EF-M040 Hollow inductive absolute position encoder module manual



EF-M040 hollow inductive absolute position encoder

product features

- Inductive absolute position encoder
- Maximum speed 8000 rpm
- 17 bits, resolution
- Self-calibration function, which can be calibrated twice (refer to)
- Not affected by oil, dust, moisture and other pollutants
- Immune magnetic interference
- Very light weight (8 g)
- Suitable for robots, CNC machine tools and automation systems
- It can be off-axis and through the axis, and is easy to install
- Supports a variety of mainstream communication protocols, such as RS485, SPI, BISS-C, etc

key parameter	
Sensor type	Inductive, single-turn absolute Angle encoding
Output type	6-pin PCB connector, 1 mm spacing
Market equipment	Industrial servo motor
size	diameter 40mm

Electrical parameters	
parameter	**EF-M040**
service voltage	5 V ± 5%
Supply current @5V	54 mA
output interface	RS485
Output Angle	0-360°
accuracy @25 °C	0.1°
Output noise (gap 1 mm, 25 °C)	± 1 LSB
resolution ratio	17 bits
Power on time	≤ 100 ms
transmission delay	≤ 15 μs
Angle update rate	≤ 16 kHz (RS485,2.5Mbps)

Mechanical specifications (all versions)	
parameter	
The mechanical angle	360°
maximum speed	8000 rpm (provide more information as required)
rotor weight	≤ 5.5 g
Stator weight	< 10 g

Environmental performance parameters	
parameter	
operating temperature range	-40 °C to +125 °C
Storage temperature range	-40 °C to +125 °C
humidity	No condensation or dew formation is allowed under 80%

protect	PCB component surface coating
Shaking conditions	0.05 g2/Hz, subjected to 20 Hz to 2000 Hz frequency vibration along the three axes for one hour
Conditions of shock	100g,6ms, half sine

Main EMC parameters and standards			
parameter	**standard**	**grade**	**explain**
Electrostatic discharge immunity (ESD)	61000 4-2 :2008	Level 4 (8 kV, contact discharge)	The equipment can withstand 8 kV contact discharge (only at the connector interface)
Radiation immunity of radio frequency electromagnetic field (80 MHz to 6 GHz)	EN 61000-4-3:2020	Level 3 (10 V/m)	The equipment can still work under the 10 V/m RF field strength
CISPR (150 kHz to 80 GHz)	EN 61000-4-6:2014	Level 3 (10 V)	The equipment is resistant to 10 V conduction interference (such as RF noise coupled by power lines).
Power frequency magnetic field immunity (50 Hz)	EN 61000-4-8:2010	Level X (1500 A/m, 2 mT)	The equipment can withstand strong power frequency magnetic fields (such as near transformers), and the grade "X" indicates that it needs to be defined according to the actual application scenario.
Radiation emission (30 MHz to 1 GHz)	EN 55011	Class A Group 1 (industrial environment (1))	The equipment has low electromagnetic radiation in the industrial environment and complies with industrial equipment standards

pay attention to

? The above EMC levels comply with EN IEC 61326-1 and are suitable for industrial environments.

? No overvoltage protection is integrated: The device does not include protective measures for switching transients or lightning transients (standard 61000-4-5). An external protection device (such as a surge protector) is required. To reduce risks, it is recommended that the power cable be no longer than 3 meters (to minimize the risk of conducted interference) and the data cable no longer than 30 meters (to reduce signal attenuation and noise coupling).

(1) Applicable environment: The equipment is designed for industrial environment and is not suitable for residential areas (may interfere with radio equipment).

Other information



pay attention to !

Precautions for handling electrostatic sensitive equipment!

Warning: When installing or replacing the sensor, the serial number of the rotor and stator must be consistent!

