1 FEATURES

1.1 Hardware

- High-performance MEMS-IMU
- Factory-calibrated for full temperature range (-40℃ to 85℃), including scale factor, cross-axis, and bias compensation
- Gyroscope bias instability up to 1.2°/h
- Accelerometer bias instability up to 12 μg
- Multiple communication interfaces: UART (RS-232/TTL), RS-485, CAN, USB
- Multifunctional IO signals (including but not limited to sync input/output, alarms, etc.)
- PPS + UTC/GPRMC Synchronization
- Supports wide voltage input up to 48V
- IP68 waterproof rating
- Excellent vibration resistance
- Integrated temperature sensor
- M12 and PG connectors
- RoHS and CE certification

1.2 Software

- Adaptive extended Kalman fusion algorithm with up to 1000Hz output and low latency
- Excellent dynamic tracking performance with effective vibration suppression
- Outstanding suppression of linear acceleration
- Startup time < 1 second
- Supports multiple protocols, including binary, CANopen,J1939,Modbus
- Direct data output without external command configuration
- Rich user configuration commands
- Multifunctional GUI for easy operation
- Supports multiple examples, including ROS, C, QT

2 APPLICATIONS

- Precision instruments
- Platform stabilization and control
- Engineering machinery
- Underground instrumentation
- Low-speed autonomous robots

3 DESCRIPTIONS

3.1 Product Appearance



Figure 1: HI14

3.2 System Block Diagram

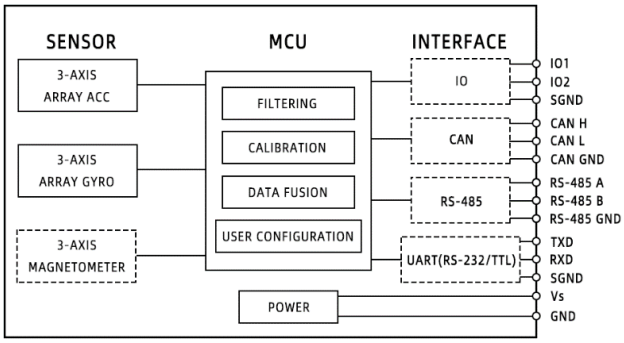


Figure 2: Functional Block Diagram

Note1: Dashed lines indicate features not supported by certain models. Refer to the product selection table (Table 1) for details.

3.3 General Description

The HI14 series consists of IMU/VRU/AHRS sensors composed of high-performance MEMS-IMU and magnetometers. It incorporates proprietary algorithms such as adaptive extended Kalman filtering, IMU noise dynamic analysis, and carrier motion state analysis. These ensure high accuracy for attitude angles under dynamic conditions while reducing drift in heading angles.

Each sensor undergoes precise factory calibration, including temperature compensation, bias correction, scale factor adjustment, and cross-axis compensation.

The multifunctional GUI facilitates rapid product evaluation, offering features such as module configuration, data display, firmware upgrades, and data recording.

For selection and purchasing information, refer to Table 1 and Table 2.

CONTENT

1 FEATURES 1
1.1 Hardware 1
1.2 Software 1
2 APPLICATIONS 1
3 DESCRIPTIONS 1
3.1 Product Appearance 1
3.2 System Block Diagram 1
3.3 General Description 1
4 PRODUCT SELECTION 4
5 ORDERING 5
5.1 Ordering Information 5
5.1.1 HI14 M12 ordering information 5
5.1.2 PG Ordering Informations 6
5.2 Contact Us 6
6 DOCUMENT INFORMATION 7
6.1 Version Information 7
6.2 Related Documents and Development Kits 7
7 SPECIFICATIONS 8
7.1 Absolute Maximum Ratings 8
7.2 Normal Operating Conditions 8
7.3 INTERFACE 9
7.4 Gyroscope 10
7.4.1 HI14M0/HI14RX Gyroscope Specifications 10
7.4.1 HI14SX Gyroscope Specifications 11
7.5 Accelerometer 12
7.5.1 HI14M0/HI14RX Accelerometer Specifications 12
7.5.2 HI14SX Accelerometer Specifications 13
7.6 Magnetometer 13
7.6.1 HI14RX Magnetometer Specifications 13
7.6.2 HI14S3 Magnetometer Specifications 13
7.7 Temperature Sensor 13
7.8 Allan Variance 14
7.8.1 HI14M0/HI14RX allan variance 14
7.8.2 HI14SX Allan Variance 15
7.9 Fusion Parameters 15
7.10 Attitude Angle Accuracy 15
7.11 Mechanical and Environmental 16
7.12 Dimensions 17
7.12.1 M12 Connector 17
7.12.2 PG Cable 17
7.13 Sensor Pin Definition 18
7.13.1 HI14 Series M12-5 Pin Connector (UART) 18

7.13.2 HI14M0/HI14RX Series M12-8 Pin Connector (UART) 18
7.13.3 M12 Connector(RS-485) 19
7.13.4 M12 Connector(CAN) 19
7.13.5 M12 Connector(CAN+RS-232) 20
7.13.6 PG Pin Definitions 21
8 Cable 22
9 HOW TO CONNECTOR 23
9.1 M12-A 5-pin Female to DB9 Female (RS-232 without synchronization) 23
9.2 M12-A 8-pin Female to DB9 Female (RS-232 with synchronization) 23
9.3 M12-A 8-pin Female to DB9 Female (RS-232 with PPS+UTC?GPRMC synchronization) 23
9.4 M12-A 8-pin Female to DB9 Female (CAN+RS-232, external power cable) 24
9.5 M12-A 5-pin Female to USB-A (RS-232 to USB) 24
9.6 M12-A 5-pin Female to OPEN 24
9.6.1 RS-485 Interface 24
9.6.2 CAN Interface 24
9.6.3 UART (RS-232/TTL) Interface 25
9.7 M12-A 8-pin Female to OPEN (UART with synchronization) 25
9.7.1 Synchronization Input/Output with UART Common Ground 25
9.7.2 Synchronization Input/Output without UART Common Ground 25
9.7.3 PPS+UTC/GPRMC Synchronization 26
10 COORDINATE SYSTEM 27
10.1 Coordinate System 27
10.2 Center of Sensor 27
10.3 Recommended Mounting Method 28
11 INITIAL CONFIGURATION 29
11.1 Interface Initial Configuration 29
11.2 Sensor Initial Configuration 29
12 PROTOCOL 30
12.1 Serial Binary Protocol 30
12.2 Modbus 30
12.3 CAN 30
12.3.1 CANopen 30
12.3.2 J1939 30
13 PACKAGING 31
13.1 HI14 Series M12 Interface 31
13.2 HI14 Series PG Interface 31
14 TERMINOLOGY 32
15 FAQ 33
15.1 Serial Port Issues 33

4 PRODUCT SELECTION

Table 2: Product selection information

HI14a-b-cde [1]						
Company	Series	a-Sensor	b-Interface	c-Sync	d-Connector	e-OEM
HI	14	M0 6DoF 3°/h 30ug	232 RS232	0 None	0 M12	0 Default
		R2 6DoF 1.6°/h 18ug	485 RS485	1 Support	1 PG	Other OEM
		R3 6DoF 1.6°/h 18ug+Magnetic	CAN CAN2.0			
		R5 6DoF 1.2°/h 14ug+Magnetic	URT UART(TTL)			
		S2 6DoF 1.7°/h 12ug	USB USB			
		S3 6DoF 1.7°/h 12ug+Magnetic	MI0 CAN+RS232			

Note1: Model example: HI14S3-232-000

Note2: It is recommended to prioritize products with M12 connectors. If space is limited and IP68 waterproofing is not required, you may choose HI16.

5 ORDERING

5.1 Ordering Information

5.1.1 HI14 M12 ordering information

Interf	Part Number	Name	Description
RS-232	HI14M0-232-000	IMU/VRU Module	6DoF 3°/h 30ug M12
	HI14R2-232-000	IMU/VRU Module	6DoF 1.6°/h 18ug M12
	HI14S2-232-000	IMU/VRU Module	6DoF 1.7°/h 12ug M12
	HI14R3-232-000	IMU/AHRS Module	6DoF+Magnetic 1.6°/h 18ug M12
	HI14S3-232-000	IMU/AHRS Module	6DoF+Largr Range Magnetic 1.7°/h 12ug M12
	HI14R5-232-000	IMU/AHRS Module	6DoF+Magnetic 1.2°/h 14ug M12
	HI14R2-232-100	IMU/VRU Module	6DoF 1.6°/h 18ug Sync M12
	HI14S2-232-100	IMU/VRU Module	6DoF 1.7°/h 12ug PPS+UTC Sync M12
	HI14R3-232-100	IMU/AHRS Module	6DoF+Magnetic 1.6°/h 18ug Sync M12
	HI14S3-232-100	IMU/AHRS Module	6DoF+ Largr Range Magnetic 1.7°/h 12ug PPS+UTC Sync M12
	HI14R5-232-100	IMU/AHRS Module	6DoF+Magnetic 1.2°/h 14ug 带同步 M12
UART(TTL)	HI14M0-URT-000	IMU/VRU Module	6DoF 3°/h 30ug M12
	HI14R2-URT-000	IMU/VRU Module	6DoF 1.6°/h 18ug M12
	HI14S2-URT-000	IMU/VRU Module	6DoF 1.7°/h 12ug M12
	HI14R3-URT-000	IMU/AHRS Module	6DoF+Magnetic 1.6°/h 18ug M12
	HI14S3-URT-000	IMU/AHRS Module	6DoF+ Largr Range Magnetic 1.7°/h 12ug M12
	HI14R5-URT-000	IMU/AHRS Module	6DoF+Magnetic 1.2°/h 14ug M12
	HI14R2-URT-100	IMU/VRU Module	6DoF 1.6°/h 18ug Sync M12
	HI14S2-URT-100	IMU/VRU Module	6DoF 1.7°/h 12ug PPS+UTC Sync M12
	HI14R3-URT-100	IMU/AHRS Module	6DoF+Magnetic 1.6°/h 18ug Sync M12
	HI14S3-URT-100	IMU/AHRS Module	6DoF+ Largr Range Magnetic 1.7°/h 12ug PPS+UTC Sync M12
	HI14R5-URT-100	IMU/AHRS Module	6DoF+Magnetic 1.2°/h 14ug Sync M12
RS-485	HI14M0-485-000	IMU/VRU Module	6DoF 3°/h 30ug M12
	HI14R2-485-000	IMU/VRU Module	6DoF 1.6°/h 18ug M12
	HI14R3-485-000	IMU/AHRS Module	6DoF+Magnetic 1.6°/h 18ug M12
	HI14R5-485-000	IMU/AHRS Module	6DoF+Magnetic 1.2°/h 14ug M12
CAN	HI14M0-CAN-000	IMU/VRU Module	6DoF 3°/h 30ug M12
	HI14R2-CAN-000	IMU/VRU Module	6DoF 1.6°/h 18ug M12
	HI14S2-CAN-000	IMU/VRU Module	6DoF 1.7°/h 12ug M12
	HI14R5-CAN-000	IMU/VRU/AHRS Module	6DoF+Magnetic 1.2°/h 14ug M12

