



Strain Gauge - Six Axis Force/Torque Sensor KWR46 Series

User Manual

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■ Introduction

This is the user manual for the strain gauge six-axis force/torque sensor (KWR46 series - RS485 communication), it is suitable for RS485 communication and RS485 to USB communication.



This manual mainly introduces the product's specifications, functions, methods of use and interface forms, and informs the user of the precautions associated with this product. Please read this manual before and during the use of the product as improper operation may lead to product failure or accidents.

■ Statement

1. The information contained in this manual is current at the date of publication. If modified, further notice is not available.
2. This manual uses two representations: decimal and hexadecimal. All unspecified values are expressed in decimal representation.
3. This product is a precision instrument and it is important to use the product within the specification range specified in this manual. In particular, use of the product under conditions where the load is greater than the rated load may cause the product to malfunction. Please ensure that all six axes (3 force axis and 3 torque axss) are within the rated load range.
4. Different batches of products may have color difference or scratch, which has no impact on performance.
5. If specific environment is necessary, such as radiation environment, dustless room, strong magnetic field, spray oil or chemicals, please contact sales for further information.
6. This product complies with protection class IP64, but only if the product is installed correctly. Please read the installation instructions described in this manual carefully and install it correctly.
7. This product has not been designed or manufactured for inclusion in systems requiring a high degree of safety and reliability such as nuclear power, aviation, railways, safety equipment, etc. If this product is incorporated into such equipment and control systems, there may be a risk of serious impact or damage to human life, health, property, etc., for which we cannot be held responsible.
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9. Kunwei Tech shall not be liable for any incidental damage (loss of business interests, business interruption, etc.)



arising from the inability to use or disable the product.

10. We are not responsible for any damage caused by failure to comply with the contents of this manual.
11. We are not responsible for any damage caused by malfunctions caused by equipment and software combinations that do not involve our company.
12. When exporting overseas, please comply with the relevant laws and regulations of China's foreign trade and the relevant laws and regulations of the importing country, and carry out the necessary procedures. Please contact our sales representatives if you require relevant information or qualification certificates.
13. The warranty period for this product is twelve months from the date of delivery of the product. Repairs after the warranty period will be subject to a charge depending on the repair. In addition, the warranty does not cover 'faults caused by the use of external specifications', 'faults caused by user negligence' or 'disassembly of the product without permission' during the warranty period.
14. KWR36 is one of the product names of our strain gauge six-axis force/torque sensors and is owned by Kunwei (Beijing) Technology Co., Ltd.
15. The copyright of this user manual belongs to Kunwei (Beijing) Technology Co.,Ltd.

■ Terms and definitions

Terms	Definitions
Rated load	The maximum load that meets the sensor specification. If this value is exceeded, there is no guarantee that the technical specifications required by the specification will be met.
Overload	The load exceeds the rated load. Failure may occur when the sensor is overloaded.
Zero output	Output value without load when the mounting section and the ground are horizontal and the mounting section is facing the ground.
Precision (Repeatability)	Precision is an evaluation indicator of the degree of agreement between multiple measured values, i.e. the degree of consistency of the output curve obtained when the sensor measure the same load group (combined of three-directional force and three-directional torque) multiple times. Repeatability precision is the standard deviation of the output error as a percentage of the rated output (%FS).
Accuracy (Deviation)	Accuracy is an evaluation indicator of the degree of deviation of the measured value from the true value. Accuracy is the standard deviation of the amount of deviation between the output and the theoretical true value as a percentage of the rated output (%FS)



Zero point temperature characteristics Changes in zero output with changes in ambient temperature. The difference between the maximum and minimum values of the zero output over the operating temperature range is divided by the operating temperature range and expressed as a percentage change per 1°C relative to the rated output (%FS /°C), expressed in absolute terms.

Baud rate Baud rate is the number of symbols transmitted per second. It is a index to measure the rate of data transmission. It is expressed by the number of carrier modulation state changes per unit time. In the information transmission channel, the signal unit carrying data information is called a code element, and the number of code elements transmitted through the channel per second is called the code element transmission rate, or baud rate for short.

IP64 The IEC (International Electrotechnical Commission) has drawn up a classification of electrical appliances according to their resistance to dust and moisture. IP64 has the following properties:

