Description**
Read	As-is value of the present axis type
Write	Set value of the present axis type
Amplifier status	The amplifier has to be deactivated
Takes effect	Immediately
Variable type	int / register
Value range	1, 2
Value following a reset	2 (rotatory)

Here, the motion of the axis is defined: either linear or rotatory.

Meaning of the values:

1 : linear

2 : rotatory

Usually, a machine consists of two kinds of axes:

- Linear axes
- Rotatory axes

In case of a linear axis, the load is moved in linear direction; all positioning parameters have been specified in the [mm] unit. In case of a rotatory axis, the load will be moved on a circular path; for this reason, all positioning parameters have been specified in the [°] unit.

These are the positioning parameters:
- Positioning parameter
- Speed parameter
- Acceleration / Deceleration parameter
- Parameter for jerk limitation

The units for a linear axis shown in detail:

- Unit defining a position: [mm]
- Unit defining speed: [mm/s]
- Unit defining acceleration / deceleration: [mm/s²]
- Unit defining jerk: [mm/s³]

The units for a rotatory axis shown in detail:

- Unit defining a position: [°]
- Unit defining speed: [°/s]
- Unit defining acceleration / deceleration: [°/s²]
- Unit defining jerk: [°/s³]

The motion mode is set within the axis section of the project settings within a JetSym ST or JetSym STX project. At establishing a connection, the motion setup checks the settings; after a query, it sets the value accordingly.

Register 192: Modulo Axis	
Function	**Description**
Read	As-is value
Write	Set value
Amplifier status	The amplifier has to be deactivated
Takes effect	Immediately
Variable type	int / register
Value range	0, 1
Value following a reset	0

Here it is defined, whether the axis is a modulo axis or not.

Meaning of values:

0 : No modulo axis

1 : Modulo axis

What is a modulo axis?

The positioning values of a modulo axis are always within a defined modulo travel range (in order to make possible endless positioning, for example), see register 193 "Modulo travel range".

If the axis moves in positive direction and reaches the positive travel limit, the position will be set back to the value of the negative travel limit. This means the axis can continue with new positioning values starting from the negative travel range.

If the axis moves in negative direction and reaches the negative travel limit, the position will be set back to the value of the positive travel limit. This means the axis can continue with new positioning values starting from the positive travel range.

Consequently, modulo axes haven't got any hardware or software limit switches.

The following figure will illustrate an endless axis motion in positive direction by a modulo travel range of 200,000 ° (negative travel limit = 0°, positive travel limit = 200,000°).

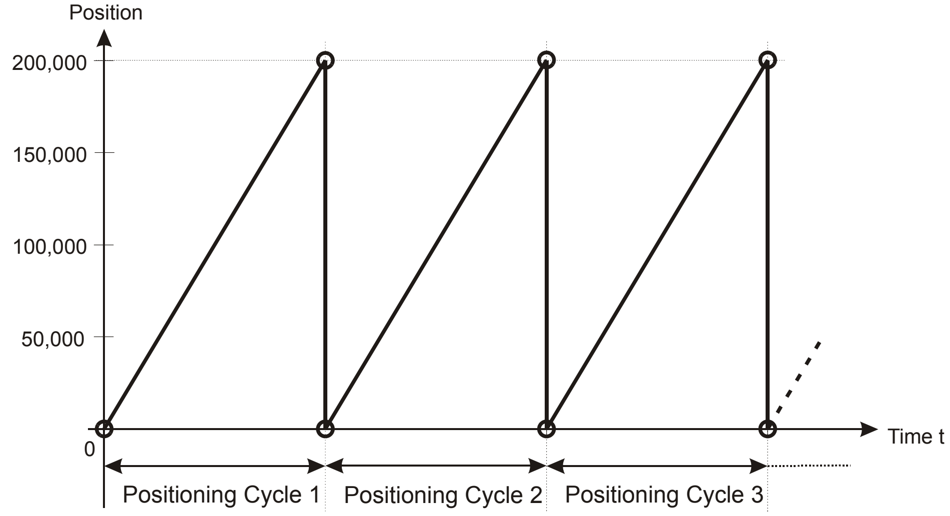


Fig. 2: Example of a modulo axis motion

The motion mode is set within the axis section of the project settings within a JetSym ST or JetSym STX project. At establishing a connection, the motion setup checks the settings; after a query, it sets the value accordingly.

4 Axis Settings

4.1 Procedure

Reversal of direction

At reversion of direction, the counting direction of the axis can be reversed altogether.
Reversion of the direction is set by bit number 5 “Register 540: Drive Mode” on page 392.

Polarity of limit and reference switches

The hardware limit switch monitoring is active by default. In order to activate the axis without an immediate error message being triggered, the “Register 510: Digital Inputs: Polarity” on page 32 has to be set according to the connected limit and reference switches. The status should now be monitored in “Register 100: Status” on page 397.
If monitoring is not required, bit number 7 has to be cleared in “Register 540: Drive Mode” on page 392.

Motor / Mechanic transmission factor

For using a drive the transmission factor has to be entered via the two parameters “Register 194: Transmission Ratio - Motor” on page 30 and “Register 195: Transmission Ratio - Mechanics” on page 31.
If no drive is applied, both parameters are set to value 1.
If a linear axis is applied, the “Register 196: Linear / Rotation Ratio” on page 31 has to be set afterwards.

Software limit switch

The software limit switch monitoring is NOT active by default. If monitoring is required, bit number 6 has to be set in “Register 540: Drive Mode” on page 392. The software limit switches have to be set after referencing in relation to the basic position. During referencing, software limit switch monitoring is internally deactivated.

Travel limits

The travel limits serve for position limiting for travel instructions in position controlling. The travel limits have to be set after referencing in relation to the basic position.

Maximum speed, acceleration and jerk

These parameters limit the dynamic of the entire axis. The maximum speed can be entered according to the required maximum speed. For first commissioning, the parameters for acceleration and jerk have got the default value. At setting the axis to greater dynamics, these parameters can be increased.

4.2 Register Description

Register 180: Maximum Acceleration	
Function	**Description**
Read	As-is acceleration value
Write	New acceleration value
Amplifier status	The amplifier has to be deactivated
Takes effect	Wait for the busy-bit in the status to be reset
Variable type	float
Value range	0 ... Pos. float limits [°/s²] oder [mm/s²] (the unit depends on the setting of the axis type)
Value following a reset	100,000 [°/s²]

Here, the maximum acceleration / deceleration of an axis is specified. The amplifier will limit each acceleration, respectively deceleration, to the specified value, even if a greater value has been specified for positioning purposes. Acceleration / deceleration will only be limited for positioning by means of position control.

The axis will also be decelerated according to this parameter, if you issue command 5.

Register 181: Maximum Jerk	
Function	**Description**
Read	Value of the as-is jerk
Write	New value of the jerk
Amplifier status	The amplifier has to be deactivated
Takes effect	Wait for the busy-bit in the status to be reset
Variable type	float
Value range	0 ... Pos. float limits [°/s³] oder [mm/s³] (the unit depends on the setting of the axis type)
Value following a reset	1,000,000 [°/s³]

Here, the maximum permitted jerk for the specific axis is specified. The amplifier will limit the jerk to this value when one kind of motion follows the other one. Jerk limiting is important, especially when linear ramps are applied. The jerk will only be limited for positioning by means of position control.

Register 182: Travel Limit, Positive	
Function	**Description**
Read	Value of the present limit
Write	New value of travel limit
Amplifier status	The amplifier has to be deactivated
Takes effect	Immediately
Variable type	float
Value range	R183 > ... positive float limit [°] or [mm] (the unit depends on the setting of the axis type)
Value following a reset	100,000 [°]

Here, the positive modulo travel range limit of a modulo axis will be specified. The modulo travel range defined in register 193 "Modulo Travel Range" will automatically be calculated as the difference between the positive and the negative travel range.

If your axis is not a modulo axis, this parameter will limit the absolute axis motion in positive direction. This means that, at a positioning run, the target position will always be limited to this value, even if a higher value is entered.

Via register 192 "Modulo Axis", the axis will be set to modulo axis.

Register 183: Travel Limit, Negative	
Function	**Description**
Read	Value of the present limit
Write	New value of travel limit
Amplifier status	The amplifier has to be deactivated
Takes effect	Immediately
Variable type	float
Value range	negative float limits ... < R182 [°] or [mm] (the unit depends on the setting of the axis type)
Value following a reset	-100,000 [°]

Here, the negative modulo travel range limit of a modulo axis will be specified. The modulo travel range defined in register 193 "Modulo Travel Range" will automatically be calculated as the difference between the positive and the negative travel range.

If your axis is not a modulo axis, this parameter will limit the absolute axis motion in negative direction. This means that, at a positioning run, the target position will always be limited to this value, even if a higher value is entered.

Via register 192 "Modulo Axis", the axis will be set to modulo axis.

Register 184: Maximum Speed	
Function	**Description**
Read	Value of the as-is maximum speed
Write	New value of the maximum speed
Amplifier status	The amplifier has to be deactivated
Takes effect	Wait for the busy-bit in the status to be reset
Variable type	float
Value range	0 ... Pos. float limits [°/s] oder [mm/s] (the unit depends on the setting of the axis type)
Value following a reset	18,000 [°/s]

Here, the maximum speed of the mechanic axis is specified. The amplifier limits the speed to this value, even if a higher speed has been set for positioning. Further, this value is necessary for monitoring the maximum acceleration / deceleration and the maximum jerk.

The greatest value that can be input here, is limited by the value in register 118 "Maximum Motor Speed" and by the values of the registers for setting the gearbox factors: Register 194 "Transmission Ratio - Motor", register 195 "Transmission Ratio - Mechanics", and register 196 "Transmission Ratio - Linear / Rotatory".

The value must not be greater than the result of the following formula:

Greatest value R184 = R118 * R196 * R195 / (R194 * 60)

Influences R435 and R436.

Register 193: Modulo Travel Range	
Function	**Description**
Read	As-is value of the virtual travel range
Write	Illegal
Variable type	float
Value range	Float limits [°] or [mm] (the unit depends on the setting of the axis type)
Value following a reset	360 [°]

The modulo travel range will automatically be calculated as the difference between the positive travel range, register 182, and the negative travel range, register 183.

Attention!

If no modulo axis has been set in register 192, the modulo mode is deactivated; this means that the value of this register is not valid and will thus not be calculated as the difference between the values of the travel ranges.

Register 194: Transmission Ratio - Motor	
Function	**Description**
Read	As-is number of motor revolutions
Write	New number of motor revolutions
Amplifier status	The amplifier has to be deactivated
Takes effect	Immediately
Variable type	float
Value range	0.01 ... pos. float limit [rev.]
Value following a reset	1 [rev.]

In case of a rotatory axis, the following parameter will be used for calculating the gear ratio:

$$i = \frac{\text{Number of motor rotations (R194)}}{\text{Number of mechanics / load rotations (R195)}}$$

If, for example, the mechanics rotate once, while the motor rotates ten times, the number of motor rotations must also be set to 10, while the number of mechanic revolutions is set to 1.

In case of a linear axis, the gear ratio, and the additional parameter "Transmission ratio - linear / rotatory" written in register 196, has to be specified. "Transmission ratio linear / rotatory" defines the transition from rotatory to linear mode.

Register 195: Transmission Ratio - Mechanics	
Function	**Description**
Read	As-is number of load rotations
Write	New number of load rotations
Amplifier status	The amplifier has to be deactivated
Takes effect	Immediately
Variable type	float
Value range	0.01 ... pos. float limit [rev.]
Value following a reset	1 [rev.]

Here, the latest rotatory transmission unit must be specified; see description of register 194 "Transmission Ratio - Motor".

Register 196: Linear / Rotation Ratio	
Function	**Description**
Read	As-is transmission ratio
Write	New transmission ratio
Amplifier status	The amplifier has to be deactivated
Takes effect	Immediately
Variable type	float
Value range	0.01 ... pos. float limit [°/rev.] or [mm/rev.]
Value following a reset	360 [°/rev.]

The transmission ratio linear /rotatory is only needed for a linear axis; it describes the linear motion of the axis related to a rotation of the latest rotatory transmission unit written in register 195 "Transmission Ratio - Mechanics".

The parameters "Transmission Ratio - Mechanics", register 195, and "Transmission Ratio - Motor", register 194, also have to be specified.

Register 510: Digital Inputs: Polarity	
Function	**Description**
Read	Value of the as-is input polarity
Write	New value of the input polarity
Amplifier status	The amplifier has to be deactivated
Takes effect	Immediately
Variable type	int / register
Value range	Bit-coded, 16 bits
Value following a reset	0b 00000001 00001111

Here, the polarity of the digital inputs can be specified.

Meaning of values:

0 : 0 V = Logical 1, 24 V = Logical 0

1 : 0 V = Logical 0, 24 V = Logical 1

Meaning of the individual bits:

Bit 0:	ENABLE (cannot be altered)	
Bit 1:	LIMIT + (positive hardware limit switch)	
Bit 2:	LIMIT - (negative hardware limit switch)	
Bit 3:	REF (reference switch)	
Bit 5:	Select (connector coding)	(*
Bit 6:	ENABLE1 (cannot be altered)	(**
Bit 7:	ENABLE2 (cannot be altered)	(**
Bit 8:	INPUT (interrupt input, special application)	

(* This bit is only available with JM-D203.
(** These bits are only available with the amplifier having got the option "Safe Standstill".

Register 511: Digital Inputs: Status	
Function	**Description**
Read	Value of the as-is input circuit state
Write	Illegal
Variable type	int / register
Value range	Bit-coded, 16 bits
Value following a reset	0

The as-is input circuit state of the digital inputs can be read out here. The input circuit state depends on the polarity settings of the digital inputs specified in register 1x510.

Meaning of values:

0 : Not active

1 : Activated

Meaning of the individual bits:

Bit 0:	ENABLE	
Bit 1:	LIMIT + (positive hardware limit switch)	
Bit 2:	LIMIT - (negative hardware limit switch)	
Bit 3:	REF (reference switch)	
Bit 5:	Select (connector coding)	(*
Bit 6:	ENABLE1	(**
Bit 7:	ENABLE2	(**
Bit 8:	INPUT (interrupt input, special application)	

(* This bit is only available with JM-D203.
(** These bits are only available with the amplifier having got the option "Safe Standstill".

5 Motor

5.1 General Information

For motor connection, please refer to the operator's manual of the JM-2xx:

Setting the commutation offset and the pole pair number:

If you apply a motor other than by Jetter, the ´Register 116: Commutation Offset' on page 58 and the ´Register 123: Pole Pair Number' on page 60 have to be set at least.

The pole pair number of Jetter motors has to be set according to the design:

Design	Poles	Pole Pair Number
JL motors	6	3
JK motors	6	3
JH motors*	10	5

* JH2 motors, as well as JL and JK motors, have got 6 poles, respectively 3 pole pairs. Any other JH motors have got 10 poles, respectively 5 pole pairs.

The default value of the pole pair number is 3.

The default commutation offset value is 0. For a motor made by another company it must possibly be adjusted. If required, an appropriate value must be set by Jetter AG.

Setting the back EMF constant:

If highly dynamic drives are used, the parameter voltage constant should be adjusted. For this, please refer to the motor data sheet or the rating plate of the motor. For further information, please turn to the register description ´Register 505: Back EMF Constant' on page 60.

Setting the back EMF constant:

The torque constant is necessary for displaying a valid as-is torque in ´Register 621: As-is Torque' on page 118. If the torque constant equals zero, the as-is torque equals zero as well.

5.2 Synchronous Motor

JM-2xx has been designed for operation of synchronous motors. For this, **a feedback function is always needed**, e.g. resolver, SinCos, HIPERFACE, or EnDat, see chapter 6 "Encoder Feedback", page 67.

5.2.1 Selection of the amplifier

For selecting an adequate amplifier, the continuous rated current and the required maximum speed of the motor are decisive factors.

The continuous rated current of the motor determines the continuous rated current of the amplifier.

The desired speed determines the maximum effective voltage that must be supplied by the amplifier.

Because of the motor-back EMF, the synchronous motor will need a certain effective voltage for a certain speed. The greater the speed, the greater must be the effective voltage. In this case, the relation is linear.

The amplifier can generate a certain maximum effective voltage out of its DC link voltage:

- The amplifier JM-105 supplies a maximum effective voltage of approximately 27 V_{eff} at +Vmot = 48 V DC.
- The amplifiers JM-D203, JM-203 and JM-206 supply a maximum effective voltage of approximately 190 V_{eff}.
- The amplifiers JM-204, JM-208 and JM-215 supply a maximum effective voltage of approximately 320 V_{eff}.

In order to be able to select the amplifier that corresponds to the required maximum speed, the effective voltage, which the motor needs in this case, must be known.

For synchronous motors, the voltage constant stands for the required effective voltage per 1,000 rpm. By means of this parameter, the required effective voltage at the desired maximum speed can be calculated in linear positive or negative direction.

Note!

The effective voltage of the amplifier should have a reserve of approximately 20 % related to the required effective voltage. This reserve is necessary for good controlling.

Example 1: Calculating the effective voltage

A motor with a continuous rated current I_n of 5.7 A and a voltage constant K_E of 51 V_{eff}/1,000 rpm is to be driven by a maximum speed of 3,000 rpm:

Voltage at 3,000 rpm = 51 V_{eff}/1,000 rpm * 3,000 rpm = 153 V_{eff}

with a controlled reserve capacity = 153 V_{eff} + 20 % of 153 V_{eff} = 153 V_{eff} + 30.6 V_{eff} = 183.6 V_{eff}

For I_n = 5.7 A and a required effective voltage of 183.6 V_{eff} , a JM-206 of I_n = 6 A and a supplied effective voltage of 190 V_{eff} is a good choice.

5.2.2 Load current carrying capability

Generally, a synchronous motor can be loaded by double the continuous rated current for a short time.

5.2.3 Parameter setting

The following motor data are needed for parameterization; they must either be read from the rating plate or taken from the data sheet of the motor:

I_n	=	Continuous rated current in the unit [A_{eff}]
Z_P	=	Pole pair number
L_{Motor}	=	Inductivity between 2 motor terminals in the unit [H]
R_{Motor}	=	Resistance between 2 motor terminals in the unit [Ohm]

The following registers must be adjusted for parameterization of the motor:

Function group "Motor"

– ´Register 123: Pole Pair Number’ on page 60

Function group "Encoder Feedback":

– ´Register 577: Encoder Type’ on page 75

Function group "Current Control":

– ´Register 503: Current Control K_p’ on page 112
– ´Register 504: Current Control T_n’ on page 115
– ´Register 618: Rated Current’ on page 116
– ´Register 619: Overload Factor’ on page 117

5.2.4 Parametering example

The nameplate of a JH-0190-42 servo motor displays the following particulars:

Parameter	Value
Continuous stall torque M_0	1.9 Nm
Rated speed N_n	3000 rev/min
Rated voltage U_{DC}	320 V
Continuous rated current I_N	2.43 A

Further particulars of the data sheet:

Parameter	Value
Back EMF constant K_E	42 V*min/1000
Torque constant K_T	0.69 Nm/A
Winding resistance R_{PH}	4 Ω
Winding inductance L_{PH}	15.4 mH
Motor pole number P_{Mot}	10

(1) The pole pair number $\mathbf{Z_P}$ is calculated as follows:

$$Z_P = P_{Mot}/2$$

The following applies to the operand:

P_{Mot} = Number of motor poles

Sample motor:

$$Z_P = 10/2 = 5$$

(2) The parameter T_n of the unit [ms] is calculated as follows:

$$T_n = \frac{L_{Motor}}{R_{Motor}}$$

The following applies to the operands:

L_{Motor} = Inductivity between 2 motor terminals in the unit [H] -> motor data sheet, or find out by measuring.

R_{Motor} = Resistance between 2 motor terminals in the unit [Ω] -> Motor data sheet, respectively measuring.

Sample motor: $T_n = \frac{15.4\ mH}{4.0\ \Omega} = 3.85\ ms$

(3) The proportional amplification of the current controller K_p is calculated as follows:

$$K_P = \frac{I_{eff} \cdot L_{Motor}}{2 \cdot T_s \cdot U_{DC}}$$

The following applies to the operands:

I_{eff}	=	Maximum output current in the unit [A_{eff}] -> value of register 618 "Rated Current ($_q$)", multiplied by the value of register 619 "Overload Factor"
L_{Motor}	=	Inductivity between 2 motor terminals in the unit [H] -> motor data sheet, or find out by measuring.
T_s	=	The sum of the small time constants in the unit [s] -> T_s is always 0.000042 s in JM-2xx.
U_{DC}	=	UDC = DC link voltage of the amplifier in the unit [V]

Sample motor at U_{DC} = 320 V and overload factor = 2:

$$:K_P = \frac{2 \cdot 2.43\ A_{eff} \cdot 15.4\ mH}{2 \cdot 42\ \mu s \cdot 320\ V} = 2.78$$

5.3 Asynchronous Motor

Besides synchronous motors, asynchronous motors can also be driven by the JM-2xx. For this, **a feedback function will always be needed**, e.g. resolver or incremental encoder, see chapter 6 "Encoder Feedback", page 67. Further, an asynchronous motor is **always** only permitted to be driven by the JM-2xx as **wye**.

5.3.1 Wye

The motor winding is only permitted to be driven as wye:

Wye

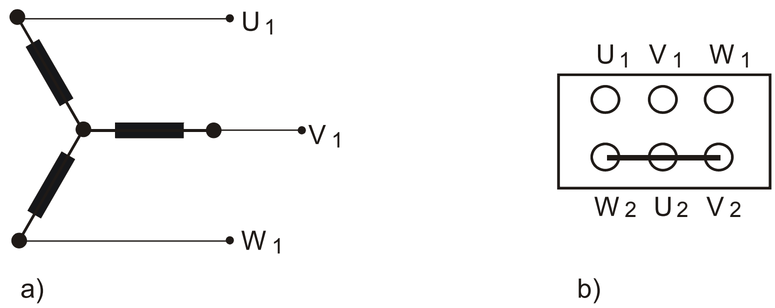
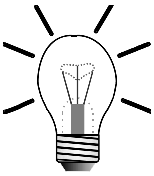


Fig. 3: Wye: a) Motor winding b) Connection terminal plate

5.3.2 Selection of the amplifier

For selecting an adequate amplifier, the continuous rated current and the required maximum speed of the motor are decisive factors.

The continuous rated current of the motor determines the continuous rated current of the amplifier.



Note!

The current that is needed for the asynchronous motor, is divided into two components, which are the magnetizing current I_d and the active current I_q. The amplifier must always be able to supply the whole amount of current, which is made up by both components. The continuous rated current of the motor is the total amount of current needed with rated load.

The desired speed determines the maximum effective voltage that must be supplied by the amplifier.

Because of the motor-back EMF, the asynchronous motor will need a certain effective voltage for a certain speed. The greater the speed, the greater must be the effective voltage. In this case, the relation is linear.

The amplifier can generate a certain maximum effective voltage out of its DC link voltage:

- The amplifier JM-105 supplies a maximum effective voltage of approximately 27 V_{eff} at +Vmot = 48 V DC.
- The amplifiers JM-D203, JM-203 and JM-206 supply a maximum effective voltage of approximately 190 V_{eff}.
- The amplifiers JM-204, JM-208 and JM-215 supply a maximum effective voltage of approximately 330 V_{eff}.

In order to be able to select the amplifier that corresponds to the required maximum speed, the effective voltage, which the motor needs in this case, must be known. Other than with synchronous motors, there is usually no specification of the voltage constant for asynchronous motors (Ke). Regarding synchronous motors, the voltage that is needed per 1,000 rpm is specified in the unit [V_{eff}].

Note!

The speed of asynchronous motors designed for direct 3-phase online-operation has usually been rated to a mains voltage of 400 V_{eff}. In a wye, this motor connected to a JM-204, JM-208 or a JM-215 will not be able to reach the rated speed. For this reason, only asynchronous motors should be used that are apt for operation with a frequency converter.

Asynchronous motors that have been designed for operation with frequency converters, have normally got a specification of the effective voltage needed for reaching the rated speed in a wye.

From the effective voltage that is needed for reaching the rated speed, linear downward or upward calculation can be made in order to reach the required effective voltage at the desired speed.

Note!

The effective voltage of the amplifier should have a reserve of approximately 20 % related to the required effective voltage. This reserve is necessary for good controlling.

Example 2: Calculation for asynchronous motors

With a wye, an asynchronous motor has got the rated current I_n= 3.15 A and the rated speed n_n = 1,370 rpm at a voltage of 133 V_{eff}. The motor is to be driven by a maximum speed of 1,000 rpm:

Voltage at 1,000 rpm = 133 V_{eff}/1,000 rpm * 1,370 rpm = 97 V_{eff}

with a controlled reserve capacity = 97 V_{eff} + 20 % of 97 V_{eff} = 97 V_{eff} + 19.4 V_{eff} = 116.4 V_{eff}

For I_n = 3.15 A and a required effective voltage of 116.4 V_{eff} , a JM-203 of I_n = 3 A and a supplied effective voltage of 190 V_{eff} is a good choice.

5.3.3 Load current carrying capability

Generally, an asynchronous motor can be loaded by 1.5 times the continuous rated current for a short time. The normally proportional ratio between current and torque can turn into a non-proportional ratio even before this loading.

5.3.4 Operation with field weakening

Field weakening is used for increasing the speed of an asynchronous motor, while the effective voltage remains the same. In turn, the torque decreases.

If a JetMove is applied, operation with field weakening is not possible.

5.3.5 Parameter setting

The following motor data are needed for parameterization; they must either be read from the rating plate or taken from the data sheet of the motor: Both inductivity and resistance might have to be measured between two motor terminals:

f_n	=	Rated frequency in the unit [Hz] (mostly 50 Hz)
I_n	=	Continuous rated current in the unit [A_{eff}] Depends on the connections of the motor winding
n_n	=	Rated speed in the unit [rpm] Depends on the connections of the motor winding
cos phi	=	Rated service factor
L_{Motor}	=	Inductivity between 2 motor terminals in the unit [H] Depends on the connections of the motor winding
R_{Motor}	=	Resistance between 2 motor terminals in the unit [Ω] Depends on the connections of the motor winding

Additionally, the following motor data are needed; they can be derived from the data specified above, though:

n_{sync}	=	Synchronous motor speed at a rated speed in the unit [rpm] (auxiliary quantity for calculating f_{slip})
Z_P	=	Pole pair number
f_{slip}	=	Rated slip frequency in the unit [Hz]
I_q	=	Continuous rated current / rated active power generating the torque, in the unit [A_{eff}] (auxiliary quantity for calculating I_d]
I_d	=	Rated magnetizing current in the unit [A_{eff}]

The following registers must be adjusted for parameterization of the motor:

Function group "Motor"

– ´Register 121: Magnetizing Current' on page 109
– ´Register 122: Slip Frequency' on page 59
– ´Register 123: Pole Pair Number' on page 60

Function group "Encoder Feedback":

– ´Register 577: Encoder Type' on page 75

Function Group "Current Control":

– ´Register 503: Current Control K_p' on page 112
– ´Register 504: Current Control T_n' on page 115
– ´Register 618: Rated Current' on page 116
– ´Register 619: Overload Factor' on page 117

5.3.6 Parametering example

The nameplate of an asynchronous motor displays the following particulars:

Parameter	Delta connection	Wye
Voltage	135 V	230 V
I_n	16 A	9.3 A
cos phi	0.79	
f_n	50 Hz	
n_n	1420 rpm	

As for the JetMove only the wye can be applied, the values of the wye are used for calculations.

The values for L_{Motor} and R_{Motor} can been specified by measuring.
Sample motor: L_{Motor} = 11.6 mH and R_{Motor} = 2 Ω

(1) The pole pair number $\mathbf{Z_P}$ at a rated frequency of 50 Hz can be read out of the following table:

Z_P	n_{sync} [rpm]	n_n [rpm]
1	3,000	2,760 - 2,910
2	1,500	1,380 - 1,455
3	1,000	920 - 970
4	750	690 - 730

Sample motor: $\mathbf{Z_P}$= 2

(2) The slip frequency f_{slip} is calculated as follows: $f_{slip} = \frac{(n_{sync} - n_n) \cdot Z_P}{60\frac{s}{min}}$

The following applies to the operands:

n_n	=	Rated motor speed in the unit [rpm], at a rated frequency (e. g. 50 Hz) and a rated torque as specified on the > nameplate
n_{sync}	=	Synchronous motor speed in the unit [rpm] -> The value is obtained by means of the rated speed (it is about 3 % - 8 % smaller than the synchronous speed, see exemplary numbers below)
Z_P	=	Pole pair number, see> motor data sheet, or obtain by means of synchronous speed and rated frequency

Sample motor: $f_{slip} = \dfrac{\left(1500\frac{U}{min} - 1420\frac{U}{min}\right) \cdot 2}{60\frac{s}{min}} = 2.66\ Hz$

(3) The rated current generating the torque (rated active current) I_q in the unit [A_{eff}] is calculated as follows:

$$I_q = I_n \cdot \cos(\varphi)$$

The following applies to the operands:

I_n	=	Continuous rated current in the unit [A_{eff}] -> nameplate, dependent on the motor winding connection
cos phi	=	Rated service factor -> nameplate of the motor

Sample motor:

$$I_q = 9.3\ A_{eff} \cdot 0.79 = 7.34\ A_{eff}$$

(**4)** The magnetizing current I_d is calculated as follows:

$$I_d = \sqrt{I_n^2 - I_q^2}$$

The following applies to the operands:

I_n	=	Continuous rated current in the unit [A_{eff}] -> nameplate, dependent on the motor winding connection
I_q	=	Rated magnetizing current in the unit [A_{eff}] -> ´Register 618: Rated Current’ on page 116

Sample motor: $I_d = \sqrt{9.3\ A_{eff}^2 - 7.34\ A_{eff}^2} = 5.71\ A_{eff}$

(5) The parameter T_n of the unit [ms] is calculated as follows:

$$T_n = \frac{L_{Motor}}{R_{Motor}}$$

Sample motor: $T_n = \frac{11.6\ \mathrm{mH}}{2.0\ \Omega} = 5.8\ \mathrm{ms}$

(6) The proportional amplification of the current controller K_p is calculated as follows:

$$K_P = \frac{I_{eff} \cdot L_{Motor}}{2 \cdot T_s \cdot U_{DC}}$$

The following applies to the operands:

I_{eff}	=	Maximum output current in the unit [A_{eff}] -> value of register 618 "Rated Current ($_q$)", multiplied by the value of register 619 "Overload Factor"
L_{Motor}	=	Inductivity between 2 motor terminals in the unit [H] -> motor data sheet, or find out by measuring. (In asynchronous motors, the inductivity depends on the motor winding connection. As in a JetMove only the wye can be used, an inductivity has to be used with the wye here.)
T_s	=	The sum of the small time constants in the unit [s] -> T_s is always 000042 s in JM-2xx.
U_{DC}	=	UDC = DC link voltage of the amplifier in the unit [V]

Sample motor at U_{DC} = 560 V and overload factor = 1.5:

$$K_P = \frac{1.5 \cdot 7.34\ A_{eff} \cdot 11.6\ \mathrm{mH}}{2 \cdot 42\ \mu s \cdot 560\ V} = 2.71$$

5.4 Stepper Motor

3-phase asynchronous motors can also be driven by the JM-2xx. For this, **feedback is not needed**.

5.4.1 Parameter setting

The following motor data are needed for parameterization; they must either be read from the rating plate or taken from the data sheet of the motor:

I_n	=	Continuous rated current in the unit [A_{eff}]
Z_P	=	Pole pair number
L_{Motor}	=	Inductivity between 2 motor terminals in the unit [H]
R_{Motor}	=	Resistance between 2 motor terminals in the unit [Ohm]

The following registers must be adjusted for parameterization of the motor:

Function group "Motor"

– ´Register 123: Pole Pair Number’ on page 60

Function group "Encoder Feedback":

– ´Register 577: Encoder Type’ on page 75

Function group "Current Control":

– ´Register 503: Current Control K_p’ on page 112
– ´Register 504: Current Control T_n’ on page 115
– ´Register 618: Rated Current’ on page 116
– ´Register 619: Overload Factor’ on page 117

Function group "Speed Control":

– ´Register 124: Speed Controller K_p’ on page 125
– ´Register 126: Speed Controller T_n’ on page 125
– ´Register 231: Current Reduction’ on page 111
– ´Register 232: Current Reduction Time’ on page 111
– ´Register 506: Speed Controller Preset’ on page 127

For stepper motors, there is no encoder system for position recording. For this reason, the virtual encoder type (value 11) has to be set by means of ´Register 577: Encoder Type’ on page 75.

Because of the missing encoder system, there is no physical as-is speed value either. Thus, ´Register 124: Speed Controller K_p’ on page 125 has to be set to "0". This causes the speed control to become ineffective.

The current setpoint needed for operation has to be predefined by means of ´Register 506: Speed Controller Preset’ on page 127. At activating the controller, the integral-action component of the speed controller is set accordingly, which can be checked via “Register 507: I-Component Speed Controller”. This value is displayed in “Register 125: Current Setpoint” at the current controller.

In order to activate current reduction, the desired value has to be written to ´Register 231: Current Reduction’ on page 111. Current reduction is activated, if the position setpoint of the position control remains unchanged over the set time.
Current reduction internally accesses ´Register 127: Current Limitation’ on page 110. When it is activated, current reduction limits the current setpoint of the speed control. This limitation is cancelled at the next change of position controller setpoint.

Note!

At activating current reduction, blocking monitoring has to be deactivated as well. This can be done via ´Register 546: Blocking Protection - Tripping Time’ on page 95 = 65535.

When the configuration steps mentioned above have been carried out, the stepper motor axis can be activated and moved as usual. Of course, only functions can be made use of that do not need any physical as-is position and torque value.

5.4.2 Parametering example

The nameplate of a motor displays the following particulars:

Parameter	Value
Continuous rated current I_N	2.43 A
Winding resistance R_{PH}	4,0 Ω
Winding inductance L_{PH}	15.4 mH
Motor pole number P_{Mot}	10

(1) The pole pair number $\mathbf{Z_P}$ is calculated as follows:

$$Z_P = P_{Mot}/2$$

The following applies to the operand:

P_{Mot} = Number of motor poles

Sample motor:

$$Z_P = 10/2 = 5$$

(2) The parameter T_n of the unit [ms] is calculated as follows:

$$T_n = \frac{L_{Motor}}{R_{Motor}}$$

The following applies to the operands:

L_{Motor}	=	Inductivity between 2 motor terminals in the unit [H] -> motor data sheet, or find out by measuring.
R_{Motor}	=	Resistance between 2 motor terminals in the unit [Ω] -> Motor data sheet, respectively measuring.

Sample motor: $T_n = \frac{15.4\ \text{mH}}{4.0\ \Omega} = 3.85\ \text{ms}$

(3) The proportional amplification of the current controller K_p is calculated as follows:

$$K_P = \frac{I_{eff} \cdot L_{Motor}}{2 \cdot T_s \cdot U_{DC}}$$

The following applies to the operands:

I_{eff}	=	Maximum output current in the unit [A_{eff}] -> value of register 618 "Rated Current ($_q$)", multiplied by the value of register 619 "Overload Factor"
L_{Motor}	=	Inductivity between 2 motor terminals in the unit [H] -> motor data sheet, or find out by measuring.
T_s	=	The sum of the small time constants in the unit [s] -> T_s is always 0.000042 s in JM-2xx.
U_{DC}	=	DC link voltage of the amplifier in the unit [V]

Sample motor at U_{DC} = 320 V and overload factor = 2:

$$K_P = \frac{2 \cdot 2.43\ A_{eff} \cdot 15.4\ \text{mH}}{2 \cdot 42\ \mu\text{s} \cdot 320\ \text{V}} = 2.78$$

(4) The preset value of the speed controller is typically set to the rated motor current.

5.5 Linear Motor

JM-2xx has been designed for operation of linear motors. For this, **a feedback function will always be needed**, e.g. incremental encoder, SinCos, or EnDat, see chapter 6 "Encoder Feedback", page 67.
If an absolute encoder has not been attached to a linear motor, either commutation finding has to be carried out, or the application program has to be written to ´Register 116: Commutation Offset’ on page 58.

Attention:

A linear motor has been designed for high acceleration and speed. Special emphasis has to be laid on machine and occupational safety at commissioning the motor and the attached encoder.

5.5.1 Selection of the amplifier

For selecting an adequate amplifier, the continuous rated current and the required maximum speed of the motor are decisive factors.

The continuous rated current of the motor determines the continuous rated current of the amplifier.

The desired speed determines the maximum effective voltage that must be supplied by the amplifier.

Because of the motor-back EMF, the linear motor will need a certain effective voltage for a certain speed. The greater the speed, the greater has to be the effective voltage. In this case, the relation is linear.

The amplifier can generate a certain maximum effective voltage out of its DC link voltage:

- The amplifier JM-105 supplies a maximum effective voltage of approximately 27 V_{eff} at +Vmot = 48 V DC.
- The amplifiers JM-D203, JM-203 and JM-206 supply a maximum effective voltage of approximately 190 V_{eff}.
- The amplifiers JM-204, JM-208 and JM-215 supply a maximum effective voltage of approximately 320 V_{eff}.

In order to be able to select the amplifier that corresponds to the required maximum speed, the effective voltage, which the motor needs in this case, must be known.

In linear motors, the back EMF constant specifies the RMS voltage per speed unit in m/s. By means of this parameter, the required effective voltage at the desired maximum speed can be calculated in linear positive or negative direction.

Note!

The RMS voltage of the amplifier should have a reserve of approximately 20 % related to the required RMS voltage. This reserve is necessary for good controlling.

Example 3: Calculating the RMS voltage

A linear motor with a continuous rated current I_n of 6.8 A and a voltage constant K_E of 91 V_{eff}/m/s is to be driven by a maximum speed of 3 m/s:

Voltage at 35 m/s = 91 V_{eff}/m/s * 3 m/s = 273 V_{eff}

with a controlled reserve capacity = 273 V_{eff} + 20 % of 273 V_{eff} = 273 V_{eff} + 54.6 V_{eff} = 327 V_{eff}

For I_n = 6.8 A and a required effective voltage of 327 V_{eff} , a JM-208 of I_n = 8 A and a supplied effective voltage of 320 V_{eff} is a good choice.

5.5.2 Load current carrying capability

Generally, a linear motor can be loaded by three to four times the continuous rated current for a short time.

5.5.3 Parameter setting

The following motor data are needed for parameterization; they must either be read from the rating plate or taken from the data sheet of the motor:

I_n	=	Continuous rated current in the unit [A_{eff}]
P	=	Pole pair pitch [m]
L_{Motor}	=	Inductivity between 2 motor terminals in the unit [H]
R_{Motor}	=	Resistance between 2 motor terminals in the unit [Ohm]

The following registers have to be adjusted for parameterization of the motor:

Note!

In software version 29, parts of parametering have to be converted to revolution values.

Please mind especially the connection to the encoder applied:
Registers for encoder adjustment: See chapter 6 "Encoder Feedback", page 67.

Function group "Motor"

- ´Register 123: Pole Pair Number’ on page 60

Function group "Current Control":

- ´Register 503: Current Control K_p’ on page 112
- ´Register 504: Current Control T_n’ on page 115
- ´Register 618: Rated Current’ on page 116
- ´Register 619: Overload Factor’ on page 117

5.5.4 Example: Parameter setting

- A linear motor has got a pole pair pitch P (north pole to north pole) of 32 mm.
- A sine incremental encoder has been attached to the motor.
- The motor has got a back EMF constant K_U of 91 V_{eff}/m/s.

1. If the ratio of encoder sine length and pole pitch is an integer value, ´Register 123: Pole Pair Number’ on page 60 should be set to value 1. Otherwise, the lowest common multiple has to be found and the pole pair number increased respectively.
2. The converted value of ´Register 505: Back EMF Constant’ on page 60 is

$$K_E = \frac{K_U \cdot P \cdot 1000}{60\frac{s}{min}} = \frac{91\frac{V}{m/s} \cdot 32\ mm \cdot 1000}{60\frac{s}{min}} = 48.53\frac{V}{1000\ \frac{rev}{min}}$$

3. The maximum motor speed at using a 400 V output stage is

$$nax.\ speed = \frac{(effective)\ voltage}{K_U} = \frac{320\ V}{91\frac{V}{m/s}} = 3.51\ \frac{m}{s}$$

4. The maximum speed is to amount to 3 m/s. The value of ´Register 118: Maximum Motor Speed’ on page 124 is calculated as follows:

$$max.\ speed = \frac{3.0\ \frac{m}{s}}{32\ \frac{mm}{rev}} = 93.75\ \frac{rev}{s} = 5625\ \frac{rev}{min}$$

Note!

For testing the sense of rotation of the motor phases at the motor, the controllers can be switched into operation of a stepper motor of low current.
Then, a small speed is set in speed mode, until the sense of motor rotation can be recognized. This sense of rotation can be compared with the counting direction of the connected encoder.

5.6 Brush-Type DC Motor

The JM-105 is also designed for operation of brush-type DC motors. Generally, in this case, an incremental encoder is applied, see chapter 6.5 "Incremental Encoder", page 71. The DC motor carries out commutation automatically.

5.6.1 Parameter setting

The following registers have to be adjusted for parameterization of the motor:

Function group "Motor"

– If a DC motor is applied, value 6 has to be written to ´Register 608: Motor Type’ on page 64.
– If a DC motor is applied, value 1 has always to be written to ´Register 123: Pole Pair Number’ on page 60.

Function group "Encoder Feedback":

– ´Register 577: Encoder Type’ on page 75

Function group "Current Control":

– ´Register 503: Current Control K_p’ on page 112
– ´Register 504: Current Control T_n’ on page 115
– ´Register 618: Rated Current’ on page 116
– ´Register 619: Overload Factor’ on page 117

5.7 2-Phase (Stepper) Motor

The JM-105 is also designed for operation of 2-phase motors.
Firstly, a 2-phase motor can be a stepper motor, which is generally applied without feedback.
Secondly, linear motors of the LinMot company can be applied. These motors have got a two-channel inductive feedback with 5 Vss, similar to a sin-cos encoder.

5.7.1 Parametering a stepper motor

The following registers have to be adjusted for parameterization of the motor:

Function group "Motor"

– If a 2-phase stepper motor is applied, value 5 has always to be written to ´Register 608: Motor Type’ on page 64.
– If a 2-phase stepper motor is applied, value 50 has always to be written to ´Register 123: Pole Pair Number’ on page 60.

Function group "Encoder Feedback":

– ´Register 577: Encoder Type’ on page 75

Function group "Current Control":

– ´Register 503: Current Control K_p’ on page 112
– ´Register 504: Current Control T_n’ on page 115
– ´Register 618: Rated Current’ on page 116
– ´Register 619: Overload Factor’ on page 117

Function group "Speed Control":

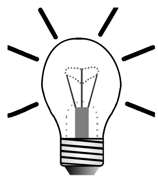
– ´Register 124: Speed Controller K_p’ on page 125
– ´Register 231: Current Reduction’ on page 111
– ´Register 232: Current Reduction Time’ on page 111

For stepper motors, there is no encoder system for position recording. For this reason, the virtual encoder type (value 11) has to be set by means of ´Register 577: Encoder Type’ on page 75.

Because of the missing encoder system, there is no physical as-is speed value either. Thus, ´Register 124: Speed Controller K_p’ on page 125 has to be set to "0". This causes the speed control to become ineffective.

The current setpoint needed for operation has to be predefined by means of ´Register 506: Speed Controller Preset’ on page 127. At activating the controller, the integral-action component of the speed controller is set accordingly, which can be checked via “Register 507: I-Component Speed Controller”. This value is displayed in “Register 125: Current Setpoint” at the current controller.

In order to activate current reduction, the desired value has to be written to ´Register 231: Current Reduction’ on page 111. Current reduction is activated, if the position setpoint of the position control remains unchanged over the set time. Current reduction internally accesses ´Register 127: Current Limitation’ on page 110. When it is activated, current reduction limits the current setpoint of the speed control. This limitation is cancelled at the next change of position controller setpoint.



Note!

At activating current reduction, blocking monitoring has to be deactivated as well. This can be done via ´Register 546: Blocking Protection - Tripping Time’ on page 95 = 65535.

When the configuration steps mentioned above have been carried out, the stepper motor axis can be activated and moved as usual. Of course, only functions can be made use of that do not need any physical as-is position and torque value.

5.7.2 Parametering a LinMot

The following registers have to be adjusted for parameterization of the motor:

Function group "Axis":

– If a LinMot is applied, value 200 mm has to be written to ´Register 196: Linear / Rotation Ratio’ on page 31.

Function group "Motor"

– If a 2-phase motor is applied, value 5 has always to be written to ´Register 608: Motor Type’ on page 64.
– If a LinMot is applied, value 1 has to be written to ´Register 123: Pole Pair Number’ on page 60.

Function group "Encoder Feedback":

– The value for "LinMot" (value 16) has to be written to ´Register 577: Encoder Type’ on page 75.

Function group "Current Control":

– ´Register 503: Current Control K_p’ on page 112
– ´Register 504: Current Control T_n’ on page 115
– ´Register 618: Rated Current’ on page 116
– ´Register 619: Overload Factor’ on page 117

5.8 Brake

The connection of the brake and the electrical data have been described in the operator's manual of the JetMove 2xx.

The motor holding brake can optionally be controlled either by the amplifier directly or by hand.

The JetMove 105 and the JetMove D203 have got a semiconductor switch to generate an error message at overcurrent.
With all other amplifiers of the JetMove 200 series, the brake is controlled via a relay in the amplifier.

5.8.1 Parameter setting

The following parameters for handling the brake are available:

- ´Register 540: Drive Mode’ on page 392
- ´Register 548: Delay After Locking the Motor Brake’ on page 62
- ´Register 547: Delay After Releasing the Motor Brake’ on page 61
- ´Register 574: Control Word 2 (Motor Brake Control)’ on page 396
- ´Register 575: Status Word 2 (Motor Brake Status)’ on page 396

Via register 540 "Drive Mode 1", a choice can be made between automatic and manual operation of the brake.:

Bit 0:	0	=	Manual operation of the brake by the user (via register 574 "Control Word 2")
	1	=	Automatic operation of the brake by the amplifier (The brake will automatically be released, respectively locked, when the amplifier is activated, respectively deactivated)

The automatic mode is set by default.

If the default values are kept, automatic operation will be set. While selecting the mode of operation, the brake will always be controlled at activating and deactivating the amplifier. At switching on, the relay contacts will be closed; at switching off, the relay contacts will be released again.

Release and lock times of various brakes differ dependent on the respective motor manufacturers and motor types. For this reason, it might be necessary to adjust the delay times for releasing and locking the brake to your requirements. For this, please turn to the register description for the parameters ´Register 547: Delay After Releasing the Motor Brake’ on page 61 and ´Register 548: Delay After Locking the Motor Brake’ on page 62.

Please mind the following delay times:

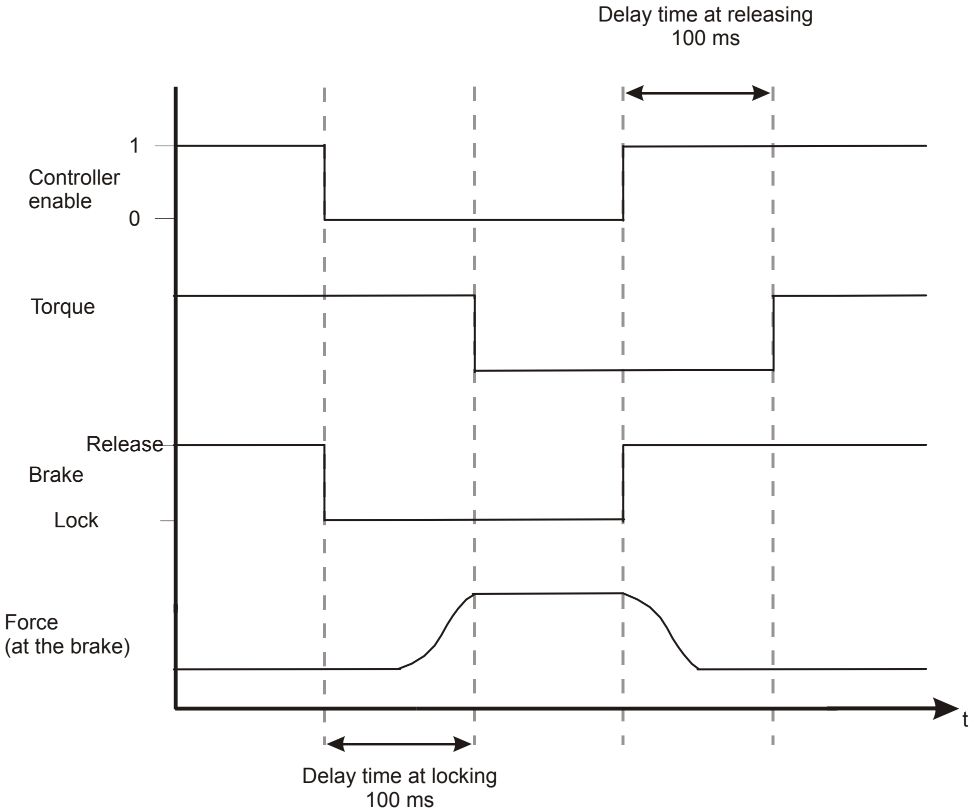


Fig. 4: Delay time of the motor brake control

If there is no brake, automatic mode can be set. This would mean, though, that the relay is always be controlled via the amplifier. Otherwise, you can select the manual mode to prevent the relay from being controlled.

If manual operation is selected, the brake can be controlled by bit 0 via register 574 "Control Word 2". In automatic mode, setting and resetting the bit is of no effect.

Bit 0:	0	=	Lock brake
	1	=	Release the brake

The control state of the brake can be read out of register 575 "Status Word 2" in bit 0 any time:

Bit 0:	0	=	Brake is locked
	1	=	Brake has been released

5.9 Description of Registers

In the column "R/W", the type of access to a parameter is identified:

R	=	Read
W	=	Write

Register 116: Commutation Offset	
Function	**Description**
Read	Value of the as-is offset
Write	Set value of the offset
Amplifier status	The amplifier has to be deactivated
Takes effect	Immediately
Variable type	float
Value range	-180 ... 180 [°]
Value following a reset	0 [°]

Here, the commutating offset of the motor will be specified. This machine parameter has been reserved for special applications. If required, the parameter is defined by the manufacturer.

Register 122: Slip Frequency	
Function	**Description**
Read	Value of the as-is slip frequency
Write	Set value of the slip frequency
Amplifier status	The amplifier has to be deactivated
Takes effect	Immediately
Variable type	float
Value range	0 ... 7.8 [Hz]
Value following a reset	0 [Hz]

Only for asynchronous motors:

Here, the rated slip frequency f_{slip} is entered in the unit [Hz]. f_{slip} is calculated as follows:

$$f_{slip} = \frac{(n_{sync} - n_n) \cdot Z_P}{60\frac{s}{min}}$$

The following applies to the operands:

n_n	=	Rated motor speed in the unit [rpm], at a rated frequency (e. g. 50 Hz) and a rated torque as specified on the > nameplate
n_{sync}	=	Synchronous motor speed in the unit [rpm] -> The value is obtained by means of the rated speed (it is about 3 % - 8 % smaller than the synchronous speed, see exemplary numbers below)
Z_P	=	Pole pair number, see> motor data sheet, or obtain by means of synchronous speed and rated frequency

Examples of synchronous speeds and pole pair numbers at a rated frequency of 50 Hz:

Z_P	n_{sync} [rpm]	n_n [rpm]
1	3,000	2,760 - 2,910
2	1,500	1,380 - 1,455
3	1,000	920 - 970
4	750	690 - 730

See also chapter 5.3 "Asynchronous Motor", page 40.

Register 123: Pole Pair Number	
Function	**Description**
Read	Value of the as-is pole pair number
Write	Set pole pair number
Amplifier status	The amplifier has to be deactivated
Takes effect	Immediately
Variable type	int / register
Value range	1 ... 200
Value following a reset	3

Here, the pole pair number of the motor is entered. This can be taken from the motor data sheet. For Jetter motors, the pole pair number usually is 3, respectively 5.

For asynchronous motors, please refer to the description of register 122 "Slip Frequency".

Register 505: Back EMF Constant	
Function	**Description**
Read	Value of the as-is voltage constant
Write	Set value of the voltage constant
Amplifier status	The amplifier has to be deactivated
Takes effect	Immediately
Variable type	int / register
Value range	0 ... 120 [V*min/1,000]
Value following a reset	0 [V*min/1,000]

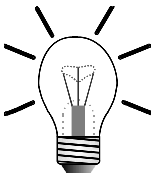
Here, the voltage constant of the motor is entered. The value of the voltage constant can be taken from the motor parameters.
The voltage constant of the Jetter motor has also been specified on the nameplate: Jetter motors of the type JL3-300-**25**-3 have got a voltage constant of **25** V*min/ 1,000.

In case a high dynamic performance is required by the drive, this parameter should be adjusted.

Register 547: Delay After Releasing the Motor Brake	
Function	**Description**
Read	As-is delay time
Write	Set delay time
Amplifier status	The amplifier has to be deactivated
Takes effect	Immediately
Variable type	int / register
Value range	0 ... 200 [ms]
Value following a reset	0 [ms]

Only for motors equipped with a brake:

Only for motors equipped with a brake. The motor brake is released immediately after issuing command 1 "Activate Output Stage". This means that the status"Brake Released" is active immediately. Not before the delay time has expired, the motor is energized and the axis controlled. The delay time can differ between various manufacturers or motor types.



Attention!

The predefined value of this parameter may only be altered by experienced users.

The following commands have an impact on releasing the brake:
- Issuing command 1 - > The brake is released.
- Setting bit 0 in register 574 "Control word 2" - > The brake is released, when the brake control has been set to "manual operation".

See also chapter 5.8 "Brake", page 56.

Register 548: Delay After Locking the Motor Brake	
Function	**Description**
Read	As-is delay time
Write	Set delay time
Amplifier status	The amplifier has to be deactivated
Takes effect	Immediately
Variable type	int / register
Value range	0 ... 200 [ms]
Value following a reset	100 [ms]

Only for motors equipped with a brake:

Here, the delay time is specified which passes (after issuing command 2 "Deactivate output stage"), until the brake has really been locked. When this time has passed, the brake is in the "Brake has been locked" state.
Up to then, the axis will still be controlled.
The delay time can differ between various motor manufacturers or motor types.

The following commands have an impact on locking the brake:

- Issuing command 2 - The brake is locked
- Resetting bit 0 in register 574 "Control Word 2" - The brake is locked, when the brake control has been set to "manual operation".

See also chapter 5.8 "Brake", page 56.

Register 562: Motor Temperature	
Function	**Description**
Read	As-is motor temperature
Write	Illegal
Variable type	int / register
Value range	1 ... 155 [°C]
Value following a reset	0 [°C]

If a motor with temperature switch is used, 1 °C is displayed for the "locked" state, while 155 °C is displayed for the "released" state.

Register 565: Motor Shaft Position	
Function	**Description**
Read	As-is position of the shaft
Write	Illegal
Variable type	float
Value range	-180 ... 180 [°]
Value following a reset	0 [°]

The as-is position of the motor shaft can be read out by means of this parameter.

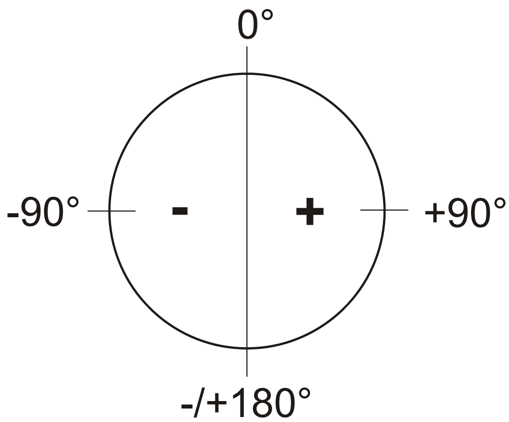


Fig. 5: Motor shaft position

Register 608: Motor Type	
Function	**Description**
Read	As-is motor type
Write	Set motor type
Amplifier status	The amplifier has to be deactivated
Takes effect	Immediately
Variable type	int / register
Value range	0 ... 6
Value following a reset	0

.

Attention!

This register has to be changed at a JM-105, if a DC or 2-phase (stepper) motor is applied.

Dependent on the motor type, the motor lines are controlled during operation. The following motor types are possible:

0	=	3-phase synchronous motor
1	=	3-phase asynchronous motor
4	=	3-phase stepper motor
5	=	2-phase (stepper) motor
6	=	DC motor

Register 609: Type of Motor Temperature Sensor	
Function	**Description**
Read	As-is type of motor temperature sensor
Write	Set type of motor temperature sensor
Amplifier status	No specific status
Takes effect	Immediately
Variable type	int / register
Value range	0 ... 3
Value following a reset	1

.

Attention!

This register is only available for JetMove D203.

The motor temperature sensor type is entered there.
The following sensor types are possible:

0 = Thermostat; display 0° C, respectively 155 °C

1 = KTY83-110; temperature display in °C

2 = KTY84-130; temperature display in °C

3 = PTC; display 0 °C respectively 155 °C

The motor temperature can be read out of register 562.

Register 616: Motor Torque Constant Kt	
Function	**Description**
Read	As-is torque constant
Write	Set torque constant
Amplifier status	No specific status
Takes effect	Immediately
Variable type	float
Value range	0 ... 2.55 [Nm/A]
Value following a reset	0 [Nm/A]

Here, the torque constant of the motor will be specified. Specifying the torque constant is necessary for displaying the as-is torque in register 621 "As-is ("Actual") Torque". If the torque constant is 0, 0 is also displayed for the as-is torque.

6 Encoder Feedback

6.1 Encoder Connection

6.1.1 JM-203, JM-206, and JM-215

The amplifiers JM-203, JM-206, and JM-215 have to be ordered according to the encoder in use. In this case, a difference is made between amplifiers with resolver evaluation and resolvers with HIPERFACE evaluation. If, for example, a sine incremental encoder is applied, it can only function in combination with an encoder featuring HIPERFACE evaluation, as the signals resemble those of a HIPERFACE encoder.

The following list is to show which encoder evaluation will be needed for which encoder type:

Encoder	
Resolver	Resolver evaluation
HIPERFACE	HIPERFACE evaluation
SinCos	HIPERFACE evaluation
Incremental encoder	Resolver evaluation

In the ordering code, the contraction of the encoder evaluation code is attached to the encoder type number. The ordering code for a JM-203 with resolver evaluation reads as follows:

JM-203-230-RS

For the same amplifier with HIPERFACE evaluation, this is the ordering code:

JM-203-230-HI

6.1.2 JM-203B, JM-206B, JM-204, JM-208, JM-215B, and JM-225

The encoders JM-203B, JM-206B, JM-204, JM-208, JM-215B, and JM-225 are equipped with an automatic recognition of the encoder type HIPERFACE. If a HIPERFACE is not recognized, the basic setting is the resolver. A correct recognition can be read out of register 577 "Encoder Type".

Encoder	
Resolver	Basic setting
HIPERFACE	Automatic recognition
1Vss-SinCos	Selection via register 577 "Encoder Type"
5 V incremental encoder	With the optional module only: JM-200-CNT: Selection via register 577 "Encoder Type"

EnDat 2.2	With the optional module only: JM-200-CNT: Selection via register 577 "Encoder Type"
Virtual encoder	Selection via register 577 "Encoder Type"

6.1.3 JM-D203

The amplifier JM-D203 is equipped with an automatic recognition function for the encoder type HIPERFACE. If a HIPERFACE is not recognized, the basic setting is the resolver. A correct recognition can be read out of register 577 "Encoder Type".

Encoder	
Resolver	Basic setting
HIPERFACE	Automatic recognition
1Vss-SinCos	Selection via register 577 "Encoder Type"
5 V incremental encoder	Selection via register 577 "Encoder Type"
Virtual encoder	Selection via register 577 "Encoder Type"

6.1.4 JM-105

The amplifier JM-105 is not equipped with an automatic recognition function. The basic setting is the resolver setting.

Encoder	
Resolver	Basic setting
1Vss-SinCos	Selection via register 577 "Encoder Type"
5 V incremental encoder	Selection via register 577 "Encoder Type"
Virtual encoder	Selection via register 577 "Encoder Type"
LinMot	Selection via register 577 "Encoder Type"

6.2 Resolver

In a resolver, a sine and cosine signal is generated by resolver excitation. These signals help to achieve one absolute position per revolution in the JM-2xx.

6.2.1 Parameter setting

Parameter setting is carried out by the JM-2xx automatically.

6.3 HIPERFACE

After start-up, a HIPERFACE encoder transmits the absolute position. A single-turn encoder can only transmit the absolute position per revolution, whereas a multi-turn encoder can transmit the absolute position for more than 4096 revolutions. After transmitting the absolute position, the HIPERFACE encoder transmits between 128 and 1024 sine and cosine periods per revolution. The HIPERFACE encoder has got the advantage over the resolver that the speed for the speed controller is made use of in a significantly better resolution.
For a HIPERFACE encoder, a JM-2xx with HIPERFACE evaluation will be needed.

6.3.1 Parameter setting

Parameter setting is carried out by the JM-2xx automatically.

6.4 Sine Incremental Encoder

A sine incremental encoder is often used as a linear feedback. A sine incremental encoder transmits a certain number of sine and cosine periods per distance.

Attention!

The maximum frequency of the SinCos evaluation is limited:
A maximum speed of 4 m/s results from a sine incremental encoder with a signal period of 40 µm and a maximum frequency of 100 kHz.

6.4.1 Parameter setting

The following registers have to be adjusted for parameterization of the encoder:

Function group encoder feedback:

– Register 117 "Encoder Resolution"
– Register 577 "Encoder Type"

The detailed register description can be found in chapter 6.8 "Description of Registers", page 73.

Example 1: Parameter setting for a sine incremental encoder at a linear motor

A linear motor has got a pole pair pitch (north pole to north pole) of 32 mm. A sine incremental encoder has been attached to the motor. The sine incremental encoder has got a signal period of 40 µm. According to example “Example: Parameter setting” on page 51, the “Register 123: Pole Pair Number” on page 60 is set to value 1.

1. The value of “Register 117: Encoder Resolution” on page 73 is calculated as follows:
   Encoder Resolution = (Pole Pair Pitch * Pole Pair Number / Signal Period) * 4
   = (32 mm * 1 / 40 µm) * 4 = 3200
2. “Register 195: Transmission Ratio - Mechanics” on page 31 is set to value 1.
3. The contents of “Register 196: Linear / Rotation Ratio” on page 31 have to be set to the following value:
   Linear / Rotatory Ratio = Pole Pair Pitch / Pole Pair Number = 32 mm / 1 = 32 mm/Umdr

6.4.2 Commutation finding

In the following cases, measuring the commutation offset is necessary:

- Applying a linear motor with a relative position transducer.
- At applying a rotatory motor, the phase position of which between motor winding to encoder feedback is not set up according to Jetter standards.
- For testing the wiring of motor and feedback.
  In this case, a commutation offset around "zero" has to be measured.

For commutation finding, there is the “Register 559: Commutation Measuring Method” on page 74.

Attention!

During commutation finding, the motor shaft or the motor itself can move!

At applying measurement method 0, the strongest motion can be expected.

A rotatory motor has got the following maximum rotation:

$$\varphi = \frac{360°}{2 \times Z_P}$$

with:
Z_P: Pole pair number of the motor winding

A linear motor has got the following maximum motion:

$$s = \frac{P}{2}$$

with:
P: Pole pair pitch (north pole to north pole) [mm]

Commutation finding is started by command 31 in “Register 101: Command” on page 387. At the end of commutation finding, the axis is deactivated again.
As a result of commutation finding, the measured value is written to “Register 116: Commutation Offset” on page 58. At this point of time it is sufficient to write the value of commutation finding into the commutation offset after activating the motion system.

6.5 Incremental Encoder

An incremental encoder as a commutation feedback can only be applied in connection with an asynchronous motor without having to carry out commutation finding..

Please note: JM-203, JM-203B, JM-206, JM-206B, JM-204, JM-208, JM-215, JM-215B, and JM-225

Only incremental encoders with a 5 V differential signal can be used. For connection to a JM-2xx, an optional module is needed. This module has been integrated in a JetMove, if it has been ordered with the *CNT* option.

For connecting a 5 V incremental encoder with differential signals to the JM-105 and JM-D203 amplifiers, an additional module is not needed.

6.5.1 Parameter setting

The following registers have to be adjusted for parameterization of the encoder:

Function group encoder feedback:

– Register 117 "Encoder Resolution"
– Register 577 "Encoder Type"

The detailed register description can be found in chapter 6.8 "Description of Registers", page 73.

6.6 EnDat 2.2

An EnDat encoder is applied as a single- or multi-turn encoder for linear and rotatory axes. It functions as a merely digital interface which cyclically transmits the absolute position in high resolution.
Only the EnDat version 2.2 is supported.

6.6.1 Parameter setting

The following registers have to be adjusted for parameter setting of the encoder:

Function group encoder feedback:

– Register 117 "Encoder Resolution"
– Register 577 "Encoder Type"

The detailed register description can be found in chapter 6.8 "Description of Registers", page 73.

6.7 LinMot

As a feedback system, a LinMot has got a two-channel inductive encoder, similar to a sin-cos encoder, with 5 Vss.

6.7.1 Parameter setting

The following registers have to be adjusted for parameter setting of the encoder:

Function group axis:

– If a LinMot is applied, value 20.00 mm has to be written to register 196 "Linear / Rotation Ratio".

Function group encoder feedback:

– Register 577 "Encoder Type"

The detailed register description can be found in chapter 6.8 "Description of Registers", page 73.

6.8 Description of Registers

In the column "R/W", the type of access to a parameter is identified:

R = Read
W = Write

Register 117: Encoder Resolution	
Function	**Description**
Read	Value of the present resolution
Write	Set value of the encoder resolution
Amplifier status	The amplifier has to be deactivated
Takes effect	Immediately
Variable type	int / register
Value range	4 ... 65,536 [incr./rev.]
Value following a reset	Dependent on the connected encoder

Dependent on the encoder type, this register has different meanings:

Resolver, HIPERFACE:
This register specifies the internal resolution of a revolution in increments. This value is dependent on the connected encoder. See register 577 "Encoder Type"

Sine incremental encoder:
If a sine incremental encoder is applied, the number of sine-periods, multiplied by 4 to the length of the set pole pair number, has to be written to this register. The encoder type in register 577 has to be set to value 5.

Quadrature incremental encoder:
If a quadrature incremental encoder is applied, the number of lines, multiplied by 4 to the length of the set pole pair number, has to be written to this register. The encoder type in register 577 has to be set to value 4 or 8.

Register 559: Commutation Measuring Method	
Function	**Description**
Read	Value gained by the present measuring method
Write	Set value gained by the measuring method
Amplifier status	The amplifier has to be deactivated
Takes effect	Immediately
Variable type	int / register
Value range	0, 2, 3
Value following a reset	Dependent on the connected encoder

These are the following commutation measuring methods:

0	The motor has to run smoothly. The drive increases the current via two motor lines up to the peak current (continuous rated current * overload factor). The motor moves up to the magnetic dead center. After stalling the motor, the commutation offset is measured. This is the reliable method.
2	The motor has to run smoothly. The drive increases the current via two motor lines up to the peak current (continuous rated current * overload factor). As soon as the motor starts moving, though, the direction of current supply is twisted in a way, that there is just minimum motion. Twisting the direction of current supply is done by means of a PI controller and the factors of a speed controller. When the maximum current has been reached and the motor has been stalled, the commutation offset is measured. If the friction of the axis is too high, the commutation offset cannot be determined correctly.
3	Special procedure in case of a disturbing force (soft buffers, gravitational force): If there is the risk of not reaching the magnetic dead point, it can be calculated by dual measuring applying half and peak current. Dual measuring should only be applied after consulting Jetter AG.

Register 577: Encoder Type	
Function	**Description**
Read	As-is encoder type
Write	Set encoder type
Amplifier status	The amplifier has to be deactivated
Takes effect	Immediately
Variable type	int / register
Value range	1 ... 14
Value following a reset	Dependent on the connected encoder

By means of this parameter, the encoder type of the connected motor can be specified; please refer to chapter 6 "Encoder Feedback", page 67.

1	=	Resolver	
2	=	HIPERFACE SRS50 (single-turn)	
3	=	HIPERFACE SRM50 (multiturn)	
4	=	High voltage incremental encoder	(*
5	=	Sine incremental encoder	
6	=	HIPERFACE SCS50 (single-turn)	
7	=	HIPERFACE SCM50 (multiturn)	
8	=	Low voltage incremental encoder	(**
9	=	HIPERFACE SKS50 (single-turn)	
10	=	HIPERFACE SKM50 (multiturn)	
11	=	Virtual encoder	
12	=	Incremental encoder with optional module JM-200-CNT	
13	=	EnDat 2.2 (single-turn) with optional module JM-200-CNT	
14	=	EnDat 2.2 (multiturn) with optional module JM-200-CNT	
15	=	EnDat 2.2 (linear) with optional module JM-200-CNT	
16	=	LinMot encoder	(***

(*
JetMove 105:
The encoder has to provide 5 V differential signals or 5 V single-ended signals for K0, K1, and K2.

JetMove D203:
The encoder has to provide 5 V differential signals for K0, K1, and K2.

JetMove 2xx series:
The encoder has to provide 24 V signals for K0, K1, and K2. For connecting the encoder, a level converter is required.

(**
JetMove 2xx series:
The encoder has to provide 24 V signals of 1 Vss for K0, K1, and K2.

6.9 Second Encoder

Introduction

The amplifiers

- JM-203/JM-203B
- JM-206/JM-206B
- JM-204
- JM-208
- JM-215/JM-215B
- JM-225

can be ordered with an optional integrated counter card. The counter card option shows in the "...CNT" abbreviation in the article designation of the amplifier. The counter card option allows for a second encoder to be connected. A second encoder can be used as follows:

1. as a load-side encoder for position control of the JetMove; speed control is carried out by means of the first encoder (main encoder)

2. as a leading axis for technological functions

First of all, the second encoder has to be generally configured first, independent of where it is to be applied.
This sub-chapter describes how the second encoder is generally configured and how it is applied for position control. The usage of the second encoder as a leading axis for technological functions has been described in chapter chapter 13.5.6 "Configuration with second encoder as leading axis", page 206.

6.9.1 General configuration

Definition of the Power Train

For the motor with the first encoder, the power train is defined via R194 *Gear Ratio - Motor*, R195 *Gear Ratio - Load*, etc.

The second encoder is connected to the load by another power train in the same way as the first encoder. Very rarely, the power train of the second encoder is identical with the power train of the first encoder. For this reason, the power train of the second encoder is defined via individual registers.

If the second encoder is to be used for position control, it is obligatory to define its power train in a way that it has got the same position unit as has the first encoder.

Travel Range

Further, there are individual registers for the second encoder to define the travel range. The position defined by the second encoder always remains within the limits of the set travel range. At an overflow, the position is continued at the opposite limit of the travel range.
If the second encoder is to be used for position control, it is obligatory for the travel range of the second encoder to be equal to the travel range set for the first encoder.

Overview of Registers

The following registers are available for general configuration tasks:

Register Name	Short Description
R190 *Position Control - Selection of As-is Value*	Selection of the as-is value (first or second encoder) for position control
R240 *Encoder2 - Status*	Status of the second encoder
R241 *Encoder2 - Type*	Encoder type of the second encoder
R242 *Encoder2 - Resolution*	Encoder resolution of the second encoder
R244 *Encoder2 - Gear Ratio - Encoder*	The number of encoder rotations for defining the gear ratio between the second encoder and its load is set.
R245 *Encoder2 - Gear Ratio - Load*	The number of encoder rotations for defining the gear ratio between the second encoder and its mechanic load is set.
R246 *Encoder2 - Gear Ratio - Linear/Rotatory*	Gear ratio between linear motion and one rotation of the load of the second encoder (R245).
R247 *Encoder2 - Travel Limit Positive*	Positive travel limit of the load of the second encoder
R248 *Encoder2 - Travel Limit Negative*	Negative travel limit of the load of the second encoder
R252 *Encoder2 - Reversal of Counting Direction*	The counting direction of the second encoder is reversed.
R249 *Encoder2 - As-is Position*	As-is position of the load of the second encoder
R250 *Encoder2 - Modulo Turns*	Positive travel limit of the load of the second encoder
R251 *Encoder2 - As-is Speed*	As-is speed of the load of the second encoder
R243 *Encoder2 - Mechanic Angle*	Mechanic angle of the second encoder

General Configuration

The following steps have to be carried out for general configuration of the second encoder after connecting the encoder and defining the axis parameters (see chapter 3 "Axis Definitions", page 19).

