GEFEG-NECKAR
ANTRIEBSSYSTEME

PRÄZISION IN BEWEGUNG

User Manual

Drives
with CAN interface

MC/MCN/PC motors
MCE/UCE/PCE controllers

Imprint

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Important information

This manual is intended primarily for planners, engineers, technicians and service personnel, and should be read carefully before using the products.

Disclaimer of warranty

This user manual was prepared with great care. It describes the functionality of the standard products. The conformity of the contents with the described hardware and software has been carefully checked. Nevertheless, variance can not be completely excluded, so that the editor can't accept responsibility or liability for the accuracy. In particular, descriptions and technical data are not guaranteed properties in the legal sense. All current standards and regulations, even if they are not mentioned here explicitly, must be observed. The company reserves the right to make modifications to the products without prior notice.

Commissioning of the product

The corresponding products in this manual may only be operated by qualified personnel which are capable (because of there training an experience) to identify/avoid risks and hazards.

Suggestions and questions

For any suggestions and proposals for improvement, please contact the above address or write an e-mail to: info@gefeg-neckar.de

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1. General

1.1. Introduction

The company GEFEG-NECKAR Antriebssysteme GmbH based in Gosheim emerged in 2004 from the merger of the motor manufacturer GEFEG established in 1948 in Augsburg and of the motor manufacturer NECKAR Kleinstmotoren established in 1967 in Deißlingen. As a pioneer in its sector, NECKAR Kleinstmotoren started in 1995, as part of a customer project, with the development of the integrated electronics used in brushless small DC motors. Only one year later, the complete MH series of brushless DC motors was established. Today the company uses a modern electronic platform for universal use in many electronically controlled drives and in external electronic units. It is based on powerful hardware components, has a CAN interface and guarantees a high degree of flexibility, functionality and user comfort.

The same electronic platform is used in the brushless motors of the MC series, brushed motors of the PC series and in the external electronic units of the MCE, UCE and PCE series. This allows the users to control the different drives always in the same way.

The parameter setting of the electronic platform is done via a CAN interface. It uses the CANopen® protocol (CiA 402 device profile). Users who do not yet use a CAN bus system can also operate the drive by means of analog and/or digital signals. However, even in this case, the integrated CAN interface offers the advantage of simple parameter setting, start-up and monitoring.

The powerful commissioning software "MotorMonitor" together with a suitable CAN/USB adapter and a PC allow the user to communicate with the drive at any time. This software not only recognizes the electronic platform, but also adjusts it such that only the parameters implemented in the concrete product are displayed. The software allows the user to change parameters, to control the drive or to monitor important data such as temperature, velocity and power consumption. For more detailed information on the software, please refer to the separately available "MotorMonitor" user manual.

1.2. Connection designation

All connections mentioned in the user manual were given an unambiguous type designation (type). The meaning of this designation can be seen from the following list. Digital states are represented throughout the user manual, as is customary in digital technology, by 0 and 1 (0 = LOW / 1 = HIGH).

1.2.1. Inputs

Power supply	
Type designation	**Connection data**
V_{CC}	$24V_{DC}$ nominal ($16…27V_{DC}$)
GND	Zero conductor / Ground
L1	Line conductor / Phase
N	Neutral conductor
PE	Protective earth conductor / Ground

Analog	
Type designation	**Connection data**
SENSOR TEMP*	Connection of a 10KΩ NTC temperature sensor to ground
ANALOG IN	$0\text{-}10V_{DC}$

Digital		
Type designation	**LOW (0)**	**HIGH (1)**
DIGITAL IN	$0–0.8V_{DC}$	$24V_{DC}$ nominal ($14…28V_{DC}$)
SENSOR*	Connection of a Hall sensor with open drain output	

* only with external electronic unit

1.2.2. Outputs

Power supply	
Type designation	**Connection data**
V_{HALL}*	$12V_{DC} \pm 5\%$

Motor connection (power supply)		
Type designation	**LOW (0)**	**HIGH (1)**
PWM	GND	V_{CC}

Digitale outputs (max. 250 mA per output)		
Type designation	**LOW (0)**	**HIGH (1)**
DIGITAL OUT	GND	V_{CC}

* only with external electronic unit

1.3. I/O-Standard function

All I/O's provided by the electronics can be parameterized in there function. The standard parameterization is, unless otherwise ordered, as follows (detailed info see section 8.2 and 8.3):

I/O Standard function	
Designation	**Function**
DIGITAL IN 1	Enable (High = Motor enabled)
DIGITAL IN 2	Brake (High = Brake function inactive)
DIGITAL IN 3	Direction (High = anticlockwise)
ANALOG IN	RPM (See section 8.4.2)
DIGITAL OUT 1	Speed indicator signal (See section 8.3)
DIGITAL OUT 2	Ready signal

2. MC motors

Brushless motors are being used nowadays in many applications, in particular because of their good efficiency, long service life, wide speed range, simple speed controllability and good dynamics. Their functional principle is similar to that of conventional DC motors. However, they are not commutated mechanically by a collector and carbon brushes, but electronically via power transistors. Thus, the service life of brushless DC motors is only .limited by the only wear component left, the ball bearings.

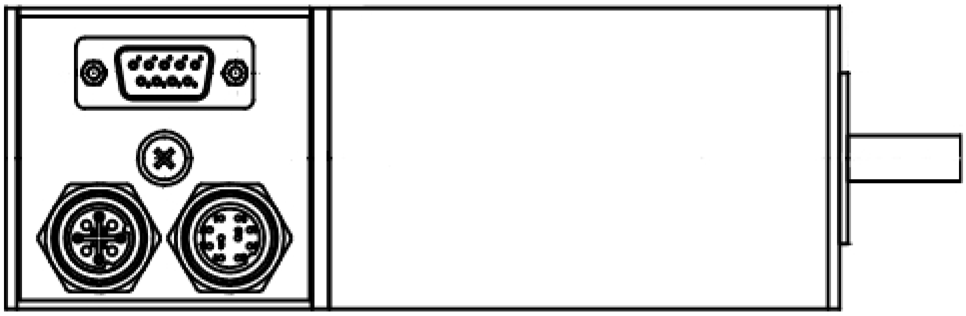
The MC series consists of permanently excited block-commutated, brushless DC motors. The special feature of these motors is not only their excellent design, but also the completely integrated electronic platform. The cylindrical motors are suitable without problems for protection types until IP65, owing to their compact and sealed design. The motor housing is made of an anodized aluminum alloy in its standard version. However, for special applications, motor housings made of stainless steel are also being offered.

All MC motors can optionally be equipped with worm, helical and planetary gears. This not only increases the range of versions, but also allows individual customer adaptations.

2.1. Characteristics

Types	MC5, MC6, MC8, MC95
Diameter	53 to 95 mm (without gear)
Control electronics	integrated
Rotor position detection	Position detection by 3 Hall sensors
Rotor	4- or 8-pole rare earth magnet (NdFeB)
Service life	20,000 h, S1 mode
Insulation class	B, optional F
Protection type	IP 40, optionally up to IP 65
Drive control	Control is by analog/digital signals or by CAN bus (CiA 402 device profile)
Parameter setting	Parameter setting is done via the CAN bus (e.g. by means of the "MotorMonitor" software)
Operating mode	PWM control, speed regulation and stepping mode
Special design	Stainless steel design
Optional	Thermal protection, special shafts, special flanges, customer-specific parameter setting, brakes, rotary encoders, gears

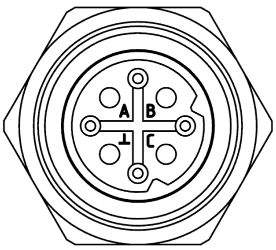
2.2. Pin assignment (2xM16 + 9pol. DSUB)



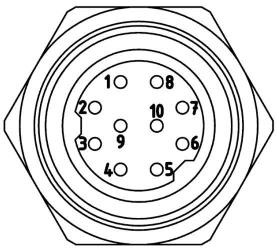
X1 / Power supply / 4+3+PE plug		
PIN	**Designation**	**Function**
A	V_{CC}	Power supply
B	GND	Ground

X2 / Inputs and outputs / 10-pin socket		
PIN	**Designation**	**Function**
1	DIGITAL IN 1	See section 8.2 Control mode
2	DIGITAL IN 2	
3	DIGITAL IN 3	
4	ANALOG IN	
5	DIGITAL OUT 1	See section 8.3 Digital outputs
6	DIGITAL OUT 2	

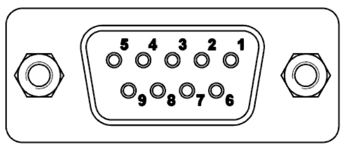
X3 / CANopen® connection / 9-pin DSUB socket		
PIN	**Designation**	**Function**
7	CANH	Differential CAN-H signal
2	CANL	Differential CAN-L signal
3	GND	CAN bus ground



