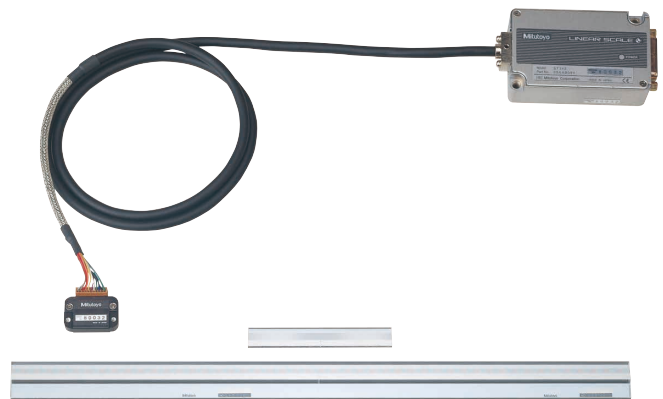




Separate Type Linear Scale System

ST422



User's Manual - Instructions for use -

Read this document thoroughly before operating the product. After reading, retain it close at hand for future reference.

This English language version of the document contains the original instructions.

No. 99MBE026B2

Date of publication: May 1, 2025 (1)



■ Product names and model numbers covered in this document

Product name	Model number
Separate Type Linear Scale System	ST422

■ Notice regarding this document

- Mitutoyo Corporation assumes no responsibilities for any damage to the product, caused by its use not conforming to the procedure described in this document.
- Upon loan or transfer of this product, be sure to attach this document to the product.
- In the event of loss or damage to this document, immediately contact the agent where you purchased the product or a Mitutoyo sales office.
- Read this document thoroughly before operating the product. In particular, be sure to fully understand  "Safety Precautions" on page 4 and  "Precautions for Use" on page 5.
- The contents of this document are based on information current as of May 2025.
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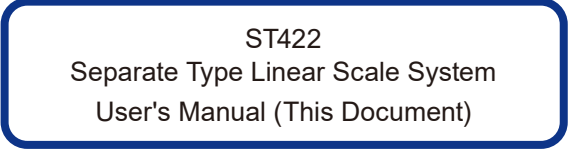
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About This Document

■ Positioning of this document, document map

The following describes positioning of this document.



ST422
Separate Type Linear Scale System
User's Manual (This Document)

This document describes mounting procedures, specifications, and troubleshooting of the ST422.

■ Intended readers and purpose of this document

● Intended readers

This document is intended for those who use the ST422 Separate Type Linear Scale System for the first time.

The users must be able to understand the instructions by reading technical drawings.

● Purpose

This document is intended to provide better understanding of the ST422 Separate Type Linear Scale System.

Conventions Used in This Document

■ Safety reminder conventions warning against potential hazards

 DANGER	Indicates a hazard with a high level of risk which, if not avoided, will result in death or serious injury .
 WARNING	Indicates a hazard with a medium level of risk which, if not avoided, could result in death or serious injury .
 CAUTION	Indicates a hazard with a low level of risk which, if not avoided, could result in minor or moderate injury .
NOTICE	Indicates a situation which, if not avoided, may result in property damage .
	Electricity Alerts the user to a specific hazardous situation that means "Caution, risk of electric shock".

■ Conventions indicating prohibited and mandatory actions

	Indicates concrete information about prohibited actions.
	Indicates concrete information about mandatory actions.
	Indicates that grounding needs to be implemented.

■ Conventions indicating referential information or reference location

IMPORTANT	Indicates information that must be known when using the product.
Tips	Indicates further information and details relevant for the operating methods and procedures that are explained in that section.
	Indicates reference location if there is information that should be referred to in this document or an extraneous User's Manual. Example: For details on system configuration, see  "1.2 System Configuration and Name of Each Part" on page 9.

Other conventions

(): Round brackets	Represent a paraphrase of an immediately preceding phrase or a supplementary explanation.
" ": Double quotation marks	Represent a highlighted phrase. They also indicate an index where information to be referenced is described.
[]: Square brackets	Represent a menu name on the screen, screen name, dialog name, button, display item, tab name, or key on the keyboard. They also indicate an item to be purposely entered or selected by the customer.
1, 2, 3... 1, 2, 3...	Indicates the order and the contents of tasks. (1 : indicates main tasks, 1 : indicates detailed tasks)
»	Indicates the action resulted from some operation(s).

Example of conventions use

3 Installation onto the Machine Main Unit

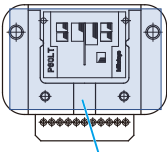
3.3 Mounting the Detector Bracket and Detector

NOTICE

Do not directly touch the I/F Box pins during installation. Otherwise, electronic parts may be damaged by static electricity. Be sure to take measures to prevent static electricity for installation.

 To use the scale with the Detector mounted, the machine main unit, as well as the attachment bracket, must be electrically grounded. Failure to do so may cause the scale unit and the Detector to be affected by external noise.

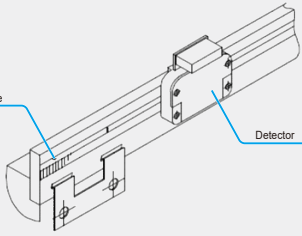
1 Peel the protection tape (blue) off the detecting surface of the Detector.



2 Attach the Detector to the Detector bracket.

IMPORTANT

Adjust the distance (gap) between the Detector and main scale to 1.2 mm.



21

No. 99MBE026B

Indicates safety information.

Indicates implementing action.

Indicates an operating procedure to be performed or its outline.

Indicates important information that must be known when using the product.

Safety Precautions

Read these "Safety Precautions" thoroughly before operating the product to use it properly. These safety precautions include such information as to prevent injury to the operator and other persons, damage to property and product defects. Be sure to observe these precautions carefully.

■ Precautions for this product

NOTICE	
	• To prevent defective contacts, do not touch the connecting terminals of the connectors with bare hands. • Do not directly touch the I/F Box pins during installation. Otherwise, electronic parts may be damaged by static electricity. • Note that the feedback cable may malfunction if bundled with other cables that may cause electrical noise, or if it is located near a switching relay dealing with a large current.
	• Read this document thoroughly before operating the system to use it properly. • Before connecting this product to the machine main unit, make sure that the power for the control unit is turned off. • Be sure to take measures to prevent static electricity for installation. • To maintain the shielding effect, firmly tighten the screws on the connectors of each connecting cable. • The main scale is made of glass. Be very careful that the scale is not damaged or scratched.

Precautions for Use

■ Use and handling of the product

- This product is a measuring instrument.

Do not use this product for any other purpose than measuring.

- This product is for industrial usage.

Do not use this product for purposes other than for industrial usage.

- This product is a precision instrument.

- Handle this product with extra care.
- Do not apply any strong impact or excessive force to the parts during use.

If the product is used beyond the conditions indicated in the specifications ( "4 Specifications" on page 33), be aware that the functions and performance cannot be guaranteed.

■ Environment for placement

Use the product in the following places.

- Where there are minimal vibrations
To install this product onto the machine main unit, select a location where there is as little vibration as possible.
If the scale unit is used for an extended period of time on a machine where there is a substantial amount of vibration, the built-in precision parts may be damaged, thereby adversely influencing the performance of the unit.
- Where protected against shock, dust, and water
To protect the scale main unit from being directly exposed to machining oil and chips, or from being bumped by a workpiece, etc., prepare a cover that protects the entire scale main unit.
- Where the ambient temperature is within 10 °C to 40 °C
- Where the humidity is within 20 % to 80 %

Electromagnetic Compatibility (EMC)

This product complies with the EMC Directive and the UK Electromagnetic Compatibility Regulations; however, if this receives electromagnetic interference that exceeds these requirements, it will be out of warranty and require appropriate measures.

This product is an industrial product, and is not intended to be used in residential environment. If this product is used in residential environment, this product may cause electromagnetic interference with other instruments. In such a case, it is required to take appropriate measures for preventing such electromagnetic interference.

Export Control Compliance

This product falls into the Catch-All-Controlled Goods and/or Catch-All-Controlled Technologies (including Programs) under Category 16 of Appended Table 1 of Export Trade Control Order or under Category 16 of Appended Table of Foreign Exchange Control Order, based on Foreign Exchange and Foreign Trade Act of Japan.

If you intend re-export of the product from a country other than Japan, re-sale of the product in a country other than Japan, or re-providing of the technology (including Programs), you shall observe the regulations of your country.

Also, if an option is added or modified to add a function to this product, this product may fall under the category of List-Control Goods, List-Control Technology (including Programs) under Category 1 - 15 of Appended Table 1 of Export Trade Control Order or under Category 1 - 15 of Appended Table of Foreign Exchange Control Order, based on Foreign Exchange and Foreign Trade Act of Japan. In that case, if you intend re-export of the product from a country other than Japan, re-sale of the product in a country other than Japan, or re-providing of the technology (including Programs), you shall observe the regulations of your country. Please contact Mitutoyo in advance.

Notes on Export to European Countries

When you intend exporting of this product to any of the European countries, it may be required to provide User's Manual(s) in English and Declaration of Conformity in English (in some cases, the official language of the country to be exported). For detailed information, please contact Mitutoyo in advance.

Disposal of Products outside the European Countries

Please follow the official instruction in each community and country.

Disposal of Old Electrical & Electronic Equipment (Applicable in the European Countries with Separate Collection Systems)



This symbol on the product or on its packaging is based on WEEE Directive (Directive on Waste Electrical and Electronic Equipment), and this symbol indicates that this product shall not be treated as household waste.

 To reduce the environmental impact and minimize the volume of landfills, please cooperate in reuse and recycle.

For how to dispose of the product, please contact the agent where you purchased the product or a Mitutoyo sales office.

China RoHS Compliance Information

This product meets China RoHS requirements. See the table below.

产品中有害物质的名称及含量

部件名称	有害物质					
	铅	汞	镉	六价铬	多溴联苯	多溴二苯醚
	(Pb)	(Hg)	(Cd)	(Cr(VI))	(PBB)	(PBDE)
本体	○	○	○	○	○	○
电气设备部分	×	○	○	○	○	○
配件	○	○	○	○	○	○

部件名称	有害物质			
	邻苯二甲酸二正丁酯	邻苯二甲酸二异丁酯	邻苯二甲酸丁基苯酯	邻苯二甲酸二(2-乙基己)酯
	(DBP)	(DIBP)	(BBP)	(DEHP)
本体	○	○	○	○
电气设备部分	○	○	○	○
配件	○	○	○	○

本表格依据 SJ/T 11364 的规定编制。

○: 表示该有害物质在该部件所有均质材料中的含量均在 GB/T 26572 规定的限量要求以下。

×: 表示该有害物质至少在该部件的某一均质材料中的含量超出 GB/T 26572 规定的限量要求。



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产品使用后,要废弃在环保使用年限内或者刚到年限的产品,请根据国家标准采取适当的方法进行处置。

另外,此期限不同于质量/功能的保证期限。

Warranty

This product has been manufactured under strict quality management, but should it develop problems within one year of the date of purchase in normal use, repair shall be performed free of charge. Please contact the agent where you purchased the product or Mitutoyo sales representative (☎ "SERVICE NETWORK" on page App-1). This warranty, however, shall not affect any provisions of the Mitutoyo Software End User License Agreement.

If this product fails or is damaged for any of the following reasons, it will be subject to a repair charge, even if it is still under warranty.

- Failure or damage owing to fair wear and tear
- Failure or damage owing to inappropriate handling, maintenance or repair, or to unauthorized modification
- Failure or damage owing to transport, dropping, or relocation of the product after purchase
- Failure or damage owing to fire, salt, gas, abnormal voltage, lightning surge, or natural disaster
- Failure or damage owing to use in combination with hardware or software other than those designated or permitted by Mitutoyo
- Failure or damage owing to use in ultra-hazardous activities

This warranty is effective only where the product is properly installed and operated in conformance with the instructions in this document within the original country of the installation.

EXCEPT AS SPECIFIED IN THIS WARRANTY, ALL EXPRESS OR IMPLIED CONDITIONS, REPRESENTATIONS, AND WARRANTIES OF ANY NATURE WHATSOEVER INCLUDING, WITHOUT LIMITATION, ANY IMPLIED WARRANTY OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, NONINFRINGEMENT OR WARRANTY ARISING FROM A COURSE OF DEALING, USAGE, OR TRADE PRACTICE, ARE HEREBY EXCLUDED TO THE MAXIMUM EXTENT ALLOWED BY APPLICABLE LAW.

You assume responsibility for all results due to the selection of this product to achieve your intended results.

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The foregoing limitations shall apply even if the above-stated warranty fails of its essential purpose. BECAUSE SOME COUNTRIES, STATES OR JURISDICTIONS DO NOT ALLOW THE EXCLUSION OR THE LIMITATION OF LIABILITY FOR CONSEQUENTIAL OR INCIDENTAL DAMAGES, IN SUCH COUNTRIES, STATES OR JURISDICTIONS, MITUTOYO'S LIABILITY SHALL BE LIMITED TO THE EXTENT PERMITTED BY LAW.

