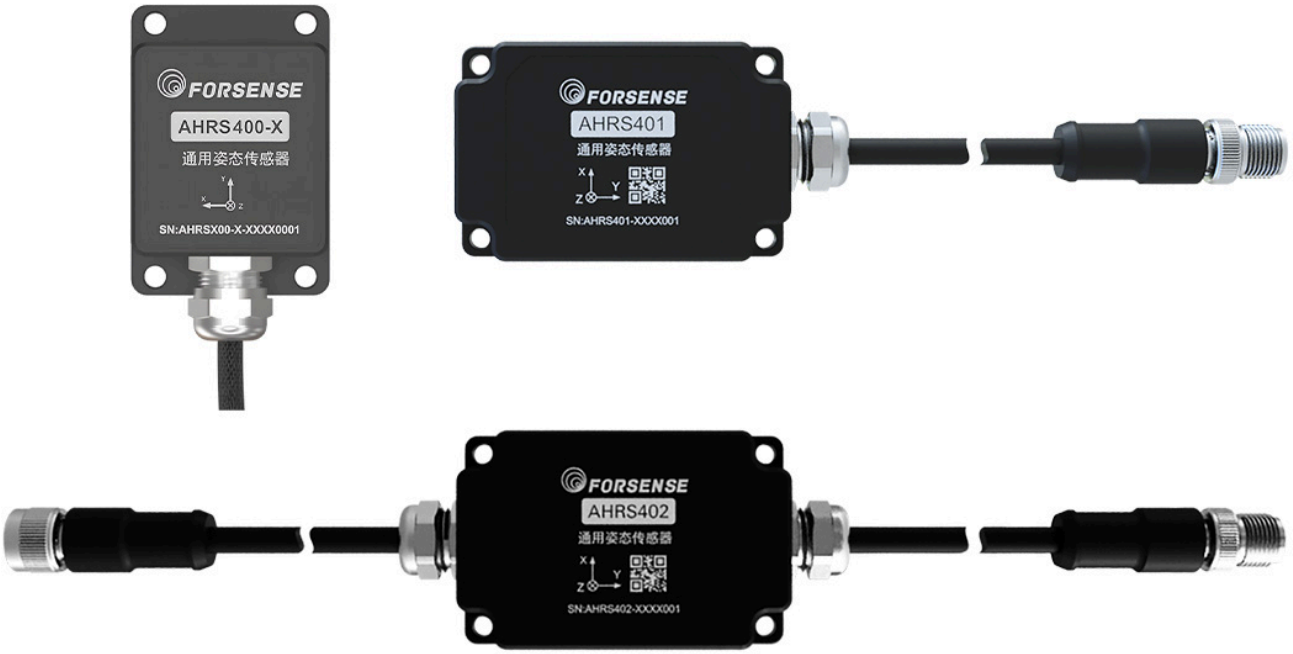
FORSENSE
原极科技

Dynamic inclination measurement module

AHRS40X

Product Sheet



Forsense (Shanghai) Technology Co., Ltd

Please read this user manual carefully before using this product.

FORSENSE
原极科技

Dynamic inclination measurement module

AHRS40x productsheet（en）

Tactical-Grade MEMS IMU

- 2.5°/h Gyroscope Bias instability
- 25μg Accelerometer Bias instability

Anti-Interference Dynamic Tilt Algorithm

- Resolution: 0.01°
- Low Dynamic accuracy < 0.4° @rms

independent rotary table calibration

- Independent Calibration of Each Module: Sensitivity, Bias, Misalignment

High-Intensity Operating Condition Tolerance

- Extreme Shock Resistance: 2000g (0.5ms, Half-Sine, 3-Axis)
- Extreme 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 Interface, Compact Size

- MaxUp to 1kHz Configurable Output Sample Rate
- Supports CAN Interface
- Supports RS-485 Interface
- Supports TTL Interface
- Supports RS-232 Interface

Product Overview

AHRS400 is a dynamic tilt measurement sensor launched by Forsense Technology based on an industrial-grade IMU platform for fields such as Construction Machinery and intelligent robots. All modules undergo fine-grained temperature compensation across an ultra-wide temperature range and independent calibration before shipment to ensure consistency and stability. The built-in attitude fusion algorithm based on Extended Kalman Filter effectively suppresses the impact of dynamic interference on Attitude Accuracy, ensuring the stability of Attitude Accuracy.

Application Fields

- Agricultural MachineryTilt Control
- Engineering Vehicle:Excavator,Unmanned Forklift,Modern Scaling Ladder
- Underwater Robot
- Static and Dynamic Tilt Monitoring, Vibration Monitoring

In addition to standard performance and Parameter output, Forsense also provides for your special needs**Customized Software and LOGO Customization Services**, helping you succeed with your products!



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1. Performance Parameter

AHRS400 product performance specifications are shown in Table 1 below:

Table 1 Performance Specifications

Sensor Performance	
Angle Measurement Range	Pitch angle:±80° Roll angle:±180°
Angle Repeatability	<0.03°[1]
Angular velocity Measurement Range	±450°/s ±2000°/s [2]
Resolution	0.01°
Dynamic accuracy	0.4°
Acceleration Measurement Range	±6g
Update Rate	See the table for details2 ModelDescription
Electrical Characteristics	
Voltage Input	5 V / 9-32 V [3]
Power Consumption	0.2-0.36W
Interface	CAN/RS-485/RS-232/TTL
Physical Characteristics(AHRS400-X)	
Connector Model	GX12 - 4-Pin (Male)
Product Dimensions	37.6*55*24mm
Waterproof Rating	IP68
Cable Length	40 cm (Built-in) + 50 cm (External)

Physical Characteristics (AHRS40X-A)	
Connector Model	M12 Aviation Connector 5 Pin (Male/Female)
Product Dimensions	**AHRS** 401 : 47*85*24mm **AHRS** 402 : 47*96.5*24mm
Waterproof Rating	IP68
Cable Length	40cm (Built-in) + 50cm (External)
Ambient Temperature	
Working Temperature	-40~85℃
Storage Temperature (Tstg)	-40~85℃

