LA11 and Artos absolute encoders
Connection to different controllers

Abstract: Setting the controller parameters to correctly process the data received from the encoder system is essential for correct operation. This document describes the most common controllers and their parameters in order to correctly interpret the data frames of the LA11 and Artos encoders. The document also contains examples based on the part numbering of the encoder system.

The LA11 and Artos are linear absolute systems and are often used as primary feedback devices in closed loop systems. Artos also supports a partial arc reading where the scale is installed on the shaft with a partial arc movement.

Related products

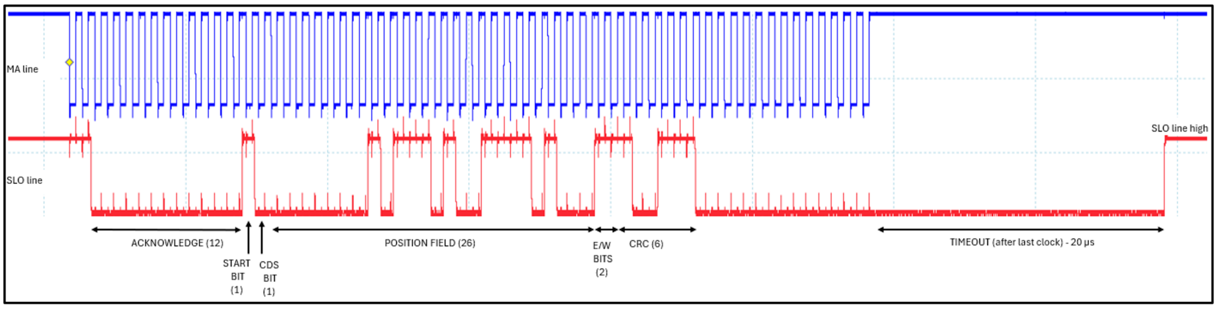
LA11 linear absolute magnetic encoder

Artos linear or rotary absolute magnetic encoder

LA11 data frame

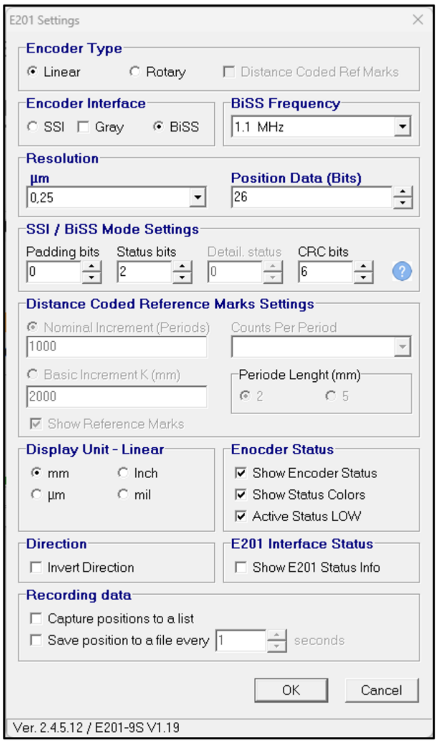
BiSS C

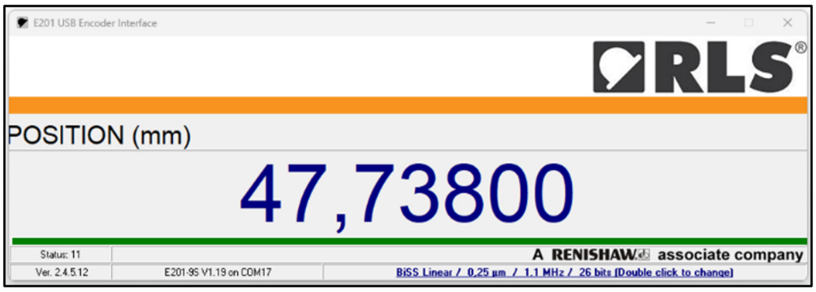
The oscilloscope capture below shows a BiSS C data frame. Communication takes place between the LA11 readhead and the E201-9S interface module, which functions as the master. The specific part number of the LA11 readhead is LA11DCA2D0KA10DA00, supporting BiSS C protocol with a 1 µm resolution. The encoder's absolute position at the time of capture is 47.738 mm.



Communication settings

The resolution is set at 0.25 µm due to the fixed position of the position field. With a resolution of 1 µm, only 24 position bits are active, so that 2 bits are unused and are set to zero. To simplify the setup, the length of the position field is set to 26 bits and the resolution of the LSB is reduced accordingly to 0.25 µm. BiSS C always has 2 status bits and a 6-bit CRC (0x43 – set by default). The status bits are active low, i.e. if an error or a warning is triggered, the bits switch to the logical zero.