Dust: protection: protection against foreign objects and dust

Waterproof: prevents splashing water from soaking in

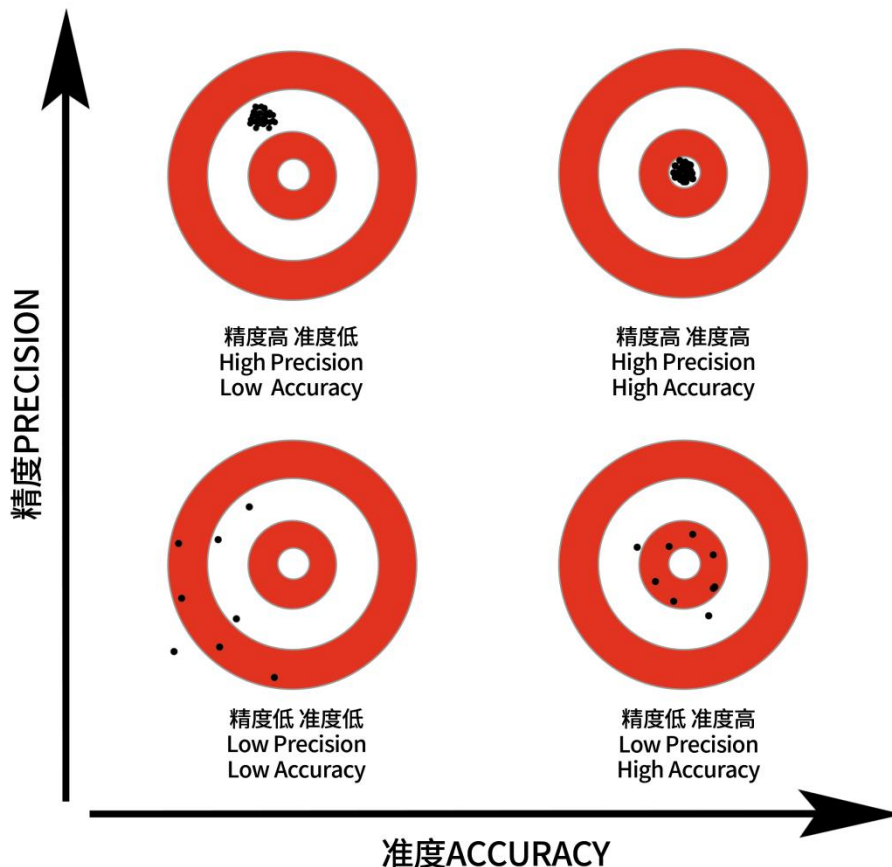


Fig.1 Precision and accuracy schematic diagram



■ Brief description of product specifications

Model	Rated force (N)		Rated torque (Nm)		Dimensions (mm)	Power supply (VDC)
	Fx, Fy	Fz	Mx, My	Mz		
KWR46A	50	50	2.0	2.0	$\Phi 46.0 \times H20.4$	9~24
KWR46B	150	150	5.0	5.0	$\Phi 46.0 \times H20.4$	9~24
KWR46C	200	200	7.0	7.0	$\Phi 46.0 \times H20.4$	9~24

Note: The overall dimensions do not include the connector housing and the input/output connection interface. For more information, please see the installation dimensions drawing.

Note: This kind of sensor needs to be used with high precision data acquisition box(9~24VDC) produced by our company.



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1 Product Overview

1.1 Product features

The model KWR46 series is a strain gauge six-axis force/torque sensor that detects three forces and three moments in real time. The sensor detects the relative deformation between the 'tool side flange' and the 'main body' caused by the applied force, and the change in the sensor's elastic unit could be measured based on the principle of strain electric measurement. The sensor contains an embedded system that collects and processes the signal changes from strain gauges and outputs the magnitude and direction of the applied force in real time, providing high accuracy and responsiveness. When using the sensor, please install it correctly to avoid any interference with the output effect.

