1 FEATURES

1.1 Hardware

- Tactical-grade MEMS-IMU
- Factory temperature compensation from -40°C to 85°C
- Calibrated scale factor, cross-axis, and bias
- Gyroscope bias instability down to 0.3°/h
- Accelerometer bias instability down to 0.01mg
- Precise synchronization signal, supporting PPS and UTC/GPRMC sync
- Excellent vibration resistance
- Integrated temperature sensor
- Compact aluminum alloy housing
- Board-to-board connector, easy to integrate
- RoHS and CE certified

1.2 Software

- Adaptive Extended Kalman Fusion Algorithm
- Outputs data including velocity, position, attitude, heave and more
- Excellent dynamic tracking performance and vibration suppression
- Superior linear acceleration suppression
- Heave accuracy: 5cm/5%
- Supports multiple protocols: Binary, CANopen, Modbus, NMEA, etc.
- Rich user configuration commands
- Multi-functional GUI for easy operation
- Supports multiple development examples including ROS, C, QT

2 APPLICATIONS

- Precision instruments
- Platform stabilization and control
- Construction machinery
- Humanoid robots
- UAVs
- Low-speed autonomous driving
- Active wave compensation
- Ship attitude control
- Dynamic positioning for vessels

3 DESCRIPTIONS

3.1 Product Appearance

Figure1: HI71

3.2 System Block Diagram

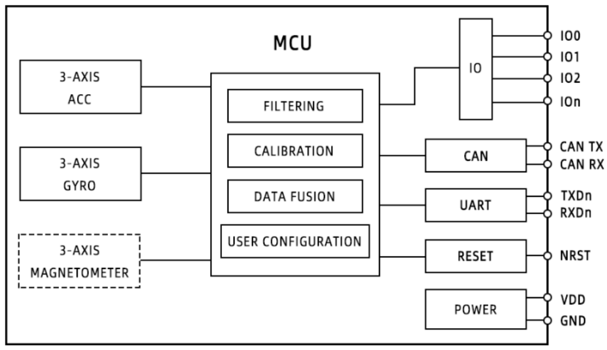

Figure2: Functional block diagram

Note1: dotted lines indicate features not supported by all models, refer to product selection table 1

3.3 General Description

The HI71 series sensors are IMU/VRU/MRU/AHRS/INS systems designed with high-performance tactical-grade MEMS-IMU. They feature proprietary adaptive extended Kalman filtering, IMU noise dynamic analysis algorithms, heave estimation algorithms, carrier motion state analysis algorithms, and GNSS fusion algorithms to provide users with precise position, attitude, velocity, and other information.

The HI71 series can synchronize with external systems through external triggers, receive UTC time, and align timing with external systems such as radar and cameras through synchronous output functionality. The multi-functional GUI (Graphical User Interface) helps quickly evaluate products, with features including but not limited to module configuration, data display, firmware upgrades, and data recording.

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CONTENT

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4 PRODUCT SELECTION

Table 1: Model Information

HI71a-b-c[1]							
Comapny	Series	a-Sensor		b-Interface		c-OEM	
HI	71	T2	6DoF 0.3°/h 0.01mg	MI0	UART/CAN requires external CAN transceiver	000	deafult
		T4	6DoF +Magnetic+Barometer 0.3°/h 0.01mg			others	oem
		M4	6DoF +Magnetic+Barometer 0.3°/h 0.01mg MRU				
		N4	6DoF +Magnetic+Barometer 0.3°/h 0.01mg INS				

Note1: Example：HI71T2-MI0-000

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5 ORDERING INFORMATION

5.1 Product List

Table 2: Product List

Part Number	Name	Description	Note
HI71T2-MI0-000	IMU/VRU Module	6DoF 0.3°/h 0.01mg	
HI71T4-MI0-000	IMU/VRU/AHRS Module	6DoF +Magnetic+Barometer 0.3°/h 0.01mg	
HI71M4-MI0-000	IMU/VRU/MRU/AHRS Module	6DoF +Magnetic+Barometer 0.3°/h 0.01mg MRU	
HI71N4-MI0-000	IMU/VRU/MRU/AHRS/INS Module	6DoF +Magnetic+Barometer 0.3°/h 0.01mg INS	

5.2 Contact us

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

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6 DOCUMENT INFORMATION

6.1 Scope

This document applies to modules with hardware version A0 and above.

6.2 Document Version

Table 3: Document Version

Version	Date	Section	Changes
1.0	Aug 20, 2025	-	Initial

6.3 Related Documents and Development Kits

1. *Command and Programmin Manual*
2. *3D Step Files*
3. *Evaluations Board EVAL HI71 Data Sheet and Design Files*
4. *RoHS Certification Documents*
5. *GUI and Reference Examples*

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7 HI71 SYSTEM ARCHITECTUR

The HI71 series is an all-in-one sensor module that integrates IMU, VRU, MRU, and AHRS functionalities. Each unit undergoes rigorous factory calibration for scale factor, cross-axis, temperature, and bias, providing users with foundational sensor data (acceleration, angular rate, geomagnetic field, barometric pressure) as well as 3D orientation data (Euler angles: pitch, roll, yaw) and quaternions. When connected to an external GNSS, it can also output velocity and position information.

The HI71 module is equipped with a 3-axis accelerometer, 3-axis gyroscope, 3-axis magnetometer, a barometric sensor, and a high-performance processor. The controller is primarily responsible for sensor synchronization, calibration, sensor fusion, and user configuration. Based on application scenarios and sensor characteristics, we offer multiple operating modes such as 6-DoF, AHRS, magnetically aided heading, humanoid robot, and high-vibration modes. For details, refer to the Command and Programming Manual.

7.1 IMU Subsystem

HI71 can operate as an IMU to provide 3D acceleration and 3D angular rate. Compared with traditional IMU chips, its advantage lies in the strict factory calibration and compensation applied to these signals, including cross-axis, scale factor, bias, and temperature compensation.

7.2 VRU Subsystem

Powered by our in-house fusion engine, HI71 can output gravity-referenced 3D orientation based on IMU data. These outputs include drift-free pitch and roll, and an unreferenced yaw (which starts at 0 degrees upon power-up and accumulates thereafter). The solution exhibits excellent vibration robustness and dynamic response. Although yaw has no absolute reference in VRU mode, it still features industry-leading low drift.

