RION TECH

CE FC RoHS

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FCC certification: AT011611744E
RoSH certification: 18300RC20410801

V1.8

HIGH ACCURACY DIGITAL TYPE MODBUS INCLINOMETER
WITH FULL TEMP-COMPENSATION

ACA616T&ACA626T

Technical Manual

RION QUALIFICATION CERTIFICATION

○ Quality management system certification: IATF16949: 2016 (Certificate No.: T178487)
○ GJB9001C-2017 Standard Weaponry Quality Management System Certification (Registration number: 02622J31799R0M)
○ Intellectual property management system certification: GB/T29490-2013 standard (Certificate No.: 41922IP00281-06R0M)
○ High-tech Enterprise (Certificate No.: GR201844204379)
○ ShenZhen Professional Dedicated Unique Innovative Enterprice(No.: SZ20210879)
○ CE certification: AT011611743E
○ FCC certification: AT011611744E
○ RoHS certification: 18300RC20410801
○ China National Intellectual Property Appearance Patent (Patent No.: ZL 201830752872.2)
○ Revision date: 2024-3-29
Note: Product functions, parameters, appearance, etc. will be adjusted as technology upgrades. Please contact our pre-sales business for confirmation when purchasing.

ACA616T/ACA626T DIGITAL TYPE MODBUS INCLINOMETER

GENERAL DESCRIPTION

ACA616T/ACA626T is a full temperature compensation high precision single / dual axis MODBUS digital output type tilt sensor developed by RION Technology on the basis of high precision tilt platform. Its excellent temperature stability can be used in a wide temperature environment of -40~85 ℃ It maintains high measurement accuracy and is more suitable for long-term field equipment monitoring and leveling. In addition, the system has a built-in high-precision 24it A/D differential converter, and through the fifth-order filtering algorithm, it can measure the tilt and pitch angle of the sensor output relative to the horizontal. Output interface RS485, RS232, TTL optional. The characteristics of non-contact installation make the product have strong system integration, only need to fix the sensor on the surface of the measured object with screws, the attitude and inclination of the object can be automatically calculated, simple to use, no need to retrieve the relative changes Installed on both sides. It has strong resistance to external electromagnetic interference and strong ability to withstand shock and vibration. It has a great competitive advantage among domestic counterparts, and is specifically used in the industrial fields required by high-end users.

FEATURES

★ Single / dual axis inclination measurement
★ Measure Range :±1～±90° optional
★ Wide temperature working: -40～+85℃
★ Highly anti-vibration performance >2000g
★ Output mode RS232/RS485/RS422/TTLare optional
★ Wide voltage input: 9～36V
★ IP67 protection grade
★ Resolution: 0.001°
★ Water-proof air-plug
★ Size: 92×48×36mm

APPLICATION

★ Engineering vehicles automatic leveling
★ Laser equipment position
★ Underground drill posture navigation
★ Geological equipment inclined monitoring
★ Railway gauging rule , gauge equipment leveling
★ Bridge & dam detection
★ Medical facilities angle control
★ Precise machine tool level control

SPECIFICATIONS

ACA616T/ACA626T	CONDITIONS	PARAMETERS				UNIT
Measure range		±10	±30	±60	±90	°
Measure axis		X/XY	X/XY	X/XY	X/XY	AXIS
Resolution		0.001	0.001	0.001	0.001	°
Measure accuracy	@25℃	0.003	0.01	0.02	0.03	° (RMS)
Zero Temp. coefficient	-40~+85℃	±0.0004	±0.0004	±0.0004	±0.0004	°/℃
Sensitivity temp-coeffi	-40~+85℃	≤50	≤50	≤50	≤100	ppm/℃
Power on time		0.5	0.5	0.5	0.5	S
Response frequency	20Hz					
Output rate	5Hz、15Hz、35Hz、50Hz can be setting					
output signal	RS232/RS485/RS422/TTL					
Communication protocol	RION 68 protocol / MODBUS protocol					
EMC	According to EN61000 and GBT17626					
MTBF	≥98000 hours/times					
Insulation Resistance	≥100MΩ					
Shockproof	100g@11ms、3 Axial Direction (Half Sinusoid)					
Anti-vibration	10grms、10～1000Hz					
Protection grade	IP67					
Cables	Standard 2m long, wear-resistant, wide temperature, shielded cable 5p * 5.7 mm aviation connector					
Weight	≤220g(without cable)					

This performance parameter only lists the measurement ranges of ± 10 °, ± 30 °, ± 60 ° and ± 90 ° for reference. For other measurement ranges, please refer to the nearest parameter.

