LinACE™

InAxis Linear Absolute Magnetic Shaft Encoder

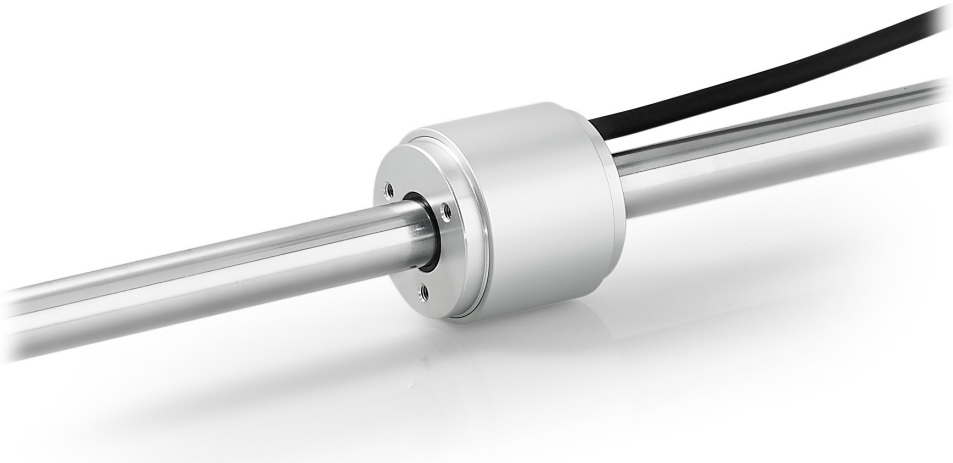
TRUE ABSOLUTE SYSTEM

ACCURACY UP TO ±5 µm

INTEGRAL BEARINGS

LinACE™ is an extremely robust absolute linear cylindrical encoder system designed to be integrated into the servomechanism as a transducer, providing accurate measurements with excellent resolution and repeatability. It can be used as a control device or integrated directly into hydraulic, pneumatic, electromechanical actuators and linear motors as a position or velocity feedback element.

The encoders are available in asynchronous serial over RS422, PWM, SSI and BiSS C output versions and offer a range of selectable resolutions from 10 µm to 0.5 µm with speeds up to 5 m/s. The position of the encoder is maintained even if the shaft rotates during forward and backward movement.



Features and benefits

- True absolute system
- Resolutions up to 0.5 µm
- Measuring lengths up to 450 mm
- Built-in self monitoring
- Excellent resistance to stray magnetic fields
- Non-magnetised hard chrome plated coded shaft
- Suitable for highly dynamic control loops
- Small footprint

MACHINE TOOL | INDUSTRIAL AUTOMATION | MEDICAL | PROCESS AND CONTROL | SERVO MECHANISMS

General information

The LinACE encoder system consists of a sliding encoder readhead and a coded solid steel shaft that serves as the measuring standard.

By replacing the main actuator shaft or one of the guide shafts with a LinACE coded, hard chrome plated shaft, the encoder becomes part of the actuator and enables measurements in the motion axis. The readhead can replace the existing sliding bearing, eliminating the need for an external encoder and reducing the space required.

The LinACE encoder has a built-in advanced self-monitoring function that continuously checks several internal parameters. Error reports, warnings and other status signals are available on all digital interfaces.

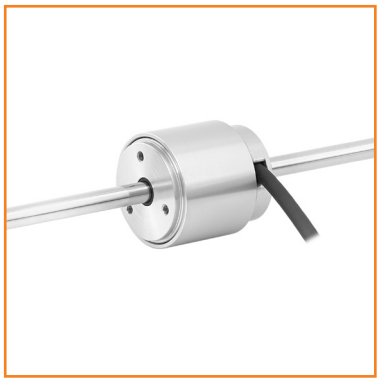
The encoder has excellent resistance to external magnetic fields, operates at temperatures from –30 °C to +105 °C and is resistant to shock and vibration. The position of the encoder is maintained even if the shaft rotates during forward and backward movement.

A custom design service for OEM integration is also available.

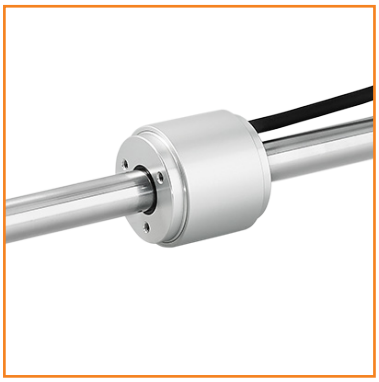
The maximum measuring length is 450 mm.

Versions of LinACE™ systems

With radial cable exit

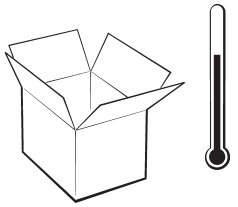


With axial cable exit



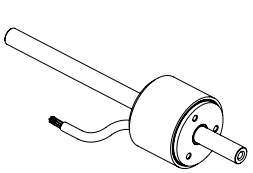
Storage and handling

Storage

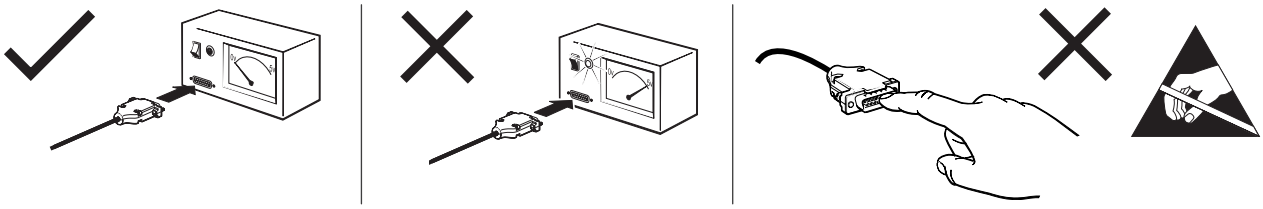


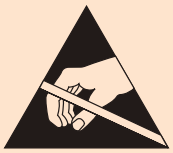
–30 °C to +105 °C
(with standard cable)

Operating



–30 °C to +105 °C
(with standard cable)





Readhead is ESD sensitive - handle with care.
Do not touch electronic circuit, wires or sensor area without proper ESD protection or outside of ESD controlled environment.

Packaging

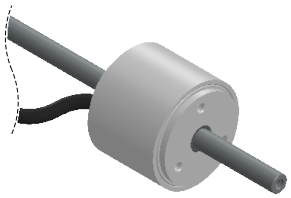
Packed individually in an antistatic bag.

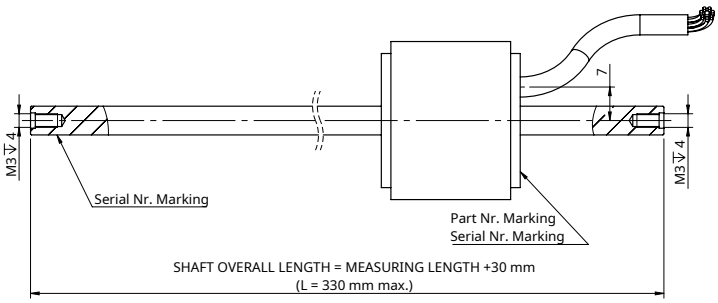
Dimensions and installation

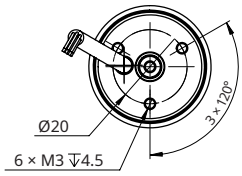
Dimensions and tolerances are in mm.