7.3 MRU Subsystem

Building on the VRU system with algorithmic adaptation, the HI71 provides heave, roll, and pitch suitable for marine motion measurements, forming an MRU system.

7.4 AHRS Subsystem

On top of the IMU/VRU foundation, we incorporate a high-precision, wide-range TMR magnetometer to upgrade HI71 into a more capable AHRS. It outputs drift-free pitch and roll, along with magnetically referenced heading relative to magnetic north.

7.5 INS Subsystem

The HI71 series can be upgraded to a powerful INS module by integrating with an external GNSS, delivering comprehensive outputs including velocity, position, attitude, and time synchronization.

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8 PIN DEFINITIONS

8.1 Pin Definitions

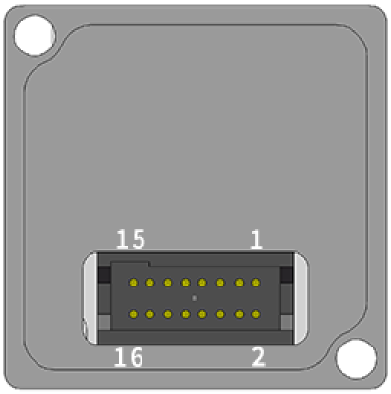

Figure3: HI71XX-MI0 pin assignment

Table 4: Pin Definitions

Pin Number	Pin Name	Type	Functional	Note
1	UART2_RX	I/O	Module UART2 receive; can receive UTC/GPRMC time	
2	UART2_TX	I/O	Module UART2 transmit	
3	UART4_RX	I/O	Module UART4 receive, currently leave unconnected	
4	UART4_TX	I/O	Module UART4 transmit, currently leave unconnected	
5	NRST	I	Reset pin. Low level resets the module. It is recommended to connect to host GPIO; can be left unconnected if not used	
6	GND	Power	Power ground	
7	VDD	power	Module power input 3.6-6 V, 5 V recommended	
8	NC	NA	Reserved, leave unconnected	
9	UART1_RX/I2C_SDA	I/O	Module UART1 receive / I2C data signal	
10	UART1_TX/I2C_SCL	I/O	Module UART1 transmit / I2C clock signal	
11	IO2(SYNC_OUT)	I/O	Synchronization output, can be used as Data Ready signal	
12	IO1(SYNC_IN/PPS)	I/O	Synchronization input, can accept external trigger signals such as GNSS PPS	
13	CAN_TX	I/O	CAN transmit signal	
14	CAN_RX	I/O	CAN receive signal	
15	UART3_TX	I/O	Module UART3 transmit, can connect to external GNSS; leave unconnected if not used	
16	UART3_RX	I/O	Module UART3 receive, can connect to external GNSS; leave unconnected if not used	

Note1: To use CAN, an external CAN transceiver is required, e.g., TJA1044.

Table 5: UART Function Description

UART	Functional
UART1	Main communication port, used for data output, command configuration input, and firmware upgrade.
UART2	Secondary communication port, same functions as UART1, and also supports additional features. See the Command and Programming Manual for details.
UART3	External GNSS interface.
UART4	Reserved

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9 INTERFACE and REFERENCE DESIGNS

9.1 Power Reference Design

The HI71 series integrates an LDO, power filtering, over-current, and over-voltage protection circuits to minimize external power noise interference.Users may supply the module via LDO or DC-DC converters,Input voltage range:3.6 - 6V,5V recommended.

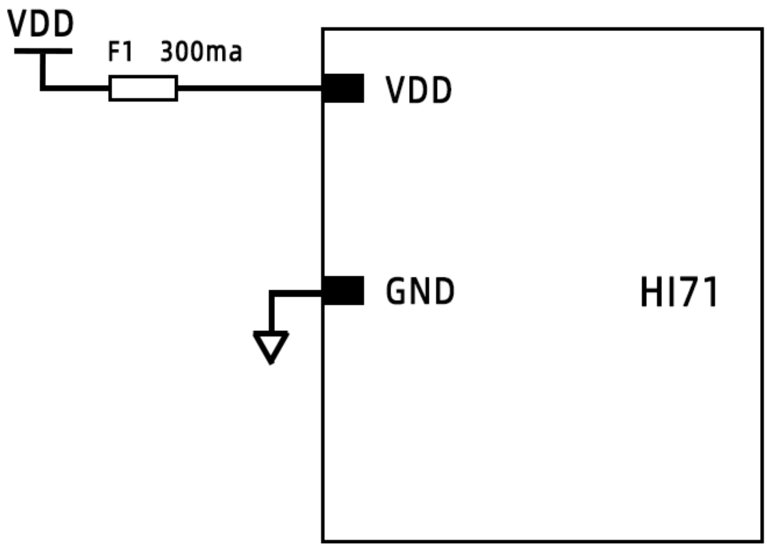

Figure4: HI71 Power Supply Example Circuit

9.2 UART1/UART2

The HI71 series sensors can communicate via UART1/UART2 in half-duplex mode. The frame format is (8N1): 115200 baud, 8 data bits, no parity, and 1 stop bit. Users may also add external RS-485/RS-422 transceivers to convert to 485/422 communication.

Note1: Both the baud rate and the data output frame rate can be modified via commands. For details, refer to the Command and Programming Manual.

9.3 Typical UART Reference Design

It is recommended that the host processor use 3.3 V logic levels. If you need to communicate with a 5 V or 1.8 V UART on the processor, you must add a level-shifting transceiver yourself.