Step	Action
1	If the second encoder has been activated for position control first, set the as-is value selection for position control to the first encoder (main encoder). Action: R190 *Position Control - As-is Value Selection* = 1 (first encoder)
2	Deactivating the Evaluation for the Second Encoder Action: R241 *Encoder2 - Type* = 0 (encoder evaluation has been deactivated) Result: R240 *Encoder2 - Status* = 0
3	Setting the Encoder Type for the Second Encoder Action: R241 *Encoder2 - Type* enter one of the following values: 12 = Incremental encoder 13 = EnDat single-turn encoder 14 = EnDat multiturn encoder Result: – If R241 *Encoder2 - Type* = 12: R240 *Encoder2 - Status* = 0 – If R241 *Encoder2 - Type* = 13 or 14 and the respective encoder have been detected at the connection of the second encoder: R240 *Encoder2 - Status* = 3 Please note: If at R241 *Encoder2 - Type* = 13 or 14 and bit R240.0 *Encoder2 - Status* has not been set, an encoder has not been found. The encoder cable might be wrongly connected, or else, the encoder could be defective, etc. In this case, configuration cannot be continued, until the problem has been resolved.
4	If in step 3 an incremental encoder (R241 = 12) has been selected as a second encoder, set the resolution value Action: R242 *Encoder2 - Resolution* = Number of Pulses per Revolution, Multiplied by 4 Result: R240 *Encoder2 - Status* = 1 Please note: For the EnDat encoders (R241 = 13 or 14), the resolution value is set automatically. It must not be changed by the user.

5	Setting the Gear Ratio between the Second Encoder and the Load Action: Describe the following registers respectively: – R244 *Encoder2 - Gear Ratio - Encoder* – R245 *Encoder2 - Gear Ratio - Load* – R246 *Encoder2 - Gear Ratio Linear/Rotatory* If the second encoder is used for position control, its gear ratio has to be set in a way that the same position unit results as in the first encoder. If R191 *Axis Type* = 2 (rotatory), R246 *Encoder2 - Gear Ratio - Linear/Rotatory* must not be written to. Example: The axis is a rotatory axis. The mechanic load rotates once, while the encoder is rotating ten times, i = 10: R244 *Encoder2 - Gear Ratio - Encoder* = 10 R245 *Encoder2 - Gear Ratio - Load* = 1 R246 *Encoder2 - Gear Ratio Linear/Rotatory* is not written to Result: – If R241 *Encoder2 - Type* = 12: R240 *Encoder2 - Status* changes from 1 to 3 – If R241 *Encoder2 - Type* = 13 or 14: R240 *Encoder2 - Status* remains 3
6	Setting the Travel Range Action: Describe the following registers respectively: – R247 *Encoder2 - Travel Limit Positive* – R248 *Encoder2 - Travel Limit Negative* If the second encoder is used for position control, the registers have to be written to as follows: – R247 *Encoder2 - Travel Limit Positive* = R182 *Travel Limit Positive* – R248 *Encoder2 - Travel Limit Negative* = R183 *Travel Limit Negative* Please note: The following applies: R247 *Encoder2 - Travel Limit Positive* > R248 *Encoder2 - Travel Limit Negative*
7	Setting the Parameters for Reversing the Counting Direction, if Necessary Action: R252 *Encoder2 - Inversion of Counting Direction* is described as follows:: 0 = **clockwise** rotating encoder provides increasing position values 1 = **anti-clockwise** rotating encoder provides increasing position values

8	At the Very First Commissioning: Checking for Correct Configuration Action: Check for plausible values in one of the following registers: – R249 *Encoder2 - As-is Position* – R250 *Encoder2 - Modulo Turns* – R251 *Encoder2 - As-is Speed* – R243 *Encoder2 - Mechanic Angle*

6.9.2 Position control by means of the second encoder

Introduction

Below, operating the second encoder by means of position control is described. The following actions are described there:

- Switching the position control from the first to the second encoder
- Switching the position control from the second to the first encoder

Switching from the First to the Second Encoder

At switching from the first to the second encoder, the operating system displays the following visible behavior:

- The following registers of the second encoder are deactivated:
  - R249 *Encoder2 - As-is Position*
  - R250 *Encoder2 - Modulo Turns*
  - R251 *Encoder2 - As-is Speed*

- The position changes of the second encoder are written to R109 *As-is Position*. In this case, the value of R109 is not newly initialized; i.e., the value of R109 is remanent. Then, following position changes of the second encoder change the value of R109 accordingly.

- R246 *Encoder2 - Gear Ratio Linear/Rotatory* is checked and probably newly set as follows:
  - If R191 *Axis Type* = 2 (rotatory), then R246 = 360

- The definition of the power drive parameters is basic for positioning. This definition is transferred from the registers of the first encoder to the registers of the second encoder:
  - Gear Ratio Encoder/Motor: R244 is used instead of R194
  - Gear Ratio - Load: R245 is used instead of R195
  - Gear Ratio Linear / Rotatory: R246 is used instead of R196

- The travel range set via R182 *Travel Range Positive* and R183 *Travel Range Negative* is newly set:
  - R182 *Travel Range Positive* takes over the value of R247 *Encoder2 - Travel Range Positive*
  - R183 *Travel Range Negative* takes over the value of R248 *Encoder2 - Travel Range Negative*

  Note: The former values of R182 and R183 are stored in the background. They do not get lost.

- If the axis has not been defined as a modulo axis (R192 = 1), R193 *Modulo Travel Range* is newly calculated:
  - R193 *Modulo Travel Range* = R182 *Travel Limit Positive* - R183 *Travel Limit Negative*

Behavior of the Operating System during Position Control

At position control by the second encoder, the operating system displays the following visible behavior:

- Position changes of the second encoder change the value of R109 accordingly.
- Encoder breakage, respectively malfunctioning of the second encoder causes error F42 and resets bit 100.0 *Reference Set*.
- If the axis has not been defined as a modulo axis, entering the target position (R102) at PtP-positioning is restricted to R247 *Encoder2 - Travel Limit Positive* respectively R248 *Encoder2 - Travel Limit Negative* .

Switching from the Second to the First Encoder

At switching from the second to the first encoder, the operating system displays the following visible behavior:

- The following registers of the second encoder are activated:
  - R249 *Encoder2 - As-is Position*
  - R250 *Encoder2 - Modulo Turns*
  - R251 *Encoder2 - As-is Speed*
- The position changes of the first encoder are written to R109 *As-is Position*. In this case, the value of R109 is not newly initialized; i.e., the value of R109 is remanent. Then, following position changes of the first encoder change the value of R109 accordingly.
- The definition of the power drive parameters is basic for positioning. This definition is transferred from the registers of the second encoder to the registers of the first encoder:
  - Gear Ratio Encoder/Motor: R194 is used instead of R244
  - Gear Ratio - Load: R195 is used instead of R245
  - Gear Ratio Linear / Rotatory: R196 is used instead of R246
- The travel range set via R182 *Travel Range Positive* and R183 *Travel Range Negative* is set to the former values that have been kept in the background:
- If the axis has not been defined as a modulo axis (R192 = 1), R193 *Modulo Travel Range* is newly calculated:
  - R193 *Modulo Travel Range* = R182 *Travel Limit Positive* - R183 *Travel Limit Negative*

Overview of Registers

The following registers are available for switching between the encoders:

Register Name	Short Description
R190 *Position Control - Selection of As-is Value*	Selection of the as-is value (first or second encoder) for position control

Switching Between the Encoders

After defing the axis (see chapter 3 "Axis Definitions", page 19) and generally configuring the second encoder, the following step has to be taken for switching from one encoder to the other:

Step	Action
1	Switching from one encoder to the other Action: R190 *Position Control - Selecting the as-is value* is described as follows: First encoder = 1 Second encoder = 2

6.9.3 Register description

Register 240: Encoder2 - Status	
Function	**Description**
Read	Status of the second encoder
Write	Illegal
Variable type	int / register
Value range	Bit-coded, 2 bits
Value following a reset	0

Meaning of the individual bits:	
Bit 0	1 = The second encoder has been initialized The bit is reset at F42 *Malfunction of Second Encoder*
Bit 1	1 = The second encoder is NOT used for position control 0 = The second encoder has not been configured completely yet, or it is being used for position control

Register 241: Encoder2 - Type	
Function	**Description**
Read	As-is encoder type for second encoder
Write	Set encoder type for second encoder
Amplifier status	No specific status
Takes effect	Immediately
Variable type	int / register

Value range	0, 12 ... 14
Value following a reset	Dependent on the connected encoder

By means of this parameter, the encoder type of the second encoder can be specified:

0	=	The evaluation for the second encoder has been deactivated
12	=	Incremental encoder with optional module JM-200-CNT
13	=	EnDat 2.2 (single-turn) with optional module JM-200-CNT
14	=	EnDat 2.2 (multiturn) with optional module JM-200-CNT

Register 242: Resolution of Encoder 2

Function	Description
Read	As-is encoder type for second encoder
Write	Set encoder type for second encoder
Amplifier status	No specific status
Takes effect	Immediately
Variable type	int / register
Value range	0...2147483647 [incr./rev.]
Value following a reset	0 [incr./rev.]

Via R242 the resolution for encoder type 12 *Incremental Encoder* is specified as follows:

R242 = pulse number of the incremental encoder, multiplied by 4

Please note: At using an EnDat encoder (R241 *Encoder2 - Type*), R242 is set automatically and cannot be changed.

Register 243: Mechanical Angle of Encoder 2

Function	Description
Read	As-is angle of the second encoder
Write	Illegal
Variable type	float
Value range	-180 ... + 180 °
Value following a reset	0 °

The mechanic angle of the encoder is output.

Register 244: Encoder 2 - Gear Ratio	
Function	**Description**
Read	As-is number of encoder revolutions
Write	New number of encoder revolutions
Amplifier status	No specific status
Takes effect	Immediately
Variable type	float
Value range	0.01 ... pos. float limit [rev.]
Value following a reset	1 [rev.]

For a detailed description, see R246 *Encoder2 - Gear Ratio Linear/Rotatory*

Register 245: Encoder2 - Gear Ratio Load	
Function	**Description**
Read	As-is number of load revolutions
Write	New number of load revolutions
Amplifier status	No specific status
Takes effect	Immediately
Variable type	float
Value range	0.01 ... pos. float limit [rev.]
Value following a reset	1 [rev.]

For a detailed description, see R246 *Encoder2 - Gear Ratio Linear/Rotatory*

Register 246: Encoder 2 - Gear Ratio Linear/Rotatory	
Function	**Description**
Read	As-is gear ratio linear/rotatory
Write	New gear ratio linear/rotatory
Amplifier status	No specific status
Takes effect	Immediately
Variable type	float
Value range	0.01 ... pos. float limit [mm/rev.]
Value following a reset	360 [mm/rev.]

R244 *Encoder2 - Gear Ratio* and R245 *Encoder2 - Gear Ratio Load* are used for specifying the rotatory gear ratio between the second encoder and its load.

The gear ratio is calculated out of these two registers as follows:

$$i = \frac{\text{Number of encoder revolutions (R244)}}{\text{Number of mechanical revolutions (R245)}}$$

If, for example, the load rotates once, while the encoder rotates ten times, the number of encoder rotations have to be set to 10, while the number of load rotations is set to 1.

If a linear encoder is applied, the gear ratio (R244 and R245) and additionally R246 *Encoder2 - Gear Ratio Linear/Rotatory* have to be specified. R246 specifies the parameters for the change from rotatory to linear mode.

Register 247: Encoder 2 - Travel Limit Positive

Function	Description
Read	Value of the as-is travel limit of the second encoder
Write	New value of the travel limit of the second encoder
Amplifier status	No specific status
Takes effect	Immediately
Variable type	float
Value range	R248 > ... positive float limit [°] or [mm] (the unit depends on the encoder load)
Value following a reset	360 [°]

Here, the positive travel limit for the load of the second encoder is specified.

Register 248: Encoder 2 - Travel Limit Negative

Function	Description
Read	Value of the as-is travel limit of the second encoder
Write	New value of the travel limit of the second encoder
Amplifier status	No specific status
Takes effect	Immediately
Variable type	float
Value range	Negative float limits ... < R248 [°] or [mm] (the unit depends on the encoder load)
Value following a reset	0 [°]

Here, the negative travel limit for the load of the second encoder is specified.

Register 249: Encoder 2 - As-is Position	
Function	**Description**
Read	As-is position of the second encoder
Write	New as-is position of the second encoder
Amplifier status	No specific status
Takes effect	Immediately
Variable type	float
Value range	R248 ... R247 [°] or [mm] (the unit depends on the encoder load)
Value following a reset	0 [°]

R249 outputs the position changes of the second encoder.

R249 is only updated, if the second encoder is not used for position control, that is, if R240.1 = 1 is displayed.

Register 250: Modulo Turns	
Function	**Description**
Read	Present modulo turns (independent of direction)
Write	Illegal
Variable type	int / register
Value range	- 2,147,483,648 ... 2,147,483,647
Value following a reset	0

R250 outputs the number of modulo turns run by the second encoder up to the present point of time.

R250 is only updated, if the second encoder is not used for position control, that is, if R240.1 = 1 is displayed.

Register 251: Encoder 2 - As-is Speed	
Function	**Description**
Read	As-is speed of the second encoder load
Write	Illegal
Variable type	float
Value range	Float limits [°/s] or [mm/s] (The unit is dependent on the axis type)
Value following a reset	0 [°/s]

R251 reads and outputs the speed of the second encoder load.

Register 252: Encoder2 - Inversion of Counting Direction	
Function	**Description**
Read	As-is counting direction of the second encoder
Write	New counting direction of the second encoder
Amplifier status	No specific status
Takes effect	Immediately
Variable type	int / register
Value range	0 ... 1
Value following a reset	0

Meaning of the values:	
0	Reversal of direction deactivated, **clockwise** rotating encoder provides increasing position values
1	Reversal of direction active, **anti-clockwise** rotating encoder provides increasing position values

This register is for reversing the counting direction of the second encoder.

7 Monitoring

7.1 Procedure

Setting the tracking error monitoring parameters

To prevent the axis from causing damage at first enable, tracking error monitoring parameters have to be limited to an adequate value.

Note!

If the combination of motor and feedback device have not been wired in the same direction, or if commutating offset is required, the tracking error monitoring detects errors even beyond the limit and can thus cause the axis to be disabled.

Setting the motor cable monitoring parameters

Setting the motor cable monitoring via register 540 "Drive Mode". Via bit 4 of drive mode 1, motor cable monitoring can be set as follows:

Bit 4:	0	=	Motor cable monitoring is deactivated by default
	1	=	Motor cable monitoring is activated

Monitoring is activated by default If motor monitoring is active, a motor cable test is carried out at the first activating of the axis after hardware reset. If the motor cable is defect, error F03 is displayed. Possible error causes can be breakage of, or ground fault on the motor cable.

If long motor cables are used, error F03 can be recognized through the monitoring function, although none of the listed error causes applies. Only in this case, deactivating the monitoring function is useful.

This function is not available for the JM-105.

Setting the monitoring of blocking protection

In case the motor is mechanically blocked at commissioning, blocking protection monitoring prevents overheating of the motor.

7.2 Register Description

Register 114: Positive Software Limit Switch	
Function	**Description**
Read	As-is value of the software limit switch
Write	Set value of the software limit switch
Amplifier status	The amplifier has to be deactivated
Takes effect	Immediately
Variable type	float
Value range	Float limits [°] or [mm] (the unit depends on the setting of the axis type)
Value following a reset	100,000 [°]

This parameter contains the position at which the software limit switch in positive direction becomes active. When the limit switch is activated, the axis is stopped and error F17 is displayed. Further, bit 8 is set in register 100 "Status".

The software limit switch monitoring can be activated, respectively deactivated, via register 540 "Operating mode 1", bit 6. The software limit switch monitoring should be active in any case, though, especially when axes are driven in manual mode.

Attention!

The software limit switch monitoring is deactivated by default.
The software limit switches are not monitored, unless the reference has been set (for absolute encoders as well).

The following figure shows the positions of the software limit switches:

Fig. 6: Position of the software limit switches

Register 115: Negative Software Limit Switch	
Function	**Description**
Read	As-is value of the software limit switch
Write	Set value of the software limit switch
Amplifier status	The amplifier has to be deactivated
Takes effect	Immediately
Variable type	float
Value range	Float limits [°] or [mm] (the unit depends on the setting of the axis type)
Value following a reset	-100,000 [°]

This parameter contains the position at which the software limit switch in negative direction becomes active. When the limit switch is activated, the axis is stopped and error F17 is displayed. Further, bit 7 is set in register 100 "Status".

The software limit switch monitoring can be activated, respectively deactivated, via register 540 "Operating mode 1", bit 6. The software limit switch monitoring should be active in any case, though, especially when axes are driven in manual mode.

Attention!

The software limit switch monitoring is deactivated by default.
The software limit switches are not monitored, unless the reference has been set (for absolute encoders as well).

The figure regarding register 114 "Position of the software limit switch" illustrates the positions of the respective software limit switches.

Register 544: DC Link Voltage - Max. Trip

Function	Description
Read	As-is max. trip
Write	New value of the max. trip
Amplifier status	The amplifier has to be deactivated
Takes effect	Immediately
Variable type	int / register
Value range	0 ... 60 [V] for JM-105 0 ... 480 [V] for JM-D203, JM-203, and JM-206 0 ... 880 [V] for JM-204, JM-208, and JM-215
Value following a reset	60 [V] for JM-105 480 [V] for JM-D203, JM-203, and JM-206 880 [V] for JM-204, JM-208, and JM-215

Here, the error limit for the maximum DC link voltage is entered. If the DC link voltage exceeds the error limit, error 21 "Overvoltage U_{zk}" is triggered.

Register 545: DC Link Voltage - Min. Trip	
Function	**Description**
Read	As-is min. trip
Write	Set value of the min. trip
Amplifier status	The amplifier has to be deactivated
Takes effect	Immediately
Variable type	int / register
Value range	0 ... 60 [V] for JM-105 0 ... 480 [V] for JM-D203, JM-203, and JM-206 0 ... 880 [V] for JM-204, JM-208, and JM-215
Value following a reset	10 [V] for JM-105 150 [V] for JM-D203, JM-203, and JM-206 400 [V] for JM-204, JM-208, and JM-215

Here, the error limit for the maximum DC link voltage is entered.
If the DC link voltage exceeds the error limit, error 20 "Undervoltage U_{zk}" is triggered.

Register 546: Blocking Protection - Tripping Time	
Function	**Description**
Read	As-is response time
Write	Set response time
Amplifier status	The amplifier has to be deactivated
Takes effect	Immediately
Variable type	int / register
Value range	0 ... 65,535 [ms]
Value following a reset	5,000 [ms]

Release time for blocking supervision of the motor brake can be defined in this parameter by preselecting a time. If the motor speed is still lower than 0.5 % after reaching the maximum output current, error F22 "Drive blocked" is triggered.

Register 549: Emergency Stop Ramp	
Function	**Description**
Read	As-is ramp value
Write	Set ramp value
Amplifier status	The amplifier has to be deactivated
Takes effect	Immediately
Variable type	int / register
Value range	0 ... 65,535 [ms]
Value following a reset	500 [ms]

The deceleration ramp, which is to be active in case of emergency stop (e.g. reaction to an error or after issuing command 7), can be defined by this parameter. The speed of the axis is decreased in relation to this deceleration ramp.
Under fault conditions, which still allow the axis to function (e.g. overtemperature), the axis will be brought to a standstill by this deceleration ramp. If the maximum output current for the deceleration ramp is not sufficient, the ramping time will be increased.

Register 600: Device Temperature - Warning	
Function	**Description**
Read	As-is device temperature warning threshold
Write	Illegal
Variable type	int / register
Value range	0 ... 255 [°C]
Value following a reset	70 ... 80 [°C], dependent on the amplifier

Here, the device temperature warning threshold can be read out. If the device temperature exceeds this value, warning W01 "Warning threshold for device temp." will be triggered.

Register 601: Device Temperature - Error	
Function	**Description**
Read	As-is shutdown threshold for device temp.
Write	Illegal
Variable type	int / register
Value range	0 ... 255 [°C]
Value following a reset	80 ... 85 [°C] dependent on the amplifier

Here, the shutdown threshold for device temperature can be read out. If the device temperature exceeds this value, error report F07 "Shutdown threshold for device temp." is triggered.

Register 602: Motor Temperature - Warning	
Function	**Description**
Read	As-is motor temperature warning threshold
Write	Illegal
Variable type	int / register
Value range	0 ... 255 [°C]
Value following a reset	120 [°C]

Here, the motor temperature warning threshold can be read out. If the motor temperature exceeds this value, warning W02 "Warning threshold for motor temp." is triggered.
This register is not available for JM-105.

Register 603: Motor Temperature - Error	
Function	**Description**
Read	As-is motor temperature error threshold
Write	Illegal
Variable type	int / register
Value range	0 ... 255 [°C]
Value following a reset	145 [°C]

Here, the shutdown threshold for motor temperature can be read out. If the motor temperature exceeds this value, error report F08 "Shutdown threshold for motor temp." is triggered.
This register is not available for JM-105.

Register 604: Ballast Load Threshold Warning	
Function	**Description**
Read	As-is warning threshold for ballast
Write	Illegal
Variable type	int / register
Value range	0 ... 100 [%]
Value following a reset	80 [%]

Here, the warning threshold for ballast can be read out. If the load of the ballast resistor exceeds this value, warning W00 "Warning threshold for ballast" will be triggered.
This register is not available for JM-105.

Register 605: Ballast Load - Error	
Function	**Description**
Read	As-is load error threshold
Write	Illegal
Variable type	int / register
Value range	0 ... 100 [%]
Value following a reset	100 [%]

Here, the shutdown threshold for the ballast resistor load error can be read out. If the load of the ballast resistor exceeds this value, error report F06 "Overload internal ballast resistor" is triggered.
This register is not available for JM-105.

7.3 I²t Monitoring

In JetMove, three independent I²t monitoring functions have been implemented.

- I²t-monitoring of the DC link voltage infeed
- I²t monitoring of the motor by means of motor model
- I²t monitoring of the motor to UL standard

The respective monitoring function, except for I²t monitoring to UL, has to be activated first. I²t monitoring to UL is always active.

The operating system monitors the I²t value of the monitoring functions. When the I²t value exceeds the user-defined warning threshold, the operating system generates a warning. When the I²t value has reached the error threshold, the operating system generates an error message.

Whether the operating system is to generate just a warning or rather an error message and the set reaction to this error can be set for both DC link voltage infeed and monitoring of the motor via motor model. Monitoring to UL standard always generates an error message and the set reaction to this error, when the respective I²t value has been reached.

The specific warnings and error messages generated by I²t monitoring are displayed as follows:

Monitoring Function	Display
Reaching the warning threshold	
I²t-monitoring of the DC link voltage infeed	- W06 I²t Mains - Bit R580.6
I²t monitoring by means of motor model	- W07 I²t Motor - Bit R580.7
I²t monitoring to UL standard	- W08 I²t Motor UL - Bit R580.8
Reaching the error threshold	
I²t-monitoring of the DC link voltage infeed	- F29 - Bit R585.29
I²t monitoring by means of motor model	- F30 - Bit R585.30
I²t monitoring to UL standard	- F31 - Bit R585.31

Each of the I²t monitoring functions has got the following parameters for configuration, respectively monitoring:

Parameter	**Brief Description**
Operating mode	This parameter defines, whether monitoring is to be active, and whether just a warning or else an error message followed by the respective reaction is to be generated. At I²t monitoring to UL standard, the operating mode cannot be selected. It is set by default to active monitoring with error message generating.
Thermal time constant [s]	Thermal time constant of the monitored object. Here, a thermal time constant for I²t monitoring by means of the motor model can be entered. For I²t monitoring of DC-link voltage infeed and monitoring to UL standard, the time constants have been pre-defined and can thus not be changed.
As-is I²t value [%]	As-is I²t monitoring value
Warning threshold	Warning threshold for generating a warning message

7.3.1 I²t-monitoring of the DC link voltage infeed

I²t monitoring of the DC-link voltage infeed is for monitoring the device input current R566 by means of I²t calculation.

For this, the following registers are available:

Register 640: I²t - DC Link - Operating Mode	
Function	**Description**
Read / Write	Operating mode of the I²t monitoring function
Variable type	int / register
Value range	0: Inactive 1: Active, with warning (W06) 2: Active, with warning (W06), error message generation and reaction to the error message (F29)
Value following a reset	0

Register 642: I²t - DC Link - Time Constant	
Function	**Description**
Read	Thermal time constant
Variable type	float
Value range	0 ... 36,000 [s]
Value following a reset	0 [s]

Register 643: I²t - DC Link - I²t Value	
Function	**Description**
Read	As-is I²t value
Variable type	float
Value range	0 ... 200 [%] related to R501 *Rated Device Current*
Value following a reset	0 [%]

Register 644: I²t - DC Link - Warning Threshold	
Function	**Description**
Read / Write	Warning threshold to generating the warning message
Variable type	float
Value range	0 ... 100 [%] related to R501 *Rated device current*
Value following a reset	80 [%]

7.3.2 I²t monitoring of the motor by means of a motor model

The JetMove calculates the model of motor power loss by an I²t calculation. The calculated value is a measure of the average power dissipation of the motor. It is calculated in percent of the maximum motor power dissipation.
For this calculation it is important, that the following motor parameters are entered correctly:

– R618 *Continuous rated motor current* (among rated motor or amplifier current, this is the smaller value)
– R619 *Motor overload factor*
– R647 *I²t - Motor model - Time constant* (thermal time constant of the motor)

I²t calculation has to be activated via R645 *I²t - Motor model - Operating mode*.
It is possible to parameterize the warning level. The error threshold for F30 is set to 100 % by default.

The JetMove calculates the I²t value for the percentage of motor power loss according to the following formula:

$$x(t) = 100\,\% \times \left(\frac{\text{average motor current}}{\text{rated current}}\right)^2 \times \left(1 - e^{-\frac{t}{T}}\right)$$

x(t) =	Displayed value of the motor power loss in %
t =	Time since start of motor running it with the average current (in seconds)
T =	Motor time constant (in seconds)

The formula shows that the 100 % value will never be reached as long as the average motor current is lower than the nominal current of the motor.
Further, calculating always starts by 0 (at t = 0, the result of the equation is 0). After some time that is by far longer than the motor time constant, the result does virtually not change any more.
The time till error stop (x = 100 %) is a result of the following formula:

$$t = -T \times \ln\left[1 - \left(\frac{\text{rated current}}{\text{average motor current}}\right)^2\right]$$

After reset, the values of the important parameters are:

Nominal current:	3 A
Overload factor:	2
Motor time constant:	1,800 s (30 min)

With these parameters the 100 % error level will be reached if, for example the motor is run by a current of 6 A for about 8 minutes and 30 seconds.

Important

Because of the fact that after reset the I²t calculation always starts with zero, the motor overload calculation is wrong if the motor is already hot when the digital servo amplifier JetMove D203 is switched on (i. e. at the time of parameters of I²t calculation are written after switching on 24 V logic power supply).
For this reason, please wait, until the motor has cooled down before re-enabling the axis.

The following registers are available for I²t monitoring:

Register 645: I²t - Motor Model - Operating Mode	
Function	**Description**
Read / Write	Operating mode of the I²t monitoring function
Variable type	int / register
Value range	0: Inactive 1: Active, with warning (W07) 2: Active, with warning (W07), error message generation and reaction to the error message (F30)
Value following a reset	0

Register 647: I²t - Motor Model - Time Constant	
Function	**Description**
Read / Write	Thermal time constant
Variable type	float
Value range	0 ... 36,000 [s]
Value following a reset	1,800 [s]

Register 648: I²t - Motor Model - I²t Value	
Function	**Description**
Read	As-is I²t value
Variable type	float
Value range	0 ... 200 [%] related to R618 *Rated motor current*
Value following a reset	0 [%]

In operating mode 1, the I²t value can become greater than 100 %.

Register 649: I²t - Motor Model - Warning Threshold	
Function	**Description**
Read / Write	Warning threshold to generating the warning message
Variable type	float
Value range	0 ... 100 [%] related to R618 *Rated motor current*
Value following a reset	80 [%]

7.3.3 I^2t monitoring of the motor to UL standard

The UL standard prescribes a motor overload detection for a servo amplifier according to the following criteria:

The "trip current" is defined to be 1.15 times the user-set continuous rated current.

- If the average motor current corresponds to the trip current, the overload protection has to switch off the motor after a limited time.
- If the average motor current is 2 times higher than the trip current the overload protection has to switch off the motor after at least 8 minutes.
- If the average motor current is six times higher than the trip current, the overload protection must switch off the motor after at least 20 seconds.

This protection (error message 31 is activated) can be parameterized only through the rated current value.
The motor overload protection is always active and cannot be deactivated.

Important

Because of the fact that after reset the motor overload calculation always starts with zero, the result is wrong if the motor is already hot when the digital servo amplifier JetMove D203 is switched on (i.e. at establishing the connection to the 24 V logic circuit voltage supply).
For this reason, please wait, until the motor has cooled down before re-enabling the axis.

The following registers are available for I^2t monitoring:

Register 650: I^2t - UL Standard - Operating Mode	
Function	**Description**
Read	Operating mode of the I^2t monitoring function
Variable type	int / register
Value range	2: Active, with warning (W08), error message generation and reaction to the error message (F31)
Value following a reset	2

Register 652: I^2t - UL Standard - Time Constant	
Function	**Description**
Read	Thermal time constant
Variable type	float
Value range	0 ... 36,000 [s]
Value following a reset	0 [s]

Register 653: I²t - UL Standard - I²t Value	
Function	**Description**
Read	As-is I²t value
Variable type	float
Value range	0 ... 200 [%] related to R618 *Rated Motor Current*
Value following a reset	0 [%]

Register 654: I²t - UL Standard - Warning Threshold	
Function	**Description**
Read / Write	Warning threshold to generating the warning message
Variable type	float
Value range	0 ... 100 [%] related to R618 *Rated Motor Current*
Value following a reset	80 [%]

8 Current Controller

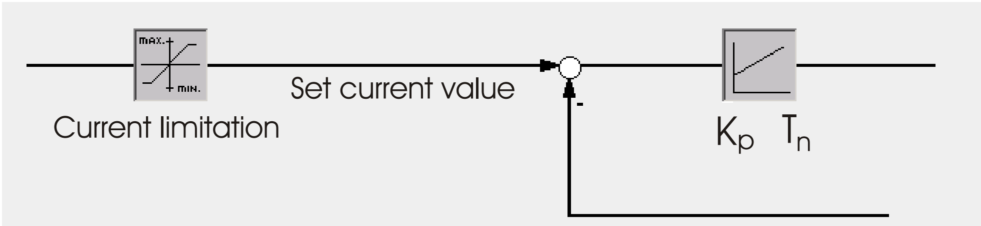


Fig. 7: Current controller

Setpoint Values	***As-is Values***
Continuous rated current [A_{eff}] R618	As-is current [A_{eff}] R561
Overload factor R619	As-is current [%] R620
Current limitation R127	As-is torque [Nm] R621
Current controller Kp R503	Max. output current [A_{eff}] R502
Current controller Tn R504	

Fig. 8: Current controller

The values for continuous rated current and overload factor should only be set once, corresponding with the selected motor. Only then, the parameters K_p and T_n are calculated. For temporary current reduction, the "current reduction" parameter is used.

Setting the peak value of the output current

The peak value of the output current is set by entering the continuous rated current value of the motor and the overload factor of the motor. The continuous rated current value can be taken from the motor parameters written on the nameplate, for example. It can range between 200 % and 50 % of the continuous rated current of the amplifier. The peak value of the output current is the product of the continuous rated current and the overload factor.

Note!

At value input, please mind the value standardization of individual registers, see register description.

Setting the controller parameters K_p and T_n

The proportional amplification $\mathbf{K}_p$ and the integral-action time $\mathbf{T}_n$ of the current control has to be calculated and input. Formulas for parameter calculation can be found in the register description.

8.1 Register Description

Register 121: Magnetizing Current	
Function	**Description**
Read	Value of the as-is magnetizing current
Write	New value of the magnetizing current
Amplifier status	No specific status
Takes effect	Immediately
Variable type	float
Value range	0 ... R502 [A_{eff}]
Value following a reset	0 [A_{eff}]

For asynchronous motors only:

Here, the rated magnetizing current I_d is entered in the unit [A_{eff}]. I_d is calculated as follows:

$$I_d = \sqrt{I_n^2 - I_q^2}$$

The following applies to the operands:

I_n	=	Continuous rated current in the unit [A_{eff}] -> nameplate, dependent on the motor winding connection
I_q	=	Rated magnetizing current in the unit [A_{eff}] -> see “Register 618: Rated Current” on page 116.

See also chapter 5.3 "Asynchronous Motor", page 40.

Register 125: Current Setpoint	
Function	**Description**
Read	As-is current setpoint
Write	New current setpoint
Amplifier status	No specific status
Takes effect	Immediately
Variable type	float
Value range	-R502 ... R502 [A_{eff}]
Value following a reset	0 [A_{eff}]

The current setpoint of the digital speed controller can be read here. When the controller operating mode current control has been preset (in this case, only the current control is active), the current setpoint can also be specified via this register. In case of all other controller operating modes, this parameter must not be written into.

Register 127: Current Limitation	
Function	**Description**
Read	Value of the present current limiting
Write	New current limiting value
Amplifier status	No specific status
Takes effect	Immediately
Variable type	float
Value range	0 ... R502 [A_{eff}]
Value following a reset	R502 [A_{eff}]

Besides registers 618 "Rated current" and register 619 "Overload factor", an additional limitation of the amplifier output current can be defined by means of this parameter. It serves for dynamically adjusting to temporary conditions.

Changing one either register 618 "Nominal Current" or 619 "Overload Factor" to another value will also change the current limitation. The value of the current limitation will then be adjusted in a way, that the ratio between the values of the current limitation and of register 502 "Max. Output Current" will remain unchanged.

Register 231: Current Reduction	
Function	**Description**
Read	As-is current reduction value
Write	New current reduction value
Variable type	float
Value range	0 ... 2 * R501 [A_{rms}]
Value following a reset	0 [A_{eff}]

For stepper motors:

Here, the value for torque reduction is entered in unis [A_{rms}].

In order to activate current reduction, the desired value has to be written to the "Current Reduction" register.

Register 232: Current Reduction Time	
Function	**Description**
Read	As-is time value of current reduction
Write	New time value of current reduction
Variable type	float
Value range	0 ... 65,535 [ms]
Value following a reset	0 [ms]

For stepper motors:

Here, the time for torque reduction is entered in the unit [ms]. Current reduction is activated, if the position setpoint of the position control remains unchanged over the set time.
Current reduction internally accesses “Register 127: Current Limitation” on page 110. When it is activated, current reduction limits the current setpoint of the speed control. This limitation is cancelled at the next change of position controller setpoint.

Register 502: Maximum Output Current	
Function	**Description**
Read	Peak value of the output current
Write	Illegal
Variable type	float
Value range	0.25 * R501 ... 2 * R501 [A_{eff}]
Value following a reset	2 * R501 [A_{eff}]

The value of this register is the product of the values of register 618 "Rated Current" and register 619 "Overload Factor". For calculation, the respective internally effective rated current and overload factor values is applied. The maximum output current can range between 200 % and 25 % of the continuous rated current of the device.

Register 503: Current Control K_p	
Function	**Description**
Read	As-is value of the K_p
Write	New value of the K_p
Amplifier status	No specific status
Takes effect	Immediately
Variable type	float
Value range	0 ... min (31.99, R504 * 7.99) for JM-2xx series 0 ... 511.99 for JM-105 and JM-D203
Value following a reset	0.7

Proportional amplification of the current control K_p is entered here. K_p has not got a unit. K_p is calculated as follows:

$$K_P = \frac{I_{eff} \cdot L_{Motor}}{2 \cdot T_s \cdot U_{DC}}$$

The following applies to the operands:

I_{eff}	=	Maximum output current in the unit [A_{eff}] -> value of R618 "Nominal Current", multiplied by the value of R619 "Overload Factor"
L_{Motor}	=	Inductivity between 2 motor terminals in the unit [H] -> motor data sheet, or find out by measuring. (In asynchronous motors, the inductivity depends on the motor winding connection)

T_s = The sum of the small time constants in the unit [s] -> T_s is always 000042 [s] in JM-2xx.

U_{DC} = DC link voltage of the amplifier in the unit [V] ->; please refer to the following table

For the DC link voltage U_{DC}, the following values have got to be considered:

Module	Type of connection	DC link voltage
JM-105	1-phase	24/48 V
JM-2xx/400	3-phase	560 V
JM-2xx/230	3-phase	325 V
JM-203B / 230 JM-206B/230 JM-D203	1-phase	325 V (without PFC)
JM-203/230 JM-206/230	1-phase	380 V (with PFC)

The K_P value calculated by the formula above is a suggested value and has to be adjusted to the requirements of the application together with “Register 504: Current Control T_n” on page 115.

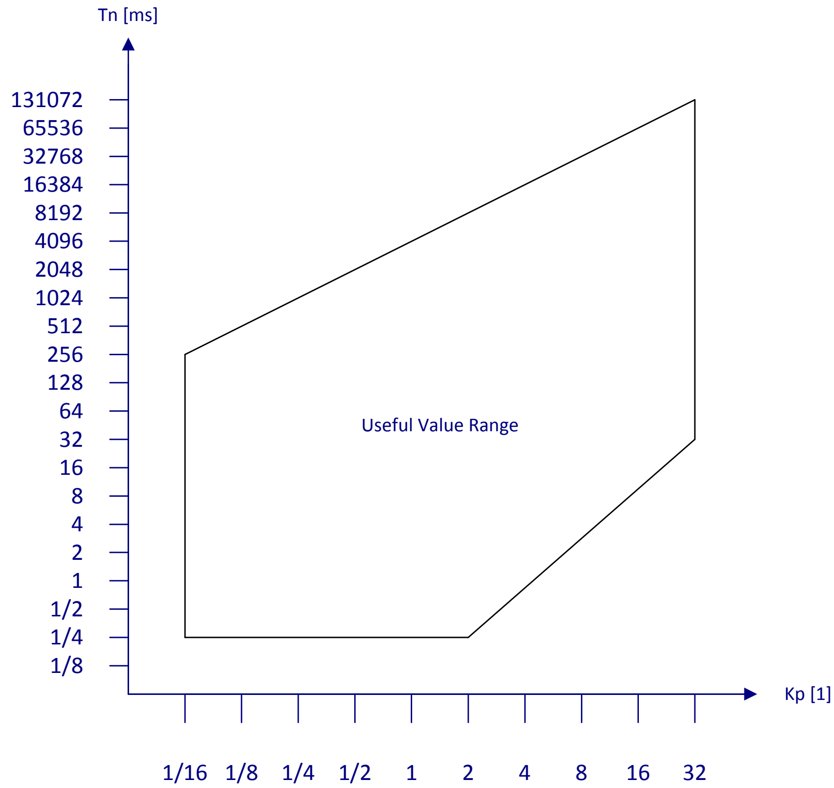


Fig. 9: Value range for K_p and T_n of the current controller belonging to the JM-2xx series

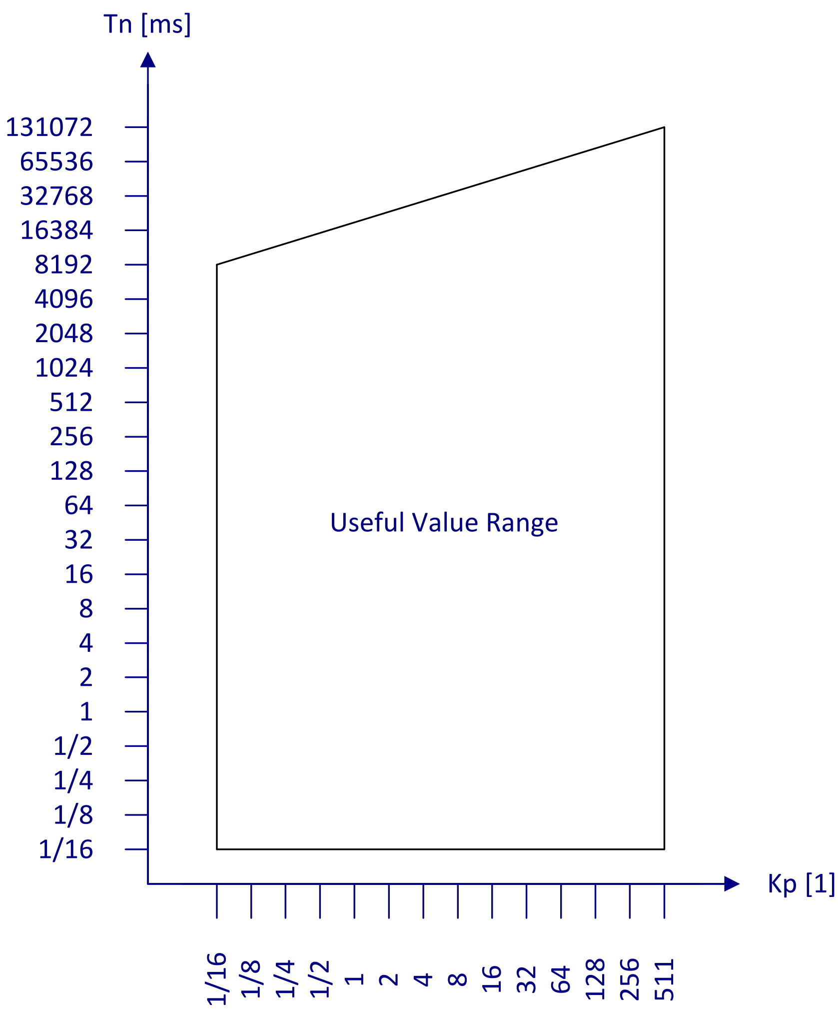


Fig. 10: Value range for K_p and T_n of the current controller belonging to the JM-105 and JM-203

Register 504: Current Control T_n	
Function	**Description**
Read	As-is value of the T_n
Write	New value of the T_n
Amplifier status	No specific status
Takes effect	Immediately
Variable type	float
Value range	R503 / 7.99 ... 8.192 [ms] for the JM-2xx series 0.0625 ... 8192 for JM-105 and JM-D203
Value following a reset	3 [ms]

Here, the parameter T_n is entered in the unit [ms]. T_n is calculated as follows:

$$T_n = \frac{L_{Motor}}{R_{Motor}}$$

The following applies to the operands:

L_{Motor} = Inductivity between 2 motor terminals in the unit [mH] -> motor data sheet, or find out by measuring.
(In asynchronous motors, the inductivity depends on the motor winding connection)

R_{Motor} = Resistance between 2 motor terminals in the unit [Ohm] -> motor data sheet, or find out by measuring.
(In asynchronous motors, the resistance depends on the motor winding connection)

T_n serves for calculating the I-factor K_I of the current controller. K_I is calculated as follows:

$$K_I = \frac{K_P}{T_n}$$

The following applies to the operands:

K_P = Proportional amplification of the current controller -> value of register 503 "Current Control K_P"

For further information on setting the speed controller, please refer to “Register 503: Current Control K_p” on page 112.

Register 561: As-is Current	
Function	**Description**
Read	As-is current value
Write	Illegal
Variable type	float
Value range	-R502 ... R502 [A_{eff}]
Value following a reset	0 [A_{eff}]

Register 618: Rated Current	
Function	**Description**
Read	As-is rated current
Write	New rated current, new maximum output current will be calculated
Amplifier status	The amplifier has to be deactivated
Takes effect	Immediately
Variable type	float
Value range	0.1 * R501 ... 2 * R501 [A_{eff}]
Value following a reset	R501 [A_{eff}]

Here, the rated current that is to be output by the device, is set according to the motor parameters.

The peak output current of the amplifier is set by the product of the values of register 618: "Rated Current" and register 619 "Overload Factor". This parameter is usually set once during axis setup. The maximum output current is displayed in “Register 502: Maximum Output Current” on page 112. It can range between 200 % and 25 % of the continuous rated current of the device.

The maximum output current is the product of the values of register 618 "Nominal Current" and register 619 "Overload Factor". The output current is newly calculated, if a new value is written into register 618 "Nominal Current" or into register 619 "Overload Factor".

PLEASE NOTE:

If one of the registers 618 "Nominal Current" or 619 "Overload Factor" are changed to another value, all registers containing values with the unit A_{eff} are newly adjusted according to their relation to the content of register 502 "Max. Output Current". This applies to register 127 "Current Limitation" or register 125 "Current Set Point".

For asynchronous motors:

Here, the rated current I_q that is used for creating the torque (rated active current) is entered in the unit [A_{eff}]. I_q is calculated as follows:

$$I_q = I_n \cdot \cos(\varphi)$$

The following applies to the operands:

I_n	=	Continuous rated current in the unit [A_{eff}] -> nameplate, dependent on the motor winding connection
cos fi	=	Rated service factor -> nameplate of the motor

See also chapter 5.3 "Asynchronous Motor", page 40.

Register 619: Overload Factor	
Function	**Description**
Read	As-is overload factor
Write	New overload factor
Amplifier status	The amplifier has to be deactivated
Takes effect	Immediately
Variable type	float
Value range	1 ... 10
Value following a reset	2

The peak output current of the amplifier is set by the product of the values of register 618 "Rated Current" and register 619 "Overload Factor". This parameter is usually set once during axis setup. The maximum output current is displayed in “Register 502: Maximum Output Current” on page 112. It can range between 200 % and 25 % of the continuous rated current of the device.

The maximum output current is the product of the values of register 618 "Nominal Current" and register 619 "Overload Factor". For calculation, the respective internally effective rated current and overload factor values is applied. The output current is newly calculated, if a new value is written into register 618 "Nominal Current" or into register 619 "Overload Factor".

Register 620: As-is Current in %	
Function	**Description**
Read	As-is current in %
Write	Illegal
Variable type	float
Value range	0 ... 100 [%]
Value following a reset	0 [%]

The percentage is related to the maximum output current, which can be read in register 502 "Maximum Output Current". The maximum output current is the product of the values of register 618 "Rated Current" and register 619 "Overload Factor".

Register 621: As-is Torque	
Function	**Description**
Read	As-is torque
Write	Illegal
Variable type	float
Value range	Float limits [Nm]
Value following a reset	0 [Nm]

The display of a valid torque depends on the torque constant of the motor. The torque constant must be written into register 616 "Motor Torque Const. Kt". If the torque constant equals zero, the displayed as-is torque equals zero as well.

9 Speed Controller

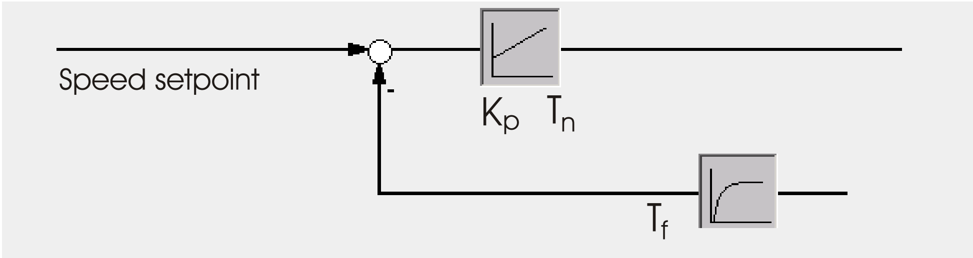


Fig. 11: Speed controller

9.1 Overview of Registers

The following registers are available for speed controlling:

Register Name	**Short Description**
R111 *Speed Controller Setpoint*	Display, respectively specification of the set speed value
R112 *As-is Motor Speed*	As-is Motor Speed
R113 *Speed Controller Tf*	Filter time constant T_f (see controller diagram above)
R118 *Speed Controller - Max. Motor Speed*	Maximum motor speed
R124 *Speed Controller Kp*	P-gain K_p of the speed controller
R126 *Speed Controller Tn*	Time constant for the integral-action component of the speed controller
R128 *Speed Limitation*	The speed controller setpoint can be limited by this controller.
R506 *Speed Controller Preset*	The current setpoint value is preset
R507 *Integral-Action Component Speed Controller*	The integral-action component of the speed controller is displayed
R628 *Mass Inertia Load*	Mass moment inertia of the power train
R629 *Scaling of the Current Pre-Control*	Scaling of the current pre-control

9.2 Current Pre-Control

The current pre-control improves the dynamic performance of the entire system in case of motion profiles of high acceleration values.

This is achieved by relieving the speed controller's integral-action component of the responsibility for providing the current setpoint value needed for acceleration. This is because the integral-action component can only be changed via the setpoint-as-is value difference at the controller input. The dynamic performance at changing the integral-active component has been defined by the integral-action time of the speed controller.

The current pre-control is deactivated by default. It has to be configured according to the intended usage. The main purpose is to find an adequate value for R628 *Inertia of Load* and R629 *Scaling of Current Pre-Control*.

Below, the procedure of configuring the current pre-control has been described:

Step	Action
1	Mechanically connect the motor with the power train and with the load corresponding to the respective axis.
2	Check the motor torque constant Action: Check, if the contents of R616 *Motor Torque Constant* K_T already coincides with the value of the torque constant specified in the motor data sheet. If it does not, R616 has to be adjusted accordingly.
3	Scale the current pre-control to 100 %. Action: Write value 100 to R629 *Scaling the Current Pre-Control*.
4	Empirical determination of the optimum current pre-control setting for the power train Action: Increase the value of R628 *Inertia of Load* as of value 0.0, until the integral-action component of the speed controller displays an optimum procedure, see chapter 9.2.1 "Ideal Current Pre-Control", page 121. Please note: For displaying the integral-action component, the oscilloscope function of the JetMove has to be used.
5	Adjust the current pre-control to the procedure, i.e. to the changes of the as-is mass inertia moment during the procedure Action: Write the respective scaling value to R629 *Scaling the Current Pre-Control*.

9.2.1 Ideal Current Pre-Control

Without a current pre-control, the integral-action component and the tracking error cause a comparatively high amplitude, see fig.12.

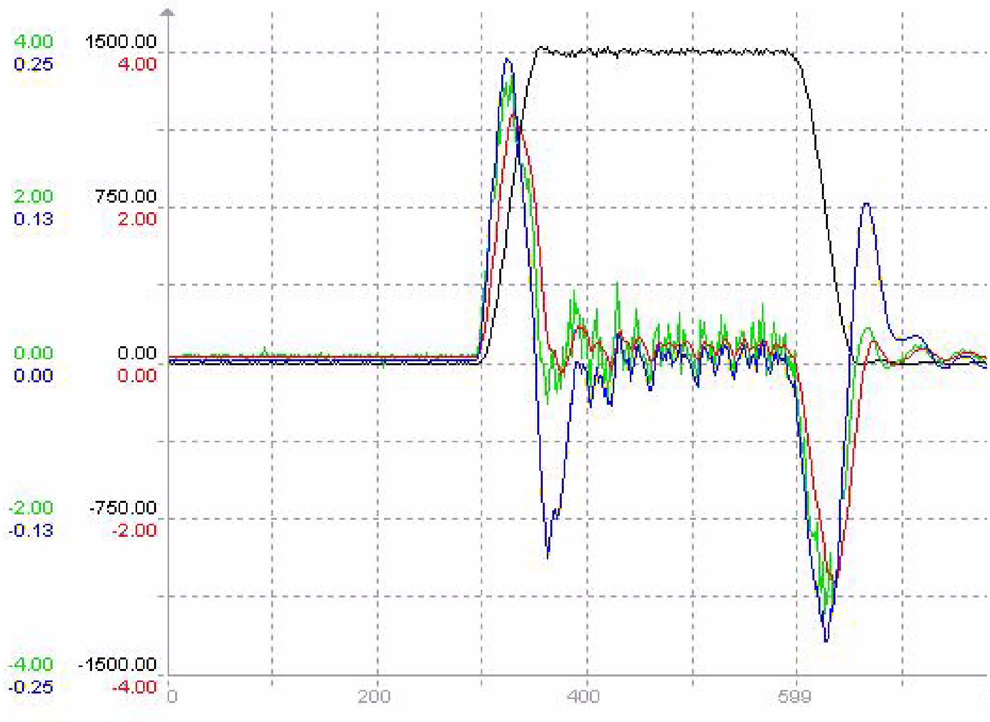


Fig. 12: Reversing without current pre-control

Legend:

–	Black	= R112 *As-is Motor Speed*
–	Blue	= R561 *As-is Current*
–	Green	= R119 *As-is Tracking Error*
–	Red	= R507 *Integral-Action Component Speed Controller*

If the current pre-control has been set best, the integral-action component of the speed controller only has to equalize the friction in the system. This means, the integral-action component will be approximately proportional to the speed value, see fig.13. The target position is being approached directly and without retraction.

The as-is mass inertia is over-compensated, when the axis starts exceeding, and then tracking back to the target position. In this case, the oscilloscope shows how the integral-action component starts partially compensating the current pre-control, i.e. working against the acceleration current. The opposite-sense behavior of the integral-action component can be slightly seen in fig.13. The setting of the current pre-control shown in fig.13, is slightly over-compensated.

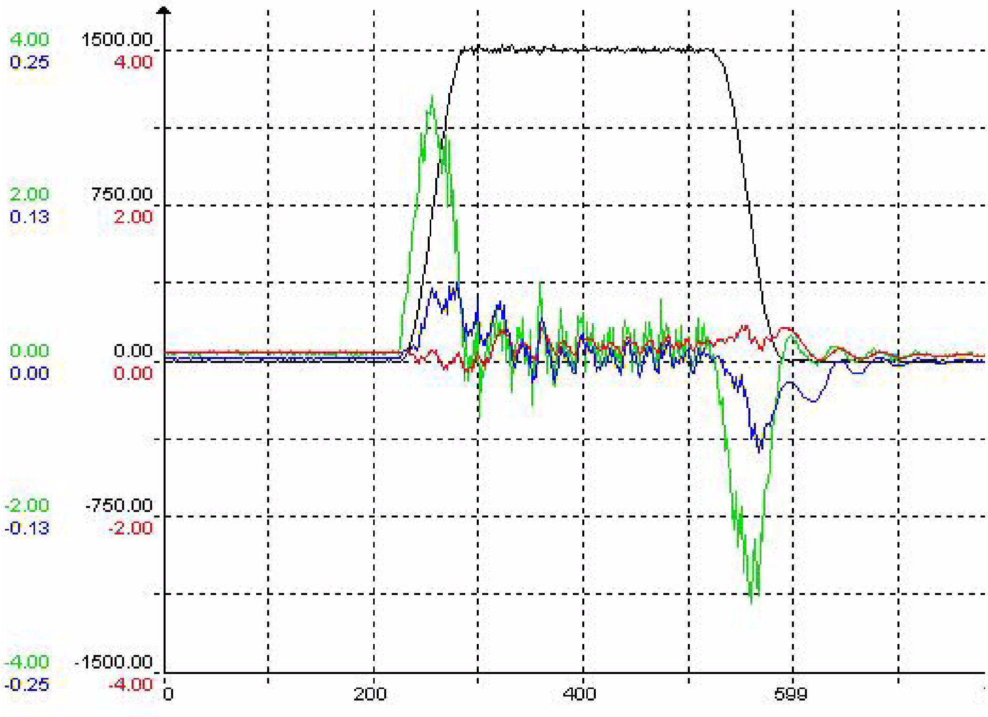


Fig. 13: Reversing with current pre-control

Legend: see fig.12.

9.3 Register Description

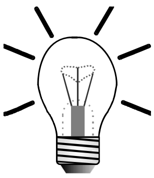
Register 111: Speed Controller Setpoint	
Function	**Description**
Read	As-is speed controller setpoint
Write	New speed controller setpoint
Amplifier status	No specific status
Takes effect	Immediately
Variable type	int / register
Value range	-12,000 ... 12,000 [rpm]
Value following a reset	0 [rpm]

From here, the speed reference of the speed controller can be read out. When the operating mode of the controller has been set to speed control, see register 572 Controller Mode, the set speed value can be specified here. In the operating mode "speed control", only the speed controller and the current controller are active. In all other operating modes, the register must not be written into.

Register 112: As-is Motor Speed	
Function	**Description**
Read	As-is speed
Write	Illegal
Variable type	int / register
Value range	-12,000 ... 12,000 [rpm]
Value following a reset	0 [rpm]

Here, the as-is motor speed can be read.

Register 113: Filter Time Constant T_f	
Function	**Description**
Read	As-is time constant of the smoothing capacitor
Write	New time constant of the smoothing capacitor
Amplifier status	No specific status
Takes effect	Immediately
Variable type	float
Value range	1 ... 32 [ms]
Value following a reset	2 [ms]



Attention!

This parameter is not the T_n for the speed controller, which will be specified in register 126.

Register 118: Maximum Motor Speed	
Function	**Description**
Read	As-is maximum speed
Write	New maximum speed
Amplifier status	The amplifier has to be deactivated
Takes effect	Immediately
Variable type	int / register
Value range	120 ... 12,000 [rpm]
Value following a reset	3,000 [rpm]

Here, the maximum motor speed is entered. This value is the absolute speed limit of the motor. Dependent on the maximum motor speed and the gearbox, the speed of the mechanic axis will be limited.

Register 124: Speed Controller K_p	
Function	**Description**
Read	As-is value of the K_p
Write	New value of the K_p
Amplifier status	No specific status
Takes effect	Immediately
Variable type	float
Value range	0 ... 127.99 for the JetMove 2xx series 0 ... 511.99 for JM-105 and JM-D203
Value following a reset	10

Here, the P-gain K_p of the digital speed controller is set.

Register 126: Speed Controller T_n	
Function	**Description**
Read	As-is value of the T_n
Write	New value of the T_n
Amplifier status	No specific status
Takes effect	Immediately
Variable type	float
Value range	0.25 ... 8.192 [ms] for the JetMove 2xx series 0.125...16.384 [ms] for the JM-105 and JM-D203 series
Value following a reset	20 [ms]

This parameter serves for calculating the I-factor of the speed controller by means of the following formula:

$K_I = K_P / T_n$

For further information on setting the speed controller, please refer to “Register 124: Speed Controller K_p” on page 125.

When value 0 is reached, the integral-action component is deactivated, while a mere proportional controller is available.

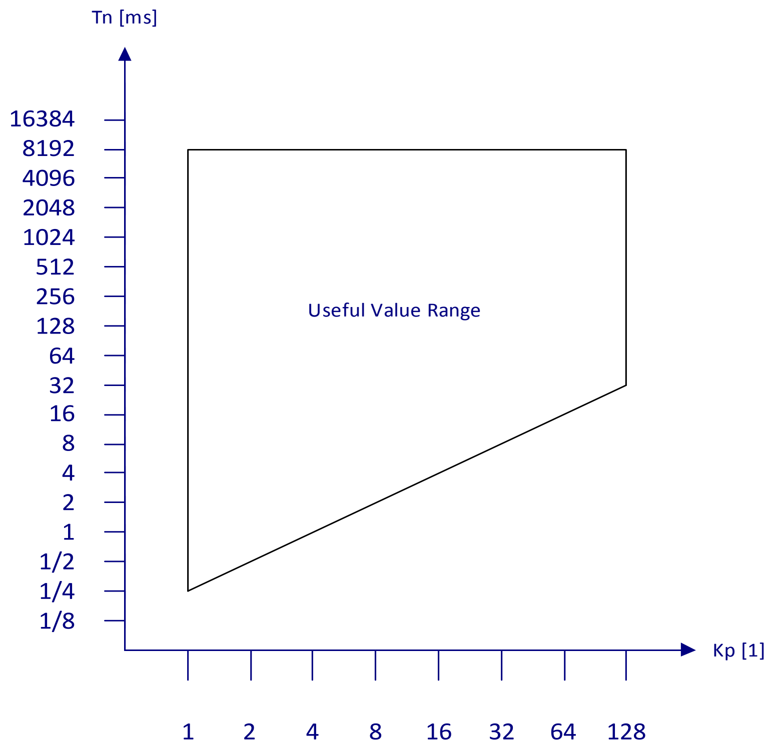


Fig. 14: Value range for K_p and T_n of the speed controller belonging to the JM-2xx series

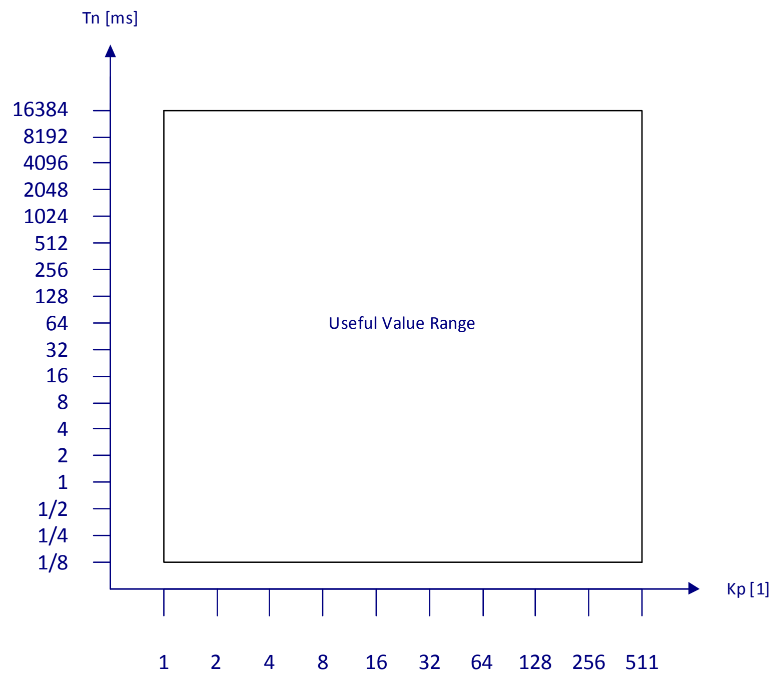


Fig. 15: Value range for K_p and T_n of the speed controller belonging to the JM-105 and JM-D203

Register 128: Limitation of Set Speed	
Function	**Description**
Read	As-are limits
Write	New limits
Amplifier status	No specific status
Takes effect	Immediately
Variable type	float
Value range	0 ... 105 % * R118
Value following a reset	3,150 [rpm]

Register 506: Speed Controller Preset	
Function	**Description**
Read	As-is preset value
Write	New preset value
Amplifier status	No specific status
Takes effect	Immediately
Variable type	float
Value range	-R502 ... R502 [A_{eff}]
Value following a reset	0 [A_{eff}]

This parameter is for compensating the load torque of a suspended load (vertical axis). If the brake is released for an axis, the following effect usually occurs: The load drops until the I-component of the speed controller has been increased to reach the respective value.

This undesired effect can be avoided by parameterizing the speed controller with a preset value. The preset value is determined empirically and contains the connection of static load torque and current setpoint (when the load is at stillstand and the controller is enabled, read the current setpoint from the parameter "current set point" and use it as preset value). The load can be prevented from dropping by correctly setting this value.

For Special Function *Torque-Controlled Shut-Off*:

Here, the preset value is entered to which the integral-action component of the speed controller is to be set after reaching the speed tripping count of R139, see chapter 18 "Special Function: Torque-Controlled Shut-Off", page 363.

For Stepper Motors:

Here, the rated motor current for the current controller is entered, see “Stepper Motor” on page 46.

Register 507: I-Component Speed Controller	
Function	**Description**
Read	Value of the as-is I-component
Write	Illegal
Variable type	float
Value range	0 ... R502 [A_{eff}]
Value following a reset	0 [A_{eff}]

From here, the as-is integral-action component of the speed controller can be read out.

Register 628: Inertia of Load	
Function	**Description**
Read	As-is torque value
Write	New torque value
Amplifier status	No specific status
Takes effect	Immediately
Variable type	float
Value range	0 ... pos. float limit [kgcm²]
Value following a reset	0 [kgcm²]

In R628, the moment of inertia for the current pre-control has to be entered.

Register 629: Scaling of the Current Pre-Control	
Function	**Description**
Read	As-is scaling of the current pre-control
Write	New scaling
Amplifier status	No specific status
Takes effect	Immediately
Variable type	float
Value range	0 ... 100 [%]
Value following a reset	0 [%]

The effect of the moment of inertia is written to R628 *Inertia of Load*. It is scaled in R629.

10 Position Feedback Controller

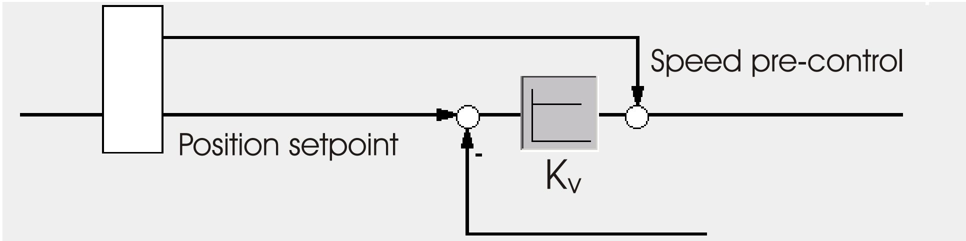


Fig. 16: Position feedback controller

10.1 Register Description

Register 110: Position Feedback Controller K_V	
Function	**Description**
Read	As-is value of the K_v
Write	New value of the K_v
Amplifier status	No specific status
Takes effect	Immediately
Variable type	float
Value range	0 ... 2.047 [1/s] for the JetMove 2xx series 0 ... 4.095 [1/s] for JM-105 and JM-D203
Value following a reset	10 [1/s]

Here, the P-gain K_v of the position feedback controller will be set.

Register 119: As-is Tracking Error	
Function	**Description**
Read	As-is tracking error
Write	Illegal
Variable type	float
Value range	Float limits [°] or [mm] (the unit depends on the setting of the axis type)
Value following a reset	0 [°]

This parameter specifies the difference between set and as-is values of the axis motion, i.e. by how many increments the as-is position of the axis deviates from the set position.

If the as-is tracking error is too great, the system concerned has to be checked. The reason might be e.g. an encoder problem, or the dimensioning of the motor has not been calculated correctly.

The as-is tracking error should be as small as possible to ensure high accuracy of axis motion. It should be maintained around 0, i.e. should never be only negative or only positive.

Via register 120 "Tracking error limit" and register 542 "Tracking error window time", tracking error monitoring can be adjusted.

Register 120: Tracking Error Limit	
Function	**Description**
Read	As-is tracking error limit
Write	New tracking error limit
Amplifier status	No specific status
Takes effect	Immediately
Variable type	float
Value range	0 ... Positive float limits [°] or [mm] (the unit depends on the setting of the axis type)
Value following a reset	10,000 [°]

Here, the tracking error limit is specified. This parameter defines, from which tracking error the amplifier should react. If the as-is tracking error exceeds this value, error 23 "Tracking error" will be triggered. Regarding the reaction to the error report, the tracking error window time written in register 542 must also be considered.

Register 130: Position Set Point	
Function	**Description**
Read	As-is position setpoint
Write	Illegal
Amplifier status	No specific status
Takes effect	Immediately
Variable type	float
Value range	Float limit [°] or [mm] (the unit depends on the setting of the axis type)
Value following a reset	0 [°]

From here, the position setpoint can be read. For this, the controller operating mode must have been set to position control via register 572 "JetMove set operating mode".

Register 190: Selection: Position Feedback Controller - As-is Value	
Function	**Description**
Read	As-is encoder for as-is value
Write	New encoder for as-is value
Amplifier status	The amplifier has to be deactivated
Takes effect	Immediately
Variable type	int / register
Value range	1 ... 2
Value following a reset	1 (first encoder)

Meaning of the values:	
1	First encoder
2	Second encoder (changing over to the second encoder is only possible with JetMoves that have got an integrated counter board (short form: "JM-2....-CNT")

By means of R190, the encoder is set which is to provide the as-is value for position control. For further information on the second encoder, see chapter 6.9 "Second Encoder", page 77.

Register 542: Tracking Error Window Time	
Function	**Description**
Read	As-is tracking window time
Write	New tracking window time
Amplifier status	No specific status
Takes effect	Immediately
Variable type	int / register
Value range	0 ... 65,535 [ms]
Value following a reset	5 [ms]

Here, tracking error monitoring can be made dependent on a certain time. Tracking error monitoring will not be active before the as-is tracking error (register 119) has exceeded the tracking error limit (register 120) for at least the tracking error window time. In this case, error report F23 "Tracking error" will be triggered.

The tracking error window time serves for filtering out the tracking error peaks.

Attention!

Tracking error monitoring will be deactivated at a tracking error window time of 65,535.

Register 550: Speed Pre-Control

Function	Description
Read	As-is speed feed forward
Write	New speed feed forward
Amplifier status	No specific status
Takes effect	Immediately
Value range	0 ... 199 [%]
Value following a reset	100 [%]

Here, the speed feed forward for the position controller with P-gain is specified. Due to the P-gain for the position controller, a constant tracking error, caused by the controller, will remain during position controlling. This tracking error will be compensated by the speed feed-forward:

During each position control cycle, the speed pre-control will add the calculated axis speed to the output value of the position controller with P-gain. Then, the position controller with P-gain will ideally only have to control the mechanically caused tracking error.

Register 551: Speed Feed Forward T1

Function	Description
Read	As-is delay time
Write	New delay time
Amplifier status	No specific status
Takes effect	Immediately
Value range	2 ... 65,534 [ms]
Value following a reset	0 [ms]

In R551, the delay time respectively time constant for a T1 controlling device filtering the change of the speed value for speed pre-control is set. The following behavior results:

- Increase of delay time -> Increase of filtering effects
- Decrease of delay time -> Decrease of filtering effects

Important!

The input of a delay time is only required,

- if the JetMove 2xx is used as a following axis with the coupling mode *Electronic Gearing* or *Table*

and

- a JX2-CNT1 or a JM-200-CNT is used as a leading axis module, to which an encoder of low resolution is connected.

The delay time can only be set in steps of 2 milliseconds, starting at 2 milliseconds: 2, 4, 6, 8 ... 65,534.

11 Referencing

Caution

Attention!

The axis could crash into the mechanical limits!

Limit switches are NOT taken into account in following cases:

- **During reference run "With zero pulse only"**
- **If the axis is positioned on the reference switch**
- **From the moment of starting the search for the reference position (reference search) to finding it.**

In case of reverse polarity of the hardware limit switches, the limit switch being positioned in the direction of the reference run will be ignored; this will cause the axis to crash into the mechanical limits.

Before starting a reference run during axis setup make sure that the hardware limit switches and the reference switch are performing reliably. Especially pay attention to the polarity and the correct assignment of the negative and positive limit switch. The polarity is defined via register 510 "Digital Inputs - Polarity".

Definitions

Zero pulse	Zero-crossing of the resolver, reset pulse of the incremental encoder
"Reference switch active" edge	The reference switch signal changes from logical zero to logical one
"Reference switch deactived" edge	The reference switch signal will change from logical one to logical zero
Switch search	The first part of referencing: Searching for the reference switch, respectively for a limit switch
Searching for the reference position	The second part of referencing, after having found the reference or limit switch: Searching for the reference position, e.g. for the zero pulse

Key to the following illustrations:

N	=	Negative limit switch	V_{ref}	=	Speed of switch search
P	=	Positive limit switch	V_{ZM}	=	Speed of search for reference position
R	=	Reference switch	ZM	=	Zero pulse ("zero mark")
SP	=	Start position	NP	=	Normal position
s	=	Space	NP distance	=	Normal position - Distance

11.1 Control Mode

For referencing, the position control mode has to be set. This is done via register 572 "Controller Mode".

11.2 Starting the Reference Run

A reference run is started by means of command 9:

```
#Include "JM2xxReg32.stp"            // JM2xx RegisterInterface
Var
JM_Axis   :JM_2XX At %VL 12000;      // Axis declaration
End_Var;

JM_Axis.JM_nm_Cmd := zkRefSearch;
When Bit_CLear (JM_Axis.JM_nw_State,
zbBusy) Continue;
...
```

Attention:

During the reference run, command 9 "Search for reference" cannot be given again.

If the parameters for referencing are changed while a reference run is in process, they will at first have no effect on this reference run. As of the next reference run, the alterations will be effective.

11.3 Interrupting the Reference Run

The user can interrupt a reference run by means of the following commands:

- Command 5
- Command 6
- Command 7

11.4 Status Information

If bit 0 "RefOK" of register 100 "Status" is set at starting the reference run, it is reset. Bit 1 "Stopped" of register 100 is also reset.

If referencing has been completed and correct, both bits are set. If referencing has been stopped due to an error or by the user (by command 6, for example), only bit 1 "Stopped" is set, as soon as the axis has come to a standstill again.

Those two bits can be used for continuing the PLC program after starting the reference run.

Error messages

Referencing errors are output in register 170 "Positioning Error". They are not displayed at the amplifier by F and error number. If a referencing error occurs, bit 0 "RefOK" of register 100 "Status" is not set. Bit 1 "Stopped" of register 100 is set in case of an error, when the axis has come to a standstill.

11.5 Axis Type

Referencing is possible without any restrictions both with settings for a linear axis and with settings for a rotatory axis via register 191 "Axis Type". If a modulo axis has been set in register 192 "Modulo Axis", there are no restrictions for referencing either.

11.6 Modes of Referencing

There are various modes of referencing to choose from:

- Referencing only with zero pulse
- Referencing by reference and limit switch
- Referencing by limit switch only (there is no reference switch, for example)
- Referencing by reference switch only

The mode of referencing is selected by the switch type parameter of register 161 "Switch Type". The modes of referencing are explained below.

