GKP3 Low Frequency Vibration Sensor
Product Manual

V1.5-20260519

V1.5-20260427

Technical Highlights

- ❖ Triaxial MEMS vibration sensor;
- ❖ Resolution 1μg;
- ❖ Measurement range ±2g;
- ❖ Output options: RS485, RS232, TTL;
- ❖ IP67 protection rating.

Product Introduction

The GKP3 is a triaxial vibration sensor independently developed for low-frequency vibration monitoring, featuring high precision and low noise. Each product undergoes calibration and compensation across the entire temperature range and approximately 336 hours of long-term stability testing before leaving the factory, ensuring stable performance under diverse operating conditions and continuous testing cycles. The sensor supports static vibration measurement in the 0Hz or 0.1–100Hz frequency bands and integrates two output protocols, including the industry-standard MODBUS protocol. The accompanying computer analysis software enables real-time display, recording, and subsequent processing of measurement data. Output interfaces offer RS485, RS232, and TTL options. The sensor employs a non-contact installation design, facilitating system integration. Users simply need to fix it to the surface of the object being measured with screws to automatically obtain the object's horizontal angle, making operation simple. The product possesses excellent resistance to external electromagnetic interference and shock vibration, making it suitable for applications such as satellite communication systems, vehicle handling platforms, special command vehicles, and radar antenna vehicles.

Application Scope

- ❖ Low-frequency vibration monitoring of ground building structures
- ❖ Vibration measurement of large rotating equipment such as hydro-generator units
- ❖ Minor vibration measurement of vibration isolation platforms, etc.
- ❖ Ultra-low frequency amplitude measurement of highly flexible structures such as suspension bridges

Performance Parameters

GKP3	Parameter	Unit
Measurement Range	±2	g
Bias Calibration	<1	mg
Measurement Axis	X,Y,Z	Axis
Upward/Power-Off Repeatability	<2	mg(Max)
Bias Temp Coefficient	0.15	mg/℃(Type)
Resolution	1	ug
Nonlinearity	<1	% FS(Max)
Bandwidth (3dB)	0.1~100	Hz
Cross-Axis Sensitivity	1	%
Transverse Vibration Sensitivity Ratio	1	%
Noise Density	21	μg/√Hz
Resonant Frequency	2.4	kHz
Acceleration Power-On Settlement Time	1S	
Output Rate	5Hz/10Hz/25Hz/35Hz/50Hz/100Hz/200Hz/500Hz	
Output Interface	RS232/TTL/S485	
Communication Protocol	Serial communication protocol and MODBUS RTU protocol	
Input (VDD_VSS)	9~36 VDC	
Operating Current Consumption	<16mA @ 12 VDC	
Wiring Information	2-meter PVC black aviation plug shielded wire, weight ≤130g	
Connector	Aircraft connector M12*1.0 male 5-core	
Product Weight	≤450g(excluding cable)	