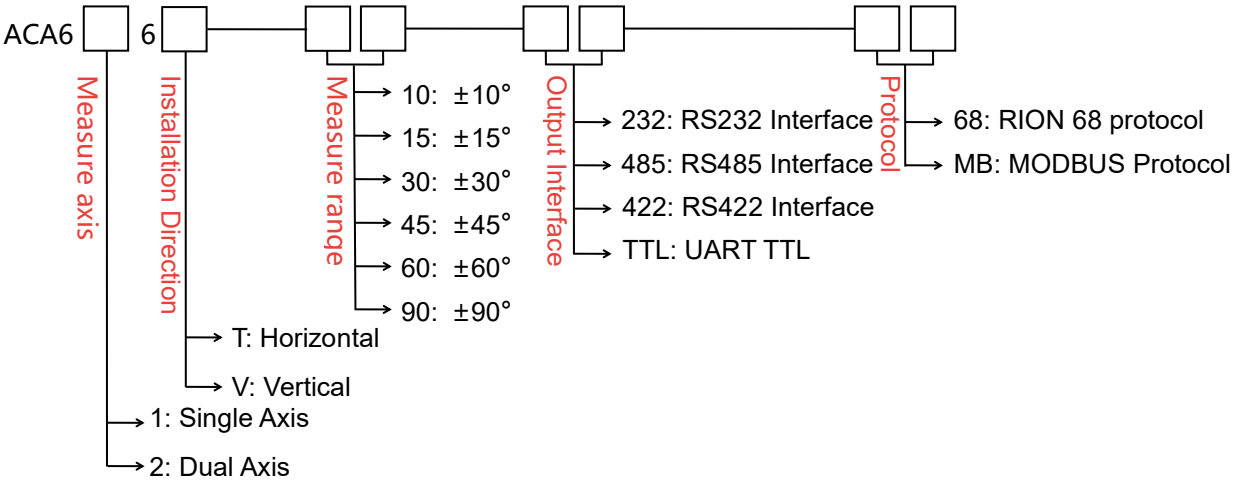
KEY WORDS：

Resolution: refers to the minimum change value of the measurand that can be detected and distinguished by the sensor within the measuring range.
Maximum absolute error of accuracy: refers to the maximum value between the measured value and the actual angle error when the product is measured at multiple angle points within the measuring range.
Root mean square error of accuracy: refers to the root mean square error between the measured value and the actual angle error when the product is within the measuring range and the angle is measured for many times (more than 16 times).
Zero temperature coefficient: It refers to the change rate of the indication value of the sensor relative to the normal temperature within its rated working temperature range under the zero value state.
Sensitivity temperature coefficient: refers to the change rate of the percentage of the full-scale indicated value relative to the full-scale indicated value at normal temperature with the temperature within the rated working temperature range of the sensor.

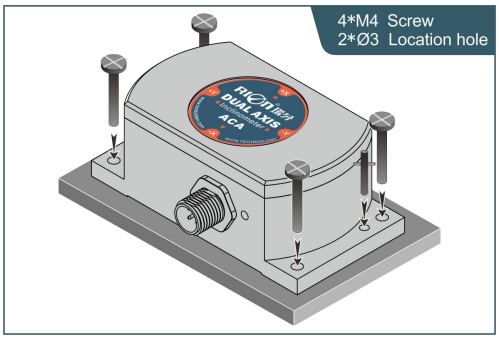
ELECTRONIC CHARACTERISTICS

PARAMETERS	CONDITIONS	MIN	STANDARD	MAX	UNIT
Power supply	Standard	9	12 24	36	V
	customized		Other voltage		V
Working current	12V		40		mA
	24V		22		mA
Working temperature		-40		+85	℃
Store temperature		-40		+85	℃

ORDERING INFORMATION



E.g:ACA616T-10--232--68： Single Axis/Horizontal /±10° measure range / RS232 output / RION 68 protocol .

