



V1.1

(wearable) AHRS IMU Gyroscope

**IMU100-BL**

**Technical Manual**

## **IMU100-BL AHRS IMU Gyroscope**

- Revision date: 2025-6-23

Note: Product functions, parameters, appearance, etc. will be adjusted as technology upgrades. Please contact our sales to confirm when purchasing.

### **Disclaimer**

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## ► PRODUCT INTRODUCTION

IMU100-BL is a cost-effective AHRS (micro-attitude reference system) that can be widely used in equipment that requires high dynamic balance, such as model aircraft, drones, robots, agricultural machinery, engineering vehicles, forklifts, etc. The device collects sensor data, integrates Kalman filtering, and outputs real-time attitude data. Due to the use of three-axis accelerometers and three-axis magnetic sensors to assist three-axis gyroscopes and temperature compensation algorithm technology, the product achieves excellent stability and real-time performance in all attitudes and is widely used in various sports attitude monitoring fields. This product can not only output attitude data, but also output three-axis acceleration, three-axis gyroscope and three-axis magnetic field 9-axis data. At the same time, it can modify and expand system operating parameters and is suitable for various application platforms. This product uses on-chip flash IAP (in application program) technology, which can maintain user parameters according to user needs and can still remember after power failure. Data output uses USB2.0 and Bluetooth wireless output, Bluetooth 5.1 wireless transmission module, BLE protocol. The integrated 2.4GHz adaptive frequency hopping technology can achieve 40-meter line-of-sight transmission (unobstructed environment), firmware upgrades, and multi-device networking synchronization, significantly improving the flexibility of industrial site deployment and facilitating secondary development and utilization by users.

## ► KEY FEATURES

- ★ Integrated nine-axis sensor and temperature sensor
- ★ Bluetooth 5.1 wireless transmission      ★ Kalman filtering algorithm
- ★ High performance drift stability      ★ DC 3.0-4.2 V Power Supply      ★ Light weight
- ★ Long life, strong stability      ★ Excellent vibration performance
- ★ 100Hz update rate      ★ Compact and lightweight design      ★ USB2.0 output
- ★ Wide temperature range      ★ Low noise      ★ Real-time 3D Dynamic Measurement

## ► APPLICATIONS

- ★ Medical rehabilitation equipment monitoring      ★ Limb rehabilitation monitoring
- ★ Human body capture      ★ Posture angle monitoring



