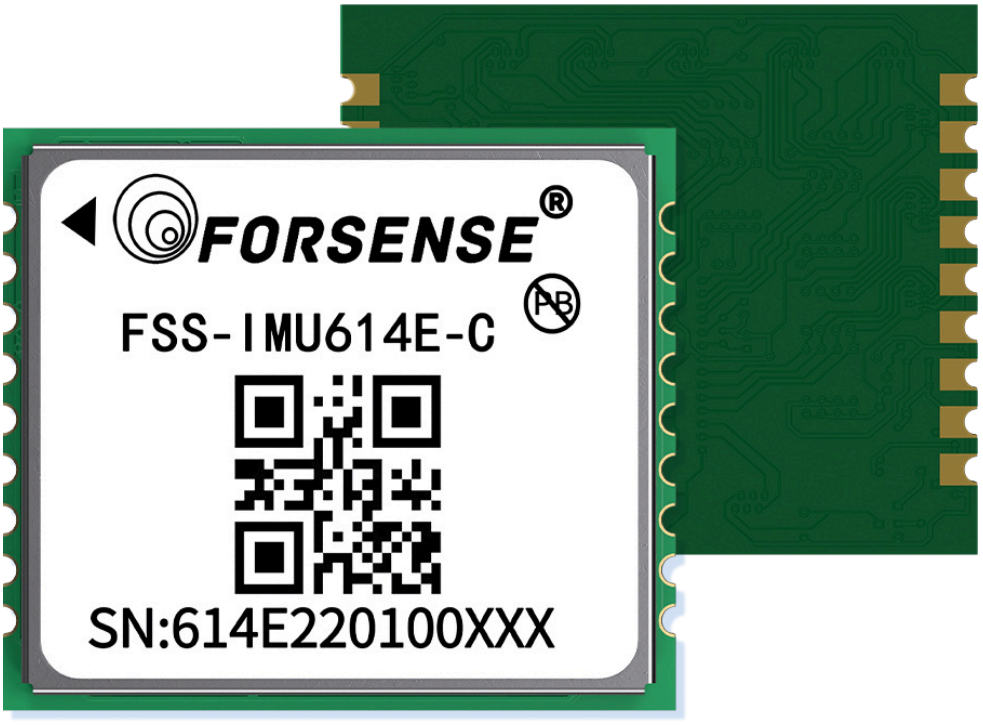
FORSENSE
原极科技

Tactical-grade MEMS 6-DOF inertial sensor

FSS-IMU614E-C

Product manual



Forsense (Shanghai) Technology Co., Ltd

Please read this user manual carefully before using this product.

FORSENSE
原极科技

Tactical-grade MEMS 6-DOF inertial sensor

FSS-IMU614E-C-Product Manual(en)

Features

Tactical-Grade MEMS Gyroscope

- 1°/hr Bias instability
- Z-axis0.1°/√hr Angle Random Walk

Tactical-Grade MEMS Accelerometer

- 15μg Bias instability
- 0.025m/s /√hr Velocity Random Walk

independent rotary table calibration

- Independent Calibration of Each Module: Sensitivity, Bias, Misalignment
- -40°C to 85°C Temperature Compensation

High-Strength Operating Condition Tolerance

- Superior Shock Resistance: 2000g (0.5ms, Half-Sine, 3-Axis)
- Superior Vibration Resistance: 10g (10~2kHz, 3-axis)
- Stable Operation Across Full Temperature Range: -40°C ~ 85°C
- 100% Magnetic Shielding

Real-time and Flexible Digital Interfaces, Compact Size

- Configurable Output Sample Rate up to 1kHz
- Supports Serial Port, I2C, SPI and Multiple Interfaces
- 14.7*17*3.3mm, Weight Only 2g

Product Overview

IMU614E-C is a 6 degrees of freedom (DOF) MEMS inertial sensor module developed by Forsense Technology. It comes standard with output of three-axis Gyroscope and acceleration information.

High precision and high resolution enable the capture of subtle vibrations and tilts. All modules undergo turntable calibration before shipment to ensure stable performance under various extreme operating conditions while maintaining high consistency across all products.

Application Fields

- Application Fields: Surveying and mapping fields such as handheld laser SLAM

Based on standard performance and output Parameter, Forsense also provides**customized software and LOGO customization services**, to support your product needs!

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1. Performance Parameter

1.1 Gyroscope Key Metrics

Table 1 Gyroscope Key Metrics

Parameter	Test Conditions/Remarks	Min	Typical	Max	Unit
Measurement Range			±500		°/s
Bias instability[1]	@25℃, Allan Variance, 1σ		1		°/hr
Bias stability	GJB, 10s Smoothing		3		°/hr
Bias Repeatability	GJB		5		°/hr
Resolution			0.0101		°/s
Misalignment between axes			0.02		deg
Internal low-pass cutoff frequency	Software Adjustable		58		Hz
ODR			1000		Hz
measure delay			5		ms
Bias over temperature	-40℃ ~ 85℃, ≤1℃/min @1σ		0.025		°/s
Random Walk	@25℃, Allan Variance, 1σ		0.1		°/√hr
scale coefficient error			xy:2.5 z:1.5		‰
scale factor nonlinear	@25℃		50		ppm

Note 1: IEEE standard, provided by the Allan variance curve in a static environment at 25°C

1.2 Accelerometer Key Metrics

Table 2 Accelerometer Key Metrics

Parameter	Test Conditions/Notes	Min	Typical	Max	Unit
Measurement Range			±8		g
Bias instability[1]	@25℃, Allan Variance, 1σ		15		μg
Bias stability	GJB, 10s Smoothing		45		μg
Bias Repeatability	GJB		0.2		mg
Resolution			0.1409		mg
Misalignment between axes			0.02		deg
Internal low-pass cutoff frequency	Software Adjustable		58		Hz
ODR			1000		Hz
measure delay			5		ms
Bias over temperature	-40℃ ~ 85℃, ≤1℃/min @1σ		1		mg
Random Walk[1]	@25℃, Allan Variance, 1σ		0.025		m/s/√hr
scale coefficient error			0.5		‰
scale factor nonlinear	@25℃		70		ppm

Note 1: IEEE standard, provided by the Allan variance curve in a static environment at 25°C

