1 FEATURES

1.1 Hardware

- High-performance, low-noise MEMS IMU
- Factory calibrated over the full -40 to +85 °C range (scale factor, cross-axis, bias)
- Gyro bias instability: down to 1 °/h (typ.)
- Accelerometer bias instability: down to 0.007 mg (typ.)
- Precision timing support: PPS and UTC/GPRMC synchronization
- Outstanding vibration robustness
- On-board temperature sensor for real-time compensation
- Supports external GNSS for integrated navigation
- Compact SMT package for easy system integration
- Compliant with RoHS and CE

1.2 Software

- Adaptive EKF sensor fusion algorithm with output rates up to 1000 Hz and low latency
- Superior dynamic tracking with effective vibration suppression
- High immunity to linear acceleration disturbances
- Fast startup: < 1 s to data output
- Multi-protocol support: proprietary binary, CANopen, Modbus, etc.
- No external command configuration required, outputs data directly
- Extensive, flexible user configuration command set
- Feature-rich, user-friendly GUI for rapid evaluation and tuning
- Comprehensive sample code / examples for ROS, C, and Qt

2 APPLICATION

- Precision instrumentation & measurement systems
- Stabilized platforms and gimbal control systems
- Construction / heavy engineering machinery
- Humanoid robotics platforms
- UAV / drone navigation and stabilization
- Low-speed autonomous ground robots (UGV / AMR)

3 DESCRIPTION

3.1 Product Overview

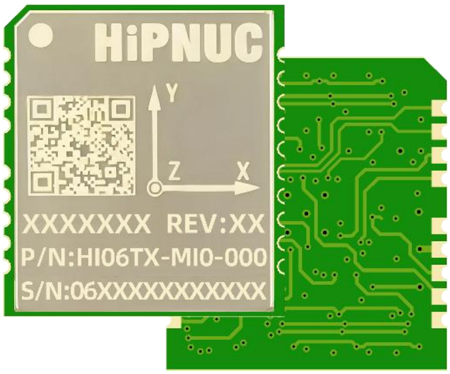

Figure1: HI06

3.2 System Block Diagram

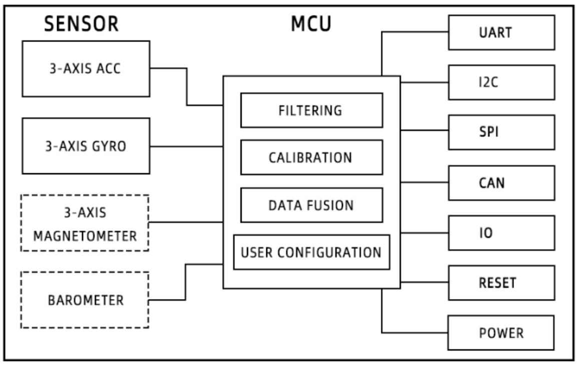

Figure2: Functional block diagram

Note1: Dashed lines denote features not available on certain models. See Table 1 (Product Selection)

3.3 General Description

HI06 Series MEMS inertial modules (IMU / VRU / AHRS / INS) integrate proprietary adaptive EKF, dynamic noise characterization, motion state analysis, and GNSS fusion (on applicable models) to deliver precise, low-latency attitude, velocity, and (GNSS variants) position outputs.

Each unit is factory calibrated for temperature, bias, scale factor, and misalignment. Standard interfaces: UART, CAN, I^2C. External trigger and UTC (e.g., PPS + time message) enable system-level time alignment; synchronization outputs support radar/camera correlation.

A PC GUI provides configuration, real-time data viewing, firmware updates, and data logging.

See Table 1 and Table 2 for model selection and ordering.

Content

4 PRODUCT SELECTION

Table 1: Product selection information

HI06a-b-c[1]							
Company	Series	a-Sensor		b-Interface		c-Others	
HI	06	T3	6DoF +Magnetic 1.0°/h 0.007mg	MI0	UART/I2C/CAN external CAN transceiver	000	Default
						Others	OEM

Note1: Model: HI06T3-MI0-000

5 ORDERING

5.1 Ordering Information

Table 2: Order information

Part Number	Name	Description	Note
HI06T3-MI0-000	IMU/AHRS Module	6DoF+Magnetic 1°/h 0.007mg	

5.2 Contact us

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

6 DOCUMENT INFORMATION

6.1 Scope

This document applies to hardware revision A0 and later.

6.2 Revision History

Table 3: Revision history

Version	Date	Sections	Change
1.0	2025-9-20	-	Initial release

6.3 Related Documents & Development Kits

1. *Command & Programming Manual*
2. *3D Step/CAE*
3. *Evaluation Board (EVAL HI06) specification & design files*
4. *Certification documents (CE, RoHS, etc.)*
5. *PC GUI software and reference examples*

7 SYSTEM ARCHITECURE

The HI06 series is a fully featured sensor module that integrates multiple functional tiers: IMU, VRU, AHRS, and INS. Each unit, before leaving the factory, undergoes strict calibration procedures covering scale factor, cross-axis alignment, temperature characteristics, and bias (zero offset), enabling it to provide users with: fundamental sensor data (acceleration, angular rate, geomagnetic field, barometric pressure); three-dimensional orientation data (Euler angles: pitch, roll, yaw); quaternion data; and—when an external GNSS is connected—additional information such as velocity and position.

The HI06 module is equipped with a 3-axis accelerometer, a 3-axis gyroscope, a 3-axis geomagnetic sensor, a barometric pressure sensor, and a high-performance processor. This controller is mainly used for sensor synchronization, calibration compensation, algorithmic fusion, and user configuration. Based on application scenarios and sensor characteristics, we provide multiple operating modes to the user, such as 6DoF, AHRS, magnetically assisted heading, humanoid robotics, and high-vibration modes. For details, refer to the Command & Programming Manual.

7.1 IMU Subsystem

When used as an IMU, the HI06 can provide the user with three-dimensional acceleration and three-dimensional angular rate data. Compared with traditional standalone IMU sensor chips, its advantage lies in the fact that these data have already undergone our factory's rigorous calibration and compensation processes, including cross-axis (misalignment), scale factor, bias (zero offset), and temperature characteristics. This reduces downstream integration workload and improves consistency under varying environmental and thermal conditions.

7.2 VRU Subsystem

Through our self-developed (proprietary) algorithm fusion engine, the HI06 can, based on the fundamental IMU data, output three-dimensional orientation referenced to the gravity frame. These orientation outputs include drift-free pitch and roll angles, as well as a yaw (heading) angle without an external absolute reference (it starts accumulating from 0 degrees upon power-up). These orientation data possess excellent vibration immunity and dynamic response. Although the yaw angle lacks an absolute reference source in this mode, it still exhibits industry-leading low drift characteristics over typical operating intervals.

7.3 AHRS Subsystem

Building upon the IMU / VRU basis, we introduce a high-precision, wide-dynamic-range TMR geomagnetic sensor, upgrading the HI06 into a more capable Attitude and Heading Reference System (AHRS). In this configuration it can output drift-free pitch and roll (gravity-referenced), as well as a yaw (heading) angle referenced to magnetic north. Magnetic fusion algorithms can mitigate soft-iron and hard-iron disturbances (with recommended procedures and user guidance available in the Command & Programming Manual).