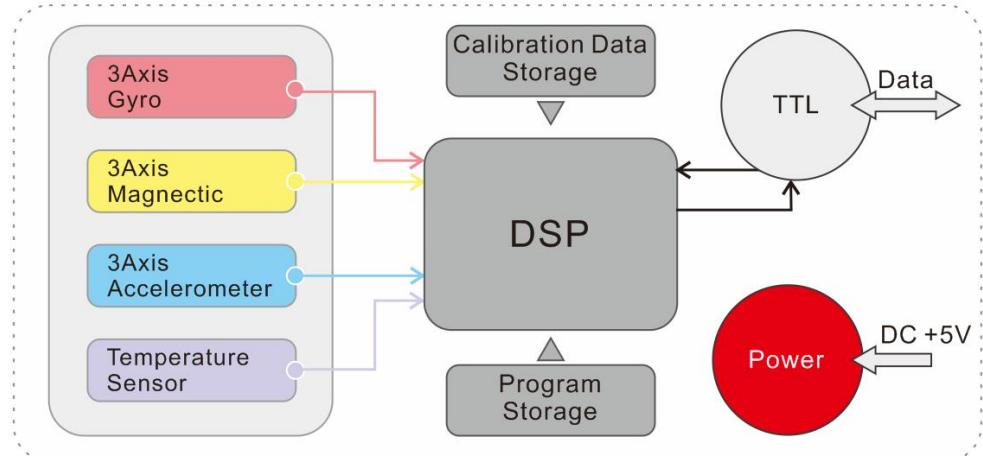
► **SPECIFICATIONS**

IMU100-BL

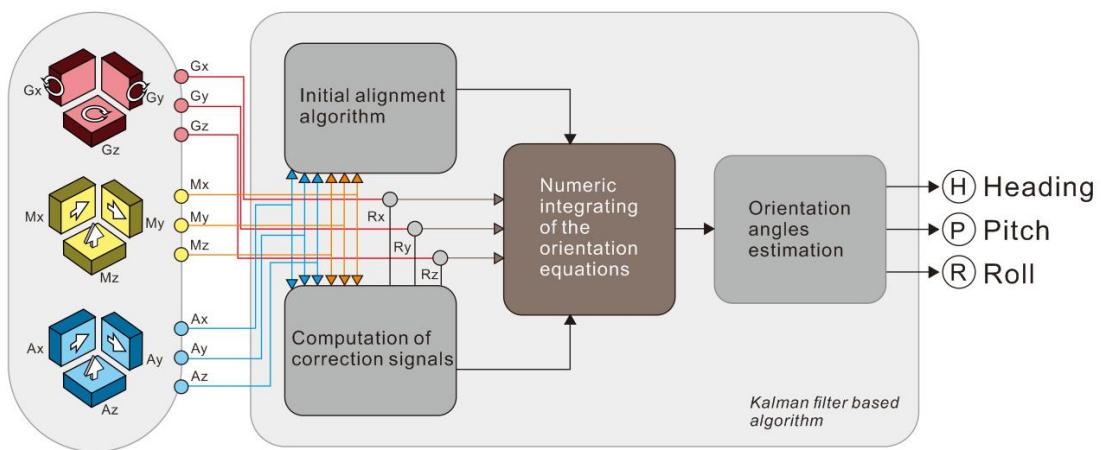
parameters

Azimuth	Measuring range	± 180 ° (optional for gyro and magnetic azimuth)
	Measurement accuracy (RMS) @ 25 °C	< 1.5 ° (without magnetic interference)
	Resolution	<0.1°
Inclination	Measuring range	Roll ± 180 °, Pitch ± 90 °
	Measurement accuracy (RMS) @ 25 °C	< ± 0.5 ° (dynamic), < ± 0.2 ° (static)
	Resolution	<0.1°
Gyroscope	Measuring range	±500°/sec
	Zero deviation stability @ 25 °C	<20°/hr
	Resolution	<0.1°/sec
	Bandwidth	>100Hz
Accelerometer	Measuring range	±8g
	Resolution	<10mg
	Bandwidth	>100Hz
Magnetic field meter	Measuring range	±8gauss
	Resolution	<2.5mgauss
	Bandwidth	14-17Hz
Electrical connection	Supply voltage	DC 3.0-4.2V
	Power consumption	50mA (typical)
	Output interface	USB2.0
	Operating temperature	-5°C~55°C
	Storage temperature	-10°C~+55°C
MTBF		≥ 98,000 hours/time
Impact resistance		100g @ 11ms, triaxial (half sine wave)
Vibration resistance		10grms / 10~1000Hz
Waterproof grade		IP65
Connector		Type-C connector
Weight		≤ 35g (excluding cable)

