1 FEATURES

1.1 Hardware

- High performance MEMS-IMU
- Factory calibrated temperature compensation from -40°C to +85°C, including scale factor, cross-axis, and bias calibration
- Gyroscope bias instability up to 1.5°/h
- Accelerometer bias instability up to 0.01mg
- Multi-functional I/O signals (including but not limited to synchronization pulse input/output, alarm functions)
- PPS+GPRMC/UTC time synchronization capability(HI12SX)
- Excellent vibration resistance
- Integrated temperature sensor
- Compact independent housing design for easy integration
- RoHS and CE certified

1.2 Software

- Adaptive Extended Kalman Fusion Algorithm with up to 1000Hz output rate and low latency
- Superior dynamic tracking performance with excellent vibration suppression
- Outstanding linear acceleration suppression
- Start-up time < 1s
- Multiple protocol support:Binary、CANopen、J1939、Modbus
- Plug-and-play operation without external configuration
- Comprehensive user configuration commands
- Multi-functional GUI for easy operation
- Multiple development support：ROS、C、QT、STM32

2 APPLICATION

- Precision instrumentation
- Platform stabilization and control
- Construction Machinery
- Underground Mining Instrumentation
- Low-speed Autonomous Robots

3 DESCRIPTIONS

3.1 Appearance

Figure1: HI12

3.2 System Block Diagram

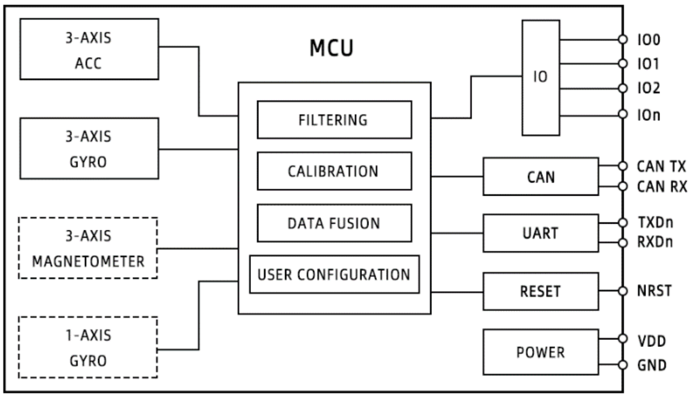

Figure2: Functional block diagram

Note1: Dotted lines indicate features not supported by all models, please refer to product selection Table 1

3.3 General Description

The HI12 series is an IMU/VRU/AHRS sensor system composed of high-performance MEMS-IMU, magnetometer, and enhanced single-axis gyroscope. It features proprietary developed adaptive Extended Kalman filtering, IMU noise dynamic analysis algorithm, and carrier motion state analysis algorithm, capable of maintaining high attitude angle accuracy under dynamic conditions while reducing heading angle drift.

The multi-functional GUI (Graphical User Interface) enables rapid product evaluation, with features including but not limited to module configuration, data display, firmware updates, and data logging.

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

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4 PRODUCT SELECTION

Table 1: Model Selection Information

HI12a-b-c-d[1]						
Company	Product	a-Sensor		b-Interface	c-Connector	d-OEM
		M0	3°/h 30ug	MI0 2XUART	0 Molex 5015680807	00 Default
		H1	2°/h 30ug	MI1 1XUART+1XCAN	1 Board-to-Board Connector	XX OEM
		S2	1.5°/h 10ug			
HI	12	S3	1.5°/h 10ug+Magnetic			
		H3	2°/h 18ug			
		H4	2°/h 18ug+Magnetic			

Note1: Model Example: HI12H3-MI1-000

Note2: All models feature full-temperature compensation, supported only in firmware version 1.5.4 and above

Note3: HI12HX series comes with high vibration-resistant single-axis gyroscope by default

5 PRODUCT ORDERING

5.1 Ordering Information

Table 2: Ordering information

Part Number	Name	Description	Note
HI12M0-MI1-000	IMU/VRU Module	6DoF 3°/h 30ug UART+CAN Molex 5015680807	
HI12S2-MI0-000	IMU/VRU Module	6DoF 1.5°/h 10ug 2XUART Molex 5015680807	
HI12S3-MI0-000	IMU/AHRS Module	6DoF 1.5°/h 10ug+Magnetic 2XUART Molex 5015680807	
HI12S2-MI1-000	IMU/VRU Module	6DoF 1.5°/h 10ug UART+CAN Molex 5015680807	
HI12S3-MI1-000	IMU/AHRS Module	6DoF 1.5°/h 10ug+Magnetic UART+CAN Molex 5015680807	
HI12H1-MI1-000	IMU/VRU Module	6DoF 2°/h 30ug UART+CAN Molex 5015680807	1
HI12H3-MI1-000	IMU/VRU Module	6DoF 2°/h 18ug UART+CAN Molex 5015680807	1
HI12H4-MI1-000	IMU/AHRS Module	6DoF 2°/h 18ug+Magnetic UART+CAN Molex 5015680807	1
HI12H3-MI1-100	IMU/VRU Module	6DoF 2°/h 18ug Board to board connector	1

5.2 Contact Us

1. Email: overseas1@hipnuc.com
2. Website: www.hipnuc.com

6 DOCUMENT INFORMATION

6.1 Scope of Application

This documentation applies to hardware version A0 and above. Version change history is as follows:

Table 3: Hardware Version Changes

Product	Version	Changes
HI12	A0	Initial version
	A1	Added geomagnetic for Molex connector interface
		Enhanced internal PCB mounting adaptability for board-to-board connector interface

6.2 Document Version Information

Table 4: Document version history

Version	Date	Sections	Changes
1.0	July 23, 2024	-	Initial version
1.1	Nov 27,2024	5.1、7.14、10.2.2、10.2.3、13	Added product models and descriptions, simplified synchronization function description
1.2	Dec 28,2024	4、5.1、6、7、8	Model changes
1.3	Mar 20,2025	5.1、7.4、7.5、7.9	Allan variance update
1.4	Aug 28,2025	5.1、7.4、7.5、7.9、10	Added HI12SX series

6.3 Related Documents and Development Kit

1. *Command and Programming Manual*
2. *CAE/Package Files*
3. *Evaluation Board EVAL-HI12 Specifications and Design Files*
4. *CE/RoHS Certification Documents*
5. *GUI Software and Reference Examples*
6. *HI12 Series Test Reports*

7 SPECIFICATIONS

Unless otherwise specified, test conditions: Temperature 25℃, Supply Voltage 5V.

7.1 Absolute Maximum Ratings

Table 5: Absolute maximum values

Parameters	Limit	Comment
Mechanical Shock	2000g	Duration <1ms
Storage Temperature	-40℃-85℃	
ESD HBM	15KV	JEDEC/ESDA JS-001
Input Voltage	6.5V	
IO To GND	-0.3-5V	

7.2 Recommended Operating Conditions

Table 6: Recommended operating conditions

Parameters	Condition	Min	Nom	Max	Unit	Note
Input Voltage		3.3	-	5.5	V	
Power Consumption	HI12M0			240	mW	
	HI12H1			245		
	HI12H3/ HI12H4			300		
	HI12SX			200		
Operating Temperature		-40	-	85	℃	
Gyroscope Range	HI12MX	125	2000	2000	°/s	1
	HI12HX Z-axis	125	400			
	HI12HX X,Y-axis	125	2000	2000		
	HI12SX	125	2000	4000		
Accelerometer Range	HI12MX/HI12HX	3	12	24	g	
	HI12SX		8	32		
Start-up Time				2	s	2

Note1: HI12H series is equipped with high vibration-resistant single-axis gyroscope, optimal performance at range <400°/s

Note2: Start-up time refers to the duration from power-on to valid data output. The module should remain stationary during this period

7.3 Interface

Table 7: Interface parameters

Interf	Parameters	Condition	Min	Nom	Max	Unit	Note
UART(TTL)	Baud Rate		9600	115200	921600	bps	
	Start Bit		0	1		bit	
	Data Length		0	8		bits	
	Stop Bit			1		bit	
	Parity			无		bit	
	Output Rate		0	100	1000	Hz	1
	Logic Voltage	High	2.0	3.3	3.6	V	
		Low			0.6		
CAN	Baud Rate		125	500	1000	kbps	2
	Output Rate		5	100	1000	Hz	1
	Logic Voltage	High	2.0	3.3	3.6	V	
		Low			0.6		
IO	Logic Voltage	High	2.0			V	
		Low			0.6	V	
	Delay (Trigger Function)	From trigger to data transmission			800	us	4

Note1: Sensor supports data output rates of 1, 5, 10, 50, 100, 200, 250, 500, 1000Hz.

Note2: CAN communication supports baud rates of 125K, 250K, 500K, 1000K.

Note3: CAN communication supports baud rates of 125K, 250K, 500K, 1000K.

