RION® RION TECH

V1.9

MEMS DIGITAL ACCELEROMETER
RION AKF392
TECHNICAL MANUAL

RION QUALIFICATION CERTIFICATION

○ Quality management system certification: GB/T19001-2016 idt ISO19001:2015 standard (certificate number: 128101)

○ High-tech Enterprise (Certificate Number: GR201844204379)

○ CE certification: registration number ATSZAHE190625020

○ ROHS certification: registration No. AT18300RC105892

○ China National Intellectual Property Appearance Patent (Patent No.: ZL 201830752896.8)

○ Revision time: 2022-3-10

○ Product functions, parameters, appearance, etc. will be adjusted as technology upgrades. Please contact our pre-sales business to confirm when purchasing.

AKF392 MEMS DIGITAL ACCELEROMETER

MEMS MICROMECHANICAL ACCELERATION SENSOR

★ HIGH PRECISION
★ HIGH STABILITY
★ HIGH FREQUENCY RESPONSE

▶ PRODUCT INTRODUCE

The AKF392B three axis accelerometer is produced using Swiss patented technology.

This acceleration series can be applied to various fields such as vibration testing and impact testing.The product adopts digital interface output, RS232/485/TTL optional, different address codes can be set, and multiple sensors can be used in series for long distances, which is convenient for multi-point measurement and data analysis. The AKF392B is a monocrystal line silicon capacitive sensor, consisting of a micromachined silicon chip、a low-power ASIC for signal conditioning、a microprocessor for storing compensation values and a temperature sensor. This product has low power consumption, Complete calibration system, solid structure and stable output.The new electronic configuration provides solid-state power for reset, and providing full protection for over-current.In the full range,Typical values for long-term stability and bias of the scale factor are less than 0.1%. This series of products has the characteristics of strong structure, low power consumption and excellent deviation stability, which guarantees outstanding output reliability.

▶ FEATURE

★ Three-axis (X、Y、Z)
★ power voltage: 9~36V
★ work temp：-40°C to +85°C
★ Excellent deviation stability

★ output: RS232；RS485；TTL
★ anti-impact: 2000G
★ Storage temp：-40°C to +85°C
★ Excellent performance (impact, vibration and temperature)

▶ Application

★ crash record, fatigue monitoring and prediction
★ Low frequency vibration and automatic monitoring
★ Large machinery, engine
★ bridge

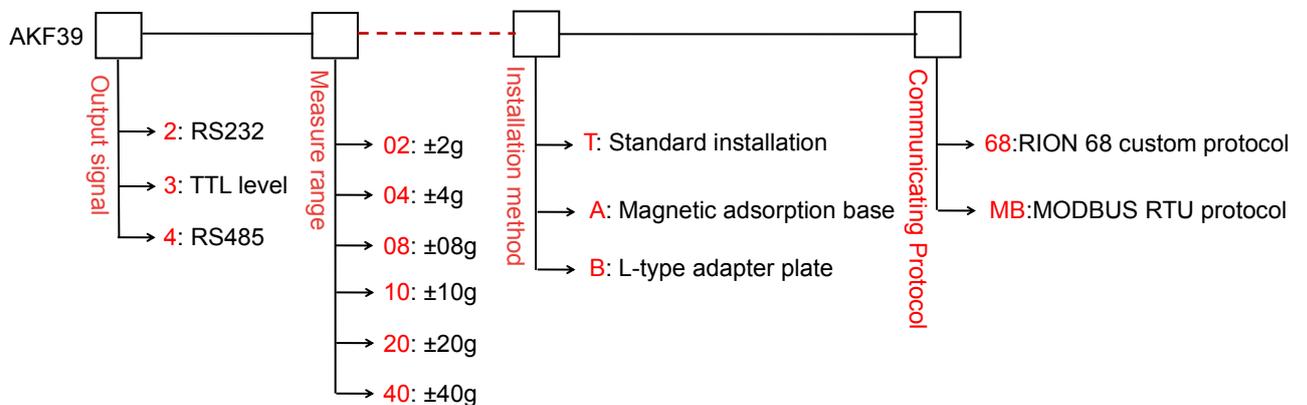★ wind power generation
★ automobile
★ armamentarium
★ road roller

