Instruction Manual

Control Unit SP01229

4-Quadrant Servo Controller for Electronically Commutated Motors (Brushless DC Motors)

Technical documentation	SP01229
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Content

1. Preface and General

1.1 Brief Description

Current controlled 4-quadrant servo controller for electronically commutated motors. It is characterized by numerous features such as:

- Wide input voltage range
- Input-side mains filter already integrated
- Temperature monitored output stage
- Phase current monitoring of the motor windings
- 10 freely configurable inputs, 4 of which can also be used as outputs
- Overvoltage and undervoltage monitoring of the DC link circuit
- Connection for ballast resistor
- Current controller for DC link voltage independent motor current
- Adjustable standstill monitoring
- Pluggable terminals
- Integrated switch mode power supply
- STO input
- Optional RS485 or CAN connection

1.2 Advantages

- Compact space saving design
- Excellent control characteristics over a wide control range
- Wide range of setpoint options:
  - Current setpoint/limit
  - Speed setpoint
  - Position setpoint
- Wide range of motor types can be connected
- Vector control for good motor efficiency
- Overload protection for servo controller and motor
- Assembly and service-friendly connection technology
- 7-segment display for operating status and error code
- Parameterization via USB with *MOSCA ELEKTRONIK Device Interface*

1.3 Scope of Delivery

- Servo controller SP01229
- Mating connectors

1.4 Legal Provisions

Liability

The information, data and notes given in these operating instructions were up to date at the time of printing. No claims can be made for equipment already supplied on the basis of the information, illustrations and descriptions in these operating instructions.

The engineering information and circuit sections shown in these operating instructions are suggestions whose transferability to the respective application must be checked. The manufacturer accepts no responsibility for the suitability of the procedures and circuit suggestions given.
No liability is assumed for damage and operational disruptions caused by:
- Disregarding these operating instructions
- Unauthorized modifications to the device
- Operating error
- Improper work on and with the device
- Operation of the device in an installation or connection mode other than described here.

Warranty

Report defects to the manufacturer immediately after the defect is detected.
The warranty is void in the event of:
- Improper use of the device
- Improper work on and with the device
- Unauthorized modifications to the device

Original Version

The original operating instructions is the German edition.
These are legally binding in all legal matters.

Up-to-dateness

The high level of safety and quality of Mosca Elektronik is guaranteed by a constant evolution of the design, equipment and accessories.
This may result in possible deviations between these operating instructions and your device. Mosca Elektronik cannot exclude the possibility of errors.
Therefore, no claims can be derived from the information, illustrations and descriptions.

1.5 Definition of terms used

Qualified Personnel

Qualified personnel are persons who, on the basis of their training, experience, instruction and knowledge of relevant standards and regulations, accident prevention regulations and operating conditions, have been authorized by the person responsible for the safety of the plant to carry out the activities required in each case and are able to recognize and avoid possible hazards.
(Definition for skilled workers according to IEC 60364)

Operator

An operator is any natural person or any entity who uses the device or on whose behalf the device is used.

2. Safety Instructions

2.1 Operating Instructions

These operating instructions are intended for safe working on and with the device. They contain safety instructions that must be observed.

In addition to the basic safety instructions in this chapter, the safety instructions in the continuous text must also be observed.
These safety instructions do not claim to be complete. If you have any questions or problems, please contact the manufacturer.

All persons working on and with the device must have the operating instructions available when carrying out their work and observe the information and notes relevant to them.
The operating instructions must always be complete and in a perfectly legible condition.

2.2 Symbolism

In this manual, important explanations are highlighted with the following symbols:

Attention:
This declaration indicates hazards which may result in personal injury or damage to property.

Attention required / Check:
Please pay special attention to the described facts.

Information:
Here you can get additional information about the product.

2.3 General Safety Instructions

The device corresponds to the state of the art at the time of delivery and is generally considered to be safe to operate. The device may be dangerous if
- unqualified personnel work on and with the device,
- the device is installed or connected in a way that is not intended, or
- the device is used improperly.

Then there is danger for:
- People
- The device
- Other tangible assets of the operator

The systems in which the device is installed must be designed in such a way that they fulfill their functions and do not cause any danger to persons when they are set up correctly and used as intended in fault-free operation. This also applies to the interaction of the device with the overall system. For applications in systems and controls with safety-related requirements as well as during installation, the relevant laws and regulations must be observed (e.g. EN 60664-1, EN 60204-1, VDE 0100).

Take additional measures to limit the consequences of malfunctions that may cause danger to persons:
- Other independent devices, which protect possible malfunction of the device
- Electrical or non-electrical protection devices (interlocking or mechanical locks)
- System-wide measures

Take appropriate measures to ensure that no material damage occurs in the event of malfunctions of the device.

When working on live equipment, the applicable accident prevention regulations must be observed.

Repairs to the device or its components may only be carried out by the manufacturer for reasons of safety and preservation of the documented system data and functions.

No liability is accepted for unsuitable, incorrect manual or automatic setting of the parameters.

2.4 Duties of the Operator

The operator or his safety representative is obliged
- to control compliance with all relevant regulations, notices and laws,
- to ensure that only qualified personnel work on and with the device,
- to ensure that personnel have the operating instructions available for all relevant work, and
- to prohibit unqualified personnel from working on and with the device.
- The operator is responsible for ensuring that all system components are installed and connected in accordance with the recognized technical regulations in the country of installation, as well as other regionally applicable regulations. Special attention must be paid to cable dimensioning, shielding, grounding, disconnection, isolation and overcurrent protection.

2.5 Personnel

Only qualified personnel may work on and with the device.

2.6 Notes on Unpacking, Setting Up and Installation

After unpacking or before initial start-up, the device must be checked for any transport damage.
All plug-in and screw connections must be checked for tightness.
Minimum requirements for installation site:
- The room should be as dust-free as possible (a dust filter must be installed in control cabinets with a fan).
- Permissible ambient temperature and humidity must not be exceeded (if necessary, provide air conditioning measures).
- The device heats up the surrounding space. Ensure sufficient distance to heat-sensitive devices.
- Housing can become hot (heat sink temperature over 70°C) during operation, provide sufficient protection against accidental contact.
- In the event of contaminated cooling air (dust, lint, greases and aggressive gases) which could impair the function of the unit, sufficient countermeasures must be taken, e.g. separate air ducting, installation of filters, regular cleaning, etc.
- The devices are designed for mounting on a mounting plate in the control cabinet.
- The mounting must be vertical.
- Ensure unobstructed access of cooling air and discharge of exhaust air. Clearances must be maintained for supply and exhaust air.

- If the device is permanently exposed to vibrations or shocks, vibration dampers may be necessary.
- The use in potentially explosive atmospheres is not permitted.
- Disassembly of the housing is not permitted, even after disconnecting the mains supply, dangerous voltages may be present in the device for up to 5 minutes.

2.7 Electrical Installation

- The device contains electrostatically sensitive components. Before carrying out installation and service work in the area of the connection terminals, personnel must free themselves from electrostatic charges. Discharge can be achieved by first touching a grounded metal surface.
- An appropriate line protection fuse is required to protect the supply line.
- Supply line cross-sections for supply line and motor line must be at least 1.5mm²!
- The motor should have a temperature switch. The evaluation can be done by the SP01229 or a suitable evaluation device.
- Control cables and power cables must always be laid separately and at a distance from each other.
- Position encoder, setpoint and analog control inputs must be laid with shielded cables.
- Observe the safety regulations in force on site.
- Power and control connections are safely isolated from each other (PELV) according to EN61800-5-1, all connected circuits must also meet this requirement.

2.8 EMC-Compliant Wiring

To ensure electromagnetic compatibility (EMC) in your control cabinets in electrically harsh environments, the following EMC rules must be observed during design and installation:

- All metallic parts of the control cabinet must be connected to each other over a large area and with good conductivity. (Not varnish on varnish!) If necessary, use contact or scratch washers. The cabinet door is to be connected to the cabinet via the ground straps (top, middle, bottom) as short as possible.
- Depending on the cable length and motor, a ferrite ring core is required on the motor cables to comply with the EMC limit values. Caution: Only loop the three motor phases through the ferrite core, not the shield or PE wire.
- Signal lines and power cables must be laid spatially separated from each other to avoid coupling distances. Minimum distance: 20 cm
- If possible, only run signal lines from one level into the cabinet.
  Unshielded lines of the same circuit (forward and return conductors) should be twisted if possible.
- Contactors, relays and solenoid valves in the cabinet, if necessary in neighboring cabinets, are to be wired with extinguishing combinations; e.g. with RC elements, varistors, diodes.
- The shields of signal lines must be connected to earth on both sides (source and destination), over a large area and with good conductivity. Earth is generally defined as all metallic conductive parts that can be connected to a protective earth conductor, e.g. cabinet housing, motor housing, foundation earth etc.. If the potential equalization between the shield connections is poor, an additional equalization conductor of at least 10mm^2 must be laid parallel to the shield to reduce the shield current.
- Do not lay the wiring freely in the cabinet, but route it as close as possible to the cabinet housing or mounting plates. This also applies to spare cables. These must be grounded at least at one end, better at both ends (additional shielding effect).
- Unnecessary line lengths are to be avoided. Coupling capacitances and inductances are thus kept small.
- The shielding of supply lines, e.g. resolver or incremental encoder cables, must be connected to housing ground. In the area where the cable is routed into the housing, the insulation must be removed by about 2cm to expose the shielding braid. The shielding braid must not be damaged during stripping. The cable must be routed at the stripped point through terminals or clamping yokes connected to earth.
- There are holes on the motor side of the SP01229 housing which can be used to attach the shield clamps (e.g. Icotek LFZ-M or Hebotec SKDZ).
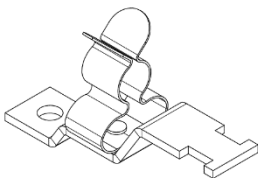
2.9 Operation of the Device

Only operate the device when it is in perfect condition. The permissible operating conditions and performance limits must be observed.

Retrofits, modifications or conversions to the device are generally prohibited. In any case, they require consultation with the manufacturer.

