1 FETAURES

1.1 Hardware

- High-performance array IMU
- Factory temperature compensation from -40 to 85℃, calibrated for scale factor, cross-axis, and zero bias
- Gyroscope zero bias instability up to 1.76°/h
- Accelerometer zero bias instability up to 21ug
- It supports multiple communication interfaces such as UART (RS-232/TTL)/RS-485/CAN/USB
- Multi-function IO output signal (including but not limited to synchronous input and output, alarm and other functions)
- Supports up to 48V wide input voltage
- IP68 waterproof
- Excellent vibration resistance
- Integrated temperature sensor
- M12 and PG connectors
- RoHS, CE certification

1.2 Software

- Adaptive Extended Kalman Filter fusion algorithm, up to 1KHz output
- Excellent dynamic tracking performance and good vibration suppression
- Outstanding suppression of linear acceleration
- Startup time <1s
- Support for multiple protocols such as binary, CANopen, Modbus, etc
- No need for external command configuration, direct output of data
- Rich user configuration commands
- Multifunctional GUI for easy operation
- Support for multiple driver such as ROS, C, QT etc

2 APPLICATION

- Precision instruments and meters
- Platform stability and control
- Engineering machinery
- Unmanned aerial vehicles
- Smart Agricultural Machinery

3 DESCRIPTION

Figure 1: HI14

3.1 Block diagram

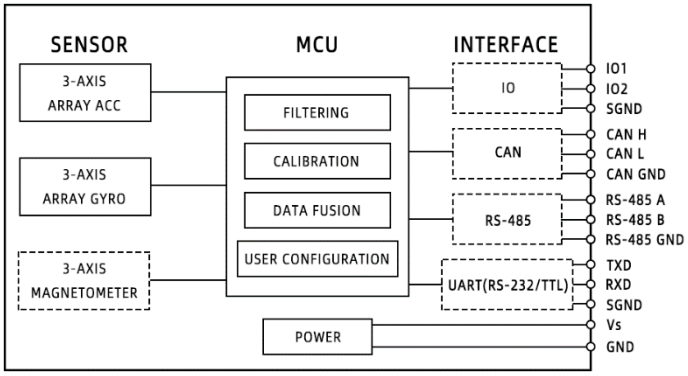


Figure 2: Functional Block Diagram

Note1: The dotted line indicates that some models are not supported, please refer to Table 1 of the product selection table for details

3.2 General description

The HI14 series is an IMU/VRU/AHRS sensor composed of array MEMS-IMU and magnetometer, and is equipped with self-developed adaptive extended Kalman filter, IMU noise dynamic analysis algorithm, and carrier motion state analysis algorithm, which can meet the accuracy of attitude angle under high dynamic and reduce the drift of heading angle.

The HI14 series can be synchronized with the system via external triggers, and can also be time-aligned with external systems such as radar and cameras via the synchronous output function.

For selection and ordering information, please refer to Table 1 and Table 2.

Contents

4 PRODUCT SELECTION

Table 2: Model information

HI14a-b-cde [1]										
Company	Product	a-Sensor		b-Interface		c- Synchronous		d-Connector		e-OEM	
HI	14	M0	1XIMU	232	RS-232	0	None	0	M12	0	Default
		R2	4XIMU	485	RS-485	1	Support	1	PG	1	OEM
		R3	4XIMU+Magnetic	CAN	CAN2.0					2	OEM
		R5	8XIMU+ Magnetic	URT	UART(TTL)						
				USB	USB						

Note1: Model example: HI14R5-232-000, all models default full temperature compensation, 1.5.3 firmware and above support

5 ORDER INFORMATION

5.1 Ordering information

Table 3: Ordering information

Interf	Part Number	Name	Description
RS-232	HI14M0-232-000	IMU/VRU Module	6DoF 5.1°/h 60ug M12
	HI14R2-232-000	IMU/VRU Module	4 Array 6DoF 2.5°/h 30ug M12
	HI14R5-232-000	IMU/AHRS Module	8 Array 6DoF+Magnetic 1.76°/h 21ug M12
	HI14M0-232-010	IMU/VRU Module	Array 6DoF 5.1°/h 60ug PG
	HI14R2-232-010	IMU/VRU Module	4 Array 6DoF 2.5°/h 30ug PG
	HI14R3-232-010	IMU/AHRS Module	4 Array 6DoF+Magnetic 2.5°/h 30ug PG
	HI14R5-232-010	IMU/AHRS Module	8 Array 6DoF+Magnetic 1.76°/h 21ug PG
	HI14R3-232-100	IMU/AHRS Module	4 Array 6DoF+Magnetic 2.5°/h 30ug M12 synchronization
	HI14R5-232-100	IMU/AHRS Module	8 Array 6DoF+Magnetic 1.76°/h 21ug M12 synchronization
UART(TTL)[1]	HI14M0-URT-000	IMU/VRU Module	6DoF 5.1°/h 60ug M12
	HI14R2-URT-000	IMU/VRU Module	4 Array 6DoF 2.5°/h 30ug M12
	HI14R3-URT-000	IMU/AHRS Module	4 Array 6DoF+Magnetic 2.5°/h 30ug M12
	HI14R5-URT-000	IMU/AHRS Module	8 Array 6DoF+Magnetic 1.76°/h 21ug M12
	HI14M0-URT-010	IMU/VRU Module	6DoF 5.1°/h 60ug PG
	HI14R2-URT-010	IMU/VRU Module	4 Array 6DoF 2.5°/h 30ug PG
	HI14R3-URT-010	IMU/AHRS Module	4 Array 6DoF+Magnetic 2.5°/h 30ug PG
	HI14R5-URT-010	IMU/AHRS Module	8 Array 6DoF+Magnetic 1.76°/h 21ug PG
	HI14R3-URT-100	IMU/AHRS Module	4 Array 6DoF+Magnetic 2.5°/h 30ug M12 synchronization
	HI14R5-URT-100	IMU/AHRS Module	8 Array 6DoF+Magnetic 1.76°/h 21ug M12 synchronization
RS-485	HI14M0-485-000	IMU/VRU Module	6DoF 5.1°/h 60ug M12
	HI14R3-485-000	IMU/AHRS Module	4 Array 6DoF+Magnetic 2.5°/h 30ug M12
	HI14R5-485-000	IMU/AHRS Module	8 Array 6DoF+Magnetic 1.76°/h 21ug M12
	HI14M0-485-010	IMU/VRU Module	6DoF 5.1°/h 60ug PG
	HI14R3-485-010	IMU/AHRS Module	4 Array 6DoF+Magnetic 2.5°/h 30ug PG
	HI14R5-485-010	IMU/AHRS Module	8 Array 6DoF+Magnetic 1.76°/h 21ug PG
CAN	HI14M0-CAN-000	IMU/VRU Module	6DoF 5.1°/h 60ug M12
	HI14R2-CAN-000	IMU/VRU Module	4 Array 6DoF 2.5°/h 30ug M12
	HI14R5-CAN-000	IMU/VRU Module	8 Array 6DoF 1.76°/h 21ug M12
	HI14M0-CAN-010	IMU/VRU Module	6DoF 5.1°/h 60ug PG
	HI14R2-CAN-010	IMU/VRU Module	4 Array 6DoF 2.5°/h 30ug PG
	HI14R5-CAN-010	IMU/VRU Module	8 Array 6DoF 1.76°/h 21ug PG
USB	HI14M0-USB-000	IMU/VRU Module	6DoF 5.1°/h 60ug M12
	HI14R2-USB-000	IMU/VRU Module	4 Array 6DoF 2.5°/h 30ug M12
	HI14R3-USB-000	IMU/VRU Module	4 Array 6DoF+Magnetic 2.5°/h 30ug M12
	HI14R5-USB-000	IMU/VRU Module	8 Array 6DoF 1.76°/h 21ug M12

5.2 Contact us

The product can be ordered through the following methods:

1.Mail: sales@hipnuc.com

2.Website

6 DOCUMENT

6.1 Version history

Table 4: Document

Version	Date	Author	Contens
A0	August 19, 2024	Hipnuc	Initial

6.2 Related documents and development kits

1. *Instruction and Programming manual*
2. *CAE/Step*
3. *CE/RoHS/IP68*
4. *GUI and Driver*
5. *HI14 Series Test Reports*

7 SPECIFICATIONS

Unless otherwise noted, the test temperature is 25℃, the supply voltage is 5V, the gyroscope range is 2000°/s, the accelerometer range is 12g, the geomagnetic range is 8 Gauss, and the test sample consists of 8 pcs.

