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# OTV-INE Series

## Absolute Inductive Encoder

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Product Specification | Technical Documentation | Installation Guide

Non-contact | Bearingless | Hollow-Shaft Design  
±0.006° Accuracy | 15-22 Bit Resolution | 13 Standard Models  
SSI | BiSS-C | RS-422 | RS-485 | Differential ABZ



## 1. Product Overview

The OTV-INE Series is a high-precision absolute inductive encoder based on non-contact electromagnetic induction and wireless energy transfer technology. It provides reliable absolute angular position measurement without optical discs, glass gratings, light sources, or permanent magnets.

The encoder consists of a stator and a rotor. The stator wirelessly transmits energy to the rotor via electromagnetic coupling. The rotor, requiring no external power supply, receives this energy and generates a modulated electromagnetic field. The stator detects this field using a dual-track code design to calculate absolute angular position in real time.

The stator integrates the angle calculation circuit and encoder output circuits. Multiple communication protocols are supported through multi-pin connectors located on the outer edge of the stator, providing compatibility with diverse controller ecosystems.

Both rotor and stator feature a thin-sheet hollow-shaft structure, enabling large through-holes for shafts, pipes, and cables. The non-contact design eliminates bearings, couplings, and friction, delivering maintenance-free, high-reliability angular measurement even in harsh environments with dust, oil, vibration, and temperature extremes.

### ○ Key Specifications

Parameter	Specification
Angular Resolution	15 – 22 bit
Static Error	$\pm 0.006^\circ - \pm 0.05^\circ$
Repeatability	$\pm 2$ LSB
Max Operating Speed	4,000 – 8,000 rpm
Supply Voltage	5 – 24 V DC
Operating Temperature	-30°C to +100°C
Output Protocols	SSI, BiSS-C, RS-422, RS-485, Differential ABZ
Material	FR-4 (Rotor & Stator)
Protection Class	Up to IP40



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## 2. Applications

- ▶ Medical devices and surgical robots
- ▶ Aerospace and defense systems (satellite antennas, radar, gimbals)
- ▶ Industrial automation (servo motors, rotary tables, packaging machinery)
- ▶ Collaborative robots and robotic joints
- ▶ AGV and mobile robot steering feedback
- ▶ Semiconductor wafer handling and optoelectronic alignment
- ▶ Optical platforms and laser scanners

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## 3. Technical Parameters

### 3.1 Model Overview

Model	OD x ID x T (mm)	Weight	Resolution	Accuracy	Max RPM	Inertia (kg-mm <sup>2</sup> )
INE-014	14.8 x 2 x 3.6	2 g	15-17 bit	±0.03°	6,000	0.006
INE-016	16.8 x 2 x 3.6	2.5 g	15-17 bit	±0.025°	6,000	0.008
INE-018	18.8 x 2 x 3.6	3 g	15-17 bit	±0.02°	6,000	0.01
INE-020	20 x 4 x 6.5	4 g	15-17 bit	±0.05°	4,000	0.01
INE-040	40 x 10 x 7.8	10 g	17-18 bit	±0.015°	6,000	0.4
INE-052	52 x 17.7 x 7.6	13 g	18-20 bit	±0.01°	8,000	1.18
INE-060	60 x 25 x 7.6	18 g	18-20 bit	±0.008°	8,000	2.43
INE-080	80 x 35 x 8	30 g	18-20 bit	±0.008°	8,000	8.6
INE-100	100 x 48 x 8	40 g	19-21 bit	±0.006°	6,000	19.7
INE-120	120 x 70 x 8	50 g	19-21 bit	±0.006°	6,000	40
INE-140	140 x 90 x 8	75 g	19-21 bit	±0.006°	6,000	99
INE-180	180 x 120 x 8	120 g	20-22 bit	±0.006°	4,000	239.2
INE-247	247 x 172 x 8	180 g	20-22 bit	±0.006°	4,000	795.6

All models: Single-turn absolute | Non-contact | FR-4 material | Stator-rotor gap 0.6 ±0.1 mm



### 3.2 Common Operating Conditions

Parameter	Value
Supply Voltage	5 – 24 V DC
Current Consumption	< 100 mA
Electrical Interface	RS-422 / RS-485
EMC Compliance	IEC 61000-6-2 / IEC 61000-6-4
Operating Temperature	-30°C to +100°C
Relative Humidity	0 – 99%
Shock Resistance	100 g / 11 ms
Vibration Resistance	20 g (10 – 2,000 Hz)
Rotation Direction	CW increment (default, configurable)
Measurement Range	Single-turn absolute
Allowable Eccentricity	±0.3 mm
Stator-Rotor Gap	0.6 ±0.1 mm



## 4. Electrical Interface

The OTV-INE encoder features output connectors on the outer edge of the stator. Two connectors support different protocol configurations, selectable via software.

### 4.1 SSI / BiSS / RS-422 / RS-485 Connector

6-Pin Low-Profile Plug: HDGC0601WR-S-6P | Mating Connector: X0600

Pin	Signal
1	VCC
2	GND
3	TX- / DATA- / SLO-
4	TX+ / DATA+ / SLO+
5	RX- / CLK- / MA-
6	RX+ / CLK+ / MA+

Cable specification: 30AWG twisted-pair wire, 25 x 0.05mm tinned copper conductor, ETFE insulation, tinned copper braided shield (>95% coverage), 0.4-0.5mm silicone jacket.

