Function

Absolute encoders with SSI/EnDat and PROFIBUS DP (top), and DRIVE-CLiQ and PROFINET IO (bottom)

Absolute encoders output an absolute angular position between 0° and 360°. They operate 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). This prevents any scanning errors from occurring. After switching on the machine, the position value is transferred immediately to the controller, travel to a reference point is not necessary.

All absolute encoders are available in single-turn and multi-turn versions.

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.

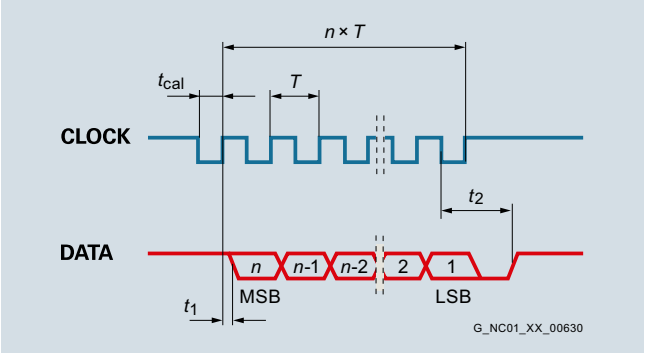
Multi-turn encoders

Multi-turn encoders 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 an additional 2^{12} = 4096 revolutions can be coded.

Interfaces

The following interfaces are supported by the absolute encoders:

Interface	Benefits
DRIVE-CLiQ	• Very high data transfer rates possible • Advantages in time-critical applications • Simple and quick automatic configuration using electronic rating plates • Fast and easy diagnostics with a single tool • One interface for connecting drives as well as indirect and direct measurement systems to the CNC.
SSI	• Advantages in time-critical applications
EnDat 2.1	• High data transfer rate, bidirectional • Advantages in time-critical applications • Incremental encoder sin/cos 1 V_{pp} • Connection via SINAMICS Sensor Modules SMC/SME
PROFIBUS DP-V2	• Parameterizable built-on encoder • Reduced wiring overhead in plants with a large number of encoders • Isochronous operation and direct data exchange
PROFINET IO	• Parameterizable built-on encoder • Reduced wiring overhead in plants with a large number of encoders • Supports RT and IRT operating modes • IRT (isochronous mode) • 2 ports



Data transfer for absolute encoders with SSI interface

n = data word length (13 bits for single-turn and 25 bits for multi-turn)
T = 1 ... 10 µs
t_{cal} = ≤ 5 µs
t_1 = ≤ 0.4 µs (without cable)
t_2 = 17 ... 20 µs

Technical specifications

Article No.		6FX2001-5.D..-1AA0	6FX2001-5.S..	6FX2001-5.E..
Product name		Motion control encoder	Motion control encoder	Motion control encoder
Product designation		Absolute encoder with DRIVE-CLiQ	Absolute encoder with SSI	Absolute encoder with EnDat 2.1
Operating voltage DC V_p on encoder	V	24 - 15 % + 20 %	4.75 ... 30	3.6 ... 14
Current consumption, approx.				
• Single-turn	mA	37	90	90
• Multi-turn	mA	43	120	120
Interface		DRIVE-CLiQ	SSI	EnDat 2.1
Clock input		–	Differential cable receiver acc. to EIA standard RS 485	Differential cable receiver acc. to EIA standard RS 485
Data output		DRIVE-CLiQ	Differential cable driver acc. to EIA standard RS 485	Differential cable driver acc. to EIA standard RS 485
Short-circuit strength		Yes	Yes	Yes
Transfer rate	Mbit/s	100	–	–
Transfer rate	kHz	–	100 ... 1000	100 ... 2000
Maximum speed				
• Electrical	rpm	14000	–	–
- At ± 1 bit accuracy	rpm	–	5000	5000
- At ± 12 bit accuracy	rpm	12000	–	–
- At ± 100 bit accuracy	rpm	–	12000	12000
• Mechanical				
- Single-turn	rpm	15000	15000	15000
- Multi-turn	rpm	12000	12000	12000
Cable length to downstream electronics, maximum [1]	m (ft)	100 (328)	–	–
• Up to 300 kHz cycle	m (ft)	–	100 (328)	150 (492)
• Up to 1 MHz cycle	m (ft)	–	50 (164)	50 (164)
• Up to 2 MHz cycle	m (ft)	–	–	10 (32.8)
Connection		Radial flange outlet M12	Axial/radial flange outlet M23	Axial/radial flange outlet M23
Resolution				
• Single-turn	bit	24	13 (8192 steps)	13 (8192 steps)
• Multi-turn	bit	36 (24 bit single-turn + 12 bit multi-turn)	25 (8192 steps × 4096 revolutions)	25 (8192 steps × 4096 revolutions)
Frame				
• Single-turn	bit	–	13 without parity	According to EnDat specification
• Multi-turn	bit	–	25 without parity	According to EnDat specification
Incremental track	S/R	2048, 1 V_{pp} (internal only)	–	512, 1 V_{pp}
Code type				
• Transfer		DRIVE-CLiQ	Gray, fir tree format	Dual
Parameterization capability				
• Preset		–	Set to zero	–
• Counting direction		–	Yes	–
Accuracy	arcsec	± 20	± 60 (with 8192 steps)	± 60 (incremental track)
Starting torque at 20 °C (68 °F)	Nm (lb_f-ft)	≤ 0.01 (0.01)	≤ 0.01 (0.01)	≤ 0.01 (0.01)

