1 FEATURES

1.1 Hardware

- High-performance, low-noise MEMS-IMU
- Factory calibration for temperature, scale factor, cross-axis, and zero bias
- Gyroscope bias instability as low as 3°/h
- Accelerometer bias instability as low as 0.03mg
- Excellent vibration resistance
- Integrated temperature sensor
- Compact surface-mount package, easy to integrate
- RoHS and CE certified

1.2 Software

- Adaptive extended Kalman fusion algorithm with up to 200Hz output and low latency
- Outstanding dynamic tracking performance with excellent vibration suppression
- Excellent suppression of linear acceleration effects
- Starup time<1s
- Custom binary protocol
- Direct data output without external command configuration
- Rich user configuration commands
- Multifunctional GUI for easy operation
- Supports multiple examples, including ROS, C, and QT

2 APPLICATION

- Lawn Mowers
- Vacuum robots
- Pool cleaning robots
- Wheeled and legged robots

3 DESCRIPTIONS

3.1 Product Appearance

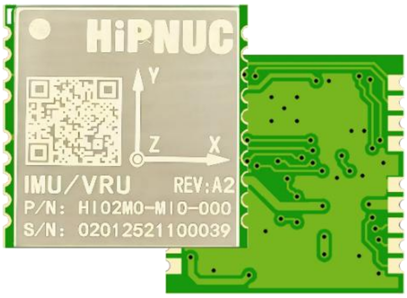


Figure1: HI02

3.2 System Block Diagram

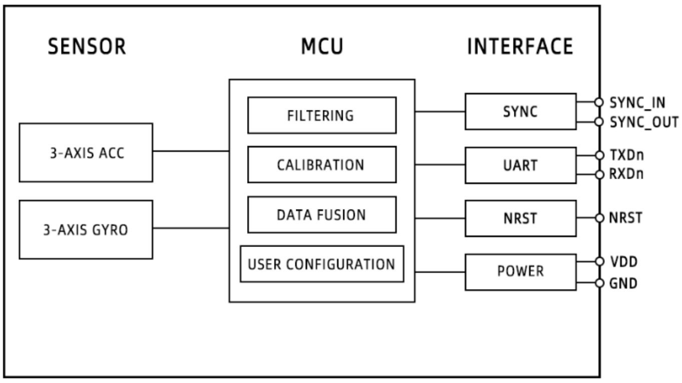


Figure2: Functional block diagram

3.3 General Description

The HI02 series is an IMU/VRU sensor built using MEMS-IMU technology. It is equipped with proprietary adaptive extended Kalman filtering, IMU noise dynamic analysis algorithms, and carrier motion state analysis algorithms. These features ensure high accuracy of attitude angles under high dynamics while reducing drift in the heading angle.

Each sensor undergoes precise compensation before leaving the factory, including adjustments for temperature, zero bias, scale factor, and cross-axis effects.

The HI02 series sensors transmit data via a UART interface and offer extensive user configuration options.

The multifunctional GUI (Graphical User Interface) facilitates rapid product evaluation.Its features include, but are not limited to, module configuration,data display, firmware upgrades,and data recording.

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

目录

4 PRODUCT SELECTION

Table 1: Selection information

HI02a-b-c						
Company	Series	a-Sensor		b-Interface	c-OEM	
HI	02	M0	6DoF 3°/h 0.03mg	MI0	000	Default
					Others	OEM

Note1: Example model: HI02M0-MI0-000

Note2: "3°/h 0.03mg" refers to the bias instability of the gyroscope and accelerometer.

5 ORDERING

5.1 Ordering Information

Table 2: Ordering information

Part Number	Name	Description	Note
HI02M0-MI0-000	IMU/VRU Module	6DoF 3°/h 0.03mg	

5.2 Contact us

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

6 DOCUMENT INFORMATION

6.1 Scope

This document applies to modules with hardware version A2 and above.

6.2 Document Version Information

Table 3: Document version

Version	Date	Section	Changes
1.0	May 31, 2025	-	Initial version

6.3 Related Documents and Development Kits

1. *Commands&Programming Manual*
2. *3D Step/CAE*
3. *Evaluation Board EVAL HI02 Data Sheet and Design Files*
4. *CE/RoHS Certification Documents*
5. *GUI Software and Reference Examples*

7 SPEXIFICATIONS

Unless otherwise noted, the test temperature is 25℃, and the supply voltage is 5V.

7.1 Absolute Maximum Ratings

Table 4: Absolute maximum ratings

Parameters	Limit	Comment
Mechanical Shock	2000g	Duration <1ms
Storage Temperature	-40℃-85℃	
ESD HBM	2KV	JEDEC/ESDA JS-001
Input Voltage	8V	
IO To GND	-0.3-5V	

7.2 Normal Operating Conditions

Table 5: Normal operating conditions

Parameters	Condition	Min	Nom	Max	Unit	Note
Input Voltage		3.2	-	5.5	V	
Power Consumption				150	mW	
Operating Temperature		-40	-	85	℃	
Gyroscope Range			2000		°/s	
Accelerometer Range			12		g	
Startup Time				2	s	1

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

7.3 Interface

Table 6: 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 Bit			无		bit	
	Output Frame Rate		0	100	200	Hz	
	Logic Voltage	High	1.9	3.0	3.6	V	
		Low			0.8		
IO	Logic Voltage	High	1.9		3.6	V	
		Low			0.8	V	
	Delay (Trigger Function)	From trigger to data transmission			800	us	

7.4 Gyroscope

Table 7: Gyroscope specifications

Parameters	Condition	Product	Min	Nom	Max	Unit	Note
Range				2000		°/s	
Resolution				16bit			
Scale Factor	100°/s			<600	800	ppm	1
Nonlinearity			-0.05	-	0.05	%Fs	2
3dB Bandwidth				80	116	Hz	
Sampling Rate				1000		Hz	
Bias Instability	Allan Variance			3		°/h	3
Bias Stability	10s Smoothing			10		°/h	
Bias Repeatability	Allan Variance			14.5		°/h	3
Angular Random Walk	Allan Variance			0.42		°/√h	3
Bias Full Temperature Variation (-40 to 85℃)				0.0015	0.002	°/s/℃	4
Accelerometer Sensitivity	All three axis			0.1		°/s/g	

Note1: Measured by rotating the turntable forward and backward 10 times on average. After user welding, this value may change,subject to actual results

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

Note3: Refer to 7.8 - Allan Variance.

Note4: Measured in SuperCore Lab temperature chamber with a temperature increase rate less than 3℃/min.

7.5 Accelerometer

Table 8: Accelerometer Parameters

Parameters	Condition	Min	Nom	Max	Unit	Note
Range			12		g	
Resolution			16bit			
Initial Bias				20	mg	1
Nonlinearity			0.5		%Fs	
3dB Bandwidth			90	145	Hz	
Sampling Rate			1600		Hz	
Bias Instability	Allan Variance		0.03		mg	2
Bias Stability	10s Smoothing		0.07		mg	
Bias Repeatability	Allan Variance		0.3		mg	2
Random Walk	Allan Variance		0.08		m/s/√h	2
Bias Full Temperature Variation (-40 to 85℃)	-40-85℃		<0.025		mg/℃	3

Note1: After user welding, this value may change, subject to actual results. Refer to 7.7 Initial Bias.

