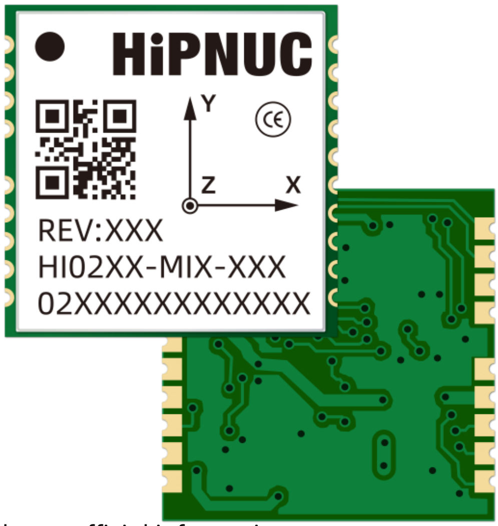
1 Features



1.1 Hardware

- High-performance, low-noise MEMS IMU
- Integrated low-noise, high-reliability LDO
- Factory calibrated for bias, scale factor, and cross-axis misalignment (Temperature compensation is available upon request. Please contact sales for details.)
- Excellent vibration resistance
- Integrated temperature sensor
- Compact surface-mount package: 15 × 15 × 2.6 mm for easy integration
- Product design complies with relevant RoHS requirements, and materials meet halogen-free requirements; certification status shall be subject to the latest official information

1.2 Software

- Adaptive extended Kalman filter (EKF) fusion algorithm with output rates up to 200 Hz and low latency
- Effective suppression of linear acceleration disturbances
- Customizable binary protocol
- Comprehensive configuration commands
- GUI tool for evaluation and configuration
- Provides reference examples for ROS 1, ROS 2, C, MATLAB, Python, and Arduino

2 Applications

The HI02 series is designed for cost-sensitive applications, including:

- Robotic vacuum cleaners
- Lawn mowers
- Pool cleaning robots

3 Description

3.1 System Block Diagram

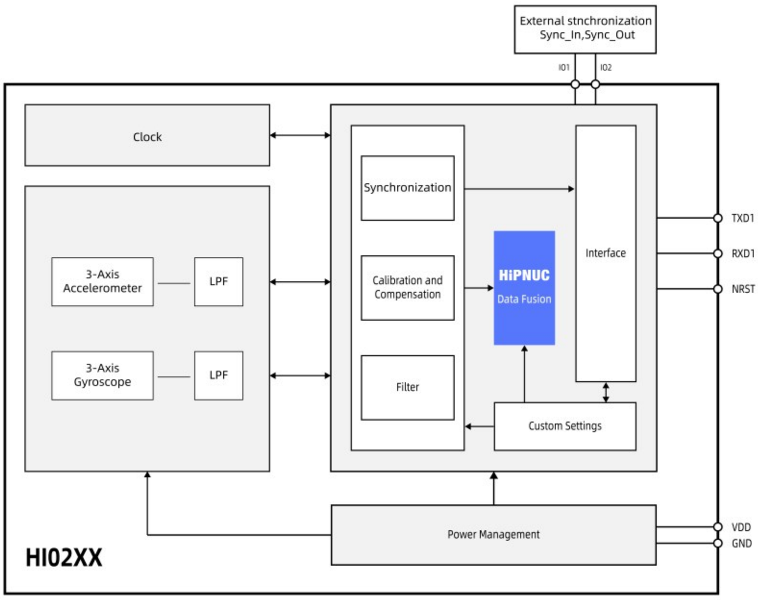


Figure 1: System Block Diagram

3.2 Description

The HI02 series is a MEMS-based IMU/VRU module. It features proprietary algorithms, including an adaptive extended Kalman filter, dynamic IMU noise analysis, and motion state analysis, providing accurate attitude, acceleration, angular rate, quaternion, and related motion data.

Each module undergoes compensation and calibration before leaving the factory, including bias, scale factor, and cross-axis error calibration. The module supports data transmission via a UART interface.

A GUI is provided for rapid evaluation and configuration, including module setup, data visualization, firmware upgrade, and data logging.

Figure 2: GUI Interface

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4 Model Selection

Table 1: Model Selection

HI02a-b-c							
Prefix	Series	a - Sensor		b - Interface		c - Other Information	
HI	02	M0	IMU/VRU	MI0	Multi-interface	000	Default

Note 1: Example model number: HI02M0-MI0-000

5 Ordering

5.1 Ordering Code

Table 2: Ordering Code

Part Number	Name	Description	Note
HI02M0-MI0-000	IMU/VRU Module	IMU/VRU	

5.2 Contact Information

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

6 Documentation

6.1 Revision History

Table 3: Revision History

Revision	Date	Author	Changes
1.0	5/31/2025	Hipnuc	Initial release
1.1	2/10/2026	Hipnuc	Updated product appearance and reorganized document layout

6.2 Related Documents and Development Kits

1. Command and Programming Manual
2. 3D STEP File
3. EVAL HI02M0 Evaluation Board Datasheet and Design Files
4. CE and RoHS compliance documents
5. GUI Software and Reference Examples

7 System Architecture

The HI02 series integrates IMU and VRU functions in a compact sensor module. Each module undergoes factory calibration and testing for scale factor, cross-axis error, and bias before shipment, providing raw sensor outputs such as acceleration and angular rate, as well as 3D orientation data.

