

Technical Manual

Multiturn Absolute encoder

AEMT-12/16 L



Imprint

Version:
1st edition, 17-09-2020

Copyright
by Dr. Fritz Faulhaber GmbH & Co. KG
Daimlerstr. 23 / 25 · 71101 Schönaich

All rights reserved, including those to the translation.
No part of this description may be duplicated, reproduced,
stored in an information system or processed or
transferred in any other form without prior express written
permission of Dr. Fritz Faulhaber GmbH & Co. KG.

This document has been prepared with care.
Dr. Fritz Faulhaber GmbH & Co. KG cannot accept any
liability for any errors in this document or for the
consequences of such errors. Equally, no liability can be
accepted for direct or consequential damages resulting
from improper use of the equipment.

The relevant regulations regarding safety engineering
and interference suppression as well as the requirements
specified in this document are to be noted and followed
when using the software.

Subject to change without notice.

The respective current version of this technical manual is
available on FAULHABER's internet site:
www.faulhaber.com

Content

1	About this document	4
1.1	Validity of this document	4
1.2	Associated documents	4
1.3	Using this document	4
1.4	List of abbreviations	5
1.5	Symbols and designations	5
2	Safety	6
2.1	Intended use	6
2.2	Safety instructions	6
2.3	Environmental conditions	7
2.4	EC directives on product safety	7
3	Product description	8
3.1	General product description	8
3.2	Product information	8
3.3	Product variants - Resolution	9
3.4	Interpretation of position values and handling of position overrun	10
3.5	Description of the interface	11
4	Installation	12
4.1	Mounting	12
4.1.1	Mounting instructions	12
4.1.2	Mounting the motor	13
4.1.3	Load of the connection cables	13
4.2	Electrical connection	14
4.2.1	Notes on the electrical connection	14
4.2.2	Pin assignment	14
4.2.3	Electrical data	15
4.2.4	Electrical circuit diagrams and external wiring	16
4.2.4.1	Line driver interface	16
4.2.4.2	Preset input	18
4.2.4.3	Connecting battery supply	18
4.3	Electromagnetic compatibility (EMC)	19
4.3.1	Cable routing	19
4.3.2	Shielding	21
4.3.3	Establishing the shield connection	22
4.3.4	Establishing shield connection with cable lug	23
4.4	Commissioning and battery change	24
4.5	Troubleshooting	25
5	Accessories	26
6	Binary numbers with and without sign	27
7	Warranty	28

About this document

1 About this document

1.1 Validity of this document

This document describes the installation and use of the following series:

- AEMT-12/16 L

This document is intended for use by trained experts authorised to perform installation and electrical connection of the product.

All data in this document relate to the standard versions of the series listed above. Changes relating to customer-specific versions can be found in the corresponding data sheet.

1.2 Associated documents

For certain actions during commissioning and operation of FAULHABER products additional information from the following manuals is useful:

Manual	Description
Motion Manager 6	Operating instructions for FAULHABER Motion Manager PC software
Quick start guide	Description of the first steps for commissioning and operation of FAULHABER Motion Controllers
Drive functions	Description of the operating modes and functions of the drive
Accessories manual	Description of the accessories

These manuals can be downloaded in pdf format from the web page www.faulhaber.com/manuals.

1.3 Using this document

- ▶ Read the document carefully before undertaking commissioning.
- ▶ Retain the document throughout the entire working life of the product.
- ▶ Keep the document accessible to the operating and, if necessary, maintenance personnel at all times.
- ▶ Pass the document on to any subsequent owner or user of the product.

About this document

1.4 List of abbreviations

Abbreviation	Meaning
AE	Absolute encoder
BiSS-C	Bidirectional, serial, synchronous interface in continuous mode
L	Line Driver
MT	Multiturn
PRE	Interface pin
SSI	Synchronous Serial Interface for Position Encoder
U _{Bat}	Battery voltage
U _{DD}	Power supply

1.5 Symbols and designations



CAUTION!

Hazards due to hot surfaces. Disregard may lead to burns.

- ▶ Measures for avoidance



NOTICE!

Risk of damage.

- ▶ Measures for avoidance



Instructions for understanding or optimising the operational procedures

- ✓ Pre-requirement for a requested action

1. First step for a requested action

- ↪ Result of a step

2. Second step of a requested action

- ↪ Result of an action

- ▶ Request for a single-step action

2 Safety

2.1 Intended use

The encoder described here has been designed as a sensor system that delivers angle information used for actuating and positioning the following motors:

- Brushless DC-servomotors

The encoder is suitable in particular for tasks in the following fields of application:

- Robotics
- Toolbuilding
- Automation technology
- Industrial equipment and special machine building
- Medical technology
- Laboratory technology

The following aspects must be taken into consideration when using an encoder:

- The encoder contains electronic components and should be handled in accordance with the ESD regulations.
- Do **not** use the encoder in environments where it will come into contact with water, chemicals and/or dust, **nor** in explosion hazard areas.
- The encoder should be operated only within the limits specified in the data sheet.
- Please ask the manufacturer for information about use under individual special environmental conditions.

2.2 Safety instructions



NOTICE!

Electrostatic discharges can damage the electronics.

- ▶ Wear conductive work clothes.
- ▶ Wear an earthed wristband.



NOTICE!

Inserting and withdrawing connectors whilst supply voltage is applied at the device can damage the electronics.

- ▶ Do not insert or withdraw connectors whilst supply voltage is applied at the device.

2.3 Environmental conditions

- ▶ Select the installation location so that clean dry air is available for cooling the motor.
- ▶ When installed within housings and cabinets take particular care to ensure adequate cooling of the motor.
- ▶ Select a power supply that is within the defined tolerance range.
- ▶ Protect the encoder and motor against heavy deposits of dust, in particular metal dust and chemical pollutants.
- ▶ Protect the encoder and motor against humidity and wet.

2.4 EC directives on product safety

Machinery Directive (2006/42/EC)

Because of their small size, no serious threats to life or physical condition can normally be expected from electric miniature drives. Therefore the Machinery Directive does not apply to our products. The products described here are not “incomplete machines”. Therefore installation instructions are not normally issued by FAULHABER.

Low Voltage Directive (2014/35/EU)

The Low Voltage Directive applies for all electrical equipment with a nominal voltage of 75 to 1500 V DC and 50 to 1000 V AC. The products described in this technical manual do not fall within the scope of this directive, since they are intended for lower voltages.

EMC Directive (2014/30/EU)

The directive concerning electromagnetic compatibility (EMC) applies to all electrical and electronic devices, installations and systems sold to an end user. In addition, CE marking can be undertaken for built-in components according to the EMC Directive. Conformity with the directive is documented in the Declaration of Conformity.

RoHS Directive (2011/65/EU)

The directive restricts the use of certain hazardous materials in electrical and electronic devices. The products described in this technical manual fall within the scope of this directive. Conformity with the directive is documented in the EC Declaration of Conformity.

WEEE Directive (2012/19/EU)

The directive on the disposal of electrical and electronic devices prescribes the separate collection of old electrical and electronic devices. The products described in this technical manual fall within the scope of this directive.