► WORKING PRINCIPLE

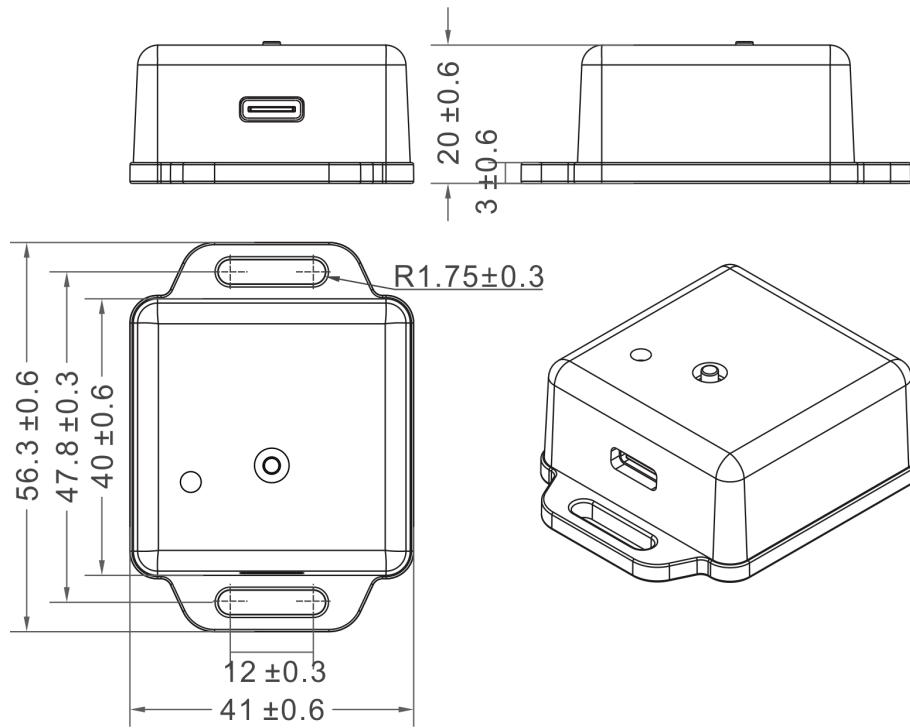


The IMU100-BL attitude heading reference integrates a three-axis gyroscope, a three-axis acceleration and a three-axis magnetic field meter, combines a Kalman filtering algorithm and an acceleration correction angular velocity initial attitude principle, corrects and determines the drift of the gyroscope in the horizontal direction (pitch angle and roll angle), Finally, the azimuth angle, pitch angle and roll angle of the moving carrier are calculated by nine-axis operation. The operation mode is divided into 6-axis and 9-axis. The 6-axis mode adopts the fusion algorithm of three-axis acceleration and three-axis gyroscope to dynamically output the real-time attitude angle, in which the azimuth angle is integrated by the gyroscope and is used to measure the relative azimuth angle. The 9-axis mode adds a three-axis magnetic field to the 6-axis mode, and the output azimuth is the magnetic azimuth (note: this application should avoid the environmental interference of magnetic objects such as iron).



IMU100-BL 9-axis heading module software block diagram

► DISIONAL DRAWING



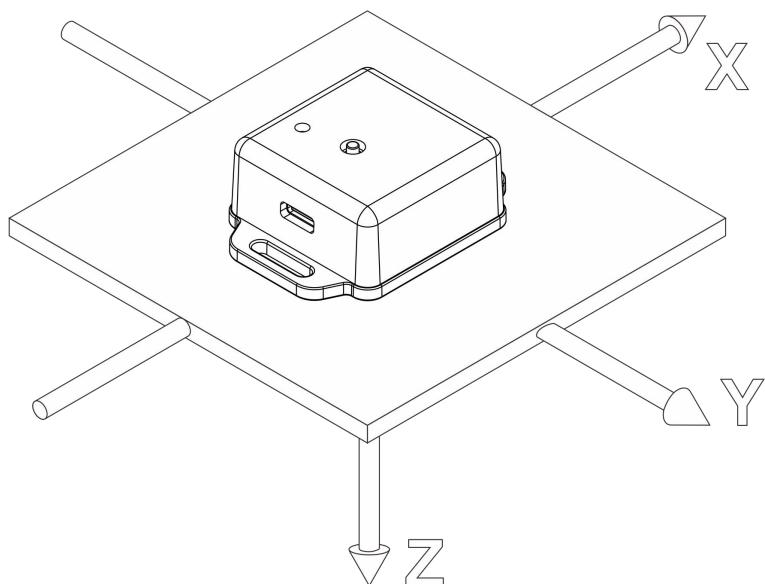
Shell size: L56.3 × W41 × H20mm  
Installation size: L47.8 × W12 × H3mm

Mounting screws: 2 M3 screws or Velcro retractable strap

► MEASUREMENT DIRECTION

Please install the tilt sensor according to the correct method. Incorrect installation will lead to measurement errors. Pay special attention to one "surface" and two "lines".

- 1) The installation surface of the sensor and the measured surface must be fixed tightly, flatly and stably. If the installation surface is uneven, it is easy to cause the sensor measurement angle error.
- 2) The axis of the sensor must be parallel to the axis of the object to be measured, and the two axes should not form an angle as far as possible.



## ► FUNCTION DESCRIPTION



NO/OFF button: press the button to start the machine and press the button to shut down the machine;

1. Indicator status:

**Red light flashes quickly:** The red LED flashes quickly when the device is turned on, indicating that it is connected to the Bluetooth host.