Table 3: Continuation of ordering information

Interf	Part Number	Name	Description
USB	HI14M0-USB-000	IMU/VRU Module	6DoF 3°/h 30ug M12
	HI14R2-USB-000	IMU/VRU Module	6DoF 1.6°/h 18ug M12
	HI14S2-USB-000	IMU/VRU Module	6DoF 1.7°/h 12ug M12
	HI14R3-USB-000	IMU/AHRS Module	6DoF+Magnetic 1.6°/h 18ug M12
	HI14S3-USB-000	IMU/AHRS Module	6DoF+ Largr Range Magnetic 1.7°/h 12ug M12
	HI14R5-USB-000	IMU/AHRS Module	6DoF+Magnetic 1.2°/h 14ug M12
MI0(CAN+232)	HI14R2-MI0-000	IMU/VRU Module	6DoF 1.6°/h 18ug M12
	HI14S2-MI0-000	IMU/VRU Module	6DoF 1.7°/h 12ug M12
	HI14S3-MI0-000	IMU/AHRS Module	6DoF+Magnetic 1.7°/h 12ug M12
	HI14R3-MI0-000	IMU/AHRS Module	6DoF+Magnetic 1.6°/h 18ug M12
	HI14R5-MI0-000	IMU/AHRS Module	6DoF+Magnetic 1.2°/h 14ug M12

Note1: Gray indicates newly added models, and it is recommended for new users to prioritize these.

5.1.2 PG Ordering Informations

Table 4: PG ordering information

Interf	Part Number	Name	Description
RS-232	HI14M0-232-010	IMU/VRU Module	6DoF 3°/h 30ug PG
	HI14R2-232-010	IMU/VRU Module	6DoF 1.6°/h 18ug PG
	HI14R3-232-010	IMU/AHRS Module	6DoF+Magnetic 1.6°/h 18ug PG
	HI14R5-232-010	IMU/AHRS Module	6DoF+Magnetic 1.2°/h 14ug PG
UART(TTL)	HI14M0-URT-010	IMU/VRU Module	6DoF 3°/h 30ug PG
	HI14R2-URT-010	IMU/VRU Module	6DoF 1.6°/h 18ug PG
	HI14R3-URT-010	IMU/AHRS Module	6DoF+Magnetic 1.6°/h 18ug PG
	HI14R5-URT-010	IMU/AHRS Module	6DoF+Magnetic 1.2°/h 14ug PG
RS-485	HI14M0-485-010	IMU/VRU Module	6DoF 3°/h 30ug PG
	HI14R2-485-010	MU/VRU Module	6DoF 1.6°/h 18ug PG
	HI14R3-485-010	IMU/AHRS Module	6DoF+Magnetic 1.6°/h 18ug PG
	HI14R5-485-010	IMU/AHRS Module	6DoF+Magnetic 1.2°/h 14ug PG
CAN	HI14M0-CAN-010	IMU/VRU Module	6DoF 3°/h 30ug PG
	HI14R2-CAN-010	IMU/VRU Module	6DoF 1.6°/h 18ug PG
	HI14R5-CAN-010	IMU/VRU/AHRS Module	6DoF+Magnetic 1.2°/h 14ug PG

Note1: It is recommended to prioritize products with M12 connectors. If space is severely limited, PG direct wiring or HI16 can be selected instead.

6 DOCUMENT INFORMATION

6.1 Version Information

Table 5: Document versions

Version	Date	Author	Changes
1.0	June 27, 2024	Hipnuc	Initial version
1.1	August 21, 2024	Hipnuc	Updated minimum input voltage for RS-232 interface
1.2	August 23, 2024	Hipnuc	Added USB interface, updated ordering information, and changed default wiring harness
1.3	August 27, 2024	Hipnuc	Updated accuracy specifications for attitude angles and default gyroscope bandwidth
1.4	December 7, 2024	HiPNUC	Added CAN+RS-232 interface and wiring description, removed label explanation, and synchronized chapters
1.5	March 17, 2025	HiPNUC	Updated Allan variance
1.6	July 10, 2025	HiPNUC	Added S series products, changed MI0 interface to MI0
1.7	November 19, 2025	HiPNUC	Modify units

6.2 Related Documents and Development Kits

1. *Commands&programming manual*
2. *3D Step*
3. *CE/RoHS/IP68 certification documents*
4. *GUI software and reference examples*

7 SPECIFICATIONS

Unless otherwise noted, the test temperature is 25℃, and the supply voltage is 24V.

7.1 Absolute Maximum Ratings

Table 6: Absolute maximum ratings

Parameters	Limit	Comment
Mechanical Shock	2000g	Duration <1ms
Storage Temperature	-40℃-85℃	
ESD HBM	30KV	JEDEC/ESDA JS-001
Power Input Voltage	50V	
IO1	0-5V	
IO2	0-3.3V	
TXD(TTL)	0-3.3V	
RXD(TTL)	0-5V	
RS-232 TX to GND	±13.2V	
RS-232 RX to GND	±24V	
CAN H or CAN L to GND	±40V	
CAN H to CAN L	±27V	
RS-485 A or RS-485 B	-8-13V	

7.2 Normal Operating Conditions

Table 7: Normal operating conditionss

Parameters	Condition	Min	Nom	Max	Unit	Note
Input Voltage	USB/UART(RS-232/TTL)	4.8	-	48	V	
	RS485/CAN	7	-	48		
Power Consumption	HI14M0			300	mW	
	HI14R2/HI14R3/HI14SX			400		
	HI14R5			600		
Operating Temperature		-40	-	85	℃	
Gyroscope Range		125	2000	2000	°/s	
			4000	4000		
Accelerometer Range		3	12	24	g	
			32	32		
Startup Time				2	s	1

Note1: Startup time refers to the time taken for the system to output valid data after power-on. During this period, the module should remain stationary.

7.3 INTERFACE

Table 8: Interface parameters

Interf	Parameters	Condition	Min	Nom	Max	Unit	Note
UART	Baud Rate	RS-232	9600	115200	921600	bps	1
	Start Bits			1		bit	
	Data Length			8		bits	
	Stop Bits			1		bit	
	Parity Bits			None		bit	
	Output Frame Rate		0	100	1000	Hz	2
	Input Impedance		3	5	7	kΩ	
	Output Impedance		300	10M		Ω	
CAN	Baud		125	500	1000	kbps	3
	Output Frame Rate		5	100	200	Hz	4
	Input Impedance	With 120Ω resistor		120		Ω	5
		Without 120Ω resistor	19	30	52	kΩ	
RS-485	Baud Rate	Modbus	9600	115200	115200	bps	
		Non-Modbus	9600	115200	460800		
	Start Bits			1		bit	
	Data Length			8		bits	
	Stop Bits			1		bit	
	Parity Bits			None		bit	
	Output Frame Rate	Modbus	0	10	50	Hz	
		Non-Modbus	0	100	250	Hz	
	Input Impedance	With 120Ω resistor		120		Ω	5
		Without 120Ω resistor	48			kΩ	
Trigger Pin	Logic Voltage	High	2.0			V	
		Low			0.6	V	6
	Delay	From trigger to data transmission			800	us	

Note1: For modifications, please refer to the instruction and programming manual.

Note2: The sensor supports data output rates of 1, 5, 10, 50, 100, 200, 250, 500, and 1000 Hz.

Note3: For modifications, please refer to the instruction and programming manual.

Note4: The sensor supports data output rates of 5, 10, 50, 100, and 200 Hz.

Note5: By default, the 120Ω resistor is not connected.

Note6: For trigger timing and configuration, please refer to the synchronization section and the instruction and programming manual.

7.4 Gyroscope

7.4.1 HI14M0/HI14RX Gyroscope Specifications

Table 9: HI14M0/HI14RX gyroscope specificationss

Parameters	Condition	Product	Min	Nom	Max	Unit	Note
Range				2000		°/s	
Resolution				16bit			
Scale Factor	100°/s	HI14M0 HI14R2/HI14R3 HI14R5		<500 <200 <100	600 350 200	ppm	1
Nonlinearity	Best-fit straight line Fs=2000°/s		-0.05	-	0.05	%Fs	2
Noise Density		HI14M0 HI14R2/HI14R3 HI14R5		0.015 0.008 0.006		°/s/√Hz	
3dB Bandwidth				90	200	Hz	
Sampling Rate				1000		Hz	
Bias Instability	Allan Variance	HI14M0 HI14R2/HI14R3 HI14R5		3 1.6 1.2		°/h	1σ
Bias Stability	10s smoothing	HI14M0 HI14R2/HI14R3 HI14R5		10 5 4		°/h	1σ
Bias Repeatability		HI14M0 HI14R2/HI14R3 HI14R5		15 12 8		°/h	1σ
Angle Random Walk	Allan Variance	HI14M0 HI14R2/HI14R3 HI14R5		0.42 0.25 0.18		°/√h	1σ
Bias Full-Temperature Variation	-40-85℃			0.07	0.2	°/s	3
Accelerometer Sensitivity	All three axis			0.1		°/s/g	

Note1: Measured by averaging after rotating the turntable 10 times forward and backward.

