Mitutoyo

Separate Type Linear Scale

ST36

User's Manual

- Instructions for use -

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

No. 99MBE048B3
Date of publication: March 1, 2019 (1)

Correspondence of product names and model numbers

Product name	Model number
Separate Type Linear Scale	ST36

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 a Mitutoyo sales office or your dealer.
- Before operation of the product, thoroughly read this document to comprehend its contents.
- Particularly, for full understanding of information, carefully read "Safety Precautions" and "Precautions for Use" at the outset of this document before using the product.
- The contents in this document are based on the information current as of March 2019.
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CONVENTIONS USED IN MANUALS

Conventions used in Mitutoyo's User's Manual are roughly divided into three types (safety reminders, prohibited and mandatory actions, and referential information and locations). Moreover, these conventions include general warnings and specific warnings. Specific warning symbols are provided with concrete pictograms inside of them.

■ Safety reminder conventions and wording warning against potential hazards

DANGER	Indicates an immediately hazardous situation which, if not avoided, will result in serious injury or death.
WARNING	Indicates a potentially hazardous situation which, if not avoided, could result in serious injury or death.
CAUTION	Indicates a potentially hazardous situation which, if not avoided, may result in minor injury.
NOTICE	Indicates a potentially hazardous situation which, if not avoided, may result in property damage.
	Alerts the user to a specific hazardous situation that means "Caution, risk of electric shock".

■ Conventions and wording 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 and wording indicating referential information or referential locations

Tips Indicates referential information such as that for when the operating methods and procedures which are printed in these sentences are to be applied to specific conditions.

Indicates referential locations if there is information that should be referred to in this document or an extraneous User's Manual.

E.g.: For further details on xxx, refer to  "1.2 System Configuration and Name of Each Part" (page 1)

Safety Precautions

Observe the following descriptions to make full use of the performance of this product:

NOTICE

- 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.
- To maintain the shielding effect, firmly tighten the screws on the connectors of each connecting cable.
- To prevent defective contacts, do not touch the connecting terminals of the connectors with bare hands.

Precautions for Use

■ General safety precautions

- This product is a measuring instrument.

  Do not use this product for any other purpose than measuring.
- This is an industrial product.

  Do not use this product for any other purpose than industrial use.
- 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.

■ Required environment for installation

● Vibration

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.

● Shock, dust, water protection

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.

● Ambient temperature and humidity

This product should be operated in an environment where the temperature is 0 °C–40 °C and where the relative humidity is 20 %RH–80 %RH. Do not use this product in a place where sudden changes in temperature or humidity are observed.

Electromagnetic Compatibility (EMC)

This product complies with the EMC Directive. Note that in environments where electromagnetic interference exceeds EMC requirements defined in this directive, appropriate countermeasures are required to ensure product performance.

EMC Directive EN61326-1

Immunity test requirement: Clause6.2 Table 2

Emission limit: Class B

For the EU Directive

Authorized representative and importer in the EU:
Mitutoyo Europe GmbH
Borsigstrasse 8-10,41469 Neuss,Germany

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 EU Member Countries

When you intend exporting of this product to any of the EU member countries, it may be required to provide User's Manual(s) in English and EU Declaration of Conformity in English (under certain circumstances, User's Manual(s) in the destination country's official language and EU Declaration of Conformity in the destination country's official language). For detailed information, please contact Mitutoyo in advance.

Disposal of Products outside the European Union and Other European Countries

Please follow the official instruction in each community and country.

Disposal of Old Electrical & Electronic Equipment (Applicable in the European Union and Other 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), which is a regulation in EU member countries, 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 your dealer or the nearest Mitutoyo sales office.

Warranty

In the event that this product should prove defective in workmanship or material, within one year from the date of original purchase for use, it will be repaired or replaced, at Mitutoyo's option, free of charge upon its prepaid return to Mitutoyo, without prejudice to the 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 all responsibility for all results arising out of its selection of this product to achieve its intended results.

Disclaimer

IN NO EVENT WILL MITUTOYO, ITS AFFILIATED AND RELATED COMPANIES AND SUPPLIERS BE LIABLE FOR ANY LOST REVENUE, PROFIT, OR DATA, OR FOR SPECIAL, DIRECT, INDIRECT, CONSEQUENTIAL, INCIDENTAL, OR PUNITIVE DAMAGES HOWEVER CAUSED AND REGARDLESS OF THE THEORY OF LIABILITY ARISING OUT OF THE USE OF OR INABILITY TO USE THIS PRODUCT EVEN IF MITUTOYO OR ITS AFFILIATED AND RELATED COMPANIES AND/OR SUPPLIERS HAVE BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

If, notwithstanding the foregoing, Mitutoyo is found to be liable to you for any damage or loss which arises out of or is in any way connected with use of this product by you, in no event shall Mitutoyo's and/or its affiliated and related companies' and suppliers' liability to you, whether in contract, tort (including negligence), or otherwise, exceed the price paid by you for the product only.

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.

About This Document

■ Positioning of this document in document map

● For linear scale

ST36
Separate Type Linear Scale
User's Manual (This Document)

■ Intended readers and purpose of this document

● Intended readers

This document is intended for first-time users of ST36 Separate Type Linear Scale.
Readers are assumed to be able to understand instructions by reading technical drawings.

● Purpose

The purpose of this document is to help you understand the ST36 Separate Type Linear Scale.

Contents

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

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.

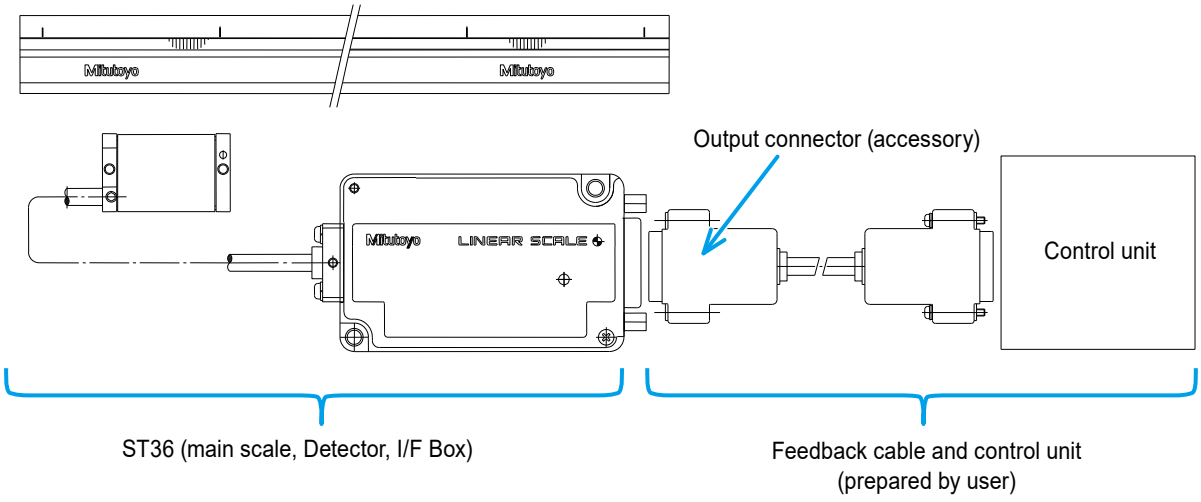
This product is a high-precision separate type linear scale with indication accuracy ±0.5 µm (effective length of up to 300 mm). With successful reduction in Detector thickness to 11.5 mm and support for the maximum effective length of 3000 mm, it can be used even for large machines. It is also equipped with the LED Display function for signal errors.

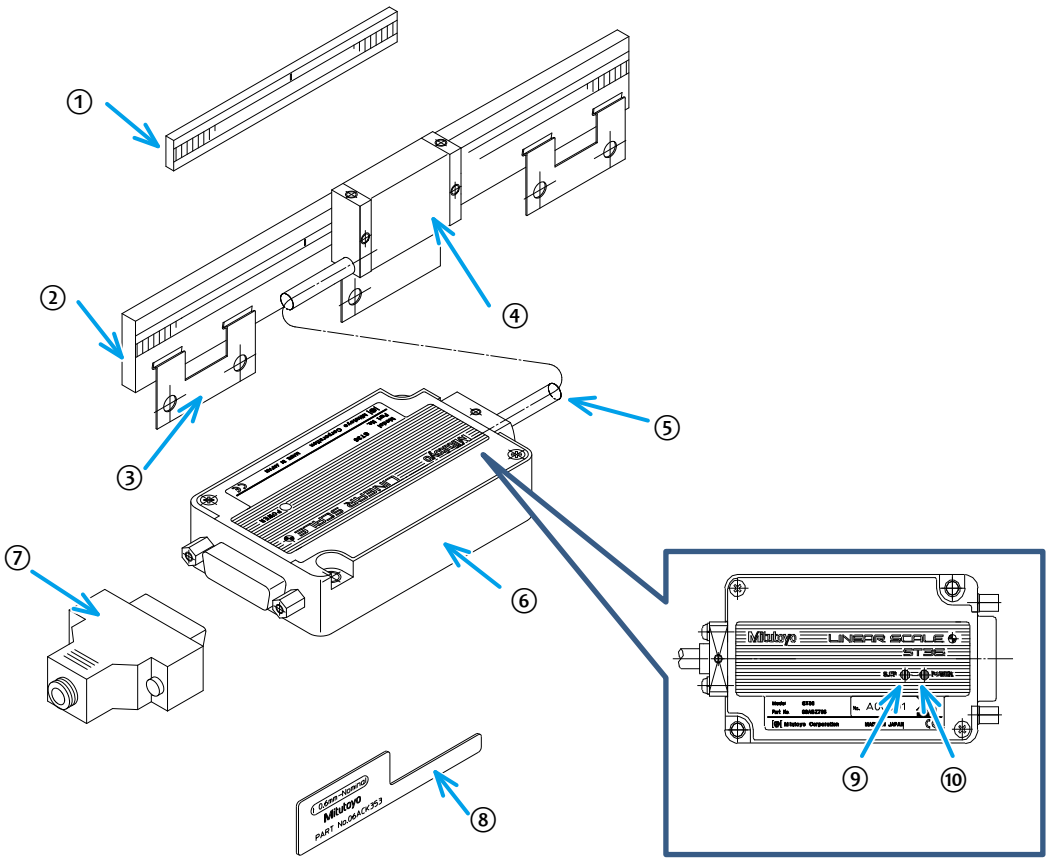
The following four output signal types are available in this product:

- Two-phase sine wave
- Two-phase square wave
- Two-phase square wave/two-phase sine wave
- Differential 1 Vpp sine 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: 10 mm–80 mm)
②	Main scale (effective length: 100 mm–3000 mm)
③	Scale retaining spring
④	Detector
⑤	Detector cable
⑥	I/F Box
⑦	Output connector
⑧	Gap spacer
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

- Checking the Equipment Model — "2.1 Checking the Equipment Model" (page 5)
- Designing the Scale Mounting Surface — "2.2 Designing the Scale Mounting Surface" (page 8)
- Designing the Detector Bracket — "2.3 Designing the Detector Bracket" (page 10)

■ Installation onto the machine main unit

- Checking the Package Contents — "3.1 Checking the Package Contents" (page 11)
- Mounting the Scale — "3.2 Mounting the Scale" (page 12)
- Mounting the Detector Bracket and Detector — "3.3 Mounting the Detector Bracket and Detector" (page 15)
- Connecting the Feedback Cable — "3.4 Connecting the Feedback Cable" (page 16)
- Adjusting the Detector Signals — "3.5 Adjusting the Detector Signals" (page 17)
- Handling the Cables and Checking the Mounting State — "3.6 Handling the Cables and Checking the Mounting State" (page 23)