The device is a piece of equipment for use in industrial plants. During operation, this equipment has dangerous, live parts. During operation, all covers must therefore be fitted to the device to ensure protection against accidental contact.

The modules are equipped with electrostatically sensitive CMOS and MOS components. Caution with electrostatic charges.

2.10 Storage

Storage temperature see Technical Data, chapter 3.1
For long-term storage, connect to mains voltage for at least 5 minutes every year.

2.11 Important Note on Leakage Current

The leakage current is not greater than 3.5mA according to EN61800-5-1. The contact current measurement method according to IEC6099 Fig. 4 was used for the determination.
High-frequency components of the current can exceed 3.5mA; operation with a residual current device (RCD) must be checked in each individual case.

3. Technical data

3.1 Technical Data SP01229

Input	
Input voltage range V_{grid}	90...250V_{AC}
Input frequency	45...66Hz
Rated input current I_N	4.65A_{AC}
Peak input current	10A_{AC}
Nominal connected load @ 230V_{AC}	750W / 1071VA
Cos φ	0.7
Inrush current @ 40°C	< 10A
Internal fuse protection	10A slow-blow
External fuse protection	Line protection
DC Link	
DC link voltage	125...400V_{DC}
Output	
Rated output voltage V_o	0...0.95 x V_{grid}
Rated output current I_o	3A_{AC}
Rated output current I_o with additional heat sink	5,5A_{AC}
Peak output current	10A_{peak}
Cycle time current controller and sensor sampling	125µs
Min. winding inductance	2mH
Control range	1:50 depending on the motor type
Switching frequency motor voltage	16kHz
Max. current ballast resistor output	10A
Min. ballast resistance	40Ω
Control Side	
Supply voltage for outputs	5...30V_{DC}
Max. current per output	500mA
Recommended fuse	2A
General	
Mounting position	vertical
Heat sink temperature	max. 80°C
Ambient temperature	0...+40°C, for >40°C see chap. 3.3
Relative humidity	max. 95%, non-condensing
Storage temperature	-25...+75°C
Protection class	IP20
Overvoltage category	III
Pollution level	2
Protection class	I
Standards and guidelines	EN 61800-5-1 EN IEC 61800-3

Technical specifications refer to 230VAC mains input voltage, 1000m installation altitude, unless otherwise specified.

3.2 Power Dissipation Diagram
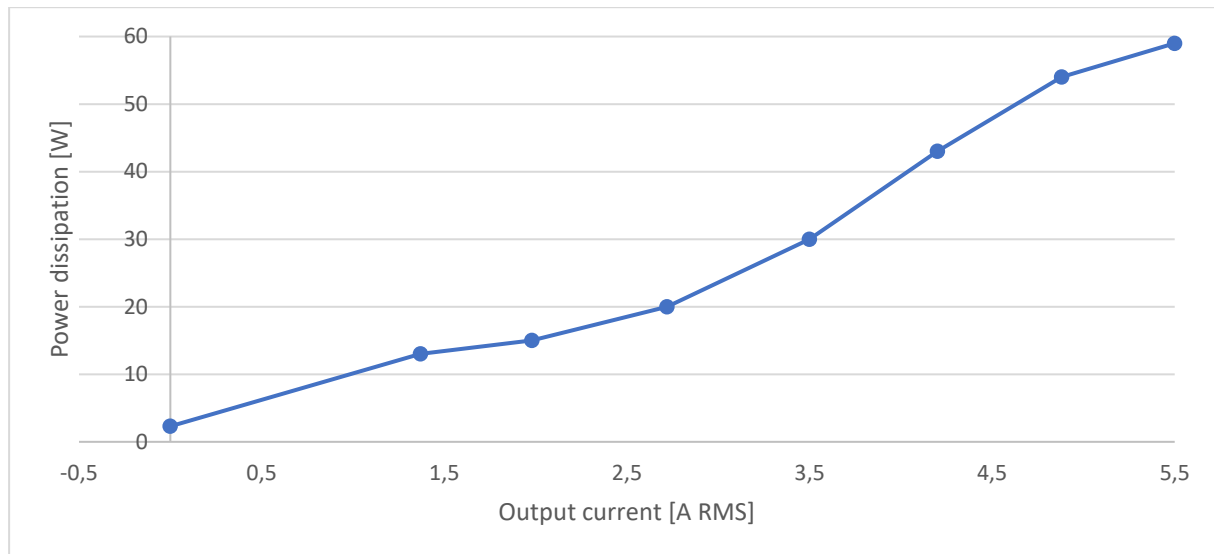
3.3 Power reduction

At installation altitudes above 1000m or at temperatures above 40°C ambient temperature, the output power of the servo controller must be reduced according to the diagrams below.

Power reduction at altitudes above 1000m

Power reduction at elevated temperatures
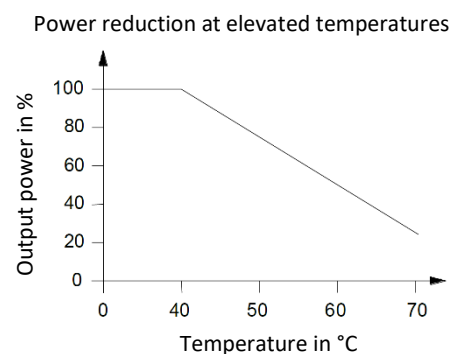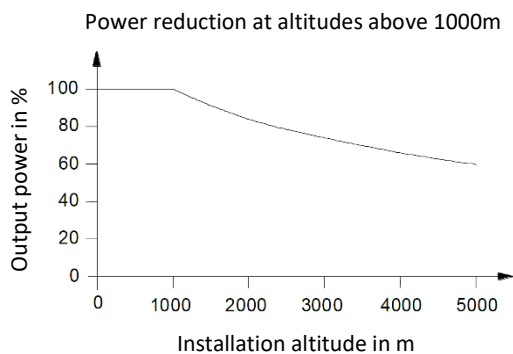
The safe separation of power and control section is no longer guaranteed by the device above an installation altitude of 2000m, external measures are required.

3.4 Power Increase

The input power of the control unit can be increased up to 1000W. Depending on the duty cycle, the service life is greatly reduced and measures must be taken. Contact the manufacturer for this.

3.5 Dimensions
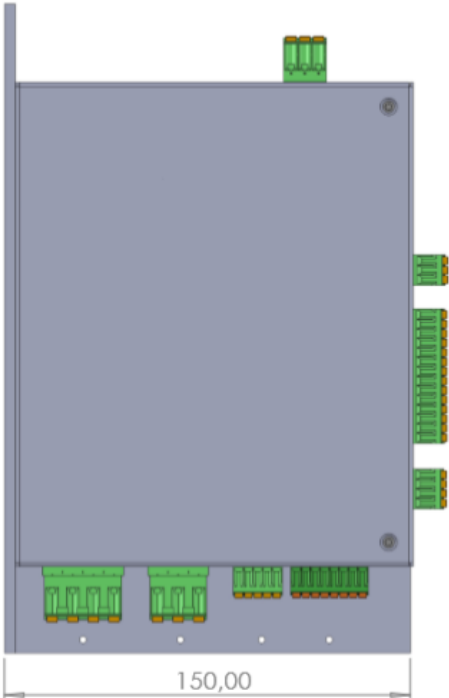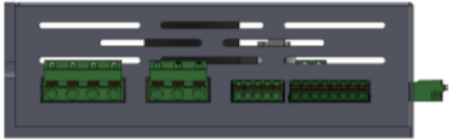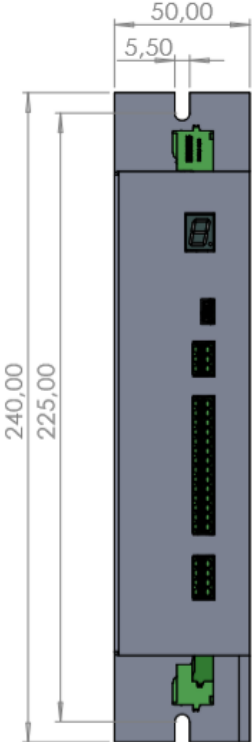
4. Connection Description