AKF392 MEMS DIGITAL ACCELEROMETER

▶ **PRODUCT PARAMETER**

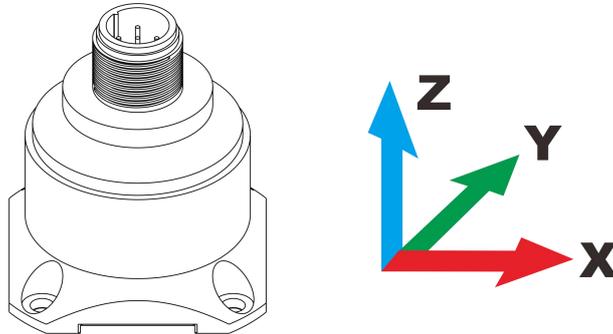| AKF392T	PARAMETER						UNIT
Range	±2	±4	±8	±10	±20	±40	g
Deviation Calibration	<1	<1	<1	<1	<1	<1	mg
Measuring Axial	X,Y,Z	X,Y,Z	X,Y,Z	X,Y,Z	X,Y,Z	X,Y,Z	Axial
Up/Off Power Repeatability	<2	<2	<2	<2	<2	<2	mg(highest)
Deviation Temp. Coefficient	0.01	0.01	0.01	0.01	0.01	0.01	%/℃(Typical value)
Resolution/Threshold (@ 1Hz)	< 1	< 1	< 1	< 1	< 1	< 1	mg(highest)
Nonlinearity	<0.5	<0.8	<1	<1	<1	<1	% FS（highest）
Bandwidth (3Db)	500	500	500	500	500	500	Hz
Cross-axis sensitivity	1	1	1	2	2	2	%
Lateral vibration sensitivity ratio	1	1	2	5	5	5	%
Noise density	21	21	21	86.6	86.6	86.6	μg/√Hz
Resonance frequency	2.4	2.4	2.4	5.5	5.5	5.5	kHz
68 protocol automatic output rate	5Hz、10Hz、25Hz、50Hz、100Hz、200Hz、500Hz、1000Hz						
MODBUS automatic output rate	10Hz、25Hz、50Hz						
Output Interface	RS232/RS485/TTL						
Protocol	Rion Standard Protocol And Modbus Rtu Protocol						
Reliability	MIL-HDBK-217，Grade 2						
Shock Resistance	100g@11ms、3 Axial Direction (Half Sinusoid)						
Recovery Time	<1ms(1000g, 1/2 Sin 1ms,Shock Acting On The i Axis)						
Vibrate	20g Rms,20~2000Hz (Random Noise ，o ,p,i Per Axis For Action 30 Minutes)						
Input（Vdd_Vss）	9-36 VDC						
Current Consumption	<60mA @ 12 VDC						
Connector	Industry standard M12 connector						
Weight	Product net weight: 82g, magnetic base: 48g, L-shaped adapter plate 20g						
Dimension	Product size: 34.3*34.3*38.5mm Magnetic adsorption base size: 34.23*34.23*6mm L-shaped adapter plate size: 36*44*15mm						

▶ **ORDERING INFORMATION**

AKF39

Output signal
→ 2: RS232
→ 3: TTL level
→ 4: RS485

Measure range
→ 02: ±2g
→ 04: ±4g
→ 08: ±08g
→ 10: ±10g
→ 20: ±20g
→ 40: ±40g

Installation method
→ T: Standard installation
→ A: Magnetic adsorption base
→ B: L-type adapter plate

Communicating Protocol
→ 68:RION 68 custom protocol
→ MB:MODBUS RTU protocol

E.g AKF392-02-T-68: RS232 signal output / ±2g range / standard installation / RION 68 custom protocol.

