No.99MBE026B
SERIES No.579

ST422

Separate-type Linear Scale System

User's Manual

Read this User's Manual thoroughly
Before operating the instrument. After reading,
retain it close hand for future reference.

Mitutoyo

CONVENTIONS USED IN USER'S MANUAL

Safety Precautions

To operate the instrument correctly and safely, Mitutoyo manuals use various safety signs (Signal Words and Safety Alert Symbols) to identify and warn against hazards and potential accidents.

The following signs indicate general warnings:

DANGER

Indicates an imminently 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 or moderate injury or property damage.

The following signs indicate specific warnings or prohibited actions, or indicate a mandatory action:

Alerts the user to a specific hazardous situation. The given example means "Caution, risk of electric shock".

Prohibits a specific action. The given example means " Do not disassemble".

Specifies a required action. The given example means "Ground".

CONVENTIONS USED IN USER'S MANUAL

On Various Types of Notes

The following types of notes are provided to help the operator obtain reliable measurement data through correct instrument operation.

IMPORTANT

- An **important note** is a type of note that provides information essential to the completion of a task. You cannot disregard this note to complete the task.
- An important note is a type of precaution, which if neglected could result in a loss of data, decreased accuracy or instrument malfunction/failure.

NOTE A **note** emphasizes or supplements important points of the main text. A note supplies information that may only apply in special cases (e.g.. Memory limitations, equipment configurations, or details that apply to specific versions of a program).

TIP A **tip** is a type of note that helps the user apply the techniques and procedures described in the text to their specific needs.
It also provides reference information associated with the topic being discussed.

PRECAUTIONS

To obtain the highest performance from your scale unit, observe the following precautions prior to use.

CAUTION

- To obtain the highest performance from your scale unit and operate it safely, be sure to read this User's Manual thoroughly prior to insallation, setup, and use.
- Before installing the scale unit be sure to turn off the power to the unit. Also, if the scale unit is connected to an NC machine, check that the power to that machine has been turned off before connecting the scale unit.
- To maintain the shielding effect, tighten the connectors of each connecting cable and the screws on the interfaces firmly. Also, to prevent defective contact, do not touch the connecting terminals of the connectors with bare hands.

Installation Requirements

- Vibration

  To install this scale unit in a machine, select a location where there is as little vibration as possible. If the scale unit is used for an extended period of time in a machine where there is a substantial amount of vibration, the built - in precision parts may be damaged, adversely influencing the measuring accuracy.

- Dust and oil protection

  To protect the scale unit from being directly exposed to cutting fluids and chips, or fro being bumped by a workpiece, etc., be sure to prepare a cover that protects the entire unit.

- Ambient temperature and humidity

  This scale unit should be operated in an environment where the temperature is between 0 and 45℃ and where the relative humidity is between 20 to 80%. Avoid installation sites where temperature and humidity fluctuate quickly.

Conformance to EC Directives

This scale unit conforms to the following EC Directives:
EMI Directive EN61326-1 : 1997+A1:1998
If this system is used with a machine which is also intended to obtain the accreditation of compatibility with the Mechanical Directive EN60204-1, take necessary measures prior to use, so that the system conforms to the standard.

WARRANTY

In the event that the Mitutoyo Linear Scale AT211 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 our option, free of charge upon its prepaid return to us.
This warranty shall not apply if the product has been subject to fair wear and tear, abuse through misuse or improper use/handling/storage/maintenance/service/repair or through adaptation/modification by the original purchaser or any third party without prior written consent of Mitutoyo or as a result of damage by an actual disaster or circumstances beyond the control of Mitutoyo.
To obtain service under this warranty the product must be returned to the nearest Mitutoyo Service Center. Any postage, insurance, or shipping charges incurred in returning the procudt for service are the responsibility of the purchaser.

- This warranty is not transferable and is only valid within the country of the original purchase.
- You may have additional rights under the laws of country of original purchase that do not allow the exclusion of implied warranties or the exclusion or limitation of certain damages. If these laws apply, Mitutoyo's limitations and exclusions may not apply to you.

CAUTION

This User's Manual primarily describes the scale unit configuration, installation, specifications, mounting dimensions, and precautions to be observed at each point.
To obtain the highest performance from this scale unit, install it according to the procedure given in this manual. If this unit is not installed according to these instructions or not within the specified tolerances, performance will be adversely affected and other problems may result. Mitutoyo assumes no liability to any party for any loss or damage, direct or indirect, caused by use of this instrument not conforming to this manual. Exercise caution.

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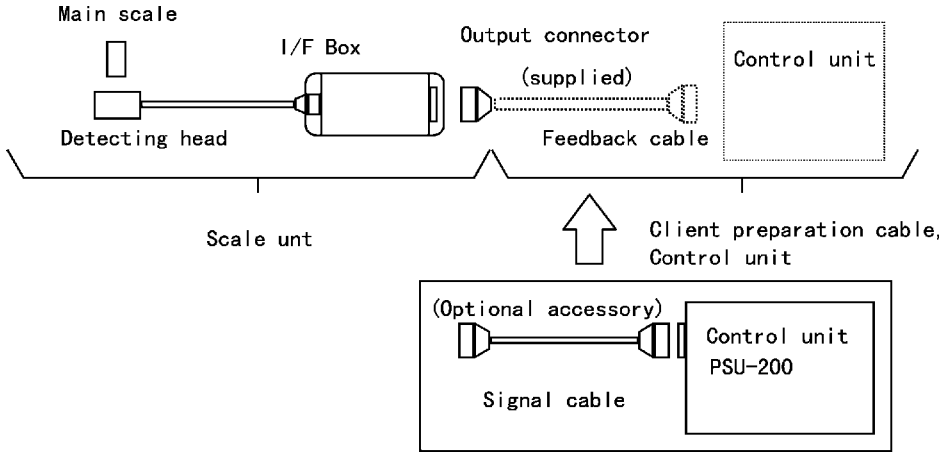
1 System Outline

ST422 series is a compact separate-type Linear Scale Unit.
The basic system consists of the scale unit, detecting head, and I/F box.
The I/F box outputs two kinds of waveforms, analog waveform (sine wave) and square wave, at the same time. Use one of them according to the purpose.

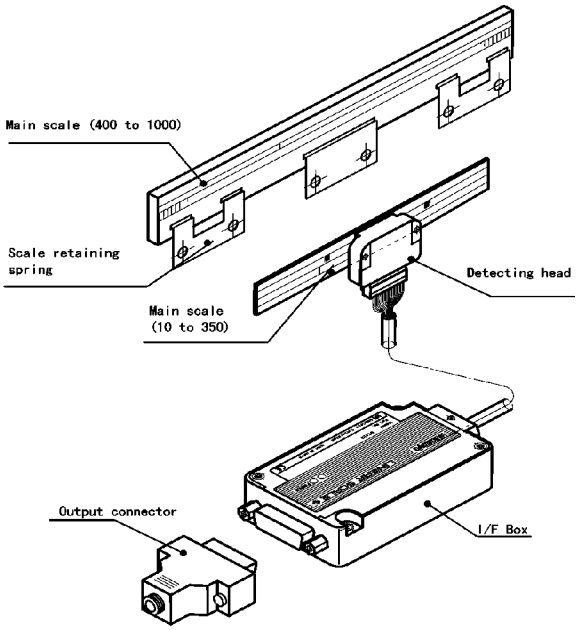
1.1 System Configuration and Each Component Name

The configuration and each component name of the Linear Scale Unit ST422 series are described in the following figure and in the figure on top of the next section.
This manual explains the installing and connecting procedures, and the mechanical and electrical adjustments required for the system.
Prior to installation check that the following components are all included in the package.

- Main scale 1 piece
- Detecting head and I/F box 1 set
- Scale retaining spring For the number of springs confirm the mounting dimensional drawing. (Used only for the effective length of 400mm or more.)
- Output connector 1 set



System diagram



Component name

1.2 Outline of Installation and Adjustments

Install the linear scale unit, observing mainly the following procedure.

