1 FEATURES

1.1 Hardware

- High performance MEMS IMU
- Factory temperature compensation from -40 to 85°C,calibrated for scale factor,cross-axis and zero bias
- Gyroscope zero bias instability up to 1.7°/h
- Accelerometer zero bias instability up to 12ug
- Durable Type-C interface for convenient use
- Excellent vibration resistance
- Integrated temperature sensor
- Compact independent shell packaging for easy integration
- RoHS and CE certification

1.2 Software

- Adaptive extended kalman fusion algorithm, up to 1000Hz output, low latency
- Excellent dynamic tracking performance and vibration suppression
- Outstanding suppression of linear acceleration
- Startup time < 1s
- HiPNUC custom binary protocol
- No external instruction configuration required, direct data output
- Rich user configuration commands
- Multifunctional GUI for easy operation
- Supports various examples such as ROS, C, QT

2 APPLICATIONS

- Low-speed autonomous driving robots
- Humanoid robots

3 DESCRIPTION

3.1 Product Appearance

Figure1: HI13

3.2 System Block Diagram

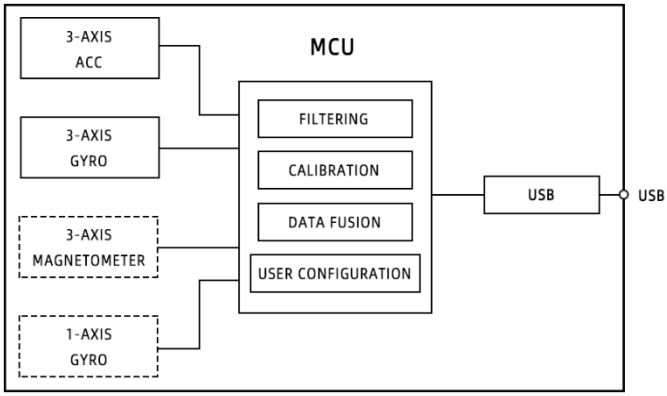

Figure2: Functional Block Diagram

Note1: Dashed lines indicate features not supported by certain models. Refer to the product selection Table 1.

3.3 General Description

The HI13 integrates a high-performance MEMS IMU, magnetometer,and barometer to provide IMU/VRU/AHRS functions.It incorporates proprietary algorithms including an adaptive Extended Kalman Filter, dynamic IMU noise analysis,and vehicle motion state analysis. These ensure accurate attitude estimation under high-dynamic conditions while mitigating heading drift.

Each unit undergoes precise factory calibration for temperature effects,bias,scale factor,and cross-axis errors.

The HI13 series communicates via a USB interface and offers extensive user-configurable parameters.

A multifunction GUI accelerates evaluation and includes module configuration, real-time data visualization,firmware upgrade, and data logging.For model selection and ordering details,see Tables 1 and 2.

目录

4 PRODUCT SELECTION

Table 1: Product selection information

HI13a-b-c[1]							
Company	Product	a-Sensor		b-Interface		c-Custom	
HI	13	M0	6DoF 3°/h 30ug	USB	USB	000	Default
		R2	6DoF 1.6°/h 18ug			Others	OEM
		S2	6DoF 1.7°/h 12ug				
		R4	6DoF 1.6°/h 18ug + Magnetic +Pressure				
		S4	6DoF 1.7°/h 12ug + Magnetic +Pressure				

Note1: Example：HI13S4-USB-000

5 ORDERING

5.1 Ordering Information

Table 2: Ordering information

Part Number	Name	Description	Note
HI13M0-USB-000	IMU/VRU Module	6DoF 3°/h 30ug	
HI13R2-USB-000	IMU/VRU Module	6DoF 1.6°/h 18ug	
HI13S2-USB-000	IMU/VRU Module	6DoF 1.7°/h 12ug	
HI13R4-USB-000	IMU/AHRS Module	6DoF 1.6°/h 18ug+Magnetic+Pressure	
HI13S4-USB-000	IMU/AHRS Module	6DoF 1.7°/h 12ug+Magnetic+Pressure	

5.2 Contact Us

The product can be ordered via:

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

6 DOCUMENT INFORMATION

6.1 Scope

This document applies to module hardware versions B3 and above.