The HI02 module is equipped with a 3-axis accelerometer, a 3-axis gyroscope, and a high-performance processor. This processor is primarily used for sensor synchronization, calibration, algorithm fusion, and user configuration.

7.1 IMU

The HI02 can be used as an Inertial Measurement Unit (IMU), providing users with precise 3-axis acceleration and angular rate data. This data is collected through internally integrated high-precision accelerometers and gyroscopes, enabling real-time measurement of motion dynamics in three-dimensional space. Compared with standalone IMU ICs, the HI02 offers improved output accuracy and stability through factory calibration and compensation. These calibrations include cross-axis error, scale factor, and bias correction.

7.2 VRU

The HI02 uses a proprietary sensor-fusion engine to process raw IMU data and provide high-accuracy 3D orientation output referenced to gravity, including pitch, roll, and yaw for attitude estimation.

8 Pin Definition

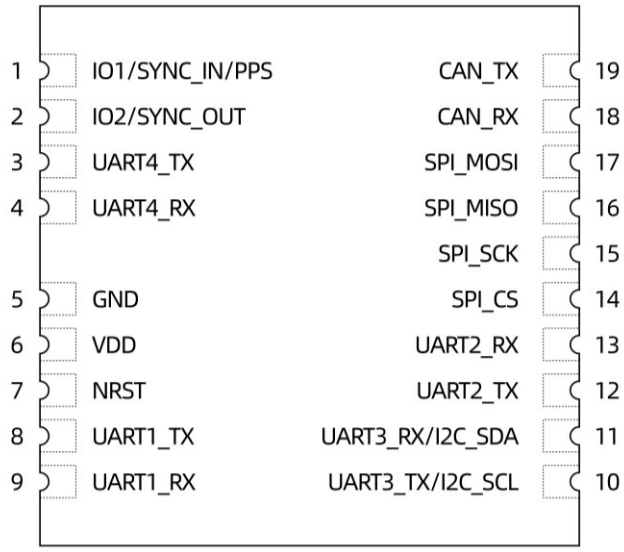

Figure 3: Pin Definition

Table 4: Pin Definition

Pin Number	Pin Name	Type	Function	Note
1	IO1(SYNC_IN)	I/O	Synchronization input; can accept external trigger signals	
2	IO2(SYNC_OUT)	I/O	Synchronization output; can be used as a data-ready signal	
3,4,10,11,14,15, 16,17,18,19	NC	N/A	Reserved; leave unconnected	
5	GND	Power	Power Ground	
6	VDD	Power	Module power input: 3.3-5.0 V	
7	NRST	I	Active-low reset input. Connect to a host GPIO if reset control is required; otherwise leave floating.	
8	UART1_TX	I/O	UART1 transmit	
9	UART1_RX	I/O	UART1 receive	
12	UART2_TX	I/O	UART2 transmit; reserved, leave unconnected	
13	UART2_RX	I/O	UART2 receive; reserved, leave unconnected	

9 Interface and Reference Designs

9.1 Power Supply

The HI02 series integrates an on-board low-dropout regulator (LDO) for power conditioning. The integrated LDO helps reduce the impact of external power-supply noise on the internal circuitry, thereby improving the stability and reliability of the system. This design improves output stability in noisy power environments. The module can be powered from a 3.3 V to 5.0 V supply derived from either an external LDO or a DC-DC converter.

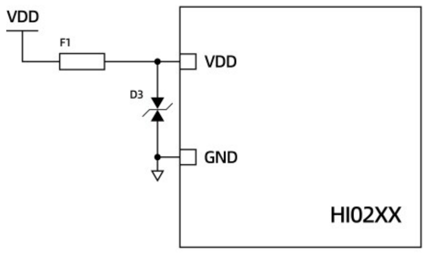

Figure 4: HI02 Power Supply Reference Design

9.2 UART

The HI02 series sensors support UART communication through UART1 in full-duplex mode. By default, the communication frame format follows the standard 8N1 mode, which is specified as follows:

- Baud rate: 115200 bps (adjustable)
- Data bits: 8 bits
- Parity: None
- Stop bits: 1 bit

This UART configuration is widely compatible with embedded systems, industrial controllers, and robotic platforms. Additionally, The HI02 can also be used with external RS-232, RS-485, or RS-422 transceivers to convert the UART interface to the required communication standard, further enhancing the module's versatility and scalability.
Note 1: Both the baud rate and output frame rate can be modified via commands. For details, please refer to the command and programming manual.

When using the HI02 series sensor for serial communication, it is recommended that the logic level of the user's processor is 3.3 V. If communication with processors using 5 V or 1.8 V logic levels is required, an external level shifter is required to ensure communication reliability and device safety.

