ADCMT

8240

Digital Electrometer

Instruction Manual

MANUAL NUMBER FOE-8335173B01

First printing March 30, 2007
Printed in Japan

Safety Summary

To ensure thorough understanding of all functions and to ensure efficient use of this instrument, please read the manual carefully before using. Note that ADC Corporation (hereafter referred to as ADC) bears absolutely no responsibility for the result of operations caused due to incorrect or inappropriate use of this instrument.

If the equipment is used in a manner not specified by ADC, the protection provided by the equipment may be impaired.

- **Warning Labels**

  Warning labels are applied to ADC products in locations where specific dangers exist. Pay careful attention to these labels during handling. Do not remove or tear these labels. If you have any questions regarding warning labels, please ask your nearest ADC dealer. Our address and phone number are listed at the end of this manual.

  Symbols of those warning labels are shown below together with their meaning.

  DANGER: Indicates an imminently hazardous situation which will result in death or serious personal injury.

  WARNING: Indicates a potentially hazardous situation which will result in death or serious personal injury.

  CAUTION: Indicates a potentially hazardous situation which will result in personal injury or a damage to property including the product.

- **Basic Precautions**

  Please observe the following precautions to prevent fire, burn, electric shock, and personal injury.

  - Use a power cable rated for the voltage in question. Be sure however to use a power cable conforming to safety standards of your nation when using a product overseas.
  - When inserting the plug into the electrical outlet, first turn the power switch OFF and then insert the plug as far as it will go.
  - When removing the plug from the electrical outlet, first turn the power switch OFF and then pull it out by gripping the plug. Do not pull on the power cable itself. Make sure your hands are dry at this time.
  - Before turning on the power, be sure to check that the supply voltage matches the voltage requirements of the instrument.
  - Connect the power cable to a power outlet that is connected to a protected ground terminal. Grounding will be defeated if you use an extension cord which does not include a protective conductor terminal.
  - Be sure to use fuses rated for the voltage in question.
  - Do not use this instrument with the case open.
  - Do not place anything on the product and do not apply excessive pressure to the product. Also, do not place flower pots or other containers containing liquid such as chemicals near this

product.

- When the product has ventilation outlets, do not stick or drop metal or easily flammable objects into the ventilation outlets.
- When using the product on a cart, fix it with belts to avoid its drop.
- When connecting the product to peripheral equipment, turn the power off.

- **Caution Symbols Used Within this Manual**

Symbols indicating items requiring caution which are used in this manual are shown below together with their meaning.

DANGER: Indicates an item where there is a danger of serious personal injury (death or serious injury).

WARNING: Indicates an item relating to personal safety or health.

CAUTION: Indicates an item relating to possible damage to the product or instrument or relating to a restriction on operation.

- **Safety Marks on the Product**

The following safety marks can be found on ADC products.

 : ATTENTION - Refer to manual.

 : Protective ground (earth) terminal.

 : DANGER - High voltage.

 : CAUTION - Risk of electric shock.

- **Replacing Parts with Limited Life**

The following parts used in the instrument are main parts with limited life.
Replace the parts listed below before their expected lifespan has expired to maintain the performance and function of the instrument.
Note that the estimated lifespan for the parts listed below may be shortened by factors such as the environment where the instrument is stored or used, and how often the instrument is used.
The parts inside are not user-replaceable. For a part replacement, please contact the ADC sales office for servicing.

Each product may use parts with limited life.
For more information, refer to the section in this document where the parts with limited life are described.

Main Parts with Limited Life

Part name	Life
Unit power supply	5 years
Fan motor	5 years
Electrolytic capacitor	5 years
LCD display	6 years
LCD backlight	2.5 years
Floppy disk drive	5 years
Memory backup battery	5 years

- **Hard Disk Mounted Products**

The operational warnings are listed below.

- Do not move, shock and vibrate the product while the power is turned on.
  Reading or writing data in the hard disk unit is performed with the memory disk turning at a high speed. It is a very delicate process.

- Store and operate the products under the following environmental conditions.
  An area with no sudden temperature changes.
  An area away from shock or vibrations.
  An area free from moisture, dirt, or dust.
  An area away from magnets or an instrument which generates a magnetic field.

- Make back-ups of important data.
  The data stored in the disk may become damaged if the product is mishandled. The hard disc has a limited life span which depends on the operational conditions. Note that there is no guarantee for any loss of data.

- **Precautions when Disposing of this Instrument**

When disposing of harmful substances, be sure dispose of them properly with abiding by the state-provided law.

Harmful substances: (1) PCB (polycarbon biphenyl)
(2) Mercury
(3) Ni-Cd (nickel cadmium)
(4) Other
Items possessing cyan, organic phosphorous and hexadic chromium and items which may leak cadmium or arsenic (excluding lead in solder).

Example: fluorescent tubes, batteries

Environmental Conditions

This instrument should be only be used in an area which satisfies the following conditions:

- An area free from corrosive gas
- An area away from direct sunlight
- A dust-free area
- An area free from vibrations
- Altitude of up to 2000 m

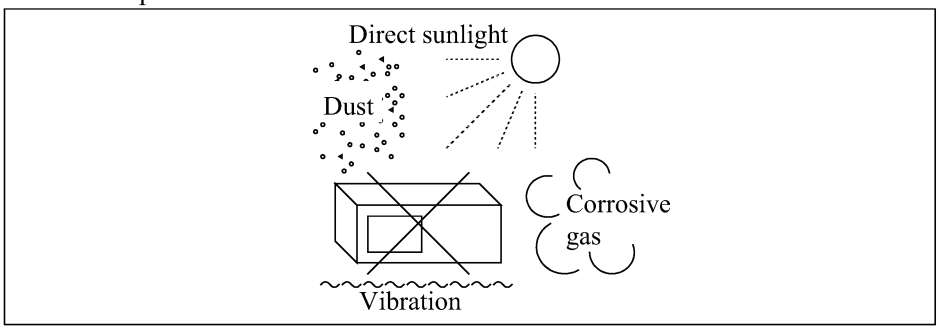


Figure-1 Environmental Conditions

- Operating position

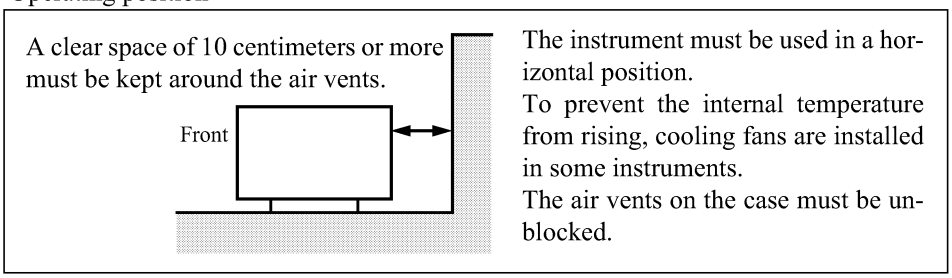


Figure-2 Operating Position

- Storage position

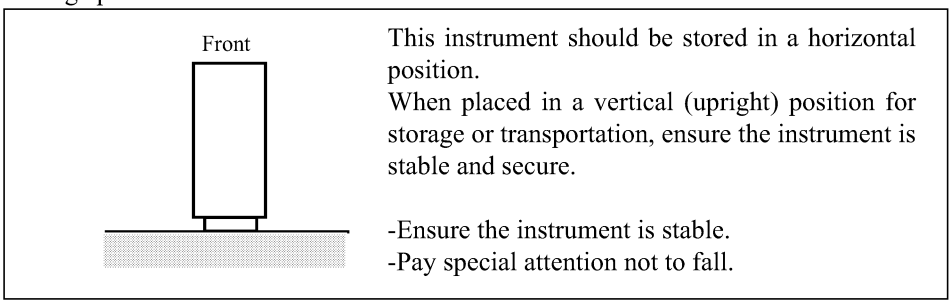


Figure-3 Storage Position

- The classification of the transient over-voltage, which exists typically in the main power supply, and the pollution degree is defined by IEC61010-1 and described below.

  Impulse withstand voltage (over-voltage) category II defined by IEC60364-4-443

  Pollution Degree 2

Types of Power Cable

Replace any references to the power cable type, according to the following table, with the appropriate power cable type for your country.

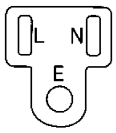
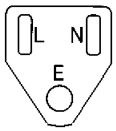
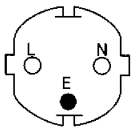
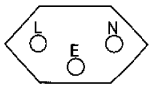
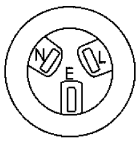
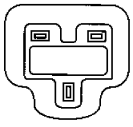
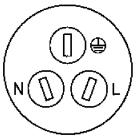
Plug configuration	Standards	Rating, color and length	Model number (Option number)
	PSE: Japan Electrical Appliance and Material Safety Law	125 V at 7 A Black 2 m (6 ft)	Straight: A01402 Angled: A01412
	UL: United States of America CSA: Canada	125 V at 7 A Black 2 m (6 ft)	Straight: A01403 (Option 95) Angled: A01413
	CEE: Europe DEMKO: Denmark NEMKO: Norway VDE: Germany KEMA: The Netherlands CEBEC: Belgium OVE: Austria FIMKO: Finland SEMKO: Sweden	250 V at 6 A Gray 2 m (6 ft)	Straight: A01404 (Option 96) Angled: A01414
	SEV: Switzerland	250 V at 6 A Gray 2 m (6 ft)	Straight: A01405 (Option 97) Angled: A01415
	SAA: Australia, New Zealand	250 V at 6 A Gray 2 m (6 ft)	Straight: A01406 (Option 98) Angled: ---------
	BS: United Kingdom	250 V at 6 A Black 2 m (6 ft)	Straight: A01407 (Option 99) Angled: A01417
	CCC:China	250 V at 10 A Black 2 m (6 ft)	Straight: A114009 (Option 94) Angled: A114109

TABLE OF CONTENTS

Table of Contents

LIST OF ILLUSTRATIONS

LIST OF TABLES

1. OVERVIEW

This chapter explains the configuration of this manual, product outline, instruction before use, and basic control method. Make sure to read this manual before use.

1.1 Configuration of Instruction Manual

Chapter 1 OVERVIEW

This chapter explains the configuration of this manual, product outline, instruction before use, and basic control method. Make sure to read this manual before use.

Chapter 2 DESCRIPTION OF PRODUCT PANEL

This chapter explains the parts on the front panel, parts on the rear panel, and safety symbols on both panels.

Chapter 3 PREPARATION FOR MEASUREMENT

This chapter explains the parameter set value for power-on, how to set power supply frequency, and various messages.

Chapter 4 MEASUREMENT METHOD

This chapter explains how to measure the DC voltage and DC current, and notes on measurement.

Chapter 5 FUNCTION AND CONTROL METHOD

This chapter explains the functions and control method of 8240.

Chapter 6 GPIB INTERFACE

This chapter explains the GPIB controlling the 8240.

Chapter 7 INPUT/OUTPUT SIGNAL

This chapter explains three types of input/output signal and AMP OUT.

Chapter 8 CHECK AND CALIBRATION

This chapter explains how to check a failure for use of the 8240 and calibrate the 8240 to the measurement precision.

Chapter 9 DESCRIPTION OF OPERATION

This chapter explains the operating principle of the 8240.

Chapter 10 EXAMPLE OF MEASUREMENT

This chapter explains the example of measurement using the 8240. Read the chapter if necessary.

Chapter 11 SPECIFICATION

This chapter explains the standard of the 8240 and its accessory (option). Read this chapter if necessary.

LIST OF ILLUSTRATIONS

The list of illustrations contains figure number, figure title, and figure on page.

LIST OF TABLES

The list of tables contains table number, table title, and table on page.

EXTERNAL VIEW

The external view has outside dimensions of the product.

1.2 Product Outline

The 8240 (this unit) is a digital electrometer that displays 4 1/2 digits and measures a direct voltage and direct current.

This unit has high input impedance of $10^{13}\Omega$, measuring the range from 10μV to 20V. It can measure a wide range of current from 10fA to 20mA. The unit enables constant measurement to the noise included in the input signal by selecting integral action time (RATE).
This unit has a GPIB interface therefore it can set measuring parameter, read it, and output data. It is suitable for an automatic measuring system.

[Features]

- Measures a direct voltage of high input impedance (more than $10^{13}\Omega$).
- Measures a direct current from 10fA to 200mA.
- Enables constant measurement by converting variable AD for integral action time.
- NULL operation can measure a relative value such as dark current compensation or offset compensation.
- Has a GPIB interface.

1.3 Before Use

1.3.1 Checking the Accessories

Check your unit for the following items.

Check

① Visually check whether the unit is damaged.

② Check the standard accessories according to Table 1-1.

If the unit is damaged or the standard accessories are short, contact an ADC CORPORATION sales representative.
Their address or telephone number are listed at the end of this manual.

Note: If you order additional accessories, use model name (or stock No.).

Table 1 - 1 Standard Accessories

Item name	Model name	Stock No.	Q'ty	Remarks
Power cable	A01402	DCB-DD2428X01	1	
Input cable	A01010	DCB-FM1645X01	1	
Power fuse	Slow blow fuse EAWK 0.16A	DFT-AAR16A	2	For 100/120 VAC
	Slow blow fuse EAWK 0.08A	DFT-AAR08A		For 220/240 VAC
Instruction manual	———	J8240	1	Japanese version
	———	E8240		English version

1.3.2 Ambient Environment

(1) Avoid using the unit in places exposed to dust, vibration, direct sunlight, and corrosive gas. The ambient temperature is 0 to +40℃, and the relative humidity is less than 85%.

(2) If draft holes on the upper and lower faces are clogged or the unit is used vertically, an internal temperature will increases. Use the unit horizontally.

(3) This unit has been designed to satisfy completely the AC power supply line noise. However, it is recommended that the unit should be used in noiseless place if possible. If there is a noise, use a noise reduction filter.

(4) Store this unit under temperatures from -25℃ to +70℃. If the unit is not used for a long term, cover it with polyvinyl cover or place it in the carton box to store it in drying place without a direct sunlight.

(5) If this unit is transported, use packing material that has been supplied at the first time. If you miss the packing material, pack the unit according to the following procedure.

① Pack this unit with polyvinyl cover.

② Insert cushioning material in the carton box whose thickness is more than 5mm, and pack the unit with the cushioning material.

③ Insert the accessories in the carton box, then re-insert the cushioning material. Close the carton box, and secure the box with the packing string.

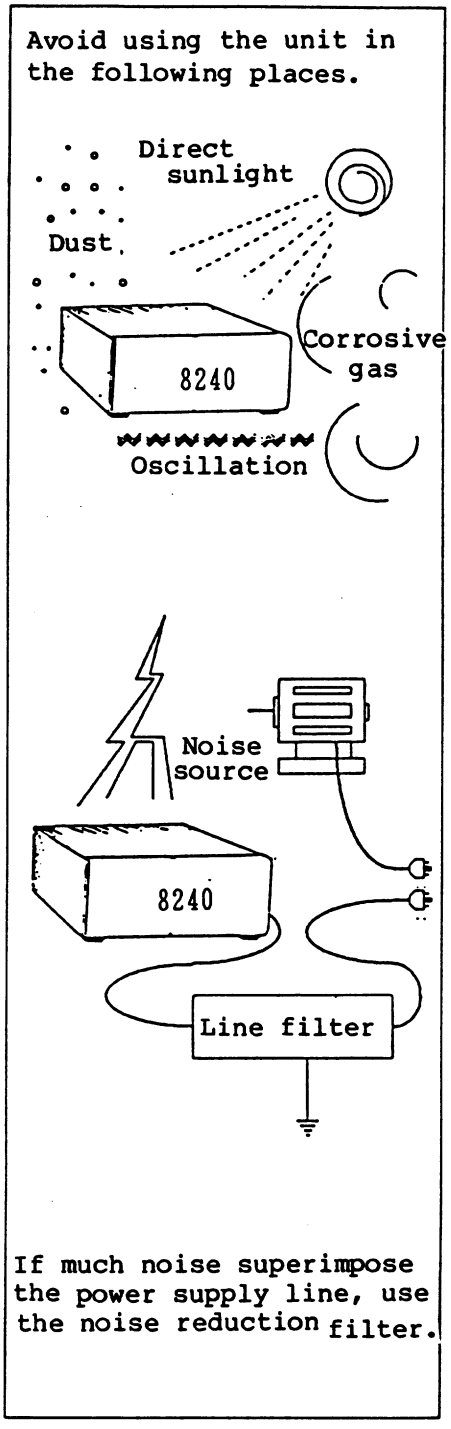


Figure 1 - 1 Ambient Environment

1.3.3 Source Voltage

When connecting the power cable, be sure to check that the power switch is off. The set state of source voltage is displayed on the rear panel (see Figure 1-2). Check that the source voltage matches the voltage for use. Adjust the source voltage to frequency (50 or 60Hz) for use. For frequency setting, see Item 3.2 Setting the Power Supply Frequency.

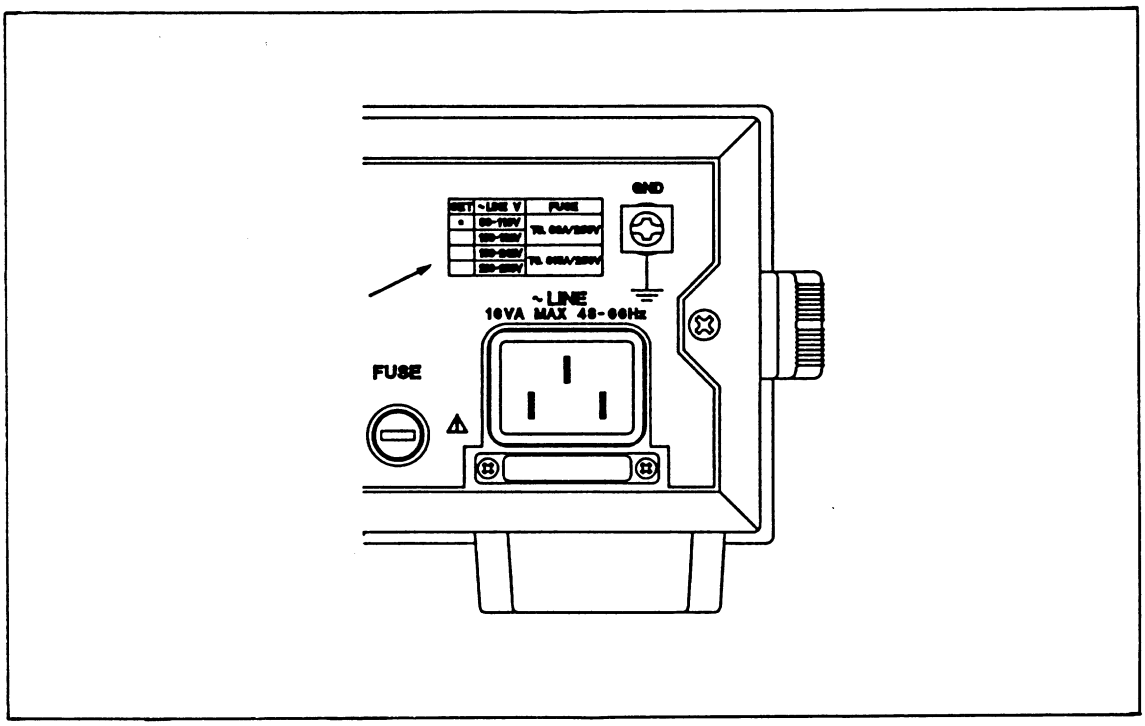


Figure 1 - 2 Source Voltage Displayed on the Rear Panel

1.3.4 Power Cable

The power cable plug has three pins. A round pin is a grounding pin (see Figure 1-3). Use the receptacle with ground.

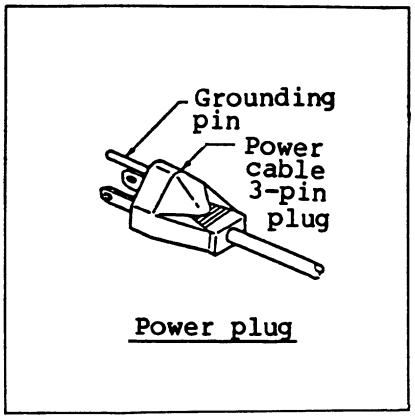


Figure 1 - 3 Power Cable Plug

1.3.5 Fuse

(1) Power Fuse

This unit has a power fuse for internal protection.

(2) Fuse Replacing Method

NOTE

Before replacing the fuse, be sure to turn off the POWER switch and remove the power cable from the receptacle. In addition to visual inspection of fuse, measure their resistance values. If they are less than 15Ω, they are normal.

Replacing Procedure

① As pressing the fuse holder cap with the screwdriver (-), turn it counter-clockwise at a 60 degrees angle. The cap turned is projected about 3mm.

② Draw the cap, and replace the fuse with a new fuse. Table 1-2 lists the standard of the fuse.

③ As pressing the cap with the screwdriver, turn it clockwise at a 60 degree angle to install the cap.

NOTE

To protect the fuse against fire, use the fuse having the same standard and rating.

Table 1 - 2 Fuse Standard

Fuse	Standard	Part code	Remarks
Power fuse	Slow blow fuse 0.16A (EAWK-0.16A)	DFT-AAR16A	For 100/120 VAC
	Slow blow fuse 0.08A (EAWK-0.08A)	DFT-AAR08A	For 220/240 VAC

1.3.6 Input Cable

Attached input cable A01010 is a double coaxial cable. Figure 1-4 shows the cable structure.

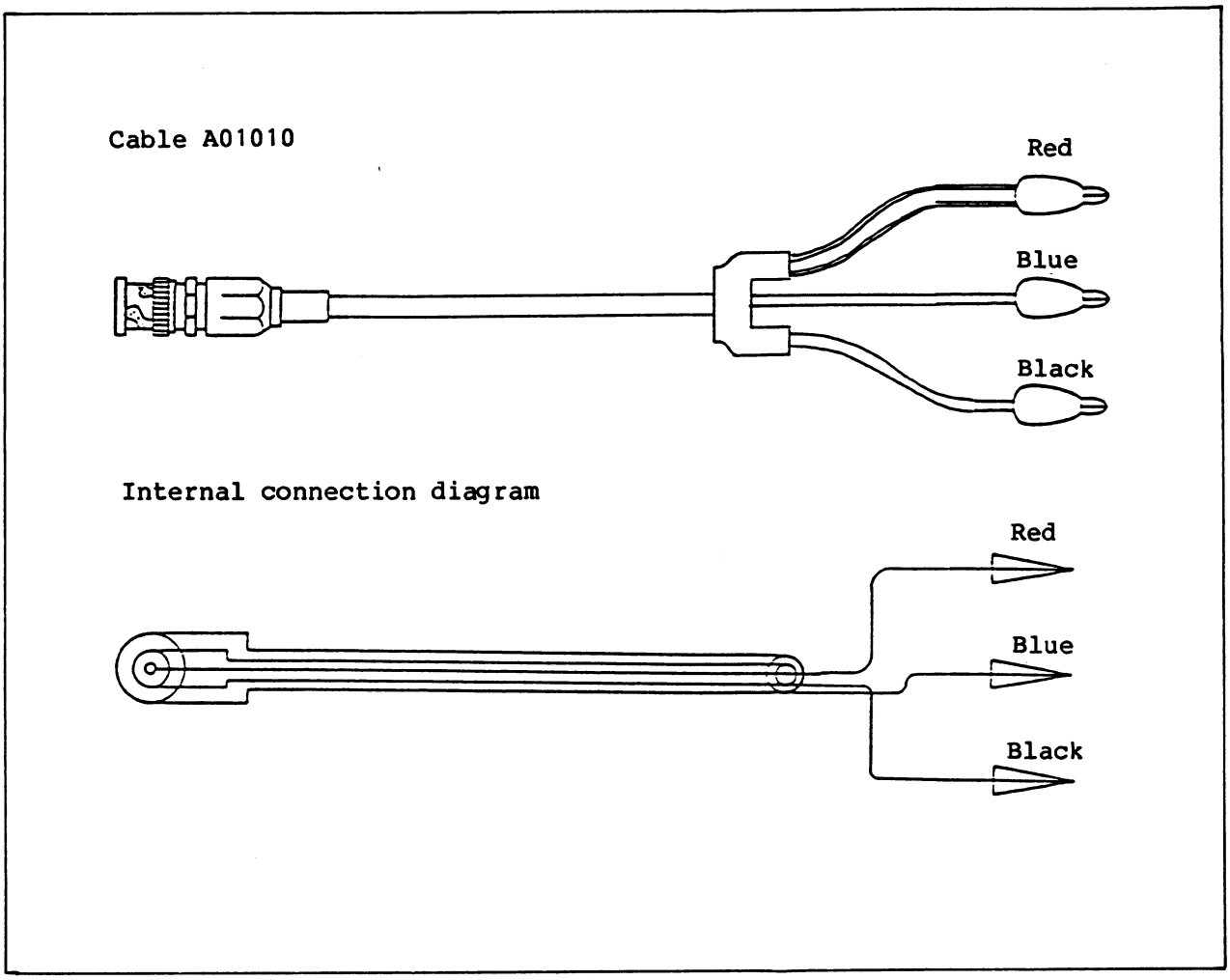


Figure 1 - 4 Input Cable Structure

1.3.7 Warm-up Time

When this unit is powered on, all functions can be used. To obtain specified precision, allow more than 30 minutes of warm-up time.

1.4 Basic Control Method

Figure 1-5 show the flowchart of the basic control method of this unit. See Item 3.1 Power On for parameter setting. See Chapter 5. FUNCTION AND CONTROL METHOD for function and control method of parameter. See Chapter 4. MEASUREMENT METHOD for the detail.

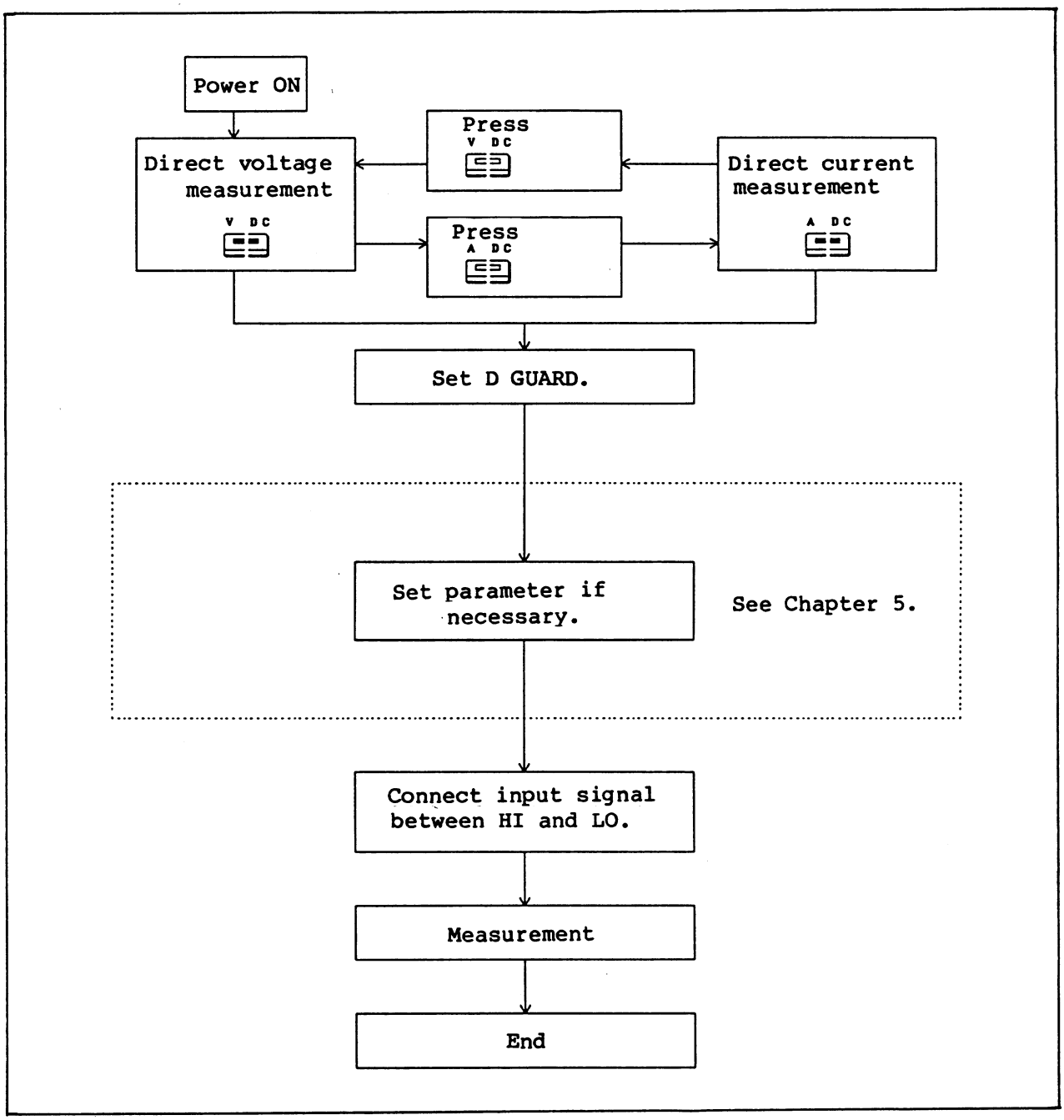


Figure 1 - 5 Flowchart of Measurement

As D GUARD (DRIVING GUARD) is set, different input signal is connected. According to Table 1-3, normally connect the input signal between HI and LO.

