STS STANDARD OUTPUT TILT SENSOR

Product manual

V1.1-20250226

Technical Characteristics

- ❖ Single/dual-axis measurement;
- ❖ Extra-wide measurement range: ±180°;
- ❖ Excellent measurement accuracy:0.01° (full range);
- ❖ Industrial-grade reliability design;
- ❖ Meets the requirements for demanding industrial environments;
- ❖ Multiple standard output interfaces facilitate system integration and expansion.

Product Introduction

The STS standard output tilt sensor is a product developed by RUICOM Technology, focusing on the field of industrial automation control. This product features a compact industrial design. Equipped with RS485/ RS232 standard serial communication interfaces. It integrates a high-performance MEMS tilt sensing unit and a 24-bit high-precision differential A/D converter. Combined with fifth-order digital filtering algorithm It can achieve high-precision measurement of horizontal tilt angle and pitch angle .

With its superior measurement accuracy, reliable industrial-grade performance, and flexible configuration options, the STS standard output tilt sensor has become a high-performance solution in the field of industrial measurement.

Application Field

This series of products is particularly suitable for: building structural health monitoring (ancient buildings, historical sites, dilapidated buildings, etc.), industrial automation control systems, and industrial sites that require long-term stable monitoring in high-precision angle measurement applications.

Specifications

STS		condition	parameter				
Measurement range		-	±10°	±30°	±60°	±90°	±180°
Measuring axis		-	X Y	X Y	X Y	X Y	X
Resolution		-	0.001°				
Accuracy	MAXE	room temp	0.01°	0.01°	0.015°	0.02°	0.02°
	RMSE	room temp	0.008°	0.008°	0.008°	0.009°	0.009°
Zero-point temp coefficient		-40 ~85℃	±0.0005°/℃				
Sensitivity temp coefficient		-40 ~85℃	≤0.01%/℃				
Power-on startup time			0.5S				
Response frequency		20 Hz					
Output signal		TTL / RS232 / RS485 optional					
Communication Protocol		Serial communication protocol / MODBUS RTU Protocol Optional					
Electromagnetic compatibility		According to EN61000 and GBT17626					
Mean Time Between Failures		≥99000hours/time					
Insulation resistance		≥100megohms					
Impact resistance		100g@11ms , triaxial (half-sine wave)					
Vibration resistance		10grms 10~1000Hz					
Waterproof rating		IP67					
cable		Standard 2-meter M12 aviation plug with PVC shielded cable, wire weight ≤ 120g					
weight		≤150g (excluding cable)					

Resolution: Refers to the sensor in measuring range to detect and identify the smallest changed value.
MAXE: refers to the biggest error of the product within the range and at multiple angle points.
RMSE: refers to the root mean square difference between the measured value and the actual angle of the product within the range and for multiple times (more than 16 times).
Zero Temperature Drift Coefficient: the change rate of the indication value relative to normal temperature within the rated operating temperature range of the sensor at the zero degree.
Sensitivity Temperature Drift Coefficient: The percentage change rate with temperature of the full-scale indication relative to the full-scale indication at room temperature of the sensor in its rated operating temperature range.

Product Dimensions

Parameter	Condition	Min value	Typical value		Max value	Unit
Power supply voltage	standard	9	12	24	36	V
Operating current	No load	-	21	12	-	mA
Operating temp	-	-40	-		+85	℃
Storage temp	-	-40	-		+85	℃

Ordering and Selection

Model	Measuring axis		Signal Output		Communication Protocol		Measurement Range		Installation Direction
STS6	X: X-axis	-	TTL: TTL	-	SP:Serial communication protocol	-	10:±10°	-	H:Horizontal installation
	Y: Y-axis		232: RS232		MB:MODBUS Protocol		15:±15°		HD:Horizontal downward
	D: Dual-axis		485: RS485				30:±30°		V:Vertical installation
							45:±45°		VL:Vertical to the left
							60:±60°		VR:Vertical to the right
							90:±90°		
							180:±180°		

E.g:STS6X-TTL-SP-10-H: Single-axis X-axis/TTL signal output/serial communication protocol/measurement range ±10°/horizontal installation.

