

Series ETS25 – singleturn, digital output, not redundant
Key features ETS25:

- Supply voltage 5 VDC +/-10%
- High-speed efficient signal transmission
(only possible via short signal cables limited by clock rate)


Electrical data ETS25 – singleturn, digital output, not redundant

Output signal	SPI
Effective electrical angle of rotation 1.)	360°
Independent linearity (best straight line) 1.)	±0,3% @ 360°
Absolute linearity 1.)	±0,6% @ 360°
Resolution	14 Bit
Update rate (cable length 15 cm max.)	200 µs
Supply voltage	5 VDC ±10%
Power consumption (no load)	≤ 12 mA
Insulation voltage 1.)	1000 VAC @ 50 Hz, 1 min
Insulation resistance 1.)	2 MOhm @ 500 VDC, 1 min
MTTF (EN29500-2005-1)	2046a

1.) According IEC 60393

Cable/colour assignment – option 05SPI, not redundant

Function:	Option R (round signal cable)	Option F (flatribbon cable)
VSUP	red	Lead 1
GND	black	Lead 2
CS, MOSI	yellow	Lead 3
CLK	green	Lead 4
DATA	orange	Lead 5
-	brown n/c	

For details on zero point definition and output programming see page 28.

Order Code ETS25 – singleturn, digital output, not redundant							
Description	Selection: standard= black/bold , possible options= <i>grey/italic</i>						
Series	ETS25						
Shaft diameter, shaft length: Shaft diameter Ø 6 mm, shaft length 22 mm <i>Shaft diameter Ø 6.35 mm, shaft length 22 mm</i> <i>Custom shaft dimensions [mm] Ø ≤6.35 mm</i>		6x22 <i>6,35x22</i> <i>XxXX</i>					
Supply voltage / output signal: 5 VDC ± 10% / SPI (14 Bit)			05SPI				
Operational torque: Standard torque <i>Improved/medium torque</i>				- <i>MT</i>			
Shaft sealing: None <i>With shaft sealing</i>					- <i>D</i>		
Electrical connection, cable length: Flat ribbon cable, standard length 0.15 <i>Flat ribbon cable with custom length [x,xx m]</i> <i>Round cable with custom length [x,xx m] (max. 1 m for SPI, recommended < 15 cm)</i>						F0,15 <i>FX,XX</i> <i>RX,XX</i>	
Anti-rotation pin, zero point definition: Pin A <i>Pin B</i> <i>None (pins removed) (no zero point definition possible)</i>							A <i>B</i> <i>-</i>

Order example ETS25 – singleturn, digital output, not redundant	
Requirement: Shaft Ø 6.00 mm, shaft length 22 mm, 14 Bit/5 VDC/SPI, no shaft sealing, flat ribbon cable 0.15 m, anti-rotation pin B	
Example for order code: ETS25 6x22 05SPI F0,15B	

Protocol description ETS25 – Serial Peripheral Interface (SPI)

Introduction

The encoder is configured as a Slave node. The serial protocol of the is a three wires protocol (/SS, SCLK, MOSI-MISO):

- /SS output is a 5 V tolerant digital input
- SCLK output is a 5 V tolerant digital input
- MOSI-MISO output is a 5 V tolerant open drain digital input/output

Basic knowledge of the standard SPI specification is required for the good understanding of the present section.

Even clock changes are used to sample the data. The positive going edge shifts a bit to the Slave's output stage and the negative going edge samples the bit at the Master's input stage.

MOSI (Master Out Slave In)

The Master sends a command to the Slave to get the angle information.

MISO (Master In Slave Out)

The MISO of the slave is an open-collector stage. Due to the capacitive load, a >1 kΩ pull-up is used for the recessive high level (in fast mode). Note that MOSI and MISO use the same physical wire of the ETS25.

/SS (Slave Select)

The /SS output enables a frame transfer. It allows a re-synchronization between Slave and Master in case of a communication error.