1 Overview

This chapter describes the features of this product, the names and functions of the parts, and the flow of the main tasks to use this product.

1.1 Features	9
1.2 System Configuration and Name of Each Part.....	9
1.3 The Flow of Main Tasks	11

1.1 Features

The optical separate type linear scale detects changes in the amount of light using light emitting elements and light receiving elements based on the glass scale grids and outputs the amount of changes. This can precisely measure moving amounts of various instruments including an aligner, wire bonding, and stage for semiconductor manufacturing.

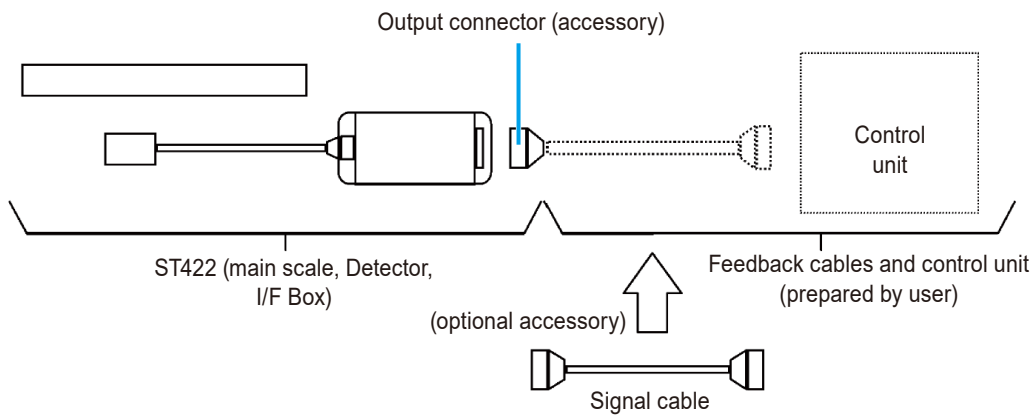
This product is a high-precision separate type linear scale with indication accuracy $\pm 1.0 \mu\text{m}$ (effective length of up to 300 mm). With successful reduction in Detector thickness to 7.5 mm and support for the maximum effective length of 3000 mm, it can be used even for large machines. It is also equipped with the LED Display function for signal errors.

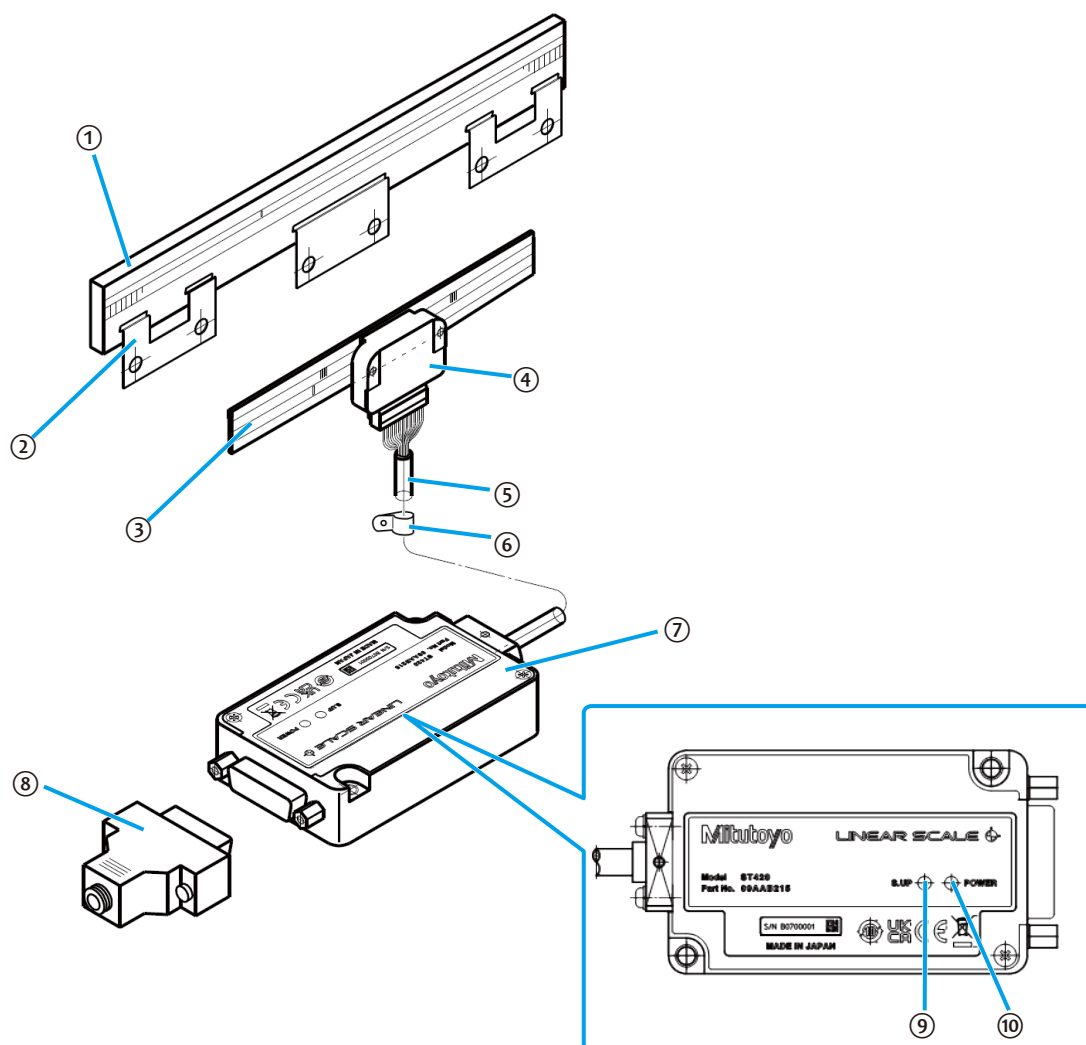
The following two output signal types are available in this product:

- Two-phase sine wave
- Two-phase square wave

1.2 System Configuration and Name of Each Part

The system configuration and the name of each part are shown below.



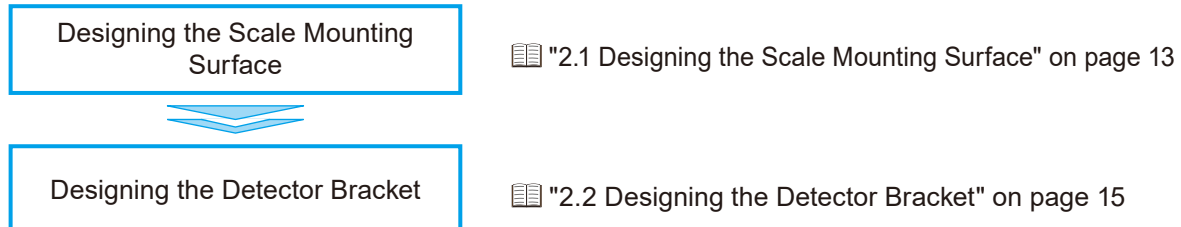


No.	Name
①	Main scale (effective length: 400 mm–3000 mm)
②	Scale retaining spring
③	Main scale (effective length: 10 mm–350 mm)
④	Detector
⑤	Detector cable
⑥	Cable clamp
⑦	I/F Box
⑧	Output connector
⑨	S.UP light
⑩	POWER light

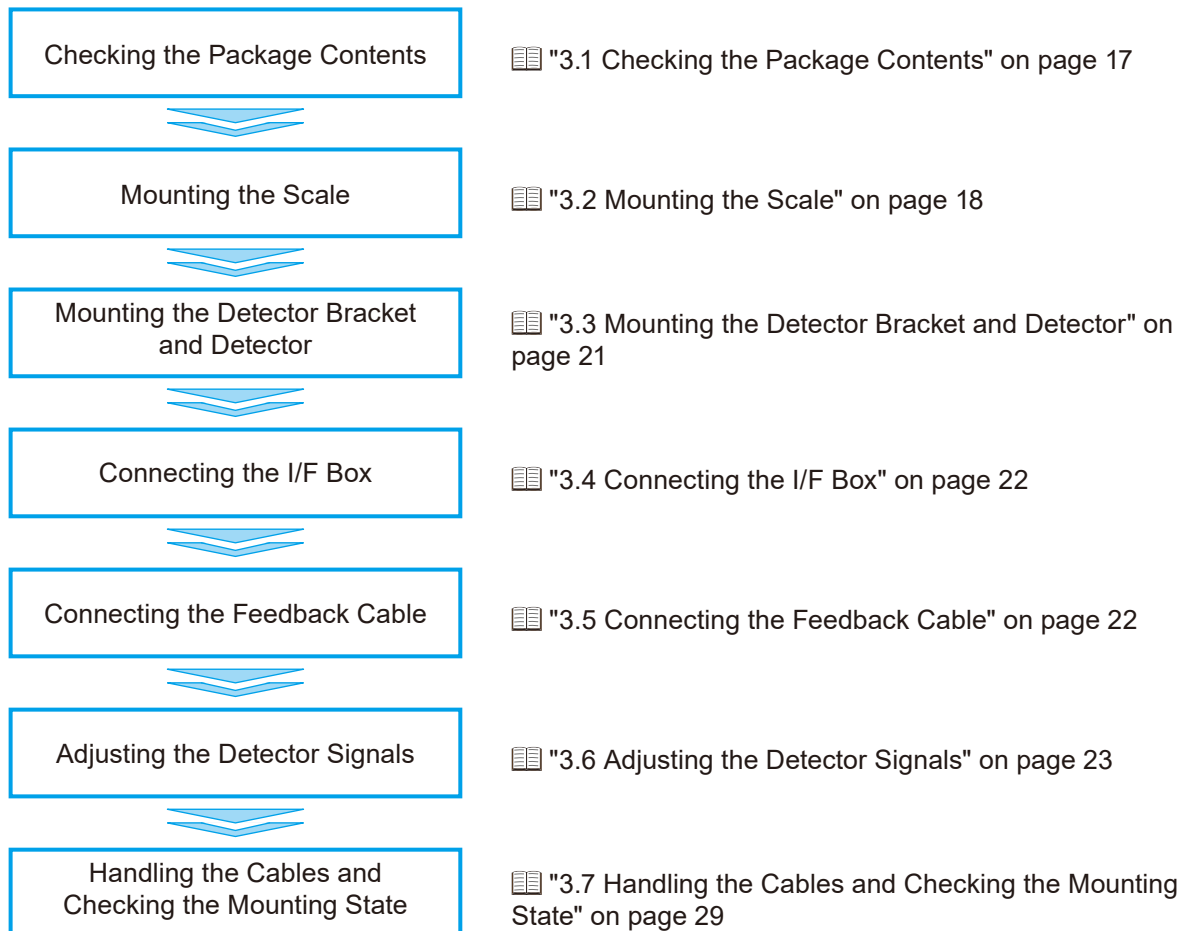
1.3 The Flow of Main Tasks

The following chart shows the flow of preliminary preparation and installation onto the machine main unit as tasks to use this product.

■ Preliminary preparation



■ Installation onto the machine main unit



MEMO

2 Preparation for Installation

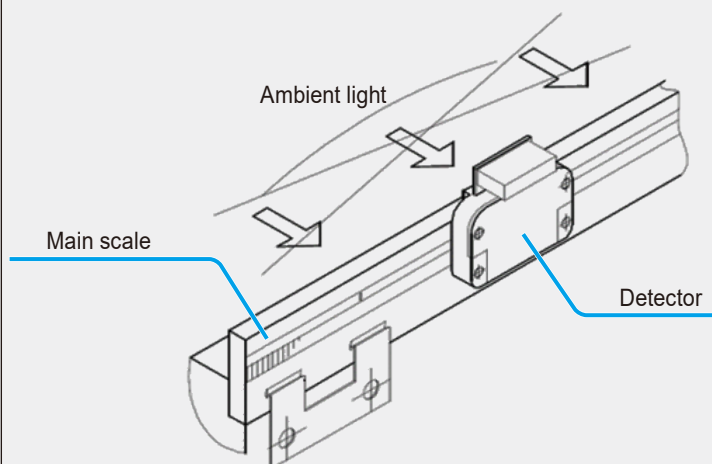
This chapter describes the preliminary preparation for installing this product onto the machine main unit.

2.1 Designing the Scale Mounting Surface	13
2.2 Designing the Detector Bracket	15

2.1 Designing the Scale Mounting Surface



If ambient light enters the main scale from the back side, it causes a malfunction. Design the main scale mounting area to prevent ambient light as shown in the figure below.