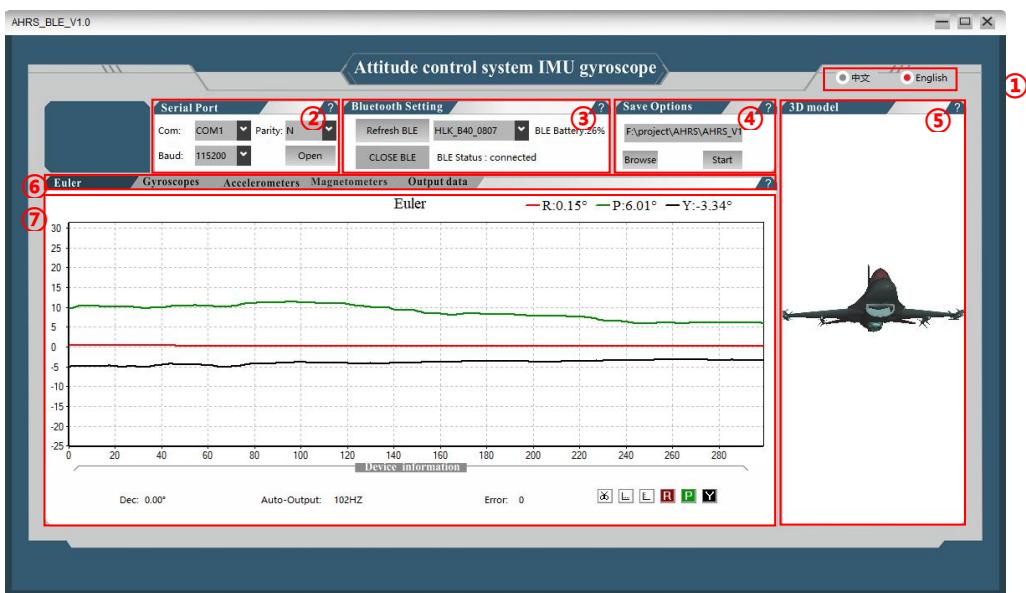
**Red light is always on:** The red LED is always on after connecting to the host.

**Red light flashes slowly:** The red LED flashes slowly when the battery is low, and the device automatically shuts down after 30 seconds.

**Green light is always on:** The green light is always on when charging.

2. Type-C charging port: It is recommended to use 5V charging plug. The charging time is about 4 hours, and the theoretical working time is 8 hours.

## ► INTRODUCTION TO THE UPPER COMPUTER INTERFACE



- ① Chinese-English switch button: select the required language and restart to take effect.
  - ② Serial port setting: Select the corresponding port, the default baud rate is 115200, and there is no parity bit.
  - ③ Bluetooth settings: Click Refresh Bluetooth device, select the Bluetooth device to be connected, and then click the Open Bluetooth button. The lower right corner shows the Bluetooth connection status and the power of the Bluetooth device.
  - ④ Save option: Click "Browse" to set the path for saving data, and click "Start" to save data.
  - ⑤ 3D model: The aircraft model is synchronized with the connected product, and the attitude can be viewed in real time.
  - ⑥ Switching to view the required data oscilloscope and data: Switching to view the required data oscilloscope and data.
  - ⑦ Waveform display: real-time output data waveform.
- \* For detailed instructions of the upper computer, please refer to the upper computer operation manual.

## ► COMMUNICATION PROTOCOL

\* The communication protocol of IMU100-BL is used for Bluetooth and USB2.0, and the protocol for modifying the baud rate is only applicable to USB2.0.

**Default parameters: baud rate: 115200bps; output frequency: 100Hz; output data: Euler angle + sensor; Operation mode 6-axis.**

**Data frame format:**

Sync1	'T'
Sync2	'M'
Class	1Byte data frame class
ID	1Byte data frame ID
Length	Length of the Data(2 Byte) Byte excluding sync, class, ID, length and Checksum domain
Data	The length of the data field varies according to the Class and ID.
Checksum	2Byte CRC16 Checksum

Frame header Sync1, Sync2: frame start synchronization word, all data frames start from the 'T' 'M' of 2 synchronization characters.