Master Start-Up

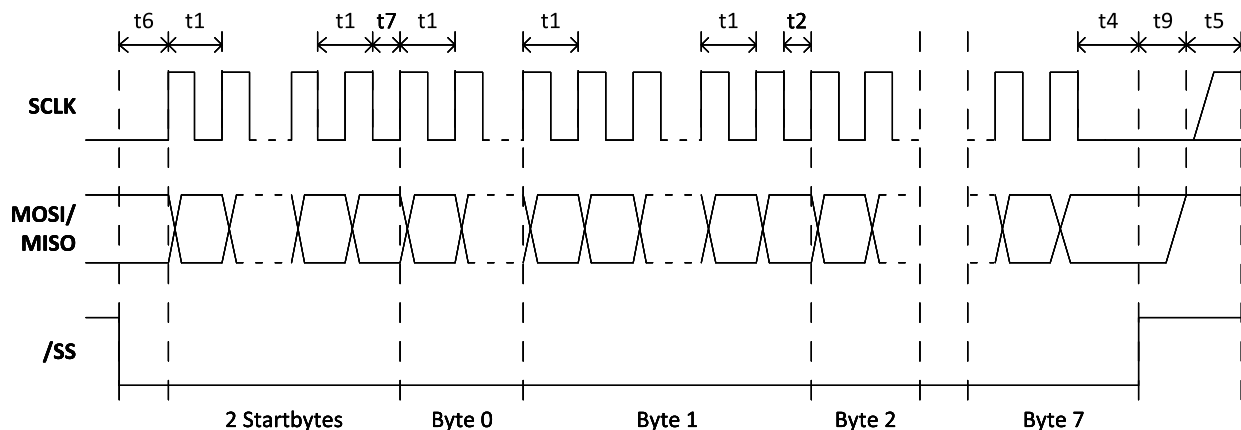
/SS, SCLK, MISO can be undefined during the Master start-up as long as the Slave is re-synchronized before the first frame transfer.

Slave Start-Up

The slave start-up (after power-up or an internal failure) takes 16 ms. Within this time /SS and SCLK is ignored by the Slave. The first frame can therefore be sent after 16 ms. MISO is Hi-Z (i.e. Hi-Impedance) until the Slave is selected by its /SS input. The encoder will cope with any signal from the Master while starting up.

Timing

To synchronize communication, the Master deactivates /SS high for at least t5 (1.5 ms). In this case, the Slave will be ready to receive a new frame. The Master can re-synchronize at any time, even in the middle of a byte transfer. Note: Any time shorter than t5 leads to an undefined frame state, because the Slave may or may not have seen /SS inactive.



Protocol description ETS25 – Serial Peripheral Interface (SPI) (continuation)
Description Timings

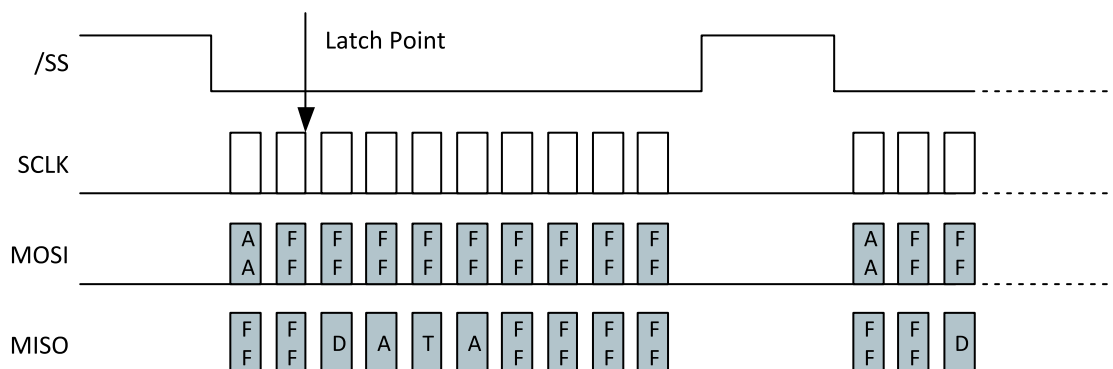
Timings	Min	Max	Remarks
t1	2.3 μ s / 6.9 μ s	-	No capacitive load on MISO. t1 is the minimum clock period for any bits within a byte.
t2	12.5 μ s / 37.5 μ s	-	t2 the minimum time between any other byte
t4	2.3 μ s / 6.9 μ s	-	Time between last clock and /SS=high=chip de-selection
t5	300 μ s / 1500 μ s	-	Minimum /SS = Hi time where it's guaranteed that a frame re-synchronizations will be started
t5	0 μ s	-	Maximum /SS = Hi time where it's guaranteed that NO frame re-synchronizations will be started.
t6	2.3 μ s / 6.9 μ s	-	The time t6 defines the minimum time between /SS = Load the first clock edge
t7	15 μ s / 45 μ s	-	t7 is the minimum time between the StartByte and the Byte0
t9	-	< 1 μ s	Maximum time between /SS = Hi and MISO Bus HighImpedance
T _{Startup}	-	< 10 ms / 16 ms	Minimum time between reset-inactive and any master signal change

Slave Reset

On internal soft failures the Slave resets after 1 second or after an (error) frame is sent. On internal hard failures the Slave resets itself. In that case, the Serial Protocol will not come up. The serial protocol link is enabled only after the completion of the first synchronization (the Master deactivates /SS for at least t5).