Table 1 - 3 Relation Between D GUARD and Input Cable

Function	D GUARD	Input cable		
		Red clip (core wire)	Black clip (inner shield)	Blue clip (outer shield)
V DC	ON*	HI	Electric potential same as input signal (connected to the output of input amplifier)	LO
	OFF	HI	LO	Connect to GUARD case only (floating).
A DC	ON	HI	LO	LO
	OFF	HI	LO	Connect to GUARD case only (floating).

* : When the V DC function and D GUARD is turned on, do not connect the black and blue clips.

2. DESCRIPTION OF PRODUCT PANEL

This chapter explains the parts on the front panel, parts on the rear panel, and safety symbols on both panels.

2.1 Safety Symbol

This section explains the safety symbols on the front and rear panels of this unit. Figure 2-1 shows the location for safety symbols on both panels, and Table 2-1 lists the description on them.

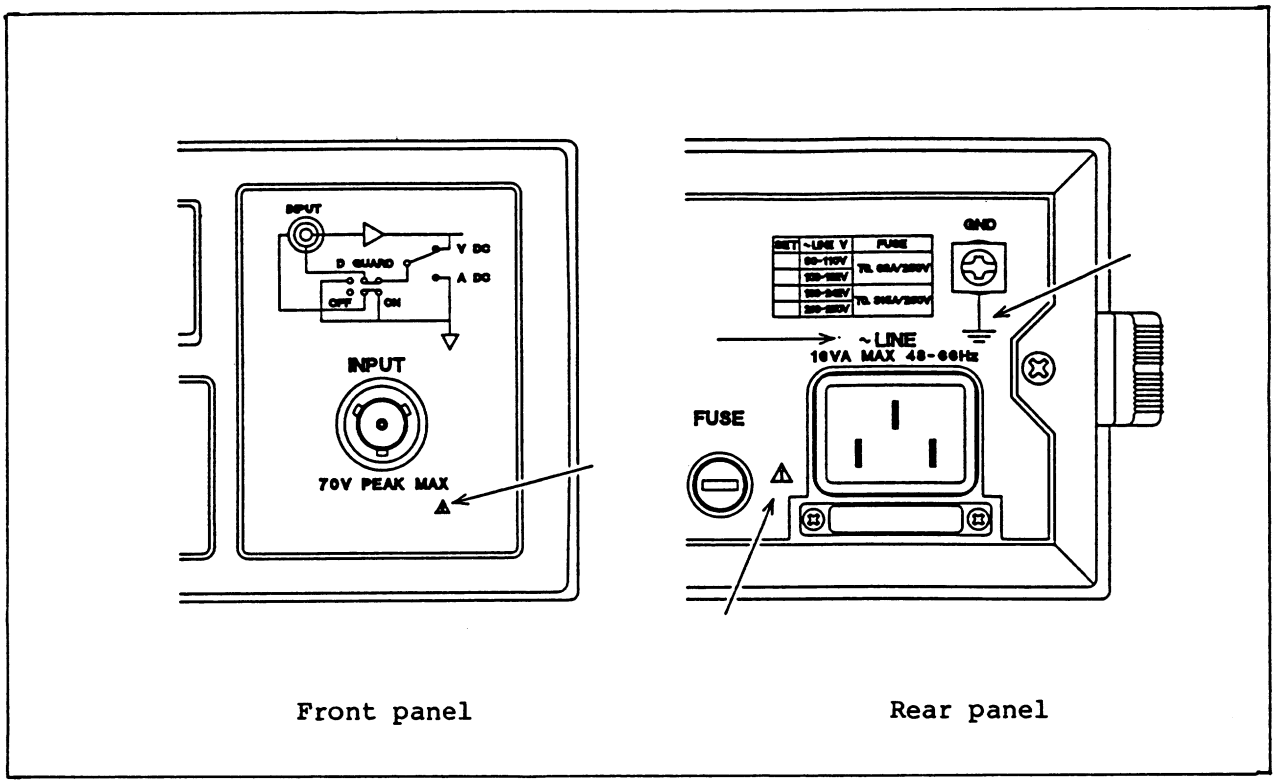


Figure 2 - 1 Location for Safety Symbols on Both Panels

Table 2 - 1 Safety Symbols

Symbol	Name	Description
⚠	Caution symbol	To avoid damaging this unit, this instruction manual must be referred.
⏚	Grounding terminal symbol	This symbol indicates a general grounding terminal. Connect this terminal to a ground.
~	AC power supply symbol	This symbol indicates the AC power supply.

2.2 Description of Front Panel

See Figure 2-2 description of front panel.

(1) Display

① Sampling indicator:

Is on during measurement.

② REMOTE indicator:

Is on during remote operation.

③ MA (My Address) indicator:

Lights 8240 receives MLA (My Listen Address) or MTA (My Talk Address).

④ Value display:

A value of 4 1/2 or 3 1/2 digits is displayed.
When the polarity is negative, - is displayed. The maximum value is ±19999.

⑤ Unit display:

If unit is set, the indicator for the unit lights.

(2) Description of Controller

⑥ POWER switch:

Power switch

⑦ Measuring function select key:

The LED of selected key lights. For a measurement range, the previously-set range is used.

V DC : Sets a measuring function for DC voltage measurement.

A DC : Sets a measuring function for DC current measurement.

⑧ HOLD key:

Switches sampling hold ON or OFF. (LED is on: hold state)

⑨ TRIG key:

Measurement start instruction in hold state.

⑩ RATE key:

Sets a sampling rate. When this key is pressed continuously, the sampling rate is changed as follows.

→2ms → 1PLC → 5PLC → 10PLC → 10PLC×4 → 10PLC×8 → 10PLC×16 →

When the 8240 is powered on, the sampling rate is set to 10 PLC. For the detail, see 5.2 RATE (Integral Time).

⑪ D GUARD key:

Sets DRIVING GUARD ON or OFF (LED lighting: ON state). For the detail, see 5.3 D GUARD (DRIVING GUARD).

⑫ AUTO/▷key:

Switches the range to AUTO or manual (LED lighting: AUTO state). This key is used for a cursor moving key when the range is calibrated or the GPIB is set.

⑬ DOWN/▽key:

AUTO state ; When this key is pressed, the range is set to manual and one range is degraded.
manual state ; When this key is pressed, one range is degraded.

When the LINE F is pressed in the shift mode, a power supply frequency is changed.

When the GP-IB is pressed in the shift mode, the GPIB header and address are canged.

Note: If the SHIFT is re-pressed finally in the shift mode, changed item is set.

⑭ UP/Δkey"

AUTO state ; When this key is pressed, the range is set to manual and one range is degraded.
manual state ; When this key is pressed, one range is degraded.
When the LINE F is pressed in the shift mode, a power supply frequency is changed.

When the GP-IB is pressed in the shift mode, the GPIB header and address are changed.

Note: If the SHIFT is re-pressed finally in the shift mode, changed item is set.

⑮ ZERO CHECK/LINE FREQUENCY key:

Cancels the offset of input unit or discharges the electric charge of DUT. When the key is pressed, ZERO CHECK ON or OFF is switched.
When the LED is on, ZERO CHECK is set to ON and the value on the display disappears.
When the LED is off, ZERO CHECK is set to OFF and the value is measured.
In the shift mode, a power supply frequency is set. Be sure to set the power supply frequency before use.
For the detail, see Item 5.4 ZERO (zero check). For power supply frequency setting method, see Item 3.2 Setting the Power Supply Frequency.

Note: If the SHIFT is re-pressed finally in the shift mode, changed item is set.

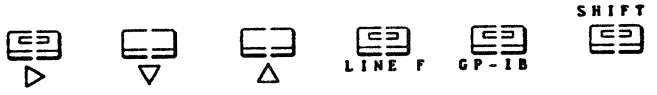
⑯ NULL/GPIB key:

When this key is pressed, NULL ON or OFF is switched.
When the LED is on, NULL is set to ON. When the key is pressed and NULL is on, the value, zero is displayed relatively.
When the LED is off, NULL is set to OFF.
In the shift mode, a GPIB header is set to ON or OFF and to address set mode.
For the detail, see Item 5.1 NULL. For the detail of GPIB, see Item 6.4 Setting the address and selecting the header ON/OFF.

Note: IF the SHIFT is re-pressed finally in the shift mode, changed item is set.

⑰ SHIFT/LOCAL key:

When the key is pressed, the shift mode and measurement state are changed.
When the LED is on, the shift mode is available. The 8240 receives the following keys.



When the LED is off, the measurement state is available.
Remote operation: Press the key when indicator ② is on.
External control is interrupted and input from the panel is enabled.

⑱ INPUT connector:

An input connector. Normally connect the input cable according to Item 4. MEASUREMENT METHOD.

2.3 Description of Rear Panel

See Figure 2-3 Description of Rear Panel.

① AMP OUT terminal:

The AMP OUT terminal is a connector outputting the pre-amplifier output voltage of measuring part. The output is not isolated from the measuring part. The connector can be used for a guard output terminal to measure the voltage.

② EXT TRIG connector:

Controls measurement start in the HOLD state with external signal.

③ COMPLETE OUTPUT connector:

Externally outputs the signal informing measurement end.

④ EXT SRQ connector:

This connector is an input signal connector sending an SRQ signal on the GPIB bus with external contact signal or logic signal.

⑤ GND terminal:

A grounding terminal is connected to the chassis of this unit.

⑥ GPIB connector:

Is controlled externally by GPIB.

⑦ EXT CAL switch:

Is used to calibrate this unit.

NOTE

The EXT CAL switch is always off.

⑧ Fuse holder:

Fuse holder for power supply

⑨ Power connector:

Power connector for power supply.
Use attached power cable A01402.

2.3 Description of Rear Panel

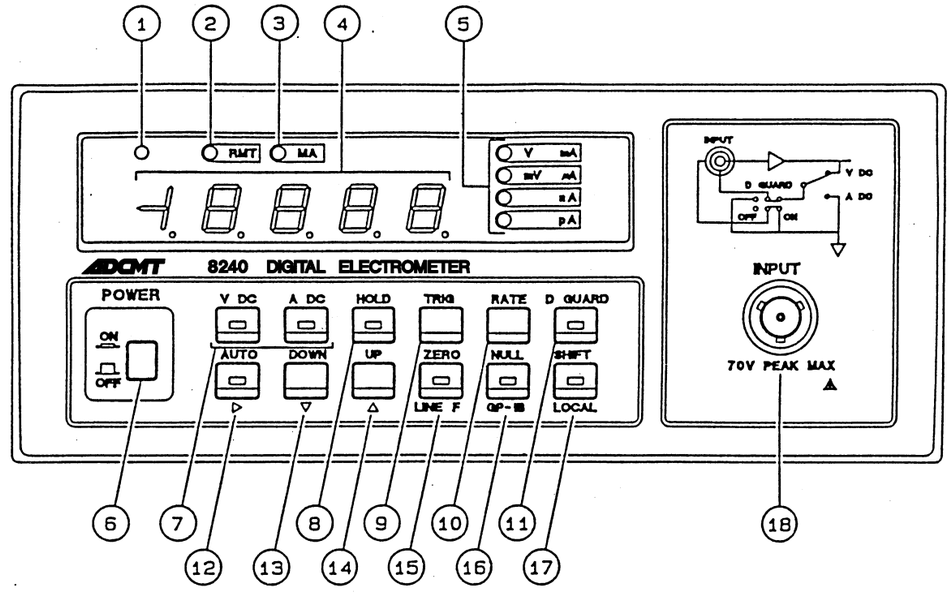


Figure 2 - 2 Description of Front Panel

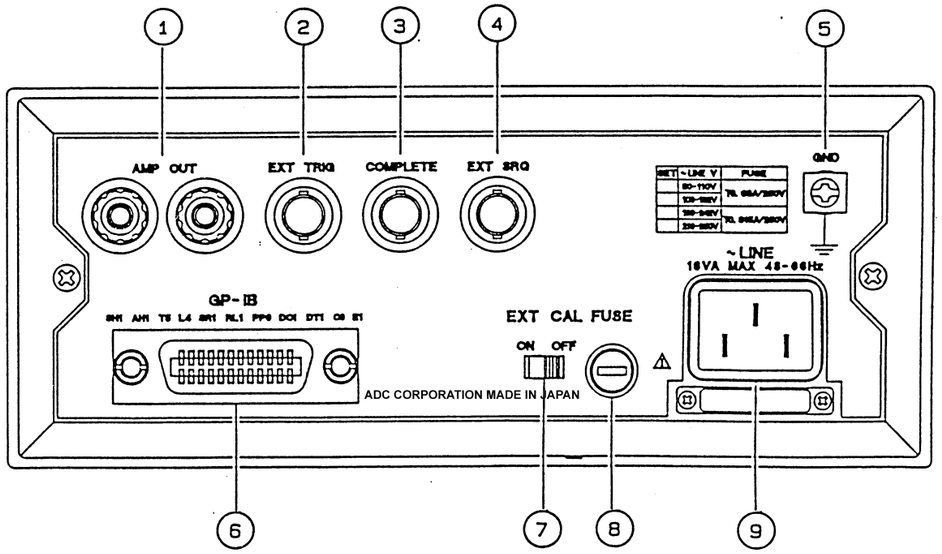


Figure 2 - 3 Description of Rear Panel

3. PREPARATION FOR MEASUREMENT

This chapter explains the parameter set value for power-on, how to set power supply frequency, and various messages.

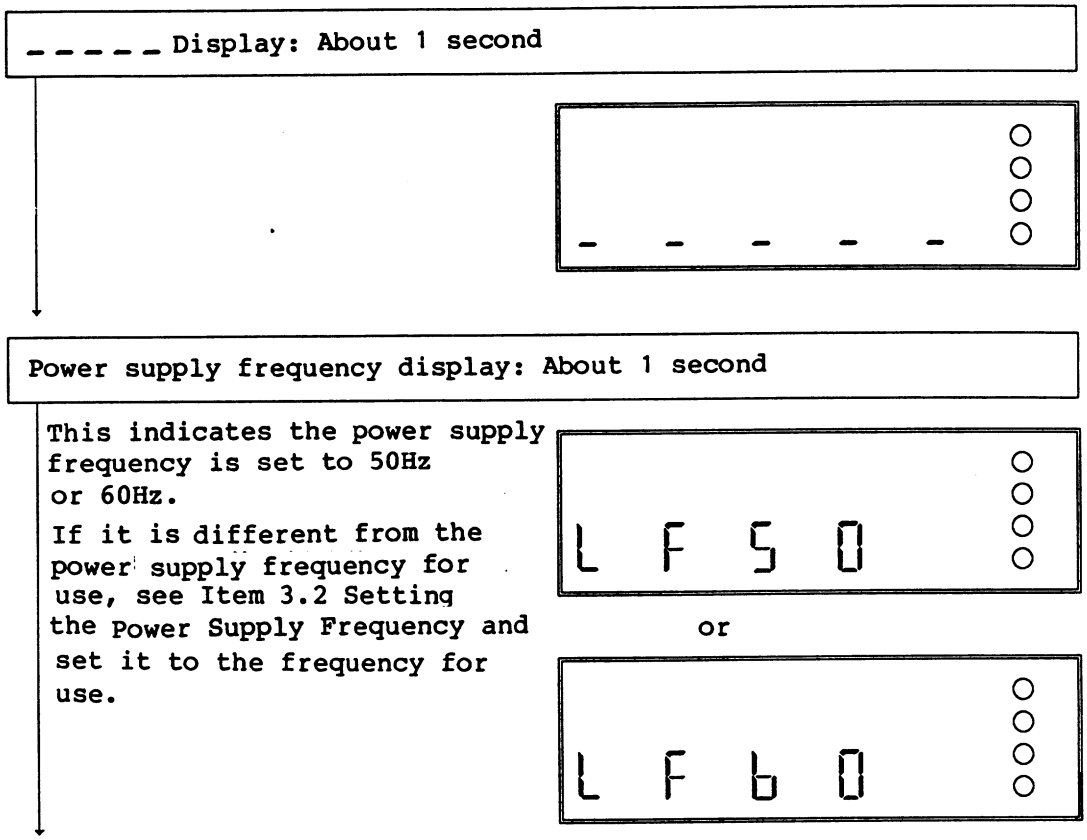
3.1 Power On

(1) Initial Operation

Procedure for power on

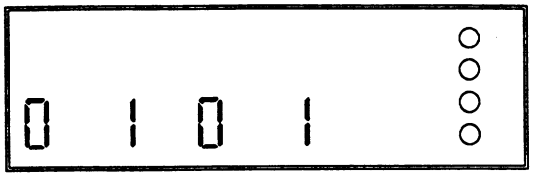
① Connect attached power cable to the power supply connector on the rear panel.

② Power on the POWER switch on the front panel.
Take the following steps.



Logic software revision update display: About 1 second

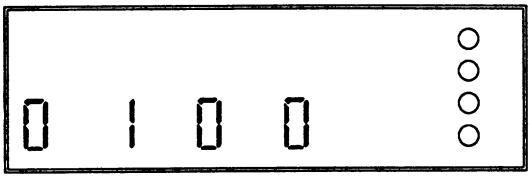
Logic software revision No. and update is displayed.
An example of display on the right is revision No. 01 and update 01.



All LED lamp OFF: About 0.5 second

Analog software revision No. and update display: About 1 second

Analog software revision No. and update is displayed.
An example of display on the right is revision No. 01 and update 00.



Measuring state

NOTE

Visually check that no error occurs during initial operation.

(2) Parameter Set Value for Power On

Table 3-1 lists the parameter set value for power on.

Table 3 - 1 Parameter Set Value for Power On

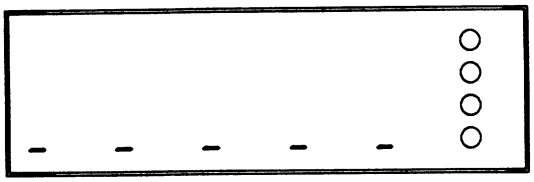
Parameter	Set value
FUNCTION	V DC
RANGE	AUTO
SAMPLING	RUN
RATE	10PLC
NULL	OFF
ZERO CHECK	OFF
DRIVING GUARD	OFF
GPIB	Previous set value
LINE FREQUENCY	

3.2 Setting the Power Supply Frequency

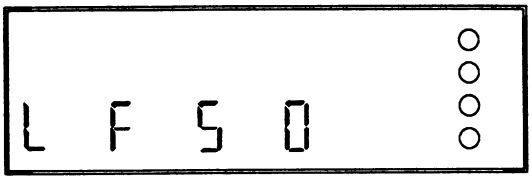
Be sure to adjust the power supply frequency of this unit to the value for use.
Use keys to set power supply frequency. Set power supply frequency is not changed even if the unit is powered off. If Er3 occurs, the power supply frequency is set to 50Hz.

Procedure for setting power supply frequency

① Press the SHIFT , and a LED of key lights and ----- is displayed.

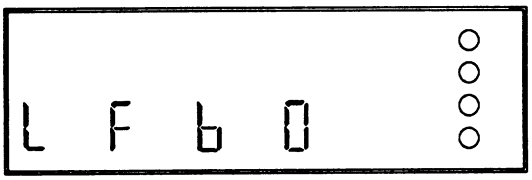


② Press the LINE F , and currently-set value is displayed.



Currently-set value

③ Press ▽ or △ , and set to required frequency.



Newly-set value

④ Press the SHIFT , and a LED goes off and setting ends.

—— If setting is released ——

Press the SHIFT in ① and ② states to return to the measurement state.

—— GPIB remote setting ——

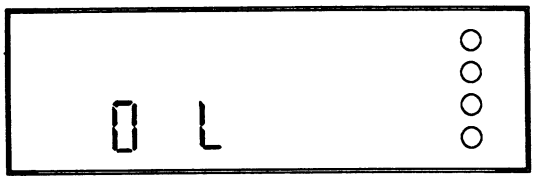
LF0 : Set power supply frequency to 50Hz.
LF1 : Set power supply frequency to 60Hz.
LFX? : Check set power supply frequency.

3.3 Various Messages

This unit displays the following messages to abnormal input while is operating.

(1) Over Range Display

When over range is displayed, raise the measuring range (press the UP key).



The above screen is displayed in the following cases.

① The full scale of this unit is 1999 for RATE 2mSec. It is 19999 for the other RATE.
When value exceeding this count is input:

② When the input end is opened in range change or VIC function GPIB status

GPIB status

- Bit 3 DDE of the standard event status register (SESR) is set.
  *ESR?: Reads SESR.

- Bit 7 of error register is set.
  ERR?: Reads error register.

(2) Error Message

Table 3-2 lists error codes.

Table 3 - 2 Error Message

Error code	Description	GPIB status (bit)		
		SESR	ERR	TST
Er 2	Calibration data was rewritten.	—	—	5
Er 3	GPIB and power supply frequency data was rewritten.			6
Er 4	Transfer error between internal CPUs	3	13	4
Er 7	AD converter fault	—	—	1
Er 8	Logic RAM read/write failure	—	—	8
Er 10	Logic ROM failure	—	—	10
Er 11	Analog ROM failure	—	—	11

Note: SESR; Standard Event Status Register
ERR ; Error Register
TST ; Self Test Error Register

(3) Error Correction

If an error occurs, do as follows.

① when Er2 occurs

See Item 8.2 Calibration, and initialize calibration data to calibrate.

② When Er3 occurs

Press the proper key switch. GPIB and power supply frequency are set as follows.

Parameter	Set value
GPIB	Header : ON ADDRESABLE Address :01
Power supply frequency	50Hz

A parameter is re-set for measurement.

③ When except Er2 and Er3 occurs

Power on the 8240 again. If an error occurs after that, the unit is considered to be out of order. Contact the nearest business office, or agency. Their address and telephone number are listed at the end of this manual.

4. MEASUREMENT METHOD

This chapter explains how to measure the DC voltage and DC current, and notes on measurement.

4.1 Before Measurement

Power on the power switch, set the 8240 to power supply frequency for use (see Item 3.2 Setting the power supply frequency), and start to measure.

NOTE

The frame must be grounded with 3-pin connector of attached cable or the GND terminal on the rear panel.

4.2 DC Voltage Measurement (V DC)

4.2.1 DC Voltage Measurement

Procedure for measuring the DC voltage

① Set the measurement function.

When the LED of the V DC is off, turn on the LED.

② Set the range.

When the LED of the AUTO is on, the range is automatically set according to the input.
When the LED of the AUTO is off, set the range for input with the DOWN and UP .

③ Set DRIVING GUARD ON or OFF

When the LED of the D GUARD is on, DRIVING GUARD is ON. When it is off, DRIVING GUARD is off. See Item 5.3 D GUARD (DRIVING GUARD), and set ON or OFF.

④ Connect the input cable

Different input cable is connected depending on DRIVING GUARD ON or OFF set in ③. Connect the input cable according to Figure 4-1.

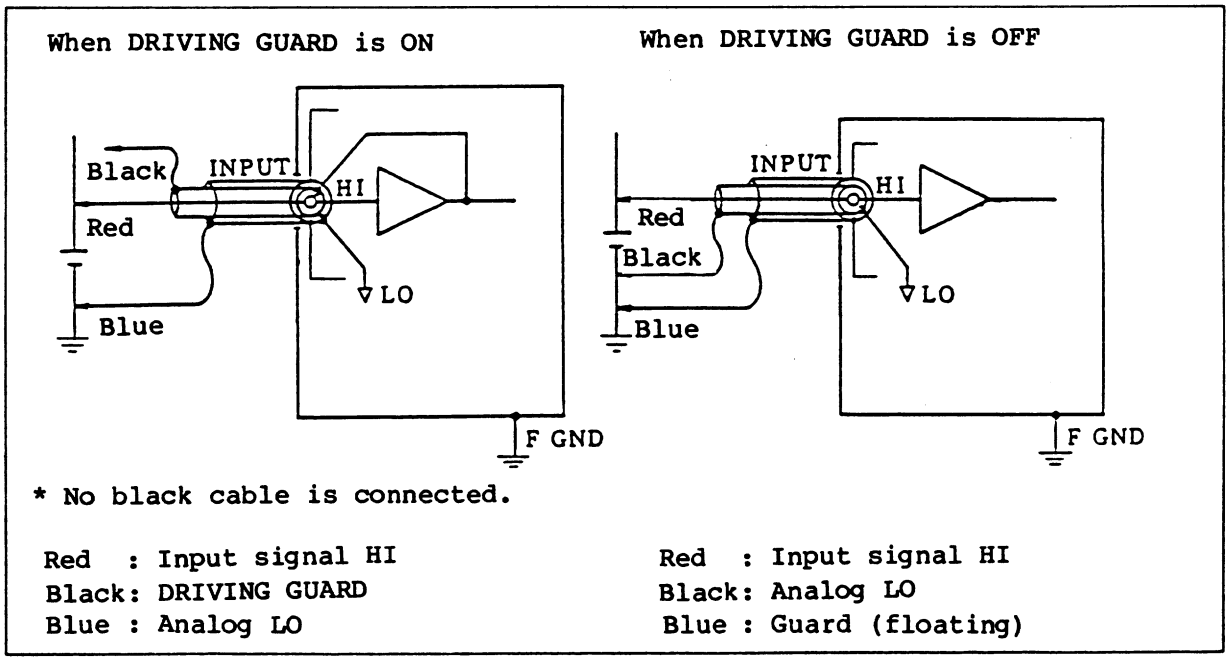


Figure 4 - 1 Input Cable Connection for DC Voltage Measurement

GPIB remote operation

```
F1  : Sets the DC voltage measurement function.
FNC?: Checks the current measurement function.
R0  : Sets the AUTO range.
R2  : Sets the 200mV range.
R3  : Sets the 2V range.
R4  : Sets the 20V range.
RNG?: Checks the current range.
DG0 : Sets DRIVING GUARD OFF.
DG1 : Sets DRIVING GUARD ON.
DGX?: Checks the currently-set DRIVING GUARD.
```

4.2.2 Notes on Measurement

(1) When DRIVING GUARD is on, do not connect the black cable.

(2) Maximum allowable apply voltage

Table 4-1 lists the maximum allowable apply voltage. Never exceed the voltage.

Table 4 - 1 Maximum Allowable Apply Voltage for DC Voltage Measurement

Apply voltage terminal	Maximum allowable apply voltage
Between HI and LO	200Vpeak
Between LO and GUARD (floating)	200Vpeak
Between GUARD (floating) and F GND	500Vpeak

(3) Input Impedance

Input impedance in ranges is more than 1 X $10^{13}\Omega$ and less than 30pF.

4.3 Direct Current Measurement (A DC)

4.3.1 Direct Current Measurement

Procedure for measuring the direct current

① Set the measurement function.

When the LED of the A DC is off, turn on the LED.

② Set the range.

When the LED of the AUTO is on, the range is automatically set according to the input.

When the LED of the AUTO is off, set the range for input with the DOWN and UP .

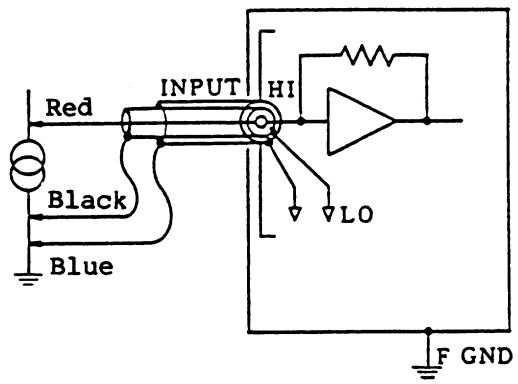
③ Connect the input cable

Connect the input cable according to Figure 4-2.

NOTE

In Figure 4-2, DRIVING GUARD ON is similar to DRIVING GUARD OFF in the connection diagram but meaning of the blue clip is different.

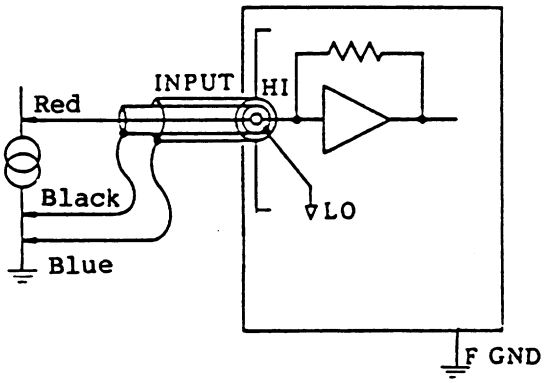
When DRIVING GUARD is ON



* A Black cable may not be connected.

