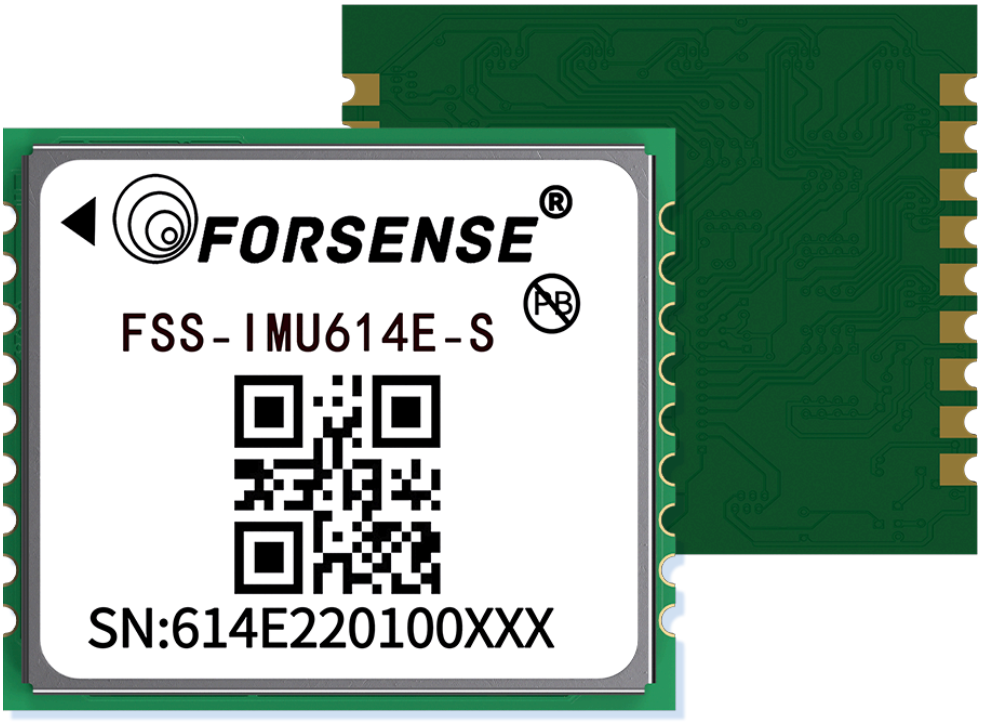
FORSENSE
原极科技

Tactical-grade MEMS 6-DOF inertial sensor

FSS-IMU614E-S

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-S-Product Manual(en)

Features

100% Domestically Produced

Tactical-Grade MEMS Gyroscope

- 2.5°/hr Bias instability
- 0.3°/√hr Angle Random Walk

Tactical-Grade MEMS Accelerometer

- 20μg Bias instability
- 0.04m/s /√hr Velocity Random Walk

independent rotary table calibration

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

High-Intensity Operating Condition Tolerance

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

Real-Time and Flexible Digital Interface, Compact Size

- Configurable Output Sampling Rate up to 1kHz
- Supports Serial Port, I2C, and SPI Interfaces
- 14.7*17*3.3mm,Weight Only 1.6g

Product Overview

IMU614E-S is a 6 degrees of freedom (DOF) MEMS inertial sensor module developed by Forsense Technology, featuring standard output of tri-axis Gyroscope and acceleration data. This IMU adopts**a fully domestically produced solution**. Whether it is the sensors, processors, or software algorithms, all use**domestically produced solutions**.

High precision and high resolution capture subtle vibrations and tilts. All modules undergo rotary table calibration before shipment to ensure stable performance under extreme conditions and consistent product specifications.

Application Areas

Yes**Domestic Sourcing Requirements** IMU application scenarios, for example:

- Attitude and Heading Reference System (AHRS) and Attitude and Heading Reference System (AHRS)
- Platform Stabilization System
- Industrial Robots

In addition to standard performance and output Parameter, Forsense also provides**customized software and LOGO customization services**, helping you succeed with your products!

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1. Performance Parameter

1.1 Key Metrics of Gyroscope

Table 1Gyroscope Key Metrics

Parameter	Test Conditions/Remarks	Min Value	Typical Value	Max Value	Unit
Measurement Range			±500		°/s
Bias instability[1]	@25℃, Allan Variance, 1σ		2.5		°/hr
Bias stability	GJB, 10s Smoothing		10		°/hr
Bias Repeatability	GJB		50		°/hr
Resolution			0.0076		°/s
g-value Sensitivity			/		°/h/g
Misalignment between axes			0.02		deg
Internal low-pass cutoff frequency	Software Adjustable		34		Hz
ODR			100	1000	Hz
measure delay			7		ms
Bias over temperature	-40℃ ~ 85℃, ≤1℃/min @1σ		XZ: 0.1 Y: 0.3		°/s
Random Walk	@25℃, Allan Variance, 1σ		0.15		°/√hr
scale coefficient error			XY:4 Z:2		‰
scale factor nonlinear	@25℃		100		ppm

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

1.2 Accelerometer Key Metrics

Table 2 Accelerometer Key Metrics

Parameter	Test Conditions/Remarks	Min Value	Typical Value	Max Value	Unit
Measurement Range			±8		g
Bias instability[1]	@25℃, Allan Variance, 1σ		20		μg
Bias stability	GJB, 10s Smoothing		80		μg
Bias Repeatability	GJB		5		mg
Resolution			0.122		mg
Misalignment between axes			0.02		deg
Internal low-pass cutoff frequency	Software Adjustable		34		Hz
ODR			100	1000	Hz
measure delay			7		ms
Bias over temperature	-40℃ ~ 85℃, ≤1℃/min @1σ		xy:1.5 z:3		mg
Random Walk	@25℃, Allan Variance, 1σ		0.04		m/s/√hr
scale coefficient error			0.5		‰
scale factor nonlinear	@25℃		200		ppm

