HIOKI

# CM4001

Instruction Manual

Complete

# AC LEAKAGE CLAMP METER




**EN**

Oct. 2024 Revised edition 1
CM4001A963-01

1.800.561.8187 www.itm.com information@itm.com

# Introduction

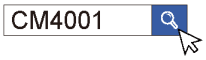
Thank you for purchasing the Hioki CM4001 AC Leakage Clamp Meter. To obtain maximum performance from the instrument, please read this manual first, and keep it handy for future reference.

See manuals relevant to your purpose.

| Manual title | Available format |
|---|---|
| Instruction Manual - Complete (this manual) | HTML/PDF |
| Instruction Manual - Basic | Printed |
| Operating Precautions (0990A909) | Printed |

## The latest edition of the instruction manual (PDF)

The contents of this manual are subject to change, for example as a result of product improvements or changes to specifications.




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# What Is Leakage Current?

Leakage current refers to the phenomenon where a minuscule amount of current flows outside the circuit in which it should normally flow. Normally, leakage current is a very small amount of current, but it occurs more easily when wires and circuit components inside electrical equipment are damaged or have deteriorated. If these problems are not dealt with, the leakage current may cause short circuits and fire. Measuring this minuscule amount of current is important for guaranteeing the safety of electrical equipment.

## Why does leakage current occur?

Leakage current primarily occurs for the following reasons:

- **Deterioration of insulating material:** Insulation deteriorates due to long-term usage and environmental factors
- **Connection problems:** Loose connecting parts and inappropriate wiring inside electrical equipment
- **Effects of humidity:** Usage in a high-humidity environment reduces insulator performance, which causes leakage current

## Measuring leakage current

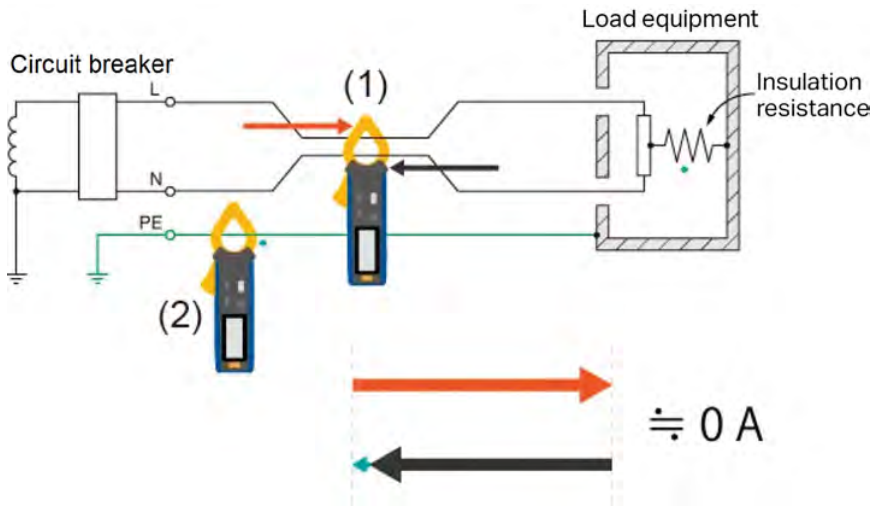
Clamp a clamp meter around the wire to measure. Using a clamp meter allows you to measure the amount of leakage current without cutting the wire.

The following two methods can be used to measure leakage current:

(1) Clamp multiple wires that supply power
The clamp meter measures two currents at the same time, which cancel each other out, resulting in 0 A.

(2) Clamp the ground wire
Current that leaks through the insulation of the load equipment flows to ground.

See “Making Measurements” (p.6)






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# Product Overview

This instrument is an AC Leakage Clamp Meter capable of measuring leakage current and overload current.

## Supports a broad range of current measurements

Leakage current and overload current can be measured from 0.60 mA to 600.0 A.

## Easy-to-clamp jaw shape

The shape of the jaws allows you to easily clamp around an electric circuit, even when the gaps between wiring are narrow.
(Up to 24 mm in diameter)

## Comparator function

Learn when a measured value exceeds the threshold value with beeping and the warning backlight.
This can reduce the time required for inspection work and identifying GFCI and RCD trip events.
See “Comparator Function (COMP)” (p.16)

## Wireless communications function (when the Z3210 Wireless Adapter is installed)

GENNECT Cross: Transfer measured values to a smartphone or tablet.
See “Using GENNECT Cross” (p.21)
Z3210-to-Excel direct data entry function (HID function): Transfer measured data directly to Excel.
See “Z3210-to-Excel direct data entry function (Excel direct input function, HID function)” (p.23)

## Measurement principles

For the measurement principles, see the relevant Hioki Technical Notes.

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# Measurement categories

IEC 61010 defines measurement categories to facilitate safe use of measuring instruments. Test and measurement circuits are classified into three categories according to the type of mains to which they are intended to be connected.

