HIOKI

Instruction Manual

3290-10

CLAMP ON AC/DC HiTESTER

HIOKI E. E. CORPORATION

July 2012 Revised edition 8 3290B981-08 12-07H

600064078

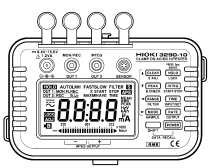
Contents

Introduction

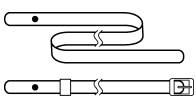
Thank you for purchasing the HIOKI “Model 3290-10 CLAMP ON AC/DC HiTESTER.” To obtain maximum performance from the meter, please read this manual first, and keep it handy for future reference.
This manual describes the operation of the 3290-10 when used with the CT9691 (9691), CT9692 (9692), or CT9693 (9693) CLAMP ON AC/DC SENSOR.

Checking the Contents of the Package

When you receive the meter, inspect it carefully to ensure that no damage occurred during shipping. In particular, check the accessories, panel buttons, and jacks. If damage is evident, or if it fails to operate according to the specifications, contact your dealer or Hioki representative.
Use the original packing materials when transporting the meter, if possible.

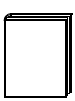


Model 3290-10 CLAMP ON AC/DC HiTESTER X 1



Strap X 1

Batteries (LR6) X 4



Instruction Manual X 1

Options

- Model 9445-02 AC ADAPTER
- Model 9445-03 AC ADAPTER
- Model 9094 OUTPUT CORD
- Model 9400 CARRYING CASE
- Model CT9691 (9691) CLAMP ON AC/DC SENSOR
- Model CT9692 (9692) CLAMP ON AC/DC SENSOR
- Model CT9693 (9693) CLAMP ON AC/DC SENSOR

Safety Notes

DANGER

This meter is designed to comply with IEC 61010 Safety Standards, and has been thoroughly tested for safety prior to shipment. However, mishandling during use could result in injury or death, as well as damage to the meter. Be certain that you understand the instructions and precautions in the manual before use. We disclaim any responsibility for accidents or injuries not resulting directly from meter defects.

Safety Symbols

This manual contains information and warnings essential for safe operation of the meter and for maintaining it in safe operating condition. Before using it, be sure to carefully read the following safety precautions.

	In the manual, the ⚠ symbol indicates particularly important information that the user should read before using the meter.
⚠	The ⚠ symbol printed on the meter indicates that the user should refer to a corresponding topic in the manual (marked with the ⚠ symbol) before using the relevant function.
⎓	Indicates DC (Direct Current).
~	Indicates AC (Alternating Current).
⧈	Indicates a double-insulated device.
⚡	Indicates that the instrument may be connected to or disconnected from a live circuit.

The following symbols in this manual indicate the relative importance of cautions and warnings.

⚠DANGER	Indicates that incorrect operation presents an extreme hazard that could result in serious injury or death to the user.
⚠WARNING	Indicates that incorrect operation presents a significant hazard that could result in serious injury or death to the user.
⚠CAUTION	Indicates that incorrect operation presents a possibility of injury to the user or damage to the meter.
NOTE	Indicates advisory items related to performance or correct operation of the meter.

Other Symbols

	Indicates the prohibited action.
❖	Indicates the reference.

Accuracy

We define measurement tolerances in terms of f.s. (full scale), rdg. (reading) and dgt. (digit) values, with the following meanings:

f.s. (maximum display value or scale length)
The maximum displayable value or scale length. This is usually the name of the currently selected range.

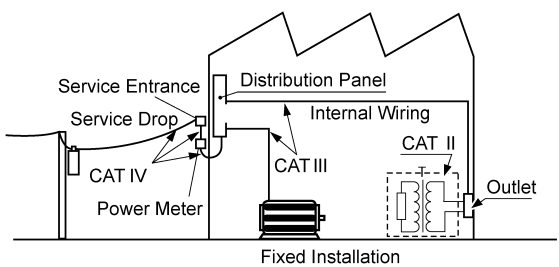
rdg. (reading or displayed value)
The value currently being measured and indicated on the measuring meter.

dgt. (resolution)
The smallest displayable unit on a digital measuring meter, i.e., the input value that causes the digital display to show a "1" as the least-significant digit.

Measurement categories

This device complies with CATIII (600 V), CATII (1000 V) safety requirements.
To ensure safe operation of measurement devices, IEC 61010 establishes safety standards for various electrical environments, categorized as CAT II to CAT IV, and called measurement categories.

CAT II	Primary electrical circuits in equipment connected to an AC electrical outlet by a power cord (portable tools, household appliances, etc.) CAT II covers directly measuring electrical outlet receptacles.
CAT III	Primary electrical circuits of heavy equipment (fixed installations) connected directly to the distribution panel, and feeders from the distribution panel to outlets.
CAT IV	The circuit from the service drop to the service entrance, and to the power meter and primary overcurrent protection device (distribution panel).



Using a measurement device in an environment designated with a higher-numbered category than that for which the device is rated could result in a severe accident, and must be carefully avoided.

Usage Notes

Follow these precautions to ensure safe operation and to obtain the full benefits of the various functions.

Setting Up the 3290-10

⚠CAUTION

Avoid the following:

Corrosive or explosive gases

High temperature
High humidity

Direct sunlight

Dust

Electomagnetic radiation

Impact, dropping

- This meter should be installed and operated indoors only, between 0 and 40°C and 80% RH or less.
- Do not use the meter where it may be exposed to corrosive or combustible gases. The meter may be damaged.
- Do not store or use the meter where it could be exposed to direct sunlight, high temperature or humidity, or condensation. Under such conditions, the meter may be damaged and insulation may deteriorate so that it no longer meets specifications.
- This meter is not designed to be entirely water- or dust-proof. Do not use it in an especially dusty environment, nor where it might be splashed with liquid. This may cause damage.
- Do not use the meter near a source of strong electromagnetic radiation, or near a highly electrically charged object. These may cause a malfunction.
- To avoid damage to the meter, protect it from physical shock when transporting and handling. Be especially careful to avoid physical shock from dropping.

NOTE

Correct measurement may be impossible in the presence of strong magnetic fields, such as near transformers and high-current conductors, or in the presence of strong electromagnetic fields such as near radio transmitters.

Preliminary Checks

Before using the meter the first time, verify that it operates normally to ensure that the no damage occurred during storage or shipping. If you find any damage, contact your dealer or Hioki representative.

⚠WARNING

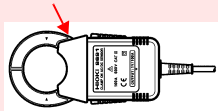
Before using the meter, make sure that the insulation on the probes is undamaged and that no bare conductors are improperly exposed. Using the meter in such conditions could cause an electric shock, so contact your dealer or Hioki representative for repair.

Measurement

⚠DANGER

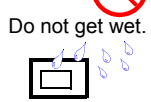
- **To avoid short circuits and potentially life-threatening hazards, never attach the clamp to a circuit that operates at more than 600V, or over bare conductors.**
- **Clamp sensor should only be connected to the secondary side of a breaker, so the breaker can prevent an accident if a short circuit occurs. Connections should never be made to the primary side of a breaker, because unrestricted current flow could cause a serious accident if a short circuit occurs.**
- **To avoid electric shock, do not touch the portion beyond the protective barrier during use.**

Barrier



This model is the 9661.

⚠WARNING



Do not get wet.

- **Do not allow the meter to get wet, and do not take measurements with wet hands. This may cause an electric shock.**
- **To avoid electric shock when measuring live lines, wear appropriate protective gear, such as insulated rubber gloves, boots and a safety helmet.**

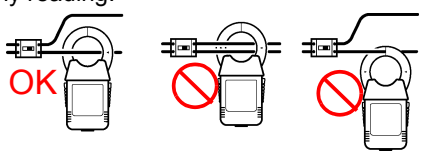
⚠CAUTION

- The maximum continuous-input limit is obtained from the temperature increase due to self-heating during measurement. To prevent damage to the clamp-on sensor, do not input a current exceeding this limit.
- The maximum continuous-input limit varies depending on the clamp-on sensor and the frequency of the current to be measured.

❖ Maximum continuous-input limit varies:
See Section 6.3 "CLAMP ON AC/DC SENSOR Specifications" (page 116)
Each sensor's derating acording to frequency

NOTE

- The B indicator appears when battery voltage becomes low. Replace the batteries as soon as possible.
- After use, always turn OFF the power.
- Attach the clamp around only one conductor. Single-phase (2-wire) or three-phase (3-wire) cables clamped together will not produce any reading.



Handling the Clamp Sensors

⚠CAUTION

- The ends of the clamp sensor are very delicate. Be careful not to drop the sensor or subject it to impact. If the sensor is deformed or the contact surfaces of the clamps are damaged, the measurement may not be accurate.
- Be careful to avoid dropping the clamps or otherwise subjecting them to mechanical shock, which could damage the mating surfaces of the core and adversely affect measurement.
- The top part of the clamp sensor above the barrier (including the clamps, but not the lever) is provided with double insulation to ensure safety. Be careful not to drop the sensor or otherwise subject it to impact. A damaged sensor may result in electric shock during measurement. In case of sensor damage, contact us immediately for repair or discard the damaged sensor to avoid subsequent use.

Overview 1

1.1 Product Overview

The 3290-10 CLAMP ON AC/DC HiTESTER is used with the CT9691 (9691), CT9692 (9692), or CT9693 (9693) CLAMP ON AC/DC SENSOR. These sensors are interchangeable and any model can be used with the 3290-10. The 3290-10 automatically detects the sensor connected and sets up the appropriate range. When combined with the CT9691 (9691), CT9692 (9692), or CT9693 (9693) Sensor, the 3290-10 HiTESTER can perform DC, AC, and AC+DC measurement of a live power line. In addition, current integral and duty measurement functions are provided.
As well as operating from batteries or AC adapter, operation from an external DC power source is supported for long-term measurements.
See page 139 for details of the differences with the Model 3290 CLAMP ON AC/DC HiTESTER.

1.2 Features

Current integration functions (total, positive and negative integrals)

Polarity-specific positive and negative current integrals can be measured (at ten samples/second)
D/A output (selectable total, positive or negative integral).
Measures the mean current value within a specified interval (total integral / integration interval).

Operating time and duty measurement

Any value can be set as the operating state threshold.
Duty (%) = operating time / measurement time X 100

Timer measurements available (integral and duty measurements)

Measurement times can be set from one minute to 99 hours, 59 minutes.

Repeating measurements

Any timer can be set to perform up to 20 repeated measurements.

Historical measurement data confirmation

Data from repeating measurements can be stored (integrals, interval mean, peak, maximum, minimum, duty and operating time).

Data storage

Measurement data and settings can be stored by pressing the HOLD button for two seconds, and upon auto power-off or forced power off due to low battery voltage.

Data recall

Holding the **SHIFT** button while pressing the POWER button to turn the meter on recalls stored data.

Peak measurement

Positive and negative current waveform peak values can be displayed in DC mode.

Low-frequency current measurement

AC current as low as 1 Hz can be measured in the SLOW AC+DC mode.

Filter function

Switchable 500-Hz low-pass filter (in AC and AC+DC modes)
Switchable 1-Hz low-pass filter (in DC mode, for MON output)

AC+DC measurement

Measures superimposed AC and DC components and full- and half-wave rectified waveforms.

Selectable measurement response time

Measurement response time can be set to FAST, NORMAL or SLOW (in AC and AC+DC modes).

Multiple power source support

Accepts power from batteries, optional AC adapter or external DC source.

Extension cable options

An extension cable can be connected between the meter and the CT9691 (9691), CT9692 (9692) or CT9693 (9693) CLAMP ON AC/DC SENSOR. Optional extension cables are available with lengths of 5, 10, 20, 30, 50 or 100 m.

1.3 Identification of Controls and Indicators

1.3.1 Model 3290-10 CLAMP ON AC/DC HiTESTER

Front Panel

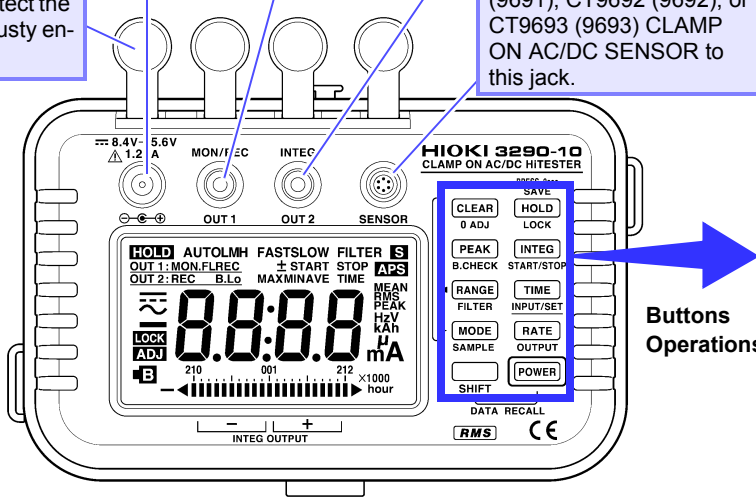
AC Adapter Connection Jack
The optional AC adapter can be connected here to power the meter.

Output Jack 1 (OUT1)
Connect the optional 9094 OUTPUT CORD to this jack to obtain output during current measurement.

Output Jack 2 (OUT2)
Connect the optional 9094 OUTPUT CORD to this jack to obtain output during integral measurement.

Dust Caps
Used to protect the jacks in a dusty environment.

Sensor Jack (SENSOR)
Connect the CT9691 (9691), CT9692 (9692), or CT9693 (9693) CLAMP ON AC/DC SENSOR to this jack.



Notation for multi-button operations

A + B: Press Button A and button B at the same time.

Example: **SHIFT** + POWER

Press the **SHIFT** and **POWER** buttons at the same time.

A → B: Press Button A and then press Button B.

Example: **SHIFT** → POWER

After pressing the **SHIFT** button (**S** appears on the display), press the **POWER** button.

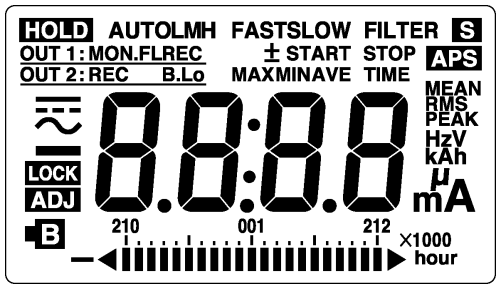
Buttons Operations

POWER	Turns power ON/OFF. CLEAR + POWER : Cancels saved settings (returned to factory defaults) and erases stored measurement data. (see pages 100 and 101) HOLD + POWER : Disables the auto power-off function. (see page 103) INTEG + POWER : Turns off the beeper. (see page 106) **SHIFT** + POWER : Stored data such as integral values can be reviewed. (see page 102)
SHIFT	• Pressing this button causes **S** to display, indicating that the additional function (in blue letters) allocated to each button is available. To turn **S** off, press the **SHIFT** button again. • Some buttons may be locked when **S** is on. • Holding the **SHIFT** button while pressing the POWER button to turn the meter on enables review of stored data such as integral values. (see page 102)
MODE **SAMPLE**	• Selects the current and frequency measurement mode. DC → AC → AC+DC → Hz (see page 52) • Button presses are ignored while **TIME** is displayed. **SAMPL** (**SHIFT** → MODE): • Switches display of refresh rate and measurement response time. (AC and AC+DC modes) (see pages 90 and 92) NORMAL (twice/ sec) → SLOW (once/ 3 sec) → FAST (10 times/ sec) DC mode is fixed at once per second. • The display update rate is usually set to NORMAL. (Note that there is no indication for **NORMAL**.) • SLOW decelerates the speed of updating on-display measurement. (with **SLOW** on) Measurement response time also becomes SLOW. • FAST accelerates the speed of updating on-display measurement. (with **FAST** on) Measurement response time also becomes FAST.

RANGE **FILTER**	Current Measurement (see page 53) • Selects auto range or manual range. (Hz mode uses auto-ranging only) AUTO → L → H • The current ranges for the CT9691 (9691) and CT9692 (9692) are 20 A and 200 A; the ranges for the CT9693 (9693) are 200 A and 2000 A. • Button presses are ignored while **TIME** is displayed. Integral Measurement (see page 70) • Selects auto range or manual range. • Available ranges depend on the connected clamp-on sensor. • Five ranges can be manually selected for each integral range (four ranges are shared in common as H and L ranges).
	FILTER (**SHIFT** → RANGE): (see page 95) • DC Mode Applies low-pass filtering at about one Hz to the output when output jack 1 (OUT1) is set to MON output (low-pass filtering at about 0.5 Hz is always applied to the display). • AC and AC+DC Modes Applies low-pass filtering at about 550 Hz to the display and output.
PEAK **B.CHECK**	• DC Mode (see page 63) Displays positive and negative peak values. Peak measurement determines the peak (crest value) of the current waveform. (Peak Hold) + PEAK → - PEAK • AC and AC+DC Modes (see page 63) Displays peak (absolute), maximum and minimum values (current measurement). PEAK → MAX → MIN
	B.CHECK (**SHIFT** → PEAK): (See page 104) • Displays remaining battery charge. When the remaining battery charge indicates 0%, the B indicator (low-battery warning) appears.
CLEAR **0 ADJ**	• When **TIME** and **STOP** are displayed, clears INTEG (integrals), RATE (duty) and PEAK data values on the corresponding displays. (see pages 69 and 80) • Clears data to “0” during peak measurement. (see page 65) • Holding down the CLEAR button and turning power on initializes the setting save function and restores the default settings. (See page 101)
	0 ADJ (**SHIFT** → CLEAR): (See page 89) • Performs auto zero adjustment in DC and AC+DC modes.

HOLD LOCK	• Suspends or deactivates the display-updating function. • Holding down the HOLD button and turning power on disables the auto power-off function. (see page 103) • Press and hold for two seconds to store settings and data. (See page 101) • When **TIME** is displayed (other than when current is displayed), after pressing HOLD button, press the ◀ ▶ buttons to review INTEG, RATE or PEAK measurement history. (see page 97)
	LOCK (**SHIFT** → HOLD): (see page 102) • Locks all buttons including the POWER button. • To cancel, press **SHIFT** button again, then press HOLD button.
INTEG START/STOP	• Displays the integral and interval mean current values (see page 74) DC Mode: total integral → positive integral → negative interval → interval mean value AC and AC+DC Modes: integral → interval mean value • Holding the INTEG button while pressing the POWER button to turn the meter on disables the beeper. (see page 106)
	START/STOP (**SHIFT** → INTEG): (see pages 74 and 85) • Starts and stops current integral and duty measurement. When **STOP** is displayed, measurement starts (and **START** appears) When **START** is displayed, measurement stops (and **STOP** appears) • **TIME** is displayed.
TIME INPUT/SET	• Displays elapsed time from when measurement was started by the **START/STOP** button, the timer setting and repetition number (alternating once per second). Elapsed time → timer setting and repetition number Elapsed time is displayed normally up to 99 hours and 59 minutes. If the total time of repeating timer measurements exceeds 100 hours, the time unit indicator (h) is displayed. • The TIME button has to be pressed in order to set the timer.
	INPUT/SET (**SHIFT** → TIME): (see pages 67 and 82) • Enables the setting display for the timer and current threshold (only for duty measurement). • Accepts displayed settings.
RATE OUTPUT	• Displays the duty, operating time and current threshold (see page 81) Duty → operating time → current threshold • Although no "%" unit indicator appears for duty measurements, the displayed value is percentage. • When the duty value exceeds 100 hours, "h" is displayed to indicate hour units. Press the RATE button to display. • The RATE button has to be pressed in order to set the current threshold.
	OUTPUT (**SHIFT** → RATE): (see pages 54 and 71) • Makes output settings (for current and integral measurements). • Settings for the two output jacks are limited according to measurement mode. • The auto power-off function is disabled. However, when the timer is set, data is stored and power turns off about 10.5 minutes after the timed measurement ends (stored data can be read by pressing **SHIFT** + POWER buttons).

LCD



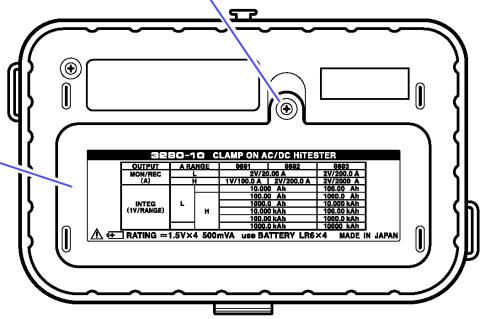
⎓	Direct Current (DC)	FILTER	500 Hz filter is active.
∼	Alternating Current (AC)	MAX	Maximum value
⎓∼	Alternating Current and Direct Current (AC+DC)	MIN	Minimum value
ADJ	Auto zero adjustment is active.	AVE	Interval mean current value
B	Low battery warning	TIME	Stores integral and duty measurement data
OUT1	Setting of OUT1	RMS	True root mean square value
OUT2	Setting of OUT2	PEAK	Wave peak value
HOLD	Data hold function	Hz	Frequency
MON	Monitor is active.	LOCK	Button lock is active.
MON.FL	1 Hz filter for monitor is active.	A	Current
REC	Record is active.	Ah	Integral value
APS	Auto power-off is active.	START	Starts integral or duty measure-ment
AUTO	Auto-range	STOP	Stops integral or duty measure-ment
L	Current L (low) range	hour	100 hours/segment (bar graph)
H	Current H (high) range	◀ ▶	Input over (bar graph)
FAST	Display-updating 10 times/sec.	S	SHIFT
SLOW	Display updating approx. once/3 sec.		

NOTE The letter of LCD is clearest, when it sees from the front side.

Bottom Panel

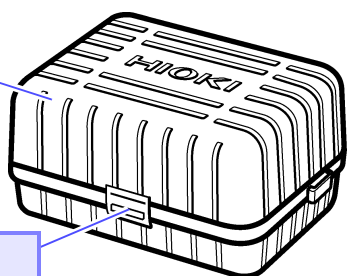
Screw

Battery Cover
Unfasten the screw, then remove the case to replace the battery.

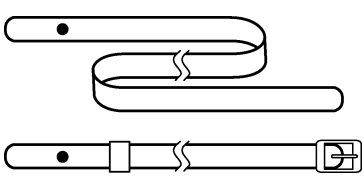


Others

Top Case
Cover the 3290-10 with this case when not in use to protect the LCD, buttons and jacks.

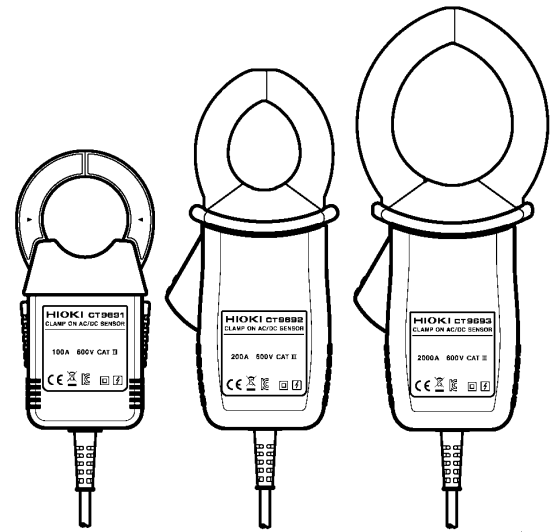


Top Case Clasp
Insert the clasp into the top case to attach the case. Move the top case to the rear during measurement.

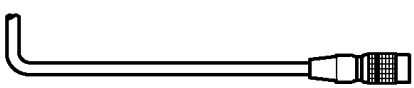


Strap
Used to hang the 3290-10 around neck so as not to drop it.

