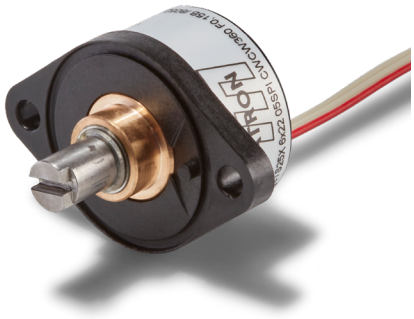
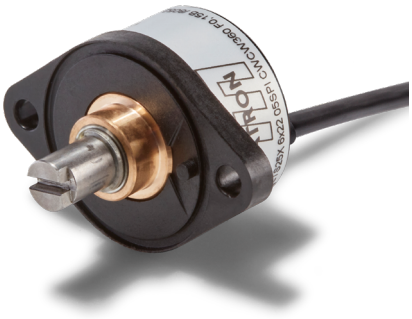


with flat ribbon cable



with round cable

Key features

- Ø25 mm housing made of glass fibre reinforced thermoplastic
- Magnetic, gradient-based signal evaluation
- Digital signal processing
- Metal sleeve bearing > 100 million shaft revolutions
- Ø6 mm / Ø6.35 mm stainless steel shaft
- Sealing up to IP55M (IP66S with special sealing option)
- Operating temperature range -40 to 85°C
- Measurement range up to 360° singleturn, 72,000° multiturn
- Electrical connection: 0.15 m flat ribbon cable, 1 m round cable, solder holes or clamping terminals
- Ex works programmable signal output functions (single turn), field-programmable signal output for multiturn version
- Higher torque available for panel encoder applications

Applications

- Mechanical engineering
- Equipment manufacturing
- Speed measurement with low operational speeds (up to 100 rpm)
- Driverless transport systems
- Medical equipment
- Special vehicles
- High requirements on the lifetime
- Requirements of a user defined signal output function
- As panel encoder for manual input

Output variants	
Singleturn absolute encoders	▪ Analogue voltage or current loop output (12 bit resolution) ▪ Analogue PWM output (12 bit resolution) ▪ Digital outputs SSI (10-18 bit), SPI (14 bit, also redundant)
Field-Programmable single or multiturn absolute encoder	▪ Analogue voltage or current loop output (12 bit resolution) ▪ Not True-Power-On (no data aquisition during voltage loss), max. 200 revolutions (72,000°)
Incremental encoders	▪ 1 to 10,000 pulses per revolution (ppr.) ▪ Outputs TTL, Push-Pull, Open Collector

ETx25F encoders – compact and versatile

The ETx25F series of encoders has been specially designed for applications where durability and adaptability are essential. Manufactured in a Ø25 mm glass-fibre reinforced thermoplastic, these contactless encoders offer a wide range of electronic and mechanical options to suit the application. Whether as incremental or absolute value encoders, they cover a wide range of applications and, depending on the output electronics, are used in systems, laboratory equipment and medical devices, for example.

The ETx25F is one of the most versatile encoders on the market. The encoders feature a high quality sleeve bearing, which is characterised by a long service life of more than 100 million shaft revolutions. Signal processing is digital and based on magnetic recording of the measured values. The gradient-based evaluation ensures high immunity, e.g. to temperature fluctuations and EMC influences. This technology overcomes the disadvantages of conventional Hall sensors. ETx25F encoders are designed for maximum lifetime. The number of defects or failures in encoders with this technology design is very low, even after decades of use.

In addition to a wide range of standard options, the modular design of the ETx25F encoders enables optimum adaptation to the specific requirements of the application. In addition, the concept allows for timely customisation (even in small batches) on the basis of a clearly structured pricing model. Typical modifications include customised shaft geometries, signal output functions, special cable lengths or customised electrical connection cables.

Table of Contents

1. GENERAL INFORMATION AND INTRODUCTION 1

2. ELECTRONICS AND ORDER CODES 4

a. Absolute Single Turn Encoders 5

i. Analogue Current Loop or Voltage Output – ETA25F 5

ii. Redundant Analogue Voltage Output – ETA25FX 7

iii. Pulse Width Modulation (PWM) – ETP25F 9

iv. Serial output SPI – ETS25F 11

b. Incremental Encoders – ETI25F 16

c. Multi/Singleturn Teach-In Encoders with Analogue Output – ETA25FPM 19

3. TECHNICAL DRAWINGS 22

4. MECHANICAL DATA, COMPLIANCE AND ENVIRONMENTAL SPECIFICATIONS 24

5. ORDER CODES – FULL OVERVIEW 26

6. ACCESSORIES 27

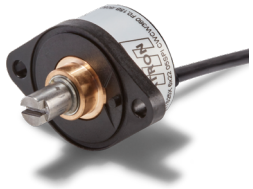
Series overview

>>Please refer to the following sections for details

		Singleturn					Teach-In Multi/Singleturn
Series		**ETI25F**	**ETS25F**	**ETA25F**	**ETA25FX**	**ETP25F**	**ETA25FPM**
Electronics redundant		NO	NO	NO	YES	NO	NO
Output signal(s)		Incremental A, B, Z	Digital absolute SPI SSI	Analogue absolute 0 to 5 V 0 to 10 V 4 to 20 mA	Analogue absolute 0 to 5 V 0 to 10 V	PWM absolute 5 V / 244 Hz / PWM 10-90 %	Analogue absolute 0 to 5 V 0 to 10 V 4 to 20 mA
Effective electrical angle of rotation		360°		7° ≤ α ≤ 360° (programmable ex works)		7° ≤ α ≤ 360° (programmable ex works)	0-10° to 0-72000° (programmable by user) factory programming 0 to 3600°
Resolution		1 to 10,000 ppr.	**SPI:** 14 bit **SSI:** 10-18 bit	12 bit			
Supply voltage(s)	**Output type**	**Push-Pull, open collector**	**SPI**	**Analogue 0 to 5 V**	**Analogue 0 to 5 V**	**PWM**	**Analogue 0 to 5 V**
	Supply voltage	5 to 30 V	5 V ± 10%	5 V ± 10% (ratiometric) or 24 V (9 to 30 V)	5 V ± 10%	5 V ± 10%	24 V (9 to 30 V)
	Output type	**TTL**	**SSI**	**Analogue 0 to 10 V**	**Analogue 0 to 10 V**		**Analogue 0 to 10 V**
	Supply voltage	3.3 V or 5 V ± 10%	5...30 V	24 V (15 to 30 V)	24 V (15 to 30 V)		24 V (15 to 30 V)
	Output type			**Current loop 4 to 20 mA**			**Current loop 4 to 20 mA**
	Supply voltage			24 V (9 to 30 V)			24 V (11 to 30 V)
		Programming options					
Programmable by customer		NO	NO	NO	NO	NO	YES
Programmable ex works		YES	YES	YES	YES	YES	YES
		Electrical connection options					
Round cable		YES					
Flat ribbon cable		YES					

