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Measuring systems

Measuring systems
Overview

Encoder type	Interface	Safety Integrated[1]	Accuracy in angular seconds	Resolution	Degree of protection without/with shaft input	Page
Incremental encoders	sin/cos 1 V$_{pp}$	Yes	± 18 mech. × 3600/ number of signals/revolution z	2500 S/R	IP67/IP64	**7/4**
	RS 422 (TTL)	[2]	± 18 mech. × 3600/ number of signals/revolution z	5000 S/R	IP67/IP64	**7/4**
	HTL	[2]	± 18 mech. × 3600/ number of signals/revolution z	2500 S/R	IP67/IP64	**7/4**
	RS 422 (TTL) double-track	[2]	Track 1: ± 63 Track 2: ± 12	Track 1: 1024 S/R Track 2: 9000 S/R	IP67/IP64	**7/4**
Absolute encoders	DRIVE-CLiQ	[2]	± 36	Single-turn 22 bit Multi-turn 34 bit (22 bit Single-turn + 12 bit Multi-turn)	IP67/IP64	**7/7**
	SSI	[2]	± 79 (with 8192 steps)	Single-turn 13 bit (8192 steps) Multi-turn 25 bit (8192 steps × 4096 revolutions)	IP67/IP64	**7/7**
	EnDat	Yes	± 60 (incremental track)	Single-turn 13 bit (8192 steps) Multi-turn 25 bit (8192 steps × 4096 revolutions)	IP67/IP64	**7/7**
	PROFIBUS DP	[2]	± 79 (with 8192 steps)	Single-turn 13 bit (8192 steps) Multi-turn 27 bit (8192 steps × 16384 revolutions)	IP67/IP64	**7/9**
	PROFINET IO	[2]	± 79 (with 8192 steps)	Single-turn 13 bit (8192 steps) Multi-turn 27 bit (8192 steps × 16384 revolutions)	IP67/IP64	**7/9**

S/R = signals/revolution

[1] Built-on rotary encoders can be used for Safety Integrated.
[2] If you require information about the usability of built-on rotary encoders for Safety Integrated, please contact your local Siemens office.

Overview

Absolute encoders, incremental encoders and mounting accessories

The built-on optoelectronic rotary encoders measure paths, angles of rotation or speeds in machines. They can be used in conjunction with computerized numerical controls, programmable logic controllers, drives and position displays, e.g. for:

- SINUMERIK CNCs
- SIMOTION Motion Control Systems
- SIMATIC programmable logic controllers
- SINAMICS drive systems
- SIMODRIVE drive systems
- 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 Synchro flange and supported flange joint versions. Encoders with a Synchro 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)

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Measuring systems
Built-on optoelectronic rotary encoders

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:

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

Incremental encoders (sin/cos 1 V_{pp}/RS 422/HTL) with cable and connector or Synchro flange

■ **Technical specifications**

	sin/cos 1 V_{pp} incremental encoder	RS 422 (TTL) incremental encoder	HTL incremental encoder	RS 422 (TTL) double-track incremental encoder
	6FX2001-3....	6FX2001-2....	6FX2001-4...0	6FX2001-2UK00
Operating voltage U_p on encoder	5 V DC ± 10 %	5 V DC ± 10 % or 10 ... 30 V DC	10 ... 30 V DC	5 V DC ± 5 %
Limit frequency, typical	≥ 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	Sinusoidal 1 V_{pp}	TTL (RS 422)	U_H ≥ 21 V at I_H = 20 mA at 24 V U_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 %) (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 Edge spacing, min. at	90° ± 10°el.	90°	90°	90°
• 1 MHz	–	–	–	Track 2: ≥ 0.125 µs
• 300 kHz	–	≥ 0.45 µs	≥ 0.45 µs	–
• 160 kHz	–	–	–	Track 1: ≥ 0.8 µs