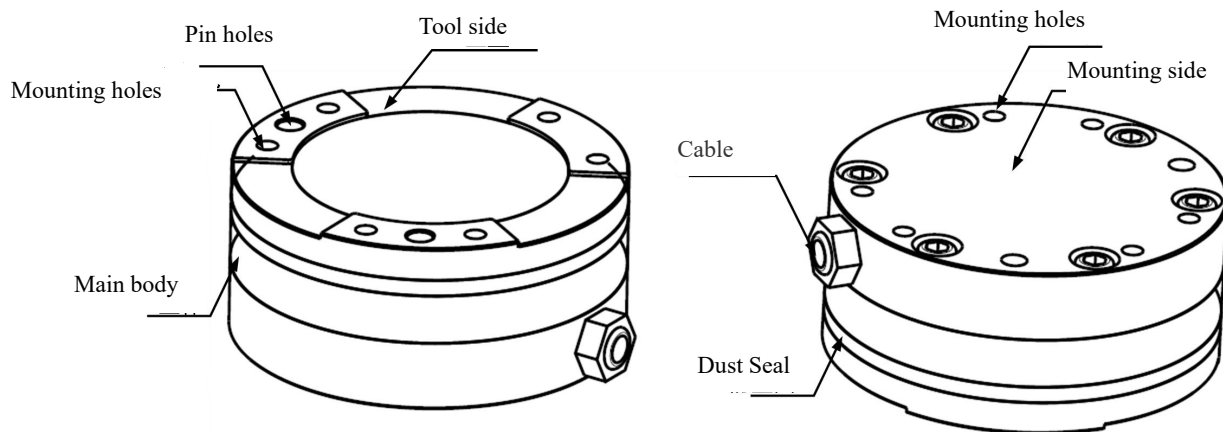


Fig.2 Sensor appearance

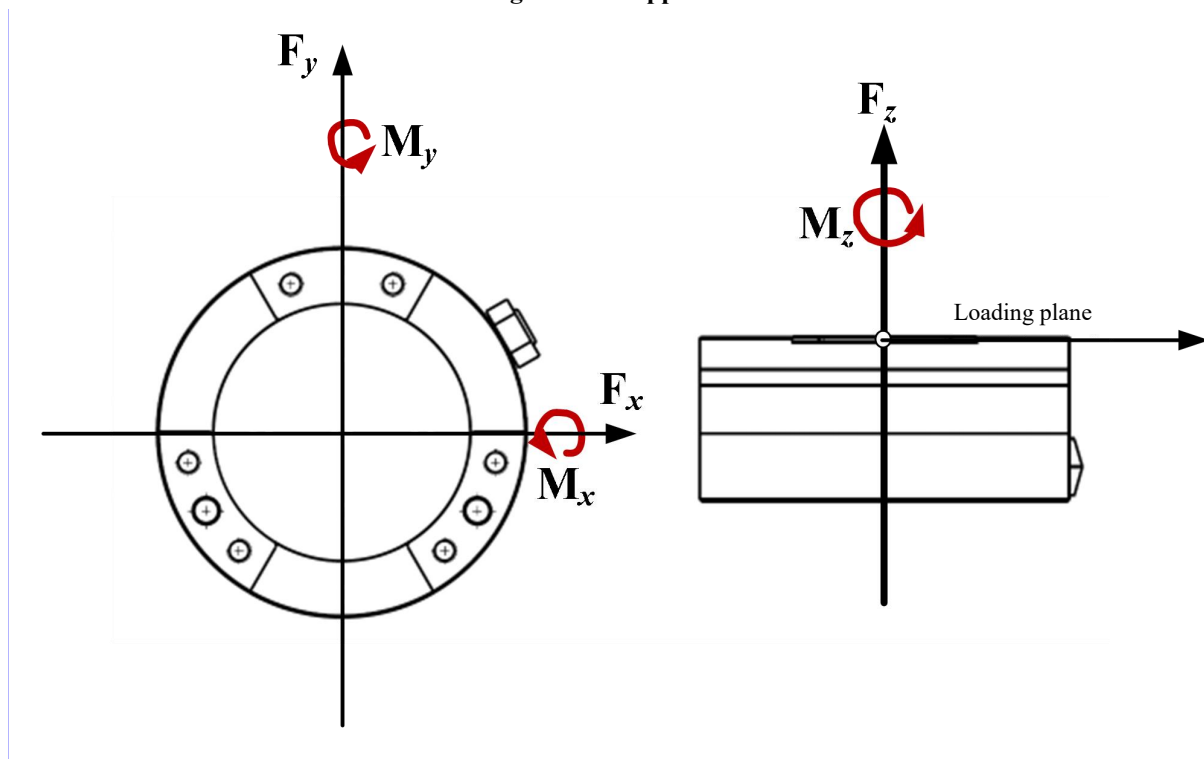


Fig.3 Definition of the sensor coordinate system (the direction of the torque conforms to the right-hand system)



1.2 Electrical characteristics

The voltage signal from the strain gauges is processed in real time by the external data acquisition module, and converted to the actual load value and output in the form of a digital signal.

2 Installation of the sensor

For details of the sensor mounting holes and mounting dimensions see "Section 4.2 Mounting Dimensions".

2.1 Operating procedures for sensor installation

The operating procedures given in this manual are typical of those for applications such as robotic arm mounting.



In the process of tightening the screws, gradually tighten the screws in the diagonal order shown in the illustration. Make sure that the sensor is in even contact with the device or adapter to be mounted.

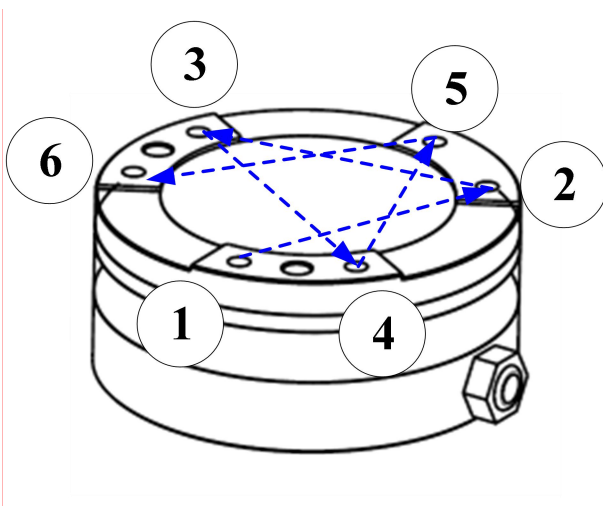


Fig.4 Screw tightening sequence

When the sensor leaves the factory, the adapter is not included by default. If you needs, you can inform the sales to determine the size and form of the adapter before confirming the order. According to user needs, the mechanical arm end flange, actuator end flange, and sensor can be assembled and shipped to reduce the customer's installation and learning process. They can also be shipped as loose parts according to customer requirements. To ensure the completeness of the manual, this tutorial includes installation instructions for the adapter flange, and the form of the adapter flange is only for illustration.

