S31.T2S/K Piezo Tip/Tilt Platform

User Manual

Version: V1.0

- This user manual applies to the following models of piezo tip/tilt platform of CoreMorrow (standard & vacuum versions):
  - S31.T2S
  - S31.T2K

Declaration

Thank you very much for choosing CoreMorrow's products!

For your smooth and correct use of this product, please read this manual carefully before use, and follow the relevant instructions in the manual for installation and use. Improper operation may cause damage to the product and/or injury to the operator, so it is required that the entire installation and operation process should be completed by professionals with a certain foundation and understanding of product principles, or under the guidance of a professional.

If you disassemble or transform the product without permission, our company will not be responsible for any consequences arising therefrom.

To change the product model and other false sales of our company's products are illegal, users should be vigilant. Once found, you should actively report or contact our company, jointly crack down on illegal acts, and prevent fraud and economic losses. CoreMorrow will investigate for the legal responsibility of the illegal subject and related parties.

With the continuous development and innovation of technology, CoreMorrow will timely add the latest information to the manual as required. If you need, please contact us, or to our website (www.coremorrow.com) for download, we apologize for any inconvenience caused to you.

Contents

1. Introduction

1.1. Purpose and content

➢ The manual is mainly for smooth and correct use of S31.T2S/K piezo tip/tilt platform and supporting controllers.

➢ The manual contains all the necessary information for S31.T2S/K piezo tip/tilt platform and supporting controllers.

➢ The manual contains the introduction of the precautions during installation and use.

1.2. Symbol and meaning

Symbol	Meaning
	**DANGER:** Improper handling may could cause injury to the operator.
	**Attention:** Improper handling can cause damage to the product.
➢	No order between items.
1. 2.	Please operating in order.

1.3. Users of this manual

The default user of this manual has knowledge of piezo tip/tilt platform and supporting controllers, and has a certain basis for their installation and use.

1.4. User manual notes

➢ When using the piezo tip/tilt platform and supporting piezo controller, the user

manual should be placed near the system for easy reference in time. If the user manual is lost or damaged, please contact our customer service department.

- If your user manual is incomplete, it will miss a lot of important information, may cause serious or fatal injuries, and cause property damage.
- You have read and understood the contents of the user manual before installing and operating the linear piezo motor and supporting piezo controller.
- Our company's official website (www.coremorrow.com) provides the latest user manual download.
- Only authorized professionals who meet the technical requirements can install, operate, maintain and clean the supporting controller.

1.5. User manual download

User manual download process instructions:

1. Open the website www.coremorrow.com;
2. Search for product model (e.g. S31.T2S) or series (e.g. piezo tip/tilt platform)on the website;
3. Click on the corresponding product to open the product details page;
4. On the product details page, scroll down to "Downloads";
5. Click on the desired file to download.

Be careful! If the manual is lost or there are problems downloading, please contact our customer service department.

2. Safety Guide

This product is designed with the most advanced technology and safety standards. For your own safety and the correct use of the product, please observe the following points when in use.

A change in temperature and pressure will charge the piezo product, and the product will remain charged for a period of time when it is disconnected from the controller, so the operator should pay attention to when in use:

- **DO NOT** disassemble the piezo product.
- Discharge the product before mounting, which can be done by connecting to the controller.
- **DO NOT** unplug the wire connecting with controller during operation.
- Before use, check whether the connection wire of the product is in good condition and whether the product and the controller are effectively grounded. During operation, strictly standardize the operation. **DO NOT** touch the product (up to 150V voltage) with your hand when power on, in case of danger.

In order to prevent damage to the product caused by improper operation, the following points should be paid attention to when in use.

- The product should be used in a dust-free, oil-free and lubricant-free environment.
- As the product is designed with flexible structure, it is recommended that the load should not exceed load capacity of product.
- When loading, **DO NOT** apply torque force and **DO NOT** pry or twist the load surface, so as not to damage the structure.
- **DO NOT** disassemble the product to avoid damage.
- **Avoid** stretching and bending the cable interface to prevent damage to thecable.
- Use the dedicated cable provided by CoreMorrow to this product to controller.
- **DO NOT** connect via an extension cable casually, if you need a longer cable, please contact CoreMorrow.

3. Product Overview

3.1. Product introduction

The piezo tip/tilt platform of CoreMorrow uses piezo actuators as driving components, adopts a flexible hinge parallel guiding structure and realizes single-axis or multi-axis angular deflection motion through the expansion and contraction of internal piezo actuators. To ensure the deflection with excellent motion accuracy and high stability, it can also use closed-loop control with built-in high-precision sensor to achieve nano-radian resolution and microradian positioning accuracy.

The S31.T2S/K piezo tip/tilt platform is a deflection platform with fast response and compact size. It provides high-precision angular motion of the top platform. Compared with other actuators, the flexible hinge-guided piezo deflection platform provides higher acceleration. It can achieve a tilt range of 3.8mrad(≈784″). Open/closed loop version optional, and the closed-loop version has a full bridge design which avoids temperature drift and ensures the high accuracy. It has the following advantages:

- High performance piezo stack

This product is driven by a highly reliable piezo ceramic actuator with a fully insulated structure, so its performance and service life are far better than the traditional actuator. The insulating layer can effectively prevent the piezoelectric ceramic from being damaged when exposed to moisture. Therefore, the stability of piezo ceramics can be guaranteed under extreme circumstances. Compared with

traditional driving mechanism, there are no transmission parts and friction. Therefore, ceramic actuator has the characteristics of no rebound, no maintenance, and no wear, etc.

