EZ TECH

AD Series of Grating Angle Encoders

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AD Series of Grating Angle Encoders

Interfaces

Incremental sinusoidal signals～1 Vpp

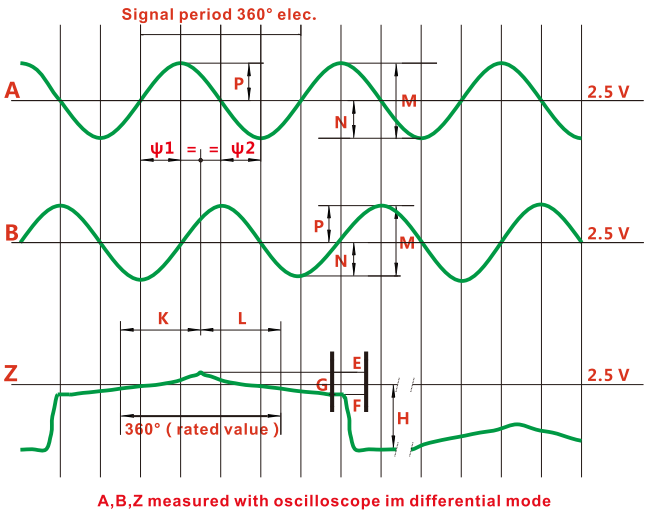
EZ TECH's grating angle encoders with ～1 Vpp interface provide voltage signals which can be highly interpolated.

The sinusoidal incremental signals A and B are phase-shifted by 90° elec. and have an typically amplitude of 1 Vpp. The dimension drawing as following shows output signals B are lagging behind A. And this sequence also applies for the illustrated direction of motion.

The reference point signal Z has two types: single signal per cycle and multi signals per cycle.

A usable component G of approximate 0.6-1 V.

Next to the reference point, the output signal can be reduced by up to 1.7 V to a quiescent level H. This must not cause the subsequent electronics to overdrive.



A,B,Z measured with oscilloscope im differential mode

Sinusoidal signals ～1 Vpp

Input circuitry of the subsequent electronics

Dimensioning

Operational amplifier TL072 or MC34074
Zo = 12 Ω
R1 = 10 kΩ and C1 = 100 pF
R2 = 34.8 kΩ and C2 = 10 pF
Ub = ± 15 V
U1 approximate equal to Uo

-3dB cutoff frequency of circuitry

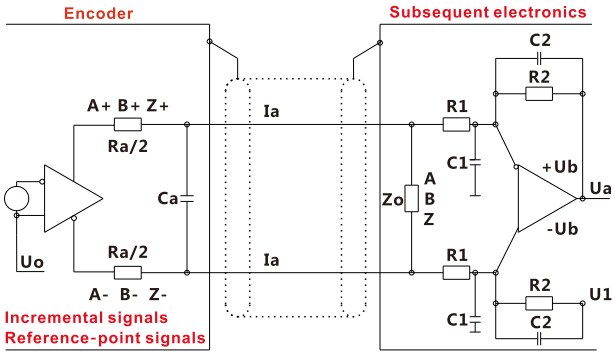
Approximate 450 kHz
Approximate 50 kHz, C1 = 1000 pF and C2 = 82 pF
The circuit with reduced the bandwidth improves its noise immunity.

Circuit output signals

Ua = 3.48 Vpp typically. Gain3.48。

Incremental signal monitoring

Signals with a threshold sensitivity of 250 mVpp are used to monitor the incremental signals ～1 Vpp.



Ra<100 Ω, typically 24 Ω Ca<50 pF ΣIa<1 mA
Uo=2.5 V±0.5 V (relative to 0 V of the power supply)

Input circuitry of the subsequent electronics

Unless otherwise indicated, all angle encoders of EZ TECH meet protection standard IP 54 according to GB4208 or IEC 60 529. The housings and cable outlets provide protection to IP 64. Splash water should not contain any substances that would have harmful effects on the encoder parts.