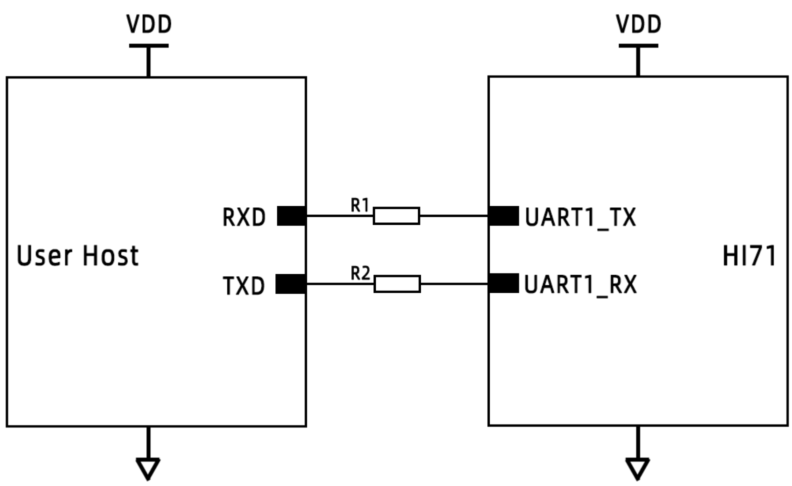

Figure5: HI71 UART Communication reference circuit

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9.4 I2C Communication

To be supported in future revisions.

9.5 CAN Communication

The module supports standard CAN 2.0B communication, with a default bitrate of 500 kbps.

9.6 Typical CAN Reference Design

HI71 supports CAN communication and requires an external CAN transceiver. The reference circuit is as follows:

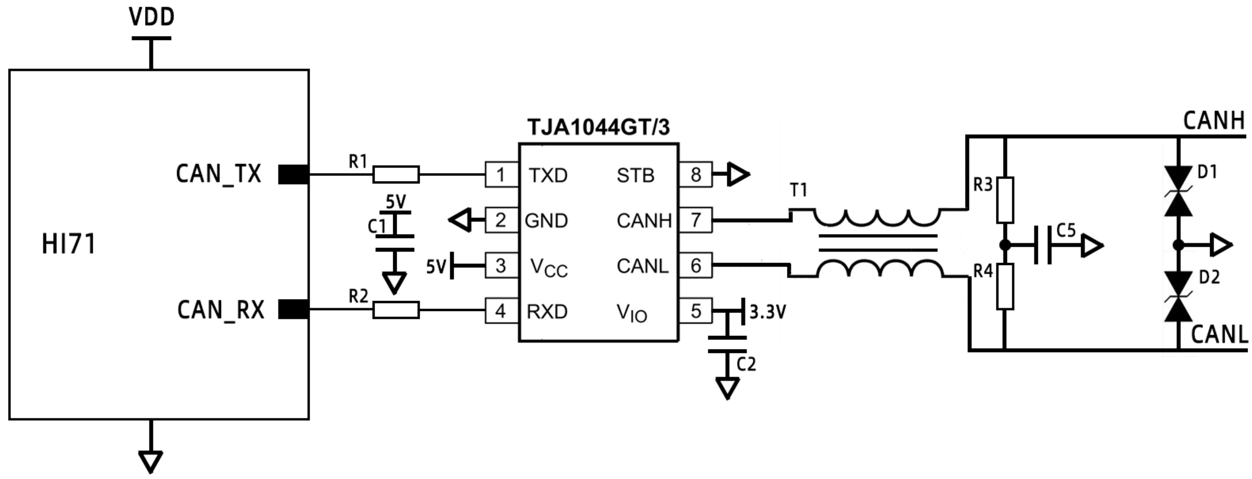

Figure6: HI71 CAN Communication Reference Circuit

Note1: The baud can be modified via commands. refer to the command and programming manual.。

Note2: R3 and R4 are bus termination/matching resistors. Populate them based on system requirements.

9.7 Reference Designs for Synchronization Systems

9.7.1 Sensor-to-Host Synchronization (UART)

In this connection method, the user connects IO1/IO2 to the host system for data synchronization. They do not need to be used simultaneously; which one to use depends on the host system design.

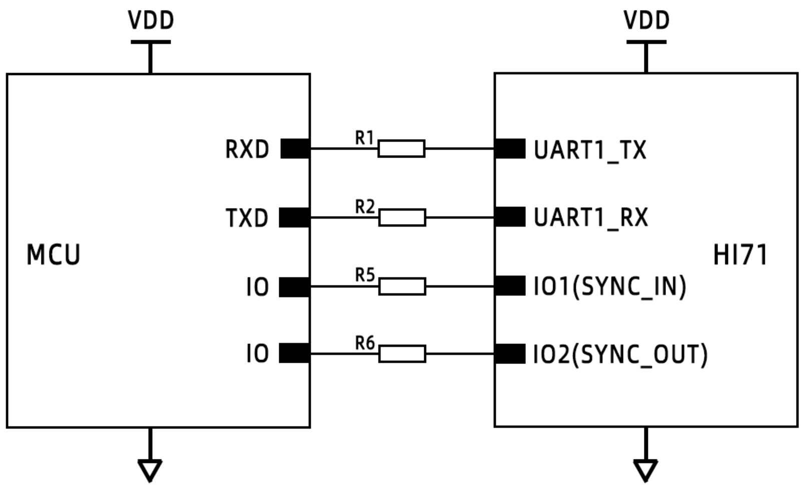

Figure7: HI71 UART Communication with Synchronization

Note1: If IO1 is used, the pulses generated by the MCU IO should have the same frequency as the data frame rate. See the Command and Programming Manual for details.

Note2: If IO2 is used, it can serve as a Data Ready signal. See the Command and Programming Manual for details.