Product description

3 Product description

3.1 General product description

The AEMT-12/16 L series encoder is a magnetic multiturn absolute encoder.

The encoder provides the absolute angle information within one revolution (singleturn position) and the current revolution count (multiturn count). The absolute position, relative to the entire drive system, can be determined from the multiturn count and the singleturn position.

The encoder is connected to a main power supply (5 V) as well as a backup battery or alternative energy storage. If the main power supply is switched off, the backup battery will still provide the encoder with enough energy to detect motor revolutions and increment or decrement the multiturn count accordingly. This way, when switching on the main supply again, the count is still valid. A new reference run is not necessary. The backup battery is not part of the encoder, and must be connected externally.

In combination with brushless DC-servomotors, the AEMT-12/16 L delivers absolute angle information with a multiturn resolution of 16 bits and a singleturn resolution of 12 bits for commutation, speed control and motion control. This position data can be queried by a SSI Interface with BiSS-C Protocol. The interface is designed differentially and is based on the RS422 standard.

The multiturn count can be reset on the hardware side via an additional interface pin (pre-set) by a voltage pulse during start-up.

3.2 Product information

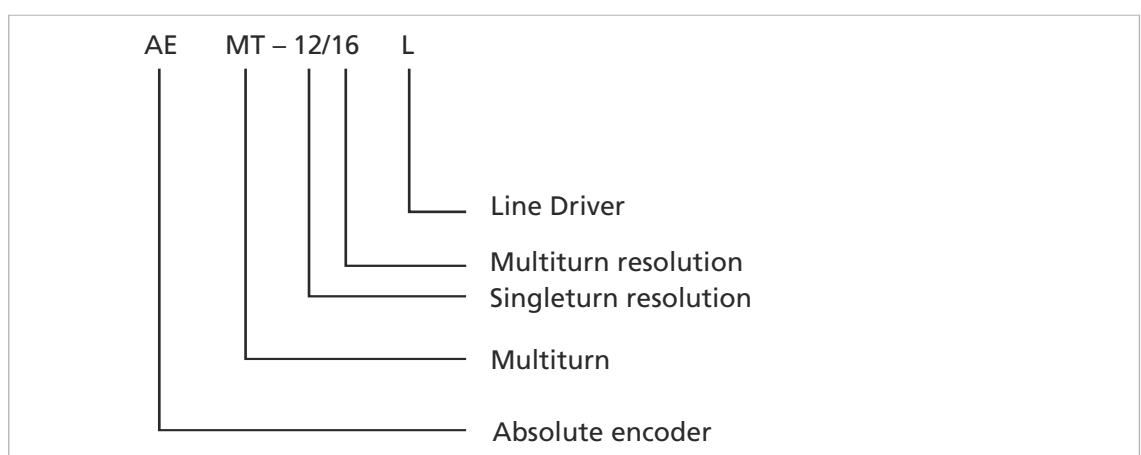


Fig. 1: Designation key

Product description

3.3 Product variants - Resolution

The encoder has a standard singleturn resolution of 12 bit (4096 increments per revolution) and a multiturn resolution of 16 bit. Thus, $2^{16} = 65536$ revolutions can be counted.

Apart from the standard configuration, other resolutions are available as special programming on request (see Tab. 1).

Tab. 1: Available singleturn and multiturn resolutions

Singleturn resolution	Multiturn resolution
10 bit	12 bit
11 bit	16 bit
12 bit	20 bit
	24 bit
	32 bit

i In combination with a FAULHABER Motion Controller of Generation V3.0, an overall resolution (multiturn + singleturn) of maximum 32 bit is possible.

- With an singleturn resolution of 12 bits, a maximum multiturn resolution of 20 bits is possible.
- With an singleturn resolution of 10 bits, a maximum multiturn resolution of 20 bits is possible.

Product description

3.4 Interpretation of position values and handling of position overrun

In the standard configuration of the AEMT-12/16 L, there is a number range from 0 to 268 435 455 positions ($2^{16} \cdot 2^{12} - 1$). Then the count starts again from the beginning.

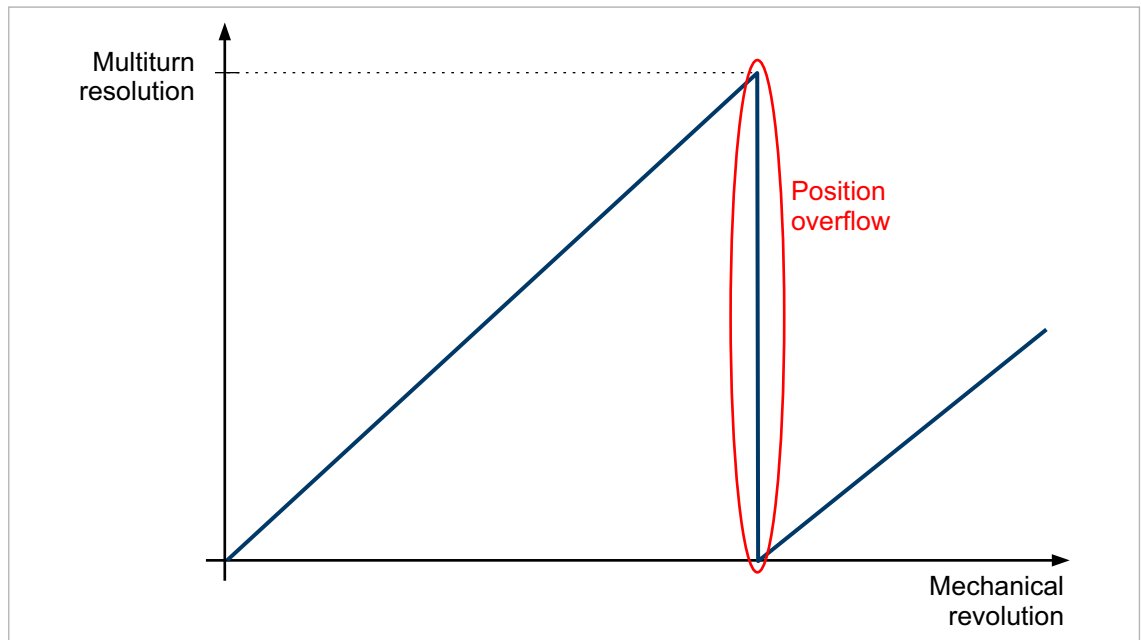


Fig. 2: Position overrun at the range limit



NOTICE! Damage to mechanics

Positioning exceeding the position overrun leads to a loss of information of the absolute position and can damage the mechanics.

- ▶ Ensure that the application travel is within the range limits of the maximum travel.
- ▶ During commissioning and after a battery change, reset the revolution count of the encoder using the preset pin, see chap. 4.4, p. 24. By interpreting the data values with sign (signed), positioning can then be made in both directions of rotation up to the overrun, see chap. 6, p. 27.
- ▶ Position limits can be defined (LL, UL) in the controller, which cannot be overrun, see Fig. 3.