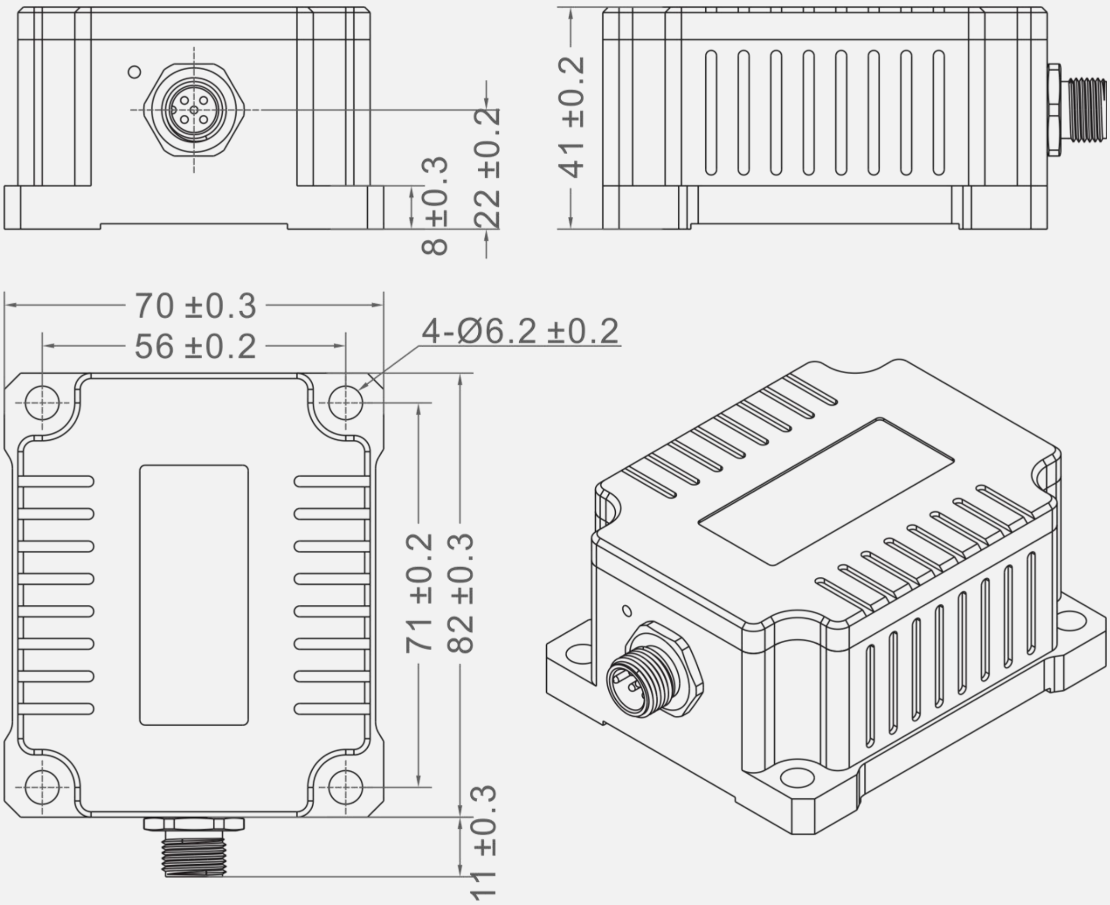
Note: Do not use beyond the specified range for extended periods.

Ordering and Selection

Model		Signal Output	Communication Protocol
GKP3	-	2: RS232	SP: Serial communication protocol
		3: TTL Level	MB: MODBUS Protocol
		4: RS485	