Series ETA25F

Key features ETA25F:
- Analogue outputs 0 to 5 V, 0 to 10 V, 4 to 20 mA
- Redundant versions available – see separate section
- Several factory programming possibilities
- Supply voltages: 5 VDC ±10%, 15 to 30 VDC, 9 to 30 VDC



Electrical data

Effective electrical angle of rotation 1.)	7° ≤ α ≤ 360° (programmable ex works), ±0.5°		
Independent linearity (best straight line) 1.)	±0.3% @ 360°		
Absolute Linearity 1.)	±0.6% @ 360°		
Output signal	0 to 5 V ratiometric	0 to 10 V	4 to 20 mA
Resolution	12 Bit		
Update rate	200 µs		
Supply voltage V_{SUP}	5 V ±10%	15 to 30 V	9 to 30 V
Power consumption (no load)	≤18 mA		
Output load	≥ 5 kOhm		≤ 500 Ohm
Insulation voltage 1.)	1000 VAC @ 50 Hz, 1 min		
Insulation resistance 1.)	2 MOhm @ 500 VDC, 1 min		
MTTF (EN29500-2005-1)	1173a	965a	379a

1.) According to IEC 60393

Wire colour/pin assignment

Function:	Option F	Option R
OUT	Strand 2	brown
VSUP	Strand 1 (red)	red
GND	Strand 3	black

For details on zero point definition and output programming see page 27.

Order Code ETA25F – singleturn, analogue output, not redundant

Description	Selection: standard=**black/bold**, possible options=*grey/italic*								
Series	**ETA25F**								
Shaft diameter, shaft length: **Shaft diameter Ø 6 mm, shaft length 15.6 mm** *Shaft diameter Ø 6.35 mm, shaft length 15.6 mm* *Custom shaft dimensions [mm] Ø ≤ 6.35 mm*		**6x15,6** *6,35x15,6* *XxXX*							
Supply voltage / output signal: **V_{SUP}=5 V (4.5 to 5.5 V) / OUT=0 to 5 V** (ratiometric) **V_{SUP}=24 V (15 to 30 V) / OUT=0 to 10 V** *V_{SUP}=24 V (9 to 30 V) / OUT=4 to 20 mA* *V_{SUP}=24 V (9 to 30 V) / OUT=0 to 5 V*			**0505** **2410** *2442* *2405*						
Sense of rotation: (when looking at the shaft, from the front) **Clockwise** *Counterclockwise*				**CW** *CCW*					
Rotation angle in [°]: **360** *320* *270* *180* *90* *Custom rotation angle* (≥7°, positive integer)					**360** *320* *270* *180* *90* *XXX*				
Operational Torque: **Standard torque** *Improved/medium torque*						**-** *MT*			
Shaft sealing: **None** *With shaft sealing*							**-** *D*		
Electrical connection, cable length: **Flat ribbon cable, standard length 0.15 m** *Flat ribbon cable with custom length [x,xx m]* **Round cable, standard length 1 m** *Round cable with custom length [x,xx m]*								**F0,15** *FX,XX* **R1,00** *RX,XX*	
Anti-rotation pin: **Pin A** *None (pin removed)*									**A** *-*

Order example ETA25F

Requirements:
Shaft Ø 6.00 mm, shaft length 15.6 mm, VSUP=5 V / OUT=0 to 5 V, sense of rotation CW, rotation angle 360°
round cable 1.00 m, anti-rotation pin A

Example for order code:
ETA25F 6x15,6 0505 CW 360 R1,00A

Series ETA25FX – singleturn, analogue output, redundant

Key features ETA25FX :

- Independent signal processing. The ETA25FX rotary encoder electronics are based mainly on one Hall IC in which two semiconductor dies independently capture, evaluate and output the measured values
- Supply voltage, signal output and ground are galvanically insulated => separate electrical connections
- Supply voltages: 2 x 5 VDC or 2 x 15 to 30 VDC
- Signal outputs: 2 x 0 to 5 V or 2 x 0 to 10 V

Electrical data ETA25FX – singleturn, analogue output, redundant

Effective electrical angle of rotation 1.)	7° ≤ α ≤ 360° (programmable ex works), ±0.5°	
Independent linearity (best straight line) 1.)	±0.3% @ 360°	
Absolute Linearity 1.)	±0.6% @ 360°	
Output signal	0 to 5 V ratiometric	0 to 10 V
Resolution	12 Bit	
Update rate	200 µs	
Supply voltage V_{SUP}	5 V ±10%	15 to 30 V
Power consumption (no load)	≤ 23 mA	
Output load	≥ 5 kOhm	
Insulation voltage 1.)	1000 VAC @ 50 Hz, 1 min	
Insulation resistance 1.)	2 MOhm @ 500 VDC, 1 min	
MTTF (EN29500-2005-1)	613a	202a

1.) According to IEC 60393

Cable and pin assignment ETA25FX – singleturn, analogue output, redundant

Function:	Option F	Option R
VSUP 1	Lead 1 (red)	red
OUT 1	Lead 2	brown
GND 1	Lead 3	black
GND 2	Lead 4	green
OUT 2	Lead 5	yellow
VSUP 2	Lead 6	orange

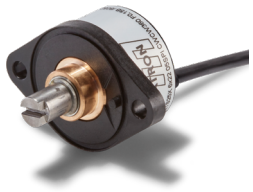
For details on zero point definition and output programming see page 27.

Order Code ETA25FX – redundant, singleturn, analogue output									
Description	Selection: standard=**black/bold**, possible options=*grey/italic*								
Series	**ETA25FX**								
Shaft diameter, shaft length: **Shaft diameter Ø 6 mm, shaft length 15.6 mm** *Shaft diameter Ø 6.35 mm, shaft length 15.6 mm* *Custom shaft dimensions [mm] Ø ≤ 6.35 mm*		**6x15,6** *6,35x15,6* *XxXX*							
Supply voltage / output signal: **V_{SUP}=5 V (4.5 to 5.5 V) / OUT=0 to 5 V** (ratiometric) **V_{SUP}=24 V (15 to 30 V) / OUT=0 to 10 V**			**0505** **2410**						
Sense of rotation: (when looking at the shaft, from the front) **Clockwise/Clockwise (ganging)** *Clockwise/Counterclockwise (counter rotational)*				**CW CW** *CW CCW*					
Rotation angle in [°]: **360** *320* *270* *180* *90* *Custom rotation angle* (≥7°, positive integer)					*360* *320* *270* *180* *90* *XXX*				
Operational Torque: **Standard torque** *Improved/medium torque*						**-** *MT*			
Shaft sealing: **None** *With shaft sealing*							**-** *D*		
Electrical connection, cable length: **Flat ribbon cable, standard length 0.15 m** *Flat ribbon cable with custom length [x,xx m]* **Round cable, standard length 1 m** *Round cable with custom length [x,xx m]*								**F0,15** *FX,XX* **R1,00** *RX,XX*	
Anti-rotation pin: **Pin A** *None (pin removed)*									**A** *-*

