Inertial Measurement Unit User Manual

1. Main technical parameters

1.1 Gyroscope specifications

| Parameter | Unit | Test conditions | BS-IC21-1D5-D6EC |
|---|---|---|---|
| Measuring range | °/s | | X: ±7200<br>Y, Z: ±450 |
| Bias instability | °/h | Allan variance | X: 5<br>Y, Z: 1 |
| Bias stability | °/h | 1s smooth, RMS, normal temperature | X: 50<br>Y, Z: 10 |
| Bias variation at full temperature | °/h | 10 s smoothing, RMS, temperature rate 1 ℃/min | X: 30<br>Y, Z: 20 |
| Random walk | °/√h | Allan variance | X: 2<br>Y, Z: 0.15 |
| Bias repeatability | °/h | Q = 6, normal temperature | X: 10<br>Y, Z: 5 |
| Bias acceleration sensitivity | °/h/g | Test at ± 1 G | X: 2<br>Y, Z: 1 |
| Resolution | °/h | | X: 5<br>Y, Z: 2 |
| Output noise | °/s | Peak (half peak, STD * 3) | X: 0.5<br>Y, Z: 0.2 |
| Scale factor nonlinearity | Ppm | normal temperature | 300 |
| Scale factor repeatability | Ppm | Q = 3, normal temperature | 300 |
| Cross coupling | % | normal temperature | 0.2 |
| Bandwidth | Hz | | 150 |

1.2 Accelerometer specification

| Parameter | Unit | Test conditions | BS-IC21-1D5-D6EC |
|---|---|---|---|
| Measuring range | g | | X: ±150<br>Y, Z: ±50 |
| Bias stability | mg | 1s smooth, RMS, normal temperature | X: 4<br>Y, Z: 1 |
| Bias variation at full temperature | mg | 10 s smoothing, RMS, temperature rate 1 ℃/min | X: 20<br>Y, Z: 5 |
| Bias repeatability | mg | Q = 6, normal temperature | X: 5<br>Y, Z: 1 |
| Resolution | mg | | X: 0.2<br>Y, Z: 0.1 |

| | | | |
|---|---|---|---|
| Scale factor nonlinearity | ppm | normal temperature | X: 1000<br>Y, Z: 500 |
| Scale factor repeatability | ppm | Q = 3, normal temperature | 500 |
| Cross coupling | % | normal temperature | 0.2 |
| Bandwidth | Hz | | 125 |

## 1.3 Dip angle specification

| **Parameter** | **Unit** | **BS-IC21-1y-x** |
|---|---|---|
| **Measuring range** | g | ±1.7 |
| **Bias stability (1s smoothing)** | mg | 0.5 |
| **Scale factor nonlinearity** | ppm | 500 |

## 1.4 Electrical characteristics

| **Parameter** | **Unit** | **BS-IC21-1y-x** |
|---|---|---|
| **Voltage** | **V** | **+5±0.5** |
| **Starting current** | **mA** | **＜400** |
| **Steady-state power consumption** | **W** | **＜1.5** |
| **Ripple** | **mV** | **100** |

## 1.5 Environmental adaptability

| **Parameter** | **Unit** | **BS-IC21-1y-x** |
|---|---|---|
| **Operating temperature** | ℃ | -45~85 |
| **Storage temperature** | ℃ | -55~105 |

## 1.6 Other

| **Parameter** | **Unit** | **BS-IC21-1y-x** |
|---|---|---|
| **Weight** | g | 55±5 |
| **Start time** | s | 1 |

# 2 Space coordinate system

## 2.1 Right-hand rule principle one

The MEMS IMU contains three axial spatial coordinate systems, namely X, Y and Z. The X axis points to the direction of the electrical connection interface, the Y axis points to the left side of the IMU, and the Z axis points to the top surface of the IMU, as shown in Figure 2-1.

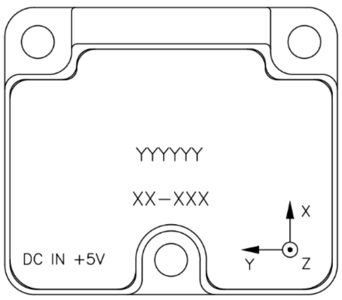


Figure 2-1 IMU Space Coordinate System

The installation of IMU should be matched with the axial direction of the coordinate system, otherwise the measured angular velocity data will be inaccurate. The axis of the coordinate system can be quickly assigned and determined by following the "right-hand rule principle 1". Stretch out the right hand and spread out the thumb, index finger and middle finger respectively. The direction of the thumb is the X axis, the direction of the index finger is the Y axis, and the direction of the middle finger is the Z axis, as shown in Figure 2-2.

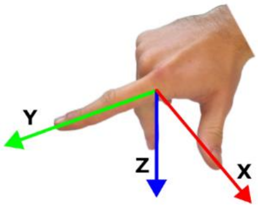


Figure 2-2 Right Hand Rule Principle 1

## 2.2 Right hand rule principle two

The three-degree-of-freedom gyroscope in the IMU can measure the angular velocity in three directions. The direction of the angular velocity of the axial rotation of the coordinate axis can be quickly determined by following the'right-hand rule principle 2 '. Stretch out the right hand and unfold the thumb. The direction of the thumb is the axial direction, and the direction of the other four fingers is the direction of the angular velocity of the axial rotation of the thumb, as shown in Figure 2-3.

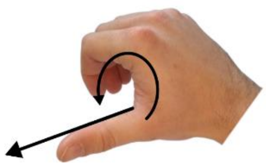

Figure 2-3 Right Hand Rule Principle 2

# 3 Dimensions, lettering and mounting

## 3.1 Overall dimensions

See Figure 3-1 for outline drawing

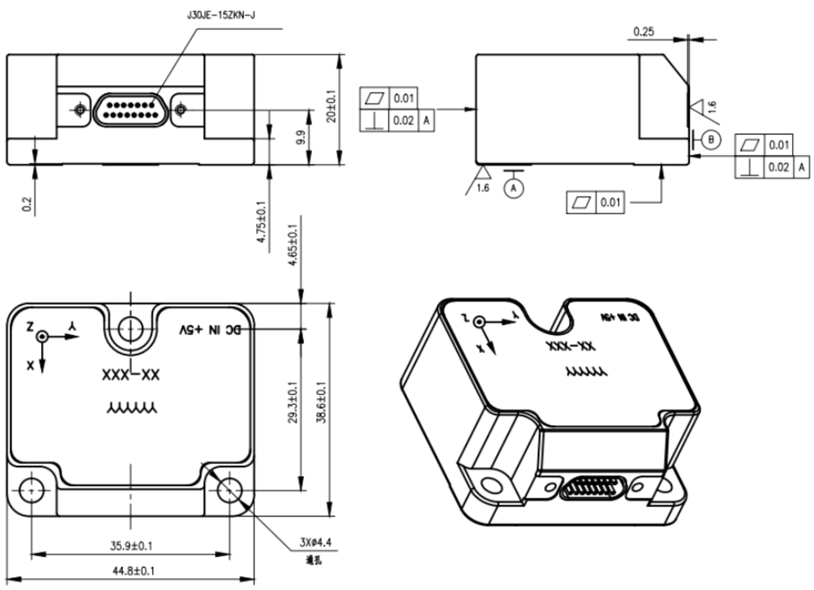

Fig. 3-1 Outline drawing of IMU

In the drawing, "BS-IC21-1y-x" is the product code ". According to the product naming rules of the company," y "in BS-IC21-1y-x can be" A "," B "," C ", etc. Or no letter to distinguish different performance index requirements, and" X "can be" 1 "," 2 "," 3 "," 4 "to distinguish different product metering ranges. "XX-XXX" is the product number.

BS-IC21-1y-x IMU is installed through three Φ4.4 through holes, and three M4 screws (with spring washer and flat washer) are used for installation. When installing the connector, the plug shall be locked with the socket and the cable shall be fixed. EQ \ o \ AC (○, A) in the figure、eq \o\ac(○,B)Is the installation datum plane of the inertia group.

It is recommended that the flatness of the mounting surface opposite to the reference surface shall not be greater than 0.01 mm, the verticality shall not be greater than 0.02 mm, and the surface roughness shall not be greater than 0.8 μm.

## 3.2 Lettering requirements

The default requirements for lettering on the product housing are as follows:

As shown in Figure 3-1, the height of product code, name and number is 2.5 mm, and the height of "DC IN + 5V" and coordinate axis "X, Y, Z" is 2 mm. Where "XX-XXX" is the product number.