**⚠ DANGER**

- **Do not use a measuring instrument for measurements on mains that exceed the rated measurement category of that instrument.**
- **Do not use a measuring instrument without a designated measurement category rating for measurements on mains.**

Otherwise, the user will suffer from a serious bodily injury or the instrument and the mains installation will be damaged.

This instrument conforms to CAT III 300 V.

### Measurement category II (CAT II)

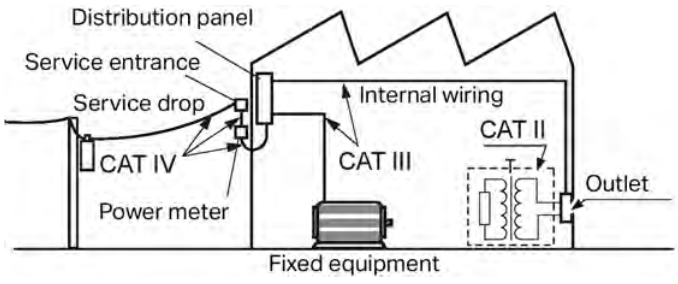
Applicable to test and measuring circuits connected directly to utilization points (socket outlets and similar points) of the low-voltage mains installation.
EXAMPLE: Measurements on household appliances, portable tools, and similar equipment, and on the consumer side only of socket-outlets in the fixed equipment.

### Measurement category III (CAT III)

Applicable to test and measuring circuits connected to the distribution part of the building's low-voltage mains installation.
EXAMPLE: Measurements on distribution boards (including secondary meters), photovoltaic panels, circuit breakers, wiring, including cables, bus-bars, junction boxes, switches, socket-outlets in the fixed equipment, and equipment for industrial use and some other equipment such as stationary motors with permanent connection to the fixed equipment.

### Measurement category IV (CAT IV)

Applicable to test and measuring circuits connected at the source of the building's low-voltage mains installation.
EXAMPLE: Measurements on devices installed before the main fuse or circuit breaker in the building installation.




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# Part Names

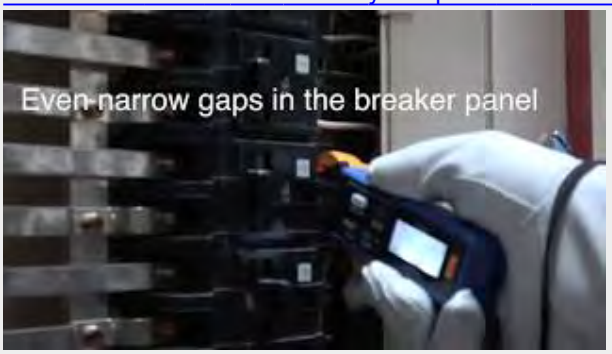



| No. | Name |
|---|---|
| 1 | Jaw |
| 2 | Operation grip |
| 3 | Barrier |
| 4 | Operation keys |
| 5 | Display |
| 6 | Power key |
| 7 | Serial number |
| 8 | Battery cover |
| 9 | Strap hole |

# Making Measurements

**Video**

Remarkable ease of use. Double your speed for checking leakage current on YouTube




## Measurement procedure

**1** Turn on the instrument.

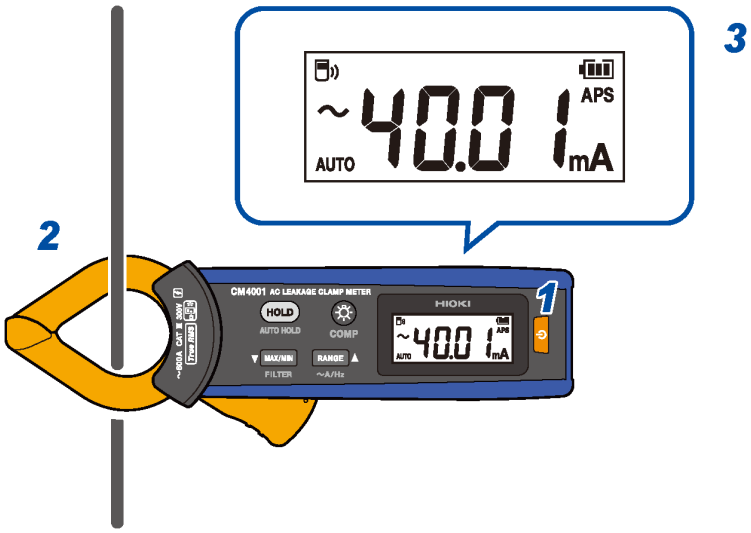
The default setting of the range is AUTO. Every time you press the **RANGE** key, the range switches. Switch the range as required.

AUTO → 60.00 mA → 600.0 mA → 6.000 A → 60.00 A → 600.0 A

**2** Clamp the instrument around the object under measurement.

Wear appropriate protective gear such as gloves.
Clamp the instrument so that the object under measurement is located at the center of the jaws.