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

Figure 1 Gyroscope Allan Variance Typical Curve

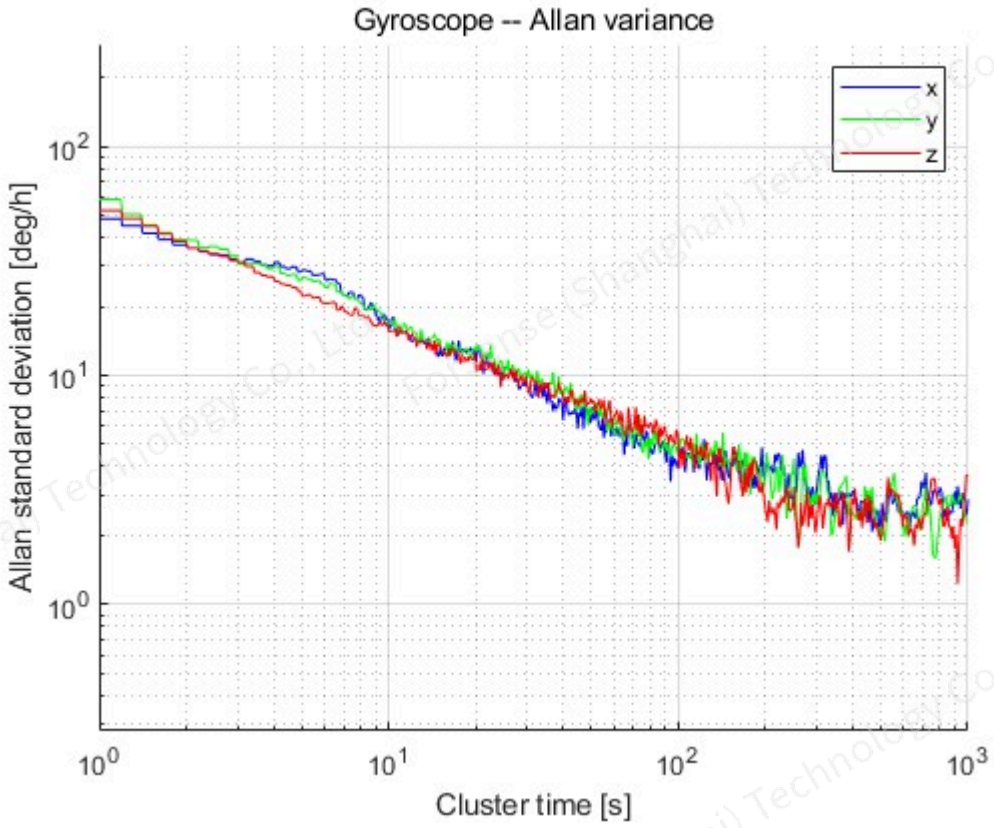
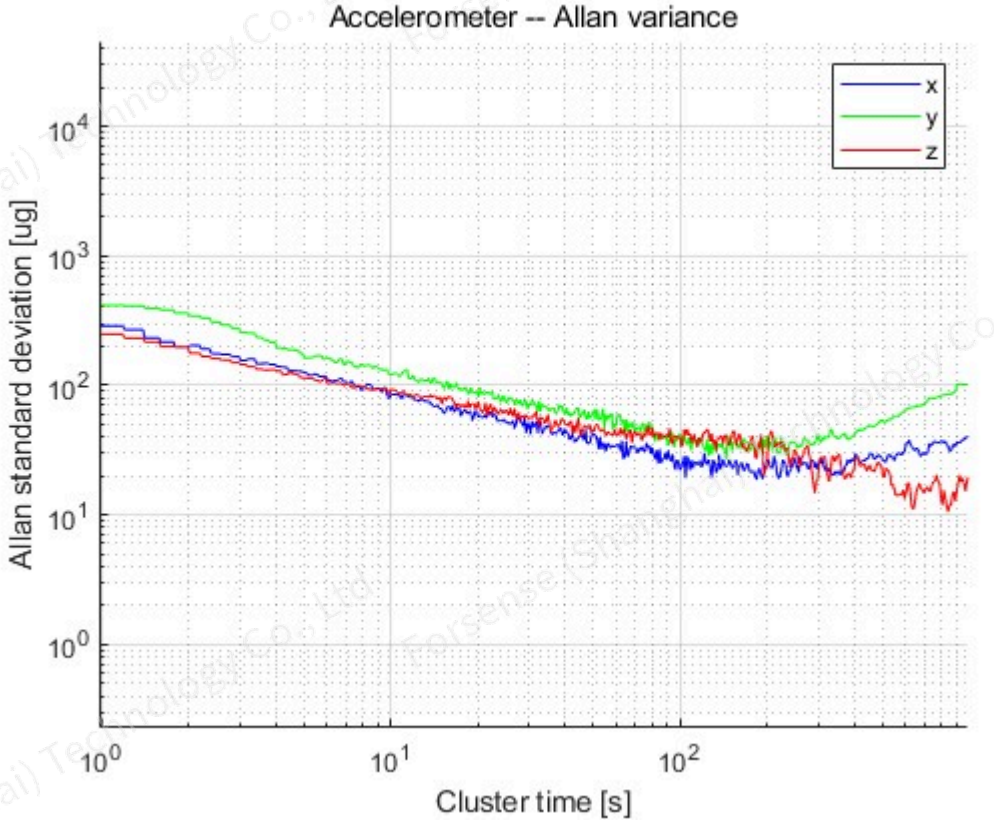
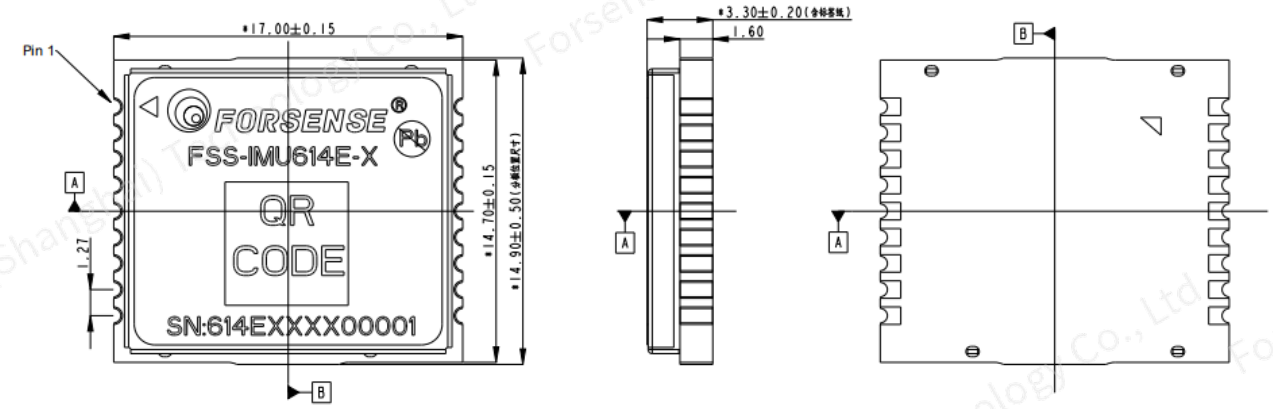


Figure 2 Accelerometer Allan Variance Typical Curve



2. Physical Structure

Figure 3 Outline Structure and Dimensions (Unit: mm)



