Strain Gauge - Six Axis Force/Torque Sensor KWR75 Series

User Manual

(Ver. 21.6.75.11.4LA)

■ Introduction

This is the user manual for the strain gauge six-axis force/torque sensor (KWR75 series - RS422 communication), which is suitable for some communications, such as RS422, RS422 converted to USB. When the RS485 receiving device is used to connect this type of sensor, the sensor only sends data and does not receive data.

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 notic 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.
8. Kunwei Tech shall not be liable for damage related to natural disasters such as earthquakes, snow, wind, floods, fires other than those for which the Company is responsible, as well as for acts of third parties and other

accidents such as damage caused by the intentional or negligent use or misuse of the Customer or other unusual circumstances.

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. KWR75 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	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	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

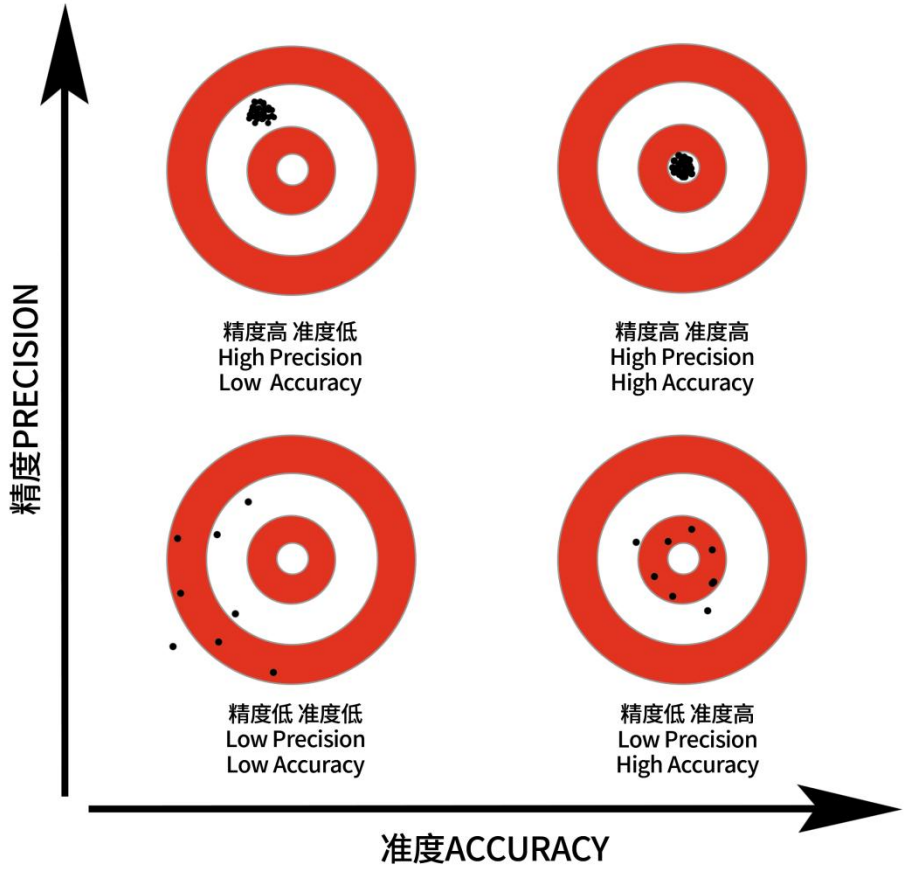


Fig.1 Precission and accuracy schematic diagram

■ Brief description of product specifications

Model	Rated force (N)		Rated torque (Nm)		Dimensions (mm)	Power supply (VDC)
	Fx, Fy	Fz	Mx, My	Mz		
KWR75A	50	50	2	2	Φ75.0×H31.5	9~24
KWR75B	200	200	8	8	Φ75.0×H31.5	9~24
KWR75C	350	500	12	12	Φ75.0×H33.5	9~24
KWR75D	500	700	18	18	Φ75.0×H33.5	9~24
KWR75E	30	30	1.5	1.5	Φ75.0×H31.5	9~24
KWR75F	100	100	4	4	Φ75.0×H31.5	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.

Contents

1 Product Overview

1.1 Product features

The model KWR75 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.