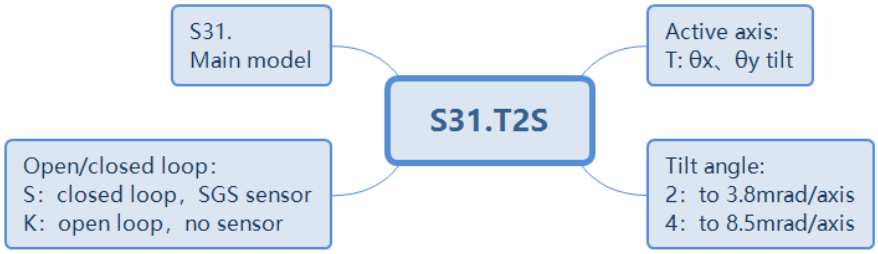
- Flexible hinge structure

This product adopting flexible hinge mechanism has advantages of no friction, high positioning accuracy. Flexible hinge is an element not affected by static and dynamic friction, based on the elastic deformation of metal material (e.g., steel) , there is no rolling and sliding parts. Flexible unit has very high load capacity and stiffness. Hinge guide needs no maintenance and no wear and tear. Suitable for a wide range of temperatures, no lubricating oil is required.

- Strain Sensor(SGS)

Strain sensor detects the position information by its own expansion. They are fixed in the proper position of the transmission part and measure the displacement of the moving part. This type of position measurement is made by contact and indirect measurement. So the displacement of the moving platform is measured by measuring lever, guide hinge, or piezo ceramic stack. The sensor is connected by full bridge without drift and can accurately do the position in the nanometer range.

3.1.1 Model interpretation



The corresponding models of S31.T2S/K piezo tip/tilt platform are as follows:

Model	Description
S31.T2S	θx, θy tilt, tilt angle to 3.8 mrad/axis or ±1.9mrad/axis, SGS sensor
S31.T2k	θx, θy tilt, tilt angle to 3.8 mrad/axis or ±1.9mrad/axis, no sensor

3.2. Product appearance

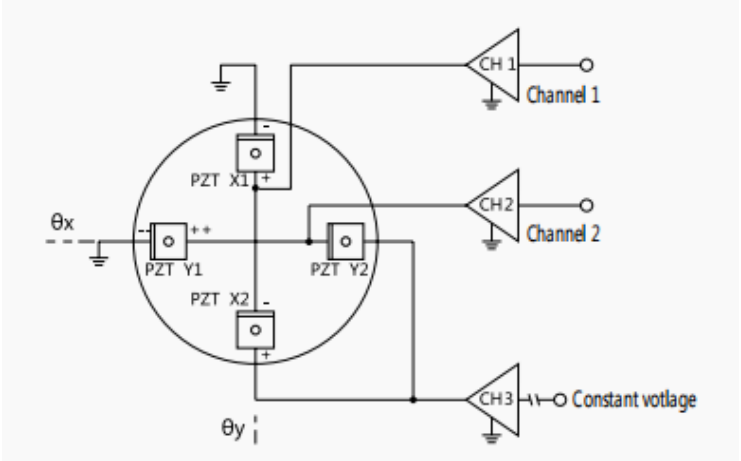
S31.T2S physical picture

3.3. Motion direction

S31.T2S motion direction diagram

3.4. Operating Principle

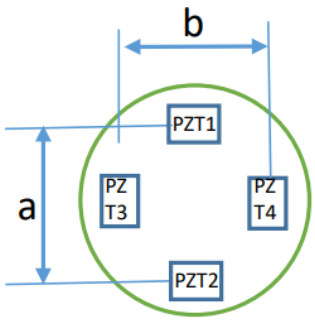
The operating principle of S31.T2S/K is as follows:



The S31.T2S/K piezo tip/tilt platform(two-axis motion) is based on parallel kinematic design with coplanar axis and moving platform. Four piezo actuators are placed at a 90° angle interval, paired differential control distribution. Two pairs of differentially driven actuators provide the highest achievable angular stability over

a wide temperature range. Its tilt motion is achieved by two pairs of piezo actuators in a push-pull motion, controlled by a bridge connection circuit.

The deflection angle of piezo tip/tilt platform is calculated as follows:



S31.T2S/K Tip/Tilt Platform schematic

The deflection angle around the X-axis:

$$\theta_X = (L_{PZT1} - L_{PZT2}) / a$$

Wherein:

L_{PZT1}-PZT1 Displacement;

L_{PZT2}-PZT2 Displacement;

a- The distance between two ceramics;

Similarly, the deflection Angle around the Y-axis is:

$$\theta_Y = (L_{PZT3} - L_{PZT4}) / b$$

Dynamic characteristics of piezo tip/tilt platform:

The maximum operating frequency of the platform strongly depends on its mechanical resonantfrequency, and also on amplifier, controller and sensor. In order to estimate the effective resonant frequency of the system (platform and mirror), the moment of inertia of the mirrors must be taken into account. The moment of inertia of a mirror can be calculated as follows:

The moment of inertia of a cylindrical lens:

$$I_m = m\left[\frac{3R^2 + H^2}{12} + \left(\frac{H}{2} + T\right)^2\right]$$

The moment of inertia of a rectangular lens:

$$I_m = m\left[\frac{L^2 + H^2}{12} + \left(\frac{H}{2} + T\right)^2\right]$$

Wherein:

I_m- moment of inertia of a mirror, g•mm²

m- mirror weight, g

R- mirror radius, mm

H- mirror thickness, mm

T- distance of pivot point to platform surface, mm

L- mirror length orthogonally to tilt axis, mm

The resonant frequency of the system is calculated with resonant frequency of the platform and the moment of inertia of the mirror, formula is as follows:

$$f' = \frac{f^0}{\sqrt{1 + I_m / I_0}}$$

Wherein:

f'- resonant frequency of platform with mirror, Hz

f^0- resonant frquency of platform without mirror, Hz

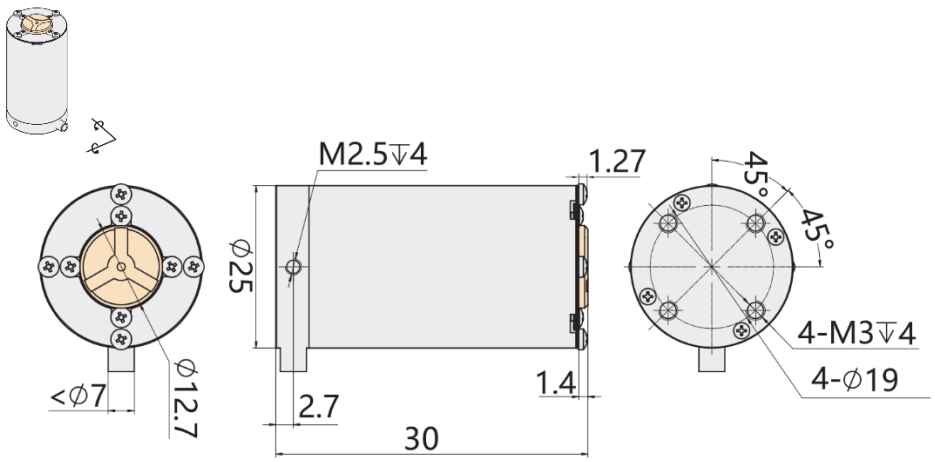
I_m- moment of inertia of a mirror, g•mm²

I_0- the moment of inertia of platform, g•mm²

3.5. Technical data

Type		S31.T2S	S31.T2K	Units
Active axes		θx, θy	θx, θy	
Control Channels	Drive	3	3	
	Sense	2	-	
Nominal tilt angle(0~120V)		3/±1.5(≈±309″)	3/±1.5(≈±309″)	mrad±10%
Max. tilt angle(0~150V)		3.8/±1.9(≈±392″)	3.8/±1.9(≈±392″)	mrad±10%
Sensor type		SGS	-	
Resolution		0.5(≈0.1″)	0.05(≈0.01″)	μrad
Linearity		0.5	-	%F.S.
Repeatability		0.5	-	%F.S.
Unloaded resonant frequency		12	12	kHz±20%
Resonant frequency		9@Φ12.7×3mm mirror	9@Φ12.7×3mm mirror	kHz±20%
El.capacitance		1.6/axis	1.6/axis	μF±20%
Material		Steel, Ti	Steel, Ti	
Mass(including wires and connectors)		115	115	g±5%

3.6. Drawing



Note: The highlighted yellow area in the above figure represents the motion

surface that can generate displacement during the actual motion process.

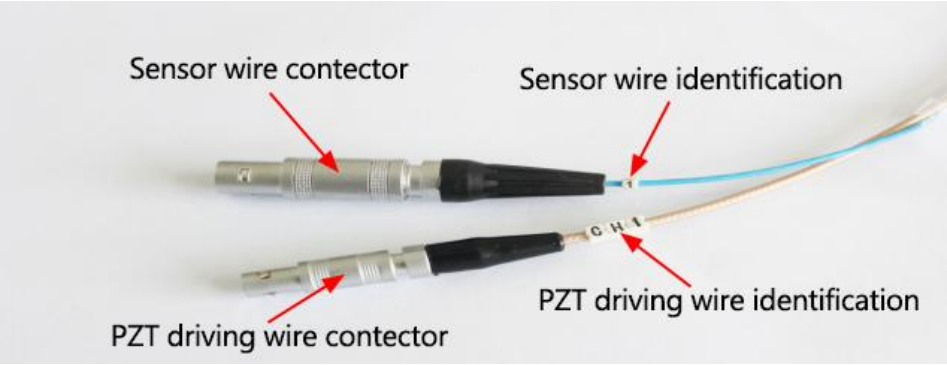
3.7. Connector pin description

The type of connector used depends on the controller interface it is paired with, and there are usually several types of connectors as follows:

※Please find the corresponding connector Pin description below based on the product received.

※ Other forms of connectors can be customized. If you have customization needs, please contact the sales engineer of CoreMorrow.

3.7.1. Single core PZT driving connector and 4-core sensing connector



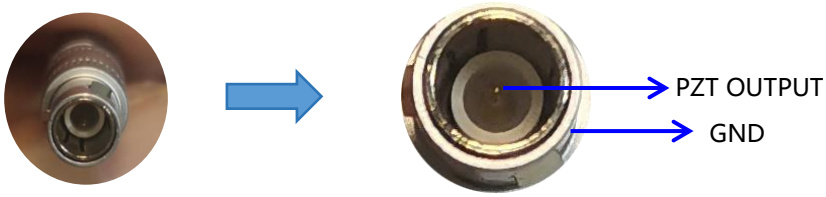
This type of connector separates the PZT driving voltage interface (i.e. the voltage signal transmission interface required by PZT piezo products) from the sensing input interface (i.e. the signal feedback signal and sensor power supply signal interface of PZT piezo products' built-in sensors) , and has its own connectors, namely PZT driving voltage connector and sensing input connector. Usually used in conjunction with E00/E01 piezo controllers.

PZT driving voltage connector (Single core)

- The cable corresponding to this connector is designed to transmit the voltage

signal required to drive piezoelectric products.

➢ The model of the connector is TFA.00S.250.CLAD20Z, with a positive core and a ground (or negative) shell. Connect to the PZT output voltage interface of the piezo controller.