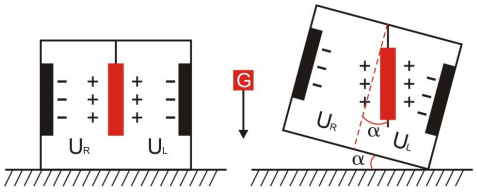


MECHANICAL PARAMETERS

○ Connectors：Air Plug Connector
(1m Direct Leading Cable Can Be Customized)
○ Enclosure Material ： Aluminum Oxide
○ Installation ： 4*M4 Screws
2*3mm Plug Position(Optional)

WORKING PRINCIPLE

Adopt imported core control unit and apply the principle of capacitive micro-pendulum. Using the principle of earth's gravity, when the tilting unit tilts, the earth's gravity will produce a gravitational component on the corresponding pendulum, and the corresponding electric capacity will change. By amplifying and filtering the electric capacity, the inclination is obtained after conversion.



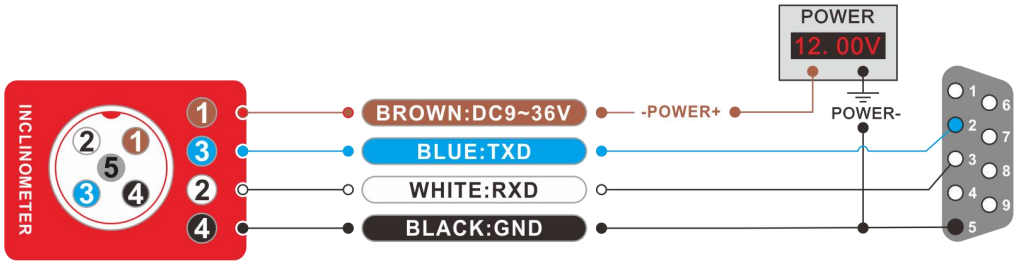
U_R, U_LRespectively is the pendulum left plate and the right plate corresponding to their respective voltage between theelectrodes, when the tilt sensor is tilted, U_R, U_L Will change according to certain rules, so $f(U_R, U_L)$ On the inclination of α function:

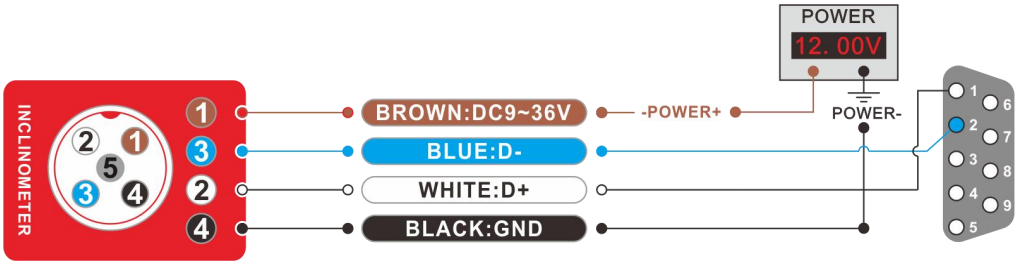
$$\alpha = (U_R, U_L)$$

ELECTRICAL CONNECTION

RS232 / RS485 Cable Wire Information

COLOR FUNCTION	BLACK	WHITE	BLUE	BROWN	GRAY
	GND Power negative	RS232(RXD) TTL(RXD) RS485(D+)	RS232(TXD) TTL(TXD) RS485(D-)	DC9~36V Power supply positive	FACTORY