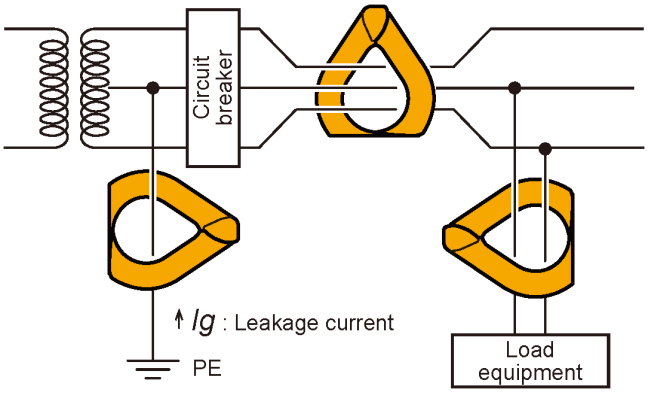
**3** Read the measured value.



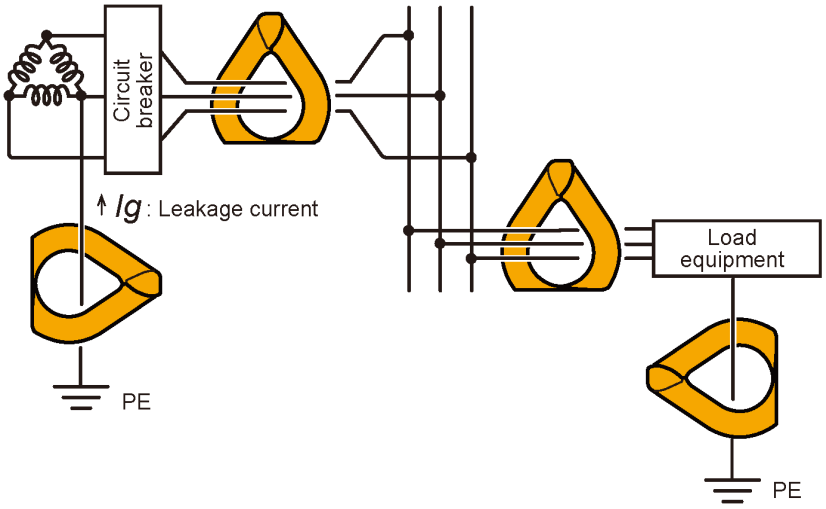
**4** Press the **RANGE** key for 1 s or more to switch between current measurement and frequency measurement.

## Leakage current measurement

### Single-phase 3-wire circuit




### 3-phase 3-wire circuit




### Other circuits

- Clamp around two wires together in a bundle in the single-phase 2-wire circuit.
- Clamp around four wires together in a bundle in the three-phase 4-wire circuit. Even when the instrument cannot be clamped, you can measure leakage current using the ground wire of the equipment instead.

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**IMPORTANT**

- The instrument can momently display large a readout when you open and close the jaws; however, this is not an error.
- The instrument cannot accurately make measurements in the following cases:
  (1) A large current flows through adjacent wires.
  (2) Special waveforms, such as that flowing through the secondary side of the inverter, is measured.
  (3) The jaws close incompletely. (In particular, if the external dimension of the object under measurement is large, such as when the instrument is clamped around three-phase wires together in a bundle, make sure that the jaws are closed completely. If the jaws are even slightly open, measured values will include errors and the accuracy cannot be ensured.

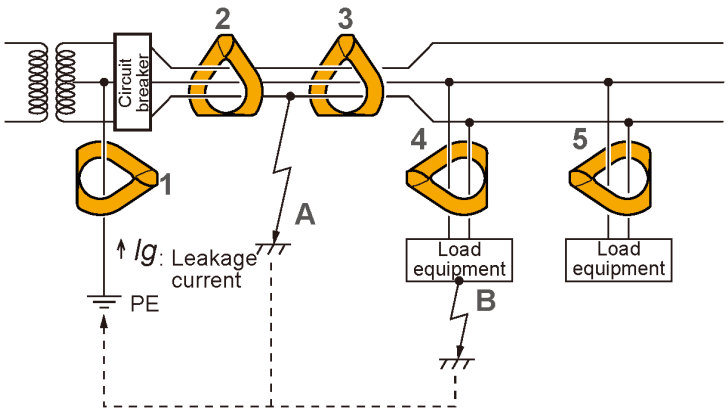
## Locating an insulation failure (identifying GFCI and RCD trip events)

By measuring leakage current of the entire circuit using the ground wire of the transformer (location 1 in the figure below), you can determine the presence or absence of an earth leakage in accordance with changes in leakage current.
When you find an earth leakage, perform the bundled measurement of all the wires from the power supply side toward the load side to locate an insulation failure.