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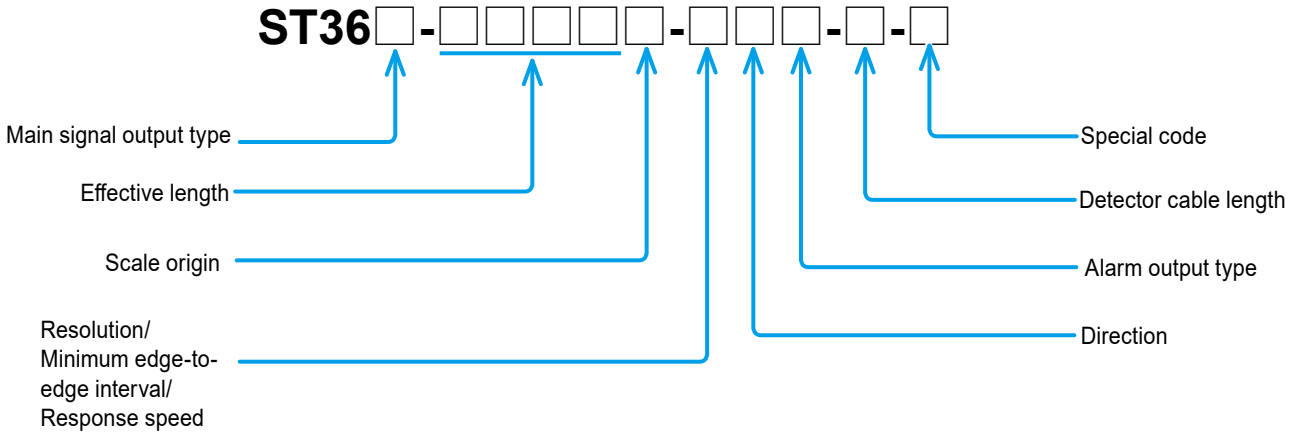
2 Setup for Installation

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

2.1 Checking the Equipment Model

The ST36 model number is determined based on the main signal output type, effective length, scale origin, resolution/minimum edge-to-edge interval/response speed, direction, alarm output type, Detector cable length, and special code.

Make sure that your scale unit model satisfies desired specifications.



■ Main signal output type

Symbol	Output
A	Two-phase sine wave
B	Two-phase square wave + external reset input
C	Two-phase square wave + two-phase sine wave
D	Differential 1 Vpp sine wave

■ Effective length

Symbol	Effective length (mm)	Symbol	Effective length (mm)
0010	10	0400	400
0025	25	0500	500
0050	50	0600	600
0075	75	0700	700
0080	80	0800	800
0100	100	0900	900
0150	150	1000	1000
0200	200	1100	1100
0250	250	1200	1200
0300	300	1300	1300
0350	350	1400	1400

Symbol	Effective length (mm)	Symbol	Effective length (mm)
1500	1500	2400	2400
1600	1600	2500	2500
1700	1700	2600	2600
1800	1800	2800	2800
2000	2000	3000	3000
2200	2200		

■ Scale origin

Symbol	Effective length of 10 mm–80 mm
B	Center point
Z	Special point specification

Symbol	Effective length of 100 mm–3000 mm
A	50-mm pitch
B	Center point
Z	Special point specification

Tips

- For the effective length of 10 mm–80 mm, the default scale origin is B (center point).
- For the effective length of 100 mm–3000 mm, the default scale origin is A (50-mm pitch).

■ Resolution/minimum edge-to-edge interval/response speed

Minimum edge-to-edge interval (ns) / Resolution (µm)	125	250	500	1000
0.01	A: 72	B: 36	C: 18	D: 9
0.02	E: 144	F: 72	G: 36	H: 18
0.05	J: 360	K: 180	L: 90	M: 45
0.1	N: 720	P: 360	Q: 180	R: 90
–	Z: When the main signal output type is A (two-phase sine wave) or D (differential 1 Vpp sine wave), the maximum response speed is 1200 mm/s at sine wave decreasing of -3 dB.			

Tips

- The number each for symbols A–R represents the maximum response speed (mm/s).
- The minimum edge-to-edge interval varies within the range between 0% and -10 % depending on the operating condition.

Direction

Symbol	Description
1	Forward: PA phase advance
2	Reverse: PB phase advance
Z	When the main signal output type is A (two-phase sine wave) or D (differential 1 Vpp sine wave), the direction is not set.

Alarm output type

Symbol	Description
S	Alarm signal
H	High impedance
Z	When the main signal output type is A (two-phase sine wave) or D (differential 1 Vpp sine wave), the alarm output type is not set.

Detector cable length

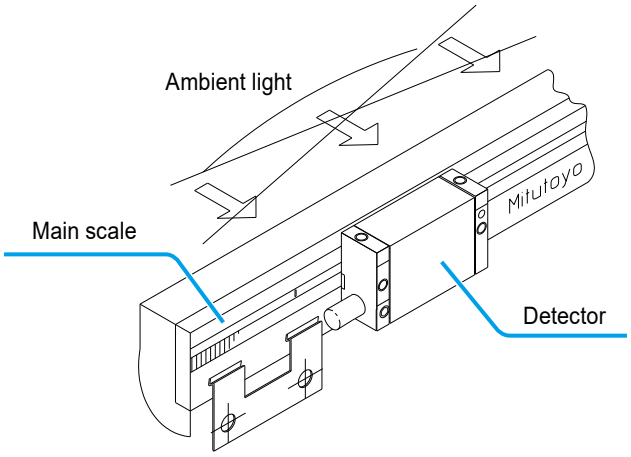
Symbol	Length
A	1 m (high flexibility specification)
B	0.5 m (high flexibility specification)
Z	Special length specification (maximum: 2.5 m)

Special code

Symbol	Description
None	Standard selection specification
Z	Special specification

2.2 Designing the Scale Mounting Surface

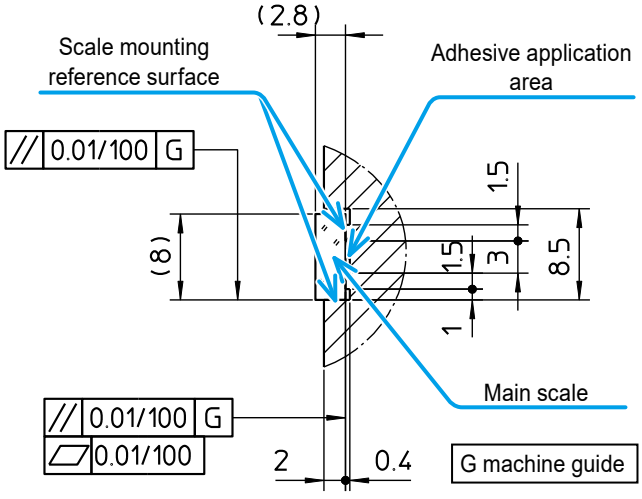
If ambient light enters the main scale from the back side, it causes a malfunction. Design the main scale mounting area to prevent ambient light as shown in the figure below.



2.2.1 Mounting the Scale with the Effective Length of 10 mm–80 mm (Adhesive Fixing Type)

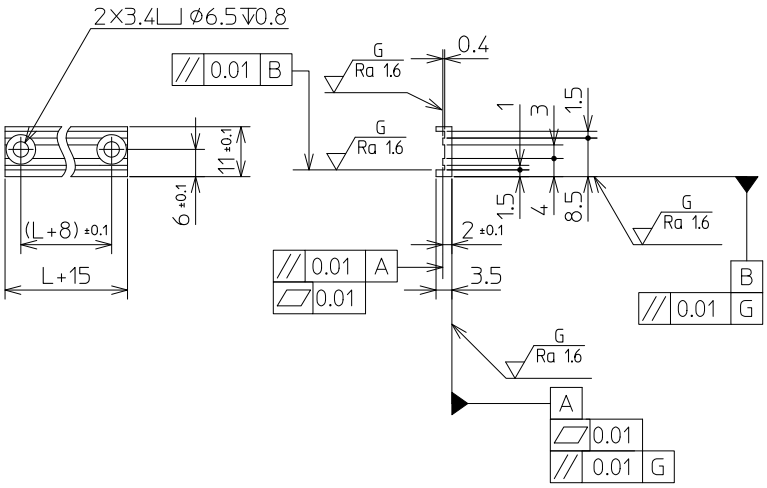
Mount the main scale with the effective length of 10 mm–80 mm (adhesive fixing type) by fixing with adhesives.

Design the main scale mounting area as shown in the figure below according to "4.10.1 Dimensional Drawings" (page 44).



Tips

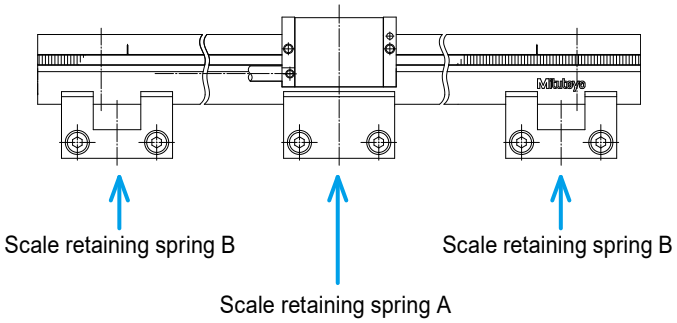
If you may need to mount the main scale with the effective length of 10 mm–80 mm (adhesive fixing type) again for maintenance, attach the main scale to the scale bracket shown in the figure below and fix it with bolts.



2.2.2 Mounting the Scale with the Effective Length of 100 mm–3000 mm

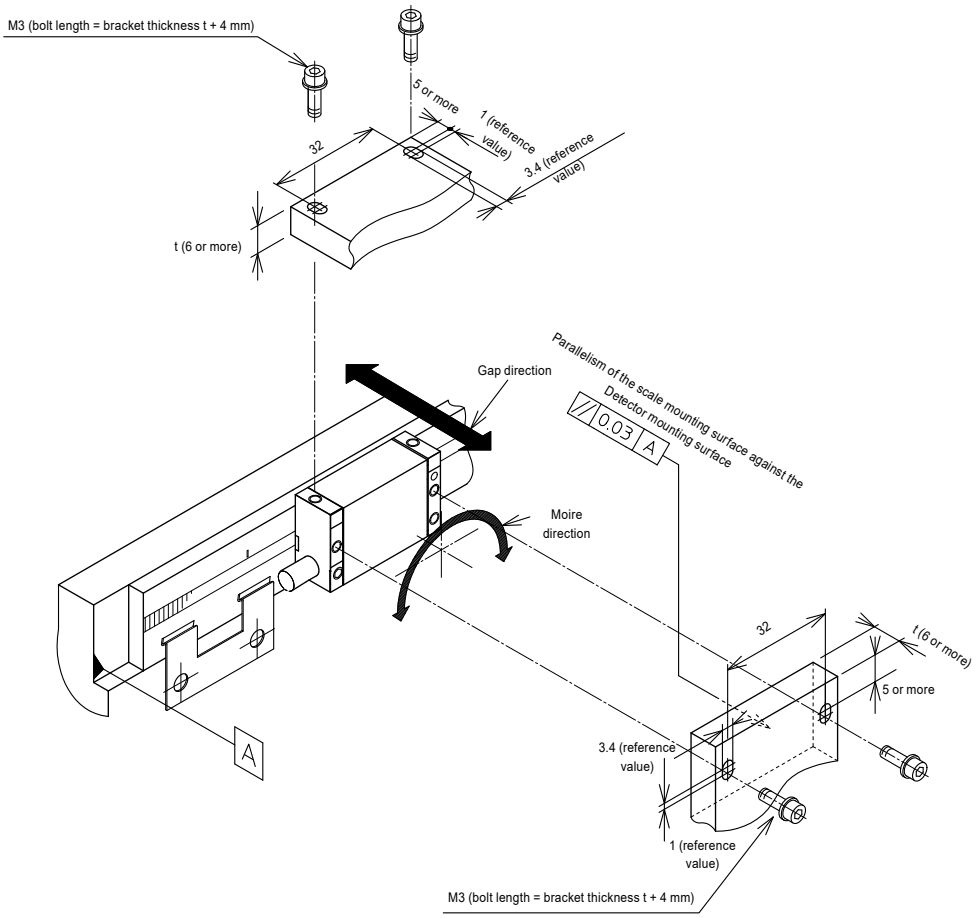
Mount the main scale with the effective length of 100 mm–3000 mm by fixing with scale retaining springs.