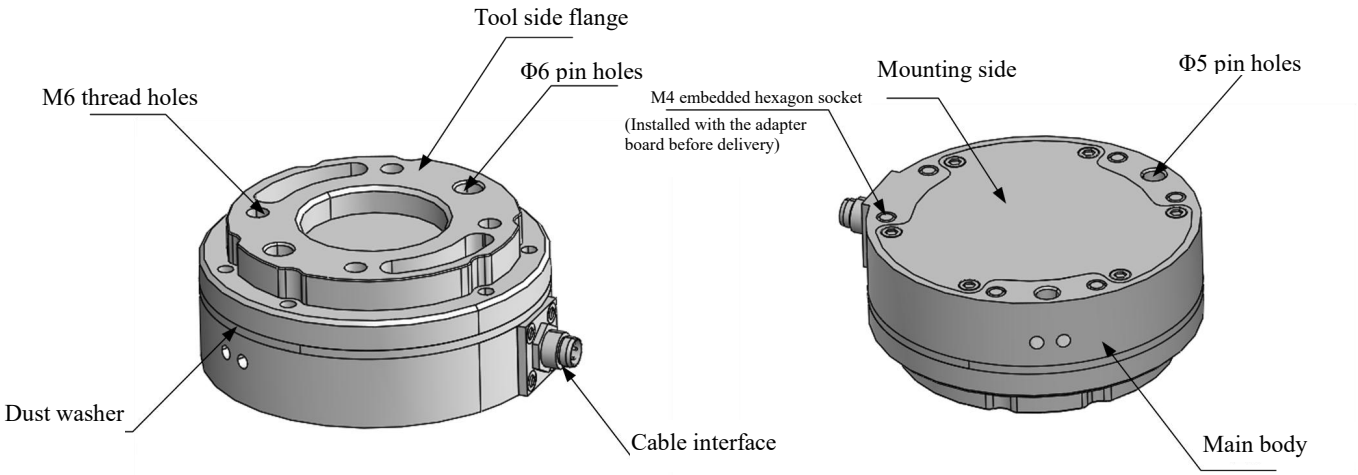


Fig.2 Sensor appearance

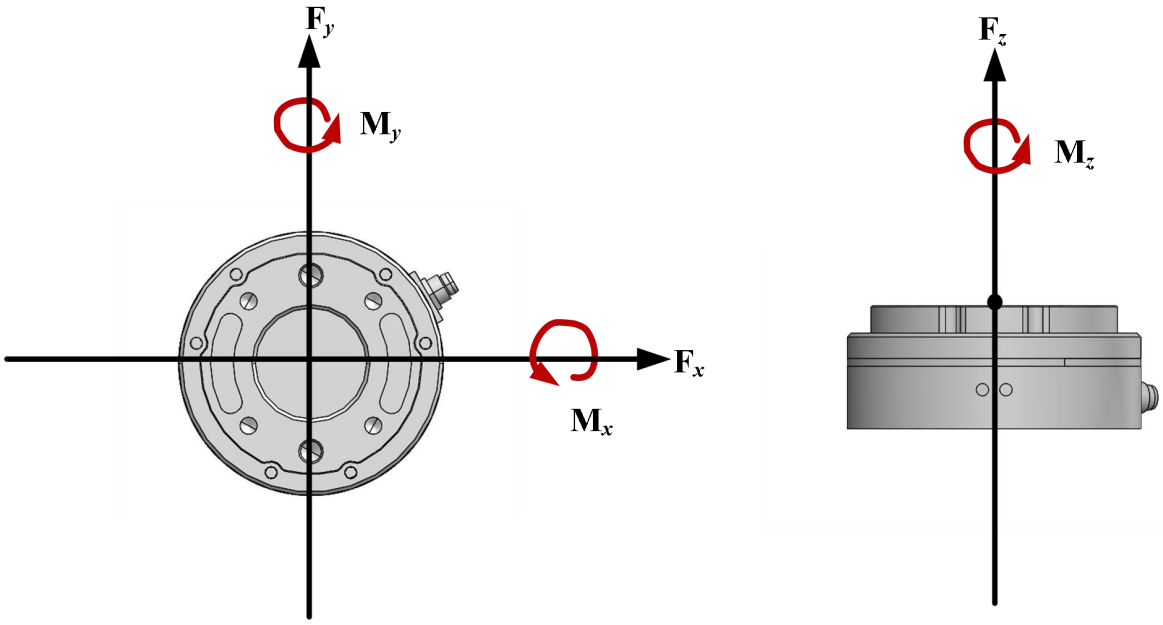


Fig.3 Definition of the sensor coordinate system (the direction of the torque conforms to the right-hand system)

1.2 Electrical characteristics

The voltage signal from the strain gauges is processed in real time by the embedded acquisition system, which built in the sensor 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.

