Electronic Test
Instruments &
Power Supplies

HARMONICS ANALYZER

HA01-PCR-L

OPERATION MANUAL

KIKUSUI

KIKUSUI PART No. Z1-001-492 M-95020
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On Power Supply Source, it is requested to replace the related places in the operation manual with the following items.

(Please apply the item of ✓ mark.)

☐ Power Supply Voltage: to _ _ _ _ _ V AC

☐ Line Fuse: to _ _ _ _ _ A

☐ Power Cable: to 3-core cable (See Fig. 1 for the colors.)

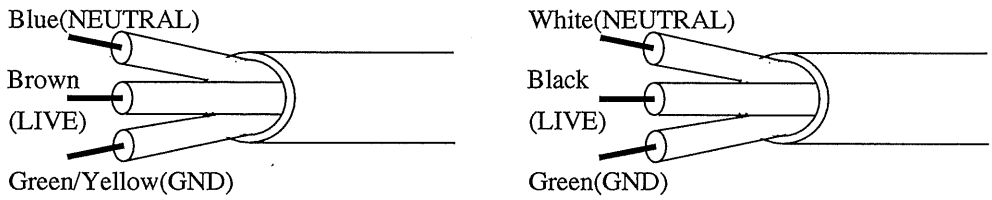


Fig. 1

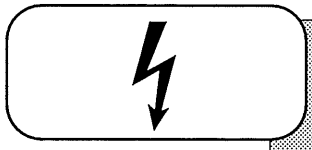
Please be advised beforehand that the above matter may cause some alteration against explanation in the operation manual.

* AC Plug: In case of Line Voltage 125V AC or more, AC Plug is in principle taken off and delivered, in view of the safety.
(AC Plug on 3-core cable is taken off in regardless of input voltages.)
To connect the AC plug to the AC power cable, connect the respective pins of the AC plug to the respective core-wires (LIVE, NEUTRAL, and GND) of the AC power cable by referring to the color cables shown in Fig. 1.

Before using the instrument, it is requested to fix a suitable plug for the voltage used.

USER SAFETY

This Operation Manual and the harmonics analyzer use the following safety symbols. Note the meaning of each of the symbols to ensure safe use of the HA01-PCR-L harmonics analyzer.



Indicates the presence of 1000 V or higher.
Never attempt to touch this part.

WARNING

Indicates the possibility of personnel injury or death.
Never fail to follow the operating procedure.
Do not proceed beyond a WARNING sign until the noted conditions are fully understood and met.

Caution

Indicates the existence of damage to this product or connected equipment.
Always follow the operating procedure. Do not proceed beyond a Caution sign until the indicted conditions are fully understood and met.

Note

Indicates additional information such as operating procedure.

Description

Describes technical terms used in this manual.

When this mark is indicated on the instrument, refer the relevant section of the Operation Manual.

Indicates a grounding (earth) terminal.

Indicates a chassis grounding terminal.

USE PRECAUTIONS

■ AC input voltage

Always use AC input voltage within a specified voltage range.

■ Input power cable

Use the input power cable provided for the instrument.

■ Input fuse

Use input fuses suitable for the instrument.

■ Instrument covers

Never remove an instrument cover, as many instrument components are dangerous to touch.

■ Protective grounding terminals

To prevent electrical shock, always connect terminal G of the INPUT terminal board of the current sensor to terminal G of the OUTPUT terminal board of the PCR-L power supply. Check that the ⏚ terminal of the INPUT terminal board of the PCR-L AC power supply has been grounded.

■ Terminals

High voltage is applied to terminals.

Always attach a terminal cover to any terminals for use after wiring. This will prevent terminal contact, which can result in electrical shock.

■ Safety in the event of failure

If the instrument has a problem or failure, disconnect all cables from the PCR-L AC power supply.

Also, make sure that the instrument is not accidentally used before repair.

TABLE OF CONTENTS

INTRODUCTION

This Operation Manual describes the structure and electrical parts of the HA01-PCR-L harmonics analyzer.

For details on how to operate the instrument, follow the instructions given in the operation manual for the dedicated software.

For instructions on how to handle hardware, including the PCR-L AC power supply, see the operation manual of the relevant equipment.

General

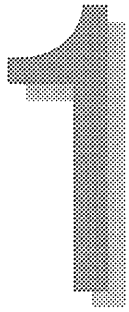
The HA01-PCR-L harmonics analyzer measures harmonic currents in a power line, including varying harmonic current. The instrument employs a time-domain measurement method using discrete Fourier transform (DFT) and is used in conjunction with a Kikusui PCR-L Series AC power supply.

Operations are achieved using dedicated software via an external personal computer. The HA01-PCR-L harmonic analyzer is an advanced measuring instrument that measures voltage fluctuation and current distortion factors in addition to harmonic current measurements.

The instrument consists of a harmonics analyzer, current sensor, and PCR-L interface.

Features

- Analysis of harmonic current including varying harmonic currents
- Continuous measurement for 2.5 minutes using a large-capacity memory
- High-speed data processing through a digital signal processor (DSP)
- High-precision voltage, current, and power measurements using 16-bit A/D converters that offer simultaneous voltage and current samplings
- Measurement of voltage fluctuations
- Meets International Electrotechnical Commission (IEC) standard(IEC 100-3-2) and Guideline to reduce Harmonic emissions caused by electrical and electronic equipment for household and general use.
- Can be used in conjunction with existing PCR-L AC power supplies



Chapter 1 SETUP

This chapter describes the basic procedures for unpacking and installing the harmonics analyzer.

(Operations other than those of the instrument are expressed in *italics*.)

1.1 Check at Unpacking

The instrument should be checked upon receipt for damage that might have occurred during transportation. Also check that all accessories have been provided.

Should the instrument be damaged or any accessory missing, notify your Kikusui agent.

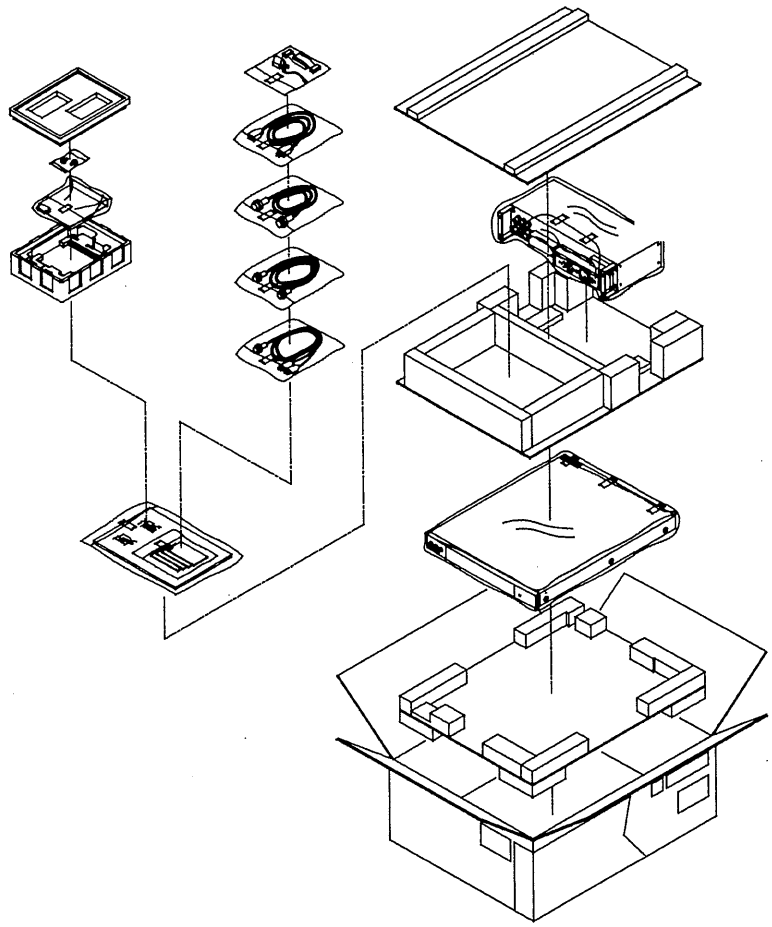


Fig. 1-1 Packing/Unpacking

Caution

- When the product needs to be transported, always use the dedicated packing materials (those used for delivery).

  If additional packing materials are required, contact your Kikusui agent.

- Disconnect the input power cable and other cables for packing.

	Accessories	Q'ty	Check
1	Current sensor cable (with 16 pins for current)	1	
2	Current sensor cable (with 3 pins for voltage)	1	
3	Voltage measurement cable with alligator clips	1	
4	PCR-L interface card	1	
5	PCR-L interface card flat cable	1	
6	PCR-L interface card mounting screws (M3)	2	
7	Input power cable	1	
8	3-pin to 2-pin conversion adapter for the input power cable	1	
9	Magnet sheets	4	
10	Operation Manual	1	

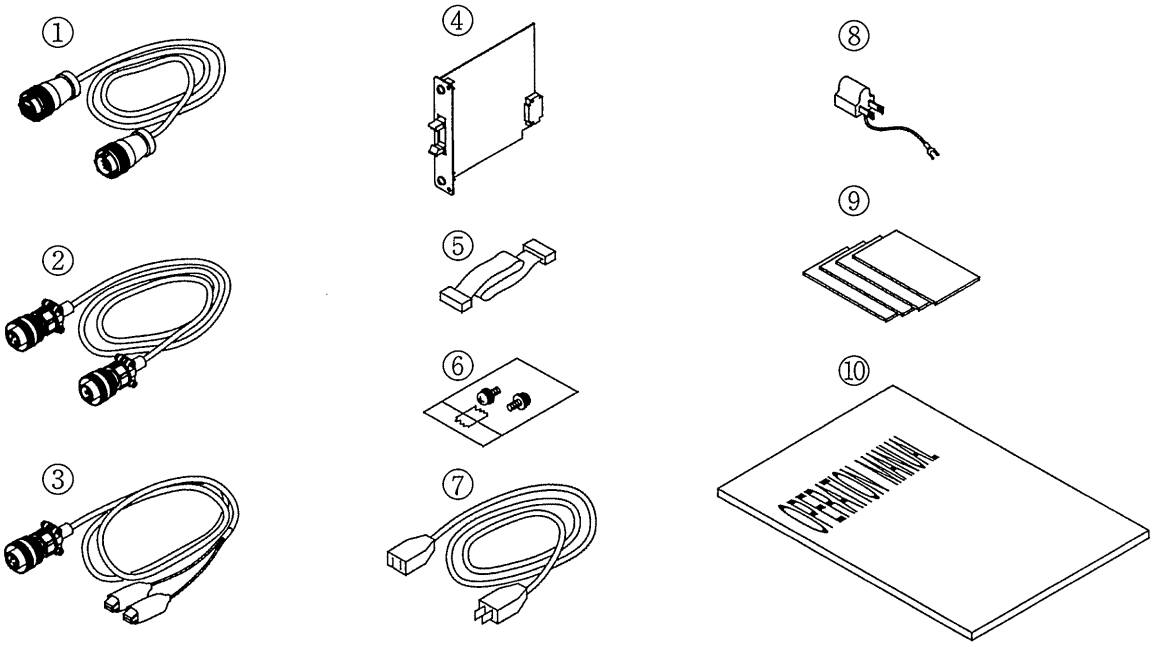


Fig. 1-2 Accessories

1.2 Installation Conditions

Do not install this instrument in the following locations.

