



HTx25 PG



HTx25 M8



HTx25 PGR



HTx25 M8R

Key features

- Ø25 mm aluminium metal housing
- Maximum life time expectation
- High continuous actuation shaft speeds
- Magnetic, gradient-based signal evaluation
- Digital signal processing
- Double ball bearings
- Ø4 or Ø6 mm stainless steel shaft
- Shaft bearings IP65, housing IP68
- Operating temperature range -30..85°C
- Measurement range up to 360° singleturn, 72000° multiturn
- Electrical connections M8 plug or round cable
- Programmable signal output function (factory or field-programmable/teach-in)
- Cable/connector M8 plug or cable, outlet radial or axial

Applications

- Plant engineering
- Mechanical engineering
- Equipment manufacturing
- Driverless transport systems
- Medical equipment
- Special vehicles
- Industrial robots
- Motor control units
- Stage technology

Output variants

Singleturn absolute encoders	▪ Analogue voltage or current loop output (12 bit resolution) ▪ PWM output (12 bit resolution) ▪ Digital outputs SPI (14 bit), SSI (10 to 18 bit resolution) ▪ Absolute linearity up to 0.6%
Programmable Multi- or singleturn absolute encoders	▪ Analogue voltage or current loop output (12 bit resolution) ▪ Not True-Power-On, max. 200 revolutions (72000°) ▪ With Teach-In Function
Incremental encoders	▪ 1 to 10.000 Impulses per revolution (ppr.)

HTx25 encoders – robust and compact

The encoders of the HTx25 series are specially designed for use in demanding environments where space is limited. Housed in a Ø25 mm metal body, these contactless encoders offer a wide range of electronic and mechanical options. Whether as incremental or absolute value encoders, they cover a wide range of applications and, depending on the output electronics, are used in machines, plants, laboratory equipment and medical devices, for example.

The HTx25 is the smallest metal encoder in the MEGATRON product range. It has a solid aluminium housing, a high IP protection and a stainless steel shaft supported by two ball-bearings, which allows for high operating speeds. Signal processing is digital and based on the latest Hall sensor technology, which ensures reliable magnetic recording of the measured values. The gradient-based evaluation ensures high immunity to temperature variations and EMC influences. The encoders are designed for maximum durability, even outperforming optical encoders. The number of defects or failures in rotary encoders with this technological design is virtually zero, even after decades of use.

In addition to a wide range of standard options, the modular design of the HTx25 encoders allows them to be tailored to the specific requirements of the application. The concept also allows for timely customisation (even in small batches) based on a clearly structured pricing model. Typical modifications include customer-specific shaft geometries, customised signal output functions, special cable lengths or customised electrical connection cables.

General

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Redundant Voltage/Current Analogue (HTA25)

PWM HTP25

Serial HTS25

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General

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Redundant
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Analogue (HTA25)

PWM
HTP25

Serial
HTS25

Incremental
HTI25

Multiturn
HTA25PM

Drawings

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Accessories

Series overview

>>Please refer to the following sections for details

		Singleturn					Multiturn
Series		HTI25	HTS25	HTA25	HTA25X	HTP25	HTA25PM
Electronics redundant		NO	NO	NO	YES	NO	NO
Output signal(s)		Incremental A, B, Z 1 to 20,000 ppr	Digital absolute SSI SPI	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 in factory)		7° ≤ α ≤ 360° (programmable in factory)	0-10° to 0-72000° (programmable by user) factory programming 0 to 3600°
Resolution		-	SSI: 10-18 bit SPI: 14 bit	12 bit			
Supply voltage(s)	Output type	TTL	SPI	Analogue 0 to 5 V	Analogue 0 to 5 V	PWM	Analogue 0 to 5 V
	Supply voltage	5 V ± 10%	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	Open collector	SSI	Analogue 0 to 10 V	Analogue 0 to 10 V		Analogue 0 to 10 V
	Supply voltage	4.8 to 42 V	4.8 to 42 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

Series HTA25

Key features HTA25:

- 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 $\pm 10\%$, 15 to 30 VDC, 9 to 30 VDC



Electrical data

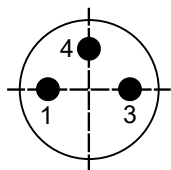
Effective electrical angle of rotation 1.)	$7^\circ \leq \alpha \leq 360^\circ$ (programmable in factory), $\pm 0.5^\circ$		
Independent linearity (best straight line) 1.)	$\pm 0.3\%$ @ 360°		
Absolute Linearity 1.)	$\pm 0.6\%$ @ 360°		
Output signal	0 to 5 V ratiometric	0 to 10 V	4 to 20 mA
Resolution	12 Bit		
Update rate	200 μ s		
Supply voltage	5 V $\pm 10\%$	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 IEC 60393

Wire colour/pin assignment

Function:	Option PG(R)	Option M8(R)	Accessory: M8-Connector
OUT	brown	Pin 3	Pin 3 - blue
VSUP	red	Pin 1	Pin 1 - brown
GND	black	Pin 4	Pin 4 - black

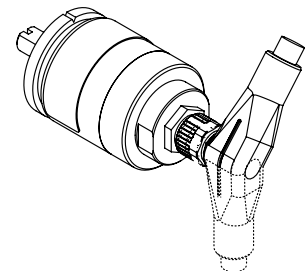
Connector M8 (R) – pin assignment for 3-pin connector



Pin-Numbering of socket connector in the encoder housing

The orientation of the connector relative to the encoder body is not defined and varies from encoder to encoder. When using right-angle connectors in combination with axial outlets, the orientation of the cable outlet is therefore not defined.

If you need a defined orientation of the cable outlet, please choose our housings with radial cable outlet and use straight mating connectors.



Orientation will vary when using angled connectors.

For details on zero point definition and output programming see page 29.