AD60i, AD40i, AD20i angle encoders are equipped with a compressed air inlet. Connection to a source of filtered compressed air slightly above atmospheric pressure can improve the protection to IP 64.

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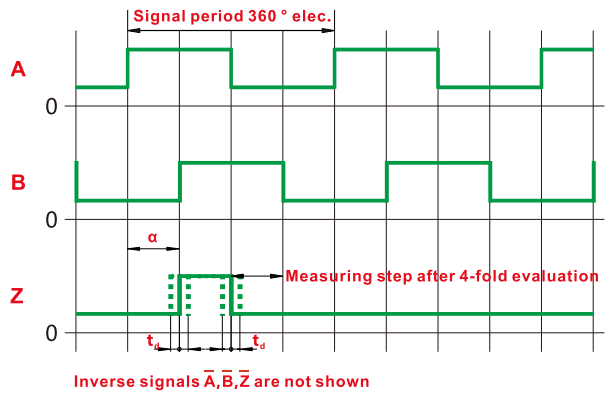
Incremental EIA-422A signals

The output signals are created by the sinusoidal signal digital electronic interpolation circuit which is incorporated in the angle encoders of **EZ TECH**. The maximum position pulses per circle are 7200000 and 3600000 respectively.

The incremental signals are transmitted as the square-wave pulse trains A and B, with 90° electronic angle phase-shifted. The reference point signal consists of one or more reference pulses Z, which are triggered by the incremental signals. Moreover, the integrated electronics produce their inverted signals $\overline{A}$、$\overline{B}$ and $\overline{Z}$ for noise-proof transmission. The dimension drawing as following shows output signals B are lagging behind A. And this sequence also applies for the illustrated direction of motion.

The permissible cable length for transmission of the EIA-422A signals to the subsequent electronics depends on the edge separation α. The maximum cable length is 100 m, and the maximum cable length for the fault detection signal is 30 m. However, the precondition is ensuring the power supply to the encoder. The sensor lines can be used to measure the voltage at the encoder. And if required, customers can correct it with an automatic control system (remote sense power supply).

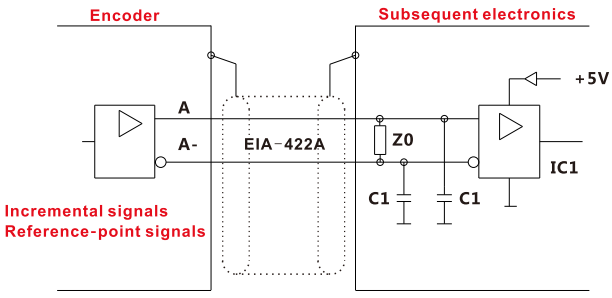


Incremental EIA-422A signals

Input circuitry of the subsequent electronics

Dimensioning

IC1 = Recommended differential line receiver
AM 26 LS 32
Only for α＞0.1 µs;
and available IC;
DS 26 C 32 AT
MC 3486
Z0 = 120 Ω
C1 = 220 pF (serves to improve noise immunity)



Input circuitry of the subsequent electronics

Connecting cable

	Connecting Cable				Incremental Signals					
Definition	+5 V	Sensor +5 V	0 V	Sensor 0 V	A+	A-	B+	B-	Z+	Z-
Color	redgray	red	orangegray	orange	green	greengray	blue	bluegray	white	whitegray

*** The housing shield the encoder from external disturbance. Vacant pins or wires must not be used!**

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Application

Angle encoders are the typically encoders with an accuracy of ± 5 ″ or better and a line count above 10,000. In contrast, rotary encoders are typically the encoders with an accuracy less than ± 10 ″.
Angle encoders are generally applied in precision angular measurements requiring an accuracy within several arc seconds.

Application:
– Rotary tables on CNC machine tools
– Swivel heads on CNC machine tool
– C-axis of CNC lathes
– CNC measuring machines for gears
– Robot joints with high accuracy
– Astronomical telescope

The main mechanical components of angle encoders include:
integral bearing、**hollow shaft** and **integrated shaft coupling**.