Note2: Refer to 7.8 - Allan variance

Note3: Measured in HiPNUC Lab temperature chamber with a temperature increase rate less than 3℃/min.

7.6 Temperature Sensor

Table 9: Temperature sensor parameters

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

7.7 Initial Bias

The initial bias of HI02M0 is as follows:

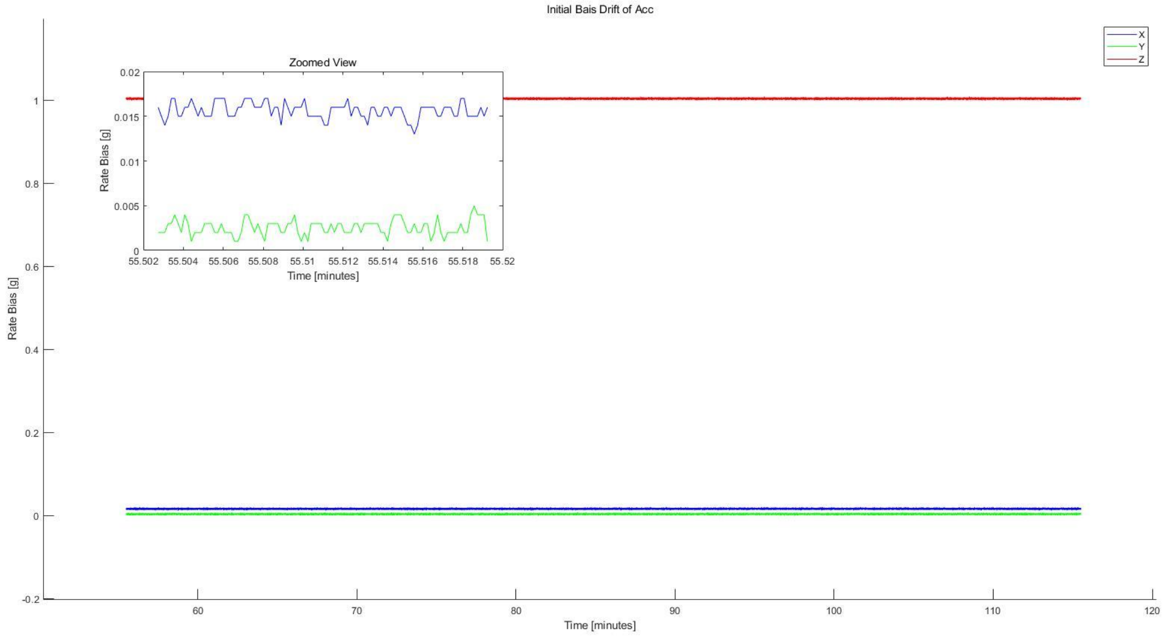


Figure3: HI02M0 initial bias drift of accelerometer

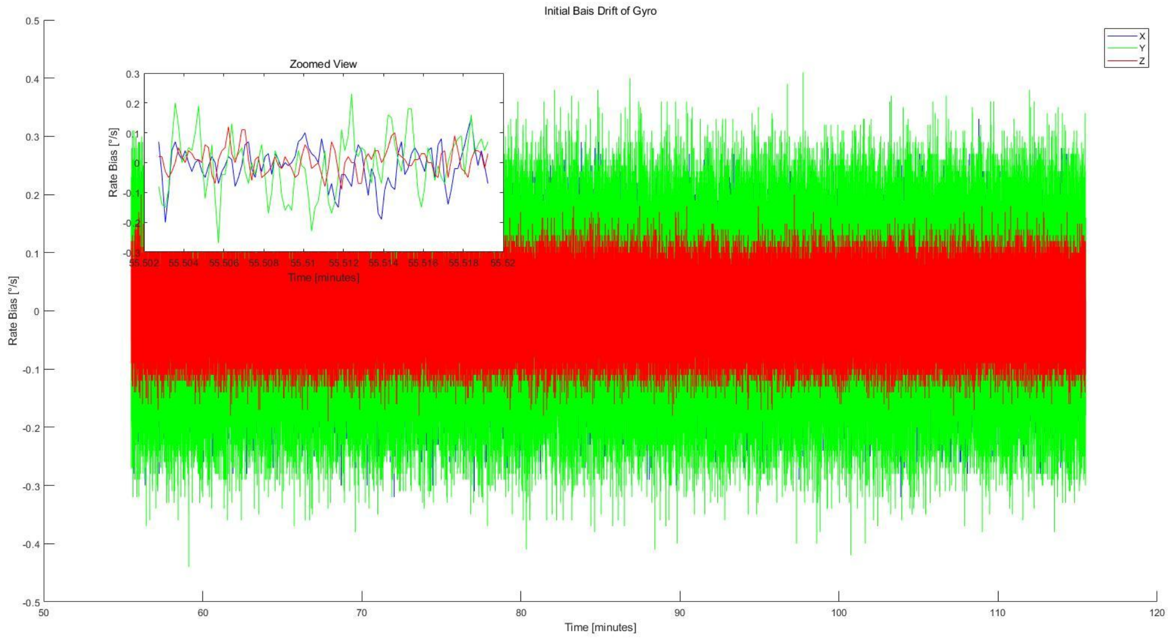


Figure4: HI02M0 initial bias drift of gyroscope

7.8 Allan Variance

The Allan variance of HI02M0 is as follows:

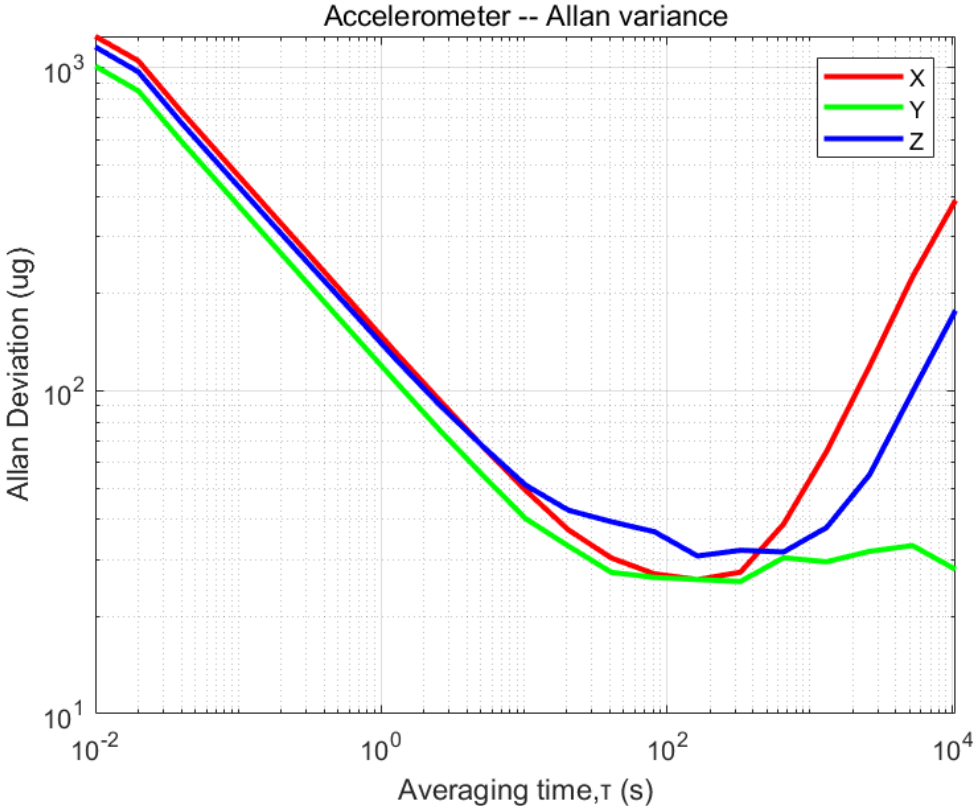


Figure5: HI02MX Accelerometer Allan Variance

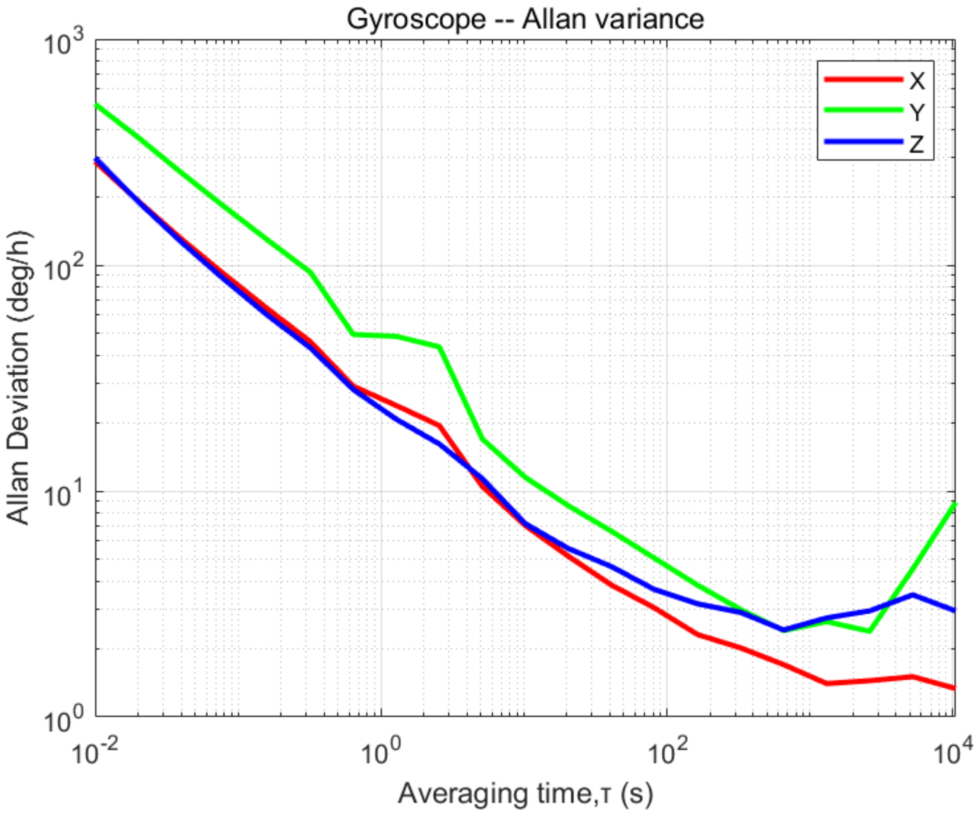


Figure6: HI02MX Gyroscope Allan Variance

7.9 Attitude Angle Accuracy

Table 10: Attitude angle accuracy

Parameters	Condition	Min	Nom	Max	Unit	Note
Pitch/Roll (Static)			0.15	0.2	°	
Pitch/Roll (Dynamic)			0.15	0.2	°	
Heading Angle Static Drift (6DOF)	Static for 2h		0.15	0.2	°	1
Heading Angle Dynamic Drift (6DOF)			9		°	2
Heading Angle Rotation Error (6DOF)	100°/s rotation		<0.8	3	°	3

Note1: Module remains level and static for 2 hours.

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

Note3: Accumulated heading angle error during 10 continuous rotations on a turntable.

7.10 Mechanical and Environmental

Table 11: Mechanical and environmental

Parameters	Product	Value	Note
Dimensions		15X15X2.6mm	
Weight		<1g	
Shielding Material		Nickel Silver	
Vibration Resistance		1.0mm(10Hz-58Hz)&≤20g(58Hz-600Hz)	
Environmental Compliance		RoHS 2011/65/EU	
CE		LVD Directive 2014/35/EU	
Drop Test		Free drop from a height of 75 cm, 3 times	
Temperature Shock		Temperature rises from -40℃ to 85℃ within 1 hour, repeated 5 times	