(1) Check the equipment to be installed and the sensor, the flange of robot arm end flange, the flange fo tool side and sensors

Verify that the equipment to be installed and the sensor surfaces and flanges are free of damage or foreign matter.

*If the contact is not uniform due to factors such as inclusions of foreign matter, gaps will form between the devices (or transfer flange) to be installed, which will not guarantee the IP64 performance of the product and will



have an effect on the actual sensor output.

(2) Install the sensor on the device

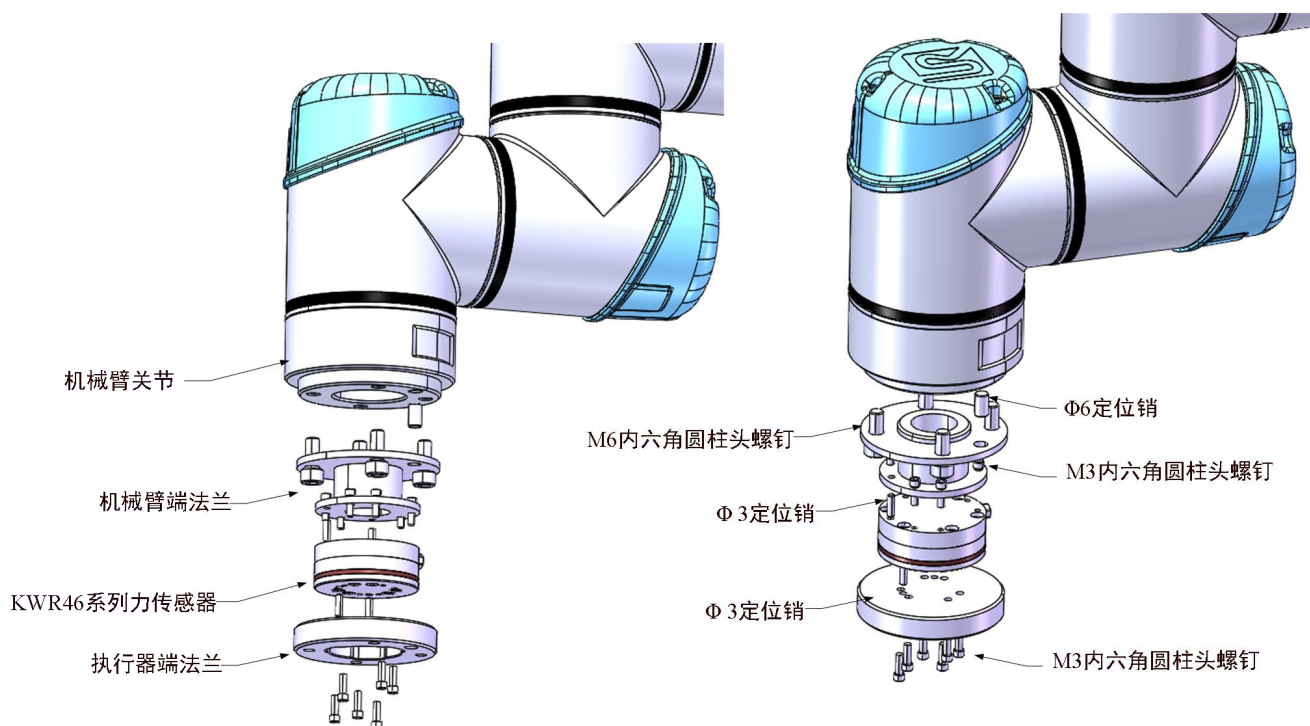
We need to install the sensor on the adapter device or a base with matching interface by using 6pcs M3 socket screws, and then after checking the mounting surface, the sensor could be successfully mounted on the surface through 6pcs M3 screw and 2pcs $\phi 3$ dowel pin.

*The dowel pins are used to obtain a consistent connection for the installation of the device, If the locating pins are not used, the sensor performance will not be affected.

(3) Install the other side(tool side) of the sensor

Use the dowel pins to position the sensor to fit the tool side and confirm that the sensor is mounted in the same direction as the equipment is used.

Fasten by using 6pcs M3 threaded screws. The screws tightening sequence is performed in the order of Figure 4.



(4) Install the assembled robot arm end flange, sensor, actuator end flange, and robot arm joint.