6.2 Document Version Information

Table 3: Version

Version	Date	Author	Change
1.0	May 23, 2023	HiPNUC	Initial release
1.1	Sep 13,2023	HiPNUC	Added bottom board-to-board connector description
1.2	Dec 1, 2024	HiPNUC	Updated HI13 P/N; removed board-to-board connector model
1.3	Mar 17,2025	HiPNUC	Updated Allan parameters
1.4	Jun 17,2025	HiPNUC	Added HI13S configuration

6.3 Related Documents

1. *Command & Programming Manual*
2. *3D Step*
3. *CE/RoHS certification documents*
4. *GUI application & reference examples*

7 SPECIFICATIONS

Unless otherwise stated, test conditions: 25℃, supply 5 V.

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	5.25V	

7.2 Recommended Operating Conditions

Table 5: Recommended operating conditions

Parameters	Condition	Min	Nom	Max	Unit	Note
Input Voltage		4.75	5	5.25	V	
Power Consumption	HI13M0 HI13RX/HI13SX			215 310	mW	
Operating Temperature		-40	-	85	℃	
Gyroscope Range	HI13M0/HI13RX HI13SX	125	2000 4000	2000 4000	°/s	
Accelerometer Range	HI13M0/HI13RX HI13SX	3	12 32	24 32	g	
Start-up Time				2	s	1

Note1: Start-up time is from power-on to valid data output;keep the module stationary during this period

7.3 Interface Parameters

Table 6: Interface parameters

Interf	Parameters	Condition	Min	Nom	Max	Unit	Note
USB	Baud Rate		9600	115200	921600	bps	1
	Start bits			1		bit	
	Data length			8		bits	
	Stop bits			1		bit	
	Parity			无		bit	
	Output Frame Rate		0	100	1000	Hz	

Note1: USB interface uses a USB-to-UART bridge (CP2102N). Driver can be downloaded if not auto-installed.

7.4 Gyroscope

7.4.1 HI13MX/HI13RX gyroscope parameters

Table 7: HI13MX/HI13RX/ gyroscope parameters

Parameters	Condition	Product	Min	Nom	Max	Unit	Note
Range				2000		°/s	
Resolution				16bit			
Scale Factor	100°/s	HI13M0 HI13R2/HI13R4		<500 <200	600 350	ppm	1
Linearity	Best-fit line,Fs=2000°/s		-0.05	-	0.05	%Fs	2
Noise Density		HI13M0 HI13R2/HI13R4		0.015 0.008		°/s/√Hz	
3dB Bandwidth				80	200	Hz	
Sampling Rate				1000		Hz	
Bias Instability	Allan Variance	HI13M0 HI13R2/HI13R4		3 1.6		°/h	1σ
Bias Stability	10s smoothing	HI13M0 HI13R2/HI13R4		10 5		°/h	1σ
Bias Repeatability	Allan Variance	HI13M0 HI13R2/HI13R4		15 12		°/h	1σ
Angle Random Walk	Allan Variance	HI13M0 HI13R2/HI13R4		0.42 0.25		°/√Hz	1σ
Full-Temp Bias Drift -40-85℃				0.07	0.2	°/s	3
Acceleration Sensitivity	All three axis			0.1		°/s/g	

Note1: Scale factor error measured via bi-directional 10-turn rate table test (average).

Note2: Maximum deviation from best-fit straight line

Note3: Measured in HiPNUC laboratory thermal chamber; temperature ramp < 3℃/min.

7.4.2 HI13SX Gyroscope Specifications

Table 8: HI13SX Gyroscope specifications

Parameters	Condition	Product	Min	Nom	Max	Unit	Note
Range			15.625	4000	4000	°/s	
Resolution				20bit			
Scale Factor	100°/s			<100	200	ppm	1
Linearity			-0.05	-	0.05	%Fs	2
Noise Density	Bandwidth 80Hz			0.025		°/s√Hz	3
3dB Bandwidth				80	200	Hz	
Zero-Rate Output					±0.1	°/s	4
Sampling Rate				1000		Hz	
Bias Instability	Allan Variance			1.7		°/h	1σ
Bias Stability	10s smoothing			4		°/h	1σ
Bias Repeatability	Allan Variance			3.7		°/h	
Angle Random Walk	Allan Variance			0.1		°/s√Hz	1σ
Full-Temp Bias Drift				0.07	0.2	°/s	5
Acceleration Sensitivity	All three axis			0.05		°/s/g	

Note1: Scale factor error measured by averaging results of ±10 rotations on a rate table.