4+3+PE plug*



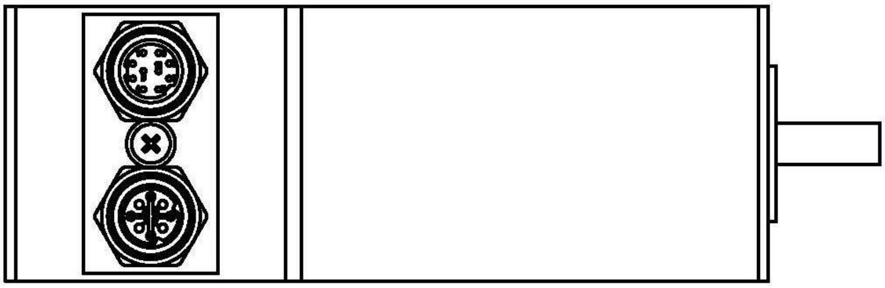
10-pin socket*



9-pin DSUB socket*

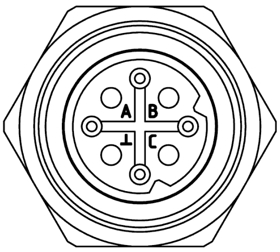
* View of connection side

2.3. Pin assignment (2xM16)

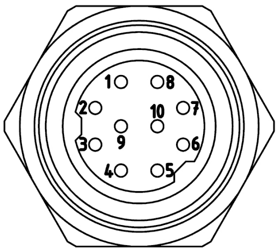


X1 / Power supply / 4+3+PE plug		
PIN	**Designation**	**Function**
A	V_{CC}	Power supply
B	GND	Ground

X2 / Inputs and outputs + CANopen® connection / 10-pin socket		
PIN	**Designation**	**Function**
1	DIGITAL IN 1	See section 8.2 Control mode
2	DIGITAL IN 2	
3	DIGITAL IN 3	
4	ANALOG IN	
5	DIGITAL OUT 1	See section 8.3 Digital outputs
6	DIGITAL OUT 2	
8	CANH	Differential CAN-H signal
9	CANL	Differential CAN-L signal
10	GND	CAN bus ground



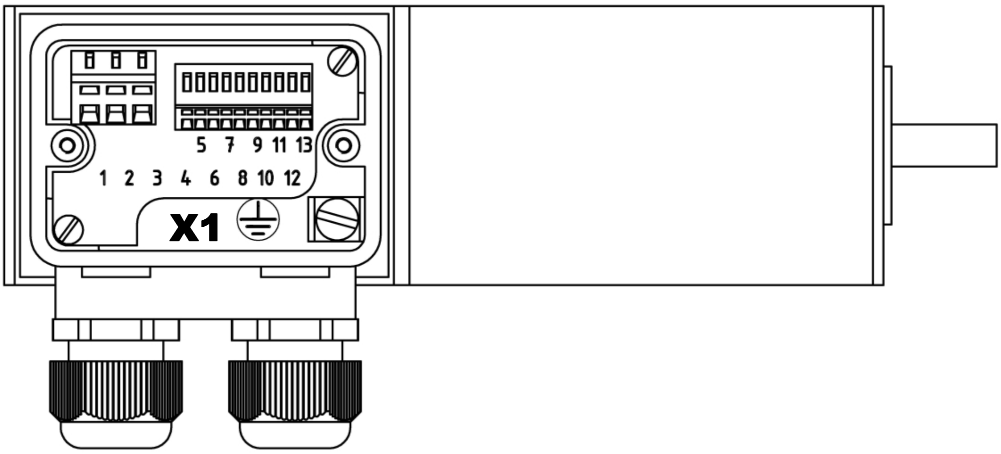
4+3+PE plug*



10-polige socket*

* View of connection side

2.4. Pin assignment (K4)



X1 / Power supply + Inputs and outputs + CANopen® connection / PCB		
PIN	**Designation**	**Function**
1	V_{CC}	Power supply
2	GND	Ground
4	DIGITAL IN 1	See section 8.2 Control mode
5	DIGITAL IN 2	
6	DIGITAL IN 3	
7	ANALOG IN	
9	DIGITAL OUT 1	See section 8.3 Digital outputs
10	DIGITAL OUT 2	
11	CANH	Differential CAN-H signal
12	CANL	Differential CAN-L signal
13	GND	CAN bus ground

3. MCN-Motoren

Brushless motors are being used nowadays in many applications, in particular because of their good efficiency, long service life, wide speed range, simple speed controllability and good dynamics. Their functional principle is similar to that of conventional DC motors. However, they are not commutated mechanically by a collector and carbon brushes, but electronically via power transistors. Thus, the service life of brushless DC motors is only .limited by the only wear component left, the ball bearings.

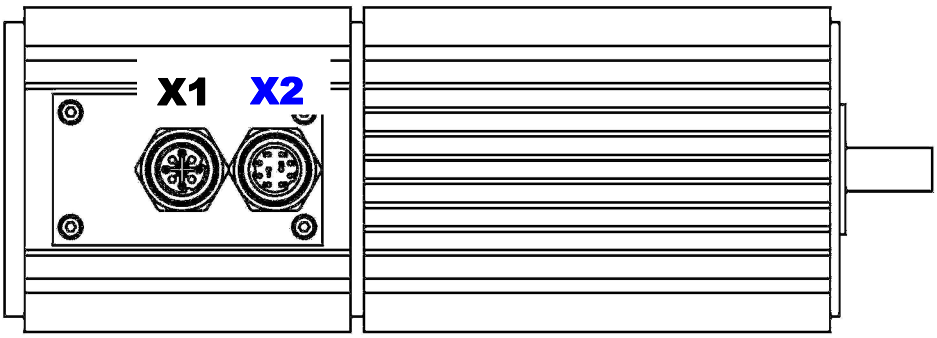
The MCN series consists of permanently excited block-commutated, brushless DC motors. The special feature of these motors is not only their excellent design, but also the completely integrated electronic platform with $230V_{AC}$ power supply. The cylindrical motors are suitable without problems for protection types until IP65, owing to their compact and sealed design. The motor housing is made of an anodized aluminum alloy in its standard version. However, for special applications, motor housings made of stainless steel are also being offered.

All MCN motors can optionally be equipped with worm, helical and planetary gears. This not only increases the range of versions, but also allows individual customer adaptations.

3.1. Characteristics

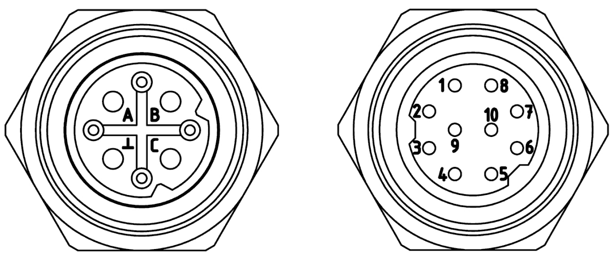
Types	MCN7, MCN9
Dimensions	75mm x 75mm x 214,5mm bis 90mm x 90mm x 214,5mm (without gear)
Control electronics	integrated
Rotor position detection	Position detection by 3 Hall sensors
Rotor	4- or 8-pole rare earth magnet (NdFeB)
Service life	20,000 h, S1 mode
Insulation class	B, optional F
Protection type	IP 40, optionally up to IP 65
Drive control	Control is by analog/digital signals or by CAN bus (CiA 402 device profile)
Parameter setting	Parameter setting is done via the CAN bus (e.g. by means of the "MotorMonitor" software)
Operating mode	PWM control and speed regulation
Optional	Thermal protection, special shafts, special flanges, customer-specific parameter setting, brakes, rotary encoders, gears

3.2. Pin assignment (2xM16)



X1 / Power supply / 4+3+PE plug		
PIN	**Designation**	**Function**
B	N	Power supply
C	L1	
PE	PE	Protective earth conductor / Ground

X2 / Inputs and outputs + CANopen® connection / 10-pin socket		
PIN	**Designation**	**Function**
1	DIGITAL IN 1	See section 8.2 Control mode
2	DIGITAL IN 2	
3	DIGITAL IN 3	
4	ANALOG IN	
5	DIGITAL OUT 1	See section 8.3 Digital outputs
6	DIGITAL OUT 2	
7	GND	Signal Ground
8	CANH	Differential CAN-H signal
9	CANL	Differential CAN-L signal
10	GND	CAN bus ground



4+3+PE plug* 10-polige socket*

* View of connection side

4. PC motors

For more than 100 years, the brushed electric motor has been an indispensable part of our lives. Even if this driving principle is nowadays losing more and more of its importance, there will always be applications for which a brushed drive is indispensable, not only for technical reasons, but also for economical ones.