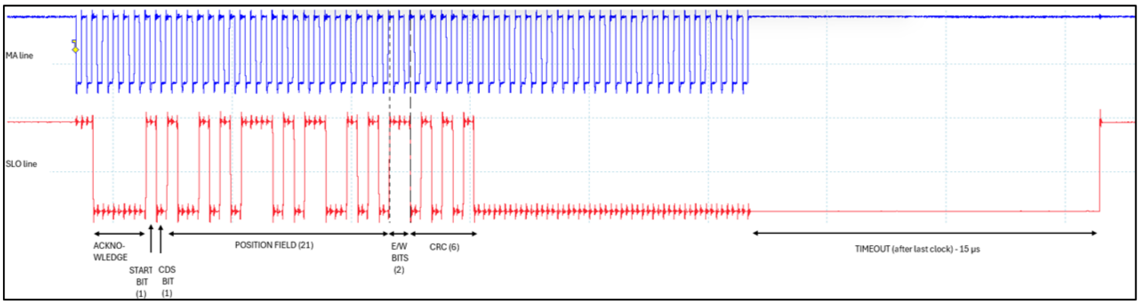




Artos data frame (DHR, DHL, DBR, DBL)

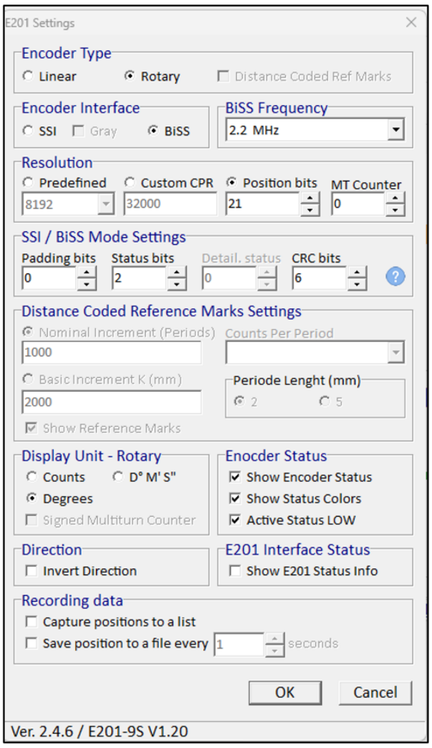
BiSS C (DHR - Rotary absolute system)

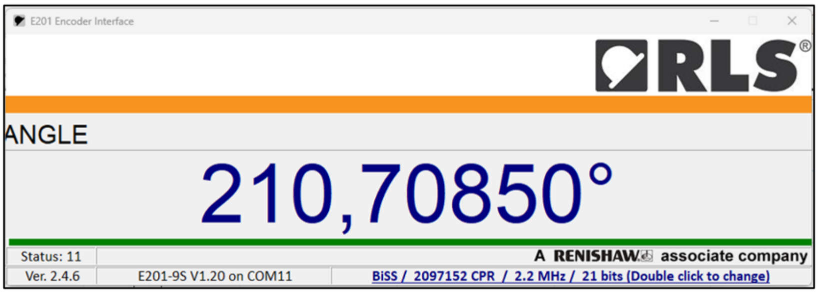
The oscilloscope capture below displays a BiSS C data frame. Communication takes place between the Artos readhead (DHR series) and the E201-9S interface, which functions as the master. The part number of the readhead is DHR114DC21BAAS10DA00, supporting BiSS C protocol with a 21-bit resolution and is compatible with the SAR114 ring. At the moment of capture, the encoder reports an absolute position of 210.70850°.



Communication settings

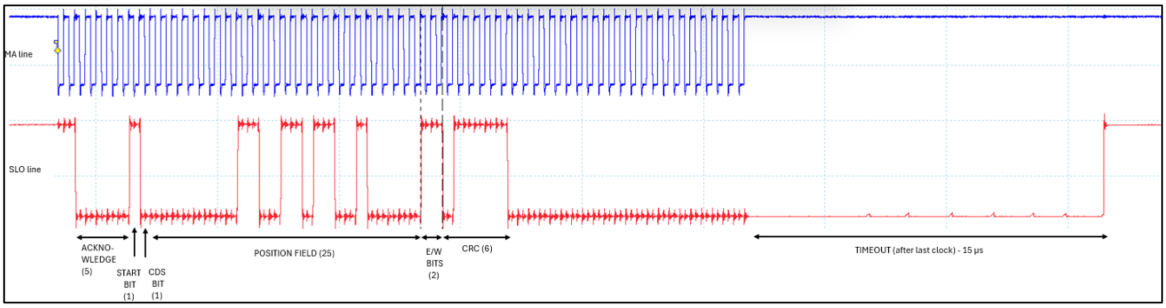
The resolution is set to 21 bits. BiSS C always has 2 status bits and a 6-bit CRC (0x43 – set by default). The status bits are active low, i.e. if an error or a warning is triggered, the bits switch to the logical zero.