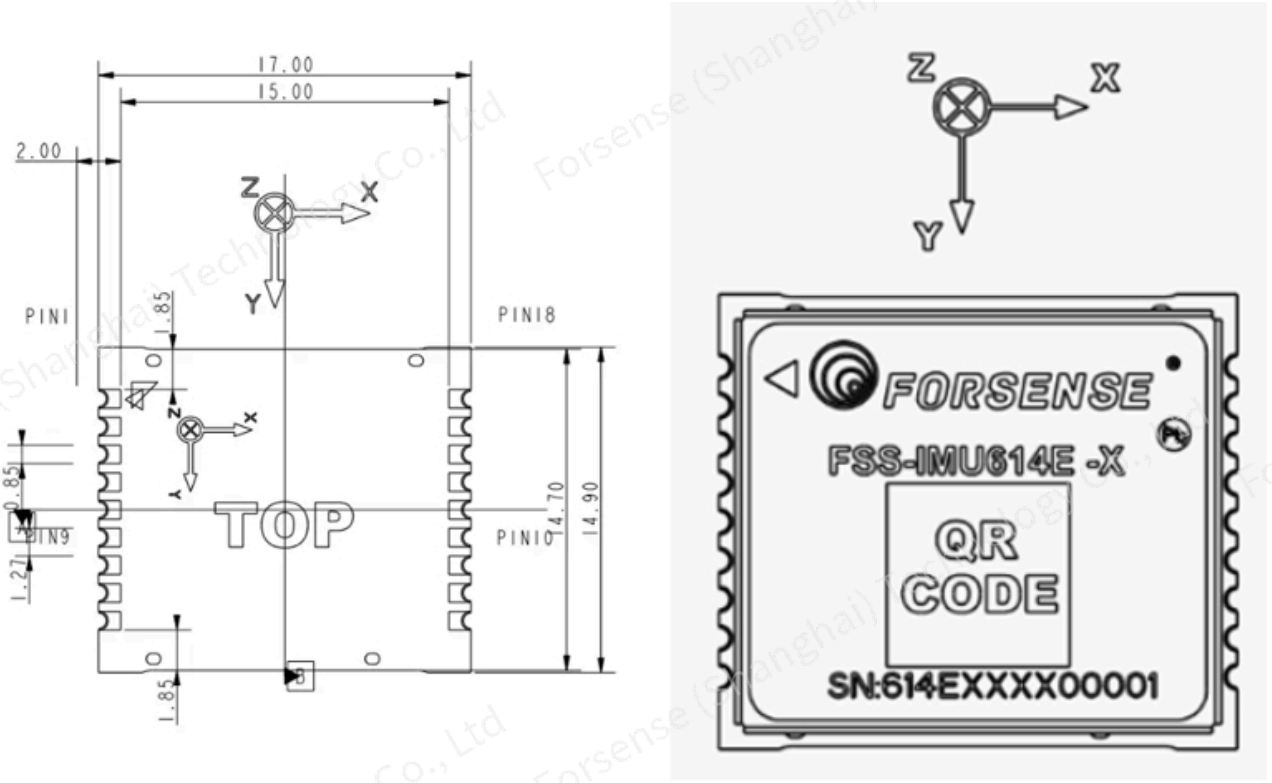
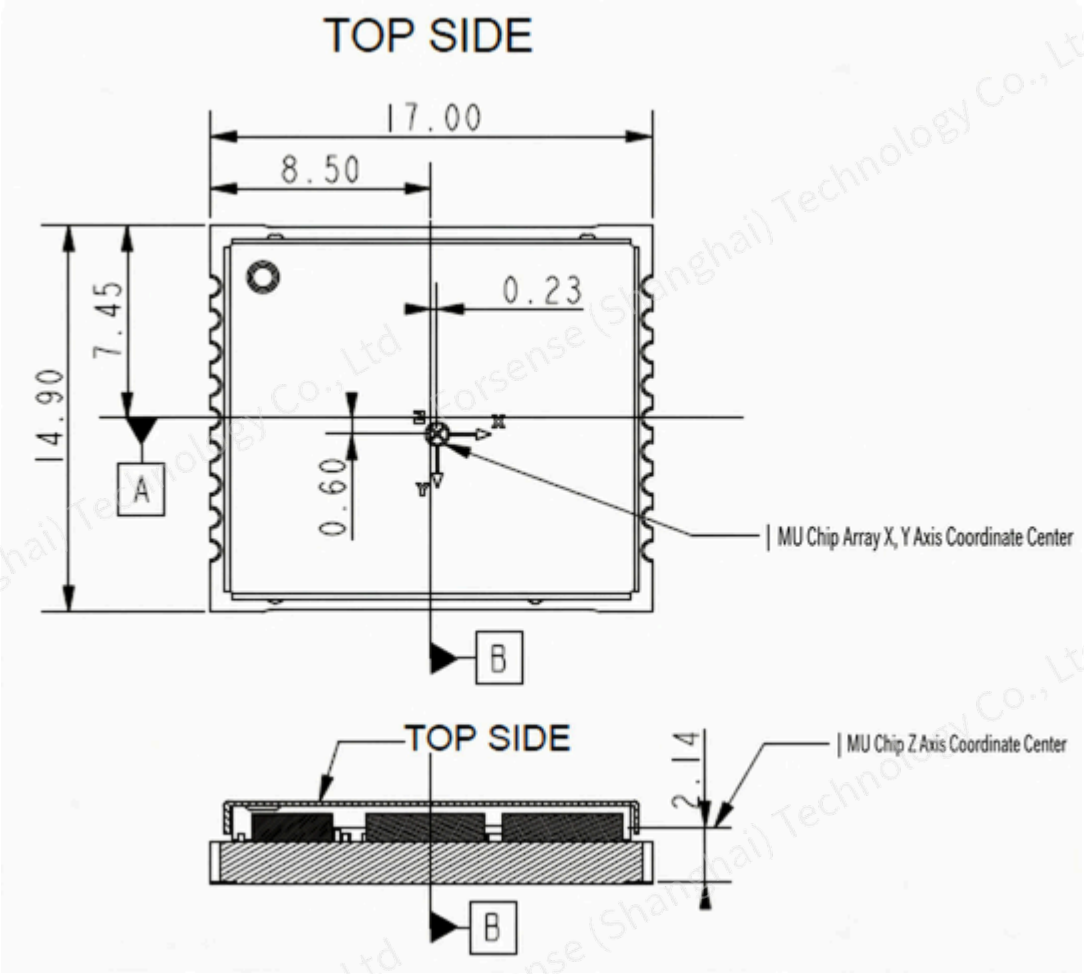


Figure 4 IMU Coordinate Center (Unit: mm)


TOP SIDE
17.00
8.50
7.45
14.90
0.23
0.60
A
B
MU Chip Array X, Y Axis Coordinate Center
TOP SIDE
2.14
MU Chip Z Axis Coordinate Center
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		0.12		W
Operating Temperature (Tot)	T	-40		85	℃
Storage Temperature (Tstg)	T	-40		85	℃