7.4 INS Subsystem

The HI06 series sensor can be upgraded into a powerful INS module by connecting an external GNSS receiver, thereby providing users with complete navigation outputs including velocity, position, attitude (pitch, roll, heading), and timing (time synchronization) data. In GNSS-challenged or intermittent environments, the inertial solution propagates (bridges) short outages to maintain continuity of navigation outputs until GNSS updates resume.

8 PIN DEFINITIONS

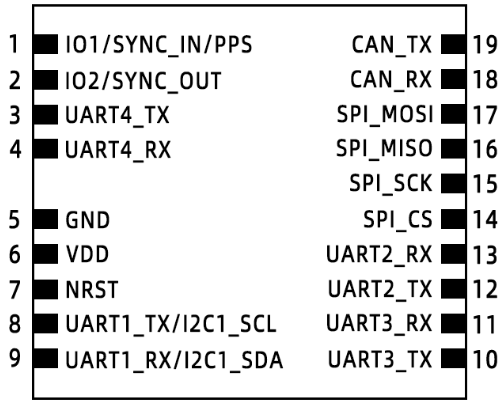

Figure3: HI06XX-MI0 pin assignment

Table 4: MI0 Pin function description

Pin Number	Pin Name	Type	Functional	Note
1	IO1(SYNC_IN/PPS)	I/O	Synchronization input. Can accept an external trigger signal, e.g. GNSS PPS signal	
2	IO2(SYNC_OUT)	I/O	Synchronization output. Can be used as a Data Ready signal.	
3	UART4_TX	I/O	Module UART4 transmit. Leave unconnected (floating) at present.	
4	UART4_RX	I/O	Module UART4 receive. Leave unconnected (floating) at present.	
5	GND	Power	Power ground	
6	VDD	power	Power input 3.3-5 V.	
7	NRST	I	Pulling low resets the module. Recommended to connect to host GPIO; can be left floating if unused.	
8	UART1_TX/I2C_SCL	I/O	Module UART1 transmit / I2C clock line.	
9	UART1_RX/I2C_SDA	I/O	Module UART1 receive / I2C data line.	
10	UART3_TX	I/O	Module UART3 transmit; can connect to external GNSS module	
11	UART3_RX	I/O	Module UART3 receive; can connect to external GNSS module	
12	UART2_TX	I/O	Module UART2 transmit	
13	UART2_RX	I/O	Module UART2 receive can receive UTC time	
14	SPI_CS	I/O	SPI chip select signal. Leave unconnected (floating) at present	
15	SPI_SCK	I/O	SPI clock signal. Leave unconnected (floating) at present	
16	SPI_MISO	I/O	SPI data output (slave). Leave unconnected (floating) at present	
17	SPI_MOSI	I/O	SPI data input (slave). Leave unconnected (floating) at present	
18	CAN_RX	I/O	CAN receive signal	1
19	CAN_TX	I/O	CAN transmit signal	

Note1: When using CAN, an external CAN transceiver (e.g. TJA1044) is required.

Table 5: 串口功能描述

UART	Functional
UART1	Main communication port: data output, command / configuration input, firmware upgrade
UART2	Secondary communication port: same functionality as UART1; also supports additional feature configuration (see Command & Programming Manual)
UART3	Can connect an external GNSS module for integrated navigation
UART4	Reserved

9 REFERENCE DESIGNS

9.1 Power Supply Reference Design

The HI06 series integrates an internal LDO as well as input power filtering, over-current and over-voltage protection circuitry to minimize external power noise interference with the internal system. Users may supply the module via an external LDO or DC-DC converter. Input voltage range: 3.3–5.0 V.

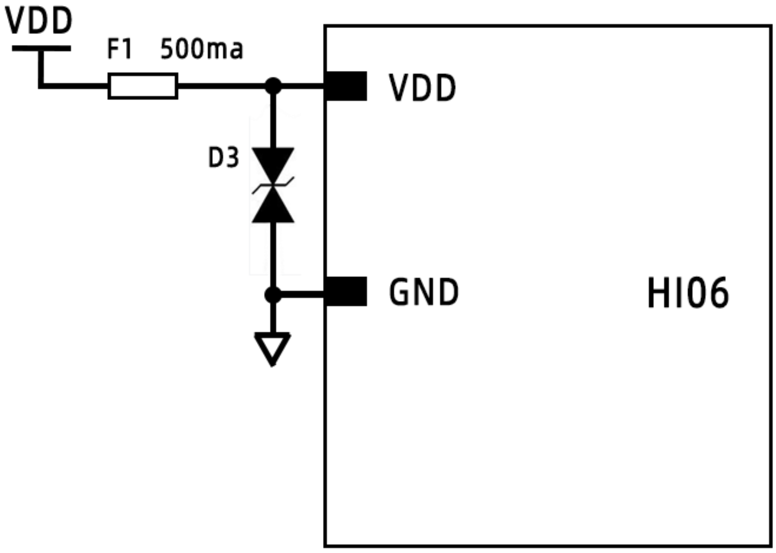

Figure4: HI06 UART communication reference circuit

9.2 UART1 / UART2 Communication

HI06 series sensors communicate over UART1 / UART2 in half-duplex mode. Frame format (8N1): 115200 baud, 8 data bits, no parity, 1 stop bit. Users may add an external RS-485 / RS-422 transceiver to enable 485 / 422 communication.

Note1: Baud rate and data output frame rate can both be modified via commands. See the Command & Programming Manual.

9.3 Typical UART Reference Design

It is recommended that the host processor logic level be 3.3 V. If interfacing to a 5 V or 1.8 V processor UART, the user must add a level-shifting device.

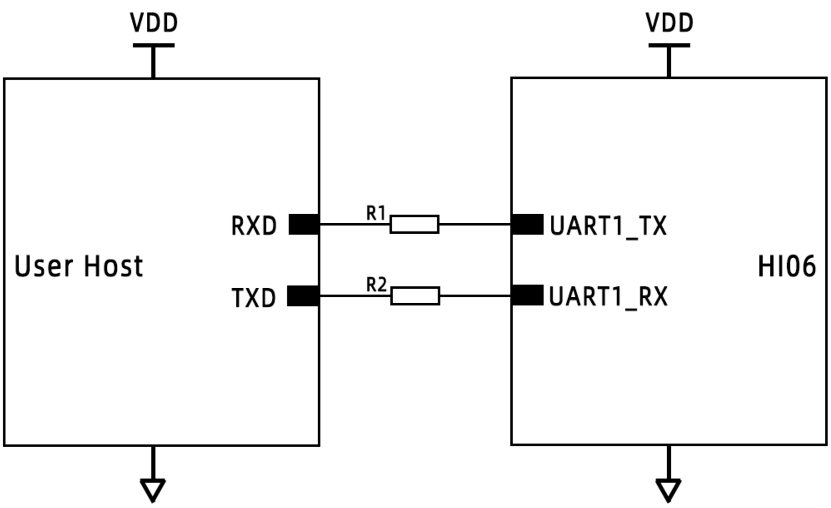

Figure5: HI06 UART communication reference circuit

9.4 I2C Communication

To be supported in a future firmware release

9.5 CAN Communication

The module supports standard CAN 2.0B,Default baud rate: 500 kbit/s.