○Inclinometer ○Digital Compass ○Digital Inclinometer ○Accelerometer ○Gyro ○North Finder ○INS&IMU

▶ **PRODUCT MEASUREMENT DIRECTION**

▶ **SIZE**

Standard positioning installation
Size:34.3*34.3*38.5mm

38.5

1.5

4-Ø3.0

25.5

34.3

Ø42

25.5

34.3
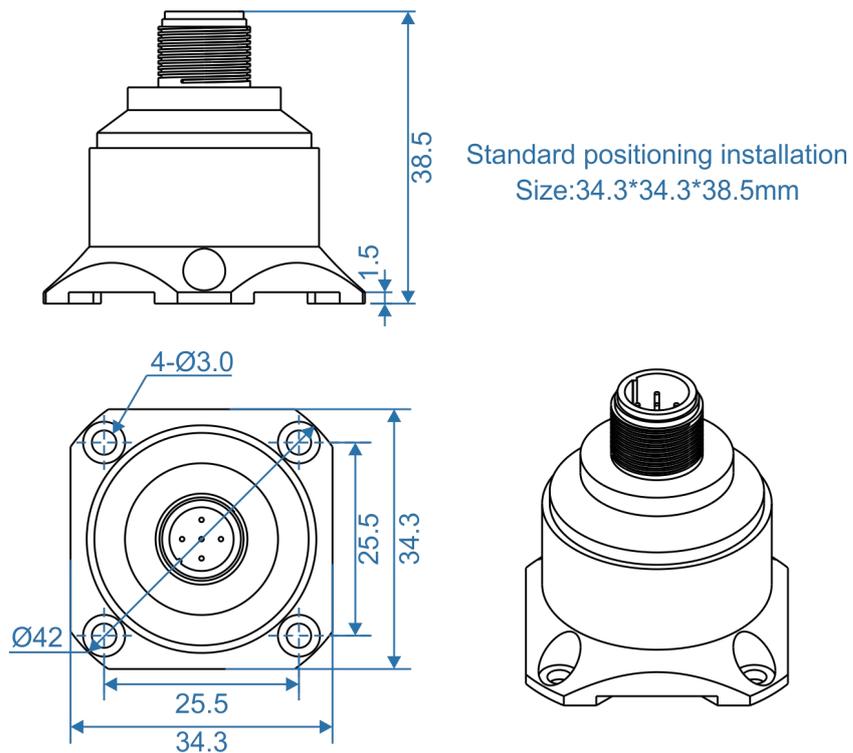
▶ MOUNTING ACCESSORIES SIZE

4-Ø3.0

25.46
34.23

25.46
34.23

6

Magnetic adsorption installation
Size:34.23*34.23*6mm

4-Ø3.0

25.46
44

25.46
36

4

15.00 mm

2-Ø5.2

20

5.5

L-shaped plate installation
Size:36*44*15mm

| Magnetic base | Material: Stainless steel | L-type pinboard | Material: aluminum alloy |