Because of the design and mounting of the integrated shaft coupling, it must absorb only the torque caused by friction in the bearing during angular acceleration of the shaft.
Therefore AD series of angle encoders provide excellent dynamic performance.
With an integrated shaft coupling, the stated system accuracy also includes deviations from the shaft coupling.

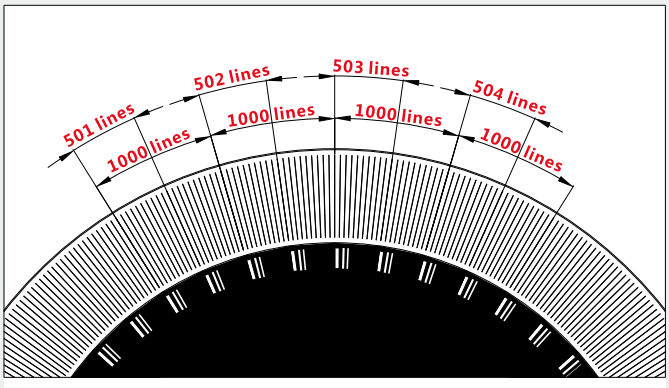
Other advantages:
– Simple installation;
– Compact size for limited installation space;
– Hollow shaft diameters up to 60 mm, to provide space for power lines and hydraulic pipes etc.

Incremental measurements

The measuring standards of **EZ TECH**'s angle encoders are based on the high precision gratings with periodic graduations. With several specially developed photolithographic technologies, these graduations are applied to a quartz glass substrate by hard chromium plating. The gratings have a high homogeneity and definition of the line edges. Together with the photoelectric scanning method, the high edge definition is a precondition for the high quality of output signals. Glass gratings are primarily used in encoders for speeds below 1 500 rpm.

The specification of **EZ TECH**'s gratings:
36000 lines/circle
18000 lines/circle

Each EZ TECH's angle encoder is prepared for individual calibration before delivery, and is guaranteed as the high accuray standerd of **EZ TECH**.



Schematic representation of a circular grating with distance-coded reference marks

With the incremental measuring method, the graduation consists of a periodic grating structure. The position information is obtained by counting the individual increments (measuring steps) from some point of origin. Since an absolute reference point is required to ascertain positions, the gratings are provided with an additional track that bears an absolute reference point. The absolute position on the grating, established by the absolute reference point, is gated with exactly one measuring step. The reference mark must therefore be scanned to establish an absolute position.

EZ TECH's gratings for the incremental measuring method have two type: single reference point type and multi reference points type. For the single reference point type, it may maximally require rotation by 360° for ascertaining the absolute position. The multi reference points type has a certain number of distance-coded reference points. The distance between two successive reference points is accordance with a certain mathematical calculation. The subsequent electronics can find the absolute position after scanning two successive reference points (maximum ＞5 ° or ＞10 ° is required respectively).

With distance-coded reference points, the absolute position is calculated by counting the signal periods between two reference points and using the following formulas:

$$\alpha_1 = (absA - sgnA - 1) \times 1/2 + (sgnA - sgnD) \times absM_{RR}/2$$

Where:
A=(2×absMRR-I)/GP
α_1=Absolute angular position of the first scanned reference point to the zero position in degrees.
abs=Absolute value
sgn=Sign function (“+1” or “-1”)
$\mathbf{M_{RR}}$=Measured distance between the scanned reference points in degrees
I=Nominal increment between two fixed reference points (see the right table)
GP=Grating period (360°/line count)
D=Direction of rotation (+1 or -1)
counterclockwise rotation results in “+1”(when viewing from the front side of the angle encoder).

Line count	Number of reference marks	Nominal increment I
36000	72, 36	5°, 10°
18000	72, 36	5°, 10°

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Mechanical component types

AD60i, AD40i, AD20i angle encoders include integral bearings, hollow shafts and integrated shaft couplings. The measured shaft is directly connected to the hollow shaft of the angle encoder. During mounting, the reference point can be assigned to a desired angular position of the measured shaft from the rear of the encoder.

