

The CL-Series: High-Precision, Reliable, Noncontact Thickness Measurement

For over 10 years Ono Sokki's innovative CL-series noncontact thickness meters have provided highly accurate measurement capabilities in a variety of challenging applications. Now, Ono Sokki introduces the latest additions to the CL-series product line:

CL-2400: Non-Contact Thickness Meter for conductive and semiconductive materials

CL-6200: Non-Contact Thickness Meter for conductive, semiconductive, and insulating materials

Based on a unique, capacitive measurement principle CL systems make use of Ono Sokki's proven VE-series high-precision, capacitive gap detectors. Measurements are possible on a wide array of materials, ranging from silicon wafers and steel plates to films and glass plates. When combined with the appropriate sensor, the following measurement ranges are possible:

Conductors or Semiconductors: 0.1 μ m to 99.9999 mm (0.004 to 999.999 mil)

Insulators: 0.1 μ m to 5.000 mm (0.004 to 196.851 mil)

FEATURES:

- The noncontact measurement process does not affect the material under measurement.
- Easy to read, large digital display.
- A simple sensor structure provides excellent durability & reliability.
- Our proprietary operating system ensures high accuracy, stability, and superior resolution.
- Configurable for in-line running thickness measurements.
- Digital output and printer interface for logging data.
- Built-in statistical processing functions (CL-6200)
- User-defined calculations (CL-6200)

Introducing the newest additions to the CL-series: CL-2400 & CL-6200 Equipped with a variety of interface methods for easy measurement automation.

■ CL-6200 Non-Contact Thickness Meter (for measurements on conductors, semiconductors, & insulators)

Designed for flexibility, the CL-6200 can be used on a variety of materials including: conductors, semiconductors, & insulators. The meter can be configured for static or running thickness measurements, or may also serve as a two-channel, high-accuracy displacement meter. User-defined calculations permit the unit to handle many different applications. A variety of I/O connections are provided for external control, analysis, and measurement automation, including: analog, comparator, BCD, & printer outputs, RS-232 interface, and remote control inputs.



■ CL-2400 Non-Contact Thickness Meter (for measurements on conductors & semiconductors)

The CL-2400 is designed for measurements on conductors, such as aluminum discs, and semiconductors, such as silicon wafers. Thickness is measured as the material under measurement passes through the gap formed between two opposing gap sensors. The CL-2400 can be used for static or running thickness measurements. BCD output, RS-232 interface, and remote control inputs are provided for external control, analysis, and measurement automation.



■ Measurable Materials

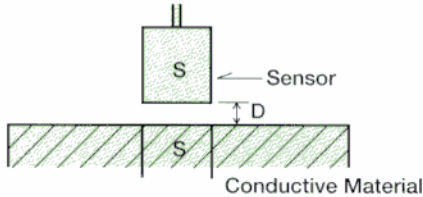
	Conductors and Semiconductors	Insulators
Measurement Examples	Silicon wafers, steel plates, aluminum plates, hard disks, printed circuit boards, and other metal plates requiring a high degree of cleanliness. Soft materials, materials with a mirror finish, or other materials that are highly susceptible to surface damage.	Glass, plastics, such as polyethylene, polypropylene, etc.
Applicable Models	CL-6200, CL-2400	CL-6200

* For measurement of intermediate materials or compound materials other than those listed above under Measurement Examples, please contact us for more information.

A High-Precision, Non-contact Thickness Measurement System for Both Conductive and Insulating Materials

Principles of Measurement

The VE Series gap detectors (shown in the photo below) are designed to measure and indicate gaps (displacements) based on the capacitance between the sensor and the material under measurement. Capacitance C is a function of the area, S , common to the sensor and the material, and the gap, D , between the sensor and the material. When two flat surfaces (those of the sensor and material) are placed parallel to each other, the capacitance can be represented by the following formula:

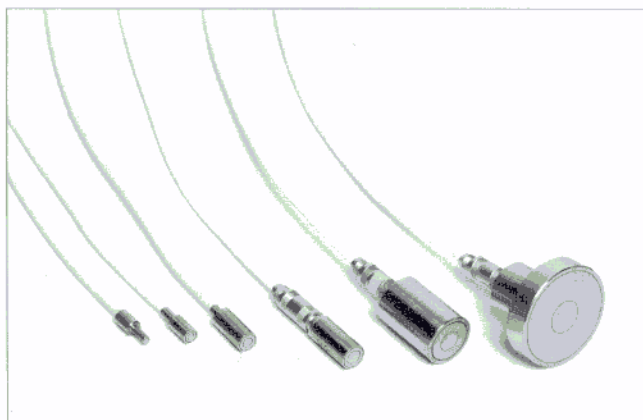


$$C = \frac{\epsilon \cdot S}{D}$$

ϵ : Dielectric constant of the material

Here, if area S is constant, then distance D will be inversely proportional to capacitance C . Whereas conventional capacitance sensors require the use of a linearizer, the CL Series directly obtains the voltage, which is proportional to the gap D , by means of a highly accurate operating circuit, converts the voltage into a digital signal, computes the thickness and displacement using a built-in microcomputer, and finally displays the result.

VE Series Gap Detectors



(With cables connected)

Measurement Method

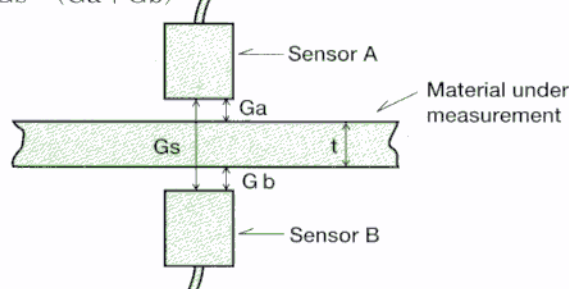
1 Measurement of conductive or semiconductive materials (CL-2400 & CL-6200):

Measurement materials:

Steel plates, aluminum plates, hard disks, two-sided printed circuit boards, other metal plates, silicon wafers, etc.

Arrange two sensors in parallel with a previously calibrated gap (G_s) between them, and set this gap in the CL-2400 or CL-6200. Place the material between sensors A and B, and measure the gaps (G_a & G_b) between each sensor and the material to determine the thickness (t).

$$t = G_s - (G_a + G_b)$$



Note: The sensor case and the material are assumed to have equal potential.

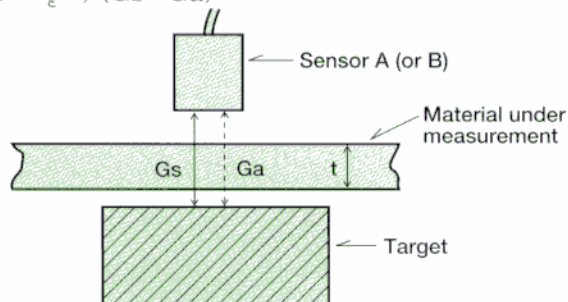
2 Measurement of insulating materials (CL-6200):

Measurement materials: Plastic films, etc.

Arrange the sensor and the conductive material (target) with a gap (G_s) between them, and place the measurement material between the sensor and the target. Since a variation in the thickness results in a variation in the sensor voltage output, thickness (t) can be determined from the voltage variation and dielectric constant ϵ of the material under measurement.

The formula for the thickness is:

$$t = \left(1 - \frac{1}{\epsilon}\right) (G_s - G_a)$$



Note: The sensor case and the target are assumed to have equal potential.

3 To measure intermediate-type materials or compound materials (CL-6200):

Please contact ONO SOKKI for more information.

The sensors can be selected to suit the required measurement range, sensor size, and sensor shape.

Type	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	0.1 μm	0.1 μm	0.1 μm	0.1 μm	1 μm	1 μm
Linearity *1	-0.15% of full scale					
Minimum target diameter	φ 3	φ 6	φ 8	φ 10	φ 20	φ 40
Cable length *2	Directly connected 2.5 m cable			VL-331(3m), VL-332(5m), VL-333(10m) Cable separately sold		
Operating temperature range	0~+80°C					
Temperature coefficient *3	$K_1=1.7 \times 10^{-5}$, $K_2=3.4 \times 10^{-5}$					
Dimensions	φ 3×17mm	φ 6×10mm	φ 8×17mm	φ 10×21mm	φ 20×30mm	φ 40×30mm
Weight	73g (Cable included)	73g (Cable included)	78g (Cable included)	7.1g	60g	123g

*1 Temperature range for guaranteed linearity applies to the CL-2400/CL-6200 is used at 20°C.

*2 The VE-121, -222 and -521 have direct cable outputs. Other types require a separately sold cable (VL Series).

Cable length of VL-331: 3 m

Cable length of VL-332: 5 m

Cable length of VL-333: 10 m

• Pay attention to the size of the connector when you fabricate sensor mounting fixtures. (Refer to the Outline and External Dimensional Diagrams on page 12.)