1 RMS error after subtracting installation misalignment angle in low-dynamic vehicle scenarios

2 Requires special firmware support

3 5V is a standalone voltage version

2. Model Description

Figure 1 Model Definition

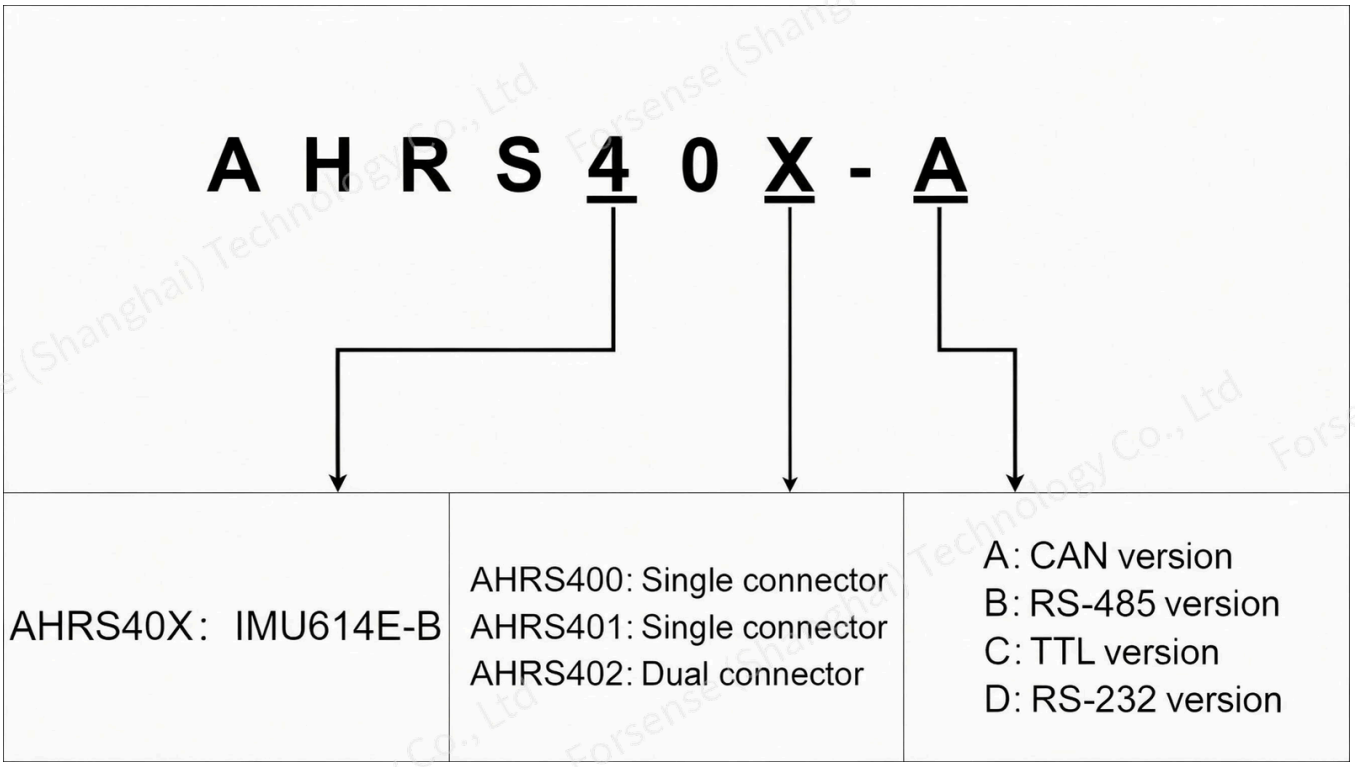
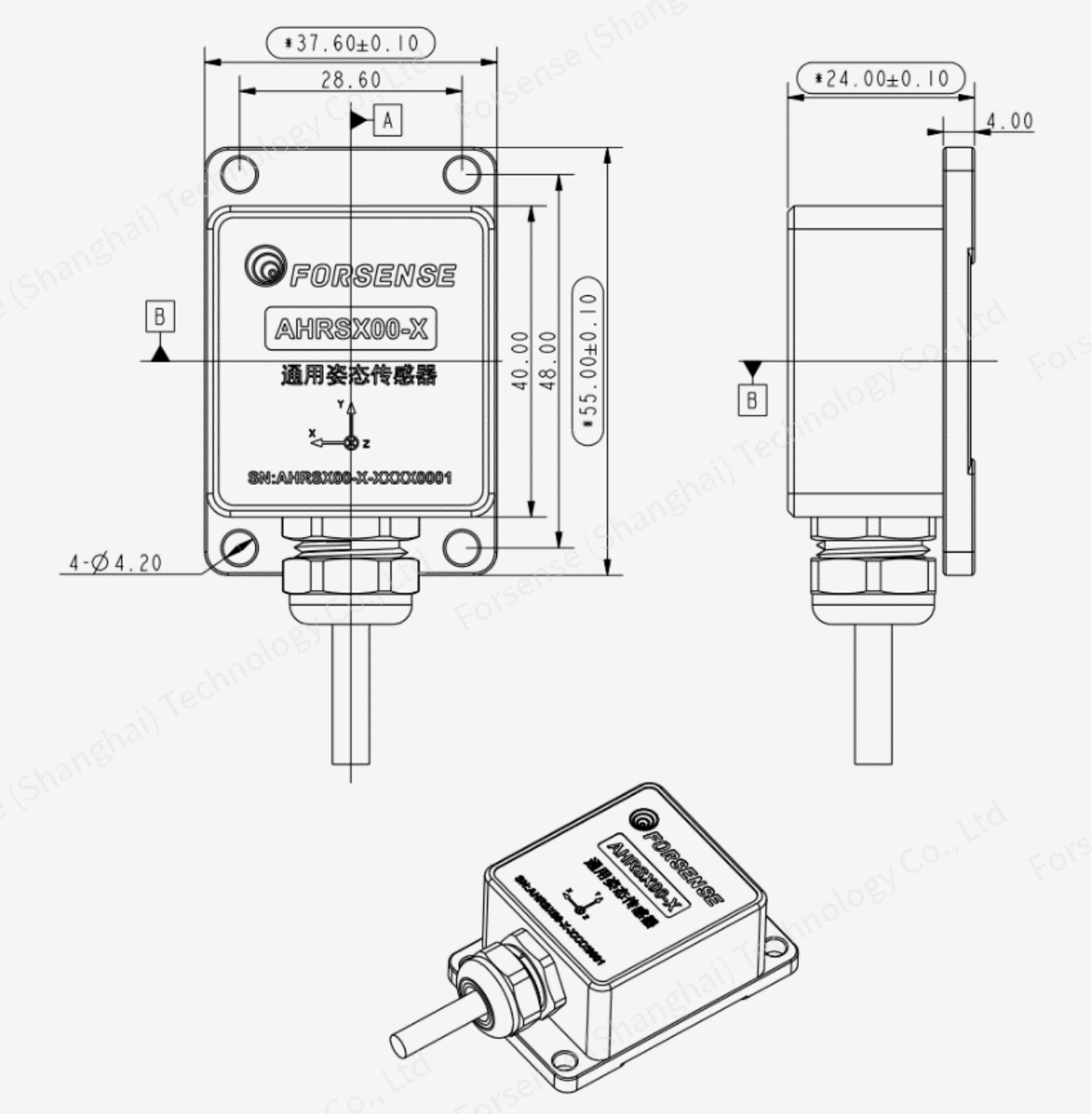