7.1 Absolute maximum value

Table 5: Absolute maximum value

Parameters	Limit	Comment
Mechanical shock	2000g	Duration <1ms
Storage temperature	-40℃-85℃	
ESD HBM	30KV	JEDEC/ESDA JS-001
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 Operating conditions

Table 6: Operating conditions

Parameters	Condition	Min	Nom	Max	Unit	Note
Input voltage		5	-	48	V	
Power consumption	HI14M0			300	mW	
	HI14R2/HI14R3			400		
	HI14R5			600		
Operating temperature		-40	-	85	℃	
Gyroscope range		125	2000	2000	°/s	1
Accelerometer range		3	12	24	g	1
Startup time				2	s	2

Note1: If you need to configure other ranges, you can refer to the instruction and programming manual for configuration

Note2: Startup time refers to the duration from when the system is powered on until valid data output is available. During this period, the module should remain stationary

7.3 Interface

Table 7: Interface parameters

Interf	Parameters	Condition	Min	Nom	Max	Unit	Note
UART	Baud		9600	115200	921600	bps	1
	Start Bit			1		bit	
	Data Length			8		bits	
	Stop bit			1		bit	
	Parity Bit			None		bit	
	Frame rate		0	100	1000	Hz	2
	Input impedance	RS-232	3	5	7	kΩ	
	Output impedance		300	10M		Ω	
CAN	Baud		125	500	1000	kbps	3
	Frame rate		5	100	200	Hz	4
	Input impedance	120Ω		120		Ω	5
		None 120Ω	19	30	52	kΩ	
RS-485	Baud	Modbus	9600	115200	115200	bps	
		None Modbus	9600	115200	460800		
	Start Bit			1		bit	
	Data Length			8		bits	
	Stop bit			1		bit	
	Parity Bit			None		bit	
	Frame rate	Modbus	0	10	50	Hz	
		None Modbus	0	100	250	Hz	
	Input impedance	120Ω		120		Ω	5
		None 120Ω	48			kΩ	
Trigger	Logic voltage	High	2.0			V	
		Low			0.6	V	6
	Delay	From trigger generation to data transmission			800	us	

Note1: If modification is required, please refer to the instruction and programming manual

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

Note3: If you need to change the baud rate, please refer to the instruction and programming manual.

Note4: The sensor supports 5, 10, 50, 100, 200, 250 Hz

Note5: By default, no 120Ω resistor is connected.

Note6: For the trigger timing and configuration, please refer to the Synchronous Function section and the Instructions and Programming Manual

7.4 Gyroscope

Table 8: Gyroscope parameters

Parameters	Condition	Product	Min	Nom	Max	Unit	Note
Range				2000		°/s	
Resolution				16bit			
Scale factor	100°/s	HI14M0		<600	800	ppm	1
		HI14R2/HI14R3		<280	350		
		HI14R5		<280	300		
Nonlinearity	Best fit straight Fs=2000°/s		-0.05	-	0.05	%Fs	2
3dB Bandwith				47		Hz	
Sample				1000		Hz	
Bias instability	Allan Variance	HI14M0		5.1		°/h	3
		HI14R2/HI14R3		2.5			
		HI14R5		1.76			
Bias repeatability	Allan Variance	HI14M0		0.09		°/s	3
		HI14R2/HI14R3		0.05			
		HI14R5		0.03			
Random walk	Allan Variance	HI14M0		0.6		°/√h	3
		HI14R2/HI14R3		0.3			
		HI14R5		0.21			
Zero-g Offset Change over Temperature-40-85℃	Z			0.015	0.035	°/s	4
	Y			0.05	0.18		
	X			0.03	0.08		
g-Sensitivity	All three axis			0.1		°/s/g	

Note1: The turntable rotates 10 times in both directions and takes the average value.

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

Note3: Test sample average value, refer to 7.8-Allan variance

Note4: The temperature rise slope is less than 3℃/min as measured by the temperature box turntable of the HiPNUC laboratory. For detailed data, please refer to the temperature compensation curve in Figure 9

7.5 Accelermoters

Table 9: Accelermoters

Parameters	Condition	Product	Min	Nom	Max	Unit	Note
Range				12		g	
Resolution				16bit			
Zero-g Offset					5	mg	
Nonlinearity	Best fit straight line Fs=3g			0.5		%Fs	1
3dB Bandwidth				145		Hz	
Sample				1600		Hz	
Bias instability	Allan Variance	HI14M0		60		ug	2
		HI14R2/HI14R3		30			
		HI14R5		21			
Bias repeatability	Allan Variance	HI14M0		2.52		mg	2
		HI14R2/HI14R3		1.5			
		HI14R5		0.6			
Random walk	Allan Variance	HI14M0		0.08		m/s√h	2
		HI14R2/HI14R3		0.04			
		HI14R5		0.028			
Zero-g Offset Change over Temperature	-40-85℃			1	2.5	mg	3

Note1: Maximum deviation from the best fit straight line within the specified range

Note2: Average value of test samples, refer to 7.8-Allan variance curve

Note3: The temperature rise slope is less than 3℃/min as measured by the temperature box turntable of the HiPNUC laboratory. For detailed data, please refer to the temperature compensation curve in Figure 9

7.6 Magnetometer

Table 10: Magnetometer

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

7.7 Temperature sensor

Table 11: Temperature sensor parameters

Parameters	Condition	Min	Nom	Max	Unit	Note
Range		-104	-	150	℃	
Offset error			±1		K	

