HiPNUC

1 FETAURES

Hardware

- High-performance array IMU
- Factory temperature compensation from -40 to 85°C, calibrated for scale factor, cross-axis, and zero bias
- Gyroscope zero bias instability up to 2.5°/h
- Accelerometer zero bias instability up to 30ug
- Fully symmetrical design
- Supports programmable IO output signals (including but not limited to synchronization input/output, alarm functions, etc.)
- Excellent vibration resistance
- Integrated temperature sensor
- Surface mount package, easy to integrate
- RoHS, CE certification
- Integrated hardware reset circuit (CH040/CH040MP only)

Software

- Adaptive Extended Kalman Filter fusion algorithm, up to 1KHz output
- Low latency
- Excellent dynamic tracking performance and good vibration suppression
- Outstanding suppression of linear acceleration
- Startup time <1s
- Support for multiple protocols such as binary, CANopen, Modbus, etc
- No need for external command configuration, direct output of data
- Rich user configuration commands
- Multifunctional GUI for easy operation
- Support for multiple driver such as ROS, C, QT etc

2 APPLICATION

- Precision instruments and meters
- Platform stability and control
- Engineering machinery
- Unmanned aerial vehicles
- Smart Agricultural Machinery

3 DESCRIPTION

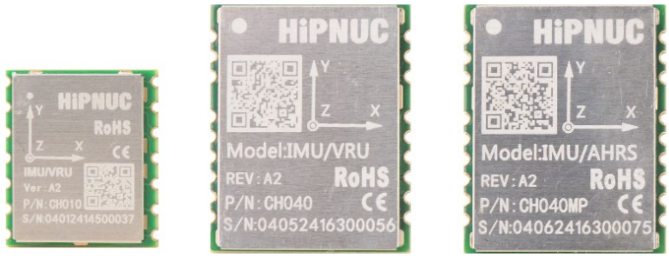


Figure1: *CH0X0*

Block diagram

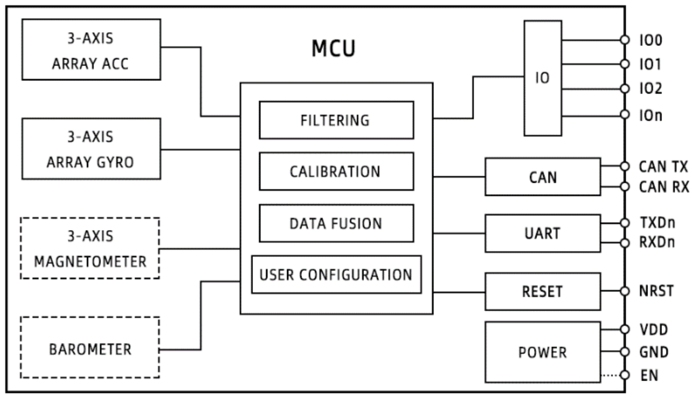


Figure2: *Functional Block Diagram*

General description

The CH0X0 series is an IMU/VRU/AHRS sensor composed of an array of MEMS-IMUs, magnetometers, and barometers. It features independently developed adaptive extended Kalman filtering, IMU noise dynamic analysis, and carrier motion state analysis algorithms, ensuring accurate attitude angles in high-dynamic conditions while reducing heading drift.

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

The CH0X0 series sensors transmit data via the UART interface and offer extensive user configuration. If a CAN interface is needed, the user should integrate a CAN transceiver circuit.

The CH0X0 series supports external synchronization and can align time with external systems like lidar and cameras.

The multifunctional GUI helps in quickly evaluating the product, including but not limited to module configuration, data display, firmware upgrades, and data logging.

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

Contents

4 PRODUCT SELECTION

Table 1: Selection information

P/N	Model	IMU Array	Auxiliary Sensors	Note
CH010	IMU/VRU Module	1	-	1
CH020	IMU/VRU Module	2	-	1
CH040	IMU/VRU Module	4	-	1
CH040MP	IMU/AHRS Module	4	Magnetometer + Barometer	1

Note1: All models default to full temperature compensation. Only firmware version 1.5.4 and above support this

5 PRODUCT ORDERING

5.1 Ordering information

Table 2: Ordering information

Part Number	Name	Description	Note
CH010	IMU/VRU Module	6DoF 5.1°/h 60ug 1 Array	
CH020	IMU/VRU Module	6DoF 3.6°/h 42ug 2 Array	
CH040	IMU/VRU Module	6DoF 2.5°/h 30ug 4 Array	
CH040MP	IMU/AHRS Module	6DoF+Magnetic+Pressure 2.5°/h 30ug 4 Array	

5.2 Contact us

The product can be ordered through the following methods:

1.Mail: sales@hipnuc.com

2.Website

6 6 DOCUMENT

6.1 Applicable range

6.1.1 Firmware version

Some features mentioned in the document are only supported in firmware versions 1.5.4 and above. For detailed features, please consult us.

6.1.2 Hardware version

The document is applicable to module hardware versions A2 and above. The version change history is as follows:

Table 3: Table3: Hardware version change history

P/N	Version	Contents	Note
CH010	A0	Initial	
	A1	Adjustment of shielding cover pins	
	A2	For version A1, reserved pins have been converted to IO, and a two-dimensional QR code containing SN and other information has been added to the shielding cover	
CH020	A0	Initial	
	A1	Adjustment of shielding cover pins	
	A2	For version A1, reserved pins have been converted to IO, and a two-dimensional QR code containing SN and other information has been added to the shielding cover	
CH040	A0	Initial	
	A1	Adjustment of shielding cover pins	
	A2	For version A1, reserved pins have been converted to IO，UART3 has been brought out, and a two-dimensional QR code containing SN and other information has been added to the shielding cover	
CH040MP	A0	Initial	
	A2	For version A1, reserved pins have been converted to IO，UART3 has been brought out, and a two-dimensional QR code containing SN and other information has been added to the shielding cover	

6.2 Version history

Table 4: Document Version

Version	Date	Author	Contents
A0	April 23, 2024	Hipnuc	Initial version
A1	July 15, 2024	Hipnuc	Modify product pin description and wiring method
A2	July 17, 2024	Hipnuc	Modify the multiplexing instructions of multi-function IO pins

6.3 Related documents and development kits

1. *Instruction and Programming Manual*
2. *CAE/Package files*
3. *CH0X0-EVK Evaluation Board User Manual and Design Files*
4. *CE/RoHS Certification Documents*
5. *GUI and Driver*
6. *CH0X0 Series Test Reports*

7 SPECIFICATIONS

Unless otherwise noted, the test temperature is 25℃, the supply voltage is 5V, the gyroscope range is 2000°/s, the accelerometer range is 12g, the geomagnetic range is 2 Gauss, and the test sample consists of 8 pcs.

7.1 Absolute maximum value

Table 5: 7.1 Absolute maximum value

Parameters	Limit	Comment
Mechanical shock	2000g	Duration <1ms
Storage temperature	-40℃-85℃	
ESD HBM	2KV	JEDEC/ESDA JS-001
Input voltage	6.5V	
IO To GND	-0.3-5V	

7.2 Operating conditions

Table 6: 7.2 Operating conditions

Parameters	Condition	Min	Nom	Max	Unit	Note
Input voltage		3.2	-	5.5	V	
Power consumption	CH010			155	mW	
	CH020			205		
	CH040/ CH040MP			475		
Operating temperature		-40	-	85	℃	
Gyroscope range		125	2000	2000	°/s	1
Accelerometer range		3	12	24	g	1
Startup time				2	s	2

Note1: If you need to configure other ranges, you can refer to the instruction and programming manual for configuration.

Note2: Startup time refers to the duration from when the system is powered on until valid data output is available. During this period, the module should remain stationary.

7.3 Interface

Table 7: Interface parameters

Interf	Parameters	Condition	Min	Nom	Max	Unit	Note
UART(TTL)	Baud		9600	115200	921600	bps	
	Start Bit		0	1		bit	
	Data Length		0	8		bits	
	Stop Bit			1		bit	
	Parity Bit			None		bit	
	Frame rate		0	100	1000	Hz	1
CAN	Baud		125	500	1000	kbps	3
	Frame rate		5	100	200	Hz	3
NRST(RESET)	Logic voltage	High	2.0			V	
		Low			0.6	V	
	Reset time		140			ms	
IO	Logic voltage	High	2.0			V	
		Low			0.6	V	
	Delay(trigger)	From trigger generation to data transmission			800	us	4

Note1: The sensor supports data output at 1, 5, 10, 50, 100, 200, 250, 500, and 1000 Hz.

Note2: The supported baud rates for CAN communication are 125K, 250K, 500K, and 1000K.

Note3: The sensor supports data output at 5, 10, 50, 100, and 200 Hz for CAN communication.

Note4: For multifunctional IO configuration and operation, please refer to the instruction and programming manual.