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9.7.2 HI71 synchronization with GNSS

HI71 可以通过外部 GNSS 的 PPS 和 UTC 时间进行数据同步，此时注意 HI71，用户主机，GNSS 三者之间共地

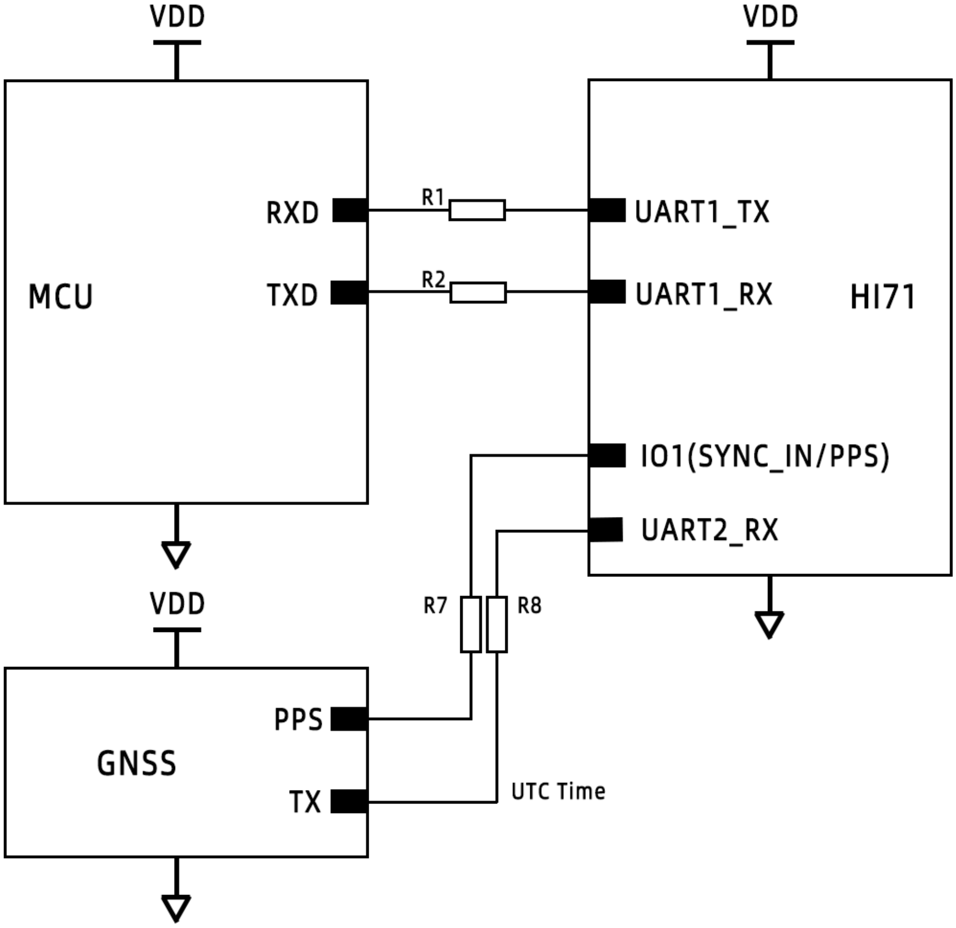

Figure8: HI71 synchronization with GNSS

Note1: If IO1 is used, IO1 receives the GNSS PPS signal, and UART2_RX receives the GNSS UTC time. Refer to the Command and Programming Manual for details.

9.7.3 Bom

Table 6: Reference Design BOM

Item	Reference	Part	P/N	Vendor
Fuse	F1	300mA	JK-SMD0603-030-6	JK
Resistor	R1,R2,R5,R6,R7,R8	1K	RC0402JR-071KL	YAGEO
Resistor	R3,R4	60.4Ω	RC1206FR-0760R4L	YAGEO
Capacitor	C1,C2	0.1uF	CC0402KRX5R7BB104	YAGEO
Capacitor	C5	1nF	CC0402KRX7R9BB102	YAGEO
Common Choke	T1	5.8kΩ@10MHz 100uH@100kHz 150mA	ACT45B-101-2P-TL003	TDK
TVS	D1,D2	SMBJ24CA	SMBJ24CA	BORN

Note1: The 1 kΩ resistors can be adjusted to match the actual application. For longer transmission distances, the value can be reduced to 33 Ω or 100 Ω.

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10 SPECIFICATIONS

10.1 Gyroscope

Table 7: Gyroscope Specifications

Parameters	Condition		Min	Nom	Max	Unit	Note
Range				300		°/s	
Resolution				16bit			
Nonlinearity	300°/s -40℃-110℃		-0.3	±0.15	0.3	°/s	1
	100°/s -40℃-110℃		-0.04	±0.01	0.04		
Cross-axis error			-0.15		0.15	%	
3 dB bandwidth				235	250	Hz	
Sampling rate				1000		Hz	
Noise density		XY		0.0004		(°/s)/√H	
		Z		0.0006			
Bias instability	Allan Variance			0.3		°/h	2
Bias stability	10s average			0.5		°/h	
Bias repeatability				0.8		°/h	
Angle random walk	Allan Variance	XY		0.015		°/√h	3
		Z		0.025			
Bias over temperature	-40-85℃	XY			0.25	°/s	
		Z		0.01	0.03		
g-sensitivity	For constant gravity input			0.00075		°/s/g	

Note1: Nonlinearity is the maximum deviation from the best-fit straight line determined from measured data, at the specified full scale.

Note2: Bias instability is obtained by dividing the minimum value of the Allan variance by 0.664. Measurement uses a 13 Hz low-pass filter setting, 200 Hz sampling rate, and a 15-minute warm-up before data collection to ensure full thermal stability.

Note3: Angle random walk is the white noise term estimated from the Allan deviation at a time constant τ = 1 s.