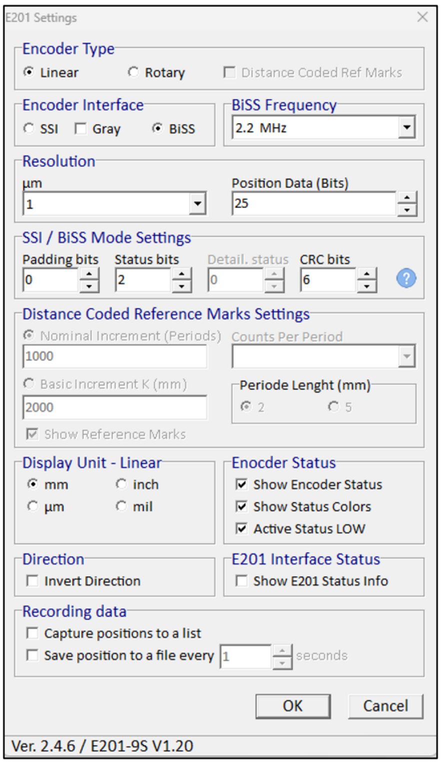
BiSS C (DHL - Linear absolute system)

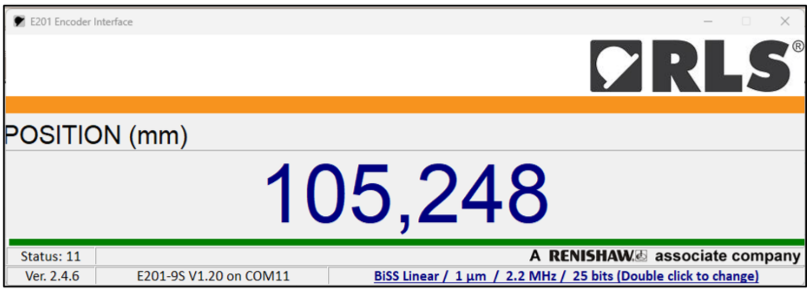
The oscilloscope capture below displays a BiSS C data frame. Communication takes place between the Artos readhead (DHL series) and the E201-9S interface, which functions as the master. The part number of the readhead is DHL001DC001AAS10DA00, supporting BiSS C protocol with with a 1 µm resolution and is compatible with the linear magnetic absolute scale DS19. At the moment of capture, the encoder reports an absolute position is 105.248 mm.



Communication settings

The resolution is set to 1 µm. Unlike the LA11 BiSS C data frame, the Artos data frame is right-aligned, meaning it contains no padding bits. In the BiSS C protocol, the data frame always includes two status bits and a 6-bit CRC, with the default polynomial set to 0x43. The status bits are active-low—they switch to a logical zero state in the presence of an error or warning condition.

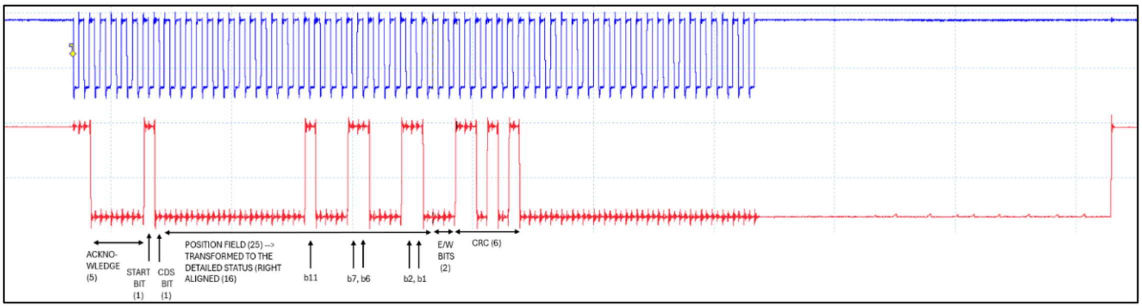




General note on BiSS C and SSI communication (valid for Artos system)

In case of an error, the position field is replaced by the detailed status field described in the table on pages 13 and 14 of the **Artos data sheet (DRD01)**.

The plot below shows the detailed status in the position field. The readhead is in an error state. The detailed status shows that bits b1, b2, b6, b7 and b11 are active. The table shows that these are decoding and signal lost errors. They indicate the misalignment between the magnetic scale and the readhead.



Controller's specifics

Binary and decimal resolutions

Some motion controllers impose limitations on the resolution setting, particularly in their support for decimal precision. In many cases, the resolution input field only accepts up to three decimal places.

For example, if the encoder's binary resolution is 0.244140625 µm, the controller may round or truncate this value to 0.244 µm, resulting in a per-step discrepancy of 0.000140625 µm (0.14 nm). Although minimal per count, this error accumulates over longer travel distances, impacting overall system accuracy.

Accumulated error example

In the following example, an encoder is configured with a 10-bit resolution corresponding to 1.953125 µm per count. However, the controller only accepts 1.953 µm, omitting the final 0.000125 µm (0.125 nm) per step due to decimal digit constraints.

