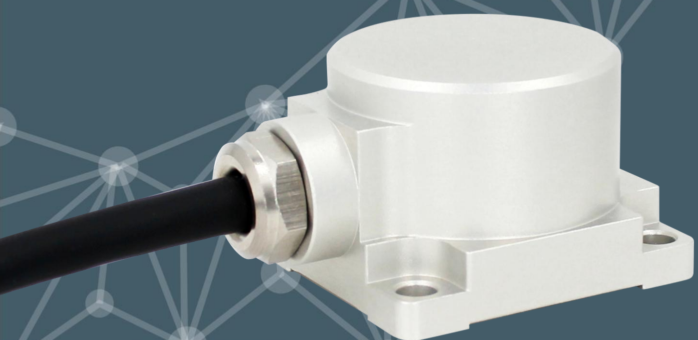


V1.0

MEMS Digital Accelerometer

RION AKM392

Technical Manual

RION QUALIFICATION CERTIFICATION

○Quality management system certification: GB/T19001-2016 idt ISO19001:2015 standard (certificate No.: 128101)

○ High-tech Enterprise (Certificate No.: GR201844204379)

○ CE certification:AT18250EC101485

○ Appearance Patent No.: ZL 202130804901.7

○ Revision date: 2022-3-10

Note: Product functions, parameters, appearance, etc. will be adjusted as technology upgrades. Please contact our sales to confirm when purchasing.

▶ PRODUCT INTRODUCTION

AKM392 triaxial accelerometer is a widely used acceleration sensor independently developed and produced by RION Technology, which can be applied to vibration testing, impact testing and other fields. The product adopts digital interface output, RS232/485/TTL is optional, and different address codes can be set. Multiple sensors are connected in series for a long distance, which is convenient for multi-point measurement and data analysis. The AKM392 is a monocrystalline 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, solid structure and stable output after calibration. The new electronic configuration provides solid state power for reset, providing protection against over-current. The long-term stability and deviation of the scale factor are typically less than 0.1% over the full scale range. This product has the characteristics of solid structure, low power consumption and excellent deviation stability, which ensures stable output reliability.

▶ PRODUCT FEATURES

★ Three-axis (X, Y, Z)
★ Output signal: RS232; RS485; TTL
★ Power supply voltage: 9~36V
★ Shock resistance: 2000G
★ Operating temperature: -40 ° C ~ + 85 ° C
★ Storage temperature: -40 ° C ~ + 85 ° C
★ Excellent deviation stability, good environmental performance (shock, vibration and temperature)

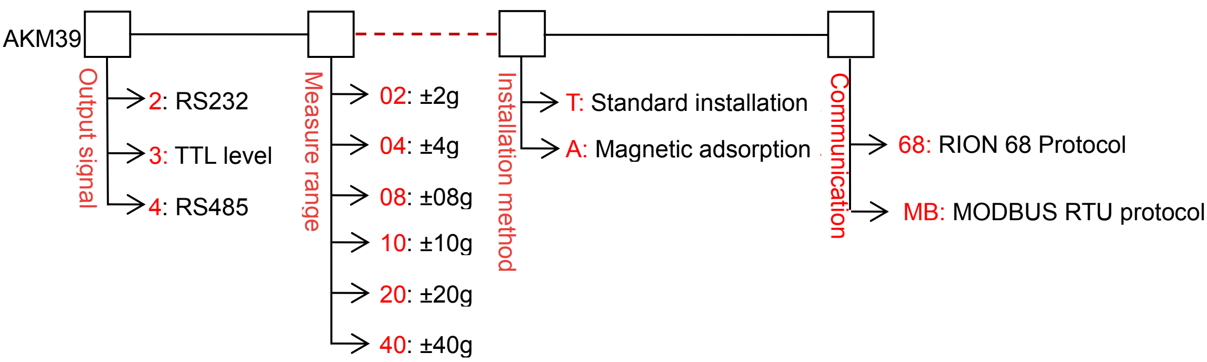
▶ Product application

★ Bridge
★ Automobile
★ Roller
★ Wind power
★ Medical equipment
★ Large machinery and engine
★ Low frequency vibration and automatic monitoring
★ Crash recording, fatigue monitoring and prediction
★ Traffic system monitoring, subgrade analysis and high-speed railway fault detection