Red : Input signal HI
Black: Analog LO
Blue : Analog LO

When DRIVING GUARD is OFF



Red : Input signal HI
Black: Analog LO
Blue : Guard (floating)

Figure 4 - 2 Input Cable Connection for Direct Current Measurement

GPIB remote operation

F2 : Sets the DC measurement function
FNC?: Checks the current measurement function.
R0 : Sets the AUTO range.
R2 : Sets the 200pA.
R3 : Sets the 2nA range.
R4 : Sets the 20nA range.
R5 : Sets the 200nA range.
R6 : Sets the 2μA range.
R7 : Sets the 20μA range.
R8 : Sets the 200μA range.
R9 : Sets the 2mA range.
R10 : Sets the 20mA range.
RNG?: Checks the current range.

4.3.2 Notes on Measurement

(1) When DRIVING GUARD is ON, do not apply the voltage between the black and blue input cables.

(2) Maximum Allowable Apply Voltage

Table 4-2 lists the maximum allowable apply voltage. Never exceed the voltage.

Table 4 - 2 Maximum Allowable Apply Voltage for Direct Current Measurement

Apply voltage terminal	Maximum allowable apply voltage
Between HI and LO	200pA to 2μA range 200Vpeak 20μA to 20mA range 70Vpeak
Between LO and GUARD (floating)	200Vpeak
Between GUARD (floating) and F GND	500Vpeak

(3) Maximum Allowable Input Capacity

The maximum input capacity that can be input between HI and LO is 0.1μF. A capacitor of more than 0.1μF cannot be measured.
The capacity of attached input cable is about 100pF.

(4) Input Voltage Drop

200pA to 2mA range : 500μV + 0.5Ω X Ix (V MAX)
20mA range : 30Ω X Ix (V MAX)
Ix : Measured current

(5) For an input cable, a low noise cable is used. An electrical charge occurs in the 200pA and 2nA ranges, and influences the measuring value. Do not use the 8240 in place exposed to oscillation.

(6) External induction greatly influences the measurement of very fine current. The object under measurement must be put in the shield case or sampling box and be measured by reducing the induction noise.

(7) If the noise included in measured current is influenced greatly, set a high sampling rate with the RATE key. When the high sampling rate is set, the measuring speed is slow. However, dispersion is decreased and a read error is reduced (see Item 5.2 RATE (integral time)).

(8) Noise for Zero Check and Range Switching

Table 4-3 and 4-4 list the noise that occurs between input terminals for zero check and range switching.

Table 4 - 3 Noise for Zero Check and Range Switching

Range	Noise (MAX)
200pA	±1V
2nA	±1V
20nA	±0.3V
200nA	±1V
2μA	±1V
20μA	±1V
200μA	±1V
2mA	±1V
20mA	±0.1V

Table 4 - 4 Noise for Range Switching

Range	Noise (MAX)
2nA → 20nA	±1V
2nA ← 20nA	±0.6V
2μA → 20μA	±1V
2μA ← 20μA	±0.6V
2mA → 20mA	±1V
2mA ← 20mA	±1V

(9) Voltage Between Input Terminals for Over-ranging

Table 4-5 lists the maximum voltage between input terminals for over-ranging (when a larger voltage than set range is applied).

Table 4 - 5 Voltage Between Input Voltages for Over-ranging

<table>
<tr><th rowspan="2">Range</th><th colspan="2">Voltage between input terminals</th></tr>
<tr><th>To input of FS to 2 X FS</th><th>To input of more than 2 X FS</th></tr>
<tr><td>200pA</td><td>Less than ±500μV</td><td rowspan="4">Less than ±(1V+3MΩ X I_{IN})*</td></tr>
<tr><td>2nA</td><td>Less than ±1V</td></tr>
<tr><td>20nA</td><td>Less than ±500μV</td></tr>
<tr><td>200nA</td><td>Less than ±500μV</td></tr>
<tr><td>2μA</td><td>Less than ±1V</td><td rowspan="3">Less than ±(1V+1kΩ X I_{IN})*</td></tr>
<tr><td>20μA</td><td>Less than ±500μV</td></tr>
<tr><td>200μA</td><td>Less than ±500μV</td></tr>
<tr><td>2mA</td><td>Less than ±1V</td><td rowspan="2">Less than ±(6V+1kΩ X I_{IN})*

Less than ±70V to input of 1.5 X FS</td></tr>
<tr><td>20mA</td><td>Less than ±(30Ω X I_{IN})* to input of FS to 1.5FS</td></tr>
</table>

* I_{IN} : Input current

NOTE

For more than 20mA and 1.5 X FS, the voltage between input terminals occurs when the input current terminal is opened.
Adjust the voltage so that it can be less than ±70V of the maximum apply voltage.

(10) In the very fine current range, especially 200pA range, the electricity is charged to the cable or insulating material by function change, cable connection, and previous measuring condition. Sequentially, the zero point is sometimes moved by several count. In this case, perform zero check and wait several second to a few minutes until measured value is constant. Start to measure the direct current (for detail of zero check, see Item 5.4 ZERO (Zero Check).

(11) If the signal source resistance is less than return resistance for ranges, an error is added to the signal source resistance apart from measuring accuracy. The following table list the example of added error.
Select range so that the signal source resistance can exceed the return resistance.

Range	Return resistance Rf (RS)	Signal source resistance Ri	Error (digit)	Signal source resistance Ri	Error (digit)
200pA	10GΩ	1GΩ	± 50	100MΩ	± 500
2nA	10GΩ	1GΩ	± 5	100MΩ	± 50
20nA	10MΩ	10MΩ	± 50	1MΩ	± 500
200nA	10MΩ	10MΩ	± 5	1MΩ	± 50
2μA	10MΩ	100kΩ	± 5	10KΩ	± 500
20μA	10kΩ	100kΩ	± 50	10kΩ	± 50
200μA	10kΩ	1kΩ	± 50	100Ω	± 500
2mA	10kΩ	1kΩ	± 5	100Ω	± 50
20mA	10Ω	1kΩ	± 582	100Ω	± 4615

Note: The 20mA range is to be shunt resistance Rs.

Expression

20nA, 20μA ranges

$$\text{Error} = \frac{\pm\ 500\mu V}{0.2V} \times \frac{Rf}{Ri} \times 20000\ (\text{digit})$$

200pA, 200nA, 200μA ranges

$$\text{Error} = \frac{\pm\ 500\mu V}{2V} \times \frac{Rf}{Ri} \times 20000\ (\text{digit})$$

2nA, 2μA, 2mA ranges

$$\text{Error} = \frac{\pm\ 500\mu V}{20V} \times \frac{Rf}{Ri} \times 20000\ (\text{digit})$$

20mA ranges

$$\text{Error} = \frac{30 \times Ix}{0.2V} \times \frac{Rs}{Ri+20+Rs} \times 20000\ (\text{digit})$$

Ix : Measured current

5. FUNCTION AND CONTROL METHOD

This chapter explains the functions and control method of 8240.

5.1 NULL

This function subtracts data on pressed NULL key from the next data, and displays the result of operation as data. This operation includes the polarity and range.

X (NULL) : Measured data when NULL is set.
X : Next measured data
R : NULL operation data

If the above items are set, the NULL operation is R=X-X (NULL).
This function is enabled to cancel a constant resistance, compensate for a dark current, and cancel a background current.

(Example 1)

If X (NULL)=-10.00pA (200pA range) and X=1.0000 nA (20nA range), R=1.0100nA (2nA range).

(Example 2)

X (NULL)=1.0000nA (2nA range) and X=0.0100nA (2nA range), R=-0.9900nA (2nA range).

Procedure for NULL

① Press the NULL , and the NULL mode is displayed and the LED lamp on the key goes on.

② Re-press the NULL , and the NULL mode is released and the LED lamp goes off.

GPIB remote operation

NM0 : NULL operation OFF
NM1 : NULL operation ON
NMX? : Checks NULL operation ON or OFF.
When NM1 is set, sub-header is D if the header is on.

NOTE

1. If the NULL mode is set, no range is degraded to less than the measuring range stored NULL data regardless of auto range and manual range.

2. If data set for ;the NULL mode is the over range, the NULL mode is also the over range.

5.2 RATE (Integral Time)

This unit can select seven types of measuring speed. Table 5-1 lists the relation among number of sampling, integral time, and maximum display. The input signal integral time of the A/D converter is as follows: 2ms, 1PLC, 5PLC, 10PLC, 10PLC X 4, 10PLC X 8, and 10PLC X 16. PLC is an abbreviation of Power Line Cycle, and is one cycle of AC power supply. 1PLC equals to 20ms at 50Hz, and is about 16.667ms at 60Hz. 10PLC X 4 to 10PLC X 16 indicates that data on integral time of 10PLC has been averaged from four to 16 times. If integral time is extended for data varying widely, data varying closely is obtained.
In integral time from 1PLC to 10PLC X 16, NMR more than 60dB is obtained and measured data is displayed as 4 1/2 digits. In 2ms, NMR is 0 dB and measured data is displayed as 3 1/2 digits.
When integral time of 2ms to 10PLC is changed, AD CAL operates and calibration for two sampling is measured.

Table 5 - 1 Integral Time, Measurement Speed, and Maximum Display

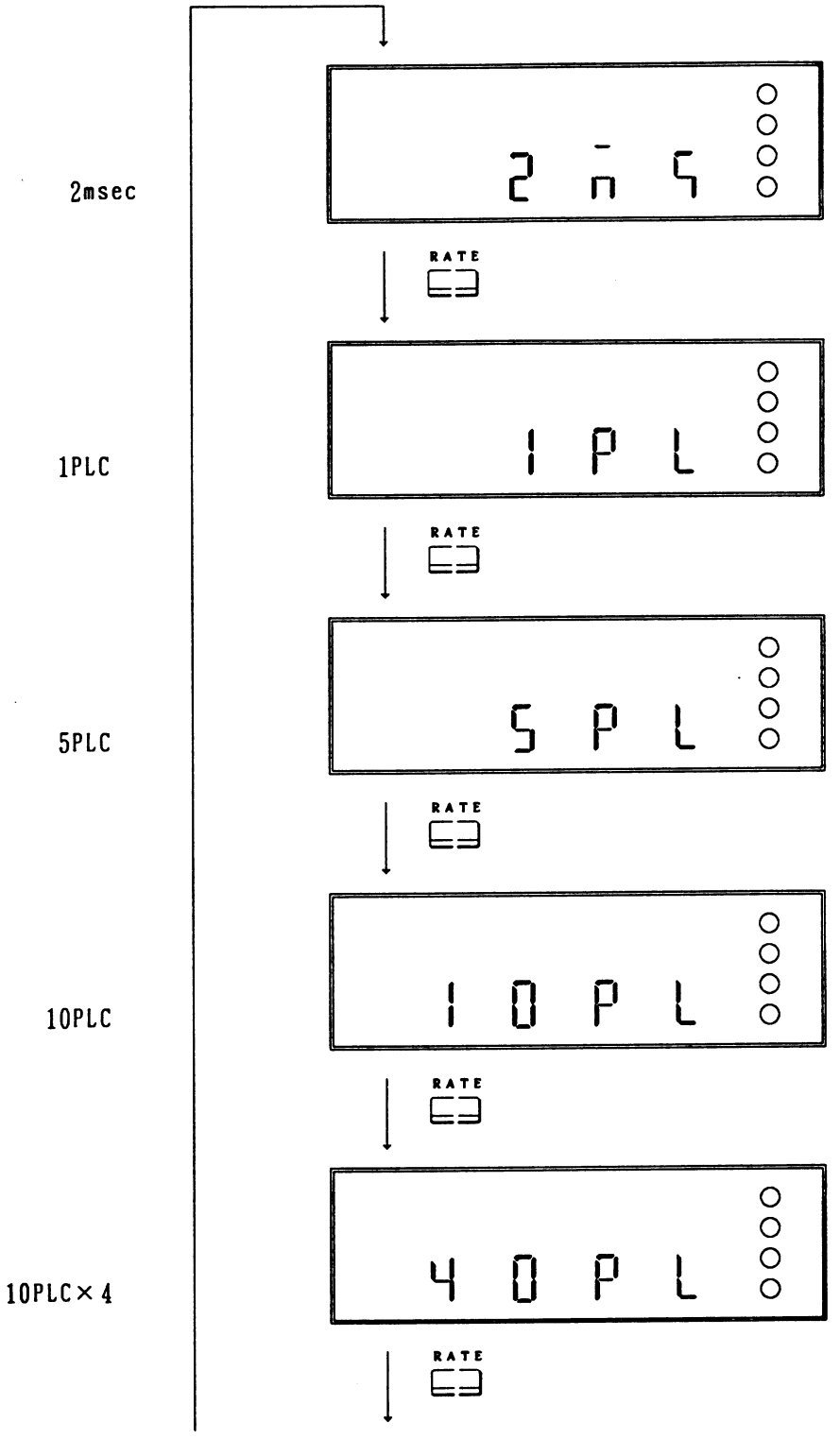
Integral time	Display	Sampling number for free run	GPIB sampling number	Maximum display
2mS	2mS	75 times/second	37 times/second	3 1/2 digits 1999
1PLC	1PL	50Hz 25 times/second, 60Hz 28 times/second	19 times/second, 20 times/second	4 1/2 digits 19999
5PLC	5PL	8 times/second	7 times/second	
10PLC	10PL	4 times/second	3 times/second	
10PLC ×4	40PL	1 time/second	0.9 time/second	
10PLC ×8	80PL	0.5 time/second	0.4 time/second	
10PLC ×16	160PL	0.25 time/second	0.2 time/second	

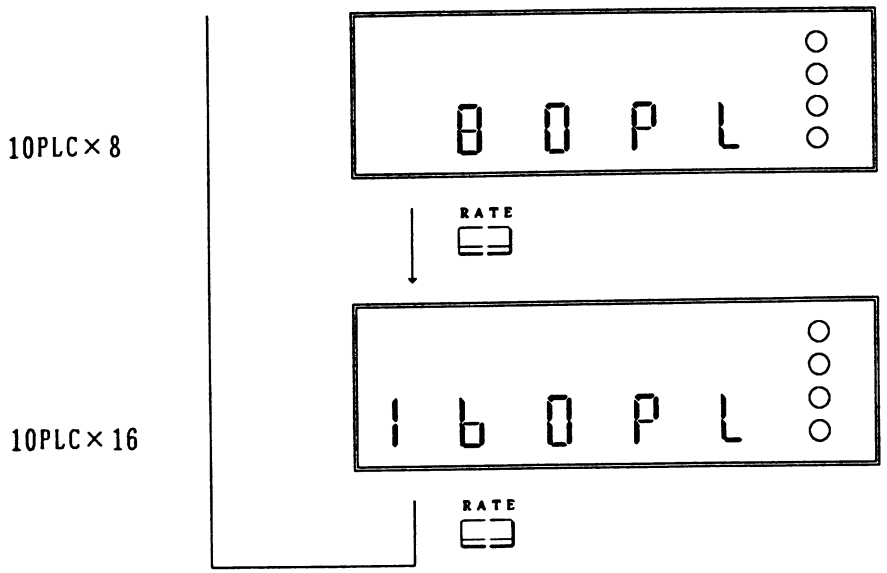
GPIB sampling number is a reference value.
Controller : PC9801RX
Header : ON
Sampling : HOLD (data acquisition with GET-INPUT@)
* When the 8240 is powered on, the integral time is set to 10PLC.

Mar 30/07

Control Procedure

① Press the RATE until desired integral time is displayed.





② Set displayed RATE, and automatically enter the measuring state.

GPIB remote operation

```
IT0  : Sets to RATE 2ms.
IT1  : Sets to RATE 1PLC.
IT2  : Sets to RATE 5PLC.
IT3  : Sets to RATE 10PLC.
IT4  : Sets to RATE 10PLC X 4.
IT5  : Sets to RATE 10PLC X 8.
IT6  : Sets to RATE 10PLC X 16.
ITK? : Checks the current RATE.
```

5.3 D GUARD (DRIVING GUARD)

DRIVING GUARD accelerates the measurement speed when the sample with a large signal source impedance is measured.
If DRIVING GUARD is turned on, the response is more than ten times as faster as that for OFF. The electrode of the HI terminal is to be the same as that of the internal shield, and a leak current is reduced. Therefore, the nominal insulating resistance increases.
However, C1 (see Figure 5-2) between the HI terminal and internal shield is positive feedback of a buffer amplifier. When a cable is extended or a large volume is used for the cable, the cable may be oscillated.

(1) Operation

Procedure

① Press the D GUARD key, and DRIVING GUARD is turned on and the LED of the key goes on.

② Re-press the D GUARD key, and DRIVING GUARD is turned off and the LED of the key goes off.

GPIB remote operation

DG0 : Sets to DRIVING GUARD OFF
DG1 : Sets to DRIVING GUARD ON
DGX? : Checks the current DRIVING ON or OFF

(2) Input Cable State

Input cable connection is changed by switching DRIVING GUARD. The condition of internal shield (black clip) and outer shield (blue clip) of the input cable is selected to LO or GUARD by DRIVING GUARD ON or OFF. For the state of the input circuit, see Figure 5-1 and 5-2. Table 5-2 and 5-3 lists states of functional input cables.

Table 5 - 2 States of Input Cable for DRIVING GUARD ON

Function	Red clip (core wire)	Black clip (internal shield)	Blue clip (outer shield)
V DC	HI	Same electrode as an input signal (connected to the output of an input amplifier)	LO
A DC	HI	LO	LO

(3) Principle

① DRIVING GUARD OFF

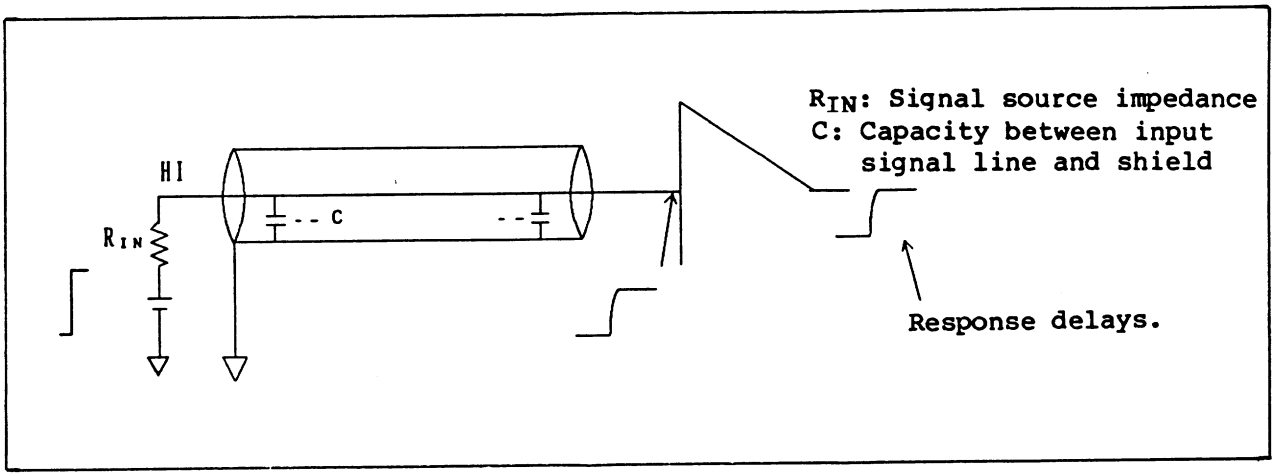


Figure 5 - 1 Principle of DRIVING GUARD OFF

When signal source impedance R_{IN} is increased by capacity C between the input signal line and shield and signal source R_{IN}, a constant is increased. Therefore, an input signal response delays at the end of cable output.

② DRIVING GUARD ON

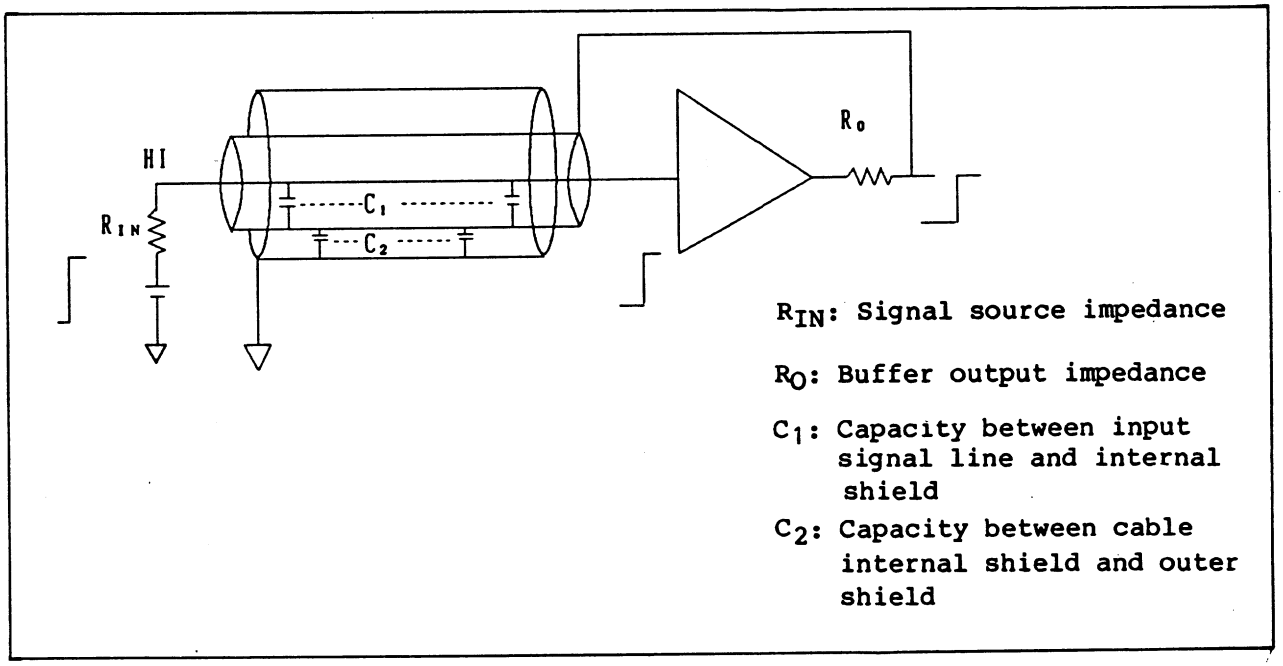


Figure 5 - 2 Principle of DRIVING GUARD ON

Table 5 - 3 States of Input Cable for DRIVING GUARD OFF

Function	Red clip (core wire)	Black clip (internal shield)	Blue clip (outer shield)
V DC	HI	LO	Connected to GUARD case (floating)
A DC	HI	LO	Connected to GUARD case (floating)

5.4 ZERO (Zero Check)

Cancel the offset of the input amplifier.
When 0 is not displayed by input short through the V DC function or 0 is not displayed by input open through the V DC function, perform zero check. For precision of zero point, see Item 11. SPECIFICATION.
In the state of zero check, an input resistance is about 2.2MΩ and an electrical charge of sample is discharged.

Procedure

① Zero check ON

Press the ZERO , and the LED goes on and zero check is performed.

The data display LED goes off.

The state of zero check is maintained until the ZERO is pressed.

② Zero check OFF

Re-press the ZERO , and zero check is released and the LED goes off

to enter the measuring state.
When the function is changed, zero check is turned off.

GPIB remote operation

MD0 : Zero check OFF (measuring state)
MD1 : Zero check ON
MDX? : Checks zero check ON or OFF.

6. GPIB INTERFACE

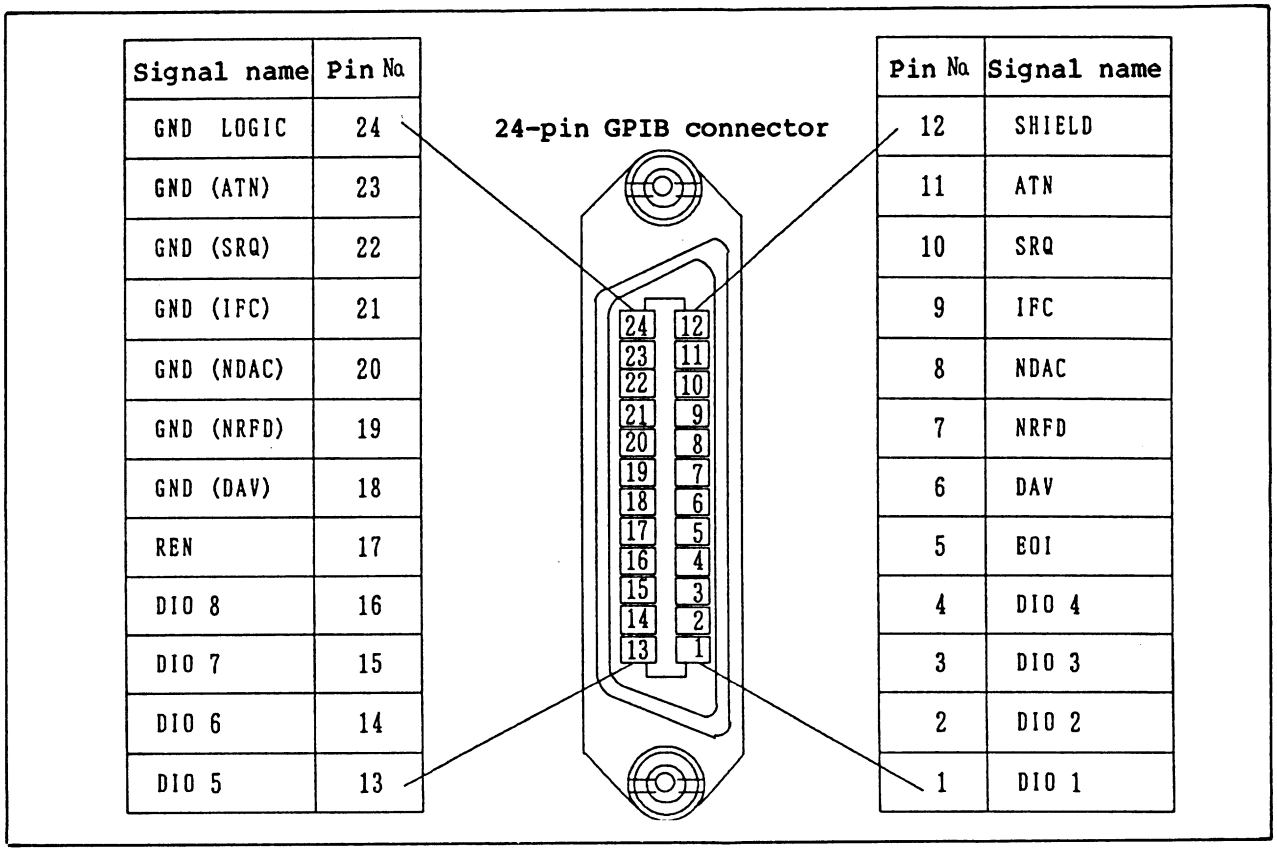
This chapter explains the GPIB controlling the 8240.

6.1 Overview

The GPIB interface connects this unit to the measuring path that is in accordance with the IEEE standard 488-1978. This unit has the GPIB interface, which can construct easily the GPIB measuring system using the personal computer. Therefore, automatic measurement and data processing can be done easily. Since the remote program through the GPIB controls most of set items for panel switches of this unit, the GPIB can be used for wide applications.

6.2 Standard

Standard : IEEE standard 488-1978
Code for use : ASCII code
Connector pin arrangement :



Signal name	Pin No.
GND LOGIC	24
GND (ATN)	23
GND (SRQ)	22
GND (IFC)	21
GND (NDAC)	20
GND (NRFD)	19
GND (DAV)	18
REN	17
DIO 8	16
DIO 7	15
DIO 6	14
DIO 5	13

Pin No.	Signal name
12	SHIELD
11	ATN
10	SRQ
9	IFC
8	NDAC
7	NRFD
6	DAV
5	EOI
4	DIO 4
3	DIO 3
2	DIO 2
1	DIO 1

Figure 6 - 1 GPIB Connector Pin Arrangement

Logical level : More than logic 0 (HIGH state) +2.4V
Less than logical 1 (LOW state) +0.4V
Signal line termination : 16bus lines are terminated as shown in Figure 6-2.