7.4 Gyroscope

7.4.1 HI12MX Gyroscope Specifications

Table 8: 陀螺仪参数

Parameters	Condition	Min	Nom	Max	Unit	Note
Range			2000	2000	°/s	
Resolution			16bit			
Scale Factor	100°/s		<600	800	ppm	1
Non-linearity		-0.05	-	0.05	%Fs	2
3dB Bandwidth			80		Hz	
Sampling Rate			1000		Hz	
Bias Instability	Allan Variance		3		°/h	1σ
Bias Stability	10s smoothing		10		°/h	1σ
Bias Repeatability	Allan Variance		14.5		°/h	1σ
Angle Random Walk	Allan Variance		0.42		°/√h	1σ
Bias Temperature Variation (-40-85℃)			0.1	0.3	°/s	
Accelerometer Sensitivity	All three axis		0.1		°/s/g	

7.4.2 HI12HX Gyroscope Specifications

Table 9: 陀螺仪参数

Parameters	Condition	Product		Min	Nom	Max	Unit	Note
Range					400	2000	°/s	
Resolution					16bit			
Scale Factor	100°/s				<280	300	ppm	1
Non-linearity				-0.05	-	0.05	%Fs	2
3dB Bandwidth					80		Hz	
Sampling Rate					1000		Hz	
Bias Instability	Allan Variance	HI12H1	X,Y		3		°/h	1σ
			Z		2			
		HI12H3/HI12H4	X,Y		1.6			
			Z		2			
Bias Stability	10s smoothing	HI12H1	X,Y		10		°/h	1σ
			Z		4.2			
		HI12H3/HI12H4	X,Y		5			
			Z		4.2			
Bias Repeatability	Allan Variance	HI12H1	X,Y		14.5		°/h	1σ
			Z		5.5			
		HI12H3/HI12H4	X,Y		8.2			
			Z		5.5			
Angle Random Walk	Allan Variance	HI12H1	X,Y		0.42		°/√h	1σ
			Z		0.07			
		HI12H3/HI12H4	X,Y		0.25			
			Z		0.07			
Bias Temperature Variation (-40-85℃)					0.1	0.3	°/s	

Accelerometer Sensitivity	All three axis			0.1		°/s/g	

7.4.3 HI12SX Gyroscope Specifications

Parameters	Condition	Min	Nom	Max	Unit	Note
Range		15.625	4000	4000	°/s	
Resolution			20bit			
Scale Factor	100°/s		<250	300	ppm	1
Non-linearity		-0.05	-	0.05	%Fs	2
Noise Density	80Hz bandwidth		0.002		°/s√Hz	
3dB Bandwidth			80	400	Hz	
Zero Rate Output				±0.1	°/s	
Sampling Rate			1000		Hz	
Bias Instability	Allan Variance		1.5		°/h	1σ
Bias Stability	10s smoothing		3.5		°/h	1σ
Bias Repeatability	Allan Variance		3		°/h	
Angle Random Walk	Allan Variance		0.08		°/√h	1σ
Bias Temperature Variation (-40-85℃)			0.1	0.3	°/s	
Accelerometer Sensitivity	All three axis		0.05		°/s/g	

Note1: Average measurement taken from 10 rotations in both forward and reverse directions on turntable

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

7.5 Accelerometer

7.5.1 HI12MX/HI12HX Accelerometer Specifications

Table 10: HI12MX/HI12HX accelerometer specifications

Parameters	Condition	Product	Min	Nom	Max	Unit	Note
Range				12		g	
Resolution				16bit			
Initial Bias					5	mg	1
Non-linearity				0.5		%Fs	
3dB Bandwidth				145		Hz	
Sampling Rate				1600		Hz	
Bias Instability	Allan Variance	HI12M0/HI12H1		0.03		mg	1σ
		HI12H3/HI12H4		0.018			
Bias Stability	10s smoothing	HI12M0/HI12H1		0.07		mg	1σ
		HI12H3/HI12H4		0.035			
Bias Repeatability	Allan Variance	HI12M0/HI12H1		0.24		mg	1σ
		HI12H3/HI12H4		0.13			
Random Walk	Allan Variance	HI12M0/HI12H1		0.08		m/s/√h	1σ
		HI12H3/HI12H4		0.04			
Bias Temperature Variation (-40-85℃)				3	10	mg	

Note1: The value may change after user installation, please refer to actual measurements.

7.5.2 HI12SX Accelerometer Specifications

Parameters	Condition	Min	Nom	Max	Unit	Note
Range		2	8	32	g	
Resolution			20bit			
Initial Bias			2	5	mg	1
Non-linearity			0.01		%Fs	
3dB Bandwidth			90	400	Hz	
Noise Density	90Hz bandwidth		0.04	0.06	mg/√Hz	
Sampling Rate			1000		Hz	
Bias Instability	Allan Variance		0.01		mg	1σ
Bias Stability	10s smoothing		0.012		mg	1σ
Bias Repeatability	Allan Variance		0.09		mg	
Random Walk	Allan Variance		0.017		m/s/√h	1σ
Bias Temperature Variation (-40-85℃)			3	10	mg	

Note1: Note1: The value may change after user installation, please refer to actual measurements