Plot descriptions

Plot 1
Depicts the interpreted position over a 1,000 mm linear travel using the truncated resolution.

Plot 2
Zoomed-in view of the absolute position error over the last 5 mm of travel. The cumulative error reaches approximately 64 µm.

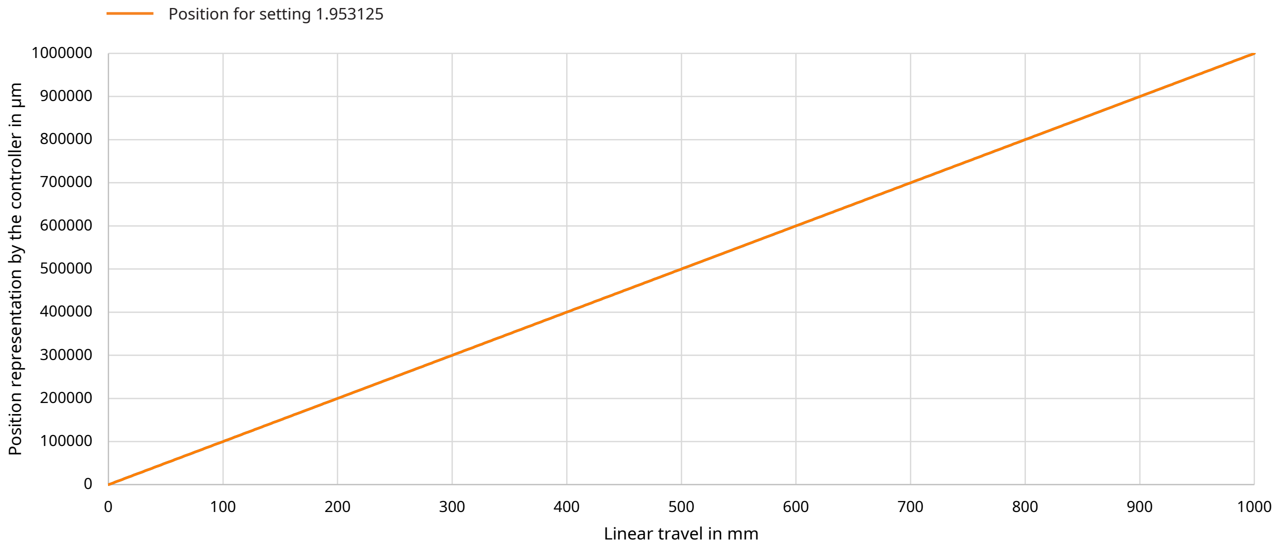
Plot 3
Shows how the position error accumulates across the full 1 m range. The error begins near zero but increases progressively, reaching ~64 µm at the end of travel.

Recommended solution

To avoid cumulative position errors caused by resolution mismatch, configure the controller with a compatible decimal resolution such as: 0.1 µm, 0.2 µm, 0.25 µm, 0.5 µm, 1 µm, 2 µm, 5 µm, or 10 µm.

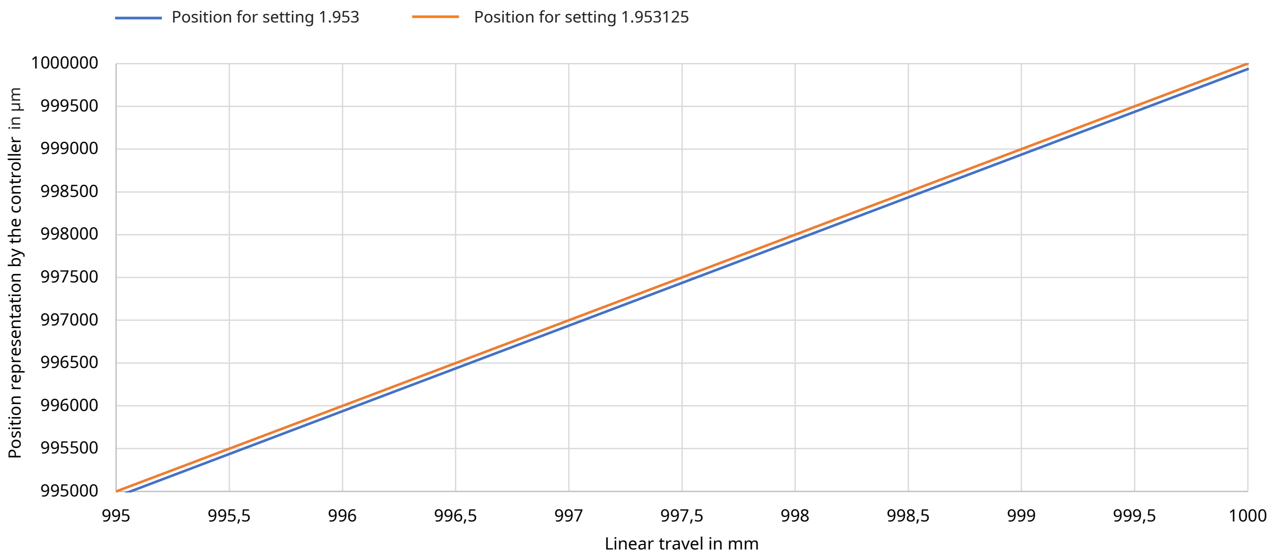
> Availability of specific resolution values depends on the encoder model (e.g., Artos or LA11). Refer to the **respective encoder datasheets** for supported settings.