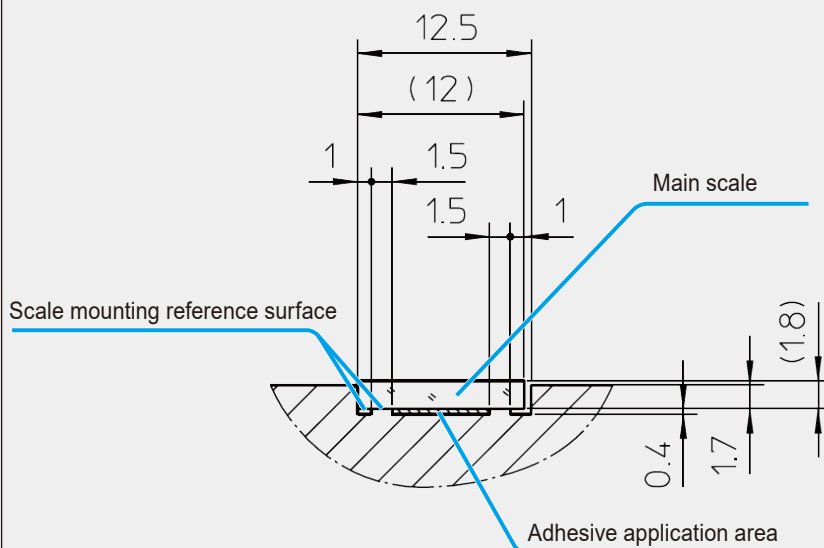
2.1.1 Mounting the Scale with the Effective Length of 10 mm–350 mm (Adhesive Fixing Type)

Mount the main scale with the effective length of 10 mm–350 mm (adhesive fixing type) by fixing with adhesives.

2 Preparation for Installation



Design the main scale mounting area as shown in the figure below according to 4.11.1 Effective Length of 10 mm–350 mm" on page 48.

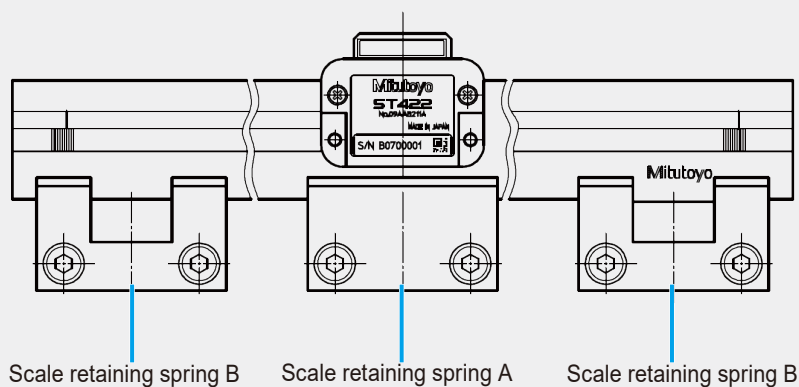


2.1.2 Mounting the Scale with the Effective Length of 400 mm–3000 mm

Mount the main scale with the effective length of 400 mm–3000 mm by fixing with scale retaining springs.



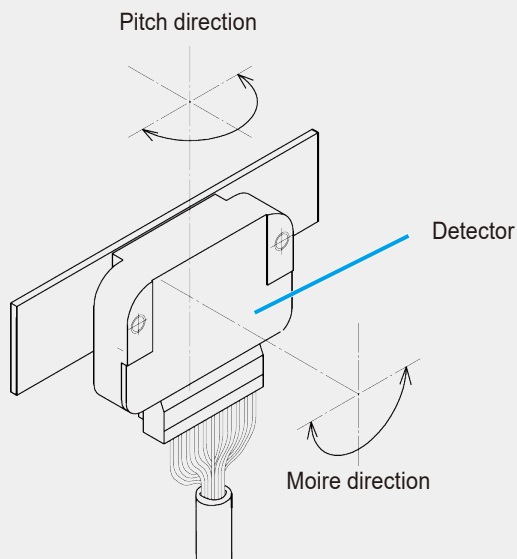
Secure working space for tightening the scale retaining spring A and scale retaining spring B according to 4.11.2 Effective Length of 400 mm–3000 mm" on page 49.



2.2 Designing the Detector Bracket



- Design the Detector bracket according to the figure below. Its shape must allow adjustment of the Detector position (moire/pitch). It is recommended that the Detector fixing screw holes should be long holes to make it easier to adjust the Detector position.



- Design it so that the parallelism of the Detector mounting surface against the scale mounting surface is within 0.05 mm.

MEMO

3 Installation onto the Machine Main Unit

This chapter describes the procedures, methods, and precautions required when mounting this product onto the machine main unit.

3.1	Checking the Package Contents.....	17
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3.6	Adjusting the Detector Signals	23
3.7	Handling the Cables and Checking the Mounting State	29

3.1 Checking the Package Contents

Before installation, make sure that the product package contains the following items.

If your scale does not satisfy the specified specifications or you have any questions or concerns about the product, please contact the agent where you purchased the product or Mitutoyo sales representative.

Name	Quantity	Note
Main scale	1	Check the effective length.
Detector + I/F Box	1	
Scale retaining spring		This accessory comes with the scale with the effective length of 400 mm or more. For details on the quantity, see  "4.11.2 Effective Length of 400 mm–3000 mm" on page 49.
Output connector	1	
Cable clamp	1	For head cable fixing
Serial number sticker	1	This accessory comes with the scale with the effective length of 10 mm–350 mm.
User's Manual	1	This document
Inspection certificate	1	
Warranty card	1	

IMPORTANT

To mount the scale with the effective length of 400 mm–3000 mm, prepare the following parts.

Part name	Quantity
Hex socket head cap screw (M4 x 0.7 x bottom hole size or less)	Number of scale retaining springs x 2
Spring washer (nominal 4)	Number of scale retaining springs x 2
Plain washer (nominal 4)	Number of scale retaining springs x 2

3.2 Mounting the Scale

NOTICE

The main scale is made of glass. Be very careful that the scale is not damaged or scratched.



- If dirt and dust are attached to the main scale, it causes a malfunction or deteriorates the accuracy. Wipe off the dirt and dust with a soft cloth soaked in alcohol or cleaning paper. Similarly, clean the scale mounting surface of the machine unit thoroughly with alcohol.
- Use elastic adhesives to attach the main scale with the effective length of 10 mm–350 mm (adhesive fixing type). Shin-Etsu Silicone's KE441T or Cemedine's EP001 is recommended.

IMPORTANT

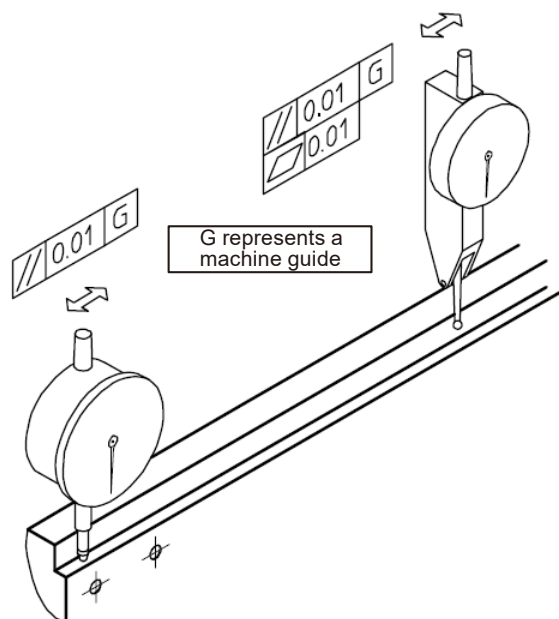
- Conduct temperature leveling thoroughly for both the main scale and mounting parts before fixing them. The accuracy of this product is guaranteed at 20 °C. The recommended temperature leveling is about 8 hours or longer at 20 °C for both the main scale and parts for mounting the scale. Perform installation after temperature leveling.
- If the temperature environment is insufficient, including temperature leveling, the predetermined indication accuracy may not be achieved.

- 1** Make sure that the scale mounting surface is prepared as shown below using a lever-type dial indicator or electric micrometer.

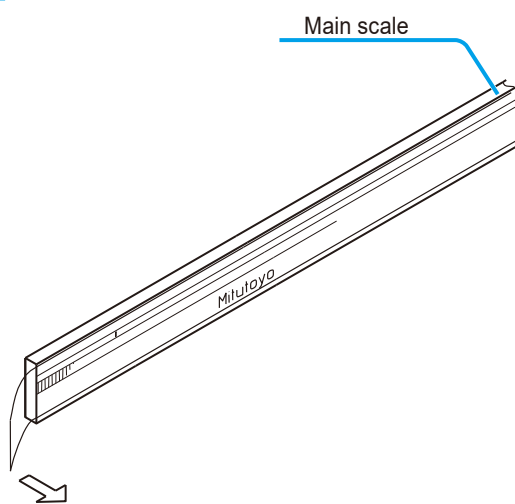


- Check the parallelism of the main scale mounting surface against the axis of motion of the machine unit.
- If the parallelism is insufficient, adjust the machine unit again.

3 Installation onto the Machine Main Unit



2 Peel the scale protection tape.

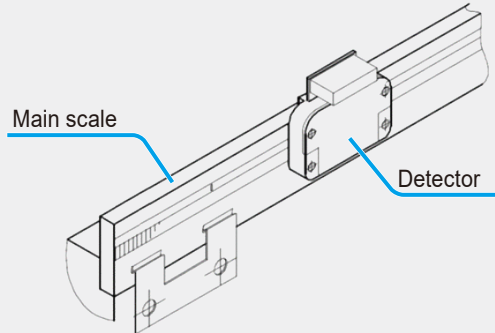


Peel the scale protection tape.

3 Mount the main scale.



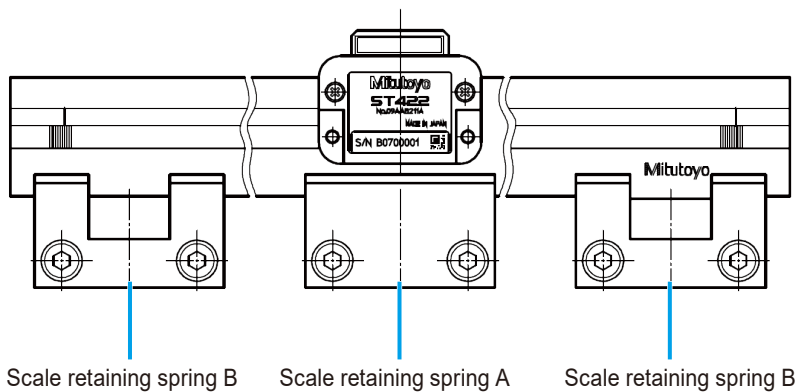
- Mount the main scale so that the Detector is placed on the grid surface (surface where rainbow colors appear when light is applied diagonally).
- For a scale with the Mitutoyo logo attached, the correct mounting direction is where the logo can be appropriately viewed from the Detector side.



- Put the serial number sticker near the location where the scale is mounted on the machine for the main scale with the effective length of 10 mm–350 mm (adhesive fixing type).

■ Installation using the scale retaining springs

1 Temporarily fix the center of the main scale with the scale retaining spring A.



2 Temporarily fix the main scale with the scale retaining springs B.



This must be performed in the order closer to the center of the main scale.

3 Conduct temperature leveling for 1 to 2 hours.

4 Fully tighten the bolts for scale retaining springs in the order from the center to both ends of the main scale.

3.3 Mounting the Detector Bracket and Detector

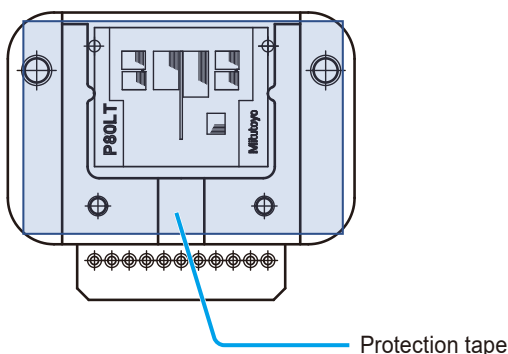
NOTICE

Do not directly touch the I/F Box pins during installation. Otherwise, electronic parts may be damaged by static electricity. Be sure to take measures to prevent static electricity for installation.



To use the scale with the Detector mounted, the machine main unit, as well as the attachment bracket, must be electrically grounded. Failure to do so may cause the scale unit and the Detector to be affected by external noise.

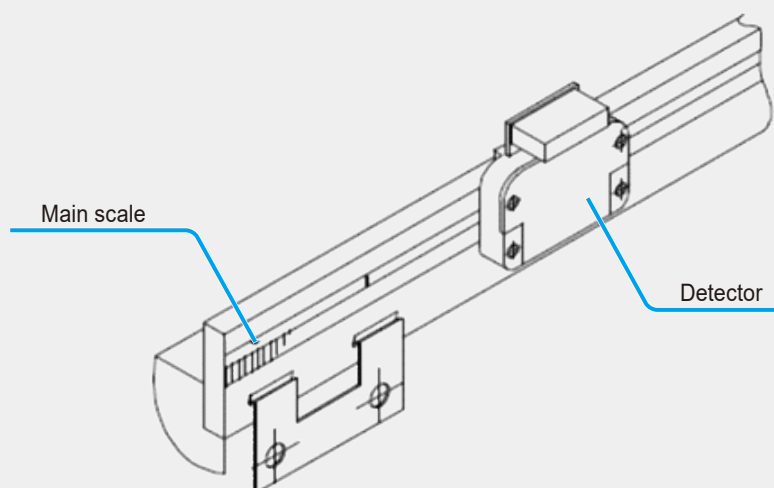
- 1 Peel the protection tape (blue) off the detecting surface of the Detector.