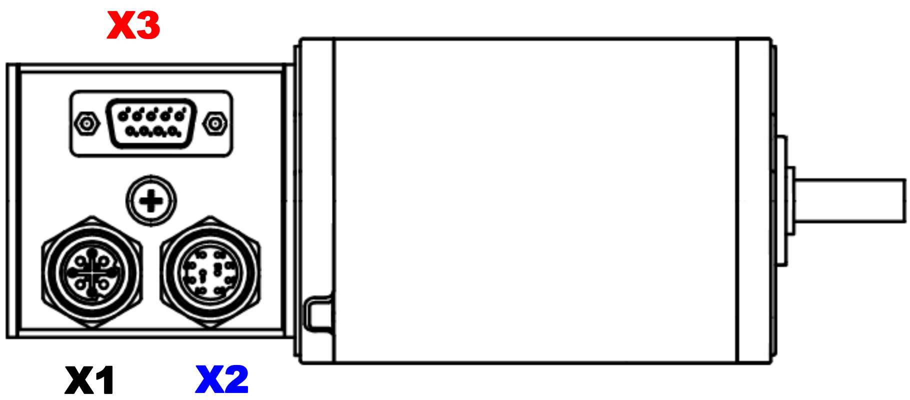
The PC series consists of permanently excited block-commutated, brushed DC motors. The special feature of these motors is not only their excellent design, but also the completely integrated electronic platform. The cylindrical motors are suitable without problems for protection types until IP65, owing to their compact and sealed design. The motor housing is made of an anodized aluminum alloy.

All PC motors can optionally be equipped with worm, helical and planetary gears. This not only increases the range of versions, but also allows individual customer adaptations.

4.1. Characteristics

Types	PC63
Diameter	63 mm (without gear)
Control electronics	integrated
Rotor position detection	Position detection by 3 Hall sensors
Commutation	mechanical
Magnetic system	2-pole hard ferrite magnet
Nominal speed	3000 rpm
Service life	3000 h, S1 mode
Insulation class	B, optionally F
Protection type	IP 40, optionally up to IP 54
Drive control	Control is by analog/digital signals or by CAN bus (CiA 402 device profile)
Parameter setting	Parameter setting is done via the CAN bus (e.g. by means of the "MotorMonitor" software)
Operating mode	PWM control and speed regulation
Special design	Design for other speeds
Optional	Thermal protection, special shafts, special flanges, customer-specific parameter setting, brakes, rotary encoders, gears

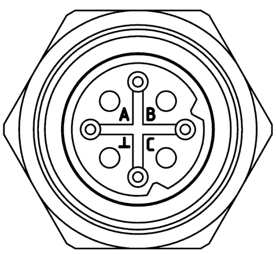
4.2. Pin assignment



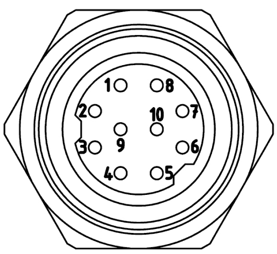
X1 / Power supply / 4+3+PE plug		
PIN	**Designation**	**Function**
A	V_{CC}	Power supply
B	GND	Ground

X2 / Inputs and outputs / 10-pin socket		
PIN	**Designation**	**Function**
1	ENABLE	See section 8.2 Control mode
2	BRAKE	
3	DIR	
4	RPM	
5	ENCODER	See section 8.3 Digital outputs
6	READY	

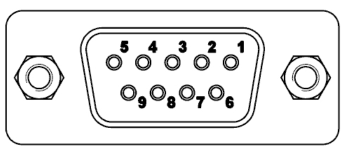
X3 / CANopen® connection / 9-pin DSUB socket		
PIN	**Designation**	**Function**
7	CANH	Differential CAN-H signal
2	CANL	Differential CAN-L signal
3	GND	CAN bus ground



4+3+PE plug*



10-pin socket*



9-pin DSUB socket*

* View of connection side

5. 4-Q controller MCE 24

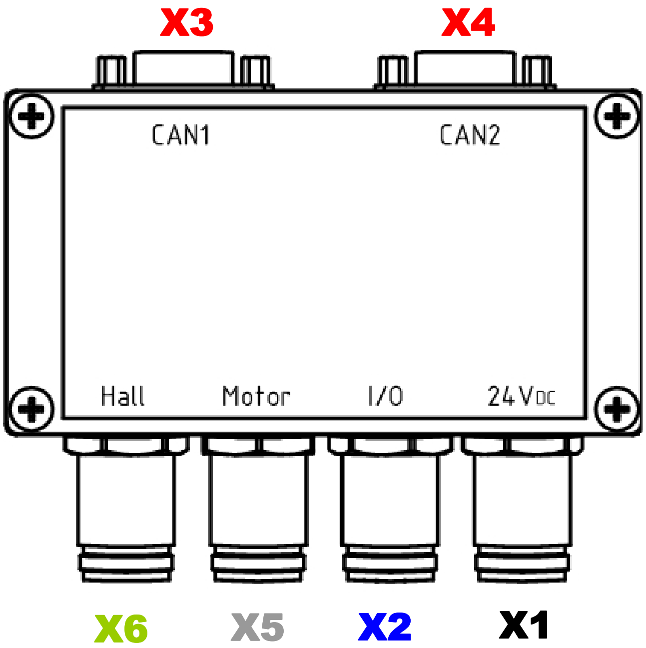
A compact drive with integrated operation electronics simplifies wiring in systems and saves room in the switch cabinet. However, there are applications in which the electronics must be housed in a separate housing and not in the motor, due to restricted space.

The 4-Q controller "MCE 24" is an external commutation electronic unit. It is not only suitable for controlling/regulating brushless block-commutated DC motors of the M and EC series, but also makes it possible to monitor them.

5.1. Characteristics

Types	MCE 24-11
Drives that can be controlled	All drives of the M and EC series can be controlled/regulated.
Dimensions	111 x 60 x 31.4 mm
Nominal voltage	$24V_{DC}$
Nominal current	$11A_{DC}$
Peak current	$25\ A_{DC}$
Protection type	up to IP 44
Drive control	Control is by analog/digital signals or by CAN bus (CiA 402 device profile)
Parameter setting	Parameter setting is done via the CAN bus (e.g. by means of the "MotorMonitor" software)
Operating mode	PWM control, speed regulation and stepping mode

5.2. Pin assignment



X1 Power supply / 4+3+PE plug		
PIN	**Designation**	**Function**
A	V_{CC}	Power supply
B	GND	Ground

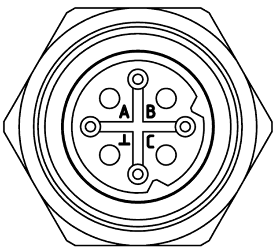
X2 / Inputs and outputs / 10-pin socket		
PIN	**Designation**	**Function**
1	DIGITAL IN 1	See section 8.2 Control mode
2	DIGITAL IN 2	
3	DIGITAL IN 3	
4	ANALOG IN	
5	DIGITAL OUT 1	See section 8.3 Digital outputs
6	DIGITAL OUT 2	

X3 / CANopen® connection / 9-pin DSUB plug		
PIN	**Designation**	**Function**
7	CANH	Differential CAN-H signal
2	CANL	Differential CAN-L signal
3	GND	CAN bus ground

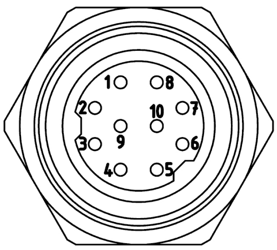
X4 / CANopen® connection 2 / 9-pin DSUB socket		
PIN	**Designation**	**Function**
7	CANH	Differential CAN-H signal
2	CANL	Differential CAN-L signal
3	GND	CAN bus ground

X5 / Motor connection / 4+3+PE socket		
PIN	**Designation**	**Function**
A	PWM 1	Winding connection A
B	PWM 2	Winding connection B
C	PWM 3	Winding connection C

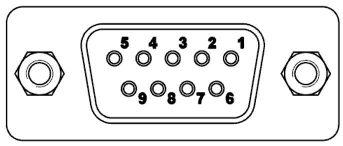
X6 / Hall sensor connection / 10-pin plug		
PIN	**Designation**	**Function**
1	V_{HALL}	Power supply for Hall sensors
2	GND	Ground
3	SENSOR 1	Sensor signal "H1" (Hall sensor 1)
4	SENSOR 2	Sensor signal "H2" (Hall sensor 2)
5	SENSOR 3	Sensor signal "H3" (Hall sensor 3)