Plot 1 Absolute position (the difference is small and therefore cannot be perceived visually)

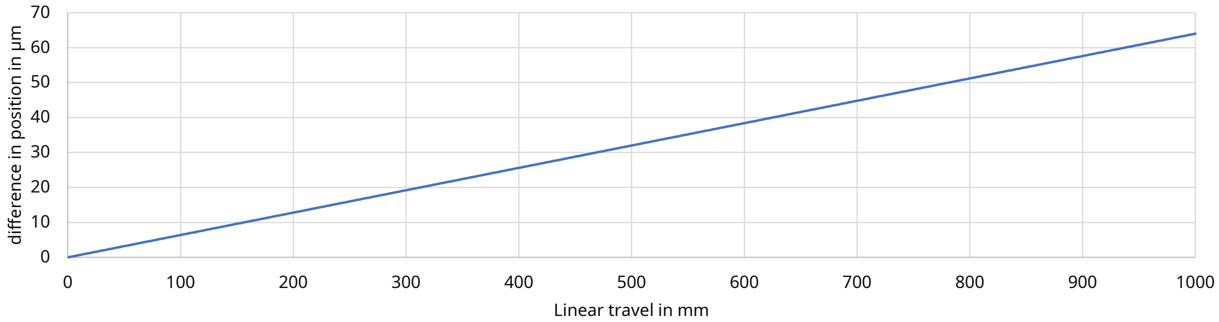


The difference is small and therefore cannot be perceived visually.

Plot 2 Positions on the plot from 995 to 1,000 mm



Plot 3 Difference in µm between real movement and captured by the controller over 1 m of travel



Clock Frequency Configuration and ACK Timing in BiSS C Systems

For proper operation, all encoder systems using synchronous communication (such as BiSS C) require the master (MA) clock frequency to fall within the specified minimum and maximum range. Incorrect clock settings may lead to communication errors or invalid CRC checks.

The LA11 encoder system supports two configurations for the maximum clock frequency, depending on the number of ACK clock periods:

- Option A: Up to 2.2 MHz (ACK = 12 clock periods)
- Option B: Up to 3.5 MHz (ACK = 20 clock periods)

The Artos encoder system supports a single configuration:

- Up to 5 MHz (ACK = 5 clock periods)

Configuring ACK timing in the controller

Different controllers interpret the ACK timing parameter differently. While the ACK length is fixed in both the LA11 and Artos encoders, some controllers require the value to be entered in microseconds (μs) rather than as a number of clock cycles.

Input data:

- MA frequency – specified by the user (e.g. 3 MHz)
- ACK length data – specified in the LA11/Artos data sheet (i.e. option B described above – 20 clock periods)

ACK time [μs] = (1/MA frequency) × ACK clock period

Example:

If the controller is configured for an MA frequency of 3 MHz, and the encoder uses 20 ACK clock periods (LA11, Option B):
ACK time = (1 / 3 MHz) × 20 = 6.7 μs

This 6.7 μs value must be entered in the controller's ACK timing or calculation delay setting. It defines the time the encoder needs to latch the position, perform internal calculations, and begin data transmission. Incorrect ACK timing will result in synchronization failure and CRC errors.

Status monitoring: Error and warning bits

Most absolute encoder systems provide status information via dedicated error and warning bits. The status bits allow the controller to verify whether the transmitted position data is valid. Typical causes of invalid data include incorrect alignment, demagnetisation of the magnetic scale, encoder failure, etc.

Setting up the error and warning bits in the controller is essential to ensure safety and correct installation.

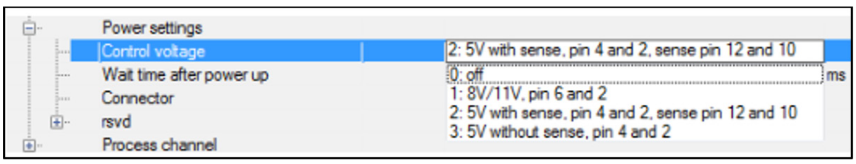
Power supply for the encoder (valid for LA11 system)

The power supply of the 5V version of the LA11 must be properly dimensioned to compensate for voltage drop over long cables. To maintain correct operation, it is essential that the read head is supplied with sufficient voltage in order to work correctly. The LA11 includes sense lines—two additional conductors that run parallel to the main power lines. These lines allow the controller to detect voltage drop and adjust the supply accordingly.