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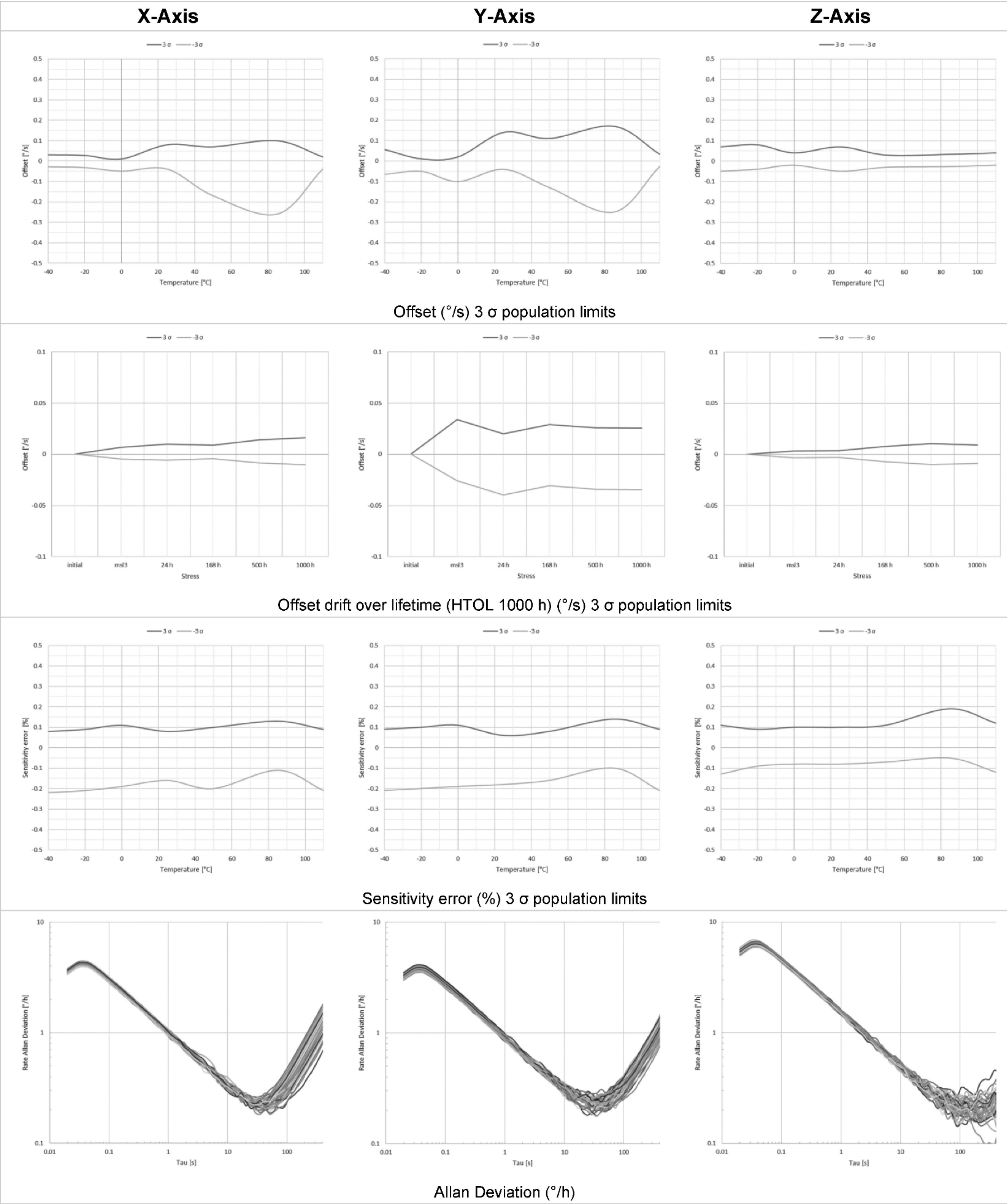

Figure9: HI70 Gyroscope typical performance characteristics

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10.2 Accelerometer

Table 8: Accelerometer Specifications

Parameters	Condition	Min	Nom	Max	Unit	Note
Range			16		g	
Resolution			16bit			
Initial bias				2	mg	
Nonlinearity	8g -40℃-110℃	15	3	15	mg	1
	1g -40℃-110℃	1	0.5	1		
Cross-axis error		-0.15		0.15	%	
3 dB bandwidth			210	235	Hz	
Sampling rate			1000		Hz	
Noise density			0.0008		$m/s^2\sqrt{Hz}$	
Bias instability	Allan Variance		0.01		mg	2
Bias stability	10s Average		0.03		mg	
Bias repeatability			0.04		mg	
Velocity random walk	Allan Variance		0.03		$m/s\sqrt{h}$	
Bias over temperature	-40-85℃		0.5	2	mg	

Note1: Note1: Nonlinearity is the maximum deviation from the best-fit straight line determined from measured data, at the specified full scale

Note2: Note2: Bias instability is obtained by dividing the minimum value of the Allan variance by 0.664. Measurement uses a 13 Hz low-pass filter setting, 200 Hz sampling rate, and a 15-minute warm-up before data collection to ensure full thermal stability

Note3: Velocity random walk is the white-noise term estimated from the Allan deviation at a time constant $\tau = 1$ s.

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10.3 Magnetometer

Table 9: Magnetometer Parameters

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

10.4 Barometer

Parameters	Condition	Min	Nom	Max	Unit	Note
Range		300	-	1200	hPa	
Resolution			0.006		hPa	
Accuracy			± 0.06		hPa	

10.5 Temperature Sensor

Table 10: Temperature Sensor Parameters

Parameters	Condition	Min	Nom	Max	Unit	Note
Range		-50	-	135	℃	
Offset error			±1		℃	

10.6 Fusion Performance

Table 11: Fusion Performance

Parameters	Condition	Min	Nom	Max	Unit	Note
Pitch/Roll			0.05	0.1	°	1
Resolution			0.01			
Heading(VRU/MRU)			0.2	0.3	°	1
Heading(AHRS)			0.5	2	°	2
Resolution			0.01			
Startup time	IMU/VRU		2		s	
	MRU（Stationary）			60		
	MRU（Marine）			180		
Heave			5/5%		cm	
Heave period			1-10		s	

Note1: Turntable rotation test.

Note2: Measured after geomagnetic calibration, with no surrounding magnetic interference, and the product configured in AHRS mode.

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11 SYSTEM AND ELECTRICAL SPECIFICATIONS

11.1 Electrical Specifications

Parameters	Condition	Min	Nom	Max	Unit	Note
Input voltage VDD		3.6	5	5.5	V	
Power consumption				370	mW	
V_{OL}			-	0.4	V	
V_{OH}		2.6			V	
V_{IL}		-0.3		1	V	
V_{IH}		1.9		3.6	V	

11.2 Interface Specifications

Interf	Parameters	Condition	Min	Nom	Max	Unit	Note
UART1/UART2	Baud rate		9600	115200	921600	bps	
	Output frame rate		0	100	1000	Hz	
UART3				115200		bps	
CAN	Baud rate		125	500	1000	kbps	
	Output frame rate		0	100	200	Hz	

11.3 System Specifications

Parameters	Product	Value	Note
Dimensions		24X24X14mm	
Weight		<13g	
Operating temperature		-40-85℃	
Enclosure material		Aluminum alloy	
Vibration resistance		1.0mm(5Hz-58Hz)	
Environmental compliance		Directive 2011/65/EU	
EMC		LVD Directive 2014/35/EU	
Drop test		Free drop from 75 cm, 3 times	
Thermal shock		Temperature ramp from -40 °C to 85 °C within 1 h, 5 cycles	
MTBF		30000h	

Note1: Time from power-on to valid data output.