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■ **Technical specifications** (continued)

	sin/cos 1 V_{pp} incremental encoder	RS 422 (TTL) incremental encoder	HTL incremental encoder	RS 422 (TTL) double-track incremental encoder
	6FX2001-3....	6FX2001-2....	6FX2001-4...0	6FX2001-2UK00
Cable length to downstream electronics, max.[1]	150 m (492 ft)	100 m (328 ft)	300 m (984 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.	2500 S/R	5000 S/R	2500 S/R	Track 1: 1024 S/R Track 2: 9000 S/R
Accuracy (in angular seconds)	± 18 mech. × 3600/number of signals/revolution z	± 18 mech. × 3600/number of signals/revolution z	± 18 mech. × 3600/number of signals/revolution z	Track 1: ± 63 Track 2: ± 12
Speed, max.				
• Electrical	$(27 \times 10^6$ rpm)/number of signals/revolution (at -6 dB)	$(18 \times 10^6$ rpm)/number of signals/revolution	$(18 \times 10^6$ rpm)/number of signals/revolution	Track 1: 9000 rpm Track 2: 6500 rpm
• Mechanical	12000 rpm	12000 rpm	12000 rpm	12000 rpm
Friction torque (at 20 °C) (68 °F)	≤ 0.01 Nm (0.09 lb$_f$-in)	≤ 0.01 Nm (0.09 lb$_f$-in)	≤ 0.01 Nm (0.09 lb$_f$-in)	≤ 0.01 Nm (0.09 lb$_f$-in)
Starting torque (at 20 °C) (68 °F)	≤ 0.01 Nm (0.09 lb$_f$-in)	≤ 0.01 Nm (0.09 lb$_f$-in)	≤ 0.01 Nm (0.09 lb$_f$-in)	≤ 0.01 Nm (0.09 lb$_f$-in)
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$_f$)	–
• $n \leq 6000$ 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 (13.5 lb$_f$)	60 N (13.5 lb$_f$)	60 N (13.5 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 (12.8×10^{-6} lb$_f$-in-s^2)	1.45×10^{-6} kgm^2 (12.8×10^{-6} lb$_f$-in-s^2)	1.45×10^{-6} kgm^2 (12.8×10^{-6} lb$_f$-in-s^2)	20×10^{-6} kgm^2 (177×10^{-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 (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)	≤ 1000 m/s^2 (3281 ft/s^2)
Degree of protection to EN 60529 (IEC 60529)				
• Without shaft input	IP67	IP67	IP67	IP67
• With shaft input	IP64	IP64	IP64	IP64
Ambient temperature				
Operation				
• Flange outlet or fixed cable				
- At U_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 U_p = 10 … 30 V	–	-40 ... +70 °C (-40 ... +158 °F)	–	–
• Flexible cable				
- At U_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 U_p = 10 … 30 V	–	-10 ... +70 °C (+14 ... +158 °F)	–	–
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)
EMC	Tested in accordance with the guidelines for electromagnetic compatibility 89/336/EEC and the regulations of the EMC guidelines (applicable basic standards)			
Approvals, according to	CE, cULus	CE, cULus	CE, cULus	CE, cULus

S/R = signals/revolution

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

Measuring systems
Built-on optoelectronic rotary encoders

Incremental encoders

■ **Selection and ordering data**

Description	Order No.			
sin/cos 1 V$_{pp}$ incremental encoder				
Synchro 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
RS 422 (TTL) incremental encoder				
Synchro 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 ■ ■ ■			
Synchro 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

S/R = signals/revolution

Description	Order No.		
HTL incremental encoder			
Synchro flange and 10 ... 30 V DC supply voltage			
Connection:			
• Axial flange outlet	6FX2001-4H ■ ■ 0		
• Radial flange outlet	6FX2001-4 F ■ ■ 0		
• Cable 1 m (3.28 ft) with connector[1]	6FX2001-4D ■ ■ 0		
Supported flange joint and 10 ... 30 V DC supply voltage			
Connection:			
• Axial flange outlet	6FX2001-4S ■ ■ 0		
• Radial flange outlet	6FX2001-4Q ■ ■ 0		
• Cable 1 m (3.28 ft) with connector[1]	6FX2001-4N ■ ■ 0		
Resolution			
100 S/R		A	1
500 S/R		A	5
1000 S/R		B	0
2500 S/R		C	5
RS 422 (TTL) double-track incremental encoder			
Synchro 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		

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

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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.

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

In plants with a large number of encoders, PROFIBUS DP or PROFINET IO are more of an advantage due to the reduced wiring overhead. PROFIBUS DP encoders are programmable and support isochronous mode with slave-to-slave communication. PROFINET IO encoders are programmable as well, they have two additional ports and support RT and IRT operation.

