Data sheet
L-9518-0027-01-B

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EVOLUTE™ absolute optical encoder system



Incorporating industry-proven technology from the RESOLUTE™ encoder series, EVOLUTE™ is a true-absolute 50 µm scale period optical encoder with wide installation tolerances and high immunity to dirt.

Using a scale period of 50 µm gives the EVOLUTE encoder system a generous 500 µm rideheight tolerance and its single-track optics are optimised for contamination resistance. Data redundancy encoded into the robust scale minimises the risk of positional error while sophisticated error checking mechanisms ensure an error flag is always asserted when the position cannot be determined.

The EVOLUTE system provides absolute position with resolution options down to 50 nm. Advanced optical design and high-speed signal processing mean sub-divisional error (SDE) is as low as ±150 nm with noise (jitter) below 10 nm RMS.

EVOLUTE encoders are mechanically identical to RESOLUTE encoders and are supplied with the RTLA50 scale that can be used, either in its self-adhesive form, RTLA50-S, or in the FASTRACK scale carrier system.

- **True-absolute non-contact optical encoder system: no batteries required**
- **EVOLUTE is available with the following serial interfaces: BiSS C (unidirectional), FANUC, Mitsubishi, Panasonic, Siemens DRIVE-CLiQ and Yaskawa**
- **Wide set-up tolerances for quick and easy installation**
- **Enhanced immunity to dirt, scratches and light oils**
- **Resolution options of 50 nm, 100 nm or 500 nm**
- **100 m/s maximum speed for all resolutions**
- **±150 nm sub-divisional error for smooth velocity control**
- **Less than 10 nm RMS jitter for improved positional stability**
- **Built-in separate position-checking algorithm provides inherent safety**
- **Readhead is reversible for flexible mounting. Scale orientation defines count direction only**
- **Integral set-up LED enables easy installation and provides diagnostics at a glance**
- **Operates up to 80 °C**
- **Integral over-temperature alarm**
- **Compatible with the RTLA50-S self-adhesive tape scale or the RTLA50 scale and FASTRACK™ carrier**
- **Scale lengths up to 10.2 m**
- **Optional Advanced Diagnostic Tool ADTa-100**

www.renishaw.com/evolutedownloads

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Compatible linear scales

	RTLA50-S [1]	RTLA50 (with FASTRACK™ carrier)
	Self-adhesive mounted stainless steel tape scale	**Stainless steel tape scale and self-adhesive mounted carrier**
		
Form (height × width)	0.4 mm × 8 mm including adhesive	RTLA50 scale: 0.2 mm × 8 mm FASTRACK carrier: 0.4 mm × 18 mm including adhesive
Accuracy (at 20 °C)	±10 µm/m	±10 µm/m
Maximum length [2]	10.2 m	RTLA50 lengths up to 10.2 m FASTRACK carrier lengths up to 25 m
Coefficient of thermal expansion (at 20 °C)	10.1 ±0.2 µm/m/°C	10.1 ±0.2 µm/m/°C

For more information about the scales refer to the *RTLA50 absolute linear encoder scale system for EVOLUTE*™ data sheet (Renishaw part no. L-9517-9628) which can be downloaded from **www.renishaw.com/evolutedownloads**.

[1] For RTLA50-S axis lengths > 2 m, the FASTRACK carrier with RTLA50 is recommended.

[2] The maximum scale length may be limited for some serial interfaces and resolutions; refer to 'Resolution and scale lengths' on page 3 for details.

Linear encoder system

Resolution and scale lengths

The maximum scale length depends upon the serial interface, readhead resolution and the number of position bits.

The table below shows the maximum scale length for each system:

		Resolution		
Serial interfaces	**Position bits**	**50 nm**	**100 nm**	**500 nm**
BiSS C (uni-directional)	26 bit	3.35 m	6.7 m	10.2 m
	32 bit	10.2 m	10.2 m	10.2 m
	36 bit	10.2 m	10.2 m	10.2 m
FANUC	37 bit	10.2 m	10.2 m	10.2 m
Mitsubishi	40 bit	10.2 m	10.2 m	10.2 m
Panasonic	48 bit	10.2 m	10.2 m	10.2 m
Siemens DRIVE-CLiQ	28 bit	10.2 m	-	-
Yaskawa	36 bit	10.2 m	10.2 m	10.2 m

Speed

The table below shows the maximum speed for each system:

		Resolution		
Serial interfaces	**Position bits**	**50 nm**	**100 nm**	**500 nm**
BiSS C (uni-directional)	26 bit	100 m/s	100 m/s	100 m/s
	32 bit	100 m/s	100 m/s	100 m/s
	36 bit	100 m/s	100 m/s	100 m/s
FANUC	37 bit	100 m/s	100 m/s	100 m/s
Mitsubishi	40 bit	100 m/s	100 m/s	100 m/s
Panasonic	48 bit (when used with A5 series)	20 m/s	40 m/s	100 m/s
	48 bit (when used with A6 series)	100 m/s	100 m/s	100 m/s
Siemens DRIVE-CLiQ	28 bit	100 m/s	-	-
Yaskawa	36 bit	100 m/s	100 m/s	100 m/s

General specifications

		BiSS C (undirectional), FANUC, Mitsubishi, Panasonic and Yaskawa	Siemens DRIVE-CLiQ [1]
Power supply		5 V ±10% 1.25 W maximum (250 mA @ 5 V) [2] Ripple: 200 mVpp maximum @ frequency up to 500 kHz maximum	3.05 W maximum (readhead: 1.25 W + single input interface: 1.8 W) [3] 24 Vdc power is provided by the DRIVE-CLiQ network Ripple: 200 mVpp maximum @ frequency up to 500 kHz maximum
Temperature	Storage (system)	–20 °C to +80 °C	–20 °C to +70 °C
	Readhead (operating)	0 °C to +80 °C	0 °C to +80 °C
	Interface (operating)	N/A	0 °C to +55 °C
Humidity		95% relative humidity (non-condensing) to IEC 60068-2-78	
Sealing	Readhead	IP64	IP64
	Interface	N/A	IP67
Acceleration	Operating	500 m/s², 3 axes (readhead only)	
Maximum acceleration of scale with respect to readhead [4]		2000 m/s²	
Vibration	Readhead (operating)	Sinusoidal 300 m/s², 55 Hz to 2000 Hz, 3 axes	Sinusoidal 300 m/s², 55 Hz to 2000 Hz, 3 axes
	Interface (operating)	N/A	Sinusoidal 100 m/s², 55 Hz to 2000 Hz, 3 axes
Shock	Non-operating (system)	1000 m/s², 6 ms, ½ sine, 3 axes	
Mass	Readhead	18 g	18 g
	Readhead cable	32 g/m	32 g/m
	Interface	N/A	218 g
EMC compliance		IEC 61800-5-2 Annex E	
Readhead cable		7 core, tinned and annealed copper, 28 AWG Single-shielded, outside diameter 4.7 ±0.2 mm Flex life > 40 × 10⁶ cycles at 20 mm bend radius UL recognised component	
Maximum readhead cable length		3 m	3 m (to controller or interface) (refer to Siemens DRIVE-CLiQ specifications for maximum cable length from interface to controller)

CAUTION: The EVOLUTE encoder system has been designed to the relevant EMC standards, but must be correctly integrated to achieve EMC compliance. In particular, attention to shielding arrangements is essential

1 EVOLUTE Siemens DRIVE-CLiQ readheads require the Siemens DRIVE-CLiQ interface to function correctly.

2 Current consumption figures refer to terminated EVOLUTE systems. Renishaw encoder systems must be powered from a 5 Vdc supply complying with the requirements for SELV of standard IEC 60950-1.