7.4 Gyroscope

Table 8: Gyroscope parameters

Parameters	Condition	Product	Min	Nom	Max	Unit	Note
Range				2000		°/s	
Resolution				16bit			
Scale factor	100°/s	CH010		<600	800	ppm	1
		CH020		<500	750		
		CH040/CH040MP		<280	350		
Nonlinearity	Best fit straight line Fs=2000°/s		-0.05	-	0.05	%Fs	2
3dB Bandwidth				116		Hz	
Sample				1000		Hz	
Bias instability	Allan Variance	CH010		5.1		°/h	3
		CH020		3.6			
		CH040/CH040MP		2.5			
Bias repeatability	Allan Variance	CH010		0.09		°/s	3
		CH020		0.07			
		CH040/CH040MP		0.05			
Random walk	Allan Variance	CH010		0.6		°/√h	3
		CH020		0.42			
		CH040/CH040MP		0.3			
Zero-rate Offset Change over Temperatur -40-85℃	Z			0.015	0.035	°/s	4
	Y			0.05	0.18		
	X			0.03	0.08		
g-Sensitivity	All three axis			0.1		°/s/g	

Note1: The turntable rotates 10 circles in both directions, and the average measurement is taken.

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

Note3: The average value of the test samples, refer to 7.9 - Allan variance curve.

Note4: Measured by the HiPNUC laboratory temperature chamber turntable, with a temperature rise rate of less than 3°C/min. For detailed data, refer to Figure 9 temperature compensation curve.

7.5 Accelerometers

Table 9: Accelerometers

Parameters	Condition	Product	Min	Nom	Max	Unit	Note
Range				12		g	
Resolution				16		bit	
Zero-g Offset					10	mg	1
Nonlinearity	Best fit straight line Fs=3g			0.5		%Fs	2
3dB Bandwidth				145		Hz	
Sample				1600		Hz	
Bias instability	Allan Variance	CH010 CH020 CH040/CH040MP		60 42 30		ug	3
Bias repeatability	Allan Variance	CH010 CH020 CH040/CH040MP		2.52 1.8 1.5		mg	3
Random walk	Allan Variance	CH010 CH020 CH040/CH040MP		0.08 0.06 0.04		m/s√h	3
Zero-g Offset Change over Temperature	-40-85℃			1	2.5	mg	4

Note1: This value may vary after user soldering, actual results may vary.

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

Note3: Test sample mean, reference to the 7.9-Allan variance curve.

Note4: Measured from the Hipnuc laboratory temperature-controlled turntable, with a temperature rise slope of less than 3℃/min. Detailed data can be found in Figure 9 temperature compensation curve.

7.6 Magnetometer

Table 10: Magnetometer

Parameters	Condition	Min	Nom	Max	Unit	Note
Range			2	8	Gauss	
Resolution	Fs=2G		2		mGauss	
Sample			200Hz			
Linearity	Best fit straight line Fs=2G		0.1		Fs%	

7.7 Barometer

Table 11: Barometer

Parameters	Condition	Min	Nom	Max	Unit	Note
Range		300	-	1200	hPa	
Resolution			± 0.006		hPa	
Sample			64Hz			
Accuracy			± 0.06		hPa	

7.8 Temperature sensor

Table 12: Temperature sensor parameters

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

7.9 Allan variance curve

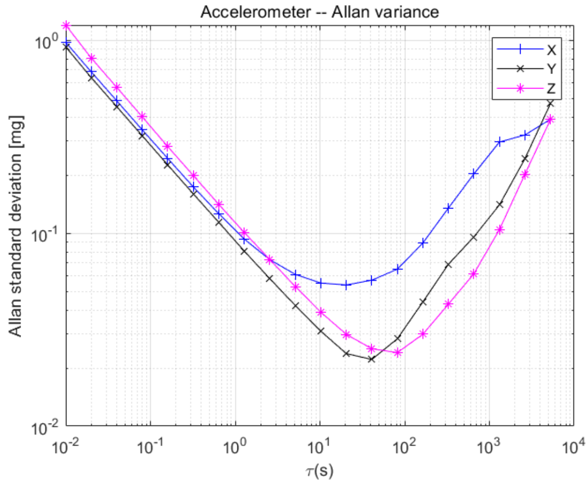


Figure3: *CH010 Accelerometer Allan Variance*

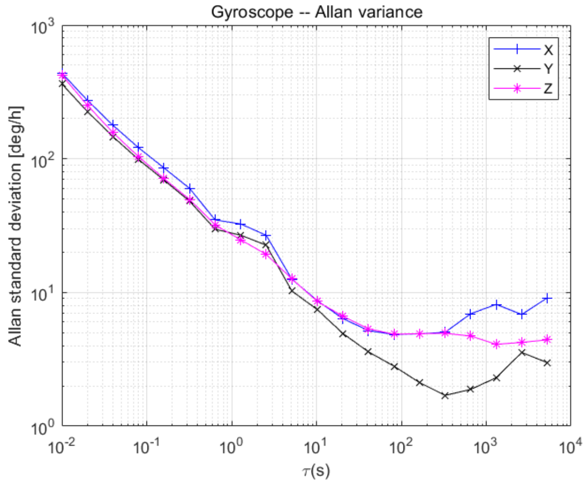


Figure4: *CH010 Gyroscope Allan Variance*

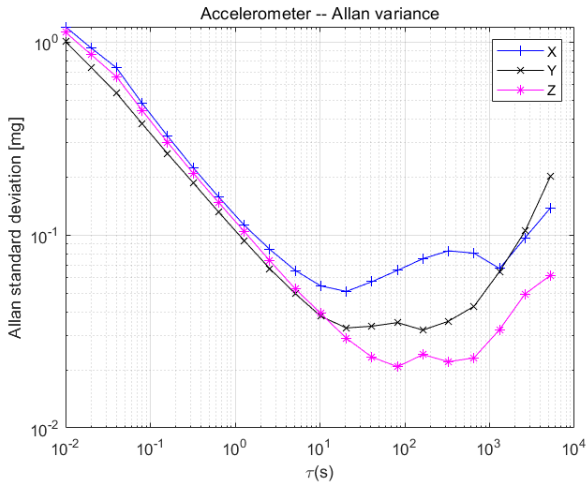


Figure5: *CH020 Accelerometer Allan Variance*

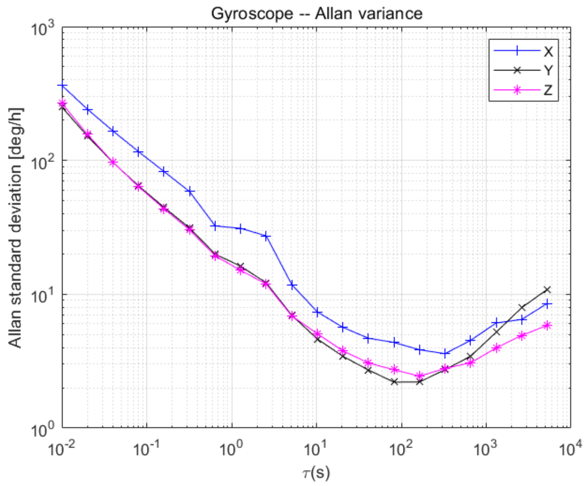


Figure6: *CH020 Gyroscope Allan Variance*

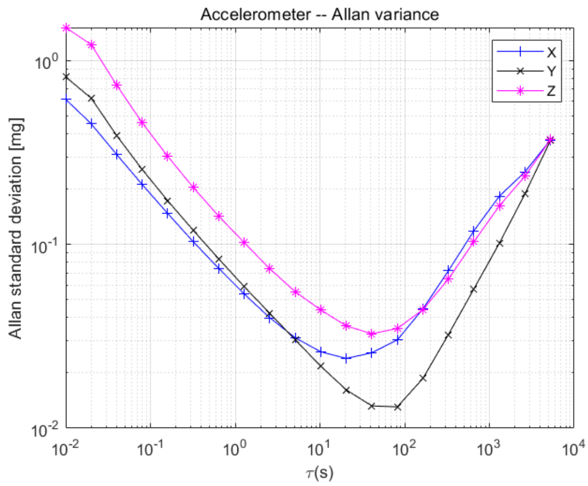


Figure7: *CH040 Accelerometer Allan Variance*

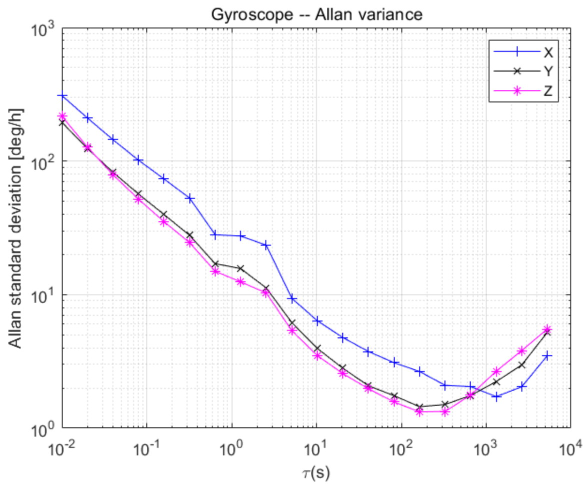


Figure8: *CH040 Gyroscope Allan Variance*

7.10 Temperature Compensation Curve

The measured sample is heated from -40℃ to 85℃, and the zero-offset data for the sample is compensated. The compensation results are as follows:

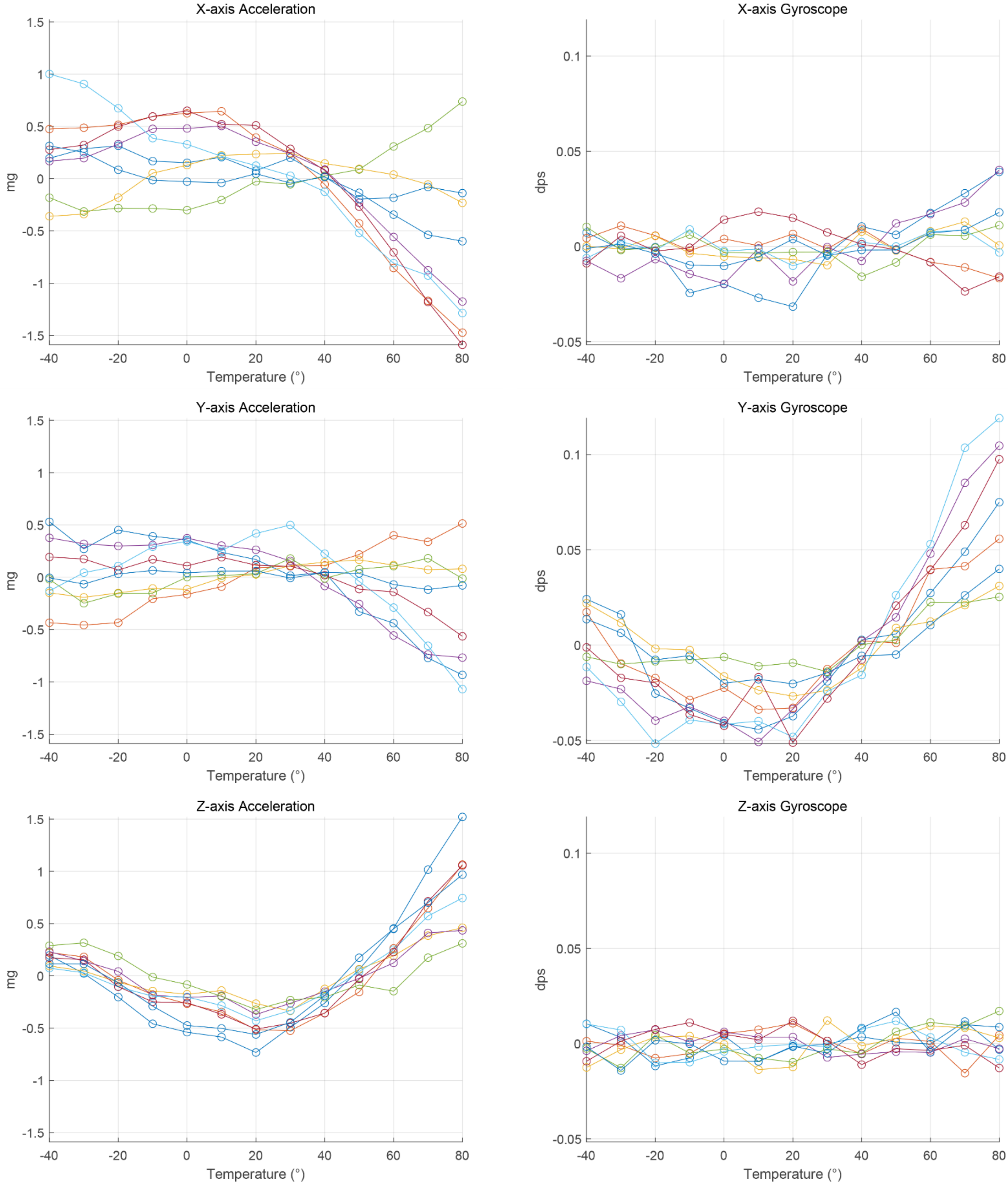


Figure9: *Accelerometer and Gyroscope Temperature Compensated Curve*

7.11 Fusion parameters

Table 13: Fusion parameters

Parameters	Value
Pitch	±90°
Roll	±180°
Heading	±180°
Resolution	0.01°

7.12 Attitude angle

Table 14: Attitude angle accuracy

Parameters	Condition	Product	Min	Nom	Max	Unit	Note
Pitch/Roll(static)				0.1	0.2	°	
Pitch/Roll(dynamic)				0.1	0.2	°	
Heading angle static drift (6DOF)	keep stationary 2h			0.1	0.2	°	1
Heading angle dynamic drift (6DOF)		CH010		9		°	2
		CH020		7			
		CH040/CH040MP		5			
Heading(AHRS)		CH040MP		2	3	°	3
Heading angle rotational error (6DOF)	100°/s Rotation	CH010		<1	3	°	4
		CH020			2.5		
		CH040/CH040MP			1.3		

Note1: Module remains horizontally stationary for 2 hours.

Note2: Module movement on indoor cleaning robot measured for 1 hour.1σ

Note3: After magnetic calibration, measured under no magnetic interference in the vicinity, it is necessary to configure the product as AHRS mode.

Note4: The turntable rotates continuously for 10 cycles, accumulating heading angle error.

7.13 Mechanical and Environmental

Table 15: Mechanical and Environmenta

Parameters	Product	Value
Dimensions	CH010/CH020	17.78X15.24X2.7mm
	CH040/CH040MP	25X20X2.7mm
Weight	CH010/CH020	<1.6g
	CH040/CH040MP	<2.5g
Shield cover material		Nickel Silver
Vibration resistance		1.0mm(10Hz-58Hz)&≤20g(58Hz-600Hz)
Environmental		RoHS 2011/65/EU
EMC		LVD Directive 2014/35/EU
Drop test		On a 75cm high test bench, free fall 3 times
Temperature shock		Temperature rises from -40°C to 85°C within 1 hour, 5 times

7.14 Dimensions

All Dimensions in mm units.

