HIOKI

INSTRUCTION MANUAL

3181-01

DIGITAL POWER HiTESTER

HIOKI E. E. CORPORATION

Contents

Introduction

Thank you for purchasing this HIOKI "3181-01 DIGITAL POWER HiTESTER ." To get the maximum performance from the unit, please read this manual first, and keep this at hand.

Inspection

When the unit is delivered, check and make sure that it has not been damaged in transit. If the unit is damaged, or fails to operate according to the specifications, contact your dealer or HIOKI representative.

Accessory

Instruction Manual	1
Power cord	1

Safety Notes

This Instruction Manual provides information and warnings essential for operating this equipment in a safe manner and for maintaining it in safe operating condition. Before using this equipment, be sure to carefully read the following safety notes.

Safety symbols

	In the manual, this mark indicates explanations which it is particularly important that the user read before using the equipment.

The following symbols are used in this Instruction Manual to indicate the relative importance of cautions and warnings.

⚠ DANGER	Indicates that incorrect operation presents extreme danger of accident resulting in death or serious injury to the user.
⚠WARNING	Indicates that incorrect operation presents significant danger of accident resulting in death or serious injury to the user.
⚠CAUTION	Indicates that incorrect operation presents possibility of injury to the user or damage to the equipment.
NOTE	Denotes items of advice related to performance of the equipment or to its correct operation.

Notes on Use

In order to ensure safe operation and to obtain maximum performance from the unit, observe the cautions listed below.

⚠ DANGER

- **Always connect the voltage cable to the secondary side of a breaker. On the secondary side of a breaker, even if the lines are shorted the breaker can trip and prevent an accident. On the primary side, however, the current capacity may be large, and in the event of a short-circuit there may be a serious accident.**
- **This unit cannot be used on voltage lines of 250 Vrms. If the voltage exceeds 250 VAC, there will be a short-circuit accident or electrocution accident will result.**

⚠WARNING

- **In order to prevent an electrical accident, do not make any connections while the power supply or the device to be measured is on. Turn off the power for both devices before proceeding.**
- **The power supply voltage for this unit is switchable. To avoid electrical accidents, check that the voltage selector is set correctly for the supply voltage you are using.**
- **In order to maintain safety and assure the stable operating performance of this unit, be sure to connect the ground terminal to a proper ground.**

⚠CAUTION

- Before measurement, check the position of the range switch. The unit may be damaged if current or voltage exceeds the measurement limit is applied for a long time.
- Before using the unit, make sure that the sheathing on the leads is not damaged and that no bare wire is exposed. If there is damage, replace it with a new one.
- Do not store or use the unit where it will be exposed to direct sunlight, high temperatures, high humidity, or condensation. If exposed to such conditions, the unit may be damaged, the insulation may deteriorate, and the unit may no longer satisfy its specifications.
- To avoid damage to the unit, do not short the output terminal and do not input voltage to the output terminal.

NOTE

- After initiating watthour measurement by pressing the start button, do not alter the settings of the range switch, the time setting dial or the time unit switch.
- The 3181-01 is not certified for commercial metering.
- The 3181-01 uses a voltage transformer (PT) and current transformer (CT), which do not transmit DC. It is therefore not possible to measure a signal (for example full-wave or half-wave rectified) which includes a DC component.
- Do not use the 3181-01 to measure equipment with ratings outside its ranges or whose current consumption continuously exceeds 15A.

Chapter 1
Introduction

The 3181-01 is a compact, multifunction power meter providing power, current, voltage and watthour measurements on equipment such as consumer products. Current and voltage are indicated as true rms values, enabling accurate measurements even on distorted waveforms.

The integrator contains a timer allowing integration time to be set in ranges 1 to 99 minutes or 1 to 99 hours. With several output terminals, the 3181-01 can be linked to a data recorder or a printer, enabling easy recording of measurement data.

1.1 Features

(1) Power, current, voltage and watthour measurements in a single unit

(2) True rms reading of voltage and current values unaffected by distorted waveforms

(3) Integrator timer can be set in ranges 1 to 99 minutes or 1 to 99 hours. (set timer at 00 for continuous integration)

(4) Auto-zero circuit ensures accurate power and watthour measurements over long time spans.

(5) Three simultaneous outputs for power, current and voltage

(6) Connecting the optional 3171 DIGITAL PRINTER to the data output connector makes it possible to record power consumption and average power values over time.

(7) Watthour data is protected against power failures by a battery backup function.

(8) Compact, lightweight and highly portable

Chapter 2
Specifications

Display	(Power meter) (Integrator)	1999 digit LCD 999999 digit LCD
Sampling rate	(Power meter)	Approx. 3 samples/s
Measurement functions	(Power meter) (Integrator)	Single-phase active power AC current and AC voltage (rms reading) Watthour value
Timer setting ranges	(Integrator)	1 to 99 min/1 to 99 h
Timer accuracy	(Integrator)	±0.01 %±1 s (at 0°C to 40°C)
Measurement range	(Power meter) (Integrator)	Power: 200/2000 W Current: 2/20 A Voltage: 0 to 250 V (resolution 1 V) Lo: 200 W range $10^3/10^5$ Wh Hi: 2000 W range $10^4/10^6$ Wh
Accuracy (Ambient temperature: 23°C±5°C, line power: 50/60 Hz, power factor: 1.0)	(Power meter) (Integrator)	Power: ±0.5% of rdg. ±0.3% of f.s. Current: ±0.5% of rdg. ±0.3% of f.s. Voltage: ±0.7% rdg. ±1 dgt. ±1% rdg. ±1 dgt. (at input of 2.5% to 120% of f.s.)
Frequency response (40 to 500 Hz)	(Power meter)	Power: ±1% of max (power factor 1.0) Current, Voltage: ±0.5 % max
Influence of power factor	(Power meter)	±0.8% of rdg. max (power factor 0.5)
Temperature characteristics (in range 0 to 40 °C)	(Power meter) (Integrator)	±0.1% f.s./°C max ±0.05% f.s./ °C max
Maximum circuit voltage	(Power meter)	250 Vrms

Rated current	(Power meter)	15 Arms (continuous rating)
Crest factor	(Power meter)	Power, current: 2 max at maximum display or 30 A peak (lower value) Voltage: 500 V peak value max
Output terminals	(Power meter) (Integrator)	2 VDC/f.s. 2 VDC output for 200 V input in voltage function only. Hi: 5V, Lo: 0 V CMOS level
External control terminal	(Integrator)	OFF: Open (or Hi: 5 V) ON: Closed (or Lo: 0V)
Dielectric strength	AC 2.4 kV/1 min (between input terminals and case)	
Power supply	100, 120, 220, 240 VAC ±15%, 50/60 Hz	
Rated power	Approx. 3.5 W	
Effect of power supply voltage	Specified accuracy satisfied within above specified line voltage ranges.	
Backup power	R6P manganese batteries×3 (supplies more than 100 hours backup capability)	
Dimensions	Approx. 218 (W) × 85 (H) × 240 (D) mm (excluding protrusions)	
Mass	2.6 kg	
Accessories	Power cord 1 Instruction Manual 1	
Options	3171 DIGITAL PRINTER 9084 CARRYING CASE 9149 CARRYING CASE	

Chapter 3
Principle of Operation

3.1 Power Measurement

Figure 3.1-1 and 2 show the block diagram. The line voltage and current of the device under measurement are detected by a voltage transformer (PT) and current transformer (CT), respectively. The resulting detected signals are voltage-level converted and input to a multiplier. Since the DC component of the output of this multiplier is proportional to the active power, after the level is adjusted, this is displayed and output as the power value.