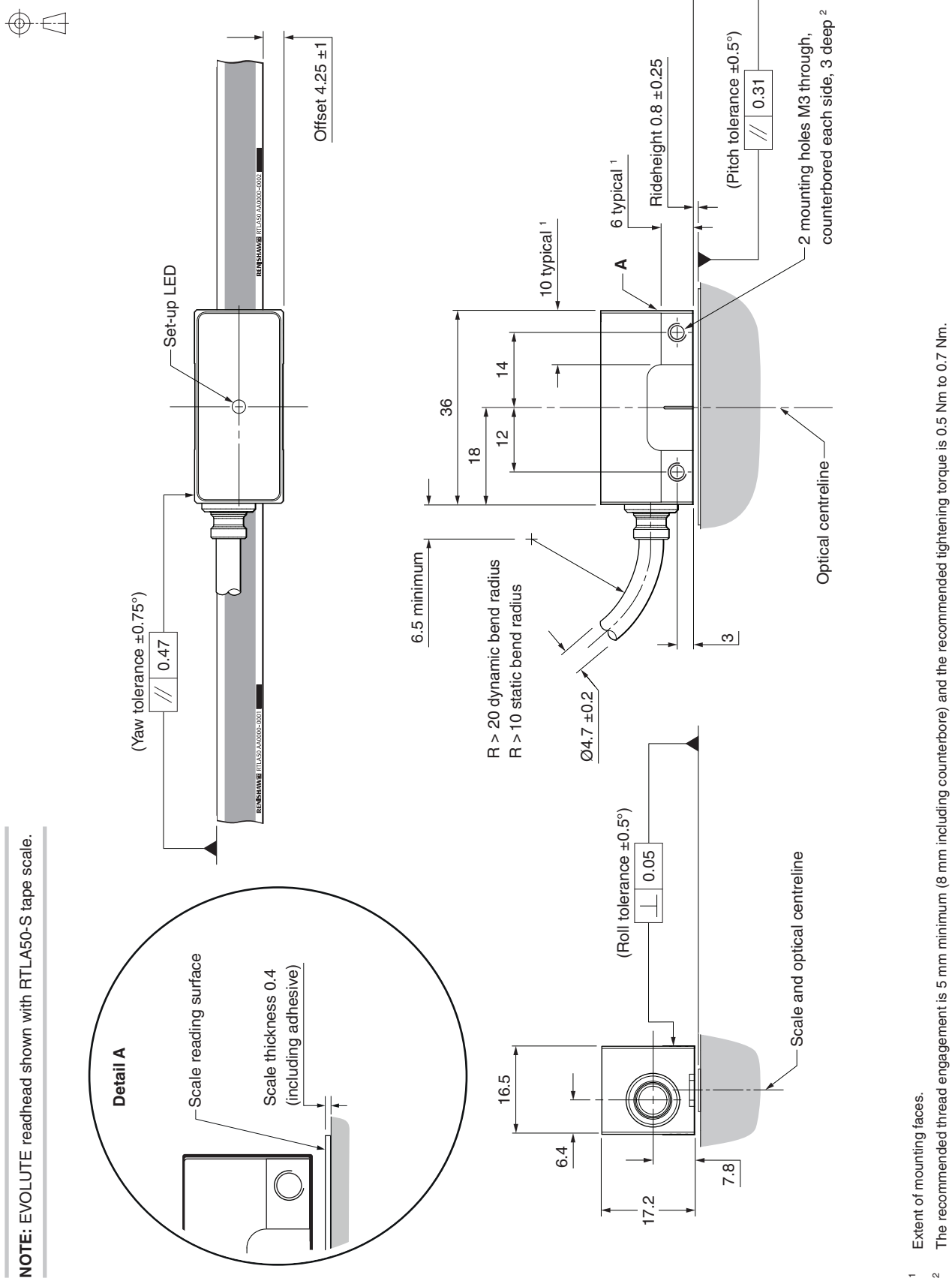
3 Current consumption figures refer to terminated EVOLUTE Siemens DRIVE-CLiQ systems. EVOLUTE Siemens DRIVE-CLiQ systems must be powered from a 24 Vdc supply complying with the requirements for SELV of standard IEC 60950-1.

4 This is the worst case figure that is correct for the slowest communications clock rates. For faster clock rates, the maximum acceleration of scale with respect to the readhead can be higher. For more details, contact your local Renishaw representative.

EVOLUTE readhead installation drawing

Standard cable outlet

Dimensions and tolerances in mm



NOTE: EVOLUTE readhead shown with RTLA50-S tape scale.

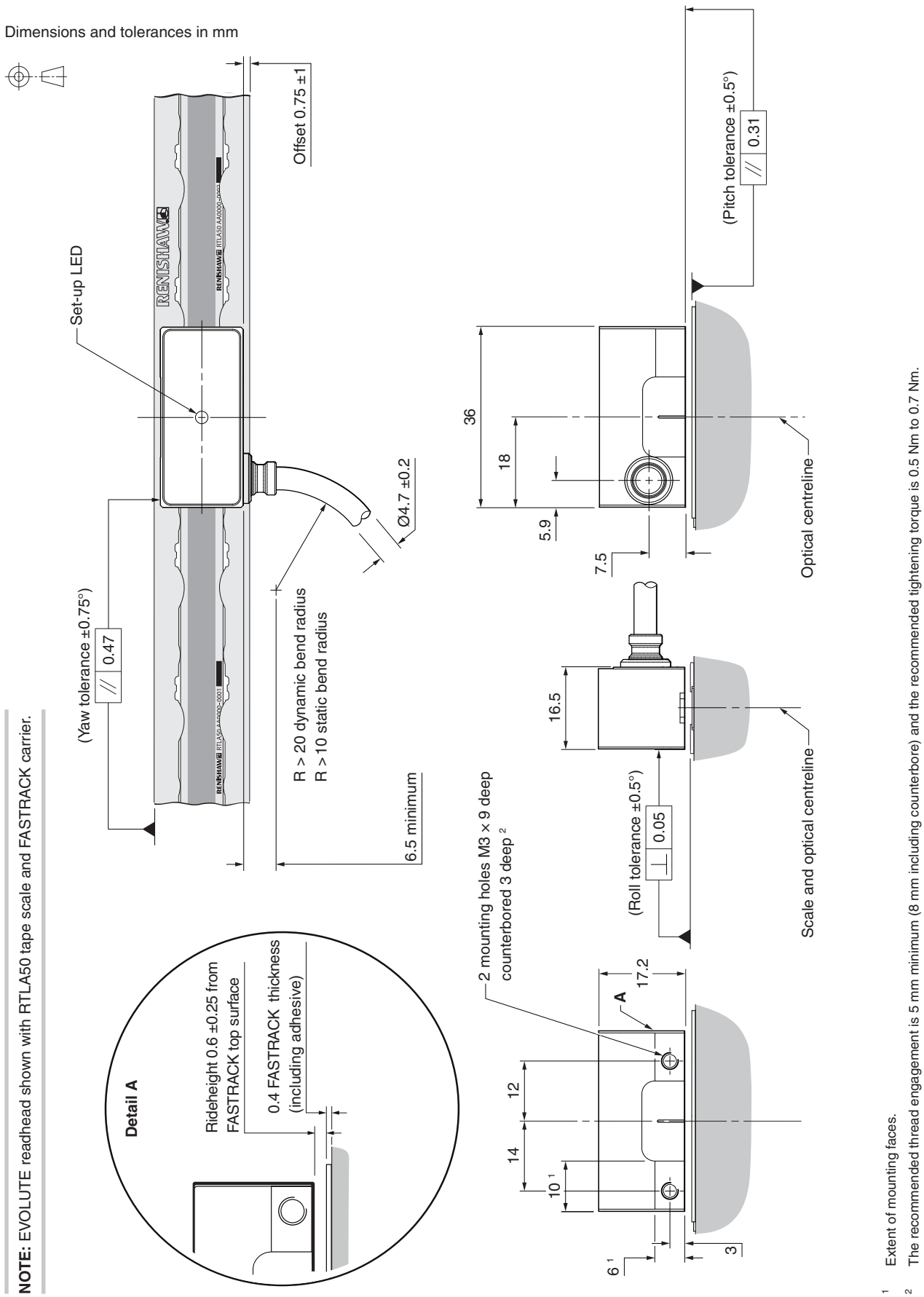
[1] Extent of mounting faces.

