Measuring systems
SIMODRIVE sensor

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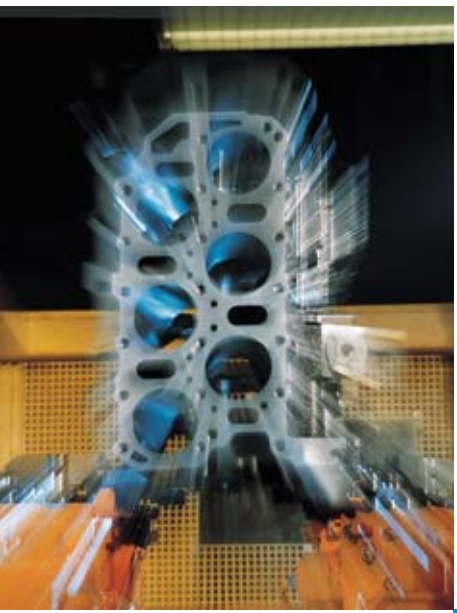

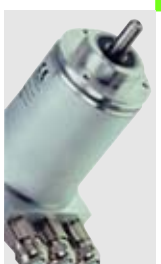

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Built-on optoelectronic rotary encoders

Introduction

Overview

SIMODRIVE sensors are built-on optoelectronic rotary encoders for the recording of paths, angles of rotation, or speeds of machines. They can be used in conjunction with numerical controllers, programmable logic controllers, drives and position displays, e.g.:

- SINAMICS drive systems
- SIMOTION Motion Control systems
- SINUMERIK CNCs
- SIMATIC programmable logic controllers
- SIMODRIVE and SIMOVERT MASTERDRIVES drive systems

Application

A distinction is made between incremental and absolute measuring procedures:

- In the case of incremental encoders, the machine must travel to a reference point after each power-off state, as the position is not usually stored in the controller, and movements of the machine while the power is off are not recorded.
- Absolute encoders, on the other hand, also record these movements while the power is off and return the actual position with power On. Travel to a reference point is not necessary.

Design

All encoders are available in synchronous flange and supported flange joint versions. Encoders with a synchronous flange can be attached to the machine with 3 clamp straps or mounted with axial screws. The encoder is driven by means of a plug-in coupling or a spring disk coupling. Alternatively, pulleys can also be used.

The encoder supply voltage is 5 V DC or alternatively 10 V to 30 V DC. The 10 V to 30 V DC version supports longer cable lengths. Most control systems apply the supply voltage directly on the measuring circuit connector. With SINAMICS, the power supply for the measuring systems is provided via the Sensor Modules.

For rotary encoders with cables, the cable length including the connector is 1 m (3.28 ft).
The following bending radii for the cables at the encoder must be complied with:

- One-time bending: ≥ 20 mm (0.79 in)
- Continuous bending: ≥ 75 mm (2.95 in)

Incremental encoders

Function

Incremental encoders deliver a defined number of electrical pulses per rotation, which represent the measurement of the traveled distance or angle.

Incremental encoders operate on the principle of optoelectronic scanning of dividing disks with the transmitted light principle. The light source is a light emitting diode (LED). The light-dark modulation generated as the encoder shaft rotates is picked up by photoelectronic elements. With an appropriate arrangement of the line pattern on the dividing disk connected to the shaft and the fixed aperture, the photoelectronic elements provide two trace signals A and B at 90° to one another, as well as a reference signal R. The encoder electronics amplify these signals and convert them into different output levels.

The following output levels are available:

- RS 422 difference signals (TTL)
  In the case of RS 422 encoders (TTL), the resolution can be improved by a factor of four by means of edge evaluation.
- 1 V_{pp} analog signals sin/cos
  Even better resolution can be achieved for encoders with sinusoidal signals by interpolating them in the higher-level controller.
- HTL (High Voltage Transistor Logic)
  Encoders with HTL interfaces are designed for applications with digital inputs with 24 V levels.

Absolute encoders

Function

Absolute encoders (absolute shaft encoders) are designed on the same scanning principle as incremental encoders, but have a greater number of tracks. For example, if there are 13 tracks, then 2^{13} = 8192 steps are coded in the case of single-turn encoders. The code used is a one-step code (Gray code), which prevents any scanning errors from occurring.

After switching on the machine, the position value is transmitted immediately to the controller. There is no need to travel to a reference point.

SSI and EnDat absolute encoders are of advantage in time-critical applications.

In plants with a large number of encoders, PROFIBUS DP is more of an advantage due to the reduced wiring overhead. PROFIBUS DP encoders are programmable and support isochronous mode with internode communication.