The end flange of the robotic arm is positioned and matched with $\phi 6$ dowel pins, and fastened with 4pcs M6 hexagon socket head screws. At this point, the installation of the sensor and its adapter flange with the robotic arm is completed, and the customer's actuator installation is carried out according to the customer's own installation method.

*The flange positioning pin on the sensor actuator end is used to achieve repeatability in actuator installation. If the positioning pin is not used, the sensor performance will not be affected.



2.2 Connecting the cable

The connection cable is delivered with the product. The connecting cable is a multi-core cable, which is directly led out from the inside of the sensor, and connected to the signal acquisition module through DB25 or HDB15 interface externally.

When connecting the signal acquisition module to the terminal, it is necessary to set the electrical interface parameters provided in this manual and connect the power and signal output cables accordingly. It should be noted that during the installation process, the wiring of each cable core wire should be strictly operated according to the color definition of the given core wire. If the positive and negative of the power supply are connected in reverse, the sensor will be damaged. Please be careful.

The specific wiring method and related electrical interface parameters are described in sections 4.3 to 4.5.



During installation, please make sure that the wiring of each cable core follows the color definitions of the given cores. If the positive and negative of the power supply are connected in the opposite direction, the sensor will be damaged, pls connect carefully.

3 Caution

- (1) Do not use in a temperature and humidity environment outside the allowable range of specifications.
- (2) The wiring must be completely correct. When switching on the power please check whether the colours of the connecting cables are connected one to the other according to the form provided in this manual. If an error is made in the connection terminals, the internal circuit of the sensor may be short-circuited and possibly damaged, so be sure to note and check this.
- (3) The sensors have been tested for vibrations and shocks due to the built-in embedded system and other sophisticated components. If the product is dropped, excessive vibration etc. It may still cause a malfunction.
- (4) Knocking is strictly forbidden during the installation of the sensor. Especially when fitting to the adapter flange, if the gap fit is tight due to the processing of the adapter flange and other factors, please do not knock the sensor, otherwise it will cause damage to the sensor performance.
- (5) The system operates at a default baud rate of 460800. If the device outputs this value for a long time, please check whether the sensor is under normal force and the force range is normal. Long-term over-range stress may cause irreversible damage to the equipment and cannot output data accurately. Due to space constraints, the circuit board does not have reverse polarity protection, please be sure to check whether the power cable connection is correct when powering up, reverse connection may cause the circuit power supply to burn out.



- (6) After the sensor has been installed and powered on, it is recommended that to preheating for half an hour.
- (7) The actual use of the sensor requires consideration of the mass of the equipment mounted on it in order to avoid overloading.
- (8) If the original package is damaged or lost, please wrap the sensor well in all directions, and ensure there will be no heavy load during the delivery process.
- (9) If you have any doubts or malfunctions during use, please do not try to operate without permission, but contact us directly.