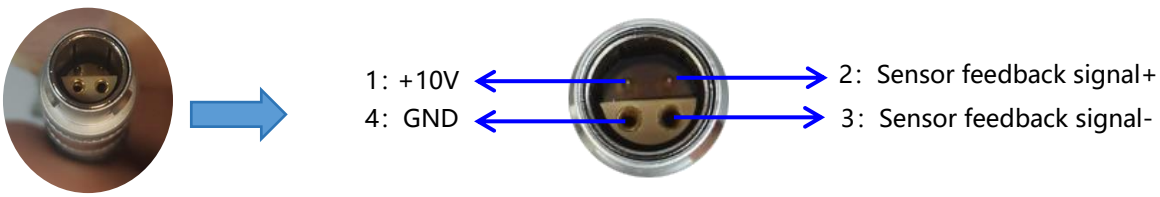


Sensing input connector(4-core)

(Note: Open loop products do not have this cable and connector)

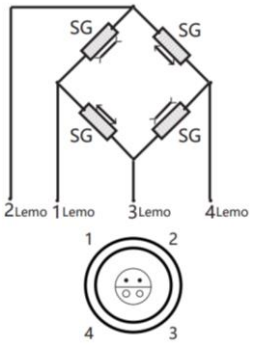
➢ The cable corresponding to this connector is used to transmit the feedback voltage signal of the internal sensor of the piezo product and provide power supply voltage for the sensor.

➢ The model of the connector is TFA.0S.304.CLAD17Z, Pin 1 and 4 are the powersupply interfaces of the sensor, which are respectively the positive pole and ground of the power supply voltage; Pin 2 and Pin 3 are the feedback signal interfaces of the sensor, with positive and negative poles respectively. Connect to the sensor input interface of the piezo controller.



When the sensing input connector of the piezo product is 4-core, the bridge connection method and pin definition of the strain sensor inside the platform are

as follows:



The pin definitions are as follows:

Pin No.	Description
1	power supply +10V
2	Sensor feedback signal+
3	Sensor feedback signal-
4	power supply GND
Shell	GND(Protect)

Note: 1, 4 for power supply; 2, 3 for sensor signal feedback.

The instructions of quantity of connectors and Line identification are as follows:

Quantity of connectors			
Model	Servo	Type	Quantity
S31.T2	Closed loop SGS sensor	PZT connectors	**3**
		Sensor connectors	**2**
	Open loop no sensor	PZT connectors	**3**
		Sensor connectors	**0**

Line identification			
Model	Type	Line identification	Notes
S31.T2	PZT	**CH1**	The number corresponds to the channel number of the controller
		CH2	
		CH3	
	Sensor	**1**	
		2	

※ Note: Open loop products only have PZT drive wires and connectors, no sensing

input cables and connectors.

※ Note: For special circumstances, please refer to the special instructions or contact customer service of CoreMorrow.

3.7.2. 12-core PZT driver&sensor connector

This type of connector combines the PZT driving voltage interface (i.e. the voltage signal transmission interface required by PZT piezo products) of three motion axes with the sensing input interface (i.e. the signal feedback signal and sensor power supply signal interface of PZT piezo products' built-in sensors) into one connector. Usually used in conjunction with E70 series piezo controllers.

The model of this connector is TGG.2B.312.CLAD62Z, and the pin description are as follows.

The pin instructions 12 core connector of the S31.T2S/K piezo tip/tilt platform are as follows:

Pin No.	S31.T2S (Closed loop，SGS)	S31.T2K (Open loop，no sensor)
1	CH1 sensor input signal -	Null
2	CH1&CH2 sensor input GND	Null
3	CH1&CH2 sensor input +10V	Null
4	CH1~CH3 drive output GND	CH1~CH3 drive output GND
5	CH3 drive output+	CH3 drive output+
6	CH2 drive output+	CH2 drive output+
7	CH1 drive output+	CH1 drive output+
8	CH1 sensor input signal +	Null
9	CH2 sensor input signal -	Null
10	Null	Null
11	Null	Null
12	CH2 sensor input signal +	Null
Shell	GND(Protect)	GND(Protect)

4. Operating Environment

The S31 piezo tip/tilt platform must comply with the following usage environment:

Environmental Condition	Condition Description
Area of application	For indoor use only
Operating temperature	-20~80℃
Storage temperature	-20~80℃
Transport temperature	-20~80℃
Environmental requirements	dust-free, clean and non-corrosive
Relative humidity	< 60%

Note: If the ambient temperature exceeds the operating temperature range of this product, please contact our customer service department.

5. Installation and Operation

Safety check should be carried out before installation, such as whether the connection wire is damaged or broken, whether the drive power supply is grounded, etc.

5.1. Installation and precautions

5.1.1. Optical lens fixation

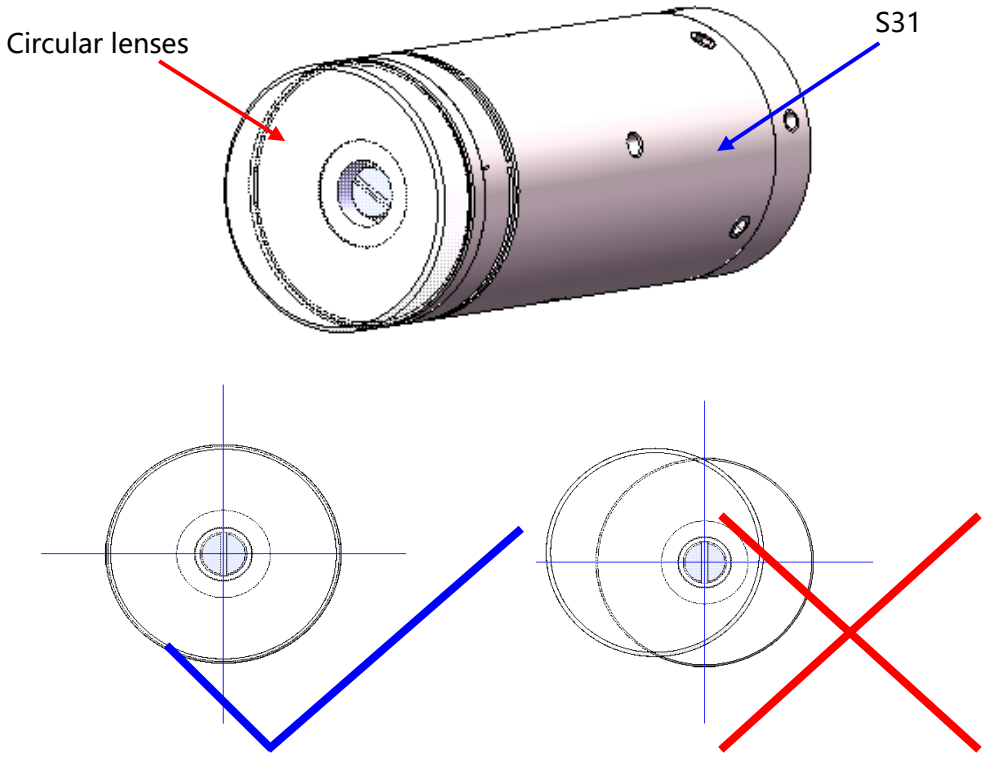
S31.T2S/K piezo tip/tilt platform are used in conjunction with optical lenses by default. There are two ways to fix optical lenses: adhesive bonding with glue or other adhesives+adapter fixing. The corresponding introduction and precautions are as follows:

Adhesive bonding with glue or other adhesives

1. Lens specifications and bonding position requirements

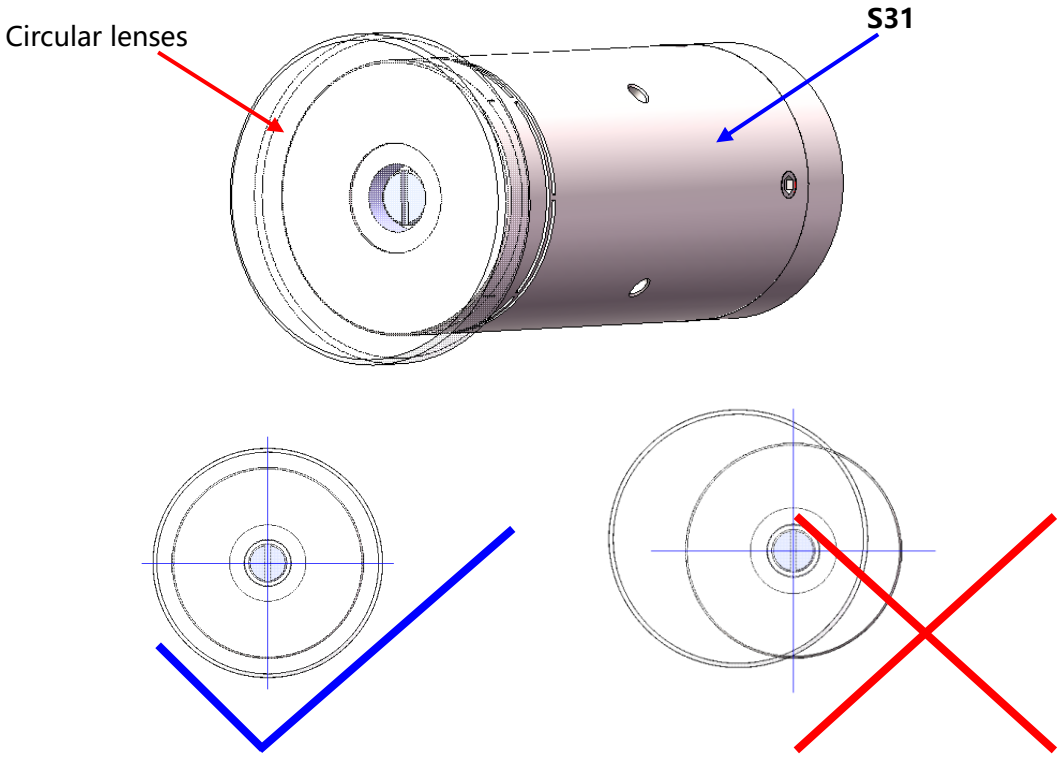
a) Circular lenses

① Circular lens diameter less than or equal to the moving platform of S31.



Adhesive precautions: Circular lenses need to be bonded coaxially with the central axis of the moving platform of S31.