Indicator light operation instructions

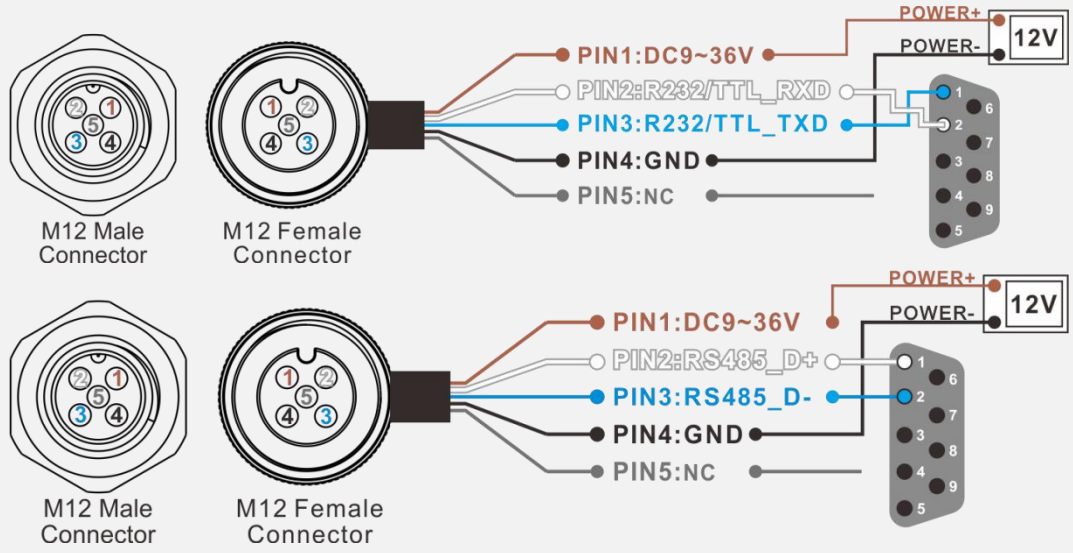
After the product is powered on, the red indicator light remains on. When the connection is successfully established and data is transmitted, the red light turns to flashing. If the red light remains on continuously during the connection process, it indicates a connection failure and a reconnection operation needs to be performed.

Connection Installation

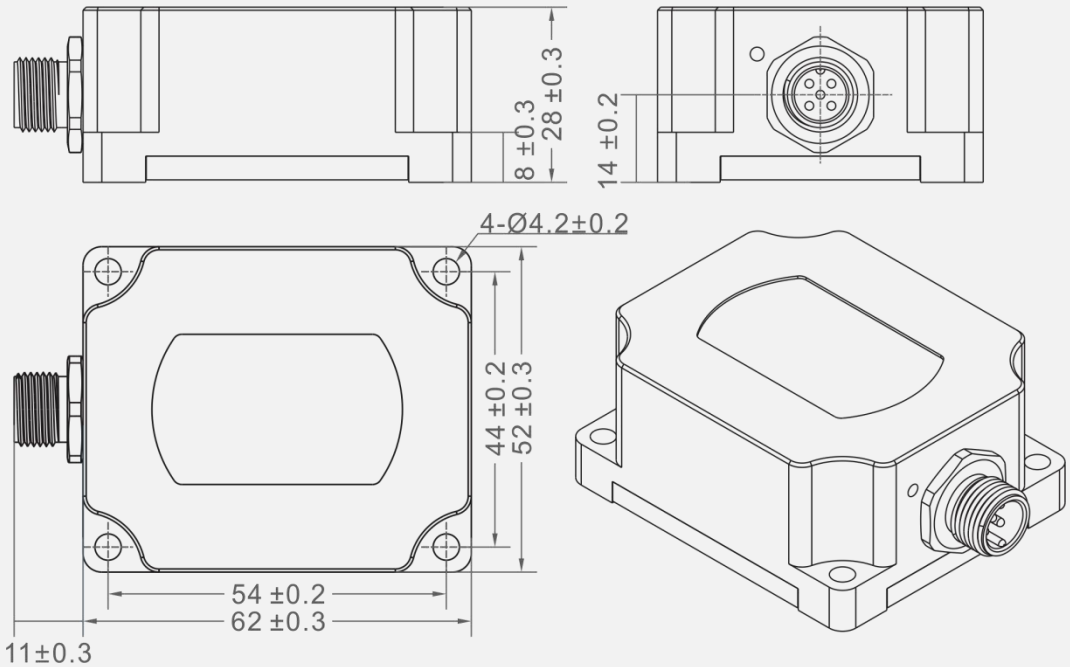
The RUICOM STS series high-precision tilt angle sensor adopts convenient and reliable connection technology, and performs outstandingly among similar products. This product is equipped with a standard aviation plug M12 interface and supports 9-36V wide voltage power supply; Standard M12-5 core 2-meter cable, using female straight connector and black PVC shielded wire design.