If there are special lettering requirements, please specify them in the manual or technical agreement.

## 3.3 Recommended installation method

The product shall be installed in parallel with the carrier installation datum plane as far as possible, and the flatness, verticality and surface roughness of the carrier. The recommend installation is shown in fig. 3-2

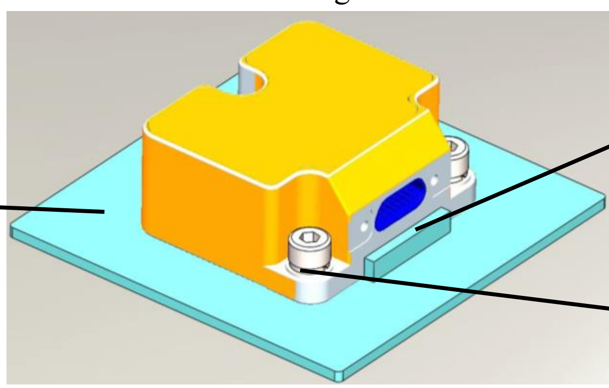


Figure 3-2 Recommended product installation method

# 4 Electrical characteristics

## 4.1 Electrical interface

The electrical connector model of BS-IC21-1y-x IMU is J30JE-15-ZKN-J. See Table 4-1 and Figure 4-1 for the specific distribution of contacts.

Table 4-1 J30JE-15ZKN-J Contact Distribution

| Contact number | Pin definition | Type | Explain |
|---|---|---|---|
| 1 | TxD- | OUTPUT | Product RS422 output interface negative terminal |
| 2 | RxD- | INPUT | Product RS422 receiving interface negative terminal |
| 4 | TOV | OUTPUT | Sync Signal (1) |
| 5 | NRST | INPUT | Reset Signal (2) |
| 8 | VSUP | SUPPLY | Positive end of product power supply, DC regulated power supply |
| 9 | TxD+ | OUTPUT | Product RS422 output interface positive terminal |
| 10 | RxD+ | INPUT | Product RS422 receiving interface positive terminal |
| 11 | ExtTrig | INPUT | External Trigger Source (3) |
| 12、13、15 | GND | SUPPLY | Product ground, power ground and serial port ground |
| 3、6~7、14 | Reserved by the manufacturer | / | / |

Notice

(1) The synchronization signal needs to be specially configured according to the requirements. The default IMU does not have this configuration and needs to be suspended.

(2) The reset signal needs to be specially configured as required. The default IMU does not have this configuration and needs to be suspended.

(3) The external trigger source needs to be specially configured according to the requirements. The default inertia group does not have this configuration and needs to be suspended.

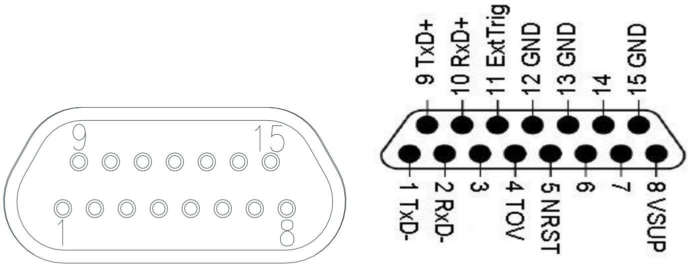


Fig. 4-1 Configuration Diagram of Connector Node (Seen from the Outside of the Product)

## 4.2 Electrical interface connections

The BS-IC21-1y-x IMU is very simple to use. If no special additional functions are required, the IMU will send data through the RS422 communication interface protocol about 1 s after it is powered on. Figure 4-2 shows a simple interconnection diagram for the BS-IC21-1y-x.

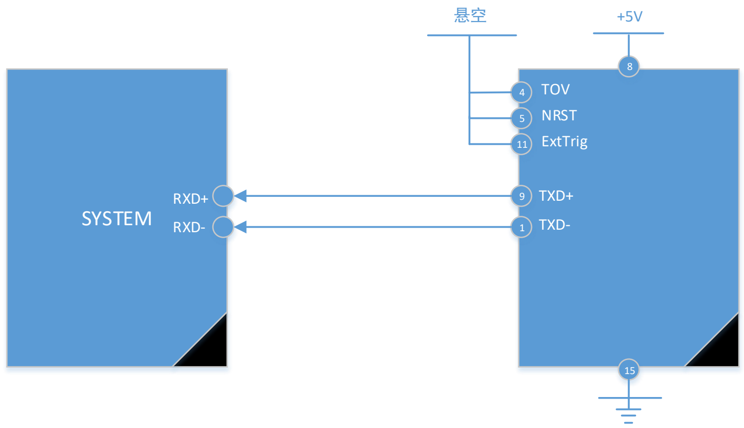


Fig. 4-2 Electrical connection 1

If all functions of BS-IC21-1y-x IMU are to be used, interconnection wiring with IMU is required as shown in Figure 4-3.

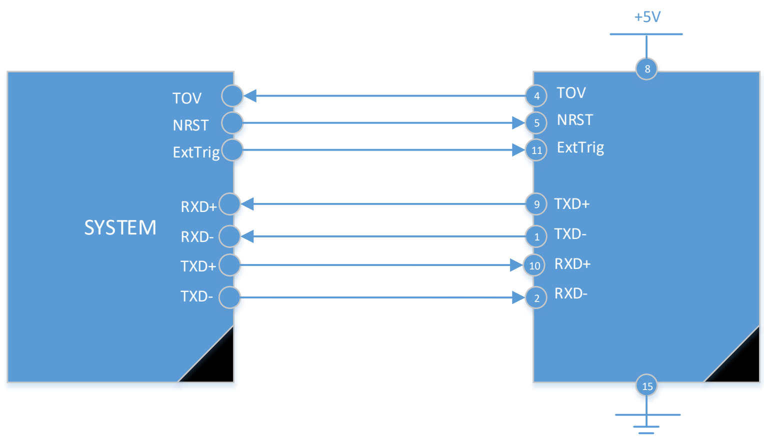


Figure 4-3 Electrical connection 2

## 4.3 Additional Function 1: Reset

The BS-IC21-1y-x IMU has a separate digital input pin (NRST) that allows the BS-IC21-1y-x to be reset without re-powering up if the IMU is configured for a particular configuration. The trigger mode of the NRST signal can be specially defined according to the requirements.

## 4.4 Additional function 2: external trigger

The BS-IC21-1y-x IMU has an independent digital input pin (ExtTrig). If the IMU has completed a specific configuration, when it receives an external trigger signal and generates an interrupt, it can send data through the RS422 communication interface protocol. The frequency of sending data is synchronized with the frequency of the ExtTrig signal. However, there are two special cases where sending data is not affected by an external trigger source:

a) In normal mode, send command 'C' to the IMU to test the RS422 interface. The IMU will transmit the configuration data stream independent of the external trigger source.

b) In the power-on initialization state, the IMU sends the initialization state data without being affected by the external trigger source.

Figure 4-4 is the timing diagram of the external trigger source sending data. The sampling frequency of the IMU is 1000Hz. The external trigger source shall not be higher than the sampling frequency. Latency is the delay of sending trigger data.

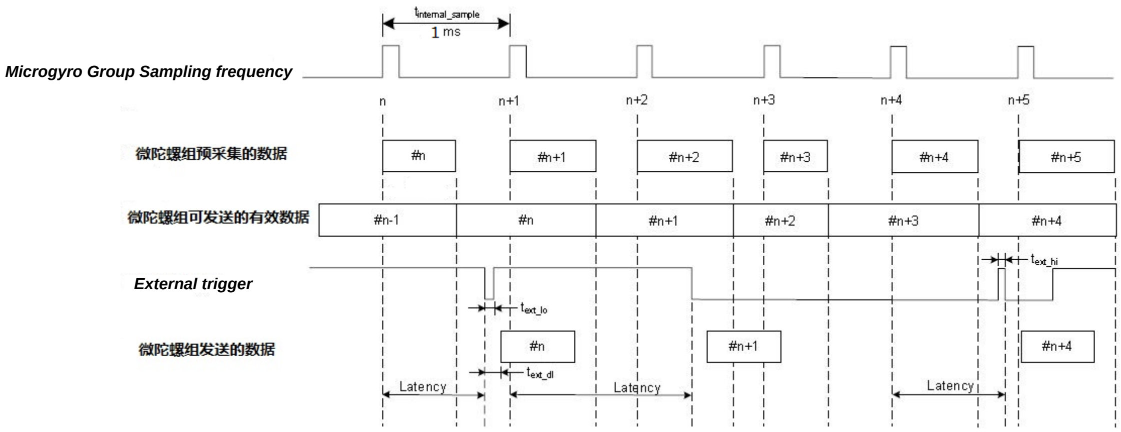


Figure 4-4 External Trigger Timing Diagram

## 4.5 Additional function 3: synchronization

The BS-IC21-1y-x IMU has an independent digital output pin (TOV). If the IMU is configured specifically, it can output a signal of a specific frequency and provide a synchronization signal. Figure 4-5 shows the synchronization timing diagram without the external trigger source. Figure 4-6 shows the synchronization timing diagram with the external trigger source. The sampling frequency is 1000 Hz.