Frame Layer
Command Device Mechanism

Before each transmission of a data frame, the Master should send a byte AAh to enable a frame transfer. The latch point for the angle measurement is at the last clock before the first data frame byte.


Data Frame Structure

A data frame consists of 10 bytes:

- 2 start bytes (AAh followed by FFh)
- 2 data bytes (DATA16 – most significant byte first)
- 2 inverted data bytes (/DATA16 - most significant byte first)
- 4 all-Hi bytes

The Master should send AAh (55h in case of inverting transistor) followed by 9 bytes FFh. The Slave will answer with two bytes FFh followed by 4 data bytes and 4 bytes FFh.

Prokollbeschreibung ETS25 – Serial Peripheral Interface (SPI) (Fortsetzung)
Timing

There are no timing limits for frames: a frame transmission could be initiated at any time. There is no interframe time defined.

Data Structure

The DATA16 could be a valid angle or an error condition. The two meanings are distinguished by the LSB.

DATA16: Angle A[13:0] with (Angle Span)/2¹⁴

Most Significant Byte								Least Significant Byte							
MSB							LSB	MSB							LSB
A13	A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	0	1

DATA16: Error

Most Significant Byte								Least Significant Byte							
MSB							LSB	MSB							LSB
E15	E14	E13	E12	E11	E10	E9	E8	E7	E6	E5	E4	E3	E2	E1	E0

DATA16: Error

BIT	Name	Description
E0	0	
E1	1	
E2	F_ADCMONITOR	ADC Failure
E3	F_ADCSATURA	ADC Saturation (Electrical failure or field too strong)
E4	F_RGTOOLOW	Analog Gain Below Trimmed Threshold (Likely reason: field too weak)
E5	F_MAGTOOLOW	Magnetic Field Too Weak
E6	F_MAGTOOHIGH	Magnetic Field Too Strong
E7	F_RGTOOHIGH	Analog Gain Above Trimmed Threshold (Likely reason: field too strong)
E8	F_FGCLAMP	Never occurring in serial protocol
E9	F_ROCLAMP	Analog Chain Rough Offset Compensation: Clipping
E10	F_MT7V	Device Supply VDD Greater than 7V
E11	-	
E12	-	
E13	-	
E14	F_DACMONITOR	Never occurring in serial protocol
E15	-	

Angle Calculation

All communication timing is independent (asynchronous) of the angle data processing. The angle is calculated continuously by the Slave every 350 µs at most. The last angle calculated is hold to be read by the Master at any time. Only valid angles are transferred by the Slave, because any internal failure of the Slave will lead to a soft reset.

Error Handling

In case of any errors listed above, the Serial protocol will be initialized and the error condition can be read by the master. The slave will perform a soft reset once the error frame is sent. In case of any other errors (ROM CRC error, EEPROM CRC error, RAM check error, intelligent watchdog error...) the Slave's serial protocol is not initialized. The MOSI/MISO output will stay Hi-impedant (no error frames are sent).

Series ETS25X – singleturn, SPI output, redundant
Key features ETS25X:

- Independent signal processing. The ETS25X rotary encoder electronics are based on one Hall IC in which two semiconductor elements independently capture, evaluate and output measured values
- Supply voltage, signal output and ground are galvanically insulated => separate electrical connections
- Supply voltage: 2 x 5 VDC $\pm 10\%$
- Signal output: 2 x SPI
- Maximum allowed signal cable length (each) 0.6 m

Electrical data ETS25X – singleturn, SPI output, redundant

Effective electrical angle of rotation 1.)	360°
Sense of rotation (when looking at the shaft, from the front)	Clockwise/clockwise (ganging)
Independent linearity (best straight line) 1.)	$\pm 0.4\%$ @ 360°
Absolute linearity 1.)	$\pm 0.8\%$ @ 360°
Output signal	SPI
Resolution	14 Bit
Update rate	200 μ s
Supply voltage	5 VDC $\pm 10\%$
Power consumption (no load)	≤ 24 mA
Insulation voltage 1.)	1000 VAC @ 50 Hz, 1 min
Insulation resistance 1.)	2 MOhm @ 500 VDC, 1 min
MTTF (EN29500-2005-1)	2046a