Single-turn encoders

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° the position values are repeated.

Multi-turn encoders

Multi-turn 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.

SSI/EnDat and PROFIBUS DP absolute encoders, top, and DRIVE-CLiQ and PROFINET IO absolute encoders, bottom

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■ Technical specifications

	Absolute encoder with DRIVE-CLiQ	SSI absolute encoder	EnDat absolute encoder
	6FX2001-5.D..-0AA0	6FX2001-5.S..	6FX2001-5.E..
Operating voltage U_p on encoder	24 V DC - 15 % + 20 %	10 ... 30 V DC	5 V DC ± 5 %
Power consumption, approx.			
• Single-turn	245 mA	160 mA	160 mA
• Multi-turn	325 mA	200 mA	200 mA
Interface	DRIVE-CLiQ	SSI	EnDat
Clock input	–	Differential cable receiver according to EIA standard RS 485	Differential cable receiver according to EIA standard RS 485
Data output	DRIVE-CLiQ	Differential cable driver according to EIA standard RS 485	Differential cable driver according to EIA standard RS 485
Short-circuit strength	Yes	Yes	Yes
Data transfer rate	100 Mbit	100 kHz ... 1 MHz	100 kHz ... 2 MHz
Speed, max.			
• Electrical	14000 rpm	–	–
- At ± 1 bit accuracy	–	5000 rpm	5000 rpm
- At ± 100 bit accuracy	–	10000 rpm	10000 rpm
• Mechanical			
- Single-turn	12000 rpm	12000 rpm	12000 rpm
- Multi-turn	10000 rpm	10000 rpm	10000 rpm
Cable length to downstream electronics, max.[1]	100 m (328 ft)	Up to 1-MHz-cycle: 50 m (164 ft)	Up to 1-MHz-cycle: 50 m (164 ft)
		Up to 300-kHz-cycle: 100 m (328 ft)	Up to 300-kHz-cycle: 150 m (492 ft)
		Up to 100-kHz-cycle: 400 m (1312 ft)	
Connection	DRIVE-CLiQ connector, radial	Flange outlet, axial/radial	Flange outlet, axial/radial

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

Measuring systems
Built-on optoelectronic rotary encoders

Absolute encoders

■ **Technical specifications** (continued)

	Absolute encoder with DRIVE-CLiQ 6FX2001-5.D..-0AA0	SSI absolute encoder 6FX2001-5.S..	EnDat absolute encoder 6FX2001-5.E..
Resolution			
• Single-turn	22 bit	13 bit (8192 steps)	13 bit (8192 steps)
• Multi-turn	34 bit (22 bit single-turn + 12 bit multi-turn)	25 bit (8192 steps × 4096 revolutions)	25 bit (8192 steps × 4096 revolutions)
Message frame			
• Single-turn	–	13 bit, without parity	According to EnDat specification
• Multi-turn	–	25 bit, without parity	According to EnDat specification
Incremental track	2048 S/R, 1 V_{pp} (encoder-internal only)	–	512 S/R, 1 V_{pp}
Code type			
• Sampling	Gray	Gray	Gray
• Transfer	DRIVE-CLiQ	Gray, fir tree format	Binary
Parameterization capability			
• Preset	–	Set to zero	–
• Counting direction	Yes	Yes	–
Accuracy (in angular seconds)	± 36	± 79 (with 8192 steps)	± 60 (incremental track)
Friction torque (at 20 °C) (68 °F)	≤ 0.01 Nm (0.09 lb_f-in)	≤ 0.01 Nm (0.09 lb_f-in)	≤ 0.01 Nm (0.09 lb_f-in)
Starting torque (at 20 °C) (68 °F)	≤ 0.01 Nm (0.09 lb_f-in)	≤ 0.01 Nm (0.09 lb_f-in)	≤ 0.01 Nm (0.09 lb_f-in)
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 (13.5 lb_f)	60 N (13.5 lb_f)	60 N (13.5 lb_f)
Angular acceleration, max.	10^5 rad/s^2	10^5 rad/s^2	10^5 rad/s^2
Moment of inertia of rotor			
• Solid shaft	1.90×10^{-6} kgm^2 (16.8×10^{-6} lb_f-in-s^2)	1.45×10^{-6} kgm^2 (12.8×10^{-6} lb_f-in-s^2)	1.45×10^{-6} kgm^2 (12.8×10^{-6} lb_f-in-s^2)
• Hollow shaft	2.80×10^{-6} kgm^2 (24.8×10^{-6} lb_f-in-s^2)	–	–
Vibration (55 ... 2000 Hz) to EN 60068-2-6	≤ 100 m/s^2 (328 ft/s^2)	≤ 300 m/s^2 (984 ft/s^2)	≤ 300 m/s^2 (984 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)
Degree of protection to EN 60529 (IEC 60529)			
• Without shaft input	IP67	IP67	IP67
• With shaft input	IP64	IP64	IP64
Ambient temperature			
• Operation	-20 ... +100 °C (-4 ... +212 °F)	-40 ... +85 °C (-40 ... +185 °F)	-40 ... +100 °C (-40 ... +212 °F)
Weight, approx.			
• Single-turn	0.40 kg (0.88 lb)	0.35 kg (0.77 lb)	0.35 kg (0.77 lb)
• Multi-turn	0.44 kg (0.97 lb)	0.35 kg (0.77 lb)	0.35 kg (0.77 lb)
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
Approvals, according to	CE, cULus	CE, cULus	CE, cULus