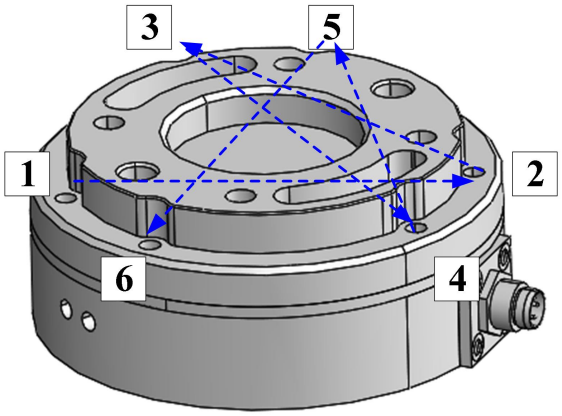


Fig.4 Screw tightening sequence

(1) Check the equipment to be installed, the transfer flange and the sensor

Verify that the equipment to be installed, the transfer flange, and the sensor surfaces 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) The sensor is separated from the transfer flange and the transfer flange is mounted on the device to be installed.

The sensor is shipped with the transfer flange connected to the sensor body by six socket head cap screws. Use a 3mm Allen key to loosen six socket head cap screws and separate the transfer flange from the sensor body.

The arm end transfer flange is positioned to the equipment to be installed by means of a Φ6 pin. The transfer

flange is fixed to the equipment to be installed by means of the four M6 hexagon socket screws included in the packaging.

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

(3) Fasten the sensor to the transfer flange.

Use the pins to position the sensor to fit the transfer flange and confirm that the sensor is mounted in the same direction as the equipment is used.

Fasten by using the sensor's six built-in screws. Insert a hexagonal wrench (width 3mm) from the mounting hole on the flange of the tool end of the sensor, and then turn it in the direction of the right-hand screw to fix it.The screw tightening sequence is performed in the order of Figure 4.