E.g: GKP3-2SP: RS232 signal output, Serial communication protocol

Product Dimensions



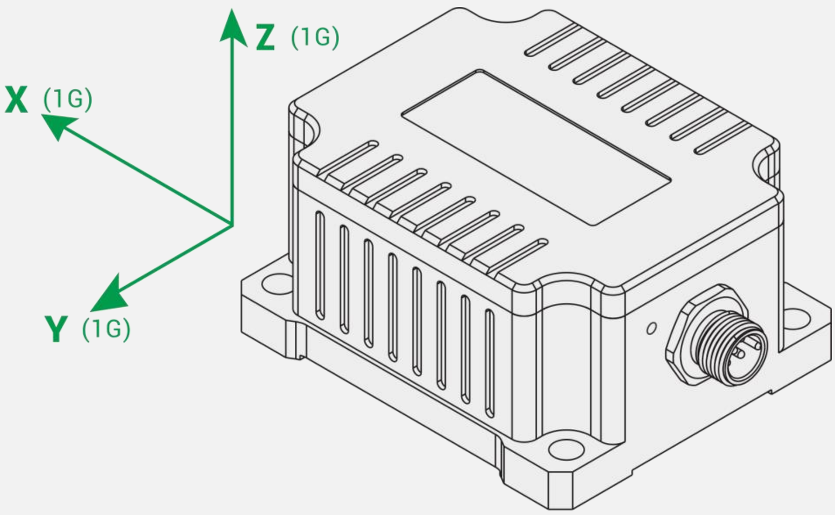
Housing dimensions: L93×W70×H41mm

Mounting dimensions: L71×W56×H8mm

Recommended screws: 4 M6 screws

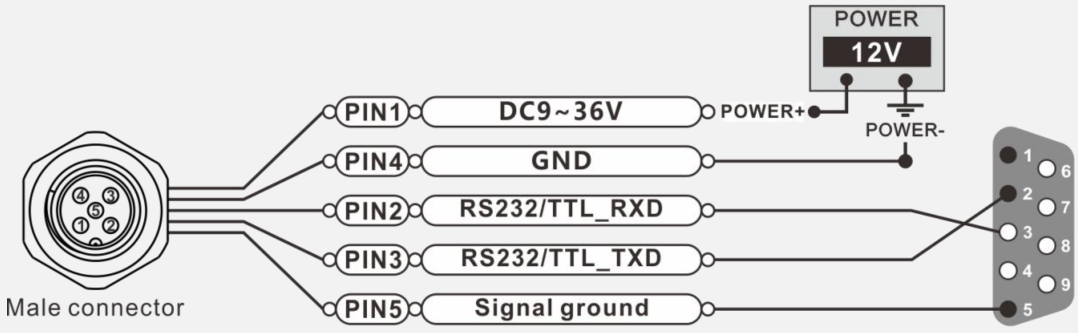
Installation Orientation

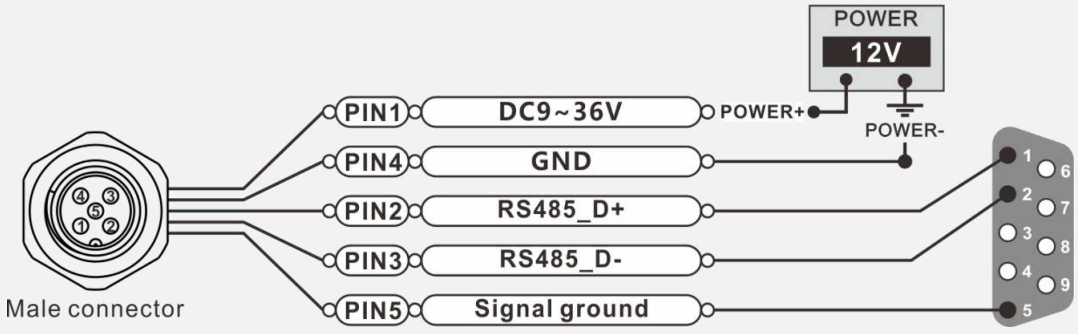
During installation, the sensor mounting surface should be kept parallel to the surface of the target object to minimize the impact of dynamics and acceleration on the sensor. This product can be installed horizontally or vertically; please refer to the diagram below for installation instructions:



PIN Definition

PIN / Thread Color	PIN Definition
PIN1/Brown	DC9 ~ 36V
PIN2/White	RS232/TTL_RXD / RS485_D+
PIN3/Blue	RS232/TTL_TXD / RS485_D-
PIN4/Black	GND
PIN5/Gray	Signal Ground





Interface connection instructions

1. Select cables that conform to RS-485/RS-232 standards, ensuring the cable quality and performance meet the requirements. Twisted-pair cable is recommended due to its better anti-interference capability.
2. At both terminal devices in the RS-485/RS-232 communication network, terminating resistors (typically 120 ohms) need to be connected to eliminate signal reflections. Avoid connecting terminating resistors on intermediate devices to prevent signal interference.
3. To ensure system stability and security, the RS-485/RS-232 communication network needs to be grounded. The signal ground wire should be connected to the grounding terminal of each device.

Vibration working principle

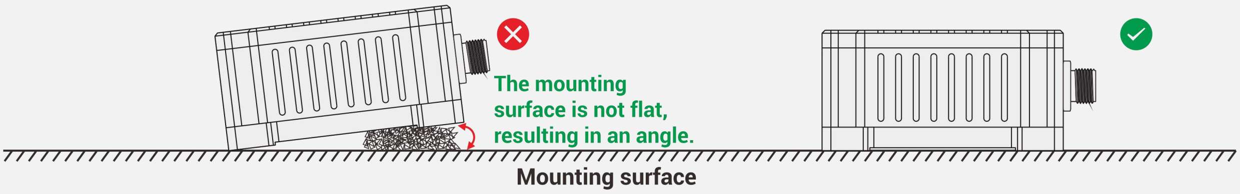
It adopts an imported core control unit and utilizes the principle of a capacitive miniature pendulum. Taking advantage of the principle of Earth's gravity, when the pendulum tilts, the Earth's gravity will generate a gravitational component on the corresponding pendulum, causing a change in capacitance. The capacitance value is amplified, filtered, and converted to obtain the acceleration. Based on the collected acceleration, algorithmic processing and data analysis are performed to obtain frequency and amplitude data.