▶ PRODUCT PERFORMANCE

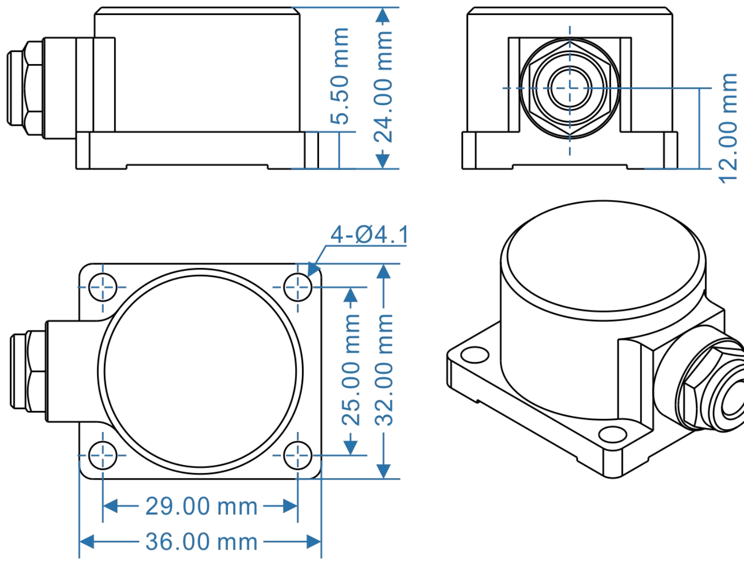
AKM392	PARAMETER						UNIT
Measure range	±2	±4	±8	±10	±20	±40	g
Deviation calibration	<1	<1	<1	<1	<1	<1	mg
Measure axis	X,Y,Z	X,Y,Z	X,Y,Z	X,Y,Z	X,Y,Z	X,Y,Z	Axis
Power on/off repeatability	<2	<2	<2	<2	<2	<2	Mg (Max)
Temp. coefficient of deviation	0.01	0.01	0.01	0.01	0.01	0.01	%/℃ (typical)
Resolution/Threshold (@ 1Hz)	< 1	< 1	< 1	< 1	< 1	< 1	Mg (Max)
Nonlinearity	<0.5	<0.8	<1	<1	<1	<1	% FS (Max)
Bandwidth (3DB)	500	500	500	500	500	500	Hz
Cross-axis sensitivity	1	1	1	2	2	2	%
Transverse vibration sensitivity ratio	1	1	2	5	5	5	%
Noise density	21	21	21	86.6	86.6	86.6	μg/√Hz
Resonant frequency	2.4	2.4	2.4	5.5	5.5	5.5	kHz
Automatic output rate of 68 protocol	5Hz、10Hz、25Hz、50Hz、100Hz、200Hz、500Hz、1000Hz						
MODBUS automatic output rate	10Hz、25Hz、50Hz						
Output interface	RS232/RS485/TTL						
Communication protocol	Reifen 68 protocol and MODBUS RTU protocol						
Reliability	MIL-HDBK-217, Class II						
Impact resistance	100g @ 11ms, triaxial (half sine wave)						
Recovery time	< 1ms (1000g, 1/2 sin 1ms, impact on i-axis)						
Vibration	20g RMS, 20-2000Hz (random noise, o, p, I 30 min per axis)						
Input (VDD _ VSS)	9-36 VDC						
Operating current consumption	<60mA @ 12 VDC						
Protection	IP67						
Material	aerospace aluminum						
Weight	Product net weight: ≤116g, magnetic base: ≤50g						
Size	Product size: L36 × W32 × H24mm Size of magnetic adsorption base plate: L36 × W32 × H7mm						