■ Areas exposed to inflammable materials

To prevent explosions or fires, do not use the instrument in any areas exposed to inflammable materials such as alcohol or thinner.

■ High-temperature areas or areas exposed to direct sunlight

Do not place the instrument near a window, heating element, or heater, or in areas exposed to rapid temperature changes.

Operating temperature range: 23±5℃

■ Humid areas

Do not place the instrument in any humid areas such as near a water heater, humidifier, or water tap.

Operating humidity range: 20% to 80% R.H. (no dew condensation)

■ Areas exposed to corrosive gases

Do not use the instrument in any areas exposed to corrosive gases or sulfuric mist.

■ Dusty areas

Do not place the instrument in a dusty area.

■ Areas exposed to magnetic or electric fields

Do not use the instrument in any areas exposed to strong magnetic or electric fields.

1.3 Attaching Magnetic Sheets

① Turn the harmonics analyzer upside down and attach four magnetic sheets to the bottom of the analyzer.
For the location of magnetic sheets, see Fig. 1-3.

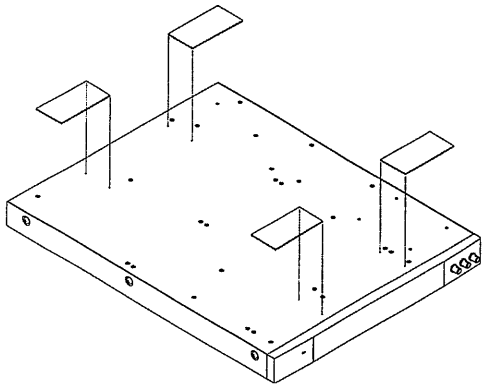


Fig. 1-3 Attaching Magnetic Sheets

② Turn the analyzer upright and place it on top of the PCR-L AC power supply.

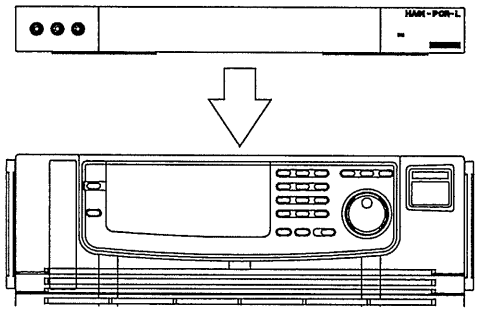


Fig. 1-4 Installing the Analyzer on an AC Power Supply

③ Check that the analyzer is firmly fixed by the magnetic sheets.

Caution

- Do not place any article on the harmonics analyzer.

  The top of the analyzer is not strong enough to support a heavy object and should also be free of any items for heat radiation. If another piece of equipment is above the analyzer, it should be kept at least 20 cm away. If such equipment generates heat, the analyzer should be kept at least 30 cm away.

- Handle with care to move the whole system by moving PCR-L AC power supply itself, because HA01-PCR-L is not physically mounted to PCR-L.

1.4 Grounding

Ground the instrument as follows:

① Connect terminal G of the INPUT terminal board of the current sensor to *terminal G* of the *OUTPUT terminal board* of the PCR-L AC power supply.

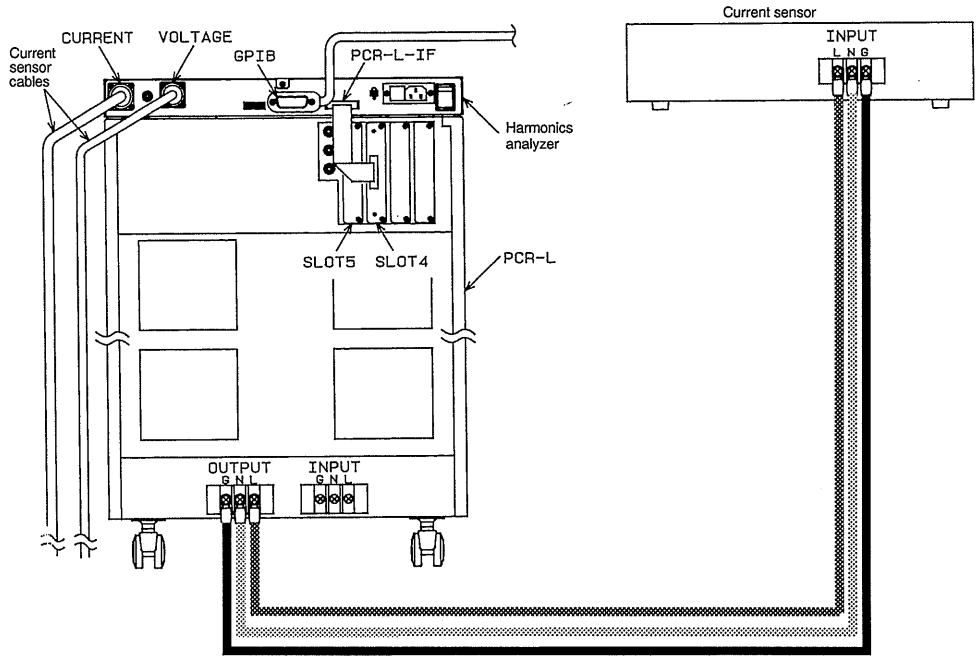


Fig. 1-5 Grounding

② Check that the ⏚ *terminal* of the *INPUT terminal board* of the PCR-L AC power supply has been grounded.

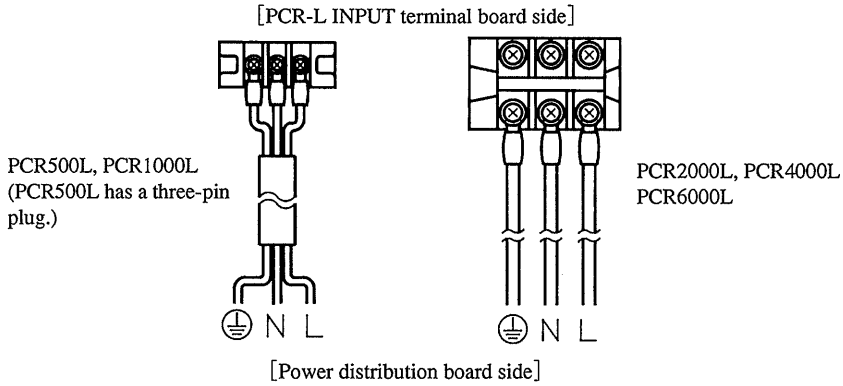


Fig. 1-6 Grounding Terminal of the PCR-L AC Power Supply

1.5 Connection to the PCR-L AC Power Supply

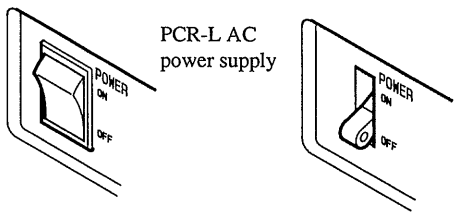
Caution

- The HA01-PCR-L harmonics analyzer is used in conjunction with a PCR-L AC power supply. However, the PCR-L AC power supplies with a built-in EMI filter (FL04-PCR-****L) cannot be used.
- Do not use the HA01-PCR-L in conjunction with a commercial power-supply system.

1.5.1 INPUT Terminal Board of the Current Sensor

Follow the steps below while referring to Fig. 1-7, "Connection to the PCR-L AC Power Supply."

① Turn OFF the *POWER switch* of the PCR-L AC power supply and also cut off the power feed from the power distribution board.



② Remove the transparent cover from the INPUT terminal board of the current sensor.
③ Connect the INPUT terminal board to the *OUTPUT terminal board* of the PCR-L AC power supply. Using the wires specified in Table 1-1, connect terminals L, N, and G to the appropriate terminals.

Load current	Conductor size	length
Up to 20 A RMS	5.5 ㎟ or more	30 cm or less
20 A to 40 A RMS	8 ㎟ or more	30 cm or less

Table 1-1 Wire Size

Note

- For more information on connection to the PCR-L AC power supply, see Chapter 5, "Connecting a Load" of the PCR-L Series Operation Manual.

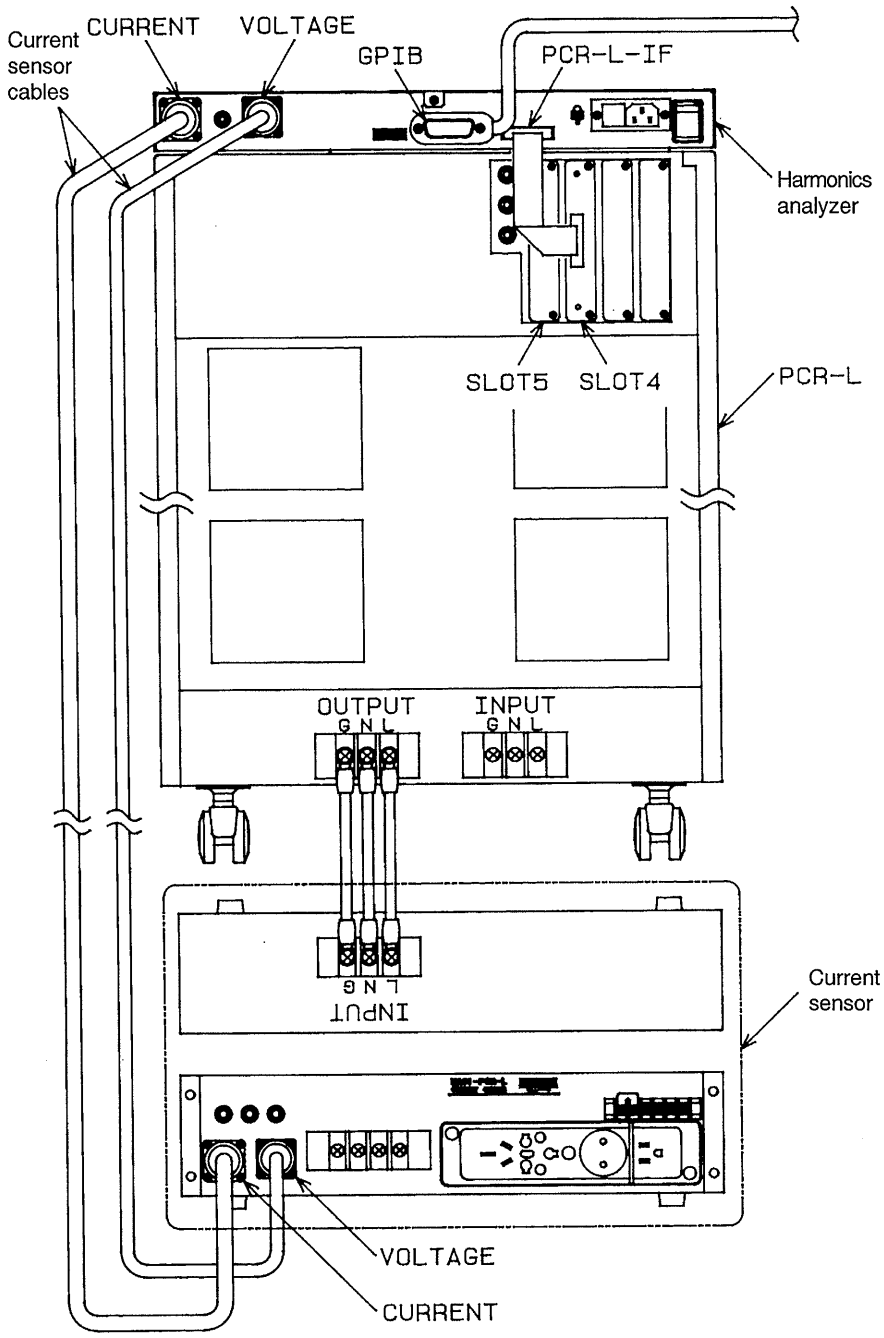


Fig. 1-7 Connection to the PCR-L AC Power Supply

④ Replace the cover removed in step ②.