Absolute Encoders with Current Loop or Voltage Output

Series HTA25

Order code HTA25 – singleturn, analogue output, not redundant

Description	Selection: standard= black/bold , possible options= <i>grey/italic</i>				
Series	HTA25				
Shaft diameter, shaft length: Shaft diameter Ø 6 mm, shaft length 12 mm <i>Shaft diameter Ø 4 mm, shaft length 10 mm</i> <i>Custom shaft dimensions [mm] Ø ≤ 6.35 mm</i>		6x12 <i>4x10</i> <i>XxXX</i>			
Supply voltage / output signal: VSUP=5 V (4.5 to 5.5 V) / OUT=0 to 5 V (ratiometric) VSUP=24 V (15 to 30 V) / OUT=0 to 10 V VSUP=24 V (9 to 30 V) / OUT=4 to 20 mA <i>VSUP=24 V (9 to 30 V) / OUT=0 to 5 V</i>			0505 2410 2442 <i>2405</i>		
Sense of rotation: (when looking at the shaft, from the front) Clockwise <i>Counterclockwise</i>			CW <i>CCW</i>		
Rotation angle* in [°]: 360 <i>320</i> <i>270</i> <i>180</i> <i>90</i> <i>Custom rotation angle (≥7°, positive integer)</i>				360 <i>320</i> <i>270</i> <i>180</i> <i>90</i> <i>XXX</i>	
Electrical connection, cable length: 1 m round cable, axial 1 m round cable, radial Connector M8, 3-pol., axial Connector M8, 3-pol., radial <i>Round cable, customer-specific cable length [X,XX m], axial</i> <i>Round cable, customer-specific cable length [X,XX m], radial</i>					PG PGR M8 M8R <i>PGX,XX</i> <i>PGRX,XX</i>

* For details see page 29.

Order example HTA25

Requirements:

Shaft Ø 6.00 mm, shaft length 12 mm, VSUP=5 V / OUT=0 to 5 V, sense of rotation CW, rotation angle 360°
round cable 1.00 m

Example for order code:

HTA25 6x12 0505 CW360 PG

Series HTA25X – singleturn, analogue output, redundant

Key features HTA25X :

- Independent signal processing. The HTA25X 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 HTA25X – singleturn, analogue output, redundant

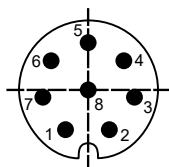
Effective electrical angle of rotation 1.)	$7^{\circ} \leq \alpha \leq 360^{\circ}$ (programmable at factory), $\pm 0.5^{\circ}$	
Independent linearity (best straight line) 1.)	$\pm 0.3\%$ @ 360°	
Absolute Linearity 1.)	$\pm 0.6\%$ @ 360°	
Output signal	0 to 5 V ratiometric	0 to 10 V
Resolution	12 Bit	
Update rate	200 μ s	
Supply voltage	5 V $\pm 10\%$	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 IEC 60393

Cable and pin assignment HTA25X – singleturn, analogue output, redundant

Function:	Option PG(R)	Option M8(R)	Accessory: M8-Connector
VSUP 1	red	1	Pin 1 - white
OUT 1	brown	2	Pin 2 - brown
GND 1	black	3	Pin 3 - green
GND 2	green	4	Pin 4 - yellow
OUT 2	yellow	5	Pin 5 - grey
VSUP 2	orange	6	Pin 6 - pink
n/c	-	7	Pin 7 - blue
n/c	-	8	Pin 8 - red

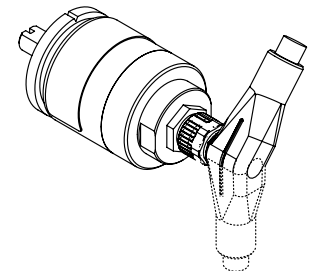
Connector M8 (R) – pin assignment for 8-pin connector



Pin-Numbering of socket connector in the encoder housing

The orientation of the connector relative to the encoder body is not defined and varies from encoder to encoder. When using right-angle connectors in combination with axial outlets, the orientation of the cable outlet is therefore not defined.

If you need a defined orientation of the cable outlet, please choose our housings with radial cable outlet and use straight mating connectors.



Orientation will vary when using angled connectors.

For details on zero point definition and output programming see page 29.

Absolute Encoders with Redundant Voltage Output

Series HTA25X

Order code HTA25X – redundant, singleturn, analogue output

Description	Selection: standard= black/bold , possible options= <i>grey/italic</i>					
Series	HTA25X					
Shaft diameter, shaft length: Shaft diameter Ø 6 mm, shaft length 12 mm <i>Shaft diameter Ø 4 mm, shaft length 10 mm</i> <i>Custom shaft dimensions [mm] Ø ≤ 6.35 mm</i>		6x12 <i>4x10</i> <i>XxXX</i>				
Supply voltage / output signal: VSUP=5 V (4.5 to 5.5 V) / OUT=0 to 5 V (<i>ratiometric</i>) VSUP=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) <i>Clockwise/Counterclockwise (counterrotational)</i>				CW CW <i>CW CCW</i>		
Rotation angle* in [°]: 360 <i>320</i> <i>270</i> <i>180</i> <i>90</i> <i>Custom rotation angle (≥7°, positive integer)</i>					360 <i>320</i> <i>270</i> <i>180</i> <i>90</i> <i>XXX</i>	
Electrical connection, cable length: 1 m round cable, axial 1 m round cable, radial Connector M8, 8-pol., axial Connector M8, 8-pol., radial <i>Round cable, customer-specific cable length [X.XX m], axial</i> <i>Round cable, customer-specific cable length [X.XX m], radial</i>						PG PGR M8 M8R <i>PGX,XX</i> <i>PGRX,XX</i>

* For details see page 29.

