JAKA 节卡

Zu se Manual

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Version number: _____

CONTENT

Chapter 1 Instruction

1.1 Background

As labor costs continue to increase, 3C, medicine, food, logistics and other industries have begun to seek robot automation solutions. These emerging industries are characterized by a wide variety of products, rapid update and iteration, and high flexible requirements for operators. In order to realize robots working side by side with humans, it is necessary to improve the perception ability of the robot body, so the sense of robot manpower arises at the right moment.

1.2 Purpose

This product aims to adopt industry-level force sense sensor and integrate force control algorithm with independent intellectual property rights, improve the perception ability of collaborative robot ontology, and provide better human-computer interaction experience for customers. As shown in Figure 1, the force sense sensor is installed on the robot side flange and the force value is transmitted to the controller in real time. When the robot side actuator receives external force, the posture of the end can be adjusted to adapt to the external force value. At the same time, the customer can drag the position and posture of the robot from the robot side more smoothly.

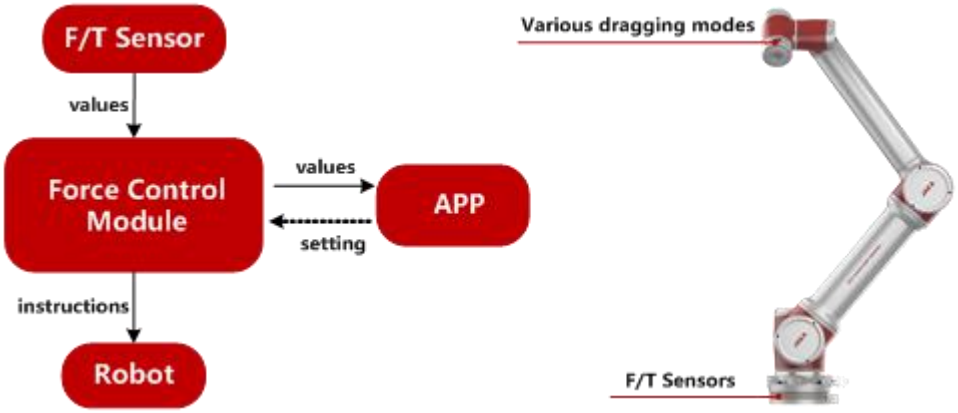


Figure 1 JAKA Zu Se Functional Diagram

Chapter 2 Product Description

The JAKA Zu se system includes an APP, a robot, a control cabinet, and a force-sensing sensor device. As shown in Figure 2, the force-sensing sensor and the robot end flange are mechanically connected. The operation on the software is realized through the force sensor module in JAKA Zu APP, as shown in Figure 3.

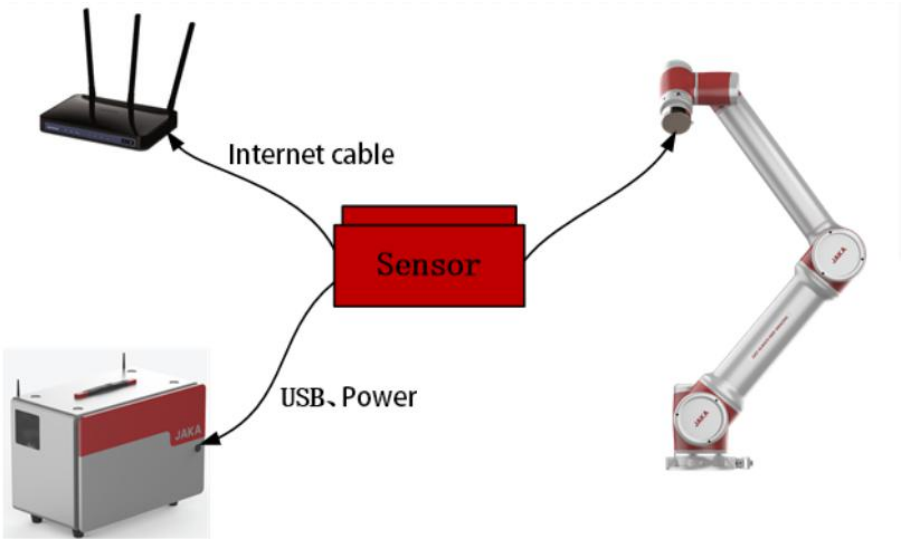


Figure 2 JAKA Zu Se System Diagram

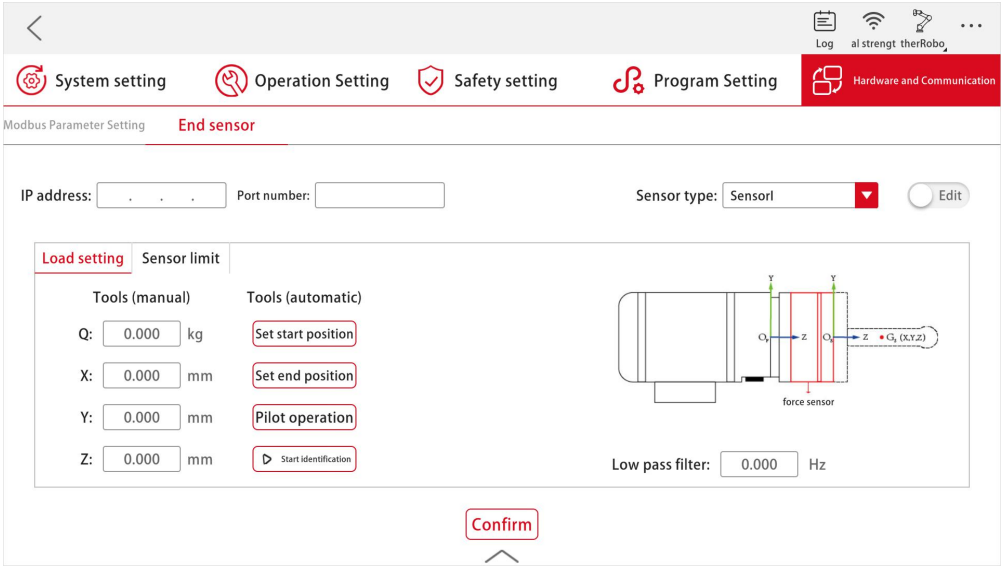


Figure 3 APP Setting Interface of Force Sensor Module

Chapter 3 JAKA Zu Se System Construction

As shown in Figure 2 and 3, users need to complete simple hardware connection and software settings to realize the setup of JAKA Zu se system. The specific setup process is as follows:

a. The user designs the connection between the force sensor and the end flange according to the actual demand, and ensures that the X+ direction of the sensor is consistent with the X+ direction of the robot flange through the connection or setting the tool coordinate system.

b. The force-sensing sensor can be powered by a robot controller or an additional 24V DC power supply to the user. According to the different communication modes of the sensor, the sensor can carry out serial communication through the USB interface connected to the control cabinet or TCP communication through the network interface.

c. If sensor I or III is selected, IP and port number settings need to be made in the APP. Please refer to the relevant sensor configuration appendix for specific setting methods. If sensor II is selected, no IP and port number settings are required.