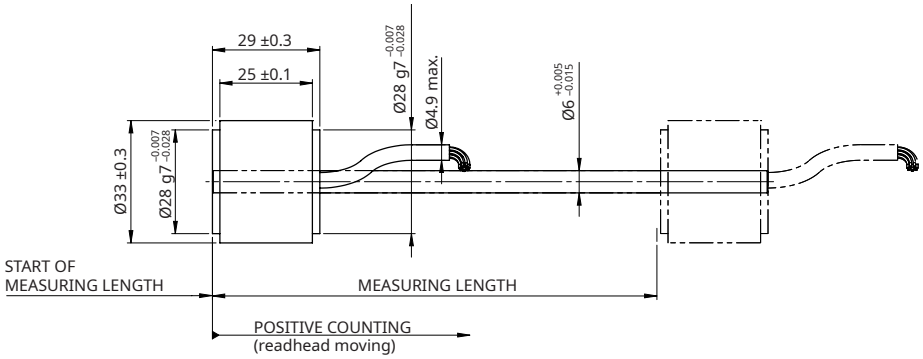
Ø6 mm shaft

Axial cable exit

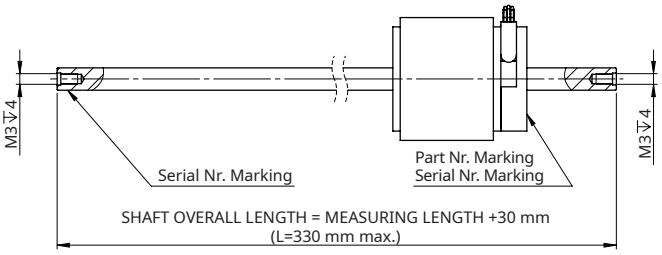


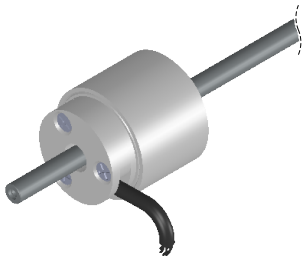


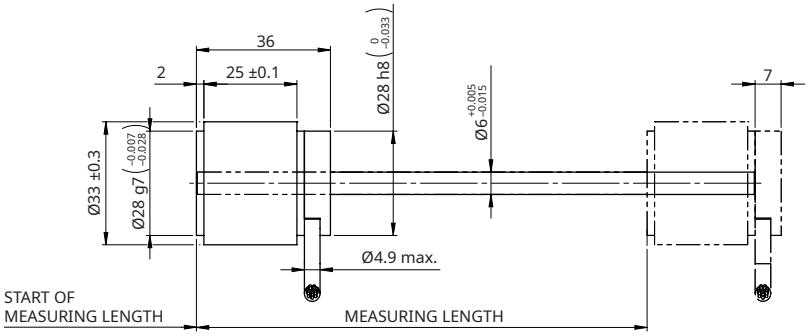


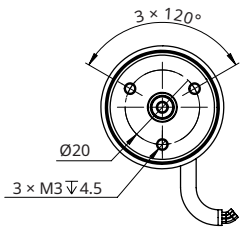


Radial cable exit





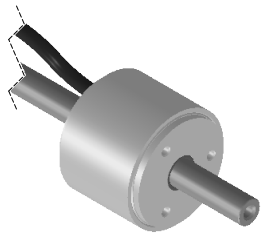


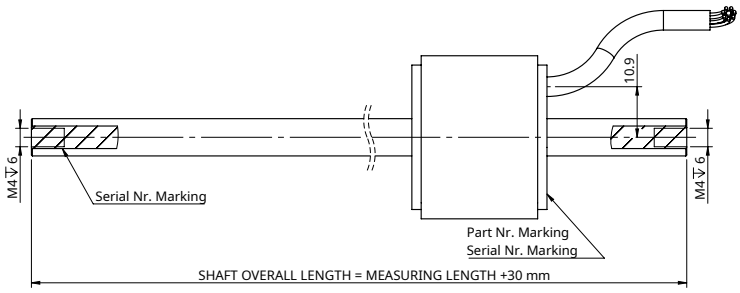


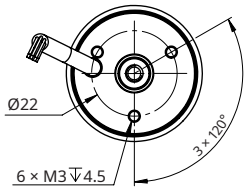
- Keep the shaft and board as matched pairs. Ser. No. must be same on the shaft and readhead.
- The shaft must be inserted with the alignment as shown in the drawing. Pay attention to the position of the serial numbers.
- Shaft/readhead fit: +0.045 / +0.010.
- The encoder shaft can be rotated independently of the linear travel.
- Use an installation kit if the mounting surfaces are not perfectly parallel (see Appendix on page 21).

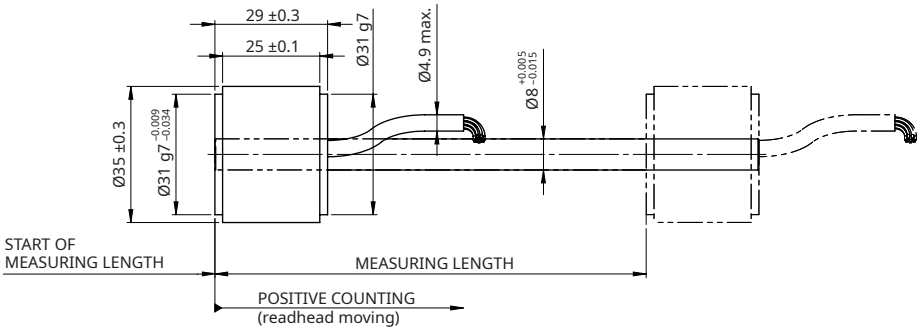
Ø8 mm shaft

Axial cable exit

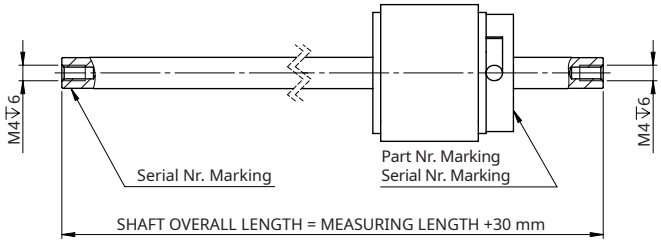


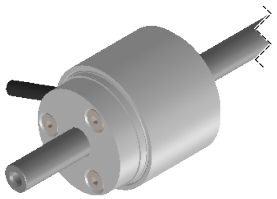


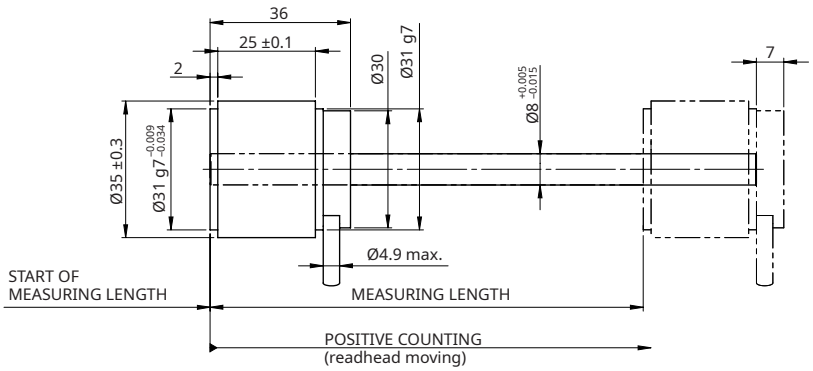


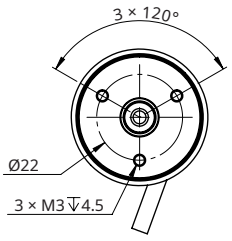


Radial cable exit









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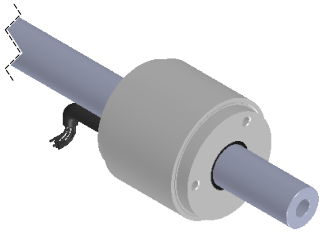
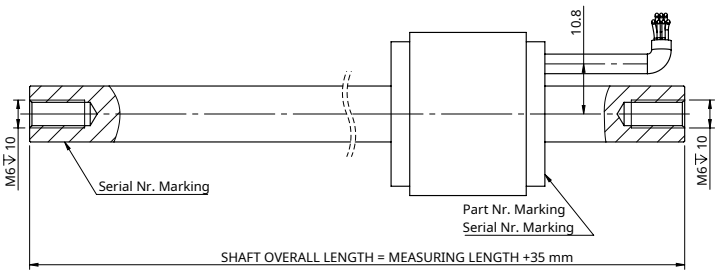
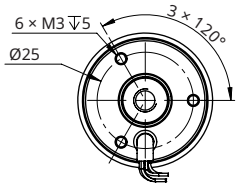
- The shaft must be inserted with the alignment as shown in the drawing. Pay attention to the position of the serial numbers.
- Shaft/readhead fit: +0.045 / +0.010.
- The encoder shaft can be rotated independently of the linear travel.
- Use an installation kit if the mounting surfaces are not perfectly parallel (see Appendix on page 21).