Order example HTA25X – redundant, singleturn, analogue output

Requirement:
Redundant, shaft Ø 6.00 mm, shaft length 12 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, M8 plug radial, 8 pin

Example for order code:
HTA25X 6x12 0505 CW CW 360 M8R

Series HTP25 – singleturn, PWM output

Key features HTP25:

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



Electrical data HTP25 – singleturn, PWM output

Effective electrical angle of rotation 1.)	$7^{\circ} \leq \alpha \leq 360^{\circ}$ (programmable in factory), $\pm 0.5^{\circ}$
Independent linearity (best straight line) 1.)	$\pm 0.4\%$ @ 360°
Absolute Linearity 1.)	$\pm 0.6\%$ @ 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	5 V $\pm 10\%$
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 IEC 60393

Function description PWM signal output HTP25

The HTP25 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 μ Controllers already have an input for PWM signals.

Absolute Encoders with Pulse Width Modulation (PWM)

Series HTP25

Order code HTP25 – singleturn, PWM output

Description	Selection: standard= black/bold , possible options= <i>grey/italic</i>					
Series	HTP25					
Shaft diameter, shaft length: Shaft diameter Ø 6 mm, shaft length 12 mm Shaft diameter Ø 4 mm, shaft length 10 mm Custom shaft dimensions [mm] Ø ≤ 6.35 mm		6x12 <i>4x10</i> <i>XxXX</i>				
Supply voltage / output signal: VSUP=5 V (4.5 to 5.5 V) / OUT=5 V / 244 Hz / PWM 10-90%			5PWM			
Sense of rotation: (when looking at the shaft, from the front) Clockwise <i>Counterclockwise</i>				CW <i>CCW</i>		
Rotation angle* in [°]: 360 <i>320</i> <i>270</i> <i>180</i> <i>90</i> <i>Custom rotation angle (≥7°, positive integer)</i>					360 <i>320</i> <i>270</i> <i>180</i> <i>90</i> <i>XXX</i>	
Electrical connection, cable length: 1 m round cable, axial 1 m round cable, radial Connector M8, 3-pol., axial Connector M8, 3-pol., radial <i>Round cable, customer-specific cable length [X.XX m], axial</i> <i>Round cable, customer-specific cable length [X.XX m], radial</i>						PG PGR M8 M8R <i>PGX,XX</i> <i>PGRX,XX</i>

* For details see page 29.

Order example HTP25 – singleturn, PWM output

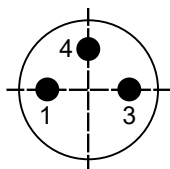
Requirement:
Shaft Ø 6.36 mm, shaft length 12 mm, VSUP=5 V / OUT=244 Hz, sense of rotation CW, rotation angle 360°, M8 connector

Example for order code:
HTP25 6,35x12 5PWM CW 360 M8

Cable and pin assignment

Function	Option PG(R)	Option M8(R)	Accessory: M8-Connector
OUT	brown	Pin 3	Pin 3 - blue
VSUP	red	Pin 1	Pin 1 - brown
GND	black	Pin 4	Pin 4 - black

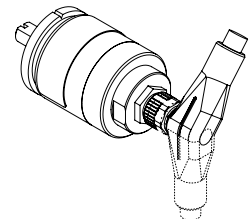
Connector M8 (R) – pin assignment for 3-pin connector



Pin-Numbering of socket connector in the encoder housing

The orientation of the connector relative to the encoder body is not defined and varies from encoder to encoder. When using right-angle connectors in combination with axial outlets, the orientation of the cable outlet is therefore not defined.

If you need a defined orientation of the cable outlet, please choose our housings with radial cable outlet and use straight mating connectors.



Orientation will vary when using angled connectors.

For details on zero point definition and output programming see page 29.

Series HTS25 – singleturn, digital output

Key features HTS25:

- SPI interface with 14 bit resolution and 5 V input voltage
Attention: Signal transmission only possible via short signal lines
- SSI interface with 10-18 bit resolution and wide input range (4.8 to 42 V)



Electrical data HTS25 – singleturn, digital output

Output signal	SPI	SSI
Effective electrical angle of rotation 1.)	360°	
Independent linearity (best straight line) 1.)	±0,3% @ 360°	please contact us
Absolute linearity 1.)	±0,6% @ 360°	please contact us
Resolution	14 Bit	10-18 Bit
Update rate	200 µs	18 µs
Supply voltage	5 VDC ±10 %	4.8 to 42 V
Power consumption (no load)	≤ 12 mA	≤ 24 mA (for 5 V input)
Insulation voltage 1.)	1000 VAC @ 50 Hz, 1 min	
Insulation resistance 1.)	2 MOhm @ 500 VDC, 1 min	
MTTF (SN29500-2005-1)	2046a	800a

1.) According IEC 60393

For details on zero point definition and output programming see page 29.

Absolute Encoders with Serial Output (SPI/SSI)

Series HTS25

Order code HTS25 – singleturn, digital output

Description	Selection: standard= black/bold , possible options= <i>grey/italic</i>			
Series	HTS25			
Shaft diameter, shaft length: Shaft diameter Ø 6 mm, shaft length 12 mm <i>Shaft diameter Ø 4 mm, shaft length 10 mm</i> <i>Custom shaft dimensions [mm] Ø ≤ 6.35 mm</i>		6x12 <i>4x10</i> <i>XxXX</i>		
Supply voltage / output signal: 4.8 to 42 V / SSI, 16 Bit resolution <i>4.8 to 42 V / SSI, custom resolution 10 to 18 bit</i> 5 VDC ± 10% / SPI (14 Bit)			SSI 16 <i>SSI [10-18]</i> 05SPI	
Electrical connection, cable length: 1 m round cable, axial 1 m round cable, radial Connector M8, 8-pol., radial <i>Connector M8, axial*</i> <i>Round cable, customer-specific cable length [X.XX m], axial</i> <i>Round cable, customer-specific cable length [X.XX m], radial</i>				PG PGR M8R <i>M8</i> <i>PGX,XX</i> <i>PGRX,XX</i>