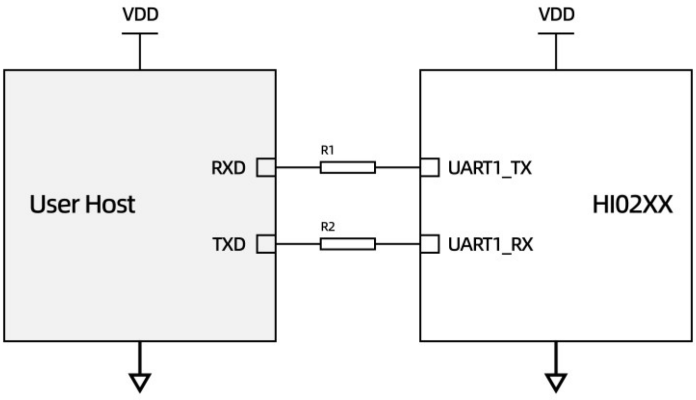

Figure 5: Minimum System for HI02 UART Communication

9.3 Synchronization System

The HI02 supports pulse-based synchronization with the host system.

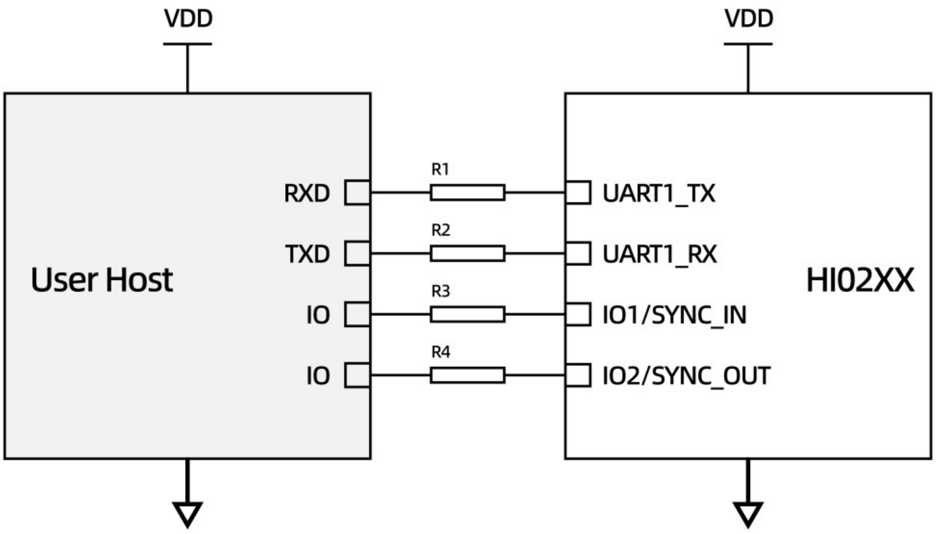

Figure 6: HI02 Host-Triggered Synchronization (UART Communication)

For synchronization, connect IO1 or IO2 directly to the host system.

When IO1 is configured as a synchronization input, the host must provide pulses at the same frequency as the output data rate.

When IO2 is configured as a synchronization output, it generates pulses at the output data rate and can be used as a data-ready signal.

IO1 and IO2 are optional and need not be used simultaneously.

9.4 Reference Design BOM

Table 5: Reference Design BOM

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

Note 1: The 1 kΩ resistor value may be adjusted according to the application and cable length. For longer transmission distances, the resistor value may be reduced to 33 Ω or 100 Ω if required.

10 Specifications

10.1 Gyroscope

Table 6: Gyroscope Parameters

Parameter	Condition		Min	Typ	Max	Unit	Note
Range			±125	±2000	±2000	°/s	
Resolution				16		bit	
Scale Factor	Pre-SMT, 100 °/s rotation			250	400	ppm	Typ: RMS
	Post-SMT, 100 °/s rotation			1390	2225		
Nonlinearity				±0.05		%FS	1
Noise Density	47 Hz			0.014		°/s/√Hz	
3 dB Bandwidth				80	200	Hz	2
Zero-Rate Output				<0.1	±0.45	°/s	3
Sampling Rate				1000		Hz	
Bias Instability	Allan Variance	X		2.5	4	°/h	Typ: 1σ Max: 3σ
		Y		3.2	5.5		
		Z		3	5.5		
Bias Stability	10 s Average	X		10	14	°/h	Typ: 1σ Max: 3σ
		Y		13	17		
		Z		10	13		
Bias Repeatability		X		20	36	°/h	4
		Y		36	61		
		Z		16	25		
Angle Random Walk (ARW)	Allan Variance	X		0.55	1.1	°/√h	Typ: 1σ Max: 3σ
		Y		0.82	1.2		
		Z		0.47	0.7		
Bias Temperature Drift	-40 °C ~ 85 °C			0.07	0.15	°/s	5
g-Sensitivity	All three axis			0.05		°/s/g	

Note 1: Maximum deviation from the best-fit straight line within the specified range.

Note 2: Bandwidth depends on the operating mode; the default 6-DoF mode uses an 80 Hz bandwidth.

Note 3: After initial bias calibration, the bias can be estimated in real time by the on-board algorithm.

Note 4: The module is powered on for 20 minutes, followed by 300 s of data collection. It is then powered off for 5 s and powered on again for another measurement. This process is repeated 10 times.

