ONO SOKKI

# CL-2400

## NONCONTACT THICKNESS METER

## INSTRUCTION MANUAL

ONO SOKKI CO., LTD.

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4. Ono Sokki shall have no liability for any effect resulting from any operation, whether or not the effect is attributable to a defect in the documentation.

# Warranty

1. This product is covered by a warranty for a period of one year from the date of purchase.
2. This warranty covers free-of-charge repair for defects judged to be the responsibility of the manufacturer, i.e., defects occurred while the product is used under normal operating conditions according to descriptions in this manual and notices on the unit label.
3. For free-of-charge repair, contact either your sales representative or our sales office nearby.
4. The following failures will be handled on a fee basis even during the warranty period.
   (a) Failures occurring through misuse, mis-operation, or modification
   (b) Failures occurring through mishandling (dropping) or transportation
   (c) Failures occurring through natural calamities (fires, earthquakes, flooding, and lightening), environmental disruption, or abnormal voltage.

* For repairs after the warranty period expired, contact your sales representative or our sales office nearby.

# PREFACE

This Instructions Manual explains the functions, specifications, connecting instructions, and precautions to use the CL-2400 Noncontact Thickness Meter.
In order to correctly use the CL-2400 Noncontact Thickness meter, be sure to read this manual thoroughly in advance.
Violating some of the precautions described in this manual might cause defects in your property rights. Be sure to follow the steps described in this manual.
Because this manual contains a warranty, please keep it after reading.

<Notes>

1. Before shipping, CL-2400 was strictly inspected and proved to function normally.
2. Upon delivery, inspect CL-2400 for damages which might be caused by transportation and make sure that it functions normally, referring to this manual.
3. If any damage or malfunction is found in CL-2400, call ONO SOKKI or the sales representative from which you have purchased it.

# FOR YOUR SAFETY

Before starting to use the CL-2400 Noncontact Thickness Meter correctly, be sure to read this manual, especially this section, in advance.

ONO SOKKI, Ltd. shall bear no responsibility or warranty on damages or defects resulting from failures to following the directions described in this manual.

## Measurement

● WARNING and CAUTION

In this document, the dangers which may arise due to operation neglecting the instructions described in it are classified into two categories, or "WARNING" and "CAUTION", according to the degree of severity.

| | |
|---|---|
| **WARNING** | This symbol is used to indicate precautions where there is a risk of death or serious personal injury to the operator if the product is handled incorrectly. |
| **CAUTION** | This symbol is used to indicate precautions where there is a risk of some personal injury to the operator or only material damage to the product if the product is handled incorrectly. |

WARNING

## Before Using

- Discharge the measurement objects.
  This product has no overvoltage protection function for the sensors and sensor amplifiers due to its sensing mechanism. Trying to measure a charged object may destroy the sensor amplifier. Before starting measurement, be sure to discharge the objects completely with a discharging brush, discharging blower, etc.

- Use CL-2400 with the rated voltage.
  The standard rated voltage range is 100 to 240 VAC ±10%. Using CL-2400 under voltage outside this range may damage CL-2400. Before turning the power ON, Make sure that the power voltage is in the allowable range. For CL-2400, use a power supply system independent of heavy electrical equipment, if any.

- Use fuses of the specified ratings (current, voltage, and melting characteristics) for CL-2400.
  Use of unacceptable fuses may cause a fire. Before replacing a fuse, be sure to turn the power OFF, disconnect the power cable, and wait more than 1 minute.

  | Power voltage supplied | | Fuse of slow-blow type |
  |---|---|---|
  | 100 to 240 VAC | → | 3 A (EAWK 3.15 A) × 2 |

- Do not use CL-2400 in environment containing gas or steam.
  Using CL-2400 in environment containing combustible or explosive gas or steam may cause explosion.

- Do not use CL-2400 under high temperature.
  To avoid fires, do not use CL-2400 under high temperature. Using CL-2400 under a temperature exceeding the allowable range (0°C to +40°C) might cause CL-2400 to burn.

- Do not disturb heat radiation. Always leave the cooling fan on the side panel ON.
  Heat held inside CL-2400 may cause a fire. Install CL-2400 away from a wall in a ventilated environment. Do not mount CL-2400 sideways.

- Never use CL-2400 with its parts removed or disassembled.
  Using CL-2400 with its parts removed or disassembled may cause damages on CL-2400 or operator. If internal adjustment, inspection, or repair is necessary, call ONO SOKKI or the sales representative from which you purchased CL-2400.

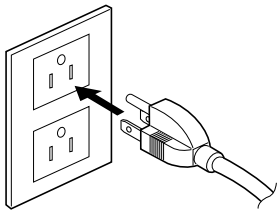
- Do not splash or spill water to CL-2400.
  Splashing or spilling water to CL-2400 may cause a fire or electrical shock. If water gets inside CL-2400, immediately disconnect the power cable and call ONO SOKKI or the sales representative from which you purchased CL-2400.
- Do not apply excessive shock or vibration to CL-2400.
- Do not use CL-2400 near devices generating strong noise (such as a large solenoid valve or large motor).
  Using CL-2400 in such an environment may cause malfunctions.
- Never perform electrostatic breakdown tests for the sensors and sensor input.
  This product has no overvoltage protection function for the sensors and sensor amplifiers due to its sensing mechanism. Never perform electrostatic breakdown tests.\

## WARNING

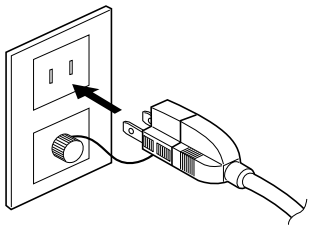
### Protective Grounding

- The "⏚" mark indicates a protective grounding. Before turning the CL-2400 power ON, be sure to connect the protective ground to the terminal with this mark in one of the ways described below.
  Failure to connect the protective ground may cause an electrical shock. Do not turn the power ON before making sure that the protective ground has been connected.

  • If a three-pronged power cable is shipped together with CL-2400 (one prong is for grounding), use a three-pronged outlet connected to a protective ground.



  • If a 3-way-to-2-way adapter is to be used for the power cable shipped with CL-2400, connect the ground wire of the adapter firmly to the protective ground terminal on the outlet.



WARNING

## Power Cable

- Be sure to use the power cable and plugs shipped with CL-2400 or those specifically designated by ONO SOKKI.
  The standard power cable shipped with CL-2400 is applicable to 125 VAC or less. If you use CL-2400 with voltage over 125 VAC, use the designated power cable (applicable to 250 VAC or more), which is optionally available.
- When CL-2400 is not to be used long time, be sure to disconnect the power cable from the outlet, or it may cause electric shock or fire due to current leakage.
- For a three-pronged power cable, do not use extension cable that has no protective grounding connection. Such a cable makes the protective ground unavailable.

## Precautions Against Electric Shock

- Never disconnect the protective ground connections inside or outside CL-2400. Never remove the connection to the protective ground terminal.
  Doing so may cause electric shock or damages to CL-2400.
- Before connecting CL-2400 to the object to be measured or an external control circuit, make sure that the protective grounding has been correctly done and CL-2400 power is OFF.
  Failure to do so may cause electric shock.
- Keep your hands off the voltage/current output of CL-2400 or from the circuit connected to the voltage/current output of CL-2400 while the power is ON.
  Failure to do so may cause an electric shock. Insulate the circuit so that it can stand the output voltage/current.
- Be sure to use the power supply with the specified voltage, power, and frequency.
  Using unallowable power supply may cause an electric shock, fire, or damages to CL-2400.
- While it is thundering, keep your hands off metallic parts of CL-2400 and plugs.
  Touching the metallic parts or plugs may cause an electrical shock due to an induced lightning. In addition, avoid using CL-2400 outdoors while thundering.

WARNING

## If a Problem Occur

- If any pieces of metal, water, or foreign objects should fall inside CL-2400, immediately disconnect the power plug.
  Using CL-2400 containing such foreign object may cause a fire or electric shock. Immediately disconnect the power plug and call ONO SOKKI or the sales representative from which you purchased CL-2400.
- When smoke or abnormal noise or odor is recognized, or when the instrument is dropped or damaged, immediately disconnect the power plug.
  When smoke or abnormal noise or odor is recognized, if the instrument continues to operate as it is, the danger of a fire or receiving an electric shock may arise. In such cases, immediately disconnect the power plug, and contact your vendor or the nearest ONO SOKKI sales office as soon as possible.

CAUTION

## Installation and Connection

- Do not install CL-2400 in an unstable place.
  If CL-2400 fall down, it may cause damages to the operator or CL-2400.
- Do not put large or heavy objects on the top of CL-2400. Do not drop objects onto the top of CL-2400.
  If objects fall down from the top of CL-2400, it may cause damages to the operator or CL-2400.
- Do not install CL-2400 in a place exposed to oily smoke or steam or in a humid or dusty place.
  Electricity would conduct through oil, steam, or dust, causing a fire or electric shock.
- Do not install CL-2400 in a place subject to very high temperature or direct sunlight.
  Failure to do so may cause a fire.
- If CL-2400 is to be mounted on a panel or rack, care should be taken so that the CL-2400's weight is supported on its bottom.

## Power Cable

- Be sure to hold the power plug when inserting or removing the power cable.
  Pulling the cable itself may give a damage to the cable, resulting in a fire or electric shock.
- Do not connect or disconnect the power cable with wet hands.
  Operating with wet hands may cause an electric shock.
- Keep the power cable away from heat-generating equipment and high-temperature objects.
  The cable coating may melt causing a fire or electric shock.
- If CL-2400 is not to be in use long time, be sure to disconnect the power cable from the outlet or set off the breaker on the power distributor board to prevent electric shock or fire due to current leakage.

CAUTION

## Measurement

- Do not insert or remove I/O connectors during measurement.
  Doing so may cause external devices to malfunction.
- Do not turn the power OFF during measurement.
  Doing so may cause external devices to malfunction.
- Before starting measurement, set the type of the VE Series electrostatic capacitance type gap detector to be used.
  See Section 5.4 “Basic Operation” for the steps.
- Take care of the voltage outputs from the REMOTE connector.
  The REMOTE connector on the rear panel has a +5 V output pin (H pin). Do not short-circuit that pin, or a trouble may occur.
- Do not short-circuit the analog voltage output connectors.
  Do not short-circuit the + and - sides of the ANALOG OUT 1 and 2 connectors on the rear panel, or a trouble may occur.
- Use a sensor cable of the specified length.
  The sensor has been calibrated including the sensor cable. If the cable is not of the specified length, correct measurement is disabled.
- During measurement, keep the VE Series electrostatic capacitance type gap detectors being used off each other, or a damage may occur.
- During measurement, do not bring the VE Series electrostatic capacitance type gap detectors being used near the object under measurement charged with static electricity or do not make them contact each other, or a damage may occur.
- Do not bend the cables with a radius less than 10mm.
  The structure of the sensor cable is very delicate, so the measurement can not be made correctly if the cable is bended over the specified value by the instruction manual.
- If the panel surface is dirty, wipe it gently using soft cloth moistened with diluted detergent or soap water.
  Do not use spirits such as thinner or chemical cloth, or the panel may deforms or discolors.

# Contents

# CHAPTER 1 INTRODUCTION

# 1.1 Overview

CL-2400 is a noncontact-type thickness meter, which allows to precisely measure the thickness of conductors and semiconductors with simple operations. It is used in combination with VE-Series electrostatic-type gap detector that has a lot of achievements as a precise noncontact-type displacement sensor.

With the remote control signal, status output, calibration signal input, and other features, CL-2400 has strengthen its interface with external equipment such as personal computers and sequencers.

The standard CL-2400 is equipped with BCD output and RS-232C features to flexibly cope with upgrading of the measurement control system.

# 1.2 Features

- Noncontact measurement that gives no influence to the measurement object
- Measurement control system upgradable with enriched interface (BCD output, RS-232C, and other I/O features available in standard model)
- Simple operation
- Displaying the maximum/minimum values and the maximum value minus minimum value
- Synchronous operations of multiple systems

# 1.3 Measurable Objects

CL-2400 is designed to measure the thickness of conductors such as metal sheets, and semiconductors. Basically, it is not affected by the materials; however, the structure of the object or the ambient conditions may make measurements impossible in some cases.