11.7 Speed Settings

Two different speed values can be set for referencing:

- Speed of the reference switch search set in register 162 "Speed of Switch Search".
- Speed of searching for the reference position set in register 166 "Speed of Reference Search".

The speed setting for switch search is also used for driving back to the normal position, see "Setting the Specific Reference Position" below.

Referencing is started by the speed of switch search. When the switch has been found, the speed of the reference point search is set for driving to the reference position.

Normally, the speed of the reference point search is lower than the speed of the switch search. These values have also been set by default.

For neither of the two speed settings there is a specific limitation. Normally, though, referencing is done in low speed.

The speed values are set once before referencing; they cannot be changed during referencing.

Fig. 17 shows a typical motions sequence of various speeds:

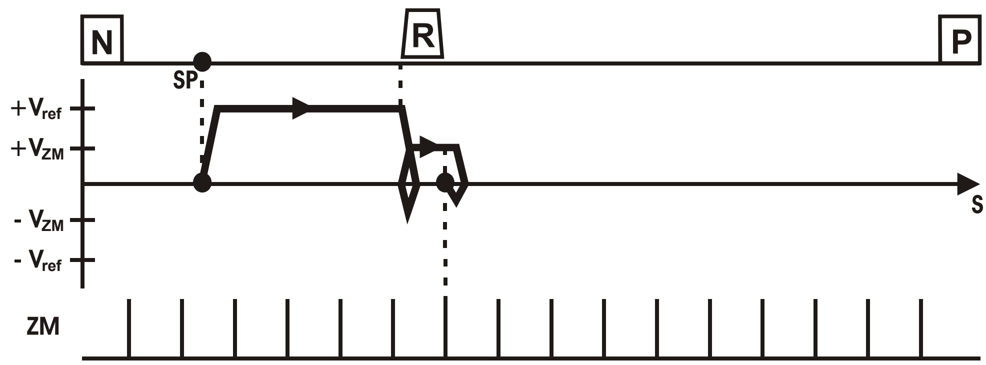


Fig. 17: Referencing by various speeds

11.8 Speed Reversal

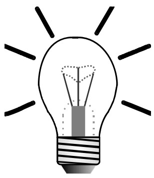
Besides setting the direction of referencing via register 160 "Referencing Direction", the rotational direction of the axis can be set via register 540 "Drive Mode 1", Bit 5 "Speed Reversal". This value applies to all axis motions, not only to referencing.

Below, referencing for setting a positive rotatory direction will be illustrated. If a negative direction of rotation has been set, the respective graphic referring to positive direction of rotation must be used for illustrating features such as the motion sequence at referencing in negative direction.

11.9 Reference Position

11.9.1 Zero pulse ("zero mark") or edge of a switch

The reference position can either be the position of the zero pulse ("zero mark") or the position of the edge of a switch, if referencing is being carried out without zero pulse.



Note!

If an incremental encoder is used as a commutation feedback for asynchronous motors, referencing by zero pulse cannot be carried out.

Register 165 "Reference Mark" defines, whether the reference point is to be the position of the zero pulse or the position of the edge of a switch.

We recommend setting the zero pulse ("zero mark") as home position ("reference mark"). Referring to the zero pulse ("zero mark") offers a much greater repeat accuracy.

Fig. 18 illustrates referencing with zero pulse for the switch types "reference and limit switch" and "limit switch only":

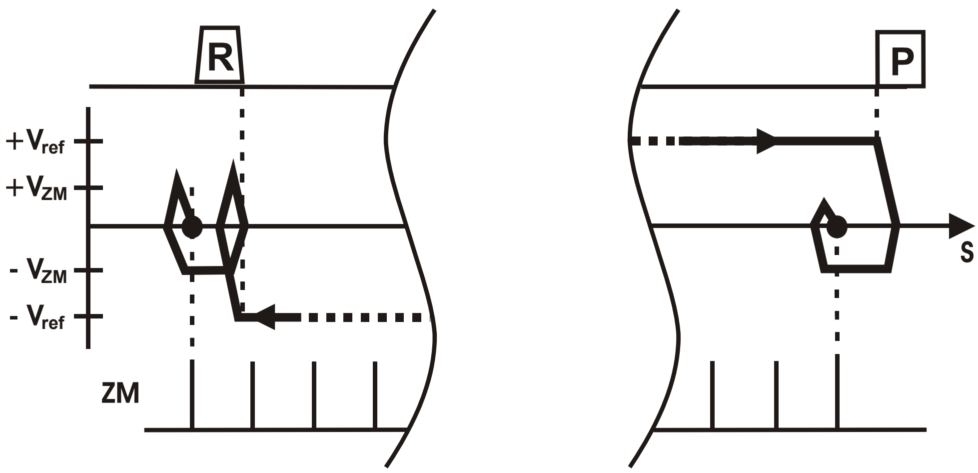


Fig. 18: Referencing with zero pulse ("zero mark")

Fig. 19 illustrates referencing without zero pulse for the switch types "reference and limit switch" and "limit switch only":

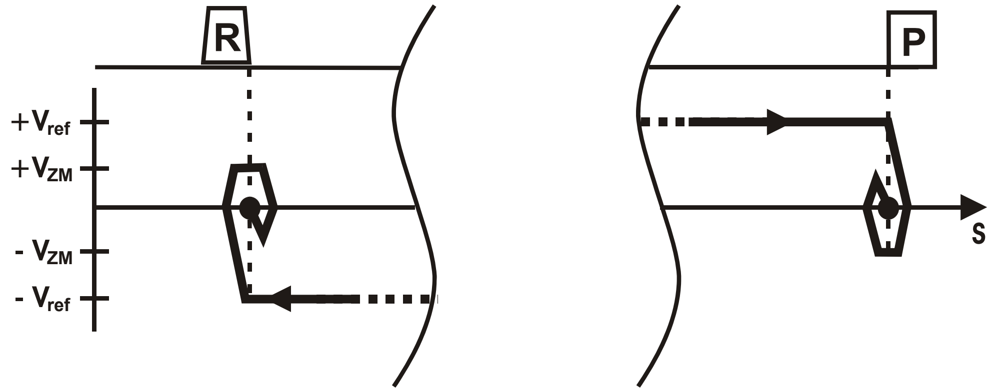


Fig. 19: Referencing without zero pulse ("zero mark")

11.9.2 One-phase referencing

At the referencing mode "Referencing only by Reference Switch", there are two further possibilities for reference position search. This special case is only helpful if modulo axes are applied, which means that only one direction is permitted for the axis to travel. Please compare with “Register 192: Modulo Axis” on page 22. It is recommended that “Register 168: Home Position - Distance” on page 157 has got a referencing direction value leset the axis has to reverse to home position during deceleration.

Register 165 "Reference Mark" defines, whether the reference point is to be the position of the zero pulse or the position of the edge of the switch.

Fig. 20 shows one-phase referencing with and without zero pulse:

Fig. 20: One-phase referencing

11.10 Setting the Specific Reference Position

There is the possibility of driving to another position in the travel range immediately after finding the reference position (register 168 "Home Position - Distance"). This position is called home position or normal position.

For a home position value, any position value can be chosen (register 169 "Home Position").

In the following illustration Fig. 21, the motion sequence of the axis when driving towards normal position is shown (NP = normal position, NP distance = normal position - distance):

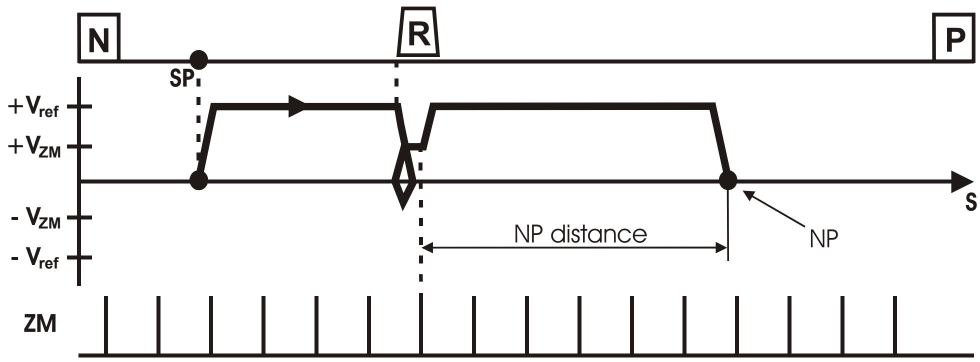


Fig. 21: Driving towards "normal position"

The speed by which the axis is driving towards normal position is the speed of the switch search; it is set in register 162 "Speed Switch Search".

Via register 168 "Home Position - Distance", the distance to be covered from reference to home position is input. A negative value causes the axis to move in negative direction, seen from the reference position.

Via register 169 "Home Position", the position is input that is to be set as as-is position after having reached the home position. The virtual position is set at the reference position, if there is no "normal position" to be driven to; this means that register 168 = 0.

11.11 Referencing by Zero Pulse Only

For this reference run, the axis starts in the set referencing direction by the set reference search speed. When the zero pulse ("zero mark") has been recognized, the axis returns towards the position of the zero pulse ("zero mark").

During this travel, the motor makes one revolution as a maximum. The setting of the home position in register 1x165 "Reference Mark" does not take effect here.

Attention:

During this reference run, limit switches are not monitored.

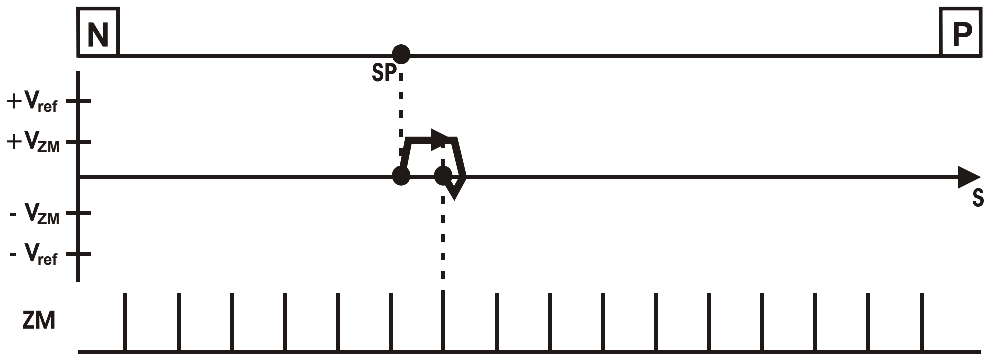


Fig. 22: Referencing only by means of zero pulse ("zero mark") in positive direction; the rotatory direction is positive; the starting position is on the negative side of the zero pulse.

11.12 Referencing by Means of Reference and Limit Switch

Prerequisites for this reference run are a reference switch, as well as the positive and negative limit switch.

The reference run with its respective starting positions and directions are explained below.

11.12.1 Positive direction

During automatic referencing, the axis is always moved so that reference search is being carried out from the negative side of the reference switch.

Starting from the positive side of the reference switch

– The axis starts in positive direction by "Speed Switch Search".
– When the positive limit switch has been recognized, the axis reverses and continues in negative direction by "Speed Switch Search".
– The axis keeps crossing the reference switch, until the "Reference switch deactivated" edge has been recognized.
– There, the axis reverses to drive in positive direction by "Speed Reference Search".
– After having recognized the "Reference switch active" edge again, the reference position is set to the first zero pulse. For referencing without zero pulse ("zero mark"), the reference position is set to the position of the "Reference switch active" edge.

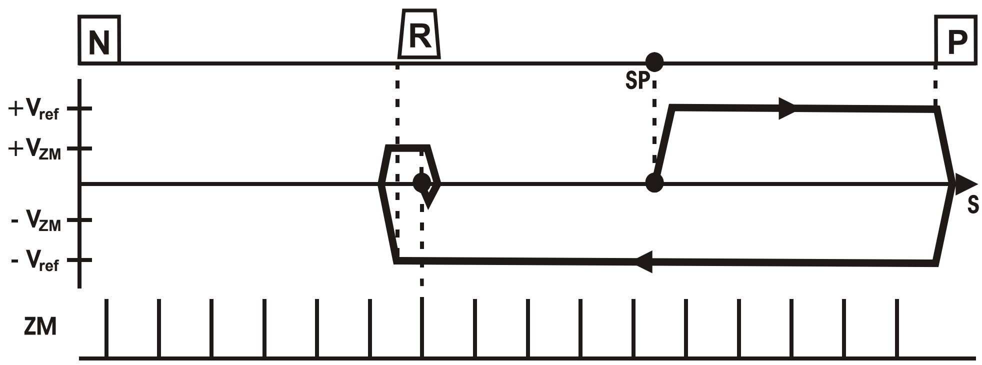


Fig. 23: Referencing by reference and limit switch in positive direction; the rotatory direction is positive; with zero pulse ("zero mark"), the starting position is on the positive side of the reference switch.

Starting from the negative side of the reference switch

– The axis starts in positive direction by "Speed Switch Search".
– When the reference switch active edge has been recognized, the axis will drive back in negative direction by "Speed Switch Search", until it reaches the position, where the reference switch active edge has been recognized.
– There, the axis reverses to drive in positive direction by "Speed Reference Search".
– After having recognized the "Reference switch active" edge again, the reference position is set to the first zero pulse. For referencing without zero pulse ("zero mark"), the reference position is set to the position of the "Reference switch active" edge.

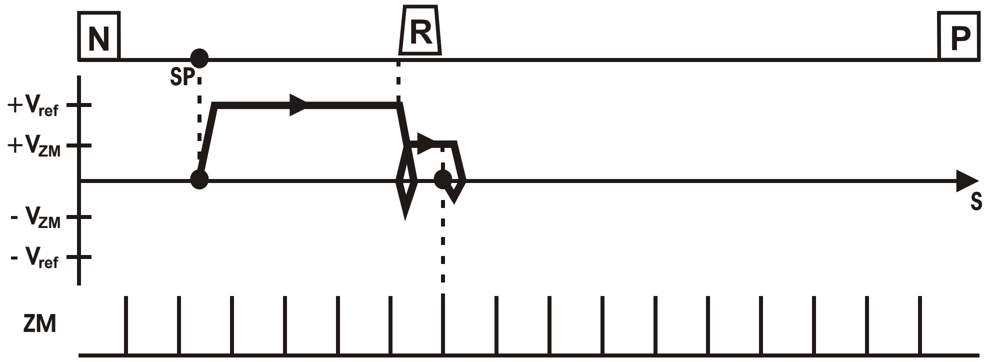


Fig. 24: Referencing by reference and limit switch in positive direction; the rotatory direction is positive; with zero pulse ("zero mark"), the starting position is on the negative side of the reference switch.

Starting on the reference switch

– The axis starts in negative direction by "Speed Switch Search".
– When the reference switch has become deactivated, the axis reverses and continues in positive direction by "Speed Reference Search".
– After having recognized the "Reference switch active" edge again, the reference position is set to the first zero pulse. For referencing without zero pulse ("zero mark"), the reference position is set to the position of the "Reference switch active" edge.

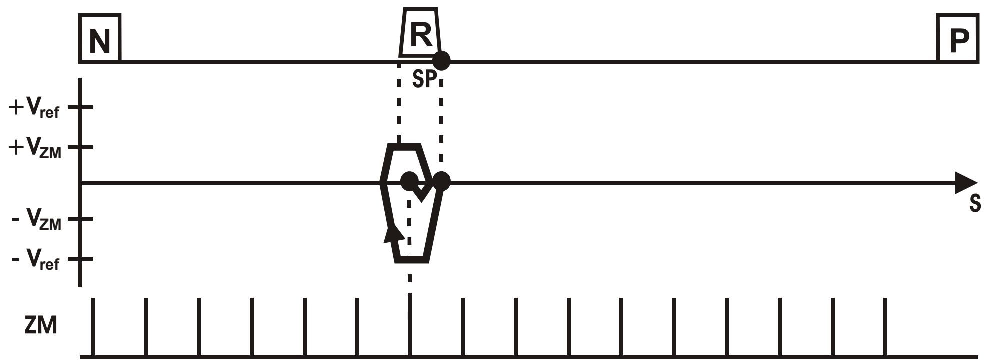


Fig. 25: Referencing by reference and limit switch in positive direction; the rotatory direction is positive; with zero pulse ("zero mark"), the starting position is on the reference switch.

11.12.2 Negative direction

During automatic referencing, the axis is always moved in a way that reference search is being carried out from the positive side of the reference switch.

Starting from the positive side of the reference switch

- The axis starts in negative direction by "Speed Switch Search".
- When the reference switch active edge has been recognized, the axis will drive back in positive direction by "Speed Switch Search", until it reaches the position, where the "Reference switch active" edge has been recognized.
- There, the axis reverses to drive in negative direction by "Speed Reference Search".
- After having recognized the "Reference switch active" edge again, the reference position is set to the first zero pulse. For referencing without zero pulse ("zero mark"), the reference position is set to the position of the "Reference switch active" edge.

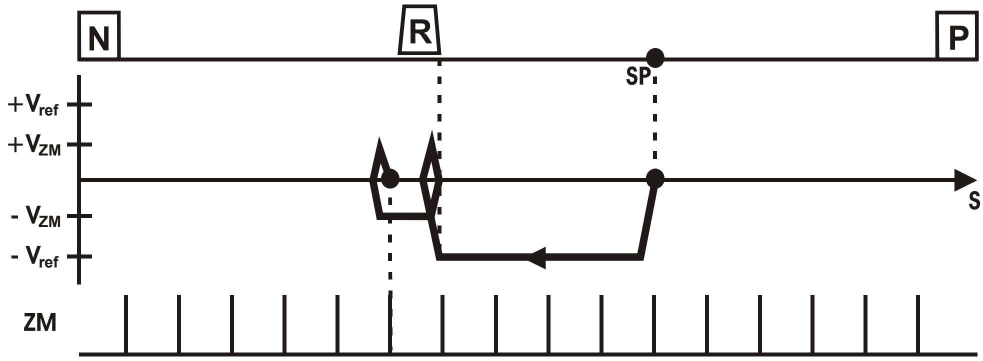


Fig. 26: Referencing by reference and limit switch in negative direction; the rotatory direction is positive; with zero pulse ("zero mark"), the starting position is on the positive side of the reference switch.

Starting from the negative side of the reference switch

- The axis starts in negative direction by "Speed Switch Search".
- When the negative limit switch has been recognized, the axis will reverse and continue in positive direction by "Speed Switch Search".
- The axis keeps crossing the reference switch, until the "Reference switch deactivated" edge has been recognized.
- There, the axis reverses to drive in negative direction by "Speed Reference Search".
- After having recognized the "Reference switch active" edge again, the reference position is set to the first zero pulse. For referencing without zero pulse ("zero mark"), the reference position is set to the position of the "Reference switch active" edge.

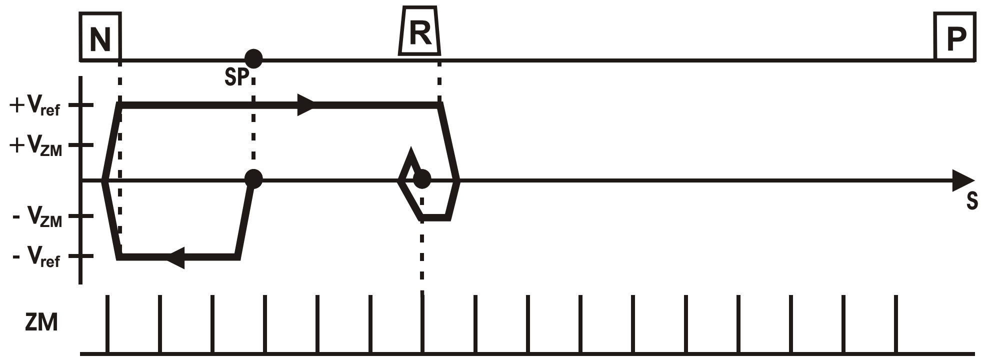


Fig. 27: Referencing by reference and limit switch in negative direction; the rotatory direction is positive; with zero pulse ("zero mark"), the starting position is on the negative side of the reference switch.

Starting on the reference switch

– The axis starts in positive direction by "Speed Switch Search".
– When the reference switch has become deactivated, the axis will reverse and continue in negative direction by "Speed Reference Search".
– After having recognized the "Reference switch active" edge again, the reference position is set to the first zero pulse. For referencing without zero pulse ("zero mark"), the reference position is set to the position of the "Reference switch active" edge.

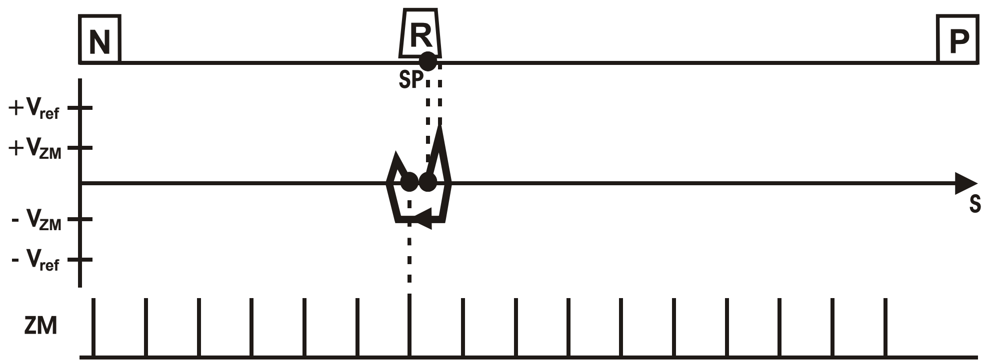


Fig. 28: Referencing by reference and limit switch in negative direction; the rotatory direction is positive; with zero pulse ("zero mark"), the starting position is on the reference switch.

11.13 Referencing by One Limit Switch Only

If the limit switch has been found when driving in referencing direction, the axis is referenced there.

The limit switch driving in opposite referencing direction is ignored, until the axis has reversed on the limit switch. When the axis has reversed and the limit switch being positioned in the new direction has been recognized, the axis is stopped and an error message is output in register 170 "Positioning Error" (bit 18 "Reference: Limit switch positive" or bit 19 "Reference: Limit switch negative").

Starting in positive direction

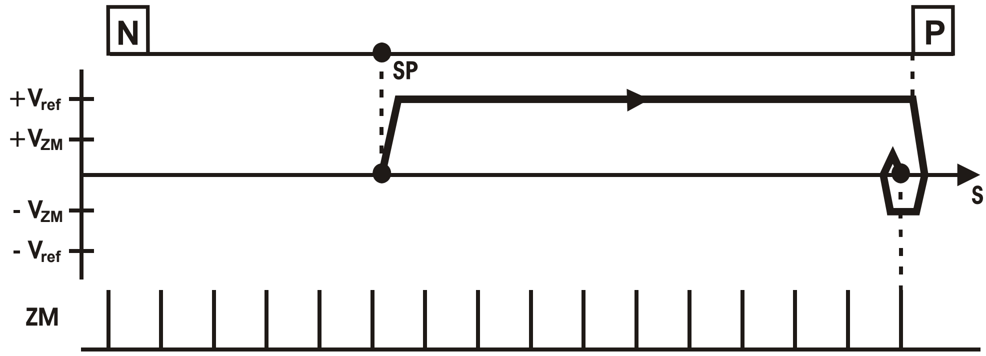


Fig. 29: Referencing by limit switch only; positive direction, positive rotatory direction, starting position preceeding the positive limit switch.

Fig. 30: Referencing by limit switch only; positive direction, positive rotatory direction, starting position on the positive limit switch.

Starting in negative direction

Fig. 31: Referencing by limit switch only; negative direction, positive rotatory direction, starting position preceeding the negative limit switch.

Fig. 32: Referencing by limit switch only; negative direction, positive rotatory direction, starting position on the negative limit switch.

11.14 Referencing by Reference Switch Only

The axis drives to the reference switch to be referenced there. When, during the reference run, the limit switch being positioned in the referencing direction has been recognized, the axis will be stopped and an error will be output in register 170 "Positioning Error" (bit 18 "Reference: Limit switch positive" or bit 19 "Reference: Limit switch negative"). The limit switch being positioned in negative direction will be ignored.

This referencing mode is used for example with a conveyor belt which has to be calibrated after every turn.

For the sequence of motions, please refer to chapter 11.12 "Referencing by Means of Reference and Limit Switch", page 145.

11.15 Register Description

Register 160: Referencing Direction	
Function	**Description**
Read	As-is direction of referencing
Write	New direction of referencing
Amplifier status	No specific status
Takes effect	Next referencing
Variable type	int / register
Value range	0, 1
Value following a reset	0

Here, the direction of referencing is specified. Referencing is then started by issuing command 9.

Meaning of the values:

0 : Positive direction

1 : Negative direction

Please also read chapter 11 "Referencing", page 137.

Register 161: Switch Type	
Function	**Description**
Read	As-is switch type
Write	New switch type
Amplifier status	No specific status
Takes effect	Next referencing
Variable type	int / register
Value range	0 ... 3
Value following a reset	1

Here it is specified, which hardware switches are to be used for referencing.

Meaning of the values:

0 : No switches, only zero pulse of the encoder

1 : Reference and limit switch

2 : Limit switch only

3 : Reference switch only

Please also read chapter 11 "Referencing", page 137.

Register 162: Speed of Switch Search	
Function	**Description**
Read	As-is search speed
Write	New search speed
Amplifier status	No specific status
Takes effect	Next referencing
Variable type	float
Value range	0 ... R184 [°/s] or [mm/s] (the unit depends on the setting of the axis type)
Value following a reset	500 [°/s]

Here the speed is specified, by which the axis starts referencing by switch search. When the switch has been found, the "reference mark" will be searched for. For searching the "reference mark", a specific speed will be set in register 166 "Speed Reference Search".

Which switch is to be used for referencing (reference switch, limit switch, zero pulse) is defined in register 161 "Switch Type".

Please also read chapter 11 "Referencing", page 137.

Register 163: Acceleration	
Function	**Description**
Read	As-is acceleration value
Write	New acceleration value
Amplifier status	No specific status
Takes effect	Next referencing
Variable type	float
Value range	0 ... R180 [°/s²] or [mm/s²] (the unit depends on the settings of the axis type)
Value following a reset	1,000 [°/s²]

Here, the acceleration for referencing is specified. This acceleration value applies to starting and stopping the reference run and to changes of speed. The changes of speed result from various speed settings for the switch search, see register 162 "Speed Switch Search", and to the search for the "reference mark", see register 166 "Speed Reference Search".

Attention!

If referencing has been interrupted by issuing command 6, the axis will be brought to a standstill by the deceleration defined in register 106 "Deceleration".

Please also read chapter 11 "Referencing", page 137.

Register 164: Max. Distance Switch Search	
Function	**Description**
Read	As-is maximum distance
Write	New maximum distance
Amplifier status	No specific status
Takes effect	Next referencing
Variable type	float
Value range	Float limits [°] or [mm] (the unit depends on the setting of the axis type)
Value following a reset	100,000 [°]

Within this maximum distance, the switch signal has to be active. The distance is measured as of the starting position of the reference run. If the maximum distance is exceeded, the axis is stopped and the error "Max. distance switch search" of bit 17 in register 170 "Error Positioning" is reported.

Please also read chapter 11 "Referencing", page 137.

Register 165: Reference Mark	
Function	**Description**
Read	As-is reference mark
Write	New reference mark
Amplifier status	No specific status
Takes effect	Next referencing
Variable type	int / register
Value range	1, 2
Value following a reset	1

Meaning of the values:

1 : Referencing by means of zero pulse

2 : Referencing without zero pulse (this means the reference position will only be the switch edge of the reference switch, respectively of the limit switch)

3 : Referencing by means of zero pulse, one-phase
For this kind of referencing, switch type "reference switch only" has to be selected.

4 : Referencing without zero pulse, one-phase (this means the reference position will only be the switch edge of the reference switch, respectively of the limit switch)
For this kind of referencing, switch type "reference switch only" has to be selected.

Please also read chapter 11 "Referencing", page 137.

Register 166: Speed Reference Search	
Function	**Description**
Read	As-is search speed
Write	New search speed
Amplifier status	No specific status
Takes effect	Next referencing
Variable type	float
Value range	0 ... R184 [°/s] or [mm/s] (the unit depends on the setting of the axis type)
Value following a reset	100 [°/s]

Here, the speed will be specified, by which the axis approaches the reference position. When the switch signal has been recognized, the reference position will be searched for. The reference position can either be the position of the zero pulse ("zero mark") or the position of the switch edge, if referencing is being carried out without zero pulse.

The switch is searched for by the speed, which has been set in register 162 "Speed of Switch Search".

Please also read chapter 11 "Referencing", page 137.

Register 167: Max. Distance Reference Search	
Function	**Description**
Read	As-is max. distance reference search
Write	New max. distance reference search
Amplifier status	No specific status
Takes effect	Next referencing
Variable type	float
Value range	Float limits [°] or [mm] (the unit depends on the setting of the axis type)
Value following a reset	1,000 [°]

Within this maximum distance, the reference mark must be active. The distance will be measured from the starting position of the reference search. If the maximum distance is exceeded, the axis is stopped and the error "Max. distance reference search" of bit 17 in register 170 "Error Positioning" is reported.

Please also read chapter 11 "Referencing", page 137.

Register 168: Home Position - Distance	
Function	**Description**
Read	As-is distance
Write	New distance
Amplifier status	No specific status
Takes effect	Next referencing
Variable type	float
Value range	Float limits [°] or [mm] (the unit depends on the setting of the axis type)
Value following a reset	0 [°]

Here, the distance between the virtual normal position and the found reference position is specified. After a successfully completed reference run, the axis is to come to a standstill at the home, respectively normal position. By "distance", the space is specified, which the axis, after having got to the reference position, still has to cover in order to reach home position.

Please also read chapter 11 "Referencing", page 137.

Register 169: Home Position	
Function	**Description**
Read	As-is position
Write	New position
Amplifier status	No specific status
Takes effect	Next referencing
Variable type	float
Value range	Float limits [°] or [mm] (the unit depends on the setting of the axis type)
Value following a reset	0 [°]

Here, the position is specified, which, at home position is to be set in register 109 as as-is position. After a successfully completed reference run, the axis comes to a standstill at the home position. For this, please also refer to the description of register 168 "Home Position - Distance".

Please also read chapter 11 "Referencing", page 137.

12 Positioning

12.1 PtP-Positioning

Ptp positioning stands for point-to-point positioning.

Attention!

In case of very small target speed values (< 100 °/s | mm/s) and very great as-is position values (> 100,000 °|mm, resp. < -100,000 °|mm), the as-is speed driven by the JetMove can be higher than the target speed value set by the user.

The reason for this is internal floating point calculation. At internal floating point calculation, small target speed values are "absorbed" by great as-is position values. Because of this behavior, axis motion would not result, unless the JetMove itself incremented the target speed to a respective value depending on the as-is position.

12.2 Endless Positioning

Attention!

Endless positioning is only allowed, if the axis is set to modulo mode.

Transition can be made from endless positioning to ptp-positioning Yet, it is not possible to make transition from a running ptp-positioning endless positioning.

Command 57 "Reversing of endless positioning" does not consider the changes in the positioning parameters, such as speed, which have been made after starting the endless positioning.

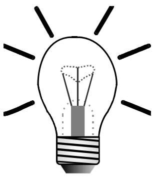
12.3 Register Description

Register 102: Target Position	
Function	**Description**
Read	As-is target position
Write	New target position
Amplifier status	No specific status
Takes effect	At the next positioning run or at command 12
Variable type	float
Value range	R183 ... R182 [°] or [mm]. The unit depends on the setting of the axis type.
Value following a reset	0 [°]

Here, the target position for the next point-to-point positioning is specified. Here, the point-to-point positioning can be either absolute or relative. The register can be written into during a positioning run.

The target position is used at the following commands:

- Command 10 "Starting an absolute positioning run"
- Command 11 "Starting an absolute positioning run related to time"
- Command 12 "Changing an absolute target position"
- Command 20 "Starting a relative positioning run"
- Command 22 "Changing a relative target position"



Attention!

Positioning is not started yet by writing into the target position. Only the respective command will cause the positioning run to be started.

The target position of a positioning run that is already in process can be changed. In order to change the target position, the new target position must be written into the register; then, one of the following commands must be issued:

Point-to-point positioning - absolute

- Command 10 "Starting an absolute positioning run"
  The entire positioning is recalculated. New general conditions can change the behaviour, e.g. speed, of the new positioning run compared to the former one.

- Command 11 "Starting an absolute positioning run related to time"
  The entire positioning is recalculated. New general conditions can change the behaviour, e.g. speed, of the new positioning run compared to the former one.

- Command 12 "Changing an absolute target position"
  Positioning is only recalculated as far as it concerns the new target position. New general conditions will not be considered; speed, for example, remains unchanged.

Point-to-point positioning - relative

- Command 20 "Starting a relative positioning run"
  The entire positioning is recalculated. New general conditions can change the behavior, e.g. speed, of the new positioning run compared to the former one.

- Command 22 "Changing a relative target position"
  Positioning is only recalculated as far as it concerns the new target position. New general conditions are not considered; speed, for example, remains unchanged.

Leading over from endless to point-to-point positioning:

- Command 10 "Starting an absolute positioning run"
  The entire positioning has to be recalculated.

Yet, it is not possible for a running ptp positioning to be led over to endless positioning.

Register 103: Target Speed	
Function	**Description**
Read	As-is target speed
Write	New target speed
Amplifier status	No specific status
Takes effect	At the next positioning run or at command 13
Variable type	float
Value range	>0 ... R184 [°/s] or [mm/s] (The unit is dependent on the axis type)
Value following a reset	200 [°/s]

Here, the target speed for all positioning runs, point-to-point positioning and endless positioning is specified. The register can be written into during a positioning run.

The target speed is used at the following commands:

- Command 10 "Starting an absolute positioning run"
- Command 13 "Changing a speed"
- Command 20 "Starting a relative positioning run"
- Command 56 "Starting endless positioning"

Attention!

If, during a positioning run, a register is written into, the new target speed will not be of any effect, unless the respective command has been issued.

The target speed of a positioning run that is already in process can be changed. For this purpose, the new target speed has to be written to the register, while command 13 "Changing a speed" has to be issued.

Changing a target speed value is also considered, when, during a positioning run already in process, the following commands are given:

- Command 10 "Starting an absolute positioning run"
- Command 20 "Starting a relative positioning run"
- Command 56 "Starting endless positioning"
  This is only permitted, if the running positioning is an endless positioning; during a running point-to-point positioning, this command is not permitted to be issued.

Register 104: Positioning Time	
Function	**Description**
Read	As-is positioning time
Write	New positioning time
Amplifier status	No specific status
Takes effect	Next positioning started by command 11
Variable type	float
Value range	0 ... 32,767 [s]
Value following a reset	0 [s]

Instead of issuing a speed via register 103, it is also possible to set a time for point-to-point positioning. Then, the speed results from the as-is position, the target position, the content of register 102, and the time set for this.

The amplifier has the calculated speed written to R103 "Target Speed"; it is used at the following positioning run, if the contents of register 103 are not changed.

Positioning related to time is started by issuing command 11 "Starting an absolute positioning run related to time".

The target speed of a positioning run that is already in process can be changed. For this purpose, the new positioning time has ti be entered into the register, while command 11 has to be issued. It is insignificant, whether the positioning running at that moment has been started by issuing command 11 or not. Please mind, though, that the speed of the new positioning run can be different from the former one.

A positioning run started by command 11 can be influenced and altered by changing the positioning parameters and by issuing the respective commands.

Register 105: Acceleration	
Function	**Description**
Read	As-is acceleration
Write	New acceleration
Amplifier status	No specific status
Takes effect	At the next positioning run or at issuing command 15
Value range	0 ... R180 [°/s²] or [mm/s²] (The unit is dependent on the axis type)
Value following a reset	500 [°/s²]

Here, the acceleration for individual positioning runs is specified. The acceleration value is used for starting a positioning run and for the change of speed during a positioning run. This means that, even if, during positioning, the speed is being decelerated, still the acceleration value is used for this deceleration. The deceleration value of register 106 is only used for deceleration when driving towards the target position, and for carrying out command 6 "Stop positioning (user ramp)".

The target speed is used at the following commands:

- Command 10 "Starting an absolute positioning run"
- Command 11 "Starting an absolute positioning run related to time"
- Command 15 "Changing an acceleration value"
- Command 20 "Starting a relative positioning run"
- Command 56 "Starting endless positioning"

Attention!

A low value results in a long ramp, while a great value results in a short ramp.

Two ramp types can be selected for acceleration:

- sine-square ramp (sine-square shaped speed profile)

or

- linear ramp (linear speed profile)

The ramp type can be selected by means of register 140 "Ramp Type". The sine-square ramp has been set as the default ramp type.

A sine-square ramp guarantees a soft and jerk-free start. When driving a sine-square ramp, the specified value is reached while acceleration is still in process.

If a linear ramp is driven, acceleration remains constant; there is linear speed increase during the entire acceleration process.

In the illustration below, various settings for acceleration by sine-square ramp are shown.

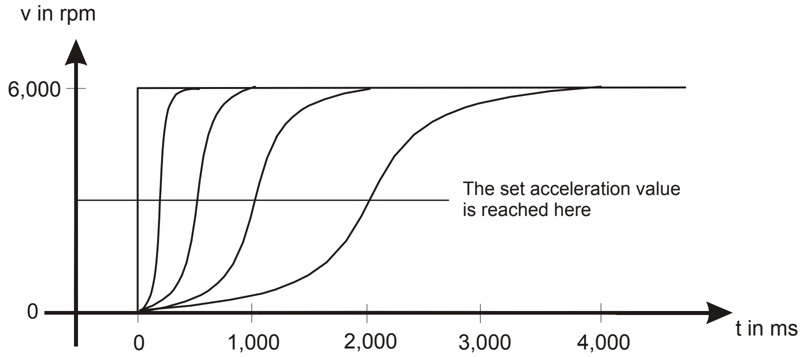


Fig. 33: Acceleration process

The acceleration rate of a positioning run that is already in process can be changed. For this purpose, the new acceleration rate has to be written into the register, and command 15 "Changing a speed" has to be issued. Yet, this change does not take effect on the as-is acceleration ramp, but on the ramp that is to follow.

Changing an acceleration value is also considered, when, during a positioning run already in process, the following commands are given:

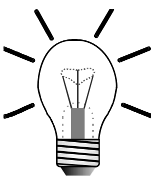
- Command 10 "Starting an absolute positioning run"
- Command 11 "Starting an absolute positioning run regarding time"
- Command 20 "Starting a relative positioning run"
- Command 56 "Starting endless positioning"
  This is only permitted, if the running positioning is an endless positioning; during a running point-to-point positioning, this command is not permitted to be issued.

Register 106: Deceleration	
Function	**Description**
Read	As-is delay
Write	New delay
Amplifier status	No specific status
Takes effect	At the next positioning run or at issuing command 16
Variable type	float
Value range	0 ... R180 [°/s²] or [mm/s²] (The unit is dependent on the axis type)
Value following a reset	500 [°/s²]

Here, the deceleration rate when driving towards the target for positioning runs is specified. The deceleration value is only used for decelerated driving towards the target position and for carrying out command 6 "Stop positioning (user ramp)". For a change of speed during positioning, the acceleration value specified in register 105 will be used. This means that, even if, during positioning, the speed is being decelerated, still the acceleration value is used for this deceleration.

The deceleration for driving towards the target is used at the following commands:

- Command 6 "Stop positioning (user ramp)"
- Command 10 "Starting an absolute positioning run regarding time"
- Command 11 "Starting an absolute positioning run related to time"
- Command 16 "Changing a deceleration value"
- Command 20 "Starting a relative positioning run"



Attention!

A low value results in a long ramp, while a great value results in a short ramp.

Two ramp types can be selected for deceleration when driving towards the target:

- sine-square ramp (sine-square shaped deceleration profile)

or

- linear ramp (sine-square shaped speed profile)

The ramp type can be selected by means of R140 "Ramp Type". The sine-square ramp has been set as the default ramp type.

A sine-square ramp guarantees soft and jerk-free deceleration. When driving a sine-square ramp, the specified value will be reached in the middle of the deceleration process.

When driving a linear ramp, the deceleration when driving towards the target (not the deceleration profile) has got a sine-square-shaped speed profile. This way, soft and jerk-free deceleration will be guaranteed as well. When driving a sine-square ramp, the specified value will also be reached in the middle of the deceleration process.

In the illustration below, various settings for deceleration by sine-square ramp when driving towards the target will be shown.

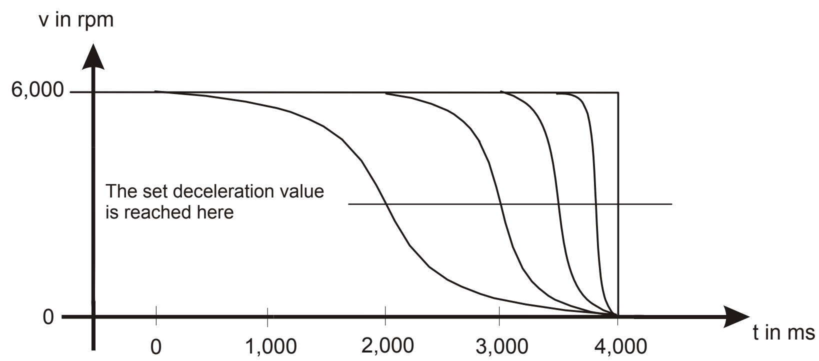


Fig. 34: Deceleration process when driving towards the target

Register 107: Target Window	
Function	**Description**
Read	As-is destination window
Write	New destination window
Amplifier status	No specific status
Takes effect	At the next positioning run or after changing the target position
Variable type	float
Value range	0 ... Positive float limit [°] or [mm] (the unit depends on the setting of the axis type)
Value following a reset	1 [°]

Here, the destination window for the target area of a point-to-point positioning can be set. If, after positioning, the axis has reached the destination window, bit 2 "Destination window" will be set in R100 "Status". The bit will not be reset, unless a new positioning (point-to-point positioning or endless positioning) has been started.

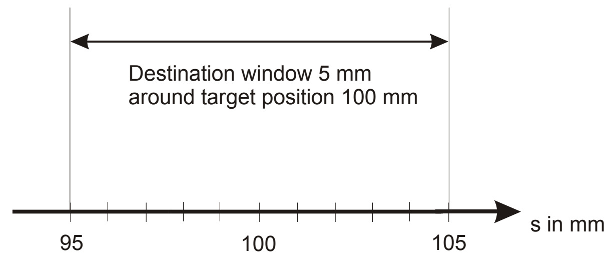
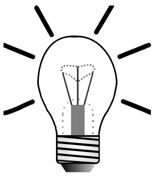


Fig. 35: Example of a destination window



Attention!

If a point-to-point positioning is stopped before the axis has reached the destination window, the destination window bit will not be set. In this case, bit 1 "Stopped" can be used in R100 "Status".

Faster program flow can be achieved by using the destination window range. The program can be continued, as soon as the axis has reached the destination window.

The general progression condition in the PLC program would be as follows:

```
#Include „JM2xxReg32.stp"               //  JM2xx RegisterInterface
Var
JM_Axis   :JM_2XX At %VL 12000;          //  Axis declaration
End_Var;
...
JM_Axis.MC_fm_PosProg := 90000;          //  Target position 90000
                                         //  (° or mm)
JM_Axis.JM_nm_Cmd :=cn_Cmd_StartPosAbs;  //  Start ptp-positioning

When Bit_Clear (JM_Axis.JM_nm_State,     //  Wait for busy-bit
cb_Status_Busy) Continue;                //  to be reset
When Bit_Set (JM_Axis.JM_nm_State,       //  Wait for dest. window bit
cb_Status_DestiWindow) Continue;         //  to be set
...
```

Difference between destination window bit and "Stopped" bit

The destination window bit is set, as soon as the as-is position of the axis has reached the destination window. The "Stopped" bit will be set, as soon as the internal set position (not the as-is position) has reached the target position. The settings of the destination window take no effect on the "Stopped" bit.

Register 109: As-is Position	
Function	**Description**
Read	As-is Position
Write	Illegal
Variable type	float
Value range	R183 ... R182 [°] or [mm]. The unit depends on the setting of the axis type.
Value following a reset	0 [°]

From here, the as-is axis position can be read out. This parameter is often used as a progression condition.

Example:

```
...
WHEN REG rmActPosition > 10000 THEN    // Wait, until the as-is
                                       // pos. is greater than 10000
                                       // (° or mm)
OUT 101                                // Set output 101
...
```

If the axis has not been set to modulo mode in register 192 "Modulo Axis", the as-is position will not exceed the travel range, which has been set via register 182 "Travel Range Limit Positive" and register 183 "Travel Range Limit Negative". Neither will there be an overflow. At the limits of the travel range, the axis will be stopped automatically. Endless positioning is not permitted here.

If the axis has been set to modulo mode in register 192 "Modulo Axis", there will be an overflow of the as-is position, when the travel range limits have been exceeded; the as-is position will be continued at the value of the other travel range limit. The axis will continue travelling as before. Endless positioning is only permitted for a modulo axis.

Register 129: As-is Speed	
Function	**Description**
Read	As-is mechanical speed
Write	Illegal
Variable type	float
Value range	-R184 ... R184 [°/s] or [mm/s] (The unit is dependent on the axis type)
Value following a reset	0 [°/s]

From here, the as-is axis speed can be read out.

Register 135: Modulo Turns	
Function	**Description**
Read	Present modulo turns (dependent on direction)
Write	Illegal
Variable type	int / register
Value range	- 2,147,483,648 ... 2,147,483,647
Value following a reset	0

This register reports the number of modulo runs having been carried out up to this instance during ptp positioning or endless positioning.

Register 140: Ramp Type	
Function	**Description**
Read	As-is ramp type
Write	New ramp type
Amplifier status	No specific status
Takes effect	At the next positioning run
Variable type	int / register
Value range	0, 1
Value following a reset	1

Here, the ramp type will be set for all positioning runs. The ramp type will only be considered when a new positioning run is started; then, it will be valid during the entire positioning process.

Meaning of the values:

0 : Linear ramps

1 : $Sine^2$ ramps

Register 141: Positioning Mode	
Function	**Description**
Read	As-is positioning mode
Write	New positioning mode
Amplifier status	No specific status
Takes effect	At the next positioning run or after changing the target position
Variable type	int / register
Value range	1 ... 4
Value following a reset	1

The following only applies to modulo axis:
Here it is specified, from which direction the target position is to be approached.

Meaning of the values:

1 : **Absolute**

The axis will never exceed the travel range; it can be operated and positioned like a standard axis

2 : **Modulo positive**

The axis will always approach the target position from positive direction

3 : **Modulo negative**

The axis will always approach the target position from negative direction

4 : **Modulo auto**

The axis always approaches the target position over the shortest possible distance

Register 142: Moving Direction	
Function	**Description**
Read	As-is direction of motion
Write	New direction of motion
Amplifier status	No specific status
Takes effect	When the next endless positioning is started
Variable type	int / register
Value range	0, 1
Value following a reset	0

This only applies to an endless positioning run:
Here, the direction of motion is specified for an endless positioning run.

Meaning of the values:

0 : Positive direction

1 : Negative direction

Register 143: Basic Type	
Function	**Description**
Read	As-is basic type
Write	New basic type
Amplifier status	No specific status
Takes effect	When the next relative positioning run is started, or when the target position of a relative positioning is changed
Variable type	int / register
Value range	0, 1
Value following a reset	0

This only applies to relative positioning:
Here, the basic position (the position, in relation to which values are counted further) is specified for the next relative positioning run.

Meaning of the values:

0 : Latest target position

1 : As-is position

Register 149: Absolute Target Position	
Function	**Description**
Read	Latest absolute target position
Write	Illegal
Amplifier status	No specific status
Variable type	float
Value range	R183 ... R182 [°] or [mm]. The unit depends on the setting of the axis type.
Value following a reset	0 [°]

From here, the absolute target position of the latest ptp positioning can be read. This register is for keeping the absolute ratio at relative positioning.

Note!

At positioning several modulo travel ranges, the absolute target position and the number of travel ranges are displayed. Each time the travel range limit has been passed, the register value is decremented by the respective travel range value.

13 Technological Functions

13.1 Introduction

Introduction

A relatively common task in industrial automation is the coupling of axes to achieve a coordinated motion. So-called "Technological Functions" serve for this purpose.

Definition - Technological Function

A technological function is a motion function encomprising several individual axes bein interdependent within an either continuous or temporary leading/following constellation. A technological function encomprises one leading axis and one or more following axes. In this function, the motion of the following axes depending on the motion of the leading axis, is set for any point in time.

A technological function describes the motion sequence of each axis involved. This way, the motion of the following axes depending on the motion of the leading axis, is set for any point in time. This means it defines for any point in time, whether and in which way the following axis is coupled with the leading axis, or whether - if uncoupled - it makes an independent positioning run or does not move at all.

Examples

The following functions are technological functions:

- Electronic gearing
- Cam disc
- Flying saw
- Cross cutter
- Winding by means of traversing axis and spindle

Examples of Non-Technological Functions - Special Functions

Other than technological functions, **special functions** refer to one single axis only. Special functions are, for example:

- Referencing on the fly
- Position capture
- PID controller

Technological Functions Realized by JetMove

The JetMove has got a function range corresponding to technological functions.

In order to establish a technological function, one or more so-called technology groups have to be configured first. This does not only concern configuring a JetMove 2xx, but also other JetMoves and/or modules.

For axis coupling that is required within a technological function, a JetMove offers the following two coupling modes:

- Coupling mode *Electronic Gearing*
- Coupling mode *Table*

13.2 Overview

In this Chapter

The chapter *Technological Functions* contains any information the user needs for establishing technological functions by means of the JetMove.

In the first sub-chapters, the user is informed of what is essential for configuring technology groups and how to carry out these configurations. Take the following three steps for configuring technology groups:

- Configuring the synchronizing procedure
- Configuring the communication within the group
- Configuring the coupling mode

In the sub-chapters, in which the coupling modes have been described, we have described extensively, how a JetMove is operated in the respective coupling mode.

At the end of this chapter, the *Virtual Position Counter* is described, which can function as a leading axis. Besides the functions, configuring and operating the *Virtual Position Counter* are described.

Technologcal Function: Flying Saw

For establishing a technological function *Flying saw* by means of JetMoves, there are two additional Application Notes:

- Flying Saw - Axes, general, APN 037
- Flying Saw - Axes, JM-2xx, APN 038

These Application Notes provide general and special procedures for realizing a *Flying saw* technological function.

Structure of this Chapter

The chapter *Technological Functions* consists of the following sub-chapters:

13.3 Configuring a Technology Group

13.3.1 Overview

Introduction

A technological function is realized by configuring one or several technology groups.

This sub-chapter describes how a technology group is configured and provides respective know-how.

What is a Technology Group?

Definition of "Technology Group":

- A group of individual axes functioning permanently or only temporarily in a leading, respectively following relationship.

Constituents of a Technology Group:

- *one* leading axis
- and one or several following axes.

The following definitions have to be made for a technology group:

- Which is the leading axis?
- Which are the following axes relating to this leading axis?
- Which is the coupling mode between the individual following axes and the leading axis?

In this Chapter

The sub-chapter "Configuring a Technology Group" deals with the following topics:

13.3.2 Which modules can be used as leading and following axis

Introduction

Please read below,

- which modules can be used as leading axes, and
- which modules can be used as following axes.

Leading Axes

The following table illustrates which modules can be used as leading axes:

Leading Axis Module	Description
JetMove	All JetMoves (JM-105, JM-2xx, JM-D203), except for JM-6xx
2. encoder at the JetMove	Only JM-2xx with integrated counter card
JX2-CNT1	JX2 counter module
Virtual Position Counter	Special function of a JetMove

Virtual Position Counter

The *Virtual Position Counter* is a special function of a JetMove which generates a leading axis position. The JetMove in which the Virtual Position Counter is active, uses this leading position for controlling its own axis as if it were the leading axis position of an external leading axis (e.g. JetMove or JX2-CNT1).

This way, in JetMove, leading and following axis have been united. The own axis is called internal following axis. It has got the same range of characteristics and functions as has a following axis which is influenced by an external leading axis position.

The leading axis position specified by the virtual position counter can also be output to the system bus as a leading axis value for external following axes. This way, the JetMove, in which the special function is active, also takes over the leading axis function for external following axes.

Following Axes

The following table illustrates which modules can be used for following axes:

Following Axis Module	Description
JetMove	All JetMoves (JM-105, JM-2xx, JM-D203), except for JM-6xx

13.3.3 Arrangement of a technology group

Introduction

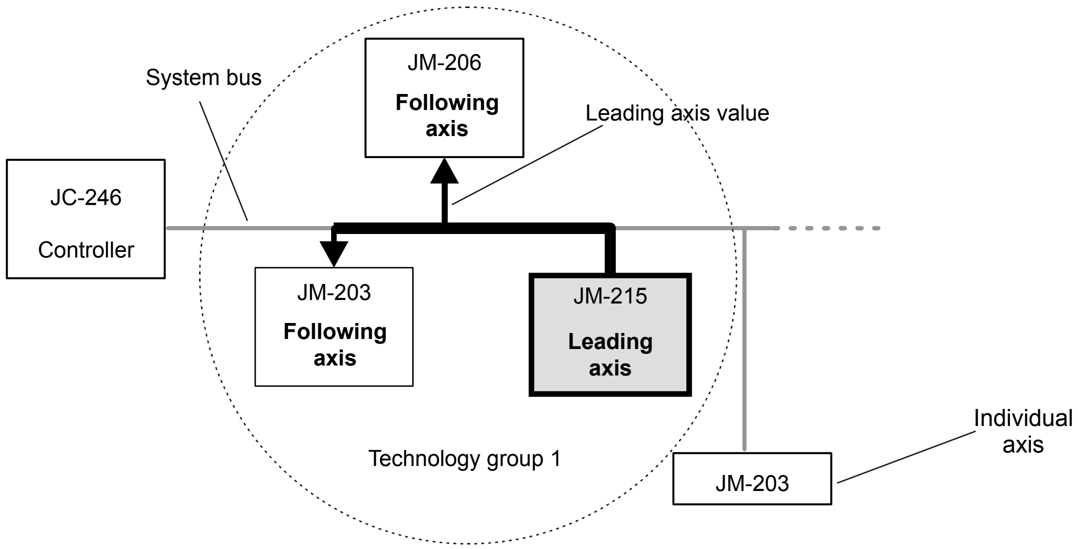
For each leading axis module, a sample arrangement is demonstrated below.

Sample Arrangement with Leading Axis Module *JetMove*

In this sample arrangement, four JM-2xx have been connected to a controller of the JC-246 type:

- Three JM-2xx belong to a technology group, by which synchronous motion of three conveyor belts is to be realized.
- The fourth JM-2xx is operated as an individual axis, in order to load one of the three conveyor belts during standstill.

The following illustration shows the sample arrangement.

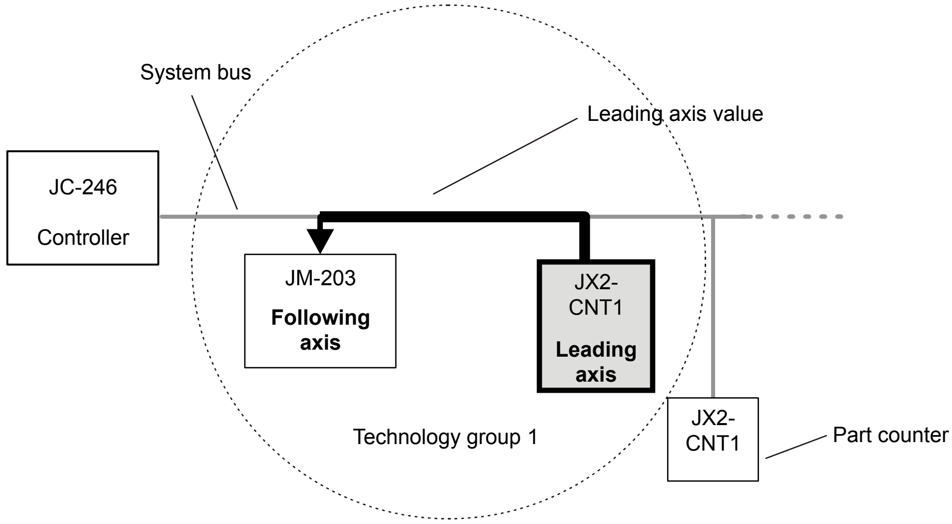


Sample Arrangement with Leading Axis Module *JX2-CNT1*

In this sample arrangement, one JM-203 and two JX2-CNT1 are connected to a controller of the type JC-246:

- The JM-203 and one JX2-CNT1 belong to a technology group. The JX2-CNT1 is a leading axis for the JM-203 in this case.
- The second JX2-CNT1 is applied as a workpiece counter. This is a sample arrangement for realizing a *Flying saw* function.

The following illustration shows the sample arrangement.

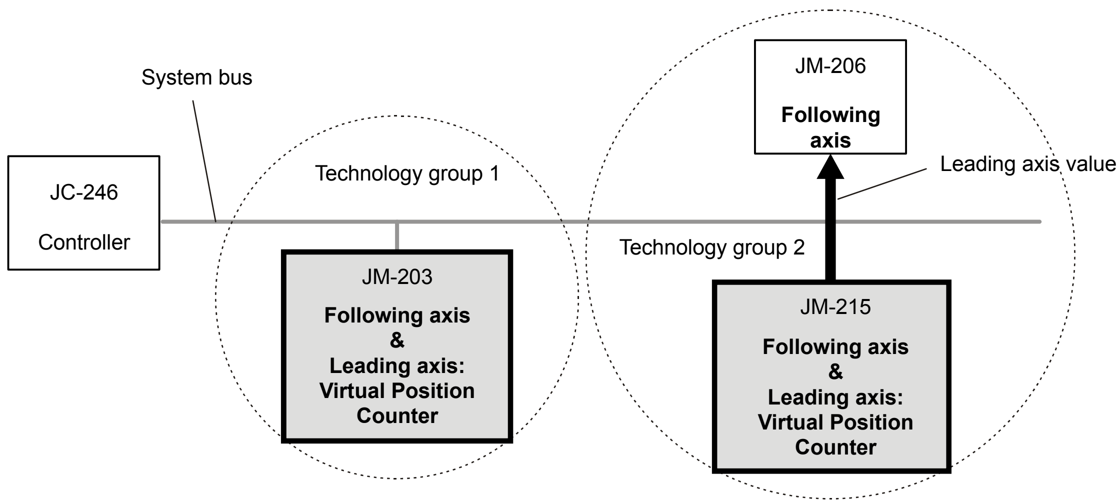


Sample Arrangement with Leading Axis Module *Virtual Position Counter*

In this sample arrangement, three JM-2xx have been connected to a controller of the JC-246 type. This sample arrangement consists of two technology groups:

- A JM-203 is the first technology group by itself. By this JetMove, a cam disc is realized by means of the Virtual Position Counter. The Virtual Position Counter is used as a timer setting the time a complete cam disc rotation is to take. In this case, the Virtual Position Counter is started via an external sensor.
- The two other JetMoves are combined to serve as the second technology group. By this technology group, two cam discs are realized. These are also moved by means of the Virtual Position Counter. The JM-215 functions as leading axis for the second JetMove. It outputs the position given by the Virtual Position Counter to the system bus.

The following illustration shows the sample arrangement.



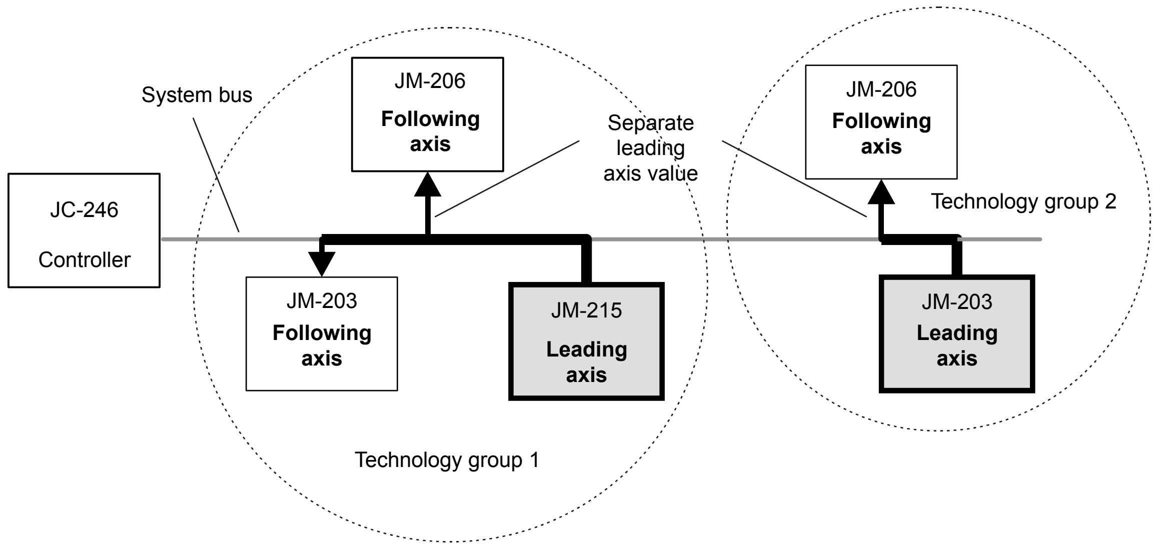
13.3.4 Several technology groups in one system bus

Introduction

As has already been shown in the sample arrangement with the Virtual Position Counter, it is possible to configure *several* technology groups in one system bus.

Sample Arrangement

In the following illustration shows a sample arrangement with *two* technology groups. Technology group 1 realizes an electronic gearing, for example, move assembly lines for placing bottles on a belt, while technology group 2 takes over screwing the bottles.

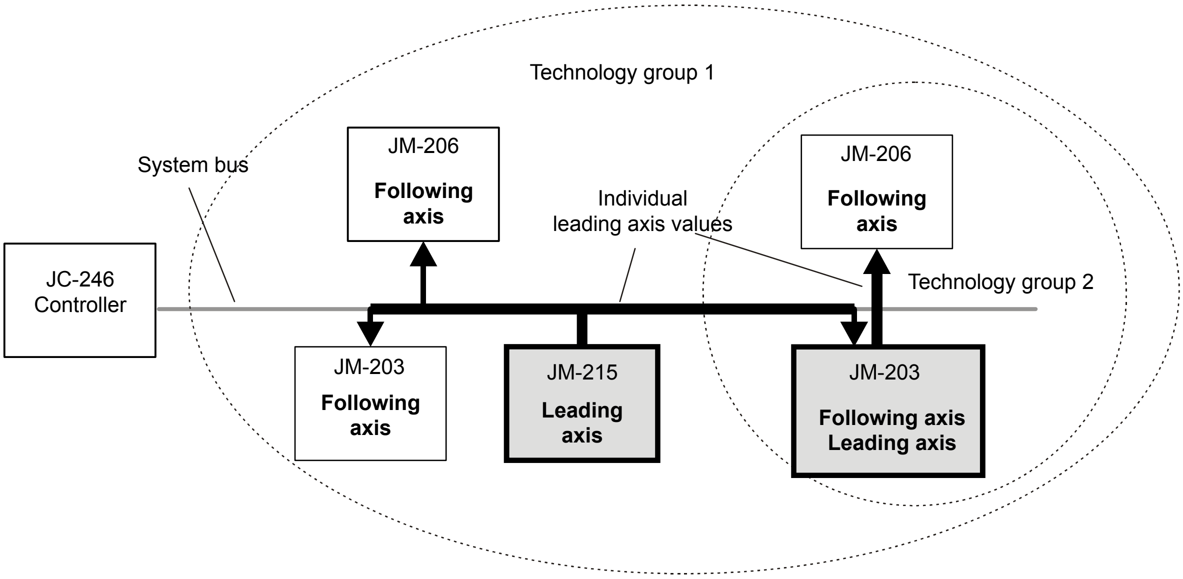


Coupled Technology Groups

There is also a way to couple several technology groups. Technology groups are coupled when the leading axis of one technology group moves in dependance from the leading axis on the other technology group. This behavior is achieved by configuring the leading axis of the subordinate technology group to be the following axis relating to the leading axis of the superordinated technology group.

This configuration is applied, for example, to processes requiring a technology group moving independently at one time and moving in relation to another one by being coupled with it. This way, you are spared frequent reconfiguring.

The following illustration shows a sample arrangement with coupled technology groups.



Rules for Configuring Several Correlating Technology Groups

At configuring several technology groups in one system bus, the following rules have to be kept to:

- At a system bus, *only one* JX2-CNT1 may be used as a leading axis.
- At a system bus, *two* modules as a maximum can be configured as a leading axis that outputs its leading axis value to the system bus.

13.3.5 Configuration of a technology group

Introduction

At configuring a technology group, two different cases can occur. The second case is rare, though.

- 1. Case: In the system bus, there is at least one technology group which is made up of at least *two* modules, e.g. JX2-CNT1 as a leading axis and JetMove as a following axis.
- 2. Case: In the system bus, there is only *one* technology group which is made up of one JetMove being supplied with leading axis positions by either special function *Virtual Position Counter* or by its second encoder (an intergrated counter board has to be available).

Configuration Steps, Case 1

The following table shows the steps to be taken for configuring case 1 of a technology group.

Step	Action	Page
1	Configuring the synchronizing procedure Note: Synchronizing is configured only once. If a technology group has already been configured, this step is left out.	page 184
2	Configuring the group communication for leading and following axis of any technology group	page 189
3	Configuring the coupling mode for all following axes	page 216

Configuration Steps, Case 1

The following table shows the steps to be taken for configuring case 2 of a technology group.

Step	Action	Page
1	• Configuring the communication of the group with Virtual Position Counter without external following axes or • Configuring the communication of the group with second encoder	page 204 resp. page 206
2	Configuring the coupling mode of the JetMove	page 216

13.4 Configuring Synchronizing via System Bus

13.4.1 Overview

Introduction

For synchronizing axis motion, the JetMoves involved have to be synchronized accordingly as regards time. This means synchronizing is necessary. Please read below how synchronizing is configured and what kind of information is needed.

How to Synchronize

The JetMoves involved are synchronized by a synchronizing pulse. The synchronizing pulse is output to the system bus in cyclic manner by the module setting the pulse.

Synchronizing Terms

The following two terms are relevant for synchronizing:

- Time-Master
- Time-Slave

Time-Master

The module that outputs the synchronizing pulse is called time-master. The time-master synchronizes *all* JetMoves at the system bus to its own pulse that are to be used for technological functions.

As time-master, either a JetMove, or a JX2-CNT1 (as of firmware version 2.11) can be used.

Time-Slave

A JetMove synchronizing its internal pulse to the synchronizing pulse is called a time-slave.

In this Chapter

The subchapter "Configuring Synchronizing" deals with the following topics:

13.4.2 Sample configuration

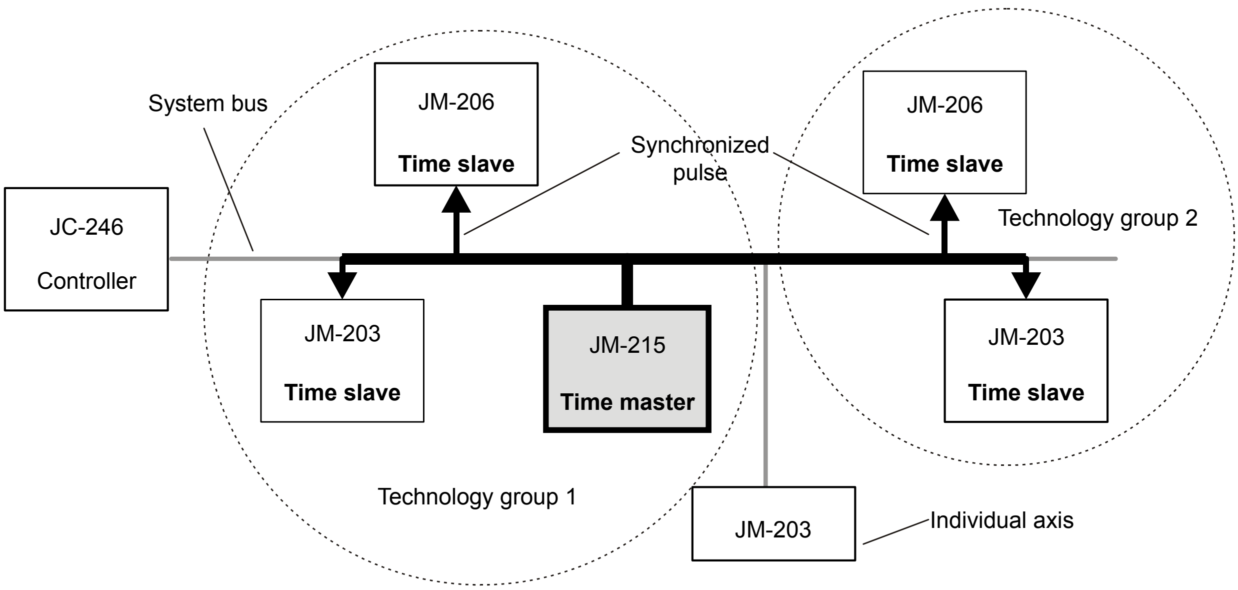
Description

In this sample configuration, three JM-2xx have been connected to a controller of the JC-246 type. The sample configuration solves the following axis tasks:

- Technology group 1: Realizing an electronic gearing with three JM-2xx
- Technology group 2: Realizing a cam disc with two JM-2xx
- One individual axis with one JM-203

Configuration Scheme

The following illustration shows the scheme of the sample configuration.



What does the Illustration Mean

The following statements are based on the illustration:

- The time-master synchronizes all JM-2xx at the system bus independent from which technology group they belong to.
- There is only one time-master for the entire system bus.
- The individual axis which is not part of a technology group need not be assigned a synchronizing pulse.

13.4.3 Configuring the synchronizing procedure

Introduction

For configuring the synchronizing procedure, the JetMoves being involved in a technological function have to be configured as a time-master, respectively time-slave following distinct rules.

Configuration Rules

For fault-free synchronizing, the following rules have to be considered:

- At the system bus, only one module is permitted to be configured as a time-master.
- Only the JetMoves being involved in a technological functions have to be considered for synchronizing.

Register Overview

Any JetMove can be configured in a way that it is either time-master or time-slave. For this, the following registers are available:

Register Name	Brief Description
R150 *Time Mode*	Output setting of the synchronizing pulse: 0 = do not output a synchronizing pulse 1 = output a synchronizing pulse
R531 *Source of Synchronizing Signal*	Selecting the source of the synchronizing signal: 1 = System bus 2 = Ethernet
R537 *Synchronizing Controller Frequency*	Frequency of the synchronizing controller in [Hz] for checking the configuration procedure of synchronizing

Configuration

One of the following tables shows the steps to be taken for configuring the synchronizing procedure completely. Which table you select depends on whether you apply *one* technology group with the leading axis module JX2-CNT1 at the system bus or not.

With JX2-CNT1

Technology group with leading axis module JX2-CNT1 at the system bus:

Step	Action
1	Configuring the JX2-CNT1 as leading axis. Note: The configuration of the JX2-CNT1 as a leading axis automatically causes the JX2-CNT one to become the time-master as well. This configuration has been described in the JX2-CNT1 user manual.
2	Configuring any other JetMove being involved in a technology group as time-slave. Action: Writing the following values to R150 *Time Mode* and R531 *Source of Synchronizing* in these JetMoves: R150 := 0 R531 := 1

3	Delay of 500 ms The reason: Synchronizing parameters have to be coordinated
4	Checking the synchronizing controller in all time-slaves for correct functioning. Action: R537 has to contain a value range between 400 and 500 Hz. If these values do not occur: Check, if the modules can be addressed by the controller, and if the correct values have been written to the respective registers.

Without JX2-CNT1 Technology group without leading axis module JX2-CNT1 at the system bus:

Step	Action
1	Selecting and configuring any JetMove that is to be the time-master. Action: Writing the following values to R150 *Time Mode* and R531 *Source of Synchronizing* in this JetMove: R150 := 1 R531 := 1
2	Configuring any other JetMove being involved in a technology group as time-slave. Action: Writing the following values to R150 *Time Mode* and R531 *Source of Synchronizing* in these JetMoves: R150 := 0 R531 := 1
3	Delay of 500 ms The reason: Synchronizing parameters have to be coordinated
4	Checking the synchronizing controller in all time-slaves for correct functioning. Action: R537 has to contain a value range between 400 and 500 Hz. If these values do not occur: Check, if the modules can be addressed by the controller, and if the correct values have been written to the respective registers.