* M8 axial connector variant not available for SSI

Order example

Requirement:

Shaft Ø 6.00 mm, shaft length 12 mm, 14 Bit/5 VDC/SPI, round cable 1 m, radial

Example for order code:

HTS25 6x12 05SPI PGR

Order example

Requirements:

Shaft Ø 4.00 mm, shaft length 20 mm, Electronics 12 Bit/4,8 to 42 VDC/SSI, round cable 1 m radial

Example for order code:

HTS25 4x20 SSI 12 PGR

**Please be aware of limiting factors in the cable lengths / transmission limits of serial communication.
Baud rate/clock frequency must be adjusted to avoid transmission problems.**

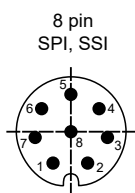
Cable and pin assignment for option 05SPI

Function:	Option PG(R), round signal cable	Option M8(R), 8 pin
VSUP	red	1
GND	black	2
CS, MOSI	yellow	3
CLK	green	4
DATA	orange	5
-	brown n/c	6 n/c
-	-	7 n/c
-	-	8 n/c

Cable and pin assignment for option SSI interface

Function:	Option PG(R), round signal cable	Option M8R, 8 pin
GND	black	1
VSUP	red	2
CLK+	brown	3
CLK-	orange	4
DATA+	yellow	5
DATA-	green	6
-	-	7 n/c
-	-	8 n/c

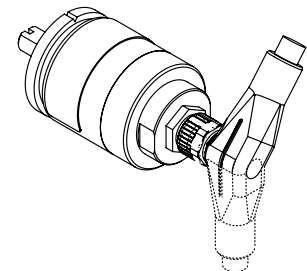
Connector M8(R) – pin assignment for 8-pin connectors



Pin-Numbering of socket connector in the encoder housing

The orientation of the connector relative to the encoder body is not defined and varies from encoder to encoder. When using right-angle connectors in combination with axial outlets, the orientation of the cable outlet is therefore not defined.

If you need a defined orientation of the cable outlet, please choose our housings with radial cable outlet and use straight mating connectors.



Orientation will vary when using angled connectors.

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 $2^{10} = 1024$ 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 $360/1024 = 0.35^\circ$.

The position information is followed by a bit sequence of status data that can be of great interest for the application. This includes, for example, the status of the electronics (readiness, correct supply voltage), but also 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:

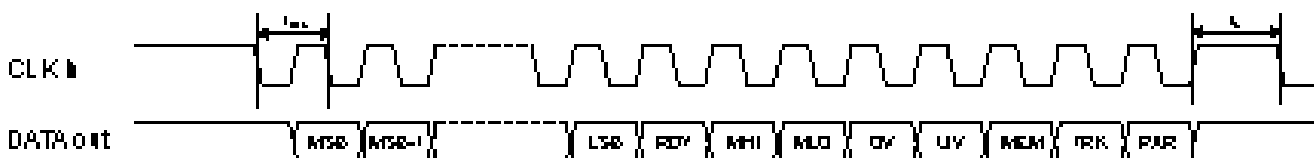
23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
16 bits position data																7 bits status data							

The data structure for any resolution is as follows:

Position data (10 to 18 bits)				Status (7-bit)							Parity 1 bit	
MSB	MSB-1	...	LSB	RDY	MHI	MLO	OV	UV	MEM	TRK	PAR	

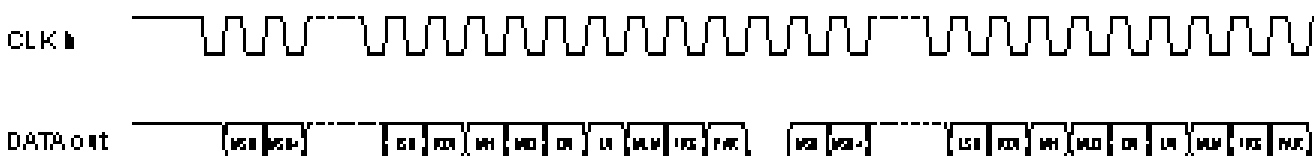
Abbreviation	Description
MSB to LSB	n-bits position data, selectable from 10 to 18 bits ex works, standard is 16 bit
RDY	The encoder is ready (if value is HIGH).
MHI	This indicates that the magnet strength detected by the Hall chip is too strong. If this is consistently HIGH, change to a weaker magnet 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.
OV	Overvoltage error at Hall Chip if HIGH. Might indicate defective voltage regulator (encoder's internal regulator).
UV	Undervoltage error if HIGH. Might indicate too low input voltage or defective voltage regulator (encoder's internal regulator).
MEM	If HIGH, a memory corruption has occurred. Perform a power cycle to reload the memory.
TRK	This indicates that the angular error has exceeded 5° within 5 ms. When this value stays at HIGH, perform a power-cycle to re-initialize the sensor.
PAR	Parity is even

Data is transmitted according to the following timing diagram:



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

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 – 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 $>1\text{ k}\Omega$ 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