*3 The temperature characteristics of the VE Series are given by the following equation:

$$\Delta D = (K_1 \times \ell + K_2 \times D) \Delta t$$

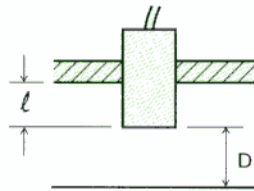
K_1 : Linear coefficient of expansion of the sensor housing material

K_2 : Surface coefficient of expansion of the sensor electrode material

Δt : Temperature variation

D : Measurement gap

ΔD : Output variation of the transducer



• Sensor Selection

The CL-Series non-contact thickness meters can be used in combination with the VE Series gap detectors listed above.

For measuring conductors or semiconductors, a pair of sensors of the same type must be used (sensors of different types cannot be combined with each other). For measuring insulating materials, a single sensor is used.

• Notes on Sensor Selection

The following three considerations should be made when selecting the sensor type to be used.

- ① Gap rating, ② Accuracy and resolution, and ③
- ④ Dimensions of the material to be measured

① Gap Rating

Gap rating is the sensor measurement range. This corresponds to gaps G_a and G_b for the measurement of conductors and semiconductors in Figure 1, and gap G_s for the measurement of insulating materials, conductors, and semiconductors in Figure 2 at the right. Define the required gap ratings in accordance with the variations in thickness and vertical movement of the material under measurement.

② Accuracy and Resolution

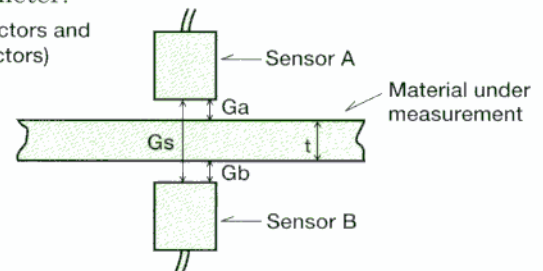
The accuracy and resolution will depend upon the sensor type selected. Sensors with small gap ratings offer better accuracy than those with large ratings.

③ Dimensions of Material to be Measured

The material to be measured must have a surface area that is at least as large as the minimum target diameter.

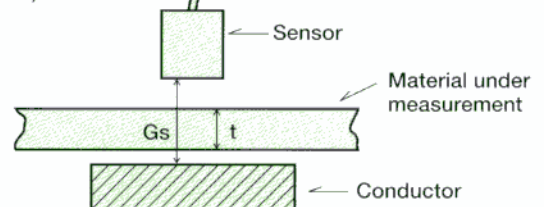
(For conductors and semiconductors)

Figure 1



(For insulators)

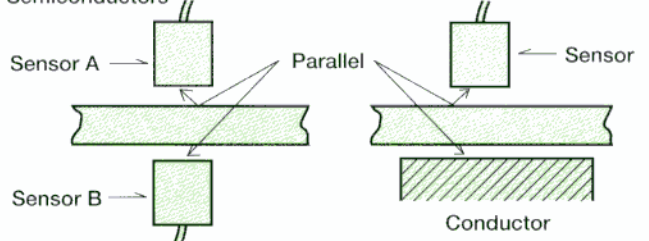
Figure 2



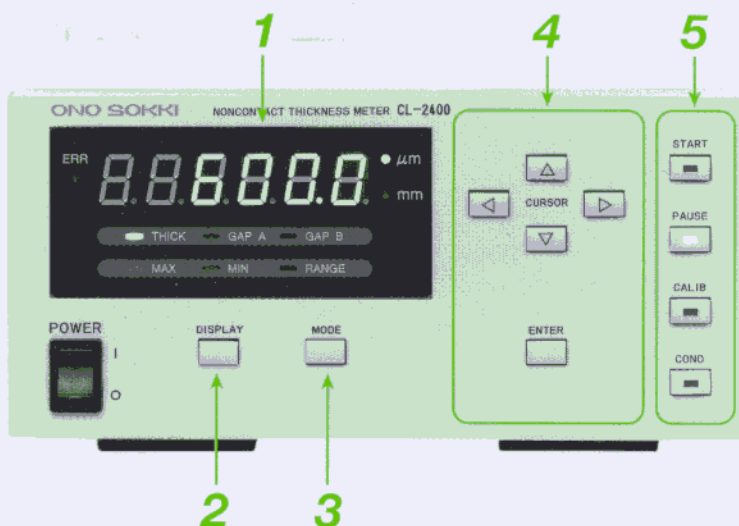
• Sensor Mounting

For measuring conductors or semiconductors, two sensors of the same type must be mounted opposite each other so that their end faces are parallel to one another. For measuring insulating materials, a single sensor must be mounted so that its end is parallel to a reference conductor.