Class field: 1 Byte. Defines the type of data frame.

ID field: 1 Byte, which defines the frame function ID.

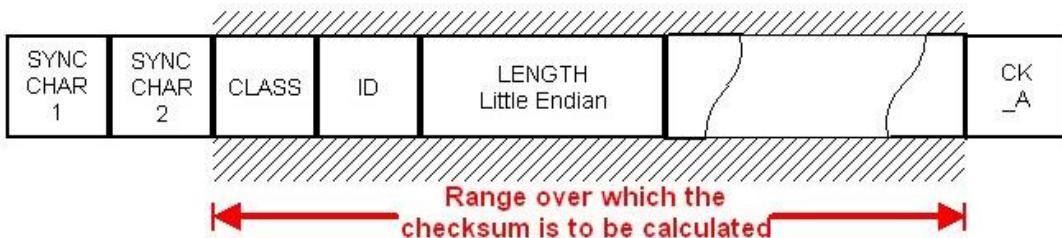
Length field: 2 Byte, which defines the byte length of the Data field, excluding the frame synchronization word. Class field, ID field and Checksum field: double-byte unsigned integer, little-endian mode, low byte first, high byte last.

Data domain: data part, variable length, content is determined by Class and ID domains.

Check sum field: double-byte unsigned integer, little-endian mode, low byte first, high byte last.

The calculation method is as follows.

Check sum calculation:



The checksum operation is a 16-bit CRC validation that includes only the CLASS, ID, LENGTH, and DATA sections.

```
INT16U const CRC16Table[256] = {
    0x0000, 0xC0C1, 0xC181, 0x0140, 0xC301, 0x03C0, 0x0280, 0xC241,
    0xC601, 0x06C0, 0x0780, 0xC741, 0x0500, 0xC5C1, 0xC481, 0x0440,
    0xCC01, 0x0CC0, 0xD80, 0xCD41, 0xF00, 0xCFC1, 0xCE81, 0xE40,
    0xA00, 0xCAC1, 0xCB81, 0xB40, 0xC901, 0x9C0, 0x0880, 0xC841,
    0xD801, 0x18C0, 0x1980, 0xD941, 0x1B00, 0DBC1, 0xDA81, 0x1A40,
    0xE00, 0xDEC1, 0xDF81, 0xF40, 0xDD01, 0xDC0, 0x1C80, 0xDC41,
    0x1400, 0xD4C1, 0xD581, 0x1540, 0xD701, 0x17C0, 0x1680, 0xD641,
    0xD201, 0x12C0, 0x1380, 0xD341, 0x1100, 0xD1C1, 0xD081, 0x1040,
    0xF001, 0x30C0, 0x3180, 0xF141, 0x3300, 0xF3C1, 0xF281, 0x3240,
    0x3600, 0xF6C1, 0xF781, 0x3740, 0xF501, 0x35C0, 0x3480, 0xF441,
```