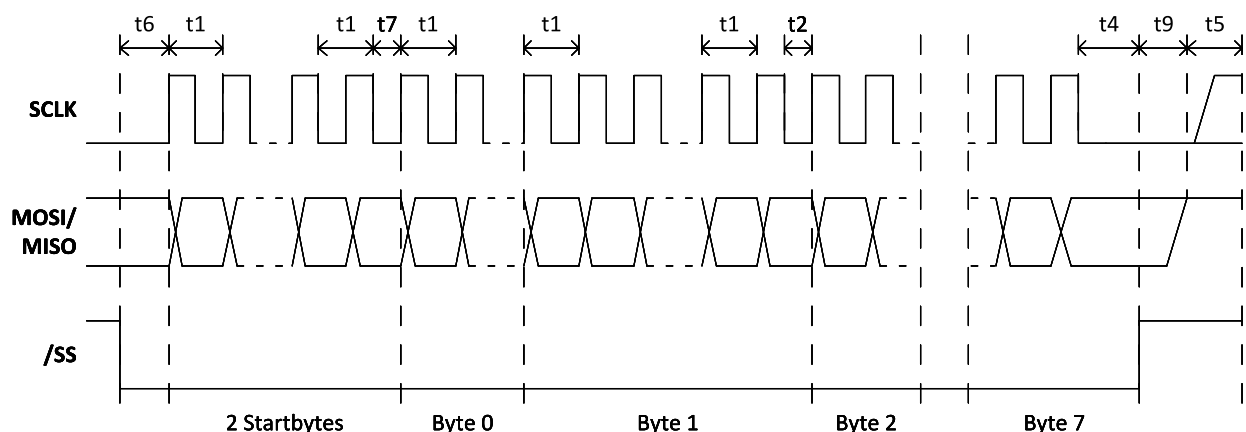
/SS, SCLK, MISO can be undefined during the Master start-up as long as the Slave is re-synchronized before the first frame transfer.

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 t_5 (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 t_5 leads to an undefined frame state, because the Slave may or may not have seen /SS inactive.



Protocol description – Serial Peripheral Interface (SPI) (continuation)

Description timings

Timings	Min	Max	Remarks
t1	2.3 μ s	-	No capacitive load on MISO. t1 is the minimum clock period for any bits within a byte.
t2	12.5 μ s	-	t2 the minimum time between any other byte
t4	2.3 μ s	-	Time between last clock and /SS=high=chip de-selection
t5	300 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	-	The time t6 defines the minimum time between /SS = Lo and the first clock edge
t7	15 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	Minimum time between reset-inactive and any master signal change

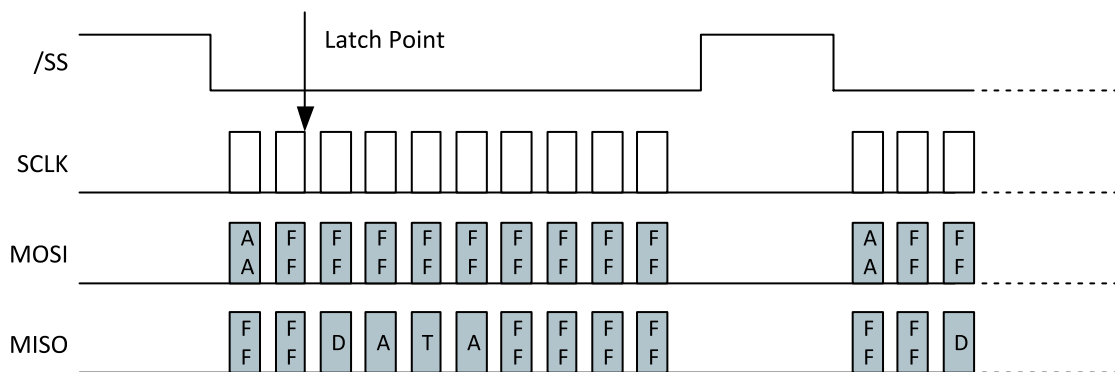
Slave Reset

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 – 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 HTI25 – singleturn, incremental output

Key features HTI25:

- Channels: A, B and index signal Z
- TTL or Open Collector electronics
- Maximum number of pulses per channel 10.000 pulses per revolution
- Option: ex works programmable number of pulses in pulse step width 1

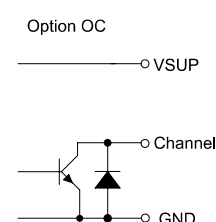
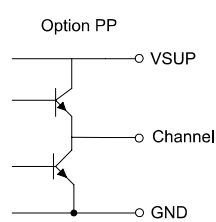
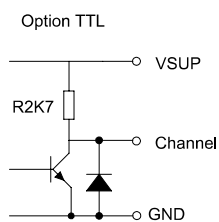


Electrical data HTI25K – singleturn, incremental output

Output Signal	TTL	Open Collector
Number of pulses	1 to 1024 ppr	1 to 10.000 ppr
Limit frequency	100 kHz	250 kHz
Switch-on delay	20 ms	6.3 ms
Supply voltage	3.3 or 5 VDC $\pm 10\%$	4.8 to 42 V
Power consumption (no load)	≤ 15 mA	≤ 24 mA (for 5 V input)
Output load	≥ 5 kOhm	
Max. pull-up voltage	-	42 VDC
Max. pull-up current	600 mA	
Insulation voltage 1.)	1000 VAC @ 50 Hz, 1 min	
Insulation resistance 1.)	2 MOhm @ 500 VDC, 1 min	
MTTF (SN29500-2005-1)	473a	1000a

1.) According to IEC 60393

Output circuit HTI25 per channel



For details on zero point definition and output programming see page 29.