[2] The recommended thread engagement is 5 mm minimum (8 mm including counterbore) and the recommended tightening torque is 0.5 Nm to 0.7 Nm.

EVOLUTE readhead installation drawing

Side cable outlet

Dimensions and tolerances in mm



NOTE: EVOLUTE readhead shown with RTLA50 tape scale and FASTRACK carrier.

[1] Extent of mounting faces.

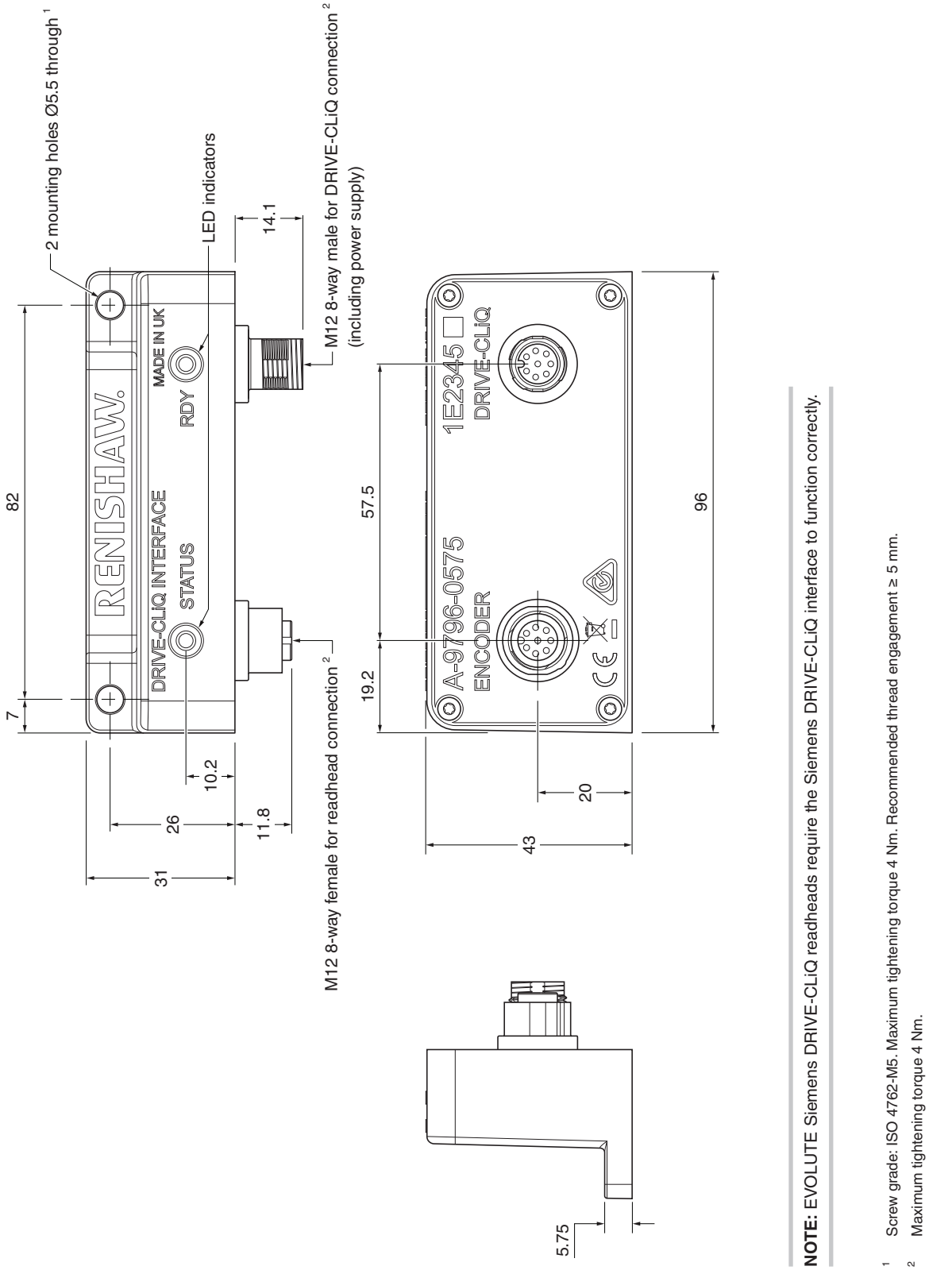
[2] The recommended thread engagement is 5 mm minimum (8 mm including counterbore) and the recommended tightening torque is 0.5 Nm to 0.7 Nm.