If the sense lines are left unconnected or not properly isolated, they can cause a short circuit or result in permanent damage to the encoder.

When using a controller (e.g., Beckhoff interface) that supports voltage sense inputs, always follow the manufacturer's wiring recommendations. For systems without sense line support, ensure the lines are insulated or connected in parallel (GND sense to GND; Vin sense to Vin) to avoid faults.

An example from the Beckhoff interface for setting up the controller. The LA11 has an option with the sense lines.

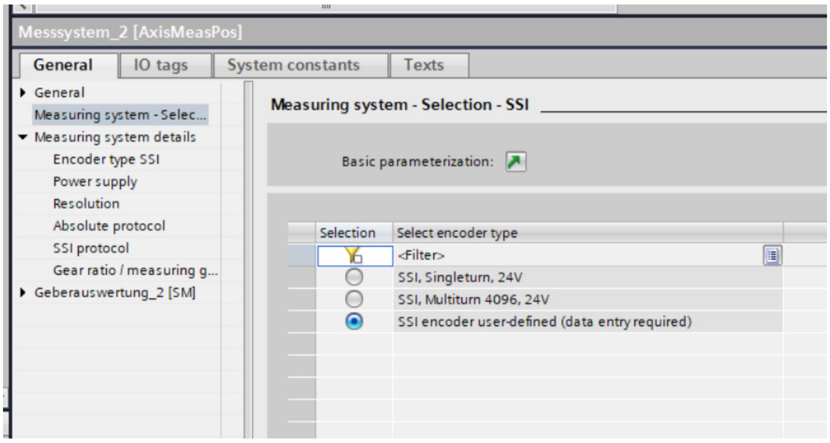


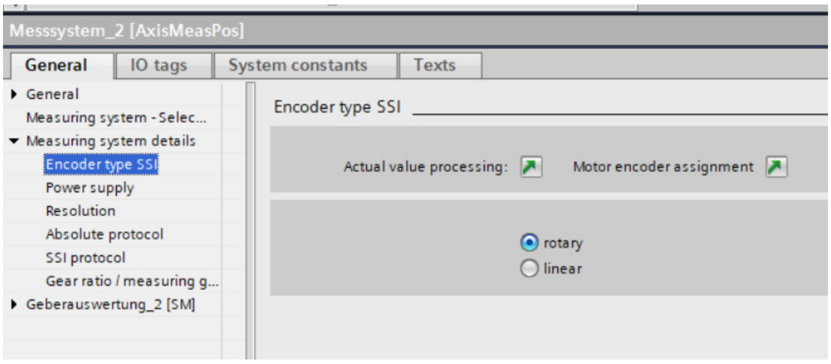
Typical encoder settings for most common controllers

Siemens Sinamics S120 + SME25 module

- Encoder system: HR162SC0IBAAS10DW00
- Interface: SSI
- Resolution: 512,000 cpr

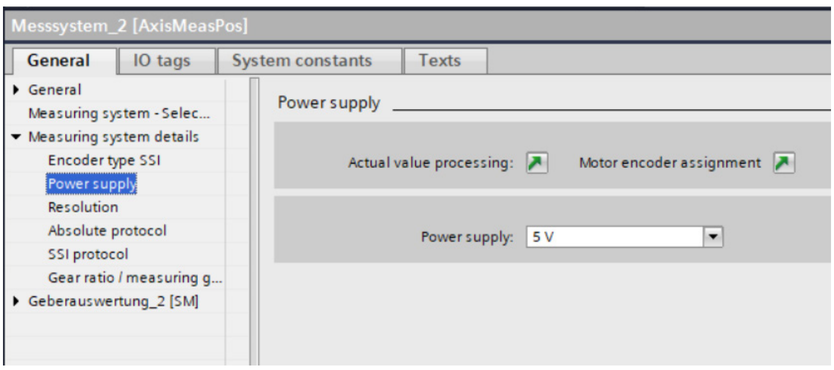
Encoder settings: Processing type and rotation





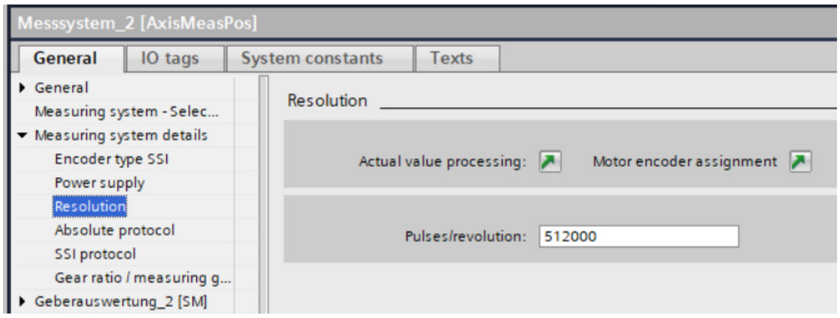
Commissioning must be performed manually due to protocol-specific requirements.