7.6 Allan

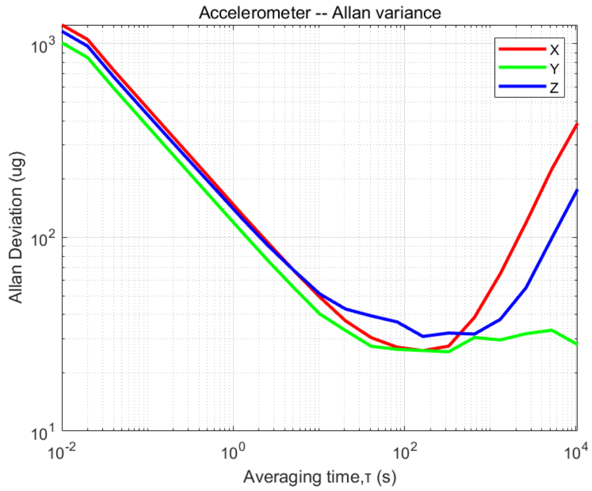

Figure3: HI12MX Accelerometer Allan Variance

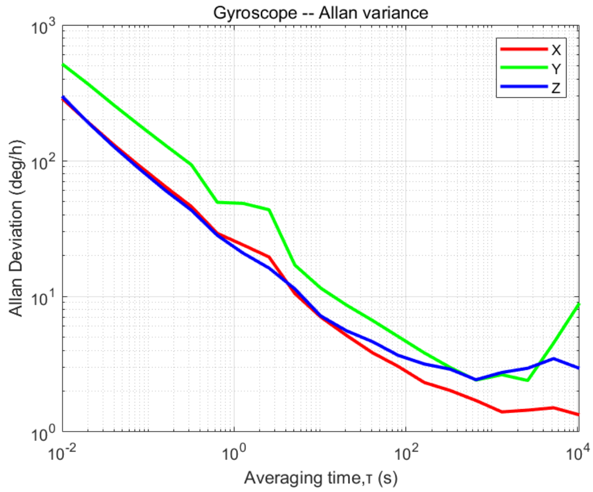

Figure4: HI12MX Gyroscope Allan Variance

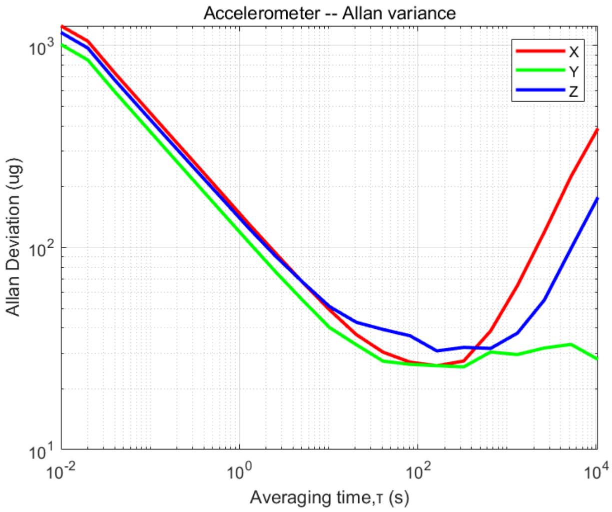

Figure5: HI12H1 Accelerometer Allan Variance

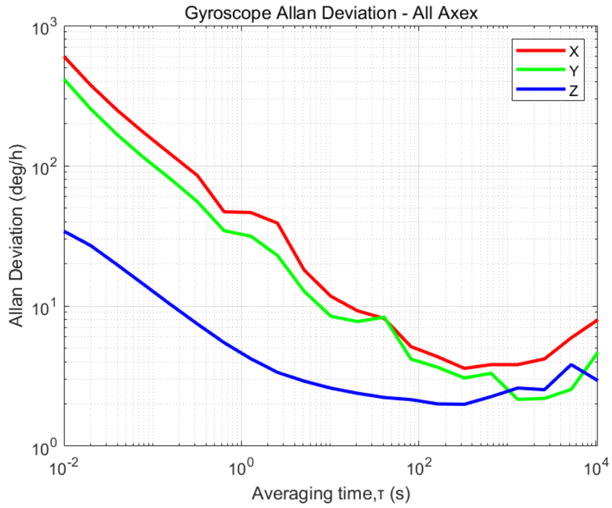

Figure6: HI12H1 Gyroscope Allan Variance

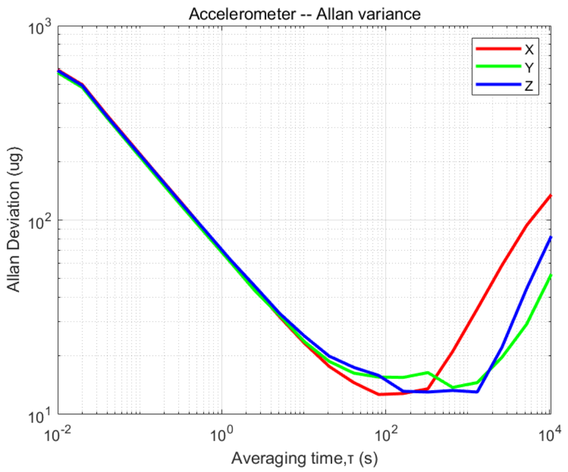

Figure7: HI12H3/HI12H4 Accelerometer Allan Variance

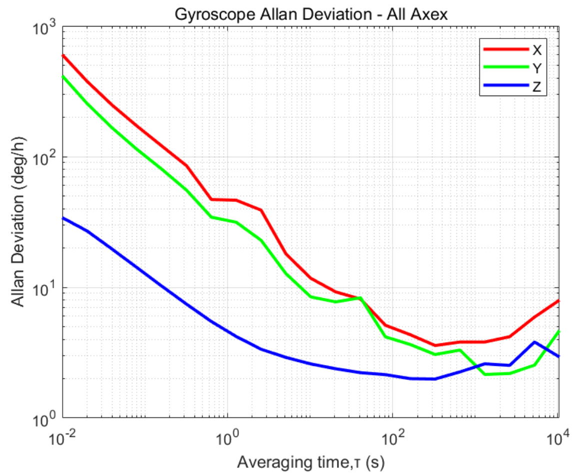

Figure8: HI12H3/HI14H4 Gyroscope Allan Variance

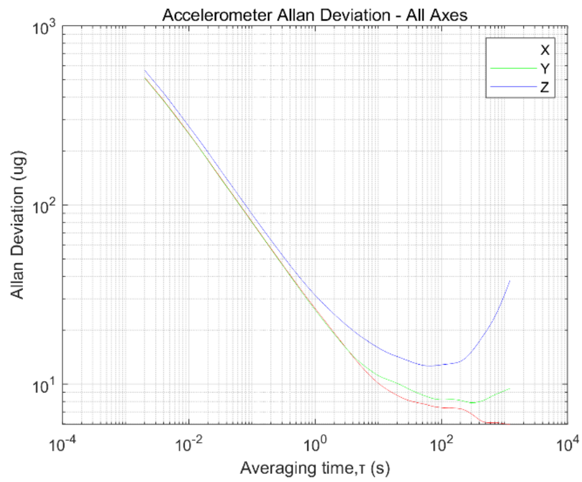

Figure9: HI12SX Accelerometer Allan Variance

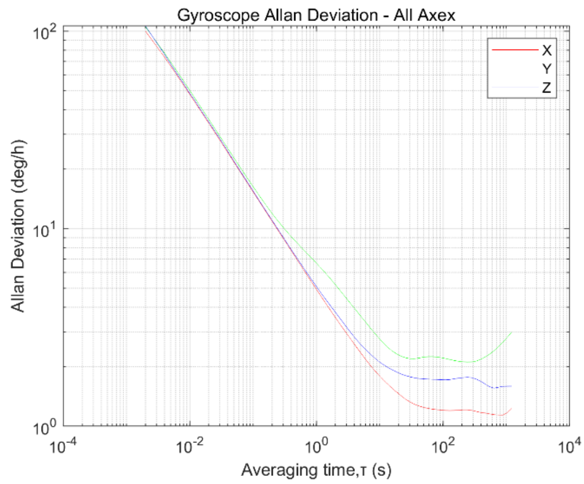

Figure10: HI12SX Gyroscope Allan Variance

7.7 Magnetometer

Table 11: Magnetometer parameters

Parameters	Condition	Min	Nom	Max	Unit	Note
Range			20		Gauss	
Sampling Rate			200Hz			
Linearity			0.1		Fs%	