7.8 Allan variance

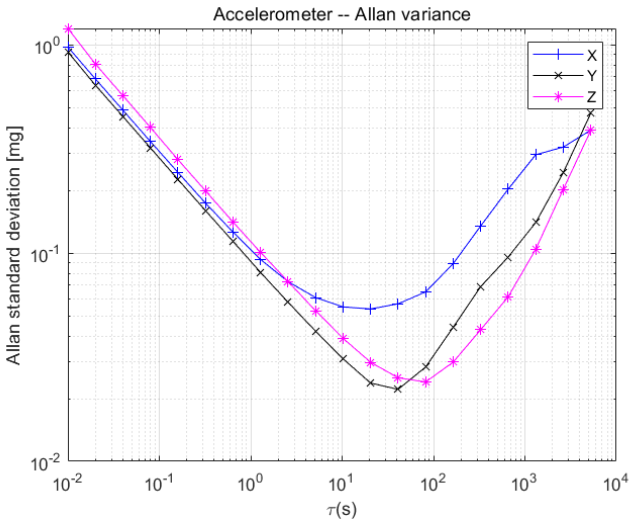


Figure 3: HI14M0 Accelerometer Allan Variance

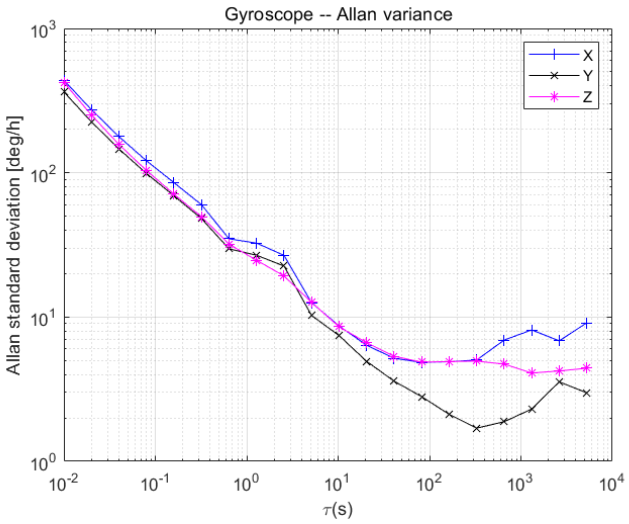


Figure 4: HI14M0 Gyroscope Allan Variance

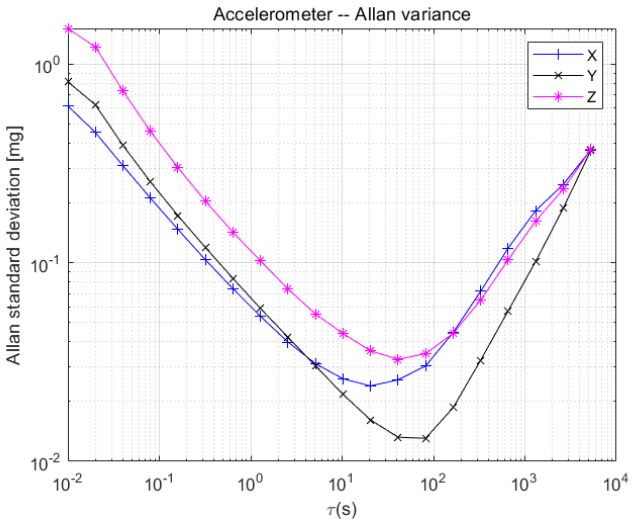


Figure 5: HI14R2/HI14R3 Accelerometer Allan Variance

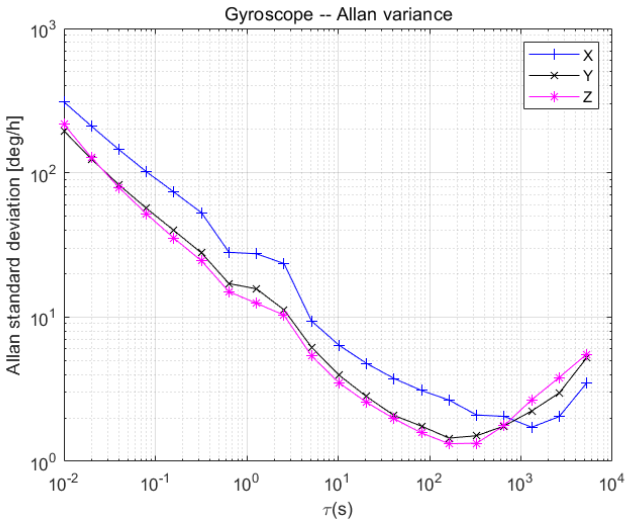


Figure 6: HI14R2/HI14R3 Gyroscope Allan Variance

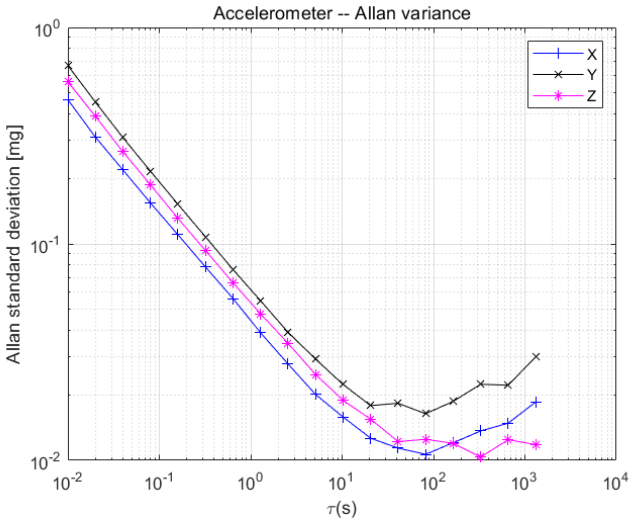


Figure 7: HI14R5 Accelerometer Allan Variance

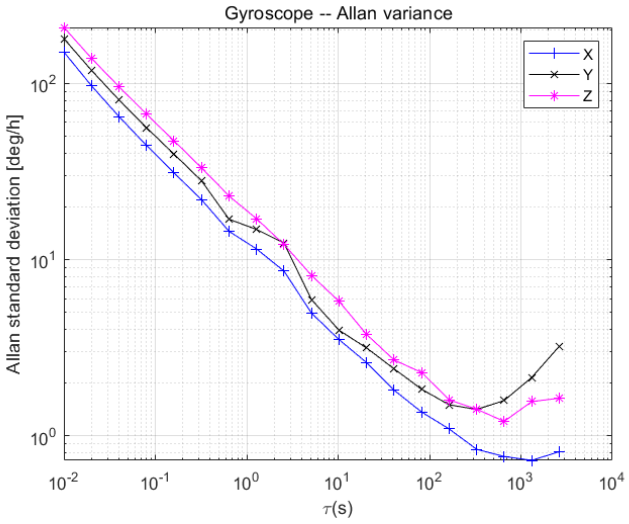


Figure 8: HI14R5 Gyroscope Allan Variance

7.9 Temperature Compensation

The measured sample is heated from -40℃ to 85℃, and the zero-offset data for the sample is compensated. The compensation results are as follows:

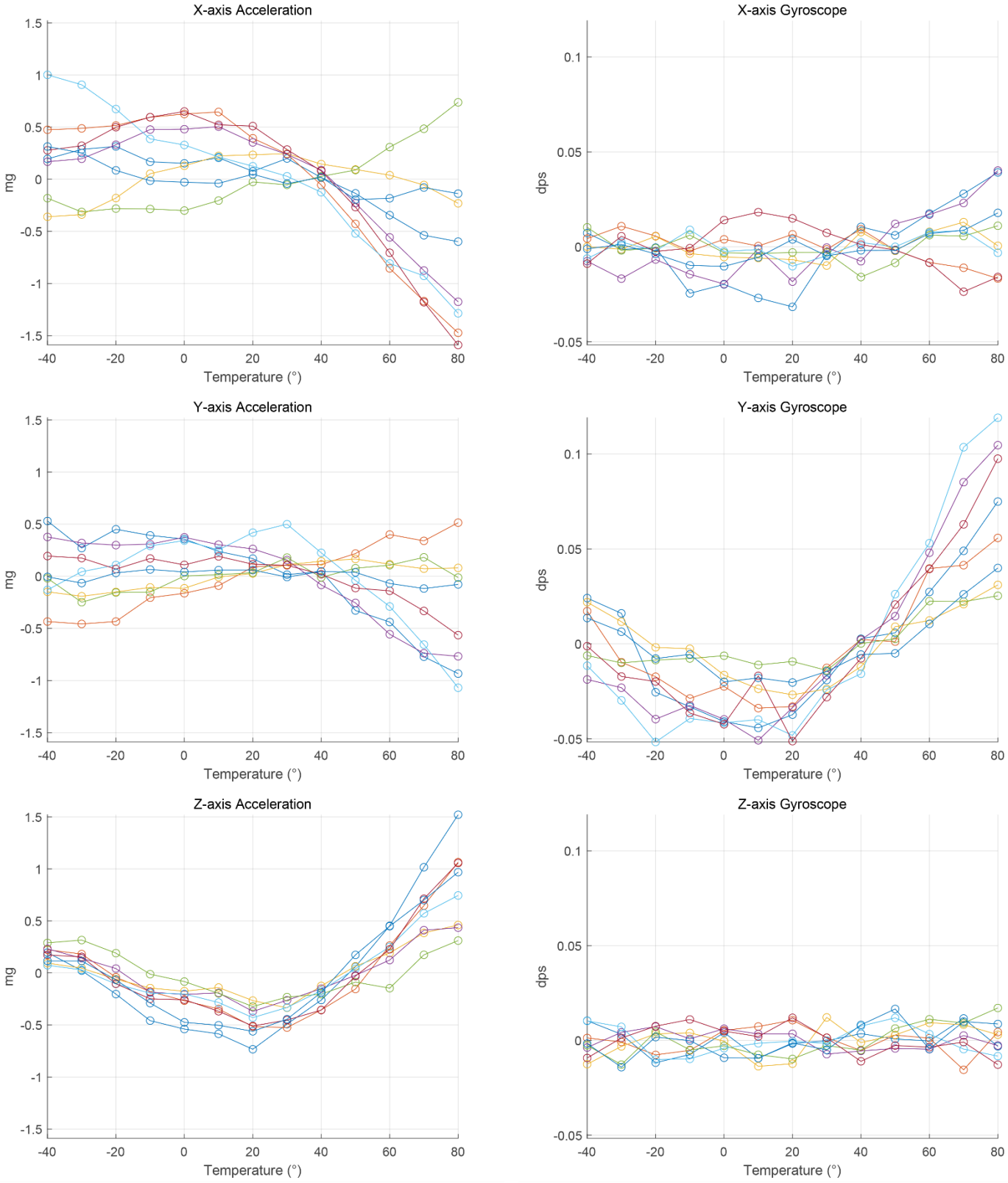


Figure 9: Accelerometer and Gyroscope Temperature Compensated Curve

7.10 Fusion parameters

Table 12: Fusion parameters

Parameters	Value
Pitch	±90°
Roll	±180°
Yaw	±180°
Resolution	0.01°

7.11 Attitude angle accuracy

Table 13: Attitude angle accuracy

Parameters	Condition	Product	Min	Nom	Max	Unit	Note
Pitch/Roll (static)				0.1	0.2	°	
Pitch/Roll (dynamic)				0.1	0.2	°	
Heading Angle Static Drift (6DOF)	Standstill 2h			0.1	0.2	°	1
Heading Angle Dynamic Drift (6DOF)		HI14M0		9		°	2
		HI14R2/HI14R3		5			
		HI14R5		5			
Heading Angle Magnetic Assistance (AHRS)				2	3	°	3
Heading angle rotation error (6DOF)	100°/s	HI14M0			3	°	4
		HI14R2/HI14R3		<0.8	1.3		
		HI14R5			1		

Note1: The module remains horizontal and still for 2 hours

Note2: The module was measured on an indoor cleaning robot for 1 hour.1σ

Note3: After geomagnetic calibration, the measurement is performed without magnetic field interference. The product needs to be configured in AHRS mode.

Note4: The turntable rotates 10 times continuously, and the heading angle accumulates error.

7.12 Mechanical and Environmental

Table 14: Mechanical and Environmental

Parameters	Product	Value
Dimensions	M12	58.5X40X20mm
	PG	40X36X16mm
Weight		<75g
Shield material		Aluminum alloy
Screw		M3
Surface treatment		Spray paint
Vibration resistance		1.0mm(10Hz-58Hz)&≤20g(58Hz-600Hz)
Certification		RoHS 2011/65/EU
		CE
		IP68
Drop test		Free fall 3 times on a 75cm high test bench
Temperature shock		The temperature was raised from -40℃ to 85℃ within 1 hour, 5 times

7.13 Product dimensions

All Dimensions in mm units.