4 Product specifications

4.1 Basic specifications

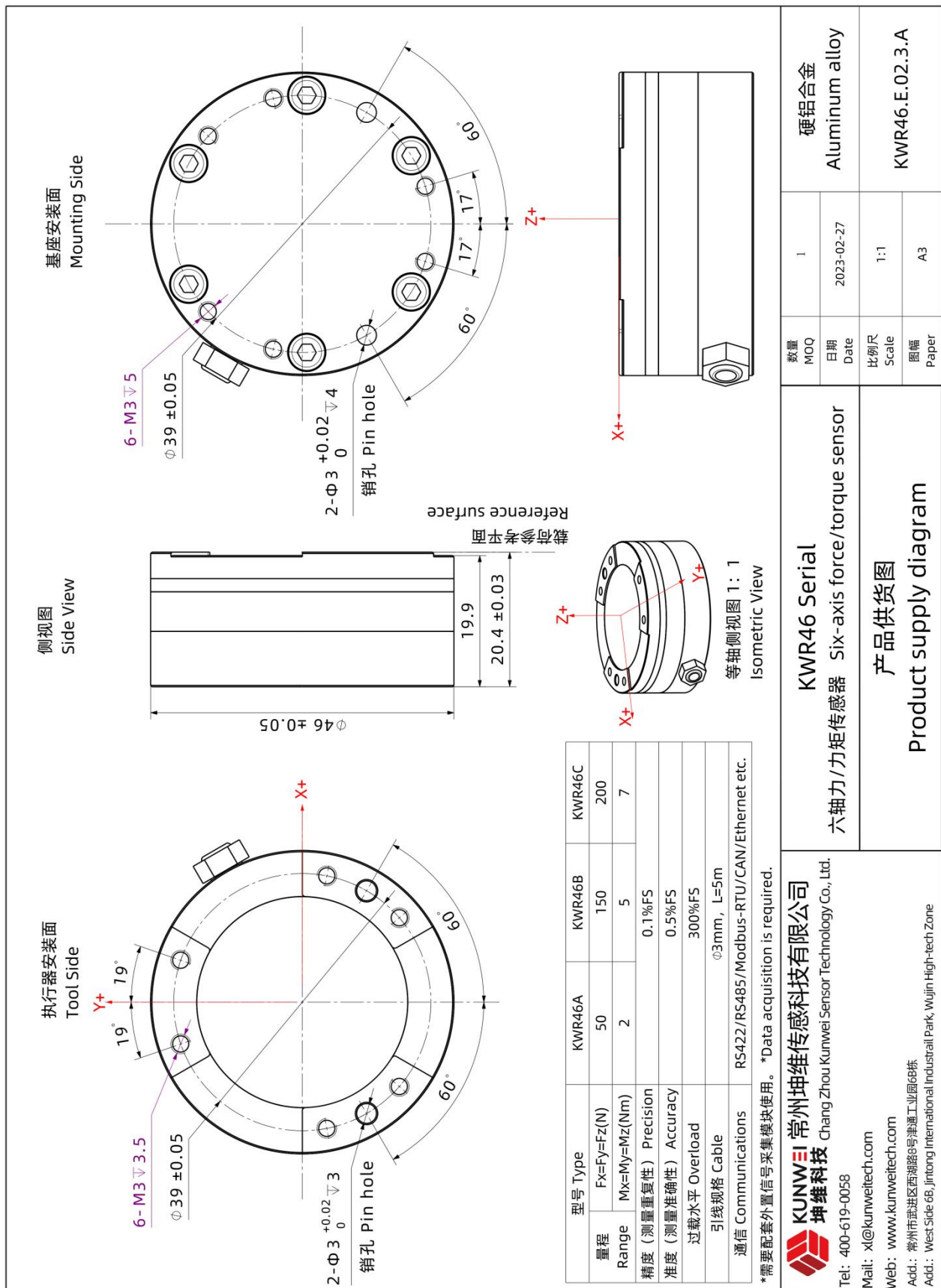
The KWR36 series six-axis force/torque sensor is a high precision and high response sensor, which equipped with an signal acquisition module to achieve a level of real-time response and output that meets the needs of most robot manufacturers. If the customer has other special size and interface requirements, we undertake a customization service to provide a one-to-one technical solution.

Model		KWR46A	KWR46B	KWR46C
F_x,F_y	(N)	50	150	200
F_z	(N)	50	150	200
M_x,M_y	(Nm)	2	5	7
M_z	(Nm)	2	5	7
Diameter (mm)		46	46	46
Height (mm)		20.4	20.4	20.4
Material		Aluminum Alloy	Aluminum Alloy	Aluminum Alloy
Surface treatment		Anodization	Anodization	Anodization
Overload level (%)		300	300	300
Precision (%FS)		0.1	0.1	0.1
Accuracy (%FS)		0.5	0.5	0.5
Sampling resolution (Bit)		24	24	24
Weight (kg)		0.06	0.07	0.07
Protection class		IP64	IP64	IP64
Operating temperature (°C)		5 ~ 80	5 ~80	5 ~ 80
Sampling frequency (kHz)		1	1	1
Supply voltage (VDC)		9~24	9~24	9~24
Communication interface		RS422/RS485/EtherCAT/Ethernet/CAN/USB		

Note: The above electrical parameters are high-precision data acquisition box parameters matched by KWR46 series sensors.



4.2 Installation dimension drawing





4.3 Data acquisition module

The product model is KWH06C80NL series, and its main function is to real-time collect and process analog signals from sensors, convert them into serial communication protocols for transmission.

The signal acquisition module is equipped with a standard HDB15 interface, which can directly interface with the force sensor products provided by Kunwei Technology.