7.8 Temperature Sensor

Table 12: Temperature sensor parameters

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

7.9 Initial Bias

7.9.1 HI12M0 Initial Bias

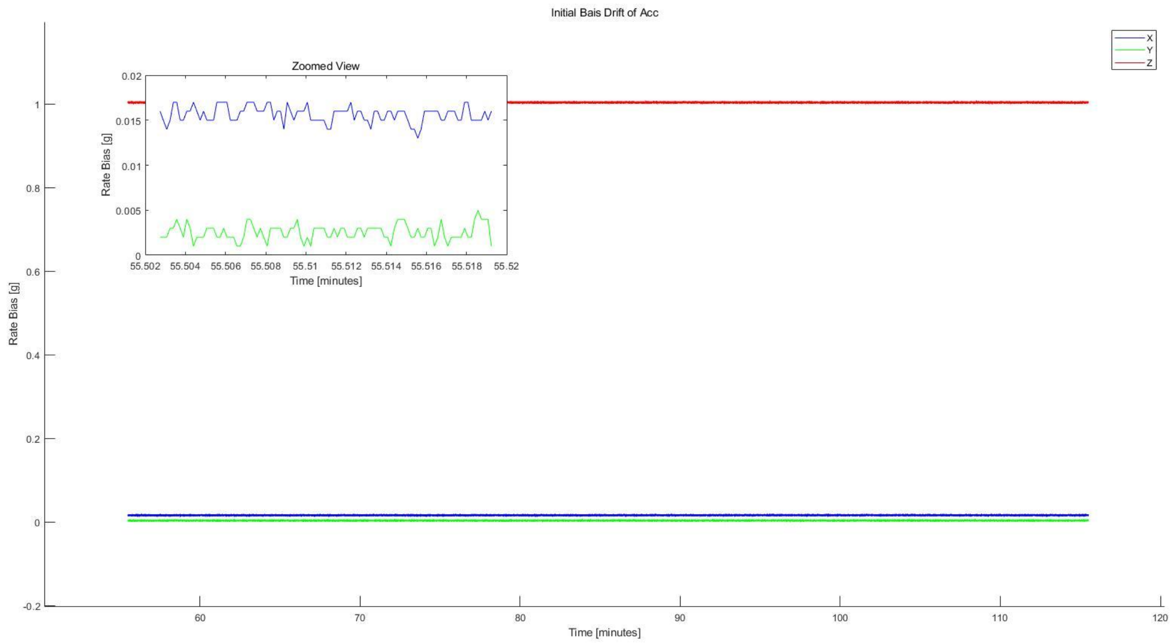

Figure11: HI12M0 initial bias drift of accelerometer

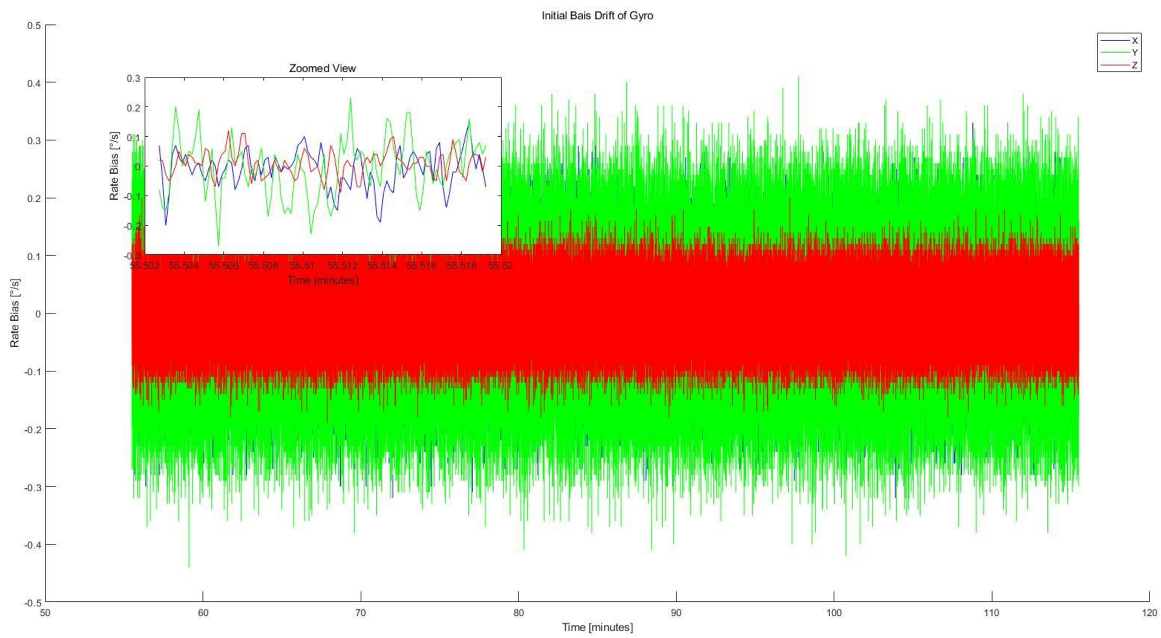

Figure12: HI12M0 initial bias drift of gyroscope

7.9.2 HI12H1 Initial Bias

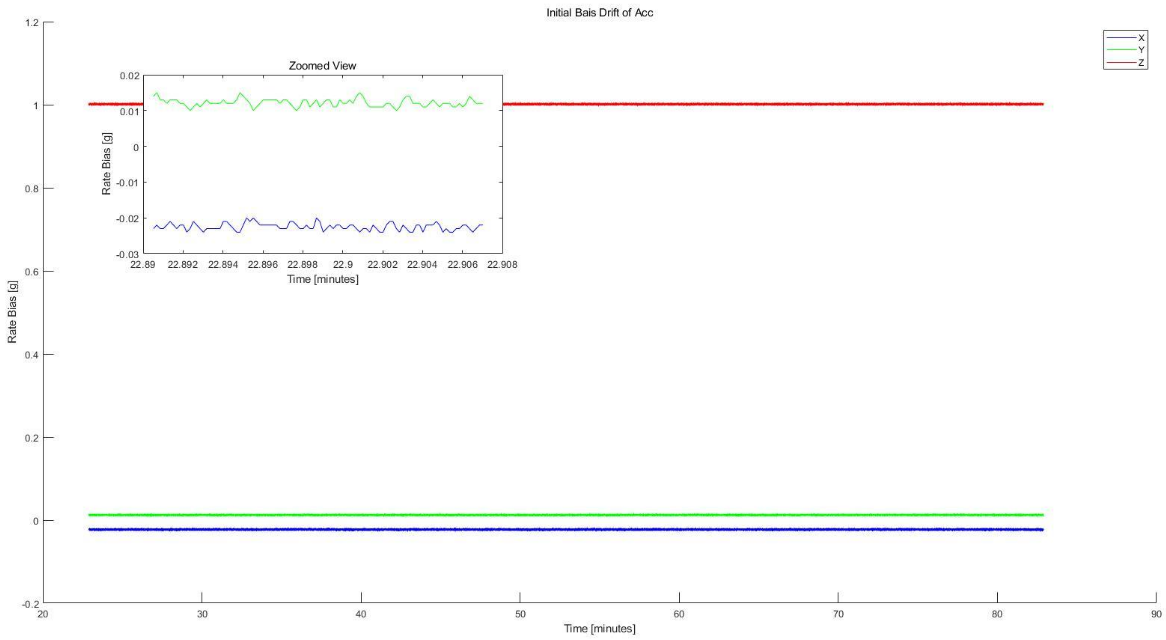

Figure13: HI12H2 initial bias drift of accelerometer

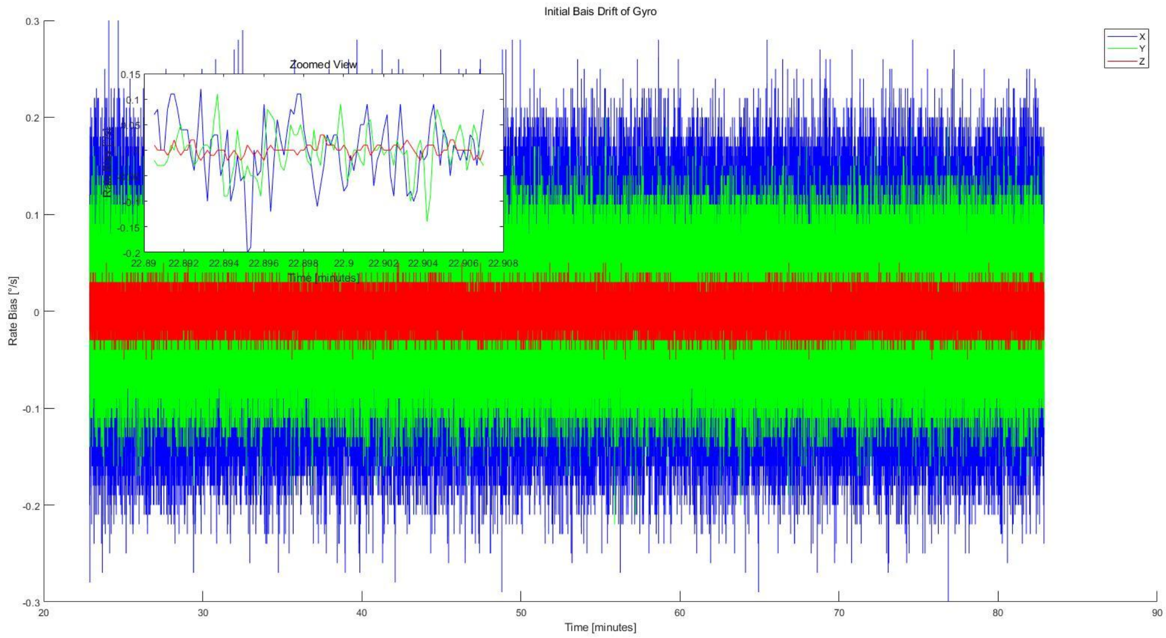

Figure14: HI12H1 initial bias drift of gyroscope

7.9.3 HI12H3//HI12H4 Initial Bias

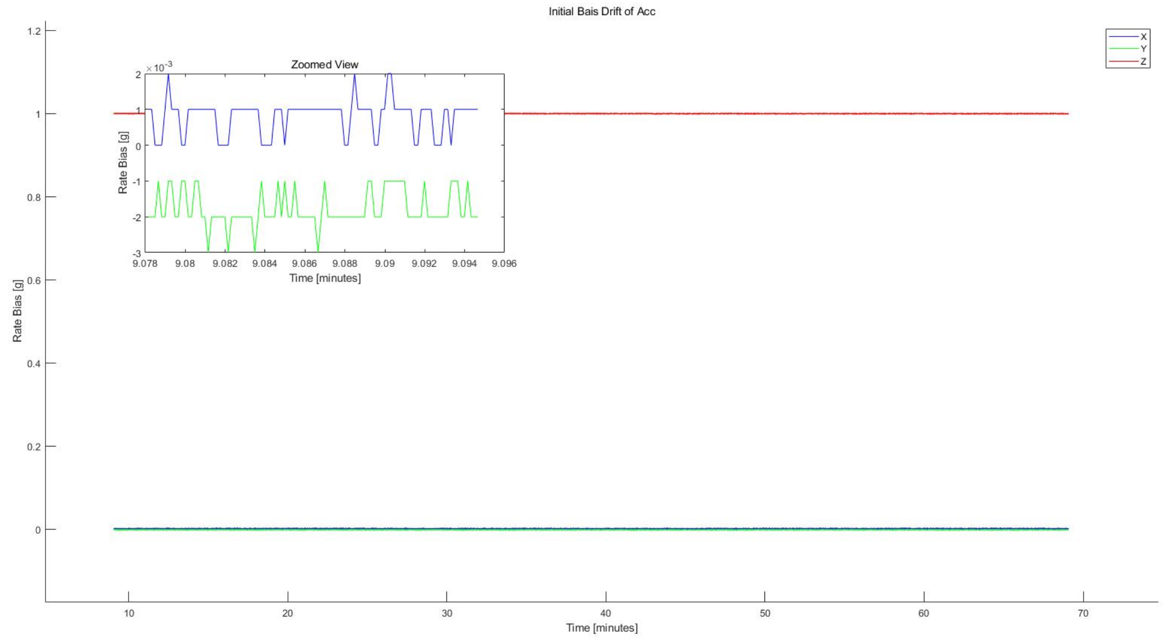

Figure15: HI12H3//HI12H4 initial bias drift of accelerometer

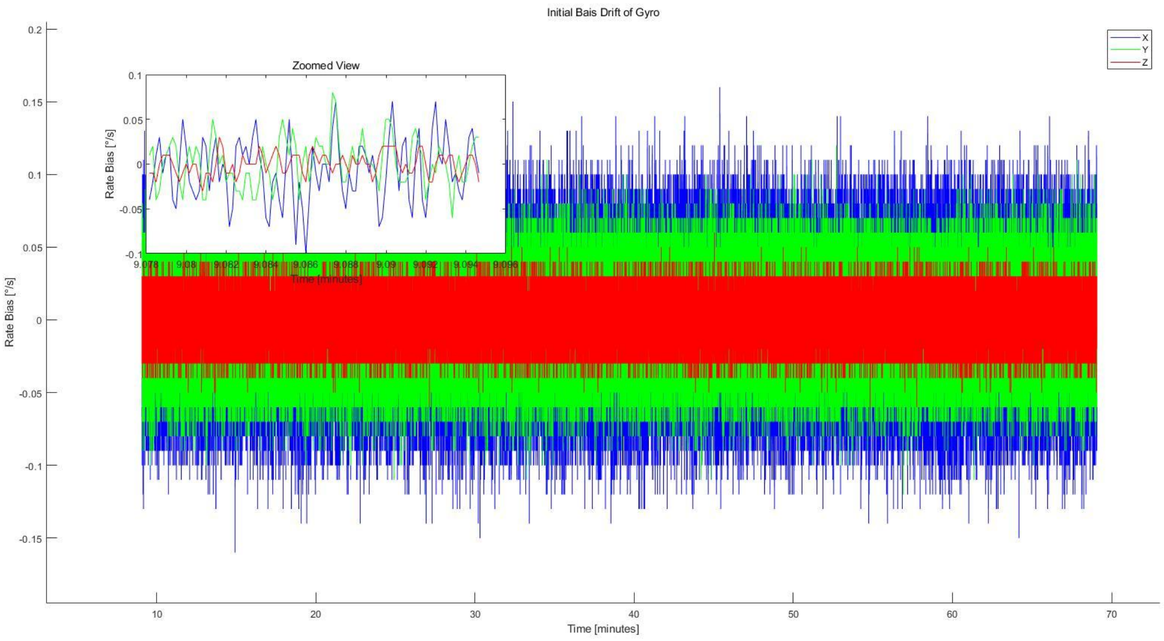

Figure16: HI12H3/HI12H4 initial bias drift of gyroscope

7.9.4 HI12SX Initial Bias

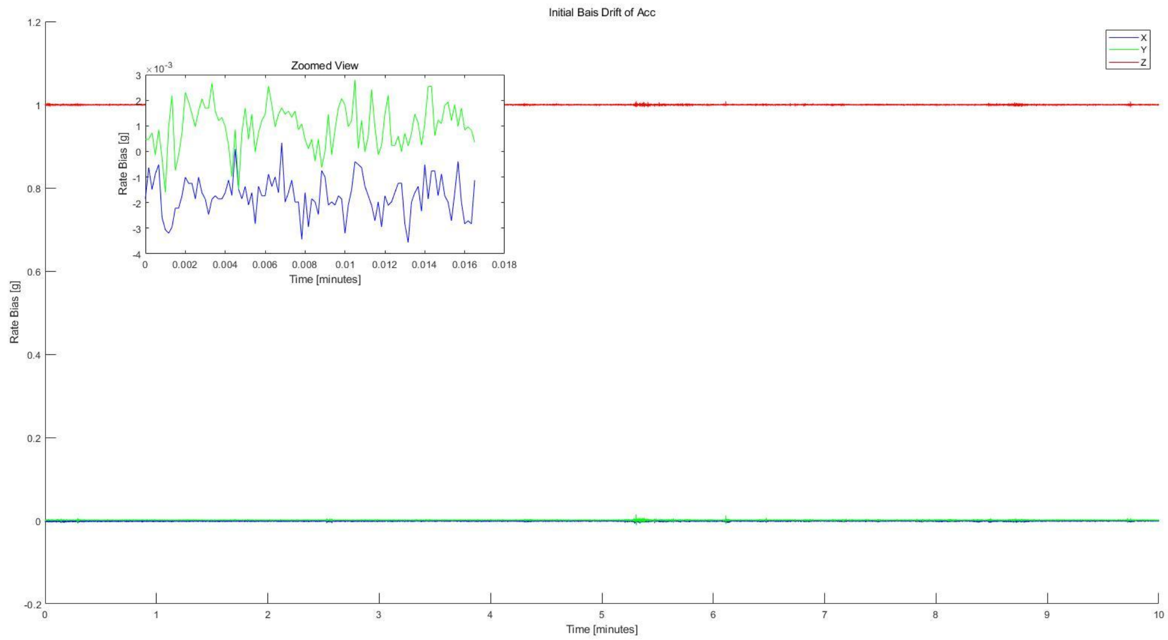

Figure17: HI12SX initial bias drift of accelerometer

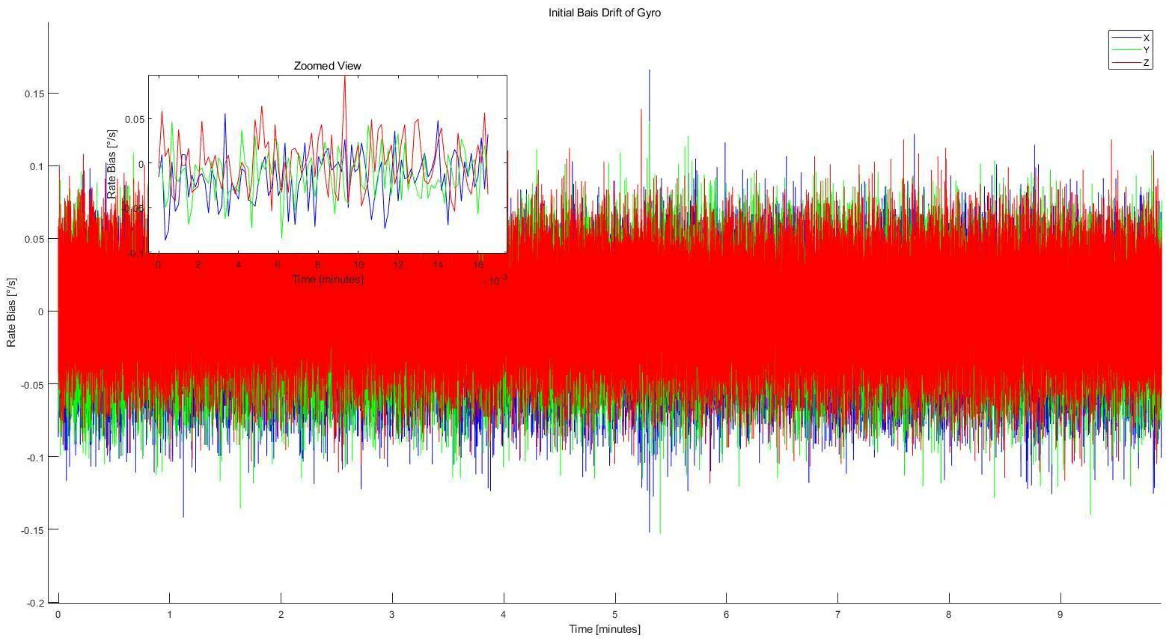

Figure18: HI12SX initial bias drift of gyroscope

7.10 Fusion Specifications

Table 13: Fusion specifications

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

7.11 Attitude Angle Accuracy

Table 14: Attitude angle accuracy

Parameters	Condition	Product	Min	Nom	Max	Unit	Note
Pitch/Roll (Static)				0.15	0.2	°	
Pitch/Roll (Dynamic)				0.15	0.2	°	
Yaw Static Drift (6DOF)	2h static			0.15	0.2	°	1
Yaw Dynamic Drift (6DOF)		HI12M0		9		°	2
		HI12HX/HI12SX		5			
Yaw with Magnetic Assist (AHRS)		HI12H4/HI12S3		2	3	°	3
Yaw Rotation Error (6DOF)	100°/s rotation	HI12M0			3		
		HI12HX		<0.8	1.5	°	4
		HI12SX			1		

Note1: Module horizontal static for 2h