7.13.1 M12 Connector

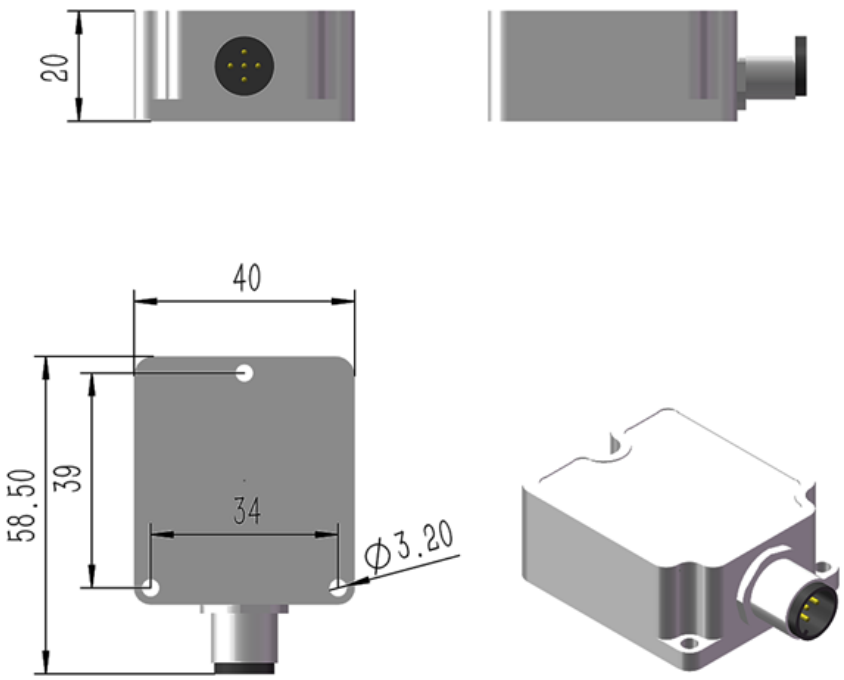


Figure 10: HI14 M12 Mechanical Dimension

7.13.2 PG Connector

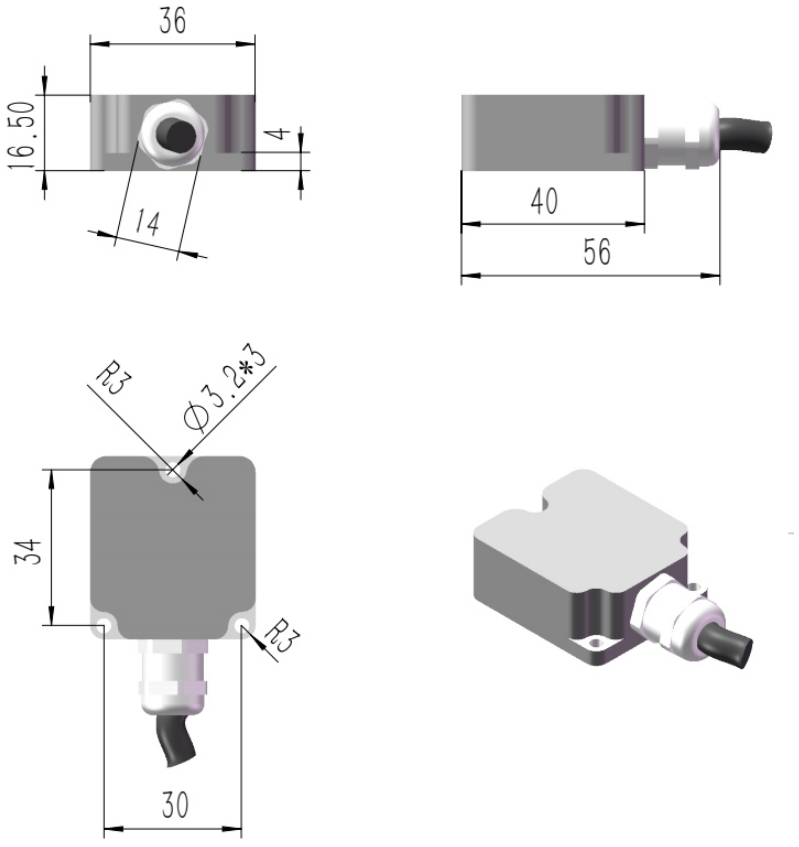


Figure 11: HI14 PG Mechanical Dimension

7.14 Pin description

7.14.1 M12 Connector(UART)

Figure 12: M12 Pin definition(sensor side)

Table 15: UART pin description

M12 5Pin	M12 8 Pin	Pin Name	Type	Description			Note
1	1	SGND	Power	Signal Ground			1
2	2	Vs	Power	Power+			
3	3	GND	Power	Power Ground			1
4	4	RXD	I	Module UART1 Receive			2
5	5	TXD	O	Module UART Transmit			
	6	SGND	Power	Signal Ground			1
	7,8	IO1, IO2	I/O	PMUX1	SYNC_IN	Synchronization input, can be left floating if not used.	3
				PMUX2	SYNC_OUT	Synchronization output, can be left floating if not used.	
				PMUX3	LED	LED Indicator, can be left floating if not used.	
				PMUX4	SOUT_DIV	Synchronization Output Divider, can be left floating if not used.	
				PMUX5	ALARM	Alarm Signal Output, can be left floating if not used.	

Note1: The signal ground is connected to the power ground through a 0Ω resistor

Note2: The serial port level depends on the interface selected by the user, if it is an RS-232 interface, then the interface level is RS-232, if it is a UART interface, then the level is TTL

Note3: Multifunction IO pins; for detailed explanations, refer to the programming manual.

Table 16: Default functions of IO pins

IO	Functional
IO1	PMUX1
IO2	PMUX2

7.14.2 M12 Connector(RS-485)

Figure 13: M12 Pin definition(sensor side)

Table 17: RS-485 pin description

M12 5Pin	Pin Name	Type	Description	Note
1	485 GND	Power	RS-485 GND can be left floating if not used	
2	Vs	Power	Power+	
3	GND	Power	Power Ground	
4	485 A	AIO	RS-485 A	
5	485 B	AIO	RS-485 B	

7.14.3 M12 Connector(CAN)

Figure 14: M12 Pin definition(sensor side)

Table 18: CAN pin description

M12 5Pin	Pin Name	Type	Description	Note
1	CAN GND	Power	CAN GND can be left floating if not used	
2	Vs	Power	Power+	
3	GND	Power	Power Ground	
4	CAN H	AIO	CAN High	
5	CAN L	AIO	CAN Low	

7.14.4 PG pin description

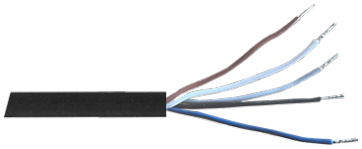
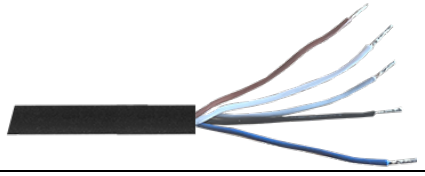


Figure 15: PG Cable

Table 19: PG pin description

PG Connector					
Number	1	2	3	4	5
Color	Brown	White	Blue	Black	Grey
UART	SGND	Vs	GND	RXD	TXD
RS-485	485 GND	Vs	GND	RS-485 A	RS-485 B
CAN	CAN GND	Vs	GND	CAN H	CAN L

8 CABLE

Description	Digram	Note
M12 5-pin straight female connector -DB9 female +OPEN External power Default applicable to HI14XX-232-00X		1
M12 8-pin straight female connector -DB9 female +OPEN External power Default applicable to HI14XX-232-10X		1
M12 5-pin straight female connector -DB9 female Power supply built-in Pin9 is Vs Default applicable to HI14XX-232-00X		1
M12 5-pin straight female connector -OPEN Default applicable to HI14XX-485-00X,HI14XX-CAN-00X HI14XX-URT-00X		1
M12 8-pin straight female connecto-OPEN Default applicable to HI14XX-URT-10X		1
M12 5-pin straight female connector-USB A male Default applicable to HI14XX-USB-00X		1,2
PG connector-OPEN Default applicable to HI14XX-485-01X, HI14XX-CAN-01X HI14XX-URT-01X, HI14XX-232-01X		
PG connector-DB9+OPEN[4] Default applicable to HI14XX-232-01X		

Note1: All cables are made of PUR, with a default length of 3m. Cable lengths of 1m and 5m are also available. If other cable lengths are required, PG connector sensors can be given priority. All cables can be customized with M12A angle cables。