Secure working space for tightening the scale retaining spring A and scale retaining spring B according to "4.10.1 Dimensional Drawings" (page 44).



2.3 Designing the Detector Bracket

- Design the Detector bracket according to the figure below. Its shape must allow adjustment of the Detector position (moire/gap). 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 0.03 mm.

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

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 your dealer or the nearest Mitutoyo sales office/service center.

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 100 mm or more. For details on the quantity, refer to "4.10.2 Dimensional Drawings Table" (page 45).
Output connector	1	
Gap spacer	1	
Serial number sticker	1	This accessory comes with the scale with the effective length of 10 mm–80 mm.
User's Manual	1	This document
Inspection certificate	1	
Warranty card	1	

- To mount the Detector, prepare the following parts.

Part name	Quantity
Hex socket head cap screw (M3 x (bracket thickness + 4 mm) or less)	2

- To mount the scale with the effective length of 100 mm–3000 mm, prepare the following parts.

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

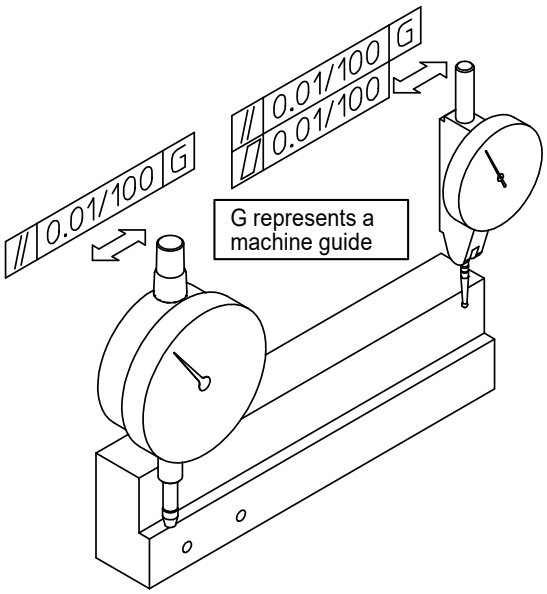
- If dirt and dust are attached to the main scale, it causes a malfunction or deteriorates the accuracy. Wipe off the dirt and dust with a soft cloth soaked in alcohol or cleaning paper. Similarly, clean the scale mounting surface of the machine unit thoroughly with alcohol.
- Use elastic adhesives to attach the main scale with the effective length of 10 mm–80 mm (adhesive fixing type). Shin-Etsu Silicones' KE441T is recommended.

Tips

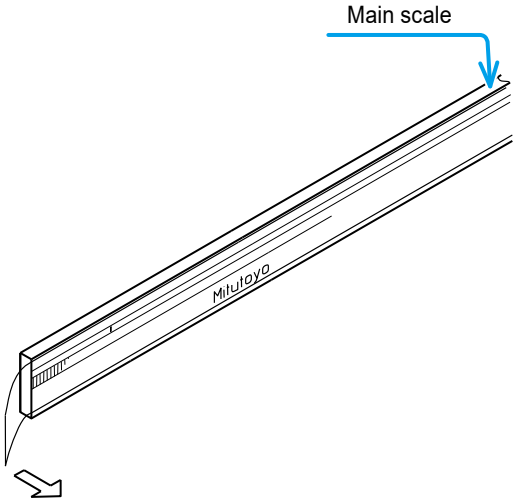
- Conduct temperature leveling thoroughly for both the main scale and mounting parts before fixing them. The accuracy of this product is guaranteed at 20 °C. The recommended temperature leveling is about 8 hours or longer at 20 °C for both the main scale and parts for mounting the scale. Perform installation 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.

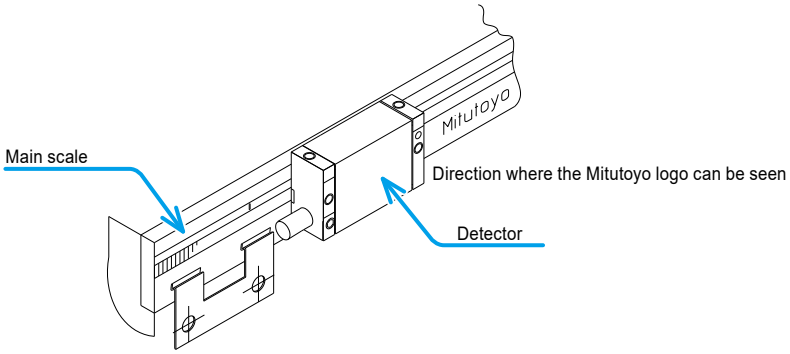


2 Peel the scale protection tape.



3 Mount the main scale.

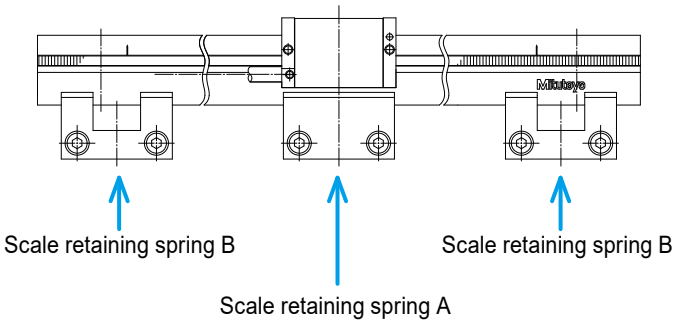
- Mount the main scale so that the Detector is placed on the grid surface (surface where rainbow colors appear when light is applied diagonally).
- For a scale with the Mitutoyo logo attached, the correct mounting direction is where the logo can be appropriately viewed from the Detector side.



- 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–80 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.

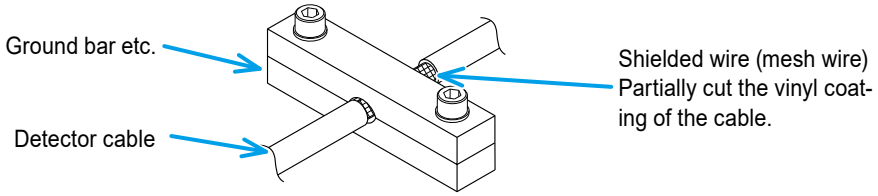
The recommended tightening torque for scale retaining spring bolts is 1.5 N•m.

3.3 Mounting the Detector Bracket and Detector

NOTICE

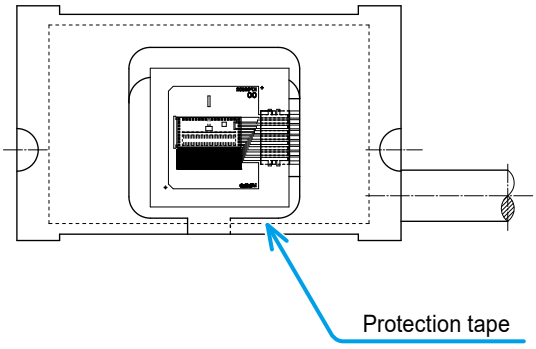
Do not directly touch the I/F Box pins during installation. Otherwise, electronic parts may be damaged by static electricity. Be sure to take measures to prevent static electricity for installation.

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. When it is difficult to ground due to the characteristics of the bracket material, make sure that the shielded part of the Detector cable is grounded using a ground bar.



Example: Drawing of using a ground bar

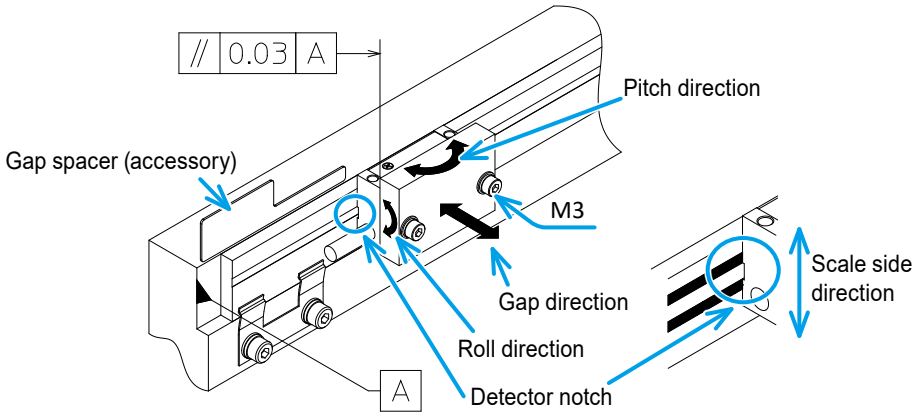
1 Peel the protection tape (blue) off the detecting surface of the Detector.



Back of the Detector

2 Attach the Detector to the Detector bracket.

Use a gap spacer as shown in the figure below to adjust the distance (gap) between the Detector and main scale to 0.6 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 0.03 mm.

4 Fix the Detector.

- The recommended tightening torque for Detector fixing screws is 1.14 N•m–1.5 N•m.
- After fixing the Detector, make sure that the distance (gap) between the Detector and main scale is 0.6 mm using the gap spacer.

3.4 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 "4.4 Production of Feedback Cable" (page 34).

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

2 Turn on the control unit.

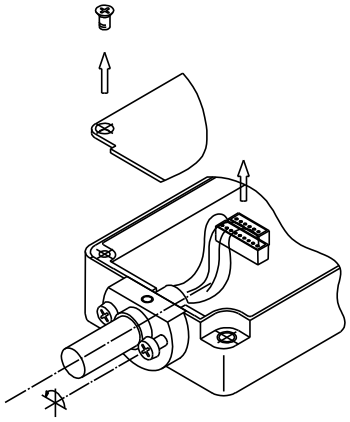
» The POWER light on the I/F Box turns on.