7.11 Product Dimensions and Pin Definition

All Dimensions in mm units

7.11.1 Product Dimensions

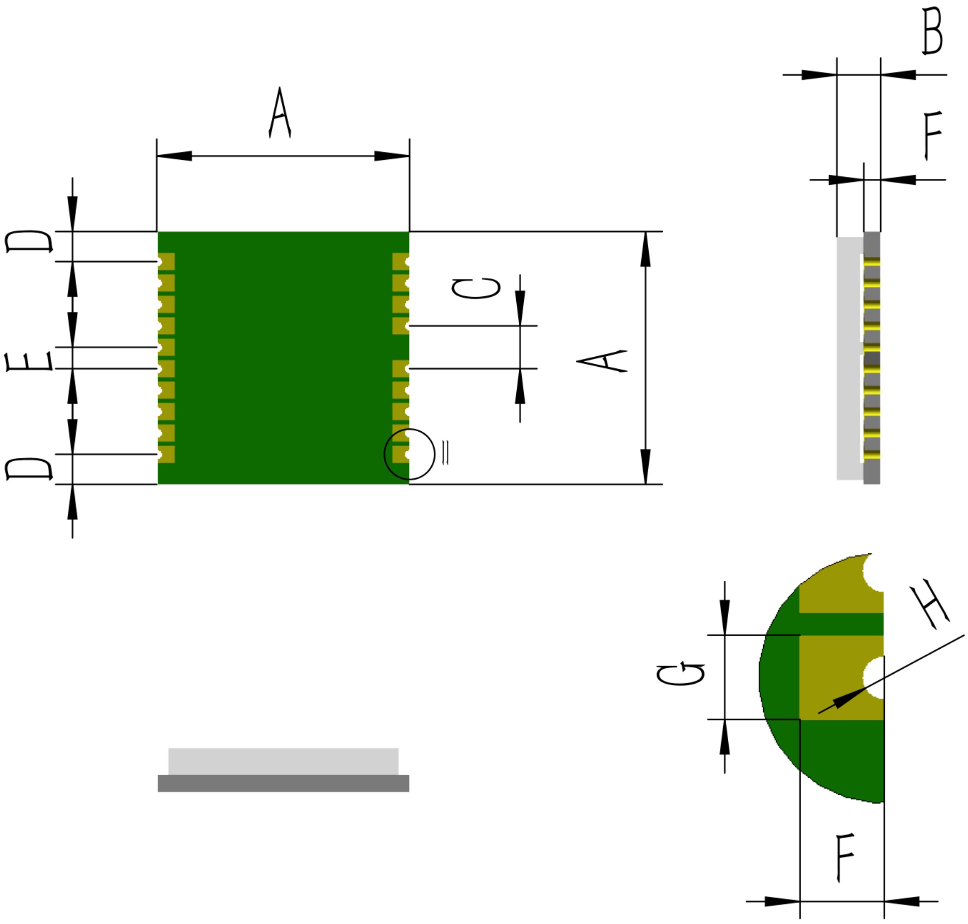


Figure7: HI02M0 mechanical specifications

7.11.2 HI02M0 Product Dimension Table

Table 12: HI02M0 Dimensions

Symbol	Min(mm)	Typ(mm)	Max(mm)
A	14.8	15	15.2
B	2.4	2.5	2.6
C	2.44	2.54	2.64
D	1.69	1.79	1.89
E	1.17	1.27	1.37
F	0.9	1	1.1
G	0.85	0.9	0.95
H	Φ0.4	Φ0.5	Φ0.6

7.11.3 HI02M0 Recommended PCB Footprint

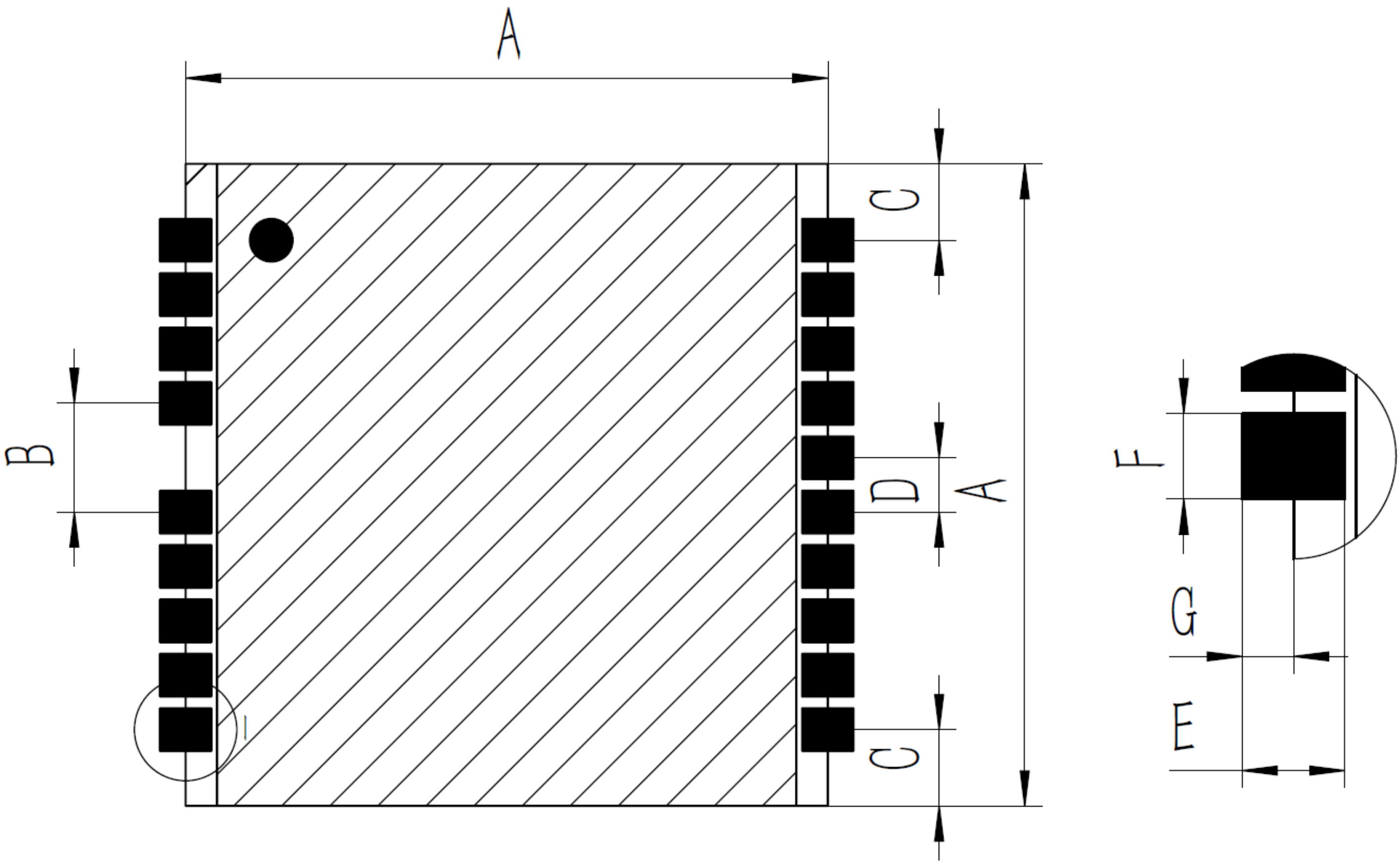


Figure8: HI02R2 recommended PCB footprint

Note1: Copper and traces should remain static within the shadowed area.

7.11.4 HI02M0 Recommended Dimension Table

Table 13: HI02M0 recommended dimension table

Symbol	Min(mm)	Typ(mm)	Max(mm)
A		15	
B		2.54	
C		1.79	
D		1.27	
E		1.2	
F		0.9	
G		0.6	