Note 5: Temperature compensation is disabled by default and is available upon request. Testing was performed using a temperature-controlled rate table at the Hipnuc laboratory with a temperature ramp rate below 3 °C/min.

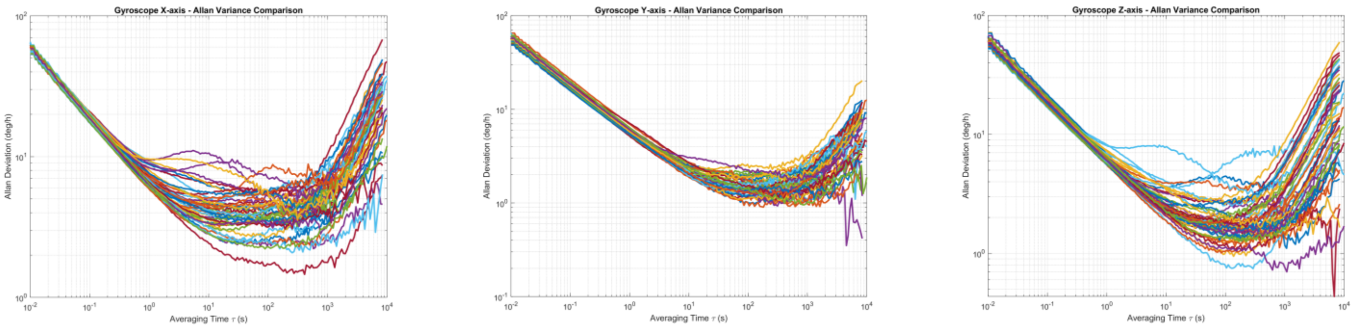

Figure 7: Gyroscope Allan Variance

10.2 Accelerometer

Table 7: Accelerometer Parameters

Parameter	Condition	Min	Typ	Max	Unit	Note
Range		±2	±12	±24	g	
Resolution			16		bit	
Initial Bias	Pre-SMT, keep horizontally stationary		1	2	mg	Typ: RMS
	Post-SMT, keep horizontally stationary		10	20		
Nonlinearity			0.01		%FS	1
3 dB Bandwidth			90	200	Hz	
Noise Density			0.16	0.2	mg/√Hz	
Sampling Rate			1000		Hz	
Bias Instability	Allan Variance X		0.021	0.035	mg	Typ: 1σ Max: 3σ
	Allan Variance Y		0.032	0.065		
	Allan Variance Z		0.023	0.03		
Bias Stability	10 s Average X		0.068	0.1	mg	Typ: 1σ Max: 3σ
	10 s Average Y		0.09	0.19		
	10 s Average Z		0.07	0.1		
Bias Repeatability	X		0.22	0.4	mg	2 Typ: 1σ Max: 3σ
	Y		0.15	0.21		
	Z		0.12	0.2		
Velocity Random Walk	Allan Variance		0.09	0.11	m/s/√h	Typ: 1σ Max: 3σ
Bias Temperature Drift	-40 °C ~ 85 °C		3	8	mg	3

Note 1: Maximum deviation from the best-fit straight line within the specified range.

Note 2: The module is powered on for 20 minutes, followed by 300 s of data collection. It is then powered off for 5 s and powered on again for another measurement. This process is repeated 10 times.

Note 3: Temperature compensation is disabled by default and is available upon request. Testing was performed using a temperature-controlled rate table at the Hipnuc laboratory with a temperature ramp rate below 3 °C/min.

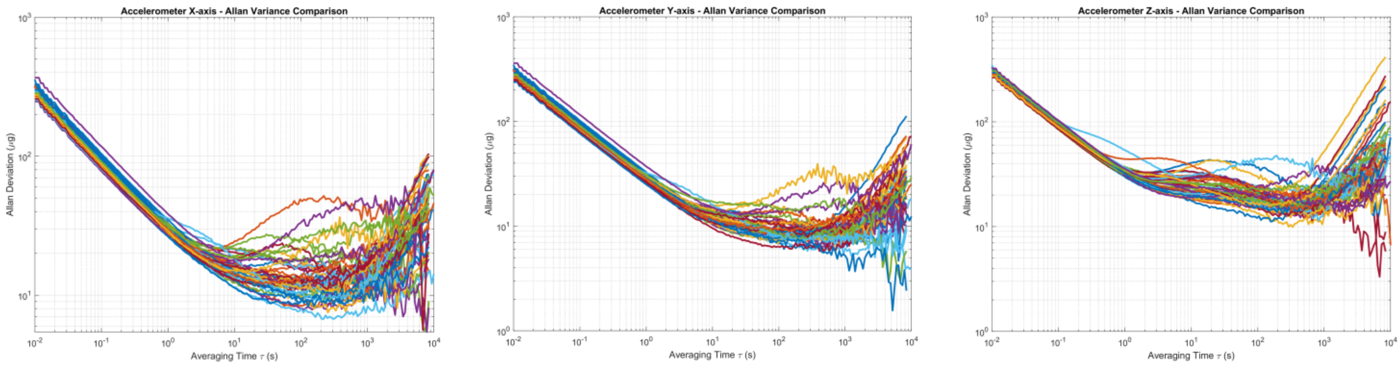

Figure 8: Accelerometer Allan Variance

10.3 Temperature Sensor

Table 8: Temperature Sensor Parameters

Parameter	Condition	Min	Typ	Max	Unit	Note
Range		-40	-	85	°C	
Offset Error			±5		°C	