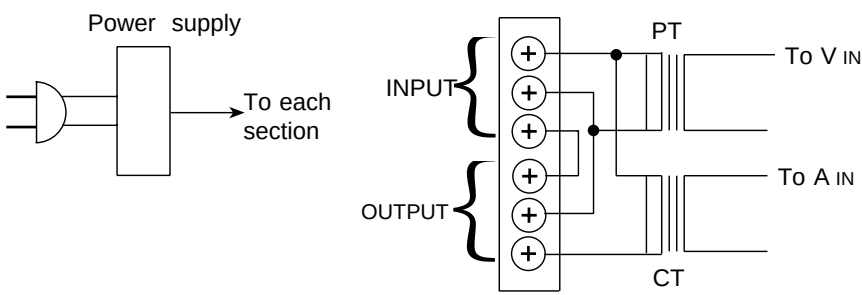


Figure 3.1-1 The Block Diagram 1

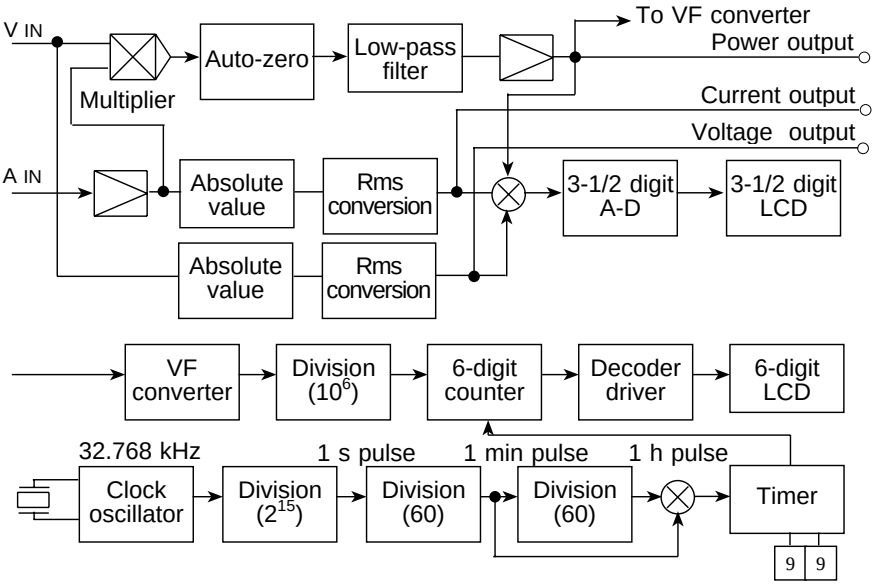


Figure 3.1-2 The Block Diagram 2

The voltage and current waveforms in Figure 3.1-3 are described by equations ① and ②.

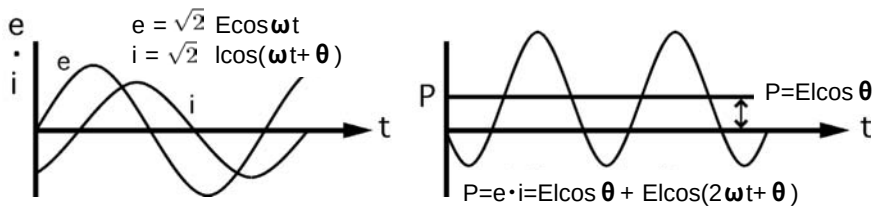


Figure 3.1-3 Power Calculation Waveform

Sinewave AC voltage $e = \sqrt{2}\ E\cos\omega t$ [V] ····· ①

Sinewave AC current $i = \sqrt{2}\ I\cos(\omega t + \theta)$ [A] ····· ②

The product of e and i representing the voltage-current product is the instantaneous power.

Instantaneous power $p = e \cdot i = 2EI\cos\omega t \cdot \cos(\omega t + \theta)$

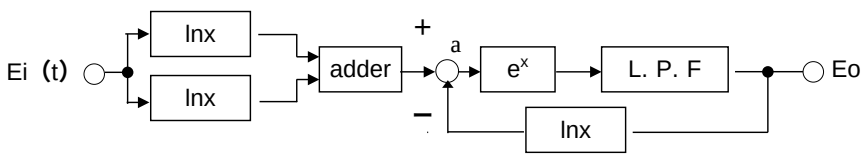
$= EI\cos(2\omega t + \theta) + EI\cos\theta$

[W] ····· ③

Thus, the active power P = EIcos θ [W] is the DC component of the product of the voltage and current (the second term in equation (③)).

3.2 Current and Voltage Measurement

When measuring AC signals using a general-purpose measuring instrument, an average-value detection is performed, after which conversion to the rms value is made. Therefore, measurements on distorted or otherwise non-sinusoidal waveforms will result in errors. In the 3181-01, the true rms value is read by an absolute value detection circuit and a true rms value conversion circuit.



True Rms Conversion Circuit

In the true rms conversion circuit shown in the figure above, if we observe point a, we find the following relationship.

$$\ln \overline{Ei\ (t)} + \ln \overline{E\ (t)} - \ln Eo = \ln Eo$$

$$\ln \overline{Ei^2\ (t)} = \ln Eo^2$$

$$\therefore \quad Eo = \sqrt{\overline{Ei^2\ (t)}}$$

Now let Ei(t) be the result of performing absolute-value detection on the voltage and current signals from the voltage transformer and current transformer, then the output voltage Eo is proportional to the voltage-current rms value.

3.3 Integrated Watt Value

The DC voltage Ei(2 V f.s.) is proportional to the power measured by the power meter. The V-F converter converts Ei into a pulse train, the pulses are counted by the counter and the result is displayed as the watthour value. (V-F conversion rate α = 27.7....(Hz/V))
For example, if 100 [W] is the power measured in the low range (200 [W] f.s.), the voltage Ei input to the V-F converter is given by the following formula.

Ei = 2 [V](f.s.)×100 [W] /200 [W]= 1 [V]

The time-unit switch on the 3181-01 front panel is also the integrator RANGE switch. If integration is performed at Wh:Lo (TIME:MIN) for one hour, the resulting integration value N is calculated thus:

N = α [Hz/V]×Ei [V]×T [s]
= 27.7.... [Hz/V]× 1 [V]× 3600 [s]
= 100000

By interlocking ranges and setting the decimal point at the fourth digit from the right, it is possible to directly display watthour values of up to 100.000 Wh. If integration is performed for one hour with Wh:Hi (TIME:HOUR) set, after the divide-into-100 circuit, the following value is obtained:

N = 27.7.... [Hz/V]× 1 [V]× 3600 [s]× 1/100
= 1000

If the decimal point is set at the second digit from the right in this case, the value 100.0 Wh is displayed. As the above discussion shows, the maximum display value of the integrator can be changed by different combinations of time units and ranges (table on the next page).

The Wh/TIME and the time setting dial on the 3181-01 front panel are used to set the integration time in the range 1 to 99 minutes or 1 to 99 h. Once the desired time is set, pressing the START switch resets the internal circuits and integration begins. When the set time is reached, the counter output is put on hold. If the integrator is started with the timer set to "00", it performs continuous integration. The HOLD/RUN switch on the front panel is used to stop the counter and start again. Below the V-F converter there is a backup battery which maintains continuous operation in the event of a power failure, so there is no danger of loosing watthour values measured up to the power failure.

Integrator Maximum Display Values

Range / Time unit	Lo (200W)	Hi (2000W)
TIME: MIN Wh: Lo	999.999 Wh	9999.99 Wh
TIME: HOUR Wh: Hi	99999.9 Wh	999999 Wh

3.4 Crest Factor

Crest factor is a measure of the dynamic range of a measurement. In measurements in which the peak value is high but the rms value is low, if the measuring instrument range is selected based on the rms value, waveform peaks will exceed the dynamic range of the circuit, causing errors since the circuit is not operating linearly in this region.

The relation between the crest factor, peak value and rms value is defined as follows.

Crest factor = Peak value/rms value

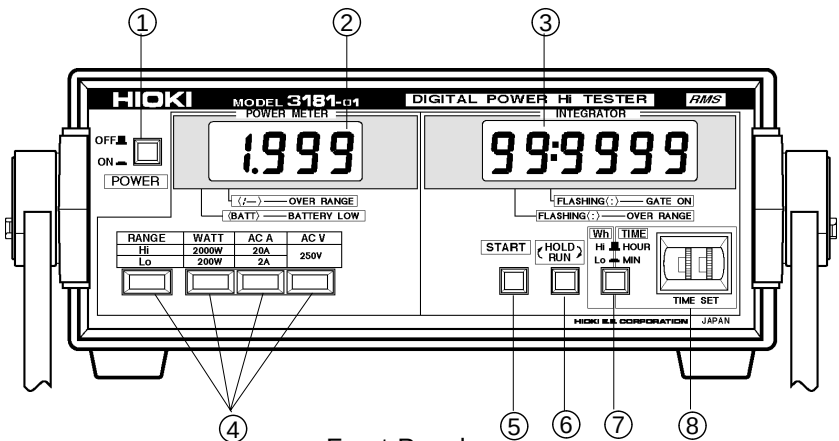
The 3181-01 has the following specifications.

AC voltage	500 V peak value max
AC current	2 max at maximum display value or 30 A peak (lower value)
Single-phase active power	same as for voltage and current

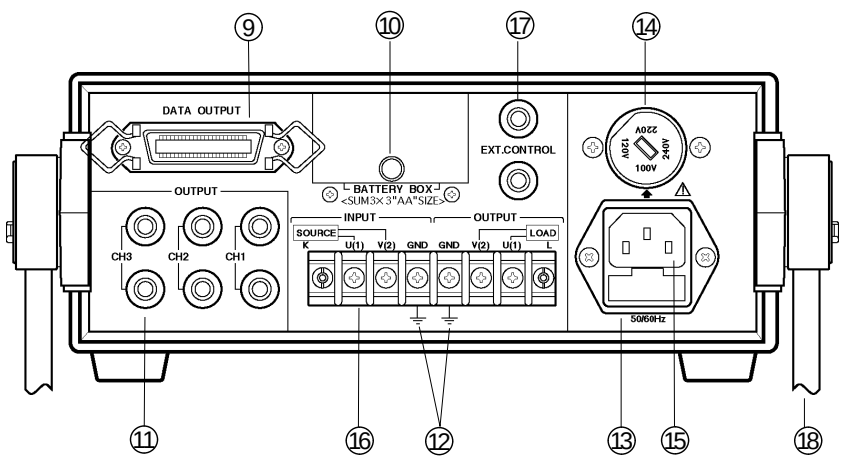
For example, using the 3181-01 to measure AC current in the Lo range, since the maximum display value is 2 A, the largest allowable peak value on the input being measured can be calculated as follows.
From the definition,

Peak value = rms value × crest factor
= 2 × 2
= 4 [A]

Chapter 4
Names and Functions of Parts



Front Panel



Rear Panel

① POWER switch

Allow approximately five minutes of warm-up before performing measurements.

② POWER METER display

This 3 1/2 digit LCD display has a maximum display value of 1999. The function switches are selected to enable it to indicate measured voltage, current and power values.

If the input exceeds the maximum display value, the uppermost digit will appear as 1 and the decimal point will be displayed, while the lower three digits will be blanked.

If the voltage of the backup battery falls below 4 V, BATT will appear in the lower left corner.

③ INTEGRATOR display

This 6-digit LCD display has a maximum display value of 999999. If the integration value exceeds this, the decimal point will occupy the uppermost digit. It will blink at approximately one-second intervals, and integration will start again from 000000. The colon (:) after the second digit from the left blinks when the display is running at approximately one-second intervals, and is blanked when the display is on hold.

④ RANGE and functions (WATT, ACA, ACV) switches

These switches are used to switch the display between power, current and voltage.

Range switch	Function switch	Maximum display value
Hi	WATT	1999 W
	AC A	19.99 A (Rating is 15 A)
Lo	WATT	199.9 W
	AC A	1.999 A

The maximum display values for voltage measurements are independent of RANGE switch settings and are ACV: "1999" V (0 to 250 V)

⑤ START switch

Immediately the START switch is pressed the watthour value accumulated up to that time is cleared and integration begins anew from 000000.
Start has priority over hold, so if the INTEGRATOR display is on hold when the START switch is pressed, integration begins immediately from zero.

⑥ HOLD/RUN switch

This button stops the INTEGRATOR display and clears the hold condition. When the HOLD/RUN switch is pressed, the INTEGRATOR display value is held. If the button is pressed a second time, the display returns to the watthour value accumulated from the time integration began and display is continued.
If the INTEGRATOR display is held because the preset time period has elapsed, this button cannot be used to release the hold condition.
This is an important point, because if a mistake is made pressing the start and HOLD/RUN switches, the watthour value is invalidated.

⑦ Wh/TIME switch (time unit switch)

This switch is used to change the time unit for the time setting dial described in the next section and the integrator range simultaneously.

Switch setting	TIME	Wh
	HOUR	Hi
	MIN	Lo

Refer to Sections 3.3, "Integrated Watt Value" and 5.3, "Integrated Watt Value Measurement."

⑧ TIME SET dial

This dial is used with the Wh/TIME to set the integration time interval.

For example, if the Wh/TIME is set at HOUR and the time setting dial is set to 24, integration is performed continuously for 24 hours after the integrator START switch is pressed and then automatically stops.

If the dial is set to "00", the timer does not operate and continuous integration is performed.

⑨ Data output connector [DATA OUTPUT]

(Integrated watt value measurements only)

This connector is used to connect the 3171. Do not connect any other equipment to this connector, as applying voltage to or shorting the terminals of this connector can cause damage.

⑩ Battery compartment [BATTERY BOX]

This holds the three R6P manganese batteries used for power backup. The batteries have a life of more than 100 hours when run continuously. BATT shown in the lower left corner of the power display indicates that the backup batteries have run down. When this happens, the batteries must be replaced immediately. (Refer to Section 7.1, "Battery Replacement.")

If the power switch is turned on while the AC plug is disconnected, only the INTEGRATOR display will operate. This indicates that the backup power batteries are functioning normally, it is not a fault. However, operation without the AC plug inserted should not be continued for any length of time, as it will run down the backup batteries.

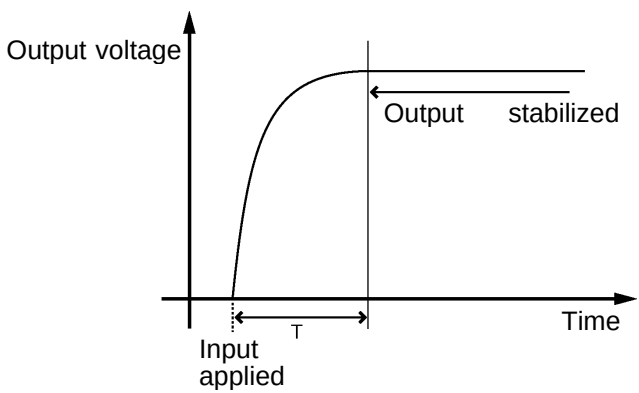
⑪ Output terminals [OUTPUT]

> **⚠CAUTION** To avoid damage to the unit, do not short the output terminal and do not input voltage to the output terminal.

These output terminals output DC voltages proportional to the measured values of current and power (2 VDC/f.s.). The voltage output (Ch1) is 2 VDC for 200 VAC.
The three channels are output simultaneously, regardless of the setting of the function switches. These channels are assigned as follows.

CH1: AC voltage
CH2: AC current
CH3: Active power

The output response time is as follows.



Response Time

T 2.3 s for voltage and current
T 3.3 s for power

⑫ Ground terminals [⏚]

> **⚠WARNING** **In order to maintain safety and assure the stable operating performance of this unit, be sure to connect the ground terminal to a proper ground.**

⑬ Fuse holder

The 3181-01 requires a fuse with ratings of 250 V and 3 A. The 3181-01 power cord must be removed from the socket before replacing the fuse. (Refer to Section 7.2, "Fuse Replacement.")

⑭ Voltage selector

This is used to select the line voltage for the 3181-01. Ensure that the number indicating the line voltage selection is aligned with the arrow (↑) below the selector switch.

⑮ AC inlet

This inlet is used to apply line power to the instrument using the accessory power cord. A line filter and a fuse are built in.

⑯ Measuring terminal

These terminals are used to make connection between the power line and the equipment being measured. When making connections, always use conductors which have sufficient current carrying capacity, tighten them securely and be careful to avoid looseness and shorts.

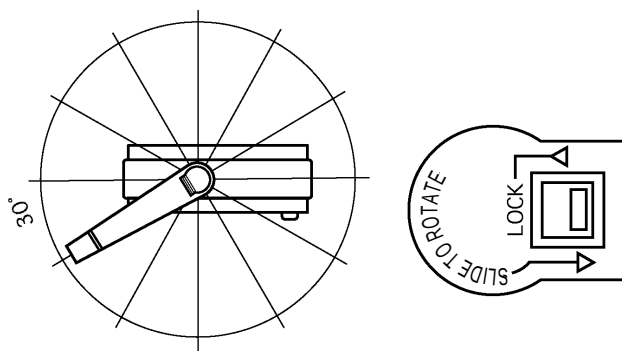
⑰ External control terminal [EXT.CONTROL]

Leave this terminal open (or at Hi level: 5 V) during normal operation. It is closed (or at Lo level: 0 V) during integration to obtain the watthour value for the specified time period. As soon as this terminal is closed, the instrument goes directly into operation as if the START switch had been pressed. That is, the integration value accumulated up to that moment is cleared and integration is begun anew. If the external control terminal is opened during integration, the instrument behaves just as if the HOLD/RUN switch had been pressed and the accumulated integration value is displayed. (Refer to Section 6.4, "External Control Terminal.")

⑱ Handle

> **⚠CAUTION** The handle can be used as a stand to incline the instrument. Force should not be applied to the instrument from above when using it in this manner.

As shown in the figure below, the handle may be rotated by sliding the grip at the sides of the handle in the direction of the SLIDE TO ROTATE arrow. When the proper position has been attained, push the slide in the LOCK arrow direction. The handle may be set at 30 ° detents to fix it in position.



Handle

Chapter 5
Operation

5.1 Preparing for Measurement

⚠WARNING

- **The power supply voltage for this unit is switchable. To avoid electrical accidents, check that the voltage selector is set correctly for the supply voltage you are using.**
- **In order to prevent an electrical accident, do not make any connections while the power supply or the device to be measured is on. Turn off the power for both devices before proceeding.**
- **In order to maintain safety and assure the stable operating performance of this unit, be sure to connect the ground terminal to a proper ground.**
- **To avoid damage to the unit, do not input a voltage/current exceeding the specified maximum to the input terminals.**

NOTE

Because of the internal circuit design, measurement of load with a certain frequency component will cause cyclic fluctuation (instability) in the power reading.
This has been observed especially for distorted waveforms with large harmonic components in multiples of 512 Hz.

(1) First make sure that the voltage selector switch agrees with the line voltage before measuring.
(2) Connect the power lines and the equipment to be measured to the measurement terminal strip as shown in Figure 5.1-1 or 5.1-2 (either way).
When measuring only voltage or current, refer to Figure 5.1-3 or 5.1-4.
(3) Turn the power on.
(4) Leave the instrument powered ON for approximately five minutes of warm-up.
(5) Set the RANGE switches appropriate to the current level of the equipment to be measured.
(Lo range: 2 A max; Hi range: 15 A max). If these are not known, select the Hi range.

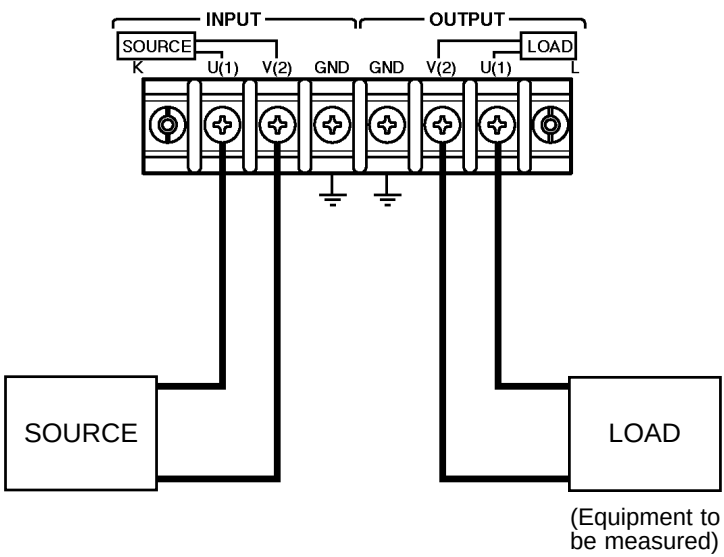


Figure 5.1-1 Power, Current and Voltage Measurement

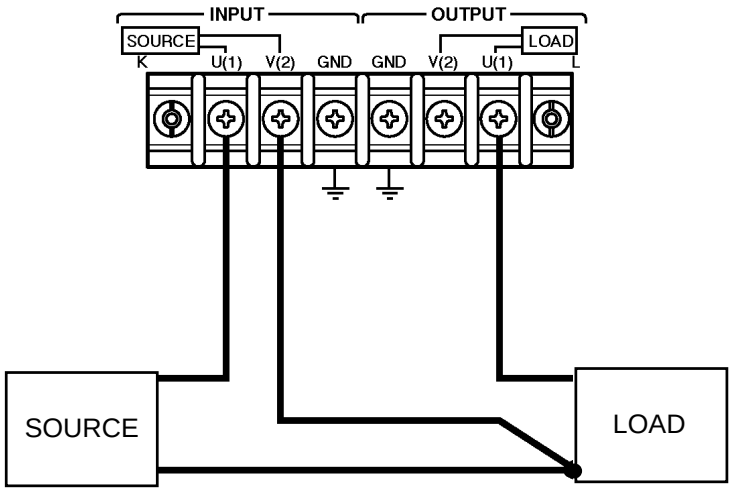


Figure 5.1-2 Power, Current and Voltage Measurement

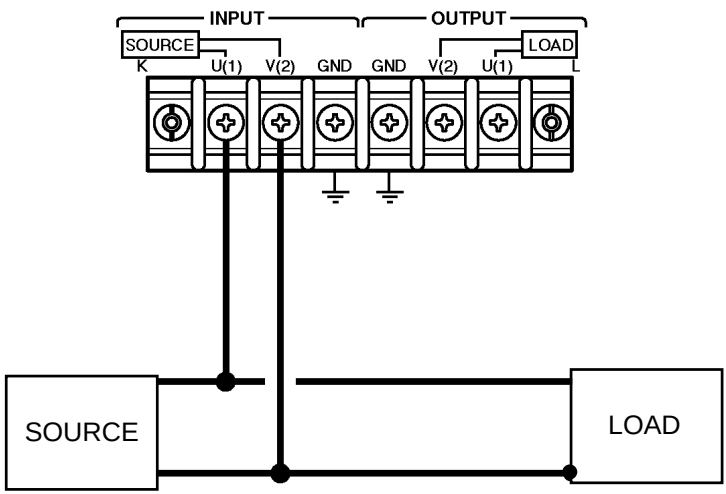


Figure 5.1-3 Voltage Measurement Only

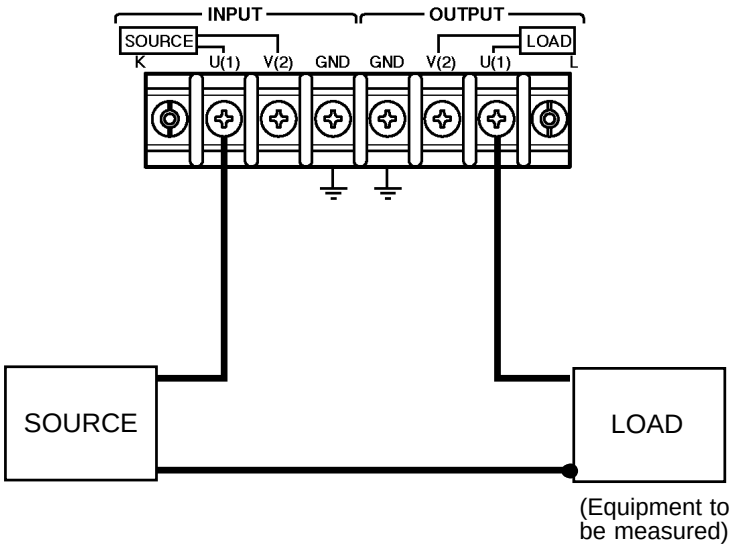


Figure 5.1-4 Current Measurement Only

5.2 Power, Current and Voltage Measurement

Once all preliminaries have been completed, power, current, and voltage are measured simply by setting the function switches.

If the display scale exceeds in the Lo range when power and current are being measured, switch the range to Hi. Measurement accuracy goes down in the Hi range when the display count falls below 200. When this happens, switch the range to Lo.

5.3 Integrated Watt Value Measurement

(1) Set the function switch to power measurement and check that the power consumption of the equipment to be measured does not exceed the power display scaly. Then the integrated watt value measurement can be measured with the function switch set to WATT, ACA, or ACV.

(2) Set the Wh/TIME switch to a value appropriate to the power to be measured and the measurement time period. Set the TIME SET dials and the timer to the desired integration time period. If integration is to extend over a long time beyond the timer setting range, if integration time is controlled via the external control terminal, or if the 3171 is connected, this dial should be set to "00" for continuous integration which will avoid all problems. A table below gives the relation between the integrator maximum display value and the timer setting ranges.

Integrator Maximum Display Value and Timer Setting Ranges

Range / Time unit	Lo (200 W)	Hi (2000 W)
TIME: MIN Wh: Lo	999.999 Wh	9999.99 Wh
	Timer : 1 to 99 min, continuous (00)	
TIME: HOUR Wh: Hi	99999.9 Wh	999999 Wh
	Timer : 1 to 99 h, continuous (00)	

(3) Integration begins at the moment the START switch is pressed (Figure 5.3-1)

(4) The settings of the RANGE switches, Wh/TIME and TIME SET dials should not be altered during measurement. If they are, the measurement value displayed will be invalid.

(5) To check the integration value, press the HOLD/RUN switch. This stops the INTEGRATOR display and displays the integrated watt value accumulated up to that point. (Refer to Figure 5.3-2.)

(6) To continue integration press the HOLD/RUN switch again. Integration continues under the conditions established when the START switch was pressed once the hold condition is cleared. (Refer to Figure 5.3-3.)

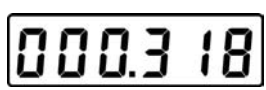
(7) The display value can be put on hold as often as desired. The value from the time integration was initiated by pressing the START switch can be read at any time simply by pressing the HOLD/RUN switch.

(8) If the integration time is set, once that time is reached the INTEGRATOR display automatically stops and goes into the hold condition.
In this situation, the hold condition can only be cleared by pressing START switch and restarting integration.

(9) If the integration value exceeds the maximum integrator display value, the uppermost digit appears as a blinking decimal point. The display starts from zero again. Thus, the integration value after this point can be obtained by simply adding 1,000,000 to the display value.
The time elapsed before an overflow occurs is obtained from the equations and the graph in Figure 5.3-4.

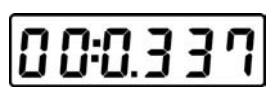
The count starts from 0 with the colon blinking.

Figure 5.3-1



The colon erased and the count is on hold.

Figure 5.3-2



Count returns to integration conditions initially set up with the colon blinking.

Figure 5.3-3

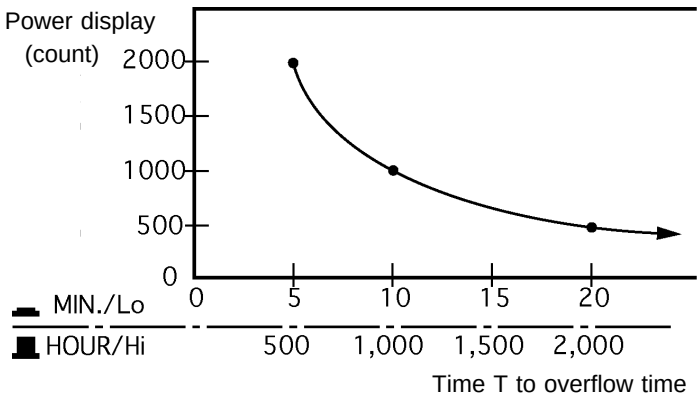


Figure 5.3-4 Time Elapsed to Scale Overflow

For MIN/Lo: T = 10,000/power display
For HOUR/Hi: T = 1,000,000/power display

Chapter 6
Applications

6.1 Determing the Power Factor

The 3181-01 measures active power, current and voltage. The power factor of the equipment under measurement is calculated from these measured values.

$$\text{Power factor } \cos\theta = \frac{\text{Effective power [W]}}{\text{Reactive power [VA]}}$$

$$= \frac{\text{(WATT) W}}{\text{(ACV)V} \times \text{(ACA)A}}$$

Thus to get the power factor, divide the measured power by the product of voltage and current.

6.2 Connecting the Recorder

⚠CAUTION To avoid damage to the unit, do not short the output terminal and do not input voltage to the output terminal.

The 3181-01 has three analog output terminals on the rear panel. They are for voltage, current, and power which are always active simultaneously. These can be connected to the input terminals of a recorder. It enables to observe and record the measured values.
Note that although the analog outputs of current and power are 2 VDC/f.s., 2 VDC is output for 200 VAC input in the voltage function only.

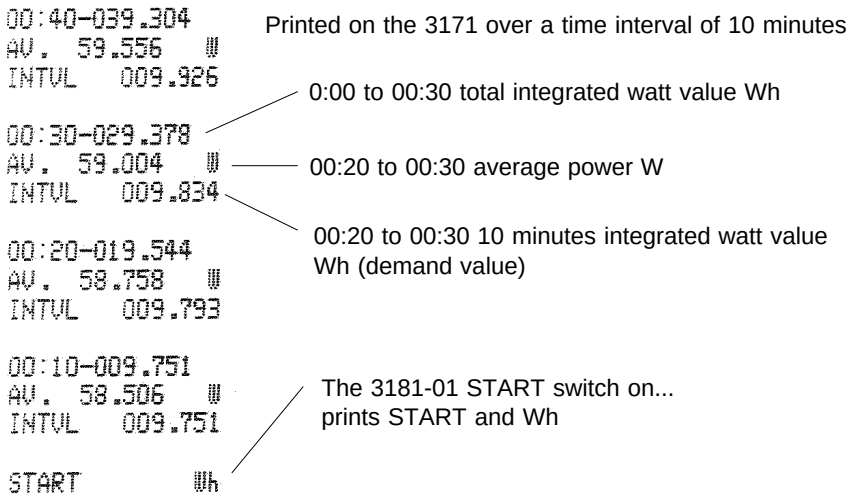
6.3 Printer Connection

The 3181-01 has a data output connector on the rear panel. The integrated watt and average power values can be printed out by connecting the 3171 at this connector.

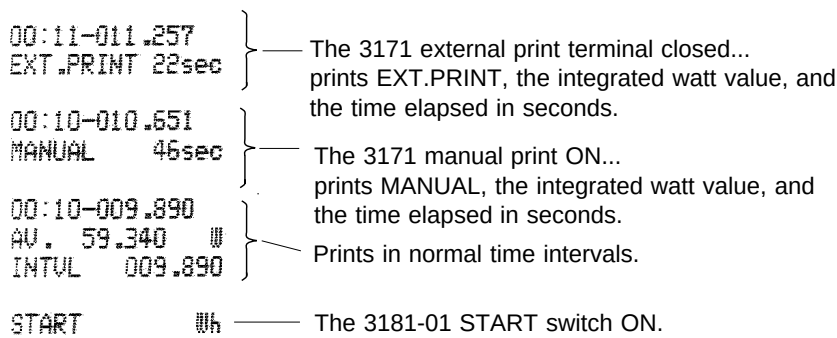
NOTE

- Do not put the INTEGRATOR display on hold when using the 3171 to print out integration values. Increases in the integration value will be ignored and the value when the display is put on hold will be printed out continuously. The same situation will arise if the display is automatically held by the timer. Thus, the timer setting also must be taken into account when using the printer.
- If the 3181-01 is connected to an old version of the 3171 (i.e., one produced before June, 1982), the units that can be printed are those on the 3171 function switches: kWh, kVar or kVarh.
- The old model printers must be modified to print units W and Wh. HIOKI will perform the necessary modifications on request.

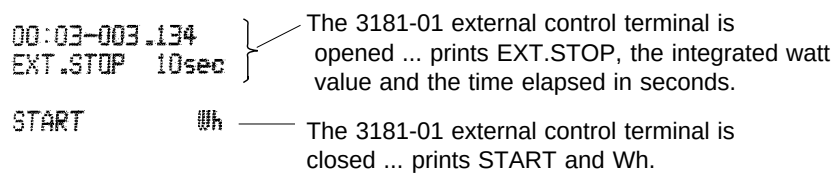
The 3171 Print Example



The 3171 Manual print and external print



Under external control



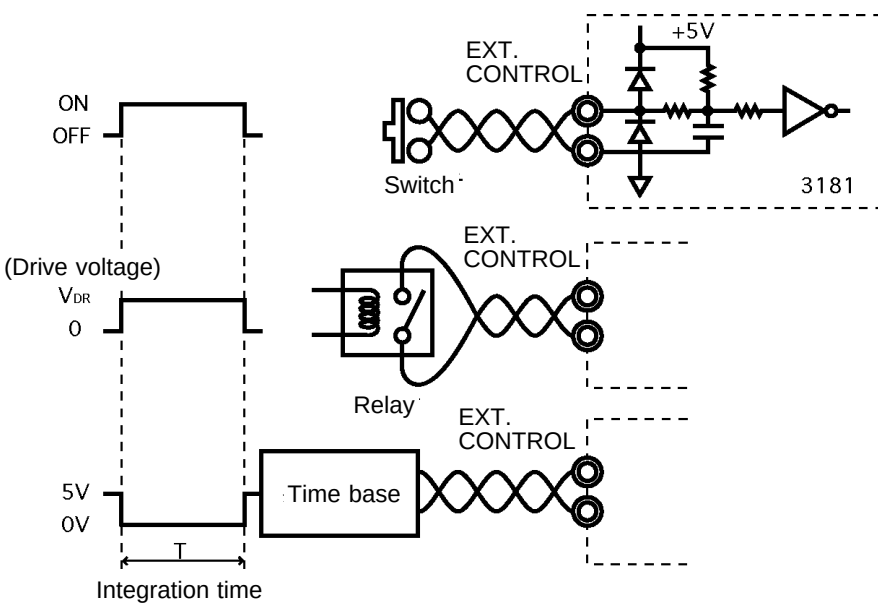
6.4 External Control Terminal

⚠CAUTION

- To avoid damage to the unit, do not short the output terminal and do not input voltage to the output terminal.
- To avoid electric shock, the wiring which is used for making the connections to the current input terminals should have sufficient current carrying capacity and insulation.

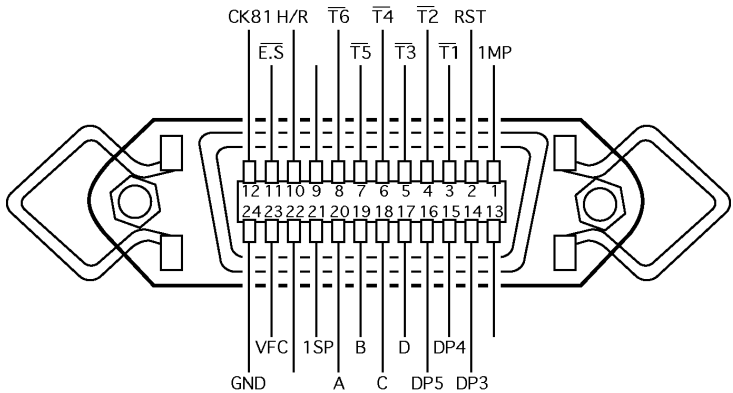
NOTE To avoid malfunction, use a shielded wire or a twisted pair, which should be as short as possible, to the external control terminal.

The 3181-01 has an external control terminal for external control of the integrated watt value measurement time.

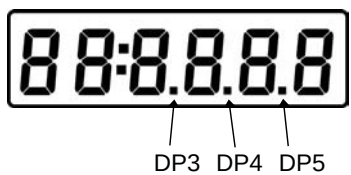


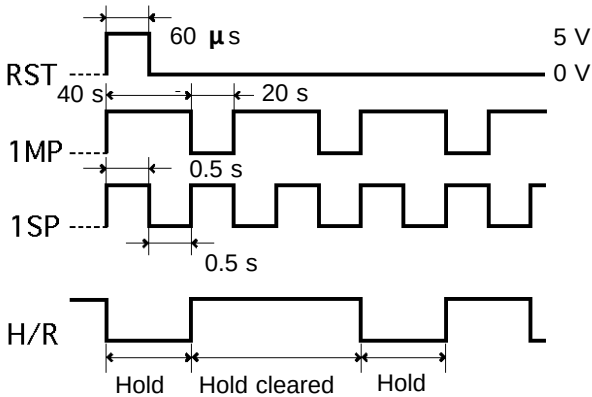
6.5 Data Output Connector (Integrated watt value only)

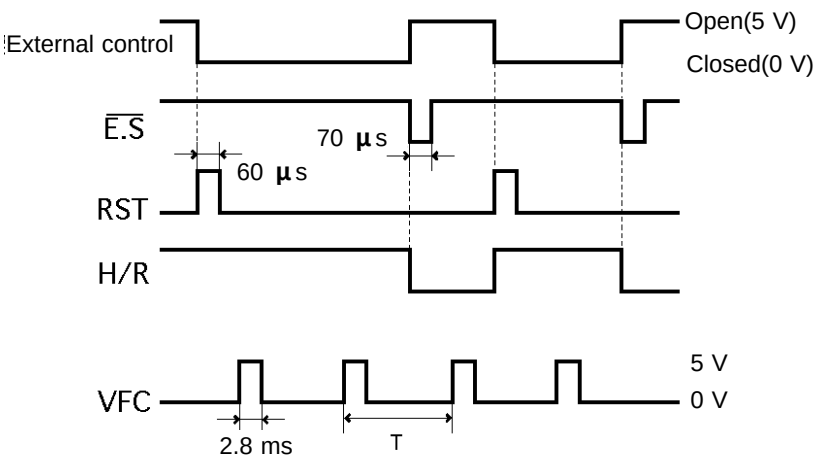
The signal levels and timing of the outputs from the data output connector are as follows.



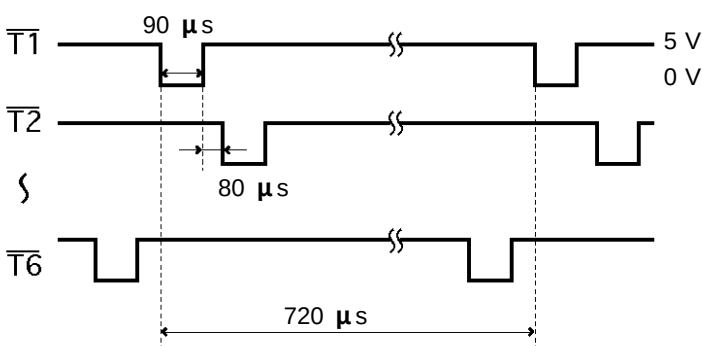
Pin No.	Name	Function
1	1MP	1 Minute pulse
2	RST	Reset Output when the START switch is pressed or when the external control terminal is closed.
3 4 5 6 7 8	$\overline{T1}$ $\overline{T2}$ $\overline{T3}$ $\overline{T4}$ $\overline{T5}$ $\overline{T6}$	Digit signal T1 corresponds to the most significant digit.
9		
10	H/R	Hold/Run Output Lo level (0 V) when the power display is put on hold, and Hi level (5 V) in all other cases.

Pin No.	Name	Function
11	E.S	External Stop Output when power measurement is stopped by external control.
12	CK81	Check the 3181-01. The 3171 identification signal, directly coupled to the 3181-01 CMOS logic power line (+ 5 V).
13		
14 15 16	DP3 DP4 DP5	Decimal Point 3 to 5 Indicate the INTEGRATOR display decimal point position, outputs Hi level (5 V) signal when display is turned on. 
17 18 19 20	D C B A	BCD data Synchronously output with the digit signals. (D is the most significant digit.)
21	1SP	1 Second Pulse
22		
23	VFC	VF converter output Output the signal to convert the DC voltage proportional to the measured power value to a pulse.
24	GND	Connected to the circuit common.



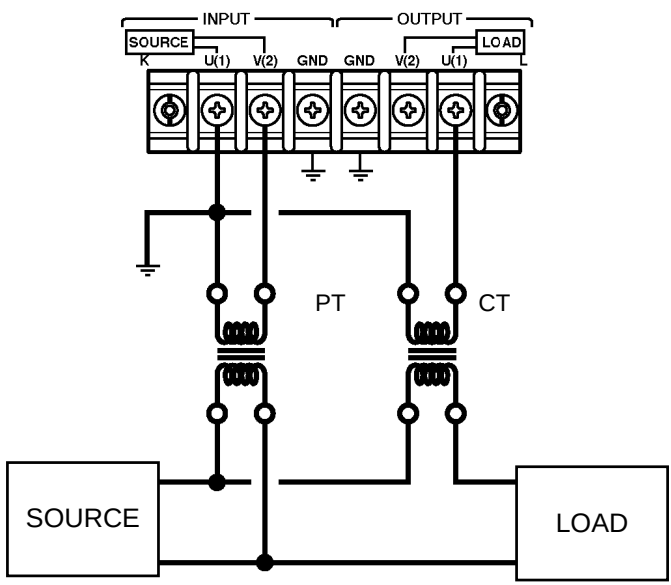


T=36/V (ms), V: DC voltage (2 V/f.s.) proportional to the measured power value.



6.6 Inputs Exceeding the Measurement Range

If the voltage or current level of the equipment under measurement exceeds the measurement range of the 3181-01, measurement should be performed after stepping these down using a voltage transformer (PT) and/or current transformer (CT). Refer to figure below for the proper method of connection. Note, however, that such transformers have a phase error which can greatly affect the power measured value. An important consideration has to be taken into if accurate power measurement is required.

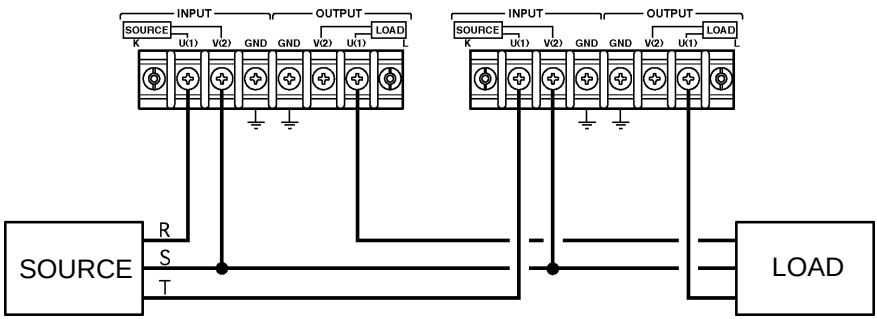


Voltage/Current Transformer Measurement Method

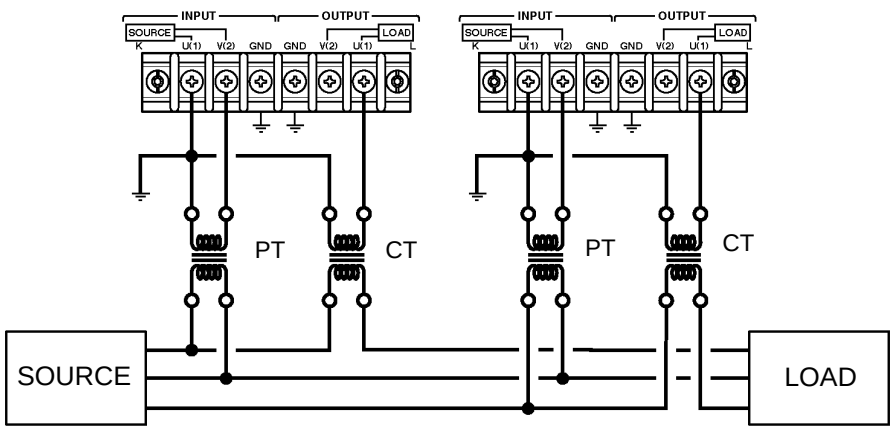
Power = (Watt display value) × (PT ratio) × (CT ratio)

6.7 Three-Phase Three-Wire Connection

Two 3181-01 units may be used to calculate the algebraic sum of measured values, enabling the determination of three-phase power. A voltage or current transformer can be used if measurement ranges are exceeded (Refer to figures below).



Three-Phase Power Measurement



Three-Phase Power Measurement using Voltage/Current Transformers

Chapter 7 Maintenance and Service

7.1 Battery Replacement

⚠WARNING

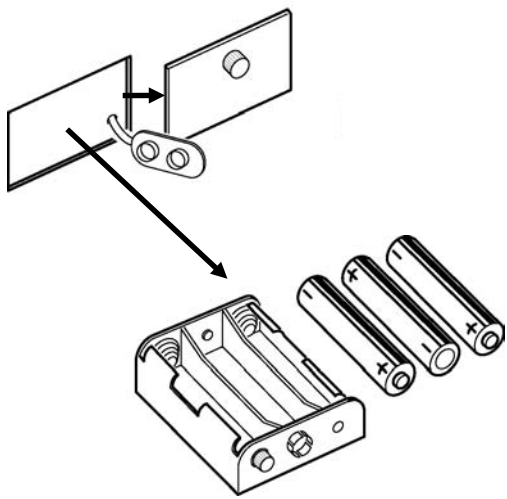
- **To avoid electric shock when replacing the batteries, first disconnect leads from the object to be measured. Also, after replacing the batteries always replace the cover before using the unit.**
- **When replacing the batteries, do not install old batteries with new ones, and do not mix different types of batteries. Check the battery polarity carefully when inserting the batteries.**
- **Do not short-circuit used batteries, disassemble them, or throw them in a fire. Doing so may cause the batteries to explode.**
- **Be sure to dispose of used batteries according to their type in the prescribed manner and in the proper location.**

(1) Remove the battery box cover.

(2) Remove the battery snap.

(3) Slide out the battery box and replace the batteries.

(4) Slide the battery box back in and replace the battery snap and battery box cover.



7.2 Fuse Replacement

⚠WARNING

- **To avoid electric shock when replacing the fuse, turn the power switch off and disconnect the power code from the connector and remove the object to be measured.**
- **Only use fuses of the specified type that is rated for the specified current and voltage. Using a fuse that does not meet the specifications or shorting the fuse holder may cause an accident that might result in injury or death.**
  3 A/250 V 20 mm × 5 mm dia.

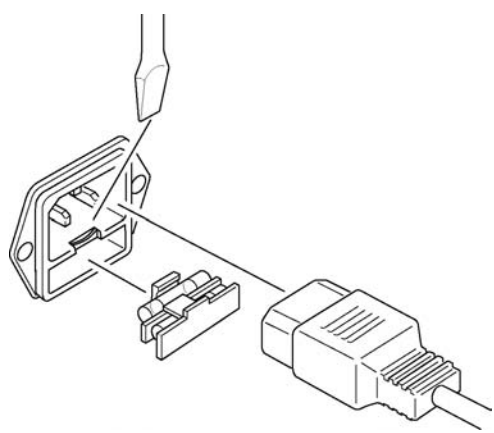
(1) Make sure that the power switch is OFF.

(2) Remove the power cord from the AC inlet.

(3) Take off the AC inlet holder using a coin or a screwdriver.

(4) After correctly disconnecting the fuse, insert the new one. Use only midget fuses with ratings of 250 V and 3 A.

(5) Return the fuse holder to its original position and attach it to the AC inlet.



7.3 Cleaning

⚠CAUTION

- Gently wipe dirt from the surface of the unit with a soft cloth moistened with a small amount of water or mild detergent.
- Do not try to clean the unit using cleaners containing organic solvents such as benzine, alcohol, acetone, ether, ketones, thinners, or gasoline. They may cause discoloration or damage.

7.4 Service

⚠CAUTION

If the unit is not functioning properly, check the batteries and fuse blowing. If a problem is found, contact your dealer or HIOKI representative. Pack the unit carefully so that it will not be damaged during transport, and write a detailed description of the problem. HIOKI cannot bear any responsibility for damage that occurs during shipment.

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