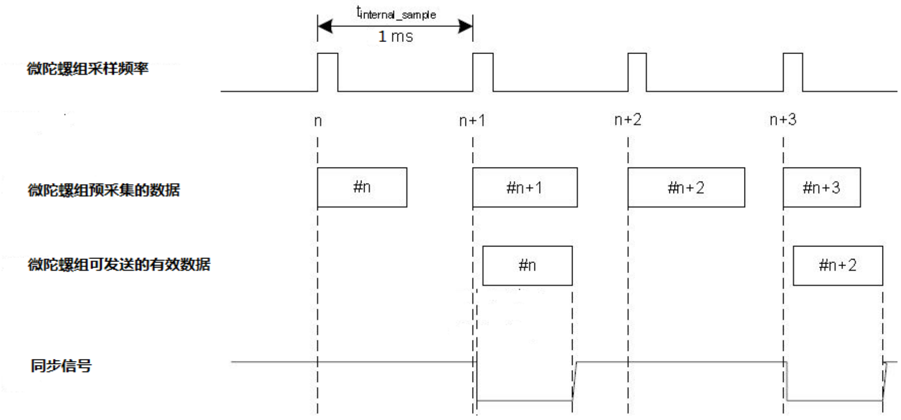


Figure 4-5 Synchronous Signal Timing 1

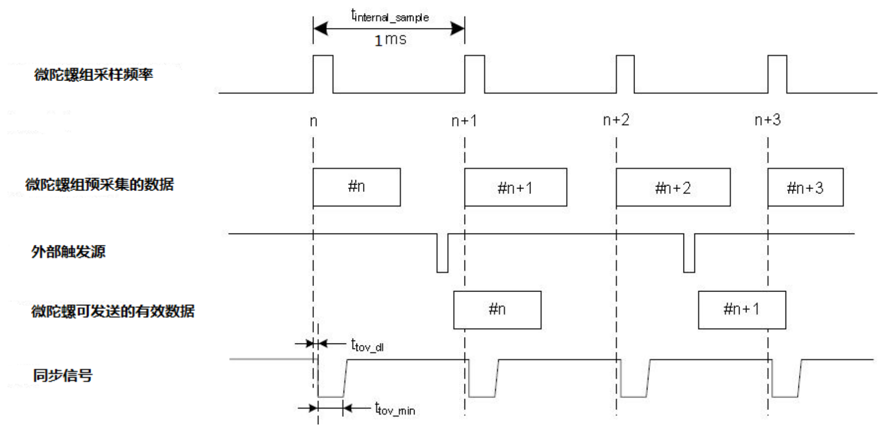


Figure 4-6 Synchronous Signal Timing 2

# 5 Communication interface

## 5.1 Configurable parameters

The configurable parameters of the product are shown in Table 5-1 below.

Table 5-1 Product Configurable Parameters

| Parameter | Configuration value | Explain |
|---|---|---|
| Data frame | Gyro data frame (ID = 0x90)<br>'Gyro + Add Table 'data frame (ID = 0x91)<br>'Gyro + Tilt 'data frame (ID = 0x92)<br>'Gyro + Add Table + Tilt 'data frame (ID = 0x93)<br>'Gyro + Temperature 'data frame (ID = 0x94)<br>'Gyro + plus meter + temperature 'data frame (ID = 0 xA5)<br>'Gyro + tilt + temperature 'data frame (ID = 0 xA6)<br>'Gyro + plus meter + tilt + temperature 'data frame (ID = 0 xA7) | Refer to Section 5.3 for specific data frame format, which can be sent by any one of them.<br>See Table 5-2 for the relationship between data frame, baud rate and update rate. |
| RS422 baud rate | 460800bps<br>921600bps | Refer to Table 5-2 for baud rate limit conditions. |
| RS422 check digit | NONE (no check)<br>ODD (odd parity) | |

| | | | |
|---|---|---|---|
| | EVEN (even parity) | | |
| RS422 stop bit | 1 bit<br>2 bits | | |
| Low-pass filter bandwidth | -3dB frequency | Group Delay (ms) | The filter setting is independent of the data update rate.<br>The low-pass filter is a second-order IIR. |
| | 16Hz<br>33Hz<br>66Hz<br>131Hz<br>262Hz | 23.4<br>11.7<br>5.9<br>3.0<br>1.6 | |
| Data update rate | 125Hz<br>250Hz<br>500Hz<br>1000Hz<br>2000Hz | | Refer to Table 5-2 for data update rate restrictions. |
| Restore factory settings | Restore factory settings<br>Restore factory settings and save | | |

## 5.2 Communication interface

It communicates with the processing circuit unit through the serial communication interface and adopts the RS-422 standard. Both the transmission baud rate and the data update rate can be configured by software. Table 5-2 shows the maximum data update rate corresponding to the transmission baud rate.

***The default communication protocol is: baud rate 921 600bps, 8 data bits, 1stop bit, no check bit, 0xA5 data frame, update rate 1000Hz.***

Table 5-2 Maximum Data Update Rate

| **Baud rate** / **Data frame format** | **460800 bit/s** | **921600 bit/s** |
|---|---|---|
| **Gyro data frame (0x90)** | 2000Hz | 2000 Hz |
| **'Gyro + Add Table 'data frame (0 x91)** | 1000 Hz | 1000 Hz |
| **'Gyro + Tilt 'data frame (0x92)** | 1000 Hz | 1000 Hz |
| **'Gyro + plus meter + tilt 'data frame (0x93)** | 1000 HZ | 1000 Hz |
| **'Gyro + Temperature 'data frame (0x94)** | 1000 Hz | 1000 Hz |
| **'Gyro + plus meter + temperature 'data frame (0 xA5)** | 500 Hz | 1000 Hz |
| **'Gyro +Inclination+ Temperature 'data frame (0 xA6)** | 500 Hz | 1000 Hz |
| **'Gyro + plus meter + tilt + temperature 'data frame (0 xA7)** | 500 Hz | 1000 Hz |

## 5.3 Data frame format

Data frame is sent by IMU in each cycle, and the data format can be configured by referring to the corresponding data frame format in the operating instructions of the supporting upper computer. All formats are shown in the following table.

Table 5-2 Data Frame Format of Gyro

| Serial number | Parameter name | Effective range | Byte | Scale | Remark |
|---|---|---|---|---|---|
| 1 | Frame header | 0x90 | 1 | —— | Packet header |
| 2 | X-axis angular velocity | [-400，400] | 3 | $2^{-14}$ | Unit °/s, first high and then low, the most significant bit of the first byte is the sign bit. See Note 1 for the specific algorithm. |
| | | [-2000，2000] | 3 | $2^{-12}$ | |
| 3 | Y-axis angular velocity | [-400，400] | 3 | $2^{-14}$ | Unit °/s, first high and then low, the most significant bit of the first byte is the sign bit. See Note 1 for the specific algorithm. |
| | | [-2000，2000] | 3 | $2^{-12}$ | |
| 4 | Z-axis angular velocity | [-400，400] | 3 | $2^{-14}$ | Unit °/s, first high and then low, the most significant bit of the first byte is the sign bit. See Note 1 for the specific algorithm. |
| | | [-2000，2000] | 3 | $2^{-12}$ | |
| 5 | Gyro status | —— | 1 | —— | All zeros are normal. See Table 5-10 for specific definitions. |
| 6 | Frame counter | [0，255] | 1 | 1 | 0-255 continuous count |
| 7 | Delay | | 2 | | Unit: us, first high and then low, the most significant bit of the first byte is the sign bit. See Note 5 for the specific algorithm. |
| 8 | CRC32 | —— | 4 | —— | CRC32 verification, see instruction 6 |