Power supply configuration



The supply voltage can be set from 5 V to 30 V. Allow for a voltage drop across the cable. It is recommended to use higher voltages to improve EMC immunity and to achieve voltage compensation when using longer cables.

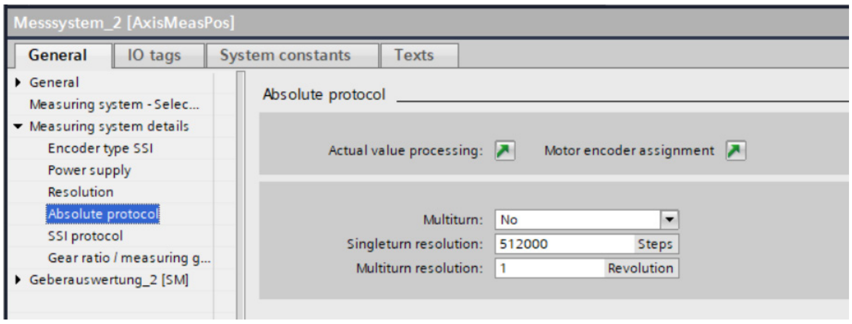
Resolution configuration



Set the encoder resolution according to the part number HR1625COIBAAS10DW00. The resolution data can be found in **the DRD01 datasheet** (see table of available resolutions for DHR readhead with SAR rings). In our case, the encoder resolution is 19 bits. This value is configured in the Resolution field under encoder settings.

Readhead	Ring size OD	Pole number	CPR (bits)	Position data length	Resolution part numbering
DHR	162	256	4,194,304 (22)	22	22B
			2,097,152 (21)	21	21B
			1,048,576 (20)	20	20B
			524,288 (19)	19	19B
			512,000	19	0IB

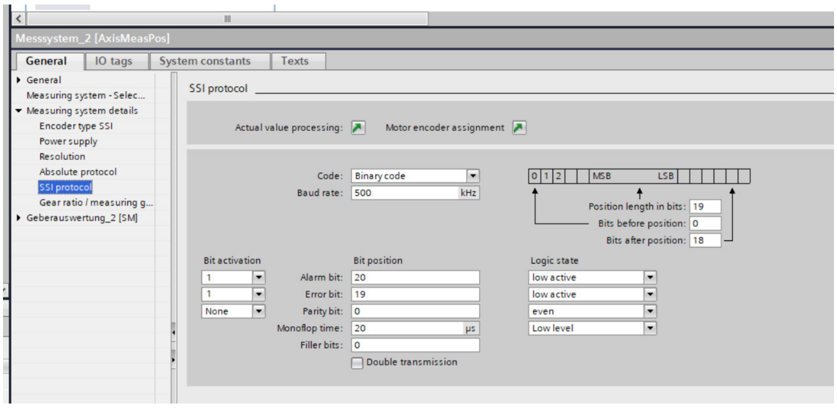
Absolute protocol configuration



Since the encoder configuration does not include a multiturn counter, the multiturn resolution is set to 1 by default.

Singleturn resolution is configured to 512,000, as defined by Siemens based on the actual encoder CPR. This matches the encoder specification and ensures accurate position feedback.

SSI protocol details



The configuration of the SSI interface for the DHR162 readhead is as follows:

- Clock frequency: Max. 500 kHz
- Position length:
  - 19 bits (position)
  - followed by 1 bit (error)
  - followed by 1 bit (warning)
- Parity bit: Not used ⟶ set to None
- Bits after position:
  - Bit 18 = 1 (error)
  - Bit 17 = 1 (warning)
  - Remaining 16 bits: detailed status (not used in Siemens configuration)

Error and warning bit logic: Active low
Monoflop time: 20 µs (line remains low during this period

Beckhoff AX5206

The controller data can be found here: **Beckhoff-BiSS information**

- Encoder system: LA11DCA2D0KA50DD00
- Interface: BiSS C
- Resolution: 1 µm (250 nm when 2 always zero bits are taken into account)

Initial encoder settings in the Beckhoff controller

- Parameter interface → 5 (for BiSS C encoders)
- Bit resolution singleturn position → 26
- Bit resolution multiturn position → 0
- Number of clock cycles to get a singleturn position or absolute position → 0
- LinearResolutionAboutDigitalInterface_Numerator_nm →250 nm

BiSS C mode settings

- Sensor mode: Data description

Value	Description
0	MSB first, left aligned, multiposition-singleposition-status-crc-mcd
1	MSB first, right aligned, multiposition-singleposition-status-crc-mcd

- Sensor mode: Number of status bits→ 2
- Sensor mode: Number of additional data bits → 0
- Sensor mode: Number of CRC bits → 67 (decimal); 43 (hexadecimal)
- Sensor mode: Number of CRC polynomials → 6
- Sensor mode: Inverted CRC → 1
- Mcd: Not supported by the LA11 system hence the values associated with the Mcd mode are irrelevant and set to zero
- Sensor mode: timeout time in µs → 20 µs
- Sensor mode: Min clock speed in kHz → 50
- Sensor mode: Max clock speed in kHz → 2200; (LA11DCA)
- Sensor mode: Max calculation time in µs→ 5.45 µs; (12 ACK bits, max clock freq. 2200 kHz)
- Register mode: The LA11 system doesn't have access to the register mode hence, the values associated with register mode are set to zero.
- Position calculation time encoder in µs → 5.45 µs; (12 ACK bits, max clock freq. 2200 kHz)

Due to internal controller processing time, an additional 3–5 µs must be added to the measured value.