Note2: Built-in USB to RS-232 chip

9 HOW TO CONNECT

9.1 M12-A 5-pin female to DB9 female (power external)

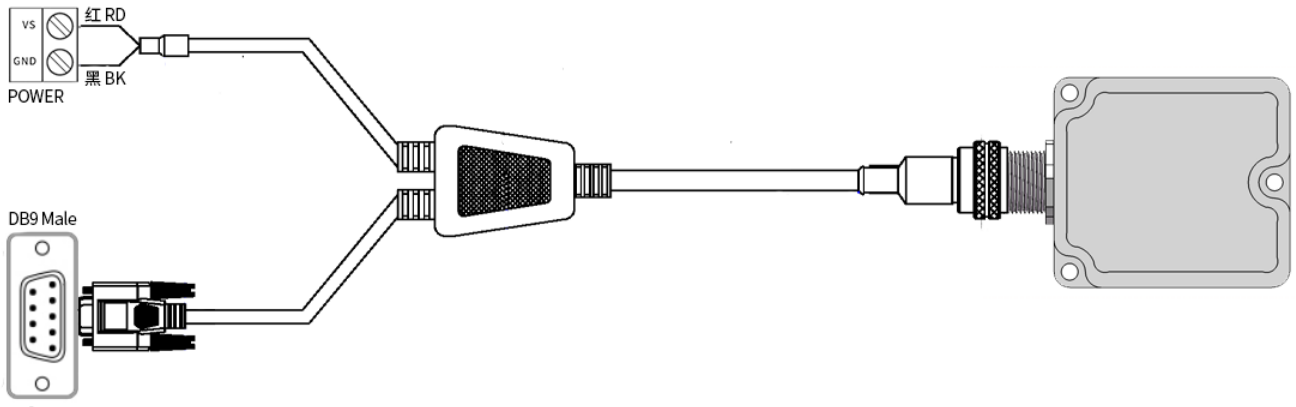


Figure 16: M12-A code 5pin to DB9+OPEN external power

9.2 M12-A 5-pin female to DB9 female (power external with sync pin)

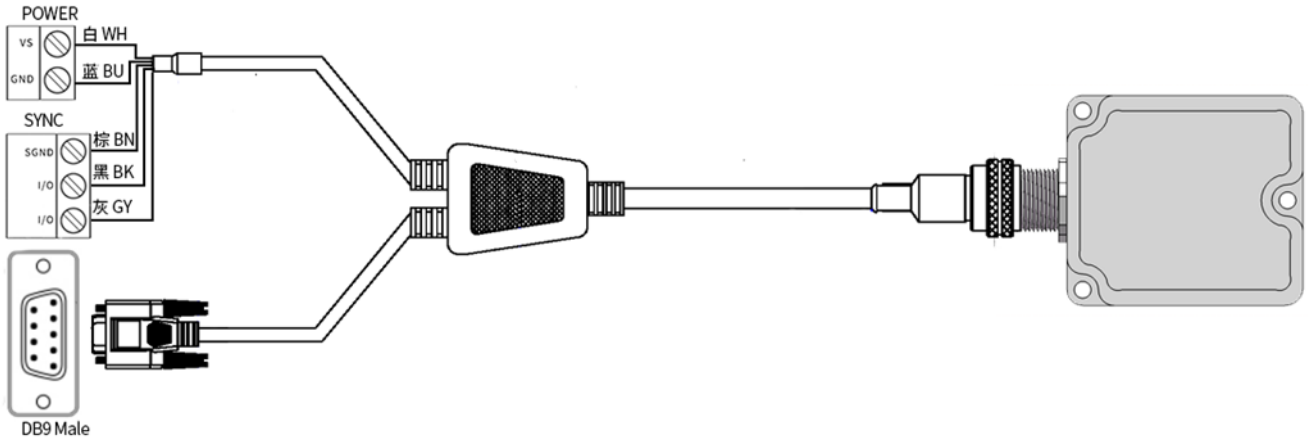


Figure 17: M12-A code 8pin to DB9+OPEN external power

9.3 M12-A 5-pin female to DB9 female (power internal)

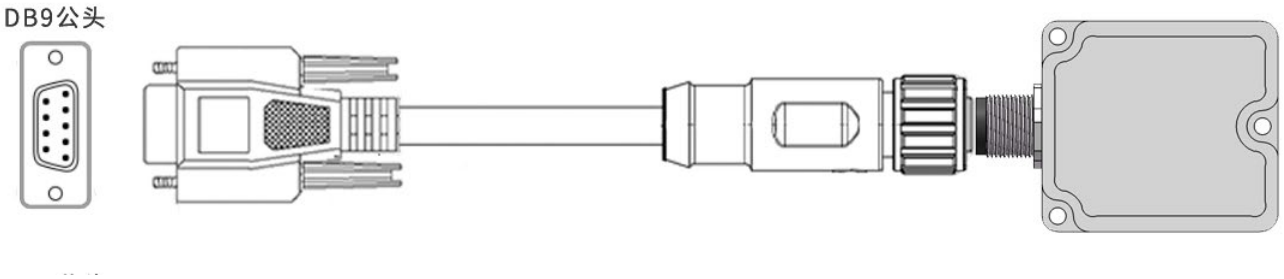


Figure 18: M12-A code 5pin to DB9 internal power

Note1: This wiring method requires that Pin 9 of DB9 is Vs

9.4 M12-A 5-pin female connector to USB-A

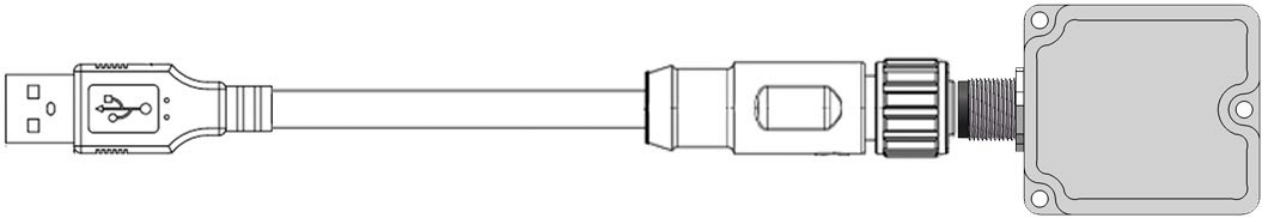


Figure 19: M12-A code 5pin to USB A

9.5 M12-A 5-pin female connector to OPEN

9.5.1 RS-485

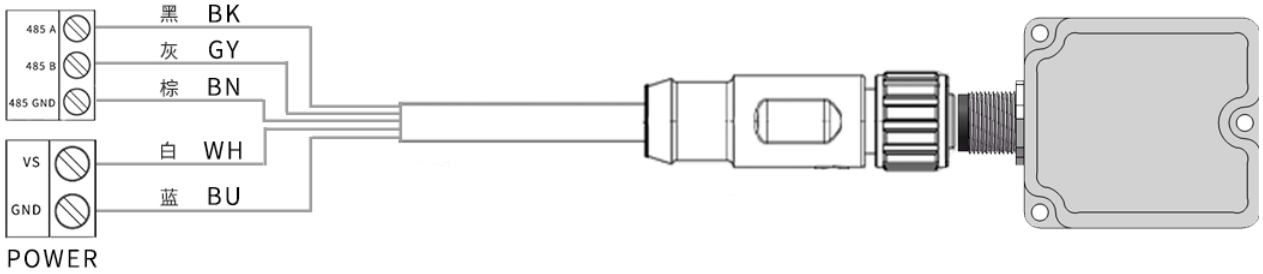


Figure 20: M12-A code 5pin to open RS-485

Note1: If the user's 485 device does not have a 485 GND pin, then the 485 GND (brown wire) can be left unconnected

9.5.2 CAN

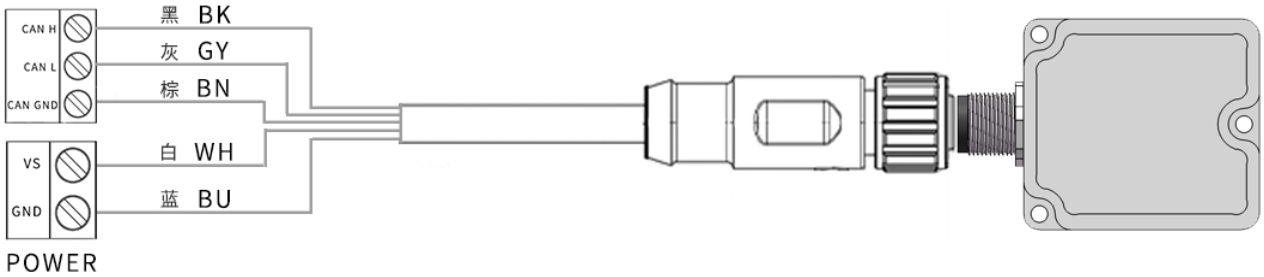


Figure 21: M12-A code 5pin to open CAN

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

9.5.3 UART(RS-232/TTL)

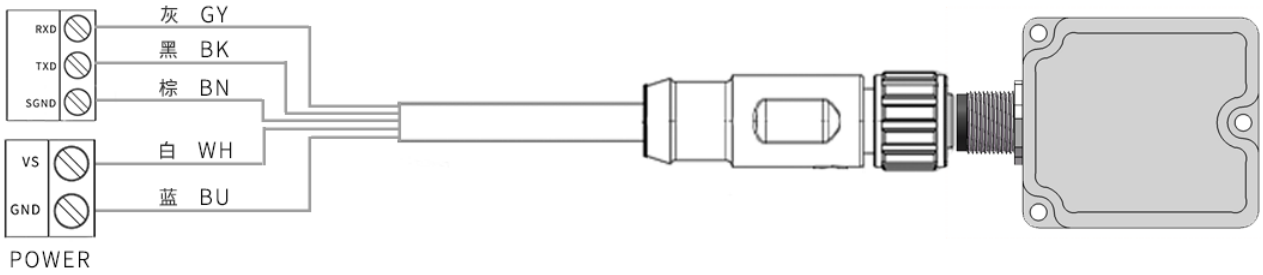


Figure 22: M12-A Code 5pin to Open UART

Note1: If the power system and the UART system have a common reference ground, then SGND (brown wire) can be disconnected