Table 5-3 Data Frame Format of "Gyro + Add Table"

| Serial number | Parameter name | Effective range | Byte | Scale | Remark |
|---|---|---|---|---|---|
| 1 | Frame header | 0x91 | 1 | —— | Packet header |
| 2 | X-axis angular velocity | [-400，400] | 3 | $2^{-14}$ | Unit °/s, first high and then low, the most significant bit of the first byte is the sign bit. See Note 1 for the specific algorithm. |
| | | [-2000，2000] | 3 | $2^{-12}$ | |
| 3 | Y-axis angular velocity | [-400，400] | 3 | $2^{-14}$ | Unit °/s, first high and then low, the most significant bit of the first byte is the sign bit. See Note 1 for the specific algorithm. |
| | | [-2000，2000] | 3 | $2^{-12}$ | |
| 4 | Z-axis angular | [-400，400] | 3 | $2^{-14}$ | Unit °/s, first high and then low, the most |

| | | | | | |
|---|---|---|---|---|---|
| | velocity | [-2000，2000] | 3 | $2^{-12}$ | significant bit of the first byte is the sign bit. See Note 1 for the specific algorithm. |
| 5 | Gyro status | —— | 1 | —— | All zeros are normal. See Table 5-10 for specific definitions. |
| 6 | X-axis acceleration | [-10，10] | 3 | $2^{-19}$ | Unit: G, first high and then low, the most significant bit of the first byte is the sign bit. See Note 2 for the specific algorithm. |
| | | [-30，30] | | $2^{-18}$ | |
| | | [-50，50] | | $2^{-17}$ | |
| | | [-80，80] | | $2^{-16}$ | |
| 7 | Y-axis acceleration | [-10，10] | 3 | $2^{-19}$ | Unit: G, first high and then low, the most significant bit of the first byte is the sign bit. See Note 2 for the specific algorithm. |
| | | [-30，30] | | $2^{-18}$ | |
| | | [-50，50] | | $2^{-17}$ | |
| | | [-80，80] | | $2^{-16}$ | |
| 8 | Z-axis acceleration | [-10，10] | 3 | $2^{-19}$ | Unit: G, first high and then low, the most significant bit of the first byte is the sign bit. See Note 2 for the specific algorithm. |
| | | [-30，30] | | $2^{-18}$ | |
| | | [-50，50] | | $2^{-17}$ | |
| | | [-80，80] | | $2^{-16}$ | |
| 9 | Add table status | —— | 1 | —— | All zeros are normal. See Table 5-10 for specific definitions. |
| 10 | Frame counter | [0，255] | 1 | 1 | 0-255 continuous count |
| 11 | Delay | | 2 | | Unit: us, first high and then low, the most significant bit of the first byte is the sign bit. See Note 5 for the specific algorithm. |
| 12 | CRC32 | —— | 4 | —— | CRC32 verification, see instruction 6 |

Table 5-4 Format of 'Gyro + Tilt' Data Frame

| Serial number | Parameter name | Effective range | Byte | Scale | Remark |
|---|---|---|---|---|---|
| 1 | Frame header | 0x92 | 1 | —— | Packet header |
| 2 | X-axis angular velocity | [-400，400] | 3 | $2^{-14}$ | Unit °/s, first high and then low, the most significant bit of the first byte is the sign bit. See Note 1 for the specific algorithm. |
| | | [-2000，2000] | 3 | $2^{-12}$ | |
| 3 | Y-axis angular velocity | [-400，400] | 3 | $2^{-14}$ | Unit °/s, first high and then low, the most significant bit of the first byte is the sign bit. See Note 1 for the specific algorithm. |
| | | [-2000，2000] | 3 | $2^{-12}$ | |
| 4 | Z-axis angular | [-400，400] | 3 | $2^{-14}$ | Unit °/s, first high and then low, the most |

| | | | | | |
|---|---|---|---|---|---|
| | velocity | [-2000，2000] | 3 | $2^{-12}$ | significant bit of the first byte is the sign bit. See Note 1 for the specific algorithm. |
| 5 | Gyro status | —— | 1 | —— | All zeros are normal. See Table 5-10 for specific definitions. |
| 6 | X-axis inclination | [-1.7，1.7] | 3 | $2^{-22}$ | Unit: G, first high and then low, the most significant bit of the first byte is the sign bit. See Note 3 for the specific algorithm. |
| 7 | Y-axis inclination | [-1.7，1.7] | 3 | $2^{-22}$ | Unit: G, first high and then low, the most significant bit of the first byte is the sign bit. See Note 3 for the specific algorithm. |
| 8 | Z-axis inclination | [-1.7，1.7] | 3 | $2^{-22}$ | Unit: G, first high and then low, the most significant bit of the first byte is the sign bit. See Note 3 for the specific algorithm. |
| 9 | Inclination state | —— | 1 | —— | All zeros are normal. See Table 5-10 for specific definitions. |
| 10 | Frame counter | [0，255] | 1 | 1 | 0-255 continuous count |
| 11 | Delay | | 2 | | Unit: us, first high and then low, the most significant bit of the first byte is the sign bit. See Note 5 for the specific algorithm. |
| 12 | CRC32 | —— | 4 | —— | CRC32 verification, see instruction 6 |

Table 5-5 Data Frame Format of 'Gyro + Add Table + Dip Angle'

| Serial number | Parameter name | Effective range | Byte | Scale | Remark |
|---|---|---|---|---|---|
| 1 | Frame header | 0x93 | 1 | —— | Packet header |
| 2 | X-axis angular velocity | [-400，400] | 3 | $2^{-14}$ | Unit °/s, first high and then low, the most significant bit of the first byte is the sign bit. See Note 1 for the specific algorithm. |
| | | [-2000，2000] | 3 | $2^{-12}$ | |
| 3 | Y-axis angular velocity | [-400，400] | 3 | $2^{-14}$ | Unit °/s, first high and then low, the most significant bit of the first byte is the sign bit. See Note 1 for the specific algorithm. |
| | | [-2000，2000] | 3 | $2^{-12}$ | |
| 4 | Z-axis angular velocity | [-400，400] | 3 | $2^{-14}$ | Unit °/s, first high and then low, the most significant bit of the first byte is the sign bit. See Note 1 for the specific algorithm. |
| | | [-2000，2000] | 3 | $2^{-12}$ | |
| 5 | Gyro status | —— | 1 | —— | All zeros are normal. See Table 5-10 for specific definitions. |

| | | | | | |
|---|---|---|---|---|---|
| 6 | X-axis acceleration | [-10，10] | 3 | $2^{-19}$ | Unit: G, first high and then low, the most significant bit of the first byte is the sign bit. See Note 2 for the specific algorithm. |
| | | [-30，30] | | $2^{-18}$ | |
| | | [-50，50] | | $2^{-17}$ | |
| | | [-80，80] | | $2^{-16}$ | |
| 7 | Y-axis acceleration | [-10，10] | 3 | $2^{-19}$ | Unit: G, first high and then low, the most significant bit of the first byte is the sign bit. See Note 2 for the specific algorithm. |
| | | [-30，30] | | $2^{-18}$ | |
| | | [-50，50] | | $2^{-17}$ | |
| | | [-80，80] | | $2^{-16}$ | |
| 8 | Z-axis acceleration | [-10，10] | 3 | $2^{-19}$ | Unit: G, first high and then low, the most significant bit of the first byte is the sign bit. See Note 2 for the specific algorithm. |
| | | [-30，30] | | $2^{-18}$ | |
| | | [-50，50] | | $2^{-17}$ | |
| | | [-80，80] | | $2^{-16}$ | |
| 9 | Add table status | —— | 1 | —— | All zeros are normal. See Table 5-10 for specific definitions. |
| 10 | X-axis inclination | [-1.7，1.7] | 3 | $2^{-22}$ | Unit: G, first high and then low, the most significant bit of the first byte is the sign bit. See Note 3 for the specific algorithm. |
| 11 | Y-axis inclination | [-1.7，1.7] | 3 | $2^{-22}$ | Unit: G, first high and then low, the most significant bit of the first byte is the sign bit. See Note 3 for the specific algorithm. |
| 12 | Z-axis inclination | [-1.7，1.7] | 3 | $2^{-22}$ | Unit: G, first high and then low, the most significant bit of the first byte is the sign bit. See Note 3 for the specific algorithm. |
| 13 | Inclination state | —— | 1 | —— | All zeros are normal. See Table 5-10 for specific definitions. |
| 14 | Frame counter | [0，255] | 1 | 1 | 0-255 continuous count |
| 15 | Delay | | 2 | | Unit: us, first high and then low, the most significant bit of the first byte is the sign bit. See Note 5 for the specific algorithm. |
| 16 | CRC32 | —— | 4 | —— | CRC32 verification, see instruction 6 |