Interface definition

Stitch/Thread Color	Pin definition	describe
PIN 1/Brown	DC 9 ~36V	Positive power terminal of supply
PIN 2/White	TTL_RXD/RS232_RXD/RS485_D+	-
PIN 3/Blue	TTL_TXD/RS232_TXD/RS485_D-	-
PIN 4/Black	GND	negative terminal of power supply
PIN 5/Grey	NC	No connection

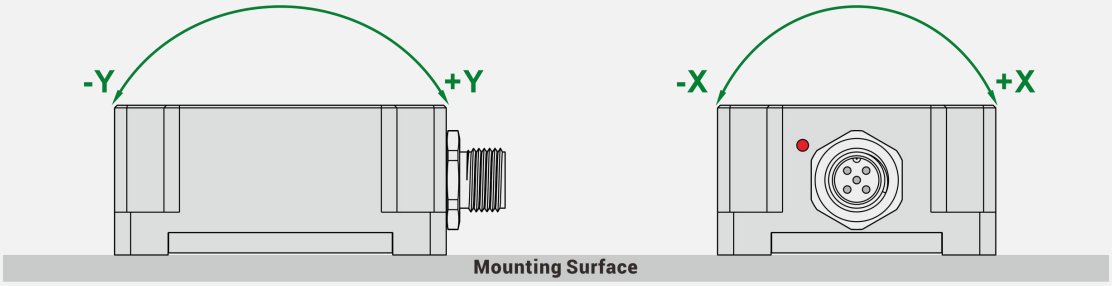


Product Dimensions

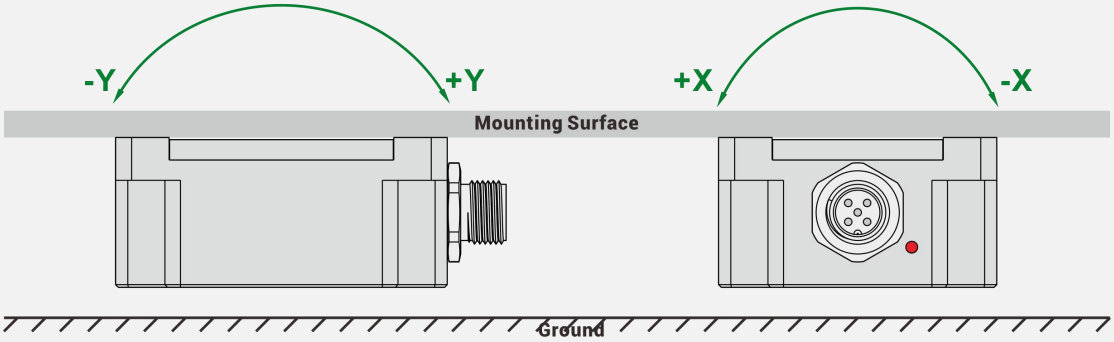


Dimensions: L62 ×W52× H28 mm
Suggested screws: 4 M4 screws

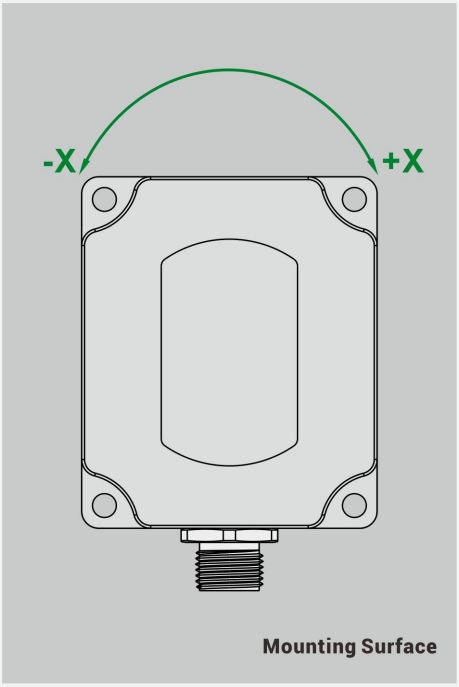
Measurement direction



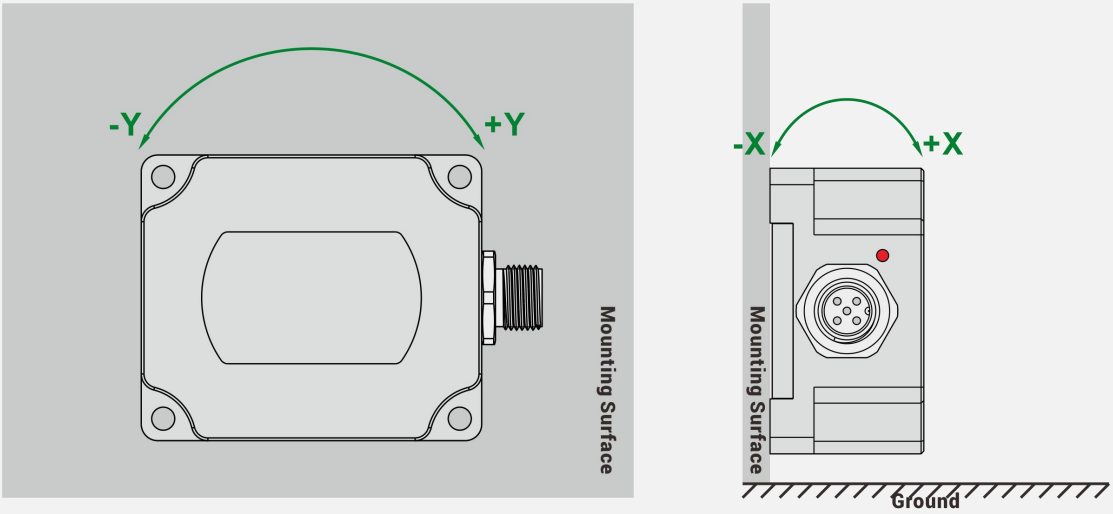
Horizontal Installation



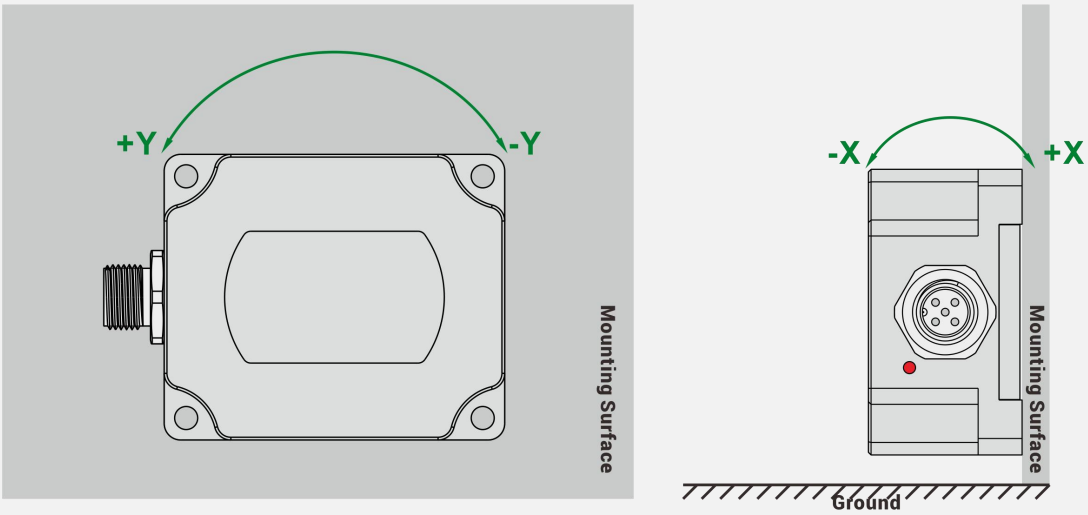
Horizontal Downward Installation



Vertical Installation



Vertical Left Installation



Install vertically to the right

Serial communication protocol

I. Data Frame Format : (8 data bits) , 1 stop bit No verification (Default speed 9600)

Identifier (1 byte)	Data length (1 byte)	Address code (1 byte)	command word (1 byte)	Data domain	Checksum (1 byte)
68					

Data format: Hexadecimal;

Identifier: Fixed at 68;

Data length: From data length to checksum (including checksum) Length;

Address code: Address of the acquisition module. The default value is 00;

The data field changes accordingly based on the different contents and lengths of the command word;

Checksum: The sum of data length, address code, command word, and data field does

not consider carry.