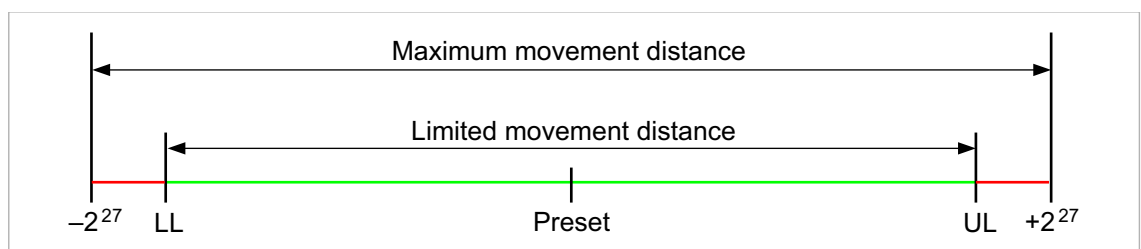


Fig. 3: Limitation of the travel distance when evaluating the binary data with sign (signed)

Product description

i The value to which the count of the encoder is reset via the preset pin is not unambiguously 0, but instead lies within a range of ± 8192 increments, depending on the singleturn position.

The preset value is set at the factory to a signed interpretation of the position data, see chap. 6, p. 27. If the position data should be interpreted without sign (unsigned), another preset value can be set at the factory.

3.5 Description of the interface

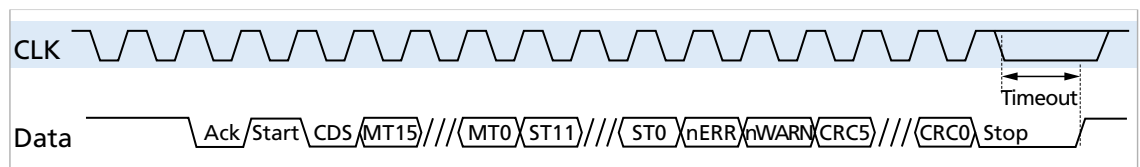


Fig. 4: Interface signals

i The $\overline{\text{Data}}$ and $\overline{\text{CLK}}$ signals are inverted in relation to the shown Data and CLK signals.

The angle information for the singleturn and multiturn position can be queried via a serial interface with BISS-C protocol. In this case, CLK is the input for the clock signal of the serial interface. The data of the serial interface is available on the Data line.

The start sequence consists of an acknowledge bit (Ack), a start bit and a control bit (CDS). All data values are transmitted with the most significant bit first, starting with the multiturn position (MT15...MT0), followed by the singleturn position (ST11...ST0). This is followed by an error bit (nERR), a warning bit (nWARN) and 6 CRC bits (CRC5...CRC0).

The error bit is set e.g. by a low battery voltage (see chap. 4.4, p. 24).

The warning bit is activated when the maximum allowed speed is exceeded. nERR and nWARN are low-active.

If no further clock signals are sent, the encoder enters a timeout after 20 μs , causing communication to be ended. The maximum clock frequency is 2 MHz.

For further information on the BISS-C protocol, see: <https://biss-interface.com/c/downloads>.

4 Installation

Only trained experts and instructed persons with knowledge of the following fields may install and commission the encoder:

- Automation technology
- Standards and regulations (such as the EMC Directive)
- Low Voltage Directive
- Machinery Directive
- VDE regulations (DIN VDE 0100)
- Accident prevention regulations

This description must be carefully read and observed before commissioning.

Also comply with the supplementary instructions for installation (see chap. 2.3, p. 7).

4.1 Mounting

4.1.1 Mounting instructions



CAUTION!

The motor can become very hot during operation.

- ▶ Place a guard against contact and warning notice in the immediate proximity of the motor.
- ▶ Ensure that adequate heat dissipation is provided.



NOTICE!

Installation and connection of the motor when the power supply is applied can damage the device.

- ▶ Prior to all aspects of installation and connection work on the motor, switch off the power supply.

Installation

4.1.2 Mounting the motor

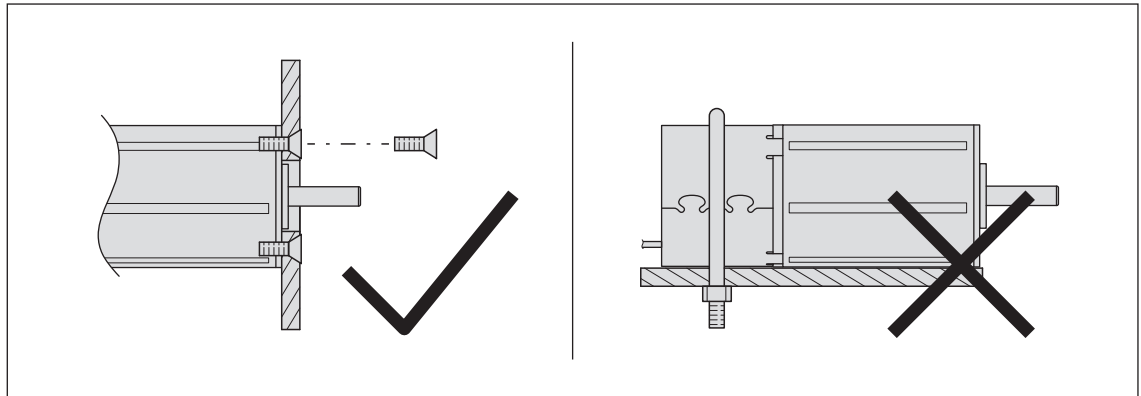


Fig. 5: Mounting example – 22xxBX4 AEMTL series



NOTICE!

Excessive radial loads on the servomotor or excessively tightened fastening screws can cause irreparable damage to the mounting flange.

- ▶ Do not apply a radial force exceeding 30 N at the rear end of the motor.
 - ▶ Make sure that the screws are tightened to max. 50 Ncm.
 - ▶ Make sure that the screws are of sufficient strength.
1. Secure the front flange of the motor to a suitable surface using fastening screws.
 2. Protect the fastening screws to prevent displacement due to the effect of heat.
 3. If necessary, attach parts to the motor shaft.

4.1.3 Load of the connection cables



NOTICE!

Extreme static or dynamic loads on the ribbon cable can cause the cable to be damaged.

- ▶ Make sure that the ribbon cable is not subjected to abrasion, crushing or excessively tight bending radii during installation and operation.
- ▶ With frequent bending, the bending radius must not be less than 10 mm. The possible number of bending cycles increases as the bending radius increases.
- ▶ Do not bend the cable at temperatures $< -10\text{ °C}$.
- ▶ Comply with permissible loads.

Permissible loads of the ribbon cable:

- Tensile load: $< 30\text{ N}$
- Continuous tensile load: $< 17\text{ N}$
- Bending radius with one-off installation: $> 1.2\text{ mm}$

Installation

4.2 Electrical connection

4.2.1 Notes on the electrical connection

NOTICE!
Installation and connection of the encoder when the power supply is applied can damage the encoder.