Table 2 Model Description

Name	Version Type	Protocol	Supports Maximum Update Rate
AHRS400	A	CAN Version	200hz
	B	RS-485 Version	400hz
	C	TTL Version	1000hz
	D	RS-232 Version	500hz
AHRS401	A	Single ConnectorCANVersion	200hz
AHRS402	A	Dual ConnectorCANVersion	200hz

3. Physical Structure

Figure2 AHRS400-XExternal Structure



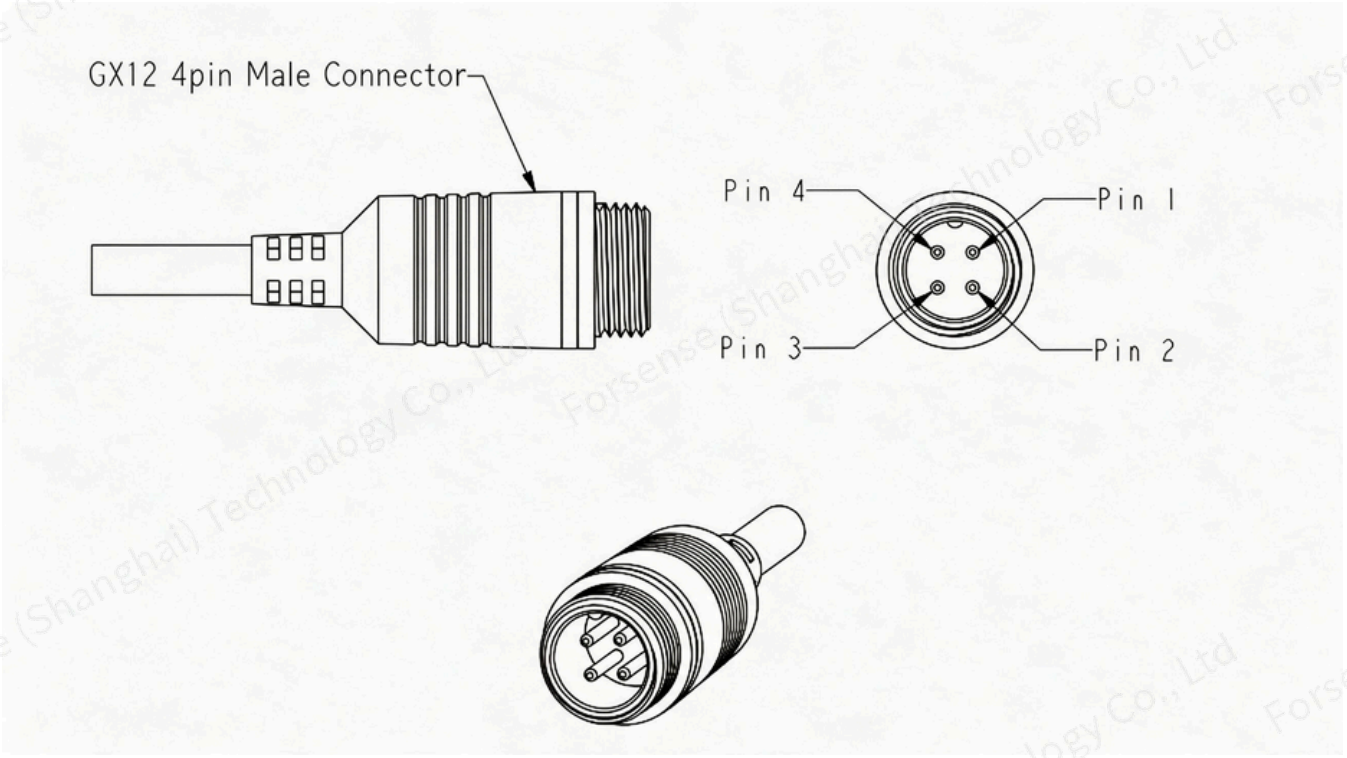
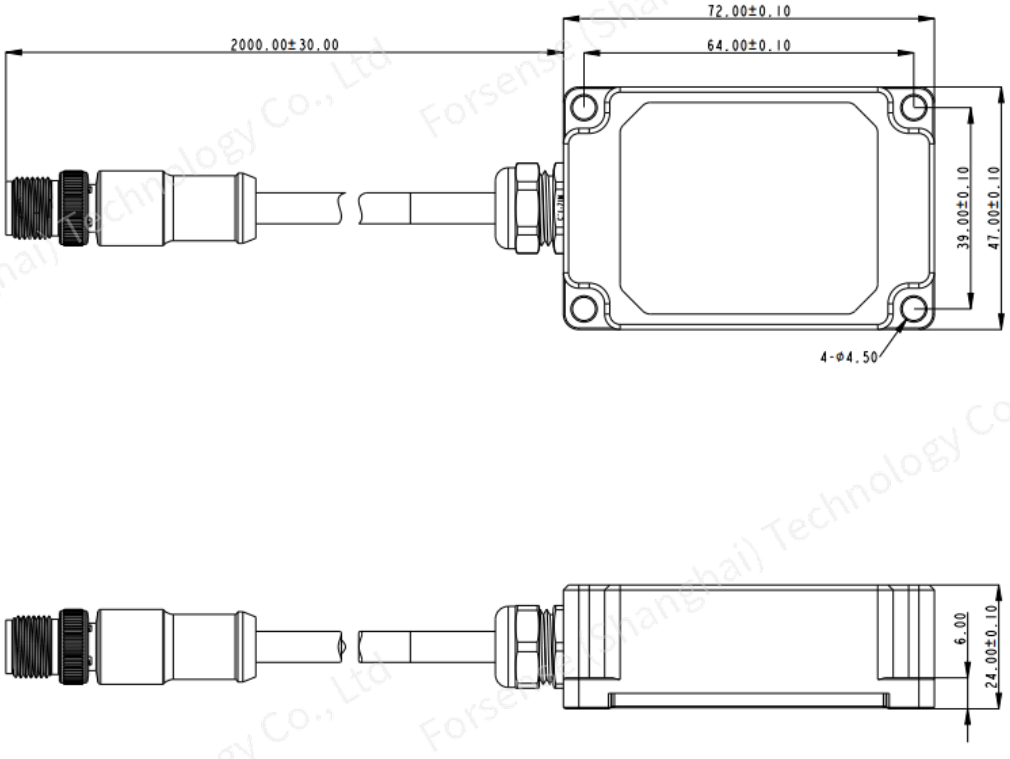
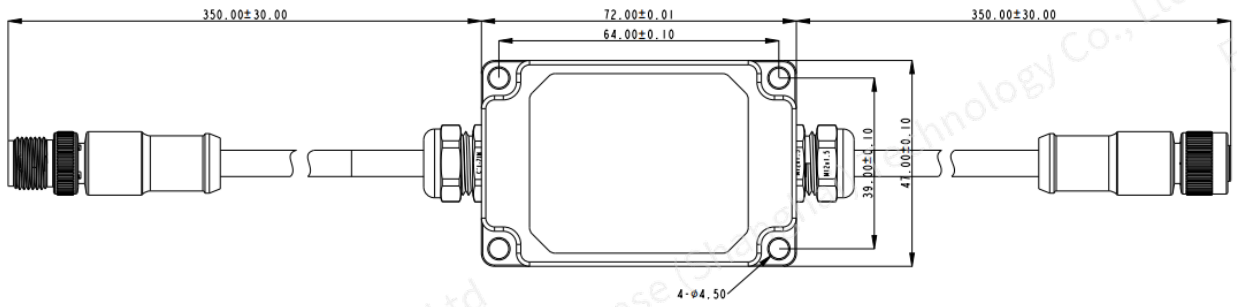
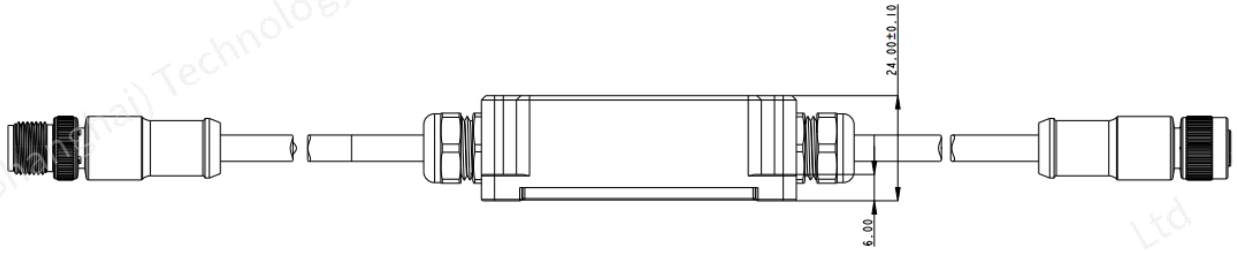
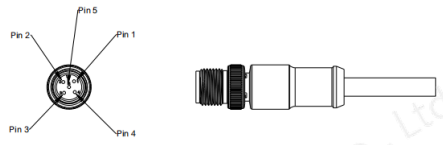


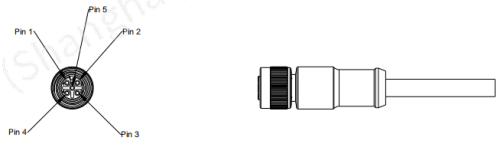
Figure3AHRS40X-A External Structure




350.00±30.00
72.00±0.01
64.00±0.10
350.00±30.00
39.00±0.10
41.00±0.10
4-ø4.50


24.00±0.10
6.00


Pin 5
Pin 2
Pin 1
Pin 3
Pin 4


Pin 5
Pin 1
Pin 2
Pin 4
Pin 3





4. Electrical Characteristics

4.1 Maximum Ratings

Table3 Absolute Maximum Ratings

Parameter	Symbol	Range	Unit
supply voltage	VCC	-0.3 to 32	V
Ground (GND)	GND	-	-
Operating Temperature (Tot)	Tot	-40 to 85	℃
Storage Temperature (Tstg)	Tstg	-40 to 85	℃