Chapter 4 Use of JAKA Zu se

a. Automatic load identification function

When the force control function is used, accurate load parameters shall be set first. Manual input can be selected in [Load Settings]; the automatic identification function can also be used. The process is as follows:

[Set the Starting Position] Enter the manual interface, move the robot to the appropriate position, and confirm to exit;

[Set the End Position] Enter the manual interface, and only joints 4, 5 and 6 are allowed to move, with the motion range within ±90° of the initial position (under the condition that the robot's motion is not interfered, the larger the motion range is, the more accurate the identification result will be), and confirm to exit;

[Pilot Operation], long press [Set the Starting Position] to return to the initial position, long press [Pilot Operation] to confirm that there is no interference in the identified track;

[Start Identification], long press [Set the Starting Position] to return to the initial position, click [Start Identification], wait for a few seconds, the APP will display the identification results, the results are correct and confirmed; If there are problems, they can be identified again.

b. Security protection function

The safety force value is set in [Sensor Limit]. During the movement of the robot, if the force at the end of the sensor is greater than the set threshold, the robot will stop its movement immediately to avoid causing danger or property loss.

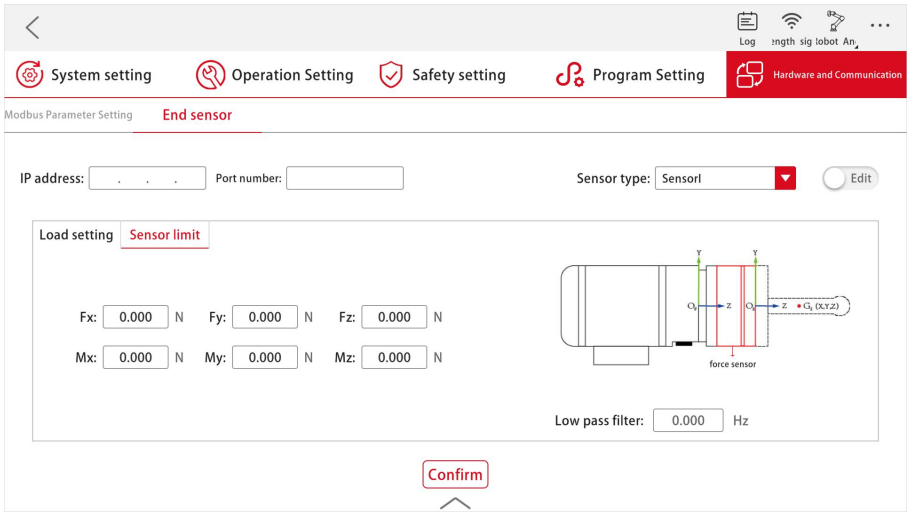


Figure 4. Settings of JAKA Zu Se Security Protection Function

c. Traction teaching function

As shown in Figure 3, after selecting the sensor type and setting IP, port number, filtering and load, etc., the controller starts to receive data from the sensor after pressing [OK] and [Run].

As shown in Figure 4, enter [Manual operation]. First, enter [Configuration] interface, where Fx, Fy and Fz correspond to displacement in X, Y and Z directions, and Mx, My and Mz correspond to rotation in X, Y and Z directions. By checking the □ in front of [Direction] to enable a certain direction or several directions, that is, after the drag and drop is opened, the robot can be dragged in the enabling direction. The smaller the setting of [Damping force] is, the smaller the drag force is required by the user. However, the smaller setting of [Damping force] is not the better. It is suggested that F is greater than 10N and M is greater than 0.2nm, and the setting value shall not be 0. [Rebound] enables the robot to return to the original position before dragging. The larger the setting value is, the greater the force is required to drag the robot;

Tick "Tool Coordinate System" to drag the robot in the set tool coordinate system. Tick [World Coordinate System], then drag the robot in the base coordinate system;

Initialize or not. After the controller runs, it enters the drag mode for the first time. tick [Initialize] to compensate the sensor bias and load, and ensure that there is no external force contact at the end of the robot during the drag, otherwise the compensation accuracy will be affected.

After the parameters are configured, click [OK] and then click [Exit] to enter the [Drag] mode. Before entering the drag mode, the robot end shall not be subjected to external force, otherwise it will cause compensation error of the sensor and cause danger.

Due to the temperature drift and other reasons of the sensor, if the robot's position drifts in the drag mode, please [Exit] and enter [Drag] to make sensor compensation again. Do not use traction teaching function, please [Exit] in time.

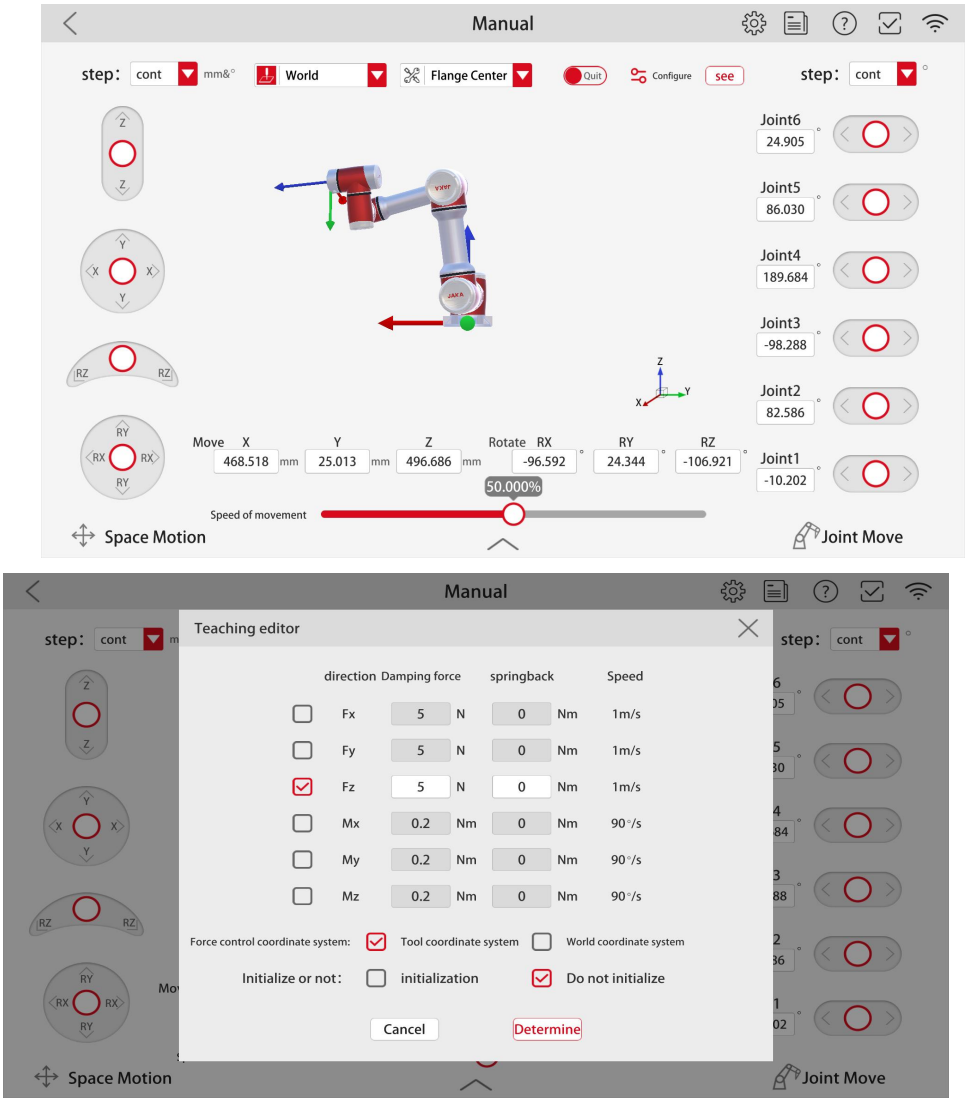


Figure 5. Settings of JAKA Zu Se Traction Teaching Function

d. Constant force model

Constant force mode ensures that the contact force between the robot end and the external environment is within the range of the set constant force value. As shown in Figure 5, the constant force mode includes [Open the Constant Force Compliance Control], [Setting the Force Control Coordinate System], Setting the Constant Force Compliance Parameter] and [Close the Constant Force Compliance Control]. On the interface of [Constant force compliance parameter setting], the configuration parameters are consistent with the traction teaching parameters. Users can set the value of [Constant Force] according to the desired contact force value. The size of [Damping Force] needs to match the external environmental stiffness. Generally speaking, the greater the environmental stiffness is, the greater the value of [Damping Force] is required. Due to the temperature drift of the