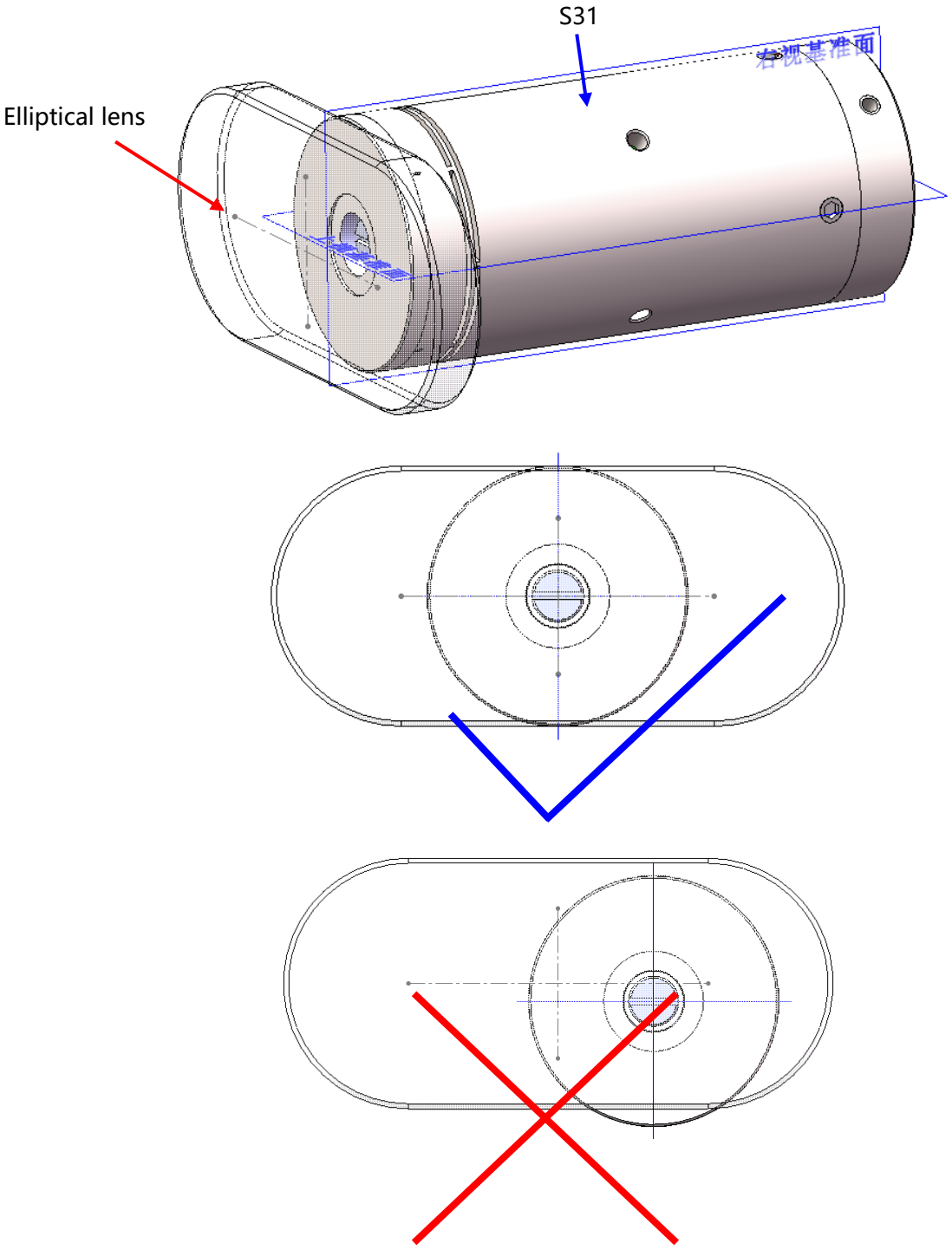
② Circular lens diameter larger than or equal to the moving platform of S31.



Adhesive precautions:

- Circular lenses need to be bonded coaxially with the central axis of the moving platform of S31;
- The mass of circular lenses shall not exceed the maximum load of S31;

b) Elliptical lens



Adhesive precautions:

- The intersection point of the long and short axes of the elliptical lens should coincide with the central axis of the moving platform of S31 and be bonded together;
- The mass of elliptical lenses shall not exceed the maximum load of S31;

2. Other precautions for lens bonding

When sticking the lens, the amount of glue on the top cover should be minimal to prevent excess glue from flowing towards the middle groove;

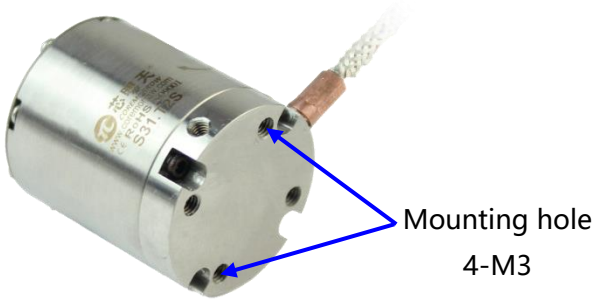
adapter fixing

CoreMorrow can provide dedicated adapters for S31. If needed, please contact our sales technical consulting engineer

5.1.2. S31 fixation

There are two ways to fix the S31: screw fixation+physical clamping. The corresponding introduction and precautions are as follows:

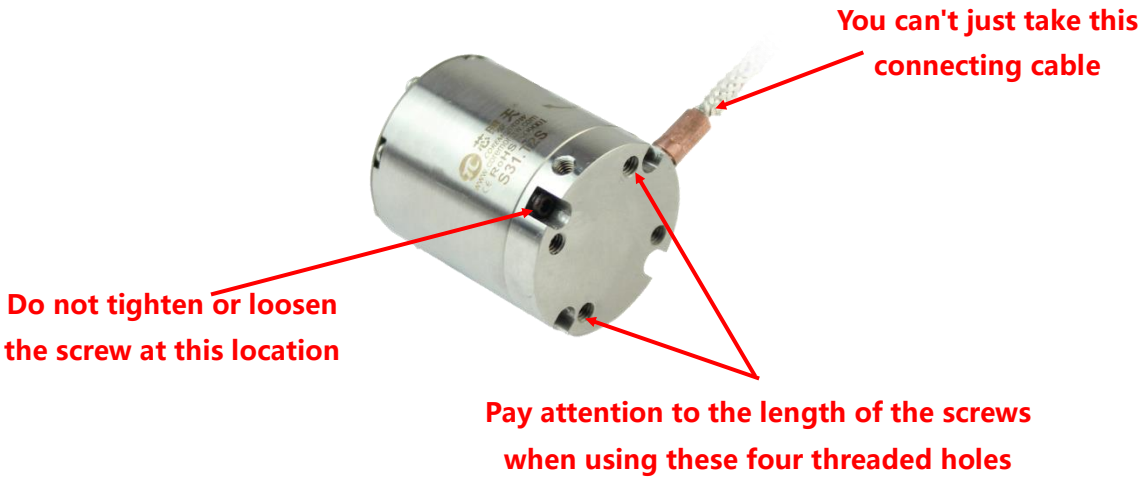
Screw fixation



Please note:

➢ Pay attention to the depth when using the threaded hole at the bottom of the swing mirror;

➢ When moving the mirror, do not only take the bottom connecting wire, as shown in the following figure:



Physical clamping

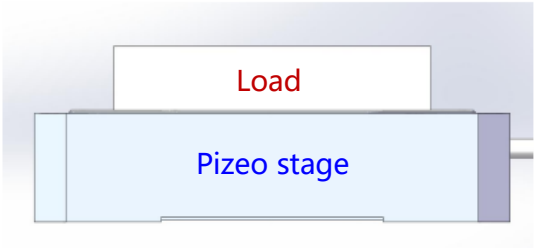
Attention! Please strictly follow the instructions for the clamping area of S31 fixed by physical clamping. The corresponding introduction is as follows:

5.2. Load

When mounting the load, ensure that the load quality is less than the maximum

load capacity of the product, and try to mount the load in the center of the moving platform.