Order example ETA25FX – redundant, singleturn, analogue output
Requirement: Redundant, shaft Ø 6.00 mm, shaft length 15.6 mm, VSUP=5 V /OUT=0...5 V, signal 1 sense of rotation CW, signal 2 sense of rotation CW, electrical rotation 360° signal 1 and 2, no shaft sealing, flat ribbon cable 0.15 m, anti-rotation pin A
Example for order code: ETA25FX 6x15,6 0505 CW CW 360 F0.15A

Series ETP25F – singleturn, PWM output, not redundant

Key features ETP25F:
- PWM signal output
- Frequency 244 Hz (constant)
- Pulse width (duty cycle) 10% (0°) to 90% (360°)
- Supply voltage: 5 VDC +/-10%



Electrical data ETP25F – singleturn, PWM output, not redundant

Effective electrical angle of rotation 1.)	7° ≤ α ≤ 360° (programmable ex works), ±0.5°
Independent linearity (best straight line) 1.)	±0.4% @ 360°
Absolute Linearity 1.)	±0.6% @ 360°
Output signal	PWM (pulse width modulation)
Output signal voltage	5 V
Carrier frequency	244 Hz (constant)
Minimum duty cycle	10%, equal to app. 0.4 ms
Maximum duty cycle	90%, equal to app. 3.5 ms
Resolution	12 Bit
Supply voltage V_{SUP}	5 V ±10%
Power consumption (no load)	≤ 10 mA
Output load	≥ 5 kOhm
Insulation voltage 1.)	1000 VAC @ 50 Hz, 1 min
Insulation resistance 1.)	2 MOhm @ 500 VDC, 1 min
MTTF (EN29500-2005-1)	1267a

1.) According to IEC 60393

Function description PWM signal output ETP25F

The ETP25F provides a constant carrier frequency with 244 Hz at the signal output, with HIGH and LOW signal levels which have a constant signal amplitude. A constant carrier frequency means a constant length of the period duration. The duty cycle and thus the pulse width changes in dependency of the rotating angle between 10% to 90% relative to the signal period.
If the CW option is selected, the duty cycle increases clockwise when turning the shaft clockwise. If the CCW option is selected, the duty cycle decreases clockwise if the shaft is turned clockwise. Normally no signal conversion is required for further processing of the output signal, because many µControllers already have an input for PWM signals.

Cable and pin assignment

Function	Option F (flat ribbon)	Option R (round cable)
OUT	Lead 2	brown
VSUP	Lead 1 (red)	red
GND	Lead 3	black

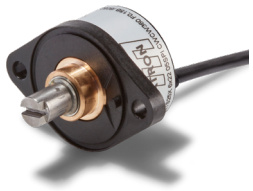
For details on zero point definition and output programming see page 27.

Order Code ETP25F – singleturn, PWM output, not redundant									
Description	Selection: standard=**black/bold**, possible options=*grey/italic*								
Series	**ETP25F**								
Shaft diameter, shaft length: **Shaft diameter Ø 6 mm, shaft length 15.6 mm** *Shaft diameter Ø 6.35 mm, shaft length 15.6 mm* *Custom shaft dimensions [mm] Ø ≤ 6.35 mm*		**6x15,6** *6,35x15,6* *XxXX*							
Supply voltage / output signal: **V_{SUP}=5 V (4.5...5.5 V) / OUT=5 V / 244 Hz / PWM 10-90%**			**5PWM**						
Sense of rotation: (when looking at the shaft, from the front) **Clockwise** *Counterclockwise*				**CW** *CCW*					
Rotation angle in [°]: **360** *320* *270* *180* *90* *Custom rotation angle* (≥7°, positive integer)					*360* *320* *270* *180* *90* *XXX*				
Operational Torque: **Standard torque** *Improved/medium torque*						**-** *MT*			
Shaft sealing: **None** *With shaft sealing*							**-** *D*		
Electrical connection, cable length: **Flat ribbon cable, standard length 0.15 m** *Flat ribbon cable with custom length [x,xx m]* **Round cable, standard length 1 m** *Round cable with custom length [x,xx m]*								**F0,15** *FX,XX* **R1,00** *RX,XX*	
Anti-rotation pin: **Pin A** *None (pin removed)*									**A** -

Order example ETP25F – singleturn, PWM output, not redundant
Requirement: Shaft Ø 6.35 mm, shaft length 15.6 mm, VSUP=5 V / OUT=244 Hz, sense of rotation CW, rotation angle 360°, no shaft sealing, anti-rotation pin A, round cable 2 m
Example for order code: ETP25F 6,35x15,6 5PWM CW360 R2,00A

Series ETS25F – singleturn, digital output, not redundant

Key features ETS25F:
- Efficient, fast signal transmission (length of signal lines limited by clock rate)
- Synchronous Serial Interface (SSI, 10 to 18 bit) or
- Serial Peripheral Interface (SPI, 14 bit)



Electrical data ETS25F – singleturn, digital output, not redundant

Output signal	SPI	SSI (binary code)
Effective electrical angle of rotation 1.)	360°	
Independent linearity (best straight line) 1.)	±0.3% @ 360°	
Resolution	14 Bit	10 to 18 Bit
Supply voltage V_{SUP}	5 VDC ±10%	5 to 30 V
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	-
Voltage level at output	5 V	±5 V (differential voltage 10 V)
Max. data- / clock rate	see details of SPI protocoll	4 MHz

1.) According to 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	

Cable/colour assignment – option SSI

Funktion:	Option R (Rundkabel)	Option F (Flachbandkabel)
VSUP	rot	Lead 1 (red)
GND	schwarz	Lead 2
CLK+	brown	Lead 3
CLK-	orange	Lead 4
DATA-	green	Lead 5
DATA+	yellow	Lead 6

For details on zero point definition and output programming see page 27.