7.14.1 CH010/CH020 Dimensions

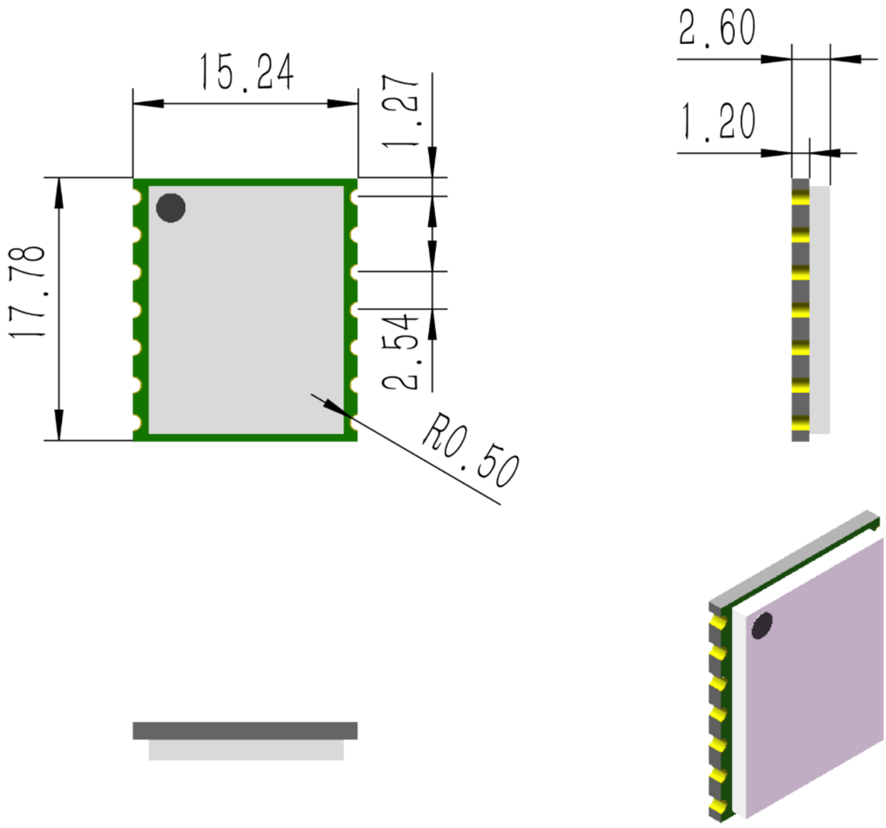


Figure10: *CH010/CH020 Mechanical Dimension*

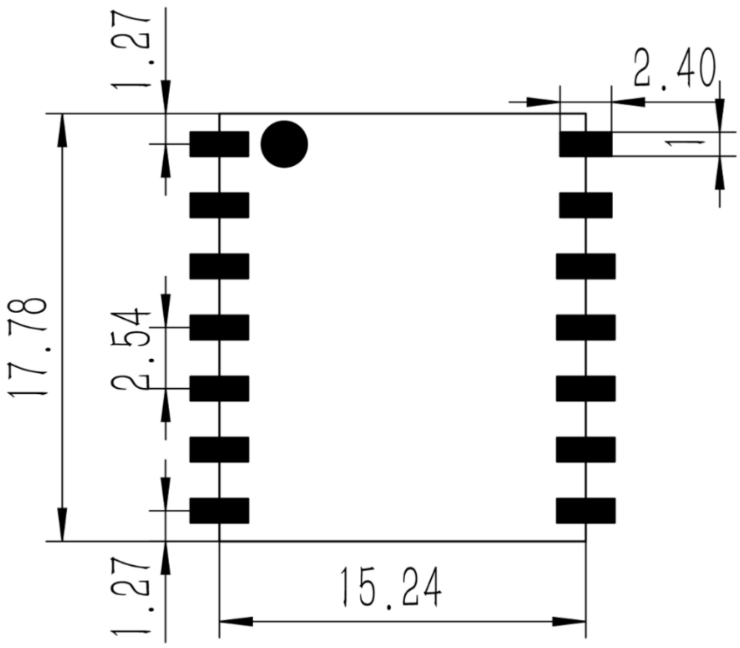


Figure11: *CH010/CH020 Recommended Footprint*

7.14.2 CH040/CH040MP Dimensions

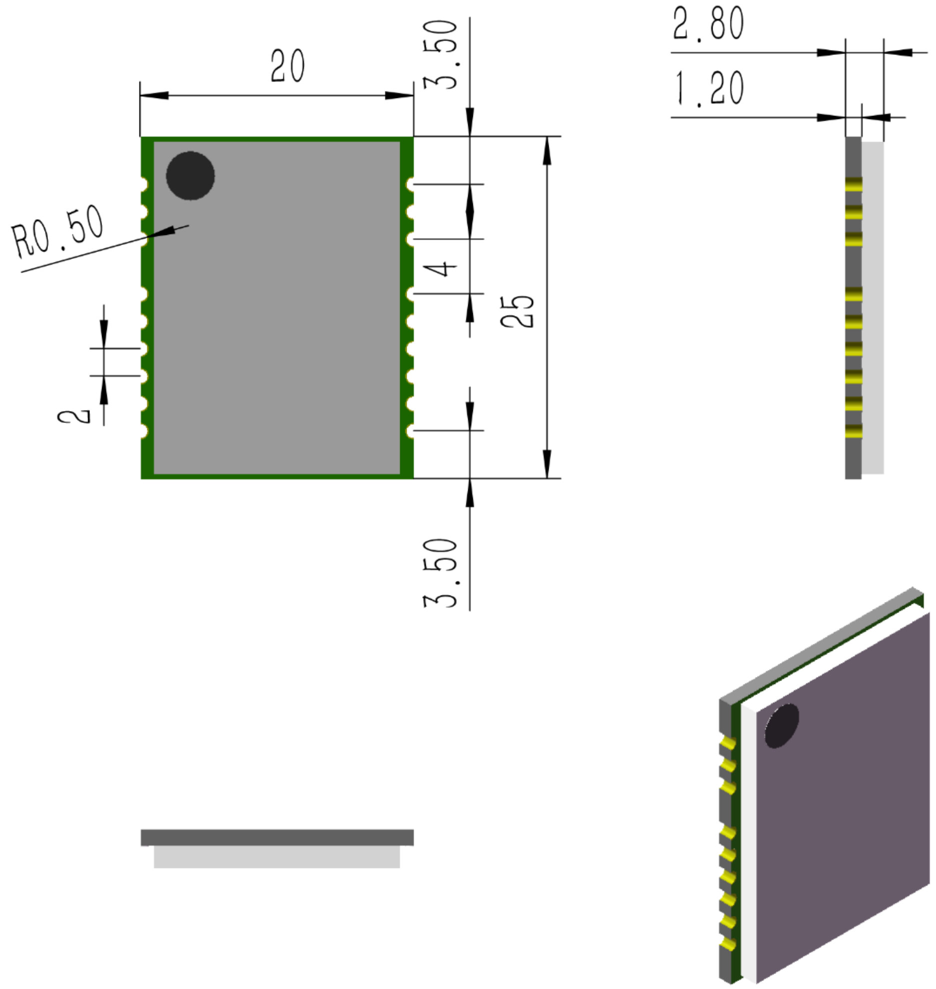


Figure12: *CH040/CH040MP Mechanical Dimension*

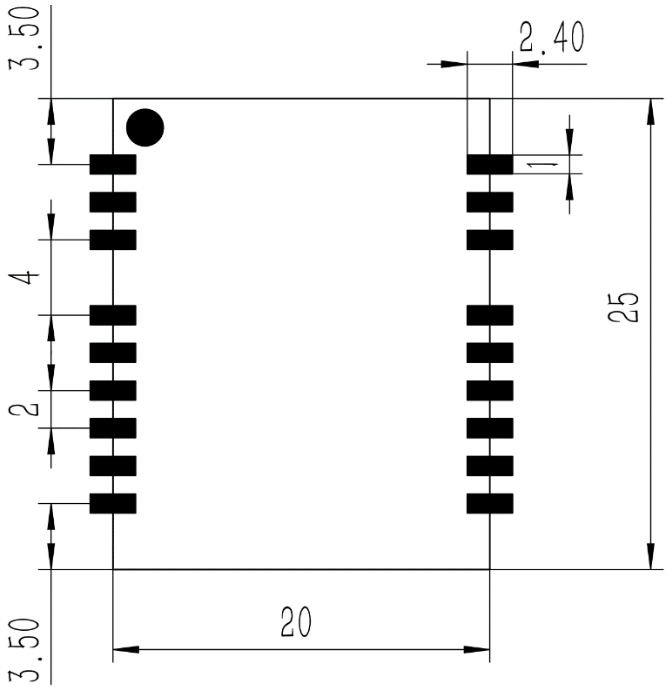


Figure13: *CH040/CH040MP Recommended Footprint*

7.15 Pin Definitions

7.15.1 CH010/CH020 Pin definitions

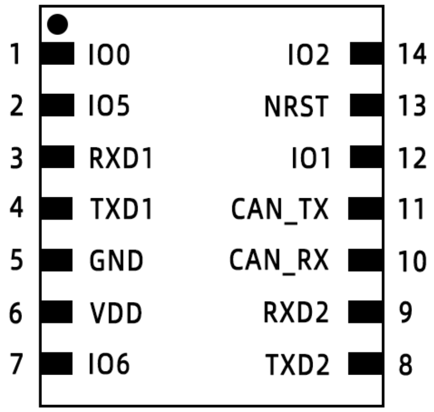


Figure14: *CH010/CH020 Pin Name*

Table 16: CH010/CH020 Pin definitions

Pin Number	Pin Name	Type	Functional			Note
1	IO0	I/O	Reserved, leave floating.			
2,7,12,14	IO5,IO6,IO1,IO2	I/O	PMUX1	SYNC_IN	Synchronization input, can be left floating if not used.	1
			PMUX2	SYNC_OUT	Synchronization output, can be left floating if not used.	
			PMUX3	LED	LED Indicator, can be left floating if not used.	
			PMUX4	SOUT_DIV	Synchronization Output Divider, can be left floating if not used.	
			PMUX5	ALARM	Alarm Signal Output, can be left floating if not used.	
3	RXD1	I	Module UART1 Receive			2
4	TXD1	O	Module UART1 Transmit			
5	GND	POWER	GND			
6	VDD	POWER	Power input 3.3-5V			
8	TXD2	O	Module UART2 Transmit, currently needs to be left floating.			
9	RXD2	I	Module UART2 Receive, currently needs to be left floating.			
10	CAN_RX	I	CAN_RX			3
11	CAN_TX	O	CAN_TX			
13	NRST	I	Reset pin, low level resets the module; can be left floating if not used.			

Note1: Multifunction IO pins; for detailed explanations, refer to the programming manual.

Note2: UART1 is primarily used for data transmission and module configuration.

Note3: To use the CAN function, an external CAN transceiver is required, such as TJA1044GT/3Z.