BiSS		
Sensor mode: Data description	Msb first, right aligned, m	Msb first, right aligne
Sensor mode: Number of status bits	2	2
Sensor mode: Number of additional data bits	0	0
Sensor mode: Number of CRC bits	6	6
Sensor mode: CRC polynomial	67	67
Sensor mode: Inverted CRC	1	1
Mcd: Type	No type (0)	No type (0)
Mcd: Complete number of data bits	0	0
Mcd: Complete number of CRC bits	0	0
Mcd: CRC polynomial	0	0
Mcd: Inverted CRC	0	0
Sensor mode: Timeout time	20 us	20 us
Sensor mode: Min. clock speed	50 kHz	50 kHz
Sensor mode: Max. clock speed	2000 kHz	2000 kHz
Sensor mode: Max calculation time	5.45 us	5.45 us
Register mode: Timeout time	0 us	0 us
Register mode: Min. clock speed	0 kHz	0 kHz
Register mode: Max. clock speed	0 kHz	0 kHz
Register mode: Max. write time	0 ms	0 ms
Register description version number	0	0
OEM: Bank number	0	0
OEM: Startaddress	0	0
OEM: Length in byte	0	0
Multi slave support	0	0
Pretrigger time encoder to sync	0 us	0 us
Position calculation time encoder	8.00 us	5.45 us

The Beckhoff controller offers a parameter "Measured calculation time". This is the value the controller measures based on the encoder system. Add an additional 3 to 5 µs to this value.

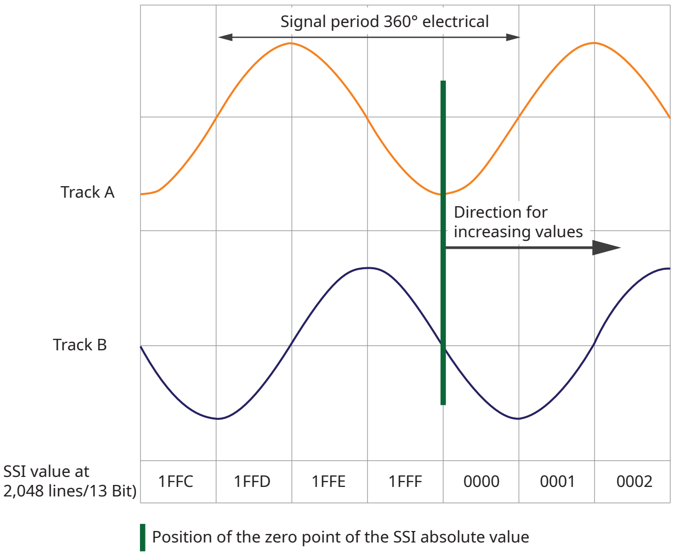
0x32E2:03	Measured calculation time	1.2E-06 s	0 s

LA11 with sin/cos output compatibility

The LA11 supports dual-channel output, providing both an absolute signal and either a sin/cos or an incremental AB signal simultaneously. For applications with high dynamic sensitivity, certain controllers support dual-channel communication. Below you will find compatibility notes for three controllers: Siemens, Beckhoff, and Kollmorgen.

Siemens requirement and LA11 compatibility

The diagram below illustrates the relationship between the sin/cos signals and the corresponding absolute channel values (bottom values). This requirement makes the LA11 incompatible with Siemens controllers as the LA11 cannot control the phase - it varies between products. The LA11 is compatible with Siemens controllers only over the SSI absolute channel and quadrature A and B RS422.



Beckhoff and Kollmorgen requirements and LA11 compatibility

Beckhoff and Kollmorgen controllers do not have the above-mentioned phase synchronisation requirement. The LA11 is therefore fully compatible with both controllers.

Head office

RLS Merilna tehnika d.o.o.

Poslovna cona Žeje pri Komendi
Pod vrbami 2
SI-1218 Komenda
Slovenia

T +386 1 5272100
E mail@rls.si

www.rls.si

Global support

Visit our **website** to contact your nearest sales representative.

Document issues

Issue	Date	Page	Description
1	2. 4. 2025	-	New document
2	30. 7. 2025	2, 8	Note added, communication settings amended
3	13. 8. 2025	11	LA11 with sin/cos output compatibility