- ▶ Prior to all aspects of installation and connection work on the encoder, switch off the power supply.

NOTICE!
Electrostatic discharges to the encoder connections can damage the electronic components.

- ▶ Observe the ESD protective measures.

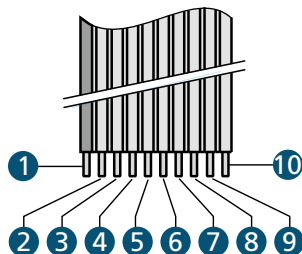
NOTICE!
Incorrect connection of the wires can damage the electronic components.

- ▶ Connect the wires as shown in the connection assignment.

4.2.2 Pin assignment

Tab. 2: Pin assignment of ribbon cable (contact spacing: 1.27 AWG28)

Wire	Designation	Meaning
1 ^{a)}	Pre	Preset: Digital input for resetting the revolution count
2	U _{DD}	Power supply
3	GND	Ground connection / battery connection (-)
4	U _{BAT}	Battery connection (+)
5	-	Reserved
6	-	Reserved
7	$\overline{\text{Data}}$	Data (logically inverted signal)
8	Data	Data
9	$\overline{\text{CLK}}$	Clock (logically inverted signal)
10	CLK	Clock



a) Wire 1 is highlighted in a different colour

Installation

4.2.3 Electrical data

Tab. 3: Encoder supply

Power supply U_{dd}	4.5...5.5 V
Rated current consumption ^{a)}	Typical: 25 mA Maximum: 35 mA
Standby current under load ^{b)}	Typical: 90 mA
Set-up time after power on	20 ms

a) $U_{dd} = 5\text{ V}$ on non-loaded outputs

b) $U_{dd} = 5\text{ V}$, terminating resistors $R_T = 120\ \Omega$ between CLK and \overline{CLK} (integrated in the encoder) and between $Data$ and \overline{Data} , current measurement in ground path

Tab. 4: Line driver interface with power supply switched on U_{dd}

Parameter	Value
Input low level (CLK, \overline{CLK})	0...0.8 V
Input high level (CLK, \overline{CLK})	2...5 V
Driver capability	See RS422
Timeout	Typical: 20 μs

Tab. 5: Preset with power supply switched on U_{dd}

Parameter	Value
Input high level ^{a)}	4.25...5 V
Input low level	0...2 V
Preset duty cycle, minimum	100 ms

a) $U_{dd} = 5\text{ V}$



- At the preset pin, a voltage of at least 4.25 V must be applied to reset the multiturn count.
- To prevent unintentional resetting, the voltage must not exceed 2 V.

Tab. 6: Battery mode

Parameter	Value
Battery voltage U_{Bat}	3.0...5.5 V
Power consumption in battery mode ^{a)}	10 μA
Maximum permissible acceleration in battery mode	$48 \cdot 10^3\text{ rad/s}^2$
Maximum permissible speed in battery mode	16 000 rpm

a) $U_{Bat} = 3.6\text{ V}$, in standstill ($n = 0\text{ rpm}$)



- For a battery voltage $U_{Bat} < 2.8\text{ V}$ the nERROR error bit is set in the BiSS-C protocol, see chap. 3.5, p. 11.
- As an option, the maximum permissible acceleration can be adjusted at the factory. The power consumption increases with increasing maximum permissible acceleration.

Installation

NOTICE! Damage to mechanics

Exceeding the maximum permissible acceleration or speed while in battery mode may result in an invalid revolution count and result in damage to the mechanics.

- ▶ When designing, take into account the maximum possible acceleration of the application.
- ▶ For higher accelerations use a special configuration of the encoder.

4.2.4 Electrical circuit diagrams and external wiring

4.2.4.1 Line driver interface

The encoder has a line driver interface based on the RS422 standard. A terminating resistor $R_T = 120 \Omega$ is integrated between the input signals CLK and $\overline{\text{CLK}}$.

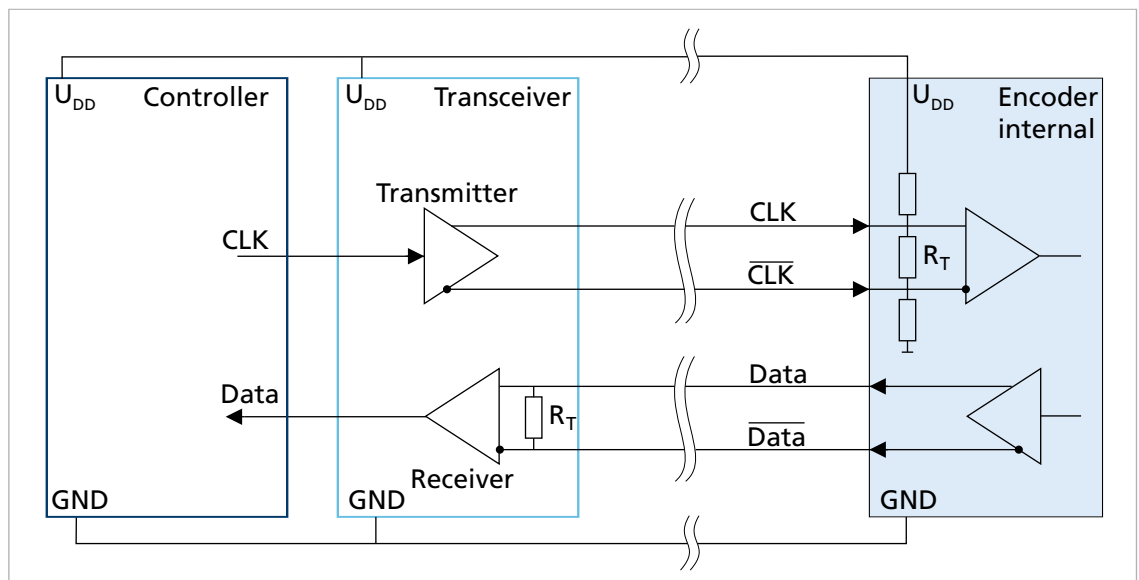


Fig. 6: Electrical circuit diagram of the encoder signals and connection to a line driver transceiver

When connecting the line driver interface on the controller side:

- ▶ Use transceiver module.
 - The transceiver is already integrated in FAULHABER Motion Controllers of generation V3.0.
 - Recommended transceiver components: iC-HF, SN65LBC179, SN75179B, DS90LV019
- ▶ Use a terminating resistor between data and $\overline{\text{data}}$ starting at a cable length of 1 m. For the termination options of signals data and $\overline{\text{data}}$ see Fig. 7