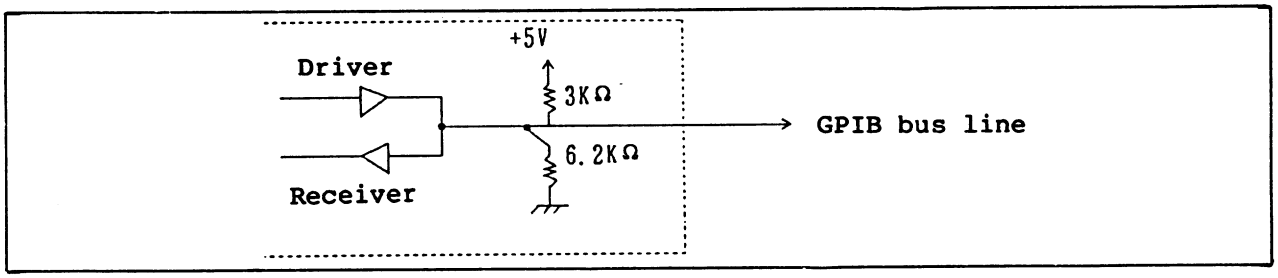


Figure 6 - 2 Signal Line Termination

Driver specification : Try state system
LOW state output voltage ; Less than +0.4V, 48mA
HIGH state output voltage; +2.4V -5.2mA
Receiver specification: LOW state is less than +0.6V
HIGH state is more than +2.0V
Bus cable length : The length of all bus cables is less than (number of devices connected to the bus) X 2m and is less than 20m.
Addressing : 31 types of talk address or listen address can be set optionally by setting the GPIB address on the front panel.
Interface function : Table 6-1 lists the functions of interface.

Table 6 - 1 Interface Function

Code	Function
SH1	Source handshake fucntion
AH1	Acceptor handshake function
T5	Basic talker function Talk only mode function Serial pole function Trigger release function specified by talker
L4	Basic listener function Talker release function specified by talker
SR1	Service request function
RL1	Remote/local switching function
PP0	Without parallel pole function
DC1	Device clear function (SDC and DCL commands can be used)
DT1	Device trigger function (GET command can be used)
C0	Without controller function
E2	Try state output

6.3 Connection to Equipment

Since the GPIB system contains several equipment, pay attention to the following items and configure the system.

Notes on System Configuration

(1) According to instruction manuals of this unit, controller, and peripheral equipment, check the condition (preparation) and operation of devices before connection.

(2) Sepcify the proper length of the cable connected to the measuring device and the bus cable connected to the controller.
Be careful to prevent the length of the cable from exceeding 200m. We prepares cables listed in Table 6-2 for a standard bus cable.

Table 6 - 2 Standard Bus Cable

Lentgh	Name
0.5m	408JE-1P5
1m	408JE-101
2m	408JE-102
4m	408JE-104

(3) The bus cable connector is a piggy back type. One cable connector contains a male and female connectors, and can be used by piling up them. When connecting the bus cable, do not pile up more than two connectors. Be sure to fasten screws securing the connector.

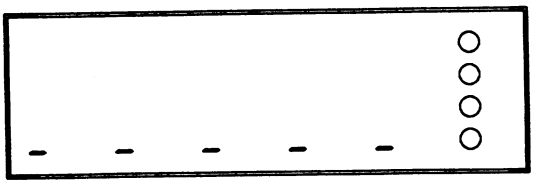
(4) After checking conditions for electric power of devices, grounding state, and set condition if necessary, then turn on devices. Be sure to turn on all devices connected to the bus. Unless a device is turned on, the overall system cannot be secured.

6.4 Addressing and Selecting Header ON or OFF

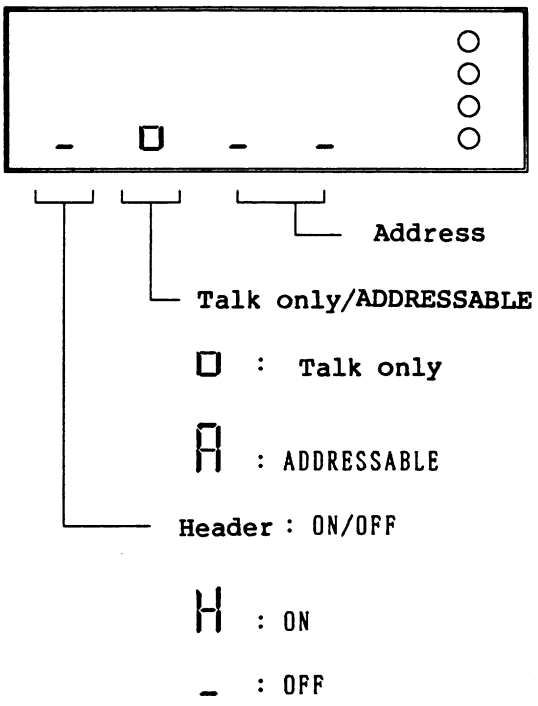
Use the panel key to specify GPIB talk or listen address and select header ON or OFF. Header ON or OFF can also be set by external controller. The state of address or header ON or OFF is not changed if the power is turned off. If Error 3 occurs, pressing the proper key allows it to be set to 50Hz, address 01.

Procedure

① Press the SHIFT , the LED lights and _ _ _ _ _ is displayed.



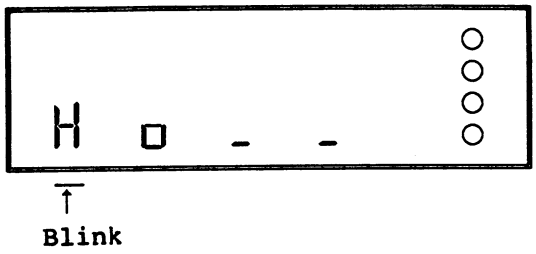
② Press the GP-IB , the current set description is displayed and the LED of HEADER ON or OFF blinks.



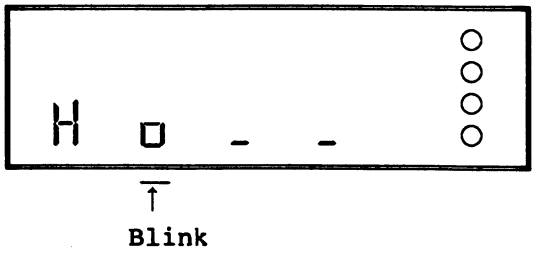
③ Newly set header ON, ADDRESSABLE, and address 27.

6.4 Addressing and Selecting Header ON or OFF

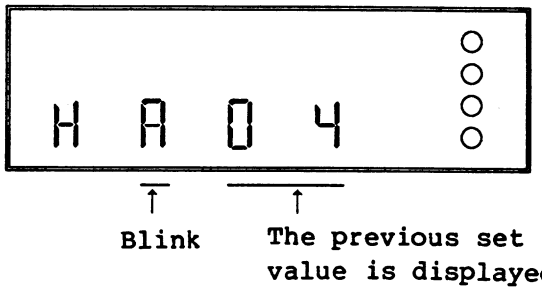
④ Press key ▽ and △ , set turn OFF to turn ON.



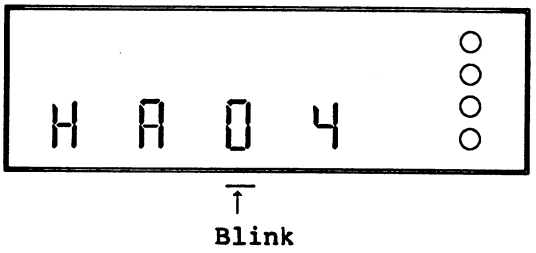
⑤ Press key ▷ and the following LED blinks.



⑥ Press key △ or ▽ , set talk only to ADDRESSABLE.

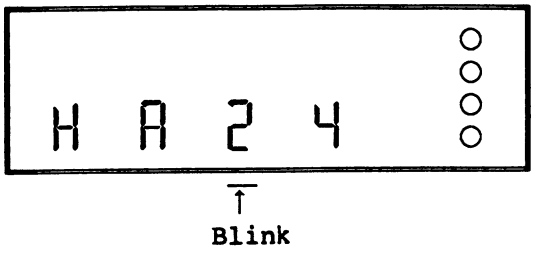


⑦ Press key ▷ , and the next LED blinks.

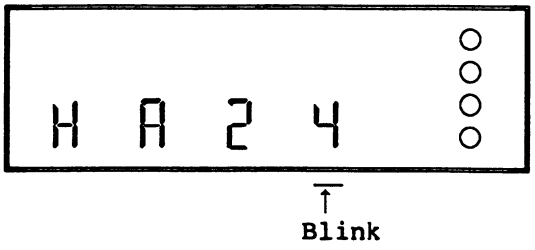


6.4 Addressing and Selecting Header ON or OFF

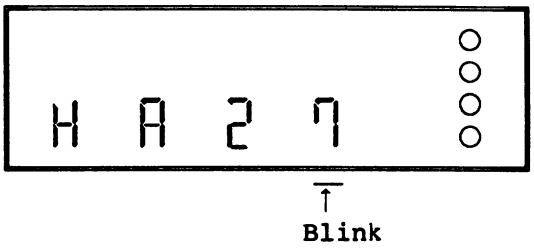
⑧ Press key △ or ▽ a few times, and change 0 to 2.



⑨ Press key ▷ , and the next LED blinks.



⑩ Press key △ or ▽ a few times, and change 4 to 7.



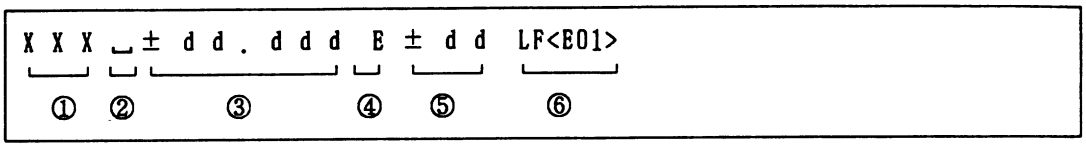
⑪ Press the SHIFT , and setting is completed and measurement can be done.

NOTE

1. If more than 31 of address is set, an error occurs.
2. Address cannot be set in the talk only mode.
3. If the talk only mode is set, data can be output directly to the listener such as a printer without controller. Do not operate the controller in listener only mode and controller modes at the same time.

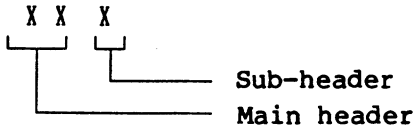
6.5 Talker Specification (Data Output)

6.5.1 Basic Format



① Header

When the header is off, space is not put before the data imaginary part and is shifted to the left.

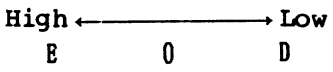


Main header
DV : Direct voltage measurement
DI : Direct current measurement

Sub-header
O : Over range*
D : Data after NULL operation
E : Measured data error*
␣ : Otherwise

* : For O and E, data error occurs. Lide DIO +99.99E+99, data and characteristic are changed to 99999 and 99, respectively.

A priority of sub-header is as follows.



② Space

When the header is on, one space must be inserted behind the header.

③ Imaginary part data

In the beginning, polarity + or - must be put. Data contains four or five digits plus a decimal point, and is four digits when integral time is specified to 2ms.

④ E

E means the exponent.

⑤ Characteristic data

In the beginning, polarity + or - must be put. This number is two digits plus polarity according to unit display (exponent and symbol). Table 6-3 lists the data on the imaginary part and characteristic in measuring conditions.

⑥ Block delimiter

The block delimiter can be changed with the program command DLd as follows.
DL0: CRLF <EOI> (<EOI> simultaneous with LF)
DL1: LF
DL2: <EOI> simultaneous with the last byte
DL3: LF <EOI> (<EOI> simultaneous with LF)

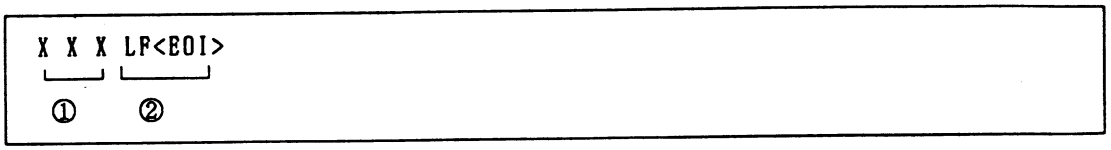
Table 6 - 3 Data on Imaginary Part and Characteristic

Function	Range	Unit=symbol (display)	
		Imaginary part	Characteristic
Direct current [D I]	200pA	±ddd.dd	-12
	2nA	±dddd.d	-12
	20nA	±dd.ddd	-09
	200nA	±ddd.dd	-09
	2μA	±dddd.d	-09
	20μA	±dd.ddd	-06
	200μA	±ddd.dd	-06
	2mA	±dddd.d	-06
	20mA	±dd.ddd	-03
Direct voltage [D V]	200mV	±ddd.dd	-03
	2 V	±dddd.d	-03
	20 V	±dd.ddd	+00

If RATE is set to 2ms, the above least significant digit is not output in measured data.

6.5.2 Response to Query Command

(1) Status Query Response

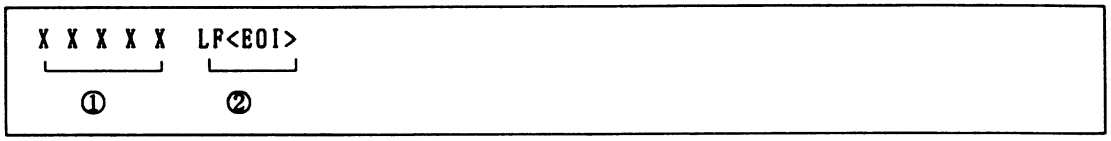


① 8-bit data : 000 to 255
16-bit data: 00000 to 32767
No zero is suppressed.

② Terminator

A terminator is set with the DLd command.

(2) Set Query Response



① A set query response is represented by a alphabetical capital letters. If is data on integral number, the range is from -32768 to +32768. For a format, see Table 6-4.

② Terminator

A terminator is set with the DLd command.

6.6 Listener Specification

The listener command for this unit is classified into three types.

(1) Command Consisting of Header Only

Example: *TRG and E executing measurement

(2) Command Consisting of Header + Data

Example1: F1 and R0 setting parameter

Example2: *SRE24 and *ESE1 setting for status register

(3) Query Command

Example3: RNG? and +STB? checking the detail of parameter or error

6.6.1 Header

(1) Space in Header

Space in the header causes a syntax error.

Example1: *TRG : OK
*T␣RG : Syntax error

Example2: *STB? : OK
*STB␣?: Syntax error

(2) Straight Command

Do not continue command is sequence behind straight commands, E, C, and Z.

Example: F1, F2, E: OK
F1, E, R2: Syntax error

6.6.2 Data Part

(1) Data

Data is available for NR1 (integral number), NR2 (fixed point data excluding exponent), and NR3 (floating point data including exponent). If data more than specified effective digits is received, the one digit lower than the effective one is rounded off.

Example: R9.3 is set to R9, and R9.5 is set to R10.

6.6.3 Terminator

A block delimiter recognizes the following terminators.
LF <EOI> , <EOI> , CRLF, LF, CR <EOI> , CRLF <EOI>

6.6.4 Query (check) Command

A Query command is used to execute set parameter, status information, self-test and to obtain the result. If this command is received, information on the command is output to the output buffer. The output data is output with data on NR1, NR2, and NR3 by command. For output data, see Table 6-4 program code.

Example1: RNG? (range set value?)
→ Output data R0

Example2: *STB? (status byte?)
→ Output data 008

6.6.5 Commands

(1) Parameter Set Command

Table 6 - 4 Parameter Set Command

Command		Description	POWER ON state
Header	Data		
F	1	Direct voltage measurement (V DC)	○
F	2	Direct current measurement (A DC)	
FNC?		Function Qyery Output data is F1 and F2.	
		V DC / A DC	○
R	0	AUTO range / Auto range	
R	2	200mVrange / 200pA range	
R	3	2 Vrange / 2nA range	
R	4	20 Vrange / 20nA range	
R	5	— / 200nA range	
R	6	— / 2μA range	
R	7	— / 20μA range	
R	8	— / 200μA range	
R	9	— / 2mA range	
R	10	— / 20mA range	
RNG?		Range Query Output data is R0 and R2 to R10.	
M0	0	Sampling RUN	○
M0	1	Sampling HOLD	
M0X?		Sampling Query Output data is M00 and M01.	
IT	0	RATE 2ms	
IT	1	〃 1PLC	
IT	2	〃 5PLC	
IT	3	〃 10PLC	○
IT	4	〃 10PLC ×4	
IT	5	〃 10PLC ×8	
IT	6	〃 10PLC ×16	
ITX?		RATE Query Output data is IT0 to IT6.	

Table 6 - 4 Parameter Set Command (cont'd)

Command		Description	POWER ON state
Header	Data		
LF	0	Power supply frequency 50Hz	
LF	1	Power supply frequency 60Hz	
LFX?		Power supply frequency Query Output data is LF0 and LF1.	
MD	0	Zero check OFF (measuring state)	○
MD	1	Zero check ON	
MDX?		Zero check Query Output data is MD0 and MD1.	
NM	0	NULL operation OFF	○
NM	1	NULL operation ON	
NMX?		NULL operation Query Output data is MD0 and MD1.	
OM	0	Measuring data output header ON	
OM	1	Measuring data output header OFF	
OMX?		Measuring data output header Query Output data OM0 and OM1.	
DL	0	Block delimiter CRLF<EOI> (<EOI> simultaneous with LF)	○
DL	1	Block delimiter LF	
DL	2	Block delimiter <EOI> (<EOI> simultaneous with the last byte)	
DL	3	Block delimiter LF<EOI> (<EOI> simultaneous with LF)	
DLX?		Block delimiter Query Output data is DL0 to DL3.	
S	0	SRQ ON (sends the SRQ signal) Note: *SRE is set to except 0.	
S	1	SRQ OFF (sends no SRQ signal)	○
SRQ?		SRQ ON/OFF Query Output data is S0 and S1.	
DG	0	DRIVING GUARD OFF	○
DG	1	DRIVING GUARD ON	
DGX?		DRIVING GUARD Query Output data is DG0 and DG1.	

(2) Device Control Command

Table 6 - 5 Device Control Command

Command		Description
Header	Data	
E		Starts measurement. Same as *TRG and GET (Group Execute Trigger).
C		Initializes the device. Same as SDC (Selected Device Clear) and DCL (Device Clear).
Z		Initializes the device parameter. Same as *RST (Reset). Same as a parameter when this unit is powered on. See Items 3.1 and 6.8.
*TRG		Specifies measurement start. Same as GET and E commands.
*RST		Same as the Z (reset) command. Initializes the set parameter. Same as a parameter when this unit is powered on. See Items 3.1 and 6.8.

Note: A terminator must be required behind the E, C, and Z commands.

(3) Register Reference and Other Command

Table 6 - 6 Register Reference and Other Command

Command		Description (processing)
Header	Data	
ERR?		Outputs the detail of an error such as a device error or execution error. Convers 16-bit error flag to the ASCII data, and outputs it. 0 to 32767 (0: no error) See Table 6-9 Error Register.
*IDN?		Outputs equipment ID. Data to be output is as follows. ADC Corp. , R8240 , 0 , 01010101, Manufacturer name / Model name / Revision No. / (No serial No.)
*OPT?		Outputs option number with ASCII data. (0: No option)

Table 6 - 6 Register Reference and Other Command (cont'd)

Command		Description (processing)
Header	Data	
*TST?		Executes the self-test and outputs the result. Converts an error flag to the ASCII data and outputs the data. 0 to 4095 (0: Self test OK) See Table 6-10 Self Test Error Register.
*CLS		Clears SBR and SESR, then clears the output buffer on the status.
*SRE	0~255	Sets SRER. SRER whether SRQ is sent when any bit of SBR is output.
*SRE?		Outputs the detail of SRER. No RQS bit (bit 6) is set, so output data is 0 to 63 and 128 to 191.
*STB?		Outputs the detail of SBR. Bit 6 of SBR is output as a MSS bit not RQS bit, and also as data containing all ORed bits. The output data is from 0 to 255.
*ESE	0~255	Sets SESER. See Item 6.7.2.
*ESE?		Outputs the detail of SESER. The output data is from 0 to 255.
*ESR?		Outputs the detail of SESR. When the output is read, SESR is cleared. The output data is from 0 to 255. See Item 6.7.2
*PSC?		Outputs the state of power-on clear flag. The output data is 1: power-on clear flag set.

Note: SBR : Status Byte Register
SESR : Standard Event Status Register
SRER : Service Request Enable Register
SESER: Standard Event Status Enable Register

6.7 Status Byte

6.7.1 Status Byte Register Structure

Figure 6-3 shows the structure of status byte register. Table 6-7 explains of this register. The detail of the register is read by serial pole or *STB? command. Bit 6 is also read as MSS (other bit logical OR) by the STB? command. Sending SRQ is limited by service request enable register. This register corresponds to the status byte register at the ratio of one to one, and the bit set to 1 can be sent by SRQ.
This is set by the *SRE command, and the set detail can be read by the *SRE? command.

Example: If the status byte register is set to S0 and *SRE1 is set, it sends SRQ with measurement end only.

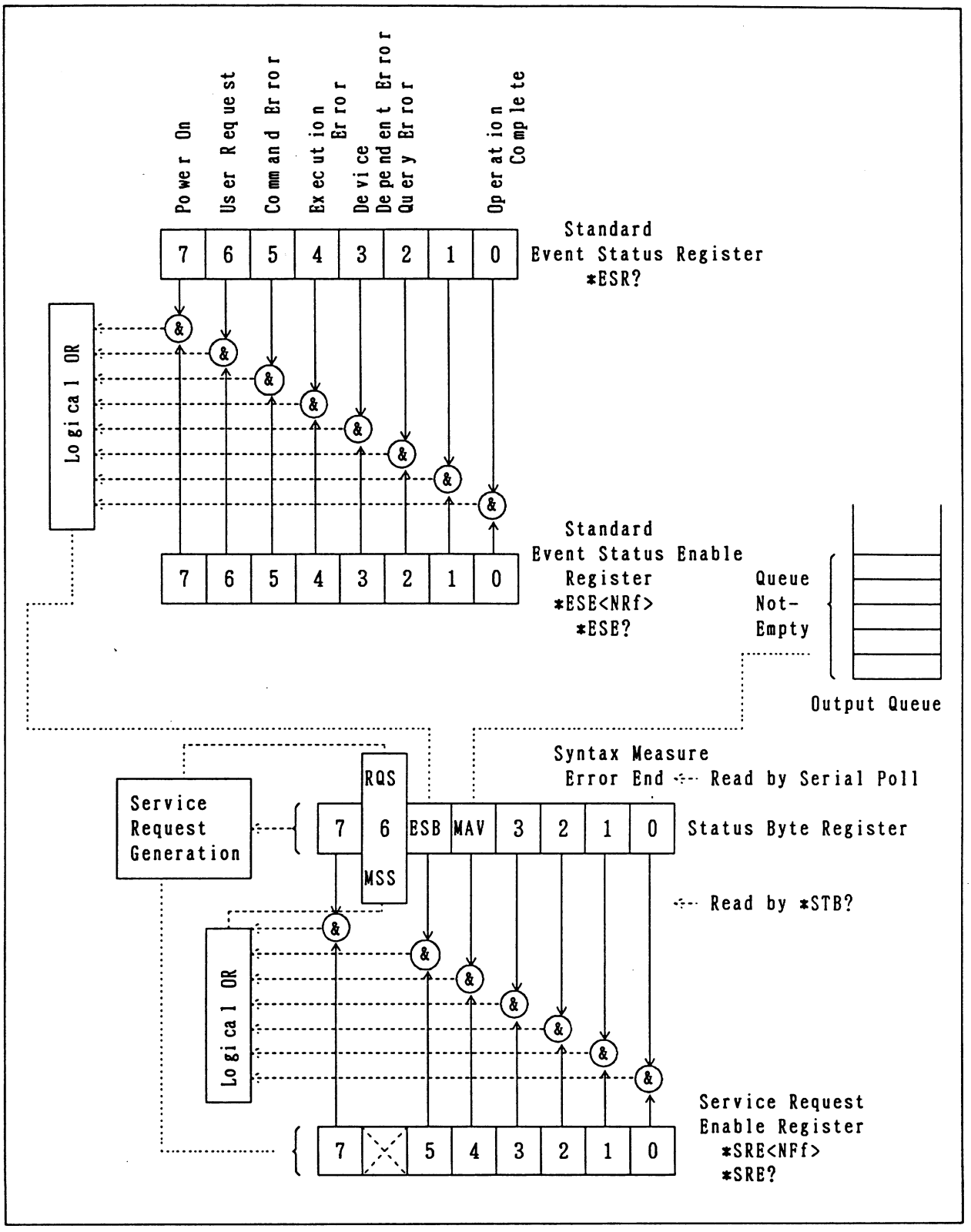


Figure 6 - 3 Status Byte Register Structure

Table 6 - 7 Status Byte Register

bit	Name	Description
0	Measure End	Sets with measurement end. Is reset by measurement start or completion of measured data output.
1	Syntax Error	Is reset if a command error (program data error, listener command error, and listener command buffering overflow) occurs.
2	——	Unused
3	——	Unused
4	MAV	Is set when the output data is set to the output buffer. Is reset when the output data is read.
5	ESB	Is reset if a cause for a bit for SESR occurs when any bit of SESER is set to ENABLE. See Item 6.7.2
6	RQS (MSS)	Is set when bit 0 to 5 are set.
7	——	Unused

NOTE

1. No status byte register is serial pole except the RQS bit (bit 6.)
2. A register related to status and the output buffer related to status are cleared by the *CLS command, but the output buffer of measured data is not cleared. Therefore, MAV bit (bit 4) is not cleared even if the *CLS command is received when measured data is in the output buffer.
3. When the POWER switch is powered on, status byte enable registers SESER and DESER are cleared and no SRQ is sent.

6.7.2 Standard Event Status Register Structure

Figure 6-4 shows the structure of Standard Event Status Register (SESR).
Table 6-8 explains bits of this register. The register is controlled by Standard Event Status Enable Register (SESER).
When SESER is set, bit 5 of status byte register is set if corresponding bit factor occurs. If bit 6 of status byte register is set in this case, SRQ is sent. SESR can be read by the *ESR? command. SESER is written by the *ESE command and can be read by the *ESE? command.

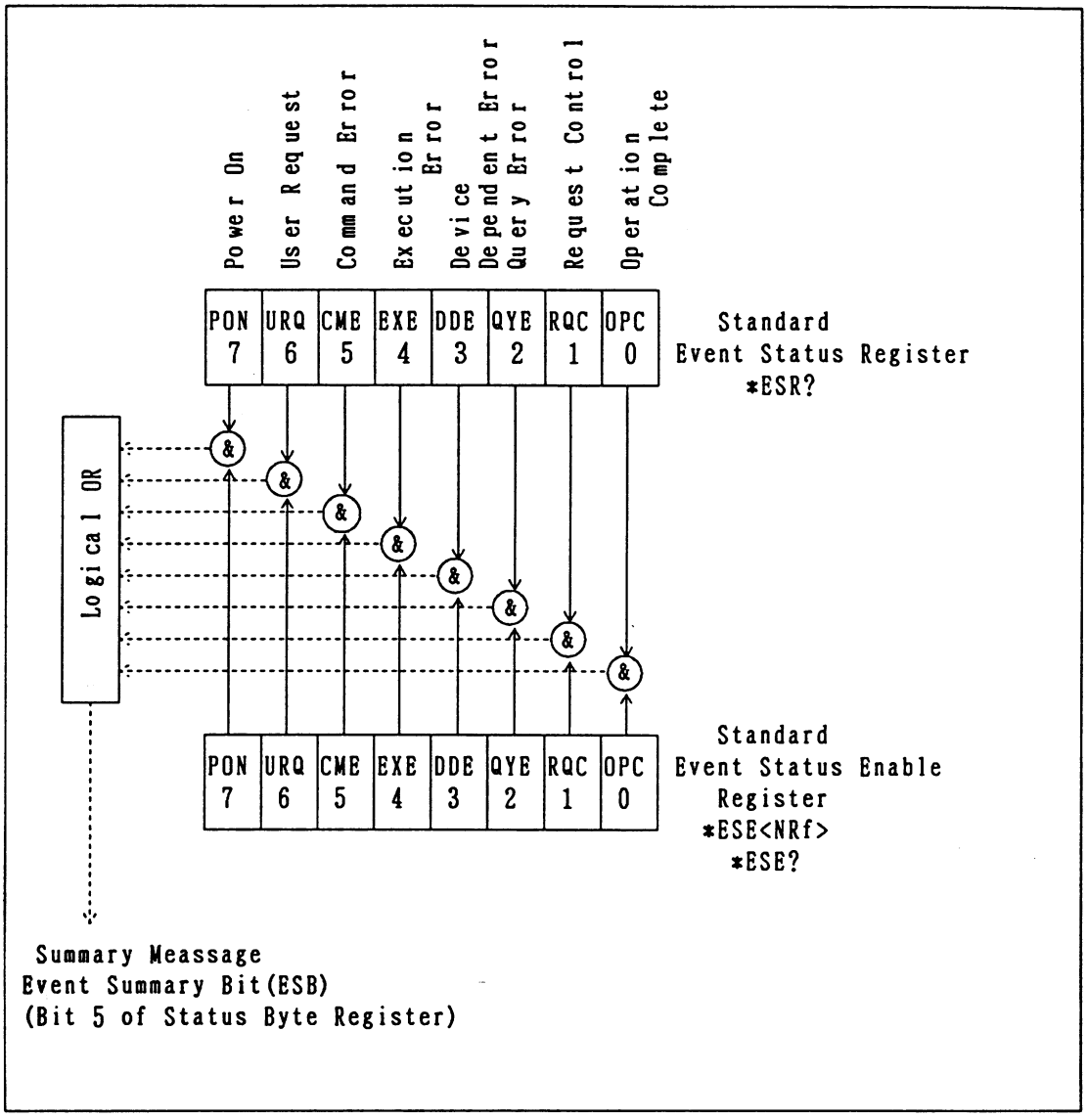


Figure 6 - 4 Standard Event Status Register

Table 6 - 8 Standard Event Status Register

bit	Name	Description
0	OPC (Operation Complete)	Unused
1	RQC	Unused
2	QYE (Query Error)	Is set when the output data is absent and is read or the output buffer overflows.
3	DDE (Devicedependent Error)	Is set when an error occurs in operation such as over-range or over-load or when the device is damaged.
4	EXE (Execution Error)	Is set when input data is output of internally-set range or a command cannot be executed. Example: When range R5 to R10 is received with V DC
5	CME (Command Error)	Is set when undefined header or data format is different or a command character string (including block delimiter) of more than 254 characters is received with one statement.
6	URQ (User Request)	Is set when EXT SRQ input signal is powered on.
7	PON (Power On)	Is set when power-on is switched to power-off.