## ■ Measurable objects

- Metal sheets
  If a metal sheet is placed on a metallic stand or is being carried on metallic rollers, it can be measured as long as the object and the CL-2400 main unit is made electrically conductive (grounded).
- Silicon wafers
  Measurement is possible in the same manner as metal sheets. ONO SOKKI provides a measurement stand with a silicon wafer carrier. For information, contact ONO SOKKI or the sales representative from which you have purchased CL-2400.
- Double-sided copper-clad boards
  Measurement is possible for double-sided copper-clad boards if they are not yet etch-processed. Both sides should be made electrically conductive (grounded).
- Pasty objects
  Many of pasty objects such as electrode plates of batteries before baking are conductive and can be measured.
- Carbon plates
  Many of plates containing carbon such as gasket are conductive and can be measured.

## ■ Conductors measurable, but requiring some precautions

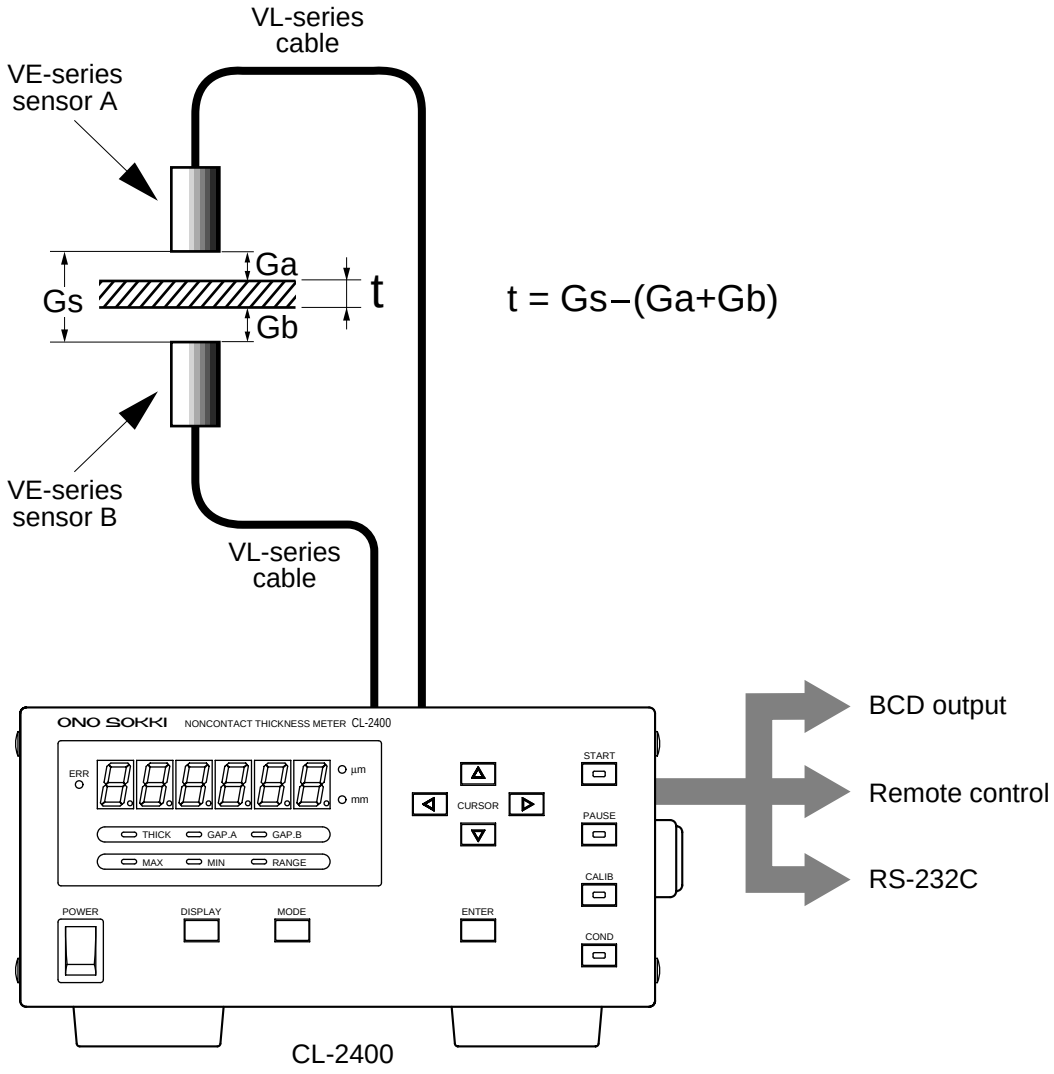
- Alumite
  An aluminum sheet which has been alumite-treated is covered with insulating film, which can cause the measurement results unstable.
- Painted objects
  If the object is painted with insulative material, the measurement results will contain errors.
- Small or narrow objects
  To exert the VE sensor's designed performance, the object being measured must be larger than the sensor outer dimensions. objects narrower or smaller than these dimensions would cause errors to be contained in the measurement results.

- Round objects
  The VE sensor is designed to measure flat objects. Round objects would cause errors to be contained in the measurement results.
- Objects with rough surface
  When a object with rough surface is measured by CL-2400, the measured thickness value displayed will be less than that obtained by a contact-type thickness meter. CL-2400 shows the measurement value which is approximately a mean value of peak and bottom values. CL-2400 may not be able to measure the thickness of objects with very rough surface.
- Porous objects
  If the object under measurement is porous, CL-2400 may show less thickness values than the actual ones, depending on the ratio of holes.
- Inclined objects
  If the object under measurement is inclined with respect to the sensor surface, CL-2400 may show the measurement values containing errors.
- Vibrating objects
  Although simple vertical vibration of the object within the sensor gap causes no problems, vibration accompanied by inclination may produce the same influence as the “Inclined object” above.
- objects which cannot be made electrically conductive (unavailable for grounding)
  Although some of these objects can be measured, others cannot.
- Objects of other types
  CL-2400 may show the measurement values containing errors, according to the object characteristics such as temperature, dust, and mist and the ambient conditions.

## ■ Unmeasurable objects

- Insulated metal sheets
  CL-2400 cannot measure the thickness of a metal sheet totally enclosed with insulative object. For example, aluminum foil laminated with film cannot be measured.
- Single-sided PC boards
- Pattern-etched PC boards
- Round rods or wires
- Floppy disks
- Magnetic tape
- GaAs wafers

# 1.4 System Configuration (for Conductor Measurement)

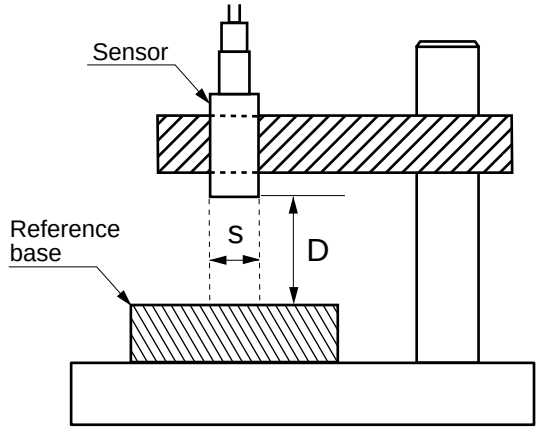



Note: This product has no overvoltage protection function for the sensors and sensor amplifiers due to its sensing mechanism. Trying to measure a charged object may destroy the sensor amplifier. Before starting the measurement, be sure to discharge the measurement objects with a discharging brush, discharging blower, etc.

# 1.5 Principles of Measurement

## ■ Overview

The VE-series gap detector is used to measure the gap or displacement based on the electrostatic capacitance between the sensor and the object under measurement. Electrostatic capacity C is a function of opposing area S of the conductors and gap D. If the opposing conductors (sensor and object under measurement) are in parallel to each other, C can be calculated by expression (1) below. Where, E is the dielectric constant of the air.



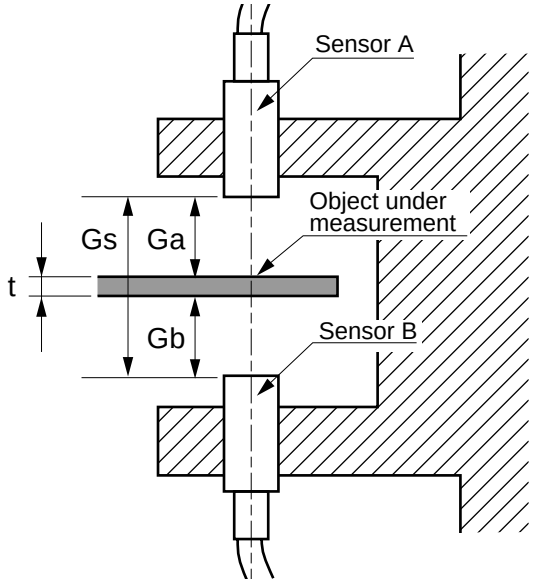

$$C = \varepsilon \frac{S}{D} \quad .....(1)$$

E = Dielectric constant of air

If area S is constant, gap D will be in inverse proportion with electrostatic capacitance C. Generally, an electrostatic capacitance sensor requires linearization. However, ONO SOKKI's CL Series thickness meters directly obtain the voltage, which is in proportion with gap D, using our own high-precision arithmetic circuit, convert the voltage to digital values, and calculates and displays the thickness or displacement using the built-in microcomputer.

## ■ Measurement for conductors

In this measurement, place two sensors in parallel to each other, keeping the precalibrated gap (Gs) between them, and then set the gap in the counter area.
Insert the object to be measured between sensors A and B, measure the gaps (Ga and Gb) to the both sensors, and obtain the object thickness (t) by subtracting the gap values from the set value.




$$t = Gs - (Ga + Gb) \quad \text{..... (2)}$$

# CHAPTER 2
# SENSORS

# 2.1 Sensor Types

## ■ VE series specifications

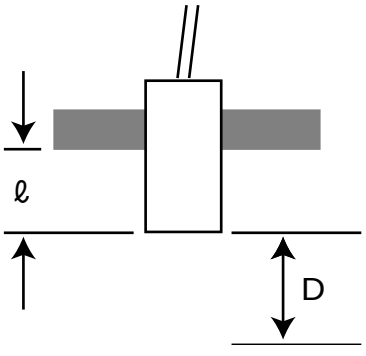
| Model | VE-121 | VE-222 | VE-521 | VE-133 | VE-231 | VE-531 |
|---|---|---|---|---|---|---|
| Gap rating | 0 to 0.1mm | 0 to 0.2mm | 0 to 0.5mm | 0 to 1.0mm | 0 to 2.0mm | 0 to 5.0mm |
| Resolution | 0.1μm | | | | 1μm | |
| Linearity | ±0.15% of full-scale | | | | | |
| Minimum target diameter | ø3 | ø6 | ø8 | ø10 | ø20 | ø40 |
| Signal cable | Cable attached (2.5 m) | | | Optional: VL-331 (3 m)/VL-332 (5 m) | | |
| Operating temperature range | 0 to +80°C | | | | | |
| Temperature coefficient | $K_1 = 1.7 \times 10^{-5}$ / $K_2 = 3.4 \times 10^{-5}$ | | | | | |
| Dimensions | ø3×17mm | ø6×10mm | ø8×17mm | ø10×21mm | ø20×30mm | ø40×30mm |
| Weight | 73 g (including cable) | 73 g (including cable) | 78 g (including cable) | 7.1g | 60g | 123g |

Notes:
1. "Gap rating" means the maximum gap between the sensor end and the object under measurement.
2. "Minimum target diameter" indicates the minimum area the surface opposed to the sensor surface must have to obtain the rated accuracy.
3. "Operating temperature range" is the range of temperatures under which the sensor is functional; this range does not assure the rated accuracy. To obtain the rated accuracy, the sensor must be used at temperature 23±5°C.
4. "Resolution" is the display resolution when the sensor is used in combination with CL-2400.
5. The VE sensor temperature characteristics are given by the following expression:

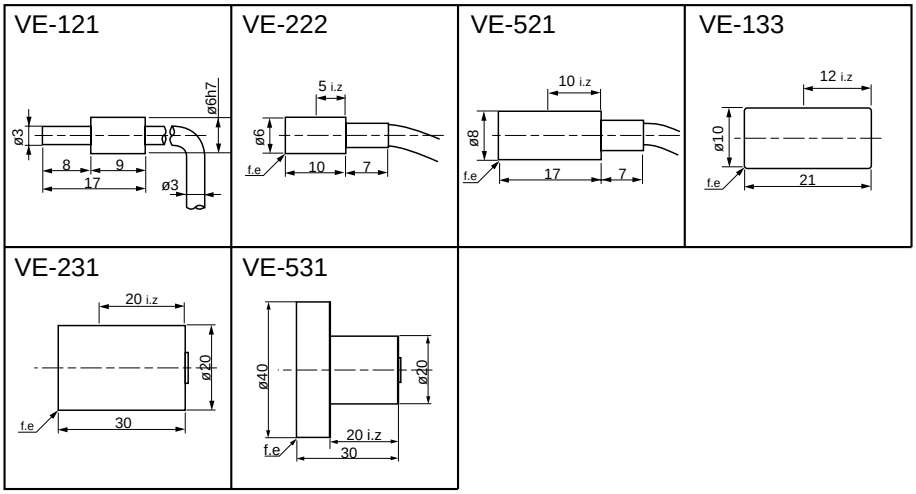
$$\triangle D = (K1 \times \ell + K2 \times D) \triangle t$$

where,

K1 : Linear inflation factor of sensor housing material
K2 : Area inflation factor of sensor electrode material
△t : Temperature change
D : Measurement gap
△D : Transducer output change

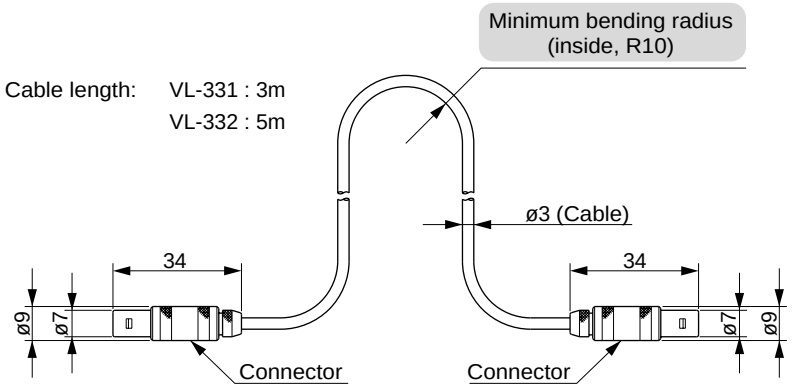


## ■ VE series outside dimensions




Notes:
1. "f.e" stands for "face end" indicating the sensor surface.
2. "i.z" stands for "insert zone" indicating the area where the sensor should be fixed.
3. VE-121, -222, and -521 have their cables attached.
   VE-231 and -531 require optional sensor cables VL-331, or -332. (See 4) in Sections 2.2 and 2.3 in page 2-3.)

## ■ VL-331, and -332 outside dimensions



## 2.2 Sensor Selection

This section gives the considerations to be made for selecting the sensors:

1) Accuracy and resolution
   The resolution is determined by the sensors used.
   A sensor with a less gap rating will produce higher resolutions, but with less gap to the target shown in 2) below.

2) Allowable gap
   If the object under measurement would vibrate while it passes through between sensors, select a sensor gap (gap between the sensor and object) which is larger than the amplitude of vibration.

3) Size of object under measurement
   The VE sensor requires that the object under measurement has an area larger than the minimum target diameter of the sensor rating.
   For example, when VE-231 (minimum target diameter is 20 mm) is used, an object 10 mm wide cannot be measured.

4) Physical limitations to mount
   VE sensors have a relatively large size to ensure the accuracy. Before actually mounting a VE sensor, make sure that there is an enough space for it. Note that cables and cable connectors also require a certain space.

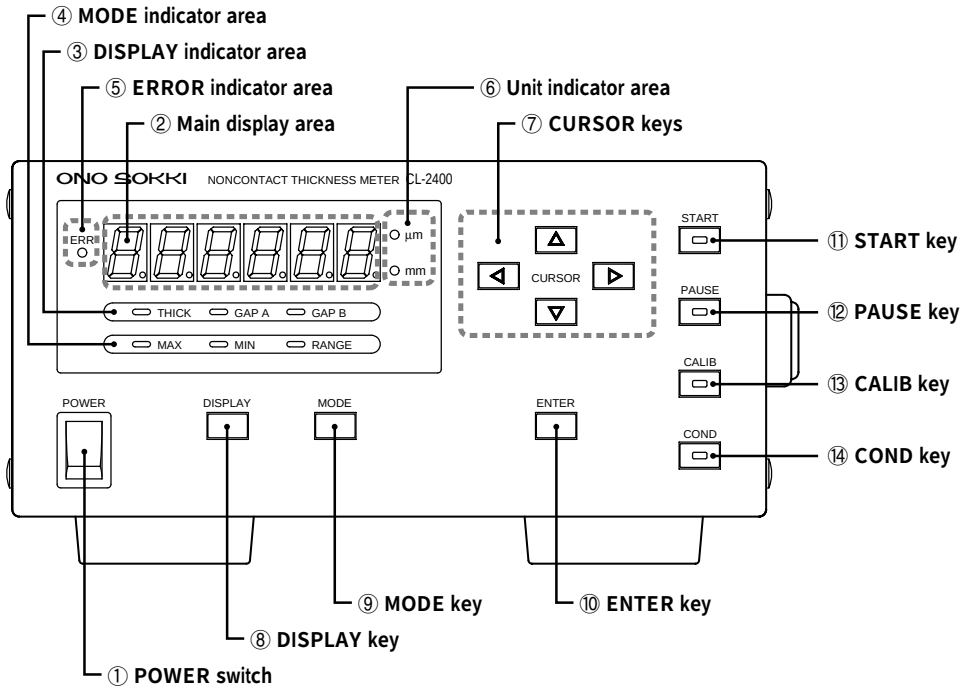
## 2.3 Sensor Cables

1) Use only the dedicated VL cables or the cables shipped with the sensor.
   Sensor cables have a special structure and should be assumed as a part of the sensor. Do not use other cables, and never extend or shorten the cables by yourself. Doing so may cause the accuracy to be lowered or troubles to occur.

2) Use the sensor with its respective cable.
   VL cables of the same length may be used interchangeably, but those of different length may cause the characteristics to be changed. For each sensor, purchase and use the respective cable.

# CHAPTER 3
# CONTROLS ON PANELS

# 3.1 Front Panel




① POWER switch

The POWER switch is used to set the power ON/OFF.
After the POWER switch is set ON, it takes 15 to 20 seconds before the display appears.

② Main display area

This area shows various measurement results and the selected items and set values for the set mode.

③ DISPLAY indicator area

The LED for the THICK, GAP A, or GAP B item selected by DISPLAY goes on.

④ MODE indicator area

The LED for the MAX, MIN, or RANGE item selected by MODE goes on. When all of them are off, the main display area indicates the average value for every 0.2 second.

⑤ ERROR indicator area

The LED goes on when one of the following errors has occurred:

- The GAP A or GAP B value has exceeded 130% of the sensor ratings.
- The calculated THICK value is negative (due to a calibration error).
- The calculated value has overflowed the display digits.

⑥ Unit indicator area

The LED for É m or mm selected in the set mode goes on.

⑦ CURSOR keys

Use the CURSOR keys to select the items to be set or to enter values. ◁ and ▷ keys are for moving the digits; △ and ▽ keys are for scrolling the item or digits.

⑧ DISPLAY key

Pressing DISPLAY key causes to scroll as THICK → GAP A → GAP B. Use this key to select the item to be displayed. The selected item can be checked with the LED in the DISPLAY indicator area.

⑨ MODE key

Pressing MODE key causes to scroll as MAX → MIN → RANGE. Use this key to select the item to be displayed. The selected item can be checked with the LED in the MODE indicator area. When all LEDs in this area are off, the average value for every 0.2 second is displayed.

⑩ ENTER key

Use the ENTER key to determine the selected and entered values. In a setting mode, pressing the ENTER key causes the next setting item to be displayed.

⑪ START key

Use this key to start the measurement. The LED remains on during the measurement. Pressing this key during the measurement stops it and the LED goes off.
When the POWER switch is turned ON, the display shows "0" before starting the measurement and shows the preceding measurement value after stopping the measurement.

⑫ PAUSE key

During measurement, pressing the PAUSE key holds the measurement, displays the preceding measurement value, and lights the LED. Pressing this key again restarts the measurement. Holding the measurement with the PAUSE key differs from stopping it with the START key in that the MAX, MIN, and RANGE data before pausing is also referenced.

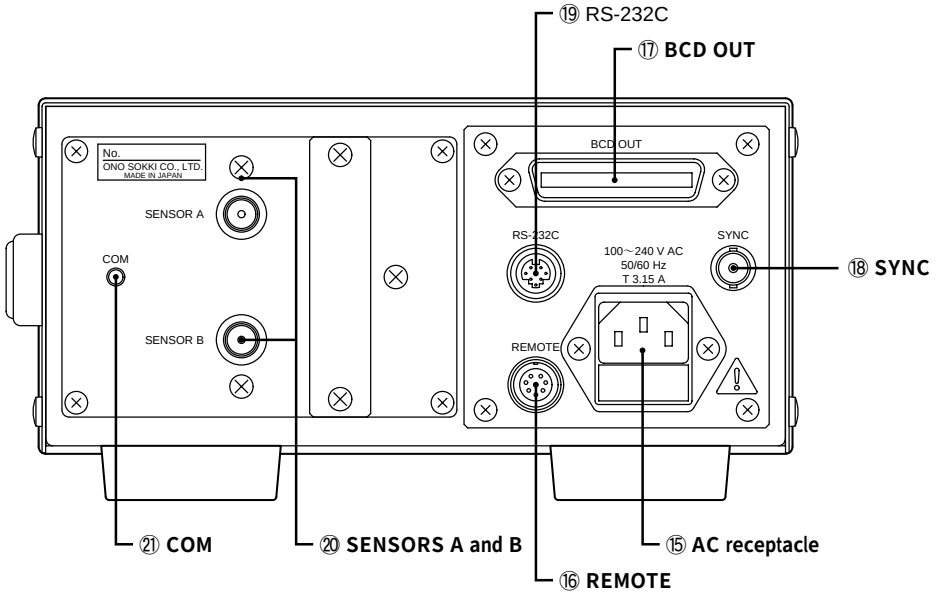
⑬ CALIB key

Pressing the CALIB key places CL-2400 in the calibration mode for setting the reference thickness and lights the LED. Select a numeric value with the CURSOR keys and determine it by ENTER. Pressing CALIB before determining the value terminates the calibration mode.

⑭ COND key

Pressing the COND key places CL-2400 in the setting mode. Each time this key is pressed, the lit LED changes as Selecting sensor → Setting averaging count → Selecting unit → Selecting BCD output item → Selecting synchronous measurement clock → Selecting fan ON/OFF → Selecting buzzer ON/OFF → Setting RS-232C baud rate. Pressing the COND key again in the setting mode validates the currently selected contents and terminates the setting mode.

# 3.2 Rear Panel




⑮ AC receptacle
Connects the AC power supply cable.
The AC receptacle contains two fuses.
Fuse ratings: 250 VAC, 3 A, slow-blow type

⑯ REMOTE connector
Connector for remote operation contact input.
Applicable connector: R03-PB8M (Tajimi) See page 68 for pin assignments.

⑰ BCD OUT connector
Used for BCD output of the measurement values.
The output items can be selected from the menu.
Applicable connector: 57-30360 (DDK) See page 49 for pin assignments.

⑱ SYNC connector
Use the SYNC connector when using multiple CL-2400 units for measurement. The synchronizing clock is output or input through this connector depending on the master or slave mode selected.
Applicable connector: C02 type (BNC)

⑲ RS-232C
RS-232C interface connector which allows a personal computer to set and collect various data.
Applicable connector: HR212-10P8PSAT3042 (Hirose)
RS-232C optional cable for PC/AT-compatible personal computer: AX-5022 (2 meters)

⑳ SENSOR A/B
Connect VE-series sensors using a cable dedicated to the VE sensors.
Applicable cable: VL series cables

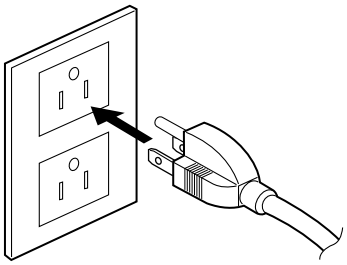
㉑ COM
Ground the measurement object with copper wire.