Installation

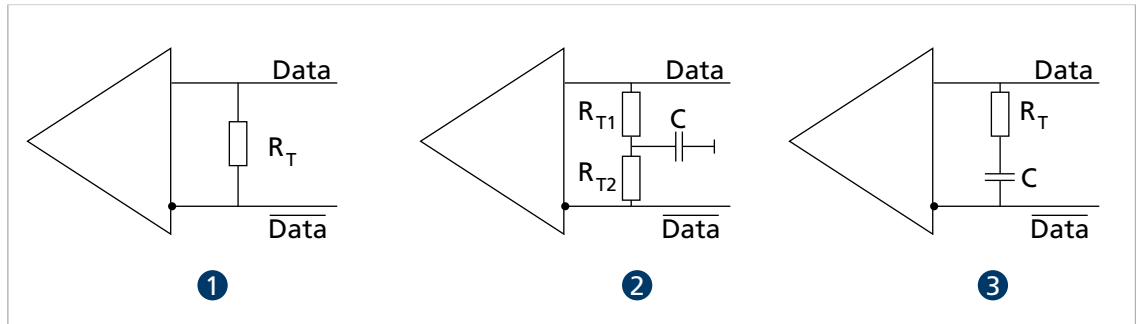


Fig. 7: Termination types

1 Standard

3 AC termination

2 Split termination

- Standard: Terminating resistor $R_T = 100 \dots 130 \Omega$
- Split termination: The terminating resistor is split symmetrically (e. g. $R_{T1} = R_{T2} = 60 \Omega$). The capacitor C (4.7...10 nF) discharges common-mode currents to ground. This leads to an increased interference resistance of the signal transmission.
- AC termination: A capacitor C in series with the terminating resistor R_T can reduce the power consumption and thus the power loss in R_T . The value of the capacitor must be adjusted to the clock frequency.

i When selecting the terminating resistor R_T , the power loss has to be considered. With a terminating resistor R_T of 120Ω , a power loss of $P_V = U^2/R_T = (5 \text{ V})^2/120 \Omega \approx 0,21 \text{ W}$ results for the termination types (1) and (2), for example.

With twisted-pair cables, proper cable routing and shielding, transmission lengths of 5 m and more are possible, see chap. 4.3, p. 19.

Installation

4.2.4.2 Preset input

During commissioning and after a battery change, a voltage pulse must be applied to the preset input (pin 1) to reset the revolution count.

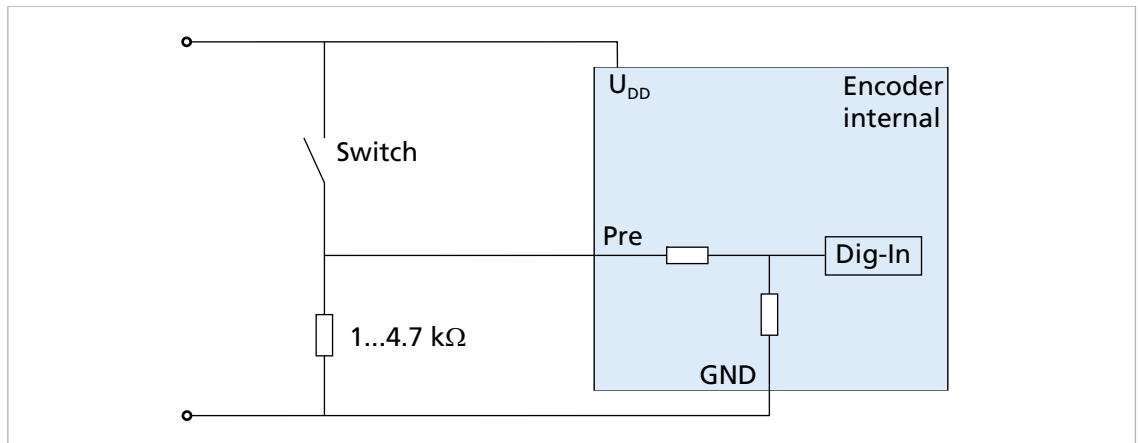


Fig. 8: Preset electrical circuit diagram

- ▶ Provide mechanical switches, see Fig. 8.
- ▶ Alternatively: Connect the preset pin to a digital output of a controller.
- ▶ Connect the preset pin to ground externally using a pull-down resistor to ensure a defined voltage of <2 V even with long cable lengths.

4.2.4.3 Connecting battery supply

- ▶ Integrate the battery either in the extension of the supply line or in the customer-specific peripherals.
- ▶ Connect the battery between pins U_{BAT} and GND.
- ▶ In case of an error (e.g. short-circuit between U_{DD} and U_{BAT}) the resistor R_{V1} integrated in the encoder limits the (reverse) current into the battery.

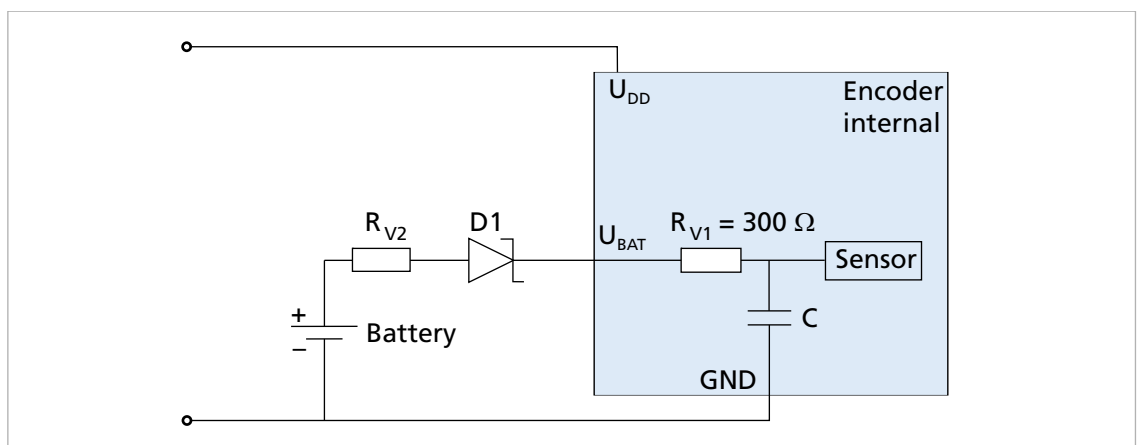



Fig. 9: Battery connection option

Installation

NOTICE! Damage to battery

In case of an error, an unacceptable charging current (reverse current) can damage the battery. The UL1642 and IEC60086-4 standards describe recommendations for the safety of lithium batteries.

- ▶ When selecting the battery, check the dimensions of the integrated resistor R_{V1} based on the maximum permissible reverse current.
- ▶ If necessary, connect another series resistor R_{V2} and/or a D1 diode in series with the battery.
- ▶ Install additional protective components (D1, R_{V2}) close to the battery.

 Depending on the type of energy storage and the requirements on the service life, more complex circuits may be required for battery management.

4.3 Electromagnetic compatibility (EMC)

- ▶ Follow the instructions in the following chapters and in the technical manual of the FAULHABER Motion Controller of generation V3.0 to perform an EMC-compliant installation.

4.3.1 Cable routing

The cable routing depends on various factors, such as:

- Is the cable shielded, twisted?
- Were interference-reducing measures taken?
- What material and what cable routing are used in the cable duct?
- Over what surface is the cable routed?