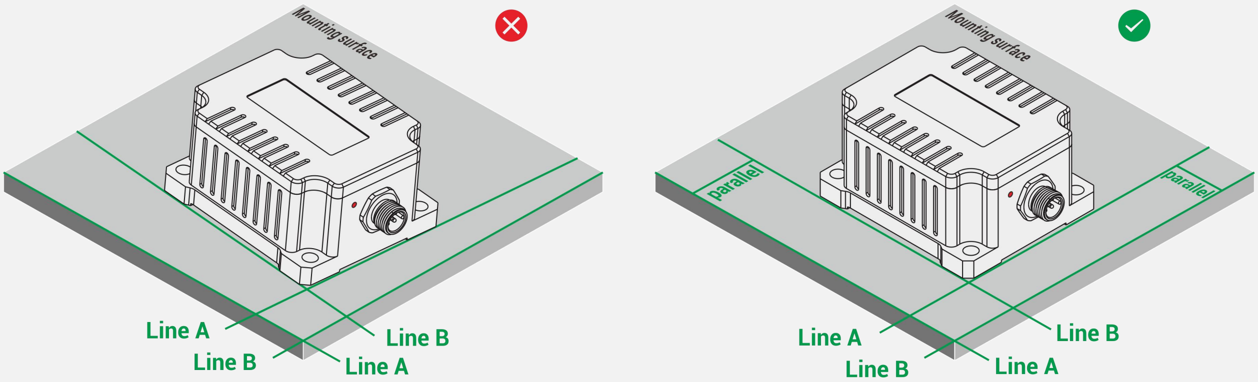
Installation Precautions

Please install the tilt sensor correctly. Incorrect installation will lead to measurement errors. Pay special attention to two key aspects:

1) The sensor mounting surface must be tightly, flat, and stable against the surface being measured. Uneven mounting surfaces can easily cause angular errors in the sensor measurement.

2) The sensor axis and the axis being measured must be parallel, and the two axes should ideally not form an angle.





Communication Protocol

The product supports two protocols: serial communication and MODBUS RTU. The default configuration parameters for the protocols are as follows:

Protocol	Serial communication protocol	MODBUS-RTU Protocol
Address Code	0	1
Broadcast Address	255	0
Serial Port Baud Rate	9600	9600
Parity Bit	No parity	Even parity
Serial Port Start Bit	1 bit	1 bit
Serial Port Data Length	8 bit	8 bit
Serial Port Stop Bit	1 bit	1 bit
Output Mode	Questions and Answers	Questions and Answers
Data Verification Method	Checksum	CRC16

Default output data field format description

Serial communication protocol format description

Serial communication read format	Identifier (1byte)	Data length (1byte)	Address code (1byte)	Command word (1byte)	Data field (1byte)	Checksum (1byte)
Read command	0x68	0x04	Address code	0x18	No	-
Serial communication return format	Identifier (1byte)	Data length (1byte)	Address code (1byte)	Command Word (1byte)	Data Field (12byte)	Checksum (1byte)
Return command	0x68	0x10	Address code	0x98	See the table below for definitions.	-

MB Protocol Format Description

MB reading format	Address code (1byte)	Function code (1byte)	Register address (2byte)	Register length (2byte)	Check CRC (2byte)
Read command	Address code	0x03	0x0028	0x0006	-
MB return format	Address code (1byte)	Function Code (1byte)	Data length (1byte)	Data Field(12byte)	-
Return command	Address code	0x03	0x0C	See the table below for definitions.	-

1. Data Type:

Type	Description
INT16	Signed 16-bit integer
UINT16	Unsigned 16-bit integer
INT32	Signed 32-bit integer
UINT32	Unsigned 32-bit integer
R	Read-only