Single-turn encoders divide one rotation (360 degrees mechanical) into a specific number of steps, e.g. 8192. A unique code word is assigned to each position. After 360 degrees the position values are repeated.

Multiturn encoders also record the number of revolutions, in addition to the absolute position within one revolution. To do this, further code discs which are coupled via gear steps with the encoder shaft are scanned. When evaluating 12 additional tracks, this means that 2^{12} = 4096 revolutions can be coded.

Incremental encoders

Technical specifications

Product name	TTL (RS 422) incremental encoder	sin/cos 1 V_{pp} incremental encoder	HTL incremental encoder	TTL (RS 422) double-track incremental encoder
Operating voltage U_p	5 V DC ± 10% or 10 … 30 V DC	5 V DC ± 10%	10 ... 30 V DC	5 V DC ± 5%
Limit frequency, typ.	–	≥ 180 kHz (-3 dB) ≥ 450 kHz (-6 dB)	–	–
Scanning frequency, max.	300 kHz	–	300 kHz	Track 1: 160 kHz Track 2: 1 MHz
No-load current consumption, max.	150 mA	150 mA	150 mA	150 mA per track
Signal level	TTL (RS 422)	sinusoidal 1 V_{pp}	V_H ≥ 21 V at I_H = 20 mA at 24 V V_L ≤ 2.8 V at I_L = 20 mA at 24 V	TTL (RS 422)
Outputs protected against short-circuit to 0 V	Yes	Yes	Yes	Yes
Switching time (10 … 90%) (with 1 m (3.28 ft) cable and recommended input circuit)	Rise/fall time t_+/t_- ≤ 50 ns	–	Rise/fall time t_+/t_- ≤ 200 ns	Rise/fall time t_+/t_- ≤ 100 ns
Phase angle, signal A to B min. edge spacing	90°	90° ±10°el.	90°	90°
• at 1 MHz	–	–	–	≥ 0.125 µs (track 2)
• at 300 KHz	≥ 0.45 µs	–	≥ 0.45 µs	–
• at 160 KHz	–	–	–	≥ 0.8 µs (track 1)
Cable length to electronic circuitry [1], max.	100 m (328 ft)	150 m (492 ft)	100 m (328 ft)	Up to 500 kHz: 100 m (328 ft) Up to 1 MHz: 50 m (164 ft)
LED failure monitoring	High-resistance driver	–	High-resistance driver	–
Resolution, max.	5000 S/R	2500 S/R	2500 S/R	Track 1: 1024 S/R Track 2: 9000 S/R
Accuracy (in angular seconds)	± 18° mech. x 3600/resolution z	± 18° mech. x 3600/resolution z	± 18° mech. x 3600/resolution z	Track 1: ± 63 Track 2: ± 12
Electr. speed, permissible	(18 × 10^6 rpm)/revolution	(27 × 10^6 rpm)/revolution (at -6 dB)	(18 × 10^6 rpm)/revolution	Track 1: 9000 rpm Track 2: 6500 rpm
Mech. speed, max.	12000 rpm	12000 rpm	12000 rpm	12000 rpm
Friction torque (at 20 °C (68 °F))	≤ 0.01 Nm (0.04 oz_f)	≤ 0.01 Nm (0.04 oz_f)	≤ 0.01 Nm (0.04 oz_f)	≤ 0.01 Nm (0.04 oz_f)
Starting torque (at 20 °C (68 °F))	≤ 0.01 Nm (0.04 oz_f)	≤ 0.01 Nm (0.04 oz_f)	≤ 0.01 Nm (0.04 oz_f)	≤ 0.01 Nm (0.04 oz_f)
Shaft loading capacity				
• n > 6000 rpm				
- Axial	10 N (2.25 lb_f)	10 N (2.25 lb_f)	10 N (2.25 lb_f)	–
- Radial at shaft extension	20 N (4.50 lb_f)	20 N (4.50 lb_f)	20 N (4.50 lb_f)	–
• n ≤ 6000 rpm				
- Axial	40 N (8.99 lb_f)	40 N (8.99 lb_f)	40 N (8.99 lb_f)	10 N (2.25 lb_f)
- Radial at shaft extension	60 N (13.49 lb_f)	60 N (13.49 lb_f)	60 N (13.49 lb_f)	20 N (4.50 lb_f)
Angular acceleration, max.	10^5 rad/s^2	10^5 rad/s^2	10^5 rad/s^2	10^5 rad/s^2
Moment of inertia of rotor	1.45 × 10^{-6} kgm^2 (12.83 x 10^{-6} lb_f-in-s^2)	1.45 × 10^{-6} kgm^2 (12.83 x 10^{-6} lb_f-in-s^2)	1.45 × 10^{-6} kgm^2 (12.83 x 10^{-6} lb_f-in-s^2)	20 × 10^{-6} kgm^2 (177 x 10^{-6} lb_f-in-s^2)
Vibration (55 … 2000 Hz) to EN 60068-2-6	≤ 300 m/s^2 (984 ft/s^2)	≤ 300 m/s^2 (984 ft/s^2)	≤ 300 m/s^2 (984 ft/s^2)	≤ 100 m/s^2 (328 ft/s^2)
Shock to EN 60068-2-27				
• 2 ms	≤ 2000 m/s^2 (6563 ft/s^2)	≤ 2000 m/s^2 (6563 ft/s^2)	≤ 2000 m/s^2 (6563 ft/s^2)	–
• 6 ms	≤ 1000 m/s^2 (3281 ft/s^2)	≤ 1000 m/s^2 (3281 ft/s^2)	≤ 1000 m/s^2 (3281 ft/s^2)	≤ 1000 m/s^2 (3281 ft/s^2)
Operating temperature				
• Flange outlet or fixed cable				
- At V_p = 5 V ± 10%	-40 ... +100 °C (-40 ... +212 °F)	-40 ... +100 °C (-40 ... +212 °F)	-40 ... +100 °C (-40 ... +212 °F)	-10 ... +70 °C (+14 ... +158 °F)
- At V_p = 10 … 30 V	-40 ... +70 °C (-40 ... +158 °F)	–	–	–
• Flexible cable				
- At V_p = 5 V ± 10%	-10 ... +100 °C (+14 ... +212 °F)	-10 ... +100 °C (+14 ... +212 °F)	-10 ... +100 °C (+14 ... +212 °F)	-10 ... +70 °C (+14 ... +158 °F)
- At V_p = 10 … 30 V	-10 ... +70 °C (+14 ... +158 °F)	–	–	–
Degree of protection to EN 60529 (IEC 60529)				
• Without shaft input	IP67	IP67	IP67	IP67
• With shaft input	IP64	IP64	IP64	IP64
EMC	Tested in accordance with the guidelines for electromagnetic compatibility 89/336/EEC and the regulations of the EMC guidelines (applicable basic standards)			
Weight, approx.	0.25 kg (0.55 lb)	0.25 kg (0.55 lb)	0.25 kg (0.55 lb)	0.7 kg (1.54 lb)
CE mark	Yes	Yes	Yes	Yes