Observe the following when laying the cables:

- ▶ Use a full-surface, u-shaped and, if possible, metal cable duct.
- ▶ Lay the cables near the corners of the cable duct.
- ▶ Separate the cables by function where possible.
- ▶ Maintain distances when laying the cables.

The distances may vary depending on the zone in the switching cabinet.

- ▶ If possible, all cables should be twisted pairs or twisted and shielded in function groups (e.g., motor phases together, encoder cables together).

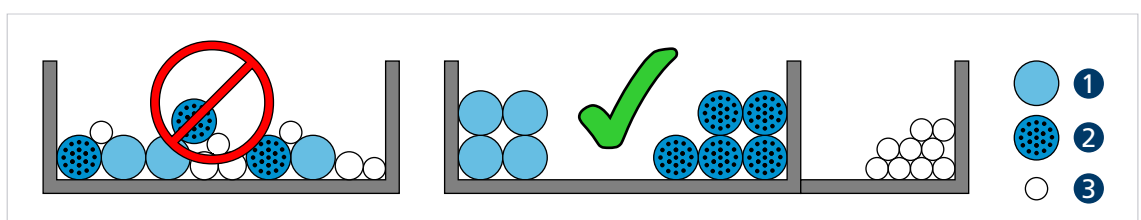


Fig. 10: Laying in the cable duct

Installation

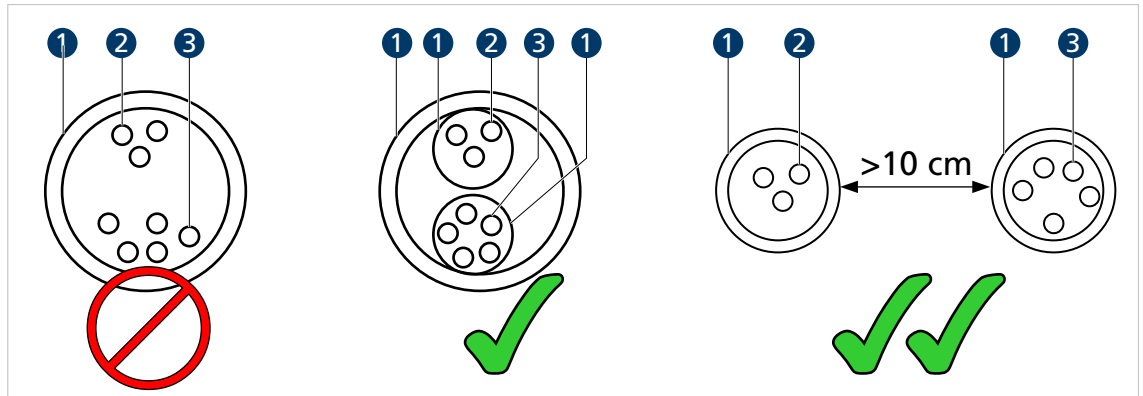


Fig. 11: Grouping and shielding of the cables

- 1 Shielding
- 2 Motor phase
- 3 Encoder cables

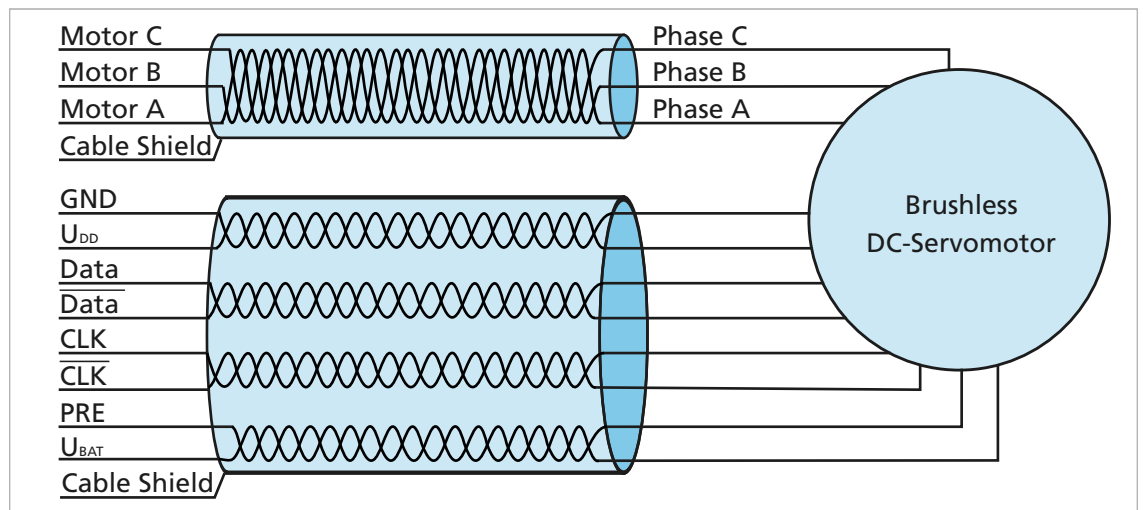


Fig. 12: Cables twisted and shielded in function groups for connection of BL servomotor with AEMT-12/16 L

Installation

4.3.2 Shielding

- ▶ Shield cables in all cases.

Shield cables that are longer than 3 m with tightly meshed copper braiding.

- ▶ Shield all supply lines according to current guidelines/standards (e.g., IPC-A-620B) and connect using (round) shield clamp.

In special cases (e.g., with pigtail) or after qualification, the shield can be omitted for the following cables:

- Cables with length <50 cm
- Cables with low power supplies (e.g., <20 V)
- Sensor cables

- ▶ Connect shield clamps to a low-impedance (<0.3 Ω) earthing bar or earth plate.

A connection to the controller housing should only be made if no earthing bar is available.

- ▶ Establish a star-point earth connection.

- ▶ Lay the motor phases in a shield, separate from the sensor or encoder signals, and connect on at least the motor side (see 1 or 2 in Fig. 13).

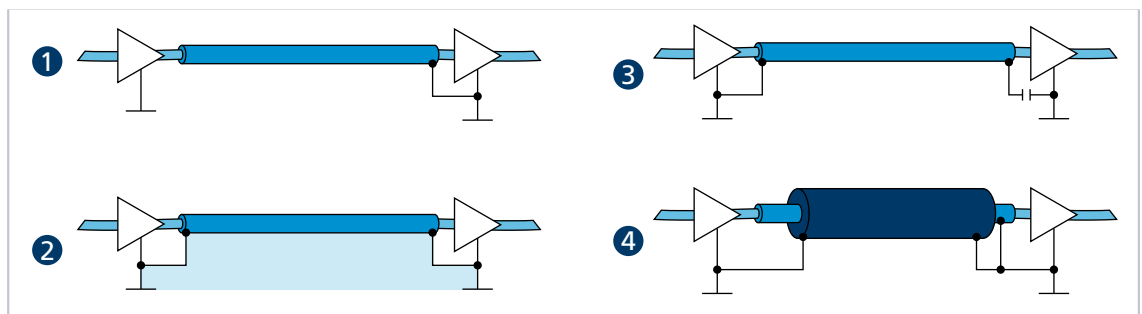


Fig. 13: Various possibilities for the shield connection

- 1 Suppressing electrical fields
- 2 Alternating magnetic field
- 3 Interruption of the earthing loop for direct currents or low-frequency currents
- 4 Discharging parasitic currents to the reference potential

The sensor signals can optionally be laid with the motor phases in a shared cable/insulation hose using another outer braided shield. This outer braided shield must be connected at both ends (e.g., 4 in Fig. 13). A solution such as 2 in Fig. 13 is not functional in every case for this configuration. If this is not possible by means of a ground offset, establish the RF connection via specially suited capacitors (e.g., safety capacitors such as Y1/Y2/X1/X2, see 3 in Fig. 13). In this case, do not connect the shield multiple times except at the motor connection and controller side.