Note2: Measured on indoor cleaning robot moving for 1h. 1σ

Note3: After geomagnetic calibration, measured without magnetic interference, product needs to be configured in AHRS mode

Note4: Accumulated yaw error after 10 continuous rotations on turntable

7.12 Mechanical and Environmental

Table 15: Mechanical and environmental

Parameters	Product	Value	Note
Dimensions	Molex	22X22X10mm	
	Board-to-board connector	22X22X9mm	
Weight		<8g	
Housing Material & Process		Aluminum Alloy CNC	
Assembly Screws		M2.5	
Connector Type	Molex	Molex 5015680807	
	Board-to-board connector	2x8P Header 1mm pitch	
Vibration Resistance		1.0mm(10Hz-58Hz)&≤20g(58Hz-600Hz)	
Environmental Protection		RoHS 2011/65/EU	
EMC		LVD Directive 2014/35/EU	
Drop Test		Free fall 3 times from 75cm high test bench	
Temperature Shock		Temperature rises from -40℃ to 85℃ within 1h, 5 cycles	

7.13 Dimensions and Pin Definitions

All Dimensions in mm units.

7.13.1 Molex Connector Product Dimensions

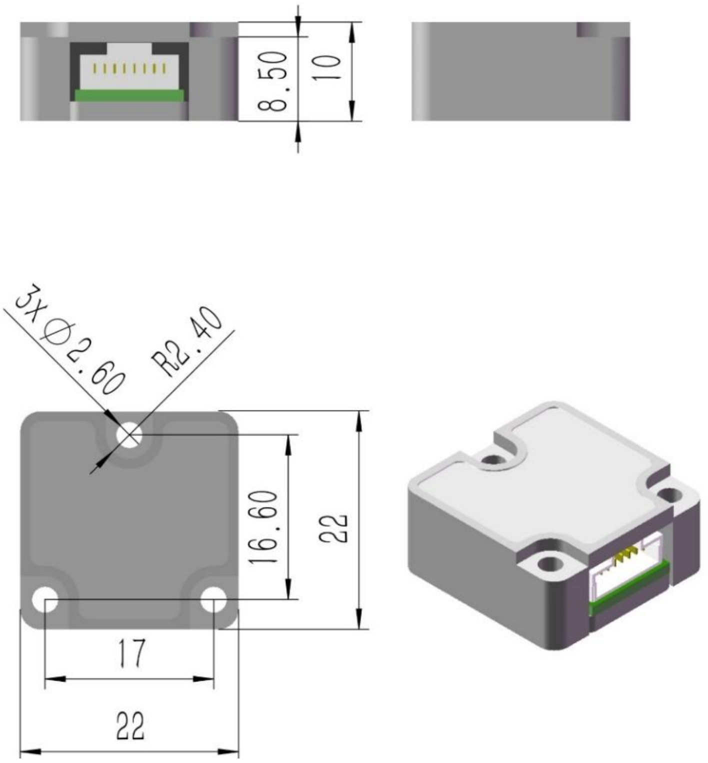

Figure19: HI12 MI0 interface mechanical dimension

7.13.2 Board to Board Connector Housing Dimensions

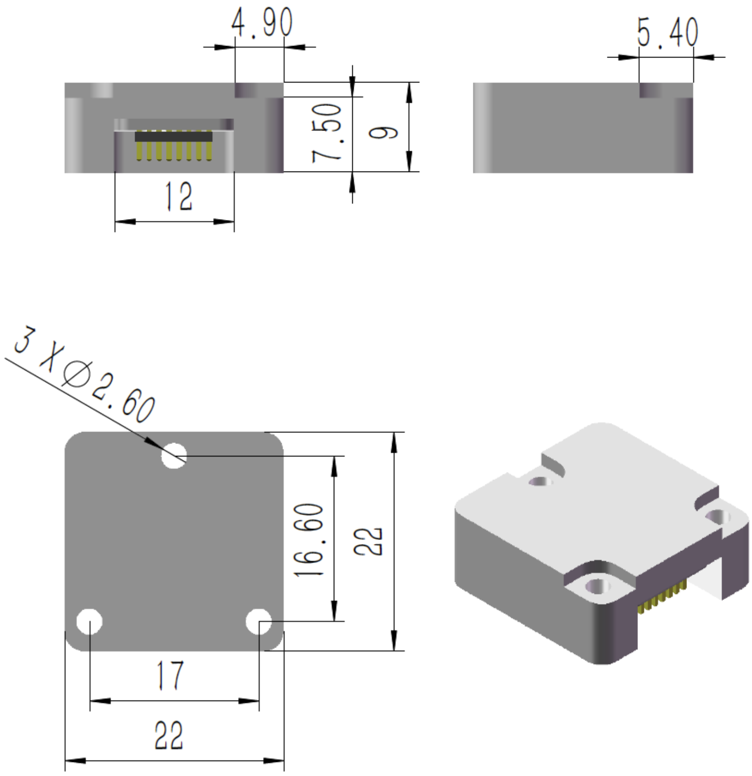

Figure20: HI12 MI1 interface mechanical dimension

7.13.3 Recommended Footprint(Board to Board)

Unit:mm

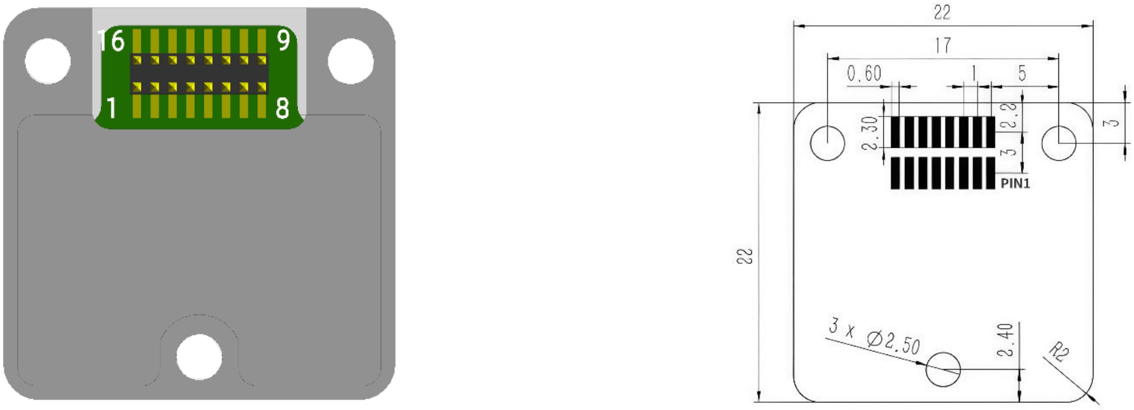

Figure21: HI12 Recommended PCB footprint for board to board connector

7.13.4 HI12XX Molex Connector Pin Definitions

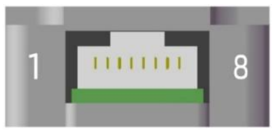

Figure22: Pin configuration as seen from front of HI12

Note1: The connector model is Molex 5015680807, and its matching connector model is 501330-0800.