11.4 Absolute Maximum Ratings

Parameters	Limit	Comment
Mechanical shock	10,000g	Duration <0.2ms
Storage temperature	-40℃-125℃	
ESD HBM	2KV	JEDEC/ESDA JS-001
Input voltage	9V	
IO To GND	-0.3-5V	

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12 DIMENSIONS AND PACKAGE

12.1 Dimensions

All Dimensions in mm units

12.1.1 Dimensions

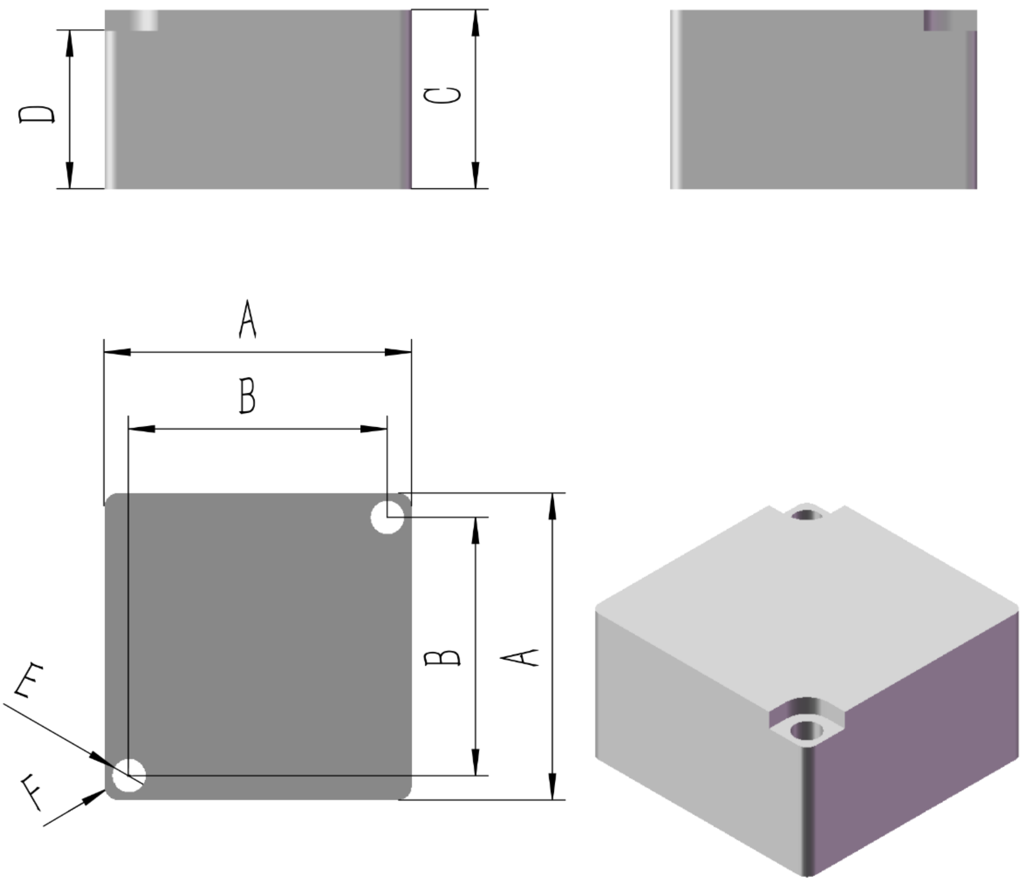

Figure10: HI71 Mechanical Specifications

12.1.2 Dimensions Table

Table 12: Dimensions Table

Symbol	Min(mm)	Typ(mm)	Max(mm)
A	23.9	24	24.1
B	20.15	20.2	20.25
C	13.9	14	14.1
D	12.3	12.4	12.5
E	Φ2.5	Φ2.6	Φ2.7
F	R2.2	R2.3	R2.4