1.) According IEC 60393

Cable and pin assignment ETS25X

Function:	Option F:	Explanation:
VSUP 1	Lead 1 (red)	5 pol. flat ribbon cable no. 1
GND 1	Lead 2	5 pol. flat ribbon cable no. 1
Data 1	Lead 3	5 pol. flat ribbon cable no. 1
Clock 1	Lead 4	5 pol. flat ribbon cable no. 1
Chipselect 1	Lead 5	5 pol. flat ribbon cable no. 1
VSUP 2	Lead 1 (red)	5 pol. flat ribbon cable no. 2
GND 2	Lead 2	5 pol. flat ribbon cable no. 2
Data 2	Lead 3	5 pol. flat ribbon cable no. 2
Clock 2	Lead 4	5 pol. flat ribbon cable no. 2
Chipselect 2	Lead 5	5 pol. flat ribbon cable no. 2

Further information regarding the signal outputs can be found in the data sheet of the IC manufacturer.

SPI-Interface

MLX90316EDC DUAL (redundant version)

URL: www.melexis.com

For details on zero point definition and output programming see page 28.

Order Code ETS25X – redundant, singleturn, digital output							
Description	Selection: standard= black/bold , possible options= <i>grey/italic</i>						
Series	ETS25X						
Shaft diameter, shaft length: Shaft diameter \varnothing 6 mm, shaft length 22 mm <i>Shaft diameter \varnothing 6.35 mm, shaft length 22 mm</i> <i>Custom shaft dimensions [mm] $\varnothing \leq 6.35$ mm</i>		6x22 <i>6,35x22</i> <i>XxXX</i>					
Supply voltage / output signal: 5 VDC \pm 10% / SPI (14 Bit), redundant			05SPI				
Operational Torque: Standard torque <i>Improved/medium torque</i>				- <i>MT</i>			
Shaft sealing: None <i>With shaft sealing</i>					- <i>D</i>		
Electrical connection, cable length: Flat ribbon cable, standard length 0.15 m, two arranged above each other <i>Flat ribbon cable with custom length [x,xx m], two arranged above each other</i> <i>Round cable with custom length [x,xx m] (max. 0.6 m)</i>						F0,15 <i>FX,XX</i> <i>RX,XX</i>	
Anti-rotation pin, zero point definition: <i>Pin A</i> Pin B <i>None (pins removed) (no zero point definition possible)</i>							A B -

Order example ETS25X
Specifications:

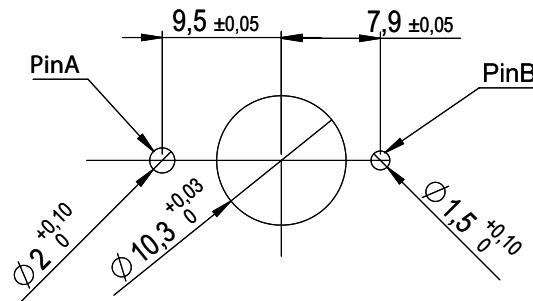
Shaft \varnothing 6.00 mm, shaft length 22 mm, 14 Bit/5 VDC/SPI, no shaft sealing, two 5 pol. flat ribbon cables arranged one above the other with cable length 0.15 m for each flat ribbon cable, anti-rotation pin B

Example for order code:

ETS25X 6x22 05SPI F0,15B

Drilling pattern

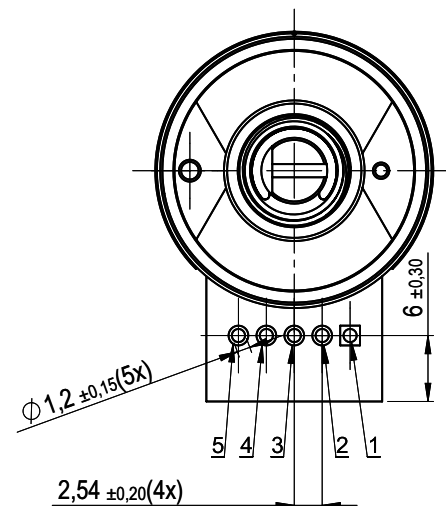
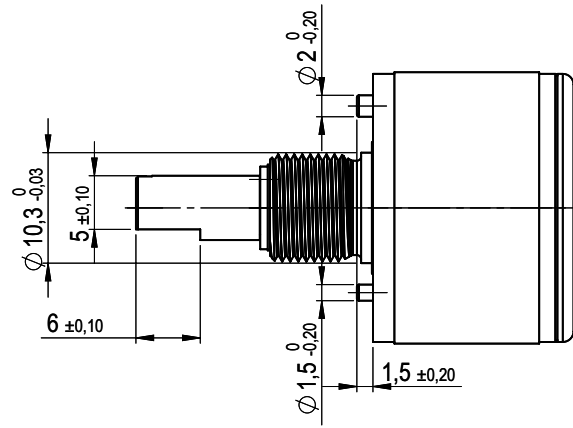
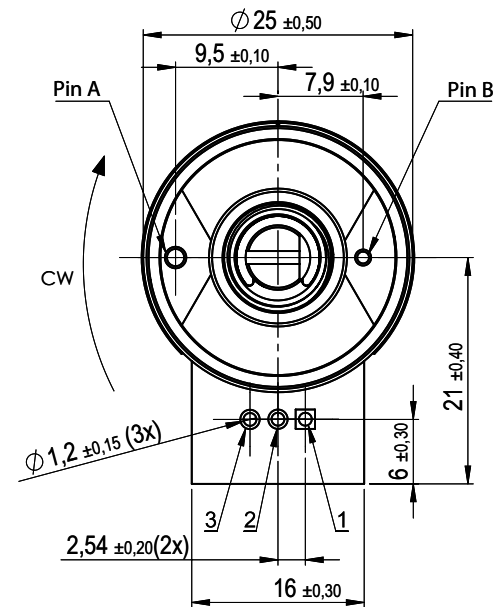
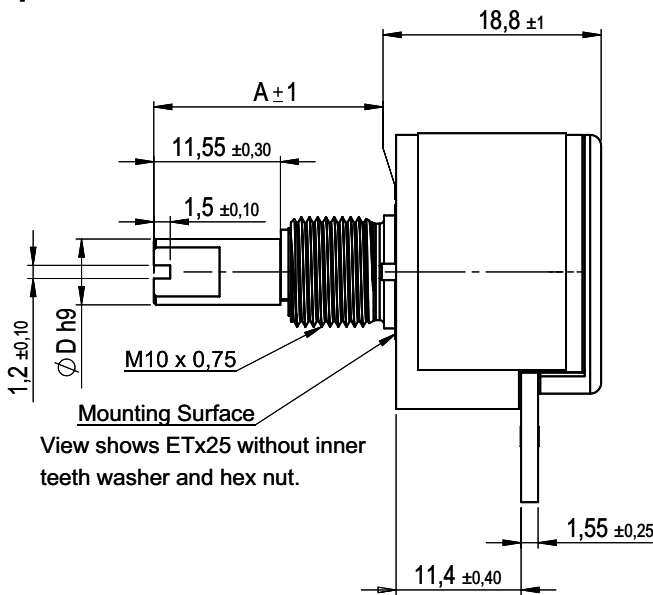
Pattern of Drilling



Either pin A or pin B must be chosen as anti-rotation pin. Please select by specifying the variant in the order code. The unused pin can be left out when drilling.

Drawings ETx25 – with solder holes (option L)