Siemens DRIVE-CLiQ interface drawing

Single readhead input (A-9796-0575)

Dimensions and tolerances in mm



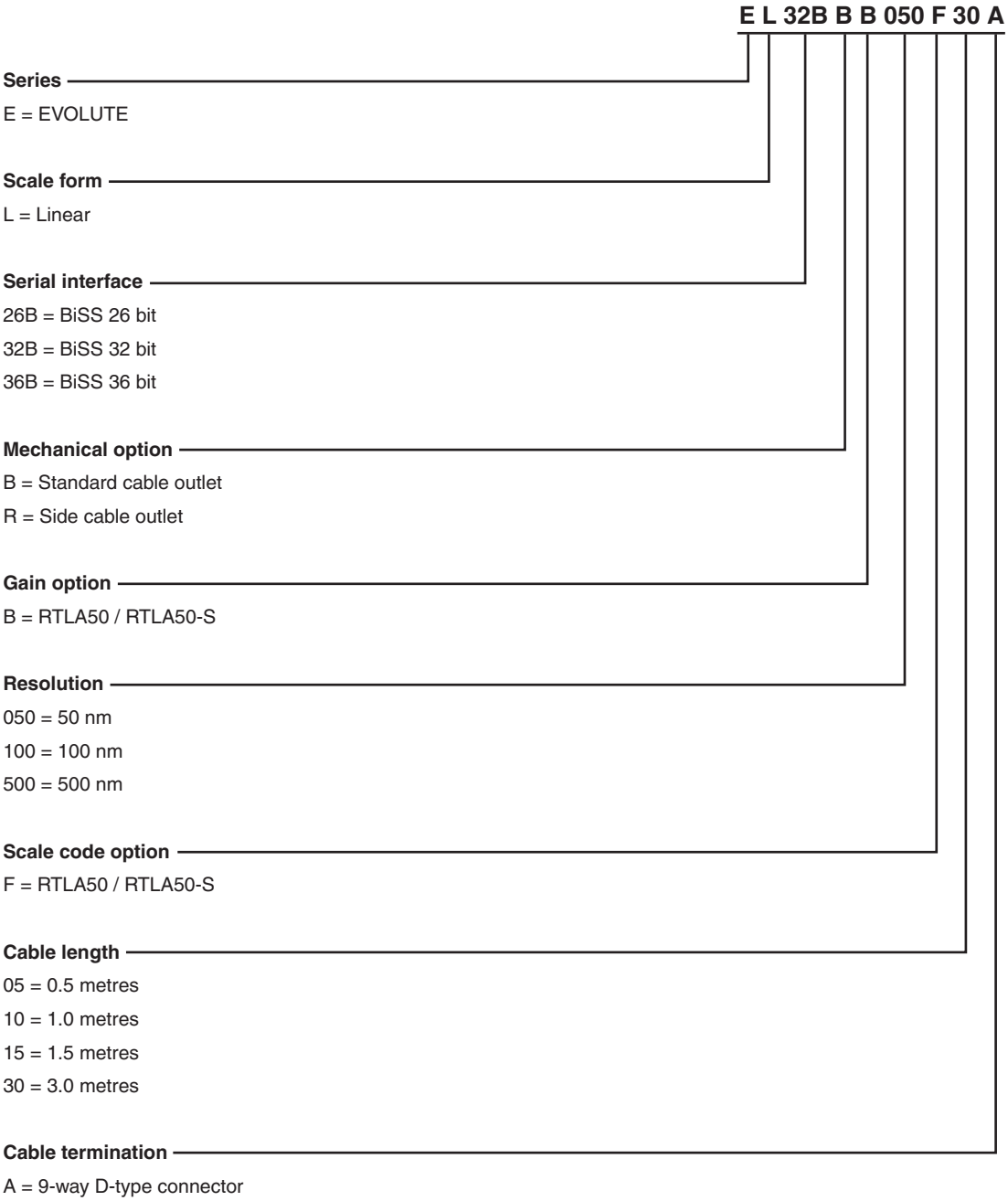


NOTE: EVOLUTE Siemens DRIVE-CLiQ readheads require the Siemens DRIVE-CLiQ interface to function correctly.

[1] Screw grade: ISO 4762-M5. Maximum tightening torque 4 Nm. Recommended thread engagement ≥ 5 mm.

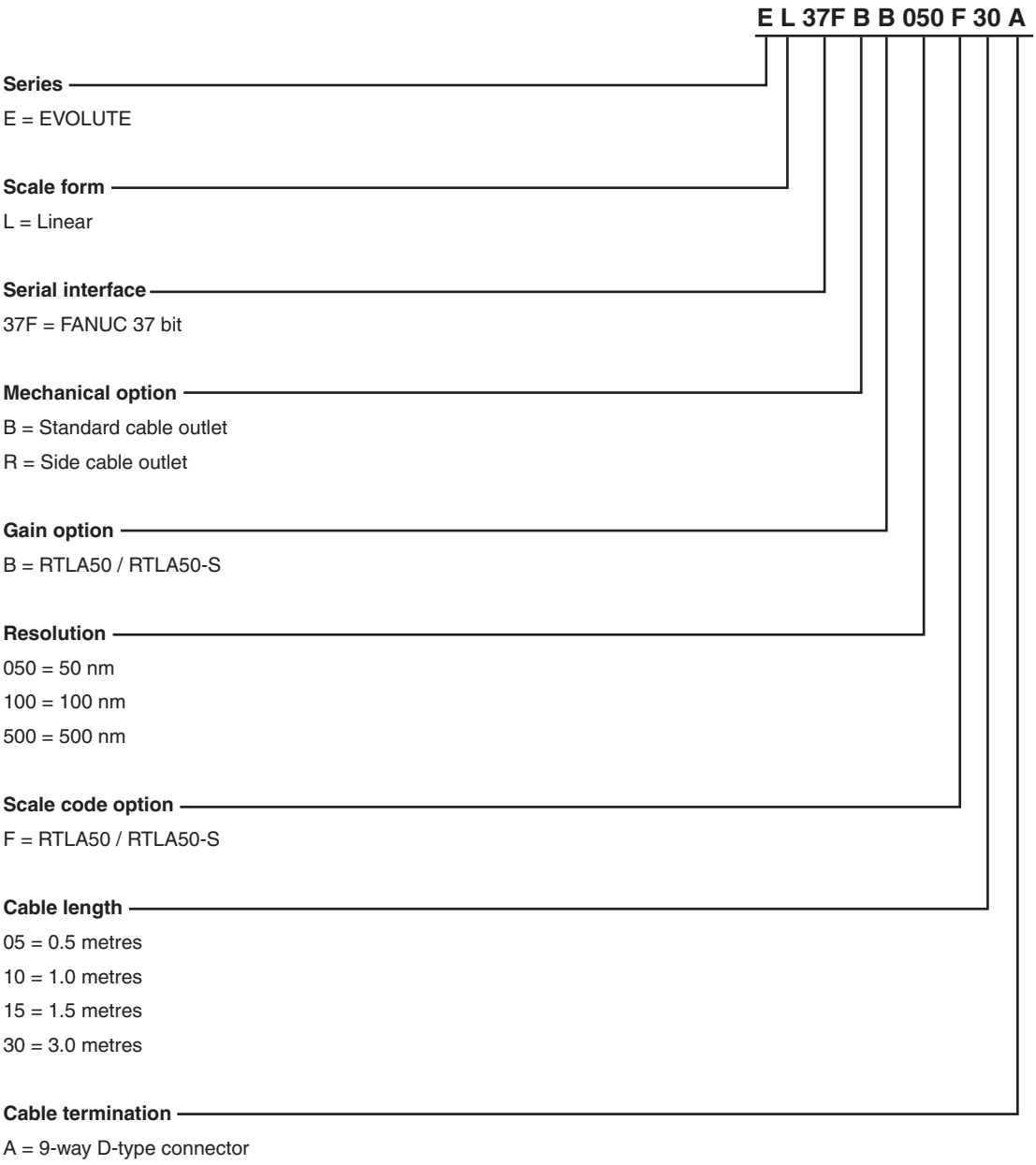
[2] Maximum tightening torque 4 Nm.