Note2: Maximum deviation from the best-fit straight line within the specified range.

Note3: Measured using a thermal chamber turntable in the HiPNUC Laboratory, with a temperature rise rate of less than 3°C/min.

7.4.1 HI14SX Gyroscope Specifications

Table 10: gyroscope specifications

Parameters	Condition	Min	Nom	Max	Unit	Note
Range		15.625	4000	4000	°/s	
Resolution			20bit			
Scale Factor	100°/s		<100	200	ppm	1
Nonlinearity		-0.05	-	0.05	%Fs	2
Noise Density			0.0025		°/s√Hz	3
3dB Bandwidth			90	400	Hz	
Zero				±0.1	°/s	4
Sampling Rate			1000		Hz	
Bias Instability	Allan Variance		1.7		°/h	1σ
Bias Stability	10s smoothing		4		°/h	1σ
Bias Repeatability			3.7		°/h	
Angle Random Walk	Allan Variance		0.1		°/√h	1σ
Bias Full-Temperature Variation-40-85℃			0.07	0.2	°/s	5
Accelerometer Sensitivity	All three axis		0.05		°/s/g	

Note1: Measured by averaging after rotating the turntable 10 times forward and backward.

Note2: Maximum deviation from the best-fit straight line within the specified range.

Note3: Mean value of test samples.

Note4: After initial bias calibration, the bias can be estimated in real-time by the algorithm engine.

Note5: Measured using a thermal chamber turntable in the Supercore Laboratory, with a temperature rise rate of less than 3°C/min.

7.5 Accelerometer

7.5.1 HI14M0/HI14RX Accelerometer Specifications

Table 11: HI14M0/HI14RX accelerometer specification

Parameters	Condition	Product	Min	Nom	Max	Unit	Note
Range				12		g	
Resolution				16bit			
Initial Bias					3	mg	
Nonlinearity	Best-fit straight line Fs=3g			0.5		%Fs	
Noise Density		HI14M0 HI14R2/HI14R3 HI14R5		0.175 0.09 0.06		mg/√Hz	
3dB Bandwidth				80		Hz	
Sampling Rate				1600		Hz	
Bias Instability	Allan Variance	HI14M0 HI14R2/HI14R3 HI14R5		0.03 0.018 0.014		mg	1σ
Bias Stability	10s smoothing	HI14M0 HI14R2/HI14R3 HI14R5		0.07 0.035 0.025		mg	1σ
Bias Repeatability		HI14M0 HI14R2/HI14R3 HI14R5		0.34 0.15 0.1		mg	1σ
Random Walk	Allan Variance	HI14M0 HI14R2/HI14R3 HI14R5		0.08 0.04 0.028		m/s√h	1σ
Bias Full-Temperature Variation	-40-85℃			2	5	mg	1σ

7.5.2 HI14SX Accelerometer Specifications

Table 12: HI14SX accelerometer specifications

Parameters	Condition	Product	Min	Nom	Max	Unit	Note
Range			2	8	32	g	
Resolution				20bit			
Initial Bias				2	3	mg	
Nonlinearity				0.01		%Fs	
3dB Bandwidth				80	400	Hz	
Noise Density				0.05	0.06	mg√Hz	
Sampling Rate				1000		Hz	
Bias Instability	Allan Variance			0.012		mg	1σ
Bias Stability	10s smoothing			0.015		mg	1σ
Bias Repeatability				0.11		mg	1σ
Random Walk	Allan Variance			0.018		m/s/√h	1σ
Bias Full-Temperature Variation	-40-85℃			2	5	mg	1σ

7.6 Magnetometer

7.6.1 HI14RX Magnetometer Specifications

Table 13: HI14RX magnetometer specifications

Parameters	Condition	Min	Nom	Max	Unit	Note
Range		-8	-	8	Gauss	
Resolution	Fs=2G		2		mGauss	
Sampling Rate			200Hz			
Linearity	Best-fit straight line Fs=2G		0.1		Fs%	

7.6.2 HI14S3 Magnetometer Specifications

Table 14: HI14SX magnetometer specifications

Parameters	Condition	Min	Nom	Max	Unit	Note
Range			20		Gauss	
Noise			450		nT	
Linearity			20		uT	

7.7 Temperature Sensor

Table 15: Temperature sensor

Parameters	Condition	Min	Nom	Max	Unit	Note
Range		-40	-	85	℃	
Offset error			±1		K	