### 4.2 ABZ / SPI Connector

8-Pin Plug: HC-1.25-8PWT (standard) / HC-0.8-8PWT (ABZ) | Mating: HC-1.25-8Y / HC-0.8-8Y

Pin	SPI	ABZ (Single-Ended)
1	CS	—
2	CLK	A
3	MISO	Z
4	MOSI	B
5	—	—
6	VCC (Multi-turn Batt.+)	



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## 5. Signal Output Parameters

Parameter	Value
Signal Delay	< 50 $\mu$ s
Output Code Format	Binary
Max Data Update Rate	25 kHz
Interface Level	Differential RS-422
Power Consumption	< 100 mA

Note: Sampling rate and clock frequency depend on the selected protocol. Refer to protocol-specific timing diagrams in Section 6 for detailed requirements.

## 6. Communication Protocols

### 6.1 SSi (Synchronous Serial Interface)

SSi is a widely-used industrial position sensor protocol implementing simple 2-wire (clock + data) synchronous communication based on the RS-422 hardware standard.

Clock frequency: 0.5 – 5.0 MHz. The encoder transmits absolute position data synchronized to the controller-generated clock signal. Data is transmitted MSB first, with the encoder updating its internal position on each clock falling edge.

Key characteristics: Unidirectional data flow, simple implementation, robust noise immunity through differential signaling, and broad compatibility with standard microcontrollers and motion control platforms.

### 6.2 BiSS-C (Bidirectional Serial Synchronous)

BiSS-C is an open digital protocol supporting bidirectional communication with built-in CRC error checking for enhanced data integrity.

Clock frequency: Up to 10 MHz. The protocol includes CRC polynomial ( $x^6 + x^1 + x^0$ ), with the start bit and "0" bit included in the CRC calculation. BiSS-C supports reading position, status, and encoder ID, and allows register read/write operations for configuration.

Key characteristics: Higher throughput than SSi, bidirectional data exchange, hardware-compatible with SSi (easy migration), CRC-protected frames, and daisy-chain capability for multi-sensor systems.

### 6.3 RS-422 (Full-Duplex Serial)

RS-422 provides asynchronous full-duplex serial communication in UART format with fixed data output at 2000 Hz and 460,800 bps baud rate.

Frame format: 1 start bit, 8 data bits, 1 even parity bit, 1 stop bit. Each frame contains 10 bytes of angle data plus status and CRC bytes.

Built on the RS-422 differential hardware standard for excellent noise immunity. The continuous fixed-rate output eliminates the need for host polling and simplifies integration, ensuring real-time reliable angular data delivery for control systems.



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#### **6.4 RS-485 (Half-Duplex Serial)**

RS-485 implements a command-response protocol at 2.5 Mbps baud rate over differential signaling for robust multi-drop communication.

Supported commands:

- Read Single-Turn Data (0x02): Returns status byte (SF) + 3-byte angle value (DF) + CRC
- Read Encoder ID (0x92): Returns status byte + fixed ID (0x11) + CRC
- Read Full Status (0x1A): Returns status byte + single-turn angle + multi-turn data + alarm flags + CRC

The encoder responds only when addressed, supporting multiple devices on a single bus.

#### **6.5 Differential ABZ (Incremental Quadrature Output)**

The ABZ interface provides industry-standard incremental quadrature A/B pulses with one Z-phase zero-position pulse per revolution.

This output is compatible with standard motor drives, motion controllers, and PLC high-speed counter inputs, enabling plug-and-play replacement of optical encoders in existing systems. The differential signaling (RS-422 levels) ensures reliable transmission in electrically noisy industrial environments.

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## 7. Product Selection Guide

The OTV-INE series uses a standardized ordering code to specify model, resolution, interface protocol, and hardware options.

### 7.1 Ordering Code Format

**INE {OD} - {Resolution} - {Protocol} - {Hardware Option} - {Supply Voltage}**

**Example: INE-014 - 16 - SSI1 - 03 - 05**

This specifies: INE series, 14mm OD, 16-bit resolution, SSI interface, standard hardware, 5V supply.

### 7.2 Code Components

Component	Description
INE-{OD}	Model code: INE-014 through INE-247 (OD in mm)
{Resolution}	Bit depth: 16, 17, 18, 19, 20, 21, or 22
{Protocol}	SSI1 = SSI, BIS1 = BiSS-C, RS41 = RS-422, RS51 = RS-485, ABZ1 = Incremental
{Hardware}	03 = Standard cable exit, 05 = Side-mount connector
{Voltage}	05 = 5V, 12 = 12V, 24 = 24V



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## 8. Software Tools

OTV provides a PC-based calibration and diagnostic utility for encoder setup, installation alignment verification, and real-time data monitoring. The software supports the following functions:

- ▶ Real-time angle position display and data logging
- ▶ Installation eccentricity detection and alignment guidance
- ▶ Encoder zero-position (Z-phase) calibration
- ▶ Protocol configuration and parameter setting
- ▶ Firmware version reading and diagnostics
- ▶ Batch configuration for production environments

Contact OTV sales for the latest software package and USB interface adapter.

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## 9. Mechanical Installation Notes

### 9.1 General Guidelines

- ▶ The encoder uses a separated stator-rotor structure. No bearings or couplings are required.
- ▶ The stator-rotor installation gap must be maintained at  $0.6 \pm 0.1$  mm.
- ▶ The rotor mounts directly on the shaft. The stator fixes to the housing.
- ▶ Ensure the rotor and stator are parallel and concentric within  $\pm 0.3$  mm eccentricity tolerance.
- ▶ Avoid mechanical stress on the stator PCB during mounting.
- ▶ For detailed dimensional drawings, refer to the model-specific data sheet or contact OTV.