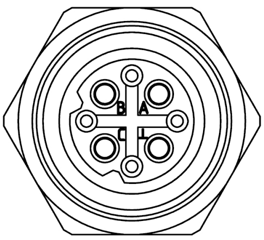
4+3+PE plug*



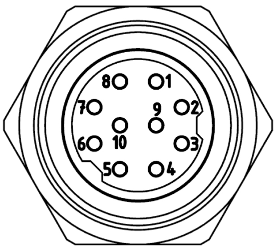
10-pin socket*



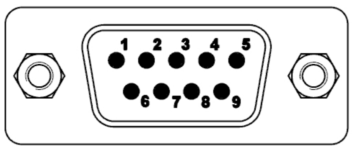
9-pin DSUB socket*



4+3+PE socket*



10-pin socket*



9-pin DSUB plug*

* View of connection side

6. 4-Q actuator PCE 24

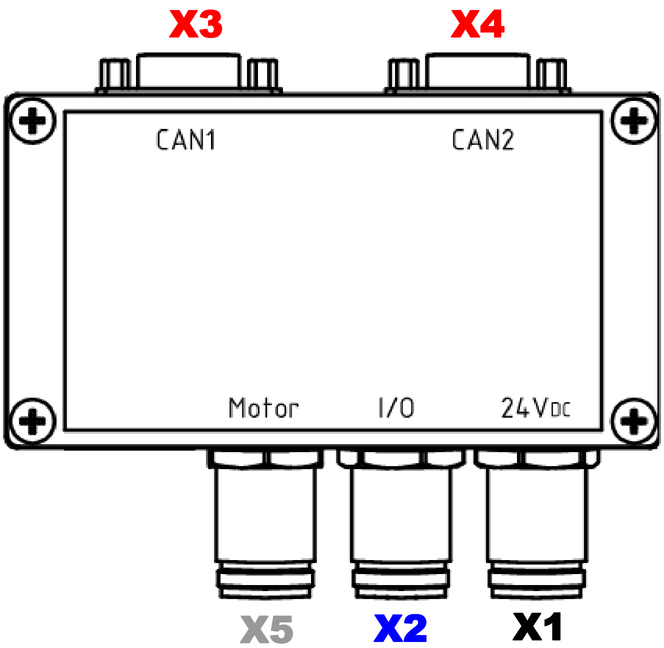
A compact drive with integrated operation electronics simplifies wiring in systems and saves room in the switch cabinet. However, there are applications in which the electronics must be housed in a separate housing and not in the motor, due to restricted space.

The 4-Q actuator "PCE 24" is an external control electronic unit. It is not only suitable for controlling brushed block-commutated DC motors of the PN, G and PG series, but also allows simple and user-friendly parameter setting.

6.1. Characteristics

Types	PCE 24-11
Drives that can be controlled	All drives of the G and PG series can be controlled.
Dimensions	111 x 60 x 31.4 mm
Nominal voltage	$24V_{DC}$
Nominal current	$11A_{DC}$
Peak current	$25\ A_{DC}$
Protection type	up to IP 44
Drive control	Control is by analog/digital signals or by CAN bus (CiA 402 device profile)
Parameter setting	Parameter setting is done via the CAN bus (e.g. by means of the "MotorMonitor" software)
Operating mode	PWM control

6.2. Pin assignment



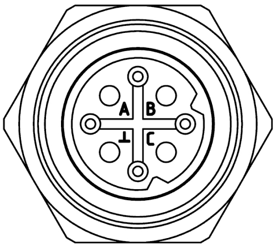
X1 / Power supply / 4+3+PE plug		
PIN	**Designation**	**Function**
A	V_{CC}	Power supply
B	GND	Ground

X2 / Inputs and outputs / 10-pin socket		
PIN	**Designation**	**Function**
1	DIGITAL IN 1	See section 8.2 Control mode
2	DIGITAL IN 2	
3	DIGITAL IN 3	
4	ANALOG IN	
6	DIGITAL OUT 2	See section 8.3 Digital outputs

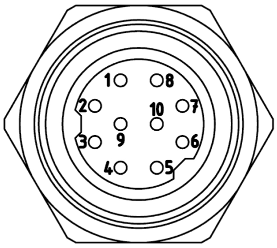
X3 / CANopen® connection / 9-pin DSUB socket		
PIN	**Designation**	**Function**
7	CANH	Differential CAN signal
2	CANL	Differential CAN signal
3	GND	CAN bus ground

X3 / CANopen® connection / 9-pin DSUB socket		
PIN	**Designation**	**Function**
7	CANH	Differential CAN-H signal
2	CANL	Differential CAN-L signal
3	GND	CAN bus ground

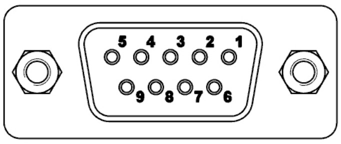
X5 / Motor connection / 4+3+PE socket		
PIN	**Designation**	**Function**
A	PWM 1	Power supply for DC drive
B	PWM 2	Ground for DC drive



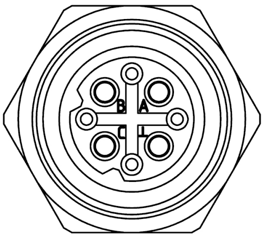
4+3+PE plug*



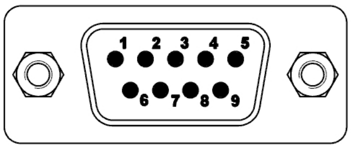
10-pin socket*



9-pin DSUB socket*



4+3+PE socket*



9-pin DSUB plug*

* View of connection side

7. 4-Q controller UCE 24

A compact drive with integrated operation electronics simplifies wiring in systems and saves room in the switch cabinet. However, there are applications in which the electronics must be housed in a separate housing and not in the motor, due to restricted space.

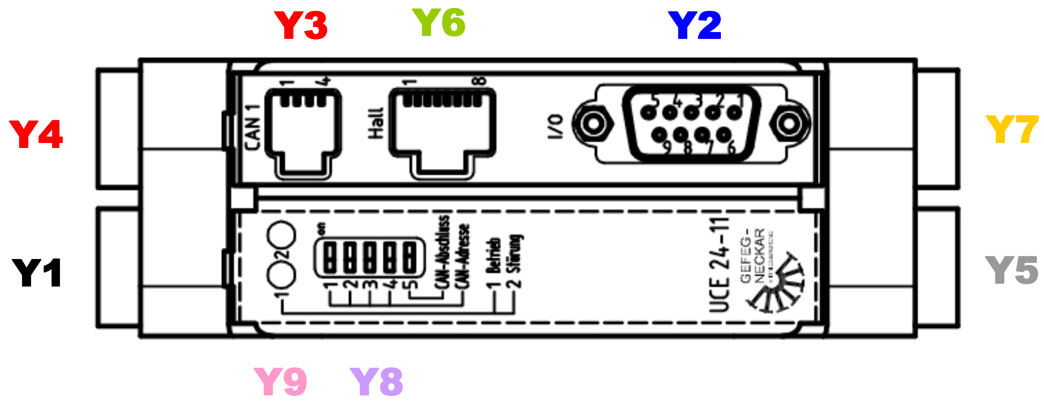
The 4-Q controller "UCE 24" is an external commutation electronic unit. It is suitable for controlling/regulating not only mechanically, but also electronically commutated DC motors. Thus, the electronic unit supports all motors of the M, EC, PN, G and PG series.

7.1. Characteristics

Types	UCE 24-11
Drives that can be controlled	All drives of the M, EC, G and PG series can be controlled/regulated.
Dimensions	35.2 x 99 x 114.4 mm
Nominal voltage	$24V_{DC}$
Nominal current	$11A_{DC}$
Peak current	$25\ A_{DC}$
Protection type	IP 00
Drive control	Control is by analog/digital signals or by CAN bus (CiA 402 device profile)
Parameter setting	Parameter setting is done via the CAN bus (e.g. by means of the "MotorMonitor" software)
Operating mode	PWM control, speed regulation* and stepping mode*

* With brushless motors only

7.2. Pin assignment



Y1 / Power supply / screw terminal 1		
PIN	**Designation**	**Function**
1	PE	Ground / Protective earth conductor
2	V_{CC}	Power supply
3	GND	Ground

Y2 / Inputs and outputs / 9-pin DSUB socket		
PIN	**Designation**	**Function**
6	DIGITAL IN 1	See section 8.2 Control mode
7	DIGITAL IN 2	
9	DIGITAL IN 3	
4	ANALOG IN	
2	DIGITAL OUT 1	See section 8.3 Digital outputs
1	DIGITAL OUT 2	
8	V_{CC}	Power supply tap
3	GND	Ground

Y3 / CANopen® connection 1 / RJ-11 socket		
PIN	**Designation**	**Function**
3	CANH	Differential CAN-H signal
4	CANL	Differential CAN-L signal
2	GND	CAN bus ground
1	PE	Ground / Protective earth conductor

Y4 / CANopen® connection 2 / screw terminal 2		
PIN	**Designation**	**Function**
1	CANH	Differential CAN-H signal
3	CANL	Differential CAN-L signal
2	GND	CAN bus ground

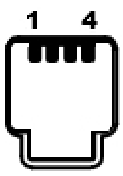
Y5 / Motor connection / screw terminal 3		
PIN	**Designation**	**Function**
3	PWM 1	Winding connection A / ground for DC drive
1	PWM 2	Winding connection B
2	PWM 3	Winding connection C / power supply for DC drive

Y6 / Hall sensor connection / RJ-45 socket		
PIN	**Designation**	**Function**
8	V_{HALL}	Power supply for Hall sensors
7	GND	Ground
2	SENSOR 1	Sensor signal “H1“ (Hall sensor 1)
6	SENSOR 2	Sensor signal “H2“ (Hall sensor 2)
4	SENSOR 3	Sensor signal “H3“ (Hall sensor 3)
1	SENSOR TEMP	Temperature sensor input

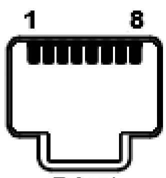
Y1 / Power supply / screw terminal 4		
PIN	**Designation**	**Function**
1-3	PE	Ground / Protective earth conductor