9.6 M12-A 8-pin female connector to OPEN

9.6.1 Synchronous input and output share the same ground with the UART

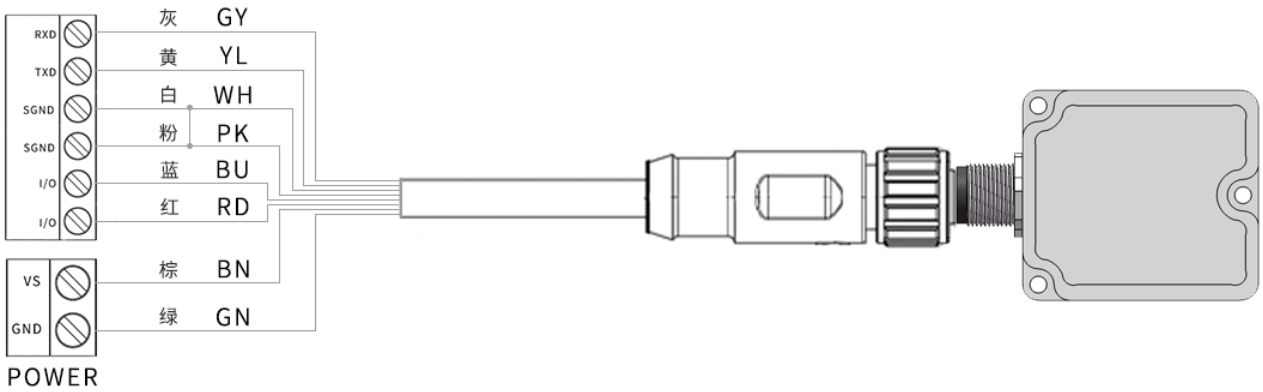


Figure 23: Synchronous with UART common ground

Note1: If the power system and the UART system have a common reference ground, then the SGND (WH, PK) can be disconnected

9.6.2 Synchronous input and output do not share the same ground with the UART

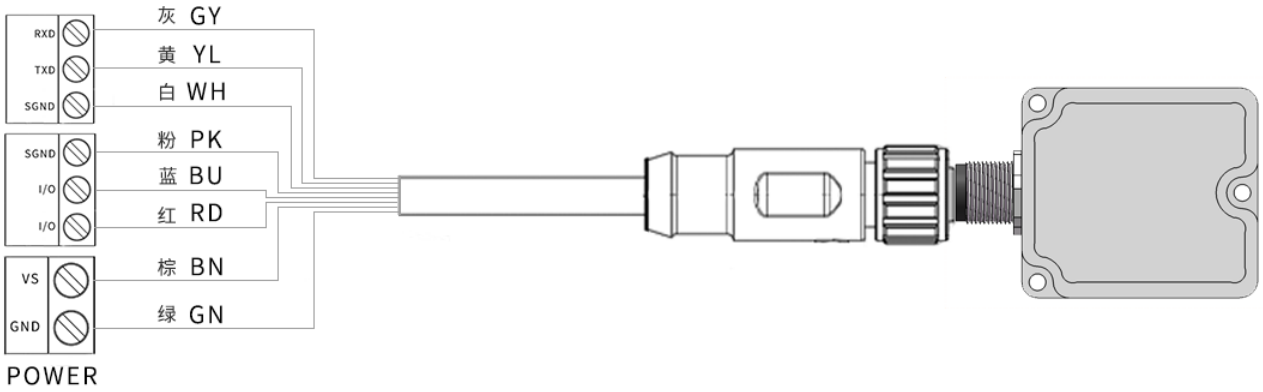


Figure 24: Synchronous with UART not common ground

Note1: If the power supply system and the UART system reference ground have a common reference ground, then the SGND (WH) can be disconnected

Note2: If the power supply system and the synchronization system do not have a common reference ground, then the SGND (PK) can be disconnected

10 COORDINATE SYSTEM AND INSTALL

10.1 Coordinate system

Carrier system uses the Right-Front-Up (RFU) coordinate system, while the geographical system uses the East-North-Up (ENU) coordinate system. The axes for acceleration and gyroscope are as shown in the following diagram

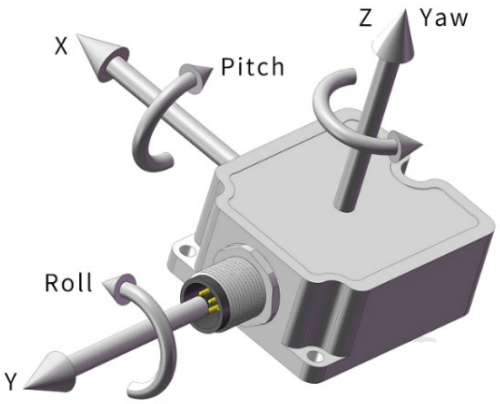


Figure 25: Coordinate System

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

- Rotate around the Z-axis direction: Heading\psi(ψ) -180° - 180°
- Rotate around the X-axis direction:Pitch\theta(θ) -90°-90°
- Rotate around the Y-axis direction: Roll\phi(ϕ) -180°-180°

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

If users need to change the default coordinate system of the sensor, they can refer to the instructions and programming manual

10.2 IMU mass center position

Table 20: HI14 mass center positio

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 Installation

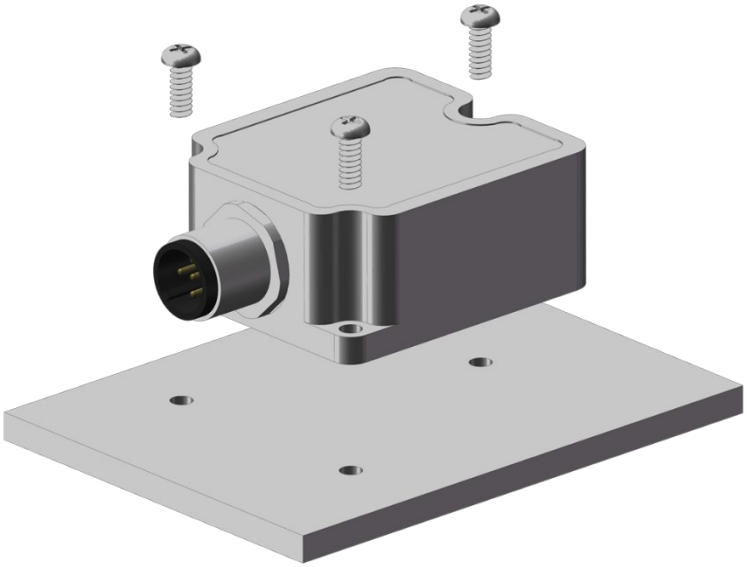


Figure 26: Mounting Example

Note1: For other installation methods, please refer to the instructions and programming manual to rotate the coordinate system

Note2: It is recommended to install the module in a position where the vibration of the measured object is small and the temperature change is small

11 INITIAL CONFIGURATION

The HI14 series is designed with the intention of allowing users to perform minimal configuration to cover the vast majority of application scenarios. Therefore, the default configuration can meet many operational conditions, but we also provide users with additional configuration options to address special situations.