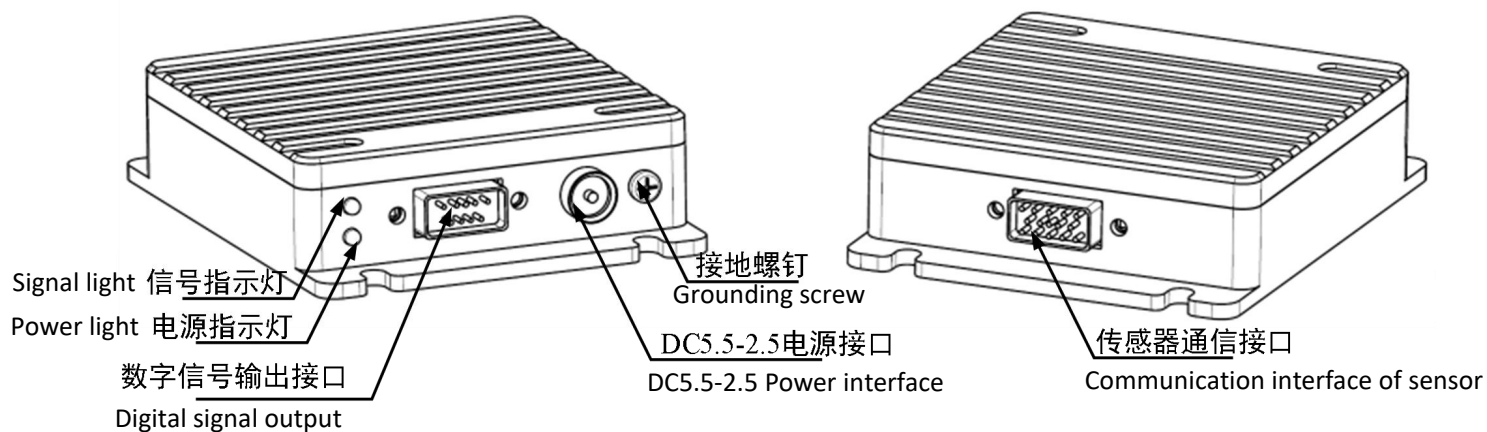


Fig.6 Supporting signal acquisition module

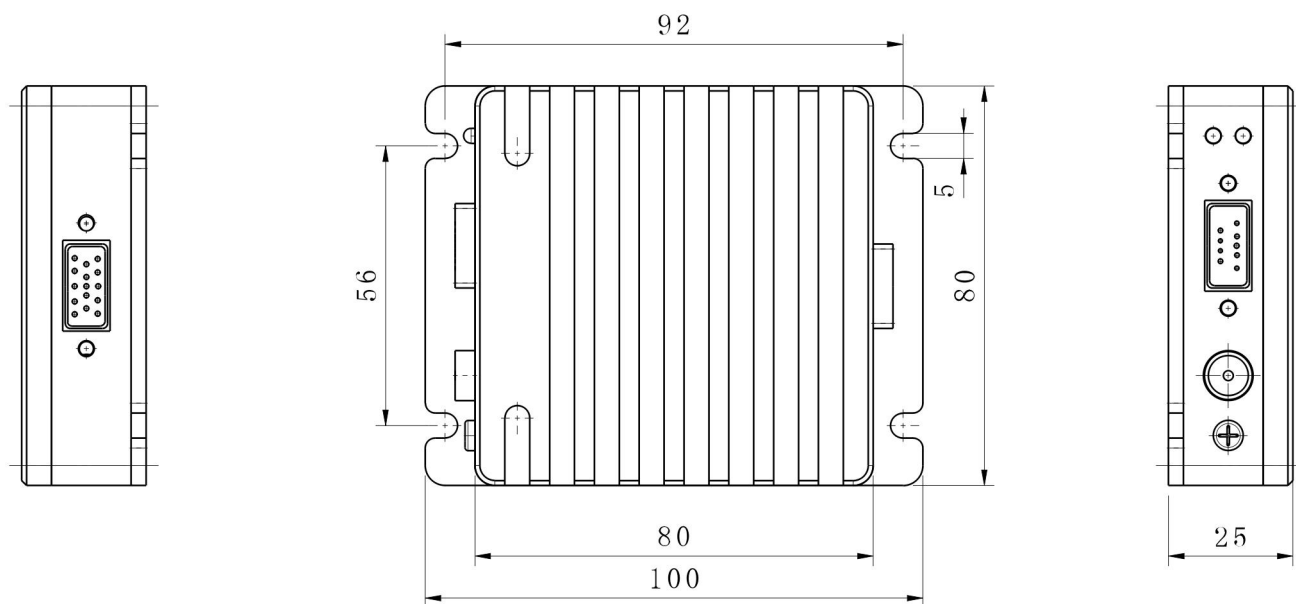


Fig.7 Dimension



4.4 Data input/output specifications

(1) The sensor can respond to input commands with the communication specifications shown in the table below.

Communication parameters	Parameter values	Remarks
Output serial port	RS485	
Supply voltage	9~24VDC	
Supply power	Less than 3W	
Baud rate	460800	
Data bits	8	
Stop bits	1	
Parity bits	0	

(2) Sensor output data format

Each frame of data is 28 bytes and is written in hexadecimal form as follows.

0x49AAB0751CC19B3FEDC0AE5CF040D4B52DBE5F55993E7C1AB0BB0D0A

Of which:

0x49 is the command code; 0xAA is the fixed identification, each frame of data is 0xAA; Since then every 4 bytes for a component of data, the transmission order is Low Byte First, MSB First; the transmission order and units of data components are: Fx (Kg), Fy (Kg), Fz (Kg), Mx (Kgm), My (Kgm), Mz (Kgm); the data ends with 0D and 0A; each component is a set of 4 bytes of single floating point (Float) type data, Supervisory Computer will arrange the received data in order and then directly defined as Float type, you can get the actual force or moment.

Specific examples are shown in the table below.