II. Command Word Parsing

CMD	Meaning/Example	explanation
0X04	**Simultaneously read X and Y angle commands** **E.g: 68 04 00 04 08**	Data Domain (0byte) Command without data domain
0X84	Sensor response reply E.g: 68 0F 00 84 00 20 10 00 10 05 25 00 50 9D	Data Domain (11byte) **SA AA BB CC SD DD EE FF SG GG HH** **00 20 10 00** These 4 characters are the X-axis return angle value, which is a compressed BCD code. The high-order bit 0 of the first byte is the sign bit (0 positive, 1 negative). 020 is a three bit integer value, and 1000 is a four bit decimal value. The analysis method for other axis data is the same, and this angle is analyzed as+20.100 °; **10 05 25 00**:4 characters represent the Y-axis; **00 50 50**: Three characters represent the temperature value, and the analysis method is the same as the X-axis angle; The angle format is analyzed using the same method as the X-axis or Y-axis; The angle in the left example is: X-axis 20.1000 °, Y-axis -5.2500 °, temperature:+50.50 ℃.
0X05	**Set relative/absolute zero point:** The current angle can be set to zero degrees for relative measurement, or it can be reset to absolute factory zero degrees and saved after power failure. Example: 68 05 00 05 00 0A	Data Domain (1byte) 00 represents absolute zero point 01 represents relative zero point
0X85	Sensor response reply command E.g: 68 05 00 85 00 8A	Data Domain (1byte) The numbers in the data domain represent the results of the sensor response 00 successfully set up FF setting failed
0X0B	**Set communication speed** **E.g: 68 05 00 0B 03 13** **Note: It takes effect immediately after setting (but not saved to FLASH)**	Data Domain (1byte) 00 represents 2400 01 represents 4800 **02 represents 9600 (default value)** 03 represents 19200 04 represents 38400 05 represents 115200
0X8B	Sensor response reply command E.g: 68 05 00 8B 00 90	Data Domain (1byte) The numbers in the data domain represent the results of the sensor response 00 Success FF Failure
0X0C	**Set sensor output mode** **Response system: The upper computer needs to send a command to read the angle before the sensor responds to the relative angle.** **Automatic output system: After the sensor is powered on, it automatically outputs X and Y angles, and the output frequency is set as shown in the table on the right.** (This function can provide	Data Domain (1byte) **00 represents the response format (default value)** **01 represents 5Hz automatic output mode** **02 represents 15Hz automatic output mode** **03 represents 25Hz automatic output mode** **04 represents 35Hz automatic output mode** **05 represents 50Hz automatic output mode** **Note: RS485 only has a response mode and no automatic output mode**

	power-off memory) 例: ***68 05 00 0C 00 11***	
0X8C	Sensor response reply command E.g: 68 05 00 8C 00 91	Data Domain（1byte） The numbers in the data domain represent the results of the sensor response 00 Success FF Failure
0X0F	**Set module address command** The default address of the sensor is 00, 1. If multiple sensors are connected to a group of buses at the same time, for example, RS485 requires setting each sensor to a different address to achieve separate control and response angles. 2. If the new address is successfully changed, the address code in the subsequent command and response packets must be replaced with the new address code, otherwise the sensor will not respond to the command. This command is for power-off saving function. E.g:***68 05 00 0F 01 15*** Set the address as 01. 68 05 FF 0F 00 13 Reset the address to 00 using a universal address.	Data Domain（1byte） XX module address, ranging from 00 to EF. Note: All products have a common address: FF. If you forget the set address during operation, you can use the FF address to operate the product and still respond normally. **Note: It takes effect immediately after setting (but not saved to FLASH).**
0X8F	Sensor response reply command E.g: **68 05 00 8F 00 94**	Data Domain（1byte） The numbers in the data domain represent the results of the sensor response 00 Success FF Failure
0X0D	**Query relative/absolute zero point** Used to query whether the current zero mode of the sensor is relative zero or absolute zero Example: 68 04 00 0D 11	Data Domain（0byte） Command without data domain
0X8D	Sensor response reply command E.g: **68 05 00 8D 00 92**	Data Domain(1byte) The numbers in the data domain represent the results of the sensor response 00 represents absolute zero point 01 represents relative zero point
0X51	Set input instructions E.g: **68 04 00 51 55**	Data Domain（0byte） Command without data domain
0X51	Sensor response reply command E.g: **68 05 00 D1 00 D6**	Data Domain（1byte） The numbers in the data domain represent the results of the sensor response 00 Success FF Failure
0X52	Set exit command E.g: **68 04 00 52 56**	Data Domain（0byte） Command without data domain
0X52	Sensor response reply command E.g: **68 05 00 D2 00 D7**	Data Domain（1byte） The numbers in the data domain represent the