7.8 Allan Variance

7.8.1 HI14M0/HI14RX allan variance

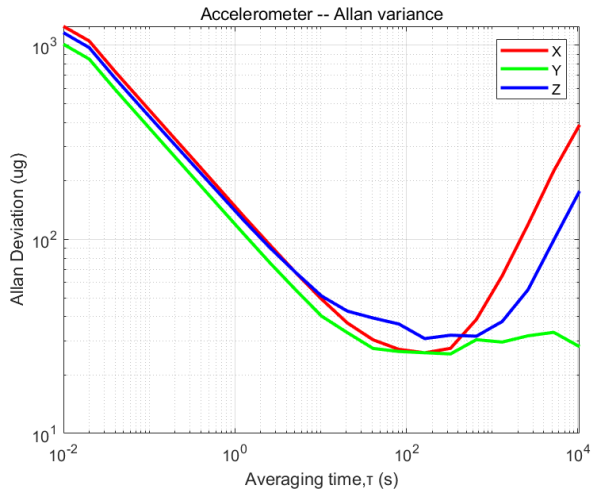


Figure 3: HI14M0 Accelerometer Allan Variance

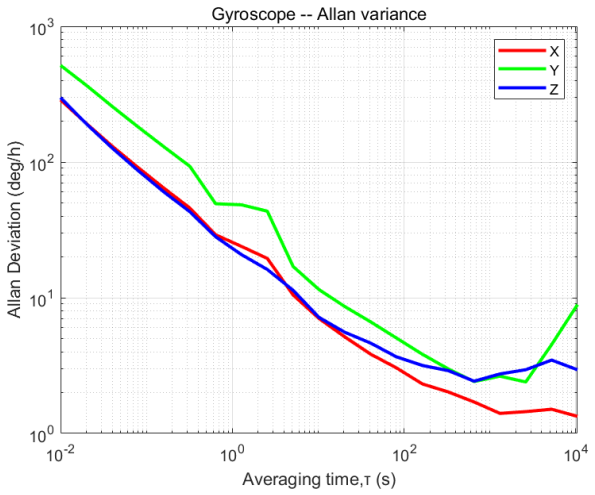


Figure 4: HI14M0 Gyroscope Allan Variance

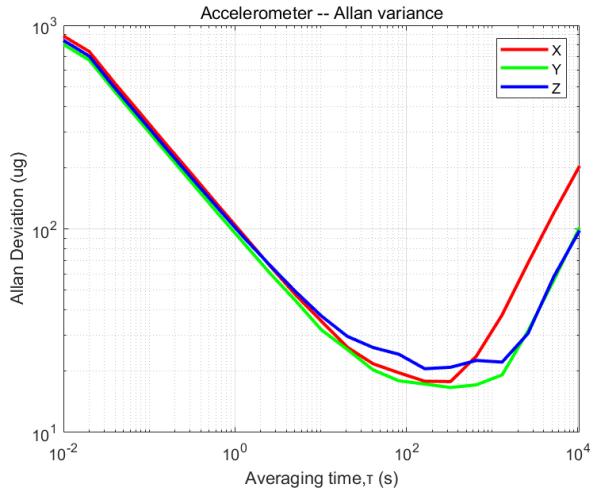


Figure 5: HI14R2/HI14R3 Accelerometer Allan Variance

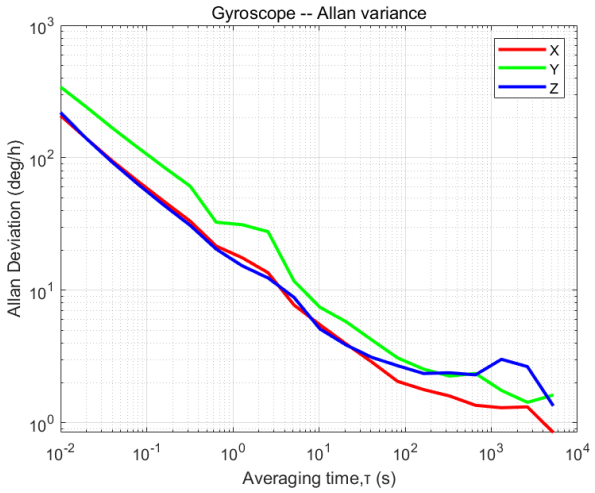


Figure 6: HI14R2/HI14R3 Gyroscope Allan Variance

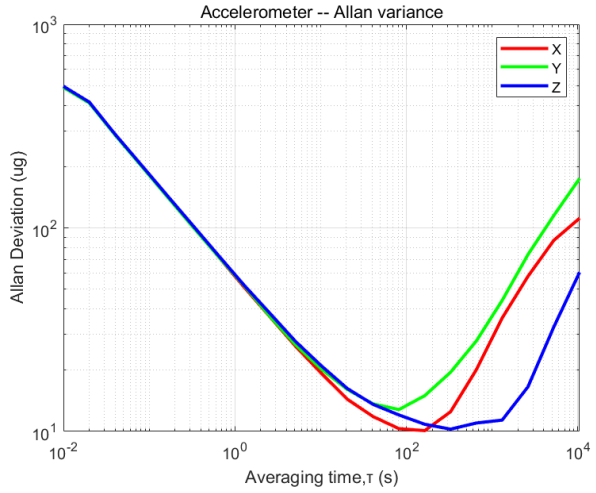


Figure 7: HI14R5 Accelerometer Allan Variance

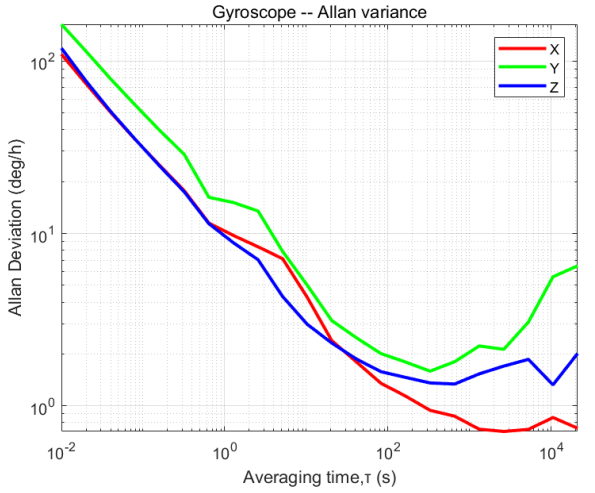


Figure 8: HI14R5 Gyroscope Allan Variance

7.8.2 HI14SX Allan Variance

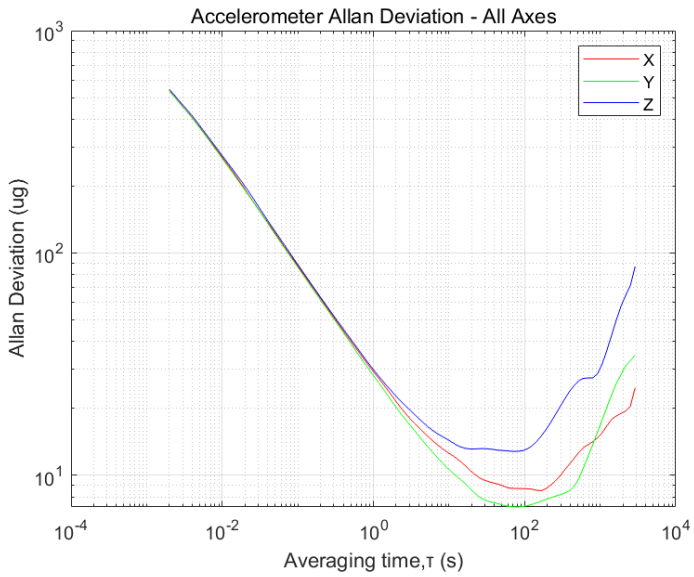


Figure 9: HI14SX Accelerometer Allan Variance

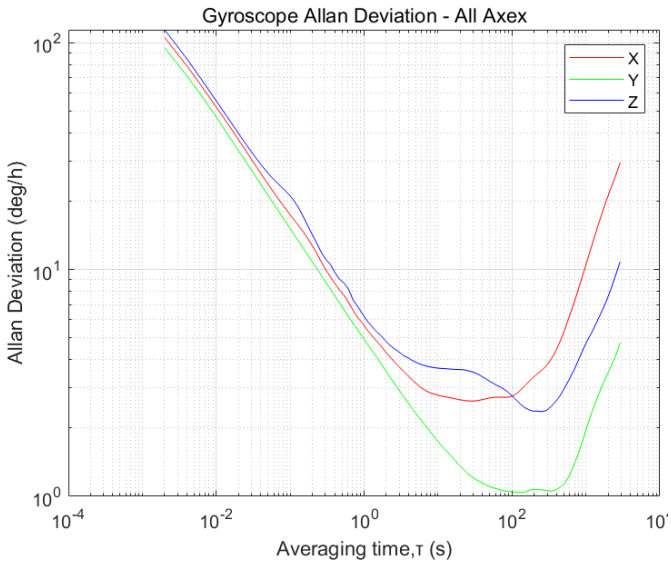


Figure 10: HI14SX Gyroscope Allan Variance

7.9 Fusion Parameters

Table 16: Fusion parameters

Parameters	Value
Pitch	±90°
Roll	±180°
Yaw	±180°
Resolution	0.01°
Quaternion	Supported
PPS+UTC/GPRMC	HI14SX Support

7.10 Attitude Angle Accuracy

Table 17: Attitude angle accuracy

Parameters	Condition	Product	Min	Nom	Max	Unit	Note
Pitch/Roll (Static)				0.15	0.2	°	
Pitch/Roll (Dynamic)	HI14M0 HI14R2/HI14R3/HI14R5/HI14SX			0.15	0.3 0.2	°	
Yaw Angle Static Drift (6DOF)	Stationary for 2h			0.15	0.2	°	1
Yaw Angle Dynamic Drift (6DOF)		HI14M0 HI14RX/HI14SX		9 5		°	2
Yaw (AHRS)				2	3	°	3
Yaw Angle Rotation Error (6DOF)	100°/s rotation	HI14M0 HI14R2/HI14R3 HI14R5/HI14SX		<0.8	3 1.3 1	°	4

Note1: Module stationary for 2 hours.

Note2: Measured during 1-hour operation on an indoor cleaning robot. 1σ.

Note3: Measured after geomagnetic calibration, with no surrounding magnetic field interference, and the product set to AHRS mode.

Note4: Accumulated yaw angle error after 10 continuous rotations of the turntable.

7.11 Mechanical and Environmental

Table 18: Mechanical and environmental

Parameters	Product	Value
Dimensions	M12	58.5X40X20mm
	PG	40X36X16mm
Weight		<75g
Housing Material		Aluminum Alloy
Fixing Screws		M3
Surface Treatment		Anodizing
Vibration Resistance		1.0mm(10Hz-58Hz)&≤20g(58Hz-600Hz)
Certifications		RoHS Directive 2011/65/EU CE IP68
Drop Test		Free drop 3 times from a height of 75 cm
Temperature Shock		Temperature rising from -40℃ to 85℃ within 1 hour, repeated 5 times

7.12 Dimensions

All Dimensions in mm units.

7.12.1 M12 Connector

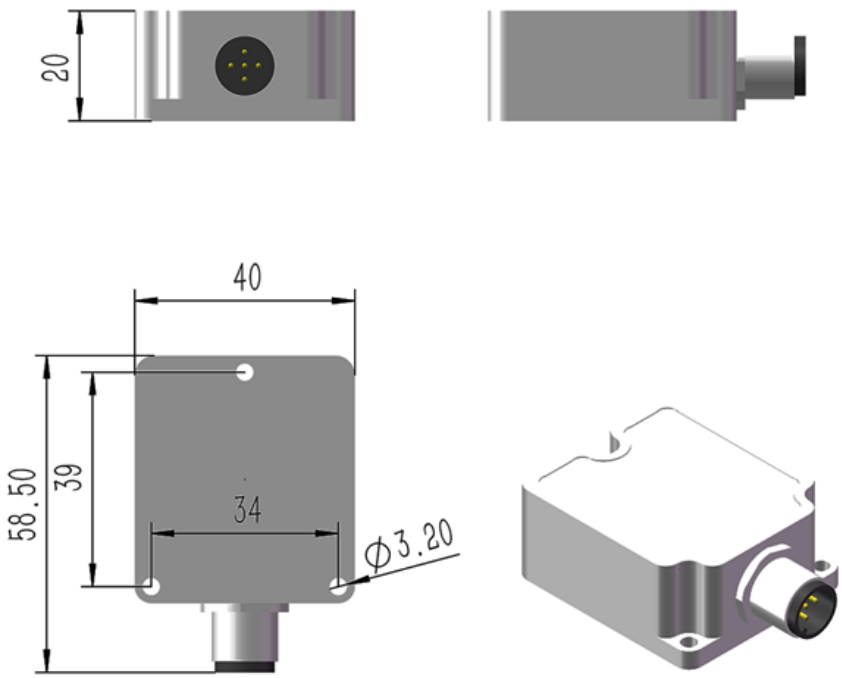


Figure 11: HI14 M12 Mechanical Dimension

7.12.2 PG Cable

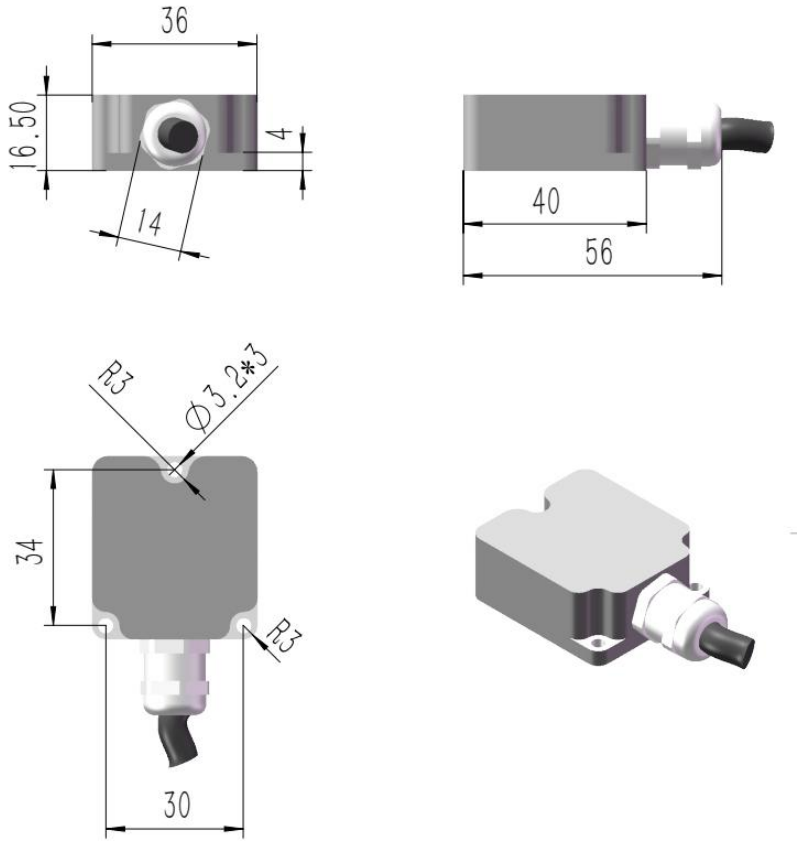


Figure 12: HI14 PG Mechanical Dimension

7.13 Sensor Pin Definition

7.13.1 HI14 Series M12-5 Pin Connector (UART)



Figure 13: M12 5 Pin definition(sensor side)