Installation

4.3.3 Establishing the shield connection

The best results when establishing a shield connection on the cable are achieved in the following way:

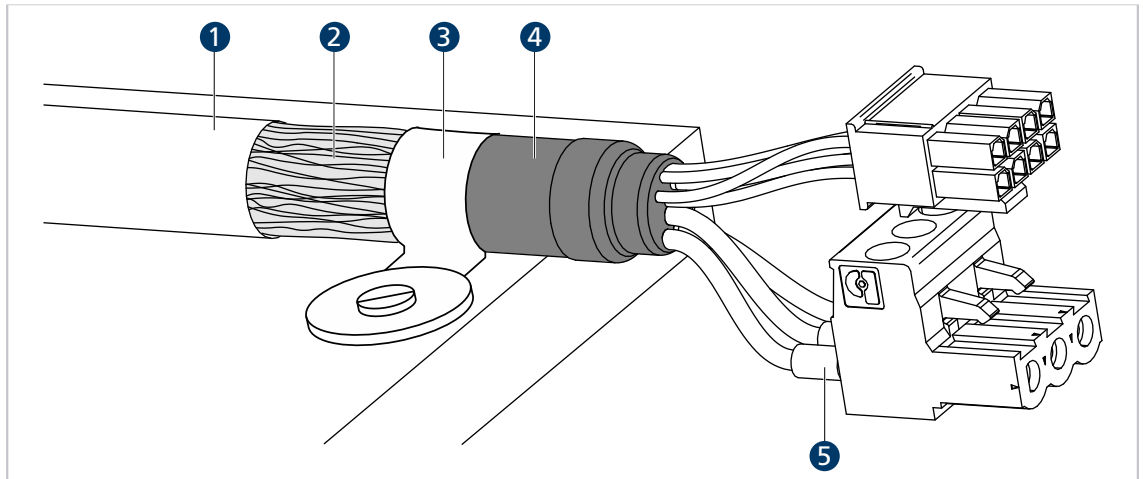


Fig. 14: Motor cable shield connection

- | | |
|----------------------|----------------------|
| 1 Outer cable shield | 4 Heat-shrink tubing |
| 2 Braided shield | 5 Crimp-sleeve |
| 3 Shield clamp | |

1. Remove approx. 50-100 mm from the outer cable shield (1). Make certain that none of the fibres of the braided shield (2) are destroyed.
2. Either push back the shield or roll it up and fasten with heat-shrink tubing (4).
3. Optionally fit crimp-sleeves on the cable ends (5) and attach to the plug connectors.
4. Fasten the shield and the fixed end of the heat-shrink tubing with a cable tie (3).

Installation

4.3.4 Establishing shield connection with cable lug

A shield connection with cable lug should be avoided whenever possible. If it is necessary, however, the connection should be established as follows.

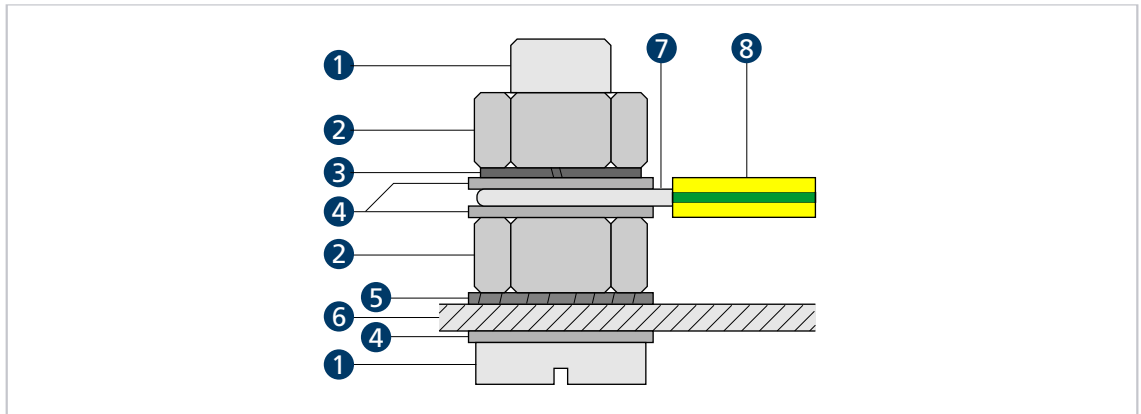


Fig. 15: Shield connection with cable lug

1 Screw	5 Lock washer
2 Nut	6 Wall
3 Spring washer	7 Wire eyelet
4 Washer	8 Protective conductor

1. Scrape the surface around the hole to remove as much of the oxide layer as possible.
2. Guide screw with washers through the cable lug.
3. Place lock washer on the screw.

Depending on the screw length, also position the lock washer against the roughened surface.

4. Fix screw with nut on the bottom side or screw into the thread.

Installation

4.4 Commissioning and battery change

- ✓ The drive system is properly mounted and wired.



NOTICE!

Damage to mechanics

The multiturn function is only guaranteed if the data of the AEMT-12/16 L are used directly for position determination.

- ▶ Do **not** set the position at the reference position on the software side in the controller to 0.
- ▶ Do **not** increment/decrement the position beyond the range limits of the encoder on the software side in the controller.

Commissioning of the encoder

5. Configure the controller and/or check the settings:

- Select the protocol of the encoder interface.
- Set the resolution.
- Evaluate the nERROR error bit for battery monitoring.
- Specify the number range of the position data, see chap. 6, p. 27.
 - signed: For the standard configuration of the encoder (revolution count = 0 after resetting the encoder)
 - unsigned: For special configuration of the encoder (customer-specific revolution count after resetting the encoder)
- Set the range limits for positioning.

↪ The controller is ready for use.

6. Switch on the encoder:

- Connect the battery.
- Switch on the power supply.

↪ The encoder can signal an error (nERROR) and under certain circumstances constantly supply the position value 0.

7. Reset the encoder:

- Apply a voltage pulse of 5 V to the PRE connection.
- Switch the power supply U_{DD} off and on again.

The battery voltage ($U_{BAT} > 3\text{ V}$) must remain on during this time.

↪ The multiturn count and any error (nERROR) are reset. The encoder is ready for use.

8. Perform a reference run:

- Move to reference position.
- Store the current value of the encoder as start position.

↪ The drive system is ready for use.

Installation

i The nERROR error bit can only be reset together with the revolution count of the encoder.