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```
0x3C00, 0xFCC1, 0xFD81, 0x3D40, 0xFF01, 0x3FC0, 0x3E80, 0xFE41,  
0xFA01, 0x3AC0, 0x3B80, 0xFB41, 0x3900, 0xF9C1, 0xF881, 0x3840,  
0x2800, 0xE8C1, 0xE981, 0x2940, 0xEB01, 0x2BC0, 0x2A80, 0xEA41,  
0xEE01, 0x2EC0, 0x2F80, 0xEF41, 0x2D00, 0xEDC1, 0xEC81, 0x2C40,  
0xE401, 0x24C0, 0x2580, 0xE541, 0x2700, 0xE7C1, 0xE681, 0x2640,  
0x2200, 0xE2C1, 0xE381, 0x2340, 0xE101, 0x21C0, 0x2080, 0xE041,  
0xA001, 0x60C0, 0x6180, 0xA141, 0x6300, 0xA3C1, 0xA281, 0x6240,  
0x6600, 0xA6C1, 0xA781, 0x6740, 0xA501, 0x65C0, 0x6480, 0xA441,  
0x6C00, 0xACC1, 0xAD81, 0x6D40, 0xAF01, 0x6FC0, 0x6E80, 0xAE41,  
0xAA01, 0x6AC0, 0x6B80, 0xAB41, 0x6900, 0xA9C1, 0xA881, 0x6840,  
0x7800, 0xB8C1, 0xB981, 0x7940, 0xBB01, 0x7BC0, 0x7A80, 0xBA41,  
0xBE01, 0x7EC0, 0x7F80, 0xBF41, 0x7D00, 0xBD1, 0xBC81, 0x7C40,  
0xB401, 0x74C0, 0x7580, 0xB541, 0x7700, 0xB7C1, 0xB681, 0x7640,  
0x7200, 0xB2C1, 0xB381, 0x7340, 0xB101, 0x71C0, 0x7080, 0xB041,  
0x5000, 0x90C1, 0x9181, 0x5140, 0x9301, 0x53C0, 0x5280, 0x9241,  
0x9601, 0x56C0, 0x5780, 0x9741, 0x5500, 0x95C1, 0x9481, 0x5440,  
0x9C01, 0x5CC0, 0x5D80, 0x9D41, 0x5F00, 0x9FC1, 0x9E81, 0x5E40,  
0x5A00, 0x9AC1, 0x9B81, 0x5B40, 0x9901, 0x59C0, 0x5880, 0x9841,  
0x8801, 0x48C0, 0x4980, 0x8941, 0x4B00, 0x8BC1, 0x8A81, 0x4A40,  
0x4E00, 0x8EC1, 0x8F81, 0x4F40, 0x8D01, 0x4DC0, 0x4C80, 0x8C41,  
0x4400, 0x84C1, 0x8581, 0x4540, 0x8701, 0x47C0, 0x4680, 0x8641,  
0x8201, 0x42C0, 0x4380, 0x8341, 0x4100, 0x81C1, 0x8081, 0x4040  
};
```