Table 16: Pin function description

Pin Number	MI0 Pin Name	MI1 Pin Name	Type	Functional	Note
1	TXD1	TXD1	O	Module UART1 Transmit	1
2	RXD1	RXD1	I	Module UART1 Receive	
3	TXD2	CAN H	O/AIO	Module UART2 Transmit/CAN High	
4	RXD2	CAN L	I/AIO	Module UART2 Receive,can connect to external GNSS GPRMC/CAN Low	
5,6	IO1,IO2	IO1,IO2	I/O	PMUX1 SYNC_IN Sync input/PPS, can be left floating if not used PMUX2 SYNC_OT Sync output, can be left floating if not used PMUX3 LED LED running indicator, can be left floating if not used PMUX4 SOUT_DIV Sync output frequency division, can be left floating if not used PMUX5 ALARM Alarm signal output, can be left floating if not used	2
7	GND	GND	POWER	GND	
8	VDD	VDD	POWER	Power input 3.3-5V	

Note1: UART1 is mainly used for data transmission and module configuration

Note2: Multi-function IO pins, refer to programming manual for detailed description

7.13.5 HI12 Board to Board Connector Pin Definitions

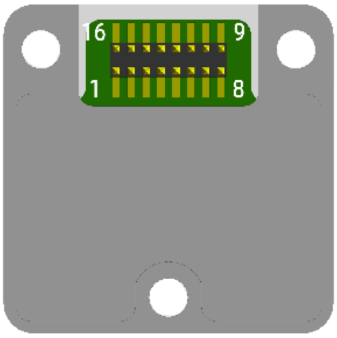

Figure23: Pin configuration

Note1: Connector specification is 2x8p header with 1mm pitch, and its matching connector is 2x8p socket with 1mm pitch

Table 17: 引脚功能描述

<table>
<tr><th>Pin Number</th><th>Pin Name</th><th>Type</th><th colspan="3">Functional</th></tr>
<tr><td>1</td><td>VDD</td><td>POWER</td><td colspan="3">Power input 3.3-5V</td></tr>
<tr><td>2</td><td>RXD1</td><td>I</td><td colspan="3">Module UART1 Receive</td></tr>
<tr><td>3</td><td>TXD1</td><td>O</td><td colspan="3">Module UART1 Transmit</td></tr>
<tr><td rowspan="5">4,11,12,14</td><td rowspan="5">IO1,IO6,IO5, IO2</td><td rowspan="5">I/O</td><td>PMUX1</td><td>SYNC_IN</td><td>Sync input/PPS, can be left floating if not used</td></tr>
<tr><td>PMUX2</td><td>SYNC_OUT</td><td>Sync output, can be left floating if not used</td></tr>
<tr><td>PMUX3</td><td>LED</td><td>LED running indicator, can be left floating if not used</td></tr>
<tr><td>PMUX4</td><td>SOUT_DIV</td><td>Sync output frequency division, can be left floating if not used</td></tr>
<tr><td>PMUX5</td><td>ALARM</td><td>Alarm signal output, can be left floating if not used</td></tr>
<tr><td>5</td><td>CAN_TX</td><td>O</td><td colspan="3">Module CAN Transmit</td></tr>
<tr><td>6</td><td>CAN_RX</td><td>I</td><td colspan="3">Module CAN Receive</td></tr>
<tr><td>7</td><td>RXD3</td><td>I</td><td colspan="3">Module UART3 Receive (Currently floating)</td></tr>
<tr><td>8</td><td>TXD3</td><td>O</td><td colspan="3">Module UART3 Transmit (Currently floating)</td></tr>
<tr><td>9</td><td>TXD2</td><td>O</td><td colspan="3">Module UART2 Transmit</td></tr>
<tr><td>10</td><td>RXD2</td><td>I</td><td colspan="3">Module UART2 Receive, can connect to external GNSS GPRMC information</td></tr>
<tr><td>13</td><td>IO9</td><td>I/O</td><td colspan="3">Reserved</td></tr>
<tr><td>15</td><td>EN</td><td>I</td><td colspan="3">Module enable pin, active high, internal pull-up, pull low to turn off module, can be left floating if not used</td></tr>
<tr><td>16</td><td>GND</td><td>POWER</td><td colspan="3">GND</td></tr>
</table>

Note1: UART1 is mainly used for data transmission and module configuration

Note2: Multi-function IO pins, refer to programming manual for detailed description, refer to table below for default functions

Table 18: Default functions of IO 拍、ins

IO	Functional
IO1	PMUX1
IO2	PMUX2
IO5	PMUX3
IO6	PMUX4

8 CABLE

8.1 Molex A (501330-0800) to DuPont Cable

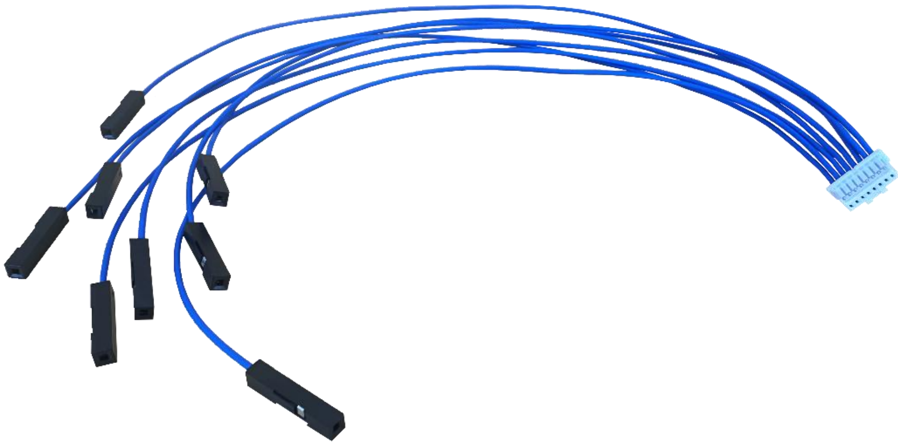

Figure24: 501330-0800 to dupont cable

Note1: This cable harness is applicable to HI12XX-XXX-000 interface products

8.2 USB to Molex A(501330-0800) Cable

Figure25: USB to Molex A(501330-0800)

Note1: This cable harness is applicable to HI12XX-XXX-000 and EVAL-HI12XX-XXX-000 products, with a cable length of 1m and built-in USB to UART(TTL) module

9 COORDINATE

9.1 Coordinate

The carrier frame uses Right-Front-Up (RFU) coordinate system, while the geographic frame uses East-North-Up (ENU) coordinate system. The acceleration and gyroscope axes are shown in the following figure:

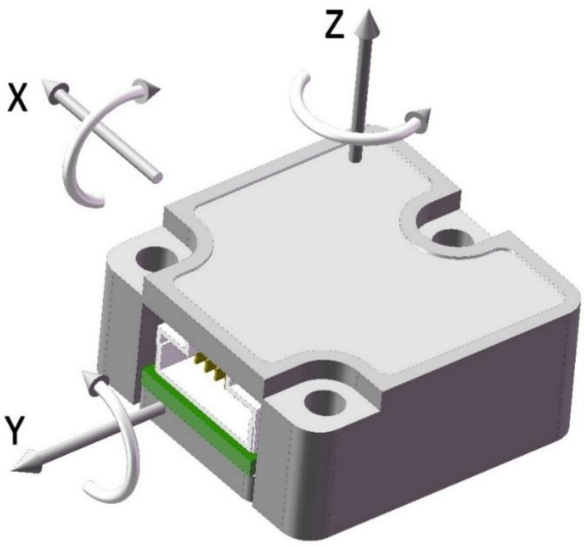

Figure26: HI12 Coordinate System

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

Rotation around Z-axis: Yaw\psi(ψ) -180° - 180°

Rotation around X-axis: Pitch\theta(θ) -90°-90°

Rotation around Y-axis: Roll\phi(ϕ) -180°-180°

If the module is viewed as an aircraft, the positive Y-axis should be considered as the heading direction. When the sensor frame aligns with the inertial frame, the ideal Euler angle output is: Pitch = 0°, Roll = 0°, Yaw = 0°.

If users need to change the default coordinate system of the sensor, please refer to the instruction and programming manual. The product supports not only East-North-Up (ENU) coordinate system, but also North-West-Up (NWU) and North-East-Down (NED) coordinate systems.

9.2 Sensor Center

Table 19: HI12M0/HI12H1 传感器中心位置

HI12 Axis	X-offset	Y-offset	Z-offset	Unit
X	6.5	-6	-1.8	mm
Y	6.5	-6	-1.8	mm
Z	6.5	-6	-1.8	mm

Table 20: HI12H3/H4/SX 传感器中心位置

HI12 Axis	X-offset	Y-offset	Z-offset	Unit
X	0	-6	-2.4	mm
Y	0	-6	-2.4	mm
Z	0	-6	-2.4	mm

9.3 Recommended Installation

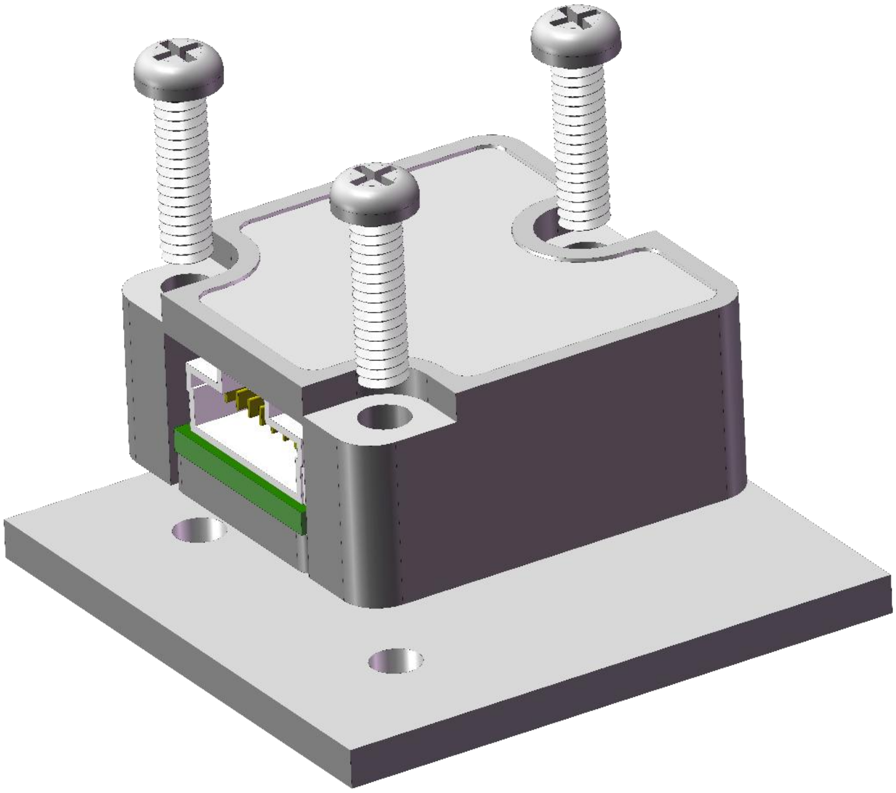

Figure27: Installation diagram

Note1: For other installation methods, please refer to the instruction and programming manual for coordinate system rotation. The system also supports North-East-Down (NED) and North-West-Up (NWU) coordinate systems.
Note2: It is recommended to install the module in a location where the test object has minimal vibration and temperature variation

10 TYPICAL REFERENCE DESIGNS

10.1 Power Supply

The HI12 series has built-in LDO and power filtering with overcurrent and overvoltage protection circuits to minimize external power noise interference with the internal system. Therefore, users can choose to power the module using LDO/DC-DC with a voltage range of 3.3-5V.