▶ PRODUCT ORDERING INFORMATION



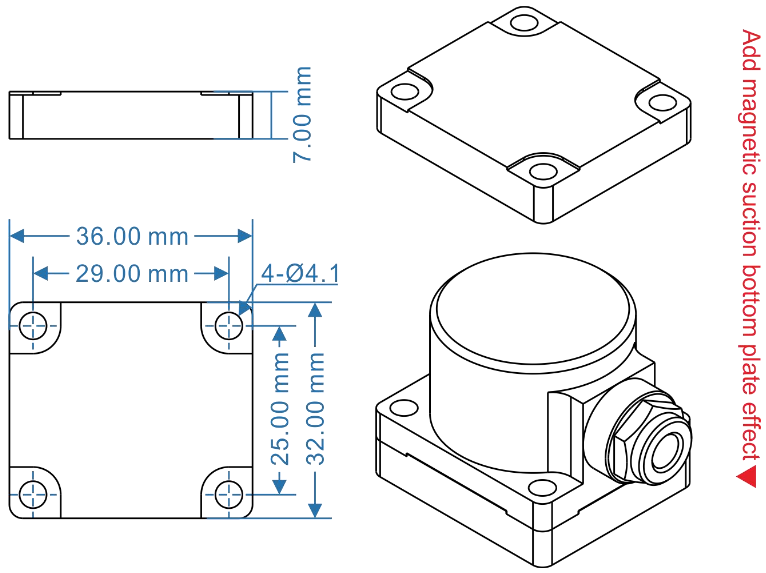
E.g: AKM392-02-T-68: indicates RS232 signal output/± 2g measurement range/standard installation mode/Ruifen68 protocol.

▶ PRODUCT DIMENSION DRAWING



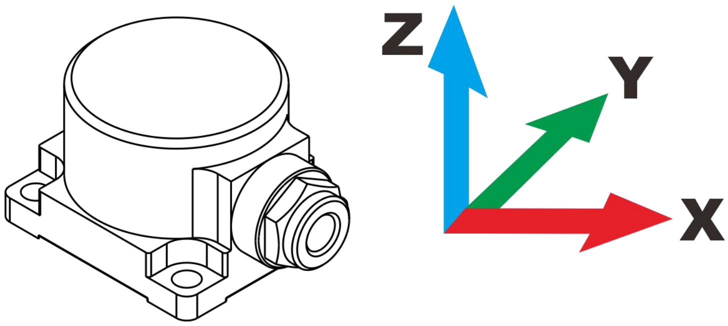
Shell size: L36 × W32 × H24mm
Installation size: L29 × W25 × H5.5mm
Mounting screws: 4 M4 screws

▶ DIMENSIONS OF MOUNTING ACCESSORIES



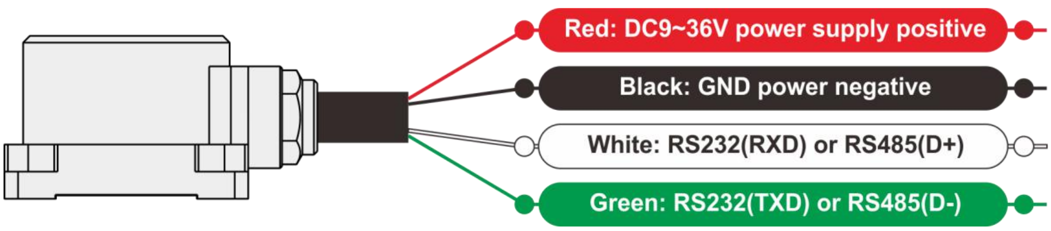
Magnetic bottom plate size: L36 × W32 × H7mm
Installation size: L29 × W25 × H7mm
Installation method: strong magnetic adsorption

▶ PRODUCT MEASUREMENT DIRECTION



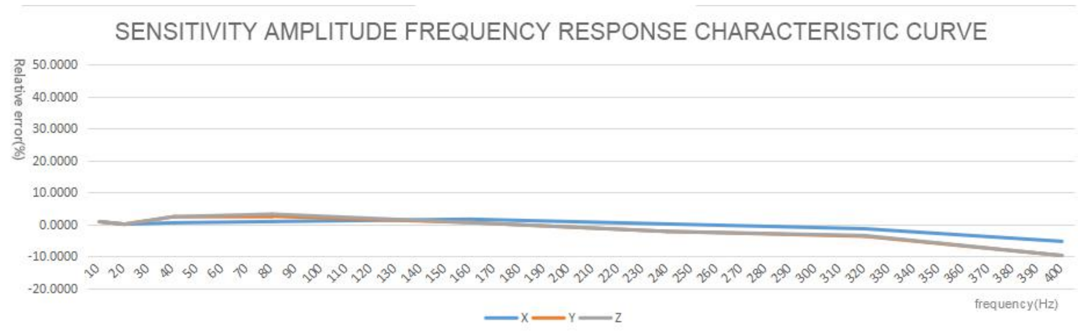
▶ ELECTRICAL CONNECTION

Color Function	RED	BLACK	WHITE	GREEN
	DC9～36V Positive pole of power supply	GND Negative pole of power supply	RS232(RXD) Or RS485 (D +)	RS232(TXD) Or RS485 (D-)



