
ADVANTEST.

R6142
**Programmable DC Voltage/
Current Generator
Operation Manual**

MANUAL NUMBER FOE-8324202C02

*This product has been discontinued.
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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 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

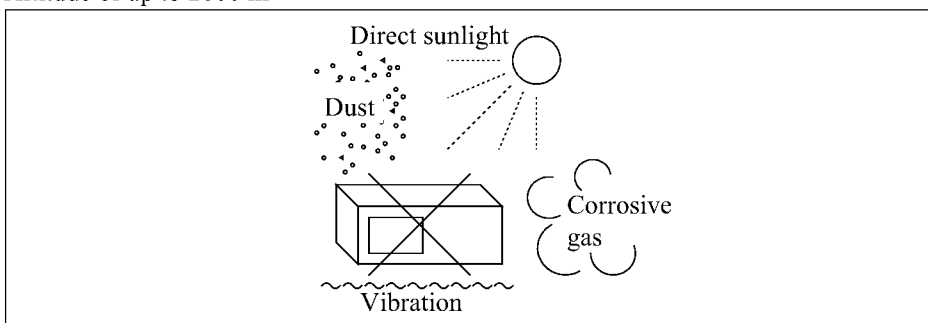


Figure-1 Environmental Conditions

- Operating position

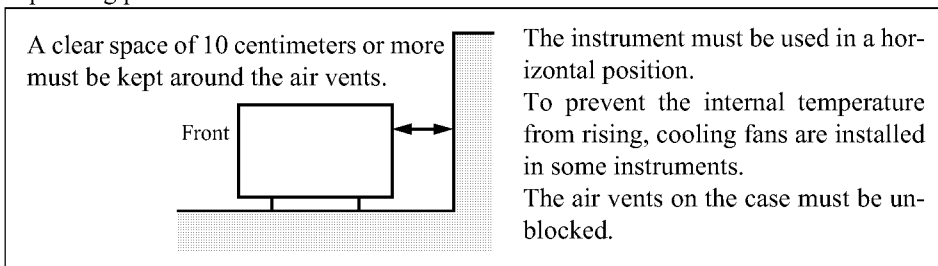


Figure-2 Operating Position

- Storage position

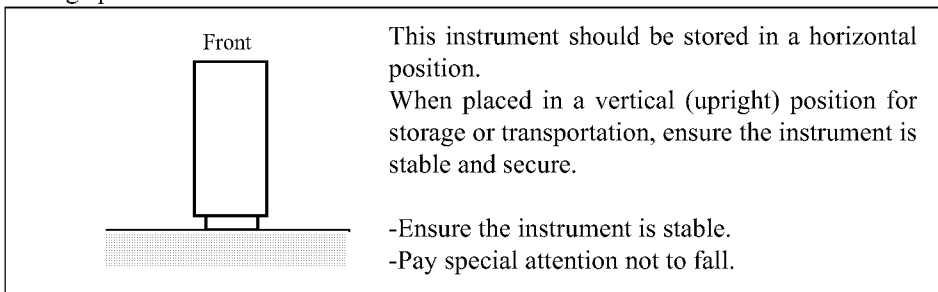


Figure-3 Storage Position

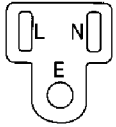
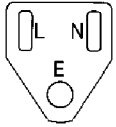
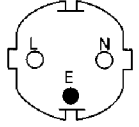
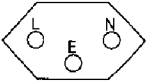
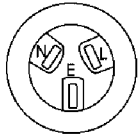

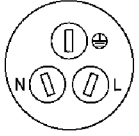
- The classification of the transient over-voltage, which exists typically in the main power supply, and the pollution degree is defined by IEC61010-1 and described below.

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

ORGANIZATION OF THIS MANUAL

This manual explains how to use the R6142 and is organized as follows:

1. OVERVIEW	This chapter outlines the functions of the R6142 and contains notes on its use. Be sure to read this chapter before use.
2. PANEL DESCRIPTIONS	This chapter describes switches, keys, controls, and indicators on the front and rear panels.
3. OPERATION	This chapter describes preparation before use, basic operations, and applied operations.
4. GPIB INTERFACE AND PROGRAMMING	This chapter describes the specifications and functions of the GPIB interface, and programming.
5. BCD PARALLEL INTERFACE	This chapter describes the specifications and functions of the BCD interface.
6. INPUT AND OUTPUT SIGNALS	This chapter describes the TRIGGER input signal and READY output signal.
7. INSPECTION AND CALIBRATION	This chapter explains how to deal with problems.
8. OPERATING PRINCIPLE	This chapter explains the operation principle of the R6142, using a block diagram.
9. SPECIFICATIONS AND ACCESSORIES	This chapter describes specifications of and accessories for the R6142.

TABLE OF CONTENTS

1. OVERVIEW	1-1
1.1 Product Outline	1-1
1.2 Before Use	1-2
1.2.1 Checking Accessories	1-2
1.2.2 Place of Use and Notes	1-3
1.2.3 Supply Voltage	1-5
1.2.4 Power Cable	1-6
1.2.5 Replacing Fuses	1-8
1.2.6 Warm-up Time	1-8
1.3 Replacing Parts with Limited Life	1-9
2. PANEL DESCRIPTIONS	2-1
2.1 Front Panel	2-1
2.2 Rear Panel	2-11
3. OPERATION	3-1
3.1 Turning Power ON	3-1
3.1.1 How to Turn Power On	3-1
3.1.2 Self-Diagnosis and Revision Number Display	3-2
3.1.3 Parameters Whose Setting Can Be Backed Up	3-3
3.1.4 Initializing Parameters	3-3
3.2 Before Getting Started	3-5
3.2.1 Basic Operation Flowchart	3-5
3.2.2 Parameters and Their Setting Range	3-7
3.2.3 Operation Mode and Operation Timing	3-8
3.3 Examples of Basic Operation	3-10
3.3.1 Generating 32 V DC	3-10
3.3.2 Generating 16 Milliampere DC	3-11
3.4 Connection with Load	3-12
3.4.1 How to Use Four Output Terminals	3-12
3.5 How to Use Limiters	3-14
3.5.1 Setting Current Limiter and Setting Range	3-14
3.5.2 Setting Voltage Limiter and Setting Range	3-15
3.6 Settling Time	3-16
3.7 Prevention of Oscillation Caused by Inductance Load	3-17
3.8 Source and Sink Operation	3-18
3.9 Turning Output ON/OFF	3-20
3.9.1 Automatically Turning Output ON at Power ON	3-20

3.9.2 Turning Output ON or OFF	3-20
3.9.3 Output ON/OFF Timing	3-21
3.10 Changing the Function from Voltage Generation to Current Generation, or from Current Generation to Voltage Generation	3-22
3.11 Changing Voltage/Current Range	3-23
3.11.1 Timing of Range Switching	3-23
3.12 How to Use the Memory	3-24
3.12.1 Storing Data in the Memory	3-24
3.12.2 Recalling Stored Data from the Memory	3-25
3.13 Sweep Function	3-28
3.13.1 Start/Stop Sweep	3-28
4. GPIB INTERFACE AND PROGRAMMING	4-1
4.1 GPIB Outline	4-2
4.2 Specifications	4-4
4.2.1 GPIB Specifications	4-4
4.2.2 Interface Functions	4-6
4.3 Connection with Component Devices	4-7
4.4 Selecting the GPIB Interface	4-8
4.5 Addressing and Selecting the Listen Only Mode	4-9
4.6 Programming Examples	4-11
4.6.1 DC Voltage Generation	4-11
4.6.2 Sweep Operation	4-12
4.6.3 Storing Data In and Recalling from the Memory	4-15
4.7 Program Code Table (TR6142/R6142/R6144)	4-20
4.8 Basic Format for Output Voltage/Current Setting	4-27
4.9 Panel Set Value Output from Talker and Response to Data Query	4-29
4.10 Service Request	4-30
4.10.1 Status Byte Register	4-30
5. BCD PARALLEL INTERFACE	5-1
5.1 Overview	5-1
5.2 Specifications	5-2
5.2.1 Input Signals for Remote Setting	5-2
5.2.2 Signal and Connector Specifications	5-2
5.2.3 Connector Pin Configuration and Codes	5-4
5.3 Selecting the BCD Parallel Interface	5-5
5.4 Operation	5-6

6. INPUT AND OUTPUT SIGNALS	6-1
6.1 TRIGGER Input Signal	6-1
6.2 READY Output Signal	6-2
7. INSPECTION AND CALIBRATION	7-1
7.1 Before Requesting for Service	7-1
7.2 Calibration	7-4
7.2.1 Preparation and Precautions	7-4
7.2.2 Calibration Procedure	7-5
7.2.3 Flowchart of Calibration for One Range and Correction	7-10
8. OPERATING PRINCIPLE	8-1
8.1 Block Diagram	8-1
8.2 Block Description	8-2
9. SPECIFICATIONS AND ACCESSORIES	9-1
9.1 Voltage/Current Generation	9-1
9.2 Execution Speed	9-4
9.3 Voltage/Current Limiter	9-4
9.4 Memory	9-5
9.5 Sweep	9-5
9.6 Input/Output	9-6
9.7 General Specifications	9-7
9.8 Accessories	9-8

EXTERNAL VIEW

LIST OF ILLUSTRATIONS

No.	Title	Page
1-1	Working Environment	1-4
1-2	Supply Voltage Selector Switch	1-5
1-3	Power Cable Plug and Adapter	1-7
2-1	Sample Operation of POLARITY Keys	2-5
2-2	△ and ▽ Keys and Output Level Display	2-6
2-3	Sample Operation of Setting the Step Time	2-9
2-4	Sample Operation for Step Operation and Scanning	2-9
2-5	Front Panel	2-13
2-6	Rear Panel	2-13
3-1	Canceling Automatic Return to the Operate ON State	3-2
3-2	Equivalent Circuits	3-12
3-3	Setting Time	3-16
3-4	Operation Zones	3-18
3-5	Example of Sink Operation	3-19
3-6	Output ON/OFF Timing	3-21
3-7	Timing of Range Switching	3-23
3-8	Key Operation Flow to Store Data in the Memory	3-24
3-9	Program Code Operation Flow to Store Data in the Memory	3-24
3-10	Operation Flow in the Step Mode	3-25
3-11	Operation Flow in the Single Scan Mode	3-26
3-12	Operation Flow in the Repeated Scan Mode	3-27
3-13	Sweep Operation Flow	3-28
3-14	Sweep Operation for the Digits of Output Level	3-29
4-1	GPIB Configuration	4-2
4-2	Signal Termination	4-4
4-3	GPIB Connector Pin Configuration	4-5
4-4	Connection Diagram for Sweep Operation	4-12
4-5	LIMIT Bit Timing Chart	4-31
4-6	SYNTAX Error Bit Timing Chart	4-31
4-7	READY Bit Timing Chart	4-32
4-8	SCAN END Bit Timing Chart	4-32
4-9	SCAN BUSY Bit Timing Chart	4-33
4-10	TRIGGER IN Bit Timing Chart	4-33
5-1	BCD Parallel Interface Input Circuit	5-3

R6142
PROGRAMMABLE DC VOLTAGE/CURRENT GENERATOR
INSTRUCTION MANUAL

List of Illustrations

<u>No.</u>	<u>Title</u>	<u>Page</u>
6-1	TRIGGER Input Circuit	6-1
6-2	READY Signal Output Timing	6-2
7-1	Calibration Flowchart	7-5
7-2	Connection with Calibration Instruments and Basic Conditions of Setting	7-6
8-1	Block Diagram	8-1
8-2	Time Division Method	8-2
8-3	Principle of the Output Amplifier and Polarity Switching Circuit	8-3

LIST OF TABLES

No.	Title	Page
1-1	Standard Accessories	1-2
1-2	Fuse Specifications	1-8
2-1	Voltage/Current Output Ranges and Display	2-3
2-2	Calibration Points and Display (Unit: V, mV)	2-4
2-3	Calibration Points and Display (Unit: mA)	2-5
2-4	Keys Used for Directly Setting Output Level	2-7
2-5	Key Operation Flow for Direct Setting and Display	2-8
3-1	Parameters Whose Setting Can Be Backed Up	3-3
3-2	Initial Conditions to Be Established by Pressing MEM CLEAR after Power ON ...	3-4
3-3	Error Caused by Cable Resistance in Four-Wire Connection	3-13
3-4	Cable Resistance Per Meter	3-13
3-5	Turning Output ON or OFF	3-20
4-1	Interface Functions	4-6
4-2	Standard Bus Cables (Option)	4-7
4-3	Addressing	4-9
4-4	Program Code Table	4-20
5-1	BCD Parallel Connector Pin Configuration and Codes	5-4
5-2	LOAD Signal Functions	5-6
6-1	Effect of the TRIGGER Signal	6-1
7-1	User Actions to Problems	7-1
7-2	Error Codes and User Actions	7-3
7-3	Instruments Required for Calibration	7-4
7-4	Cables Required for Calibration	7-4
7-5	Operation Check	7-7
7-6	Ranges to Be Calibrated and Range with Calibration Error	7-10

1. OVERVIEW

This chapter outlines the functions of the R6142 and contains notes on its use. Be sure to read this chapter before use.

1.1 Product Outline

The R6142 is a DC voltage/current generator employing a time-division D/A conversion technique.

The R6142 generates a DC voltage of 0 to ± 12 V at a minimum step of one microvolt, and a DC current of 0 to ± 120 mA at a minimum step of 0.1 microampere. The R6142 features excellent linearity and stability, high throughput, and highly reliable and accurate outputs with low noise.

A 160-step memory and the all-digit sweep function implement a greater applicability to electronic components tests and lessen operation and test time.

The R6142 has the GPIB interface and BCD parallel interface as standard for connection with various host machines, such as personal computers, minicomputers, and sequence controllers, to construct automatic evaluation systems.

Features:

- A maximum voltage/current output of 12 V/120 mA
- High-resolution output at a minimum of one microvolt/100 nanoamperes
- Six-month assurance of voltage generation at as high an accuracy as 0.03%, and a current generation at 0.04%
- 110 ppm linearity and monotonicity for use over full scale
- Low noise, 3 mVpp (BW = 20 MHz), for high measurement reliability
- Memory to store up to 160 data setting
- All-digit sweep function for a greater measurement applicability
- GPIB interface and BCD parallel interface, provided as standard, for connection to various host machines

1.2 Before Use

1.2.1 Checking Accessories

When the R6142 is delivered, check the following:

Check

- ① Check the product appearance for damage.
- ② Check the quantity and specifications of standard accessories in Table 1-1.

If any damage or a missing accessory is found, contact the nearest dealer or the sales and support offices. See the end of this manual for the locations and telephone numbers of our sales and support offices.

Note: Designate a model or stock No. when ordering an accessory.

Table 1-1 Standard Accessories

Accessory	Specification		Qty	Remarks
	Model	Stock No.		
Power cable	A01402	DCB-DD2428X01	1	
Power fuse	Slow blow fuse 0.315 A (EAWK0.315 A)	DFT-AAR315A	2	100/120 VAC
	Slow blow fuse 0.16 A (EAWK0.16 A)	DFT-AAR16A		220/240 VAC
User's manual	—	JR6142	1	Japanese version
	—	ER6142		English version

1.2.2 Place of Use and Notes

(1) Place of use

Avoid using the R6142 in the following environments and under the following conditions:

- Dusty environment
- Corrosive gas environment
- Exposure to direct sunlight
- Near noise sources
- Exposure to excessive mechanical impact
- Exposure to vibration

(2) Working conditions

- Use the R6142 in an ambient temperature of 0°C to +50°C and a humidity of 85% or less.
- Use a grounded outlet.
- To protect the R6142 from overheating, do not block the ventilations holes on top exercise care that the unit is well ventilated. Do not place the R6142 near a heat source.
- Take antistatic measures (earth band) for the R6142 and connected devices.
- Use a line filter when using the R6142 near a noise source.

(3) Storage

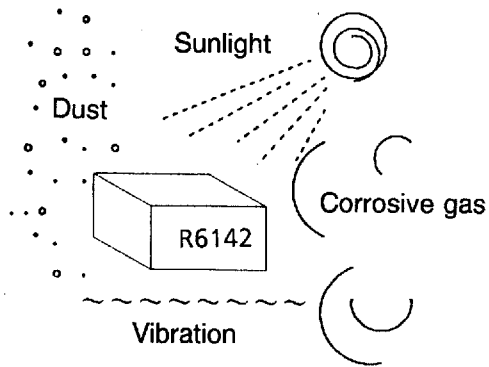
When the R6142 is not to be used for a long period of time, cover the unit with a vinyl cover or placed in a cardboard box store the unit in an areas which are not subject to direct sunlight, or high humidity and temperatures. The storage temperature should not exceed -25°C to +70°C.

(4) Cleaning

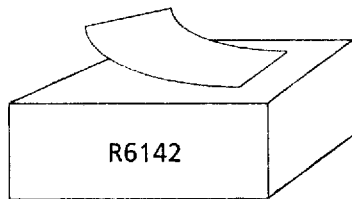
—CAUTION—

When conducting maintenance or cleaning the machine, do solvents that deteriorate plastics (e.g. organic solvents such as benzene and acetone).

(a) Avoid using the unit in the following environment.



(b) Do not put paper or other objects on the unit.



(c) Use a line filter if noise interference might otherwise reach the R6142 through the power line.

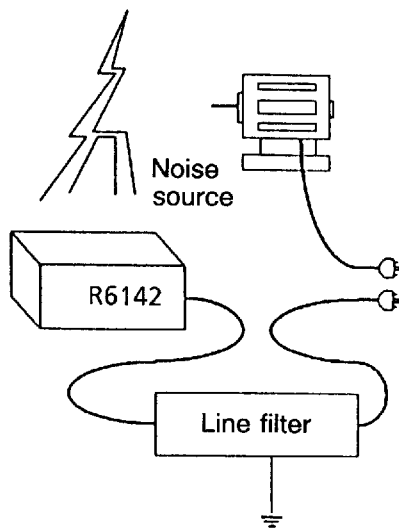


Figure 1-1 Working Environment

R6142
PROGRAMMABLE DC VOLTAGE/CURRENT GENERATOR
INSTRUCTION MANUAL

1.2 Before Use

(5) Transport

When transporting the R6142, reuse the packing materials that were supplied with the unit on delivery. If they are not available, pack the R6142 using the following procedure:

Procedure

- ① Wrap the R6142 in a vinyl sheet.
- ② Wrap the unit in a cushioning material and place it in a cardboard box 5 mm or thicker.
- ③ Put in the accessories, followed by more cushioning material, and close and seal the box.

1.2.3 Supply Voltage

- Notes:
- Before plugging in the R6142, make sure that the power switch is OFF.
 - Make sure that the supply voltage ② to be used matches the set position of the units supply voltage selector switch ①. (See Fig. 1-2)
 - The power frequency can be either 50 Hz or 60 Hz. (See ③)

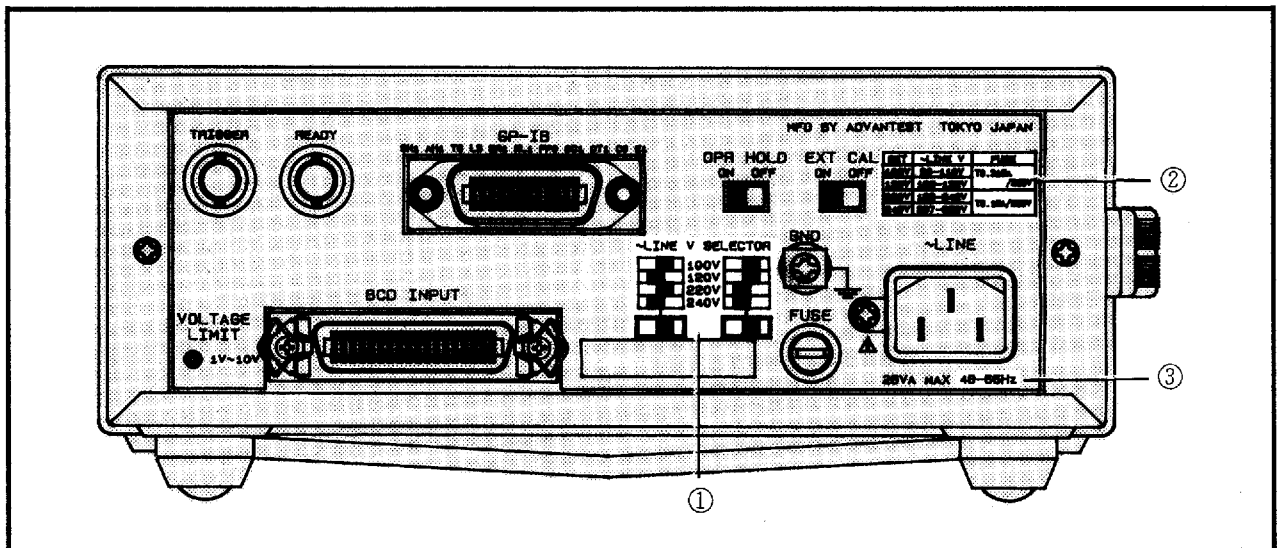


Figure 1-2 Supply Voltage Selector Switch

1.2.4 Power Cable

The power cable is supplied with a three-pin plug. The round pin is the grounding pin (see Fig. 1-3 (a)). Use a grounded outlet with the unit.

For connection to a two-pin outlet, fit the attached adapter (A09034) to the plug. Connect the grounding lead of the adapter or the GND terminal on the rear panel to an external grounding terminal or earth.

As shown in Figure 1-3 (b), the two pins of adapter A09034 differ in width. Fit the adapter into the outlet accordingly.

If adapter A09034 does not fit the outlet, use adapter KPR-13 (option).

— CAUTION —

Be careful that the grounding lead of the adapter does not touch the AC power source (Fig. 1-3 (c)). Otherwise, the R6142 and other connected devices may be damaged.

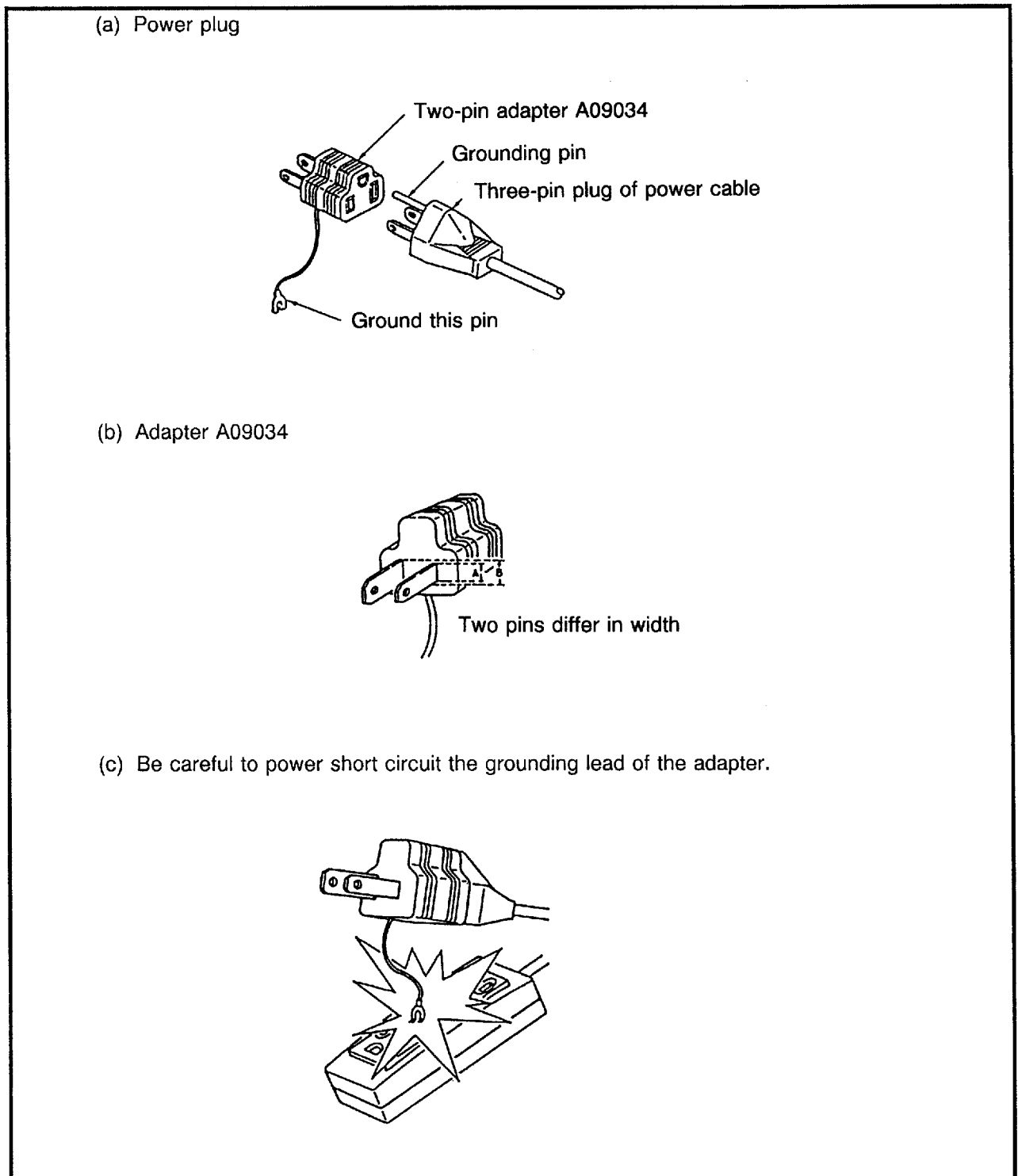


Figure 1-3 Power Cable Plug and Adapter

1.2.5 Replacing Fuses

CAUTION

1. Before replacing fuses, turn the POWER switch OFF and unplug the R6142.
2. A visual inspection of a fuse alone is insufficient. Measure the fuse's resistance. The normal resistance is 15 ohms or under.
3. Use a fuse of the same type and rating for replacement to prevent the danger of fire breakout.