2. Register table

Register address	Data content	Data type	Coefficient	Unit	Remarks
40035~40040	Reserved	-	-	-	-
40040	Status	UINT16(R)	1	-	Bit 15 is 1, indicating valid data.
40041	Real-time X-axis acceleration	INT32(R)	0.000001	g	-2~2g
40043	Real-time Y-axis acceleration	INT32(R)	0.000001	g	-2~2g
40045	Real-time Z-axis acceleration	INT32(R)	0.000001	g	-2~2g
40071	Temperature	INT16(R)	0.01	℃	-50~125℃

3. Analysis and Explanation

The data field format uses big-endian mode, which is parsed as a data value multiplied by a coefficient. For example, the X-axis acceleration FF FF 4C 58 is -45992, and the result is -45992*0.000001=-0.045992g. The Y-axis acceleration 00 01 86 A0 is 100000*0.000001=0.1g.

Automatically output data items

This output item is related to the automatic output mode command. The corresponding bit position determines the output, with lower bits indicating earlier data content. The automatic output item is 07F7H, meaning all content is output in the following order from left to right: Reservation Count | Status | Acceleration | Temperature.

Bit0	Bit1	Bit2	Bit3
-	Status	Acceleration	-
Bit4	Bit5	Bit6	Bit7
-	-	-	-
Bit8	Bit9	Bit10	Bit11
Temperature	-	-	-
Bit12	Bit13	Bit14	Bit15

Serial communication protocol

1. Data Frame Format:

Identifier (1byte)	Data Length (1byte)	Address Code (1byte)	Command Word (1byte)	Data Field	Checksum (1byte)
0x68	-	-	-	-	-

Default communication parameters: Address 0, Baud rate 9600, 1 start bit, 8 data bits, no parity, 1 stop bit
Valid address range: 0~254
Identifier: Fixed at 0x68;
Data length: Length from data length to checksum (including checksum);
Data field: Varies depending on the content and length of the command word;
Checksum: The sum of data length, address code, command word, and data field, ignoring carry, i.e., Sum & 0xFF.

*Note: Please read the following items carefully before use:

1>To ensure normal communication, please leave a 10ms time interval between each data frame. Master sends command – 10ms idle – Slave replies – 10ms idle – Master sends command...

2>The protocol specifies a broadcast address – 255. This sensor can also receive broadcast address content, but will not reply (except for the address code reading function). Therefore, broadcast address 255 can be used for the following purposes, for reference only:

1. Set the address of all tilt sensors of this model connected to the bus to a specific address.
2. Set all tilt sensors of this model connected to the bus to relative/absolute zero.
3. Test all sensors of this model on the entire bus; that is, the master sends a data query command to the bus using address 255. If the communication indicator light flashes, communication is normal.

3>Setting Commands and Procedures

1. All settings are not saved after power failure. The settings take effect immediately upon issuing a command. To save, a save command must be issued.
2. Operation: Issue setting command → Return success, settings take effect → Issue save command → Return success, settings are saved.

4>Normal communication indicator flashes once per second.