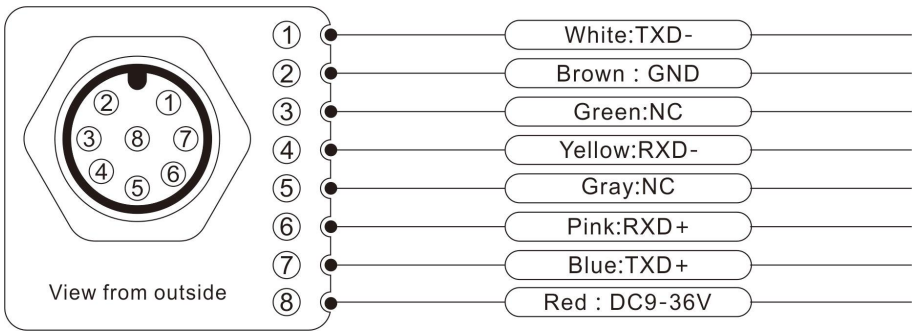




RS422 CABLE WIRE INFORMATION

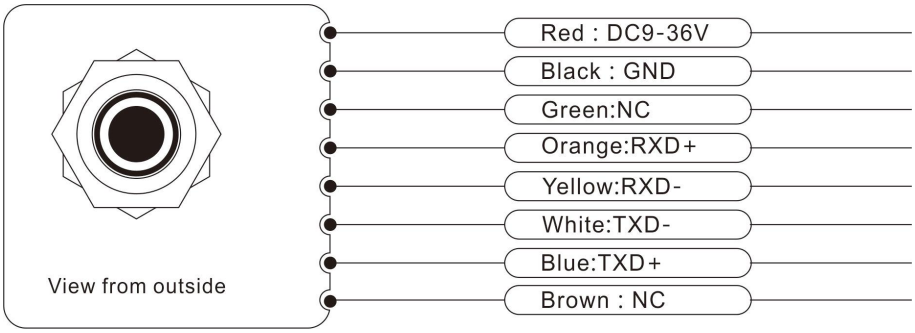
Connector With Cable Information

COLOR FUNCTION	RED	BLUE	WHITE	PINK	YELLOW	BROWN
	DC9~36V Power supply positive	TXD+	TXD-	RXD+	RXD-	GND Power negative

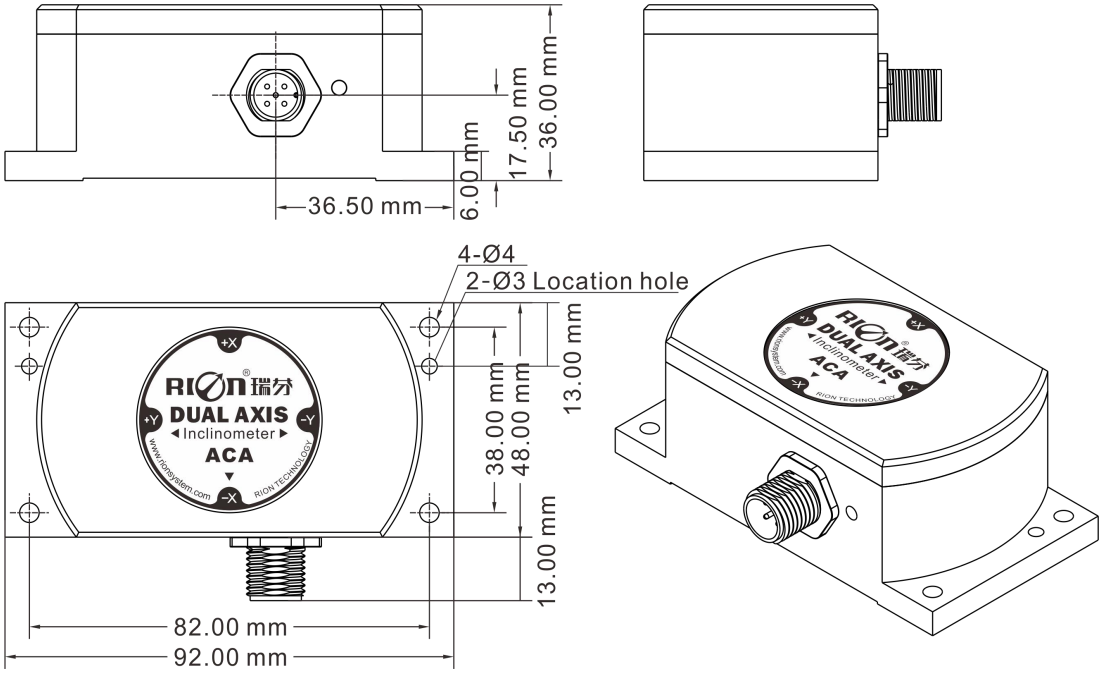


Direct Leading Cable Information

COLOR / FUNCTION	RED	BLACK	WHITE	ORANGE	YELLOW	BLUE
	DC9~36V Power supply Positive	GND Power Negative	TXD-	RXD+	RXD-	TXD+