Procedure

- ① Lightly press the fuse holder cap with a standard screwdriver and turn it counter clockwise about 60 degrees. Release the screwdriver. A rotary piece will project toward you about 3 mm.
- ② Remove the rotary piece. Replace the mounted fuse with a new one.
- ③ Lightly press the rotary piece with the screwdriver and turn it clockwise about 60 degrees to secure it.

Table 1-2 Fuse Specifications

Fuse	Specification		Remarks
	Type	Part code	
Power fuse	Slow blow fuse 0.315 A (EAWK0.315 A)	DFT-AAR315A	100/120 VAC
	Slow blow fuse 0.16 A (EAWK0.16 A)	DFT-AAR16A	220/240 VAC

1.2.6 Warm-up Time

All functions of the R6142 are available as soon as the R6142 is turned on. However obtain the specified accuracy, allow the unit to heat up for approximately 30 minutes.

R6142
PROGRAMMABLE DC VOLTAGE/CURRENT GENERATOR
INSTRUCTION MANUAL

1.3 Replacing Parts with Limited Life

1.3 Replacing Parts with Limited Life

The R6142 uses the following parts with limited life that are not listed in Safety Summary. Replace the parts listed below after their expected lifespan has expired.

Part name	Life
Relay	200,000 times

2. PANEL DESCRIPTIONS

2.1 Front Panel

Read the following description, referring to Figure 2-5.

① OUTPUT terminals

Voltage/current output terminals.

For two-wire connection, connect the OUTPUT terminals to the load, and set the SENSE switch to 2WIRE.

For four-wire (remote sensing) connection, also use the SENSE terminals.

② SENSE terminals

Input terminals for remote sensing.

If a voltage drop across a cable is to be ignored, set the SENSE switch to 4WIRE, and run cables from the OUTPUT and SENSE terminals separately to the load. (See Section 3.4.1 "How to Use Four Output Terminals.")

<Output Terminal Voltage/Current Maximums >

The voltage and current next to the terminals on the front panel indicate the following.

- The maximum output level between the Hi OUTPUT/Hi SENSE and Lo OUTPUT/Lo SENSE terminals is 12 V.
The maximum output current is 120 mA.
- The maximum applied voltage peak between the Lo OUTPUT/Lo SENSE and GND terminals is 500 V.

CAUTION

When applying external voltages, do not apply voltages which exceed the following maximum voltages between the terminals, or, this instrument can be damaged.

1. For ranges of 1 V to 10 V



For positive polarity (+) output voltage : Between - 0.5 V peak and + 32 V peak

For negative polarity (-) output voltage : Between + 0.5V peak and - 32 V peak

2. For ranges of 10 mV to 100 mV

Regardless of output voltage polarity : Between - 0.5 V peak and + 0.5 V peak

③ SENSE switch

This switch selects the type of connection with a load, two-wire (2WIRE ) connection or four-wire connection (4WIRE ) , where a voltage drop across a connection cable is ignored.

④ POWER switch

A switch to turn on or off the generator power.

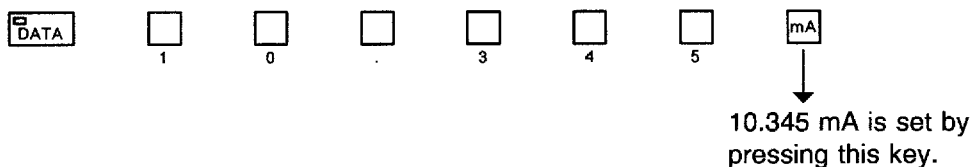
When this switch is turned on, the power is supplied to the R6142. The R6142 severally displays the product name and the software revision number/update number for about three seconds, then it becomes ready for operation. (See Section 3.1 "Turning Power On.")

⑤ V, mV, and mA keys

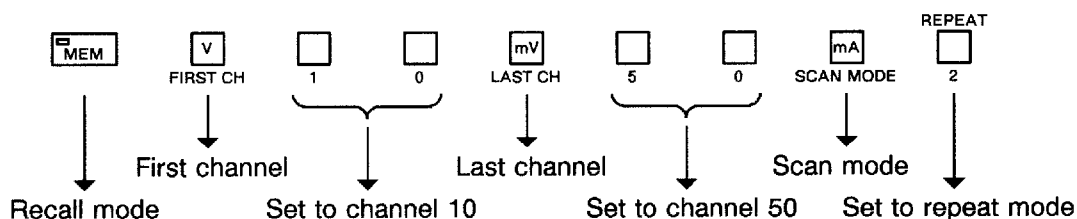
- Used to select the voltage/current output range.

V : 1 V range
 mV : 10 mV range
 mA : 1 mA range

- Used to select the unit for voltage/current to be generated in the direct setting mode after an output level has been set using the numeric keys.



- Used to set the scan mode, first channel, and last channel in the recall mode.



Pressing MEM terminates the recall mode to return to the normal operation mode. (See Section 3.12 "How to Use the Memory.")

- Used to select a voltage/current calibration point in the calibration mode.

STEP mV : Zero calibration for 10 mV range
 STEP mA : Zero calibration for 1 mA range

Use the RANGE Δ and ∇ , mV, and mA keys to select the next calibration point.

Pressing STEP terminates the calibration mode to return to the normal operation mode.

⑥ RANGE Δ and ∇ keys and range display

- Usually used to select the voltage/current output range. Table 2-1 lists voltage/current output ranges and associated display.
- Used as numeric keys 9 and 4.
- Used to select a calibration point in the calibration mode. Tables 2-2 and 2-3 show calibration points and associated display.

R6142
PROGRAMMABLE DC VOLTAGE/CURRENT GENERATOR
INSTRUCTION MANUAL

2.1 Front Panel

Table 2-1 Voltage/Current Output Ranges and Display

	△ and ▽ key operation	Display	Range
Voltage generation	▽ △	● V 10.000 mV mA	10 V
	▽ △	● V 1.0000 mV mA	1 V
	▽ △	V 100.00 ● mV mA	100 mV
	▽ △	V 10.000 ● mV mA	10 mV
Current generation	▽ △	V 100.00 ● mV mA	100 mA
	▽ △	V 10.000 ● mV mA	10 mA
	▽ △	V 1.0000 ● mV mA	1 mA

R6142
PROGRAMMABLE DC VOLTAGE/CURRENT GENERATOR
INSTRUCTION MANUAL

2.1 Front Panel

Table 2-2 Calibration Points and Display (Unit: V, mV)

△ and ▽ key operation	Display	Calibration point
▽ △	1 2 . _ _ _ ● V mV mA	10 V range, full scale
▽ △	0 0 . _ _ _ ● V mV mA	10 V range, zero
▽ △	1 . 2 _ _ _ ● V mV mA	1 V range, full scale
▽ △	0 . 0 _ _ _ ● V mV mA	1 V range, zero
▽ △	1 2 0 . _ _ V ● mV mA	100 mV range, full scale
▽ △	0 0 0 . _ _ V ● mV mA	100 mV range, zero
▽ △	1 2 . _ _ _ V ● mV mA	10 mV range, full scale
▽ △	0 0 . _ _ _ V ● mV mA	10 mV range, zero

Table 2-3 Calibration Points and Display (Unit: mA)

△ and ▽ key operation	Display	Calibration point
▽ (left) → (right) △	<div style="display: flex; justify-content: space-between;"> 1 2 0 . _ _ V mV ● mA </div>	100 mA range, full scale
▽ (left) → (right) △	<div style="display: flex; justify-content: space-between;"> 0 0 0 . _ _ V mV ● mA </div>	100 mA range, zero
▽ (left) → (right) △	<div style="display: flex; justify-content: space-between;"> 1 2 . _ _ _ V mV ● mA </div>	10 mA range, full scale
▽ (left) → (right) △	<div style="display: flex; justify-content: space-between;"> 0 0 . _ _ _ V mV ● mA </div>	10 mA range, zero
▽ (left) → (right) △	<div style="display: flex; justify-content: space-between;"> 1 . 2 _ _ _ V mV ● mA </div>	1 mA range, full scale
▽ (left) → (right) △	<div style="display: flex; justify-content: space-between;"> 0 . 0 _ _ _ V mV ● mA </div>	1 mA range, zero

⑦ POLARITY keys -, 0, and +

- Usually used to set the polarity the of output levels.

Pressing the 0 key set the output level to zero.

Figure 2-1 shows a sample operation of the POLARITY keys.

- Used as the (decimal point), (polarity), and (key clear) keys in the direct setting mode.

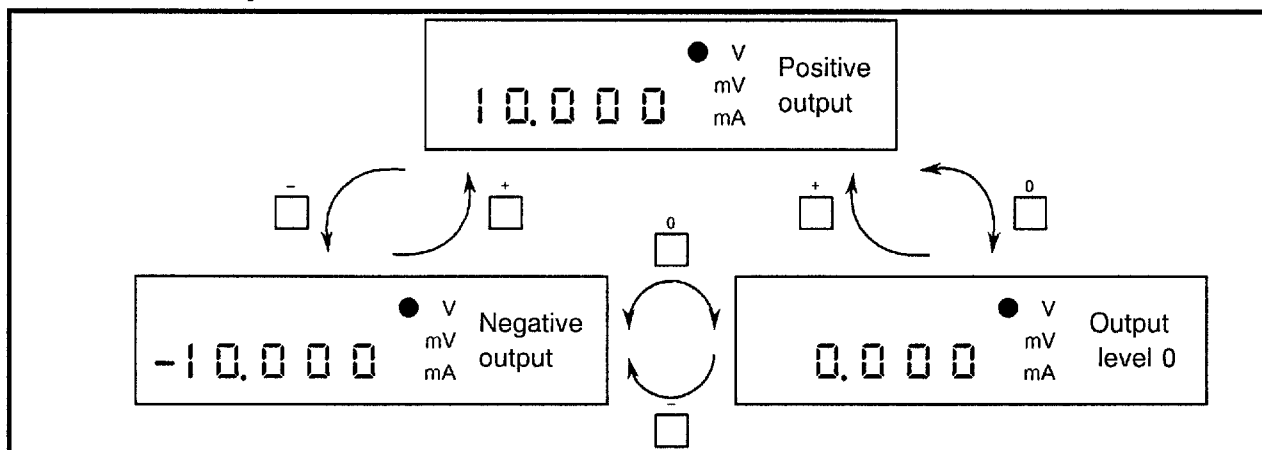


Figure 2-1 Sample Operation of POLARITY Keys

⑧ CURRENT LIMIT control

A control to adjust the current limiter when the R6142 serves as a current source.

Turning the control clockwise increases the current limit value.

Current limit can be adjusted in a range from 5 mA to 120 mA. (See Section 3.5 "How to Use Limiters.")

⑨ Output level Δ and ∇ keys and output level display

- Usually used to set an output level.

Pressing a key on the Δ side increases the output level toward the full-scale value; pressing a key on the ∇ side decreases the output level toward zero.

Note: If another press causes the output level to exceed 11999 or to drop below 00000, pressing the Δ or ∇ key does not cause the output level to change.

Figure 2-2 shows the correspondence between the output level keys and the digits of a displayed output level.

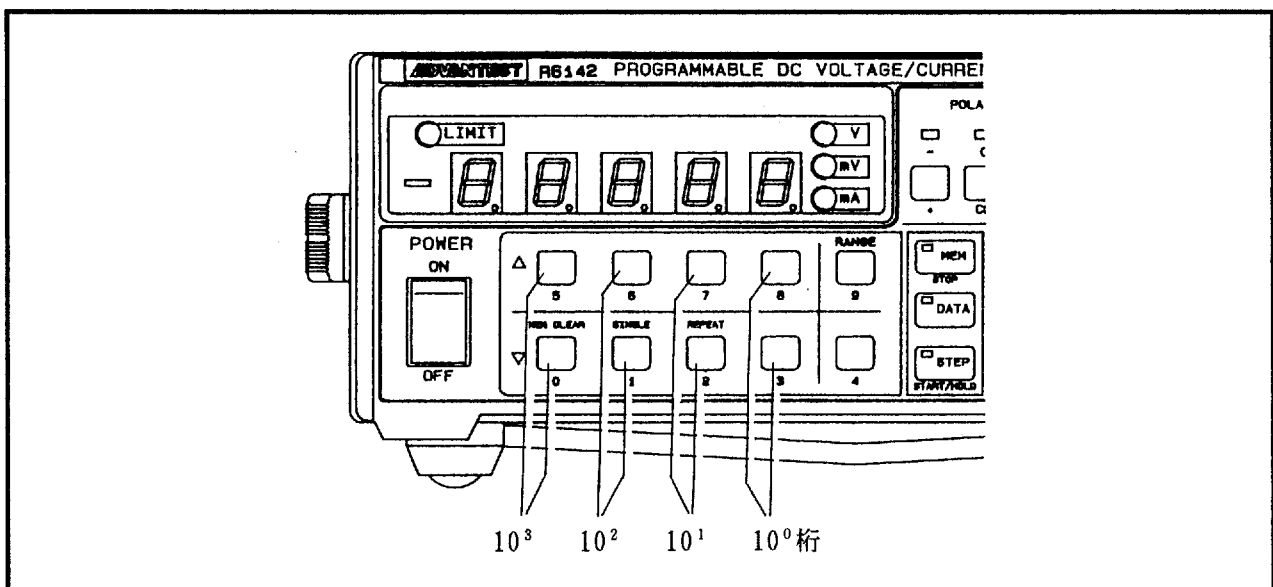


Figure 2-2 Δ and ∇ Keys and Output Level Display

If a key is held down for over 500 milliseconds, the output level starts changing continuously and keeps changing even after the key is released. (See Section 3.13 "Sweep Function.")

- Used as numeric keys \square_0 to \square_3 and \square_5 to \square_8 .

- If $\square_{MEM\ CLEAR}$ is pressed two or three seconds after the POWER switch is turned ON, backed-up parameters including memory data are initialized.

During the initialization, \square_{CLEAR} is displayed. (See Section 3.1.4 "Initializing Parameters.")

R6142
PROGRAMMABLE DC VOLTAGE/CURRENT GENERATOR
INSTRUCTION MANUAL

2.1 Front Panel

SINGLE REPEAT

- and are used to select the type of scan in the scan mode.

 S I N G L E : Single scan

 R E P E A T : Repeated scan

⑩ MEM (Memory) key

- Usually used for programming or recalling (recall mode) memory data. (See Section 3.12 "How to Use the Memory.")
- Used to exit the recall mode when the R6142 is in the recall mode.

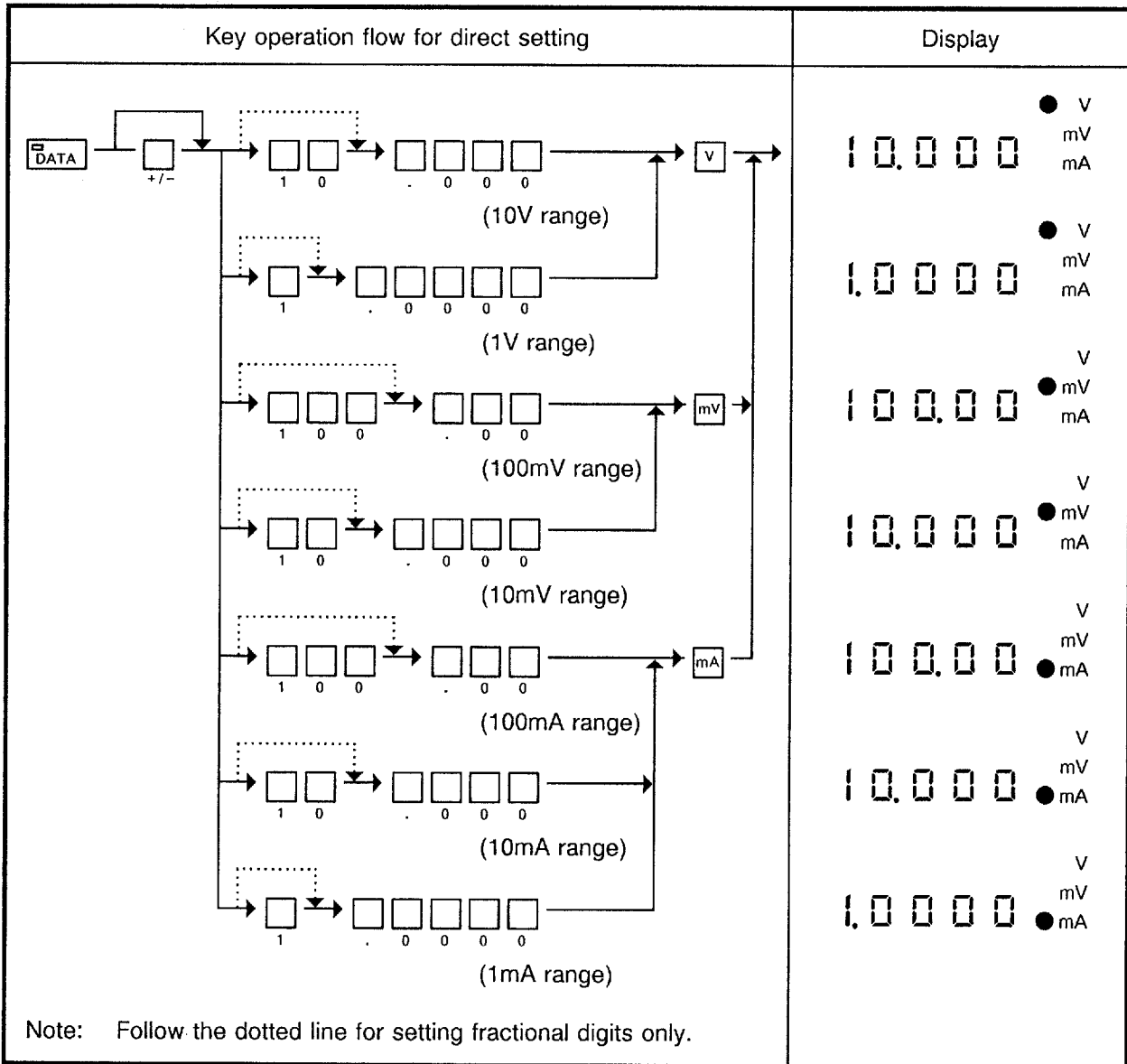
⑪ DATA key

- Used, together with numeric keys, to directly set the output level. Table 2-4 lists keys used for the direct setting. Table 2-5 shows the key operation flow for the direct setting.

Table 2-4 Keys Used for Directly Setting Output Level





Direct setting keys	Function
<input type="checkbox"/> +/-	Sets polarity.
<input type="checkbox"/> to <input type="checkbox"/> 0 9	Sets a value.
<input type="checkbox"/> .	Sets the decimal point position (range).
<input type="checkbox"/> CE	Clears setting.
<input type="checkbox"/> V , <input type="checkbox"/> mV , <input type="checkbox"/> mA	Enters a set value when the range is set.
<input type="checkbox"/> DATA	Exits the direct setting procedure without doing anything.

Table 2-5 Key Operation Flow for Direct Setting and Display



- In the recall mode, program the memory data by direct setting.
- In the calibration mode, enter a calibration value. (See Section 7.2.2 "Calibration Procedure.")

⑫ STEP key

- Usually used to set the step time.
 Press  and enter a step time with  to  (in units of 0.1 second).
 Then press  to activate the setting.

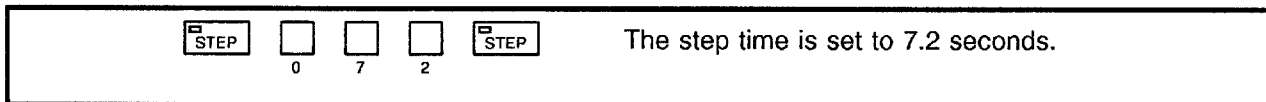








Figure 2-3 Sample Operation of Setting the Step Time

- Used to switch the GPIB interface to and from the BCD interface.
 Press  and . Then press  to select the GPIB or BCD interface. If the GPIB interface is selected, a device address can be set with  to .
 Press  again to exit the setting procedure.
- Used to advance the channel by one or to start/hold scanning in the recall mode.
 Figure 2-4 shows a sample operation for step operation and scanning.

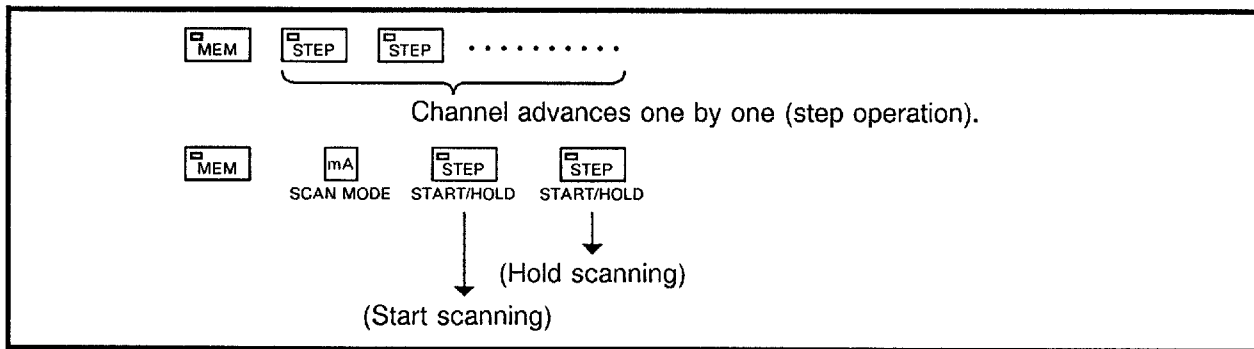



Figure 2-4 Sample Operation for Step Operation and Scanning

⑬ OPERATE key and OPERATE lamp

Used to turn ON or OFF the output.

OPERATE
 (lamp OFF) : The output is turned OFF.

OPERATE
 (lamp ON) : The output is turned ON.

(See Section 3.9 "Turning Output ON/OFF.")

⑭ LIMIT lamp

- When voltage is generated, this lamp indicates that the load current is limited to the setting of the current limiter.
- When current is generated, this lamp indicates that the load voltage is limited to the setting of the voltage limiter.