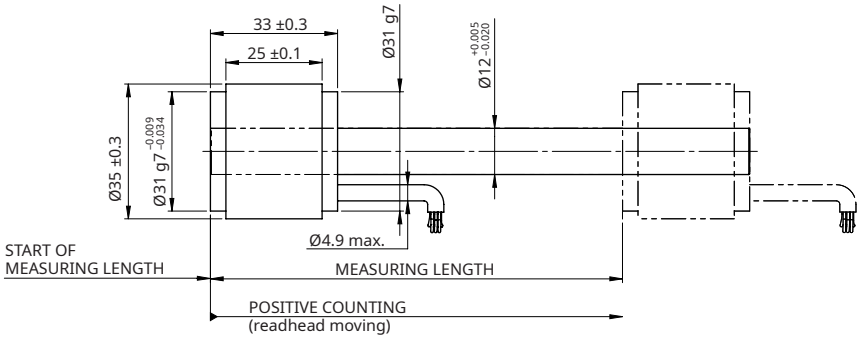
Ø12 mm shaft

Axial cable exit

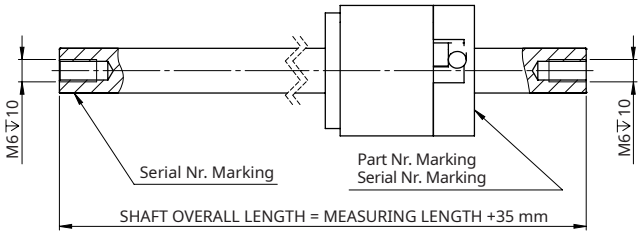


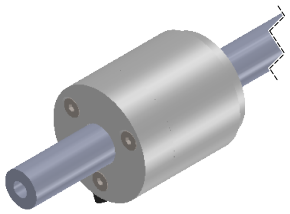


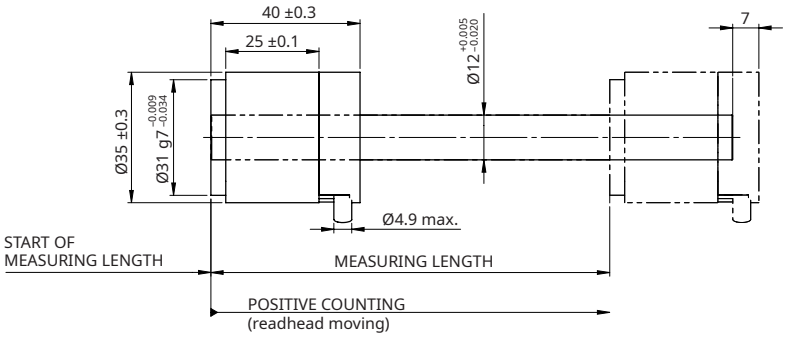


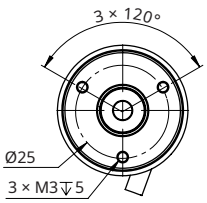


Radial cable exit









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- The shaft must be inserted with the alignment as shown in the drawing. Pay attention to the position of the serial numbers.
- Shaft/readhead fit: +0.045 / +0.010.
- The encoder shaft can be rotated independently of the linear travel.
- Use an installation kit if the mounting surfaces are not perfectly parallel (see Appendix on page 21).

Technical specifications

System data

Maximum measuring length	450 mm
Shaft diameter	6 mm, 8 mm or 12 mm
Shaft linear expansion coefficient	~11 × 10^{-6}/K
Maximum speed	5 m/s
Resolution *	0.5 µm, 1 µm, 5 µm, 10 µm
System accuracy	±5 µm – only available for Ø6 mm shaft diameter for measuring lengths up to 100 mm ±10 µm, ±25 µm, ±50 µm, ±100 µm – for measuring lengths up to 450 mm
Hysteresis	Less than unit of resolution (without mechanical assembly influence)
Repeatability	Less than unit of resolution

* See page 10 for PWM output resolutions.

Electrical data

Supply voltage	4.5 V to 5.5 V – voltage on readhead. Consider voltage drop over cable (see page 8).	
Set-up time	200 ms (after switch-on)	
Current consumption	Typ. 100 mA, max. 120 mA (without output load)	
Output load	RS422	±40 mA
	PWM	5 mA (LVTTL logic level)
Voltage drop over cable	~ 55 mV/m (without output load)	
ESD protection	ESD IEC 61000-4-2, Level 2	
	PWM output: HBM, Class 2, max. 2 kV (on connection side)	

Mechanical data

Material	Shaft	Carbon steel, 30 µm to 40 µm Hard chrome coating 800 HV to 1100 HV (except end surfaces and threaded holes)
	Readhead housing	Aluminium 6082; anodized 10-15 µm (except threaded holes)
	Linear bushings	PEEK CA30; High performance polymer reinforced with carbon fibers
Mass	Shaft	Ø6 mm: 22 g / 100 mm; Ø8 mm: 39 g / 100 mm; Ø12 mm: 90 g / 100 mm
	Readhead	Ø6 mm: 45 g (axial cable exit), 55 g (radial cable exit) Ø8 mm: 51 g (axial cable exit), 62 g (radial cable exit) Ø12 mm: 55 g (axial cable exit), 66 g (radial cable exit) High flex cable: 34 g / m; Standard cable: 37.5 g / m

Environmental data

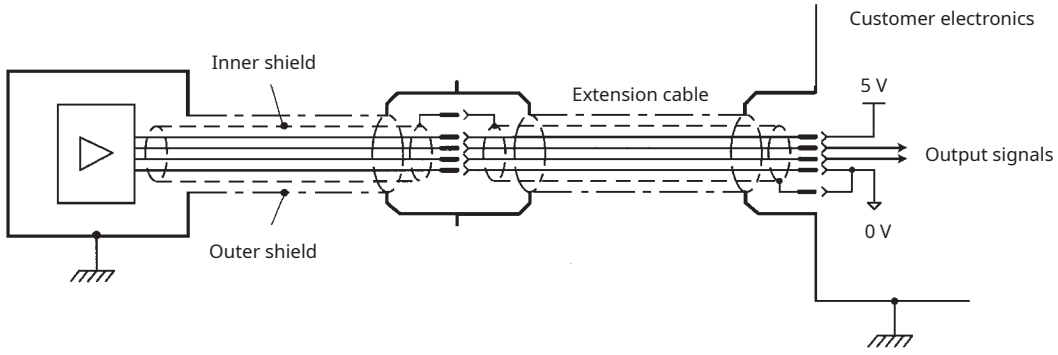
Temperature	Operating	–30 °C to +105 °C (high flex cable: –20 °C to +80 °C)
	Storage	–30 °C to +105 °C (high flex cable: –20 °C to +80 °C)
Humidity		Up to 70 % non-condensing
Environmental sealing		IP40 (according to IEC 60529)
Stray magnetic fields		Readhead max. 100 mT. Stray magnetic fields bigger than 100 mT may result in wrong position reading. Coded shaft is insensitive to stray magnetic fields.
Small particles with high permeability (eg. steel dust)		Not permitted
Shock		100 G (6 ms, half-sine, EN 60068-2-27:2009)
Vibration		40 G (55 Hz - 2000 Hz, EN 60068-2-6:2008)