Caution

- Never fail to install the cover on the INPUT terminal, as high voltage will be applied to the terminal.

1.5.2 Current-Sensor Cables

Two current sensor cables are provided: one with 16 pins for current signals and the other with 3 pins for voltage signals. The current sensor cables have a pin connector with a metal cover at one end and a socket connector with a metal cover at the other end.

The pin connector is connected to the current sensor; the socket connector is connected to the harmonics analyzer.

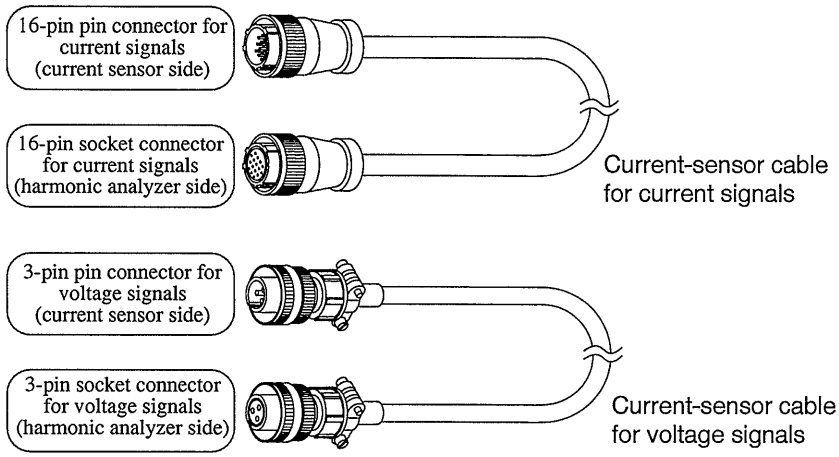


Fig. 1-8 Current-Sensor Cables

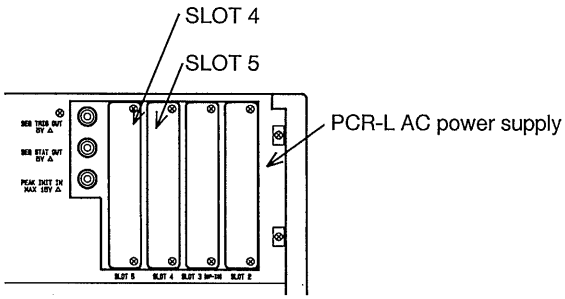
Connect the current-sensor cables between the current sensor and harmonics analyzer as shown in Fig. 1-7 and turn a locking ring to firmly connect the cables.

Caution

- The current sensor must be installed at least 20 cm away from other equipment to avoid electromagnetic interference.
- When the harmonics analyzer needs to be moved, always disconnect the current-sensor cables (both 16-pin current use and 3-pin voltage use) from the analyzer. Otherwise, stress will be applied to the connectors.
- Before disconnecting a current-sensor cable (either for 16-pin current use or 3-pin voltage use), always turn OFF the POWER switch of the harmonics analyzer.

1.5.3 PCR-L Interface Card

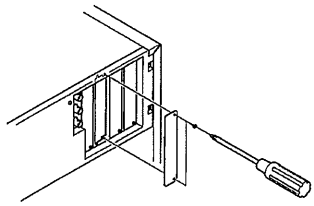
A PCR-L interface card must be installed in *slot 4 or 5* of the PCR-L AC power supply.



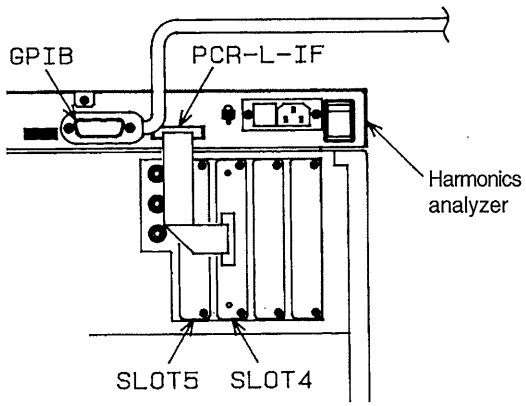
(1) Installing the PCR-L Interface Card

Before installing the interface card (hereafter referred to as "Card"), always turn OFF the *POWER switch* of the PCR-L AC power supply.

① Remove the *slot* cover.



② Hold the panel part of the Card.
③ Hold the Card so that the parts-mounted side of the Card PCB is to the right, and lower the PCB part onto the grooves of the slot.
④ Carefully insert the Card into the far end of the slot, making sure that the Card stays in the grooves.
⑤ After inserting the Card to the far end of the slot, fix it to the PCR-L AC power supply with the provided screws. This completes installation of the Card.
⑥ Connect the flat cable provided for the instrument between the Card's connector and the PCR-L-IF connector in the harmonics analyzer.



1.6 Connection When Using the LIN40M-PCR-L

Follow the procedure below while referring to Fig. 1-9.

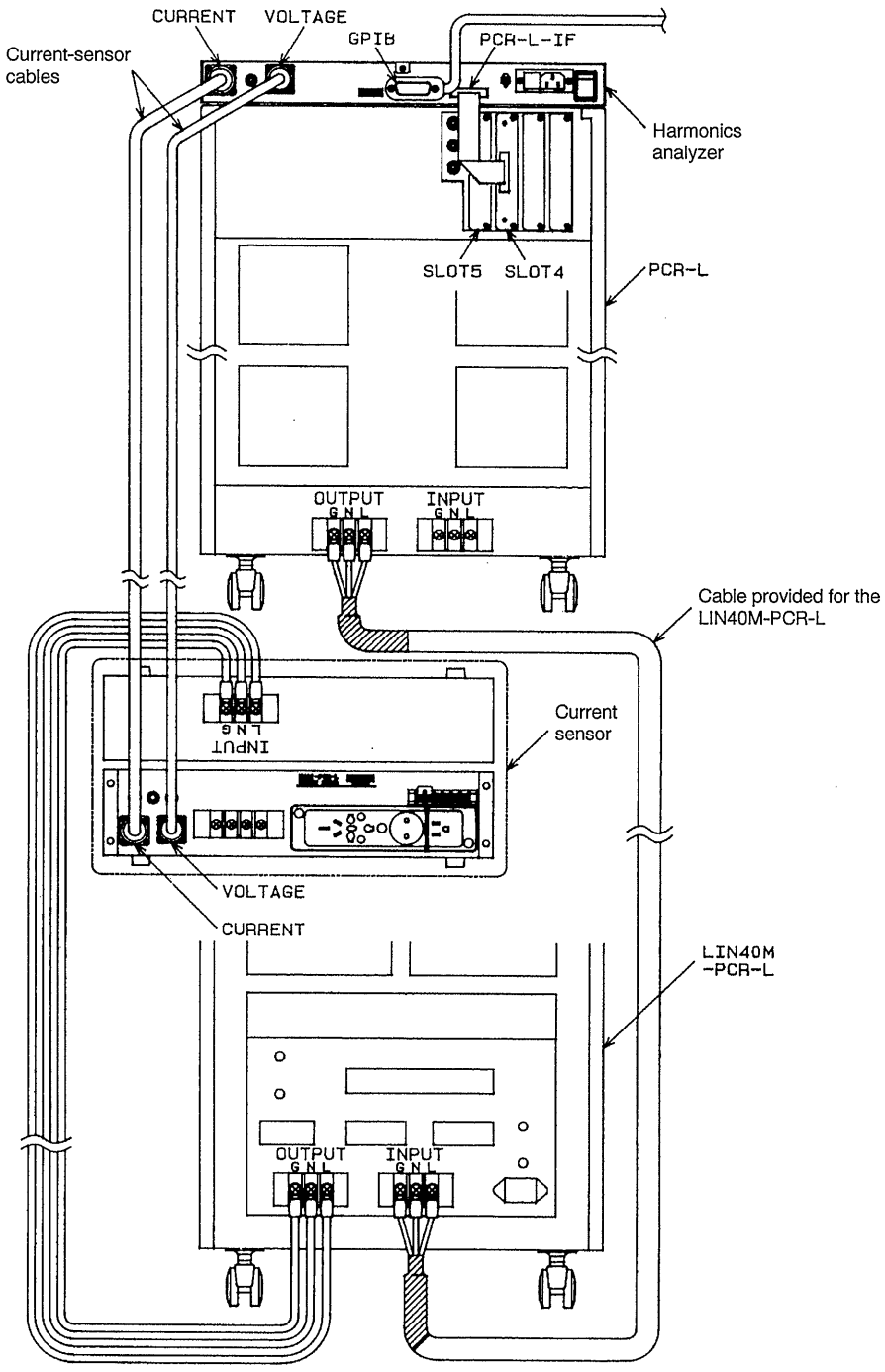


Fig. 1-9 Connection When Using the LIN40M-PCR-L

① Turn OFF the *POWER switch* of the PCR-L AC power supply and also cut off the power feed from the power distribution board.
② Remove the transparent cover from the INPUT *terminal board* of the current sensor.
③ Connect the INPUT terminal board to the *OUTPUT* terminal board of the LIN40M-PCR-L.
Using the wires specified in Table 1-2, connect terminals L, N, and G to the appropriate terminals.

Load current	Conductor size	length
Up to 20 A RMS	5.5 ㎟ or more	30 cm or less
20 A to 40 A RMS	8 ㎟ or more	30 cm or less

Table 1-2 Wire Size

Caution

- Always use the cable provided for the LIN40M-PCR-L for connection between the INPUT terminals of the LIN40M-PCR-L and the OUTPUT terminals of the PCR-L AC power supply.

1.7 Connecting the GPIB Cable

Caution

- Before connecting the GPIB cable, always turn OFF the POWER switches of the HA01-PCR-L harmonics analyzer and personal computer (PC) used to control the instrument.

Align the plug configuration of the GPIB cable with the connector configuration of the instrument, then connect the cable.

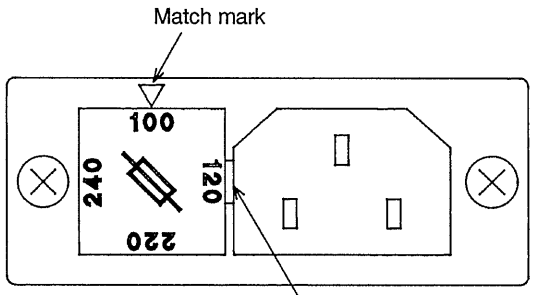
For requirements of the PC to be used for instrument control, refer to the instructions given in the operation manual for the software dedicated to the HA01-PCR-L.

Note

- No GPIB cable is provided for the HA01-PCR-L.

1.8 Connecting the Power Supply

① Check that no input power cable is connected to the AC INPUT of the harmonics analyzer.
② Switch the voltage selector that also acts as a fuse holder to the appropriate setting.
③ Connect the input power cable to the AC INPUT. Always use the input power cable provided for the HA01-PCR-L.



Insert the tip of a screwdriver here to remove the cover.
Set the indication corresponding to the input voltage range to the match mark, then replace the cover.