7.11.5 HI02M0 Pin Assignment

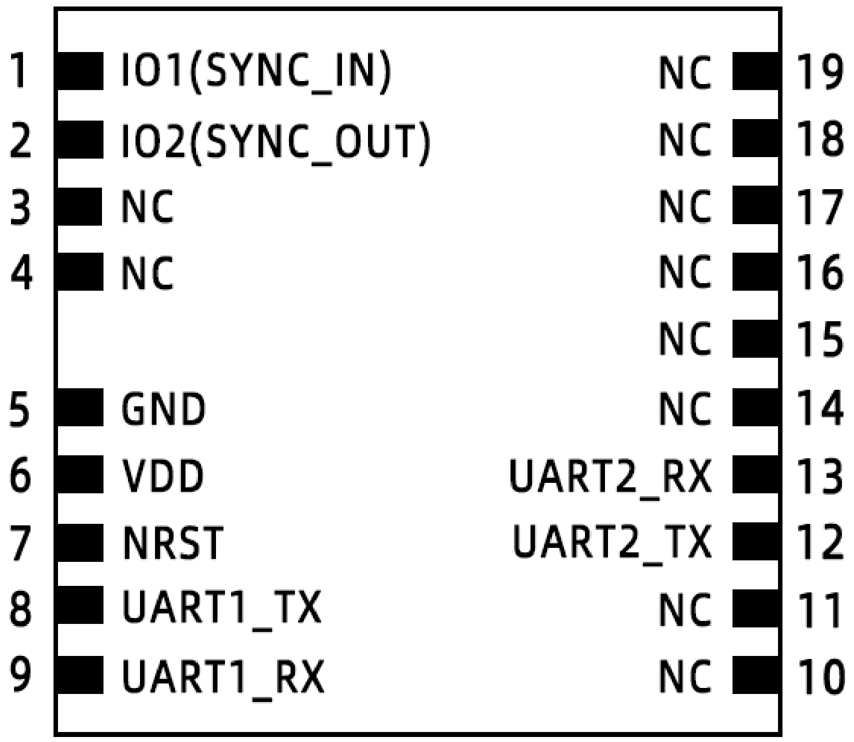


Figure9: HI02M0 pin assignment

7.11.6 HI02M0 Pin Definition

Pin Number	Pin Name	Type	Functional	Note
1	IO1(SYNC_IN)	I/O	Synchronization input, can be left floating if unused	
2	IO2（SYNC_OUT）	I/O	Synchronization output, can be left floating if unused	
3,4,10,11,14,15,16,17,18,19	NC	N/A	Reserved, must remain floating currently	
5	GND	POWER	GND	
6	VDD	POWER	Power input 3.3-5V	
7	NRST		Reset pin, low-level resets the module. No external RC required. Suggested connection to host GPIO; can be left floating if unused	
8	UART1_TX	O	Module UART1 transmit	
9	UART1_RX	I	Module UART1 receive	
14	UART2_TX	O	Module UART2 transmission (currently floating)	
15	UART2_RX	I	Module UART2 reception (currently floating)	

Note1: UART1 is required for current data communication.

8 COORDINATE SYSTEM

8.1 Coordinate System

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

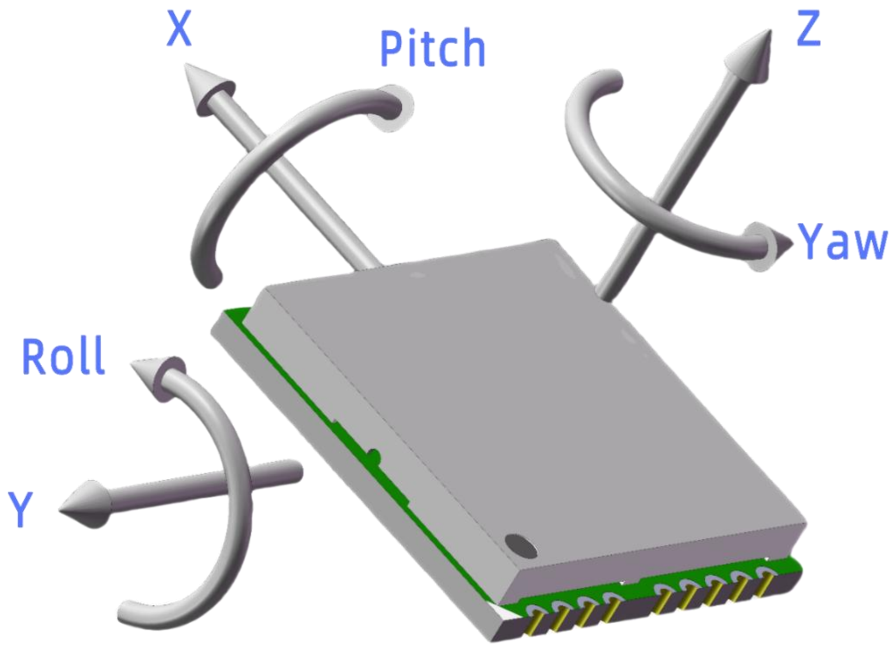


Figure10: HI02 Coordinate System

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

Users who need to change the default sensor coordinate system can refer to the instruction and programming manual.

8.2 Sensor Center

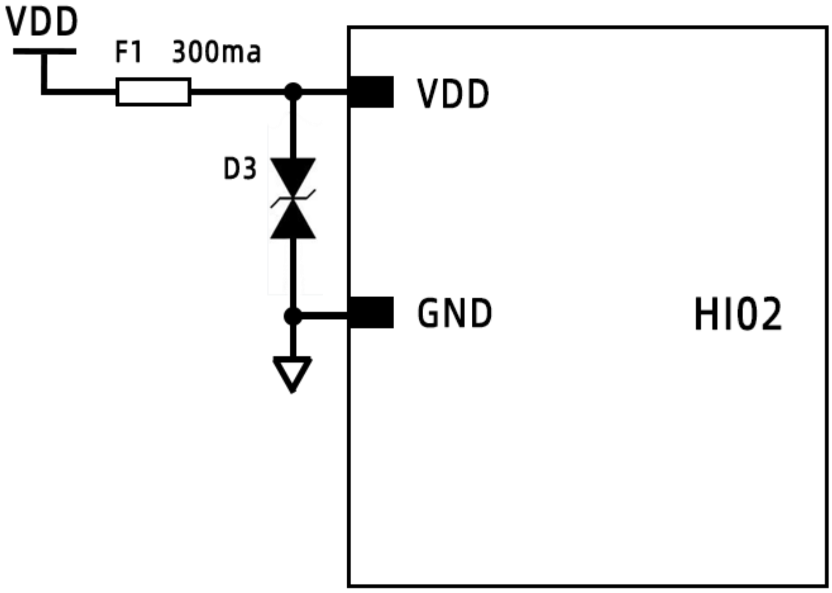
Table 14: HI02 Sensor center

Axis	X-offset	Y-offset	Z-offset	Unit
X	0	-3	0	mm
Y	0	-3	0	mm
Z	0	-3	0	mm

9 TYPICAL REFERENCE DESIGN

9.1 Power Supply

The HI02 series has a built-in LDO, power filtering, overcurrent, and overvoltage protection circuits. These features minimize external power noise interference with the internal system. Users can choose LDO/DC-DC to power the module, with a voltage range of 3.3-5V.



9.2 Serial Communication

It is recommended that the processor's logic level be 3.3V, If communication with a 5V or 1.8V processor is required, users must add a level conversion chip.