sensor, it is suggested that after running for a period of time, the robot shall choose [Initialize] to make compensation for the sensor if there is no external force contact at the end of the robot.

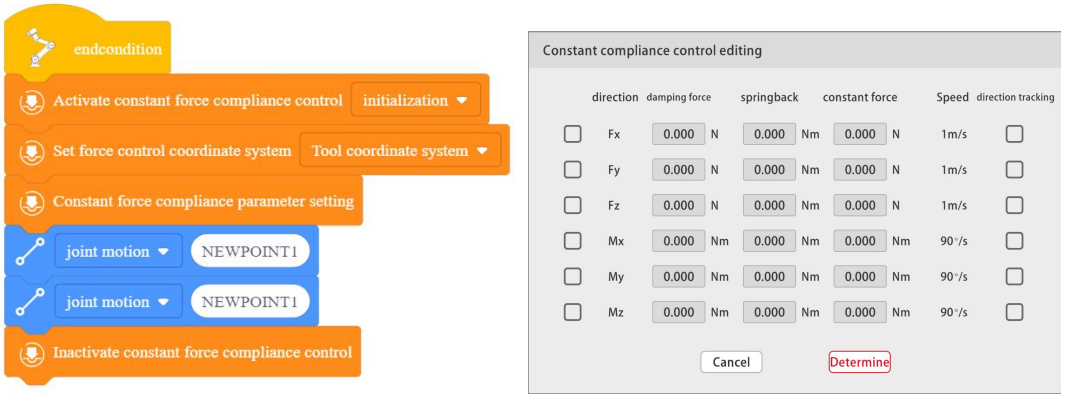
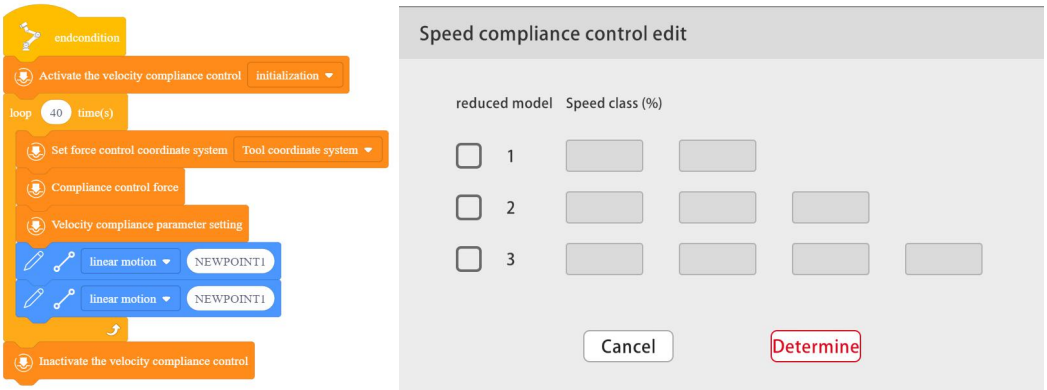


Figure 6. JAKA Zu Se Constant Force Mode Programming

e. Speed Mode:

In the speed mode, when the force at the robot side is greater than the set value of control force, the robot will decelerate until the sensor detection value is less than the set value of control force. As shown in Figure 6, the speed mode includes [Open Speed Compliance Control], [Speed Compliance Parameter Setting], [Compliance Control] and [Close Speed Compliance Control]. In the interface of [Speed Compliance Parameter Setting], configure the speed ladder, and select the size of control force in the interface of [Speed Compliance Control Force].



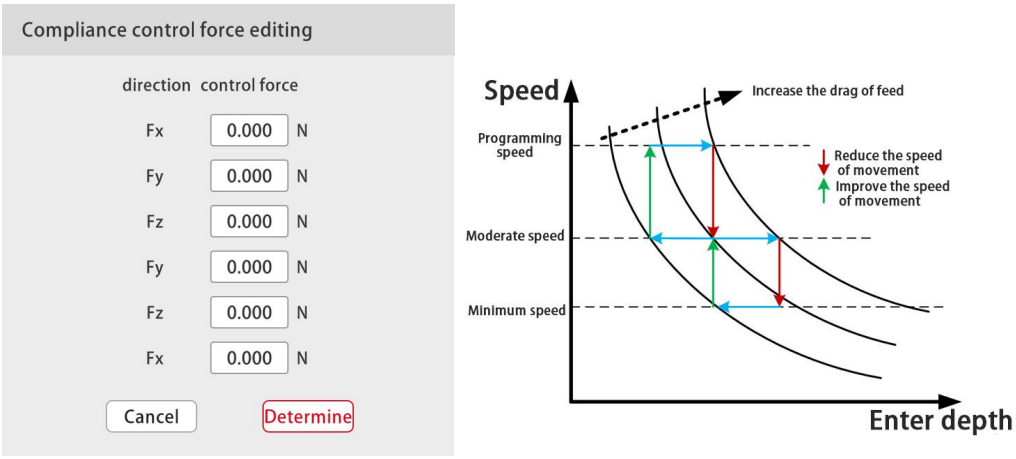


Figure 7. JAKA Zu se speed mode programming

f. Motion Termination Condition

On the Motion Termination Condition Setting interface, select the direction to be monitored and set the upper limit or lower limit; When the contact force value is less than the lower limit value or greater than the upper limit value, the motion termination condition will be triggered. [Motion Termination Condition] Monitor the next motion instruction next to each other. If the motion termination condition is triggered, the robot will immediately move from its current position to the end of the next motion directed. It is important to note that all parameters shall be set to 0 in [Constant Force Compliance Parameter Setting] without any direction being selected.

