MINS200

Low Cost Digital Output MINS

Technical Manual

MINS200
Low Cost Digital Output




Introduction

MINS200 is a low cost digital MINS developed and produced by Bewis Sensing Technology LLC. Without relying on external signal input, it can automatically calculate the azimuth angle, roll angle, and roll angle of the measured carrier through acceleration and angular velocity information. Pitch angle, angular velocity, acceleration, Euler angle, quaternion information, suitable for inertial attitude measurement in various states of motion, vibration or static.

MINS200 uses highly reliable MEMS accelerometers and gyroscopes. The attitude information data deviation is estimated by the 6-state Kalman filter with appropriate gain, and the measurement accuracy is ensured by the algorithm. The attitude motion parameters are compensated through nonlinear compensation, orthogonal compensation, Various compensations such as temperature compensation and drift compensation can greatly eliminate errors and improve product accuracy. This product has a digital interface and can be easily integrated into the system.

Features

- Dynamic accuracy：0.5°
- Static accuracy：0.01°
- Heading keeping accuracy：0.3°/60s
- Special offset tracking algorithm to eliminate drift
- Output mode: RS485/232/TTL optional
- Operating temperature：-40℃~+85℃
- High-performance Kalman filter algorithm
- Small size： L60 × W59× H29mm

Applications

- Unmanned boats and underwater vehicles
- Robot
- Stable platform
- Large ships
- AGV
- Automatic and unmanned driving
- Special vehicles
- Unmanned aerial vehicle

Specifications

Electrical Specifications

Power supply	9-35VDC
Operating current	30mA （40mA Max)
Operating temperature	-40~+85℃
Store temperature	-55~+100℃

Performance Specifications

Attitude parameters	Dynamic accuracy	0.5°
	Static accuracy	0.01°
	Measuring range	Pitch ± 90°, Roll ± 180°
	heading accuracy	0.3°/60s
Gyro	Resolution	0.01°/sec
	Range	±400°/sec
	Bias stability at full temperature	20 °/h（10s,1σ)
	Angle random walk coefficient	< 0.1 °/√h
	Bias repeatability	< 50 °/h（1σ)
	Scale factor nonlinearity	≤100ppm（1σ)
	Scale factor nonlinearity	≤100ppm（1σ)
	Bandwidth	100Hz
Accelerometer	Range：X,Y,Z	±3.6 g
	Bias stability	0.001mg（25℃，100s，1σ) 0.01mg（25℃，10s，1σ)
Interface characteristics	Way of communication	RS232/RS485/TLL
	Maximum output frequency	200Hz
MTBF	≥100000 hours/time	
Electromagnetic compatibility	According toGBT17626	
Insulation resistance	≥100 MΩ	
Shock resistance	2000g，0.5ms，3times/axis	
Weight（With line)	280g	

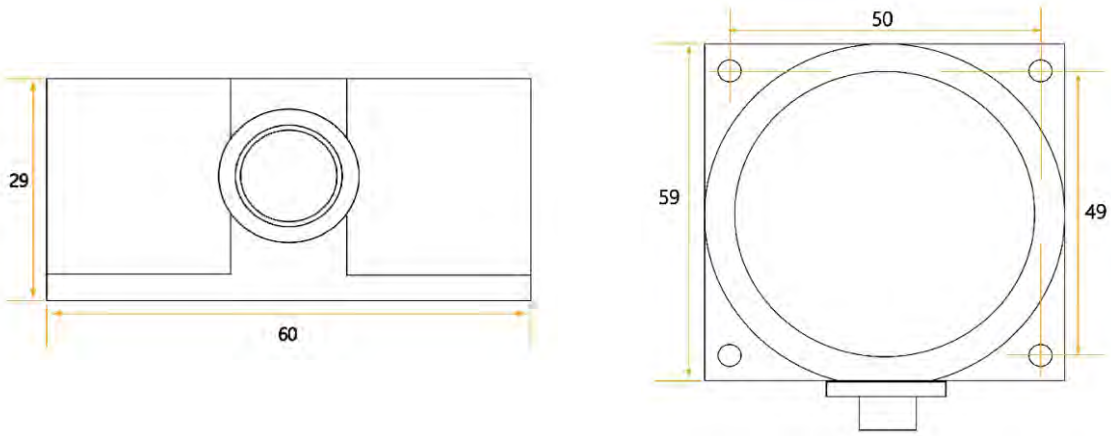
Resolution: The measured minimum change value that the sensor can detect and resolve within the measurement range.
Accuracy: The error between the actual angle and the Root mean square(RMS) of the measured angle of the sensor (≥16 times).