9.2.1 Serial Communication Minimum System Reference Design

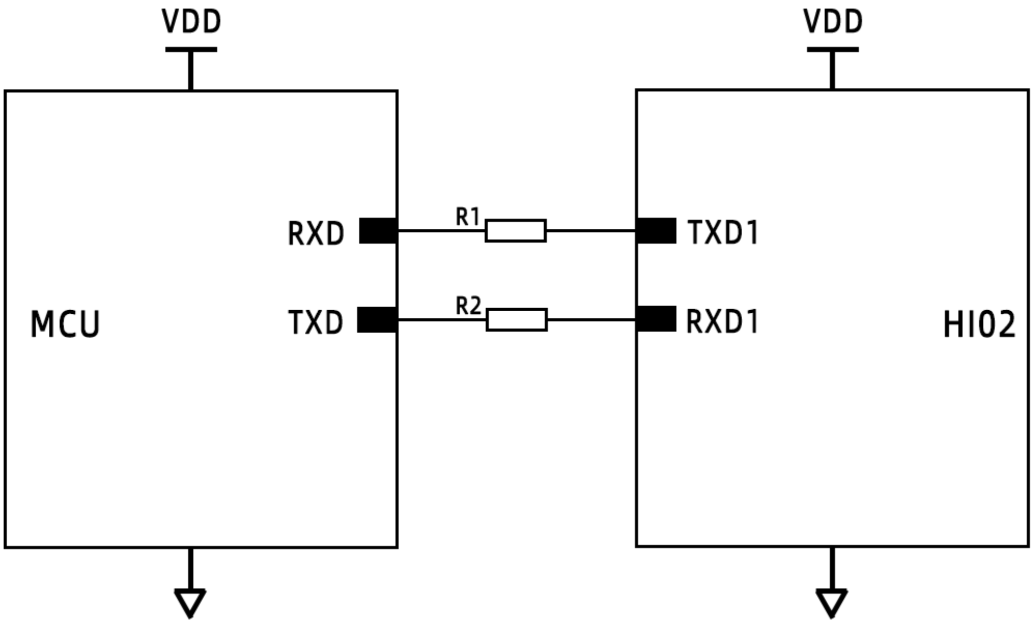


Figure11: HI02 Serial communication reference circuit

9.2.2 Serial Communication (IMU and Host Synchronization)

This connection method requires users to connect SYNC_IN/SYNC_OUT with the host system for data synchronization. SYNC_IN and SYNC_OUT do not need to be used simultaneously.Usage depends on user system design.

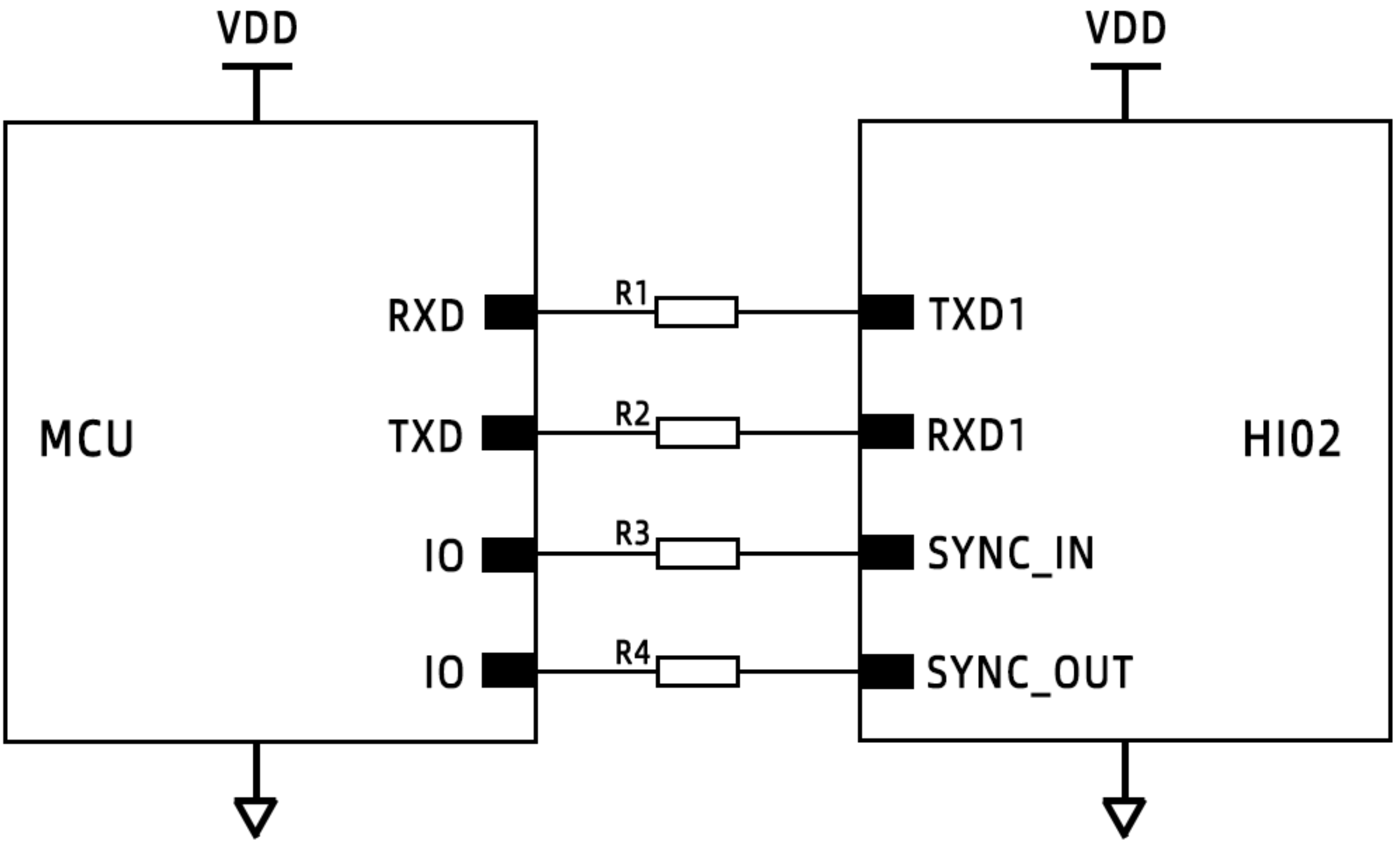


Figure12: HI02 Serial Communication With Synchronization

Note1: If users use SYNC_IN, the pulse generated by the host IO should match the data frame rate frequency. Refer to the programming manual for details.

Note2: If users use SYNC_OUT, it can be used as a Data Ready signal. Refer to the programming manual for details.

Table 15: Reference design material Information

Item	Reference	Part	P/N	Vendor
Fuse	F1	300mA	JK-SMD0603-030-6	JK
TVS	D3	SMF5.0CA	SMF5.0CA	TWGMC
Resistor	R1,R2,R3,R4	1K	RC0402JR-071KL	YAGEO

10 EVALUATION BOARD

Figure13: HI02 Cable of evaluation board

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

11 PROTOCOL

To facilitate user operations, we provide a wide range of serial protocols for selection. For more detailed information, please refer to the Instruction and Programming Manual.