9.6 Typical CAN Reference Designs

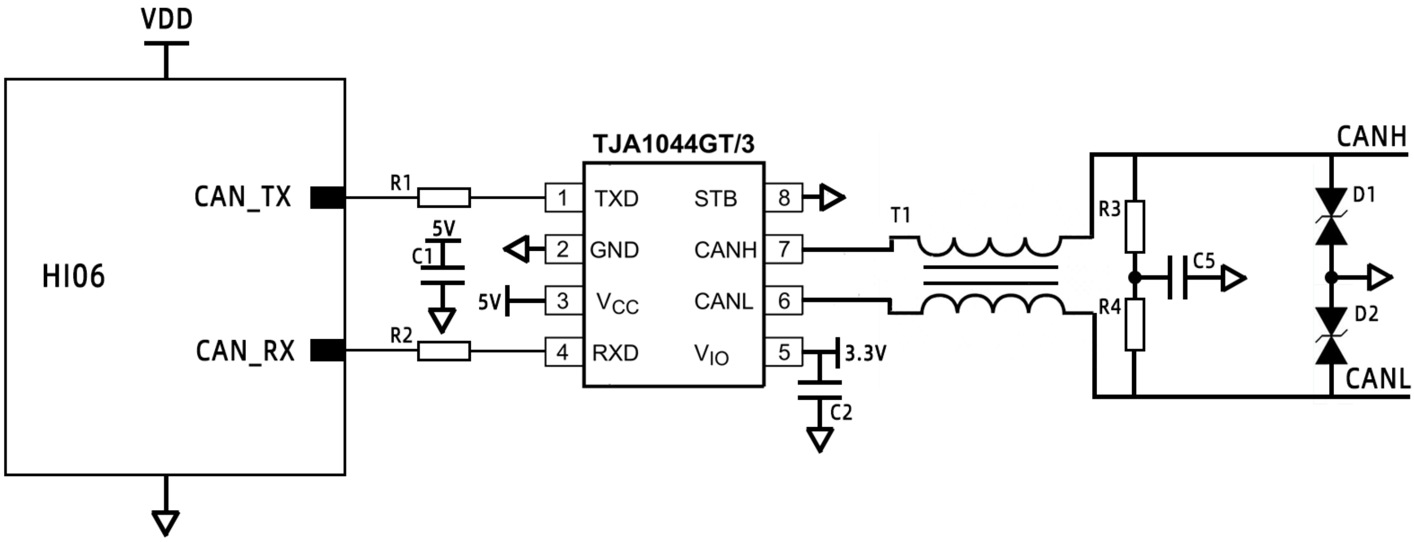

Figure6: HI06XX-MI0 CAN communication reference circuit

Note1: Baud rate is configurable via commands.

Note2: R3 and R4 implement (split) bus termination; populate according to network length and topology.

9.7 Synchronization System Reference Designs

9.7.1 Sensor-Host Synchronization (UART Communication)

In this configuration, IO1 and/or IO2 are connected to the host system for data synchronization. They do not have to be used simultaneously; which one is selected depends on the host system design.

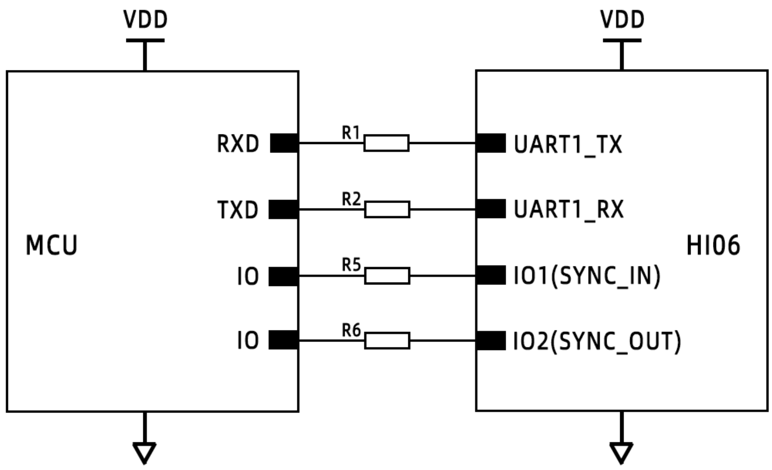

Figure7: HI06 UART communication with synchronization

Note1: If IO1 is used, the MCU must generate pulses at the same frequency as the data frame rate. See the Command & Programming Manual for details.

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

9.7.2 GNSS Synchronization

HI06 can synchronize its data using an external GNSS module's PPS and UTC time. Ensure a common ground is shared by HI06, the host, and the GNSS module.

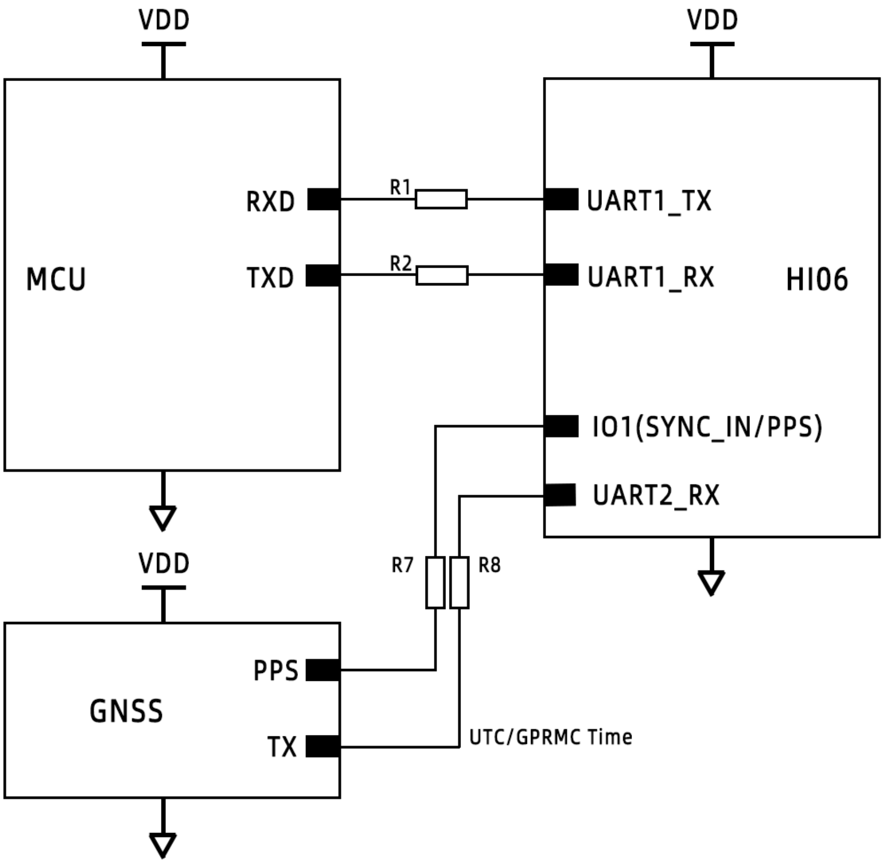

Figure8: HI06 GNSS-based synchronization

Note1: IO1 can be configured as a PPS input (rising edge of GNSS PPS). UART3_RX inputs the GNSS UTC time (e.g., NMEA sentences). Refer to the Command & Programming Manual for accepted sentence formats, baud rate, pulse width, alignment latency and jitter limits.