Order Code ETS25F – singleturn, digital output, not redundant							
Description	Selection: standard=**black/bold**, possible options=*grey/italic*						
Series	**ETS25**						
Shaft diameter, shaft length: **Shaft diameter Ø 6 mm, shaft length 15.6 mm** *Shaft diameter Ø 6.35 mm, shaft length 15.6 mm* *Custom shaft dimensions [mm] Ø ≤ 6.35 mm*		**6x15,6** *6,35x15,6* *XxXX*					
Supply voltage / output signal: **SPI (14 Bit) / V_{SUP} = 5 VDC ± 10%** **SSI, 16 bit / V_{SUP} = 5...30 V** *SSI, custom resolution 10..18 bit / V_{SUP} = 5...30 V*			**05SPI** **SSI** *SSI [10-18]*				
Operational torque: **Standard torque** *Improved/medium torque*				**-** *MT*			
Shaft sealing: **None** *With shaft sealing*					**-** *D*		
Electrical connection, cable length: **Flat ribbon cable, standard length 0.15** *Flat ribbon cable with custom length [x,xx m]* *Round cable with custom length [x,xx m]* *(max. 1 m for SPI, recommended < 15 cm)*						**F0,15** *FX,XX* *RX,XX*	
Anti-rotation pin: **Pin A** *None (pin removed)*							**A** -

Order example ETS25F – singleturn, digital output, not redundant
Requirement: Shaft Ø 6.00 mm, shaft length 15.6 mm, 14 Bit/5 VDC/SPI, no shaft sealing, flat ribbon cable 0.15 m, anti-rotation pin A
Example for order code: ETS25 6x15,6 05SPI F0,15A

Synchronous Serial Interface (SSI) - A simple yet robust interface

The synchronous serial interface (SSI) is a serial interface, i.e. the individual bits are transmitted in chronological order. The basis of data transmission is a shift register in which the encoder provides its current measured value. The rotary encoders function as so-called SSI slaves, because they only supply the values from the shift register at the DO (data out) output on receipt of a clock sequence sent out by the SSI master, the so-called "clock" signal (CLK). This clock signal is applied to the CLK input of the encoder. Both the clock signal and the data signal are transmitted differentially, which makes this type of data interface particularly robust against interference. In short, SSI enables the memory of a sensor to be read out reliably from an external source.

Data transmission
The SSI electronics of the encoder reacts to the first falling edge that arrives via the CLK line of the master, loads the current data into the register and transmits it bit by bit to the receiver with each rising edge of the clock. The composition of the transmitted information is not standardised and varies from manufacturer to manufacturer, sometimes even from product to product.

In MEGATRON's encoders, the position information is transmitted first (starting with the Most Significant Bit MSB, ending with the Least Significant Bit LSB). The maximum value of this information is limited by the number of bits transmitted. This is also the resolution of the measurement data. For example, a resolution of 10 bits corresponds to a number of 210 = 1024 steps, which are divided over the angular range of 360°. Thus, after receiving the position information, it is easy to calculate back to the absolute angle, because each single step would correspond to 360/1024 = 0.35°.
The position information is followed by a bit sequence of status data that can be of great interest for the application. This includes whether the magnetic field acting on the Hall sensor is within the permissible limits (i.e. the distance of the magnet from the sensor). The last bit is the parity bit. This takes the values HIGH or LOW as required, so that the encoder always sends an even number of bits (even parity). The receiver, i.e. the SSI master, must be set to the total length of the transmitted information including the parity bit.

At the end of the process, the master usually does not send any further edges to the encoder via the CLK line. The encoder then waits for a time t_m, (retriggerable monoflop) since the last CLK edge and then updates the data in the shift register. This is therefore the minimum pause time between two consecutive clock sequences when the master requires new, updated measurement data. The exact protocol description of the HTS encoders follows on the next page

Ring shift
However, if clock edges continue to be sent, then the encoder will start transmitting the same data set repeatedly after a zero bit. This procedure is also called ringshift. This makes sense, for example, if the parity bit would be incorrect from the master's point of view, if the data is otherwise corrupt and a new transmission is therefore requested, or if a higher transmission reliability is generally desired by comparing multiple transmissions of the same data. With ring shift, the transmission is also terminated and the latest measurement data is only loaded into the register again when no more clock signals arrive at the encoder for a minimum time t_m.

Early stop
The transmission of the data can be interrupted by the master at any time, e.g. also after the 10th bit. Even then, the internal timer (monoflop) expires, causing the data in the register to be reloaded after the time t_m. In this way, for example, only a part of the encoder data can be read out (e.g. 10 of the available 16 bits, no status data at all) and a higher update rate can be achieved, as the remaining information is simply omitted.

Notes on cable length
The higher the transmission rate (clock rate), the smaller the realisable cable length with SSI. These are physical limits that are not limited by the sensor product itself. A simple blanket statement about the actual realisable length is not easily possible.

The cable length that can actually be realised in the application is influenced by the following factors:
- Quality and design of the cable (shielding, conductor cross-section, conductor resistance, twisted cores, etc.).
- Ambient conditions (sources of interference such as motors, etc.)

We explicitly refer to the RS-422 standard regarding cable lengths.

Protocol description – Synchronous Serial Interface (SSI)

The HTS25K SSI encoder provides a 10-bit to 18-bit absolute position output, while 16 bit is the standard (ex works) configuration. This means that the full rotation angle (360°) is divided into steps of the respective resolution (16 bits yields 65.536 steps of approx. 0.005 degrees).
Standard configuration (16 bit output) yields the following pulse train, consisting both of position and status data:

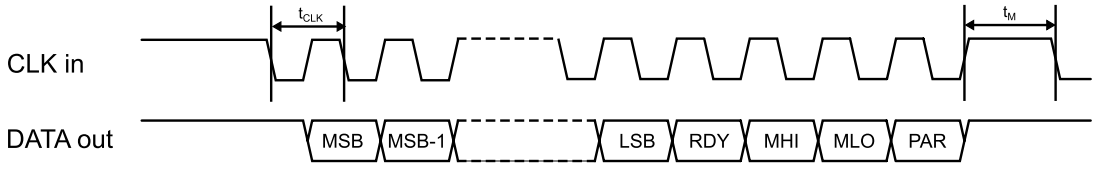
20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
16 bits position data																	3 bits status data			

The data structure for any resolution is as follows:

Position data (10 to 18 bits)				Status (3-bit)			Parity 1 bit
MSB	MSB-1	...	LSB	RDY	MHI	MLO	PAR

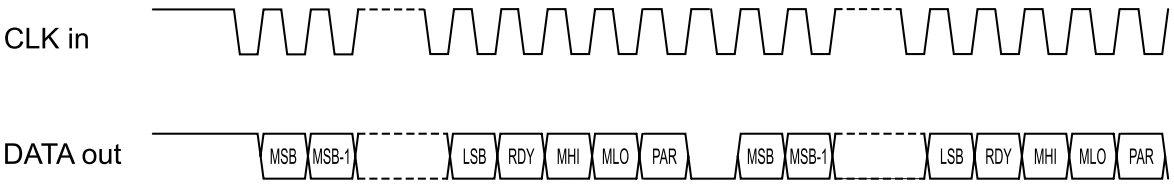
Abbreviation	Description
MSB to LSB	n-bits position data, selectable from 10 to 18 bits ex works, standard is 16 bit
RDY	The encoder is ready (if value is HIGH).
MHI	This indicates that the magnet strength detected by the Hall chip is too strong. If this is consistently HIGH, change to a weaker magnet or increase the distance between the encoder and the magnet. The value for this alarm is displayed as 1.
MLO	This indicates that the magnet strength detected by the Hall chip is too weak. If this is consistently HIGH, change to a stronger magnet or decrease the distance between the encoder and the magnet. The value for this alarm is displayed as 1.
PAR	Parity is even

Data is transmitted according to the following timing diagram:



Symbol	Description	Min.	Typ.	Max.
t_{CLK}	Serial clock period	4 µs		$t_{M/2}$
t_M	monoflop, time between two successive SSI reads		16.5 µs	18 µs

Data is latched on the first CLK falling edge and is transmitted on the next falling edge. Both signals are transmitted differentially and therefore have 2 connections (+/-) each. Data will be refreshed when the next monoflop (t_M) expires. If another clock train is sent before this time expires, the same position data is output, and the data is separated by a single low bit:



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.