Tips To investigate an intermittent earth leakage, such as intermittent ground-fault circuit interrupter (GFCI) and residual-current device (RCD) trip events, the event recording function will help you. When a measured value exceeds the set threshold value, the function records the event data (event occurrence time, event stop time, maximum value). The Z3210 Wireless Adapter (option) is required.

### Single-phase 3-wire circuit

- If the insulation on the wire has deteriorated at location **A** in the figure, you can detect the leakage current through the measurement by clamping around bundled wires, not at location 3 but location 2.
- If the insulation on the load device has deteriorated at location **B** in the figure, you can detect the leakage current through the measurement by clamping around the bundled wires, not at location 5 but location 4.

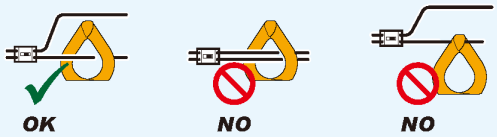


## Measuring load current

### Precautions for measuring load current

**IMPORTANT**

- Clamp the instrument around only one conductor wire. The instrument cannot measure load current when clamped around two or more wires together in a bundle, regardless of the single-phase and three-phase.
- Put the conductor perpendicular to the sensor.
- The instrument may not be able to measure rush current or significantly fluctuating current correctly.
- The instrument can display a readout of other than zero without input at a low temperature; however, this does not affect any measurement.




Tips

- The instrument may not be able to measure special waveforms, such as those flowing through the secondary side of an inverter.
- Depending on the magnitude of the input current, the jaws may generate a sound due to resonance; however, this does not affect any measurement.
- When you cannot find the magnitude of an input current, disable the filter function and start measurement using the auto range or 600.0 A range.

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# Filter Function (FILTER)

When an object under measurement is connected to a line that includes a switching power supply or an inverter, high-frequency components may be superimposed on its leakage current waveform. Using the filter function (low-pass filter) can eliminate unnecessary high-frequency components.

*1* Hold down the **MAX/MIN** key for 1 s or more.

The **[FILTER]** symbol appear on the display.
(To cancel, hold down the **MAX/MIN** key for 1 s or more.)
The filter function startup setting can be switched on and off by turning the instrument on while holding down the **MAX/MIN** key.

**IMPORTANT**

When the filter function is enabled, the instrument may a display value lower than the actual current value.
If current is measured by switching the range, and those measured values greatly vary depending on the range, trust the one measured using the upper range.
Example:
If 10.05 mA is displayed in the 60.00 mA range and 30.2 mA is displayed in the 600.0 mA range, trust 30.2 mA in the 600.0 mA range.

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# Hold Function (HOLD)

## Manual hold

You can stop the display refresh at any time.

**1** Press the **HOLD** key.

The **HOLD** key lights up, and the **[HOLD]** symbol appears on the display.
(To cancel, press the **HOLD** key again.)




## Auto hold

When the measured value becomes stable, the display refresh stops automatically.

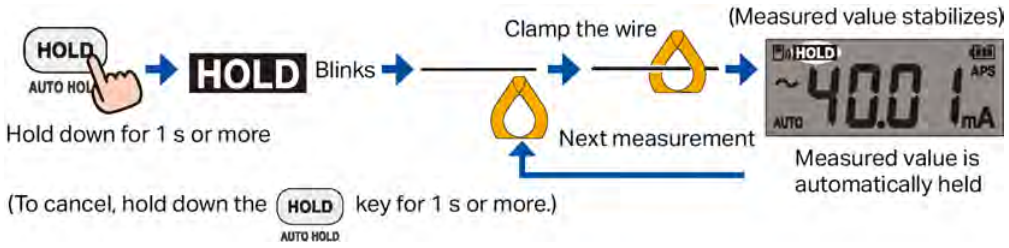
**1** Hold down the **HOLD** key for 1 s or more.

The **HOLD** key lights up, and the **[HOLD]** symbol blinks on the display.

**2** Clamp the instrument around an object to be measured.

When the measured value become stable, the display refresh stops automatically.

When performing the next measurement, remove the instrument from the wire and clamp the instrument around the object under measurement again.
(To cancel, hold down the **HOLD** key for 1 s or more.)




## Auto-hold conditions

When both the following conditions are satisfied, the instrument freezes the readout.