# CHAPTER 4 PREPARATION FOR MEASUREMENT

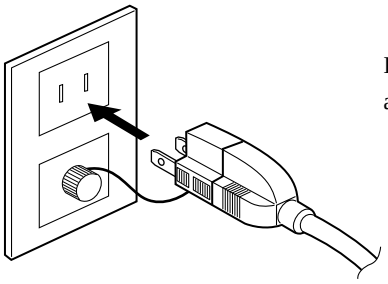
# 4.1 Grounding Power cable

To prevent accidents due to the AC power, be sure to connect the CL-2400 ground terminal to an external grounding line. Especially, CL-2400, which has been designed to be very sensitive, requires complete grounding to perform accurate measurement. Improper grounding may disable accurate measurements due to noise. The power cable shipped with CL-2400 has a three-pronged plug whose central round prong is for grounding. If the power inlet is of three-position type, the central prong will be grounded. If not, use the attached adapter (CM-32) for grounding.

## ■ Grounding



Insert the three-pronged plug into the three-position inlet.



If no three-position inlets are available, use the attached adapter for grounding.

# 4.2 Installing Sensors

CL-2400 is to be used in combination with VE series sensors. If sensors are installed incorrectly, it may cause to lower the measurement accuracy.

## ■ Precautions for installing sensors

① Because VE series sensors are used to detect minute capacitance, their electrode surface is precisely ground. Care should be taken not to give scratches to the surface.
② Using the sensors with oil or other dirt accumulated on the electrode surface may cause measurement errors.
③ Heat-proof glass such as Pyrex is used as insulative materials in the VE series sensors. The sensors may be broken when an excessive force or shock is given.
④ Oil or water put on the connectors of the VE series sensor connectors may cause to lower the measurement accuracy. Keep the connectors and cables always clean.

## ■ Installing sensors

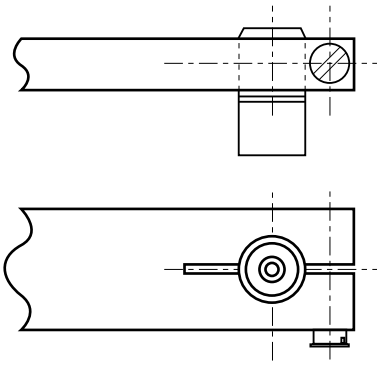
VE series sensors (except VE-525) can be installed in one of two ways described below. A sensor must be fixed at the insert zone shown by "i.z" (see sensor drawings in page 23). Place the sensor electrode surface in parallel with the object under measurement to ensure the measurement accuracy and then fix the sensor securely so that it is not affected by vibration and so forth. The VE series sensor's outside diameter at the insert zone is finished with JIS h7 fit tolerance. Therefore, the inner surface of the hole in the arm which holds the sensor should be finished with JIS G7 fit tolerance.

● Push screw

Using a push screw is a relatively easy way to fix the sensor, but the screw may tend to loosen. Therefore, this method should be used only for measurements in quiet locations such as a tabletop. Care should be taken not to tighten the screw excessively, or it may damage or deform the sensor.

● Grip holdlng

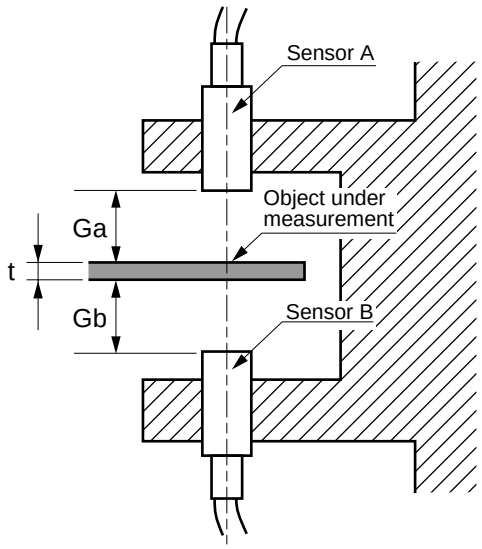
As shown in the figure, the arm is split at its end and the sensor is tightened with a screw. In this way, the sensor height can be easily adjusted and the sensor itself is less affected by vibration. This is a recommended method.



# 4.3 Installing VE Series Sensors

## ■ For measuring conductors

Install the sensors carefully observing the following guidelines:




① Direct the sensors toward the object under measurement.

② It does not make any difference which sensor (A or B) is at the top.

③ Position sensors A and B so that their center lines are aligned.

④ The arm which holds the sensors should have a sufficient stiffness. Fix the sensors so that the sensor gap is not changed by deformation due to heat or vibration. Fluctuation of the sensor gap should be limited to within the measurement accuracy required.

⑤ The sensor must be installed in a metallic fixture. Make sure that the object under measurement and the sensor fixture (that is, sensor case) are connected to each other in good electrical conditions or they are grounded.

⑥ Determine the sensor gaps Ga and Gb so that they do not exceed the sensor measurement range (for example, 5 mm for VE-531), regardless of the position of the object under measurement within the gap.

⑦ Hold the object under measurement so that its surface is perpendicular to the center line of the sensors. Inclination of the object may lead to measurement errors.

⑧ Place the object under measurement near the center of sensors A and B (that is, Ga ≒ Gb).

⑨ Place each sensor so that its head protrudes a little from the sensor fixture.

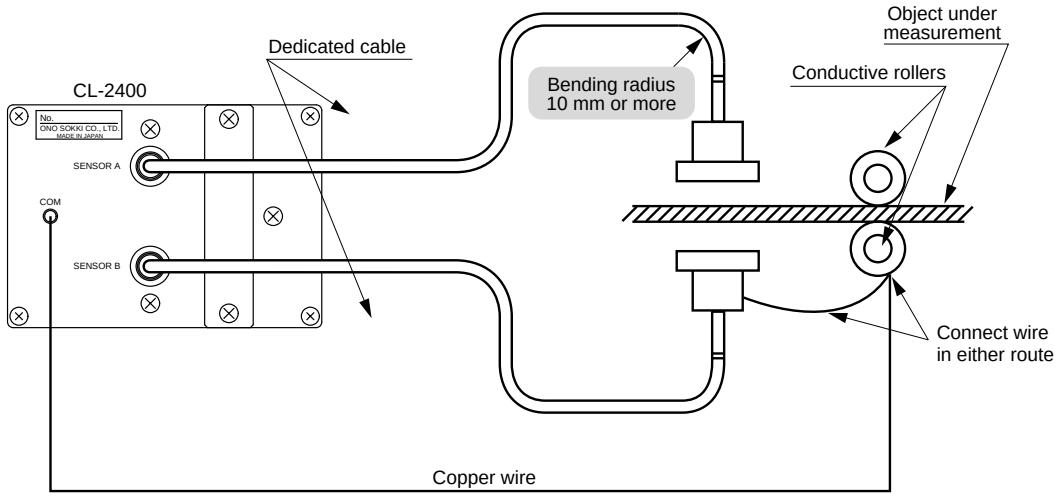
⑩ If anything other than air or the object under measurement exists between the two sensors, it may cause measurement errors. For this reason, do not place any cover on the sensor surface, and keep it clean.

⑪ The object under measurement must have an area greater or equal to the sensor diameter.

# 4.4 Connecting VE Series Sensors to CL-2400

## ■ For measuring conductors

Connect the sensors to CL-2400 carefully observing the following guidelines:




① The sensors and CL-2400 were adjusted in combination before shipping. Measurement using other sensors may not produce the expected accuracy. Equalized sensors A and B are predefined and not interchangeable. Check the sensor manufacturing numbers (for procedures for checking the VE sensor manufacturing numbers registered in CL-2400, see Section 5.1 "Selecting Sensors"). If sensors A and B are not connected as defined, the expected accuracy will not be obtained.

② Use the dedicated cables (VL series) to connect the sensors to CL-2400.

③ Insert the sensor cable securely to the connector, holding the knurled part of the cable.

④ Do not bend the cable with a radius less than 10 mm.

⑤ The measurement can not be made correctly if the cable is bended over the specified value by the instruction manual.

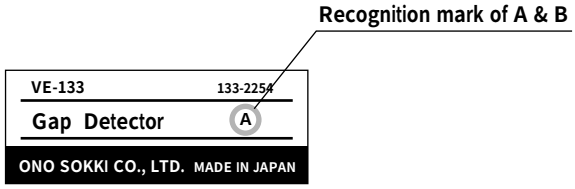
⑥ Fix the sensor cables so that they do not vibrate during measurement.

⑦ To ensure the accuracy, make sure that the object under measurement is electrically connected to the sensor case or the object under measurement is grounded. If necessary, connect them using a copper wire.

# CHAPTER 5
# BASIC OPERATIONS

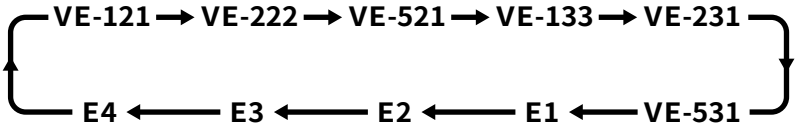
# 5.1 Selecting Sensors

Set the type of the sensor to be used. If the sensor was not equalized when purchasing CL-2400, select the sensor type now. Before the shipment, the adjustment in combination is made between CL-2400 & VE sensors if these two items are purchased at the same time.
The result of equalization are usually input at "E1" and "E2". So, SA(Sensor A) at "E1" and Sb(Sensor B) at "E2" are set separately at the "Selection of Sensor" at "COND" setup.
The serial number and recognition mark(A or B) are printed at the sensor's case. The sensor with printed "A" should be connected at the "SENSOR A", "B" at the "SENSOR B". Without the equalization at the purchasing, the model of the sensor should be selected. If the sensor is replaced after purchasing CL-2400 and VE-series sensor, the sensor should be equalized by ONO SOKKI. For details, please contact ONO SOKKI.
* "Equalizing" means deviation matching (fine adjustment) of the VE-series sensor against CL-2400. The measurement accuracy is acquired by using equalized sensors.




① Press COND to enter the set mode.
For each setting mode, "Selecting sensor" is the first item. Select the sensor from this item.

② Select the sensor-A type name by ▲ or ▼.
Each time ▼ is pressed, the type name displayed changes as shown below.




If the sensor has not been selected after purchasing, the E1 sensor is selected by default. If any sensor type has been selected, the sensor of the selected type is displayed. When it is acceptable, go to step ③.

③ Determine the sensor-A type name by ENTER.
A sample display for selecting E1 as sensor A is given below.


When it has been determined, "Selecting sensor B" mode starts.

④ Repeat steps ② and ③ above to select the sensor-B type name.
A sample display for selecting E2 as sensor B is given below.


When it has been determined, "Setting averaging count" mode starts.
The setting mode can be terminated by pressing COND again.

# 5.2 Selecting Units

Select the unit for measurement.

① Press COND to enter the setting mode.

② Press ENTER three times to enter [Setting unit] mode.
Because [Setting unit] is the third item in each setting mode, the setting item must be changed by ENTER .

③ Select the display unit μm or mm by △ or ▽ .
On the display, "0" means μm and "1" means mm.
If the unit has not been selected after purchasing, the unit is selected as "0" (μm) by default. If any unit has been selected, the selected unit is displayed. When it is acceptable, go to step ④.

④ Determine the display unit by ENTER .


After determining the display unit, [Selecting BCD output item] mode starts.
The setting mode can be terminated by pressing COND again.

# 5.3 Setting Display

The main display area can display the item selected by the DISPLAY and MODE keys. The selected item is indicated by the lit LED as shown below.