Figure 1 Gyroscope Allan Variance Typical Curve

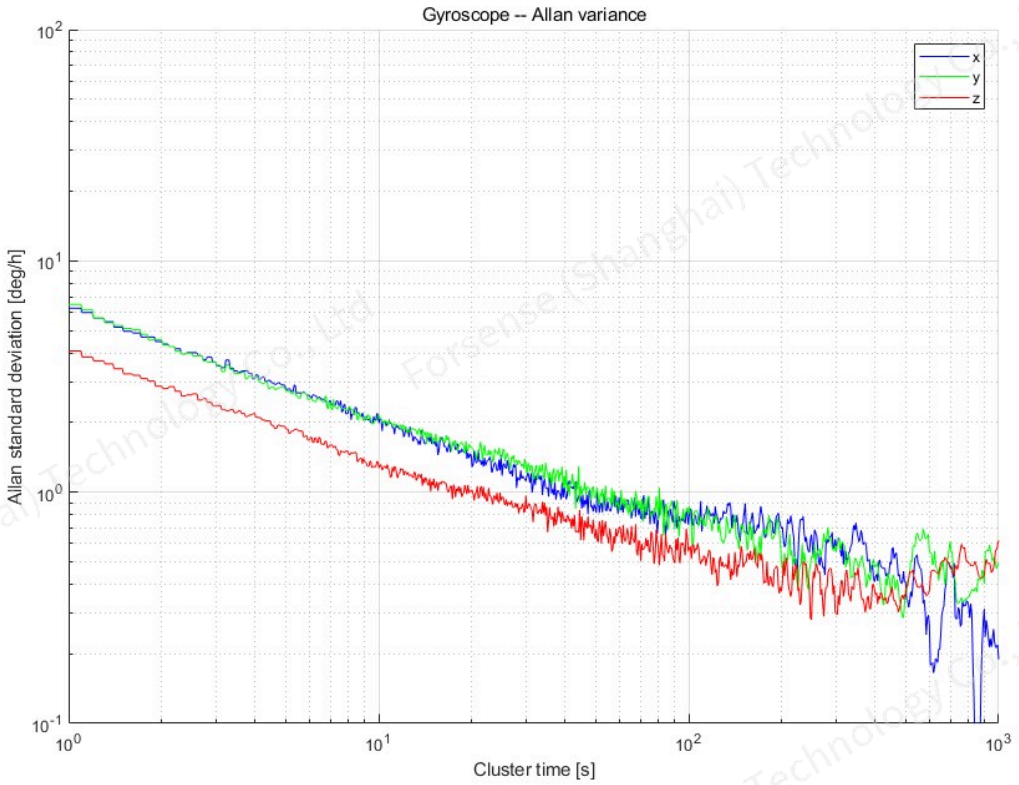
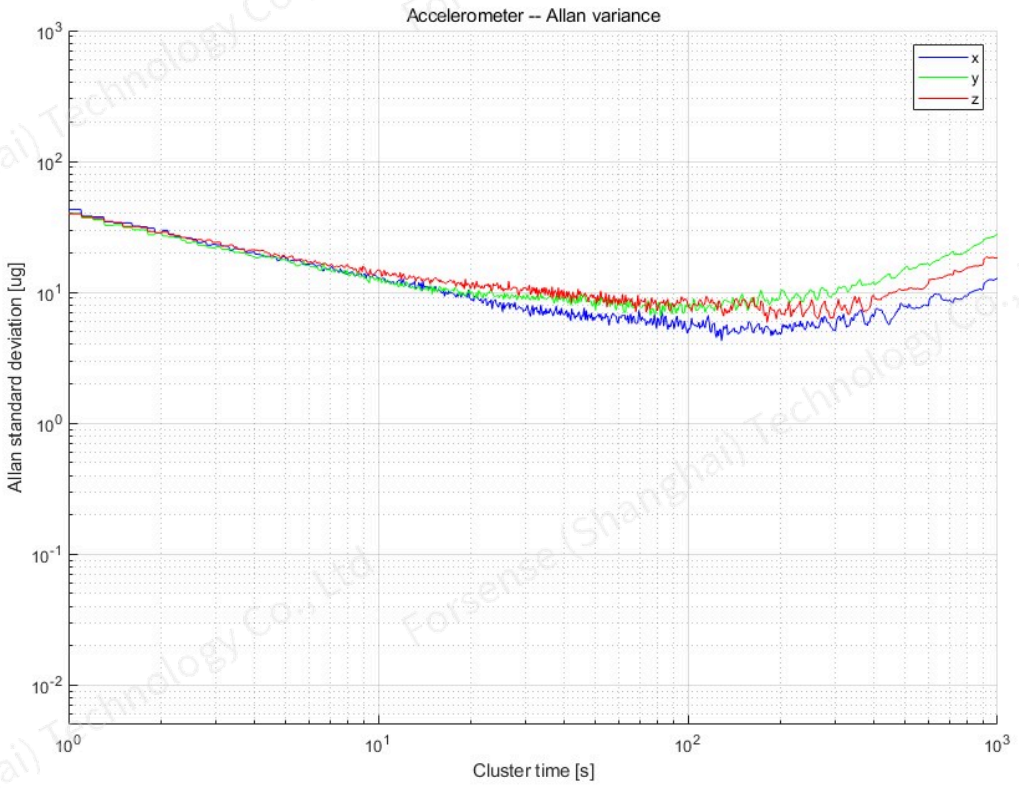


Figure 2 Accelerometer Allan Variance Typical Curve



2. Physical Structure

Figure 3 Outline and StructureRecommended PadsDimensions (Unit: mm)

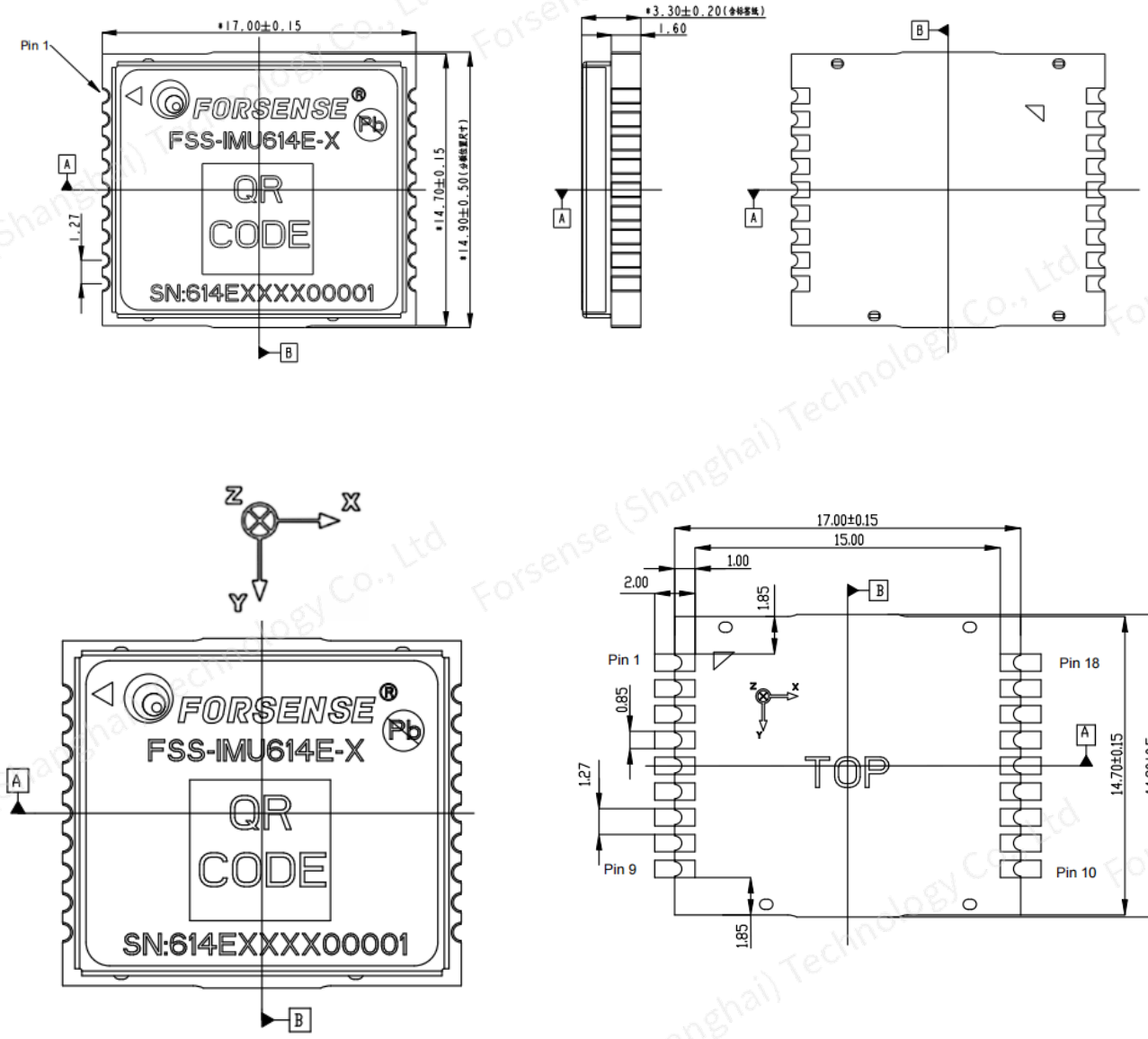
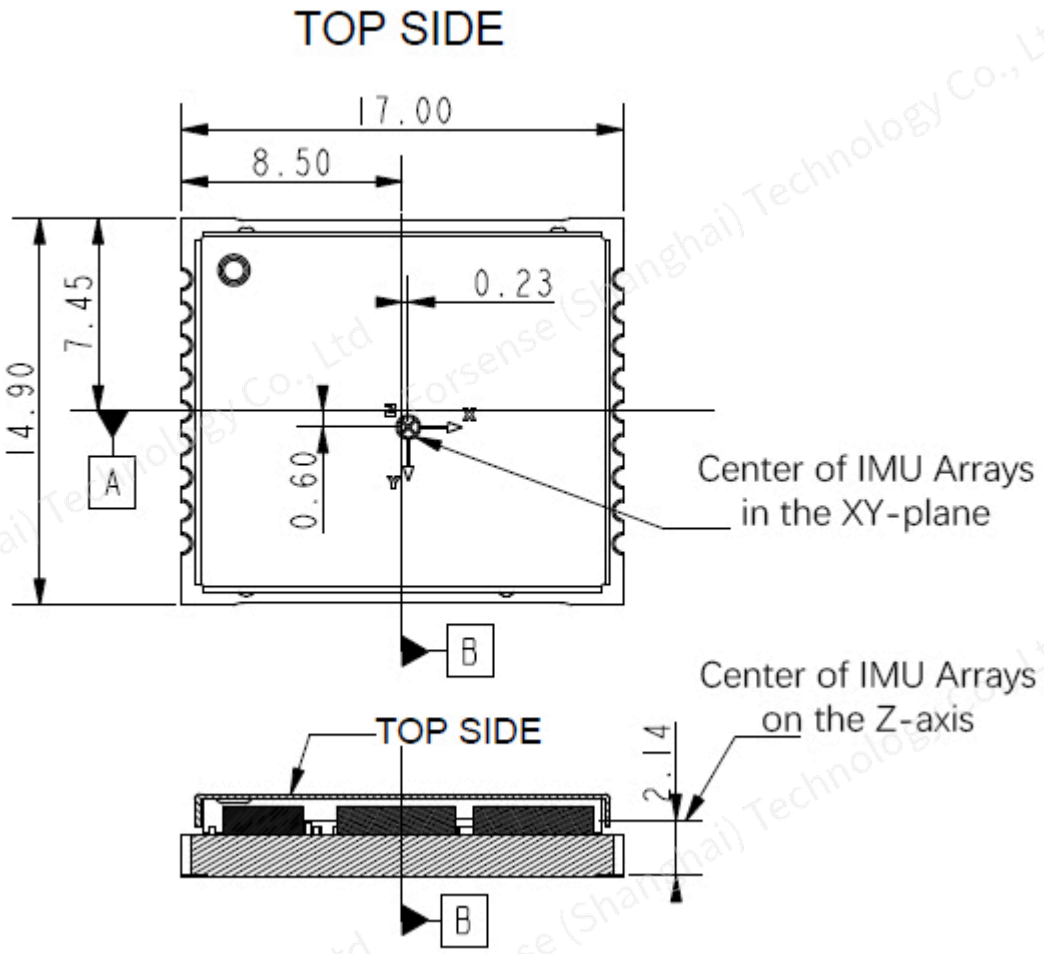