```
INT16U CRC16(INT8U *p, INT16U length)  
{  
    INT16U checksum = 0;  
    for( ; length > 0; length-- )  
    {  
        checksum = ( checksum >> 8 ) ^ CRC16Table[ (checksum&0xFF) ^ *p ];  
        p++;  
    }  
    return checksum;  
}
```

Set the communication baud rate (**0x0c 0x02**):

Host sends:

Message	Set the communication baud rate				
Description	Set the communication baud rate				
Transmissio n direction	Command				
Message Structure	Header 'T'M'	Class, ID 0x0C, 0x02	Length(1)	Data (Length)Byte	Checksum
Data Contents:					

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Byte Offset	No. Format		Name	Unit	Comment
0	INT8U	-	Baud rate	-	3: 9600 4: 14400 5: 19200 6: 28800 7: 38400 8: 56000 9: 57600 <b>10: 115200</b>

Slave reply:

Message	Set the communication baud rate				
Description	Set the communication baud rate				
Transmission direction	Respond				
Message Structure	Header 'T'M'	Class, ID 0x0c, 0x02	Length(0)	Data (Length )Byte	Checksum

Example: Set the baud rate to the 115200:

TX: 54 4D 0C 02 01 00 0A C0 7E

RX: 54 4D 0C 02 00 00 XX XX

Set the data output frequency (**0x0f 0x15**):

Host sends:

Message	Set the data output frequency				
Description	Set the data output frequency				
Transmission direction	Command				
Message Structure	Header 'T'M'	Class, ID 0x0f, 0x15	Length(1)	Data (Length)Byte	Checksum
Data Contents:					
Byte Offset	No. Format	Scaling	Name	Unit	Comment
0	INT8U	-	Data output Frequency	-	0: 1HZ 1: 5HZ 2: 10HZ 3: 25HZ 4: 50HZ <b>5: 100HZ</b>

Slave reply:

Message	Data output frequency				
Description	Data output frequency				
Transmission direction	B Response				
Message Structure	Header 'T' 'M'	Class, ID 0x0f, 0x15	Length(0)	Data (Length)Byte	Checksum

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Set the output data type (**0x0f 0x25**):

Host sends:

Message	Output data type				
Description	Output data type				
Transmission direction	Command				
Message Structure	Header 'T' 'M'	Class, ID 0x0f, 0x25	Length(1)	Data (Length )Byte	Checksum
<b>Data Contents:</b>					
Byte Offset	Number Format	Scaling	Name	Unit	Comment
0	INT8U	-	Data output mode	-	<b>0: Euler angle + 9-axis data</b> 1: Euler angle + 9-axis data (body acceleration) 2: Euler angle

Slave reply:

Message	Output data type				
Description	Output data type				
Transmission direction	B Response				
Message Structure	Header 'T' 'M'	Class, ID 0x0f, 0x25	Length(0)	Data (Length )Byte	Checksum

0: Euler angle + 9-axis data: normal operation mode, data output is Euler angle and sensor value.

1: Euler angle + 9-axis data (body acceleration): The data output is the output of the Euler angle and the linear acceleration after removing the gravity acceleration, and the others are the same as the **0: Euler angle + sensor** mode.

2: Euler angle: Compared with the **1: Euler angle + body acceleration** mode, the payload only has the Euler angle, and the sensor value is not included in the data segment, which is suitable for the case of low baud rate and high frequency data packet output.

**Set the operating mode (0x0f 0x24):**

Host sends:

Message	Operation mode				
Description	Operation mode				
Transmission direction	Command				
Message Structure	Header 'T' 'M'	Class, ID 0x0f, 0x24	Length(1)	Data (Length )Byte	Checksum
<b>Data Contents:</b>					
Byte Offset	No. Format	Scaling	Name	Unit	Comment
0	INT8U	-	Running mode	-	<b>1:6 axis</b> 2:9 axis

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Slave reply:

Message	Operation mode				
Description	Operation mode				
Transmission direction	B Response				
Message Structure	Header 'T' 'M'	Class, ID 0x0f, 0x24	Length(0)	Data (Length )Byte	Checksum

Magnetic azimuth horizontal calibration start (**0x0f, 0x16**):

Host sends:

Message	Start of horizontal calibration				
Description	Start of horizontal calibration				
Transmission direction	B Response				
Message Structure	Header 'T' 'M'	Class, ID 0x0f, 0x16	Length(0)	Data (Length )Byte	Checksum

Slave reply:

Message	Start of horizontal calibration				
Description	Start of horizontal calibration				
Transmission direction	B Response				
Message Structure	Header 'T' 'M'	Class, ID 0x0f, 0x16	Length(0)	Data (Length )Byte	Checksum

Magnetic azimuth horizontal calibration stop (**0x0f, 0x17**):

Host sends:

Message	Horizontal calibration stops				
Description	Horizontal calibration stops				
Transmission direction	B Response				
Message Structure	Header 'T' 'M'	Class, ID 0x0f, 0x17	Length(0)	Data (Length )Byte	Checksum

Slave reply:

Message	Horizontal calibration stops				
Description	Horizontal calibration stops				
Transmission direction	B Response				
Message Structure	Header 'T' 'M'	Class, ID 0x0f, 0x17	Length(0)	Data (Length )Byte	Checksum