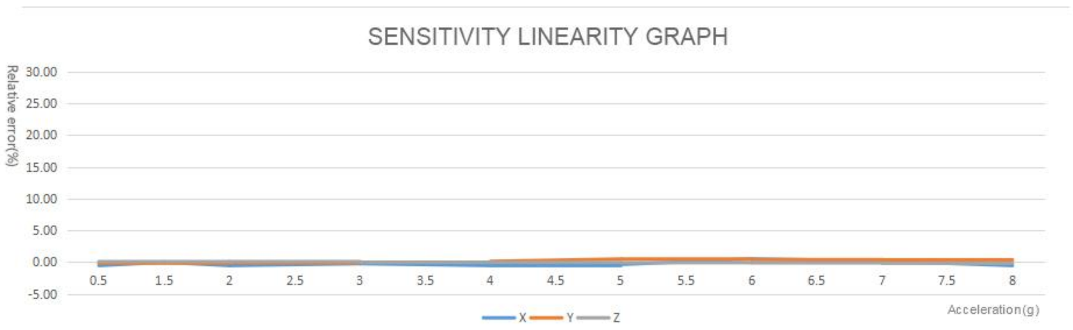
▶ SENSITIVITY AMPLITUDE-FREQUENCY RESPONSE CHARACTERISTIC CURVE

(reference condition: f=20.000Hz, a=2.000G)



Reference diagram of measuring range ±8G

▶ SENSITIVITY LINEARITY GRAPH



▶ Communication protocol (factory default RION custom protocol)

1、Data frame format: (8 data bits, 1stop bit, no check, default rate 9600)

Identifier (1byte)	Data length (1byte)	Address Code (1byte)	Command word (1byte)	Data domain	Checksum (1byte)
68					

Data format: hexadecimal;
Designator: fixed as 68;
Data length: length from data length to checksum (including checksum);
Address code: the address of the acquisition module, the default is 00;
Data field: change according to different content and length of command word;
Checksum: The sum of the data length, address code, command word, and data field without regard to carry.

2. Command word analysis

Desc.	Meaning/Example	Description
0X04	**Simultaneous read acceleration command** **E.g:** ***68 04 00 04 08***	Data field (0 byte) No data domain command
0X84	Sensor reply 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	Set the communication rate **E.g:** ***68 05 00 0B 03 13***	Data domain（1byte） Baud rate：default :9600 00 means 2400 01 means 4800 02 means 9600 03 means 19200 04 means 38400 05 means 115200 06 means 230400

0X8B	The sensor answers the reply command **Example: 68 05 00 8B 00 90**	Data field (1byte) The number in the data field indicates the result of the sensor response 00 Success FF Fail
0X0C	**Setting the Sensor Output Mode** Response system: the sensor responds to the relative acceleration only after the upper computer sends the read acceleration command Automatic output system: after the sensor is powered on, it automatically outputs X, Y acceleration, and the output frequency is based on the set value. For high frequency output, set the baud rate to 115 200. **E.g:*68 05 00 0C 00 11***	The factory default value of data field (1byte) is: 00 00 response system 01 5Hz Auto Output Mode 02 10Hz automatic 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 rates 115200, 230400) 08 1000Hz Auto Output Mode (230400 baud rate) 09 300Hz Auto Output Mode (Baud rates 115200, 230400) 10 400Hz Auto Output Mode (Baud rates 115200, 230400)
0X8C	The sensor answers the reply command **E.g: 68 05 00 8C 00 91**	Data field (1byte) The number in the data field indicates the result of the sensor response 00 Success FF Fail
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, such as RS485, each sensor needs to be set to a different address to control and respond to acceleration separately. 2. If the new address is successfully changed, the address code in all subsequent command and response data packets must be changed to the new address code after the change, otherwise the sensor will not respond to the command. **E.g: *68 05 00 0F 01 15*** Set the address to 01. ***68 05 FF 0F 00 13*** Reset the address to 00 with the	Data field (1byte) XX module address, 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 it can still respond normally.**