6.7.3 Error Register

The detail of internal error register is output by the ERR? command. This register consists of 16-bits that are listed in Table 6-9. Output data by the ERR? command converts the detail of an error register through ASCII, and outputs it as data from 0 to 32767.

Table 6 - 9 Error Register

bit	SESR set bit		Error description	Error display
	Name	bit		
0			------	
1			------	
2			------	
3	QYE	bit2	Is set when the output data is absent and is read or the output buffer overflows.	------
4	CME	bit5	Program data format error	------
5			Listener command error	------
6			Listener command input buffer overflow	------
7	DDE	bit3	Over-range	0 L
8			------	
9			------	
10			------	
11			------	
12			------	
13			Internal serial transfer error	E r 4
14			------	
15			------	

6.7.4 Self Test Error Register

The detail of 16-bit self test error register is converted through the ASCII by *TST? command, and 0 to 4095 is output as data. When an error is detected by a self test, bit 3 DDE of SESR is set. When output data is zero, the self test is okayed.

Table 6 - 10 Self Test Error Register

bit	Error description	Error display
0		
1	AD converter failure	Er 1
2		
3		
4	Serial transfer failure	Er 4
5	Calibration data destruction	Er 2
6	GPIB data and power supply frequency data destruction	Er 3
7		
8	RAM read or write error	Er 8
9		
10	Logic ROM failure	Er10
11	Analog ROM failure	Er11
12		
13		
14		
15		

6.8 State of Initialization and Command Receive

Command	Talker (TLK)	Listener (LTN)	SRQ (RQS bit)	Status byte SESR	SRQ enable SESER	Data output buffer	Set parameter
Power On	Clear	Clear	Clear	Clear except PON bit	Clear	Clear	Initialization
"*RST" "Z"							Initialization
DCL, SDC "C"				Clear MAV bit only		Clear	Initialization (Note 2)
IFC	Clear	Clear					
"*CLS"			Owing to MAV bit	Clear MAV bit only			
GET, "B" "*TRG"				Clear Measure End bit			
Talker specification	Set	Clear					
Talker release specification	Clear						
Listener specification	Clear	Set					
Listener release specification		Clear					
Serial poring			Clear				

Note1: DCL: Device Clear
SDC: Selected Device Clear
GET: Group Execute Trigger

Note2: Block delimiter and SRQ mode (S0/S1) are not changed.

6.9 Example of Program

The following lists examples of program using the HP9816 (from Hewlett-Packard) and the PC9801 (from NEC).

6.9.1 DC Voltage Measurement

Measurement of DC voltage is made by external start under the 200mV range and sampling HOLD. Address of 8240 is set to 1.

(1) Example of Program Using the HP 9816

- Example of Program

```
10    !
20    ! SAMPLE PROGRAM 1
30    !
40    DIM A$[20]
50    !
60    OUTPUT 701;"C"
70    OUTPUT 701;"F1,R2,MO1,DG1"
80    !
90    FOR I=1 TO 30
100    TRIGGER 701
110    ENTER 701;A$
120    PRINT A$
130   NEXT I
140   END
```

- Description of Program

	Description
40	Define data area
60	Initialize 8240
70	Set 8240 parameter "F1" : DC voltage measuring function "R2" : 200mV range "MO1": Sampling HOLD "DG1": DRIVING GUARD
90	Make 30 measurements
100	Make external start
110	Receive measured data
120	Display measured data
130	Return to line 90
140	Program end

(2) Example of Program Using the PC9801

- Example of Program

```
10    '
20    ' SAMPLE PROGRAM 1
30    '
40    ISET IFC
50    ISET REN
60    CMD DELIM=0
70    '
80    PRINT @1;"C"
90    PRINT @1;"F1,R2,MO1,DG1"
100   '
110   FOR I=1 TO 30
120    PRINT @1;"E"
130    INPUT @1;A$
140    PRINT A$
150   NEXT I
160   END
```

- Description of Program

	Description
40	Interface clear
50	Remote enable
60	Set delimiter to CR+LF
80	Initialize 8240
90	Set 8240 parameter "F1" : DC voltage measuring function "R2" : 200mV range "MO1": Sampling HOLD "DG1": DRIVING GUARD
110	Make 30 measurements
120	Make external start
130	Receive measured data
140	Display measured data
150	Return to line 110
160	Program end

- Example of Measured data Display

```
DV   +123.46E-03
DV   +123.46E-03
DV   +123.46E-03
DV   +123.17E-03
DV   +123.46E-03
DV   +123.46E-03
DV   +123.46E-03
DV   +123.46E-03
DV   +123.46E-03
DV   +123.46E-03
DV   +123.46E-03
DV   +123.46E-03
DV   +123.46E-03
DV   +123.45E-03
DV   +123.46E-03
DV   +123.46E-03
DV   +123.45E-03
DV   +123.46E-03
DV   +123.46E-03
DV   +123.46E-03
DV   +123.46E-03
DV   +123.46E-03
DV   +123.46E-03
DV   +123.45E-03
DV   +123.46E-03
DV   +123.46E-03
DV   +123.46E-03
DV   +123.46E-03
DV   +123.46E-03
DV   +123.46E-03
```

6.9.2 Measurement of Diode Reverse Leak Current

Using the 6144 DC voltage or current generator, make measurement start with an external SRQ signal to measure the diode reverse leak current. The 8240 address is specified to 1, and the 6144 address is specified to 2. For connection of both units, see Item 10.3 Measurement of Diode Reverse Leak Current.

(1) Example of Program Using the HP 9816

- Example of Program

```
10     !
20     ! SAMPLE PROGRAM 2
30     !
40     DIM A$[20]
50     !
60     ON INTR 7 GOSUB Meas
70     !
80     OUTPUT 701;"C"
90     OUTPUT 701;"F2,R0,M01,D61"
100    OUTPUT 701;"*ESE64,*SRE32,S0"
110    OUTPUT 702;"C"
120    OUTPUT 702;"HV5 D5"
130    !
140    ENABLE INTR 7;2
150    !
160    GOTO 160
170    !
180 Meas:  !
190    S=SPOLL(701)
200    OUTPUT 702;"E"
210    WAIT 1
220    OUTPUT 701;"E"
230    ENTER 701;A$
240    PRINT A$
250    OUTPUT 702;"H"
260    ENABLE INTR 7;2
270 RETURN
280    END
```

- Description of Program

	Description
40	Define data area
60	Define interrupt routine
80	Initialize 8240
90	Set 8240 parameter
	"F2" : DC current measuring function
	"R0" : Auto range
	"M01" : Sampling HOLD
	"DG1" : DRIVING GUARD
	"*ESE64": Standard event status enable register bit 6 set
	"*SRE32": Service request enable register bit 5 set
	"S0" : SRQ ON
110	Initialize 6144
120	Set 6144 parameter
	"HV5 D5": Standby, 10V range, generated voltage 5V
140	Enable interrupt from GPIB
160	Wait for external SRQ signal input
180	Interrupt routine name
190	Poll 8240 and read status byte
200	Operate 6144
210	Wait until the 6144 output is constant
220	Start external measurement of 8240
230	Receive measured data
240	Display measured data
250	6144 standby
260	Enable interrupt from GPIB
270	Return to main routine
280	Program end

(2) Example of Program Using the PC9801

- Example of Program

```
10    '
20    ' SAMPLE PROGRAM 2
30    '
40    ISET IFC
50    ISET REN
60    CMD DELIM=0
70    '
80    ON SRQ GOSUB *MEAS
90    '
100   PRINT @1;"C"
110   PRINT @1;"F2,R0,M01,DG1"
120   PRINT @1;"*ESE64,*SRE32,S0"
130   PRINT @2;"C"
140   PRINT @2;"HV5 D5"
150   '
160   SRQ ON
170   '
180   GOTO 180
190   '
200 *MEAS
210    POLL 1,S
220    PRINT @2;"E"
230    FOR I=1 TO 5000 : NEXT I
240    PRINT @1;"E"
250    INPUT @1;A$
260    PRINT A$
270    PRINT @2;"H"
280    SRQ ON
290 RETURN
300    END
```

- Description of Program

	Description
40	Interface clear
50	Remote enable
60	Set delimiter to CR+LF
80	Define SRQ interrupt routine
100	Initialize 8240

```
110   Set 8240 parameter
      "F2"     : DC current measuring function
      "R0"     : Auto range
      "M01"    : Sampling HOLD
      "DG1"    : DRIVING GUARD
      "*ESE64": Standard event status enable register bit 6 set
      "*SRE32": Service request enable register bit 5 set
      "S0"     : SRQ ON
130   Initialize 6144
140   Set  6144  parameter
      "HV5 D5": Standby, 10V range, generated voltage 5V
160   Allow SRQ receive
180   Wait for external SRQ signal input.
200   Interrupt routine name
210   Poll 8240 and read status byte
220   Operate 6144
230   Wait until the  6144  output is constant
240   Start external measurement of 8240
250   Receive measured data
260   Display measured data
270   6144 standby
280   Allow SRQ receive
290   Return to main routine
300   Program end
```

- Example of Measured Data Display

```
DI   +04.830E-09
DI   +04.831E-09
DI   +04.830E-09
DI   +04.832E-09
DI   +04.829E-09
DI   +04.834E-09
DI   +04.835E-09
DI   +04.831E-09
DI   +04.835E-09
DI   +04.836E-09
DI   +04.818E-09
```

6.9.3 Measurement of Diode Forward I-V Characteristics

Change the apply current as apply current source of 6144. Make measurement start with the external SRQ signal of 8240 to measure the diode forward I-V characteristics. The 8240 address is specified to 1, and the 6144 address is specified to 2. For connection of both units, see Item 10.4 Measurement of Diode Forward I-V Characteristics.

(1) Example of Program Using the HP 9816

- Example of Program

```
10    !
20    ! SAMPLE PROGRAM 3
30    !
40    DIM A$[20]
50    !
60    ON INTR 7 GOSUB Meas
70    !
80    OUTPUT 701;"C"
90    OUTPUT 701;"F1,R0,M01,DG1"
100   OUTPUT 701;"*ESE64,*SRE32,S0"
110   OUTPUT 702;"C"
120   !
130   ENABLE INTR 7;2
140   !
150   GOTO 150
160   !
170 Meas:  !
180   S=SPOLL(701)
190   FOR I=0 TO .3 STEP .01
200     OUTPUT 702;"HI2D";I;"E"
210     WAIT 1
220     TRIGGER 701
230     ENTER 701;A$
240     PRINT I;"mA",A$
250   NEXT I
260   ENABLE INTR 7;2
270 RETURN
280   END
```

● Description of Program

	Description
40	Define data area
60	Define interrupt routine
80	Initialize 8240
90	Set 8240 parameter
	"F1" : DC current measuring function
	"R0" : Auto range
	"M01" : Sampling HOLD
	"DG1" : DRIVING GUARD
100	"*ESE64": Standard event status enable register bit 6 set
	"*SRE32": Service request enable register bit 5 set
	"S0" : SRQ ON
110	Initialize 6144
130	Enable interrupt from GPIB
150	Wait for external SRQ signal input
170	Interrupt routine name
180	Poll 8240 and read status byte
190 to 200	Generate the current from 0 to 0.3mA at 0.01mA step with 6144.
210	Wait until the 6144 output is constant
220	Start external measurement of 8240
230	Receive measured data
240	Display apply current and measured data
250	Return to line 190
260	Enable interrupt from GPIB
270	Return to main routine
280	Program end

(2) Example of Program Using the PC9801

- Example of Program

```
10    '
20    ' SAMPLE PROGRAM 3
30    '
40    ISET IFC
50    ISET REN
60    CMD DELIM=0
70    '
80    ON SRQ GOSUB *MEAS
90    '
100   PRINT @1;"C"
110   PRINT @1;"F1,R0,M01,DG1"
120   PRINT @1;"*ESE64,*SRE32,S0"
130   PRINT @2;"C"
140   '
150   SRQ ON
160   '
170   GOTO 170
180   '
190 *MEAS
200   POLL 1,S
210   FOR I=0 TO .3 STEP .01
220     Is=STR$(I)
230     PRINT @2;"HI2D"+Is+"E"
240     FOR J=1 TO 5000 : NEXT J
250     PRINT @1;"E"
260     INPUT @1;A$
270     PRINT I;"mA",A$
280   NEXT I
290   SRQ ON
300 RETURN
310   END
```

- Description of Program

	Description
40	Interface clear
50	Remote enable
60	Set delimiter to CR+LF
80	Define SRQ interrupt routine
100	Initialize 8240

110	Set 8240 parameter "F1" : DC current measuring function "R0" : Auto range "M01" : Sampling HOLD "DG1" : DRIVING GUARD
120	"*ESE64": Standard event status enable register bit 6 set "*SRE32": Service request enable register bit 5 set "S0" : SRQ ON
130	Initialize 6144
150	Allow SRQ receive
170	Wait for external SRQ signal input
190	Interrupt routine name
200	Poll 8240 and read status byte
210 to 230	Generate the current from 0 to 0.3mA at 0.01mA step with 6144.
240	Wait until 6144 output is constant
250	Start external measurement of 8240
260	Receive measured data
270	Display apply current and measured data
280	Return to line 210
290	Allow SRQ receive
300	Return to main routine
310	Program end

- **Example of Measured Data Display**

```
0 mA          DV  +000.01E-03
.01 mA        DV  +0372.4E-03
.02 mA        DV  +0400.3E-03
.03 mA        DV  +0423.6E-03
.04 mA        DV  +0436.7E-03
.05 mA        DV  +0447.0E-03
.06 mA        DV  +0455.9E-03
.07 mA        DV  +0463.1E-03
.08 mA        DV  +0469.7E-03
.09 mA        DV  +0474.9E-03
.1 mA         DV  +0479.7E-03
.11 mA        DV  +0484.4E-03
.12 mA        DV  +0488.2E-03
.13 mA        DV  +0491.8E-03
.14 mA        DV  +0495.4E-03
.15 mA        DV  +0498.5E-03
.16 mA        DV  +0501.4E-03
.17 mA        DV  +0504.4E-03
.18 mA        DV  +0507.0E-03
.19 mA        DV  +0509.4E-03
.2 mA         DV  +0512.0E-03
.21 mA        DV  +0514.2E-03
.22 mA        DV  +0516.5E-03
.23 mA        DV  +0518.5E-03
.24 mA        DV  +0520.4E-03
.25 mA        DV  +0522.5E-03
.26 mA        DV  +0524.2E-03
.27 mA        DV  +0525.8E-03
.28 mA        DV  +0527.7E-03
.29 mA        DV  +0529.2E-03
.3 mA         DV  +0530.8E-03
```

7. INPUT/OUTPUT SIGNAL

This chapter explains three types of input/output signals and the AMP OUT of this unit. They are also explained in the following order.

(1) COMPLETE output signal

(2) TRIGGER input signal

(3) EXT SRQ input signal

(4) AMP OUT

7.1 COMPLETE Output Signal

The COMPLETE output signal informs the external equipment of measurement end. This output signal is a TTL level negative pulse signal.

HI level : +2.7 to +5.25V, 400μA max.
LO level : 0 to +0.6V, -5mA max.
Pulse width: About 1ms (negative pulse)

7.2 TRIGGER Input Signal

The TRIGGER input signal starts an external measurement. If SAMPLING on the front panel of this unit is set to HOLD, this signal is enabled. The input signal is started with a negative pulse, and SAMPLING is started with edge.

HI level : +3.2 to +5.25V
LO level : 0 to +0.5V
Pulse width: More than 100μs (operated by starting a pulse)
Chattering : Within 5ms

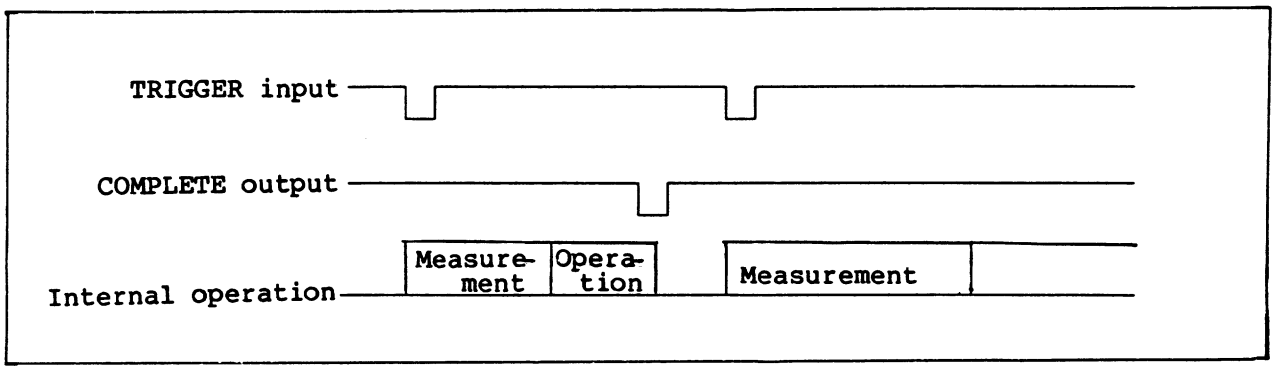


Figure 7 - 1 TRIGGER Input and COMPLETE Output Timing

NOTE

If the measurement is started by TRIGGER input, TRIGGER re-input is ignored until the COMPLETE signal is output.

7.3 EXT SRQ Input Signal

The EXT SRQ input signal sends the SRQ signal on the GPIB bus by external contact signal or logic signal. If this signal is input, bit 6 of the standard event status register is set (For detail of this register, see Item 6.7.2).

HI level : +3.2 to +5.25V
LO level : 0 to +0.5V
Pulse width: More than 100µs (operated by starting a pulse)
Chattering : Within 5ms

7.4 AMP OUT

AMP OUT outputs the pre-amplifier output voltage of measuring part. The output is not isolated from the measuring part. It can be used for a guard output terminal in voltage measurement and a current-to-voltage conversion output teminal in current measurement. It can also be used for an impedance conversion output terminal in measurement of high impedance voltage.
Table 7-1 lists the full-scale output voltage in ranges. For A DC function, it is output by reverse polarity to the input.

Table 7 - 1 AMP OUT

V DC	A DC	Full-scale output voltage
200mV	-	±200mV
2V	200pA	±2V
20V	2nA	±20V
-	20nA	±200mA
-	200nA	±2V
-	2µA	±20V
-	20µA	±200mV
-	200µA	±2V
-	2mA	±20V
-	20mA	±200mV

8. CHECK AND CALIBRATION

This chapter explains how to check a failure for use of the 8240 and calibrate the 8240 to the measurement precision.

8.1 Read Before Repairing

If a failure occurs in use of this unit, be sure to check items in Table 8-1 and contact an ADC CORPORATION sales representative. Even if repairing item is in the following table, we drequest a repairing charge. Check the following items before asking us to repair.

Table 8 - 1 Checking Item

Trouble	Cause	Measure for a trouble
Nothing is displayed.	• A power fuse was burned out.	• Replace it with attached fuse. See Item 1.3.5.
Measured value is inconstant, or abnormal value is displayed.	• Function range setting is incorrect. • Power supply frequency 50/60Hz setting is incorrect.	• Re-check function range. • Adjust to the AC power supply frequency used currently. See Item 3.2.
Even though an input signal is applied, it is not displayed.	• Cable is connected to different input terminal. • Cable was cut.	• Connect the input cable to specific input terminal. See Chapter 4. • Check the cable with a tester, and replace it if a failure is found.

8.2 Calibration

To maintain the measurement precision in Item 11. SPECIFICATION, one cycle of measurement precision secure period (six months) is used for calibration. The following explains the calibration method.

8.2.1 Preparation for Calibration and General Caution

The following explains the unit required for calibration and caution.

(1) Unit Required for Calibration

Use the unit listed in Table 8-2 or its equivalent.

Table 8 - 2 Unit Required for Calibration

Calibration unit	Range	Precision	Recommended unit
Standard direct voltage generator	±0mV to ±20V	Within ±0.005%	6161 (From ADC Corp.)
Standard direct current generator	±0μA to ±20mA	Within ±0.01%	6161 (From ADC Corp.)
Standard resistor	1MΩ	Within ±0.01%	
	10GΩ	Within ±0.14%	

(2) Cable Required for Calibration

Table 8-3 lists the cable required for calibration.

Table 8 - 3 Cable Required for Calibration

Item name	Standard	Remarks
Input/output cable	A01010	Standard accessory
Input cable	BI-109	
TRIAX cables having coaxial connectors		

(3) General Caution on Calibration

① Use specified voltage for AC power supply.

② Use the parameter key according to power supply frequency in use, and set 50 or 60Hz.

③ Calibrate under the following ambient conditions.
Temperature : +23℃ ±3℃
Humidity : Less than 70%
Calibrate in place without dust, vibration, and noise.

④ Allow specified pre-heating time of calibration units.

⑤ Specify more than one hour for pre-heating time of this unit. (during calibration).

⑥ After calibration ends, it is convenient to indicate the calibration data or the next calibration period on the card or sticker.

8.2.2 Outline of Calibration Mode

The following three calibration modes are available.

(1) Calibration check mode : Checks an input value and display data.

(2) Calibration operation mode : Execute the operation so that an input value can be equal to display data.

(3) Calibration correction mode: Increase or decrease digit 0.5 or 5 with keys so that an input value can be equal to display data.

For normal calibration, check calibrated value in the calibration check mode and calibrate in the calibration correction mode. In the following three cases, calibrate in the calibration operation mode and check data in the calibration check mode.

- When more than several tens of count are shifted between display values of standard calibration unit and this unit.
- When calibration data is initialized
- When ER2 occurs

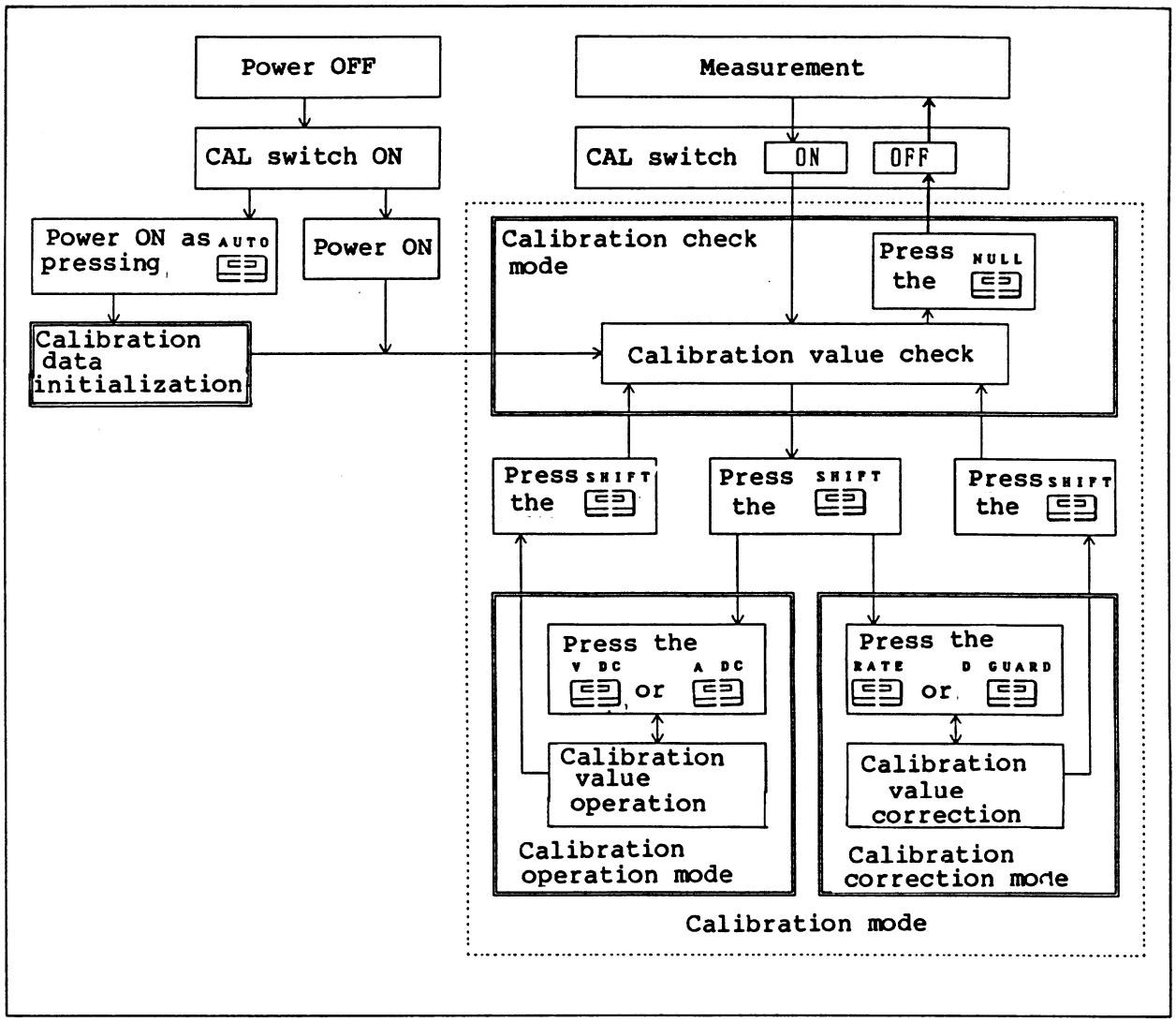


Figure 8 - 1 Outline of Calibration Mode

8.2.3 Calibration Data Initialization

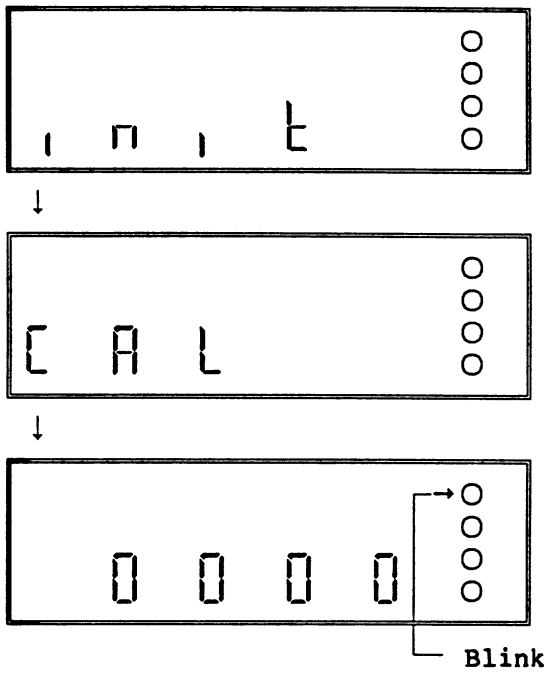
Initialize calibration data, and all calibration data is erased and particular initial value is set.
If ER2 occurs (primary calibration data is destroyed), initialize the calibration data and calibration according to Item 8.2.5 Calibration Operation Mode.

Operation Procedure

① Power off this unit.

② Power on the EXT CAL switch on the rear panel.

③ As pressing the AUTO key, power on the unit. | n | t is displayed.



④ Initialize the calibration data to enter the calibration check mode.

8.2.4 Calibration Check Mode

The calibration value is checked in the calibration check mode.

(1) Entering the Calibration Check Mode

The following four methods are available.

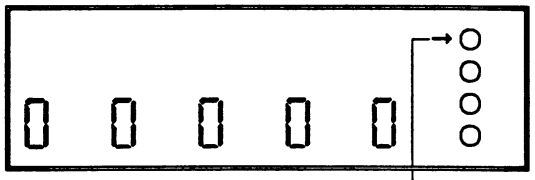
① Power on the EXT CAL switch on the rear panel and power on the unit.