7.15.2 CH040/CH040MP Pin Definitions

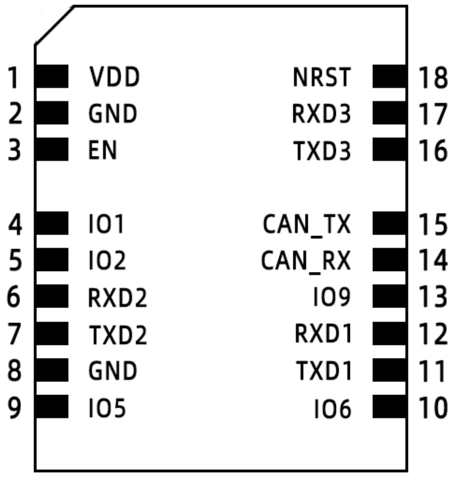


Figure15: *CH040/CH040MP Pin Name*

Table 17: CH040/CH040MP Pin definitions

Pin Number	Pin Name	Type	Description	Note
1	VDD	POWER	Power input3.3-5V	
2	GND	POWER	GND	
3	EN	I	Enable pin, active high, with internal pull-up. The module can be disabled by pulling EN low; if not used, it can be left floating.	
4,5,9,10	IO1,IO2,IO5,IO6	I/O	PMUX1 SYNC_IN Synchronization input, can be left floating if not used. PMUX2 SYNC_OUT Synchronization output, can be left floating if not used. PMUX3 LED LED Indicator, can be left floating if not used. PMUX4 SOUT_DIV Synchronization Output Divider, can be left floating if not used. PMUX5 ALARM Alarm Signal Output, can be left floating if not used.	1,
6	RXD2	I	Module UART2 Receive, currently needs to be left floating.	
7	TXD2	O	Module UART2 Transmit, currently needs to be left floating.	
8	GND	POWER	GND	
11	TXD1	O	Module UART1 Transmit	2
12	RXD1	I	Module UART1 Receive	
13	IO9	I/O	currently needs to be left floating	
14	CAN_RX	I	CAN_RX	3
15	CAN_TX	O	CAN_TX	
16	TXD3	O	Module UART3 Transmit, currently needs to be left floating.	
17	RXD3	I	Module UART3 Receive, currently needs to be left floating.	
18	NRST	I	Reset pin, low level resets the module; can be left floating if not used.	

Note1: Multifunction IO pins; for detailed explanations, refer to the programming manual.

Note2: UART1 is primarily used for data transmission and module configuration.

Note3: To use the CAN function, an external CAN transceiver is required, such as TJA1044GT/3Z.

Table 18: Default functions of IO pins

IO	Function
IO1	PMUX1
IO2	PMUX2
IO5	PMUX3
IO6	PMUX4

8 COORDINATE SYSTEM

8.1 COORDINATE SYSTEM

Carrier system uses the Right-Front-Up (RFU) coordinate system, while the geographical system uses the East-North-Up (ENU) coordinate system. The axes for acceleration and gyroscope are as shown in the following diagram:

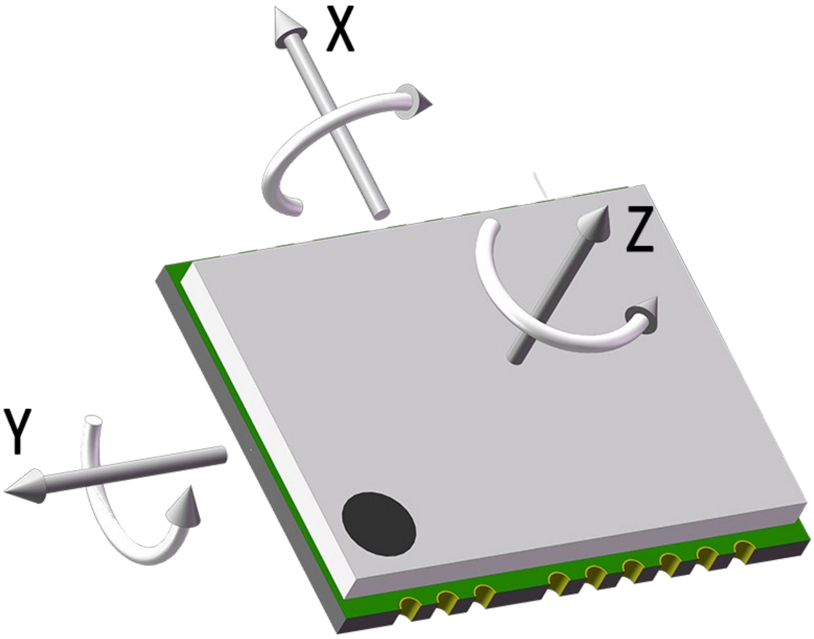


Figure16: *CH0X0 Coordinate System*

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

- Rotate around the Z-axis direction: Heading\psi(ψ) -180° - 180°
- Rotate around the X-axis direction:Pitch\theta(θ) -90°-90°
- Rotate around the Y-axis direction: Roll\phi(ϕ) -180°-180°

If the module is considered as an aircraft, the positive direction of the Y-axis should be considered as the direction of the aircraft's nose. When the sensor system coincides with the inertial system, the ideal output of the Euler angles should be: Pitch = 0°, Roll = 0°, Heading = 0°.

If users need to change the default coordinate system of the sensor, they can refer to the instructions and programming manual.

8.2 IMU mass center position

Table 19: CH0X0 mass center position

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

9 REFERENCE DESIGN

9.1 Power supply

The CH0x0 series is equipped with built-in LDO (Low Dropout Regulator) and power filtering circuits to minimize external power supply noise interference to the internal system. Therefore, users can choose to power the module using LDO/DC-DC within the voltage range of 3.3-5V.

9.2 Serial communication

We recommend users to use the logic level of 3.3V for their processors. If they need to communicate with processors operating at 5V or 1.8V, they will need to add level-shifting chips themselves. To ensure that the communication speed is not affected, we recommend the use of the 74LVCH1T45GW,125 level-shifting chip.

9.2.1 Minimum System Design for Serial Communication

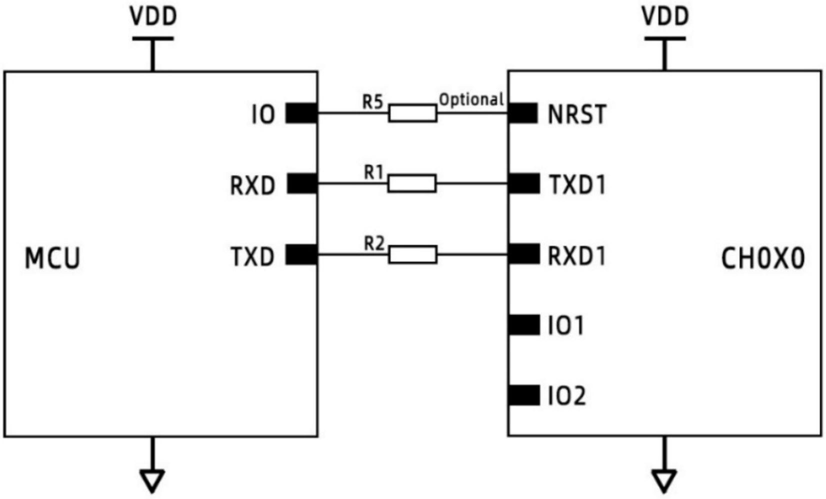


Figure17: *CH0X0 Serial Communication Reference Circuit Diagram*

9.2.2 Serial Communication (IMU and Host Synchronization)

This connection method requires the user to connect IO1/IO2 to the host system for data synchronization. They can be used separately, and the specific choice depends on the user's system design.

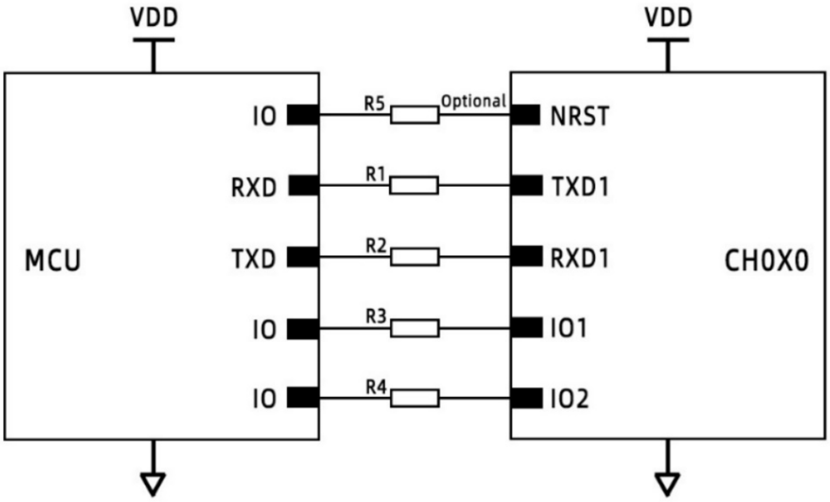


Figure18: *CH0X0 Serial Communication with Synchronization*

Note1: If the user uses IO1, then IO1 should be in synchronous input mode (PMUX1). At this time, the pulses generated by the MCU IO should match the data frame rate. For details, refer to the synchronization function and programming manual.
Note2: If the user uses IO2, then IO2 should be in synchronous output mode (PMUX2). At this time, the pulses received by the MCU IO can either match or differ from the data frame rate. By default, they match and can serve as a Data Ready signal. For details, refer to the synchronization function and programming manual.