S/R = signals/revolution

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■ **Technical specifications** (continued)

	PROFIBUS DP absolute encoder	PROFINET IO absolute encoder
	6FX2001-5.P..	6FX2001-5.N..
Operating voltage U_p on encoder	10 ... 30 V DC	10 ... 30 V DC
Power consumption, approx.		
• Single-turn	300 ... 100 mA (2.5 W)	400 ... 130 mA (< 4 W)
• Multi-turn	300 ... 100 mA (2.5 W)	400 ... 130 mA (< 4 W)
Interface	PROFIBUS DP-V2	PROFINET IO with RT/IRT
Clock input	Differential cable receiver according to EIA standard RS 485	2 IRT ports
Data output	Differential cable driver according to EIA standard RS 485	2 IRT ports
Short-circuit strength	Yes	Yes
Data transfer rate	12 Mbit/s	100 Mbit/s
LED for diagnostics	Yes (green/red)	Yes (green/red/yellow)
Speed, max.		
• Electrical	–	
- At ± 1 bit accuracy	5800 rpm	5800 rpm
• Mechanical		
- Single-turn	12000 rpm	12000 rpm
- Multi-turn	6000 rpm	6000 rpm
Cable length to down-stream electronics, max.[1]	Up to 12 Mbit/s: 100 m (328 ft)	85 m (279 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	Terminal block with address selector switch and bus terminating resistor in removable cover with radial cable glands (3 units)	2 × 4-pin M12 connector for PROFINET ports 1 × 4-pin M12 connector for operating voltage
• Cable diameter	6.5 ... 9 mm (0.26 ... 0.35 in) Removal of cover possible without interrupting bus	
Resolution		
• Single-turn	13 bit (8192 steps)	13 bit (8192 steps)
• Multi-turn	27 bit (8192 steps × 16384 revolutions)	27 bit (8192 steps × 16384 revolutions)
Telegram	According to PNO encoder profile V4.1 Class 1, Class 2, Class 3 Standard telegram 81	According to PNO encoder profile V4.1 Class 1, Class 2, Class 3, Class 4 Standard telegrams 81/82/83/84 Siemens telegram 860
Code type		
• Sampling	Gray	Gray
• Transfer	Binary, PROFIBUS	Binary, PROFINET
Network load, approx.	20 µs per encoder at 12 Mbit/s	–
Cycle time	667 µs	1 ... 100 ms

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

Measuring systems
Built-on optoelectronic rotary encoders

Absolute encoders

Technical specifications (continued)