### 9.2 Environmental Precautions

- ▶ Operating temperature range:  $-30^{\circ}\text{C}$  to  $+100^{\circ}\text{C}$ .
- ▶ The encoder is rated IP40. For harsh environments, provide additional enclosure protection.
- ▶ FR-4 material is flame-retardant but not suitable for direct chemical exposure.
- ▶ Avoid sustained condensation on the encoder surfaces.

## 10. Individual Model Specifications

Each model in the INE series has specific mechanical dimensions, mounting requirements, and performance characteristics. The following pages provide detailed data for all 13 standard models.

### 10.1 INE-014

Performance Parameter	Value
Resolution	15-17 bit
Static Error	$\pm 0.03^{\circ}$
Repeatability	$\pm 2$ LSB
Max Operating Speed	6,000 rpm
Measurement Range	Single-turn absolute
Rotation Direction	CW increment (default, configurable)

### Mechanical Dimensions

Mechanical Parameter	Value
OD / ID / Thickness	14.8 / 2 / 3.6 mm
Installation Eccentricity	$\pm 0.1$ mm
Stator-Rotor Gap	$0.4 \pm 0.1$ mm



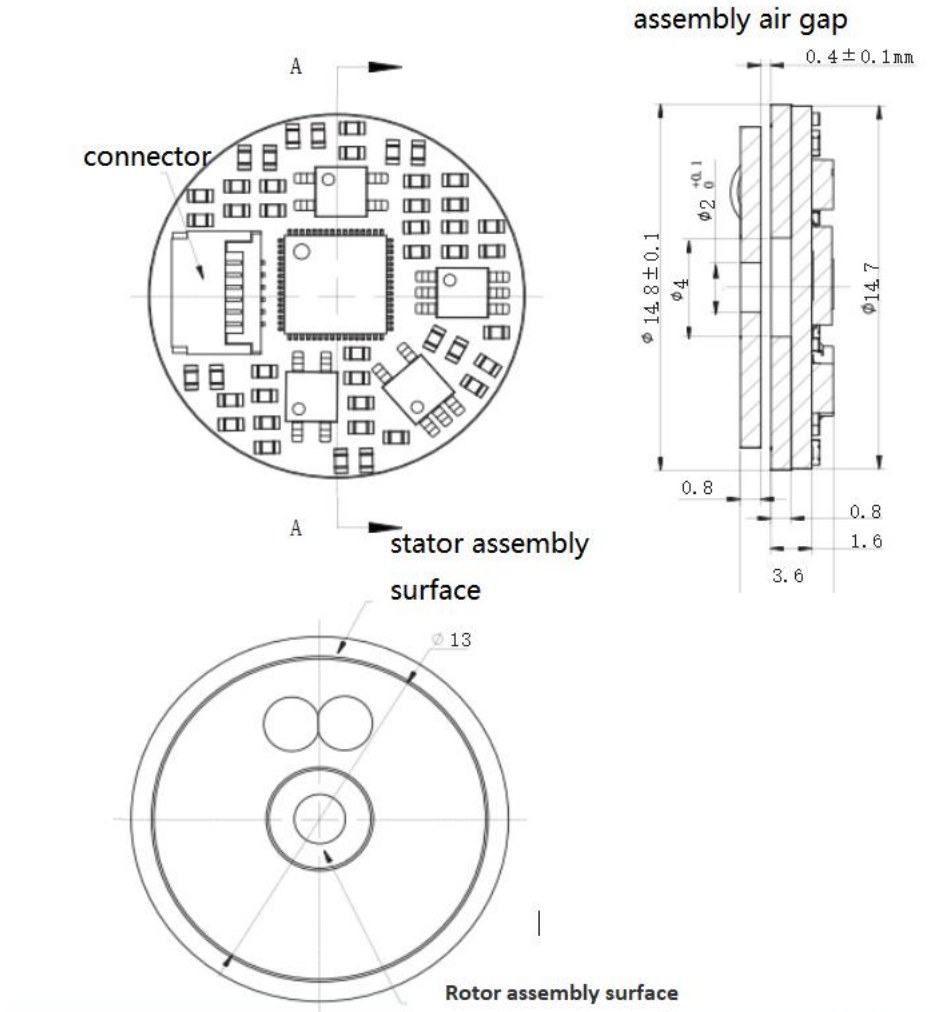
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Rotor Inertia 0.006 kg-mm<sup>2</sup>