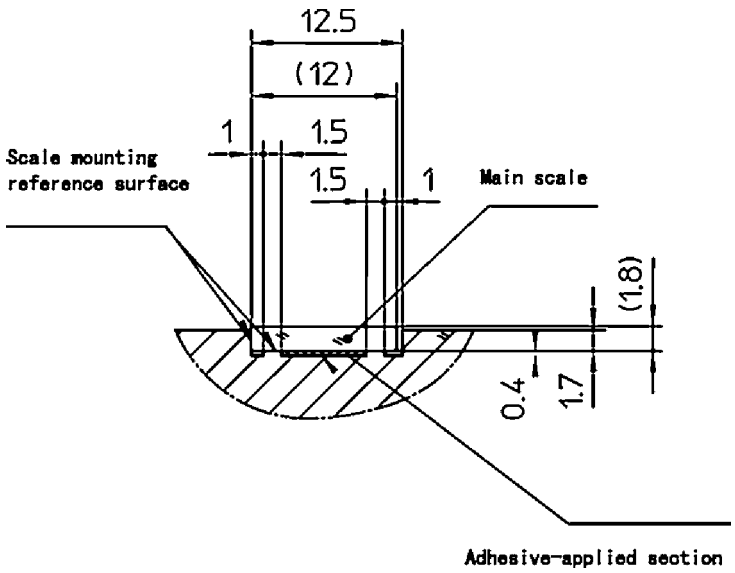
Designing the Scale Mounting Position and Detecting Head Bracket	See section 2
Mounting the Main Scale and Detecting Head	See section 3
Connecting the Cables	See section 4
Mechanical Adjustment of the Detector	See section 5
Electrical Adjustment of the I/O Box	See section 6
Processing the Cables (Routing and Clamping)	See section 7
Confirming the Mounting and Adjusting Conditions	See section 7

2 Designing the Scale Mounting Position and Detecting Head Bracket

2.1 Designing the Scale Mounting Position

2.1.1 Mounting position for the scale of effective length 10 to 350mm

Mount the scale of effective length 10 to 350mm in place by fixing it with an adhesive.
Referring to the mounting dimensional drawing, design the main scale mounting position as shown in the following figure.



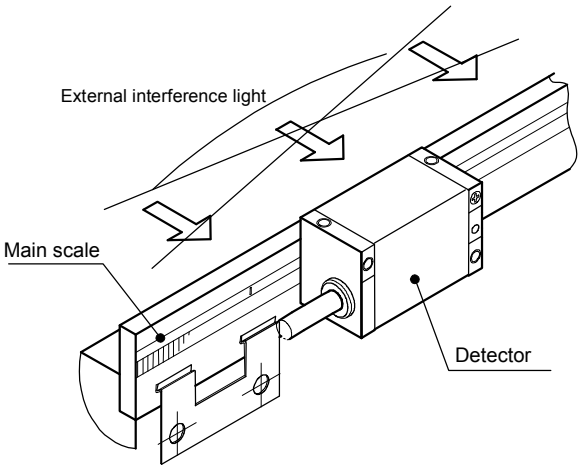
10～350mm scale mounting position (recommended dimensions)

NOTE If external interference light comes in the scale unit from any side of the detector unit, the scale unit may cause a malfunction.
Design the main scale mounting orientation so the external interference light will not come in the main scale.

2.1.2 Mounting place for the scale of effective length 400 to 1000mm

Mount the scale of effective length 400 to 1000mm in place by fixing it with scale retaining springs. Referring to the mounting dimensional drawing, design the main scale mounting position so that a space is ensured for tightening the screws of the scale retaining springs.

NOTE If external interference light comes in the scale unit from the rear of the main scale, the scale unit may cause an error.
Design the main scale mounting position so the external interference light as shown in the figure below will not come in the scale unit.



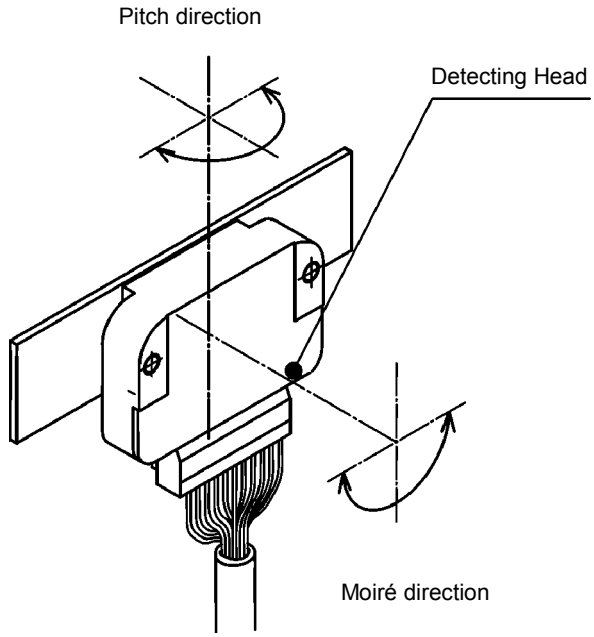
Note on the scale rear

2.2 Designing the Detecting Head Bracket

The detecting head will affect the output signals depending on its positional relationship.
Design such a detecting head bracket that can adjust the detecting head in two orientations as shown below before mounting it on a machine.

・Relationship between an adjusting orientation and output signals

1. Moiré orientation
   The main signal amplitude (Vpp) varies according to this orientation.
2. Pitch orientation
   The phase difference (ϕ) between the main signals varies according to this orientation.



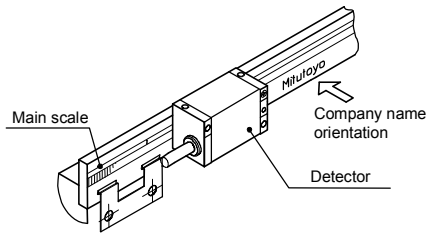
Example of designing the detecting head bracket

3 Mounting the Main Scale and Detecting Head

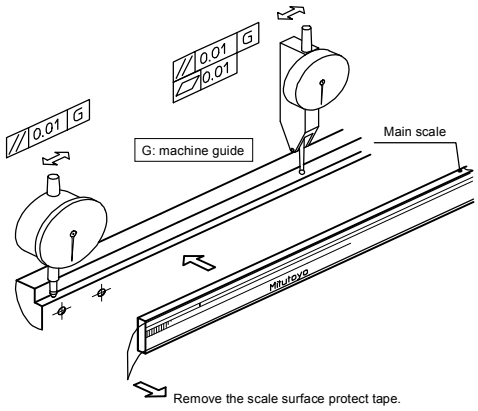
3.1 Mounting the Main Scale and Detecting Head

3.1.1 Mounting the main scale

- Mount the main scale so that the detecting head can be arranged on the scale graduated surface (that is as bright as rainbow colors if subject to oblique light).
  (If Mitutoyo company name is indicated on the scale, arrange the scale so that the company name can be read in the correct orientation when viewed from the detecting head side.)
- Check the scale mounting surface if it is arranged in accordance with the mounting dimensional drawing in section 8.12, using a test indicator or an electric micrometer while relatively moving the head bracket unit and scale mounting unit.



Scale mounting orientation



Scale parallel alignment and mounting

- Thermally stabilize the scale along with the assembling parts sufficiently before securing them. This instrument accuracy is guaranteed at 20°C. After thermal stabilization of the scale and assembling parts for about 8 hours or more at 20°C, exercise the mounting and securing procedure (securing with screws or adhesive). Note that the guaranteed accuracy may not be obtained if the operation temperature environments including thermal stabilization are not proper.
- To glue the scale of effective length 10 to 350mm, use an elastic type adhesive.
  Recommended adhesives are KE441T supplied by Shinetsu Silicon Corporation, EP001 supplied by Cemedyne Corporation, or equivalent.

NOTE
- About a scale serial number
  A serial number seal is supplied with each scale unit of effective length 10 to 350mm. Apply the seal to the vicinity of the scale mounting position on the installing machine.
- About a detecting head surface protection tape
  Remove the protection tape applied to the detecting surface on the detecting head before mounting the head.

3.1.2 Mounting the detecting head

- Remove the protection tape applied to the detecting surface on the detecting head. Temporarily mount the detecting head on the bracket with mounting bolts so that the distance (gap) between the detecting head and main scale becomes the specified value.

4 Connecting the Cables

Connect the signal cables between the units that comprise the system, and then clamp the cables.

* If using dual-phase square wave output, use the cable that has be wired according to section 4.3.

4.1 Connecting Procedure

1. Connect the cable (head cable) from the detecting head to the interface.
2. Connect the interface and the control unit with the signal cable.
3. Clamp the shield sheath of the head cable with the supplied cable clamp.

4.2 Removing the Head Cable

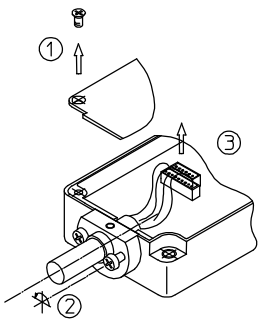
To remove the head cable on the I/F box side, observe the following procedure referring to the following figure.

① Unscrew the two screws, then remove the I/F box cover.

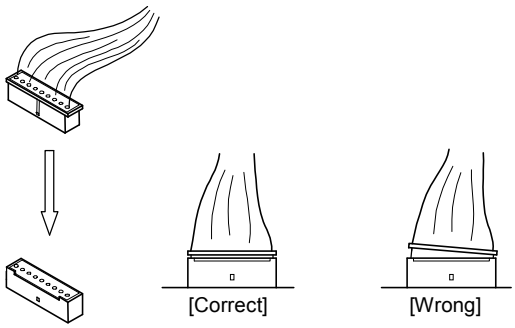
② Loosen the two screws on the cable flange.