- 2 Attach the Detector to the Detector bracket.

IMPORTANT

Adjust the distance (gap) between the Detector and main scale to 1.2 mm.



- 3 Check the parallelism of the Detector against the main scale with a lever-type dial indicator or electric micrometer.**



The parallelism of the Detector against the main scale must be within 0.05 mm.

- 4 Fix the Detector.**

3.4 Connecting the I/F Box

- 1 Connect the detector cable connector to the Detector.**



Do not insert the Detector cable connector upside down.

3.5 Connecting the Feedback Cable



- Be sure to turn off the control unit before connecting the scale unit to the control unit with a feedback cable.
- A feedback cable must be prepared by the user. Find a cable that supports your model according to  "4.5 Production of Feedback Cable" on page 41.

- 1 Connect the I/F Box to the control unit with the feedback cable.**

- 2 Turn on the control unit.**

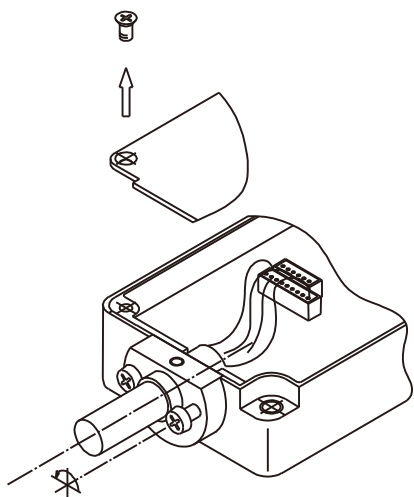
» The POWER light on the I/F Box turns on.

3.6 Adjusting the Detector Signals

After mounting the main scale and Detector and connecting the Detector cable and feedback cable, adjust the Detector signals.

3.6.1 Adjusting the Detector Mounting Position

- 1 Remove the two screws and remove the I/F Box cover.

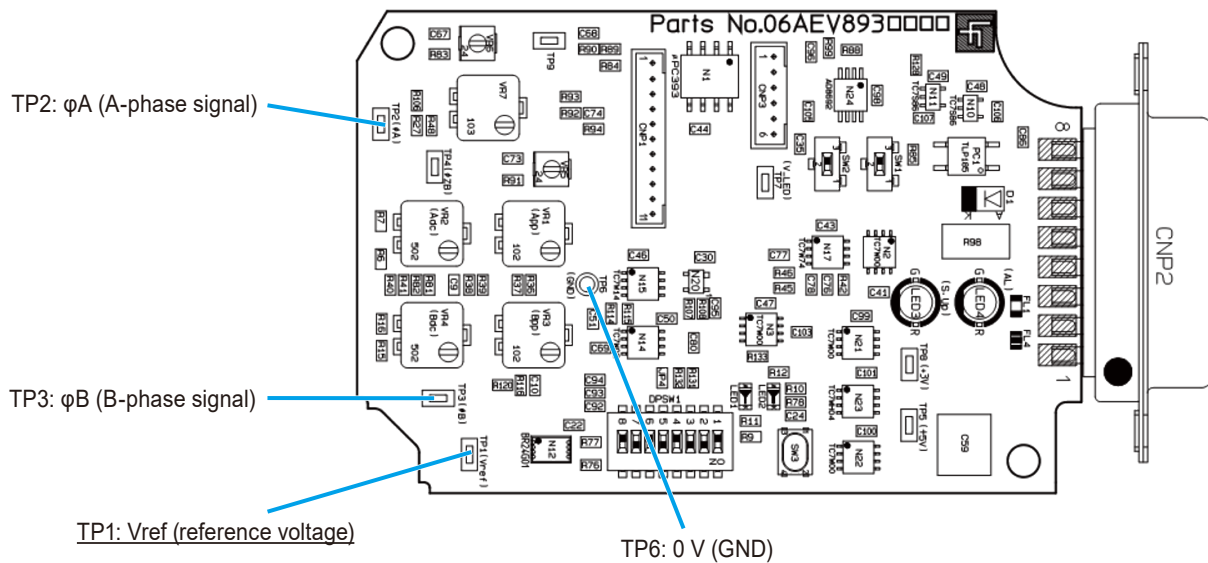


- 2 Set the oscilloscope as follows.

Item	Setting description
Measurement pressure range	0.5 V/div (50 mV/div when using a 10:1 probe)
Scan mode	X-Y

- 3 Clip the two oscilloscope probes to TP1: Vref (reference voltage) on the I/F Box, and the oscilloscope GND probe to TP6: 0 V (GND) on the I/F Box.

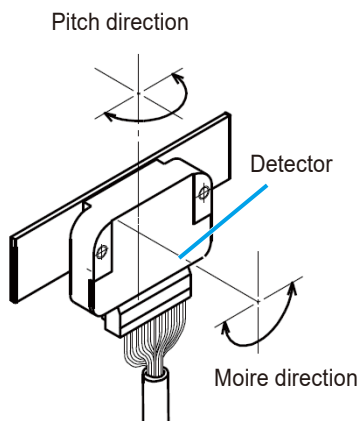
■ Main signal output type: A (two-phase sine wave)



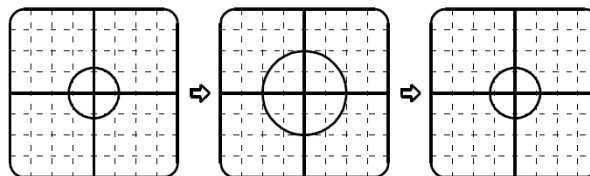
4 Adjust the horizontal/vertical positioning knob so that the oscilloscope's bright line is located in the center.

5 Clip the ch1 probe to TP2: ϕA (A-phase signal) and ch2 probe to TP3: ϕB (B-phase signal).

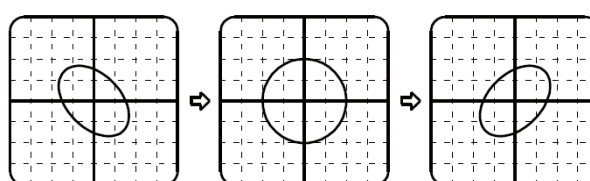
6 Adjust the moire direction and pitch direction of the Detector by moving the main scale or Detector to maximize the Lissajous waveform.



Lissajous waveform change during moire direction adjustment



Lissajous waveform change during pitch direction adjustment



Tips

- If the specified output signal cannot be obtained by adjusting the mounting position of the Detector, make electrical adjustments to obtain the specified output signal. The amplitude voltage (V_{pp}) and center voltage (V_{dc}) of the Lissajous waveform can be further fine-adjusted by electrical adjustments. For details on electrical adjustments, see ["3.6.2 Adjusting the Signals"](#) on page 25.
- Make sure that the oscilloscope does not drift during measurement. If drift occurs, readjust the oscilloscope's bright line.

7 Fix the Detector.

3.6.2 Adjusting the Signals

■ Adjusting the main signals

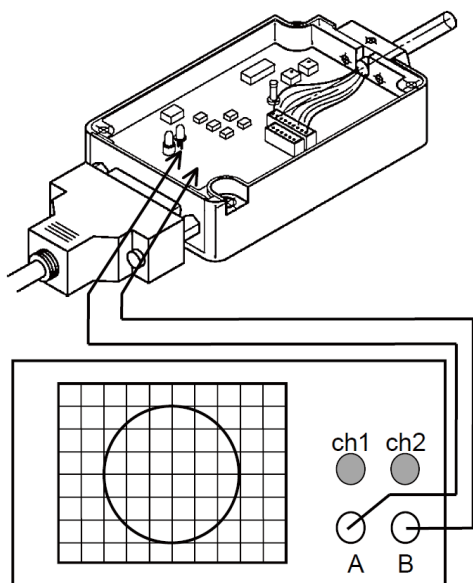
1 Set the oscilloscope as follows.

Item	Setting description
Measurement pressure range	0.5 V/div DC mode (50 mV/div when using a 10:1 probe)
Scan mode	X-Y

2 Clip the two oscilloscope probes to TP1: Vref (reference voltage) on the I/F Box, and the oscilloscope GND probe to TP6: 0 V (GND) on the I/F Box.

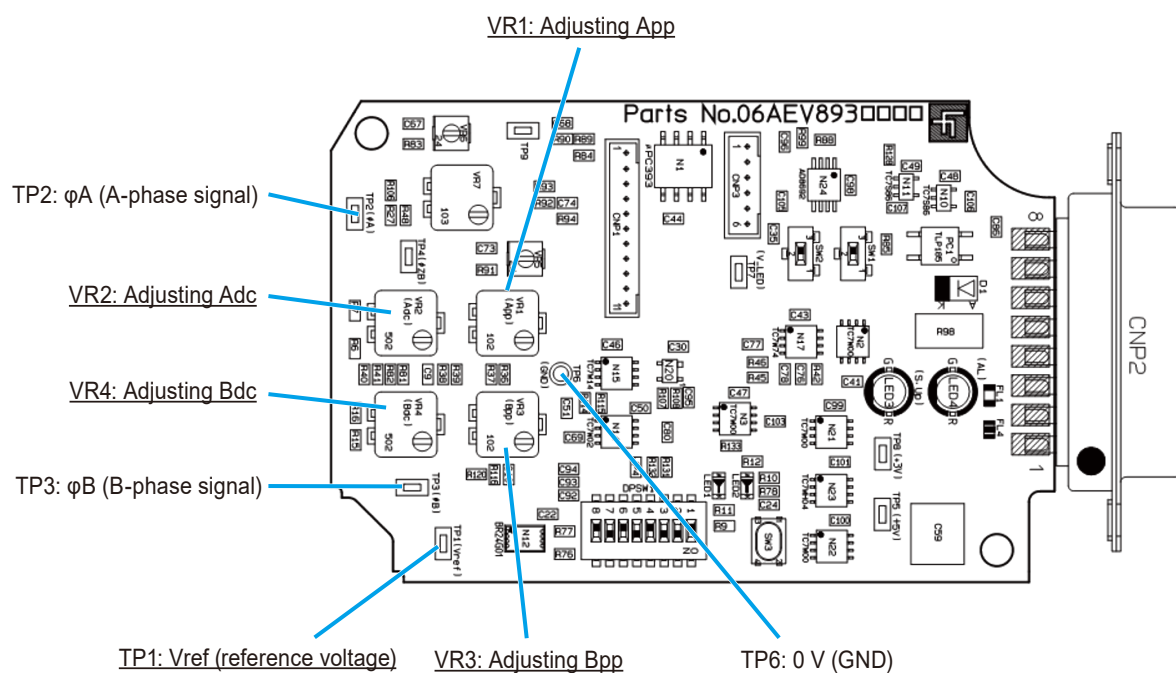
3 Adjust the horizontal/vertical positioning knob so that the oscilloscope's bright line is located in the center.

4 Clip the ch1 probe to TP2: ϕA (A-phase signal) and ch2 probe to TP3: ϕB (B-phase signal).



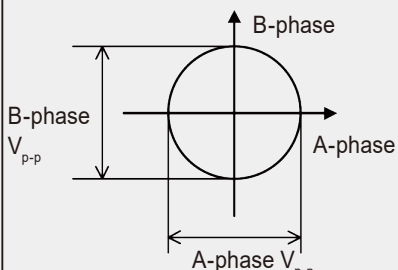
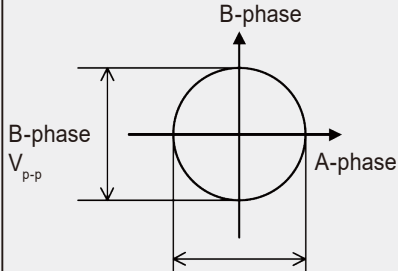
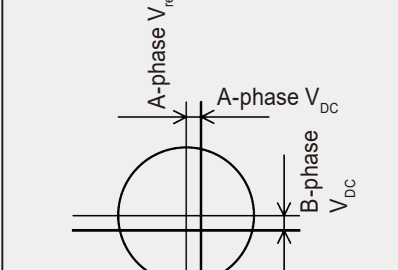
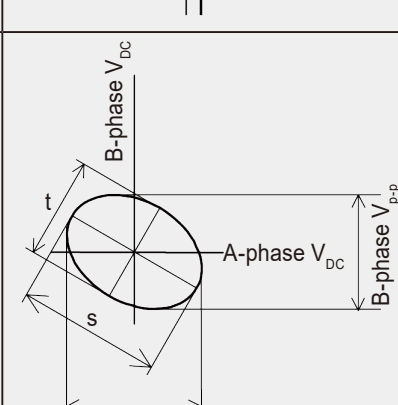
5 Adjust the main signals with volume VR1–VR4 on the board while moving the Detector.