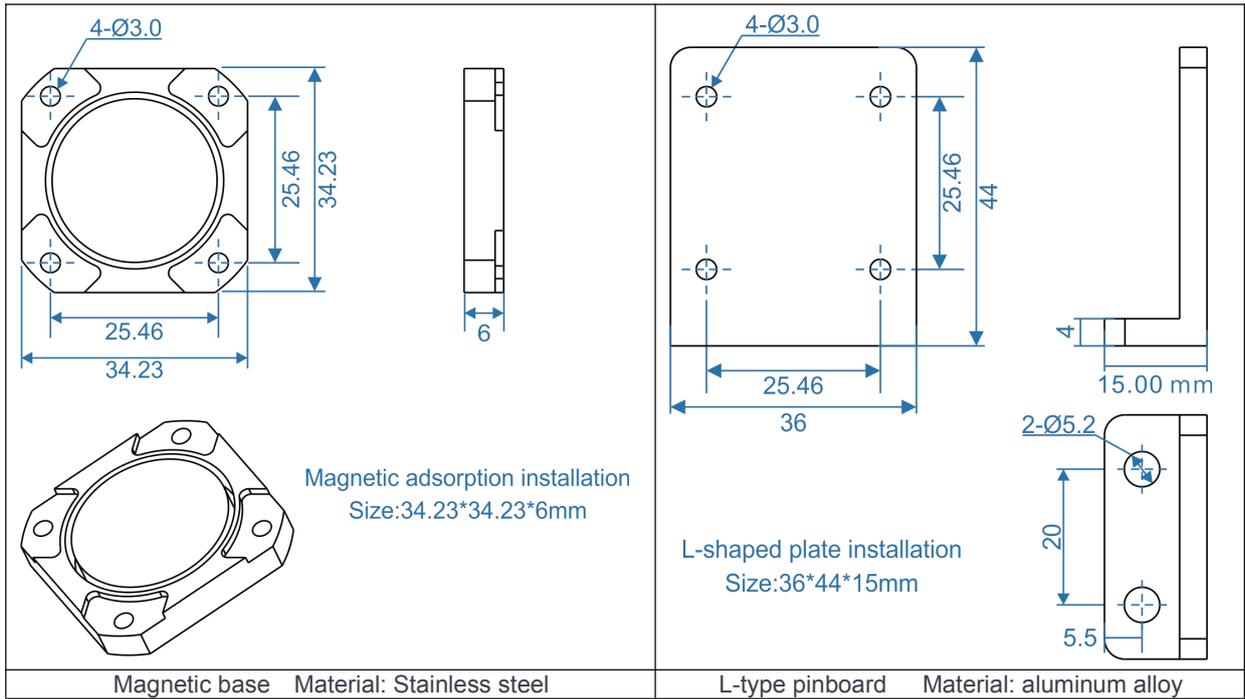
▶ ELECTRICAL CONNECTION

LINE COLOR FUNCTION	BLACK	WHITE	BLUE	BROWN
	GND Power negative	RS232(RXD) Or RS485(D+)	RS232(TXD) Or RS485(D-)	Vcc 9～36V Power supply positive

CONNECTOR
FRONT DIRECTION

BROWN:Vcc9~36V Power positive
BLACK:GNDPower negative
WHITE:RS232(RXD) OR RS485(D+)
BLUE:RS232(TXD) OR RS485(D-)

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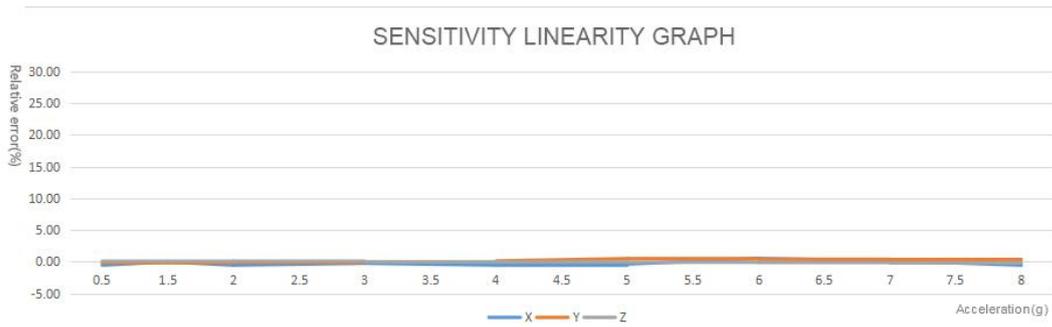RION TECHNOLOGY SINCE2008 · ATTITUDE & POSITION SOLUTION PROVIDER
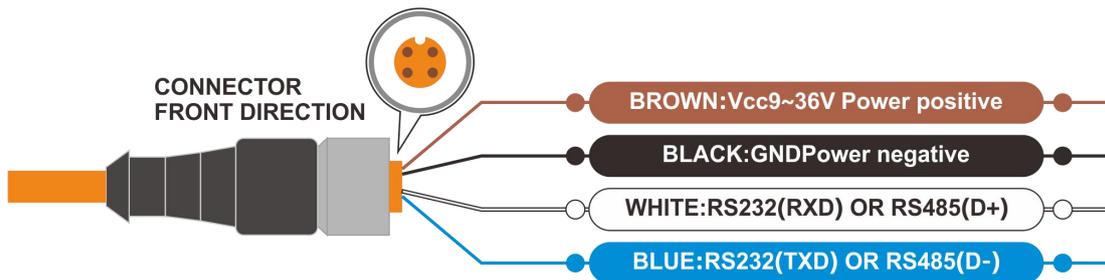
▶ SENSITIVITY AMPLITUDE-FREQUENCY RESPONSE CHARACTERISTIC CURVE