Y8 / CAN parameter setting / DIP switch		
Switch	**Designation**	**Function**
1-4	CAN address	CAN node address setting (node ID)
5	CAN terminating resistor	Connectable terminating resistor for both CANopen® connections

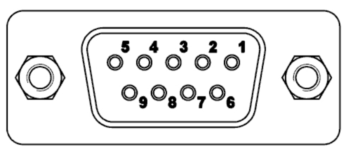
Y9 / Operating status indicator / LED display		
Display	**Designation**	**Function**
1	Operation	LED display for the ready-to-operate signal
2	Fault	LED display for faults



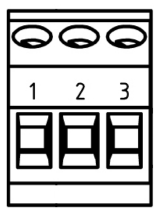
RJ11*



RJ45*



9-pin DSUB socket*



Screw terminal*

* View of connection side

8. Start-up

8.1. CAN communication

The abbreviation CAN stands for "Controller Area Network". It is an asynchronous serial bus system developed in 1983 by Bosch for the linking of control devices in automobiles and presented in 1987 together with Intel. The CAN bus works by the "multi-master principle", i.e., several bus users of equal rights are connected to one another. This system is used nowadays in almost all vehicles, not only because of the reduction in wiring and weight and its easy handling, but also because of its robust and interference-insensitive data transmission. Since the CAN bus, due to its many advantages, is highly suitable for automation technology, the organization "CAN in Automation e.V." (CiA) has developed the CANopen protocol (CiA 402 device profile) especially tailored to automation technology.

CANopen®

All communication and user objects are summarized in the object directory. It thus forms the link between the application and the CANopen communication unit. Each entry in the object directory represents an object and is identified by a 16-bit index. Each index can in turn have up to 256 subindices.

8.1.1. Node address *(Node ID, Obj. 0x2003)*

As-delivered, the node address, also known as Node ID, is 127. It is recommended to adapt it to the particular situation of the bus system. The allowed range of values is from 1 to 127. Parameter setting takes place via the **object 0x2003**. The value stored there is the node address. 4-Q controllers of the "UCE 24" type are an exception. There the node address can be modified on the hardware via the DIP switches located on the front.

Caution!!!
The node address of the CAN user may only be used once in the CAN network. A newly set node address will not become effective in the device until a successful backup (see section 8.1.5) and a "Reset communication" or "Reset application" have taken place.

8.1.2. Baud rate *(Obj. 0x2004)*

The standard baud rate is 125 kbits/s. However, upon request, it can be changed without problems to 50, 100, 125, 250, 500 or 1000 kbits/s. To do so, the desired baud rate only has to be written to the **object 0x2004**.

Caution!!!
A newly set baud rate will not become effective in the device until a successful backup (see section 8.1.5) and a reset communication or reset application have taken place.

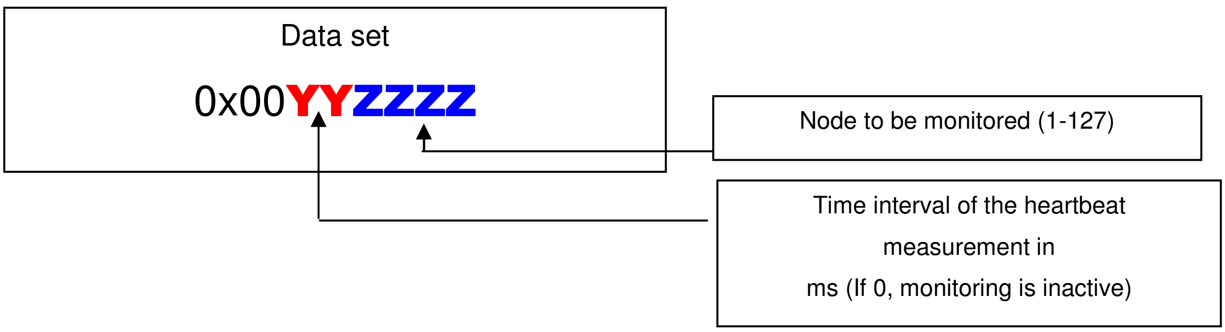
8.1.3. Terminating resistor

All drives and 4-Q actuators described here and the 4-Q controller "MCE 24" have no terminating resistor. It must be connected externally to the bus. The terminating resistor is usually 120 Ohm. 4-Q controllers of the "UCE 24" type have a connectable terminating resistor that is effective in both connections. This resistor can be connected via a DIP switch located on the front.

Caution!!!
The terminating resistor is indispensable for direct communication between PC and drive/actuator/controller. It can be purchased optionally in the form of an adapter.

8.1.4. Heartbeat consumer *(Obj. 0x1016)*

The "heartbeat" of a CAN user can be monitored by means of the **object 0x1016**. Parameter setting of the object is done via a data set of the following structure in hexadecimal notation.



Caution!!!
Monitoring of a CAN user will not be started until the first heartbeat telegram has been transmitted!

8.1.5. Saving the parameter setting *(Obj. 0x1010)*

Changed parameters will be reset during reset or in case of power failure, unless they have been saved. To permanently save a change, the parameter value "SAVE" or 0x65766173 must be written to the **object 0x1010**. When the "MotorMonitor" software is used, this is done via the Save function. For more detailed information, see the "MotorMonitor" user manual.

8.2. Control mode

Each drive, 4-Q actuator or 4-Q controller can be controlled via control lines implemented in the hardware or via the CAN bus. Switching between the individual available control types is done via **object 0x2002**. For control, several different control types are available. They will be explained in the following table.

8.2.1. Overview of control types *(Obj. 0x2002)*

Parameter value (as decimal number) / **Control mode**	**Inputs** DIGITAL IN 1	DIGITAL IN 2	DIGITAL IN 3	ANALOG IN [*4]	**State**
(0) **Standard (analog)** X2.1 state-controlled	0	x	x	0-10V (Set value)	Freewheeling [*1]
	1	1	0		Clockwise rotation
	1	1	1		Counter clockwise rotation
	1	x	x		Braking [*3]
(-1) **Analog 2** X2.1 flank-controlled [*2]	0	x	x	0-10V (Set value)	Freewheeling [*1]
	1	1	0		Clockwise rotation
	1	1	1		Counter clockwise rotation
	1	0			Braking [*3]
(1) **CANopen** [*5]	Control via CAN (CANopen® CiA 402 device profile)				
(2) **Preset**	0	x	x	x	Freewheeling [*1]
	1	1	0		Set value A [*6]
	1	1	1		Set value B [*6]
	1	0	x		Braking [*3]

Parameter value (as decimal number) / Control mode	Inputs				State
	DIGITAL IN 1	DIGITAL IN 2	DIGITAL IN 3	ANALOG IN *4	
(3) Preset 2	0	x	x	0V: Set value A*6 10V: Set value B*6	Freewheeling *1
	1	1	0		Clockwise rotation
	1	1	1		Counter clockwise rotation
	1	0	x		Braking *3
(4) Analog 3	0	x	0	0-10V (Analog set value)	Freewheeling *1
	0	1	1		Counter clockwise rotation (set value A *6,7)
	0	0	1		Counter clockwise rotation (analog set value *4)
	1	1	0		Clockwise rotation (set value A *6,7)
	1	0	0		Clockwise rotation (analog set value *4)
	1	x	1		Braking *3
(5) Preset 3	0	x	0	x	Freewheeling *1
	0	0	1		Counter clockwise rotation (set value A *6,7)
	0	1	1		Counter clockwise rotation (set value B *6,7)
	1	0	0		Clockwise rotation (set value A *6,7)
	1	1	0		Clockwise rotation (set value B *6,7)
	1	x	1		Braking *3
(6) Preset 4	x	0	x	x	Braking *3
	1	1	0		Clockwise rotation (set value A *6,7)
	0	1	0		Clockwise rotation (set value B *6,7)
	1	1	1		Counter clockwise rotation (set value A *6,7)
	0	1	1		Counter clockwise rotation (set value B *6,7)
(7) Preset 5	x				Set value A *6

*1 The power transistors are not activated, all windings are dead

*2 For active operation, a 0 -> 1 flank is required

*3 Fore more detailed information on the braking options, see section 8.6

*4 For more detailed information, see section 8.2.3.

*5 Control is done via the CAN bus only. For more detailed information on CANopen® drive initialization and on all objects, please refer to the respective sections or the overview table item 13.

*6 Permanently defined speed or PWM value. For more detailed information, see section 8.2.4.

*7 Rotation direction refers to a positive setpoint

8.2.2. Digital inputs (Obj. 0x2025)

Errors caused by wrong or faulty wiring of the digital inputs ("DIGITAL" type) can be detected using the **object 0x2025**. The read parameter value corresponds to the following input wiring.