After the battery voltage drops to $U_{BAT} < 2.8 \text{ V}$ and following battery change, repeat steps 2 to 4.

When selecting an appropriate battery with a battery voltage of 3.6 V and a capacity of 1 Ah, a typical service life of 10 years is possible with the standard configuration. During this time the battery charge level should still be monitored.

Recommendation:

- Evaluate the nERROR error bit for battery monitoring.
- Define and perform regular maintenance.
- Change the battery at a regular fixed interval.

4.5 Troubleshooting

If unexpected malfunctions occur during operation according to the intended use, please contact your support partner.

5 Accessories

For combining the encoder with other products of the FAULHABER portfolio, the available accessories are described in chapter "Accessories":

Article no.	Description
6501.00368	Battery adapter AEMTL - MC50xx, consisting of: <ul style="list-style-type: none"> ▪ Connection options for the controller and encoder ▪ Switch to reset the AEMT-12/16 L ▪ Bracket for 1/2AA batteries
6501.00369	MC50xx cable – Battery adapter AEMTL L = 150 mm
6501.00370	Cable AEMTL L = 2 m

The battery is not included in the delivery contents.

Recommended batteries: SL-350, ER14250, LS14250.

The exact connections options can be found in the data sheet of the battery adapter.

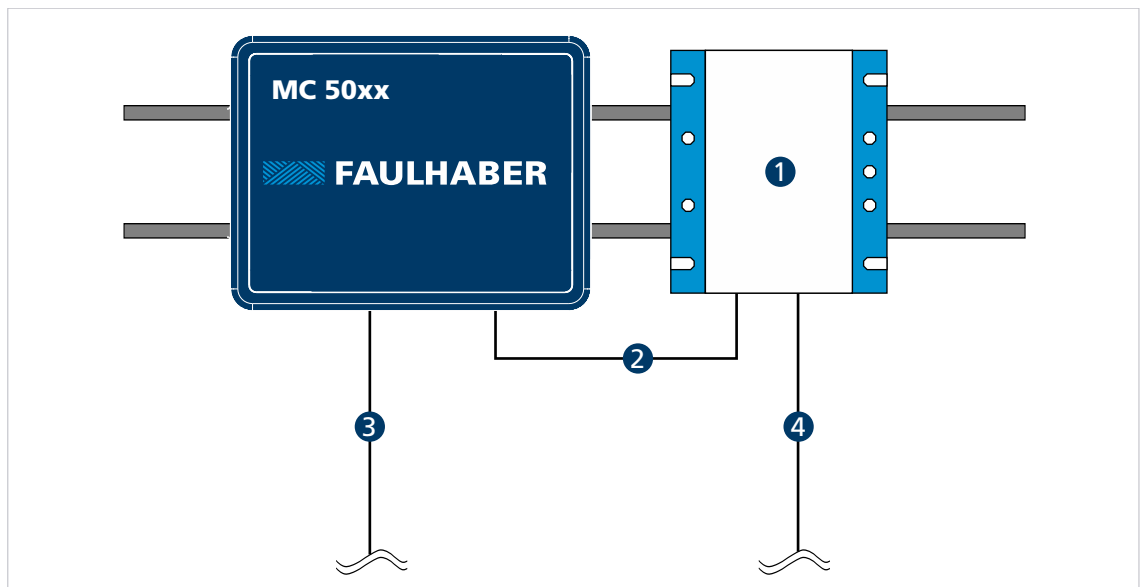


Fig. 16: Example of a top-hat rail mounting for a MC 50xx with battery adapter

- | | |
|---|--------------------------|
| 1 Battery adapter 6501.00368 | 3 Motor phases |
| 2 MC50xx cable - Battery adapter AEMTL 6501.00369 | 4 Cable AEMTL 6501.00370 |

Binary numbers with and without sign

6 Binary numbers with and without sign

Binary numbers can be interpreted in a number range without sign (unsigned) and with sign (signed):

Unsigned

With 28 bit (16 bit multirun + 12 bit singleturn) there is a number range from 0 to $2^{28} - 1$.

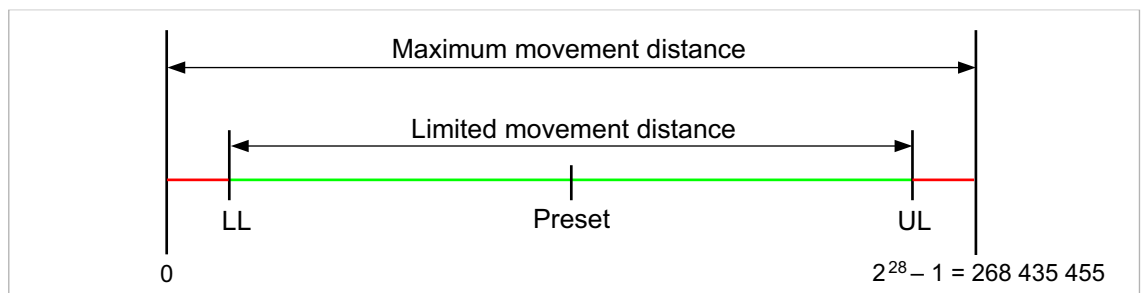


Fig. 17: Number range without sign (unsigned)

Signed

The bit with the highest weighting (MSB) can be evaluated as sign. In the AEMTL-12/16 L this is bit 27:

- Bit 27 = 0: positive sign
- Bit 27 = 1: negative sign

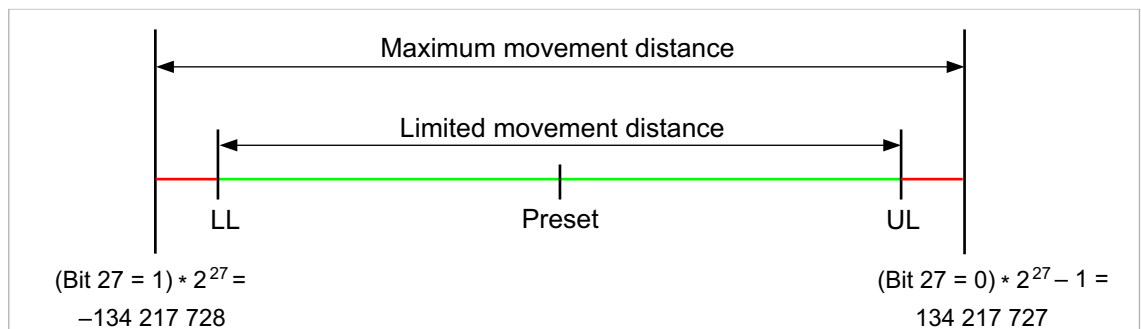


Fig. 18: Number range with sign (signed)

7 Warranty

Products of the company Dr. Fritz Faulhaber GmbH & Co. KG are produced using the most modern production methods and are subject to strict quality inspections. All sales and deliveries are performed exclusively on the basis of our General Conditions of Sale and Delivery which can be viewed on the FAULHABER home page <https://www.faulhaber.com/gtc> and downloaded from it.