1.3.2 Model CT9691 (9691), CT9692 (9692), CT9693 (9693) CLAMP ON AC/DC SENSOR (Optional)



Model CT9691 Model CT9692 Model CT9693



Output Connector

1.4 Buttons Operations

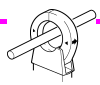
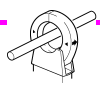
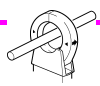
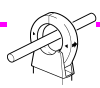
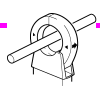
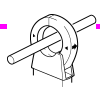
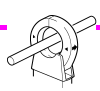
MODE	DC → AC → AC+DC → Hz			
RANGE	AUTO range L range H range	AUTO range L range H range	AUTO range L range H range	AUTO range
PEAK	+ PEAK - PEAK	PEAK MAX MIN	PEAK MAX MIN	--
INTEG	Total integral Positive integral Negative integral Elapsed time	Integral value Interval mean current value	Integral value Interval mean current value	--
TIME	Elapsed time Timer setting time (repetition number)			--
RATE	Duty Operating time Current threshold	Duty Operating time Current threshold	Duty Operating time Current threshold	--
SAMPLE SHIFT → MODE	--	NORMAL SLOW FAST	NORMAL SLOW FAST	--
FILTER SHIFT → RANGE	MON MON.FL	OFF ON	OFF ON	--

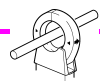
1.5 Measurement Modes

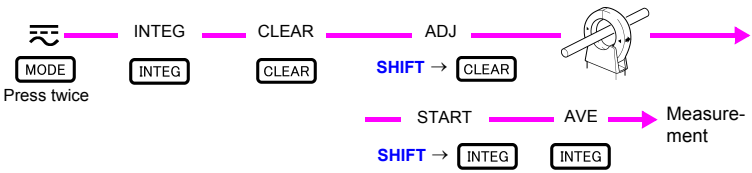
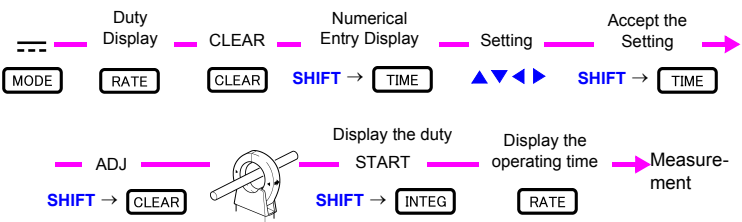
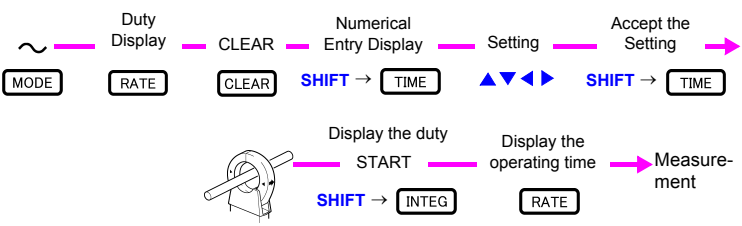
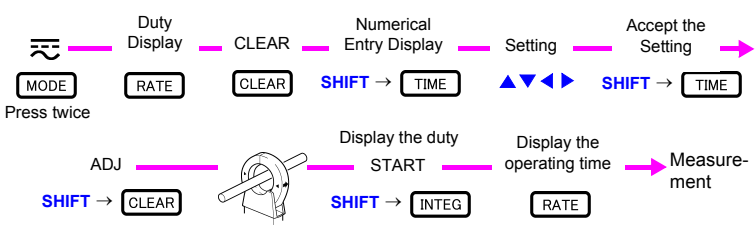
For current, three modes are provided: DC (direct current, ⎓), AC (alternating current, ∼), and AC+DC (alternating current and direct current, ⎓∼) modes. Select a proper mode according to the waveform shown below:

Mode	Input waveform	Display	OUTPUT (only for current mode)		
			REC	MON	MON.FL
DC (⎓)		Yes	Setting impossible		
		No Not measurable			
		Average measurement			
AC (∼)		No Not measurable (zero displayed)			--
		Yes			
		No Not measurable			
		No Not measurable			
AC+DC (⎓∼) $\sqrt{AC^2+DC^2}$		Yes (without polarity)			--
		Yes			
		Yes			
		Yes			

1.6 Quick References

Operations	Page
DC measurement	
⎓ → ADJ →  → Measure-ment MODE → SHIFT → CLEAR	51
DC peak measurement	
⎓ → ADJ →  → PEAK → CLEAR → Measure-ment MODE → SHIFT → CLEAR → PEAK → CLEAR	62
AC measurement	
~ →  → Measure-ment MODE	51
AC peak measurement	
~ →  → PEAK → CLEAR → Measure-ment MODE → PEAK → CLEAR	62
AC+DC measurement	
⎓~ → ADJ →  → Measure-ment MODE (Press twice) → SHIFT → CLEAR	51
AC+DC peak measurement	
⎓~ → ADJ →  → PEAK → CLEAR → Measure-ment MODE → SHIFT → CLEAR → PEAK → CLEAR	62
Hz measurement	
Hz →  → Measure-ment MODE (Press three times)	51

Operations	Page
DC integral measurement	
MODE → INTEG → CLEAR → ADJ → SHIFT → CLEAR → START → Measure-ment; SHIFT → INTEG	66
DC interval mean current measurement	
MODE → INTEG → CLEAR → ADJ →  → SHIFT → CLEAR → START → AVE → Measure-ment; SHIFT → INTEG; INTEG (Press three times)	66
AC integral measurement	
MODE → INTEG → CLEAR →  → START → Measure-ment; SHIFT → INTEG	66
AC interval mean current measurement	
MODE → INTEG → CLEAR →  → START → AVE → Measure-ment; SHIFT → INTEG; INTEG	66
AC+DC integral measurement	
MODE (Press twice) → INTEG → CLEAR → ADJ →  → SHIFT → CLEAR → START → Measure-ment; SHIFT → INTEG	66

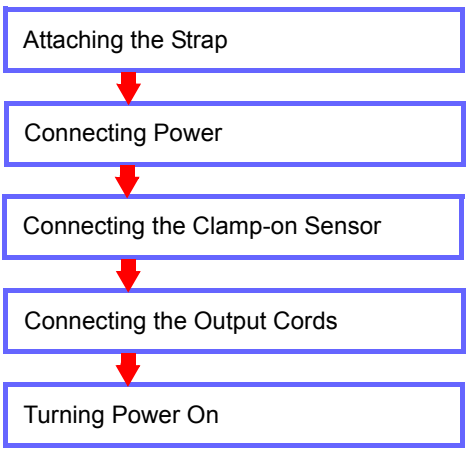
Operations	Page
AC+DC interval mean current measurement	
	66
DC duty and operating time measurements	
	79
AC duty and operating time measurements	
	79
AC+DC duty and operating time measurements	
	79

Operations	Page
View elapsed measurement time	
TIME	66, 79
Set the timer	
Timer Display (TIME) → Numerical Entry Display (SHIFT → TIME) → Setting (▲▼◀▶) → Accept the Setting (SHIFT → TIME)	66, 79
Set the number of repetitions	
Timer Display (TIME) → Numerical Entry Display (SHIFT → TIME) → Number of Times Display (▶ Press four times, ▲▼◀▶) → Accept the Setting (SHIFT → TIME)	66, 79
View timer and repetition settings	
TIME Press twice	66, 79
View current threshold setting	
RATE Press three times	79
Low-frequency (below 10 Hz) current measurement	
MODE Press twice → SLOW (SHIFT → MODE) → ADJ (SHIFT → CLEAR) → Measure-ment	51, 92
Measure starting current	
MODE → FAST (SHIFT → MODE Press twice) → MAX (PEAK Press twice) → CLEAR (CLEAR) → Measure-ment	51, 90

Operations	Page
Make output settings	
Output SHIFT → RATE DC: OUT1: MON, OUT2: REC → MON REC → MON REC Bar graph (±) (+) (-) AC, AC+DC: OUT1: REC, OUT2: REC → MON REC	51, 62
Change the display update rate (AC and AC+DC modes)	
SHIFT → MODE SLOW → FAST → NORMAL	90, 92
Obtained through a low-pass filter (LPF) set to 1 Hz (MON Output Filter Function) (DC mode)	
SHIFT → RANGE OUT1: MON, OUT2: REC → MON.FL REC Disable: SHIFT → RANGE	95
Obtained through a low-pass filter (LPF) to measurement value and output. (Filter Function) (AC and AC+DC modes)	
SHIFT → RANGE **FILTER** is displayed. Disable: SHIFT → RANGE	95
Store data (while TIME is displayed)	
HOLD Hold down 2 seconds dAtA SAuE Disable: Power ON: CLEAR + POWER dAtA clr	100
Store settings (while TIME is not displayed)	
HOLD Hold down 2 seconds SAuE Disable: Power ON: CLEAR + POWER dAtA clr	101
Recall stored data (data recall)	
Power ON SHIFT + POWER d iSP dAtA	102

Operations	Page
View repetition data (TIME is displayed)	
HOLD → INTEG / RATE / PEAK → ◀ ▶	97
Verify remaining battery charge	
SHIFT → PEAK	104
Suspend display updating (TIME is not displayed)	
HOLD **HOLD** is displayed. Disable: HOLD	96
Button lock	
SHIFT → HOLD **LOCK** is displayed. Disable: SHIFT → HOLD	102
Disabling the auto power off function	
Power ON: HOLD + POWER **APS** is not displayed.	103
Disabling the beep tone	
Power ON: INTEG + POWER	106

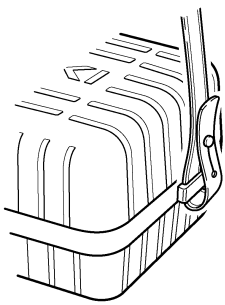
Measurement Preparations 2



- See Section 2.1 "Attaching the Strap" (page 28)
- See Section 2.2 "Connecting Power" (page 29)
- See Section 2.3 "Connecting the CLAMP ON AC/DC SENSOR" (page 33)
- See Section 2.4 "Connecting the Output Cords (Optional)" (page 34)
- See Section 2.5 "Turning Power On and Off" (page 35)

2.1 Attaching the Strap

Using the 3290-10 with the strap attached improves operability.



1. Fasten the two straps together into one.
2. Attach each end to the 3290-10 as shown in the figure above.

2.2 Connecting Power

2.2.1 Installing/ Changing the Batteries

⚠WARNING

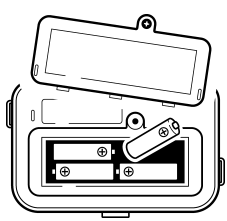
- **To avoid electric shock when replacing the batteries, first disconnect the clamp from the object to be measured.**
- **After replacing the batteries, replace the cover and screws before using the meter.**
- **Do not mix old and new batteries, or different types of batteries. Also, be careful to observe battery polarity during installation. Otherwise, poor performance or damage from battery leakage could result.**
- **To avoid the possibility of explosion, do not short circuit, disassemble or incinerate batteries.**
- **Handle and dispose of batteries in accordance with local regulations.**

⚠CAUTION

Remove the batteries when operating from external power. When the batteries are installed, the 3290-10 will turn on even if the polarity of the external power is reversed, damaging the meter.

NOTE

- The B indicator appears when battery voltage becomes low. Replace the batteries as soon as possible.
- If AC power is lost due to a power outage, measurement can continue if the batteries have been installed (available backup time depends on battery condition).
- While operating from the AC adapter, the remaining battery charge indicator (bar graph) indicates the loaded output voltage (about 6V) of the AC adapter. Although this may not display as 100%, measurements are unaffected.



1. Confirm that the 3290-10 is turned off.
2. Use a Phillips screwdriver to unfasten the setscrew on the battery cover.
3. Remove the battery cover.
4. Insert (Change) four new batteries while confirming the correct polarity.
5. First fit the tab of the cover, then fit the cover. Secure the cover in place by tightening the setscrew.

2.2.2 Connecting the AC Adapter (Optional)

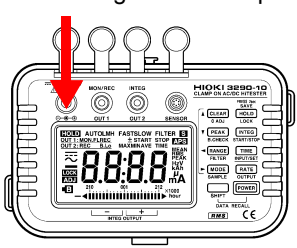
WARNING

- **Turn the meter off before connecting the AC adapter to the meter and to AC power.**
- **Use only the specified Model 9445-02 AC ADAPTER or 9445-03 AC ADAPTER. AC adapter input voltage range is 100 to 240 VAC (with ±10% stability) at 50/60 Hz. To avoid electrical hazards and damage to the meter, do not apply voltage outside of this range.**

NOTE

- Make sure the power is turned off before connecting or disconnecting the AC adapter.
- When using the AC adapter, note that current of approximately 3 mA is consumed regardless of whether the power switch of the meter is on or off. (Battery power is not consumed, however, when power is turned off.)
- When the power supply is switched over from the battery to the AC adapter or vice versa during peak measurement, an inaccurate measurement result (i.e., value larger than the actual value) may be displayed.
- While operating from the AC adapter, the remaining battery charge indicator (bar graph) indicates the loaded output voltage (about 6V) of the AC adapter. Although this may not display as 100%, measurements are unaffected.
- The AC adapter may be used either with or without the batteries.
- If the AC adapter is connected but not providing power, measurement is still possible if the batteries have been installed (available backup time depends on battery condition).
  When operating from the AC adapter, voltage is internally regulated to about 6 V. When battery voltage is higher than this (such as with new batteries), the batteries power the meter until battery voltage decreases, at which point operation switches to the AC adapter.

Connecting the AC Adapter



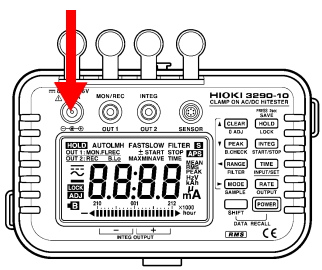
1. Confirm that the 3290-10 is turned off.
2. Remove the dust cap over the AC adapter jack, and plug in the AC adapter securely.
3. Plug the AC adapter into a wall outlet.

2.2.3 Using External Power

WARNING

- **To avoid electric shock and short-circuit accidents when connecting the optional 2m external power cable, first be sure the meter is turned off.**
- **The external voltage requirements are 8.4 to 15.6 V DC at 1.2 VA. To avoid malfunctions or damage to the meter and electric accidents, use only a power source that meets these requirements.**
- **To avoid electric shock, connect the negative side to an earth or chassis ground.**

Connecting the External Power Cable

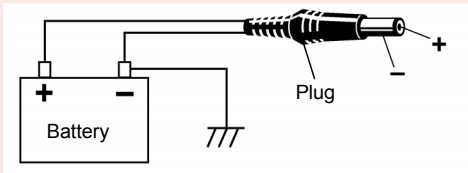


1. Confirm that the meter is turned off.
2. Remove the dust cap over the AC adapter jack, and plug in the external power cable securely.
3. Connect the external power cable to the external power source.

⚠CAUTION

Observe the following to avoid damaging the meter:

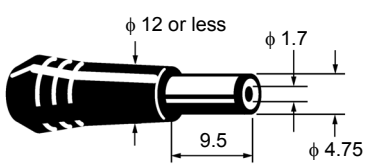
- When using an external power source such as a battery, connect the positive (center) conductor of the external power cable to the "+" battery terminal.



- Remove the batteries when operating from external power. When the batteries are installed, the meter will turn on even if the polarity of the external power is reversed, damaging the meter.
- If the device under test is earth grounded, connect the negative conductor to earth.
  (Example: Indoor and outdoor line measurements R connect the negative conductor to earth)
- If the device under test uses a ground level that is isolated from earth, connect the negative conductor to the ground level used.
  (Example: In a mobile installation, if the device under test is grounded to the vehicle chassis R connect the negative conductor to the chassis)

NOTE

- Make sure the power is turned off before connecting or disconnecting the external power cable.
- When using the external power, note that current of approximately 3 mA is consumed regardless of whether the power switch of the 3290-10 is on or off.
- While operating from the external power, the remaining battery charge indicator (bar graph) indicates the loaded output voltage (about 6V) of the external power. Although this may not display as 100%, measurements are unaffected. However, proper operation cannot be guaranteed if external power drops below 8.4 V.
- Please observe the following if providing your own external power cable.



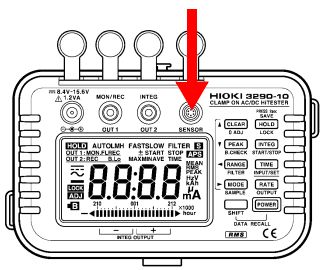
- An external power cable longer than about 3m may introduce undesirable environmental EMC effects such as noise emission.

2.3 Connecting the CLAMP ON AC/DC SENSOR

⚠CAUTION

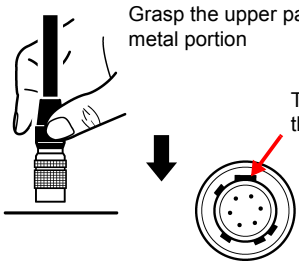
- To prevent damage to the meter, never connect or disconnect a sensor while the power is on, or while the sensor is clamped around a conductor.
- When disconnecting the output connector of the clamp-on sensor from the 3290-10 sensor jack, be sure to hold it by the metal part and pull it upward. Because the connectors lock, pulling or twisting the cable can damage the cable.

Connecting the Clamp Sensor

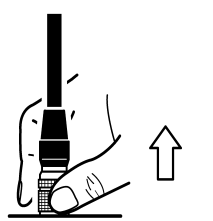


1. Confirm that the 3290-10 is turned off.
2. Remove the dust cap from the sensor jack and insert the plug from the clamp-on sensor.
   The clamp-on sensor model is recognized automatically.

Connecting



Disconnecting



❖ The sensor's specifications:
See Section 6.1.1 "Current Measurement" (page 108)

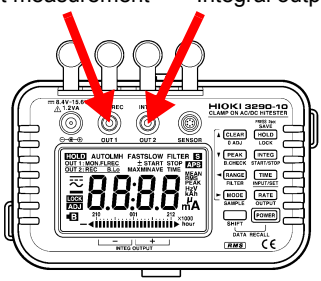
2.4 Connecting the Output Cords (Optional)

To use current measurement output (OUT1) or integral output (OUT2), connect the optional Model 9094 OUTPUT CORD to the output jack.

Connecting the Output Cord

OUT 1:
Current measurement output

OUT 2:
Integral output



1. Confirm that the 3290-10 is turned off.

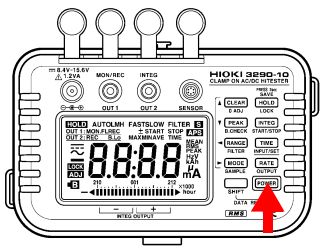
2. Remove the dust cap from the output jack and insert the output cord plug securely.

   Current measurement output:
   OUT 1 (Output jack 1)
   Integral output:
   OUT 2 (Output jack 2)

NOTE If the output cord plug is not inserted securely, poor connection may prevent proper output.

2.5 Turning Power On and Off

Power On



1. Press the POWER button to turn the meter on.
2. All display segments should appear.
3. After displaying the model name (3290), the bar graph shows the remaining battery charge.
4. The DC measurement mode is enabled.

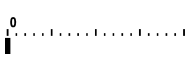
Power Off

Press the POWER button again to turn the meter off.

Remaining Battery Charge

100% remaining battery charge, new batteries

50% remaining battery charge



0% remaining battery charge
The B indicator appears and three beeps sound.

Low-Battery Detection Function

If battery voltage continues to drop after B appears, the meter is forced to turn itself off. At this time, bAtt Lo is displayed.

NOTE

If the save-setting function has been used, the pre-specified initial mode is enabled (the save-setting function is executed by holding down the HOLD button for two seconds).
To cancel the setting, first turn the meter off, then hold the CLEAR button while pressing POWER button to turn the meter back on. The default initial mode (DC) setting is restored.
❖ See Section 5.8 "Saving Settings" (page 101)

Basic Measurement Procedure 3

⚠DANGER

- **To avoid short circuits and potentially life-threatening hazards, never attach the clamp to a circuit that operates at more than 600V, or over bare conductors.**
- **Clamp sensor should only be connected to the secondary side of a breaker, so the breaker can prevent an accident if a short circuit occurs. Connections should never be made to the primary side of a breaker, because unrestricted current flow could cause a serious accident if a short circuit occurs.**

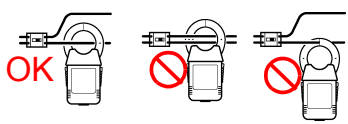
⚠CAUTION

- To avoid damage to the meter, do not short-circuit the output jacks and do not input voltage to the output jacks.
- The maximum continuous-input limit is obtained from the temperature increase due to self-heating during measurement. To prevent damage to the clamp-on sensor, do not input a current exceeding this limit.
- The maximum continuous-input limit varies depending on the clamp-on sensor and the frequency of the current to be measured.

❖ Maximum continuous-input limit varies:
See Section 6.3 "CLAMP ON AC/DC SENSOR Specifications" (page 116)
Each sensor's derating acording to frequency

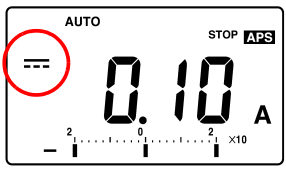
NOTE

- Be sure to read the instruction manual for the clamp sensor to be used before starting measurement.
- The hall element is used for the detector of the clamp-on sensor. The hall element tends to drift with age or due to the ambient temperature. Keep this fact in mind when performing measurement continuously.
  ❖See "Sensor Temperature Characteristics" (page 58)
- Correct measurement may be impossible in the presence of strong magnetic fields, such as near transformers and high-current conductors, or in the presence of strong electromagnetic fields such as near radio transmitters.
- The reading may show a measurement greater than the actual value due to magnetic-field interference. The amount of interference varies depending on the sensor.
  ❖See Section 6.3 "CLAMP ON AC/DC SENSOR Specifications" (page 116)
- The CT9691 (9691) has a lock mechanism for the clamps so that the clamps will not open due to vibration or other similar causes during measurement. Lock the clamps as necessary. (If the clamps should open even slightly during measurement, the accuracy cannot be guaranteed.)
- Attach the clamp around only one conductor. Single-phase (2-wire) or three-phase (3-wire) cables clamped together will not produce any reading.



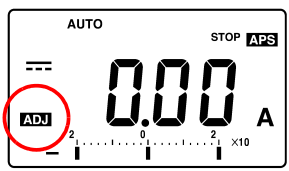
3.1 Measuring DC Current

Sensor used : Model CT9691 (9691) CLAMP ON AC/DC SENSOR
Range : AUTO



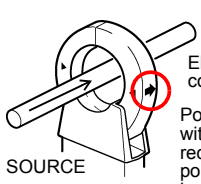
1. Press the MODE button to select DC (⎓).

Button presses are ignored if **TIME** is displayed: press INTEG → CLEAR to clear it.



2. Press **SHIFT** → CLEAR (**0 ADJ**) to execute automatic zero adjustment.
ADJ is displayed.

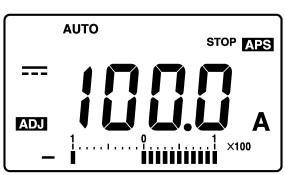
The CT9691 (9691) CLAMP ON AC/DC SENSOR



Position the clamp with the current direction indicator pointing toward the load side.

3. Clamp around a conductor to be measured so that it is centered in the clamp.

The figure shows the CT9691 CLAMP ON AC/DC SENSOR.
The current direction mark on Models CT9692 (9692) and CT9693 (9693) CLAMP ON AC/DC SENSORs is in a different location.

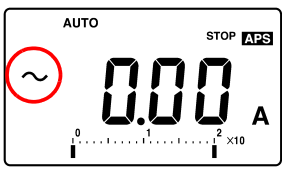


4. Read the displayed value.

Since the range is AUTO, you do not need to set it.

3.2 Measuring AC Current

Sensor used : Model CT9691 (9691) CLAMP ON AC/DC SENSOR
Range : AUTO



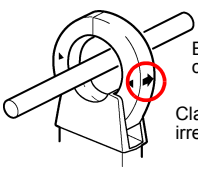
1. Press the MODE button to select AC (〜).

Button presses are ignored if **TIME** is displayed: press INTEG → CLEAR to clear it.

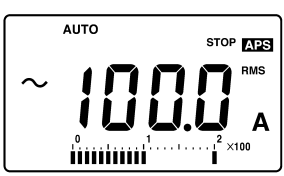
When measuring current below 10 Hz, use the AC+DC mode and press **SHIFT** → MODE (**SAMPLE**) to set the display update rate (measurement response time) to SLOW.

❖See Section 5.3 "Measurement Response Time" (page 92)

The CT9691 (9691) CLAMP ON AC/DC SENSOR



2. Clamp around a conductor to be measured so that it is centered in the clamp.

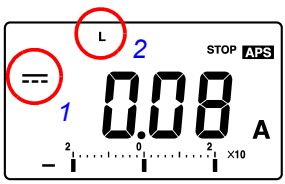


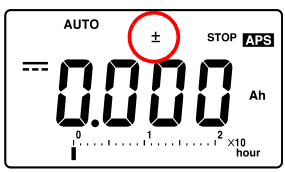
3. Read the displayed value.

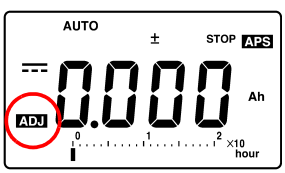
Since the range is AUTO, you do not need to set it.

3.3 DC Integration

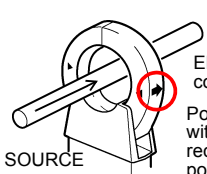
Sensor used : Model CT9691 (9691) CLAMP ON AC/DC SENSOR
Measured current : 20 A or less
Manually stop measuring (no timer)



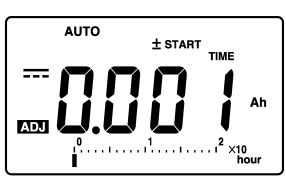




The CT9691 (9691) CLAMP ON AC/DC SENSOR



Position the clamp with the current direction indicator pointing toward the load side.



1. Press the [MODE] button to select DC (⎓).

   Button presses are ignored if **TIME** is displayed: press [INTEG] → [CLEAR] to clear it.

2. Press [RANGE] button once to select the L range (20 A).

3. Press [INTEG] button to display the integral.
   Unless output is required, the integrating range can be left as AUTO.

4. Press **SHIFT** → [CLEAR] (**0 ADJ**) to execute automatic zero adjustment.
   ADJ is displayed.

5. Clamp around a conductor to be measured so that it is centered in the clamp.

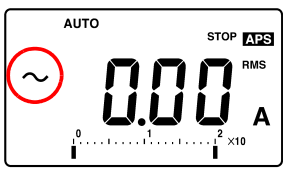
   The figure shows the CT9691 CLAMP ON AC/DC SENSOR.
   The current direction mark on Models CT9692 (9692) and CT9693 (9693) CLAMP ON AC/DC SENSORs is in a different location.

6. Press **SHIFT** → [INTEG] (**START/STOP**) to start integral measurement.
   START and **TIME** are displayed.

7. Press **SHIFT** → [INTEG] (**START/STOP**) to stop integral measurement.
   STOP is displayed.

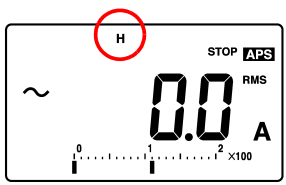
3.4 AC Integration by Timer

Sensor used	: Model CT9691 (9691) CLAMP ON AC/DC SENSOR
Measured current	: at least 20 A
Timer	: 30 minutes
Number of repetitions	: 10 times

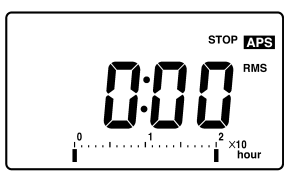


1. Press the MODE button to select AC (〜).

   Button presses are ignored if **TIME** is displayed: press INTEG → CLEAR to clear it.

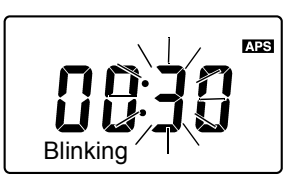


2. Press RANGE button twice to select the H range (200 A).

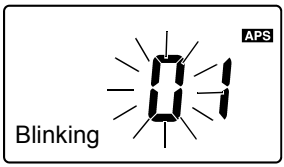


3. Press TIME button to display the timer.

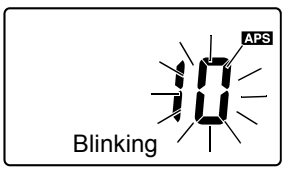
4. Press **SHIFT** → TIME (**INPUT/SET**) to display the numerical entry display.



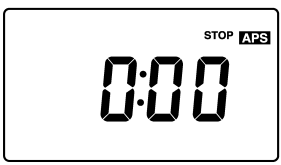
5. Press the ▲▼◀▶ buttons to enter 30 minutes.



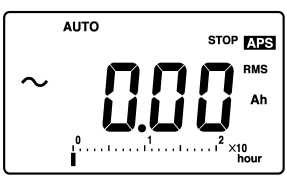
6. Press ▶ to display the repetition entry display.



7. Press the ▲▼◀▶ to set 10 repetitions.

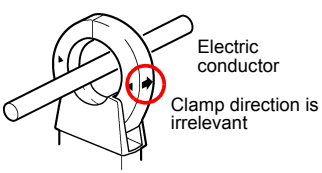


8. Press **SHIFT** → TIME (**INPUT/SET**) to accept the entered values.



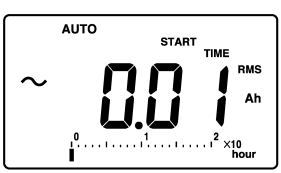
9. Press INTEG button to display the integral.
Unless output is required, the integrating range can be left as AUTO.

The CT9691 (9691)
CLAMP ON AC/DC SENSOR



10. Clamp around a conductor to be measured so that it is centered in the clamp.

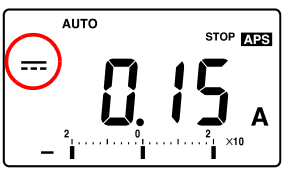
11. Press **SHIFT** → INTEG (**START/STOP**) to start integral measurement.
START and **TIME** are displayed.