		results of the sensor response 00 Success FF Failure
0X53	Set save command E.g: **68 04 00 53 57**	Data Domain（0byte） Command without data domain
0X53	Sensor response reply command E.g: 68 05 00 D3 00 D8	Data Domain（1byte） The numbers in the data domain represent the results of the sensor response 00 Success FF Failure

Set instructions and procedures

You must first enter the settings mode before entering and saving the settings

1. Enter settings mode → Send command: 68 04 00 51 55
2. Set relevant parameters

A Set address code B Set baud rate

C Set calibration parameters D Automatic or inquiry mode E Relative zero point

3. Save parameters and write all parameters to FLASH → Send command: 68 04 00 53 57.
4. Exit the setting mode → Send command: 68 04 00 52 56.

MODBUS communication protocol

Please read the following items carefully before use:

1> Because of the MODBUS protocol stipulates between the two data frames should be at least more than 3.5 bytes of time (such as the baud rate of 9600, the time is 3.5 X (1/9600) X 11=0.004s). However, in order to leave enough margin, the sensor will be increased this time to 10ms, so please leave at least of the time interval between each data frame.

The master computer sends commands - - 10ms idle - - slave computer reply command - - 10ms idle - The master computer sends commands.....

2> MODBUS protocol stipulates the broadcast address----0 relevant content, the sensor can also accept the broadcast address content, but will not reply. Therefore, the broadcast address 0 can be used for the following purposes, for reference only.

1.All the sensors mounted on BUS are all set to an address.

2.All the sensors mounted on BUS are all set to relative / absolute zero.

3.Test all sensors mounted on BUS , that is, the master computer send 0 address to BUS for query angle command, communication lights can flicker that means the communication is normal.

3> In order to improve the reliability of the system, set the address command and set the absolute / relative command, set the baud rate, these three commands must be sent for two consecutive times will be valid. "Two consecutive send" refers to two times sent successfully (the slave machine reply every time) ,must be consecutive in two times, that's means the master computer can not insert other frames in the middle of two replies , otherwise, the command will be locked until the power off .

setting process refer to below :

Send set address command - - waiting for the slave computer to send command of successful commands - (no other commands) to send the set address command again - waiting for the successful settings from the slave computer to send the command - modify the success

4> After power up, the above two sets of commands can be set only once, if necessary, again need to re power.

5> when the normal communication accumulated to a certain number of times, the communication indicator will flash once.

1.DATA FRAMES FORMAT :

RTU Mode

Communication Parameter: Baud rate 9600 bps

Data frames: 1 Start bit,8 data,even parity check,1 stop bit

2.READ ANGLE DATA :

Modbus function code 03H

Host query command:		Slave response:		
Sensor address	01H	Sensor address	01H	
function code	03H	function code	03H	
Access register first address	00H	data field length	08H	
	02H	data field	5AH	X-axis data
Number of registers	00H		60H	
	04H		01H	
CRC	E5C9H		00H	
			47H	Y-axis data
			62H	
			01H	
			00H	
		CRC	C5B9H	

Application Example 1 of Read Measurement Data Command:												
Master computer sending					01 H	03 H	00 H	02 H	00 H	04 H	E5H	C9H
Slave computer response												
01H	03 H	08 H	5A	60 H	01 H	00 H	47 H	62 H	01 H	00 H	C5 H	B9 H

Note: The slave reply frame are 5AH, 60H, 01H, 00H, 47H, 62H, 01H, 00H

The X-axis is the 1-4 bytes of the data field, the Y-axis is the 5-8 bytes of the data field, and the low byte is first. The representation method of the angle is the number of points notation, one point corresponds to 0.001°, and 0.001×(number of points-offset) is the angle. If the measurement range is +-180°, the total number of points is 360000 points. So 0 corresponds to -180°, 360000 corresponds to +180°, and 180000 corresponds to 0°.