③ Pull out the connector on the circuit board.

To connect the head cable to the I/F box, reverse the above procedure. When plugging the cable connector in the connector on the board, exercise care not to mistake the connector notch orientation, and then plug it in all the way to the end firmly. Tighten the two screws on the cable flange. If the connector is not plugged in sufficiently, or if the screws are not tightened firmly, a system malfunction will result. (See the following figure)



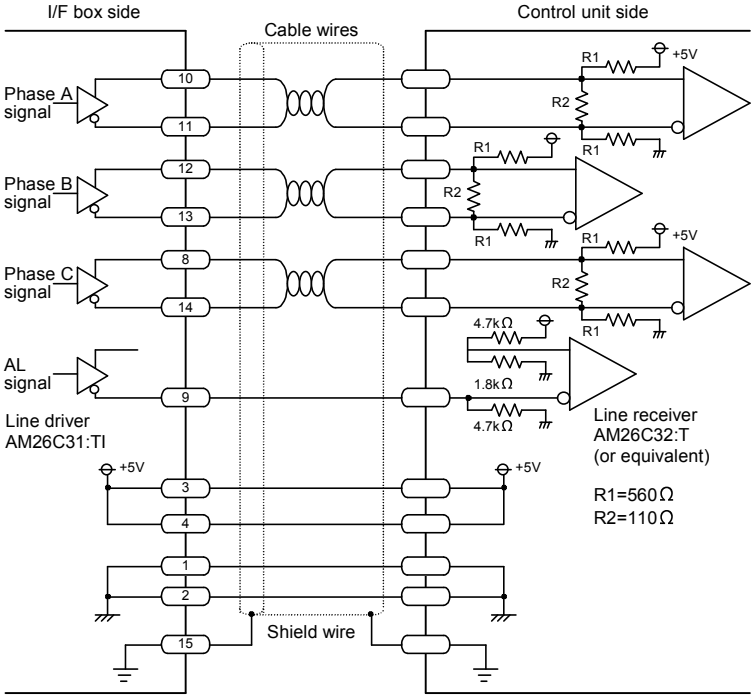
Removing the head cable



Plugging in the head cable

4.3 Connecting the Cable Wires (If Using Square Wave Output Signals)

If using square wave output signals connect the output signal cable wires as shown in the figure below.



Connecting the cable wires

*1: If the control unit has the broken wire detection function for phase A and B signals (PA, PA-bar, PB, PB-bar), it is not necessary to connect the AL output signal.
If this is the case, set the output condition to the high impedance mode (set the DPSW1-7 switch to ON, referring to section 8.7, "Output Settings").
If the control unit does not have the broken wire detection function as described above, or if the high impedance mode of phase A and phase B signal outputs becomes a problem on the system, connect the AL signal output. In this case set the output condition to the alarm output mode (set the DPSW1-7 switch to OFF, referring to section 8.7, "Output Settings").

*2: Use a shielded cable for this signal cable.

*3: Clamp the shield braided wire (FG) to the metal shell of the supplied connector. If this is difficult to be made, connect the shielding wire to pin number 15.

*4: For information about the connector pin assignment, refer to section 8.10, "Connector Pin Assignment".

*5: Set the cable impedance and length so that the power voltage on the I/F box side becomes 4.75V or more. (Check the voltage between TP5 (+5V) and TP6 (GND).)
Vsp - (Rc/3) x L x 2 (0.25 [scale current consumption]) ≥ 4.75V
Vsp = Power voltage (volts) supplied from the control unit
Rc: Power ground wire impedance (Ω/m) of the cable
L: Cable length (m)

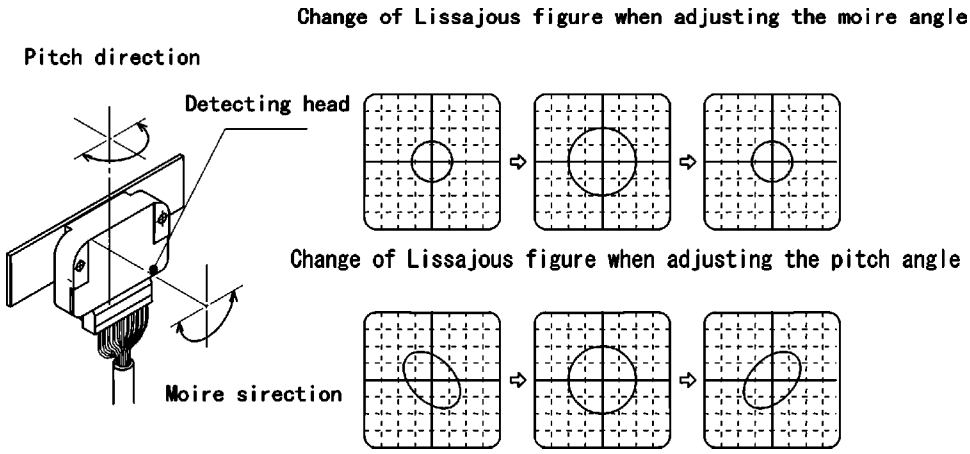
5 Mechanical Adjustment of the Detector

5.1 Checking the Scale Output Signal

1. Turn on the power to the control unit.
2. Set up an oscilloscope as follows:
   Measuring voltage range : 0.5V/div (50mV/div. when a [10:1] probe is used)
   Scanning mode : X–Y
3. Open the I/F box cover. Clip two oscilloscope probes (ch1, ch2) to test pin TP1 (Vref) and the GND probe to TP6 (S. GND) on the board.
   Adjust the horizontal and vertical positioning knobs on the oscilloscope so that the spot is in the center of the CRT.
4. Next, clip the ch1 probe to TP2 (phase A) and the ch2 probe to TP3 (phase B).

5.2 Securing the Detector

As show in the figure below, adjust the moiré angle of the detector so that the Lissajous figure on the oscilloscope becomes maximal, and then secure the detector.



Mechanical adjustment of the detecting head (and the Lissajous figure)

Precautions for mechanical adjustment

(1) The amplitude voltage (V_{PP}) and center voltage (V_{DC}) of the scale signal can be adjusted finely through electrical measurement.

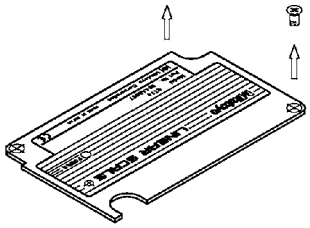
(2) Be careful of a drift in the oscilloscope. It is recommended that an oscilloscope to be used be sufficiently warmed up prior to adjustment. If a drift occurs readjust the luminescent spot on the oscilloscope to the correct position.

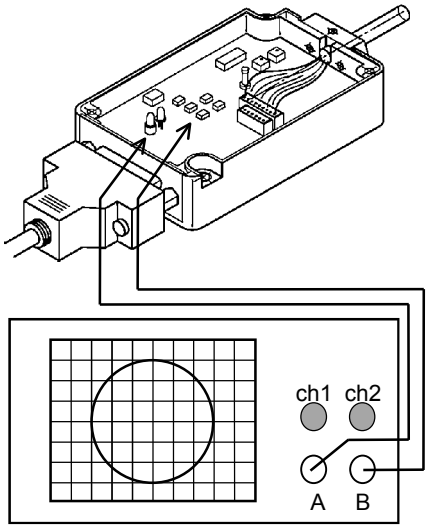
(3) Note that the output signal may vary when the clamp screws are tightened.

NOTE When the detector has been secured after moire angle adjustment, re-check the output signal.

6 Electrical Adjustment of the I/F Box Board

6.1 Electrical Adjustment of the Main Signal





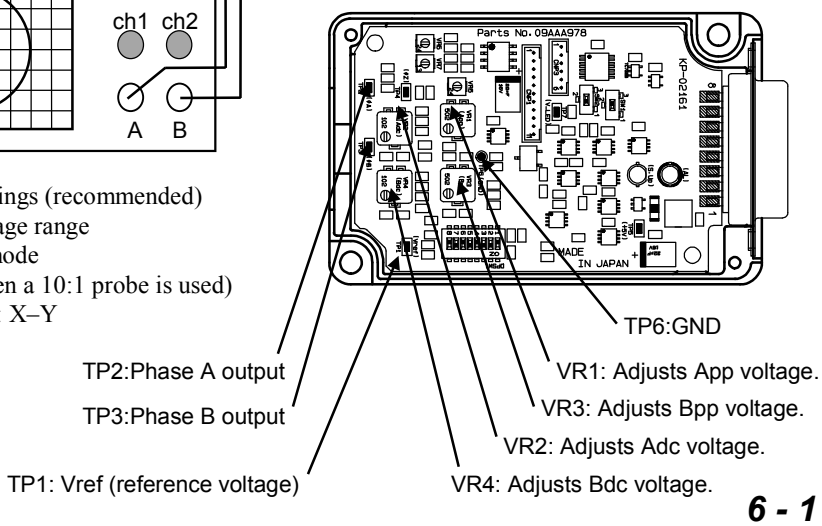
Oscilloscope settings (recommended)
- Measuring voltage range
  0.5V/div. DC mode
  (50mV/div. when a 10:1 probe is used)
- Scanning range: X–Y

Connect the scale system as shown in the left figure.
While moving the detecting head adjust the center voltage and amplitude voltage of the scale signal with the volume controls on the I/F box board.
Input the phase A output signal (TP2) to the X axis and the phase B output signal (TP3) to the Y axis to display a Lissajous figure. The horizontal axis and vertical axis of the figure represent the X axis and Y axis of the oscilloscope.