4.2 Operating Conditions

Table4 Operating Conditions

Parameter	Symbol	Minimum	Typical	Maximum Value	Unit
supply voltage	VCC	9	12	32	V
VCC Maximum Ripple	Vrpp	0		40	mV
AHRS400-A Power Consumption	P		0.36		W
AHRS400-B Power Consumption	P		0.3		W
AHRS400-C Power Consumption	P		0.2		W
AHRS400-D Power Consumption	P		0.24		W
AHRS401-A Power Consumption	P		0.36		W

AHRS402-A Power Consumption	P		0.36		W
Operating Temperature (Tot)	Tot	-40		85	℃
Storage Temperature (Tstg)	Tstg	-40		85	℃

4.3 Interface Definition

Table5 AHRS400-A Interface Definition

PIN	Definition	Description
1	VIN	9-32VDC Input
2	GND	Ground (GND)
3	CAN_H	CAN_BUS
4	CAN_L	

Note: The CAN communication baud rate is500kHz, with a built-in matching resistor of 120 Ω;

Table6 AHRS400-B Interface Definition

PIN	Definition	Description
1	VIN	9-32V DC Input
2	GND	Ground (GND)
3	DATA A	RS-485
4	DATA B	

Table7 AHRS400-C Interface Definition

PIN	Definition	Description
1	VIN	9-32V DC Input

2	GND	Ground (GND)
3	RXD	LVTTL
4	TXD	

Table8 AHRS400-D Interface Definition

PIN	Definition	Description
1	VIN	9-32V DC Input
2	GND	Ground (GND)
3	RXD	RS232
4	TXD	

Table 9 AHRS40X-A Interface Definition

PIN	Color	Definition	Description
1	Shield	PE	Protecting Earthing(PE)
2	Red	VIN	9-32V DC Input
3	Black	GND	Ground (GND)
4	Green	CAN_H	CAN_BUS
5	White	CAN_L	

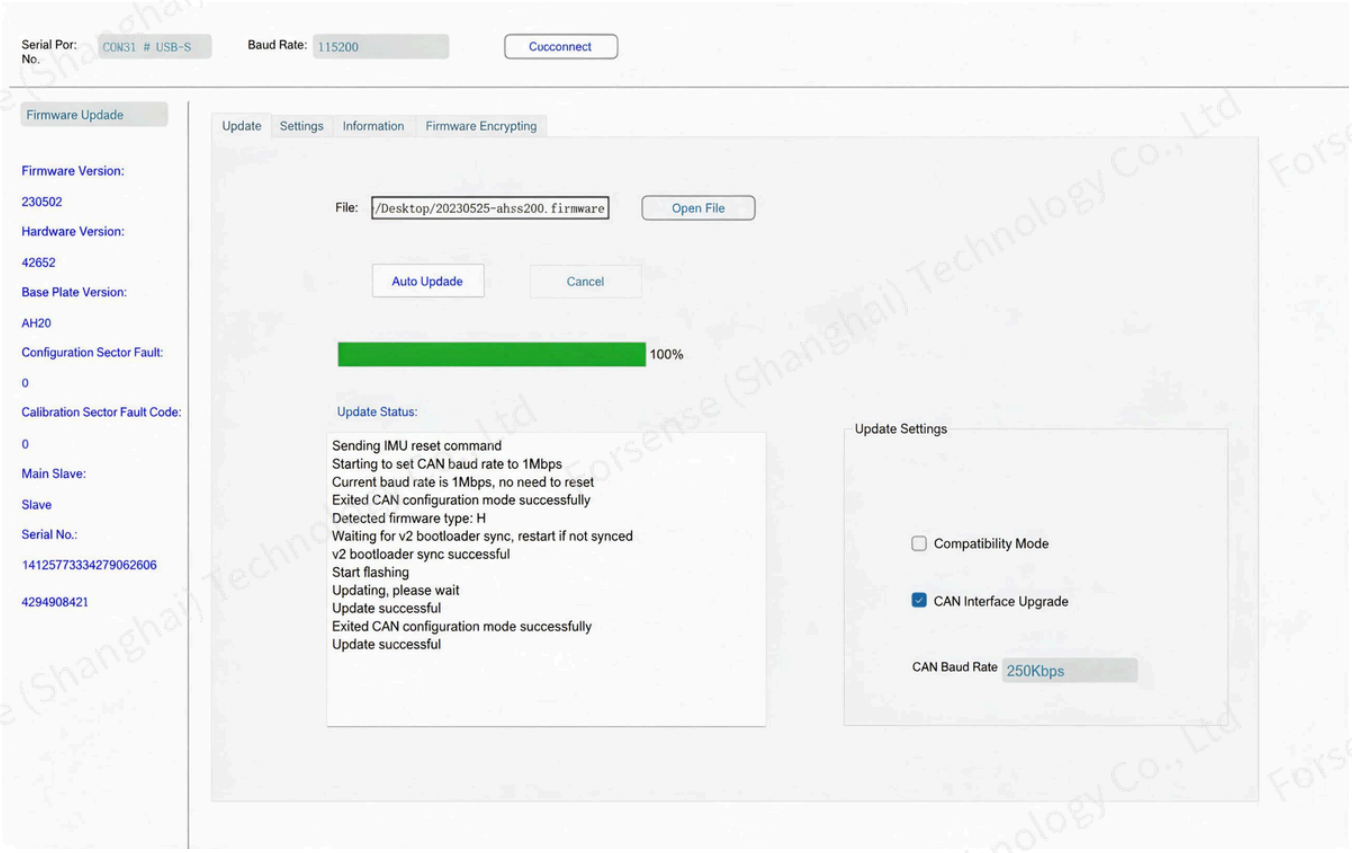
Note:CAN communication baud rate is 500 KHz(Default value, modifiable), built-in matching resistor of 120 Ω

5. Upgrade Function

5.1 CAN Version Firmware Update

UsageConnect the attached USB-to-CAN module to the PC. OpenForsense IMU Test PC software —Select the corresponding Serial Port number —Select Firmware Update — Open Firmware — Select CAN Interface Update — Set the baud rate for the updated firmware — Click Auto Update.