Note2: Maximum deviation from best-fit straight line

Note3: Mean value over test sample set.

Note4: After initial bias calibration, residual bias is continuously estimated in the fusion/algorithm engine.

Note5: Measured using HiPNUC laboratory thermal chamber + rate table; temperature ramp < 3°C/min.

7.5 Accelerometer

7.5.1 HI13MX/HI13RX Accelerometer Specifications

Table 9: 7.5.1 HI13MX/HI13RX accelerometer specifications

Parameters	Condition	Product	Min	Nom	Max	Unit	Note
Range				12		g	
Resolution				16bit			
Initial Zero Bias					3	mg	
Linearity	Best-fit line,Fs=3g			0.5		%Fs	
Noise Density		HI13M0		0.175		mg/√Hz	
		HI13RX		0.09			
3dB Bandwidth				145		Hz	
Sampling Rate				1600		Hz	
Bias Instability	Allan Variance	HI13M0		0.03		mg	1σ
		HI13RX		0.018			
Bias Stability	10s smoothing	HI13M0		0.07		mg	1σ
		HI13RX		0.035			
Bias Repeatability	Allan Variance	HI13M0		0.34		mg	1σ
		HI13RX		0.15			
Velocity Random Walk	Allan Variance	HI13M0		0.08		m/s√Hz	1σ
		HI13RX		0.04			
Full-Temp Bias Variation	-40-85℃			2	5	mg	1σ

7.5.2 Accelerometer Specifications (HI13SX)

Table 10: Accelerometer specifications (HI13SX)

Parameters	Condition	Product	Min	Nom	Max	Unit	Note
Range			2	8	32	g	
Resolution				20bit			
Initial Zero Bias				2	3	mg	
Linearity				0.01		%Fs	
3dB Bandwidth				90	200	Hz	
Noise Density	Bandwith 90Hz			0.5	0.7	mg	
Sampling Rate				1000		Hz	
Bias Instability	Allan Variance			0.012		mg	1σ
Bias Stability	10s smoothing			0.015		mg	1σ
Bias Repeatability	Allan Variance			0.11		mg	1σ
Velocity Random Walk	Allan Variance			0.018		m/s/√Hz	1σ
Full-Temp Bias Variation	-40-85℃			2	5	mg	1σ

7.6 Magnetometer

Table 11: Magnetometer specifications

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

7.7 Temperature Sensor Specifications

Table 12: Temperature sensor specifications

Parameters	Condition	Min	Nom	Max	Unit	Note
Range		-40	-	85	℃	
Offset error			±1		K	