12. After ten 30-minute measurements have occurred, integral measurement stops automatically.
STOP is displayed.

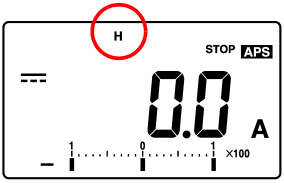
3.5 Outputting Integral Values

Sensor used : Model CT9691 (9691) CLAMP ON AC/DC SENSOR
Measured current : 100 A or less
After two hours or less, stop measurement manually (no timer)
→ Maximum integral value derived from measured current and measurement time is 200 Ah (100 A X 2 h) or less
OUT1 : MON output
OUT2 : Positive integral output

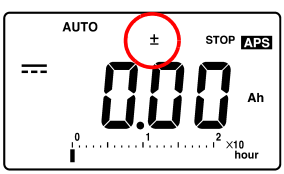


1. Press the MODE button to select DC (⎓).

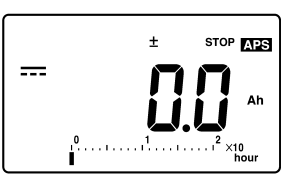
   Button presses are ignored if **TIME** is displayed: press INTEG → CLEAR to clear it.



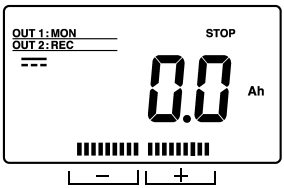
2. Press RANGE button twice to select the H range (200 A).



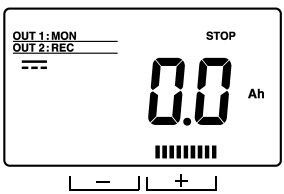
3. Press INTEG button to display the integral.



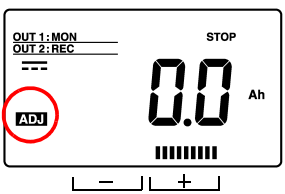
4. Press the RANGE button twice to select the 1000.0 Ah range (999.9 Ah max. display).



5. Press **SHIFT** → RATE (**OUTPUT**) to display the output settings.
The bar graph appears in both "+" and "-" regions.

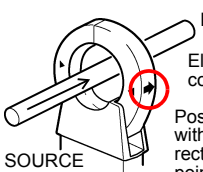


6. Press **SHIFT** → RATE (**OUTPUT**) so that the bar graph appears only in the "+" region.



7. Press **SHIFT** → CLEAR (**0 ADJ**) to execute automatic zero adjustment.
ADJ is displayed.

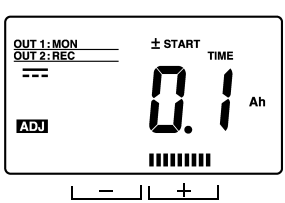
The CT9691 (9691) CLAMP ON AC/DC SENSOR



Position the clamp with the current direction indicator pointing toward the load side.

8. Clamp around a conductor to be measured so that it is centered in the clamp.

The figure shows the CT9691 CLAMP ON AC/DC SENSOR.
The current direction mark on Models CT9692 (9692) and CT9693 (9693) CLAMP ON AC/DC SENSORs is in a different location.

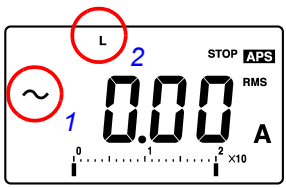


9. Press **SHIFT** → INTEG (**START/STOP**) to start integral measurement.
START and **TIME** are displayed.

10. Press **SHIFT** → INTEG (**START/STOP**) to stop integral measurement.
STOP is displayed.

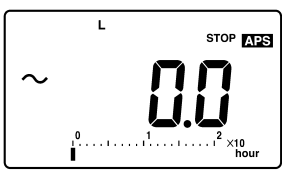
3.6 Measuring Duty by Timer

Sensor used	: Model CT9691 (9691) CLAMP ON AC/DC SENSOR
Measured current	: 20 A or less
Current threshold	: 2 A AC (defines the operating state as 2 A or higher current)
Timer	: 24 hours
Repetitions	: none (one time only)

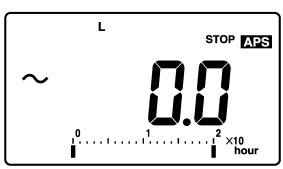


1. Press the MODE button to select AC (〜).

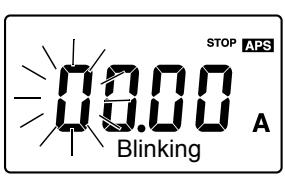
   Button presses are ignored if **TIME** is displayed: press INTEG → CLEAR to clear it.



2. Press RANGE button to select the L range (20 A).



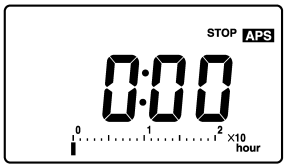
3. Press the RATE button to display the duty.



4. Press **SHIFT** → TIME (**INPUT/SET**) to display the numerical entry display.

5. Press the ▲▼◀▶ buttons to enter 2.00 A.

6. Press **SHIFT** → TIME (**INPUT/SET**) to accept the entered values.

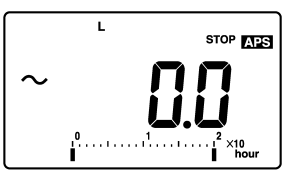


7. Press **SHIFT** → TIME (**INPUT/SET**) to display the timer display.

8. Press **SHIFT** → TIME (**INPUT/SET**) to display the numerical entry display.

9. Press the ▲▼◀▶ buttons to enter 24 hours.

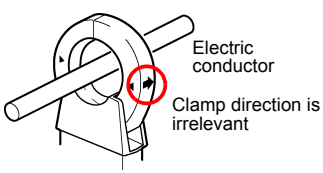
10. Press **SHIFT** → TIME (**INPUT/SET**) to accept the entered values.



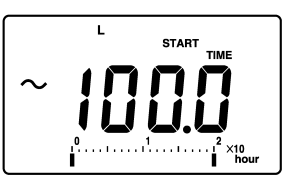
11. Press the RATE button to display the duty.

Although no "%" unit indicator appears, the displayed value is percentage.

The CT9691 (9691)
CLAMP ON AC/DC SENSOR



12 Clamp around a conductor to be measured so that it is centered in the clamp.



13. Press **SHIFT** → INTEG (**START/STOP**) to start duty measurement.
START and **TIME** are displayed.

14. Press **SHIFT** → INTEG (**START/STOP**) again to stop duty measurement.
STOP is displayed.

Measurement Procedure 4

4.1 Verifications Before Measuring

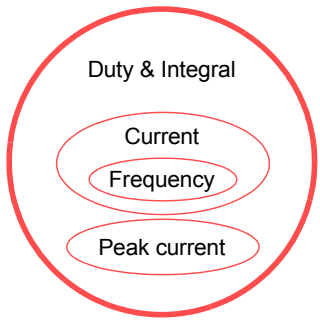
Before using the meter the first time, verify that it operates normally to ensure that the no damage occurred during storage or shipping. If you find any damage, contact your dealer or Hioki representative.

Verification Location		Verification Content	Corrective Procedure
Clamp-on sensor	Jaw teeth	Are they been deformed?	If the teeth are deformed, current measurement cannot be performed. Contact your dealer or Hioki representative.
	Sensor element	Is it cracked or damaged or bare metal exposed?	If damaged, an electric shock accident could occur, so contact your dealer or Hioki representative.
Cables		Is the insulation damaged or bare metal exposed?	If damaged, contact your dealer or Hioki representative.
Model 3290-10	Battery	Is the B indicator displayed?	B indicates low battery voltage. In this state, proper measurement may not be possible, so the batteries should be replaced.
	Range	Is the range supported by the clamp-on sensor?	Verify the selected range with the RANGE button (range are described on the battery cover). If the current being measured exceeds the selected range, current consumption is high and the batteries are discharged quickly.
	Zero confirmation	In AC mode, is the displayed value near 0 A?	If the displayed value is not near 0 A, contact your dealer or Hioki representative.
		In DC mode, is the displayed value near 0 A?	Press SHIFT → CLEAR (0ADJ) to execute automatic zero adjustment. Verify that the displayed value is now near 0 A.
		In DC or AC mode, with output enabled and an output cord connected to OUT1 or OUT2, is the value read by a DMM near 0 V DC?	If the output is not near 0 V, contact your dealer or Hioki representative.

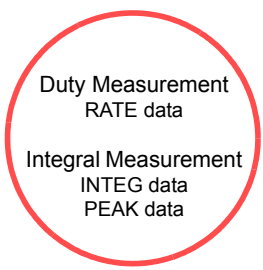
4.2 Selecting the Measurement Parameter

Select the parameter to measure from the following.

- Current (see page 51)
- Frequency (see page 51)
- Peak Current (see page 62)
- Integral (see page 66)
- Duty (see page 79)



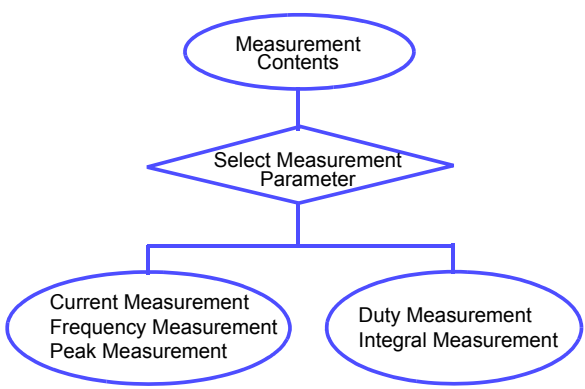
Current is measured during both integral and duty measurements. Also, when duty is measured, integral measurement occurs at the same time.
A current threshold must be set in order to perform duty measurement.



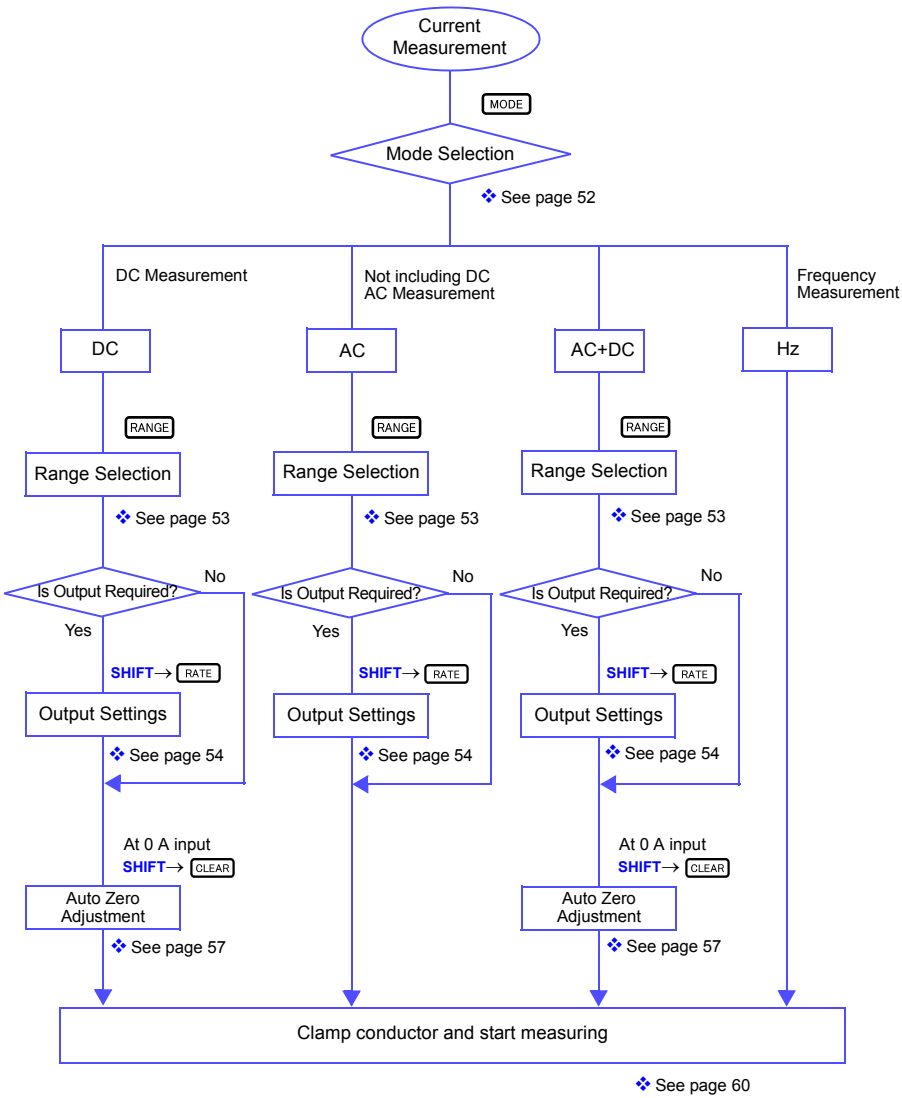
RATE data : duty and operating time

INTEG data : integral and interval mean values (current)

PEAK data : Peak, maximum and minimum values



4.3 Measuring Current



Mode Selection

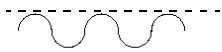
1. Press the MODE button to select the mode.

Button presses are ignored if **TIME** is displayed: press INTEG → CLEAR to clear it.

For Current Measurement

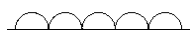
⎓	DC Mode
	Select this to measure DC current.
~	AC Mode
	Select this to measure AC current.
⎓~	AC+DC Mode
	Select this to measure current other than the above. Examples are shown below: waveforms with both AC and DC components, and half- and full-wave rectified waveforms.

Waveforms with both AC and DC components



Half-wave rectified waveform

Full-wave rectified waveform



For Frequency Measurement

Hz	Hz Mode
	Select this to measure frequency (in AC Mode)

NOTE

- In the DC mode, a low-pass filter* of about 0.5 Hz is applied to suppress 50/60 Hz AC mains current ripple. This filter suppresses AC components leaving only the DC component for display. However, this filter also slows measurement response, so rapid current variations are not detected.
  * Low-pass filter (LPF): a filter that passes only low frequencies
  ❖ See Section 5.4 "Filter Function" (page 95)
- In the AC mode, any DC component is removed. However, when AC and DC components are both present and waveform peaks exceed 2.5 times the range (crest factor), the waveform is clipped by internal circuitry, and correct measurements are not possible unless a higher range is selected.
  ❖ See "Range Selection" (page 53)
- To measure both AC and DC together, we recommend rms measurement with the AC+DC Mode. However, to measure only the DC component, use the DC Mode.
- When measuring current at 10 Hz or less, select AC+DC mode and set the display update rate (measurement response time) to SLOW. The SLOW display update rate is slower with the AC mode selected than it is with the AC+DC mode selected.
- Frequency measurement uses AUTO ranging, so no current range setting is needed.

Range Selection

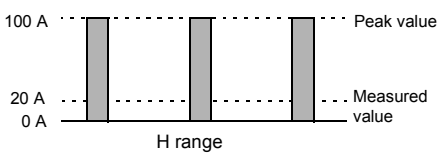
2. Press the [RANGE] button to select the range.

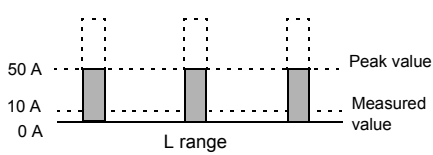
For Current Measurement

AUTO	AUTO Ranging When using the CT9691 (9691) or CT9692 (9692) : 20.00 A/ 200.0 A When using the CT9693 (9693) : 200.0 A/ 2000 A
L	L (Low) Range When using the CT9691 (9691) or CT9692 (9692) : 20.00 A When using the CT9693 (9693) : 200.0 A
H	H (High) Range When using the CT9691 (9691) or CT9692 (9692) : 200.0 A When using the CT9693 (9693) : 2000 A

NOTE

- When measuring only current (so that no output settings are needed), AUTO ranging can be used, but if the range is exceeded during current integral or duty measurement, correct measurements cannot be obtained.
- If you press the [INTEG] or [RATE] button after AUTO ranging is selected, the range that is active at setting time becomes the fixed range (the L range if nothing is being measured).
- When selecting a range, both rms and peak values need to be considered. For example, if the rms current is low but the peak value is high, the waveform may be clipped (depending on the range). The figure below left shows a waveform that can be measured in the H range (200 A range). The waveform is not clipped, so the measured value is 20 A. On the other hand, the figure below right shows clipping at 50 A because of the 2.5 crest factor limitation (50 A in the case of the 20 A range). The (incorrectly) measured value in this case is 10 A, and correct measurement is not performed (crest factor is the peak value / range rating).





For Frequency Measurement

AUTO	AUTO Ranging Internal ranges 10.00, 100.0 and 1000 Hz The current range does not need to be set.

NOTE

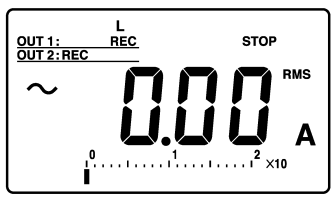
The range switches upward at 1250 counts, and downward at 100 counts.
Example: 12.50 Hz → 12.6 Hz, 10.0 Hz → 9.99 Hz

Output Settings

If you don't need to make any output settings, proceed to "Auto Zero Adjustment (for DC and AC+DC modes)" (page 57).

3. Confirm that the optional 9094 OUTPUT CORD is inserted securely into output jack 1 (OUT1) (OUT2 is for integral value output).

4. Press **SHIFT** → [RATE] (**OUTPUT**) to display the output settings.



5. Set OUT1 to REC or MON.

MON	MON (Monitor) Output
	Outputs the measured waveform (settable for all measurement modes).
REC	REC (Record) Output
	The measured waveform is converted from rms (RMS/DC conversion) for output (settable for AC and AC+DC modes). The response speed can be changed by pressing **SHIFT** → [MODE] (**SAMPLE**).

Only REC output is available at OUT2.

NOTE

- Be sure to select the measurement range before making output settings. If you make output settings with AUTO ranging selected, the range that is active at setting time becomes the fixed range (the L range if nothing is being measured).
- In the DC mode, INTEG OUTPUT (bar graph display) switches between ±, + and -. Integral output can be set with current measurement output settings.
  For AC and AC+DC modes there is no ±, + or - selection.
- Auto power-off is disabled (**APS** not displayed) when making output settings. Output settings do not affect battery consumption.

NOTE Current measurement output levels are shown on the meter's battery cover. Determine the appropriate output range from the range of the meter and that of the connected instrument (e.g., data recorder). Conversion tables are shown here.

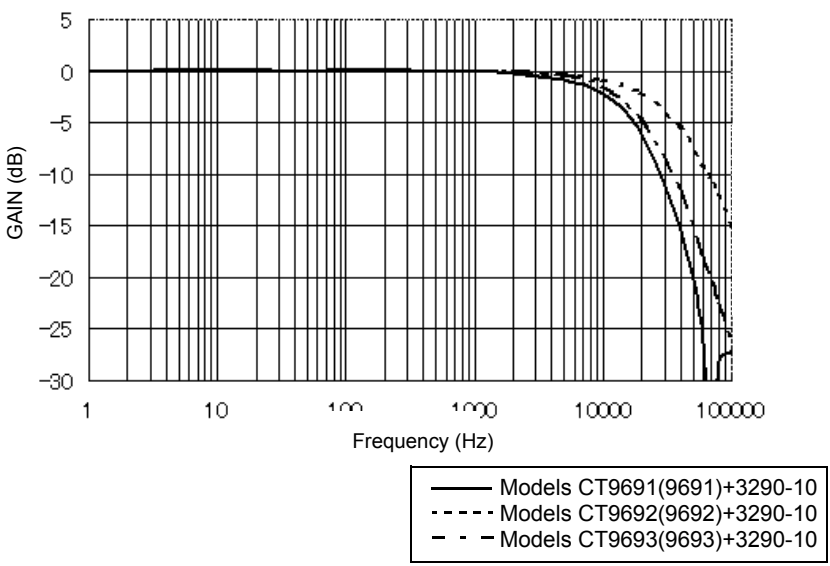
Connected Instrument Measuring Range /DIV	10 mV	20 mV	50 mV	0.1 V	0.2 V	0.5 V	1 V	2 V
20 A range	0.1 A	0.2 A	0.5 A	1 A	2 A	5 A	10 A	20 A
200 A range	1 A	2 A	5 A	10 A	20 A	50 A	100 A	200 A

* Numerical values are current per division on the connected instrument (e.g., data recorder).

Connected Instrument Measuring Range /DIV	10 mV	20 mV	50 mV	0.1 V	0.2 V	0.5 V	1 V	2 V
200 A range	1 A	2 A	5 A	10 A	20 A	50 A	100 A	200 A
2000 A range	10 A	20 A	50 A	100 A	200 A	500 A	1000 A	2000 A

* Numerical values are current per division on the connected instrument (e.g., data recorder).

Frequency Characteristics of clamp-on sensor + Model 3290-10 MON Output



NOTE

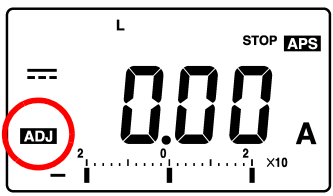
- The input impedance of the connected instrument should be at least 1 MΩ. If the impedance is lower, displayed values may be affected.
- To use the output function, be sure that **OUT1** is displayed by pressing **SHIFT** → [RATE] (**OUTPUT**). Output is still available when it is not displayed, but because the auto power-off function is enabled, power will turn off after about 10 minutes.
- When measuring current of 10 Hz or less, select the AC+DC mode and set the display update rate (measurement response time) to SLOW. The SLOW display update rate is slower with the AC mode selected than it is with the AC+DC mode selected.
- Guaranteed output accuracy is applicable to current display values that do not cause **O.L.** to be displayed in the L range (MON output can be saturated when output exceeds 3.5 V in the L range). Also, in the H range, output is limited by the maximum peak current capability of the clamp-on sensor.
- Maximum MON output is 3.5 V just before the B indicator appears. When using the AC adapter or when remaining battery charge is 50% or more, maximum output is 4 V.
- Pressing the [HOLD] button during output does not affect output values.
- Use the optional 9445-02 AC ADAPTER for long-term recording. If using the AC adapter with very noisy mains power, displayed measurements may be unstable, or noise may appear in the output. Connect the grounding or L terminal of the connected instrument (data recorder) to earth ground.

Auto Zero Adjustment (for DC and AC+DC modes)

❖ See Section 5.1 "Auto Zero Adjustment Function" (page 89)

6. Verify that the measurement current is zero, or that the clamp-on sensor is not clamped around a conductor.

7. Press **SHIFT** → CLEAR (**0ADJ**) to execute auto zero adjustment.



NOTE

- If Auto zero adjustment is not performed, the displayed (and output) current value is always added to measurements.
- Auto zero adjustment is unnecessary in AC mode.
- Auto zero adjustment should be performed in DC and AC+DC modes. In the L range, auto zero adjustment is possible when the displayed value is up to ± 450 counts, and in the H range, up to ± 45 counts.
- To cancel auto zero adjustment, turn the power off and back on.
- Auto zero adjustment cannot be performed during integral or duty measurement (while **START** is displayed).

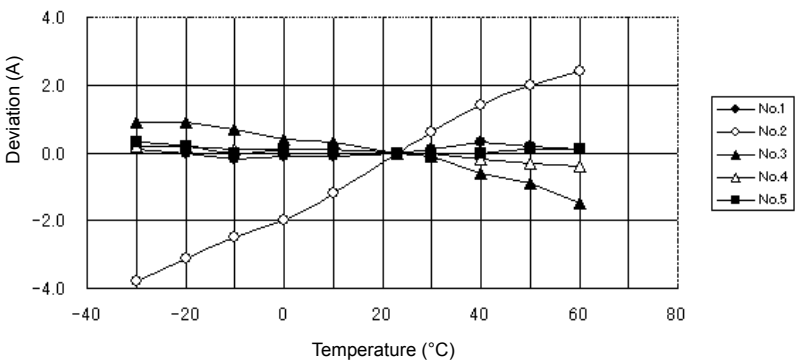
Sensor Temperature Characteristics

The CT9691(9691), CT9692 (9692) and CT9693 CLAMP ON AC/DC SENSORs employ a Hall-effect element for current detection. The zero point and sensitivity are therefore temperature dependent according to the characteristics of the individual Hall-effect element.

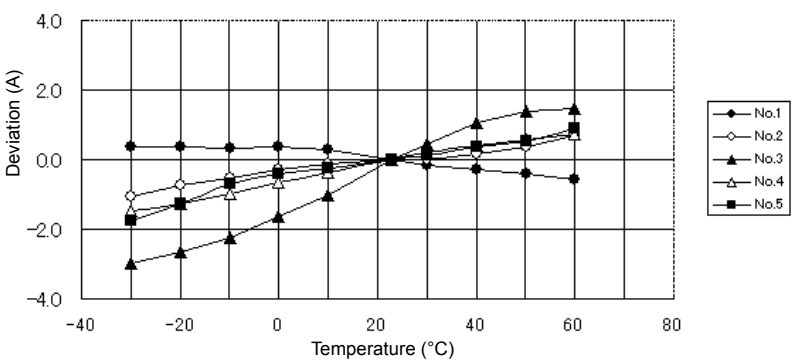
Zero-Point Temperature Characteristics

Because of the individual differences between Hall-effect elements, the actual offset and rate of change cannot be specified. In an operating environment with wide temperature variations, we suggest being aware beforehand of changes to the zero point with no input. However, while zero point variations affect DC values, they have no effect in the AC mode. The examples show zero point variations (normalized to 23°C) with temperature change for different sensors (characteristics vary widely from one element to another).
Specified operating temperature range is 0 to 40°C.

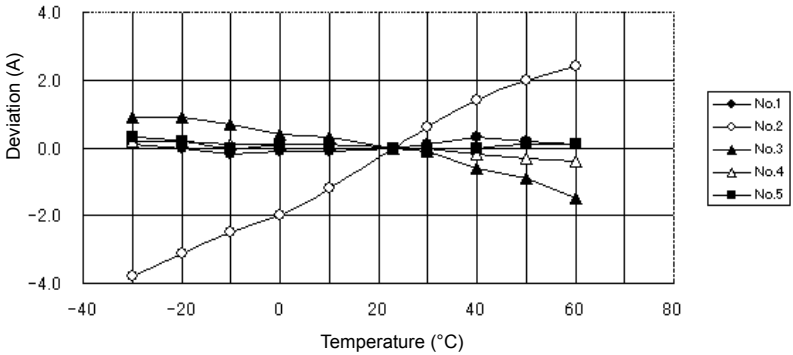
Model CT9691 (Equivalent to model 9691) Zero Point vs. Temperature



Model CT9692 (Equivalent to model 9692) Zero Point vs. Temperature



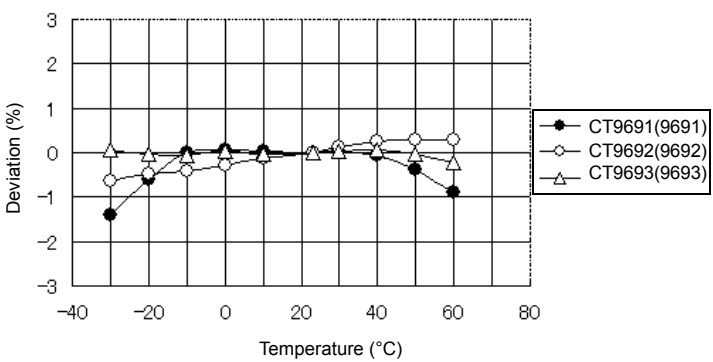
Model CT9693 (Equivalent to model 9693) Zero Point vs. Temperature



Sensor Sensitivity Temperature Characteristics

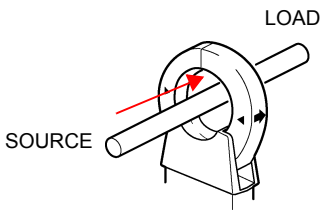
Hall-element sensitivity is temperature dependent, so temperature compensation is provided in the circuitry.
The examples show sensitivity variations (normalized to 23°C) with temperature change for different sensors (characteristics vary slightly from one element to another).
Specified operating temperature range is 0 to 40°C.