Table 5-6 Format of 'Gyro + Temperature' Data Frame

| Serial number | Parameter name | Effective range | Byte | Scale | Remark |
|---|---|---|---|---|---|
| 1 | Frame header | 0x94 | 1 | —— | Packet header |

| | | | | | |
|---|---|---|---|---|---|
| 2 | X-axis angular velocity | [-400，400] | 3 | $2^{-14}$ | Unit °/s, first high and then low, the most significant bit of the first byte is the sign bit. See Note 1 for the specific algorithm. |
| | | [-2000，2000] | 3 | $2^{-12}$ | |
| 3 | Y-axis angular velocity | [-400，400] | 3 | $2^{-14}$ | Unit °/s, first high and then low, the most significant bit of the first byte is the sign bit. See Note 1 for the specific algorithm. |
| | | [-2000，2000] | 3 | $2^{-12}$ | |
| 4 | Z-axis angular velocity | [-400，400] | 3 | $2^{-14}$ | Unit °/s, first high and then low, the most significant bit of the first byte is the sign bit. See Note 1 for the specific algorithm. |
| | | [-2000，2000] | 3 | $2^{-12}$ | |
| 5 | Gyro status | —— | 1 | —— | All zeros are normal. See Table 5-10 for specific definitions. |
| 6 | X-axis gyro temperature | [-128，128] | 2 | $2^{-8}$ | Unit: ℃, from high to low, the most significant bit of the first byte is the sign bit. See Note 4 for the specific algorithm. |
| 7 | Y-axis gyro temperature | [-128，128] | 2 | $2^{-8}$ | Unit: ℃, from high to low, the most significant bit of the first byte is the sign bit. See Note 4 for the specific algorithm. |
| 8 | Temperature of Z-axis gyroscope | [-128，128] | 2 | $2^{-8}$ | Unit: ℃, from high to low, the most significant bit of the first byte is the sign bit. See Note 4 for the specific algorithm. |
| 9 | Gyro Thermometer Status | —— | 1 | —— | All zeros are normal. See Table 5-10 for specific definitions. |
| 10 | Frame counter | [0，255] | 1 | 1 | 0-255 continuous count |
| 11 | Delay | | 2 | | Unit: us, first high and then low, the most significant bit of the first byte is the sign bit. See Note 5 for the specific algorithm. |
| 12 | CRC32 | —— | 4 | —— | CRC32 verification, see instruction 6 |

Table 5-7 Data Frame Format of 'Gyro + Add Table + Temperature'

| Serial number | Parameter name | Effective range | Byte | Scale | Remark |
|---|---|---|---|---|---|
| 1 | Frame header | 0xA5 | 1 | —— | Packet header |
| 2 | X-axis angular velocity | [-450，450] | 3 | $2^{-14}$ | Unit °/s, first high and then low, the most significant bit of the first byte is the sign bit. See Note 1 for the specific algorithm. |
| | | [-2000，2000] | 3 | $2^{-12}$ | |
| | | [-7200，7200] | | $2^{-10}$ | |
| 3 | Y-axis angular velocity | [-450，450] | 3 | $2^{-14}$ | Unit °/s, first high and then low, the most significant bit of the first byte is the sign bit. See Note 1 for the specific algorithm. |
| | | [-2000，2000] | 3 | $2^{-12}$ | |
| | | | | | |
| 4 | Z-axis angular velocity | [-450，450] | 3 | $2^{-14}$ | Unit °/s, first high and then low, the most significant bit of the first byte is the sign bit. See Note 1 for the specific algorithm. |
| | | [-2000，2000] | 3 | $2^{-12}$ | |
| | | | | | |
| 5 | Gyro status | —— | 1 | —— | All zeros are normal. See Table 5-10 for specific definitions. |
| 6 | X-axis acceleration | [-10，10] | 3 | $2^{-19}$ | Unit: G, first high and then low, the most significant bit of the first byte is the sign bit. See Note 2 for the specific algorithm. |
| | | [-30，30] | | $2^{-18}$ | |
| | | [-50，50] | | $2^{-17}$ | |
| | | [-80，80] | | $2^{-16}$ | |
| | | [-150，150] | | $2^{-15}$ | |
| 7 | Y-axis acceleration | [-10，10] | 3 | $2^{-19}$ | Unit: G, first high and then low, the most significant bit of the first byte is the sign bit. See Note 2 for the specific algorithm. |
| | | [-30，30] | | $2^{-18}$ | |
| | | [-50，50] | | $2^{-17}$ | |
| | | [-80，80] | | $2^{-16}$ | |
| 8 | Z-axis acceleration | [-10，10] | 3 | $2^{-19}$ | Unit: G, first high and then low, the most significant bit of the first byte is the sign bit. See Note 2 for the specific algorithm. |
| | | [-30，30] | | $2^{-18}$ | |
| | | [-50，50] | | $2^{-17}$ | |
| | | [-80，80] | | $2^{-16}$ | |
| 9 | Add table status | —— | 1 | —— | All zeros are normal. See Table 5-10 for specific definitions. |
| 10 | X-axis gyro temperature | [-128，128] | 2 | $2^{-8}$ | Unit: ℃, from high to low, the most significant bit of the first byte is the sign bit. See Note 4 for the specific algorithm. |

| | | | | | |
|---|---|---|---|---|---|
| 11 | Y-axis gyro temperature | [-128，128] | 2 | $2^{-8}$ | Unit: °C, from high to low, the most significant bit of the first byte is the sign bit. See Note 4 for the specific algorithm. |
| 12 | Temperature of Z-axis gyroscope | [-128，128] | 2 | $2^{-8}$ | Unit: °C, from high to low, the most significant bit of the first byte is the sign bit. See Note 4 for the specific algorithm. |
| 13 | Gyro Thermometer Status | —— | 1 | —— | All zeros are normal. See Table 5-10 for specific definitions. |
| 14 | X-axis plus surface temperature | [-128，128] | 2 | $2^{-8}$ | Unit: °C, from high to low, the most significant bit of the first byte is the sign bit. See Note 4 for the specific algorithm. |
| 15 | Y-axis plus surface temperature | [-128，128] | 2 | $2^{-8}$ | Unit: °C, from high to low, the most significant bit of the first byte is the sign bit. See Note 4 for the specific algorithm. |
| 16 | Z-axis plus surface temperature | [-128，128] | 2 | $2^{-8}$ | Unit: °C, from high to low, the most significant bit of the first byte is the sign bit. See Note 4 for the specific algorithm. |
| 17 | Add thermometer status | —— | 1 | —— | All zeros are normal. See Table 5-10 for specific definitions. |
| 18 | Frame counter | [0，255] | 1 | 1 | 0-255 continuous count |
| 19 | Delay | | 2 | | Unit: us, first high and then low, the most significant bit of the first byte is the sign bit. See Note 5 for the specific algorithm. |
| 20 | CRC32 | —— | 4 | —— | CRC32 verification, see instruction 6 |