Volume name	Adjustment description
VR1	Fine-adjust the magnitude (Vpp: amplitude voltage) of A-phase (horizontal axis).
VR2	Fine-adjust the position (Vdc: center voltage) of A-phase (horizontal axis).
VR3	Fine-adjust the magnitude (Vpp: amplitude voltage) of B-phase (vertical axis).
VR4	Fine-adjust the position (Vdc: center voltage) of B-phase (vertical axis).



IMPORTANT

- Adjust the main signal so that it is within the following specified values.

Item	Lissajous waveform	Reference value	Note
Amplitude voltage (Vpp)		$2.0 \pm 0.2 \text{ V}$	This value changes due to an adjustment error in the gap amount (between the Detector and main scale), parallelism, and moiré angle. VR1: A-phase VR3: B-phase
Mutual difference of amplitude voltages (B-phase Vpp minus A-phase Vpp)		$0 \pm 0.2 \text{ V}$	Same as the above
Center voltage		$[V_{ref}] \pm 0.1 \text{ V}$	Same as the above VR2: A-phase VR4: B-phase
Phase error (ϕ)		$0 \pm 10^\circ$	

- Calculate the phase error (ϕ) from t/s (ratio of major axis to minor axis) shown in the figure above.

Phase error	0°	2°	4°	6°	8°	10°
t/s	1.000	0.966	0.933	0.901	0.871	0.841

- Make sure that the oscilloscope does not drift during measurement. If drift occurs, readjust the oscilloscope's bright line.

■ Adjusting the origin signals

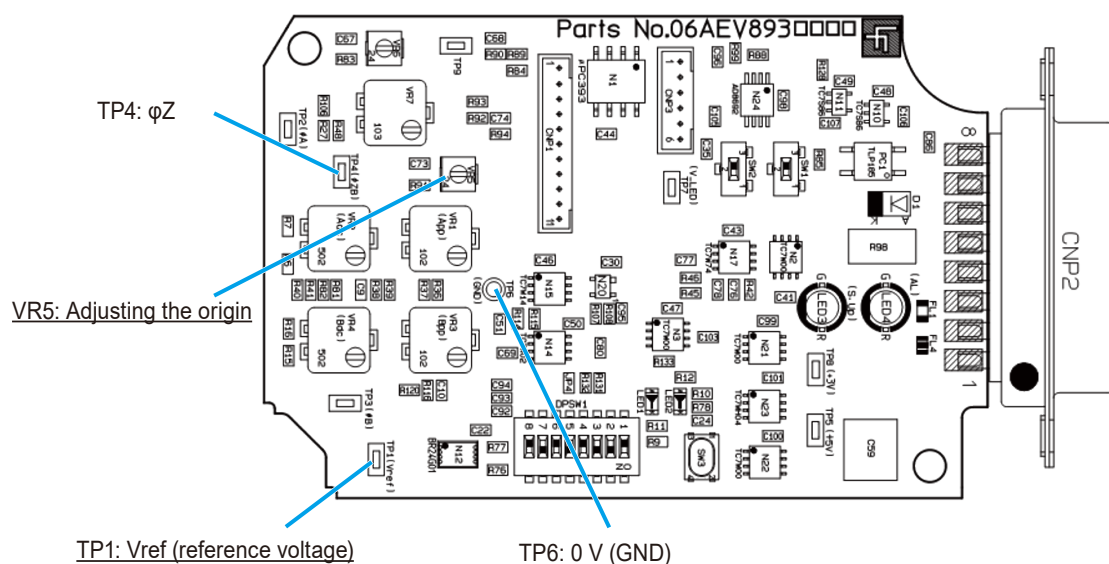


- If the scale has multiple origins, adjust the origin signals at the origin (one position) you use.
- Use the Detector and I/F Box with the same serial number.

1 Set the oscilloscope as follows.

Item	Setting description
Measurement pressure range	0.5 V/div DC mode (50 mV/div when using a 10:1 probe)
Scan mode	T-Y 20 ms

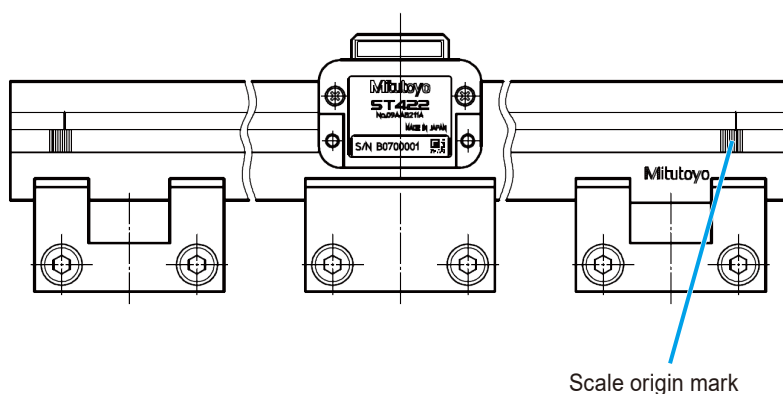
2 Clip the two oscilloscope probes to TP1: Vref (reference voltage) on the I/F Box, and the oscilloscope GND probe to TP6: 0 V (GND) on the I/F Box.



3 Adjust the horizontal/vertical positioning knob so that the oscilloscope's bright line is located in the center.

4 Clip the ch1 probe to TP4: φZ.

5 Move the center of the Detector to near the scale origin mark on the main scale.



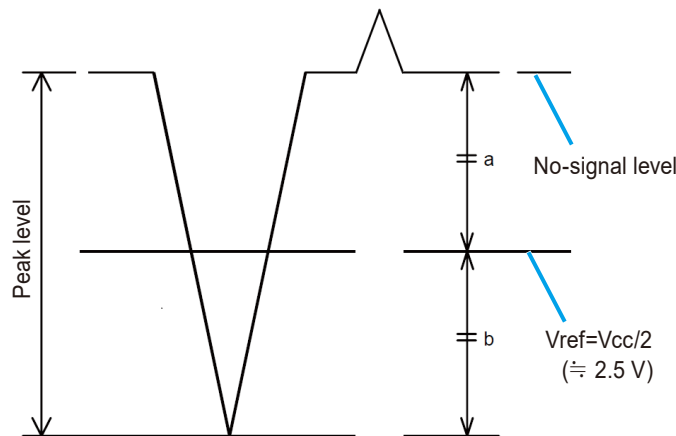
6 Move the scale or Detector in the measurement direction.

- » When the vicinity of the center of the Detector passes through the origin mark, the origin signal waveform is displayed on the oscilloscope screen.

7 Adjust the origin signals.

Tips

- The peak level and no-signal level of the origin signal are changed with VR5.
- The no-signal level of the origin signal is changed with VR6.



Adjustment standard value: $\frac{a}{b} = 0.9 \text{ to } 1.1$ $a, b = 0.4 \text{ V or more}$

3.7 Handling the Cables and Checking the Mounting State

3.7.1 Handling the Cables

After adjusting the signals, fix the Detector cable, I/F Box and feedback cable.

1 Perform wiring paying attention to the twisting or bends of the cables.

NOTICE

- Note that the feedback cable may malfunction if bundled with other cables that may cause electrical noise, or if it is located near a switching relay dealing with a large current.
- The bend radius of the Detector cable and feedback cable should be as follows.

Fixing the Detector (fixing the Detector cable and feedback cable)	Radius 50 mm or greater
Detector movement (repetitive flexing of Detector cable and feedback cable)	Radius 100 mm or greater

Please contact your Mitutoyo sales representative for needs such as high-flexibility cables.

2 Fix the Detector cable, I/F Box and feedback cable with cable clamps.



Clamp the feedback cable to a nearby part that moves along with the Detector so that force is not applied to the Detector when the machine unit is running.



- Be sure to ground the exposed shield of the Detector cable with the supplied cable clamp.
- Be sure to fix the I/F Box enclosure to the machine main unit with screws.

3.7.2 Checking the Mounting and Adjustment States

After fixing the Detector cable, I/F Box and feedback cable, check the mounting and adjustment states of the main scale and Detector again.

Tips

Perform this operation while making sure that the Detector does not make contact or interfere with any part of the machine unit or main scale.

1 Make sure that all the part screws and clamps are firmly tightened.

2 Turn off the control unit and turn it on again after 5 to 10 seconds.

Tips

Turning off the control unit resets the alarm that occurred during adjustment.

3 Make sure that the input power voltage is $5\text{ V} \pm 5\%$ at TP5: +5 V (power supply voltage) and TP6: 0 V (GND) on the I/F Box board.

4 Make sure that the output signals are within the specified values throughout the entire travel range of the machine unit.

Tips

If the specified values are not satisfied, check again if the main scale is dirty, fine-adjust the Detector position, and electrically fine-adjust the signals.

5 Make sure that no control unit alarm occurs throughout the entire travel range of the machine unit.

6 Remove the oscilloscope probes.

7 Attach the I/F Box cover with the two screws.

3.7.3 Putting the Protection Cover

After checking the mounting and adjustment states of the main scale and Detector again, put the protection cover.



- Make sure that the protection cover does not make contact with any machine unit part or scale unit cable.
- Check the above for the entire travel range of the machine unit.

MEMO

4 Specifications

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4.9 Maximum Response Speed	47
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4.1 Specifications

Item	Specifications
Detection method	Reflective photoelectric linear encoder
Main scale grid pitch	40 μm
Main signal (sine wave) output pitch	40 μm
Output signal type	90° phase difference two-phase sine wave and two-phase square wave, scale origin, alarm signal
Effective length	10 mm–3000 mm
Indication accuracy (20 °C)	Effective length of 10 mm–300 mm: $\pm 1.0 \mu\text{m}$ Effective length of 350 mm–500 mm: $\pm 2.0 \mu\text{m}$ Effective length of 600 mm–1000 mm: $\pm 3.0 \mu\text{m}$ Effective length of 1100 mm–3000 mm: $\pm 3.0 \mu\text{m/m}$
Coefficient of linear expansion	$(8 \pm 1) \times 10^{-6} / ^\circ\text{C}$
Resolution	5 μm , 1 μm , 0.5 μm , 0.2 μm (switchable)
Minimum edge-to-edge interval	125 ns, 250 ns, 500 ns, 1000 ns (switchable)
Maximum response speed	2000 mm/s (at two-phase sine wave output) For a two-phase square wave, the value changes depending on the resolution as follows (when the minimum edge-to-edge interval is 125 ns): 5 μm : 5000 mm/s 1 μm : 5000 mm/s 0.5 μm : 3600 mm/s 0.2 μm : 1500 mm/s
Scale origin	Available (50 mm pitch, center point for effective length of 10 mm–75 mm)

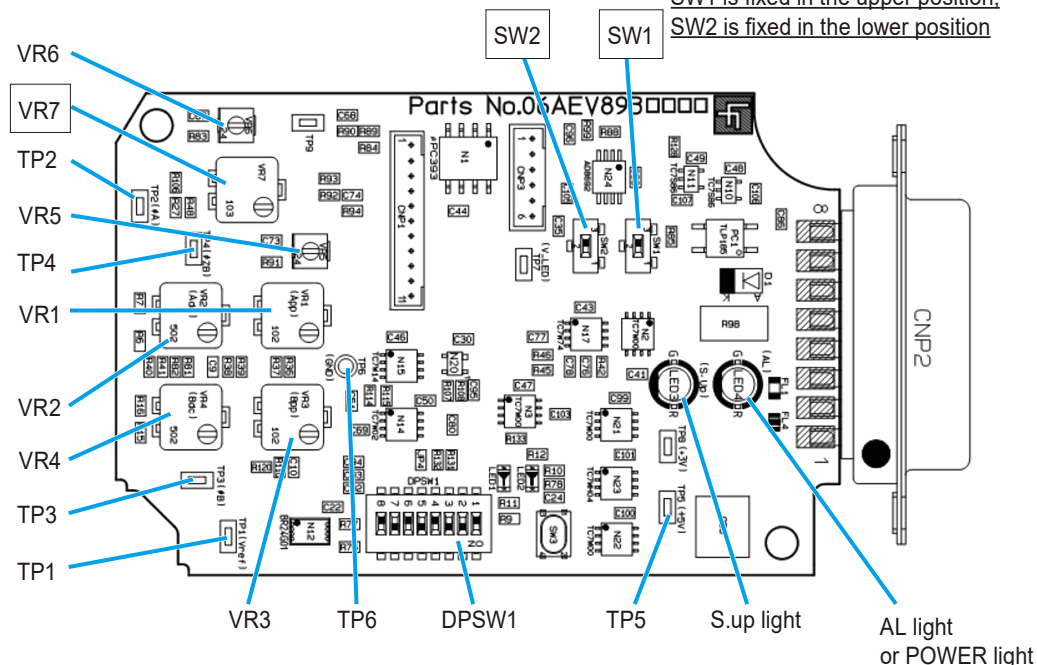
4 Specifications

Response speed at scale origin detection	20 mm/s
Power supply voltage	DC5 V±5 %
Maximum current consumption	250 mA
Used temperature range	0 °C–40 °C
Storage temperature range	-20 °C–60 °C
Used/storage humidity range	20 %RH–80 %RH (non condensation)
Alarm Display function	A scale unit alarm is indicated with a LED on the I/F Box.
Detector cable length	1 m (cable length between Detector and I/F Box)
Signal cable length (option)	Standard: 3 m
Detector mass	Approx. 10 g
Interface mass	Approx. 170 g (including Detector cable)
CE marking/UKCA marking	EMC Directive/Electromagnetic Compatibility Regulations: EN61326-1 Immunity test requirement: Clause 6.2 Table 2 Emission limit: Class B RoHS Directive/The Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations: EN IEC 63000