Mechanical Characteristic

Connector	Metal connector (standard cable is 1.5m)
Protection level	IP67
Shell material	Magnesium alloy sanding oxidation
Installation	Four M4 screws

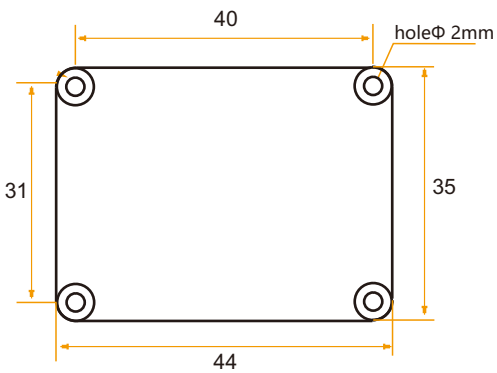
Package size

Product Size：L60*W59*H29（mm）



Bare plate product size

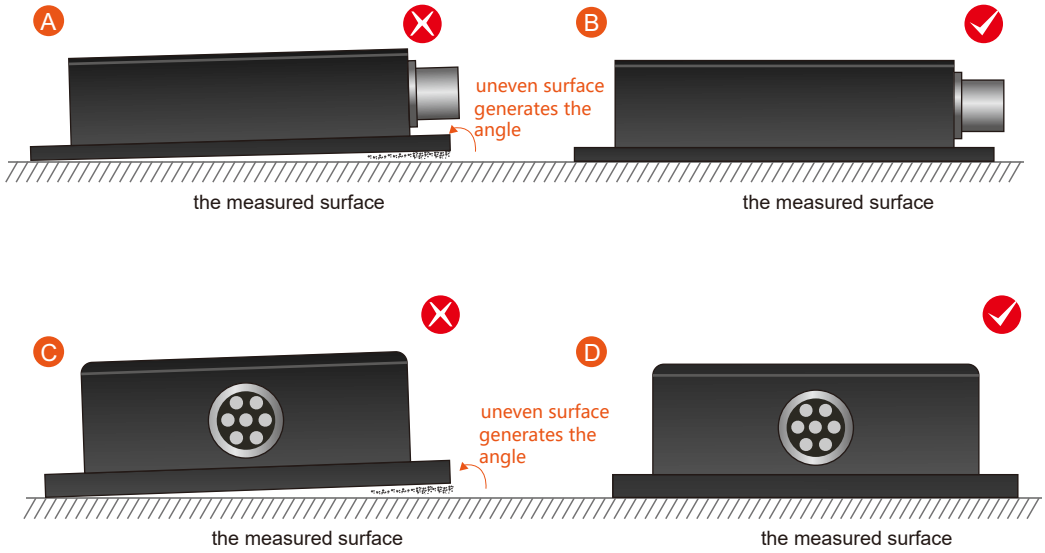
Product size：L44*W35*H11（mm） Note: ±1mm error for length and width dimensions, please refer to actual size



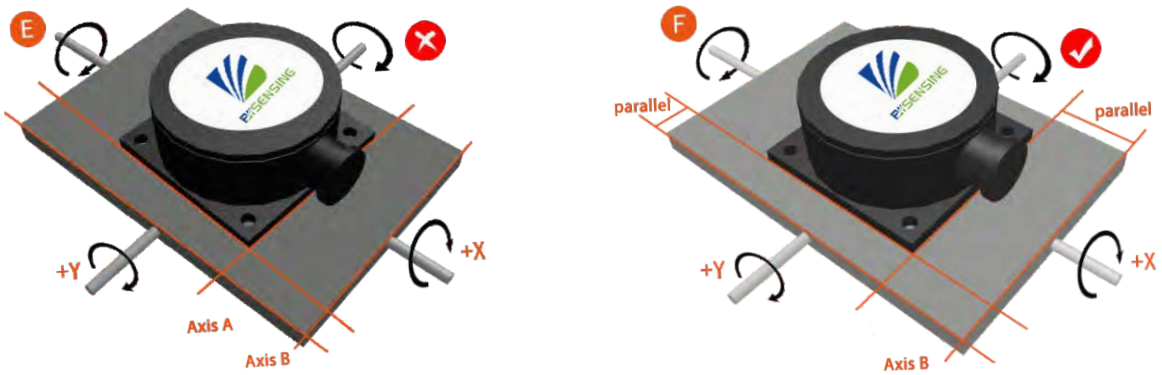
Installation direction

The correct installation method can avoid measurement error. The following points should be made when installing the sensor:

First of all, to ensure that the sensor mounting surface and the measured surface completely close, the measured surface should be as horizontal as possible, can not have the angle shown in Figure A and Figure C, the correct installation is shown in Figure B and Figure D.



Secondly, the bottom cable of the sensor and the axis of the measured object shouldn't generate the angle shown in E. When installing, the bottom cable of the sensor should be kept parallel or orthogonal to the rotation axis of the measured object. This product can be installed horizontally or vertically (vertical installation requires customization). The correct installation method is shown in Figure F.

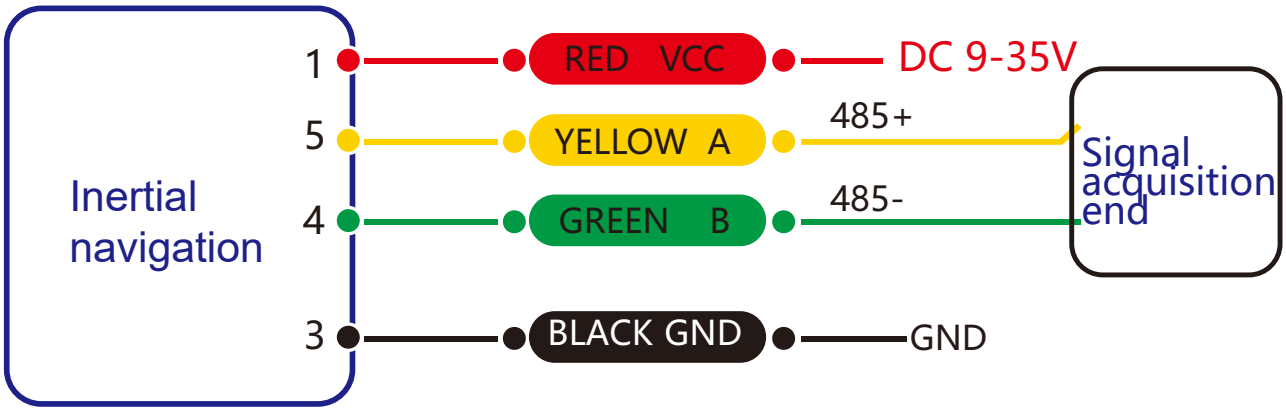


Finally, the installation surface of the sensor must be fixed with the measured surface tightly and smoothly, to avoid measurement error that may be caused by the acceleration and vibration.

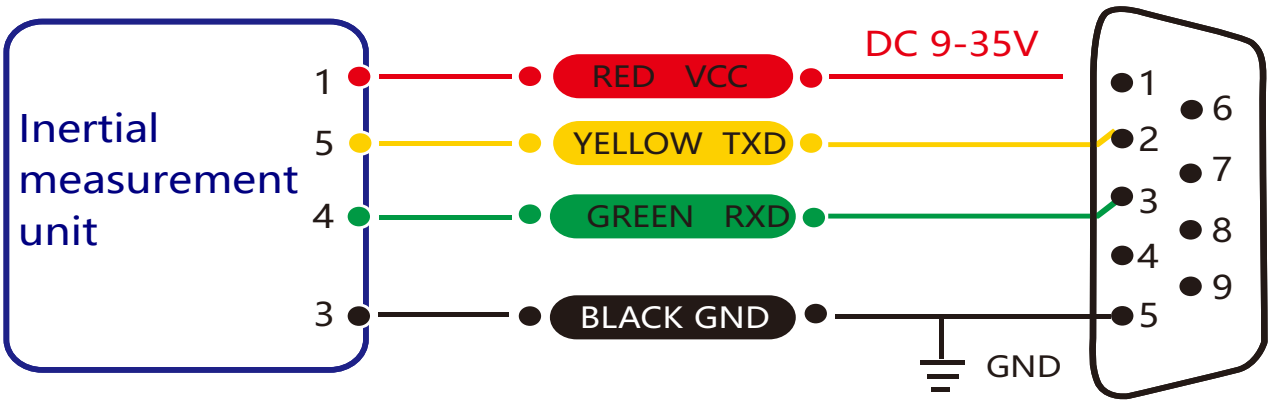
电气连接

Electrical interfaces

Cable color & function	RED	BLUE	BLACK	GREEN	YELLOW
	1	2	3	4	5
	VCC DC 9-35V	NC	GND	RXD (B、D-)	TXD (A、D+)