	general addr	
0X8F	The sensor answers the reply command **E.g: 68 05 00 8F 00 94**	Data field (1byte) The number in the data field indicates the result of the sensor response 00 Success FF Fail
0X53	Set the save command 68 04 00 53 57	
0XD3	Set Save Command Reply 68 05 00 D3 00 57	Data field (0BYTE) The number in the data field indicates the result of the sensor response 00 Success FF Fail
0XFF	Version Software Number Directive 68 04 00 FF 03	
	Read Software Version Reply AKM392,SW V1.1	Data field (0BYTE) The number in the data field indicates the result of the sensor response Return to ASCII format, model AKM392, software version 1.1

Set up instructions and processes

1. Set the relevant parameters (baud rate, address code, automatic output frequency). At this time, only the settings are valid, but they are not saved to FLASH. They are not saved in case of power failure.

A Set the address code B Set the baud rate C Set the calibration parameters D Automatic or interrogation mode

Note: When the address code and baud rate are set, they will take effect immediately (but not saved to FLASH). The following operation instructions need to change the corresponding address code and baud to set successfully.

2. Save parameters Write all parameters to FLASH

▶ MODBUS communication protocol

1. Data frame format:

RTU mode

Communication parameters: baud rate 9600 bps (default)

Data frame: 1start bit, 8 data bits, even parity, 1stop bit

Note that please read the following items carefully before use:

1) Because the MODBUS protocol stipulates that the time between two data frames should be at least more than 3.5 bytes (for example, under the baud rate of 9600, the time is 3.5 × (1/9600) × 11 = 0.004s). However, in order to leave enough margin, the sensor increases this time to 10 ms, so leave at least 10 ms between each data frame.

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

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

1. Set the address of all the acceleration sensors of this model mounted on the bus to a certain address.

2. Set all acceleration sensors of this model mounted on the bus to the relative/absolute zero point.

3. This model of sensor is tested on the entire bus by the host sending an address of 0 to the bus to interrogate the acceleration Command, if the communication indicator can flash, the communication is normal.

3) In order to improve the reliability of the system, set the address command and set the baud rate. Both commands must be sent twice in a row to be valid. "Consecutive sending twice" means that the sending is successful twice (the slave replies each time), and the two questions and answers must be consecutive, that is, the host cannot insert other data frames between the two questions and answers, otherwise, this command will be locked.Until the power is cut off, the setting process refers to the following:

Send the set address command -- wait for the set success command sent by the slave -- (no other commands are allowed) Send the set address command again -- wait for the set success command sent by the slave -- modify successfully

4) After power-on, the above two setting commands can only be set once respectively. If it needs to be set again, it needs to be powered on again.

5) When the normal communication accumulates to a certain number of times, the communication indicator will flash once.

2. Read the holding register to get the acceleration data:

Modbus function code 03H, which is output in format 1.

Host query command:		Slave response:		
Sensor address	01H	Sensor address	01H	
Function Code	03H	Function Code	03H	
Access register	00H	Data length 9 bytes	09H	
First address	02H	Upper 8 bits of data word 1	50H	X-axis data
Data length	00H	Lower 8 bits of data word 1	46H	
Four words	04H	Data word 2 upper 8 bits	00H	
CRC	E5C9H	Lower 8 bits of data word 2	23H	Y-axis data
		Data word 3 upper 8 bits	20H	
		Lower 8 bits of data word 3	00H	
		Data word 4 upper 8 bits	00H	Z-axis data
		Lower 8 bits of data word 4	00H	
		Data word 5 upper 8 bits	00H	
		CRC	B827H	

Read Measurement Data Command Application Example 1:								
Host sends	01 H	03 H	00 H	02 H	00 H	04 H	E5H	C9H

Slave replies												
01H	03H	09H	50H	46H	00H	23H	20H	00H	00H	00H	B8H	27H

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

The X axis is the first to third bytes of the data field, the Y axis is the fourth to sixth bytes of the data field, and the Z axis is the seventh to ninth bytes, with the low byte first. Acceleration is expressed in points, one point corresponds to 0.001°, 0.001 × (points-offset) is acceleration, and the offset 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 in the front, the X axis is 004650H, the Y axis is 002023H, and the Z axis is 0.