(See Section 3.5 "How to Use Limiters.")

⑮ LOCAL key and GPIB status lamps

- Pressing STEP and LOCAL keys switches the GPIB interface to and from the BCD interface. (See ⑫ "STEP key", Section 4.4 "Selecting the GPIB Interface," and Section 5.3 "Selecting the BCD Parallel Interface.")
- When the GPIB interface is selected, pressing the LOCAL key switches the remote mode (REMOTE lamp ON) for external control over GPIB to the local mode for control from the front panel. In the local mode, the REMOTE lamp is OFF.

Note: If the local lockout (LLO) command is issued over GPIB, the remote mode cannot be deactivated.

The status lamps, SRQ, LISTEN, and REMOTE, indicate the device status of the unit when it is controlled over GPIB. The SRQ lamp lights up when the R6142 is sending a service request to the controller.

LISTEN lamp : This lamp lights up when the R6142 is a listener that receives data.

REMOTE lamp : This lamp lights up when the R6142 is remote controlled. When this lamp is lit, all panel keys and switches except LOCAL, SENSE, OPR HOLD, and EXT CAL are inactive.

- When the BCD parallel interface is selected, the LOCAL key switches the full remote mode to and from the half-remote mode.

REMOTE (lamp OFF) : Half-remote mode

REMOTE (lamp ON) : Full remote mode

2.2 Rear Panel

Read the following description carefully, referring to Figure 2-6.

① ~LINE V SELECTOR and supply voltage list

A selector switch for AC supply voltage.

Note: Before connecting the R6142 to an outlet, make sure that the supply voltage to be used matches the setting of the supply voltage selector switch.

Use tweezers or a standard screwdriver to select the required supply voltage on the selector switch.

The supply voltage list gives the operating ranges of usable supply voltages and the specifications for corresponding fuses.

② GND terminal

A grounding terminal.

When the two-pin adapter is fitted to the power cable plug, ground the R6142 using the grounding wire of the adapter, or the unit's GND terminal.

③ ~LINE power connector

A connector for connection with an AC power supply.

Connect the attached power cable (A01402) to this connector.

Note: Before connecting the R6142 to an outlet, make sure that the supply voltage to be used matches the setting on the supply voltage selector switch. (See ① "~LINE V SELECTOR and supply voltage list.")

④ FUSE holder

Use the correct fuse specified in the supply voltage list in ① .

To remove the holder for fuse replacement, slightly de-press the cap and rotate in the direction of the arrow.

⑤ V LIMIT control

The V LIMIT control is used to adjust the voltage limiter.

Turning the control clockwise increases the voltage limit. The voltage limit can be adjusted over a range of 1 V to 10 V.

(See Section 3.5 "How to Use Limiters.")

⑥ OPR HOLD switch

Used for automatic return to the output ON state at recovery from a power failure.

Usually set this switch to the OFF position for safety. Set the switch to the ON position for automatic return to the output ON state.

This switch cannot be remote controlled.

(See Section 3.9 "Turning Output ON/OFF.")

⑦ EXT. CAL switch

Used to calibrate output voltage and current ranges.

Usually set this switch to the OFF position. For calibration, set the switch to the ON position after the power is turned on.

This switch cannot be remote controlled.

(See Section 7.2.1 "Preparation and Precautions.")

⑧ BCD INPUT connector

Used to connect a BCD parallel interface cable for remote control of the R6142 using BCD parallel signals.

(See Chapter 5 "BCD Parallel Interface.")

⑨ TRIGGER input terminal

Used to input a trigger signal into the R6142.

(See Section 3.2.3 "Operation Mode and Operation Timing" for operation timing.)

The input signal is a TTL negative-logic pulse (pulse width: 5 msec or more).

(See Section 6.1 "TRIGGER Input Signal.")

⑩ READY output terminal

Used to output a synchronizing signal in order to trigger measurement with an external digital multimeter (DMM) when the voltage/current output has been settled.

The output signal is a TTL negative-level pulse (pulse width: about 10 msec).

(See Section 6.2 "READY Output Signal.")

⑪ GPIB connector

Used to connect a GPIB interface cable for remote control of the R6142 using GPIB signals.

(See Section 4.3 "Connection with Component Devices.")

2.2 Rear Panel

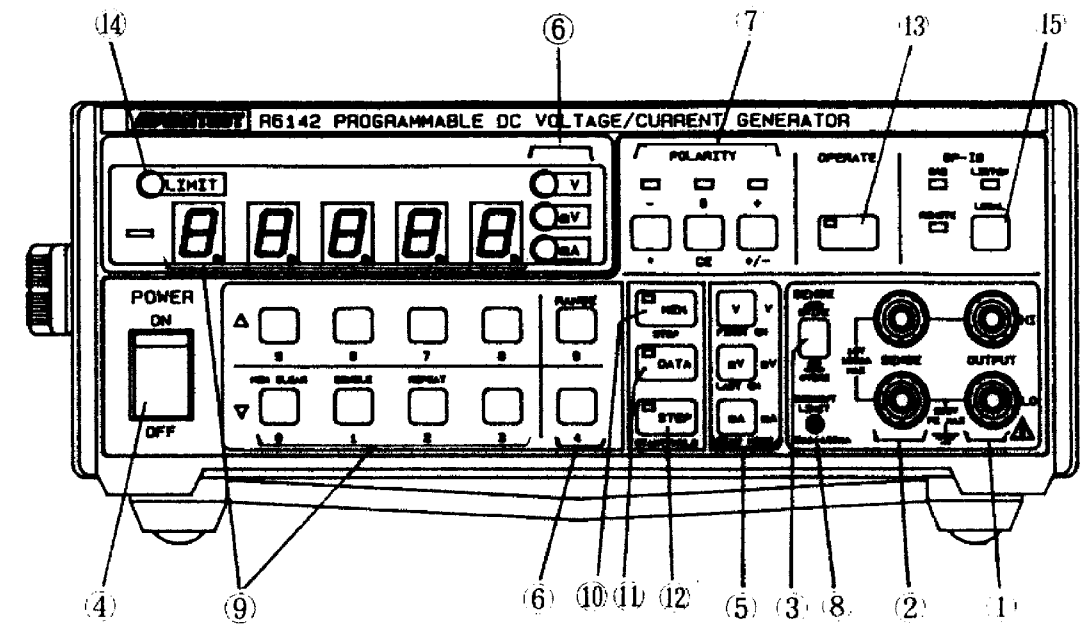


Figure 2-5 Front Panel

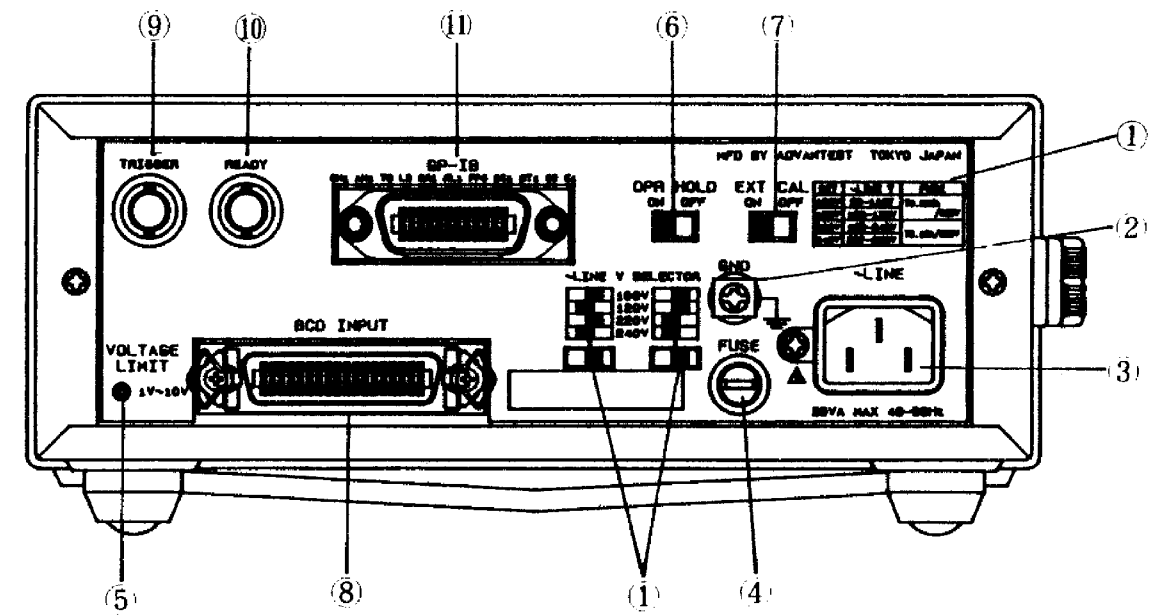


Figure 2-6 Rear Panel

3. OPERATION

3.1 Turning Power ON

3.1.1 How to Turn Power On

Procedure

- ① Make sure that the supply voltage to be used matches the setting on the supply voltage selector switch on the rear panel.
(See Section 1.2.4 "Power Cable" and Section 2.2 ① "~LINE V SELECTOR and supply voltage list.")
- ② Make sure that the OPR HOLD switch on the rear panel is set for the required mode.

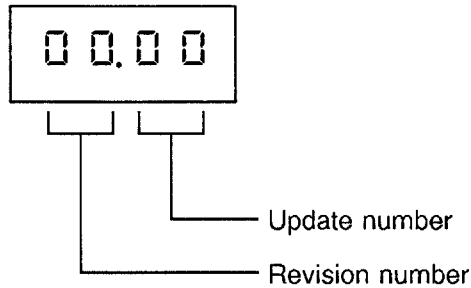
OPR HOLD switch position	Description
OFF	After the power is turned on, the R6142 enters the operate OFF (output OFF) state.
ON	After the power is turned on, the R6142 returns to the last operate state before the power was turned off. For example, if the power is turned off in the operate ON state, the R6142 automatically returns to the operate ON state when the power is turned on again.

(See Section 3.9.1 "Automatically Turning Output ON at Power ON.")

- ③ Make sure that the input and output terminal connections are properly connected. Turn the POWER switch ON.
(See Section 2.1 ④ "POWER switch.")

3.1.2 Self-Diagnosis and Revision Number Display

When the POWER switch is turned ON, the R6142 automatically performs self-diagnosis. All LEDs on the front panel are lit during self-diagnosis if the R6142 is free of error. If any error is detected, a relevant error code is displayed. (See Table 7-2 "Error Codes and User Actions.") Then, the current revision number and update number of the internal software is displayed.



If the OPR HOLD switch is set to the ON position and, if automatic return to the operate ON state is set effective, the OPERATE lamp blinks for about 10 seconds and the R6142 then returns to the operate ON state.

To cancel the automatic return, press the OPERATE key while the OPERATE lamp is blinking.

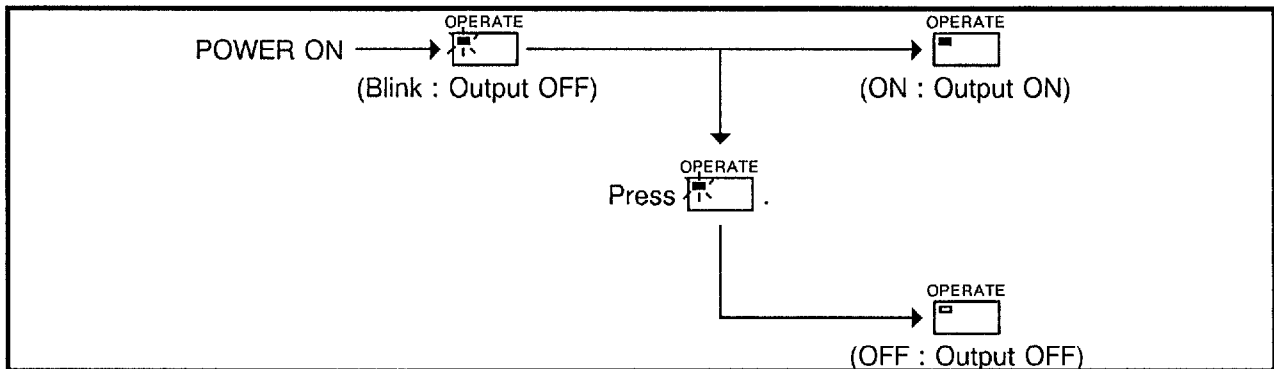


Figure 3-1 Canceling Automatic Return to the Operate ON State

3.1.3 Parameters Whose Setting Can Be Backed Up

When self-diagnosis is completed (indicating that the R6142 is free of error) parameters are set to the last setting. Table 3-1 lists parameter whose setting can be backed up.

Table 3-1 Parameters Whose Setting Can Be Backed Up

Parameters whose setting can be backed up
Output range/polarity/output level
Memory data
First/last channel
Scan mode
Step time
OPERATE (when the OPE.HOLD switch is set to the ON position)
GPIB/BCD remote mode
GPIB device address

3.1.4 Initializing Parameters

To initialize the memory and all parameters, follow the procedure given below.




Procedure

- ① Turn the POWER switch ON. Two or three seconds later, press ^{MEM CLEAR}.
- ② will be displayed, indicating that the R6142 is ready for regular operation. (See Section 2.1 ⑨ "Output level and keys and output level display.")

R6142
PROGRAMMABLE DC VOLTAGE/CURRENT GENERATOR
INSTRUCTION MANUAL

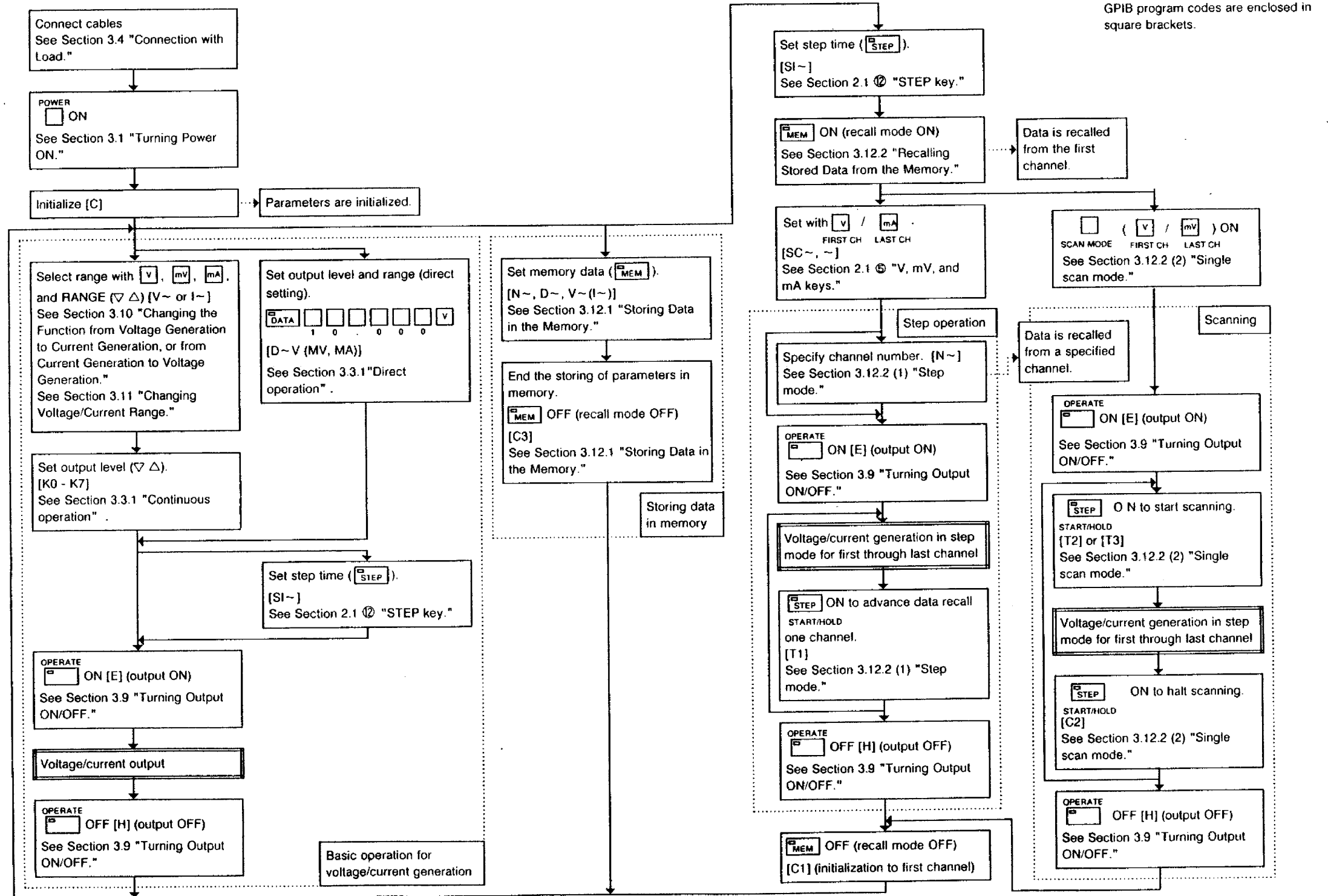
3.1 Turning Power ON

Table 3-2 Initial Conditions to Be Established by Pressing MEM CLEAR after Power ON

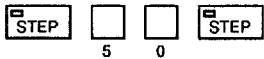
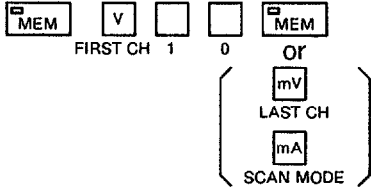
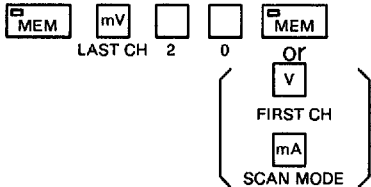
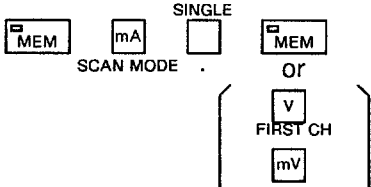
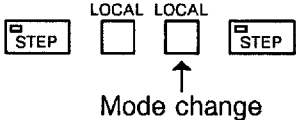
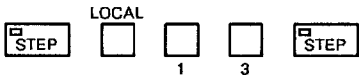
Parameter	Initial condition
Range	1 V range
Output data	. 0 0 0 0 v
Step time	0.1s
Memory data (all channels)	 V  mV  mA
First channel	Channel 0
Last channel	Channel 159
Automatic scan mode	Single scan
Output ON/OFF	Output OFF
Block delimiter	CR LF (EOI)
Service request	Not issued
Device address (GPIB)	01

3.2 Before Getting Started

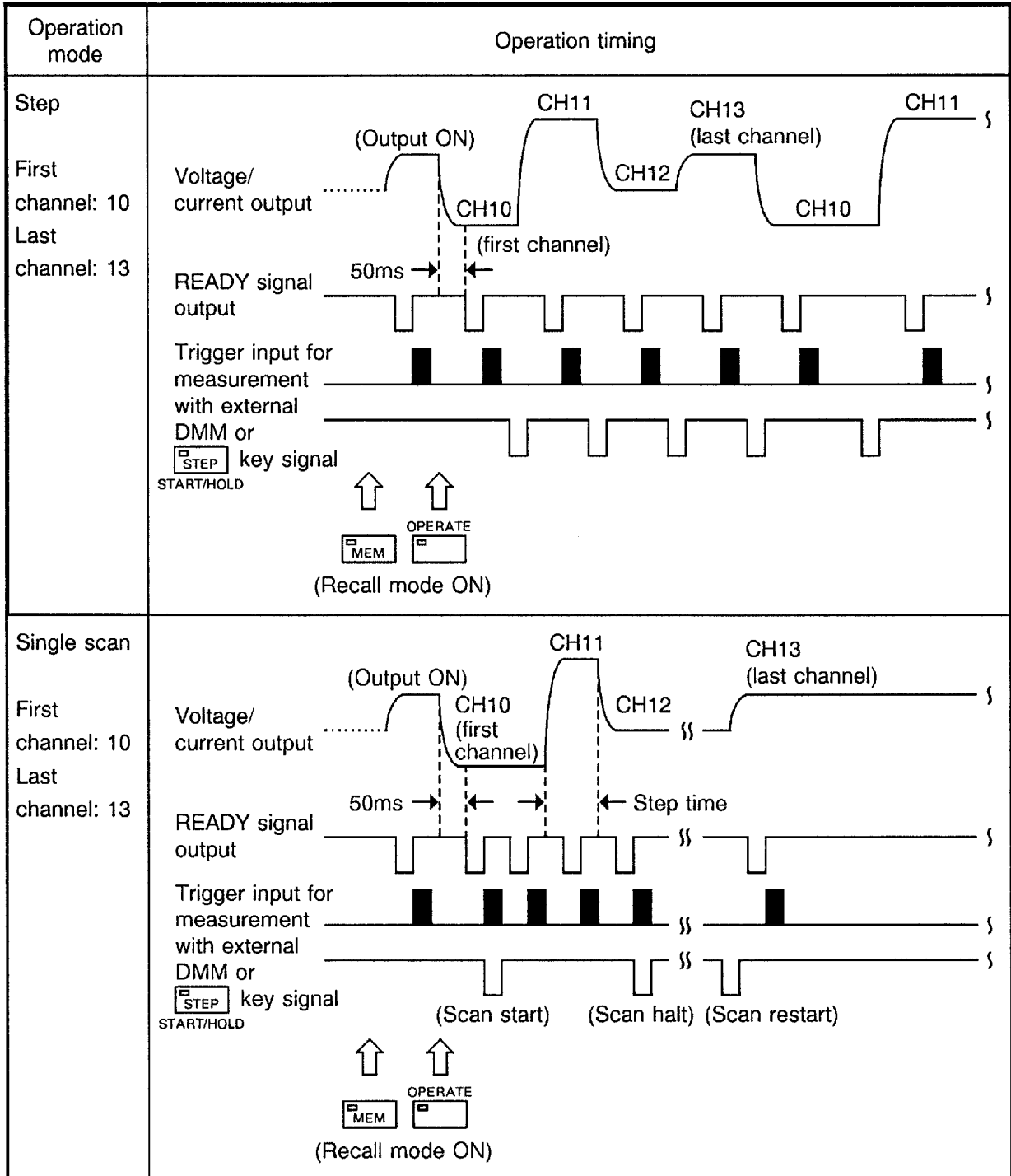
3.2.1 Basic Operation Flowchart



3.2.2 Parameters and Their Setting Range

Parameter	Description	Setting range	Operation
Step time	Time of one-step output operation in single or repeated scan or sweep mode	001 to 100 (in units of 0.1 second)	 (Example of setting step time to 5 seconds)
First channel	The channel (address) of memory from which data is first recalled in step operation or scanning	000 to 159	 (Example of setting first channel to channel 10)
Last channel	The channel (address) of memory from which data is last recalled in step operation or scanning	000 to 159	 (Example of setting last channel to channel 20)
Scan mode	Single scan or repeated scan	single or REP	 (Example of setting scan mode to single scan)
GPIB/BCD remote mode	A switch to select GPIB interface or BCD parallel interface	bcd or A-00	 Mode change
GPIB address	Device address in GPIB remote mode	A-00 to A-30 or L0nL (Listen only)	 (Example of setting device address to 13) (Set device address to 31 or more for "listen only")