12 SMT&INSTALL

12.1 SMT temperature curve

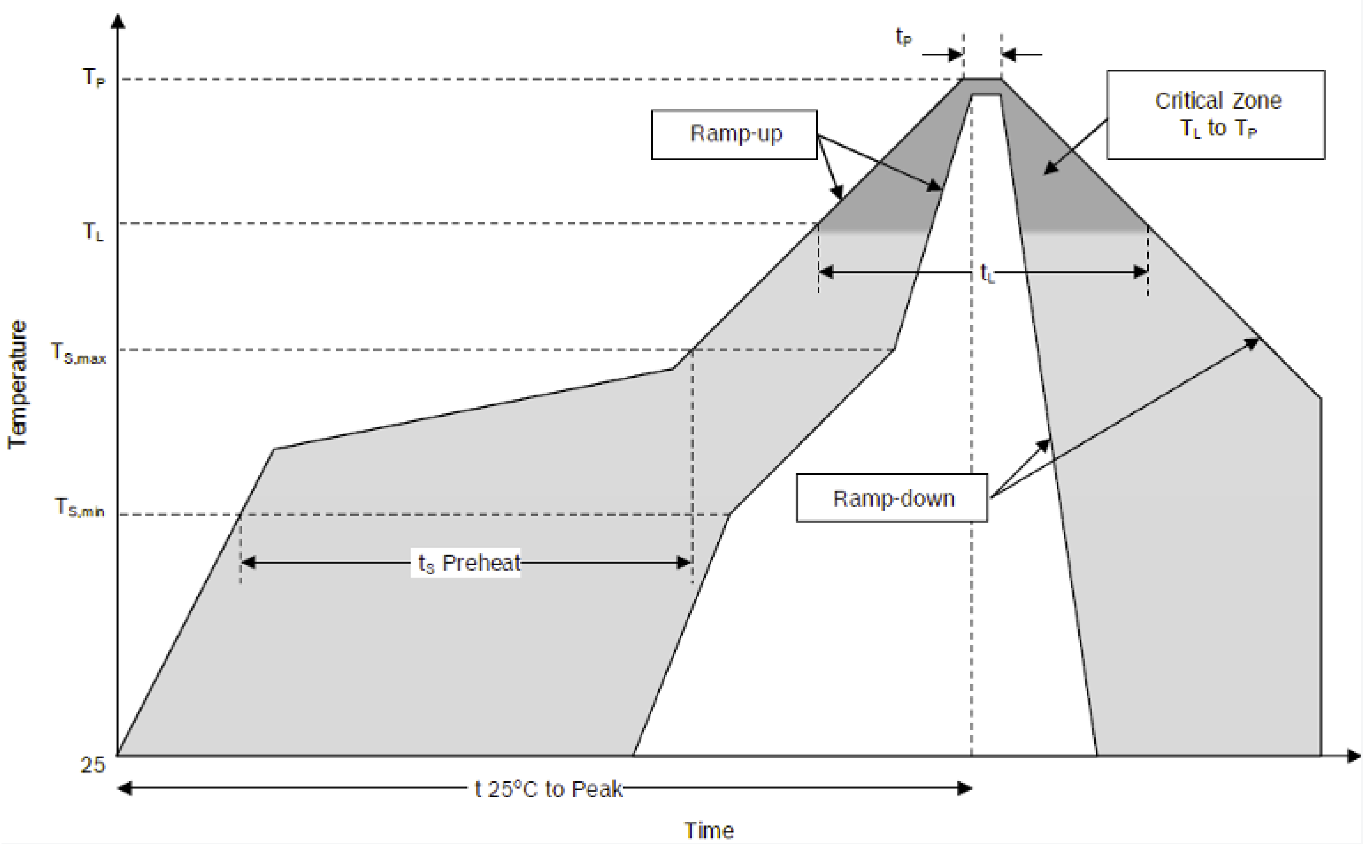


Figure14: SMT temperature curve

Table 16: 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

12.2 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.

13 PACKAGE

13.1 Tape Dimension

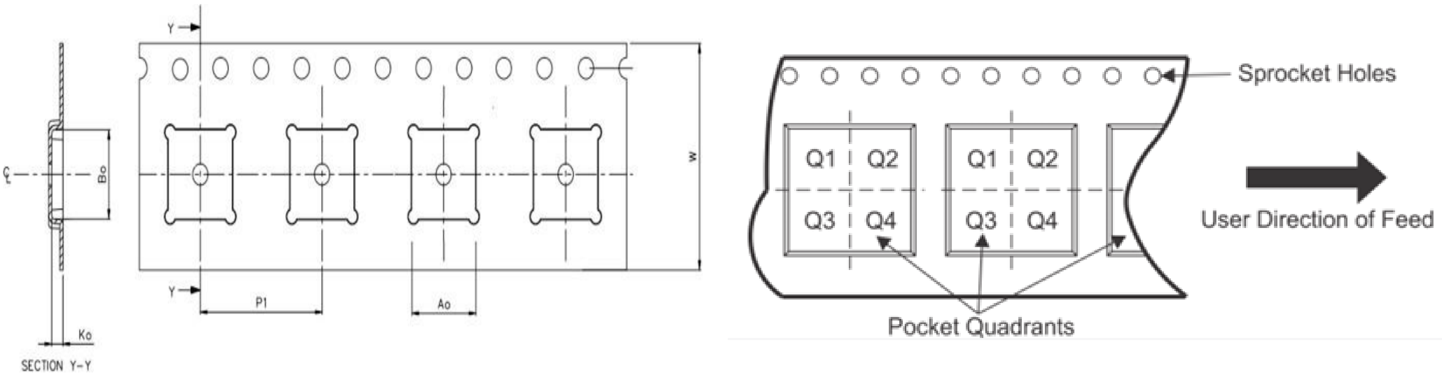


Figure15: Tape Dimension and pin 1

Table 17: Tape Dimension Information

Device	A0(mm)	B0(mm)	K0(mm)	P1(mm)	W(mm)
HI02	15.4	15.4	2.9	20	24

13.2 Reel Dimension

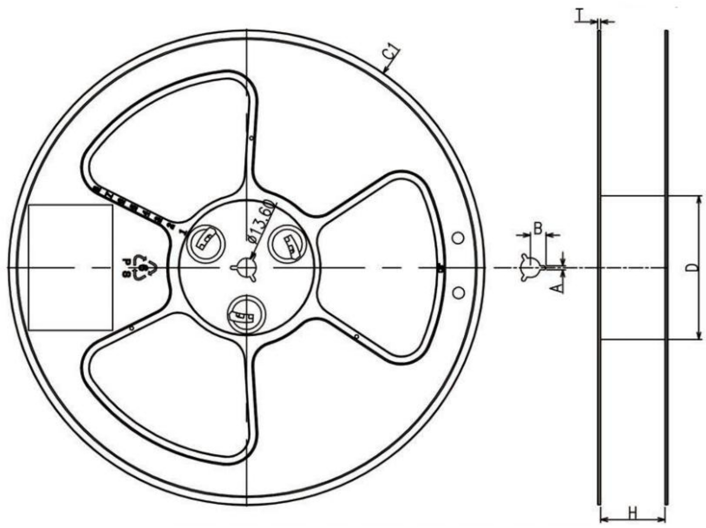


Figure16: Reel Dimension

Table 18: Reel Dimension Information

Device	SPQ(PCS)	Reel Diameter C1(mm)	Reel Width H(mm)	A(mm)	B(mm)	T(mm)	D(mm)
HI02	1000	330	16.8	2.5	11	2.0	100

13.3 Packing Method

The HI02 series uses standard carton packaging.