7.8 Barometer Specifications

Table 13: Barometer specifications

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

7.9 Allan Variance

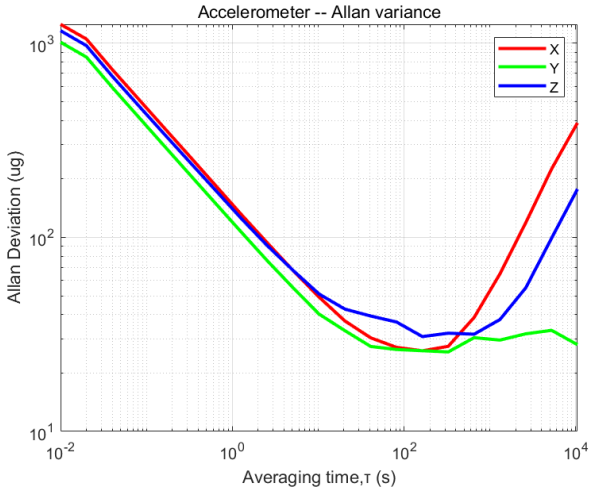

Figure3: HI13M0 Accelerometer Allan Variance

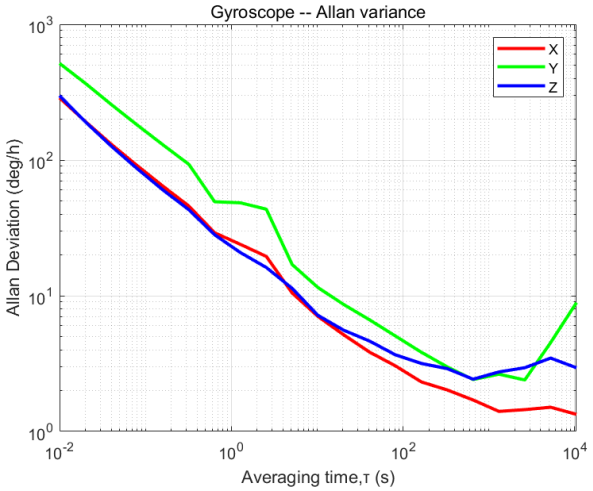

Figure4: HI13M0 Gyroscope Allan Variance

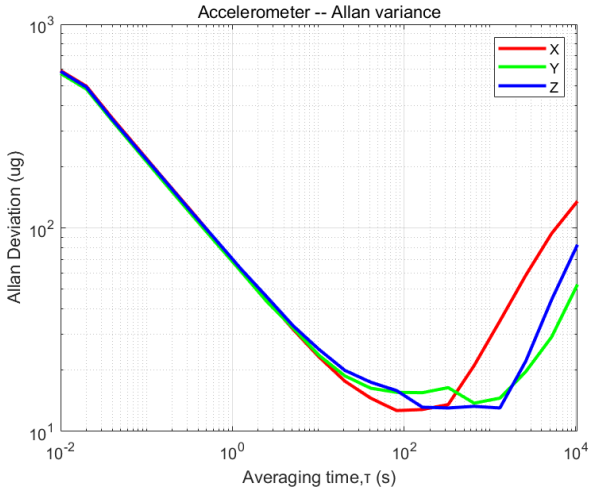

Figure5: HI13R2/HI13R4 Accelerometer Allan Variance

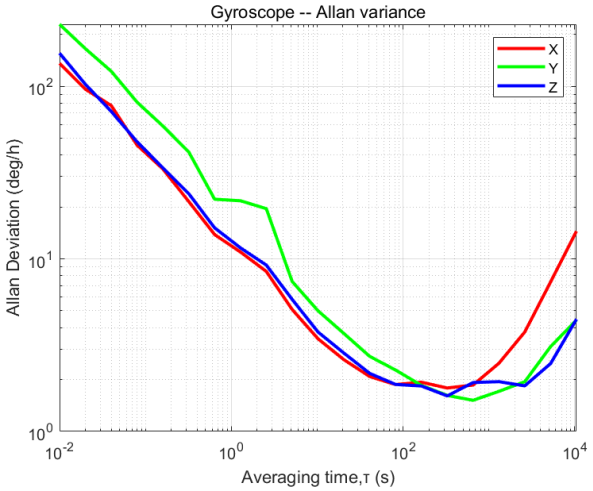

Figure6: HI13R2/HI13R4 Gyroscope Allan Variance

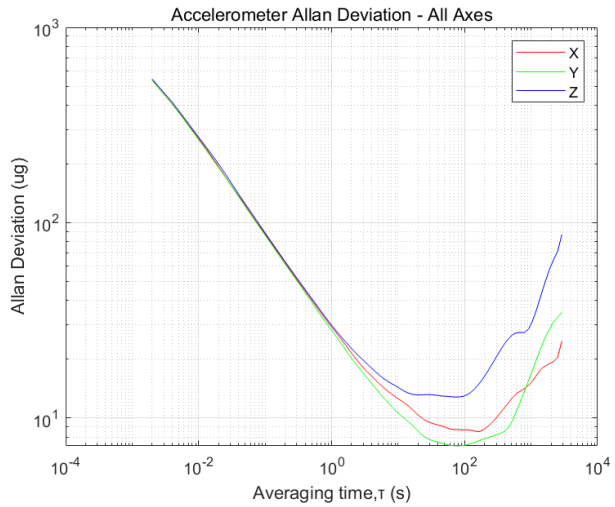

Figure7: HI13SX Accelerometer Allan Variance

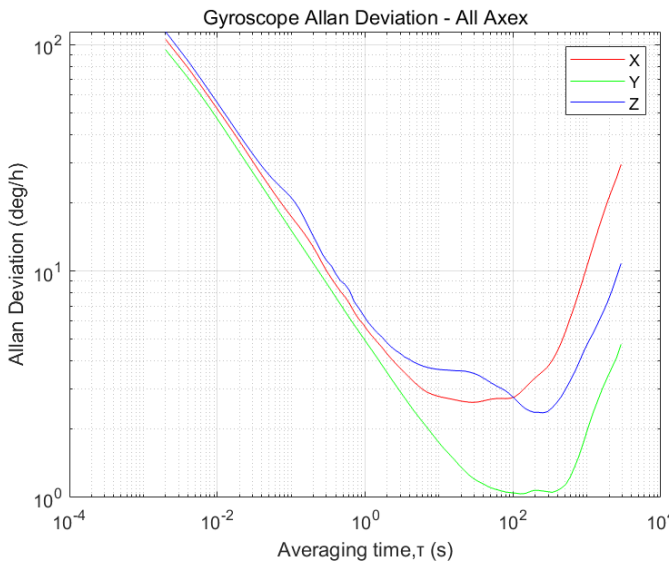

Figure8: HI13SX Gyroscope Allan Variance

7.10 Fusion Parameters

Table 14: Fusion parameters

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

7.11 Attitude Angle Accuracy

Table 15: 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	°	
Heading static drift (6DOF)	Stationary 2h			0.15	0.2	°	1
Heading dynamic drift (6DOF)		HI13M0		9		°	2
		HI13R2/HI13R4/HI13SX		5			
Heading(AHRS)		HI13R4		2	3	°	3
Heading rotation error (6DOF)	100°/s rotation	HI13M0		<0.8	3	°	4
		HI13R2/HI13R4/HI13SX			1.5		

Note1: Module kept horizontally stationary for 2 hours.

Note2: Measured while the module operated on an indoor cleaning robot for 1 hour; 1σ.

Note3: After geomagnetic calibration, in an environment without magnetic interference; product configured in AHRS mode.

Note4: Cumulative yaw error over 10 continuous rotations on a rate table.

7.12 Mechanical and Environmental Parameters

Table 16: Mechanical and environmental parameters

Parameters	Value	Note
Dimensions	25.7X24X12mm	
Weight	<11g	
Enclosure material/ process	CNC machined aluminum alloy	
Mounting screws	M2.5	
Connector	Type C	
Vibration resistance	1.0mm(10Hz-58Hz)&≤20g(58Hz-600Hz)	
Environmental	RoHS Directive 2011/65/EU	
EMC	LVD Directive 2014/35/EU	
Drop test Free	drop 3 times from 75 cm test bench	
Thermal shock	Temperature raised from –40°C to +85°C within 1 h, 5 cycles	

7.13 Dimensions

All Dimensions in mm units.