## ● Description of display items (selected by DISPLAY key)

THICK :Thickness of measurement object (A and B sensors placed opposite to each other)
GAP A :Distance between sensor A and measurement object surface
GAP B :Distance between sensor B and measurement object surface

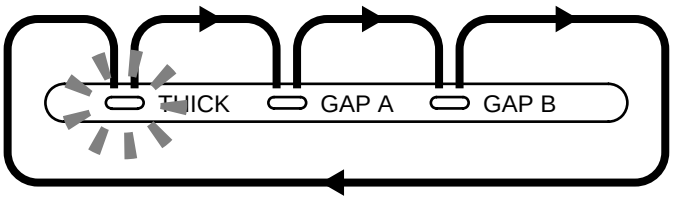
## ● Description of display items (selected by MODE key)

For each of THICK, GAP A, and GAP B above, the following values can be displayed:
All LEDs off: Average value for every 0.2 second
MAX : Maximum value from measurement start
MIN : Minimum value from measurement start
RANGE : Maximum minus minimum value from measurement start

## ■ Selecting display item

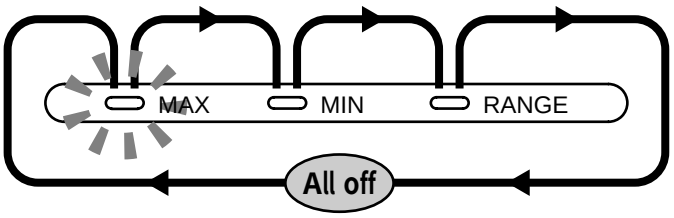
### ● Selecting by DISPLAY key

① Press the DISPLAY key.
Each time the DISPLAY key is pressed, the lit LED in the DISPLAY indicator area sequentially changes as THICK → GAP A → GAP B. Press this key until the LED of the desired display item goes on.




### ● Selecting by MODE key

① Press the MODE key.
Each time the MODE key is pressed, the lit LED in the MODE indicator area sequentially changes as All off → MAX → MIN → RANGE. Press this key until none of the LEDs or the LED of the desired display item goes on. When all LEDs are off, the display shows the average value for every 0.2 second.



# 5.4 Measuring Conductors

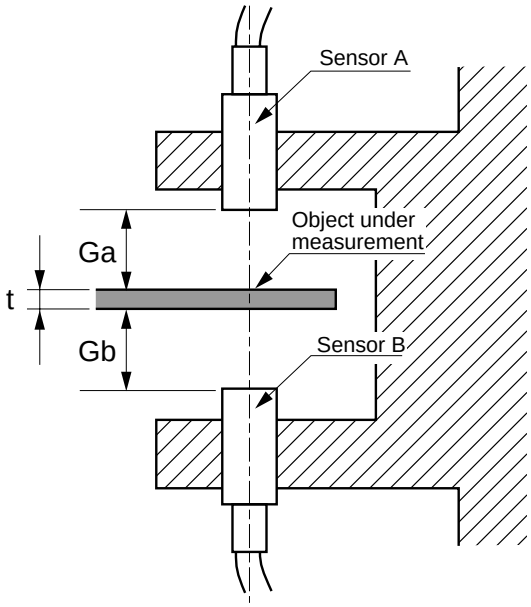
## ■ Setting

① Power ON
Insert the power plug into the receptacle and turn the POWER switch ON.
Wait 15 to 20 seconds before the display appears.
Start the operation when the measurement screen appears after the title screen.

② Selecting sensor type
Refer to Section 5.1 "Selecting sensor."

③ Starting measurement
Pressing START starts the measurement.

④ Checking and adjusting sensor mounting location




Mount the sensor securely so that the gaps (Ga and Gb) between the sensors and measurement object are within the sensor gap ratings.
If the gaps between the sensors and measurement object exceed the sensor gap ratings, "WARN" is displayed in the main display area. In this case, check the gaps between the sensors and measurement object in the procedure explained below and then remount the sensor.

① Each time the DISPLAY key is pressed, the lit LED in the DISPLAY indicator area sequentially changes as THICK → GAP A → GAP B.
② Adjust the sensor A mounting location so that the sensor A gap is within the ratings (5 mm or 5000μ m for VE-531).
③ Adjust the sensor B mounting location so that the sensor B gap is within the ratings (5 mm or 5000μ m for VE-531).

## ■ Calibration for thickness measurement

Before measuring the thickness of a conductor by CL-2400, the gap between sensors (Gs) must be set. To set this gap, use the master chip that has the reference thickness as described below.
Insert a master chip with the known thickness (t) between sensors A and B (reference thickness "t" should be close to the thickness of the actual measurement object). Make sure that the gaps between the sensors and master chip (Ga and Gb) do not exceed the sensor gap ratings. If the master chip thickness entered is less than the actual value, the THICK polarity may become negative, causing the ERR LED in the ERROR indicator area to go on. When this LED goes on, check and re-enter the master chip thickness.

① Insert the reference master chip between sensors A and B.

② Press START .

③ Press CALIB .

④ Enter the reference thickness.
When entering reference thickness t, use ◁ and ▷ keys for moving the digits; △ and ▽ keys for scrolling the item or digits. When CALIB is pressed, the previous set value for the master chip is displayed. If the displayed value is acceptable, go to step ⑤.

⑤ Press ENTER to determine the set value.
If CALIB is pressed before determining the set value, the calibration mode is terminated.

## ■ Starting measurement

After setting is completed, start the measurement.

① Check that the THICK LED in the DISPLAY indicator area is on.

② Insert the measurement object between sensors A and B.

③ Press START .
The measurement starts and the measurement object thickness is displayed.
If the display fluctuates, take the necessary action referring to Section 6.1 "Averaging" in Chapter 6 "Operation Procedures."

④ Press START .
The measurement stops.

# CHAPTER 6
# APPLICATIONS

# 6.1 Averaging

## ■ Averaging

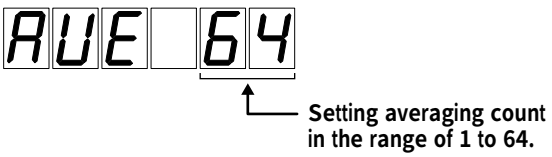
When the measurement values fluctuate, use this function to calculate the average value. The averaging count may be set within the range of 1 to 64. The method of simple moving average is used for calculation. This averaging method is valid for BCD output and MDR command of RS-232C. Simple interval averaging for 0.2 second is used for measurement value display.

① Press COND to enter the setting mode.

② Press ENTER twice to enter [Setting averaging count] mode.
Since [Selecting averaging count] is the second item in each setting mode, the setting item must be changed by ENTER .

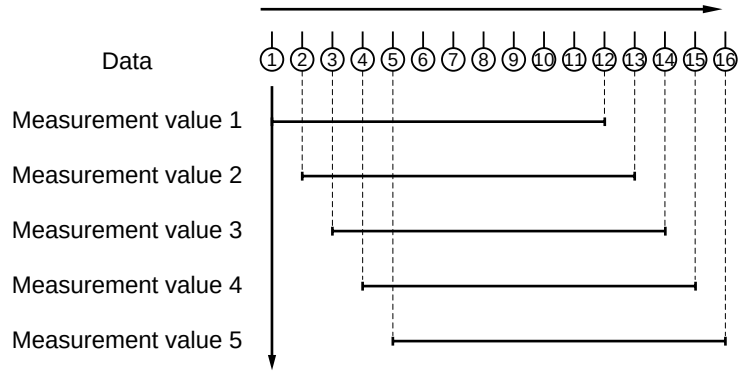
③ Enter the moving averaging count.
Enter the moving averaging count in the range of 1-64 using ◁ and ▷ keys to move the cursor on the digits and △ and ▽ keys to scroll the display.
If the averaging count has not been selected after purchasing, the averaging count 16 is selected by default. If the averaging count has been selected, the selected averaging count is displayed. When it is acceptable, go to step ④.

④ Determine the averaging count by ENTER .
A sample display for setting averaging count 64 is given below.




When it has been determined, "Selecting unit" mode starts.
The setting mode can be terminated by pressing COND again.

● Example: When Averaging count (N) is 12




Measurement value 1 = $\frac{① + ② + \cdots ⑫}{12}$

Measurement value 2 = $\frac{② + ③ + \cdots ⑬}{12}$

Measurement value 3 = $\frac{③ + ④ + \cdots ⑭}{12}$

# 6.2 BCD Output

This is the BCD output for each measurement item. The data is updated at each sample time.

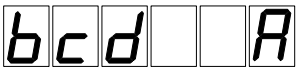
## ■ Selecting output item

① Press COND to enter the setting mode.

② Press ENTER four times to enter [Selecting BCD output item] mode.
Since [Selecting BCD output] is the fourth item in each setting mode, the setting item must be changed by ENTER .

③ Select the output item.
Select THICK, GAP A, or GAP B by ▲ or ▼ .
If the BCD output item has not been selected after purchasing, THICK is selected by default. If any BCD output item has been selected, the selected item is displayed. When it is acceptable, go to step ④.

④ Determine the output item by ENTER .
A sample display for setting GAP A is given below.



**Select the output item**
**A:GAP A、B:GAP B or ¬:THICK**

When it has been determined, [Selecting synchronous measurement clock] mode starts.
The setting mode can be terminated by pressing COND again.

## ■ BCD OUT connector

CL-2400 outputs all measurement data as open-collector outputs.

This section describes the BCD OUT signals, viewed from an external device, assuming that they are connected to the external device through the recommended interface.

| Pin | I/O | Signal | Pin | I/O | Signal |
|---|---|---|---|---|---|
| 1 | 0 | 1 | 19 | 0 | 4 |
| 2 | 0 | 2 Data $10^0$ output | 20 | 0 | 8 Data $10^4$ output |
| 3 | 0 | 4 | 21 | 0 | 0 |
| 4 | 0 | 8 | 22 | 0 | 1 DP |
| 5 | 0 | 1 | 23 | 0 | 2 |
| 6 | 0 | 2 | 24 | 0 | – SIGN |
| 7 | 0 | 4 Data $10^1$ output | 25 | 0 | 0 |
| 8 | 0 | 8 | 26 | 0 | 1 UNIT |
| 9 | 0 | 1 | 27 | 0 | 2 |
| 10 | 0 | 2 | 28 | | |
| 11 | 0 | 4 Data $10^2$ output | 29 | 0 | $\overline{\text{START}}$ |
| 12 | 0 | 8 | 30 | | $\overline{\text{ERROR}}$ |
| 13 | 0 | 1 | 31 | I | HOLD |
| 14 | 0 | 2 | 32 | | |
| 15 | 0 | 4 Data $10^3$ output | 33 | | |
| 16 | 0 | 8 | 34 | | |
| 17 | 0 | 1 | 35 | 0 | $\overline{\text{DAV}}$ |
| 18 | 0 | 2 | 36 | | COM |

Measurement data $1^{00}$-$1^{04}$/DP/SIGN/UNIT is positive-logic open-collector output. $\overline{\text{START}}$/$\overline{\text{DAV}}$ is negative-logic open-collector output.

$\overline{\text{START}}$ (output) : The level is "L" while START or PAUSE LED is on (operating).

$\overline{\text{ERROR}}$ (output) : This is output when the GAP A or GAP B value exceeds 130% of the sensor ratings, when the calculated THICK value is a negative value, or when the calculated value overflows the display digits.

$\overline{\text{DAV}}$ (output) : When DAV is in the H level, the BCD data is valid; when DAV is in the L level, the BCD data is invalid. Check that DAV is not in the L level before reading the data.

$\overline{\text{HOLD}}$ (input) : When HOLD is in the L level, the BCD data is held.