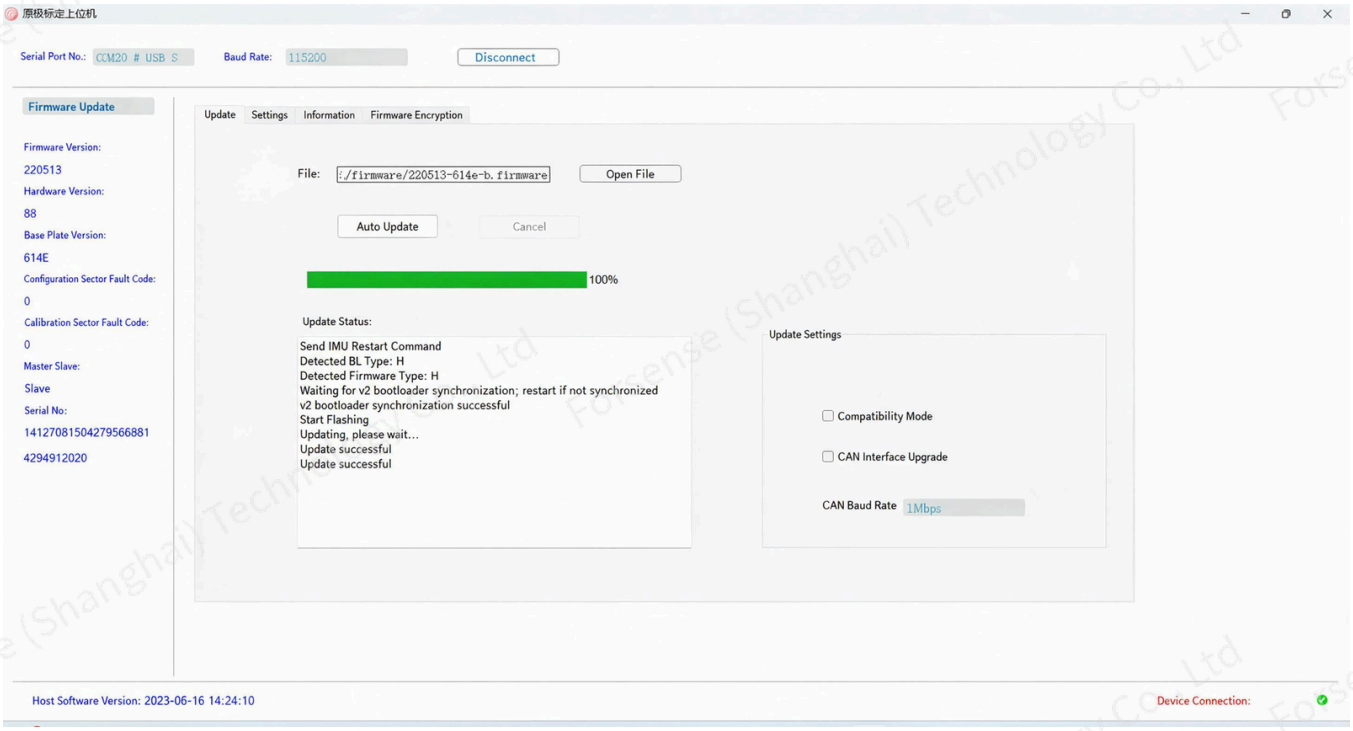
Figure 4 CAN Version PC software Firmware Update Interface



5.2 Firmware Update for RS-485/RS-232/TTL Version

Use Forsense IMU to test PC software — Select Firmware Update — Open Firmware — Click Auto Update.

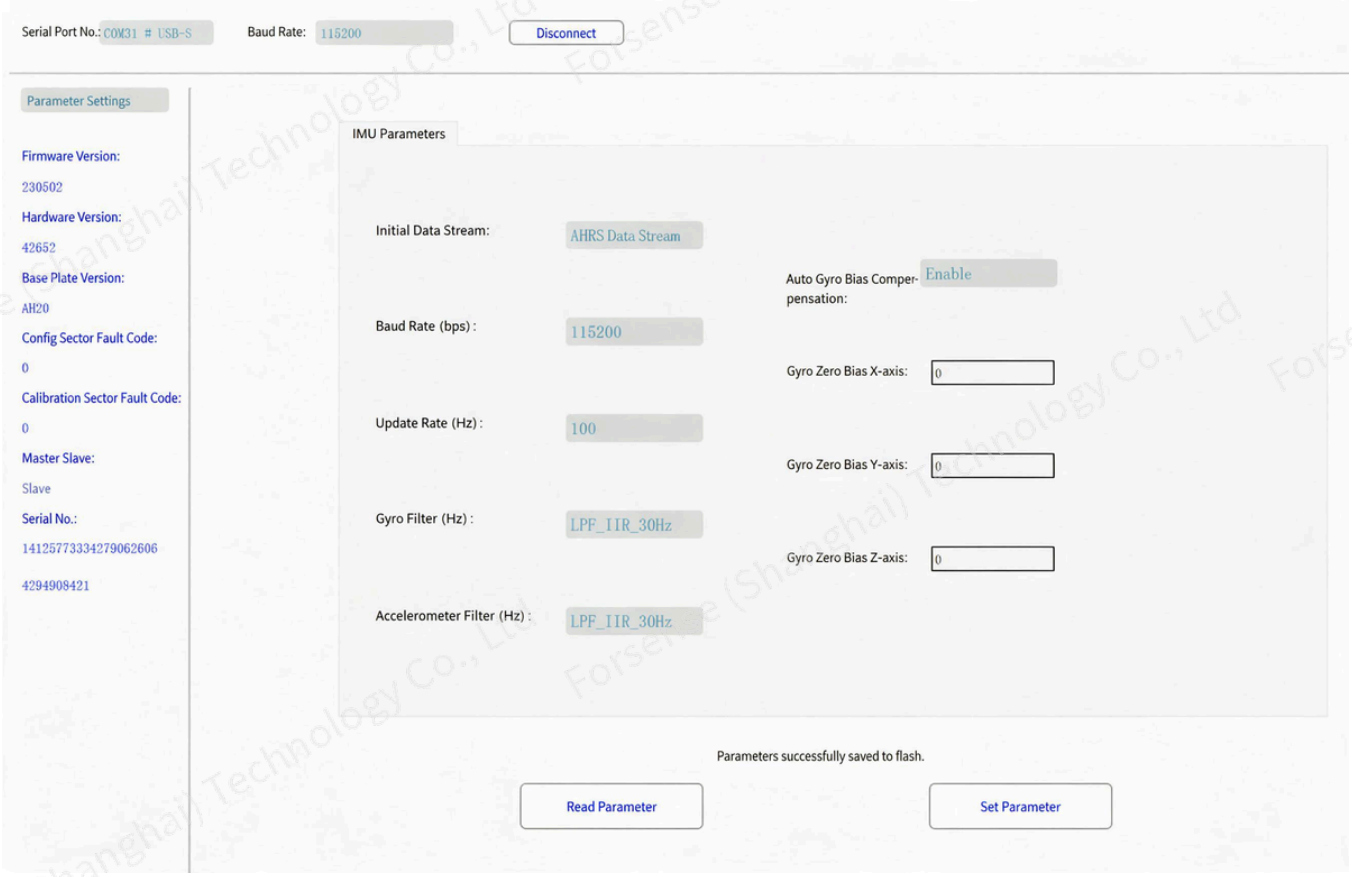
Figure 5 RS-485/RS-232/TTL Version PC software Firmware Update Interface