11.1 Interface initial configuration

Table 21: Interface initial configuration

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

Note1: For changing the baud rate, please refer to the instruction and programming manual

Note2: For changing the output frame rate, please refer to the instruction and programming manual

Note3: For changing the protocol, please refer to the instruction and programming manual

Note4: There is no 120Ω resistor by default, please contact us if needed

11.2 Sensor initial configuration

Table 22: Sensor initial configuration

Parameters	Value	Unit	Note
Gyroscope range	±2000	°/s	1
3dB Bandwidth	47	Hz	1
Accelerometer range	±12	g	1
3dB Bandwidth	145	Hz	1
Magnetometer range	±8	Gauss	1
Mode	6DOF		1

Note1: For changing parameters such as range, bandwidth, and mode, please refer to the instruction and programming manual

12 COMMUNICATION PROTOCOL

12.1 Binary protocol

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

12.2 Modbus

The RS485 communication protocol follows the Modbus RTU protocol specification. Data is transmitted 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 instruction and programming manual.

12.3 CAN

12.3.1 CANopen

The CAN interface complies with the CANopen protocol, where all communication uses standard data frames. Data is transmitted using TPDO1-7. Remote frames and extended data frames are not received/sent. All TPDOs use asynchronous timed-trigger mode. For detailed protocol information, please refer to the instruction and programming manual.

12.3.2 J1939

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

13 SYNCHRONIZATION

If the user's system includes multiple subsystems, such as LiDAR and cameras, data synchronization between the systems becomes extremely important. Our IMU supports synchronized pulse input and output, making it more convenient for users during operation

Note1: The IMU and the external synchronization system need to share a common ground

13.1 External system triggering the IMU

Synchronized Pulse Input (SYNC_IN): Pull-up input, with a high level in the idle state. When the module detects a falling edge, it will output a frame of data. At this time, the module should be in synchronized trigger mode, also known as ONMARK mode.

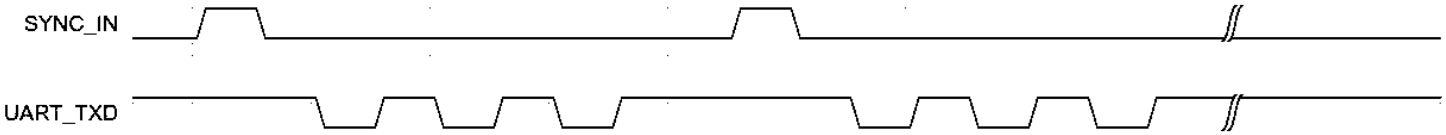


Figure 27: Sync_In Timing

13.2 IMU triggering external systems (SYNC_OUT/SYNC_OUT_DIV)

The data synchronization output can serve as a pin for the IMU to trigger external systems, such as cameras and LiDAR. This pin is set to output mode by default, and when there is no data output, it remains at a low level (idle).

The IMU synchronization output pin can operate in a mode that matches the data output frequency, acting as a Data Ready signal, or it can work at a different frequency through a division factor.

13.2.1 Synchronized output pulse at the same frequency as data output

When a frame of data begins to be sent, a high pulse is generated on the SYNC_OUT pin, with a pulse width of 80 μs. Therefore, if the module outputs data at 100 Hz, there will be 100 corresponding synchronized pulses.

Example: The module outputs data at 100 Hz, and the SYNC_OUT pin outputs a 100 Hz pulse signal. Example of synchronized output waveform:

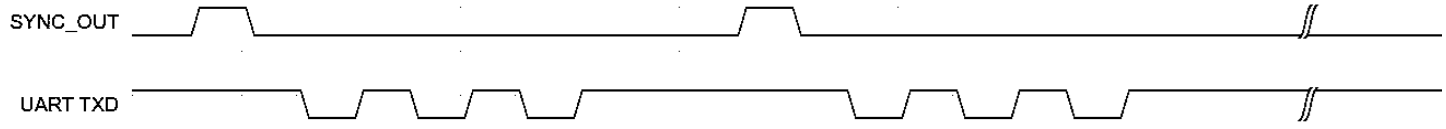


Figure 28: Sync_Out Timing

13.2.2 Synchronized output pulse at a different frequency from data output

If the user's system requires the synchronized output pin to operate at a different frequency from the data output, this can be achieved by configuring the division factor. For specific configurations, please refer to the instruction and programming manual.

Example: The module outputs data at 100 Hz, and the SYNC_OUT pin outputs a 50 Hz pulse signal. Example of synchronized output waveform:

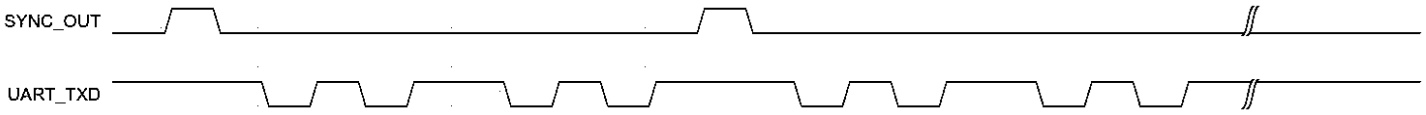


Figure 29: Sync_Out Division Timing

Note1: SYNC_OUT_DIV is set to an 8-fold division of SYNC_OUT by default. If a different division is needed, users should refer to the instruction and programming manual to make changes

13.3 Synchronized timestamp

The IMU can output a PPS synchronized timestamp. The PPS synchronized timestamp refers to the time elapsed from when the module detects the most recent falling edge signal to the current frame of data sampling.

Note1: For instructions on how to configure it for ONMARK triggering, please refer to the instruction and programming manual

14 LABEL

The HI14 series has the following label on the side. The label description is as follows:

Table 23: Label description

Diagram	Description
Model: IMU/VRU Module REV: B6A1 1.3.7 I/F: UART(RS-232) P/N: HI14R2-232-000 S/N: 14022427400003	Model：Product name REV：B6A1 Hardware Version　1.3.7 Software Version I/F: Hardware Interface P/N: Part Number S/N: Serial Number

15 PACKAGE

The HI14 series modules are available with a custom-made EPE foam substrate that is then packed into a box.

15.1 M12

Note1: The box is also loaded with the wiring harness used by the user.

Table 24: Box dimensions

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

Note1: The carton height of the PG interface is 70±3mm

15.2 PG

Since the HI14 series PG interface adopts the direct cable exit method, the direct line product is not packed in the anti-static bag, but directly packed in the EPE foam substrate, and then packed into the box, the size reference 15.1.

16 TERMINOLOGY

IMU:Inertial Measurement Unit

Array IMU: The product contains multiple IMU, such as HI14R2 contains 4 IMU and HI14R5 contains 8 IMU

VRU:Vertical Reference Unit

AHRS:Attitude and Heading Reference System