	PROFIBUS DP absolute encoder 6FX2001-5.P..	PROFINET IO absolute encoder 6FX2001-5.P..
Parameterization capability		
• Resolution per revolution	Arbitrary 1 ... 8192	Arbitrary 1 ... 8192
• Total resolution	Arbitrary 1 ... 16384	Arbitrary 1 ... 16384
• Preset	Arbitrary	Arbitrary
• Counting direction	Yes	Yes
• Speed signal	Yes	Yes
• Limit switches	Yes, 2 units	No
• Isochronous mode	Yes	Yes
• Slave-to-slave communication	Yes	No
Online parameterization	Yes	Yes
PNO certificate	Yes	Yes
Supported profiles	PNO encoder profile V4.1	PNO encoder profile V4.1
Accuracy (in angular seconds)	± 79 with 8192 steps (± ½ LSB)	± 79 with 8192 steps (± ½ LSB)
Friction torque (at 20 °C) (68 °F)	≤ 0.01 Nm (0.09 lb_f-in)	≤ 0.01 Nm (0.09 lb_f-in)
Starting torque (at 20 °C) (68 °F)	≤ 0.01 Nm (0.09 lb_f-in)	≤ 0.01 Nm (0.09 lb_f-in)
Shaft loading capacity		
• n > 6000 rpm		
- Axial	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)
• n ≤ 6000 rpm		
- Axial	40 N (8.99 lb_f)	40 N (8.99 lb_f)
- Radial at shaft extension	110 N (24.7 lb_f)	110 N (24.7 lb_f)
Angular acceleration, max.	10^5 rad/s^2	10^5 rad/s^2
Moment of inertia of rotor		
• Solid shaft	1.90×10^{-6} kgm^2 (16.8×10^{-6} lb_f-in-s^2)	1.90×10^{-6} kgm^2 (16.8×10^{-6} lb_f-in-s^2)
• Hollow shaft	2.80×10^{-6} kgm^2 (24.8×10^{-6} lb_f-in-s^2)	2.80×10^{-6} kgm^2 (24.8×10^{-6} lb_f-in-s^2)
Vibration (55 ... 2000 Hz) to EN 60068-2-6	≤ 100 m/s^2 (328 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)
• 6 ms	≤ 1000 m/s^2 (3281 ft/s^2)	≤ 1000 m/s^2 (3281 ft/s^2)
Degree of protection to EN 60529 (IEC 60529)		
• Without shaft input	IP67	IP67
• With shaft input	IP64	IP64
Ambient temperature		
• Operation	-40 ... +85 °C (-40 ... +185 °F)	-40 ... +85 °C (-40 ... +185 °F)
Weight, approx.		
• Single-turn	0.5 kg (1.10 lb)	0.5 kg (1.10 lb)
• Multi-turn	0.7 kg (1.54 lb)	0.7 kg (1.54 lb)
EMC	Tested in accordance with EN 50081 and EN 50082	Tested in accordance with EN 50081 and EN 50082
Approvals, according to	CE, cULus	CE, cULus

■ Selection and ordering data

Description	Order No.
Absolute encoder with DRIVE-CLiQ	
24 V DC supply voltage Radial connection	
• Synchro flange Solid shaft 6 mm (0.24 in)	6FX2001-5FD ■■-0AA0
• Supported flange joint Solid shaft 10 mm (0.39 in)	6FX2001-5QD ■■-0AA0
• Torque bracket Hollow shaft 10 mm (0.39 in)	6FX2001-5VD ■■-0AA0
• Torque bracket Hollow shaft 12 mm (0.47 in)	6FX2001-5WD ■■-0AA0
Resolution	
• Single-turn 22 bit	1 3
• Multi-turn 34 bit	2 5
SSI absolute encoder	
Synchro 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	
Synchro 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

Description	Order No.
PROFIBUS DP absolute encoder	
10 ... 30 V DC supply voltage Radial connection	
• Synchro flange Solid shaft	6FX2001-5FP ■■
• Supported flange joint Solid shaft	6FX2001-5QP ■■
• Torque bracket 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
PROFINET IO absolute encoder	
10 ... 30 V DC supply voltage Radial connection	
• Synchro flange Solid shaft	6FX2001-5FN ■■
• Supported flange joint Solid shaft	6FX2001-5QN ■■
• Torque bracket Hollow shaft 8 mm/10 mm/12 mm/15 mm (0.31 in/0.39 in/0.47 in/0.59 in)	6FX2001-5WN ■■
Resolution	
• Single-turn 8192 steps/revolution (13 bit)	1 3
• Multi-turn 8192 steps/revolution, 16384 revolutions (27 bit)	2 5

■ More information

Description	Order No.
Decentralizing with PROFIBUS DP	**ISBN 3-89578-074-X**

7

Measuring systems
Built-on optoelectronic rotary encoders

Accessories

■ Overview

Couplings and clamp straps

Couplings/clamp straps

Couplings and clamp straps are available as mounting accessories for the built-on rotary encoders. The clamp straps are used to fix the encoders with Synchro flange.