13.4.4 Description of registers.

Register 150: Time Mode	
Function	**Description**
Read	As-is time mode of the system bus
Write	Set time mode of the system bus
Amplifier status	No specific status
Takes effect	Immediately
Variable type	int / register
Value range	0: The JetMove is the time-slave 1: The JetMove is the time-master
Value after reset	0 (the JetMove is the time-slave)

Register 531: Source Synchronizing Signal	
Function	**Description**
Read	As-is source of synchronizing signal
Write	Set source of synchronizing signal
Amplifier status	No specific status
Takes effect	Immediately
Variable type	int / register
Value range	1 = Synchronizing the JetMove via system bus 2 = Synchronizing the JetMove via Ethernet
Value after reset	1 = if an Ethernet interface has not been recognized 2 = if an Ethernet interface has been recognized

Register 537: Frequency of the Synchronizing Controller	
Function	**Description**
Read	As-is frequency
Write	Illegal
Variable type	int / register
Value range	0 ... 500 [Hz]
Value after reset	0 [Hz]

13.5 Configuring Communication Within the Group

13.5.1 Overview

Introduction

The communication within the group provides the following axes of a technology group with the essential leading values of the leading axis. For each technology group, communication has to be configured.

Configuration

Take the following steps to configure communication within the group:

Step	Action
1	The leading axis of a technology group has to be caused to output the leading values to the system bus. Exception: If the Virtual Position Counter is applied which only functions as leading axis for the internal following axis, the leading axis value is not output to the system bus.
2	The following axes of a technology group have to be got to adapt the leading values of their leading axis and to standardize them accordingly.

Combination of Leading and Following Axes

Because of the possible leading axis modules, the following combinations of leading and following axes result for the technology groups:

- JetMove with JetMoves
- JX2-CNT1 with JetMoves
- Virtual position counter with external following axes
- Virtual position counter without external following axes
- JetMove with second encoder (in this case, it does not matter whether with or without external following axes)

The configuration of each of these combinations has been described in this subchapter.

In this Chapter

The subchapter "Configuring the Technology Group" deals with the following topics:

13.5.2 Configuration with leading axis module *JetMove*

Introduction

The technology group communication between leading and following axes is configured by the leading axis module *JetMove*. This is described below.

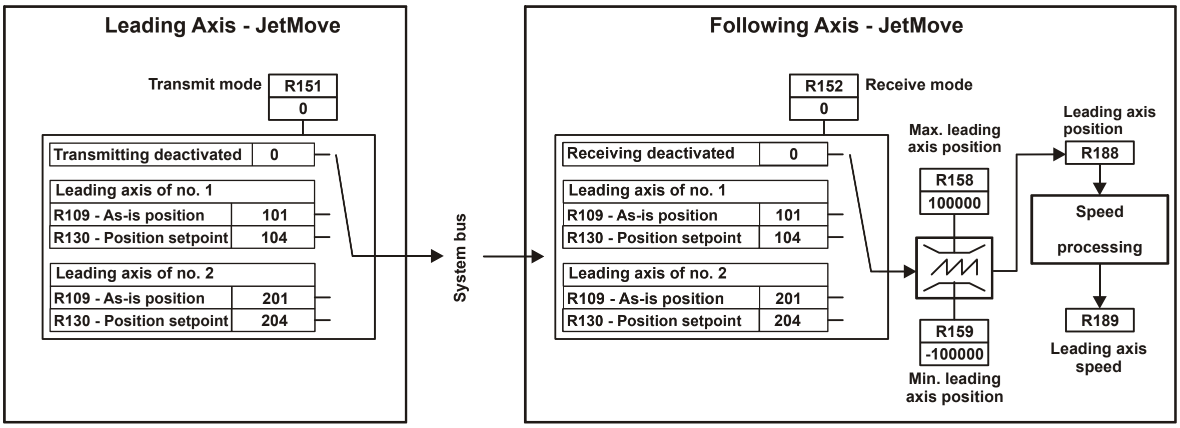
Register Overview

The following registers are available for configuring the leading and following axis.

Register Name	Brief Description
Registers of the Leading Axis	
R151 *Transmit Mode*	Activating / Deactivating the leading axis value output
Registers of the Following Axis	
R152 *Receive Mode*	Activating / Deactivating the leading axis value reception
R158 *Maximum Leading Axis Position*	Leading axis position max.
R159 *Minimum Leading Axis Position*	Leading axis position min.
R188 *Leading Axis Position*	As-is leading axis position
R189 *Leading Axis Speed*	As-is leading axis speed

Function Plan

The following function plan illustrates both the register functions and the default register values needed for configuration.



Description of the Function Plan

The transmit mode, R151, functions like a switch determining by which leading axis number the leading axis transmits which axis leading type to the system bus. The receive mode, R152, also functions like a switch determining from which leading axis the following axis is to receive the leading axis value from the system bus, and which leading axis value type it is. The value of the transmit mode, R151, and the value of the receive mode, R152, have got data format yxx: y = leading axis number (1 or 2), xx = leading value type (as-is position = 01 or set position value = 04).

The leading axis position range of the following axis set by R158 and R159 determines the value range for the leading axis position, R188. The leading axis position has got modulo behavior. This means if it passes the limit at R158 or R159, it will continue at the opposite side. The leading axis speed, R189, is calculated out of the leading axis position.

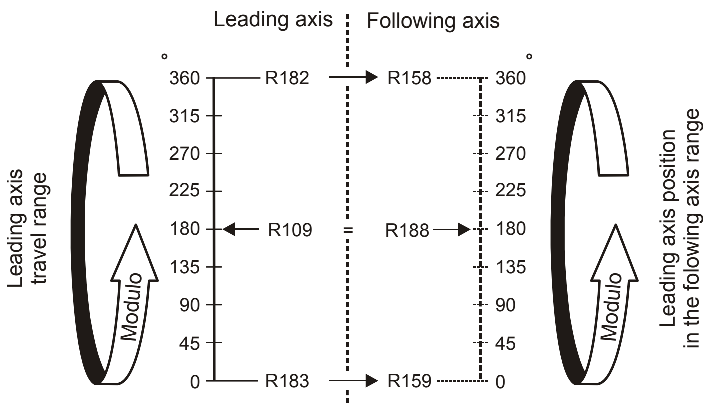
Configuration Rules

The following rules have to be considered for configuration:

- The receive mode of the following axis has to have the same value as has the transmit mode of the leading axis.
- The leading axis position range in the following axis has to be set in a way that exactly corresponds to the travel range of the leading axis (R182 *Positive Travel Limit* and R183 *Negative Travel Limit)*.

Determinating the Leading Axis Position

The following illustration shows how the leading axis position range is determined. Here, the leading axis has got a travel range 0° to 360°. It has been configured as a modulo axis.



Configuration Steps of the Leading Axis

The following steps have to be carried out for configuring the leading axis.

Step	Action
1	Deactivating the transmit function Action: Write value 0 to R151 *Transmit Mode* of the leading axis. Result: This way, the transmit function can be re-configured. Even the previously active transmit function is deactivated now.
2	Setting the transmit mode Action: Write a free leading axis number and the leading axis value type "as-is position" (y01) or "set position" (y04) to R151 *Transmit Mode* of the leading axis. Result: The leading axis transmits values to the system bus together with the respective leading axis number and leading axis value type.

Configuration Steps of the Following Axis

The following steps have to be carried out for configuring the following axis.

Step	Action
1	Deactivating the receive function Action: Write value 0 to R152 *Receive Mode* of the following axis. Result: This way, re-configuring is achieved.
2	Set the leading axis position range in the following axis by the values of the leading axis travel limits Action: Write the value of leading axis register 183 *Travel Limit Negative* to R159 *Minimum Leading Axis Position* of the following axis. Following the same procedure, write the value of R182 *Travel Limit Positive* to R158 *Maximum Leading Axis Position*. **Important:** After writing to R159 and R158, wait for resetting the busy-bit.

Step	Action
3	Setting the receive mode Action: Write the value of leading axis register 151 *Transmit Mode* to R152 *Receive Mode* of the following axis. Result: The following axis activates the receive function. The leading axis position specifies the as-is position (R109), respectively the set position (R130) of the leading axis, depending the leading value type of the leading axis.
4	Carry out this step at the very first commissioning of a technology group: Checking the Communication of the Technology Group Action: At turning, respectively reversing, the leading axis, the values of R188 *Position Leading Axis* and R189 *Speed Leading Axis* of the following axis are changed. These registers have to report realistic values. Notes on the registers: The position of the leading axis (R188) is in a 1:1 ratio to the as-is position (R109) or to the set position value (R130) of the leading axis. These values depend on the leading value type reported by the leading axis. The speed value of the leading axis (R189) is made up of the difference between the leading axis positions within one second. Thus, it corresponds to the speed reported by the leading axis in R129.

13.5.3 Configuration with leading axis module *JX2-CNT1*

Introduction

The technology group communication between leading and following axes is configured by the leading axis module *JX2-CNT1*. This is described below.

None Configurating the Leading Axis

The configuration of the technology group communication for the JX2-CNT1 has already been carried out at configuring the synchronizing process. For synchronizing, the JX2-CNT1 has already been configured as a leading axis.

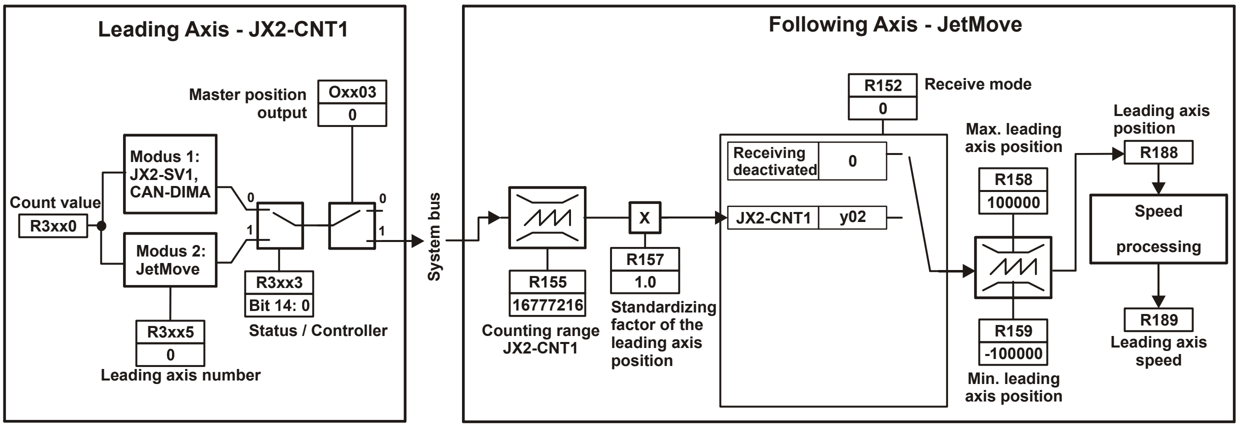
Register Overview

The following registers serve for configuring the following axis:

Register Name	Brief Description
Registers of the Following Axis	
R152 *Receive Mode*	Activating / Deactivating the leading axis value reception
R155 *Counting Range JX2-CNT1*	Position range of the JX2-CNT1 This is important when using an SSI encoder.
R157 *Master Position Factor Position of the leading axis*	Conversion factor of the increments to °, respectively mm
R551 *Speed Feed Forward T1*	Filter time for the speed calculated by the JetMove out of the position values transmitted by the JX2-CNT1
R158 *Maximum Leading Axis Position*	Leading axis position max.
R159 *Minimum Leading Axis Position*	Leading axis position min.
R188 *Leading Axis Position*	As-is leading axis position
R189 *Leading Axis Speed*	As-is leading axis speed

Function Plan

The following function plan illustrates both the register functions and the default register, respectively virtual output values needed for configuration.



Description of the Function Plan

In the JX2-CNT1, bit R3xx3.14 determines the leading-following mode, by which the JX2-CNT1 processes the count value. For the leading-following mode 2 - operation by JetMoves - the value of R3xx5 determines the leading axis number added by the JX2-CNT1 to the count value to be reported. Via the virtual output 0xx3, the output of the count value to the system bus is activated, respectively deactivated.

At receiving the count value, the following axis determines a leading axis position. For this purpose, the following axis requires the count value range of R155, and the master position factor R157. The count range provides information on the overflow behavior of the count value. The master position factor, though, sets the standardizing of increments to one of the two mechanic reference variables, which are degrees, respectively millimeters.

The receive mode, R152 of the following axis, also functions like a switch determining from which leading axis the following axis is to receive the leading axis value, and which leading value type it is. The receive mode R152 has got the data format yxx: y = leading axis number (1 or 2), xx = leading axis value type. In order to receive the leading axis value from a JX2-CNT1, leading axis value type 02 has to be specified.

The leading axis position range of the following axis set by R158 and R159 determines the value range for the leading axis position, R188. The leading axis position has got modulo behavior. This means if it passes the limit at R158 or R159, it will continue at the opposite side. The leading axis speed, R189, is calculated out of the leading axis position.

Standardizing the Leading Axis Position

The JX2-CNT1 transmits the counter value in the shape of encoder increments to the following axis. In order to standardize the encoder elements of the following axis to mechanic units (mm or °), the master position factor (R157) is applied.

The master position factor, in this case, specifies the ratio between the encoder increments and the mechanic unit.

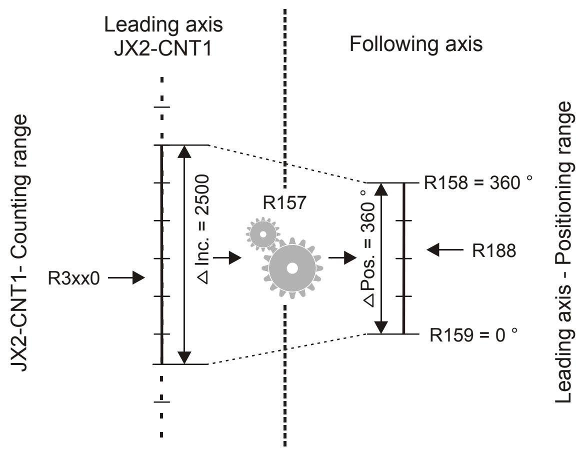
Example of Standardizing

Example of Standardizing: An incremental encoder has been mounted to a mechanic cam disc. The pulse number is 2,500 per revolution. The following axis is to carry out a motion depending on the cam disc. With the following axis, the leading position is to be used in the unit of degrees. The "Master-Position-Factor" is calculated as follows:

Leading axis "Master" position factor = 360° / encoder resolution [increments]
Leading axis ("Master") position factor" = 360° / (4 * 2,500 [increments]) = 0360 [° / increments]

Note: Because of evaluating the incremental encoder four times, the value of the encoder resolution is the pulse number times four.

Below, this example is illustrated.



Setting the Leading Axis Position Range

In the following axis, the master position range of the leading axis module JX2-CNT1 can be user-defined by means of the maximum leading axis position (R158) and the minimum leading axis position (R159).

Filtering the Leading Axis Speed

The leading axis speed value (R188) is taken over as speed pre-control value by the position controller. Low leading axis speeds and / or low encoder resolution at the JX2-CNT1 can lead to irregular behavior of the following axis. To prevent this, the speed pre-control value can be filtered. For this, the respective delay time hasto be set in R551 *Speed Pre-Control T1*.

Configuration Steps

The following steps have to be carried out for configuring the following axis.

Step	Action
1	Deactivating the receive function Action: Write value 0 to R152 *Receive Mode* of the following axis. Result: By this, receiving is disabled, so a new configuration can be made.

Step	Action
2	Only carry out this action, if an SSI-encoder has been connected to the JX2-CNT1 which has got a resolution of less than 24 bits (less than 4096 x 4096): Setting the Counting Range of the JX2-CNT1 Action: Write the counting range of the SSI encoder to R155 *Counting Range JX2-CNT1* of the following axis. **Important:** After writing to R155, wait for resetting the busy-bit. Example: SSI encoder of 12 bits: R155 = 4096
3	Setting the master position factor Action: Write the respective master position factor to R157 *Master Position Factor* of the following axis. **Important:** After writing to R157, wait for resetting the busy-bit.
4	Setting the leading axis position range Action: Write both maximum and minimum leading axis position to R159 *Minimum Leading Axis Position* and R158 *Maximum Leading Axis Position* of the following axis. **Important:** After writing to R158 and R159, wait for the busy-bit to be reset.
5	Setting the delay time for speed pre-control (this is only required in case of low leading axis speed, respectively low encoder resolution values) Action: Write the respective delay value to R551 *Speed Pre-Control T1*. Note: The optimum delay time has to be determined empirically during commissioning. Action: Set R551 = 0 and increment, respectively decrement, the value in steps of 2 ms, until the behavior of the following axis is satisfactory.
6	Setting the receive mode Action: Write value 102 or 202, depending on the leading axis number of the JX2-CNT1, to R152 *Receive Mode*. Result: The following axis activates receiving, while the leading position is automatically set to the middle of the leading position range, e.g. leading position range from - 10,000 to + 10,000: R188 = 0

Step	Action
7	Carry out this step at the very first commissioning of a technology group: Checking the Communication of the Technology Group Action: At turning, respectively reversing, the leading axis, the values of R188 *Position Leading Axis* and R189 *Speed Leading Axis* of the following axes are changed. These registers have to report realistic values or value changes. Please note regarding R188 and R189: The leading axis position (R188) has not got any *absolute* relation to the counter value (R3xx0) of the JX2-CNT. The leading axis position is made up of the counter value and the master position factor (R157). Further, the leading axis position is influenced at overflow as follows: 1. Case: Overflow of the counter value (R3xx0): Leading axis position continues moving up to its own limit position 2. Case: Overflow of the leading axis position value: The leading axis position displays a modulo behavior: It continues at the opposite position limit. The speed value of the leading axis (R189) is made up of the difference between the leading axis positions within one second. It corresponds to the number of increments of the JX2-CNT1 count value within one second, multiplied by the leading axis position factor (R157).

13.5.4 Configuration by virtual position counter and external following axes

Introduction

Below, configuring the communication of a technology group with the leading axis module *Virtual Position Counter* and one or several external following axes.

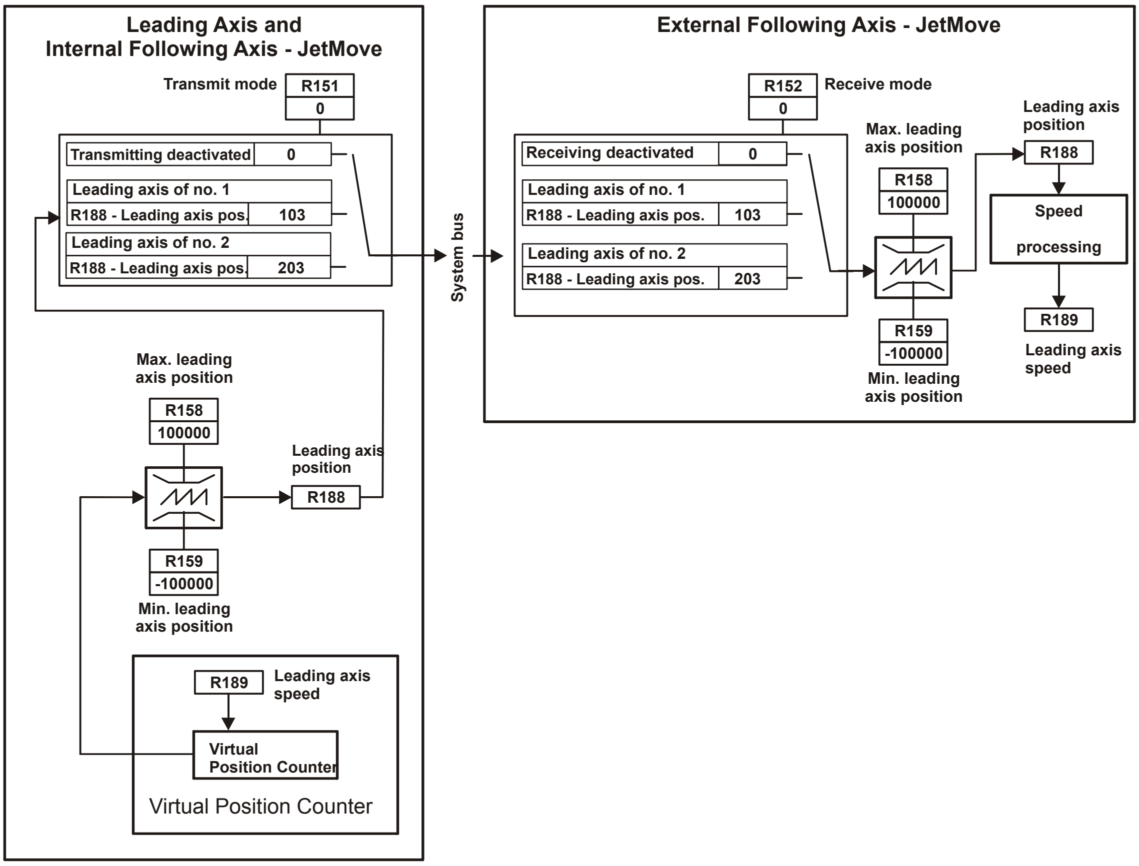
Register Overview

The following registers serve for configuring the leading and following axes:

Register Name	Brief Description
Registers of the Leading Axis	
R151 *Transmit Mode*	Activating / Deactivating the leading axis value output
Registers of the Internal Following Axis	
R158 *Maximum Leading Axis Position*	Leading axis position max.
R159 *Minimum Leading Axis Position*	Leading axis position min.
R188 *Leading Axis Position*	As-is leading axis position
Registers of the External Following Axis	
R152 *Receive Mode*	Activating / Deactivating the leading axis value reception
R158 *Maximum Leading Axis Position*	Leading axis position max.
R159 *Minimum Leading Axis Position*	Leading axis position min.
R188 *Leading Axis Position*	As-is leading axis position
R189 *Leading Axis Speed*	As-is leading axis speed

Function Plan

The following function plan illustrates both the register functions and the default register values needed for configuration.



Description of the Function Plan

The JetMove, in which the special function *Virtual Position Counter* is active, serves both for leading and following axis. There, the Virtual Position Counter, dependent on the leading axis speed (R189), generates the leading axis position (R188) for the internal following axis. The leading axis position displays modulo behavior in the leading position range which is set by R158 and R159.

If there are external following axes, the JetMove outputs the leading axis position to the system bus by setting the leading axis number and the leading axis value type in the transmit mode of R151. The transmit mode functions like a switch. This also applies to the receive mode (R152). It is to determine in the external following axis, from which leading axis the following axis is to receive the leading axis value, and which leading value type it is. Both the transmit mode and the receive mode have got data format yxx: y = leading axis number (1 or 2), xx = leading axis value type. Leading axis value 03 is intended for transmitting the leading axis value of the Virtual Position Counter.

The leading axis position range of the external following axis set by R158 and R159 determines the value range for the leading axis position, R188. The leading axis position displays modulo behavior in the leading axis position range. The leading axis speed, R189, is calculated out of the leading axis position.

Configuration Rules

The following rules have to be considered for configuration:

- The leading axis position range, which is - in other words - the count range of the Virtual Position Counter, can be freely set in the internal following axis by the maximum leading axis position (R158) and the minimum leading axis position (R159).
- The receive mode (R152) of an external following axis has to have the same value as has the transmit mode (R151) of the leading axis.
- In the external following axis, the leading position range has to be set in a way that it exactly corresponds to the leading position range of the leading axis.

Configuration Steps of the Leading Axis

The following steps have to be carried out for configuring the leading axis.

Step	Action
1	Deactivating the transmit function Action: Write value 0 to R151 *Transmit Mode* of the leading axis. Result: This way, the transmit function can be re-configured. Even the previously active transmit function is deactivated now.
2	Setting the transmit mode Action: Write a free leading axis number (1 or 2) and the leading value type for the leading axis position (03) to R151 *Transmit Mode* of the leading axis. Result: The leading axis transmits the leading axis position together with the corresponding leading axis number to the system bus.

Configuration Steps the Internal Following Axis

The following steps have to be carried out for configuring the internal following axis.

Step	Action
1	Deactivating the receive function Action: Write value 0 to R152 *Receive Mode* of the internal following axis. Result: Any external leading axis value is cleared.

Step	Action
2	Setting the leading axis position range Action: Write both maximum and minimum leading axis position to R159 *Minimum Leading Axis Position* and R158 *Maximum Leading Axis Position* of the internal following axis. **Important:** After writing to R158 and R159, wait for the busy-bit to be reset. Result: The counting range of the Virtual Position Counter is set this way.

Configuration Steps the External Following Axis

The following steps have to be carried out for configuring the external following axis.

Step	Action
1	Deactivating the receive function Action: Write value 0 to R152 *Receive Mode* of the external following axis. Result: By this, receiving is disabled, so a new configuration can be made.
2	Setting the leading axis position range in the external following axis by the values of the leading axis position range Action: Write the value of leading axis register 159 *Minimum Leading Axis Position* to R159 *Minimum Leading Axis Position* of the external following axis. Also write the value of leading axis register 158 *Maximum Leading Axis Position* to R158 *Maximum Leading Axis Position* of the external following axis. **Important:** After writing to R158 and R159, wait for the busy-bit to be reset.
3	Setting the receive mode Action: Write the value of leading axis register 151 *Transmit Mode* to R152 *Receive Mode* of the external following axis. Result: The external following axis activates the receive function. The leading position (R188) of the external following axis shows the leading position (R188) of the leading axis.

Step	Action
4	Carry out this step at the very first commissioning of a technology group: Checking the communication of the technology group Action: Check, whether the leading position (R188) of the leading axis is displayed as leading position (R188) of the following axis. Note: The leading position (R188) of the external following axis is in 1:1 ratio to the leading position (R188) of the leading axis.

13.5.5 Configuration by virtual position counter without external following axes

Introduction

Below, configuring the communication of a technology group by the leading axis module *Virtual Position Counter* without external following axes is described. This means that the technology group consists of only one JetMove with an active Virtual Position Counter.

No Configuration of the Leading Axis

As in this technology group the leading axis value is not output to the system bus, configuration of the group communication is not needed for the leading axis.

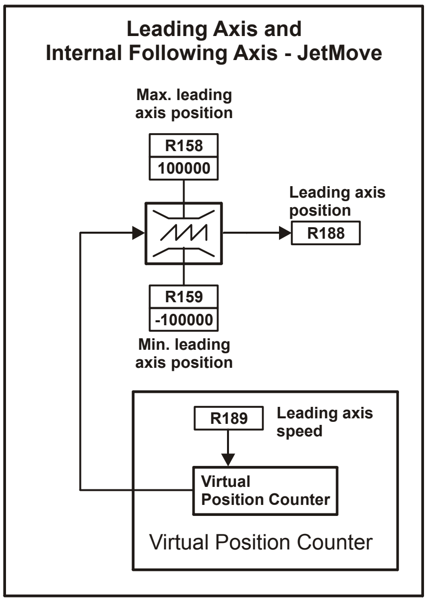
Register Overview

The following registers serve for configuring the internal following axis:

Register Name	Brief Description
Registers of the Internal Following Axis	
R158 *Maximum Leading Axis Position*	Leading axis position max.
R159 *Minimum Leading Axis Position*	Leading axis position min.
R188 *Leading Axis Position*	As-is leading axis position

Function Plan

The following function plan illustrates both the register functions and the default register values needed for configuration.



Description of the Function Plan

In the JetMove, the special function *Virtual Position Counter* is active. It is both leading and following axis. The Virtual Position Counter, dependent on the leading axis speed (R189), generates the leading axis position (R188) for the internal following axis. The leading axis position displays modulo behavior in the leading position range which is set by R158 and R159.

Setting the Leading Axis Position Range

In the internal following axis, the leading axis position range, which is - in other words - the count range of the Virtual Position Counter, can be freely set by defining the maximum leading axis position (R158) and the minimum leading axis position (R159).

Configuration Steps of the Internal Following Axis

The following steps have to be carried out for configuring the internal following axis.

Step	Action
1	Deactivating the receive function Action: Write value 0 to R152 *Receive Mode* of the internal following axis. Result: Any external leading axis value is cleared.
2	Setting the leading axis position range Action: Write both maximum and minimum leading axis position to R159 *Minimum Leading Axis Position* and R158 *Maximum Leading Axis Position* of the internal following axis. Result: The counting range of the Virtual Position Counter is set this way.

13.5.6 Configuration with second encoder as leading axis

Introduction

The technology group communication between leading and following axes is configured, the second encoder being the leading axis.

The configuration described here applies to a technology group, either with or without external following axes.

Hardware Requirements

Only a JM-2xx makes available the functions of the second encoder being the leading axis.

Second Encoder at the JetMove Also being the Following Axis

The JetMove to which the second encoder has been connected can be used in two ways: Once for setting the leading position for external following axes, further as an axis following the leading position set by its second encoder.

If the JetMove also serves as following axis, respectively one of the axes following the leading position of its second encoder, it receives the leading position set by the second encoder via system bus, as if it had been set by an external leading axis.

This means that in order to function as a following axis, the following axis registers of the JetMove (see register overview) has to be configured the same way, as if the leading position of the second encoder had been transmitted by an external JetMove functioning as leading axis via system bus.

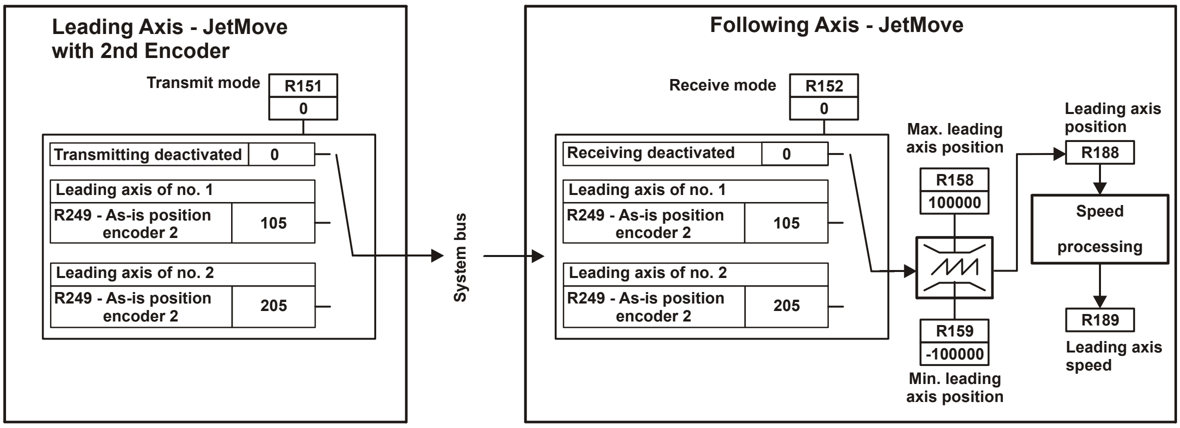
Register Overview

The following registers are available for configuring the leading and following axis.

Register Name	Brief Description
Leading Axis Register (JetMove with second encoder)	
R151 *Transmit Mode*	Activating / Deactivating the leading axis value output
Registers of the Following Axis	
R152 *Receive Mode*	Activating / Deactivating the leading axis value reception
R158 *Maximum Leading Axis Position*	Leading axis position max.
R159 *Minimum Leading Axis Position*	Leading axis position min.
R188 *Leading Axis Position*	As-is leading axis position
R189 *Leading Axis Speed*	As-is leading axis speed

Function Plan

The following function plan illustrates both the register functions and the default register values needed for configuration.



Description of the Function Plan

The transmit mode, R151, functions like a switch determining by which leading axis number the leading axis transmits which axis leading type to the system bus. The receive mode, R152, also functions like a switch determining from which leading axis the following axis is to receive the leading axis value from the system bus, and which leading axis value type it is.

The value of the transmit mode, R151, and the value of the receive mode, R152, have got data format yxx: y = leading axis number (1 or 2), xx = leading axis value type. For transmitting the leading value from, and receiving it by the second encoder of a JetMove, leading axis value type 05 has to be specified.

The leading axis position range of the following axis set by R158 and R159 determines the value range for the leading axis position, R188. The leading axis position has got modulo behavior. This means if it passes the limit at R158 or R159, it will continue at the opposite side. The leading axis speed, R189, is calculated out of the leading axis position.

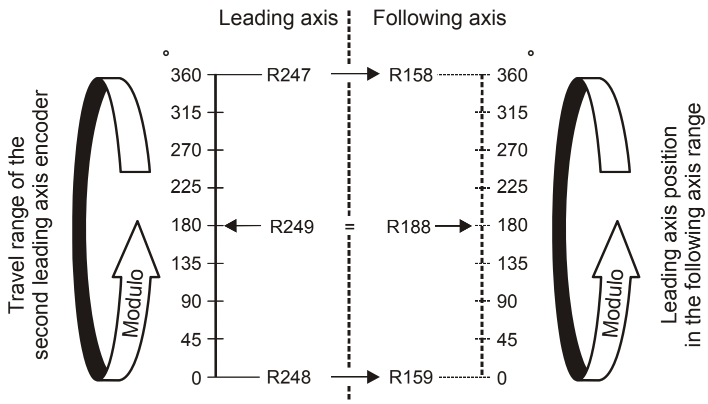
Configuration Rules

The following rules have to be considered for configuration:

- The receive mode of the following axis has to have the same value as has the transmit mode of the leading axis.
- The leading axis position range of the following axis (determined by R158 and R159) has to be set in a way that it exactly corresponds to the travel range of the second encoder (R247 *encoder2 - travel limit positive* and R248 *encoder2 - travel limit negative)* of the leading axis.

Determinating the Leading Axis Position

The following illustration shows how the leading axis position range is determined. Here, the leading axis has got a travel range 0° to 360°. It has been configured as a modulo axis.



Configuration Steps of the Leading Axis

The following steps have to be carried out for configuring the leading axis (JetMove with second encoder).

Step	Action
1	General configuration of the second encoder Action: See chapter 6.9 "Second Encoder", page 77, in this document.
2	Deactivating the transmit function Action: Write value 0 to R151 *Transmit Mode* of the leading axis. Result: This way, the transmit function can be re-configured. Even the previously active transmit function is deactivated now.
3	Setting the transmit mode Action: Write a free leading axis number and the leading axis value type "As-is position of the second encoder (y05) to R151 *Transmit Mode* of the leading axis. Result: The leading axis transmits values to the system bus together with the respective leading axis number and leading axis value type.

Configuration Steps of the Following Axis

The following steps have to be carried out for configuring the following axis.

Step	Action
1	Deactivating the receive function Action: Write value 0 to R152 *Receive Mode* of the following axis. Result: This way, re-configuring is achieved.
2	Set the leading axis position range in the following axis by the values of the travel limits of the second encoder belonging to the leading axis Action: Write the value of R159 *Minimum Leading Axis Position* referring to the following axis, which is also in R248 *Travel Limit Negative* of the leading axis. Following the same procedure, write the value of R247 *Travel Limit Positive* to R158 *Maximum Leading Axis Position*. **Important:** After writing to R159 and R158, wait for resetting the busy-bit.
3	Setting the receive mode Action: Write the value of leading axis register 151 *Transmit Mode*to R152 *Receive Mode* of the following axis. Result: The following axis activates the receive function. The leading axis position represents the as-is position of the second leading axis encoder (R249).
4	Carry out this step at the very first commissioning of a technology group: Checking the communication of the technology group Action: At turning, respectively reversing, the leading axis, the values of R188 *Position Leading Axis* and R189 *Speed Leading Axis* of the following axis are changed. These registers have to report realistic values. Notes on the registers: The leading axis position (R188) corresponds 1:1 to the as-is position of the second leading axis encoder (R249). The speed value of the leading axis (R189) is made up of the difference between the leading axis positions within one second. Thus, it corresponds to the speed of the second encoder output by the leading axis in R251 *Encoder2 - As-is Velocity*.

13.5.7 Description of registers

Register 151: Transmit Mode	
Function	**Description**
Read	As-is transmit mode
Write	Set transmit mode
Amplifier status	No specific status
Takes effect	Immediately
Variable type	int / register
Value range	0, 101 ... 205
Value after reset	0 (transmitting has been deactivated)

Activating / deactivating the object.

Value	Meaning
0	Transmitting has been deactivated
101 ... 204	Transmitting has been activated by respective leading axis number and leading axis value type. Interpretation of the values by means of the yxx key: y: Leading axis number y = 1: Leading axis number 1 y = 2: Leading axis number 2 xx: Leading axis value type xx = 01: As-is position (R109) xx = 03: Leading axis position (R188), if the Virtual Position Counter is used xx = 04: Set position value (R130) xx = 05: As-is position of the second encoder (R249)

Example:

Transmitting the as-is position as second leading axis: R151 = 201

Register 152: Receive Mode	
Function	**Description**
Read	As-is receive mode
Write	Set receive mode
Amplifier status	No specific status
Takes effect	Immediately
Variable type	int / register
Value range	0, 101 ... 205
Value after reset	0 (receiving is deactivated)

Receiving the leading axis value is activated / deactivated.

Value	Meaning
0	Receiving has been deactivated
101 ... 204	Receiving has been activated by the corresponding leading axis number with corresponding leading axis value type. Interpretation of the values by means of the yxx key: y: Leading axis number y = 1: Leading axis number 1 y = 2: Leading axis number 2 xx: Leading axis value type xx = 01: As-is position (R190) xx = 02: Count value (R3xx0) of a JX2-CNT1 serving as leading axis xx = 03: Leading axis position (R188), if the Virtual Position Counter is used in the leading axis xx = 04: Set position value (R130) xx = 05: As-is position of the second encoder (R249)

Example:

Receiving the count value of a JX2-CNT1 serving as second leading axis: R152 = 202

Register 155: Counting Range JX2-CNT1	
Function	**Description**
Read	As-is count value
Write	Set count value
Amplifier status	No specific status
Takes effect	**Wait for the busy-bit in the status to be reset**
Variable type	int / register
Value range	0 ... 16,777,216 [increment]
Value after reset	16,777,216 [increment]

The counting range defines the modulo position range of the JX2-CNT1. R155 only has to be written to, if an SSI encoder of a > 24 bit resolution has been connected.

Examples:

Count value	Description
16777216	The count value in the JX2-CNT1 has an overflow at -8,388,608, respectively 8,388,607. An incremental or an SSI encoder with a position resolution of 24 bits has been connected to the JX2-CNT1.
4096	The count value in the JX2-CNT1 has an overflow at 0, respectively 4096. An SSI encoder with a position resolution of 12 bits has been connected to the JX2-CNT1.
1024	The count value in the JX2-CNT1 has an overflow at 0, respectively 1024. An SSI encoder with a position resolution of 12 bits has been connected to the JX2-CNT1.

Register 157: Standardizing Factor	
Function	**Description**
Read	As-is standardizing factor
Write	Set standardizing factor
Amplifier status	No specific status
Takes effect	**Wait for the busy-bit in the status to be reset**
Variable type	float
Value range	0 ... Pos. float limits [°/Increment] or [mm/Increment]
Value after reset	1 [°/Increment] or [mm/Increment]

If a JX2-CNT1 serves as leading axis module, the leading axis position is output in encoder-oriented position units. The leading axis position in the JetMove is outut in mechanics-oriented position units (degrees or millimeter). The standardizing factor serves for calculating the leading axis position in the JetMove..

Register 158: Leading Axis Position Max.	
Function	**Description**
Read	As-is maximum leading axis position
Write	Set maximum leading axis position
Amplifier status	No specific status
Takes effect	**Wait for the busy-bit in the status to be reset**
Variable type	float
Value range	Float limits [°] or [mm]
Value after reset	100,000 [°] or [mm]

Maximum leading axis position in the following axis.

Register 159: Leading Axis Position Min.	
Function	**Description**
Read	As-is minimum leading axis position
Write	Set minimum leading axis position
Amplifier status	No specific status
Takes effect	**Wait for the busy-bit in the status to be reset**
Variable type	float
Value range	Float limits [°] or [mm]
Value after reset	-100,000 [°] or [mm]

Minimum leading axis position in the following axis

Register 188: Position of the Leading Axis	
Function	**Description**
Read	As-is leading axis position
Write	Set leading axis position (only, if the leading axis module is *Virtual Position Counter*)
Amplifier status	No specific status
Takes effect	Immediately
Variable type	float
Value range	R159 ... R158 [°] or [mm]
Value after reset	0 [°] or [mm]

Leading axis position in the following axis The way the leading axis position is displayed depends on the leading axis module being applied:

Leading Axis Module	Description
JetMove	The leading axis position is the as-is position (R109), respectively the set position value (R130) of the leading axis. This depends on whether the JetMove transmits the as-is position or the set position value.
JX2-CNT1	The leading axis position (R188) has not got any *absolute* relation to the counter value (R3xx0) of the JX2-CNT. The leading axis position is made up of the counter value and the master position factor (R157). Further, the leading axis position behaves at overflow as follows: 1. Case: Overflow of the counter value (R3xx0): Leading axis position continues moving up to its own limit position 2. Case: Overflow of the leading axis position value: The leading axis position displays a modulo behavior: It continues at the opposite position limit.
Virtual Position Counter	• Internal following axis: Counting value of the Virtual Position Counter • External following axis: Its position relates to the position of the leading axis (R188) 1:1.

Register 189: Leading Axis Speed	
Function	**Description**
Read	As-is leading axis speed
Write	Setting the speed for the Virtual Position Counter
Amplifier status	No specific status
Takes effect	Immediately
Variable type	float
Value range	float limits [°/s] or [mm/s]
Value after reset	0 [°/s] or [mm/s]

Leading axis speed within the following axis, respectively set speed, if the special function *Virtual Position Counter* is applied

General rule applying to the following axis: The speed value of the leading axis (R189) is made up of the difference between the leading axis positions (R188) within one second.

13.6 Introduction to Coupling Modes

13.6.1 Survey

Introduction

At carrying out a technological function, the following axes are coupled with the leading axis. *In the following axis*, the way of coupling is defined by the coupling mode.

Coupling Modes

A JetMove supplies the following coupling modes:

- *Electronic Gearing*
- *Table Mode*

In this Chapter

The subchapter *Introduction to the Coupling Modes* first of all outlines the way of functioning of each coupling mode. Further, it contains general information on configuring and working in both coupling modes.

The subchapter is structured as follows:

Further Subchapters on Coupling Modes

Configuring and working in the coupling modes, respectively their way of functioning has been described in detail in further subchapters.

The function range of the coupling mode *Table* is by far greater than the function range of the *Electronic Gearbox* coupling mode. This means there is the additional subchapter *How the "Table" coupling mode works*.

Please find below another survey of these subchapters:

13.6.2 Introduction to the *Electronic Gearing* coupling mode

Introduction

The motion of a following axis that is coupled with the leading axis in the coupling mode *Electronic Gearing* synchronizes with the motion of the leading axis. A gear ratio that can be set individually defines the proportional ratio between the motions of following and leading axis.

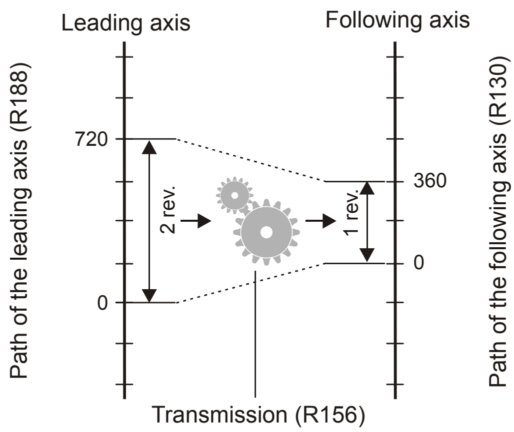
Transmission Ratio

The gear ratio is a factor that specifies the distance to be covered by the following axis at a certain distance covered by the leading axis.

Example

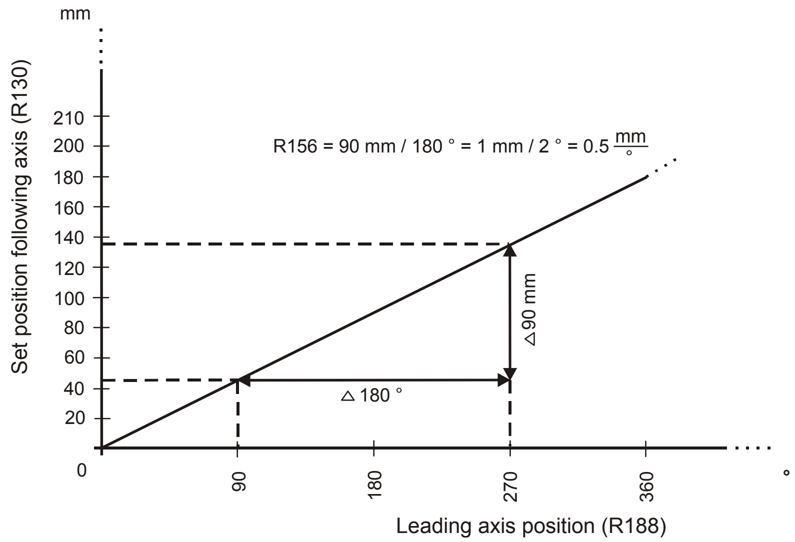
The following example is to illustrate the influence of the geear ratio:

- Both leading and following axis are to be rotatory axes
- The following axis is coupled to the leading axis in the gear ratio 1:2.
- This means that if a leading axis rotates twice, the following axis rotates once.



Sample Motion

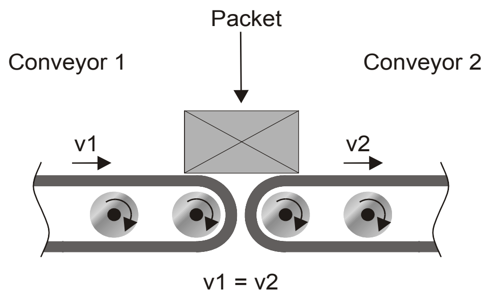
In the leading - following axis diagram, the gear ratio between the following and leading axis paths of motions is 1:2.



Sample Application

The coupling mode *Electronic Gearing* is used in the following application, for example:

- Two conveyor belts are to move in the same direction by the same speed to enable packets to be handed over.



Transmission Precision

Although the gear ratio (R156) is specified as a floating-point number, it is not of unlimited precision. A JetMove functions by floating point numbers of single precision. This means that the JetMove calculates the gear ratio by a precision of 7 mantissa digits. Mantissa digits are tens digits inclusively the decimal places.

A 2:9 gear ratio allows for specifying by 0.2222222 (which is 2.222222e-001 in mantissa and exponent representation). Within this gear ratio, there remains a minor imprecision which can yet be decreased or even compensated by appropriate measures.

Relative Position Coupling

In the coupling mode *Electronic Gearing,* the following axis is coupled to the leading axis via the leading axis position (R188). This means that the following axis calculates its set positions and the speed for its position control by the leading axis position.

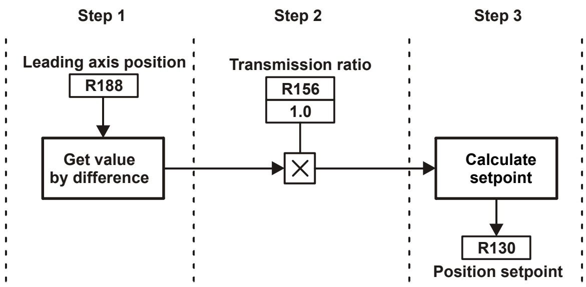
For this, the following axis is coupled with the leading axis position *in relative mode*. This means that the following axis is coupled to the leading axis position by means of a positioning offset. The following axis automatically calculates this positioning offset when it is coupling.

This relative position coupling brings about the following advantage for the *Electronic Gearing* coupling mode:

- For coupling the following axis, the user need not pay heed to the leading axis position. The user couples the following axis at the as-is leading axis position. This will cause the following axis to move from its as-is set position (R130) related to the leading axis position.

Processing by the Following Axis

In the following axis, this coupling is physically established in three steps. In coupled mode, these steps are run through every two milliseconds.



Step	Action
1	Calculating the difference between new and former value of the leading axis position (R188)
2	Multiplication of this difference with the transmission ratio (R156)
3	Calculating the new set position (R130) of the following axis: • Addition of the result of step 2 to the set position calculated last

13.6.3 Introduction to the *Table* coupling mode

Introduction

When in *Table* coupling mode, a following axis can run **any** motion path, relating on the leading axis position.

Example: Sine-Shaped Motion

The resulting motion consisting of individual leading and following axis motions can be sine-shaped, for example, as is shown in the leading and following axis diagram below.

Sample Application

The *Table* coupling mode is used in applications implying the following technological functions:

- Cam Disc
- Flying Saw
- Winding by means of traversing axis and spindle

Motion Definition

Whithin the physical and safety-related limits, the resulting motion path is user-defined. This motion has to be defined for the following axis by means of an array of interpolation points. The user stores the parameters of the interpolation points representing the motion profile into this array. Each interpolation point contains

- a leading axis position
- and the desired position of the following axis in relation to this leading axis position.

The user has to define the individual leading and following axis position. These positions for complex motions can be calculated in the PC (e.g. in MS Excel). Then, they can be uploaded to the array of interpolation points by means of a DA file transfer.

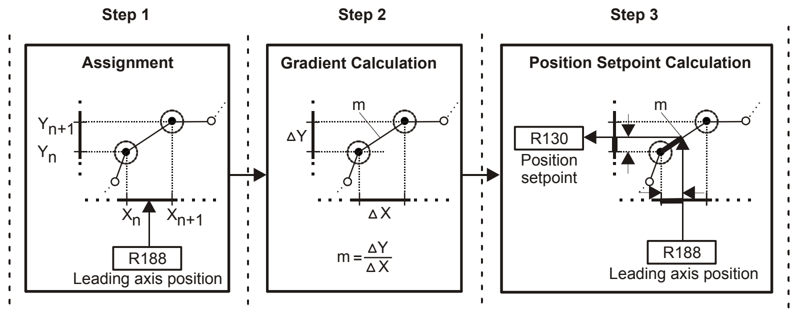
Definition of Terms - Table

The definition of motions saved to the array of interpolation points is called "Table".

Converting the Table into Motion

The table is converted into a motion by the operating system of the following axis being in coupled status as follows:

The operating system continuously generates set position values for the following axis (definition of motions) taken from the table. For this purpose, it takes the steps explained below. They are to illustrate the essentials of the conversion. In practice, some further offset values have to be considered.



Step	Action
1	Assigning the as-is leading axis position (R188) to two corresponding nodes that are next to each other. X is the leading axis position assigned to the respective node, while Y is the set position of the following axis assigned to the respective node.
2	Calculating gradient m by means of the stored node positions for leading and following axis.
3	Calculating the new set position (R130) for the follower by means of linear interpolation, gradient m and of one of the stored node positions for leading and following axis.

Result:
The coupled following axis moves the path defined in relation to the leading position (R188).

In general, the leading axis is moved by point-to-point or endless positioning.

Characteristics of the Motion

The resulting motion is characterized as follows:

- The axis drives to the table nodes.
- The axis carries out linear interpolation between the nodes. This means that between the nodes, the axis covers straight lines of the respective gradient.
- The leading axis determines the direction of the motion.

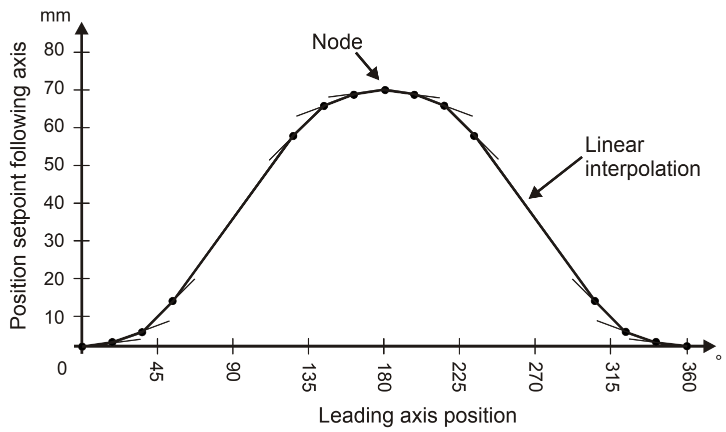
Sample Motion

The leading axis - following axis diagram of the example below illustrates the leading and following axis motion resulting in a sine-shaped motion.

From the illustration, we learn:

- The axis motion covers to the individual nodes.
- The axis carries out linear interpolation between the nodes.

For better visibility, the straight lines of the illustration that are resulting from linear interpolation are extended beyond the nodes.



13.6.4 Introduction to configuring and operating in the coupling modes

Coupling mode "Configuring and Operating"

Following axes can be driven, a coupling mode has to be selected from a technology group and then configured for each following axis.

Various Configurations

The respective operating principles of the two available coupling modes are totally different from each other. This is why they have to be configured differently. Each coupling mode has got its own register for configuring.

Operating

Operating within these coupling modes mainly comprise the following procedures:
- *Coupling*
- *Uncoupling*

Coupling and Uncoupling

Coupling and *uncoupling* are explained in the table below:

Procedure	Description
Coupling	Couples the set position value of the following axis with the leading axis position, depending on the coupling mode selected.
Uncoupling	Uncouples the set position value of the following axis from the leading position. After uncoupling, the following axis determines the set position value not depending on the leading axis position and the coupling mode selected.

Please Heed when Operating the Axis:

When operating the axis in a coupling mode, please heed the following:

- **At coupling and uncoupling, and in coupled mode, the following axis is *not* jerk-free**.
  The following factors can cause jerks in the following axis:
  - e. g. an incorrect coupling position (only with "Table" coupling mode)
  - e. g. an imprecision in the leading position

- Under the following conditions, bits R100.1 *cb_Status_Stopped* and R100.2 *cb_Status_DestiWindow* in R100 *Status* are *not* processed by the operating system of the following axis. This means that these bits are not considered:
  - at coupling
  - in coupled condition

- At uncoupling, it depends on the way of uncoupling, whether bits R100.1 *cb_Status_Stopped* and R100.2 *cb_Status_DestiWindow* can be considered or not. These bits are applied at uncoupling by point-to-point positioning, for example.

13.7 Operating in the *Electronic Gearing* Mode

13.7.1 Overview

Introduction

This sub-chapter mainly describes the procedure of configuring and operating in the coupling mode *Electronic Gearing*.

For operating in this coupling mode, the most frequent cases of application have been described. The user decides which applications to activate.

Further, information on the overflow behavior of leading and following axes in this coupling mode are provided in this chapter. This information is needed, if, during operation, the leading and following axis exceeds its positioning range.

At the end of this sub-chapter, all registers especially needed for configuring and operating in this coupling mode are described.

In this Chapter

This sub-chapter is structured as follows:

13.7.2 Position overflows

Introduction

If, at coupling by the *Electronic Gearing* coupling mode, the leading or following axis reaches the end of the positioning range, this is automatically processed in the following axis. The way of defining the positioning ranges for both axes and of processing position overflow, is explained below.

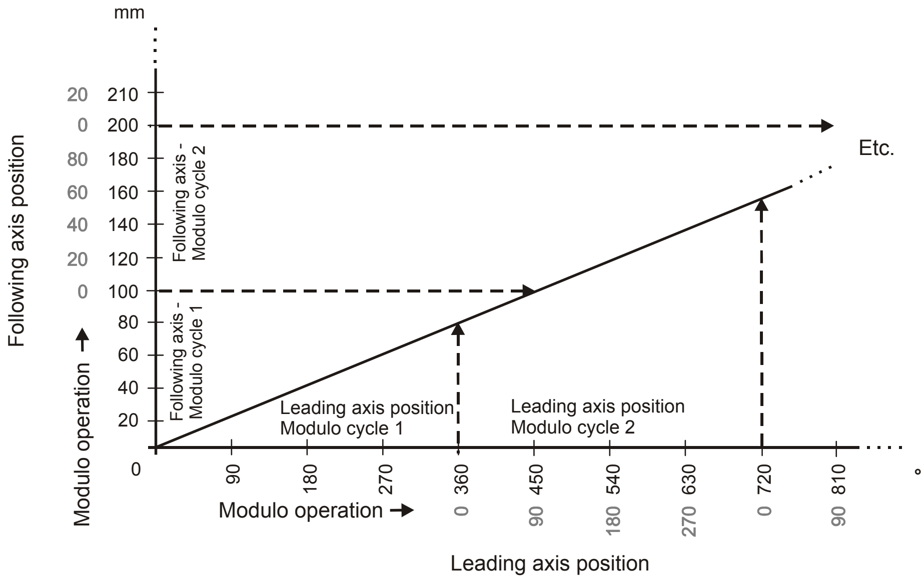
Position Overflows

The position overflows during coupling have been defined for leading and following axis as follows:

- Leading axis: Definition via leading axis positioning range by R158 and R159
- Following axis Definition via travel range by R182 and R183

By means of relative position coupling, both axes reach their overflow position independently of each other.

This behavior is illustrated in the example below.



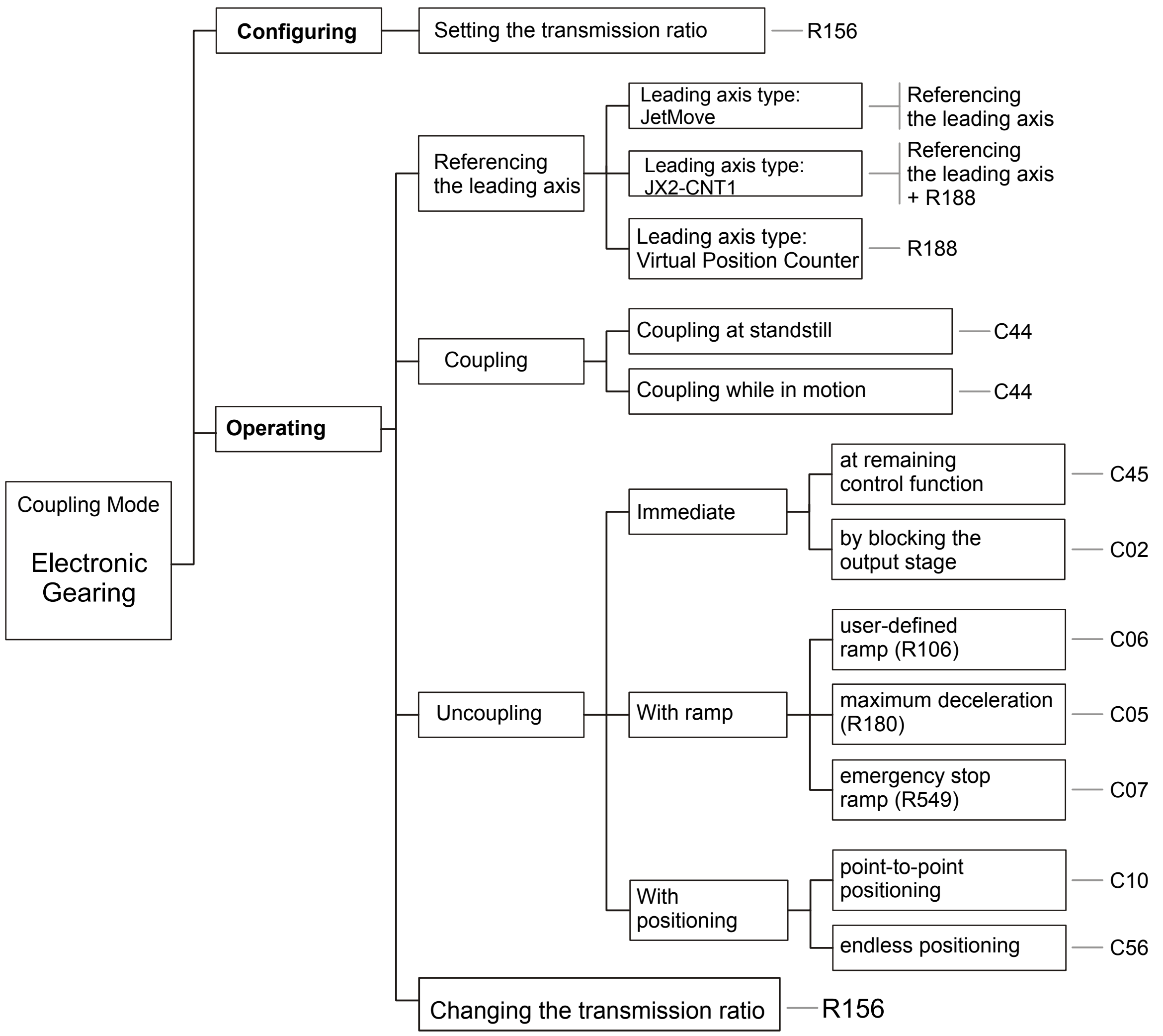
13.7.3 Survey: Configuration and operation

Overview

The following structure tree shows all possibilities of configuring and operating in the *Electronic Gearing* coupling mode, that will be described below.

This overview contains the most relevant registers and commands that will be used in the following descriptions.

R = Register; C = Command via R101



13.7.4 Configuring

Introduction

The configuration of the *Electronic Gearing* coupling mode explicitely consists of the definition of the gear ratio.

Register Overview

In order to define the gear ratio, the following register has been provided in the following axis:

Register Name	Brief Description
R156 *Gear Ratio*	Gear ratio

Please Heed during Configuration:

To be observed during configuration:

- During configuration, the following axis has to be at standstill.
- The JetMove calculates the gear ratio by a precision of 7 mantissa digits.

  Mantissa digits = tens places, post-comma places included
- In order to achieve a good coupling behavior of the following axis, it must not move faster than the leading axis.

  Gear ratio: $\frac{\text{Following axis}}{\text{Leading axis}} \leq 1$

Configuration Step

The following step has to be taken for configuration:

Step	Action
1	Setting the gear ratio Action: Write the value to R156 *Gear Ratio*

13.7.5 Referencing the leading axis position

Introduction

Referencing the leading axis position (R188) in the following axis before coupling may be needed for establishing a relation with the leading axis position. Referencing differs depending on the respective leading axis module.

Register Overview

For referencing the leading axis position, the following register has been provided in the following axis:

Register Name	Brief Description
R188 *Leading Axis Position*	Position of the leading axis

Configuration Steps Leading Axis Module *JetMove*

The following step has to be carried out for referencing the leading axis position by means of the leading axis module *JetMove*.

Step	Action
1	Referencing the leading axis Action: Referencing the leading axis, or setting a reference position by command, e.g. command C03 *Set Reference*. Result: Leading axis position (R188) in the following axis shows the referencing position of the leading axis.

Configuration Steps Leading Axis Module *JX2-CNT1*

The following steps have to be carried out for referencing the leading axis position by means of the leading axis module *JX2-CNT1*.

Step	Action
1	Referencing the leading axis Action: Referencing in the leading axis, or else setting a reference position by writing the value to R3xx0
2	Setting the respective leading axis position Action: Corresponding to the reference position (R3xx0) of the leading axis, the leading axis position in the following axis is set by writing to R188. Example: The reference position (R3xx0) is referenced to position 0. The leading axis position (R188) is also to have position 0: R188 := 0

Configuration Steps Leading axis Module *Virtual Position Counter*

The following steps have to be carried out for referencing the leading axis position by means of the leading axis module *Virtual Position Counter*.

Step	Action
1	Setting the leading axis position Action: Writing the desired referencing position to R188 "Leading Axis Position" in the leading axis. Result: Leading axis position (R188) in all external following axes shows the referencing position of the leading axis position (R188).

13.7.6 Coupling

Introduction

Here, coupling the following axis with the leading axis is described. There are two options to do this:

- Option 1: Coupling, while leading and following axis are at standstill.
- Option 2: Coupling, while leading and following axis are in motion.

For applying option 2, the following axis has to be moved to endless positioning first by point-to-point or endless posiitoning:

Requirements for Option 1

The following conditions have to be met in order to apply option 1 for coupling:

- Both leading and following axis have to be at standstill, i.e. the stop bit in status (R100.1) has to be set for both.
- In the following axis, no bit must be set in R400 *Table Status*.

Requirements for Option 2

The following conditions have to be met in order to apply option 2 for coupling:

- The following axis has to move in the direction of the leading axis
- The following axis has to move by the speed of the leading axis

Please Heed during Axis Coupling:

Please observe the following at coupling:

- **At coupling, the following axis is not jerk controlled**, i.e., if one of the two axes is still in motion, or if there is a difference between the speed of leading axis and following axis, the following axis might jerk. The intensity of the jerk depends on the speed difference and the gear ratio.
- As coupling of the following axis is a relative position coupling, the following axis can be coupled with any leading axis.
- The following axis does not change bits R100.1 *cb_Status_Stopped* and R100.2 *cb_Status_DestiWindow* in R100 *Status* at coupling .

Overview of Commands

For coupling, the following command of command register R101 *Command* is issued:

Designation of Command	Brief Description
C44 *Electronic Gearing*	Coupling by coupling mode *Electronic Gearing*

Action

The following steps have to be taken for coupling:

Step	Action
1	Issue command C44 Action: Write 44 to R101 *Command* and wait for the busy-bit in R100.13 "cb_Status_Busy" to be reset. Result: The following axis is coupled. This is shown by bit *cb_Tab_Status_GearLinked* (R400) that is "electronic gearing is active", in the status report of the coupling modes.

13.7.7 Uncoupling options

Introduction

Uncoupling is not only required in average processes, but it is also essential in emergency situations. Various options of uncoupling are presented below.

Uncoupling Options

There are various options of uncoupling. They are listed and described below:

Uncoupling Option	Description
• Immediate uncoupling	
- control function remains	The following axis uncouples immediately without driving a ramp. It remains at this point by position control.
- by blocking the output stage	The following axis uncouples immediately without driving a ramp. The output stage is blocked.
• Uncoupling by a ramp	
- by user-defined ramp	The following axis uncouples immediately by the user-defined ramp (R106). After driving the ramp, it remains at this point by position control.
- by maximum deceleration	The following axis uncouples immediately by maximum deceleration (R180). After driving the ramp, it remains at this point by position control.
- by emergency stop ramp	The following axis uncouples immediately by driving the emergency stop ramp (R549) in speed-controlled manner. After driving the ramp, the output stage is blocked automatically.
• Uncoupling by positioning	
- by point-to-point positioning	The following axis uncouples immediately and changes into absolute point-to-point positioning in jerk-free manner.
- by endless positioning	The following axis uncouples immediately and changes to endless positioning in jerk-free manner.

Action

In the following subchapters the procedure of each uncoupling option has been described.

13.7.8 Immediate uncoupling

Immediate Uncoupling

- control function remains

Below, immediate uncoupling by remaining control function remains:

Please note:	When the following axis is in motion, it can cause a tracking error.
Procedure:	1. The user issues command C45 2. The following axis carries out these steps: - Immediate position controlling of the motor to as-is position - Resetting bit R400.0 *Electronic Gearing active*
Action	1. Issue command C45 Action: Write value 45 to R101 *Command* and wait for resetting bit R100.13 *Busy* and resetting bit R400.0 *Electronic Gearing active*

Immediate Uncoupling

- by blocking the output stage

Below, immediate uncoupling by blocking the output stage is described:

Please note:	When the following axis is in motion without having got a brake, it can coast down depending on the moment of inertia.
Procedure:	1. The user issues command C02 2. The following axis carries out these steps: - Immediate blocking of the output stage - Resetting bit R400.0 *Electronic Gearing active*
Action	1. Issuing command C02 Action: Write value 45 to R101 *Command* and wait for resetting bit R100.13 *Busy* and resetting bit R400

13.7.9 Uncoupling by a ramp

Uncoupling by a Ramp

- by user-defined ramp

or

- by maximum deceleration

Below, uncoupling by user-defined ramp (C06), respectively by maximum deceleration (C05) is described:

Please note:	Maximum deceleration is for driving a ramp in an emergency situation. The following axis drives the ramp by the value of R180 *Maximum Acceleration*, which usually is very high.
Note:	The following axis drives the user-defined ramp by the value of R106 *Deceleration*.
Procedure:	1. The user issues C06, respectively C05 2. The following axis carries out these steps: - Immediate ramp start - Resetting bit R400.0 *Electronic Gearing active* - Resetting bit R100.1 *Stopped* - Setting bit R100.16 *Deceleration ramp* 3. At the end of the ramp, the following axis carries out the following steps: - Resetting bit R100.16 *Deceleration ramp* - Setting bit R100.1 *Stopped*
Procedure until axis standstill	1. Issuing command C06, respectively C05 Action: Write value 6 to R101 *Command* and wait for resetting bit R100.13 *Busy* and resetting bit R400.0 *Electronic Gearing active* 2. Wait for the ramp to be completed Action: Wait for bit R100.1 *Stopped* to be set.

Uncoupling by a Ramp

- by emergency stop ramp

Below, uncoupling by emergency stop ramp is described:

Please note:	At the end of the emergency stop ramp, the output stage is blocked automatically.
Note:	The following axis drives the emergency stop ramp by the value of R549 *Emergency Stop Ramp*.
Procedure:	1. The user issues command C07 2. The following axis carries out these steps: - Immediate ramp start - Resetting bit R400.0 *Electronic Gearing active* 3. At the end of the ramp, the following axis carries out the following steps: - Blocking of the output stage
Procedure until axis comes to standstill	1. Issuing command C06 Action: Write value 6 to R101 *Command* and wait for resetting bit R100.13 *Busy* and resetting bit R400.0 *Electronic Gearing active* 2. Wait for the ramp to be completed Action: Wait for bit R100.11 *Controller enabled* to be reset.

13.7.10 Uncoupling by point-to-point positioning

Introduction

Below, uncoupling by point-to-point positioning is described.

Note

For point-to-point positioning, speed and target position can be user-defined. The target position can also be determined in a way, for example, that the following axis has to change directions.

At transition to positioning, the following axis carries out all changes in motion by an acceleration, respectively deceleration ramp. For acceleration and deceleration during axis motion, the following axis takes the value of register R105 *Acceleration.* For deceleration towards target position, respectively to a direction turning point, the following axis takes over the value of R106 *Deceleration.*

Procedure

Uncoupling is carried out as follows:
1. The user determines the parameters of point-to-point positioning
2. The user issues command C10
3. The following axis carries out these steps:
   - Immediate transition to positioning (mostly this is the ramp)
   - Resetting bit R400.0 *Electronic Gearing active*
   - Resetting bit R100.1 *Stopped*
   - Setting bit R100.15 *Acceleration ramp,* respectively R100.16 *Deceleration ramp,*respectively R100.14 *Maximum speed*, depending on which ramp, respectively if at all a ramp has to be driven by the following axis
4. At the destination, the following axis carries out the following steps:
   - Resetting bit R100.16 *Deceleration ramp*
   - Setting bit R100.1 *Stopped*
   - Setting bit R100.2 *Destination window reached*

Processing Up to the End

The following steps have to be taken in order to carry out uncoupling by point-to-point positioning:

Positioning

Step	Action
1	Setting the positioning parameters Action: Writing to • R102 *Target Position* and • R103 *Speed*
2	Starting the positioning run Action: • Write value 10 to R101 *Command* and wait for • bit R100.13 *Busy* and • bit R400.0 *Electronic Gearing active* to be reset
3	Wait for the destination to be reached Action: Wait for • bit R100.2 *In Destination Window* or • bit R100.1 *Stopped* to be set

13.7.11 Uncoupling by endless positioning

Introduction

Below, uncoupling by endless positioning is described.

Note

For endless positioning, both speed and direction can be freely determined. The direction can also be determined in a way, for example, that the following axis has to change directions.

At transition to endless positioning, the following axis carries out all changes in motion by an acceleration, respectively deceleration ramp. For acceleration and deceleration during axis motion, the following axis takes the value of register R105 *Acceleration*.

Procedure

Uncoupling is carried out as follows:
1. The user sets the parameters for endless positioning
2. The user issues command C56
3. The following axis carries out these steps:
   - Transition to endless positioning (mostly this is the ramp)
   - Resetting bit R400.0 *Electronic Gearing active*
   - Resetting bit R100.1 *Stopped*
   - Setting bit R100.15 *Acceleration ramp,* respectively R100.16 *Deceleration ramp,*respectively R100.14 *Maximum speed*, depending on which ramp, respectively if at all a ramp has to be driven by the following axis
4. At the destination, the following axis carries out the following steps:
   - Resetting bit R100.16 *Deceleration ramp*
   - Setting bit R100.1 *Stopped*
   - Setting bit R100.2 *Destination window reached*

Processing Up to the End

The following steps have to be taken for uncoupling by means of endless positioning:

Positioning

Step	Action
1	Setting the positioning parameters Action: Writing to • R103 *Speed* • R142 *Motion Direction*
2	Starting endless positioning Action: • Write value 56 to R101 *Command* and wait for • bit R100.13 *Busy* and • bit R400.0 *Electronic Gearing active* to be reset
3	Wait for the destination to be reached Action: Wait for • bit R100.2 *In Destination Window* or • bit R100.1 *Stopped* to be set

13.7.12 Changing the gear ratio

Introduction

The gear ratio (R156) can be changed any time after configuring the coupling mode *Electronic Gearing*. This change takes effect immediately.

Register Overview

In order to define the gear ratio, the following register has been provided in the following axis:

Register Name	Brief Description
R156 *Gear Ratio*	Gear ratio

What has to Be taken Heed of at Changing the Gear Ratio?

Please observe the following at changing the gear ratio:

- **At changing, the following axis is not jerk controlled**, i.e., if the following axis is in motion, it might jerk. The intensity of the jerk depends on the extent to which the gear ratio is changed.
- The JetMove calculates the gear ratio by a precision of 7 mantissa digits.