Sensor Mounting for Measurement of Insulators, Conductors, or Semiconductors



Functions and Panel Key Layout of the CL-2400 Non-Contact Thickness Meter (for conductors and semiconductors)



1 Display

Large, bright green LEDs indicate both measured values (thickness and gap) and setting values.

2 DISPLAY Key

THICK: Thickness measurement
GAP A: Measurement of gap between sensor A and the material under measurement
GAP B: Measurement of gap between sensor B and the material under measurement
 Any of the indications above can be selected using this key.

3 MODE Key

MAX: Maximum value of measured data
MIN: Minimum value of measured data
RANGE: Max. value of measured data - min. value of measured data.

The user can choose any of the indications above after the measurement begins. (The LED display shows an average value every 0.2 sec, and then shuts off.)

4 DATA Key Group

These keys are used to input numerical values for settings.

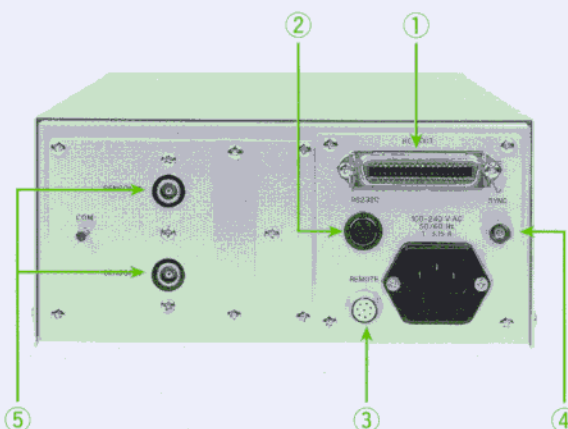
5 COMMAND Key Group

START: Used to start and stop measurement operations, perform initialization for maximum and minimum measurements
PAUSE: Used to pause measurement
CALIB: Used to set up a thickness measurement
COND: Used to set the number of averages, BCD output items, baud rate for RS-232C, etc.

CL-2400 Rear Panel

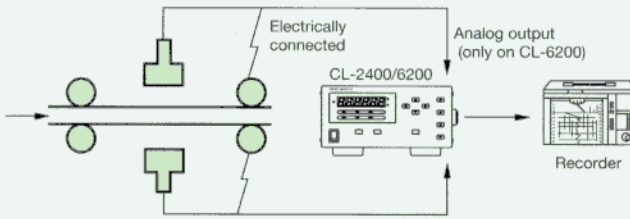
[Input and output signals]

- ① BCD output, status output, and error signal output (Amphenol 36-pin connector)
- ② RS-232C interface
- ③ Remote control inputs (inputs for start, stop, pause, and calibration start)
- ④ SYNC input and output (clock for synchronous measurement)
- ⑤ Sensor input terminals A and B

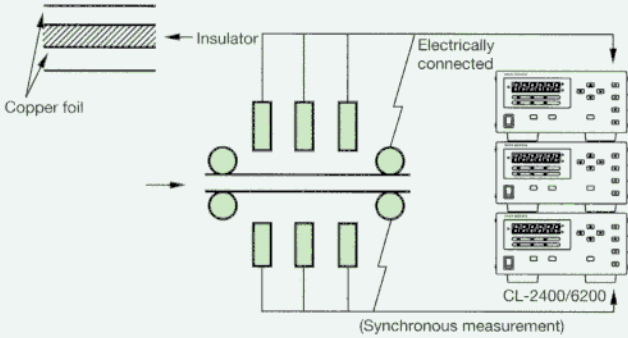


● Measurement of Conductors and Semiconductors

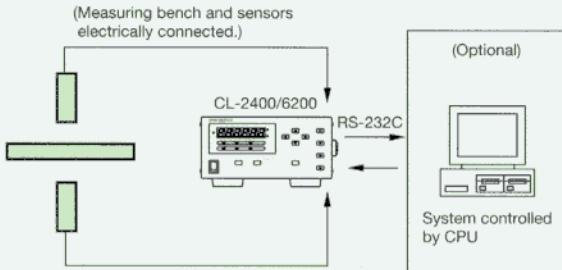
1. On-Line Non-Contact Thickness Measurement of Conductors