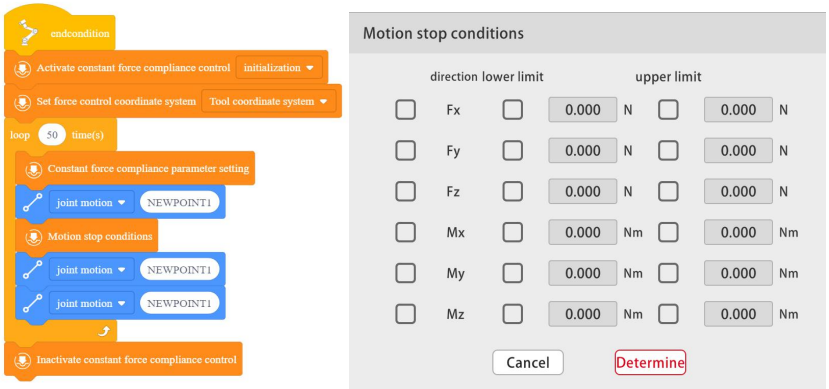


Figure 8. JAKA Zu Se Motion Termination Programming

G. Real-time display of external forces

Select [View] on the manual interface to display the contact external force value in real time. It is important to note that in manual mode, it is required to display the contact force value in force control [Free-drive] mode.

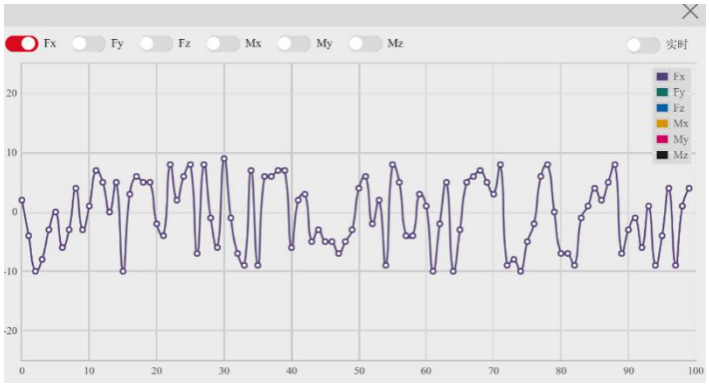


Figure 9. Force Display Interface of the APP

Chapter 5 JAKA Zu Se Precautions for Use

a. The integrated force sensor is a precision instrument. Please be sure to use the product within the specification range specified in the manual. In particular, the working condition with the load greater than the rated load may cause a product failure. Please ensure that all directions of the force sensor are within the load range;

b. Ensure that the load setting in the robot sensor side is accurate;

c. Ensure that the X+ direction of the sensor is consistent with the X+ direction of the robot flange; Or set the tool coordinate system to ensure the same direction;

d. Before entering force control, there shall be no contact force between the robot side and the external environment.

Chapter 6 Appendix

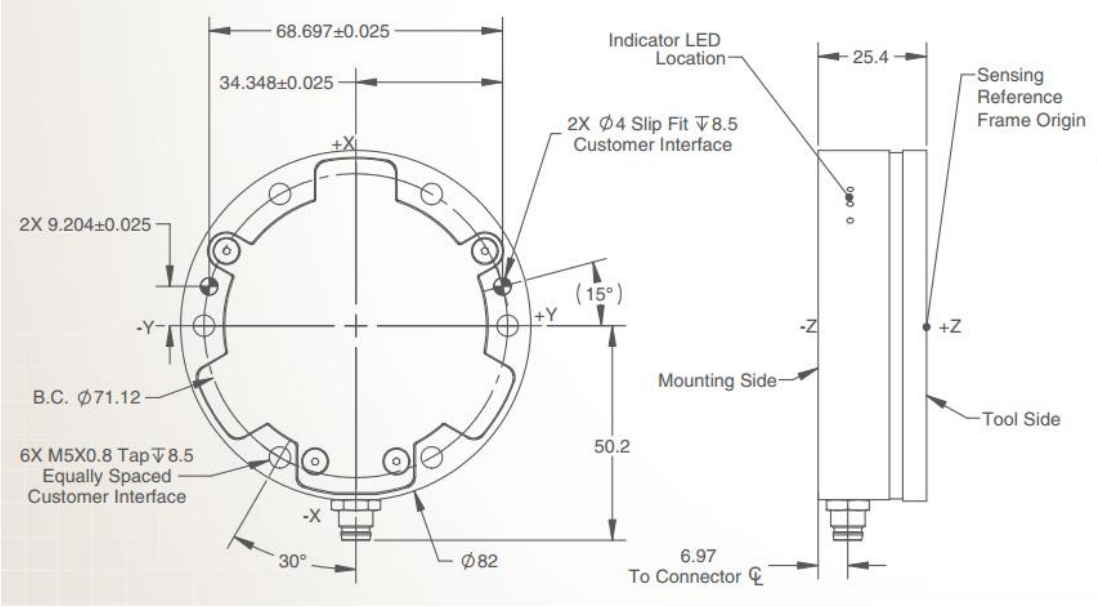
6.1 Description of sensor I

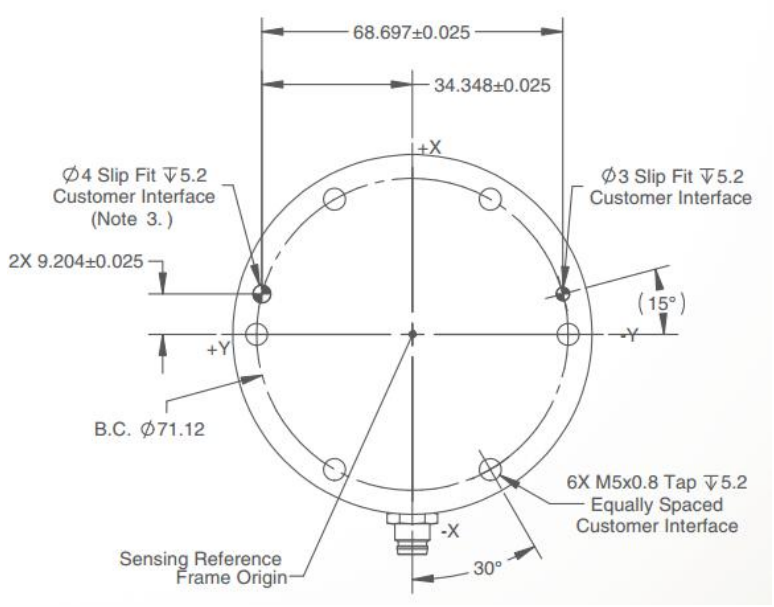
1.1 Overview

This strain type six-axis force/torque sensor can detect three forces and three torques simultaneously. The sensor detects the relative deformation between the "Tool Side Flange" and the "Body" caused by the applied force, and uses a resistance strain gauge to measure changes in the sensor's elastic unit. The sensor contains an embedded system, which can collect and process the signal changes of the resistance strain gauge in real time, and output the magnitude and direction of the applied force in real time, with high precision and high response capability. When using the sensor, please install it correctly avoid interference with the output result.

1.2 Sensor Installation

The sensor mounting hole position and mounting dimensions are as follows.