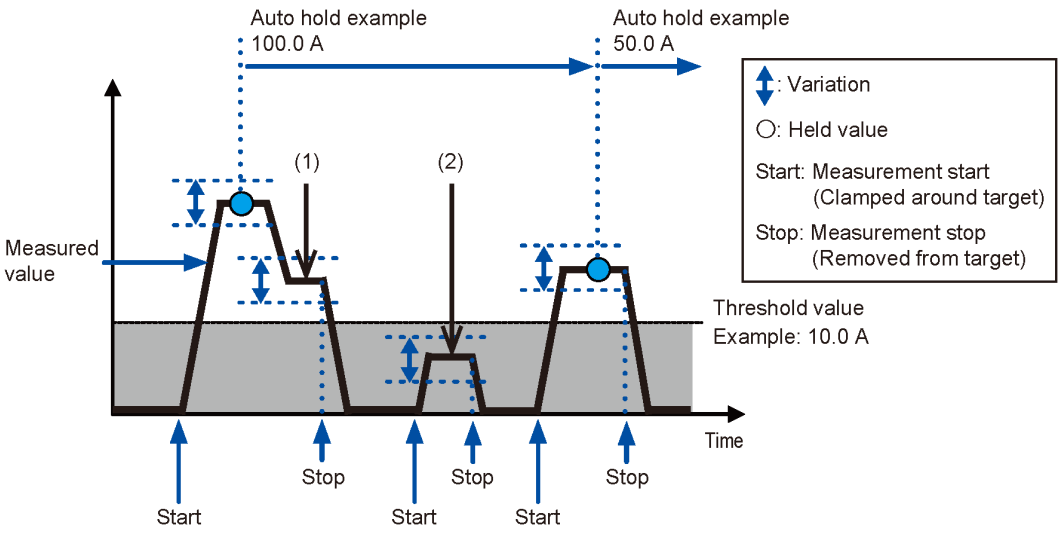
- The measured value does not fluctuate beyond the variation range for a certain period.
- The measured value exceeds the threshold value.

The instrument continues to freeze the readout until the auto-hold conditions are satisfied again.



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Hold Function (HOLD)




(1) The instrument does not freeze the readout automatically. (The measured value does not become less than the threshold value.)

(2) The instrument does not freeze the readout automatically. (The measured value does not exceed the threshold value.)

The variation range and threshold value may vary depending on the range.

| Range | Variation width | Threshold value |
|---|---|---|
| 60.00 mA | 400 counts or less | 150 counts |
| 600.0 mA | | |
| 6.000 A | | |
| 60.00 A | 500 counts or less | |
| 600.0 A | | |

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# Max., Min., Average, and Peak Values (MAX, MIN)

The instrument can display the maximum, minimum, average, highest peak, or lowest peak values of the measured data. The auto power save function is disabled.

**1** Clamp the instrument around an object to be measured.

**2** Press the **RANGE** key switch the range.

If you switch from the auto range to MAX or MIN mode, the range is fixed at the presently set range.

**3** Press the **MAX/MIN** key.

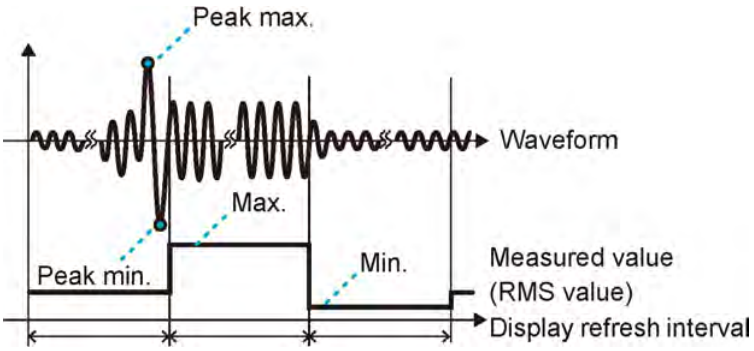
Every time you press the key, another item is displayed.

MAX → MIN → AVG → PEAK MAX → PEAK MIN → Presently measured value

(To cancel, hold down the **MAX/MIN** key for 1 s or more.)

**Tips**

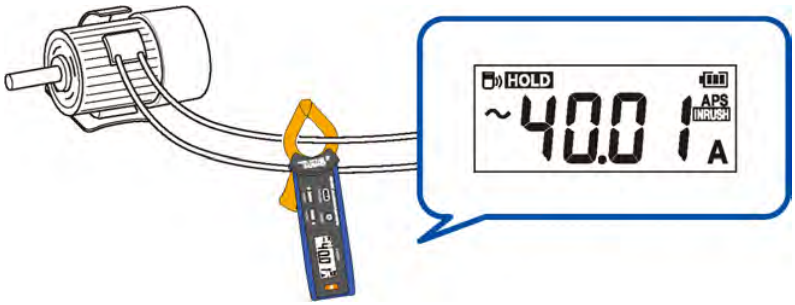
- To freeze the readouts, press the **HOLD** key.
- The instrument measures the RMS value. AVG means the average value of all measured values.