9.7.3 Bom

Table 6: Reference design BOM

Item	Reference	Part	P/N	Vendor
Fuse	F1	500mA	JK-SMD0603-050-6	JK
TVS	D3	SMF5.0CA	SMF5.0CA	TWGMC
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 (R1, R2, R5-R8) may be adjusted according to the application. For longer transmission distance the value can be reduced (e.g. 100 Ω or 33 Ω).

10 SENSOR SPECIFICATIONS

10.1 Gyroscope

Table 7: Gyroscope specifications

Parameters	Condition	Min	Nom	Max	Unit	Note
Range		15.625	4000	4000	°/s	
Resolution			20bit			
Scale Factor	100°/s		150	200	ppm	1
Nonlinearity		-0.05	-	0.05	%Fs	2
Noise Density	Bandwith 80Hz		0.0015		°/s√Hz	3
3dB Bandwidth			80	400	Hz	
Zero-Speed Output				±0.1	°/s	4
Sampling Rate			1000		Hz	
Zero Bias Instability	Allan Variance		1	1.2	°/h	1σ
Zero Bias Stability	10s Smoothing		2.3		°/h	1σ
Zero Bias Repeatability	Allan Variance		1.8		°/h	
Angular Random Walk	Allan Variance		0.05		°/√h	1σ
Zero Bias Full Temperature Variation			0.07	0.2	°/s	5
Accelerometer Sensitivity	All three axis		0.05		°/s/g	

Note1: Measured as the average after 10 rotations in both directions on a turntable. Values may change after user soldering; actual values should be used.

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

Note3: Average value of test samples.

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

Note5: Measured in a thermal chamber with a turntable at the HiPNUC Laboratory; temperature rise rate is less than 3℃/min.

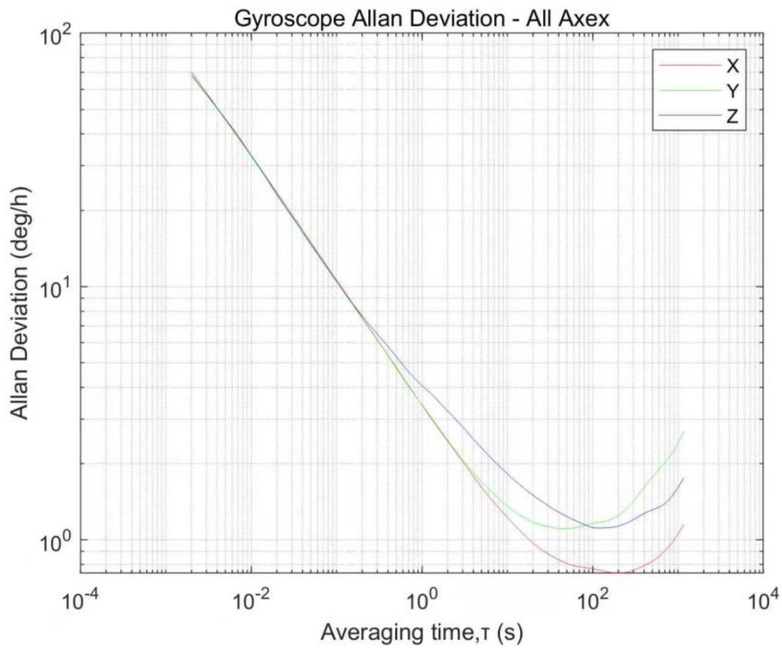

Figure9: HI06RX Gyroscope Allan Variance

10.2 Accelerometer

Table 8: Accelerometer specifications

Parameters	Condition	Min	Nom	Max	Unit	Note
Range		2	8	32	g	
Resolution			20bit			
Initial Zero Bias			2	10	mg	1
Nonlinearity			0.01		%Fs	
3dB Bandwidth			90	400	Hz	
Noise Density	Bandwidth 90Hz		0.025	0.038	mg/√Hz	2
Sampling Rate			1000		Hz	
Zero Bias Instability	Allan Variance		0.007		mg	1σ
Zero Bias Stability	10s Smoothing		0.008		mg	1σ
Zero Bias Repeatability	Allan Variance		0.05		mg	
Random Walk	Allan Variance		0.01		m/s/√h	1σ
Zero Bias Full Temperature Variation	-40-85℃		2.5	5	mg	3

Note1: This value may change after user soldering; actual values should be used.

Note2: Average value of test samples, 1σ.

Note3: Measured in a thermal chamber with a turntable at the HiPNUC Laboratory; temperature rise rate is less than 3℃/min.

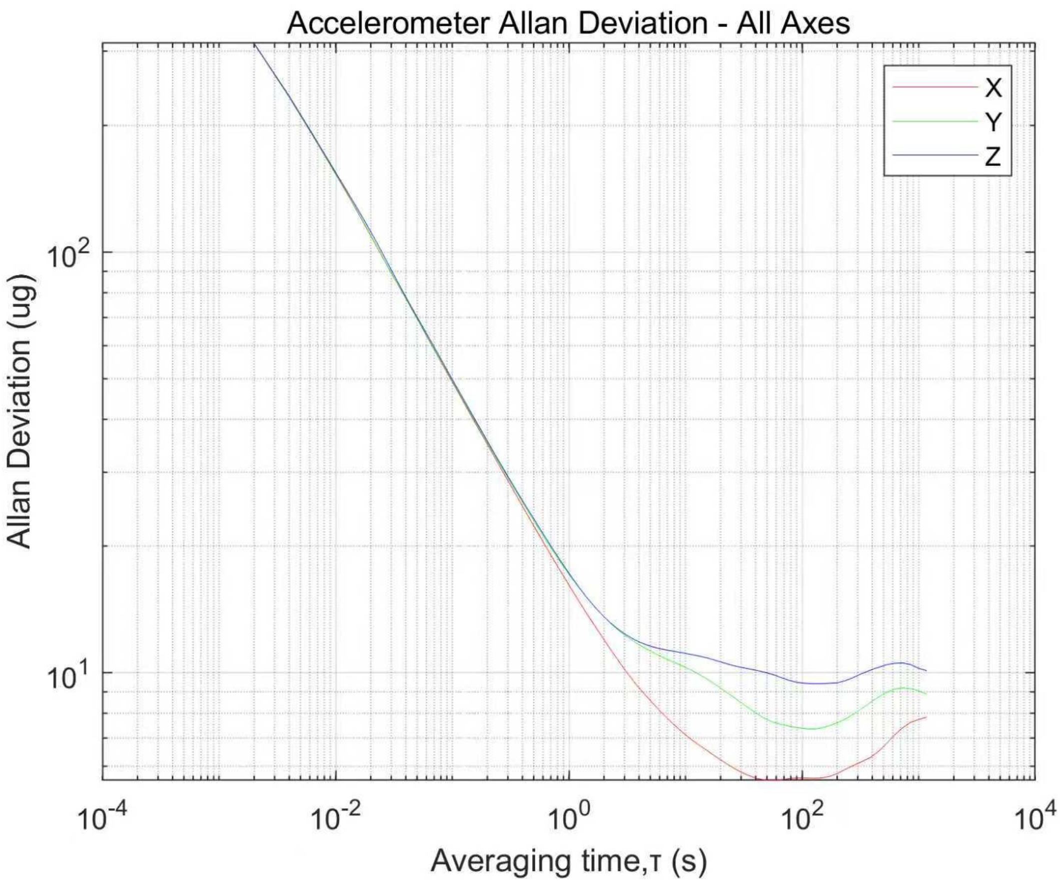

Figure10: HI06RX Accelerometer Allan Variance

10.3 Magnetometer

Table 9: Magnetometer specifications

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

10.4 Temperature Sensor

Table 10: Temperature sensor specifications

Parameters	Condition	Min	Nom	Max	Unit	Note
Range		-40	-	85	℃	
Offset error			±5		℃	