Fig. 1-10 Fuse Holder

Voltage Indications and Input Voltage Range

100	85V~110V	220	198V~242V
120	108V~132V	240	207V~250V

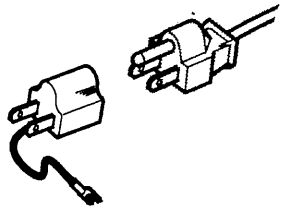
Table 1-3 Voltage Indications and Input Voltage Range

Fuses

Use 250 V, 1 A normal-type fuses (6.3 diameter × 32 mm).

Power plug

At shipment, the power cable has a plug configuration for use in North America.



A power plug with different plug configurations for other voltages should be obtained by the customer.

1.9 OPTION BRACKET

The following optioanal brackets are available to fix the current sensor on the PCR-L AC Power Supply.

MODEL	adapt to PCR-L AC Power Supply
KJB01 HA01-PCR-L	PCR1000L , PCR2000L
KJB02 HA01-PCR-L	PCR4000L , PCR6000L

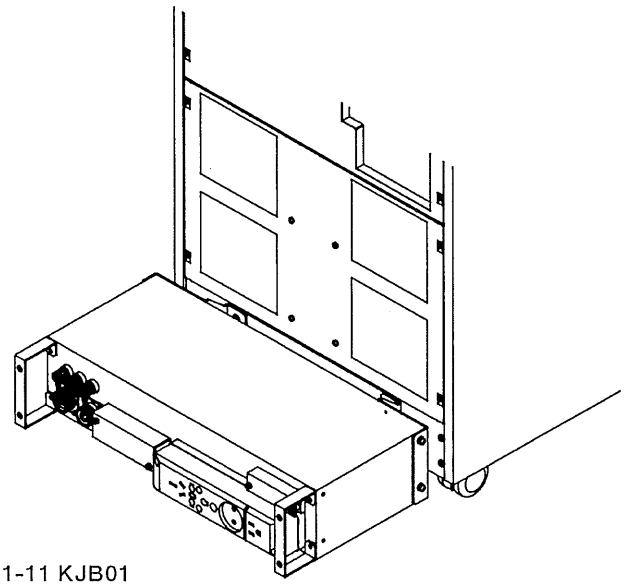


Fig. 1-11 KJB01

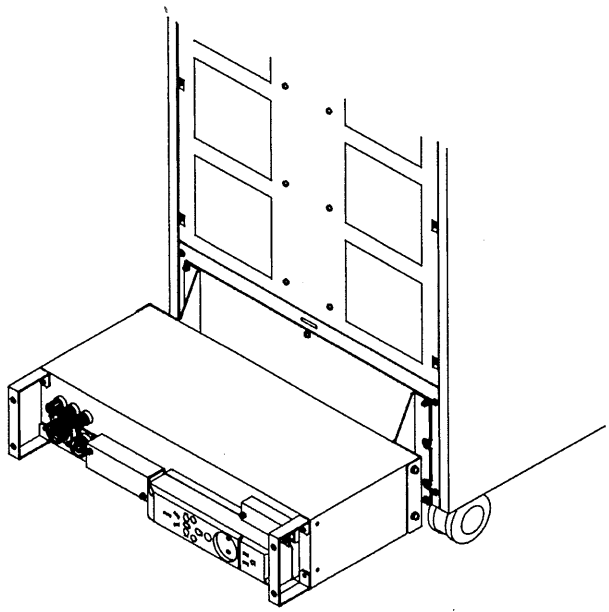
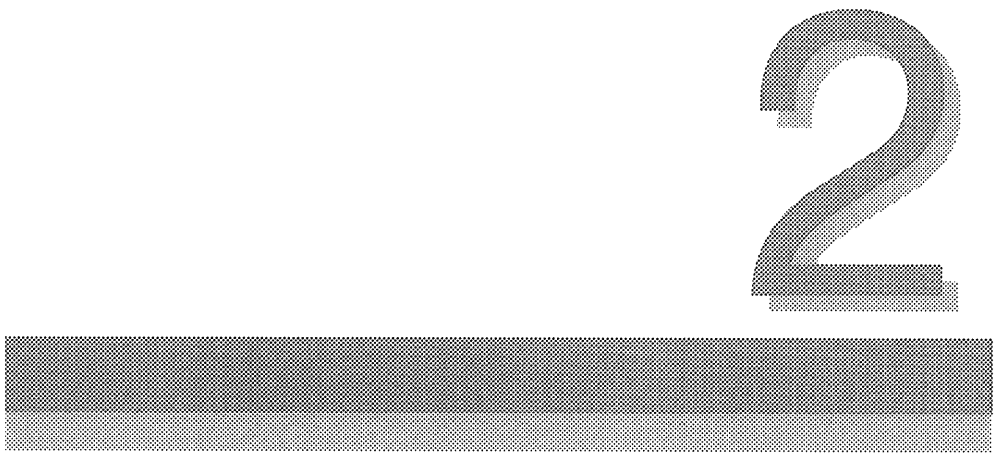


Fig. 1-12 KJB02



Chapter 2 OPERATION METHOD

This chapter describes operations from power-ON to actual operations.
(Operations other than those of the instrument are expressed in *italics*.)

2.1 Checking Power-ON Operations

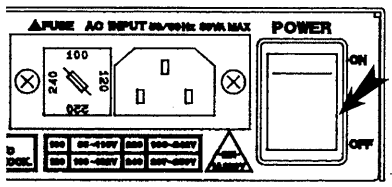
The HA01-PCR-L harmonics analyzer can be turned ON by either independent operation or controlled operation (controlled by a PCR-L AC power supply).

Caution

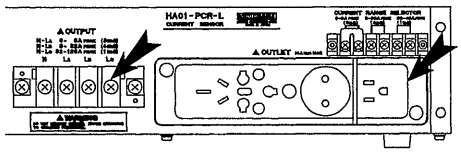
- To check power-ON operations, the OUTPUT terminal board and OUTLET of the current sensor should be free of cables.
- Check that the current-sensor cables (one with 16 pins for current signals and the other with 3 pins for voltage signals) are connected between the harmonics analyzer and current sensor.

2.1.1 Independent Operation

① Check that the POWER switch at the rear of the harmonic analyzer is OFF.

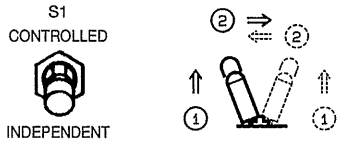


② Check that no cables are connected to the OUTPUT terminal board and OUTLET of the current sensor.



③ Check that the current-sensor cables (one with 16 pins for current signals and the other with 3 pins for voltage signals) are connected between the harmonics analyzer and current sensor.

④ Set the S1 switch at the rear of the analyzer to INDEPENDENT. (This switch is a lock-type toggle switch; pull and switch the knob.)



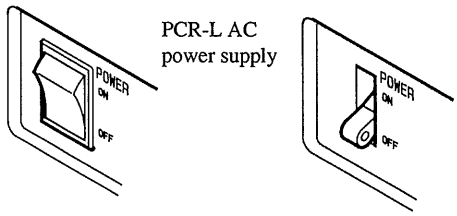
⑤ Turn ON the POWER switch at the rear of the analyzer. The green POWER LED on the front panel of the analyzer lights up.

This completes checking of the independent power-ON operation.

2.1.2 Controlled Operation (Controlled by the PCR-L AC Power Supply)

Checking controlled power-ON operation requires operations of the PCR-L AC power supply. Therefore, you should also refer to the operation manual for the AC power supply.

① Check that the POWER switch at the rear of the harmonics analyzer is OFF.
② Check that the *POWER switch* of the PCR-L AC power supply is also OFF.



③ Check that no cables are connected to the OUTPUT terminal board and OUTLET of the current sensor.
④ Check that the current sensor cables (one with 16 pins for current signals and the other with 3 pins for voltage signals) are connected between the harmonics analyzer and current sensor.
⑤ Set the S1 switch at the rear of the analyzer to CONTROLLED. (This switch is a lock-type toggle switch; pull and switch the knob.)
⑥ Turn ON the POWER switch at the rear of the harmonics analyzer.
⑦ Turn ON the *POWER switch* of the PCR-L AC power supply. This allows power to be fed to the instrument, lighting the green POWER LED on the front panel of the analyzer.
⑧ Turn OFF the *POWER switch* of the PCR-L AC power supply.

This completes checking of controlled power-ON operation.

Note

- For controlled operation, leave the POWER switch of the instrument ON. The instrument's power is automatically turned ON/OFF by turning ON/OFF the *POWER switch* of the PCR-L AC power supply.
- If the POWER switch of the instrument cannot be normally turned ON/OFF by controlled operation, check the following.
  ① A PCR-L interface card must be installed in *SLOT 4 or 5* of the PCR-L AC power supply.
  ② The PCR-L interface card connector must be connected to the PCR-L-IF connector of the instrument using the flat cable provided for the instrument.

2.1.3 Warm-up period

The instrument requires a warm-up period of more than 30 minutes before starting measurement operations.

2.2 How to Use Output Terminals

2.2.1 OUTLET (Multi-outlet)

This outlet is available when the input power cable of equipment whose harmonic current is to be measured has a power plug. The OUTLET is compatible with most of the power plugs used worldwide.

Countries	Standards	Plug configu-ration	Rating	WCF 5901	WCF 5900
Japan, USA, Canada	JIS UL CSA		2P 15A 125V	○	○
			Two pins and a ground 15A 125V	○	○
Australia	AS		2P 10A 250V	○	○
			2P 7.5A 250V	○	○
			Two pins and a ground 10A 250V	○	○
			Two pins and a ground 15A 250V	○	○
Swiss	SEV		2P 10A 250V	○	○
			Two pins and a ground 10A 250V	○	○
Italy	CEI		Two pins and a ground 10A 250V	○	○

Countries	Standards	Plug configu-ration	Rating	WCF 5901	WCF 5900
Europe	CEE DIN		2P 2.5A 250V	○	○
			2P 10/16A 250V	○	○
			Two pins and a ground 10/16A 250V Side-part earth	○	○
			Two pins and a ground 10/16A 250V Double earth	○	○
			Two pins and a ground 10/16A 250V Pin earth	×	○
United Kingdom	BS		2P 5A 250V	○	○
			Two pins and a ground 5A 250V	○	○
			Two pins and a ground 15A 250V	○	×
			Two pins and a ground 13A 250V	○	○

Excerpt from a catalog of Matsushita Electric Works

(1) Current-detection system

Figure 2-1 shows the principle diagram of current detection in the current sensor.

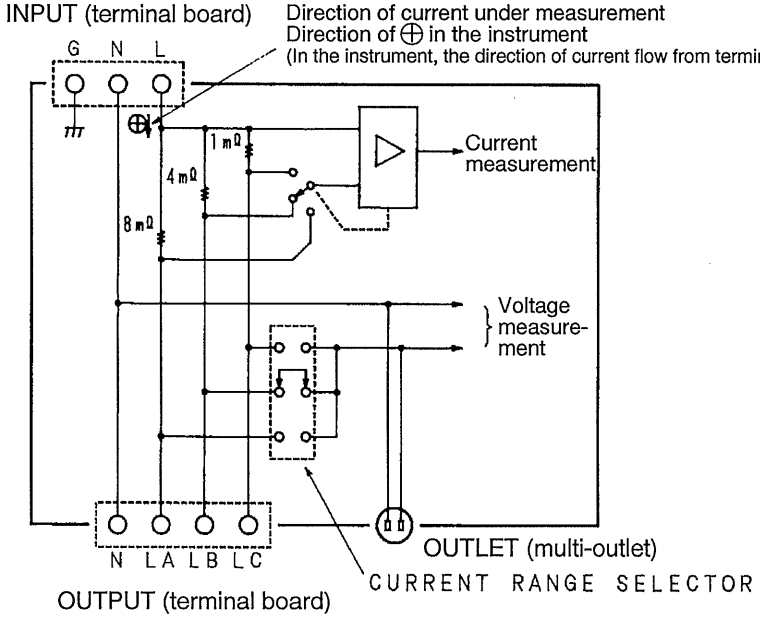


Fig. 2-1 Principle of Current Detection

(2) Setting the current-range selector

① Check that the *POWER switch* of the PCR-L AC power supply is OFF.