Configuration Step

The following steps have to be taken for changing the gear ratio:

Step	Action
1	Changing the gear ratio Action: Write the value to R156 *Gear Ratio*

13.7.13 Description of registers

Register 156: Gear Ratio	
Function	**Description**
Read	As-is gear ratio
Write	Set gear ratio
Amplifier status	No specific status
Takes effect	Immediately
Variable type	float
Value range	Float limits
Value after reset	1

In this register, the gear ratio between leading axis position and the following axis position is set in the following axis for the coupling mode *Electronic Gearing*.

The JetMove calculates the gear ratio by a precision of 7 mantissa digits.

Register 400: Status	
Function	**Description**
Read	As-is coupling status
Write	Illegal
Variable type	int / register
Value range	Bit-coded, 32 bits
Value after reset	0

Meaning of the individual bits:	
Bit 0:	1 = Coupled in coupling mode "Electronic Gearing"

13.8 How the *Table* Coupling Mode Works

13.8.1 Overview

Introduction

The coupling mode *Table* can be applied in many cases. In order to apply this coupling mode correctly, the user has to be acquainted with the functioning principle and the behavior of the operating system, as well as of the leading and the following axis in this coupling mode.

In this Chapter

The topics of the following sub-chapter provide the needed know-how:

13.8.2 Definition of terms

Introduction

In this sub-chapter, the terms needed for understanding the configuring and operating of the *Table* coupling mode are defined.

Term	Definition
Table mode	The definition of a motion stored to an array of nodes
Table configuration	In the table configuration, the data framework needed by the operating system for processing a table is stored. This could be the information, for example, which nodes of the node array of the table.
Table positions	The leading and following axis positions that have been stored for the nodes of a table
Table limits	The first and the last node of the table
Table position range	The position range between the first and the last node of the table referring to the leading and following axis respectively
Axis position range	The range in which the leading and following axis positions are located. It has been defined differently for leading and following axis. For the leading axis: The leading axis position range is in the following axis. It is defined by the maximum and minimum leading axis position (R158 and R159). For the following axis: Travel range being defined by positive and negative travel limit (R182, R183). For modulo axes, it is the modulo travel range.
Position of the leading axis	The position of the leading axis in the following axis (R188). The leading position is within the leading axis posiiton range.
Positioning offset	The positioning offset in the coupling mode *Table* is an internal offset which, at certain events when running in the *Table*coupling mode is generated and maintained by the operating system for leading and following axis individually. There are two kinds of this positioning offset: • Position offset that cannot be corrected • Position offset that can be corrected
Configuration offset	An offset applied to the stored table positions, in order to achieve shifting the table. It is part of the table configuration.

13.8.3 Calculating the set position

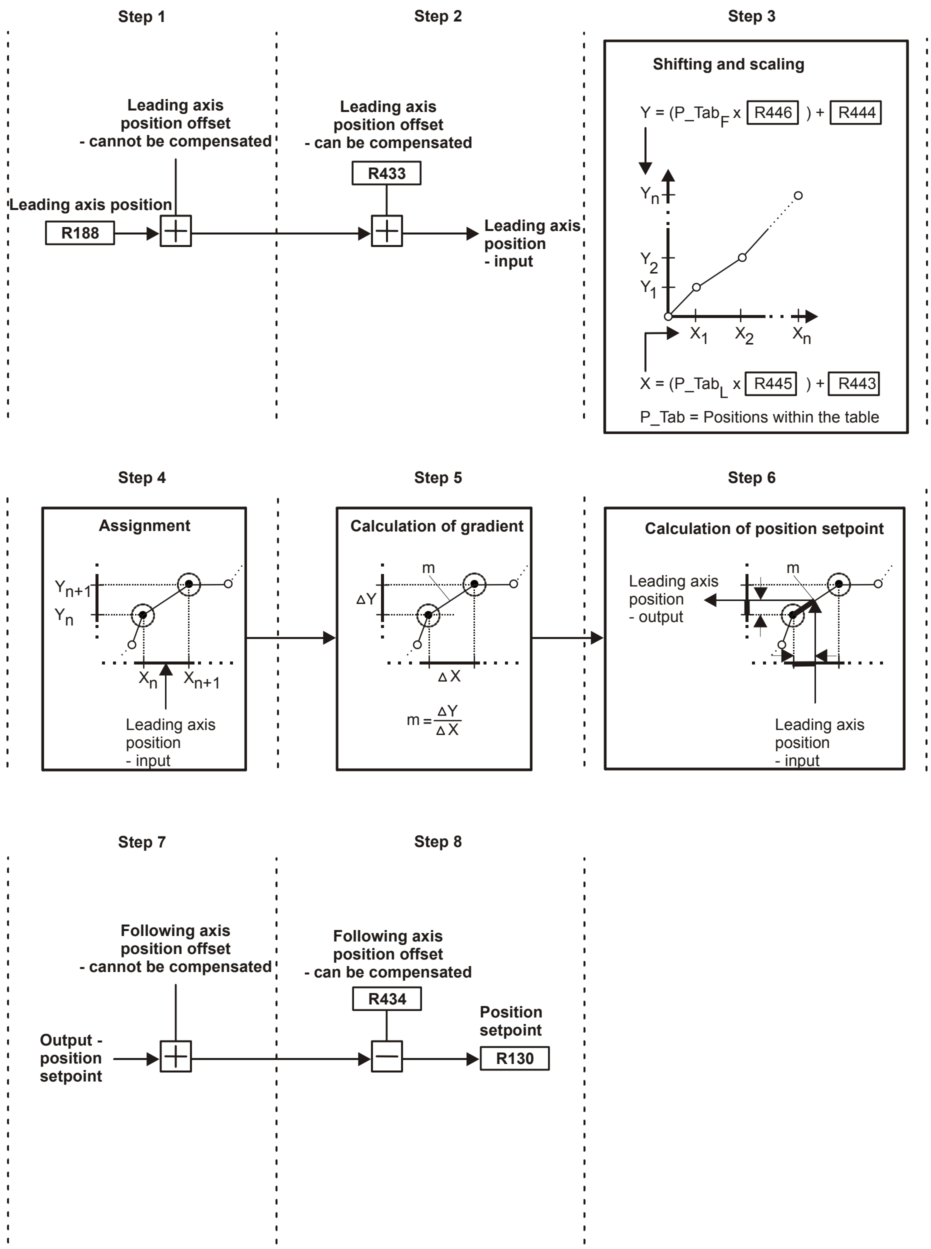
Introduction

In this sub-chapter, calculating the set position for the following axis is described extensively.

Calculating the Set Position for the Following Axis

The operating system of the following axis generates new set positions for the following axis in a cycle of 2 ms, in order to represent the table in the motion.

Below, calculation of following axis values is described step by step:



Step	Action
1	The non-compensable position offset value of the leading axis is added to the leading axis position value put down in R188.
2	The compensable position offset value of the leading axis is added to the result of step 1. The result is the *initial leading axis position*.
3	The leading axis position and each of the set following axis positions that have been stored in the table by the user are multiplied by the scaling factor of the table. The configuration offset of the table is added to each result. The result is the respective x- and y-position to continue the process with.
4	Assigning the calculated *initial leading axis position* to two apt neighboring nodes in the x value range.
5	Calculating the gradient m by means of the x- and y-values of the two table nodes.
6	Calculating the *resulting set position* by linear interpolation by means of gradient m and the x- respectively y-values of the two nodes.
7	The non-compensable position offset value of the following axis is added to the *resulting set position value*.
8	The compensable position offset value of the following axis is added to the result of step 7. The result is the set position value of the following axis written in R130.

Position Offset

The non-compensable position offset and the compensable position offset are internal offsets. They are individually generated and managed by the operating system while functioning in the *Table* coupling mode at certain events. On the following pages, these position offsets are described in detail.

Shifting and Scaling

By the scaling factor and the configuration offset, which are set for each table individually, the user can even belayed scale and shift a table. On the following pages, shifting and scaling are described in detail.

13.8.4 Absolute and relative position coupling

Introduction

Both leading and following axis can individually be coupled to the table positions either absolutely or relatively. The subchapter below describes the following items: Absolute and relative position coupling, when does which coupling type exist, how can the user influence the respective coupling type?

Absolute Position Coupling:

At absolute position coupling, the axis positions are coupled with the table positions without a position offset.

Relative Position Coupling

At relative position coupling, the axis positions are coupled with the table positions via position offset.

Positioning Offset

A position offset relating to position coupling is an internal offset. It is generated and managed by the operating system for leading and following axis individually during operation by *Table* coupling mode at certain events.

When does Which Type of Position Coupling Exist?

Absolute position coupling exists, as long as none of these events occurs.

Relative position coupling is needed from the moment, when at least one of these events has occurred.

When an absolute position coupling existed before, there is an automatic transition into relative position coupling as soon as one of the events has occurred.

Two Position Offsets

For each axis, two kinds of position offset can be generated:

- Position offset that cannot be corrected
- Position offset that can be corrected

Position offset that cannot be corrected:

> The position offset that cannot be corrected remains up to an event by which it is cleared.

Position offset that can be corrected:

> The position offset that can be corrected can automatically be corrected by means of the operating system.

Events Triggering a Position Offset

The operating system generates position offsets for leading and following axis individually, if certain events occur during operation in *Table* coupling mode.

In the table below, these events have been listed, grouped into leading and following axis events and into different position offset types.

Axis	Event
Leading Axis	*Position offset that cannot be corrected*
	Coupling, if the leading axis position is outside the table limits
	Overflow of the leading axis position within the table limits
	Reaching the table limit in endless positioning mode, if the leading axis position range <> table position range
	Position offset that can be corrected
	Change of tables, if there is a difference between starting node of the table that is following and the reference point of the table presently applied
Following axis	*Position offset that cannot be corrected*
	Overflow of the set leading axis position within the table limits
	Reaching the table limit in endless positioning mode, if the travel range <> table position range
	Position offset that can be corrected
	Coupling by a position difference between as-is set position (R130) and the calculated coupling-in set position
	Change of tables, if there is a difference between starting node of the table that is following and the reference point of the table presently applied

Cumulating the Offset Values and Clearing the Position Offsets

If several events referring to one axis occur simultaneously or in sequence before clearing or reaching the position offset values, the operating system cumulates the individual offset values either in position offset that can, or in position offset that cannot be compensated.

The *Coupling* event causes former position offset values for leading and following axis to be cleared and a new cumulating session to be started. If position offsets occur at the *Coupling* event, their values are the first cumulated values.

Displaying the Position Offset

The value of the position offset that cannot be compensated is invisible to the user. The position offset that can be compensated is visible to the user. It is displayed for leading and following axis individually by means of the following registers:

- R433 "Position Difference Leading Axis"
- R434 "Position Difference Following Axis"

Compensating for Position Offset

In default setting, the operating system immediately compensates a position offset that has occurred by the maximum speed of the following axis.

The users can influence the compensation. They can specify another compensating speed. They enter the compensating speed both for leading and following axis into the following registers individually:

- R435 "Correction Velocity Leading Axis"
- R436 "Correction Velocity Following Axis"

In default setting, the correction speed is set to maximum speed (R184).

The following behavior can be achieved by the correction speed:

Behavior	Set Speed v
No correction (i.e. relative position coupling remains)	v = 0
Immediate correction, i.e. there might be a jerk of the following axis	v = max. speed (R184)
Correction within a defined time	0 > v < max. speed

Correcting a position offset explicitely results in a motion of the following axis. This means that correcting a position offset of the leading axis also results in a motion of the following axis as well as correction of a position offset of the following axis itself.

This motion is linear. The operating system carries out correction overlaying an already existing table motion. If a position offset is corrected for both leading and following axis simultaneously, this results in an additional overlaid motion.

A certain correction speed can cause the following axis to briefly change its direction of motion.

Maintaining the Absolute Position Coupling

The user can keep up absolute position coupling for leading and following axis by giving heed to the following aspects:

- Make modulo settings for leading and following axis
- Configure the tables for leading and following axis in a way that the table position range is equal to the modulo position range of the axes
- The as-is set position (R130) corresponds to the set coupling position
- At coupling and table change make sure there is no position offset, e.g. correction speed = max. speed (R184).

13.8.5 Coupling

Introduction

This subchapter contains a definition of coupling and describes the processes for various coupling modes in the operating system.

Definition - Coupling

Coupling means that the set position of the following axis is coupled with the set position output value of the *Table* coupling mode.

Coupling Options

The *Table* coupling mode offers two coupling options:

- Immediate coupling
- Conditioned coupling

The main difference of these two coupling options is the following:

Coupling Option	Difference
Immediate coupling	Immediate coupling at the *as-is leading axis position*
Conditioned coupling	Coupling, when the leading axis position exceeds a set *reference leading axis position* of the table definition

Immediate Coupling

At coupling option *immediate coupling* , the operating system immediately couples the following axis at the *as-is leading axis position* of the table.

Immediate Coupling - How does the Operating System Work?

The operating system carries out immediate coupling as follows:

<table>
<tr><th>Step</th><th colspan="2">Action</th></tr>
<tr><td>1</td><td colspan="2">All existing position offsets of leading and following axis are set to 0.</td></tr>
<tr><td rowspan="3">2</td><td colspan="2">The operating system checks, whether the as-is leading axis position (R188) < a negative table limit:</td></tr>
<tr><td>If so:</td><td>The operating system keeps adding the table position range to the leading axis position, until a position results, which is inside the table position range. This position is then made the as-is leading axis position for the further process.
The total of addition values is stored as uncorrectable position offset. To be continued with step 4.</td></tr>
<tr><td>If this is not the case:</td><td>To be continued with step 3.</td></tr>
</table>

Step	Action	
3	The operating system checks, whether the as-is leading axis position (R188) > a positive table limit:	
	If so:	The operating system keeps subtracting the table position range from the leading axis position, until a position results, which is inside the table position range. This position is then made the as-is leading axis position for the further process. The total of subtraction values is stored as uncorrectable position offset. To be continued with step 4.
	If this is not the case:	To be continued with step 4.
4	The operating system assigns the as-is leading axis position (R188) to two corresponding table nodes.	
5	The operating system calculates the set coupling position of the following axis by information taken from the table definition.	
6	The operating system calculates the position offset that can be corrected between as-is position of the following axis and the calculated as-is position. It stores the position offset to R434 "Position Difference Following Axis". The operating system considers the table position range as a modulo system. This means that table start and end are identical and that any table position can be reached either by covering the table nodes in clockwise or in anti-clockwise direction. In this case, the operating system calculates the position offset marking the shortest distance between the as-is position and the set coupling position from the modulo viewpoint.	
7	The operating system couples te set position of the following axis with the set value output in *Table* coupling mode.	

Conditioned Coupling

At the coupling option *conditioned coupling,* the operating system causes the following axis to be coupled no sooner than when the *as-is leading axis position* either exceeds or comes short of a reference leading axis position. The user has to set the reference leading axis position and the coupling condition. It defines, whether the as-is leading axis position is to exceed or come short of the reference leading axis position.

To define the reference leading axis position, the user selects a node from the table definition. The leading axis position that has been stored for this node will then be used as reference leading axis position.

The coupling condition is defined by the user with the help of the so-called start type.

Coupling Conditions

The user can choose one of two coupling conditions:

– Condition 1: as-is leading axis position >= reference leading axis position
– Condition 2: as-is leading axis position <= reference leading axis position

The coupling conditions have been designed for these corresponding purposes:

Condition	Purpose
Condition 1:	The leading axis enters the table position range from the left
Condition 2:	The leading axis enters the table position range from the right

Conditioned Coupling - How does the Operating System Work?

The operating system carries out conditioned coupling as follows:

Step	Action
1	All existing position offsets, including the correctable position offset, of leading and following axis are set to 0.
2	Wait, until precondition has been met. The pre-condition is the negation of the selected coupling condition. It is needed to first of all get into the stage, where the selected coupling condition has not been met. The pre-conditions relate to the conditions as follows: – Pre-condition for condition 1: as-is leading axis position < reference leading axis position – Pre-condition for condition 2: as-is leading axis position > reference leading axis position In this case, the pre-condition cannot be set by comparing the leading axis positions: – axis position range = table position range – and the reference leading axis position is at one of the table limits In this case, exceeding the respective modulo limit is checked in addition: – At condition 1: Positive modulo limit exceeding is checked – At condition 2: Negative modulo limit exceeding is checked

Step	Action
3	Wait, until the selected coupling condition has been met. – Condition 1: as-is leading axis position >= reference leading axis position – Condition 2: as-is leading axis position <= reference leading axis position
4	The operating system calculates the set coupling position of the following axis by information taken from the table definition.
5	The operating system calculates the position offset that can be corrected between as-is position of the following axis and the calculated as-is position. It stores the position offset to R434 "Position Difference Following Axis". The operating system considers the table position range as a modulo system. This means that table start and end are identical and that any table position for an axis can be reached either by covering the table nodes in clockwise or in anti-clockwise direction. In this case, the operating system calculates the position offset marking the shortest distance between the as-is position and the set coupling position from the modulo viewpoint.
6	The operating system couples te set position of the following axis with the set value output in *Table* coupling mode.

Application - Conditioned Coupling

The coupling option *conditioned coupling* is mainly used in applications, where the following axis is to be coupled to a leading axis which is continually in motion, such as a *flying saw*.

Error Message at Coupling

At coupling, the operating system checks correctness of the respective table. If it detects errors in table configuration or in the set nodes, it issues the following error messages via the following bits: Bit 20 *Faulty leading axis position range*, respectively bit 21 *Table configuration is invalid* in R170 *Error Referencing / Positioning / Table*. In these error cases, the axes are not coupled with the table.

13.8.6 Uncoupling

Introduction

Uncoupling is not only required in average processes, but it is also essential in emergency situations. Various options of uncoupling are presented below.

Definition - Uncoupling

Uncoupling means that the set position of the following axis is separated from the set position output value of the *Table* coupling mode.

Uncoupling Options

There are various options of uncoupling. They are listed and described below:

Uncoupling Option	Action
• Immediate Uncoupling	
- control function remains	The following axis uncouples immediately without driving a ramp. It remains at this point by position control.
- by blocking the output stage	The following axis uncouples immediately without driving a ramp. The output stage is blocked.
• Uncoupling at the end of the table	The following axis uncouples without a ramp no earlier than at the table end. At this position, it remains in position control.
• Uncoupling by a ramp	
- by user-defined ramp	The following axis uncouples immediately by the user-defined ramp (R106). After driving the ramp, it remains at this point by position control.
- by maximum deceleration	The following axis uncouples immediately by maximum deceleration (R180). After driving the ramp, it remains at this point by position control.
- by emergency stop ramp	The following axis uncouples immediately by driving the emergency stop ramp (R549) in speed-controlled manner. After driving the ramp, the output stage is blocked automatically.
• Uncoupling by positioning	
- by point-to-point positioning	The following axis uncouples immediately and changes into absolute point-to-point positioning in jerk-free manner.
- by endless positioning	The following axis uncouples immediately and changes to endless positioning in jerk-free manner.

13.8.7 Processing the table

Introduction

When the following axis has been coupled, table processing can start. Below, the term "Table Processing" is explained and some options of table processing will be presented.

Definition - Table Processing

Table processing means that leading and following axis are completely covering the defined nodes either by exceeding the table limits or by changing direction within the table limits.

Table Processing Options

The table can be processed in different ways: They have been listed below:

Processing Option
Positive, negative processing
Change of direction
One-time processing
Triggered processing
Endless processing
Changing tables on the fly

The individual processing options have been described in detail partially in this and partially in the following two sub-chapters.

Positive, Negative Processing

The table can be processed both in positive and in negative direction. The motion direction of the leading axis determines the processing direction.

Change of Direction

At table processing, change of direction is permitted. For a change of table processing direction, the leading axis has to change its direction.

One-Time Table Processing

The following axis can be coupled in a way that it is automatically uncoupled by the operating system when the leading axis position exceeds a table limit.

In this case, the operating system carries out immediate uncoupling at remaining control function.

Triggered Table Processing

There is the option to start table processing by an external trigger signal.

The Virtual Position Counter has to be defined as leading axis in order to make use of this option. This option has been described in detail in the Virtual Position Counter section of this manual.

13.8.8 Endless table processing

Introduction

Below, endless table processing has been described and how the operating system handles endless table processing.

Definition - Endless Table Processing

Endless table processing means that, at reaching a table limit, the leading axis continues table processing automaticallly at the opposite table limit and without a jerk of leading or following axis. This way, table processing can be repeated continuously.

Requirements

The following axis has to be configured as a modulo axis for endless table processing. If a JetMove functions as leading axis module, the leading axis has to be configured as a modulo axis as well.

Processing at the Table Limit

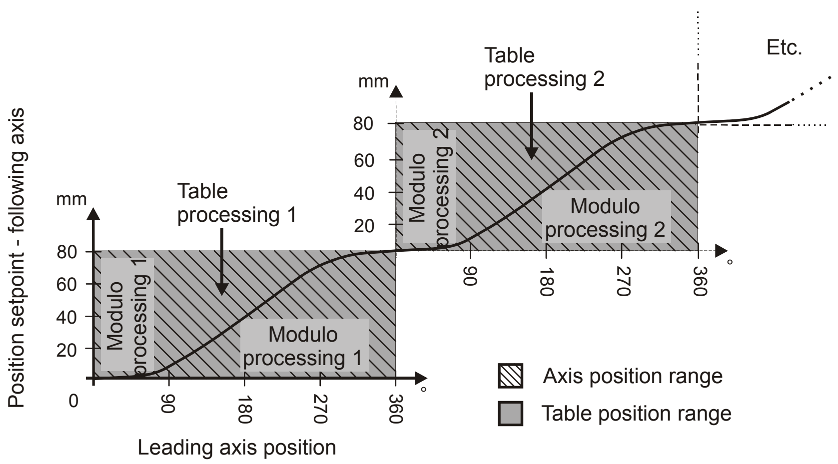
The operating system processes the change from one table limit to the other depending on the position ranges. It is crucial that the axis position range corresponds to the table position range of the leading, respectively of the following axis. There are two cases for both leading and following axis:

- Case 1: Axis position range = table position range
- Case 2: Axis position range <> table position range

Processing and Behavior in Case 1

If the axis position range = table position range, the operating system does not have to calculate a position offset. If the axis is in absolute position coupling, it remains even after changing from one table limit to the other.

The leading/following axis diagram illustrates the behavior of the axis positions at the table limit, if case 1 applies both to leading and following axis. In the leading/following axis diagram, the table is processed in positive direction. The leading axis position has got an axis position range from 0 to 360°, while the following axis has got an axis position range from 0 to 80 mm. For both axes, the table position range is equal to their axis position range.



Processing and Behavior in Case 2

If the axis position range <> table position range, the operating system has to calculate a position offset at the following events:

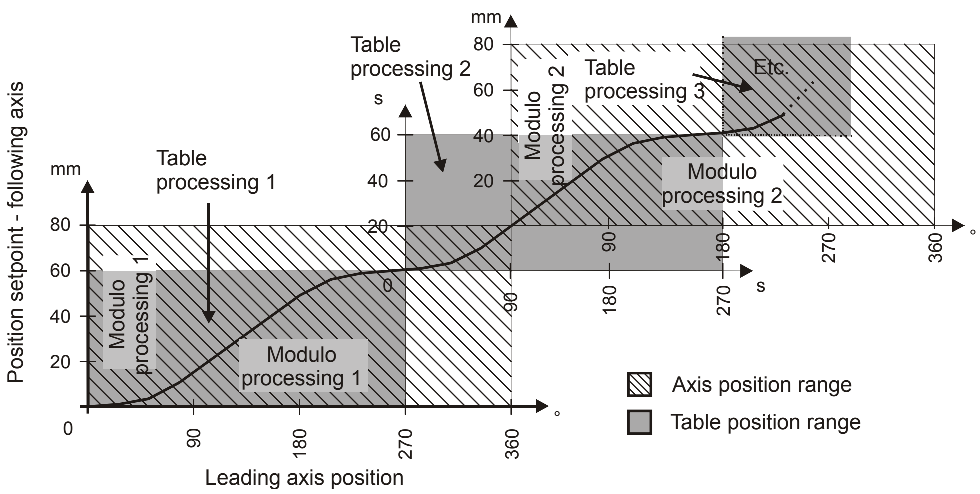
Event
Overflow of the axis position within the table limits
Reaching the table limit

The calculated position offset cannot be compensated. If, preceding one of these events, the axis is in absolute position coupling, this mode will automatically turn into relative position coupling.

The leading / following axis diagram illustrates the transition behavior of the axis at the table limits, if the following factors apply to leading and following axis:

- Leading axis: Axis position range > table position range
- Following axis Axis position range > table position range

In the leading /following axis diagram, the table is processed in positive direction. The leading axis position has got an axis position range from 0 to 360°, while the following axis has got an axis position range from 0 to 80 mm. The table position range, though, is 0 to 60 mm for the following axis and 0 to 270° for the leading axis.



Recommendation For the sake of easy handling, we recommend to process endless mode by case 1.

13.8.9 Changing tables on the fly

Introduction

For a following axis, several tables can be created. It is possible to change between these tables on the fly. Below, we give an explanation of what changing tables on the fly means and how it is performed.

Definition - Changing Tables on the Fly

At changing tables on the fly, a changeover between tables is made while a table is being processed, i.e. while leading and following axis are in motion.

Application

Changing tables on the fly allows for dynamic modification of the motion profile for the following axis.

At which Position can the Changeover be Performed?

JetMove supports changing tables on the fly at the table limits only.

Changeover Process

The operating system links the axis positions of the old table and the new table, in order to enable the changeover.

For this, it establishes a relation from a leading axis position stored in one table to a leading axis position stored in the other table. It also establishes a relation between two set positions of the following axis that have been stored in the two different tables. These are only positions that have been stored in the first and last node of the respective table.

Table processing in positive direction: The last or first node of the first table (depending on the respective axis) must have the same position value as the first node of the new table.

Table processing in negative direction: The last node of the new table must have the same position value as the first or last node of the first table (depending on the respective axis).

If the positions of a position pair are not identical, the position difference for the axis of the respective position pair is added to a position offset that can be compensated for.

Modulo Processing

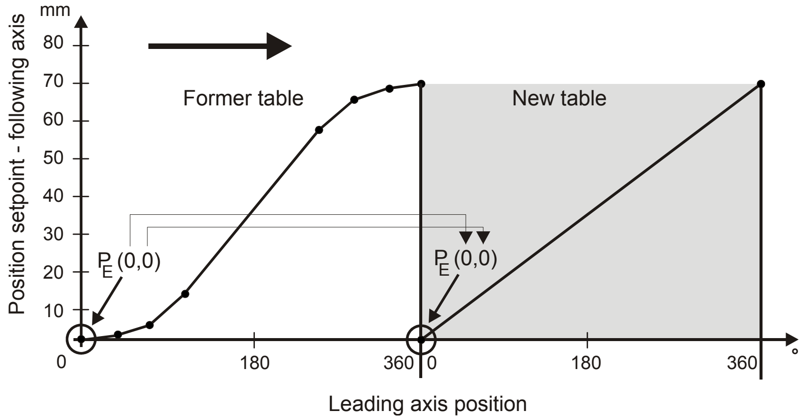
Mainly, changeover means to define, whether, when changing over to a new table, the system is to carry out modulo operation for the leading axis position, respectively for the set position of the following axis.

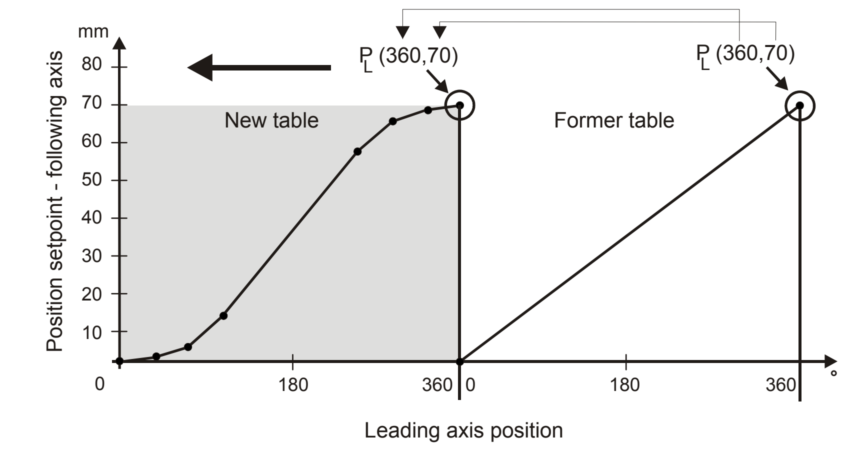
Changeover Types

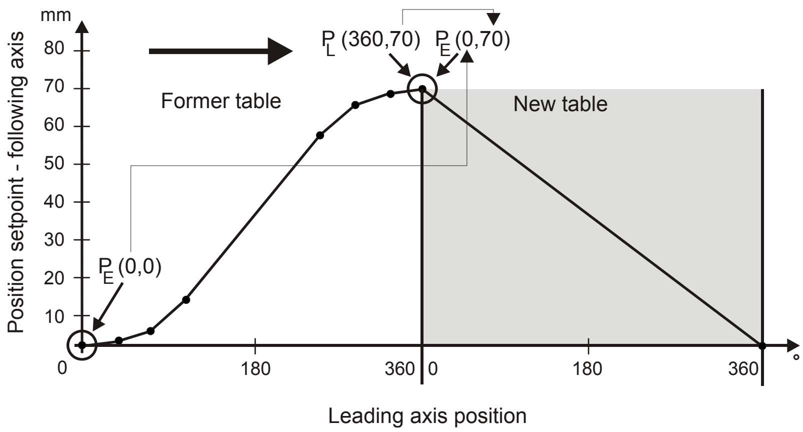
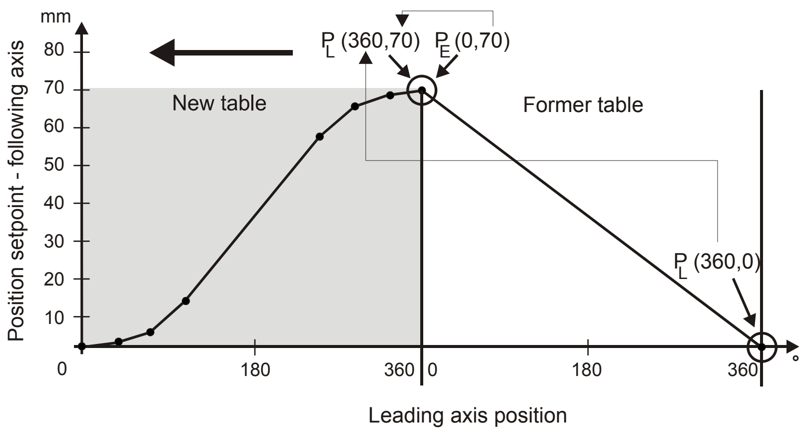
Via R432 *Change Type*, the user defines the position (leading axis position, respectively set position), for which the operating system is to carry out modulo operation, in other words - which position of the former table is assigned to which position of the new table for the respective axis.

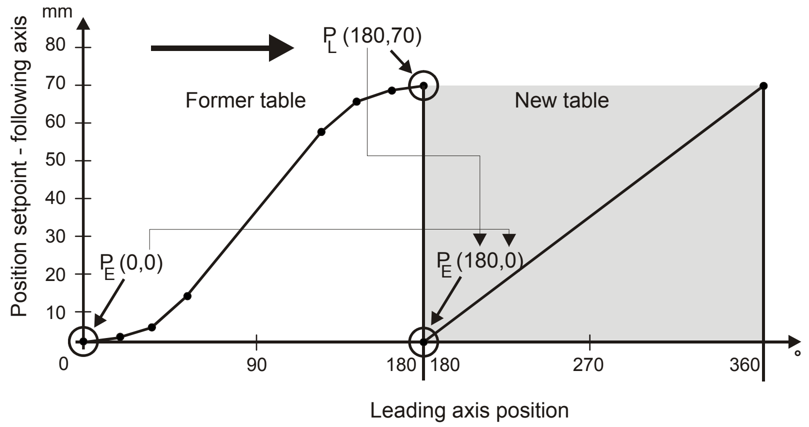
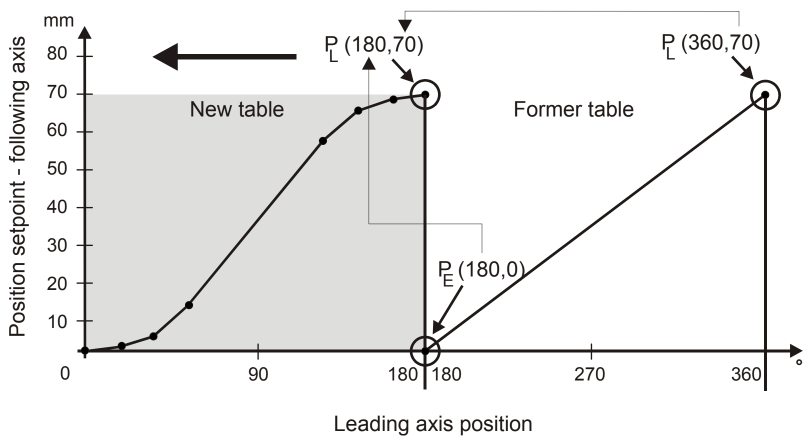
There are four changeover types. The following list specifies these changeover types and the position assignments depending on the table processing direction. The following symbols are used in the list:

- Type = Changeover type
- P_E = first node, and P_L = last node of a table
- Fat arrow in the graphics = direction of table processing

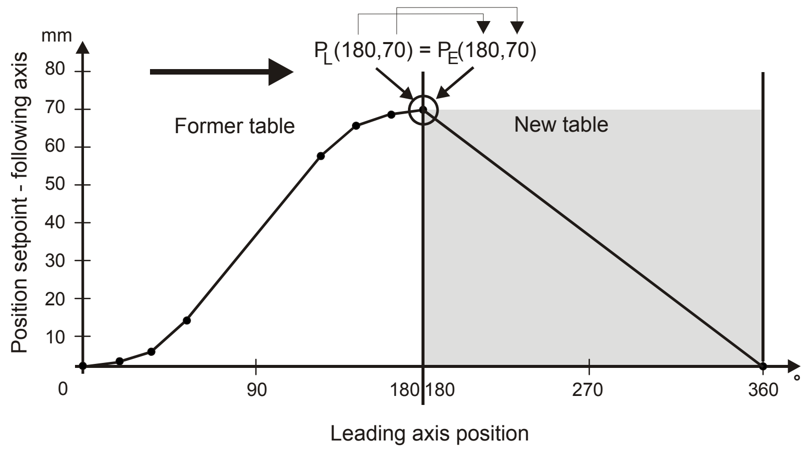
<table>
<tr><th rowspan="2">Type</th><th rowspan="2">Axis</th><th colspan="2">Relation of Positions</th></tr>
<tr><th>First Table</th><th>Set Table</th></tr>
<tr><td rowspan="9">0</td><td colspan="3">Leading Axis: Modulo Operation
Following Axis: Modulo Operation</td></tr>
<tr><td colspan="3">Positive Processing Direction</td></tr>
<tr><td>Leading axis</td><td>First node</td><td>First node</td></tr>
<tr><td>Following axis</td><td>First node</td><td>First node</td></tr>
<tr><td colspan="3">
</td></tr>
<tr><td colspan="3">Negative processing direction</td></tr>
<tr><td>Leading axis</td><td>Last node</td><td>Last node</td></tr>
<tr><td>Following axis</td><td>Last node</td><td>Last node</td></tr>
</table>


mm
80
70
60
50
40
30
20
10
0
Position setpoint - following axis
P_L (360,70)
P_L (360,70)
New table
Former table
180
360
0
180
360
°
Leading axis position

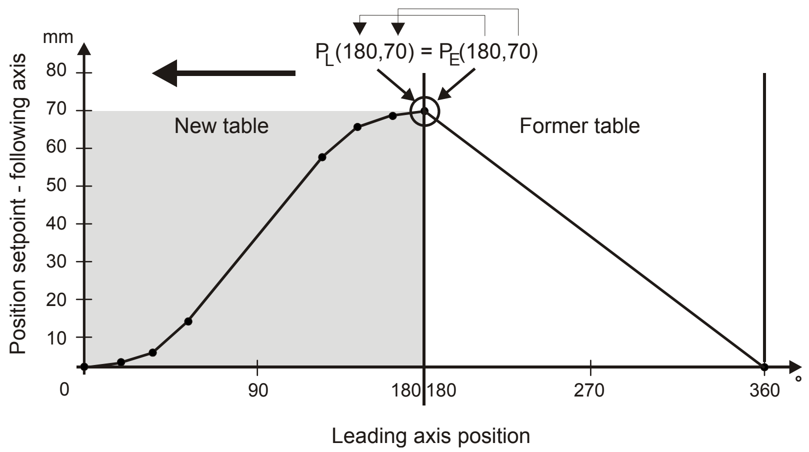
<table>
<tr><th rowspan="2">Type</th><th rowspan="2">Axis</th><th colspan="2">Position Pairs</th></tr>
<tr><th>First Table</th><th>Set Table</th></tr>
<tr><td rowspan="9">1</td><td colspan="3">Leading Axis: Modulo operation
Following Axis No modulo operation</td></tr>
<tr><td colspan="3">Positive processing direction</td></tr>
<tr><td>Leading axis</td><td>First node</td><td>First node</td></tr>
<tr><td>Following axis</td><td>Last node</td><td>First node</td></tr>
<tr><td colspan="3">
</td></tr>
<tr><td colspan="3">Negative processing direction</td></tr>
<tr><td>Leading axis</td><td>Last node</td><td>Last node</td></tr>
<tr><td>Following axis</td><td>First node</td><td>Last node</td></tr>
<tr><td colspan="3">
</td></tr>
</table>

<table>
<tr><th rowspan="2">Type</th><th rowspan="2">Axis</th><th colspan="2">Position Pairs</th></tr>
<tr><th>First Table</th><th>Set Table</th></tr>
<tr><td rowspan="9">2</td><td colspan="3">Leading Axis: No modulo operation
Following Axis: Modulo operation</td></tr>
<tr><td colspan="3">Positive processing direction</td></tr>
<tr><td>Leading axis</td><td>Last node</td><td>First node</td></tr>
<tr><td>Following axis</td><td>First node</td><td>First node</td></tr>
<tr><td colspan="3">
</td></tr>
<tr><td colspan="3">Negative processing direction</td></tr>
<tr><td>Leading axis</td><td>First node</td><td>Last node</td></tr>
<tr><td>Following axis</td><td>Last node</td><td>Last node</td></tr>
<tr><td colspan="3">
</td></tr>
</table>

Type	Axis	Position Pairs	
		First Table	**Set Table**
3	Leading Axis: No modulo operation Following Axis: No modulo operation		
	Positive processing direction		
	Leading axis	*Last* node	*First* node
	Following axis	*Last* node	*First* node



	Negative processing direction		
	Leading axis	*First* node	*Last* node
	Following axis	*First* node	*Last* node



13.8.10 Axis position overflow within the table

Introduction

If the axis position range of the leading or following axis is smaller than the table position range, the axis position range overflows during table processing. Please see below which are the requirements for axis position overflow, how the operating system proceeds the overflow, which are the consequences of the overflow, which can be the results of an overflow.

Requirements

In order to correctly carry out axis overflow for the respective axis, the axis has to be configured as a modulo axis.
For the leading axis, this is only required, if the leading axis module is a JetMove. In the leading axis modules JX2-CNT1 and *Virtual Position Counter*, the modulo setting has been implemented.

Processing

In case of an overflow, the operating system calculates a position offset that cannot be compensated. In this case, the operating system adds the amount of the modulo travel range to the position offset of the respective axis. This position offset cannot be compensated.

Result of the Overflow

If, preceding the overflow, the axis was in absolute position coupling, this mode will automatically turn into relative position coupling.

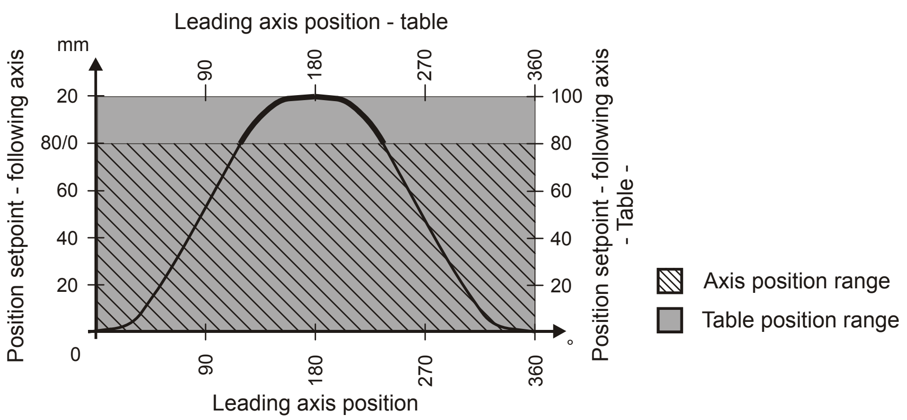
Two Overflow Situations

Relating to complete table processing in one direction, an overflow results in one of the following two situations:

- Short-time overflow situation
- Permanent overflow situation

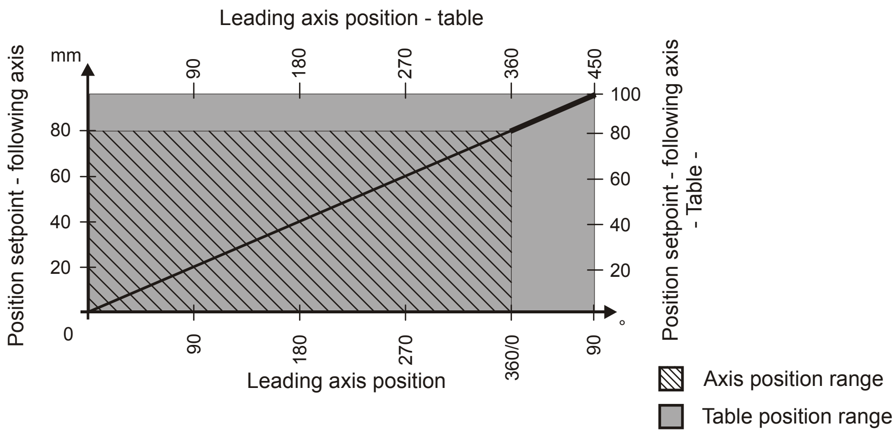
Short-Time Overflow Situation

In case of a short-time overflow situation, the table is defined for an axis as follows: The axis has an overflow at a certain table position. Later in the process it returns to get back to its last modulo operation. This means that, if absolute position coupling existed before the process started, it is re-established at the end of the process. This is only possible for the following axis.



Permanent Overflow Situation

For a permanent table overflow situation, the overflowing axis has been set to not returning in the further process. This means that the relative position coupling remains set even at the end of the process. This can be applied to both axes.



13.8.11 Moving the table - Configuration offset

Introduction

By means of a configuration offset, a table can be moved in relation to the stored table positions. This way, the table can be adjusted to an axis position range other than the set one.
Below, the functioning of moving an axis, as well as the available registers are described.

Operating Principle

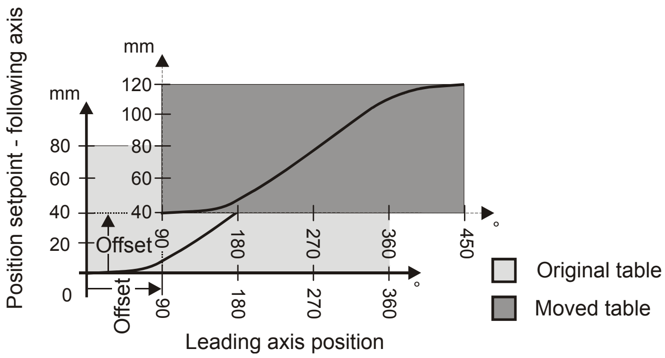
Both for leading and following axis, there is the possibility of specifying a configuration offset. It is added to all saved table positions of the axis. This results in new table positions which are used for coupling instead of the stored ones. A change of a configuration offset will not take effect before the next C46.

Example

Below, a sample offset is illustrated. The leading axis position is set to an offset of 90°, while the set position of the following axis is set to an offset of 40 mm.

This way, the following axis processes the table by the same motion, yet performing the following changes:
- The motion does not take place any more in the position range from 0 - 80 mm, but in a position range from 40 - 120 mm.
- If absolute position coupling is to be carried out, the starting node of the following axis motion is no more 0, but at 40 mm.

For the leading axis, there is the following change:
- It does not move between 0° and 360°, but between 90° and 450°.
- The axis position range between 0° and 90° is now outside the table position range.



Registers

The configuration offset can be specified via the following registers for leading and following axis:
- R443 *Configuration Offset - Leading Axis Position*
- R444 *Configuration Offset - Following Axis Position*

13.8.12 Scaling the table - Scaling factor

Introduction

With the help of the scaling factor, a table can be scaled to be different from the stored table positions. This means it can be compressed, respectively flattened. This way, the table can be adjusted to an axis position range other than the set one.
Below, the functioning of scaling, as well as the available registers are described.

Operating Principle

Both for leading and following axis, there is the possibility of specifying a scaling factor. All stored table position values of the axis are multiplied by this scaling factor. This results in new table positions which are used for coupling instead of the stored ones. A change of a scaling factor will not take effect before the next C46.

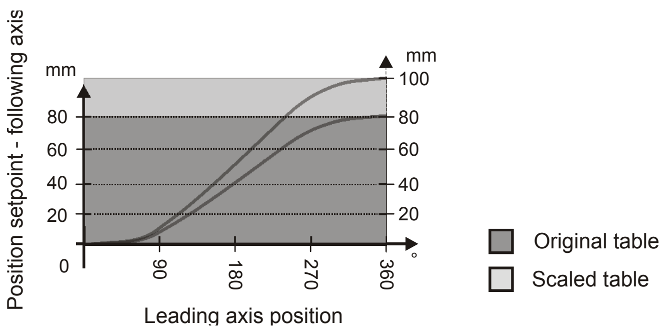
Example

Below, a sample scaling is illustrated. The leading axis position having got the default scaling factor 1 remains unchanged. For the set position of the following axis, a scaling factor of 1.25 has been specified.

This way, the following axis processes the table by the original motion profile, yet performing the following changes:

- The following axis moves in a profile flattened by factor 1.25.
- The following axis travels a distance longer by factor 1.25.
- At the same speed as the leading axis has got, the following axis reaches a higher maximum speed.

In this example, no changes result for the leading axis.



Registers

The scaling factor can be specified via the following registers both for leading and following axis:

- R445 *Scaling Factor - Leading Axis Position*
- R444 *Scaling Factor - Following Axis Position*

13.9 Configuring the *Table* Coupling Mode

13.9.1 Overview

Introduction

In this subchapter, configuring the *Table* coupling mode is described in detail.

In this Chapter

This sub-chapter contains the following topics:

13.9.2 Axis and table position range

Introduction

Below, the rules for defining the axis and table position range for operating a following axis of the *Table* coupling mode is described.

Miscellaneous Options

The axis position range of both leading and following axis can be set in a defined relation to the table position range of both leading and following axis as regards the sizes:

The axis position range can be

- equal to,
- greater or
- smaller

than the table position range.

Rules

The following rule applies to those two position ranges covering each other in each of the cases listed above:

Case	Covering
equal	The axis position range completely covers the table position range.
greater	The axis position range completely covers the table position range.
smaller	The table position range completely covers the axis position range.

Applying the Configuration Offset

If the respective rules have not been complied with, the table position range can be moved by means of the configuration offset in such a way that the desired amount of covering results.

Coupling in the *Smaller* Case

In case the axis position range is smaller than the table position range, please note: The following axis cannot be coupled at any table position, but only in a table position range covered by the axis position range.

13.9.3 Basics on setting the nodes

Introduction

The purpose of nodes is to define the motion profile resulting from the leading and following axis motions as precisely as possible. Defining motion elements by means of nodes, as well as restrictions and rules to be considered are described below.

Straight Lines and Curves

A motion consists of the two elements straight line and curve. In the table below, defining these motion elements by means of nodes.

Motion Element	Action
Straight line	Two nodes, initial and end point of the straight line
Curve	Several nodes, all of them being positioned on the curved path The profile of the curve during the process depends on the number of nodes. The greater the density of the nodes, the more differentiated is the profile.

Maximum Density of Nodes

At the maximum leading axis speed required for an application, not all nodes are considered, if the nodes are too close to each other. In this case, nodes are skipped, which means they do not contribute to the motion profile.

After 2 milliseconds max., the operating system switches over to the next node. This switching-over time cannot be influenced. It defines the maximum density of nodes at a given maximum leading axis speed.

Minimum Number of Nodes

A table has to consist of at least two nodes.

Rules of Defining a Leading Axis Position

At defining the leading axis positions, please comply to the following rules:

1. The values of the leading axis positions have to be continually increasing from the first to the last node.
2. Each leading axis position may only occur once.

Remarks - Set Position

Please mind when defining the set node positions:

1. The set node position values can be in increasing or decreasing order.
2. Following axis positions are allowed to occur several times, e.g., if the following axis is to remain in one position, while the leading axis is moving.

13.9.4 The configuration objects

Introduction

For configuring the *Table* coupling mode, there are configuration objects available which serve as a means of communication with the user. Please read below, which are these configuration objects, how they are structured and how the user can access them.

Life of the Data

Data which contain the configuation objects remain stored as long as the JetMove is being supplied with power, or until a software reset is triggered.

Configuration Objects

The following configuration objects are available for configuration:

- Node array
- Table configurations

Node Array

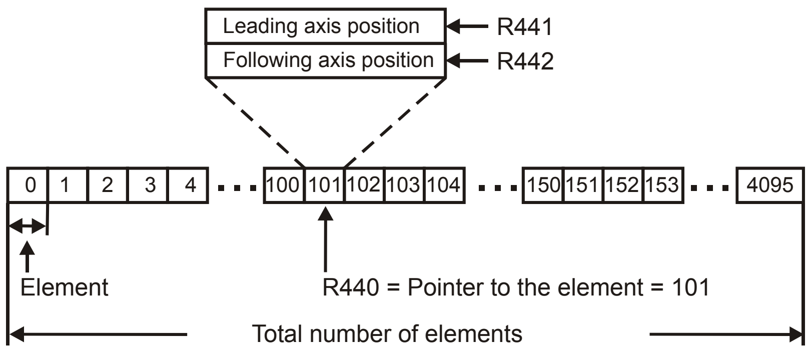
The nodes of a table are stored to the node array. The node array is structured as follows:

- It contains 4,096 elements
- Every element can store two positions as float values:
  - Leading axis position
  - Following axis position

The following registers are available for the user to access the node array:

- R440 = Pointer to elements (0 ... 4,095)
- R441 = Leading axis position of the presently active element
- R442 = Following axis position of the presently active element

The following illustration shows the structure of, and the access to the node array:



All Tables in Node Array

The node array stores the nodes for *all* defined tables. The number and positions of the nodes and the node array referring to the respective table can be determined at will by the user.

The following illustration gives an example of three tables sharing the node array. Registers R410, R411, R413 are registers of this table configuration: R410 = Table pointer, R411, R413 = Index of the first and last node in the node-array.

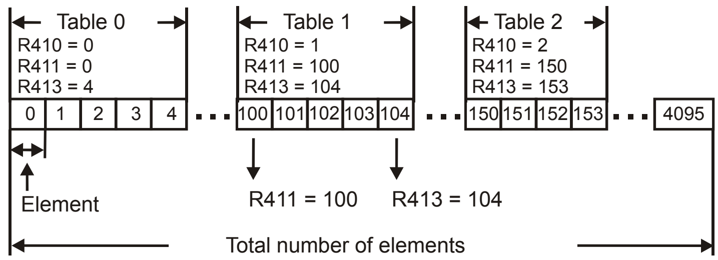


Table Configuration

The table configuration is a data structure, to which the entire data framework of the table has been stored. A JetMove provides 24 of these table configurations.

A table configuration comprises the following elements:

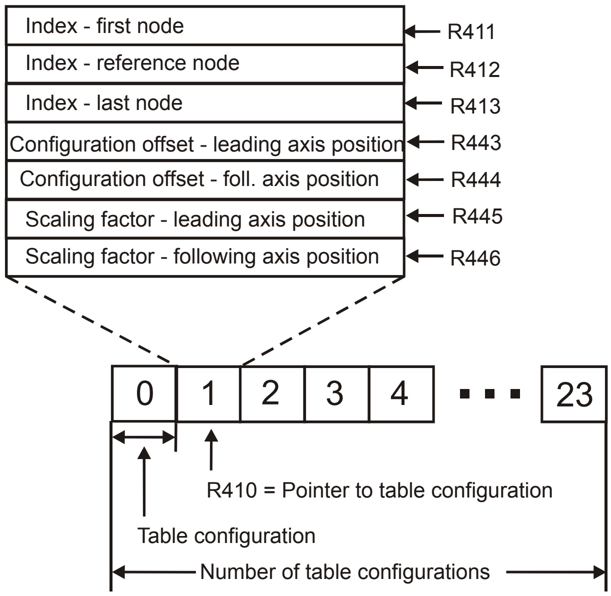
- Index of the first table node in the node array
- Index of the last table node in the node array
- Index for the reference node in the node array at conditioned coupling
- Configuration offset for the leading axis position
- Configuration offset for the following axis position
- Scaling factor for the leading axis position
- Scaling factor for the following axis position

These registers are available to the user for accessing the table configuration:

Selection of the table configuration:
- R410 = Pointer to the Table Configuration (0 ... 23)

Access to the individual elements of the table configuration having been selected via R410:
- R411 = Index - First Node
- R412 = Index - Reference Node
- R413 = Index - Last Node
- R443 = Configuration Offset - Leading Axis Position
- R444 = Configuration Offset - Following Axis Position
- R445 Scaling Factor - Leading Axis Position
- R446 = Scaling Factor - Following Axis Position

The following illustration shows the structure of, and the access to, the table configurations:


Index - first node
Index - reference node
Index - last node
Configuration offset - leading axis position
Configuration offset - foll. axis position
Scaling factor - leading axis position
Scaling factor - following axis position
R411
R412
R413
R443
R444
R445
R446
0
1
2
3
4
23
R410 = Pointer to table configuration
Table configuration
Number of table configurations

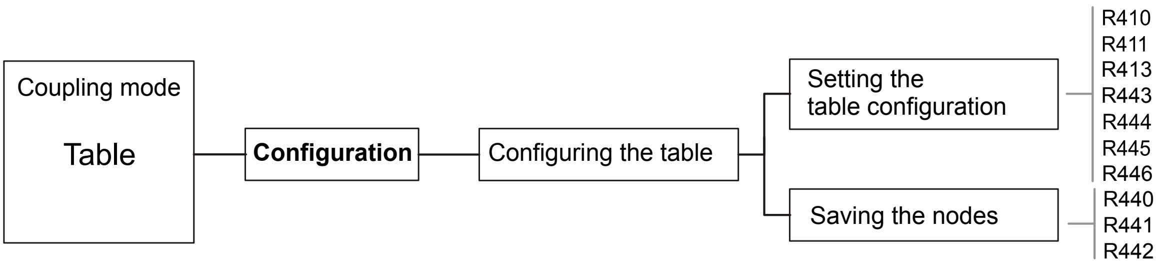
13.9.5 Overview of configurations

Overview

The following structure tree shows all possibilities of configuring the *Table* coupling mode, that will be described below.

This overview contains the most relevant registers and commands that will be used in the following descriptions.

R = Register; C = Command via R101



13.9.6 Configuring the table

Introduction

Configuring a table implies the two following steps:

- Setting the table configuration
- Saving the nodes

These two steps are described in detail below.

Register Overview of the Table Configuration

For setting the table configuration, the data framework of the table is written to the table configuration. The registers for accessing the table configuration have been listed below.

Register Name	Brief Description
R410 *Pointer to Table Configuration*	Pointer to table configuration (0 ... 23)
R411 *Index - First Table Point*	Index - first table node
R412 *Index - Start Table Point*	Index - reference node
R413 *Index - Last Table Point*	Index - last table node
R443 *Configuration Offset - Leading Axis Position*	Configuration offset of the leading axis position
R444 *Configuration Offset - Following Axis Position*	Configuration offset of the following axis position
R445 *Scaling Factor - Leading Axis Position*	Scaling factor of the leading axis position
R446 *Scaling Factor - Following Axis Position*	Scaling factor of the following axis position

Setting the Table Configuration

To set a table configuration in the following axis, take the following steps:

Step	Action
1	Selecting the table configuration to be applied Action: Writing the respective number to R410 *Pointer to Table Configuration*
2	Setting the index of the node array, in which the first table node is to be stored Action: Writing to R411 *Index - First Table Point* the respective index Reaction: R412 *Index - Start-Table Point* is automatically set to this index as well.

3	Setting the index of the node array, in which the last table node is to be stored Action: Writing to R413 *Index - Last Table Point* the respective index
4	Setting the configuration offset for the leading and following axis position Action: Writing the respective offset to R443 *Configuration Offset - Leading Axis Position* and R444 *Configuration Offset - Following Axis Position*
5	Setting the scaling factor for the leading and following axis position Action: Writing the respective factor to R445 *Scaling Factor - Leading Axis Position* and R446 *Scaling Factor - Following Axis Position*

Register Overview for Saving Nodes

For saving nodes to JetMove, the node array is written to at the respective position. Below, the registers for accessing the node array have been listed:

Register Name	Brief Description
R440 *Index to Table Node*	Index to an element of a node array
R441 *Leading Axis Position*	Leading axis position of the node
R442 *Following Axis Position*	Following axis position of the node

Saving the Nodes

To save the nodes in the following axis, take the following steps:

Step	Action
1	Selecting the index of the node array, to which the first table node is to be saved Action: Writing the respective index to R440 *Index to Table Node*
2	Saving the leading axis position Action: Writing the respective position value to R441 *Leading Axis Position*
3	Saving the following axis position Action: Writing the respective position value to R442 *Following Axis Position* Reaction: R440 *Table Node* is automatically incremented by 1
4	Repeating the procedure starting from step 2, until all the positions of all nodes have been entered

13.9.7 Description of registers

Register 410: Table Config Index	
Function	**Description**
Read	As-is index of the table configuration that is to be edited
Write	Set index
Amplifier status	No specific status
Takes effect	Immediately
Variable type	int / register
Value range	0 ... 23
Value after reset	0

Register 411: Index - First Table Node	
Function	**Description**
Read	Index of the first table node in the node array
Write	Set index
Amplifier status	No specific status
Takes effect	Immediately
Variable type	int / register
Value range	0 ... 4,095
Value after reset	0

Register 412: Index - Start Table Node	
Function	**Description**
Read	Index of the reference table node in the node array
Write	Set index
Amplifier status	No specific status
Takes effect	Immediately
Variable type	int / register
Value range	0 ... 4,095
Value after reset	0

The leading axis position of the starting node is used for conditioned coupling as a reference leading axis position.

Register 413: Index - Last Table Node	
Function	**Description**
Read	Index of the first table node in the node array
Write	Set index
Amplifier status	No specific status
Takes effect	Immediately
Variable type	int / register
Value range	0 ... 4,095
Value after reset	0

Register 440: Table Node	
Function	**Description**
Read	As-is index of the node-array element that is to be edited
Write	Set table node
Amplifier status	No specific status
Takes effect	Immediately
Variable type	int / register
Value range	0 ... 4,095
Value after reset	0

Register 441: Leading Axis Position	
Function	**Description**
Read	As-is leading axis position of the selected element
Write	Set leading axis position
Amplifier status	No specific status
Takes effect	Immediately
Variable type	float
Value range	Float limits [°] or [mm] This unit depends on the setting of the axis type defined in R191 in the leading axis
Value after reset	0 [°]

Register 442: Following Axis Position

Function	Description
Read	As-is following axis position of the selected element
Write	Set following axis position
Amplifier status	No specific status
Takes effect	Immediately
Variable type	float
Value range	Float limits [°] or [mm] This unit depends on the setting of the axis type defined in R191 of the following axis.
Value after reset	0 [°]

Note!

When R442 is written into, R440 will be incremented by one automatically.

Register 443: Configuration Offset - Leading Axis Position

Function	Description
Read	As-is offset for shifting the table in the direction of the leading axis position (abscissa)
Write	Set offset
Amplifier status	No specific status
Takes effect	Next C46
Variable type	float
Value range	Float limits [°] or [mm] This unit depends on the setting of the axis type defined in R191 in the leading axis
Value after reset	0 [°]

Register 444: Configuration Offset - Following Axis Position	
Function	**Description**
Read	As-is offset for shifting the table in the direction of the following axis position (ordinate)
Write	Set offset
Amplifier status	No specific status
Takes effect	Next C46
Variable type	float
Value range	Float limits [°] or [mm] This unit depends on the setting of the axis type defined in R191 of the following axis.
Value after reset	0 [°]

Register 445: Scaling Factor - Leading Axis Position	
Function	**Description**
Read	Scaling factor for flattening / compressing the table in the direction of the leading axis position (abscissa)
Write	Set scaling factor
Amplifier status	No specific status
Takes effect	Next C46
Variable type	float
Value range	**Positive** float limits (negative factors are permitted)
Value after reset	0

Register 446: Scaling Factor - Following Axis Position	
Function	**Description**
Read	Scaling factor for flattening / compressing the table in the direction of the following axis position (ordinate)
Write	Set scaling factor
Amplifier status	No specific status
Takes effect	Next C46
Variable type	float
Value range	Float limits
Value after reset	0

13.10 Carrying out the *Table* Coupling Mode

13.10.1 Overview

Introduction

This sub-chapter describes in detail how the user has to proceed in detail when carrying out the *Table* coupling mode, and what the user has to know and to consider.

In this Chapter

This sub-chapter contains the following topics:

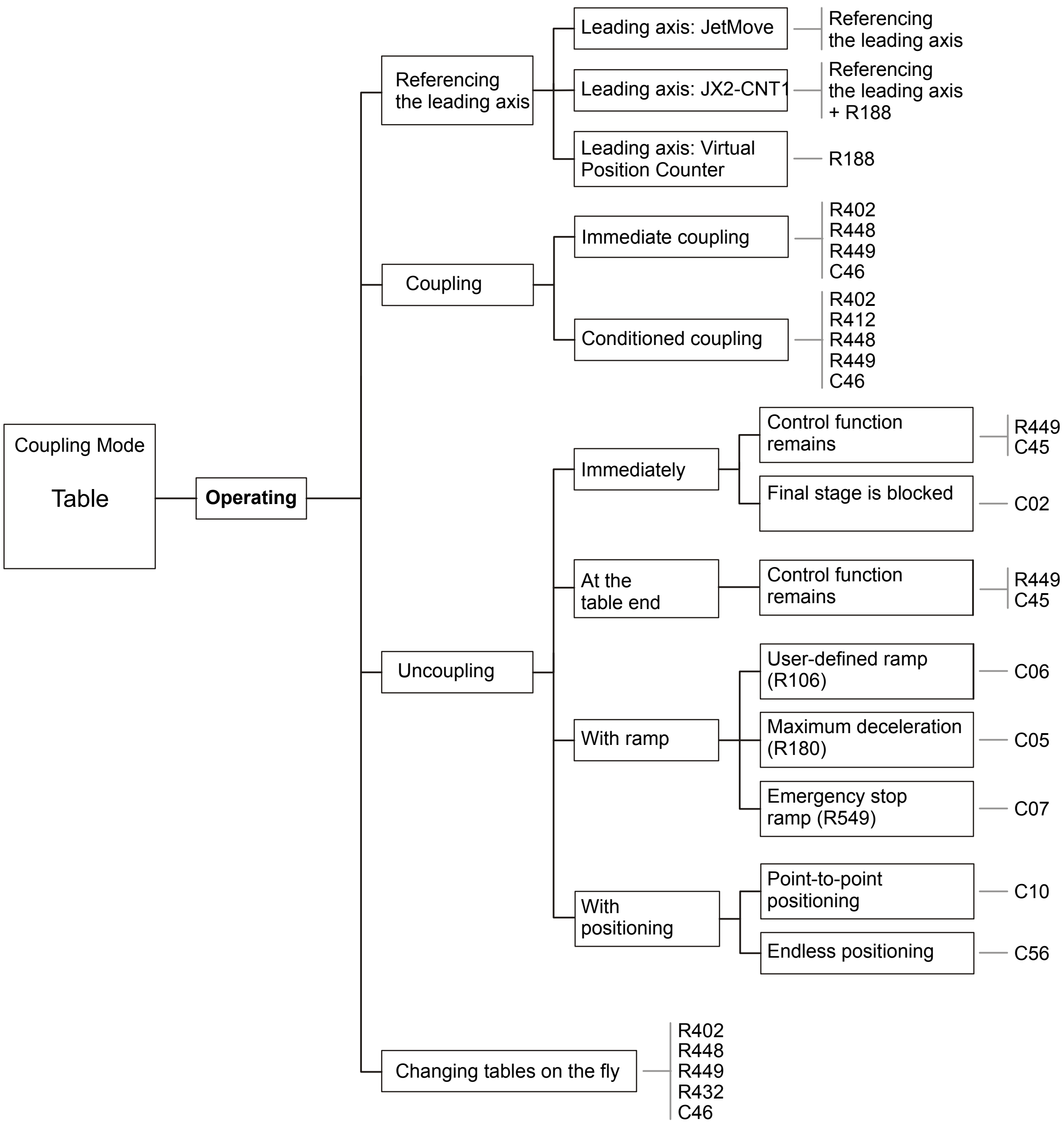
13.10.2 Overview of operations

Overview

The following structure tree shows all possibilities of operating in the *Table* coupling mode, that will be described below.

This overview contains the most relevant registers and commands that will be used in the following descriptions.

R = Register; C = Command via R101



13.10.3 Referencing the leading axis position

Introduction

Referencing the leading axis position (R188) in the following axis before coupling may be needed for establishing a relation with the leading axis position. Referencing differs depending on the respective leading axis module.

Register Overview

For referencing the leading axis position, the following register has been provided in the following axis:

Register Name	Brief Description
R188 *Leading Axis Position*	Leading axis position

Configuration Steps: Leading Axis Module *JetMove*

The following step has to be carried out for referencing the leading axis position by means of the leading axis module *JetMove*.

Step	Action
1	Referencing the leading axis Action: Referencing the leading axis, or setting a reference position by command, e.g. command C03 *Set Reference*. Result: Leading axis position (R188) in the following axis shows the referencing position of the leading axis.

Configuration Steps: Leading Axis Module *JX2-CNT1*

The following steps have to be carried out for referencing the leading axis position by means of the leading axis module *JX2-CNT1*.

Step	Action
1	Referencing the leading axis Action: Referencing in the leading axis, or else setting a reference position by writing the value to R3xx0
2	Setting the respective leading axis position Action: Corresponding to the reference position (R3xx0) of the leading axis, the leading axis position in the following axis is set by writing to R188. Example: The reference position (R3xx0) is referenced to position 0. The leading axis position (R188) is also to have position 0: R188 := 0

Configuration Steps: Leading Axis Module *Virtual Position Counter*

The following steps have to be carried out for referencing the leading axis position by means of the leading axis module *Virtual Position Counter*.

Step	Action
1	Setting the leading axis position Action: Writing the desired referencing position to R188 "Leading Axis Position" in the leading axis. Result: Leading axis position (R188) in all external following axes shows the referencing position of the leading axis position (R188).

13.10.4 Immediate coupling

Introduction

Immediate coupling of the following axis can be carried out in the following two variants:

- Variant 1: Immediate coupling at table processing once
- Variant 2: Immediate coupling at endless table processing

Below, secondary information regarding both variants are described. Then, the detailed procedure for each variant is described in an individual table.

What is to be Given Heed to when Coupling the Axis?

Please mind the following details before immediate coupling:

In each case:

The details listed below have to be considered both in absolute and in relative position coupling:

- Both leading and following axis have to be at standstill.
- The following axis has to be in uncoupled condition. This can be checked from R400 *Status Word of the Coupling Modes* .

Absolute position coupling:

If the following axis is to be coupled by absolute position coupling, please mind the following details:

- The correction speed of the following axis (R436) has to be set to value > 0.
- The set position (R130) of the following axis has to be at the set coupling position.

If the axis position range is smaller than the table position range, and if coupling at the left or right table edge is required, please mind the following as well:

- The set position (R130) of the following axis has to be exactly on the respective position at the table edge. **The output stage being activated**, this can be done by positioning or by setting a reference (command 3) on the respective position at the table edge.

- The leading axis has to be set in such a way, that it will transmit (R151 = y04) its set position (R130). The set position (R130) has to be exactly on the position at the table edge, just as the set position of the following axis. As it is with the following axis, this also has to be done by positioning or setting a reference (command 3), **the output stage being activated**.

If those two items are not given heed to, the following axis will jerk.

What is to be Given Heed to when Coupling the Axis?

(continued)

Relative position coupling

If the following axis is to be coupled by relative position coupling, please mind the following details:

- The correction speed of the following axis (R436) has to be set to value = 0.
- If the set position of the following axis is outside the table position range, the following applies: The set position of the following axis is only allowed to be outside the table position range by the value of one table position range.

Command and Register Overview

For immediate coupling, the following registers and commands out of command register R101 *Command* are applied. In this case, the abbreviations have got the following meanings: R = Register, C = Command

Name of Command / Register	Brief Description
C46 *Table coupling*	Coupling by the *Table* coupling mode
R400 *Status*	The status of the coupling modes are displayed
R402 *Table Start Index*	Index for selecting the table configuration, the table of which is to be coupled.
R420 *As-Is Table Index*	Index for displaying the table configuration, the table of which presently coupled.
R432 *Change Type*	Type of changeover between tables
R448 *Start Type*	Coupling mode
R449 *Stop Type*	Uncoupling mode

Error Message at Coupling

At coupling, the operating system checks correctness of the respective table. If it detects errors in table configuration or in the set nodes, it issues the following error messages via the following bits: Bit 20 *Faulty leading axis position range*, respectively bit 21 *Table configuration is invalid* in R170 *Error Referencing / Positioning / Table*. In these error cases, the axes are not coupled with the table.

Steps at Processing the Table Once

The following steps have to be taken at immediate coupling for processing the table once:

Step	Action
1	Selecting the table to be coupled Action: Writing the respective table configuration index to R402 *Table Start Index*

2	Setting the mode of immediate coupling and of uncoupling at processing the table once Action: R448 *Start Type* = 0 R449 *Stop Type* = 1
3	Activate coupling Action: R101 *Command* = 46
4	Checking the coupling (optional) Action: Check, whether the corresponding values are displayed: – Bit R400.1 *cb_Tab_Status_TabLinked* = 1 (table has been coupled) – R420 *As-Is Table Index* = Table index that has been set in R402

Steps at Endless Table Processing

The following steps have to be taken at immediate coupling for endless table processing:

Step	Action
1	Selecting the table to be coupled Action: Writing the respective table configuration index to R402 *Table Start Index*
2	Setting the mode of immediate coupling and of uncoupling at endless table processing Action: R448 *Start Type* = 0 R449 *Stop Type* = 0
3	Making sure the changeover type has been set to the default value Action: R432 *Changeover Type* = 0 Comment: The changeover type is needed for changing between tables. If it were not set on the default value, it would influence endless table processing.
4	Activate coupling Action: R101 *Command* = 46
5	Checking the coupling (optional) Action: Checking, whether the corresponding values are displayed: – Bit R400.1 *cb_Tab_Status_TabLinked* = 1 (table has been coupled) R420 *As-Is Table Index* = Table index that has been set in R402

13.10.5 Conditioned coupling

Introduction

Conditioned coupling of the following axis can be carried out in the following two variants:

- Variant 1: Conditioned coupling with the table being processed once
- Variant 2: Conditioned coupling with endless table processing

Below, secondary information regarding both variants is described. Then, the detailed procedure for each variant is described in an individual table.

What has to be Given Heed to when Coupling the Axis?

Please mind the following details before conditioned coupling:

- The following axis must be at standstill
- The following axis must be in uncoupled condition. This can be checked from R400 *Status*.
- If the following axis is to be coupled by absolute position coupling, please mind the following details:
  - The correction speed of the following axis (R436) has to be set to value > 0.
  - The set position (R130) of the following axis has to be at the set coupling position.
- If the following axis has to be coupled by relative position coupling, the correction speed for the following axis (R436) has to be set to zero.
- If the set position of the following axis is outside the table position range, the following applies: The set position of the following axis is only allowed to be outside the table position range by the value of one table position range.

What has to be Done Before Coupling?

Before conditioned coupling, a reference position has to be set the as-is leading axis position is to be compared with.
In order to set a reference leading axis position, turn to table configuration register R412 *Index - Start Table Point*. There, set the index indicating the leading axis position node in the node array for comparison of values.

Displaying the "Wait" Condition

After issuing the coupling command and as long as the leading axis has not reached the reference leading axis position yet, the coupling procedure is in "Wait" condition. This "Wait" condition is displayed by Bit R400.3 *cb_Tab_Status_TabWaitForLink*=1. When the leading axis has exceeded the reference position, the bit is automatically reset and bit R400.1 *cb_Tab_Status_TabLinked* is set.