3.3 IO Threshold Characteristics

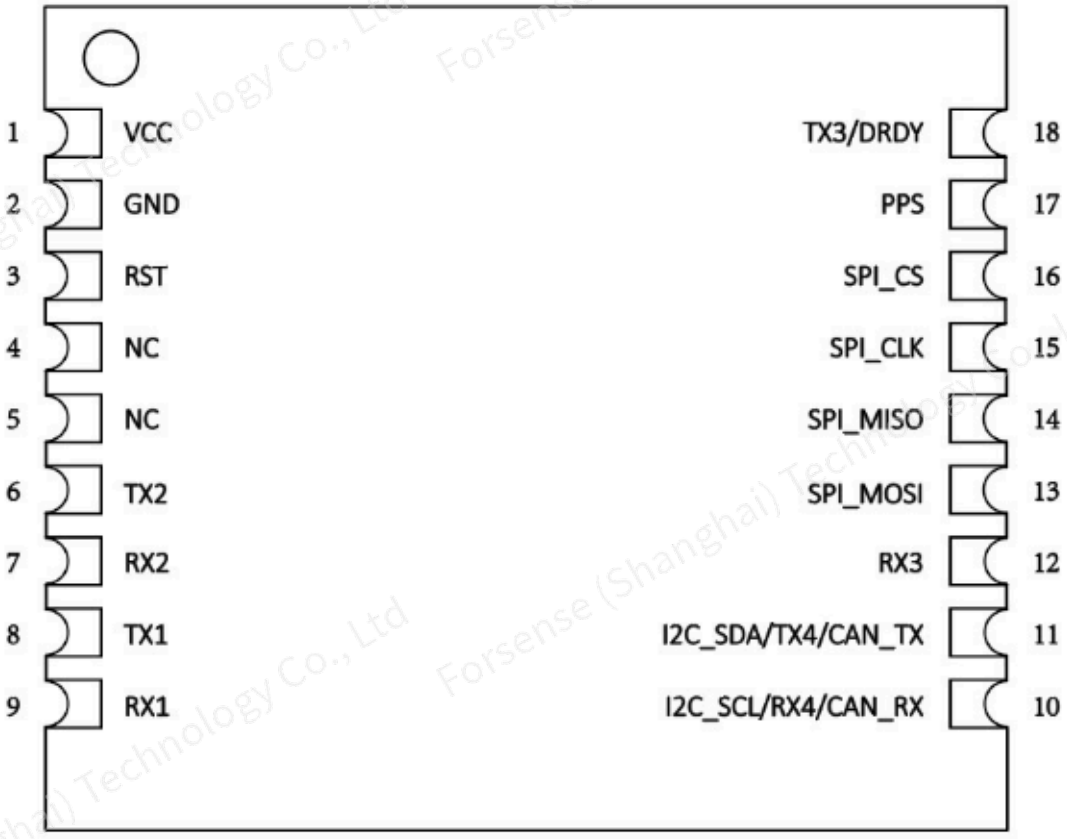
Table 5 IO Threshold Characteristics

Parameter	Symbol	Min	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

Figure 5 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 receives 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 Send 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 Perform a Hardware Reset of the IMU Once

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

5. Recommended Soldering Reflow Profile

Figure 6 Soldering Reflow Profile

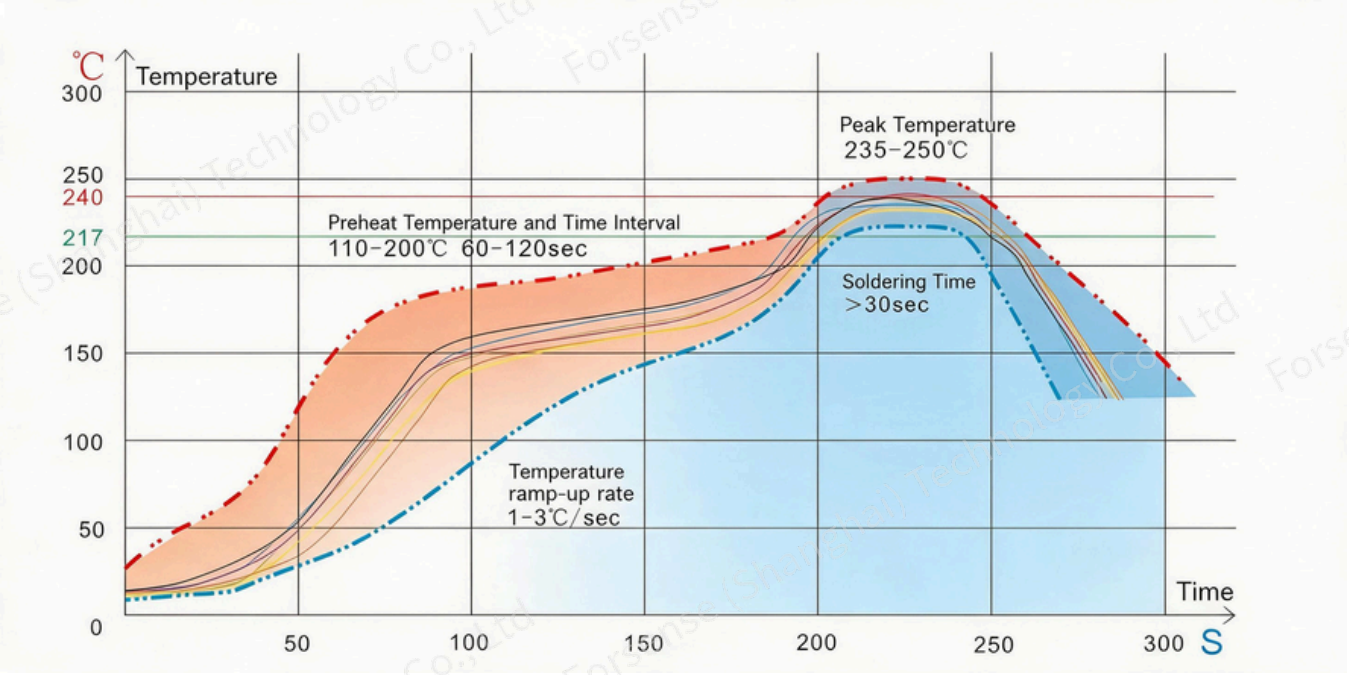


Table 7 Temperature Setting Modes

Item	Lower Limit	Upper 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 reflow soldering, it is recommended to use eight temperature zones or higher 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 PCB mainboards with high TG values to avoid deformation during high-temperature reflow, which can cause warping, compression, cold joints, and solder bridging.
- 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 brand and model: Alpha OM-338 SAC305 Sn96.5Ag3.0Cu0.5
- Due to sensitive components inside the module, secondary reflow should be avoided to prevent performance degradation;
- Cooling:
- Controlled cooling ramp rate prevents adverse soldering effects (such as brittle joints) and internal mechanical stress. Controlled cooling helps achieve bright solder surfaces, 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. Refer to the IPC-A-610F standard for specific requirements.
- **When soldering with a soldering iron, control the temperature between 260°C and 290°C, limit each soldering duration 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 and poses significant risks to electronic products. Analysis indicates that most failures are due to ESD damage;

Therefore, electrostatic protection for the module is critical. Production and transportation must strictly follow ESD protection procedures, adhering 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 anti-static wrist straps are prohibited; anti-static gloves are recommended).
- Packaging and PCBs must be made of qualified anti-static materials.