▸ DIMENSION



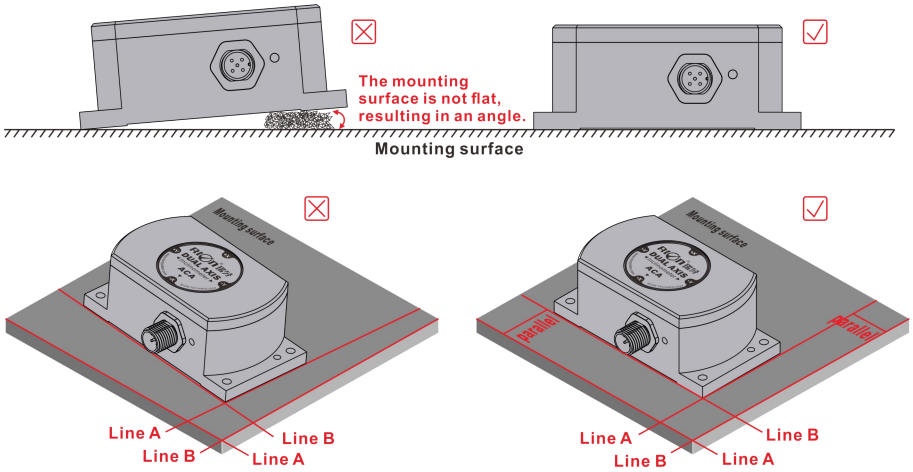
Dimension: L92×W48×H36mm
Installation size: L82×W38×H6mm
Mounting screws: 4 M4 screws/2 M3 dowel pins

PRODUCTION INSTALLATION NOTES

Please follow the correct way to install tilt sensor, incorrect installation can cause measurement errors, with particular attention to the "surface", "line" :

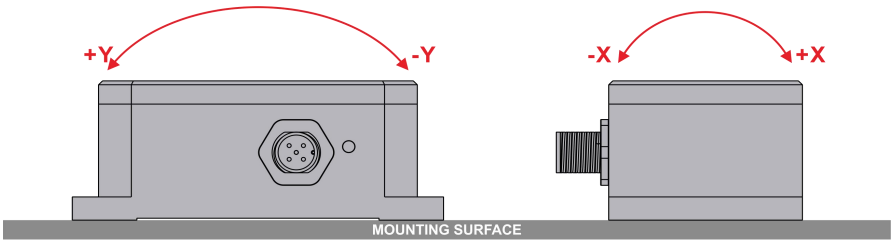
1）The Sensor mounting surface and the measured surface must be fixed closely, smoothly, stability,if mounting surface uneven likely to cause the sensor to measure the angle error.

2) The sensor axis and the measured axis must be parallel ,the two axes do not produce the angle as much as possible.