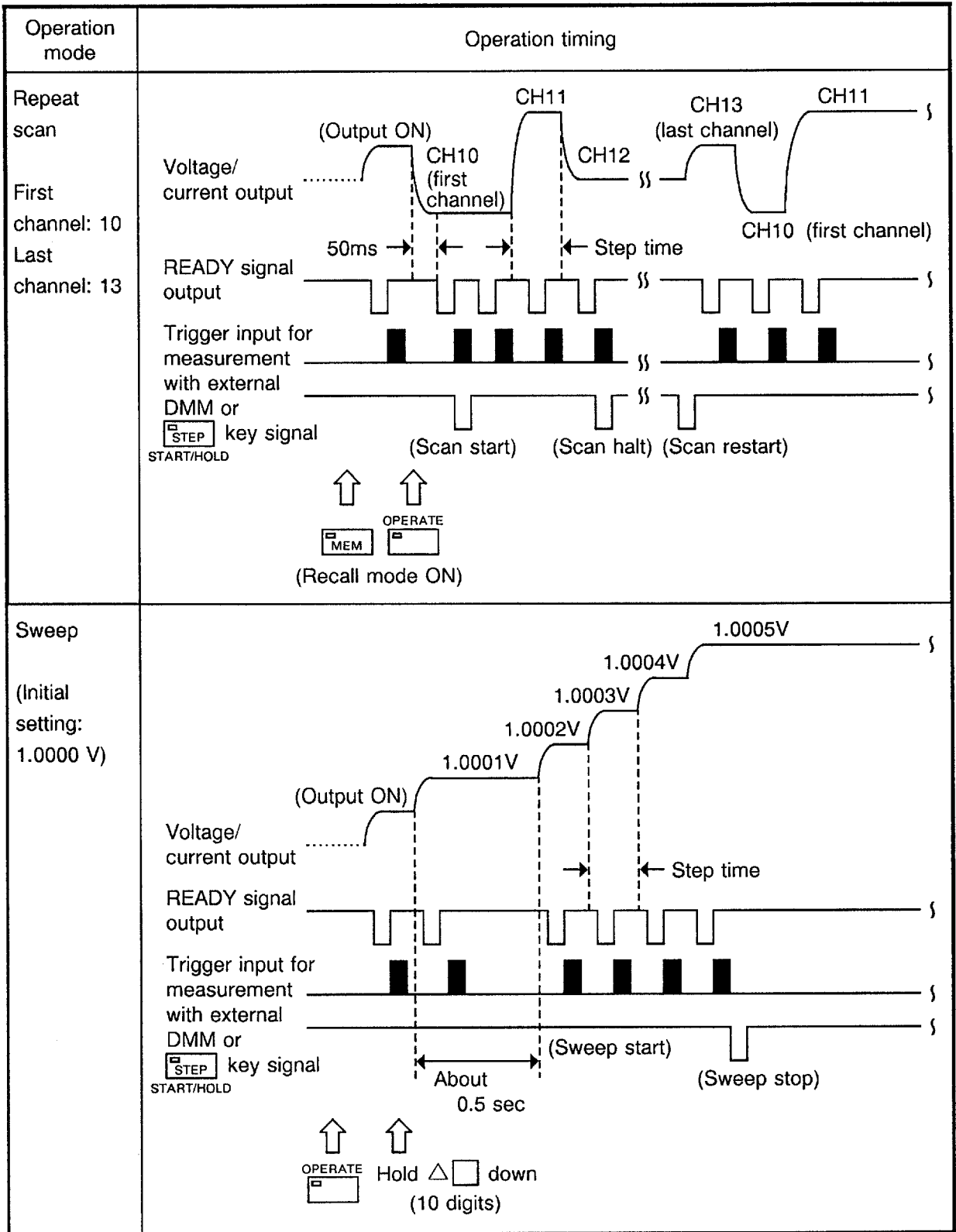
3.2.3 Operation Mode and Operation Timing



R6142
PROGRAMMABLE DC VOLTAGE/CURRENT GENERATOR
INSTRUCTION MANUAL

3.2 Before Getting Started

(cont'd)

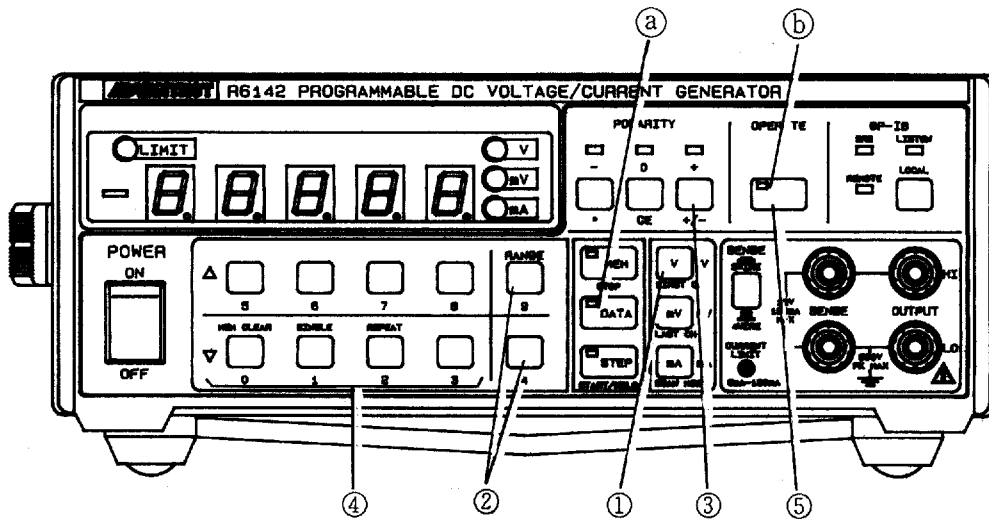


R6142
 PROGRAMMABLE DC VOLTAGE/CURRENT GENERATOR
 INSTRUCTION MANUAL

3.3 Examples of Basic Operation

3.3 Examples of Basic Operation

3.3.1 Generating 32 V DC



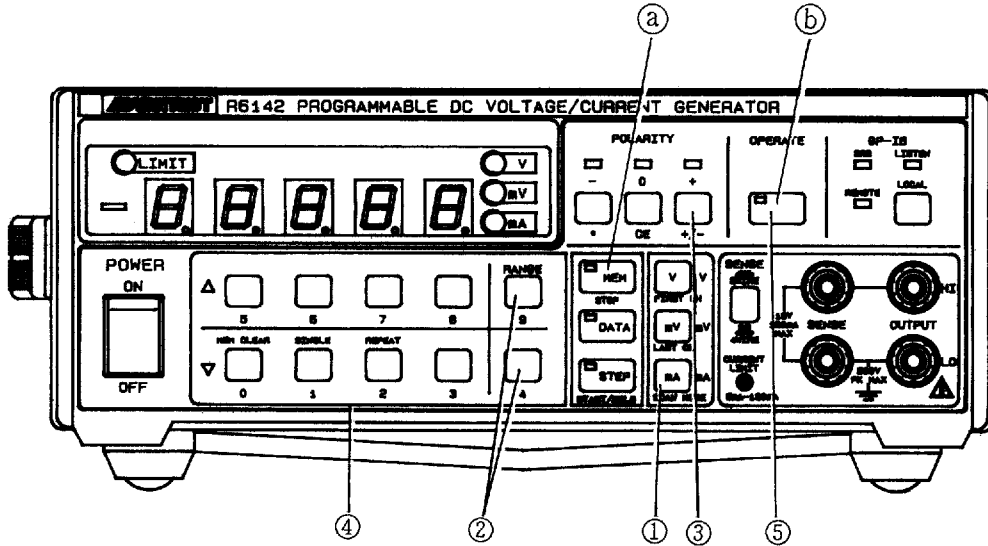
Procedure

Continuous operation	Direct operation
<p>① Press <input type="button" value="V"/> to select voltage generation.</p> <p>RANGE</p> <p>② Press <input type="button" value="RANGE"/> and set the voltage range to 10 V. (Decimal point: 4th digit from right; unit: V)</p> <p>③ Press <input type="button" value="+"/> to set polarity to "positive."</p> <p>④ Press <input type="button" value="▲"/> <input type="button" value="▼"/> <input type="button" value="RANGE"/> to set voltage to 11.999 V.</p> <p>OPERATE</p> <p>⑤ Press <input type="button" value="OPERATE"/> to turn the output ON.</p>	<p>③ Press <input type="button" value="DATA"/> <input type="button" value="1"/> <input type="button" value="1"/> <input type="button" value="."/> <input type="button" value="9"/> <input type="button" value="9"/> <input type="button" value="9"/> <input type="button" value="V"/>.</p> <p>⑤ Press <input type="button" value="OPERATE"/> to turn the output ON.</p>

R6142
PROGRAMMABLE DC VOLTAGE/CURRENT GENERATOR
INSTRUCTION MANUAL

3.3 Examples of Basic Operation

3.3.2 Generating 16 Milliamperes DC




Procedure

Continuous operation	Direct operation
<p>① Press mA to select current generation.</p> <p style="text-align: center;">RANGE</p> <p>② Press □ and set the current range to 10 mA. (Decimal point: 4th digit from right)</p> <p>③ Press + to set polarity to "positive."</p> <p>④ Press △ ▽ □ to set current to 11.999 mA.</p> <p style="text-align: center;">OPERATE</p> <p>⑤ Press □ to turn the output ON.</p>	<p>② Press DATA □ □ □ □ □ □ □ mA.</p> <p style="text-align: center;">OPERATE</p> <p>⑤ Press □ to turn the output ON.</p>

3.4 Connection with Load

3.4.1 How to Use Four Output Terminals

The R6142 has four output terminals, two OUTPUT terminals (positive (red) and negative (black)) and two SENSE terminals (positive (red) and negative (black)). Usually, the OUTPUT and SENSE terminals of the same polarity are short-circuited with the SENSE switch ( 2WIRE).




When a voltage range (1 V or 10 V) is used and the load current is high because of a long distance between the R6142 and the load, set the SENSE switch to  4WIRE for four-wire connection.

Figure 3-2 shows the equivalent circuits of two-wire connection ( 2WIRE) and four-wire connection ( 4WIRE).

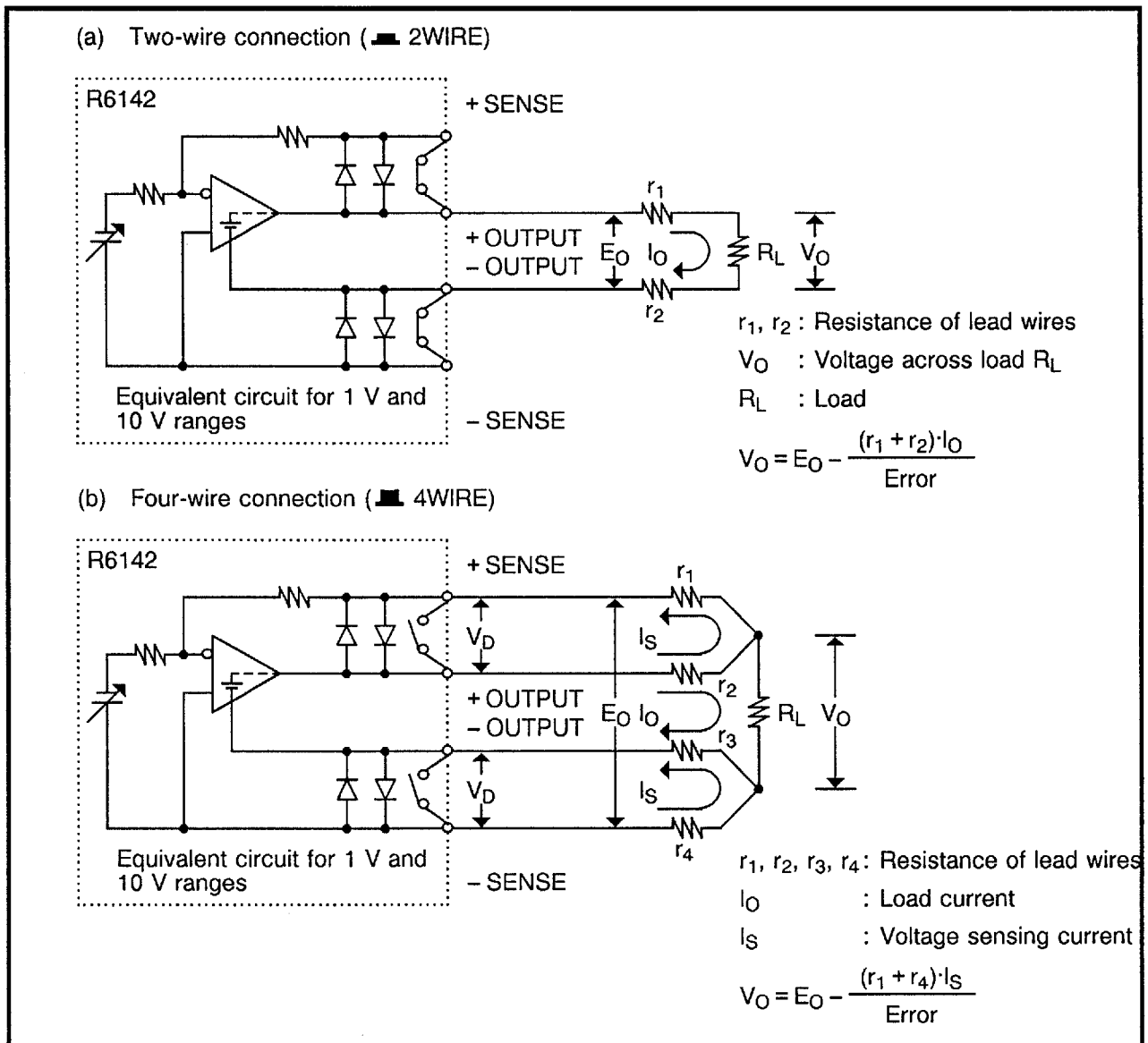


Figure 3-2 Equivalent Circuits

R6142
PROGRAMMABLE DC VOLTAGE/CURRENT GENERATOR
INSTRUCTION MANUAL

3.4 Connection with Load

In the equivalent circuits, the polarity of the R6142 is set to positive.

The voltage sensing current (I_S) is about 160 microamperes at full scale. If the load current (I_O) is smaller than the voltage sensing current, the two-wire connection (the SENSE switch is set to **2WIRE** to short-circuit the OUTPUT and SENSE terminals of the same polarity) will provide a higher output accuracy. For example, when a high-impedance load, such as a digital multimeter (DDM), is connected to the R6142, use the two-wire connection.

If the load current is greater than the voltage sensing current, use the four-wire connection (the OUTPUT and SENSE terminals are connected at the load). Table 3-3 lists resistances of cables connected to the SENSE terminals and associated errors, and Table 3-4, lists cable resistances per meter.

CAUTION

1. In Figure 3-2, $V_O = E_O - (r_1 + R_4) I_S$ is satisfied only when V_D does not exceed 0.3 V.
2. If V_D exceeds 0.3 V, the output accuracy is not guaranteed. When a cable is disconnected from the OUTPUT and SENSE terminals, V_D increases to about 0.6 V to protect the R6142.

Table 3-3 Error Caused by Cable Resistance in Four-Wire Connection

Range	Resistance of r_1 and r_4	Error
1 V	1 Ω	0.03%
10 V	10 Ω	0.03%

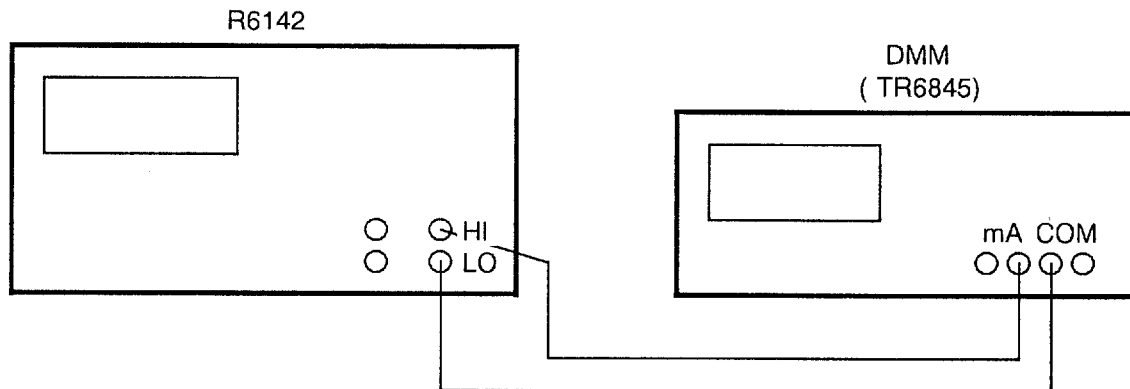
Table 3-4 Cable Resistance Per Meter

Nominal cross section	Conductor resistance
0.08 mm ²	Approx. 270 m Ω /m
0.2 mm ²	Approx. 100 m Ω /m
0.3 mm ²	Approx. 62 m Ω /m
0.5 mm ²	Approx. 37 m Ω /m

3.5 How to Use Limiters

3.5.1 Setting Current Limiter and Setting Range

Connection diagram for current limiter setting



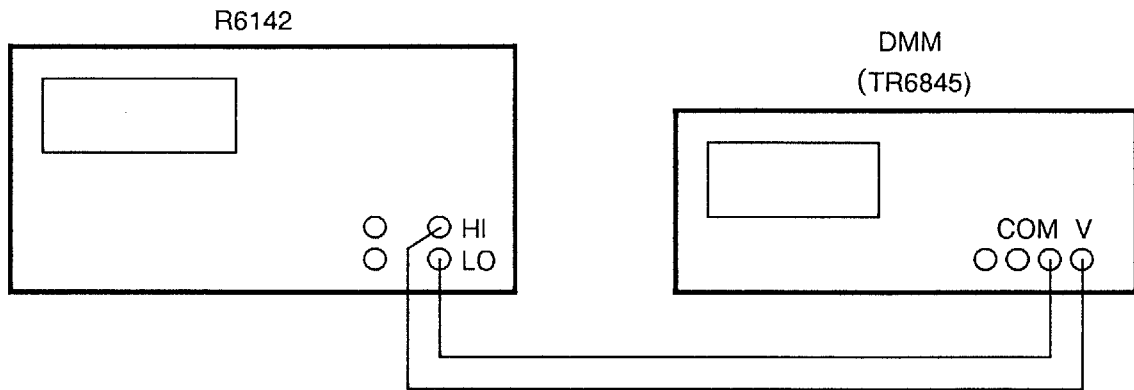
- Setting of the R6142 : 10 V range
11.999 V
OPERATE ON
- Setting of DMM : $\overline{\text{mA}}$ DC (DC current measurement)
300 mA range
- Current limiter setting : Turn the CURRENT LIMIT control on the front panel until the measurement on the DMM matches the set value on the current limiter.
- Setting range of current limiter : 5 mA to 120 mA

CAUTION

The current limiter is effective when the R6142 is in the source mode. When the R6142 is in the sink mode, the current limit value cannot be adjusted because it is fixed to 100 mA.

3.5.2 Setting Voltage Limiter and Setting Range

Connection diagram for voltage limiter setting



- | | |
|----------------------------------|---|
| Setting of the R6142 | : 100 mA range
119.99 mA
OPERATE ON |
| Setting of DMM | : $\overline{\text{---}}$ V DC (DC voltage measurement)
30 V range |
| Voltage limiter setting | : Turn the LIMIT V control on the rear panel until the measurement on the DMM matches the set value on the voltage limiter. |
| Setting range of voltage limiter | : 1 V to 10 V |

3.6 Settling Time

The settling time (response time) is the time interval, following the setting of a certain voltage (current), required for voltage (current) to reach the set value. The R6142 takes no more than 50 milliseconds to attain 0.1% of the full-scale value for a change from zero to the full-scale value.

When remote control is to be used, this settling time should be allowed for.

Figure 3-3 shows the settling time for a change from zero to the full-scale value, or for a change of one-tenth the full-scale value from a set value.

In the figure, time should be read along the axis of abscissa, and for a change in percentage along the axis of ordinate.

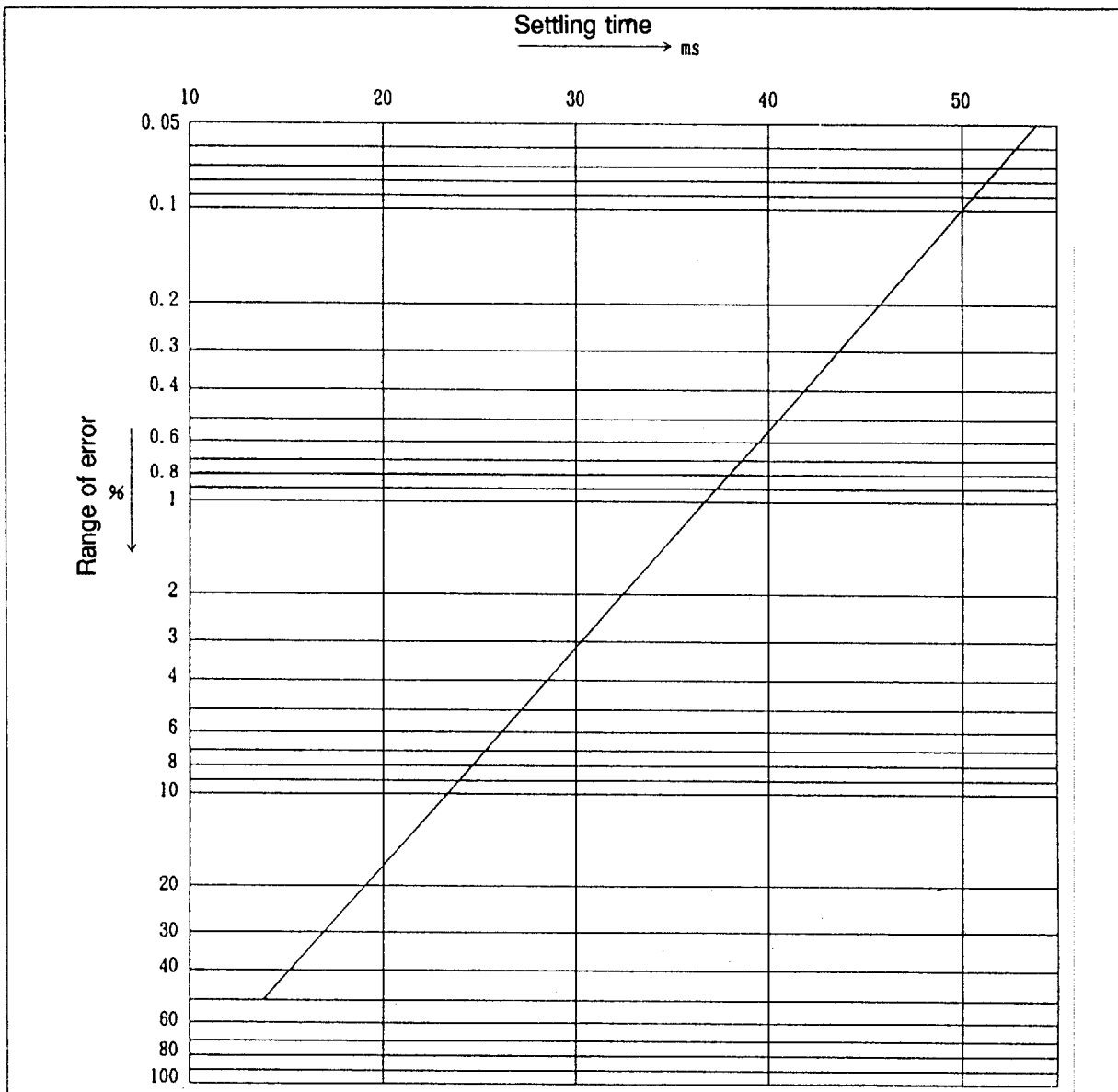


Figure 3-3 Settling Time

3.7 Prevention of Oscillation Caused by Inductance Load

When the R6142 is used as a current source, oscillation may occur if the inductance of a load exceeds the maximum load inductance. In such a case, insert a resistor of 10 ohms to 1 kilohm in series with the load to prevent oscillation.

3.8 Source and Sink Operation

The output from the R6142 is unipolar. When operating as a voltage source, the R6142 can supply current to and draw from a load.

Supplying current to a load is called source operation, and drawing current from a load is called sink operation. Figure 3-4 shows the zones of source and sink operations.