② Initialize the calibration data.

③ Press the SHIFT key in the calibration operation and calibration correction modes.

④ Power on the EXT CAL switch on the rear panel in normal measuring state.

After the above operations, the range LED blinks and the calibration check mode is enabled.



(2) Key Functions in the Calibration Check Mode

The following lists the operational flow of calibration value check in the calibration check mode.

① V DC function setting
② Zero check
③ Range selection
④ Calibration value check
⑤ Take Items ② to ④ in the whole range.
⑥ A DC function setting
⑦ Zero check
⑧ Range selection
⑨ Calibration value check
⑩ Take Items ⑦ to ⑨ in the whole range.
⑪ End

Table 8-4 lists key functions in the calibration check mode.

Table 8 - 4 Key Functions in Calibration Check Mode

	Calibration value check		Calibration data save
	Function selection	Range selection	
SHIFT	V DC or A DC	△ or ▽	NULL
The LED of SHIFT key is off.	V DC	200mV ↓↑ 2 V ↓↑ 20 V	Modify calibration data and save.
	A DC	2μA ↓↑ 200nA ↓↑ 20nA ↓↑ 2nA ↓↑ 200pA; 20μA ↓↑ 200μA ↓↑ 2mA ↓↑ 20mA	

(3) Calibration Value Check

Table 8-5 lists the error limit in ranges. Check whether the calibration value is in the error range.

NOTE

1. After performing zero check of ranges (see Item 5.4), check the current range.
2. In the calibration operation mode, full-scale can be calibrated up to 22000. However, measured display is up to 19999 that is the same as in normal measurement in the calibration check and calibration correction modes. During check, adjust full-scale to about 18000.

Table 8 - 5 Calibration Value Error Limit

Function	Range	Error
V DC	200mV range zero point	± 2d
	200mV range F.S.	± 2d
	2V range F.S.	± 2d
	20V range F.S.	± 2d
A DC	20mA range F.S.	± 4d
	2mA range F.S.	± 3d
	2μA range F.S.	± 4d
	2nA range F.S.	± 5d
	200pA range F.S.	± 10d
	20mA range zero point	± 1
	2mA range zero point	± 1
	200μA range zero point	± 1
	20μA range zero point	± 1
	200pA range zero point	± 2

Operation Procedure

① Check the direct voltage measuring range.

①-1 Set the voltage measuring range with the V DC, △, and ▽.

①-2 Connect in the same way as in measurement of direct voltage.

①-3 Input the standard voltage if full-scale is calibrated to about 18000.

①-4 Check with the range in Table 8-5.

② Check the direct current measuring range.

②-1 Set the current measuring range with the A DC, △, and ▽.

②-2 Perform zero check (see Item 5.4).

②-3 Connect in the same way as in measurement of direct current.

②-4 Input the standard current if full-scale is calibrated to about 18000.

②-5 Check with the range in Table 8-5.

8.2.5 Calibration Operation Mode

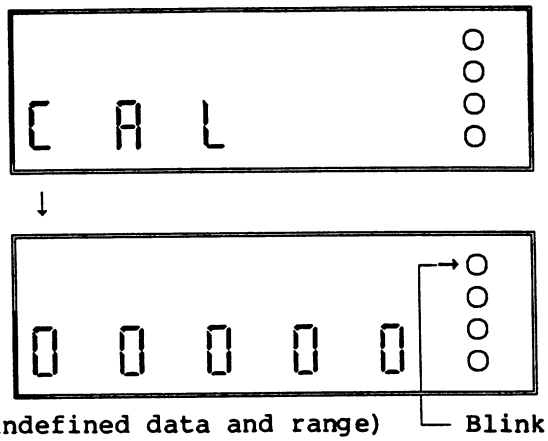
Calibration is performed in the 200mV range zero point of V DC and full-scale (F.S.) of ranges, or in ranges of in 20mA, 2mA, 2μA, 2nA and the 200pA range zero point.

(1) Entering the Calibration Operation Mode

Operation Procedure

① Power on this unit, and allow pre-heating time of more than one hour.

② Power on the EXT CAL switch on the rear panel, and CAL is displayed.



The range LED blinks and the calibration check mode is enabled.

NOTE

When the LED of the D GUARD is off, press this key and power on DRIVING GUARD.

③ Press the SHIFT . Press the V DC or A DC to enter the calibration operation mode.

(2) Key Operations in Calibration Operation Mode

The following lists the flow of operation in the calibration operation mode.

① V DC function selection
② Range selection
③ Standard voltage input
④ Operation start
⑤ Operation end
⑥ Take Item ② to ⑤ in the 200mV range zero point and F.S. in ranges.
⑦ A DC function selection
⑧ Range selection

⑨ Standard current input
⑩ Operation start
⑪ Operation end
⑫ Take Items ⑧ to ⑪ in the 20mA, 2mA, 2μA, 2nA F.S. and in the 200pA range zero position.
⑬ End

Table 8-6 lists key operations in the calibration operation mode.

Table 8 - 6 Key Operations in Calibration Operation Mode

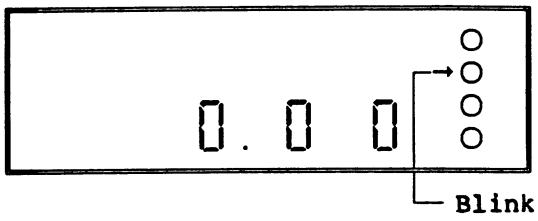
The LED of SHIFT is off.	Function selection	Range selection and data change		Operation start
	V DC or A DC	▷	△ ▽	TRIG
V DC		Range	200mV → 200mV F.S. → 2 V F.S. → 20V F.S. → 200mV zero point	Perform operation
		10^4 digit	0 → 1 → 2	
		10^3 digit 10^2 digit 10^1 digit 10^0 digit	0 → 1 → 2 → 3 → 4 → 5 → 6 → 7 → 8 → 9 → 0	
A DC		Range	20 mA F.S. → 2 mA F.S. → 2μA F.S. → 200pA → 2 nA F.S → 200pA zero point	
		10^4 digit	0 → 1 → 2	
		10^3 digit 10^2 digit 10^1 digit 10^0 digit	0 → 1 → 2 → 3 → 4 → 5 → 6 → 7 → 8 → 9 → 0	

(3) Calibration of DC Voltage Measurement

Operation Procedure

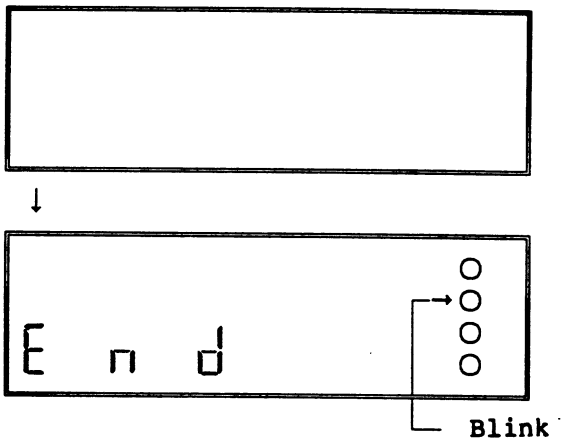
① Calibrate the 200mV range zero point.

①-1 Press the V DC , and the LED lights and 0.00 mV is displayed.



①-2 Connect the input cable, and short-circuit red and blue clips. Do not connect the black, and put in the floating state.

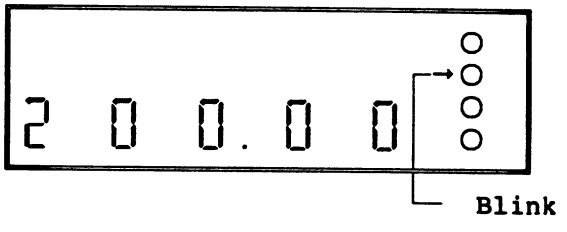
①-3 Press the TRIG , and displayed item disappears and the operation is started.



End is displayed, and calibration of 200mV zero point ends.

② Calibrate the 200mV full-scale.

②-1 Press the △, and 200.00 mV is displayed.



Press the △, and the calibration range is changed as follows.

→200mV zero point→200mV F.S.→2V F.S. →20V F.S. →

Press the ▽, and it is changed in the reverse direction.

②-2 Connect the standard direct voltage/current generator (generator) as shown in Figure 8-2, and generate +200.00mV.

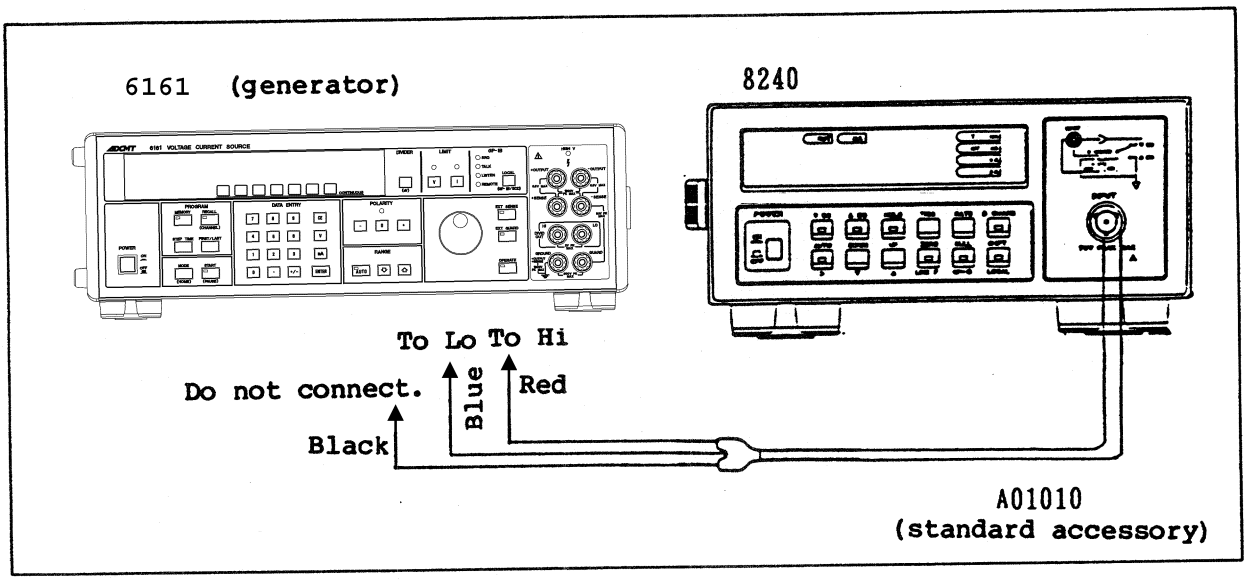


Figure 8 - 2 Direct Voltage Measurement Calibration and Direct Current Measurement 2mA, and 20mA range Calibration Connection

When the output of the generator cannot be set to a proper value

Set this unit so that its display can be equal to the output voltage. Press the ▷, and range display blink is changed to data display blink.

Set the blink section to proper value with ▽ and △.

Press the ▷, and the blink section (change enable section) is changed as follows.

→Range →10^4 digit → 10^3 digit → 10^2 digit → 10^1 digit → 10^0 digit →

Press the △, set data is changed as follows.

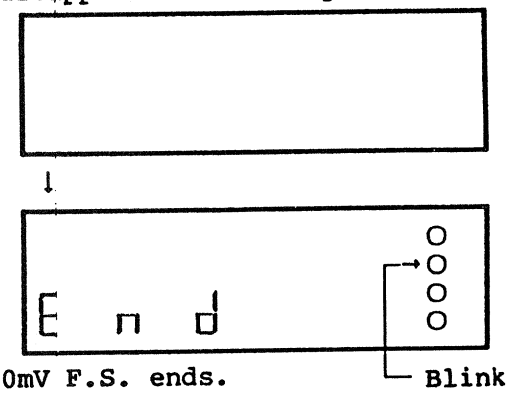
10^4 digit: →0 →1 →2 →

10^3 digit to 10^0 digit: →0 →1 →2 →3 →4 →5 →6 →7 →8 →9 →

NOTE

The set range is from 7000 to 22000.
Use the generator in this range.

② -3 Press the TRIG ▷, and displayed item disappears and the operation is started.



End is displayed, and calibration of 200mV F.S. ends.

③ Calibrate the 2V/20V full-scale.

Calibrate in the same way as in Item ② .

(4) Calibration of DC Current Measurement

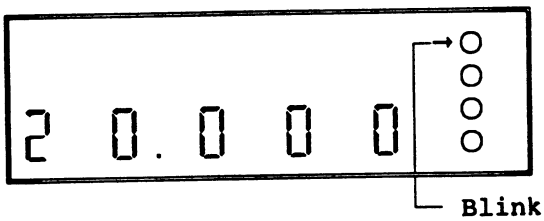
NOTE

Before calibrating direct current measurement in the calibration operation mode, be sure to perform Item (3) Calibration of Direct Voltage Measurement. The following explains the operation after end of (3) Calibration of Direct Voltage Measurement.

Operation Procedure

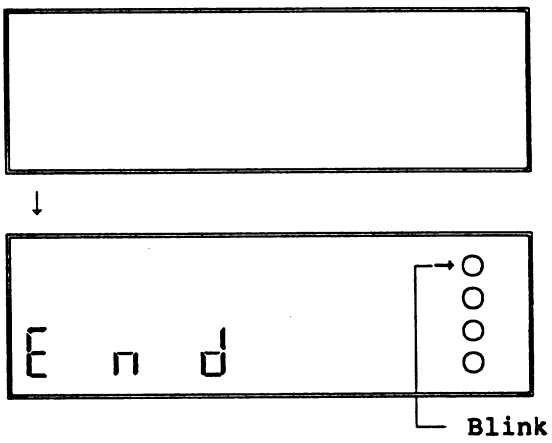
④ Calibrate the 20mA full-scale.

④-1 Press the A DC key, and the LED lights and 20.000 mA is displayed.



④-2 The connection of the generator is shown in Figure 8-2, and 20.000mA is output. When the output of the generator cannot be set optionally, see Item ②-2 and set this unit so that its display can be equal to the output current.

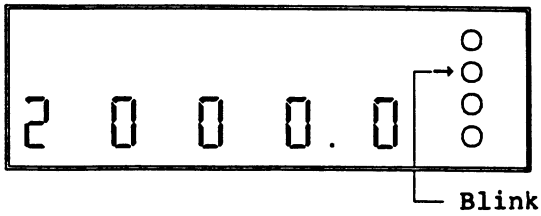
④-3 Press the TRIG key, and displayed item disappears and the operation is started.



End is displayed, and calibration of 2mA F.S. ends.

⑤ Calibrate the 2mA full-scale.

⑤-1 Press the ▽ key, and 2000.0 µA is displayed.



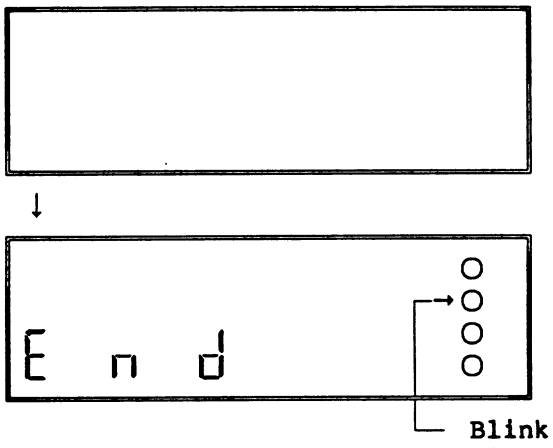
Press the ▽, and the calibration range is changed as follows.

→20mA F.S. →2mA F.S.→ 2μA F.S.→2nA F.S.→ 200pA zero point→

Press the △, and it is changed in the reverse direction.

⑤-2 Set the generator to 2.00000mA and output.

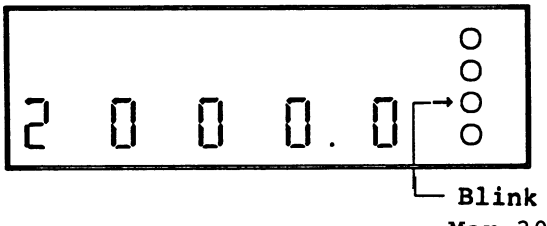
⑤-3 Press the TRIG, displayed item disappears and the operation is started.



End is displayed, and calibration of 2mA F.S. ends.

⑥ Calibrate the 2μA full-scale.

⑥-1 Press the ▽, and 2 0 0 0. 0 nA is displayed.



⑥-2 Connect the generator as shown in Figure 8-3. Output the voltage determined by the following expression, and input 2.00000μA to this unit.

The output voltage of the 6161 is determined by the following expression.
Voltage = 2 X calibration value of standard resistor X 10^{-6} (V)
(Example) When the calibration value of the standard resistor is 0.9234 X $10^{6}\Omega$, the voltage is as follows.
V = 2 X 0.9234 X 10^{6} X 10^{-6} = 1.8468 (V)

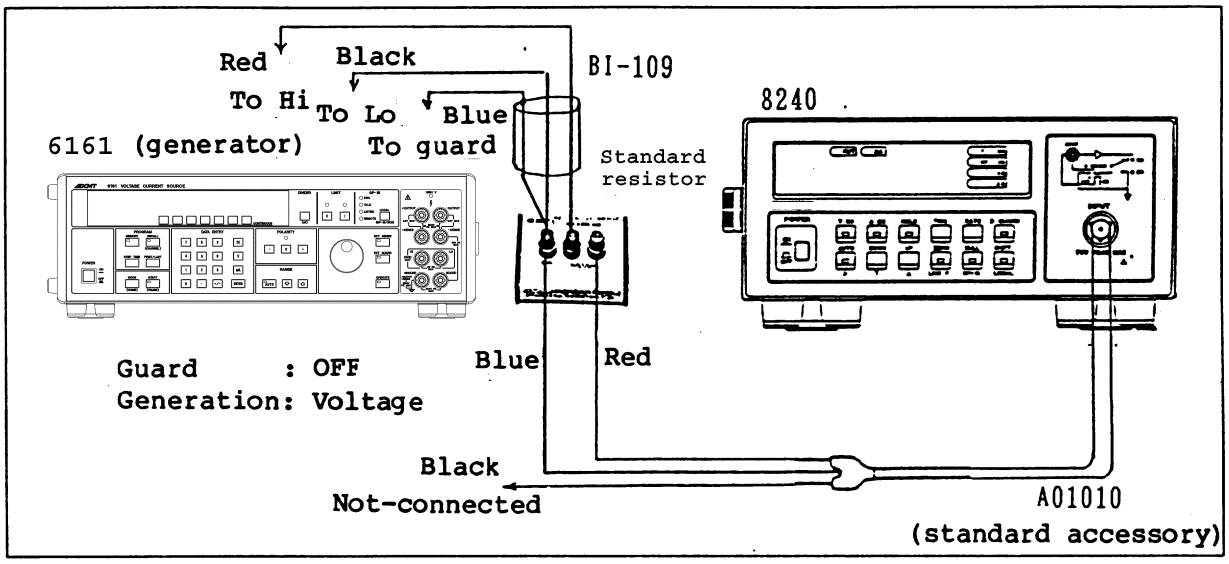
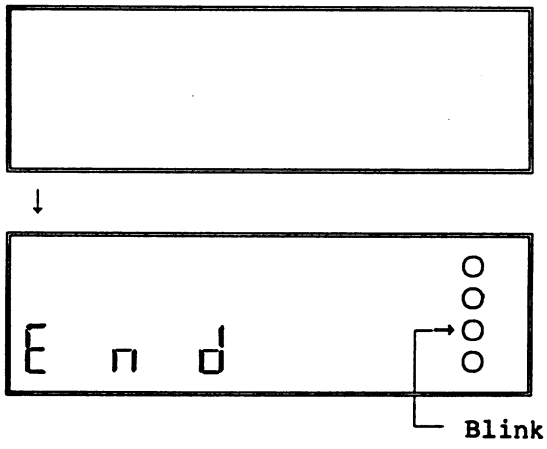


Figure 8 - 3 Connection of Direct Current Measurement 2μA Range Calibration

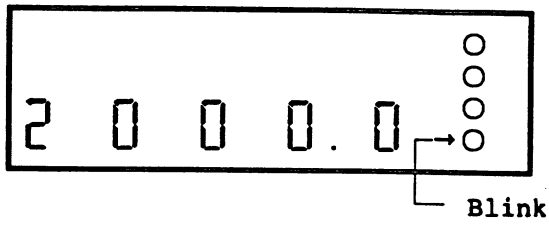
⑥-3 Press the TRIG key, displayed item disappears and the operation is started.



End is displayed, and calibration of 2μA F.S. ends.

⑦ Calibrate the 2nA full-scale.

⑦-1 Press the ▽ , and 2 0 0 0.0 pA is displayed.



⑦-2 Connect the generator as shown in Figure 8-4. Output the voltage determined by the following expression, and input 2.00000nA to this unit.

The output voltage of the 6161 is determined by the following expression.
Voltage = 2 X calibration value of standard resistor X 10^{-6} (V)

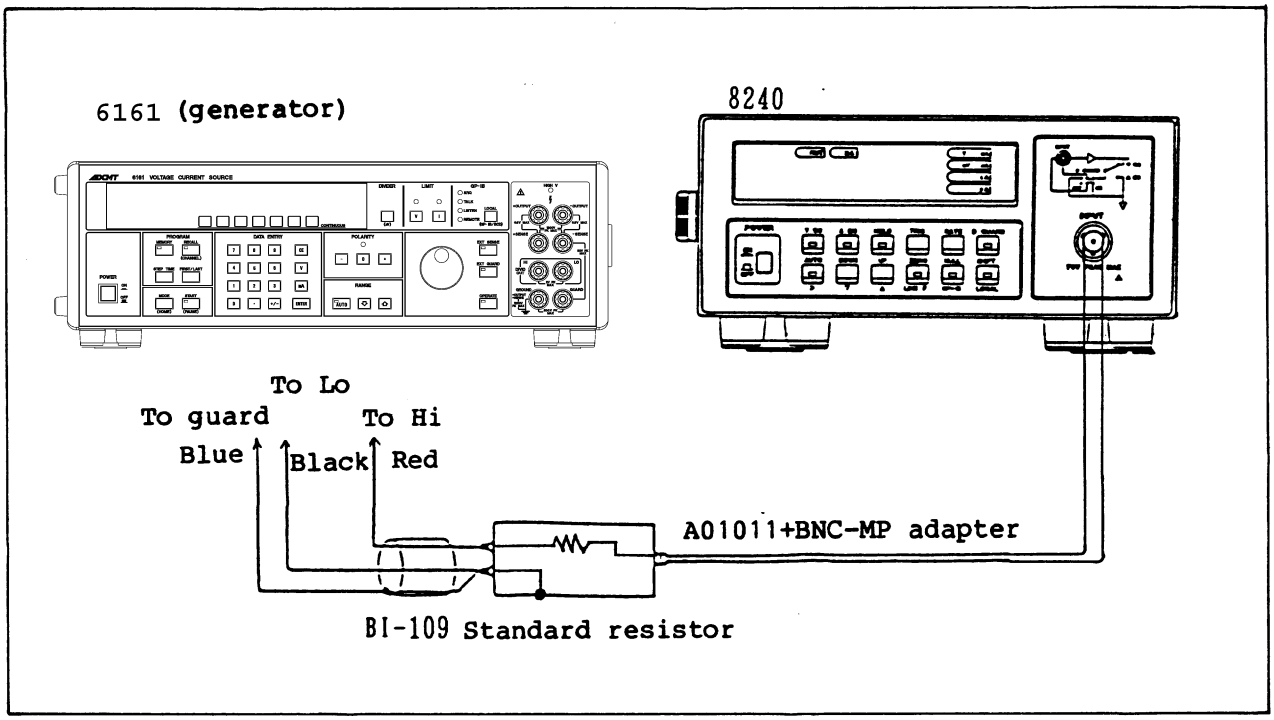
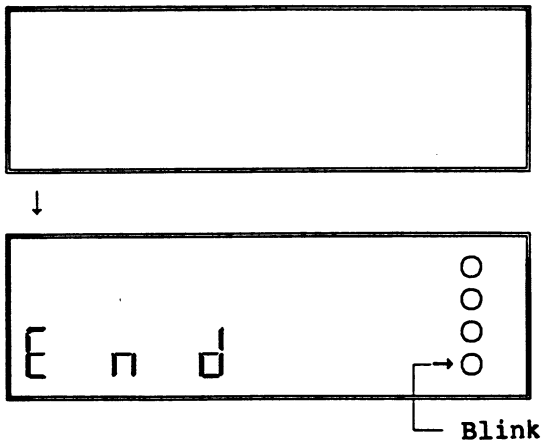


Figure 8 - 4 Connection of DC Current Measurement 2nA Range

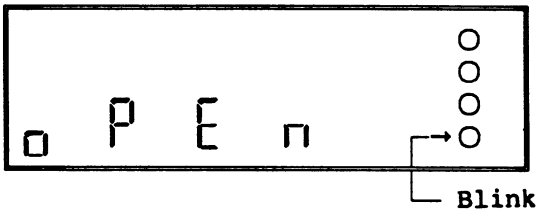
⑦-3 Press the TRIG , displayed item disappears and the operation is started.



End is displayed, and calibration of 2nA F.S. ends.

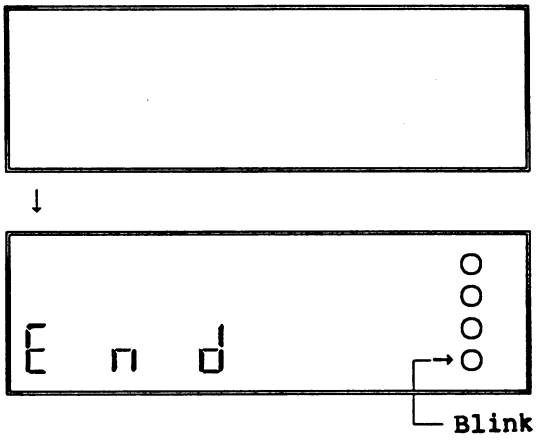
⑧ Calibrate the 200pA zero point.

⑧-1 Press the , oPEn is displayed.



⑧-2 Remove the input cable.

⑧-3 Press the TRIG , displayed item disappears and the operation is started.



End is displayed, and calibration of 200pA zero point ends.

NOTE

1. When calibrating the current with the TR6120, do not use except the 2mA, 20mA range.
2. Use the V function and standard resistor for calibration of less than 2μA.
3. For the calibration in the 2nA range, it is recommended that cables having coaxial connectors (TRIAX or M-connector) be used between the generator and standard resistor to avoid the effect of induced noises.
4. Calibration of less than 2nA range requires several seconds to 40 or 50 seconds. Avoid vibrating the cable and the main unit during calibration.

(5) End of Calibration Operation Mode

Press the SHIFT , and enter the calibration check mode.

NOTE

After calibration in the calibration operation mode, check calibration data in the calibration check mode. When an error is large, correct the calibration data in the calibration correction mode. After modification, save the calibration data with the NULL .

8.2.6 Calibration Correction Mode

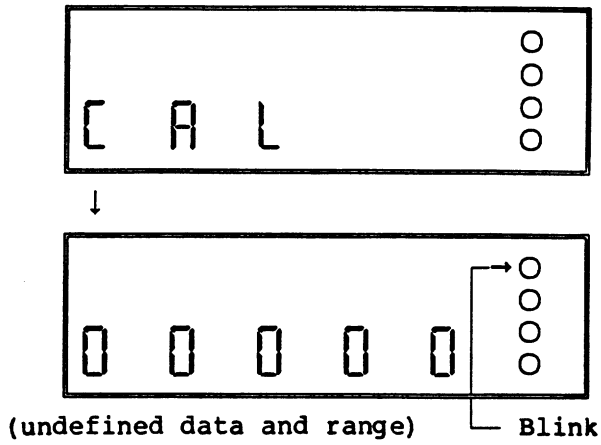
When the error range is more than that in Table 8-5, correct the range in the calibration value check.

(1) Entering the Calibration Correction Mode

Operation Procedure

① Power on this unit, and allow pre-heating time for more than one hour.

② Power on the EXT CAL switch on the rear panel, and [AL is displayed.



The range LED lights, and the calibration check mode appears.

③ Press the SHIFT . Press the RATE or D GUARD , and enter the calibration correction mode.

(2) Key Functions in Calibration Correction Mode

The following lists the flow of operation for correcting the calibration value in the calibration correction mode.

① V DC function setting
② Zero check
③ Range selection
④ Calibration value correction
⑤ Check data.
⑥ Perform Item ③ to ⑤ with the range in Table 8-5.
⑦ A DC function selection
⑧ Zero check
⑨ Range selection
⑩ Calibration value correction
⑪ Check data.
⑫ Perform Items ⑨ to ⑪ with the range in Table 8-5.
⑬ End

Table 8-7 lists key operations in the calibration correction mode.