4.1 Connection Arrangement
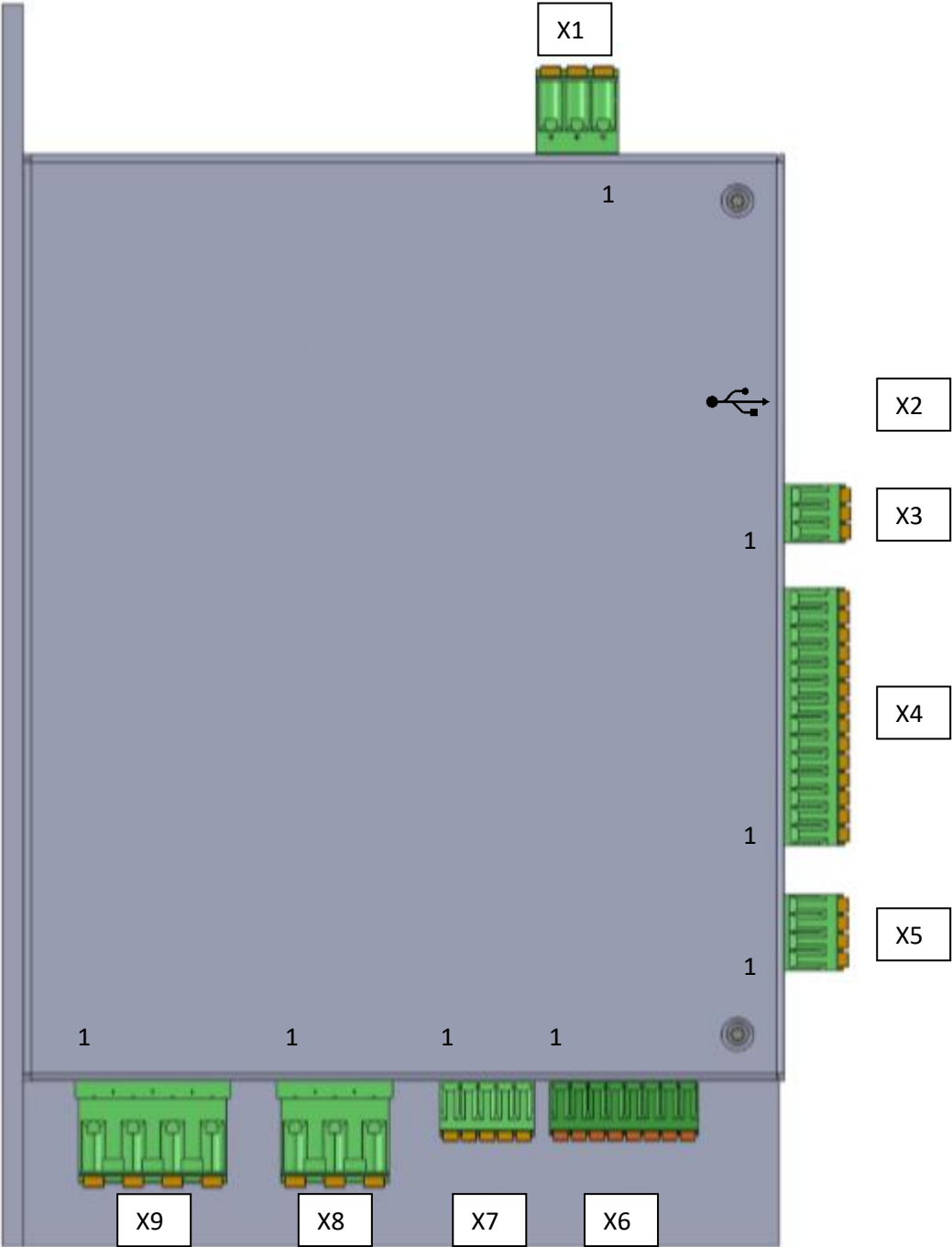
4.2 X1 Power Input

Mating connector	Phoenix Contact FKC 2.5/ 3-ST-5.08
Conductor cross section	1.5...2.5mm²
Stripping length	10mm

Pin	Designation	Function
X1-1	PE	Protective earth
X1-2	N	Mains input neutral
X1-3	L	Mains input phase

See chapter 3.1.

4.3 X2 USB Interface

Plug type: Mini USB type B

The USB interface is based on the FT230X chip. This is compliant with the USB 2.0 specification and has received the USB-IF Test ID (TID) 40001463 (Rev D).

4.4 X3 RS485/CAN Interface (OPTIONAL)

Mating connector	Phoenix Contact FMC 1.5/ 3-ST-3.5
Conductor cross section	0.2...1.0mm²
Stripping length	10mm

Pin	Designation	Function
X3-1	RS485-A / CAN-H	RS485/CAN interface
X3-2	RS485-B / CAN-L	RS485/CAN interface
X3-3	GND	Mass reference

RS485: Compliant with RS-485 EIA/TIA-485 standard

CAN: Compatible with ISO 11898-2

An integrated 120Ω bus terminating resistor can be activated via P4001.

4.5 X4 Inputs and Outputs

Mating connector	Phoenix Contact FMC 1.5/14-ST-3.5
Conductor cross section	0.2...1.0mm²
Stripping length	10mm

Pin	Designation	Function
X4-1	IN1 / OUT1	Analog input 0...30V, 0/4...20mA Digital input IEC61131-2 type 1/3 Digital output 5...30V, max. 500mA, see X4-13
X4-2	IN2 / OUT2	Analog input 0...30V, 0/4...20mA Digital input IEC61131-2 type 1/3 Digital output 5...30V, max. 500mA, see X4-13
X4-3	IN3 / OUT3	Analog input 0...30V, 0/4...20mA Digital input IEC61131-2 type 1/3 Digital output 5...30V, max. 500mA, see X4-13

X4-4	IN4 / OUT4	Analog input 0...30V, 0/4...20mA Digital input IEC61131-2 type 1/3 Digital output 5...30V, max. 500mA, see X4-13
X4-5	IN5	Analog input 0...30V, 0/4...20mA Digital input IEC61131-2 type 1/3
X4-6	IN6	Analog input 0...30V, 0/4...20mA Digital input IEC61131-2 type 1/3
X4-7	IN7	Analog input 0...30V, 0/4...20mA Digital input IEC61131-2 type 1/3
X4-8	IN8	Analog input 0...30V, 0/4...20mA Digital input IEC61131-2 type 1/3
X4-9	IN9	Analog input 0...30V, 0/4...20mA Digital input IEC61131-2 type 1/3
X4-10	IN10	Analog input 0...30V, 0/4...20mA Digital input IEC61131-2 type 1/3
X4-11	GND	Ground reference
X4-12	5V	Output 5V±10%, maximum output current 100mA (total current of all 5V outputs)
X4-13	+IN	Power supply 5...30V_{DC} for OUT1...4, current voltage is displayed via P62F0
X4-14	GND	Mass reference

The I/O interfaces can be assigned either as analog input, digital input or digital output depending on the parameter setting.

Input settings
INx Mode, P6001, P6011, P6021, P6031, P6041, P6051, P6061, P6071, P6081, P6091:

Off	Input signal is ignored
Digital 1V / 2V	HIGH at >2V, LOW at <1V Current sink 3mA active
Digital 1V / 2V inv.	LOW at >2V, HIGH at <1V Current sink 3mA active
Digital 1V / 2V	HIGH at >2V, LOW at <1V Input impedance 112kΩ
Digital 1V / 2V inv.	LOW at >2V, HIGH at <1V Input impedance 112kΩ
Digital 5V / 11V	Meets IEC61131-2 type 1+3 HIGH at >10.5V, LOW at <5.5V Current sink 3mA active
Digital 5V / 11V inv.	Meets IEC61131-2 type 1+3 (inverted) LOW at >10.5V, HIGH at <5.5V Current sink 3mA active
0...5V = 0...100%	Input impedance 112kΩ
0...5V = -100...+100%	Input impedance 112kΩ
0...10V = 0...100%	Input impedance 112kΩ
0...10V = -100...+100%	Input impedance 112kΩ
0...24V = 0...100%	Input impedance 112kΩ
0...24V = -100...+100%	Input impedance 112kΩ
0...20mA = 0...100%	Input impedance 300Ω
0...20mA = -100...+100%	Input impedance 300Ω
4...20mA = 0...100%	Input impedance 300Ω

4...20mA = -100...+100%	Input impedance 300Ω
	At <2mA 0% is output
C1	Analog input range Custom 1
C2	Analog input range Custom 2

The cut-off frequency of the input filters is approx. 1.5kHz.

The current values in volts and percent and the digital status can be read out via parameters, see parameter overview chapter 8.

The parameters P60F0...P60F5 can be used to define the user-defined input ranges C1 and C2:

Example: 0...15V→ 0...100%
Multiplier = 6.7%/V
Offset = 0V
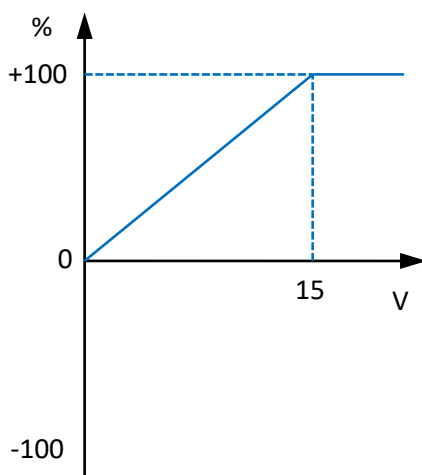
Example: 0...15V→ -100...+100%
Multiplier = 13.3%/V
Offset = 7.5V
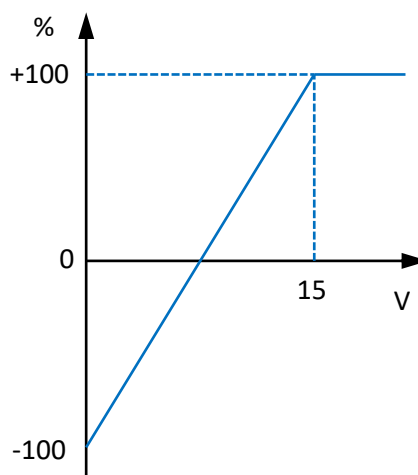
For user-defined current input ranges, the 300Ω shunt must also be activated via P60F2/P60F5.

Output settings
OUTx Source, P6201, P6211, P6221, P6231:

Off
On
Ready
Ready or Enabled
Motor Enabled
STO active
Warning
Error
Speed Status
Position Status
IN1
IN2
IN3
IN4
IN5
IN6
IN7

IN8
IN9
IN10

OUTx Inverted, P6202, P6212, P6222, P6232:

Off
On

The state of the outputs is displayed via parameters P6203, P6213, P6223, P6233.

4.6 X5 STO

Mating connector	Phoenix Contact FMC 1.5/ 4-ST-3.5
Conductor cross section	0.2...1.0mm²
Stripping length	10mm

Pin	Designation	Function
X5-1	STO-1	Input STO 1
X5-2	STO-GND1	Ground reference STO 1
X5-3	STO-GND2	Ground reference STO 2
X5-4	STO-2	Input STO 2

Input voltage 18...30V_{DC}, input current <5mA

The status of the STO inputs is displayed via P1100 and P1110.

4.7 X6 Incremental Encoder (ABZ)

Mating connector	Phoenix Contact FMC 1.5/ 8-ST-3.5
Conductor cross section	0.2...1.0mm²
Stripping length	10mm

Pin	Designation	Function
X6-1	5V	Output 5V±10%, maximum output current 100mA (total current of all 5V outputs)
X6-2	QENC-A	Encoder A+ input (RS422 / TIA/EIA-422)
X6-3	QENC-/A	Encoder A- Input (RS422 / TIA/EIA-422)
X6-4	QENC-B	Encoder B+ input (RS422 / TIA/EIA-422)
X6-5	QENC-/B	Encoder B- Input (RS422 / TIA/EIA-422)
X6-6	QENC-Z	Encoder Z+ input (RS422 / TIA/EIA-422)
X6-7	QENC-/Z	Encoder Z- Input (RS422 / TIA/EIA-422)
X6-8	GND	Ground reference

4.8 X7 Position Sensor (Hall Sensor)

Mating connector	Phoenix Contact FMC 1.5/ 5-ST-3.5
Conductor cross section	0.2...1.0mm²
Stripping length	10mm

Pin	Designation	Function

X7-1	5V Hall	Output 5V±10%, maximum output current 50mA. 100mA (total current of all 5V outputs) must not be exceeded here either.
X7-2	Hall 1	Hall sensor input 1 (Open collector, 3.3kΩ pull up to 5V in the device)
X7-3	Hall 2	Hall sensor input 2 (Open collector, 3.3kΩ pull up to 5V in the device)
X7-4	Hall 3	Hall sensor input 3 (Open collector, 3.3kΩ pull up to 5V in the device)
X7-5	GND Hall	Mass reference

Connection is galvanically isolated to the mains/motor side and to the control side according to EN61800-5-1 (PELV). Shielded cable is recommended.