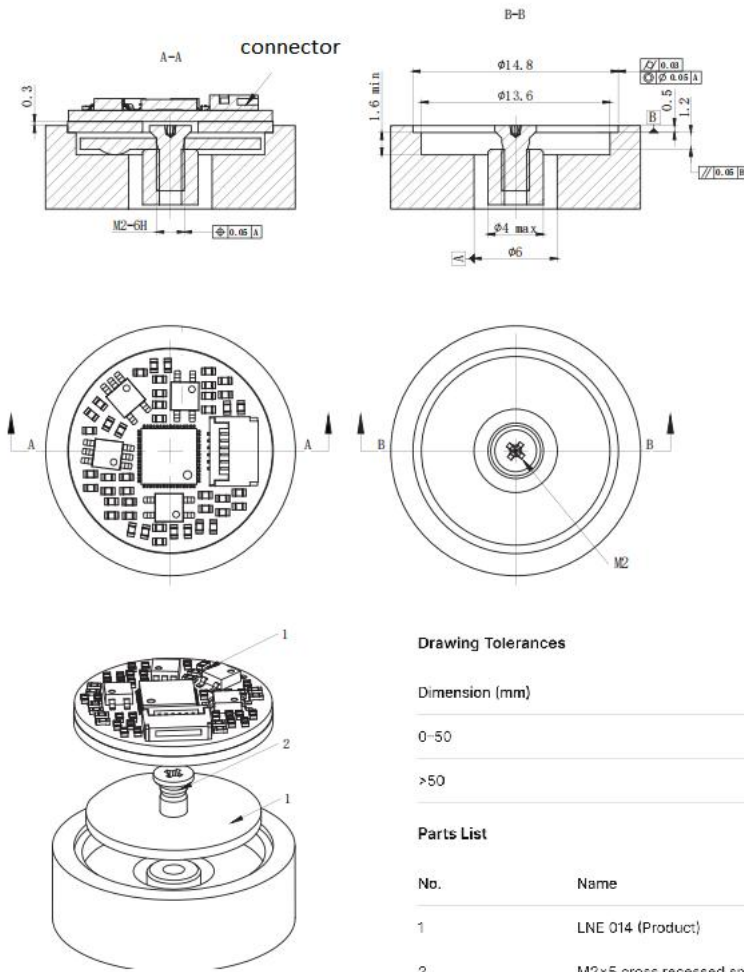
Weight (Approx.) 2 g

Material FR-4

### External Dimensions



### Installation Dimensions



**Drawing Tolerances**

Dimension (mm)	Tolerance
0-50	±0.05 mm
>50	±0.10 mm

**Parts List**

No.	Name	Qty.
1	LNE 014 (Product)	1
2	M2×5 cross recessed small countersunk head screw	1

**10.2 INE-016**

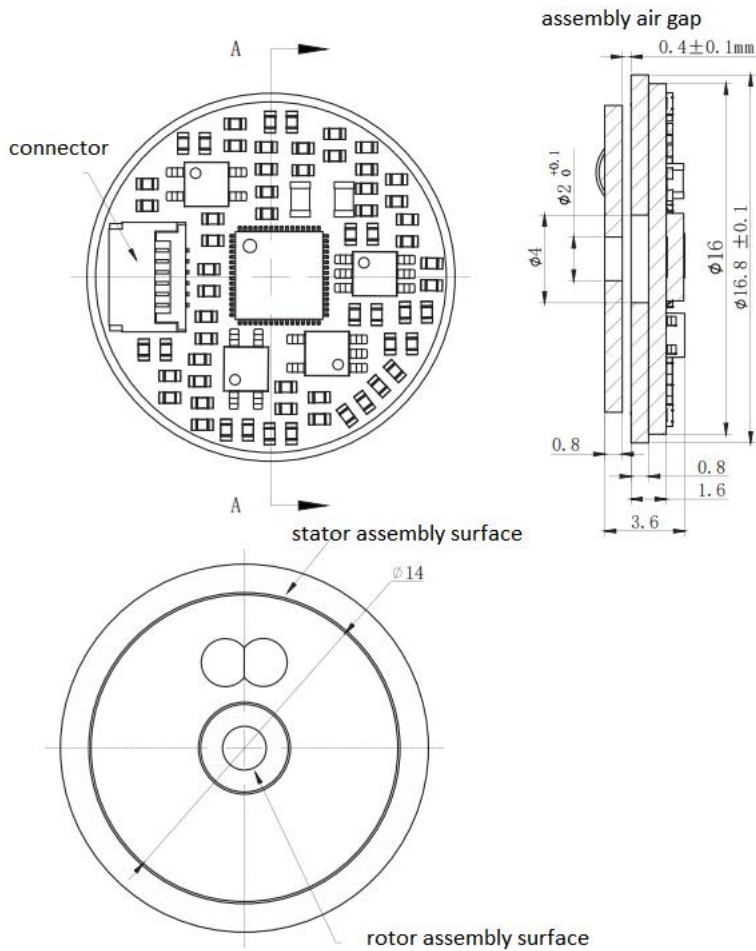
Performance Parameter	Value
Resolution	15-17 bit
Static Error	±0.025°
Repeatability	±2 LSB
Max Operating Speed	6,000 rpm
Measurement Range	Single-turn absolute
Rotation Direction	CW increment (default, configurable)