RS 485wiring diagram



RS 232 wiring diagram

Debugging software

Users can directly download serial assistant on official website (Supports-Download). You can also use more convenient and intuitive PC software.

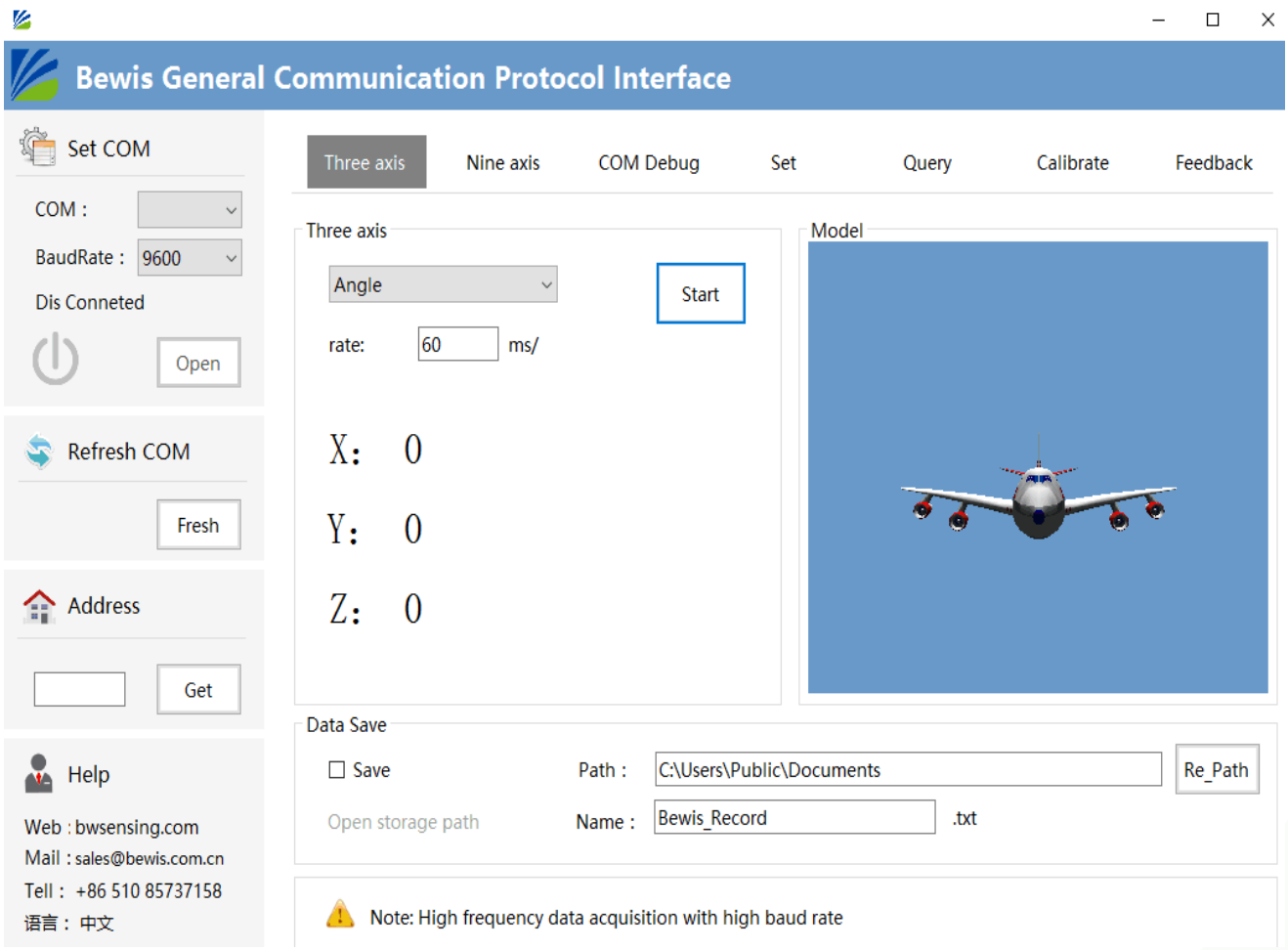
BW-IMU200 supporting serial debugging software can be connected to the inclinometer on the computer for angle display. The software debugging interface is as shown in the figure below. Using the debug software, it can conveniently display the current X-direction tilt angle, and you can also modify and set other parameters by yourself.