Electrical connections

Cable

Type	**Standard cable**	**High flex cable (axial cable exit only)**
Outer diameter	4.7 ±0.2 mm	4.2 ±0.2 mm
Jacket material	PUR type ESTANE 58888; Loose Extrusion	Extruded polyurethane (PUR)
Wires	0.65 ±0.1 mm diameter, 28 AWG, 19 × 0.08 mm, 0.23 Ω/m	White wire: 0.9 ±0.07 mm diameter, 26 AWG (19 strands REF 6), 0.13 Ω/m Other wires: 0.6 ±0.07 mm diameter, 30 AWG (7 strands REF 6), 0.35 Ω/m
Durability	/	20 million cycles at 20 mm bend radius
Bend radius	Static 40 mm (internal radius)	Dynamic 25 mm, static 10 mm (internal radius)
Temperature range (cable only)	–30 °C to +120 °C	–20 °C to +80 °C
Mass	37.5 g/m	34 g/m

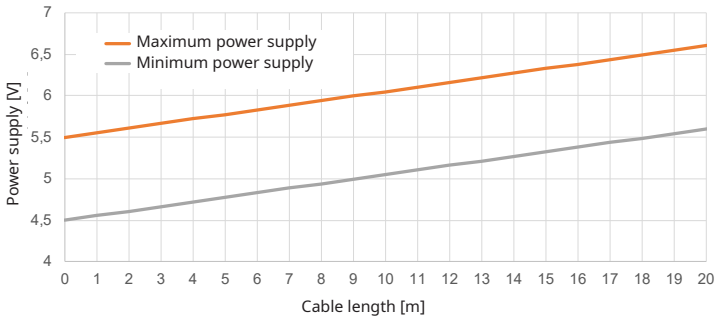
Output cables may require strain relief. Always provide strain relief for cable lengths > 0.5 m.



Housing is electrically connected to the outer shield of the cable.

Voltage drop over cable

For cables longer than 5 meters input voltage on the cable must be adjusted so the voltage drop is taken into account.
Voltage drop over cable ~55 mV/m – without output load:



Connector and flying leads options

9 pin D type plug (options A and B) 	Wire colour	Asynchronous serial RS422	PWM	SSI	BiSS C
Housing	Outer shield	Encoder / machine case (Earth connection)			
1	Inner shield	0 V (GND)	0 V (GND)	0 V (GND)	0 V (GND)
2	Red	RX command in+	–	Clock+	MA+
3	Blue	RX command in–	–	Clock–	MA–
4	Grey	–	Status	–	–
5	Brown	5 V supply	5 V supply	5 V supply	5 V supply
6	Green	TX data out+	–	Data+	SLO+
7	Yellow	TX data out–	–	Data–	SLO–
8	Pink	–	PWM out	–	–
9	White	0 V (GND)	0 V (GND)	0 V (GND)	0 V (GND)

Voltage difference between Ground (white wire and inner shield) and encoder housing (outer shield) should not exceed 10 V_{pp}.

Communication interfaces

Asynchronous serial RS422 (UART)

Baud rate	115.2 kbps, 256 kbps, 1 Mbps
Data format	8 bits, no parity, 1 stop bit
Update rate	On demand or continuous
Resolutions	0.5 µm, 1 µm, 5 µm, 10 µm
Latency	250 µs

PWM

Base frequency	122.07 Hz
Update rate	Same as base frequency
Output resolution	16 bits
Resolutions	1 µm/step at up to 50 mm measuring length 5 µm/step at up to 300 mm measuring length 10 µm/step at up to 450 mm measuring length
Latency	250 µs

SSI *

Data format	Binary
Clock frequency	50 kHz to 500 kHz (2.5 MHz**)
Update rate	4 kHz
Resolutions	0.5 µm, 1 µm, 5 µm, 10 µm
Latency	250 µs to 500 µs
Timeout (monoflop time)	20 µs

BiSS C

Maximum clock frequency	5 MHz
Maximum request rate	30 kHz
Bandwidth	2 kHz max.
Resolutions	0.5 µm, 1 µm, 5 µm, 10 µm
Latency	<10 µs
Timeout (monoflop time)	20 µs

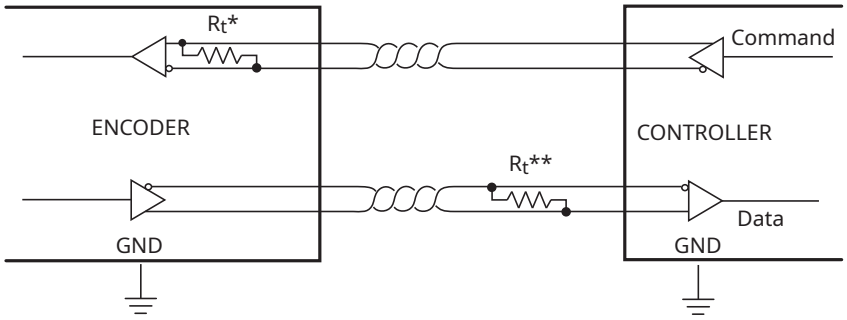
* Slave type interfaces might not be suitable for high-speed closed control loops because of the variable latency time.
** With *Delay First Clock* function on the controller.

Asynchronous serial communication interface (UART) over RS422

SF output type

Encoder identification and position data are available via the request-response type of communication through the asynchronous serial link. There are two unidirectional communication channels that form a bidirectional full duplex data link. Each channel consists of a two-wire differential twisted-pair connection that complies with the RS422 signalling standard.

Electrical connection



* The Command and Data signals are 5 V RS422 compatible differential pairs with RC termination inside the readhead.
** Termination at the controller is required if total cable length is longer than 5 m. The nominal impedance of the cable is 120 Ω. Recommended termination is 120 Ω or RC termination (120 Ω and 1 nF in series) if there is requirement for lower power consumption.

Output protection

An excessive output current and power dissipation caused by errors or bus conflicts are prevented by two mechanisms. A foldback current limit on the output stage provides immediate protection against short circuits. In addition, a thermal shutdown circuit forces the driver outputs into a high-impedance state if the chip temperature becomes too high.

Communication parameters

Link speed	115.2 kbps, 256 kbps, 1 Mbps
Character length	8 bits
Parity	None
Stop bits	1
Repetition rate	4 kHz max.
Sample rate	115.2 kbps 1.05 kHz max. 256 kbps 1.77 kHz max. 1 Mbps 3 kHz max.
Position latency	Fixed at 250 µs between the position acquisition and first start bit sent out.

Command set

Command “v” (small character “v”)

6b header (LinACE)
1b space
6b serial number
2b space
1b Firmware version major (1)
1b Firmware version minor (48)
1b Firmware version comm interface (3)
4b Firmware build number
1b sensor revision (32)
1b resolution of encoder
6b string with shaft code type

Command “1” (ASCII one)

Response - position and status, transmitted once
1 byte constant header 0xEA
4 bytes binary absolute position, big-endian, right aligned
2 bytes encoder status – see table on next page
1 byte constant footer 0xEF

The next request should not be sent sooner than 250 µs after the end of the previous response from the readhead to allow refreshing of the position data. If request is sent sooner, data will arrive on the end of the refresh cycle.