**Mechanical Dimensions**

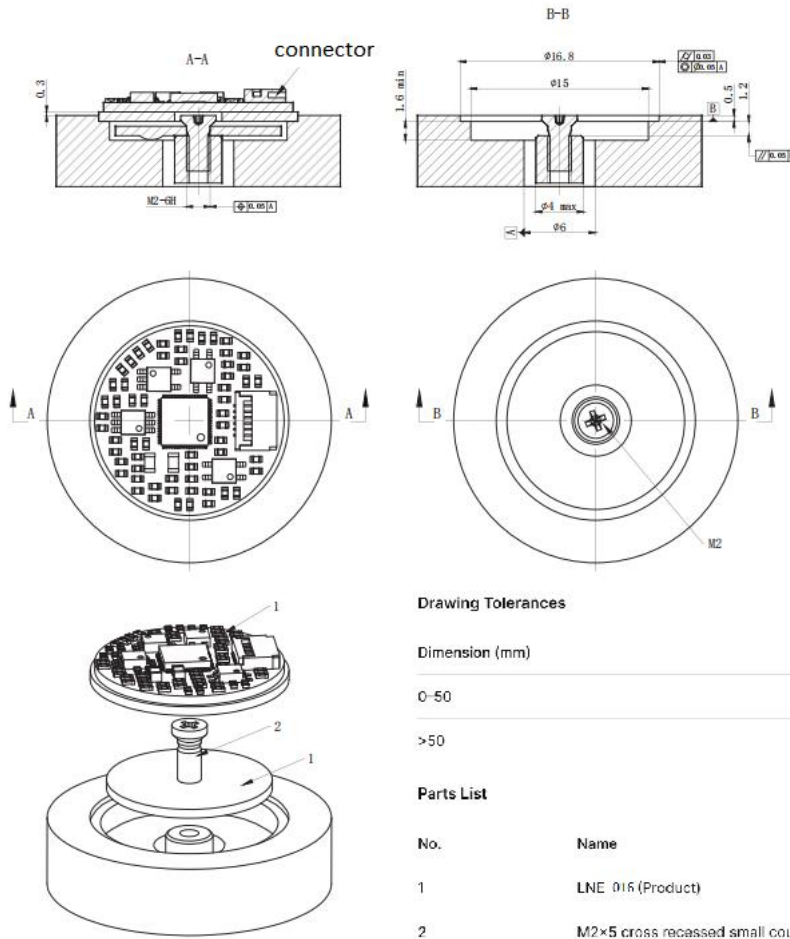


Mechanical Parameter	Value
OD / ID / Thickness	16.8 / 2 / 3.6 mm
Installation Eccentricity	±0.1 mm
Stator-Rotor Gap	0.4 ±0.1 mm
Rotor Inertia	0.008 kg-mm <sup>2</sup>
Weight (Approx.)	2.5 g
Material	FR-4

### External Dimensions



### Installation Dimensions



**Drawing Tolerances**

Dimension (mm)	Tolerance
0-50	±0.05 mm
>50	±0.10 mm

**Parts List**

No.	Name	Qty.
1	LNE Ø16 (Product)	1
2	M2×5 cross recessed small countersunk head screw	1

### 10.3 INE-018

Performance Parameter	Value
Resolution	15-17 bit
Static Error	±0.02°
Repeatability	±2 LSB
Max Operating Speed	6,000 rpm
Measurement Range	Single-turn absolute
Rotation Direction	CW increment (default, configurable)

### Mechanical Dimensions

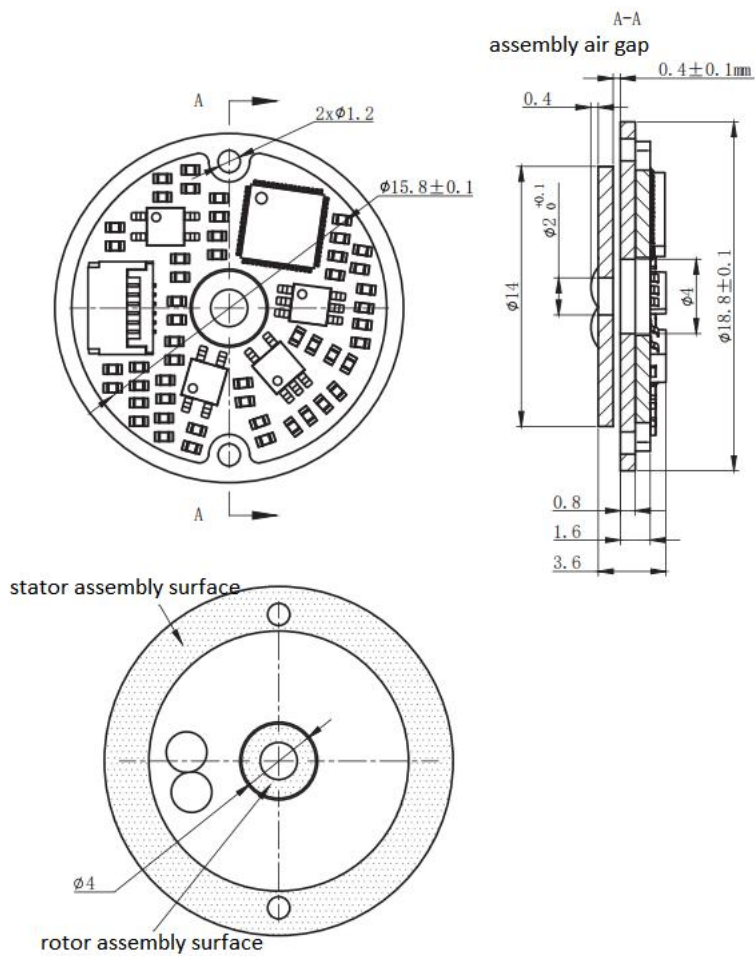
Mechanical Parameter	Value
OD / ID / Thickness	18.8 / 2 / 3.6 mm