Table 19: M 12 5-Pin UART Pin Description

M12 5Pin	Color	Pin Name	Type	Description	Note
1	Brown	SGND	Power	Signal ground	1
2	White	Vs	Power	Power input +	
3	Blue	GND	Power	Power ground	1
4	Black	RXD	I	Module serial receive	2
5	Gray	TXD	O	Module serial transmit	

7.13.2 HI14M0/HI14RX Series M12-8 Pin Connector (UART)



Figure 14: M12 8 Pin definition(sensor side)

Table 20: HI14M0/HI14RX M12-8 Pin UART pin functional description

M12 8 Pin	Color	Pin Name	Type	Description	Note
1	White	SGND	Power	Signal ground	1
2	Brown	Vs	Power	Power input +	
3	Green	GND	Power	Power ground	1
4	Yellow	RXD	I	Module serial receive	2
5	Gray	TXD	O	Module serial transmit	
6	Pink	SGND	Power	Signal ground	1
7	Blue	SYNC_IN	I/O	Synchronization Input (can be left floating if unused)	3
8	Red	SYNC_OUT	I/O	Synchronization Output (can be left floating if unused)	

Table 21: HI14SX M12-8 M12-8 Pin UART pin functional description

M12 8 Pin	Color	Pin Name	Type	Description	Note
1	White	SGND	Power	Signal ground	1
2	Brown	Vs	Power	Power input +	
3	Green	GND	Power	Power ground	1
4	Yellow	RXD1	I	Module serial receive	2
5	Gray	TXD1	O	Module serial transmit	
6	Pink	SGND	Power	Signal ground	1
7	Blue	IO1,	I/O	SYNC_IN/PPS (connect external PPS, can be left floating if unused)	3
8	Red	RXD2	I	Can connect external GNSS or virtual UTC/GPRMC time devices	

Note1: Signal ground and power ground are connected.

Note2: Serial port level depends on the interface selected by the user. If RS-232 interface is selected, the port level is RS-232. If UART interface is selected, the level is TTL

Note3: Multi-functional IO; refer to the instructions and programming manual for specific usage methods.

7.13.3 M12 Connector(RS-485)



Figure 15: M12 Pin definition(sensor side)

Table 22: RS-485 Pin functional descriptions

M12 5Pin	Color	Pin Name	Type	Description	Note
1	Brown	485 GND	Power	RS-485 GND Shield Ground can be left floating if unused	
2	White	Vs	Power	Power input +	
3	Blue	GND	Power	Power ground	
4	Black	485 A	AIO	RS-485 A	
5	Gray	485 B	AIO	RS-485 B	

7.13.4 M12 Connector(CAN)



Figure 16: M12 Pin definition(sensor side)

Table 23: CAN Pin functional description

M12 5Pin	Color	Type	Description	Note
1	Brown	Power	CAN GND Shield Ground can be left floating if unused	
2	White	Power	Power input +	
3	Blue	Power	Power ground	
4	Black	AIO	CAN High	
5	Gray	AIO	CAN Low	

7.13.5 M12 Connector(CAN+RS-232)



Figure 17: M12 Pin definition(sensor side)

Table 24: CAN+RS-232 Pin functional descriptions

M12 8 Pin	Color	Pin Name	Type	Description	Note
1	White	SGND	Power	Signal ground	
2	Brown	Vs	Power	Power input +	
3	Green	GND	Power	Power ground	
4	Yellow	RXD	I	Module serial receive(RS-232)	
5	Gray	TXD	O	Module serial transmit(RS-232)	
6	Pink	CAN GND	Power	CAN GND Shield Ground can be left floating if unused	
7	Blue	CAN H	AIO	CAN High	
8	Red	CAN L	AIO	CAN Low	

7.13.6 PG Pin Definitions

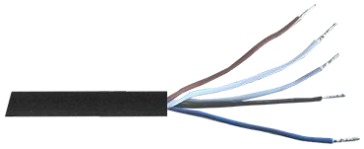
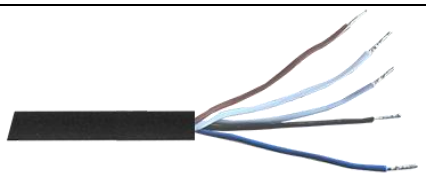


Figure 18: PG Cable

Table 25: PG pin definitions

5 Pin PG					
Number	1	2	3	4	5
Color	Brown(BN)	White(WH)	Blue(BU)	Black(BK)	Gray(GY)
UART	SGND	Vs	GND	RXD	TXD
RS-485	485 GND Shield Ground	Vs	GND	RS-485 A	RS-485 B
CAN	CAN GND Shield Ground	Vs	GND	CAN H	CAN L

8 Cable

Description	Digram	Note
M12 5-pin Female to DB9 Female + OPEN Default for HI14XX-232-00X		1
M12 8-pin Female to DB9 Female + OPEN Default for HI14XX-232-10X		1
M12 5-pin Female to OPEN Default for HI14XX-485-00X, HI14XX-CAN-00X, HI14XX-URT-00X，also support HI14XX-232-00X		1
M12 8-pin Female to OPEN Default for HI14XX-URT-10X, HI14XX-MI0-00X also support HI14XX-232-10X		1
M12 5-pin Female to USB A Male Default for HI14XX-USB-00X		1,2
PG Direct Cable to OPEN Suitable for HI14XX-485-01X, HI14XX-CAN-01X, HI14XX-URT-01X, HI14XX-232-01X		
PG Cable-DB9+OPEN		

Note1： The default cable length is 3m. Cable lengths of 1m and 5m are also available. For other lengths, please contact us for customization.