EVOLUTE BiSS readhead part numbers



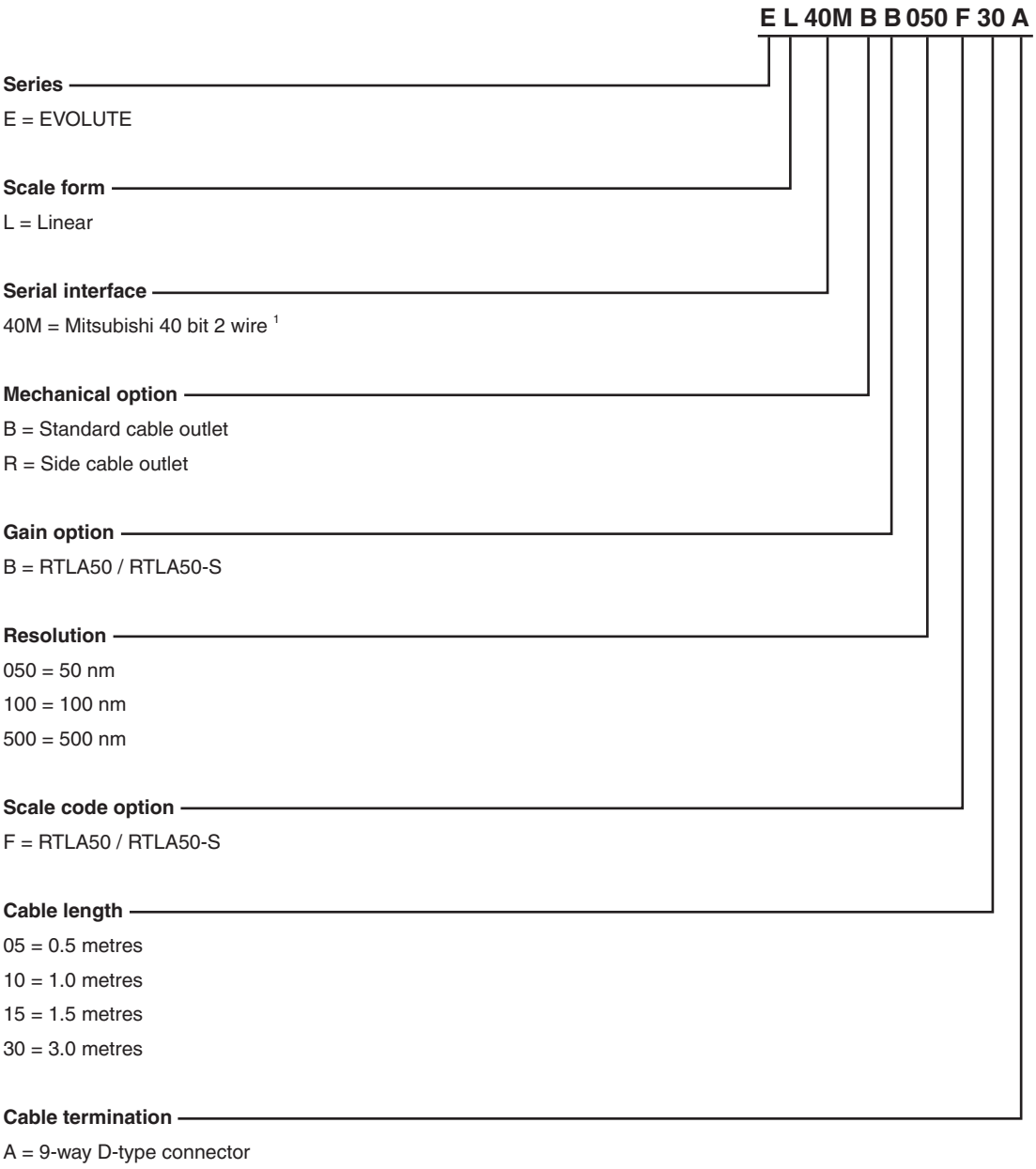
Valid system configurations (readheads and scale) can be checked at www.renishaw.com/epc.

EVOLUTE FANUC readhead part numbers



Valid system configurations (readheads and scale) can be checked at www.renishaw.com/epc.