Option L

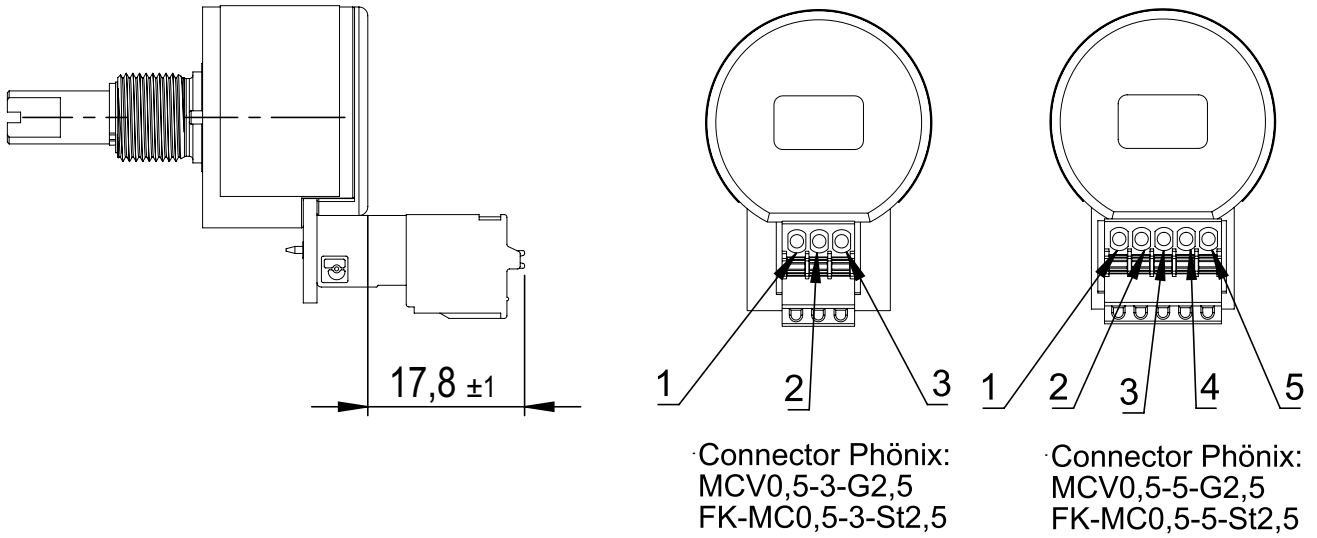


Standard shaft dimensions / tolerances	
Shaft length A	22 +/- 1 mm
Shaft diameter D	6 h9 mm, 6.35 h9 mm
Shaft flattening (D-flat)	6 +/- 0.1 mm

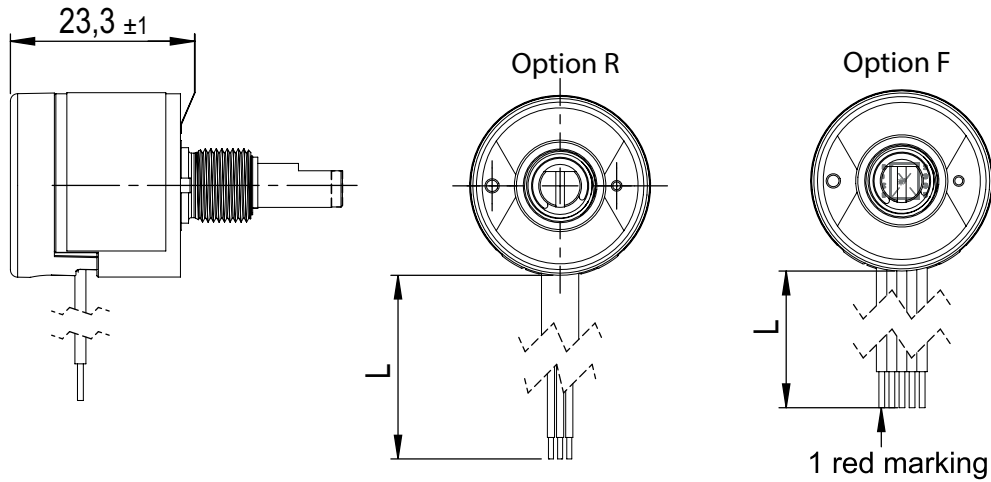
All dimensions in mm

Drawings ETx25 – clamping terminals (option K) and cable versions (options R and F)

Option K (clamping terminals)