[1] With recommended cable and input circuitry of the follow-up electronics, observe max. permissible cable length of module to be evaluated.

Selection and Ordering Data

Designation	Order No.
TTL (RS 422) incremental encoder	
Synchronous flange and 5 V DC supply voltage	
Connection:	
• Axial flange outlet	**6FX2001-2G■■■**
• Radial flange outlet	**6FX2001-2E■■■**
• Cable 1 m (3.28 ft) with connector [1]	**6FX2001-2C■■■**
Synchronous flange and 10 ... 30 V DC supply voltage	
Connection:	
• Axial flange outlet	**6FX2001-2H■■■**
• Radial flange outlet	**6FX2001-2F■■■**
• Cable 1 m (3.28 ft) with connector [1]	**6FX2001-2D■■■**
Supported flange joint and 5 V DC supply voltage	
Connection:	
• Axial flange outlet	**6FX2001-2R■■■**
• Radial flange outlet	**6FX2001-2P■■■**
• Cable 1 m (3.28 ft) with connector [1]	**6FX2001-2M■■■**
Supported flange joint and 10 ... 30 V DC supply voltage	
Connection:	
• Axial flange outlet	**6FX2001-2S■■■**
• Radial flange outlet	**6FX2001-2Q■■■**
• Cable 1 m (3.28 ft) with connector [1]	**6FX2001-2N■■■**
Resolution	
500 S/R	**A 5 0**
1000 S/R	**B 0 0**
1024 S/R	**B 0 2**
1250 S/R	**B 2 5**
1500 S/R	**B 5 0**
2000 S/R	**C 0 0**
2048 S/R	**C 0 4**
2500 S/R	**C 5 0**
3600 S/R	**D 6 0**
5000 S/R	**F 0 0**