Figure 4 IMU Coordinate Center (Unit: mm)


TOP SIDE
17.00
8.50
7.45
14.90
0.23
0.60
A
B
Center of IMU Arrays
in the XY-plane
TOP SIDE
2.14
Center of IMU Arrays
on the Z-axis
B

3. Electrical Characteristics

3.1 Maximum Ratings

Table 3 Absolute Maximum Ratings

Parameter	Symbol	Range	Unit
supply voltage	VCC	-0.3 to 4	V
Ground (GND)	GND	-	-
Input Pin Voltage (Vin)	Vin	-0.3 to VCC+0.2	V
Operating Temperature (Tot)	Tot	-40 to 85	℃
Storage Temperature (Tstg)	Tstg	-40 to 85	℃

3.2 Operating Conditions

Table 4 Operating Conditions

Parameter	Symbol	Min.	Typ.	Max.	Unit
supply voltage	VCC	3.2	3.3	3.4	V
VCC Max Ripple	Vrpp		±40		mV
Power Consumption	P		0.09		W
Operating Temperature (Tot)	T	-40		85	℃
Storage Temperature (Tstg)	T	-40		85	℃

3.3 IO Threshold Characteristics

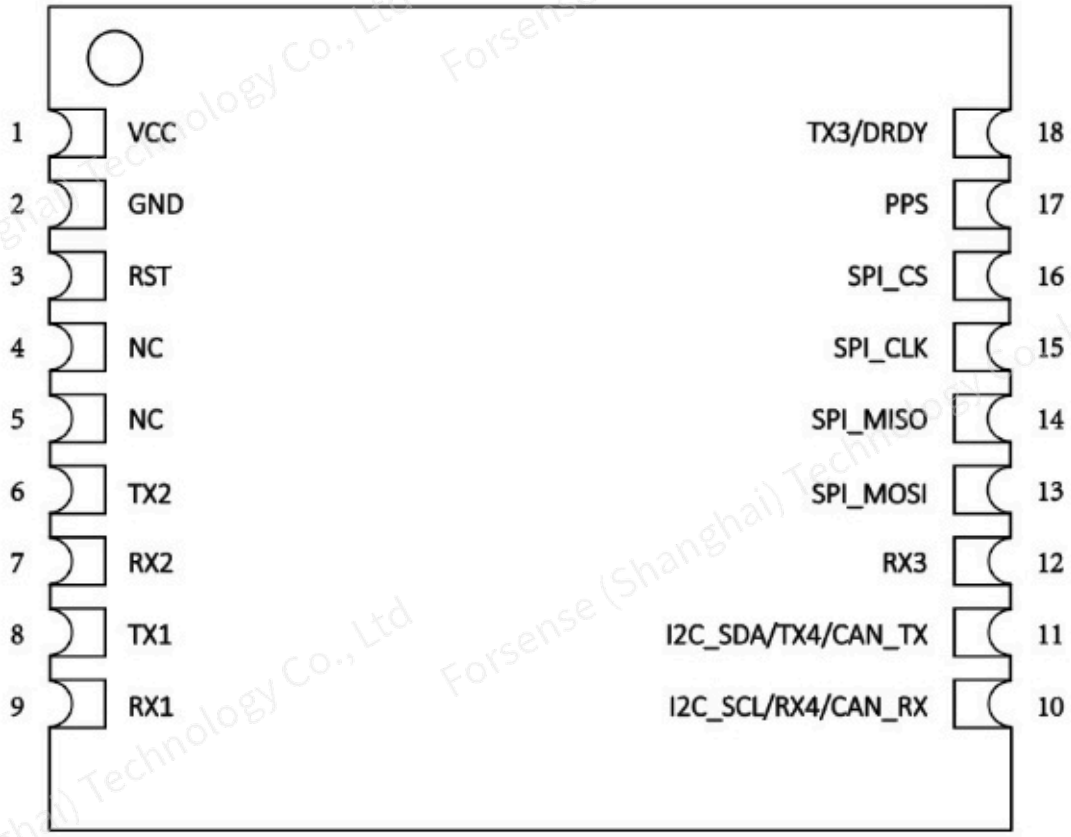
Table 5 IO Threshold Characteristics

Parameter	Symbol	Minimum	Typical Value	Maximum Value	Unit
Input Pin Low Level	Vin_low	0		VCC*0.2	V
Input Pin High Level	Vin_high	VCC*0.7		VCC+0.2	V
Output Pin Low power level	Vout_low	0		0.45	V
Output Pin High power level	Vout_high	VCC-0.45		VCC	V

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4. Pin Definition

Figure5 Pin Schematic



IMU614E-X Pin Layout (Top View)

Table 6 Pin Definitions

Pin No.	Pin Name	Pin Description		
1	VCC	Power Input, +3.3V Input, 40mA, Ripple ≤ ±40mV		
2	GND	Ground (GND)		
3	RST [1]	External Hardware Reset Input, Internal Pull-up (for SPI Mode)		
4	NC	No Connection		
5	NC	No Connection		
6	TX2	Receive asynchronous data Output		
7	RX2	Receive asynchronous data Input		
8	TX1	Receive asynchronous data Output (Data Communication Interface (LVTTL))		
9	RX1	Receive asynchronous data Input (Data Communication Interface (LVTTL))		
10	CAN RX / RX4 / I2C_SCL	Mode	Function	Description
		1	CAN_RX	CAN Receive Pin; Read data from the bus to the CAN controller
		2	RX4	Receive asynchronous data input
		3	I2C_SCL	I2C serial clock
11	CAN TX / TX4 / I2C_SDA	Mode	Function	Description
		1	CAN_TX	CAN Transmit Pin; Read Data from CAN Controller to bus driver
		2	TX4	Receive asynchronous data Output
		3	I2C_SDA	I2C serial data
12	RX3	Receive asynchronous data Input		
13	SPI_MOSI	SPI serial data Input		
14	SPI_MISO	SPI serial data Output		
15	SPI_CLK	SPI serial clock		

16	SPI_CS	SPI chip select
17	PPS	External Synchronous Sampling Trigger Signal; (Connect to RTK PPS Pin)
18	TX3/DRDY	Receives asynchronous data Output / Can Be Used for Data Ready

Note 1: When Master initialize, Use /RST to Reset the IMU Hardware Once

For hardware design information related to the module, refer to the document 《IMU614E-XX Hardware Design Manual》 .