2. Command word parsing

Command words	Meaning / Examples	Explanation
0X14	**Read the X, Y, Z accelerations** E.g: ***68 04 00 14 18***	Data Field (0 bytes) No Data Field Command
0X94	Sensor response E.g: **68 10 00 84 00 00 20 08 10 00 25 28 10 35 00 80 DE**	Data Field(12byte) **00 00 20 08** The four red bytes represent the X-axis angle value, in compressed BCD code, The high-order bit of the first byte is **0**(0 positive, 1 negative)**0** represents the integer value, **00 20 08** represents the six-digit decimal value. Other axis data are parsed in the same way; this angle is parsed as +0.002008g. The blue Y-axis data and green Z-axis data are parsed in the same way. **DE** Checksum: The hexadecimal sum of all data, excluding the prefix 68. If it exceeds one byte, the low-order byte is used.
0X18	**Read All Data** E.g: ***68 04 00 18 1C***	Data Field (0 bytes) No Data Field Command
0X98	Sensor Response: **68 10 00 98** Data Field and Checksum	Data Field(12byte) **See Output Data Field Format Description**
0X53	**Save Sensor Settings** E.g: **68 04 00 53 57**	No Data Field
0XD3	Sensor Response: Example: **68 04 00 D3 D7**	No Data Field
0X0C	**Set Sensor Output Mode** **Question-and-Answer Mode**: The sensor only responds with corresponding data after the host computer sends a read data command. **Automatic Output Mode**: See the automatic output item description for data details. E.g: ***68 05 00 0C 00 11***	Data Field(1byte) **00 Question-and-Answer Mode (Factory Default)** 01 5Hz Auto Output Mode 02 10Hz Auto Output Mode 03 25Hz Auto Output Mode 04 35Hz Auto Output Mode 05 50Hz Auto Output Mode 06 100Hz Auto Output Mode 07 200Hz Auto Output Mode 08 500Hz Auto Output Mode Note: When the setting value is greater than 128, the output frequency is XX minus 128; for example, 81H is 1Hz. Automatic output can only be used when connecting only one product using the 485 bus.
0X8C	Sensor Response Command E.g: **68 05 00 8C 00 91**	Data Field (1 byte) The number in the data field represents the sensor's response result. 00: Setting successful FF: Setting failed
0X0F	**Set Module Address Command** The sensor's default address is 00; 1. If multiple sensors are connected to a single bus, such as RS485, each sensor needs to be set to a different address to achieve separate control and data response.	Data Field (1 byte) XX module address, ranging from 00 to EF. Note: All products share a common address. **FF: If the set address is forgotten during operation, the FF address can be used to operate the product.**

	2. If the new address is successfully changed, all subsequent commands and response data packets must use the new address code to take effect; otherwise, the sensor will not respond to commands. E.g: ***68 05 00 0F 01 15*** sets the address to 01. ***68 05 FF 0F 00 13*** resets the address to 00 using a general address	
0X8F	Sensor Response Command E.g: **68 05 00 8F 00 94**	Data Field (1 byte) The number in the data field represents the sensor response result. 00: Setting successful FF: Setting failed
0X0B	**Set Serial Port Baud Rate** E.g: ***68 05 00 0B 03 13***	Data Field (1 byte) 00 represents 2400 01 represents 4800 **02 represents 9600 (default value)** 03 represents 19200 04 represents 38400 05 represents 115200 06 represents 230400 07 represents 460800
0X8B	Sensor Response Command E.g: **68 05 00 8B 90**	Data Field (1 byte) The number in the data field represents the sensor response result. 00: Setting successful FF: Setting failed
0X10	**Set Serial Port Parity Bit** E.g: **68 05 00 10 00 15**	Data Field (1 byte) 00: Even parity 01: No parity 02: Odd parity
0X9D	Sensor Response Command E.g: **68 05 00 9D 00 A2**	Data Field (1 byte) The number in the data field represents the sensor response result. 00: Setting successful FF: Setting failed
0X11	**Set Automatic Output Data Items** E.g: **68 07 00 11 07 F5 14**	Data Field(2byte) See automatic output data item description
0X91	Sensor Response Command E.g: **68 05 00 91 00 96**	Data Field(1byte) The number in the data field represents the sensor response result. 00: Setting successful FF: Setting failed
0X05	**Set Relative/Absolute Zero Point:** Sets the current angle to zero degrees, and the acceleration values X, Y, Z to 0, 0, 1g for relative measurement. It can also be reset to the factory absolute zero point and saved after power failure. E.g: ***68 05 00 05 00 0A***	Data Field (1 byte) 00 Absolute zero 01 Relative zero
0X85	Sensor Response Command E.g: **68 05 00 85 00 8A**	Data Field (1 byte) The numbers in the data field represent the sensor's response. 00 Setting successful FF Setting failed

MODBUS Communication Protocol

MODBUS uses RTU mode, with 'big-Endian' indicating address and data items, employs CRC16 checksum for data, supports reading holding registers at 0x03, and writing single registers at 0x06.

1. Data Frame Format:

Default communication parameters: Address 1, Baud rate 9600, 1 start bit, 8 data bits, even parity, 1 stop bit;

Valid address range: 1~247;

CRC checksum: Checksum of all bytes before the CRC field, using 16-bit CRC checksum.