Command and Register Overview

For conditioned coupling, the following registers and commands out of command register R101 *Command* are applied. In this case, the abbreviations have got the following meanings: R = Register, C = Command

Name of Command / Register	Brief Description
C46 *Table coupling*	Coupling by the *Table* coupling mode

R400 *Status*	The status of the coupling modes are displayed
R402 *Table Start Index*	Index for selecting the table configuration, the table of which is to be coupled.
R420 *As-Is Table Index*	Index for displaying the table configuration, the table of which presently coupled.
R432 *Change Type*	Type of changeover between tables
R448 *Start Type*	Coupling mode
R449 *Stop Type*	Uncoupling mode

Error Message at Coupling

At coupling, the operating system checks correctness of the respective table. If it detects errors in table configuration or in the set nodes, it issues the following error messages via the following bits: Bit 20 *Faulty leading axis position range*, respectively bit 21 *Table configuration is invalid* in R170 *Error Referencing / Positioning / Table*. In these error cases, the axes are not coupled with the table.

Procedure at Table Processing

The following steps have to be taken at conditioned coupling for processing the table once:

Step	Action
1	Selecting the table to be coupled Action: Writing the respective table configuration index to R402 *Table Start Index*
2	Reference leading axis position has been set Action: Writing the respective index to R412 *Index - Start Table Point*
3	Setting the mode of conditioned coupling and of uncoupling at processing the table once Action: – R448 *Start Type* = 2, if the leading axis position runs from left to right = 3, if the leading axis position runs from right to left – R449 *Stop Type* = 1
4	Activate coupling Action: R101 *Command* = 46
5	Checking the coupling (optional) Action: Checking, if the respective values are displayed, after the leading axis has exceeded the reference position: – Bit R400.1 *cb_Tab_Status_TabLinked* = 1 (table has been coupled) – R420 *As-Is Table Index* = Table index that has been set in R402

Steps at Endless Table Processing

The following steps have to be taken at conditioned coupling for endless table processing:

Step	Action
1	Selecting the table to be coupled Action: Writing the respective table configuration index to R402 *Table Start Index*
2	Reference leading axis position has been set Action: Writing the respective index to R412 *Index - Start Table Point*
3	Setting the mode of immediate coupling and of uncoupling at endless table processing Action: – R448 *Start Type* = 2, if the leading axis position runs from left to right = 3, if the leading axis position runs from right to left – R449 *Stop Type* = 0
4	Making sure the changeover type has been set to the default value Action: R432 *Changeover Type* = 0 Comment: The changeover type is needed for changing between tables. If it were not set on the default value, it would influence endless table processing.
5	Activate coupling Action: R101 *Command* = 46
6	Checking the coupling (optional) Action: Checking, if the respective values are displayed, after the leading axis has exceeded the reference position: – Bit R400.1 *cb_Tab_Status_TabLinked* = 1 (table has been coupled) – R420 *As-Is Table Index* = Table index that has been set in R402

13.10.6 Uncoupling

Introduction

For the *Table* coupling mode, there are the same uncoupling options, as there are for the coupling mode *Electronic Gearing*. The procedure of carrying out individual uncoupling options is identical with the coupling mode *Electronic Gearing*, except for the uncoupling option *Immediate Uncoupling at Remaining Control Function*.

For this reason, in this chapter, only the uncoupling option *Immediate Uncoupling at Remaining Control Function*, especially for the *Table* coupling mode, and also the new uncoupling option *Uncoupling at the Table End* is described.

Concerning all the other uncoupling options, please refer to the description of uncoupling as of chapter 13.7.7 "Uncoupling options", page 232. Yet, in order to apply this description to the *Table* coupling mode, instead of applying bit R400 *cb_Tab_Status_GearLinked* (i.e. electronic gearing is active), R400.1 *cb_Tab_Status_TabLinked* (i.e. the table has been coupled) has to be applied.

Command and Register Overview

Hints for carrying out the following uncoupling options:

- *Immediate uncoupling at remaining control function*

and

- *Uncoupling at the end of the table*

the following registers and commands are available. In this case, the abbreviations have got the following meanings: R = Register, C = Command

Name of Command / Register	**Brief Description**
C45 *Uncoupling the following axis*	Uncoupling the following axis from the coupling modes
R449 *Stop Type*	Uncoupling mode

Immediate Uncoupling

- control function remains

Below, immediate uncoupling by remaining control function remains:

Please note:	When the following axis is in motion, it can cause a tracking error.
Procedure:	1. The user issues command C45 2. The following axis carries out these steps: - Immediate position controlling of the motor to as-is position - Resetting bit R400.1 *cb_Tab_Status_TabLinked*
Action	1. Setting the stop type to *immediate uncoupling* Action: Writing value 0 to R449 *Stop Type* 2. Issuing command C45 Action: Writing value 45 to R101 *Command* and wait for resetting bit R100.13 *cb_Status_Busy* and resetting bit R400.1 *cb_Tab_Status_TabLinked*

Uncoupling at the End of the Table

- control function remains

Below, immediate uncoupling at the end of the presently processed table and the control function remaining, is described:

Please note:	When the following axis is in motion, it can cause a tracking error.
Procedure:	1. The user issues command C45 2. The following axis carries out these steps: - Immediate position controlling of the motor to as-is position - Resetting bit R400.1 *cb_Tab_Status_TabLinked*
Action	1. Setting stop type to *At the table end* Action: Writing value 1 to R449 *Stop Type* 2. Issuing command C45 Action: Writing value 45 to R101 *Command* and wait for resetting bit R100.13 *cb_Status_Busy* and resetting bit R400.1 *cb_Tab_Status_TabLinked*

13.10.7 Changing tables on the fly

Introduction

Below, detailed information is provided on changing tables on the fly and on what has to be considered in the process.

What has to be Given Heed to Before Changing Tables?

Please mind the following details before changing tables on the fly:

- The following axis must have been coupled already. This can be checked from R400 *Status*.
- If changing tables for the following axis is to be carried out by absolute position coupling, please mind the following details:
  - The correction speed of the following axis (R436) has to be set to value > 0.
  - The first following axis position of the table to follow has to be identical with the reference following axis position of the as-is table.
- If changing tables for the following axis is to be carried out by relative position coupling, please mind the following details:
  - The correction speed of the following axis (R436) has to be set to zero.
  - The first following axis position of the table to follow need not be identical with the reference following axis position of the as-is table.
- If changing tables for the leading axis is to be carried out by absolute position coupling, please mind the following details:
  - The correction speed of the leading axis (R435) has to be set to value > 0.
  - The first leading axis position of the table to follow has to be identical with the reference leading axis position of the as-is table.
- If changing tables for the leading axis is to be carried out by relative position coupling, please mind the following details:
  - The correction speed of the leading axis (R435) has to be set to zero.
  - The first leading axis position of the table to follow need not be identical with the reference leading axis position of the as-is table.

Processing Mode of the As-Is Table

As far as changing tables on the fly is concerned, it is irrelevant, whether the as-is table has been coupled for endless or for one processing. Yet, R449 *Stop Type* has to be set to zero = *endless processing* for changing tables.

Displaying the Active State

As long as the as-is table has not reached the respective table limit yet, changing tables is still in the "active" state. This "Wait" condition is displayed by Bit R400.2 *cb_Tab_Status_TabCmdPending* (i.e. "changing tables is active") =1. When the table limit has been reached and the operating system has carried out table changeover, this bit is automatically reset.

Command and Register Overview

For changeover between tables, the following registers and commands out of command register R101 *Command* are applied. In this case, the abbreviations have got the following meanings: R = Register, C = Command

Name of Command / Register	Brief Description
C46 *Table coupling*	Coupling by the *Table* coupling mode
R400 *Status*	The status of the coupling modes is displayed
R402 *Table Start Index*	Index for selecting the table configuration, the table of which is to be coupled.
R420 *As-Is Table Index*	Index for displaying the table configuration, the table of which presently coupled.
R432 *Change Type*	Type of changeover between tables
R448 *Start Type*	Coupling mode
R449 *Stop Type*	Uncoupling mode

Action

The following steps have to be taken in order to process changing tables on the fly by one or by endless processing of the next table.

Step	Action
1	Selecting the table to be changed into Action: Writing the respective table configuration index to R402 *Table Start Index*
2	Setting the coupling mode for table changeover at the end of the table, as well as the mode of uncoupling, in order to change over to the next table Action: – R448 *Start Type* = 1, change over at the end of the table being presently be processed – R449 *Stop Type* = 0 Note: For changing between tables, R449 *Stop Type* always has to be set to 0.

3	Setting the changeover mode Action: R432 *Change Type* = Value for the respective reference combination: – 0: Leading axis: Modulo operation Following axis: Modulo operation see page 255 – 1: Leading axis: Modulo operation Following axis: *No* modulo operation see page 257 – 2: Leading axis: *No* modulo operation Following axis: Modulo operation see page 258 – 3: Leading axis: *No* modulo operation Following axis: *No* modulo operation see page 259
4	Activating the change Action: R101 *Command* = 46 Note: Actually, activating the changeover means re-coupling with the table configuration indicated by R402.
5	Checking the changeover (optional) Action: Wait for – Bit R400.2 *cb_Tab_Status_TabCmdPending* = 0 and – Bit R400.1 *cb_Tab_Status_TabLinked* = 1 (table has been coupled) and – R420 *As-Is Table Index* = Table index that has been set in R402.

13.10.8 Register description

Register 400: Status	
Function	**Description**
Read	As-is coupling status
Write	Illegal
Variable type	int / register
Value range	Bit-coded, 32 bits
Value after reset	0

Meaning of the individual bits:	
Bit 0:	-
Bit 1:	1 = Table has been coupled
Bit 2:	1 = Wait for table changeover
Bit 3:	1 = Wait for coupling

Register 402: Table Start Index	
Function	**Description**
Read	Index of the table configuration which will be started next (table changeover) or which is presently being processed
Write	Index of the table configuration, which will be processed next
Amplifier status	No specific status
Takes effect	Immediately
Variable type	int / register
Value range	0 ... 23
Value after reset	0

Register 420: As-Is Table Index	
Function	**Description**
Read	Index to the table configuration, which is presently being processed, respectively which was processed last
Write	Illegal
Variable type	int / register
Value range	0 ... 23
Value after reset	0

Register 421: As-Is Index - First Table Point	
Function	**Description**
Read	Index of the first table node of the as-is table index
Write	Illegal
Variable type	int / register
Value range	0 ... 4,095
Value after reset	0

Register 422: As-Is Index - Start Table Point	
Function	**Description**
Read	Index of the reference table node of the as-is table index
Write	Illegal
Variable type	int / register
Value range	0 ... 4,095
Value after reset	0

Register 423: As-Is Index - Last Table Point	
Function	**Description**
Read	Index of the last table node of the as-is table index
Write	Illegal
Variable type	int / register
Value range	0 ... 4,095
Value after reset	0

<table>
<tr><th colspan="4">Register 432: Change Type</th></tr>
<tr><th>Function</th><th colspan="3">Description</th></tr>
<tr><td>Read</td><td colspan="3">Next, respectively last changeover type</td></tr>
<tr><td>Write</td><td colspan="3">Type of the next changeover</td></tr>
<tr><td>Amplifier status</td><td colspan="3">No specific status</td></tr>
<tr><td>Takes effect</td><td colspan="3">Immediately</td></tr>
<tr><td>Variable type</td><td colspan="3">int / register</td></tr>
<tr><td rowspan="9">Value range</td><td></td><td>Leading Axis</td><td>Following Axis</td></tr>
<tr><td rowspan="2">0</td><td>Modulo operation</td><td>Modulo operation</td></tr>
<tr><td colspan="2">see page 255</td></tr>
<tr><td rowspan="2">1</td><td>Modulo operation</td><td>No Modulo operation</td></tr>
<tr><td colspan="2">see page 257</td></tr>
<tr><td rowspan="2">2</td><td>No Modulo operation</td><td>Modulo operation</td></tr>
<tr><td colspan="2">see page 258</td></tr>
<tr><td rowspan="2">3</td><td>No Modulo operation</td><td>No Modulo operation</td></tr>
<tr><td colspan="2">see page 259</td></tr>
<tr><td>Value after reset</td><td colspan="3">0</td></tr>
</table>

Register 433: Position Difference - Leading Axis	
Function	**Description**
Read	As-is position difference
Write	Illegal
Variable type	float
Value range	Float limits [°] or [mm]
Value after reset	0

Register 434: Position Difference - Following Axis	
Function	**Description**
Read	As-is position difference
Write	Illegal
Variable type	float
Value range	Float limits [°] or [mm]
Value after reset	0

Register 435: Correction Velocity - Leading Axis	
Function	**Description**
Read	As-is correction velocity
Write	Set correction velocity value
Amplifier status	No specific status
Takes effect	Immediately
Variable type	float
Value range	Float limits [°/s] or [mm/s]
Value after reset	R184

Is influenced by R184 and R447

Register 436: Correction Velocity - Following Axis	
Function	**Description**
Read	As-is correction velocity
Write	Set correction velocity value
Amplifier status	No specific status
Takes effect	Immediately
Variable type	float
Value range	Float limits [°/s] or [mm/s]
Value after reset	R184

Is influenced by R184 and R447

Register 447: Reference Type

Function	Description		
Read	As-is type of reference between leading and following axis and the table		
Write	Set reference type		
Amplifier status	No specific status		
Takes effect	Immediately		
Variable type	int / register		
Value range		**Leading Axis**	**Following Axis**
	0	Absolute reference	Absolute reference
	1	Absolute reference	Relative reference
	2	Relative reference	Absolute reference
	3	Relative reference	Relative reference
Value after reset	0		

Influences R435 and R436.
This register is an alternative to registers R435 and R436. If in this register a certain reference type is set, the values of R435 and R436 will be set accordingly.

Example 1:
If reference type = 0, the values of R435 and R436 are set to the value of R184, which is absolute position coupling.

Example 2:
If reference type = 1, the value of R435 is set to the value of R184. The value of R436 is set to zero. This is absolute position coupling for the leading axis and relative position coupling for the following axis.

Register 448: Start Type

Function	Description
Read	As-is mode of coupling to start processing the table
Write	Set coupling mode
Amplifier status	No specific status
Takes effect	Immediately
Variable type	int / register

.

Register 448: Start Type - continued	
Value range	0: Immediately at issuing command 46 1: At the end of the table that is just being processed 2: Conditioned coupling with position referencing: As-is leading axis position >= reference leading axis position (if table is processed from left to right) 3: Conditioned coupling with position referencing: As-is leading axis position <= reference leading axis position (if table is processed from right to left)
Value after reset	0

Register 449: Stop Type	
Function	**Description**
Read	As-is mode of ending processing the table
Write	Set mode of uncoupling
Amplifier status	No specific status
Takes effect	Immediately
Variable type	int / register
Value range	0 ... 1 (for a detailed description, see below)
Value after reset	0

R449 has another effect if applied with command C45 than it has with command C46:

Issuing command C45:

0	Immediately after issuing command C45, the following axis is uncoupled and position controlled to the as-is set position. **NOTE:** If the following axis is still moving at that instant of time, there will be NO ramp to be driven. How the following axis will come to a standstill in this case, mainly depends on the settings of the position controller and the mechanics.

1	After issuing command C45, the following axis will no sooner be uncoupled than when the table limits have been reached. The following axis is position-controlled to the as-is set position. **NOTE:** If the following axis is still moving at that instant of time, there will be NO ramp to be driven. How the following axis will come to a standstill in this case, mainly depends on the settings of the position controller and the mechanics.

Issuing command C46:

0	After starting processing the table by issuing command C46, the table will be processed in endless mode. Depending on the direction of rotation, a changeover will be made from the last/first interpolation point back to the first/last one.
1	Depending on the direction of rotation, the table will, after issuing command C6, be processed once; also depending on the direction of rotation, processing will automatically be stopped again at the last/first interpolation point. The following axis is position-controlled to the as-is set position. **NOTE:** If the following axis is still moving at that instant of time, there will be NO ramp to be driven. How the following axis will come to a standstill in this case, mainly depends on the settings of the position controller and the mechanics.

13.11 Virtual Position Counter

13.11.1 Overview

Introduction

The *Virtual Position Counter* is a special function of a JetMove which generates a leading axis position. The JetMove, in which the Virtual Position Counter is active, uses this leading axis position for controlling its own axis. It also uses the leading axis value which is read out from an external leading axis.

This way, in JetMove, leading and following axis have been united in one module. Below, the own axis will be called internal following axis. It has got the same range of characteristics and functions as has a following axis which is influenced by an external leading axis value.

Leading Axis Value for External Following Axes

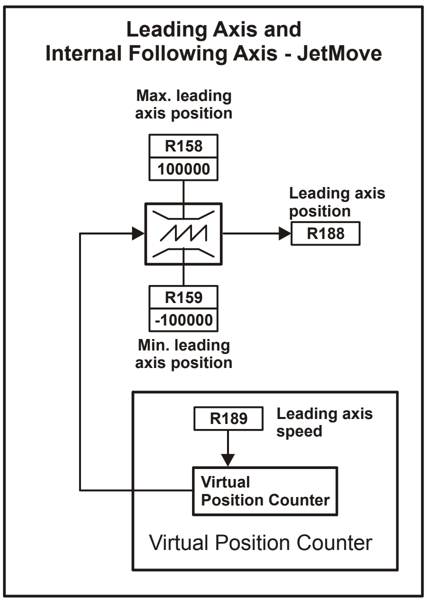
The leading axis position specified by the virtual position counter can also be output to the system bus as a leading axis value for external following axes. This way, the JetMove, in which the special function is active, also takes over the leading axis function for external following axes.

Operating Principle

Depending on a set speed (R189), the Virtual Position Counter counts a position value automatically up or down.

When the position value has reached the maximum or minimum limit of the leading axis position value (R158 and R159), modulo correction is carried out, in order to get to the leading position value (R188) which is within the set leading axis position limits.

The following sequential function chart displays the signal flow and the corresponding special function registers.



Unit of the Leading Axis Position

The leading axis position value generated by the Virtual Position Counter is without unit. The user standardizes and interprets the leading axis position depending on the application given.

Application

For example, the Virtual Position Counter can be used as a timer for table processing.

Conditions of Usage

The following conditions have to be met, in order to make use of the Virtual Position Counter:

- The JetMove, in which the Virtual Position Counter is active, must not have been configured as a following axis of a leading axis. This means that the receive mode (R152) of the axis must have got value 0.
- Communication between the technology group and the Virtual Position Counter has to be configured:

  - with external following axes, see chapter 13.5.4 "Configuration by virtual position counter and external following axes", page 199

  - without external following axes, see chapter 13.5.5 "Configuration by virtual position counter without external following axes", page 204

In this Chapter

The sub-chapter *Virtual Position Counter* comprises the following topics:

13.11.2 The modes of the Virtual Position Counter

Introduction

The Virtual Position Counter can be operated in the following two modes:

- Mode 1: Operation without a trigger signal
- Mode 2: Operation with a trigger signal

The Virtual Position Counter has to be activated for the respective mode.

Mode 1: Without a Trigger Signal

In mode 1, the Virtual Position Counter is manually started and stopped by means of the leading axis speed (R189). Here, the following applies:

– Leading axis speed = 0: The Virtual Position Counter does not count
– Leading axis speed <> 0: Virtual Position Counter counts

Mode 2: With Trigger Signal

In mode 2, the Virtual Position Counter is started by a trigger signal.

In this mode, the Virtual Position Counter runs through the set leading axis position range *once*, starting from the as-is leading axis position, and it stops *automatically*, when the leading axis position limit has been reached.

If the JetMove receives another trigger signal, while the Virtual Position Counter is still running, table processing will not be terminated at reaching a leading axis position limit. Instead, the leading axis position range is covered a second time.

Mode 2 cannot only be started by trigger signal. As an alternative, it can also be started manually.

Connection of the Trigger Sensor

The trigger sensor is connected with the digital input *INPUT*.

Delay Time and Jitter

Starting the Virtual Position Counter by the trigger signal results in two actuating variables:

- Delay time
- Jitter

The Virtual Position Counter compensates both by means of the leading axis speed.

Acceleration and Deceleration Ramps

In both modes, the Virtual Position Counter does neither generated acceleration nor deceleration ramps for the leading axis position. The user has to take care of this.

13.11.3 Operation without a trigger signal

Introduction

In order to operate the Virtual Position Counter without a trigger signal, i.e. in mode 1, the special function has to be activated first accordingly. Then, the following steps can be taken:

- Referencing the leading axis position
- Starting
- Stopping
- Deactivating the special function

These steps are described in detail below.

Register Overview

For operating the Virtual Position Counter in mode 1, the following registers are available:

Register Name	Brief Description
R188 *Leading Axis Position*	Leading axis position
R189 *Leading Axis Speed*	Leading axis speed
R451 *Mode*	Operating mode of the Virtual Position Counter

Activating in Mode 1

The following step has to be taken, in order to activate the Virtual Position Counter in mode 1:

Step	Action
1	Activating mode 1 Action: Writing value 1 into R451 *Mode*

Deactivating

The following step has to be taken to deactivate the Virtual Position Counter:

Step	Action
1	Deactivating the Virtual Position Counter Action: Writing value 0 into R451 *Mode*

Starting

The following steps have to be taken to start the Virtual Position Counter:

Step	Action
1	Referencing the leading axis position Action: Writing the reference position value into R188 *Leading Axis Position*
2	Setting the leading axis speed Action: Writing the desired speed to R189 *Leading Axis Speed*

Changing the Speed

The following step has to be taken to change the speed while the Virtual Position Counter is running:

Step	Action
1	Setting a new leading axis speed Action: Writing a new value to R189 *Leading Axis Speed*.

Stopping

The following step has to be taken to stop the Virtual Position Counter:

Step	Action
1	Setting the leading axis speed to 0 Action: Writing value 0 to R189 *Leading Axis Speed*

13.11.4 Operation with a trigger signal

Introduction

In order to operate the Virtual Position Counter with a trigger signal, i.e. in mode 2, the special function has to be activated first accordingly. Then, the following steps can be taken:

- Referencing the leading axis position
- Starting, automatically and manually
- Stopping, manually
- Deactivating the special function

These steps are described in detail below.

Manual Stopping

In mode 2, the Virtual Position Counter is automatically stopped by the special function, when a leading axis position limit has been reached. Yet, it can also be stopped before that manually.

After manual stopping, there are two options on how to continue:
- Continue up to the leading axis position limit
- Terminate processing at that point

Please observe the following at continuing:

If, in further process, the JetMove recognizes another trigger signal, another process will automatically added after reaching the leading axis position limit.

Please note when terminating the process:

Before the next trigger signal is issued, the leading axis position might have to be referenced again.

Register Overview

For operating the Virtual Position Counter in mode 2, the following registers are available:

Register Name	Brief Description
R188 *Leading Axis Position*	Leading axis position
R189 *Leading Axis Speed*	Leading axis speed
R451 *Mode*	Operating mode of the Virtual Position Counter

Activating in Mode 2

The following step has to be taken, in order to activate the Virtual Position Counter in mode 2:

Step	Action
1	Activating mode 2 Action: Writing value 6 to R451 *Mode*

Deactivating

The following step has to be taken to deactivate the Virtual Position Counter:

Step	Action
1	Deactivating the Virtual Position Counter Action: Writing value 0 to R451 *Mode*

Referencing

The following step has to be taken for referencing the leading axis position:

Step	Action
1	Referencing the leading axis position Action: Writing the reference position value to R188 *Leading Axis Position*

Starting by a Trigger Signal

The Virtual Position Counter is automatically started by means of the special function, when a trigger signal has been recognized.

Manual Starting

The following step has to be taken in mode 2 to start the Virtual Position Counter manually and without a trigger signal:

Step	Action
1	Software start in mode 2 Action: Writing value 7 to R451 *Mode* Note: Value 7 remains in R451, until you write another value to this register.

Changing the Speed

The following step has to be taken to change the speed while the Virtual Position Counter is running:

Step	Action
1	Setting a new leading axis speed Action: Writing a new value to R189 *Leading Axis Speed*.

Manual Stopping

The following step has to be taken to manually stop the Virtual Position Counter:

Step	Action
1	Setting the leading axis speed to 0 Action: Writing value 0 to R189 *Leading Axis Speed*

13.11.5 Description of registers

Register 188: Leading Axis Position	
Function	**Description**
Read	As-is leading axis position
Write	Set reference position
Amplifier status	No specific status
Takes effect	Immediately
Variable type	float
Value range	R159 ... R158 [°] or [mm]
Value after reset	0 [°] or [mm]

Leading axis position in the following axis: Modulo-corrected position value of the Virtual Position Counter at the leading axis position limits (R158 and R159).

Register 189: Leading Axis Speed	
Function	**Description**
Read	As-is leading axis speed
Write	Setting the speed for the Virtual Position Counter
Amplifier status	No specific status
Takes effect	Immediately
Variable type	float
Value range	Float limits [°/s] or [mm/s]
Value after reset	0 [°/s] or [mm/s]

The speed value of the leading axis (R189) is made up of the difference between the leading axis positions (R188) within one second.

Register 451: Mode	
Function	**Description**
Read	As-is mode
Write	Set mode
Amplifier status	No specific status
Takes effect	Immediately
Variable type	int / register
Value after reset	0 = Virtual position counter is deactivated

Value	Meaning
0	Virtual position counter is deactivated
1	Virtual position counter has been activated in mode 1 (without trigger signal)
6	Virtual position counter has been activated in mode 2 (with trigger signal)
7	Manual start of the Virtual Position Counter in mode 2 (with trigger signal)

13.12 Precise Following

13.12.1 Overview

Introduction

A primary goal of running a following axis in various coupling modes, is to make the following axis follow the leading axis as precisely as possible.

This chapter is to explain the possible reasons of following inconsequences and gives tips on how to improve the preciseness.

In this Chapter

This sub-chapter contains the following topics:

13.12.2 Inaccuracies of the following axis

Introduction

Inaccuracies related to coupling modes can have various causes. Below, the most significant causes will be described.

Inaccuracies of the Following Axis

The following causes can contribute to following axis inaccuracies:

- Smooth mechanic coupling (the opposite of rigid mechanism)
- Calculational inaccurate gear ratios
- Dead times of set value communication between JetMoves
- Coupling mode *Table*: Excessive speed of the master axis

Mechanical Flexibility

If the mechanics coupled to a JetMove has not got the rigidity needed, system deviations from JetMove cannot be controlled the best way.

Gear Ratios

Some mechanic gear ratios, such as, for example, 1:3, result in an (indefinitely) long floating point number. For processing floating point numbers, a JetMove offers single accuracy (32 bits). This means that a floating point number is evaluated to an accuracy of 7 significant digits. Significant digits are tens digits, decimal places included.

As a result, certain gear ratios cannot be processed in JetMove without a rest being left over.

On one hand, this pertains to mechanical gear ratios of the individual axes and to the ratio between leading and following axis.

Dead Time

Between the instance of calculating the set values of the leading axis and the instance of the following axis processing these set values, there is a dead time of 2 milliseconds.

Table: Excess Speed

In the *Table* coupling mode, excessive speed of the leading axis can be the cause of inaccurate following axis performance. In this case, the following axis does not manage to cover all nodes of the motion profile, so certain nodes are left out.

13.12.3 Compensating the inaccuracies

Introduction

Some results of follower inaccuracy can be compensated by a JetMove. These possibilities are described below.

Cause and Compensation

In the table below, previously described causes which can be compensated by JetMove, have been listed.

Cause	Compensation
Gear ratios	Referencing on the fly with initiator
Dead time	Compensation of dead time

Referencing on the Fly

To compensate for calculational inaccurate gear ratios, the JetMove special function *Referencing on the fly* may be helpful.

For this, a proximity switch is needed, which, at each rotation of the mechanical unit, be it before or after the gearbox, triggers an impulse for the special function to diagnose and compensate for a deviation from the internal as-is position.

For a detailed description of the special function, please turn to chapter 14 "Special Function: Referencing on the Fly", page 313.

Dead Time Compensation

The dead time that arises at transmitting the set values from the leading to the following axis can be compensated by the JetMove function *Dead Time Compensation*.

For this, a dead time is specified in the following axis. It serves for calculating the as-is leading position at the instance of processing withn the following axis.

For a detailed description of the function, please turn to chapter 13.12.4 "Dead time compensation", page 311.

13.12.4 Dead time compensation

Introduction

The dead time that arises at transmitting the set values from the leading to the following axis can be compensated by the JetMove function *Dead Time Compensation*.
Below, the usage of this function has been described.

Operating Principle

For compensating, the user enters a dead time in milliseconds applied to the following axis which is used for calculating a dead time correction position. The dead time correction position is added to the set value received by the leading axis.
The result is the as-is set position taken by the leading axis at the instance of set value position calculation of the following axis. This is based on the assumption that the leading axis has not changed its speed during dead time.

Note

Dead time compensation renders best results at constant leading axis speed, e.g. coupling mode *Electronic Gearing* at constant leading axis speed.

Register Overview

The following register serves for making use of this function.

Register Name	Brief Description
R460 *Dead Time Compensation*	Dead time in milliseconds
R461 *Dead Time Correction Position*	Calculated position of dead time correction

Starting

The following steps have to be taken to make use of dead time compensation:

Step	Action
1	Determining empirically the ideal dead time for a combination of leading and following axis Action: Writing values from 2 ms upward to R460 in small steps, until the maximum preciseness of the following axis has been reached

13.12.5 Dead time compensation - Register description

Register 460: Dead Time Compensation	
Function	**Description**
Read	As-is dead time
Write	Set dead time
Amplifier status	No specific status
Takes effect	Immediately
Variable type	float
Value after reset	0 [ms]

Register 461: Position of Dead Time Correction	
Function	**Description**
Read	As-is correction position
Write	Illegal
Variable type	float [°], resp. [mm]
Value after reset	0 [°]

14 Special Function: Referencing on the Fly

14.1 Introduction

This chapter contains information on the following topics:

- What is referencing on the fly?
- How can this function be made use of?
- Sample program "Labelling a Package"
- Description of registers

14.2 What is Referencing on the Fly?

"Referencing on the fly" means that, at receiving a trigger signal, the axis is being referenced onto a new position. To achieve this, the position difference between old and new position is adjusted with a correction controller P. For this, the P correction controller changes its as-is position. Due to this adjustment, the axis is set in motion. This compensating motion will overlap the axis motions already going on, such as positioning.

This function can be made use of in print mark correction, for example. In a cyclic motion, the processing position relates to a label applied to the product; "on the fly", the axis will be moved to this processing position.

14.3 Overview of Registers

Register

Register Name	Short Description
Functional Group: Controller	
R450 "Function Status"	It specifies the number of the correct trigger signals
R451 "Function Mode"	The function is activated and the mode is defined
R514 "INPUT Edge Definition"	Edge definition of the additional digital input INPUT
R527 "Dead Time for Interrupt Input" = Dead time correction	Dead time compensation of the INPUT signal
Functional Group: Position Feedback Controller	
R110 "Position Controller K_v"	Correction factor K_v of the position controller
Functional Group: Referencing on the Fly	
R452 "Position Reference"	Position, by which the function checks the as-is position value of R454 against the trigger signal
R453 "Position Window"	Position window in which the as-is position value of R454 must be included, in order to have the function make compensations automatically
R454 "As-is Position Value"	The as-is position value at the trigger signal is specified
R455 "Position Difference"	The position difference to be compensated is specified
R456 "Correction Factor K_v"	Amplification of the correction controller
R457 "Max. Correction Speed"	Maximum speed of position difference compensation, which must not be exceeded by the correction controller
R458 "Correction Speed"	As-is correction speed

The registers of the "Referencing on the fly" group of functions have been specified in chapter 14.8 "Description of Registers", page 321. All other registers have been explained in the respective chapters.

14.4 How does Referencing on the Fly Function?

A positioning reference is set in R452. It is to define which is to be the axis position at the moment of issuing the trigger signal. At that moment, the as-is axis position is measured. This as-is position is displayed by means of R454. This as-is position value will be checked against the position reference specified in R452; then the difference between the two positions will be calculated in R455 according to the formula below in the units [°], respectively [mm].

$$R455 = R452 - R454$$

The following applies to the operands:

R452	=	Position reference in the units [°], respectively [mm] (the unit is dependent on the axis type specified in R191)
R454	=	Measured as-is position value in the units [°], respectively [mm] (the unit is dependent on the axis type specified in R191)

If the difference between the positions is unequal zero, a P-correction controller is automatically triggered to compensate the difference by and by, until the difference between the position is zero again. Please also refer to “The P-Correction Control” on page 317.

In R453, a position window for measuring the as-is position can be defined. The reference point of the position window specifies the positioning reference written in R452. This "position reference" is in the middle of the position window, cf. fig.36. If the measured as-is position is within this window, the calculation of the difference and the P-correction controller will be triggered automatically. If the position is outside the window, there will be no reaction to the trigger signal.

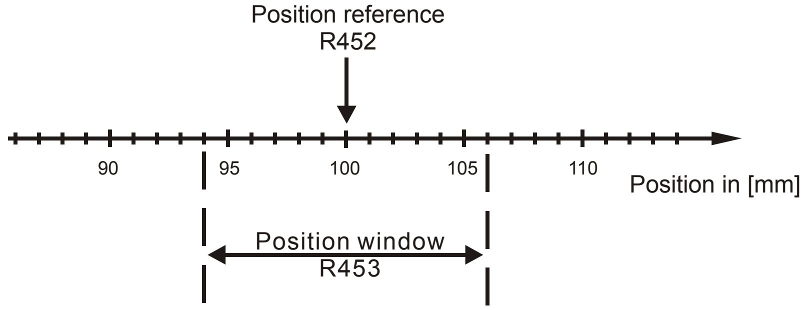


Fig. 36: Position window for the "Referencing on the fly" function

In fig.36, the position reference specified in R452 has got the value 100 mm, while the position window specified in R453 has got the value 12 mm.

Function Mode R451	
Mode	**Description**
2	Measuring the leading position of the leading axis (this is only possible with JX2-CNT1)
3	The own as-is position is measured

4	See 2, but Single Shot
5	See 3, but Single Shot

For the function, a selection among four different modes can be made by means of R451, as has been shown in the table above. In mode 2 and 4, not the own as-is position of the axis is measured, but the leading position of a JX2-CNT1, which serves as a leading axis. For this mode, setting up a technology group is necessary, cf. chapter 13 "Technological Functions", page 175.

If every trigger signal is to be reacted to, modes 2 and 3 must be applied. If only specific trigger signals are to be reacted to, single-shot modes 4 and 5 must be applied. In mode 4 and 5, the function will react to the next trigger signal to be automatically deactivated again when the correction process has been completed. For this, the function mode value written in R451 is set to zero. In order to make the function react to a trigger signal again, value 4, respectively 5, has to be written into R451 again.

All cycles, of which the measured as-is position has been within the position window defined in R453, are considered for the function status defined in R450. The count value can be reset to zero again by hand. In mode 4 and 5, the count value is automatically reset to zero when the correction process has been completed.

14.5 Trigger Signal

The sensor causing the trigger signal is connected to the terminal point INPUT. In the JM-2xx series, the terminal point is on terminal X10, in the JM-D203 it is on terminal X72, respectively X82. By means of the edge definition of R514, the signal edge that is to be reacted to can be specified.

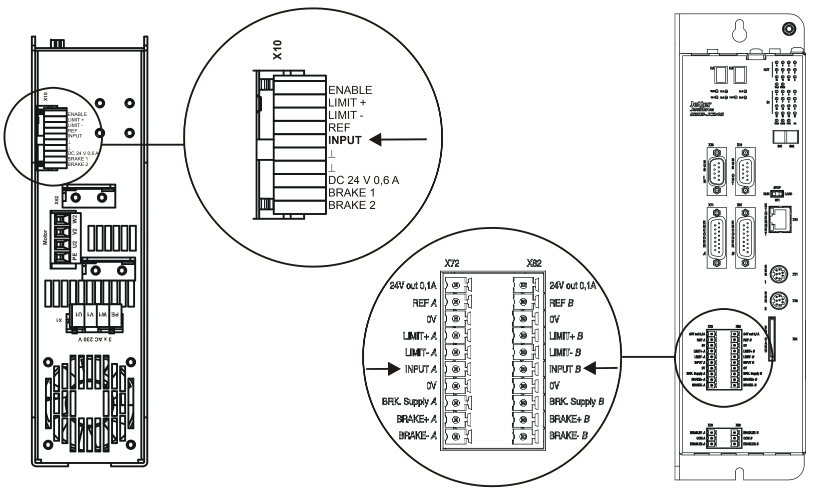


Fig. 37: Examples: Terminal point INPUT of JM-206, respectively JM-D203

The trigger signal depends on dead time, that is, between the sensor reaction and recognizing the signal change in the operating system of the JetMove, some time will pass. It is caused by processing times in the sensor and by filtering the signal in the JetMove. By means of R527 *Dead Time for Interrupt Input* = dead time correction, there is the possibility of reducing this dead time to a great deal.

14.6 The P-Correction Control

The difference (R455) between the measured as-is position (R454) and the position reference (R452) will be compensated by means of the as-is position value read by the encoder. The as-is position is corrected by the value of the position difference in the respective direction. This correction will not be carried out in one step only, but by means of a P-correction controller, see fig.38.

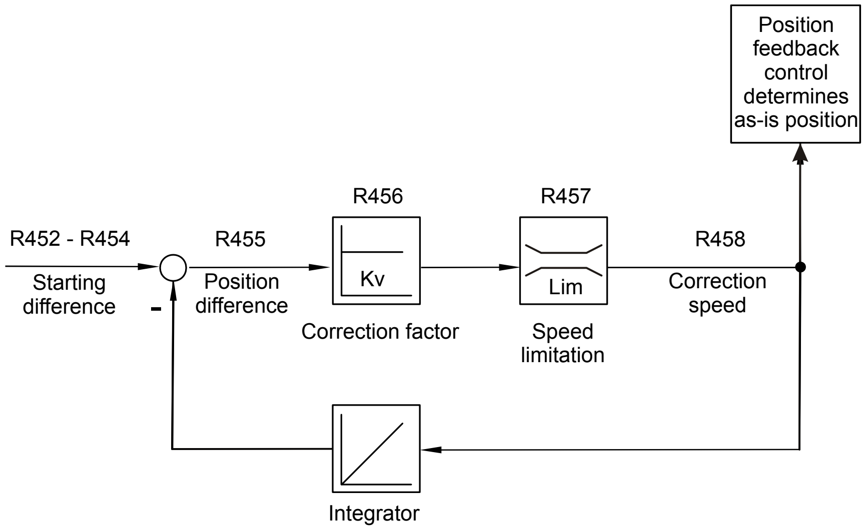


Fig. 38: P-correction controller of the "Referencing on the fly" function

By means of its correction factor K_V specified in R456, the P-correction controller will calculate a correction speed (R458) in the unit [°/s] respectively [mm/s] applying the following formula:

$$R458 = R455 \cdot R456$$

The following applies to the operands:

R455	=	Position difference in the unit [°] respectively [mm] (the unit depends on the settings of the axis type defined in R191)
R456	=	Correction factor K_V in the unit [1/s]

The correction speed specifies the changes of the as-is position within one second.

The integrator in the control circuit (see fig.38), will add the speed values that have already been output, in relation to time. The result will be a position value specifying the amount of the as-is value correction. Substracting this position value from the difference calculated first will result in the new difference of positions that is still to be corrected. During position control, the as-is position difference can be read in R455.

The P-correction control loop will be run through every two milliseconds.

The correction speed decreases, the more the position difference decreases. The correction factor K_V will determine the steepness of the graph showing the decreasing correction speed, cf. fig.39. The time t (unit [s]) that passes until the position difference equals zero can be calculated by the following formula:

$$t = \frac{2}{R456}$$

The following applies to the operands:

R456 = Correction factor K_V in the unit [1/s]

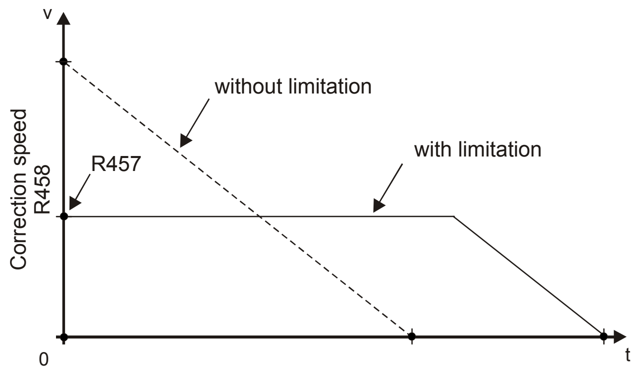


Fig. 39: Course of the correction speed graph of referencing on the fly

Note!

A correction speed (R458) that is too high might lead to a short-time conversion of the rotating direction.

The correction speed can be limited by means of R457. fig.39 illustrates the behaviour at limitation of the correction speed. Time t is increased by a limitation. The steepness of the decrease in correction speed at the end of the correction run will remain the same with and without the limitation of the correction speed.
If for the correction factor K_V value > 500 [1/s] is set, the position difference might not have been compensated completely by the end of the correction run. In this case, the P-correction controller oscillates.

The change of the as-is position by the P-correction controller effects the position controller as a disturbance variable. The tracking error increases in relation to the change of the as-is position by means of the P-correction controller. Depending on the correction factor K_V of the position controller (R110), the axis reacts to the influence of the changes in the as-is position value quickly or slowly.

Note!

For optimum functioning of the P-correction controller, a correctly set K_V of the position controller is required. This way, the tracking error will be decreased best.

14.7 Sample Program

Address labels are to be applied to packages, see fig.40. In random distances, the packages arrive at the labelling position on the conveyor belt one after the other. At the labelling position, the belt stops for labelling. For positioning on the labelling position, a print-mark is read by a sensor. By means of the trigger signal (24 V active) activated by the sensor, positioning in relation to the respective labelling position is altered by referencing on the fly. The process of loading the packages on the belt guarantees for the print mark of the following packet to be labelled always being on a distance d to the packet being labelled at the moment.

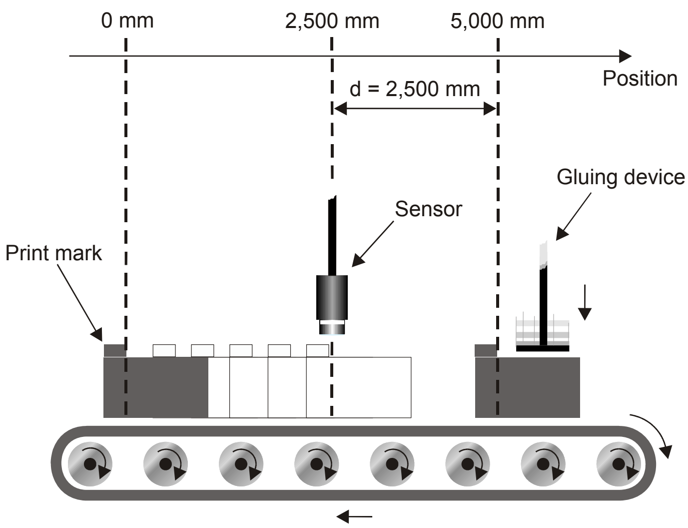


Fig. 40: Sample application of referencing on the fly

Labelling a packet is defined to be a cyclic process. The following process per cycle is defined:

- Setting the as-is position to zero
- Enabling of the trigger signal
- Absolute positioning to the target position 5,000 mm
- Recognizing the print mark within the positioning range
- Shifting the as-is position to position 2,500 mm, if the as-is position is unequal to position 2,500 mm
- If the target position has been reached and a trigger signal has been issued, start the labelling process; otherwise continue to the next cycle

For implementation, a JC-241 is used for controlling and a JM-206 as an axis for the motion system of the conveyor belt. The JM-206 has got the slave module number 2.

Initialization

```
#Include „JM2xxReg32.stp"              // JM2xx RegisterInterface
Var
JM_Axis       :JM_2XX At %VL 12000;     // Axis declaration
End_Var;
...
```

```
// Basic configuration for the conveyor belt axis:
// The axis is defined as a linear axis.
//
//
...
// Setting up the positioning run:
// Set corr. factor Kv of the pos. controller:
JM_Axis.CtrlP_fm_Kv := 10;
// Set dest. window for positioning:
JM_Axis.MC_fm_TargetWin := 1;
...
// Set Referencing on the fly:
// Edge def. for sensor signal: Rising edge
JM_Axis.DI_nm_TrigInEdge := 1;
// Set pos. reference to 2,500 mm:
JM_Axis.FRef_fm_PosRef := 2500;
// Set pos. window to 5,000 mm:
JM_Axis.FRef_fm_PosWin := 5000;
// Set corr. factor Kv of referencing on the fly:
JM_2JM_AxisXX.FRef_fm_Kv := 1;
// Max. corr. speed of referencing on the fly:
//
JM_Axis.FRef_fm_CorrSpeedMax := 10;
...
```

Sequence

```
...
// Cycle "Labelling the Package":
While True Do
// Setting the set position to zero: At command 3,
// the as-is position takes over the value of the target position.
JM_Axis.MC_fm_PosProg := 0;
// Setting the as-is position to zero:
JM_JM_Axis2XX.JM_nm_Cmd := cn_Cmd_SetReference;
// Wait for the BUSY-bit to be reset.
When Bit_Clear (JM_2JM_AxisXX.JM_nm_State,  cb_State_Busy) Continue;
// Function mode 5: Single shot to its own as-is position.
JM_Axis.Vax_nm_Mode := 5;
// Set the absolute target position:
JM_Axis.MC_fm_PosProg := 5000;
// Start absolute positioning:
JM_2XJM_AxisX.JM_nm_Cmd := 10;
When Bit_Clear (JM_Axis.JM_nm_State, cb_State_Busy) Continue;
// Wait, until destination window has been reached:
When Bit_Set (JM_Axis.JM_nm_State,  cb_State_DestWindow) Continue;
// Check, if referencing on the fly is still active:
When JM_Axis.Vax_nm_State = 0 Continue;
// Check, if referencing on the fly has been carried out:
If JM_Axis.Vax_nm_Mode = 0 Then
      // If  desired, carry out labelling process.
   End_If;                              // End of the IF branch
   ...
End_While;                              // Restart cycle
...
```

14.8 Description of Registers

In the column "R/W", the type of access to a parameter is identified:

R = Read
W = Write

Register 452: Position Reference	
Function	**Description**
Read	As-is position reference
Write	Set position reference
Amplifier status	No specific status
Takes effect	Immediately
Variable type	float
Value range	Float limits [°] or [mm] (the unit depends on the setting of the axis type, see register 191)
Value following a reset	10 [°]

Here the positioning reference will be specified, by which the function will compare the measured as-is position (register 544) at the trigger signal, in order to find a possible position difference (register 455).

Register 453: Position Window	
Function	**Description**
Read	As-is position window
Write	Set position window
Amplifier status	No specific status
Takes effect	Immediately
Variable type	float
Value range	Float limits [°] or [mm] (the unit depends on the setting of the axis type, see register 191)
Value following a reset	10 [°]

Here, the position window is specified, in which the measured as-is position must be included. This position reference value (register 452) is exactly in the centre of the position window.

Register 454: As-is Position Value	
Function	**Description**
Read	Present as-is position value
Write	Illegal
Amplifier status	No specific status
Takes effect	Immediately
Variable type	float
Value range	Float limits [°] or [mm]
Value following a reset	0 [°]

Here, the as-is position measured at receiving the trigger signal can be read. The measured as-is position must be within the position window (register 453), in order for the function to calculate the position difference (register 455) and to start automatic correction, if the difference is unequal zero.

Register 455: Position Difference	
Function	**Description**
Read	As-is position difference
Write	Set position difference
Amplifier status	No specific status
Takes effect	Immediately
Variable type	float
Value range	Float limits [°] or [mm]
Value following a reset	0 [°]

Here, the calculated initial position difference before starting the correction run can be read. During the correction run, the remaining position difference can be read in this register.

For calculating the position difference, only those measuring values of register 454 are used, which are in the position window of register 453.

Register 456: Correction Factor K_v	
Function	**Description**
Read	As-is correction factor
Write	Set correction factor
Amplifier status	No specific status
Takes effect	Immediately
Variable type	float
Value range	0 ... 500 [1/s]
Value following a reset	1 [1/s]

Here, the correction factor K_v of the P-correction controller is specified.

Note!

In case of values > 1 there might occur feedback behaviour at the end of a correction run. Feedback will cause the position difference not to decrease any more.

Register 457: Maximum Speed Correction	
Function	**Description**
Read	As-is maximum correction speed
Write	Set maximum correction speed
Amplifier status	No specific status
Takes effect	Immediately
Variable type	float
Value range	Float limits [°/s] or [mm/s]
Value following a reset	10 [°/s]

Here, the limitation of the correction speed will be set.

Note!

A correction speed that is too high might lead to a short-time conversion of the rotating direction.

Register 458: Correction Speed	
Function	**Description**
Read	As-is correction speed
Write	Illegal
Amplifier status	No specific status
Takes effect	Immediately
Variable type	float
Value range	-R457 ... +R457 [°/s] or [mm/s]
Value following a reset	0 [°/s]

Here, the as-is correction speed is displayed. If the result is greater than the limitation value specified in register 457, the limitation value will be output.

15 Special Function: Position Capture

15.1 Introduction

This chapter contains information on the following topics:

- What does "Position Capture" imply?
- Which registers are available?
- Which digital inputs are used?
- What does this function imply?
- Sample program "Length Measurement"
- Register description

15.2 What does "Position Capture" Imply?

By means of the "Position Capture" function, the as-is axis position can be stored independently of a capture event. The as-is position can then be utilized for further calculations, e.g. for calculating the length of an object.
The capture event is activated by an input signal edge at one of the digital inputs. The edge is adjustable. The scan rate of the Capture events is 16 kHz.

15.3 Overview of Registers

For the Position Capture function, the following registers are available:

Register Name	Short Description
R510 *Digital Inputs - Polarity*	Setting the input polarity
R511 *Digital Inputs - Circuit State*	Logic status of the input circuit
R513 *Digital Inputs - Capture Status*	Status of the capture events
R518 *Digital Inputs - Capture Edge Definition*	Setting the edge of the input signal that is to trigger the Capture event
R631 *Capture Command Set*	Activating the "Position Capture" function:
R632 *Capture Command Clear*	Deactivating the "Position Capture" function:
R521 *Capture Position LIMIT+*	Position at the capture result of the positive limit switch
R522 *Capture Position LIMIT-*	Position at the capture result of the negative limit switch

R523 *Capture Position REF*	Position at the capture result of the reference switch
R524 *Capture Position INPUT*	Position at the capture result of the additional digital input

15.4 The Digital Inputs

The digital inputs that can be used for the Capture event, are positioned on terminal X62 of JetMove 105, on terminals X72, respectively X82, of Jetmove D203, and on terminal X10 of JetMove 2xx series devices, see fig.41.

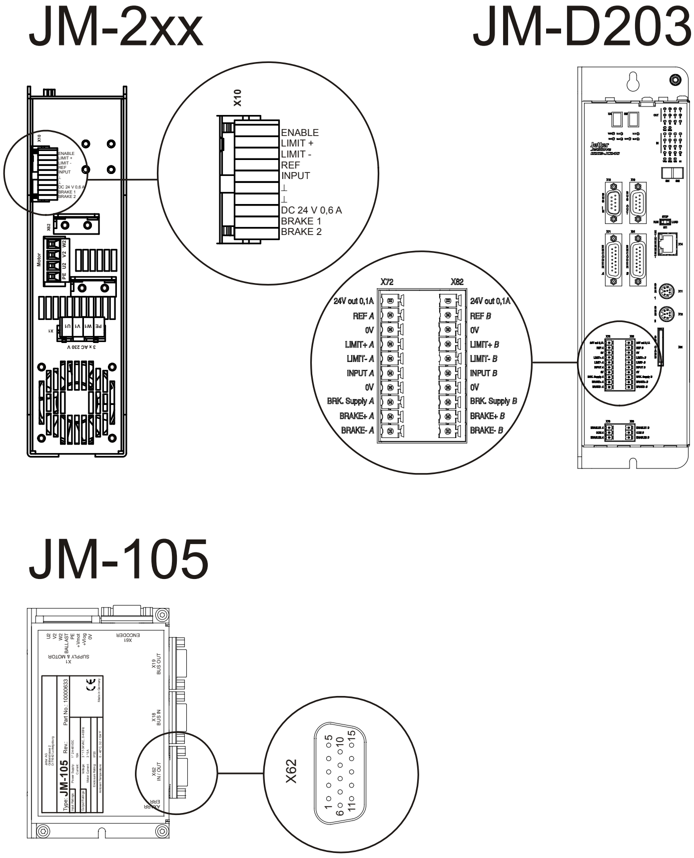


Fig. 41: Plug-in connection for the digital inputs

The following digital inputs can be used for the Position Capture function:

Input Description	**Designation JM-2xx**	**Designation JM-D203**	**Designation JM-105**
Positive limit switch	X62.LIMIT+	X72/X82.LIMIT+	X62.13 (*Positive limit switch)*
Negative limit switch	X62.LIMIT-	X72/X82.LIMIT+	X62.14 (*Negative limit switch)*

Reference switch	X62.REF	X72/X82.REF	X62.12 (*Reference switch)*
Additional digital input	X62.INPUT	X72/X82.INPUT	X62.15 (*Digital input)*

The input polarity (24 V = logical 1, or 0 V = logical 1) can be set in R510 *Input Polarity.* The logical input status, that is, the input status after polarity processing, can be read out of R511..

Notice!

The input polarity must have been set before activating the function; otherwise changing the input polarity while the function is active can trigger a capture event, although the as-is input status has not changed.

15.5 What Does this Function Imply?

Via R631 *Capture Command Set*, one or more than one inputs are activated to serve the Position Capture function. Via R632 *Capture Command Clear*, the Position Capture function can be deactivated again. R519 *Capture Active State* displays the inputs, for which the Position Capture Function is active.

The activated function will cause the selected inputs to be checked for edge change. The capture event is triggered by a rising, respectively falling, logic edge of the activated input. The edge triggering the Capture event can be defined for each individual input specified in R518 *Capture Edge Definition*. The edge is called logic, because it is not the edge change of the real input signal that is checked, but the change of state of the respective input in R511 *Input State*. R511 shows the input circuit state of the input signal after setting the polarity by R510 *Input Polarity*.

Notice!

The edge must have been defined before activating the function; otherwise changing the edge definition while the function is active can trigger a capture event, although the as-is input signal has not changed.

The capture event is displayed by means of a set bit of the respective input in R513 *Digital Inputs - Capture Status*. At the same time, the bit of the respective input is reset in R519 *Capture Active State*, while the Position Capture function is automatically deactivated for this input. This function deals with the Capture event of one input simultaneously with, and independent from, the other inputs. During a Capture event, the as-is position (R109) is stored. Each input, though, has been assigned a specific register for Capture events. Registers R521 through R524 contain the as-is position.

For re-activating the Position Capture function, the input has to be re-activated via register R631 *Capture Command Set*. In fig.42, the "Position Capture" function has been illustrated.

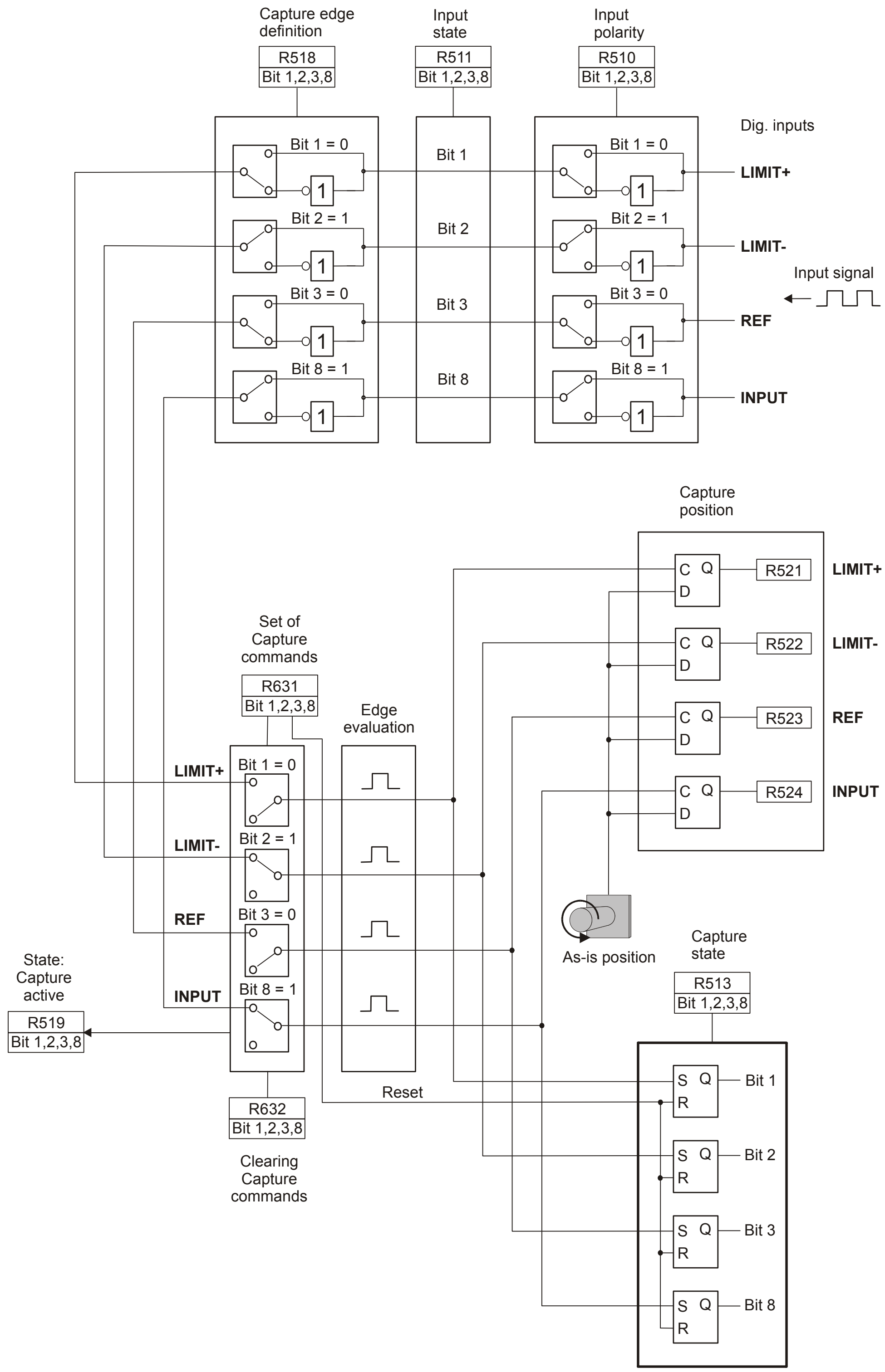


Fig. 42: Function diagram of the "Position Capture" function

15.6 Sample Program "Length Measurement"

On a conveyor belt, packets of variable length are being transported. In order to adjust the next station, a handling system, to the individual length of each packet, the packets must be measured, see fig.43.

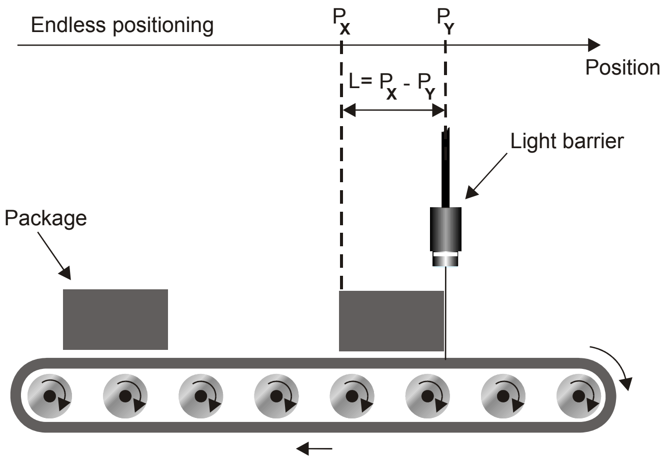


Fig. 43: Sample application of the "Position Capture" function

Measuring is done by means of a light barrier and the "Position Capture" function. At the output, the light barrier displays a high signal (24 V level), when the light beam is interrupted, that is, when the front edge of the packet is recognized. The light barrier displays a low signal (0 V level), when the light beam is can show through, that is, when the rear edge of the packet is recognized. The light barrier signal has been connected to the digital input INPUT.

The lengths of the packets are to be calculated in millimeters and stored to a FIFO memory. The handling system will take the length measurements out of the FIFO according to the sequence of the packets. The conveyor belt is only driven in positive direction.

JC-24x is used as a controller. The JetMove 2xx driving the conveyor belt has got the slave module number 2.

Initialization

```
#include „JM2xxReg32.stp"
...
Var
JM_Axis       :JM_2XX At %VL 12000;     // declaration of the axis
CapPos        :INT AT %vl 65024         :
Length        :INT AT %vl 65025         :
Overflow1     :INT AT %vl 65026         :
Overflow2     :INT AT %vl 65027         :
End_Var
...
```

```
// Basic configuration of the conveyor belt axis:
// The axis is set as a linear modulo axis; i.e. it is an endless axis
// of the positioning unit mm.
//
//
// Example of Modulo Setting:
JM_Axis.Ax_nm_AxisType:= cn_Ax_AxisType_Lin;
JM_Axis.Ax_nm_ModuloAxis := cn_Ax_ModuloAxis_Yes;
JM_Axis.Ax_fm_GearRatioMotor := 4;      // Gear Ratio - Motor
JM_Axis.Ax_fm_GearRatioLoad := 1;       // Gear Ratio - Mechanism
// Linear / Rotation Ratio:
// e.g. 30 mm, i.e. one revolution of the gearbox results in a linear
// motion of 30 mm.
JM_Axis.Ax_fm_LeadScrewPitch :=30;
JM_Axis.Ax_fm_TravelPosMin := 0;        // Travel Limit - Negative:
JM_Axis.Ax_fm_TravelPosMax := 10000;    // Travel Limit - Positive:
...
// Setting up the "Position Capture" function:
// Deactivate the capture function:
JM_Axis.DI_nm_CapCmdClr := 0x10E;
When Bit_Clear (JM_Axis.JM_nm_State, cb_State_Busy) Continue;
...
```

Process

```
...
// Cycle: Measure the length of the
   packet
While True Do
// Set the polarity of the digital input INPUT to 24 V = logical 1.
// This means that the rising edge will trigger the Capture event.
JM_Axis.DI_nm_CapEdge := 0x0100;
// Activate the "Position Capture" function (R513.Bit8 = 0 is set):
JM_Axis.DI_nm_CapCmdSet := 0x0100;
// Wait, until the Capture event takes place:
When Bit_Set(JM_Axis.DI_nm_CapStatus, 8) Continue;
// Temporarily store the first capture position value in a floating-
// point register.
CapPos := JM_Axis.DI_fm_CapPosInt;
// Set the polarity of the digital input INPUT to 0 V = logical 1.
// This means that the falling edge will trigger the Capture event.
JM_Axis.DI_nm_CapEdge := 0x0000;
// Activate the "Position Capture" function (R513.Bit8 = 0 is set):
JM_Axis.DI_nm_CapCmdSet := 0x0100;
// Wait, until the Capture event takes place:
When Bit_Set(JM_Axis.DI_nm_CapStatus, 8) Continue;
// Calculate the length:
// Check for position overflow
If JM_Axis.DI_fm_CapPosInt > CapPos Then
   //   No position overflow.
        Length = JM_Axis.DI_fm_CapPosInt - CapPos;
   ELSE
   //   Position overflow:
   //   Calculate the difference between the positive maximum
   //   position and the latest measuring.
        Overflow1 := JM_Axis.Ax_fm_TravelPosMax - REG CapPos;
```

```
   //   Add the distance covered since position overflow to the
   //   result.
        Overflow2 := JM_Axis.DI_fm_CapPosInt -
        JM_Axis.Ax_fm_TravelPosMin;
        Length = Overflow1 + Overflow2;
End_If;                                  // End of the IF branch
...
Store the length to the FIFO memory
...
End_While;                               // Restart cycle
   ...
```

15.7 Description of Registers

Register 513: Capture Status	
Function	**Description**
Read	Value of the present capture position
Write	Illegal
Variable type	int / register
Value range	bit-coded, 16 bits, only bits 1, 2, 3, and 8
Value following a reset	0

If the "position capture" function has been applied to the selected digital input, this register will inform the user, whether the capture event has taken place, and whether the capture position can be read out of R521 through 524. By writing into R631 *Capture Command Set*, the respective bit is cleared.

Meaning of the values:

0 : The capture event has not taken place at the input yet

1 : The capture event has taken place at the input

Meaning of the individual bits:

Bit 1:	LIMIT + (positive hardware limit switch)
Bit 2:	LIMIT - (negative hardware limit switch)
Bit 3:	REF (reference switch)
Bit 8:	INPUT (additional digital input)

Register 518: Capture Edge Definition	
Function	**Description**
Read	Value of the capture definition
Write	New value of the capture edge definition
Amplifier status	No specific status
Takes effect	Immediately
Variable type	int / register
Value range	bit-coded, 16 bits, only bits 1, 2, 3, and 8
Value following a reset	0b000 0001 0000 1110

Here, the edge can be selected for the capture event of the "Position Capture" function. The assignment of the bits to the inputs is identical to the assignment in R513 *Capture Status*.

Meaning of the values:

0 : a logically falling edge has been selected

1 : a logically rising edge has been selected

Register 519: Capture Active State	
Function	**Description**
Read	As-is input state for which the Position Capture function is active
Write	Illegal
Amplifier status	No specific status
Takes effect	Immediately
Variable type	int / register
Value range	bit-coded, 16 bits, only bits 1, 2, 3, and 8
Value following a reset	0

R519 shows, for which inputs the Position Capture function is presently active, respectively deactivated. The bits of R519 are set, respectively reset, by R631 *Capture Command Set* and R632 *Capture Command Clear*. The assignment of the bits to the inputs is identical to the assignment in R513 *Capture Status*.

Meaning of the values:

0 : The Position Capture function has been deactivated for the input

1 : The Position Capture function is active for the input

Register 521: Capture-Position LIMIT+	
Function	**Description**
Read	Value of the presently active capture position for the positive limit switch
Write	Illegal
Variable type	float
Value range	Float limits [°] or [mm] (the unit depends on the setting of the axis type)
Value following a reset	0 [°]

Here, the as-is position of the axis at the capture event is entered for the input of the positive limit switch.

Register 522: Capture-Position LIMIT-	
Function	**Description**
Read	Value of the presently active capture position for the negative limit switch
Write	Illegal
Variable type	float
Value range	Float limits [°] or [mm] (the unit depends on the setting of the axis type)
Value following a reset	0 [°]

Here, the as-is position of the axis at the capture event is entered for the input of the negative limit switch.

Register 523: Capture Position REF	
Function	**Description**
Read	Value of the presently active capture position for the reference switch
Write	Illegal
Variable type	float
Value range	Float limits [°] or [mm] (the unit depends on the setting of the axis type)
Value following a reset	0 [°]

Here, the as-is position of the axis at the capture event is entered for the input of the reference switch.

Register 524: Capture Position INPUT	
Function	**Description**
Read	Value of the presently active capture position for the additional digital input
Write	Illegal
Variable type	float
Value range	Float limits [°] or [mm] (the unit depends on the setting of the axis type)
Value following a reset	0 [°]

Here, the as-is position of the axis at the capture event is entered for the additional digital input.

Register 631: Capture Command Set	
Function	**Description**
Read	Bit mask of the inputs activated last
Write	New bit mask of the inputs to be activated
Amplifier status	No specific status
Takes effect	Immediately
Variable type	int / register
Value range	bit-coded, 16 bits, only bits 1, 2, 3, and 8
Value following a reset	0

R631 is used for activating the Position Capture function for the individual inputs. R631 defines a pattern of setting bits. A bit set in a register means that the input assigned to this bit, is to be activated, respectively has been activated. A bit that has not been set means that the input is not addressed, respectively has not been addressed. The assignment of the bits to the inputs is identical to the assignment in R513 *Capture Status*. The activated inputs are shown in R519.

Register 632: Capture Command Clear	
Function	**Description**
Read	Bit mask of the inputs deactivated last
Write	New bit mask of the inputs to be deactivated
Amplifier status	No specific status
Takes effect	Immediately
Variable type	int / register
Value range	bit-coded, 16 bits, only bits 1, 2, 3, and 8
Value following a reset	0

R632 is used for deactivating the Position Capture function for the individual inputs. R632 defines a pattern of resetting bits. A bit set in a register means that the input assigned to this bit, is to be deactivated, respectively has been deactivated. A bit that has not been set means that the input is not addressed, respectively has not been addressed. The assignment of the bits to the inputs is identical to the assignment in R513 *Capture Status*. The activated inputs are shown in R519.

16 Special Function: PID Controller

16.1 General Information

As of operating system version 23, every JetMove 2xx is equipped with a PIDT1 controller, which, in combination with the analog input card JM-IA1, is apt for various process control applications.
For the JM-D203, the controller is available as of operating system version 1.00. It makes use of the internal analog inputs on the system bus plug-in connector X18 for axis A, respectively X19 for axis B.
By specific parametering, the individual components of the controller (P, I, D and T1 component) can be activated or deactivated. This way, flexible adjustment to individual control tasks is possible.
The controller functions by a sample time of TS = 2 ms; it is synchronous with the drive control system, so that interfacing with the drive control system is easy.

16.2 Configuration

Before commissioning the PID controller, its interfaces to the periphery must be set properly.
This also implies, for example, that in a JetMove 2xx series, an analog input board is available (hardware module JM-IA1 in AnyBus slot 2).

This step touches on the following registers:
- R211 "PID Selection As-is Value"
- R212 "PID Selection Correction"
- R213 "PID Selection Set Point"
- R572 "JetMove Controller Mode"

At the moment, two configurations are useful; they will be described below.

16.2.1 PID Controller with Lower-Level Current Control

This configuration, for example, can be applied for controlling a press, if the pressure sensor is connected to the analog input of the JM-IA1.

- R211 = 221: The as-is value is taken from the analog input no. 1 of the analog input card JM-IA1 (the input voltage is 0 ... 10 V of a 12 bit resolution)
- R213 = 220: The setpoint value is directly taken from register 220
- R212 = 125: The manipulated variable is transmitted to the current control
- R572 = 101: Of the entire drive control system, only the current control is active

16.2.2 PID controller with lower-level speed and current control

This configuration can, for example, be used for controlling the flow rate of liquid media, if the respective sensor has been connected to the analog input of the JM-IA1.

- R211 = 221: The as-is value is taken from the analog input no. 1 of the analog input card JM-IA1 (the input voltage is 0 ... 10 V of a 12 bit resolution)
- R213 = 220: The setpoint value is directly taken from register 220
- R212 = 111: The manipulated variable is transmitted to the speed controller
- R572 = 102: Of the entire drive control system, only the current control is active

16.3 Commissioning

For commissioning the above named configurations, the following steps will be required:

- R101 = 1: Activate the drive control
- R201 = 1: Activate the PID controller
- R220 = Specify the desired setpoint value

16.4 Optimizing the Controller

As optimizing the controller depends on the selected controller structure, only basic remarks on this topics can be made here.

Here, the basically possible controller structures and their respective parametering are still to be listed.