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

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

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

3. Read input register acceleration data:

Modbus function code 04H, which is output in format 2. The user adjusts the register address and length to access the data of different axes as required. The registers are as follows:

Register address	Data content	Data type	Unit	Remark
30003	X-axis acceleration	UINT32 (R)	g	The data analysis is as follows
30005	Y-axis acceleration	UINT32 (R)	g	The data analysis is as follows
30007	Z-axis acceleration	UINT32 (R)	g	The data analysis is as follows

Read Measurement Data Command Application Example 1:

Host query command:		Slave response:		
Sensor address	01H	Sensor address	01H	
Function Code	04H	Function Code	03H	
Access register First address	00H	Data length 12 bytes	0CH	
	02H	Data domain	94H	X-axis data
Data length 6 words	00H		5FH	
CRC	06H		01H	
	D1 C8 H		00H	
			65H	Y-axis data
			63H	
			01H	
			00H	
			47H	Z-axis data
			60H	
			01H	
			00H	
		CRC	1BE4H	

In the above table, the X axis is the data field of 1-4 bytes, the Y axis is the data field of 5-8 bytes, and the Z axis is data field of 9-12 bytes. Low byte first. Acceleration is expressed in points, one point corresponds to 0.001°, 0.001 × (points-offset) is acceleration, and the offset is 90000.

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

Get the current number of acceleration points. Note that the low byte is in the front. The X axis is 00015F94H, the Y axis is 00016365H, and the Z axis is 00016047H.

Convert to decimal, x-axis: 00015F94H → 90004, y-axis: 00016365H → 90981, z-axis: 00016047H-> 90183.

Subtract offset 90000 (note: this value is a fixed quantity), X axis: 90004-90000 = 4, Y axis: 90981-90000 = 981, Z axis 90183-90004 = 183.

The final accelerometer is obtained, X axis: 4 × 0.001 = 0.004 G, Y axis: 981 × 0.001 = 0.981 G, Z axis: 183 × 0.001 = 0.183 G.

4. Set the sensor address:

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 in a row to be valid

Application example of the command for setting the sensor address:								
Host sends	01H	06H	00H	11H	00H	04H	D8H	0CH
Slave replies								
01H	06H	00H	11H	00H	04H	D8 H	0CH	

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

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

Command to set sensor address code:		Slave response:	
Sensor address	01H	Sensor address	01H
Function Code	06H	Function Code	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

Application example of the command for setting the sensor address:								
Host sends	01H	06H	00H	12H	00H	A2H	A8H	76H
Slave replies								
01H	06H	00H	12 H	00 H	A2H	A8H	76H	

Note: 0012H is the register address that 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. Set the character format of the sensor communication: (the factory default is even check)

Set the sensor communication character format:		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	00 H	New format for sensor	00H
	01H		01H
CRC	9808	CRC	9808

Application example of zero point setting command:								
Host sends	01 H	06 H	00 H	09 H	00 H	01H	98H	08H
Slave replies								
01 H	06 H	00 H	09 H	00 H	01H	98 H	08H	

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

Valid after power up again. Factory default is one start bit + 8 data bits even parity + 1stop bit

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

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

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

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

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
	13H		13H
Output frequency of the sensor	00H	Output frequency of the sensor	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 Setup Command	00H	01H	02H	03H
Format Two Output Setup Command	00H	A1H	A2H	A3H

Application example of the command for setting the sensor address:								
Host sends	01H	06H	00H	13H	00H	A2H	A8H	76H
Slave replies								
01H	06H	00H	13H	00 H	A2H	A8H	76H	

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

Note: Method for mutual switching between Ruifen custom protocol and MODBUS protocol:

During power-on, the upper computer always sends 0 xAA. When the accelerometer replies 0 XAA, 0 XAA, 0 XBB, it indicates that the change is successful.

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