●Adjustment procedure

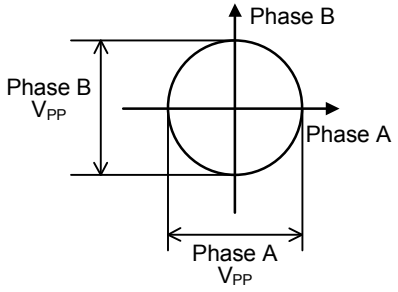
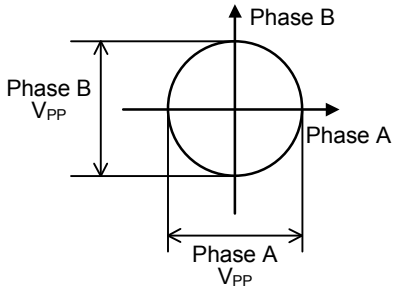
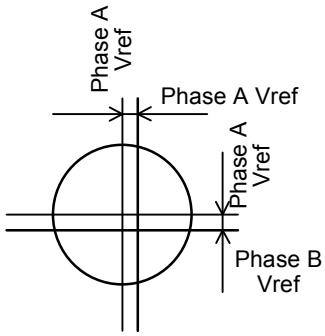
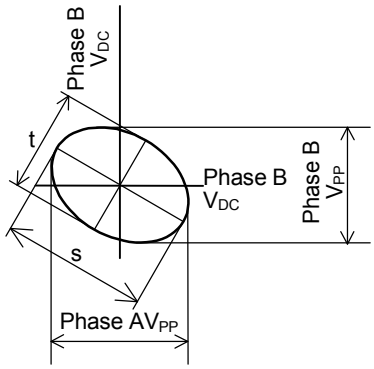
Clip the two oscilloscope probes to TP1 (Vref) and the GND probe to TP6 (S. GND) on the board. Adjust the horizontal and vertical positioning knobs on the oscilloscope so that the spot on the screen (CRT) is aligned to the center of the cross-hairs.
Next, clip the ch1 probe to TP2 and the ch2 probe to TP3, then adjust the figure using the volume controls on the board as described below.
- Finely adjust the amplitude of phase A output on the horizontal axis (Vpp: amplitude output) with VR1.
- Finely adjust the position of phase A output on the horizontal axis (V_{DC}: center voltage) with VR2.
- Finely adjust the amplitude of phase B output on the horizontal axis (Vpp: amplitude output) with VR3.
- Finely adjust the position of phase B output on the horizontal axis (V_{DC}: center voltage) with VR4.

(Refer to section 6.1.1, "Electrical adjustment of the main signal".)



6.1.1 Electrical adjustment of the main signal

Adjust the main signal so as to meet the specifications shown in the following figures.

Item	Lissajous figure	Rated value	Remark
Amplitude voltage (Vpp)		2.0±0.2V	The voltage varies depending on the adjustment error of the gap (between the detecting head and main scale), parallelism, and moire angle. VR1-Phase A VR3-Phase B
Difference between amplitude voltages (Phase B Vpp – Phase A Vpp)		0±0.2V	The voltage varies depending on the adjustment error of the gap (between the detecting head and main scale), parallelism, and moire angle.
Center voltage (V_{DC})		[Vref]±0.1V	The voltage varies depending on the adjustment error of the gap (between the detecting head and main scale), parallelism, and moire angle. VR2-Phase A VR4-Phase B
Phase error (ø)*1		0±10°	

*1: Phase error ø is determined from t/s (ratio of short diameter to long diameter) shown in the above figure.

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

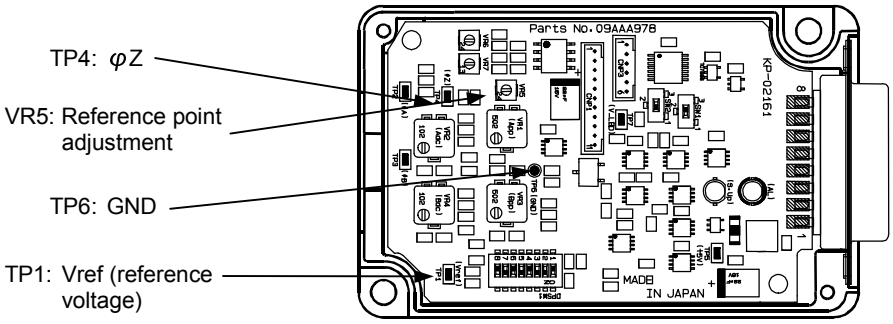
Main signal adjustment specifications

6.2 Electrical Adjustment of the Origin Signal

●Electrical adjustment procedure

Adjust the output signal according to the following procedure, referring to the following figure.

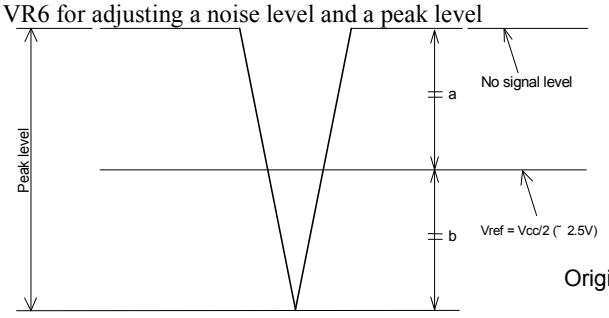
1. Clip the GND probe of the oscilloscope to TP6 (GND) on the I/F box board.
2. Clip the two oscilloscope probes to the check pin TP1 (Vref: 2.5V approx.) on the I/F box board, and then adjust the oscilloscope positioning knobs so that the spot comes to the center of the screen.
3. Clip the ch1 probe to the check pin TP4.
4. Move the detecting head so that the head center comes to the vicinity of the origin signal mark on the main scale. When the main scale or the detecting head is moved along the measuring axis, an origin signal waveform is observed each time the detecting head center passes through the origin signal mark.
5. Adjust VR5 so that the center voltage of the origin signal waveform peak level and noise level becomes Vref (2.5V approx.) indicated by the ch2 probe.



Oscilloscope settings (recommended)
• Measuring voltage range
  0.5V/div. DC mode
  (50mV/div. when a 10:1 probe is used)
• Scanning range: T – Y, Approx. 20msec

6.2.1 Origin signal adjustment specifications

VR6 for adjusting a noise level and a peak level

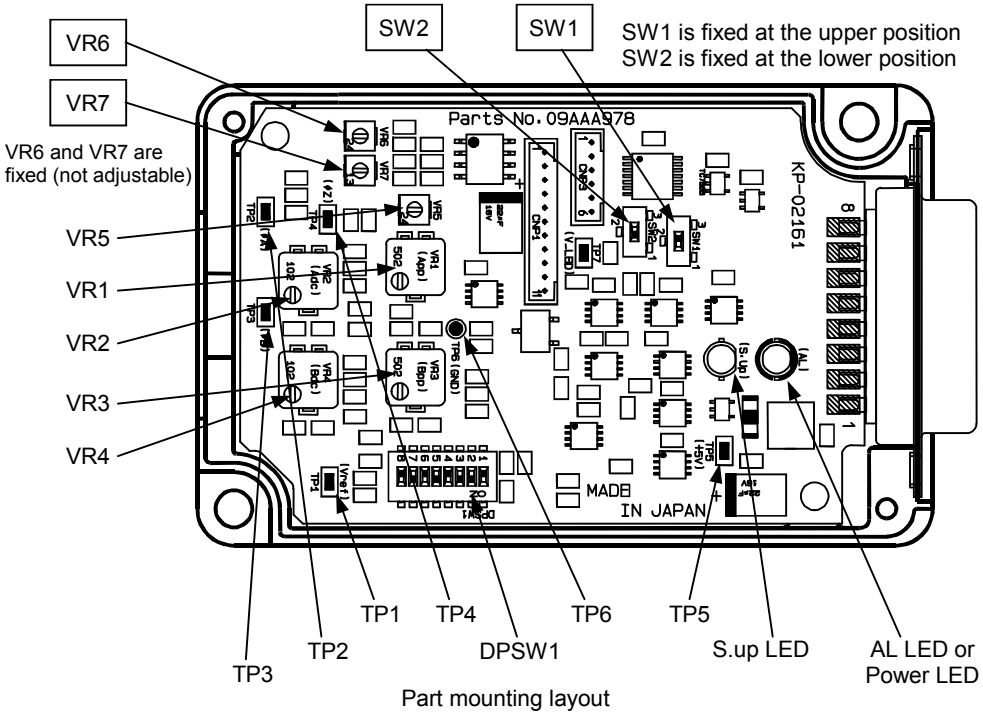


Origin signal waveform

Rated value for adjustment: a/b = 0.9 to 1.1 a, b = 0.4V or more

IMPORTANT Be sure to use the detecting head and interface that have the same serial number.