3.5 Adjusting the Detector Signals

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

3.5.1 Adjusting the Detector Mounting Position

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

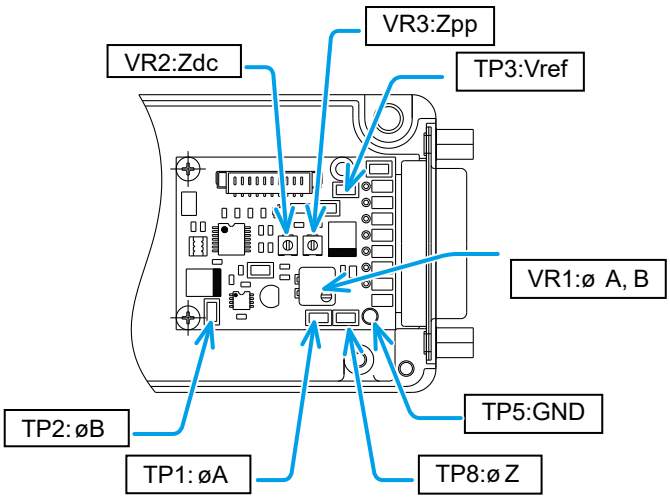


2 Set the oscilloscope as follows.

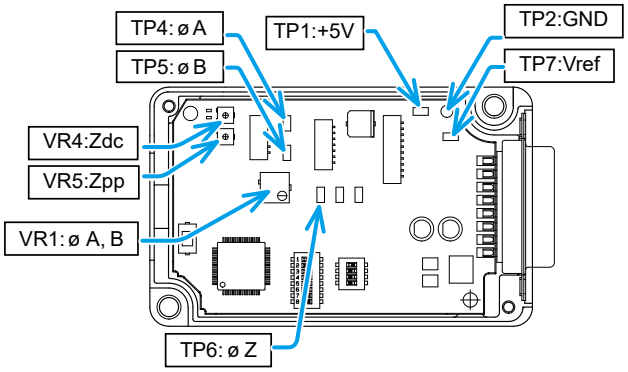
Item	Setting description
Measurement pressure range	0.5 V/div (50 mV/div when using a 10:1 probe)
Scan mode	X-Y

3 Clip the two probes and GND probe of the oscilloscope to Vref and GND on the I/F Box, respectively.

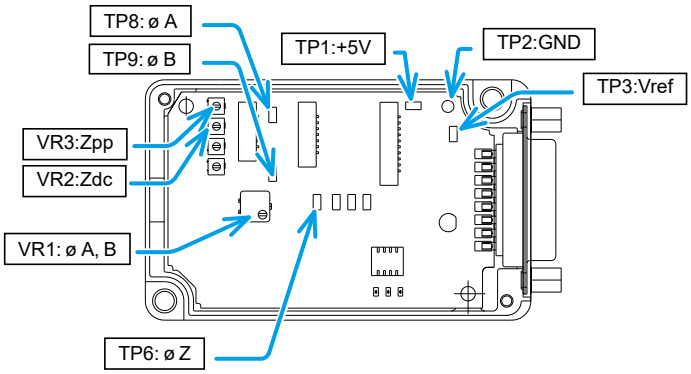
■ Main signal output type: A (two-phase sine wave)



■ Main signal output type: B (two-phase square wave + external reset input), C (two-phase square wave + two-phase sine wave)



■ Main signal output type: D (differential 1 Vpp sine wave)



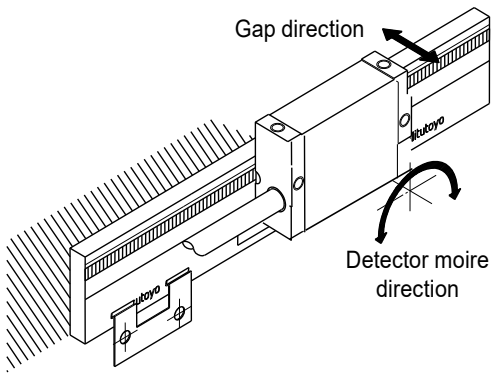
4 Adjust the horizontal/vertical positioning knob so that the blip on the oscilloscope is located in the center.

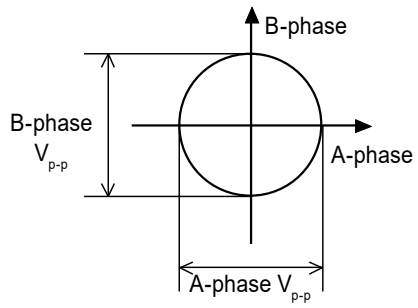
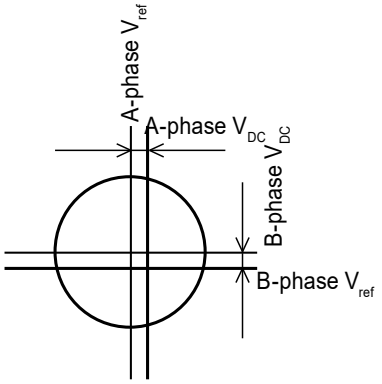
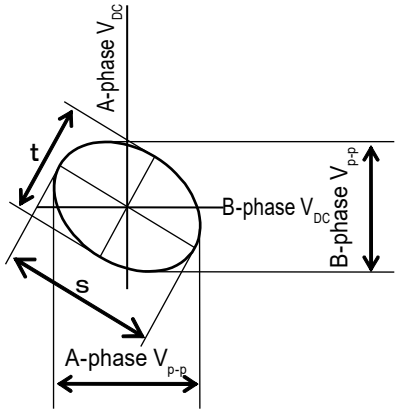
5 Clip the ch1 probe to øA (A-phase) and ch2 probe to øB (B-phase).

6 Make sure that the output signals from the I/F Box are within the following specified values.

Tips

If the signals are outside the specified values, adjust the moire direction of the Detector while moving the main scale or Detector.



Item	Lissajous waveform	Specified value	Note
Amplitude voltage (Vpp)		2.0±0.2 V	This value changes due to an adjustment error in the gap amount (between the Detector and main scale), parallelism, and moire angle.
Center voltage (VDC)		[Vref] ±0.1 V	Same as the above
Phase error (ø)		0±2 °	Same as the above

If measured values do not fall within the specified values, adjust the gap (gap: 0.6±0.1 mm).

Tips

- The Detector and I/F Box were already factory adjusted so that output signals fall within 1.8 V–2.2 V.
- You can fine-adjust the amplitude voltage (Vpp) by electrical adjustment described in "3.5.2 Adjusting the Signals" (page 20).
- Calculate the phase error (ø) 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.

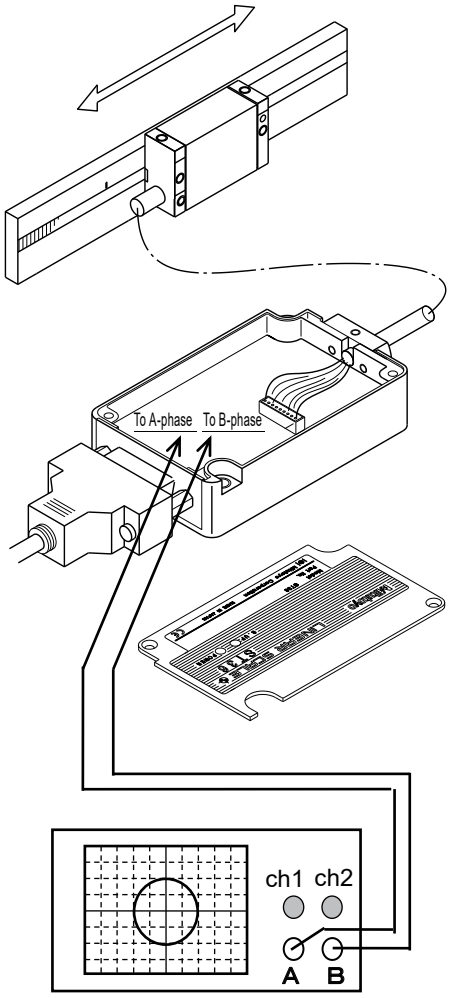
7 Fix the Detector.

8 Make sure that the output signals from the I/F Box are within the specified values.

3.5.2 Adjusting the Signals

■ Adjusting the main signals

1. Clip the two probes and GND probe of the oscilloscope to Vref and GND on the I/F Box, respectively.
2. Adjust the horizontal/vertical positioning knob so that the blip on the oscilloscope is located in the center.
3. Clip the ch1 probe to øA (A-phase) and ch2 probe to øB (B-phase).
4. Adjust the main signals (amplitude voltage) with the volume VR1 on the board while moving the Detector.



Tips

- The positions of the check pin (TP) and volume (VR1) on the I/F Box board are different depending on the main signal output type.
- Make sure that the oscilloscope does not drift during measurement.

For the details on the specified values of the amplitude voltage, center voltage, and phase error, refer to "3.5.1 Adjusting the Detector Mounting Position" (page 17).

■ Adjusting the origin signals

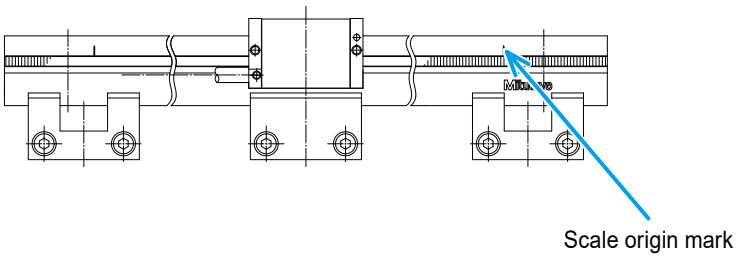
If the scale has multiple origins, adjust the origin signals at the origin (one position) you use.

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

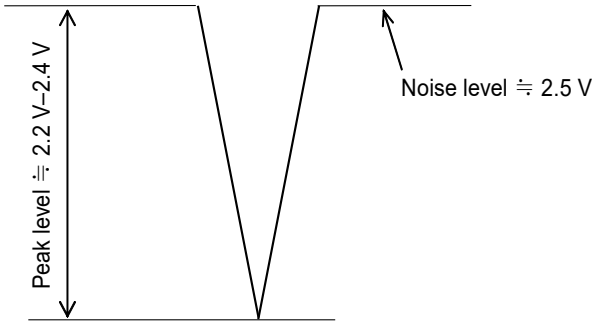
2 Clip the ch1 probe and GND probe of the oscilloscope to the check pin øZ and check pin GND on the I/F Box board, respectively.

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



4 Move the scale or Detector in the measurement direction.

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



5 Adjust the noise level of the origin signal waveform to about 2.5 V with the volume on the board.

Main signal output type	Volume to adjust
A (two-phase sine wave)	VR2
B (two-phase square wave + external reset input)	VR4
C (two-phase square wave + two-phase sine wave)	VR4
D (differential 1 Vpp sine wave)	VR2

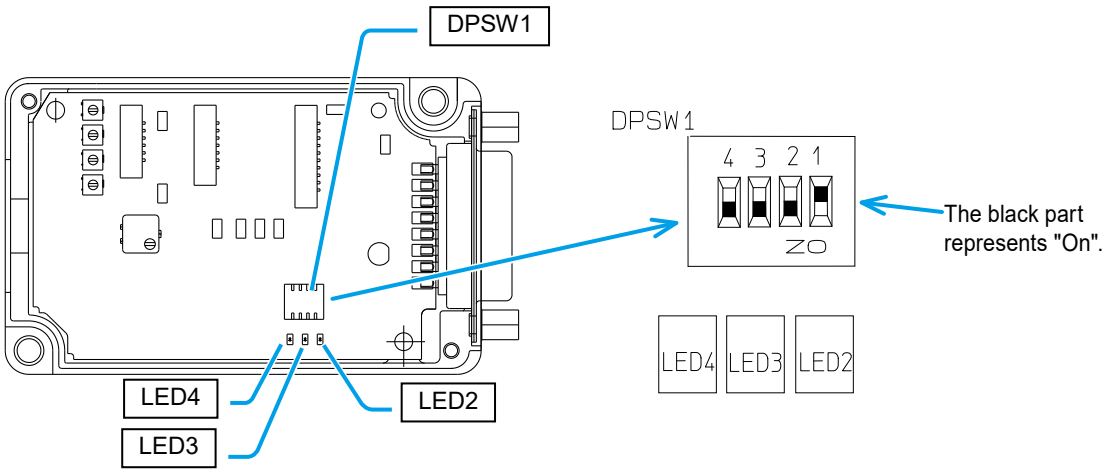
6 Adjust the peak level of the origin signal waveform to about 2.2 V with the volume on the board.

Main signal output type	Volume to adjust
A (two-phase sine wave)	VR3
B (two-phase square wave + external reset input)	VR5
C (two-phase square wave + two-phase sine wave)	VR5
D (differential 1 Vpp sine wave)	VR3

■ Adjusting the origin signals with the main signal output type D

- For the scale unit with the main signal output type D (differential 1 Vpp sine wave), you need to perform not only adjustment in "Adjusting the origin signals" (page 21) but also origin signal adjustment as shown below.
- Origin signal adjustment must be performed at the origin (one position) you use with the origin return method.
- After mounting the scale unit or performing other adjustment, be sure to adjust the origin signals again.