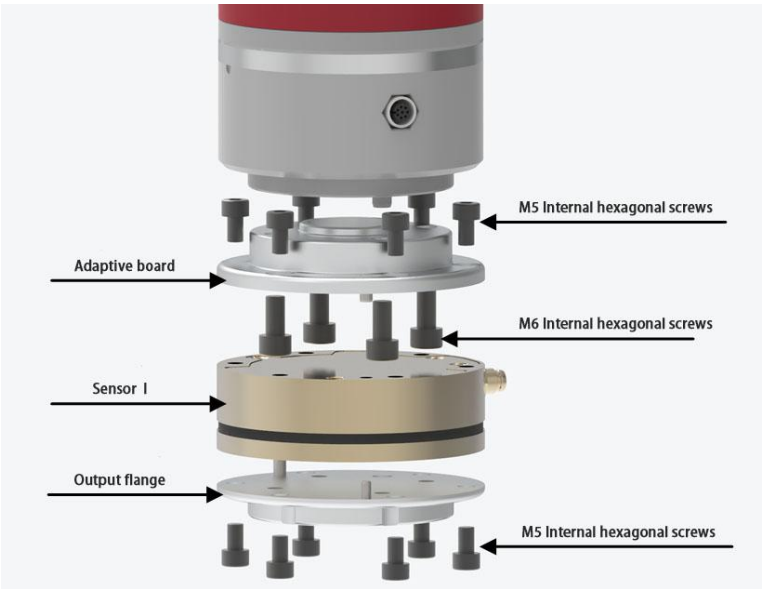


Sensor Size

a. Before installation, please check that there is no damage or foreign matter on the surface of installation equipment, adaptor plate and sensor. If the contact is not uniform due to foreign matters and other factors, a gap will be formed between the equipment (or adaptor board) to be installed, which cannot guarantee the IP64 performance of the product and will impact the output effect of the actual sensor.

b. Separate the sensor from the adaptor plate and install the adaptor plate on the robot side flange. It is important to note that before the installation of the sensor, the X and Y directions of the sensor coordinate system shall be guaranteed to be consistent with the X and Y directions of the robot side flange coordinate system through pre-installation, that is, the TIO direction of the robot side flange center shall be consistent with the -Y direction of the sensor. If the installation direction is inconsistent, it will affect the subsequent use.

c. Tighten the connection between the sensor and the adaptor plate. 6 M5 hexangular set bolts shall be gradually tightened diagonally to make uniform contact between the sensor and the adapter plate.



Schematic Diagram of Connection and Installation of the Sensor and Equipment

d. Connect the output flange to the output side of the sensor. The mechanical interface of the output flange shall be the same as that of the robot side flange.

1.3 Basic Sensor Parameters

Fx/Fy(N)	200	Fz(N)	360
Mx/My(Nm)	8	Mz(Nm)	8
Overload level (%)	500	Accuracy (%)	0.5
Precision (%)	0.1	Protective class	IP64
Operating temperature (°C)	5~80	Power supply voltage (V)	12~24
Communication Interface	Ethernet	System Resolution (Bit)	16

Precision: Precision is the evaluation index symbolizing the extent of consistency between multiple measured values, that is, the output curve consistency degree obtained by the sensor when the input is tested for multiple times in a unified direction. The precision of reproducibility is the percentage of the standard deviation of the output error to the rated output (%FS).

Accuracy: Accuracy is the evaluation index of the deviation degree between the measured value and the true value. Accuracy refers to the percentage of the standard deviation of the deviation between the output and the theoretical truth value and the rated output (%FS).

1.4 Precautions for use

Do not use in an environment with temperature and humidity outside the allowed range of specifications.

The wiring must be completely correct. When the power is turned on, please check whether the color of the connection cable is correct in accordance with the manual. If an error occurs at the connection terminal, the internal circuit of the sensor may be short cut and possibly be damaged. Please be sure to check.

The sensor has an embedded system and other precision parts. our company has carried out relevant vibration and impact tests, but please pay attention to the product drop, excessive vibration will lead to malfunction.

Do not knock when installing the sensor. Especially when it is matched with the adaptor plate, if the clearance fit is tight due to the adaptor plate processing and other factors, do not knock the sensor, otherwise it will cause damage to the sensor performance.

After the sensor is installed and powered on, it is recommended to preheat it for an hour before operation.

In the actual use of the sensor, the quality of the mounted equipment shall be taken into consideration to avoid overloading.

If there is any doubt or failure during use, please do not try operate without permission and directly contact our Company.

2. Reference value of tightening torque of sensor mounting bolt

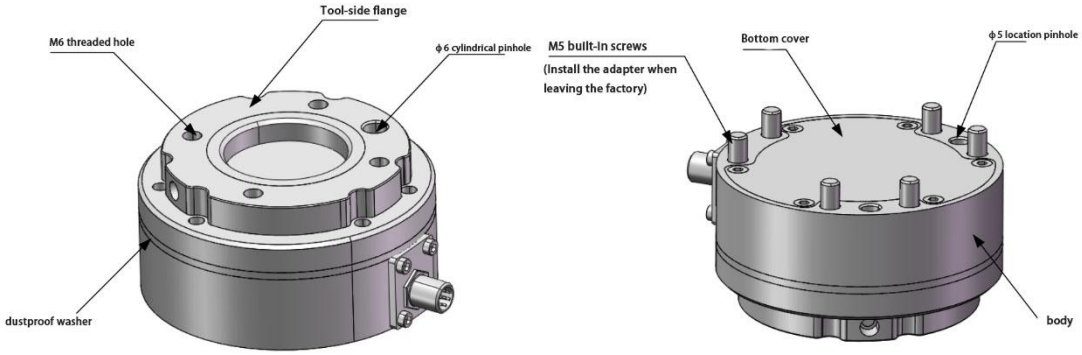
Metric	Reference tightening torques (Nm)
M2	0.4
M3	2.0
M4	4.0
M5	8.0
M6	13.0
M8	35.0

6. 2 Description of Sensor II

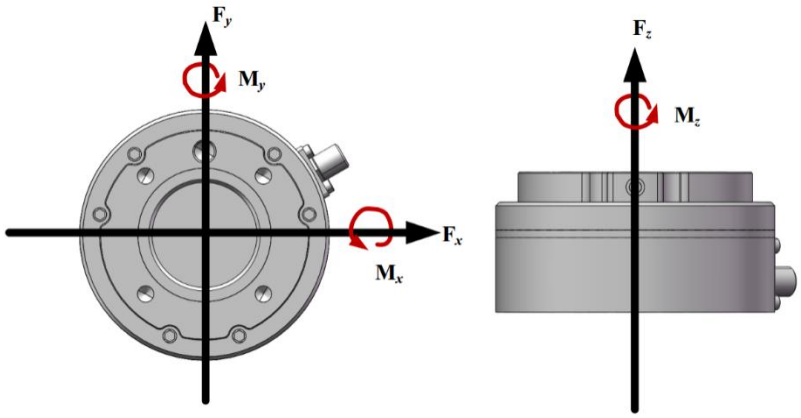
1.1 Overview

This strain type six-axis force/torque sensor can detect three forces and three torques

simultaneously. The sensor detects the relative deformation between the "Tool Side Flange" and the "Body" caused by the applied force, and uses a resistance strain gauge to measure changes in the sensor's elastic unit. The sensor contains an embedded system, which can collect and process the signal changes of the resistance strain gauge in real time, and output the magnitude and direction of the applied force in real time, with high precision and high response capability. When using the sensor, please install it correctly avoid interference with the output result.