原极标定上位机
Serial Port No.: CCM20 # USB S
Baud Rate: 115200
Disconnect
Firmware Update
Firmware Version:
220513
Hardware Version:
88
Base Plate Version:
614E
Configuration Sector Fault Code:
0
Calibration Sector Fault Code:
0
Master Slave:
Slave
Serial No:
14127081504279566881
4294912020
Update
Settings
Information
Firmware Encryption
File:
:/firmware/220513-614e-b.firmware
Open File
Auto Update
Cancel
100%
Update Status:
Send IMU Restart Command
Detected BL Type: H
Detected Firmware Type: H
Waiting for v2 bootloader synchronization; restart if not synchronized
v2 bootloader synchronization successful
Start Flashing
Updating, please wait...
Update successful
Update successful
Update Settings
Compatibility Mode
CAN Interface Upgrade
CAN Baud Rate
1Mbps
Host Software Version: 2023-06-16 14:24:10
Device Connection:

6. User Parameter Function

Using the Forsense IMU Test PC software, users can configure values for Update Rate and filters;

Figure 6 User Parameter Configuration Interface



7. Communication Protocol

Reference Document: Forsense IMU Communication Protocols（en）

Includes CAN/serial communication protocols, Coordinate System Configuration, Filter Settings, Parameter Settings, OTA Update Method, etc.

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8. Coordinate System Definition

Figure7 Coordinate System Diagram



Figure8 AHRS401 Coordinate System Diagram

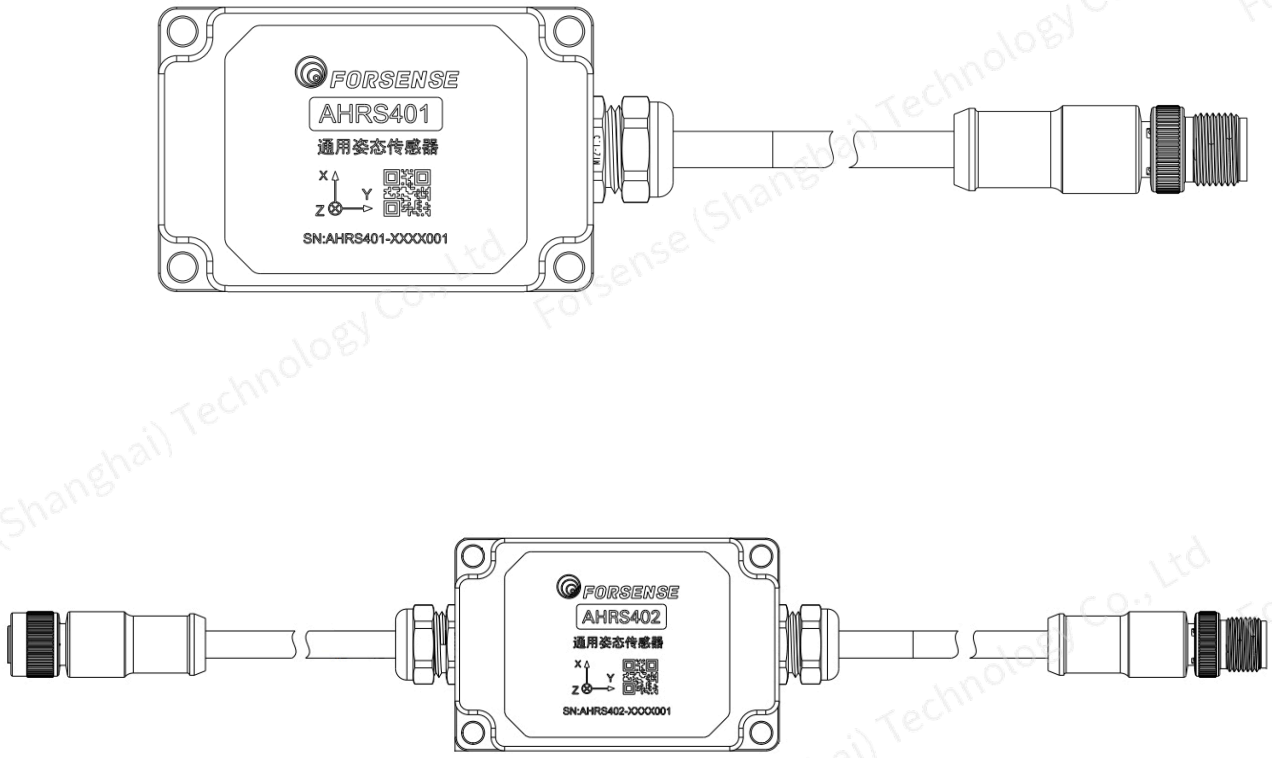
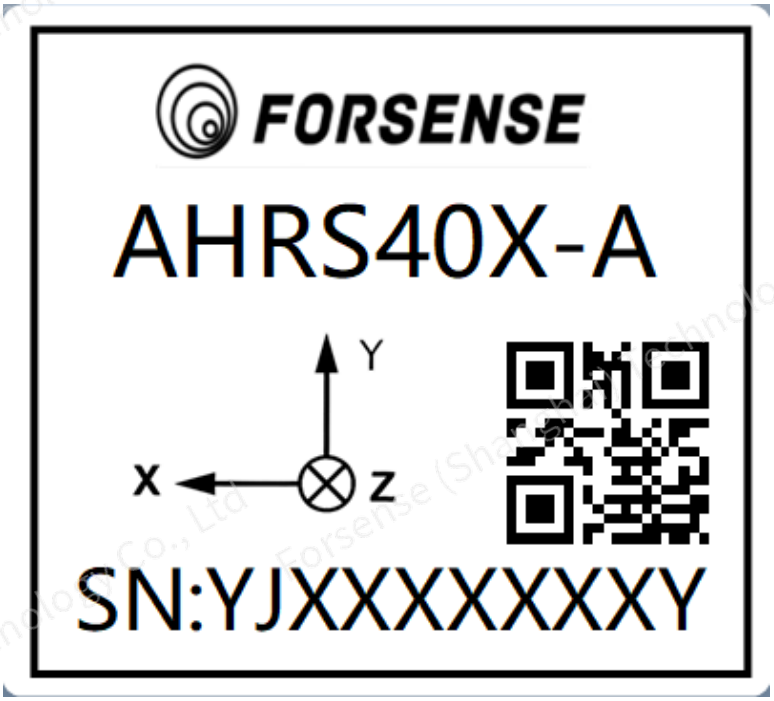