1 Turn on the switch 3 of the DIP switch DPSW1 on the I/F Box board.



2 Move the scale or Detector slowly (at a speed of 20 mm/s or less) in the origin return direction.

3 When it passes through the scale origin mark, make sure that LED4 turns on and LED2 and LED3 turns on or off.

If the scale has multiple origins, make it pass through the origin (one position) you use.

4 Set the switches 1 and 2 of the DIP switch DPSW1 according to the LED2 and LED3 on/off state.

LED on/off state		DPSW1 setting	
LED2	LED3	Switch 1	Switch 2
On	On	On	On
On	Off	On	Off
Off	On	Off	On
Off	Off	Off	Off

Tips

- The switch 4 of the DIP switch DPSW1 is always on.
- The switches 1 and 2 are factory set to off and on, respectively.

5 Turn off the switch 3 of the DIP switch DPSW1.

3.6 Handling the Cables and Checking the Mounting State

3.6.1 Handling the Cables

After adjusting the signals, fix the 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.

2 Fix the 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 fix the I/F Box enclosure to the machine main unit with screws.

3.6.2 Checking the Mounting and Adjustment States

After fixing the 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.

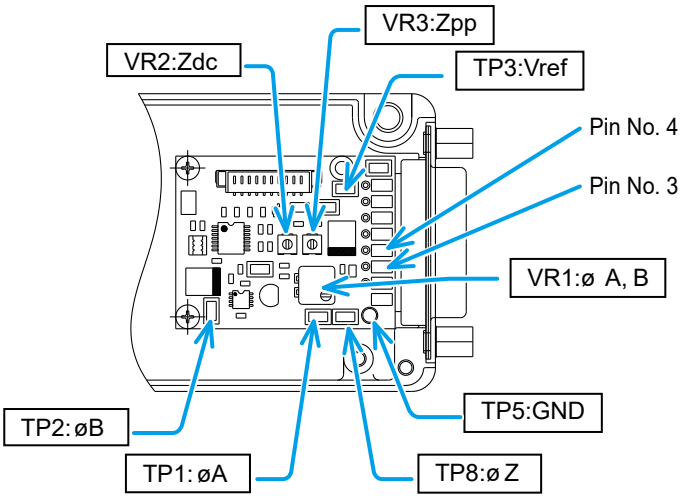
Tips

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

3 Make sure that the input power voltage is 5 V±5 % at the +5 V check pin and GND check pin on the I/F Box board.

Tips

For the I/F Box with the main signal output type A (two-phase sine wave), check the input power voltage at pins No.3 and No. 4 on the output connector.



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.

3.6.3 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

4.1 Specifications

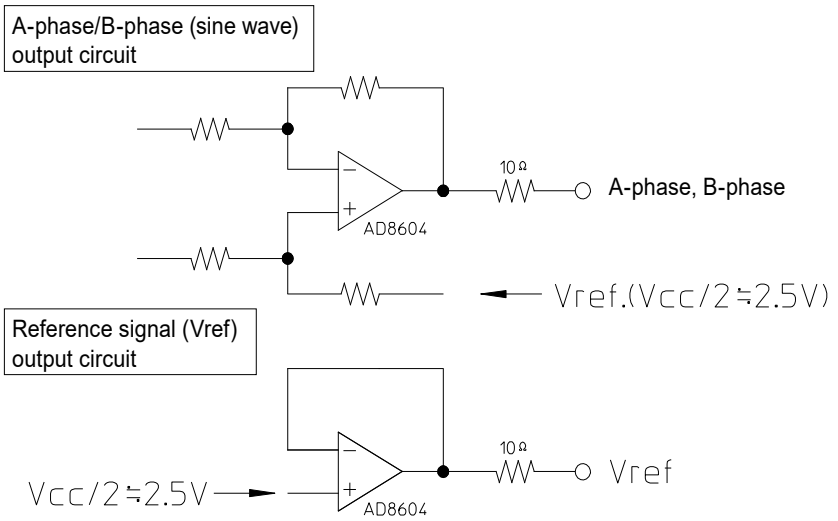
Item	Specification
Detection method	Optical reflection type linear encode
Main scale grid pitch	8 µm
Main signal output pitch	4 µm
Output signal type	A: Two-phase sine wave B: Two-phase square wave (reset input specification) C: Two-phase square wave, two-phase sine wave D: Differential 1 Vpp sine wave
Effective length	10 mm–3000 mm
Indication accuracy (20 °C)	Effective length of 10 mm–300 mm: ±0.5 µm Effective length of 350 mm–500 mm: ±1.0 µm Effective length of 600 mm–1000 mm: ±2.0 µm Effective length of 1100 mm–3000 mm: ±2.0 µm/m
Coefficient of linear expansion	≈8×10^{-6}/K
Maximum response speed	1200 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): 0.1 µm: 720 mm/s 0.05 µm: 360 mm/s 0.02 µm: 144 mm/s 0.01 µm: 72 mm/s * When the minimum edge-to-edge interval doubles, the maximum response speed halves.
Scale origin	Available (50 mm pitch, center point for effective length of 10 mm–80 mm)
Response speed at scale origin detection	20 mm/s
Power supply voltage	DC5 V±5 %
Maximum current consumption	A: 120 mA B: 250 mA C: 250 mA D: 190 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.

4.2 Output Circuits and Signal Waveforms

4.2.1 Main Signal Type: Type A, Type C

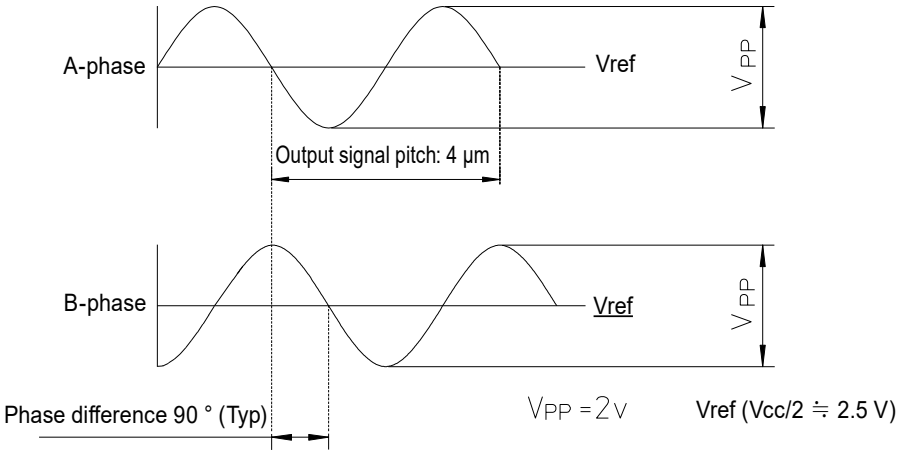
■ Output circuit

The output circuits of the sine wave output signals (A-phase, B-phase) and reference signal are as shown in the figure below.



■ Signal waveform

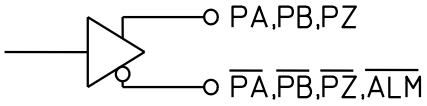
The waveforms of the sine wave output signals (A-phase, B-phase) are as shown in the figure below.



4.2.2 Main Signal Type: Type B, Type C

■ Output circuit

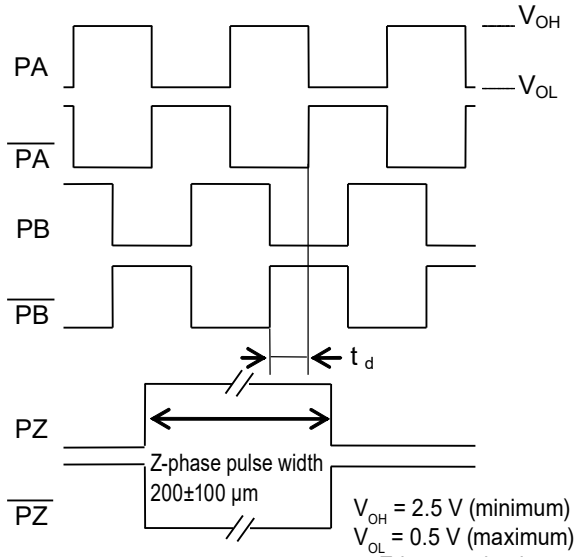
The output circuit of the square wave output signals (A-phase, B-phase), origin signals, and alarm signal is as shown in the figure below.



Differential line driver
Equivalent to AM26C31

■ Signal waveform

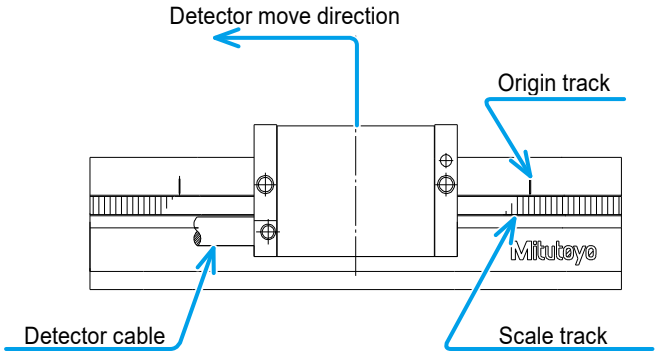
The waveforms of the square wave output signals (A-phase, B-phase) and origin signals are as shown in the figure below.



V_{OH} = 2.5 V (minimum)
V_{OL} = 0.5 V (maximum)
t_d: Edge-to-edge interval, resolution

Tips

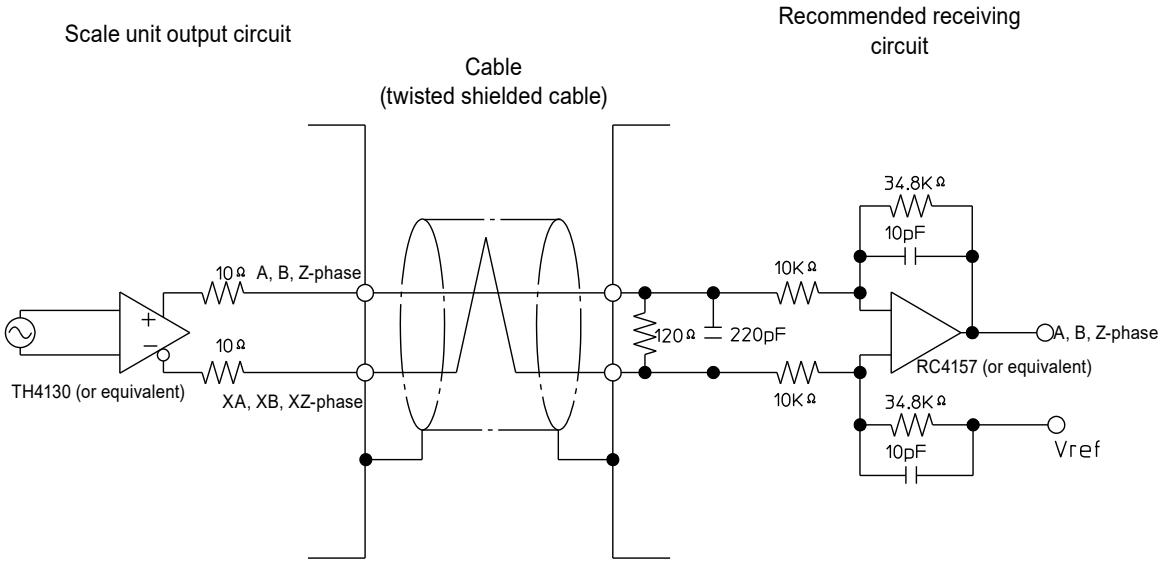
- A phase difference between PZ signal and PA signal (or PB signal) does not matter.
- The above figure shows waveforms when the Detector moves as follows with the switch 8 of the DIP switch DPSW2 on the I/F Box set to "On".