Table 8 - 7 Key Functions in the Calibration Correction Mode

The LED of SHIFT is on.	Correction every about 5 digits		Correction every about 0.5 digits	
	RATE	△ or ▽	D GUARD	△ or ▽
	Select correction every about 5 digits.	Go up and down by about 5 digits.	Select correction every about 0.5 digits.	Go up and down by about 0.5 digits.

(3) Correcting Calibration Value

Operation Procedure

① Set the function range to be corrected in the calibration check mode, input the standard voltage or standard current.

② Press the SHIFT .

③ Press the RATE , and go up and down by about 5 digits with △ and ▽ .

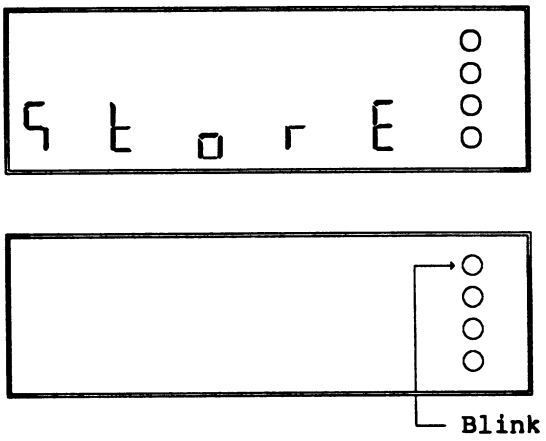
④ Press the D GUARD , and go up and down by about 0.5 digits with △ and ▽ .

⑤ After zero check, check measured data.

⑥ Press the SHIFT , and enter the calibration check mode.

⑦ Repeat item ① to ⑥ for correction.

⑧ Press the NULL , and StorE is displayed to save calibration data.



Return to the NULL unpressed state, then end data correction and save.

NOTE

After the operation and correction of calibration value ends, be sure to save calibration data with the NULL . If the calibration mode is released without such operation, the calibration value cannot be secured.

8.2.7 Calibration Mode Release

Operation Procedure

① Check that the LED of the SHIFT is off. If the LED is on, press the SHIFT and press the NULL to save calibration data.

② Power off the EXT CAL switch on the rear panel.

③ Release the calibration mode, and put it in the measuring state.

NOTE

Release the calibration mode in the calibration check mode (the LED of the SHIFT is off). If you release in the calibration operation and calibration correction modes (the LED of the SHIFT is on), the calibration data cannot be saved.

9. DESCRIPTION OF OPERATION

This chapter explains the operating principle of the 8240.

9.1 Outline of Operation

Figure 9-1 shows the block diagram of this unit. The unit contains two microprocessors. One is the CPU controlling the AD converter and the I-V converter, the other is the CPU interfacing with the external equipment or displaying data. Thus, the photo-coupler transfers data between the CPUs. The unit consists of the following blocks.

- Pre-amplifier functioning as a high impedance buffer and fine current-to-voltage converter
- Ranging amplifier normalizing the input to the A/D converter as ±2V
- Switch driver controlling voltage measurement, current measurement, and DRIVING GUARD
- A/D converter converting the analog signal to the digital signal
- Basic voltage generator
- CPU controlling the guard section
- Photo-coupler transferring data between the guard section and the logic section
- GPIB controller
- LED display displaying the measurement result
- Panel switch controlling this unit with key functions
- Single line a signal making external control simple

To maintain the high measurement precision, a thin film resistor is used for the ranging, amplifier, A/D section, and basic voltage generator.

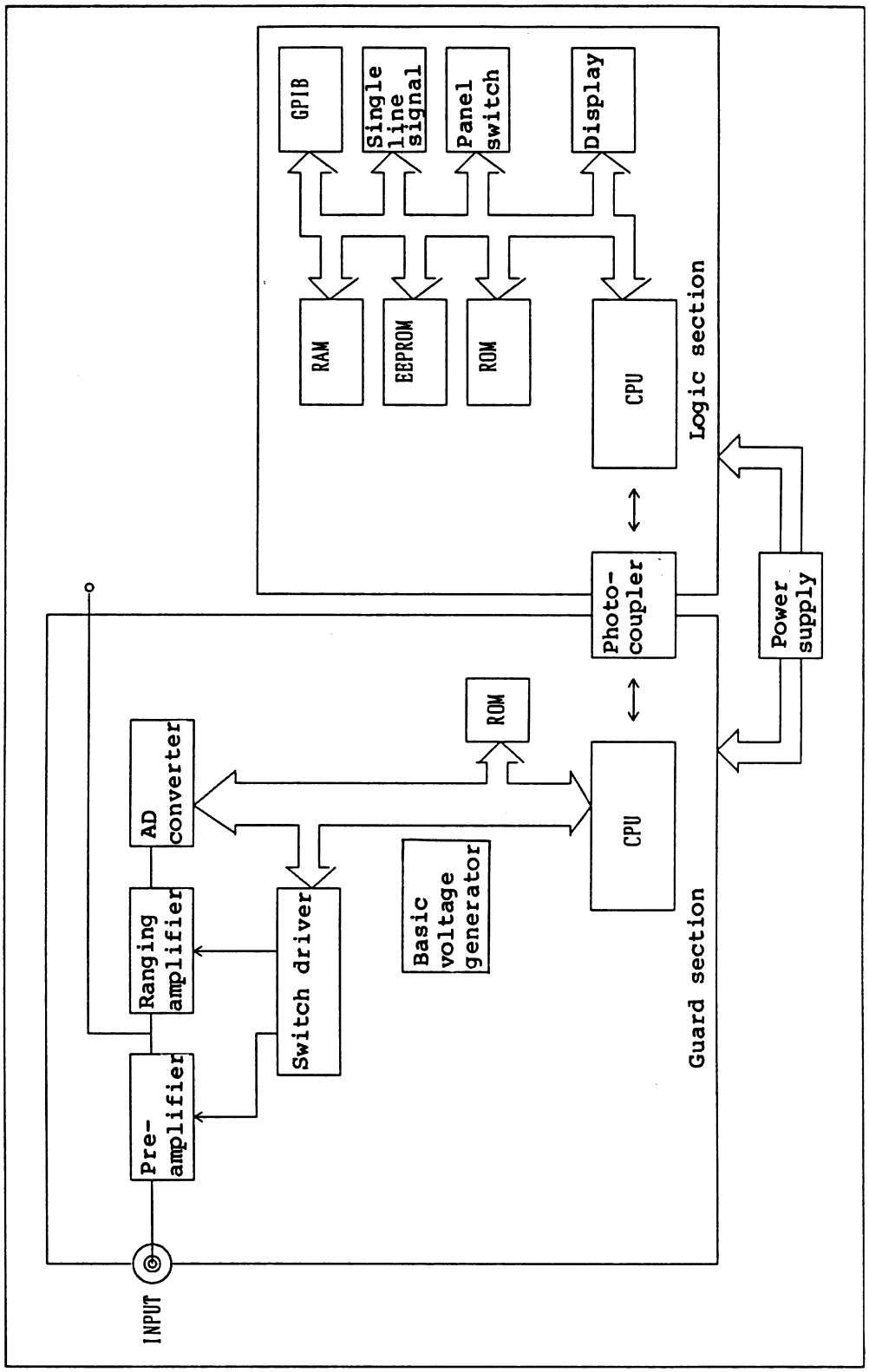


Figure 9 - 1 Block Diagram

9.2 Pre-amplifier Circuit

The pre-amplifier convers the input signal to the voltage. Figure 9-2 shows the schematic diagram of the pre-amplifier circuit.

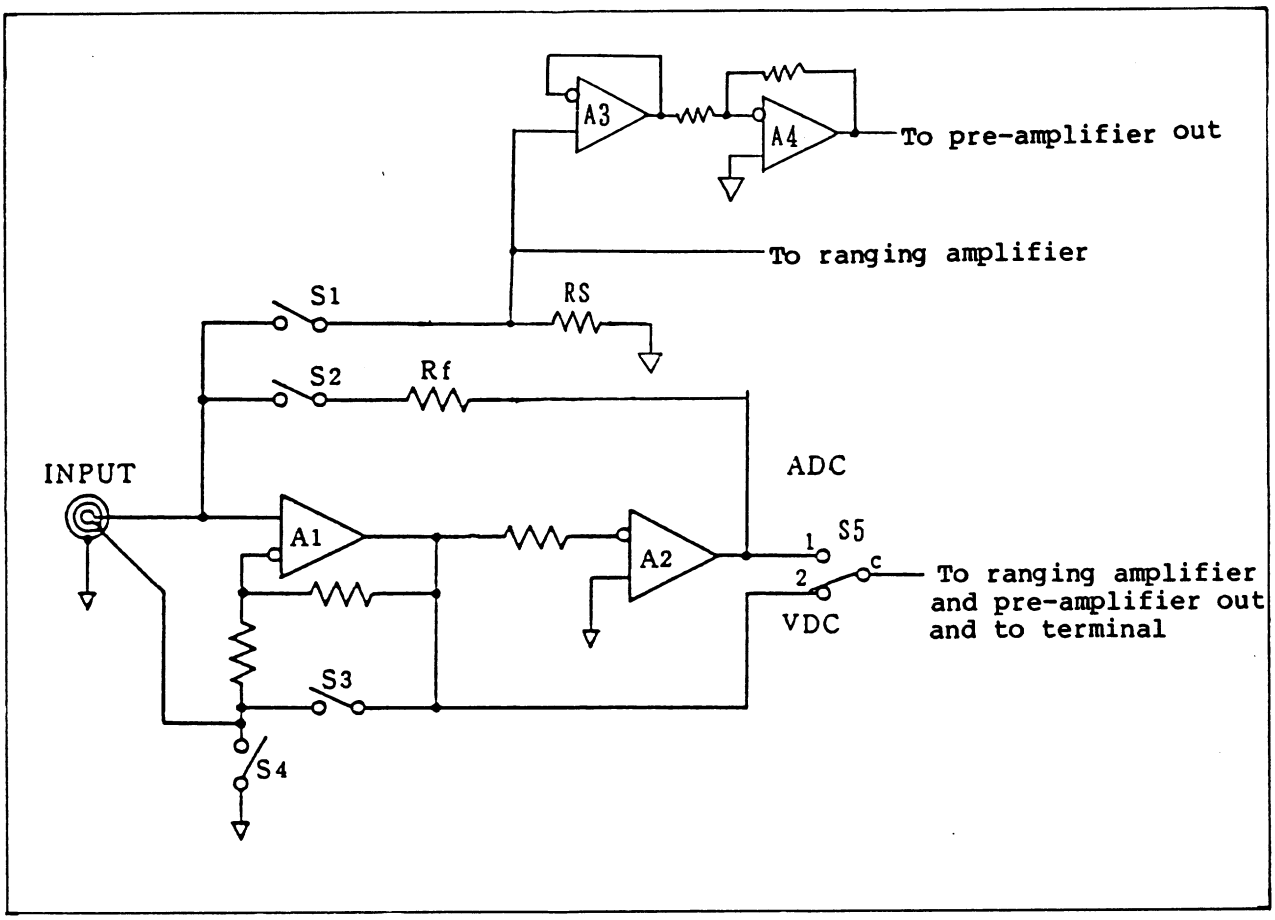


Figure 9 - 2 Schematic Diagram of Pre-amplifier Circuit

Switches S_1 to S_5 are switched with function or range as shown in Figues 9-3 to 9-5.

(1) V DC Functional Configuration

Switches S_1 to S_5 are connected as follows.
S_1, S_2, S_4 : OFF S_3 : ON S_5 : C-2

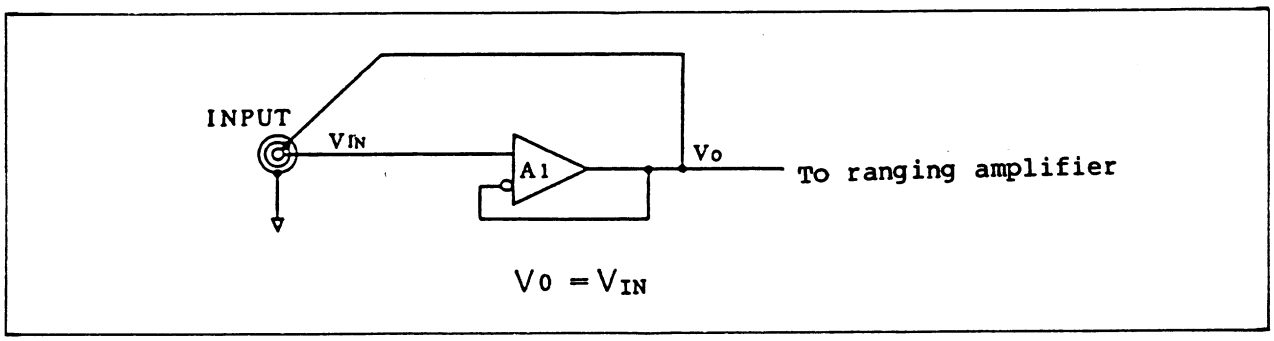


Figure 9 - 3 V DC Functional Configuration

(When DRIVING GUARD is ON)

The A1 amplifier operates as a high-impedance amplifier of gain X 1.

(2) A DC Functional Configuration (200pA to 2mA range)

Switches S_1 to S_5 are connected as follows.
S_1, S_3 : OFF S_2, S_4 : ON S_5 : C-1

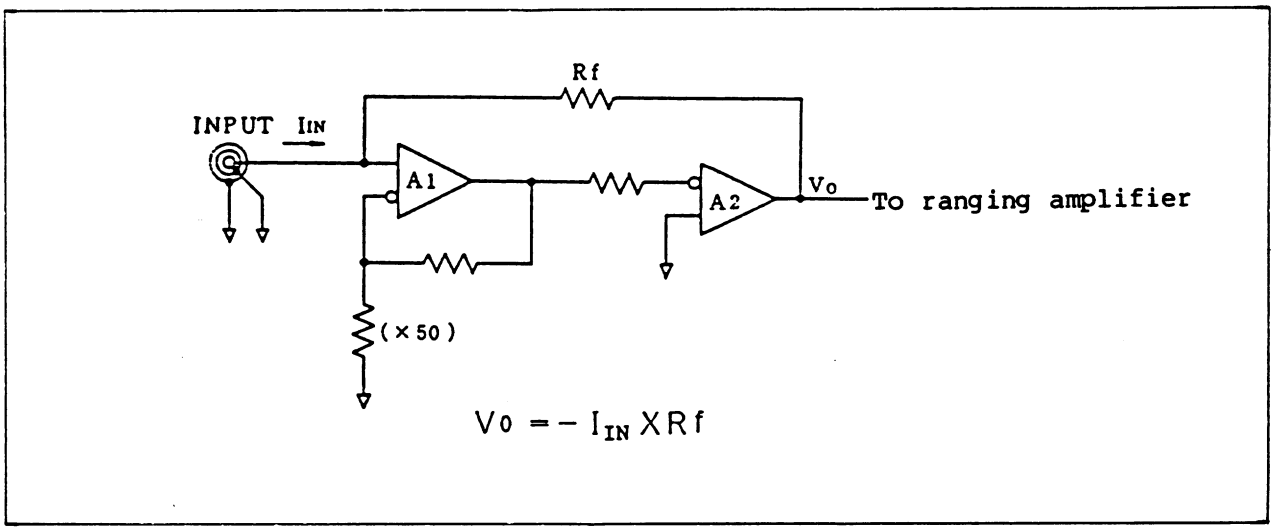


Figure 9 - 4 A DC Functional Configuration (200pA to 2mA range)

(When DRIVING GUARD is ON)

A1 and A2 amplifiers operate as one inverting amplifier. Feedback resistance Rf is switched by range.

(3) A DC Functional Configuration (20mA range)

Switches S_1 to S_5 are connected as follows.
S_1, S_4 : ON S_2, S_3 : OFF S_5 : C-1

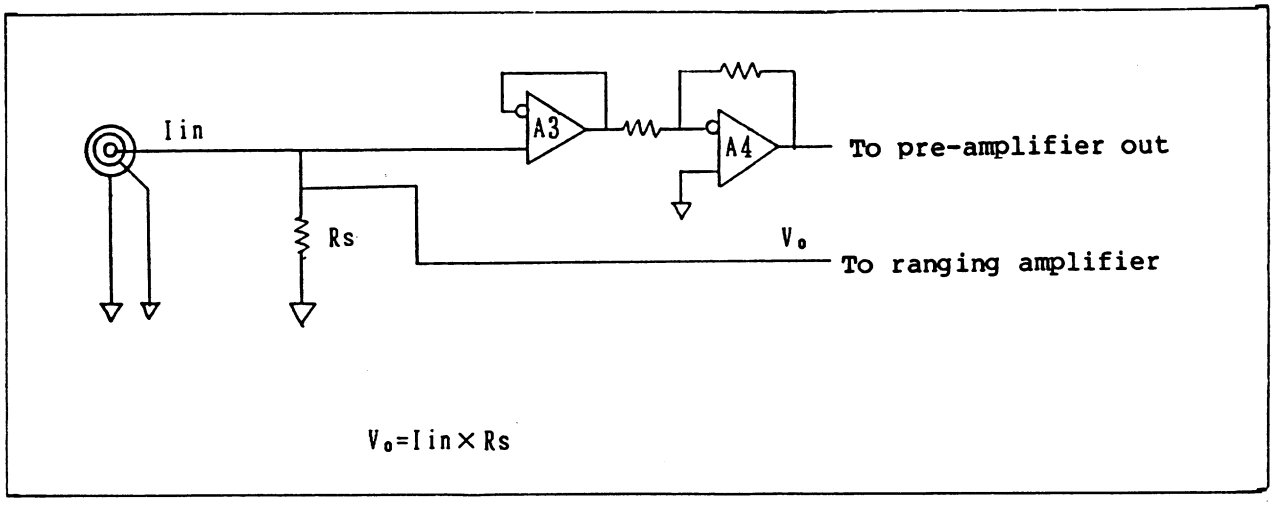


Figure 9 - 5 A DC Functional Configuration (20mA range)

(When DRIVING GUARD is on)

R_S is shunt resistance. Since this polarity is equal to the input current, reverse the polarity with a high impedance reverse buffer from A3 and A4 to correspond the polarity to other range, and connect the R_S to the output of pre-amplifier out.

9.3 Ranging Amplifier

The voltage output of a pre-amplifier depends on ranges, therefore it is classified into ±0.2V full-scale, ±2V full-scale, and ±20V full-scale. Since the AD converter is ±2V full-scale, it normalizes the pre-amplifier out to ±2V with 10-time amplifier and 1/10 attenuator.

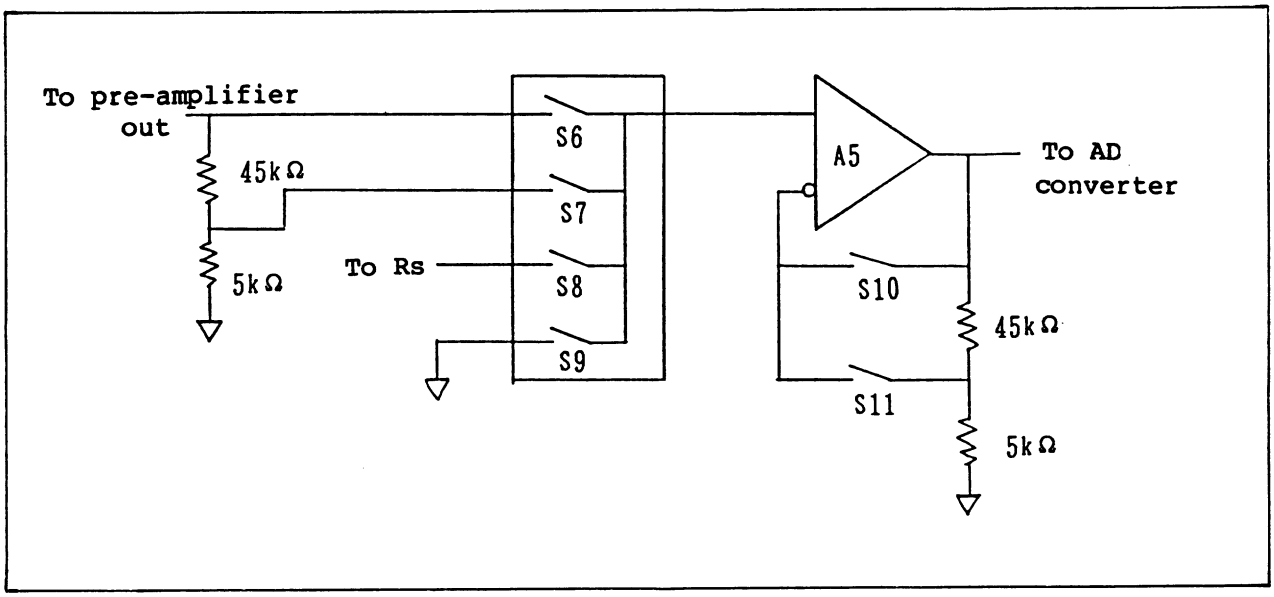


Figure 9 - 6 Ranging Amplifier Configuration

Table 9-11 lists the relation between the range and switch in functions.

Table 9 - 1 Switch Operation of Ranging Amplifier

V DC	A DC	S_6	S_7	S_8	S_9	S_{10}	S_{11}
2 V	200pA	ON	OFF	OFF	OFF	ON	OFF
20 V	2nA	OFF	ON	OFF	OFF	ON	OFF
200mV	20nA	ON	OFF	OFF	OFF	OFF	ON
	200nA	ON	OFF	OFF	OFF	ON	OFF
	2μA	OFF	ON	OFF	OFF	ON	OFF
	20μA	ON	OFF	OFF	OFF	OFF	ON
	200μA	ON	OFF	OFF	OFF	ON	OFF
	2mA	OFF	ON	OFF	OFF	ON	OFF
	20mA	OFF	OFF	ON	OFF	OFF	ON
AD zero calibration 1		OFF	OFF	OFF	ON	ON	OFF
AD zero calibration 2		OFF	OFF	OFF	ON	OFF	ON

9.4 A/D Converter

The input integral variable A/D converter is used in this unit. The stable measurement with high noise reduction rate or high-speed sampling can be set according to the purpose of measurement by selecting input integral time. Figure 9-7 shows the schematic operation of the A/D converter.
If S_1 is turned on, integral voltage V_{in} is integrated. If the output value of an integrator U_1 is minus after after constant time, turn on S_2, apply reference voltage V_{ref} until the outpt of the integrator is reversed to plus, and measure time. Repeat this operation during input integral time. If input integral time ends, turn off S_1. Turn on S_2 until the polarity of the integrator is reversed to plus, and end the integral operation. The polarity of the integrator output is determined by the output of comparator U_2 connected to the output of the integrator. While the S_2 is on, the total time is accounted as A/D conversion data. When the A/D conversion data inputs zero or full-scale to be set for calibration, calibration data is displayed as a reference value or operation data is output digitally.

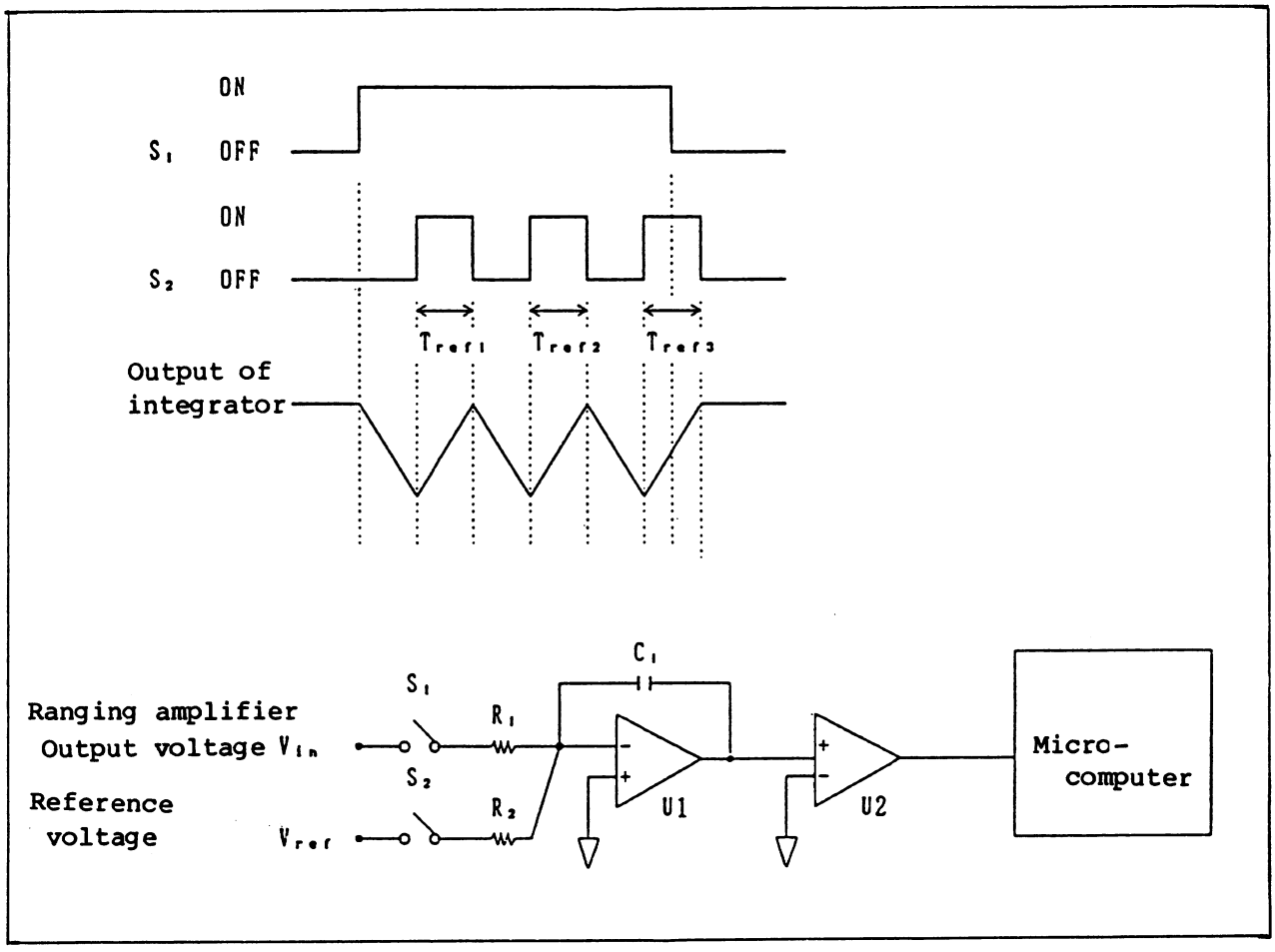


Figure 9 - 7 Schematic Diagram of A/D Converter

10. EXAMPLE OF MEASUREMENT

This chapter explains the example of measurement using the 8240. Refer to the chapter if necessary.

10.1 Measurement of Object Floating at Regular Voltage from Ground

Figure 10-1 shows how to connect the object to be measured floating at regular voltage from the ground.

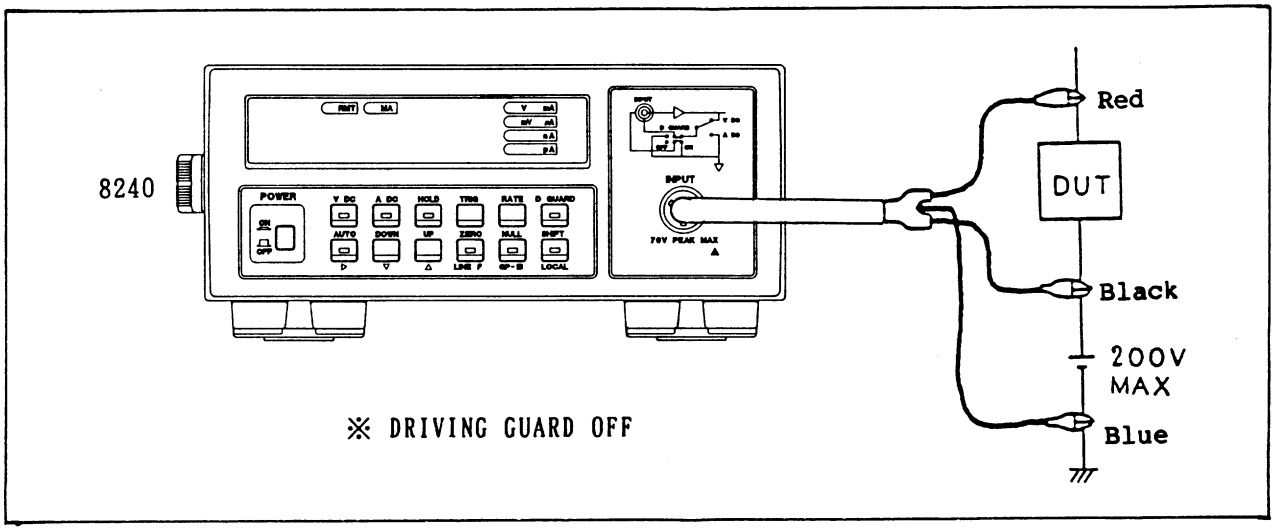


Figure 10 - 1 Measurement of Object Floating at Regular Voltage from Ground

Operation Procedure

① Connect this unit according to Figure 10-1.