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Magnetic azimuth vertical up-calibration start (**0x0f, 0x0B**):

Host sends:

Message	Vertical Up Calibration Start				
Description	Vertical Up Calibration Start				
Transmission direction	B Response				
Message Structure	Header 'T' 'M'	Class, ID0x0f, 0x0B	Length(0)	Data (Length )Byte	Checksum

Slave reply:

Message	Vertical Up Calibration Start				
Description	Vertical Up Calibration Start				
Transmission direction	B Response				
Message Structure	Header 'T' 'M'	Class, ID0x0f, 0x0B	Length(0)	Data (Length )Byte	Checksum

Magnetic azimuth vertical up-calibration stop (**0x0f, 0x0C**):

Host sends:

Message	Vertical Up Calibration Stop				
Description	Vertical Up Calibration Stop				
Transmission direction	B Response				
Message Structure	Header 'T' 'M'	Class, ID0x0f, 0x0C	Length(0)	Data (Length )Byte	Checksum

Slave reply:

Message	Vertical Up Calibration Stop				
Description	Vertical Up Calibration Stop				
Transmission direction	B Response				
Message Structure	Header 'T' 'M'	Class, ID0x0f, 0x0C	Length(0)	Data (Length )Byte	Checksum

Read declination size (**0x0f, 0x0f**):

Host sends:

Message	Read the magnetic declination				
Description	Read the magnetic declination				
Transmission direction	B Response				
Message Structure	Header 'T' 'M'	Class, ID0x0f, 0x0F	Length(0)	Data (Length )Byte	Checksum

Slave reply:

Message	Read the magnetic declination				
Description	Read the magnetic declination				

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Transmission direction	Command				
Message Structure	Header 'T' 'M'	Class, ID 0x0f, 0x0F	Length (0x0035)	Data (Length )Byte	Checksum
<b>Data Contents:</b>					
Byte Offset	Number Format	Scaling	Name	Unit	Comment
0	INT8U	-	0	-	0
1	INT8U	-	0	-	0
...		-	0		0
48	INT8U	-	0		0
49	FP32		Magnetic declination		Magseth, little-endian storage

Set the declination size (**0 x0f, 0 x10**):

Host sends:

Message	Set the magnetic declination				
Description	Set the magnetic declination				
Transmission direction	Command				
Message Structure	Header 'T' 'M'	Class, ID 0x0f, 0x10	Length (0x0035)	Data (Length )Byte	Checksum
<b>Data Contents:</b>					
Byte Offset	Number Format	Scaling	Name	Unit	Purpose/ Comment
0	INT8U	-	0	-	0
1	INT8U	-	0	-	0
...		-	0		0
48	INT8U	-	0		0
49	FP32		Magnetic declination		Magseth, little-endian storage

Slave reply:

Message	Set the magnetic declination				
Description	Set the magnetic declination				
Transmission direction	B Response				
Message Structure	Header 'T' 'M'	Class, ID 0x0f, 0x10	Length(0)	Data (Length )Byte	Checksum

Clear magnetic declination (**0x0f, 0x11**):

Host sends:

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Message	Clear magnetic declination				
Description	Clear magnetic declination				
Transmission direction	B Response				
Message Structure	Header 'T' 'M'	Class, ID 0x0f, 0x11	Length(0)	Data (Length )Byte	Checksum

Slave reply:

Message	Clear magnetic declination				
Description	Clear magnetic declination				
Transmission direction	B Response				
Message Structure	Header 'T' 'M'	Class, ID 0x0f, 0x11	Length(0)	Data (Length )Byte	Checksum

### **IMU data output**

**Set through the data output mode.**

Standard attitude and sensor output (**0 x0f, 0x01**):

Message	Attitude output				
Description	Standard attitude and sensor output				
Transmission direction	Output only				
Message Structure	Header 'T' 'M'	Class, ID 0x0f, 0x01	Length (50)	Payload (Length )Byte	Checksum

#### **Payload Contents:**

Byte Offset	Number Format	Scaling	Name	Unit	Purpose / Comment
0	INT8U	-	Flags	-	Reserved
1	FP32	-	Roll	degree	+/-180 Roll
5	FP32	-	Pitch	degree	+/-90 Pitch
9	FP32	-	Yaw	degree	+/-180 Heading
13	FP32	-	Gx	deg/s	Gyro x
17	FP32	-	Gy	deg/s	Gyro y
21	FP32	-	Gz	deg/s	Gyro z
25	FP32	-	Ax	g	Acceleration x
29	FP32	-	Ay	g	Acceleration y
33	FP32	-	Az	g	Acceleration z
37	FP32	-	Mx	uT	Mag x
41	FP32	-	My	uT	Mag y
45	FP32	-	Mz	uT	Mag z
49	INT8U		SOC	%	Percentage of battery charge

**Note: Floating-point numbers are stored in little-endian mode, with the low byte preceding the high byte.**

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Attitude output (**0x0f, 0x01**):

Message	Attitude output				
Description	Attitude output				
Transmission direction	Output only				
Message Structure	Header 'T' 'M'	Class, ID 0x0f , 0x01	Length (14)	Payload (Length )Byte	Checksum
<b>Payload Contents:</b>					
Byte Offset	Number Format	Scaling	Name	Unit	Purpose / Comment
0	INT8U	-	Flags	-	Reserved
1	FP32	-	Roll	degree	+/-180 Roll
5	FP32	-	Pitch	degree	+/-90 Pitch
9	FP32	-	Yaw	degree	+/-180 Heading
13	INT8U		SOC	%	Percentage of battery charge