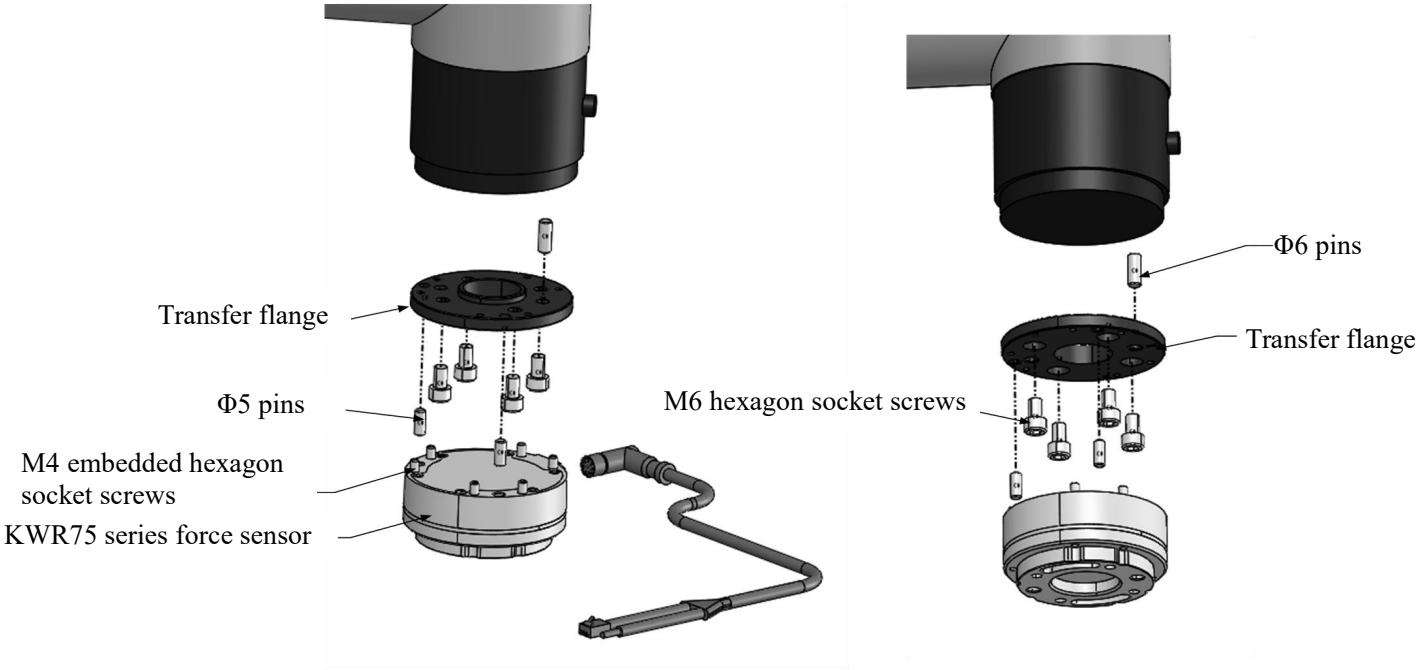


Fig.5 Diagram of the sensor and device connection installation

(4) Connect the tool interface of the device to the flange of the tool end of the sensor.

The sensor tool side flange provides four M6 screw holes and Φ6 pin holes in the form of a common interface for the connection of equipment tools.

*The sensor tool end flange locating pins are used to obtain a consistent installation of the equipment tool. If the locating pins are not used, the sensor performance will not be affected.

2.2 Connecting the cable

The connection cable is delivered with the product. The connection cable is a multi-core cable with an interface that matches the cable interface on the sensor. As shown in the figure 6, align the connector of the multi-core cable with

the sensor's cable connector, then push it into the sensor connector. Once pushed in, the threaded connection housing out of the multi-core cable interface must be tightened to avoid loosening of the cable and to achieve IP64 performance.

Fig.6 Diagram of the cable connection operation

When connecting the multi-core cable to the data acquisition terminal, set the electrical interface parameters according to this manual and connect the output cables for the power supply and the signal accordingly.

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

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) 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 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