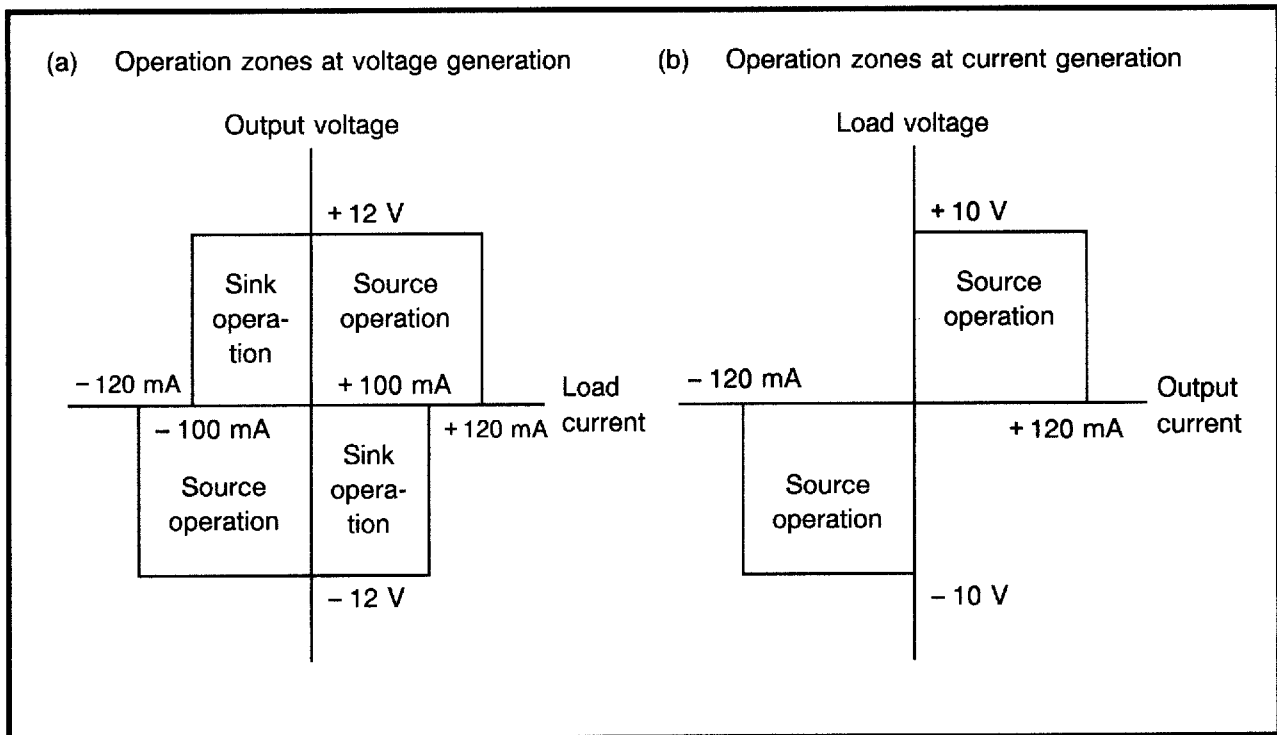


Figure 3-4 Operation Zones

Figure 3-5 gives an example of sink operation.

CAUTION

Do not apply external voltages to the output terminal when using 10 and 100mV ranges. The overcurrent protection circuit cannot be used since a 2 ohm resistor(0.75W) is connected between the output terminals.

R6142
PROGRAMMABLE DC VOLTAGE/CURRENT GENERATOR
INSTRUCTION MANUAL

3.8 Source and Sink Operation

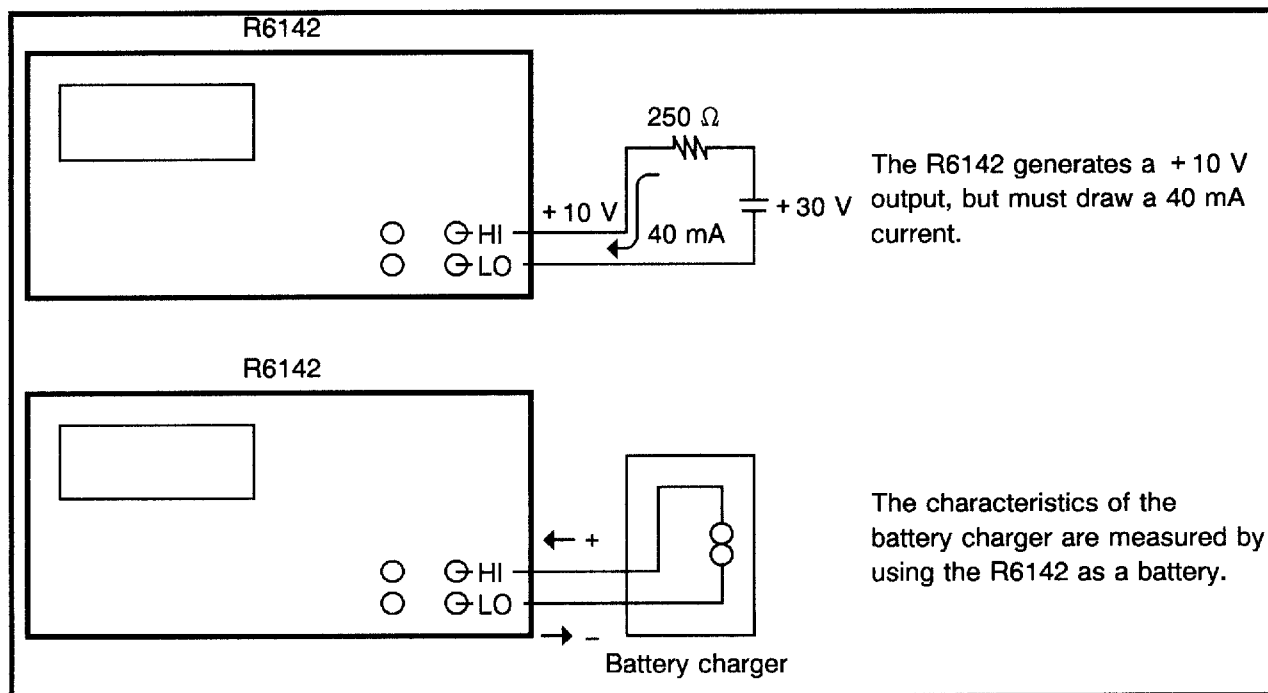


Figure 3-5 Example of Sink Operation

CAUTION

When applying external voltages, do not apply voltages which exceed the following maximum voltages between the terminals, or, this instrument can be damaged.

1. For ranges of 1 V to 10 V
For positive polarity (+) output voltage : Between -0.5 V peak and +32 V peak
For negative polarity (-) output voltage : Between +0.5V peak and -32 V peak
2. For ranges of 10 mV to 100 mV
Regardless of output voltage polarity : Between -0.5 V peak and +0.5 V peak

3.9 Turning Output ON/OFF

3.9.1 Automatically Turning Output ON at Power ON

The R6142 has an operate hold function which automatically turn the output ON after recovery from a power failure for a long-hour test and a test system without a host computer.

Set the OPR HOLD switch on the rear panel to the ON position for automatic return to the output ON state at recovery from a power failure.




—CAUTION—

1. When the power is turned ON again after a power failure has occurred or the POWER switch has been turned OFF in the output ON state, the output is automatically turned ON if the OPR HOLD switch is set to the ON position.
2. To prevent the output from being automatically turned ON at power ON, set the OPR HOLD switch to the OFF position before turning the power ON, or press the OPERATE key while the OPERATE lamp is blinking after the power has been turned ON. (See Section 3.1 "Turning Power ON.")

3.9.2 Turning Output ON or OFF

Table 3-5 shows how to turn output ON or OFF.

Table 3-5 Turning Output ON or OFF

Item	Turning output ON	Turning output OFF
OPERATE 	Turn on the  LED.	Turn off the  LED.
Program code	E	H.C
Power ON/OFF	Turn the POWER switch ON. (If the power has gone OFF in the operate ON state and the OPR HOLD switch is in the ON position)	Turn the POWER switch ON. (If the OPR HOLD switch is in the OFF position or if the power has gone OFF in the operate OFF state)
Others		Change the function from voltage generation to current generation, or from current generation to voltage generation.

3.9.3 Output ON/OFF Timing

Figure 3-6 is the timing chart of output ON/OFF initiated by the OPERATE key operation and a program code.

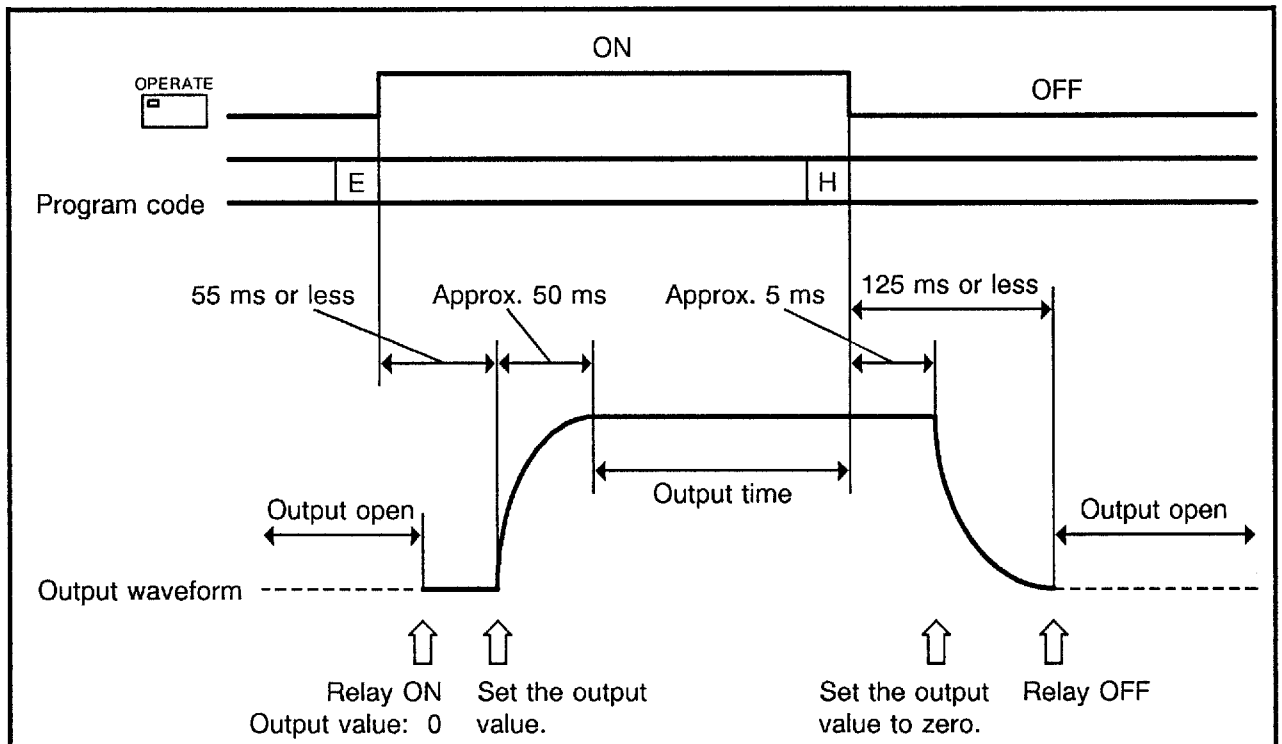



Figure 3-6 Output ON/OFF Timing

3.10 Changing the Function from Voltage Generation to Current Generation, or from Current Generation to Voltage Generation

If the range (function) is changed from voltage generation to current generation or from current generation to voltage generation, the output goes OFF. After changing the function, be sure to turn the output ON. (See Section 2.1  "V, mV, and mA keys.")

See Section 3.9.3 "Output ON/OFF timing" for the timing for the output to go OFF.

3.11 Changing Voltage/Current Range

3.11.1 Timing of Range Switching

If range switching is initiated, the range changes with the output being zero. Then, the output is generated at a specified level.

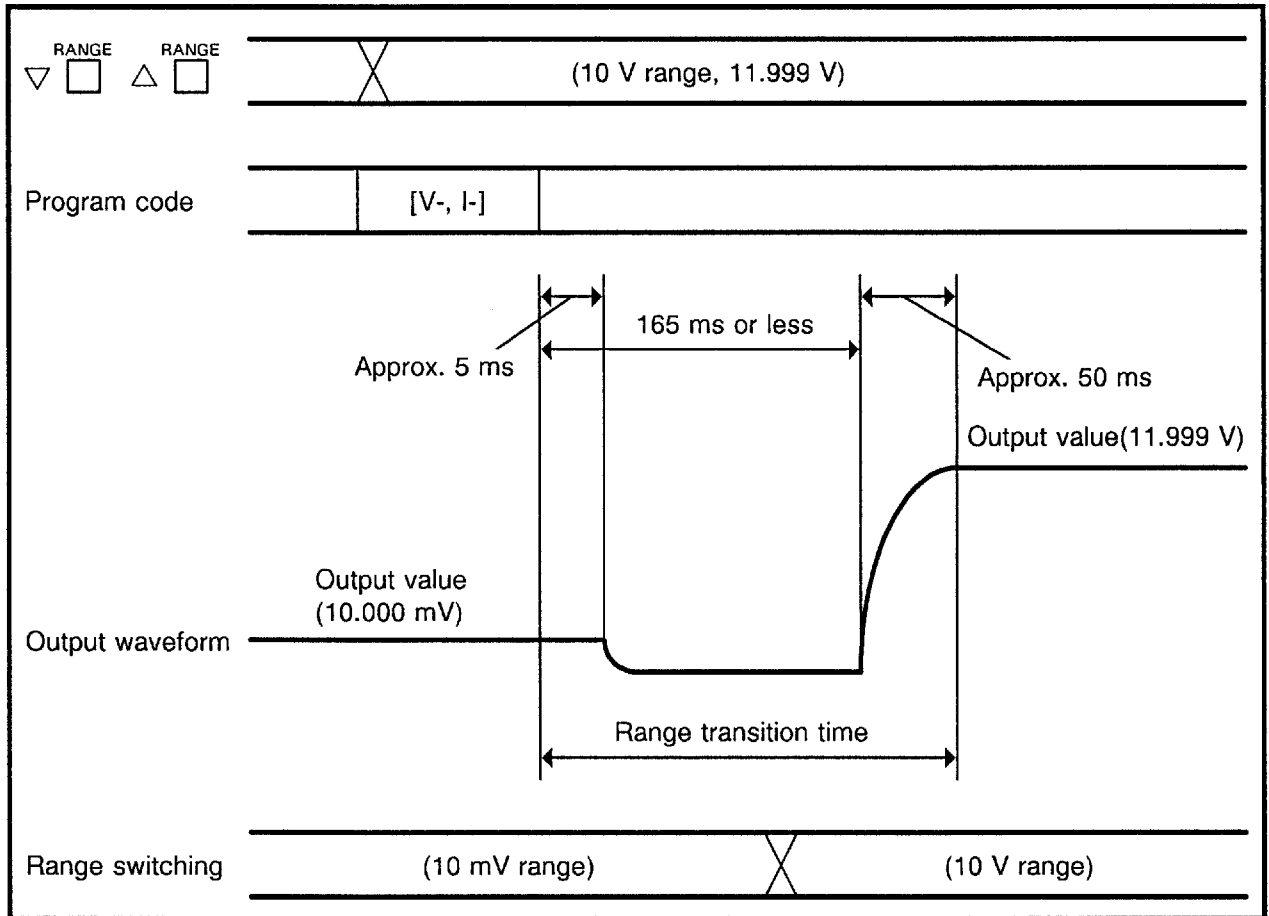


Figure 3-7 Timing of Range Switching

3.12 How to Use the Memory

3.12.1 Storing Data in the Memory

The memory of the R6142 can contain 160 data on output levels and ranges (including functions), which can be recalled. How to store the data in the memory is illustrated below.

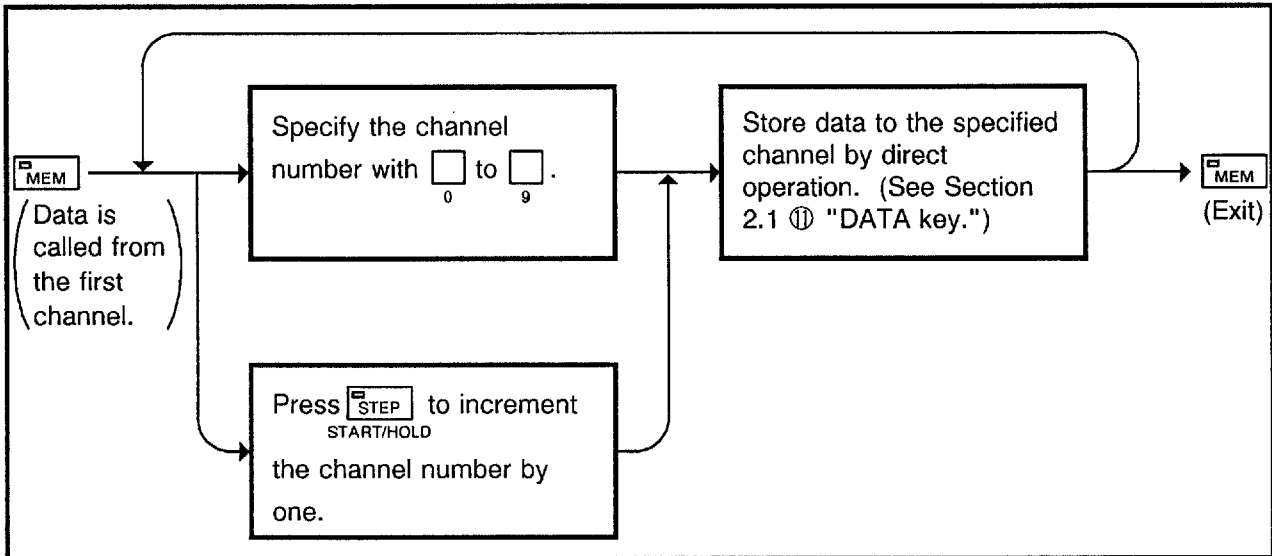


Figure 3-8 Key Operation Flow to Store Data in the Memory

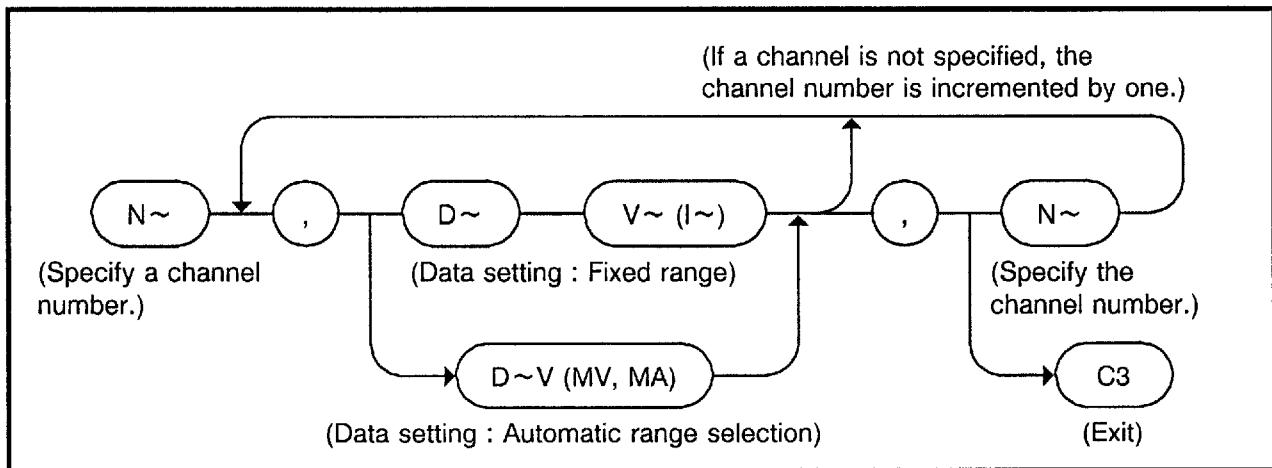


Figure 3-9 Program Code Operation Flow to Store Data in the Memory

3.12.2 Recalling Stored Data from the Memory

The stored data can be recalled from the memory in the following three modes.

Recall mode	Description	Remarks
Step	Specify the channel number one by one or increment the channel number one by one to recall the stored data.	See (1)
Single scan	The first through last channels are scanned at a specified step time to recall the stored data.	See (2)
Repeated scan	The first through last channel are repeatedly scanned to recall the stored data.	See (3)

(1) Step mode

The data is recalled from the memory channel by channel. Figure 3-10 shows the operation flow in the step mode.

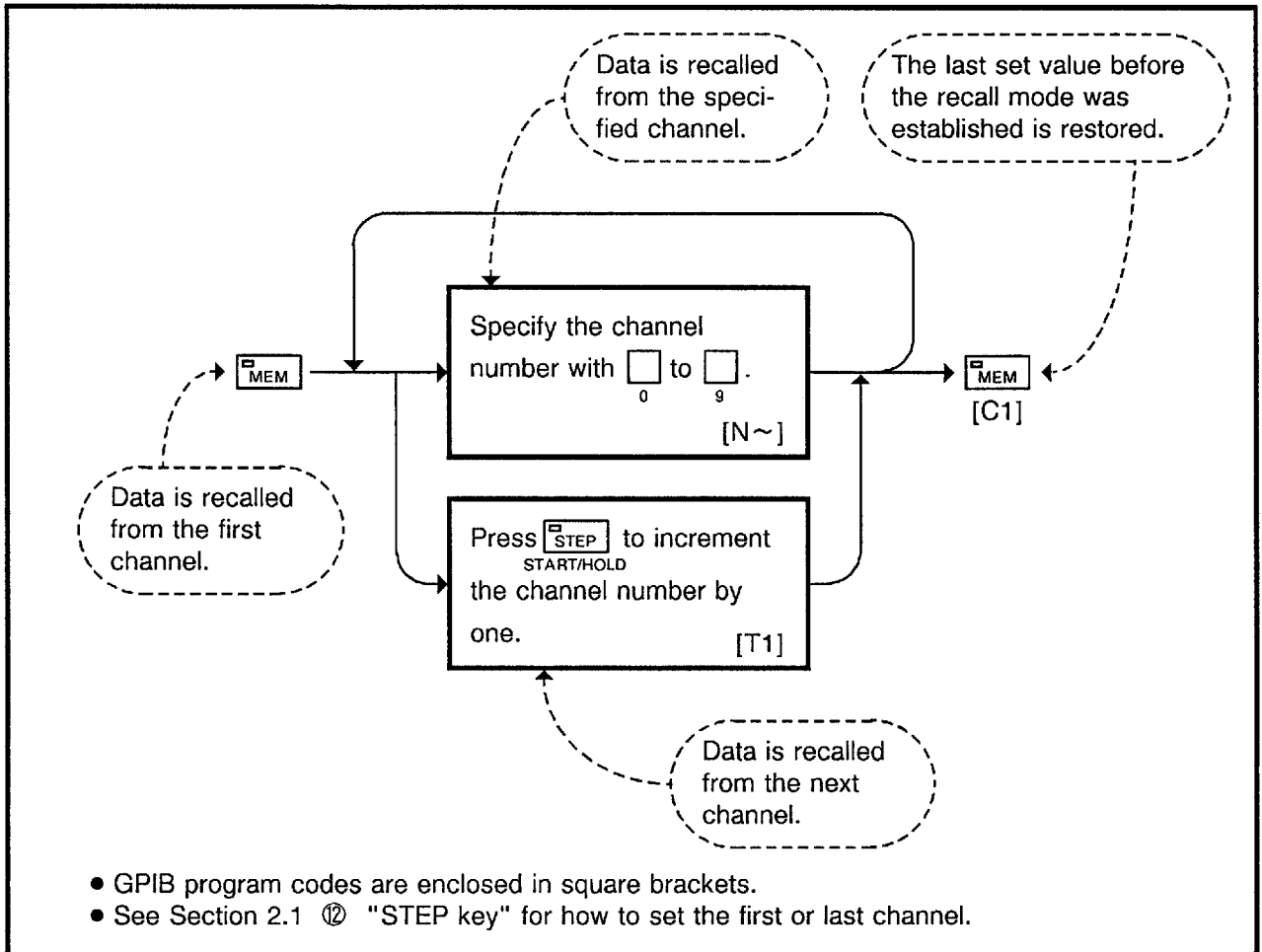


Figure 3-10 Operation Flow in the Step Mode

(2) Single scan mode

The first through last channels are scanned at a specified step time to automatically recall the stored data. Figure 3-11 shows the operation flow in the single scan mode.