Parameter value (as decimal number)	**DIGITAL IN 1**	**DIGITAL IN 2**	**DIGITAL IN 3**
0	0	0	0
1	1	0	0
2	0	1	0
3	1	1	0
4	0	0	1
5	1	0	1
6	0	1	1
7	1	1	1

8.2.3. Analog input *(Obj. 0x2026)*

The analog input ”ANALOG IN” is mainly used for speed control. 10 Volt DC correspond to the maximum speed. For more detailed information, see section 8.4. Errors caused by wrong or faulty wiring can be detected using the **object 0x2026**. The resolution of the parameter that can be read out is 0.1 V, i.e., a value of 50 corresponds to a voltage 5.0 V.

8.2.4. Set value A / B *(Obj. 0x2018, 0x2019)*

The two permanently definable set values A and B can be set on the basis of two objects. Set value A can be set via the **object 0x2018**, and set value B via the **object 0x2019**. The value to be entered corresponds either to the desired speed value or the PWM factor in ‰, depending on the selected operating mode.

8.3. Digital outputs *(Obj. 0x200F)*

The following control functions are available to the user. He can use these outputs to monitor, for example, the speed (with or without detection of the direction) and/or output the ready-to-operate signal. Parameter setting of the outputs is done via the **object 0x200F**. The current direction of rotation can be determined by means of the flank time offset between the encoder ouputs "H1" and "H2". The motor is rotating counter clockwise if the signal on "H1" is leading, relative to "H2", and clockwise if the signal on "H1" is trailing, relative to "H2". In CAN operation, the outputs can also be used as freely programmable 24V digital outputs. The following table gives an overview of the available parameter setting.

Parameter value decimal (hex)	**DIGITAL OUT 1**	**DIGITAL OUT 2**
0 (0x00)	Encoder ouput "H1"	Ready-to-operate signal
1 (0x01)	Encoder output "H1"	Encoder ouput "H2"
2 (0x02)	0	0
18 (0x12)	0	1
34 (0x22)	1	0
50 (0x32)	1	1

Caution!!!
Starting from firmware version V1.1, all motors generate 2 pulses per mechanical revolution, regardless of the number of poles.

8.4. Operating mode

8.4.1. Selection of the operating mode *(Obj. 0x6060)*

The user can use the **object 0x6060** to choose from three implemented operating modes, "Speed control", "PWM control" and "Stepping mode". Unless agreed otherwise, all products are delivered in the "PWM control" operating mode (parameter value "-1"). The operating mode "Speed control" is activated via the parameter value "2". The parameter value "-7" must be chosen if a sensorless DC-drive should be operated on an external electronics, The "Stepping mode" operation will not be described in this operating manual in more detail. If interested, you can obtain more information upon request.

8.4.2. Speed and speed range setting

in "Speed control" operating mode ***(Obj. 0x6060 = 2)***

The "Speed control" operating mode is only working if all control (see section 8.4.3) and speed parameters were set correctly. The set value input (speed) is done as a function of the control mode (see section 8.2), either via the analog input “ANALOG IN”, the preset value parameters A and B (see 8.2.4) or in CAN mode via the **object 0x6042**. When an analog input is used, the voltage 0V corresponds to standstill, the voltage 10V to maximum speed. The speed range is defined via the **object 0x6046**. The minimum speed corresponds to the value in subindex 1, the maximum to the value in subindex 2. The direction of rotation input is done as a function of the control mode via at least one digital input. When using the set value parameters A and/or B, selection is done as a function of the control mode via at least one digital input. In the CANopen control mode, the speed input is done via the **object 0x6042** ("Speed input"). In both these cases, the direction of rotation is value-dependent, i.e., a negative value corresponds to clockwise rotation, a positive value to counter clockwise rotation. The current speed set value (after the ramp, see 8.5) can be read from the **object 0x6043** ("Velocity demand"). The actual motor speed is available from the **object 0x6044** ("Control effort").

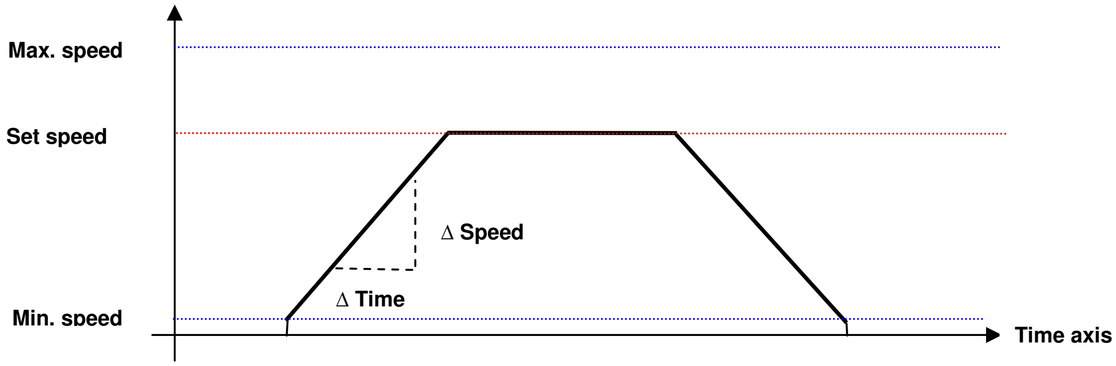
in "PWM control" operating mode ***(Obj. 0x6060 = -1) or (Obj. 0x6060 = -7)***

As-delivered, the "PWM control" operating mode is set. The set value input (PWM factor) is done as a function of the control mode (see section 8.2), either via the analog input “ANALOG IN”, the nominal value parameter A or B (see 8.2.4) or via the **object 0x2016**. When using the analog input, the voltage 0V corresponds to a PWM factor of 0%, the voltage 10V to a PWM factor of 100%. When using the set value parameters A and/or B, switchover is done as a function of the control mode via at least one digital input. In the CANopen control mode, the PWM input is done via the **object 0x2016**. In both these cases, the direction of rotation is value-dependent, i.e., a negative value corresponds to clockwise rotation, a positive value to counter clockwise rotation. The resolution of the set value input is 1 ‰, i.e., the value ±1000 corresponds to a PWM factor of 100%.

8.4.3. Controller parameter setting *(Obj. 0x2007, 0x2008)*

Parameter setting of the speed controller implemented via the software is done via two objects. The P component of the controller can be set via the **object 0x2007**, and the I component via the **object 0x2008**. The default value for the P component is 200 and 20 for the I component.

8.5. Ramp setting *(Obj. 0x6048, 0x6049, 0x604A)*



Parameter settings for the acceleration, deceleration and quick stop ramps are done separately. Each ramp has an object with two subindices. Subindex 1 contains the Δ speed value in rpm, subindex 2 the Δ time value in seconds.

Caution!!!
Δ Speed was specified prior to firmware V1.1 as a function of the operating mode, i.e., the value was specified in the "PWM control" mode in % PWM/min, in the "Speed control" mode in rpm. Moreover, parameter setting was done with values differing from the current ones.

Ramp function	Parameter	Object	Subindex
Acceleration	Δ Speed (rpm)	0x6048	1
	Δ Time (s)	0x6048	2
Deceleration	Δ Speed (rpm)	0x6049	1
	Δ Time (s)	0x6049	2
Quick stop	Δ Speed (rpm)	0x604A	1
	Δ Time (s)	0x604A	2

Example:

Desired ramp behavior:	from 1000 rpm to 2500 rpm in 3 s
Values to be set:	Δ Speed = 1500 rpm; Δ Time = 3 s or Δ Speed = 500 rpm; Δ Time = 1 s

8.6. Braking methods *(Obj. 0x200D)*

The control electronics supports different electrical braking methods. Selection is done via the **object 0x200D**. The standard braking method is "Quick stop", which is activated by the parameter value "0". Short-circuit braking can be activated by the parameter value "1".

8.6.1. Short-circuit braking *(Obj. 0x200D = 1)*

During braking all motor windings are pulled to ground by means of low-side MOSFETs. This will brake the motor quickly and safety, but in uncontrolled fashion.

Caution!!!
This method is not suitable for braking higher kinetic energies (high momentum of inertia) and for higher speeds (> 3500 rpm), since braking results in excessively high winding currents, which could damage power transistors! This is the reason why the parameter is not available everywhere.

8.6.2. Quick stop *(Obj. 0x200D = 0)*

During braking the motor is decelerated to 0 rpm via the quick stop ramp and then automatically switched to the "Short-circuit brake" mode. This creates a stoppage/holding torque. Parameter setting of the quick stop ramp is as described in section 8.5.

Caution!!!
For active braking, the motor will work in generator mode and try to feed back the electrical energy. If the direct voltage network cannot absorb the energy, the link circuit voltage will increase. If braking takes place too quickly, this may result in the motor being switched off, due to the error "Overvoltage".

8.7. Stall protection *(Obj. 0x200E)*

With the stall protection active, the drive is switched off, as soon it stalls, and outputs an error message. The stall protection is activated/deactivated via the **object 0x200E**. If the parameter value of the object is "1", the stall protection is active. If the parameter value is "0", the stall protection is inactive.

8.8. Max. peak current *(Obj. 0x2010)*

The maximum allowed peak current can be set by means of the **object 0x2010**. The resolution of the parameter is 1 mA, i.e., a value of, for example, 2000 corresponds to a current of 2 A. The maximum allowed peak current is 25 A.