Designation	Order No.
sin/cos 1 V_{pp} incremental encoder	
Synchronous flange and 5 V DC supply voltage	
Connection:	
• Axial flange outlet	**6FX2001-3G■■■**
• Radial flange outlet	**6FX2001-3E■■■**
• Cable 1 m (3.28 ft) with connector [1]	**6FX2001-3C■■■**
Resolution	
1000 S/R	**B 0 0**
1024 S/R	**B 0 2**
2500 S/R	**C 5 0**
HTL incremental encoder	
Synchronous flange and 10 ... 30 V DC supply voltage	
Connection:	
• Axial flange outlet	**6FX2001-4H■■■**
• Radial flange outlet	**6FX2001-4F■■■**
• Cable 1 m (3.28 ft) with connector [1]	**6FX2001-4D■■■**
Supported flange joint and 10 ... 30 V DC supply voltage	
Connection:	
• Axial flange outlet	**6FX2001-4S■■■**
• Radial flange outlet	**6FX2001-4Q■■■**
• Cable 1 m (3.28 ft) with connector [1]	**6FX2001-4N■■■**
Resolution	
100 S/R	**A 1 0**
500 S/R	**A 5 0**
1000 S/R	**B 0 0**
2500 S/R	**C 5 0**
TTL (RS 422) double-track incremental encoder	
Synchronous flange and 5 V DC supply voltage	
Connection:	
• Cable 1 m (3.28 ft) with axial connector 2 types of resolution: 9000/1024 S/R	**6FX2001-2UK00**

S/R = Signals/Revolution

[1] Universal integrated cable outlet for axial and radial outlet direction.

Absolute encoders

Technical specifications

Product name	SSI absolute encoder	EnDat absolute encoder	PROFIBUS DP absolute encoder (EN 50170)
Operating voltage U_p	10 ... 30 V DC	5 V DC ± 5%	10 ... 30 V DC
Power consumption, approx.			
• Single-turn	160 mA	160 mA	300 ... 100 mA (2.5 W)
• Multi-turn	200 mA	200 mA	300 ... 100 mA (2.5 W)
Clock input	Differential cable receiver according to EIA standard RS 485	Differential cable receiver according to EIA standard RS 485	Differential cable receiver according to EIA standard RS 485
Data output	Differential cable driver according to EIA standard RS 485	Differential cable driver according to EIA standard RS 485	Differential cable driver according to EIA standard RS 485
Short-circuit resistance	Yes	Yes	Yes
Data transfer rate	100 kHz to 1 MHz	100 kHz to 2 MHz	12 Mbit/s
LED for bus diagnostics	–	–	Yes (green/red)
Electr. speed, permissible			
• At ± 1 bit-accuracy	5000 rpm	5000 rpm	5800 rpm
• At ± 100 bit-accuracy	10000 rpm	10000 rpm	–
Mech. speed, max.			
• Single-turn	12000 rpm	12000 rpm	12000 rpm
• Multi-turn	10000 rpm	10000 rpm	6000 rpm
Cable length to electronic circuitry [1], max.	Up to 1 MHz-cycle: 50 m (164 ft) Up to 300-kHz-cycle: 100 m (328 ft) Up to 100-kHz-cycle: 400 m (1312 ft)	Up to 1 MHz-cycle: 50 m (164 ft) Up to 300-kHz-cycle: 150 m (492 ft)	Up to 12 Mbit/s: 100 m (328 ft) Up to 1.5 Mbit/s: 200 m (656 ft) Up to 93.75 kbit/s: 1200 m (3937 ft)
Number of nodes	–	–	99
Connection	Flange outlet, axial/radial	Flange outlet, axial/radial	Terminal block with address selector switch and bus terminating resistor in removable cover with 3 radial cable glands
Cable diameter	–	–	6.5 ... 9 mm (0.26 in ... 0.35 in) Removal of cover possible without interrupting bus
Resolution			
• Single-turn	13 bits (8192 steps)	13 bits (8192 steps)	13 bits (8192 steps)
• Multi-turn	25 bits (8192 × 4096 steps)	25 bits (8192 × 4096 steps)	27 bits (8192 × 16,384 steps)
Message frame length			
• Single-turn	13 bits, without parity	According to EnDat specification	–
• Multi-turn	25 bits, without parity	According to EnDat specification	–
Incremental track	–	512 S/R, 1 V_{pp}	–
Code type			
• Sampling	Gray	Gray	Gray
• Transfer	Gray, fir tree format	Binary	Binary
Parameterization capability		–	
• Resolution per revolution	–	–	Arbitrary 1 ... 8,192
• Total resolution	–	–	Arbitrary 1 ... 16,384
• Preset	–	–	Yes
• Counting direction	Yes	–	Yes
• Speed signal	–	–	Yes
• Limit switches	–	–	Yes, 2 units
• Isochronous mode and internode communication acc. to DP V2	–	–	Yes
Online parameterization	–	–	Yes
Network load, approx.	–	–	20 µs per encoder at 12 Mbit/s
Cycle time	–	–	667 µs
Accuracy	± 60 angular seconds	± 60 angular seconds (incr. track)	± ½ LSB
EMC	Tested in accordance with EN 50081 and EN 50082	Tested in accordance with EN 50081 and EN 50082	Tested in accordance with EN 50081 and EN 50082
Friction torque at 20 °C (68 °F)	≤ 0.01 Nm (0.04 oz_f)	≤ 0.01 Nm (0.04 oz_f)	≤ 0.01 Nm (0.04 oz_f) at 20 °C (68 °F)
Starting torque at 20 °C (68 °F)	≤ 0.01 Nm (0.04 oz_f)	≤ 0.01 Nm (0.04 oz_f)	≤ 0.01 Nm (0.04 oz_f) at 20 °C (68 °F)
Shaft loading capacity			
• n > 6000 rpm			
- Axial	10 N (2.25 lb_f)	10 N (2.25 lb_f)	10 N (2.25 lb_f)
- Radial at shaft extension	20 N (4.50 lb_f)	20 N (4.50 lb_f)	20 N (4.50 lb_f)
• n ≤ 6000 rpm			
- Axial	40 N (8.99 lb_f)	40 N (8.99 lb_f)	40 N (8.99 lb_f)
- Radial at shaft extension	60 N (13.49 lb_f)	60 N (13.49 lb_f)	110 N (24.73 lb_f)