S/R = signals/revolution

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

Technical specifications (continued)

Article No.		6FX2001-5.D..-1AA0	6FX2001-5.S..	6FX2001-5.E..
Product name		Motion control encoder	Motion control encoder	Motion control encoder
Product designation		Absolute encoder with DRIVE-CLiQ	Absolute encoder with SSI	Absolute encoder with EnDat 2.1
Solid shaft loading capacity				
• $n \leq 6000$ rpm				
- Axial	N (lb_f)	40 (8.99)	40 (8.99)	40 (8.99)
- Radial at shaft extension	N (lb_f)	60 (13.5)	60 (13.5)	60 (13.5)
• $n > 6000$ rpm				
- Axial	N (lb_f)	10 (2.25)	10 (2.25)	10 (2.25)
- Radial at shaft extension	N (lb_f)	20 (4.50)	20 (4.50)	20 (4.50)
Shaft diameter				
• Synchro flange	mm (in)	6 (0.24) with flat face	6 (0.24)	6 (0.24)
• Clamp flange	mm (in)	10 (0.39) with flat face	10 (0.39)	10 (0.39)
• Torque arm Hollow shaft	mm (in)	10 (0.39) or 12 (0.47)	–	–
Shaft length				
• Synchro flange	mm (in)	10 (0.39)	10 (0.39)	10 (0.39)
• Clamp flange	mm (in)	20 (0.79)	20 (0.79)	20 (0.79)
Angular acceleration, maximum	rad/s^2	10^5	10^5	10^5
Moment of inertia of rotor				
• Solid shaft	kgm^2 (lb_f-in-s^2)	2.9×10^{-6} (2.57×10^{-5})	2.9×10^{-6} (2.57×10^{-5})	2.9×10^{-6} (2.57×10^{-5})
• Hollow shaft	kgm^2 (lb_f-in-s^2)	4.6×10^{-6} (4.07×10^{-5})	–	–
Vibration (55 ... 2000 Hz) according to EN 60068-2-6				
• Solid shaft	m/s^2 (ft/s^2)	≤ 300 (984)	≤ 300 (984)	≤ 300 (984)
• Hollow shaft	m/s^2 (ft/s^2)	≤ 150 (492)	–	–
Shock according to EN 60068-2-27				
• 6 ms				
- Solid shaft	m/s^2 (ft/s^2)	≤ 2000 (6562)	≤ 2000 (6562)	≤ 2000 (6562)
- Hollow shaft	m/s^2 (ft/s^2)	≤ 1000 (3281)	–	–
Degree of protection				
• At housing		IP67	IP67	IP67
• At shaft input		IP64	IP64	IP64
Ambient temperature during				
• Operation	°C (°F)	-30 ... +100 (-22 ...+212)	-40 ... +100 (-40 ...+212)	-40 ... +100 (-40 ...+212)
Net weight				
• Single-turn	kg (lb)	0.35 (0.77)	0.35 (0.77)	0.35 (0.77)
• Multi-turn	kg (lb)	0.35 (0.77)	0.35 (0.77)	0.35 (0.77)
EMC		EMC Directive 2014/30/EC and regulations of EMC directives (applicable basic standards)		
Certificate of suitability		CE, CSA, UL	CE, CSA, UL	CE, CSA, UL

Technical specifications (continued)