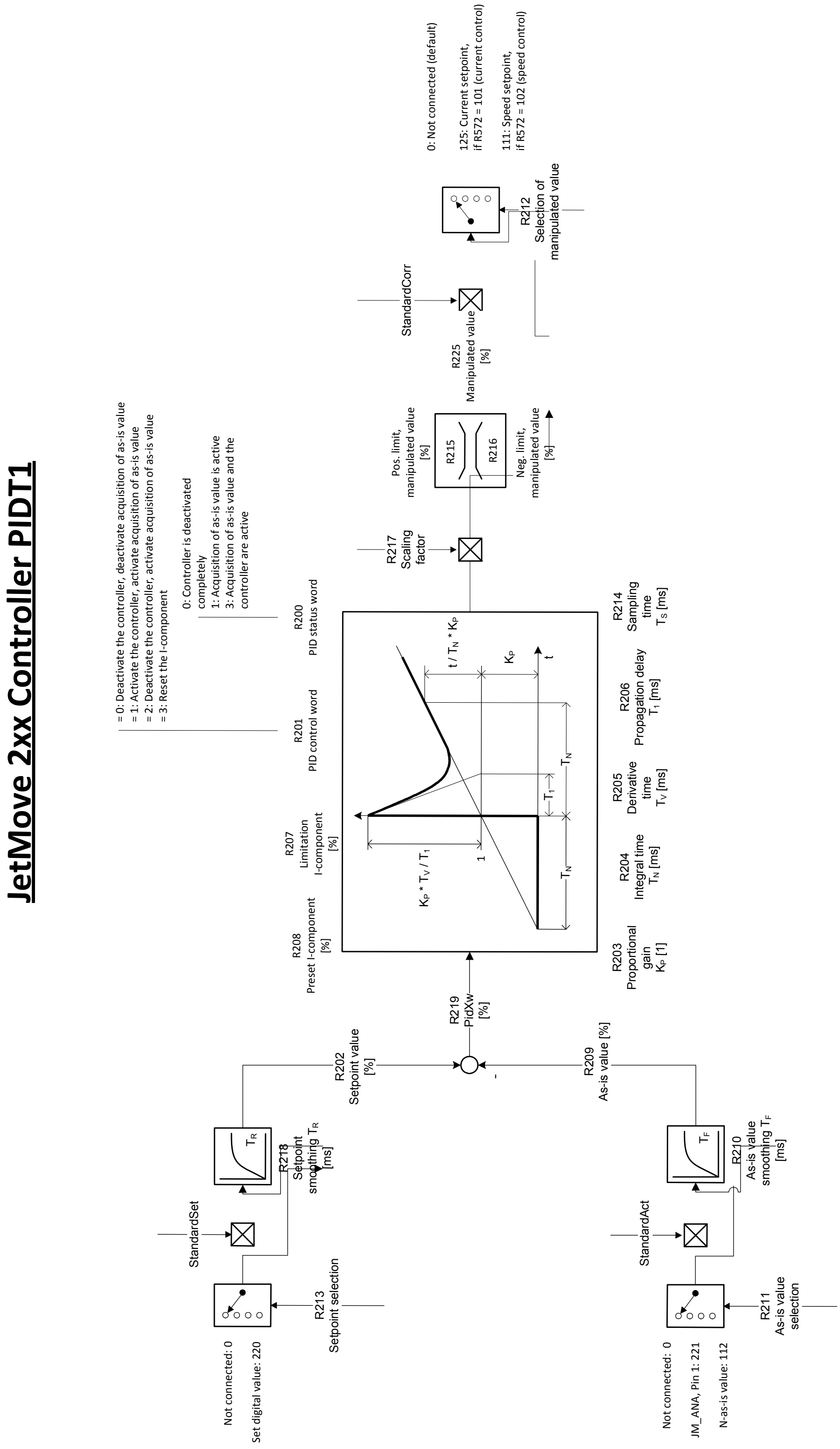


Fig. 44: Structure of the PID controller

16.5 Register Description

Register 200: Status Register	
Function	**Description**
Read	Status register of the PID controller
Variable type / unit	int32 / [-]
Value range	0: The controller has been deactivated 1: The controller is active
Value following a reset	0

Register 201: PID Command	
Function	**Description**
Read/Write	Command register of the PID controller
Variable type / unit	int32 / [-]
Value range	0: (Default value after a reset) 1: Switch controller ON 2: Switch controller OFF 3: Clear integral-action components of the controller
Value following a reset	0

Register 202: Setpoint	
Function	**Description**
Read	PID setpoint
Variable type / unit	float / [%]
Value range	-100 ... +100
Value following a reset	0

This setpoint results of the digital setpoint of R220, which in turn is a result of the standardizing and setpoint filtering value stored to R218. The setpoint value has always got the same standards as the as-is value, see “Register 213: Selection of the Setpoint” on page 347.

Register 203: Proportional Gain K_P	
Function	**Description**
Read/Write	Proportional amplification K_p of the PID controller, respectively of the p-component
Variable type / unit	float / [1]
Value range	0 ... MaxFloat 0 = (p-component is deactivated)
Value following a reset	1

Register 204: Integral Time T_n	
Function	**Description**
Read/Write	Integral-action time T_N of the PID controller, respectively the integral-action components
Variable type / unit	float / [ms]
Value range	0 ... MaxFloat 0 = (integral-action component is deactivated)
Value following a reset	100

Register 205: Derivative Time T_V	
Function	**Description**
Read/Write	Derivative-action time T_V of the PID controller, respectively of the D-component.
Variable type / unit	float / [ms]
Value range	0 ... MaxFloat 0 = (D-component is deactivated)
Value following a reset	0 (D-component is deactivated)

Register 206: Delay Time T_1	
Function	**Description**
Read/Write	Time constant of the T1-constituent in the D-component of the PIDT1 controller
Variable type / unit	float / [ms]
Value range	0 ... MaxFloat 0 = (T1-constituent has been deactivated)
Value following a reset	0 (T1-constituent has been deactivated)

Register 207: Limitation Integral-Action Component	
Function	**Description**
Read/Write	Symmetrical limit of the integral-action component
Variable type / unit	float / [%]
Value range	0 ... +100
Value following a reset	+100

Register 208: PID I-Factor Preset	
Function	**Description**
Read/Write	Value for initializing the integral-action component of the PID controller. This initializing value is assigned to the integral-action component once by means of controller command 1.
Variable type / unit	float / [%]
Value range	-100 ... +100
Value following a reset	0

Register 209: As-is Value	
Function	**Description**
Read	As-is PID value
Variable type / unit	float / [%]
Value range	-100 ... +100
Value following a reset	0

see “Register 211: Selection of the As-is Value” on page 345.

Register 210: As-is Value Filtering T_F	
Function	**Description**
Read/Write	Time constant T_F of the as-is value filtering of the PID controller
Variable type / unit	float / [ms]
Value range	0 ... MaxFloat 0 = (as-is value filtering has been deactivated)
Value following a reset	0

Register 211: Selection of the As-is Value	
Function	**Description**
Read/Write	Source of the as-is PID controller values
Variable type / unit	int32 / [-]
Value range	See table below
Value following a reset	0

0 There is no feedback of an as-is value. Yet, the as-is value can be written to R209.

112 The as-is value of the PID controller has been connected with the as-is speed value sent by the encoder evaluation (R112).

The as-is value has been standardized by the maximum speed of the speed control loop specified in R118.

An as-is value of +/- 100 [%] corresponds to +/- R 118 [rpm]

221 The as-is value of the PID controller is connected with analog input 1 of the analog input module JM-IA1 (R221).

The as-is value is standardized by the measuring range of the AD converter (0 - 10 V); it is independent from its resolution (12 bit)

An as-is value of 0 ... 100 [%] corresponds to 0 ... 10 [V]

Register 212: Selection of the Manipulated Variable	
Function	**Description**
Read/Write	Target for the manipulated variable of the PID controller
Variable type / unit	int32 / [-]
Value range	See table below
Value following a reset	0

0 The manipulated variable is not connected. It can directly be read out of R219.

111 The manipulated variable of the PID controller has been connected with the nominal speed value of the speed controller (R111). For this purpose, the nominal operation mode of the JetMove must be set to speed control (R572 = 102).
This means that the PID controller has got priority over the speed controller.

The manipulated variable has been standardized by the maximum speed of the speed control loop specified in R118.

An as-is value of +/- 100 [%] corresponds to +/- R118 [rpm]

125 The manipulated variable of the PID controller has been connected with the current setpoint of the current controller (R125). For this purpose, the set operation mode of the JetMove has to be set to current control (R572 = 101).
This means that the PID controller has got priority over the current controller.

The manipulated variable has been standardized by the peak current of the current control loop specified in R502.

A manipulated variable of +/- 100 [%] corresponds to +/- R502 [A_{rms}]

Register 213: Selection of the Setpoint	
Function	**Description**
Read/Write	Source of the setpoint values of the PID controller
Variable type / unit	int32 / [-]
Value range	0
Value following a reset	0

0 The setpoint cannot be input. Yet, it can directly be written via R202.

220 The setpoint of the PID controller is unseparabely connected to R220.

Register 214: Sampling Time T_S	
Function	**Description**
Read	Sampling interval of the PID controller
Variable type / unit	float / [ms]
Value range	2
Value following a reset	2

Register 215: Max. Value of the Manipulated Variable	
Function	**Description**
Read/Write	Limitation of the manipulated variable of the PID controller
Variable type / unit	float / [%]
Value range	0 ... +100
Value following a reset	+100

Register 216: Min. Value of the Manipulated Variable	
Function	**Description**
Read/Write	Limitation of the manipulated variable of the PID controller
Variable type / unit	float / [%]
Value range	-100 ... 0
Value following a reset	-100

Register 217: Scaling Factor for the Manipulated Value	
Function	**Description**
Read/Write	Scaling factor for the manipulated variable of the PID controller
Variable type / unit	float / [%]
Value range	-1 ... +1
Value following a reset	+1

With the scaling factor, the manipulated value of the PID controller can be negated. This is necessary, for example, if, because of electrical, respectively mechanical circumstances of the closed-up controlled system, there is a positive feedback.

Register 218: Setpoint Value Filtering T_R	
Function	**Description**
Read/Write	Time constant T_R of the setpoint filtering of the PID controller
Variable type / unit	float / [ms]
Value range	0 ... MaxFloat 0 = (setpoint filtering has been deactivated)
Value following a reset	0 (setpoint filtering has been deactivated)

Register 219: Control Deviation X_w	
Function	**Description**
Read	As-is control deviation
Variable type / unit	float / [%]
Value range	-100 ... +100
Value following a reset	0

Register 220: Digital Setpoint	
Function	**Description**
Read/Write	As-is digital PID controller setpoint
Variable type / unit	float / [1]
Value range	-100 ... +100
Value following a reset	0

Register 221: Measuring Value Analog Input 1	
Function	**Description**
Read	The reading access directly starts a new measuring at the AD converter. After about 200 µs, the measured value will be reported in the feedback
Variable type / unit	int32 / [-]
Value range	0 ... 32,767 (measuring range of the ADC has been moved to 16 bit left justified)
Value following a reset	0

Register 225: Manipulated Variable	
Function	**Description**
Read	Manipulated variable of the PID controller
Variable type / unit	float / [%]
Value range	-100 ... +100
Value following a reset	0

Manipulated variable of the PID controller after scaling with R217 and after limitation by R215 and R216.

17 Special Function: Position Trigger

17.1 Introduction

JetMoves with digital outputs (JM-204, JM-208, JM-215, JM-225) can change the switching state of their digital outputs at a set as-is position. In this case, the set trigger condition has been fulfilled, that is, if the as-is position exceeds or falls below a set comparative position, the outputs are set, respectively reset. For setting, respectively resetting, a delay time can be set as well. First the trigger condition has to be met, then the delay time has to expire, then setting, respectively resetting can be carried out.

There are two registers for defining the output pattern which, after having met the trigger condition, has to be written to the digital outputs. One of these registers specifies the setting pattern, the other one specifies the resetting pattern. The digital outputs have been assigned to corresponding bits of these registers. A bit set in these registers means that the respective output has been selected for setting, respectively resetting. A bit that has not been set means that the corresponding output is not considered.

When the condition has been met and the digital outputs have been changed by the JetMove, the function is terminated automatically.

If the trigger condition has already been met at activating the function, the procedure is blocked. When the condition is not met any more, the blockage is cleared. This means that the trigger condition has to have the "not met" status first. After releasing the blockage and meeting the trigger condition once more, the procedure is continued.

The trigger condition is checked and the outputs are modified by a sampling rate of 16 kHz.

The function has got two individually functioning channels. Each of them checks the trigger condition and modifies the digital outputs.

The channels are characterized as follows:

- Each channel monitors the as-is position (R109)
- Each channel can modifiy any digital output on connector X31
- Each channel has got its individual register set
- Both channels are operated the same way. They have got analog behavior toward each other.

Note!

At parameterizing the two channels accordingly, their mutual access to the the digital outputs can coincide.

17.2 Overview of Registers

For the Position Trigger function, the following registers are available:

Register Name	**Short Description**
Registers - Both Channels	
R515 *DigOut-Status*	The switching state of the digital outputs is displayed.
R596 *DigOutStatus-Set*	Setting pattern for manually setting the digital outputs
R597 *DigOutStatus-Clear*	Resetting pattern for manually resetting the digital outputs
Registers - Channel 1	
R525 *DigOut-Typ*	Setting the comparing condition and the delay function
R516 *DigOut-Set*	Pattern for setting the digital outputs at exceeding or falling below the comparative position.
R517 *DigOut-Clear*	Pattern for resetting the digital outputs at exceeding or falling below the comparative position.
R526 *DigOut-PosX*	Comparative position
R529 *DigOut-Delay*	Delay time
Registers - Channel 2	
R623 *DigOut-Typ2*	Setting the comparing condition and the delay function
R624 *DigOut-Set2*	Pattern for setting the digital outputs at exceeding or falling below the comparative position.
R625 *DigOut-Clear2*	Pattern for resetting the digital outputs at exceeding or falling below the comparative position.
R626 *DigOut-PosX2*	Comparative position
R527 *DigOut-Delay2*	Delay time

17.3 Configuring and Carrying Out the Function

Below, the proceedings for configuring and carrying out the function are described.

Initialization:

For carrying out the function, the JetMove has to be activated. Then, the output driver has to be initialized. This is done as follows:

Step	Action
1	Initializing the Digital Outputs Action: Writing any output pattern into R515 *DigOut - Status* Please note: This way, the output driver component is activated and initialized.

Manually Setting and Resetting the Outputs:

The outputs can be set and reset manually by means of R596 *DigOutStatus-Set* and R597 *DigOutStatus-Clear*, even while the active position trigger function is carried out.

If the position trigger function of channel 1 is not active, R516 *DigOut - Set* and R517 *DigOut - Clear* can be used as an alternative to R596 and R597. R516 and R517 have got the same function as R596 and R597, if the position trigger function for channel 1 is not active.

How to carry out this function:

When making use of this function, the procedure described below has to be kept to. It is described for channel 1, yet, the procedure for channel 2 is the same.

Step	Action
1	Set the comparative position for the changing-over event Action: Write the comparative position to R526 *DigOut - PosX*.
2	Define the performance characteristic of the function, activate the function Action: Write the respective type to R525 *DigOut - Type*.
3	Specify the outputs to be set at the event Action: Set the respective bits in R516 *DigOut - Set*.

Step	Action
4	Specify the outputs to be reset at the event Action: Set the respective bits in R517 *DigOut - Clear*.

How to deactivate the channel:

As long as switching has not been carried out yet, the function in process can deactivated again without modifying the switch status of the outputs. For this, the step described below has to be taken. It is described for channel 1, yet, the procedure for channel 2 is the same.

Step	Action
1	Deactivating the function Action: - Set R516 *DigOut - Set* = 0 - Set R517 *DigOut - Clear* = 0 - Set R525 *DigOut - Type* = 0

17.4 Register Description

Register 515: DigOut - Status	
Function	**Description**
Read/Write	Switch status of the digital outputs on X31:1-4
Amplifier status	No specific status
Takes effect	Immediately
Variable type	int / register
Value range	Bit-coded, 32 bits
Value following a reset	0

A write access to R515 causes the digital outputs to be set exactly following the assignments listed below. The initial write access switches the hardware driver to the active state.

Meaning of the values:

0 : The output has been / is reset (=0 V)

1 : The output has been set / is set (= +24 V)

R515: Assignments of the Bits to the respective Outputs	
Bit 0	Output 1 at X31:1
Bit 1	Output 2 at X31:2
Bit 2	Output 3 at X31:3
Bit 4	Output 4 at X31:4

Register 596: DigOutStatus - Set	
Function	**Description**
Read/Write	Register for setting the digital outputs 1-4 - the position trigger function is active
Amplifier status	No specific status
Takes effect	Immediately
Variable type	int / register
Value range	Bit-coded, 32 bits
Value following a reset	0

R596 is used for manually setting the digital outputs. If the position trigger function is active, the outputs can also be set manually via this register. If the position trigger function is not active, either R515 *DigOut-Status* or R516 *DigOut-Set* can be used as an alternative to R596 for setting the digital outputs.

The bit assignment of R596 to the outputs, as well as the meaning of 0 and 1, is identical with bit assignment and meaning of R515.

Register 597: DigOutStatus - Clear	
Function	**Description**
Read/Write	Register for resetting the digital outputs 1-4 - the position trigger function is active
Amplifier status	No specific status
Takes effect	Immediately
Variable type	int / register
Value range	Bit-coded, 32 bits
Value following a reset	0

R597 is used for manually resetting the digital outputs. If the position trigger function is active, the outputs can also be set manually via this register. If the position trigger function is not active, either R515 *DigOut-Status* or R517 *DigOut-Clear* can be used as an alternative to R597 for resetting the digital outputs.

The bit assignment of R596 to the outputs, as well as the meaning of 0 and 1, is identical with bit assignment and meaning of R515.

Register 525: DigOut - Type	
Function	**Description**
Read/Write	Performance characteristic of the digital outputs - channel 1
Amplifier status	No specific status
Takes effect	Immediately
Variable type	int / register
Value range	0 ... 4
Value following a reset	0

Value list for R525 *DigOut - Type*	
0	The position trigger function is deactivated
1	Trigger Mode 1: - Trigger condition: R109 *As-is Position* >= R526 *DigOut PosX* - R516 *DigOut - Set* It takes effect on the outputs immediately after meeting the trigger condition. - R517 *DigOut - Clear*: It does not take effect unless the trigger condition has been met and the delay time specified in R529 has expired.
2	Trigger Mode 2: - Trigger condition: R109 *As-is Position* <= R526 *DigOut PosX* - R516 *DigOut - Set:* It takes effect on the outputs immediately after meeting the trigger condition. - R517 *DigOut - Clear*: It does not take effect unless the trigger condition has been met and the delay time specified in R529 has expired.
3	Trigger Mode 3: - Trigger condition: R109 *As-is Position* >= R526 *DigOut PosX* - R516 *DigOut - Set:* It does not take effect unless the trigger condition has been met and the delay time specified in R529 has expired. - R517 *DigOut - Clear*: It takes effect on the outputs immediately after meeting the trigger condition.
4	Trigger Mode 4: - Trigger condition: R109 *As-is Position* <= R526 *DigOut PosX* - R516 *DigOut - Set* It does not take effect unless the trigger condition has been met and the delay time specified in R529 has expired. - R517 *DigOut - Clear*: It takes effect on the outputs immediately after meeting the trigger condition.

Types 1 and 2

The operating system carries out the following program sequence for types 1 and 2:

1. R516 *DigOut - Set* takes effect on the outputs immediately
2. R517 *DigOut - Clear* takes effect on the outputs after a delay that has to be set via R529 *DigOut - Delay*
3. R525 *DigOut - Type* = 0

Types 1 and 2 can be used for generating the following signal patterns:
- Active high pulses of a defined length
- Immediate rising edges
- Delayed falling edges

Types 3 and 4

The operating system carries out the following program sequence for types 3 and 4:

1. R516 *DigOut - Set* takes effect on the outputs after a delay that has to be set via R529 *DigOut - Delay*
2. R517 *DigOut - Clear* takes effect on the outputs after a delay that has to be set via R529 *DigOut - Delay*
3. R525 *DigOut - Type* = 0

Types 3 and 4 can be used for generating the following signal patterns:
- Active low pulses of a defined length
- Delayed rising edges
- Immediate falling edges

Register 516: DigOut - Set	
Function	**Description**
Read/Write	Pattern for setting the digital outputs - channel 1
Amplifier status	No specific status
Takes effect	Immediately
Variable type	int / register
Value range	Bit-coded, 32 bits
Value following a reset	0

R516 can be used for manually setting the digital outputs, if the position trigger function for channel 1 is *not* active. If the position trigger function for channel 1 is active, the setting pattern is specified via R516. It is for setting thre respective digital outputs when the trigger condition has been met.

The bit assignment of R516 to the outputs, as well as the meaning of 0 and 1, is identical with bit assignment and meaning of R515.

Register 517: DigOut - Clear	
Function	**Description**
Read/Write	Pattern for resetting the digital outputs - channel 1
Amplifier status	No specific status
Takes effect	Immediately
Variable type	int / register
Value range	Bit-coded, 32 bits
Value following a reset	0

R517 can be used for manually setting the digital outputs, if the position trigger function for channel 1 is *not* active. If the position trigger function for channel 1 is active, the resetting pattern is specified via R517. It is for resetting thre respective digital outputs when the trigger condition has been met.

The bit assignment of R517 to the outputs, as well as the meaning of 0 and 1, is identical with bit assignment and meaning of R515.

Register 526: DigOut PosX	
Function	**Description**
Read/Write	Comparative position - channel 1
Amplifier status	No specific status
Takes effect	Immediately
Variable type	float
Value range	R182 ... R183 [°] respectively [mm]
Value following a reset	0 [°]

For correct functioning, please make sure the comparison position is within the limits defined for the axis motion (R182 to R183).

Register 529: DigOut - Delay	
Function	**Description**
Read/Write	Delay time for pulse generation - channel 1
Amplifier status	No specific status
Takes effect	Immediately
Variable type	float
Value range	0 ... 2,000 [ms]
Value following a reset	0 [ms]

The delay time defines the instance between setting and resetting the digital outputs.

Register 623: DigOut Type2	
Function	**Description**
Read/Write	Performance characteristic of the digital outputs - channel 2
Amplifier status	No specific status
Takes effect	Immediately
Variable type	int / register
Value range	0 ... 4
Value following a reset	0

Values and behavior by analogy with R525 *DigOut - Type*.

Register 624: DigOut - Set2	
Function	**Description**
Read/Write	Registers for setting the digital outputs - channel 2
Amplifier status	No specific status
Takes effect	Immediately
Variable type	int / register
Value range	Bit-coded, 32 bits
Value following a reset	0

R624 specifies the setting pattern. When the trigger condition of channel 2 has been met, it sets the respective digital outputs.

The bit assignment of R624 to the outputs, as well as the meaning of 0 and 1, is identical with bit assignment and meaning of R515.

Register 625: DigOut - Clear2	
Function	**Description**
Read/Write	Clearing register for the digital outputs 1-4 - channel 2
Amplifier status	No specific status
Takes effect	Immediately
Variable type	int / register
Value range	Bit-coded, 32 bits
Value following a reset	0

R625 specifies the resetting pattern. When the trigger condition of channel 2 has been met, it resets the respective digital outputs.

Register 626: DigOut PosX2	
Function	**Description**
Read/Write	Comparison value - channel 2
Amplifier status	No specific status
Takes effect	Immediately
Variable type	float
Value range	R182 ... R183 [°] respectively [mm]
Value following a reset	0 [°]

Values and behavior by analogy with R526 *DigOut-PosX*.

Register 627: DigOut - Delay2	
Function	**Description**
Read/Write	Delay time for pulse generation - channel 2
Amplifier status	No specific status
Takes effect	Immediately
Variable type	float
Value range	0 ... 2,000 [ms]
Value following a reset	0 [ms]

Values and behavior in analogy by R529 *DigOut-Delay*.

18 Special Function: Torque-Controlled Shut-Off

In this chapter, behavior, configuration, and applying the special function *Torque-Controlled Shut-Off* will be dealt with.

18.1 Introduction

The function *Torque-Controlled Shut-Off* causes quick stopping of the axis, when a set current (this results in a set torque) is reached. Before being stopped, the axis can be moved by PtP-positioning, endless positioning, or coupling methods such as electronic gearing and table mode.

One application of this function is screw capping.

Torque-controlled shut-off can be carried out in two different modes. In the individual modes, the axis behaves as follows:

Mode 1: The motion is stopped quickly after exceeding the set current. After standstill, the operating system automatically switches to "normal" position control.

Mode 2: The motion is stopped quickly after exceeding the set current. Then the system changes to a previously set holding torque.

Below, the modes have been described in detail.

18.2 Overview of Registers

For this function, the following registers are needed:

Register Name	Short Description
R100 *Status*	Status of the JetMove
R101 *Command*	Command register
R136 *Status - Torque-Controlled Shut-Off*	Status of the Function
R137 *Torque-Controlled Shut-Off Value*	Current shut-off threshold, at which the axis is to be stopped.
R138 *Torque-Controlled Shut-Off Count*	Number of the current values measured before torque-controlled shut-off, being greater than the torque-controlled shut-off value.
R139 *Speed Tripping Value*	Speed limit, at which the value of R506 *Speed Controller Preset* is taken over as a new value for the integral-action component of the speed controller (R507).

R506 *Speed Controller Preset*	Integral-action component, which is taken over as a value for the speed controller integral-action component (R507) at reaching the speed tripping value.
R607 *Shut-Off Current*	Tripping current for transition from deceleration to holding torque. The register is only needed for mode 2.
R630 *Zero Speed Count*	Number of the measured speed values for which the following applies: Before the operating system internally sets the status "standstill", their as-is speed is smaller than 0.5 % of the maximum possible speed. The register is only needed for mode 1.

18.3 Mode 1

In mode 1, the operating system proceeds as follows when the function is active:

Stage	Description
1	Wait for as-is current (R561) to reach the current shut-off value (R137).
2	Set internal speed limit = 0. Explanation: This causes the speed controller to immediately control to value 0, that is, to immediate standstill. The speed controller transmits this information togehter with a high current setpoint value to the current control unit in the opposite direction. This leads to an extreme delay of the axis. The maximum current for delay is set via R127 *Current Limitation*.
3	When the speed tripping value has been reached, set the integral-action component (R507) of the speed control unit to the speed control preset value (R506). Explanation: This results in an abrupt change of current direction which is to lighten the extreme delay, in order to prevent undershooting of the as-is speed at standstill position (speed = 0) causing the axis to change the rotatory direction to standstill.
4	If axis standstill is recognized, adjust the set position control value to the as-is position (R109), then re-integrate the position controller into the controller cascade. Explanation: At the beginning of torque-controlled shut-off, the position control was separated from the controller cascade. A tracking error has resulted. Before re-integrating the position controller in the controller cascade, the tracking error has to be fixed. This is done by adjusting the set and the as-is position value.

After step 4, the axis remains under "normal" position control conditions at the standstill point. From there, it can be driven "normally", that is, by means of PtP positioning, without further steps being necessary, such as resetting the integral-action component of the speed controller.

18.4 Mode 2

In mode 2, the operating system proceeds as follows when the function is active:

Stage	Description
1	Wait for as-is current (R561) to reach the current shut-off value (R137).
2	Set internal speed limit = 0. Explanation: This causes the speed controller to immediately control to value 0, that is, to immediate standstill. The speed controller transmits this information togehter with a high current setpoint value to the current control unit in the opposite direction. This leads to an extreme delay of the axis. The maximum current for delay is set via R127 *Current Limitation*.
3	When the set speed tripping value has been reached, proceed as follows: • Set the integral-action component (R507) of the speed controller to the preset value of the speed controller (R506) • The current limitation (R127) is set to the shut-off current value (R607) • The internal speed limitation is cancelled Explanation: This results in an abrupt change of the current direction which is to continually decrease the previously extreme delay. Then, the set holding torque can be kept at standstill (speed = 0) without undershooting and without a change of rotation direction. Attention: The holding torque can only be reached, if there is at least one resistance of the same value as the holding torque.

After stage 3, the axis being affected by the holding torque is at standstill.

Below, an example of screw-capping by means of torque-controlled shut-off is graphically illustrated.

18.4.1 Mode 2 - Sequential Program

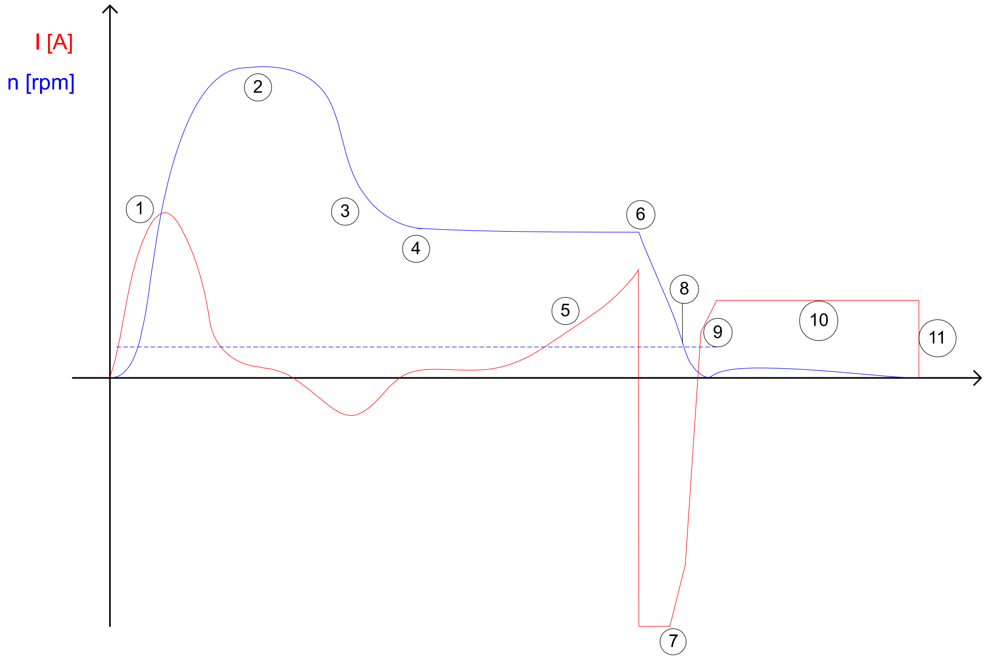


Fig. 45: Exemplary sequential program - Idealized screw capping

Explanations on the Illustration:

1. Acceleration phase up to high speed
2. At high speed, the main part of the screwing distance is covered.
3. Deceleration to low speed
4. When low speed has been reached, torque-controlled shut-off can be activated.
5. The capping to be screwed reaches its final position. This way, a torque is generated, as well as a motor current to maintain the speed.
6. The current shut-off value is reached:
   In R127 *Current Limitation*, the maximum current value for decelerating the axis is specified. The speed decreases fast.
7. As the difference between the as-is speed value and zero also decreases, the speed controller does not cause the maximum delay current any more.
8. At reaching the speed tripping value, speed limitation is neutralized. The axis is to travel on, which results in a current rise.
9. When the speed tripping value has been reached, a "positive" current has to be output quickly to prevent negative speed, that is, a retraction of the axis. Setting the integral-action component of the speed controller (R507) by the preset value of the speed controller is helpful.
10. The current limitation is set to the shut-off current value. During shut-off time, the cap still slides a small distance to its final position.

11. At the end of the screw-capping procedure, the axis is deactivated by command 2.

18.5 Accuracy

The axis can be stopped by torque-controlled shut-off under two possible operating conditions:

- driving by constant speed
- during acceleration or deceleration

The as-is current measured in the JetMove 2xx is basic for torque-controlled shut-off. Depending on the operating condition, this as-is current coincides more or less with the active torque at the end of the power train.

The best possible coincidence at applying this method is gained by driving at constant speed.

During acceleration, respectively deceleration, additional moments of inertia are created that are made visible in the as-is current. In this case, as-is current and active torque at the end of the power train coincide.

This has to be considered at activating the function.

18.6 Mode 1 - Configuring and Operating

18.6.1 Configuring

Below, the configuration of torque-controlled shut-off in mode 1 is described. For some parameters, adequate values have to be determined empirically. This requires a respective commissioning period with several test runs. In the following configuration steps, the parameters that are needed for empiric value determination have been marked specifically.

For optimum commissioning, applying the oscilloscope function of the JetMove 2xx is necessary. By means of the oscilloscope, the following registers values are registered and evaluated at each deactivation (see also fig.45):

- Speed (R112)
- As-is Current (R561)

Torque-controlled shut-off in mode 1 has to be configured as follows:

Step	Action
1	Specify the current shut-off value Action: Write the respective current value standing for the desired torque into R137 *Current Shut-Off Value*. During the commissioning phase, do the fine-tuning by adjusting the value upwards or downwards. Please note: The current needed for the desired torque can be calculated with the help of the torque constant specified in the motor data sheet.
2	Specify the current shut-off count Action: Set R138 *Torque-Controlled Shut-Off Count* to ten, and adjust the value upwards or downwards during commissioning, if needed.
3	Set the speed tripping value Action: Set R139 *Speed Tripping Value*to an adequate initial value (e. g. default value). At the subsequent commissioning, adjust the value upwards or downwards.
4	Specify Speed Controller Preset Action: Set *Current Preset Value* to zero. In the subsequent commissioning phase adjust upwards. Please note: Optimum setting is achieved, if the preset value is determined with the help of R139 Speed Tripping Value. The preset value and the speed tripping value are set best, if there is no siginificant undershooting of speed at the end of a shut-off procedure.
5	Set zero speed recognition Action: Set R630 *Zero Speed Count* to an adequate initial value (e. g. default value). At the subsequent commissioning, adjust the value upwards or downwards.

18.6.2 Activating and deactivating the function

For each shut-off procedure, the function has to be activated at an adequate point of time as shown in the sample program:

Step	Action
1	Wait, until the axis in an operating phase, at which no further current rise exceeding the current shut-off value is expected, except for the one leading to torque-controlled shut-off. This is, for example, the operating phase, in which, all acceleration and deceleration processes being completed, the axis is moving at constant speed.
2	Issue command 28 Action: Write value 28 into R101 *Command*. Result: Bit R136.0 = 1, Bit R136.1 = 0, Bit R136.2 = 0

The function can be deactivated **prematurely**, that is, if the operating system is not carrying out torque-controlled shut-off yet (bit R136.1 = 0), as follows:

Step	Action
1	Issue command 29 Action: Write value 29 into R101 *Command*. Result: R136 = 0

18.6.3 Transition to normal operation

After stopping by torque-controlled shut-off in mode 1, the operating system automatically deactivates the function and sets the axis to position control again. In this case, the axis stops in standstill position. The user does **not** have to carry out further steps, such as resetting the integral-action component of the speed controller, etc.

Please read below, how completed transition to position control can be recognized:

Step	Action
1	Wait for R136 "Shut-Off Status" to display the function status *Torque-Controlled Shut-Off Ended*. Action: Wait for R136.2 = 1.

18.7 Mode 2 - Configuring and Operating

18.7.1 Configuring

Below, the configuration of torque-controlled shut-off in mode 2 is described. For some parameters, adequate values have to be determined empirically. This requires a respective commissioning period with several test runs. In the following configuration steps, the parameters that are needed for empiric value determination have been marked specifically.

For optimum commissioning, applying the oscilloscope function of the JetMove 2xx is necessary. By means of the oscilloscope, the following registers values are registered and evaluated at each deactivation (also see fig.45):

- Speed (R112)
- As-is Current (R561)

Torque-controlled shut-off in mode 2 has to be configured as follows:

Step	Action
1	Specify the current shut-off value Action: Write the respective current value standing for the desired torque into R137 *Current Shut-Off Value*. During the commissioning phase, do the fine-tuning by adjusting the value upwards or downwards. Please note: The current needed for the desired torque can be calculated with the help of the torque constant specified in the motor data sheet.
2	Specify the current shut-off count Action: Set R138 *Torque-Controlled Shut-Off Count* to ten, and adjust the value upwards or downwards during commissioning, if needed.
3	Set the speed tripping value Action: Set R139 *Speed Tripping Value* to an adequate initial value (e. g. default value). At the subsequent commissioning, adjust the value upwards or downwards.
4	Specify Speed Controller Preset Action: Set *Current Preset Value* to zero. In the subsequent commissioning phase adjust upwards. Please note: Optimum setting is achieved, if the preset value is determined with the help of R139 *Speed Tripping Value*. The preset value and the speed tripping value are set best, if there is no siginificant undershooting of speed at the end of a shut-off procedure.

5	Specify the holding torque Action: Set the value of R607 *Holding Torque* to the desired current value. At the subsequent commissioning, adjust the value upwards or downwards. Please note: The current needed for the desired torque can be calculated with the help of the torque constant specified in the motor data sheet.

18.7.2 Activating and deactivating the function

For each shut-off procedure, the function has to be activated at an adequate point of time as shown in the sample program:

Step	Action
1	Wait, until the axis in an operating phase, at which no further current rise exceeding the current shut-off value is expected, except for the one leading to torque-controlled shut-off. This is, for example, the operating phase, in which, all acceleration and deceleration processes being completed, the axis is moving at constant speed.
2	Issue command 27 Action: Write value 27 into R101 *Command*. Result: Bit R136.0 = 1, Bit R136.1 = 0, Bit R136.2 = 0

The function can be deactivated **prematurely**, that is, if the operating system is not carrying out torque-controlled shut-off yet (bit R136.1 = 0), as follows:

Step	Action
1	Issue command 29 Action: Write value 29 into R101 *Command*. Result: R136 = 0

18.7.3 Transition to normal operation

The operating system does **not** automatically deactivate the function after stopping by torque-controlled shut-off. The function rather stays active and causes the axis to be moved, respectively pressed against the "blockage", the holding torque being set.

Please read below, how completed transition to the holding torque can be recognized:

Step	Action
1	Wait for R136 "Shut-Off Status" displays the function status *Torque-Controlled Shut-Off Ended*. Action: Wait for R136.2 = 1.

There are the following possibilities of completely deactivating the function and setting the axis back to "normal" position control:

- Disabling the axis (issue command 2)
- Re-initializing the enabled position generator (issue command 4)

After this, the axis can be driven as usual.

18.8 Sample Programs

The following sample programs have been based on the following hardware configuration: JC-241 with a JM-2xx, which is directly connected to the system bus interface of the controller. In the JetSym axis definition, the JM-2xx has got the designation *Axis1*.

The following variable declaration applies to the following sample programs:

```
//    Variable Declaration:

Var
 JM_nm_Status:          INT At %VL 12100;    // Status Register
 JM_nm_Cmd:             INT At %VL 12101;    // Command Register
 MC_fm_PosAct:          FLOAT At %VL 12109;  // As-is Position
 Torq_nm_IqTripState:   INT At %VL 12136;    // Status of Torque
                                             // Deactivation
 Torq_fm_IqTripValue:   FLOAT At %VL 12137;  // Current Shut-Off
                                             // Value
 Torq_nm_IqTripCnt:     INT At %VL 12138;    // Filter of the
                                             // Shut-Off Value
 Torq_nm_SpeedTripVal:  INT At %VL 12139;    // Speed
                                             // Tripping Value
 CtrlV_fm_ISumPreset:   FLOAT At %VL 12506;  // Speed Controller
                                             // Preset
 Torq_fm_IqHoldValue:   FLOAT At %VL 12607;  // Holding Torque
 Torq_nm_ZeroSpeedCnt:  INT At %VL 12630;    // Filter of Zero Speed
                                             // Count
End_Var;
```

18.8.1 Sample program - Mode 1

```
...
//   Reset the preset value before enabling the axis:
CtrlV_fm_ISumPreset := 0;

//   Enable the axis
MotionPower(Axis1, Enable);

//   Initialize the parameters for torque-controlled shut-off
Torq_fm_IqTripValue := 0.5;        //  Torque-controlled shut-off
                                       value (current) [A]
Torq_nm_IqTripCnt := 10;           //  Torque-controlled shut-off
                                       count
Torq_nm_SpeedTripVal := 300;       //  Speed tripping value [rpm]
                                   //
CtrlV_fm_ISumPreset := 3;          //  Speed controller preset [A]
                                   //
Torq_nm_ZeroSpeedCnt := 5;         //  Filter of zero speed count
                                   //

//   Start motion
```

```
MotionMovePtp(Axis1,<<Target Position>>, <<Speed>>, <<Destination
Window>>);

//   When reaching a defined position, decelerate
When MC_fm_PosAct > DEFINED_POSITION Continue;
MotionMovePtp(Axis1, New Speed, <<Speed>>);

//   Wait, until speed has been reached:
When MotionReadStatus(Axis1, Maximum Speed) Continue;

//   Activate torque-controlled shut-off mode 1
JM_nm_Cmd:= 28;
When JM_nm_Status.13 Continue;       //  Wait for busy-bit

//   Wait, until torque or target position have been reached
When Torq_nm_IqTripState <> 1 Or MotionReadStatus(Axis1, In
Destination Window) Continue;

//   Evaluate WHEN statement
If Torq_nm_IqTripState <> 1 Then

 //  Torque has been reached, axis is stopped
 WHEN BitSet(Torq_nm_IqTripState, 2) Continue;

 //  Torque-controlled shut-off has been ended; to be continued by
     homeward voyage, for example:
 MotionMovePtp(Axis1, <<Target Position>>);
 ...

Else

 //  Destination window has been reached without reaching the torque.
 //  To be continued by blocking the axis, for example:
 MotionStop(Axis1);

End if;
...
```

18.8.2 Sample program - Mode 2

```
...
//   Reset the preset value before enabling the axis:
CtrlV_fm_ISumPreset := 0;

//   Enable the axis
MotionPower(Axis1, Enable);

//   Initialize the parameters for torque-controlled shut-off
Torq_fm_IqTripValue := 0.5;          //  Torque-controlled shut-off
                                         value (current) [A]
Torq_nm_IqTripCnt := 10;             //  Torque-controlled shut-off
                                         count
Torq_nm_SpeedTripVal := 300;         //  Speed tripping value [rpm]
                                     //
```

```
CtrlV_fm_ISumPreset := 3;           //  Speed controller preset [A]
                                    //
Torq_fm_IqHoldValue := 0.8;         //  Holding current [A]
                                    //

//   Start motion
MotionMovePtp(Axis1,<<Target Position>>, <<Speed>>, <<Destination
Window>>);

//   When reaching a defined position, decelerate
When MC_fm_PosAct > DEFINED_POSITION Continue;
MotionMovePtp(Axis1, New Speed, <<Speed>>);

//   Wait, until speed has been reached:
When MotionReadStatus(Axis1, Maximum Speed) Continue;

//   Activate torque-controlled shut-off mode 2
JM_nm_Cmd:= 27;
When JM_nm_Status.13 Continue;      //  Wait for busy-bit

//   Wait, until torque or target position have been reached
When Torq_nm_IqTripState <> 1 Or MotionReadStatus(Axis1, In
Destination Window) Continue;

//   Evaluate WHEN statement
If Torq_nm_IqTripState <> 1 Then

 //   Torque has been reached, axis is stopped
 WHEN BitSet(Torq_nm_IqTripState, 2) Continue;

 //   Torque-controlled shut-off has been ended; to be continued for
      example:

 //   Tripping time
 Delay(<<Tripping Time>>);

 //   IMPORTANT: For resetting the axis to normal position control
 JM_nm_Cmd:= 4;  // Re-initializing the position generator
 When JM_nm_Status.13 Continue;     //  Wait for busy-bit

 //   Homeward voyage
 MotionMovePtp(Axis1, <<Target Position>>);
 ...

Else

 //   Destination window has been reached without reaching the torque.
 //   To be continued by blocking the axis, for example:
 MotionStop(Axis1);

End if;
...
```

18.9 Register Description

Register 136: Status of Torque-Controlled Shut-Off	
Function	**Description**
Read	Status of torque-controlled shut-off
Write	Illegal
Variable type	int / register
Value range	Bit-coded, 3 bits
Value following a reset	0

Meaning of the individual bits:	
Bit 0	1 = torque-controlled shut-off is active
Bit 1	1 = Current shut-off current has been exceeded; the axis is stopped
Bit 2	Torque-controlled shut-off has been ended

At command 27 and 28, bit 0 is set, while all other bits are cleared. At command 29, all bits are cleared.

Register 137: Current Shut-Off Value	
Function	**Description**
Read	As-is shut-off value
Write	New shut-off value
Amplifier status	No specific status
Takes effect	Immediately
Variable type	float
Value range	0 ... R502 [A_{eff}]
Value following a reset	0

The shut-off value can only be set as an amount of current. However, this setting applies to both current directions. With the help of the motor constant K_T [Nm/A] specified in the motor data sheet, the shut-off count can be converted into a torque generated by the motor.

Register 138: Torque-Controlled Shut-Off Count	
Function	**Description**
Read	As-is number of measuring values
Write	New number of measuring values
Amplifier status	No specific status
Takes effect	Immediately
Variable type	int / register
Value range	0 ... 32,767
Value following a reset	0

The number of measuring values that have to be greater than the current shut-off value of R137, is written to R138, before torque-controlled shut-off is activated. This is like a filter for the current shut-off value. Even if just one single measured current value is smaller than the current shut-off value, the internal counter for this filter function is reset to zero.

The current measuring values are registered in a frequency of 16 kHz.

Register 139: Speed Tripping Value	
Function	**Description**
Read	As-is torque-controlled shut-off count
Write	New torque-controlled shut-off count
Amplifier status	No specific status
Takes effect	Immediately
Variable type	int / register
Value range	0 ... 32,767 [rpm]
Value following a reset	150

At reaching the speed tripping count, the integral-action component of the speed controller is set to the value of R506 *Speed Controller Preset*.

Register 607: Holding Current	
Function	**Description**
Read	As-is holding current
Write	New holding current
Amplifier status	No specific status
Takes effect	Immediately
Variable type	float
Value range	0 ... R502 [A_{eff}]
Value following a reset	0

R607 is exceptionally reserved for mode 2 of torque-controlled shut-off.

After the axis has been stopped by torque deactivation, the holding current moves or presses the axis against the obstacle until the user program ends this. It might, for example, block the axis by issuing command 2.

The holding current is entered as a current amount. Accordingly, it will affect both current directions. With the help of the motor constant K_T [Nm/A] specified in the motor data sheet, the shut-off count can be converted into a torque generated by the motor.

Please Note!

When the holding current is 0, the value of R137 *Torque-Controlled Shut-Off Value* is used as a holding current after incrementation (compatible with older versions).

Register 630: Filter of Zero Speed Count	
Function	**Description**
Read	As-is number of measuring values
Write	New number of measuring values
Amplifier status	No specific status
Takes effect	Immediately
Variable type	int / register
Value range	0 ... 32.767
Value following a reset	10

R630 is exceptionally reserved for mode 1 of torque-controlled shut-off.

The number of speed measuring values that have to be smaller than 0.5 % of the maximum motor speed (R118), before the operating system sets bit R136.2 *Current shut-off ended*. Even if just one single measured speed value is greater than 0.5 % of the maximum motor speed, the internal counter for this filter function is reset to zero.

19 Further Functions

19.1 Oscilloscope

The oscilloscope function can be applied any time with any operating mode of the JetMove. The following registers can also be used with the oscilloscope function in JetSym:

Parameters	
Positioning	
R109	As-is Position
R129	As-is Mechanical Speed
R144	Set Speed (Load)
Position feedback controller	
R119	As-is Tracking Error
R130	Position Controller Setpoint
Speed controller	
R111	Speed Controller Setpoint
R112	As-is Motor Speed
R507	I-Component Speed Controller
Current controller	
R125	Current Setpoint
R127	Current Limitation
R561	As-is Current
Motor	
R562	Motor Temperature
R565	As-is shaft position
Monitoring	
R119	As-is Tracking Error
R646	I^2t Input
R648	As-is I^2t Input in R647

Parameters	
Amplifiers	
R560	DC Link Voltage
R563	As-is Temperature
R564	As-is Ballast Load
R566	Input Current
R567	Mains Voltage
R568	As-is Board Temperature
Technological functions	
R188	Leading Axis Position
R189	Leading Axis Speed
PID controller	
R202	Setpoint
R209	As-is Value
R219	Control Deviation
R221	Measuring Value Analog Input 1
R225	Regulated Value
Referencing on the fly	
R455	As-is Position Deviation
R458	As-is Speed Correction

19.2 Trailing Indicator

The JetMove always evaluates the following tracking indicators:

- Min. / Max. value of the as-is position (R109)
- Min. / Max. value of the tracking error value (R119)

By writing to the trailing indicator registers, the tracking indicators are reset to zero.

19.2.1 Trailing indicator - As-is position

The slave pointers referring to the as-is position can be read out of the following registers:

Register 438: Trailing Indicator - Max. As-is Position Value	
Function	**Description**
Read/Write	Maximum as-is position since last reset to zero
Variable type	float
Value range	Float limits [°] or [mm]
Value following a reset	0 [°]

Register 439: Trailing Indicator - Min. As-is Position Value	
Function	**Description**
Read	Minimum as-is position since last reset to zero
Variable type	float
Value range	Float limits [°] or [mm]
Value following a reset	0 [°]

19.2.2 Trailing indicator - Tracking error

By means of the slave pointers referring to the tracking error value, a tolerance band for motions in position differences can be determined. Slave pointer values can be read out of the following registers:

Register 538: Trailing Indicator for Tracking Error in Positive Direction	
Function	**Description**
Read	Max. tracking error since last reset to zero
Variable type	float
Value range	Float limits [°] or [mm]
Value following a reset	0 [°]

Register 539: Trailing Indicator for Tracking Error in Negative Direction	
Function	**Description**
Read	Min. tracking error since last reset to zero
Variable type	float
Value range	Float limits [°] or [mm]
Value following a reset	0 [°]

19.3 Triggered Emergency Stop Ramp

JetMove provides the possibility to trigger an emergency stop ramp by means of the INPUT signal.

The operating principle is as follows:

While the function is active, the operating system of the JetMove is monitoring INPUT. When the input has been activated (the polarity settings have to be considered!), the operating system automatically carries out an emergency stop ramp. It further blocks the output stage at the end of the emergency stop ramp.

To release the output stage again, INPUT has to be reset to "deactivated".

The function is activated by writing 1 to R557. It is deactivated by writing 0 to R557.

The emergency stop ramp activated by this function is carried out in all operating modes except in the *current control* mode.

20 Generally Valid Parameters

Registers are the interface between the user and the amplifier. Every register has got an unambiguous number and a name. Below, all available registers are explained; they are classified according to function groups and register sets.

Description of the register block:

Function	Description
Read	Reading action
Write	Writing action
Amplifier status	Required amplifier status for the writing action
Takes effect	Instant or condition of a writing action taking effect
Variable type	The data type for being placed in the JetSym setup window is specified; it defines, whether decimal positions can be input or not: – float: Decimal positions can be input – int (integer) / register: Decimal positions cannot be input
Value range	Beginning and end of the permitted value range
Value following a reset	Register value after activating, respectively resetting the amplifier

20.1 Control Parameters

Register 101: Command	
Function	**Description**
Read	Latest command
Write	Giving a new command
Amplifier status	No specific status
Takes effect	Wait for the busy-bit in the status to be reset
Variable type	int / register
Value range	0 ... 32,767
Value following a reset	0

Attention:

When a command has been given, the PLC program cannot make another access to the amplifier, unless the busy-bit in the status register has been reset by the amplifier.

Commands:

The following commands are available:

1	Activate the output stage
2	Deactivate the output stage
3	Set the reference (as-is position = target position, also considering the tracking error)
4	Re-initialize the position generator
5	Stop positioning by the maximum deceleration rate that is permitted (see R180)
6	Stop positioning by the deceleration ramp (R106)
7	Stop an axis motion by the emergency stop ramp (R549) **ATTENTION:** When the ramp has been covered, the output stage is automatically deactivated.
8	Acknowledge an error
9	Search for reference
10	Start an absolute positioning run
11	Start an absolute positioning run related to time
12	Change an absolute target position
13	Change a speed value
14	Reset bit 100.0 *Home position is set*
15	Change an acceleration value
16	Change a deceleration value
20	Start a relative positioning run
22	Change a relative target position
27	Activate torque-controlled shut-off, mode 2
28	Activate torque-controlled shut-off, mode 1
29	Deactivate torque-controlled shut-off
31	Start commutation finding

The following commands are available:

34	Activate position capture
35	Deactivate position capture
44	Couple the following axis by coupling mode *Electronic Gearing*
45	Decouple of the following axis from the coupling modes
46	Couple the following axis by coupling mode *Table*
56	Start an endless positioning run **Attention!** Endless positioning is only allowed, if the axis is set to modulo mode. The direction of rotation is defined via register 142.
57	Reverse an endless positioning run **PLEASE NOTE:** Command 57 is used in order to reverse an endless positioning run that has already been started. This means that the as-is motion direction is reversed.

Register 450: Status	
Function	**Description**
Read	As-is function status
Write	Set function status
Amplifier status	No specific status
Takes effect	Immediately
Variable type	int / register
Value range	0 ... 65,535
Value following a reset	0

In function mode (R451) 2, 3, 4, 5, the number of correct trigger signals is displayed in this register, see “Special Function: Referencing on the Fly” on page 313. This number can be set to zero any time by writing into this register. In function mode 4 and 5 (R451), the register is set to zero automatically at the end of the correction run.

Register 451: Function Mode	
Function	**Description**
Read	As-is function mode
Write	Set function mode
Amplifier status	No specific status
Takes effect	Immediately
Variable type	int / register
Value range	0 ... 5
Value following a reset	0

Meaning of the values:

0 : No function active

1 : Virtual master

2 : Referencing on the fly to the position of the leading axis* (possible for leading axis module JX2-CNT1 only)

3 : Referencing on the fly onto the own position*

4 : see 2, but as Single Shot*

5 : see 3, but as Single Shot*

6 : see 1, but start towards triggering as Single Shot*

7 : Software trigger for mode 6

* see “Special Function: Referencing on the Fly” on page 313.

In function mode 4 and 5, the value is automatically reset to zero, when the next correction run of referencing on the fly has been finished.

Register 514: Input Edge	
Function	**Description**
Read	As-is input edge
Write	Set input edge
Amplifier status	No specific status
Takes effect	Immediately
Variable type	int / register
Value range	0 ... 3
Value following a reset	1

Meaning of the values:

0 : The input is deactivated; trigger signals are not evaluated

1 : A rising edge is evaluated as a trigger signal

2 : A falling edge is evaluated as a trigger signal

3 : Both a rising and a falling edge are evaluated as a trigger signal (*

(* The respective value is not available for JM-D203

On the JM-D203, the terminal point INPUT is on plug-in connectors X72, respectively X82, and on all other JM-2xx on plug-in connector X10.

The terminal point INPUT is used for the following special function:

- Referencing on the fly
- Position capture

Register 527: Dead Time Interrupt INPUT = Dead Time Correction INPUT	
Function	**Description**
Read	As-is dead time correction
Write	Set dead time correction
Amplifier status	No specific status
Takes effect	Immediately
Variable type	float
Value range	0 ms ... 5 ms
Value following a reset	0.4 ms

Dead time compensation for the additional digital input INPUT. The input INPUT used for the special function *Referencing on the fly*, for example.

Register 540: Drive Mode	
Function	**Description**
Read	As-is state value of drive mode 1
Write	New state value of drive mode 1
Amplifier status	The amplifier has to be deactivated
Takes effect	Immediately
Value range	Bit-coded, 16 bits
Value following a reset	0b 00000010 1001x011

(* The respective bits are not available for JM-105 and JM-D203

Meaning of the individual bits:

Bit 0: Automatic control of the brake by means of the amplifier

0 = Manual control by the user (via R574, bit 0)

1 = Automatic control by the amplifier

Value following a reset: 1

Bit 1: Automatic control of the ventilator placed in the amplifier (*

0 = The ventilator is always switched on

1 = Depending on the respective temperature, the ventilator automatically switched off or switched on

Value following a reset: 1

Bit 2: RESERVED

Bit 3: Phase monitoring

Here, the decision is made, whether, in 3-phase-mode, phase monitoring is to be activated or not. If phase monitoring has been activated, yet not all three phases are active, error message F02 is output.

0 = Phase monitoring has been deactivated

1 = Phase monitoring has been activated

Value following a reset: JM-204, JM-208, and JM-215: 1; JM-203, JM-206, and JM-206B: 0

Bit 4: Motor cable monitoring (**

Meaning of the individual bits:

Here, a decision is made, whether motor cable monitoring is to be carried out or not. Switching off might be necessary in case of long motor cables. When motor cable monitoring has been activated, and when a ground fault of the motor or a motor cable break have been detected, error message F03 is output.

0 = Motor cable monitoring has been deactivated

1 = Motor cable monitoring has been activated

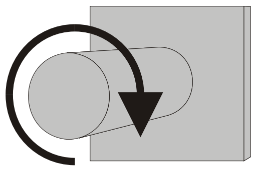
Value following a reset: 1

Bit 5: Speed reversal

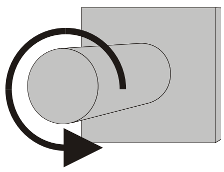
By means of this bit, for all axis motions (position, speed and current control), the direction of rotation is reversed.

ATTENTION:
Please mind correct assignment of the hardware limit switches

0 = Positive direction of rotation (clockwise rotation of the motor shaft, looking at the shaft from the A-side; the set values are positive)



1 = Negative direction of rotation (counterclockwise rotation of the motor shaft, looking at the shaft from the A-side; the set values are positive)



Value following a reset: 0 (positive direction of rotation)

Bit 6: Software limit switch

0 = The software limit switch evaluation has been deactivated

1 = The software limit switch evaluation has been activated

Value following a reset: 0

Bit 7: Hardware limit switch

0 = The hardware limit switch evaluation has been deactivated

1 = The hardware limit switch evaluation has been activated

Value following a reset: 1

Bit 8: RESERVED

Meaning of the individual bits:

Bit 9: JetMove 2xx at the NANO / ConMove

This bit is only useful, if the JM-2xx is used in connection with a NANO-CPU or a ConMove.
For using a JM-2xx in connection with a JC-24x, the bit must be set to 1; this is also the default value.

Value following a reset: 1

(* The respective bits are not available for JM-105 and JM-D203
(T**he respective bits are not available for JM-105

Register 541: Operating Mode of the 7-Segment Display	
Function	**Description**
Read	Number of the as-is operating mode
Write	Set number of the operating mode
Variable type	int / register
Value range	0 ... 1
Value following a reset	0

See JetMove 2xx operator's manual
This register is not available for JM-105.

Meaning of the values:

0 : Normal operation

1 : Installation

Register 557: Operating Mode - Trigger Input	
Function	**Description**
Read	As-is operating mode of the trigger input
Write	Set operating mode
Amplifier status	No specific status
Takes effect	Immediately
Variable type	int / register
Value range	0 ... 1
Value following a reset	0

Here, the operating mode for the digital input of the JetMove called INPUT is specified.

Meaning of the values:

0 : No function active

1 : Triggered emergency stop ramp is active

Register 572: Set Operating Mode	
Function	**Description**
Read	Number of the as-is set operating mode
Write	Set number of the set operating mode
Amplifier status	The amplifier has to be deactivated
Takes effect	Next activation of the amplifier
Variable type	int / register
Value range	101, 102, 103
Value following a reset	103

Here, the operating mode for the controller is set.

Meaning of the values:

101 : Current control (only the current control is active)
A set current value can be input via register 125

102 : Speed control (current control and speed control are active)
A set speed value can be input via register 111

103 : Position control (current control, speed control and position control are active)

Register 573: As-Is Operating Mode	
Function	**Description**
Read	Value of the as-is operating mode
Write	Illegal
Variable type	int / register
Value range	101 ... 103
Value following a reset	103

Here, the as-is operating mode the controller had when the output stage was switched on last, can be read.

Meaning of the values:

101 : Current control (only the current control is active)

102 : Speed control (current control and speed control are active)

103 : Position control (current control, speed control and position control are active)

Register 574: Control Word 2 (Motor Brake Control)	
Function	**Description**
Read	Value of the as-is control word
Write	Set value of the control word
Variable type	int / register
Value range	Bit-coded, 24 bits
Value following a reset	0

Meaning of the individual bits:

Bit 0: Manual control of the brake

0 = Lock brake 1 = Release the brake

(A requirement for manual control: In register 540 "Drive Mode 1", bit 0 must be set to "Manual operation by the user".)

Register 575: Status Word 2 (Motor Brake Status)	
Function	**Description**
Read	Value of the as-is status word
Write	Illegal
Variable type	int / register
Value range	Bit-coded, 24 bits
Value following a reset	0

Meaning of the individual bits:

Bit 0: Brake

0 = The brake is locked / the relay contacts have been released

1 = The brake has been released / the relay contacts are locked

20.2 Diagnostics Parameters

Register 100: Status	
Function	**Description**
Read	As-is status
Write	Illegal
Variable type	int / register
Value range	Bit-coded, 24 bits
Value following a reset	0

From here, the amplifier status can be read. It contains information on the most important amplifier parameters.

Meaning of the individual bits:

Bit 0:	Home position set Bit 0 is reset at F09 *Malfunction encoder 1* respectively F42 *Malfunction encoder 2*. Resetting due to F09 respectively F42 relates to R190 *Position Control - As-is Value* as follows: R190 = 1 and malfunction encoder 1 (F09): R100.0 is reset R190 = 1 and malfunction encoder 2 (F42): R100.0 remains unchanged R190 = 2 and malfunction encoder 1 (F09): R100.0 remains unchanged R190 = 2 and malfunction encoder 2 (F42): R100.0 is reset
Bit 1:	Stopped
Bit 2:	Target window
Bit 3:	-
Bit 4:	Hardware limit switch negative
Bit 5:	Hardware limit switch positive
Bit 6:	Reference switch
Bit 7:	Software limit switch, negative
Bit 8:	Software limit switch, positive
Bit 9:	"Safe Standstill" option is available
Bit 10:	The power section is ready for operation
Bit 11:	Power has been released
Bit 12:	Setup mode active

Meaning of the individual bits:

Bit 13:	Busy Bit: 1 = Amplifier is busy: Neither can a command be given, nor can a register be read or written into. 0 = Amplifier is ready: A command be given; a register can be read or written into. The busy bit is set for the following actions: Giving a command via R101, and writing into the following registers: R156, R180, R181, R184.
Bit 14:	The maximum positioning speed has been reached (the axis has driven beyond the range of the ramps)
Bit 15:	Acceleration ramp
Bit 16:	Deceleration ramp
Bit 17:	-
Bit 18:	Message
Bit 19:	Errors
Bit 20:	Warning
Bit 21:	The pulses havee been released (hardware release)

Register 170: Referencing Error / Positioning Error / Table	
Function	**Description**
Read	As-are errors
Write	Illegal
Variable type	int / register
Value range	Bit-coded, 24 bits
Value following a reset	0

As-are errors can be read here during referencing or positioning.

Attention!

A number of these errors will NOT be shown on the display of the JetMove 2xx.

Meaning of the individual bits:

Bit 16: Machine referencing: Max. distance reference search

The permitted maximum distance of reference search has been exceeded. The distance can be set via register 167 "Max. Distance Reference Search".

Bit 17: Machine referencing: Max. distance switch search

The permitted maximum distance of switch search has been exceeded. The distance can be set via register 164 "Max. Distance Switch Search".

Bit 18: Machine referencing: Positive limit switch

Reference switch type consisting of reference and limit switch:
The positive limit switch has been found after changing direction at the negative limit switch during a reference run in negative direction.

Reference switch type, with limit switch only:
The positive limit switch has been found after changing direction at the negative limit switch during a reference run in negative direction.

Reference switch type, with reference switch only:
The positive limit switch has been found during a reference run in positive direction.

Bit 19: Machine referencing: Negative limit switch

Reference switch type consisting of reference and limit switch:
The negative limit switch has been found after changing the direction at the positive limit switch during a reference run in positive direction.

Reference switch type, with limit switch only:
The negative limit switch has been found after changing the direction at the positive limit switch during a reference run in positive direction.

Reference switch type, with reference switch only:
The negative limit switch has been found during a reference run in negative direction.

Bit 20: Coupling mode *Table*: Faulty leading axis positioning range

The leading position range that stretches between the first and the last table node is zero. For the operating system, this means that the leading axis is not moving. Table nodes between the first and the last table node are not checked in this case.

Bit 21: Coupling mode *Table*: The table configuration is invalid

The table configuration is not correct in the index specifications both in R411 *Index - First Table Node* and R413 *Index - Last Table Node*, e.g. R411 >= R413.

Register 580: Warnings Mask	
Function	**Description**
Read	As-is warnings mask
Write	Set warnings mask (This can only be changed with an expert's access authorization)
Variable type	int / register
Value range	Bit-coded, 24 bits
Value following a reset	0b 00000000 0000001 11111111

In the warnings mask, a definition can be made of which warnings are to be displayed and which are not. The assignment of bits can be taken out of the description of register 581 "Warnings".

Meaning of the values:

0 : The warning is not displayed

1 : The warning is displayed

Register 581: Warnings	
Function	**Description**
Read	As-is Warnings
Write	Warnings are reset
Variable type	int / register
Value range	Bit-coded, 24 bits
Value following a reset	0

Meaning of the individual bits:

Bit 0:	W00 Warning threshold ballast resistor overload	(*
Bit 1:	W01 Warning threshold for device temp.	
Bit 2:	W02 Warning threshold for motor temp.	(*
Bit 3:	W03 Overload PFC	(*
Bit 4:	W04 Input overcurrent	(*
Bit 5:	W05 Warning threshold for board temp.	(*
Bit 6:	W06 Warning threshold mains power	(*

Meaning of the individual bits:

Bit 7:	W07 Warning threshold I²t error
Bit 8:	W08 Warning threshold motor overload protection according to UL
Bit 9:	W09 Short circuit of the digital outputs (JM-204, JM-208, JM-215, JM-225)

(* The respective bits are not available for JM-105

Register 582: AutoClear Mask for Warnings	
Function	**Description**
Read	As-is AutoClear mask
Write	Set AutoClear mask
Amplifier status	Expert access authorization has to be set
Takes effect	The access authorization is valid, when the next warning occurs
Variable type	int / register
Value range	24 bit
Value following a reset	0b 00000000 00000000 00000001 11111111

Definitions to be made via AutoClear mask:

- Which warnings are to be automatically reset by the amplifier, as soon as they are not relevant any more
- Which warnings are to be manually reset by the user

Manual resetting is carried out by writing into the respective bit in register 581 "Warnings".

Meaning of the statuses of each bit:

0 : The warning is manually reset by the user

1 : The warning is automatically reset by the amplifier

The bit assignment can be taken from the description of register 581 "Warning"; this means bit 0 = W00 Warning threshold for ballast, bit 1 = W00 Warning threshold device temperature, etc.

Register 584: Error Mask	
Function	**Description**
Read	As-is error message enable mask for errors of numbers 00 through 31
Write	Set error message enable mask
Amplifier status	Expert access authorization has to be set
Takes effect	The access authorization takes effect, when the next error occurs
Variable type	int / register
Value range	Bit-coded, 32 bits
Value following a reset	0b 11111111 11111111 11111111 11111111

By means of the error mask, a definition can be made for each error, whether the amplifier is to give an error message in case of an error or not.

Meaning of the statuses of each bit:

0 : An error message is not given

1 : An error message is given

Please take the bit assignment from the description of register 585 "Error 00 ... 31", which means bit 0 = F00 Hardware error, bit 1 = F01 Internal voltage supply error, etc.

Register 585: Error 00 ... 31	
Function	**Description**
Read	As-is errors numbered 00 through 31
Write	Illegal
Variable type	int / register
Value range	Bit-coded, 32 bits
Value following a reset	0

Meaning of the individual bits:

Bit 0:	F00 Hardware error	
Bit 1:	F01 Internal voltage supply error	(**
Bit 2:	F02 One mains phase has failed	(*
Bit 3:	F03 Motor or cable fault	(**

Meaning of the individual bits:

Bit 4:	F04 DC link overvoltage U_{ZK}
Bit 5:	F05 Current overload
Bit 6:	F06 Overload internal ballast resistor (**
Bit 7:	F07 Shutdown threshold for device temp.
Bit 8:	F08 Shutdown threshold for motor temp. (**
Bit 9:	F09 Encoder error
Bit 10:	F10 Overspeed
Bit 11:	F11 Current overrange
Bit 12:	F12 Earth fault (*
Bit 13:	F13 EEPROM failure (**
Bit 14:	F14 AVR timeout (**
Bit 15:	F15 Pulse enable failure
Bit 16:	F16 Input overcurrent (**
Bit 17:	F17 Software limit switch
Bit 18:	F18 Limit switch hardware error Referencing: The same hardware limit switch is pressed twice within a short time.
Bit 19:	F19 Timeout external error reaction
Bit 20:	F20 U_{ZK}, DC link voltage min. trip
Bit 21:	F21 U_{ZK}, DC link voltage max. trip
Bit 22:	F22 Drive blocked
Bit 23:	F23 Tracking error
Bit 24:	F24 Power supply 24 V failure (*
Bit 25:	F25 Power supply 15 V failure (*
Bit 26:	F26 Power supply 5 V failure (*
Bit 27:	F27 Power supply AVR failure (**
Bit 28:	F28 Error in power charging circuit (this is only possible with JM-D203, JM-203B, JM-204, JM-208, JM-215, and JM-215B)
Bit 29:	F29 Mains power too high (**
Bit 30:	F30 I^2t error
Bit 31:	F31 Motor overload protection according to UL

(* These errors do not occur in JM-105 and JM-D203.
(** These errors do not occur in JM-105.

In your amplifier manual, you will find a detailed error description.

Register 586: Error 32 ... 63	
Function	**Description**
Read	As-is errors numbered 32 through 63
Write	Illegal
Variable type	int / register
Value range	Bit-coded, 32 bits
Value following a reset	0

Meaning of the individual bits:

Bit 0:	F32 External error class A	
Bit 1:	F33 External error class B	
Bit 2:	F34 External error class C	
Bit 3:	F35 External error class D	
Bit 4:	F36 External error class E	
Bit 5:	F37 External error class F	
Bit 6:	F38 Encoder signal assymmetric	
	The two encoder signals sine and cosine (presently in the resolver only) differ in their amplitude by more than 5 %.	
Bit 7:	F39 Error at commutation finding	
Bit 8:	F40 Overload motor brake	(*
Bit 9:	F41 Overload encoder supply	(*
Bit 10:	F42 Malfunction Encoder 2	(***

(* These errors only exist in JM-105 and JM-D203
(** This error only exists in JM-D203
(*** These errors do not occur in JM-105 and JM-D203

20.3 Amplifier Parameters

Register 500: Rated Voltage of the Device	
Function	**Description**
Read	Value of the as-is rated voltage
Write	Illegal
Variable type	int / register
Value range	48 [V] (JM-105) 230 [V] (JM-203 and JM-206) 400 [V] (JM-204, JM-208 and JM-215)
Value following a reset	Dependent on the amplifier type (particulars can be found on the identification plate of the respective device)

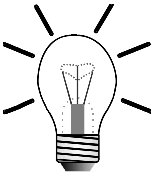
From here, the rated voltage of the device can be read out.

Register 501: Rated Current of the Device	
Function	**Description**
Read	Value of the as-is rated voltage of the device
Write	Illegal
Variable type	float
Value range	3 ... 15 [A_{eff}]
Value following a reset	Dependent on the amplifier type (particulars can be found on the identification plate of the respective device)

From here, the continuous rated current of the device can be read out.

Register 508: PWM Frequency	
Function	**Description**
Read	Value of the as-is PWM frequency
Write	Set value of the PWM frequency
Amplifier status	The amplifier has to be deactivated
Takes effect	Immediately
Value range	8, 16 [kHz]
Value following a reset	16 [kHz] for JM-105, JM-D203, JM-203, and JM-206 8 [kHz] for JM-204, JM-208, and JM-215

With a JM-105 and JM-D203, the PWM frequency cannot be altered.
Here, the frequency of the output pulse can be altered.



Attention!

Only instructed personnel is to make alterations on the register value.

Register 560: DC Link Voltage	
Function	**Description**
Read	As-is DC link voltage
Write	Illegal
Variable type	int / register
Value range	0 ... 640 [V]
Value following a reset	0 [V]

Here, the latest DC link voltage can be read.

Register 563: As-Is Temperature (of the device)	
Function	**Description**
Read	As-is value of the device temperature
Write	Illegal
Variable type	int / register
Value range	1 ... 95 [°C]
Value following a reset	0 [°C]

Here, the as-is internal temperature of the device can be read.

Register 564: As-Is Ballast Load	
Function	**Description**
Read	As-is value of the ballast load
Write	Illegal
Variable type	int / register
Value range	0 ... 100 [%]
Value following a reset	0 [%]

Here, the as-is load of the internal ballast resistor can be read.
This register is not available for the JM-105.

Register 566: Input Current	
Function	**Description**
Read	As-is input current
Write	Illegal
Variable type	float
Value range	0 ... 25.5 [A_{eff}]
Value following a reset	0 [A_{eff}]

The as-is input current value of the supply feed can be read out here.
This register is not available for the JM-105.

Register 567: Mains Voltage	
Function	**Description**
Read	As-is mains voltage
Write	Illegal
Variable type	int / register
Value range	0 ... 520 [V_{eff}]
Value following a reset	0 [V_{eff}]

The as-is input current value of the supply feed can be read out here.
This register is not available for the JM-105.

Register 568: As-Is Board Temperature	
Function	**Description**
Read	As-is value of the board temperature
Write	Illegal
Variable type	int / register
Value range	20 ... 75 [°C]
Value following a reset	0 [°C]

Here, the as-is temperature of the controller board can be read.
This register is not available for the JM-105.

Register 576: Interfaces - Access Level	
Function	**Description**
Read	As-is access level
Write	Set access levels
Amplifier status	The amplifier has to be deactivated
Takes effect	Immediately
Variable type	int / register
Value range	0 ... 65,535
Value following a reset	0

In this register, access authorization for the register interface is defined. There are two kinds of access authorization:

0 = Standard user access authorization
1 = Expert user access authorization

In order to specify expert user access authorization, a respective code must be written into this register. If a new user access authorization has been specified successfully, the respective number, as quoted above, is read out. Certain registers can only be modified, if the user has got the expert access authorization. If for changing the value of a register, expert user access authorization is needed. This is pointed out in the register description.

Assigning access authorization is a safety precaution for the protection of persons and assets.

Register 606: Ballast Threshold	
Function	**Description**
Read	As-is ballast threshold
Write	Set ballast threshold
Variable type	int / register
Value range	10 ... 60 [V]
Value following a reset	55

Starting from the set ballast threshold, excess energy that might be generated at decelerating an axis, is integrated into the externally connected braking resistor.