EVOLUTE Mitsubishi readhead part numbers

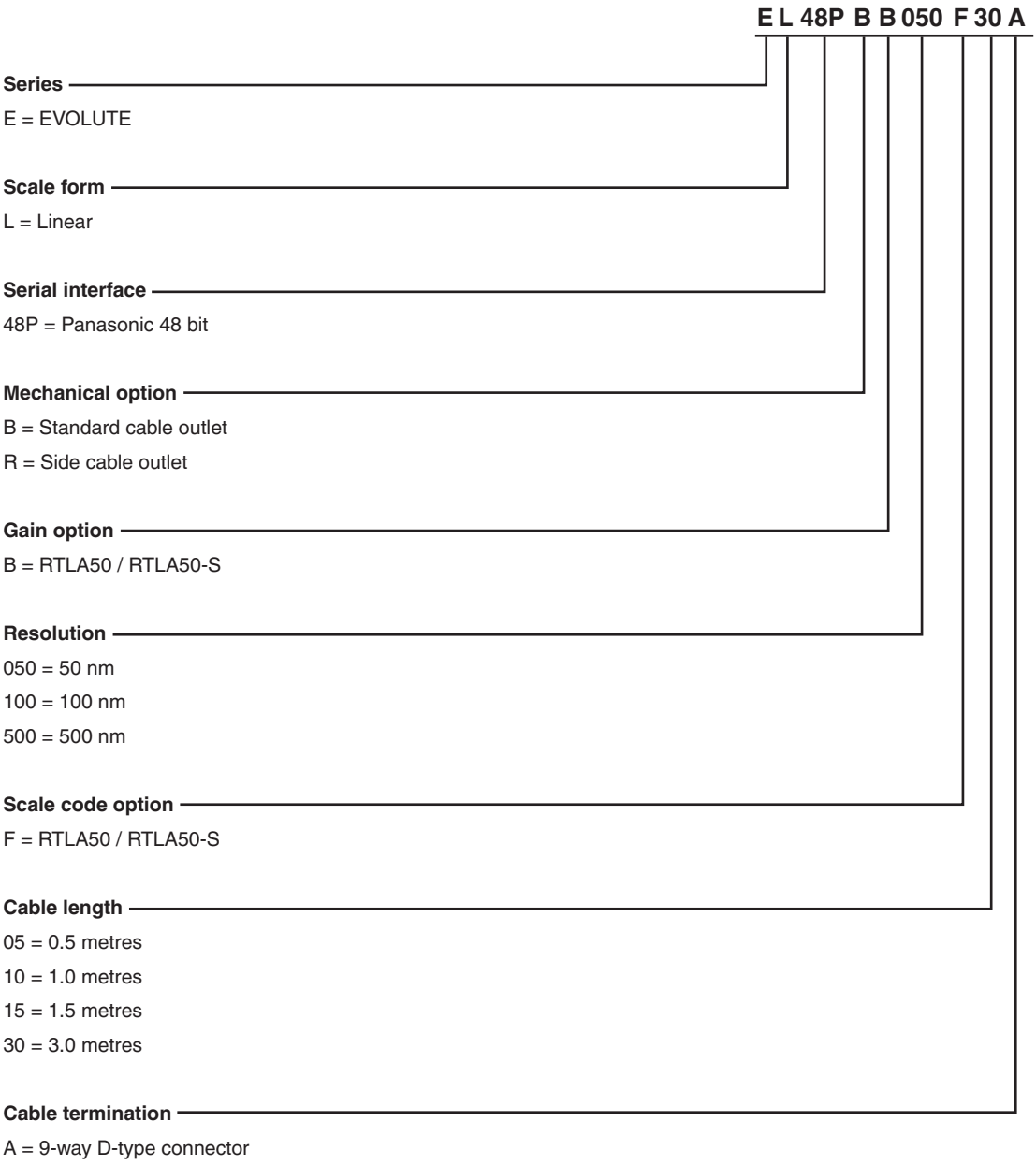


For more information about Mitsubishi drives, contact Mitsubishi.

Valid system configurations (readheads and scale) can be checked at **www.renishaw.com/epc**.