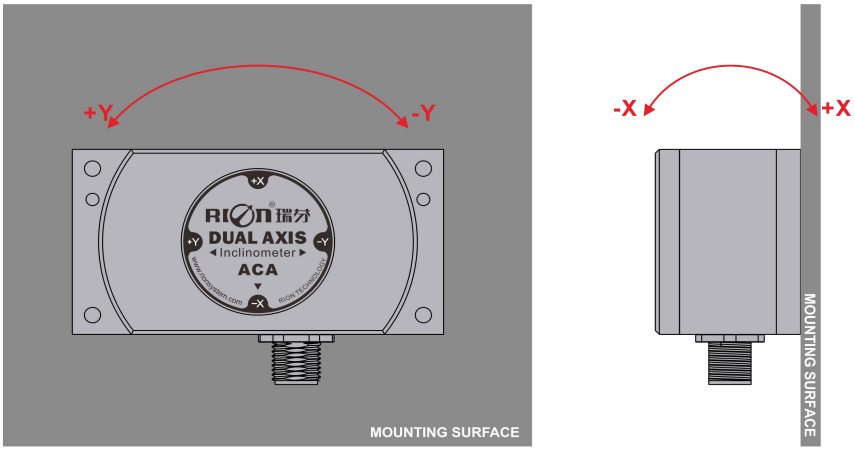


MEASURING DIRECTIONS

The installation must guarantee the product bottom is parallel to measured face, and reduce the influence of dynamic and acceleration to the sensor. This product can be installed horizontally or mounted vertically (mounted vertically selection must confirm before production), for installation please refer to the following scheme.



Horizontal installation



Vertical installation

RION PROTOCOL

1.DATA FRAME FORMAT

(8 bits date，1 bit stop，No check，Default baud rate 9600)

Identifier (1byte)	Date Length (1byte)	Address code (1byte)	Command Word (1byte)	Date domain	Check sum (1byte)
68					

Date format: hexadecimal

Identifier：Fixed68

Data length：From data length to check sum（including check sum）length

Address code：Accumulating module address，Default :00

Date domain will be changed according to the content and length of command word

Check sum：Data length、Address code、Command word and data domain sum,No carry.

2.COMMAND word analysis

Desc.	Meaning/Example	Description
0X04	**Meanwhile read angle command** E.g: ***68 04 00 04 08***	Data domain(0byte) No Data domain command
0X84	sensor data response Eg: 68 10 00 84 **00 00 20 08 10 00 25 28 10 35 00 80 DE**	data field(9byte) 68 is prefix of data packets, fixed. 10 is data lenght, fixed. 00 is address code, revisable. 84 is command code, fixed. **00 00 20 08** the four red bytes are the X axis returned angle value in compact BCD code. the high order **0** of first byte is sign bit(0: positive; 1: negative), **00 0** are three digit integer value, **20 08** are four decimal digit. other axis data analysis method is similar. the angle is +000.2008 deg by analizing. **10 00 25 28**, the four blue bytes are Y axis returned angle value, analysis method is similar to X axis **10 35 00 80**, the four green bytes are internal temperature value, analysis method is similar to X axis. DE : check sum, hexadecimal sum of all data, exclude prefix 68,if surpass one byte, pick low-order.
0X05	**Setting relative/absolute ZERO:** Can set the current angle to Zero degree, relative measurement, can also be set to absolute ex-factory zero, power off save E.g: ***68 05 00 05 00 0A***	Data domain（1byte） 00: absolute ZERO 01: relative ZERO
0X85	Sensor answer reply command E.g: **68 05 00 85 00 8A**	Data domain（1byte） Data domain in the number means the sensor response results 00 : Setting successfully FF : Setting failure

0X0B	**Setting communication rate** **E.g: *68 05 00 0B 03 13*** The command setting is effective after power off then restart (power off with save function)	Data domain（1byte） Baud rate： 00 means 2400　01 means 4800 02 means 9600（default）　03 means 19200 04 means 38400　05 means 115200
0X8B	Sensor answer reply command E.G:**68 05 00 8B 90**	Data domain（1byte） Data domain in the number means the sensor response results 00　Success　FF　Failure
0X0C	**Setting sensor output mode** Response rule; Need upper computer send reading angle command , the sensor answer the corresponding angle Automatic output rule: The sensor with power on can Automatically output X angle , The output frequency base on what be setted，if you need output High frequency，please set baud rate as 115200 (Power off with save function) E.g: ***68 05 00 0C 00 11***	Data domain（1byte） 00　Answer reply mode　(Factory default) 01　5Hz Automatical output mode 02　15Hz Automatical output mode 03　25Hz Automatical output mode 04　35Hz Automatical output mode 05　50Hz Automatical output mode
0X8C	The sensor answer reply command E.g: **68 05 00 8C 00 91**	Data domain（1byte） Data domain in the number means the sensor response results 00　Success　FF　Failure
0X0F	**Setting module address command** The sensor default address is 00, 1, such as a plurality of sensor to be connected with a bus cable, e.g RS485.requires each sensor is set to a different address, in order to achieve control and response angle . 2, If successfully changed the new address, follow all of the commands and responding Packet address code has to switch to the new address code which already changed then to be effective, otherwise the sensor will not respond to	Data domain （1byte）XX Module address Address from 00 to EF range Note: All products have a common address :FF, If forget the address what has been set during operation , can use FF address to operate the product can still normally respond