Taking the above data frame as an example: the conversion process of the angle is as follows:

1) Get the current angle points. Note that the low byte is first, the X axis is 0001605AH, and the Y axis is 00016247H.

2) Convert to decimal, X axis: 0001605AH→90202, Y axis: 00016247H→90695.

3) Subtract the offset 180000 (note: this value is an amount related to the measurement range), X-axis: 90202-180000=-89798, Y-axis: 90695-180000=-89305.

Get the final angle, X-axis: -89798×0.001=-89.798°, Y-axis: -89305×0.001=89.305°.

1. SET SENSOR RELATIVE /ABSOLUTE ZERO

Modbus FUNC 06H

Set relative / absolute zero command :		Slave computer response :	
Sensor address	01H	Sensor address	01H
FUNC	06H	FUNC	06H
Access register First address	00H	Register address	00H
	10H		10H
If the word is non-zero, otherwise it is an absolute ZERO	00 H	If the word is non-zero, then it is a relative ZERO,otherwise it is an absolute ZERO	00H
	FFH / 00H Relative / Absolute		FFH / 00H Relative / Absolute
CRC	C84FH/ 880FH	CRC	C84FH/ 880FH

Set ZERO command application example :								
Master computer sending	01 H	06 H	00 H	10 H	00 H	FFH	C8H	4FH
Slave computer response								
01 H	06 H	00 H	10 H	00 H	FFH	C8 H	4FH	

Note: 0010 is the register address, the register control sensor output is relative zero, or absolute zero. If nonzero (as in the example above, is written to 00FFH), the output is relative zero. On the contrary, if zero (Change the 5th and 6th bytes to 00H), is the absolute zero. The last two bytes are CRC checksum.

2. SET SENSOR ADDRESS

Set sensor address code command :		Slave compueter response :	
Sensor add	01H	Sensor add	01H
FUNC	06H	FUNC	06H
ADD	00H	Register address	00H
	11H		11H
Sensor new address	00 H	Sensor new address	00 H
	04H		04H
CRC	D80C	CRC	D80C

Commands must be sent two times to be valid

Set sensor address command example :								
Master computer sending	01 H	06 H	00 H	11 H	00 H	04H	D8H	0CH
Slave computer response								
01 H	06 H	00 H	11 H	00 H	04H	D8 H	0CH	

Note: 0011H is the register address, which controls the baud rate of the sensor. In the above example,

The address of the sensor is changed to 0004H, and the last two bytes are the CRC checksum.

3. SET SENSOR BAUD RATE (DEFAULT IS 9600bps)

Set sensor baud rate command :		Slave computer response :	
Sensor address	01H	Sensor address	01H
FUNC	06H	FUNC	06H
Add	00H	Register address	00H
	12H		12H
Sensor baud rate	00 H	Sensor baud rate	00 H
	XX		XX
CRC	CRC LH	CRC	CRC LH

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

Commands must be sent two times to be valid

Set sensor baud rate command example :								
Mastercomputersending	01H	06H	00H	12H	00H	A2H	A8H	76H
Slavecomputerresponse	01H	06H	00H	12H	00H	A2H	A8H	76H

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

4. SET SENSOR COMMUNICATION CHARACTER FORMAT

Set sensor communication character format command :		Slave computer response :	
Sensor address	01H	Sensor address	01H
FUNC	06H	FUNC	06H
Add	00H	Register address	00H
	09H		09H
Sensor changes communication character format	00 H	Sensor new format	00 H
	01H		01H
CRC	9808	CRC	9808

Set sensor communication character format command example :								
Master computer sending	01H	06H	00H	09H	00H	01H	98H	08H
Slave computer response	01H	06H	00H	09H	00H	01H	98 H	08H

The above example is to set the byte format to: a start bit + 8 data bits without parity + 1 stop bit

It is valid after power on again. The factory default is a start bit + 8 data bits, even parity + 1 stop bit

Note: 0009 is the register address, which controls the character format of the sensor communication.

0000H: one start bit + 8 data bits, even parity + 1 stop bit
0001H: one start bit + 8 data bits without parity + 1 stop bit