10.5 Initial Bias

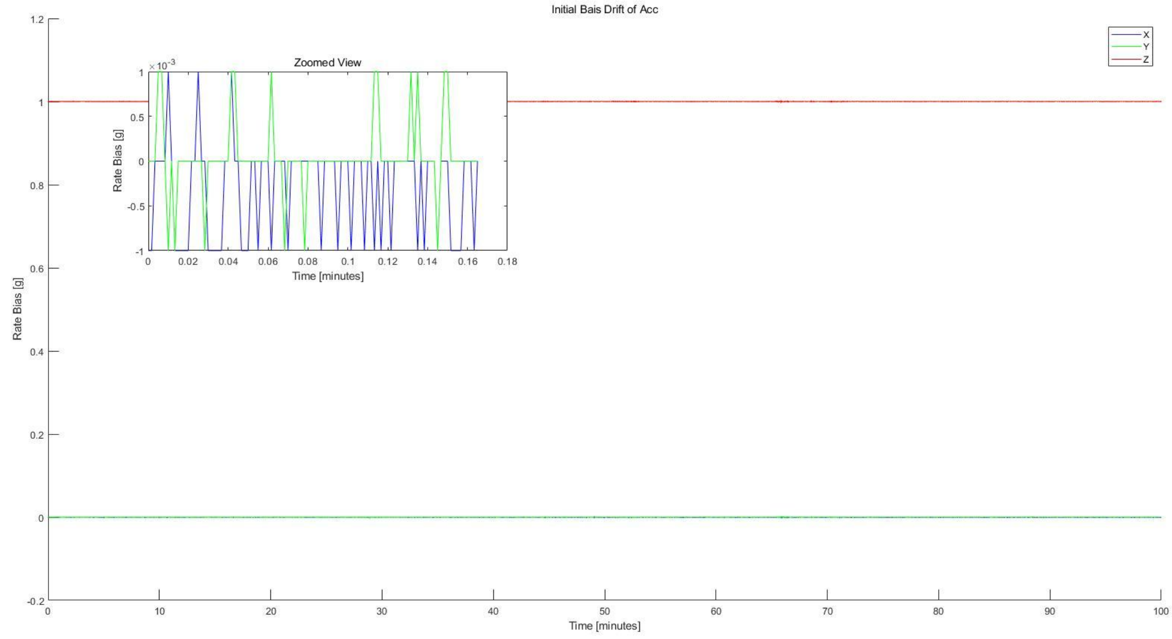

Figure11: HI06 initial bias drift of accelerometer

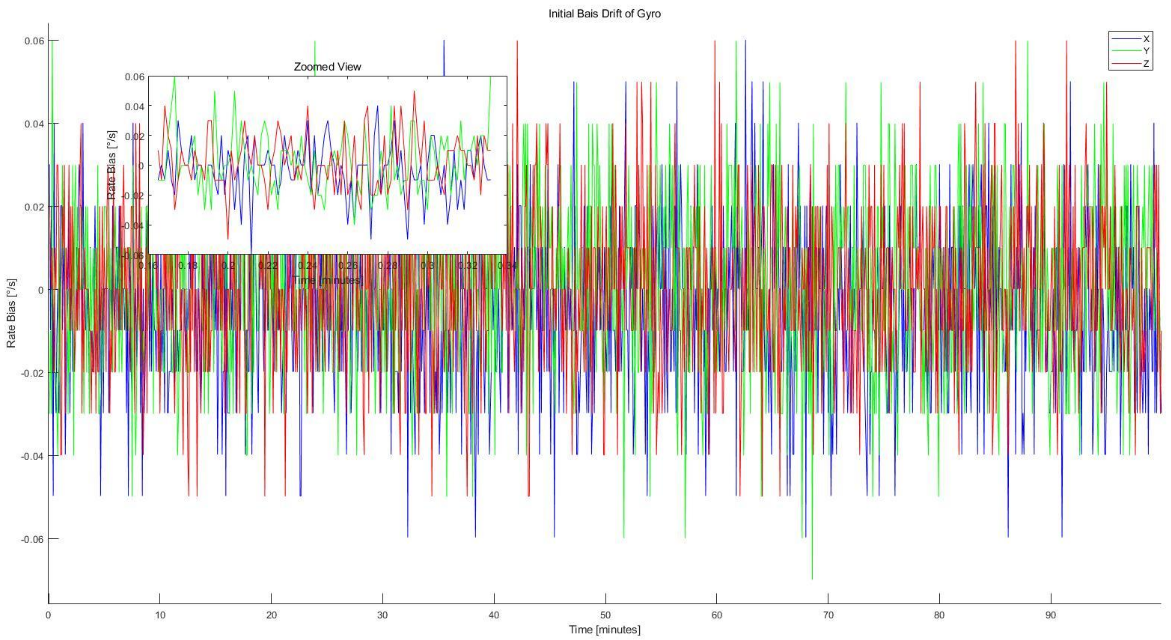

Figure12: HI06 initial bias drift of gyroscope

10.6 Attitude Angle Accuracy

Table 11: 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 Angle Static Drift (6DOF)	Stationary for 2h			0.15	0.2	°	1
Yaw Angle Dynamic Drift (AHRS)				2	3	°	2
Yaw Angle Rotation Error	Rotation at100°/s			<0.6	1.2	°	3

Note1: The module remains level and stationary for 2 hours.

Note2: Measured after magnetic calibration, with no surrounding magnetic interference. The product must be configured to AHRS mode.

Note3: Accumulated yaw angle error after 10 continuous rotations on a turntable.

11 SYSTEM & ELECTRICAL PARAMETERS

11.1 Electrical parameters

Parameters	Condition	Min	Nom	Max	Unit	Note
Input Voltage VDD		3.2	-	5.5	V	
Power Consumption				220	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 Parameters

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	
I2C					400	kHz	

11.3 System Parameters

Parameters	Product	Value	Note
Dimensions		18X20X2.6mm	
Weight		<2g	
System Startup Time		2s	1
Operating Temperature		-40-85℃	
Shielding Material		Nickel Silver	
Vibration Resistance		1.0mm(10Hz-58Hz)&≤20g(58Hz-600Hz)	
Environmental Compliance		RoHS 2011/65/EU	
EMC		LVD Directive 2014/35/EU	
Drop Test		Free fall from a height of 75 cm, 3 times	
Temperature Shock		Temperature changes from -40℃ to 85℃ within 1 hour, repeated 5 times	