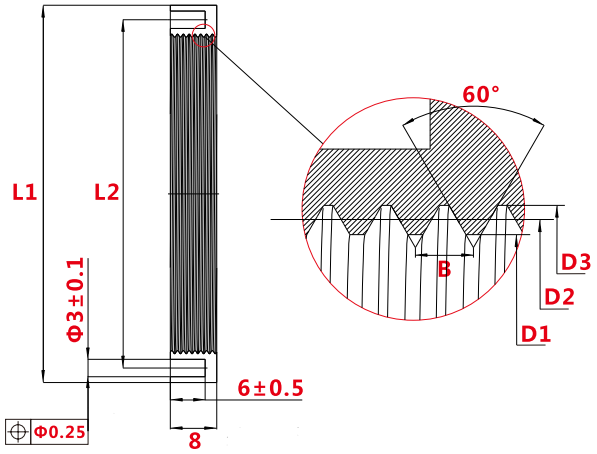
The grating and other main mechanical components are rigidly fastened to the hollow shaft in the angle encoder. The scanning unit is fixed on ball bearings and is connected to the housing with the integrated shaft coupling. During angular acceleration of the shaft, the shaft coupling must absorb only that torque caused by friction in the bearing. Therefore, angle encoders with integrated shaft coupling provide excellent dynamic performance.

Mounting

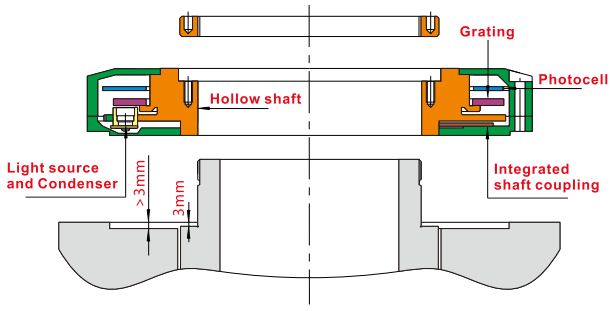
There are two recommended mounting methods for AD60i, AD40i, AD20i angle encoders. One is mounting with a shaft coupling fastened by ring nut. The other is mounting with a shaft coupling by the front end. Customers can select either suitable mounting method according to the mechanical structure of the products.

Shaft coupling fixed with ring nut

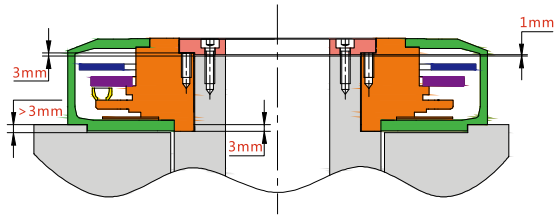
AD60i、AD40i、AD20i angle encoders have a hollow through shaft. For installation, the angle encoder is placed over the machine shaft through the hollow shaft, and is fixed with a ring nut from the front of the encoder.



Cutaway view of ring nut



Cutaway view of mounting
an angle encoder with a ring nut



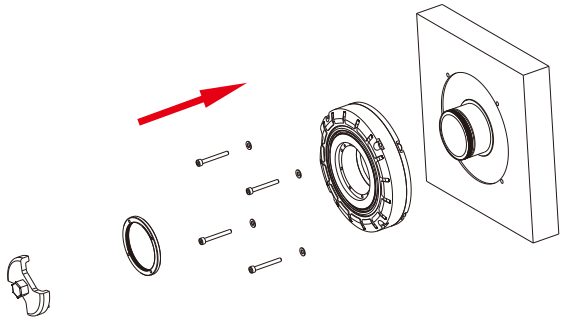
Cutaway view of mounting an angle encoder
with a shaft coupling by the front end

Mounting tool for ring nuts and its usage

A mounting tool is used for tightening ring nut. The ring nut is fastened to the hollow shaft with the mounting tool. The constant torque wrench must be used during tightening with the torque no less than 22 Nm, and no more than 25 Nm.