[1] Observe the maximum permissible cable length of the connected module.

Technical specifications (continued)

Product name	SSI absolute encoder	EnDat absolute encoder	PROFIBUS DP absolute encoder (EN 50170)
Angular acceleration, max.	10^5 rad/s^2	10^5 rad/s^2	10^5 rad/s^2
Moment of inertia of rotor	1.45 × 10^{-6} kgm^2 (12.834 x 10^{-6} lb$_f$-in-s^2)	1.45 × 10^{-6} kgm^2 (12.834 x 10^{-6} lb$_f$-in-s^2)	1.45 × 10^{-6} kgm^2 (12.834 x 10^{-6} lb$_f$-in-s^2)
Vibration (55 … 2000 Hz) to EN 60068-2-6	≤ 300 m/s^2 (984 ft/s^2)	≤ 300 m/s^2 (984 ft/s^2)	≤ 100 m/s^2 (328 ft/s^2)
Shock to EN 60068-2-27			
• 2 ms	≤ 2000 m/s^2 (6562 ft/s^2)	≤ 2000 m/s^2 (6562 ft/s^2)	≤ 2000 m/s^2 (6562 ft/s^2)
• 6 ms	≤ 1000 m/s^2 (3281 ft/s^2)	≤ 1000 m/s^2 (3281 ft/s^2)	≤ 1000 m/s^2 (3281 ft/s^2)
Operating temperature	-40 ... +85 °C (-40 ... +185 °F)	-40 ... +100 °C (-40 ... +212 °F)	-40 ... +85 °C (-40 ... +212 °F)
Degree of protection to EN 60529 (IEC 60529)			
• Without shaft input	IP67	IP67	IP67
• With shaft input	IP64	IP64	IP64
Weight, approx.			
• Single-turn	0.35 kg (0.77 lb)	0.35 kg (0.77 lb)	0.5 kg (1.10 lb)
• Multi-turn	0.35 kg (0.77 lb)	0.35 kg (0.77 lb)	0.7 kg (1.54 lb)
CE mark	Yes	Yes	Yes
PROFIBUS certificate	–	–	Yes
Supported profiles	–	–	Class 1, Class 2

Selection and Ordering Data

Designation	Order No.
SSI absolute encoder	
Synchronous flange and 10 ... 30 V DC supply voltage	
Connection:	
• Axial flange outlet	**6FX2001-5HS■■**
• Radial flange outlet	**6FX2001-5FS■■**
Supported flange joint and 10 ... 30 V DC supply voltage	
Connection:	
• Axial flange outlet	**6FX2001-5SS■■**
• Radial flange outlet	**6FX2001-5QS■■**
Resolution	
• Single-turn 8192 steps/revolution (13-bit)	**1 2**
• Multi-turn 8192 steps/revolution, 4096 revolutions (25-bit)	**2 4**
EnDat absolute encoder	
Synchronous flange and 5 V DC supply voltage	
Connection:	
• Axial flange outlet	**6FX2001-5HE■■**
• Radial flange outlet	**6FX2001-5FE■■**
Supported flange joint and 5 V DC supply voltage	
Connection:	
• Axial flange outlet	**6FX2001-5SE■■**
• Radial flange outlet	**6FX2001-5QE■■**
Resolution	
• Single-turn 8192 steps/revolution (13-bit)	**1 3**
• Multi-turn 8192 steps/revolution, 4096 revolutions (25-bit)	**2 5**