(reference condition: f=20.000Hz, a=2.000G)
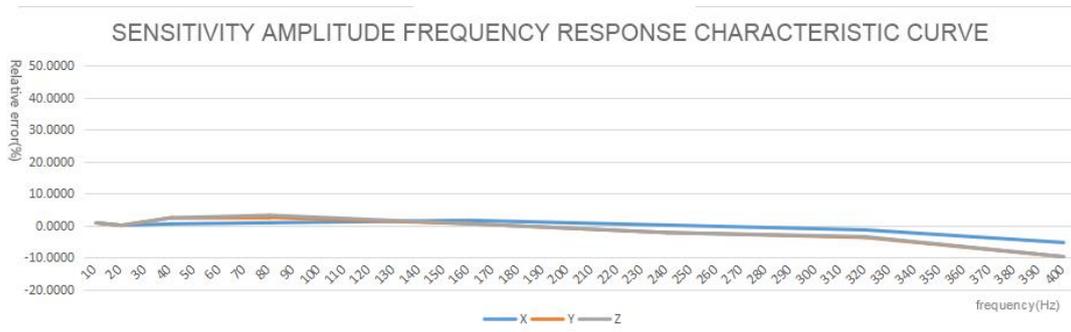
Reference diagram of measuring range ±8G

▶ SENSITIVITY LINEARITY GRAPH

► **COMMUNICATING 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					

data format : Hex

Identifier：Fixed 68H

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	**Read the acceleration simultaneously** E.g: *68 04 00 04 08*	Data domain(0byte) No Data domain command
0X84	Sensor answer reply E.g: 68 0D 00 84 00 20 10 10 40 00 05 05 00 1B	Data domain（9byte） AA AB BB CC CD DD EE EF FF AA AB BB:three character means X axis; CC CD DD:three character means Y axis; EE EF FF:3 characters means Z axis; The angle format is the same as the X axis or Y axis analysis method. The angle in the left example: X axis 02.010g, Y axis -04.000g, Z axis : +50.500g. 00 20 10 red three bytes return the angle value for the X-axis，For compressed BCD codes，The upper 0 of the first byte is the sign bit (0 positive, 1 negative) 02 is a two-digit integer value, 010 is a three-digit decimal value. The other axis data parsing methods are the same, This angle is resolved to +02.010g. 10 40 00 Blue three bytes return the angle value for the Y axis, the analytical method is the same as the X axis. 05 05 00 Green three bytes are the internal temperature value of the product, and the analytical method is the same as the X-axis angle. 1B: checksum, all data hexadecimal sum, no prefix 68.
0X0B	**Setting communication rate** **E.g: *68 05 00 0B 03 13*** The command setting is effective after power off then restart	Data domain（1byte） Baud rate：default :9600 00 means 2400 01 means 4800 02 means 9600 03 means 19200

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	(power off with save function)	04 means 38400 05 means 115200 06 means 230400
0X8B	Sensor answer reply command E.g: **68 05 00 8B 00 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,Y 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)Factory default: 00 00 Response system 01 5Hz Auto output mode 02 10Hz Auto output mode 03 25Hz Auto output mode 04 50Hz Auto output mode 05 100Hz Auto output mode 06 200Hz Auto output mode 07 500Hz Auto output mode（Baud rate adopt 115200、230400） 08 1000Hz Auto output mode（Baud rate adopt 230400） 09 300Hz Auto output mode（Baud rate adopt 115200、23040） 10 400Hz Auto output mode（Baud rate adopt 115200、23040）
0X8C	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 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	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.**

	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
0X53	Set save command 68 04 00 53 57	
0XD3	Set save command reply 68 05 00 D3 00 D8	Data domain（0BYTE） Data domain in the number means the sensor response results 00　Success　FF　Failure
0XFF	Read version software number instruction 68 04 00 FF 03	
	Read software version reply AKF392,SW V1.1	Data domain（BYTE） Data domain in the number means the sensor response results Return is in ASCII code format，model（AKF392），Software version number 1.1

3. Setting instructions and processes

3.1.Set related parameters(Baud rate, address code, automatic output frequency.)Only valid settings are set at this time, but not saved to FLASH,. Power down is not saved.