Figure9 AHRS402 Coordinate System Diagram



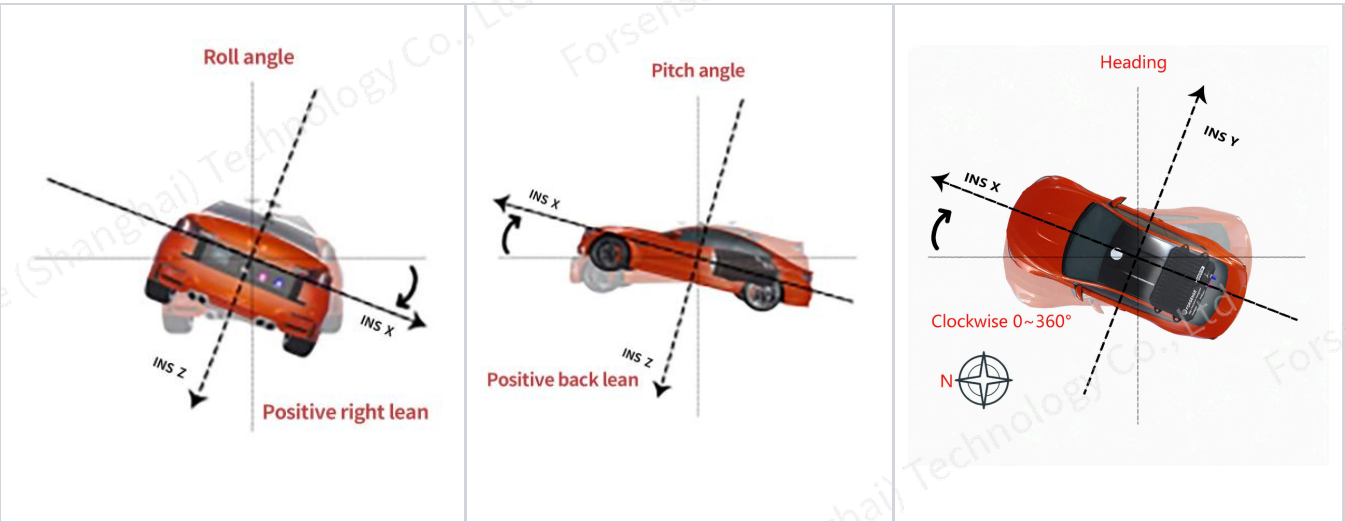
This product uses the Forward-Right-Down (FRD) coordinate system. The Euler angle ranges are as follows:

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° to 90°. The diagram below illustrates Roll, Pitch, and Yaw angle angles:

Figure 9 Schematic of Roll, Pitch, Yaw angle



9. Optional AccessoriesAccessories



USB to CAN Module



485 Serial Port Cable



TTL Serial Port Cable



232 Serial Port Cable



Power Signal Adapter Cable

10. Update Log

Latest Manual Version: AHRS40x productsheet（en）

Version	Date	Status/Notes
Version 1.0	2023.07.18	Initial Release
Version 1.1	2023.10.07	Updated Coordinate System Definition
Version 1.2	2023.12.14	Added Accessories
Version 1.3	2024.03.18	Added 401A & 402A Series
Version 1.4	2024.06.17	Added CAN Parameter Commands
Version 1.5	2024.08.15	Added some AT commands
Version 1.6	2025.01.02	Added coordinate system diagram
Version 1.7	2025.01.23	Adjust Table and Figure Numbering
Version 1.8	2025.08.04	Simplify Communication Protocol