Command “2” (ASCII two)

Response - position and status, transmitted continuously every cycle (250 µs + time of transmission depandant on baud rate)
1 byte constant header 0xEA
4 bytes binary absolute position, big-endian, right aligned
2 bytes encoder status – see table on next page
1 byte constant footer 0xEF

Command “0” (ASCII zero)

Stop continuous transmission

Structure of Detailed status bits (two bytes)

Encoder status (two bytes):		
	b15 : b10	Reserved; always zero
General status		
	b9	Error bit. If set, the position is not valid.
	b8	Warning bit. If set, the encoder operational is close to its limits. The position is still valid, but the resolution and / or accuracy might be lower than specified.
		Error and Warning bits can be set at the same time; in this case Error bit has priority. The general warning or error status is more closely defined by the Detailed status bits.
Detailed status		
	b7	Warning - Signal amplitude too high. The readhead is too close to the shaft.
	b6	Warning - Signal amplitude low. The distance between the readhead and the shaft is too large.
	b5	Error - Signal lost. The readhead is too far away from the shaft.
	b4	Warning - Temperature. The readhead temperature is out of specified range.
	b3	Error - Power supply error. The readhead power supply voltage out of specified range.
	b2	Error - System error. Malfunction inside the circuitry or inconsistent calibration data is detected. To reset the System error bit try to cycle the power supply while the rise time is shorter than 20 ms.
	b1	Error - Wrong code. Shaft might be inserted in the wrong direction.
	b0	Error - Acceleration error. The position data changed too fast. Shaft might be inserted in the wrong direction.

PWM - Pulse width modulation interface

PW output type

The PWM communication interface consists of two digital signals: the Status signal and the PWM Out signal. It is 3.3 V TTL compatible.

Electrical connection

The Status and PWM Out signals are 3.3 V TTL compatible. These signal outputs have weak ESD protection, therefore the readhead must be handled with additional care in ESD controlled environment and with ESD protection.

Maximum current sourced from or sunk into signal lines should not exceed 20 mA.

Status signal

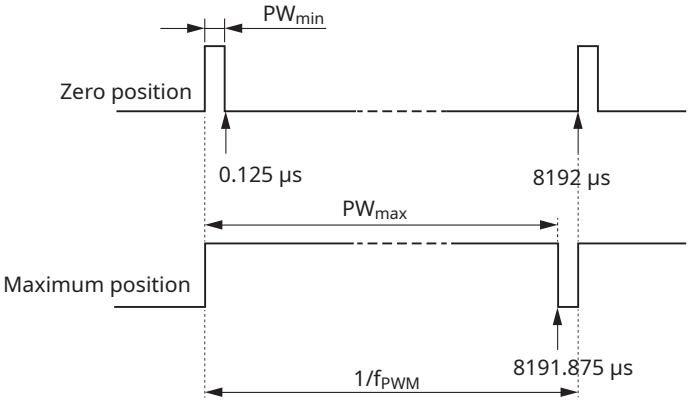
The Status signal indicates the current status of the encoder. The Status signal is high for faultless operation and valid position information. The low state of the Status signal indicates an error state of the encoder which can be caused by:

- Operation outside installation tolerances
- Sensor malfunction
- System error
- No power supply

When the Status signal is low, the PWM Out signal is low and no pulses are output.
PWM signal duty cycle is updated with current encoder position at every PWM signal rising edge. The Status signal should also be checked at the rising edge of the PWM Out signal. If the Status signal changes during the PWM period, it does not affect the currently transmitted position information.

PWM Out signal

The PWM Out is a pulse width modulated output with 16-bit resolution whose duty cycle is proportional to the measured position. The change of the pulse width by PW_{min} corresponds to a change in position by one unit of the selected encoder resolution (in µm).



Communication parameters

Communication interface variant in the part number defines the PWM frequency and all other dependent parameters.

		Communication interface variant		
Parameter	**Symbol**	**A**	**Unit**	**Note**
PWM frequency	f_{PWM}	122.07	Hz	
Signal period	t_{PWM}	8192	µs	
Minimum pulse width	PW_{min}	0.125	µs	Position 0
Maximum pulse width	PW_{max}	8191.875	µs	Positions 65534 and 65535 *
Min. counter frequency	f_{CNTR}	8	MHz	Receiving counter frequency

* Note that positions 65534 and 65535 result in the same pulse width PW_{max}.

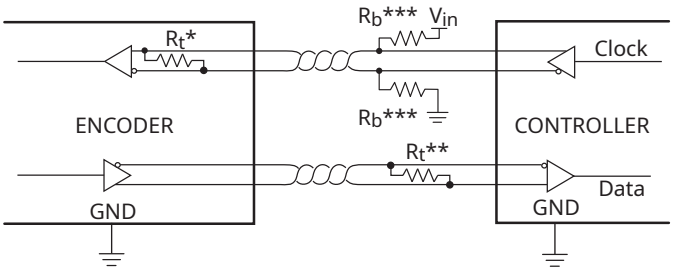
$$\text{Position [µm]} = \left(\frac{t_{on} \times 65536}{T_{PWM}} - 1 \right) \times \text{Resolution}$$

SSI - Synchronous serial interface

SC output type

The encoder position, in 21 bit natural binary code, and the encoder status are available through the SSI protocol. The position data is right aligned. LSB represents selected encoder resolution. After the position data there are two general status bits followed by the detailed status information.

Electrical connection

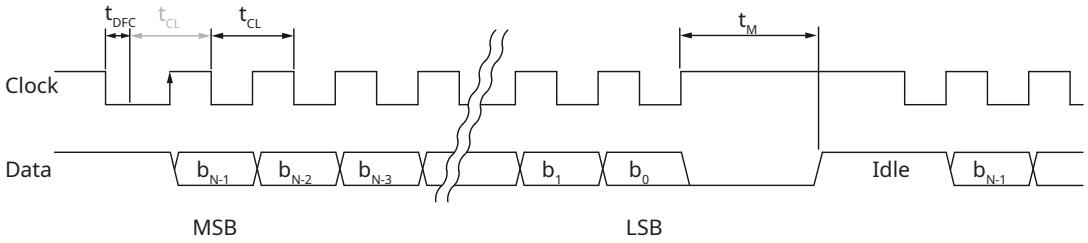


* The Clock and Data signals are 5 V RS422 compatible differential pairs with RC termination inside the readhead.
** Termination at the controller is required, if total cable length is longer than 5 m. The nominal impedance of the cable is 120 Ω. Recommended termination is 120 Ω or RC termination (120 Ω and 1 nF in series) if there is requirement for lower power consumption.
*** Clock should have a defined state during encoder start up. Recommended value for R_b is 1 kΩ.

Output protection

An excessive output current and power dissipation caused by errors or bus conflicts are prevented by two mechanisms. A foldback current limit on the output stage provides immediate protection against short circuits. In addition, a thermal shutdown circuit forces the driver outputs into a high-impedance state, if the chip temperature becomes too high.

Timing diagram

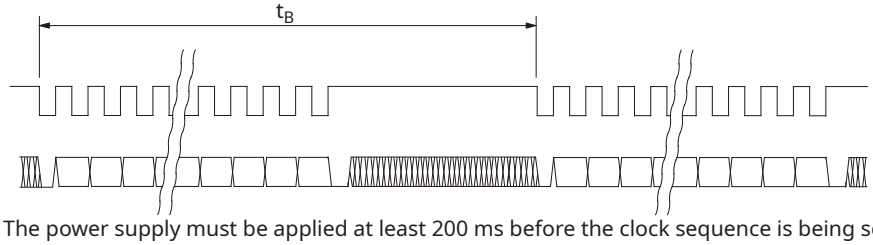


The controller requests the position and status data of the encoder by sending a pulse train to the Clock input. The Clock signal always starts from high. The first falling edge of the Clock latches the last position data available and on the first rising edge of the Clock the most significant bit (MSB) of the position is transmitted to the Data output. The Data output should then be read on the following falling or rising edge. On subsequent rising edges of the Clock signal the next bits are transmitted.

After the transmission of the last bit the Data output goes to low. When the tM time expires, the Data output goes high. The Clock signal must remain high until TB expires. If encoder is queried more frequently, same position value will be transmitted twice.

While reading the data, the half of a Clock period t_{CL} must always be less than t_M. However, reading the encoder position can be terminated at any time by setting the Clock signal to high for the duration of t_M.

In order for the position data to be updated, at least t_B should elapse between two successive readings. If the read request arrives earlier than t_B after the previous read, the encoder position is not updated.