Note2： Built-in USB-to-UART chip

9 HOW TO CONNECTOR

9.1 M12-A 5-pin Female to DB9 Female (RS-232 without synchronization)

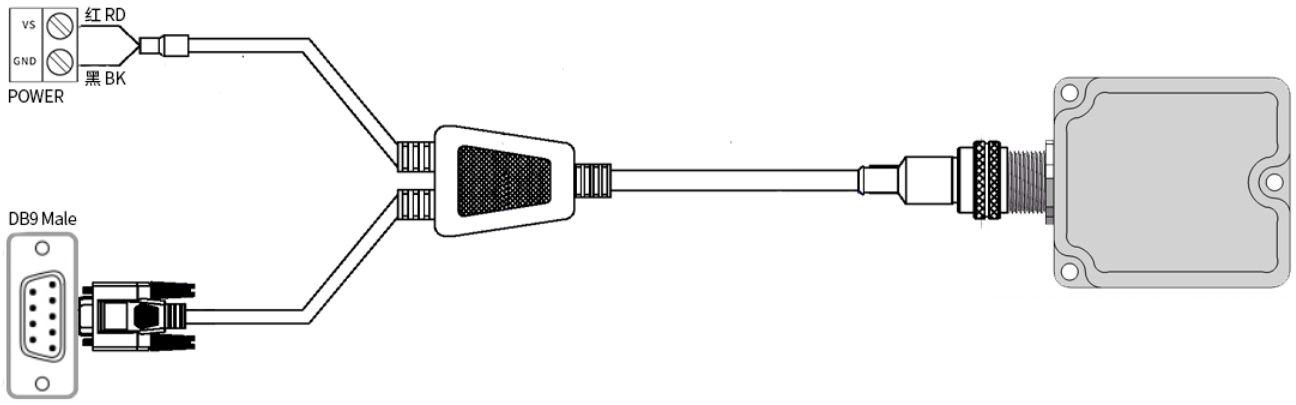


Figure 19: M12-A code 5pin to DB9+OPEN external power RS-232

9.2 M12-A 8-pin Female to DB9 Female (RS-232 with synchronization)

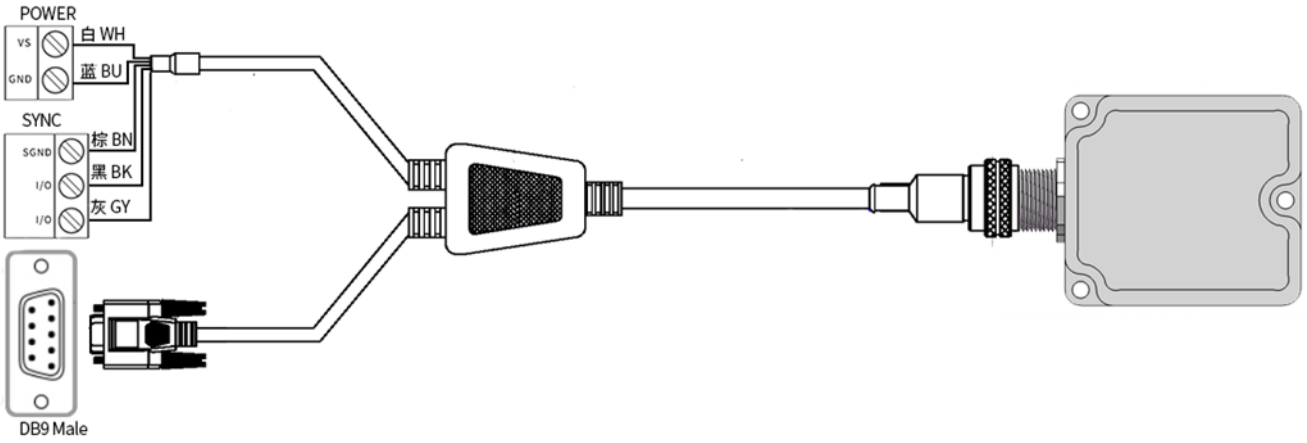


Figure 20: M12-A code 8pin to DB9+OPEN

9.3 M12-A 8-pin Female to DB9 Female (RS-232 with PPS+UTC?GPRMC synchronization)

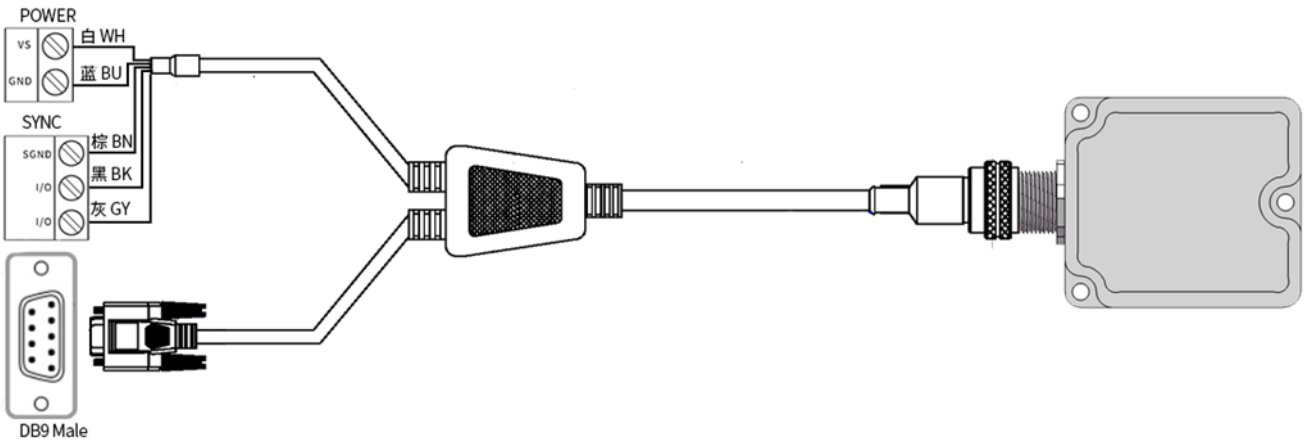


Figure 21: M12-A code 8pin to DB9+OPEN PPS+UTC

9.4 M12-A 8-pin Female to DB9 Female (CAN+RS-232, external power cable)

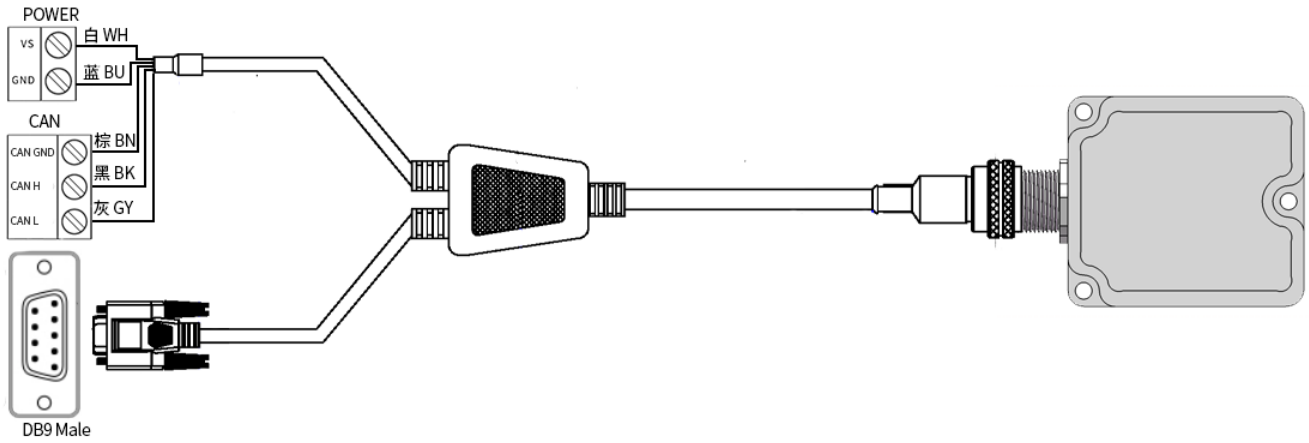


Figure 22: M12-A code 8pin to DB9+OPEN external power CAN+RS-232

9.5 M12-A 5-pin Female to USB-A (RS-232 to USB)

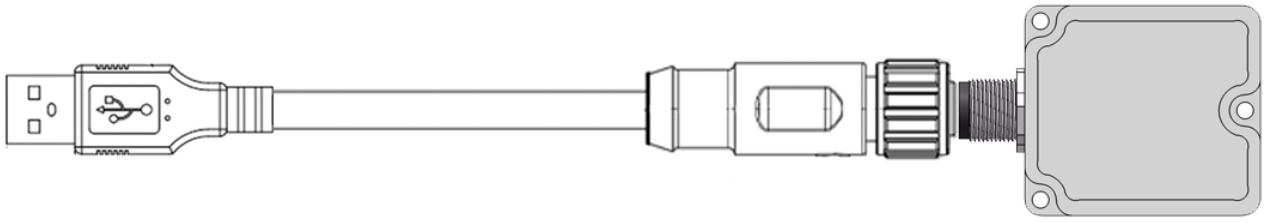


Figure 23: M12-A code 5pin to USB A

9.6 M12-A 5-pin Female to OPEN

9.6.1 RS-485 Interface

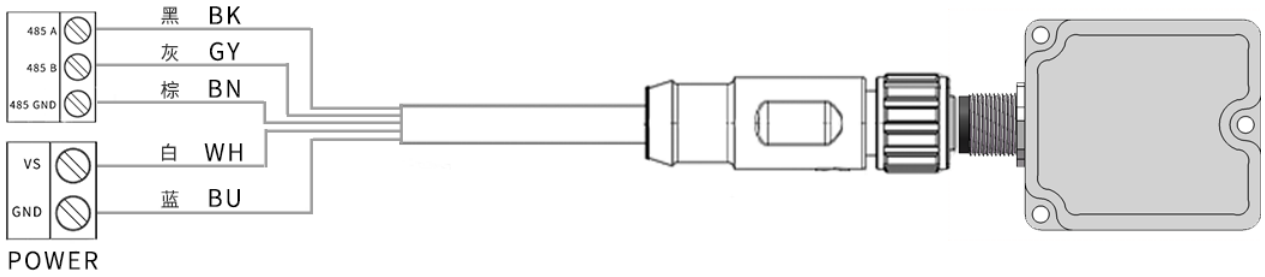


Figure 24: M12-A code 5pin to open RS-485

Note1: If the user's RS-485 device does not have a 485 GND pin, the 485 GND (Brown wire) can be left unconnected.

9.6.2 CAN Interface

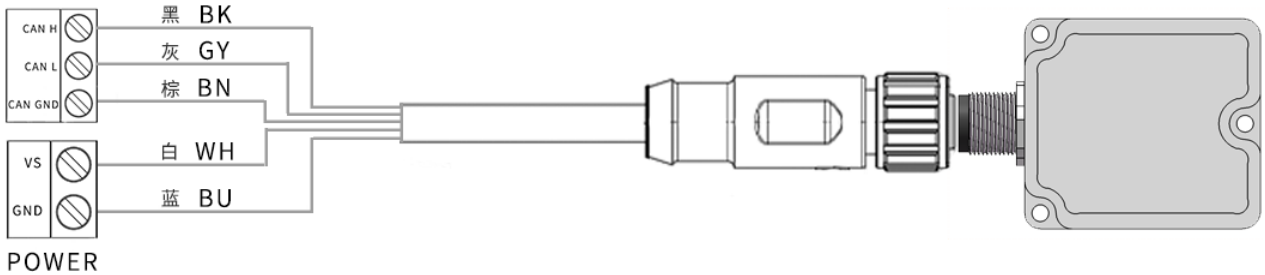


Figure 25: M12-A code 5pin to open CAN

Note1: If the user's CAN device does not have a CAN GND pin, the CAN GND (Brown wire) can be left unconnected.

9.6.3 UART (RS-232/TTL) Interface

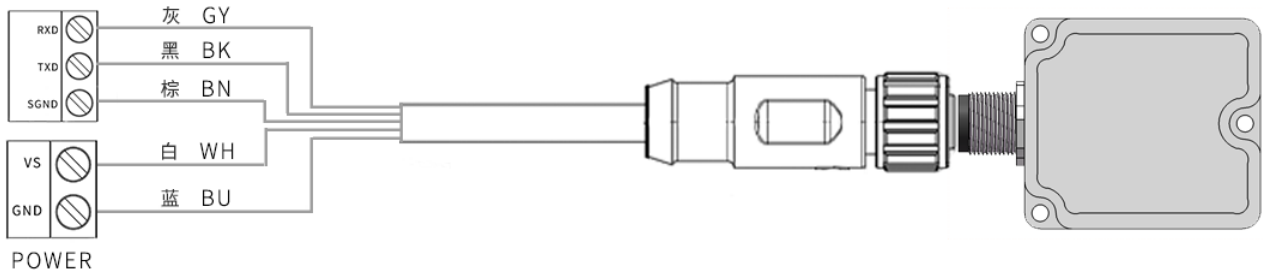


Figure 26: M12-A Code 5pin to Open UART

Note1: If the power system and UART system share a common reference ground, the SGND (Brown wire) can be left unconnected.

9.7 M12-A 8-pin Female to OPEN (UART with synchronization)

9.7.1 Synchronization Input/Output with UART Common Ground

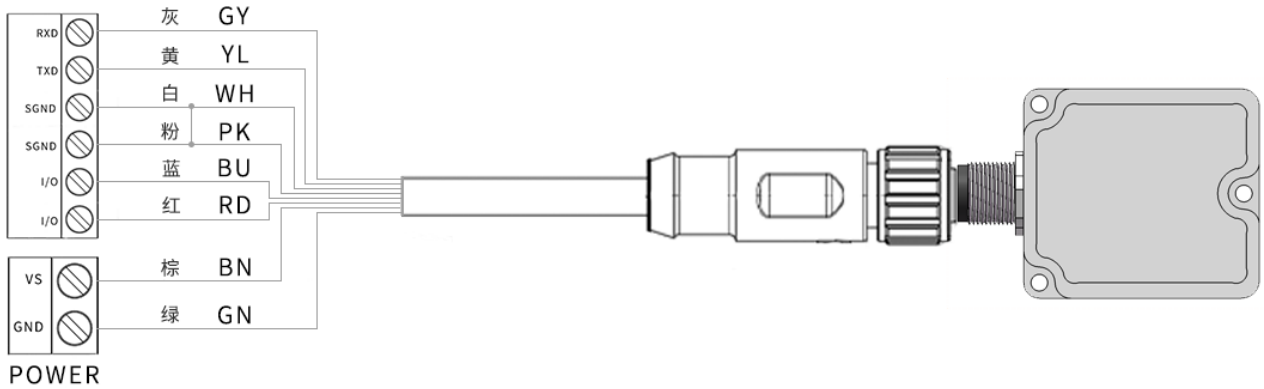


Figure 27: Synchronous with UART common ground

Note1: In this system, if the power and UART systems share a common ground, the SGND (White, Pink wires) can be left floating.