9.2.3 Serial Communication (IMU Synchronization with External System)

The CH0X0 series supports synchronization with external systems (cameras/LiDAR). In this case, it is important to ensure that different systems share a common ground.

- Connection Method 1

This connection method requires the IMU to be connected simultaneously to the user's host and the external synchronization device.

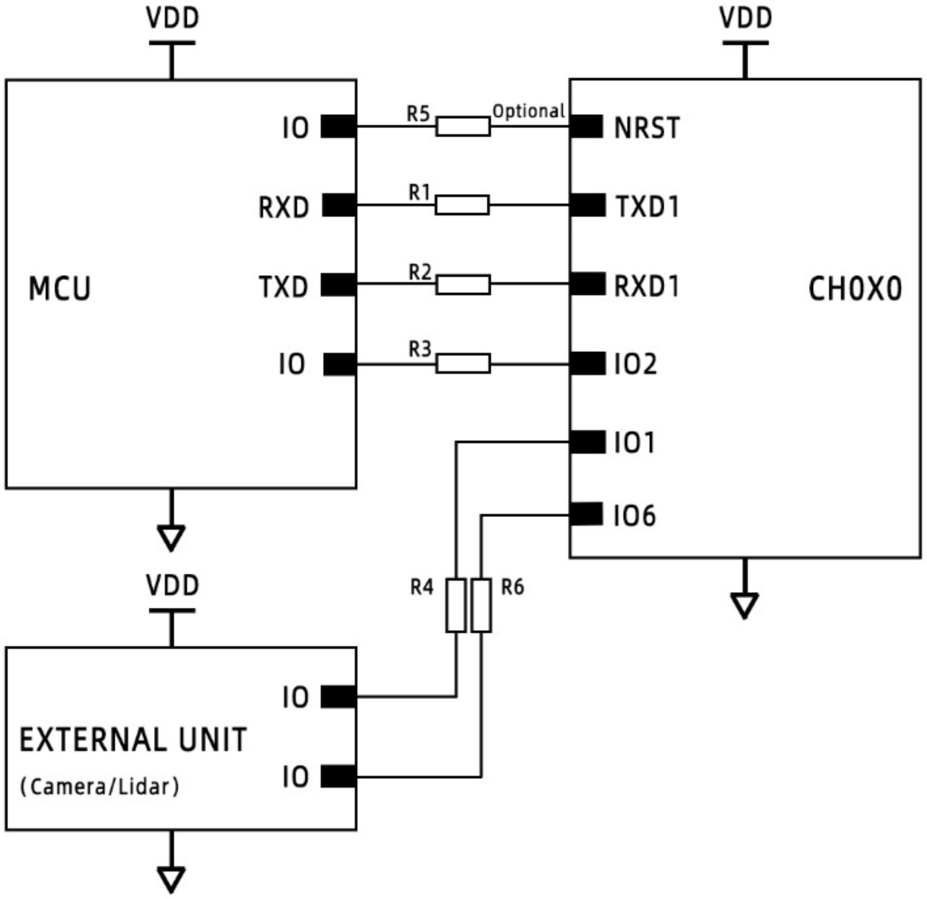


Figure19: *CH0X0 Serial Communication with External System Synchronization 1*

Note1: If the user uses IO2, then IO2 should be in synchronization output function (PMUX2). At this time, the pulses received by the MCU IO will be at the same frequency as the data frame rate and can serve as a Data Ready signal. For details, refer to the synchronization function and programming manual.
Note2: If the user uses IO1, then IO1 should be in synchronization output function (PMUX1). In this case, the pulses generated by the MCU IO should be at the same frequency as the data frame rate. For details, refer to the synchronization function and programming manual.
Note3: If the user uses IO6, then IO6 should be in synchronization output function (SYNC_OUT_DIV) to trigger devices such as cameras/LiDAR. It is important to ensure that the synchronization frequency of IO6 is within the acceptable range for the user's external system.

- Connection Method 2

This connection method only requires the IMU to be connected to the user's external synchronization device.

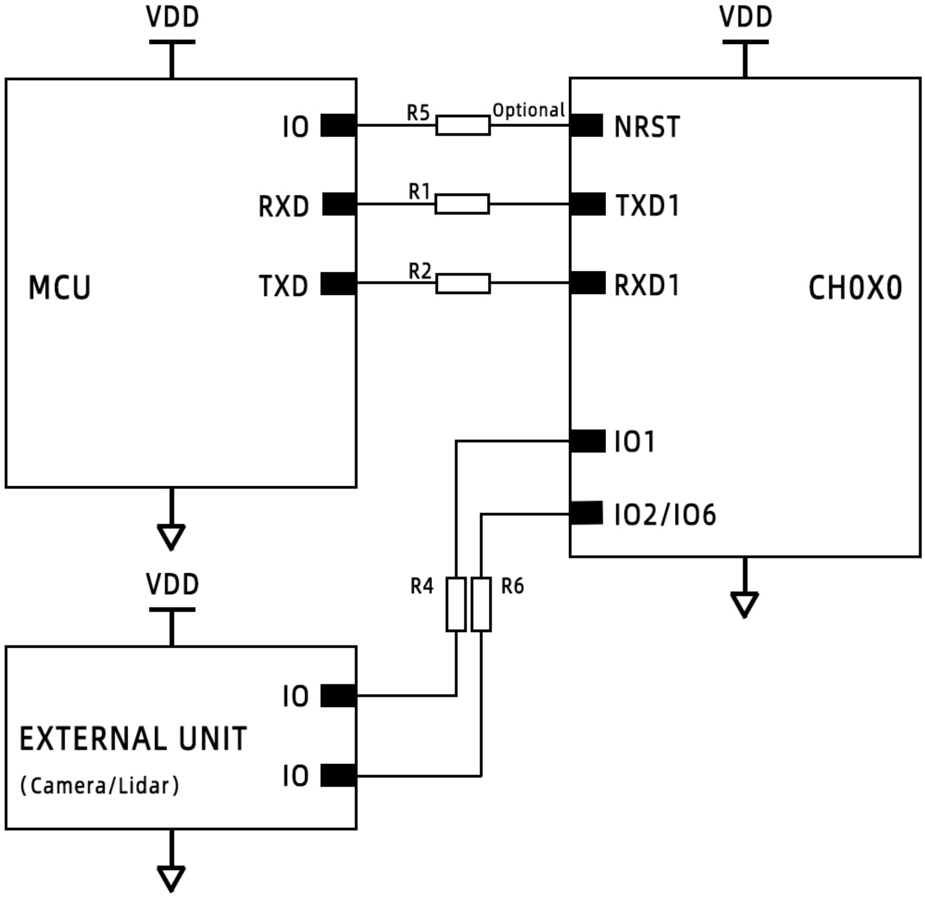


Figure20: *CH0X0 Serial Communication with External System Synchronization 2*

Note1: If the user uses IO1, then IO1 should be in synchronization input function (PMUX1). In this case, the pulses generated by the MCU IO should be at the same frequency as the data frame rate. For details, refer to the synchronization function and programming manual.

Note2: If the user uses IO2/IO6, then IO2/IO6 should be in synchronization output function (PMUX1/PMUX4) to trigger devices such as cameras/LiDAR. It is important to ensure that the synchronization frequency of IO2/IO6 is within the acceptable range for the user's external system.

9.3 CAN communication

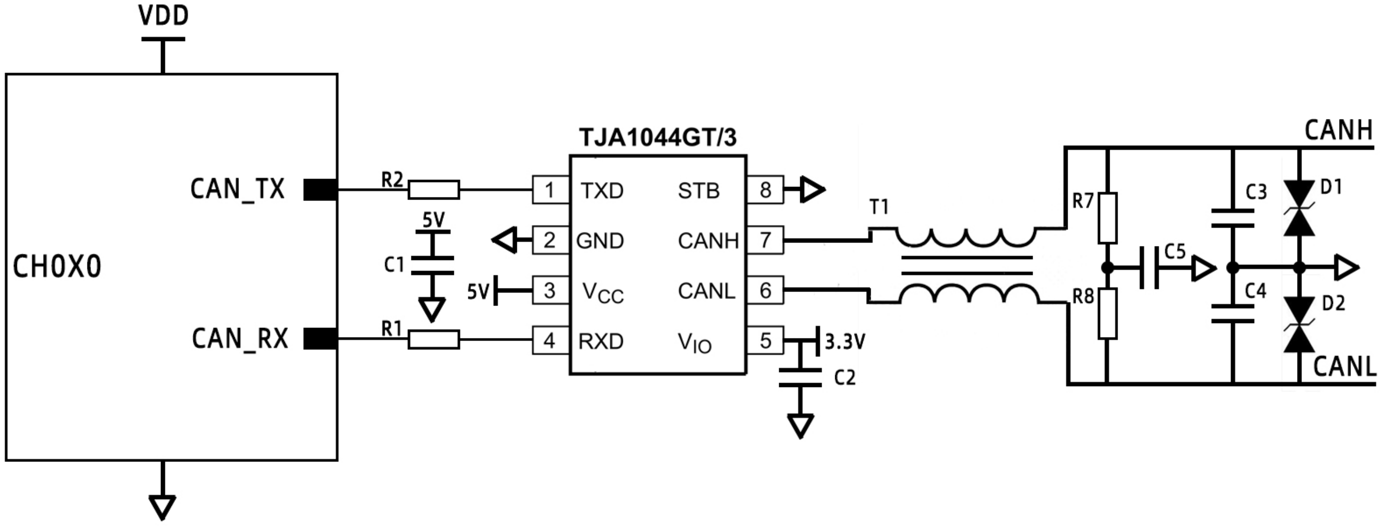


Figure21: *CH0X0 series CAN communication circuit reference*

Note1: R6 and R7 are the CAN bus termination resistors, with a resistance value of 60.4 Ω. Users can consider whether to solder them based on actual conditions.