10.4 Fusion Accuracy

Table 9: Attitude Accuracy

Parameter	Condition	Min	Typ	Max	Unit	Note
Pitch/Roll (Static)	Pre-SMT		0.1	0.2	°	1
	Post-SMT		0.3	0.5		
Pitch/Roll (Dynamic)	Pre-SMT		0.2	0.3	°	
	Post-SMT		0.4	0.8		
Heading Drift (Static,6-DoF)	Static for 2 h		0.15	0.2	°	
Heading Drift (Dynamic,6-DoF)			10	18	°	2
Heading Rotation Error (6-DoF)	Pre-SMT, 100 °/s rotation		0.2	0.3	°	3
	Post-SMT, 100 °/s rotation		0.4	0.7		

Note 1: Data is referenced to the calibration plane; derived from tests on 20 samples.

Note 2: Measured over 1 hour of operation on an indoor cleaning robot; 1σ

Note 3: Average error per revolution measured over 10 revolutions on a rate table.

11 System and Electrical Parameters

11.1 Electrical Specifications

Table 10: Electrical Specifications

Parameter	Condition	Min	Typ	Max	Unit	Note
Supply Voltage (VDD)		3.2	-	5.5	V	
Power Consumption				150	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

Table 11: Interface Specifications

Interface	Parameter	Min	Typ	Max	Unit	Note
UART1	Baud Rate	9600	115200	921600	bps	
	Output Data Rate	0	100	200	Hz	

11.3 System Specifications

Table 12: System Parameters

Parameter	Value	Note
Dimensions	15 × 15 × 2.6 mm	
Weight	<1.5 g	
System Startup Time	2 s	1
Operating Temperature	-40 °C ~ 85 °C	
Shield Material	Cupronickel	
Vibration Resistance	1.0 mm (10 Hz to 58 Hz), ≤20 g (58 Hz to 600 Hz)	
Environmental Compliance	Complies with relevant RoHS requirements	
Compliance Information	Refer to the latest official information for related certification and conformity documents	
Drop Test	Free-fall drop from a 75 cm test bench	
Temperature Shock Test	55 cycles from -40 °C to 85 °C within 1 hour	
Moisture Sensitivity Level (MSL)	MSL2	

Note 1: Time from power-on to valid data output.

11.4 Absolute Maximum Ratings

Parameter	Limit	Comment
Mechanical Shock	10,000 g	Duration: <0.2 ms
Storage Temperature	-40 °C ~ 125 °C	
ESD (HBM)	2 kV	JEDEC/ESDA JS-001
Input Voltage	6 V	
I/O to GND	-0.3 V to 5.0 V	