Table 5-8 Format of 'Gyro + Tilt + Temperature' Data Frame

| Serial number | Parameter name | Effective range | Byte | Scale | Remark |
|---|---|---|---|---|---|
| 1 | Frame header | 0xA6 | 1 | —— | Packet header |
| 2 | X-axis angular velocity | [-400，400] | 3 | $2^{-14}$ | Unit °/s, first high and then low, the most significant bit of the first byte is the sign bit. See Note 1 for the specific algorithm. |
| | | [-2000，2000] | 3 | $2^{-12}$ | |
| 3 | Y-axis angular velocity | [-400，400] | 3 | $2^{-14}$ | Unit °/s, first high and then low, the most significant bit of the first byte is the sign bit. See Note 1 for the specific algorithm. |
| | | [-2000，2000] | 3 | $2^{-12}$ | |
| 4 | Z-axis angular | [-400，400] | 3 | $2^{-14}$ | Unit °/s, first high and then low, the most |

| | | | | | |
|---|---|---|---|---|---|
| | velocity | [-2000，2000] | 3 | $2^{-12}$ | significant bit of the first byte is the sign bit. See Note 1 for the specific algorithm. |
| 5 | Gyroscope status | —— | 1 | —— | All zeros are normal. See Table 5-10 for specific definitions. |
| 6 | X-axis inclination | [-1.7，1.7] | 3 | $2^{-22}$ | Unit: G, first high and then low, the most significant bit of the first byte is the sign bit. See Note 3 for the specific algorithm. |
| 7 | Y-axis inclination | [-1.7，1.7] | 3 | $2^{-22}$ | Unit: G, first high and then low, the most significant bit of the first byte is the sign bit. See Note 3 for the specific algorithm. |
| 8 | Z-axis inclination | [-1.7，1.7] | 3 | $2^{-22}$ | Unit: G, first high and then low, the most significant bit of the first byte is the sign bit. See Note 3 for the specific algorithm. |
| 9 | Inclination state | —— | 1 | —— | All zeros are normal. See Table 5-10 for specific definitions. |
| 10 | X-axis gyro temperature | [-128，128] | 2 | $2^{-8}$ | Unit: °C, from high to low, the most significant bit of the first byte is the sign bit. See Note 4 for the specific algorithm. |
| 11 | Y-axis gyro temperature | [-128，128] | 2 | $2^{-8}$ | Unit: °C, from high to low, the most significant bit of the first byte is the sign bit. See Note 4 for the specific algorithm. |
| 12 | Temperature of Z-axis gyroscope | [-128，128] | 2 | $2^{-8}$ | Unit: °C, from high to low, the most significant bit of the first byte is the sign bit. See Note 4 for the specific algorithm. |
| 13 | Gyro Thermometer Status | —— | 1 | —— | All zeros are normal. See Table 5-10 for specific definitions. |
| 14 | X-axis tilt temperature | [-128，128] | 2 | $2^{-8}$ | Unit: °C, from high to low, the most significant bit of the first byte is the sign bit. See Note 4 for the specific algorithm. |
| 15 | Y-axis tilt temperature | [-128，128] | 2 | $2^{-8}$ | Unit: °C, from high to low, the most significant bit of the first byte is the sign bit. See Note 4 for the specific algorithm. |
| 16 | Z-axis tilt temperature | [-128，128] | 2 | $2^{-8}$ | Unit: °C, from high to low, the most significant bit of the first byte is the sign bit. See Note 4 for the specific algorithm. |
| 17 | Dip Thermometer Status | —— | 1 | —— | All zeros are normal. See Table 5-10 for specific definitions. |
| 18 | Frame counter | [0，255] | 1 | 1 | 0-255 continuous count |

| | | | | | |
|---|---|---|---|---|---|
| 19 | Delay | | 2 | | Unit: us, first high and then low, the most significant bit of the first byte is the sign bit. See Note 5 for the specific algorithm. |
| 20 | CRC32 | —— | 4 | —— | CRC32 verification, see instruction 6 |

Table 5-9 Data Frame Format of 'Gyro + Add Table + Inclination + Temperature'

| Serial number | Parameter name | Effective range | Byte | Scale | Remark |
|---|---|---|---|---|---|
| 1 | Frame header | 0xA7 | 1 | —— | Packet header |
| 2 | X-axis angular velocity | [-400，400] | 3 | $2^{-14}$ | Unit °/s, first high and then low, the most significant bit of the first byte is the sign bit. See Note 1 for the specific algorithm. |
| | | [-2000，2000] | 3 | $2^{-12}$ | |
| 3 | Y-axis angular velocity | [-400，400] | 3 | $2^{-14}$ | Unit °/s, first high and then low, the most significant bit of the first byte is the sign bit. See Note 1 for the specific algorithm. |
| | | [-2000，2000] | 3 | $2^{-12}$ | |
| 4 | Z-axis angular velocity | [-400，400] | 3 | $2^{-14}$ | Unit °/s, first high and then low, the most significant bit of the first byte is the sign bit. See Note 1 for the specific algorithm. |
| | | [-2000，2000] | 3 | $2^{-12}$ | |
| 5 | Gyroscope status | —— | 1 | —— | All zeros are normal. See Table 5-10 for specific definitions. |
| 6 | X-axis acceleration | [-10，10] | 3 | $2^{-19}$ | Unit: G, first high and then low, the most significant bit of the first byte is the sign bit. See Note 2 for the specific algorithm. |
| | | [-30，30] | | $2^{-18}$ | |
| | | [-50，50] | | $2^{-17}$ | |
| | | [-80，80] | | $2^{-16}$ | |
| 7 | Y-axis acceleration | [-10，10] | 3 | $2^{-19}$ | Unit: G, first high and then low, the most significant bit of the first byte is the sign bit. See Note 2 for the specific algorithm. |
| | | [-30，30] | | $2^{-18}$ | |
| | | [-50，50] | | $2^{-17}$ | |
| | | [-80，80] | | $2^{-16}$ | |
| 8 | Z-axis acceleration | [-10，10] | 3 | $2^{-19}$ | Unit: G, first high and then low, the most significant bit of the first byte is the sign bit. See Note 2 for the specific algorithm. |
| | | [-30，30] | | $2^{-18}$ | |
| | | [-50，50] | | $2^{-17}$ | |
| | | [-80，80] | | $2^{-16}$ | |
| 9 | Add table status | —— | 1 | —— | All zeros are normal. See Table 5-10 for specific definitions. |

| | | | | | |
|---|---|---|---|---|---|
| 10 | X-axis inclination | [-1.7，1.7] | 3 | $2^{-22}$ | Unit: G, first high and then low, the most significant bit of the first byte is the sign bit. See Note 3 for the specific algorithm. |
| 11 | Y-axis inclination | [-1.7，1.7] | 3 | $2^{-22}$ | Unit: G, first high and then low, the most significant bit of the first byte is the sign bit. See Note 3 for the specific algorithm. |
| 12 | Z-axis inclination | [-1.7，1.7] | 3 | $2^{-22}$ | Unit: G, first high and then low, the most significant bit of the first byte is the sign bit. See Note 3 for the specific algorithm. |
| 13 | Inclination state | —— | 1 | —— | All zeros are normal. See Table 5-10 for specific definitions. |
| 14 | X-axis gyro temperature | [-128，128] | 2 | $2^{-8}$ | Unit: °C, from high to low, the most significant bit of the first byte is the sign bit. See Note 4 for the specific algorithm. |
| 15 | Y-axis gyro temperature | [-128，128] | 2 | $2^{-8}$ | Unit: °C, from high to low, the most significant bit of the first byte is the sign bit. See Note 4 for the specific algorithm. |
| 16 | Temperature of Z-axis gyroscope | [-128，128] | 2 | $2^{-8}$ | Unit: °C, from high to low, the most significant bit of the first byte is the sign bit. See Note 4 for the specific algorithm. |
| 17 | Gyro Thermometer Status | —— | 1 | —— | All zeros are normal. See Table 5-10 for specific definitions. |
| 18 | X-axis plus surface temperature | [-128，128] | 2 | $2^{-8}$ | Unit: °C, from high to low, the most significant bit of the first byte is the sign bit. See Note 4 for the specific algorithm. |
| 19 | Y-axis plus surface temperature | [-128，128] | 2 | $2^{-8}$ | Unit: °C, from high to low, the most significant bit of the first byte is the sign bit. See Note 4 for the specific algorithm. |
| 20 | Z-axis plus surface temperature | [-128，128] | 2 | $2^{-8}$ | Unit: °C, from high to low, the most significant bit of the first byte is the sign bit. See Note 4 for the specific algorithm. |
| 21 | Add thermometer status | —— | 1 | —— | All zeros are normal. See Table 5-10 for specific definitions. |
| 22 | X-axis tilt temperature | [-128，128] | 2 | $2^{-8}$ | Unit: °C, from high to low, the most significant bit of the first byte is the sign bit. See Note 4 for the specific algorithm. |

| | | | | | |
|---|---|---|---|---|---|
| 23 | Y-axis tilt temperature | [-128，128] | 2 | $2^{-8}$ | Unit: ℃, from high to low, the most significant bit of the first byte is the sign bit. See Note 4 for the specific algorithm. |
| 24 | Z-axis tilt temperature | [-128，128] | 2 | $2^{-8}$ | Unit: ℃, from high to low, the most significant bit of the first byte is the sign bit. See Note 4 for the specific algorithm. |
| 25 | Dip Thermometer Status | —— | 1 | —— | All zeros are normal. See Table 5-10 for specific definitions. |
| 26 | Frame counter | [0，255] | 1 | 1 | 0-255 continuous count |
| 27 | Delay | | 2 | | Unit: us, first high and then low, the most significant bit of the first byte is the sign bit. See Note 5 for the specific algorithm. |
| 28 | CRC32 | —— | 4 | —— | CRC32 verification, see instruction 6 |

Explain

1) Gyro angular velocity output [°/s] $= \dfrac{AR_1 \cdot 2^{16} + AR_2 \cdot 2^8 + AR_3}{2^{14}}$ See Figure 5-1 for data bit format;

Among $AR_1$ Outputting the high eight bits of the three bytes for the angular velocity of each axis of the gyroscope;

$AR_2$ Outputting the middle eight bits of the three bytes for the angular velocity of each axis of the gyroscope;

$AR_3$ Outputs the lower eight bits of the three bytes for the angular velocity of each axis of the gyro.