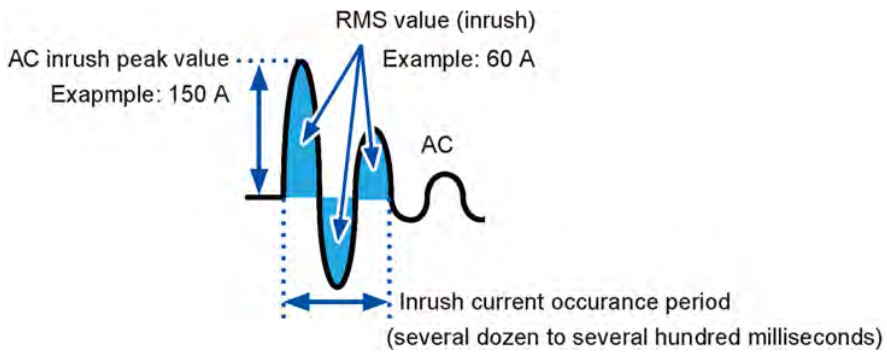
# Inrush Current Measurement (AC INRUSH)

The instrument can measure AC inrush current.

1. Turn off the power to the object under measurement.
2. Press **RANGE** to set the range.
3. Press and hold the **MAX/MIN** key and **RANGE** key simultaneously for 1 s or more to enable inrush current measurement.
   The instrument cannot measure inrush current including DC components accurately.
4. Clamp the wire.




5. Turn on the power to the object under measurement.
   If inrush current occurs, the measured value will be held.




The inrush measurement range is set as follows depending on the range when the current is measured.

| Range when the current is measured | Inrush measurement range | Trigger threshold value (PEAK value) |
|---|---|---|
| 60.00 mA<br>600.0 mA | 600.0 mA range | Greater than or equal to +60.0 mA or less than or equal to −60.0 mA |
| 6.000 A | 6.000 A range | Greater than or equal to +0.600 A or less than or equal to −0.600 A |



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| Range when the current is measured | Inrush measurement range | Trigger threshold value (PEAK value) |
|---|---|---|
| 60.00 A | 60.00 A range | Greater than or equal to +2.00 A or less than or equal to −2.00 A |
| 600.0 A<br>Auto | 600.0 A range | Greater than or equal to +20.0 A or less than or equal to −20.0 A |

(To return to current measurement, hold down the **MAX/MIN** and **RANGE** keys simultaneously for 1 s or more.)

# Comparator Function (COMP)

When a measured value exceeds the threshold value, a buzzer sounds and the warning backlight lights up.
See “Warning backlight” (p.20)
You can also disable the buzzer sound.
The auto range cannot be used when the comparator function is enabled.

**1** Hold down the key for 1 s or more.

The comparator function is enabled.




(To cancel, hold down the key for 1 s or more.)

**2** Press the **MAX/MIN** key or **RANGE** key to set the threshold value.

Holding down the key increases or decreases the value continuously.







**3** Press the **HOLD** key.

The threshold value is confirmed, and the instrument displays the measurement screen.

**Video**

Find issues faster with a comparator function on YouTube



# Simple Event Logging Function

The instrument can update the maximum value display from the start to the stop of recording. When the maximum value exceeds the set threshold value, the backlight flashes on and off in red to warn.

**1** Turn the instrument on while holding down the **HOLD** key and key simultaneously.

The **HOLD** key blinks.



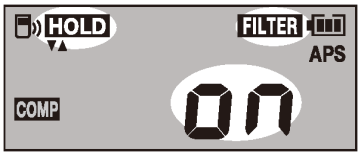

**2** Press the **MAX/MIN** key (▼) or **RANGE** key (▲) to select the threshold value.




**3** Press the **HOLD** key.

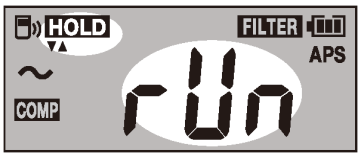
The threshold value is confirmed, and the **HOLD** key blinks.

**4** Press the **MAX/MIN** or **RANGE** key to enable or disable the filter function.




**5** Press the **HOLD** key.

The filter setting is confirmed, and the **[HOLD]** symbol and the **[rUn]** segments blink on the display.




> Tips **To change the threshold value**
>
> Press the **MAX/MIN** key or **RANGE** key to return to the threshold value selection screen (step **2**).

**6** Press the **HOLD** key.

The instrument starts event logging.

**7** Press the **MAX/MIN** or **RANGE** key.

The logging stopping confirmation screen appears.
The display returns to the logging screen after approximately four seconds of inactivity.




**8** Press the **HOLD** key.

The instrument stops the event logging. The instrument resets the maximum value and returns the logging start screen (step **5**)

### Event logging in progress

The instrument display the maximum value from the recording start.
The blinking red backlight warns you that the maximum value exceeds the set threshold value.




Tips Press **HOLD** to freeze the readout.

## Finishing the simple event logging

Cycle the instrument.

# Auto Power Save Function (APS)

Using the auto power save function can reduce the battery consumption.
When you turn on the instrument, the auto power save function is enabled automatically.
When using the instrument continuously for an extended period of time, turn on the instrument while holding down the **HOLD** key to disable the auto power save function.