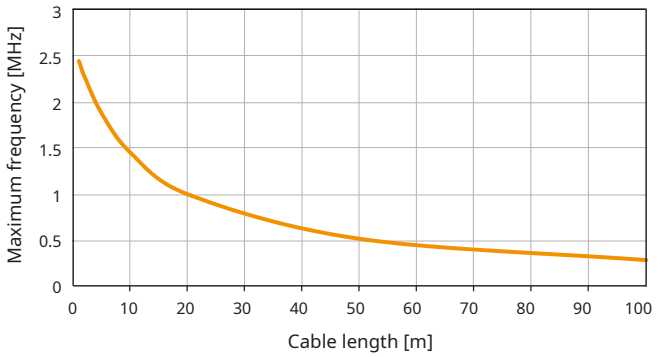


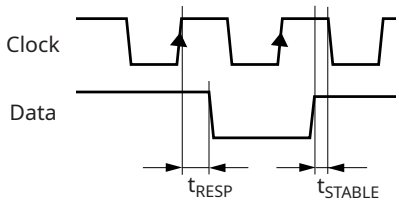
The power supply must be applied at least 200 ms before the clock sequence is being sent to the encoder.

Maximum frequency

The readhead needs 170 ns to respond to incoming clocks (t_{RESP}). Change on Data signal is delayed for 170 ns after the rising edge on Clock line. An additional delay is caused by the time it takes for the signal needs to propagate through the cable to the readhead and back (t_{PROP}). This delay is typically 14 ns per 1 meter cable. The Data signal must be stable over at least 10 % of the length of the clock period before the value is latched. The clock frequency must be reduced with a longer cable. The total cable length from the encoder to the receiver must be considered.

Frequency derating versus cable length:





$t_{DELAY} = t_{RESP} + t_{PROP} \times$ cable length

Communication parameters

Parameter	Symbol	Min	Typ	Max
Delay first clock	t_{DFC}	1 µs		10 µs
Clock period	t_{CL}	2 µs		20 µs
Clock frequency	f_{CL}	50 kHz		500 kHz (2.5 MHz *)
Timeout (Monoflop time)	t_M		20 µs	
Update time	t_B	250 µs		
Readhead response delay	t_{RESP}		170 ns	
Cable propagation delay	t_{PROP}		14 ns/m	
Latency		250 µs		500 µs

* With *Delay First Clock* function on the controller.

Start bit and idle line value are defined by the *Communication interface variant.*

Communication interface variant	Line state selection	Usage
B	Start bit = 1; idle line = 1	Standard

Structure of data packet

Bit	b30 : b10	b9 : b8	b7 : b0
Data length	21 bits	2 bits	8 bits
Meaning	Encoder position	General status	Detailed status

Structure of data packet

Encoder position		
	b30 : b10	Encoder position – Right aligned, MSB
General status		
	b9	Error bit. If set, the position is not valid.
	b8	Warning bit. If set, the encoder operational is close to its limits. The position is still valid, but the resolution and/or accuracy might be out of specification.
		The Error and Warning bits can be set at the same time, in this case the Error bit has priority. The general warning or error status is more closely defined by the Detailed status bits.
Detailed status		
	b7	Warning - Signal amplitude too high. The readhead is too close to the shaft.
	b6	Warning - Signal amplitude low. The distance between the readhead and the shaft is too large.
	b5	Error - Signal lost. The readhead is too far away from the shaft.
	b4	Warning - Temperature. The readhead temperature is out of specified range.
	b3	Error - Power supply error. The readhead power supply voltage out of specified range.
	b2	Error - System error. Malfunction inside the circuitry or inconsistent calibration data is detected. To reset the System error bit try to cycle the power supply while the rise time is shorter than 20 ms.
	b1	Error - Wrong code. Shaft might be inserted in the wrong direction.
	b0	Error - Acceleration error. The position data changed too fast. Shaft might be inserted in the wrong direction.

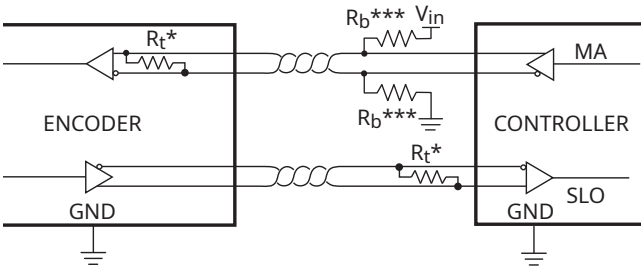
BiSS C unidirectional

DC output type

The encoder position, in 26 bit natural binary code, and the encoder status are available through the BiSS C protocol. The position data is right aligned. After the position data there are two status bits (active low) followed by CRC (inverted).

BiSS C is implemented for point-to-point operation; multiple slaves are not supported.
Communication is unidirectional, readhead is not user programmable, also custom parameters can not be stored into the readhead.

Electrical connection



Signals	
MA	Master clock. Max. clock frequency is 5 MHz.
SLO	Slave out. Data is output on rising edge on MA. Data is valid on the falling edge of MA signal.

* The MA and SLO lines are 5 V RS422-compatible differential pairs. The termination resistor on the MA line is integrated in the encoder.

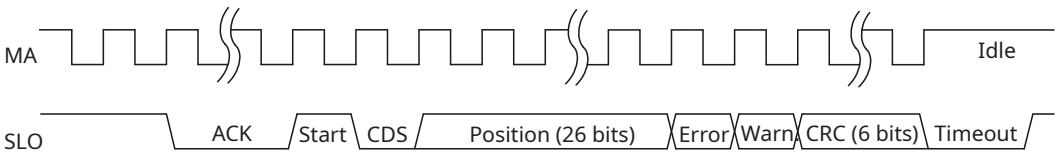
** If the total cable length is more than 5 m, termination on the controller is required. The nominal impedance of the cable is 120 Ω. Recommended termination is 120 Ω or RC termination (120 Ω and 1 nF in series) if there is requirement for lower power consumption.

*** Clock should have a defined state during encoder start up. Recommended value for R_b is 1 kΩ.

Output protection

An excessive output current and power dissipation caused by errors or bus conflicts are prevented by two mechanisms. A foldback current limit on the output stage provides immediate protection against short circuits. In addition, a thermal shutdown circuit forces the driver outputs into a high-impedance state, if the chip temperature becomes too high.

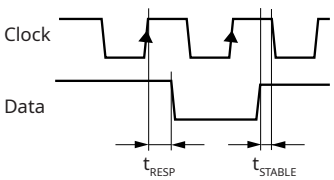
Timing diagram



MA is idle high. Communication is initiated with the first falling edge. The encoder responds by setting the SLO low on the second rising edge on MA. When the encoder is ready for the next request cycle, it indicates this to the master by setting SLO to high. The absolute position and the CRC data are in binary format and are sent MSB first. Multicycle data is not implemented, therefore the CDS bit is always zero. The power supply must be applied at least 200 ms before the clock sequence is being sent to the encoder.

Cable length compensation

The readhead needs 170 ns to respond to incoming clocks (t_{RESP}). The change on the Data signal is delayed by 170 ns after the rising edge on the Clock line. An additional delay is caused by the time the signal takes to propagate through the cable to the readhead and back (t_{PROP}). This delay is typically 14 ns per 1 m cable. The total cable length from the encoder to the receiver must be considered.



$t_{DELAY} = t_{RESP} + t_{PROP} \times$ cable length

The data signal must be stable before the value is latched. If the cable is longer than 1 m and has a clock frequency of more than 2.5 MHz, this delay must therefore be compensated in the receiver (controller) to which the encoder is connected.

Communication parameters

Communication interface variant in the part number defines the functionality of the encoder.