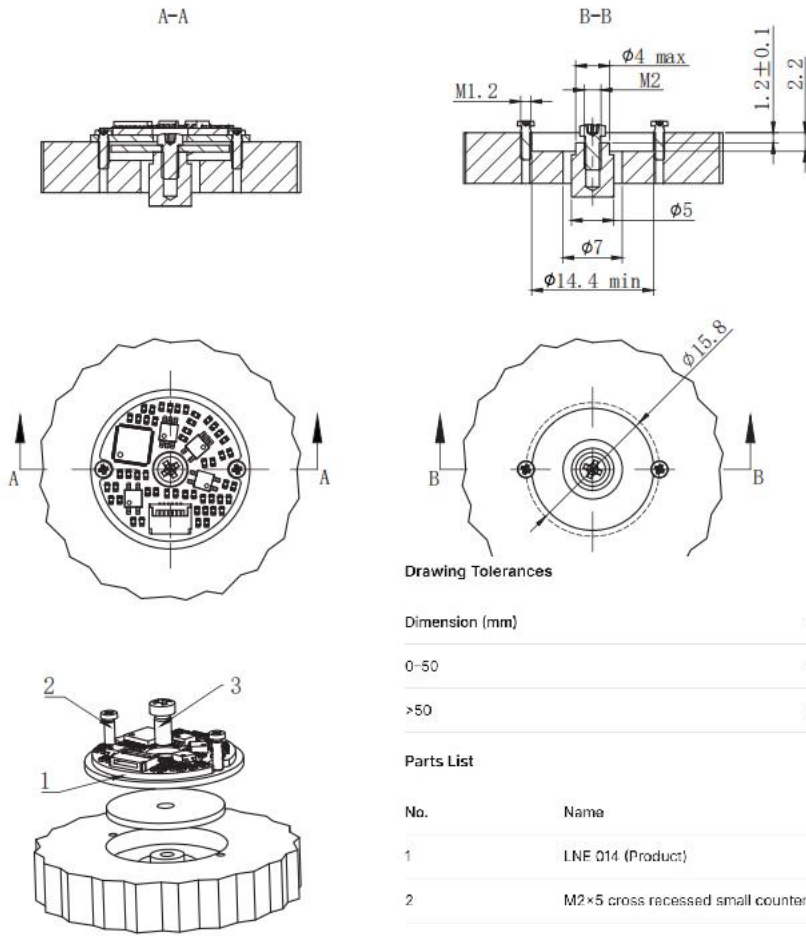
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Installation Eccentricity	±0.1 mm
<b>Stator-Rotor Gap</b>	<b>0.4 ±0.1 mm</b>
Rotor Inertia	0.01 kg-mm <sup>2</sup>
<b>Weight (Approx.)</b>	<b>3 g</b>
Material	FR-4

### External Dimensions



### Installation Dimensions



**Drawing Tolerances**

Dimension (mm)	Tolerance
0-50	$\pm 0.05$ mm
>50	$\pm 0.10$ mm

**Parts List**

No.	Name	Qty.
1	LNE 014 (Product)	1
2	M2×5 cross recessed small countersunk head screw	1
3	M2×4 cross recessed small countersunk head screw	1

### 10.4 INE-020

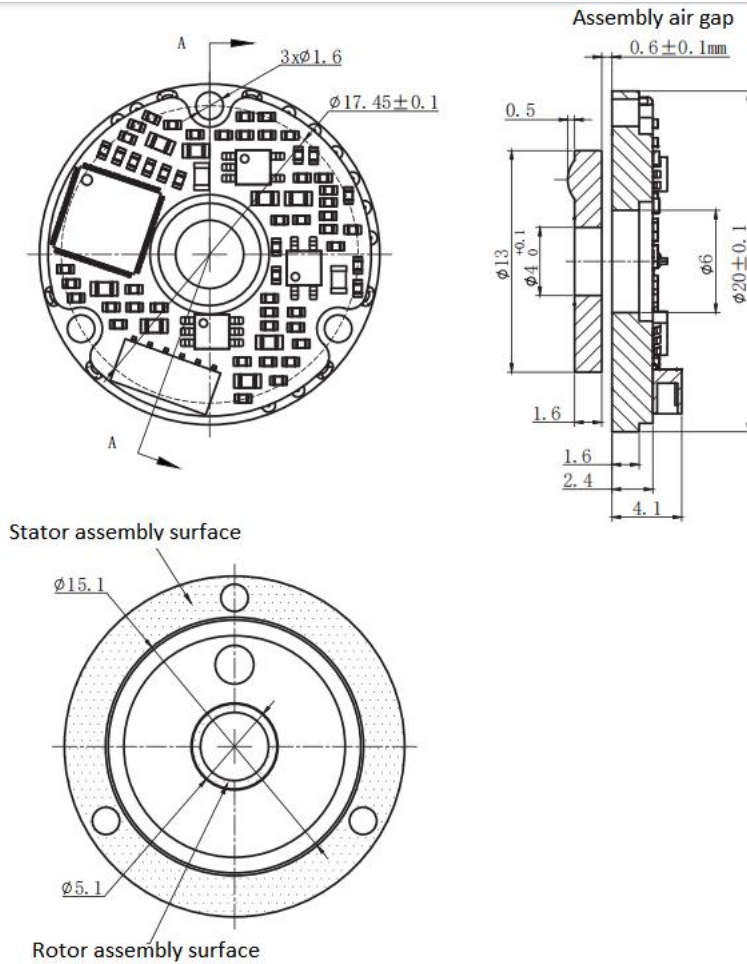
Performance Parameter	Value
Resolution	15-17 bit
Static Error	$\pm 0.05^\circ$
Repeatability	$\pm 2$ LSB
Max Operating Speed	4,000 rpm
Measurement Range	Single-turn absolute
Rotation Direction	CW increment (default, configurable)

### Mechanical Dimensions



Mechanical Parameter	Value
OD / ID / Thickness	20 / 4 / 6.5 mm
Installation Eccentricity	±0.1 mm
Stator-Rotor Gap	0.4 ±0.1 mm
Rotor Inertia	0.01 kg-mm <sup>2</sup>
Weight (Approx.)	4 g
Material	FR-4