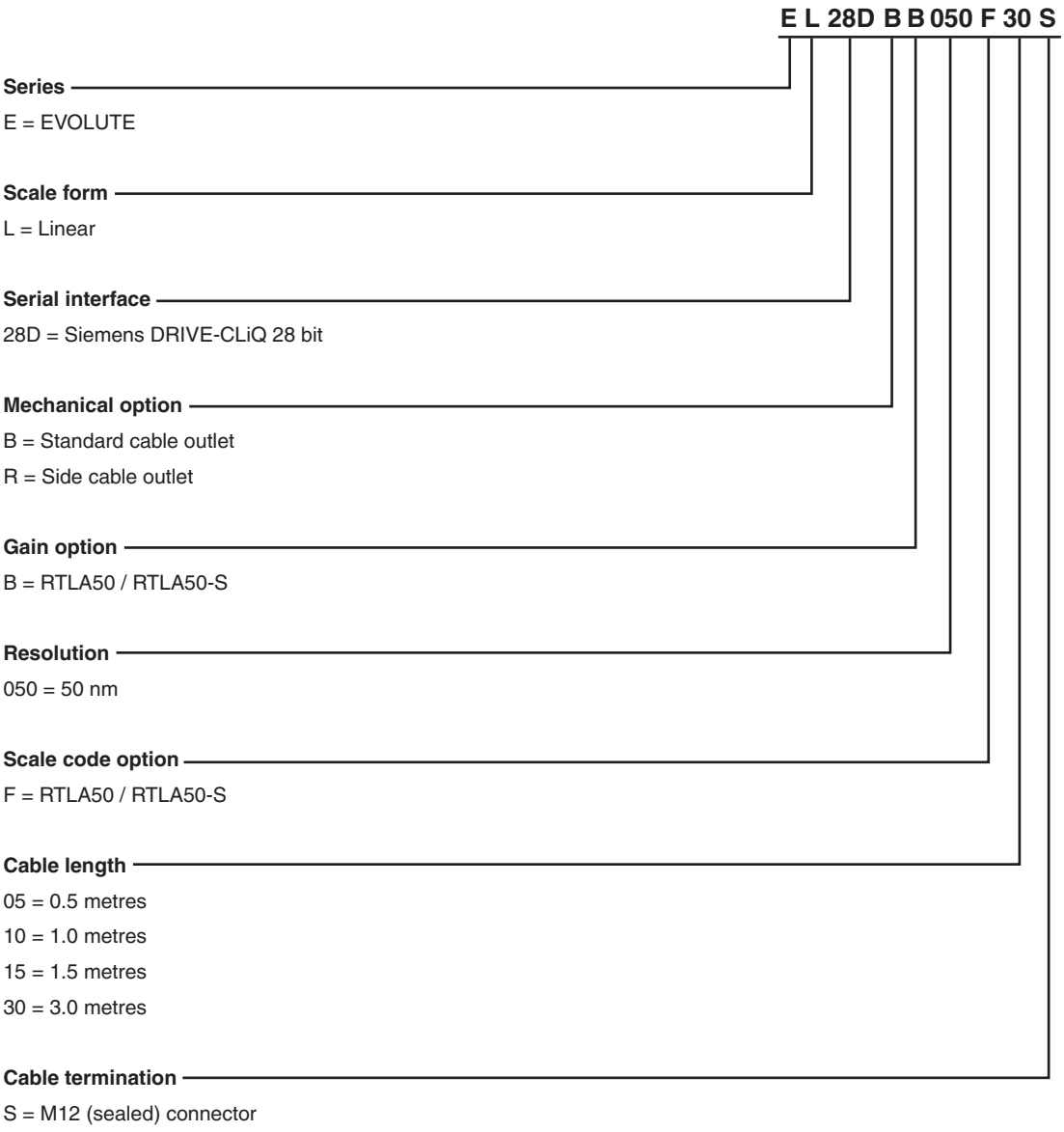
[1] 2 wire: MR-J4 series/MR-J5 series

EVOLUTE Panasonic readhead part numbers



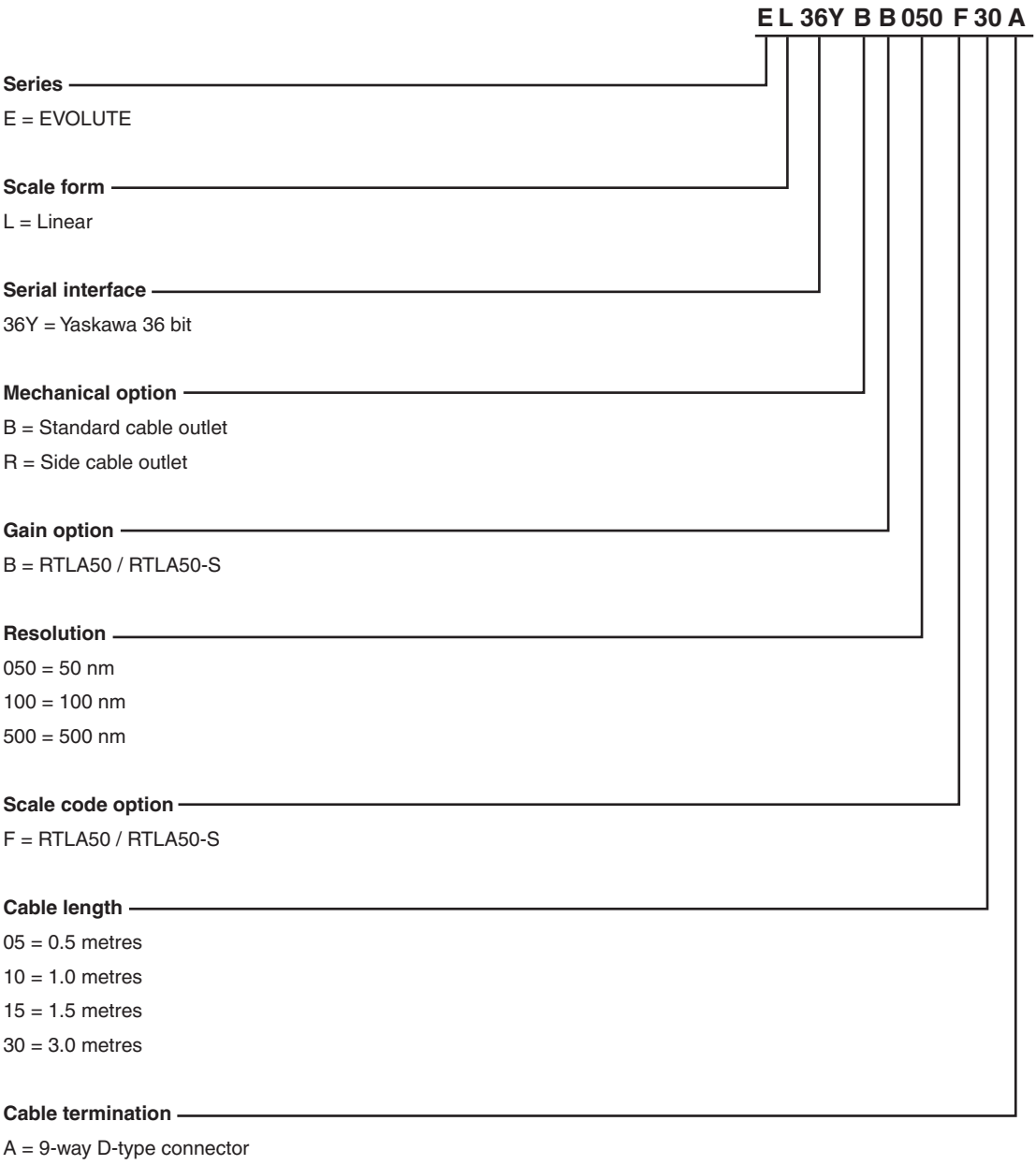
Valid system configurations (readheads and scale) can be checked at **www.renishaw.com/epc**.

EVOLUTE Siemens DRIVE-CLiQ readhead part numbers



Valid system configurations (readheads and scale) can be checked at **www.renishaw.com/epc**.

EVOLUTE Yaskawa readhead part numbers



Valid system configurations (readheads and scale) can be checked at www.renishaw.com/epc.

Optional Advanced Diagnostic Tool

The EVOLUTE encoder system is compatible with the Advanced Diagnostic Tool ADTa-100 [1] and ADT View software, which acquire detailed real-time data from the readhead to allow easy set-up, optimisation and in-field fault finding.

The intuitive software interface provides:

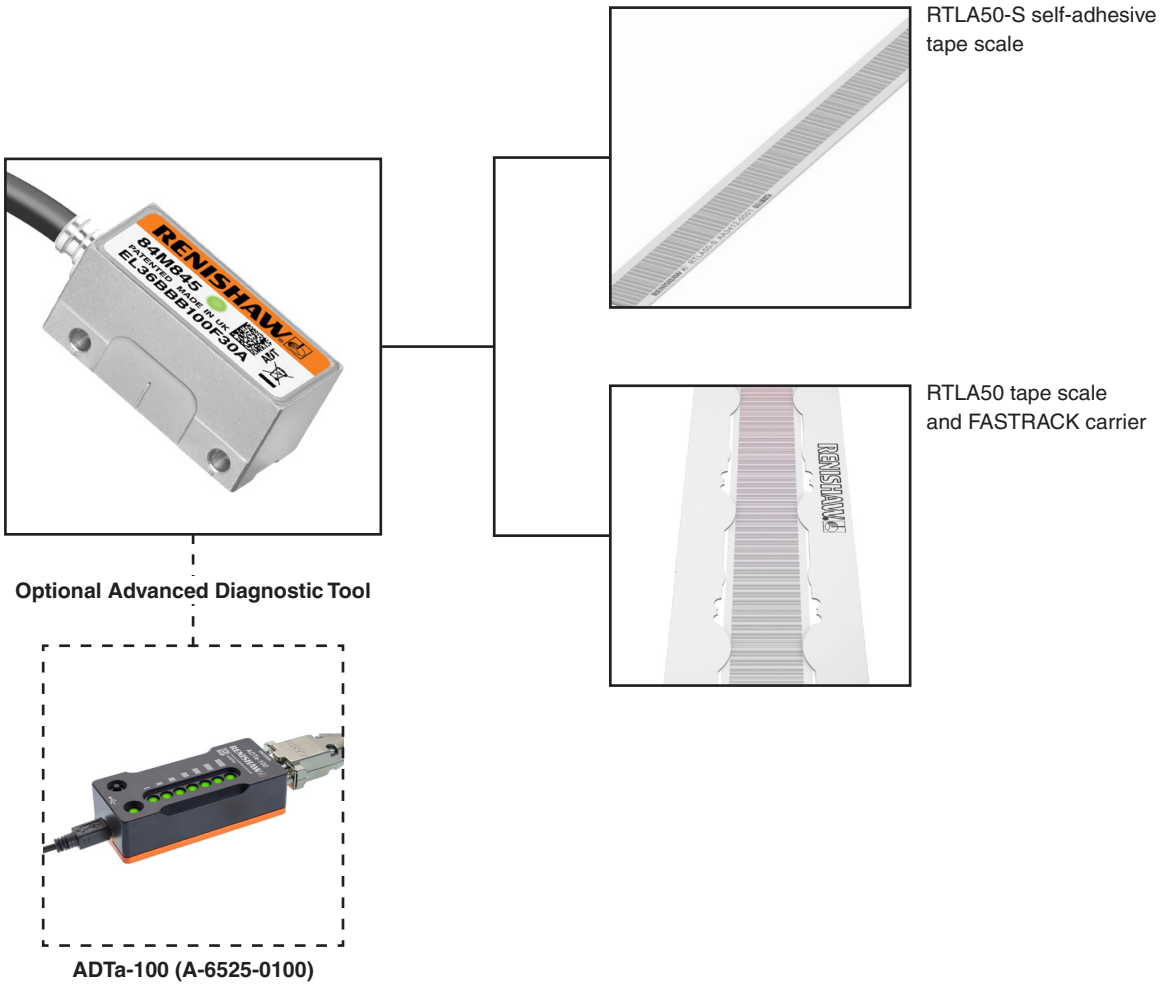
- Digital readout of encoder position and signal strength
- Graph of signal strength over the entire axis travel
- Ability to set a new zero position for the encoder system
- System configuration information



[1] ADTa-100 compatible readheads are marked with the symbol ADT

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EVOLUTE series compatible products



For more information about the ADTa-100 and the scale, refer to the relevant data sheets and installation guides which can be downloaded from **www.renishaw.com/evolutedownloads**.

www.renishaw.com/contact

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BiSS® C-mode (unidirectional) for EVOLUTE™ encoders

About EVOLUTE™ with BiSS interface

Renishaw EVOLUTE BiSS encoders use the C-mode (unidirectional) BiSS serial interface, (**www.renishaw.com/biss-serial-interface-support**).