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5. Recommended Soldering Reflow Profile

Figure 6 Soldering Reflow Profile

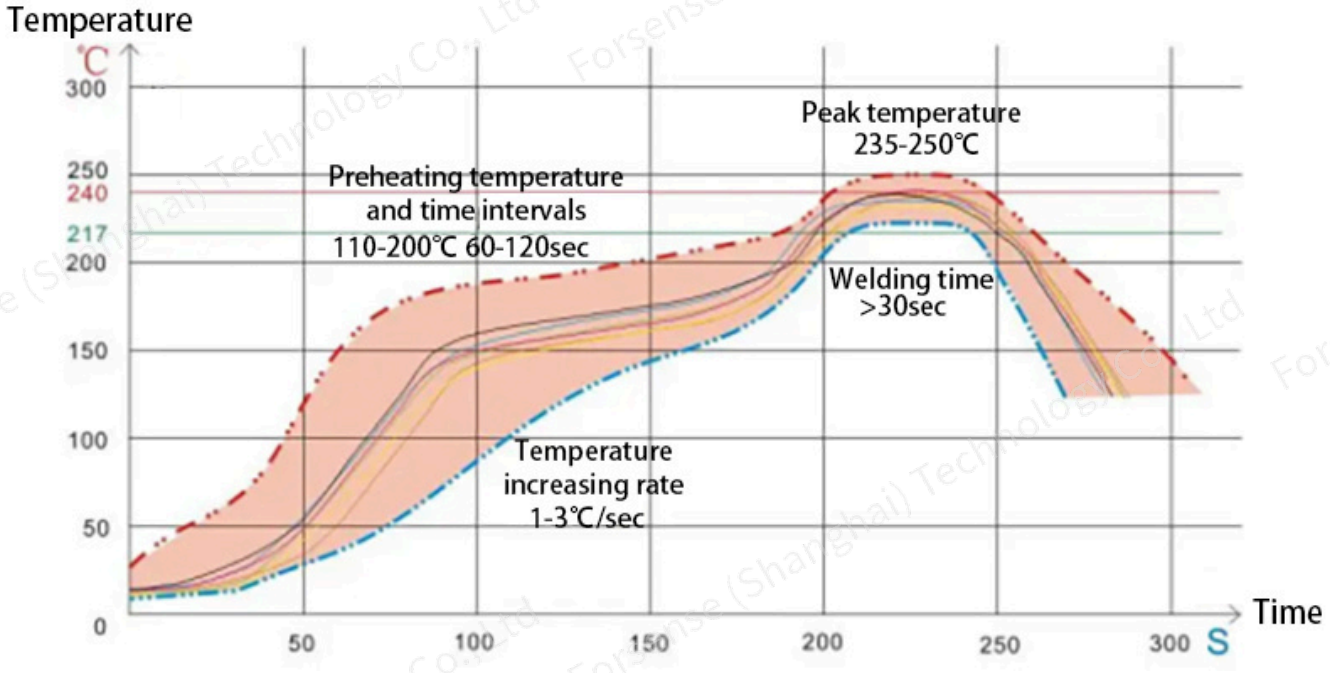


Table 7 Temperature Setting Modes

Item	Minimum Limit	Maximum Limit	Unit
Maximum Temperature Ramp Rate (Target = 0.8) (Time interval for slope calculation = 60 s)	1	3	°/s
Maximum Temperature Drop Slope (Time interval for slope calculation = 60 s)	-3	-1	°/s
Preheat Temperature and Time Interval	60	120	s
Reflow Time (Duration Above 217°C)	40	70	s
Maximum Temperature	235	250	°C
Max Reflow Count		1	times

For more SMT-related information about the module, refer to the document《Forsense-LCC Module_SMT Application Guide》.

Notes:

- For module soldering reflow, it is recommended to use eight temperature zones or higher-grade reflow soldering equipment;
- Since the module is a high-precision sensor product, it is sensitive to any deformation:
- If the PCB thickness is less than 1.0 mm, it is recommended to fabricate reflow fixture to prevent PCB deformation at high temperatures, which may affect the coplanarity of the soldering.
- It is recommended that customers select high-TG value materials for the main PCB to avoid deformation during high-temperature reflow, which can cause warping, compression, cold joints, and solder bridging defects.
- Due to sensitive components inside the module, the maximum temperature of the customer's reflow oven must not exceed 260 °C (referring to the top package temperature measured on the package surface).
- It is recommended to use lead-free no-clean solder paste. Recommended solder paste brands and models: Alpha OM-338 SAC305 Sn96.5Ag3.0Cu0.5
- Due to sensitive components inside the module, secondary reflow should be avoided to prevent degradation of module performance;
- Cooling:
- Controlled cooling ramp rate prevents adverse soldering effects (such as brittle joints) and internal mechanical stress. Controlled cooling helps achieve a shiny solder surface with fine crystal grains and low contact angles, while avoiding shielding can warping caused by rapid temperature drops.
- Visual Inspection:
- After module soldering, inspect solder quality using X-ray and optical magnification methods, in accordance with IPC-A-610F standards.
- **When soldering with an electric iron, control the temperature between 260°C and 290°C, limit each soldering session to no more than 3 s, and ensure proper ESD protection;**

6. ESD Protection

Figure 7 ESD Protection



Electrostatic discharge causes intermittent or permanent circuit damage, posing significant risks to electronic products; analysis indicates that most cases are due to ESD damage;

Therefore, electrostatic protection for the module is particularly important. Production and transportation processes must strictly follow electrostatic protection procedures and adhere to the following conditions:

- Do not touch the module with bare hands, especially at Pin.
- Equipment such as SMT placement machines, workbenches, and soldering irons must be grounded.
- Operators must wear anti-static wrist straps with good grounding wires (cordless static straps are prohibited; anti-static gloves are recommended).
- Packaging and PCBs must be made of qualified anti-static materials.

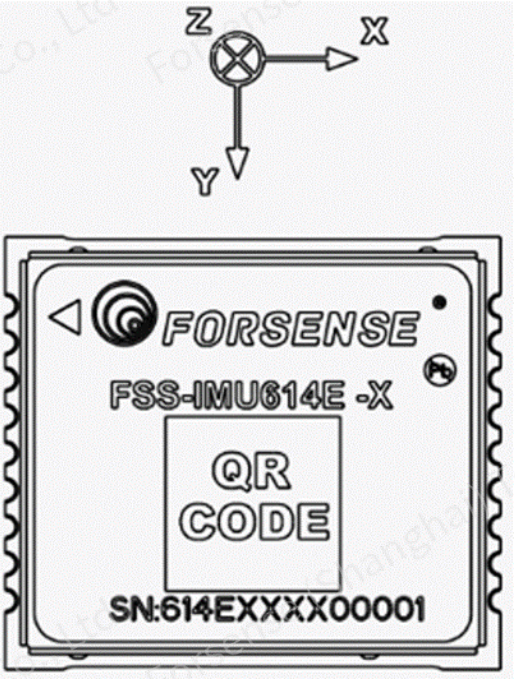
7. Communication Protocols

Reference Document: Forsense IMU Communication Protocols（en）

Includes Serial Port/SPI/CAN communication protocols, coordinate system settings, filter settings, Parameter settings, OTA update methods, time synchronization, etc.