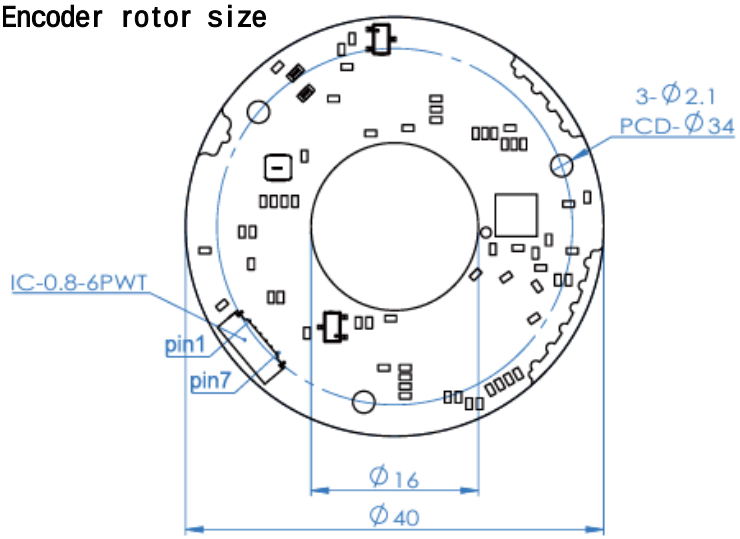
? The sensor is delivered in an anti-static package and can only be removed from the anti-static bag within the electrostatic protection area (EPA).

? Do not damage the surface of the rotor.

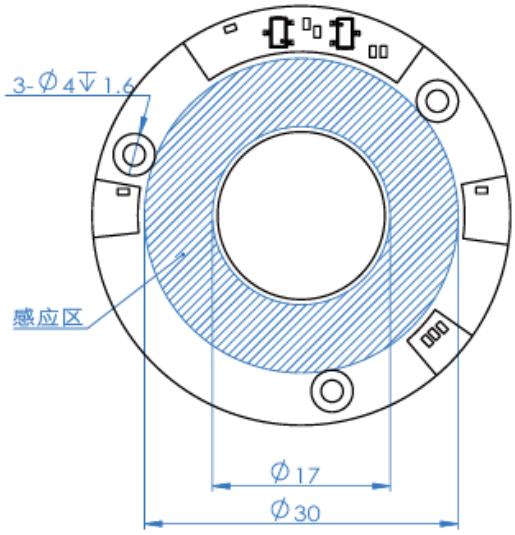
? Do not use cleaning products or chemicals.

? Environmental protection: When used in heavy load environment (such as metal particles, oil, grease, salt spray, moisture, corrosion, etc.), protective coating or potting can be used according to requirements.