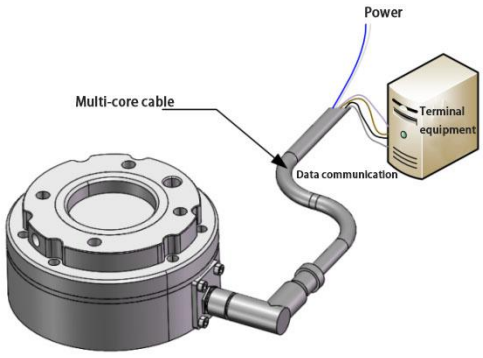


Sensor Appearance



Definition of the Sensor Coordinate System

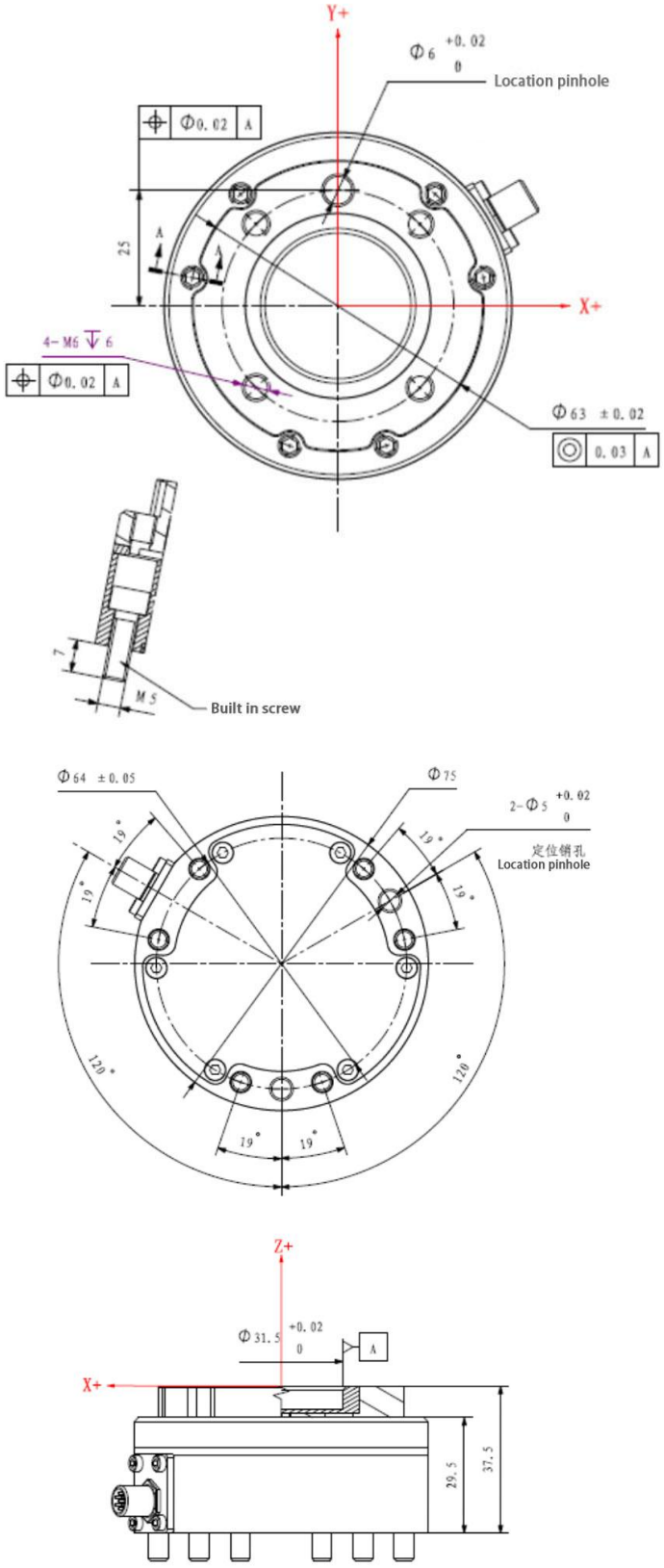
The embedded acquisition system in the sensor body processes the voltage signal of the strain gauge in real time, converts it into the actual load value, and outputs it in the form of digital signal.



Schematic Diagram of Electrical Connection of Sensor

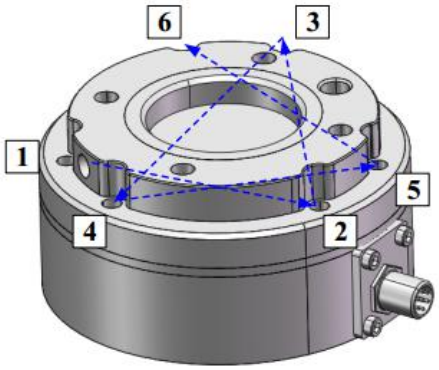
1.2 Sensor Installation

The sensor mounting hole position and mounting dimensions are as follows.



Sensor Size

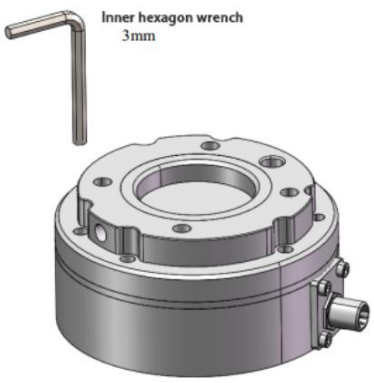
During tightening the bolts, please tighten the bolts gradually in the diagonal order as shown in the figure to make uniform contact between the sensor and the equipment to be installed or the transfer fixture.



Bolt Tightening Sequence

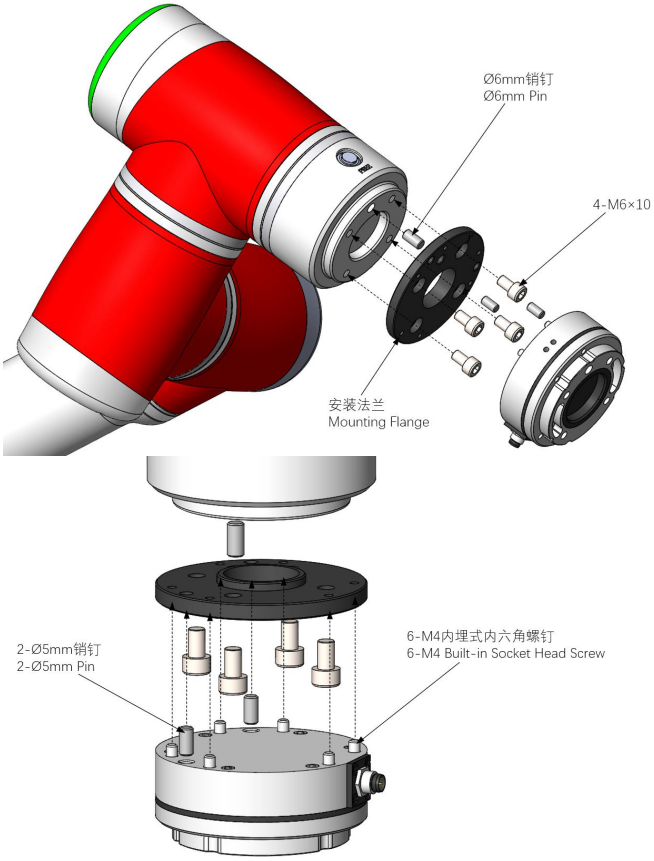
a. Before installation, please check that there is no damage or foreign matter on the surface of installation equipment, adaptor plate and sensor. If the contact is not uniform due to foreign matters and other factors, a gap will be formed between the equipment (or adaptor board) to be installed, which cannot guarantee the IP64 performance of the product and will impact the output effect of the actual sensor.

b. Separate the sensor from the adaptor plate and install the adaptor plate on the equipment to be installed. When the sensor is delivered from the factory, the adaptor plate and the sensor body are connected by 6 embedded hexangular bolts. Loosen 6 embedded hexagon socket bolts with 3mm hexagon socket wrench and separate the adaptor plate from the sensor body. Use a φ6 alignment pin to position the adaptor at the robotic arm end and the equipment to be installed. Use 2 M6 standard hexagon socket bolts and 2 M6 non-standard hexagon socket bolts in the packaging accessories of this product to fix the adaptor and the equipment to be installed. The alignment pin is used to obtain repeatability of the equipment installation and connection. If the locating pin is not used, the sensor performance will not be affected.