Table 20: Bom

Item	Reference	Part	P/N	Vendor
Resistor	R1,R2,R3,R4,R5,R6	1K	RC0402JR-071KL	YAGEO
Resistor	R7,R8	60.4Ω	RC1206FR-0760R4L	YAGEO
Capacitor	C1,C2	0.1uF	CC0402KRX5R7BB104	YAGEO
Capacitor	C3,C4	100pF	CC0402JRNPO9BN101	YAGEO
Capacitor	C5	1nF	CC0402KRX7R9BB102	YAGEO
Common Choke	T1	5.8kΩ@10MHz 100uH@100kHz 150mA	ACT45B-101-2P-TL003	TDK
TVS	D1,D2	SMBJ15CA	SMBJ15CA	BORN

10 INITIAL CONFIGURATION

The CH0X0 series is designed with the intention of allowing users to perform minimal configuration to cover the vast majority of application scenarios. Therefore, the default configuration can meet many operational conditions, but we also provide users with additional configuration options to address special situations.

10.1 Interface initial configuration

Table 21: Interface initial configuration

Interf	Parameters	Value	Unit	Note
UART	Baud	115200	bps	1
	Start bit	1	bit	
	Data Length	8	bits	
	Stop Bit	1	bit	
	Parity Bit	None		
	Protocol	Binary Protocol (91)		2
	Data Frame Rate	100	Hz	3
CAN	Protocol	CANopen		2
	Baud	500K	bps	1
	Data Frame Rate	100	Hz	3

Note1: For changing the baud rate, please refer to the instruction and programming manual.

Note2: For changing the protocol, please refer to the instruction and programming manual.

Note3: For changing the output frame rate, please refer to the instruction and programming manual.

10.2 Sensor initial configuration

Table 22: Sensor initial configuration

Parameters	Value	Unit	Note
Gyroscope range	±2000	°/s	1
3dB Bandwidth	47	Hz	1
Accelerometer range	±12	g	1
3dB Bandwidth	145	Hz	1
Magnetometer range	±2	Gauss	1
Mode	6DOF		1

Note1: For changing parameters such as range, bandwidth, and mode, please refer to the instruction and programming manual.

11 COMMUNICATION PROTOCOL

11.1 Binary protocol

To facilitate user usage, we provide a variety of serial protocols for users to choose from. For more detailed information, please refer to the instruction and programming manual.

11.2 Modbus

The RS485 communication protocol follows the Modbus RTU protocol specification. Data is transmitted and received in units of registers, with each register occupying 2 bytes. It uses big-endian mode (high byte first). For detailed protocol information, please refer to the instruction and programming manual.

11.3 CAN

11.3.1 CANopen

The CAN interface complies with the CANopen protocol, where all communication uses standard data frames. Data is transmitted using TPDO1-7. Remote frames and extended data frames are not received/sent. All TPDOs use asynchronous timed-trigger mode. For detailed protocol information, please refer to the instruction and programming manual.

11.3.2 J1939

The module default output protocol is CANopen. If you require the SAE J1939 protocol, please contact us.

12 SYNCHRONIZATION

If the user's system includes multiple subsystems, such as LiDAR and cameras, data synchronization between the systems becomes extremely important. Our IMU supports synchronized pulse input and output, making it more convenient for users during operation.

Note1: The IMU and the external synchronization system need to share a common ground.

12.1 External system triggering the IMU

Synchronized Pulse Input (SYNC_IN): Pull-up input, with a high level in the idle state. When the module detects a falling edge, it will output a frame of data. At this time, the module should be in synchronized trigger mode, also known as ONMARK mode.

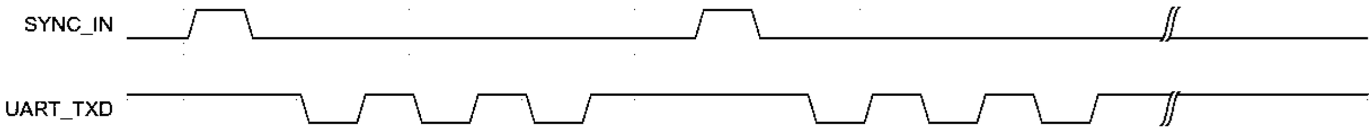


Figure22: *Sync_In Timing*

12.2 IMU triggering external systems (SYNC_OUT/SYNC_OUT_DIV)

The data synchronization output can serve as a pin for the IMU to trigger external systems, such as cameras and LiDAR. This pin is set to output mode by default, and when there is no data output, it remains at a low level (idle).

The IMU synchronization output pin can operate in a mode that matches the data output frequency, acting as a Data Ready signal, or it can work at a different frequency through a division factor.

12.2.1 Synchronized output pulse at the same frequency as data output

When a frame of data begins to be sent, a high pulse is generated on the SYNC_OUT pin, with a pulse width of 80 μs. Therefore, if the module outputs data at 100 Hz, there will be 100 corresponding synchronized pulses.

Example: The module outputs data at 100 Hz, and the SYNC_OUT pin outputs a 100 Hz pulse signal. Example of synchronized output waveform:

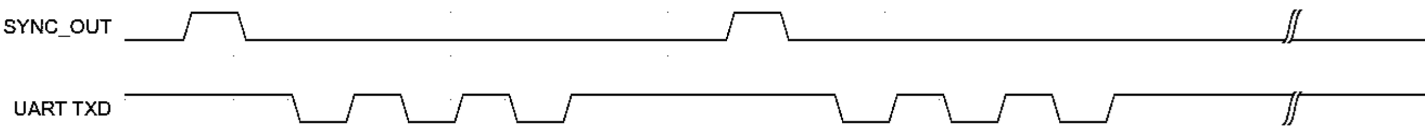


Figure23: *Sync_Out Timing*

12.2.2 Synchronized output pulse at a different frequency from data output

If the user's system requires the synchronized output pin to operate at a different frequency from the data output, this can be achieved by configuring the division factor. For specific configurations, please refer to the instruction and programming manual.

Example: The module outputs data at 100 Hz, and the SYNC_OUT pin outputs a 50 Hz pulse signal. Example of synchronized output waveform:

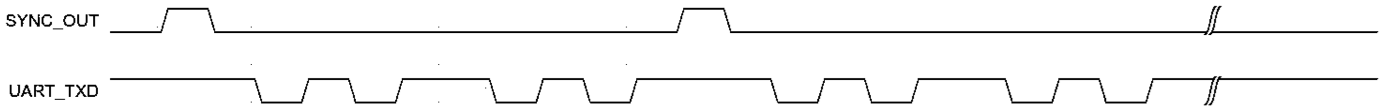


Figure24: *Sync_Out Division Timing*

Note1: SYNC_OUT_DIV is set to an 8-fold division of SYNC_OUT by default. If a different division is needed, users should refer to the instruction and programming manual to make changes.

12.3 Synchronized timestamp

The IMU can output a PPS synchronized timestamp. The PPS synchronized timestamp refers to the time elapsed from when the module detects the most recent falling edge signal to the current frame of data sampling.

Note1: For instructions on how to configure it for ONMARK triggering, please refer to the instruction and programming manual.

13 SMT AND INSTALLATION

13.1 Soldering curve

The recommended soldering curve is shown below, with a peak temperature reaching 250℃. Generally, it is not advisable for users to manually solder the module, as it may affect the module's accuracy.