Article No.		6FX2001-5.P..	6FX2001-5.N..
Product name		Motion control encoder	Motion control encoder
Product designation		Absolute encoder with PROFIBUS DP	Absolute encoder with PROFINET IO
Operating voltage DC V_p on encoder	V	10 ... 30	10 ... 30
Current consumption, approx.			
• Single-turn	mA	300 ... 100 (2.5 W)	400 ... 130 (4 W)
• Multi-turn	mA	300 ... 100 (2.5 W)	400 ... 130 (4 W)
Interface		PROFIBUS DP-V2	PROFINET IO with RT/IRT
Clock input		Differential cable receiver acc. to EIA standard RS 485	2 ports IRT
Data output		Differential cable driver acc. to EIA standard RS 485	2 ports IRT
Short-circuit strength		Yes	Yes
Transfer rate	Mbit/s	12	100
LED for diagnostics		Green/red	Green/red/yellow
Maximum speed			
• Electrical			
- At ± 1 bit accuracy	rpm	5800	5800
• Mechanical			
- Single-turn	rpm	12000	12000
- Multi-turn	rpm	6000	6000
Cable length to downstream electronics, maximum [1]			
• Up to 93.75 kbit/s	m (ft)	1200 (3937)	–
• Up to 1.5 Mbit/s	m (ft)	200 (656)	–
• Up to 12 Mbit/s	m (ft)	100 (328)	100 (328)
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 × M12 connectors, 4-pole for PROFINET ports 1 × M12 connector, 4-pole for operating voltage
• Cable diameter	mm (in)	6.5 ... 9 (0.26 ... 0.35) Removal of cover possible without interrupting bus	–
Resolution			
• Single-turn	bit	13 (8192 steps)	13 (8192 steps)
• Multi-turn	bit	27 (8192 steps × 16384 revolutions)	27 (8192 steps × 16384 revolutions)
Frame		According to PNO encoder profile V 4.1 Class 1, Class 2, Class 3, Class 4 Standard frame 81	According to PNO encoder profile V 4.1 Class 1, Class 2, Class 3, Class 4 Standard frames 81/82/83/84 Siemens frame 860
Code type			
• Sampling		Gray	Gray
• Transfer		Binary, PROFIBUS	Binary, PROFINET
Bus load, approx.			
• At 12 Mbit/s per encoder	µs	20	–
Cycle time	ms	1	1 ... 100
Parameterization capability			
• Resolution per revolution		1 ... 8192	1 ... 8192
• Total resolution		1 ... 134217728	1 ... 134217728
• Preset		Yes	Yes
• Counting direction		Yes	Yes
• Velocity signal		Yes	Yes
• Limit switches		Yes, 2 units	No
• Isochronous mode		Yes	Yes
• Direct data exchange		Yes	No

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

Technical specifications (continued)

Article No.		6FX2001-5.P..	6FX2001-5.N..
Product name		Motion control encoder	Motion control encoder
Product designation		Absolute encoder with PROFIBUS DP	Absolute encoder with PROFINET IO
Online parameterization		Yes	Yes
PNO certificate		Yes	Yes
Supported profiles		PNO encoder profile V 4.1	PNO encoder profile V 4.1
Accuracy with 8192 steps	arcsec	± 79 (± ½ LSB)	± 79 (± ½ LSB)
Friction torque at 20 °C (68 °F)	Nm (lb_f-ft)	≤ 0.03 (0.02)	≤ 0.03 (0.02)
Starting torque at 20 °C (68 °F)	Nm (lb_f-ft)	≤ 0.03 (0.02)	≤ 0.03 (0.02)
Shaft loading capacity			
• $n \leq 6000$ rpm			
- Axial	N (lb_f)	40 (8.99)	40 (8.99)
- Radial at shaft extension	N (lb_f)	110 (24.7)	110 (24.7)
• $n > 6000$ rpm			
- Axial	N (lb_f)	10 (2.25)	10 (2.25)
- Radial at shaft extension	N (lb_f)	20 (4.50)	20 (4.50)
Shaft diameter			
• Synchro flange	mm (in)	6 (0.24)	6 (0.24)
• Clamp flange	mm (in)	10 (0.39)	10 (0.39)
Torque arm Hollow shaft [1]	mm (in)	15 (0.59)	15 (0.59)
Shaft length			
• Synchro flange	mm (in)	10 (0.39)	10 (0.39)
• Clamp flange	mm (in)	20 (0.79)	20 (0.79)
Angular acceleration, maximum	rad/s^2	10^5	10^5
Moment of inertia of rotor			
• Solid shaft	kgm^2 (lb_f-in-s^2)	1.90×10^{-6} (1.68×10^{-5})	1.90×10^{-6} (1.68×10^{-5})
• Hollow shaft	kgm^2 (lb_f-in-s^2)	2.80×10^{-6} (2.47×10^{-5})	2.80×10^{-6} (2.47×10^{-5})
Vibration (55 ... 2000 Hz) according to EN 60068-2-6	m/s^2 (ft/s^2)	≤ 100 (328)	≤ 100 (328)
Shock according to EN 60068-2-27			
• 2 ms	m/s^2 (ft/s^2)	≤ 2000 (6562)	≤ 2000 (6562)
• 6 ms	m/s^2 (ft/s^2)	≤ 1000 (3281)	≤ 1000 (3281)
Degree of protection			
• At housing		IP67	IP67
• At shaft input		IP64	IP64
Ambient temperature during			
• Operation	°C (°F)	-40 ... +85 (-40 ... +185)	-40 ... +85 (-40 ... +185)
Net weight			
• Single-turn	kg (lb)	0.4 (0.88)	0.4 (0.88)
• Multi-turn	kg (lb)	0.5 (1.1)	0.5 (1.1)
EMC		EMC Directive 2014/30/EC and regulations of EMC directives (applicable basic standards)	
Certificate of suitability		CE, CSA, UL	CE, CSA, UL