A Set address code

B Set baud rate

C Set the calibration parameters

D Automatic or inquiry mode

Notice：Take effect immediately after setting the address code and baud rate (but not saved to FLASH)，The subsequent operation instructions need to change the corresponding address code and baud rate to be set successfully.

3.2.Save parameters，write all parameters to FLASH

▶ MODBUS RTU PROTOCOL

1. Data frames format:

RTU Mode

Communication Parameter：Baud rate 9600 bps

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

> **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 idel - 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.
>
> ①All the sensors mounted on BUS are all set to an address.
>
> ②All the sensors mounted on BUS are all set to relative / absolute zero.
>
> ③Test 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 compuetr can not insert other frames in the midele 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 compueter 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.

2. Read the holding register to fetch acceleration data

Modbus FUNC 03H

Master Computer Inquiry Command:		Slave Computer Response:		
Inclinometer Address	01H	Inclinometer Address		01H
FUNC	03H	FUNC		03H
Visit Register first	00H	Data Length 9 bytes		09H
Address	02H	Data word 1 upper 8 bits	50H	
Data Length 4 bytes	00H	Data word 1 lower 8 bits	46H	X Axis Data
	04H	Data word 2 upper 8 bits	00H	
CRC	E5C9H	Data word 2 lower 8 bits	23H	Y Axis Data
		Data word 3 upper 8 bits	20H	

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		Data word 3 lower 8 bits	00H	
		Data word 4 upper 8 bits	00H	
		Data word 4 lower 8 bits	00H	Z Axis Data
		Data word 5 upper 8 bits	00H	
		CRC	B827H	

Read the measured data command applicaton example 1:								
Master computer sending		01 H	03 H	00 H	02 H	00 H	04 H	E5H	C9H

Slave computer response											
01H	03H	08H	50H	46H	00H	23H	20H	00	00H	00H	B8H	27H

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

The X axis is the 1-3 bytes of the data field, the Y axis is the 4-6 bytes of the data field, and the Z axis is the 7-9 bytes of the data field, with the low byte first. The expression method of acceleration is the number of points, one point corresponds to 0.001º, 0.001×(number of points-bias) is the acceleration, and the bias is 90000.

Take the above data frame as an example: the conversion process of acceleration is as follows:

1) Get the current acceleration points. Note that the low byte is first, the X axis is 004650H, the Y axis is 002023H, and the Z axis is 0.

Converted to decimal, X axis: 4650H→18000, Y axis: 2023H→8227, Z axis: 0.

2) Subtract the bias of 90000 (note: this value is a fixed amount), X axis: 18000-90000=-72000, Y axis: 8227-90000=-891773, Z axis 0-90000=-90000.

3) Get the final accelerometer, X axis: -72000×0.001=-72.000G, Y axis: -81773×0.001=-81.773G, Z axis: -90000×0.001=-90G.

Read acceleration data of input register

Modbus function code 04H, this is format two outputs. Users can adjust the register address and length to access different axis data according to their needs. The register table is as follows:

Register address	Data content	Data type	Unit	Remark
30003	X acceleration	UINT32 (R)	g	data analysis as follow
30005	Y acceleration	UINT32 (R)	g	data analysis as follow
30007	Z acceleration	UINT32 (R)	g	data analysis as follow

Application example of reading measurement data command 1:

Host query command :		Slave response :			
Sensor address	01H	Sensor address	01H		
Function code	04H	Function code	04H		
Access register	00H	Data length12 bytes	0CH		
First address	02H	Data domain	94H	X axis value
Data length 6 bytes	00H		5FH	
CRC	06H		01H	
	D1 C8 H		00H	
			65H	
			63H	Y axis value
			01H	
			00H	

			47H	Z axis
			60H	
			01H	value
			00H	
		CRC	1BE4H	

In the above table, the X axis is the data field 1-4 bytes, the Y axis is the data data field 5-8 bytes, and the Z axis is the data data field 9-12 bytes. Low byte first. The representation method of acceleration is the number of points, one point corresponds to 0.001º, 0.001×(number of points-bias) is the acceleration, and the bias is 90000.