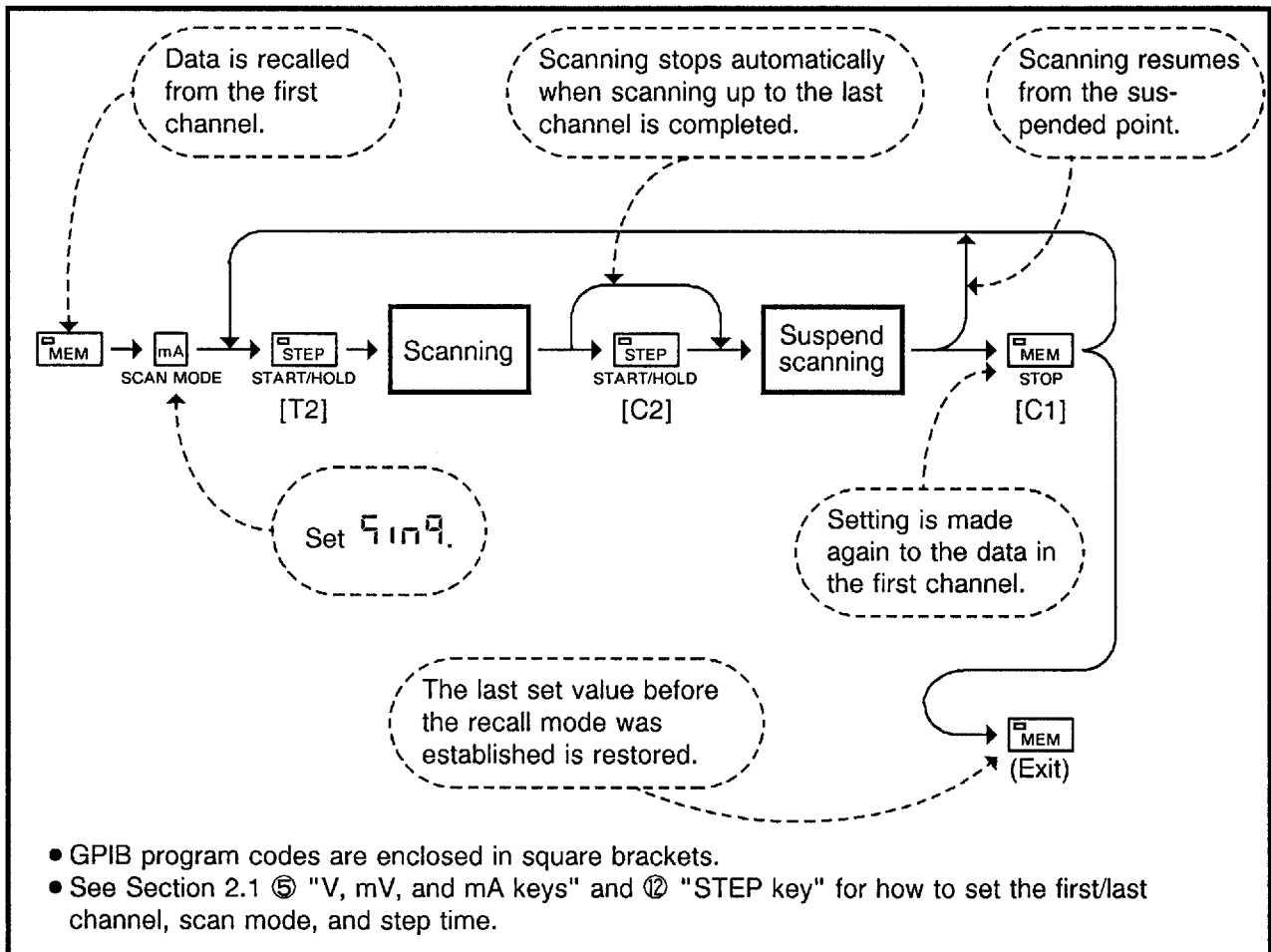


Figure 3-11 Operation Flow in the Single Scan Mode

(3) Repeated scan mode

The first through last channels are repeatedly scanned at a specified step time to automatically recall the stored data. Figure 3-12 shows the operation flow in the repeated scan mode.

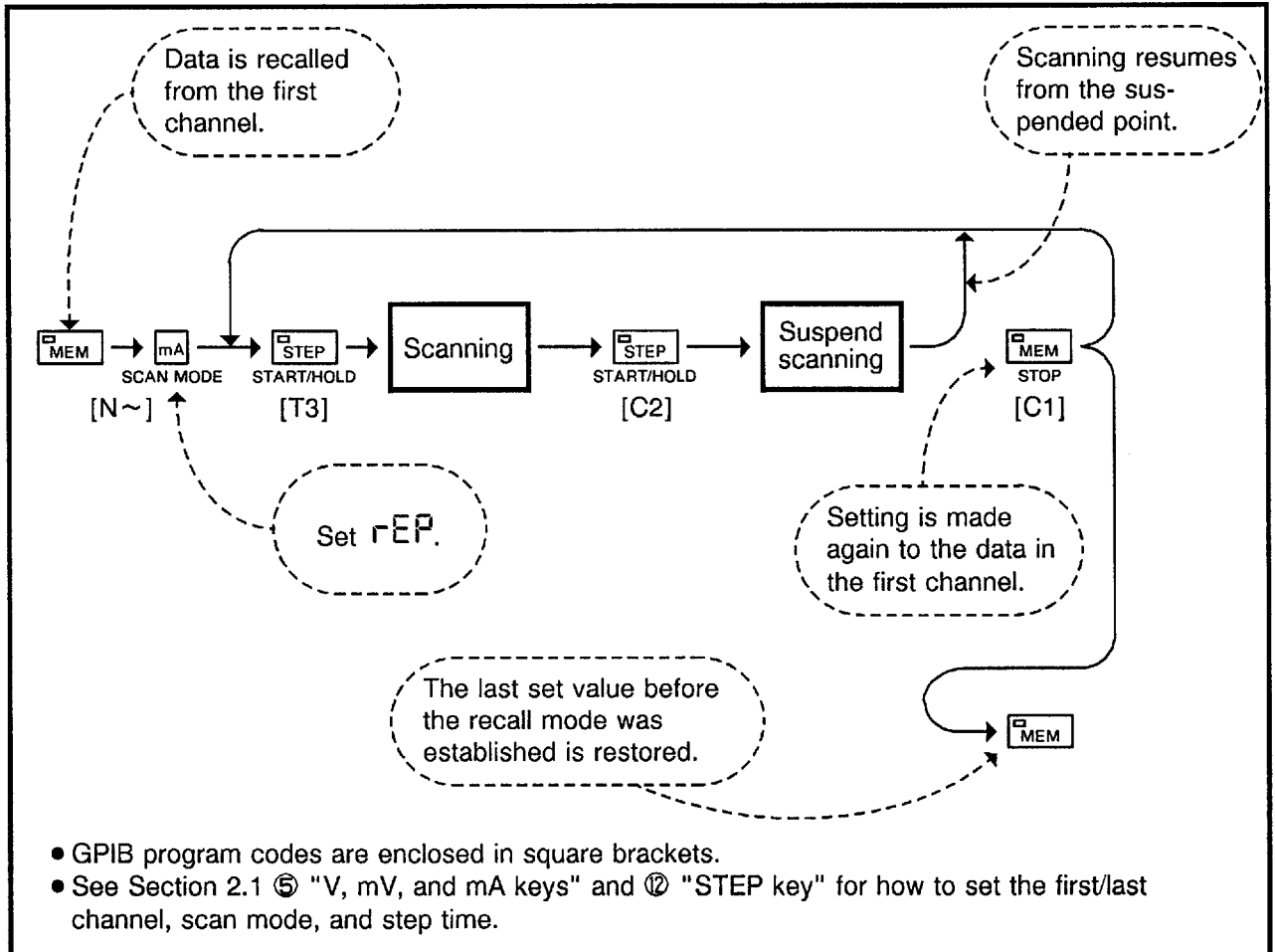


Figure 3-12 Operation Flow in the Repeated Scan Mode

3.13 Sweep Function

3.13.1 Start/Stop Sweep

The R6142 has a sweep function to continuously increment or decrement, at a specified step time, a number in each digit position of an output level for setting. Figure 3-13 shows the sweep operation flow.

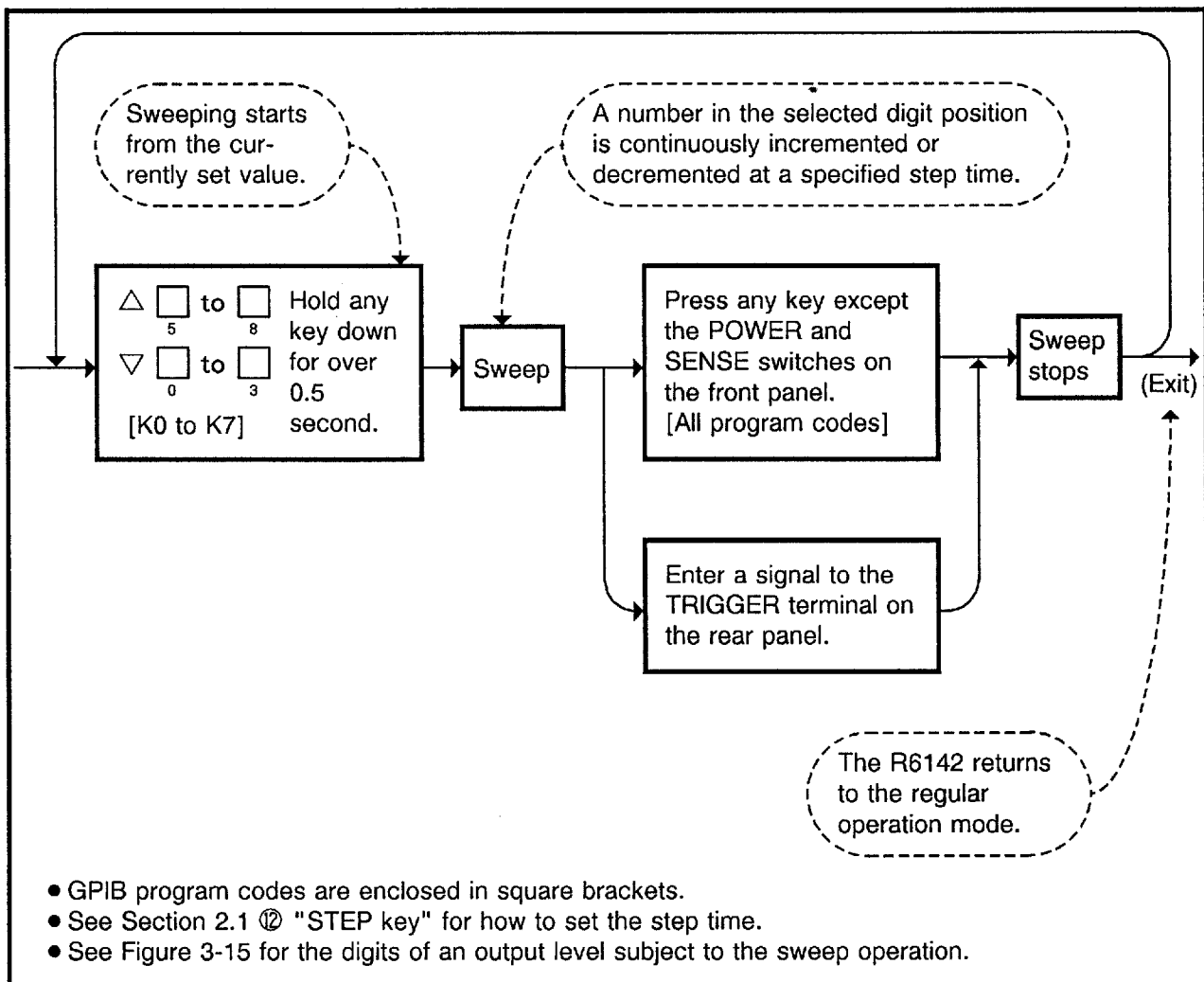


Figure 3-13 Sweep Operation Flow

R6142
PROGRAMMABLE DC VOLTAGE/CURRENT GENERATOR
INSTRUCTION MANUAL

3.13 Sweep Function

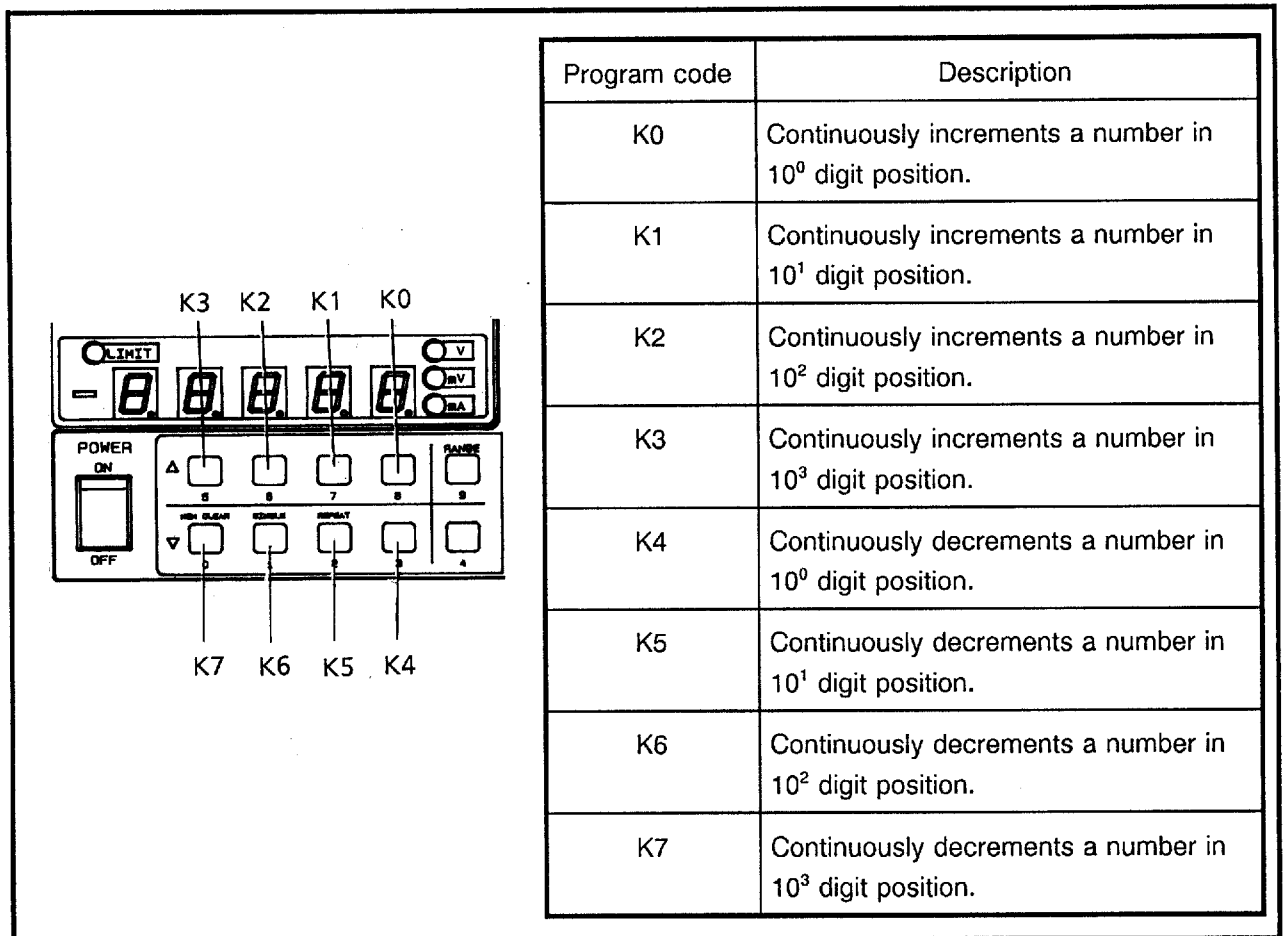


Figure 3-14 Sweep Operation for the Digits of Output Level

4. GPIB INTERFACE AND PROGRAMMING

The GPIB interface, provided as standard, enables the R6142 to be connected to a general purpose interface bus (GPIB); IEEE Standard 488-1978.

This chapter explains the specifications and functions of the GPIB interface, and programming.

4.1 GPIB Outline

The GPIB is an interface system that uses simple passive cabling (bus line) between the components of an instrumentation system, including a controller and its peripheral equipment. The GPIB is much easier to use than conventional interface systems and includes a greater expansion capacity. Since it has electrical, mechanical, and functional compatibility with other suppliers' instruments, a wide variety of systems can be built, from relatively simple systems to high-performance automatic instrumentation systems, just using a bus cable.

In a GPIB system, the "address" of individual components connected to the bus should be first set. Each of these devices may be a controller, talker, or listener, or two of the three functions at one time. During system operation, only one talker can send data over the bus and multiple listeners can receive the data. The controller designates the talker and listener addresses to cause the talker to transfer data to the listener. The controller can designate itself as a talker to transfer measurement conditions or other information to a listener.

The GPIB transfers data between the components of an instrumentation system on eight bit-parallel, byte-serial, bidirectional data lines. Data is transferred asynchronously. Because of the asynchronous nature of the bus, high-speed and low-speed devices can be mixed on the bus.

Data (messages) transferred over the bus include measurement data, measurement conditions (program), and commands. All the information uses ASCII code.

In addition to the eight data lines, the GPIB also includes three handshake lines to control asynchronous data transfer between components, and five control lines to control data flow on the bus.

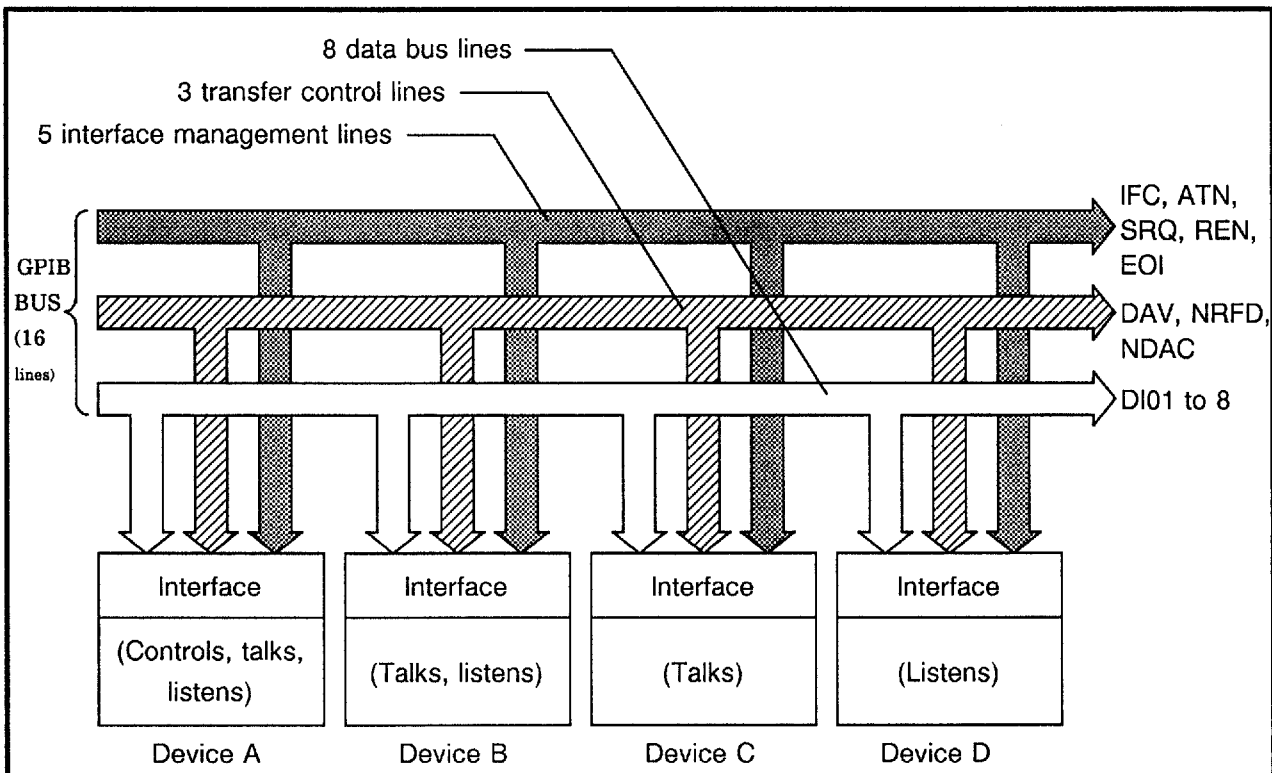


Figure 4-1 GPIB Configuration

- The handshake lines use the following signals:
 - DAV (Data Valid) : Indicates data validity.
 - NRFD (Not Ready For Data) : Indicates data receive ready.
 - NDAC (Not Data Accepted) : Indicates the completion of data reception

- The control lines use the following signals:
 - ATN (Attention) : Used to determine whether the information on the data lines is an address/command or other information.
 - IFC (Interface Clear) : Clears the interface.
 - EOI (End or Identify) : Used to identify the end of data transfer.
 - SRQ (Service Request) : Used by any device to request service from the controller.
 - REN (Remote Enable) : Used to remotely control a remote programmable device.