# Backlight

## Display backlight

Backlighting the display allows you to see the display clearly even in a dark place.

Pressing the key can turn the display backlight on and off. The backlight automatically is turned off after about 40 s of inactivity.

To disable the automatic backlight shutoff, turn on the instrument while holding down the key.

## Warning backlight

When any of the following occurs, the backlight lights up or blink in red to warn you.

- Overload (if the measured current value exceeds the measurement range)
  The full-scale value blinks and the buzzer sounds. Quit the measurement immediately.
- When the measured current exceeds the measurable range (overrange, with a manual range used)
  The full-scale value blinks. Set the instrument to a proper range.
- If the measured value exceeds the threshold value with the comparator function or event recording function




The warning backlight works only for the present measured value. The warning backlight does not work for the freezing value and recorded values of the MAX, MIN, AVG, PEAK MAX, and PEAK MIN display functions.

# Wireless Communications Function

When the Z3210 Wireless Adapter (option) is installed, the wireless communications function can be used. Concurrent use of GENNECT Cross and the HID function is not available.
See “Z3210-to-Excel direct data entry function (Excel direct input function, HID function)” (p.23)

## Using GENNECT Cross

Using GENNECT Cross allows you to check and record the measured data of the instrument and create measurement reports using your mobile device.
For more information about this functionality, see the Help function in the GENNECT Cross (application software, free of charge).

- The communications range is approximately 10 m (line of sight). The communications range varies significantly depending on the presence of obstructions (walls, metallic shielding, etc.) and the distance between the floor (ground) and the instrument. To ensure the stable communication, make sure that the radio wave intensity is sufficient.
- GENNECT Cross is free, but you may be subject to Internet data fees when downloading and using the app.
- GENNECT Cross may not work properly on some devices.
- The Z3210 uses the 2.4 GHz band wireless technology. It may not be possible to establish communications if there is equipment that uses the same frequency band, for example a wireless network (IEEE802.11.b/g/n), nearby.

Tips When the instrument is placed on the floor or ground, the communication distance becomes shorter. It is recommended that you move the instrument from the floor or ground and place it on a desk or table or hold it by hand.

## Using the wireless communications function

1. Connect the Z3210 Wireless Adapter (option) to the instrument.
2. Install GENNECT Cross on your mobile device.
3. Turn on the instrument, and then hold down the **HOLD** and **MAX/MIN** keys simultaneously for 1 s or more.
   The wireless communications function is enabled.

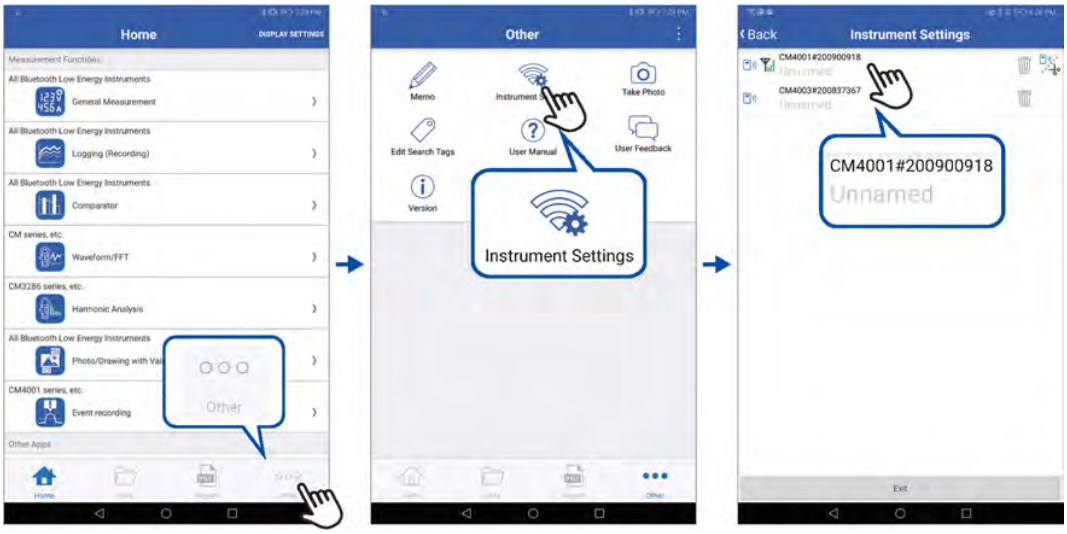



flashes: communicating
appears: wireless function on
disappears: wireless function off



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**4** Launch GENNECT Cross and pair it with the instrument.




- When GENNECT Cross is started for the first time (when there is no registered instrument), the Instrument Settings screen appears.
- When the instrument is placed near your mobile device, its connection is registered automatically on the Instrument Settings screen of GENNECT Cross (up to eight instruments).
- Wait for 5 to 30 s until the connection of the instrument is registered after turning on the instrument. If the connection of the instrument is not registered after 1 minute has elapsed, restart GENNECT Cross and the instrument.