6.3 Check Pin, Volume Control, and Switch Layout on the I/F Box Board



Part mounting layout

Check pin (silk print)	Signal name	Signal description
TP1	Vref	Reference voltage (2.5V approx.)
TP2	ϕ A	Phase A signal
TP3	ϕ B	Phase B signal
TP4	ϕ Z	Phase Z input signal
TP5	+5V	Power voltage
TP6	0V	GND

Volume control (silk print)	Signal to be adjusted	Description
VR1	ϕA_{PP}	øApp voltage adjustment
VR2	ϕA_{DC}	øA_{DC} voltage adjustment
VR3	ϕB_{PP}	øBpp voltage adjustment
VR4	ϕB_{DC}	øB_{DC} voltage adjustment
VR5	ϕ Z	øZ voltage adjustment
VR6	—	Fixed (Do not adjust)
VR7	—	Fixed (Do not adjust)

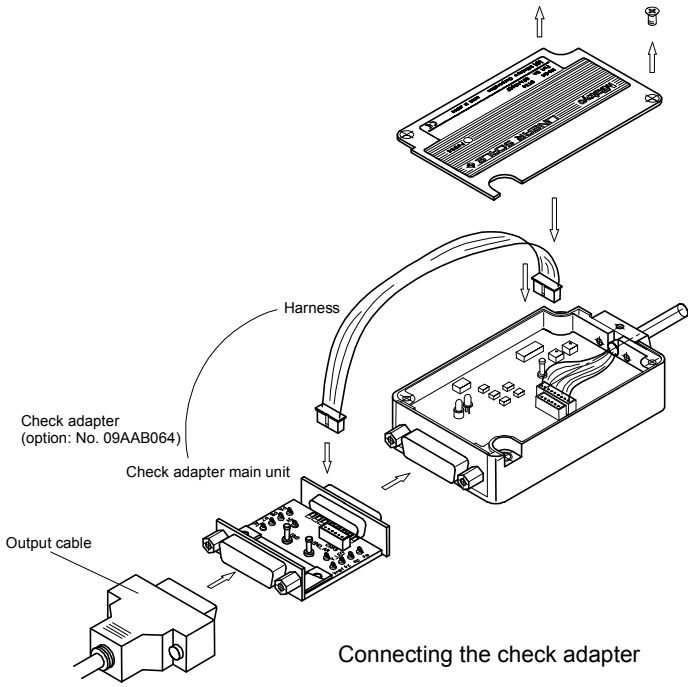
Switch (silk print)	Description
SW1	Fixed (Not selectable) [Fixed at the upper position.]
SW2	Fixed (Not selectable) [Fixed at the lower position.]
DPSW1	Refer to section 8.7, "Output Settings".

6.4 Signal Adjustment with the Check Adapter

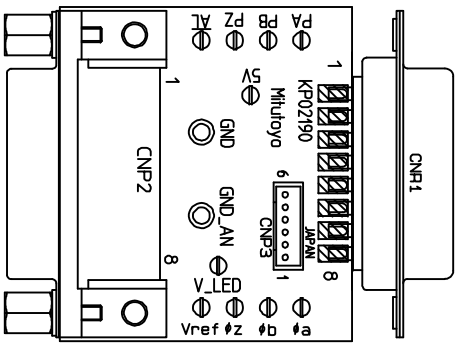
If the check adapter (option: order No. 09AAB064) is used, signal adjustment can be made more efficiently.

Perform signal adjustment according to the following procedure. (See the following figure)

1. (Connection)
   Connect the check adapter between the I/F box output connector and the connecting cable. Connect the supplied harness (lead wire with square type connectors) between CNP1 on the check adapter board and CNP3 on the I/F box board.
2. (Connecting the GND probe)
   Clip the GND probe of the oscilloscope to GND_AN (corresponding to TP6 on the I/F box board) on the check adapter.
3. (Adjusting the main signal)
   Perform the same adjustment as described in section 6.1, using the check adapter's reference voltage Vref (corresponding to the voltage at TP6 on the I/F box board), phase A main signal øa (corresponding to the signal at TP2 on the I/F box board), and phase B main signal øb (corresponding to the signal at TP3 on the I/F box board), respectively.
4. (Adjusting the origin signal)
   Perform the same adjustment as described in section 6.2, using the check adapter's Vref (corresponding to the voltage at TP1 on the I/F box board) and øz (corresponding to the signal at TP4 on the I/F box board).
   It is possible to confirm a square wave divided by PA, PB, and PZ of the check adapter and the origin pulse signal. (At this time clip the GND probe of the oscilloscope to GND on the check adapter.)



Connecting the check adapter



Pin layout on the check adapter

NOTE Since the check adapter is not shielded as the system component, some noises may be generated.
Connect the check adapter to the I/F box only for performing signal adjustment of the I/F box board.

7 Processing the Cables (Routing and Clamping)

7.1 Processing the Cables (Routing and Clamping)

Connect the signal cables between the units that comprise the system, then clamp those cables.

* If using the dual-phase square wave output signals use the shielded cable that has been wired according to section 4.3, "Connecting the Cable Wires (If Using Square Wave Output Signals)".

■Precautions in routing cables

- In order not to apply force to the detecting head during machine operation, clamp the head cable to a component which is near the detecting head and moves along with it.
- Be sure to ground the I/F box case to the machine body.
- Be sure to ground the shield sheath of the head cable with the supplied cable clamp.

Also process the cables according to the following precautions.

NOTE

- Confirm that the input power voltage at the inlet of the I/F box is 5V ±5%. (Check the voltage between TP5 [+5V] and TP6 [GND].)
- Use a shielded cable for the signal cable.
- Do not bind the head cable and the signal cable along with the power line of a motor, etc.
- Clamp the shield braided wire (FG) to the metal shell of the supplied connector. If this is difficult to be made, connect the shield wire to pin number 15.
- An alarm is reset when the power is turned on. If it is necessary to reset alarms from the I/F box side, connect the cable wires as shown in section 8.6, "Alarm Reset Input (Only for the Reset Input Specification)".
- For information about the connector pin assignment, refer to section 8.10, "Connector Pin Assignment".
- Curvature of the signal cable
  The radius of curvature of signal cable must not be smaller than the following.
  - If the cable is fixed: R50
  - If the cable has slack and is repeatedly bent/extended: R100

  High-flexing resistance cable is available. Please contact the nearest Mitutoyo sales office.

7.2 Confirming the Mounting and Adjusting Conditions

When the mechanical adjustment of the detecting head and the electrical adjustment of the interface have been completed, recheck the mounting and adjusting conditions of the main scale and the detecting head.

●Confirmation precaution

Proceed confirmation while carefully checking that the detecting head will not come into contact or interfere with the main scale or any component on the machine system.

●Confirmation procedure

1. Confirm that there are no screws or clamps on each part, which have not been tightened yet.
2. Turn off the control unit power once, then turn it on again after 5 to 10 seconds.
   (The alarm function may be performed during adjustment procedure. To reset an alarm, exercise the above operation.)
3. Confirm that the output signals meet the rated values over the entire travel range of the machine. If any of them does not meet the rating, recheck the main scale contamination, electrical and mechanical adjustments, etc.
4. Confirm that the alarm device on the control unit will not activate over the entire travel range of the machine.
5. Remove the oscilloscope probes, and then remount the interface cover.

7.3 Mounting the Protect Cover

Mount the protect cover that has been made when the mounting surface on the machine was designed in section 2.1, "Designing the Scale Mounting Position".

●Precaution during mounting operation

Exercise care so that the protect cover will not come into contact with a part of machine body, scale unit cable, and other moving members. Confirm that this problem will not occur over the entire travel range of the machine.

This completes the mounting and adjusting procedure of the scale unit.