4.2 Specifications

4.2.1 GPIB Specifications

- Standard : IEEE Standard 488-1978
- Code : ASCII, binary code for packed format
- Logical level : Logical 0 : High, +2.4 V or more
Logical 1 : Low, +0.4 V or less
- Signal termination : The 16 bus lines are terminated as follows:

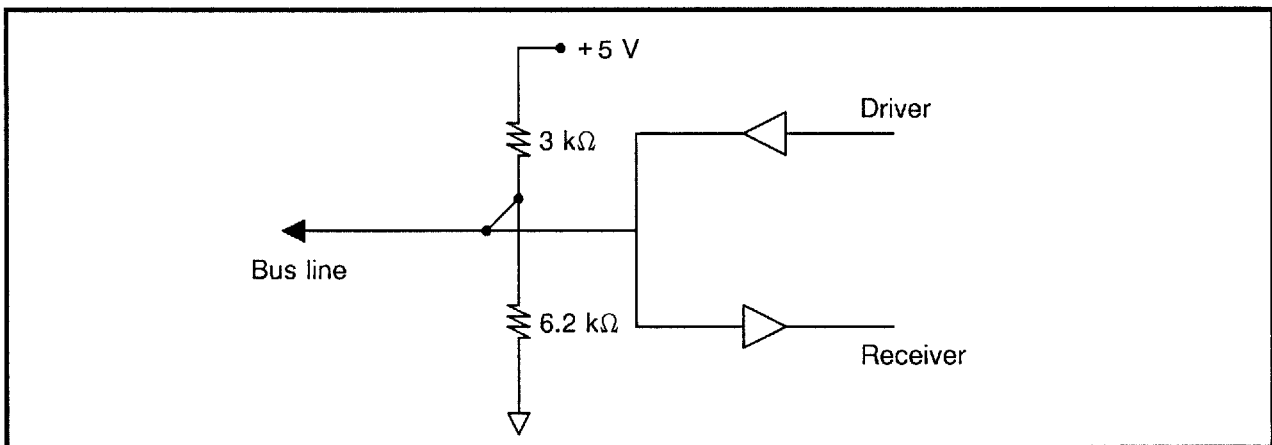


Figure 4-2 Signal Termination

- Driver : Open collector
Output voltage for Low : +0.4 V or less, 48 mA
Output voltage for High : -2.4 V or more, -5.2 mA
- Receiver : Low at +0.6 V or less
High at +2.0 V or over
- Bus cable length : The length of cable between devices cannot exceed 4 meters. The total transmission length of the bus cannot exceed 2 meters times the number of connected devices, or 20 meters, whichever is less.
- Address assignment : Up to 31 talker and listener addresses can be assigned by key operation from the front panel.
- Connector : 24-pin GPIB connector
57-20240-D35A (Amphenol) or equivalent

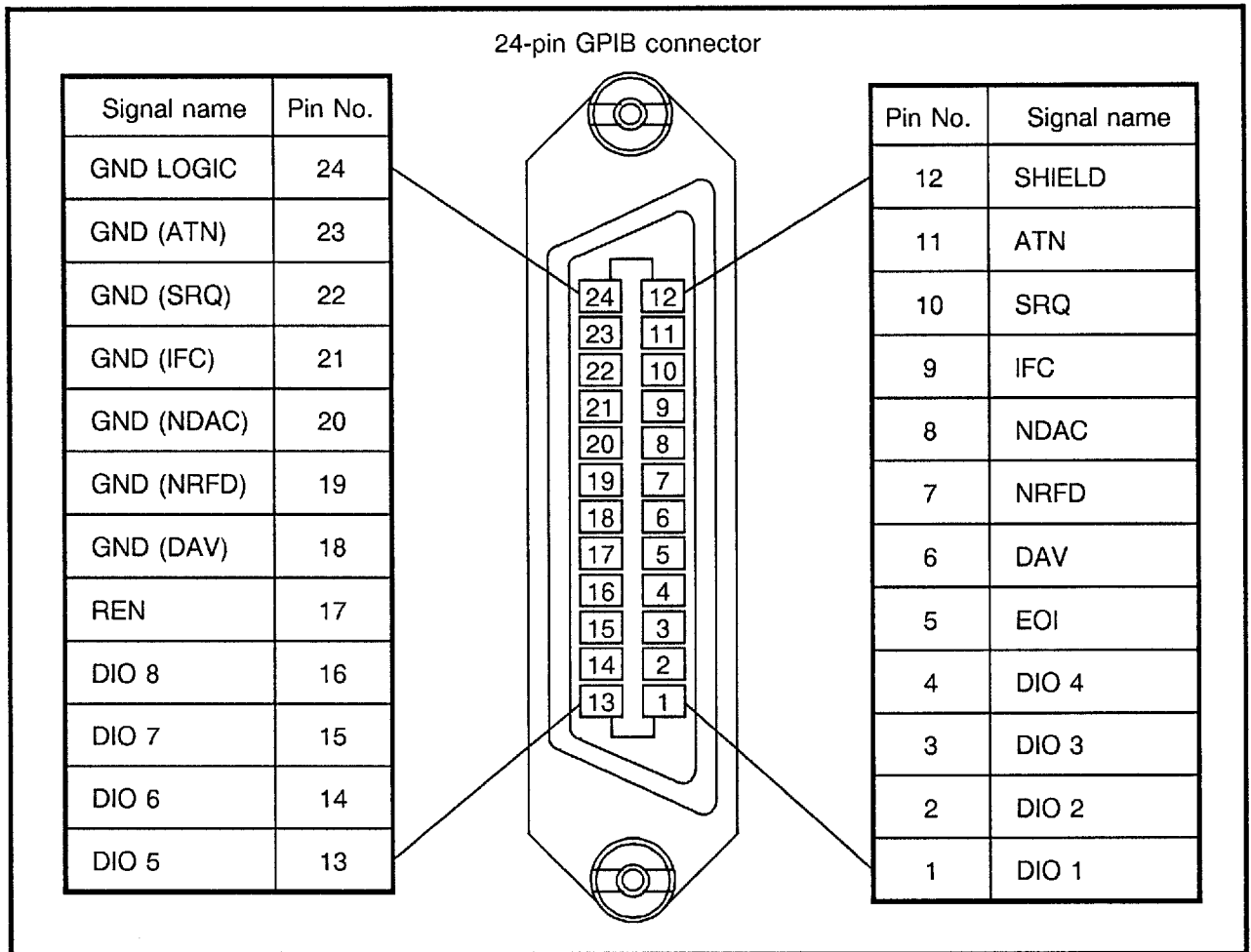


Figure 4-3 GPIB Connector Pin Configuration

4.2.2 Interface Functions

Table 4-1 Interface Functions

Code	Function and description
SH1	Source handshake
AH1	Acceptor handshake
T6	Basic talker, Unaddressed to talk if addressed to listen, Serial poll
L3	Basic listener, Listen only mode, Unaddressed to listen if addressed to talk
SR1	Service request
RL1	Remote-local selection
PP0	No parallel poll function
DC1	Device clear (SDC and DCL commands are available)
DT1	Device trigger (GET command is available)
C0	No controller function
E1	The open-collector bus driver is used. EOI and DAV, however, uses a three-state bus driver.

4.3 Connection with Component Devices

Since a GPIB system accommodates multiple device, exercise the following care when configuring the system.

- (1) Before connecting devices and a controller and its peripheral equipment, check their conditions and operation in accordance with their manuals.
- (2) Bus cables connected to instruments and the controller should be minimized in length. The length of cable between device cannot exceed 4 meters. The total transmission length of the bus cannot exceed 2 meters times the number of connected devices, or 20 meters, whichever is less. Table 4-2 lists the standard bus cables that Advantest supplies.
- (3) The bus cable connector is the piggyback type, providing both male and female connectors. Do not connect bus cables with three or more connectors being put on another. Tighten connector clamp screws for secure connection.
- (4) Before turning on devices that are connected to the bus, check their power conditions, grounding, and setting.
Turn ON the power switches of all component devices. If there is a device whose power switch is not turned on, the system cannot be guaranteed to operate properly.

Table 4-2 Standard Bus Cables (Option)

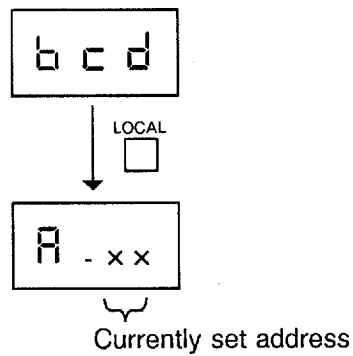
Length	Name
0.5 m	408JE-1P5
1 m	408JE-101
2 m	408JE-102
4 m	408JE-104

4.4 Selecting the GPIB Interface

The R6142 has both a GPIB interface and a BCD parallel interface as standard. Use either one. How to select the GPIB interface is described below. (See Section 5.3 for how to select the BCD parallel interface.)

Procedure

- ① Press LOCAL.
- ② Press LOCAL again to select "R - x x."



- ③ Press to return to the regular operation mode.

4.5 Addressing and Selecting the Listen Only Mode

The GPIB talk/listen can be addressed and the listen only mode can be selected by key operation from the front panel. Table 4-3 lists 31 addresses in decimal code for selection.

Table 4-3 Addressing

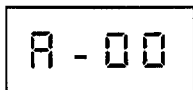
Lower two digits (Decimal code)	ASCII code	
	Listen	Talk
0	SP	@
1	!	A
2	"	B
3	#	C
4	\$	D
5	%	E
6	&	F
7	'	G
8	(H
9)	I
10	*	J
11	+	K
12	,	L
13	-	M
14	.	N
15	/	O
16	0	P
17	1	Q
18	2	R
19	3	S
20	4	T
21	5	U
22	6	V
23	7	W
24	8	X
25	9	Y
26	:	Z
27	;	[
28	<	/
29	=]
30	>	~

R6142
PROGRAMMABLE DC VOLTAGE/CURRENT GENERATOR
INSTRUCTION MANUAL

4.5 Addressing and Selecting the Listen Only Mode

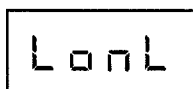
Procedure

- ① Press and . The following display will appear.



Specify these digits to select an address.

- ② Specify the address with numeric keys to .
- ③ To select the listen only mode, specify 31 or greater for the address. After about 700 milliseconds, the following display will appear, indicating that the listen only mode has been established.



- ④ Press to exit the address setting procedure.

CAUTION

1. In the listen only mode, do not use the controller.
2. One program code line can contain up to 128 characters excluding space.
3. Hold the REN line low for five milliseconds or more after a program code has been transmitted.

4.6 Programming Examples

This section gives examples of programming on the HP200 Series Hewlett-Packard. If an other controller is to be used, "wait" in "Program description" should be changed to the proper value.

4.6.1 DC Voltage Generation

A sample program to generate a DC voltage is given below.

Output voltage : 5 V (automatic range selection mode)

(1) Sample program (TR6142/R6142/R6144 common)

HP200 Series as controller

```
10      !      * * * * * * * * * * * *
20      !      *
30      !      *      DC 5V OUTPUT      *
40      !      *
50      !      * * * * * * * * * * * *
60      !
70      !
80      ABORT 7
90      REMOTE 7
100     !
110     R6144=701
120     CLEAR R6144
130     !
140     OUTPUT R6144;"D5V"
150     OUTPUT R6144;"E"
160     WAIT 5
170     OUTPUT R6144;"H"
180     WAIT 1
190     LOCAL 7
200     END
```

(2) Program description

Line No.	Description
80	Interface clear
90	Remote enable
100	Comment
110	Assign address 1 to the R6142.
120	Initialize the device with the GPIB interface.
130	Comment
140	Set the output value from the R6142. D5V ... 5 V at the 10 V range (automatic range selection)
150	Turn ON the output from the R6142.
160	Hold the output ON for several seconds.
170	Turn OFF the output from the R6142.
180	Wait and maintain the remote mode.
190	Release the R6142 from the remote mode.
200	Program end

4.6.2 Sweep Operation

This section gives a sample program to display the operating voltage of a relay by continuously changing voltage and using the service request function.

Starting value : 1,000 V

Unit of change : 0.001 V

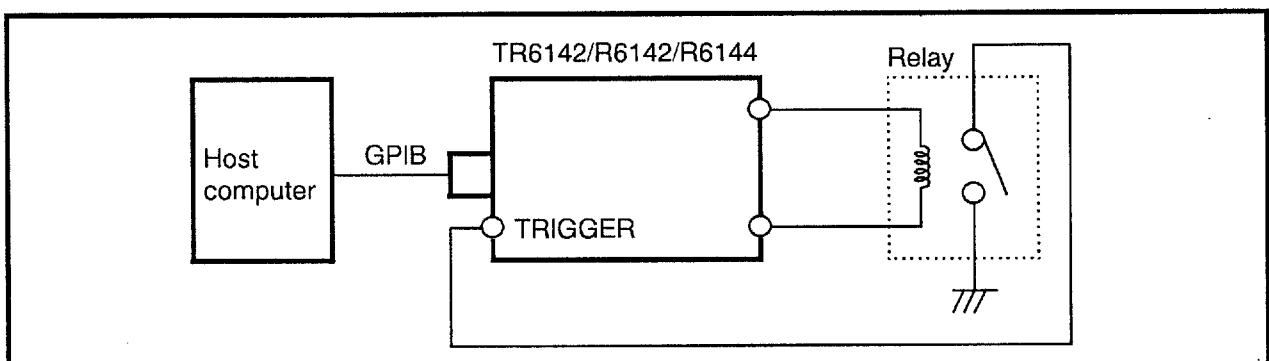


Figure 4-4 Connection Diagram for Sweep Operation

R6142
PROGRAMMABLE DC VOLTAGE/CURRENT GENERATOR
INSTRUCTION MANUAL

4.6 Programming Examples

(1) Sample program (TR6142/R6142/R6144 common)

HP200 Series as controller

```

100 !*****
110 !*****
120 !*****
130 !***** RELAY SET LEVEL TEST *****
140 !***** SAMPLE PROGRAM *****
150 !*****
160 !*****
170 !*****
180 !
190 !
200 ABORT 7
210 REMOTE 7
220 !
230 !
240 DISABLE INTR 7
250 ON INTR 7 GOSUB Onsrq
260 !
270 Flag=0
280 R6144=701
290 CLEAR R6144
300 OUTPUT R6144;"C,SI05,V5,E"
310 OUTPUT R6144;"S"
320 St00: !
330 OUTPUT R6144;"D1"
340 OUTPUT R6144;"KO"
350 ENABLE INTR 7;2
360 !
370 Waitsrq !
380 IF Flag=0 THEN GOTO Waitsrq
390 !
400 BEEP
410 ENTER R6144;D$
420 PRINT D$
430 STOP
440 !
450 !*****
460 !*****
470 !
480 Onsrq: !
490 S=SPOLL<R6144>
500 IF BIT(S,6)=0 THEN GOTO Notsrq
510 IF BIT(S,5)=0 THEN GOTO Nosrq
520 Flag=1
530 GOTO Retsrq
540 !
550 Notsrq: !
560 WAIT .1
570 !
580 !
590 !
600 !
610 !
620 Nosrq: !
630 ENABLE INTR 7
640 !
650 Retsrq: !
660 RETURN
670 !
680 END

```

R6142
PROGRAMMABLE DC VOLTAGE/CURRENT GENERATOR
INSTRUCTION MANUAL

4.6 Programming Examples

(2) Program description

Line No.	Description
100 to 190	Comment
200 210	Interface clear Remote enable
220 230	Comment
240 250	Inhibit the reception of an SRQ. Define a jump to ONSRQ at interruption.
260	Comment
270 280	Initialize the interruption flag to 0. Assign address 1 to the R6142.
290	Initialize the device (R6142) connected to the GPIB interface.
300 310	Initialize the parameters of the R6142. C Initialize SI05 Step time 500 ms V5 10 V range E Output ON S0 Permit the issue of SRQ.
320 330 340 350	Set the output from the R6142 to +1.000 V. Start changing the output from the R6142 in the +1 count mode. Permit the reception of an SRQ.
360 370 380	Loop until an interruption occurs.
390 400 410 420 430	Sounds the buzzer. Read the set values from the memory of the R6142. Display the set values of the R6142 on the screen. End

(Cont'd)

Line No.	Description
440 to 470	Comment
480 490 500 510 520 530	SRQ interrupt subroutine Serial polling Jump to NOTSRQ if there is no interruption source in the R6142. Jump to NOSRQ if the R6142 status byte is set other than TRIGGER IN. Set the interruption flag to 1. Return
550 to 610	Comment The WAIT statement is meaningless for compatibility with the processing time of the PC9801.
620 630 640	NOSRQ routine Permit an SRQ interruption again.
650 660 670	Return to the main program.

4.6.3 Storing Data In and Recalling from the Memory

This section gives a sample program to store in the memory the values of the K thermocouple at an interval of 10 °C over the range from -200 °C to 200 °C. The stored data can be recalled one by one by pressing the STEP key or inputting a signal to the TRIGGER input terminal on the rear panel for the purpose of calibrating or adjusting a thermocouple thermometer.

R6142
PROGRAMMABLE DC VOLTAGE/CURRENT GENERATOR
INSTRUCTION MANUAL

4.6 Programming Examples

(1) Sample program (TR6142/R6142/R6144 common)

HP200 Series as controller

```

100 !*****
110 !*****
120 !*****
130 !***** THERMOCOUPLES THERMOMETER *****
140 !***** CALIBRATION DATA OUT *****
150 !***** SAMPLE PROGRAM *****
160 !*****
170 !*****
180 !*****
190 !
200 !
210 DIM Temp <160> ,Jisdt <160>
220 !
230 ABORT 7
240 REMOTE 7
250 !
260 !
270 R6144=701
280 RESTORE Dtable
290 OUTPUT R6144;"C"
300 !
310 READ Maxch ! DATA VALUE GET
320 OUTPUT R6144;"NO" ! R6144 DATA MEMORY MODE ON
330 FOR I=0 TO Maxch-1 !
340 READ Temp <I> ! TEMPERATURE DATA READ
350 READ Jisdt <I> ! THERMOCOUPLES JIS DATA READ
360 Dd=Jisdt <I> / 1000 ! UV=>MV DATA
370 !
380 OUTPUT R6144;"D";Dd;"MV"
390 PRINT "D";Dd;"MV"
400 NEXT I
410 OUTPUT R6144;"C3"
420 OUTPUT R6144;"SCO,";Maxch-1
430 !
440 WAIT 1
450 LOCAL 7
460 STOP
470 !
480 !
490 !
500 !*****
510 !*****
520 !
530 Dtable: !
540 DATA 41
550 !

```

R6142
PROGRAMMABLE DC VOLTAGE/CURRENT GENERATOR
INSTRUCTION MANUAL

4.6 Programming Examples

(Cont'd)

560	DATA	-200,-5891
570	DATA	-190,-5730
580	DATA	-180,-5550
590	DATA	-170,-5354
600	DATA	-160,-5141
610	DATA	-150,-4912
620	DATA	-140,-4669
630	DATA	-130,-4410
640	DATA	-120,-4138
650	DATA	-110,-3852
660	DATA	-100,-3553
670	DATA	-90,-3242
680	DATA	-80,-2920
690	DATA	-70,-2586
700	DATA	-60,-2243
710	DATA	-50,-1889
720	DATA	-40,-1527
730	DATA	-30,-1156
740	DATA	-20,-777
750	DATA	-10,-392
760	DATA	0,0
770	DATA	10,397
780	DATA	20,798
790	DATA	30,1203
800	DATA	40,1611
810	DATA	50,2022
820	DATA	60,2436
830	DATA	70,2850
840	DATA	80,3266
850	DATA	90,3681
860	DATA	100,4095
870	DATA	110,4508
880	DATA	120,4919
890	DATA	130,5327
900	DATA	140,5733
910	DATA	150,6137
920	DATA	160,6539
930	DATA	170,6939
940	DATA	180,7338
950	DATA	190,7737
960	DATA	200,8137
970	!	
980	END	

R6142
PROGRAMMABLE DC VOLTAGE/CURRENT GENERATOR
INSTRUCTION MANUAL

4.6 Programming Examples

(2) Program description

Line No.	Description
100 to 200	Comment
210 220	Allocate an area to the table of storing the temperature data and JIS standard values of thermocouples.
230 240	Interface clear Remote enable
250 260	Comment
270 280 290 300	Assign address 1 to the R6142. Define the starting address of the data statement. Transfer the C command (initialization command) to the R6142.
310 320 330 340 350 360 370 380 390	Set the number of data items in MAXCH. Transfer the N0 command that initiates the storage of data in the memory of the R6142 from address 0. Store the contents of the table in the memory of the R6142 as specified in MAXCH. Set the temperature data of the R6142 in TEMP(I). Set the thermocouple data (JIS standard data) of the R6142 in JISDT(I). Convert the JIS standard data in the R6142 from μV to mV. Comment Store the data in the memory of the R6142 in the automatic range selection mode.
400 410 420	Turn OFF the memory storage mode with the C3 command. Specify the start and stop channels for scanning.
440 450 460	Wait and maintain the remote mode. Put the R6142 in the local mode. End

R6142
PROGRAMMABLE DC VOLTAGE/CURRENT GENERATOR
INSTRUCTION MANUAL

4.6 Programming Examples

(Cont'd)

Line No.	Description
460 to 510	Comment
520 530 540	Data table (DTABLE) The number of data items
550 to 950	Temperature data, JIS standard (K thermocouple)

R6142
PROGRAMMABLE DC VOLTAGE/CURRENT GENERATOR
INSTRUCTION MANUAL

4.7 Program Code Table

4.7 Program Code Table (TR6142/R6142/R6144)

For how to use program codes, see Section 3.2.1 "Basic Operation Flowchart."

Table 4-4 Program Code Table

Item	Code	Description			State after initialization with C command	Effective command during step operation
		TR6142	R6142	R6144		
Initialization	C C0	Turns the output OFF, interrupts all operations, and initializes the range, output value, block delimiter, and Service Request. The data in the memory is not initialized.				○
Output ON/OFF	E	Brings the device into the operating state (output ON).				○
	H	Brings the device into the standby state (output OFF).			○	○
	E? H?	/	Query on output status, ON or OFF Response : E (output ON) H (output OFF)			○
Function/ range	V2	Voltage generation, 10 mV range				
	V3	Voltage generation, 100 mV range				
	V4	Voltage generation, 1 V range			○	
	V5	Voltage generation, 10 V range				
	V6	/	/	Voltage generation, 30 V range		
	I1	Current generation, 1 mA range				
	I2	Current generation, 10 mA range				
	I3	Current generation, 100 mA range				

R6142
PROGRAMMABLE DC VOLTAGE/CURRENT GENERATOR
INSTRUCTION MANUAL

4.7 Program Code Table

(Cont'd)

Item	Code	Description			State after initialization with C command	Effective command during step operation
		TR6142	R6142	R6144		
	I? V?	/	Query on function/range Response : V2 to V5 or I1 to I3	V2 to V6 or I1 to I3		○
Voltage generation/ current generation	D~	Initial value : D + 0.0000 Fixed-range format : D ± ddddd Automatic-range-selection format : D ± dddddunit See Section 4.8 "Basic Format for Output Voltage/Current Setting."				
	D?	/	Query on voltage generation/current generation See Section 4.9 "Panel Set Value Output from Talker"			○
Block delimiter	DL0	CR, LF, or LF with EOI is output.			○	○
	DL1	LF is output.				○
	DL2	The last character with EOI is output.				○
	DL?	/	Query on block delimiter Response: DL0, DL1, DL2			○

R6142
PROGRAMMABLE DC VOLTAGE/CURRENT GENERATOR
INSTRUCTION MANUAL

4.7 Program Code Table

(Cont'd)

Item	Code	Description			State after initialization with C command	Effective command during step operation
		TR6142	R6142	R6144		
Memory setting		<p>④ Channel Omissible. If the channel is omitted, the channel is automatically incremented by one for the storage of the next data.</p> <p>⑤ Block delimiter Any of the following delimiters can be used: CR LF LF CR EOI</p> <p>⑥ Memory setting end code If program code C3 is input, the memory setting mode ends.</p> <p>See Section 3.12 "How to Use the Memory."</p>				
	N?	/		Query on currently set memory channel Response: Nddd (ddd is a 3-digit number)		○
	P?	/		Query on memory setting mode status Response: P0 (memory setting mode OFF) P1 (memory setting mode ON)		○

R6142
PROGRAMMABLE DC VOLTAGE/CURRENT GENERATOR
INSTRUCTION MANUAL

4.7 Program Code Table

(Cont'd)

Item	Code	Description			State after initialization with C command	Effective command during step operation
		TR6142	R6142	R6144		
Query command on external switch status	0?	/	Query on OPR HOLD switch Response: 00 (OFF) 01 (ON)			○
	X?		Query on EXT.CAL switch status Response: X0 (OFF) X1 (ON)			○
Sweep	K0	Continuously increments a number in 10 ⁰ digit position. See Section 3.13 "Sweep Function."				
	K1	Continuously increments a number in 10 ¹ digit position. See Section 3.13 "Sweep Function."				
	K2	Continuously increments a number in 10 ² digit position. See Section 3.13 "Sweep Function."				
	K3	Continuously increments a number in 10 ³ digit position. See Section 3.13 "Sweep Function."				
	K4	Continuously decrements a number in 10 ⁰ digit position. See Section 3.13 "Sweep Function."				
	K5	Continuously decrements a number in 10 ¹ digit position. See Section 3.13 "Sweep Function."				
	K6	Continuously decrements a number in 10 ² digit position. See Section 3.13 "Sweep Function."				
	K7	Continuously decrements a number in 10 ³ digit position. See Section 3.13 "Sweep Function."				