SIGN (output) : H level –
L level +

DP (output) : Outputs the decimal place in the measurement value.

| DP2 | DP1 | DP0 | |
|---|---|---|---|
| L | L | H | XXXX.X |
| L | H | L | XXX.XX |
| L | H | H | XX.XXX |
| H | L | L | X.XXXX |
| H | L | H | XXXXX |

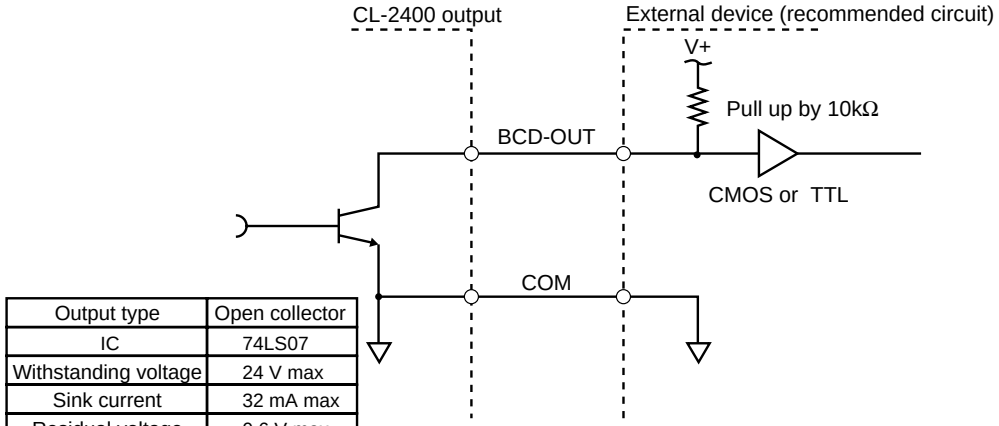
UNIT (output) : Outputs the unit currently being selected.

| UNIT2 | UNIT1 | UNIT0 | |
|---|---|---|---|
| H | L | H | User defined |
| H | H | L | mm |
| H | H | H | μm |

## ■ Recommended interface

The recommended interface is shown below.

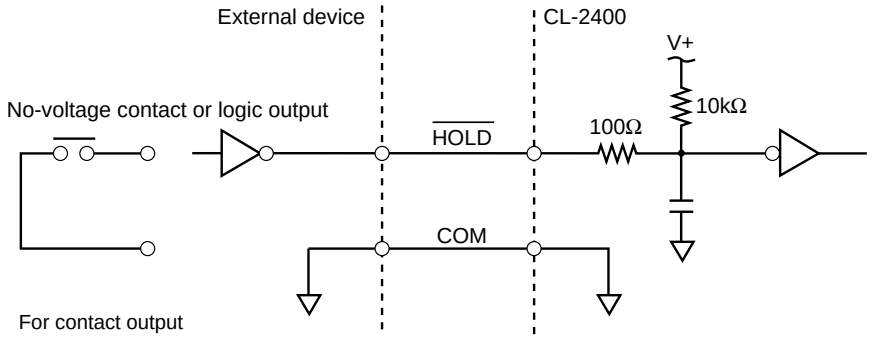
① $10^0$ to $10^4$, DP, SIGN, UNIT, START, DAV outputs




| Output type | Open collector |
|---|---|
| IC | 74LS07 |
| Withstanding voltage | 24 V max |
| Sink current | 32 mA max |
| Residual voltage | 0.6 V max |

② HOLD input

Input signals with no chattering.




For contact output

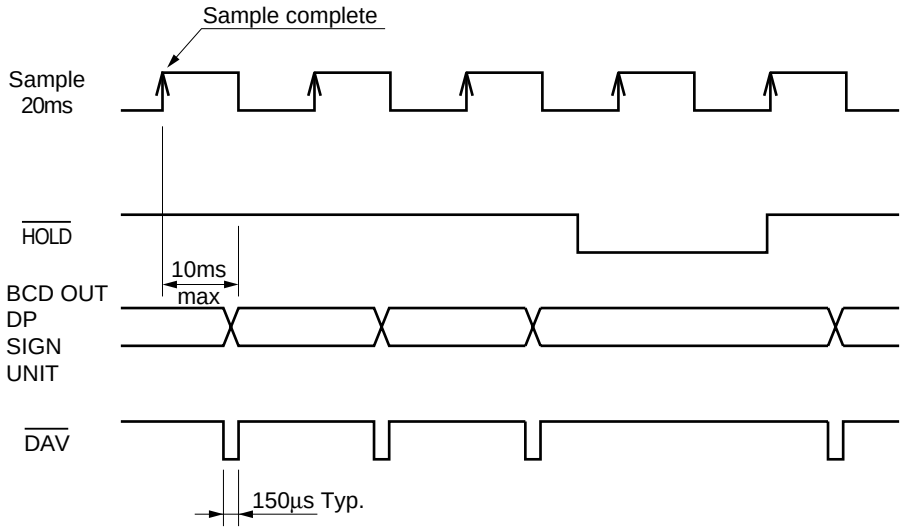
| Load voltage | 5 $V_{DC}$ min |
|---|---|
| Load current | 100 mA min |
| On resistance | 10Ωmax |
| Off resistance | 500 kΩmin |

* Do not input signals while CL-2400 power is OFF.

For logic output

| Output low-level voltage | 0 to 1.0 V |
|---|---|
| Output high-level voltage | 3.5 to 5.25 V |
| Output impedance | 1 kΩ max |

## ■ BCD output timing chart

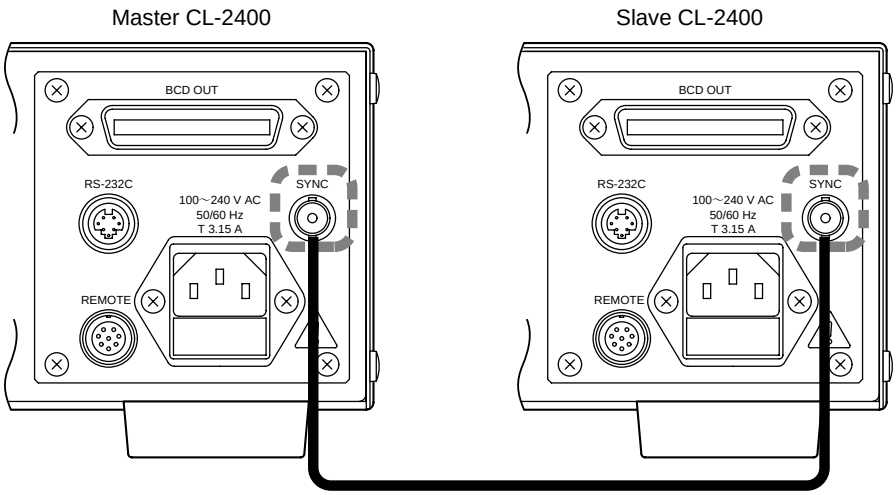



Note: Hold signal is recognized at the timing of sampling being completed.
It takes 20ms max. to hold BCD OUT actually.

# 6.3 Synchronous Operation

When multiple CL-2400 units are used in combination to measure the same object, sensors may interfere with each other generating beats. In this case, the measured values are dispersed. Measurement value dispersion can be reduced by doing synchronous operation.

In synchronous operation, one CL-2400 unit is used as a master and another CL-2400 unit is used as a slave.




The master and slave CL-2400 units are connected at their SYNC connectors via a BNC cable.

Note: Two or more slaves may be used. To do so, use a JPJ connector to branch the SYNC signal. (A maximum of three units including the master and slave can be connected.)

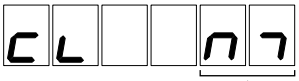
## ■ Selecting synchronous measurement clock

① Press COND to enter the setting mode.

② Press ENTER five times to enter [Selecting synchronous measurement clock] mode. Since [Selecting synchronous measurement clock] is the fifth item in each setting mode, the setting item must be changed by ENTER .

③ Select the clock.
Select MASTER or SLAVE by △ or ▽ .
If the synchronous measurement clock has not been selected after purchasing, MASTER is selected by default. If any synchronous measurement clock has been selected, the selected item is displayed. When it is acceptable, go to step ④.

④ Determine the synchronous measurement clock by ENTER .
A sample display for setting MASTER is given below. (The rightmost two 7-segment digits represent "m.")



**Select the synchronous measurement clock**
**M:MASTER or S:SLAVE**

After determining the synchronous measurement clock, the [Selecting fan ON/OFF] mode starts.
The setting mode can be terminated by pressing COND again.

# 6.4 Selecting Fan ON/OFF

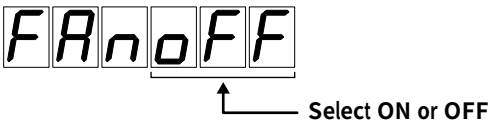
Turn ON/OFF the cooling fan inside the unit.
Turn the fan OFF only when use of the fan is inhibited for dusting in the clean room.
If the unit ambient temperature exceeds 28℃, be sure to turn the fan ON.

① Press COND to enter the setting mode.

② Press ENTER six times to enter [Selecting fan ON/OFF] mode.
Since [Selecting fan ON/OFF] is the sixth item in each setting mode, the setting item must be changed by ENTER .

③ Select ON or OFF.
Select ON or OFF by ▲ by ▼ .
If fan ON/OFF has not been selected after purchasing, ON is selected by default. If fan ON/OFF has been selected, the selected item is displayed. When it is acceptable, go to step ④.

④ Determine ON/OFF by ENTER .
A sample display for setting OFF is given below




After determining ON/OFF, the [Selecting buzzer ON/OFF] mode starts.
The setting mode can be terminated by pressing COND again.

# 6.5 Selecting Buzzer ON/OFF

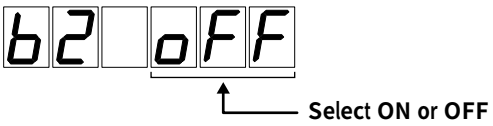
Whether or not to turn the buzzer ON when a key is pressed can be selected.

① Press COND to enter the setting mode.

② Press ENTER seven times to enter [Selecting buzzer ON/OFF] mode.
Since [Selecting buzzer ON/OFF] is the seventh item in each setting mode, the setting item must be changed by ENTER .

③ Select ON or OFF.
Select ON or OFF by ▲ by ▼ .
If buzzer ON/OFF has not been selected after purchasing, OFF is selected by default. If buzzer ON/OFF has been selected, the selected item is displayed. When it is acceptable, go to step ④.

④ Determine ON/OFF by ENTER .
A sample display for setting OFF is given below




After determining the output item, the [Setting RS-232C baud rate] mode starts.
The setting mode can be terminated by pressing COND again.

# 6.6 RS-232C

## ■ Overview

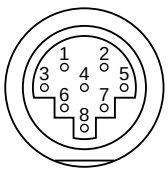
RS-232C is a serial communication interface defined by EIA (Electronic Industries Association). The CL-2400's RS-232C interface allows setting up of the CL-2400 panel, remote control, data sending or receiving, etc. using appropriate programs in minicomputer or personal computer.

## ■ Specifications

| | |
|---|---|
| Ratings | : Compatible with EIA and JIS X5101 |
| Communication mode | : Start-stop full-duplex |
| Transmission rate (baud rate) | : 1200, 2400, or 9600 bps |
| Character length | : 8 bits |
| Parity check | : No check |
| X parameter control | : Hardware |
| Terminator | : CR + LF |

## ■ Connector pin assignments

Connector type : HR12-10R-8SD (Hirose)




| Pin | Name | Function | Input/Output |
|---|---|---|---|
| 1 | FG (AA) | No connection | ― ― ― |
| 2 | RxD (BB) | Receive data | Input |
| 3 | TxD (BA) | Send data | Output |
| 4 | CTS (CB) | Clear to send | Input |
| 5 | RTS (CA) | Request to send | Output |
| 6 | DSR (CC) | No connection | ― ― ― |
| 7 | SG (AB) | Signal ground | |
| 8 | ― ― ― ― | No connection | ― ― ― |

Applicable connector: HR212-10P8PSAT3042 (Hirose)
RS-232C optional cable for PC/AT-compatible personal computer: AX-5022 (2m)

## ■ Setting baud rate

When using RS-232C, the baud rate on the PC side must match with that of CL-2400.

① Press COND to enter the setting mode.

② Press ENTER eight times to enter [Setting RS-232C baud rate] mode.
Since [Setting RS-232C baud rate] is the eighth item in each setting mode, the setting item must be changed by ENTER .

③ Select the baud rate.
Select 9600, 2400, or 1200 by ▲ or ▼ .
If the RS-232C baud rate has not been selected after purchasing, 9600 is selected by default. If any RS-232C baud rate has been selected, the selected item is displayed. When it is acceptable, go to step ④.

④ Determine the baud rate by ENTER .
A sample display for setting 2400 is given below


After determining the baud rate, the setting mode is terminated and the COND LED goes off.

## ■ COMMAND keys

### CST Command of SrarT

Starts the measurement.

Send CST CRLF

Equivalent to pressing [START] key.

Within 500 ms after sending this command, do not send any other commands.

### CSP Command of StoP

Stops the measurement.