8. Coordinate System Definition

Figure8 Coordinate System Definition



This product uses the Front-Right-Down (FRD) coordinate system. The Euler angle ranges are as follows:

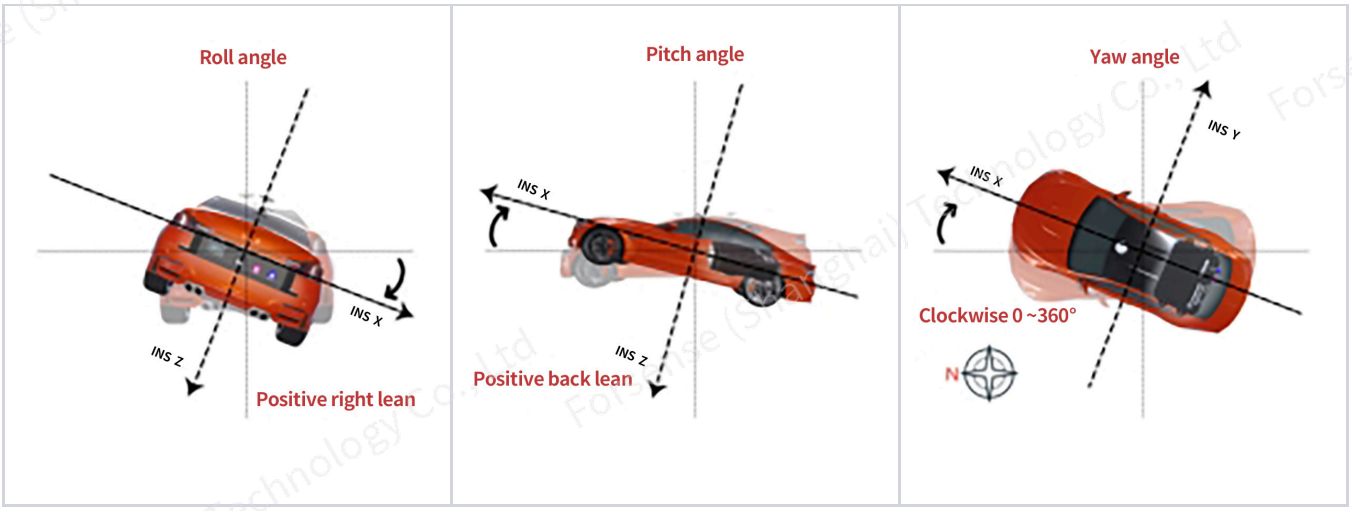
Rotation about the Z-axis: Yaw angle Yaw range: 0° ~360°

Rotation about the X-axis: Roll angle Roll range: -180°~180°

Rotation about the Y-axis: Pitch angle Pitch range: -90°~90°

The schematic diagram of Roll, Pitch, and Yaw angle is shown below:

Figure 9 Roll, Pitch, and Yaw angle Diagram


Roll angle
INS X
INS Z
Positive right lean
Pitch angle
INS X
INS Z
Positive back lean
Yaw angle
INS Y
INS X
Clockwise 0 ~360°
N