Please note that you should read the following items carefully before use:

1>The MODBUS protocol stipulates that there should be at least 3.5 bytes of time between two data frames (e.g., at a baud rate of 9600, this time is 3.5 × (1/9600) × 11 = 0.004s). However, to allow sufficient margin, please leave a 10ms time interval between each data frame. Note that the product's automatic output does not consider the T3.5 time.

Master sends command -- 10ms idle -- Slave replies -- 10ms idle -- Master sends command...

2>The MODBUS protocol specifies the content related to broadcast address ---- 0. This sensor can also receive broadcast address content, but will not reply (except for the address code reading function). Therefore, broadcast address 0 can be used for the following purposes, for reference only:

1. Set the address of all tilt sensors of this model connected to the bus to a certain address.
2. Set all tilt sensors of this model connected to the bus to relative/absolute zero point.
3. Test all sensors of this model on the entire bus. The master sends an angle query command to address 0 on the bus; if the communication indicator light flashes, communication is normal.

3>To improve system reliability, all commands must be sent twice consecutively to be effective. Both sends must be successful (the slave device must respond each time), and the two queries and responses must be consecutive. The master cannot insert other data frames between the two queries and responses. The setting process is as follows: Send the address setting command → Wait for the slave device to send the successful setting command → (No other commands should appear) Send the address setting command again → Wait for the slave device to send the successful setting command → Modification successful.

4>Except for setting the relative zero point and output mode, parameters are changed only once per power-on. The normal communication indicator light flashes once per second.

2. Read sensor data(Modbus Function Code 03H)

<table>
<tr><th colspan="2">Read sensor data command:</th><th colspan="2">Slave response:</th></tr>
<tr><td>Sensor Address</td><td>01H</td><td>Sensor Address</td><td>01H</td></tr>
<tr><td>Function Code</td><td>03H</td><td>Function Code</td><td>03H</td></tr>
<tr><td rowspan="2">Access Register Start Address</td><td>00H</td><td rowspan="2">Data length</td><td rowspan="2">0CH</td></tr>
<tr><td>28H</td></tr>
<tr><td rowspan="2">Access Register Start Length</td><td>00H</td><td rowspan="2">Data field</td><td rowspan="2">See output data field Format description</td></tr>
<tr><td>06H</td></tr>
<tr><td>CRC</td><td>45 C0H</td><td>CRC</td><td>CRC H/CRCL</td></tr>
</table>

3. Set the sensor address: (The sensor address is set to 1 by default at the factory)

Command to set sensor address code:		Slave response:	
Sensor Address	01H	Sensor Address	01H
Function Code	06H	Function Code	06H
Address	00H	Register Address	00H
	11H		11H
New address of the sensor	00H	New address of the sensor	00H
	04H		04H
CRC	D80C	CRC	D80C

Commands must be sent twice consecutively to be effective.

Example of using the command to set the sensor address:								
Host sends	01H	06H	00H	11H	00H	04H	D8H	0CH
Slave Response	01H	06H	00H	11H	00H	04H	D8H	0CH

Note: 0011H is the register address, which controls the sensor address. In the example above, the sensor address has been changed to 0004H, and the last two bytes are the CRC checksum.

4.Set the sensor serial port baud rate: (The factory default is 9600bps)

Command to set sensor serial port baud rate:		Slave response:	
Sensor Address	01H	Sensor Address	01H
Function Code	06H	Function Code	06H
Address	00H	Register Address	00H
	12H		12H
sensor baud rate	00H	sensor baud rate	00H
	XX		XX
CRC	CRC LH	CRC	CRC LH

XX : A0H:4800 A1H:9600 A2H:19200 A3H:38400 A4H:115200 A5H:230400

Commands must be sent twice consecutively to be effective.

Setting the sensor serial port baud rate: Application example:								
Host sends	01 H	06 H	00 H	12 H	00 H	A2H	A8H	76H
Slave Response	01 H	06 H	00 H	12 H	00 H	A2H	A8 H	76H

Note: 0012H is the register address, which controls the sensor baud rate. In the example above, the sensor baud rate is set to 19200, and the last two bytes are the CRC checksum.