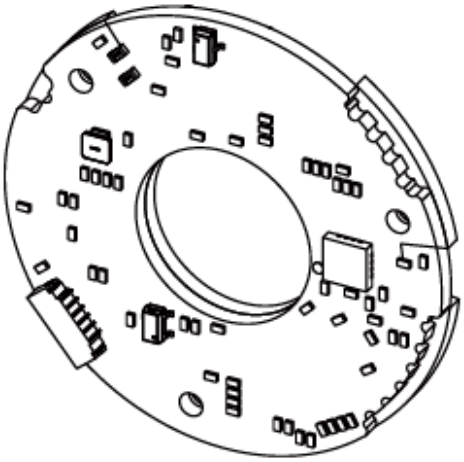
Encoder rotor size



front



the back

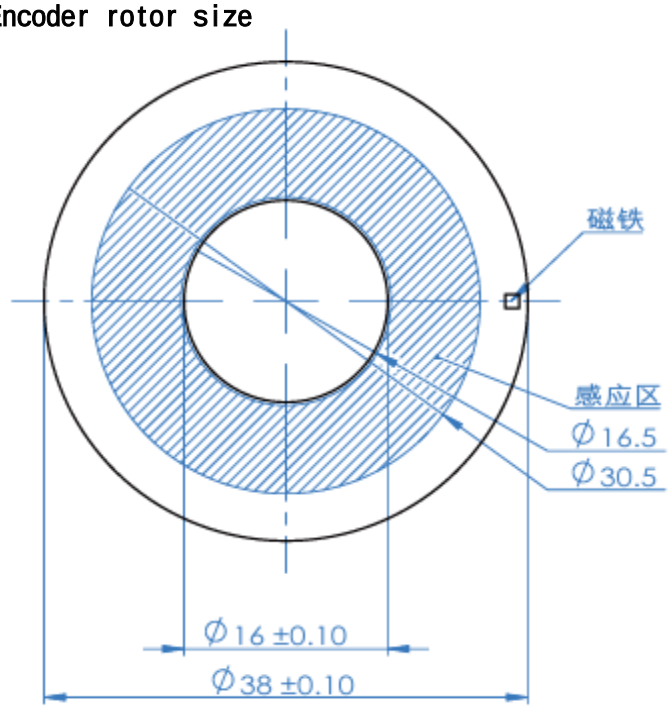




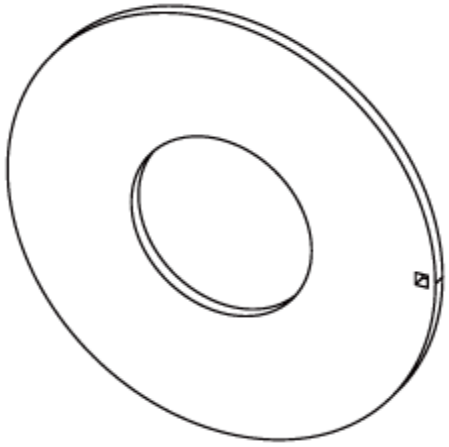
side

Stator appearance

Encoder rotor size



front



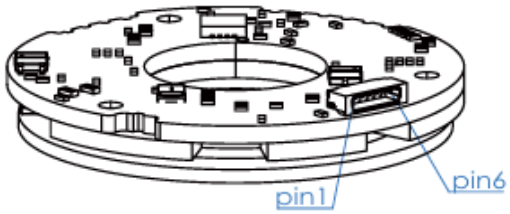
Rotor appearance



side

Assembly and commissioning requirements





bisect

Install a list of allowable errors					
position	type	standard value	scope	unit	explain
a	Air gap	0.8	±0.2	mm	Axial distance to be guaranteed during static installation
b	deflection (skew)	0	0.1	mm	Maximum axial swing range during rotor rotation
c	Axis tilt (tilt)	0	0.3	degree	The encoder stator plane is not perpendicular to the shaft
d	Wobbling	0	0.1	mm	Radial installation error between rotor code disk and shaft
e	Off-axis (eccentric)	0	0.2	mm	Radial installation error between encoder stator and shaft

A	reference axis				Shaft-concentricity measurement reference
B	base level				Encoder surface coil-oscillation/tilt measurement reference

Rotor installation error

The code disk is mounted on the rotating shaft, and its operation significantly affects precision. Particularly, the skew of the b code disk and the eccentricity of the d rotor directly impact the encoder's absolute positioning accuracy. The error b primarily results from the bending of the shaft or the non-perpendicular installation of the code disk on the shaft. The error d typically occurs during assembly; therefore, it is essential to use jigs or other high-precision inspection methods to minimize installation errors when installing the rotor code disk.

Stator encoder installation error

The core encoder uses self-developed sensor chip to read inductive data, and the inherent compensation algorithm is used to achieve a more tolerant difference range. Among them, the a c e error mainly affects the signal strength and linearity, which can be compensated to a certain extent through self-correction.

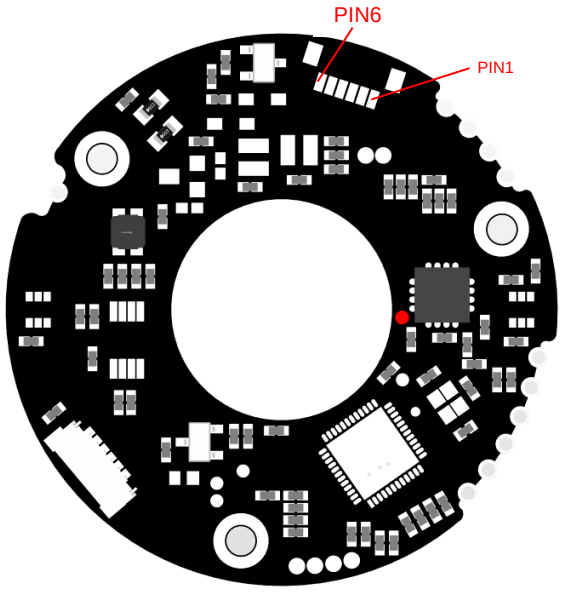
CI

This product uses the RS485 communication interface protocol. To ensure strong EMC immunity, it is strongly recommended to use twisted pair cables, such as the A and B signal lines in the RS485 communication interface being twisted together. Power signals (VCC, GND) do not require twisted pairs. The typical impedance of the signal lines is 120 Ω, and the requirements for terminal resistors depend on the total length of the communication bus and the communication speed.