Loosen the embedded screw with 3mm inner hexagon wrench

c. Tighten the connection between the sensor and the adaptor plate. The alignment pin is used to coordinate the sensor with the adaptor plate to ensure that the sensor is installed in the same direction as the equipment. Tighten with the sensor's 6 embedded bolts. Insert the hexagon socket wrench (3mm) from the mounting hole of the sensor tool side flange, and then rotate along the right screw to fix it. Screw tightening shall be operated in the following sequence. In order to better guarantee the IP64 protection level of the sensor, 6 M5 plug head screws can be screwed into 6 corresponding threaded holes on the tool side flange after the sensor is installed, so as to ensure a certain degree of isolation between the internal cavity of the sensor and the external environment.



Schematic Diagram of Connection and Installation of the Sensor and Equipment

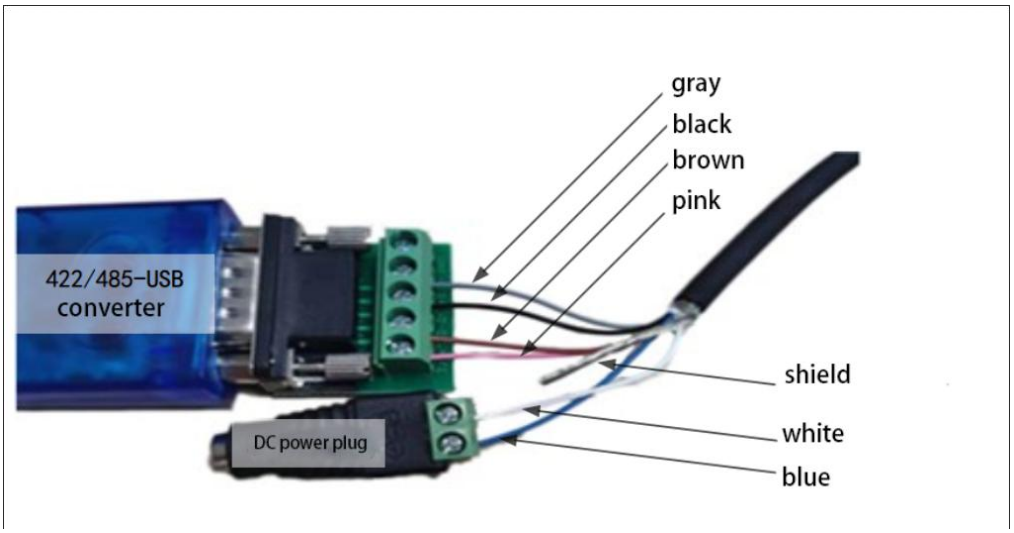
d. Connect the tool interface of the equipment to the sensor tool side flange. The sensor tool side flange provides 4 M6 bolt holes and φ6 pin hole form of general interface for the connection of equipment and tools. The sensor tool side flange alignment pin is to obtain the repeatability of equipment and tool installation. If the alignment pin is not used, the sensor performance will not be affected.

e. The connection cables are delivered with the product. The connection cable is a multi-core

cable with interfaces matching the cable interface on the sensor. Align and push the multi-core cable interface with the sensor cable interface as shown below. After being pushed in, the threaded connection shell from the multi-core cable interface shall be tightened to avoid looseness of the cable, so as to achieve the performance of IP64. It shall be noted that during installation, the wiring of each cable core is operated strictly according to the color definition of the given core. If the positive and negative poles of the power supply are connected in reverse, the sensor will be damaged. Please be careful!

Cable Connection Operation

No.	Core color	Definition
1	Blue	Power supply+
2	White	Power supply –
3	Powder	Bus 422 sensor receiving terminal +
4	Brown	Bus 422 sensor receiving terminal -
5	Black	422 or 485 bus sensor sending terminal +
6	Gray	422 or 485 bus sensor sending terminal -
7	Shield	



422/485-USB Wiring Diagram of Converter and Power Plug

1.3 Basic Sensor Parameters

Fx/Fy (N)	200	Fz (N)	200
Mx/My (Nm)	8	Mz (Nm)	8
Overload level (%)	300	Accuracy (%)	0.5
Precision (%)	0.1	Protective class	IP64
Operating temperature (°C)	5~80	Power supply voltage (V)	9~24
Communication Interface	RS422	Sampling Resolution (Bit)	24

Precision: Precision is the evaluation index symbolizing the extent of consistency between multiple measured values, that is, the output curve consistency degree obtained by the sensor when the input is tested for multiple times in a unified direction. The precision of reproducibility is the percentage of the standard deviation of the output error to the rated output (%FS).

Accuracy: Accuracy is the evaluation index of the deviation degree between the measured value and the true value. The accuracy is the percentage of the standard deviation of the deviation between the output and the theoretical truth value and the rated output (%FS)

1.4 Precautions for Use

a. Do not use in an environment with temperature and humidity outside the allowed range of specifications.

b. The wiring must be completely correct. When the power is turned on, please check whether the color of the connection cable is correct in accordance with the manual. If an error occurs at the connection terminal, the internal circuit of the sensor may be short cut and possibly be damaged. Please be sure to check.

c. The sensor has an embedded system and other precision parts. our company has carried out relevant vibration and impact tests, but please pay attention to the product drop, excessive vibration will lead to malfunction.

d. Do not knock when installing the sensor. Especially when it is matched with the adaptor plate, if the clearance fit is tight due to the adaptor plate processing and other factors, do not knock the sensor, otherwise it will cause damage to the sensor performance.

After the sensor is installed and powered on, it is recommended to preheat it for an hour before operation.

In the actual use of the sensor, the quality of the mounted equipment shall be taken into consideration to avoid overloading.

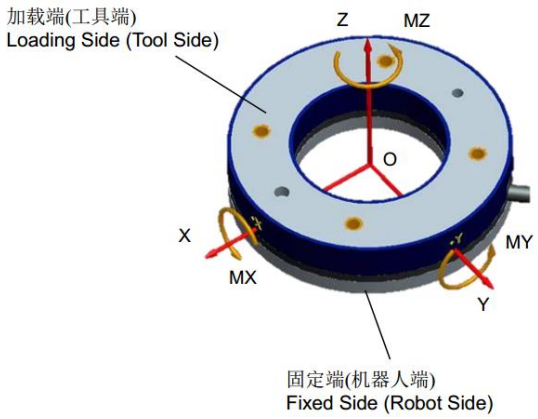
If there is any doubt or failure during use, please do not try to operate without permission and directly contacting our Company.

6. 2 Description of Sensor III

1.1 Overview

This strain type six-axis force/torque sensor can detect three forces and three torques simultaneously. Six-axial load sensors are generally divided into fixed side (robot side) and loading side (tool side). When the two sides of the sensor are under relative force, elastic deformation occurs and the resistance of the strain gauge inside the sensor changes, which is then converted into voltage signal output.