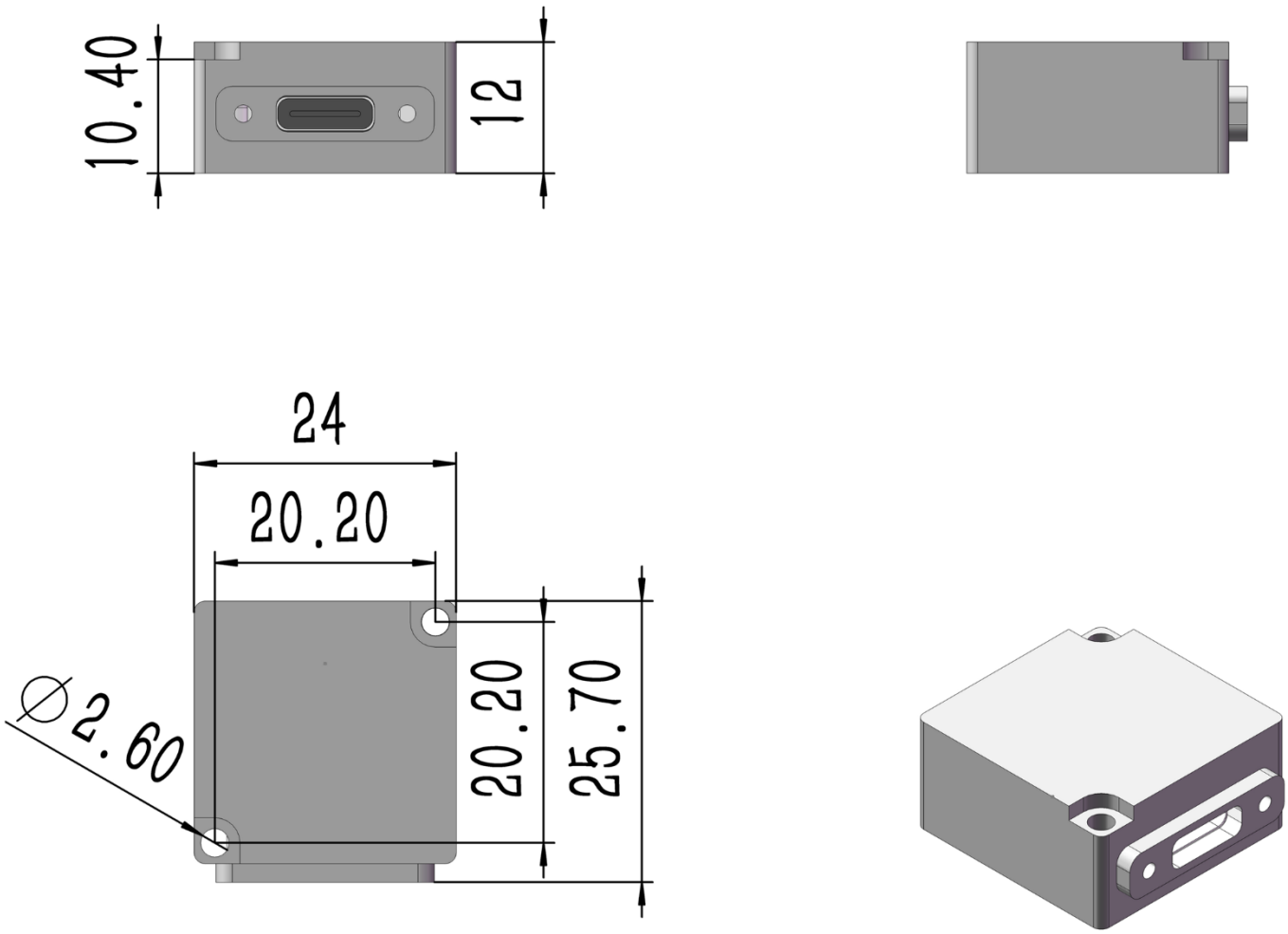

Figure9: HI13 mechanical dimension

8 COORDINATE SYSTEMS

8.1 Coordinate Systems

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

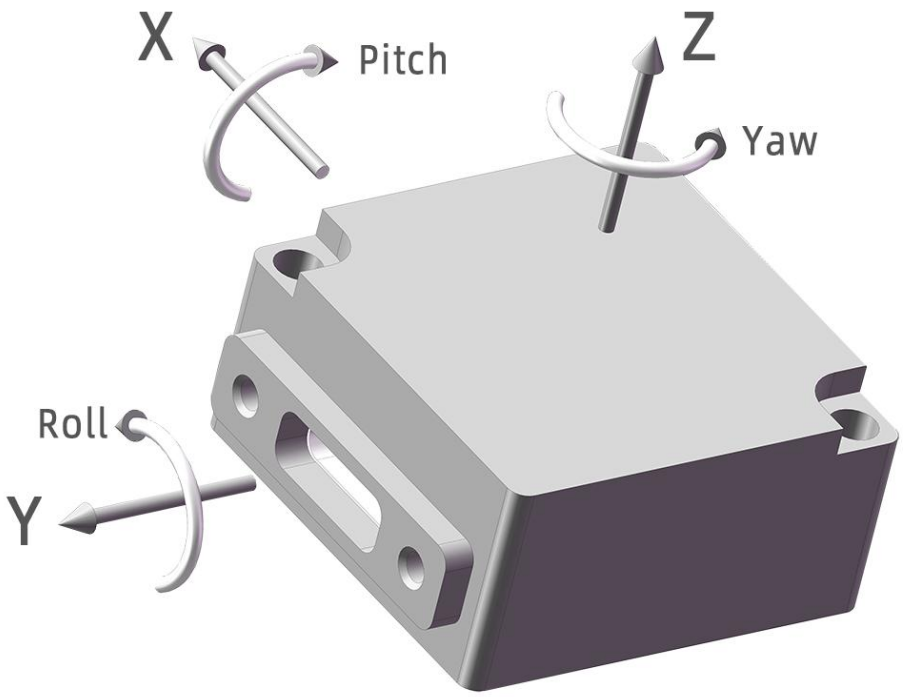

Figure10: HI13 Coordinate System

The Euler angle rotation order adopts ENU-312 (a Z-X-Y intrinsic Tait-Bryan sequence: first rotate about the Z axis, then about the X axis, and finally about the Y axis). The specific definitions are:

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

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

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

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

Users may change the coordinate system as needed, including but not limited to converting to NWU (North-West-Up) or NED (North-East-Down). For details, refer to the Command & Programming Manual.。

8.2 Sensor Center of Mass Position

Table 17: Sensor center (reference) position for HI13 series

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

8.3 Recommended Installation Method

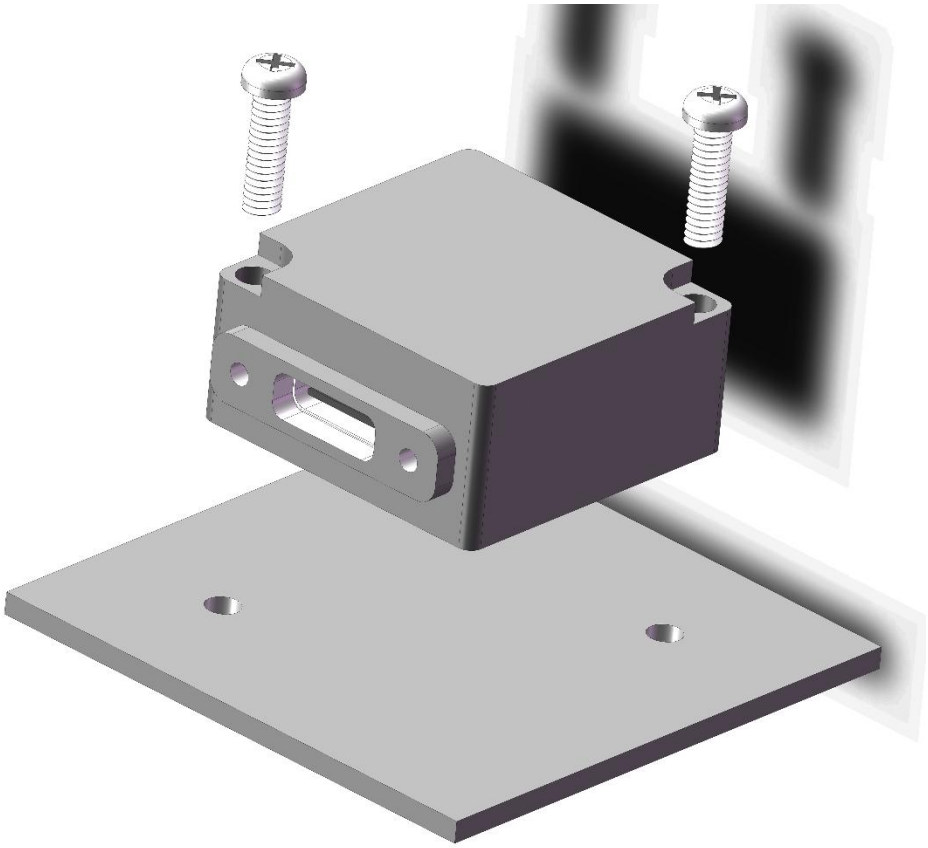

Figure11: Installation diagram

Note1: Install the module in a horizontal orientation. If another mounting orientation is required, please refer to the Command & Programming Manual for instructions on rotating / remapping the coordinate frame.

Note2: It is recommended to mount the module at a location with low vibration and minimal temperature variation.

Note3: Rigidly fasten (mechanically secure) the IMU to the carrier structure.

Note4: The Y-axis should point toward the front (forward heading) of the vehicle.

9 CABLE

Figure12: Cable

The length of cable is 1.2m

10 COMMUNICATION PROTOCOL

10.1 Serial Binary Protocol

To facilitate user integration, we provide a rich set of serial protocol options for selection. For more detailed information, please refer to the Command and Programming Manual.