5. Configure the parity bit of the sensor serial port: (The factory default is even parity)

Command to set the parity bit of the sensor serial port:		Slave response:	
Sensor Address	01H	Sensor Address	01H
Function Code	06H	Function Code	06H
Address	00H	Register Address	00H
	09H		09H
Sensor serial port Parity check bit	00H	Sensor serial port Parity check bit	00H
	01H		01H
CRC	9808	CRC	9808

Example of using the command to set the parity bit of the sensor serial port:								
Host sends	01H	06H	00H	09H	00H	01H	98H	08H

Slave Response	01H	06H	00H	09H	00H	01H	98 H	08H

The above example sets the byte format to: one start bit + 8 data bits, no parity + 1 stop bit. This setting takes effect after a power cycle. The factory default is one start bit + 8 data bits, even parity + 1 stop bit.

Note: 0009 is the register address; this register controls the parity bit of the sensor serial port.

0000H: One start bit + 8 data bits, even parity + 1 stop bit
0001H: One start bit + 8 data bits, no parity + 1 stop bit
0002H: One start bit + 8 data bits, odd parity + 1 stop bit

6.Set sensor output mode: (Factory default 0Hz)

Command to set sensor output mode:		Slave response:	
Sensor Address	01H	Sensor Address	01H
Function Code	06H	Function Code	06H
Address	00H	Register Address	00H
	13H		13H
Sensor output mode	00H	Sensor output mode	00H
	XX		XX
CRC	CRC LH	CRC	CRC LH

XX: 00H: Question and Answer Mode 01H: 5HZ 02H: 10HZ 03H: 25HZ
04H: 35HZ 05H: 50HZ 06H: 100HZ

Note: When the setting value is greater than 128, the output frequency is XX minus 128; for example, 81H is 1Hz. When using the 485 bus, automatic output can only be used when only one product is connected.

Example of using the command to set sensor output mode:								
Host sends	01H	06H	00H	13H	00H	02H	F9H	CEH
Slave Response	01H	06H	00H	13H	00 H	02H	F9H	CEH

Note: 0013H is the register address, which controls the sensor output mode. In the example above, the sensor is set to output at 10Hz, and the last two bytes are the CRC checksum.

7. Set automatic data output items:

Command to set automatic data output items:		Slave response:	
Sensor Address	01H	Sensor Address	01H
Function Code	06H	Function Code	06H
Address	00H	Register Address	00H
	20H		20H
Automatic output data items of the sensor	XX	Automatic output data items of the sensor	XX
	XX		XX
CRC	CRC LH	CRC	CRC LH

XX : 10~100

Example of using the command to set automatic data output items:								
Host sends	01H	06H	00H	20H	07H	F5H	4AH	77H
Slave Response	01H	06H	00H	20H	07H	F5H	4AH	77H

Note: 0020H is the register address, which controls the automatic output data items. In the example above, the sensor's automatic output data items are set to all data outputs, and the last two bytes are the CRC checksum.

8. Set the sensor's relative/absolute zero point: (Modbus function code 06H)

Command to set relative/absolute zero point:		Slave response:	
Sensor Address	01H	Sensor Address	01H
Function Code	06H	Function Code	06H
Access register starting address	00H	Register Address	00H
	10H		10H
If the value of this character is non-zero, it represents a relative zero; if it is zero, it represents an absolute zero.	00H	If the value of this character is non-zero, it represents a relative zero; if it is zero, it represents an absolute zero.	00H
	FFH / 00H Relative / Absolute		FFH / 00H Relative / Absolute
CRC	C84FH/ 880FH	CRC	C84FH/ 880FH

Example of using the command to set relative/absolute zero point:								
Host sends	01 H	06 H	00 H	10 H	00 H	FFH	C8H	4FH
Slave Response	01 H	06 H	00 H	10 H	00 H	FFH	C8 H	4FH

Note: 0010 is the register address, which controls the sensor's current angle to be zero degrees, and the accelerations X, Y, Z to be 0, 0, 1g. If it is non-zero (as in the example above, it is written to 00FFH), the output is a relative zero point. Conversely, if it is zero (by changing the 5th and 6th bytes to 00H), it is an absolute zero point. The last two bytes are the CRC checksum.