**5** Choose a measurement function to perform measurement.

| | |
|---|---|
| | General measurement |
| | Waveform graph, FFT |
| | Photo drawing function |
| | Event logging<br>See “Event Logging Function (EVENT)” (p.23) |
| | Logging |
| | Comparator |
| | Harmonic analysis |
| UPDATE | Firmware updating of the instrument |

### Event Logging Function (EVENT)

The event logging function logs the data when measured values exceed a desired threshold value, which can be set with GENNECT Cross. For details, see the Help function in GENNECT Cross.
The number of logged events can be checked using the instrument.

1 Hold down the **HOLD** and keys simultaneously for 1 s or longer.

The number of logged events is displayed.

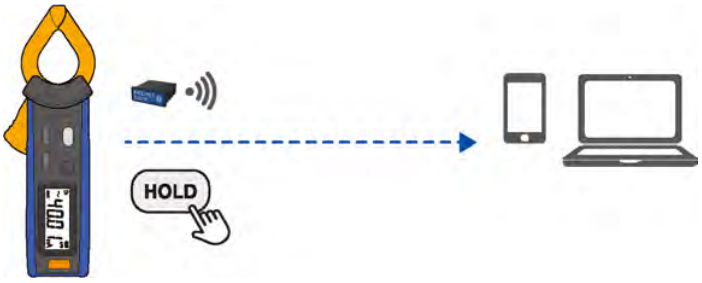
- The instrument may not measure events with a duration time of less than 200 ms accurately, failing to detect events.
- The instrument can record up to 99 events. The event recording terminates when the recorded events reach 99 in number.
- When you start another event logging session, the instrument deletes previously logged data.

## Z3210-to-Excel direct data entry function (Excel direct input function, HID function)

Concurrent use of GENNECT Cross and the HID function is not available.
See “Using GENNECT Cross” (p.21)
The human interface device (HID) profile, with which the Z3210 Wireless Adapter is equipped, is a profile same as that wireless keyboards use.

| | |
|---|---|
| **HID ON** | Preparatory to data entry, open an Excel file on your mobile device or computer and choose a cell. When the instrument’s display freezes, the measured values are entered on the cells.<br>The use of this function with the auto hold function enabled comes in handy.<br>See “Auto hold” (p.11) |
| **HID OFF** | When you wish to use GENNECT Cross, disable the HID function. |

The setting whether the HID function has been enabled or disabled is not saved in the instrument but in the Z3210.




### Confirming and toggling the HID setting

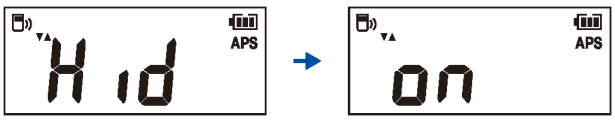
1 Remove the instrument from the object under measurement and turn off the instrument.

2 Connect the Z3210 Wireless Adapter (option) to the instrument.

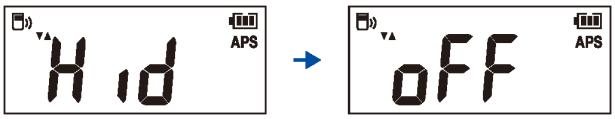
3 Turn the power on while holding down the and **RANGE** keys simultaneously.

The HID setting saved in the Z3210 is displayed.

When the HID function is enabled



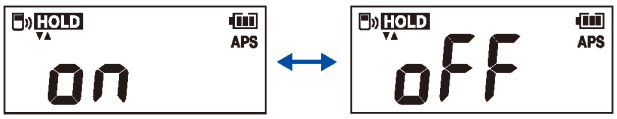

When the HID function is disabled




Tips If you do not wish to change the HID setting, press the power key to turn off the instrument.

**4** Press the **MAX/MIN** or **RANGE** key to enable or disable the HID function.

The **HOLD** key blinks. Every time you press the key, the HID function switches on and off.




**5** Press the **HOLD** key.

The HID setting is toggled, and the instrument is automatically turned off.

## If the HID function cannot be enabled

Use the firmware updating function of GENNECT Cross (ver. 1.8 or later) to update the Z3210.

**IMPORTANT**

**To switch from the HID function to GENNECT Cross**

If you start GENNECT Cross without canceling the paring between the mobile device and the instrument, GENNECT Cross may not be able to recognize the instrument as a connectible device. Follow the procedure below to reconnect the instrument to GENNECT Cross.

1. Use the **Bluetooth®** setting of your mobile device to delete the instrument.
2. Disable the Z3210's HID function.
3. Use the Instrument Setting of GENNECT Cross to reconnect the instrument.

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HIOKI

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