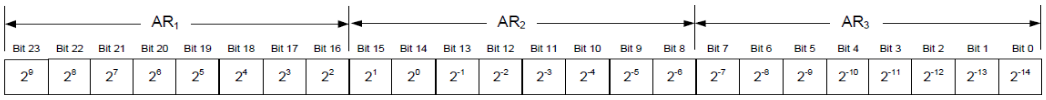


Figure 5-1 Converting the Gyro Angular Velocity Output to [°/s]

If the angular velocity range of the gyro is configured as ± 2000 °/s, the scale factor is 212;

2) Acceleration speed output [G] $= \dfrac{AR_1 \cdot 2^{16} + AR_2 \cdot 2^8 + AR_3}{2^X}$;

Among $AR_1$ Outputs the upper eight bits of the three bytes for the angular velocity of each axis of the accelerometer;

$AR_2$ Outputs the middle eight bits of the three bytes for the angular velocity of each axis of the accelerometer;

$AR_3$ Outputs the lower eight bits of the three bytes for the angular velocity of each axis of the accelerometer.

X is the tabulated scale index, and 10g, 30g, 50g, and 80g are tabulated for X = 19, 18, 17, and 16.

3) Tilt speed output [G] = $\frac{AR_1 \cdot 2^{16} + AR_2 \cdot 2^8 + AR_3}{2^{22}}$;

Among $AR_1$ Outputs the upper eight bits of the three bytes for the angular velocity of each axis of the tilt angle;

$AR_2$ The middle eight bit of that three bytes are output for the angular velocity of each axis of the tilt angle;

$AR_3$ The lower eight bits of the three bytes are output for the angular velocity of each axis of the tilt angle.

4) Temperature output [°C] = $\frac{T_1 \cdot 2^8 + T_2}{2^8}$ ? See Figure 5-2 for data bit format.

Among $T_1$ Outputs the upper eight bits of the two bytes for each axis temperature;

$T_2$ Outputs the lower eight bits of the two bytes for each axis temperature.

| $T_1$ | | | | | | | | $T_2$ | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bit 15 | Bit 14 | Bit 13 | Bit 12 | Bit 11 | Bit 10 | Bit 9 | Bit 8 | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
| $2^7$ | $2^6$ | $2^5$ | $2^4$ | $2^3$ | $2^2$ | $2^1$ | $2^0$ | $2^{-1}$ | $2^{-2}$ | $2^{-3}$ | $2^{-4}$ | $2^{-5}$ | $2^{-6}$ | $2^{-7}$ | $2^{-8}$ |

Figure 5-2 Converting Temperature Output to [°C]

5) Delay time output [us] = $T_1 \cdot 2^8 + T_2$

Wherein, T1 is the high eight bits in the two bytes of the delay time output;

T2 is the lower eight bits of the two bytes of the delay time output.

6) CRC check method

CRC checks all bytes from the data frame header to the check bit, using the standard CRC-32 polynomial:

$$x^{32} + x^{26} + x^{23} + x^{22} + x^{16} + x^{12} + x^{11} + x^{10} + x^{8} + x^{7} + x^{5} + x^{4} + x^{2} + x + 1$$

seed = 0xFFFFFFFF

See Appendix B for a list of table and table lookup function codes generated from this polynomial.

## 5.4 Self-check function and real-time output function of working status

The product has the functions of self-checking and real-time output of working status. The data frame contains a byte indicating the status, and the real-time output of the working status information of the product is started after the power-on start is completed. The status bits are defined in Table 5-10.

Table 5-10 Product Status Bit Definitions

| Bit | Definition |
|---|---|
| 7 | 0 = normal, 1 = system-wide abnormal |
| 6 | 0 = normal, 1 = starting |
| 5 | 0 = normal, 1 = abnormal external environment |
| 4 | 0 = normal, 1 = three axes out of service condition |
| 3 | 0 = normal, 1 = error in three-axis output |
| 2 | 0 = OK, 1 = Z axis out of use condition or error |
| 1 | 0 = OK, 1 = Y axis out of use condition or error |
| 0 | 0 = OK, 1 = X axis out of use condition or error |

# 6 Functional testing

## 6.1 Test equipment and instrumentation required

The equipment and instruments required in the test include: DC regulated power supply, computer, turntable, test tooling and test cable.

## 6.2 Functional testing

The product is in a static state, and the DC regulated power supply is used to supply power to the product. The power supply requirements meet the requirements of 1.2. The specific connection mode of the product is shown in Figure 6-1. Data is received according to the communication protocol, and the angular velocity output of the product is received and displayed by the upper computer receiving software.

Rotate the gyro assembly in the X, Y and Z directions respectively (input by the turntable if conditions permit, and rotate by hand if no conditions permit), and the angular velocity output of the corresponding axis can be monitored as the positive angular rate. Rotate the product reversely around X, Y and Z respectively, and the angular velocity output of the corresponding axis can be monitored to be a negative angular velocity. It indicates that the angular velocity output polarity of the product is correct. The three angular rate values at the output of the product shall be in the vicinity of 0 deg/s under stationary conditions.

The acceleration output of the corresponding axis can be monitored to be 1G by overtaking X, Y and Z in the forward direction respectively. Under static conditions, the acceleration of the product is about 0 G at the output of two axes and about 1 G at the output of the third axis.

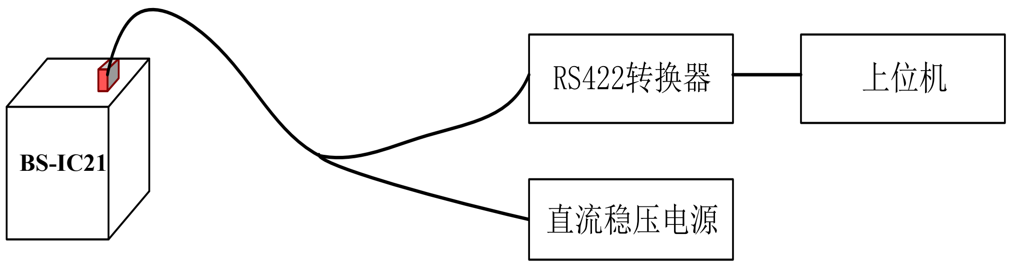


Fig. 6-1 Schematic diagram of IMU test connection

## 7 Use and maintenance requirements

Before use, the installation position of the system must be checked to ensure correct installation. Carefully check the connection of each signal line to ensure that the connection is correct.

Before power-on, check the cable network contact and power supply value, and the polarity of power supply shall not be reversed.

In use, the mechanical grounding of the system shall be well grounded.

This product contains precision instruments. Knocking and falling are prohibited.

This product should be stored in a well-ventilated warehouse with a temperature of (15 ~ 35) ℃, a relative humidity of not more than 75%, and free of acid, alkali and corrosive gases.

# 8 Common fault phenomena

The following is a list of several common faults that may occur during use. You can check them according to the fault mode first. If you have other problems, you can contact the after-sales service.