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12.1.3 Package

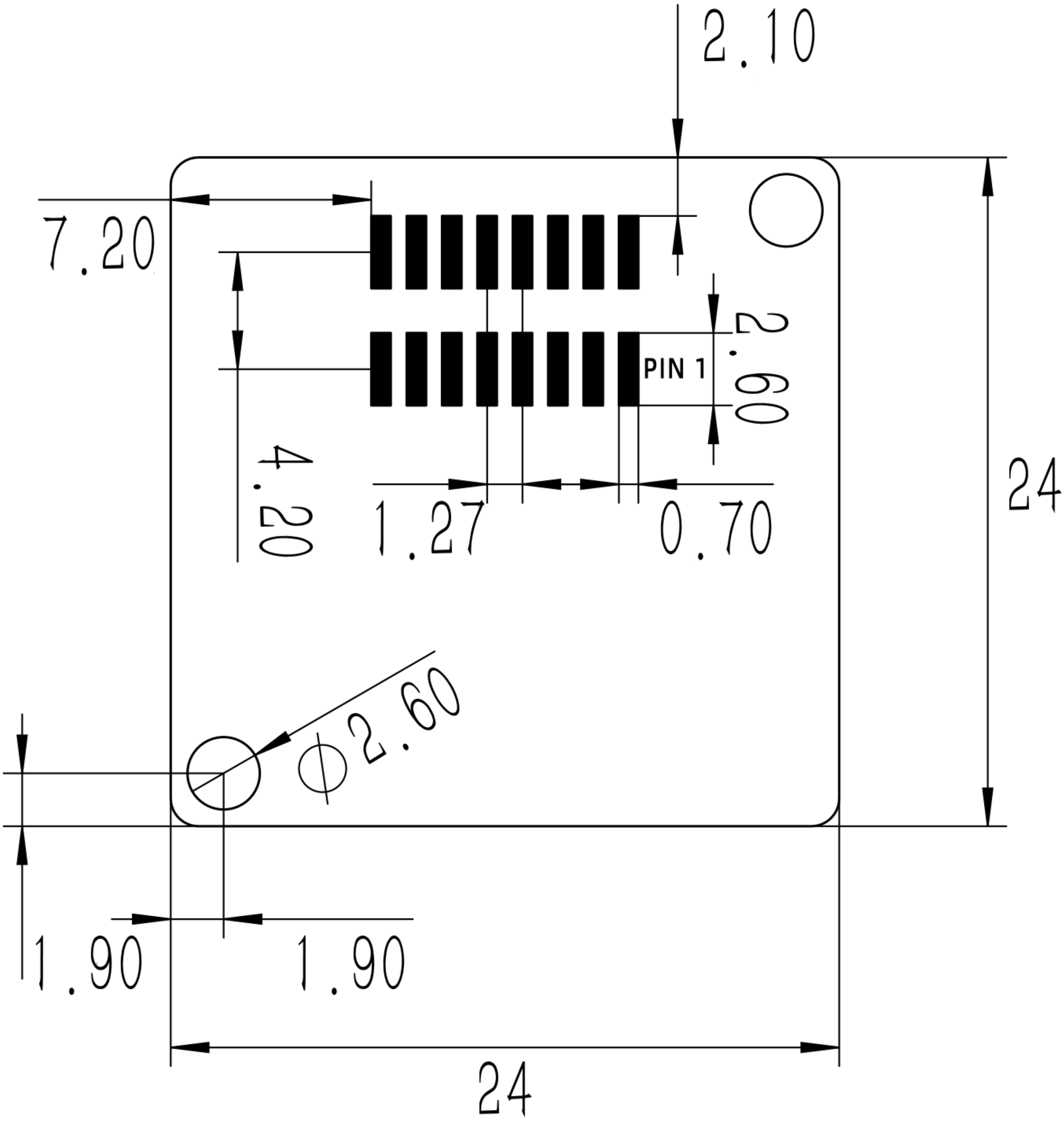

Figure11: Recommend footprint

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13 COORDINATE SYSTEM

13.1 Coordinate System

The body frame uses a Right-Front-Up (RFU) coordinate system, and the geographic frame uses an East-North-Up (ENU) coordinate system. The accelerometer and gyroscope axes are shown below:

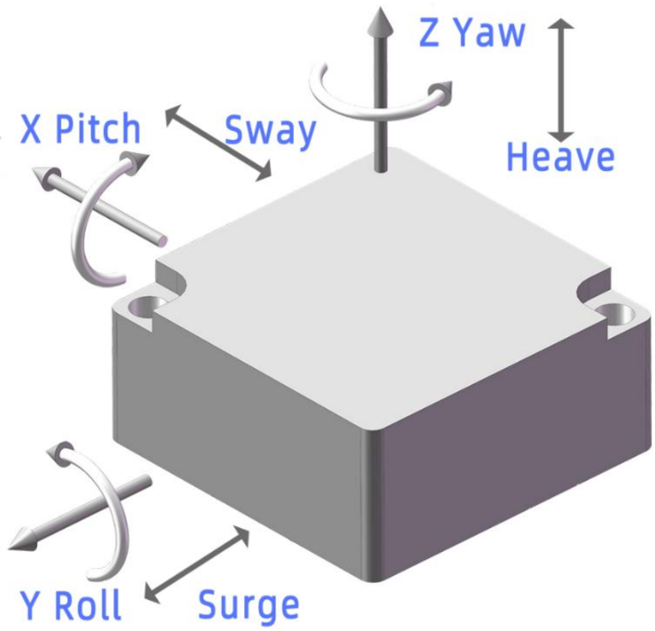

Figure12: HI71 Coordinate System

The Euler angle rotation sequence is ENU-312 (rotate about Z first, then X, and finally Y). Detailed definitions:

Rotation about the Z-axis: Yaw ψ, range: -180° to 180°

Rotation about the X-axis: Pitch θ, range: -90° to 90°

Rotation about the Y-axis: Roll ϕ, range: -180° to 180°

If the module is regarded as an aircraft, the positive Y-axis should be considered the nose direction. When the sensor frame coincides with the inertial frame, the ideal Euler angle outputs are: Pitch = 0°, Roll = 0°, Yaw = 0°.

If the module is regarded as a marine vessel, the positive Y-axis should be considered the bow direction. When the sensor frame coincides with the inertial frame, the ideal Euler angle outputs are: Pitch = 0°, Roll = 0°, Yaw = 0°. Motion along the Z-axis is Heave, along the X-axis is Sway, and along the Y-axis is Surge.

If users need to change the sensor's default coordinate system, please refer to the Command and Programming Manual.

13.2 Sensor Center

Table 13: Sensor Center

Axis	X-offset	Y-offset	Z-offset	Unit
X	0	0	1.5	mm
Y	0	0	1.5	mm
Z	0	0	1.5	mm

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14 EVALUATION BOARD

Figure13: HI71 Cable of evaluation board

Note1: The length of usb cable is 1m，open cable is 20cm

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15 PROTOCOLS

15.1 Serial Binary Protocol

To facilitate user integration, we provide a rich set of serial protocols to choose from. For more details, please refer to the Command and Programming Manual.

15.2 Modbus

The RS485 communication protocol complies with the Modbus RTU specification. For detailed protocol information, please refer to the Command and Programming Manual.

15.3 CAN

CAN communication supports CANopen and SAE J1939. For details, refer to the Command and Programming Manual.

15.4 NMEA 0183

The product supports the standard NMEA protocol. Please refer to the Command and Programming Manual.