Connector type

The communication interface connector installed on the EF-M040 is HC-0.8-6PWT, which has a total of six pins. The pin sequence and definition are shown in the figure below and the table below. Customers can root

Select the wiring of the connector according to the following table.



Output port pin sequence

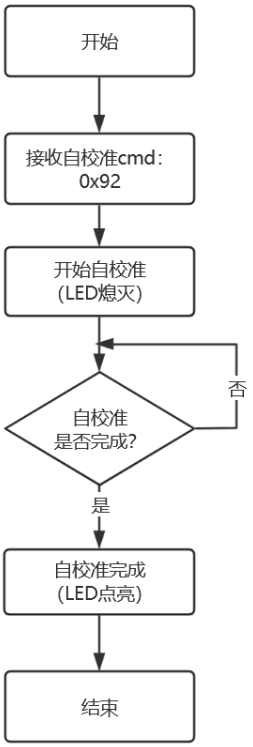
RS485 communication protocol				
Pin number	definition	description	type	Optional: connector wiring (Cable type: HC-0.8-6PWT)
1	VCC	power input	Power pin	black
2	NC	Not defined	Pull up pin	brown
3	GND	the earth	Power pin	red
4	A	RS485, data transmission line	Output pin	Citrus sinensis
5	B	RS485, data transmission line	Output pin	yellow
6	NC	Not defined	Pull up pin	hispid arthraxon

Communication interface connector pin definition

Self-calibration procedure

Ideally, the encoder's rotor and stator are perfectly aligned, with no installation issues such as eccentricity or tilt. However, in real-world applications, mechanical installation errors between the stator and rotor, such as eccentricity and tilt, can significantly impact the encoder's performance. The EF-M040 module supports self-calibration during the downstream product development phase, which helps eliminate signal misalignment and matching errors caused by installation tolerances. Additionally, self-calibration can also address issues like amplitude mismatch, misalignment, phase inaccuracy, and code channel zero alignment.

To ensure the effectiveness of the self-calibration function, maintain a steady rotation of the shaft during the calibration process. It is recommended to start the shaft before sending the calibration command and maintain a stable speed to ensure the chip accurately calculates the effective calibration parameters. When calibrating at 6 rpm, the entire process takes about 20 seconds; conversely, the faster the speed, the shorter the required calibration time (calibration at 1000 rpm takes less than 2 seconds). The self-calibration process is illustrated in the figure below: the upper computer sends a self-calibration command, which the chip receives and extinguishes the indicator light, indicating the start of the self-calibration. Once the calibration is complete, the chip automatically updates the calibration parameters to the corresponding address, and the indicator light turns on, signaling the completion of the self-calibration process.



Self-calibration process

Self-calibration command description

Command: 0x92 + Para1;

0x92: Self-calibration frame header

Para1: indicates the motor speed during calibration; (speed support 6~1000 rpm) for example: 0x9200; self-calibrate at about 6 rpm.

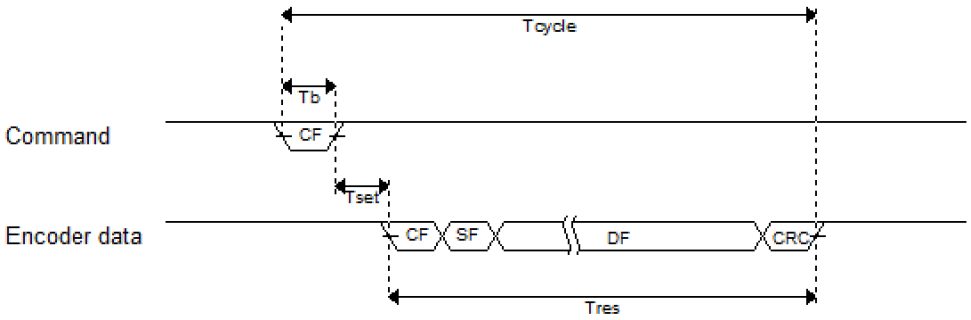
Self-calibration command		
cell	description	explain