9.7.2 Synchronization Input/Output without UART Common Ground

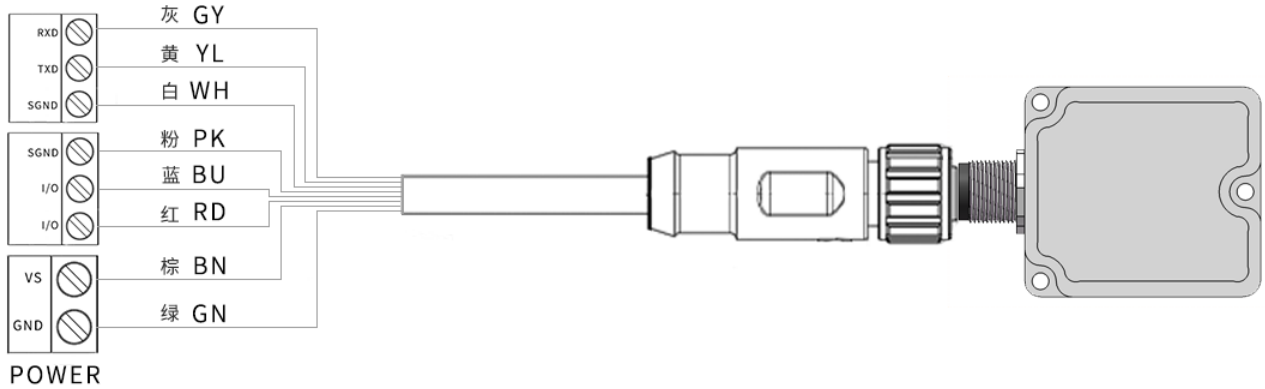


Figure 28: Synchronous with UART not common ground

Note1: If the power system and UART system share the same reference ground, the SGND (White wire) can be left unconnected.

Note2: If the power system and synchronization system share the same reference ground, the SGND (Pink wire) can be left unconnected.

9.7.3 PPS+UTC/GPRMC Synchronization

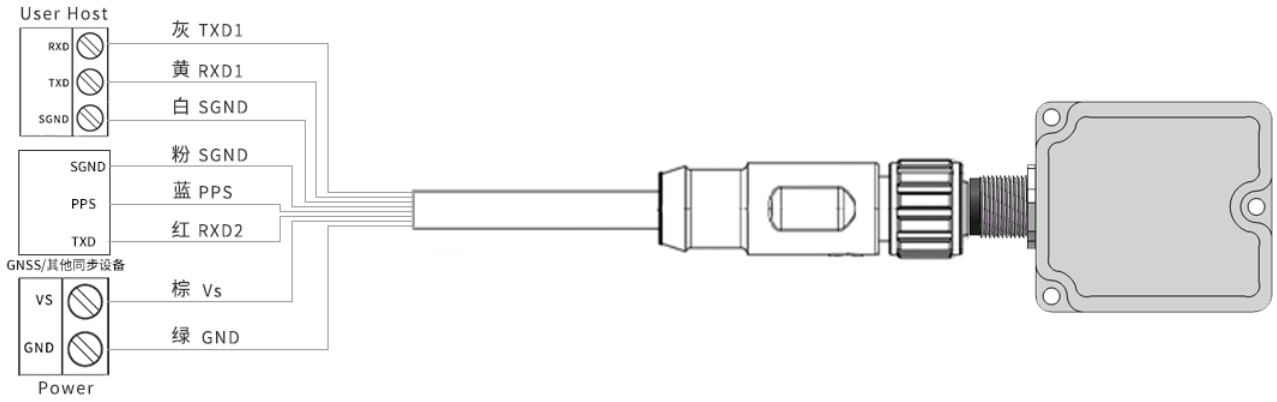


Figure 29: PPS+UTC Synchronous

10 COORDINATE SYSTEM

10.1 Coordinate System

The carrier system uses the Right-Forward-Up (RFU) coordinate system, while the geographic coordinate system uses the East-North-Up (ENU) coordinate system. The axes of the accelerometer and gyroscope are shown in the figure below:

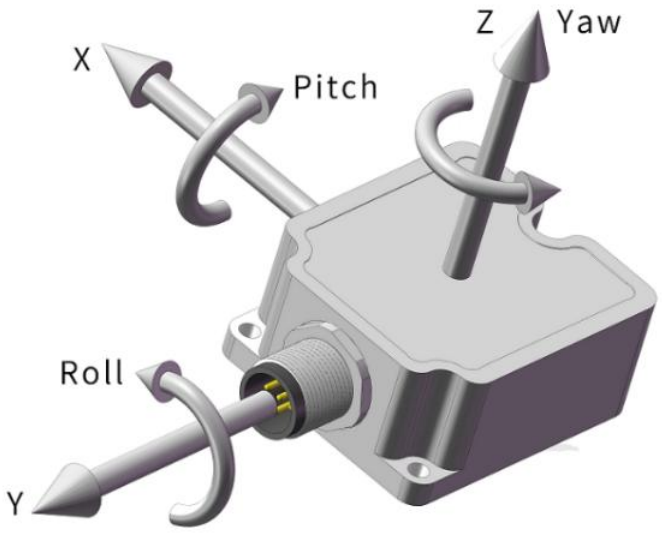


Figure 30: Coordinate System

The Euler angle rotation sequence is East-North-Up-312 (rotate Z-axis first, then X-axis, and finally Y-axis). The specific definitions are as follows:

- Rotation around the Z-axis: Heading angle -180° - 180°
- Rotation around the X-axis: Pitch angle -90°-90°
- Rotation around the Y-axis: Roll angle -180°-180°

If the module is considered as an aircraft, the positive direction of the Y-axis should be regarded as the nose direction. When the sensor coordinate system coincides with the inertial coordinate system, the ideal output of the Euler angles is: Pitch = 0°, Roll = 0°, Yaw = 0°.

If users need to modify the default coordinate system of the sensor, such as North-West-Up or North-East-Down, please refer to the instructions and programming manual.

10.2 Center of Sensor

Table 26: HI14 Series center of sensor

Axis	X-offset	Y-offset	Z-offset	Unit
X	0	0	6.2	mm
Y	0	0	6.2	mm
Z	0	0	6.2	mm

10.3 Recommended Mounting Method

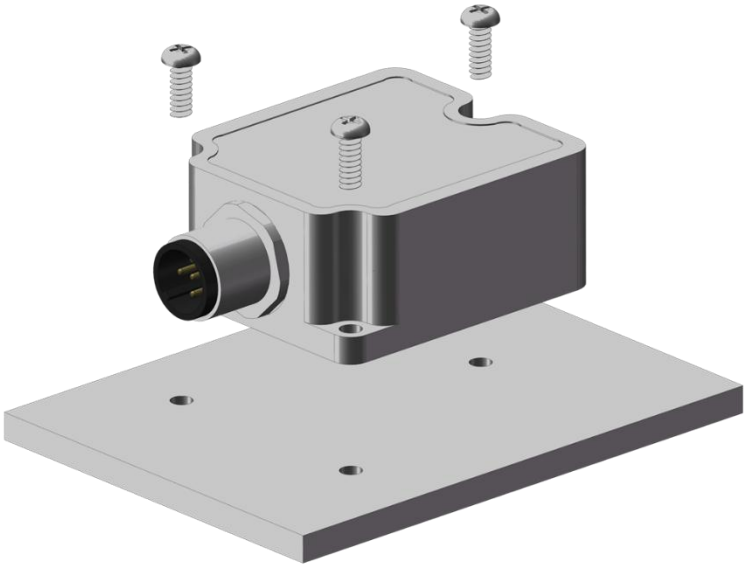


Figure 31: Mounting Example

Note1: For other mounting methods, please refer to the instructions and programming manual for coordinate system rotation.

Note2: It is recommended to install the module in a location on the measured object where vibration and temperature changes are minimal.

11 INITIAL CONFIGURATION

he HI14 series is designed with the goal of requiring minimal configuration by users to cover most application scenarios. The default configuration already meets many working conditions, but additional configuration options are provided for special scenarios.

11.1 Interface Initial Configuration

Table 27: default interface configuration

Interf	Parameters	Condition	Value	Unit	Note
UART	Baud Rate		115200	bps	1
	Start Bit		1	bit	
	Data Length		8	bits	
	Stop Bit		1	bit	
	Parity Bit		None	bit	
	Output Frame Rate		100	Hz	2
	Protocol		Binary Protocol 91		3
CAN	Baud Rate		500	kbps	1
	Output Frame Rate		100	Hz	2
	Protocol		CANopen		3
	120Ω Resistor		None		4
RS-485	Baud Rate		115200	bps	1
	Start Bit		1	bit	
	Data Length		8	bits	
	Stop Bit		1	bit	
	Parity Bit		None	bit	
	Output Frame Rate		10	Hz	2
	Protocol		Modbus		3
	120Ω Resistor		无		4

Note1: To change the baud rate, please refer to the instructions and programming manual.

Note2: To change the data frame rate, please refer to the instructions and programming manual.

Note3: To change the output protocol, please refer to the instructions and programming manual.

Note4: The factory default does not include a 120Ω resistor. If required, please contact us.