[1] Hollow shaft diameter 12 mm, 10 mm or 8 mm (0.47 in, 0.39 in or 0.31 in) possible using supplied reduction sleeves.

Selection and ordering data

Description	Article No.
Absolute encoders with DRIVE-CLiQ	
24 V DC supply voltage	
• Radial connection	
- Synchro flange Solid shaft	**6FX2001-5FD■■-1AA0**
- Clamp flange Solid shaft	**6FX2001-5QD■■-1AA0**
- Torque arm Hollow shaft diameter 10 mm (0.39 in)	**6FX2001-5VD■■-1AA0**
- Torque arm Hollow shaft diameter 12 mm (0.47 in)	**6FX2001-5WD■■-1AA0**
Resolution	
• Single-turn 24 bit	**1 3**
• Multi-turn 36 bit	**2 5**
Absolute encoders with SSI	
4.75 ... 30 V DC supply voltage	
• Synchro flange and connection via	
- Axial flange outlet	**6FX2001-5HS■■**
- Radial flange outlet	**6FX2001-5FS■■**
• Clamp flange and connection via	
- 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**
Absolute encoders with EnDat 2.1	
3.6 ... 14 V DC supply voltage	
• Synchro flange and connection via	
- Axial flange outlet	**6FX2001-5HE■■**
- Radial flange outlet	**6FX2001-5FE■■**
• Clamp flange and connection via	
- 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	Article No.
Absolute encoders with PROFIBUS DP	
10 ... 30 V DC supply voltage	
• Radial connection	
- Synchro flange Solid shaft	**6FX2001-5FP■■**
- Clamp flange Solid shaft	**6FX2001-5QP■■**
- Torque arm Hollow shaft diameter 15 mm (0.59 in) [1]	**6FX2001-5WP■■**
Resolution	
• Single-turn 8192 steps/revolution (13 bit)	**1 2**
• Multi-turn 8192 steps/revolution, 16384 revolutions (27 bit)	**2 4**
Absolute encoders with PROFINET IO	
10 ... 30 V DC supply voltage	
• Radial connection	
- Synchro flange Solid shaft	**6FX2001-5FN■■**
- Clamp flange Solid shaft	**6FX2001-5QN■■**
- Torque arm Hollow shaft diameter 15 mm (0.59 in) [1]	**6FX2001-5WN■■**
Resolution	
• Single-turn 8192 steps/revolution (13 bit)	**1 3**
• Multi-turn 8192 steps/revolution, 16384 revolutions (27 bit)	**2 5**

Additional information

Since the DRIVE-CLiQ interface has been disclosed, it is possible to use absolute encoders with integrated DRIVE-CLiQ interface from a range of different manufacturers.

You can find additional information on the Internet at:

https://support.industry.siemens.com/cs/document/65402168

[1] Hollow shaft diameter 12 mm, 10 mm or 8 mm (0.47 in, 0.39 in or 0.31 in) possible using supplied reduction sleeves.