Caution

- High voltage is applied to the terminals. Always turn OFF the *POWER switch* of the PCR-L AC power supply before setting the current-range selector.

② Connect the power plug of equipment under test to the corresponding part of the OUTLET.
③ Remove the transparent cover from the current-range selector.
④ Install the short bar of the current-range selector in the position corresponding to the input current of the equipment under test. (See Description below.)
⑤ Replace the cover removed in step ③.

Caution

- High voltage is present at the terminals; always use the instrument with the transparent cover in place.

This completes the setting of the current-range selector.

Description

Further instructions on setting the current-range selector in relation to the power consumption of the equipment under test

◎For capacitor-input-type rectifying circuits

With a power factor of 0.6 and a current waveform crest factor of 3:

Position of the Short Bar and Power Consumption of Equipment Under Test

Short bar	100 V supply voltage	230 V supply voltage
0~8A peak	0~160W	0~368W
8~32A peak	160W~640W	368W~1.47kW
32A~45A peak	640W~900W	1.47kW~2.07kW

* Values in the table above are obtained by converting currents by RMS values. All rated currents are specified using peak values.

Caution

- The maximum load current of the OUTLET (multi-outlet) is 15 A RMS.
- As shown in Fig. 2-1, Principle of Current Detection, the current-range selector is used to select the current-detecting resistor. It also plays the role of switching the input of the terminal voltage measurement of the equipment under test.
- Since the measurement of the equipment's power is also important in the harmonic current measurement of the equipment's power line, the measurement of current and voltage is essential.

2.2.2 OUTPUT Terminal Board

(1) Connecting the equipment under test

Use the terminal corresponding to load current.

① Check that the *POWER switch* of the PCR-L AC power supply is OFF.

Caution

- High voltage is applied to the terminals. Always turn OFF the *POWER switch* of a PCR-L AC power supply before connecting the equipment under test.

② Remove the transparent cover from the OUTPUT terminal board.
③ Connect the input power cable of the equipment under test to the N-LA, N-LB, or N-LC terminal. (See Description below.)

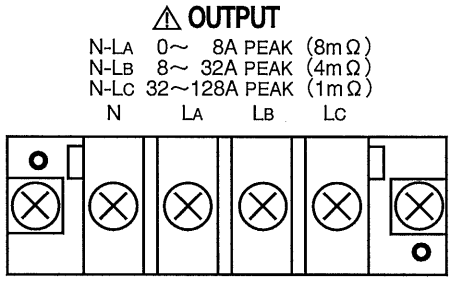


Fig. 2-2 OUTPUT Terminal Board

Description

Further instructions on selecting the terminal in relation to the power consumption of the equipment under test

◎For capacitor-input-type rectifying circuits

With a power factor of 0.6 and a current waveform crest factor of 3:

Terminal to be Connected and Power Consumption of Equipment Under Test

Terminal to be connected	100 V supply voltage	230 V supply voltage
N－L A (0~8A peak)	0~160W	0~368W
N－L B (8~32A peak)	160W~640W	368W~1.47kW
N－L C (32A~128A peak)	640W~2.4kW	1.47kW~5.52kW

* Values in the table above are obtained by converting currents by RMS values. All rated currents are specified using peak values.

④ Replace the cover removed in step ②.

Caution

- High voltage is applied to the terminals; always use the instrument with the transparent cover in place.

⑤ Set the current-range selector according to the table below.

Terminal to Which Equipment Under Test is Connected and Position of the Current-Range Selector's Short Bar

Terminal to which equipment under test is connected	Position of short bar
N-LA	0～ 8A PEAK
N-LB	8～32A PEAK
N-LC	32～45A PEAK

Caution

- Overcurrent flow may burn the current detecting resistor; the OUTPUT terminal board should be used at less than the peak current specified for each terminal. The terminal board is designed to withstand current twice the peak current of each terminal; however, allow the terminal board to cool for more than 30 minutes if current greater than the rated current flows.

(2) Using the OUTPUT terminal board together with OUTLET (multi-outlet)

Both the OUTPUT terminal board and OUTLET (multi-outlet) can simultaneously bear loads. However, make sure that the total value of current at the OUTPUT and OUTLET is within the set current range of the OUTPUT terminal board.

2.2.3 Maximum Measuring Current

Current detecting resistor	Current range	Maximum RMS to be measured	
		For a crest factor of 1.41	For a crest factor of 3
8mΩ	8A PEAK	5.65A RMS	2.66A RMS
4mΩ	32A PEAK	22.6 A RMS	10.66A RMS
1mΩ	128A PEAK	40.0 A RMS	40.0 A RMS

For more information on measurement ranges, see Appendix, "Relationship Between Peak Value and RMS Value for Voltage-and Current-Measurement Ranges."

2.3 How to Use as a Voltmeter

The HA01-PCR-L harmonics analyzer can be used as a general AC voltmeter to measure voltage inside equipment. However, this feature is not available if the instrument is being used for harmonic current measurements.

2.3.1 Connection Method

① As shown in the figure below, use the alligator clips provided with the instrument to connect the voltage measurement cable to the VOLTAGE INPUT connector of the harmonics analyzer.

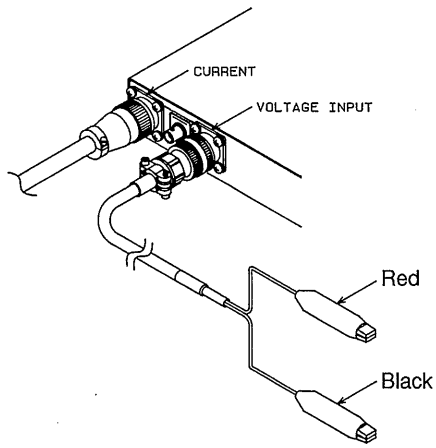


Fig. 2-3 Voltage Measurement Cable with Alligator Clips

② Connect the black alligator clip to a measuring point with lower potential with respect to the N terminal the current sensor's of INPUT terminal board.

③ Connect the red alligator clip to a measuring point with higher potential with respect to the N terminal of the current sensor's INPUT terminal board.

This allows the VOLTAGE INPUT connector to act as the input of an AC voltmeter.

2.3.2 Operating Conditions

Measurement range:

Measurement is available for 20 V, 40 V, 80 V, 160 V, 320 V, or 600 V.

Electrical conditions:

The fundamental waveform of a signal to be measured should be 50/60 Hz.

Electrical specifications at the input of a voltmeter:

Input resistance is approximately 4 MΩ.
Voltmeter input block is isolated from the current-detecting block (OUTPUT or OUTLET of the current sensor).
Withstand voltage is 600 Vpeak between the black alligator clip of the voltage measurement cable and the current-detecting block (OUTPUT or OUTLET of the current sensor).

Note

- Measured data may not return to 0 even when input is disconnected.
- The polarity of the power value measured may give a negative reading due to the phase of current under measurement.
- Measurement of a signal not synchronized with the PCR-L AC power supply may result in improper measurement results.

2.3.3 Maximum Voltage to be Measured

Voltage range	Allowable peak value	Maximum RMS to be measured
		For a crest factor of 3
600V RMS	848.5A PEAK	282V RMS

For more information about measurement ranges, see Appendix, "Relationship Between Peak Value and RMS Value for Voltage-and Current-Measurement Ranges."

Chapter 3 PART NAMES AND FUNCTIONS

This chapter denotes the names of indications, switches, and connectors on the front and rear panels of the instrument and describes the functions of the parts.

3.1 Front Panel of the Harmonics Analyzer

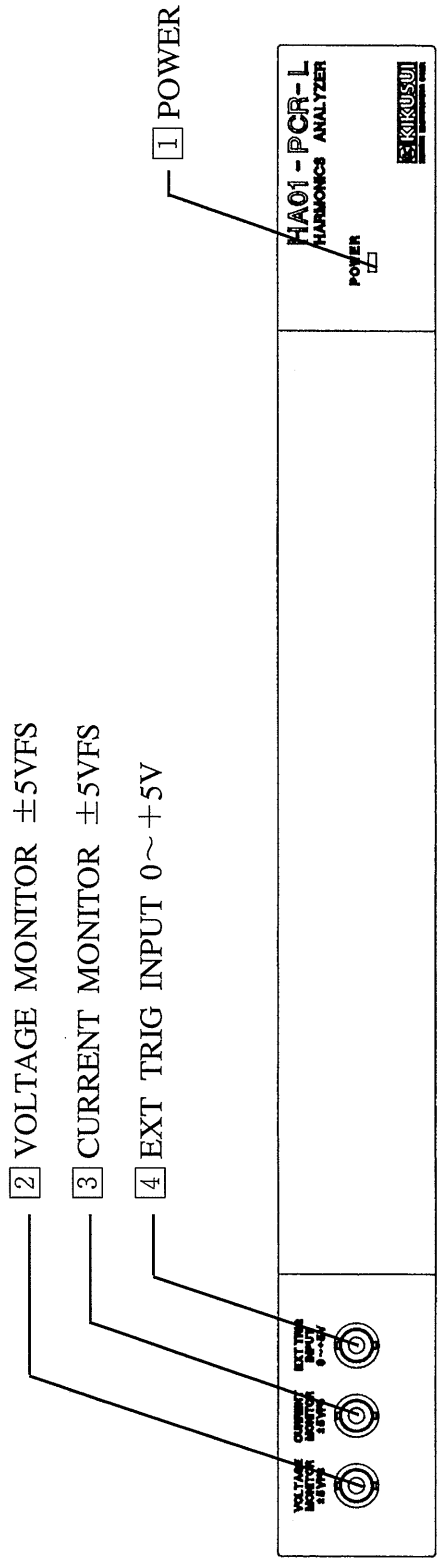


Fig. 3-1 Front Panel of the Harmonics Analyzer

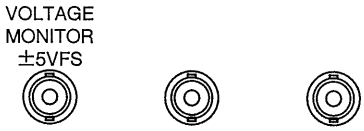
[1] POWER

Power indicator LED

[2] VOLTAGE MONITOR ±5VFS

Enables the monitoring instrument to output the voltage signal under measurement. This output connector allows an oscilloscope to be connected for waveform observation.

Output voltage is ±5 V full scale and is isolated from measured signals.



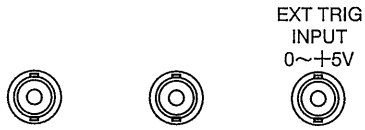
[3] CURRENT MONITOR ±5VFS

Enables the monitoring instrument to output the current signal under measurement. This output connector allows an oscilloscope to be connected for waveform observation. Output voltage is ±5 V full scale,and is isolated from measured signals.

[4] EXT TRIG INPUT 0 to +5V

Allows input of a trigger signal.