Incremental Encoders

Series HTI25

Order code HTI25 – singleturn, incremental output

Description	Selection: standard= black/bold , possible options= <i>grey/italic</i>			
Series	HTI25			
Shaft diameter, shaft length: Shaft diameter Ø 6 mm, shaft length 12 mm <i>Shaft diameter Ø 4 mm, shaft length 10 mm</i> <i>Custom shaft dimensions [mm] Ø ≤ 6.35 mm</i>		6x12 <i>4x10</i> <i>XxXX</i>		
Number of pulses (ppr): 32 64 128 256 512 1024 <i>User-defined number of pulses</i>			32 64 128 256 512 1024 <i>XXXX</i>	
Supply voltage / output signal: VSUP=5 V ± 10% / OUT=TTL A, B, Z VSUP=4.8 to 42 V / OUT=open collector A, B, Z			05BZTTL BZOC	
Electrical connection, cable length: 1 m round cable, axial 1 m round cable, radial Connector M8, 8 pol., radial* <i>Round cable, customer-specific cable length [X.XX m], axial</i> <i>Round cable, customer-specific cable length [X.XX m], radial</i>				PG PGR M8R <i>PGX,XX</i> <i>PGRX,XX</i>

* M8 axial connector variant not available

Order example HTI25 – singleturn, incremental output

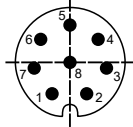
Requirement: Shaft Ø 6.00 mm, shaft length 12 mm, number of pulses 1024 TTL output, VSUP=5 V/TTL, round cable 1 m
Example for order code: HTA25 6x12 1024 05BZTTL PG

Cable and pin assignments – single outputs

Option M8(R), 8 pin		Option PG(R), round cable	
Pin-No.	Function	Wire colour	Function
Pin 1	VSUP	red	VSUP
Pin 2	GND	black	GND
Pin 3	A	brown	A
Pin 4	B	orange	B
Pin 5	Z	yellow	Z
Pin 6	n/c	green	n/c
Pin 7	n/c		
Pin 8	n/c		

Connector M8 – pin assignment for 8-pin connector

Pin-Numbering of socket connector in the encoder housing



8 pin (HTI25)

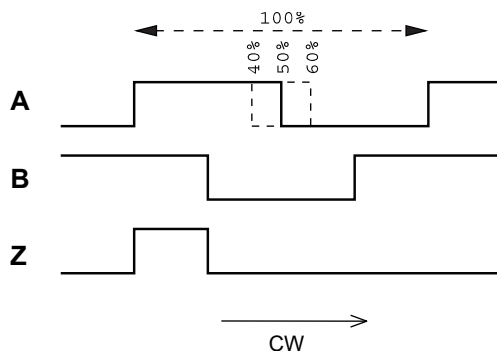
The orientation of the connector relative to the encoder body is not defined and varies from encoder to encoder. When using right-angle connectors in combination with axial outlets, the orientation of the cable outlet is therefore not defined.

If you need a defined orientation of the cable outlet, please choose our housings with radial cable outlet and use straight mating connectors.

Signal details

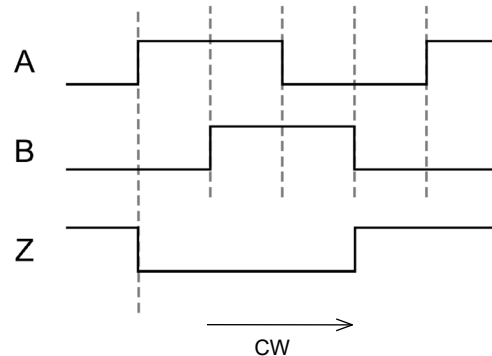
Incremental signal output function

A, B, Z (version 05BZTTL)



The percentage information describes the proportion of a pulse in dependency to the duration of one period

A, B, Z (version BZOC)



Series HTA25PM – multi-/singleturn, programmable, analogue output

Key features HTA25PM :

- Measuring range 10° to max. 72000° (200 shaft revolutions)
- Programmable by the user. 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



Electrical data HTA25PM – multi-/singleturn, programmable, analogue output

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 IEC 60393

Signal output function (factory programming). 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 HTA25PM 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 10 V signal output



Programmable Multi-/Singleturn Encoders

HTA25PM

Order code HTA25PM – singleturn or multiturn, analogue output

Description	Selection: standard= black/bold , possible options= <i>grey/italic</i>			
Series	HTA25PM			
Shaft diameter, shaft length: Shaft diameter Ø 6 mm, shaft length 12 mm <i>Shaft diameter Ø 4 mm, shaft length 10 mm</i> <i>Custom shaft dimensions [mm] Ø ≤ 6.35 mm</i>		6x12 <i>4x10</i> <i>XxXX</i>		
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	
Electrical connection, cable length: 1 m round cable, axial 1 m round cable, radial Connector M8, 8-pol., axial Connector M8, 8-pol.radial <i>Round cable, customer-specific cable length [X.XX m], axial</i> <i>Round cable, customer-specific cable length [X.XX m], radial</i>				PG PGR M8 M8R <i>PGX,XX</i> <i>PGRX,XX</i>

Order example HTA25PM

Requirement:

Shaft Ø 6.00 mm, shaft length 12 mm, VSUP=24 V / OUT=0 to 5 V, sense of rotation CW, rotation angle ex works 3600° (can be programmed by customer), round cable 1 m radial

Example for order code:

HTA25PM 6x12 2405 PGR

Cable and pin assignment

Function	Roundcable (Option R)	Option M8(R), 8 pin	Accessory: M8-Connector
GND	black	Pin 1	Pin 1 - white
VSUP	red	Pin 2	Pin 2 - brown
OUT	brown	Pin 3	Pin 3 - green
DIR	orange	Pin 4	Pin 4 - yellow
START	yellow	Pin 5	Pin 5 - grey
END	green	Pin 6	Pin 6 - pink
-	-	Pin 7 n/c	Pin 7 - blue
-	-	Pin 8 n/c	Pin 8 - red

For details on output programming see page 29.