Data	Descriptions
0x49	The start command code, which is determined by the supervisory computer sending 0x48 or 0x49 command
0xAA	Fixed identification, each frame of data is 0xAA
0xB0751CC1	In Float format it should be 0xC11C75B0, which means that the force in Fx direction is -9.7787 Kg
0x9B3FEDC0	In Float format it should be 0xC0ED3F9B, which means that the force in the Fy direction is -7.4140kg
0xAE5CF040	The arrangement in Float type format should be 0x40F05CAE, which means that the force in the Fz direction is 7.5113 Kg
0xD4B52DBE	In Float format it should be 0xBE2DB5D4, which means that the force in the Mx direction is -0.16964 Kgm
0x5F55993E	In Float format it should be 0x3E99555F, which means that the force in the My direction is



0.29948Kgm

0x7C1AB0BB In Float format it should be 0xBBB01A7C, which means that the force in the Mz direction is -0.00537 Kgm

0x0D0A terminator, occupying two bytes

4.5 Input Command Definitions

Orders	Descriptions
0x43 AA 0D 0A	Stopping data conversion and transmission
0x49 AA 0D 0A	When the sensor is commanded to send a conversion result, the sensor will immediately reply with 28 bytes of data starting with 0x49 and ending with 0x0D0A, which will be constantly refreshed at a rate of 1 KHz inside the sensor (the sensor will only start refreshing the first time it receives this command after power-up, and will start replying from the second time it receives the command)



The system works at the 460800 baud rate by default. The output range of the device should be within the range of the device, if the device output exceeds the range for a long time, please check whether the sensor is under stressed normally and whether the stress range is normal, long-term over-range stress may cause irreversible damage to the device and can't output data accurately.

4.6 Dedicated cables and wiring definitions

The sensor communication adopts a dedicated multi-core cable for communication. By default, it is directly connected to the 422/485-USB converter through a dual head DB9 cable, which is converted to USB and connected to the computer. If there is a need for loose wire connection, you can directly contact our sales engineer.

The sensor adopts an embedded acquisition system for real-time data acquisition and processing, which can ensure accurate and effective output of digital signals.



USB converted to serial devices have a default delay of 16ms when communicating, which is often unacceptable in control tasks, to improve this, you need to change the latency to a minimum value of 1.

In a Windows environment, this can be done as follows :

Right click Properties - Port Settings - Advanced - Delay Timer (milliseconds) set to 1 (see right for details)

In a Linux environment, this can be done as follows.

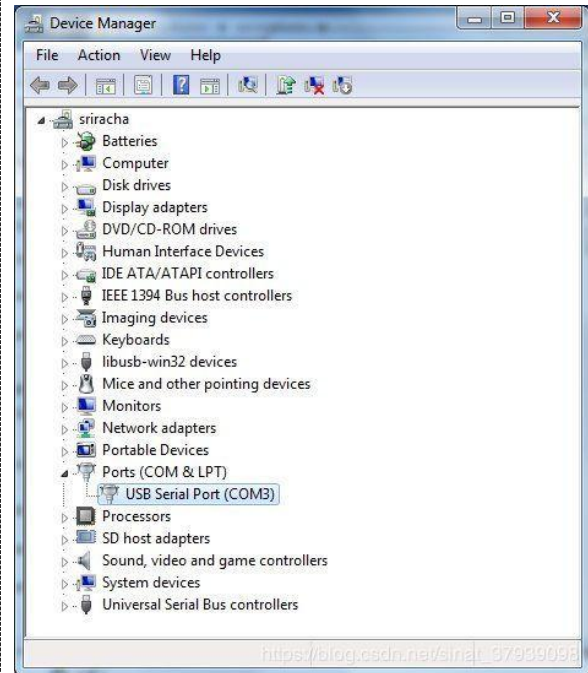
```
sudo usermod -aG dialout $USER && echo 1 | sudo tee
```

```
/sys/bus/usb-serial/devices/ttyUSB0/latency_timer
```

Available at :

```
cat/sys/bus/usb-serial/devices/ttyUSB0/latency_timer
```

if it is 1, then the modification is successful.



Source: https://blog.csdn.net/sinat_37939098/article/details/87915031



5 Product packaging

- | | |
|-----------------------------------|-------------------------------|
| ● KWR46 Series Sensor | 1 pcs |
| ● Data acquisition module | 1 pcs |
| ● KWR36 Series Sensor User Manual | One copy (electronic version) |
| ● Package box | 1 pcs |

6 Contact us

Kunwei (Beijing) Technology Co., Ltd

Address: Room A-6338, Building 3, No. 20 Yong'an Road, Shilong Economic Development Zone, Mentougou District,
Beijing

Tel: +86-18911370706

Website: www.czkunweitech.com

Email: sales01@kunweitech.com

Changzhou Kunwei Sensing Technology Co.,Ltd

Address: Building 6B, Jintong Industrial Park, No.8 Xihu Road, Hutang Town, Wujin District, Changzhou City,
Jiangsu Province

Tel: +86 400-619-0058



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