	commands.(power off with save function) E.g: ***68 05 00 0F 01 15*** Setting the address to 01 ***68 05 FF 0F 00 13*** Use the common address to reset address to 00	
0X8F	The sensor answer reply command E.g: 68 05 00 8F 94	Data domain（1byte）， Data domain in the number means the sensor response results 00 Success FF Failure
0X0D	**Query relative/absolute ZERO** Used to query the sensor current ZERO mode is relative ZERO or absolute ZERO E.g : **68 04 00 0D 11**	Data domain（0byte） No data domain commands
0X8D	The sensor answer reply command E.g:**68 05 00 8D 00 92**	Data domain (1byte）， Data domain in the number means the sensor response results 00 Absolute ZERO 01 Relative ZERO

RION PRODUCT MODBUS PROTOCOL

Note, please read the following items carefully before use:
1> The MODBUS protocol specifies that the time between two data frames should be at least greater than 3.5 bytes (for example, at 9600 baud rate, the time is 3.5 × (1/9600) × 11 = 0.004s) For the margin, the shortening time of this sensor is increased to 10ms, so please keep at least 10ms time interval between each data frame.
The host sends the command--10ms idle--the slave responds to the command--10ms idle--the host sends the command .....

2> The content of the broadcast address ---- 0 is specified in the MODBUS protocol. The sensor can also accept the content of the broadcast address, but it will not reply (except for the function of reading the address code). Therefore, the broadcast address 0 can be used for the following purposes, for reference only.
1. Set the addresses of all tilt sensors of this model mounted on the bus to a certain address.
2. Set all the tilt sensors of this model mounted on the bus to relative / absolute zero.
3. Test this type of sensor on the entire bus, that is, the host sends a 0 address query angle command to the bus, and the communication indicator flashes when 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 twice in order to be effective. "Two consecutive transmissions" means that both transmissions are successful (the slave has a reply every time), and the two questions and answers must be consecutive before and after, that is, the master cannot insert other data frames in the middle of the two questions and answers, otherwise, this kind of command It will be locked, and the setting process is as follows:
Send setting address command-wait for setting success command sent by slave-(no other commands can appear) Send setting address command again-wait for setting success command sent by slave-modification successful .

1. Data frame format
RTU mode

Communication parameter: Baud rate 9600 bps（factory default ）

Data frame：1 start bit, 8 data bits, even parity, 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 length 8 bits	0AH	
	02H	Data word 1 high 8 bits	50H	X axis data
Data length 4 words	00H	Data word 1 low 8 bits	46H	
	05H	Data word 2 high 8 bits	00H	
CRC	2409H	Data word 2 low 8 bits	00H	
		Data word 3 high 8 bits	23H	Y axis data
		Data word 3 low 8 bits	20H	
		Data word 4 high 8 bits	00H	
		Data word 4 low 8 bits	00H	
		Data word 5 high 8 bits	03	Temperature
		Data word 5 low 8 bits	57	

		CRC	FA0EH

Application example of reading measurement data command1:								
Host sending	01H	03H	00H	02H	00H	05H	24H	09H
Slave response								

01 H	03 H	0A H	50 H	46 H	00 H	00 H	23 H	20 H	00 H	00 H	03 H	57 H	FAH	0EH

Note: The data field of the slave reply frame is 50H, 46H, 00H, 00H, 23H, 20H, 00H, 00H, 03H, 57H

The X axis is the first 1-4 bytes of the data field, and the Y axis is the fifth to eighth bytes of the data field, with the low byte first. The angle is expressed in points,One point corresponds to 0.0001º, and 0.0001 × (points-offset) is the angle. If the measuring range is ± 10º, the total number of points is 100000 points. So 0 corresponds to -10º, 200000 corresponds to + 10º, and 100000 corresponds to 0º.