Order example HTA25PM programmer

Key features HTA25 PM 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:

135945

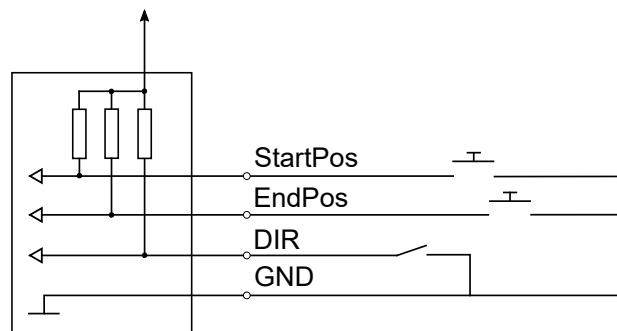
Order code:

Programmer Tool for ETA HTA PM

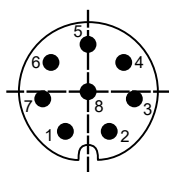
Programming of HTA25PM

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

To program the HTA25PM rotary encoder either the following circuit must be built, or the programmer must be ordered from MEGATRON.



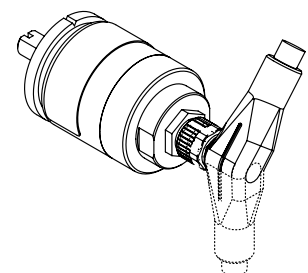
Connector M8(R) – pin assignment for 8-pin connector



Pin-Numbering of socket connector in the encoder housing

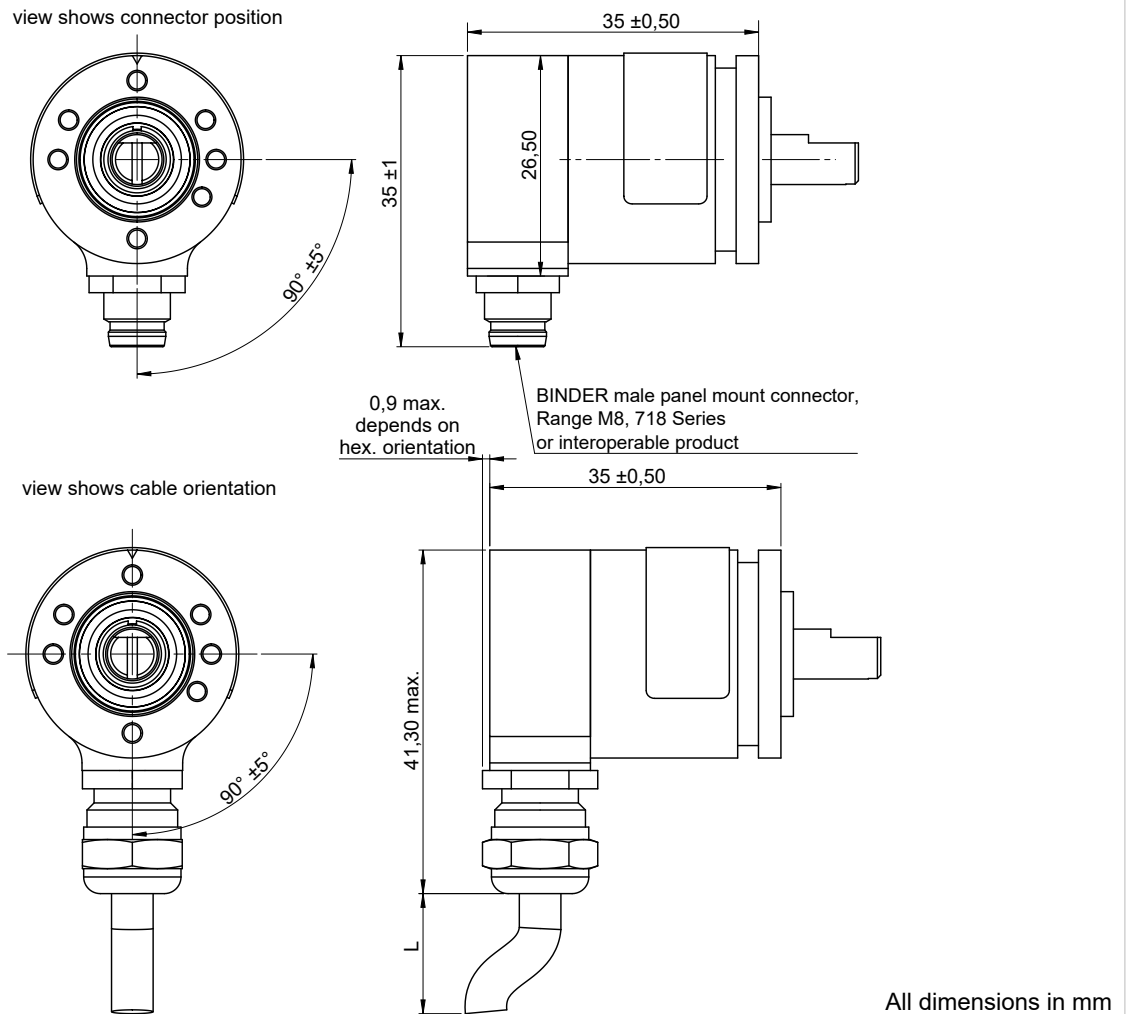
The orientation of the connector relative to the encoder body is not defined and varies from encoder to encoder. When using right-angle connectors in combination with axial outlets, the orientation of the cable outlet is therefore not defined.

If you need a defined orientation of the cable outlet, please choose our housings with radial cable outlet and use straight mating connectors.



Orientation will vary when using angled connectors.

Drawings HTx25 – Radial cable versions with orientation



Cable specs for option PG(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
PG PGR	Standard 1000 mm	3		AWG26	-20 mm to +40 mm	10 x D Ø (D = cable sheath diameter Ø)
		6				
		8				
		10		AWG28		
		12				

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	+40 mm / -20 mm
> 1.5 m - 3 m	+100 mm / -40 mm
> 3 m - 7.5 m	+150 mm / -60 mm

Wire harness length measured from sensor face including connector. Minimum cable length: 0.08 m (for round cable). Please contact us for lengths > 3 m regarding handling and packaging.