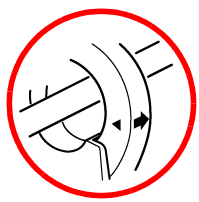
Sensor Sensitivity vs. Temperature



Starting Measurement

8. Open the sensor clamp and clamp it around the conductor to be measured, position the conductor at the center of the clamp, and start measuring.





(DC mode case)
Make sure that the direc tion of current flow in the conductor matches that of the arrow on the clamp.

NOTE

- The most precise measurements are obtained when the conductor to be measured is centered in the clamp, to minimize the effects of conductor proximity to the clamp. However, if the conductor to be measured is not positioned orthogonally to the clamp-on sensor, current measurements will be slightly affected at higher frequencies.
- Measurement values may differ when the direction of the clamp-on sensor is changed, but any such differences should be within the specified accuracy.
- In AC, AC+DC, and Hz modes, the direction of current flow in the conductor does not need to match that of the arrow on the clamp.

NOTE

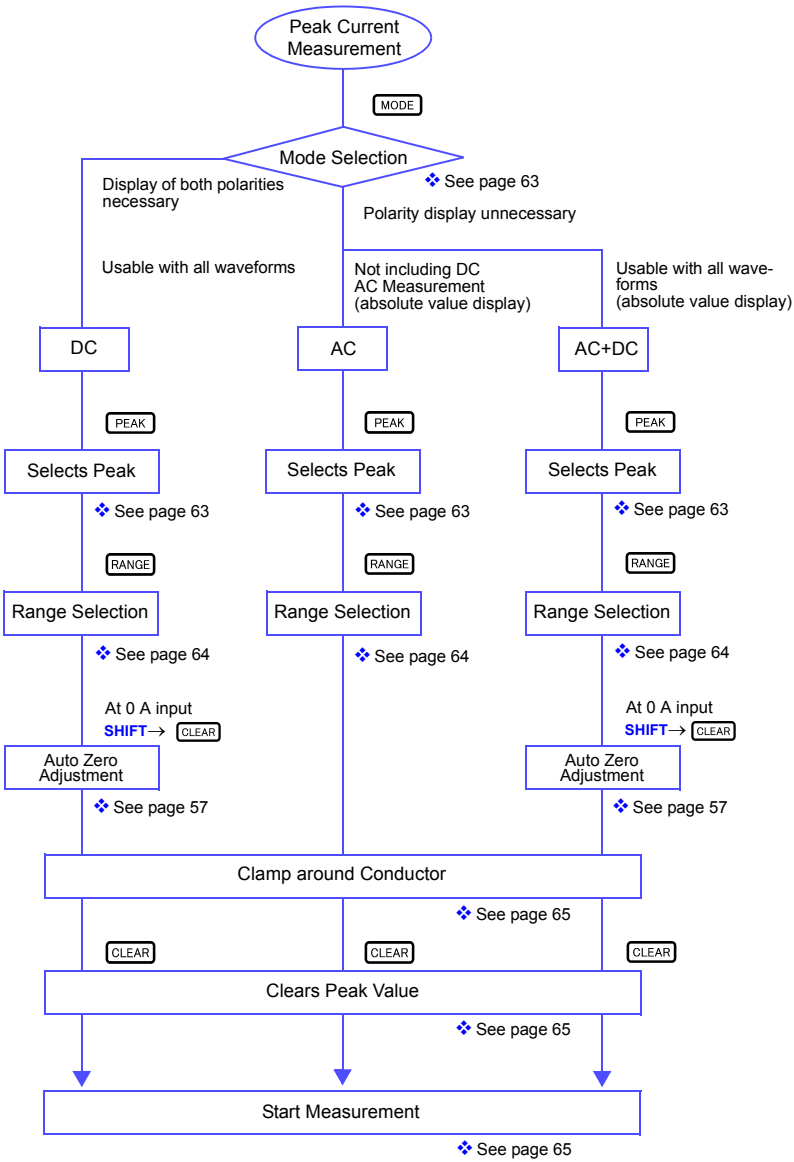
For Current Measurement

- AC and AC+DC modes
  If fluctuations cause measured values to be hard to read, press **SHIFT** → MODE (**SAMPLE**) to select the SLOW display update rate.
- When the display update rate is **SLOW** and the measurement range changes automatically (by AUTO ranging) as a result of a change in measured current, correct measurement is temporarily inhibited (because the display update rate is faster than the measurement response time affected by the range change). Erroneous MAX and MIN values may also be displayed.
  If the range can be expected to change because of a change in measured current, manually select the H range.
- When measuring a fast-rising current such as starting current, set the display update rate to FAST. Also, by pressing the PEAK button so that MAX is displayed, the maximum value can be read.
- In the L range, the maximum display is 2500 dgt.
- **O.L.** indicates over-range.
- When ◀ or ▶ is displayed on the bar graph, it indicates that an over-range negative or positive condition occurred during peak current measurement.

For Frequency Measurement

- When the amplitude of the current being measured is near the bottom of the L range (5% or less of the full range), frequency measurement may be incorrect. The bar graph indicates the current measurement value. In this case, "— — — —" or **O.L.** is displayed, or the displayed value becomes unstable.
- If the measured frequency is 1 Hz or less, the bar graph indicates "— — — —". If the measured frequency is 1 kHz or more, **O.L.** is displayed.
- Depending on the measured frequency, some time may be necessary for the measurement to stabilize.
- When measuring 10 Hz or less, depending on the amplitude of the current being measured, the frequency may not be displayed. In this case, set the display update rate to SLOW in the AC mode before switching to the Hz mode.
- Frequency measurement is performed by zero-crossing detection. However, because non-sinusoidal waveforms such as inverter outputs are low-pass filtered, the frequency may not be measurable in some cases (if the carrier frequency is as low as several kHz, the carrier component may not be sufficiently suppressed by the filter, so zero crossings are improperly detected and the indicated frequency is too high).
- If the waveform includes DC bias, zero crossings may not be detected and the indicated frequency may be too high or unstable.

4.4 Measuring Peak Current



Mode Selection

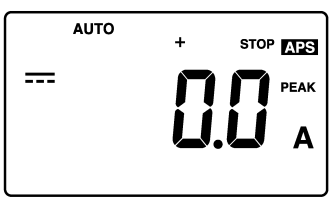
1. Press the MODE button to select the mode.

Button presses are ignored if **TIME** is displayed: press INTEG → CLEAR to clear it.

⎓	DC Mode
	Usable with all waveforms. Displays + (positive) and - (negative) peak values.
~	AC Mode
	Usable with AC waveforms with no DC component. Displays absolute value.
⎓~	AC+DC Mode
	Usable with all waveforms. Displays absolute value.

Peak Selection

2. Press the PEAK button to select PEAK.



NOTE

- In DC mode, both positive and negative peak values are displayed. Select this to measure peaks of both polarities.
- Auto zero adjustment is required when selecting DC or AC+DC mode.

Range Selection

3. Press the [RANGE] button to select the range.

AUTO	AUTO Ranging
	When using the CT9691 (9691) or CT9692 (9692): 20 A/ 200 A When using the CT9693 (9693) : 200 A/ 2000 A
L	L (Low) Range
	When using the CT9691 (9691) or CT9692 (9692): 20 A When using the CT9693 (9693) : 200 A
H	H (High) Range
	When using the CT9691 (9691) or CT9692 (9692): 200 A When using the CT9693 (9693) : 2000 A

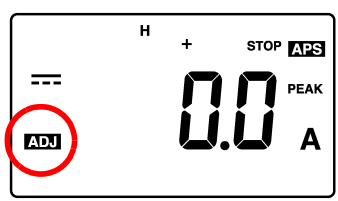
NOTE

- If the appropriate range cannot be estimated, measure using the H range first, and then select a lower range if necessary.
- If peak values exceeds the L range when measuring with AUTO ranging, some time is required for range switching, so a short-duration peak may not be detected.
- See Section 6.1.1 "Current Measurement" (page 108) for maximum display limitations.

Auto Zero Adjustment (for DC and AC+DC modes)

❖ See Section 5.1 "Auto Zero Adjustment Function" (page 89)

4. Verify that the measurement current is zero, or that the clamp-on sensor is not clamped around a conductor.
5. Press **SHIFT** → [CLEAR] (**0ADJ**) to execute auto zero adjustment.

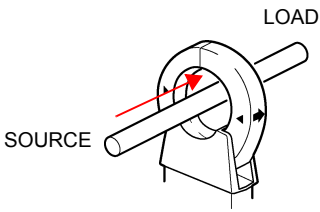


NOTE

- Executing auto zero adjustment clears peak value data at the same time.
- Auto zero adjustment is unnecessary in AC mode.

Starting Measurement

6. Open the sensor clamp and clamp it around the conductor to be measured, position the conductor at the center of the clamp, and start measuring.



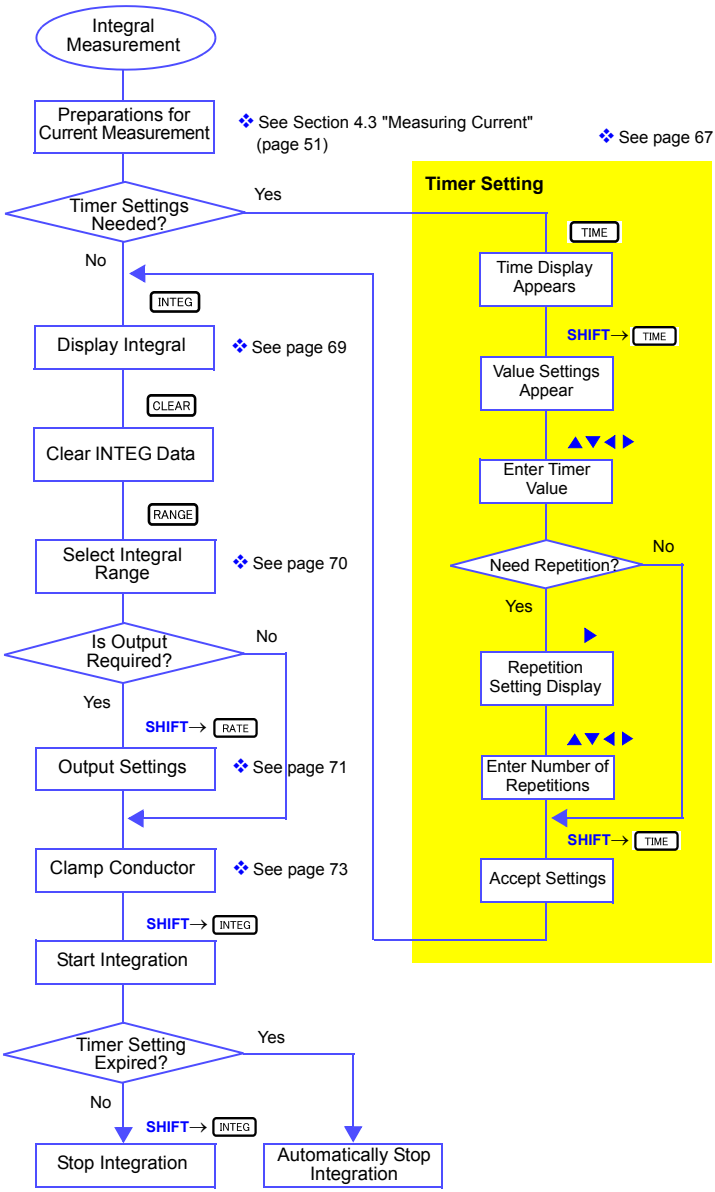
(DC mode case)
Make sure that the direc tion of current flow in the conductor matches that of the arrow on the clamp.

7. Press the CLEAR button to clear peak values.

NOTE

- The most precise measurements are obtained when the conductor to be measured is centered in the clamp, to minimize the effects of conductor proximity to the clamp. However, if the conductor to be measured is not positioned orthogonally to the clamp-on sensor, current measurements will be slightly affected at higher frequencies.
- Measurement values may differ when the direction of the clamp-on sensor is changed, but any such differences should be within the specified accuracy.
- In AC, AC+DC, and Hz modes, the direction of current flow in the conductor does not need to match that of the arrow on the clamp.
- When measuring peaks in the AC mode, press the CLEAR button a few seconds after changing the range.
- Pressing the CLEAR button does not clear peak values while **TIME** and **START** are displayed.
- **O.L.** indicates an over-range measurement.

4.5 Current Integration



Preparations for Current Measurement

1. Preparing for current measurement.

Follow the procedure beginning at Section 4.3 "Measuring Current" (page 51) up until "Starting Measurement" (page 60).
Be aware of the temperature characteristics the CT9691 (9691), CT9692 (9692) and CT9693 (9693) CLAMP ON AC/DC SENSORs.

NOTE

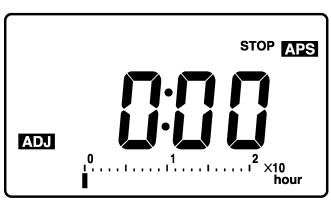
- In DC and AC+DC modes, always perform auto zero adjustment (page 89) before starting integral measurement.
- Because of the temperature characteristics of the clamp-on sensors, their zero points are temperature dependent. This affects measurements in DC and AC+DC modes, so be sure to read "Sensor Temperature Characteristics" (page 58) to familiarize yourself with the characteristics before measuring.

Timer Setting

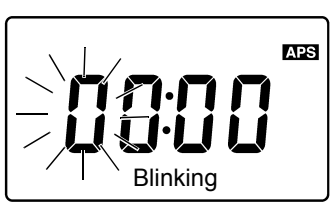
If no timer settings are needed, confirm that the timer is disabled by pressing the TIME button (twice), and skip ahead to "Integral Value Display" (page 69).

2. Press the TIME button to display the timer.

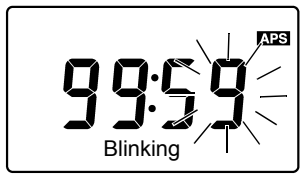
If **TIME** is displayed, press the CLEAR button.



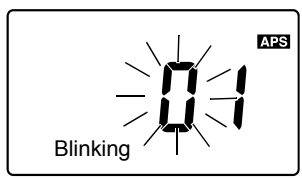
3. Press **SHIFT** → TIME (**INPUT/SET**) to display the numerical entry display.



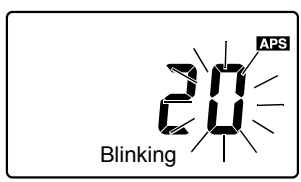
4. Press the ▲▼◀▶ buttons to set the timer (from 1 minute to 99 hours, 59 minutes).
   ▲▼: Increment/decrement digit
   ◀▶: Move cursor to another digit



5. Press the ▶ button to move the cursor to the right to display the repetition setting.



6. Press the ▲▼◀▶ buttons to set the number of times to repeat the measurement (up to 20 repetitions).



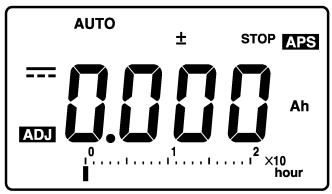
7. Press **SHIFT** → TIME (**INPUT/SET**) to accept your settings.

NOTE

- By using the timer, an integral can be measured over a specified interval.
- The integration time set on the timer can be repeated up to 20 times. For example, a 30 minute integration time might be repeated 10 times.
- If you don't need repeated integral measurements, or if you want to cancel the repetition setting, set the value on the repetition display to "1" (the default setting).
- To cancel the timer setting, set the timer to zero.
- During repeated measurements, in addition to the timer tolerance, a maximum 0.1-second delay can occur per timer interval (timer setting).
- When the timer stops automatically, **APS** appears and ten minutes later, the meter turns itself off.

Integral Value Display

8. Press the INTEG button to display the integral.

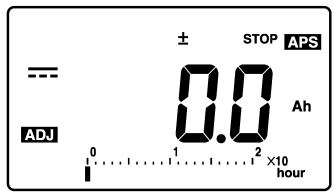


9. Press the CLEAR button to clear INTEG data (integral and interval mean values).

NOTE Clearing INTEG data on the integral display clears RATE and PEAK data as well.

Integral Range Setting

10. Press the RANGE button to select the range for the integral.



NOTE

- If no integral value output is needed, select AUTO ranging.
- The integral range consists of five components for each current range (four are common, so there are a total of six range components).
  When the timer is set, a large integrating range is unnecessary because the time and current range settings are not displayed even if the RANGE button is pressed.
- If no output settings are made, the integral range can be changed during integral measurement.

Integral Range Table

	Current Rage	Integral Range						
Model CT9691 (9691)	20 A	10.000 Ah	100.00 Ah	1000.0 Ah	10.000 kAh	100.00 kAh	--	--
	200 A	--	100.00 Ah	1000.0 Ah	10.000 kAh	100.00 kAh	1000.0 kAh	--
Model CT9692 (9692)	20 A	10.000 Ah	100.00 Ah	1000.0 Ah	10.000 kAh	100.00 kAh	--	--
	200 A	--	100.00 Ah	1000.0 Ah	10.000 kAh	100.00 kAh	1000.0 kAh	--
Model CT9693 (9693)	200 A	--	100.00 Ah	1000.0 Ah	10.000 kAh	100.00 kAh	1000.0 kAh	--
	2000 A	--	--	1000.0 Ah	10.000 kAh	100.00 kAh	1000.0 kAh	10000 kAh

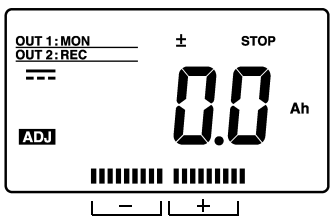
Maximum display is 9999 counts.

Output Settings

If no integral value output is needed, skip ahead to "Starting Measurement" (page 73).

11. Confirm that the optional 9094 OUTPUT CORD is inserted securely into output jack 1 (OUT1) (OUT2 is for integral value output).

12. Press **SHIFT** → [RATE] (**OUTPUT**) to display the output settings.



13. In DC mode, select the integral value for output by pressing **SHIFT** → [RATE] (**OUTPUT**).

On the display, **OUT2** is fixed to **REC** (12-bit D/A output of integral value: 1 mV per count up to ± 999.9 mV).

Mode Setting	Bar Graph Display	OUT2: REC
DC	±	Total integral output
	+	Positive integral output
	-	Negative integral output
AC, AC+DC	none	Integral output (fixed)

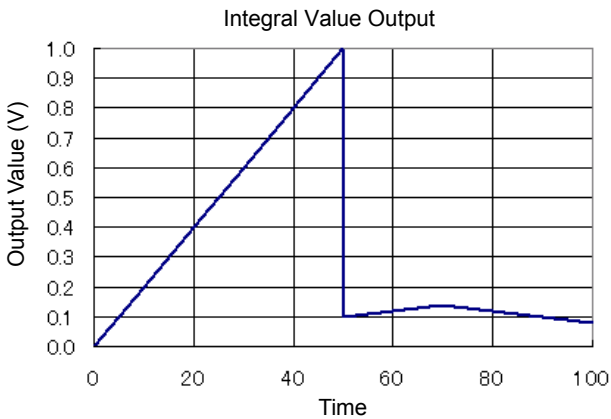
Output setting is disabled when neither OUT1 or OUT2 is displayed.

NOTE

- No polarity sign (±, + or -) is displayed in AC and AC+DC modes.
- Select the appropriate current range before making output settings.
  ❖ See "Integral Range Setting" (page 70)
- Each five counts increments or decrements the output by 0.5 mV (0.5 mV resolution).
- During repeating measurement, the integral value output is reset to 0 V at the end of each measurement interval.
- See "Output Settings" (page 54) for settings applicable to the OUT1 jack.
- The refresh rate of the integral value (D/A) output is the same as the display update rate.
  This rate is 100 ms when FAST is selected.

NOTE

- The maximum count of 9999 produces 999.9 mV output. If the count exceeds 9999, the integral range is automatically incremented.
  Example: 99.99 Ah → 100.0 Ah, 999.9 Ah → 1.000 kAh
  When this increment occurs, output steps from 999.9 mV → 0.1 V (or with negative integral output, from -999.9 mV → -0.1 V).
  On the other hand, when the measurement count decrements below 1000, the range does not change.
  Example: Measured current of 100.0 Ah → 99.9 Ah produces output of 0.1 V → 0.0999 V



- During repeating measurements, the range of the latest measurement is retained.
- Integral measurement output levels are shown on the meter's battery cover.
- Determine the appropriate output range from the integral range of the meter and the input range of the connected instrument (e.g., data recorder). Conversion tables are shown here.

Connected Instrument Measuring Range /DIV	10 mV	20 mV	50 mV	0.1 V	0.2 V	0.5 V
10.000 Ah	0.1 Ah	0.2 Ah	0.5 Ah	1 Ah	2 Ah	5 Ah
100.00 Ah	1 Ah	2 Ah	5 Ah	10 Ah	20 Ah	50 Ah
1000.0 Ah	10 Ah	20 Ah	50 Ah	100 Ah	200 Ah	500 Ah
10.000 kAh	100 Ah	200 Ah	500 Ah	1 kAh	2 kAh	5 kAh
100.00 kAh	1 kAh	2 kAh	5 kAh	10 kAh	20 kAh	50 kAh
1000.0 kAh	10 kAh	20 kAh	50 kAh	100 kAh	200 kAh	500 kAh
10000 kAh	100 kAh	200 kAh	500 kAh	1000 kAh	2000 kAh	5000 kAh

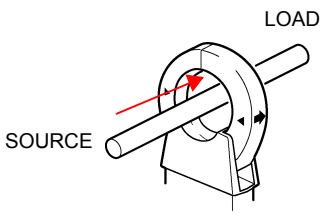
* Numerical values are integral value per division on the connected instrument (e.g., data recorder).

NOTE

- The input impedance of the connected instrument should be at least 1 MΩ to avoid affecting the displayed value.
- Output is unaffected by pressing the HOLD button.
- Use the optional 9445-02 AC ADAPTER for long-term recording. If using the AC adapter with very noisy AC mains power, displayed values may be unstable, or noise may appear in the output, in which case connect the ground of the connected instrument (data recorder) or L terminal at the recorder side to earth ground.

Starting Measurement

14. Open the sensor clamp and clamp it around the conductor to be measured, position the conductor at the center of the clamp, and start measuring.



(DC mode case)
Make sure that the direc tion of current flow in the conductor matches that of the arrow on the clamp.

NOTE

- The most precise measurements are obtained when the conductor to be measured is centered in the clamp, to minimize the effects of conductor proximity to the clamp. However, if the conductor to be measured is not positioned orthogonally to the clamp-on sensor, current measurements will be slightly affected at higher frequencies.
- Measurement values may differ when the direction of the clamp-on sensor is changed, but any such differences should be within the specified accuracy.
- In AC, AC+DC, and Hz modes, the direction of current flow in the conductor does not need to match that of the arrow on the clamp.

15. Press **SHIFT** → [INTEG] (**START/STOP**) to start integration.
START appears, and the colon (:) in the elapsed time display blinks.
Auto power-off is disabled (**APS** not displayed).

16. Press **SHIFT** → [INTEG] (**START/STOP**) to stop integration.
STOP appears, and the colon (:) in the elapsed time display stops blinking.

If the timer is enabled, integration stops automatically after the preset timer and repetition settings.
Unless output has been enabled, auto power-off is re-enabled (**APS** displayed).

NOTE

- Pressing the [INTEG] button displays the integral and interval mean values.
  The interval mean value indicates the current value as the interval / integrating time.
  DC mode: Total Integral → Positive Integral → Negative Integral → Interval Mean Value
  AC and AC+DC modes: Integral → Interval Mean Value
- The display update rate changes to the setting value.
- Press the [PEAK] button to display peak, maximum and minimum values (in DC mode, only positive and negative peak values).
- Stopping integration also stops the elapsed time count.
- The appearance of the "**+**" or "**-**" symbol blinking while an integral value is displayed indicates than an over-range measurement occurred in the currently selected range and with the indicated polarity.
- When an over-range current measurement occurs (**O.L.** displayed), the maximum value of the current range is used for integration.
  ❖ Current range: see Section 6.1.1 "Current Measurement" (page 108)
- The appearance of the ◀ or ▶ indicator on the bar graph while an integral value is displayed indicates than either a negative or positive over-range condition occurred during current measurement.
- If the measured current value becomes 0 A because of the zero suppression function (counts of 5 or less are forced to display as 0), then 0 A is used for integration.
- Maximum integration time is 2,000 hours. Press the [TIME] button to display values after 100 hours.
- When the frequency of the measured current is 45 Hz or higher, measure using the FAST mode, which provides the fastest measurement response to follow rapid fluctuations.