The terminal accepts a CMOS logic level signal of 0 to +5 V, which should be given at level L (0.9 V or less) for 1 μs or more. The validity of the input signal may depend on the software controlling the instrument.



Description

- The external metal parts of the VOLTAGE MONITOR, CURRENT MONITOR, EXT TRIG INPUT terminals have the same potential. These metal parts have a withstand voltage of 600 Vpeak with respect to the voltage or current-measurement terminal or measurement point.

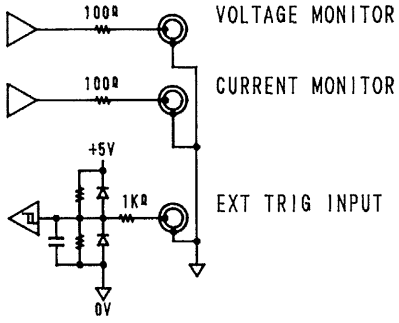


Fig. 3-2 BNC Connectors

3.2 Rear Panel of the Harmonics Analyzer

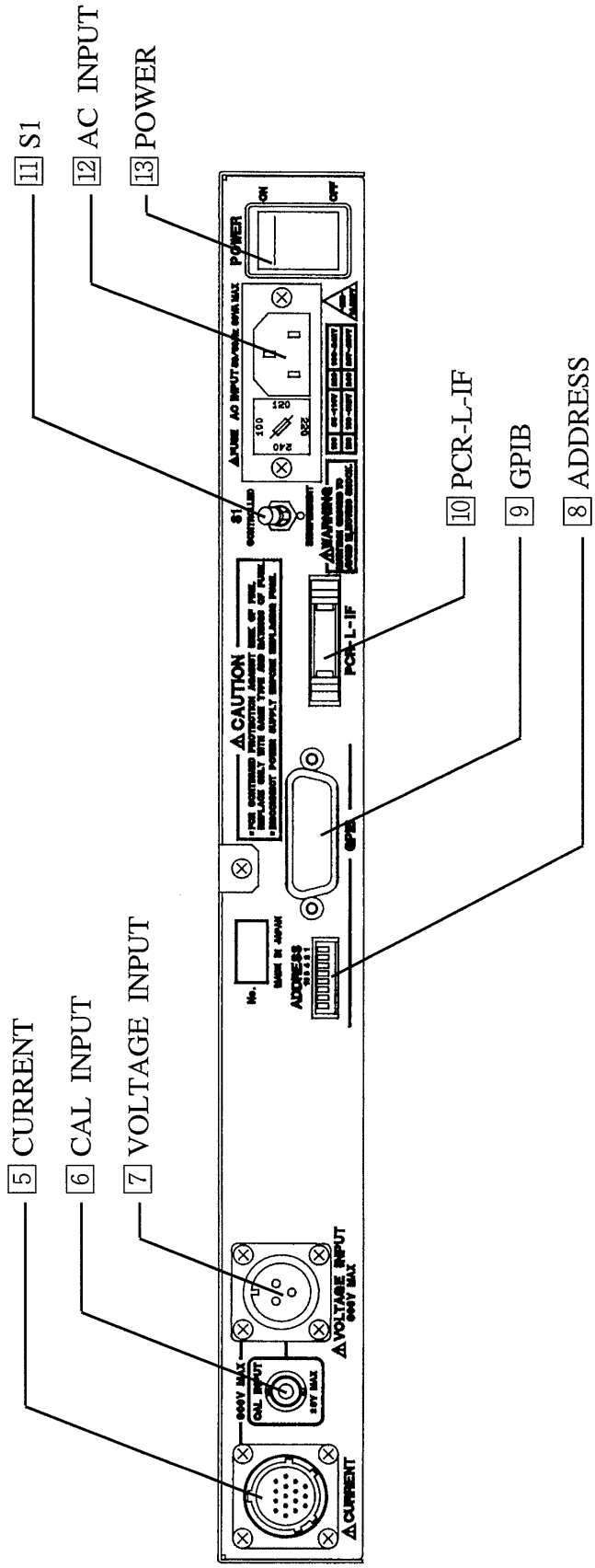


Fig. 3-3 Rear Panel of the Harmonics Analyzer

[5] CURRENT

Connects the current-sensor cable (with 16 pins for current use). This connector accepts the socket connector of the current-sensor cable.

[6] CAL INPUT

Input terminal for calibration. Generally, this terminal is not internally connected.

[7] VOLTAGE INPUT

Connects the current-sensor cable (with 3 pins for voltage use). This connector accepts the socket connector of the current-sensor cable. The connector also allows connection of the voltage-measurement cable using the alligator clips provided for the instrument. In this case, the maximum input is 600 V RMS and the withstand voltage to the current-sensor's current circuit (OUTPUT terminal board) is 600 Vpeak.

[8] ADDRESS

GPIB address setting switch. For instructions on use, refer to the Software Operation Manual.

[9] GPIB

GPIB connector for connecting a GPIB cable.

[10] PCR-L-IF

Connects the flat cable which is provided to connect the instrument to the PCR-L-IF interface card. The HA01-PCR-L receives synchronous clock pulses and controlled power-ON control signals from the PCR-L AC power supply through this cable.

[11] S1

Selects power-ON operation. This switch is a lock-type switch and requires the knob to be pulled for switching. The instrument is controlled by the *POWER* switch of the PCR-L AC power supply when the switch is set to CONTROLLED, or operates independently when set to INDEPENDENT.

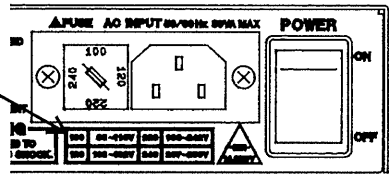
[12] AC INPUT

50/60 Hz 80 VA max

Input socket for power supply. The input power cable provided should be connected to this socket. The instrument requires selection of the voltage selector, which also acts as a fuse holder, in accordance with the supply voltage.

Fuse: 250 V, 1 A normal type (6.3 diameter × 32 mm)

100	85V~110V	220	198V~242V
120	108V~132V	240	207V~250V



[13] POWER

Power switch. When the S1 switch is set to CONTROLLED, use the instrument with the POWER switch set to ON.

3.3 Current Sensor

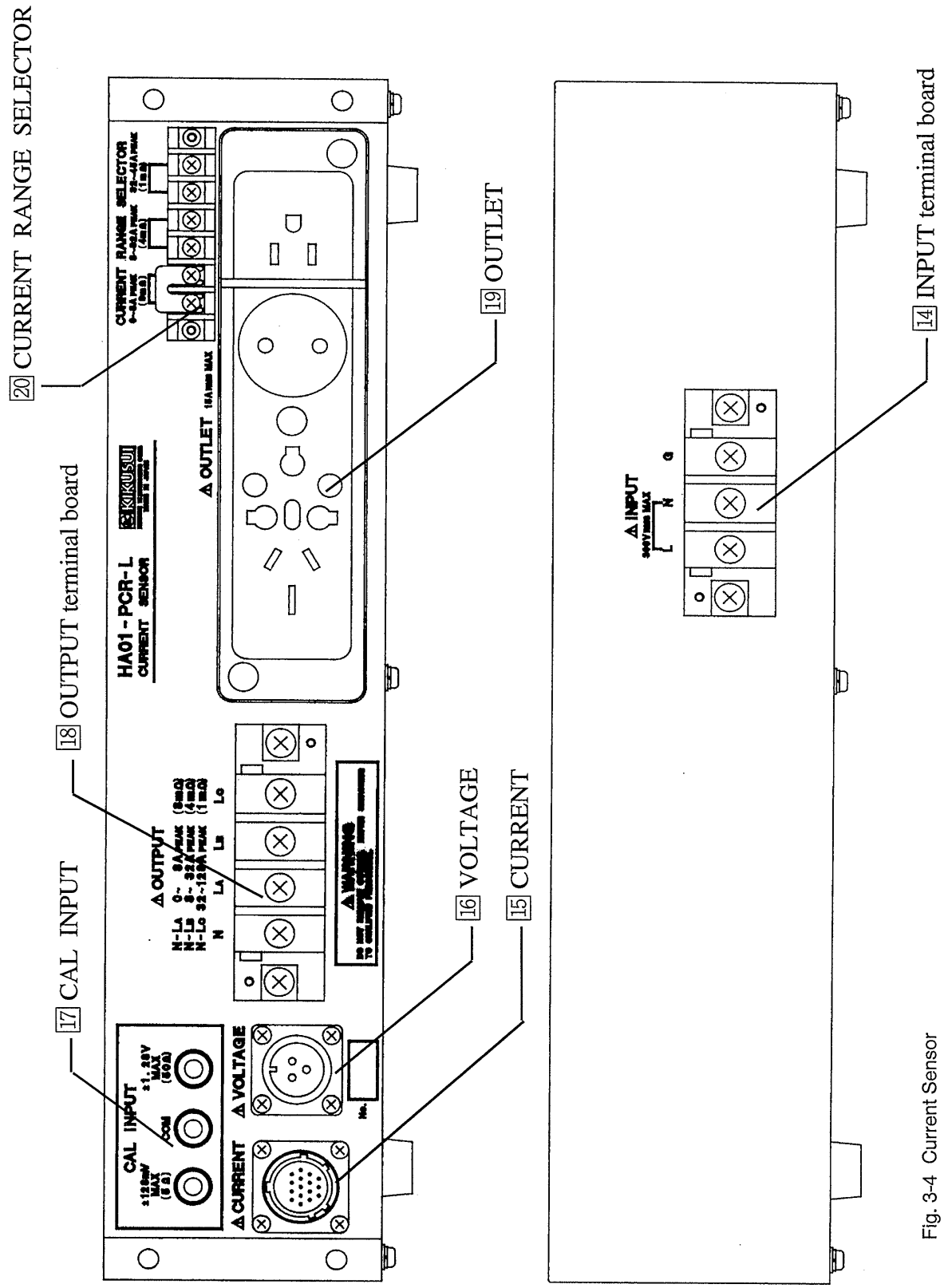


Fig. 3-4 Current Sensor

14 INPUT terminal board

Connect this terminal board to the OUTPUT terminal board of the PCR-L AC power supply or that of the LIN40M-PCR-L.

The current sensor has current-detecting resistors between its INPUT and OUTPUT terminal boards.

15 CURRENT

Connects the current-sensor cable (with 16 pins for current use). This connector accepts the pin connector of the current-sensor cable.

16 VOLTAGE

Connects the current-sensor cable (with 3 pins for voltage use). This connector accepts the pin connector of the current-sensor cable.

17 CAL INPUT

Input terminal for calibration. This terminal is not generally used for measurements.

18 OUTPUT terminal board

Output terminal board of the instrument. Connects the equipment under test (load). This terminal board can be regarded as an output terminal when the instrument is used in conjunction with the PCR-L AC power supply. The corresponding terminals must be used to meet the current-

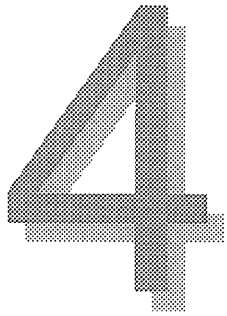
detecting resistance selected according to the load current.

19 OUTLET

Multi-outlets. If the input power cable of the equipment under test has a plug configuration, the input power cable is connected here. The OUTLET is compatible with most of the power plug configurations used worldwide.

20 CURRENT-RANGE SELECTOR

Since current-detecting resistance is selected in accordance with the load current from OUTLET, the corresponding range must be set using a short bar. The current-range selector also plays the role of switching the terminal voltage measurement of the equipment under test.



Chapter 4 MAINTENANCE AND CALIBRATION

This chapter describes how to maintain, inspect, and calibrate the HA01-PCR-L harmonics analyzer.

4.1 Cleaning

If the panel surface becomes dirty, gently wipe the surface using a soft cloth dampened with a diluted, neutral detergent.

Caution

- Always turn the POWER switch OFF before cleaning.
- Do not use volatile substances such as thinner or benzene. Otherwise, the panel surface may become discolored, printed letters erased, or the LED display may turn whitish.

4.2 Inspection

■ Input power cable and cables provided

Check the input power cable and cables for torn coverings, loose plugs or connectors, or cracks.

Caution

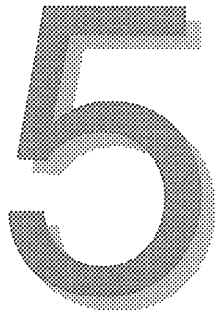
- The presence of a torn covering may result in electrical shock. Immediately stop using the instrument and replace the torn cord or cable with a new one.
- For purchasing of accessories, contact your Kikusui agent.

4.3 Calibration

The HA01-PCR-L harmonics analyzer has been properly calibrated upon shipment from the factory. However, recalibration may be necessary after long-term use.

Caution

- Since the product handles high voltage, calibration can be a dangerous operations. Accordingly, recalibration should only be performed by a Kikusui service engineer.



Chapter 5 SPECIFICATIONS

This chapter shows the electrical and mechanical specifications.

5.1 Current Measurement

Conditions where no specification is requested (fundamental wave: 50/60 Hz, temperature: 23±5℃)

Item		Conditions	Description
AC peak value measurement	Measurement range		1, 2, 4, 8, 16, 32, 64, 128A peak
	Maximum current RMS to be measured	· A value in parentheses indicates the current-detecting resistance. · For a crest factor of 1.41	5.65A RMS／8A peak (8mΩ) 22.6A RMS／32A peak (4mΩ) 40.0A RMS／128A peak (1mΩ)
	Accuracy	· At 50/60 Hz with filter set to OFF · Positive or negative peak value, whichever is greater.	1, 2, 4, 8, 16, 32A peak ranges: ±(0.75% of rdg + 0.2% of range) 64, 128A peak ranges: ±(2% of rdg + 0.5% of range)
	Frequency characteristics	· 50 Hz to 2.4 kHz, 50 Hz standard · With filter set to OFF	±0.75dB
AC-current RMS measurement	Measuring range		AC-peak value measurement range is used.
	Maximum RMS to be measured/peak current	· A value in parentheses indicates the current-detecting resistance. · For a crest factor of 1.41	5.65A RMS／8A peak (8mΩ) 22.6A RMS／32A peak (4mΩ) 40.0A RMS／128A peak (1mΩ)
	Accuracy	· "Range" refers to the range of peak-value measurement. · Input coupling is AC. · At 50/60 Hz with filter set to OFF	20 A RMS or less: ±(0.3% of rdg + 0.075% of range) More than 20A RMS to 40A RMS: ±(0.6% of rdg + 0.15% of range)
	Frequency characteristics	· 50 Hz to 2.4 kHz, 50 Hz standard · With filter set to OFF	±0.5dB
Current-detecting resistance (nominal value)			1 to 8A peak range: 8mΩ 8 to 32A peak range: 4mΩ 32 to 128A peak range: 1mΩ

5.2 Voltage Measurement

Conditions where no specification is requested (fundamental wave: 50/60 Hz, temperature: 23±5℃)

Item		Conditions	Description
AC voltage RMS measurement	Measurement range	For a crest factor of 1.41	20, 40, 80, 160, 320, 600V RMS
	Maximum voltage to be measured		600V RMS
	Accuracy	· At 50/60 Hz with filter set to OFF	± (0.3% of rdg + 0.075% of range)
	Frequency characteristics	· 50 Hz to 2.4 kHz, 50 Hz standard · With filter set to OFF	±0.5dB
Input resistance			Approx. 4MΩ

5.3 Harmonic Current Analysis

Conditions where no specification is requested (fundamental wave: 50/60 Hz, temperature: 23±5℃)

<table>
<tr><th colspan="3">Item</th><th>Conditions</th><th>Description</th></tr>
<tr><td colspan="3">Method</td><td></td><td>Time-domain-type measurement using discrete Fourier transform (DFT)</td></tr>
<tr><td colspan="3">Number of operation data points</td><td></td><td>256~16384</td></tr>
<tr><td colspan="3">Processing word length</td><td></td><td>32 bits</td></tr>
<tr><td colspan="3">Window
(Fundamental cycle count)</td><td></td><td>1, 2, 4, 8, 16, 32, 64</td></tr>
<tr><td colspan="3">Window function</td><td></td><td>Rectangular window</td></tr>
<tr><td colspan="3">Continuous analysis time</td><td></td><td>2.5 minutes maximum No gaps or overlap between windows</td></tr>
<tr><td rowspan="4">Harmonics analysis accuracy</td><td rowspan="2">20A RMS or less</td><td>Fundamental wave</td><td rowspan="4">・n = 2, 3, 4, ... 40 (2nd to 40th order)
・"Range" refers to the range of peak value measurement.
・With filter set to ON
・For input of triangular wave</td><td>±(0.3% of rdg + 0.075% of range)</td></tr>
<tr><td>Harmonics</td><td>±{0.3(1+ $\sqrt{n}$ % of rdg + 0.075% of range}</td></tr>
<tr><td rowspan="2">More than 20A RMS to 40A RMS</td><td>Fundamental wave</td><td>± (0.6% of rdg + 0.15% of range)</td></tr>
<tr><td>Harmonics</td><td>±{0.6(1+ $\sqrt{n}$ % of rdg + 0.15% of range}</td></tr>
<tr><td colspan="3">Anti-aliasing filter's aliasing attenuation</td><td></td><td>70 dB or more</td></tr>
<tr><td colspan="3">Averaging</td><td></td><td>Exponential averaging by a first-order low-pass filter with 1.5 seconds ±10% time constant</td></tr>
<tr><td colspan="3">Synchronization</td><td></td><td>Synchronization based on PCR-L series AC power supply clock (PCR-L series frequency clock accuracy ±1×10^{-4})</td></tr>
</table>

5.4 Voltage Fluctuation Analysis

Conditions where no specification is requested (fundamental wave: 50/60 Hz, temperature: 23±5℃)

Item		Conditions	Description
Voltage fluctuation analysis			1) Voltage change measurement △U(t) 2) Maximum voltage change measurement △U max 3) Steady state voltage change measurement △Uc 4) Relative voltage change characteristic measurement d(t) 5) Maximum relative voltage change measurement d max 6) Relative steady state voltage change measurement dc
RMS definition time			50/60 Hz half cycle
Accuracy		· Voltage range (V range) is either 160 V RMS or 320 V RMS · To 2% or more voltage change of the V range · Nominal input voltage: 100 V RMS, 230 V RMS · With filter set to OFF	△U(t)、△U max、△UC： ±(0.3% of rdg + 0.075% of V range) d(t)、d max、dc： ±(0.6% of rdg + 0.15% of V range)

5.5 Power Measurement

Conditions where no specification is requested (fundamental wave: 50/60 Hz, temperature: 23±5℃)

Item		Conditions	Description
Maximum power to be measured			6.4kW
Accuracy	20A RMS or less	· 50/60 Hz · Both voltage and current are obtained when an input of 25% or more of the voltage or current range is made. · Range: A combination of voltage range (AC RMS measurement range) and current range (AC peak-measurement range)	±(0.6% of rdg+ 0.15% of range)
	More than 20A RMS to 40A RMS	· Voltage range is selected regarding the crest factor as 1.41. · At a power factor of 1.0	±(0.9% of rdg+ 0.2% of range)
Power-factor measurement		· 50/60 Hz · Both voltage and current are obtained when an input of 25% or more of the voltage or current range is made.	0.000～±1.000

5.6 Current-Distortion-Factor Measurement

Conditions where no specification is requested (fundamental wave: 50/60 Hz, temperature: 23±5℃)

Item		Conditions	Description
Definition of distortion factor			U1: Fundamental wave level Un: Harmonics level n: 2、3、……40 $\frac{1}{U1}\sqrt{\sum_{n=2}^{40} Un^2} \times 100(\%)$
Measuring range			0.2%~255%
Accuracy	20A RMS or less	· The current obtained when an input of 25% or more of the current range is made.	±(6% of rdg + 0.4% ×100/rdg)
	More than 20A RMS to 40A RMS		±(7.5% of rdg + 0.8% × 100/rdg)

5.7 Monitoring Output

Conditions where no specification is requested (monitoring voltage/current, temperature: 23±5℃)

Item	Conditions	Description
Output voltage		±(5V±10%) full scale
Output DC offset voltage		±0.1V or less
Output resistance		About 100Ω

5.8 External Trigger Input

Conditions where no specification is requested (temperature: 23±5℃)

Item	Conditions	Description
Signal level		0 to +5V(CMOSlevel) A trigger signal is accepted at level L.

5.9 General Specifications

Item			Condition	Description
Operating environment	Temperature range			23℃±5℃
	Humidity range			20% to 80% R.H. (no condensation)
Warm-up period				Approx. 30 minutes
Insulation resistance	Voltage input to case			500 V DC, 50MΩ or more
	Current input to case			
	Voltage input to current input			
	Voltage input to voltage monitoring output			
	Current input to current monitoring output			
	Power plug to case			500 V DC, 30MΩ or more
Withstand voltage	Voltage input to case			600 Vpeak continuous, 1.5 kV AC for 1 minute
	Current input to case			600 Vpeak continuous, 1.5 kV AC for 1 minute
	Voltage input to current input			600 Vpeak continuous
	Voltage input to voltage monitoring output			600 Vpeak continuous
	Current input to current monitoring output			600 Vpeak continuous
	Power plug to case			1.5 kV AC for 1 minute
Power supply	Frequency			50/60Hz
	Setting range			100: Voltage range 85 V to 110 V 120: Voltage range 108 V to 132 V 220: Voltage range 198 V to 242 V 240: Voltage range 207 V to 250 V
	Power consumption		100VAC, 50Hz	80 VA maximum
Dimensions and weight	Harmonics analyzer	Dimensions		430W×44H×550D mm (Maximum part: 430 W×44 H×590 D mm)
		Weight		9kg
	Current sensor	Dimensions		416W×93H×170D mm (Maximum part: 416 W×103 H×260 D mm)
		Weight		4kg