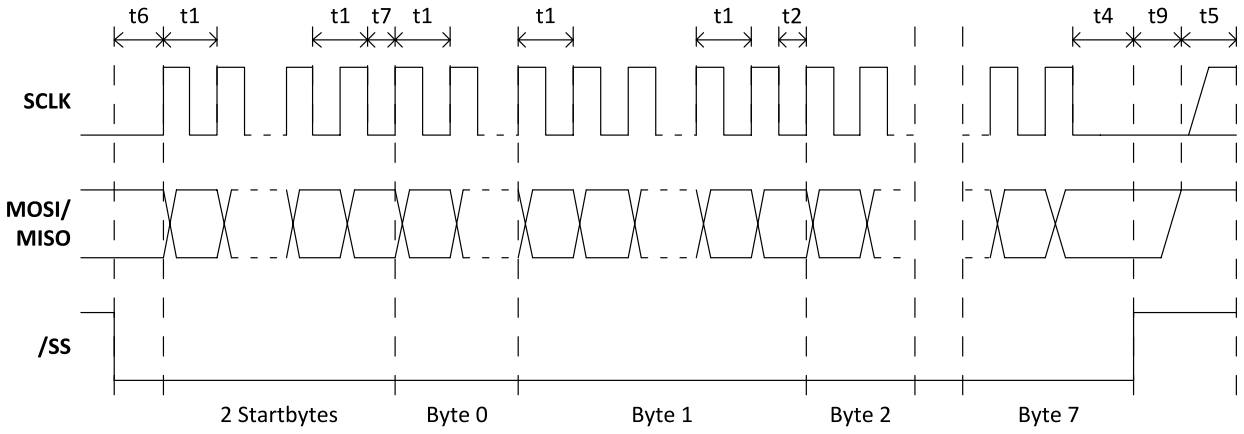
MISO (Master In Slave Out)
The MISO of the slave is an open-collector stage. Due to the capacitive load, a >1 kΩ pull-up is used for the recessive high level (in fast mode). Note that MOSI and MISO use the same physical wire of the ETS25.

/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)

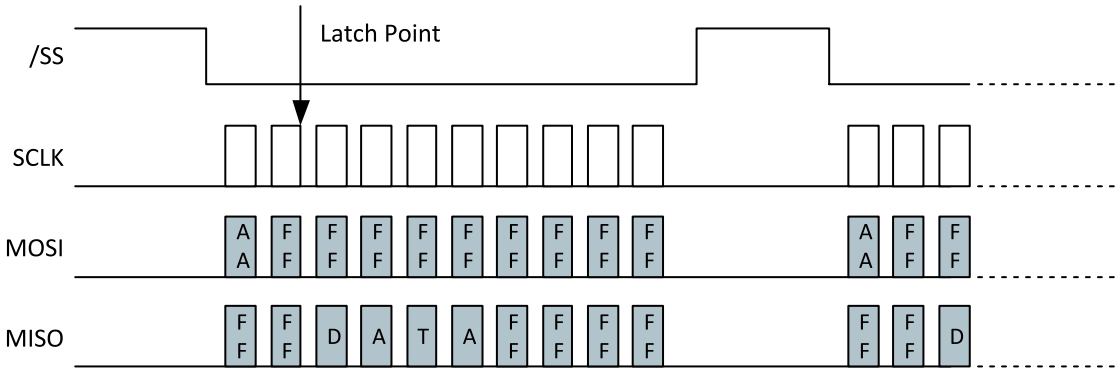
Description Timings

Timings	Min	Max	Remarks
t1	2.3 µs / 6.9 µs	-	No capacitive load on MISO. t1 is the minimum clock period for any bits within a byte.
t2	12.5 µs / 37.5 µs	-	t2 the minimum time between any other byte
t4	2.3 µs / 6.9 µs	-	Time between last clock and /SS=high=chip de-selection
t5	300 µs / 1500 µs	-	Minimum /SS = Hi time where it's guaranteed that a frame re-synchronizations will be started
t5	0 µs	-	Maximum /SS = Hi time where it's guaranteed that NO frame re-synchronizations will be started.
t6	2.3 µs / 6.9 µs	-	The time t6 defines the minimum time between /SS = Loand the first clock edge
t7	15 µs / 45 µs	-	t7 is the minimum time between the StartByte and the Byte0
t9	-	< 1 µs	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.

Protocol description 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)/2^{14}

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	-	

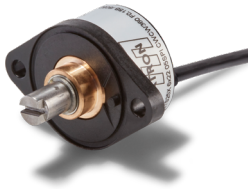
Angle Calculation
All communication timing is independent (asynchronous) of the angle data processing. The angle is calculated continuously by the Slave every 350 µs at most. The last angle calculated is hold to be read by the Master at any time. Only valid angles are transferred by the Slave, because 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 ETI25F – singleturn, incremental output, not redundant

Key features ETI25F:

- Channels: A, B and index signal Z
- TTL, Push Pull or Open Collector electronics
- Option: ex works programmable number of pulses from 1 to 10,000 ppr in one pulse step-width

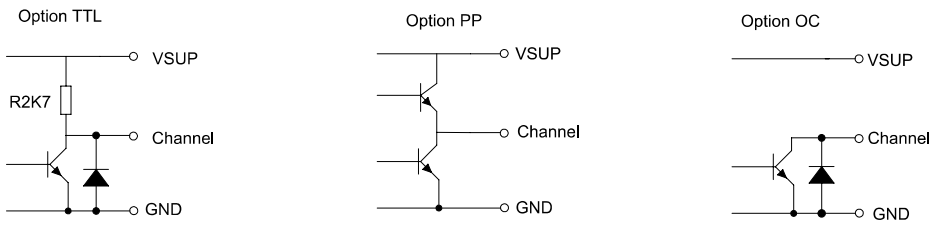


Electrical data ETI25F – singleturn, incremental output

Output Signal	TTL	Push-Pull	Open Collector
Number of pulses	1 to 10,000 ppr.		
Limit frequency	250 kHz		
Switch-on delay	20 ms		
Supply voltage	3.3 or 5 VDC ±10%	5 to 30 V	5 to 30 V
Power consumption (no load)	≤ 15 mA	≤ 50 mA	≤ 25 mA
Output load	≥ 5 kOhm		
Max. pull-up voltage	-		30 VDC
Insulation voltage 1.)	1000 VAC @ 50 Hz, 1 min		
Insulation resistance 1.)	2 MOhm @ 500 VDC, 1 min		

1.) According to IEC 60393

Output circuit ETI25F per channel



For details on zero point definition and output programming see page 27.