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	

12 MENCHANICAL DIMENSIONS

12.1 Package Dimensions and Pin Definition

All Dimensions in mm units

12.1.1 HI06 Dimensions

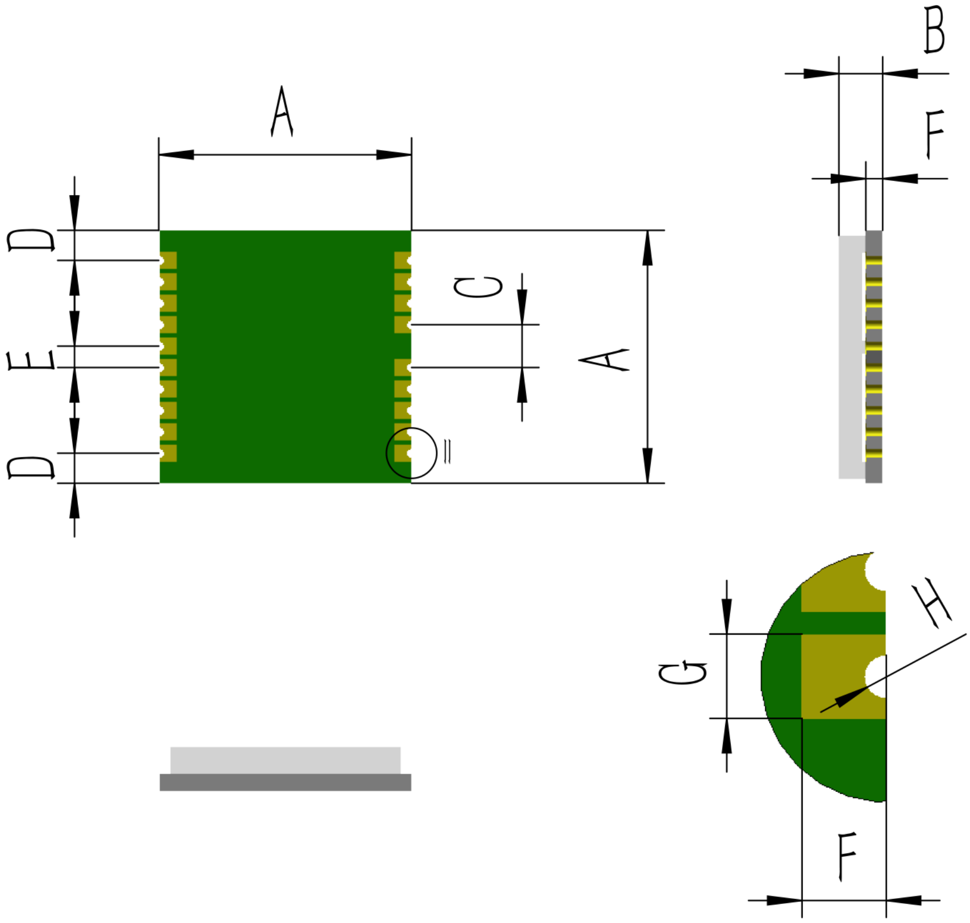

Figure13: HI06 mechanical specifications

12.1.2 HI06 Dimensions Table

Table 12: HI06 dimensions table

Symbol	Min(mm)	Typ(mm)	Max(mm)
A	19.8	20	20.2
B	2.5	2.6	2.7
C	2.9	3	3.1
D	1.69	1.79	1.89
E	1.45	1.5	1.55
F	0.9	1	1.1
G	0.85	0.9	0.95
H		R0.25	

12.1.3 HI06 Recommended PCB Footprint

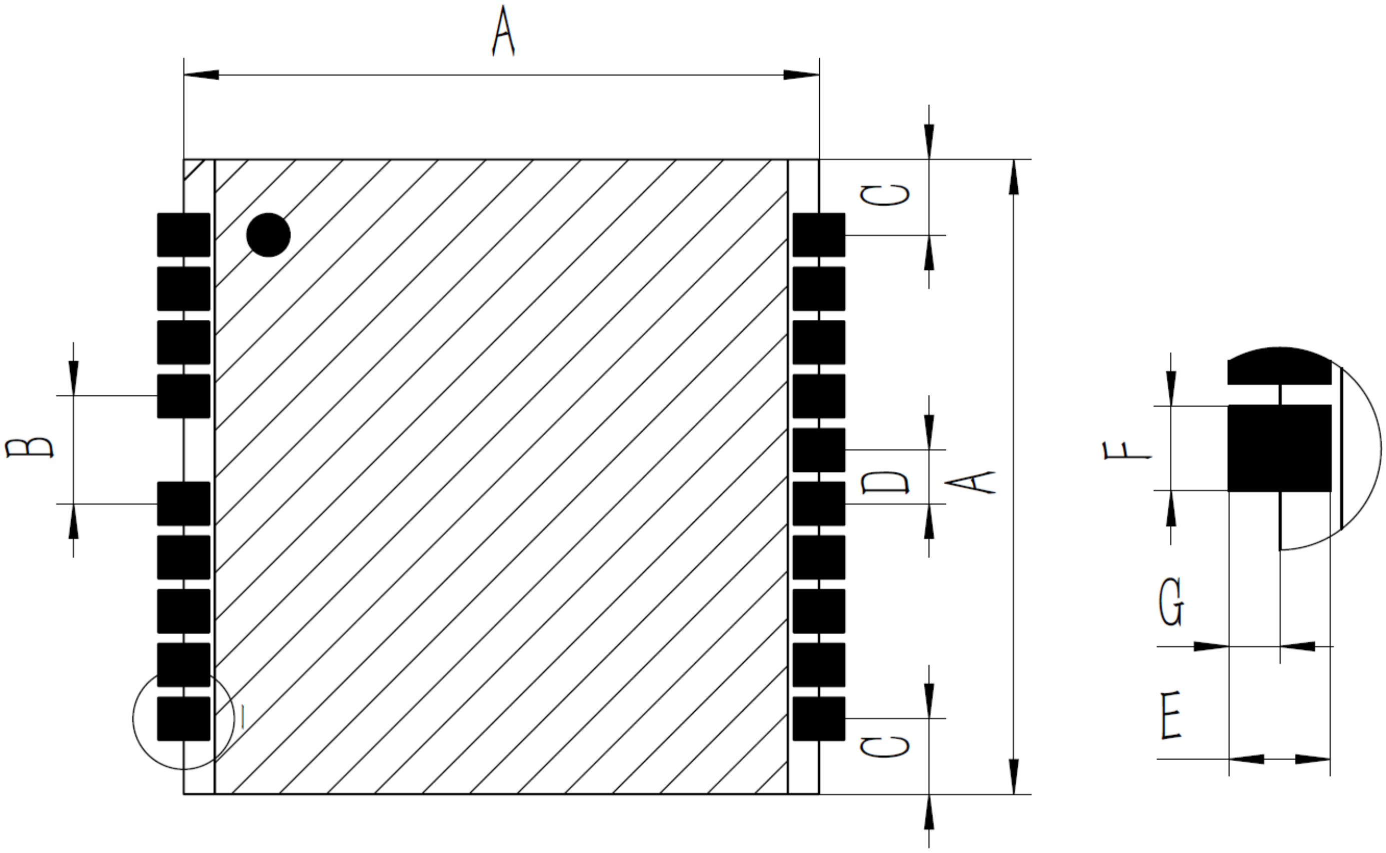

Figure14: HI06 recommended PCB footprint

Note1: No copper pour, vias, or signal traces are allowed within the shaded keep-out area on any layer (unless otherwise noted).