8 Specifications

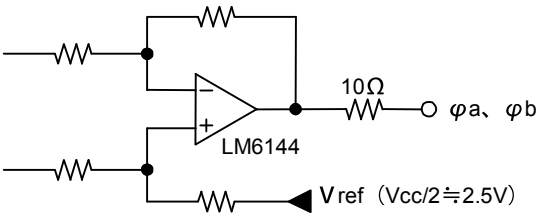
8.1 Major Specifications

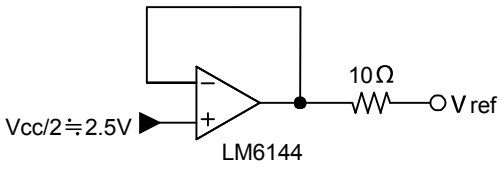
Item	Specification
External dimensions	See section 8.11, "External View".
Detecting method	Optical reflection type: linear encoder Light source: LED Photoelectric device: photodiode
Main scale grating pitch	40 μm
Main signal (sine wave) output pitch	40 μm
Resolution	5, 1, 0.5, 0.2 (μm) selectable
Minimum pulse edge interval	125, 250, 500, 1000 (ns) selectable
Output format	Dual-phase square wave, sine wave (40 pitch) concurrent output
Output system	Differential line driver (dual-phase square wave)
Displacement accuracy (at 20°C)	$\pm$1 μm (10 to 300mm) $\pm$2 μm (350 to 500mm) $\pm$3 μm (600 to 1000mm)
Maximum feed speed	2000mm/sec (max. speed for use with the sine wave) The max. feed speed for use with the square wave is as follows depending on the resolution. 5000mm/sec for 5µm resolution 5000Mm/sec for 1µm resolution 3600mm/sec for 0.5µm resolution 1500mm/sec for 0.2µm resolution (at the minimum pulse edge interval 125ns) * When the minimum pulse edge interval is doubled, the maximum feed speed is halved.
Scale origin detection function	Installed
Response speed for scale origin detection	20mm/sec
Coefficient of linear expansion of the main scale	$(8\pm1)\times10^{-6}$ ℃

Item	Specification
Detecting head mass	Approx. 10g
Interface mass	Approx. 170g (including the cable)
Supplied power voltage	DC5V±5%
Maximum current consumption	250mA
Operating temperature range	0 to 40°C
Storage temperature range	-20 to 60°C
Operating/storage humidity range (relative humidity)	20 to 80% RH (with no condensation)
Head cable length	1m (cable length between the detecting head and I/F box)
Signal cable length (optional accessory)	Standard: 3m

8.2 Sine Wave Signal Output Circuit

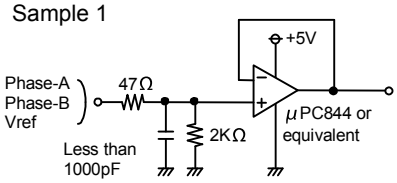
The output circuits of main signal sine waves (Phase A and Phase B) and reference voltage are as given in the figure below.



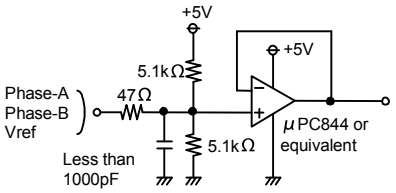


Recommended output circuits of main signal sine wave (phase-A, phase-B)

Sample 1

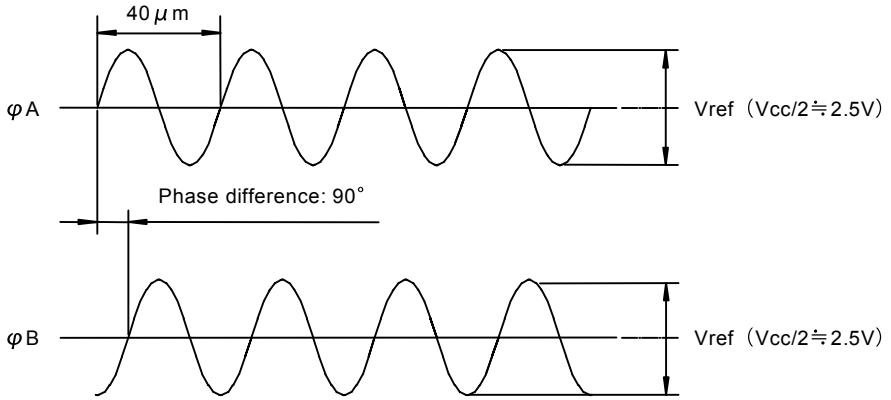


Sample 2



8.3 Sine Wave Output Signal Waveform

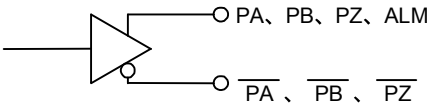
The waveforms of sine wave output signals (phase A and phase B) are as given in the figure below.



* If the alarm reset input is specified for the I/F box, the sine waves are not outputted.

8.4 Square Wave Signal Output Circuit

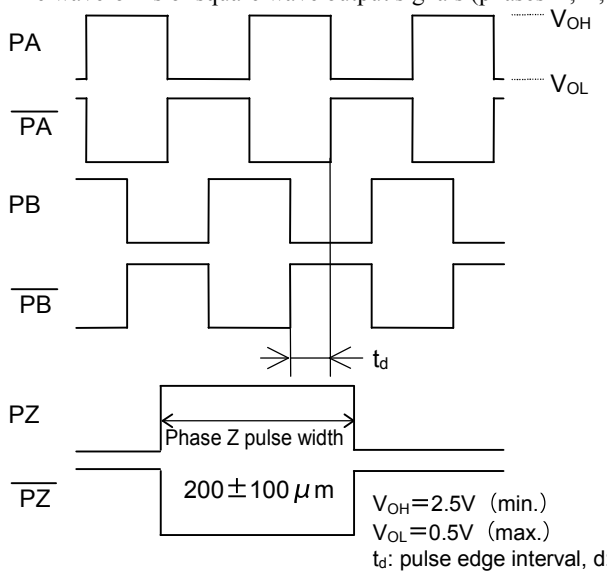
The output circuits of square wave output signals (phase A and phase B), are as given in the figure below.



Differential line driver
AM26LS31 or equivalent Differential line driver
AM26LS31 or equivalent

8.5 Square Wave Signal Output Waveform

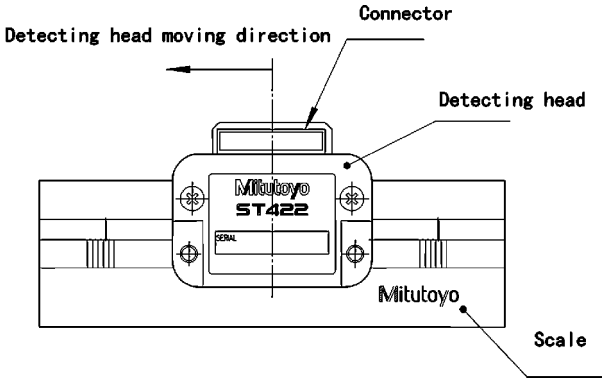
The waveforms of square wave output signals (phases A, B, and Z) are as given in the figure below.



V_{OH}=2.5V (min.)
V_{OL}=0.5V (max.)
t_d: pulse edge interval, d: resolution

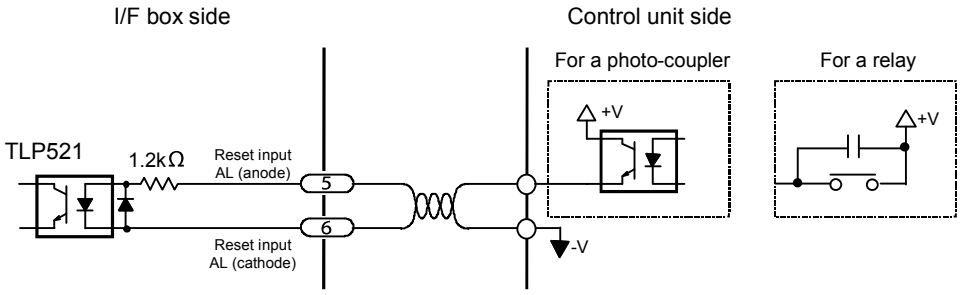
NOTE There is no relationship with the phase difference between the PZ signal and PA signal (or PB signal).

* The above waveforms are given if the DPSW1-8 switch is set to OFF and if the detecting head is moved as shown below.



8.6 Alarm Reset Input (Only for the Reset Input Specification)

• Alarm reset input connection



• Reset input circuit

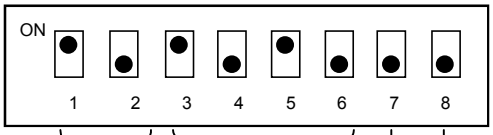
The alarm reset input circuit must be connected so that the operating current is 3 to 10mA. Since the circuit is provided with a built-in resistance (1.2kΩ) on the I/F box board, it is possible to execute alarm reset by giving a voltage of 5 to 12V between the AL (anode) line and AL (cathode) line.

If more than 12V is applied between the anode and cathode lines, add a resistance to the external.

8.7 Output Settings

The I/F box output conditions can be set using the DIP switch DPSW1 on the I/F box board.