4.9 X8 Bake Resistor

Mating connector	Phoenix Contact GFKIC 2.5/ 3-ST-7.62
Conductor cross section	0.2...2.5mm²
Stripping length	10mm

Pin	Designation	Function
X8-1	DCL-	Ground reference of DC link
X8-2	BR	Connection 1 for brake resistor
X8-3	DCL+	DC link voltage, terminal 2 for brake resistor

Generally use a shielded cable.
See chapter 3.1.

4.10 X9 Motor Connection

Mating connector	Phoenix Contact GFKIC 2.5/ 4-ST-7.62
Conductor cross section	0.2...2.5mm²
Stripping length	10mm

Pin	Designation	Function
X9-	L1	Motor phase 1 (or + for DC motors)
X9-	L2	Motor phase 2 (or – for DC motors)
X9-	L3	Motor phase 3
X9-	PE	Protective earth

Generally use a shielded cable.
See chapter 3.1.

5. Commissioning

5.1 Switch-On Sequence

- Switch on supply voltage
- During initial startup: Parameterize the device for the application
- Enable controller, select direction
- Specify setpoints for speed and motor current

5.2 Operation and Parameterization

5.2.1 Display

Displays operating status and error codes via 7-segment display:

Display	Description
0	Device is ready, enable inactive
1	Motor enable active
2	Magnet enable active
-	STO active
_	Precharge DC link
F□□□.	Error message, see chapter 7 For error codes

5.2.2 Operating Software

In order to be able to parameterize and monitor the SP01229 controller, the *MOSCA ELEKTRONIK Device Interface* (MEDI) monitoring software is required.
The latest version can be downloaded free of charge from the homepage at http://www.mosca-elektronik.de/medi.

Note: Please refer to the MEDI operating instructions for installation and operation of the software. These can also be found at the above Internet address.

The connection to the PC is made via USB (X2).

5.2.3 RS485 (OPTIONAL)

Currently without function.

5.2.4 CAN (OPTIONAL)

Currently without function.

6. Operating Modes and Functions

6.1 Motor Properties

Before an operating mode is selected and parameterized, the properties of the connected motor must be entered. P5001 to P5005 are to be determined by measurement or via the data sheet of the motor.

5001	Pole Pair Count	The number of pole pairs of the motor	
5002	Nominal Motor Current (RMS)	Motor current from motor nameplate for overload protection	A
5003	Speed Constant	Speed to EMF from data sheet	RPM/V
5004	Winding Resistance	Ohmic resistance of the motor from data sheet	Ω
5005	Thermal Time Constant of Motor	Time until motor temperature has reached 63% of its steady-state value	s

6.2 Position Feedback

6.2.1 Hall Sensor

To detect the rotor position, the Hall sensors can be activated via P7001. The Hall sensors are aligned to the EMF via P7002; a total of 12 alignments are possible. Alignments 1 to 6 rotate the measured rotor position by 60° in each step. The same applies to alignments 7 to 12, but in the reverse direction of rotation.

Since the alignment of the Hall sensors of the motor can differ between manufacturers and series, the correct alignment for a new motor type is determined experimentally:

1. Parameterize current and speed controller so that the motor can rotate. If possible, test with a known motor beforehand.
    If the motor accelerates to maximum speed without control in the following steps, the actual speed value must be inverted (P7211).
    Caution: Never change parameters if enable signal is active.
2. Set alignment to 1.
3. Activate enable signal briefly and observe motor shaft: If the shaft rotates, the alignment can be limited to the range 1...6. If the shaft only oscillates but does not rotate, the directions of rotation of the stator and Hall sensors are in opposite directions and the alignment can be narrowed down to the range 7...12. If the shaft does not move, repeat the same with alignment 2.
4. Test all alignments of the previously defined range one after the other and note the direction of rotation. There should be three adjacent alignments for each direction of rotation. Note that 1 is also adjacent to 6, and 7 is adjacent to 12.
    Example: Clockwise at 3, 4, 5 and counterclockwise at 6, 1, 2.
    It may happen that the motor does not start by itself with some alignments. In the example this can be the case at 3, 5, 6 and 2.
5. Limit the alignments to the direction of rotation matching the current setpoint (usually clockwise rotation for positive setpoint).

6. Select the middle alignment from the remaining three alignments and test it (4 or 1 in the example). This is the alignment you are looking for. The adjacent alignments (3 and 5, or 6 and 2 in the example) only provide a low torque, if the motor starts at all.

6.2.2 Encoder

For a higher resolution, an incremental encoder can also be used (P7010). The Hall sensors and the encoder must have the same direction of rotation. This can be adjusted by P7012. P7013 and P7014 can be found in the data sheet of the encoder.

Attention: Usually the number of pulses of a channel is given in the data sheet. This value must be multiplied by the factor 4 for P7014, because a quadrature decoder is used.

Setting angular offset P7015:
Record current value at transition Hall sensor 6-1: X
Record current value at transition Hall sensor 1-2: Y

$$Offset = 360° - \frac{X + Y}{2}$$

6.2.3 Parameter

7001	Enable Hall Sensor	Activate position feedback via Hall sensor	
7002	Hall Sensor Alignment	12 different alignments for Hall sensors to motor winding	
7003	Rotor Position Hall Sensor	Current Hall sensor position	
7010	Enable Encoder	Activate position feedback via encoder	
7011	Use Encoder for FOC	Enable for higher speed and positioning accuracy, Hall sensor is still required for startup.	
7012	Reverse Encoder	Adjustment of direction	
7013	Encoder Index Signal at	Datasheet info for Z-track	
7014	Encoder Scaling	Number of signal edges per revolution of encoder signal	Inc/Rev
7015	Encoder Offset	Adjustment of mechanical position from encoder to Hall sensor	°
7020	Rotor Position (electrical)	Current rotor position	°

6.3 Current Controller

The current controller is always active as the innermost control loop and must therefore be set first. As current control mode P7101, FOC is preferable to the 6-step method, as it offers acoustic and control advantages. For the current setpoint scaling P7114, refer to the percentage setpoints. At the same time this is the maximum current of the system, it must be selected so that damage to the connected machine can be excluded. Current controller Kp P7130 is preset to 1.8V/A and must be adjusted if necessary. Current controller Ki P7131 is set to the ratio of winding resistance to winding inductance.

If current limitation P7111 is active, the current can be limited as required from 0% to 100% via an external signal. The parameter braking current limit P7112 reduces the maximum current during braking. Static torque feed forward control can be implemented via current offset P7113.

7101	Current Control Mode	FOC, 6-step or DC	
7110	Current Setpoint Source	Configuration of the current setpoint source	
7111	Current Limit Source	Configuration of the current limitation source	
7112	Brake Current Limit	Maximum braking current, based on P7114	%
7113	Current Offset	Offset which is added to current setpoint, based on P7114	%
7114	Current Setpoint Scaling	Maximum value of the current	A
7115	Current Setpoint Q	Current setpoint, vector length in Q direction	A
7120	Actual Current L1	Actual current of phase 1	A
7121	Actual Current L2	Actual current of phase 2	A
7122	Actual Current L3	Actual current of phase 3	A
7123	Actual Current Q	Actual current (vector length) in Q direction	A
7124	Actual Current D	Actual current (vector length) in D direction	A
7130	Current Control Kp	P term of current controller	V/A
7131	Current Control Ki (= Rs/Ls)	I term of current controller	Ohm/H
7132	PWM DC / 6-Step	PWM mode Symmetrical or Asymmetrical	
7133	Zero Modulation FOC	FOC Mode Symmetrical or Asymmetrical	
7140	Output Voltage Q	Actual voltage value in Q direction	V
7141	Output Voltage D	Actual voltage value in D direction	V
7150	Output Power (FOC only)	Calculated electrical output power	W

6.4 Speed Control

If speed-controlled operation is desired, set the source current setpoint P7110 to speed controller. The scaling speed setpoint is set via P7202, the value in RPM is the maximum speed and the reference value of the percentage speed setting. It must be selected so that the connected motor including attachments such as gearboxes cannot exceed their maximum speed. Acceleration limits (speed ramps) for smooth startup/shutdown are activated via P7203 and set with P7204-P7207. The controller values themselves are parameterized via P7220-P7226.

6.4.1 Actual Speed Source P7210

The speed feedback can be done in three different ways:

Hall sensor:
This type of feedback is suitable when high absolute speed accuracy is required at medium to high speeds.

Encoder:
High accuracy even at low speeds, depending on the resolution of the encoder.

EMF:

This type of feedback is suitable when very smooth behavior even at very low speeds is required. The achievable speed accuracy depends strongly on the linearity and the temperature response of the motor, as well as on the accuracy of the entered motor parameters.

6.4.2 Speed Status Signal

If the current speed reaches speed status threshold (P7240) and remains there for at least the delay time in milliseconds (P7241), the corresponding digital output (if parameterized) is activated. An inversion of the switching logic can be assigned to the corresponding output in group P62xx.