12.1.4 Recommended Dimensions

Table 13: Recommended dimensions

Symbol	Min(mm)	Typ(mm)	Max(mm)
A		20	
B		3	
C		3.25	
D		1.5	
E		1.8	
F		0.9	
G		1	

13 COORDINATE SYSTEM

13.1 Coordinate System

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

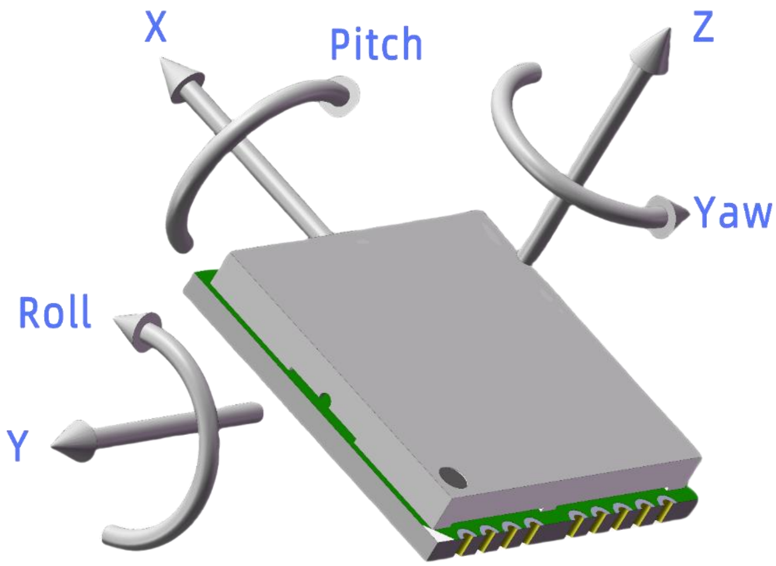

Figure15: HI06 Coordinate System

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

Rotation around the Z-axis:Yaw -180° - 180°

Rotation around the X-axis: Pitch -90°-90°

Rotation around the Y-axis:Roll -180°-180°

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

If users need to change the default coordinate system of the sensor, it can also be switched to the North-West-Up (NWU) or North-East-Down (NED) coordinate system. Please refer to the Instruction and Programming Manual for details.

13.2 Sensor Center

Table 14: HI06 Sensor center

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

14 EVALUATION BOARD

Figure16: HI06 Cable of evaluation board

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

15 PROCOTOLS

15.1 Serial Binary Protocol

To facilitate user operation, we provide a variety of serial protocols for users to choose from. For more detailed information, please refer to the Instruction and Programming Manual.

15.2 Modbus

The RS485 communication protocol follows the Modbus RTU protocol specification. For detailed protocol information, please refer to the Instruction and Programming Manual.

15.3 CAN

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

16 SMT&INSTALL

16.1 SMT temperature curve

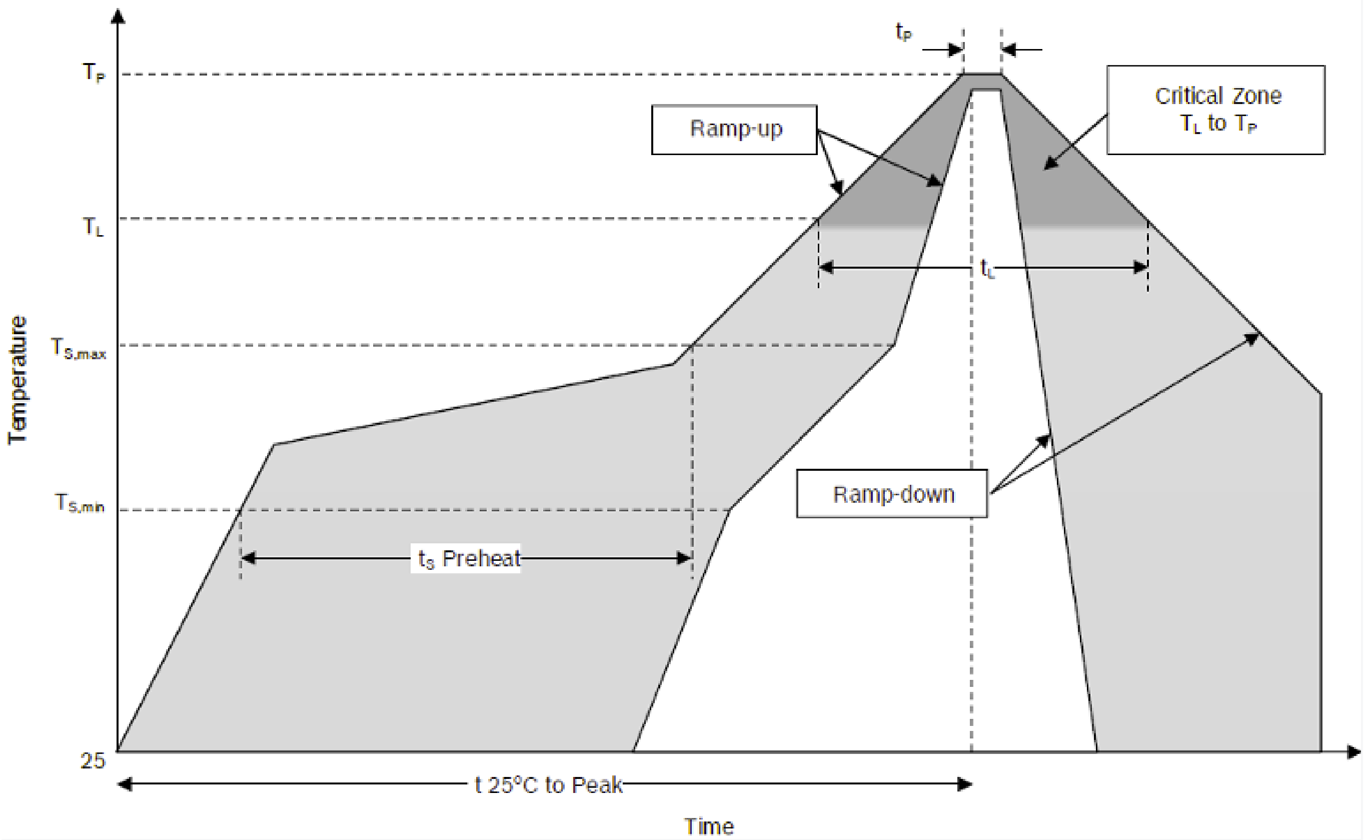

Figure17: SMT temperature curve

Table 15: SMT temperature curve

Parameters	Description
Average ramp-up rate (T_{Smax} to T_p)	3℃/s max
Temperature min (TSmin)	150℃
Temperature max (T_{Smax})	200℃
Time (TSmin to TSmax)	60-180s
Temperature (T_L)	170℃
Time (tL)	60-150s
Peak classification temperature (T_P)	250℃
Time within 5 °C of actual peak temperature (tp)	20-40s
Ramp-down rate	6℃/min max
Time 25°C to peak temperature	8min max

16.2 Installation Recommendations

MEMS sensors are high-precision measurement devices composed of electronic and mechanical structures, designed to achieve accuracy, efficiency, and mechanical robustness. When installing the sensor on a printed circuit board (PCB), the following recommendations should be considered:

- It is recommended to place the module horizontally on the measured carrier.
- Avoid placing the sensor directly under or next to button contacts, as this can cause mechanical stress.
- Avoid placing the sensor near high-temperature hotspots (e.g., controllers or graphic chips), as this can lead to rapid PCB heating and cause the sensor to overheat.
- Avoid placing the sensor in areas with maximum mechanical stress (e.g., at the center of diagonal intersections), as mechanical stress can cause bending of the PCB and sensor.
- Avoid installing the sensor too close to screw holes.
- Avoid installing the sensor in areas of the PCB where resonance (vibration) may occur or is expected.