DPSW1



Minimum pulse edge interval

	1	2	Minimum Pulse edge interval
	OFF	OFF	1 μ sec
	OFF	ON	500nsec
●	ON	OFF	250nsec
	ON	ON	125nsec

* The operation at a setting other than those in the table cannot be guaranteed.

Resolution

	3	4	5	6	Resolution
	ON	OFF	OFF	OFF	5 μ m
●	ON	OFF	ON	OFF	1 μ m
	OFF	ON	ON	OFF	0.5 μ m
	OFF	OFF	OFF	ON	0.2 μ m

* The operation at a setting other than those in the table cannot be guaranteed.

High-impedance mode

	ON	If an alarm occurs, the I/F box output becomes high-impedance.
●	OFF	If an alarm occurs, the I/F box outputs an alarm signal.

Direction switching (factory-setting: OFF)
(Switching to ON reverses the count direction.)
Refer to section 8.9.4, "Count direction".

●mark: Factory-setting

(Factory-settings may be modified according to the user's request.)

NOTE Do not change switches "SW1" and "SW2" on the I/F box board.

8.8 Maximum Response Speed

Maximum response speed is depending on the following setting.

Setting		Maximum response speed (mm/sec) (Scale pitch: 40 μm)
Resolution (number of divisions)	Minimum pulse edge interval [+0, -10%]	
5 μm (8)	125ns	5000
	250ns	5000
	500ns	3600
	1 μs	1800
1 μm (40)	125ns	5000
	250ns	3600
	500ns	1800
	1 μs	900
0.5 μm (80)	125ns	3600
	250ns	1800
	500ns	900
	1 μs	450
0.2 μm (200)	125ns	1500
	250ns	700
	500ns	300
	1 μs	150

8.9 Alarm Function

8.9.1 Contents of alarm detection

(1) Over-speed detection

The over-speed detection function detects an over-speed of the maximum response speed that has been determined by the settings of the minimum pulse edge interval and resolution, and then turns the "AL_Lamp" red.

(2) Abnormal signal detection

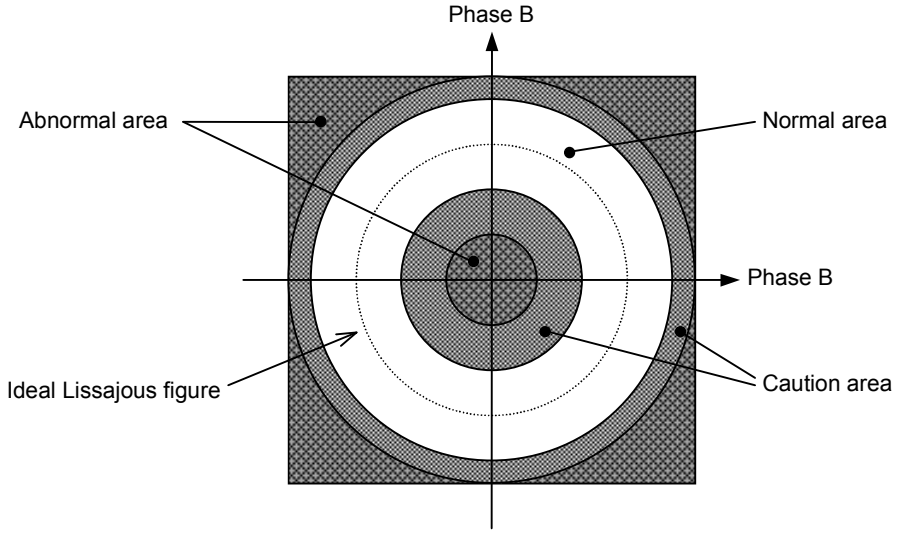
The abnormal signal detection function detects an abnormal waveform of input sine wave signals, and then turns the "AL_Lamp" and "S. Up_Lamp" (setup lamp) to the following combinations of colors as listed in the table.

Area	S. Up_Lamp*1	AL_Lamp	Alarm output
Abnormal*2	Goes off	Turns red	Present
Caution*2	Turns red	Turns green	Absent
Normal*2	Turns green	Turns green	Absent

*1: The S. Up_Lamp is mounted on the I/F box board. To identify the lamp state, remove the cover.

*2: About Abnormal, Caution. and Normal areas

- As shown in the figure below, the size (larger/smaller) of input sine wave signals is expressed by dividing it into three kinds of areas. With these areas displayed by LEDs, the Lissajous figure conditions of input sine wave signals can be easily recognized.
- It is recommendable to use the scale unit in the Normal area. If the scale unit is used in the Caution area, the resolution accuracy will deteriorate although an alarm does not occur.



Guide to the voltage range of Abnormal or Caution area

Area	Voltage range to be set (guide)
Abnormal	0.5Vpp or less, 2.9Vpp or more
Caution	0.9Vpp or less, 2.7Vpp or more

* The above setup ranges are determined when the power voltage is 5.0V. If the power voltage fluctuates, those ranges also fluctuate along with the input range in proportion to the power voltage. Use the voltage ranges as a guide.

8.9.2 Alarm operation

(1) Line driver output

- When the high-impedance mode is ON:
  All the outputs become high-impedance.
  (High impedance is not electrically "H (high)" or "L (low)", but a state of floating.)
- When the high-impedance mode is OFF:
  The AL signal (active "L") is outputted.
  (However, other output signals (PA, PA-bar, PB, PB-bar, PZ, and PZ-bar) are successively outputted.)

(2) Alarm lamp

The power lamp turns red from green.

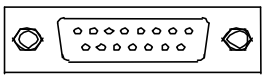
8.9.3 Alarm resetting

After the cause of an alarm has been cleared, reset the alarm by either of the following:

- Restart the system power. (Turn the power on again in 10 seconds or more after turning the power off.)
- Input the alarm reset signal from the external. (Pulse width: 100ms or more)

8.10 Connector Pin Assignment

I/F box output connector



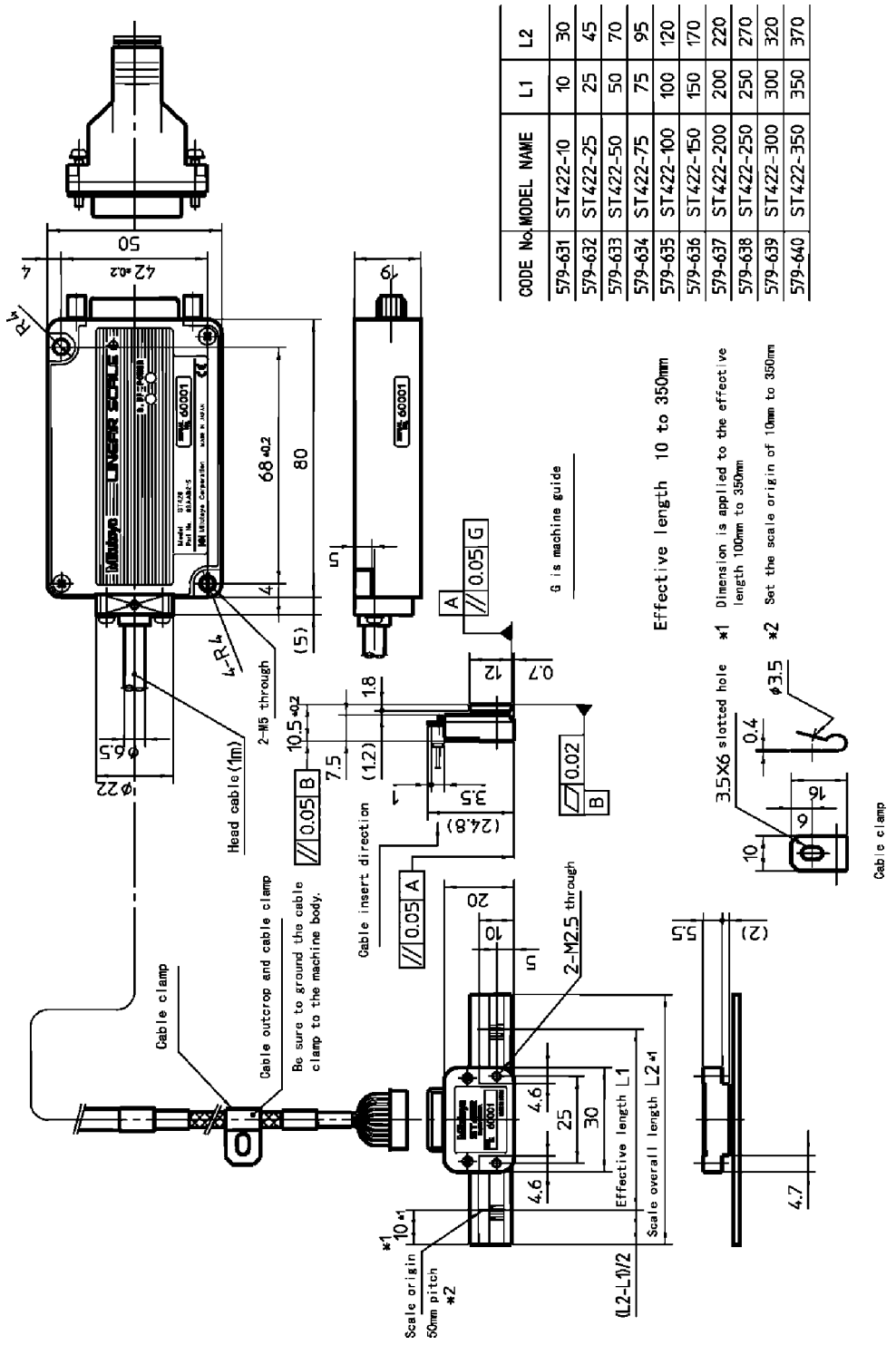
Output connector: RDBD-15P-LNA (05) (Hirose)
Applicable plug: D15-403N-110 (Chuomusen) [Standard accessory]