6.4.3 Parameter

7201	Speed Setpoint Source	Configuration of the speed setpoint source	
7202	Speed Setpoint Scaling	Maximum speed	RPM
7203	Acceleration Limits On	Activate acceleration limits (speed ramps)	
7204	Pos. Acceleration Limit	Acceleration limit in positive direction of rotation	RPM/s
7205	Neg. Acceleration Limit	Acceleration limit in negative direction of rotation	RPM/s
7206	Pos. Deceleration Limit	Deceleration limit in positive direction of rotation	RPM/s
7207	Neg. Deceleration Limit	Deceleration limit in negative direction of rotation	RPM/s
7208	Speed Setpoint	Current speed setpoint	RPM
7210	Actual Speed Source	Source for speed feedback	
7211	Invert Actual Speed	Adapt actual speed value to direction of rotation	
7212	Actual Speed	Current actual speed value	RPM
7220	Speed Control Feed Forward	Speed controller feed forward term	%/RPM
7221	Speed Control Kp 1	P term 1 of speed controller	%/RPM
7222	Speed Control Ki 1	I term 1 of speed controller	1/s
7223	Speed Control Kp 2	P term 2 of speed controller	%/RPM
7224	Speed Control Ki 2	I term 2 of speed controller	1/s
7225	Speed Control Selection Source	Source for control term selection	
7226	Speed Control Threshold	Threshold at which switchover from Kp/Ki 1 to Kp/Ki 2 takes place	RPM
7230	Speed Controller Output	Output value of the speed controller	%
7240	Speed Status Threshold	Threshold for the speed status signal	RPM
7241	Speed Status Delay	Delay time for speed status signal	ms

6.5 Motion Control

6.5.1 Right/Left Rotation

Required basic setting for clockwise/anticlockwise rotation mode:
P6E01 = Motion Controller Enable
P7201 = Motion Controller Speed

With selection of the corresponding running direction and controller enable via P6501 and P6502, the connected motor rotates continuously in the selected direction. When the direction of rotation is changed while the motor is running, the motor is decelerated with the parameterized braking ramp (P7206/P7207) (or at the maximum current limit) and accelerated again in the other direction of rotation with the parameterized ramp (P7204/P7205).

The braking current limit P7112 must be parameterized in such a way that no damage can occur to the motor and mechanics in this device state.

6.5.1.1 Fixed Speed

Fixed speeds can be set according to the following table:

	Speed Setpoint Selection 1 P6510	Speed Setpoint Selection 2 P6511
Analog setpoint (P6512)	LOW	LOW
Speed setpoint 1 (P6513)	HIGH	LOW
Speed setpoint 2 (P6514)	LOW	HIGH
Speed setpoint 3 (P6515)	HIGH	HIGH

6.5.2 Hold Control

The hold control has the same basic configuration as right/left rotation mode. If both enable signals (P6501 and P6502) are active, the controller holds the motor at standstill (hold control) or free-wheels, depending on what is set with P6505. For hold control, the position controller gain P7320/P7321 and the maximum positioning speed P7323 must be set. If an external torque is applied to the motor, the controller generates a counter-torque to maintain the position.

For position determination, the edges of the commutation sensors or the encoder are incremented or decremented in a memory register.

If the motor is moved out of its position (by an external torque), the motor will rotate back to the stored position (as long as the external torque permits this). This also applies if the "Hold Control" operating mode is activated during clockwise or counterclockwise rotation: The motor brakes to a standstill and turns back until it has reached the position in which the holder control was activated.

In the "Hold Control" mode, overrun increments P6520/P6521 can also be defined. I.e. when switching from "Clockwise" or "Anticlockwise" mode to "Hold control", a parameterizable number of increments are added, e.g. to prevent the increments passed over during braking from running back.

Examples:
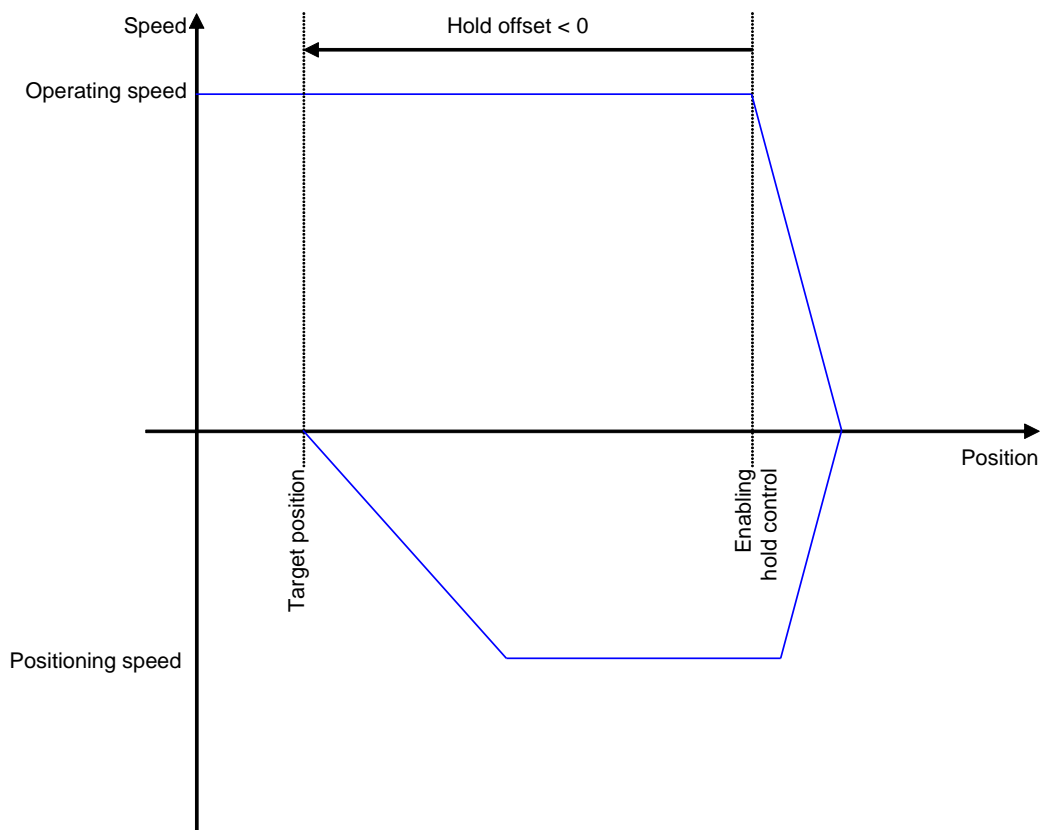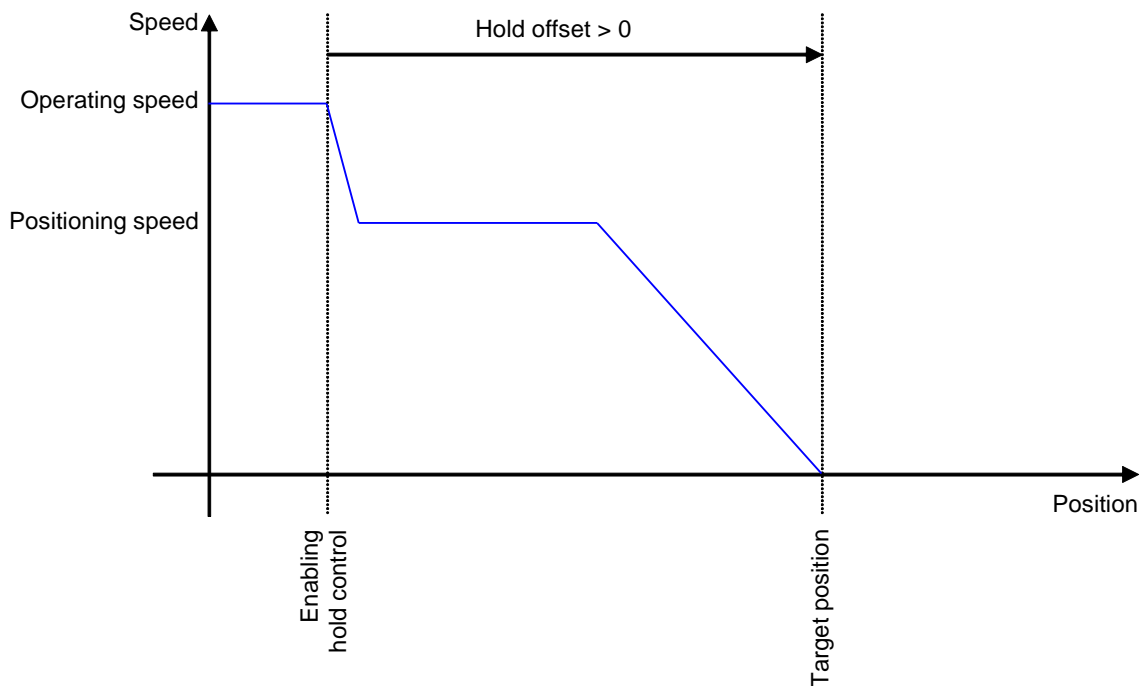
6.5.3 Distance Run

If the drive is to move a certain number of increments, the device must be configured as a hold controller. In P6533 the number of increments is defined, via P6531 and P6532 the start command for this is given in positive or negative direction. Directions of rotation P6501 and P6502 must be selected at the same time and P6505 must be set to position control.

6.5.4 Teach Mode

The "Distance" parameter (P6533) can also be programmed directly by machine movement.
For this purpose, the "Controller enable", "Counterclockwise rotation" and "Clockwise rotation" inputs must be deactivated. The machine should then be brought into the starting position. Now activate input "Teach" and bring the machine into end position. When "Teach" is switched off, the distance traveled is transferred to parameter P6533 "Distance".

ATTENTION:

Switching off the controller enable is <u>not</u> a safe shutdown in the sense of the Machinery Directive. It is essential to ensure that the machine does not pose a risk to persons (even in the event of a possible malfunction of the device).