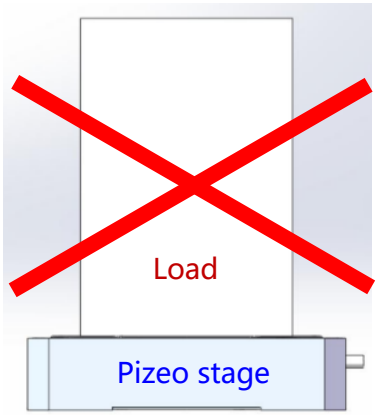
The correct position to mount the load is shown in the figure below.



The load is applied to the center of the moving platform

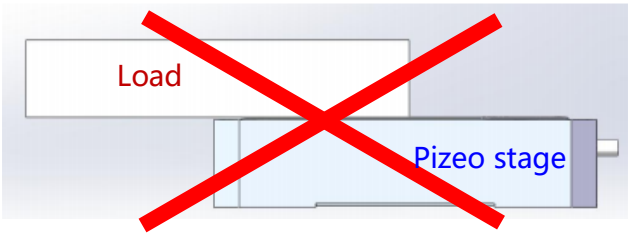
For the protection of the product, we do not recommend that the load is too high. If a higher load must be used, please appropriately low the position of the center of gravity of the load.

The wrong mounting way is shown in the figure below:



Try not to let the position of the center of gravity far exceed the active platform

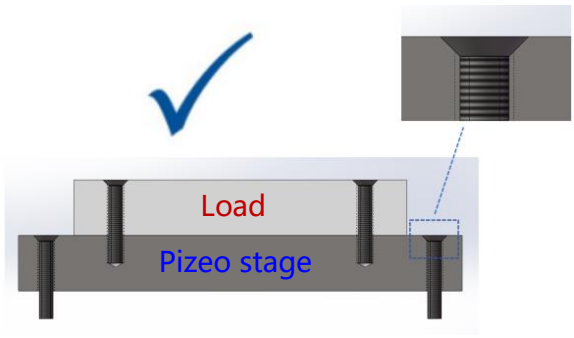
It is forbidden to mount the load on one side of the moving platform, which will cause serious damage to the product, as shown in the figure below.



Do not mount long loads on one side of the platform

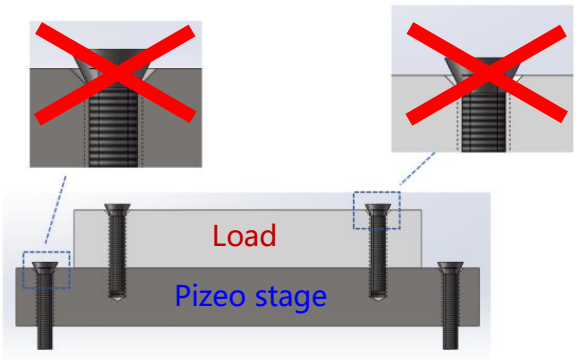
Too long screws selected in the fastening and connection process will lead to failure of mounting or part of bolts will be exposed, which will scratch the product and affect the motion accuracy of the product. If the bolt is too short, the connection will be weak, and it is easy to be loosened. Loosening during operation will damage the internal structure of the product.

We recommend using the connection method shown in the figure below:



The **correct** bolt connection

Please do not connect in this way as shown below:



Inappropriate bolt selection

5.3. Operating

5.3.1. Connection precautions

When plugging or unplugging cables, please hold the middle position of the connector with your fingers to avoid pulling the cable directly. Pulling the cable directly may cause damage to the cable. (Note: Please refer to the schematic diagram below for cable insertion and removal. The controller in the diagram is for reference only.)

The **correct** way of plugging and unplugging cables

The **Inappropriate** way of plugging and unplugging cables

- Use the dedicated cable provided by CoreMorrow to connect the product and the controller.
- **Do Not** connect via an extension cable casually, if you need a longer cable, please contact CoreMorrow.
- If the grounding protection wire is not connected, there may be a risk of electric shock;
- The use of piezo products in environments with increased electrical conductivity may be damaged by electric flashover;
- Continuous high pressure may shorten the life of piezo ceramics;
- Incorrect connection of the operating voltage may cause damage to the piezo product;
- Uncontrolled vibration can cause irreversible damage to piezo products.

5.3.2. Operation precautions

After confirming the startup status, perform the following related operations on

the controller:

1. Please read the user manual of the controller carefully before operation, and then start the controller.

2. Set the output voltage of the controller to zero first.

3. Check no abnormal phenomenon, then input voltage value according to specified input voltage range.

4. Operating normally within the rated voltage range of piezo ceramics.

5. After use, please carry out voltage reset operation.

Please take light steps when the product in operation, do not knock the product, so as not to affect the use of the product or even damage the product.The resolution of the product itself is unlimited, and the resolution depends on the performance of the controller. In order to achieve better motion precision, it is recommended to use our company's supporting controller. Please refer to the user manual of the controller for the specific operation to ensure correct operation before relevant operation.

Notes:

- Do not remove the grounding protection during the operation. If you need to remove it temporarily, please reconnect the grounding protection before starting it again.
- The driving voltage shall not exceed the voltage range of the PZT product.
- If any abnormal noise or oscillation occurs during use, turn off the power immediately and check the parameter setting.