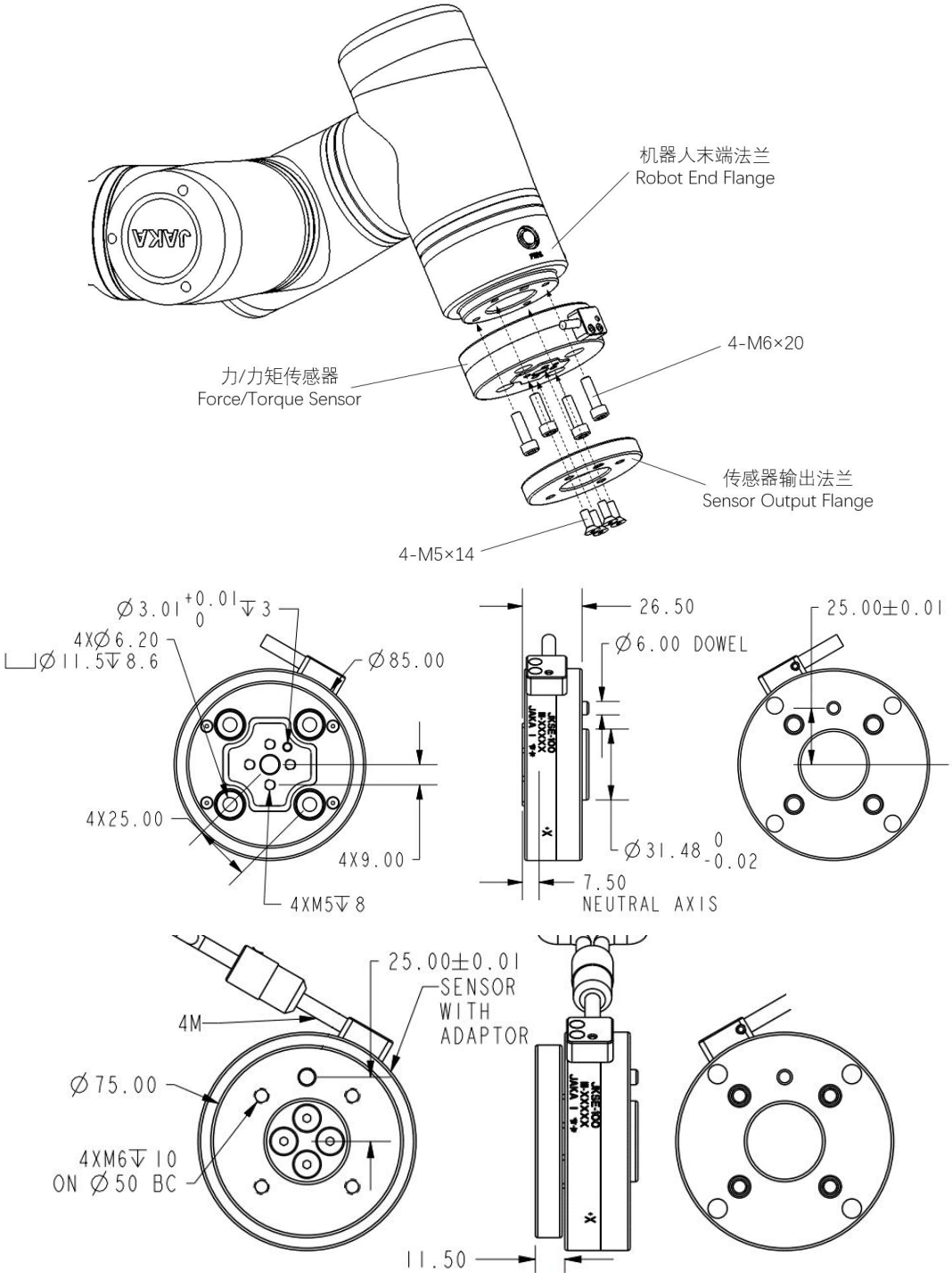
The output force and torque of the six-axis force sensor are relative to the neutral coordinate system, which is generally located in the geometric center of the sensor.



Definition of the Sensor Coordinate System

1.2 Sensor Installation

The sensor size, location of the fixed side (robot side) and the loading side (tool side) are installed as shown in the figure below. The wire or joint is fixed at the fixed side to prevent the swing or pull of the wire from affecting the measurement of the force sensor. The fixed side must be fixed and external force is loaded from the loading side.



Sensor Installation

To tighten the screws, please tighten them gradually in the diagonal sequence. to make uniform contact between the sensor and the equipment to be installed or the transfer fixture.

a. Before installation, please check that there is no damage or foreign matter on the surface of the installation device and sensor. If the contact is not uniform due to foreign matters and other

factors, a gap will be formed between the equipment (or adaptor board) to be installed, which cannot guarantee the IP64 performance of the product and will impact the output effect of the actual sensor.

b. The alignment pin is used to obtain repeatability of the equipment installation and connection. If the locating pin is not used, the sensor performance will not be affected.

c. The connection cable is delivered with the product. The connection cable is a multi-core cable with interfaces matching the cable interface on the sensor. As shown in the figure below, the power is supplied by DC 24V. If the positive and negative poles of the power supply are connected in reverse, the sensor will be damaged. Please be careful. The default IP of the sensor is 192.168.2.108. If you need to change it, please refer to the sensor III configuration instructions or contact us. Connect the network port to the robot controller under the same network segment.

Cable Connection Operation

No.	Core color	Definition
1	Blue	Power supply+
2	White blue	Power supply –
3	Black	Shield line

1.3 Precautions for use

a. Do not use in an environment with temperature and humidity outside the allowed range of specifications.

b. The wiring must be completely correct. When the power is turned on, please check whether the color of the connecting cable is correct in accordance with this manual.

If an error occurs at the connection terminal, the internal circuit of the sensor may be short cut and possibly be damaged. Please be sure to check.

c. The sensor contains an embedded system and other precision parts, please pay attention to

product drop, and excessive vibration will cause malfunction.

d. Do not knock the sensor when installing the sensor, otherwise it will damage the sensor performance.

e. After the sensor is installed and powered on, it is recommended to preheat it for an hour before operation.

f. In the actual use of the sensor, the quality of the mounted equipment shall be taken into consideration to avoid overloading.

g. If there is any doubt or failure during use, please do not try to operate without permission and directly contact our company.

1.4 Basic Sensor Parameters

Fx/Fy(N)	100	Fz(N)	100
Mx/My(Nm)	8	Mz(Nm)	8
Overload level (%)	200	Accuracy (%)	0.5
Precision (%)	0.5	Protective class	IP64
Operating temperature (°C)	-40~100	Power supply voltage (V)	24
Communication Interface	Ethernet	Sampling Resolution (Bit)	24

Precision: Precision is the evaluation index symbolizing the extent of consistency between multiple measured values, that is, the output curve consistency degree obtained by the sensor when the input is tested for multiple times in a unified direction. The precision of reproducibility is the percentage of the standard deviation of the output error to the rated output (%FS).

Accuracy: Accuracy is the evaluation index of the deviation degree between the measured value and the true value. The accuracy is the percentage of the standard deviation of the deviation between the output and the theoretical truth value and the rated output (%FS)