12 Mechanical

All dimensions are in mm

12.1 Mechanical Dimensions

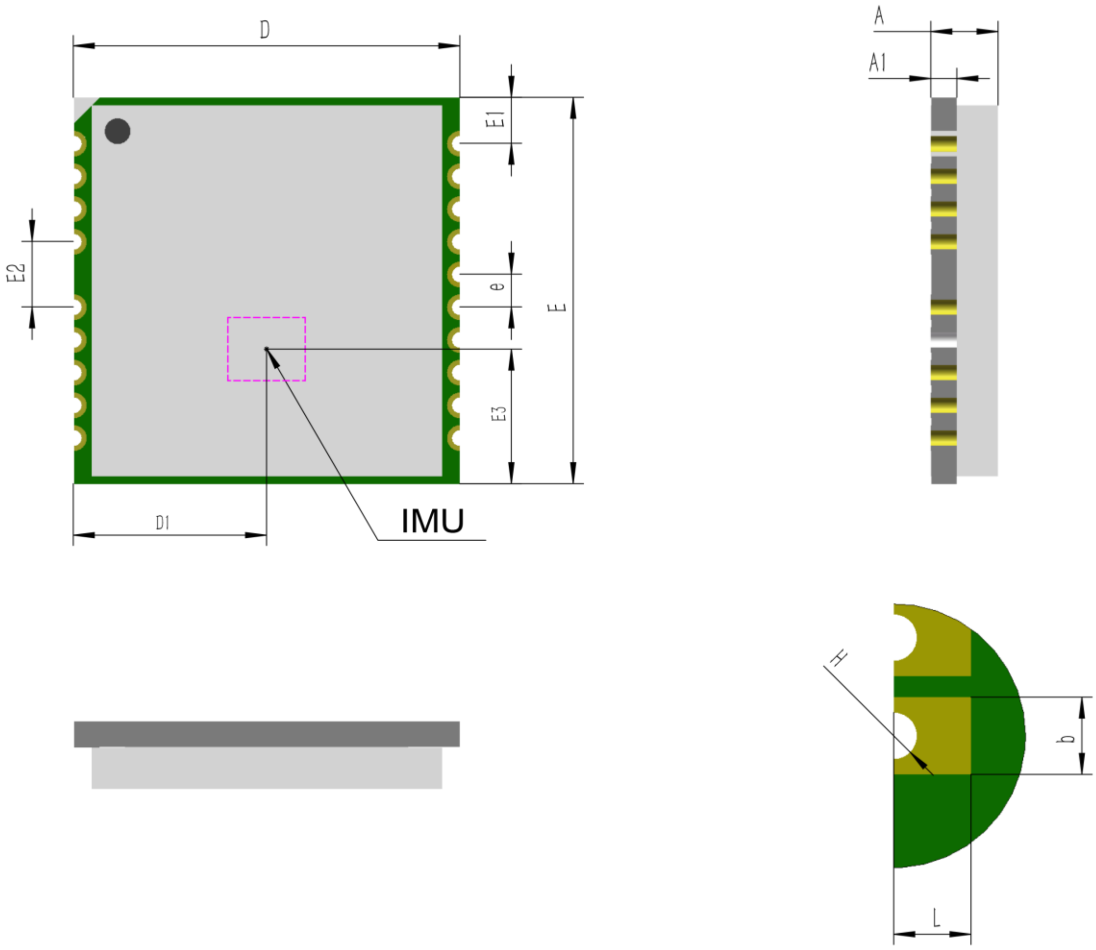

Figure 9: Mechanical Dimensions and IMU Position

Table 13: Mechanical Dimensions

Symbol	Min (mm)	Typ (mm)	Max (mm)
A	2.5	2.6	2.7
A1	0.95	1	1.05
D	14.8	15	15.2
D1	7.45	7.5	7.55
E	14.8	15	15.2
E1	1.69	1.79	1.89
E2	2.5	2.54	2.55
E3	4.9	5	5.1
e	1.25	1.27	1.28
L	0.95	1	1.05
b	0.87	0.9	0.92
H	R0.26	R0.27	R0.28

12.2 Recommended Land Pattern

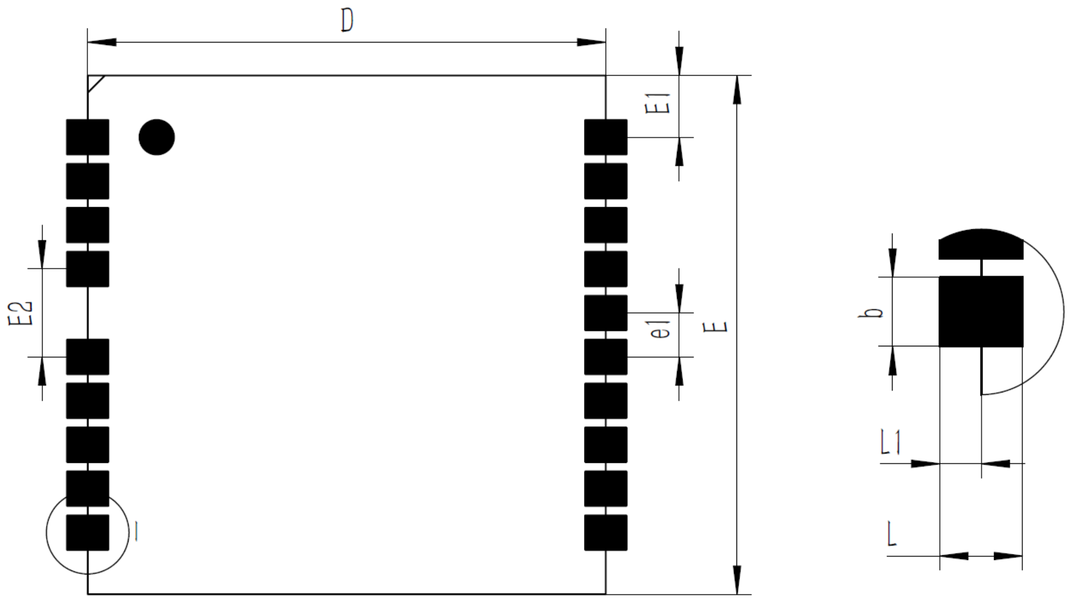

Figure 10: Recommended Land Pattern

Note 1: Exposed copper is not recommended beneath the device.

Table 14: Recommended Land Pattern

Symbol	Min (mm)	Typ (mm)	Max (mm)
D		15	
E		15	
E1		1.79	
E2		2.54	
e		1.27	
b		0.9	
L		2	
L1		1	

13 Coordinate System

The body frame uses a Right-Forward-Up (RFU) coordinate system, while the navigation frame uses an East-North-Up (ENU) coordinate system.