6.5.5 Parameter

6501	Enable P Source	Source to enable positive setpoint (clockwise)	
6502	Enable N Source	Source to enable negative setpoint (counterclockwise)	
6505	Mode at P=1 N=1	Behavior when both enable signals are active	
650A	MC Mode	Current status of motion controller	
6510	Speed Setpoint Selection 1 Source	Source of speed setpoint selection signal 1	
6511	Speed Setpoint Selection 2 Source	Source of speed setpoint selection signal 2	
6512	External Speed Setpoint Source	Source of the external speed setpoint	
6513	Fixed Speed Setpoint 1	Speed setpoint 1, scaled by P7201	%
6514	Fixed Speed Setpoint 2	Speed setpoint 2, scaled by P7201	%
6515	Fixed Speed Setpoint 3	Speed setpoint 3, scaled by P7201	%
6520	Hold Offset positive	Number of increments that are moved after hold signal when speed setpoint was positive	Inc
6521	Hold Offset negative	Number of increments that are moved after hold signal when speed setpoint was negative	Inc
6530	Start Teach Mode Source	Source for the signal that starts the teaching mode	
6531	Start Distance Run Pos. Source	Source that starts a distance run in positive direction	
6532	Start Distance Run Neg. Source	Source that starts a distance run in negative direction	
6533	Distance	Distance set point	Inc

6.6 Position Controller

If P7201 is configured as a position controller, the position setpoint can be entered directly via P7302. The actual position can be measured via Hall sensor of via encoder. Kp terms (P7320, P7321), switchover threshold (P7322) and maximum positioning speed (P7323) must be adjusted to the respective system.

The position/hold control has the following characteristics.
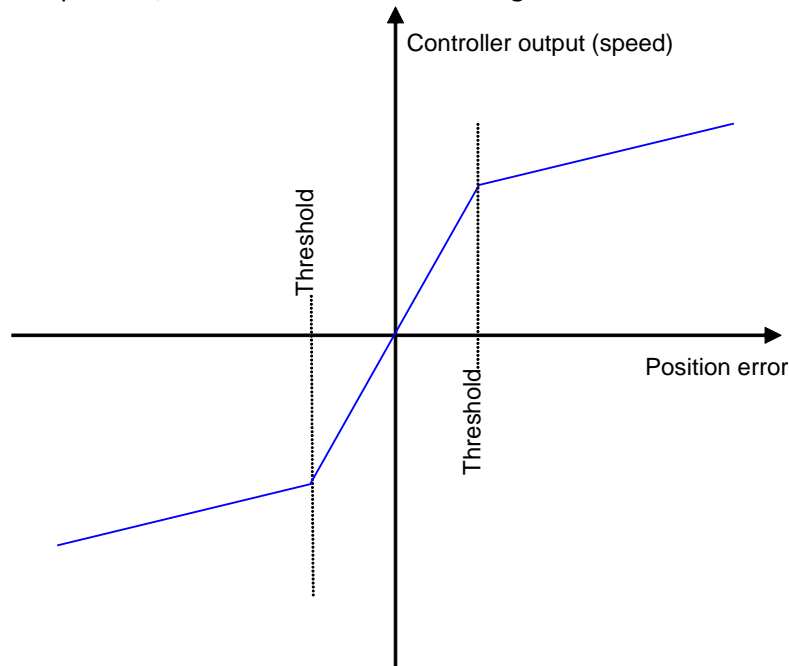
When approaching the target position, the maximum deceleration is determined by the controller gain P7320/P7321. The deceleration limits stored in the speed controller are automatically deactivated in this quadrant so that they do not interfere with the position controller. The acceleration limits of the speed controller are not affected.

Reaching the target position can be signaled by a digital output. For this purpose, the target window must be defined with P7340 and P7341 (Position Status Threshold).

7301	Position Setpoint Source	Source of position setpoint	
7302	Position Setpoint	Current position setpoint	Inc
7303	Position Setpoint Offset	Static offset for position setpoint	Inc
7310	Actual Position Source	Source of position actual value	
7311	Invert Actual Position	Inverts the actual position value	
7312	Actual Position	Actual position value	Inc
7320	Position Control Kp 1	P term 1 of position controller	%/Inc
7321	Position Control Kp 2	P term 2 of position controller	%/Inc
7322	Threshold Position Control 1/2	Threshold at which switchover from Kp 1 to Kp 2 takes place	Inc
7323	Max. Positioning Speed	Maximum permissible speed at which positioning is performed	%
7330	Position Controller Output	Current output of the position controller	%
7340	Pos. Position Status Threshold	Threshold in positive direction for position status signal	Inc
7341	Neg. Position Status Threshold	Threshold in negative direction for position status signal	Inc

6.7 Power Stage Channel 4

6.7.1 Braking Operation

If the controller is to operate in 4Q mode, the Power Stage Channel 4 Mode (P8001) must be set to "Brake resistor" and a suitable brake resistor must be connected. Due to the DC link capacitors, the thresholds P8010 and P8011 can be parameterized to a maximum of 450V.

6.7.2 Electromagnet

Alternatively, the output for the braking resistor can also be used to control a suitable electromagnet. For this purpose, the Power Stage Channel 4 Mode (P8001) must be set to magnet. P8020 and P8021 define pull and hold voltage of the electromagnet. The enable configuration is done via P6E11 and P6E12.

6.7.3 Parameter

8001	Power Stage Channel 4 Mode	Configuration brake resistor / electro-magnet output	
8010	Brake Resistor Threshold 0%	Voltage at which the brake resistor output starts switching on	V
8011	Brake Resistor Threshold 100%	Voltage at which the brake resistor output is fully switched on	V
8020	Magnet Pull Voltage	Voltage 1s at power-on, then cyclically for 100ms every second	V
8021	Magnet Hold Voltage	Voltage to hold the magnet	V

6.8 EMF Speed Feedback with IxR Compensation

In an ideal DC motor without losses, the terminal voltage of the motor would be equal to the EMF voltage, which in turn is proportional to the speed.

Ideal Motor
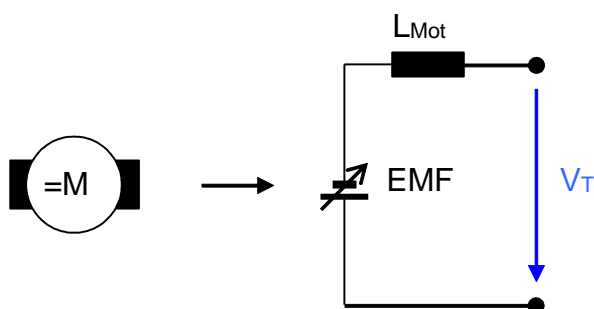
EMF: Electromotive force
L_{Mot} : Inductance of the motor (not important for the momentary consideration)
V_T : Terminal voltage of the motor

Real Motor
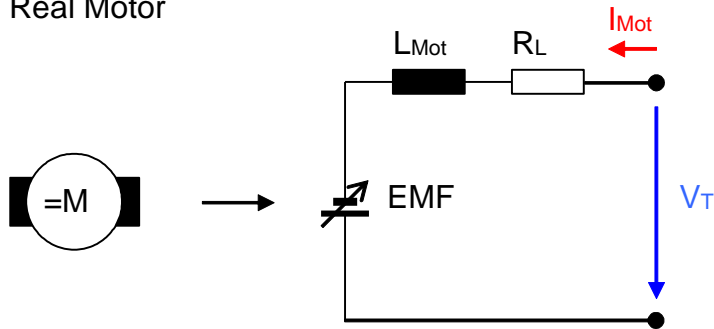
EMF: Electromotive force
L_{Mot} : Inductance of the motor (not important for the momentary consideration)
R_L : Loss resistance of the motor (all losses of the motor combined)
V_T : Terminal voltage of the motor
I_{Mot} : Motor current

Unfortunately, real motors have losses (ohmic losses, re-magnetization losses, commutator losses), which makes speed detection via terminal voltage more complicated. However, if you know the resistance R_L, you can use the relation

$$EMF = V_T - (I_{Mot} \cdot R_L)$$

to calculate the actual emf voltage and thus the speed. The correction value $I_{Mot} \cdot R_L$ is subtracted from the terminal voltage to calculate the EMF voltage that cannot be measured directly.
The correct setting of the parameter R_L is therefore of great importance for good control behavior of the drive controller. It contains not only the pure ohmic resistance of the motor winding, but represents all losses that occur in the motor including the supply line.

6.9 Device Protection

The current power stage temperature is displayed in P5101, switch-off occurs at 85°C. A warning message can be displayed before shutdown, adjustable via P5102.

5101	Temperature Output Stage	Displays output stage temperature	°C
5102	Warning Thresh. Output Stage Temp.	Adjustable warning threshold	°C

6.10 Motor Protection

A connected motor can be thermally protected via an external temperature switch or an I²t model (P5201). For the correct function of the I²t model, the motor properties must be specified as accurately as possible. The temperature switch is configured via P5220 and P5221.

5201	Motor Protection	Configuration of the motor protection, either I²t or temperature switch	
5210	Nominal Current at < 10RPM	Configuration of the rated current reduction when the motor is stationary or blocked	%
5211	Motor Load	Current load of the motor	%
5212	Warning Thresh. Motor Load	Adjustable warning threshold	%
5220	Source Motor Temp. Switch	Selection of temperature switch input	
5221	Motor Overtemperature when	Input high or low at overtemperature	

6.11 Brake Resistor Protection

A connected brake resistor can be thermally protected via an external temperature switch or a Pt model (P5301). For the Pt model to function correctly, the nominal power P5310, resistance P5311 and thermal time constant P5312 must be specified as accurately as possible. The temperature switch is configured via P5320 and P5321.