Software usage steps

① Connect the serial port hardware of the inclinometer correctly and connect the power supply.

② Select the computer serial port and baud rate and click to connect to the serial port.

③ Click Start and the tilt angle of the inclinometer in the X and Y directions will be displayed on the screen.



Protocol

1Data Frame Format : (8 data bits , 1 stop bit , No parity check , default baud rate 9600)

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (Xbyte)	Checksum (1byte)
0x77H					

Data Format: Hexadecimal
Identifier: Fixed to 77
Frame Length: Length from Frame Length to Checksum (included)
Address Code: Address of acquiring module, default 0x00
Data: Content and length variable according to Command
Checksum: Sum of Frame Length, Address Code, Command and Data. (Please pay attention that when the command or data changes, the checksum will change.)

2 Command Format

2.1 Read PITCH angle Command : 77 04 00 01 05

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (0byte)	Checksum (1byte)
0x77	0x04		0x01		0x05

Command response :

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (3byte)	Checksum (1byte)
0x77	0x07		0x81	SXXX.YY	

Note: Data represents 3 byte angle value in format of compressed BCD code. S is the sign bit (0 means positive, 1 means negative), XXX is the three digit integer part, YY is the fractional part. For example, if the return value is 77 07 00 81 10 34 63 2F, the pitch angle data is “10 34 63”, which means “-34.63 degrees”.”

2.2 Read ROLL angle Command : 77 04 00 02 06

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (0byte)	Checksum (1byte)
0x77	0x04		0x02		0x06

Command response :

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (3byte)	Checksum (1byte)
0x77	0x07		0x82	SXXX.YY	

Note: Data represents 3 byte angle value in format of compressed BCD code. S is the sign bit (0 means positive, 1 means negative), XXX is the three digit integer part, YY is the fractional part.For example, if the return value is 77 07 00 82 01 23 57 04, the roll angle data is "01 23 57", which means "123.57 degrees"

2.3 Read heading azimuth angle Command: 77 04 00 03 07

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (0byte)	Checksum (1byte)
0x77	0x04		0x03		

Command response :

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (3byte)	Checksum (1byte)
0x77	0x07		0x83	SXXX.YY	

Note: The data field is a 3-byte return angle value, which is a compressed BCD code, S is the sign bit (0 positive, 1 negative), XXX is a three-digit integer value, and YY is a two-digit decimal value. If the return value is 77 07 00 83 01 47 03 D5, the azimuth angle data is "01 47 03", which means "147.03 degrees".

2.4 Read PITCH, ROLL axis angle Command : 77 04 00 04 08

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (0byte)	Checksum (1byte)
0x77	0x04		0x04		

Command response :

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (9byte)	Checksum (1byte)
0x77	0x0D		0x84	SXXX.YY	

PITCH axis: -1.47°, ROLL axis: -2.70°, YAW axis: 90.91°

77 0D 00 84 10 01 47 10 02 70 00 90 91 8C

Identifier; fixed as 77

The length of the data, fixed to 0D means that in addition to 77, there are 13 bytes behind

Address code, default is 00

Command word, fixed at 84

PITCH axis angle:
The first digit of the first byte is the sign bit, 0 is the positive angle, and 1 is the negative angle.
The second and second bytes of the first byte are integer bits of the angle, which are compressed BCD codes.
The third byte is the decimal place of the angle, which is the compressed BCD code.

ROLL axis angle: The format is the same as the PITCH axis

YAW axis or reserved bit angle: the format is the same as the PITCH axis

The last byte is the sum of all the previous data except the first number (0x77). If there is a carry, the lower data is taken.