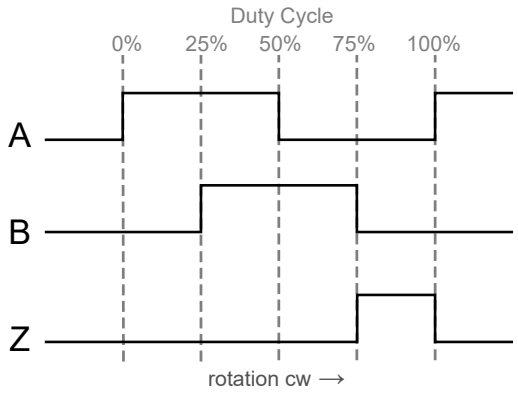
Order Code ETI25F – singleturn, incremental output								
Description	Selection: standard=**black/bold**, possible options=*grey/italic*							
Series	**ETI25F**							
Shaft diameter, shaft length: **Shaft diameter Ø 6 mm, shaft length 15.6 mm** *Shaft diameter Ø 6.35 mm, shaft length 15.6 mm* *Custom shaft dimensions [mm] Ø ≤ 6.35 mm*		**6x15,6** *6,35x15,6* *XxXX*						
Number of pulses (ppr): *32* *64* *128* *256* *512* **1024** *Custom number of pulses 1 to 10,000 ppr., increment 1 pulse*			*32* *64* *128* *256* *512* **1024** *XXX*					
Supply voltage / output signal: **Push-pull A, B, Z / V_{SUP} = 5 to 30 V** **TTL A, B, Z / V_{SUP}= 3,3 V or 5 V ± 10%** **Open collector A, B, Z / V_{SUP} = 5 to 30 V**				**BZPP** **BZTTL** **BZOC**				
Operational Torque: **Standard torque** *Improved/medium torque*					**-** *MT*			
Shaft sealing: **None** *With shaft sealing*						**-** *D*		
Electrical connection, cable length: **Flat ribbon cable, standard length 0.15 m** *Flat ribbon cable with custom length [x,xx m]* **Round cable, standard length 1 m** *Round cable with custom length [x,xx m]*							**F0,15** *FX,XX* **R1,00** *RX,XX*	
Anti-rotation pin: **Pin A** *None (pin removed)*								**A** *-*

Order example ETI25F – singleturn, incremental output
Requirement: Shaft Ø 6.00 mm, shaft length 15.6 mm, number of pulses 1024 TTL output, VSUP=5 V/TTL, no shaft sealing, round cable 1.20 m, anti-rotation pin A
Example for order code: ETAI25 6x15,6 1024 05BZTTL R1,20A

Cable/colour assignment

Flat ribbon cable (option F)		Round signal cable (option R)	
Lead	**Function**	**Wire colour**	**Function**
Lead 1 (red)	VSUP	red	VSUP
Lead 2	GND	black	GND
Lead 3	A	brown	A
Lead 4	B	orange	B
Lead 5	Z	yellow	Z
		green	n/c

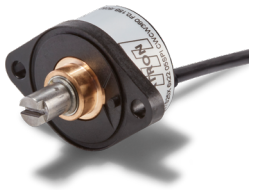
Signal details



Series ETA25FPM – single/multiturn, programmable, analogue output, not redundant

Key features ETA25FPM :

- Measuring range 10° to max. 72000° (200 shaft revolutions)
- Programmable by the user using teach-in function. Programmable are the sense of rotation (CW/CCW) and the effective electrical angle [°]
- Programmable up to 10000 times
- Can also be used as a programmable singleturn rotary encoder
- Maximum rotation of the shaft in a voltage-free state without loss of the angle information +/-179°
- Factory programming (ex works): effective electrical angle of rotation 3600° (10 shaft revolutions), sense rotation CW
- Supply voltage: 9 to 30 VDC, 15 to 30 VDC
- Output signal: 4 to 20 mA, 0 to 5 V, 0 to 10 V



Electrical data ETA25FPM – multi/singleturn, programmable, analogue output, not redundant

Effective electrical angle of rotation 1.)	0 to 10° - 0 to 72000° (max. 200 turns) Start point, endpoint and sense of rotation programmable by the customer. Ex works the angle is set to 3600°. For detecting absolute position >360° the sensor should not be turned more than ±179° without supply voltage.		
Independent linearity (best straight line) 1.)	±0.05% @ 3600°		
Absolute Linearity 1.)	±0.1% @ 3600°		
Output signal	0 to 5 V	0 to 10 V	4 to 20 mA
Resolution 1.)	12 Bit		
Update rate	3 ms		
Supply voltage	9 to 30 V	15 to 30 V	11 to 30 V
Power consumption (no load)	< 10 mA		< 14 mA
Output load	≥ 5 kOhm		≤ 500 Ohm
Insulation voltage 1.)	1000 VAC @ 50 Hz, 1 min		
Insulation resistance 1.)	2 MOhm @ 500 VDC, 1 min		
Max. number of programming cycles	10000		
MTTF (EN29500-2005-1)	224a		229a

1.) According to IEC 60393

Order Code ETA25FPM – multi/singleturn, analogue output, not redundant							
Description	Selection: standard=**black/bold**, possible options=*grey/italic*						
Series	**ETA25FPM**						
Shaft diameter, shaft length: **Shaft diameter Ø 6 mm, shaft length 15.6 mm** *Shaft diameter Ø 6.35 mm, shaft length 15.6 mm* *Custom shaft dimensions [mm] Ø ≤ 6.35 mm*		**6x15,6** *6,35x15,6* *XxXX*					
Supply voltage / output signal: **VSUP=24 V (15 to 30 V) / OUT=0 to 10 V** **VSUP=24 V (9 to 30 V) / OUT=4 to 20 mA** **VSUP=24 V (9 to 30 V) / OUT=0 to 5 V**			**2410** **2442** **2405**				
Operational Torque: **Standard torque** *Improved/medium torque*				**-** *MT*			
Shaft sealing: **None** *With shaft sealing*					**-** *D*		
Electrical connection, cable length: **Flat ribbon cable, standard length 0.15 m** *Flat ribbon cable with custom length [x,xx m]* **Round cable, standard length 1 m** *Round cable with custom length [x,xx m]*						**F0,15** *FX,XX* **R1,00** *RX,XX*	
Anti-rotation pin: **Pin A** *None (pin removed)*							**A** *-*

Order example ETA25FPM

Requirement:
Shaft Ø 6.00 mm, shaft length 15.6 mm, VSUP=24 V / OUT=0...5 V, sense of rotation CW, rotation angle ex works 3600° (can be programmed by customer), no shaft sealing, flat ribbon cable 1.00 m, anti-rotation pin A