4.2 Placement of Check Pins, Volumes and Switches in the I/F Box

VR7 is fixed
(not adjustable)

SW1 is fixed in the upper position.
SW2 is fixed in the lower position



● Check pins

Check pin name	Signal	Signal description
TP1	Vref	Reference voltage (approx. 2.5 V)
TP2	ϕA	A-phase signal
TP3	ϕB	B-phase signal
TP4	ϕZ	Z-phase input signal
TP5	+5 V	Power supply voltage
TP6	0 V	GND

● Volumes

Volume name	Signal adjusted	Description
VR1	ϕApp	ϕ App voltage adjustment
VR2	ϕAdc	ϕ Adc voltage adjustment
VR3	ϕBpp	ϕ Bpp voltage adjustment
VR4	ϕBdc	ϕ Bdc voltage adjustment
VR5	ϕZ	Peak level, no-signal level
VR6	ϕZ	No-signal level
VR7	—	Fixed (do not adjust)

● Switches

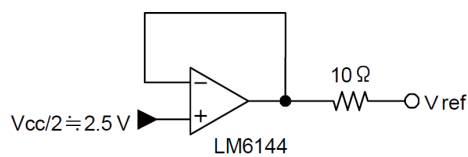
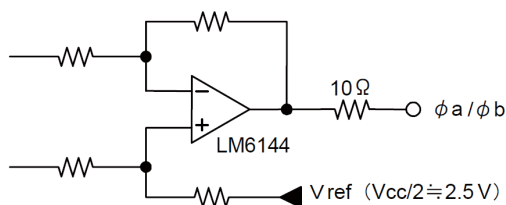
Switch name	Description
SW1	Fixed (non-switchable, fixed in upper position)
SW2	Fixed (non-switchable, fixed in lower position)
DPSW1	 See "4.8 Changing the Output Settings" on page 45.

4.3 Output Circuits and Signal Waveforms

4.3.1 Two-Phase Sine Wave

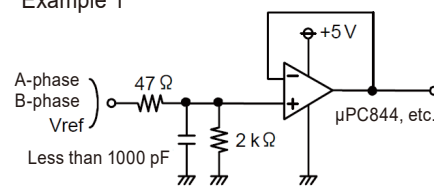
■ Output circuit

The following shows output circuits for the main signal sine wave (A-phase, B-phase) and reference voltage.

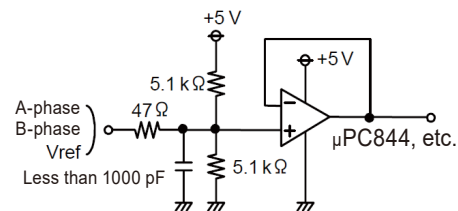


Main signal (A-phase, B-phase) recommended receiving circuit

Example 1

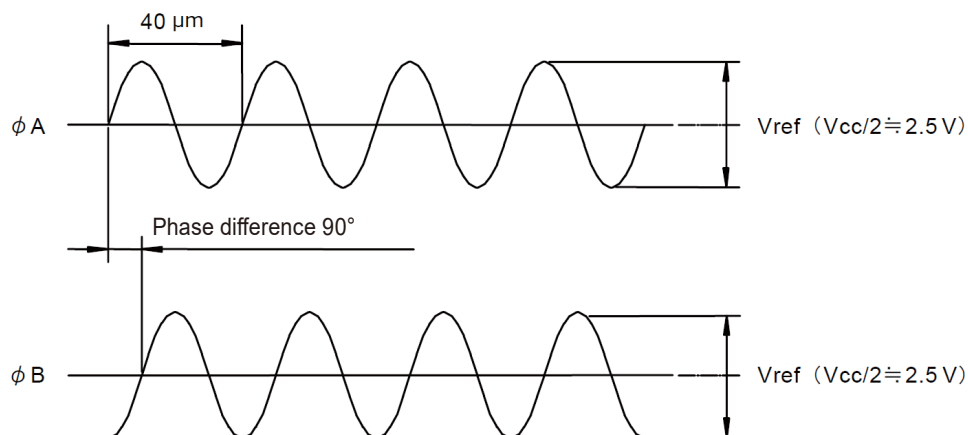


Example 2



■ Signal waveform

The following shows waveforms of the sine wave output signals (A-phase, B-phase).



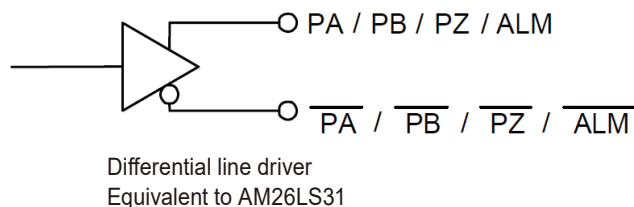
IMPORTANT

If the I/F Box is equipped with alarm reset input, no sine wave is output.

4.3.2 Two-Phase Square Wave

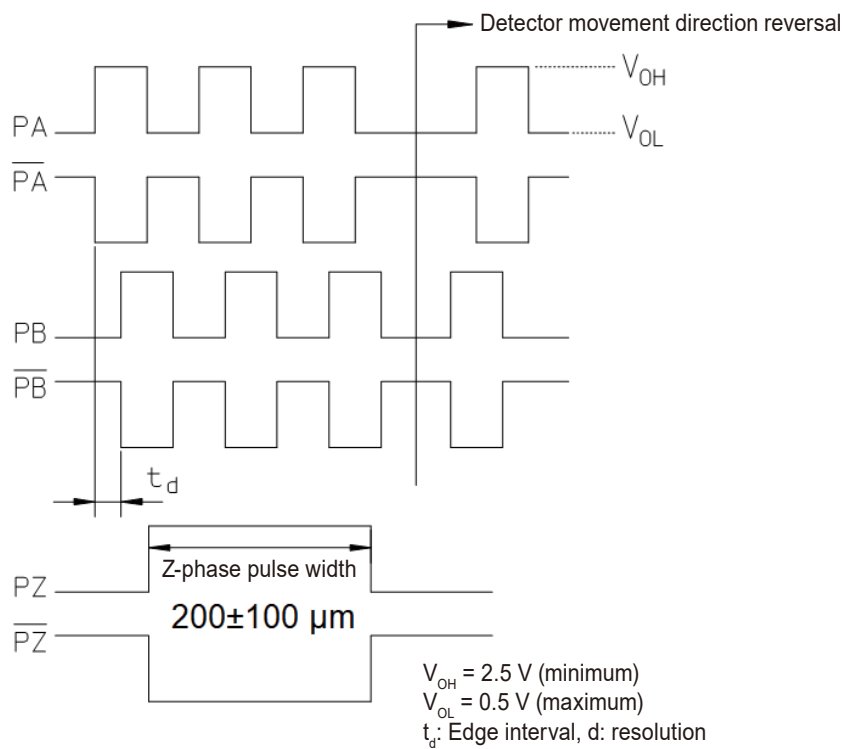
■ Output circuit

The following shows the output circuit for square wave output signals (A-phase, B-phase).



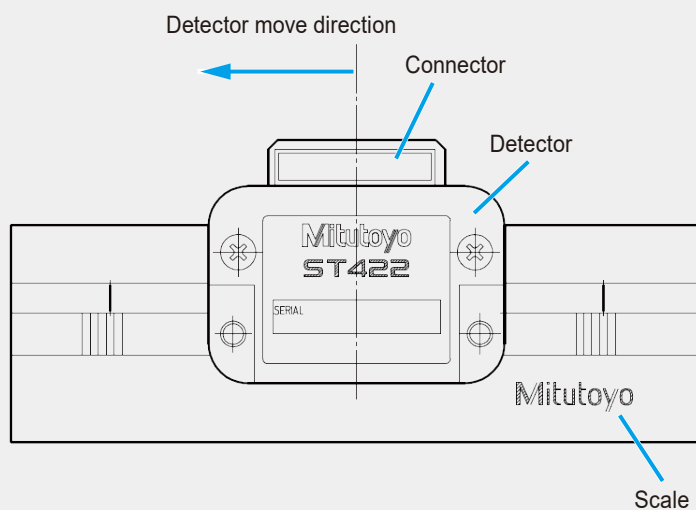
■ Signal waveform

The following shows waveforms of square wave output signals (A-phase, B-phase, and Z-phase).

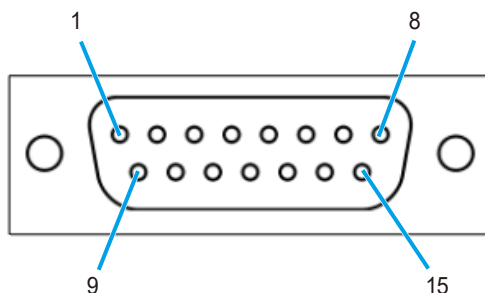


IMPORTANT

- A phase difference between PZ signal and PA signal (or PB signal) does not matter.
- The above figure shows waveforms when the Detector moves as follows with the switch 8 of the DIP switch DPSW1 in the I/F Box set to "Off".



4.4 Pin Assignment



Pin No.	Signal
1	0 V (GND)
2	0 V (GND)
3	+5 V (Vcc)
4	+5 V (Vcc)
5	A-phase (sine wave) (AL (anode) if equipped with alarm reset input)
6	B-phase (sine wave) (AL (cathode) if equipped with alarm reset input)
7	Vref ($\div$ Vcc/2)
8	PZ (scale origin)
9	ALM (alarm)
10	PA
11	$\overline{\text{PA}}$
12	PB
13	$\overline{\text{PB}}$
14	$\overline{\text{PZ}}$
15	F.G

IMPORTANT

- The output connector being used is RDBD-15P-LNA (05) (Hirose).
- The compatible plug (supplied accessory) is D15-403N110 (Chuo Musen Denki).

4.5 Production of Feedback Cable



The following conditions must be met for the feedback cable:

- Use a shielded cable.
- Clamp the shield (FG) to the metal case of the supplied connector. If it is difficult to clamp, connect it to pin No. 15.
- Set the cable impedance and length so that the power voltage is 4.75 V or more on the I/F Box.

$$V_{sp} - (R_c \div 3) \times L \times 2 \times 0.25 \geq 4.75 \text{ V}$$

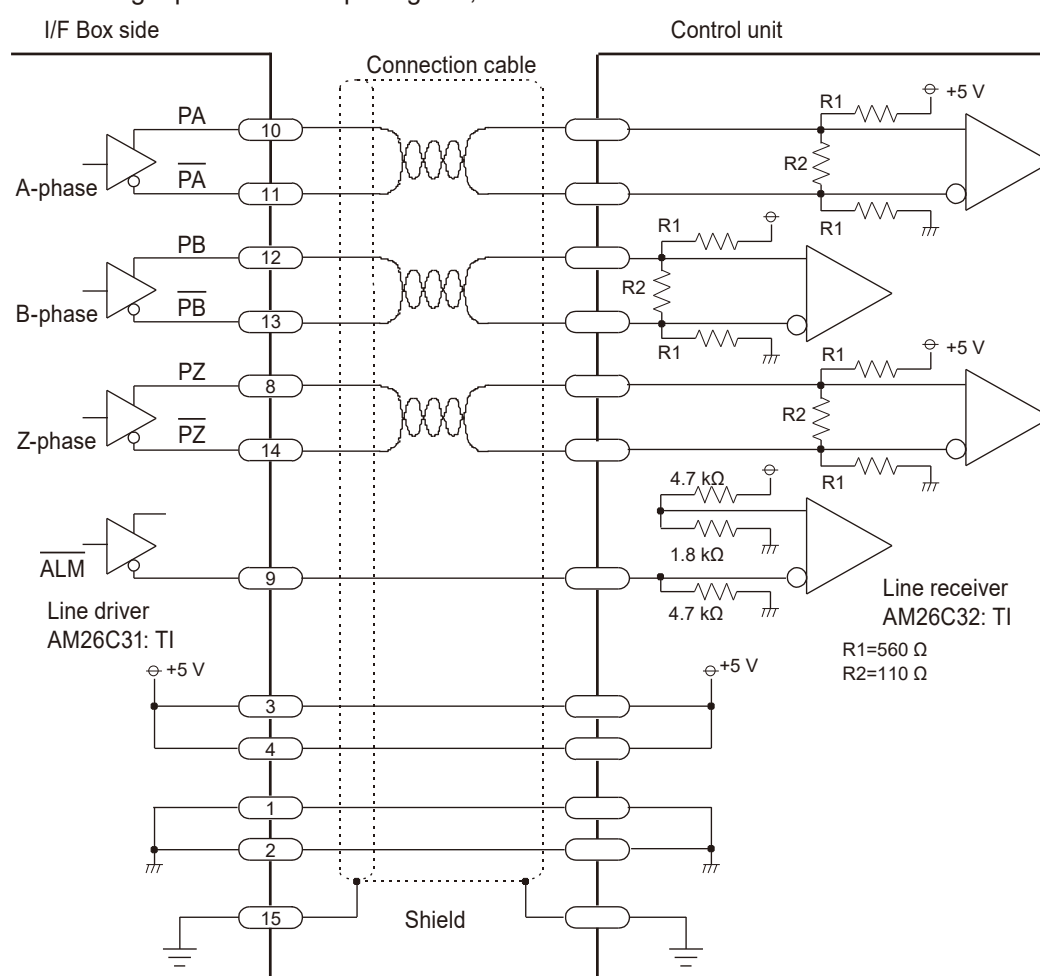
$$V_{sp}$$
: Power voltage supplied from the control unit (Volts)

$$R_c$$
: Cable power, ground wire impedance (Ω/m)

$$L$$
: Cable length (m)

$$0.25$$
: Maximum current consumption of the scale unit (A)

When using square wave output signals, connect the I/F Box to the control unit as shown below.