Mechanical and Environmental data	
Shaft type	Solid shaft
Mechanical angle of rotation ^{1.)}	Endless
Lifetime ^{2.)}	@100 % of max. permissible radial shaft load >1.4x10E8 shaft revolutions @80 % of max. permissible radial shaft load >2x10E9 shaft revolution @20 % of max. permissible radial shaft load >1.7x10E10 shaft revolutions
Bearing	2 pcs. groove ball bearings type 2RS
Max. operational speed (with shaft sealing)	max. 12.000 rpm
Operational torque: (@ room temperature and 10 rev/min)	≤ 0.3 Ncm
Operating temperature range	Option M8 (connector) ▪ -25 to +80°C Option PG (cable gland incl. cable) ▪ -30 to +85°C Kabel fest verlegt ▪ -10 to +85°C Kabel in Bewegung
Storage temperature range	-30 to +105°C
Protection grade (IEC 60529) front side	IP65S
Protection grade (IEC 60529) rear side	Option PG: IP68 (cable ends excluded) Option M8: IP67 (when mated with IP67 type M8 cable)
Vibration (DIN EN 60068-2-64:2008 + A1: 2019)	±1.5 mm / 30 g / 10 to 2000 Hz / 16 frequency cycles (3x4 h)
Shock (DIN EN 60068-2-27)	400 m/s ² / 6 ms / half sine (100±5) shocks
Housing diameter	Ø 25 mm
Housing depth	In dependency to the electrical connection position: ▪ axial 51.7 mm (PG) / 43.9 mm (M8) ▪ radial 35 mm
Shaft diameter	Standards: Ø6 mm, Ø4 mm, details see drawings Option Custom diameter [mm] Ø ≤ 6.35 mm
Max. radial load	80 N (load point 80% in dependency to the visible standard shaft length)
Max. axial load	40 N (axial application of force onto the shaft end)
Masse (zirka)	HTx25 mit Stecker M8(R) 40 g HTx25 mit Kabelverschraubung und 1 m Signalkabel PG(R) 69 g

1.) According IEC 60393

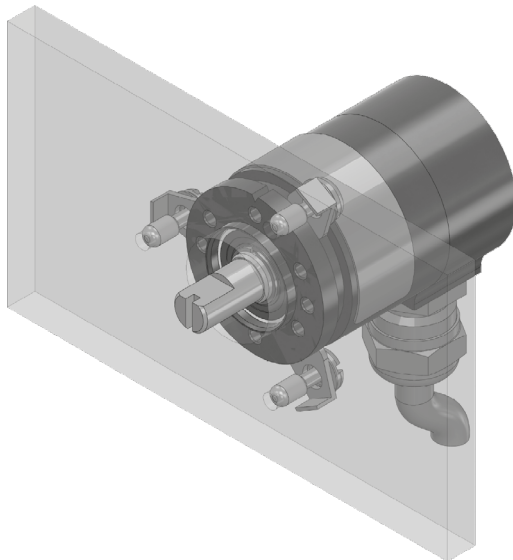
2.) Determined by climatic conditions according to IEC 68-1, para. 5.3.1 without load collectives

Mechanical Data

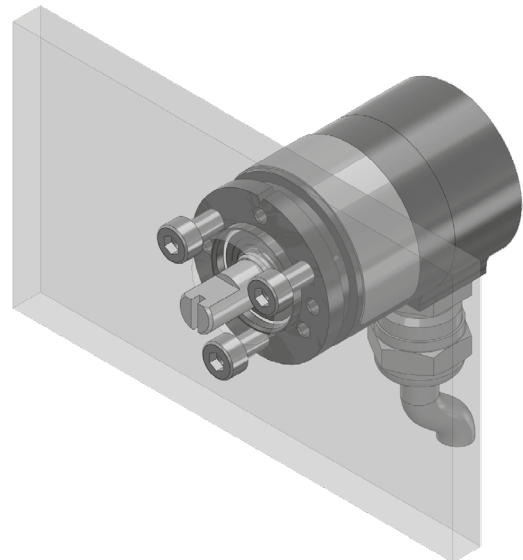
Family HTx25

Mechanical and environmental data, miscellaneous

Sensor mounting	1. Via threaded holes integrated in the sensors head by use of stainless steel screws M3x0.5 2. Via synchro flange with optional available servo mount fixing nails SFN1 incl. screws M3 x 0.5 from MEGATRON (not enclosed), recommended at angles of 120°
Mounting hardware included	none ▪ To attach the rotary encoder using a synchro flange, the MEGATRON SFN1 synchro clamps available as accessories ▪ For the electrical connection option M8 (R), cables and mating connectors are not part of the scope of delivery. M8 connectors with cables are available as accessories from MEGATRON
Fastening torque per screw for fastening of the rotary encoder	≤ 0.6 Nm (M3 screw, thread tensile strength class 5.6) For screw securing, the use of a medium-strength thread securing adhesive is recommended
Material shaft	Stainless steel
Material housing	Aluminium
Material cable gland (PG)	Stainless steel
Material connector M8	CuZn nickel-plated



Servo mount using fixing nails SFN1
incl. 3 screws M3 x 0.5



Flange mount using 3 screws M3

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:

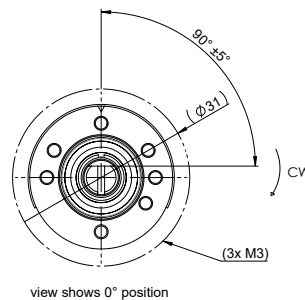
HTA25 (analogue outputs): Output signal 0% full scale (F. S.)

HTP25 (PWM output): duty cycle 10% (10% duty cycle)

HTS25 (serial output): Output signal 0% full scale (F. S.)

HTI25 (incremental output): The index signal is output (Z)

Position of the zero position see drawing below (nodge at top)



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.