EVOLUTE Linear encoders are available with a range of different resolutions (and maximum measuring lengths) as specified in the *EVOLUTE™ absolute optical encoder system* data sheet (Renishaw part no. L-9518-0027) which can be downloaded from **www.renishaw.com/evolutedownloads**.

More information on BiSS serial interfaces is available on the BiSS website: **www.biss-interface.com**.

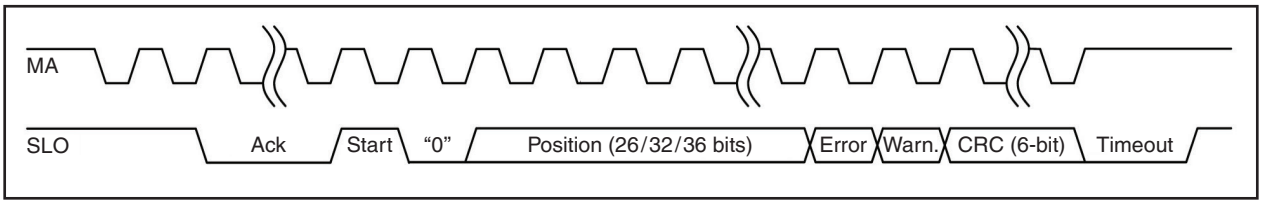
Description of the BiSS interface

BiSS C-mode (unidirectional) is a fast synchronous serial interface for acquiring position data from an encoder.
It is a master-slave interface. The master controls the timing of position acquisition and the data transmission speed, and the encoder is the slave. The interface consists of two unidirectional differential pairs of lines:

- MA transmits position acquisition requests and timing information (clock) from master to encoder.
- SLO transfers position data from encoder to master, synchronised to MA.

The diagram below shows the data transmitted.

Data format



The master-slave signal communication format is RS485/RS422 differential line-driven.

A typical request cycle proceeds as follows:

1. When idle, the master holds MA high. The encoder indicates it is ready by holding SLO high.
2. The master requests position acquisition by starting to transmit clock pulses on MA.
3. The encoder responds by setting SLO low on the second rising edge on MA.
4. After the Ack period is complete, the encoder transmits data to the master synchronised with the clock as shown in the Data format diagram.
5. When all data has been transferred, the master stops the clock and sets MA high.
6. If the encoder is not yet ready for the next request cycle, it sets SLO low (the Timeout period).
7. When the encoder is ready for the next request cycle, it indicates this to the master by setting SLO high.

Description of data

Ack

This is the period during which the readhead calculates the absolute position. See the timing information table on the next page.

Start and “0” (1 bit each)

The encoder transmits the start bit to signal to the master that it is starting to transmit data. The start bit is always high and the “0” bit is always low.

Position (26, 32 or 36 bits)

The absolute position data is sent MSB first in binary format. Lower resolutions may be achieved by ignoring the least significant bit(s) of the position data.

Error (1 bit)

The error bit is active low: “1” indicates that the transmitted position information has been verified by the readhead’s internal safety checking algorithm and is correct; “0” indicates that the internal check has failed and the position information should not be trusted. The error bit is also set to “0” if the temperature exceeds the maximum specified for the product. The operating temperature limits of EVOLUTE systems are specified in the *EVOLUTE™ absolute optical encoder system* data sheet (Renishaw part no. L-9518-0027) which can be downloaded from **www.renishaw.com/evolutedownloads**.

Warning (1 bit)

The warning bit is active low: “0” indicates that the encoder scale (and/or reading window) should be cleaned.

NOTE: The warning bit is not an indication of the trustworthiness of the position data. Only the error bit should be used for this purpose.

CRC for position data (6 bit)

The CRC polynomial for position, error and warning data is: $x^6 + x^1 + x^0$. The CRC start value is 0x00. It is transmitted MSB first and inverted. The start bit and “0” bit are omitted from the CRC calculation.

Timeout

EVOLUTE encoders are capable of acquiring a new position reading every 31.25 µs (a maximum request cycle rate of 32 kHz). Therefore 31.25 µs must elapse between the start of one request cycle and the start of the next.

Nominal timeout is 1.5 x MA clock period.

However, it is possible for data transmission to be complete before 31.25 µs have elapsed. In this case, the encoder signals this to the master by holding the SLO line low until 31.25 µs have elapsed. This extends the timeout period.

Resetting the encoder

The master may reset the encoder at any time during a request cycle by stopping the clock and setting MA high. MA must be held high for the remaining duration of the full request cycle, including timeout period if applicable.

NOTE: SLO may be high or low during resetting (typically depending on the state of the last bit transmitted).

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Line delay compensation

Signals travelling between master and encoder experience a time delay due to the cable length and signal propagation delays within the master and encoder. The time delay has no effect at low clock speeds (where the time delay is much shorter than the clock period). However, for high clock speeds, it is necessary for the master to implement line delay compensation.

The master determines the round-trip time delay by measuring the time between transmitting the second rising edge on MA and receiving the falling edge of “Ack” on SLO.

MA clock speed	Maximum cable length	
	Without line-delay compensation	With line-delay compensation
250 kHz	95 m	100 m
1 MHz	20 m	100 m
2 MHz	8 m	100 m
5 MHz	0.5 m	100 m
10 MHz	-	50 m

NOTES:

- All figures relate to installations using EVOUTE readhead with original Renishaw cable up to 10 m in length, with the remainder cable length consisting of Renishaw 14-core extension cable (A-9531-0238),
- Care should be taken to ensure supply voltage is maintained within 5 V ±10% at the readhead connector.

  For extension cable lengths greater than 50 m, it is recommended that the spare 8 × 26 AWG cores are also used for power supply and the EVOLUTE readhead cable should be limited to 5 m to minimise voltage drop.
- This table makes no allowance for propagation delays within the master.

Timing information

	Minimum	Typical	Maximum	Units	Notes
Ack time	-	-	20	µs	The Ack period always ends on a rising edge of MA. Therefore at low MA clock frequencies, the Ack time may exceed 20 µs.
MA clock frequency	0.25	-	10	MHz	Within any one request cycle, the MA clock frequency must be constant. The duty cycle should be 1:1.
Request cycle rate	-	-	32	kHz	32 kHz is not achievable for all MA clock frequencies (because data transmission takes too long).
Sampling moment	3.225	3.250	3.275	µs	Timed from the first rising edge on MA.
EVOLUTE internal line-delay	-	-	42.5	ns	This is the internal propagation delay (MA-SLO) within EVOLUTE encoders.
Line-delay due to cable length	-	10	-	ns/m	This is the round-trip delay experienced by signal travelling through the cable (that is, from master to encoder and back to master again).

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