4.2.3 Main Signal Type: Type D

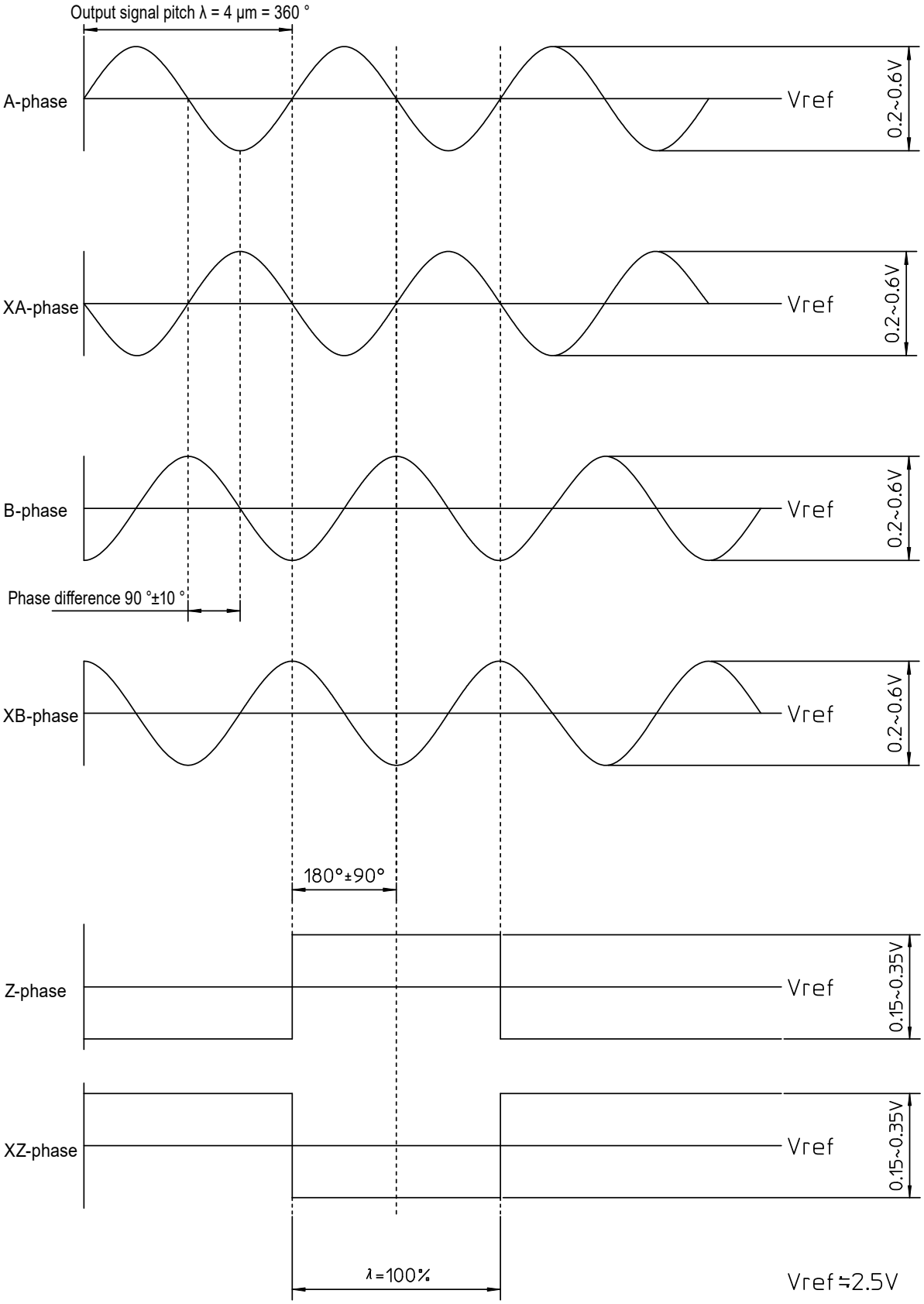
■ Output circuit

The output circuit and recommended receiving circuit of the differential 1 Vpp sine wave signals (A-phase, XA-phase, B-phase, XB-phase) and origin signals (Z-phase, XZ-phase) are as shown in the figure below.



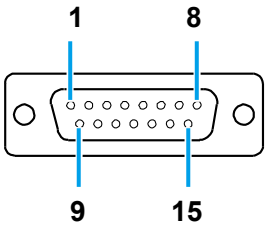
Signal waveform

The waveforms of the differential 1 Vpp sine wave signals (A-phase, XA-phase, B-phase, XB-phase) and origin signals (Z-phase, XZ-phase) are as shown in the figure below.



4.3 Pin Assignment

4.3.1 Main Signal Type: Type A

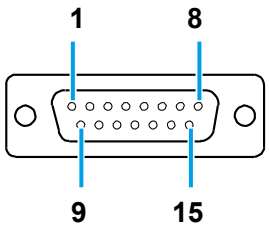


Pin No.	Signal
1	0 V (GND)
2	0 V (GND)
3	+5 V (Vcc)
4	+5 V (Vcc)
5	A-phase (sine wave)
6	B-phase (sine wave)
7, 10	Vref (≒ Vcc/2)
8	PZ (origin signal pulse)
9, 11–14	N.C.
15	F.G

Tips

The applicable connector (accessory) is D15-403N-110 (Technical Electron).

4.3.2 Main Signal Type: Type B

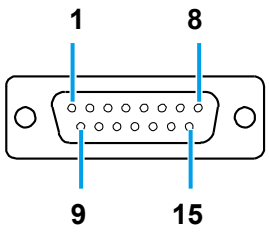


Pin No.	Signal
1	0 V (GND)
2	0 V (GND)
3	+5 V (Vcc)
4	+5 V (Vcc)
5	Reset input AL (anode)
6	Reset input AL (cathode)
7	Vref (≒ Vcc/2)
8	PZ (origin signal pulse_positive phase)
9	$\overline{\text{ALM}}$ (alarm)
10	PA (main signal pulse_positive phase)
11	$\overline{\text{PA}}$ (main signal pulse_reverse phase)
12	PB (main signal pulse_positive phase)
13	$\overline{\text{PB}}$ (main signal pulse_reverse phase)
14	$\overline{\text{PZ}}$ (origin signal pulse_reverse phase)
15	F.G

Tips

The applicable connector (accessory) is D15-403N-110 (Technical Electron).

4.3.3 Main Signal Type: Type C

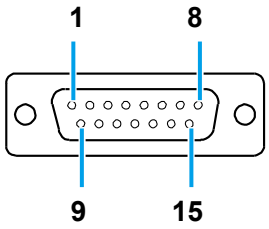


Pin No.	Signal
1	0 V (GND)
2	0 V (GND)
3	+5 V (Vcc)
4	+5 V (Vcc)
5	A-phase (sine wave)
6	B-phase (sine wave)
7	Vref (≒ Vcc/2)
8	PZ (origin signal pulse_positive phase)
9	$\overline{\text{ALM}}$ (alarm)
10	PA (main signal pulse_positive phase)
11	$\overline{\text{PA}}$ (main signal pulse_reverse phase)
12	PB (main signal pulse_positive phase)
13	$\overline{\text{PB}}$ (main signal pulse_reverse phase)
14	$\overline{\text{PZ}}$ (origin signal pulse_reverse phase)
15	F.G

Tips

The applicable connector (accessory) is D15-403N-110 (Technical Electron).

4.3.4 Main Signal Type: Type D



Pin No.	Signal
1	XA-phase (sine wave)
2	XB-phase (sine wave)
3	Z-phase (pulse)
4	+5 V (Vcc)
5	+5 V (Vcc)
6	N.C.
7	N.C.
8	N.C.
9	A-phase (sine wave)
10	B-phase (sine wave)
11	XZ-phase (pulse)
12	0 V (GND)
13	0 V (GND)
14	N.C.
15	F.G

Tips

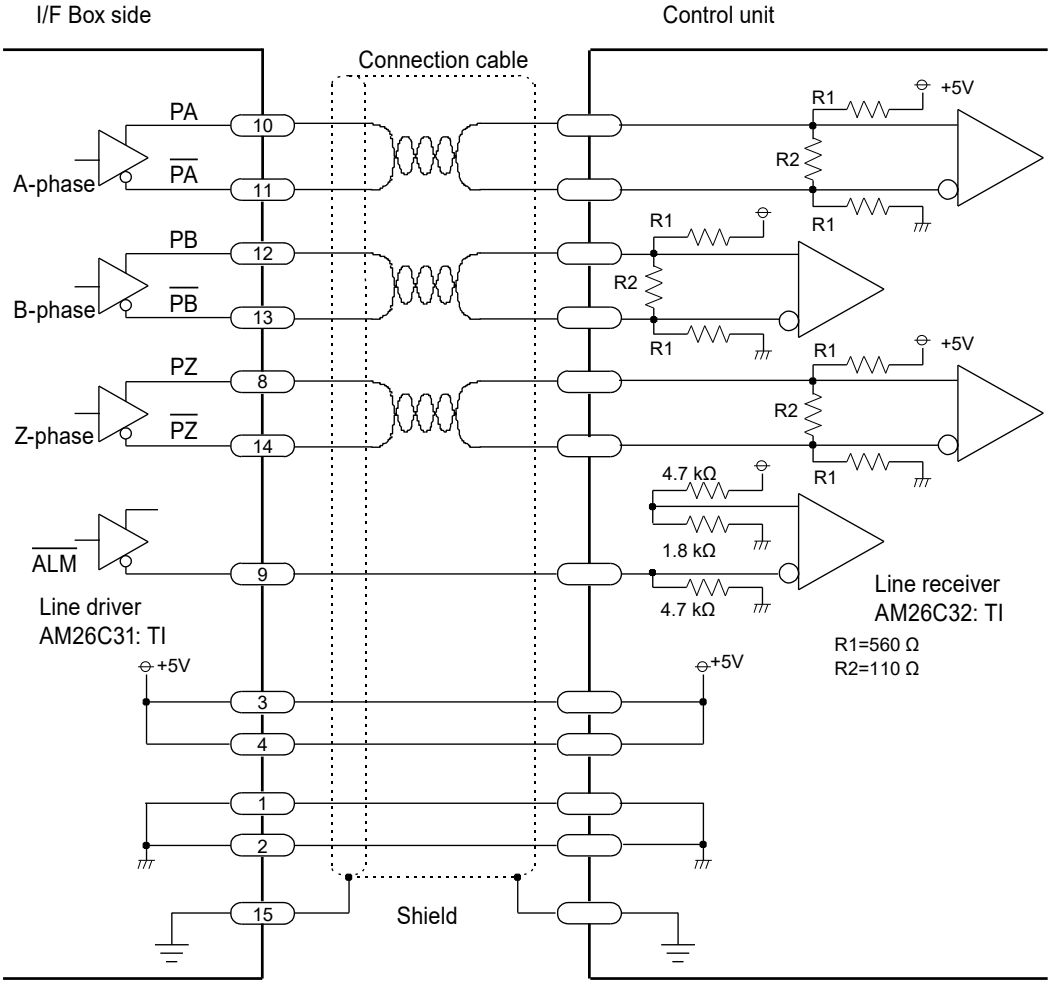
The applicable connector (accessory) is D15-403N-150 inch thread specification (Technical Electron).

4.4 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} - (Rc ÷ 2) x L x 2 x 0.25 ≧ 4.75 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 a two-phase square wave is used on the scale unit with the main signal output type B (two-phase square wave + external reset input) or C (two-phase square wave + two-phase sine wave), 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, $\overline{PA}$, PB, $\overline{PB}$), you do not need to connect the $\overline{ALM}$ output. In this case, turn on the switch 7 of the DIP switch DPSW2 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 $\overline{ALM}$ output. In this case, turn off the switch 7 of the DIP switch DPSW2 on the I/F Box board to output the alarm signal.