7. Communication Protocol

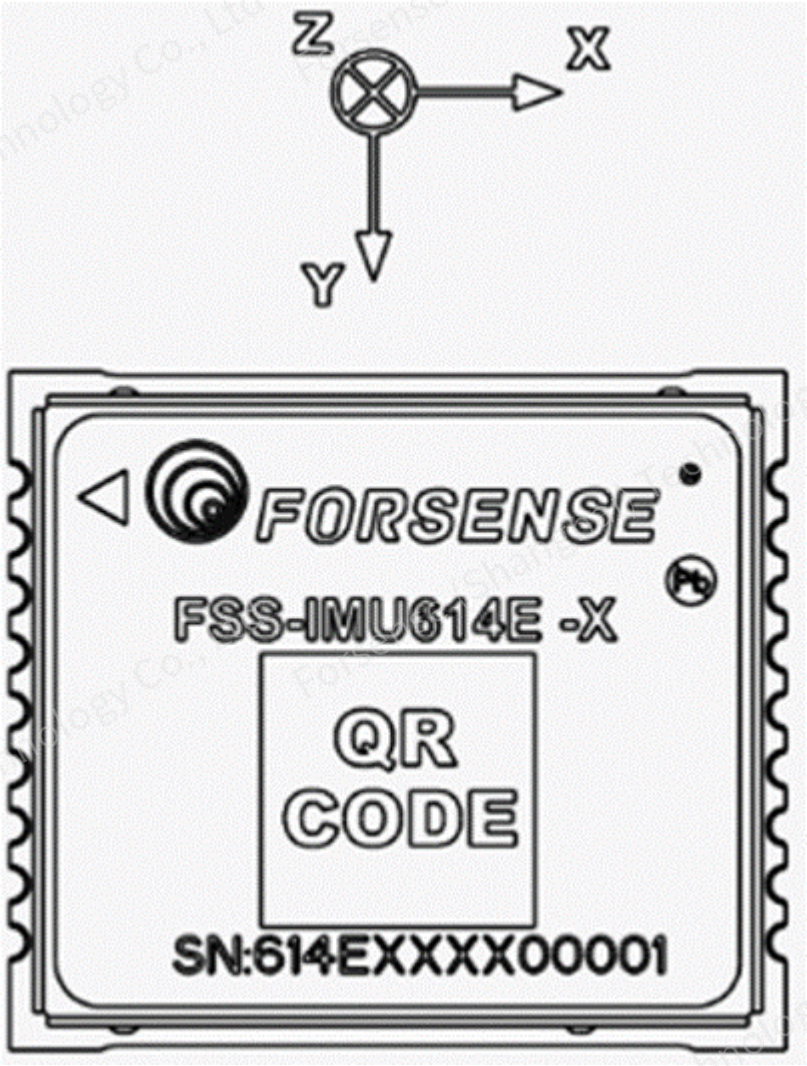
Reference Document Forsense IMU Communication Protocols（en）

Includes serial communication protocols, coordinate system settings, filter settings, Parameter settings, OTA update methods, time synchronization, etc.

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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:

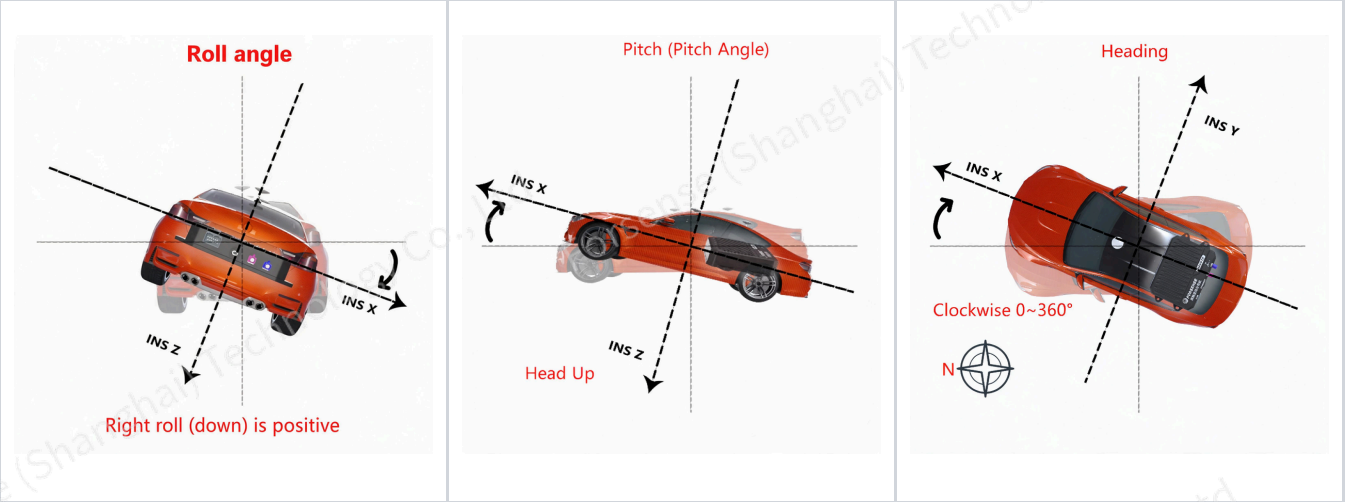
Rotation about the Z-axis: Yaw angle Yaw range: 0° ~ 360°