5301	Brake Resistor Protection	Configuration of the ballast resistor protection, either Pt or temperature switch	
5310	Nominal Brake Resistor Power	Data sheet value of the resistor	W
5311	Brake Resistor	Data sheet value of the resistor	Ω
5312	Thermal Time Constant of Brake Res.	Time until resistor temperature has reached 63% of its steady-state value	s
5313	Brake Resistor Load	Current load of the resistor	%
5314	Warning Threshold Utilization Brakewid.	Adjustable warning threshold	%
5320	Source Brake Res. Temp. Switch	Selection of temperature switch input	
5321	Brake Res. Overtemp. when	Input high or low at overtemperature	

7. Error and Warning Messages

Message-Nr.	Type	Priority (1)	Manual Reset (2)	Automatic Reset (2)	Error Memory	Description	Primary Cause (3)
0	-	-				No message active	-
100	Error	1			●	Internal	Internal
110	Error	1			●	CAN: Error during initialisation	Internal or bus blocked during startup
111	Error	1			●	CAN: Error while operating	Internal or bus
200	Error	1			●	Internal	Internal
201	Error	1			●	Internal	Internal
202	Error	1			●	Internal	Internal
203	Error	1			●	Internal	Internal
204	Error	1			●	Internal	Internal
209	Error	2	●		●	Internal	Internal
210	Error	2	●		●	Write parameter: parameter is read-only	Internal or Interface
211	Error	2	●		●	Check parameter value: U32 value is too high	Internal, Interface or invalid value in NVM
212	Error	2	●		●	Check parameter value: U32 value is too low	Internal, Interface or invalid value in NVM
213	Error	2	●		●	Check parameter value: I32 value is too high	Internal, Interface or invalid value in NVM
214	Error	2	●		●	Check parameter value: I32 value is too low	Internal, Interface or invalid value in NVM
215	Error	2	●		●	Check parameter value: BOOL value is invalid	Internal, Interface or invalid value in NVM
216	Error	2	●		●	Check parameter value: ENUM value is invalid	Internal, Interface or invalid value in NVM
217	Error	2	●		●	Check parameter value: F32 value is too high	Internal, Interface or invalid value in NVM
218	Error	2	●		●	Check parameter value: F32 value is too low	Internal, Interface or invalid value in NVM
219	Warning	1				Internal	Internal
300	Error	3			●	STO error	STO signals unequal for >2s
301	Error	3			●	Overtemperature output stage	Insufficient heat sinking (limit = 85℃)
302	Error	3			●	Overcurrent output stage	Short circuit
304	Error	3	●	3s		Undervoltage	Supply can't deliver enough current
305	Error	3	●		●	Overvoltage	Energy from braking can't be dissipated (limit = 420Vdc)
306	Error	3	●		●	Hall sensor error	All Hall sensor signals either 0 or 1
307	Error	3	●		●	Encoder index error	No index signal for more than two revolutions
400	Error	4	●		●	Motor overload	Motor overloaded
401	Error	4	●		●	Brake resistor overload	Brake resistor overloaded
402	Error	4	●		●	Output driver OUT1..4 error	Output shorted
403	Error	4	●		●	Speed error	Speed error limit exceeded
500	Warning	5	●	3s		Output stage temperature warning	Warning threshold exceeded
501	Warning	5	●	3s		Motor overload warning	Warning threshold exceeded
502	Warning	5	●	3s		Brake resistor overload warning	Warning threshold exceeded

7.1 Notes

(1) 1 = highest priority, n = lowest priority
Messages with higher priority have priority. If two or more messages with the same priority are present, the message triggered first has priority. However, the messages do not overwrite each other, but must all be reset one after the other, if possible.

(2) If neither the manual nor the automatic reset is activated, the reset must be performed by a restart.

(3) If the same error occurs repeatedly with an internal cause, there may be a firmware error or a hardware defect, contact the manufacturer.

7.2 Error Memory

A total of 6 errors with associated operating time are stored in PE100 to PE151. The first error is not overwritten, all further errors are stored according to the FIFO principle.

7.3 Fault Reset

a) OFF / ON of the supply voltage
b) E001 Error reset source

When sending the device for inspection or repair, please specify the following:
- Type of error
- Accompanying circumstances
- Own suspected cause of error
- Previous unusual occurrences

8. Parameter Overview

All parameters may only be changed when the controller is inhibited!

Number	Name	Description	Unit
	General		
0010	FW Version	The firmware version of the device	
0020	HW Version	The hardware version of the device	
0021	HW Variant	The hardware variant of the device	
0030	Serial Number	The serial number of the device	
0040	Comment	Free comment	
0050	Address	Device address	
0060	Language	Language selection	
0070	Status	Current status of the device	
0080	Message	Current error or warning message	
0081	Further Messages	All other errors/warnings	
1000	DC-Link Voltage	Current DC link voltage	V
1001	Undervoltage Threshold	Automatically determined undervoltage threshold (60Vdc below DC-link voltage after switch on, or absolute minimum of 125Vdc)	V
1100	STO1	STO1 input state	
1110	STO2	STO2 input state	
	Bus		
4001	BusTermination	Configuration 120Ω bus terminating resistor	
4100	Bus D-IN1	Digital bus variable	
4101	Bus D-IN2	Digital bus variable	
4102	Bus D-IN3	Digital bus variable	
4200	Bus A-IN1	Analog bus variable	%
4201	Bus A-IN2	Analog bus variable	%
4300	Bus P-IN1	Position bus variable	Inc
	Motor Properties		
5001	Pole Pair Count	The number of pole pairs of the motor	
5002	Nominal Motor Current (RMS)	Motor current from motor nameplate for overload protection	A
5003	Speed Constant	Speed to EMF from data sheet	RPM/V
5004	Winding Resistance	Ohmic resistance of the motor from data sheet	Ω
5005	Thermal Time Constant of Motor	Time until motor temperature has reached 63% of its steady-state value	s
	Device Protection		
5101	Temperature Output Stage	Displays output stage temperature	°C
5102	Warning Thresh. Output Stage Temp.	Adjustable warning threshold	°C
	Motor Protection		

5201	Motor Protection	Configuration of the motor protection, either I²t or temperature switch	
5210	Nominal Current at < 10RPM	Configuration of the rated current reduction when the motor is stationary or blocked	
5211	Motor Load	Current load of the motor	%
5212	Warning Thresh. Motor Load	Adjustable warning threshold	%
5220	Source Motor Temp. Switch	Configuration of temperature switch input	
5221	Motor Overtemperature when	Input high or low at overtemperature	
	Brake Resistor Protection		
5301	Brake Resistor Protection	Configuration of the ballast resistor protection, either I²t or TW	
5310	Nominal Brake Resistor Power	Data sheet value of the brake resistor	W
5311	Brake Resistor	Data sheet value of the brake resistor	Ω
5312	Thermal Time Constant of Brake Res.	Time until temperature of the resistor has reached 63% of its steady-state value	s
5313	Brake Resistor Load	Current load of the resistor	%
5314	Warning Thresh. Brake Res. Load.	Adjustable warning threshold	%
5320	Source Brake Res. Temp. Switch	Configuration of temperature switch input	
5321	Brake Res. Overtemp. when	Input high or low at overtemperature	
	Inputs		
6001	IN1 Mode	Input configuration	
6002	IN1 Voltage	Current input voltage	V
6003	IN1 analog	Current analog input value	%
6004	IN1 digital	Current digital input value	
6011	IN2 Mode	Input configuration	
6012	IN2 Voltage	Current input voltage	V
6013	IN2 analog	Current analog input value	%
6014	IN2 digital	Current digital input value	
6021	IN3 Mode	Input configuration	
6022	IN3 Voltage	Current input voltage	V
6023	IN3 analog	Current analog input value	%
6024	IN3 digital	Current digital input value	
6031	IN4 Mode	Input configuration	
6032	IN4 Voltage	Current input voltage	V
6033	IN4 analog	Current analog input value	%
6034	IN4 digital	Current digital input value	
6041	IN5 Mode	Input configuration	
6042	IN5 Voltage	Current input voltage	V
6043	IN5 analog	Current analog input value	%
6044	IN5 digital	Current digital input value	
6051	IN6 Mode	Input configuration	
6052	IN6 Voltage	Current input voltage	V
6053	IN6 analog	Current analog input value	%

6054	IN6 digital	Current digital input value	
6061	IN7 Mode	Input configuration	
6062	IN7 Voltage	Current input voltage	V
6063	IN7 analog	Current analog input value	%
6064	IN7 digital	Current digital input value	
6071	IN8 Mode	Input configuration	
6072	IN8 Voltage	Current input voltage	V
6073	IN8 analog	Current analog input value	%
6074	IN8 digital	Current digital input value	
6081	IN9 Mode	Input configuration	
6082	IN9 Voltage	Current input voltage	V
6083	IN9 analog	Current analog input value	%
6084	IN9 digital	Current digital input value	
6091	IN10 Mode	Input configuration	
6092	IN10 Voltage	Current input voltage	V
6093	IN10 analog	Current analog input value	%
6094	IN10 digital	Current digital input value	
60F0	C1 Offset	Offset for user-defined input range 1	V
60F1	C1 Multiplier	Multiplier for user-defined input range C1	%/V
60F2	C1 Shunt (300Ω)	Activate shunt in user-defined input range C1	
60F3	C2 Offset	Offset for user-defined input range C1	V
60F4	C2 Multiplier	Multiplier for user-defined input range C1	%/V
60F5	C2 Shunt (300Ω)	Activate shunt in user-defined input range C2	
	Outputs		
6201	OUT1 Source	Output configuration	
6202	OUT1 Inverted	Invert digital output	
6203	OUT1 State	Current status of the output	
6211	OUT2 Source	Output configuration	
6212	OUT2 Inverted	Invert digital output	
6213	OUT2 State	Current status of the output	
6221	OUT3 Source	Output configuration	
6222	OUT3 Inverted	Invert digital output	
6223	OUT3 State	Current status of the output	
6231	OUT4 Source	Output configuration	
6232	OUT4 Inverted	Invert digital output	
6233	OUT4 State	Current status of the output	
62F0	OUT1...4 Supply	Current voltage at X4-13	V
62F1	OUT1...4 Driver Status	Current output driver status	
	Motion Controller		
6501	Enable P Source	Source to enable positive setpoint (clock-wise)	
6502	Enable N Source	Source to enable negative setpoint (counterclockwise)	