Pin No.	Signal name
1	0V (GND)
2	0V (GND)
3	+5V (Vcc)
4	+5V (Vcc)
5	Phase A (sine wave) [Reset input-AL (anode)]
6	Phase B (sine wave) [Reset input-AL (cathode)]
7	Vref（≒Vcc/2）
8	PZ (scale origin)
9	ALM (alarm)
10	PA
11	PA
12	PB
13	PB
14	PZ
15	F.G

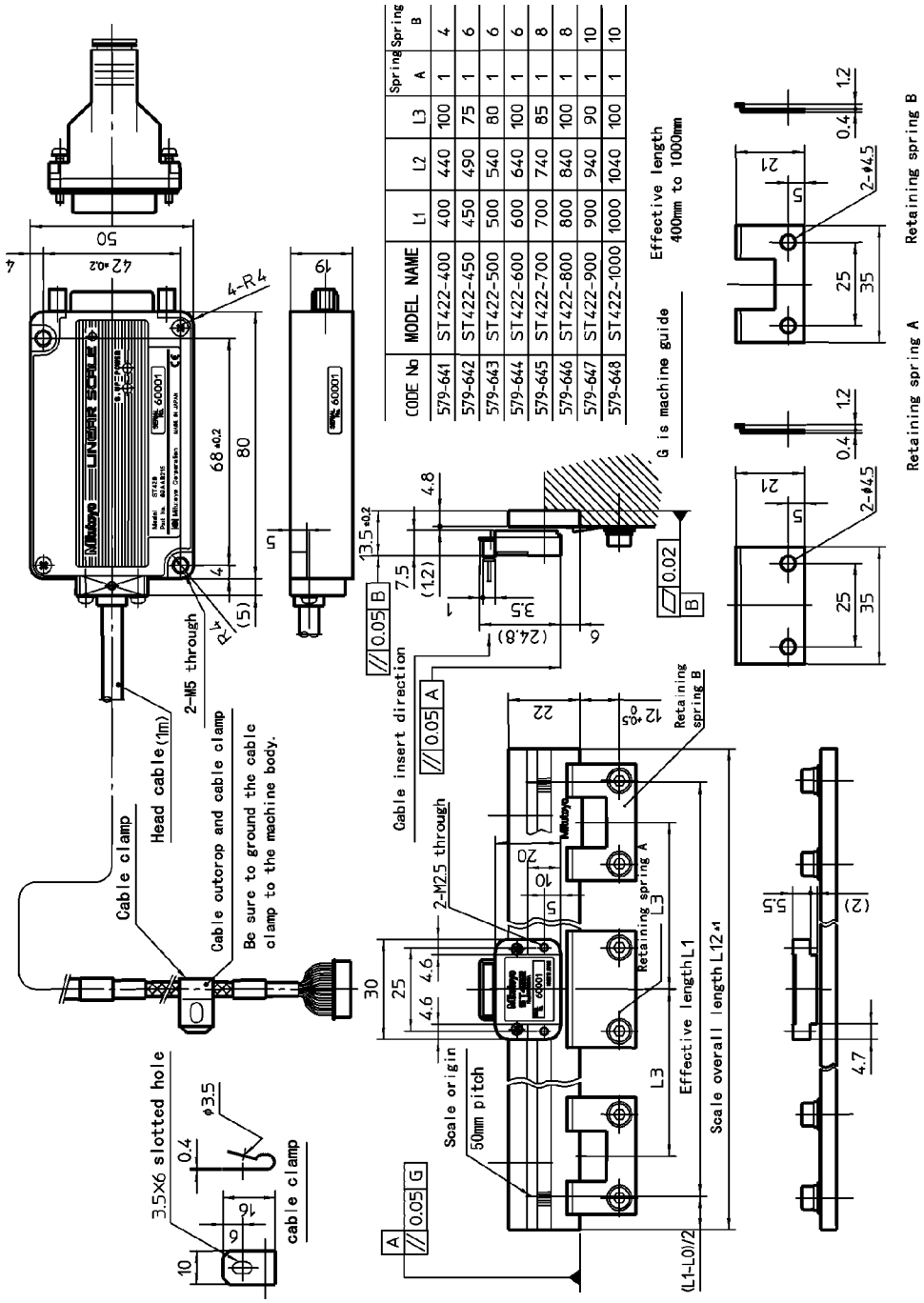
* The content in [ ] indicates the alarm reset specification.

8.11 External View

8.11.1 Effective length (10 to 350mm)

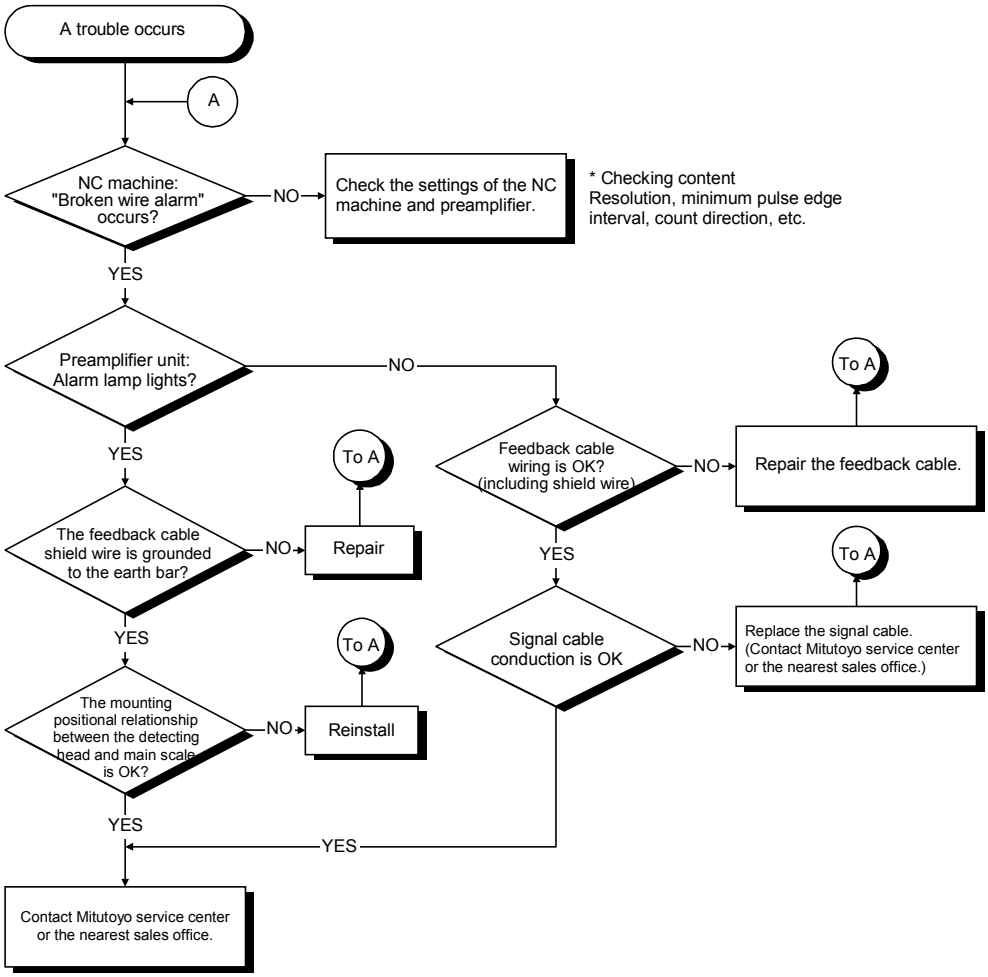


8.11.2 Effective length (400 to 1000mm)



9 Troubleshooting

If the system does not operate when the power is turned on for the first time after installing the scale unit, or if an alarm occurs due to some cause during continuous operation, check the NC machine, scale unit and relevant devices according to the following troubleshooting flow.



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