Communication interface variant	Description	Parameter	Value
H	Long response high frequency	ACK length	12 bits
		MA frequency	Max. 5 MHz

Parameter	Symbol	Worst case
Latency		<10 µs
Bandwidth *		2 kHz
Maximum request rate		30 kHz
Timeout (Monoflop time)		20 µs
Readhead response delay	t_{RESP}	170 ns
Cable propagation delay	t_{PROP}	14 ns/m

* Bandwidth parameter is mechanical bandwidth. LinACE samples at 4 kHz therefore any mechanical changes that are appearing faster than 2 kHz are not detectable on the output (Nyquist theorem). If request for position comes faster than sampling frequency, LinACE encoder recalculates the position at the time of request based on current shaft velocity.

Structure of data packet

Data packet length is fixed to 34 bits. It consists of 26 bits of Position, 2 Status bits and 6 CRC bits (see table below).

Encoder position		
	b33 : b8	Encoder position - Right aligned
General status		
	b7	Error bit. If set, the position is not valid.
	b6	Warning bit. If set, the encoder operational is close to its limits. The position is still valid, but the resolution and/or accuracy might be out of specification.
		The Error and Warning bits can be set at the same time, in this case the Error bit has priority. The general warning or error status is more closely defined by the Detailed status bits.
CRC (inverted)		
	b5 : b0	Polynomial for CRC calculation of position, error and warning data is: x6 + x1 + 1. Represented also as 0x43. It is inverted and transmitted MSB first.

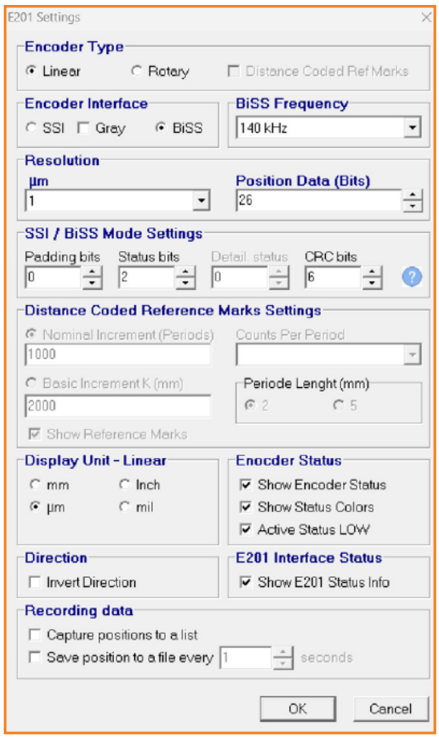
For further information regarding CRC calculation example, refer to the document CRCD01 available at **RLS Media center**.

Deatiled status

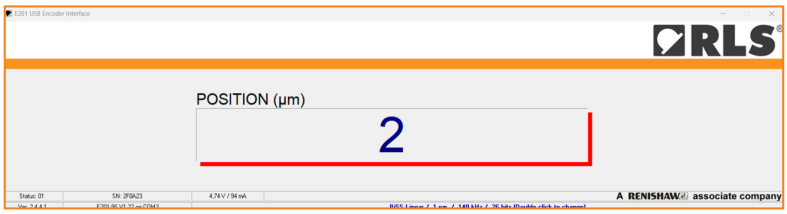
In case of problems with the encoder, detailed status bits are available that communicate the type of error.

When the encoder is in the error state, the red LED is on and the error bit is active. Position information is replaced by detailed status information (red line is visible, which represents error state). For easy reading of the BiSS encoder, the E201-9S interface can be used and the Demo software set to a resolution of 1 um.

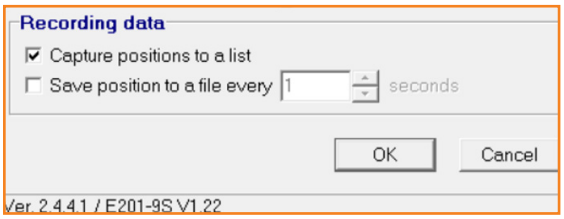
The software settings must be as follows:



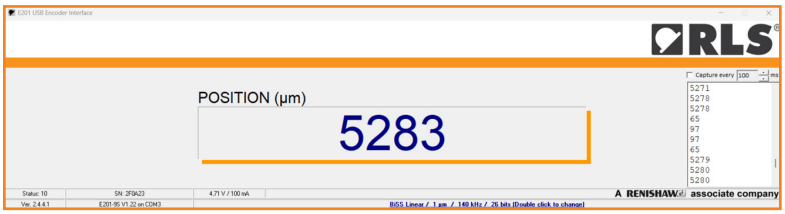
In the event of an active error on the encoder, the software display is as follows (red line is visible, which represents error state):

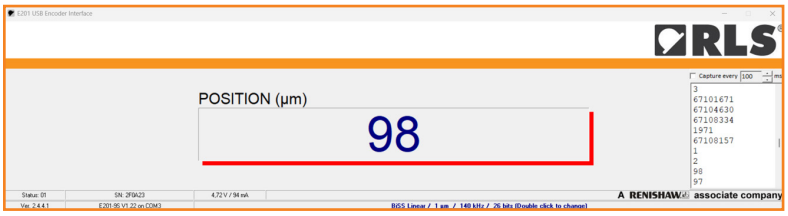


If the error only occurs for a very short time, the data storage function can be enabled in the software:



Only the values where error was active should be observed.





The numbers displayed by the software can be converted to the individual status bits using a Windows Calculator to convert from Decimal to Binary value:

The binary value is then used to look-up the active warning and error bits in the table Detailed status.

Detailed status

b7	Warning - Signal amplitude too high. The readhead is too close to the shaft.
b6	Warning - Signal amplitude low. The distance between the readhead and the shaft is too large.
b5	Error - Signal lost. The readhead is too far away from the shaft.
b4	Warning - Temperature. The readhead temperature is out of specified range.
b3	Error - Power supply error. The readhead power supply voltage out of specified range.
b2	Error - System error. Malfunction inside the circuitry or inconsistent calibration data is detected. To reset the System error bit try to cycle the power supply while the rise time is shorter than 20 ms.
b1	Error - Wrong code. Shaft might be inserted in the wrong direction.
b0	Error - Acceleration error. The position data changed too fast. Shaft might be inserted in the wrong direction.

Warning bits can be observed only if they are active together with one of the error bits. In case only warning is active, encoder will output valid position information, not status bits.

Example:

- Decimal value: 97
- Binary value: 0110 0001
- Active bits: b6, b5, b0
- Active errors: Signal low, Signal lost, Acceleration error.
- Solution: Move readhead closer to the shaft.

Alternatively, common values can be directly interpreted using the table below.

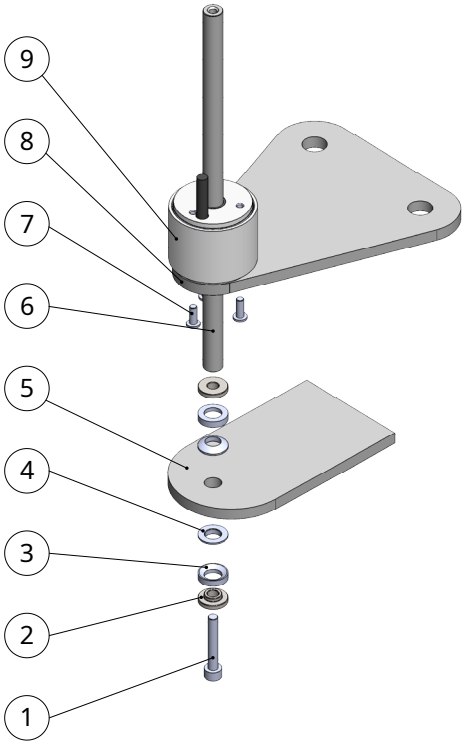
Position reading	Detailed status	Cause and solution
01	Acceleration error	Indicates that Corrupted pattern error was active in the past, causing position value to jump.
02	Corrupted pattern	Adjust mechanical alignment and check for external magnetic field.
65	Signal low & Acceleration error	Adjust readhead closer to the shaft.
66	Signal low & Corrupted pattern	Adjust readhead closer to the shaft and check for external magnetic field.
67	Signal low & Corrupted pattern & Acceleration error	Adjust readhead closer to the shaft and check for external magnetic field.
97	Signal lost & Acceleration error	Readhead is too far away from the shaft.
98	Signal lost & Corrupted pattern	Readhead is too far away from the shaft.