For details on the DIP switch on the I/F Box board, refer to "4.8 Changing the Output Settings" (page 41).

4.5 Alarm Function

4.5.1 Main Signal Type: Type A

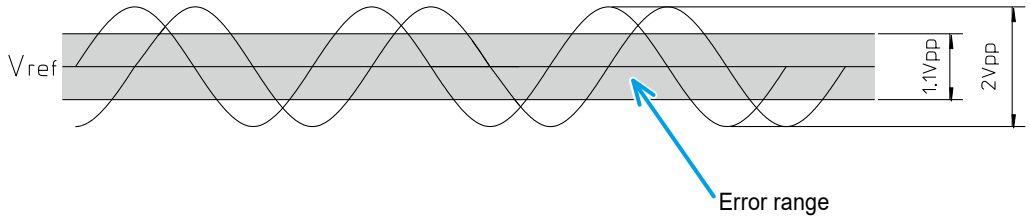
■ Detection details

If the waveform of the sine wave signal input to the I/F Box is within the following setting range, the POWER light turns on in red as it considers that an error signal is detected.

Range	POWER light	Setting range (approximate value)
OK	Solid green	2.0±0.2 Vpp
Error	Solid red	1.1 Vpp or less

Tips

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.



■ Resetting the alarm

1. Eliminate the cause of the error signal.
2. Turn off the control unit and turn it on again after 10 seconds or more.

4.5.2 Main Signal Type: Type B, Type C

■ 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.

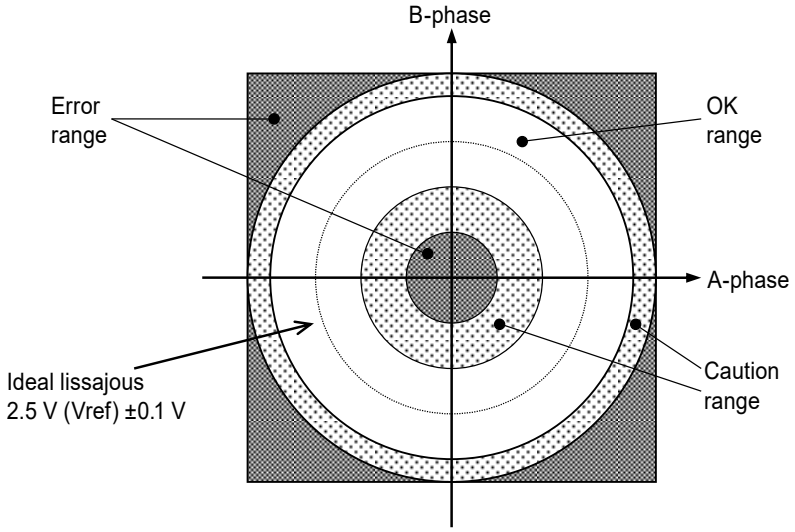
● Error signal detection

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	Not available
Caution	Flashing red	Solid green	Not available
Error	Off	Solid red	Available

Tips

- 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.

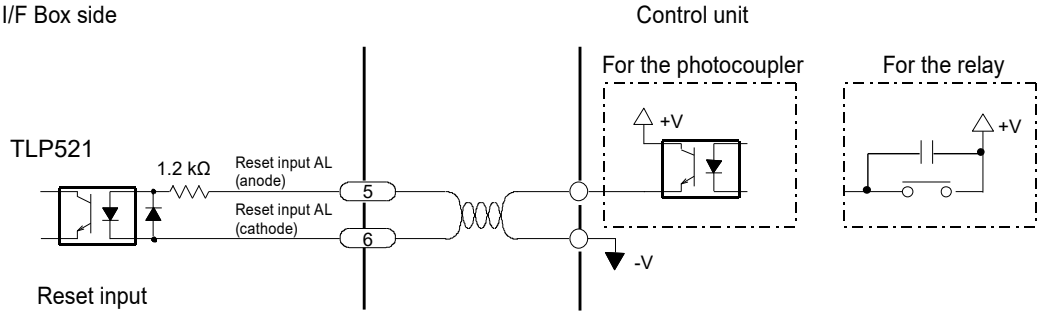
● Alarm reset signal

3 Eliminate the cause of the alarm.

4 Input the alarm reset signal (pulse width of 10 ms or more).

Tips

- The alarm can be reset by the alarm reset signal only when the main signal output type is B (two-phase square wave + external 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 kΩ) 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.

4.6 Adjusting the Signals Using the Check Adapter (Option)

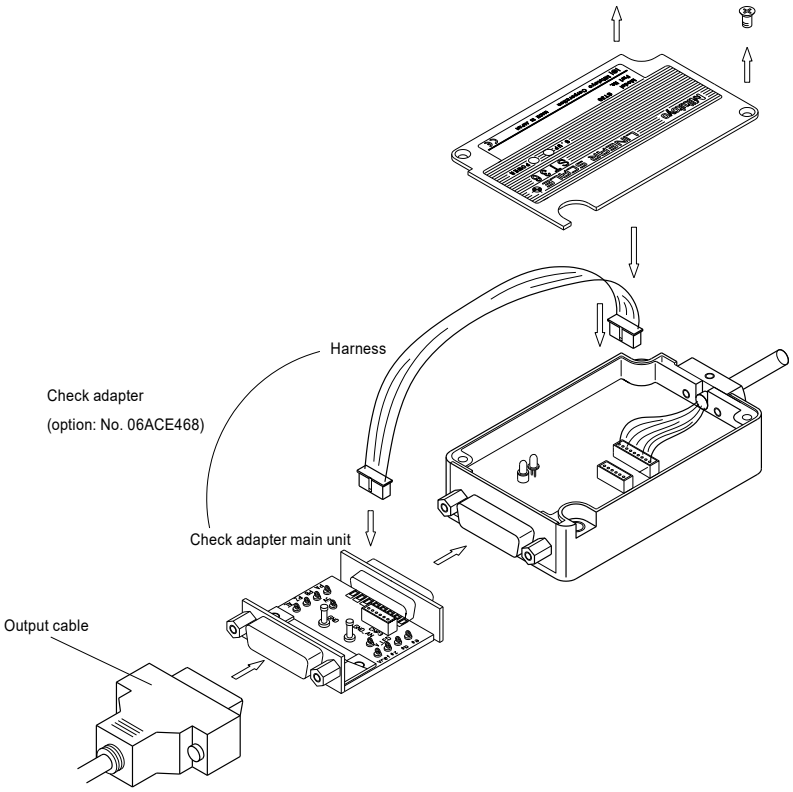
When you do not adjust the signals, remove the check adapter from the I/F Box.

Tips

- Signal adjustment using the check adapter is available only on the scale unit with the main signal output type B (two-phase square wave + external reset input) or C (two-phase square wave + two-phase sine wave).
- Only a little noise may be added to measured values during signal adjustment because the check adapter is not shielded.

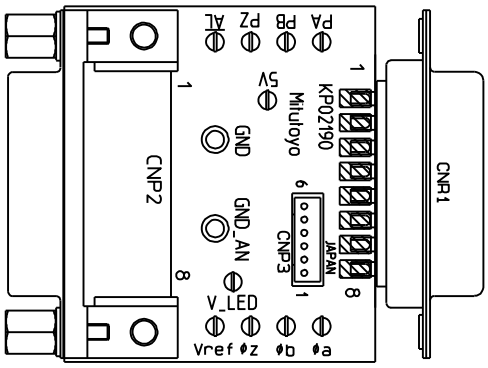
You can adjust the signals more efficiently by using the optional check adapter (P/N: 06ACE468).

1 Connect the check adapter between the output connector of the I/F Box and the feedback cable.



2 Connect the harness (lead wire with a square connector) supplied with the check adapter between CNP3 on the check adapter board and CNP3 on the I/F Box board.

3 Clip the GND probe of the oscilloscope to GND_AN on the check adapter.



4 Clip the two probes of the oscilloscope to Vref on the check adapter board.

5 Adjust the horizontal/vertical positioning knob so that the blip on the oscilloscope is located in the center.

6 Clip the ch1 probe to øA (A-phase) and ch2 probe to øB (B-phase) on the check adapter board.

7 Adjust the main signals (amplitude voltage) with the volume VR1 on the I/F Box board while moving the Detector.

» For details on how to adjust the main signals, refer to "Adjusting the main signals" (page 20).

Tips

You can check the divided square waves and origin signal pulse at PA, PB, and PZ on the check adapter. To check the values, clip the GND probe of the oscilloscope to GND on the check adapter.

8 Clip the ch1 probe to øZ on the check adapter board.

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

10 Move the scale or Detector in the measurement direction.

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

» For details on how to adjust the origin signals, refer to "Adjusting the origin signals" (page 21).

11 Adjust the noise level of the origin signal waveform to about 2.5 V with VR4 on the I/F Box board.

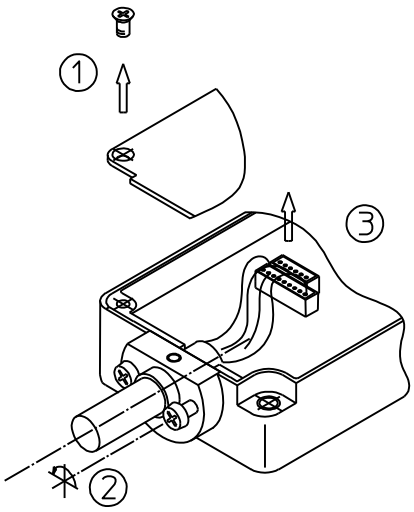
12 Adjust the peak level of the origin signal waveform to about 2.2 V with VR5 on the I/F Box board.

13 Remove the check adapter and harness.

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.

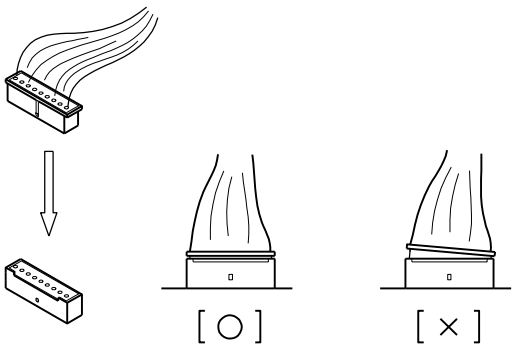


2 Loosen the two cable flange screws.

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.

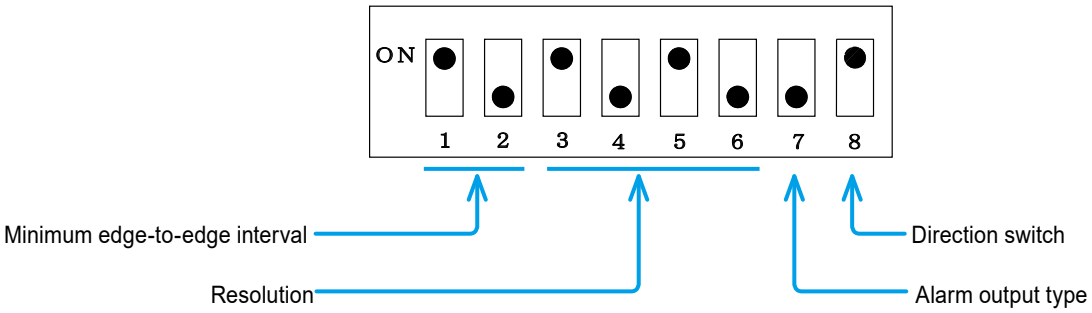


4.8 Changing the Output Settings

Tips

Output setting change is available only on the scale unit with the main signal output type B (two-phase square wave + external reset input) or C (two-phase square wave + two-phase sine wave).