0x92	Command type	Self-calibration command (motor speed is 12 rpm)

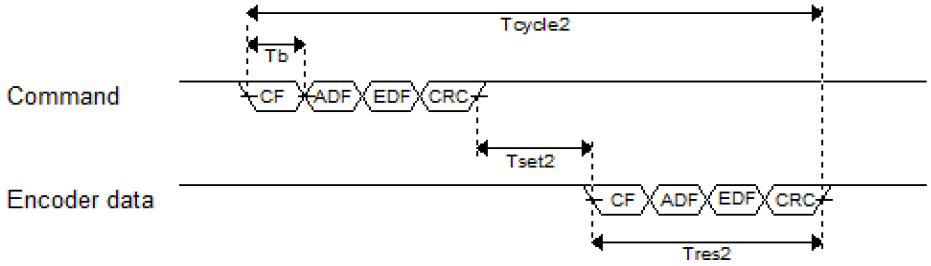
Register configuration list

Configuration registers			
address	**register**	**name**	**explain**
0xFE00	[31:0]	ZeroShift	Zero position Angle data
0xFE04	[31:0]	Mode	Mode switching
0xFE08	[15:8]	MultNum	Multi-pole coil pole number
	[8:0]	MinNum	The number of poles is less than the number of coil poles
0xFE0C	[31:0]	Direction	Rotate the angle in a clockwise direction
0xFE10	[95:0]	ID0	Device unique ID
0xFE14		ID1	
0xFE18		ID2	

Command and protocol format



Read and write data transmission format



Read and write FLASH data format

Command and protocol format timing parameters					
sign	**least value**	**representative value**	**crest value**	**description**	**unit**
Tcycle	51			RS485, read data cycle	μs

Tcycle2	35 or 94			RS485 write Flash instruction cycle 35 μs@ Address/data preparation 94 μs@Flash write	μs
Tb		4		Single Byte, transmission time	μs
Tset	3	3		Encoder response time to CF command	μs
Tset2	3 or 62			Returns the time required for the instruction response data 3 μs@ Address/data preparation 62 μs@Flash write	μs
Tres		4*N		The encoder reads the data and returns the total duration of the frame, where N is the number of bytes returned	μs
Tres2		32		The encoder writes the Flash return frame duration	μs

Command summary

The chip has two working modes: factory mode and normal mode. The factory mode is entered by default when the chip leaves the factory. It will not switch to normal operation mode until the calibration is completed and the corresponding registers are set. When switching modes, the chip needs to be powered off and restarted.

work pattern	function	explain
The factory model	Configure the front end in simulation mode	The configuration TX amplitude is out of balance with the AFE gain
	self calibrate	Correct SIN COS raw data
	Angle direction setting	Set the rotation direction
	Extreme logarithmic configuration	The logarithm of the number of pairs for many and few pairs
	Work mode switch	Switching between factory mode and normal mode
	Set the device Unique_ID	Set the user ID
Normal operation mode	Read the Angle and circle information	Read the single and multiple circle angles
	Read the Angle information	Read the single circle Angle
	Set the zero position Angle	Set the current position to zero

function	order	remarks
Switch the factory mode	0x 7E FF FF 7E	Restart takes effect
Switch to normal mode	0x 7E 1A 1A 7E	Restart takes effect
Configure the number of coil poles	0x 5E + 2Bytes address (Address[15:0]+ 4Bytes data +CRC	
Set the orientation of the configuration	0x 5E + 2Bytes address (Address[15:0]+ 4Bytes data +CRC	
Read the Angle and number of turns	0x 1A	Standard Tama River Agreement
Read the Angle information	0x 02	
Set the zero position Angle	0x C2	

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