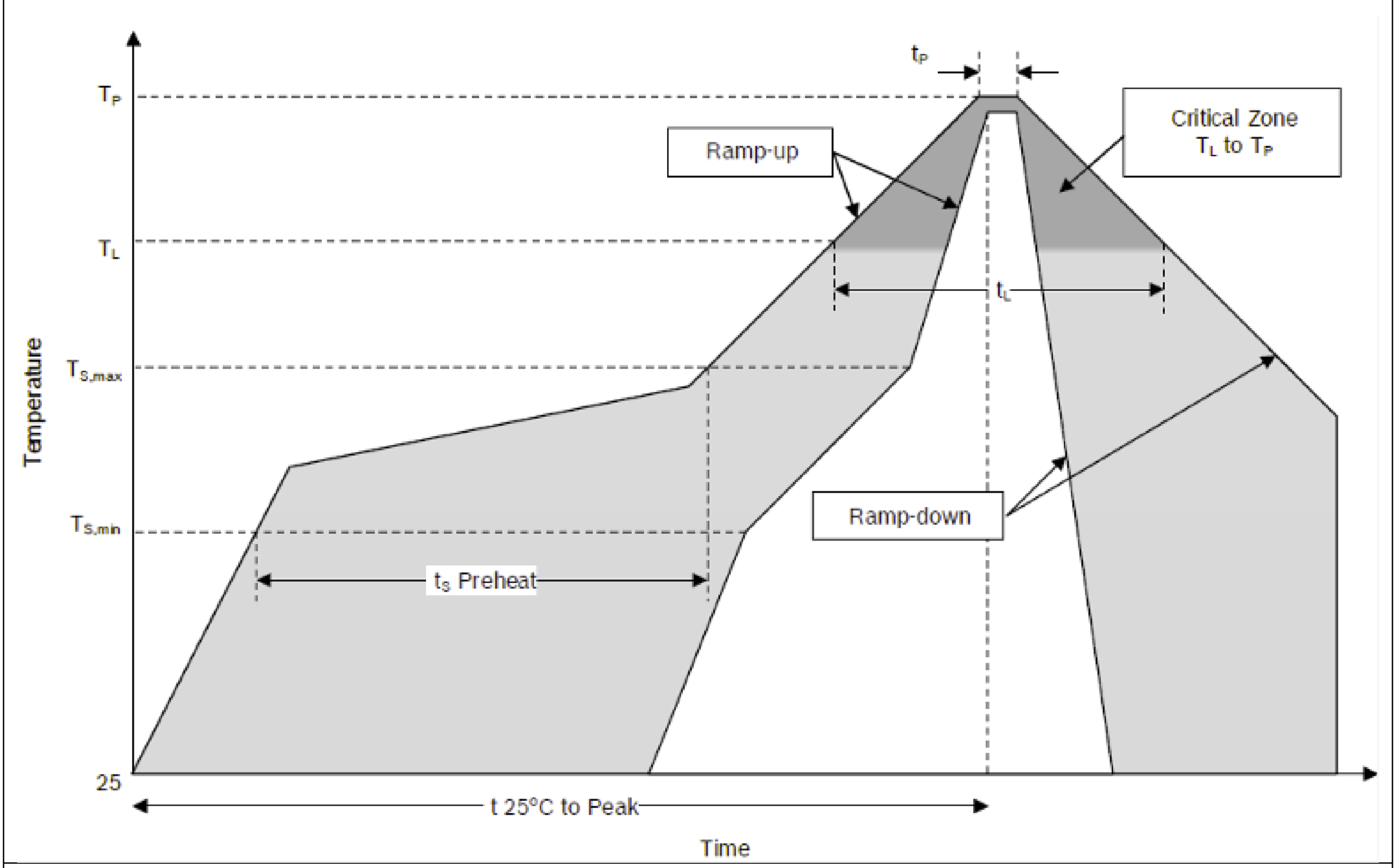


Figure25: *SMT temperature curve*

Table 23: Soldering curve parameters

参数	说明
Average ramp-up rate (T_{Smax} to T_p)	3℃/s max
Temperature min (T_{Smin})	150℃
Temperature max (T_{Smax})	200℃
Time (TSmin to T_{Smax})	60-180s
Temperature (T_L)	170℃
Time (t_L)	60-150s
Peak classification temperature (T_P)	250℃
Time within 5 ℃ of actual peak temperature (t_p)	20-40s
Ramp-down rate	6℃/min max
Time 25℃ to peak temperature	8min max

13.2 Installation recommendations

Generally , MEMS sensors are high-precision measurement devices composed of electronic and mechanical structures. 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.
- It is not advisable to place the sensor directly below or next to the button contacts, as this can cause mechanical stress.
- It is not advisable to place the sensor near high-temperature hotspots (such as controllers or graphics chips), as this can cause the PCB to heat up, leading to sensor overheating. It is also not recommended to place the sensor near areas of maximum mechanical stress (e.g., at the center of diagonal intersections), as mechanical stress can cause bending of the PCB and sensor.
- It is not advisable to install the sensor too close to screw holes. Avoid placing the sensor in areas of the PCB where resonance (vibration) may occur or is expected.

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

14 PACKAGE

14.1 Tape Dimension

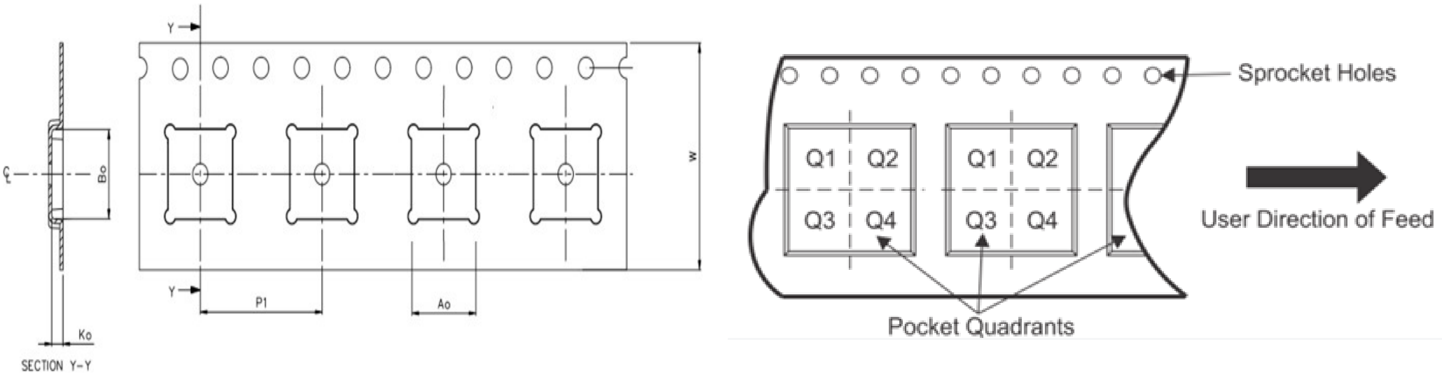


Figure26: *Tape Dimension and pin 1*

Table 24: Tape Dimension Information

Device	A0(mm)	B0(mm)	K0(mm)	P1(mm)	W(mm)
CH010/CH020	16.5	20	3.5	20	32
CH040/CH040MP	23	28	3.5	28	44

14.2 Reel Dimension

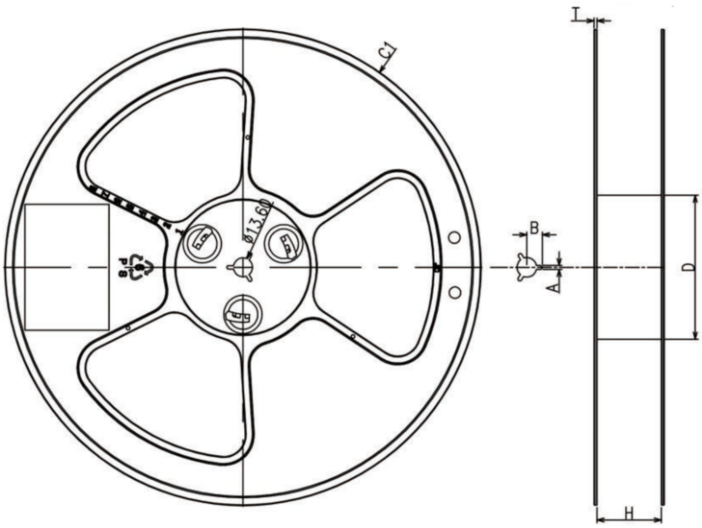


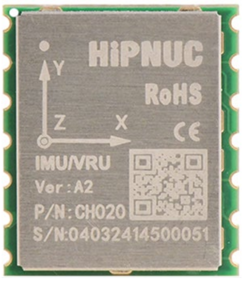
Figure27: *Reel Dimension*

Table 25: Reel Dimension Information

Device	SPQ(PCS)	Reel Diameter C1(mm)	Reel Width H(mm)	A(mm)	B(mm)	T(mm)	D(mm)
CH010/CH020	1000	330	32.8	2.5	11	2.0	100
CH040/CH040MP	500	330	44.8	2.5	11	2.0	100

14.3 Box

The CH0X0 series is packaged in standard cardboard boxes



CH0X0

Reel

Vacuumize

Box

Table 26: Box dimensions

Device	SPQ(PCS)	L(mm)	W(mm)	H(mm)
CH010/CH020	1000	360	360	40
CH040/CH040MP	500	360	360	55