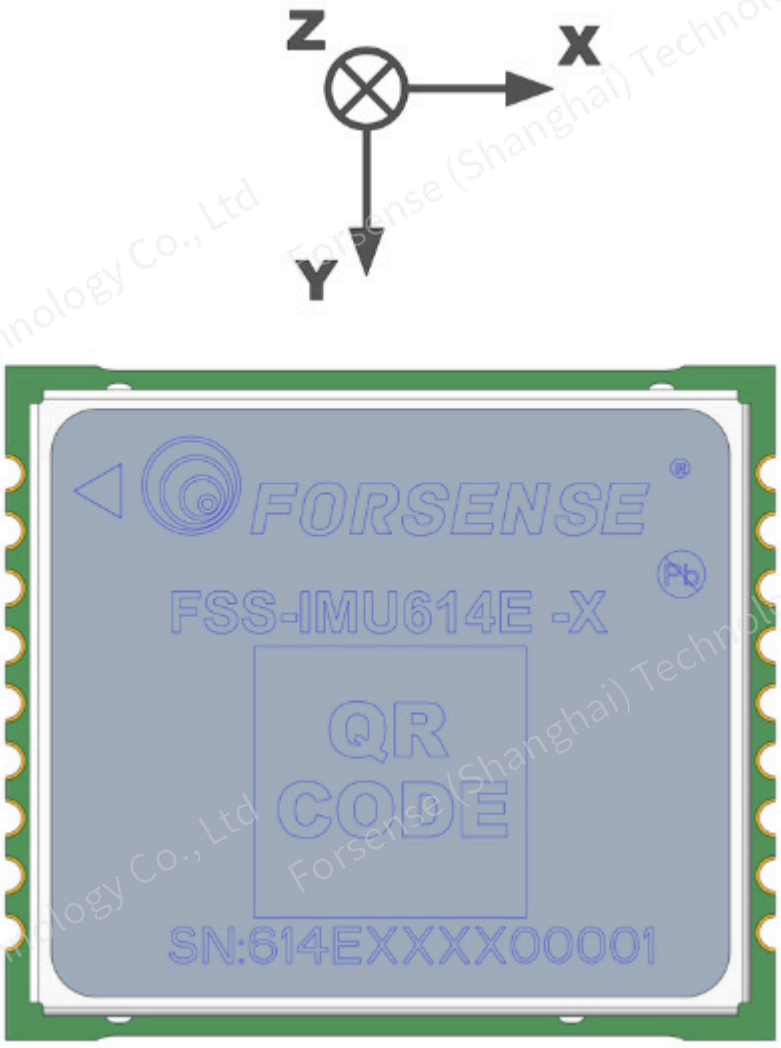
9. Usage Example

9.1 Device Installation

1. The module shall be securely fixed to a rigid plane and avoid installation in locations with significant vibration.

2. The module's installation orientation shall align with the vehicle's forward direction.

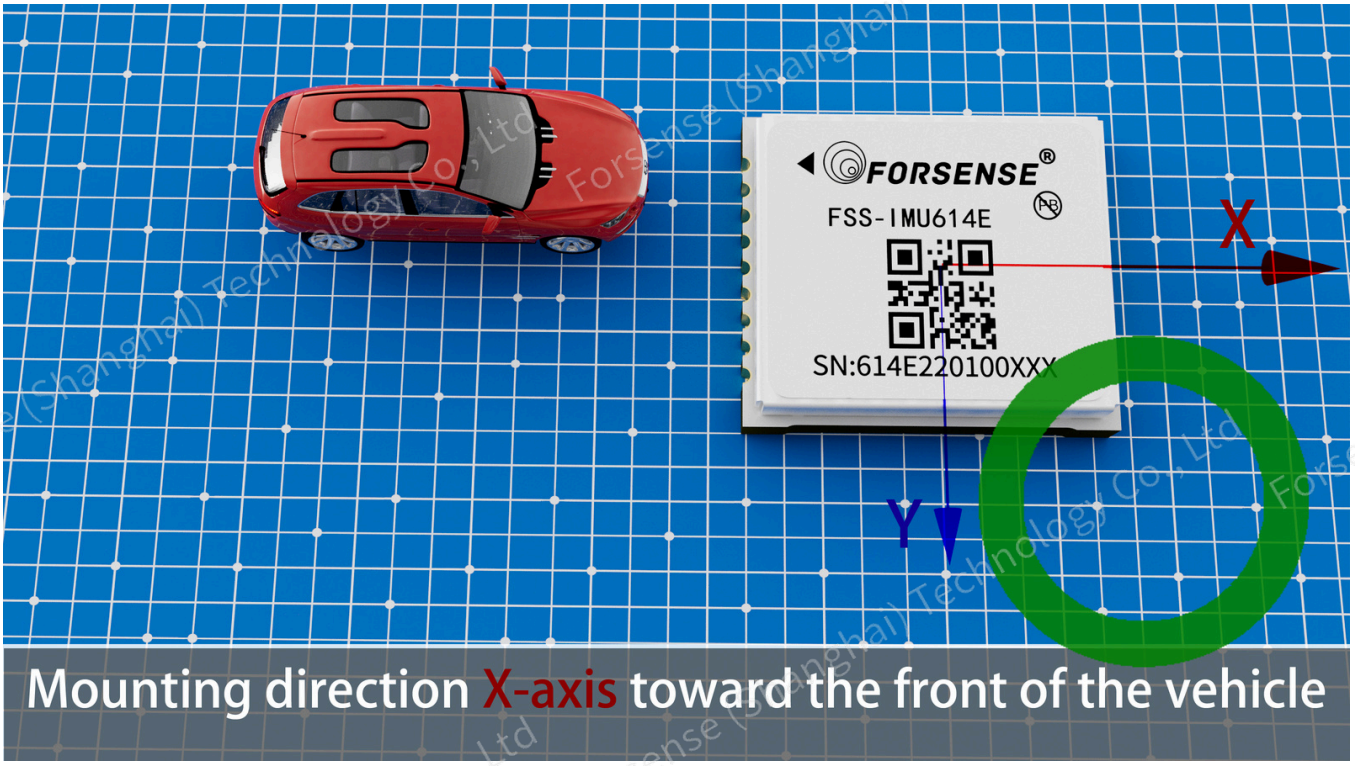
Figure10 Module Installation Diagram



The correct installation diagram is shown below

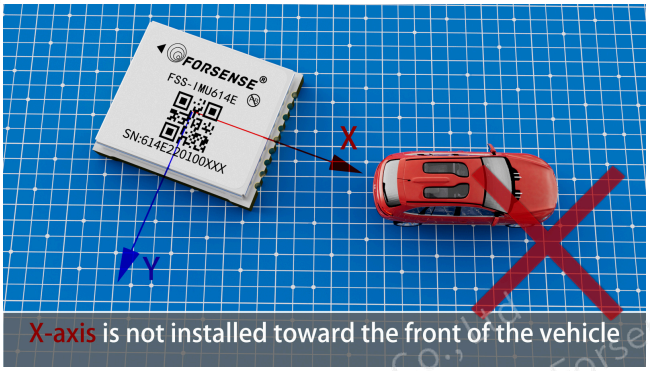
X-axis points toward the front of the vehicle

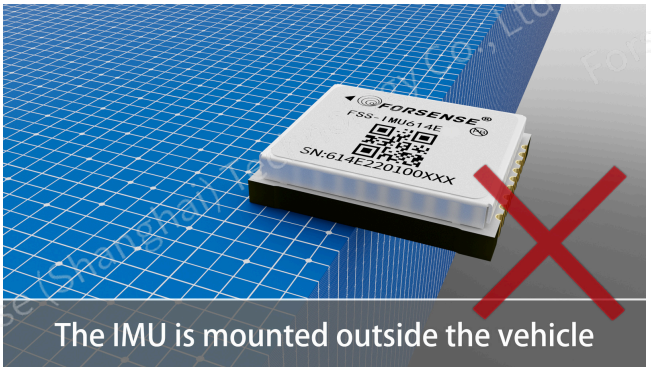
Figure 11 Correct Installation Diagram

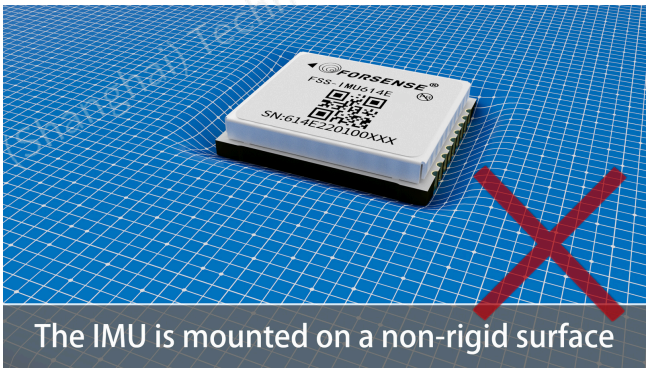


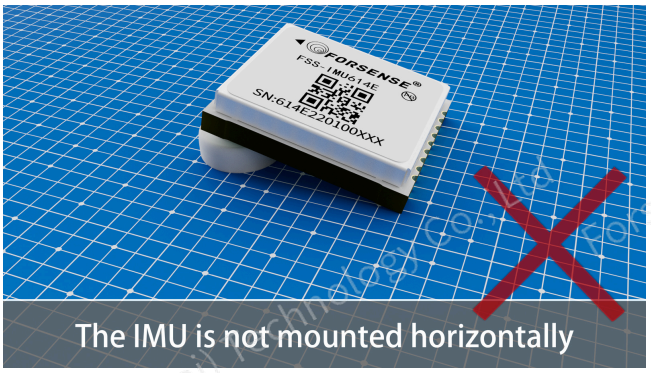
The following installation methods are all incorrect.