Designation	Order No.
PROFIBUS DP absolute encoder (EN 50170)	
10 ... 30 V DC supply voltage Radial connection	
• Synchronous flange solid shaft	**6FX2001-5FP■■**
• Supported flange joint solid shaft	**6FX2001-5QP■■**
• Torque counteracting support hollow shaft 8 mm/10 mm/12 mm/15 mm (0.31 in/0.39 in/0.47 in/0.59 in)	**6FX2001-5WP■■**
Resolution	
• Single-turn 8192 steps/revolution (13-bit)	**1 2**
• Multi-turn 8192 steps/revolution, 16384 revolutions (27-bit)	**2 4**
User Manual for start-up and parameterization of PROFIBUS encoders (German/English)	**6SN1197-0AB10-0YP4**

More information

Designation	Order No.
Decentralizing with PROFIBUS DP	**ISBN3-89578-074-X**

8

Mounting accessories

Overview

Clamp straps/couplings

Clamp straps and couplings are available as mounting accessories for the rotary encoders. The clamp straps are used to fix the encoders with a synchronous flange.

Mating connector

A mating connector is available for the encoder with flange outlet or with cable and encoder connector for cable diameters 5.5 mm (0.22 in) to 12 mm (0.47 in). Connectors with 12 contacts are suitable for all incremental encoders, as well as SSI absolute encoders. Connectors with 17 contacts are suitable for EnDat encoders.

Replacement connector

A replacement connector is available for encoders with cable.

Technical specifications

Product name	Spring disk coupling	Plug-in coupling
Transmission torque, max.	0.8 Nm (2.88 oz_f)	0.7 Nm (2.52 oz_f)
Shaft diameter	6 mm (0.24 in) both ends or d_1 = 6 mm (0.24 in), d_2 = 5 mm (0.20 in)	6 mm (0.24 in) both ends or 10 mm (0.39 in) both ends
Center offset of shafts, max.	0.4 mm (0.02 in)	0.5 mm (0.02 in)
Axial offset	±0.4 mm (0.02 in)	±0.5 mm (0.02 in)
Angular displacement of shafts, max.	3°	1°
Torsional rigidity	150 Nm/rad (539.51 oz_f/rad)	31 Nm/rad (111.5 oz_f/rad)
Lateral spring stiffness	6 N/mm (1.35 lb_f)	10 N/mm (2.25 lb_f)
Moment of inertia	19 gcm^2 (168 x 10^{-7} lb_f-in-s^2)	20 gcm^2 (177 x 10^{-7} lb_f-in-s^2)
Speed, max.	12000 rpm	12000 rpm
Operating temperature	-40 ... +150 °C (-40 ... +302 °F)	-40 ... +80 °C (-40 ... +176 °F)
Weight, approx.	16 g (0.56 oz)	20 g (0.71 oz)

Selection and Ordering Data

Designation	Order No.
Clamp strap for double-track encoder and encoder with synchronous flange (3 units are required)	**6FX2001-7KP01**
Spring disk coupling Shaft diameter:	
• 6 mm/6 mm (0.24 in/0.24 in)	**6FX2001-7KF10**
• 6 mm/5 mm (0.24 in/0.20 in)	**6FX2001-7KF06**
Plug-in coupling Shaft diameter:	
• 6 mm/6 mm (0.24 in/0.24 in)	**6FX2001-7KS06**
• 10 mm/10 mm (0.39 in/0.39 in)	**6FX2001-7KS10**
Mating connector for flange outlet or encoder plug with cap nut (1 set) Crimp version, socket contacts for cable diameters 5.5 … 12 mm (0.22 … 0.47 in)	
• 12-pin, insulator with 12 socket contacts (1 unit) for TTL, sin/cos 1 V_{pp}, HTL incremental encoder or for SSI absolute encoder	**6FX2003-0SU12**
• 17-pin, insulator with 17 socket contacts (1 unit) for EnDat absolute encoder	**6FX2003-0SU17**
Replacement connectors with external thread for encoders (1 set)	**6FX2003-0SA12**
• 12-pin, insulator with 12 contact pins (1 unit) for RS 422, sin/cos 1 V_{pp}, HTL incremental encoder for SSI absolute encoder	

8

SIMAG H2 hollow-shaft measuring system

Application

SIMAG H2 is an incremental system for measuring angles of rotation and rotational speeds. The application range comprises hollow-shaft applications with direct drives, as well as applications as an autonomous spindle encoder.