② Set the object to be measured to V DC or A DC.

③ Power off the D GUARD (power off the LED).

NOTE

1. Be sure to power off DRIVING GUARD.
2. Pay attention to the circuit loop of object to be measured, and measure the A DC function
3. Never measure the object to be measured floating at the voltage more than 500V.

10.2 High Voltage Measurement

Figure 10-2 show the example of high voltage measurement using the 12602 voltage divider probe. The 12602 has an input and output division ratio of 100 to 1, therefore it can measure up to 2000V by combining the probe with this unit measuring up to 20V.

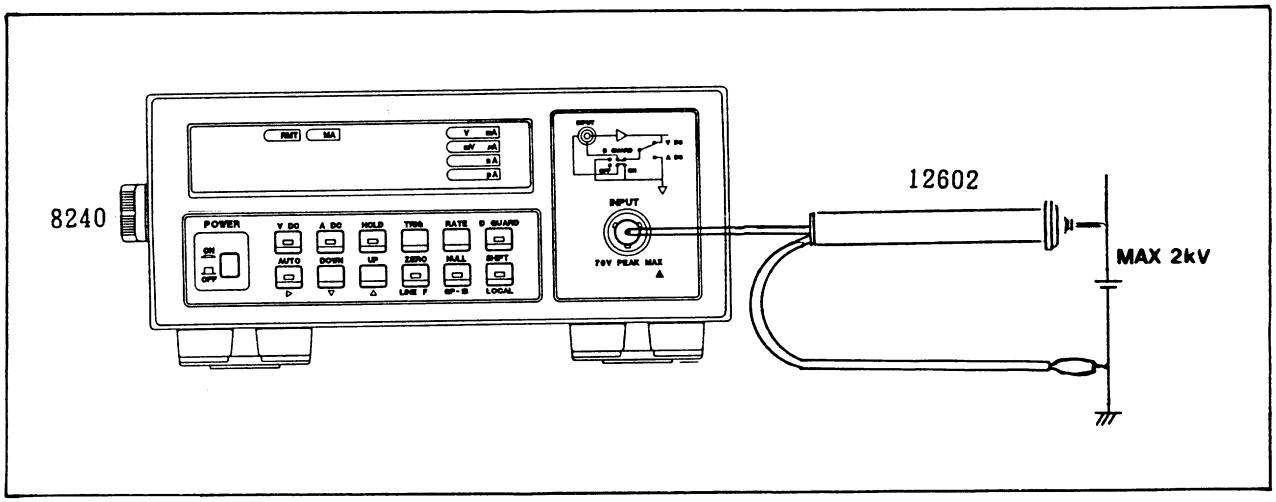


Figure 10 - 2 Connection to 12602

Operation Procedure

① Connect this unit according to Figure 10-2.

② Set this unit to the V DC function.

③ Power on the D GUARD (power on the LED).

The 12602 has an input and output division ratio of 100 to 1, therefore it displays 1000V if the 8240 displays 10.000V.

10.3 Measurement of Diode Reverse Leak Current

Figure 10-3 shows the example of measurement of diode reverse leak current by combining this unit with the 12701 test fixture and 6144 DC voltage current generator.

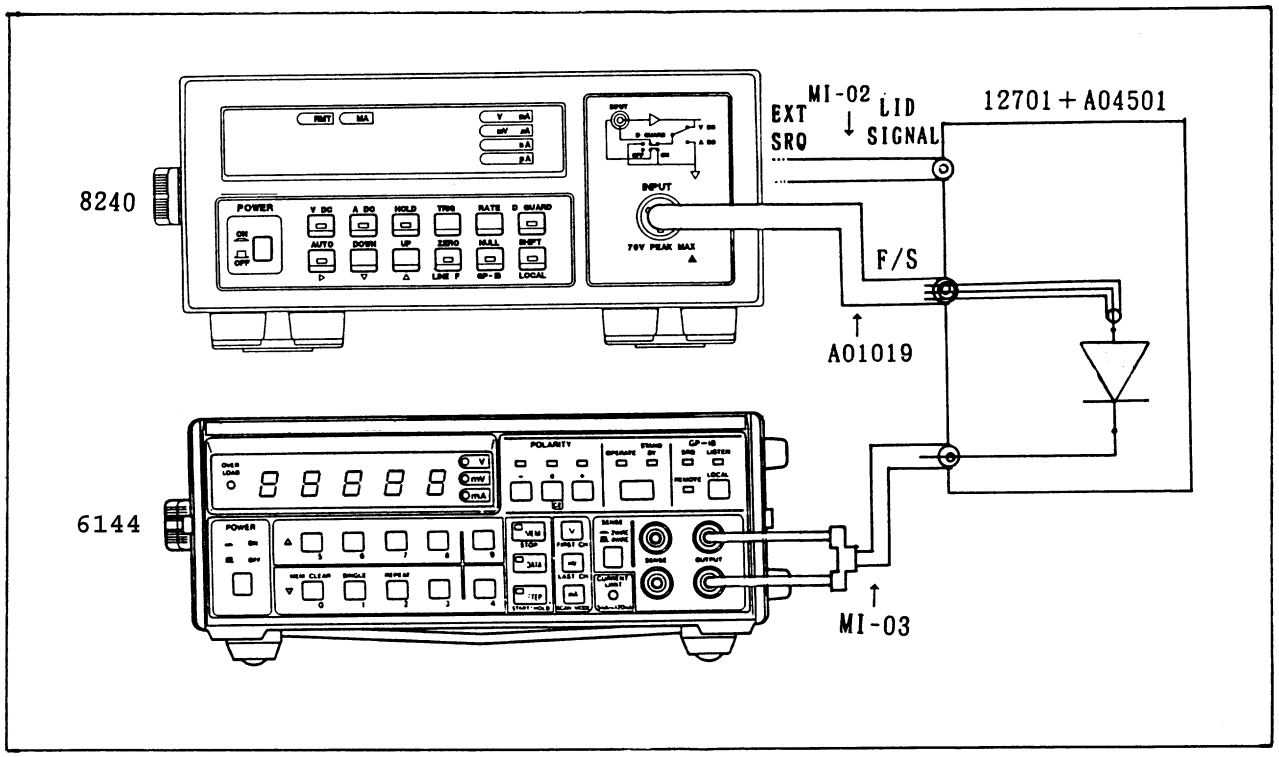


Figure 10 - 3 Measurement of Diode Reverse Leak Current

Operation Procedure

① Set this unit to the A DC function

② Set the 6144 in the voltage generation mode, and set desired voltage.

③ Operate the 6144 .

NOTE

In figure 10-3, when the personal computer is used to control this unit and the 6144 with GPIB and to make an automatic measurement, the MI-02 cable is required to start the measurement by opening and closing the 12701 cover. See a sample program (in Item 6.9.2 Measurement of Diode Reverse Leak Current).

10.4 Measurement of Diode Forward I-V Characteristics

Figure 10-4 shows the example of measurement of diode forward I-V characteristics by combining this unit with the 12701 test fixture and 6144 DC voltage current generator.

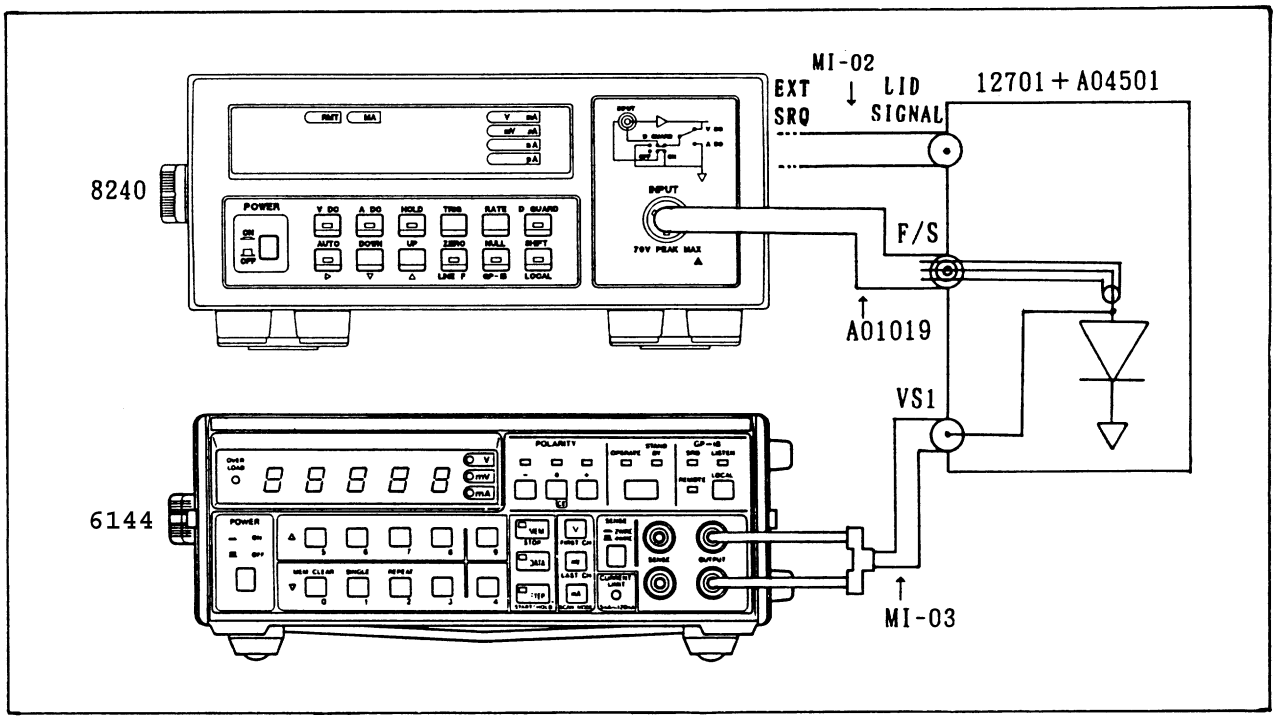


Figure 10 - 4 Measurement of Diode Forward I-V Characteristics

Operation Procedure

① Set this unit to the V DC function.

② Set the 6144 in the current generation mode and operate.

③ Change the current generated by the 6144, and read measured value on this unit.

NOTE

In Figure 10-4, when the personal computer is used to control this unit and the 6144 with GPIB and to make an automatic measurement, the MI-02 cable is required to start the measurement by opening and closing the 12701 cover. See a sample program (in Item 6.9.3 Measurement of Diode Forward I-V Characteristics).

10.5 Cautions on using a high-voltage power supply

When performing voltage source and current measurement (VSIM) with an external power supply, be careful not to exceed the maximum allowable applied voltage.

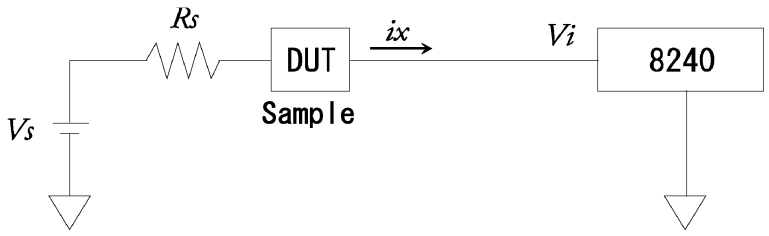
The maximum allowable applied voltage of the 8240 is as follows:

70 V peak (range between 20 µA and 20 mA)

200 V peak (range between 200 pA and 2 µA)

If the voltage other than the above is applied to the device under test (DUT), there is no problem if the measured current does not exceed the full-scale value. However, the measured current may exceed the full-scale value and the voltage across the input terminals may exceed the maximum allowable voltage if the DUT is short-circuited or the moment that a voltage is applied to a capacitive sample.

As an input protection, a resistor Rs may be inserted in the measurement line in series.



Insert the series resistor Rs onto the voltage source side, as shown above, to prevent a leak current.

Selecting the over-current protection resistor Rs

The DC current function of the 8240 is a limited current of about 25 mA.

Calculate the value of Rs when the DUT is short-circuited.
The voltage at the input terminal is 70 V maximum, but use 50 V for calculations to allow a margin of safety.
The applied voltage is 500 V.

$$Rs = \frac{Vs - Vi}{ix} = \frac{500-50}{0.025} \fallingdotseq 18000 \Longrightarrow 22k\Omega$$

In the calculation, 22 kΩ is sufficient for input protection.
The capacity is as follows:

$$P = 450V \times 0.025A = 11.25W$$

Therefore, a high-capacity resistor is required.
(The resistor may be allowed to burn out in order to protect the input.)

If Rs is multiplied by 10 to become 220 kΩ, the capacity is about 1W. In this case, the limited current value is 2.3 mA, and any current over this value cannot be measured.

This section describes cases where a high voltage is applied by necessity; no recommendation of applying such a high voltage is intended. Inserting a protective resistor does not eliminate the possibility of damage to an input part.

11. SPECIFICATION

This chapter explains the standard of the 8240 and its accessory (option).

11.1 DC Voltage Measurement

Measuring range	Maximum display	Resolution	Measurement precision ±(% of rdg. + digit)		Temperature coefficient
			Zero check OFF	Zero check ON	± (% of rdg. + digit)/℃
200mv	199.99mV	10μV	0.06 + 15	0.06 + 3	0.004 + 1.8
2V	1999.9mV	100μV	0.06 + 3	0.06 + 3	0.004 + 0.2
20V	19.999V	1mV	0.06 + 2	0.06 + 2	0.004 + 0.1

Measurement accuracy :

Zero check OFF ; Indicates the value for six months under the temperature of +23℃ ±5℃ and relative humidity of less than 70% with ±(% of reading + digit).

Zero check ON ; Indicates the precision within ±1℃ with ±(% of reading + digit) after zero check. However, the temperature is + 23℃ ±5℃ and relative humidity is less than 70%.

Temperature coefficient: Indicates the value under 0 to 40℃ and relative humidity of less than 70% with ±(% of reading + digit)/℃.

Input resistance : More than 1 X $10^{13}\Omega$

Input capacity : Less than 30pF

Settling time : Less 2.5ms (time within ±1% of full-scale under signal source resistance of less than 1MΩ. Range change-over time is excluded)

Maximum allowable apply voltage:
200V peak continuous

Noise reduction : More than NMRR 60dB (50/60Hz±0.09%)
More than ECMRR 120dB (50/60 Hz±0.09%, 1kΩ unbalanced resistance)

11.2 DC Current Measurement

Measuring range	Maximum display	Resolution	Measurement precision ±(% of rdg. + digit)		Temperature coefficient ±(% of rdg. + digit)/ ℃	Settling time (ms)
			Zero check OFF	Zero check ON		
200pA	199.99pA	10fA	0.7+7	0.7+6	0.03+0.7	250
2nA	1999.9pA	100fA	0.6+2	0.6+2	0.03+0.1	250
20nA	19.999nA	1pA	0.25+17	0.25+3	0.01+1.9	5
200nA	199.99nA	10pA	0.2+3	0.2+2	0.01+0.2	5
2 μA	1999.9nA	100pA	0.2+2	0.2+2	0.01+0.1	5
20μA	19.999μA	1nA	0.1+17	0.1+3	0.01+1.9	2.5
200μA	199.99μA	10nA	0.1+3	0.1+2	0.01+0.2	2.5
2mA	1999.9μA	100nA	0.1+2	0.1+2	0.01+0.1	2.5
20mA	19.999mA	1μA	0.1+3	0.1+2	0.01+0.2	2

Measurement accuracy :

Zero check OFF ; Indicates the value for six months under the temperature of +23℃ ±5℃ and relative humidity of less than 70% with ±(% of reading + digit).

Zero check ON ; Indicates the precision within ±1℃ with ±(% of reading + digit) after zero check. However, the temperature is + 23℃ ±5℃ and relative humidity is less than 70%.

Temperature coefficient: Indicates the value under 0 to 40℃ and relative humidity of less than 70% with ± (% of reading + digit)/℃.

Settling time : Indicates time within ±1% of full-scale. However, range change-over time is excluded)

Input voltage drop : Less than 500μV + 0.5Ω X Ix (200pA to 2mA range)
Less than 30Ω X Ix (20mA range)
Ix : Measured current

Input bias current : Less than 100fA (+23℃ ±1℃ and less than 50% of relative humidity)

Maximum allowable apply voltage:
70V peak continuous (20μA to 20mA range)
200V peak continuous (200pA to 2μA range)

Noise reduction : More than NMRR 55dB (50/60 Hz±0.09%)

Maximum allowable input capacity:
0.1μF

11.3 Measurement Speed

Integral time	Free-run sampling number (number/second)	GPIB sampling number (number/second)	Maximum display
2msec	75	37	3 1/2 digits 1999
1PLC	25 (50Hz)	19	4 1/2 digits 19999
	28 (60Hz)	20	
5PLC	8	7	
10PLC	4	3	
10PLCX4	1	0.9	
10PLCX8	0.5	0.4	
10PLCX16	0.25	0.2	

GPIB sampling number is a reference number.
Controller : PC9801RX
Header : ON
Sampling : HOLD (data obtain by GET-INPUT@)

11.4 Other Function

NULL : R=X-X(NULL) (subtract measured data setting NULL from measured data)
R: Operation result (display value)
X: Measured value
X (NULL): Measured data setting NULL

Zero check: Manual zero point compensation

Input/output function:
GPIB interface : In accordance with IEEE Std. 488-1978.
Can measured data, output status state, set the parameter, and output an error message.
Single line signal (BNC connector):
TRIGGER (input), COMPLETE (output), and external SRQ (input)
AMP OUT (binding post):
Output of direct voltage converted by impedance
Output voltage : ±200mV, ±2V, ±20V in full-scale (owing to measuring function range)
Output impedance : About 1kΩ
Maximum output voltage: Less than ±30V

11.5 General Specification

Measurement system : Integral system

Data display : 7 segment green LED

Unit display : Green LED

Input terminal : TRIAXIAL connector

Terminal-to-terminal maximum apply voltage:

DRIVING GUARD	ON	OFF
Between HI and LO	70 or 200V peak with function and range	70 or 200V peak with function and range
Between LO and GUARD	200V peak	200V peak
Between GUARD chassis	500V peak	500V peak

Note: Short-circuit is made between LO and GUARD with A DC function.

Pre-heating time : About 30 minutes (to specific precision)

Environmental range : Temperature 0℃ to +40℃, less than 85% of relative humidity

Save environmental range : -25℃ to +70℃

Power Supply : Set to specification when ordered.

Option No.	Standard	32	42	44
Source voltage	90 to 110	103 to 132	198 to 242	207 to 250

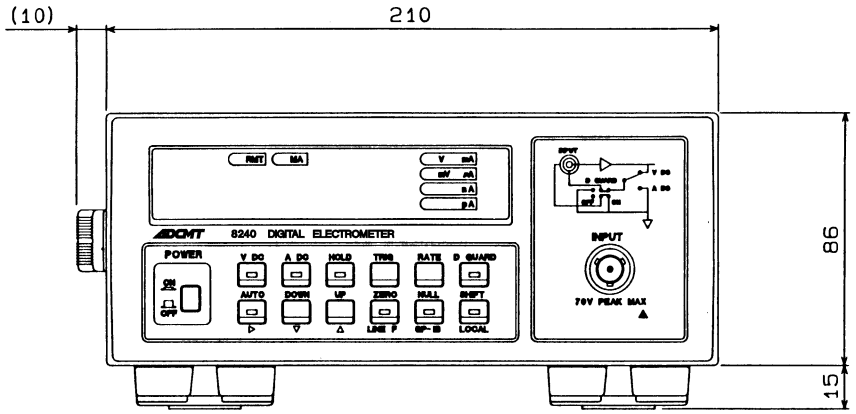
Power consumption : Less than 16VA

Outside dimensions : About 210 (W) X 86 (H) X 350 (D) mm

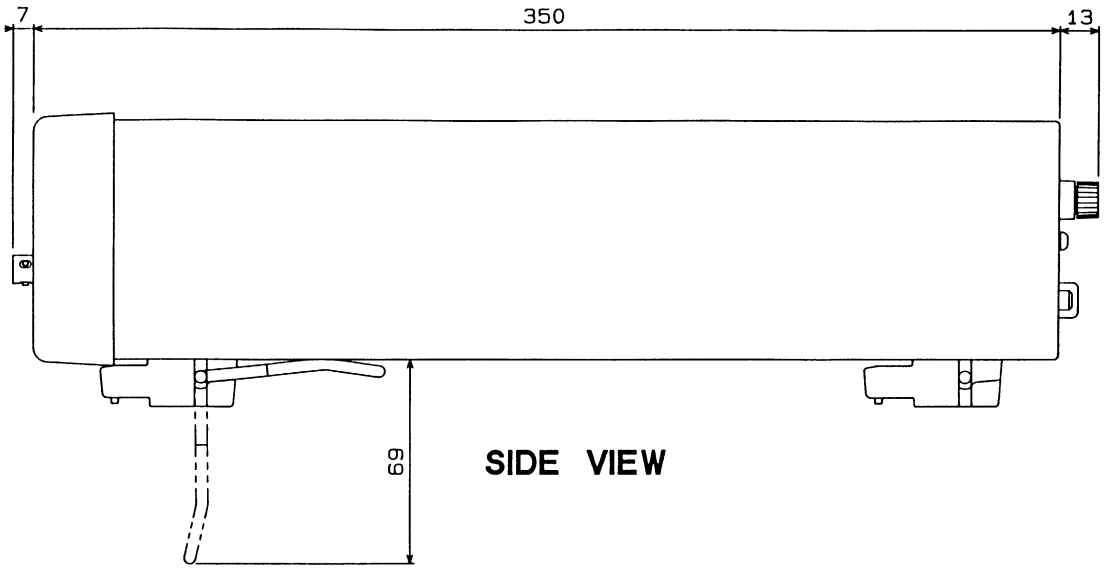
Weight : Less than 3.0kg

11.6 Accessory (option)

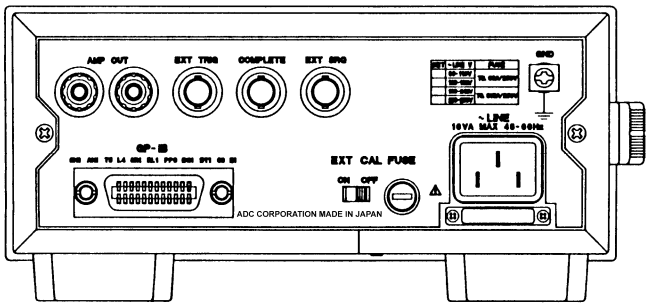
12701	Test fixture
12702A/B	Resistivity chamber (pressure variable, thickness measurement)
12704	Resistivity chamber
42	Ultra-high resistance measuring sample box
TR43C	Ultra-high resistance measuring sample box
44	Liquid resistance measuring sample box
TR300C	Insulation resistance measuring sample box
12602	Voltage divider probe (100:1 High voltage measurement)
12603	Test read
A01009-50, 100, 150, 200,	Input cable (TRIAX-TRIAX connector)
MC-04SX01, 02, 03, 04, 05	Input cable (to connect TRIAX and 44)
A02237	Rack mount kit (JIS standard) single
A02238	Rack mount kit (JIS standard) double
A02435	Rack mount kit (EIA standard) single
A02436	Rack mount kit (EIA standard) double
A02028	Panel mount kit single
A02029	Panel mount kit double



FRONT VIEW



SIDE VIEW



REAR VIEW

EXT1-9004-A

8240
EXTERNAL VIEW

IMPORTANT INFORMATION FOR ADC CORPORATION SOFTWARE

PLEASE READ CAREFULLY: This is an important notice for the software defined herein. Computer programs including any additions, modifications and updates thereof, operation manuals, and related materials provided by ADC CORPORATION (hereafter referred to as "SOFTWARE"), included in or used with hardware produced by ADC CORPORATION (hereafter referred to as "PRODUCTS").

SOFTWARE License

All rights in and to the SOFTWARE (including, but not limited to, copyright) shall be and remain vested in ADC CORPORATION. ADC CORPORATION hereby grants you a license to use the SOFTWARE only on or with ADC CORPORATION PRODUCTS.

Restrictions

(1) You may not use the SOFTWARE for any purpose other than for the use of the PRODUCTS.
(2) You may not copy, modify, or change, all or any part of, the SOFTWARE without permission from ADC CORPORATION.
(3) You may not reverse engineer, de-compile, or disassemble, all or any part of, the SOFTWARE.

Liability

ADC CORPORATION shall have no liability(1) for any PRODUCT failures, which may arise out of any misuse (misuse is deemed to be use of the SOFTWARE for purposes other than its intended use) of the SOFTWARE.
(2) For any dispute between you and any third party for any reason whatsoever including, but not limited to, infringement of intellectual property rights.

LIMITED WARRANTY

1. Unless otherwise specifically agreed by Seller and Purchaser in writing, ADC CORPORATION will warrant to the Purchaser that during the Warranty Period this Product (other than consumables included in the Product) will be free from defects in material and workmanship and shall conform to the specifications set forth in this Operation Manual.

2. The warranty period for the Product (the "Warranty Period") will be a period of one year commencing on the delivery date of the Product.

3. If the Product is found to be defective during the Warranty Period, ADC CORPORATION will, at its option and in its sole and absolute discretion, either (a) repair the defective Product or part or component thereof or (b) replace the defective Product or part or component thereof, in either case at ADC CORPORATION's sole cost and expense.

4. This limited warranty will not apply to defects or damage to the Product or any part or component thereof resulting from any of the following:

   (a) any modifications, maintenance or repairs other than modifications, maintenance or repairs (i) performed by ADC CORPORATION or (ii) specifically recommended or authorized by ADC CORPORATION and performed in accordance with ADC CORPORATION's instructions;

   (b) any improper or inadequate handling, carriage or storage of the Product by the Purchaser or any third party (other than ADC CORPORATION or its agents);

   (c) use of the Product under operating conditions or environments different than those specified in the Operation Manual or recommended by ADC CORPORATION, including, without limitation, (i) instances where the Product has been subjected to physical stress or electrical voltage exceeding the permissible range and (ii) instances where the corrosion of electrical circuits or other deterioration was accelerated by exposure to corrosive gases or dusty environments;

   (d) use of the Product in connection with software, interfaces, products or parts other than software, interfaces, products or parts supplied or recommended by ADC CORPORATION;

   (e) the occurrence of an event of force majeure, including, without limitation, fire, explosion, geological change, storm, flood, earthquake, tidal wave, lightning or act of war;

   (f) any negligent act or omission of the Purchaser or any third party other than ADC CORPORATION; or

   (g) any product exported from a country where the product was sold.

5. EXCEPT TO THE EXTENT EXPRESSLY PROVIDED HEREIN, ADC CORPORATION HEREBY EXPRESSLY DISCLAIMS, AND THE PURCHASER HEREBY WAIVES, ALL WARRANTIES, WHETHER EXPRESS OR IMPLIED, STATUTORY OR OTHERWISE, INCLUDING, WITHOUT LIMITATION, (A) ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE AND (B) ANY WARRANTY OR REPRESENTATION AS TO THE VALIDITY, SCOPE, EFFECTIVENESS OR USEFULNESS OF ANY TECHNOLOGY OR ANY INVENTION.

6. THE REMEDY SET FORTH HEREIN SHALL BE THE SOLE AND EXCLUSIVE REMEDY OF THE PURCHASER FOR BREACH OF WARRANTY WITH RESPECT TO THE PRODUCT.

7. ADC CORPORATION WILL NOT HAVE ANY LIABILITY TO THE PURCHASER FOR ANY INDIRECT, INCIDENTAL, SPECIAL, CONSEQUENTIAL OR PUNITIVE DAMAGES, INCLUDING, WITHOUT LIMITATION, LOSS OF ANTICIPATED PROFITS OR REVENUES, IN ANY AND ALL CIRCUMSTANCES, EVEN IF ADC CORPORATION HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES AND WHETHER ARISING OUT OF BREACH OF CONTRACT, WARRANTY, TORT (INCLUDING, WITHOUT LIMITATION, NEGLIGENCE), STRICT LIABILITY, INDEMNITY, CONTRIBUTION OR OTHERWISE.

CLAIM FOR DAMAGE IN SHIPMENT TO ORIGINAL BUYER

The product should be thoroughly inspected immediately upon original delivery to buyer. If the product is damaged in any way, a claim should be filed by the buyer with carrier immediately.

CUSTOMER SERVICE DESCRIPTION

Contact an ADC CORPORATION sales representative if a failure occurs.

(1) The repair service lasts ten years from the delivery date of the Product.

(2) The repair and calibration services may be declined if either of the following situations arise.

1) When required parts cannot be procured.

2) When the performance of the Product cannot be maintained after repair.

ADCMT® ADC CORPORATION

77-1, Miyako, Namegawa-machi, Hiki-gun, Saitama 355-0812, Japan