Signal connector as mating connector

A signal connector is available as mating connector for encoders with flange outlet or with cable and connector. The connector with 12 contacts is suitable for all incremental encoders. The connector with 17 contacts is suitable for EnDat absolute encoders.

Signal connector

A signal connector is available as replacement for encoders with cable and connector.

■ Technical specifications

	Spring disk coupling 6FX2001-7KF10 6FX2001-7KF06	Plug-in coupling 6FX2001-7KS06 6FX2001-7KS10
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 × 10^{-7} lb$_f$-in-s^2)	20 gcm^2 (177 × 10^{-7} lb$_f$-in-s^2)
Speed, max.	12000 rpm	12000 rpm
Ambient temperature		
• Operation	-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

Description	Order No.
Spring disk coupling Shaft diameter: • 6 mm/6 mm (0.24 in/0.24 in) • 6 mm/5 mm (0.24 in/0.20 in)	 **6FX2001-7KF10** **6FX2001-7KF06**
Plug-in coupling Shaft diameter: • 6 mm/6 mm (0.24 in/0.24 in) • 10 mm/10 mm (0.39 in/0.39 in)	 **6FX2001-7KS06** **6FX2001-7KS10**
Clamp strap (1 unit) For double-track encoders and encoders with Synchro flange (3 units are required.)	**6FX2001-7KP01**
Signal connector with cap nut (1 unit) Mating connector for TTL, sin/cos 1 V$_{pp}$, HTL incremental encoders and SSI absolute encoders 12-pin, insulator with 12 socket contacts 0.08 ... 0.22 mm^2 and 0.20 ... 0.56 mm^2, 2 × cable clamping 6.5 ... 10 mm and 10.1 ... 13 mm	**6FX2003-0SU12**
Signal connector with cap nut (1 unit) Mating connector for EnDat absolute encoders 17-pin, insulator with 17 socket contacts 0.20 ... 0.56 mm^2, 2 × cable clamping 6.5 ... 10 mm and 10.1 ... 13 mm	**6FX2003-0SU17**
Signal connector with external thread for encoders with cable (1 unit) Replacement connector for RS 422, sin/cos 1 V$_{pp}$ and HTL incremental encoders 12-pin, insulator with 12 contact pins 0.20 ... 0.56 mm^2, 2 × cable clamping 6.5 ... 10 mm and 10.1 ... 13 mm	**6FX2003-0SA12**
Power connecting cable Pre-assembled cable for power supply of PROFINET IO absolute encoders with M12 connector and M12 socket, A-coded, 4-pin • Length: 2 m (6.56 ft) • Length: 3 m (9.84 ft) • Length: 5 m (16.4 ft) • Length: 10 m (32.8 ft) • Length: 15 m (49.2 ft)	 **6XV1801-5DH20** **6XV1801-5DH30** **6XV1801-5DH50** **6XV1801-5DN10** **6XV1801-5DN15**
IE connecting cable Pre-assembled signal cable for PROFINET IO absolute encoders with M12 and RJ45 connectors, D-coded, 4-pin • Length: 2 m (6.56 ft) • Length: 3 m (9.84 ft) • Length: 5 m (16.4 ft) • Length: 10 m (32.8 ft) • Length: 15 m (49.2 ft)	 **6XV1871-5TH20** **6XV1871-5TH30** **6XV1871-5TH50** **6XV1871-5TN10** **6XV1871-5TN15**
IE FC RJ45 Plug 145 (1 unit) 2 × 2 RJ45 plug connector with rugged metal enclosure and FC connecting method, cable outlet 145°	**6GK1901-1BB30-0AA0**
IE FC M12 Plug PRO (1 unit) M12 plug connector with metal enclosure and FC connecting method, axial cable outlet, D-coded	**6GK1901-0DB20-6AA0**
IE FC TP Trailing Cable 2 × 2 (Type C) 4-wire, shielded, PROFINET compliant, TP installation cable for use in cable carriers Sold by the meter Max. consignment: 2000 m (6562 ft) Min. ordering quantity: 20 m (65.62 ft)	**6XV1840-3AH10**