The electrical signals and the flange outlet are compatible with existing motor measuring systems. SIMAG H2 can be operated with all commonly available controls as a motor measuring system or as a direct measuring system.

Design

The SIMAG H2 measuring system consists of three components:

- Measuring wheel
- Scanning head with connecting lead
- Connection kit

The magnetic division on the measuring wheel is used as unit of measurement. Different internal diameters are available for each outer diameter, whereby the internal diameter can be re-worked. The measuring wheel is attached with the shaft nut; alternatives are screw fitting to a shaft shoulder (not possible with all measuring wheel variants) or shrink fitting.

The non-contact sensor head scans the incremental and reference tracks on the measuring wheel and amplifies the signals.

It is connected via a cable attached to the scanning head. The end of the cable is pre-assembled with contacts and an insulation insert. For assembly, the insulation insert can be fixed into a straight or angular flange outlet. For confined spaces, the encoder can also be supplied with open wire ends.

Technical specifications

Product name	SIMAG H2 hollow-shaft measuring system
Output signals	2 voltage signals 1 V_{pp} in quadrate; 1 reference signal per encoder rotation
Operating voltage	5 V DC ±5%
Power consumption, typical	30 mA
Resolution (with external diameter D_a)	192 S/R (D_a = 60.72 mm/2.39 in) 256 S/R (D_a = 81.14 mm/3.19 in) 400 S/R (D_a = 126.92 mm/5 in) 480 S/R (D_a = 152.39 mm/6 in) 800 S/R (D_a = 254.25 mm/10.01 in)
Indexing accuracy of measuring wheel	
• At a resolution of 192 S/R	± 96 angular seconds
• At a resolution of 256 S/R	± 72 angular seconds
• At a resolution of 400 S/R	± 46 angular seconds
• At a resolution of 480 S/R	± 38 angular seconds
• At a resolution of 800 S/R	± 23 angular seconds
Limit speed	
• At a resolution of 192 S/R	≤ 33000 rpm
• At a resolution of 256 S/R	≤ 25000 rpm
• At a resolution of 400 S/R	≤ 16000 rpm
• At a resolution of 480 S/R	≤ 13000 rpm
• At a resolution of 800 S/R	≤ 8000 rpm
Distance between measuring wheel and scanning head	200 µm
Operating temperature range	-20 ... +120 °C (-4 ... +248 °F)
Shock resistance (11 ms)	1000 m/s² (3,281 ft/s²)
Vibration (50 ... 2000 Hz)	200 m/s² (656 ft/s²)
Degree of protection to EN 60529 (IEC 60529)	IP67 when installed
Bending radius of connecting cable	
• One-time bending	≥ 25 mm (0.98 in)
• Repeated bending	≥ 60 mm (2.36 in)
Length of cable to converter, max.	50 m (164 ft)
Dimensions, approx. Scanning head (mounted)	
• Width	36 mm (1.42 in)
• Height	18 mm (0.71 in)
• Depth	15 mm (0.59 in)

SIMAG H2 hollow-shaft measuring system

Technical specifications (continued)