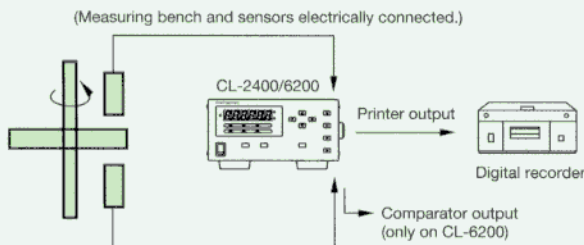
2. On-Line Non-Contact Thickness Measurement of Printed Circuit Boards



3. Non-Contact Thickness Measurement of Silicon Wafers

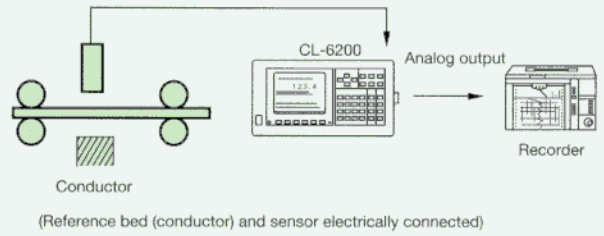


4. Non-Contact Thickness Measurement of Aluminum Discs

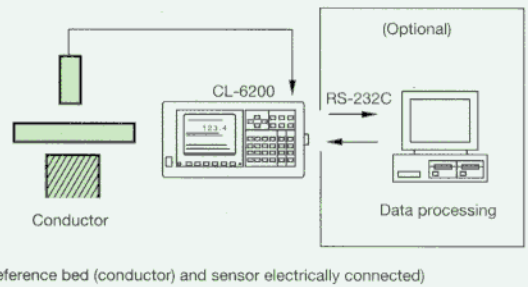


● Measurement of Insulators

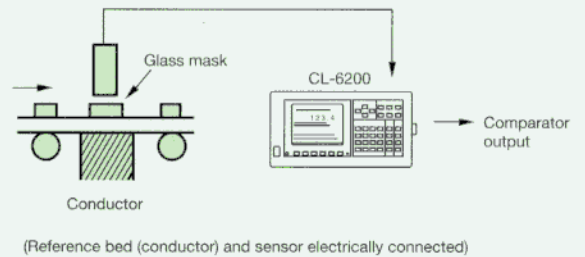
1. On-Line Non-Contact Thickness Measurement of Films



2. Non-Contact Thickness Measurement of Films and Data Processing



3. On-Line Non-Contact Thickness Measurement of Glass Masks for Semiconductors



* The system configuration examples indicated here represent only a few of the diverse system configurations that are possible.

Specifications

CL-2400	
Measurement items	Thickness of material under measurement Gap between sensor A and material under measurement Gap between sensor B and material under measurement
Display modes	Absolute value display of thickness or gaps Maximum value, minimum value, and maximum value - minimum value of measured data
Resolution	Automatically established by means of presetting the sensor in the CL-2400. A maximum of seven sensor types can be set. VE-121, VE-222, VE-521, VE-525A, and VE-133 for 0.1 μ m resolution (in steps of 0.004 mil) VE-231 and VE-531 for 1 μ m resolution (in steps of 0.0397 mil)
Parameter settings	Parameters required for measurement and calculations are set via the various keys on the panel and stored in internal memory. Those setting values are held in the power-off memory even after the unit is switched off.
Sampling time	20 ms
Averaging	For BCD output Number of averages: Moving average of 1 to 64 The measured value displayed on the LED is a simple sector average of 0.2 sec.
Real-time data processing	Maximum value, minimum value, and maximum value - minimum value of measured data are displayed in real time. Data initialized at the start. Data held at the stop.
Data memory	
Comparator function	
Display	LED: 7-segment, 6-digit, green LED display, including units and error messages
Analog output	
Printer output	BCD output is used using print using RQ-1410 (optional digital printer).
External control	Control is possible using external contact signals. Controlled items: •START/STOP •PAUSE •CALIBRATION START INPUT Input specifications: Photocoupler input (forward current $I_f = 10$ mA typ.)
Interface/input signal	BCD: 5-digit BCD output Connector: Amphenol 36-pin Output format: Open-collector output RS-232C: Connector: HR12-10R-8SD Baud rate: 9600, 2400, and 1200, selectable Parameter setting: Xon-Xoff, 8 bits, no parity, stop bit 1 fixed * Optional: Connection cable AX-5022 (between CL-2400 and PC-AT) SYNC: Input/output of clock for carriers when multiple CL-2400s are connected in cascade. Connector: C02 (BNC)
Power requirements	100 to 240 VAC, 50/60 Hz, power consumption: 30VA or less
Operating environment (main unit only)	Temperature: +18°C to +28°C (guaranteed accuracy range) 0°C to +40°C (operating range) Humidity: 20% to 80% R.H. (with no condensation).
External dimensions	210 (W) x 99 (H) x 350 (D) mm
Weight	Approx. 3.7 kg