Take the above data frame as an example: The angle conversion process is as follows:

1) Get the current angle points. Note that the low byte is first, the X axis is 4650H, and the Y axis is 2023H.

2) Convert to decimal, X axis: 4650H → 18000, Y axis: 2023H → 8227.

3) Subtract the offset of 100000 (Note: This value is an amount related to the measurement range, multiply the measurement range value by 10000, if the offset of the measurement range ± 10º is 10 * 10000, the measurement range is an offset of ± 30 degrees The displacement is 30 * 10000), X axis: 18000-100000=-82000, Y axis: 8227-100000 = -9.1773º.

4) Get the final angle, X axis: -82000×0.00001= -8.2000º, Y axis: -1773×0.001=-1.773º.

The temperature is the 9-10th byte of the data field.

Analysis:

The upper four bits of the ninth byte are the sign bits, 1: negative temperature 0: positive temperature

The lower four bits of the ninth byte are tens, the upper four bits of the tenth byte are ones, and the lower four bits of the tenth byte are tenth;

If the slave returns 03H, 57H temperature is: 35.7 ℃.

3.Set the sensor relative / absolute zero:

Modbus function code 06H

Set relative/absolute ZERO commands		Slave response ：	
Sensor address	01H	Sensor address	01H
Function code	06H	Function code	06H
Access register first address	00H	Register Address	00H
	10H		10H
If the word is non-zero, it is a relative zero point, and if it is zero, it is an absolute zero point	00 H	If the word is non-zero, it is a relative zero point, and if it is zero, it is an absolute zero point	00H
	FFH / 00H Relative/ absolute		FFH / 00H Relative/ absolute
CRC	C84FH/ 880FH	CRC	C84FH/ 880FH

Commands must be sent twice in succession to be effective

Application Example of Set Zero Command:								
Host sending	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. This register controls the sensor output to be relative zero or absolute zero. If it is non-zero (as in the above example, 00FFH is written), the output is relative

zero. Conversely, if it is zero (change the 5th and 6th bytes to 00H), it is an absolute zero. The last two bytes are the CRC checksum.

4.Set sensor address：（sensor address default is 1）

set sensor address code commands ：		Slave response ：	
Sensor address	01H	Sensor address	01H
Function code	06H	Function code	06H
Address	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 twice in succession to be effective

Application example of command to set sensor address:								
Host sending		01 H	06 H	00 H	11 H	00 H	04H	D8H	0CH
Slave response								
01 H	06 H	00 H	11 H	00 H	04H	D8 H	0CH	

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

5.Set sensor baud rate : (factory default 9600bps)

Set sensor baud rate code commands ：		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

Commands must be sent twice in succession to be effective

Application example of Set sensor baud rate command:								
Host sending		01 H	06 H	00 H	12 H	00 H	A2H	A8H	76H
Salve 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 above example, the baud rate of the sensor is set to 19200, and the last two bytes are the CRC checksum.

6.Read sensor address code :

set Read sensor address commands :		Slave response :	
Sensor address	00H	Sensor address	01H
Function code	42H	Function code	42H
Address	00H	Return data length	02H
	11H		
Data length	00H	Sensor address	01H
	01H		01H
CRC	CRC LH	CRC	CRC LH

Application example of setting Read sensor address command:								
Host sending		00 H	42 H	00 H	11 H	00 H	01H	E9H	D1H
Slave response								
01 H	42 H	02 H	01 H	01 H	6CH	28H		

7.Set sensor communication character format: (factory default is even parity)

Set sensor communication character format code commands:		Slave response :	
Sensor address	01H	Sensor address	01H
Function code	06H	Function code	06H
Address	00H	Register Address	00H
	09H		09H
Sensor changes communication character format	00H	Sensor new forma	00H
	01H		01H
CRC	9808	CRC	9808

Application Example of Set sensor communication character format Command:								
Host sending		01 H	06 H	00 H	09 H	00 H	01H	98H	08H
Slave response								
01 H	06 H	00 H	09 H	00 H	01H	98 H	08H	

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

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

0001H: 1 start bit + 8 data bits without checksum + 1 stop bit

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