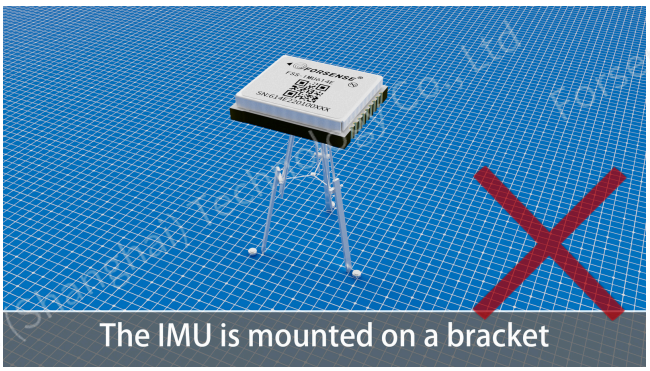
Figure12 Incorrect Installation Diagram









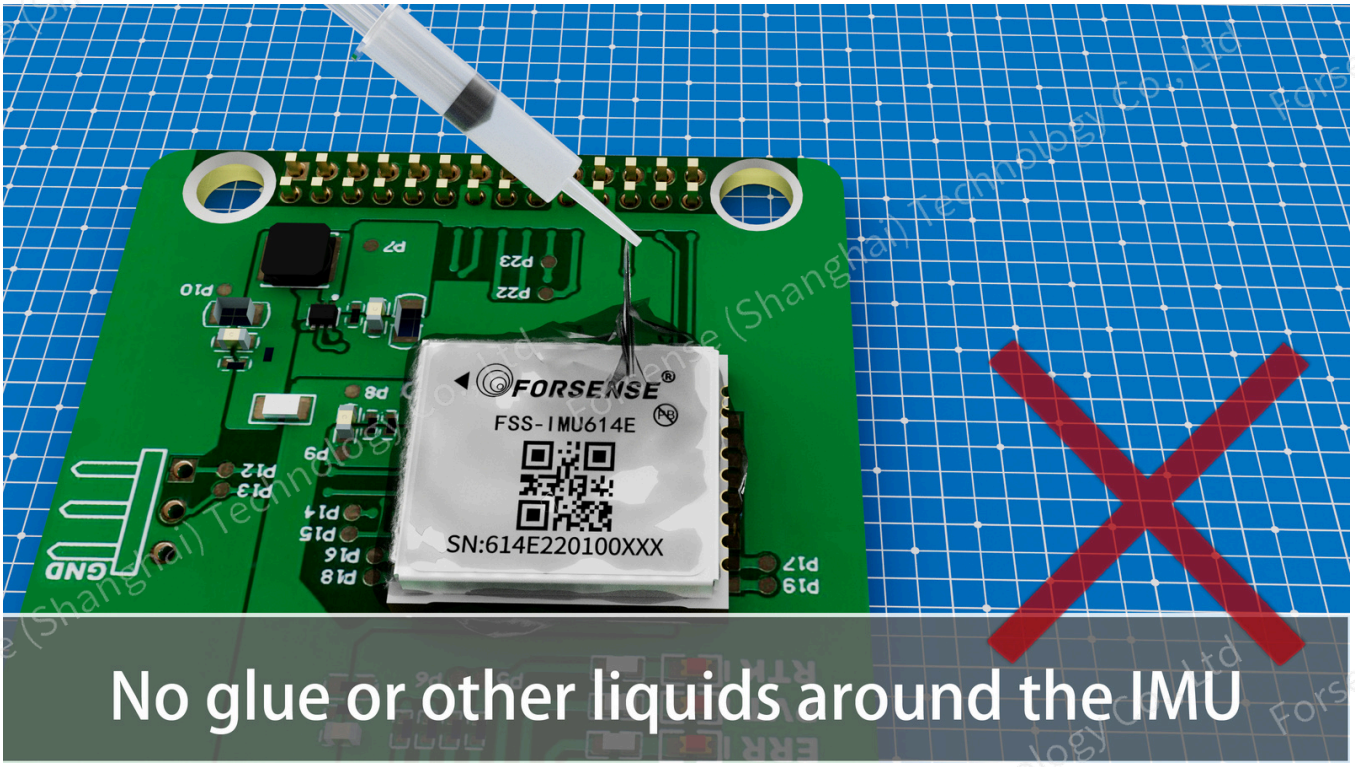




3. IMU Installation Precautions

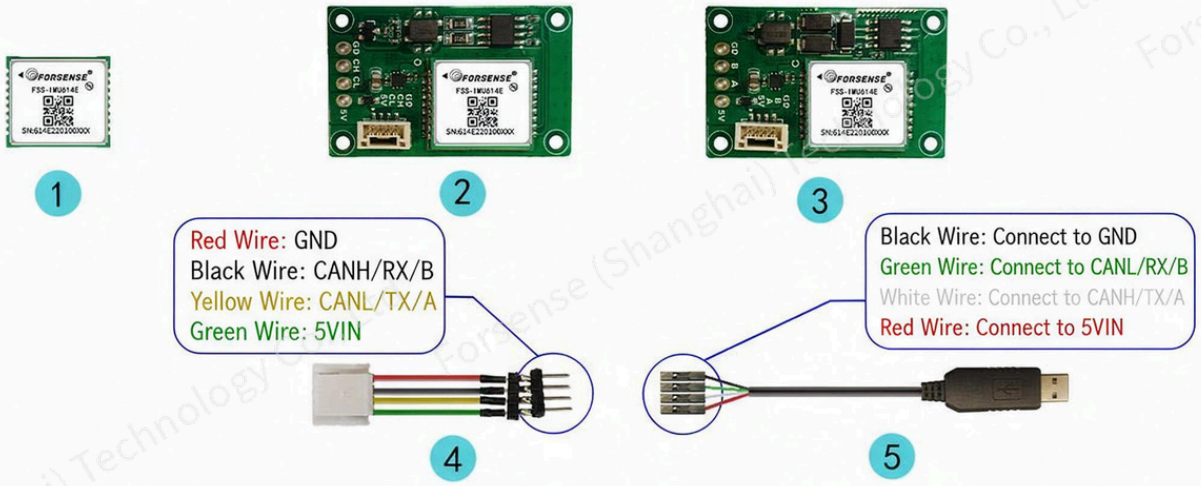
Do not apply adhesive or other flowing liquids around the IMU to prevent liquid from seeping into the IMU through gaps and affecting its performance.

Figure 13 Incorrect Installation Diagram



9.2 Connection PC software Example

Figure 14 Module Connection PC software Diagram



	Name	Quantity
1	IMU614E Series Module	1 pc
	Accessory Name	Quantity
2	SMD CAN Version Test Base Plate	1 pc
3	SMD 485 Version Test Base Plate	1 pc
4	4-PIN Header	1 pc
5	TTL Serial Port Cable	1 pc

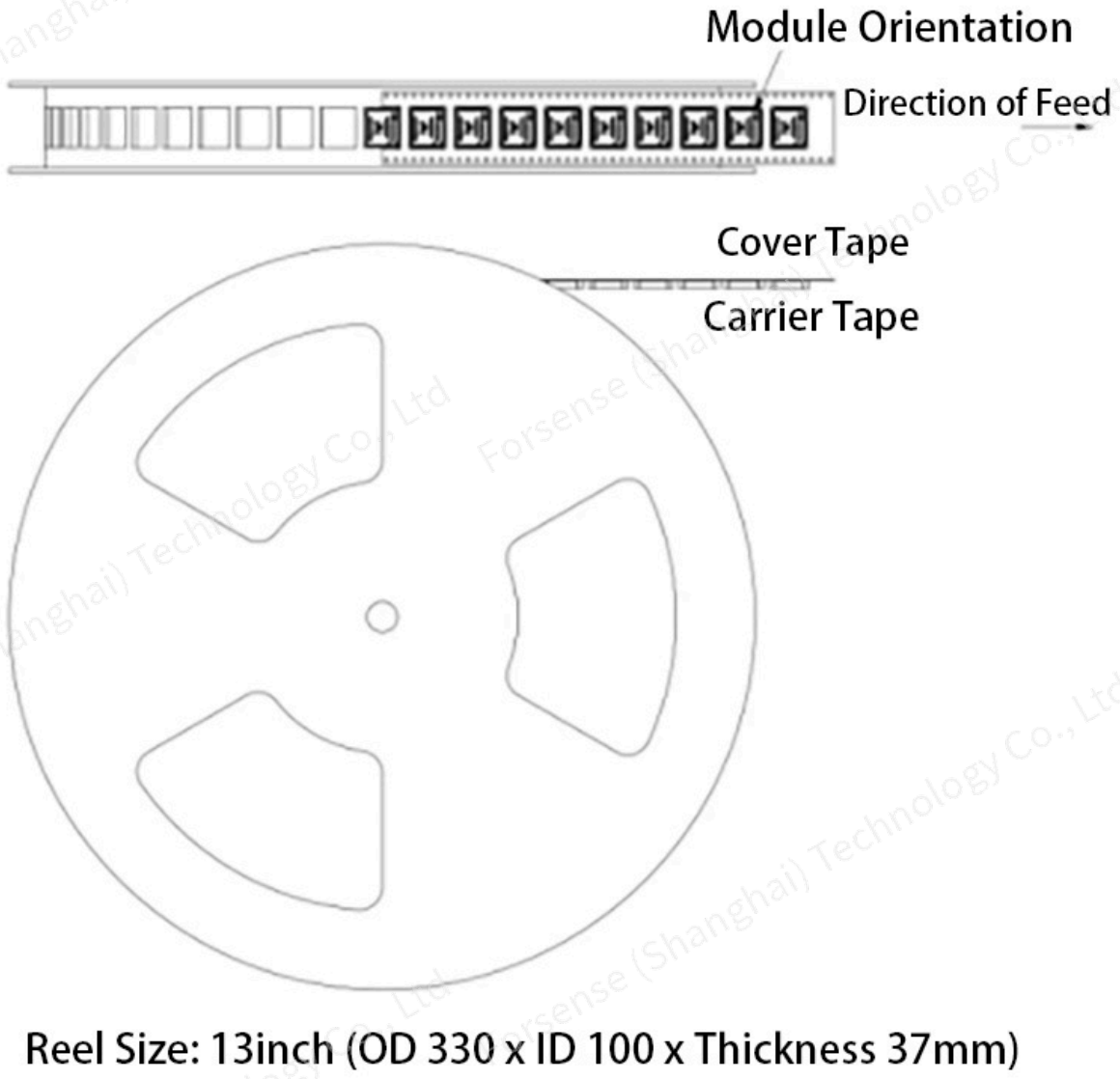
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10. Packaging

The IMU614E-C module uses tape-and-reel sealed packaging to meet high-efficiency production requirements.