2.5 Set baud rate

Command: 77 05 00 0B 02 12

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (1byte)	Checksum (1byte)
0x77	0x05		0x0B	XX	

Command response :

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (1byte)	Checksum (1byte)
0x77	0x05		0x8B	0x00: success 0xFF: failure	

Note: 0x00 means 2400, 0x01 means 4800, 0x02 means 9600, 0x03 means 19200, 0x04 means 115200, 0x05 means 38400, 0x06 means 57600, 0x07 means 256000, the default value is 0x02:9600, each time the communication baud rate is successfully changed , Will send back the response command at the original baud rate, and then immediately change the device communication baud rate.
Note: If you need high frequency output, please set the baud rate to 115200 or 256000. Modifying the baud rate does not need to send a save command, it will take effect immediately.

2.6 Set module address

Command: 77 05 00 0F 01 15

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (1byte)	Checksum (1byte)
0x77	0x05	correct address	0x0F	new address	

Command response :

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (1byte)	Checksum (1byte)
0x77	0x05	new address	0x8F	0x00: success 0xFF: failure	

Note: For example, the following command "77 05 00 0F 0A 1E" means that the address of the product is changed from hexadecimal address 00 to 0A.

2.7 Query current address

Command: 77 04 00 1F 23

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (0byte)	Checksum (1byte)
0x77	0x04	0x00	0x1F		0x23

Command response :

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (1byte)	Checksum (1byte)
0x77	0x05	new address	0x1F	new address	

Note: The query address command is to fix the command.。

2.8 Set the output frequency

Command: 77 05 00 0C 00 11

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (1byte)	Checksum (1byte)
0x77	0x05		0x0C	XX	

Command response：

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (1byte)	Checksum (1byte)
0x77	0x05		0x8C	0x00: success 0xFF: failure	

The transmitted data field XX is the automatic output frequency option: 00 indicates the answer mode,
01 indicates 5Hz automatic output corresponding data type parameter
02 indicates 10Hz automatic output corresponding data type parameter
03 indicates 20Hz automatic output corresponding data type parameter
04 indicates 25Hz automatic output corresponding data type parameter
05 indicates 50Hz automatic output corresponding data type parameter
06 indicates 100HZ automatic output Corresponding data type parameter

Note: 1. When the automatic output frequency setting is high, the baud rate needs to be set to a high baud rate. Under some data types, 100HZ cannot be output due to the baud rate limit.
2. The automatic output data type parameter is determined according to the following data type selection command. The default is the automatic output angle.

2.9 Query gravitational acceleration g　Command: 77 04 00 54 58

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (0byte)	Checksum (1byte)
0x77	0x04		0x54		

Command response：

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (9byte)	Checksum (1byte)
0x77	0x0D		0x54	SXYYYY	

Note: The data field part is the value of g value of pitch, roll, Z axis (vertical horizontal plane), which consists of 1 bit sign bit + 1 bit integer bit + 4 decimal places.
If the return value is "77 0D 00 54 00 01 07 00 94 21 10 06 30 64", they are 0.0107g, 0.9421g, -0.0630g respectively.

2.10 Query angular velocity　Command: 77 04 00 50 54

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (0byte)	Checksum (1byte)
0x77	0x04		0x50		

Command response:

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (9byte)	Checksum (1byte)
0x77	0x0D		0x50	SXXXYY	

Note: The data field is the pitch, roll, and Z-axis (vertical horizontal) angular velocity. It consists of 1 sign bit + 3 integer bits + 2 decimal places.
For example, the return value is "77 0D 00 50 10 93 76 14 98 87 00 14 03 C0" . The data field parts are: pitch axis angular velocity: -93.76°/s, roll axis angular velocity: -498.87°/s Z-axis angular velocity :+14.03°/s

2.11 Save settings　Command: 77 04 00 0A 0E

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (0byte)	Checksum (1byte)
0x77	0x04		0x0A		

Command response:

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (1byte)	Checksum (1byte)
0x77	0x04		0x8A	00:success FF: failure	

Note: It is not necessary to save the settings to set the baud rate. Other settings need to send the save settings.