5.10 Dimensional Diagrams

5.10.1 Harmonics Analyzer

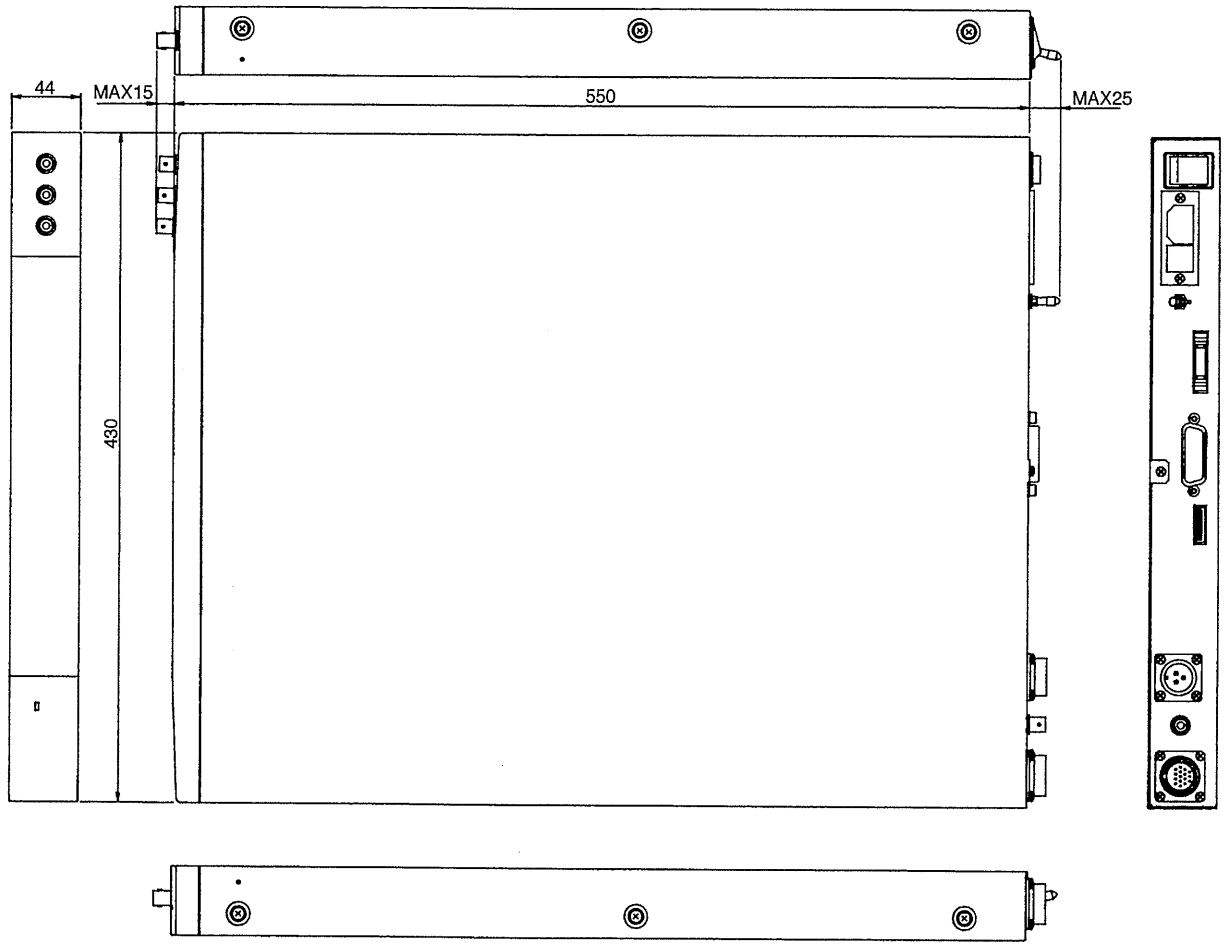


Fig. 5-1 Dimensions of Harmonics Analyzer

5.10.2 Current Sensor

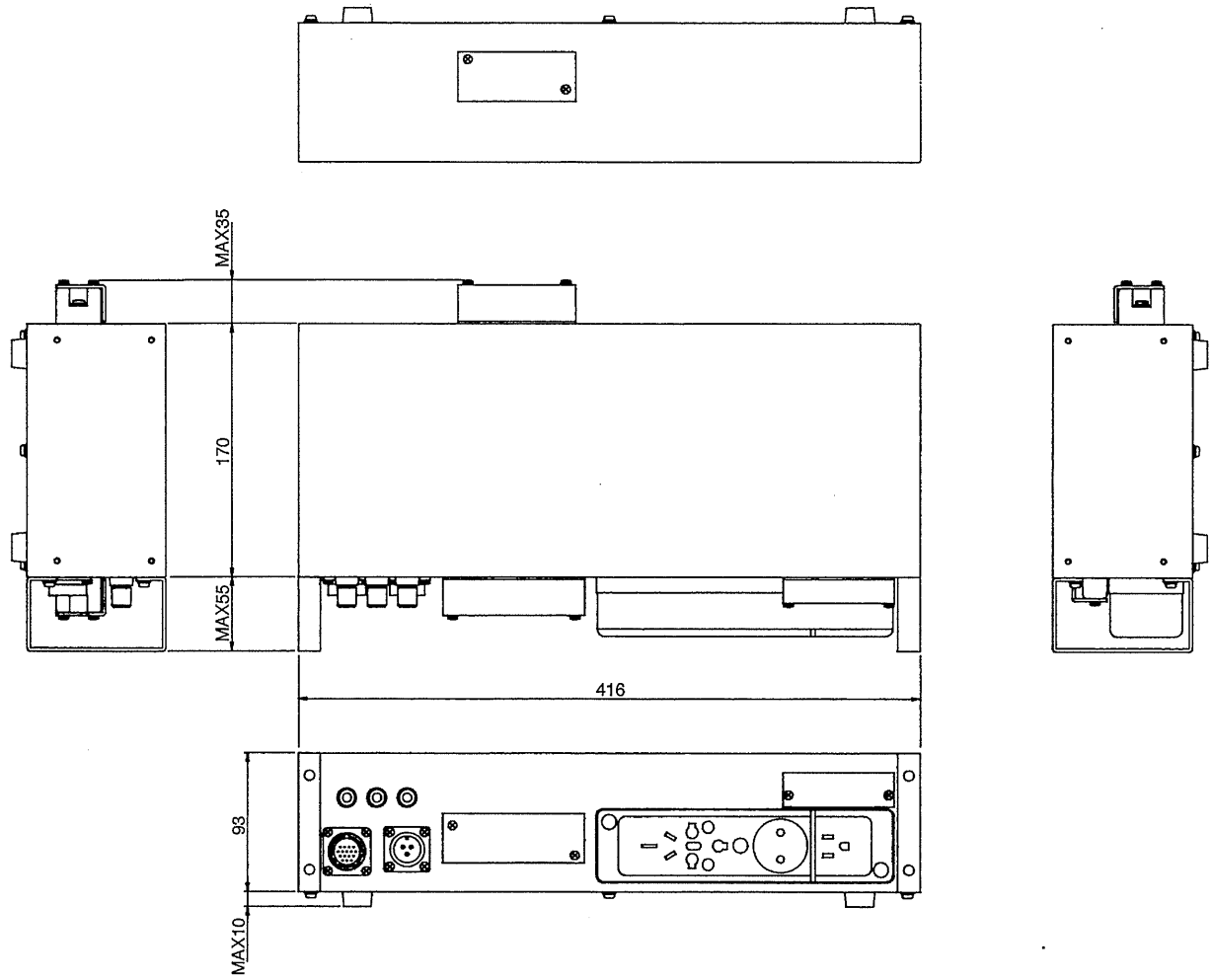


Fig. 5-2 Dimensions of Current Sensor

APPENDIX

Appendix 1 Loss in Power Measurement
Appendix 2 Relationship Between Peak Value and RMS Value for Voltage- and Current-Measurement Ranges

Appendix 1 Loss in Power Measurement

The power-measurement circuit of the HA01-PCR-L harmonics analyzer is as shown in Fig. A-1.

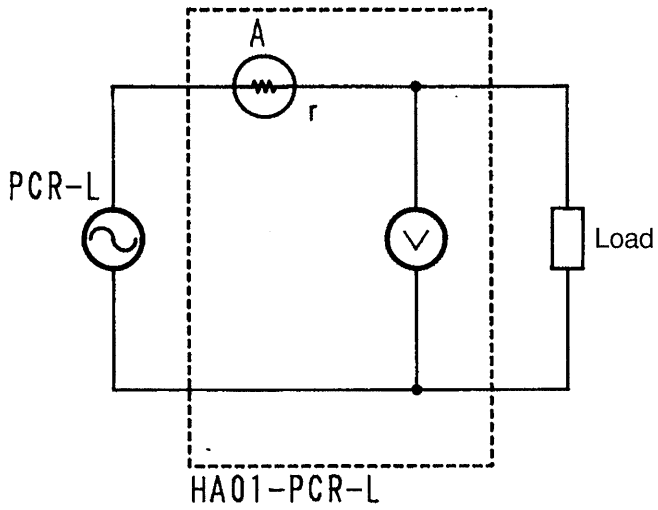


Fig. A-1 Power Measurement Circuit

Power loss is caused as described below due to internal resistance r (current detecting resistance) of the ammeter.

(1) Example of calculating power loss

Where internal resistance is in the 8 mΩ range:

1) For measurement of 5.65 A $(5.65 = 8/\sqrt{2})$

$$(5.65)^2 \times 8\text{m}\Omega = 0.26\text{W}$$

2) For measurement of $\frac{8}{3}$ A (= 2.67 A) $(22.6 = 32/\sqrt{2})$

$$(\frac{8}{3})^2 \times 8\text{m}\Omega = 0.057\text{W}$$

Where internal resistance is in the 4 mΩ range:

1) For measurement of 22.6 A

$$(22.6)^2 \times 4\text{m}\Omega = 2.04\text{W}$$

2) For measurement of $\frac{32}{3}$ A (= 10.67 A)

$$(\frac{32}{3})^2 \times 4\text{m}\Omega = 0.46\text{W}$$

Where internal resistance is in the 1 mΩ range:

1) For measurement of 40 A

$$40^2 \times 1\text{m}\Omega = 1.6\text{W}$$

Example of calculating power loss caused by the voltmeter input resistance

When input resistance is 4 MΩ, power loss becomes as follows with respect to 600 V input.

$$\frac{600 \times 600}{4 \times 10^6} = 0.09\text{W}$$

Appendix 2 Relationship Between Peak Value and RMS Value for Voltage-and Current-Measurement Ranges

(1) Relationship between voltage-measurement ranges and peak values

The relationship between the voltage-measurement ranges (specified by peak value. The peak value is determined by a positive or negative peak, whichever is greater) and measurable peak values is shown in Table A-1.

When the voltage waveform crest factor is 3, the RMS that can be measured at each range is as shown in Table A-1.

Voltage range	Allowable peak values	Maximum measurable RMS
		For a crest factor of 3
V RMS	V PEAK	V RMS
20	28.28	9.43
40	56.56	18.8
80	113.1	37.7
160	226.2	75.4
320	452.5	150
600	848.5	282

Table A-1 Relationship between Voltage-Measurement Ranges and Peak Values

(2) Relationship between current-measurement ranges and peak values

The relationship between the current-measurement ranges (specified by peak value. The peak value is determined by a positive or negative peak, whichever is greater) and measurable RMS values is shown in Table A-2.

When the current waveform crest factor is 3, the RMS that can be measured at each range is as shown in Table A-2.

Current waveform with a crest factor of 3 is generally equivalent to input current waveform in a capacitor-input-type rectifying circuit.

Current-detecting resistance	Current range	Maximum measurable RMS	
		For a crest factor of 1.41	For a crest factor of 3
mΩ	A PEAK	A RMS	A RMS
8	1	0.707	0.333
	2	1.41	0.666
	4	2.82	1.33
	8	5.65	2.66
4	2	1.41	0.666
	4	2.82	1.33
	8	5.65	2.66
	16	11.3	5.33
	32	22.6	10.66
1	8	5.65	2.66
	16	11.3	5.33
	32	22.6	10.66
	64	40.0	21.3
	128	40.0	40.0

Table A-2 Relationship between Current Measurement Range and Peak Values