### External Dimensions



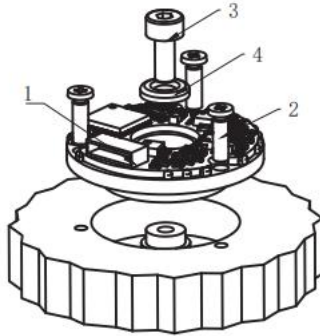
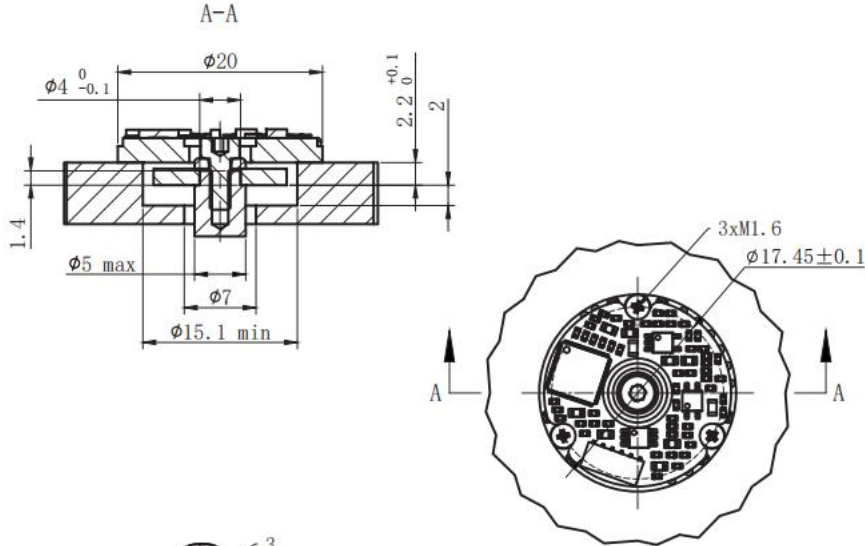


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### Installation Dimensions



#### Drawing Tolerances

Range	Tolerance
0-50	±0.05 mm
50 and above	±0.1 mm

No.	Description	Qty
1	INE 020	1
2	M1.6x5 bolt	1
3	M2x5 hex socket bolt	1
4	INE 020 retaining ring	1

### 10.5 INE-040

Performance Parameter	Value
Resolution	17-18 bit
Static Error	±0.015°
Repeatability	±2 LSB
Max Operating Speed	6,000 rpm
Measurement Range	Single-turn absolute
Rotation Direction	CW increment (default, configurable)



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### Mechanical Dimensions

Mechanical Parameter	Value
OD / ID / Thickness	40 / 10 / 7.8 mm
Installation Eccentricity	±0.3 mm
Stator-Rotor Gap	0.6 ±0.1 mm
Rotor Inertia	0.4 kg-mm <sup>2</sup>
Weight (Approx.)	10 g
Material	FR-4

### External Dimensions

### Installation Dimensions

## 10.6 INE-052

Performance Parameter	Value
Resolution	18-20 bit
Static Error	±0.01°
Repeatability	±2 LSB
Max Operating Speed	8,000 rpm
Measurement Range	Single-turn absolute
Rotation Direction	CW increment (default, configurable)

### Mechanical Dimensions



Mechanical Parameter	Value
OD / ID / Thickness	52 / 17.7 / 7.6 mm
Installation Eccentricity	±0.3 mm
Stator-Rotor Gap	0.6 ±0.1 mm
Rotor Inertia	1.18 kg-mm <sup>2</sup>
Weight (Approx.)	13 g
Material	FR-4

#### Installation Dimensions

### 10.7 INE-060

Performance Parameter	Value
Resolution	18-20 bit
Static Error	±0.008°
Repeatability	±2 LSB
Max Operating Speed	8,000 rpm
Measurement Range	Single-turn absolute
Rotation Direction	CW increment (default, configurable)

#### Mechanical Dimensions

Mechanical Parameter	Value
OD / ID / Thickness	60 / 25 / 7.6 mm
Installation Eccentricity	±0.3 mm
Stator-Rotor Gap	0.6 ±0.1 mm
Rotor Inertia	2.43 kg-mm <sup>2</sup>
Weight (Approx.)	18 g



#### External Dimensions

#### Installation Dimensions

### 10.8 INE-080

Performance Parameter	Value
Resolution	18-20 bit
Static Error	$\pm 0.008^\circ$
Repeatability	$\pm 2$ LSB
Max Operating Speed	8,000 rpm
Measurement Range	Single-turn absolute
Rotation Direction	CW increment (default, configurable)

#### Mechanical Dimensions

Mechanical Parameter	Value
OD / ID / Thickness	80 / 35 / 8 mm
Installation Eccentricity	$\pm 0.3$ mm
Stator-Rotor Gap	0.6 $\pm$ 0.1 mm
Rotor Inertia	8.6 kg-mm <sup>2</sup>
Weight (Approx.)	30 g
Material	FR-4

#### External Dimensions

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Installation Dimensions

## 10.9 INE-100

Performance Parameter	Value
Resolution	19-21 bit
Static Error	$\pm 0.006^\circ$
Repeatability	$\pm 2$ LSB
Max Operating Speed	6,000 rpm
Measurement Range	Single-turn absolute
Rotation Direction	CW increment (default, configurable)

## Mechanical Dimensions

Mechanical Parameter	Value
OD / ID / Thickness	100 / 48 / 8 mm
Installation Eccentricity	$\pm 0.3$ mm
Stator-Rotor Gap	0.6 $\pm$ 0.1 mm
Rotor Inertia	19.7 kg-mm <sup>2</sup>
Weight (Approx.)	40 g
Material	FR-4

## External Dimensions

## Installation Dimensions

## 10.10 INE-120

Performance Parameter	Value
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Resolution	19-21 bit
Static Error	±0.006°
Repeatability	±2 LSB
Max Operating Speed	6,000 rpm
Measurement Range	Single-turn absolute
Rotation Direction	CW increment (default, configurable)