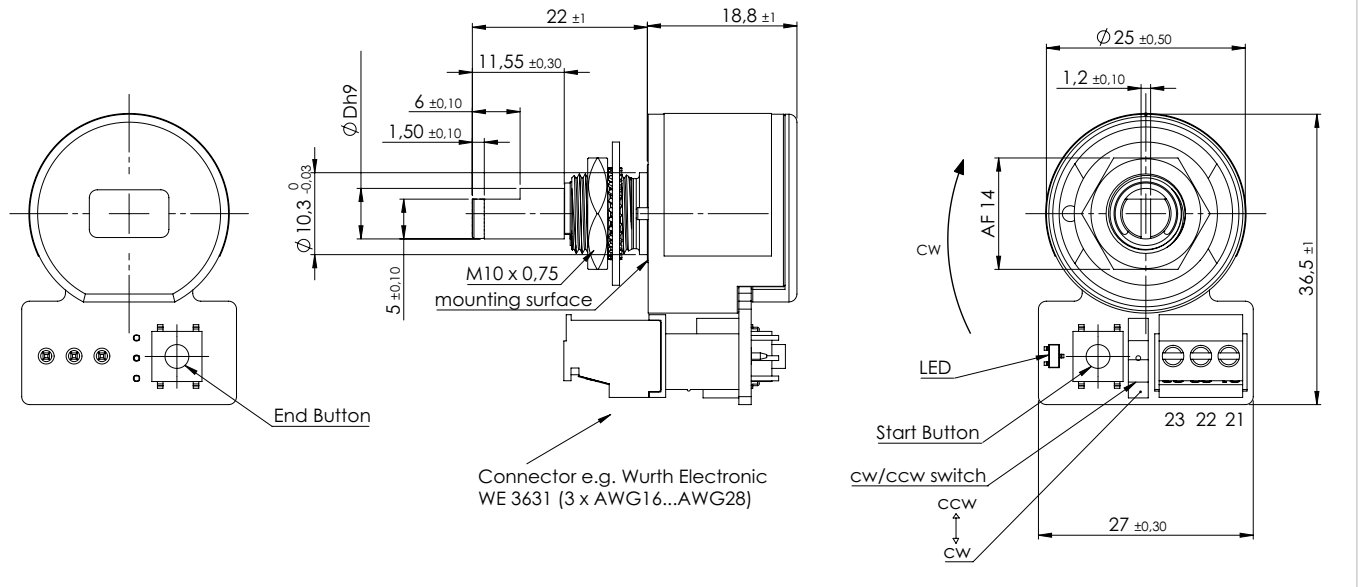


Options F (flat ribbon cable) and R (round control cable)



Drawings ETx25PM – teach-in feature

ETA25PM – Multiturn (option TS) with teach-in feature



Cable specs for option F (flat ribbon cable) and R (round control cable)

Option	Standard cable length L	Number of single strands (depends on electronics)	Cable sheath \varnothing or width	Single strands cross section	Allowed tolerance (L)	Minimum bending radius
R	Standard 1000 mm	3	4.3 mm	AWG26	-20 mm to +50 mm	3 x D \varnothing (D = cable sheath diameter \varnothing)
		6	5.2 mm			
		8	5.6 mm			
		12	6 mm	AWG28		
F	150 mm	3 to 12	ca. 1.25 per strand	AWG26	-20 mm to +25 mm	-

Cables without cable shield

(*) Tolerances according IPC Association

Cable length tolerances – custom lengths

Length L	Tolerance
≤ 0.3 m	+25 mm / -20 mm
> 0.3 m - 1.5 m	+50 mm / -20 mm
> 1.5 m - 3 m	+100 mm / -40 mm
> 3 m - 7.5 m	+150 mm / -60 mm

Cable harness length measured from sensor surface or soldering pad including connector.
 Minimum cable length: 0.08 m (for round cable), 0.05 m for ribbon cable

Mechanical and environmental data, miscellaneous	
Mechanical angle of rotation 1.)	Endless or 320° (270°/180°/90°), ±5° with mechanical stop option
Lifetime 2.)	> 100 Mio. shaft rotation movements Option D: Sealing of the shaft is working ≥ 200 000 shaft rotation movements
Bearing	Sleeve bearing
Max. operational speed	100 rpm (< 1 min. 800 rpm)
Operational torque	0.1 ≤ M ≤ 0.6 Ncm (without shaft sealing) 0.3 ≤ M ≤ 1.3 Ncm (@RT, 10 rpm) (with increased torque)
Operating temperature range	Standard: -40 to +85 °C (cable fixed installed) Option TS: -25 to +70 °C
Storage temperature range	Standard: -40 to +105 °C Option TS: -40 to +90 °C (teach-In multiturn)
Protection grade (IEC 60529) front side	From shaft side: ▪ IP40 standard ▪ IP55M (IP66S) with shaft sealing (option D)
Protection grade (IEC 60529) rear side	▪ IP50 Solder holes / clamping terminals (solder holes / connector excluded) ▪ IP66 flat ribbon and round signal cable (cable ends excluded) ▪ IP00 option TS (teach-in multiturn)
Vibration (DIN EN 60068-2-6)	±1.5 mm / 30 g / 10 to 2000 Hz / 16 frequency cycles (3x4 h)
Shock (DIN EN 60068-2-27)	100 g / 6 ms / half sine (3x6 shocks)
Housing diameter	Ø 25 mm
Housing depth	see drawings
Shaft diameter	Standards: Ø 6 mm, Ø 6.35 mm Option: User defined shaft diameter [mm]
Max. radial load	1 N
Max. axial load	1 N
Mass (circa)	▪ ca. 26 g (option L: solder lugs) ▪ ca. 60 g (option R: cable, valid for 1 m only) ▪ ca. 32 g (option F: flat ribbon cable, valid for 15 cm only) ▪ ca. 27 g (option K: clamping terminals) ▪ ca. 31 g (option TS: teach-In multiturn)
Connection type	▪ Solder lugs (option L) ▪ Ribbon cable (option F) ▪ Cable (option R) ▪ Connector (option K)
Connection position	Radial
Sensor mounting	Bushing via M10 x 0,75
Fastening parts included in delivery	Hex nut and tooth washer, if option D is ordered then an additional O-Ring is part of delivery as sealing between mounting panel and rotary encoder.
Fastening torque mounting nut	≤ 3 Nm
Material shaft	Stainless steel
Material housing	Plastic / Bronze