You can change the output settings with the DIP switch DPSW2 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	

Tips

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

■ Resolution

Resolution	3	4	5	6	Factory setting
0.01 µm	Off	On	Off	On	
0.02 µm	Off	Off	Off	On	
0.05 µm	Off	On	On	Off	
0.1 µm	On	Off	On	Off	●

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

Tips

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

■ 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	●

Tips

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

■ 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

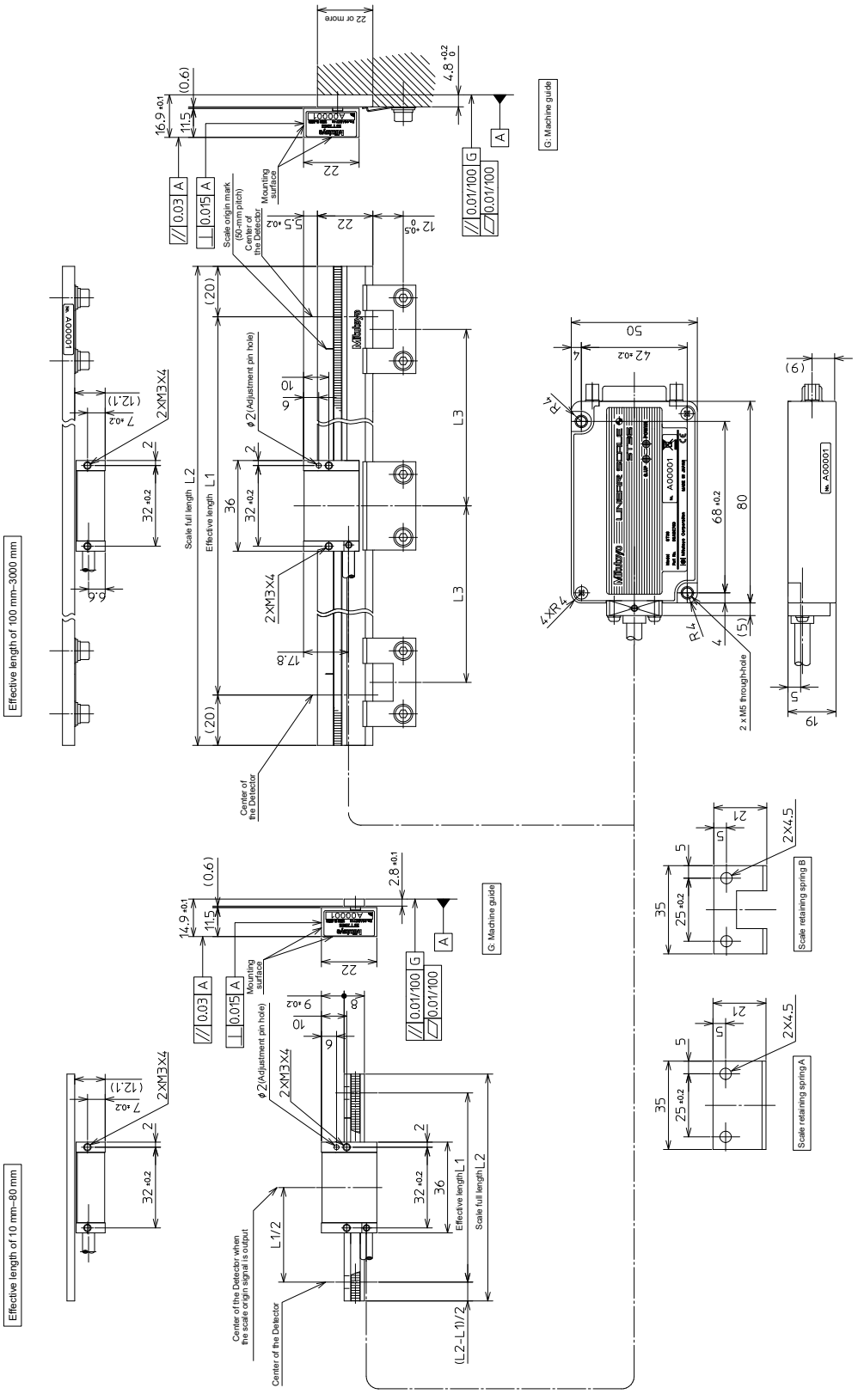
Tips

Maximum response speed change is available only on the scale unit with the main signal output type B (two-phase square wave + external reset input) or C (two-phase square wave + two-phase sine wave) that allows output setting change with the DIP switch DPSW2 on the I/F Box board.

Setting		Maximum response speed (mm/s) (main signal output pitch: 4 µm)
Resolution (number of divisions)	**Minimum edge-to-edge interval +0 %, -10 %**	
0.01 µm (400)	125 ns	72
	250 ns	36
	500 ns	18
	1 µs	9
0.02 µm (200)	125 ns	144
	250 ns	72
	500 ns	36
	1 µs	18
0.05 µm (80)	125 ns	360
	250 ns	180
	500 ns	90
	1 µs	45
0.1 µm (40)	125 ns	720
	250 ns	360
	500 ns	180
	1 µs	90

4.10 External View and Dimensional Drawings

4.10.1 Dimensional Drawings



4.10.2 Dimensional Drawings Table

Code No. (*1)	Model number (*2)	Effective length L1 (mm)	Scale full length L2 (mm)	Scale fixed pitch L3 (mm)	Scale retaining spring A (quantity)	Scale retaining spring B (quantity)
579-501-0□	ST36◇-10	10	30	–	–	–
579-502-0□	ST36◇-25	25	45	–	–	–
579-503-0□	ST36◇-50	50	70	–	–	–
579-504-0□	ST36◇-75	75	90	–	–	–
579-505-0□	ST36◇-80	80	100	–	–	–
579-506-0□	ST36◇-100	100	140	50	1	2
579-507-0□	ST36◇-150	150	190	75	1	2
579-508-0□	ST36◇-200	200	240	100	1	2
579-509-0□	ST36◇-250	250	290	60	1	4
579-510-0□	ST36◇-300	300	340	75	1	4
579-511-0□	ST36◇-350	350	390	85	1	4
579-512-0□	ST36◇-400	400	440	100	1	4
579-513-0□	ST36◇-450	450	490	75	1	6
579-514-0□	ST36◇-500	500	540	80	1	6
579-515-0□	ST36◇-600	600	640	100	1	6
579-516-0□	ST36◇-700	700	740	85	1	8
579-517-0□	ST36◇-800	800	840	100	1	8
579-518-0□	ST36◇-900	900	940	90	1	10
579-519-0□	ST36◇-1000	1000	1040	100	1	10
579-520-0□	ST36◇-1100	1100	1140	90	1	12
579-521-0□	ST36◇-1200	1200	1240	100	1	12
579-522-0□	ST36◇-1300	1300	1340	130	1	10
579-523-0□	ST36◇-1400	1400	1440	100	1	14
579-524-0□	ST36◇-1500	1500	1540	125	1	12
579-525-0□	ST36◇-1600	1600	1640	100	1	16
579-526-0□	ST36◇-1700	1700	1740	120	1	14
579-527-0□	ST36◇-1800	1800	1840	100	1	18
579-528-0□	ST36◇-2000	2000	2040	100	1	20
579-529-0□	ST36◇-2200	2200	2240	100	1	22
579-530-0□	ST36◇-2400	2400	2440	100	1	24
579-531-0□	ST36◇-2500	2500	2540	95	1	26
579-532-0□	ST36◇-2600	2600	2640	100	1	26
579-533-0□	ST36◇-2800	2800	2840	100	1	28
579-534-0□	ST36◇-3000	3000	3040	100	1	30

*1: The □ mark in Code No. represents as follows:
1: Two-phase sine wave
2: Two-phase square wave + external reset input
3: Two-phase square wave + two-phase sine wave
4: Differential 1 Vpp sine wave
*2: The ◇ mark in Model number represents as follows:
A: Two-phase sine wave
B: Two-phase square wave + external reset input
C: Two-phase square wave + two-phase sine wave
D: Differential 1 Vpp sine wave

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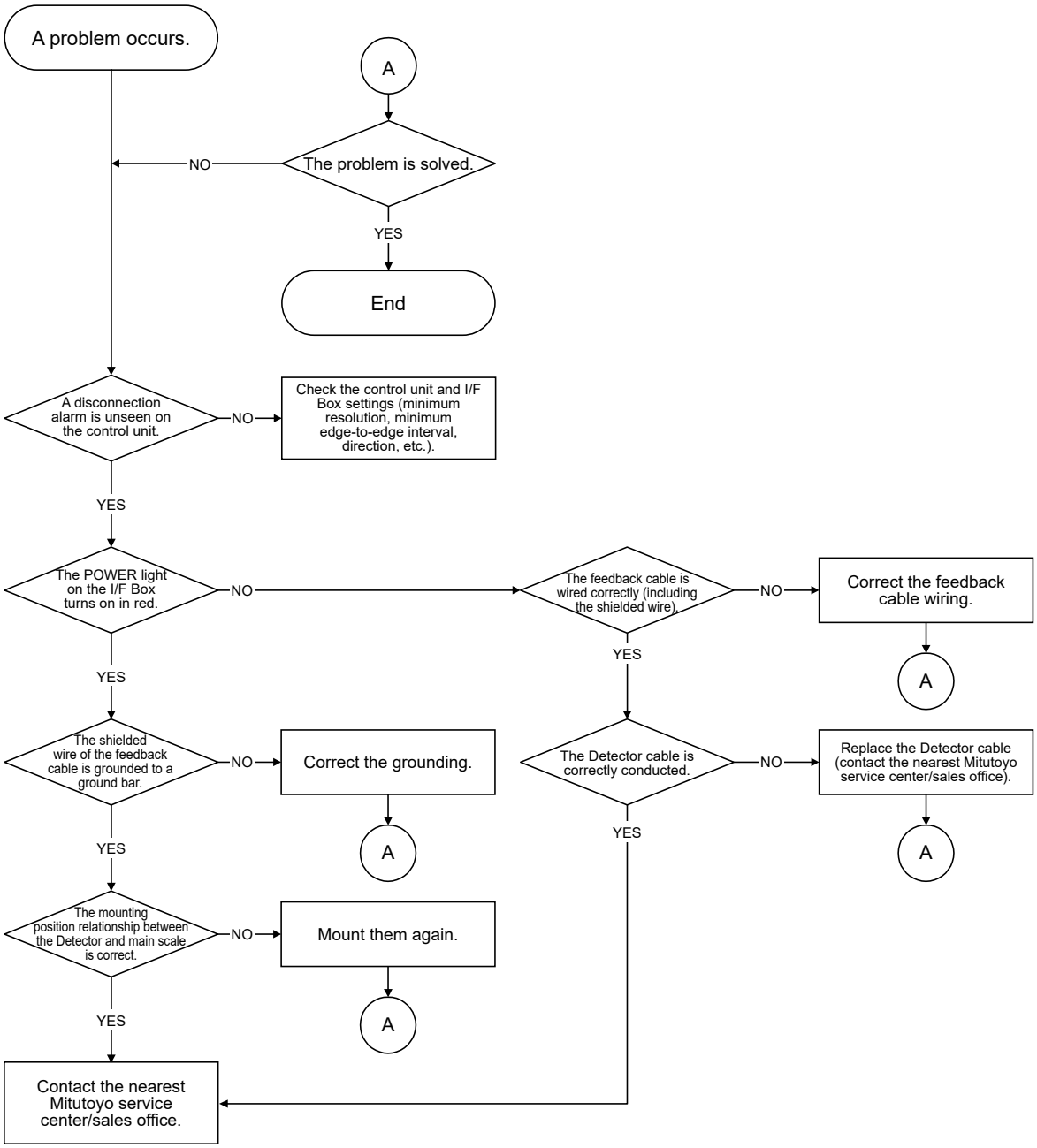
5 Troubleshooting

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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*As of January 2019

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