### Mechanical Dimensions

Mechanical Parameter	Value
OD / ID / Thickness	120 / 70 / 8 mm
Installation Eccentricity	±0.3 mm
Stator-Rotor Gap	0.6 ±0.1 mm
Rotor Inertia	40 kg-mm <sup>2</sup>
Weight (Approx.)	50 g
Material	FR-4

### External Dimensions

### Installation Dimensions

## 10.11 INE-140

Performance Parameter	Value
Resolution	19-21 bit
Static Error	±0.006°
Repeatability	±2 LSB
Max Operating Speed	6,000 rpm
Measurement Range	Single-turn absolute



### Mechanical Dimensions

Mechanical Parameter	Value
OD / ID / Thickness	140 / 90 / 8 mm
Installation Eccentricity	±0.3 mm
Stator-Rotor Gap	0.6 ±0.1 mm
Rotor Inertia	99 kg-mm <sup>2</sup>
Weight (Approx.)	75 g
Material	FR-4

### External Dimensions

### Installation Dimensions

## 10.12 INE-180

Performance Parameter	Value
Resolution	20-22 bit
Static Error	±0.006°
Repeatability	±2 LSB
Max Operating Speed	4,000 rpm
Measurement Range	Single-turn absolute
Rotation Direction	CW increment (default, configurable)

### Mechanical Dimensions

Mechanical Parameter	Value
OD / ID / Thickness	180 / 120 / 8 mm
Installation Eccentricity	±0.3 mm



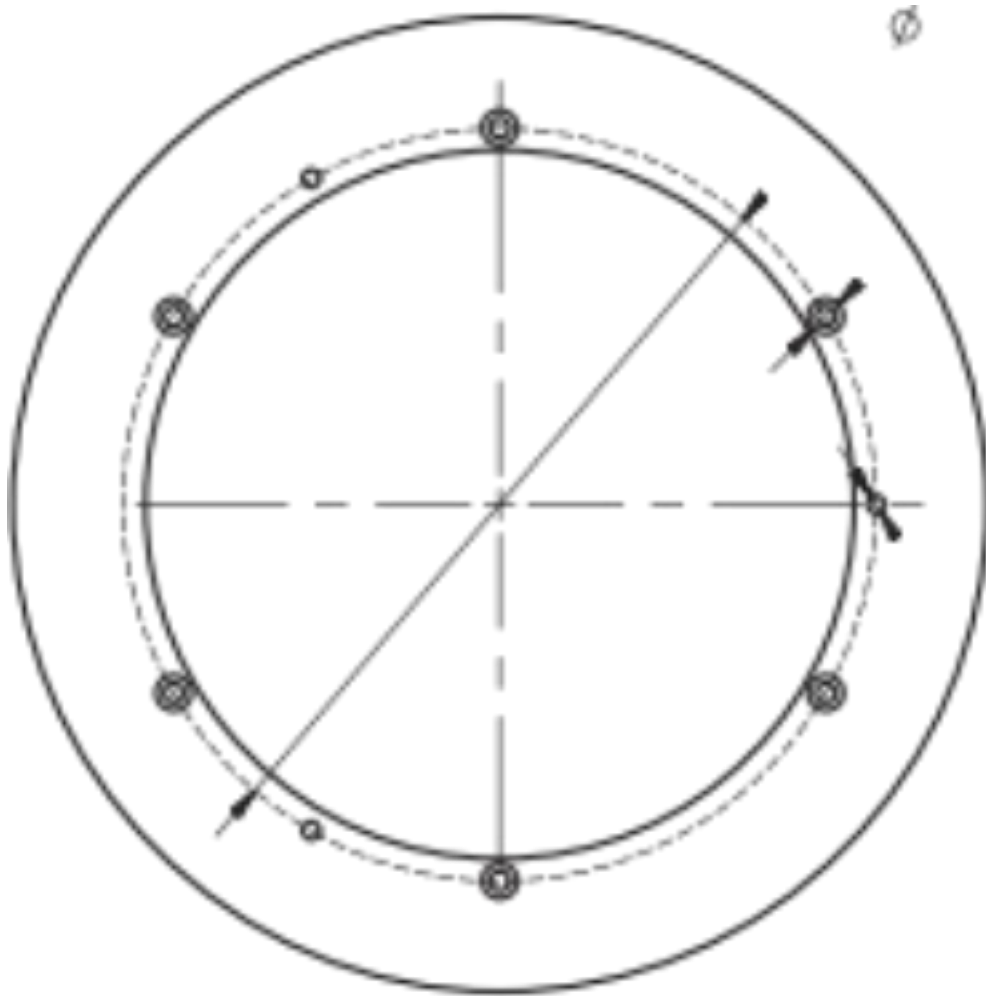
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Stator-Rotor Gap	0.6 ±0.1 mm
Rotor Inertia	239.2 kg-mm <sup>2</sup>
Weight (Approx.)	120 g
Material	FR-4

**External Dimensions**



**10.13 INE-247**



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Performance Parameter	Value
Resolution	20-22 bit
Static Error	$\pm 0.006^\circ$
Repeatability	$\pm 2$ LSB
Max Operating Speed	4,000 rpm
Measurement Range	Single-turn absolute
Rotation Direction	CW increment (default, configurable)

### Mechanical Dimensions

Mechanical Parameter	Value
OD / ID / Thickness	247 / 172 / 8 mm
Installation Eccentricity	$\pm 0.3$ mm
Stator-Rotor Gap	0.6 $\pm$ 0.1 mm
Rotor Inertia	795.6 kg-mm <sup>2</sup>
Weight (Approx.)	180 g
Material	FR-4

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### Installation Dimensions



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