Measuring wheel external diameter D_a = 60.72 mm (2.39 in)				
Internal diameter [1]	mm (in)	40^{H6} (1.57^{H6})		
Thickness	mm (in)	15 (0.59)		
Number of signals/revolution		192		
Moment of inertia, approx.	kgm^2 (lb_f-in-s^2)	1.0×10^{-4} (8.851×10^{-4})		
Weight, approx.	kg (lb)	0.20 (0.44)		
Measuring wheel external diameter D_a = 81.14 mm (3.19 in)				
Internal diameter [1]	mm (in)	45^{H6} (1.76^{H6})	60^{H} (2.36^{H6})	65^{H} (2.56^{H6})
Thickness	mm (in)	15 (0.59)	15 (0.59)	15 (0.59)
Number of signals/revolution		256	256	256
Moment of inertia, approx.	kgm^2 (lb_f-in-s^2)	3.8×10^{-4} (33.633×10^{-4})	2.8×10^{-4} (24.782×10^{-4})	2.2×10^{-4} (19.472×10^{-4})
Weight, approx.	kg (lb)	0.35 (0.77)	0.25 (0.55)	0.20 (0.44)
Measuring wheel external diameter D_a = 126.92 mm (5 in)				
Internal diameter [1]	mm (in)	65^{H6} (2.56^{H6})	85^{H6} (3.35^{H6})	100^{H6} (3.94^{H6})
Thickness	mm (in)	15 (0.59)	15 (0.59)	15 (0.59)
Number of signals/revolution		400	400	400
Moment of inertia, approx.	kgm^2 (lb_f-in-s^2)	25×10^{-4} (221.268×10^{-4})	21×10^{-4} (185.865×10^{-4})	16×10^{-4} (141.612×10^{-4})
Weight, approx.	kg (lb)	1.0 (2.20)	0.75 (1.65)	0.5 (1.10)
Measuring wheel external diameter D_a = 152.39 mm (6 in)				
Internal diameter [1]	mm (in)	80^{H6} (3.15^{H6})	110^{H6} (4.33^{H6})	
Thickness	mm (in)	15 (0.59)	15 (0.59)	
Number of signals/revolution		480	480	
Moment of inertia, approx.	kgm^2 (lb_f-in-s^2)	54×10^{-4} (477.94×10^{-4})	42×10^{-4} (371.731×10^{-4})	
Weight, approx.	kg (lb)	1.5 (3.31)	1.0 (2.20)	
Measuring wheel external diameter D_a = 254.25 mm (10.01 in)				
Internal diameter [1]	mm (in)	150^{H6} (5.91^{H6})		
Thickness	mm (in)	15 (0.59)		
Number of signals/revolution		800		
Moment of inertia, approx.	kgm^2 (lb_f-in-s^2)	420×10^{-4} (3717.30×10^{-4})		
Weight, approx.	kg (lb)	3.9 (8.60)		

Selection and Ordering Data

Designation	Order No.
Scanning head, incremental 1 mm (0.04 in.) pole pitch, 1 V_{pp}	
• With plug insert, with 0.2 m (7.87 in) signal cable and 0.3 m (11.81 in) temperature cable (2-core)	**6FX2001-6AA12-1CA0**
• With plug insert, with 0.5 m (19.69 in) signal cable and 0.3 m (11.81 in) temperature cable (2-core)	**6FX2001-6AA12-1FA0**
• With plug insert, with 2.0 m (6.56 ft) signal cable and 0.3 m (11.81 in) temperature cable (2-core)	**6FX2001-6AA12-3AA0**
• Open wire ends, with 1.0 m (3.28 ft) signal cable	**6FX2001-6AA12-2AA5**
Measuring wheel D_a = 60.72 mm (2.39 in)	
• Internal diameter 40^{H6} mm (1.57^{H6} in)	**6FX2001-6RB12-3EA0**
Measuring wheel D_a = 81.14 mm (3.19 in)	
• Internal diameter 45^{H6} mm (1.77^{H6} in)	**6FX2001-6RB12-4EF0**
• Internal diameter 60^{H6} mm (2.36^{H6} in)	**6FX2001-6RB12-4GA0**
• Internal diameter 65^{H6} mm (2.56^{H6} in)	**6FX2001-6RB12-4GF0**
Measuring wheel D_a = 126.92 mm (5 in)	
• Internal diameter 65^{H6} mm (2.56^{H6} in)	**6FX2001-6RB12-5GF0**
• Internal diameter 85^{H6} mm (3.35^{H6} in)	**6FX2001-6RB12-5JF0**
• Internal diameter 100^{H6} mm (3.94^{H6} in)	**6FX2001-6RB12-5LA0**
Measuring wheel D_a = 152.39 mm (6 in)	
• Internal diameter 80^{H6} mm (3.15^{H6} in)	**6FX2001-6RB12-6JA0**
• Internal diameter 110^{H6} mm (4.33^{H6} in)	**6FX2001-6RB12-6MA0**
Measuring wheel D_a = 254.25 mm (10.01 in)	
• Internal diameter 150^{H6} mm (5.91^{H6} in)	**6FX2001-6RB12-7SA0**
Connection kit for insulation insert	
• Straight flange outlet	**6FX2001-6FA12-0GA0**
• Angular flange outlet	**6FX2001-6FA12-0WA0**
Extraction tool for insulation insert of straight or angular flange outlet	**6FX2001-6FK12-0AA0**

[1] The measuring wheels can be re-worked (by increasing the inner diameter or by drilling holes/tapping threads). See Configuring/Installation Guide.