Send CSP CRLF

Equivalent to pressing [START] key after it has been pressed.

Within 100 ms after sending this command, do not send any other commands.

### CPS Command of PauSe

Pauses the measurement.

Send CPS CRLF

Equivalent to pressing [PAUSE] key after pressing the [START] key.

### CCS Command of Continue Start

Restarts the paused measurement.

Send CCS CRLF

Equivalent to pressing [PAUSE] key after it has been pressed.

### STR Status Read

Reads the command key status.

① = 0 STOP state (neither START nor PAUSE)

= 1 PAUSE mode

= 2 START mode

= 3 STORE mode

Send STR CRLF

Receive ① CRLF

## ■ Setting display contents

### DIS① Display Set

Set the item to be displayed.

① = 0 THICK
= 1 GAP 1
= 2 GAP 2

Send DIS① CRLF

### DMS① Display Mode Set

Set the display mode.

① = 0 IMEDIATE
= 1 MAX
= 2 MIN
= 3 RANGE

Send DMS① CRLF

## ■ Reading measurement value

### MDR① Measurement data Read

Read out the 1 sample data(20ms) immediately after the command is set.

*Can be possible after 500ms when the measurement starts.

① = 0 THICK
= 1 GAP A
= 2 GAP B

Send MDR① CRLF

Receive oooooooo CRLF

"oooooooo" means maximum eight characters including a sign and decimal point.

The unit is the one currently being selected.

## ■ Reading the displayed value

DDR Display Data Read

Read the displayed value (average value for every 0.2 second).

Send DDR CRLF

Receive oooooooo CRLF

"oooooooo" means maximum eight characters including a sign and decimal point.

The unit is the one currently being selected.

## ■ BCD output

BOS ① Bcd Out item Set

Selects the BCD output item.

① = 0 THICK

= 1 GAP A

= 2 GAP B

Send BOS ① CRLF

BOR Bcd Out item Read

Reads the set BCD output item.

① = 0 THICK

= 1 GAP A

= 2 GAP B

Send BOR CRLF

Receive ① CRLF

## ■ Synchronizing clock

### SYS ① SYnchronous measure Set

Selects whether to set MASTER (internal) or SLAVE (external) as the measurement clock.

① = 0 MASTER (default)
= 1 SLAVE

Send SYS ① CRLF

### SYR SYnchronous measure Read

Reads the measurement clock set value.

① = 0 MASTER (default)
= 1 SLAVE

Send SYR CRLF
Receive ① CRLF

## ■ Setting averaging time

### ANS ① Average Number Set

Set the moving averaging count.

① = 1 to 64

Send ANS ① CRLF

### ANR Average Number Read

Read the moving averaging count.

① = 1 to 64

Send ANR CRLF
Receive ① CRLF

## ■ Selecting sensors

### STS ①, ②　　Sensor Type Set

Selects the channel and type of the sensor to be used.

| | | | |
|---|---|---|---|
| ① | = 1 | CH A | |
| | = 2 | CH B | |
| ② | = 0 | VE-121 | |
| | = 1 | VE-222 | |
| | = 2 | VE-521 | |
| | = 3 | VE-133 | |
| | = 4 | VE-231 | |
| | = 5 | VE-531 | |
| | = 6 | Equl 1 | Equl1 to 4 cannot be selected simultaneously for channels A and B. |
| | = 7 | Equl 2 | |
| | = 8 | Equl 3 | |
| | = 9 | Equl 4 | |

Send STS ①, ② CRLF

### SRD ①, ②　　Sensor type ReaD

Reads the channel type of the set sensor.

| | | | |
|---|---|---|---|
| ① | = 1 | CH A | |
| | = 2 | CH B | |
| ② | = 0 | VE-121 | |
| | = 1 | VE-222 | |
| | = 2 | VE-521 | |
| | = 3 | VE-133 | |
| | = 4 | VE-231 | |
| | = 5 | VE-531 | |
| | = 6 | Equl 1 | Equl1 to 5 cannot be selected simultaneously for channels A and B. |
| | = 7 | Equl 2 | |
| | = 8 | Equl 3 | |
| | = 9 | Equl 4 | |

Send SRD ① CRLF

Receive ② CRLF

### SLS ①, ②　　Sensor Lot.number Set

Sets the manufacturing number of the sensor registered in sensor correction mode.

① = 1　Equl 1
= 2　Equl 2
= 3　Equl 3
= 4　Equl 4

② = ooo-oooo

Send SLS ①, ooo-oooo CRLF

"o" means only a digit. If no sensors are registered, ooo-oooo must be 000-0000, The first three digits indicate the sensor model name, that is, one of 121, 222, 521, 133, 231, or 531.

### SLR ①　Sensor Lot.number Read

Reads the manufacturing number of the sensor registered in sensor correction mode.

① = 1　Equl 1
= 2　Equl 2
= 3　Equl 3
= 4　Equl 4

Send SLR ① CRLF

Receive ooo-oooo CRLF

"o" means only a digit. If no sensors are registered, ooo-oooo must be 000-0000,

### SCS ①, ②, ③, ④, ⑤, ⑥　　Sensor Corr.coefficient Set

Sets the coefficient of the correction polynomial for Equl1 to 5.

① = 1　Equl 1
= 2　Equl 2
= 3　Equl 3
= 4　Equl 4

② = a　X.XXXXX　Default value　a = 0
③ = b　X.XXXXX　b = 0
④ = c　X.XXXXX　c = 0
⑤ = d　X.XXXXX　d = 0
⑥ = f　X.XXXXX　f = 0

Send SCS ①, ②, ③, ④, ⑤, ⑥ CRLF

### SCR ① Sensor Corr.coefficient Read

Reads the coefficient of the correction polynomial for Equl1 to 4.

① = 1 Equl 1
= 2 Equl 2
= 3 Equl 3
= 4 Equl 4
② = a X.XXXXX
③ = b X.XXXXX
④ = c X.XXXXX
⑤ = d X.XXXXX
⑥ = f X.XXXXX

Send SCR ① CRLF

Receive ②, ③, ④, ⑤, ⑥, CRLF

# ■ [CALIB] Calibration

### GAS ① GAp Set

The calibration is conducted for the measurement of the thickness.
The master piece being inserted between sensor A & B for the measurement, it is calibrated by setting the thickness at ① and it being sent.

To execute this command, the START LED must be on (measurement being done). This command does not function in the PAUSE state.

① = ooooooo
(Maximum seven characters including a sign and decimal point)
Send GAS ① CRLF
The unit is the one currently being selected.

### GAR GAp Set Read

Reads the gap between sensors A and B.

Send GAR ① CRLF
Receive oooooooo CRLF
"oooooooo" means maximum eight characters including a sign and decimal point.
The unit is the one currently being selected.

## ■ OTHERS

### BFS ① Buzzer on/oFf Set

Sets the buzzer feature ON/OFF.

① = 0 ON
= 1 OFF

### BFR ① Buzzer on/oFf Read

Reads the buzzer feature ON/OFF state.

① = 0 ON
= 1 OFF
Send BFR CRLF
Receive ① CRLF

### FFS ① Fan on/off Set

Sets the unit fan ON/OFF.

① = 0 ON
= 1 OFF

### FFR ① Fan on/off Read

Reads the unit fan ON/OFF state.

① = 0 ON
= 1 OFF

### UNS ① UNit Set

Sets the unit.

① = 0 μm
= 1 mm

### UNR ① UNint Read

Reads the set unit.

① = 0 μm
= 1 mm
Send UNR CRLF

### VER rom VERsion read

Reads the ROM version of the CPU main program.

Send VER CRLF
Receive oooooooo CRLF
"oooooooo" means maximum eight characters including a sign and decimal point.

# 6.7 Remote Operation

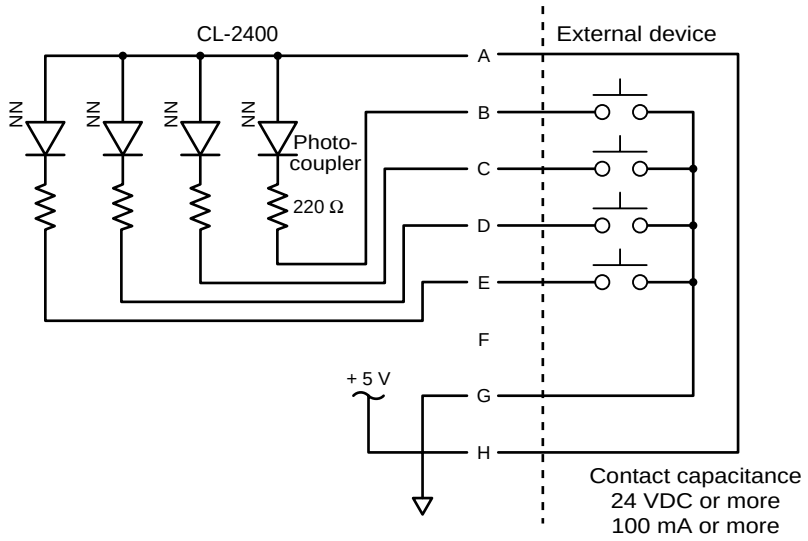
The keys in the COMMAND area can be operated remotely, for example, from an external sequencer.

To control CL-2400 from an external sequencer, incorporating the START signal (L level while START or PAUSE is active) output from BCD OUT connector pin 29 recommended.

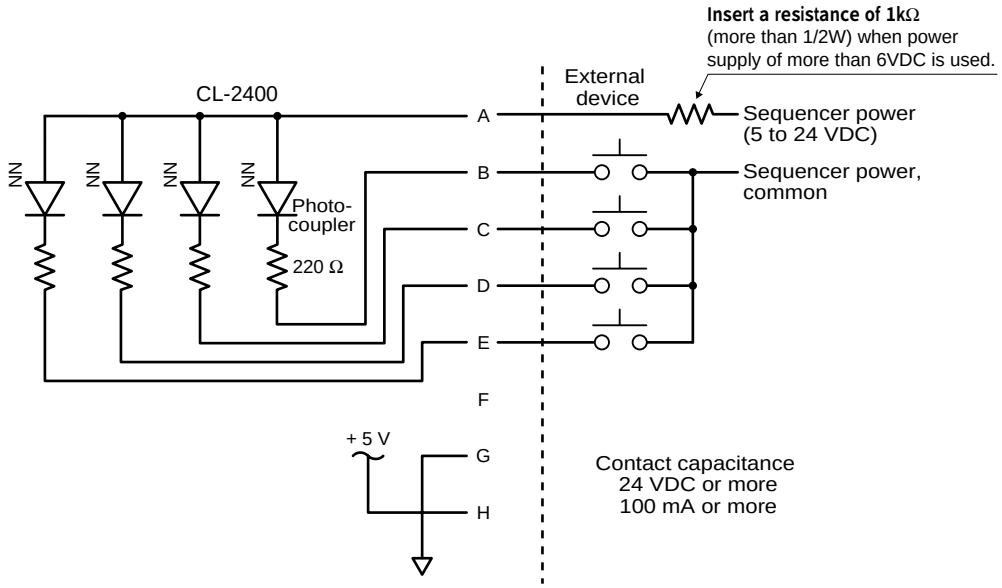
| Pin | Signal name |
|---|---|
| A | Power supply (5 to 24 VDC) |
| B | START |
| C | STOP |
| D | PAUSE |
| E | STORE |
| F | PRINT |
| G | Common |
| H | +5 V output |

When supplying the power from the external sequencer, etc., connect the + power line to pin A.
When supplying the power using a no-voltage contact, connect connector pins A and H on the cable side.
The CALIB function allows to do "calibration for thickness measurement." As the reference thickness, the previously set value is used; it is equivalent to pressing CALIB key and then ENTER key.

## ■ Recommended interface 1 (when using internal power supply)




## ■ Recommended interface 2 (when using internal power supply)



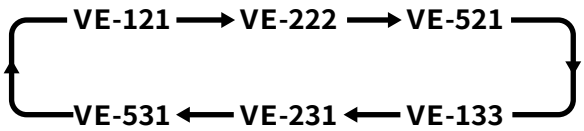
# 6.8 Entering Sensor Correction Factor

Since matching between the sensor and CL-2400 requires a special jig, it must be done by ONO SOKKI. If, for some reason, data memory for the matching correction factor is destroyed, the data can be entered again.