10.1 Tape-and-Reel Packaging

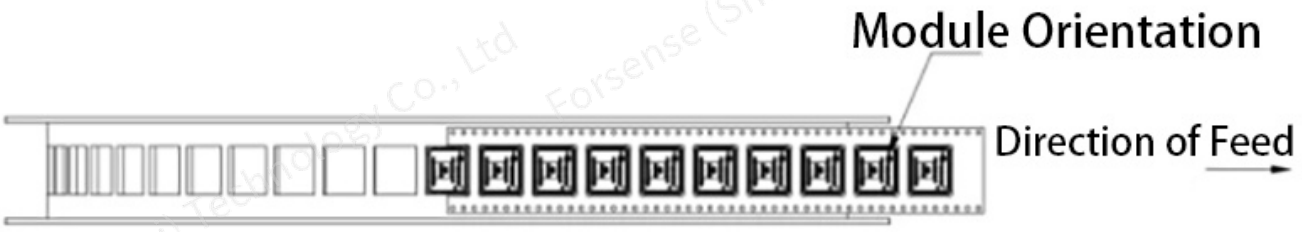
Figure 15 Tape-and-Reel Packaging Diagram



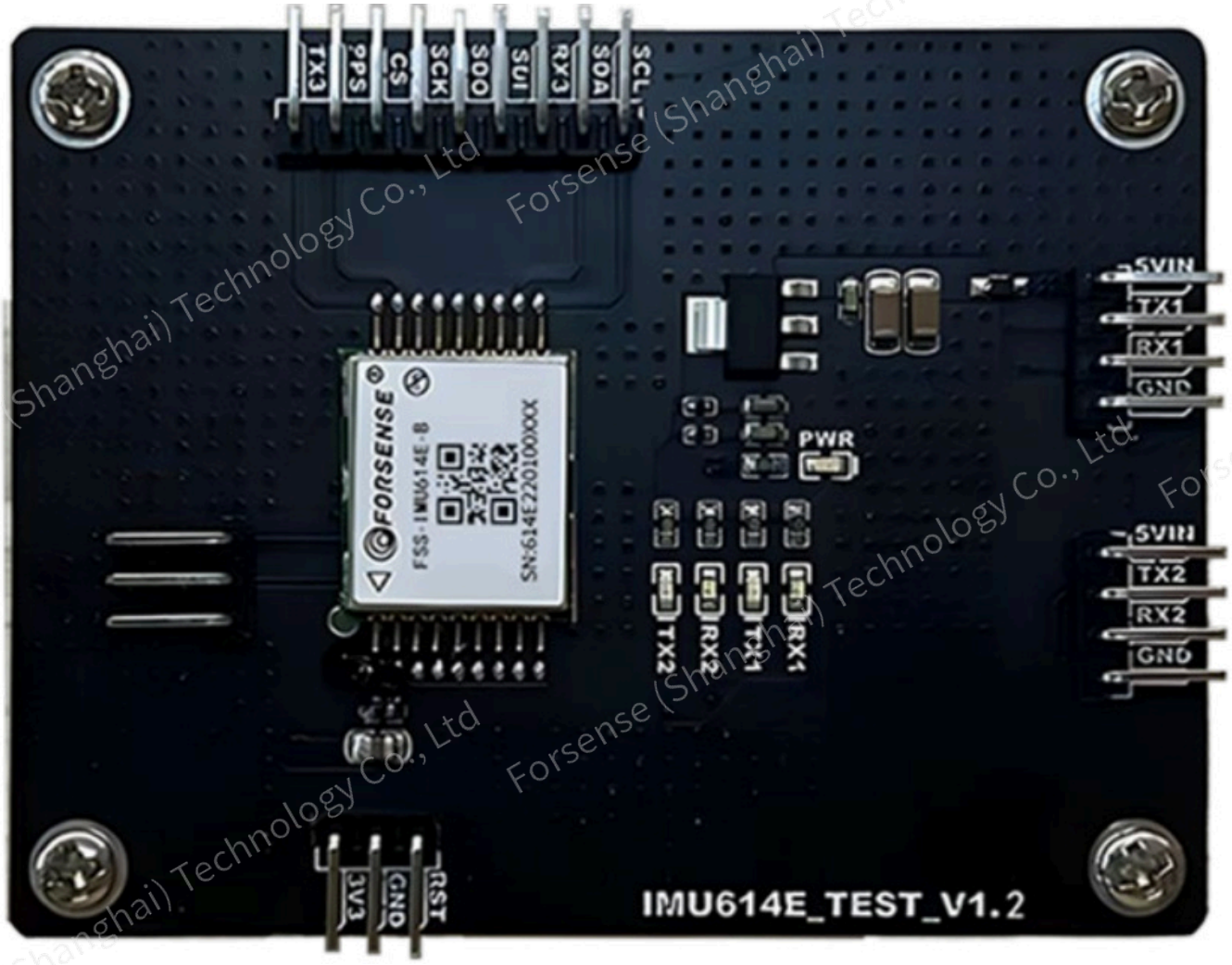
10.2 carrier tape

The position and orientation of the IMU614E-C module as placed on the carrier tape at factory shipment are shown in the figure below:

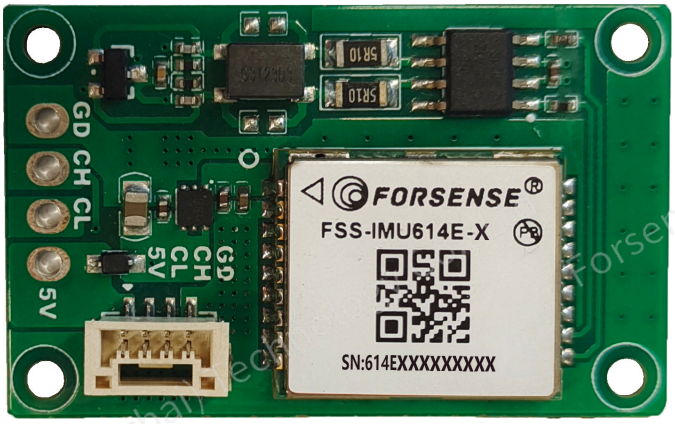
Figure16 Module Position and Orientation in carrier tape

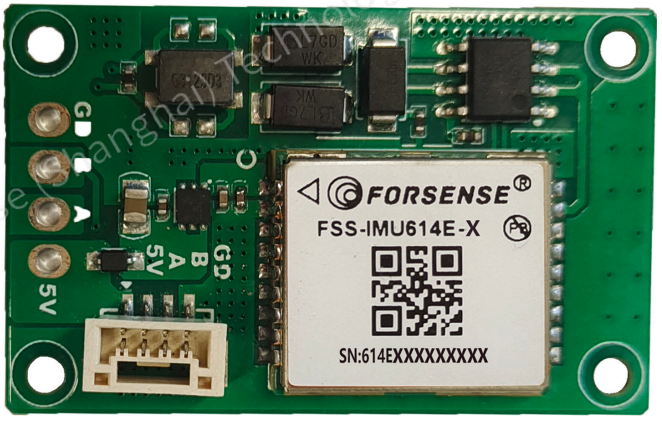


11. Optional Accessories



IMU614E-X Test Base Plate





SMD CAN Version IMU614E Series SMD RS-485 Version IMU614E Series





USB to CAN Module TTL Serial Port Cable

12. Revision History

Latest Manual Version: IMU614E-C_Datasheet_Product Manual(en)

Version	Date	Status/Notes
Version 1.0	2024.01.03	Initial Release
Version 1.1	2024.02.04	Updated Electrical Characteristics
Version 1.2	2024.02.27	Updated Reflow Soldering Profile and ESD Protection Guidelines
Version 1.3	2024.03.26	Updated Pin Definition
Version 1.4	2024.05.10	Added PC software Connection Diagram
Version 1.5	2024.09.05	Added time synchronization steps
Version 1.6	2025.01.23	Adjusted table and figure numbering and section numbers
Version 1.7	2025.07.23	Updated gyroscope Accelerometer performance specifications and Power Consumption
Version 1.8	2025.08.01	Simplified communication protocol
Version 1.9	2025.12.03	Updated Outline Dimensions Diagram
Version 1.10	2025.12.24	Removed TTL Test Base Plate
Version 1.11	2026.2.10	Updated "Base Plate testing for the SMD CAN version IMU614E series","Base Plate testing for the SMD RS-485 version IMU614E series", "Recommended Pad Dimensions"