5.3.3. Disassembly precautions

Discharging the PZT product connected to the controller

In closed-loop operation:

1. Switch off the servo mode on the controller.
2. Set the piezo voltage to 0V on the controller.

In open-loop operation:

Set the piezo voltage to 0V on the controller.

Discharging the PZT product not connected to the controller

Connect the the PZT product to the switched-off piezo controller from CoreMorrow.

6. Transportation and Inspection

6.1. Transportation

This product is packed in cartons. Transportation is carried out under the packaging conditions. This product can be transported by various means of transport under normal circumstances. In the process of transportation, direct rain and snow, corrosive substances, strong collision, extrusion, irregular placement and other improper behaviors should be avoided as far as possible.

6.2. Open-box inspection

- Improper external force applied to the surface of piezo products can cause damage to mechanisms such as flexible hinges and sensors and thus not function properly.
- The tension at the cable outlet and the bending of the connecting cable may cause the piezo product to fail to connect properly with the controller and thus not function properly.

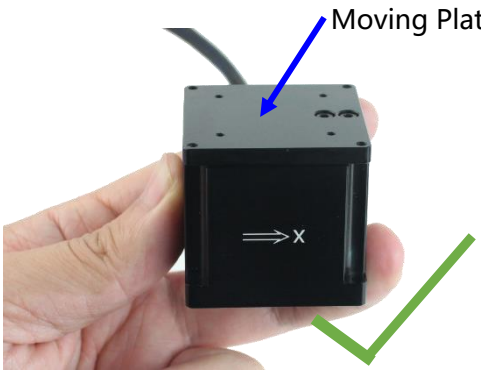
6.2.1. Open-box

- Before opening the package, please check the outer packing carefully to see if there is any breakage, wetting, dampness, deformation, etc.
- Please do not use heavy tools or rough way to open, and prevent the product from being scratched or damaged by blades or other sharp objects.
- When removing the product from the packaging box, do not pull the cable of the product to prevent improper force from damaging the cable.

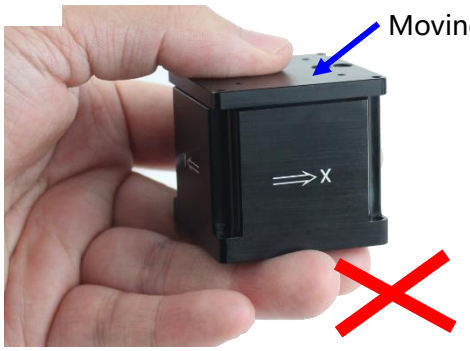
➢ Please handle with care when opening the package, so as not to knock against the product and cause permanent damage to it.

➢ When holding the product, **DO NOT** hold the product's moving platform to avoid damaging the internal structure of the product due to improper force. (Note: See the schematic diagram of the handheld product below. The piezo product in the diagram is for reference only.)

➢ Keep all packaging materials in case the product needs to be returned.



Avoid holding the moving paltform



No holding the moving paltform

6.2.2. Item verification

➢ Please check the completeness of package contents one by one according to the supply contract and packing list.

➢ Please check whether the surface of the product has obvious damage.

➢ Please check whether the product identification is clear and complete.

➢ Please check whether the connector is loose and the connector wire is broken or damaged.

Note! In case of any of the above, please make a detailed record and take a photo of it. Meanwhile, please contact us for processing immediately.

7. Maintenance and Treatment

7.1. Problem handling

FAQ are shown in the table below.

Problem description	Possible reason	Solution
No displacement or less displacement	The connection wire is not connected properly or poor contact	Check the connection wire
	Sensor zero drift	Check the sensor
Low accuracy	Mounting surface unevenness	Mount the platform on a flat surface
	Loose connection	Fasten connection
Vibration or inaccurate positioning at startup	Incorrect input control parameters	Stop immediately and check the parameter Settings
	Resonance occurs	Lower operating frequency less than resonance frequency

- If the user cannot solve the problem by himself in the process of using, please record the problem in detail and contact CoreMorrow, and professional technical personnel will help to solve.
- Problems caused by improper operation are not covered by the warranty.
- CoreMorrow is not responsible for any problems caused by dismantling products without permission.

7.2. Daily maintenance

- If the product is not used for a long time, please store it in a dust-free,

well-ventilated, clean and non-corrosive indoor environment after packaging.

- In the daily maintenance, please do not loosen the bolts on the product structure, so as not to affect the movement accuracy of the product.

Daily cleaning:

- Please disconnect the product from the controller before cleaning the surface.
- When cleaning, gently wipe the surface of the product with a towel dipped in a small amount of detergent, and then clean it with alcohol. Please do not use ultrasonic cleaner.
- When cleaning the surface, try not to pick up the product. If you have to pick up the product, it is better to put the sponge under the product for protection. The product should not be too high from the sponge, in case the product falls off.

7.3. Disposal

Waste products should be disposed according to national and local rules and regulations. In order to fulfill our responsibility as a product manufacturer, we will dispose all old equipments on the market in an environmentally friendly manner. If you have equipment that cannot be disposed, you can ship it to CoreMorrow. **However**, the shipping costs will be borne by the sender. We do not accept freight collect shipments.

Address: Building I2, No.191 Xuefu Road, Nangang District, Harbin, Heilongjiang, China

Tel: +86-451-86268790

8. Customer Service

8.1. Use question consultation

If you have questions about the products you are currently using, please let us know the following information:

- Product model and relevant number.
- The controller model.
- Software driver version.
- Computer operating system that installs supporting software.

8.2. Contact us

CoreMorrow Ltd.

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Web: www.coremorrow.com Email: info@coremorrow.com

Address: Building I2, No.191 Xuefu Road, Nangang District, Harbin, HLJ, China

After-sale service

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CoreMorrow Official and CTO WeChat are below: