HIOKI

INSTRUCTION MANUAL

3182 · 3183

DIGITAL POWER Hi TESTER

⚠ WARNING

This instrument is designed to prevent accidental shock to the operator when properly used. However, no engineering design can render safe an instrument which is used carelessly. Therefore, this manual must be read carefully and completoly before making any measuremant. Failure to follow directions can result in a serious or fatal accident.

Contents

INSPECT THE TESTER

Upon receiving the tester, check for any evidence of damage during shipment. Pay particular attention to parts such as switches on the panel. If any damage is apparent, or if the tester does not function according to specification, contact your nearest Hioki distributor for assistance.

Before Turning Power On

Confirm that you power supply matches the TESTER rating and that the correct fuse is installed in the unit.

⚠ WARNING

1. **When connecting a power source or a load to the measurement terminal, be sure to confirm that it is off to prevent electrical accidents.**
2. **To prevent damage to the tester, never exceed rated overload limits.**
3. **Before replacing a fuse, unplug the power cord from the connector and confirm that there is no cable connected to the measurement terminal.**
4. **To prevent fuse, use type 0.5A/250V fuse only.**

⚠ CAUTION

Do not short-circuit the output terminal or the data out connector, and do not apply voltage to them.

1. Introduction

The 3182/3183 is a single-phase power meter suitable for power measurements on low-power consumption equipment such as consumer products.
A single unit provides voltage, current and power measurement functions with voltage and current being indicated astrue rms values, enabling accurate measurements even on distorted waveforms such as those encountered in thyristor circuits.
Three channels of analog output (for voltage, current and power) are available simultaneously and, used in combination with 3172 GP-IB Interface Adaptor, use in a GP-IB system is possible as well.

2. FEATURES

① Voltage, current and power measurements
② True rms reading of voltage and current values
③ Low inherent power dissipation
④ Three simultaneous analog outputs for voltage, current and power
⑤ BCD output and digital outputs for function and range
⑥ Addition of a GP-IB interface adaptor (separately sold) enables use in GP-IB systems
⑦ Easy connection and operation
⑧ 3-1/2 digital LED display (maximum display of 1999)
⑨ Compact, lightweight and highly portable

3. SPECIFICATIONS

3-1 Measurement specifications by model

Function		3182	3183
Measurement function		AC voltage, current (true rms) reading, single-phase real power	AC voltage, current (true rms) reading, single-phase real power
Measurement range	ACV	200 V/250 V	200 V/250 V
	ACA	2 A/20 A	0.2 A/2 A
	WATT	200W/2000W	20W/200W
Maximum display value	ACV	199.9 V/250 V	199.9 V/250 V
	ACA	1.999 A/19.99 A	.1999 A/1.999 A
	WATT	199.9W/1999W	19.99W/199.9W

Resolution	ACV	0.1V/1 V	0.1V/1 V
	ACA	1mA/ 10mA	0.1mA /1mA
	WATT	0.1W/1W	0.01W/0.1W
Crest factor	ACV	2 max. at maximum display value	2 max. at maximum display value
	ACA	2 max. at maximum display or 30A peak, whichever is lowest	2 max. at maximum display value
	WATT	AC voltage, current (true rms) reading, single-phase effective power	AC voltage, current (true rms) reading, single-phase effective power
Inherent power dissipation	ACV	0.20VA at 250V	0.13VA at 250V
	ACA	0.016VA at 2A 1.0VA at 15A	0.001VA at 0.2A 0.15VA at 2A
(Approx. values at 55Hz)			
Maximum allowable input (continuous)	ACV	250 V	250 V
	ACA	15 A	4 A

3-2 Common Specifications

Display: 3-1/2 digit, LED (maximum display value of 1999)

Sampling rate: Approx, 5 samples/s

Measurement functions:

AC voltage and AC current — True rms reading
Same as for voltage and current — True rms reading
Single-phase effective power

Accuracy (Ambient temperature 23℃±5℃ line power: 50/60Hz)

AC voltage: ±0.7% of rdg. ±1dgt.
AC current: ±0.5% of rdg. ±0.3% of fs
Single-phase effective power: ±0.5% or rdg. ±0.3% of fs (power factor 1.0)

Frequency response (with respect to 40 to 500Hz response)

AC voltage: ±0.5%
AC current: ±0.5%
Single-phase effective power: ±1% (power factor 1.0)

Influence of power factor: ±0.8% of rdg. at a power factor of 0.5

Temperature characteristics: ±2.0% at 0℃ to 40℃

Digital output: Cmoss level (high=5V, low=0V) (BCD code, decimal point, function, range, etc.)

Anolog output: Simultaneous 2V full scale DC output of voltage, corrent and power. (When measuring AC voltage, the 3182 outputs a DC voltage in the ratio of 1 Vdc for 100 Vac of input. This function operates only in the ACV range.)

Power requirements: 100/120/220/240VAC ±15% (one selected), 50/60Hz

Effect of line regulation: Specified accuracy satisfied within above specified line voltages ranges

Power consumption: Approx. 3W (approx. 4VA) (at 100VAC, 60Hz)

Outer dimensions: Approx. 85(H)×218(W)×240(D)mm (excluding protrusions)

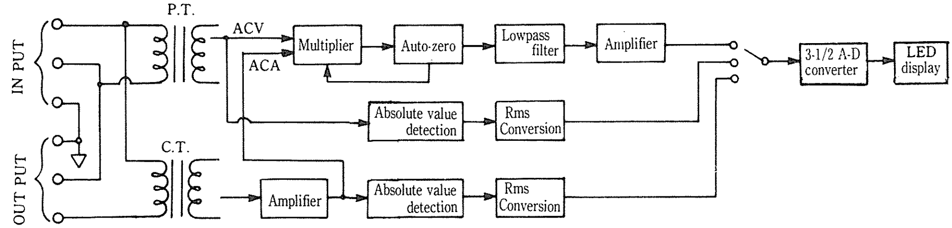
Weight: approx. 2.1kg

Accessories:

Fuse (250V/0.5A)
Power cord
Instruction manual

4. PRINCIPLE OF OPERATION

Fig. 4-1 Circuit Block Diagram



4-1 Single-Phase Effective Power Measurement

Fig. 4-1 shows the block diagram.

As shown in the figure, the line voltage and current of the device under measurement are detected by a power transformer and current transformer, respectively. The resulting detected signals are voltage level converter and input to a multiplier. Since the DC component of the output of this multiplier is proportional to the effective power, after the level is adjusted, this is displayed and output as the power value. Essentially, the voltage and current waveforms shown in Fig. 4-2 are described by equations 4-1 and 4-2.

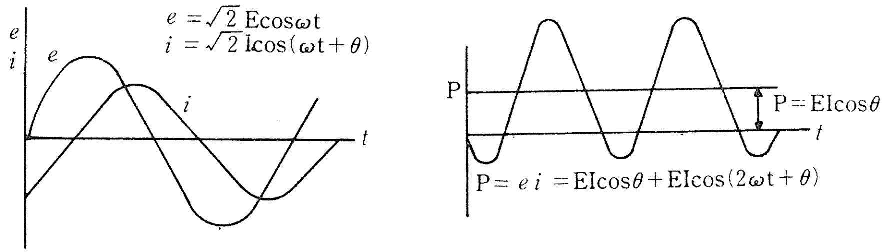


Fig. 4-2 Power Calculation Waveforms

Sinewave AC voltage $e=\sqrt{2}$ E cos ωt 〔V〕 (4-1)

Sinewave AC current $i=\sqrt{2}$ I cos (ωt+θ) 〔A〕 (4-2)

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

Instantaneous power $p = e\,i$

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

$$= EI\cos(2\omega t + \theta) + EI\cos\theta \ \text{〔W〕} \quad (4\text{-}3)$$

From the above, the effective power P=EIcos 〔W〕 is the DC componet of the product of the voltage and current (corresponding to the second term in equation (4-3)).

4-2 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 3182/3183, the true rms value is read by performing an absolute value detection circuit and a true rms value conversion circuit.

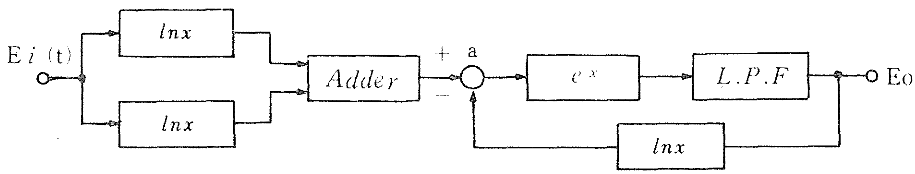


Fig. 4-3 True Rms Conversion Circuit

In the true rms conversion circuit shown in Fig. 4-3, if we observe point a, we will find the following relationship.

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

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

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

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

The rms value conversion circuit uses a monolithic rms conversion IC so that the risetime characteristics of the PN junctions forming the logarithmic and inverse log amplifiers are matched and thermal stability is achieved, providing ideal rms value conversion.

(Example)

Fig.4-4 shows the measurement error occurring when a thyristor (SCR) controlled current is measured.

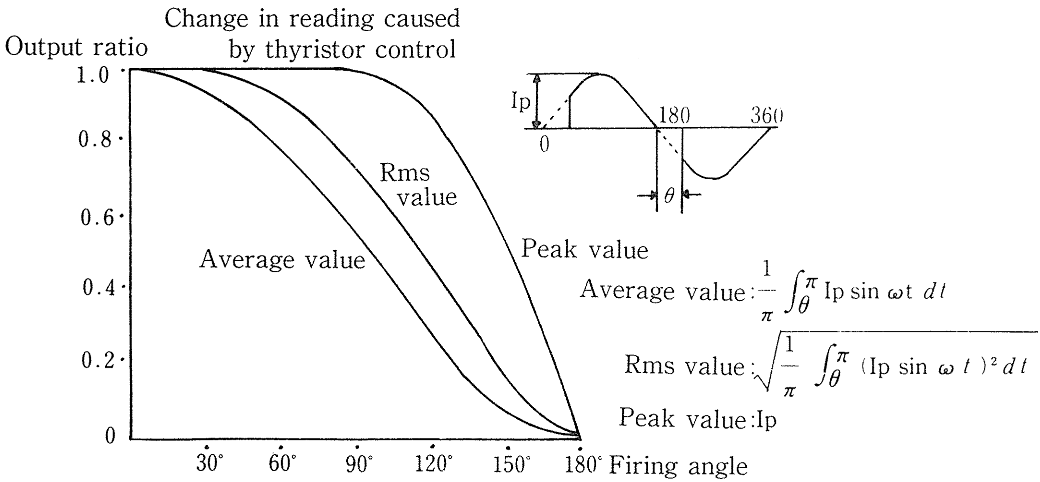


Fig.4-4

From Fig.4-4 it can be seen that there may be a large error between the rms value and the average value, depending upon the firing angle θ.

(With the firing angle at 90°, there is an approximate error of -30% in the average value with respect to the true rms value.)

4-3 Crest Factor

Crest factor is a measure of the dynamic range of a measurement, and is expressed as follows.

$$\text{Crest factor} = \frac{\text{Peak value}}{\text{rms value}}$$

In measurements in which the peak value is high but the rms value is low (e.g., in thyristor controlled waveforms), 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 3182/3183 has the following crest factor specifications for the various measurement functions.

	3182	3183
AC voltage	2 max. at maximum display value	
AC current	2 max. at maximum display value or 30A peak, whichever is lower	2 max. at maximum display value
Single-phase effective power	Same as for voltage and current	

For example, using the 3182 to measure AC current in the Lo range, since the maximum display value is 2A, the largest allowable peak value on the input being measured can be calculated as follows.

Crest factor=peak value

From the above definition of crest factor as (peak value/rms value), we have:

Peak value=rms value×crest factor

For ACA Lo range: 2A×2=4A (peak value)

In the Hi AC voltage range, since the maximum display value is 250V, we have for the ACV Hi peak the following.

ACV Hi range: 250V×2=500V (peak value)

5. NAMES OF PARTS

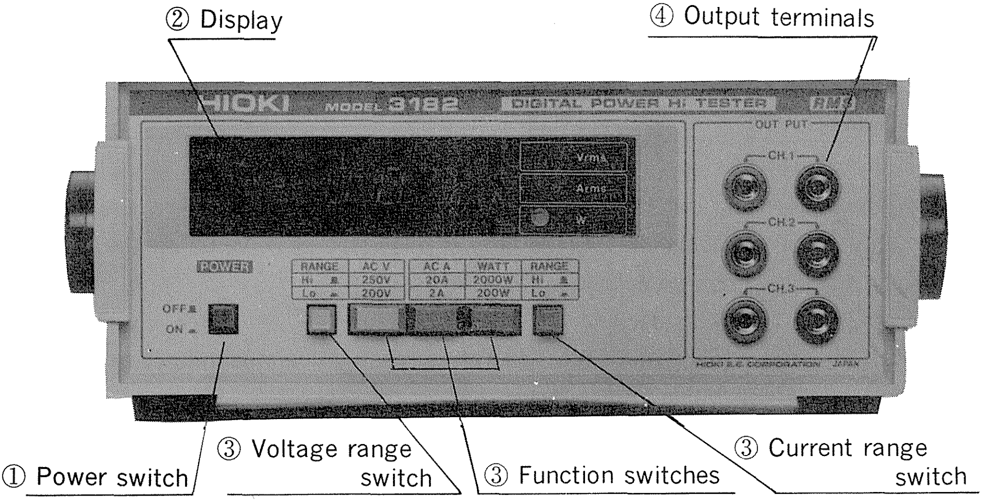


Fig.5-1 Front Panel Layout

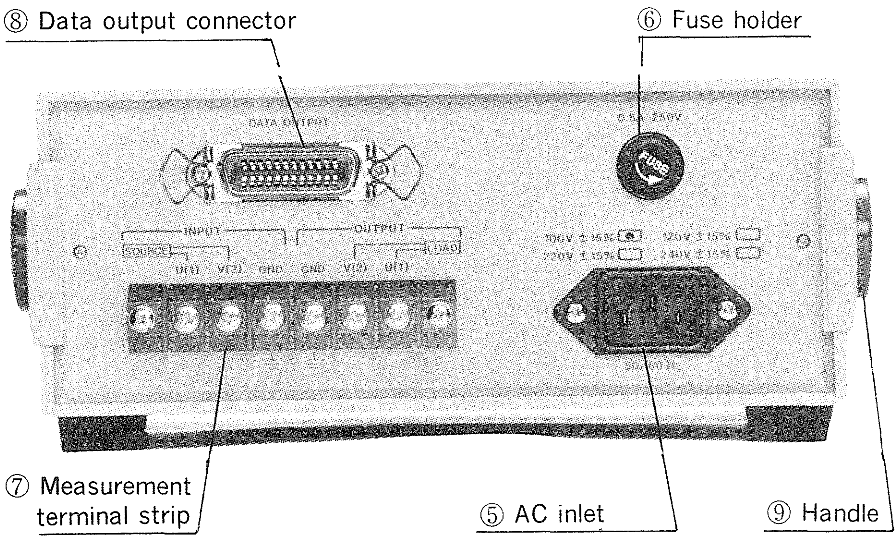


Fig.5-2 Rear Panel Layout

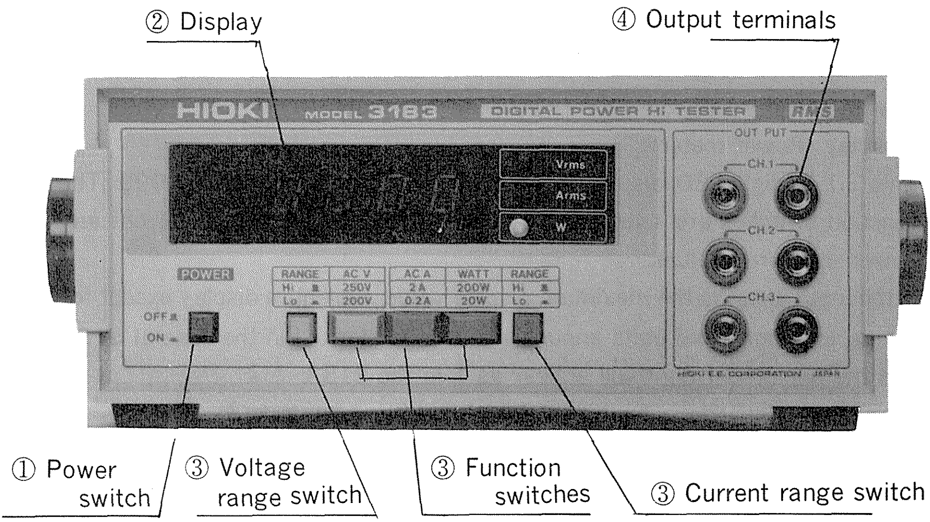


Fig.5-3 Front Panel Layout

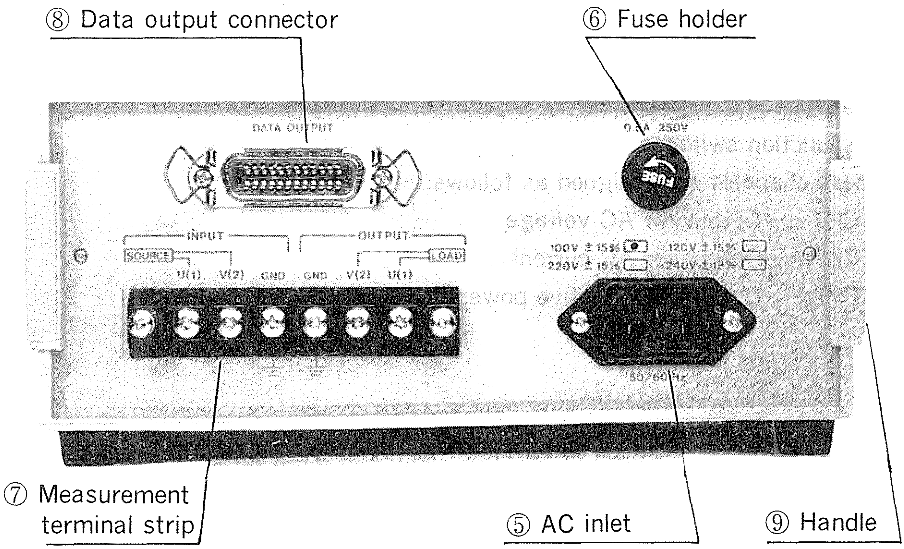


Fig.5-4 Back Panel

6. DESCRIPTION OF PARTS

① **POWER Switch**

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

② **Display** (Power meter)

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

If the input exceeds the maximum display value, the entire display except for the decimal point and units annunciator will be blanked in the case of 3182 and the uppermost digit will appear as 1 in the 3183.

③ **Range and Functions Switches** (RANGE, ACV, ACA, WATT)

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

A range switch is provided for the voltage function (blue) and for the current and power functions (gray).

④ **Output Terminals**

These output terminals make available DC voltages which are proportional to the measured values of voltage, current and power (2VDC/full scale). The exception to this is the voltage output (CH1) which is 2VDC for 200VAC.

The three channels are output simultaneously, regardless of the setting of the function switches.

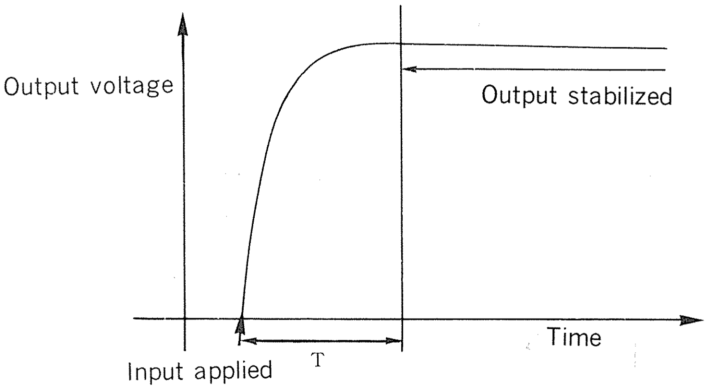
These channels are assigned as follows.

CH1······Output for AC voltage
CH2······Output for AC current
CH3······Output for effective power

⚠ CAUTION

Shorting between terminals or applying voltage to these terminals can cause damage to the 3182/3183 and should always be avoided.

The output response is as follows.



T=2.3s for voltage, current and power

⑤ **AC Inlet**

This inlet is used to apply line power to the instrument using the accessory power cord.

The line voltage appropriate to the particular instrument being used is indicated above the AC inlet. Under no circumstance should the instrument be operated off of a power line having a voltage different than this marking.

⑥ **Fuse Holder**

A 250V/0.5A fuse is used. When replacing the fuse, always remove the power cord first.

⑦ **Measuring Terminal Strip**

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.

⑧ **Data Output Connector**

This connector is used to make connection to the HIOKI GP-IB Interface Adaptor using a connecting cable.

When this unit is not used, do not connect any equipment to this connector, as applying voltage to or shorting the terminals of this connector can cause damage.

⑨ Handle

As shown in Fig.6-1, the handle may be rotated and set at 30 °detents by sliding the grips 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 to fix it in position.

The handle can be used as a stand to incline the instrument but force should not be applied to the instrument from above when using it in this manner.

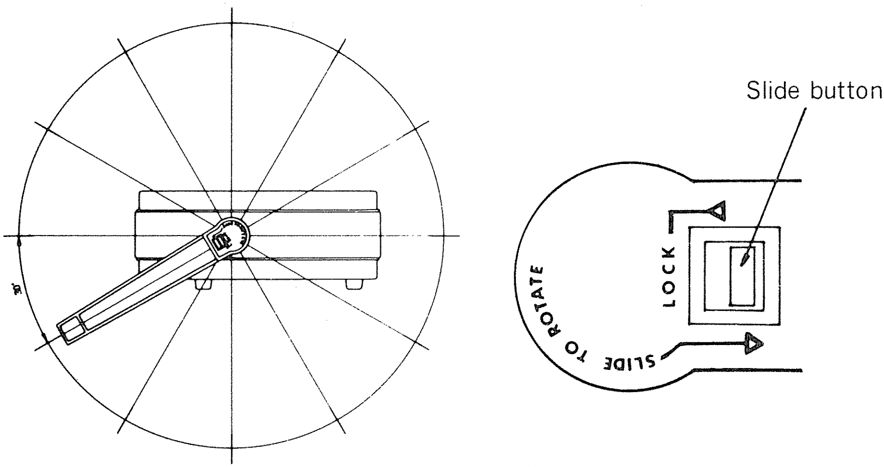


Fig.6-1 Handle

7. OPERATION

① **Before measuring, turn the power on and leave the instrument powered ON for approximately five minutes of warm up.**

② Set the range switches appropriate to the voltage and current levels to be measured. If these are not known, select the Hi range.

③ Connect the power line and the equipment to be measured as shown in Fig. 7-1, close the protective cover and apply power ((a)or (b) connection can be used).

④ By changing the function switch setting, the various measured values may be displayed. Do not press two or more function switches at the same time as this can cause damage. With all function switches OFF (i. e., not depressed), the 3182 display will indicate "−0000" (flashing sign) and the 3183 will indicate "0000".

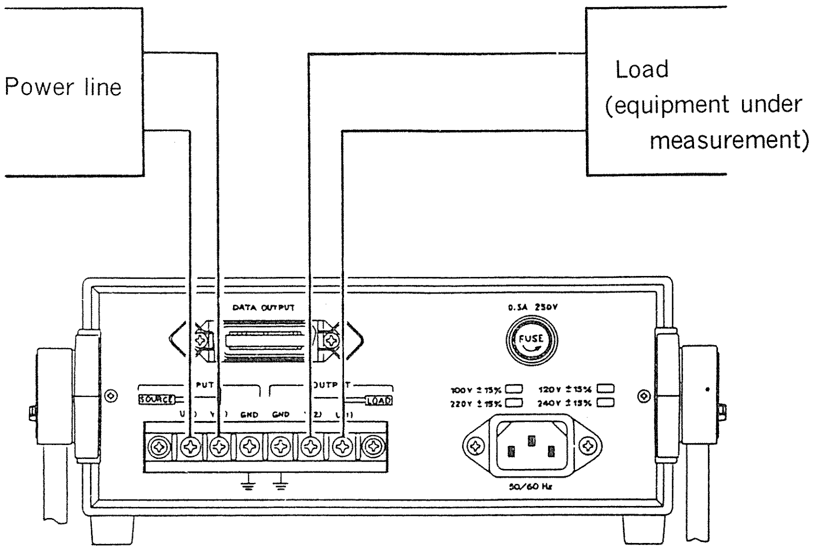


Fig.7-1 (a)

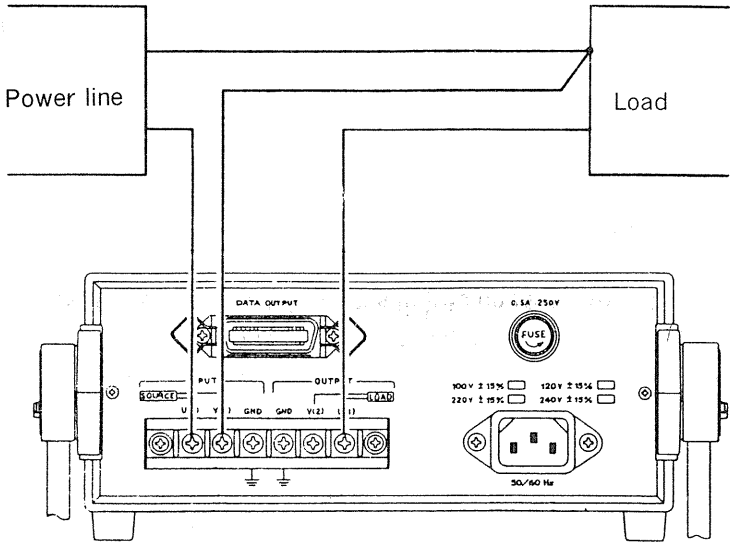


Fig.7-1 (b)

Notes

1) Always be use to observe the connection methods shown in Fig.7-1.
2) It is extremely dangerous to make power line connection or connections to the equipment under measurement while the power is applied. Always remove power first.
3) To ensure stable, safe operation, always connect the GND terminal to an electrical ground. The two center terminals of the measurement terminals are ground terminals.
4) The measurement ranges are indicated in Fig.7-2. Care should be taken that excessive inputs are not applied.
5) If voltage only or current only is to be measured, the connections shown in Fig.7-3 and 7-4 can be used.

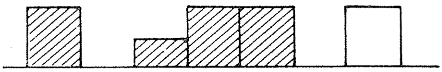
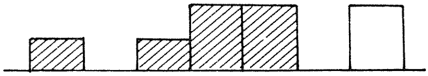
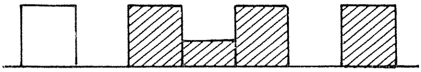
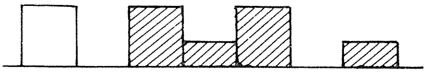
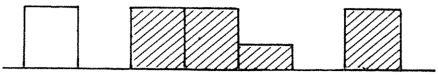
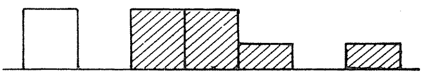
 Hi ACV	0~250V (250V max.)
 Lo ACV	0~200V (199.9V max.)
 ACA Hi	3182 : 0~15A (15.00A max.) 3183 : 0~2A (1.999A max.)
 ACA Lo	3182 : 0~2A (1.999A max.) 3183 : 0~0.2A (.1999A max.)
 WATT Hi	3182 : 0~2000W (1999W max.) 3183 : 0~200W (199.9W max.)
 WATT Lo	3182 : 0~200W (199.9W max.) 3183 : 0~20W (19.99W max.)

Fig.7-2 Range and Function Switch Settings and Measurement Ranges

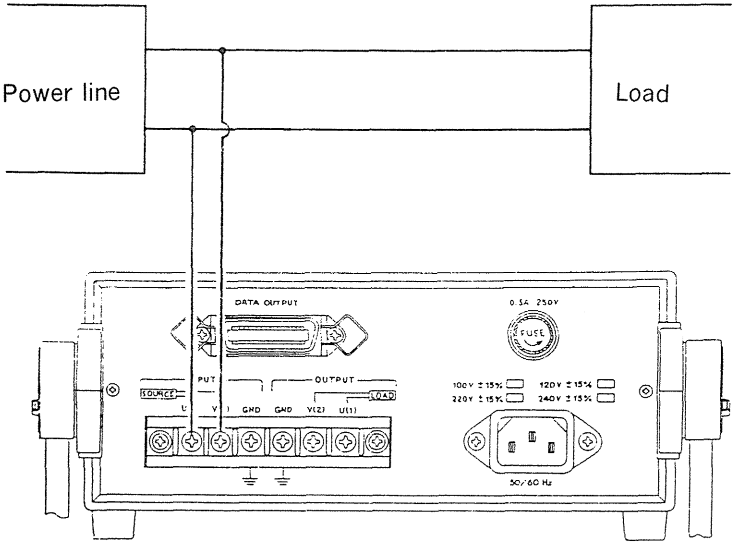


Fig.7-3 Voltage Measurement

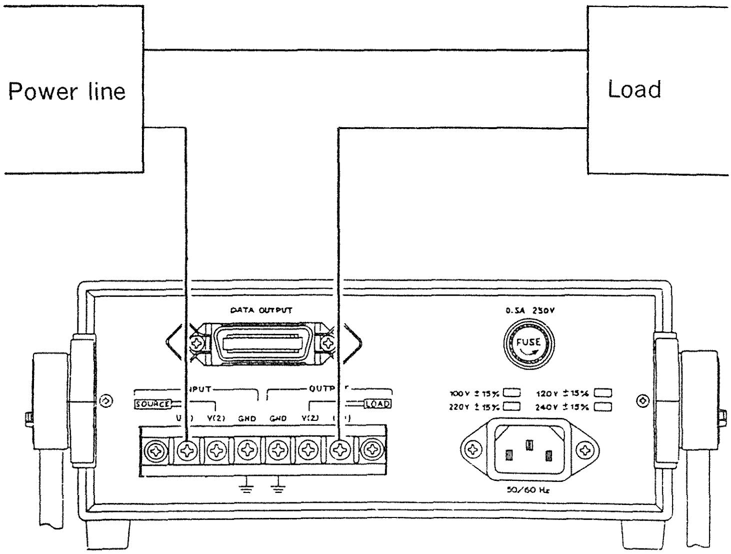


Fig.7-4 Current Measurement

8. APPLICATIONS

8-1. Using the Analog Output Terminals

The 3182/3183 has three analog output terminals on the front panel for voltage, current and power. These can be connected to a recorder to enable recording and observation of measured values. Since all three of these output channels are always active simultaneously, a digital multimeter can be connected to them to enable simultaneous observation of two or more quantities.

8-2. Determining the Power Factor

It is possible to calculate the power factor of the equipment under measurement from the measured values obtained using the 3182/3183.

$$\text{Power factor } \cos\phi = \frac{\text{Effective power [W]}}{\text{Reactive power [VA]}} = \frac{\text{WATT [W]}}{\text{ACV (B)} \times \text{ACA (A)}}$$

Essentially the measured power is divided by the product of the voltage and current to determine the power factor.

8-3. Inputs Exceeding the Measurement Range

If the voltage or current level of the equipment under measurement exceeds the measurement range of the 3182/3183, measurement should be performed after stepping these down using a power transformer and/or current transformer. Refer to Fig.8-1 for the proper method of connection.

Note, however, that such transformers have a phase error which can greatly affect the measured value of power and this an important consideration if accurate power measurement is required.

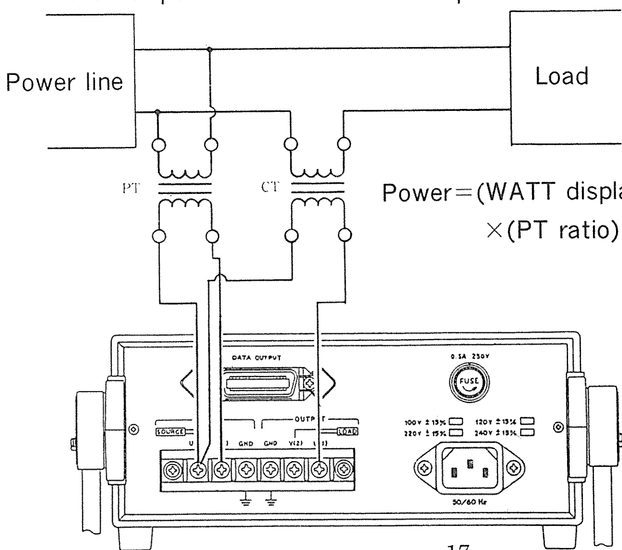


Fig.8-1
Power/Current Transformer Measurement Method

8-4. Three-Phase Three-Wire Connection

Two units may be used to calculate the algebraic sum of measured values, enabling the determination of three-phase power. Using this method as well, /a power or current transformer can be used if measurement ranges are exceeded.

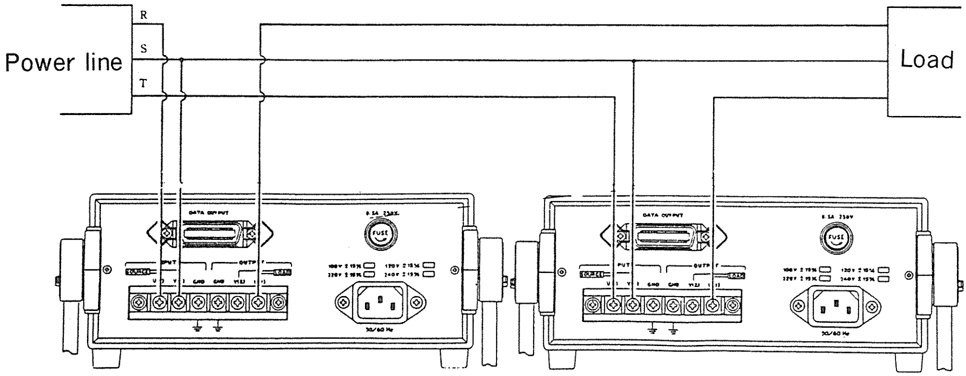


Fig.8-2 Three-Phase Power Measurement

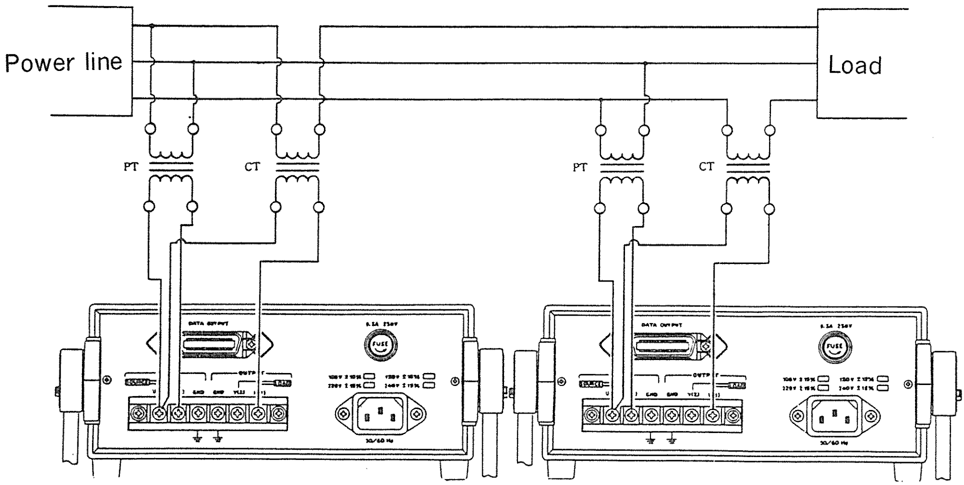
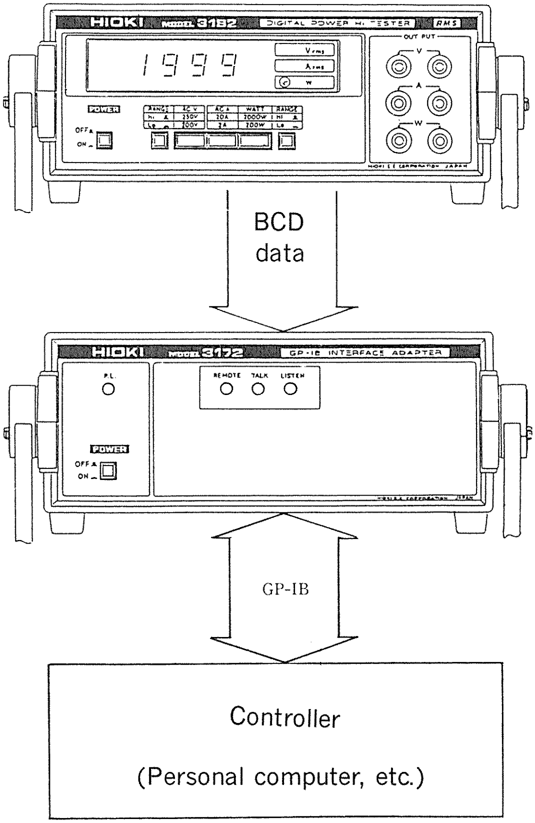


Fig.8-3 Three-Phase Power Measurement using Power/Current Transformers

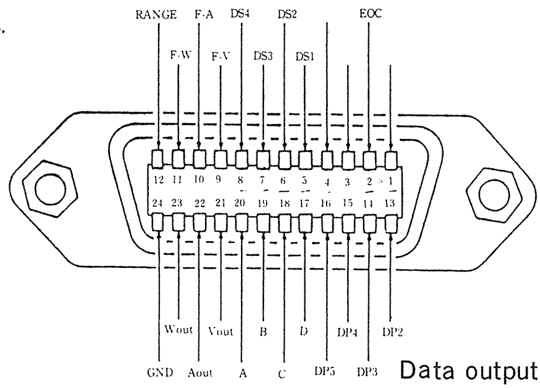
8-5. Using the GP-IB Interface Adaptor

The 3182/3183 may be used in combination with the model 3172 GP-IB Interface Adaptor enabling this bus to be used to read measured values (although functions and ranges may not be specified via the bus).

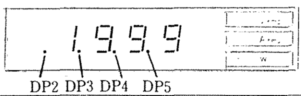


8-6. Data Output Connector

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



Data output pin arrangement

Pin No.	Name	Function
1.		.
2.	EOC	End of conversion. A pulse of approx. 6μs is output at the end of each conversion cycle.
3.		
4.		
5. 6. 7. 8.	DS1. DS2. DS3. DS4.	Digit select 1 to 4. A pulse of approx. 220μs is output when the corresponding digit has been selected. The EOC and DS1 to DS4 timing chart is shown in Fig.8-4.
9. 10. 11.	F—V. F—A. F—W.	Function V, A, W. A High-level (+5V) signal is output when the corresponding function has been selected from the front panel. Non-selected function lines are at low level (0V).
12.	RANGE	A high or low signal (+5V or 0V) is output depending upon the range corresponding to the function selected by the front panel switches.
13. 14. 15. 16.	DP2. DP3. DP4. DP5.	Decimal point 2 to 5. A high level (+5V) is output when the corresponding position has been selected as the decimal point position in the display and a low-level (0V) is output when the position is not the decimal point position. Note: The uppermost order digit is for model 3183 only. 
17. 18. 19. 20.	D C B A	BCD data. These lines are output in sync with the digit signals DS1 thru DS4.
21. 22. 23.	Vout Aout Wout	Voltage, current and power analog outputs. These are connected in parallel with the front panel output terminals.
24.	GND	Connected to the circuit common.

※ The sign, under range and over range are output in the following coded fashion when the DS1 digit signal (most significant digit) is output.

Most significant digit	D	C	B	A	B C D → 7-segment conversion
+ 0	1	1	1	0	Blank
− 0	1	0	1	0	〃
+ 0 UR	1	1	1	1	〃
− 0 UR	1	0	1	1	〃
+ 1	0	1	0	0	4 → 1
− 1	0	0	0	0	0 → 1
+ 1 OR	0	1	1	1	7 → 1
− 1 OR	0	0	1	1	3 → 1

Note

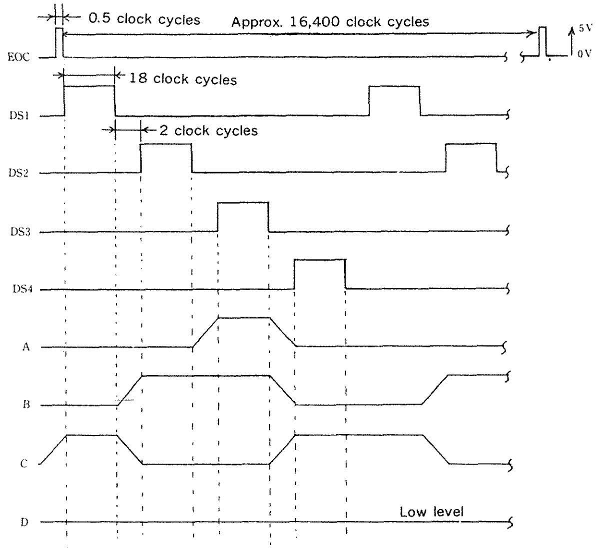
D: High level when the MSD is 0 and low level when 1.

C: High level when the sign is (+) and low level when it is (−).

UR……(Under range): A display count of 180 counts or less.

OR……(Over range): A display count of 1999 or greater.

Fig.8-4 Timing Chart (Output of **123.4**W from the 3182)



F-W, DP5 are high level (+5V)
F-V, FA, RANGE, DP3 and DP4 are low level (0V)

1 clock cycle: Approx. 12 μs

1 conversion rate: Approx. 0.2s

* The data output signals are CMOS high (5V) and low (0V) levels. Care should be taken when interfacing to other CMOS lines or to TTL families.

9. OPERATING PRECAUTIONS

① Operation in a strong electromagnetic field can cause erroneous operation and large measurement error. Always keep the instrument as far away as possible from such sources of strong magnetic fields.

⚠ WARNING

② When connecting the power and the load to the measuring terminal strip, always verify that power has been removed first, as making these connections with power applied is extremely dangerous.

③ Always verify the range to be used before beginning measurements and take care that excessive input is not applied.

④ The data output connector outputs are Cmoss high (5V) and low (0V) levels. Care should be taken when interfacing to other CMOS lines or to TTL families.

⑤ Care should be taken to short or apply voltage to the output terminals or pins of the output connector as this can cause failures.

⑥ Avoid using or storing the instrument in the following types of locations.

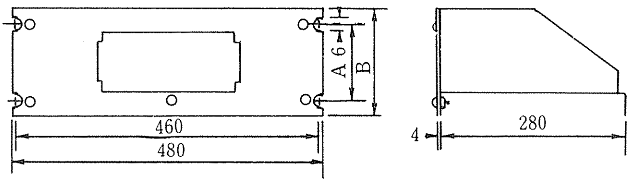
- ○ Locations subjecting it to excessive vibration and shock.
- ○ Locations subjecting it to direct sunlight, high temperatures and high humidity.

Particular care should be paid with respect to the front panel and case, as high temperatures can cause deformation and damage to these parts.

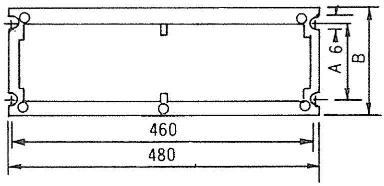
10. ACCESSORIES

Carrying case:	9084	(holds one unit)
Rack mount set:	9411	Japan Industrial standart for one unit
	9411-11	EIA rack for one unit
	9421	Japan Industrial standard for two units
	9421-01	EIA rack for two units

● 9410 series



● 9420 series



	JIS	EIA
A dimension	100	89
B dimension	149	132.5

Note

When mounting two units, it is necessary to remove the handle and machine away protrusions; it is impossible for this type of mounting to be made without such machining. For this reason, the 9420 rack mounts are fabricated on a per order basis.

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