For more information regarding BiSS protocol see **www.biss-interface.com**.

Appendix - Installation kit for LinACE

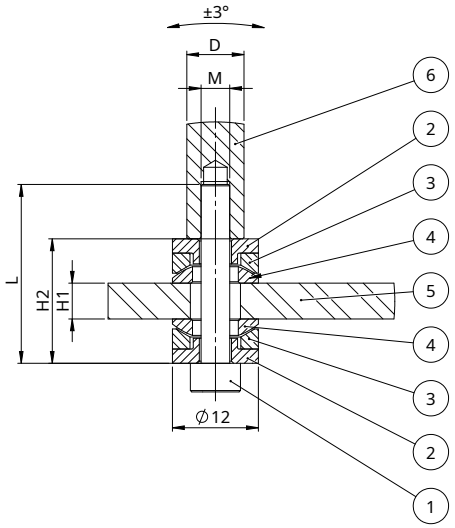
Installation kit should be applied if mounting surfaces parallelism can not be ensured.

Exploded view:



1. Attach LinACE readhead (No. 9) onto the beam (No. 8) using 3 fasteners M3 (No. 7) with torque 1 Nm.
2. Insert LinACE shaft (No. 6) through LinACE readhead (No. 9).
3. On the lower beam (No. 5) assemble the joint according to the figure below.
4. Gently attach the LinACE shaft (No. 6) to the joint with fastener (No. 1) so that the joint assembly can be easily moved by hand.
5. Move the upper part (LinACE readhead on beam) as close as possible to the joint.
6. Tighten fastener (No. 1) with specified torque.

D [mm]	H2 [mm]	M [mm]	L [mm]	Torque [Nm]
6	H1+12.4	M3	H1 + 17	1
8	H1+12.4	M4	H1 + 17	2
12	H1+8.4	M6	H1 + 16	6



Fasteners No. 1 and 7 are not included in the installation kit.

Shaft size	No. 2	No. 3	No. 4	Mounting kit No.
D6	2×	2×	2×	CAACC004
D8	2×	2×	2×	CAACC001
D12	0	2×	2×	CAACC003

Part numbering

CH B 08 SC B 200 B 10 F T 00

Accuracy

A - ±5 µm *
B - ±10 µm
C - ±25 µm
D - ±50 µm
E - ±100 µm

* Available for Ø6 mm shaft diameter and for measuring lengths up to 100 mm

Shaft diameter

06 - Ø6 mm *
08 - Ø8 mm
12 - Ø12 mm

* Available for measuring lengths up to 300 mm.

Output type and parameter

DC - BiSS C, RS422, 5 V
H - BiSS C, low latency, 12 ACK bits, max. 5 MHz
PW - Pulse width modulation (PWM), 5 V
A - 122.07 Hz base frequency
SC - Binary synchro-serial (SSI), RS422, 5 V
B - Start bit and idle data line 1
SF - Asynchronous-serial, RS422, 5 V
A - 115.2 kbps
D - 256 kbps
F - 1000 kbps

Measuring length

	Coded shaft overall length	
	Ø6 / Ø8 mm	Ø12 mm
020 - 20 mm	50 mm	55 mm
050 - 50 mm	80 mm	85 mm
100 - 100 mm	130 mm	135 mm
150 - 150 mm	180 mm	185 mm

	Coded shaft overall length	
	Ø6 / Ø8 mm	Ø12 mm
200 - 200 mm	230 mm	235 mm
250 - 250 mm	280 mm	285 mm
300 - 300 mm	330 mm	335 mm
450 - 450 mm *	480 mm	485 mm

* Available for shaft diameters 8 mm and 12 mm only.

Resolution

DC, **SC** and **SF**:
A - 0.5 µm
B - 1 µm
D - 5 µm
E - 10 µm

PW:
B - 1 µm/step at up to 50 mm measuring length
D - 5 µm/step at up to 300 mm measuring length
E - 10 µm/step at up to 450 mm measuring length

Cable length

DC, **SC** and **SF**:
05 - 0.5 m
10 - 1.0 m
20 - 2.0 m
30 - 3.0 m
50 - 5.0 m

PW:
05 - 0.5 m
10 - 1.0 m

Connector and cable exit option

A - 9 pin D type plug, axial cable exit
B - 9 pin D type plug, radial cable exit
F - Flying leads (no connector), axial cable exit
G - Flying leads (no connector), radial cable exit

Temperature range

T - Extended temperature (–30 °C to +105 °C)
H - With high flex cable (axial cable exit only, –20 °C to +80 °C)

Special requirements

00 - Standard (No special requrements)

Not all part number combinations are valid. Please refer to the Table of available combinations on the next page.

Table of available combinations

Series	Accuracy	Shaft diameter	Output type	Output type parameter	Measuring length	Reso-lution	Cable length	Connec-tor	Temper-ature range	Special require-ments
CH	A	06	PW	A	020 / 050	B	05 / 10	A / B / F / G	T / H*	00
			DC	H	020 / 050 / 100	A / B	05 / 10 / 20 / 30 / 50			
			SC	B						
			SF	A / D / F						
	B	06	PW	A	020 / 050	B	05 / 10			
			DC	H	020 / 050 / 100 / 150 / 200 / 250 / 300	A / B	05 / 10 / 20 / 30 / 50			
			SC	B						
			SF	A / D / F						
		08 / 12	PW	A	020 / 050	B	05 / 10			
			DC	H	020 / 050 / 100 / 150 / 200 / 250 / 300 / 450	A / B	05 / 10 / 20 / 30 / 50			
			SC	B						
			SF	A / D / F						
	C	06	PW	A	020 / 050	B	05 / 10			
					020 / 050 / 100 / 150 / 200 / 250 / 300	D				
			DC	H		A / B / D	05 / 10 / 20 / 30 / 50			
			SC	B						
			SF	A / D / F						
		08 / 12	PW	A	020 / 050	B	05 / 10			
					020 / 050 / 100 / 150 / 200 / 250 / 300	D				
			DC	H	020 / 050 / 100 / 150 / 200 / 250 / 300 / 450	A / B / D	05 / 10 / 20 / 30 / 50			
			SC	B						
			SF	A / D / F						
	D / E	06	PW	A	020 / 050	B	05 / 10			
					020 / 050 / 100 / 150 / 200 / 250 / 300	D / E				
			DC	H	020 / 050 / 100 / 150 / 200 / 250 / 300	A / B / D / E	05 / 10 / 20 / 30 / 50			
			SC	B						
			SF	A / D / F						
		08 / 12	PW	A	020 / 050	B	05 / 10			
					020 / 050 / 100 / 150 / 200 / 250 / 300	D				
					020 / 050 / 100 / 150 / 200 / 250 / 300 / 450	E				
			DC	H		A / B / D / E	05 / 10 / 20 / 30 / 50			
			SC	B						
			SF	A / D / F						

* Available for axial cable exit only.

Accessories

USB interface (for SSI and BiSS communication interface)
E201-9S

LinACE Serial Demo software will work with LinACE with Asynchronous Serial Interface using FTDI (FTDI USB-RS44-WE-1800_BT)

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Document issues

Issue	Date	Page	Description
4	15. 10. 2021	7	Technical specifications amended
		12	Command amended
	18. 7. 2022	6	Readhead dimension changed /typo amended/
5	7. 10. 2024	4 - 6	Axial cable exit drawing amended
6	14. 4. 2025	14	SSI timing diagram amended
		18-20	BiSS Structure of data packet amended
		23	Accessories added