2.12 Quaternion Command: 77 04 00 57 5B

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (0byte)	Checksum (1byte)
0x77	0x04		0x57		

Command response :

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (16byte)	Checksum (1byte)
0x77	0x14		0x57	SXYYYYYY	

Note: The data field contains 16 bytes, 4 bytes are a group, respectively quaternary q0, q1, q2, q3, which is a compressed BCD code, the format is SX YY YY YY, S is a sign bit (0 positive, 1 negative), X is a 1-bit integer bit, and YYYYYY is a 6-digit decimal place. For example, the return command 77 14 00 57 00 99 99 96 00 00 02 90 10 00 26 73 10 00 00 01 7F
Then the quaternion data are:
Where q0 is 00 99 99 96, representing 0.999996.
q1 is 00 00 02 90, which means 0.000290
q2 is 10 00 26 73, which means -0.002673
q3 is 10 00 00 01, indicating -0.000001

2.13 Simultaneous reading angle, accelerometer, gyroscope, quaternion Command: 77 04 00 59 5D

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (0byte)	Checksum (1byte)
0x77	0x04		0x59	-	

Command response :

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (43byte)	Checksum (1byte)
0x77	0x2F		0x59	Data field	

Note: The data field contains 43 bytes, which are angle, gravitational acceleration g value, angular velocity, quaternion, compressed BCD code, four elements are the last 16 bytes, 4 bytes are a group, a total of 4 groups The rest is a group of 3 bytes, indicating the method to see the corresponding parameter return value.
For example, the return value is:
77 2F 00 59 10 00 60 10 03 06 00 00 00
10 01 07 10 05 43 01 01 54
10 00 13 10 00 04 00 00 09
10 87 06 35 00 01 76 91 00 02 06 94 00 49 11 75 5C
Then: the three axis angles are -0.6 degrees, -3.06 degrees, 0 degrees;
The g values of the three axes were -0.0107 g, -0.0543 g, and 1.0154 g, respectively;
The three angular angular velocities are -0.13 ° / s, -0.04 ° / s, 0.09 ° / s;
The four quaternions are -0.870635, 0.017691, 0.020694, 0.491175

2.14 Automatic output data type selection

Command: 77 05 00 56 00 5B

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (1byte)	Checksum (1byte)
0x77	0x05		0x56	XX	

Command response :

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (1byte)	Checksum (1byte)
0x77	0x05		0x56	00	

Note: The data field XX is the corresponding output data type, which needs to be carried out in automatic output mode:
0x00: During automatic output, the output parameter is three-axis angle data, and the output format refers to command 2.4;
0x01: During automatic output, the output parameter is the three-axis acceleration value, and the output format refers to command 2.9;
0x02: During automatic output, the output parameter is the value of the three-axis gyroscope, and the output format refers to command 2.10;
0x03: During automatic output, the output parameter is three-axis angle data (other data types are reserved);
0x04: During automatic output, the output parameter is a quaternary value, and the output format refers to command 2.12;
0x05: During automatic output, the output parameters are composed of angle, acceleration, angular velocity, and quaternion. For the output format, refer to command 2.13.

2.15 Clear heading angle

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (1byte)	Checksum (1byte)
0x77	0x04		0x82	-	

Command response :

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (1byte)	Checksum (1byte)
0x77	0x04		0x82	-	

Note: The program uses manual command to clear the azimuth angle. After sending the command, the program starts to recalculate the azimuth angle. The real-time calculated angle can be read by the host computer.

2.16 Relative angle setting

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (3byte)	Checksum (1byte)
0x77	0x07		0x84	-	

Command response :

Identifier (1byte)	Frame Length (1byte)	Address Code (1byte)	Command (1byte)	Data (3byte)	Checksum (1byte)
0x77	0x07		0x84	-	

Note: In the command, SX XX YY is the BCD code, S is the sign bit (0 is positive, 1 is negative), XXX is a three-digit integer, and YY is two decimal places. For example, you need to set the sensor heading angle start point to 100 , Then SX XX YY is 01 00 00.
The corresponding complete command is 77 07 00 84 01 00 00 8C

Ordering Information

Product number	Way of communication	Package condition
MINS200-485	RS485	IP67 Package/Metal Connector
MINS200-232	RS232	IP67 Package/Metal Connector
MINS200-TTL	TTL	IP67 Package/Metal Connector

Executive standard

- Enterprise Quality System Standard：ISO9001:2015 Standard（Certificate No. 23919Q10455R0S）
- CE certification（Certificate No. M.2019.103.UY1151）
- ROHS (Certificate No. G190930099)

MINS200

Low Cost Digital Output

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