① Turn the POWER switch ON while pressing both of ◁ and ▷ keys.
If ◁ and ▷ keys are being pressed when the POWER switch is turned ON, [Reading and setting sensor correction value] mode starts.

② Select the sensor type name and then press ENTER .

Select the sensor type name by △ or ▽ and then determine it by ENTER .
By default, VE-133 is set, and each time ▽ is pressed, the model name is displayed as follows:




The sample display for setting VE-133 as E1 is given below.


③ Enter the sensor manufacturing number and press ENTER .

By default, 0000 is set. Enter the number in the range of 0000 to 9999 by △ , ▽ , ◁ , or ▷ and determine it by ENTER .
A sample display for setting manufacturing number 0123 is given below.

④ Enter correction factor a and press ENTER .

Enter the correction factor given in the inspection result and determine it by ENTER .
The correction factor default values are as listed below. Factor e is fixed to 0.
a=0.0000 b=1.0000 c=0.0000 d=0.0000 e=0（Fixed） f=0.0000

⑤ In the same way, enter the other correction factors and press ENTER .
Enter and determine the correction factors in the order of a → b → c → d → f.

⑥ Set E2, E3, and E4.
In the same way as steps ①-⑤ above, set E2, E3, and E4. If the displayed values are acceptable, go to the next step by ENTER . After determining correction factor f for E4, the display disappears.

⑦ Turn the POWER switch OFF to terminate the setting mode.
To exit [Reading and setting sensor correction factors] mode, the POWER switch must be turned OFF. To start measurement, turn the POWER switch ON again.

# CHAPTER 7
# TROUBLESHOOTING

## 7.1 Troubleshooting

# 7.1 Troubleshooting

If CL-2400 seems abnormal, check the states and take necessary actions referring to this section.
If CL-2400 still does not normally function after the actions, contact ONO SOKKI or the sales representative from which you have purchased CL-2400.

| Symptom | Possible causes | Inspection | Reaction |
|---|---|---|---|
| Power not supplied | AC power cable disconnected. | Check the connection. | Securely insert the power plug to the AC inlet. |
| | AC power cable broken. | Check for cable's conductivity. | Replace the cable. |
| | Fuse blown | Check the fuse in the fuse holder. | Check the cause and replace necessary parts, or call ONO SOKKI or the sales representative from which you have purchased CL-2400. |
| System not activated by power ON | Error in backup memory | Check that the initial screen is displayed after power ON. | Clear the backup memory. |
| | Defects in internal circuitry | Check that the power is supplied by inspecting the LCD or LEDs. | Call ONO SOKKI or the sales representative from which you have purchased CL-2400. |
| Failure of display | Errors in display settings | Check set item settings. | |
| | Sensor selection error | Check sensor item settings. | |
| | Errors in sensor cable connector constant | Turn the power OFF, disconnect the connector, and reconnect it. | |

Clearing backup memory

Turn the POWER switch ON while pressing both of [△] and [▽] keys. The main display area shows [Allclr] and the backup memory is cleared.

Checking software version

When the POWER switch is turned ON, the main display area shows the software version, succeeding the type name.

Note: Before replacing the fuse, be sure to remedy the cause of the blown fuse and disconnect the AC power cable. If the cause of blown fuse is not unknown, call ONO SOKKI or the sales representative from which you have purchased CL-2400.

# CHAPTER 8 SPECIFICATIONS

# 8.1 Specifications

Measurement object
: Conductor/Semiconductor

Measurement items
: THICK : Measurement object thickness
GAP A : Gap between sensor A and measurement object
GAP B : Gap between sensor B and measurement object

Display area
: Main display: Six digits with seven green LED segments
Display item :MAX, MIN, RANGE, or average value for every 0.2 second for one of THICK, GAP A, and GAP B items
Unit indicator :Selected from μm and mm
Error indicator :The LED goes on in one of the following states:
- The GAP A or GAP B value is 130% or more of the sensor ratings.
- The calculated THICK value is negative.
- The display digits have overflowed.

Display resolution
: 0.1 m m（when used in combination with VE-121/222/521/133）
1 μ m（when used in combination with VE-231/531）

Sampling time
: 20 ms

Averaging
: Moving average with count 1 to 64

External interface
: BCD : 5-digit BCD output
Connector : Amphenol 36P
Output format : Open-collector output
RS-232C : Connector : HR12-10R-8SD
Baud rate : Selected from 9600, 2400, and 1200
Parameter setting : Xon_Xoff, 8 bits
No parity, Stop bit 1 (fixed)
SYNC : Carrier clock input/output for CL-2400 cascade connection
Connector : C02 (BNC)
Remote : START/STOP, PAUSE, calibration
Connector : R03R8M
Input format : Photocoupler input (Forward current IF=10mAtyp)

Power supply
: 100 to 240 VAC, 50/60 Hz

Power consumption
: 50 VA or less

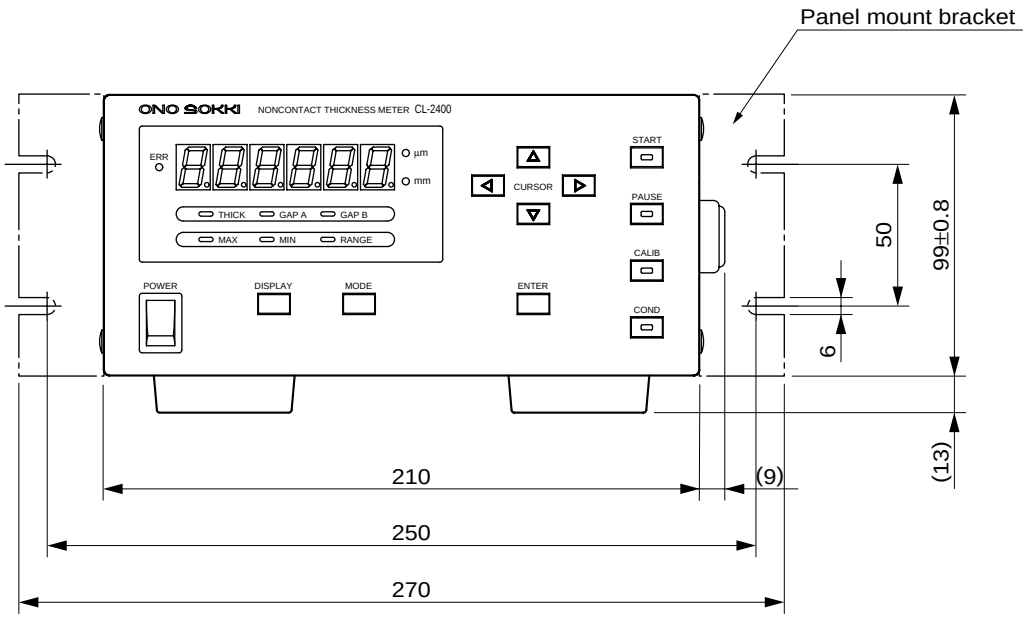
Operation environment
: Temperature : +18 to +28 ℃ (Accuracy guaranteed)
0 to +40 ℃ (Operational range)
Relative humidity : 20 to 80% (No dew allowed)

Outside dimensions
: 210（W）×99（H）×350（D）mm

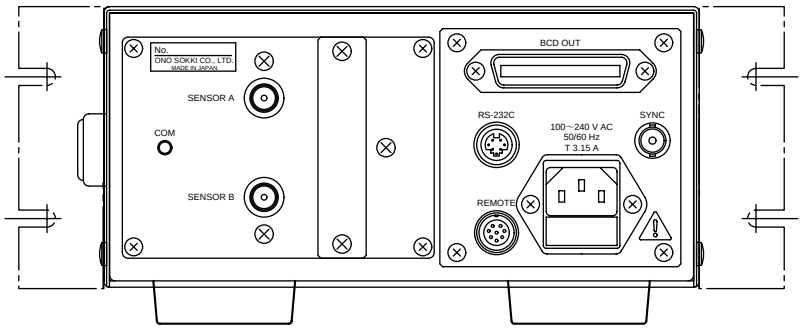
Weight
: Approximately 3.7 kg

Accessories
: Power cable ×1
Conversion adapter CM-33 ×1
REMOTE connector ×1
Instructions manual ×1

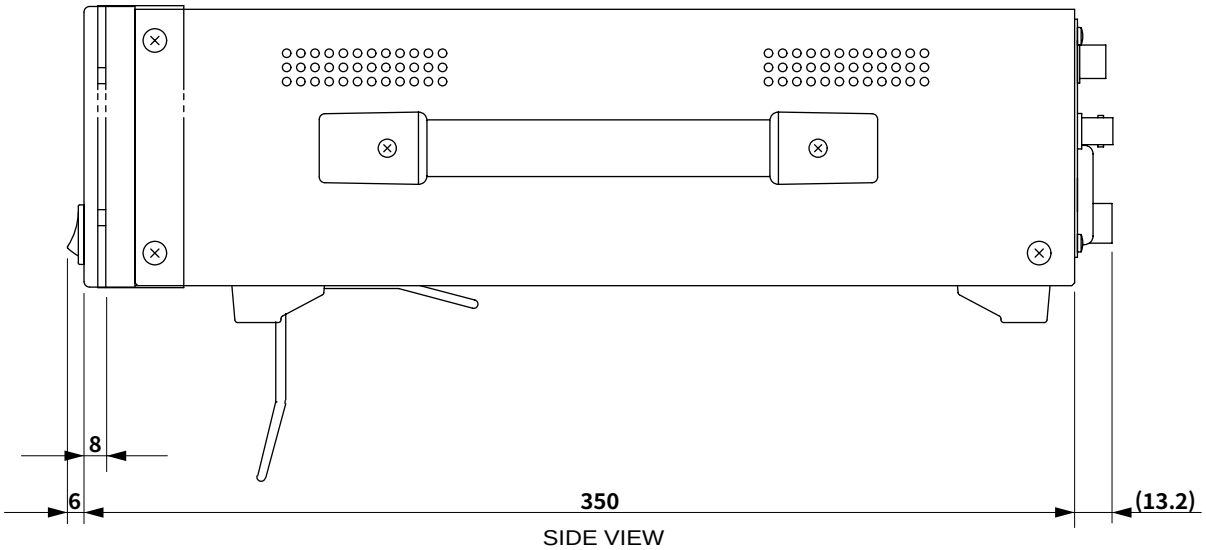
# 8.2 Outside Dimensions



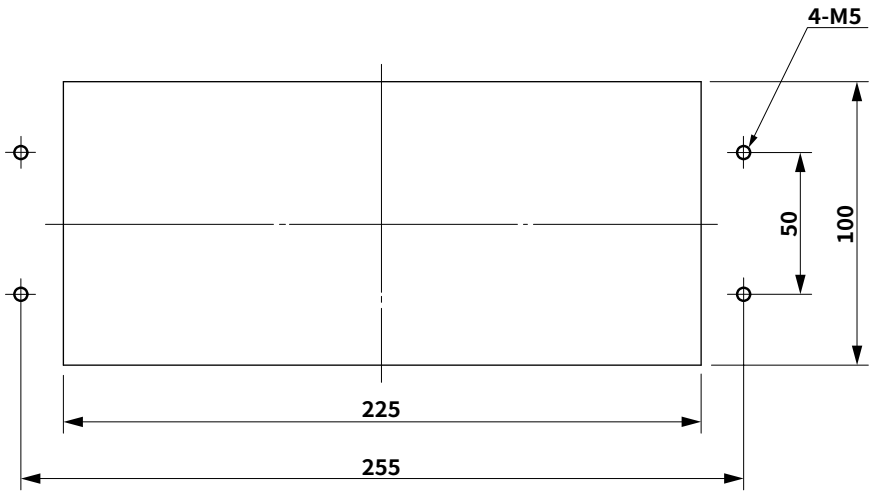

FRONT VIEW




REAR VIEW




SIDE VIEW




Dimensions with panel removed

Notes: 1. CL-2400 with rubber feet removed and the panel mount bracket installed will become panel type.

ONO SOKKI

*Outer appearance and specifications are subject to change without prior notice.

ONO SOKKI
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B00001657/IM99092001(2),007(MS)030