11.2 Sensor Initial Configuration

Table 28: 11.2 Sensor initial configuration

Parameters	Value		Unit	Note
Gyroscope Range	HI14MX/RX	±2000	°/s	1
	HI14SX	±2000		
3dB Bandwidth	90		Hz	1
Range	HI14MX/RX	±12	g	1
	HI14SX	±32		
3dB Bandwidth	80		Hz	1
Mode	6DOF			1

12 PROTOCOL

12.1 Serial Binary Protocol

To facilitate user operations, we provide a variety of serial protocols for users to choose from. For more detailed information, please refer to the instructions and programming manual.

12.2 Modbus

The RS485 communication protocol follows the Modbus RTU protocol specification. Data is sent and received in units of registers, with each register occupying 2 bytes. It uses big-endian mode (high byte first). For detailed protocol information, please refer to the instructions and programming manual.

12.3 CAN

12.3.1 CANopen

The CAN interface complies with the CANopen protocol. All communications use standard data frames and transmit data using TPDO1-7. It does not send/receive remote frames or extended data frames. All TPDOs adopt asynchronous timed trigger mode. For detailed protocol information, please refer to the instructions and programming manual.。

12.3.2 J1939

The default output protocol of the module is CANopen. If SAE J1939 protocol is required, please contact us.

13 PACKAGING

HI14 series modules are equipped with custom EPE foam substrates, which are then placed into boxes.

13.1 HI14 Series M12 Interface



Note1: The packaging box also includes the harness used by the user.

Table 29: Carton Dimensions

Device	SPQ(PCS)	L(mm)	W(mm)	H(mm)
HI14	2	150±3	150±3	60±3

Note1: The carton height for PG direct output interface is 70 ± 3 mm.

13.2 HI14 Series PG Interface

Since the HI14 series PG interface uses direct output wiring, the products with direct output wiring are not packed in anti-static bags. Instead, they are directly placed in EPE foam substrates and then packed into boxes. Dimensions refer to section 13.1

14 TERMINOLOGY

IMU:Inertial Measurement Unit

VRU:Vertical Reference Unit

AHRS:Attitude and Heading Reference System

PPS： Pulse Per Second

15 FAQ

15.1 Serial Port Issues

There are many reasons why the IMU cannot be configured or the IMU data cannot be correctly received. The most typical scenarios include the following:

1. IMU's serial port is not cross-connected with the host's serial port

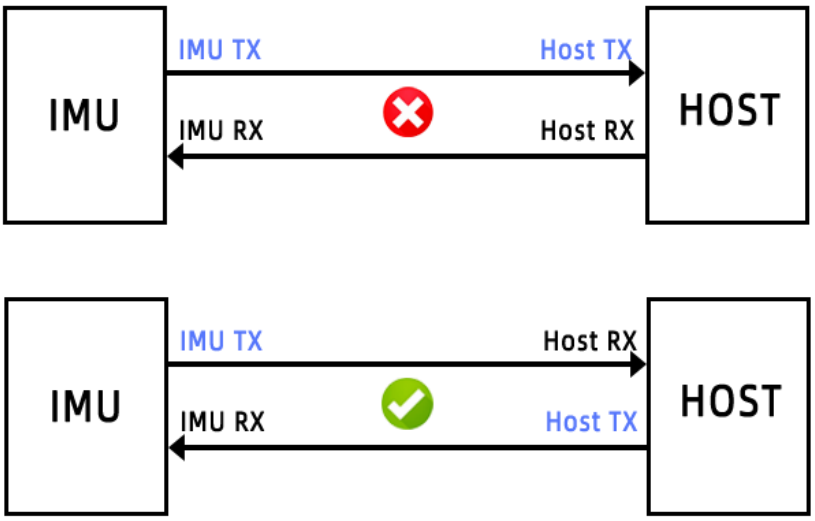


Figure 32: IMU serial port connected to a single host

2. Incorrect serial port configuration

Serial port configurations include many parameters such as baud rate, start bit, data length, parity, and stop bit. The default configuration can be referenced in Chapter 10.1. The most common error is mismatched baud rates, especially when users change the IMU's baud rate but forget to adjust the host's baud rate accordingly. The phenomenon is that the IMU cannot be configured and IMU data cannot be received, as shown in the figure below:

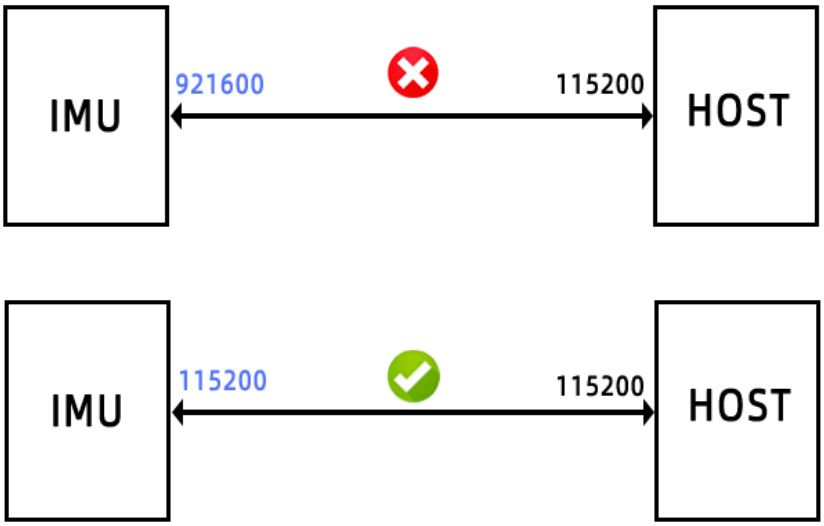


Figure 33: IMU serial port connected to a single host

The above baud rate issue also applies to the CAN interface. The CAN interface also requires the IMU and the user's host to have matching baud rates.

3. IMU's receive (RX) is simultaneously connected to multiple devices' transmit (TX)

Sometimes, users unknowingly connect the serial port to two host devices. In this case, both of the user's hosts will receive IMU data, but the IMU cannot be configured. The most typical scenario is when the IMU is mistakenly connected to both the user's host and our upper computer software, as shown in Figure 27:

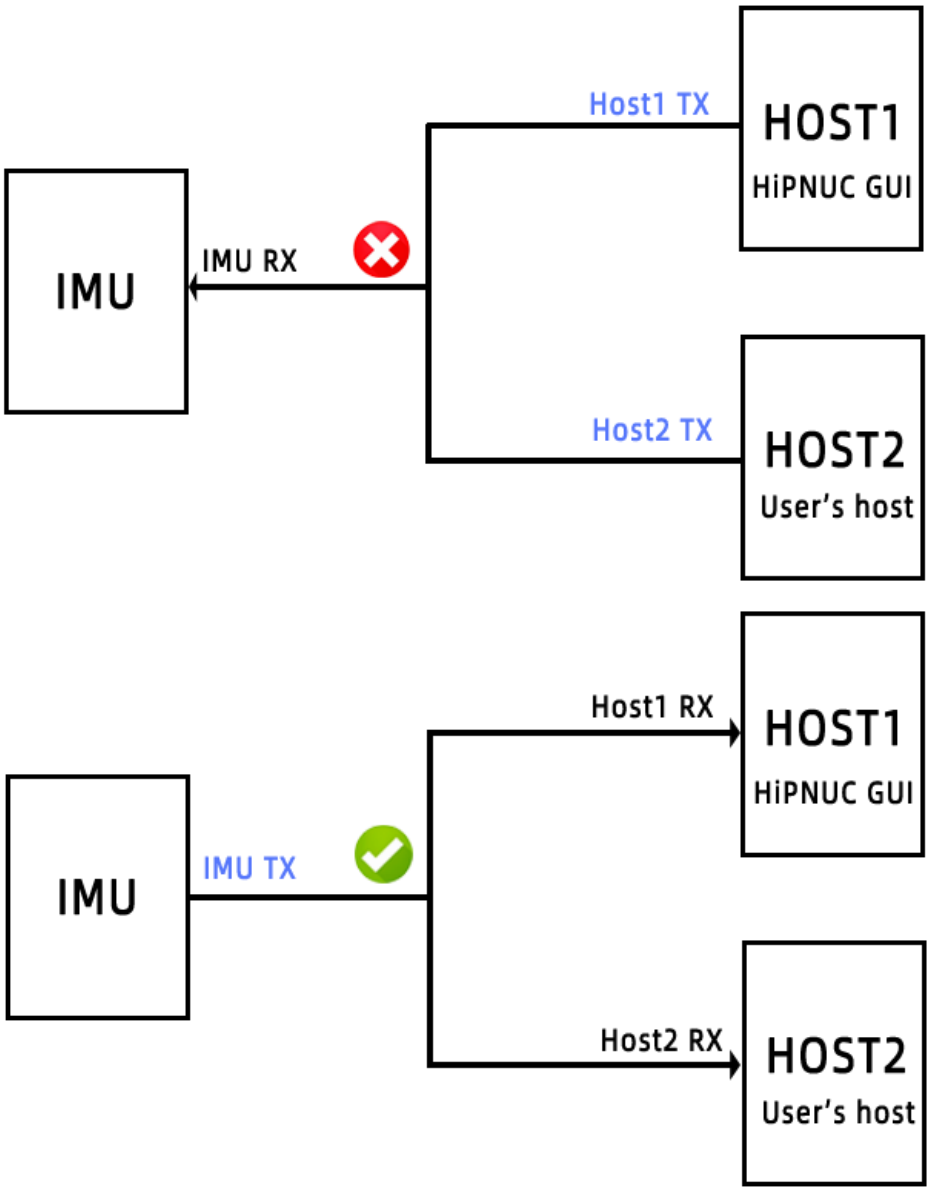


Figure 34: IMU serial port simultaneously connected to the user's host and HiPNUC GUI

4. Software issues

The user's receiving program may not be robust, such as failing to correctly parse data or mismatched CRC checks, which can result in the inability to correctly receive and configure IMU data. In this case, please refer to our official parsing examples or contact us for technical support.

5. Other issues

Hardware issues such as cold solder joints or loose connections, excessively long or poor-quality cables can cause problems. We recommend prioritizing the use of the USB-to-serial cable we provide for users. Our cables are designed to accommodate full-scenario user applications.