Take the above table data as an example: the conversion process of acceleration is as follows:

1) Get the current acceleration points. Note that the low byte is first, the X axis is 00015F94H, the Y axis is 00016365H, and the Z axis is 00016047H.

Converted to decimal, X axis: 00015F94H → 90004, Y axis: 00016365H → 90981, Z axis: 00016047H->90183.

2) Subtract the bias of 90000 (note: this value is a fixed amount), X axis: 90004-90000=4, Y axis: 90981-90000=981, Z axis 90183-90000=183.

3) Get the final accelerometer, X axis: 4×0.001= 0.004G, Y axis: 981×0.001=0.981G, Z axis: 183×0.001=0.183G.

4. Set the sensor address:

Set sensor address code command:		Slave response :	
Sensor address	01H	Sensor address	01H
Function code	06H	Function code	06H
Address	00H	Register address	00H
	11H		11H
Sensor new address	00H	Sensor new address	00H
	04H		04H
CRC	D80C	CRC	D80C

Commands must be sent two times to be valid

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

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

5 Set sensor Baud rate : (factory default 9600bps)

Set sensor address code command:		Slave computer response:	
Sensor address	01H	Sensor Address	01H
FUNC	06H	FUNC	06H
Register address	00H	Register address	00H
	12H		12H
Baud rate of the sensor	00H	Baud rate of the sensor	00H
	XX		XX

	CRC		CRC LH		CRC		CRC LH

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

Set sensor address command example:								
Master computer sending		01H	06H	00H	12H	00H	A2H	A8H	76H

Slave computer response							
01H	06H	00H	12 H	00 H	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.

6. Set the sensor communication character format: (Factory default is even parity)

Set sensor address code command ：		Slave response ：	
Sensor Address	01H	Sensor Address	01H
FUNC	06H	FUNC	06H
address	00H	register	00H
	09H	address	09H
Sensor changes communication character format	00 H	New format of sensors	00H
	01H		01H
CRC	9808	CRC	9808

Application example of setting zero command:								
Host send		01 H	06 H	00 H	09 H	00 H	01H	98H	08H

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

The above example is to set the byte format to: one start bit + 8 data bits, no parity, + 1 stop bit

It is effective after power-on again. The factory default is one start bit + 8 data bits, even parity check + 1 stop bit

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

0000H: One start bit + 8 data bits, even parity +1 stop bit

0001H: One start bit + 8 data bits No parity + 1 stop bit

7. Set sensor automatic output: (factory default 0HZ)

Set sensor address code command ：		Slave response ：	
Sensor address	01H	Sensor address	01H
Function code	06H	Function code	06H
Address	00H	Register address	00H
	13H		13H
Sensor output frequency	00H	Sensor output frequency	00H
	XX		XX
CRC	CRC LH	CRC	CRC LH

The following table shows the valid values of the data field XX ：

frequency	0HZ	10HZ	25HZ	50HZ
Format one output setting command	00H	01H	02H	03H
Format two output setting command	00H	A1H	A2H	A3H

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Set sensor address command example :								
Host send			01H	06H	00H	13H	00H	A2H	A8H	76H
Slave reply								
01H	06H	00H	13H	00 H	A2H	A8H	76H

Note: 0013H is the register address, which controls the output frequency of the sensor. In the above example, the sensor is set to output data at 25HZ according to format two, and the last two bytes are the CRC checksum.

Note: RION custom protocol and MODBUS protocol switch methods to each other:

At power-on, the upper computer always sends 0xAA. When the accelerometer returns 0XAA, 0XAA, 0XBB, 0XBB, the change is successful.

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