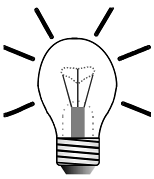
This register is available for the JM-105.

Register 997: OS Build Version	
Function	**Description**
Read	Value of the as-is revision state
Write	Illegal
Variable type	int / register
Value range	0.0.0.0 ... FF.FF.FF.FF (IP format)
Value following a reset	Dependent on the revision state

From here, the number of the operating system software build version can be read out. It has to be presented in IP format. Interpreting the value:

2.09.0.12	=	Version 2.09, Branch 0, Debug-Version 12
2	=	Major version
09	=	Minor version
0	=	Branch
12	=	Debug version

The version number is combined of the major and minor version number.
A branch is an "offshoot" or a parallel development of a function.
If the branch number and the debug version number is zero, this is an official operating system version.



Attention!

When submitting technical support queries, the number of the software version has to be quoted.

Appendices

Appendix A:Recent Revisions

Chapter	Comment	Revised	Added	Deleted
Chapter 13	Technological functions: Second encoder as a leading axis: • German "1." translated by "first" • German "2." translated by "second"	✓		
Chapter 13	Technological functions: Uncoupling by emergency stop ramp - procedure: C07 instead of C06	✓		

Appendix B: List of Abbreviations

AC	**A**lternating **C**urrent Alternating Current
DC V	**D**irect **C**urrent **V**oltage: Direct Current Voltage
EMC	**E**lectro **M**agnetic **C**ompatibility
ELCB	**E**arth-**L**eakage Current Breaker
GND	**G**rou**nd**: “Ground
HIPERFACE	**Hi**gh **Per**formance Inter**face**
Hz	Hertz
IEC	**I**nternational **E**lectrotechnical **C**ommission: "International Electrotechnical Commission"
IP	**I**nternational **P**rotection
JX2-SBK1	**J**etter E**x**tended Module **2** - **S**ystem bus**c**able **1.** The **2** stands for PROCESS-PLC NANO and JetControl 200
LED	**L**ight - **E**mitting **D**iode: "Light Emitting Diode"
n	Speed
NN	**N**ormal **N**ull = Sea Level
PE	**P**rotective **E**arth: "Protective Earth", respectively "Protective Earth Conductor"
PELV	**P**rotective **E**xtra **L**ow **V**oltage: "Protective Extra Low Voltage"
PFC	**P**ower **F**actor **C**ontrol: "Power Factor Control"
P_V	**P**ower loss ["**V**erlust" = loss]
PWM	**P**ulse **W**idth **M**odulation: "Pulse Width Modulation"
RS-485	**RS**: **R**ecommended **S**tandard - an accepted industry standard for serial communications connections. RS -485 is used for transmission distances over 15 m, two lines for differential mode evaluation; transmitting and sending on the same line.
SELV	**S**afe **E**xtremly **L**ow **V**oltage: Voltage up to 60 V, galvanically separated from the network.
SUB-D	Type name of a plug-in connector
Temp	**Temp**erature
U	Symbol for voltage (electric potential difference)

Appendix C: Register Overview by Numeric Order

In the column "R/W", the possibility of access to the parameter has been defined:

R = Read
W = Write

Register Number	Name	R/W	Description
100	Status	R	Functional group: Diagnostics Unit: - Default value: 0 Variable type: int / register page 397
101	Command	R/W	Functional group: Controller Unit: - Default value: 0 Variable type: int / register page 387
102	Target Position	R/W	Functional group: Positioning Unit: [°] or [mm] Default value: 0 [°] Variable type: float page 160
103	Target Speed	R/W	Functional group: Positioning Unit: [°/s] or [mm/s] Default value: 200 [°/s] Variable type: float page 162
104	Positioning Time	R/W	Functional group: Positioning Unit: [s] Default value: 0 Variable type: float page 163
105	Acceleration	R/W	Functional group: Positioning Unit: [°/s²] or [mm/s²] Default value: 500 [°/s²] Variable type: float page 164
106	Deceleration	R/W	Functional group: Positioning Unit: [°/s²] or [mm/s²] Default value: 500 [°/s²] Variable type: float page 166

Register Number	Name	R/ W	Description
107	Destination Window	R/ W	Functional group: Positioning Unit: [°] or [mm] Default value: 1 [°] Variable type: float page 167
109	As-is Position	R	Functional group: Positioning Unit: [°] or [mm] Default value: 0 [°] Variable type: float page 169
110	Position Feedback Controller Kv	R/ W	Functional group: Position feedback controller Unit: [1/s] Default value: 10 Variable type: float page 131
111	Speed Controller Setpoint	R/ W	Functional group: Speed controller Unit: [rpm] Default value: 0 Variable type: int / register page 123
112	As-is Motor Speed	R	Functional group: Speed controller Unit: [rpm] Default value: 0 Variable type: int / register page 123
113	Filter Time Constant T_f	R/ W	Functional group: Speed controller Unit: [ms] Default value: 2 Variable type: float page 124
114	Software Limit Switch, Positive	R/ W	Functional group: Monitoring Unit: [°] or [mm] Default value: 100,000 [°] Variable type: float page 92
115	Software Limit Switch, Negative	R/ W	Functional group: Monitoring Unit: [°] or [mm] Default value: -100,000 [°] Variable type: float page 93
116	Commutation Offset	R/ W	Functional group: Motor Unit: [°] Default value: 0 Variable type: float page 60

Register Number	Name	R/W	Description
117	Encoder Resolution	R/W	Functional group: Encoder Unit: [Increments / Revolutions] Default value: Dependent on the encoder Variable type: int / register page 73
118	Maximum Motor Speed	R/W	Functional group: Speed controller Unit: [rpm] Default value: 3,000 Variable type: int / register page 124
119	As-is Tracking Error	R	Functional group: Position feedback controller Unit: [°] or [mm] Default value: 0 [°] Variable type: float page 131
120	Tracking Error Limit	R/W	Functional group: Position feedback controller Unit: [°] or [mm] Default value: 10,000 [°] Variable type: float page 132
121	Magnetizing Current	R/W	Functional group: Current controller Unit: [A_{eff}] Default value: 0 Variable type: float page 109
122	Motor Slip Frequency	R/W	Functional group: Motor Unit: [Hz] Default value: 0 Variable type: float page 59
123	Pole Pair Number	R/W	Functional group: Motor Unit: - Default value: 3 Variable type: int / register page 60
124	Speed Controller Kp	R/W	Functional group: Speed controller Unit: - Default value: 10 Variable type: float page 125
125	Current Setpoint	R/W	Functional group: Current controller Unit: [A_{eff}] Default value: 0 Variable type: float page 110

Register Number	Name	R/ W	Description
126	Speed Controller Tn	R/ W	Functional group: Speed controller Unit: [ms] Default value: 20 Variable type: float page 125
127	Current Limitation	R/ W	Functional group: Current controller Unit: [A_{eff}] Default value: R502 Variable type: float page 110
128	Limitation of Set Speed	R/ W	Functional group: Speed controller Unit: [rpm] Default value: 3150 [rpm] Variable type: float page 127
129	As-is Speed	R	Functional group: Positioning Unit: [°/s] or [mm/s] Default value: 0 [°/s] Variable type: float page 170
130	Position Setpoint	R/ W	Functional group: Position feedback controller Unit: [°] or [mm] Default value: 0 [°] Variable type: float page 132
135	Modulo Turns	R	Functional group: Positioning Unit: - Default value: 0 Variable type: int / register page 170
136	Status of Torque-Controlled Shut-Off	R	Functional group: Torque-controlled shut-off Unit: - Default value: 0 Variable type: int / register page 376
137	Current Shut-Off Value	R/ W	Functional group: Torque-controlled shut-off Unit: [A_{eff}] Default value: 0 [A_{eff}] Variable type: float page 376

Register Number	Name	R/ W	Description
138	Filter of the Shut-Off Threshold	R/ W	Functional group: Torque-controlled shut-off Unit: - Default value: 0 Variable type: int / register page 377
139	Shut-Off Speed Value	R/ W	Functional group: Torque-controlled shut-off Unit: [rpm] Default value: 150 Variable type: int / register page 377
140	Ramp Type	R/ W	Functional group: Positioning Unit: - Default value: 1 (Sine square ramps) Variable type: int / register page 170
141	Positioning Mode	R/ W	Functional group: Positioning Unit: - Default value: 1 (absolute) Variable type: int / register page 171
142	Moving Direction	R/ W	Functional group: Positioning Unit: - Default value: 0 (positive direction) Variable type: int / register page 172
143	Basic Type	R/ W	Functional group: Positioning Unit: - Default value: 0 (latest target position) Variable type: int / register page 172
149	Absolute Target Position	R	Functional group: Positioning Unit: [°] or [mm] Default value: 0 [°] Variable type: float page 173
150	Time Mode	R/ W	Functional group: Technological functions Unit: [-] Default value: 0 Variable type: int / register page 188

Register Number	Name	R/ W	Description
151	Transmit Mode	R/ W	Functional group: Technological functions Unit: [-] Default value: 0 Variable type: int / register page 210
152	Receive Mode	R/ W	Functional group: Technological functions Unit: [-] Default value: 0 Variable type: int / register page 211
155	Counting Range JX2-CNT1	R/ W	Functional group: Technological functions Unit: [-] Default value: 16777216 Variable type: int / register page 212
156	Gear Ratio	R/ W	Functional group: Technological functions Unit: [-] Default value: 1 Variable type: float page 238
157	Standardizing Factor - Leading Axis Position	R/ W	Functional group: Technological functions Unit: [°/Ink] or [mm/Ink] Default value: 1 Variable type: float page 213
158	Maximum Leading Axis Position	R/ W	Functional group: Technological functions Unit: [°] or [mm] Default value: 100,000 [°] Variable type: float page 213
159	Minimum Leading Axis Position	R/ W	Functional group: Technological functions Unit: [°] or [mm] Default value: -100,000 [°] Variable type: float page 213
160	Referencing Direction	R/ W	Functional group: Referencing Unit: - Default value: 0 (positive direction) Variable type: int / register page 152

Register Number	Name	R/W	Description
161	SwitchType	R/W	Functional group: Referencing Unit: - Default value: 1 (Reference switch and limit switch) Variable type: int / register page 152
162	Speed of Switch Search	R/W	Functional group: Referencing Unit: [°/s] or [mm/s] Default value: 500 [°/s] Variable type: float page 153
163	Referencing Acceleration	R/W	Functional group: Referencing Unit: [°/s²] or [mm/s²] Default value: 1,000 [°/s²] Variable type: float page 154
164	Max. Distance Switch Search	R/W	Functional group: Referencing Unit: [°] or [mm] Default value: 100,000 [°] Variable type: float page 154
165	Reference Label	R/W	Functional group: Referencing Unit: - Default value: 1 (Referencing by zero pulse) Variable type: int / register page 155
166	Speed Reference Search	R/W	Functional group: Referencing Unit: [°/s] or [mm/s] Default value: 100 [°/s] Variable type: float page 156
167	Max. Distance Reference Search	R/W	Functional group: Referencing Unit: [°] or [mm] Default value: 100,000 [°] Variable type: float page 156
168	Home Position - Distance	R/W	Functional group: Referencing on the fly Unit: [°] or [mm] Default value: 0 [°] Variable type: float page 157

Register Number	Name	R/ W	Description
169	Home Position	R/ W	Functional group: Referencing on the fly Unit: [°] or [mm] Default value: 0 [°] Variable type: float page 157
170	Referencing Error / Positioning Error / Table	R	Functional group: Diagnostics Unit: - Default value: 0 Variable type: int / register page 398
180	Maximum Acceleration	R/ W	Functional group: Axis settings Unit: [°/s²] or [mm/s²] Default value: 100,000 [°/s²] Variable type: float page 27
181	Maximum Jerk	R/ W	Functional group: Axis settings Unit: [°/s³] or [mm/s³] Default value: 1,000,000 [°/s³] Variable type: float page 28
182	Travel Limit, Positive	R/ W	Functional group: Axis settings Unit: [°] or [mm] Default value: 100,000 [°] Variable type: float page 28
183	Travel Limit, Negative	R/ W	Functional group: Axis settings Unit: [°] or [mm] Default value: -100,000 [°] Variable type: float page 29
184	Maximum Speed	R/ W	Functional group: Axis settings Unit: [°/s] Default value: 18,000 Variable type: float page 29
188	Leading Axis Position	R/ W	Functional group: Technological functions Unit: [°] or [mm] Default value: 0 [°] Variable type: float page 214
189	Leading Axis Speed	R/ W	Functional group: Technological functions Unit: [°/s] or [mm/s] Default value: 0 [°/s] Variable type: float page 215

Register Number	Name	R/W	Description
190	Position Feedback Controller - As-is Value Selection	R/W	Functional group: Position controller Unit: - Default value: 1 ... 2 Variable type: int / register page 133
191	Axis Type	R/W	Functional group: Axis definitions Unit: - Default value: 2 (rotatory) Variable type: int / register page 20
192	Modulo Axis	R/W	Functional group: Axis definitions Unit: - Default value: 0 (no modulo axis) Variable type: int / register page 22
193	Modulo Travel Range	R	Functional group: Axis settings Unit: [°] or [mm] Default value: 360 [°] Variable type: float page 30
194	Gear Ratio - Motor	R/W	Functional group: Axis settings Unit: [rev.] Default value: 1 Variable type: float page 30
195	Gear Ratio - Mechanism	R/W	Functional group: Axis settings Unit: [rev.] Default value: 1 Variable type: float page 31
196	Gear Ratio - Linear / Rotatory	R/W	Functional group: Axis settings Unit: [°/rev] or [mm/rev.] Default value: 360 [°/rev.] Variable type: float page 31
200	Status Register	R	Functional group: PID controller Unit: [-] Default value: 0 Variable type: int / register page 342
201	PID Command	R/W	Functional group: PID controller Unit: [-] Default value: 0 Variable type: int / register page 342

Register Number	Name	R/ W	Description
202	Set Value	R/ W	Functional group: PID controller Unit: [%] Default value: 0 Variable type: float page 342
203	Proportional Gain K_P	R/ W	Functional group: PID controller Unit: [-] Default value: 1 Variable type: float page 343
204	Integral Time T_n	R/ W	Functional group: PID controller Unit: [ms] Default value: 100 Variable type: float page 343
205	Derivative Time T_V	R/ W	Functional group: PID controller Unit: [ms] Default value: 0 Variable type: float page 343
206	Delay Time T_1	R/ W	Functional group: PID controller Unit: [ms] Default value: 0 Variable type: float page 344
207	Limitation Integral-Action Component	R/ W	Functional group: PID controller Unit: [%] Default value: +100 Variable type: float page 344
208	Preset Integral-Action Component	R/ W	Functional group: PID controller Unit: [%] Default value: 0 Variable type: float page 344
209	PID As-is Value	R/ W	Functional group: PID controller Unit: [%] Default value: 0 Variable type: float page 344
210	As-is Value Filtering T_F	R/ W	Functional group: PID controller Unit: [ms] Default value: 0 Variable type: float page 345

Register Number	Name	R/ W	Description
211	Selection of the As-is Value	R/ W	Functional group: PID controller Unit: [-] Default value: 0 Variable type: int / register page 345
212	Selection of the Manipulated Variable	R/ W	Functional group: PID controller Unit: [-] Default value: 0 Variable type: int / register page 346
213	Selection of the Setpoint	R/ W	Functional group: PID controller Unit: [-] Default value: 0 Variable type: int / register page 347
214	Sampling Time T_S	R	Functional group: PID controller Unit: [ms] Default value: 2 Variable type: float page 347
215	Max. Value of the Manipulated Variable	R/ W	Functional group: PID controller Unit: [%] Default value: +100 Variable type: float page 347
216	Min. Value of the Manipulated Variable	R/ W	Functional group: PID controller Unit: [%] Default value: -100 Variable type: float page 347
217	Scaling Factor for the Manipulated Variable	R/ W	Functional group: PID controller Unit: [%] Default value: 1 Variable type: float page 348
218	Setpoint Value Filtering T_R	R	Functional group: PID controller Unit: [ms] Default value: 0 Variable type: float page 348
219	Manipulated Variable	R	Functional group: PID controller Unit: [%] Default value: 0 Variable type: float page 348

Register Number	Name	R/W	Description
220	Digital Setpoint	R	Functional group: PID controller Unit: [-] Default value: 0 Variable type: float page 349
221	Measuring Value Analog Input 1	R	Functional group: PID controller Unit: [-] Default value: 0 Variable type: float page 349
225	Manipulated Variable	R	Functional group: PID controller Unit: [%] Default value: 0 Variable type: float page 349
231	Current Reduction	R	Functional group: Current controller Unit: [A_{rms}] Default value: 0 Variable type: float page 111
232	Current Reduction Time	R	Functional group: Current controller Unit: [ms] Default value: 0 Variable type: int / register page 111
240	Encoder2 - Status	R	Functional group: Encoder Unit: - Default value: 0 Variable type: int / register page 84
241	Encoder2 - Type	R/W	Functional group: Encoder Unit: - Default value: 0 Variable type: int / register page 84
242	Encoder2 - Resolution	R/W	Functional group: Encoder Unit: [Increments / Revolutions] Default value: 0 Variable type: int / register page 85
243	Encoder2 - Mechanical Angle	R	Functional group: Encoder Unit: [°] Default value: 0 Variable type: float page 85

Register Number	Name	R/ W	Description
244	Encoder2 - Gear Ratio	R/ W	Functional group: Encoder Unit: - Default value: 1 Variable type: float page 86
245	Encoder2 - Gear Ratio Load	R/ W	Functional group: Encoder Unit: - Default value: 1 Variable type: float page 86
246	Encoder2 - Gear Ratio Linear / Rotatory	R/ W	Functional group: Encoder Unit: [mm/rev.] Default value: 360 Variable type: float page 86
247	Encoder2 - Travel Limit Positive	R/ W	Functional group: Encoder Unit: [°] or [mm] Default value: 360° Variable type: float page 87
248	Encoder2 - Travel Limit negative	R/ W	Functional group: Encoder Unit: [°] or [mm] Default value: 0° Variable type: float page 87
249	Encoder2 - As-is Position	R/ W	Functional group: Encoder Unit: [°] or [mm] Default value: 0° Variable type: float page 88
250	Encoder2 - Modulo Turns	R	Functional group: Encoder Unit: - Default value: 0 Variable type: int / register page 88
251	Encoder2 - As-is Speed	R	Functional group: Encoder Unit: [°/s] or [mm/s] Default value: 0 Variable type: float page 88
252	Encoder2 - Inversion of Counting Direction	R/ W	Functional group: Encoder Unit: - Default value: 0 Variable type: int / register page 89

Register Number	Name	R/W	Description
400	Status	R	Functional group: Technological functions Unit: [-] Default value: 0 Variable type: int / register page 292
402	Table Start Index	R/W	Functional group: Technological functions Unit: [-] Default value: 0 Variable type: int / register page 292
410	Table Config Index	R/W	Functional group: Technological functions Unit: [-] Default value: 0 Variable type: int / register page 273
411	Index - First Table Node	R/W	Functional group: Technological functions Unit: [-] Default value: 0 Variable type: int / register page 273
412	Index - Start Table Node	R/W	Functional group: Technological functions Unit: [-] Default value: 0 Variable type: int / register page 273
413	Index - Last Table Node	R/W	Functional group: Technological functions Unit: [-] Default value: 0 Variable type: int / register page 274
420	As-is Table Index	R/W	Functional group: Technological functions Unit: [-] Default value: 0 Variable type: int / register page 293
421	As-is Index - First Table Node	R	Functional group: Technological functions Unit: [-] Default value: 0 Variable type: int / register page 293

Register Number	Name	R/ W	Description
422	As-is Index - Start Table Node	R	Functional group: Technological functions Unit: [-] Default value: 0 Variable type: int / register page 293
423	As-is Index - Last Table Node	R	Functional group: Technological functions Unit: [-] Default value: 0 Variable type: int / register page 293
432	Change Type	R/ W	Functional group: Technological functions Unit: [-] Default value: 0 Variable type: int / register page 294
433	Position Difference - Leading Axis	R/ W	Functional group: Technological functions Unit: [°] or [mm] Default value: 0 [°] Variable type: float page 294
434	Position Difference - Following Axis	R/ W	Functional group: Technological functions Unit: [°] or [mm] Default value: 0 [°] Variable type: float page 295
435	Correction Velocity - Leading Axis	R/ W	Functional group: Technological functions Unit: [°/s] or [mm/s] Default value: R184 [°/s] Variable type: float page 295
438	Trailing Indicator - Max. As-is Position	R/ W	Functional group: Trailing indicator Unit: [°] or [mm] Default value: 0 [°] Variable type: float page 383
439	Trailing Indicator - Min. As-is Position	R/ W	Functional group: Trailing indicator Unit: [°] or [mm] Default value: 0 [°] Variable type: float page 383

Register Number	Name	R/ W	Description
440	Table Node	R/ W	Functional group: Technological functions Unit: [-] Default value: 0 Variable type: int / register page 274
441	Leading Axis Position	R/ W	Functional group: Technological functions Unit: [°] or [mm] Default value: 0 [°] Variable type: float page 274
442	Following Axis Position	R/ W	Functional group: Technological functions Unit: [°] or [mm] Default value: 0 [°] Variable type: float page 275
443	Configuration Offset - Leading Axis Position	R/ W	Functional group: Technological functions Unit: [°] or [mm] Default value: 0 [°] Variable type: float page 275
444	Configuration Offset - Following Axis Position	R/ W	Functional group: Technological functions Unit: [°] or [mm] Default value: 0 [°] Variable type: float page 276
445	Scaling Factor - Leading Axis Position	R/ W	Functional group: Technological functions Unit: [-] Default value: 0 Variable type: float page 276
446	Scaling Factor - Following Axis Position	R/ W	Functional group: Technological functions Unit: [-] Default value: 0 Variable type: float page 276
447	Reference Type	R/ W	Functional group: Technological functions Unit: [-] Default value: 0 Variable type: int / register page 296

Register Number	Name	R/W	Description
448	Start Type	R/W	Functional group: Technological functions Unit: [-] Default value: 0 Variable type: int / register page 297
449	Stop Type	R/W	Functional group: Technological functions Unit: [-] Default value: 0 Variable type: int / register page 297
450	Status	R/W	Functional group: Controller Unit: [-] Default value: 0 Variable type: int / register page 389
451	Function Mode	R/W	Functional group: Controller Unit: [-] Default value: 0 Variable type: int / register page 390
452	Position Reference	R/W	Functional group: Referencing on the fly Unit: [°] or [mm] Default value: 10 Variable type: float page 321
453	Position Window	R/W	Functional group: Referencing on the fly Unit: [°] or [mm] Default value: 10 Variable type: float page 321
454	As-is Position Value	R/W	Functional group: Referencing on the fly Unit: [°] or [mm] Default value: 0 Variable type: float page 322
455	As-is Position Deviation	R/W	Functional group: Referencing on the fly Unit: [°] or [mm] Default value: 0 Variable type: float page 322

Register Number	Name	R/W	Description
456	Correction Factor K_v	R/W	Functional group: Referencing on the fly Unit: [1/s] Default value: 1 Variable type: float page 323
457	Maximum Speed Correction	R/W	Functional group: Referencing on the fly Unit: [°/s] or [mm/s] Default value: 10 Variable type: float page 323
458	As-is Speed Correction	R/W	Functional group: Referencing on the fly Unit: [°/s] or [mm/s] Default value: 0 Variable type: float page 324
460	Dead Time Compensation	R/W	Functional group: Technological functions Unit: [-] Default value: 0 Variable type: float page 312
461	Position of Dead Time Correction	R	Functional group: Technological functions Unit: [-] Default value: 0 Variable type: float page 312
500	Rated Voltage of the Device	R	Functional group: Amplifier Unit: [V] Default value: Dependent on the amplifier type Variable type: int / register page 405
501	Rated Current of the Device	R	Functional group: Amplifier Unit: [A_{eff}] Default value: Dependent on the amplifier type Variable type: float page 405
502	Maximum Output Current	R	Functional group: Current controller Unit: [A_{eff}] Default value: 2*R501 Variable type: float page 112

Register Number	Name	R/W	Description
503	Current Controller Kp	R/W	Functional group: Current controller Unit: - Default value: 0.7 Variable type: float page 112
504	Current Controller Tn	R/W	Functional group: Current controller Unit: [ms] Default value: 3 Variable type: float page 115
505	Back EMF Constant	R/W	Functional group: Motor Unit: [V*min/1,000] Default value: 0 Variable type: int / register page 60
506	Speed Controller Preset	R/W	Functional group: Speed controller Unit: [A_{eff}] Default value: 0 Variable type: float page 127
507	I-Component Speed Controller	R/W	Functional group: Speed controller Unit: [A_{eff}] Default value: 0 Variable type: float page 128
508	PWM Frequency	R/W	Functional group: Amplifier Unit: [kHz] Default value: Dependent on the amplifier type Variable type: float page 406
510	Digital Inputs: Input Polarity	R/W	Functional group: Axis settings Unit: - Default value: 0b 00000001 00001111 Variable type: int / register page 32
511	Digital Inputs: Status	R	Functional group: Axis settings Unit: - Default value: 0b 00000000 00000000 Variable type: int / register page 33
513	Capture Status	R	Functional group: Position capture Unit: - Default value: 0 Variable type: int / register page 333

Register Number	Name	R/ W	Description
514	Input Edge	R/ W	Functional group: Controller Unit: - Default value: 1 Variable type: int / register page 391
515	DigOut-Status	R/ W	Functional group: Position trigger Unit: - Default value: 0 Variable type: int / register page 355
516	DigOut-Set	R/ W	Functional group: Position trigger Unit: - Default value: 0 Variable type: int / register page 358
517	DigOut-Clear	R/ W	Functional group: Position trigger Unit: - Default value: 0 Variable type: int / register page 358
518	Capture edge definition	R/ W	Functional group: Position capture Unit: - Default value: 0b 00000001 00001110 Variable type: int / register page 334
519	Capture active state	R	Functional group: Position capture Unit: - Default value: 0 Variable type: int / register page 334
521	Capture position LIMIT+	R	Functional group: Position capture Unit: [°] or [mm] Default value: 0 [°] Variable type: float page 335
522	Capture position LIMIT-	R	Functional group: Position capture Unit: [°] or [mm] Default value: 0 [°] Variable type: float page 335
523	Capture position REF	R	Functional group: Position capture Unit: [°] or [mm] Default value: 0 [°] Variable type: float page 335

Register Number	Name	R/ W	Description
524	Capture position INPUT	R	Functional group: Position capture Unit: [°] or [mm] Default value: 0 [°] Variable type: float page 336
525	DigOut-Type	R/ W	Functional group: Position trigger Unit: - Default value: 0 Variable type: int / register page 356
526	DigOut-PosX	R/ W	Functional group: Position trigger Unit: [°] or [mm] Default value: 0 [°] Variable type: float page 359
527	Dead Time Interrupt INPUT = Dead Time Correction INPUT	R/ W	Functional group: Controller Unit: [ms] Default value: 0.4 [ms] Variable type: float page 391
529	DigOut-Delay	R/ W	Functional group: Position trigger Unit: [ms] Default value: 0 [ms] Variable type: float page 359
538	Trailing indicator - Max. tracking error	R/ W	Functional group: Trailing indicator Unit: [°] or [mm] Default value: 0 [°] Variable type: float page 384
539	Trailing indicator - Min. tracking error	R/ W	Functional group: Trailing indicator Unit: [°] or [mm] Default value: 0 [°] Variable type: float page 384
540	Operating mode 1	R/ W	Functional group: Controller Unit: - Default value: 0b 00000010 1001x011 Variable type: int / register page 392
541	Operating mode of the 7-segment display	R/ W	Functional group: Controller Unit: - Default value: 0 Variable type: int / register page 394

Register Number	Name	R/ W	Description
542	Window time of tracking error	R/ W	Functional group: Position controller Unit: [ms] Default value: 5 Variable type: int / register page 133
544	DC link voltage - Max. trip	R/ W	Functional group: Monitoring Unit: [V] Default value: Dependent on the amplifier type Variable type: int / register page 94
545	DC link voltage - Min. trip	R/ W	Functional group: Monitoring Unit: [V] Default value: Dependent on the amplifier type Variable type: int / register page 95
546	Blocking protection - tripping time	R/ W	Functional group: Monitoring Unit: [ms] Default value: 5000 Variable type: int / register page 95
547	Delay after releasing (motor) brake	R/ W	Functional group: Motor Unit: [ms] Default value: 0 Variable type: int / register page 61
548	Delay after locking (motor) brake	R/ W	Functional group: Motor Unit: [ms] Default value: 100 Variable type: int / register page 62
549	Emergency stop ramp	R/ W	Functional group: Monitoring Unit: [ms] Default value: 500 Variable type: int / register page 96
550	Speed pre-control	R/ W	Functional group: Position controller Unit: [%] Default value: 100 Variable type: float page 134
551	Speed feed forward T1	R/ W	Functional group: Position controller Unit: [ms] Default value: 2 [ms] Variable type: int / register page 134

Register Number	Name	R/W	Description
557	Operating mode - Trigger input	R/W	Functional group: Controller Unit: [-] Default value: 0 Variable type: int / register page 394
559	Commutation measuring method	R	Functional group: Encoder Unit: - Default value: Dependent on the encoder Variable type: int / register page 74
560	DC link voltage	R	Functional group: Amplifier Unit: [V] Default value: 0 Variable type: int / register page 406
561	As-is current	R	Functional group: Current controller Unit: [A_{eff}] Default value: 0 Variable type: float page 116
562	Motor temperature	R	Functional group: Motor Unit: [°C] Default value: 0 Variable type: int / register page 62
563	As-is temperature (of the device)	R	Functional group: Amplifier Unit: [°C] Default value: 0 Variable type: int / register page 407
564	As-is ballast load	R	Functional group: Amplifier Unit: [%] Default value: 0 Variable type: int / register page 407
565	Motor shaft position	R	Functional group: Motor Unit: [°] Default value: 0 Variable type: float page 63
566	Input current	R	Functional group: Amplifier Unit: [A_{eff}] Default value: 0 Variable type: float page 407

Register Number	Name	R/ W	Description
567	Mains voltage	R	Functional group: Amplifier Unit: [V_{eff}] Default value: 0 Variable type: int / register page 408
568	As-is board temperature	R	Functional group: Amplifier Unit: [°C] Default value: 0 Variable type: int / register page 408
572	Set operating mode	R/ W	Functional group: Controller Unit: - Default value: 103 Variable type: int / register page 395
573	As-is operating mode	R	Functional group: Controller Unit: - Default value: 3 Variable type: int / register page 395
574	Control word 2 (motor brake control)	R/ W	Functional group: Controller Unit: - Default value: 0 Variable type: int / register page 396
575	Status word 2 (motor brake status)	R	Functional group: Controller Unit: - Default value: 0 Variable type: int / register page 396
576	Interfaces - access level	R/ W	Functional group: Amplifier Unit: - Default value: 0 Variable type: int / register page 409
577	Encoder type	R	Functional group: Motor Unit: - Default value: Dependent on the encoder Variable type: int / register page 75
580	Warnings mask	R/ W	Functional group: Diagnostics Unit: - Default value: 0 Variable type: int / register page 400

Register Number	Name	R/ W	Description
581	Warnings	R/ W	Functional group: Diagnostics Unit: - Default value: Variable type: int / register page 400
582	AutoClear mask for warnings	R/ W	Functional group: Diagnostics Unit: - Default value: 0b 00000000 00001100 11111111 Variable type: int / register page 401
584	Error mask	R/ W	Functional group: Diagnostics Unit: - Default value: 0xFFFF Variable type: int / register page 402
585	Error 00 ... 31	R	Functional group: Diagnostics Unit: - Default value: 0 Variable type: int / register page 402
585	Error 32 ... 63	R	Functional group: Diagnostics Unit: - Default value: 0 Variable type: int / register page 404
596	DigOutStatus - Set	R/ W	Functional group: Position trigger Unit: - Default value: 0 Variable type: int / register page 355
597	DigOutStatus - Clear	R/ W	Functional group: Position trigger Unit: - Default value: 0 Variable type: int / register page 356
600	Device temperature warning	R	Functional group: Monitoring Unit: [°C] Default value: 70 Variable type: int / register page 96
601	Device temperature error	R	Functional group: Monitoring Unit: [°C] Default value: 80 Variable type: int / register page 97

Register Number	Name	R/ W	Description
602	Motor temperature warning	R	Functional group: Monitoring Unit: [°C] Default value: 110 Variable type: int / register page 97
603	Motor temperature - error	R	Functional group: Monitoring Unit: [°C] Default value: 135 Variable type: int / register page 97
604	Ballast Load - warning	R	Functional group: Monitoring Unit: [%] Default value: 80 Variable type: int / register page 98
605	Ballast Load - error	R	Functional group: Monitoring Unit: [%] Default value: 100 Variable type: int / register page 98
607	Torque-controlled shut-off current	R/ W	Functional group: Torque-controlled shut-off Unit: [A_{eff}] Default value: 0 [A_{eff}] Variable type: float page 378
608	Motor type	R/ W	Functional group: Motor Unit: [1] Default value: 0 Variable type: int / register page 64
609	Type of motor temperature densor	R/ W	Functional group: Motor Unit: [1] Default value: 0 Variable type: int / register page 65
616	Motor torque constant Kt	R/ W	Functional group: Motor Unit: [Nm/A] Default value: 0 Variable type: float page 65
618	Rated current	R/ W	Functional group: Current controller Unit: [A_{eff}] Default value: R501 Variable type: float page 116

Register Number	Name	R/ W	Description
619	Overload factor	R/ W	Functional group: Current controller Unit: [-] Default value: 2 Variable type: float page 117
620	As-is current in %	R	Functional group: Current controller Unit: [%] Default value: 0 Variable type: float page 118
621	As-is torque	R	Functional group: Current controller Unit: [Nm] Default value: 0 Variable type: float page 118
623	DigOut -T ype2	R/ W	Functional group: Position trigger Unit: - Default value: 0 Variable type: int / register page 360
624	DigOut - Set2	R/ W	Functional group: Position trigger Unit: - Default value: 0 Variable type: int / register page 360
625	DigOut - Clear2	R/ W	Functional group: Position trigger Unit: - Default value: 0 Variable type: int / register page 360
626	DigOut - PosX2	R/ W	Functional group: Position trigger Unit: [°] or [mm] Default value: 0 [°] Variable type: float page 361
627	DigOut - Delay2	R/ W	Functional group: Position trigger Unit: [ms] Default value: 0 [ms] Variable type: float page 361
628	Inertia of load	R/ W	Functional group: Speed controller Unit: [kgcm²] Default value: 0 [kgcm²] Variable type: float page 128

Register Number	Name	R/ W	Description
629	Scaling of the current pre-control	R/ W	Functional group: Speed controller Unit: [%] Default value: 0 [%] Variable type: float page 129
630	Filter of the zero speed count	R/ W	Functional group: Torque-controlled shut-off Unit: - Default value: 10 Variable type: int / register page 378
631	Capture command set	R/ W	Functional group: Position capture Unit: - Default value: 0 Variable type: int / register page 336
632	Capture command clear	R/ W	Functional group: Position capture Unit: - Default value: 0 Variable type: int / register page 336
640	I²t - DC link - Mode	R/ W	Functional group: Monitoring Unit: - Default value: 0 Variable type: int / register page 100
642	I²t - DC link - Time constant	R	Functional group: Monitoring Unit: [s] Default value: 0 Variable type: float page 101
643	I²t - DC link - I²t value	R	Functional group: Monitoring Unit: [%] Default value: 0 Variable type: float page 101
644	I²t - DC link - Alarm threshold	R/ W	Functional group: Monitoring Unit: [%] Default value: 80 Variable type: float page 101
645	I²t - Motor model - Mode	R/ W	Functional group: Monitoring Unit: - Default value: 0 Variable type: int / register page 103

Register Number	Name	R/W	Description
647	I²t - Motor model - time constant	R/W	Functional group: Monitoring Unit: [s] Default value: 0 Variable type: float page 103
648	I²t - Motor model - I²t value	R	Functional group: Monitoring Unit: [%] Default value: 0 Variable type: float page 103
649	I²t - Motor model - Alarm threshold	R/W	Functional group: Monitoring Unit: [%] Default value: 80 Variable type: float page 103
650	I²t - UL standard - Mode	R	Functional group: Monitoring Unit: - Default value: 2 Variable type: int / register page 104
652	I²t - UL standard - time constant	R	Functional group: Monitoring Unit: [s] Default value: 0 Variable type: float page 104
653	I²t - UL standard - I²t value	R	Functional group: Monitoring Unit: [%] Default value: 0 Variable type: float page 105
654	I²t - UL standard - Alarm threshold	R/W	Functional group: Monitoring Unit: [%] Default value: 80 Variable type: float page 105
997	OS build version	R	Functional group: Amplifier Unit: - Default value: Dependent on the software version Variable type: int / register page 410

Appendix D: Register Overview - Sequence of Functions

In the column "R/W", the possibility of access to the parameter has been defined:

R = Read
W = Write

Register Number	Name	R/W	Description
Controller			
101	Command	R/W	Functional group: Controller Unit: - Default value: 0 Variable type: int / register page 387
450	Function Status	R/W	Functional group: Controller Unit: [-] Default value: 0 Variable type: int / register page 389
451	Function Mode	R/W	Functional group: Controller Unit: [-] Default value: 0 Variable type: int / register page 390
514	Edge Definition INPUT	R/W	Functional group: Controller Unit: - Default value: 1 Variable type: int / register page 391
527	Dead Time Correction INPUT	R/W	Functional group: Controller Unit: [ms] Default value: 0.4 [ms] Variable type: float page 391
540	Drive Mode 1	R/W	Functional group: Controller Unit: - Default value: 0b 00000010 1001x011 Variable type: int / register page 392
541	Operating Mode of the 7-Segment Display	R/W	Functional group: Controller Unit: - Default value: 0 Variable type: int / register page 394

Register Number	Name	R/W	Description
557	Operating Mode - Trigger Input	R/W	Functional group: Controller Unit: [-] Default value: 0 Variable type: int / register page 394
572	Set Operating Mode	R/W	Functional group: Controller Unit: - Default value: 103 Variable type: int / register page 395
573	As-is Operating Mode	R	Functional group: Controller Unit: - Default value: 3 Variable type: int / register page 395
574	Control Word 2	R/W	Functional group: Controller Unit: - Default value: 0 Variable type: int / register page 396
575	Status Word 2	R	Functional group: Controller Unit: - Default value: 0 Variable type: int / register page 396
Diagnostics			
100	Status	R	Functional group: Diagnostics Unit: - Default value: 0 Variable type: int / register page 397
170	Referencing Error / Positioning Error / Table	R	Functional group: Diagnostics Unit: - Default value: 0 Variable type: int / register page 398
580	Warning Mask	R/W	Functional group: Diagnostics Unit: - Default value: 0 Variable type: int / register page 400
581	Warnings	R/W	Functional group: Diagnostics Unit: - Default value: 0 Variable type: int / register page 400

Register Number	Name	R/ W	Description
582	AutoClear Mask for Warnings	R/ W	Functional group: Diagnostics Unit: - Default value: 0b 00000000 00001100 11111111 Variable type: int / register page 401
584	Error Mask	R/ W	Functional group: Diagnostics Unit: - Default value: 0xFFFF Variable type: int / register page 402
585	Error 00 ... 31	R	Functional group: Diagnostics Unit: - Default value: 0 Variable type: int / register page 402
585	Error 32 ... 63	R	Functional group: Diagnostics Unit: - Default value: 0 Variable type: int / register page 404
Positioning			
102	Target Position	R/ W	Functional group: Positioning Unit: [°] or [mm] Default value: 0 [°] Variable type: float page 160
103	Target Speed	R/ W	Functional group: Positioning Unit: [°/s] or [mm/s] Default value: 200 [°/s] Variable type: float page 162
104	Positioning Time	R/ W	Functional group: Positioning Unit: [s] Default value: 0 Variable type: float page 163
105	Acceleration	R/ W	Functional group: Positioning Unit: [°/s ^{2}] or [mm/s ^{2}] Default value: 500 [°/s ^{2}] Variable type: float page 164

Register Number	Name	R/ W	Description
106	Deceleration	R/ W	Functional group: Positioning Unit: [°/s^2] or [mm/s^2] Default value: 500 [°/s^2] Variable type: float page 166
107	Destination Window	R/ W	Functional group: Positioning Unit: [°] or [mm] Default value: 1 [°] Variable type: float page 167
109	As-is Position	R	Functional group: Positioning Unit: [°] or [mm] Default value: 0 [°] Variable type: float page 169
129	As-is Speed	R	Functional group: Positioning Unit: [°/s] or [mm/s] Default value: 0 [°/s] Variable type: float page 170
135	Modulo Turns	R	Functional group: Positioning Unit: - Default value: 0 Variable type: int / register page 170
140	Ramp Type	R/ W	Functional group: Positioning Unit: - Default value: 1 (sine^2 ramps) Variable type: int / register page 170
141	Positioning Mode	R/ W	Functional group: Positioning Unit: - Default value: 1 (absolute) Variable type: int / register page 171
142	Moving Direction	R/ W	Functional group: Positioning Unit: - Default value: 0 (positive direction) Variable type: int / register page 172
143	Basic Type	R/ W	Functional group: Positioning Unit: - Default value: 0 (latest target position) Variable type: int / register page 172

Register Number	Name	R/ W	Description
149	Absolute Target Position	R	Functional group: Positioning Unit: [°] or [mm] Default value: 0 [°] Variable type: float page 173
Referencing			
160	Referencing Direction	R/ W	Functional group: Referencing Unit: - Default value: 0 (positive direction) Variable type: int / register page 152
161	Switch Type	R/ W	Functional group: Referencing Unit: - Default value: 1 (Reference switch and limit switch) Variable type: int / register page 152
162	Speed of Switch Search	R/ W	Functional group: Referencing Unit: [°/s] or [mm/s] Default value: 500 [°/s] Variable type: float page 153
163	Referencing Acceleration	R/ W	Functional group: Referencing Unit: [°/s²] or [mm/s²] Default value: 1,000 [°/s²] Variable type: float page 154
164	Max. Distance Switch Search	R/ W	Functional group: Referencing Unit: [°] or [mm] Default value: 100,000 [°] Variable type: float page 154
165	Reference Label	R/ W	Functional group: Referencing Unit: - Default value: 1 (Referencing by zero pulse) Variable type: int / register page 155
166	Speed Reference Search	R/ W	Functional group: Referencing Unit: [°/s] or [mm/s] Default value: 100 [°/s] Variable type: float page 156

Register Number	Name	R/W	Description
167	Max. Distance Reference Search	R/W	Functional group: Referencing Unit: [°] or [mm] Default value: 100,000 [°] Variable type: float page 156
168	Home Position - Distance	R/W	Functional group: Referencing Unit: [°] or [mm] Default value: 0 [°] Variable type: float page 157
169	Home Position	R/W	Functional group: Referencing Unit: [°] or [mm] Default value: 0 [°] Variable type: float page 157
Axis Definitions			
191	Axis Type	R/W	Functional group: Axis Definitions Unit: - Default value: 2 (rotatory) Variable type: int / register page 20
192	Modulo Axis	R/W	Functional group: Axis Definitions Unit: - Default value: 0 (no modulo axis) Variable type: int / register page 22
Axis Settings			
180	Maximum Acceleration	R/W	Functional group: Axis settings Unit: [°/s^2] or [mm/s^2] Default value: 100,000 [°/s^2] Variable type: float page 27
181	Maximum Jerk	R/W	Functional group: Axis settings Unit: [°/s^3] or [mm/s^3] Default value: 1,000,000 [°/s^3] Variable type: float page 28
182	Travel Limit, Positive	R/W	Functional group: Axis settings Unit: [°] or [mm] Default value: 100,000 [°] Variable type: float page 28

Register Number	Name	R/ W	Description
183	Travel Limit, Negative	R/ W	Functional group: Axis settings Unit: [°] or [mm] Default value: -100,000 [°] Variable type: float page 29
184	Maximum Speed	R/ W	Functional group: Axis settings Unit: [°/s] Default value: 18,000 Variable type: float page 29
193	Modulo Travel Range	R	Functional group: Axis settings Unit: [°] or [mm] Default value: 360 [°] Variable type: float page 30
194	Gear Ratio - Motor	R/ W	Functional group: Axis settings Unit: [rev.] Default value: 1 [rev.] Variable type: float page 30
195	Gear Ratio - Mechanism	R/ W	Functional group: Axis settings Unit: [rev.] Default value: 1 [rev.] Variable type: float page 31
196	Linear / Rotation Ratio	R/ W	Functional group: Axis settings Unit: [°/rev] or [mm/rev.] Default value: 360 [°/rev.] Variable type: float page 31
510	Digital Inputs: Polarity	R/ W	Functional group: Axis settings Unit: - Default value: 0b 00000001 00001111 Variable type: int / register page 32
511	Digital Inputs: Status	R	Functional group: Axis settings Unit: - Default value: 0 Variable type: int / register page 33
Amplifiers			

Register Number	Name	R/W	Description
500	Rated Voltage of the Device	R	Functional group: Amplifier Unit: [V] Default value: Dependent on the amplifier type Variable type: int / register page 405
501	Rated Current of the Device	R	Functional group: Amplifier Unit: [A_{eff}] Default value: Dependent on the amplifier type Variable type: float page 405
508	PWM Frequency	R/W	Functional group: Amplifier Unit: [kHz] Default value: Dependent on the amplifier type Variable type: int / register page 406
560	DC Link Voltage	R	Functional group: Amplifier Unit: [V] Default value: 0 Variable type: int / register page 406
563	Device Temperature	R	Functional group: Amplifier Unit: [°C] Default value: 0 Variable type: int / register page 407
564	Ballast Load	R	Functional group: Amplifier Unit: [%] Default value: 0 Variable type: int / register page 407
566	Input Current	R	Functional group: Amplifier Unit: [A_{eff}] Default value: 0 Variable type: float page 407
567	Mains Voltage	R	Functional group: Amplifier Unit: [V_{eff}] Default value: 0 Variable type: int / register page 408
568	Board Temperature of the Controller	R	Functional group: Amplifier Unit: [°C] Default value: 0 Variable type: int / register page 408

Register Number	Name	R/ W	Description
576	Interfaces - Access Level	R/ W	Functional group: Amplifier Unit: - Default value: 0 Variable type: int / register page 409
997	OS Build Version	R	Functional group: Amplifier Unit: - Default value: Dependent on the software version Variable type: int / register page 410
Motor			
116	Commutation Offset	R/ W	Functional group: Motor Unit: [°] Default value: 0 Variable type: float page 58
122	Motor Slip Frequency	R/ W	Functional group: Motor Unit: [Hz] Default value: 0 Variable type: float page 59
123	Pole Pair Number	R/ W	Functional group: Motor Unit: - Default value: 3 Variable type: int / register page 60
505	Voltage Constant	R/ W	Functional group: Motor Unit: [V*min/1000] Default value: 0 Variable type: int / register page 60
547	Delay After Releasing the Motor Brake	R/ W	Functional group: Motor Unit: [ms] Default value: 0 Variable type: int / register page 61
548	Delay After Locking the Motor Brake	R/ W	Functional group: Motor Unit: [ms] Default value: 100 Variable type: int / register page 62
562	Motor Temperature	R	Functional group: Motor Unit: [°C] Default value: 0 Variable type: int / register page 62

Register Number	Name	R/W	Description
565	Motor Shaft Position	R	Functional group: Motor Unit: [°] Default value: 0 Variable type: float page 63
608	Motor Type	R/W	Functional group: Motor Unit: [1] Default value: 0 Variable type: int / register page 64
609	Motor Temperature Sensor Type	R/W	Functional group: Motor Unit: [1] Default value: 0 Variable type: int / register page 65
616	Motor Torque Constant Kt	R/W	Functional group: Motor Unit: [Nm/A] Default value: 0 Variable type: float page 65
Encoders			
117	Encoder Resolution	R/W	Functional group: Encoder Unit: [Increments / Revolutions] Default value: Dependent on the encoder Variable type: int / register page 73
240	Encoder2 - Status	R	Functional group: Encoder Unit: - Default value: 0 Variable type: int / register page 84
241	Encoder2 - Type	R/W	Functional group: Encoder Unit: - Default value: 0 Variable type: int / register page 84
242	Resolution of Encoder 2	R/W	Functional group: Encoder Unit: [Increments / Revolutions] Default value: 0 Variable type: int / register page 85
243	Mechanical Angle of Encoder 2	R	Functional group: Encoder Unit: [°] Default value: 0 Variable type: float page 85

Register Number	Name	R/ W	Description
244	Gear Ratio of Encoder 2	R/ W	Functional group: Encoder Unit: - Default value: 1 Variable type: float page 86
245	Gear Ratio of Encoder 2	R/ W	Functional group: Encoder Unit: - Default value: 1 Variable type: float page 86
246	Linear/Rotatory Ratio of Encoder 2	R/ W	Functional group: Encoder Unit: [mm/rev.] Default value: 360 Variable type: float page 86
247	Travel Limit Positive of Encoder 2	R/ W	Functional group: Encoder Unit: [°] or [mm] Default value: 360° Variable type: float page 87
248	Travel Limit Negative of Encoder 2	R/ W	Functional group: Encoder Unit: [°] or [mm] Default value: 0° Variable type: float page 87
249	As-is Position of Encoder 2	R/ W	Functional group: Encoder Unit: [°] or [mm] Default value: 0° Variable type: float page 88
250	Modulo Turns of Encoder 2	R	Functional group: Encoder Unit: - Default value: 0 Variable type: int / register page 88
251	As-is Speed of Encoder 2	R	Functional group: Encoder Unit: [°/s] or [mm/s] Default value: 0 Variable type: float page 88
252	Reversal of Counting Direction of Encoder 2	R/ W	Functional group: Encoder Unit: - Default value: 0 Variable type: int / register page 89

Register Number	Name	R/ W	Description
559	Commutation Measuring Method	R	Functional group: Encoder Unit: - Default value: Dependent on the encoder Variable type: int / register page 74
577	Encoder type	R	Functional group: Encoder Unit: - Default value: Dependent on the encoder Variable type: int / register page 74
Monitoring			
114	Software Limit Positive	R/ W	Functional group: Axis Unit: [°] or [mm] Default value: 100,000 [°] Variable type: float page 92
115	Software Limit Negative	R/ W	Functional group: Axis Unit: [°] or [mm] Default value: -100,000 [°] Variable type: float page 92
544	DC Link Voltage - Max. Trip	R/ W	Functional group: Monitoring Unit: [V] Default value: Dependent on the amplifier type Variable type: int / register page 94
545	DC Link Voltage - Min. Trip	R/ W	Functional group: Monitoring Unit: [V] Default value: Dependent on the amplifier type Variable type: int / register page 95
546	Blocking Tripping Time	R/ W	Functional group: Monitoring Unit: [ms] Default value: 5,000 Variable type: int / register page 95
549	Emergency Stop Ramp Time	R/ W	Functional group: Monitoring Unit: [ms] Default value: 500 Variable type: int / register page 96

Register Number	Name	R/W	Description
600	Device Temperature Threshold - Warning	R	Functional group: Monitoring Unit: [°C] Default value: 70 Variable type: int / register page 96
601	Device Temperature Threshold - Error	R	Functional group: Monitoring Unit: [°C] Default value: 80 Variable type: int / register page 97
602	Motor Temperature Threshold - Warning	R	Functional group: Monitoring Unit: [°C] Default value: 110 Variable type: int / register page 97
603	Motor Temperature Threshold - Error	R	Functional group: Monitoring Unit: [°C] Default value: 135 Variable type: int / register page 97
604	Ballast Load Threshold - Warning	R	Functional group: Monitoring Unit: [%] Default value: 80 Variable type: int / register page 98
605	Ballast Load Threshold - Error	R	Functional group: Monitoring Unit: [%] Default value: 100 Variable type: int / register page 98
640	I^2t - DC Link - Operating Mode	R/W	Functional group: Monitoring Unit: - Default value: 0 Variable type: int / register page 100
642	I^2t - DC Link - Time Constant	R	Functional group: Monitoring Unit: [s] Default value: 0 Variable type: float page 101
643	I^2t - DC Link - I^2t Value	R	Functional group: Monitoring Unit: [%] Default value: 0 Variable type: float page 101

Register Number	Name	R/W	Description
644	I²t - DC Link - Alarm Threshold	R/W	Functional group: Monitoring Unit: [%] Default value: 80 Variable type: float page 101
645	I²t - Motor Model - Operating Mode	R/W	Functional group: Monitoring Unit: - Default value: 0 Variable type: int / register page 103
647	I²t - Motor Model - Time Constant	R/W	Functional group: Monitoring Unit: [s] Default value: 0 Variable type: float page 103
648	I²t - Motor Model - I²t Value	R	Functional group: Monitoring Unit: [%] Default value: 0 Variable type: float page 103
649	I²t - Motor Model - Alarm Threshold	R/W	Functional group: Monitoring Unit: [%] Default value: 80 Variable type: float page 103
650	I²t - UL Standard - Operating Mode	R	Functional group: Monitoring Unit: - Default value: 2 Variable type: int / register page 104
652	I²t - UL Standard - Time Constant	R	Functional group: Monitoring Unit: [s] Default value: 0 Variable type: float page 104
653	I²t - UL Standard - I²t Value	R	Functional group: Monitoring Unit: [%] Default value: 0 Variable type: float page 105
654	I²t - UL Standard - Alarm Threshold	R/W	Functional group: Monitoring Unit: [%] Default value: 80 Variable type: float page 105
Position Feedback Controller			

Register Number	Name	R/ W	Description
110	Position Controller Kv	R/ W	Functional group: Position Feedback Controller Unit: [1/s] Default value: 1,000 Variable type: float page 131
119	As-is Tracking Error	R	Functional group: Position Feedback Controller Unit: [°] or [mm] Default value: 0 [°] Variable type: float page 131
120	Tracking Error Limit	R/ W	Functional group: Position Feedback Controller Unit: [°] or [mm] Default value: 10,000 [°] Variable type: float page 132
130	Position Set Point	R/ W	Functional group: Position Feedback Controller Unit: [°] or [mm] Default value: 0 [°] Variable type: float page 132
190	Position Feedback Controller - As-is Value Selection	R/ W	Functional group: Position Feedback Controller Unit: - Default value: 1 ... 2 Variable type: int / register page 133
542	Tracking Error Window Time	R/ W	Functional group: Position Feedback Controller Unit: [ms] Default value: 5 Variable type: int / register page 133
550	Speed Pre-Control	R/ W	Functional group: Position Feedback Controller Unit: [%] Default value: 100 Variable type: float page 134
551	Speed Feed Forward T1	R/ W	Functional group: Position Feedback Controller Unit: [ms] Default value: 2 [ms] Variable type: int / register page 134

Register Number	Name	R/ W	Description
Speed Controller			
111	Speed Set Point	R/ W	Functional group: Speed controller Unit: [rpm] Default value: 0 Variable type: int / register page 123
112	As-is Motor Speed	R	Functional group: Speed controller Unit: [rpm] Default value: 0 Variable type: int / register page 123
113	Filter Time Constant T_f	R/ W	Functional group: Speed controller Unit: [ms] Default value: 2 Variable type: float page 124
118	Speed Controller - Maximum Motor Speed	R/ W	Functional group: Speed controller Unit: [rpm] Default value: 3,000 Variable type: int / register page 124
124	Speed Controller Kp	R/ W	Functional group: Speed controller Unit: - Default value: 10 Variable type: float page 125
126	Speed Controller Tn	R/ W	Functional group: Speed controller Unit: [ms] Default value: 20 Variable type: float page 125
128	Limitation of Set Speed	R/ W	Functional group: Speed controller Unit: [rpm] Default value: 3,150 [rpm] Variable type: float page 127
506	Speed Controller Preset	R/ W	Functional group: Speed controller Unit: [A_{eff}] Default value: 0 Variable type: float page 127
507	I-Component Speed Controller	R/ W	Functional group: Speed controller Unit: [A_{eff}] Default value: 0 Variable type: float page 128

Register Number	Name	R/ W	Description
628	Driveline - Moment of Inertia	R/ W	Functional group: Speed controller Unit: [kgcm²] Default value: 0 [kgcm²] Variable type: float page 128
629	Scaling of the Current Pre-Control	R/ W	Functional group: Speed controller Unit: [%] Default value: 0 [%] Variable type: float page 129
Current Controller			
121	Magnetizing Current	R/ W	Functional group: Current controller Unit: [A_{eff}] Default value: 0 Variable type: float page 109
125	Current Setpoint	R/ W	Functional group: Current controller Unit: [A_{eff}] Default value: 0 Variable type: float page 110
127	Current Limitation	R/ W	Functional group: Current controller Unit: [A_{eff}] Default value: R502 Variable type: float page 110
231	Current Reduction	R	Functional group: Current controller Unit: [A_{rms}] Default value: 0 Variable type: float page 111
232	Time of Current Reduction	R	Functional group: Current controller Unit: [ms] Default value: 0 Variable type: int / register page 111
502	Max. Output Current	R	Functional group: Current controller Unit: [A_{eff}] Default value: 2*R501 Variable type: float page 112
503	Current Controller Kp	R/ W	Functional group: Current controller Unit: - Default value: 0.7 Variable type: float page 112

Register Number	Name	R/ W	Description
504	Current Controller Tn	R/ W	Functional group: Current controller Unit: [ms] Default value: 3 Variable type: float page 115
561	As-is Current	R	Functional group: Current controller Unit: [A_{eff}] Default value: 0 Variable type: float page 116
618	Rated Current	R/ W	Functional group: Current controller Unit: [A_{eff}] Default value: R501 Variable type: float page 116
619	Overload Factor	R/ W	Functional group: Current controller Unit: Default value: 2 Variable type: float page 117
620	As-is Current in %	R	Functional group: Current controller Unit: [%] Default value: 0 Variable type: float page 118
621	As-is Torque	R	Functional group: Current controller Unit: [Nm] Default value: 0 Variable type: float page 118
Position Capture			
513	Capture Status	R	Functional group: Position capture Unit: - Default value: 0 Variable type: int / register page 333
518	Capture Edge Definition	R/ W	Functional group: Position capture Unit: - Default value: 0b 00000001 00001110 Variable type: int / register page 334
519	Capture Active State	R	Functional group: Position capture Unit: - Default value: 0 Variable type: int / register page 334

Register Number	Name	R/W	Description
521	Capture Position LIMIT+	R	Functional group: Position capture Unit: [°] or [mm] Default value: 0 [°] Variable type: float page 335
522	Capture Position LIMIT-	R	Functional group: Position capture Unit: [°] or [mm] Default value: 0 [°] Variable type: float page 335
523	Capture Position REF	R	Functional group: Position capture Unit: [°] or [mm] Default value: 0 [°] Variable type: float page 335
524	Capture Position INPUT	R	Functional group: Position capture Unit: [°] or [mm] Default value: 0 [°] Variable type: float page 336
631	Capture Command Set	R/W	Functional group: Position capture Unit: - Default value: 0 Variable type: int / register page 336
632	Capture Command Clear	R/W	Functional group: Position capture Unit: - Default value: 0 Variable type: int / register page 336
PID Controller			
200	PID Status	R	Functional group: PID controller Unit: [-] Default value: 0 Variable type: int / register page 342
201	PID Command	R/W	Functional group: PID controller Unit: [-] Default value: 0 Variable type: int / register page 342
202	Setpoint Value	R/W	Functional group: PID controller Unit: [%] Default value: 0 Variable type: float page 342

Register Number	Name	R/ W	Description
203	Proportional Gain K_P	R/ W	Functional group: PID controller Unit: [-] Default value: 0 Variable type: float page 343
204	Integral Time T_n	R/ W	Functional group: PID controller Unit: [ms] Default value: 100 Variable type: float page 343
205	Derivative Time T_V	R/ W	Functional group: PID controller Unit: [ms] Default value: 0 Variable type: float page 343
206	Delay Time T_1	R/ W	Functional group: PID controller Unit: [ms] Default value: 0 Variable type: float page 344
207	Limitation Integral-Action Component	R/ W	Functional group: PID controller Unit: [%] Default value: +100 Variable type: float page 344
208	Preset Integral-Action Component	R/ W	Functional group: PID controller Unit: [%] Default value: 0 Variable type: float page 344
209	As-is PID Value	R/ W	Functional group: PID controller Unit: [%] Default value: 0 Variable type: float page 344
210	As-is Value Filtering T_F	R/ W	Functional group: PID controller Unit: [ms] Default value: 0 Variable type: float page 345
211	Selection As-is Value	R/ W	Functional group: PID controller Unit: [-] Default value: 0 Variable type: int / register page 345

Register Number	Name	R/ W	Description
212	Selection Manipulated Variable	R/ W	Functional group: PID controller Unit: [-] Default value: 0 Variable type: int / register page 346
213	Selection Setpoint	R/ W	Functional group: PID controller Unit: [-] Default value: 0 Variable type: int / register page 347
214	Sampling Time T_S	R	Functional group: PID controller Unit: [ms] Default value: 2 Variable type: float page 347
215	Max. Value of the Manipulated Variable	R/ W	Functional group: PID controller Unit: [%] Default value: +100 Variable type: float page 347
216	Min. Value of the Manipulated Variable	R/ W	Functional group: PID controller Unit: [%] Default value: -100 Variable type: float page 347
217	Scaling Factor for the Manipulated Value	R/ W	Functional group: PID controller Unit: [%] Default value: 1 Variable type: float page 348
218	Setpoint Value Filtering T_R	R	Functional group: PID controller Unit: [ms] Default value: 0 Variable type: float page 348
219	Manipulated Value X_W	R	Functional group: PID controller Unit: [%] Default value: 0 Variable type: float page 348
220	Digital Setpoint Value	R	Functional group: PID controller Unit: [-] Default value: 0 Variable type: float page 349

Register Number	Name	R/ W	Description
221	Measuring Value Analog Input 1	R	Functional group: PID controller Unit: [-] Default value: 0 Variable type: float page 349
225	Manipulated Variable	R	Functional group: PID controller Unit: [%] Default value: 0 Variable type: float page 349
Technological Functions - General			
150	Time Mode	R/ W	Functional group: Technological Functions Unit: [-] Default value: 0 Variable type: int / register page 188
151	Transmit Mode	R/ W	Functional group: Technological Functions Unit: [-] Default value: 0 Variable type: int / register page 210
152	Receive Mode	R/ W	Functional group: Technological functions Unit: [-] Default value: 0 Variable type: int / register page 211
155	Counting Range JX2-CNT1	R/ W	Functional group: Technological functions Unit: [-] Default value: 16,777,216 Variable type: int / register page 212
157	Standardizing Factor - Leading Axis Position	R/ W	Functional group: Technological functions Unit: [°/Ink] or [mm/Ink] Default value: 1 Variable type: float page 213
158	Maximum Leading Axis Position	R/ W	Functional group: Technological functions Unit: [°] or [mm] Default value: 100,000 [°] Variable type: float page 213

Register Number	Name	R/ W	Description
159	Minimum Leading Axis Position	R/ W	Functional group: Technological functions Unit: [°] or [mm] Default value: -100,000 [°] Variable type: float page 213
188	Leading Axis Position	R/ W	Functional group: Technological functions Unit: [°] or [mm] Default value: 0 [°] Variable type: float page 214
189	Leading Axis Speed	R/ W	Functional group: Technological functions Unit: [°/s] or [mm/s] Default value: 0 [°/s] Variable type: float page 215
400	Coupling Status	R	Functional group: Technological functions Unit: [-] Default value: 0 Variable type: int / register page 292
460	Dead Time Compensation	R/ W	Functional group: Technological functions Unit: [-] Default value: 0 Variable type: float page 312
461	Position of Dead Time Correction	R	Functional group: Technological functions Unit: [-] Default value: 0 Variable type: float page 312
Technological Functions - Electronic Gearing			
156	Gear Ratio	R/ W	Functional group: Technological functions Unit: [-] Default value: 1 Variable type: float page 238
Technological Functions - Table			

Register Number	Name	R/W	Description
402	Table Start Index	R/W	Functional group: Technological functions Unit: [-] Default value: 0 Variable type: int / register page 292
410	Table Config Index	R/W	Functional group: Technological functions Unit: [-] Default value: 0 Variable type: int / register page 273
411	Index - First Table Node	R/W	Functional group: Technological functions Unit: [-] Default value: 0 Variable type: int / register page 273
412	Index - Start Table Node	R/W	Functional group: Technological functions Unit: [-] Default value: 0 Variable type: int / register page 273
413	Index - Last Table Node	R/W	Functional group: Technological functions Unit: [-] Default value: 0 Variable type: int / register page 274
420	As-is Table Index	R	Functional group: Technological functions Unit: [-] Default value: 0 Variable type: int / register page 293
421	As-is Index - First Table Node	R	Functional group: Technological functions Unit: [-] Default value: 0 Variable type: int / register page 293
422	As-is Index - Start Table Node	R	Functional group: Technological functions Unit: [-] Default value: 0 Variable type: int / register page 293

Register Number	Name	R/W	Description
423	As-is Index - Last Table Node	R	Functional group: Technological functions Unit: [-] Default value: 0 Variable type: int / register page 293
432	Change Type	R/W	Functional group: Technological functions Unit: [-] Default value: 0 Variable type: int / register page 294
433	Position Difference - Leading Axis	R/W	Functional group: Technological functions Unit: [°] or [mm] Default value: 0 [°] Variable type: float page 294
434	Position Difference - Following Axis	R/W	Functional group: Technological functions Unit: [°] or [mm] Default value: 0 [°] Variable type: float page 295
435	Correction Velocity - Following Axis	R/W	Functional group: Technological functions Unit: [°/s] or [mm/s] Default value: R184 [°/s] Variable type: float page 295
440	Table Node	R/W	Functional group: Technological functions Unit: [-] Default value: 0 Variable type: int / register page 274
441	Leading Axis Position	R/W	Functional group: Technological functions Unit: [°] or [mm] Default value: 0 [°] Variable type: float page 274
442	Following Axis Position	R/W	Functional group: Technological functions Unit: [°] or [mm] Default value: 0 [°] Variable type: float page 275

Register Number	Name	R/ W	Description
443	Configuration Offset - Leading Axis Position	R/ W	Functional group: Technological functions Unit: [°] or [mm] Default value: 0 [°] Variable type: float page 275
444	Configuration Offset - Following Axis Position	R/ W	Functional group: Technological functions Unit: [°] or [mm] Default value: 0 [°] Variable type: float page 276
445	Scaling Factor - Leading Axis Position	R/ W	Functional group: Technological functions Unit: [-] Default value: 0 Variable type: float page 276
446	Scaling Factor - Following Axis Position	R/ W	Functional group: Technological functions Unit: [-] Default value: 0 Variable type: float page 276
447	Reference Type	R/ W	Functional group: Technological functions Unit: [-] Default value: 0 Variable type: int / register page 296
448	Start Type	R/ W	Functional group: Technological functions Unit: [-] Default value: 0 Variable type: int / register page 296
449	Stop Type	R/ W	Functional group: Technological functions Unit: [-] Default value: 0 Variable type: int / register page 297
Technological Functions - Virtual Position Counter			

Register Number	Name	R/ W	Description
451	Mode	R/ W	Functional group: Technological functions Unit: [-] Default value: 0 Variable type: int / register page 307
Referencing on the Fly			
452	Position Reference	R/ W	Functional group: Referencing on the fly Unit: [°] or [mm] Default value: 10 Variable type: float page 321
453	Position Window	R/ W	Functional group: Referencing on the fly Unit: [°] or [mm] Default value: 10 Variable type: float page 321
454	As-is Position Value	R/ W	Functional group: Referencing on the fly Unit: [°] or [mm] Default value: 0 Variable type: float page 322
455	Position Difference	R/ W	Functional group: Referencing on the fly Unit: [°] or [mm] Default value: 0 Variable type: float page 322
456	Correction Factor K_v	R/ W	Functional group: Referencing on the fly Unit: [1/s] Default value: 1 Variable type: float page 323
457	Maximum Speed Correction	R/ W	Functional group: Referencing on the fly Unit: [°/s] or [mm/s] Default value: 10 Variable type: float page 323

Register Number	Name	R/ W	Description
458	Correction Speed	R/ W	Functional group: Referencing on the fly Unit: [°/s] or [mm/s] Default value: 0 Variable type: float page 324
Position Trigger			
515	DigOut - Status	R/ W	Functional group: Position trigger Unit: - Default value: 0 Variable type: int / register page 355
516	DigOut - Set	R/ W	Functional group: Position trigger Unit: - Default value: 0 Variable type: int / register page 358
517	DigOut - Clear	R/ W	Functional group: Position trigger Unit: - Default value: 0 Variable type: int / register page 358
525	DigOut - Type	R/ W	Functional group: Position trigger Unit: - Default value: 0 Variable type: int / register page 356
526	DigOut - PosX	R/ W	Functional group: Position trigger Unit: [°] or [mm] Default value: 0 [°] Variable type: float page 359
529	DigOut - Delay	R/ W	Functional group: Position trigger Unit: [ms] Default value: 0 [ms] Variable type: float page 359
596	DigOutStatus - Set	R/ W	Functional group: Position trigger Unit: - Default value: 0 Variable type: int / register page 355
597	DigOutStatus - Clear	R/ W	Functional group: Position trigger Unit: - Default value: 0 Variable type: int / register page 356

Register Number	Name	R/ W	Description
623	DigOut - Type2	R/ W	Functional group: Position trigger Unit: - Default value: 0 Variable type: int / register page 360
624	DigOut - Set2	R/ W	Functional group: Position trigger Unit: - Default value: 0 Variable type: int / register page 360
625	DigOut - Clear2	R/ W	Functional group: Position trigger Unit: - Default value: 0 Variable type: int / register page 360
626	DigOut - PosX2	R/ W	Functional group: Position trigger Unit: [°] or [mm] Default value: 0 [°] Variable type: float page 361
627	DigOut - Delay2	R/ W	Functional group: Position trigger Unit: [ms] Default value: 0 [ms] Variable type: float page 361
Torque-Controlled Shut-Off			
136	Status of Torque-Controlled Shut-Off	R	Functional group: Torque-controlled shut-off Unit: - Default value: 0 Variable type: int / register page 376
137	Triggering Threshold - Current	R/ W	Functional group: Torque-controlled shut-off Unit: [A_{eff}] Default value: 0 [A_{eff}] Variable type: float page 376
138	Filter of the Triggering Threshold	R/ W	Functional group: Torque-controlled shut-off Unit: - Default value: 0 Variable type: int / register page 377

Register Number	Name	R/ W	Description
139	Speed Shut-Off Threshold	R/ W	Functional group: Torque-controlled shut-off Unit: [rpm] Default value: 150 Variable type: int / register page 377
607	Holding Current	R/ W	Functional group: Torque-controlled shut-off Unit: [A_{eff}] Default value: 0 [A_{eff}] Variable type: float page 378
630	Filter of the Zero Speed Count	R/ W	Functional group: Torque-controlled shut-off Unit: - Default value: 10 Variable type: int / register page 378

Register Number	Name	R/ W	Description
Trailing Indicator			
438	Trailing Indicator - max. as-is position	R/ W	Functional group: Trailing indicator Unit: [°] or [mm] Default value: 0 [°] Variable type: float page 383
439	Trailing Indicator - min. as-is position	R/ W	Functional group: Trailing indicator Unit: [°] or [mm] Default value: 0 [°] Variable type: float page 383
538	Trailing Indicator - Max. Tracking Error	R/ W	Functional group: Trailing indicator Unit: [°] or [mm] Default value: 0 [°] Variable type: float page 384
539	Trailing Indicator - Min. Tracking Error	R/ W	Functional group: Trailing indicator Unit: [°] or [mm] Default value: 0 [°] Variable type: float page 384

Appendix E: Overview of Functions

Functions	Referencing	Positioning	Virtual Position Counter	Coupling mode: Electronic Gearing	Coupling mode: Table	Referencing on the Fly	Position Capture	PID Controller	Position Trigger	Torque-Controlled Shut-Off
Referencing		O	✓	O	O	✓	✓	O	✓	✓
Positioning	O		✓	O	O	✓	✓	O	✓	✓
Virtual Position Counter	✓	✓		✓	✓	O	✓	✓	✓	✓
Coupling mode: Electronic Gearing	O	O	✓		O	✓	✓	O	✓	✓
Coupling mode: Table	O	O	✓	O		✓	✓	O	✓	✓
Referencing on the Fly	✓	✓	O	✓	✓		✓	O	✓	✓
Position Capture	✓	✓	✓	✓	✓	✓		✓	✓	✓
PID Controller	O	O	✓	O	O	O	✓		✓	O
Position Trigger	✓	✓	✓	✓	✓	✓	✓	✓		✓
Torque-Controlled Shut-Off	✓	✓	✓	✓	✓	✓	✓	O	✓	

✓ = Functions are available at the same time O = Functions are not available at the same time

Appendix F: Index of Illustrations

Appendix G: Index

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W

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