Example for order code:
ETA25FPM 6x15,6 2405 R1,00A

Cable and pin assignment

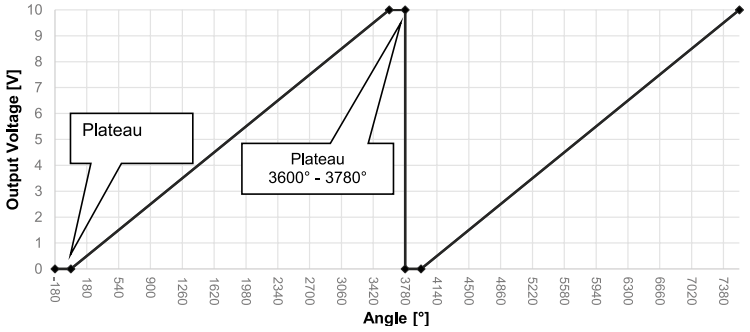
Function	Option F	Option R
DIR	Strand 1 (red)	orange
END	Strand 2	grün
START	Strand 3	gelb
VSUP	Strand 4	rot
OUT	Strand 5	braun
GND	Strand 6	schwarz

For details on zero point definition see next page and page 27.

Signal output function (factory programming only). Automatic function for inserting signal plateaus

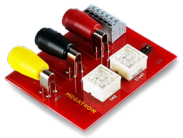
The function represents the relationship between the zero degree marking on the rotary encoder housing in dependency to the 0° position of the shaft and the resulting output signal in the state of delivery, when turning the shaft clockwise (sense of rotation CW). The effective electrical angle of rotation is 3600° ex works. Before and after the linearly rising output signal for 3600° the ETA25FPM integrates automatically signal plateaus for a rotation angle of each 180° .
The following example shows the output signal pattern when actuating the shaft in the delivery state for 11 revolutions clockwise (sense of rotation CW), starting at the 0° position:
1. 10 rotations of the shaft clockwise 0° to 3600°, linearly increasing output signal 0% to 100% FS
2. 1/2 rotation of the shaft 180° (3600° to 3780°) signal plateau 100% FS
3. 1/2 rotation of the shaft 180° (3780° to 3960°) signal plateau 0% FS

The drawing shows the signal-amplitude function for 0 to 10V signal output



Programming device PRO for programming the encoder in the field

Key features programmer:
- Programmable measuring range from 10° to max. 72000° (200 shaft revolutions)
- Programmable: sense of rotation (CW/CCW), effective electrical angle [°]
- Up to 10.000 programming cycles per rotary encoder

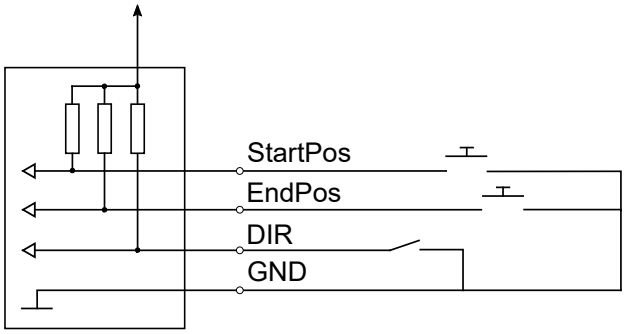


Order number:	Order code:
135945	Programmer Tool for ETA HTA PM

Circuit for field-programming

The programming guide is available for download on the MEGATRON web page https://www.megatron.de/

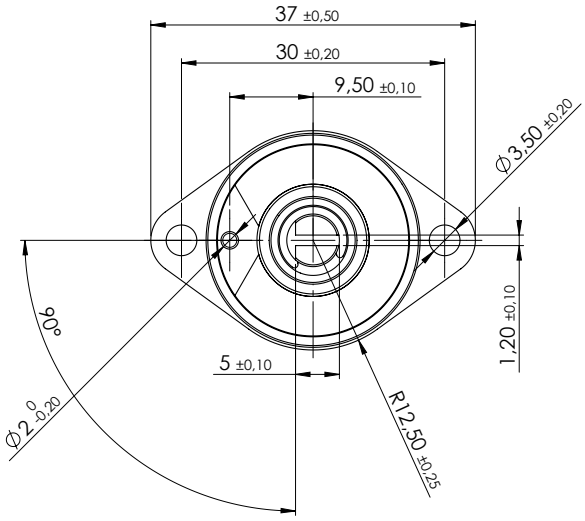
To program the encoder either the following circuit can be implemented, or one uses the programmer from MEGATRON.



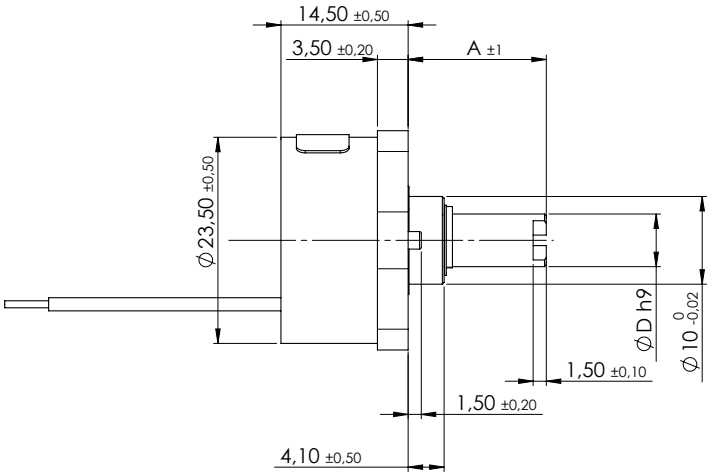
Teach-In function – manual field programming

When manual programming in the field using the teach-in function, the remaining angle for the next full revolution is divided equally into high and low. There are no further signal plateaus. Please see the programming guide on our website for more details.

Drawing ETx25F Family



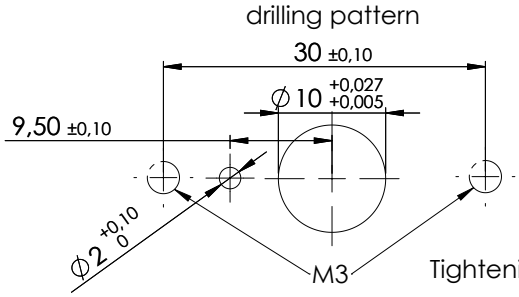
View shows 0° position



Standard shaft dimensions	
Shaft length A	15,6 mm
Shaft diameter D	6 mm

planarity of installation surface ⏥ 0,1

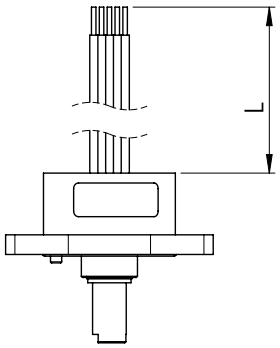
roughness of installation surface √Ra 6,3