If the above recommendations cannot be properly implemented, performing specific online offset calibration after placing the device on the PCB may help minimize potential impacts.

17 FAQ

17.1 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

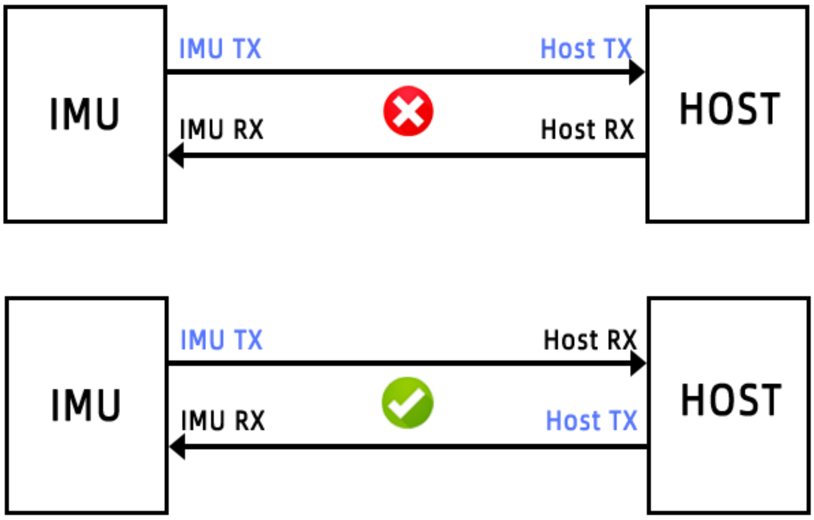

Figure18: IMU serial port connected to a single host

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:

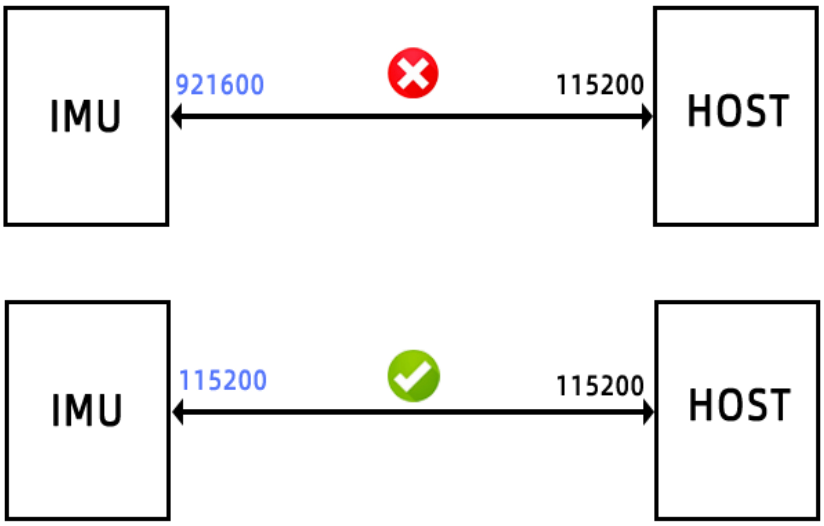

Figure19: IMU serial port connected to a single host

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.

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:

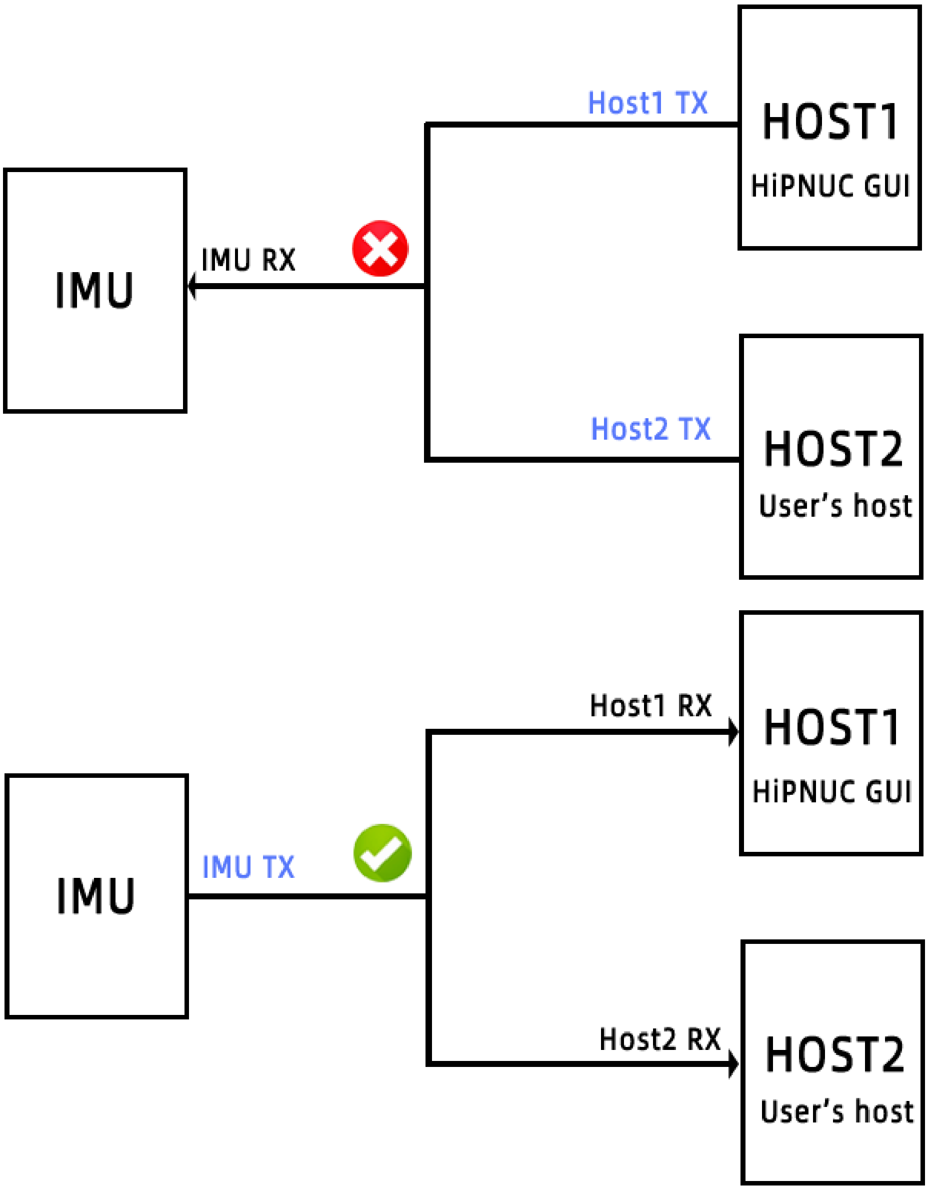

Figure20: IMU serial port simultaneously connected to the user's host and HiPNUC GUI

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.