8.9. Max. average current *(Obj. 0x2011)*

The maximum allowed average current can be set by means of the **object 0x2011**. The resolution of the parameter is 1 mA, i.e., a value of, for example, 2000 corresponds to a current of 2 A. The maximum allowed average current is 11 A.

The actual current values can be read out via the CAN bus. **Object 0x2020** contains the measured motor input current. **Object 0x2021** contains the calculated winding current. The motor current is proportional to the power consumption, while the winding current is proportional to the torque. At low speeds, high winding currents can be created even with low input current (= low power consumption) and result in switch-off. The calculated power consumption is available from the **object 0x2029**.

8.10. Warning temperature of output stage *(Obj. 0x2014)*

The warning temperature limit of the output stages in °C can be set by means of the **object 0x2014**. When this temperature is exceeded, the motor will send a warning telegram via the CAN bus. The current output stage temperature is available from the **object 0x2022**. When the maximum output stage temperature (**object 0x2015**) set ex works is exceeded, the motor will be switched off, and an error message displayed.

8.11. Access rights *(Obj. 0x2006)*

Object 0x2006 determines the access rights to different objects. With a value of "1", all customer parameters can be changed. If the parameter value "0" is written to the object, write access to all other objects is disabled.

8.12. Customer text *(Obj. 0x2032)*

The **object 0x2032** gives the user the opportunity to store a freely selectable text. However, the text length is limited to a maximum of 61 characters.

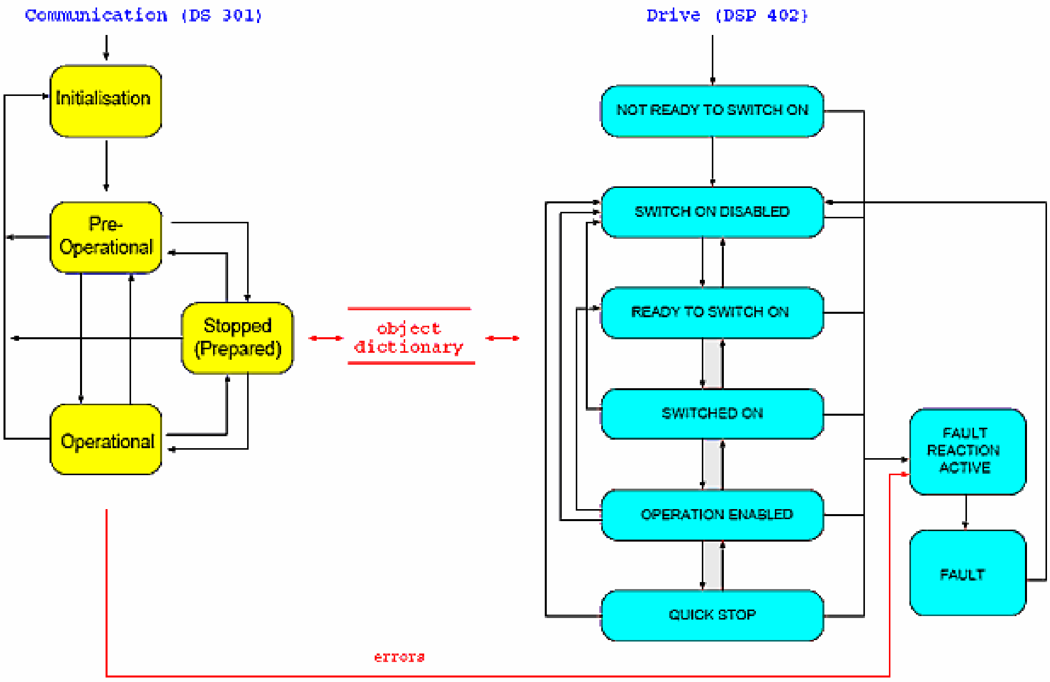
8.13. Position detection *(Obj. 0x202A, 0x202B)*

The rotor position of the drive can be monitored by means of the **object 0x202A**. The counter implemented specifically for this purpose will count the pulses of the Hall sensors. For clockwise rotation, the position value will be decremented and incremented for counter clockwise rotation. The number of pulses for mechanical revolution is available from the **object 0x202B**. After switch-on or following a reset, the numeric value of the counter is set to the initial value 0x8000000. The control can initialize the counter and thus start it by writing any desired value. The value 0x8000000 shows that the counter was not yet initialized and that for this reason the numeric value is invalid!

Caution!!!
The number of pulses per mechanical motor revolution depends on the motor type an can be found in object 0x202B

9. CiA 402 device profile

The control word is used to control the finite state machine (CiA 402 device profile). The "Operation Enabled" state puts the motor in a ready-to-operate state.



In the operational mode, three receive and transmit PDOs each are made available.

Transmit PDO:

PDO No.	Object	Bit length	Designation
1	0x6041	16	Status word
17	0x6043 0x6044 0x2020 0x2024	16 16 16 16	Speed set value in rpm Speed actual value in rpm Motor current (in ‰) Current PWM factor (in ‰)
18	0x6041 0x6044	16 16	Status word Speed actual value in rpm
19	0x2021 0x6044	16 16	Winding current (in ‰) Speed actual value in rpm
20	0x202A 0x6044 0x2020	32 16 16	Rotor position Speed actual value in rpm Motor current (in ‰)

Receive PDO:

PDO No.	Object	Bit length	Designation
1	0x6040	16	Control word
6	0x6040 0x6042	16 16	Control word Speed set value in rpm
17	0x6040 0x2016	16 16	Control word Set value in PWM mode (in ‰)

10. CAN start phase

If a drive is operated directly by means of the CAN bus, the finite state machine must be run according to the CiA 402 device profile. The following tables show the required data transfer for reaching the "Operation enabled" state by means of SDO and by means of PDO. In the example selected for this purpose, the node address 127 and a nominal PWM factor of 50% were used. For the sake of clarity, the following areas were marked in colour.

Master is transmitting **Motor is transmitting**

10.1. PDO start phase

Description	ID	Number of bytes	Data bytes	Control word (0x6040)	Status word (0x6041)
Drive transmits node address 0x7F	0x077F	0x01	0x00		
Master sets node to "Operational" (NMT service)	0x0000	0x02	0x01 0x7F		
Master requests status word (0x6041)	0x067F	0x08	0x40 0x41 0x60 0x00 0x00 0x00 0x00 0x00		
Drive transmits status word to master	0x05FF	0x08	0x4B 0x41 0x60 0x00 0x40 0x00 0x00 0x00		Switch on disabled 0x40
Master transmits control word (0x6040)	0x067F	0x08	0x40 0x40 0x60 0x00 0x00 0x00 0x00 0x00		
Drive confirms correct writing					
Master transmits PDO	0x127F	0x04	0x06 0x00 0xF4 0x01	Shutdown 0x06	
Master requests status word (0x6041)	0x067F	0x08	0x40 0x41 0x60 0x00 0x00 0x00 0x00 0x00		
Drive transmits status word to master	0x05FF	0x08	0x4B 0x41 0x60 0x00 0x21 0x00 0x00 0x00		Ready to switch on 0x21
Master transmits PDO 17	0x127F	0x04	0x07 0x00 0xF4 0x01	Switch on 0x07	
Master requests status word (0x6041)	0x067F	0x08	0x40 0x41 0x60 0x00 0x00 0x00 0x00 0x00		
Drive transmits status word to master	0x05FF	0x08	0x4B 0x41 0x60 0x00 0x23 0x00 0x00 0x00		Switched on 0x23
Master transmits PDO 17	0x127F	0x04	0x0F 0x00 0xF4 0x01	Enable operation 0x0F	
Master requests status word (0x6041)	0x067F	0x08	0x40 0x41 0x60 0x00 0x00 0x00 0x00 0x00		
Drive transmits status word to master	0x05FF	0x08	0x4B 0x41 0x60 0x00 0x27 0x00 0x00 0x00		Operation enabled 0x27