- When the control unit has the Disconnection Detection function for A-phase/B-phase (PA, $\overline{\text{PA}}$, PB, $\overline{\text{PB}}$), you do not need to connect the ALM output. In this case, turn on the switch 7 of the DIP switch DPSW1 on the I/F Box board to set the high impedance mode.
- If the control unit has no Disconnection Detection function or putting the A-phase/B-phase output in high impedance causes a problem for the system, connect the ALM output. In this case, turn off the switch 7 of the DIP switch DPSW1 on the I/F Box board to output the alarm signal.

For details on the DIP switch on the I/F Box board, see "4.8 Changing the Output Settings" on page 45.

4.6 Alarm Function

■ Detection details

● Over speed error

If the value exceeds the maximum response speed set in the minimum edge-to-edge interval and the number of divisions of the output pulse, the POWER light turns on in red.

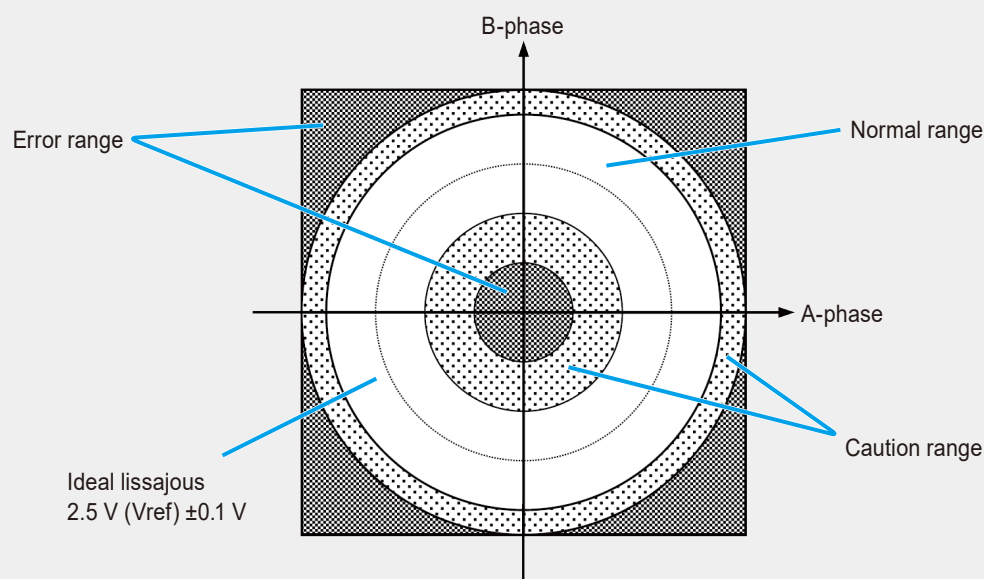
● Error signal detection

If the waveform of the sine wave signal input to the I/F Box is within the caution range or error range, the POWER light and S.UP (setup) light flash/turn on in red.

Range	S.UP light	POWER light	Alarm output
OK	Solid green	Solid green	None
Caution	Solid red	Solid green	None
Error	Off	Solid red	Available

IMPORTANT

- If the scale is used within the caution range, no alarm occurs, but the accuracy of division is reduced.
- In error signal detection, the LED indicates one of the three ranges - normal, caution, and error - for the waveform levels (too large or too small) of the input sine wave signal as shown below.



- The caution and error setting ranges are as follows.

range	Setting range (approximate value)
Caution	0.9 Vpp or less or 2.7 Vpp or more
Error	0.5 Vpp or less or 2.9 Vpp or more

- The above setting range is applied when the power voltage is 5.0 V. If the power voltage changes, the setting range also changes together with the input range in proportion to voltage.

Alarm behaviors

Item		Behavior
Line driver output	When the high impedance mode is on	All output is put in high impedance (not electrically H nor L but like floating).
	When the high impedance mode is off	The AL signal (active L) is output. However, others (PA, $\overline{PA}$, PB, $\overline{PB}$, PZ, $\overline{PZ}$) also continue to be output.
Alarm light		The POWER light changes from green to red.

Resetting the alarm

- Turning on the power again

1 Eliminate the cause of the alarm.

2 Turn off the control unit and turn it on again after 10 seconds or more.

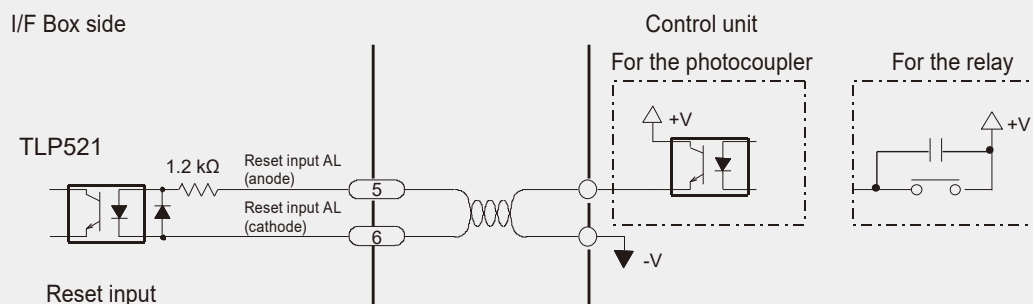
- Alarm reset signal

3 Eliminate the cause of the alarm.

4 Input the alarm reset signal (pulse width of 100 ms or more)

Tips

- Alarm reset by alarm reset signal is possible only if equipped with alarm reset input.
- Connect the alarm reset input circuit so that the current is 3 mA–10 mA.
- Since the product is equipped with a resistor (1.2 k Ω) inside, applying 5 V–12 V between the reset input AL (anode) and reset input AL (cathode) resets the alarm.

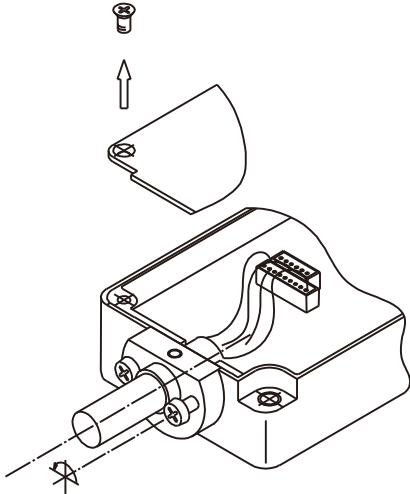


- To apply 12 V or more, add a resistor externally.

4.7 Removing the Detector Cable

When you need to replace the Detector or I/F Box, remove the Detector cable from the I/F Box.

- 1 Remove the two screws and remove the I/F Box cover.

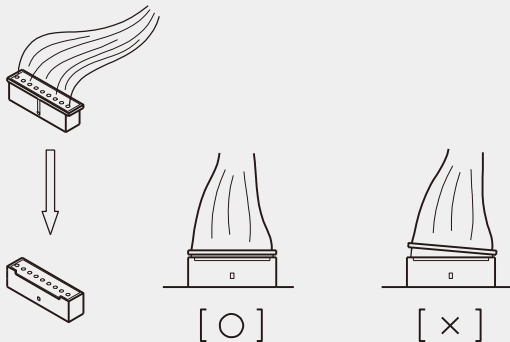


- 2 Loosen the two cable flange screws.

- 3 Pull the Detector cable from the connector on the board.

Tips

- To attach the Detector cable, perform the above procedure in reverse order.
- To insert the Detector cable into the connector on the board, make sure that it is inserted all the way in the correct connector notch direction.
- Firmly fix the two cable flange screws.
- If insertion into the connector or screw fixing is insufficient, it causes a malfunction.

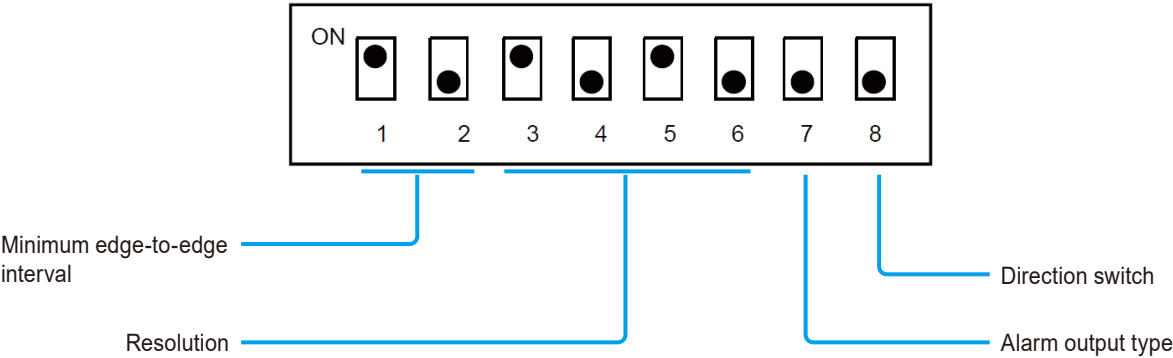


4.8 Changing the Output Settings



Do not change the settings of switches SW1 and SW2 on the I/F Box board.

You can change the output settings with the DIP switch DPSW1 on the I/F Box board.



■ Minimum edge-to-edge interval

Minimum edge-to-edge interval	1	2	Factory setting
125 ns	On	On	
250 ns	On	Off	●
500 ns	Off	On	
1000 ns	Off	Off	



The operation is not guaranteed for any other setting than the above.

■ Resolution

Resolution	3	4	5	6	Factory setting
0.2 μm	Off	Off	Off	On	
0.5 μm	Off	On	On	Off	
1.0 μm	On	Off	On	Off	●
5.0 μm	On	Off	Off	Off	



The operation is not guaranteed for any other setting than the above.

■ Alarm output type

	7	Factory setting
When an alarm occurs, output is put in high impedance.	On	
When an alarm occurs, the alarm signal is output.	Off	•

■ Direction switch

Direction	8	Factory setting
Forward: PA phase advance	On	
Reverse: PB phase advance	Off	•

Tips

The factory settings are subject to change upon customer's request.