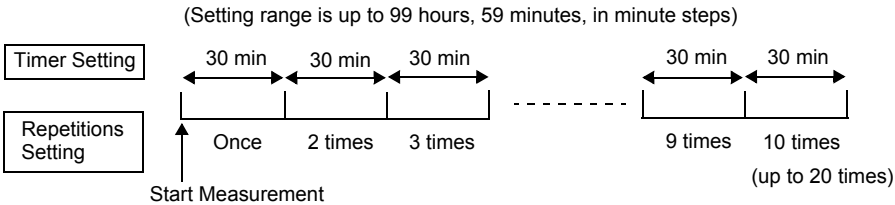
To integrate continuously (Cumulative integration)	Press **SHIFT** → INTEG (**START/STOP**) again to start integration. **START** is displayed.If the timer has been set, refer to the following table regarding limitations (data is not stored when stopped).
To resume integration after clearing INTEG data (New integration)	Press the INTEG button and then the CLEAR button to clear the integral value, then press **SHIFT** → INTEG (**START/STOP**).
To cancel or change the timer setting	Set again according to "Timer Setting" (page 67).
To view data by stopping the display while integrating (Data hold)	Press the HOLD button. At this point, integration and elapsed time progress are not interrupted. Displayed value update is stopped, but measurement continues internally. ❖ See Section 5.5 "Data Hold" (page 96)
To determine the repetition number of the occurring measurement during repeating measurement	Press the HOLD button. The repetition number of the occurring measurement is indicated on the bar graph.
To view historical INTEG data (integrals and interval mean values)	After pressing the HOLD button (**HOLD** displayed), press the INTEG button. Press the ◀ or ▶ button to select on the bar graph which measurement data (that is, which repetition number) to view. When multiple bars are displayed, the displayed values are the cumulative integral and mean of all measurements up to the present. ❖ See Section 5.6 "Viewing Historical Data" (page 97)
To view history of PEAK data (Peak values)	After pressing the HOLD button (**HOLD** displayed), press the PEAK button. Press the ◀ or ▶ button to select on the bar graph which measurement data (that is, which repetition number) to view. When multiple bars are displayed, the displayed values are the peak, maximum and minimum values from all measurements up to the present. ❖ See Section 5.6 "Viewing Historical Data" (page 97)

Timer and Repetition Setting Examples

	Timer Setting	Repetition Setting	Start	Stop	Cumulative Integration	Timer Setting
1	None	None	Manual	Manual	Available (Until stopped manually)	Not available*
2	Yes (30 min)	None (Once)	Manual	Manual (Before timer stops)	Available (Stops 30 min after restart)	
				Timer (30 min)		
3	Yes (30 min)	Yes (Five times)	Manual	(Before timer stops)	Not available	
				Timer (5 x 30 min)		

* Not available if INTEG data is being retained (**TIME** displayed), but can be set if data is cleared.

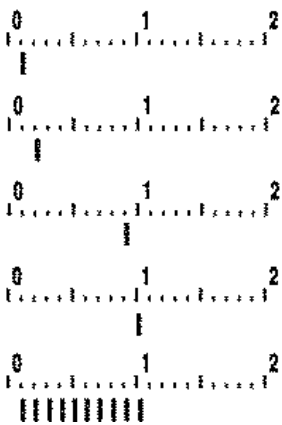
Setting Example



View Data History (After pressing HOLD button)

INTEG button: Integral and interval mean value

PEAK button: Peak, maximum and minimum values



Data from first measurement

Data from second measurement

Data from ninth measurement

Data from tenth measurement

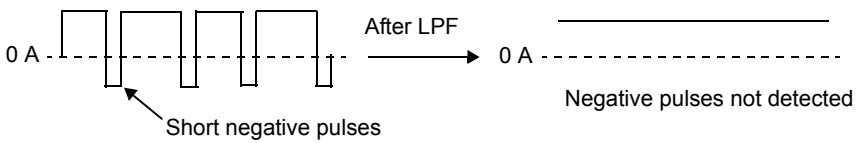
Total data
Total data from first through tenth measurements

To display an integration over periods longer than 100 hours, press the TIME button.

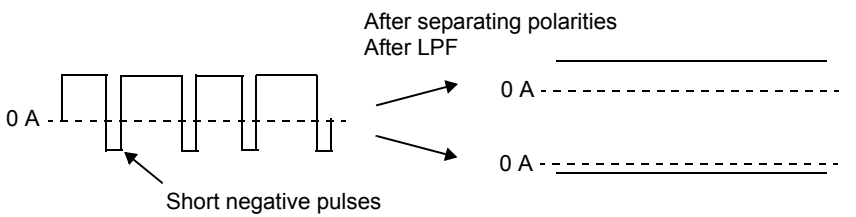
❖ To view stored data, see Section 5.6 "Viewing Historical Data" (page 97)

About the Measurement Process

The DC measurement method of this meter separates the input signal into positive and negative polarity components.
A typical current integrator passes the signal through a low-pass filter (LPF), then converts the waveform (e.g., square wave) into DC for measurement. These current measurements are then summed to produce the integral. However, because of the inherent response time of the low-pass filter, brief negative pulses cannot be detected, as illustrated below. As a result, the negative integral is zero or too small, and the positive integral may be too small (although there is no net error in the total integral).



On the other hand, this meter splits the waveform into positive and negative components before processing. Each polarity is then processed independently so there is no loss of either, and therefore more accurate detection. As a result, it is possible to measure very slight control errors by positive and negative integration. The total integral value is obtained by summing positive and negative integrals. Sampling is 10 time/s (alternating polarities 5 times/s).



In AC and AC+DC modes, all waveforms are made positive by RMS-DC conversion, so there is no meter-inherent difference as described above.

Functions available during measurement (START displayed)

- View INTEG data (integral and interval mean value)
- View PEAK data (peak values, etc.)
- View elapsed time
- View timer setting and repetition
- View present current value
- Stop integration
- Change integration range if no output has been enabled
- Data hold
- View remaining battery charge
- Turn meter off by [POWER] button (data is stored automatically)

Functions not available during measurement (both START and TIME displayed)

- Change measurement mode ([MODE] button disabled)
- Change current range ([RANGE] button disabled)
- Change integration range when output has been enabled ([RANGE] button disabled)
- Clear INTEG data ([CLEAR] button disabled)
- Clear PEAK data ([PEAK] button disabled)
- Change timer setting (**SHIFT** → [TIME] (**INPUT/SET**) button disabled)
- Change output settings (**SHIFT** → [RATE] (**OUTPUT**) button disabled)
- Change display update rate (**SHIFT** → [MODE] (**SAMPLE**) button disabled)
- Auto zero adjustment (**SHIFT** → [CLEAR] (**0 ADJ**) button disabled)
- Change filter setting (**SHIFT** → [RANGE] (**FILTER**) button disabled)

Functions not available while INTEG data is being retained (both START and TIME displayed)

- Change measurement mode ([MODE] button disabled)
- Change current range ([RANGE] button disabled)
- Change timer setting (**SHIFT** → [TIME] (**INPUT/SET**) button disabled)
- Clear data other than that the integral, elapsed time and duty displays ([CLEAR] button disabled)

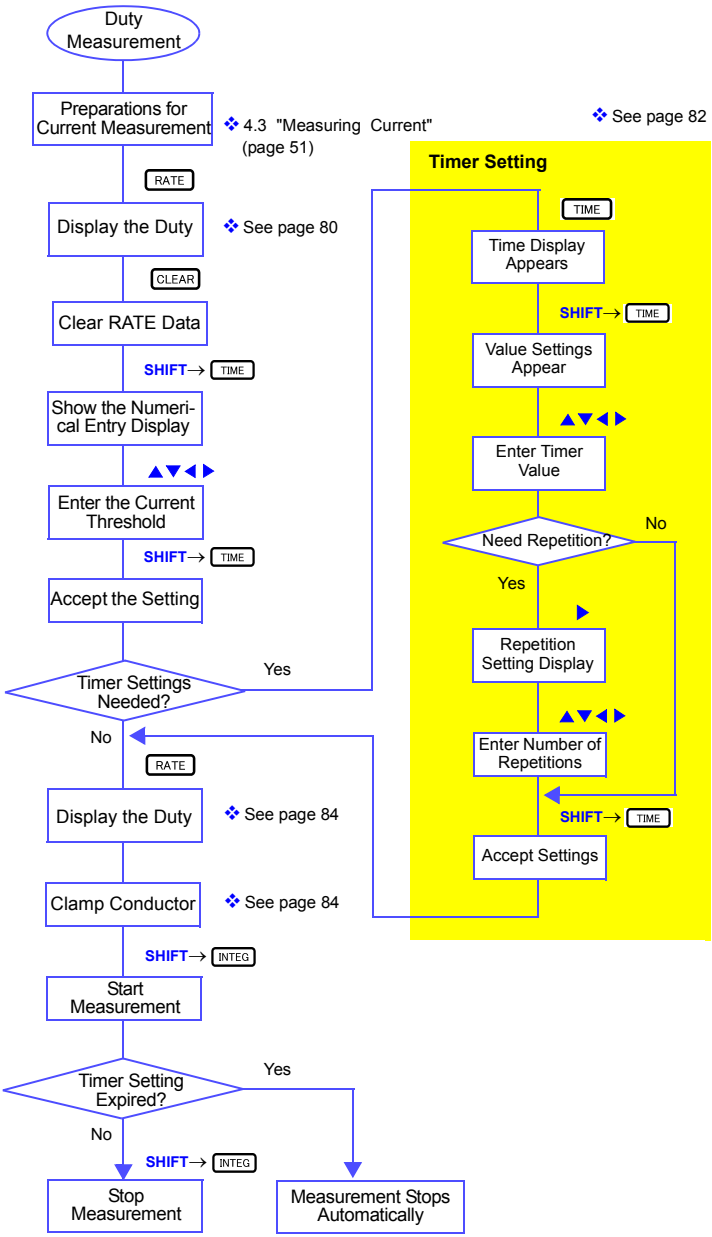
Deleting INTEG Data

- With the integral value displayed, press the [CLEAR] button (**TIME** not displayed).

Recalling Stored Data

- While holding the **SHIFT** button, press the [POWER] button to turn the meter on. View stored data by pressing [INTEG], [PEAK], ◀ and ▶.
- To resume measuring, turn the meter off and back on.

4.6 Measuring Duty



Preparations for Current Measurement

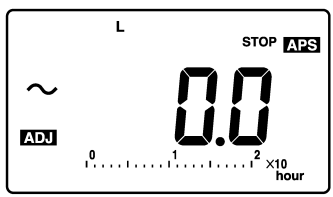
1. Preparing for current measurement.

   Follow the procedure beginning at Section 4.3 "Measuring Current" (page 51) up until "Starting Measurement" (page 60).
   Be aware of the temperature characteristics the CT9691 (9691), CT9692 (9692) and CT9693 (9693) CLAMP ON AC/DC SENSORs.
   ❖ See "Sensor Temperature Characteristics" (page 58)

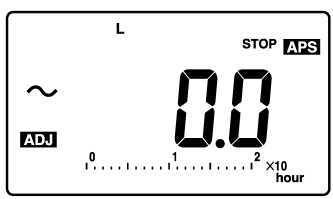
Current Threshold Setting

2. Press the RATE button to display the duty.

   If **TIME** is displayed, press CLEAR button to clear it.

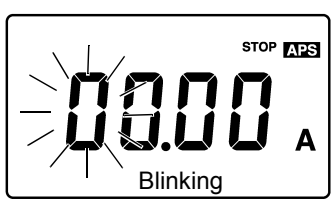


3. Press CLEAR button to clear any RATE data (duty, operating time*).
   * The current threshold is not cleared.



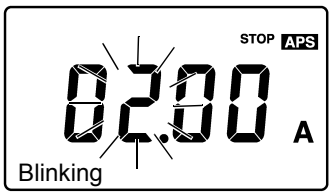
NOTE When clearing RATE data on the duty display, INTEG and PEAK data are also cleared.

4. Press **SHIFT** → TIME (**INPUT/SET**) to display the numerical entry display.



5. Press the ▲▼◀▶ buttons to set the current threshold.

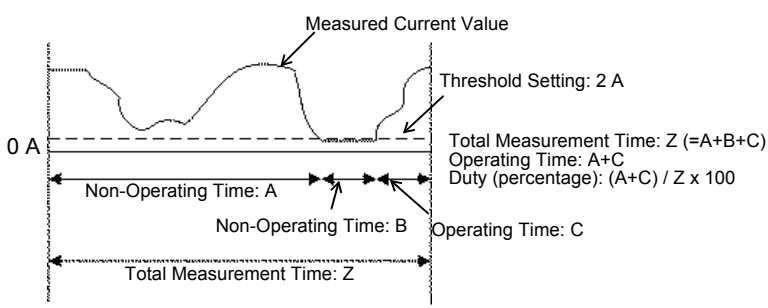
The current threshold is the value used for judging the operating state.



6. Press **SHIFT** → TIME (**INPUT/SET**) to accept the setting.

NOTE

- Do not change the current range after setting the current threshold. Changing the range causes the threshold to shift up or down by a factor of 10. Select the appropriate current range before setting the current threshold on page 80.
- For any digit, pressing the ▼ button when the value is zero changes the polarity to negative. To change the setting to positive (0 A or more), press the ▲ button so that the "-" sign disappears.
- In AC and AC+DC modes, setting are made with rms (positive polarity).
- In DC mode, the setting may be positive or negative (for example, when the threshold is set to -20 A and -10 A is measured, the operating state is judged to be active (on), and -30 A is judged to be the non-operating (off) state.
- The current threshold cannot be set to 1 to 5 counts because zero suppression (forcing counts of 5 or less to display as zero) causes the current measurement value to display as 0 A (the next setting after 0 is 6).
- To change the current threshold, see "Current Threshold Setting" (page 80).
- Measurement of operating time works as shown below.



Measurement Process

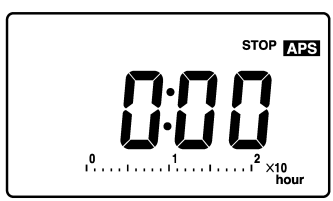
For DC measurements, the meter splits the signal into positive and negative components before low-pass filtering. The inherent response time of the filter suppresses the detection of short pulses, so errors can result in the operating time measurement. This error can affect the duty measurement (although current values below the threshold have no affect on the measurement).

In AC and AC+DC modes, measurement response time is affected by RMS/DC conversion. If severe current fluctuations (at 45 Hz and above) are present, we recommend measuring in FAST mode.

Timer Setting

If no timer settings are needed, confirm that the timer is disabled by pressing the TIME button (twice), and skip ahead to "Starting Measurement" (page 84).

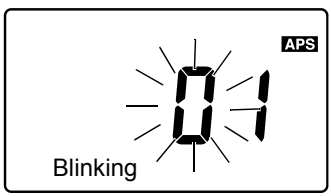
7. Press the TIME button to display the timer.



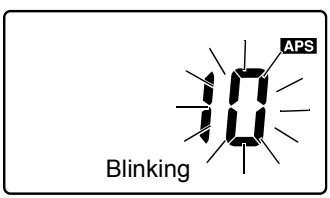
8. Press **SHIFT** → TIME (**INPUT/SET**) to display the numerical entry display.

9. Press the ▲▼◀▶ buttons to set the timer (from 1 minute to 99 hours, 59 minutes).
▲▼: Increment/decrement digit
◀▶: Move cursor to another digit

10. Press the ▶ button to move the cursor to the right to display the repetition setting.



11. Press the ▲▼◀▶ buttons to set the number of times to repeat the measurement (up to 20 repetitions).



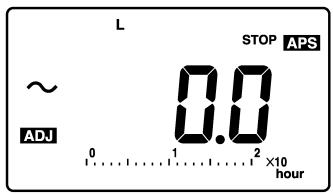
12. Press **SHIFT** → TIME (**INPUT/SET**) to accept your settings.

NOTE

- By using the timer, an integral can be measured over a specified interval.
- The integration time set on the timer can be repeated up to 20 times. For example, a 30 minute integration time might be repeated 10 times.
- If you don't need repeated measurements, or if you want to cancel the repetition setting, set the value on the repetition display to "1" (the default setting).
- To cancel the timer setting, set the timer to zero.
- During repeated measurements, in addition to the timer tolerance, a maximum 0.1-second delay can occur per timer interval (timer setting).

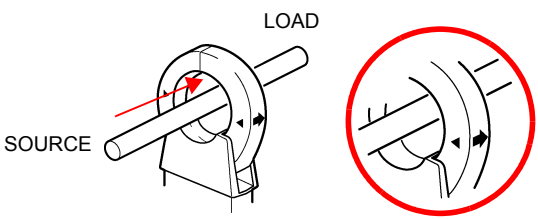
Duty Display

13. Press the RATE button to display the duty.



Starting Measurement

14. Open the sensor clamp and clamp it around the conductor to be measured, position the conductor at the center of the clamp, and start measuring.



(DC mode case)
Make sure that the direc tion of current flow in the conductor matches that of the arrow on the clamp.

NOTE

- The most precise measurements are obtained when the conductor to be measured is centered in the clamp, to minimize the effects of conductor proximity to the clamp. However, if the conductor to be measured is not positioned orthogonally to the clamp-on sensor, current measurements will be slightly affected at higher frequencies.
- Measurement values may differ when the direction of the clamp-on sensor is changed, but any such differences should be within the specified accuracy.
- In AC, AC+DC, and Hz modes, the direction of current flow in the conductor does not need to match that of the arrow on the clamp.

15. Press **SHIFT** → [INTEG] (**START/STOP**) to start duty measurement.
START appears, and the colon (:) in the elapsed time display blinks.
Auto power-off is disabled (**APS** not displayed).

16. Press **SHIFT** → [INTEG] (**START/STOP**) to stop duty measurement.
STOP appears, and the colon (:) in the elapsed time display stops blinking.

If the timer is enabled, measurement stops automatically after the preset timer and repetition settings.
Unless output has been enabled, auto power-off is re-enabled (**APS** displayed).

NOTE

- Press the [RATE] button to display the duty percentage (Operating Time / Measurement Time X 100), operating time and current threshold.
  Duty Percentage → Operating Time → Current Threshold
- Although the percent sign (%) is not displayed, the displayed duty value is a percentage.
- The display update rate changes to the setting value.
- Press the [PEAK] button to display peak, maximum and minimum values (in DC mode, only positive and negative peak values).
- Stopping measurement also stops the elapsed time count.
- When displaying current, the ◀ or ▶ indicator may appear on the bar graph indicating that either a negative or positive overrange current measurement occurred.
- When the frequency of the measured current is 45 Hz or higher, measure using the FAST mode, which provides the fastest measurement response to follow rapid fluctuations.

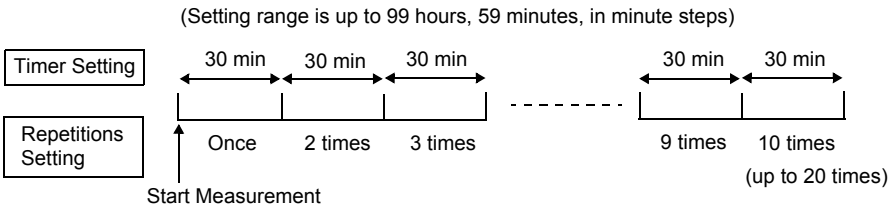
To measure continuously (Continuous measurement)	Press **SHIFT** → INTEG (**START/STOP**) again to start measuring. **START** is displayed.If the timer has been set, refer to the following table regarding limitations.
To resume measuring after clearing RATE data (New measurement)	Press the RATE button and then the CLEAR button to clear the measurement value, then press **SHIFT** → INTEG (**START/STOP**).
To change the current threshold	See "Current Threshold Setting" (page 80) to reset.
To cancel or change the timer setting	Set again according to "Timer Setting" (page 82).
To view data by stopping the display while measuring duty (Data hold)	Press the HOLD button. At this point, actual duty measurement and elapsed time progress are not interrupted. Display update is stopped, but duty measurement continues internally. ❖ See Section 5.5 "Data Hold" (page 96)
To determine the repetition number of the occurring measurement during repeating measurement	Press the HOLD button. The repetition number of the occurring measurement is indicated on the bar graph.
To view history of RATE data (Duty and Operating Time)	After pressing the HOLD button (**HOLD** displayed), press the RATE button.Press the ◀ and ▶ buttons to select on the bar graph which data (that is, which repetition number) to view. When multiple bars are displayed, the displayed values are the duty and operating time up to the present. ❖ See Section 5.6 "Viewing Historical Data" (page 97)
To view history of PEAK data (Peak values)	After pressing the HOLD button (**HOLD** displayed), press the PEAK button.Press the ◀ or ▶ button to select on the bar graph which measurement data (that is, which repetition number) to view. When multiple bars are displayed, the displayed values are the peak, maximum and minimum values from all measurements up to the present. ❖ See Section 5.6 "Viewing Historical Data" (page 97)

Timer and Repetition Setting Examples

	Timer Setting	Repetition Setting	Start	Stop	Cumulative Integration	Timer Setting
1	None	None	Manual	Manual	Available (Until stopped manually)	Not available*
2	Yes (30 min)	None (Once)	Manual	Manual (Before timer stops)	Available (Stops 30 min after restart)	
				Timer (30 min)		
3	Yes (30 min)	Yes (Five times)	Manual	(Before timer stops)	Not available	
				Timer (5 x 30 min)		

* Not available if RATE data is being retained (**TIME** displayed), but can be set if data is cleared.

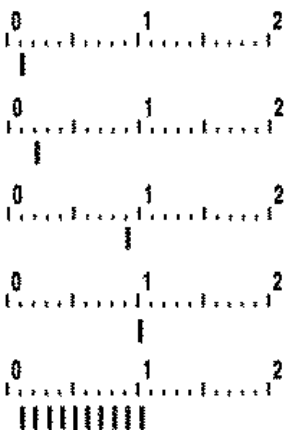
Setting Example



View Data History (After pressing HOLD button)

PEAK button: Peak, maximum and minimum values

RATE button: Duty and operating time



Data from first measurement

Data from second measurement

Data from ninth measurement

Data from tenth measurement

Total data
Total data from first through tenth measurements

To display a measurement over periods longer than 100 hours, press the TIME button.

❖ To view stored data, see Section 5.6 "Viewing Historical Data" (page 97)

Functions available during measurement
(START displayed)

- View INTEG data (integral and interval mean value)
- View RATE data (duty, operating time, and current threshold)
- View PEAK data (peak, maximum, and minimum values)
- View elapsed time
- View timer setting and repetition
- View present current value
- Stop duty measurement
- Data hold
- View remaining battery charge
- Turn meter off by [POWER] button (data is stored automatically)

Functions not available during measurement
(both START and TIME displayed)

- Change measurement mode ([MODE] button disabled)
- Change current range ([RANGE] button disabled)
- Clear RATE data ([CLEAR] button disabled)
- Clear PEAK data ([PEAK] button disabled)
- Change current threshold setting
  ([SHIFT] → [TIME] (**INPUT/SET**) button disabled)
- Change timer setting ([SHIFT] → [TIME] (**INPUT/SET**) button disabled)
- Change output settings ([SHIFT] → [RATE] (**OUTPUT**) button disabled)
- Change display update rate ([SHIFT] → [MODE] (**SAMPLE**) button disabled)
- Auto zero adjustment ([SHIFT] → [CLEAR] (**0 ADJ**) button disabled)

Functions not available while RATE data is being retained
(both START and TIME displayed)

- Change measurement mode ([MODE] button disabled)
- Change current range ([RANGE] button disabled)
- Change timer setting ([SHIFT] → [TIME] (**INPUT/SET**) button disabled)
- Change current threshold setting
  ([SHIFT] → [TIME] (**INPUT/SET**) button disabled)
- Clear data other than that the integral, elapsed time and duty displays
  ([CLEAR] button disabled)

Deleting RATE Data

- With the duty displayed, press the [CLEAR] button (**TIME** not displayed).

Recalling Stored Data

- While holding the **SHIFT** button, press the [POWER] button to turn the meter on. View stored data by pressing [RATE], [PEAK], ◀ and ▶.
- To resume measuring, turn the meter off and back on.

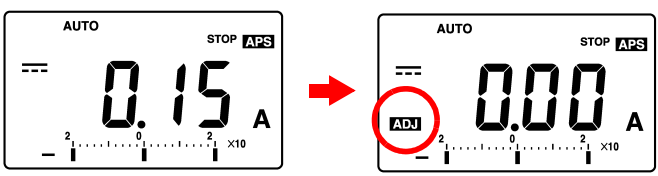
Applicable Measurement Modes 5

5.1 Auto Zero Adjustment Function

Measurement Modes: DC and AC+DC

The auto-zero adjustment function automatically adjusts the offset in the internal circuit that results from temperature characteristics or clamp-sensor magnetization. The clamp core is magnetized when a large DC current is measured or a powerful magnet is placed close to the clamp core.

1. Close the clamp-on sensor tightly.
2. Verify that the display is stable with no signal applied.
3. Press **SHIFT** → CLEAR (**0ADJ**) to execute auto zero adjustment.



Before Adjustment　　Finished

4. **ADJ** appears when finished.

NOTE

- Because the zero suppression function may be enabled (forcing counts of five or less to display as zero), perform auto zero adjustment even if the displayed value is zero.
- The maximum adjustment ranges in current measurement mode are as follows:
  L range: approx. ± 450 dgt., H range: approx. ± 45 dgt.
  Auto zero adjustment cannot be performed if the displayed value is outside of these ranges.
- If auto-zero adjustment is performed during current measurement or while the reading fluctuates, zero adjustment may not be performed correctly.
- When AUTO ranging is enabled, auto zero adjustment is performed in both L and H ranges.
- See "Sensor Temperature Characteristics" (page 58) for the temperature characteristics of the clamp-on sensors.

5.2 Display Update Rate

Measurement Modes: AC, AC+DC

The display update rate can be changed to suit measurement conditions.
In the DC mode, this is fixed at about once per second.

1. Press **SHIFT** → MODE (**SAMPLE**).

2. The display update rate changes as follows.

NOTE

- The measurement response time (rms measurement conversion speed) is affected by this selection.
- Display of integral and duty measurements is the same as the display update rate.
- Integral value output (D/A output) is refreshed with the same timing as the display update rate.

NORMAL

- The digital display update rate at power on is about twice per second.

SLOW

- If fluctuations make the measured value hard to read during current measurement, set the display update rate to SLOW (about once every three seconds) to improve readability.
- Measurement response time is about eight seconds, so if the measurement fluctuates severely, some time may be needed for the display value to stabilize.
- When **SLOW** is selected with AUTO ranging and the range switches automatically in response to a change in measured current, measurement is temporarily inhibited (because the display update is fast and measurement response is slow, range changes are delayed). An error also occurs in MAX and MIN displayed values.
  Therefore, if the measured current is expected to change, manually select the H range.
- For current measurements at 10 Hz and lower, accuracy in AC+DC mode is only guaranteed with SLOW display update rate (measurement response time).

FAST

- During current measurement, the display update rate for measured values is set to about ten times per second. This rate is most suitable for applications such as starting current measurement. So that starting current will be easy to read, press the [PEAK] button to enable MAX value display.
- For starting current measurement, a continuous waveform of at least 200 ms is required. Measured values will be too low if the waveform is shorter than that.
- Accuracy cannot be guaranteed for measured current frequencies below 45 Hz.

5.3 Measurement Response Time

Measurement Modes: AC, AC+DC

1. Press **SHIFT** → MODE (**SAMPLE**).
2. The measurement response time changes.
❖ See pages 93 and 94

SLOW → **FAST** → **NORMAL**

NOTE

- Changes to the display update rate and measurement response time are interdependent.
- MON output is independent of measurement response time.

FAST (0.2s) : Meets specifications at 45 Hz and above.
NORMAL (0.8s) : Meets specifications at 10 Hz and above.
SLOW (8s) : Meets specifications at 1 Hz and above.

NORMAL

- Unless set otherwise using the save settings function, the measurement response time is set to NORMAL at power on. There is no display indication for the NORMAL rate.