6505	Mode at P=1 N=1	Behavior when both enable signals are active	
650A	MC Mode	Current status of motion controller	
6510	Speed Setpoint Selection 1 Source	Source of speed setpoint selection signal 1	
6511	Speed Setpoint Selection 2 Source	Source of speed setpoint selection signal 2	
6512	External Speed Setpoint Source	Source of the external speed setpoint	
6513	Fixed Speed Setpoint 1	Speed setpoint 1, scaled by P7201	%
6514	Fixed Speed Setpoint 2	Speed setpoint 2, scaled by P7201	%
6515	Fixed Speed Setpoint 3	Speed setpoint 3, scaled by P7201	%
6520	Hold Offset positive	Number of increments that are moved after hold signal when speed setpoint was positive	Inc
6521	Hold Offset negative	Number of increments that are moved after hold signal when speed setpoint was negative	Inc
6530	Start Teach Mode Source	Source for the signal that starts the teaching mode	
6531	Start Distance Run Pos. Source	Source that starts a distance run in positive direction	
6532	Start Distance Run Neg. Source	Source that starts a distance run in negative direction	
6533	Distance	Distance set point	Inc
	Enable Signals		
6E01	Motor Enable Source	Source configuration of motor enable signal	
6E02	Motor Enable Mode	Configuration whether the motor enable reacts to static signals or to edge	
6E11	Magnet Enable Source	Source configuration of magnet enable signal	
6E12	Magnet Enable Mode	Configuration whether the magnet enable reacts to static signals or to edge	
	Position Feedback		
7001	Enable Hall Sensor	Activate position feedback via Hall sensor	
7002	Hall Sensor Alignment	12 different alignments for Hall sensors to motor winding	
7003	Rotor Position Hall Sensor	Current Hall sensor position	
7010	Enable Encoder	Activate position feedback via encoder	
7011	Use Encoder for FOC	Enable for higher speed and positioning accuracy, Hall sensor is still required for startup	
7012	Reverse Encoder	Adjustment of direction	
7013	Encoder Index Signal at	Datasheet info for Z-track	
7014	Encoder Scaling	Number of signal edges per revolution of encoder signal	Inc/Rev
7015	Encoder Offset	Adjustment of mechanical position from encoder to Hall sensor	°
7020	Rotor Position (electrical)	Current rotor position	°

	Current Controller		
7101	Current Control Mode	FOC, 6-step or DC	
7110	Current Setpoint Source	Configuration of the current setpoint source	
7111	Current Limit Source	Configuration of the current limitation source	
7112	Brake Current Limit	Maximum braking current, based on P7114	%
7113	Current Offset	Offset which is added to current set-point, based on P7114	%
7114	Current Setpoint Scaling	Maximum value of the current	A
7115	Current Setpoint Q	Current setpoint, vector length in Q direction	A
7120	Actual Current L1	Actual current of phase 1	A
7121	Actual Current L2	Actual current of phase 2	A
7122	Actual Current L3	Actual current of phase 3	A
7123	Actual Current Q	Actual current (vector length) in Q direction	A
7124	Actual Current D	Actual current (vector length) in D direction	A
7130	Current Control Kp	P term of current controller	V/A
7131	Current Control Ki (= Rs/Ls)	I term of current controller	Ohm/H
7132	PWM DC / 6-Step	PWM mode Symmetrical or Asymmetrical	
7133	Zero Modulation FOC	FOC Mode Symmetrical or Asymmetrical	
7140	Output Voltage Q	Actual voltage value in Q direction	V
7141	Output Voltage D	Actual voltage value in D direction	V
7150	Output Power (FOC only)	Calculated electrical output power	W
	Speed Controller		
7201	Speed Setpoint Source	Configuration of the speed setpoint source	
7202	Speed Setpoint Scaling	Maximum speed	RPM
7203	Acceleration Limits On	Activate acceleration limits (speed ramps)	
7204	Pos. Acceleration Limit	Acceleration limit in positive direction of rotation	RPM/s
7205	Neg. Acceleration Limit	Acceleration limit in negative direction of rotation	RPM/s
7206	Pos. Deceleration Limit	Deceleration limit in positive direction of rotation	RPM/s
7207	Neg. Deceleration Limit	Deceleration limit in negative direction of rotation	RPM/s
7208	Speed Setpoint	Current speed setpoint	RPM
7210	Actual Speed Source	Source for speed feedback	
7211	Invert Actual Speed	Adapt actual speed value to direction of rotation	
7212	Actual Speed	Current actual speed value	RPM
7220	Speed Control Feed Forward	Speed controller feed forward term	%/RPM
7221	Speed Control Kp 1	P term 1 of speed controller	%/RPM

7222	Speed Control Ki 1	I term 1 of speed controller	1/s
7223	Speed Control Kp 2	P term 2 of speed controller	%/RPM
7224	Speed Control Ki 2	I term 2 of speed controller	1/s
7225	Speed Control Selection Source	Source for control term selection	
7226	Speed Control Threshold	Threshold at which switchover from Kp/Ki 1 to Kp/Ki 2 takes place	RPM
7230	Speed Controller Output	Output value of the speed controller	%
7240	Speed Status Threshold	Threshold for the speed status signal	RPM
7241	Speed Status Delay	Delay time for speed status signal	ms
	Position Controller		
7301	Position Setpoint Source	Source of position setpoint	
7302	Position Setpoint	Current position setpoint	Inc
7303	Position Setpoint Offset	Static offset for position setpoint	Inc
7310	Actual Position Source	Source of position actual value	
7311	Invert Actual Position	Inverts the actual position value	
7312	Actual Position	Actual position value	Inc
7320	Position Control Kp 1	P term 1 of position controller	%/Inc
7321	Position Control Kp 2	P term 2 of position controller	%/Inc
7322	Threshold Position Control 1/2	Threshold at which switchover from Kp 1 to Kp 2 takes place	Inc
7323	Max. Positioning Speed	Maximum permissible speed at which positioning is performed	%
7330	Position Controller Output	Current output of the position controller	%
7340	Pos. Position Status Threshold	Threshold in positive direction for position status signal	Inc
7341	Neg. Position Status Threshold	Threshold in negative direction for position status signal	Inc
	Power Stage Channel 4		
8001	Power Stage Channel 4 Mode	Configuration brake resistor / electro-magnet output	
8010	Brake Resistor Threshold 0%	Voltage at which the brake resistor output starts switching on	V
8011	Brake Resistor Threshold 100%	Voltage at which the brake resistor output is fully switched on	V
8020	Magnet Pull Voltage	Voltage 1s at power-on, then cyclically for 100ms every second	V
8021	Magnet Hold Voltage	Voltage to hold the magnet	V
	Runtime		
D001	Runtime Total	Operating time while device is powered up	
D002	Runtime Enabled	Operating time while motor is enable	
D010	Runtime <40.0°C	Operating time while device temperature is below 40°C	
D011	Runtime 40.0...49.9°C	Operating time while device temperature is between 40°C and 50°C	
D012	Runtime 50.0...59.9°C	Operating time while device temperature is between 50°C and 60°C	
D013	Runtime 60.0...69.9°C	Operating time while device temperature is between 60°C and 70°C	

D014	Runtime 70.0…79.9°C	Operating time while device temperature is between 70°C and 80°C	
D015	Runtime ≥80.0°C	Operating time while device temperature is greater than/equal to 80°C	
	Error		
E001	Error Reset Source	Source selection for error reset signal	
E010	Reset Error	Resets error	
E100	First Error	First error that ever occurred	
E101	First Error Time	Time at which the first error occurred	
E110	Error Memory 1	Overwritten when a new error occurs	
E111	Error Time 1	Time at which the error occurred	
E120	Error Memory 2	Overwritten with error 1 when a new error occurs	
E121	Error Time 2	Time at which the error occurred	
E130	Error Memory 3	Overwritten with error 2 when a new error occurs	
E131	Error Time 3	Time at which the error occurred	
E140	Error Memory 4	Overwritten with error 3 when a new error occurs	
E141	Error Time 4	Time at which the error occurred	
E150	Error Memory 5	Overwritten with error 4 when a new error occurs	
E151	Error Time 5	Time at which the error occurred	

9. Maintenance and Cleaning

9.1 Maintenance

The control unit is maintenance-free if the specified operating conditions are observed.

9.2 Cleaning

<u>Do not </u>clean the surfaces of the device with solvent-based or aggressive cleaners.

ELEKTRONIK UND ANTRIEBSTECHNIK GMBH

10. Manufacturer's Declaration

MOSCA
ELEKTRONIK UND ANTRIEBSTECHNIK GMBH

CE EU-Konformitätserklärung
EC declaration of conformity

Hersteller / Anschrift
Manufacturer / Address

Mosca Elektronik u. Antriebstechnik GmbH
Albert-Einstein-Straße 5
D-74722 Buchen

Produktbezeichnung
Product designation

SP01229_XXXX
Regler für BLDC Motoren

Die oben beschriebenen Produkte erfüllen die einschlägigen Harmonisierungsrechtsvorschriften und Normen der Union:
The object of the declaration described above is in conformity with the relevant Union harmonization legislation and norms:

Angewandte Richtlinien

2006/42/EG Maschinenrichtlinie
2014/30/EU EMV Richtlinie
2011/65/EU ROHS Richtlinie, (EU) 2015/863 Änderung Anhang II
2014/35/EU Niederspannungsrichtlinie

Angewandte Sicherheitsnormen

DIN EN 60664-1 VDE 0110-1:2008-01
Isolationskoordination für elektrische Betriebsmittel in Niederspannungsanlagen Teil 1: Grundsätze,
Anforderungen und Prüfungen (IEC 60664-1:2007); Deutsche Fassung EN 60664-1:2007

DIN EN 60204-1 VDE 0113-1:2019-06
Sicherheit von Maschinen – Elektrische Ausrüstung von Maschinen Teil 1: Allgemeine Anforderungen
(IEC 60204-1:2016, modifiziert); Deutsche Fassung EN 60204-1:2018

DIN EN 61800-5-1:2003-09; VDE 0160-105:2003-09
Elektrische Leistungsantriebssysteme mit einstellbarer Drehzahl - Teil 5-1: Anforderungen an die Sicherheit;
Elektrische, thermische und energetische Anforderungen (IEC 61800-5-1:2003-02); Deutsche Fassung
EN 61800-5-1:2003

Angewandte EMV Normen

EN IEC 61800-3:2018
Drehzahlveränderbare elektrische Antriebssysteme - Teil 3: EMV-Anforderungen einschließlich spezieller
Prüfverfahren (IEC 61800-3:2017); Deutsche Fassung EN IEC 61800-3:2018

Die alleinige Verantwortung für die Ausstellung dieser Konformitätserklärung trägt der Hersteller.
This declaration of conformity is issued under the sole responsibility of the manufacturer.

Buchen, den 21.12.2022
Ort / Datum
place / date

Unterschrift / Name / Funktion
Signature / name / function

11. Version History

Version	Date	Change
1.0	09.01.2023	First version
1.1	28.03.2023	Miscellaneous corrections and additions