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, Yaw angle Schematic



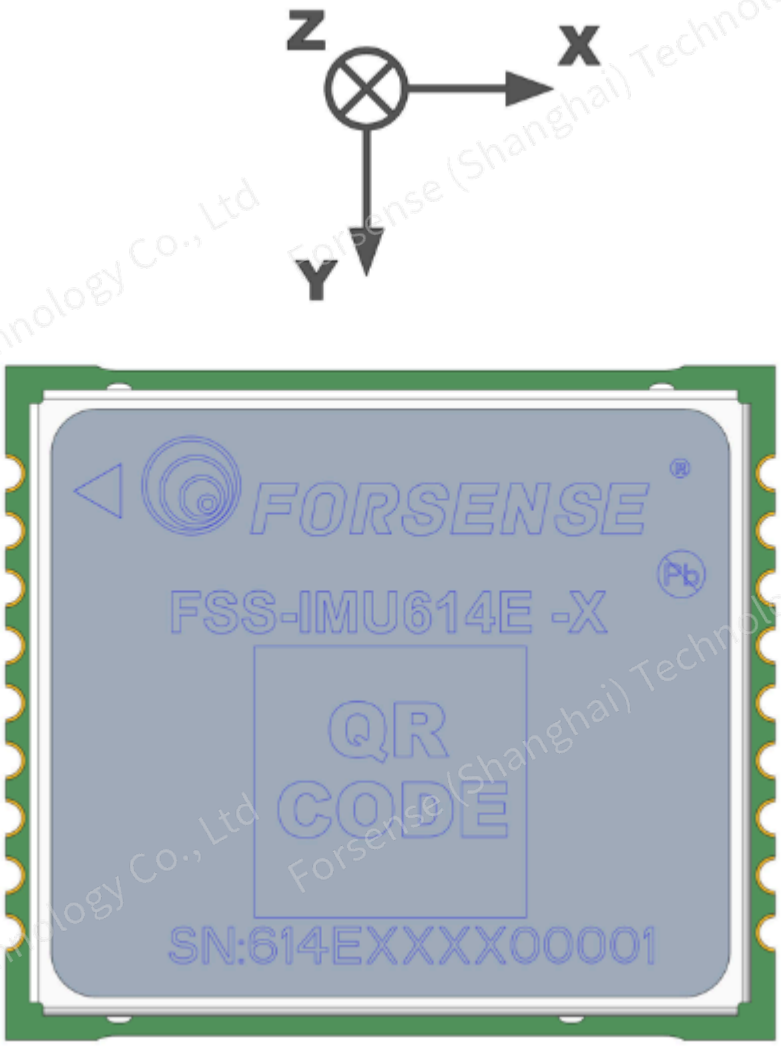
9. Usage Example

9.1 Device Installation

1. The module should be securely fixed to a rigid plane, avoiding installation in locations with high vibration.

2. The module installation orientation should be consistent with the vehicle's forward direction.

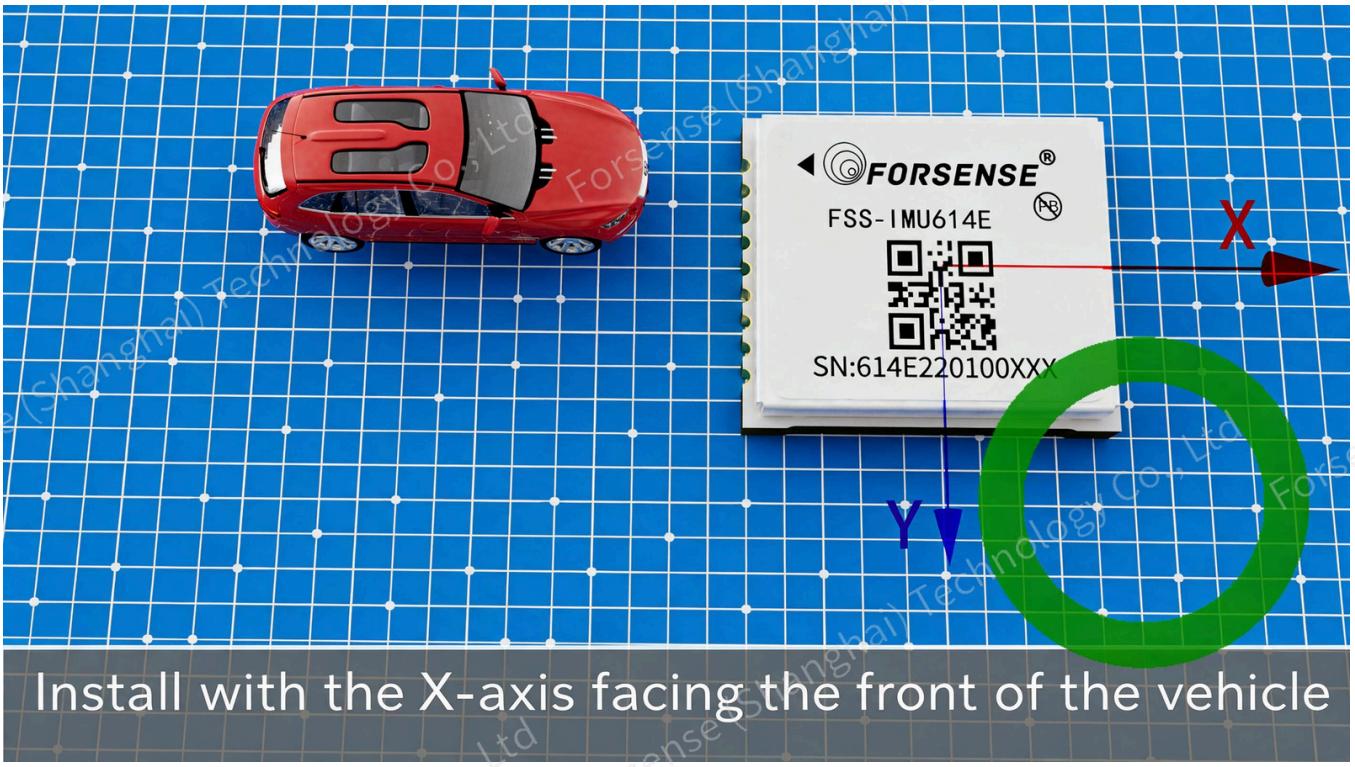
Figure10 Module Installation Diagram



The correct installation diagram is shown below

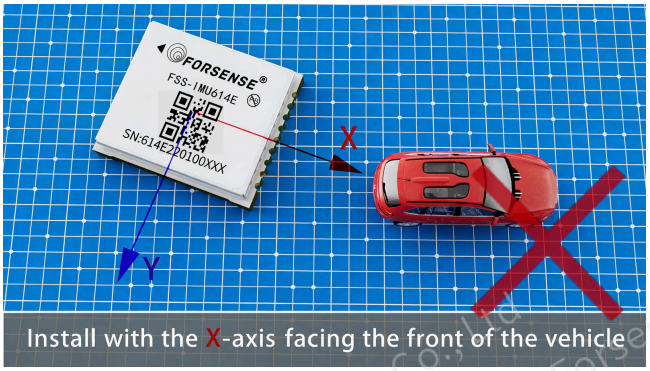
X-axis points toward the front of the vehicle

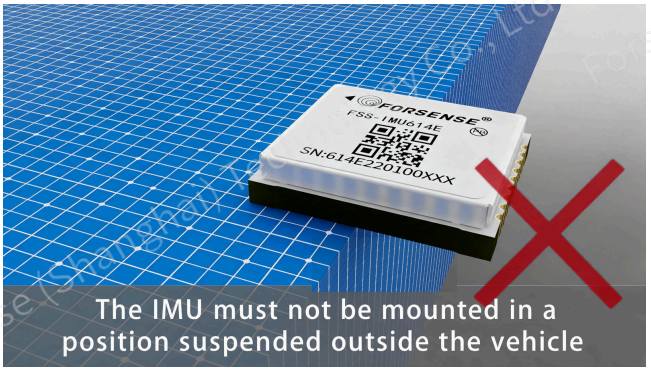
Figure 11 Correct Installation Schematic



The following installation methods are all incorrect.