SLOW

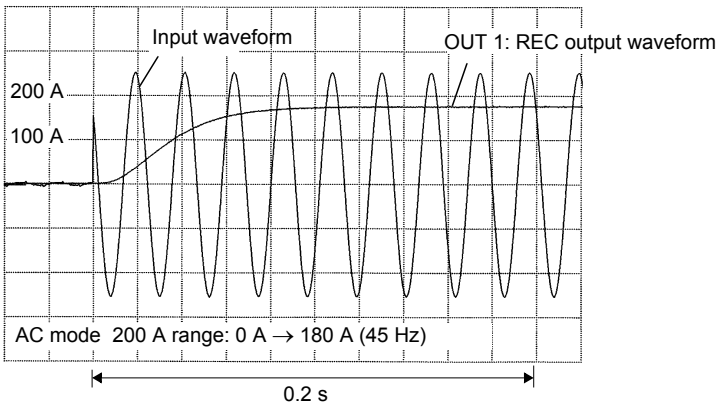
- **SLOW** is displayed when the SLOW measurement response time is selected.
- With the slow display update rate (measurement response time), low frequencies (10 Hz and below) can be measured correctly in AC+DC mode, but rapid fluctuations cannot be followed due to the slow response.
- When **SLOW** is selected with AUTO ranging and the range switches automatically in response to a change in measured current, current measurement is temporarily inhibited (because the display update is fast and measurement response is slow, range changes are delayed). An error also occurs in MAX and MIN displayed values.
  If the measured current is expected to change, manually select the H range.
- For current measurements at 10 Hz and lower, accuracy in AC+DC mode is only guaranteed with SLOW display update rate (measurement response time).

FAST

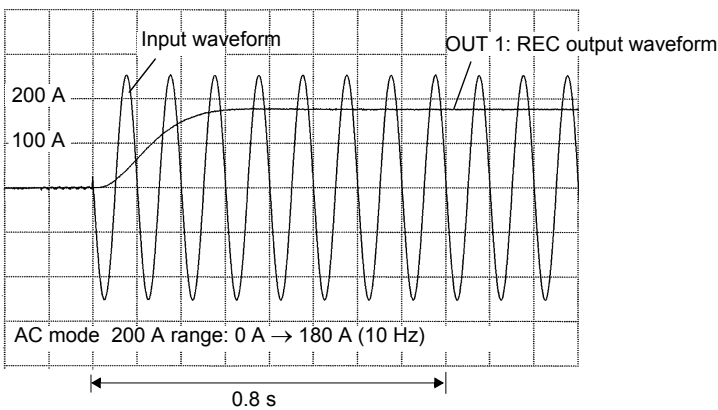
- **FAST** is displayed when the FAST measurement response time is selected.
- The FAST response time can follow rapid fluctuations, but low frequencies (below 45 Hz) cannot be measured correctly.
- Accuracy cannot be guaranteed for current measurements at frequencies below 45 Hz.

Output Response Waveform (Rising Edge)

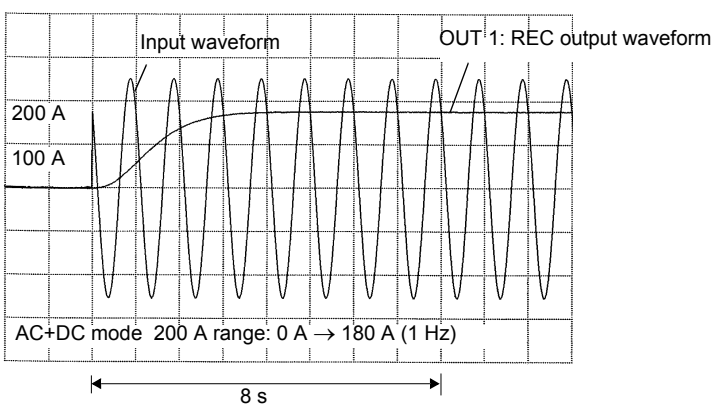
FAST



NORMAL

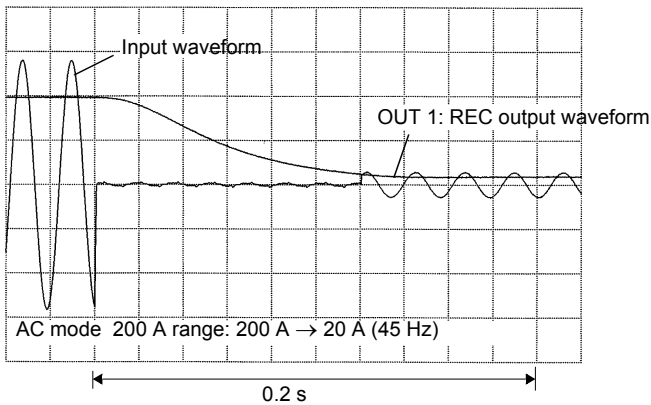


SLOW

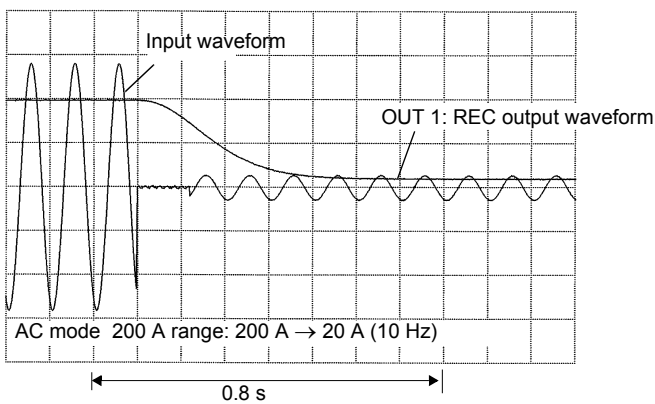


Output Response Waveform (Falling Edge)

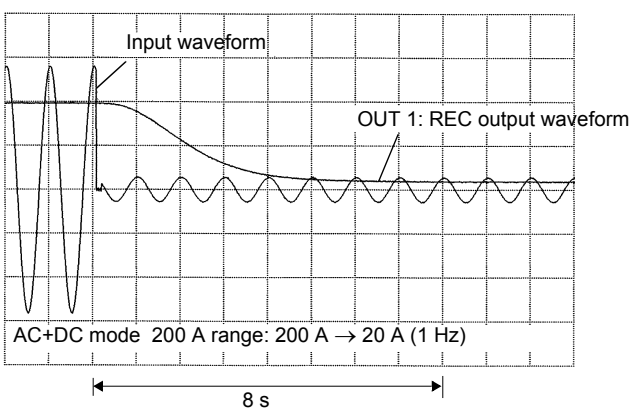
FAST



NORMAL



SLOW



5.4 Filter Function

Measurement Modes: DC, AC, AC+DC

This function can remove unwanted frequency components such as noise.

1. Press **SHIFT** → RANGE (**FILTER**).
2. The Filter function is enabled.

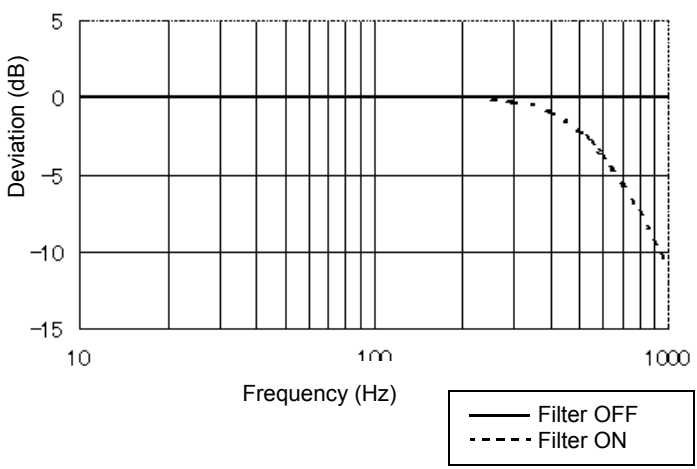
DC Mode

When OUT1 is set to MON output, press **SHIFT** → RANGE (**FILTER**) to change the OUT1 display to **MON.FL**.
The OUT1 output is passed through a low-pass filter with cut-off frequency (fc) of about 1 Hz. AC components such as mains frequencies are removed, so this function is useful if noise or ripple is present on DC current. The displayed value is always passed through another low-pass filter of about 0.5 Hz.

AC and AC+DC Modes

Press **SHIFT** → RANGE (**FILTER**) so that **FILTER** is displayed.
Both displayed and output values are passed through a low-pass filter with cut-off frequency (fc) of about 550 Hz. Values can be reduced by about -3 dB (about 30%) when the Filter function is enabled. Use this function to suppress the carrier component on the secondary side of inverters, or to suppress noise. The figure shows an example of its use.

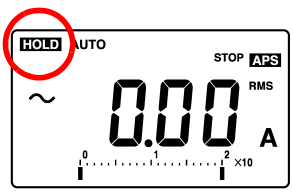
Filter Characteristics



5.5 Data Hold

Use this function to suspend changes to the current display.
HOLD is displayed, and the measured value and bar graph indications are retained (display updating is suspended).
During repeating measurements of integral or duty (**TIME** displayed), historical data can be viewed.
❖ See Section 5.6 "Viewing Historical Data" (page 97)

1. Press the [HOLD] button.
2. **HOLD** is displayed, and the display is suspended.



To resume normal display activity, press [HOLD] again.

NOTE

- During integral and duty measurement, pressing the [HOLD] button does not interrupt integration or elapsed time measurement (only display changes are suspended).
- When output is enabled, pressing the [HOLD] button does not affect output.
- To read the current value without stopping measurement, press the [HOLD] button to switch to the current display, then press it again. Unless current measurement is displayed, pressing the [HOLD] button does not cause the current value to be displayed.

5.6 Viewing Historical Data

Historical measurement data can be viewed while measuring.

1. Press the [HOLD] button during repeating measurement (**HOLD** is displayed).
2. The bar graph indicates the sequential number of the currently displayed measurement.
3. Use the ◀ and ▶ buttons to scroll through collected measurement data.

To view INTEG (integral and interval mean value) data history:
1. After pressing the [HOLD] button during repeating measurement, press the [INTEG] button.
2. The bar graph indicates the sequential number of the currently displayed measurement.

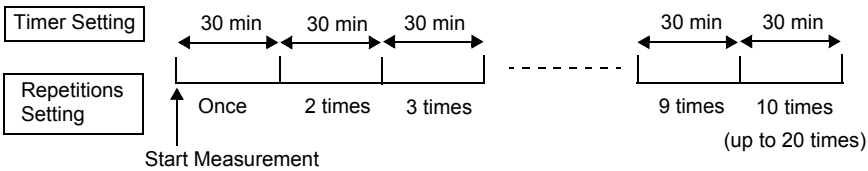
To view RATE (duty and operating time) data history:
1. After pressing the [HOLD] button during repeating measurement, press the [RATE] button.
2. The bar graph indicates the sequential number of the currently displayed measurement.

To view PEAK (peak, maximum and minimum) data history:
1. After pressing the [HOLD] button during repeating measurement, press the [PEAK] button.
2. The bar graph indicates the sequential number of the currently displayed measurement.

NOTE

- The appearance of ◀ or ▶ in the bar graph indicates that either a negative or positive over-range condition occurred during peak current measurement.
- After pressing the [HOLD] button, the display of multiple bars when you press ◀ or ▶ indicates that the total data up to the present.

(Setting range is up to 99 hours, 59 minutes, in minute steps)

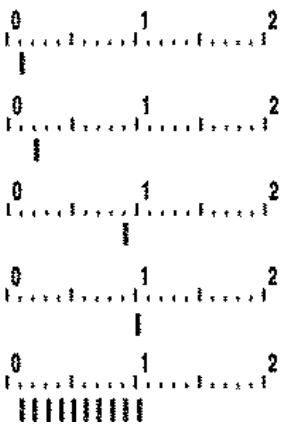


View Data History (After pressing HOLD button)

INTEG button: Integral and interval mean value

PEAK button: Peak, maximum and minimum values

RATE button: Duty and operating time



Data from first measurement

Data from second measurement

Data from ninth measurement

Data from tenth measurement

Total data
Total data from first through tenth measurements

Stored data for timer setting S and 20 repetitions is as follows.

DC Mode

	Data Item No.	1	2	...	20	total
INTEG Data	Total Integral (Ah)	$A_1(=B_1+C_1)$	$A_2(=B_2+C_2)$	$A_i(=B_i+C_i)$	$A_{20}(=B_{20}+C_{20})$	$\Sigma A_n(=\Sigma B_n+\Sigma C_n)$
	Positive Integral (Ah)	B_1	B_2	B_i	B_{20}	ΣB_n
	Negative Integral (Ah)	C_1	C_2	C_i	C_{20}	É×C_n
	Interval Mean Value (A)	$D_1(=A_1/S)$	$D_2(=A_2/S)$	$D_i(=A_i/S)$	$D_{20}(=A_{20}/S)$	$D_n(=\Sigma A_n/S)$
RATE Data	Duty (%)	$E_1(=F_1/S$ X 100)	$E_2(=F_2/S$ X 100)	$E_i(=F_i/S$ X 100)	$E_{20}(=F_{20}/S$ X 100)	$E_n(=\Sigma F_n/(20$ SÁjÁj
	Operating Time (h)	F_1	F_2	F_i	F_{20}	ΣF_n
	Current Threshold (A)	G	G	G	G	G
PEAK Data	Positive Peak Value (A)	H_1	H_2	H_i	H_{20}	H_n (MAX)
	Negative Peak Value (A)	I_1	I_2	I_i	I_{20}	I_n (MAX)

AC and AC+DC Modes

	Data Item No.	1	2	...	20	total
INTEG Data	Integral (Ah)	J_1	J_2	J_i	J_{20}	ΣJ_n
	Interval Mean Value (A)	$K_1(=J_1/S)$	$K_2(=J_2/S)$	$K_i(=J_i/S)$	$K_{20}(=J_{20}/S)$	$K_n(=\Sigma J_n/S)$
RATE Data	Duty (%)	$L_1(=M_1/S$ X 100)	$L_2(=M_2/S$ X 100)	$L_i(=M_i/S$ X 100)	$L_{20}(=M_{20}/S$ X 100)	$L_n(=\Sigma M_n/(20$ X S))
	Operating Time (h)	M_1	M_2	M_i	M_{20}	ΣM_n
	Current Threshold (A)	N	N	N	N	N
PEAK Data	Peak Value (A)	O_1	O_2	O_i	O_{20}	ΣO_n
	Maximum Value (A)	P_1	P_2	P_i	P_{20}	P_n (MAX)
	Minimum Value (A)	Q_1	Q_2	Q_i	Q_{20}	Q_n (MIN)

- The "Data Item No." is the data sequence number (indicated on the bar graph).
- Press the INTEG button to display the interval mean value, then press the ▶ button to advance through each Data Item (D1→D2→Di) so the values can be viewed.
- If the number of measurement repetitions has been set (for example, twice), press the INTEG button repeatedly to advance through the data in sequence (A2→B2→C2→D2).

5.7 Saving Data

Data that you want to view after measuring (when **TIME** is displayed) can be stored. (Data cannot be manually stored during measurement.) Settings are stored at the same time data is stored. However, because of the overwriting method employed, only one set of measurements can be stored (including the set of values of repeating measurements).
❖ See Section 5.8 "Saving Settings" (page 101)

1. With the meter turned on, press the HOLD button for about two seconds.
2. dAtA and SAvE are displayed, and the data is stored.

Storable Data (Batch Save)
- INTEG data (integral and interval mean value)
- RATE data (duty and operating time)
- PEAK data (peak, maximum and minimum values)

To Erase Stored Data

1. Hold the CLEAR button while pressing the POWER button to turn the meter on.
2. dAtA and clr are displayed, and the data is erased.

To Recall Stored Data

❖ See Section 5.9 "Recalling Stored Data" (page 102)

NOTE

Aside from this procedure, data is stored in the following cases:
- When INTEG or RATE data is being retained (**TIME** displayed), and when the meter is turned off by the auto power-off function.
- When the B indicator appears while using batteries, data is retained (**TIME** displayed), and the meter is turned off automatically by the low battery voltage detection function.
  ❖See Section 2.5 "Turning Power On and Off" (page 35)
- During integral or duty measurement, when the meter is turned off by the POWER button (however, if the meter is powered by the AC adapter or external power, data is not saved when the power supply is interrupted).

5.8 Saving Settings

A frequently used measurement mode can be set up and saved as the meter power-on default.
Other settings can also be saved (using the same overwriting procedure as for saving data).

1. With the meter turned on, set the desired measurement mode and range.
2. Press and hold the HOLD button for two seconds.
3. SAVE is displayed, and the settings are stored.

NOTE

- When **TIME** is displayed, because data is being retained, DATA and SAVE are displayed (data and settings are retained).
- If settings are saved after auto zero adjustment, the auto zero adjustment offset data is also saved. However, auto zero adjustment should always be performed before measuring with DC and AC+DC modes.
- Auto power-off and beeper settings can be saved. When the auto power-off function is enabled or the beeper is enabled, hold the CLEAR button while pressing the POWER button to turn the meter on.
- The results of automatic sensor recognition cannot be stored. The meter recognizes the connected clamp-on sensor whenever power is turned on.If using the 3290 after it has been repaired or recalibrated, the saved settings may have been deleted. Check that the settings saved prior to repair work are still valid before using the instrument; otherwise reset and re-save the settings as appropriate.
- If using the 3290 after it has been repaired or recalibrated, the saved settings may have been deleted. Check that the settings saved prior to repair work are still valid before using the instrument; otherwise reset and re-save the settings as appropriate.

To Return Settings to Factory Defaults

1. Hold the CLEAR button while pressing the POWER button to turn the meter on.
2. DATA and CLr are displayed.

The factory default settings are as follows:

Measurement mode	DC
Range	AUTO
Output Settings	None
Auto Power-Off	Enabled

5.9 Recalling Stored Data

Stored data can be recalled.

❖ See Section 5.7 "Saving Data" (page 100)

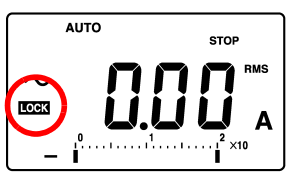
1. Hold the **SHIFT** button while pressing the POWER button to turn the meter on.
2. Stored data is recalled.
3. Verify the data.
   The procedure is the same as the second procedure in Section 5.6 "Viewing Historical Data" (page 97).

NOTE Measurement cannot be performed while using this function. To resume measuring, turn the meter off and back on.

5.10 Button Lock

This function locks (deactivates) buttons, including the POWER button, to prevent changing settings. The auto power-off function is disabled.

1. Press **SHIFT** → HOLD (**LOCK**).
2. **LOCK** is displayed, and the button lock function is enabled.



To Disable the Button Lock

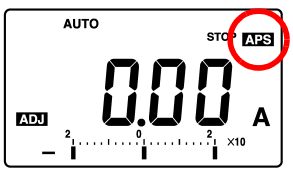
1. Press **SHIFT** → HOLD (**LOCK**).
2. **LOCK** is cleared from the display, and the button lock function is disabled.

5.11 Auto Power-off Enabled

When approximately 10 minutes have elapsed since the last button operation, the power to the 3290-10 is automatically turned off. This prevents the 3290-10 from being left on unintentionally and minimizes battery consumption.

When "APS" is displayed, the auto power off function is enabled. "APS" will start blinking and the beep tone will sound for approximately 30 seconds just before power is turned off.

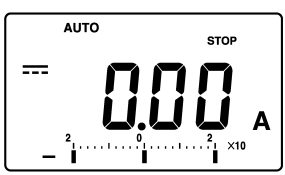
Press any button except the POWER button to extend operation by 10 minutes.



The Auto Power-off is Enabled

To Disable the Auto Power-Off Function

1. Hold the HOLD button while pressing the POWER button to turn the meter on.
2. The auto power-off function is disabled.



To enable the auto power-off function, turn the meter off and back on.

NOTE

When the auto power-off has been disabled and settings have been saved, the settings must first be returned to their factory defaults in order to re-enable auto power-off. Hold the CLEAR button while pressing the POWER button to turn the meter on.

❖ See Section 5.8 "Saving Settings" (page 101)

Auto power-off is disabled (APS not displayed) in the following cases:

- During integral and duty measurements
- While output is enabled
- After pressing SHIFT → HOLD (LOCK)

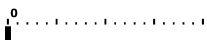
5.12 Battery Checking

This function indicates remaining battery charge on the bar graph.

1. Press **SHIFT** → PEAK (**B.CHECK**).
2. Battery charge condition (0, 25, 50, 75 or 100%) is indicated for about two seconds.

New battery


50% remaining charge


0% remaining charge
B is displayed, and three beeps sound.

100% indicates full battery charge, and 0% indicates empty batteries. In the 0% case, the B indicator (low-battery warning) is displayed.

NOTE

- Meter accuracy is not guaranteed when the B indicator is displayed. The batteries should be replaced immediately.
- When operating with the 9445-02 AC ADAPTER or external power, remaining battery charge is not displayed. If the B indicator is displayed while operating with external power, proper operation cannot be guaranteed.

5.13 Battery-Low Warning

If the unit is operated with very low battery power, accuracy cannot be guaranteed. When the battery-low warning indicator (B) appears, replace all batteries with new batteries.

NOTE

- Be aware that current measurement conditions which cause O.L. to be displayed also increase meter current consumption, resulting in shortened charge life when running on batteries.
- When the B indicator is displayed, MON output may fail to remain within the ± 3.5 V limits for L-range current measurement.
- Remaining battery charge can be viewed on the display immediately upon turning the meter on. It can also be viewed on the bar graph by pressing SHIFT → PEAK (B.CHECK). However, because the remaining battery charge indication is merely an approximation, careful attention is advisable during long-term measurements.
- If the meter is turned off when the B indicator is displayed, it may not reappear for some time after power is again turned on. This reflects the battery characteristic of slight voltage increase after a rest period. The B indicator will reappear soon, so the batteries should be replaced as soon as possible.
  ❖See Section 2.2.1 "Installing/ Changing the Batteries" (page 29)
- After the B indicator appears, continuing operation will cause bAtt and Lo to appear, and the meter will shut itself off.
  ❖See Section 2.5 "Turning Power On and Off" (page 35)

5.14 Beeper

The beeper normally beeps once when any button is pressed.

To Disable the Beeper

1. Hold the INTEG button while pressing the POWER button to turn the meter on.
2. The beeper is disabled.

To re-enable the beeper, press the POWER button to turn the meter off and back on.

NOTE When the beeper has been disabled and settings have been saved, the settings must first be returned to their factory defaults in order to re-enable the beeper. Hold the CLEAR button while pressing the POWER button to turn the meter on.
❖ See Section 5.8 "Saving Settings" (page 101)

Specifications 6

6.1 Measurement Specifications

Measurement items are as follows:

- DC
- AC
- AC+DC
- Hz (Frequency)
- Current Integral
- Duty (Percentage) and Operating Time

6.1.1 Current Measurement

Current Ranges

The meter automatically recognizes the sensor capabilities at the time of connection (maximum continuous measuring range and maximum peak current value for the particular sensor).
Range selection methods consist of auto ranging, and L and H manual ranges.

Connected Sensor	Standard Measurement			Peak Measurement		
	Range	Resolution	Maximum Displayed	Range	Resolution	Maximum Displayed
Model CT9691 (9691)	20 A	0.01 A	25.00 A	20 A	0.1 A	50.0 A
	200 A	0.1 A	105.0 A	200 A	0.1 A	150.0 A
Model CT9692 (9692)	20 A	0.01 A	25.00 A	20 A	0.1 A	50.0 A
	200 A	0.1 A	210.0 A	200 A	0.1 A	300.0 A
Model CT9693 (9693)	200 A	0.1 A	250.0 A	200 A	1 A	500 A
	2000 A	1 A	2100 A	2000 A	1 A	3000 A

Measurement Sampling

- DC Mode
  10 samples/second (alternating polarities five times per second)
- AC and AC+DC Modes
  10 samples/second

Measurement Response Time

In AC and AC+DC modes, when the measured value changes from 0%→90% or from 100%→10% of the range, some time is required for the analog output value to stabilize.
FAST (0.2 s) : Specifications satisfied at 45 Hz and above
NORMAL (0.8 s) : Specifications satisfied at 10 Hz and above
SLOW (8.0 s) : Specifications satisfied at 1 Hz and above

Function

- Peak Measurement
  DC Mode: Both positive and negative polarities displayed
  AC and AC+DC Modes: Absolute value display
- Maximum/Minimum Value Measurement
  (AC and AC+DC modes only)
  Maximum and minimum current measurement values are retained
- Outputs
  OUT1: Selectable MON or REC output (only MON in DC mode)
  Output Rate: 2 V/range

Accuracy

- Auto zero adjustment must be performed before measuring in DC and AC+DC modes
- Measurement response times are FAST, NORMAL and SLOW
- When the 550-Hz LPF is enabled, specifications are satisfied at 60 Hz and below

❖ See "Display Accuracy" (page 109)
❖ See "REC Output Accuracy (2 V/range)" (page 109)
❖ See "MON Output Accuracy (2 V/range)" (page 109)
❖ See "Peak Display Accuracy (Peak hold function)" (page 109)

Display Accuracy

± (rdg.+dgt.)

		DC	1 ≤ f < 10 (Hz)	10 <f < 45 (Hz)	45 ≤ f ≤ 66 (Hz)	66 ≤ f ≤ 1 k(Hz)
DC		± (0.3%+5)	--	--	--	--
AC AC+DC	FAST	± (0.3%+7) (AC+DC only)			± (0.3%+3)	± (0.3%+3)
	NORMAL			± (0.3%+3)		
	SLOW		± (1.0%+3) (AC+DC only)			

REC Output Accuracy (2 V/range)

± (rdg.+mV)

		DC	1 ≤ f < 10 (Hz)	10 <f < 45 (Hz)	45 ≤ f ≤ 66 (Hz)	66 ≤ f ≤ 1 k(Hz)
AC+DC	FAST	± (0.8%+10) (AC+DC only)	--	--	± (0.8%+5)	± (0.8%+5)
	NORMAL			± (0.8%+5)		
	SLOW		± (1.3%+5) (AC+DC only)			

MON Output Accuracy (2 V/range)

± (rdg.+mV)

	DC	1 ≤ f < 10 (Hz)	10 <f < 45 (Hz)	45 ≤ f ≤ 66 (Hz)	66 ≤ f ≤ 1 k(Hz)
DC AC+DC	± (0.3%+5)	± (0.3%+5)	± (0.3%+5)	± (0.3%+5)	± (0.3%+5)
AC	--	--			

Peak Display Accuracy (Peak hold function)

L Range

± (rdg.+dgt.)

	DC	1 ≤ f < 10 (Hz)	10 <f < 45 (Hz)	45 ≤ f ≤ 66 (Hz)	66 ≤ f ≤ 1 k(Hz)
DC AC+DC	± (0.5%+2)	± (0.5%+2)	± (0.5%+2)	± (0.5%+2)	± (0.5%+2)
AC	--	--			

H Range

± (rdg.+dgt.)