Table 8-1 Failure Mode Conditions

| Serial number | Fault symptom | Cause of failure |
|---|---|---|
| 1. | Abnormal current output (large or small) | Abnormal power supply of the product caused by excessive power supply voltage (beyond the tolerance of the product) or reverse connection of the positive and ground of the power supply |
| 2. | Current output is 0 | The power cable inside the product is disconnected. |
| 3. | There is no data on the serial port | 1) If the serial port transceiver cable is connected incorrectly, the product Tx shall be connected to the user Rx, and the product Rx shall be connected to the user Tx;<br>2) The serial port cable inside the product is disconnected |
| 4. | Incorrect serial port data | Receiving serial port setting error, such as baud rate, parity bit, etc. |
| 5. | Unpacking data exception | Unpacking function writing error, such as high and low byte order error, etc |
| 6. | Glitch or jitter in sensor data | The product was not tested in a static environment while collecting data |
| 7. | Sensor does not respond to external input | No Response Due to Soldering Problem of Sensor Sensing Element |

# Appendix A Packing List

Product supporting table

| Serial number | Name | Quantity | Unit | Remark |
|---|---|---|---|---|
| 1 | Products | 1 | | |
| 2 | Product certificate | 1 | Share | |
| 3 | Product certificate | 1 | Share | |
| 4 | Instructions for use (electronic version) | 1 | Share | |
| 5 | Anti-static packaging bag | 1 | A | |

};

# Annex B Informative Annex

## B1 CRC32 lookup table

```
static Uint32 crc_table[256]={
0x00000000, 0x04c11db7, 0x09823b6e, 0x0d4326d9, 0x130476dc, 0x17c56b6b, 0x1a864db2,
0x1e475005, 0x2608edb8, 0x22c9f00f,   0x2f8ad6d6, 0x2b4bcb61, 0x350c9b64, 0x31cd86d3,
0x3c8ea00a, 0x384fbdbd,0x4c11db70, 0x48d0c6c7, 0x4593e01e, 0x4152fda9,   0x5f15adac,
0x5bd4b01b, 0x569796c2, 0x52568b75, 0x6a1936c8, 0x6ed82b7f, 0x639b0da6, 0x675a1011,
0x791d4014, 0x7ddc5da3,   0x709f7b7a, 0x745e66cd,0x9823b6e0, 0x9ce2ab57, 0x91a18d8e,
0x95609039, 0x8b27c03c, 0x8fe6dd8b, 0x82a5fb52, 0x8664e6e5,   0xbe2b5b58, 0xbaea46ef,
0xb7a96036, 0xb3687d81, 0xad2f2d84, 0xa9ee3033, 0xa4ad16ea, 0xa06c0b5d, 0xd4326d90,
0xd0f37027,   0xddb056fe, 0xd9714b49, 0xc7361b4c, 0xc3f706fb, 0xceb42022, 0xca753d95,
0xf23a8028, 0xf6fb9d9f, 0xfbb8bb46, 0xff79a6f1,   0xe13ef6f4, 0xe5ffeb43, 0xe8bccd9a,
0xec7dd02d,0x34867077, 0x30476dc0, 0x3d044b19, 0x39c556ae, 0x278206ab, 0x23431b1c,
0x2e003dc5, 0x2ac12072, 0x128e9dcf, 0x164f8078, 0x1b0ca6a1, 0x1fcdbb16, 0x018aeb13,
0x054bf6a4, 0x0808d07d, 0x0cc9cdca,   0x7897ab07, 0x7c56b6b0, 0x71159069, 0x75d48dde,
0x6b93dddb, 0x6f52c06c, 0x6211e6b5, 0x66d0fb02, 0x5e9f46bf, 0x5a5e5b08,   0x571d7dd1,
0x53dc6066, 0x4d9b3063, 0x495a2dd4, 0x44190b0d, 0x40d816ba,0xaca5c697, 0xa864db20,
0xa527fdf9, 0xa1e6e04e,   0xbfa1b04b, 0xbb60adfc, 0xb6238b25, 0xb2e29692, 0x8aad2b2f,
0x8e6c3698, 0x832f1041, 0x87ee0df6, 0x99a95df3, 0x9d684044,   0x902b669d, 0x94ea7b2a,
0xe0b41de7, 0xe4750050, 0xe9362689, 0xedf73b3e, 0xf3b06b3b, 0xf771768c, 0xfa325055,
0xfef34de2,   0xc6bcf05f, 0xc27dede8, 0xcf3ecb31, 0xcbffd686, 0xd5b88683, 0xd1799b34,
0xdc3abded, 0xd8fba05a,0x690ce0ee, 0x6dcdfd59,   0x608edb80, 0x644fc637, 0x7a089632,
0x7ec98b85, 0x738aad5c, 0x774bb0eb, 0x4f040d56, 0x4bc510e1, 0x46863638, 0x42472b8f,
0x5c007b8a, 0x58c1663d, 0x558240e4, 0x51435d53,0x251d3b9e, 0x21dc2629, 0x2c9f00f0,
0x285e1d47, 0x36194d42, 0x32d850f5,   0x3f9b762c, 0x3b5a6b9b, 0x0315d626, 0x07d4cb91,
0x0a97ed48, 0x0e56f0ff, 0x1011a0fa, 0x14d0bd4d, 0x19939b94, 0x1d528623,   0xf12f560e,
0xf5ee4bb9, 0xf8ad6d60, 0xfc6c70d7, 0xe22b20d2, 0xe6ea3d65, 0xeba91bbc, 0xef68060b,
0xd727bbb6, 0xd3e6a601,   0xdea580d8, 0xda649d6f, 0xc423cd6a, 0xc0e2d0dd, 0xcda1f604,
0xc960ebb3,0xbd3e8d7e, 0xb9ff90c9, 0xb4bcb610, 0xb07daba7,   0xae3afba2, 0xaafbe615,
0xa7b8c0cc, 0xa379dd7b, 0x9b3660c6, 0x9ff77d71, 0x92b45ba8, 0x9675461f, 0x8832161a,
0x8cf30bad,   0x81b02d74, 0x857130c3, 0x5d8a9099, 0x594b8d2e, 0x5408abf7, 0x50c9b640,
0x4e8ee645, 0x4a4ffbf2, 0x470cdd2b, 0x43cdc09c,   0x7b827d21, 0x7f436096, 0x7200464f,
0x76c15bf8, 0x68860bfd, 0x6c47164a, 0x61043093, 0x65c52d24,0x119b4be9, 0x155a565e,
0x18197087, 0x1cd86d30, 0x029f3d35, 0x065e2082, 0x0b1d065b, 0x0fdc1bec, 0x3793a651,
0x3352bbe6, 0x3e119d3f, 0x3ad08088,   0x2497d08d, 0x2056cd3a, 0x2d15ebe3, 0x29d4f654,
0xc5a92679, 0xc1683bce, 0xcc2b1d17, 0xc8ea00a0, 0xd6ad50a5, 0xd26c4d12,   0xdf2f6bcb,
0xdbee767c, 0xe3a1cbc1, 0xe760d676, 0xea23f0af, 0xeee2ed18, 0xf0a5bd1d, 0xf464a0aa,
0xf9278673, 0xfde69bc4, 0x89b8fd09, 0x8d79e0be, 0x803ac667, 0x84fbdbd0, 0x9abc8bd5,
0x9e7d9662, 0x933eb0bb, 0x97ffad0c, 0xafb010b1, 0xab710d06,   0xa6322bdf, 0xa2f33668,
0xbcb4666d, 0xb8757bda, 0xb5365d03, 0xb1f740b4
    };
```

B2 is a table lookup function that returns the calculated CRC value

```
void CRC32(Uint16 *pch,int len)
{
Uint32 reg = 0xFFFFFFFF; //initial value
    int i;
int Res=0; Remainder of//4
if((len%4)! =0)
     {
Res=4-len%4; //Need to supplement the number of 0 for calculating crc32
     }
   for( i = 0; i < len; i++)
     {
        reg = (reg<<8) ^ crc_table[(((reg>>24)&0xFF) ^ pch[i])];
     }
for( i = 0; i < Res; I + +)//Extra 0 needs to be asked to participate in CRC
     {
          reg = (reg<<8) ^ crc_table[(((reg>>24)&0xFF) ^ 0x00)];
     }
    crc_data[0] = (reg>>24) & 0xFF;
    crc_data[1] = (reg>>16) & 0xFF;
    crc_data[2] = (reg>>8) & 0xFF;
    crc_data[3] = reg & 0xFF;
    return;
}
```

The CRC _ data [0] to the CRC _ data [3] is the calculated CRC32 value.