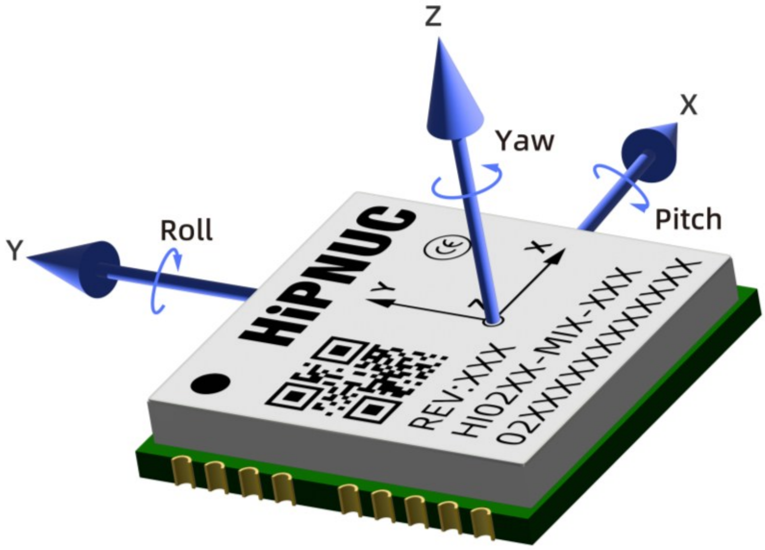

Figure 11: HI02 Coordinate System

The Euler angle rotation sequence follows the ENU 3-1-2 convention (rotation about the Z-axis, then the X-axis, and finally the Y-axis). The specific definitions are as follows:

- Rotation around the Z-axis: Heading (ψ); Range: -180° – 180°
- Rotation around the X-axis: Pitch (θ); Range: -90° – 90°
- Rotation around the Y-axis: Roll (ϕ); Range: -180° – 180°

If the module is modeled as an aircraft, the positive Y-axis corresponds to the nose direction. When the sensor frame is aligned with the reference frame, the ideal output of Euler angles is: Pitch = 0°, Roll = 0°, Yaw = 0°.

For coordinate-system configuration, refer to the Command and Programming Manual.

14 Evaluation Board

EVAL HI02 is a compact evaluation board for rapid evaluation of HI02 series sensors. It includes a Molex J1 connector for connection to a host device through a compatible USB-to-Molex cable or an open-ended wiring harness. During operation, the EVAL HI02 must be rigidly mounted to the host equipment or test fixture.

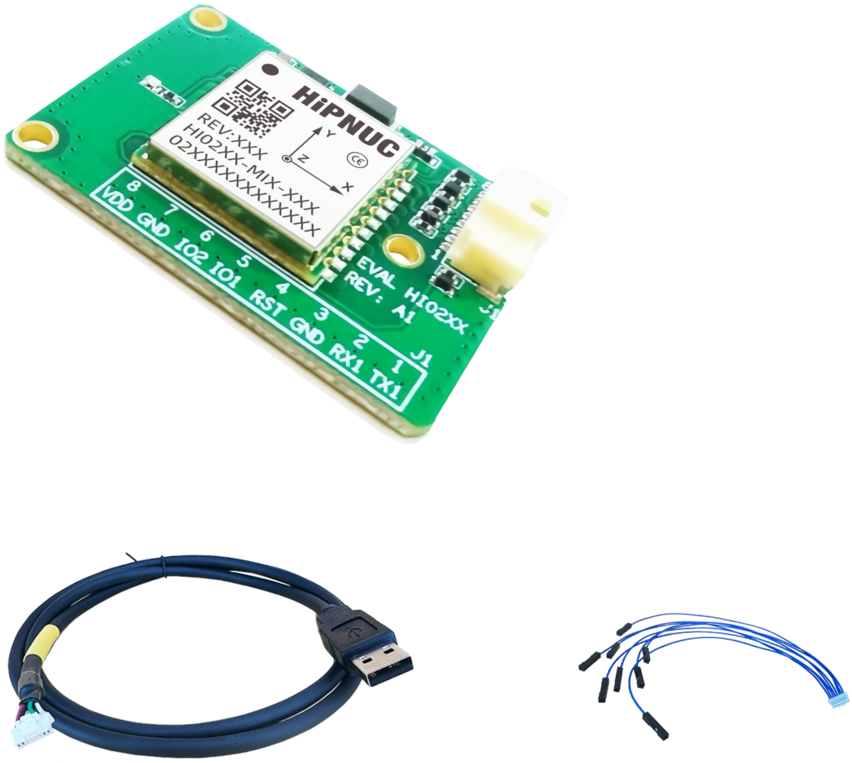

Figure 12: Evaluation Board and Cable

Note 1: The USB-to-Molex wiring harness has a length of 1 m, and the Molex-to-Dupont terminal wiring harness has a length of 30 cm.

15 Serial Protocol

The module supports a configurable binary serial protocol. For details, refer to the Command and Programming Manual.