	DC	1 ≤ f < 10 (Hz)	10 <f < 45 (Hz)	45 ≤ f ≤ 66 (Hz)	66 ≤ f ≤ 1 k(Hz)
DC AC+DC	± (0.5%+5)	± (0.5%+5)	± (0.5%+5)	± (0.5%+5)	± (0.5%+5)
AC	--	--			

When sine waves are continuously input after peak reset

6.1.2 Frequency Measurement

Frequency Ranges	Range is selected automatically (Internal Ranges: 10.00, 100.0 and 1000 Hz)
Accuracy	• When input is 5% or larger of the current range

DIsplay Accuracy ± (rdg.+dgt.)

Range (Accuracy Range)	Resolution	Maximum Display	
10 Hz (1.00 to 12.50 Hz)	0.01 Hz	12.50 Hz	± (0.3%+1)
100 Hz (10.0 to 125.0 Hz)	0.1 Hz	125.0 Hz	
1000 Hz (100 to 1000 Hz)	1 Hz	1000 Hz	± (1.0%+1)

6.1.3 Current Integral Measurement

Integral Ranges	Range selections are auto ranging or manual (6 ranges) ❖ See "Integral Range Table" (page 111)
Measurement Process	Calculated from current measurement values
Measurement Sampling	Same as current measurement
Measurement Ranges	Model CT9691 (9691): 0 to ± 210.0 kAh Model CT9692 (9692): 0 to ± 420.0 kAh Model CT9693 (9693): 0 to ± 4200 kAh
Valid Input Range	Limited by current measurement
Function	• Polarity-independent integration (total, positive and negative) • Integration start, stop and data clear (button operations) • Integration stop by timer (setting from 1 min to 99 hours and 59 min, in minute steps) • Repeating timer measurements (1 to 20 times) • Integrating elapsed time display (0 minutes to 2000 hours) • Cumulative integration by repeating start and stop Integration interval mean value display (= total integral value / integrating time) When integral data is retained (**TIME** displayed), the data is saved upon auto power-off Data saving when battery charge is depleted • Data saving (overwriting method) by holding the HOLD button for two seconds • View repeating measurement historical data • Output OUT2: selectable from total, positive and negative integrals (fixed in AC and AC+DC modes) Output rate is 1 V/range (0.5 mV output for each five display counts: 12-bit D/A output, output refresh is the same as the display update rate)
Accuracy	• Integral Measurement (total, positive and negative integrals) • Display accuracy Current measurement accuracy ±1 dgt. • Output accuracy Display accuracy ± 2 mV • Measurement timing accuracy Within ± 0.2 s per hour (23°C/73°F)

Integral Range Table

	Current Rage	Integral Range						
Model CT9691 (9691)	20 A	10.000 Ah	100.00 Ah	1000.0 Ah	10.000 kAh	100.00 kAh	--	--
	200 A	--	100.00 Ah	1000.0 Ah	10.000 kAh	100.00 kAh	1000.0 kAh	--
Model CT9692 (9692)	20 A	10.000 Ah	100.00 Ah	1000.0 Ah	10.000 kAh	100.00 kAh	--	--
	200 A	--	100.00 Ah	1000.0 Ah	10.000 kAh	100.00 kAh	1000.0 kAh	--
Model CT9693 (9693)	200 A	--	100.00 Ah	1000.0 Ah	10.000 kAh	100.00 kAh	1000.0 kAh	--
	2000 A	--	--	1000.0 Ah	10.000 kAh	100.00 kAh	1000.0 kAh	10000 kAh

6.1.4 Duty Measurement

Measurement method	Calculated from measured current and measurement time
Measurement sampling	Same as current measurement
Valid input range	Determined by current measurement
Function	• Operating time Operating time is the amount of time during which the measured current exceeds the specified current threshold • Duty Operating time / measurement time X 100 (%) • Current threshold setting (minimum setting is 5 counts) Measurement start, stop and data clear (button operations) • Measurement stop by timer (setting from 1 min to 99 hours and 59 min, in minute steps) • Repeating timer measurements (1 to 20 times) • Elapsed time display (0 minutes to 2000 hours) • Continuous measurement by repeating start and stop • When measurement data is retained (**TIME** displayed), the data is saved upon auto power-off • Data saving when battery charge is depleted • Data saving (overwriting) by holding the HOLD button for two seconds • View repeating measurement historical data • Recall stored data
Accuracy	• Duty and Operating Time Not regulated • Measurement timer accuracy within ± 0.2 s per hour (23°C/73°F)

6.2 General Specifications

Functions

Auto zero adjustment	Press the **SHIFT** → [CLEAR] buttons to perform auto zero adjustment (in DC and AC+DC modes).
Data hold	Press the [HOLD] button to retain the current value on the display.
Filter switching	LPF toggled by **SHIFT** → [RANGE] buttons • In DC mode, with MON output setting MON output of 1 Hz passes through LPF from OUT1 • In AC and AC+DC modes Filter characteristic is -3 dB at 550 Hz ±10% (display and output)
Setting the save function	Hold down the [HOLD] button (for more than 2 sec.) to save the current settings. To initialize, hold down the [CLEAR] button and turn on the [POWER] button.
Button lock	Press the **SHIFT** → [HOLD] buttons to lock the buttons. Press the same buttons again to unlock the buttons.
Battery check	Press the **SHIFT** → [PEAK] buttons to check the remaining battery power.
Auto power-off	Automatic shutdown occurs after 10.5 ± 1 minutes. A beep tone warning sounds before shutdown. You can extend the time or disable the function (by holding down the [HOLD] button and turning power on).
Beep tone	ON/OFF (Holding down the [INTEG] button and turning power on switches off the beep sound.)

Display

- Liquid crystal display (LCD)
- Digital counter
  Max. 3000 counts (current)
  Max. 3000 counts (peak current)
  Max. 1250 counts (frequency)
  Max. 9999 counts (integration)
  Max. 1000 counts (duty)
- Bar graph display
  21 segments
- Over-range
  O.L. is indicated by ◀ / ▶ on the bar graph when a measurement exceeds the full scale of the range or the maximum displayable peak value
- Low battery warning
  B goes on (during which time accuracy cannot be guaranteed).
- Data hold indicator
  HOLD
- Auto power-off active indicator
  APS
- Units
  A, Hz, and Ah
- Zero suppression
  5 counts (current measurement and peak current measurement)

Display update rate (at 23°C/73°F)

- Digital counter

DC Mode	--	1 s ± 0.1 ms (approx. once/second)
AC and AC+DC Modes	NORMAL	500 ms ± 0.05 ms (approx. twice/second)
	SLOW	3 s ± 0.3 ms (approx. once/3 seconds)
	FAST	100 ms ± 0.01 ms (approx. ten times/second)
Hz Mode	--	500 ms ± 0.05 ms (approx. twice/second)

- Bar graph display

DC Mode	200 ms ± 0.02 ms (approx. five times/second)
AC and AC+DC Modes	100 ms ± 0.01 ms (approx. ten times/second)
Hz Mode	100 ms ± 0.01 ms (approx. ten times/second)

Circuit dynamic characteristics (crest factor)
Max. 2.5
(The upper limit of H range is the maximum peak current of the sensor connected. The maximum output voltage of L range is 3.5 V.)

Output impedance
100 Ω or less

Temperature characteristics
0 to 40°C range: 0.1 x accuracy specifications/°C
(32 to 104°F range: 0.18 x accuracy specifications/°F)

Location for use
Indoor, altitude up to 2000 m (6566 feet)

Temperature characteristics	0 to 40°C range: 0.1 x accuracy specifications/°C (32 to 104°F range: 0.18 x accuracy specifications/°F)
Location for use	Indoor, altitude up to 2000 m (6566 feet)
Operating temperature and humidity range	0 to 40°C (32 to 104°F), 80% RH or less (no condensation)
Storage temperature and humidity	-10 to 50°C (14 to 122°F), 80% RH or less (no condensation)
Operating temperature and humidity for guaranteed accuracy Guaranteed accuracy period	23 ± 5°C (73 ± 9°F), 80% RH or less (no condensation) For one year
Power supply	Four type LR6 ("AA") 1.5 V batteries, optional AC adapter or +8.4 to 15.6 V DC external power
Maximum rated power	1.2 VA (with AC adapter and sensor connected) 500 mVA (with batteries and sensor connected)
Battery life	Approx. 22 hours (continuous, no load, with a sensor connected)
Effect of conducted radio-frequency electromagnetic field	At 3 V, 10% f.s. or less of L range
Dimensions	Approx. 155W x 98H x 47D mm (Approx. 6.10"W x 3.86"H x 1.85"D, excluding protruding parts)
Mass	Approx. 545 g (Approx. 19.2 oz., including batteries)
Accessories	Strap ..... 1 LR6 batteries ..... 4 Instruction manual 1
Options	Model 9445-02 AC ADAPTER Model 9445-03 AC ADAPTER Model 9094 OUTPUT CORD Model 9400 CARRYING CASE Model CT9691 (9691) CLAMP ON AC/DC SENSOR Model CT9692 (9692) CLAMP ON AC/DC SENSOR Model CT9693 (9693) CLAMP ON AC/DC SENSOR
Applying standards	Safety EN61010 EMC EN61326 EN61000-3-2 EN61000-3-3

6.3 CLAMP ON AC/DC SENSOR Specifications

6.3.1 Model CT9691 (9691) CLAMP ON AC/DC SENSOR

Rated current	AC/DC 100 A
Output voltage	AC/DC 1 V /100 A
Maximum permissible input (rms)	100 A continuous (Derating according to frequency)
Maximum peak current value	150 A peak
Continuous input	❖ See "Continuous Input" (page 117)
Peak input	❖ See "Peak Input" (page 117)
Frequency band	DC to 10 kHz (-3dB)
Effect of conductor position	Within ± 1.0% (at 80 A (55 Hz))
Effect of external electromagnetic field	0.5 A equivalent or less (in an external electromagnetic field of 400 A/m)
Temperature characteristics	0 to 40°C range: 0.1 x accuracy specifications/°C 32 to 104°F range: 0.18 x accuracy specifications/°F
Location for use	Indoor, altitude up to 2000 m (6566 feet)
Operating temperature and humidity range	0 to 40°C (32 to 104°F), 80% RH or less (no condensation)
Storage temperature and humidity	-10 to 50°C (14 to 122°F), 80% RH or less (no condensation)
Operating temperature and humidity for guaranteed accuracy	23 ± 5°C (73 ± 9°F), 80% RH or less (no condensation)
Guaranteed accuracy period	For one year (Opening and closing of the sensor: 10,000 times)
Maximum permitted circuit voltage	600 V
Dielectric strength	5.55 kV AC for 1 minute (sensor - case, sensor - circuit)
Maximum rated power	50 mVA
Measurable conductor diameter	35 mm (1.38") or less

Dimensions	Approx. 53W X 129H X 18D mm (Approx. 2.09"W X 5.08"H X 0.71"D)	
Mass	Approx. 230 g (8.1 oz.)	
Cable length	Approx. 2 m (6.5 feet)	
Accessory	Instruction manual..... 1	
Applying standards	Safety	EN61010 Measurement categories III (Anticipated Transient Overvoltage: 6000 V) Pollution Degree 2
	EMC	EN61326

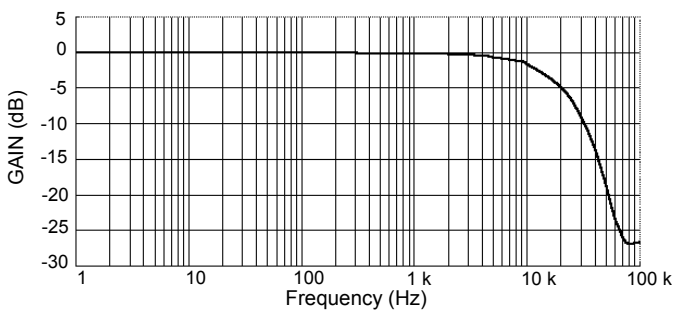
Continuous Input

Range	DC	DC < f ≤ 66 (Hz)	66 < f ≤ 500 (Hz)
I ≤ 80 (A)	± 1.0%rdg. ± 0.5 mV	± 1.0%rdg. ± 0.5 mV	± 2.0%rdg. ± 0.5 mV
80 I ≤ 100 (A)			± 2.5%rdg. ± 0.5 mV

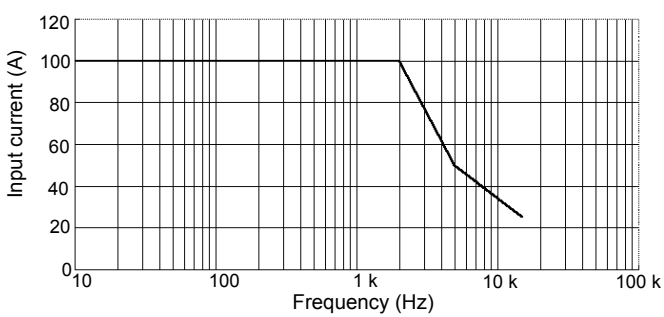
Peak Input (only available for 3290 or 3290-10)

Range	DC	DC < f ≤ 66 (Hz)	66 < f ≤ 500 (Hz)
|Ipeak| ≤ 110 (Apeak)	± 1.0%rdg. ± 2 mV	± 1.0%rdg. ± 2 mV	± 2.0%rdg. ± 2 mV
110 <|Ipeak| ≤ 150 (Apeak)			± 2.5%rdg. ± 2 mV

Model CT9691 (Equivalent to 9691) Frequency Characteristics



Model CT9691 (Equivalent to 9691) Derating According to Frequency



6.3.2 Model CT9692 (9692) CLAMP ON AC/DC SENSOR

Rated current	AC/DC 200 A
Output voltage	AC/DC 2 V/ 200 A
Maximum permissible input (rms)	200 A continuous (Derating according to frequency)
Maximum peak current value	300 A peak
Continuous input	❖ See "Continuous Input" (page 119)
Peak input	❖ See "Peak Input" (page 119)
Frequency band	DC to 20 kHz (-3dB)
Effect of conductor position	Within ± 0.5%
Effect of external electromagnetic field	0.7 A equivalent or less (in an external electromagnetic field of 400 A/m)
Temperature characteristics	0 to 40°C range: 0.1 x accuracy specifications/°C 32 to 104°F range: 0.18 x accuracy specifications/°F
Location for use	Indoor, altitude up to 2000 m (6566 feet)
Operating temperature and humidity range	0 to 40°C (32 to 104°F), 80% RH or less (no condensation)
Storage temperature and humidity	-10 to 50°C (14 to 122°F), 80% RH or less (no condensation)
Operating temperature and humidity for guaranteed accuracy	23 ± 5°C (73 ± 9°F), 80% RH or less (no condensation)
Guaranteed accuracy period	For one year (Opening and closing of the sensor: 10,000 times)
Maximum permitted circuit voltage	600 V
Dielectric strength	5.55 kV AC for 1 minute (sensor - case, sensor - circuit)
Maximum rated power	50 mVA
Measurable conductor diameter	33 mm (1.30") or less
Dimensions	Approx. 62W x 167H x 35D mm (Approx. 2.44"W x 6.57"H x 1.38"D)
Mass	Approx. 410 g (14.5 oz.)
Cable length	Approx. 2 m (6.5 feet)

Accessory	Instruction manual..... 1	
Applying standards	Safety	EN61010 Measurement categories III (Anticipated Transient Overvoltage: 6000 V) Pollution Degree 2
	EMC	EN61326

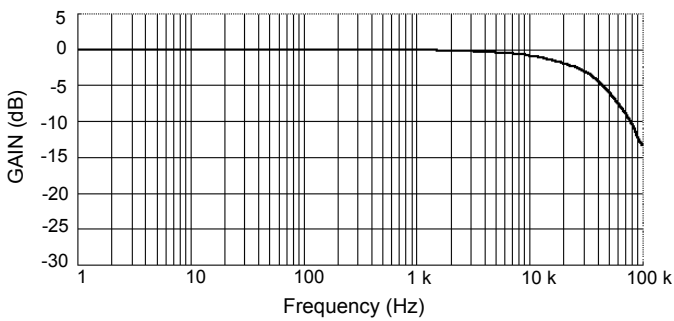
Continuous Input

Range	DC	DC < f ≤ 66 (Hz)	66 < f ≤ 1 k(Hz)
I ≤ 200 (A)	± 1.0%rdg. ± 0.5 mV	± 1.0%rdg. ± 0.5 mV	± 2.0%rdg. ± 0.5 mV

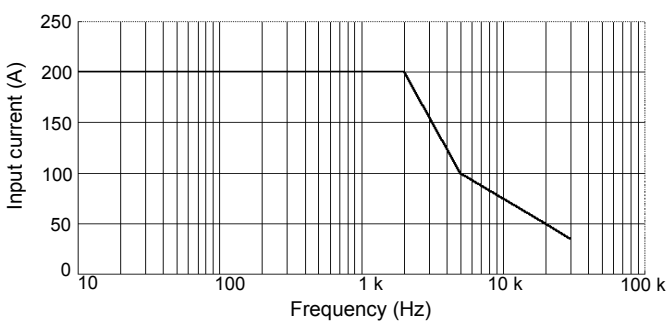
Peak Input (only available for 3290 or 3290-10)

Range	DC	DC < f ≤ 66 (Hz)	66 < f ≤ 1 k(Hz)
|Ipeak| ≤ 300 (Apeak)	± 1.0%rdg. ± 2 mV	± 1.0%rdg. ± 2 mV	± 2.0%rdg. ± 2 mV

Model CT9692 (Equivalent to model 9692) Frequency Characteristics



Model CT9692 (Equivalent to model 9692) Derating According to Frequency



6.3.3 Model CT9693 (9693) CLAMP ON AC/DC SENSOR

Rated current	AC/DC 2000 A
Output voltage	AC/DC 2 V/ 2000 A
Maximum permissible input (rms)	2000 A (Derating according to frequency)
Maximum peak current value	2840 A peak
Continuous input	❖ See "Continuous Input" (page 121)
Peak input	❖ See "Peak Input" (page 121)
Frequency band	DC to 15 kHz (-3dB)
Effect of conductor position	Within ± 0.7%
Effect of external electromagnetic field	2.0 A equivalent or less (in an external electromagnetic field of 400 A/m)
Temperature characteristics	0 to 40°C range: 0.1 x accuracy specifications/°C 32 to 104°F range: 0.18 x accuracy specifications/°F
Location for use	Indoor, altitude up to 2000 m (6566 feet)
Operating temperature and humidity range	0 to 40°C (32 to 104°F), 80% RH or less (no condensation)
Storage temperature and humidity	-10 to 50°C (14 to 122°F), 80% RH or less (no condensation)
Operating temperature and humidity for guaranteed accuracy	23 ± 5°C (73 ± 9°F), 80% RH or less (no condensation)
Guaranteed accuracy period	For one year (Opening and closing of the sensor: 10,000 times)
Maximum permitted circuit voltage	600 V
Dielectric strength	5.55 kV AC for 1 minute (sensor - case, sensor - circuit)
Maximum rated power	50 mVA
Measurable conductor diameter	55 mm (2.17") or less
Dimensions	Approx. 62W x 196H x 35D mm (Approx. 2.44"W x 7.72"H x 1.38"D)
Mass	Approx. 500 g (17.6 oz.)
Cable length	Approx. 2 m (6.5 feet)

Accessory	Instruction manual..... 1	
Applying standards	Safety	EN61010 Measurement categories III (Anticipated Transient Overvoltage: 6000 V) Pollution Degree 2
	EMC	EN61326

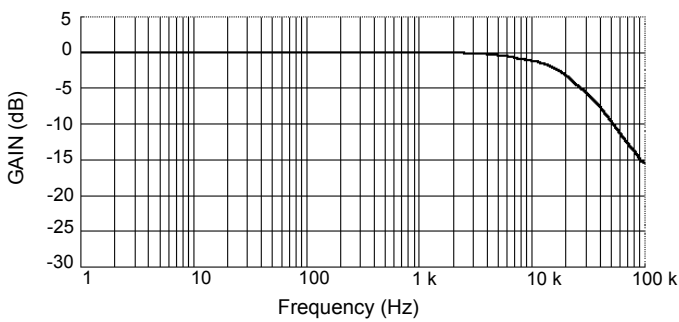
Continuous Input

Range	DC	45 ≤ f ≤ 66 (Hz)	DC < f < 45, 66< f ≤1k (Hz)
I ≤ 1800 (A)	± 1.5%rdg. ± 0.5 mV	± 1.0%rdg. ± 0.5 mV	± 2.0%rdg. ± 0.5 mV
1800 < I ≤ 2000 (A)		± 2.0%rdg. ± 0.5 mV	--

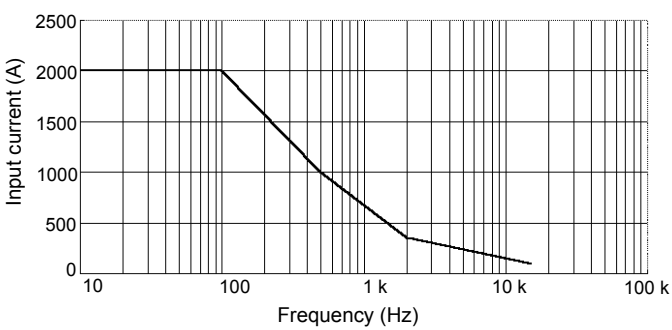
Peak Input (only available for 3290 or 3290-10)

Range	DC	45 ≤ f ≤ 66 (Hz)	DC < f < 45, 66< f ≤1k (Hz)
|Ipeak| ≤ 2300 (Apeak)	± 1.5%rdg. ± 2 mV	± 1.0%rdg. ± 2 mV	± 2.0%rdg. ± 2 mV
2300 <|Ipeak|≤ 2840 (Apeak)	± 6.0%rdg. ± 2 mV	± 6.0%rdg. ± 2 mV	--

Model CT9693 (Equivalent to model 9693) Frequency characteris



Model CT9693 (Equivalent to model 9693) Derating according to frequency



6.4 Combined Accuracy

This section shows the accuracy tables when the 3290-10 is combined with the CT9691 (9691), CT9692 (9692), or CT9693 (9693), and describes the method of calculation.

6.4.1 Models CT9691 (9691) + 3290-10 Combined Accuracy

Display Accuracy

± (%rdg.+A)

			DC	1 ≤ f < 10 (Hz)	10 ≤ f ≤ 66 (Hz)	66 < f ≤ 500 (Hz)
L	DC		1.3%+0.10 A	--		
	AC+DC		1.3%+0.12 A	2.0%+0.08 A	1.3%+0.08 A	2.3%+0.08 A
	AC		--			
H	DC		1.3%+0.5 A	--		
	AC+DC	to 80 A	1.3%+0.7 A	2.0%+0.3 A	1.3%+0.3 A	2.3%+0.3 A
		80 to 100 A				2.8%+0.3 A
	AC	to 80 A	--			2.3%+0.3 A
		80 to 100 A				2.8%+0.3 A

REC Output Accuracy

± (%rdg.+mV)

			DC	1 ≤ f < 10 (Hz)	10 ≤ f ≤ 66 (Hz)	66 < f ≤ 500 (Hz)
L	AC+DC		1.8%+15 mV	2.3%+10 mV	1.8%+10 mV	2.8%+10 mV
	AC		--			
H	AC+DC	to 80 A	1.8%+10.5 mV	2.3%+5.5 mV	1.8%+5.5 mV	2.8%+5.5 mV
		80 to 100 A				3.3%+5.5 mV
	AC	to 80 A	--			2.8%+5.5 mV
		80 to 100 A				3.3%+5.5 mV

MON Output Accuracy

± (%rdg.+mV)

			DC	1 ≤ f < 10 (Hz)	10 ≤ f ≤ 66 (Hz)	66 < f ≤ 500 (Hz)
L	DC			--		
	AC+DC		1.3%+10 mV			2.3%+10 mV
	AC		--			
H	DC			--		
	AC+DC	to 80 A	1.3%+5.5 mV			2.3%+5.5 mV
		80 to 100 A				2.8%+5.5 mV
	AC	to 80 A	--			2.3%+5.5 mV
		80 to 100 A				2.8%+5.5 mV

Peak Display Accuracy

± (%rdg.+A)

			DC	1 ≤ f < 10 (Hz)	10 ≤ f ≤ 66 (Hz)	66 < f ≤ 500 (Hz)
L	DC			--		
	AC+DC		1.5%+0.4 A			2.5%+0.4A
	AC		--			
H	DC			--		
	AC+DC	to 110 A	1.5%+0.7 A			2.5%+0.7 A
		110 to 150 A				3.0%+0.7 A
	AC	to 110 A	--			2.5%+0.7 A
		110 to 150 A				3.0%+0.7 A

6.4.2 Model CT9692 (9692) + 3290-10 Combined Accuracy

Display Accuracy

± (%rdg.+A)

		DC	1 ≤ f < 10 (Hz)	10 ≤ f ≤ 66 (Hz)	66 < f ≤ 1k (Hz)
L	DC	1.3%+0.10 A	--		
	AC+DC	1.3%+0.12 A	2.0%+0.08 A	1.3%+0.08 A	2.3%+0.08 A
	AC	--			
H	DC	1.3%+0.5 A	--		
	AC+DC	1.3%+0.7 A	2.0%+0.3 A	1.3%+0.3 A	2.3%+0.3 A
	AC	--			

REC Output Accuracy

± (%rdg.+mV)

		DC	1 ≤ f < 10 (Hz)	10 ≤ f ≤ 66 (Hz)	66 < f ≤ 1k (Hz)
L	AC+DC	1.8%+15 mV	2.3%+10 mV	1.8%+10 mV	2.8%+10 mV
	AC	--			
H	AC+DC	1.8%+10.5 mV	2.3%+5.5 mV	1.8%+5.5 mV	2.8%+5.5 mV
	AC	--			

MON Output Accuracy

± (%rdg.+mV)

		DC	1 ≤ f < 10 (Hz)	10 ≤ f ≤ 66 (Hz)	66 < f ≤ 1k (Hz)
L	DC		--		
	AC+DC	1.3%+10 mV			2.3%+10 mV
	AC	--			
H	DC		--		
	AC+DC	1.3%+5.5 mV			2.3%+5.5 mV
	AC	--			

Peak Display Accuracy

± (%rdg.+A)

		DC	1 ≤ f < 10 (Hz)	10 ≤ f ≤ 66 (Hz)	66 < f ≤ 1k (Hz)
L	DC		--		
	AC+DC	1.5%+0.4 A			2.5%+0.4A
	AC	--			
H	DC		--		
	AC+DC	1.5%+0.7 A			2.5%+0.7A
	AC	--			

6.4.3 Model CT9693 (9693) + 3290-10 Combined Accuracy

Display Accuracy

± (%rdg.+A)

			DC	1 ≤ f < 10 (Hz)	10 ≤ f < 45 (Hz)	45 ≤ f ≤ 66 (Hz)	66 < f ≤ 1k (Hz)
L	DC		1.8%+1.0 A	--			
	AC+DC		1.8%+1.2 A	3.0%+0.8 A	2.3%+0.8 A	1.3%+0.8 A	2.3%+0.8 A
	AC		--				
H	DC		1.8%+5 A	--			
	AC+DC	to 1800 A	1.8%+7 A	3.0%+3 A	2.3%+3 A	1.3%+3 A	2.3%+3 A
		1800 to 2000 A				2.3%+3 A	--
	AC	to 1800 A		--	2.3%+3 A	1.3%+3 A	2.3%+3 A
		1800 to 2000 A				2.3%+3 A	--

REC Output Accuracy

± (%rdg.+mV)

			DC	1 ≤ f < 10 (Hz)	10 ≤ f < 45 (Hz)	45 ≤ f ≤ 66 (Hz)	66 < f ≤ 1k (Hz)
L	AC+DC		2.3%+15 mV	3.3%+10 mV	2.8%+10 mV	1.8%+10 mV	2.8%+10 mV
	AC		--				
H	AC+DC	to 1800 A	2.3%+10.5 mV	3.3%+5.5 mV	2.8%+5.5 mV	1.8%+5.5 mV	2.8%+5.5 mV
		1800 to 2000 A				2.8%+5.5 mV	--
	AC	to 1800 A		--	2.8%+5.5 mV	1.8%+5.5 mV	2.8%+5.5 mV
		1800 to 2000 A				2.8%+5.5 mV	--

MON Output Accuracy

± (%rdg.+mV)

			DC	1 ≤ f < 10 (Hz)	10 ≤ f < 45 (Hz)	45 ≤ f ≤ 66 (Hz)	66 < f ≤ 1k (Hz)
L	DC		1.8%+10 mV	--			
	AC+DC			2.3%+10 mV		1.3%+10 mV	2.3%+10 mV
	AC		--				
H	DC		1.8%+5.5 mV	--			
	AC+DC	to 1800 A		2.3%+5.5 mV		1.3%+5.5 mV	2.3%+5.5 mV
		1800 to 2000 A				2.3%+5.5 mV	--
	AC	to 1800 A		--	2.3%+5.5 mV	1.3%+5.5 mV	2.3%+5.5 mV
		1800 to 2000 A				2.3%+5.5 mV	--

Peak Display Accuracy

± (%rdg.+A)

			DC	1 ≤ f < 10 (Hz)	10 ≤ f < 45 (Hz)	45 ≤ f ≤ 66 (Hz)	66 < f ≤ 1k (Hz)
L	DC		2.0%+4 A	--			
	AC+DC		2.0%+4 A	2.5%+4 A	2.5%+4 A	2.0%+4 A	2.5%+4 A
	AC		--		2.5%+4 A	2.0%+4 A	2.5%+4 A
H	DC	to 2300 A	2.0%+7 A	--			
		2300 A to	6.5%+7 A	--			
	AC+DC	to 2300 A	2.0%+7 A	2.5%+7 A	2.5%+7 A	2.0%+7 A	2.5%+7 A
		2300 A to	6.5%+7 A			6.5%+7 A	--
	AC	to 2300 A	--		2.5%+7 A	2.0%+7 A	2.5%+7 A
		2300 A to				6.5%+7 A	--

6.4.4 Method of Calculation

This section describes the method of calculation by assuming that measurement is performed in AC A mode using the CT9692 (9692).