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16 FAQ

16.1 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

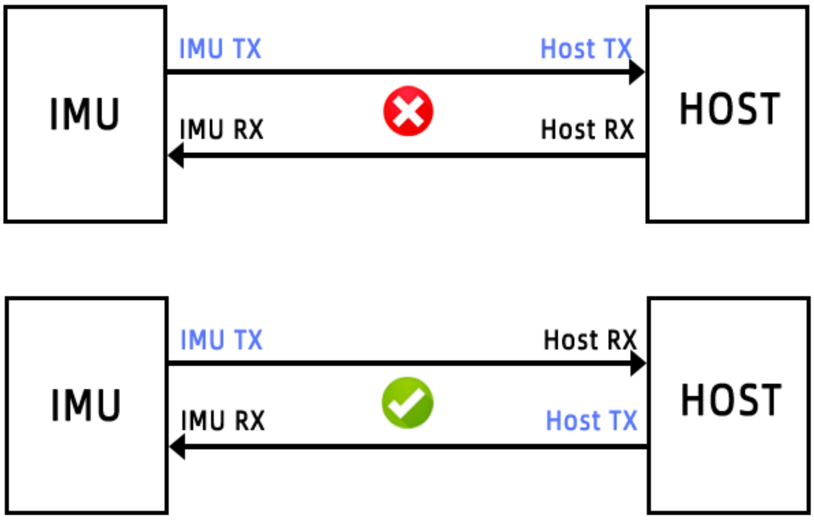

Figure14: IMU serial port connected to a single host

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:

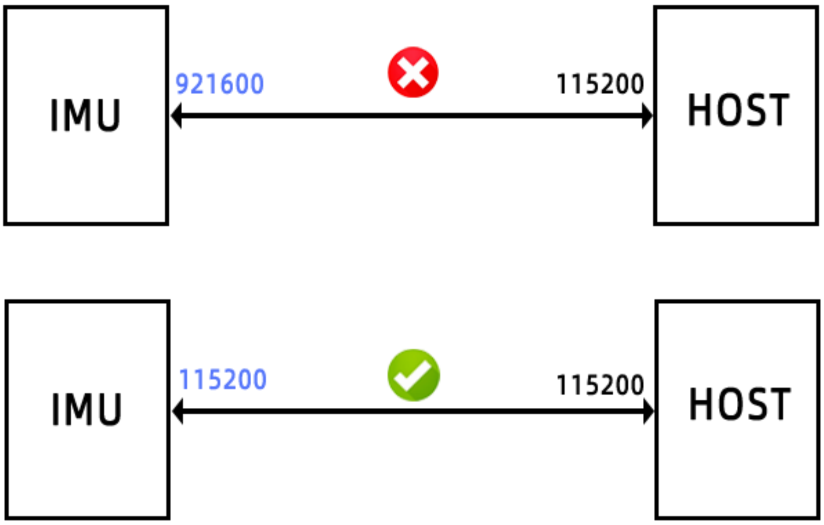

Figure15: IMU serial port connected to a single host

Note2: 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.

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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:

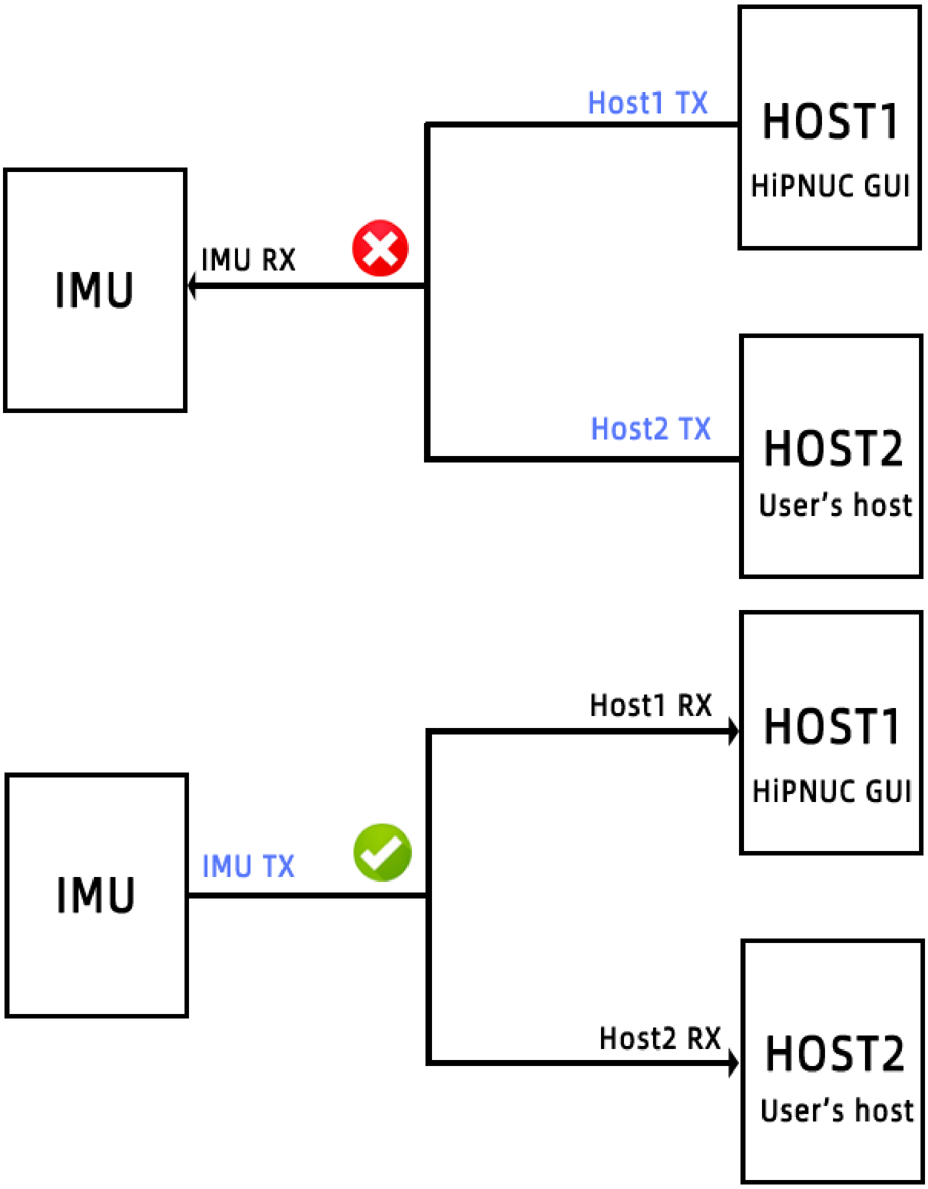

Figure16: IMU serial port simultaneously connected to the user's host and HiPNUC GUI

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.

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