16 SMT and Installation

16.1 SMT Temperature Profile

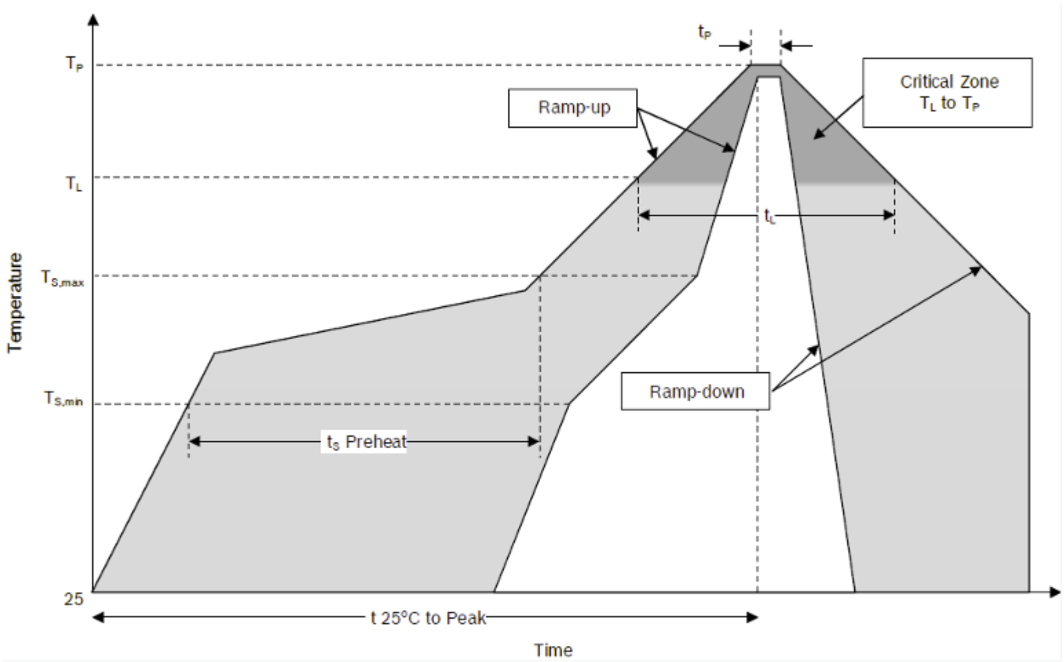

Figure 13: SMT Temperature Profile

Table 15: SMT Temperature Profile Descriptions

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

16.2 Installation Recommendations

MEMS sensors are precision devices that combine electronic and mechanical structures. To achieve optimal performance, the following PCB mounting recommendations should be followed:

- It is recommended to mount the module horizontally on the target platform.
- It is not recommended to place the sensor directly under or next to button contacts, as this will cause mechanical stress.
- It is not recommended to place the sensor directly near high-temperature hotspots (e.g., controllers or graphics chips), as this will cause rapid temperature rise of the PCB and thus heat up the sensor.
- Avoid placing the sensor in regions of high PCB stress, such as areas prone to bending or warpage. Mechanical stress can cause bending of the PCB and the sensor.

- It is not recommended to mount the sensor too close to screw holes. Avoid mounting the sensor in areas where the PCB may or is expected to resonate (vibrate).

If these recommendations cannot be fully implemented, in-system offset calibration after PCB assembly may help reduce the resulting errors.

17 Packaging

17.1 Tape Dimensions

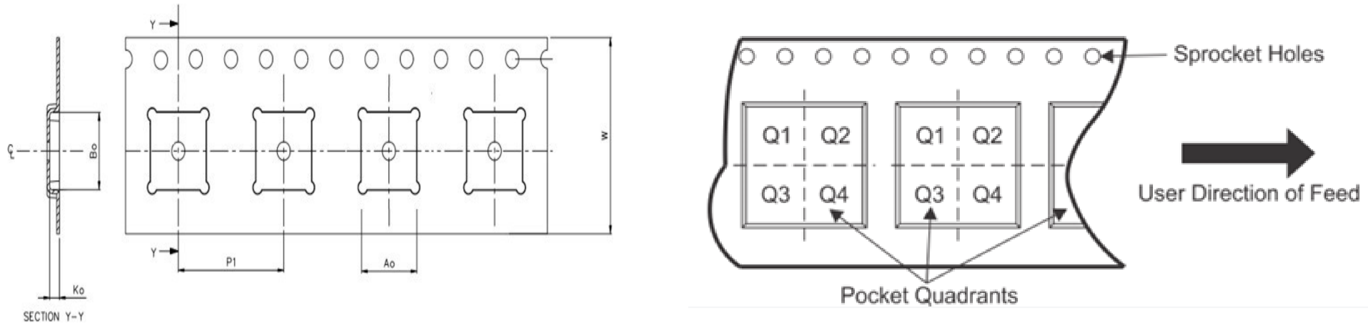

Figure 14: Tape Dimensions and Pin 1 Orientation

Table 16: Tape Dimension Information

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

17.2 Reel Dimensions

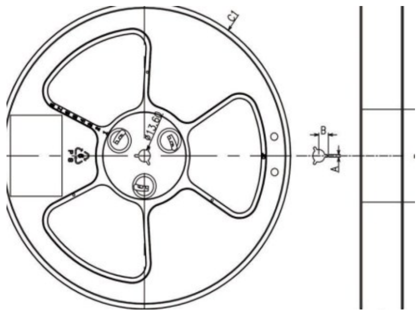

Figure 15: Reel Dimension

Table 17: 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

17.3 Packaging Method

The HI02 series is packaged in standard cartons.

Table 18: Packing Configuration

HI02 | Reel | Vacuum Packaging | Box

Table 19: Carton Dimensions

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

18 Disclaimer

The parameters listed in this document are typical values, maximum values, or measured values obtained under specified test conditions and do not constitute final delivery commitments. Hipnuc reserves the right to modify the product, document, and related information without prior notice.