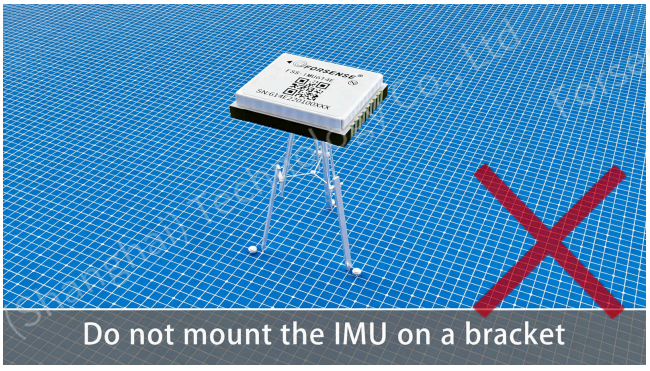
Figure 12 Incorrect Installation Diagram

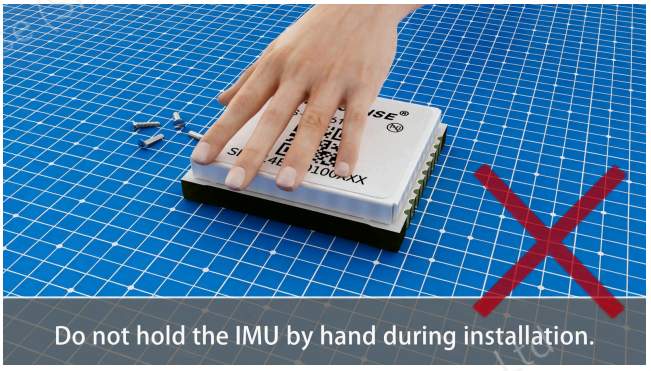












3. IMU Installation Precautions

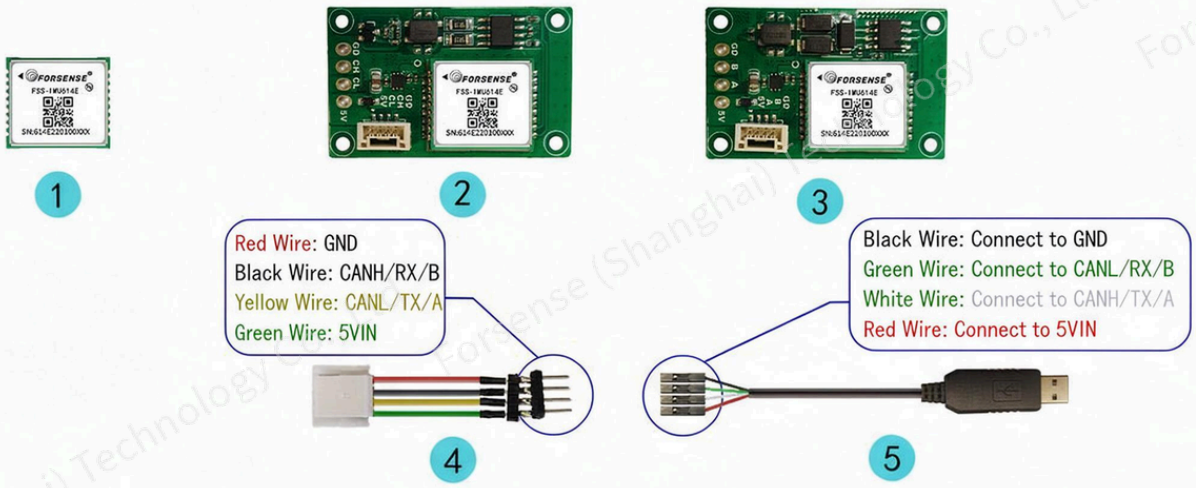
Do not apply adhesive or other flowing liquids around the IMU to prevent liquid from seeping into the IMU through gaps and affecting its performance.

Figure 13 Prohibited Installation Diagram



9.2 Connection PC software Example

Figure 14 Module Connection PC software Schematic



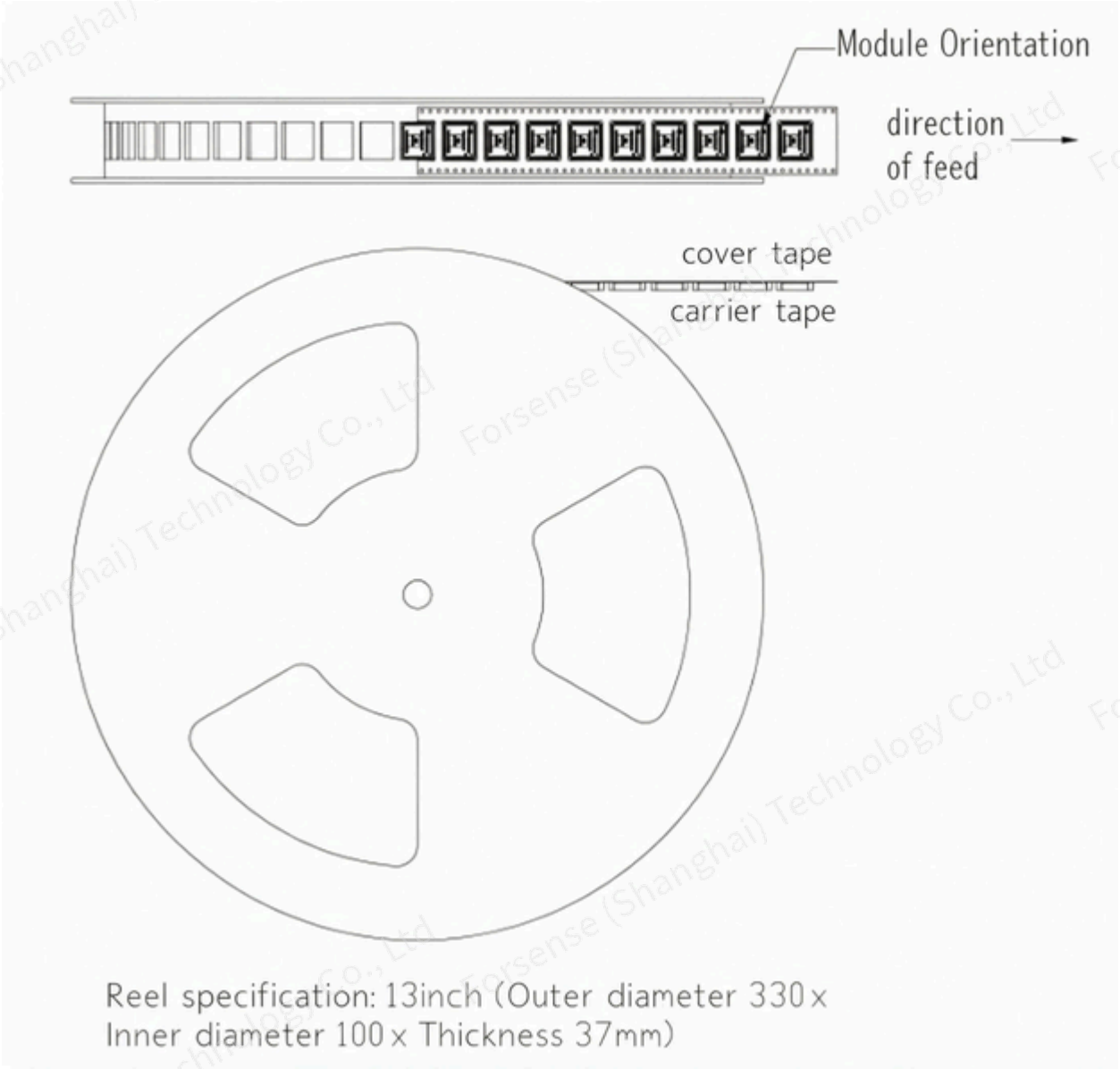
	Name	Quantity
1	IMU614E Series Module	1 pc
	Accessory Name	Quantity
2	SMD CAN Version Test Base Plate	1 pc
3	SMD 485 Version Test Base Plate	1 pc
4	4-PIN Connector	1 pc
5	TTL Serial Port Cable	1 pc