Table 19: Packing

HI02 Reel Vacuumize Box

Table 20: Box dimensions

Device	SPQ(PCS)	L(mm)	W(mm)	H(mm)
HI02	1000	360	360	40

14 FAQ

14.1 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

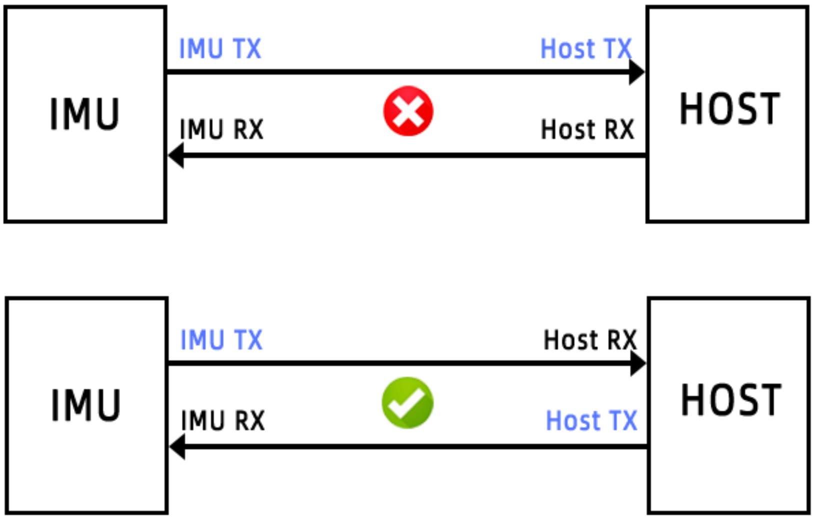


Figure17: IMU serial port connected to a single host

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:

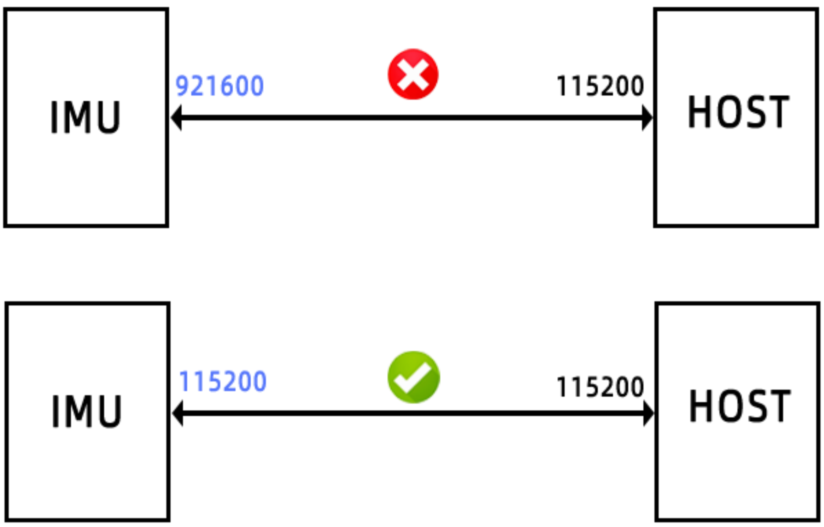


Figure18: IMU serial port connected to a single host

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:

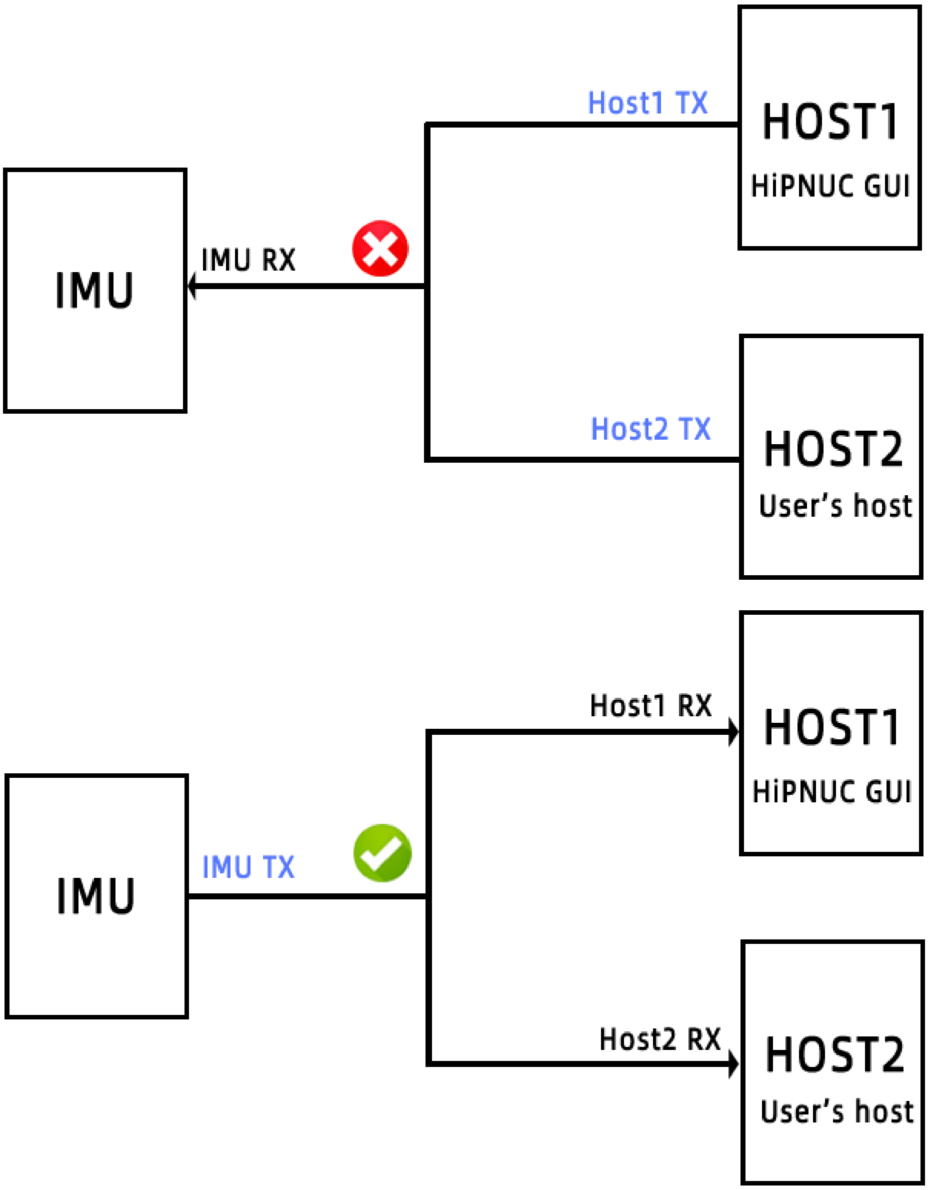


Figure19: IMU serial port simultaneously connected to the user's host and HiPNUC GUI

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.