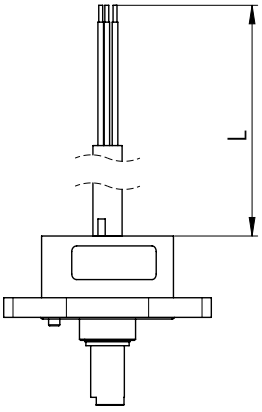
Tightening toque <= 0,5Nm

Option F - Flat ribbon cable

red marking = PIN 1



Option R - Round cable



Standard shaft dimensions	
Shaft length A	15.6 +/- 1 mm
Shaft diameter D	6 h9 mm, 6.35 h9 mm
Shaft flattening (D-flat)	1 +/- 0.1 mm

All dimensions in mm

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 Ø 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 Ø (D = cable sheath diameter Ø)
		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
Lifetime 2.)	> 100 Mio. shaft rotation movements Option D: Sealing specified for ≥ 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 not moving)
Storage temperature range	Standard: -40 to +105 °C
Protection grade (IEC 60529) front side	▪ IP40 standard ▪ IP55M (IP66S) with shaft sealing (option D)
Protection grade (IEC 60529) rear side	IP66 (cable ends excluded)
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)	50 g / 11 ms / half sine (3x6 shocks)
Housing diameter	Ø 23.5 mm (dimensions of the mounting flange, height: 37 mm, width 25 mm)
Housing depth	14.5 mm
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. 40 g (option R: cable, valid for 1 m only) ▪ ca. 23 g (option F: flat ribbon cable, valid for 15 cm only)
Connection type	▪ Ribbon cable (option F) ▪ Cable (option R)
Connection position	Axial
Sensor mounting	Flange, by means of two screws M3 (not enclosed)
Fastening parts included in delivery	If option D is ordered 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 to IEC 60393
2.) Determined by climatic conditions according to IEC 68-1, para. 5.3.1 without load collectives

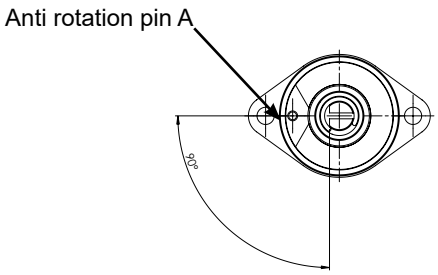
Immunity / Electrostatic Discharge	
EN 61000-4-3 RF sine wave	Class A
EN 61000-4-6 Conducted sine wave	Class A
EN 61000-4-8 Power frequency magnetic fields	Class A
EN 61000-4-2 ESD	Class B

Definition of the zero position / anti-rotation pin

Output at the zero point:
ETA25F (analogue outputs): Output signal 0% full scale (F. S.)
ETP25F (PWM output): duty cycle 10% (10% duty cycle)
ETS25F (serial output): Output signal 0% full scale (F. S.)
ETI25F (incremental output): The index signal is output (Z)

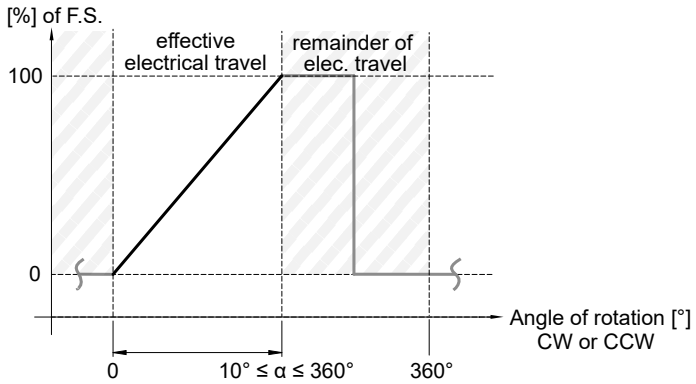
Position of the zero position:

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



Signal definition for custom rotation angles

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.



Order Code – Full Overview

>>Please refer to the series sections for details and valid selection criteria

Series

ETA25F	- single turn absolute, analogue voltage or current loop output
ETA25FX	- redundant, single turn absolute analogue voltage output
ETA25FPM	- multi-/singleturn absolute, analogue voltage or current output
ETP25F	- single turn absolute, PWM output
ETS25F	- single turn absolute, serial output (SSI/SPI)
ETS25X	- redundant single turn serial output (SPI)
ETI25F	- single turn incremental

(Shaft diameter) x (length)

6x15,6	- Ø 6 mm, length 15,6 mm
6,35x15,6	- Ø 6.35 mm, length 15,6 mm
XxXX	- User-defined [mm] Ø ≤ 6.35 mm

Pulses per revolution (only applicable for ETI25F)

blank	- not applicable
XXX	- custom ppr value
128	- 128 ppr
256	- 256 ppr
512	- 512 ppr
1024	- 1024 ppr

Sense of rotation (only applicable for analogue and PWM outputs)

blank	- not applicable
CW	- clockwise
CCW	- counterclockwise
CW CW	- (redundant) both CW
CW CCW	- (redundant) counter-rotational

Effective electrical angle (only applicable for analogue and PWM outputs)

360	- 360°
320	- 320°
270	- 270°
180	- 180°
90	- 90°
XXXX	- custom [integer]
blank	- not applicable

Cable length (only applicable for flat ribbon or round signal cable)

0,15	- 150 mm
1,00	- 1 m
X,XX	- custom
blank	- not applicable/no cable

Shaft sealing

blank	- none
D	- with sealing

ETA25F	6x15,6		0505	CW	360			F	0,15	A

Electronics: supply voltage / output signal

0505	- VSUP = 4.5 to 5.5 V / OUT = 0 to 5 V
2410	- VSUP = 15 to 30 V / OUT = 0 to 10 V
2442	- VSUP = 9 or 11 to 30 V / OUT = 4 to 20 mA
2405	- VSUP = 9 to 30 V / OUT = 0 to 5 V
5PWM	- VSUP = 4.5 to 5.5 V / OUT = 5 V / PWM 10-90%
24BZPP	*- (veraltet) VSUP = 10...30 V / OUT = Push-Pull A, B, Z*
24BZOC	*- (veraltet) VSUP = 10...30 V / OUT = Open Collector A, B, Z*
05BZTTL	*- (veraltet) VSUP = 5 V ± 10% / OUT = TTL A, B, Z*
05SPI	- VSUP = 5 V ± 10% / OUT = SPI 14 bit
SSI [10-18]	- VSUP = 5...30 V / OUT = SSI, [10..18] bit, 16 Bit wenn nicht angegeben
BZPP	- VSUP = 5...30 V / OUT = Push-Pull A, B, Z
BZOC	- VSUP = 5...30 V / OUT = Open Collector A, B, Z
BZTTL	- VSUP = 3,3 V oder 5 V ± 10% / OUT = TTL A, B, Z

Operational torque

blank	- standard (low)
MT	- medium torque

Electrical connection

F	- flat ribbon cable
R	- round signal cable

Anti-rotation pin

blank	- none / pin removed
A	- anti-rotation pin A