Ring nuts for AD series of angle encoders

EZ TECH offers special ring nuts for AD60i, AD40i, AD20iangle encoders with integral bearing, which are optional products. Customers can produce the ring nuts by themselves according to the technical drawing on the right. Choose the tolerance of the shaft thread so that the ring nut can be tightened easily, with a minor axial play. This guarantees that the load is evenly distributed on the shaft coupling connected with the hollow shaft of the encoder, and prevents distortion from the hollow shaft.



Mounting an angle encoder with ring nut

Ring nuts for the hollow shafts Φ60、Φ40、Φ20 (unit: mm)

Hollow shafts	L1	L2	D1	D2	D3	B
Φ60	Φ74.0 ± 0.2	Φ68.0	$\Phi58.376^{+0.190}_{0.000}$	$\Phi59.026^{+0.132}_{0.000}$	Φ60.000	1.5
Φ40	Φ54.0 ± 0.2	Φ48.0	$\Phi38.376^{+0.190}_{0.000}$	$\Phi39.026^{+0.132}_{0.000}$	Φ40.000	1.5
Φ20	Φ34.0 ± 0.2	Φ28.0	$\Phi18.917^{+0.150}_{0.000}$	$\Phi19.350^{+0.100}_{0.000}$	Φ20.000	1

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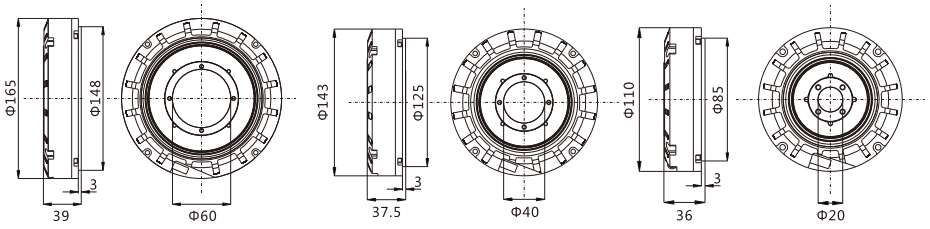
Technical parameters

Model	AD60i	AD40i	AD20i
Dimensions(mm)			
System accuracy	± 3 ″, ± 5 ″	± 3 ″, ± 5 ″	± 3 ″, ± 5 ″
Recommended measuring step	0.36″, 0.18″	0.36″, 0.18″	0.36″
Electrical permissible speed	800 rpm	800 rpm	800 rpm
Linecount	36000, 18000	36000, 18000	18000
Shaft dimension	60 mm	40 mm	20 mm
Starting torque	≤0.5 Nm(under20℃)	≤0.3 Nm(under20℃)	≤0.07 Nm(under20℃)
Moment of inertia of rotor	1×10^{-3} kg•m^2	6×10^{-4} kg•m^2	1×10^{-4} kg•m^2
Weight	2.2 kg	1.6 kg	0.9 kg
Position pulses per circle	7200000, 3600000	7200000, 3600000	3600000
Reference point	Single reference point /Multi reference points(72, 36)	Single reference point /Multi reference points(72, 36)	Single reference point /Multi reference points(36)
Clock frequency	≤5 MHZ		
Calculation time t_{cal}	5 μs		
Incremental signals	~ 1 Vpp sinusoidal wave and EIA-422A		
Cutoff frequency 3dB	> 180 kHz		
Power supply with out loa	3.7-5.2V/maximum 350 mA		
Maximum cable length	100 m		
Mechanically permissible speed	≤3000 rpm		
Natural frequency	> 1200 Hz		
Permissible axial play of measured shaft	±0.1 mm		
Vibration 55-2000Hz	≤100 m/s^2 (GB/T2423.10)		
Shock 6ms	≤1000 m/s^2 (GB/T2423.5)		
Operating temperaturea	0-50 ℃		
Protection	IP 54		

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