10. Packaging

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

10.1 Reel and Tape Packaging

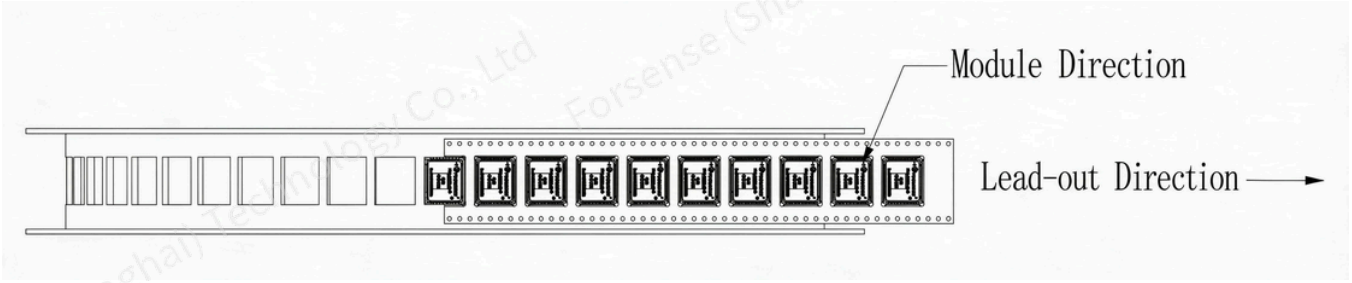
Figure 15Tape and Reel Packaging Schematic



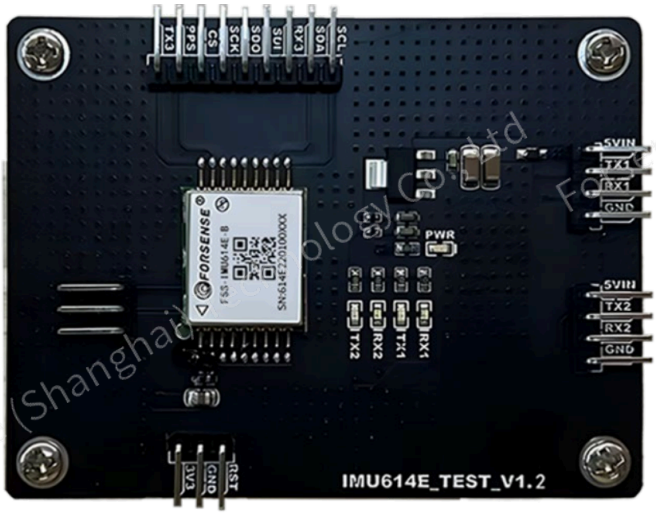
10.2 carrier tape

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

Figure16 Module Position and Orientation in carrier tape



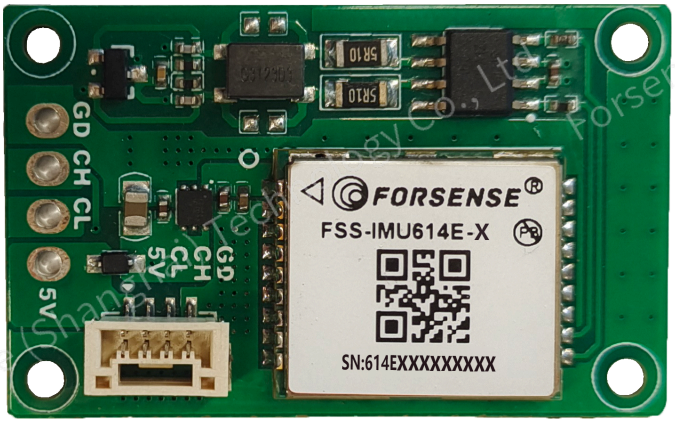
11. Optional Accessories



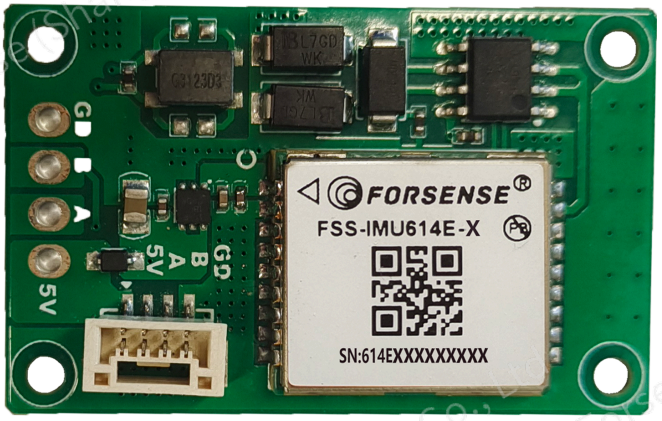
IMU614E-X Test Base Plate



IMU614E Series SMD TTL Version Test Base Plate



IMU614E Series SMD CAN Version Test Base Plate



IMU614E Series SMD RS-485 Version Test Base Plate



USB to CAN Module



TTL Serial Port Cable

12. Update Log

Latest Manual Version: IMU614E-S_Datasheet_Product Manual(en)

Version	Date	Status/Notes
Version 1.0	2024.08.21	First Edition
Version 1.1	2025.01.23	Adjusted Figure Order
Version 1.2	2025.08.01	Simplified Communication Protocol
Version 1.3	2025.12.10	Modified Label Size
Version 1.4	2026.2.10	UpdateIMU614E Series SMT CAN Version Base Plate Test","IMU614E Series SMT RS-485 Version Base Plate Test"