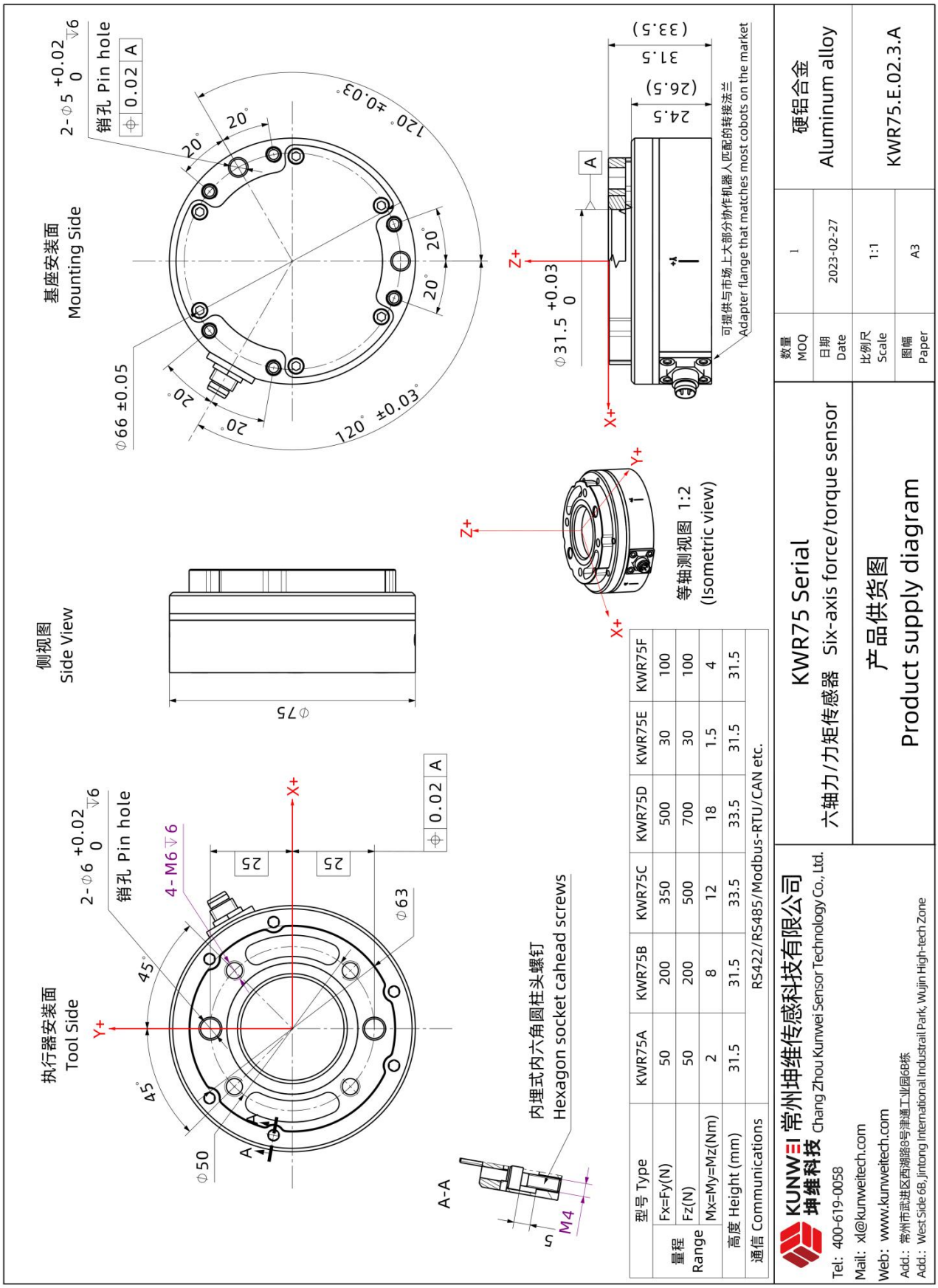
4.1 Basic specifications

The KWR75 series six-axis force/torque sensor is a high precision and high response sensor, which equipped with an embedded acquisition system 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		KWR75A	KWR75B	KWR75C	KWR75D	KWR75E	KWR75F
Fx,Fy	(N)	50	200	350	500	30	100
Fz	(N)	50	200	500	700	30	100
Mx,My	(Nm)	2	8	12	18	1.5	4
Mz	(Nm)	2	8	12	18	1.5	4
Diameter (mm)		75	75	75	75	75	75
Height (mm)		31.5	31.5	33.5	33.5	31.5	31.5
Material		Aluminum Alloy	Aluminum Alloy	Aluminum Alloy	Aluminum Alloy	Aluminum Alloy	Aluminum Alloy
Surface treatment		Anodization	Anodization	Anodization	Anodization	Anodization	Anodization
Overload level (%)		300	300	300	300	300	300
Precision (%FS)		0.1	0.1	0.1	0.1	0.1	0.1
Accuracy (%FS)		0.5	0.5	0.5	0.5	0.5	0.5
Sampling resolution (Bit)		24	24	24	24	24	24
Weight (kg)		0.26	0.28	0.32	0.36	0.26	0.28
Protection class		IP64	IP64	IP64	IP64	IP64	IP64
Operating temperature (°C)		0 ~ 80	0 ~ 80	0 ~ 80	0 ~ 80	0 ~ 80	0 ~ 80
Sampling frequency (kHz)		1	1	1	1	1	1
Supply voltage (VDC)		9~24	9~24	9~24	9~24	9~24	9~24
Communication interface		RS422/RS485/ModBUS/CAN/Ethernet/EtherCAT/USB etc.					

***12~48VDC version product is also available, further information could be acquired from sales.**

4.2 Installation dimension drawing



型号 Type		KWR75A	KWR75B	KWR75C	KWR75D	KWR75E	KWR75F
量程 Range	Fx=Fy(N)	50	200	350	500	30	100
	Fz(N)	50	200	500	700	30	100
	Mx=My=Mz(Nm)	2	8	12	18	1.5	4
高度 Height (mm)		31.5	31.5	33.5	33.5	31.5	31.5
通信 Communications		RS422/RS485/Modbus-RTU/CAN etc.					