1.) According IEC 60393

2.) Determined by climatic conditions according to IEC 68-1, para. 5.3.1 without load collectives

Immunity / Electrostatic Discharge / REACH / RoHS

EN 61000-4-3 RF sine wave	Class A
EN 61000-4-6 Conducted sine wave	Class A
EN 61000-4-8 Power frequency magnetic fields	Class A
EN 61000-4-2 ESD 3.)	Class B
REACH Regulation (EC) 1907/2006 including the SVHC list	
RoHS Directive 2011/65/EU	

3.) Not tested for Option TS

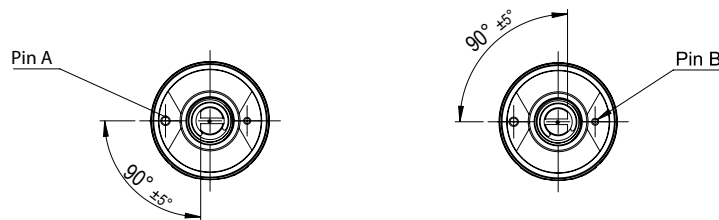
Definition of the zero position / anti-rotation pin

Output at the zero point:

ETA25 (analogue outputs): Output signal 0% full scale (F. S.)
 ETP25 (PWM output): duty cycle 10% (10% duty cycle)
 ETS25 (serial output): Output signal 0% full scale (F. S.)
 ETI25 (incremental output): The index signal is output (Z)

Position of the zero position:

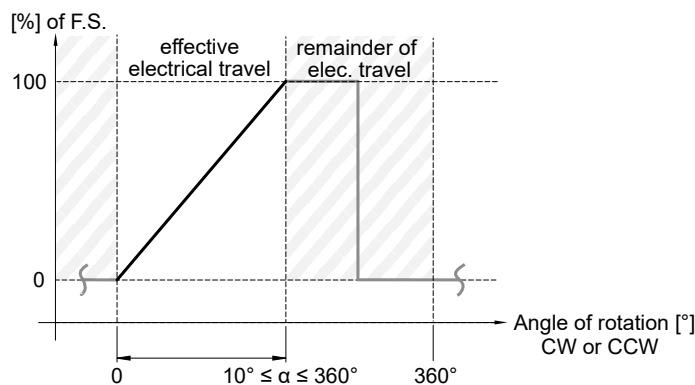
Option anti-rotation pin A	Zero position when shaft flattening faces anti-rotation pin A
Option anti-rotation pin B	Zero position when shaft flattening faces anti-rotation pin A



Signal definition for custom rotation angles (without mechanical stop)

Custom angles <360°

When programming the electrical angle of rotation of <360°, the remaining non-effective range of rotation is divided equally into high and low. Valid only for encoders without mechanical stop!



Mechanical stop and centre detent for manual encoder applications

- A mechanical stop limits the rotation to either 320°, 270°, 180° or 90° (±5°). Other angles are not available. Due to the mechanical tolerances (±5°), the effective electrical angle is reduced by 10°.
- Optionally a centre detent can be selected in addition to the mechanical stop. It enables the operator to e. g. feel the centre position when operating the encoder by hand
- The zero point definition for mechanical stop option differs from the standard zero point definition. Only drilling pattern B (pin B) is available. See the details below.

Mechanical stop only: Relationship between mechanical and effective electrical angle of rotation

Mechanical angle of rotation (±5°)	Effective electrical angle of rotation (±0.5°)
320°	310°
270°	260°
180°	170°
90°	80°