10.2. SDO start phase

Description	ID	Number of bytes	Data bytes	Control word (0x6040)	Status word (0x6041)
Drive transmits node address 0x7F	0x077F	0x01	0x00		
Master sets node to "Operational" (NMT service)	0x0000	0x02	0x01 0x7F		
Master writes 50% nominal PWM (value 0x01F4) to 0x2016	0x067F	0x08	0x2B 0x16 0x20 0x00 0xF4 0x01 0x00 0x00		
Drive confirms correct writing	0x05FF	0x08	0x60 0x16 0x20 0x00 0x00 0x00 0x00 0x00		
Master requests status word (0x6041)	0x067F	0x08	0x40 0x41 0x60 0x00 0x00 0x00 0x00 0x00		
Drive transmits status word to master	0x05FF	0x08	0x4B 0x41 0x60 0x00 0x40 0x00 0x00 0x00		Switch on disabled 0x40
Master requests control word (0x6040)	0x067F	0x08	0x40 0x40 0x60 0x00 0x00 0x00 0x00 0x00		
Drive transmits control word (value 0) to master	0x05FF	0x08	0x4B 0x40 0x60 0x00 0x00 0x00 0x00 0x00		
Master transmits control word (0x6040)	0x067F	0x08	0x2B 0x40 0x60 0x00 0x06 0x00 0x00 0x00	Shutdown 0x06	
Drive confirms correct writing	0x05FF	0x08	0x60 0x40 0x60 0x00 0x00 0x00 0x00 0x00		
Master requests status word (0x6041)	0x067F	0x08	0x40 0x41 0x60 0x00 0x00 0x00 0x00 0x00		
Drive transmits status word to master	0x05FF	0x08	0x4B 0x41 0x60 0x00 0x21 0x00 0x00 0x00		Ready to switch on 0x21
Master requests control word (0x6040)	0x067F	0x08	0x40 0x40 0x60 0x00 0x00 0x00 0x00 0x00		
Drive transmits control word (value 0) to master	0x05FF	0x08	0x4B 0x40 0x60 0x00 0x06 0x00 0x00 0x00		
Master transmits control word (0x6040)	0x067F	0x08	0x2B 0x40 0x60 0x00 0x07 0x00 0x00 0x00	Switch on 0x07	
Drive confirms correct writing	0x05FF	0x08	0x60 0x40 0x60 0x00 0x00 0x00 0x00 0x00		
Master requests status word 0x6041	0x067F	0x08	0x40 0x41 0x60 0x00 0x00 0x00 0x00 0x00		
Drive transmits status word to master	0x05FF	0x08	0x4B 0x41 0x60 0x00 0x23 0x00 0x00 0x00		Switched on 0x23
Master requests control word (0x6040)	0x067F	0x08	0x40 0x40 0x60 0x00 0x00 0x00 0x00 0x00		
Drive transmits control word (value 0x07) to master	0x05FF	0x08	0x4B 0x40 0x60 0x00 0x07 0x00 0x00 0x00		
Master transmits control word (0x6040)	0x067F	0x08	0x2B 0x40 0x60 0x00 0x0F 0x00 0x00 0x00	Enable operation 0x0F	
Drive confirms correct writing	0x05FF	0x08	0x60 0x40 0x60 0x00 0x00 0x00 0x00 0x00		
Master requests status word (0x6041)	0x067F	0x08	0x40 0x41 0x60 0x00 0x00 0x00 0x00 0x00		
Drive transmits status word to master	0x05FF	0x08	0x4B 0x41 0x60 0x00 0x27 0x00 0x00 0x00		Operation enabled 0x27

11. Diagnostics

11.1. System diagnostics

The following objects are available to the user for system diagnostics.

Object	Diagnostics parameter	Description
0x2000	Firmware version	Firmware version
0x2015	Max. output stage temperature	Maximum output stage temperature in °C
0x2020	Motor current	Motor input current in mA
0x2021	Winding current	Calculated winding current in mA
0x2022	Output stage temperature	Current output stage temperature in °C
0x2024	Current PWM factor	Current PWM factor (pulse width modulation) in ‰
0x2028	Input voltage	Input voltage in 0.1 V
0x2029	Power consumption	Calculated power consumption in Watt
0x202B	Steps per revolution	Resolution of rotor position detection
0x6043	Velocity demand	Speed set value in rpm
0x6044	Control effort	Speed actual value in rpm
0x6402	Motor type	(0) None (1) Phase modulated DC motor (2) Frequency controlled DC motor (3) PM synchronous motor (4) FC synchronous motor (5) Switched reluctance motor (6) Wound rotor induction motor (7) Squirrel cage induction motor (8) Stepper motor (9) Micro-step stepper motor (10) Sinusoidal PM BL motor (11) Trapezoidal PM BL motor (12) AC synchronous reluctance motor (13) DC commutator PM motor (14) DC commutator wound field series (15) DC commutator wound field shunt (16) DC commutator wound field compound

11.2. Description of the error codes *(Obj. 0x603F)*

The electronics has been designed such that it protects itself when an error occurs and switches off the drive. For the diagnostics of unambiguous causes of errors, error codes have been introduced. When an error occurs, they will be written to the **object 0x603F**.

The electronic platform generates two types of error descriptions: warnings and errors. When the warning limit is exceeded, the device status is not changed, i.e., the drive continues running normally, but a warning telegram is transmitted. When the error limit is exceeded, the drive will be de-energized. The following table gives an overview of possible errors and warnings.

Error number	Meaning of each error
0x2200	Maximum peak current exceeded
0x2220	Maximum average current exceeded
0x3210	Maximum voltage exceeded
0x3220	Voltage dropped below minimum
0x4210	Maximum output stage temperature exceeded
0x4310	Maximum motor temperature exceeded
0x5530	CRC error in parameter set
0x7121	Stall, motor is not rotating
0x7320	Hall error, error in rotor position detection
0x8130	Heartbeat error
0xFFF6	PDO6 error (maximum speed exceeded)
0xFFF7	Motor warning temperature exceeded
0xFFF9	Output stage warning temperature exceeded

12. Troubleshooting

The following table was created for troubleshooting. Its purpose is to give an overview of occurring errors and the possible causes of the error.

Fault Description	Possible cause of the error
Maximum peak current exceeded	- impulsive change in load torque
Maximum average current exceeded	- load torque too high - acceleration ramp too steep - wrong parameter setting of controller
Maximum voltage exceeded	- supply voltage too high - braking too quick, delay or quick stop ramp too steep
Voltage dropped below minimum	- supply voltage too low - supply voltage drop - acceleration ramp too steep
Maximum output stage temperature exceeded	- ambient temperature too high - drive heated up too much due to a high load torque
Warning limit of output stage temperature exceeded	- ambient temperature too high - drive heated up too much due to a high load torque
CRC error in parameter set	- error during data storage
Motor not rotating / stalling	- load torque too high - drive shaft mechanically blocked or running sluggishly - gear blocked or running sluggishly
Hall error, error in rotor position detection	- magnetic faults - one or several Hall sensors defective
Heartbeat error	- user to be monitored overloaded - fault in user to be monitored
Maximum speed exceeded	- drive is operated in generator mode
No communication possible	- CAN adapter defective - terminating resistor forgotten - wrong node address - wrong baud rate - faulty power supply - power supply not switched on - drive, actuator or controller not connected

13. Object directory

The following list gives the user an overview of all objects

(white)	**Write access with customer rights**
(green)	**Write access with customer rights** (parameters can be permanently saved)
(orange)	**Write access with manufacturer rights only**
(yellow)	**Read access only**

Object	Subindex	Function
0x1010		Saving parameter set
0x1016		Heartbeat Consumer
	01	Node ID + Time (Consumer Node ID + Heartbeat Consumer Time)
0x2000		Firmware version
0x2001		Parameter version
0x2002		Control mode
0x2003		Node ID (node address)
0x2004		Baud rate (in kbits/s)
0x2005		Output stage parameter (in °C)
0x2006		Access rights
0x2007		P component of speed controller
0x2008		I component of speed controller
0x2009		Idling speed (in rpm) *[1]
0x200B		Offset of the current-measuring circuit
0x200C		Current-measuring factor (compensation factor of the current-measuring circuit)
0x200D		Braking method
0x200E		Stall protection
0x200F		Digital outputs
0x2010		Max. peak current (in mA)
0x2011		Max. average current (in mA)
0x2014		Output stage warning temperature (in °C)
0x2015		Max. output stage temperature (in °C)
0x2016		Set value in PWM mode (PWM factor in ‰)
0x2018		Preset value A
0x2019		Preset value B
0x201B		Min. PWM factor in ‰
0x2020		Motor current (input current in mA)

Object	Subindex	Function
0x2021		Winding current (calculated winding current in mA)
0x2022		Output stage temperature (in °C)
0x2024		Current PWM factor (in ‰)
0x2025		Digital inputs
0x2026		Analog input (voltage value at the analog input in 0.1 V)
0x2028		Input voltage (voltage value of the supply voltage in 0.1 V)
0x2029		Power consumption (in W)
0x202A		Rotor position
0x202B		Steps per revolution (resolution of the rotor position detection)
0x202F		Number of poles*[1]
0x2030		Manufacturer code of the control board
0x2031		Manufacturer text
0x2032		Customer text (max. 61 characters)
0x603F		Error code
0x6040		Control word
0x6041		Status word
0x6042		Target velocity (speed set value in CANopen mode in rpm)
0x6043		Velocity demand (speed set value after the ramp in rpm)
0x6044		Control effort (speed actual value in rpm)
0x6046		Velocity Min Max (limit of the speed set value for the speed control)
	01	Minimum (rpm)
	02	Maximum (rpm)
0x6048		Velocity Acceleration (ramp)
	01	Delta Speed
	02	Delta Time
0x6049		Velocity Deceleration (ramp)
	01	Delta Speed
	02	Delta Time
0x604A		Quick stop (ramp)
	01	Delta Speed
	02	Delta Time
0x6060		Modes of Operation
0x6402		Motor type
0x6404		Motor manufacturer

*1 Just for external electronics

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