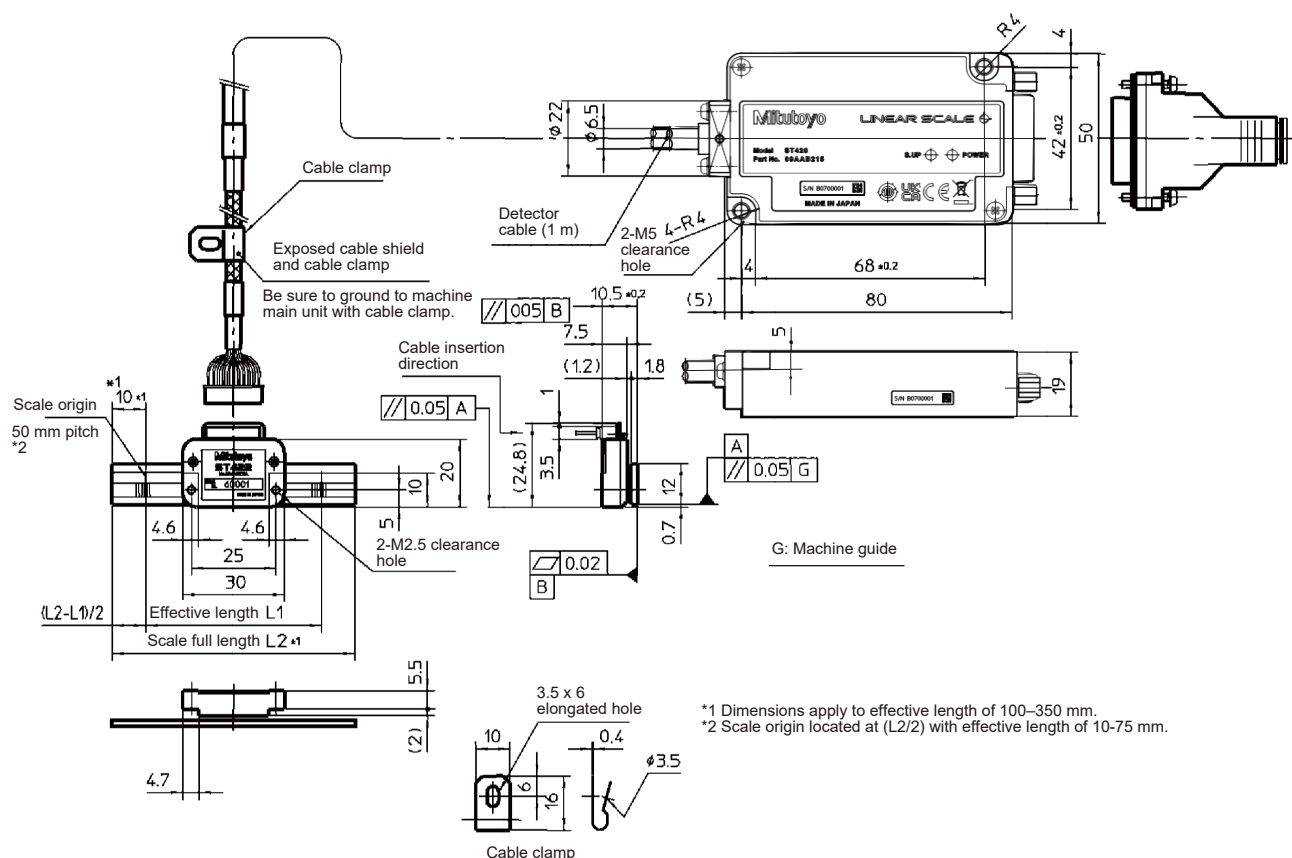
4.9 Maximum Response Speed

Setting		Maximum response speed (mm/s) (scale pitch: 40 μ m)
Resolution (number of divisions)	Minimum edge-to-edge interval +0, -10 %	
5 μ m (8)	125 ns	5000
	250 ns	5000
	500 ns	3600
	1000 ns	1800
1 μ m (40)	125 ns	5000
	250 ns	3600
	500 ns	1800
	1000 ns	900
0.5 μ m (80)	125 ns	3600
	250 ns	1800
	500 ns	900
	1000 ns	450
0.2 μ m (200)	125 ns	1500
	250 ns	700
	500 ns	300
	1000 ns	150

4.10 External View and Dimensional Drawings

4.10.1 Effective Length of 10 mm–350 mm

■ Dimensional drawings

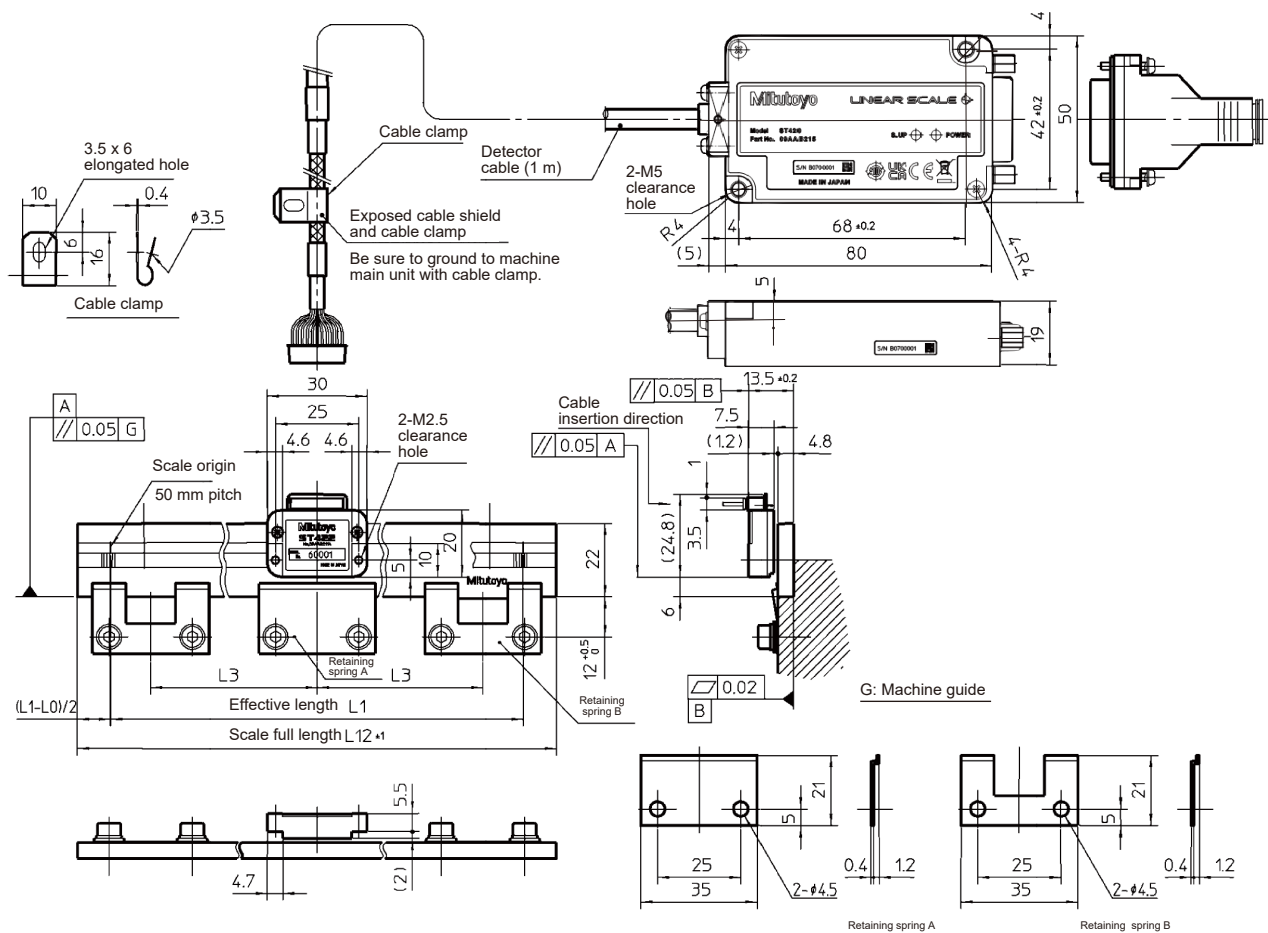


■ Dimensional drawings table

Code No.	Model number	Effective length L1 (mm)	Scale full length L2 (mm)
579-631	ST422-10	10	30
579-632	ST422-25	25	45
579-633	ST422-50	50	70
579-634	ST422-75	75	95
579-635	ST422-100	100	120
579-636	ST422-150	150	170
579-637	ST422-200	200	220
579-638	ST422-250	250	270
579-639	ST422-300	300	320
579-640	ST422-350	350	370

4.10.2 Effective Length of 400 mm–3000 mm

■ Dimensional drawings

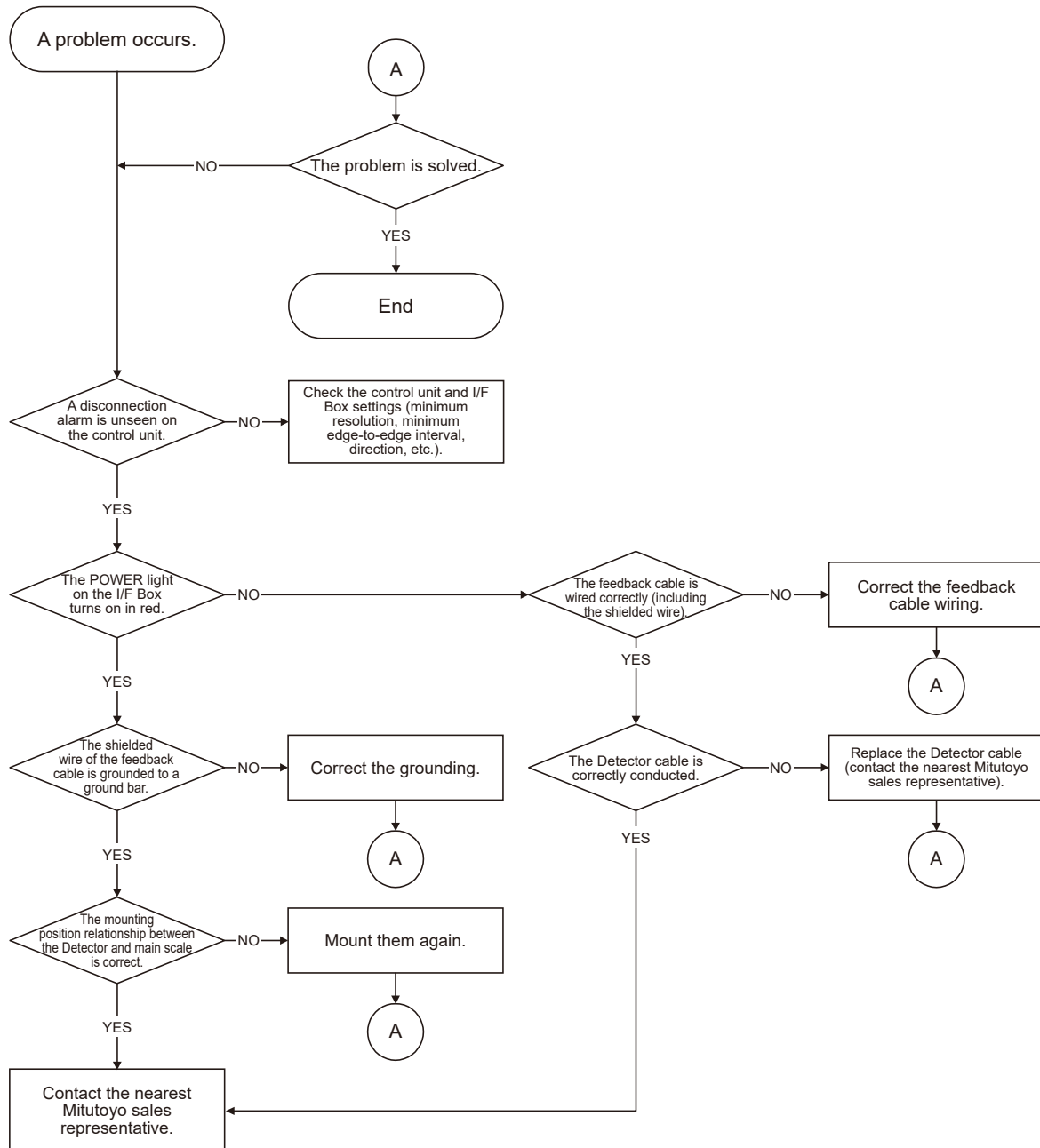


■ Dimensional drawings table

Code No.	Model number	Effective length L1 (mm)	Scale full length L2 (mm)	Scale fixed pitch L3 (mm)	Scale retaining spring A (quantity)	Scale retaining spring B (quantity)
579-641	ST422-400	400	440	100	1	4
579-642	ST422-450	450	490	75		6
579-643	ST422-500	500	540	80		
579-644	ST422-600	600	640	100		
579-645	ST422-700	700	740	85		8
579-646	ST422-800	800	840	100		
579-647	ST422-900	900	940	90		10
579-648	ST422-1000	1000	1040	100		
579-649	ST422-1100	1100	1140	90		12
579-650	ST422-1200	1200	1240	100		
579-651	ST422-1300	1300	1340	130		10
579-652	ST422-1400	1400	1440	100		14
579-653	ST422-1500	1500	1540	125		12
579-654	ST422-1600	1600	1640	100		16
579-655	ST422-1700	1700	1740	120		14
579-656	ST422-1800	1800	1840	100		18
579-657	ST422-2000	2000	2040	100		20
579-658	ST422-2200	2200	2240	100		22
579-659	ST422-2400	2400	2440	100		24
579-660	ST422-2500	2500	2540	95		26
579-661	ST422-2600	2600	2640	100		
579-662	ST422-2800	2800	2840	100		28
579-663	ST422-3000	3000	3040	100		30

5 Troubleshooting

This chapter describes how to check for the reasons why problems occur when initially powering on, or for when alarms are generated during operation.



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