Support of Absolute Encoders with SSI / BiSS-C interface

Summary

Faulhaber AES(L) encoders and Faulhaber AEMTL encoders are natively supported by Faulhaber controllers.

Third party absolute encoders (multiturn or singleturn) with SSI or BiSS-C interface need to fulfill a few prerequisites.
These requirements are listed on pages 3 and 4.

The application note also explains how to configure an absolute encoder using Motion Manager 6.7 or higher.

Applies To

Faulhaber Motion Controller MC5004, MC5005, MC5010 using firmware L or higher

Content overview

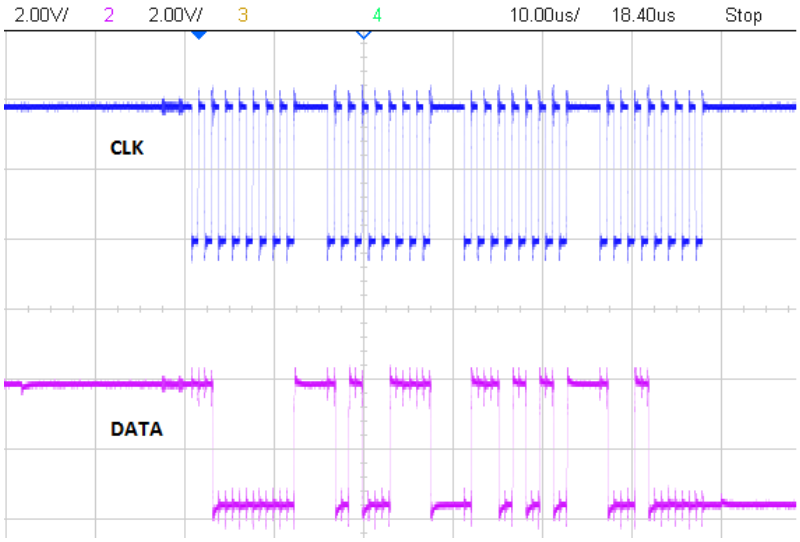
Description

Specification of absolute encoder / controller combination

Clock frequency	650 (for SSI) 1000 (for BiSS-C)	kHz
Encoder Power Supply	5 <= 100	V mA
Singleturn Resolution	up to 22	Bits
Multiturn Resolution	up to (32 - # of singleturn bits)	Bits
Encoder Power On Time	<= 200	ms
Controller Update Rate	100	µs
SSI	▪ Formats: binary / gray ▪ Preceding bits: up to 8 bits can be masked out	
BiSS-C (with restrictions)	▪ Sensor Mode, Point-to-Point ▪ Please note: Acknowledge must not exceed one clock cycle. ▪ CRC is checked, if not correct an encoder error is signaled ▪ Error bit is checked, if low an encoder error is signaled.	
Cable length	Encoder with line driver: ▪ up to 15 twisted pair: Clock, /Clock and Data, /Data ▪ 120 Ohm termination resistor between Data and /Data is recommended, if cable length exceeds about 1 m Encoder without line-driver: ▪ up to 0.3	m m
Controller Hardware	▪ RS422-compatible transceiver / receiver ▪ Option 6419 - 120 Ohm termination resistor	

The FAULHABER motion controllers MC5010, MC5005 and MC5004 use a uart hardware interface to read the data of an absolute encoder.

The sequence of clock and data signals is shown in the following graph.



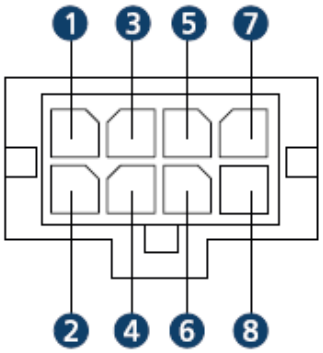
The data is read in blocks of 8 bits. In between the blocks is a time delay of **2.5 to 4 µs** depending on the usage of BiSS-C or SSI respectively.

The third-party absolute encoder must not run into a **timeout condition** during these delays to be compatible with a FAULHABER MC5010, MC5005 or MC5004.

The following list shows third party absolute encoders which are verified to be compatible:

Supplier	Encoder type
Heidenhain	- ROQ 1025 SSI41r1, 12 Bit MT, 13 Bit ST, SSI, gray
Hengstler	- AD 36, 12 Bit MT, 13 Bit ST, SSI, gray - AD 36, 12 Bit ST, SSI, gray
Pepperl + Fuchs	- ENA36IL,12 Bit MT, 13 Bit ST, SSI , binary
Posital	- UCD, 12 Bit MT, 13 Bit ST, SSI, binary
PWB Encoders	- MEM 16 Multi / MEM 22 Multi, 12 Bit MT, 13 Bit ST, BiSS-C with option for fixed timeout of 20 µs
Leine Linde	- ISA 607, 13 Bit ST, SSI, gray
SCANCON	- 2RMHF, 16 Bit MT, 13 Bit ST, SSI, binary

Pinout of hardware



Pin	Designation	Meaning
1	U_{DD}	Power supply for absolute encoder
2	GND	Ground
3	$\overline{CS}$	Command Specifier for absolute encoder (logically inverted signal)
4	CS	Command Specifier for absolute encoder
5	$\overline{Data}$	Data for absolute encoder (logically inverted signal)
6	Data	Data for absolute encoder
7	$\overline{CLK}$	Clock for absolute encoder (logically inverted signal)
8	CLK	Clock for absolute encoder

If the encoder does not have an CS signal leave the pin open.
If an encoder without line-driver is used leave the inverted pins open.

Please Note:
Depending on the encoder and the cable length an additional capacitor (100 nF.. 2µF) might be needed to stabilize the 5 V supply voltage U_{DD}.

Configuration of an absolute encoder using Motion Manager 6.7 or higher

Absolute encoder as source of actual values:

Position actual value

☑ **Fully supported**

Additional configuration information	**Encoder on load-side of gearbox / transmission element** **➔ see also App Note 159** **Linear absolute encoder** **➔ see also page 17**

Velocity actual value

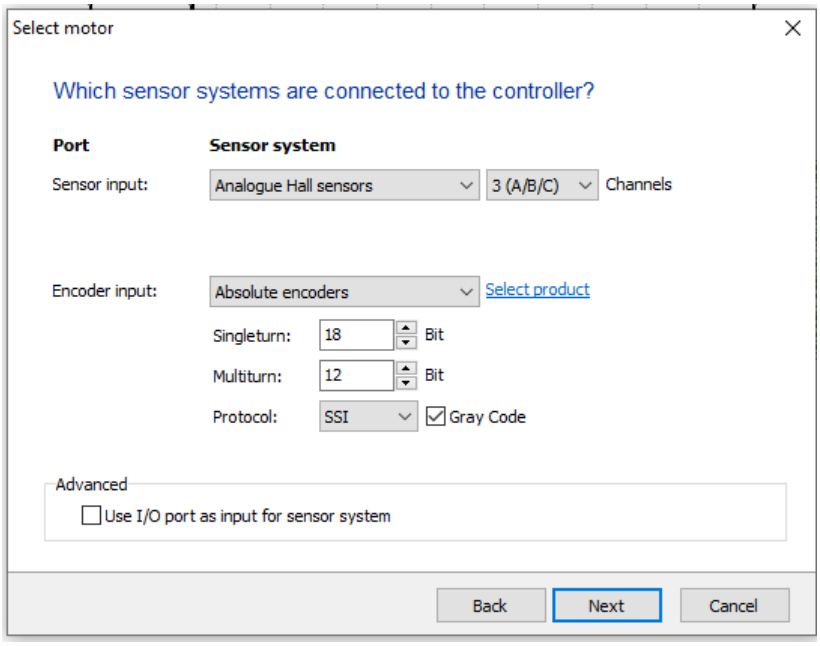
Supported	**☑ Rotary motor + torsionally stiff / rigid coupling between encoder and motor**
Not supported	**⊗ Non-rigid coupling between encoder and motor** **➔ In this case a motor with integrated linear hall sensors could be used to close the velocity loop**

Commutation angle

Supported	**☑ Faulhaber AES(L), AEMT(L) encoders**
Additional information	**Commutation based on third party absolute encoders can be possible under certain circumstances.** **Please contact your FAULHABER sales partner.**

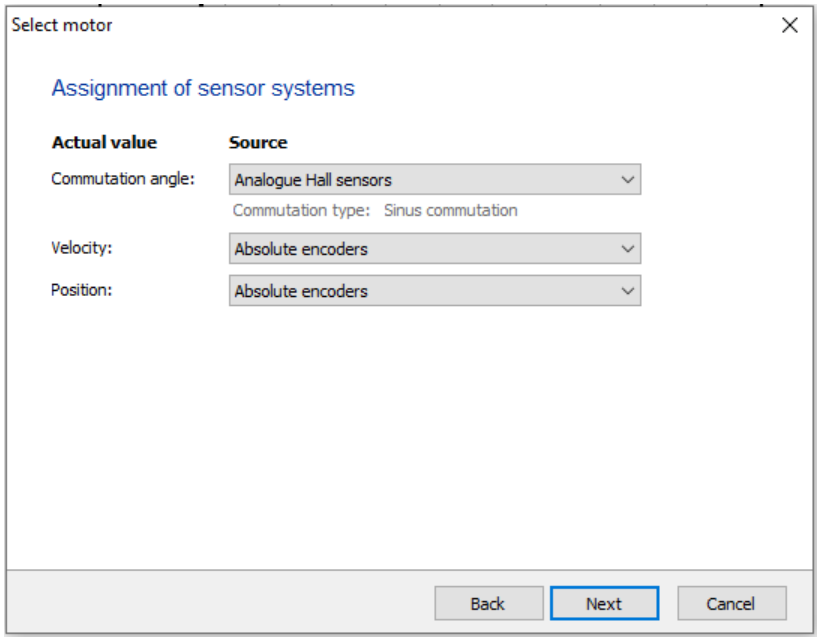
Configuration example (1):

- **12-bit multiturn, 18-bit singleturn, SSI, gray code**
- **with a BLDC motor with linear hall sensors**



Motor Selection Wizard

Absolute Encoder as **source** for position actual value and velocity actual value, commutation via analog hall sensors:

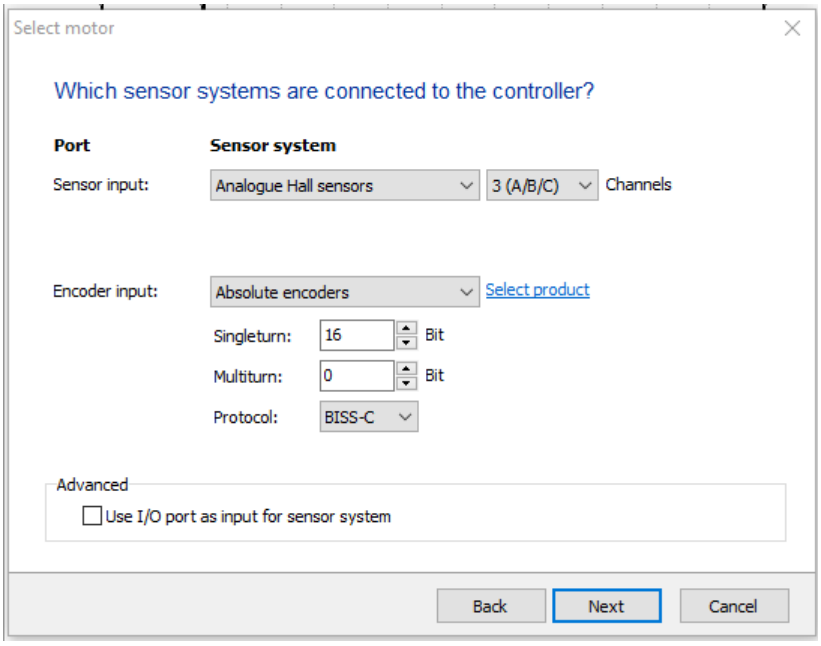


Motor Selection Wizard

To complete the configuration, make sure to perform a reset after saving the configuration.
This is done by tipping “reset” into the terminal window or doing a power cycle.

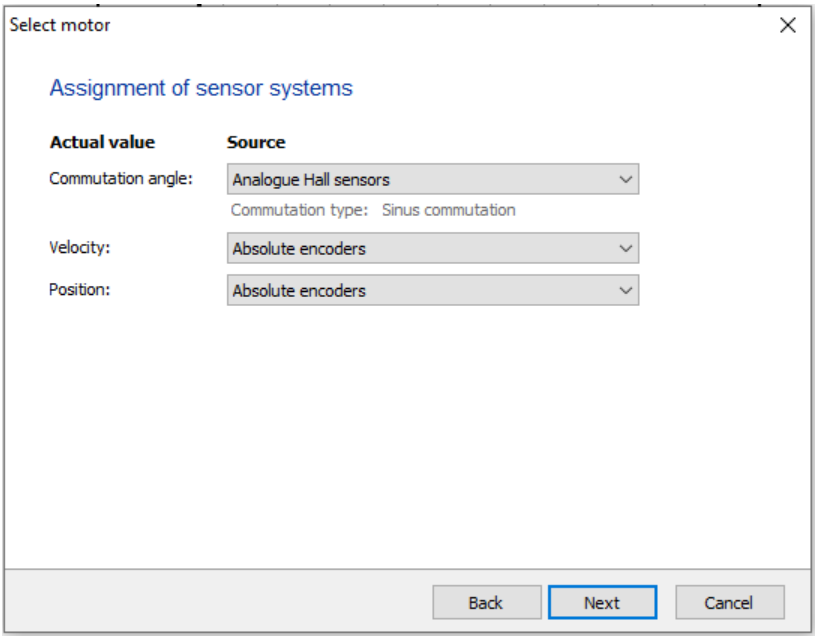
Configuration example (2):

- **16-bit singleturn, BiSS-C**
- **with a BLDC motor with linear hall sensors**



Motor Selection Wizard

Absolute Encoder as **source** for position actual value, velocity actual value and commutation via analog hall sensors:



Motor Selection Wizard

To complete the configuration, make sure to perform a reset after saving the configuration.
This is done by tipping “reset” into the terminal window or doing a power cycle.

Direction of Rotation:

If the motor turns **clockwise** (looking onto the shaft)

- the velocity actual value has to be **positive** and
- the position actual value must **increase**

If these values are not consistent, the system will run away when activated. So, consistency should be checked turning the motor manually or in voltage mode, only.

Examples of setups which might cause an inconsistency:

- A motor with hall sensors and absolute encoder is mounted on the same shaft facing each other (one running clockwise, the other one counterclockwise).
- Absolute encoder mounted on the load-side of a gearbox which inverts the direction of rotation of the shaft.

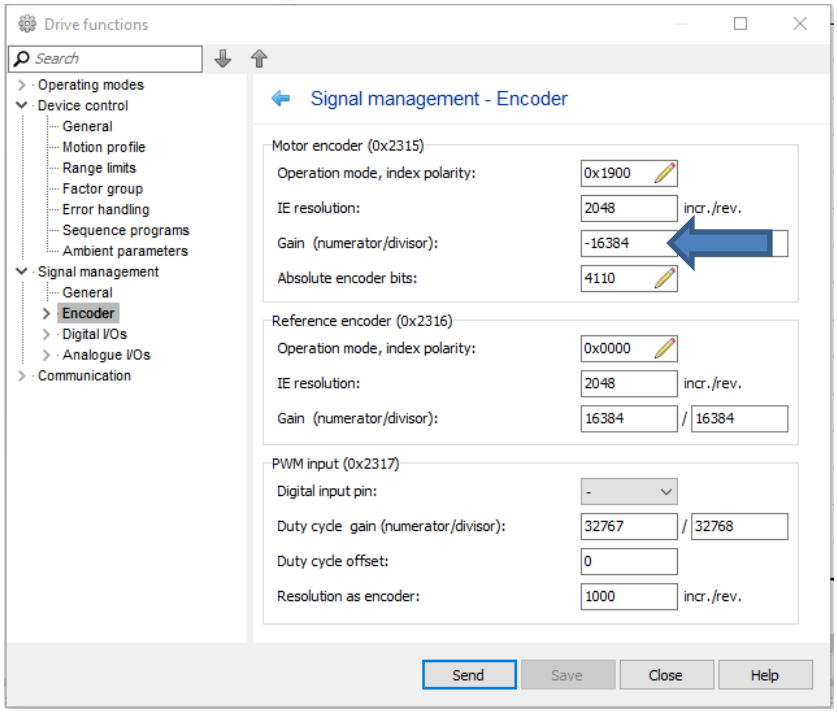
To correct any inconsistency check if the used absolute encoder provides the option to:

- Modify the "**Direction of rotation**". This is the recommended way to proceed.

If the encoder does not provide this option, use:

- Object 2315.04 and add a negative sign (-) to the gain value
- Afterwards the settings must be sent and saved.
- Then a **reset** is mandatory! Tipping reset into the terminal window or do a power cycle.

If no reset is performed the position value will be incorrect and will be lost at next power down, even if a multiturn encoder is used.



Drive functions / Signal management / Encoder

Application range - Position actual values

Singleturn encoders:

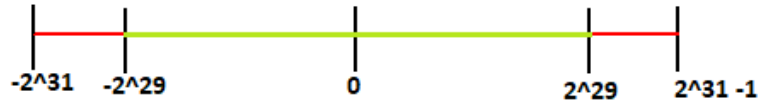
Position will **not** roll over at max / min value of the encoder – but position will be lost after (power) reset, if more than one turn was used for the actual position.

Multiturn encoders:

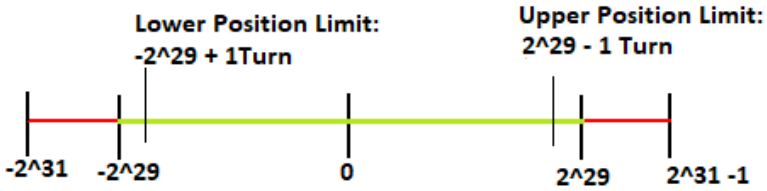
The position would **roll over** at the max / min value, which is to be prevented under all circumstances.

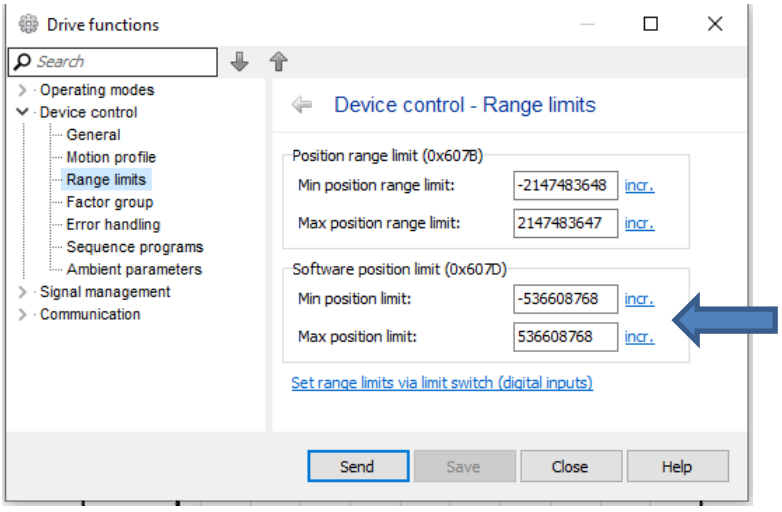
By default, the data is interpreted as signed.

Referring to example 1 - total number of 30 bits



To prevent an accidental rollover of the position, Software Position Limits (object 607D) are set by default.





Drive functions / Device Control / Range limits

Linear absolute encoder as position encoder

Linear absolute encoders require some additional configuration when used as position encoder while the speed loop is closed via a motor sensor.
The position controller needs to know how many bits there are in one magnetic pitch, respectively in one spindle pitch.

Usage of object 0x2319 reduction ratio:
In below examples 3a and 3b the object reduction ratio is used to map a fraction of the total linear absolute encoder resolution to 1 magnetic pitch, respectively to 1 spindle pitch.

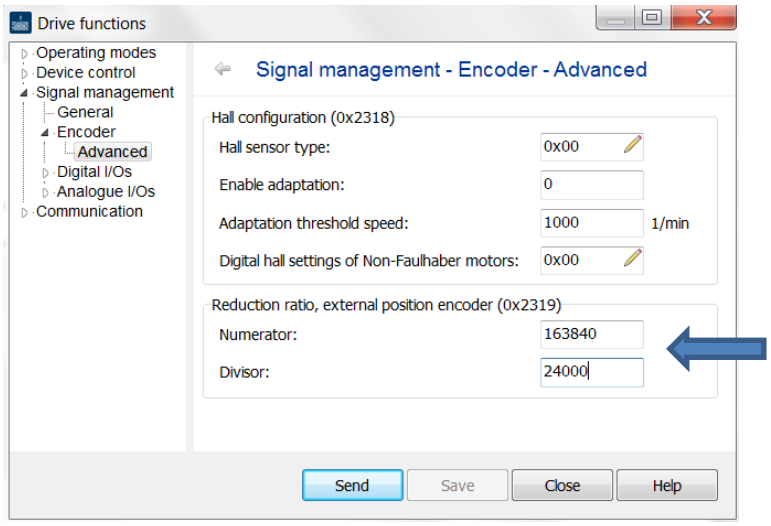
No position tuning should be performed before the reduction ratio is set correctly, since the reduction ratio affects the feedback control parameter Kv.

Examples:

- **Total Measuring Length: 163.84 mm, digital interface: # of singleturn bits = 16**

  (3a) Linear Servomotor: magnetic pitch = 24 mm

  - Configuration of the digital interface see configuration example 2 on page 9
  - Reduction ratio object:
    2319.01 = Total measuring length in µm = 163840
    2319.02 = Magnetic pitch in µm = 24000



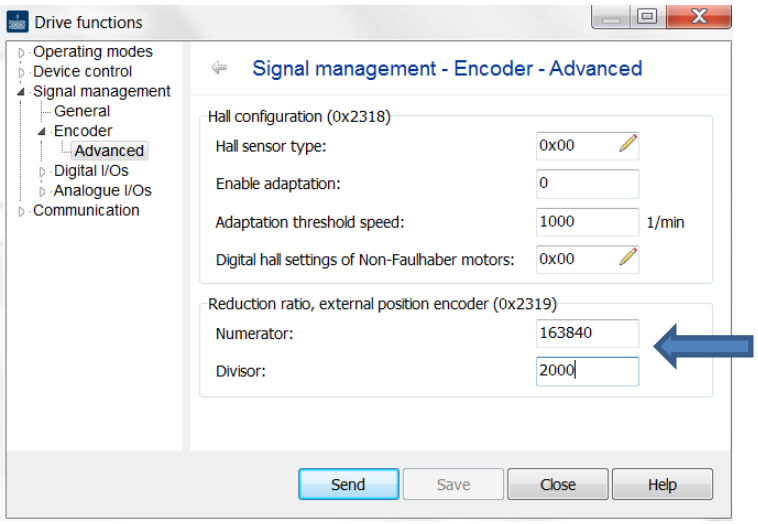
Drive functions / Signal management / Encoder / Advanced

(3b) Direct Drive with spindle: pitch 2 mm (= 1 Motor turn)

- Configuration of the digital interface see configuration example 2 on page 9
- Reduction ratio object 2319.01

  2319.01 = Total measuring length in µm = 163840

  2319.02 = Spindle pitch in µm = 2000



Drive functions / Signal management / Encoder / Advanced

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