Total error when displayed value is 160.0 A (60 Hz)

Total error = ± (1.3%rdg. + 0.3 A) *1
= ± (2.08 A + 0.3 A) *2
= ± 2.3 A
True value when 160.0 A is shown: 157.5 A to 162.3 A

*1 See the accuracy at 10 to 66 Hz in AC mode for H range in the CT9692 (9692)+3290-10 combined display accuracy table on page 124.
*2 rdg. error = 160 A x 1.3%

Total error when REC output is 1.2 V (60 Hz) (for L range)

Total error = ± (1.8%rdg. +10 mV) *3
= ± (21.6 mV+10 mV) *4
= ± 31.6 mV
True value of 1.2 V output: 1.1684 V to 1.2316 V
(11.684 A to 12.316 A in terms of current)

*3 See the REC Output Accuracy at 10 to 66 Hz in AC mode for L range in the CT9692 (9692)+3290-10 combined REC output accuracy table on page 124.
*4 rdg. error = 1.2 V x 1.8%

Maintenance and Service 7

⚠CAUTION

- Calibration and repair of this meter should be performed only under the supervision of qualified technicians knowledgeable about the dangers involved.
- If the protective functions of the meter are damaged, either remove it from service or mark it clearly so that others do not use it inadvertently.

NOTE To avoid corrosion from battery leakage, remove the batteries from the meter if it is to be stored for a long time.

7.1 Cleaning

- To clean the meter, wipe it gently with a soft cloth moistened with water or mild detergent. Never use solvents such as benzene, alcohol, acetone, ether, ketones, thinners or gasoline, as they can deform and discolor the case.
- Wipe the LCD gently with a soft, dry cloth.

⚠CAUTION

Measurements are degraded by dirt on the mating surfaces of the clamp-on sensor, so keep the surfaces clean by gently wiping with a soft cloth.

7.2 Repair and Servicing

- If damage is suspected, check the "Troubleshooting" section before contacting your dealer or Hioki representative.
- If uncertain whether the problem can be attributed to the 3290-10 or clamp sensor, request that both be repaired.
- The minimum stocking period for replacement parts is five years after end of production.
- When transporting the meter, use the original packing materials in which it was shipped, and pack in a double carton. Damage occurring during transportation is not covered by warranty.
  Pack the meter so that it will not sustain damage during shipping, and include a description of existing damage. We cannot accept responsibility for damage incurred during shipping.

Troubleshooting

If problems are encountered with operation, check the appropriate items below.

Symptom	Items to Check
• Meter does not turn on • Meter turns off during use	**When using AC adapter**
	• Is the AC adapter plug securely inserted into the jack, and the power cord into the outlet? • Is the AC adapter the specified Model 9445-02? • Does the meter turn on when only the batteries and not when the AC adapter is connected? The AC adapter may be faulty. ❖ See Section 2.2.2 "Connecting the AC Adapter (Optional)" (page 30)
	When using external power
	• Is the external power plug inserted all the way into the jack? • Is the external power cable connected to the power source? • Is the polarity correct? • Is the external supply voltage between 8.4 and 15.6 V, and capable of providing at least 1.2 VA? ❖ See Section 2.2.3 "Using External Power" (page 31)
	When using batteries
	• Are the batteries discharged? Replace if discharged. • Have the batteries passed their expiration date? Even if batteries have not been used, they may be unusable because of reduced capacity as a result of self discharge. • Are the battery contacts damaged or corroded? ❖ See Section 2.2.1 "Installing/ Changing the Batteries" (page 29)
• B indicator displayed • Meter turns off immediately after B indicator appears	**When using batteries**
	• Are the batteries discharged? Replace if discharged. ❖ See Section 2.2.1 "Installing/ Changing the Batteries" (page 29) and Section 5.13 "Battery-Low Warning" (page 105)
• Button presses are not accepted	• Is integration, duty measurement or data saving in progress? (**START** and **TIME** displayed) Button presses are not accepted during these processes. ❖ See pages 78 and 88 • When S is displayed (after pressing the **SHIFT** button), some buttons are ignored.
• Displayed numbers appear alternating	• Pressing the TIME button causes the timer and repetitions settings to display alternately once per second. ❖ See page 15

Symptom	Items to Check
• Display does not return to zero	• Occurs after switching to peak measurement or changing range? Always press CLEAR button to clear data after switching to peak measurement or changing range. ❖ See "Starting Measurement" (page 65)
	• Is the DC or AC+DC mode selected? Perform auto zero adjustment with 0 A measurement signal. • Is the auto zero adjustment range exceeded? Range is about ± 450 dgt. in L range, and ± 45 dgt. in H range.If the range is exceeded, the clamp-on sensor may need to be repaired. ❖ See Section 5.1 "Auto Zero Adjustment Function" (page 89)
	• Is the display update rate set to SLOW? If so, the display may not return to zero immediately. ❖ See Section 5.2 "Display Update Rate" (page 90)
• Displayed values seem too low	**Current Measurement**
	• Are the tips of the clamp-on sensor in good condition? • Does the clamp-on sensor close tightly? If not, measurements will be too low.
	• Is the intended measurement mode selected? ❖ See Section 1.5 "Measurement Modes" (page 20)
	• Has auto zero adjustment been performed correctly in DC and AC+DC modes? If the displayed value is negative, measurement values will be low. ❖ See Section 5.1 "Auto Zero Adjustment Function" (page 89)
	• Is the frequency of the measured current 10 Hz or lower? To measure at 10 Hz or lower, select the AC+DC mode and set the display update rate to SLOW. • Is the measured current (such as starting current) continuous? If it is not continuous, the measured value will decrease. ❖ See Section 5.3 "Measurement Response Time" (page 92) • Is SLOW selected with AUTO ranging? Has the range changed? ❖ See Section 5.2 "Display Update Rate" (page 90)
	• Is the filter function enabled? If a waveform component at 60 Hz or higher is present, the measured value is low. ❖ See Section 5.4 "Filter Function" (page 95)
	• Is the B indicator (low-battery warning) displayed? ❖ See Section 5.13 "Battery-Low Warning" (page 105)

Symptom	Items to Check
• Displayed values seem too low	• Is the frequency of the measured current out of the specified range of either the 3290-10 or clamp-on sensor? If the carrier frequency of an inverter is high, the displayed value may be smaller than the total rms value. ❖ See Section 6.4 "Combined Accuracy" (page 122) • Does the peak value exceed the crest factor specification? If possible, select a higher current range. • Does the crest factor (=peak/rms) exceed the specification? ❖ See page 53
	Integral Measurement
	• The measured current may be too small. Verify the current measurement items on page 130.
	• Has measurement been stopped by the automatic timer? The setting can be viewed by pressing the TIME button.
	• Has a measurement exceeded the current range? If a measured value exceeds the current range, the maximum displayable value in that range is used in the integration. ❖ See page 74
	Duty
	• The measured current may be too small. Verify the current measurement items on page 130.
	• Is the current threshold properly set? Verity the current threshold setting (RATE button).
	• Is the time to exceed the threshold too short? In certain cases, because of the interaction between current measurement sampling and internal processing, the operating current may be improperly detected. ❖ See page 82
	Frequency Measurement
	• Is the measured waveform non-sinusoidal (such as an inverter)? • Is the measured current at least 5% of the L range? ❖ See page 61
• Output values seem too low	• Check the same items as for displayed values. • Is the plug on the Output Cord inserted all the way into the jack? • Is the Output Cord broken? ❖ See Section 2.4 "Connecting the Output Cords (Optional)" (page 34)
	• Is the output selection (REC or MON) correct? ❖ See "Output Settings" (page 54)
	• Does the connected instrument employ AC coupling? Is the filter function enabled? • Is the filter function of the meter enabled?

Symptom	Items to Check
• Displayed values seem too high	**Current Measurement**
	• Are the tips of the clamp-on sensor in good condition? • Is the range correct? • Has auto zero adjustment been performed correctly in DC and AC+DC modes? If the displayed value is positive, measurement values will be high. ❖ See 5.1 "Auto Zero Adjustment Function" (page 89) • Are other (unanticipated) frequency components present? Verity the waveform using MON output. • Is SLOW selected with AUTO ranging? Has the range changed? ❖ See Section 5.2 "Display Update Rate" (page 90) • Is a strong ambient magnetic field, RF field or noise? • Is the B indicator (low-battery warning) displayed? ❖ See Section 5.13 "Battery-Low Warning" (page 105) • Was the peak measurement display cleared by the CLEAR button? • During peak current measurement, was the power source switched between the batteries and AC adapter? This could cause the displayed value to be too high.
	Frequency Measurement
	• Is a strong ambient magnetic field, RF field or noise? • Is the measured current at least 5% of the L range? • Is the measured waveform non-sinusoidal (such as an inverter)? In some cases, measurement may not be possible. Verify the waveform on the MON output. • Is the measurement waveform full-wave rectified? The measured frequency of a full-wave rectified waveform is double that of its pre-rectified state. • Does the waveform include a DC bias component?
	Integral Measurement
	• The measured current level may be too high, so perform the above current measurement checks.
	Duty
	• The measured current level may be too high, so perform the above current measurement checks.
	• Is the current threshold properly set? Verity the current threshold setting (RATE button).
	• Is the decay time to the threshold value too short? In certain cases, because of the interaction between current measurement sampling and internal processing, the operating current may be improperly detected. ❖ See page 82

Symptom	Items to Check
• Output values seem too high	• Perform the same checks as for display values. • Is the output selection (REC or MON) correct? ❖ See "Output Settings" (page 54)
• ◀ or ▶ appears on the bar graph	• During peak current measurement, indicates negative or positive over-range occurrence. ❖ See pages 61 ad 74
• A + or - sign blinks when an integral is displayed	• During integration, indicates over-range measured current at the indicated polarity. ❖ See page 74
• The displayed value is unstable	• The value may be unstable for waveforms that lack a consistent period. Using the MON output, confirm that the current load to be measured is stable. • Are the sensor cable and other cables making good contact? • Are you trying to measure the frequency of a non-sinusoidal waveform (such as from an inverter)? In some cases, frequency measurement of non-sinusoidal waveforms may not be possible. Verify the waveform on the MON output.
	• Does the selected display update rate (measurement response time) suit the frequency of the current to be measured? ❖ See Section 5.3 "Measurement Response Time" (page 92)
• The 3290-10 turns off and data cannot be viewed	• Data may be stored by the Data Save function. Use the Data Recall function to view saved data. ❖ See Section 5.9 "Recalling Stored Data" (page 102)
• The time display remains 00:00	• Is **START** displayed? • If **TIME** is displayed and ":" blinks, less than one minute has elapsed since starting measurement. The same condition occurs between 100 hours, 0 min and 100 hours, 1 min. During this period, the bar graph indicates 100 hours. Pressing the TIME button displays the number of **100**'s.

NOTE

- When APS (auto power-off) is effective, the unit is automatically shut down when no button is pressed for about 10 minutes.
  ❖See Section 5.11 "Auto Power-off Enabled" (page 103)
- Hold down RATE button and turn the power on. The indication "3290" and version of software then appear on the LCD.
- The LCD is easiest to read when viewed from the front. When viewed from directly above, the darkness of the display may appear uneven, but this is not indicative of a problem.

If the display shows E.001 to E.004 immediately after turn on, the meter requires repair.

Error No.	Contents	Solution
E.001	ROM Checksum Error in the one-chip internal microcontroller	A component requires replacement. Contact your dealer or Hioki representative.
E.002	RAM R/W Error in the one-chip internal microcontroller	
E.003	EEPROM Checksum Error	
E.004	EEPROM Data Error	

Appendix

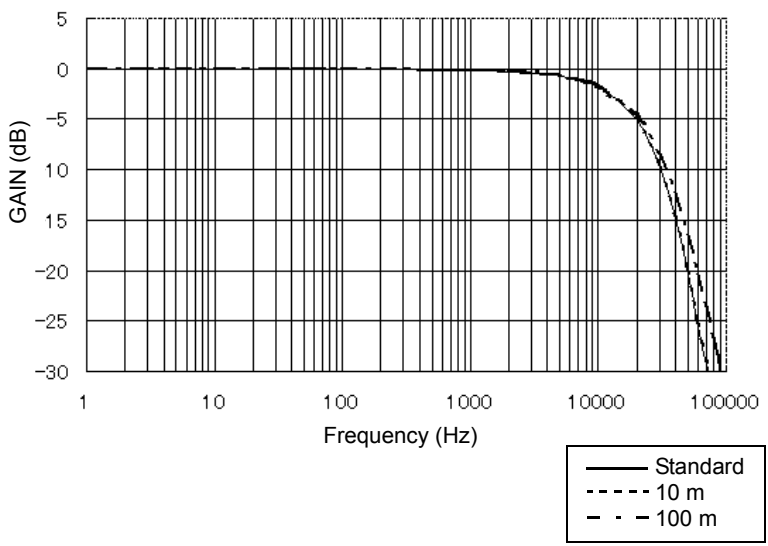
Extension Cables

The clamp-on sensors are equipped with a 2-m cable for connection to the meter, but an extension cable can be inserted if necessary. Available extension cable lengths are 5, 10, 20, 30, 50 and 100 m.

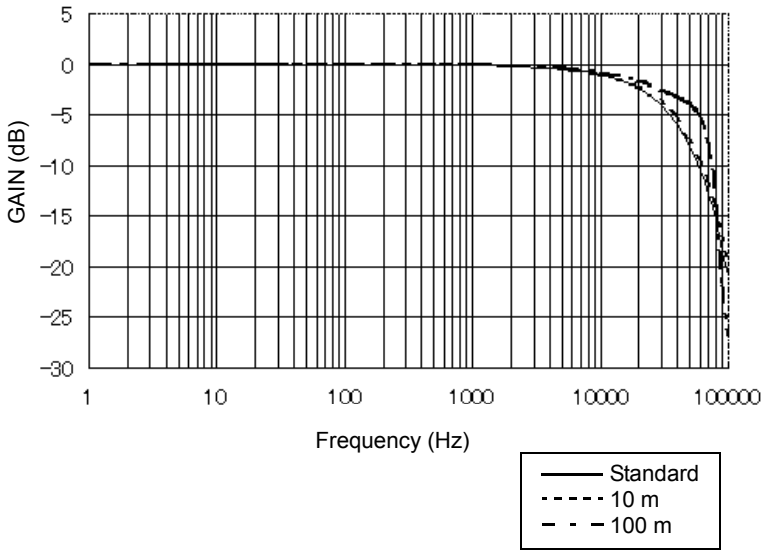
NOTE

- Note that a long cable may result in a larger value being displayed when no or low input is made due to noise.
- When using an extension cable, note that the accuracy will be within the specifications, but the frequency characteristic may vary. Moreover, the longer the extension cable, the greater the variation in accuracy.
  The graph below shows frequency characteristic differences among standard equipment, that with a 10 m extension cable, and that with a 100 m extension cable.

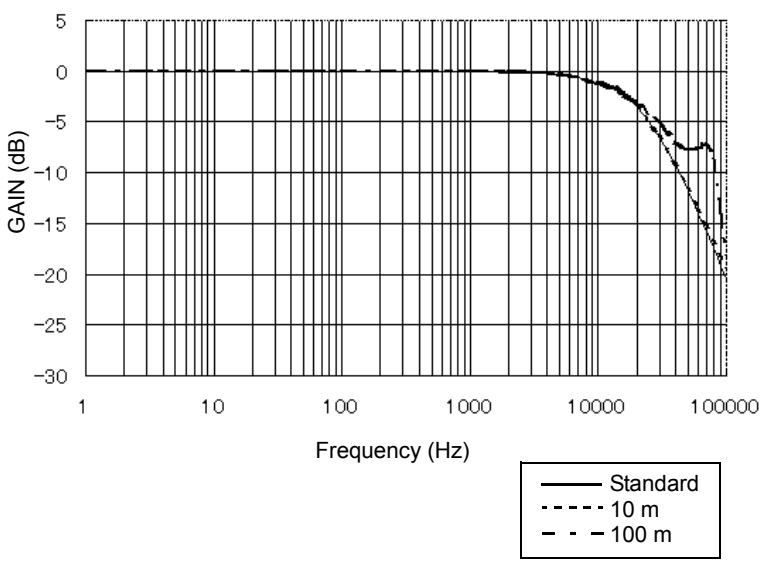
Model CT9691 (9691) + extension cable + Model 3290-10 MON output frequency characteristics



Model CT9692 (9692) + extension cable + Model 3290-10 MON output frequency characteristics



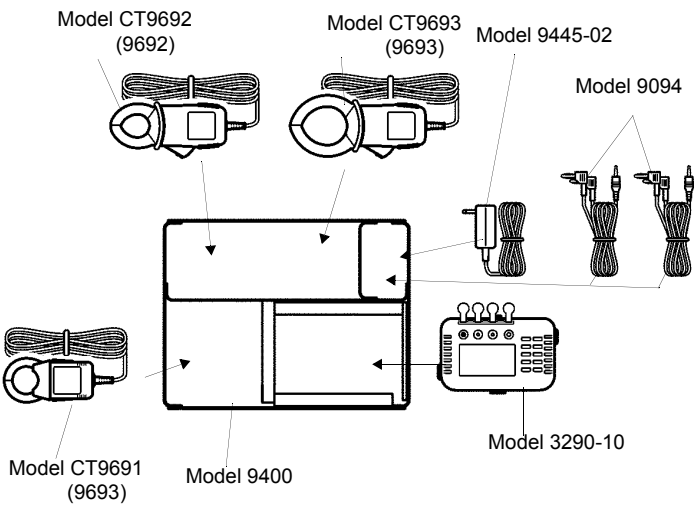
Model CT9693 (9693) + extension cable + Model 3290-10 MON output frequency characteristics



Carrying Case

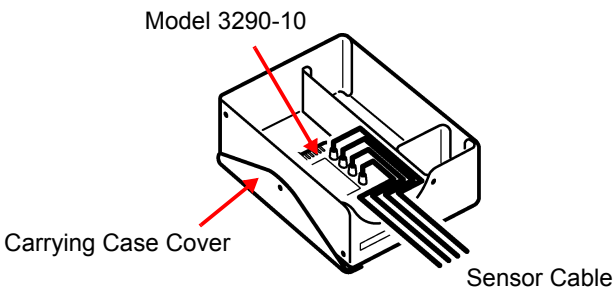
The optional 9400 CARRYING CASE is used to house the instruments described below.

- Model 3290-10 CLAMP ON AC/DC HiTESTER.....1
- Model CT9691 (9691) CLAMP ON AC/DC SENSOR.....1
- Model CT9692 (9692) CLAMP ON AC/DC SENSOR.....1
- Model CT9693 (9693) CLAMP ON AC/DC SENSOR 1
- Model 9094 OUTPUT CORD.....2
- Model 9445-02 AC ADAPTER 1
- Instruction Manual.....1
- Strap.....1

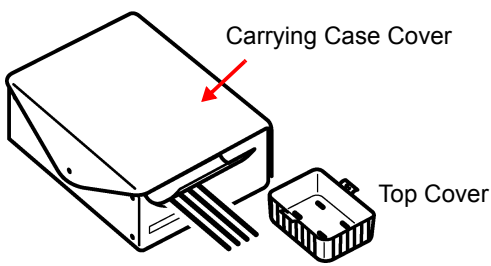


The carrying case can be used as follows:

1. Open the carrying case cover.
2. Fold the cover under the case.
3. Remove the top cover from the meter.
4. Connect the clamp-on sensor to the meter.



5. Close the carrying case cover.



6. Start measuring.

NOTE When closing the cover, be careful to avoid squeezing the sensor cable under the bulge of the manual storage pocket on the rear of the cover.

Differences between Models 3290 and 3290-10

HiTester Model		3290-10	3290
Supported sensor models		Models CT9691 (9691), CT9692 (9692) and CT9693 (9693) CLAMP ON SENSORs	
Clamp-on sensor correspondence		Automatic sensor recognition	
Current Measurement	Measurement Modes	DC, AC and AC+DC	
	Measurement system switching	No	RMS/ MEAN (AC)
	Peak values	Dual-polarity display (DC)	Absolute value display
	Max/min value display	Max/min rms values (AC and AC+DC)	Max/min, mean and elapsed measurement time display
	Separate AC and DC outputs	No	Yes
	Measurement response time setting	0.2, 0.8 and 8 s (linked to display update rate in the 3290-10)	
	AC filter function	In AC and AC+DC modes, fc = 550 Hz settable on/off	
	DC filter function	MON output of DC: 1 Hz settable on/off	MON output of DC and AC+DC: 1 Hz settable on/off
	Output 1	Selectable current waveform (2 VDC/range) or current recording (2 VDC/range)	
	Output 2	Integral (D/A) output	Selectable current recording or low battery warning
Integration Functions	Timer setting	1 min to 99 h, 59 min (repeating up to 20 times)	No
	Elapsed time display	00:00 (hours:mins) maximum 2000h	
	Interval mean value measurement	Mean value = integral / integration time	
	Output 1	Selectable current waveform or current recording	
	Output 2	Integral output	
Duty Measurement	Duty	Duty Operating Time / measuring time	No
	Operating time measurement	Integrating time display	
Frequency Measurement	Range	Auto ranging	Auto or Manual ranging
	Output 1	No	Frequency recording (1 VDC/range)
	Output 2		Current recording
Save Settings function		Settable by button operation	
Data Storage function		Settable by button operation	No
Data Recall function		Upon turning on, and by button operation	No

Shaded items are different

HiTester Model		3290-10	3290
Data Hold function		Suspends display update	
Button Lock function		Settable by button operation	
Bar Graph display		Indicates data memory number	Range magnification function
Display update switching		DC: Once/ s (fixed) AC and AC+DC: NORMAL Twice/s FAST Ten times/s SLOW Once/3s	NORMAL Twice/s FAST Four times/s SLOW Once/3s
Auto Power Off function		Approx. 10.5 minutes (can be disabled)	
Battery Check function		Yes (bar graph display)	
Power Source	AC Adapter	9 V: Model 9445-02	
	Batteries	Four "AA" alkaline batteries (approx. 22 h operation)	
	External Power support	Accepts 8.4 to 15.6 VDC with optional cable	No
Extension Cables		Selectable from 5, 10, 20, 30, 50 and 100 m	
External Dimensions		Approx. 155W X 98H X 47D mm	
Weight		Approx. 545 g	
Standard		CE	

Shaded items are different

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HIOKI

HIOKI E.E. CORPORATION

Headquarters
81 Koizumi, Ueda, Nagano 386-1192, Japan
TEL +81-268-28-0562 FAX +81-268-28-0568 E-mail: os-com@hioki.co.jp
URL http://www.hioki.com/
(International Sales and Marketing Department)

HIOKI USA CORPORATION
6 Corporate Drive, Cranbury, NJ 08512, USA
TEL +1-609-409-9109 FAX +1-609-409-9108 E-mail: hioki@hiokiusa.com
URL http://www.hiokiusa.com

HIOKI (Shanghai) Sales & Trading Co., Ltd.
1608-1610, Shanghai Times Square Office 93 Huaihai Zhong Road Shanghai,
P.R.China POSTCODE: 200021
TEL +86-21-63910090 FAX +86-21-63910360 E-mail: info@hioki.com.cn
URL http://www.hioki.cn

HIOKI INDIA PRIVATE LIMITED
Khandela House, 24 Gulmohar Colony Indore 452 018 (M.P.), India
TEL +91-731-6548081 FAX +91-731-4020083 E-mail: info@hioki.in
URL http://www.hioki.in

HIOKI SINGAPORE PTE. LTD.
33 Ubi Avenue 3, #03-02 Vertex Singapore 408868
TEL +65-6634-7677 FAX +65-6634-7477 E-mail: info@hioki.com.sg

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Edited and published by Hioki E.E. Corporation Printed in Japan