4.3 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	RS-422	When RS422 communication products are connected to RS485 devices using two data transmission lines, the sensor can only send data, not receive date.
Supply voltage	9~24VDC	
Supply power	Less than 3W	
Serial port baud rate	460800	
Data bits	8	
Stop bits	1	
Check digit	0	

(2) Sensor output data format

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

0x48AAB0751CC19B3FEDC0AE5CF040D4B52DBE5F55993E7C1AB0BB0D0A

Of which:

0x48 (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	**Description**
0x48(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 -7.4140kgm
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
00xD0A	terminator, occupying two bytes

4.4 Input command definitions

Orders	Description
0x43 AA 0D 0A	Stopping data conversion and transmission
0x48 AA 0D 0A	Convert and send results at the speed of 1KHz, data starts with 0x48
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.

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.

4.5 Dedicated cables and wiring definitions

Sensor communication is carried out using a dedicated multi-core cable. The output signal is RS-422, the default connection requirement is the RS-422 serial port. If the RS-485 serial port is connected, the sensor can only send data, not receive it. But it can also output signals in other formats through various converter, such as analog signal and USB, please contact us if you need.

The sensor uses an embedded acquisition system for real time data acquisition and processing, which ensures the digital signal is output accurately and effectively.

It is important to check whether the wiring between the sensor and the application is correct, especially if the "Power+" and "Power-" are connected in reserve, the sensor may be damaged..

Serial number	Core wire colour	Definition
1	**Blue -**	Power supply +
2	**White -**	Power supply -
3	**Powder -**	422 Bus sensor receives +
4	**Brown -**	422 Bus sensor receives-
5	**Black -**	422 Bus sensor sends +
6	**Grey -**	422 Bus sensor sends-
7	**Shielding**	

Upon explicit request, we can provide 422/485-USB converters and the corresponding DC power supply to provide maximum convenience to our customers when they use this product. At the same time, we will provide technical support to help customers better understand the working and performance of the product.

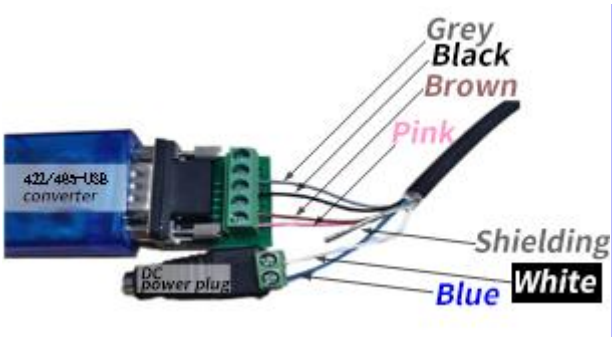


Fig.9 Diagram of 422/485-USB converter and power plug wiring

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)

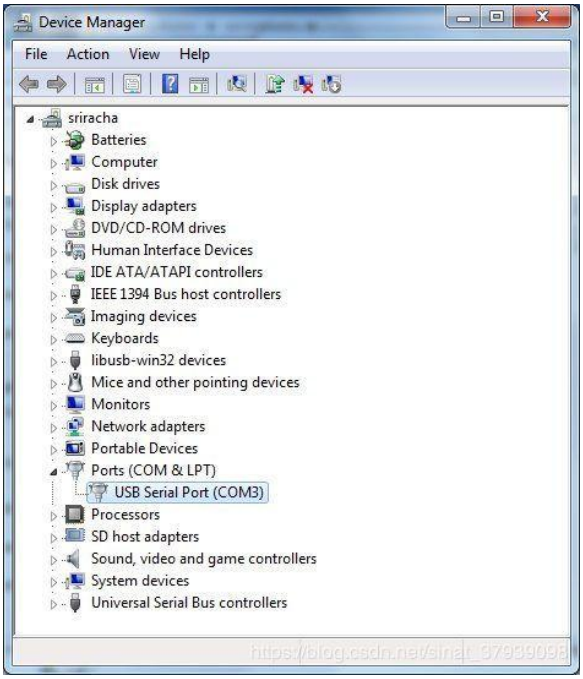
In a Linux environment, this can be done as follows.

sudo usermod -aG dialout $USER && echo 1 | sudo tee /sys/bus/usb-serial/devices/ttyUSB0/latency_timer

Available at :

/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

- KWR75 Series Sensor 1 pcs
- Cable (with plug) 1 pcs
- KWR75 Series Sensor User Manual One copy (electronic version)
- Package box 1 pcs
- Sensor transfer flange 1 pcs

6 Contact us

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