● CL-015 Wafer Slide Table



The wafer slide table is an easy-to-operate manual slide table that can be combined with the CL-2400/6200 and a VE-133 sensor to perform non-contact thickness measurements on conductive wafers, such as silicon wafers.

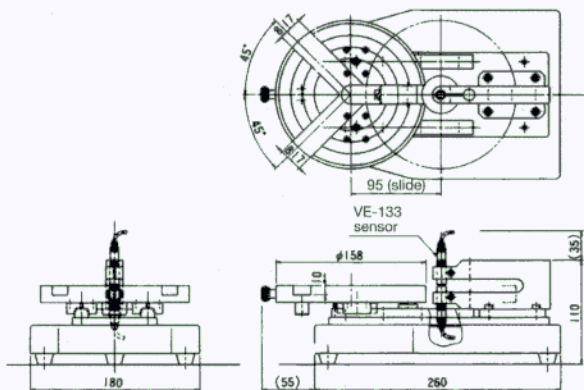
A slot is provided in the slide table for easy access by suction handlers.

Outer diameter: 100 to 150 mm

Thickness: 0.1 to 1 mm

Outline and Dimensional Diagram

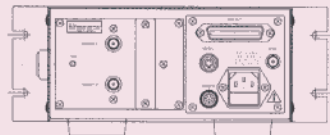
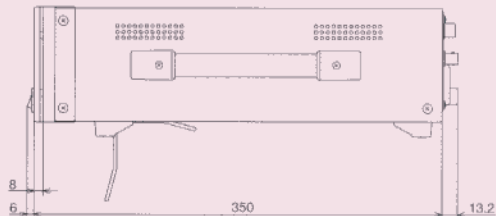
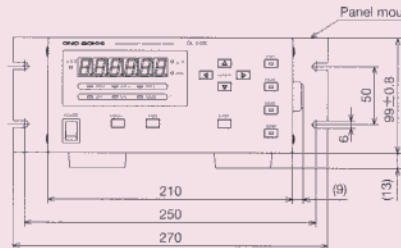
(Unit: mm)



For special models of the CL-015 (for 200-mm or 300-mm wafers), please consult us.

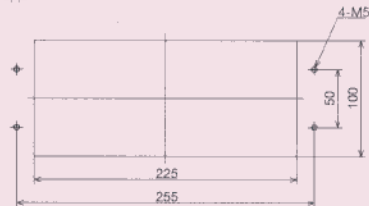
Outline and Dimensional Diagrams

CL-2400



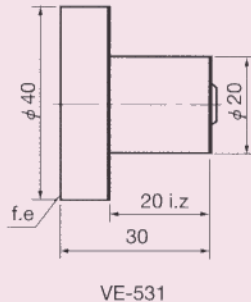
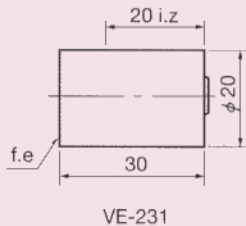
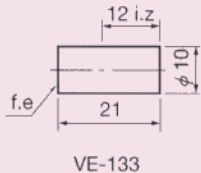
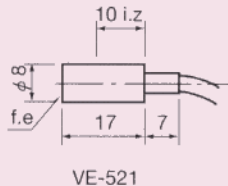
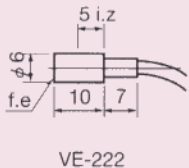
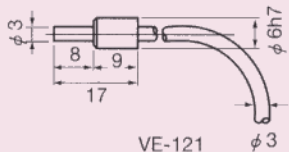
Rear

- Notes: 1. When the footings are removed from the unit and panel mounting fixtures are installed on it, the unit is converted to a panel-mount model.
2. To mount the unit on a panel, use a holding fixture at the bottom.



Panel cutout dimensions

VE Series (sensors)



VL Series (sensor cables for VE-133, 231, 531)