10.2 Serial Communication

It is recommended that the user's processor logic level be 3.3V. If communication with 5V or 1.8V processor serial ports is needed, users need to add their own level conversion chip. Without affecting serial transmission speed, we recommend 74LVCH1T45GW,125 for users.

10.2.1 Minimum System for Serial Communication

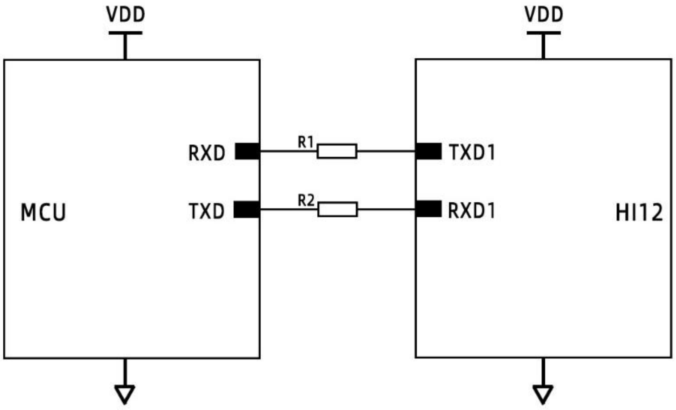

Figure28: HI12 Serial Communication Reference Circuit

10.2.2 Serial Communication (IMU and Host Synchronization)

This connection method requires users to connect IO1/IO2 with the host system for data synchronization. They don't need to be used simultaneously; the specific choice depends on the user's system design.

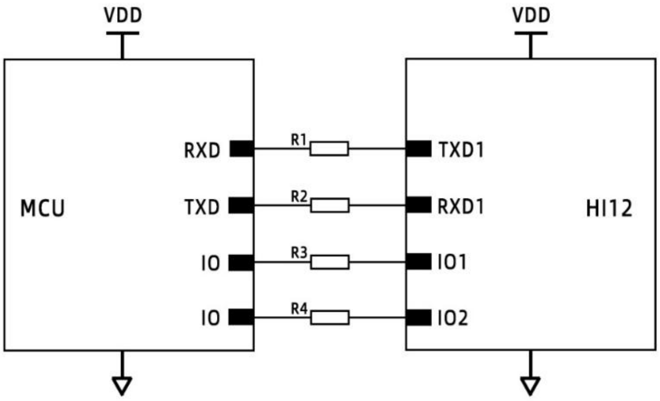

Figure29: HI12 Serial Communication Without Synchronization

Note1: If users use IO1, then IO1 should be in synchronous input function (PMUX1). The MCU IO pulse should be at the same frequency as the data frame rate. Refer to synchronization function and programming manual for details.
Note2: If users use IO2, then IO2 should be in synchronous output function (PMUX2). The pulse received by MCU IO can be at the same or different frequency as the data frame rate. By default, it's at the same frequency and can be used as a Data Ready signal. Refer to synchronization function and programming manual for details.

10.2.3 Serial Communication (IMU and GNSS PPS Synchronization)

HI12XX-MI0 can achieve precise time synchronization by connecting PPS signal through IO1 and receiving GPRMC/UTC time signal through RXD2, as shown in the following diagram:

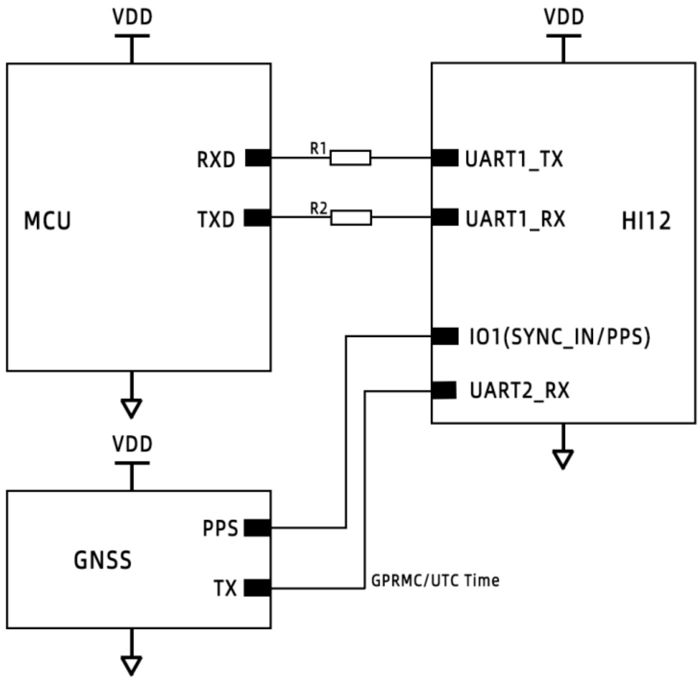

Figure30: HI12 Serial Communication with GNSS PPS Synchronization

10.3 CAN Communication

10.3.1 Minimum System CAN Communication for HI12XX-MI1

HI12XX-MI1 series integrates CAN transceiver that can directly communicate with user host CAN.

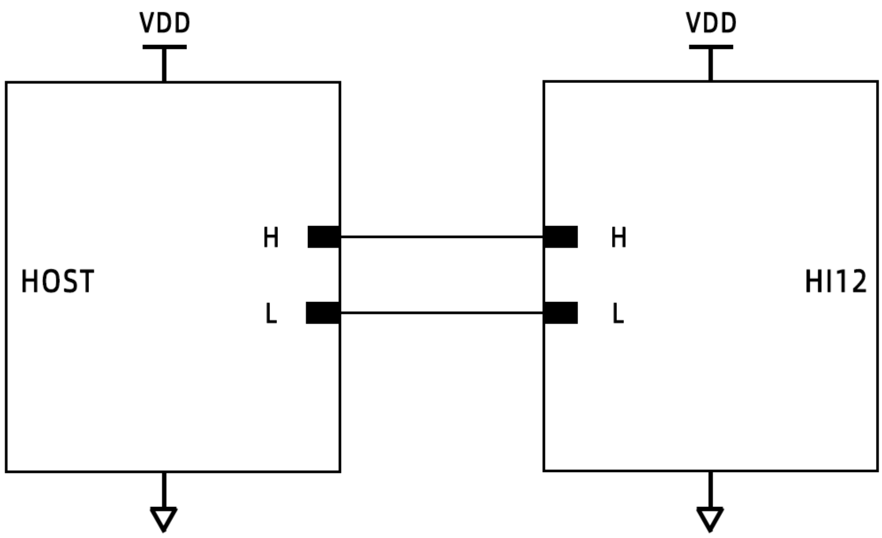

Figure31: HI12XX-MI1 CAN Communication

10.3.2 HI12XX-MI1 CAN Communication (GNSS PPS Synchronization)

HI12XX-MI1 can achieve precise time synchronization by connecting PPS signal through IO1 and receiving GPRMC/UTC time signal through RXD1, as shown in the following diagram:

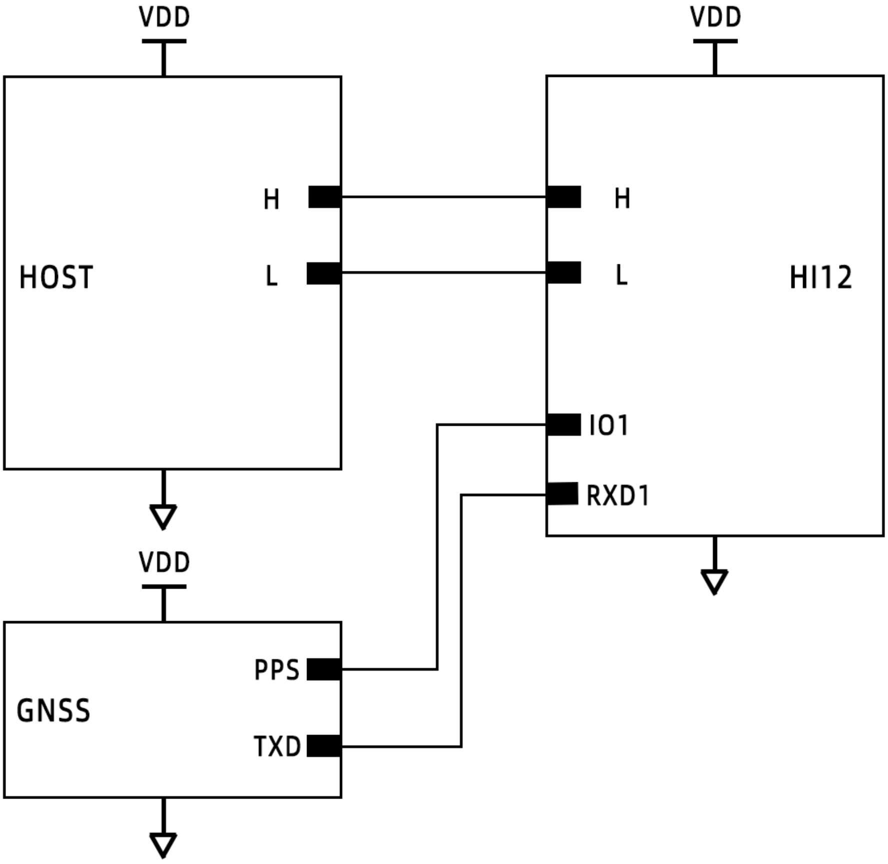

Figure32: HI12 CAN Communication with GNSS PPS Synchronization

10.4 HI12XX CAN Communication of Board-to-Board Connector

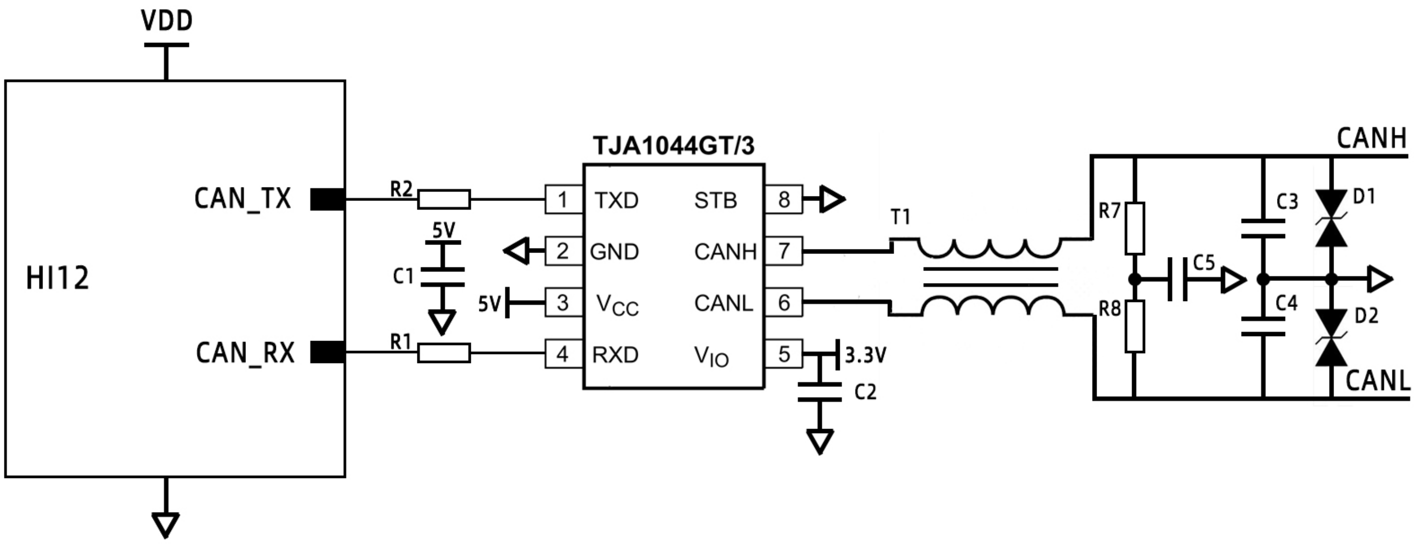

Figure33: HI12 CAN Communication with GNSS PPS Synchronization

Note1: R6, R7 are CAN bus matching resistors with value 60.4Ω. Users can decide whether to solder them based on actual conditions.

Note2: This circuit is only suitable for board-to-board connector products.

Table 21: Reference design BOM information

Item	Reference	Part	P/N	Vendor
Resistor	R1,R2,R3,R4,R6	1K	RC0402JR-071KL	YAGEO
Resistor	R7,R8	60.4Ω	RC1206FR-0760R4L	YAGEO
Capacitor	C1,C2	0.1uF	CC0402KRX5R7BB104	YAGEO
Capacitor	C3,C4	100pF	CC0402JRNPO9BN101	YAGEO
Capacitor	C5	1nF	CC0402KRX7R9BB102	YAGEO
Common Choke	T1	5.8kΩ@10MHz 100uH@100kHz 150mA	ACT45B-101-2P-TL003	TDK
TVS	D1,D2	SMBJ15CA	SMBJ15CA	BORN

Note1: The 1K resistor is optional but recommended to be reserved on the user's PCB for debugging purposes.

11 PROTOCOL

11.1 Serial Binary

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

11.2 Modbus

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

11.3 CAN

The CAN interface supports both CANopen and J1939 protocols. For detailed protocol information, please refer to the instruction and programming manual.

12 FAQ

12.1 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

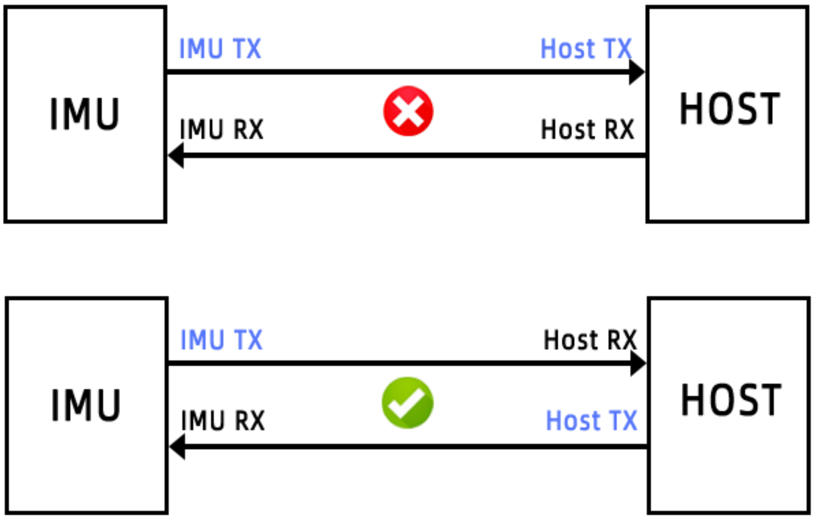

Figure34: IMU serial port connected to a single host

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:

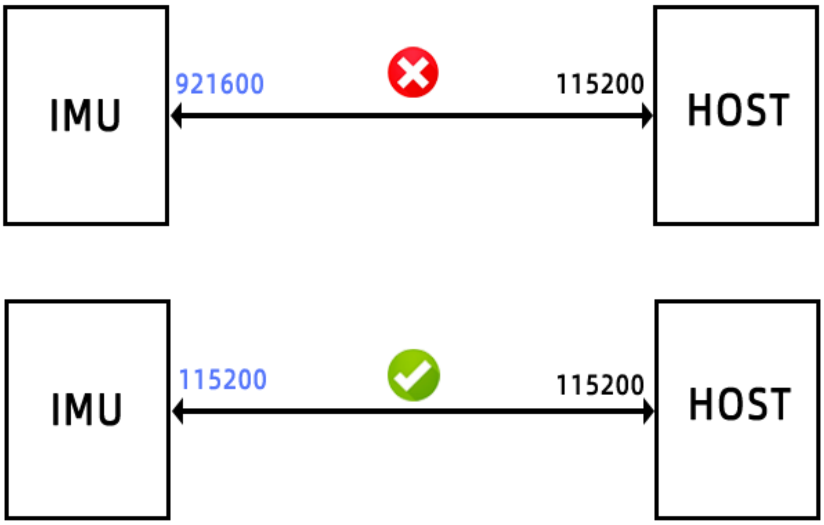

Figure35: IMU serial port connected to a single host

Note1: 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:

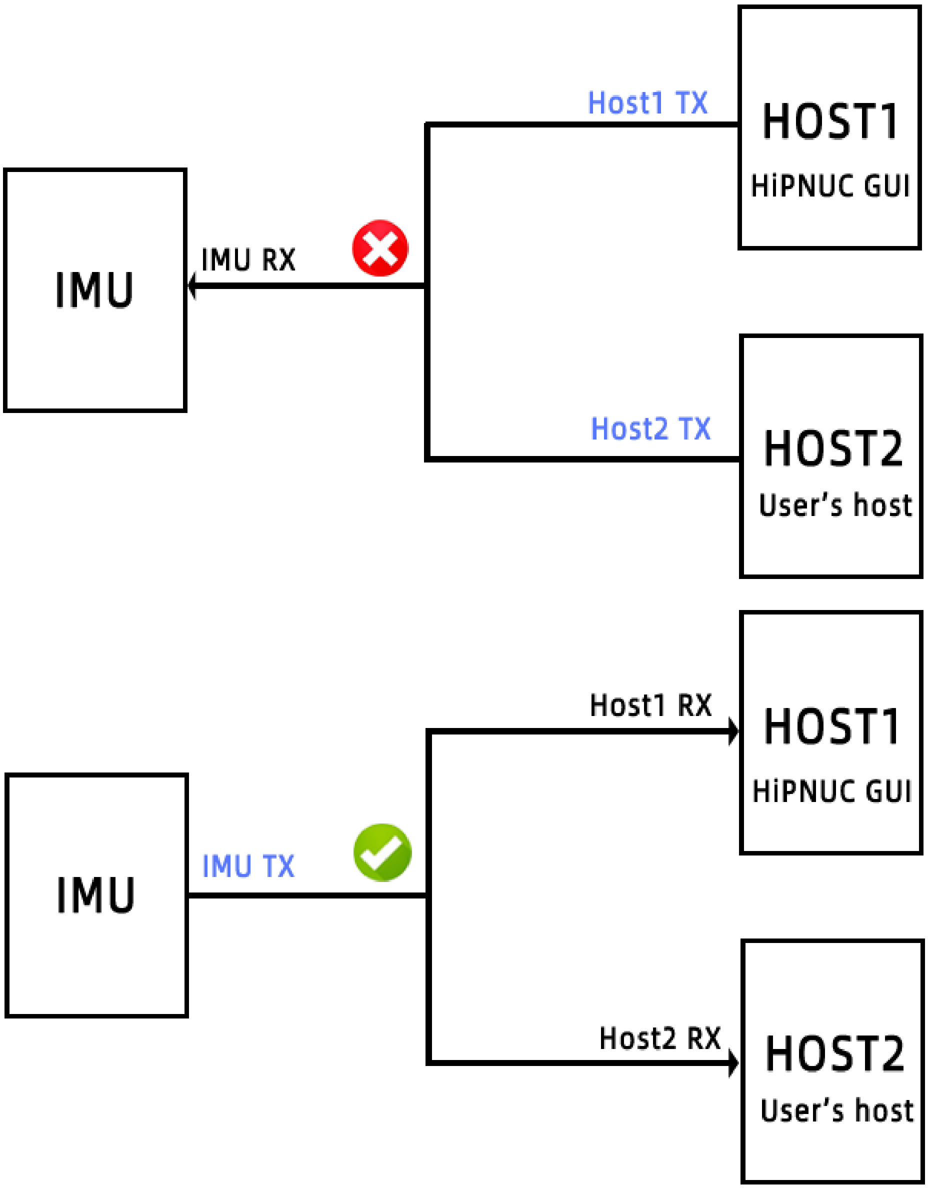

Figure36: IMU serial port simultaneously connected to the user's host and HiPNUC GUI

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.