R6142
PROGRAMMABLE DC VOLTAGE/CURRENT GENERATOR
INSTRUCTION MANUAL

4.7 Program Code Table

(Cont'd)

Item	Code	Description			State after initialization with C command	Effective command during step operation
		TR6142	R6142	R6144		
Data buffering function	B	The next data and range code are buffered. The buffered data is output in response to the operate code "E".				
	B?	/	Query on buffering status Response: B0 (OFF) B1 (ON)			○
Service Request	S0	Service Request (SRQ) is issued.				○
	S1	Service Request (SRQ) is not issued.			○	○
	S?	/	Query on whether Service Request is issued Response: S0 (issued) S1 (not issued)			○
Scanning start/stop	T1	Scanning in the step mode See Section 3.12 "How to Use the Memory."				
	T2	Starts single scanning. See Section 3.12 "How to Use the Memory."				○
	T3	Starts repeated scanning. See Section 3.12 "How to Use the Memory."				○
	C1	Quits scanning. The contents of channel are initialized to the data in the first channel. See Section 3.12 "How to Use the Memory."				○
	C2	Suspends scanning. Scanning resumes from the channel at suspension in response to T1, T2, or T3. See Section 3.12 "How to Use the Memory."				○

R6142
PROGRAMMABLE DC VOLTAGE/CURRENT GENERATOR
INSTRUCTION MANUAL

4.7 Program Code Table

(Cont'd)

Item	Code	Description			State after initialization with C command	Effective command during step operation
		TR6142	R6142	R6144		
Scanning start/stop	T?	/	Query about the type of scanning Response: T2 (single scanning) T3 (repeated scanning)		○	
Step time setting	SI~	<u>SI ddd</u> ① ② ① SI : Header ② ddd : Step time (1 to 100)				○
	SI?	/	Query on step time Response: SIddd (ddd is a 3-digit number)		○	
First/last channel	SC~	<u>SC mmm , nnn</u> ① ② ③ ④ ① SC : Header ② mmm : First channel (0 to 159) ③ , : String delimiter ④ nnn : Last channel (0 to 159) <u>SC nnn</u> ① ② ① SC : Header ② nnn : Last channel (0 to 159) The first channel is at address 0.				○
	SC?	/	Query on first/last channel Response: SC mmm nnn mmm = First channel nnn = Last channel mmm and nnn are 3-digit numbers.		○	

4.8 Basic Format for Output Voltage/Current Setting

Basic format

$\frac{\text{Head}}{\text{①}} \quad \frac{\pm}{\text{②}} \quad \frac{\text{dddd}}{\text{③}} \quad \frac{\text{E} \pm \text{dd}}{\text{④}} \quad :$

$\frac{\text{Head}}{\text{①}} \quad \frac{\pm}{\text{②}} \quad \frac{\text{dddd}}{\text{③}} \quad \frac{\text{Unit}}{\text{④}} \quad :$

① Header

The header specification is as follows:

Header	Contents	Usable format	
		Fixed range	Automatic range selection
D	DC output value stored in memory	○	○

② Polarity

The default is "positive."

③ Data

Decimal point + Number of up to 5 digits

④ Characteristic part

E + Polarity + Number of up to 2 digits

The default is E + 0.

⑤ Unit symbol

V : Volt

MV : Millivolt

MA : Milliampere

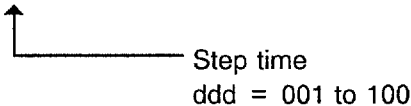
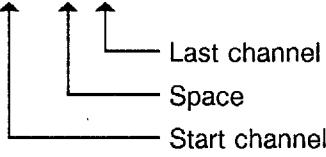
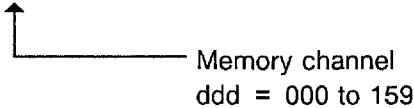
R6142
PROGRAMMABLE DC VOLTAGE/CURRENT GENERATOR
INSTRUCTION MANUAL

4.8 Basic Format for Output Voltage/Current Setting

The table below lists the range of setting in the automatic range selection mode and fixed range mode.

Nominal range	Range of setting	
	Automatic range selection	Fixed range
10 mV	D ± 0 MV to D ± 11.999 MV D ± 0 V to D ± 0.011999 V	D ± 0 to D ± 11.999
100 mV	D ± 12 MV to D ± 119.99 MV D ± 0.012 V to D ± 0.11999 V	D ± 0 to D ± 119.99
1 V	D ± 120 MV to D ± 1199.9 MV D ± 0.12 V to D ± 1.1999 V	D ± 0 to D ± 1.1999
10 V	D ± 1200 MV to D ± 11999 MV D ± 1.2 V to D ± 11.999 V	D ± 0 to D ± 11.999
1 mA	D ± 0 MA to D ± 1.1999 MA	D ± 0 to D ± 1.1999
10 mA	D ± 1.2 MA to D ± 11.999 MA	D ± 0 to D ± 11.999
100 mA	D ± 12 MA to D ± 119.99 MA	D ± 0 to D ± 119.99

4.9 Panel Set Value Output from Talker and Response to Data Query

Query	Format of response
Panel set value : D?	10 mV : DV ±d.ddd E - 2 100 mV : DV ±d.ddd E - 1 1 V : DV ±d.ddd E + 0 10 V : DV ±d.ddd E + 1 1 mA : DI ±d.ddd E - 3 10 mA : DI ±d.ddd E - 2 100 mA : DI ±d.ddd E - 1 No data : DD ±9.9999 E + 9
Step time : SI?	<u>Slddd</u> 
First/last channel setting : SC?	<u>SCmmm _ nnn</u>  mmm, nnn = 000 to 159
Memory channel : N?	<u>Nddd</u> 

4.10 Service Request

Service Request of the GPIB enables the user to detect the status of the R6142. Use the GPIB commands, S0 and S1, to turn ON/OFF Service Request.

The contents of the status byte register can be read by serial polling. For repeated serial polling, put an interval of at least 10 milliseconds in between.

4.10.1 Status Byte Register

Bit number	Name of bit	Description
0	LIMIT	This bit is set when a limiter is detected. This bit is reset when the use of a limiter is canceled. If the use of a limiter is canceled before the R6142 is polled, the SRQ bit is held set until the R6142 is polled.
1	SYNTAX ERROR	This bit is set when an invalid code, syntax error, or excess range of setting is detected during processing. If a program code error is detected, the code and subsequent codes are skipped over until a block delimiter is detected. This bit is reset when valid program codes have been read up to a block delimiter.
2	READY	When the R6142 has shifted from the standby state to the operating state, this bit is set about 50 milliseconds after an output voltage/current is set. This bit is reset when the R6142 is processing data, enters the standby state, or is polled.
3	SCAN END	This bit is set when scanning reaches the last channel in the single scan mode. This bit is reset when the R6142 starts another scanning or is polled.
4	SCAN BUSY	This bit is set while the R6142 is engaged in single scanning or repeated scanning.
5	TRIGGER IN	In the sweep mode, this bit is set when a signal input from the TRIGGER input terminal on the rear panel is detected. This bit is reset when the R6142 receives a sweep code or is polled.
6	SRQ	Service request This bit is set when any one or more of bits 0 to 3 and bit 5 are set.
7		Unused

(1) LIMIT bit (bit 0)

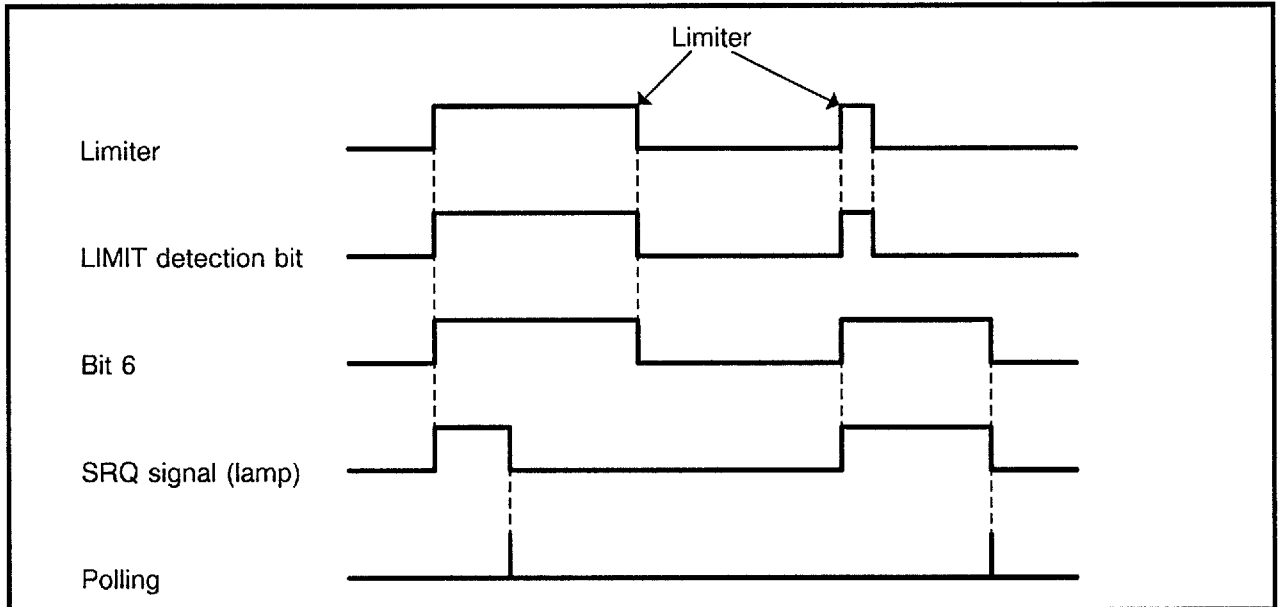


Figure 4-5 LIMIT Bit Timing Chart

(2) SYNTAX ERROR bit (bit 1)

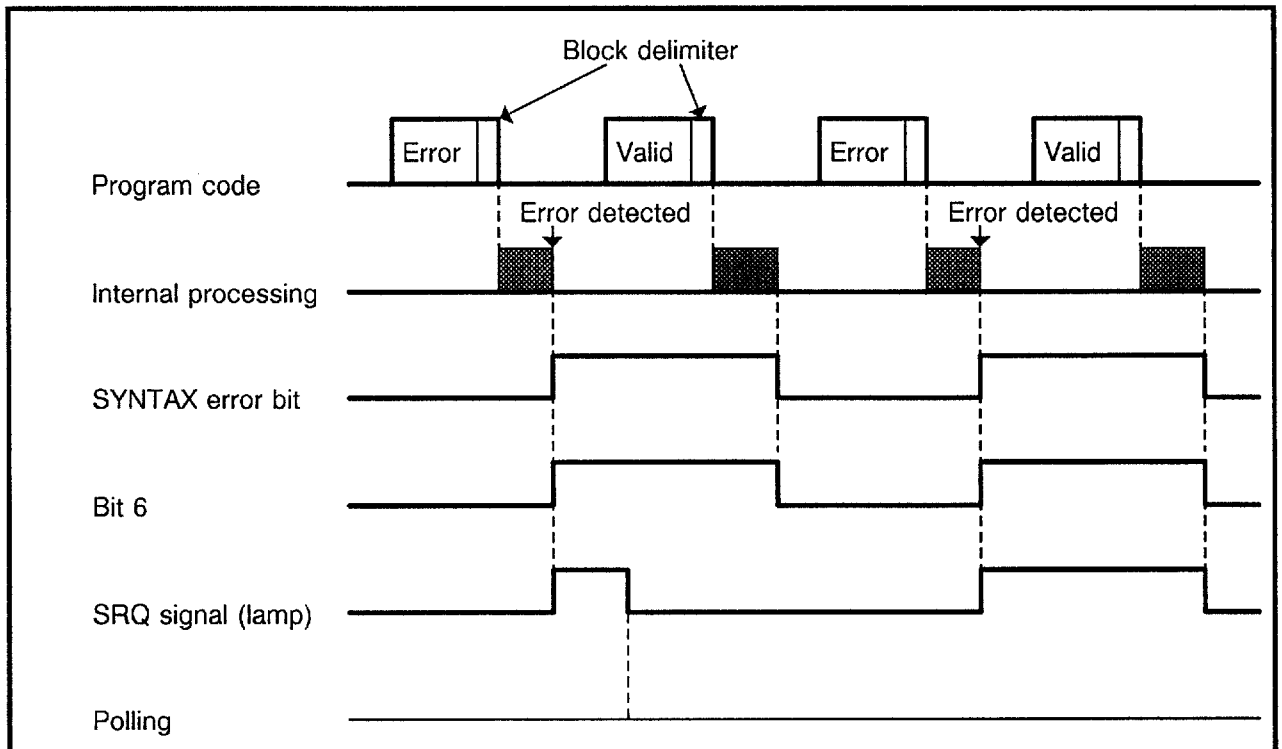


Figure 4-6 SYNTAX Error Bit Timing Chart

(3) READY bit (bit 2)

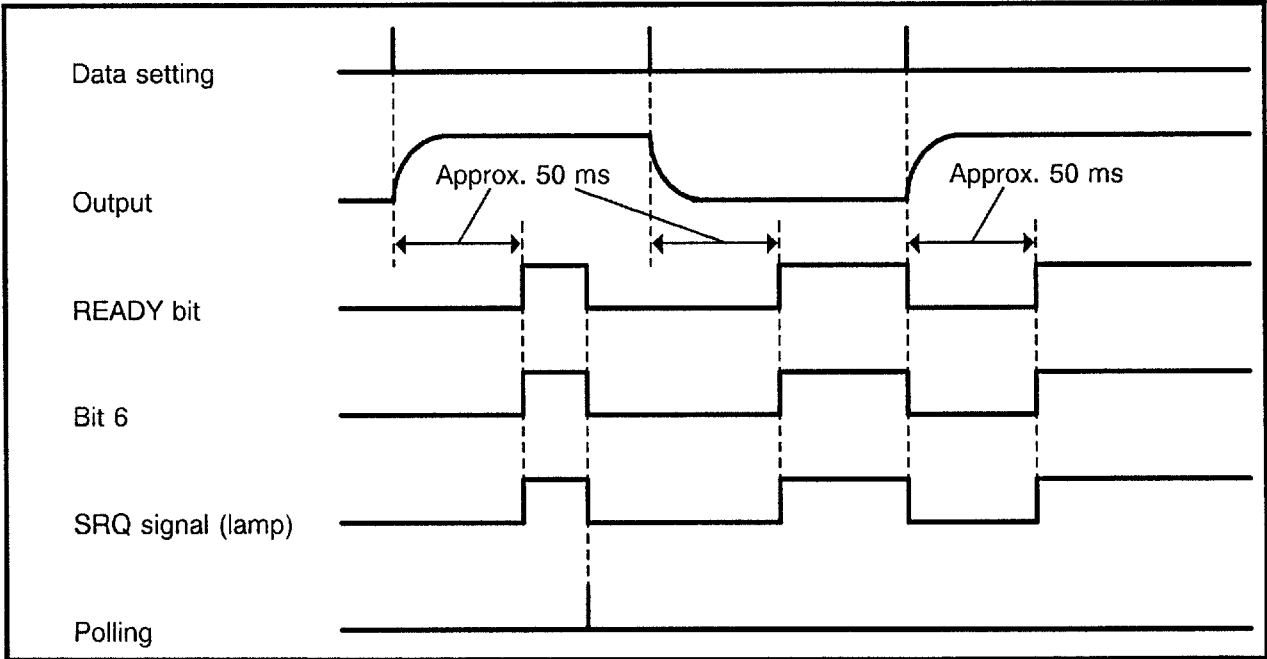


Figure 4-7 READY Bit Timing Chart

(4) SCAN END bit (bit 3)

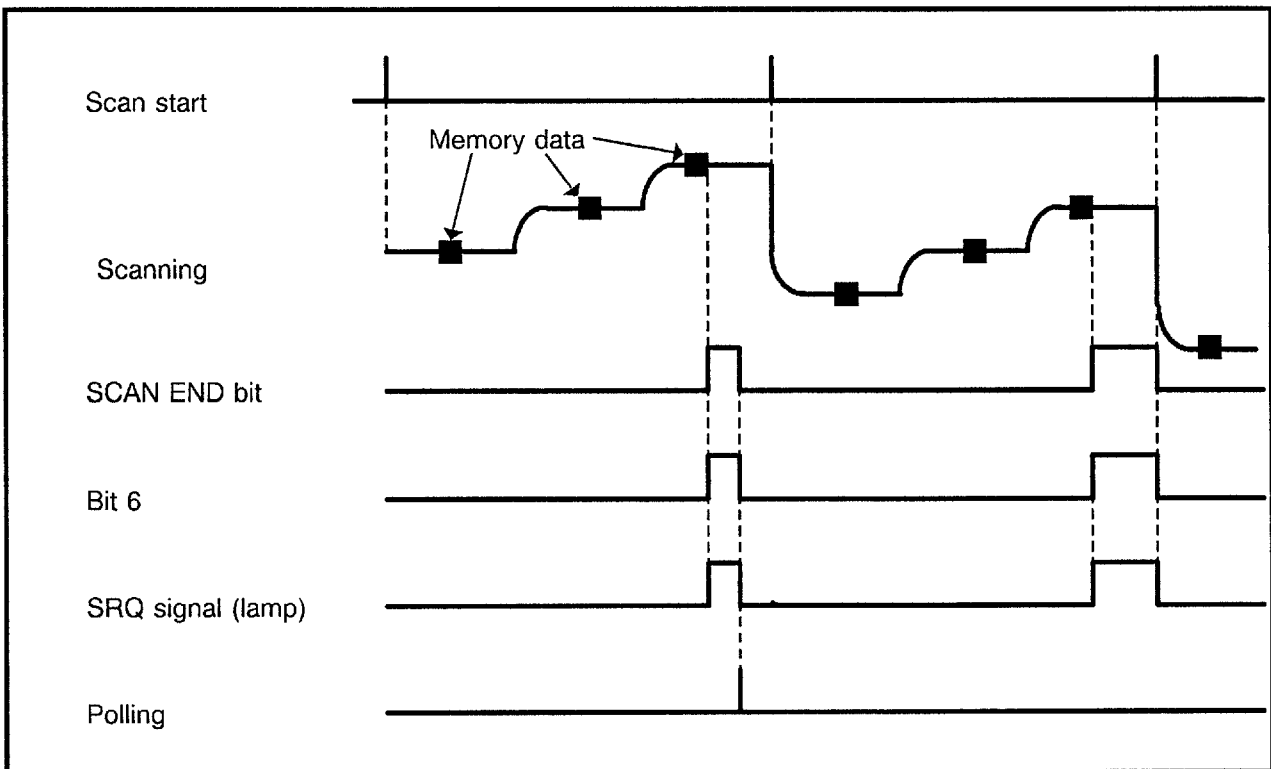


Figure 4-8 SCAN END Bit Timing Chart

(5) SCAN BUSY bit (bit 4)

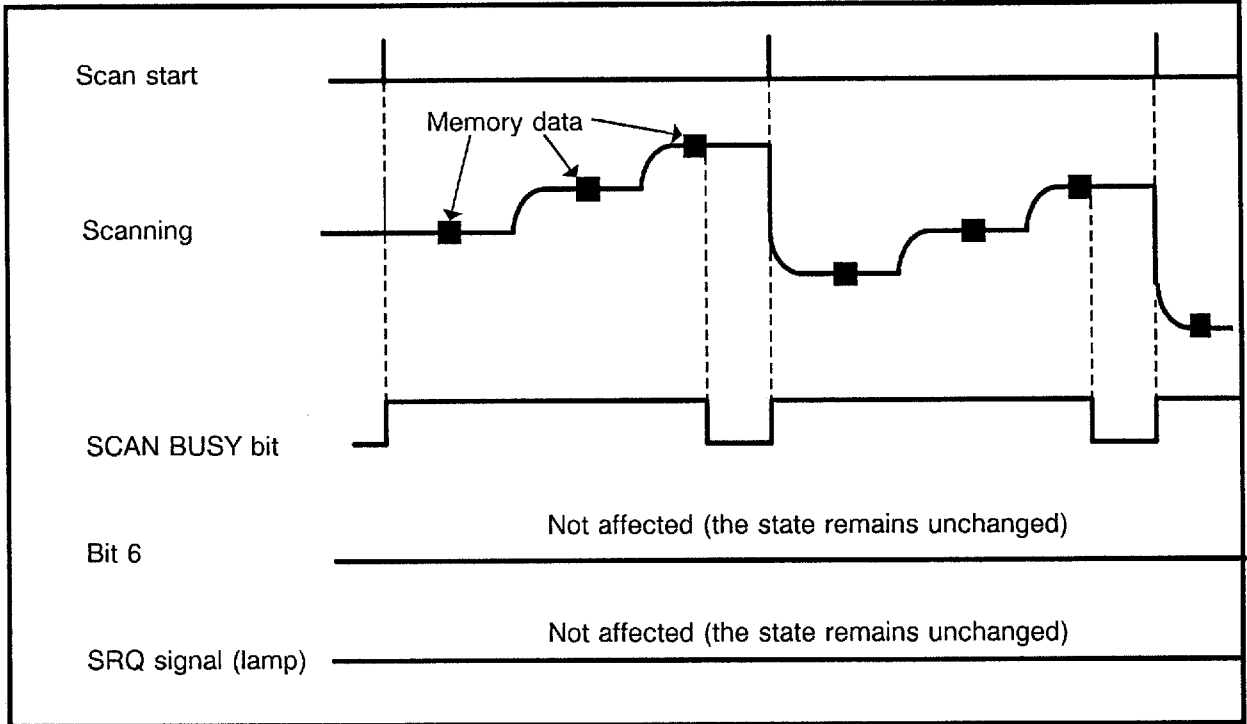


Figure 4-9 SCAN BUSY Bit Timing Chart

(6) TRIGGER IN bit (bit 5)

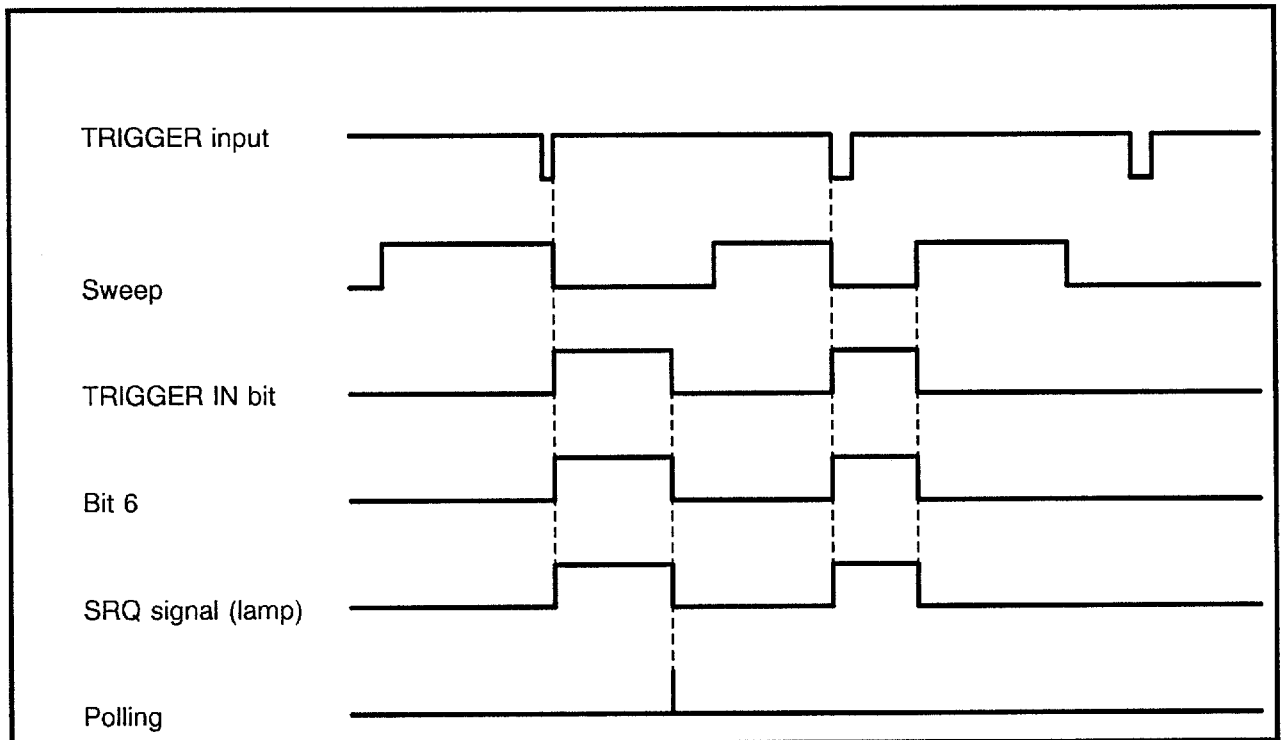
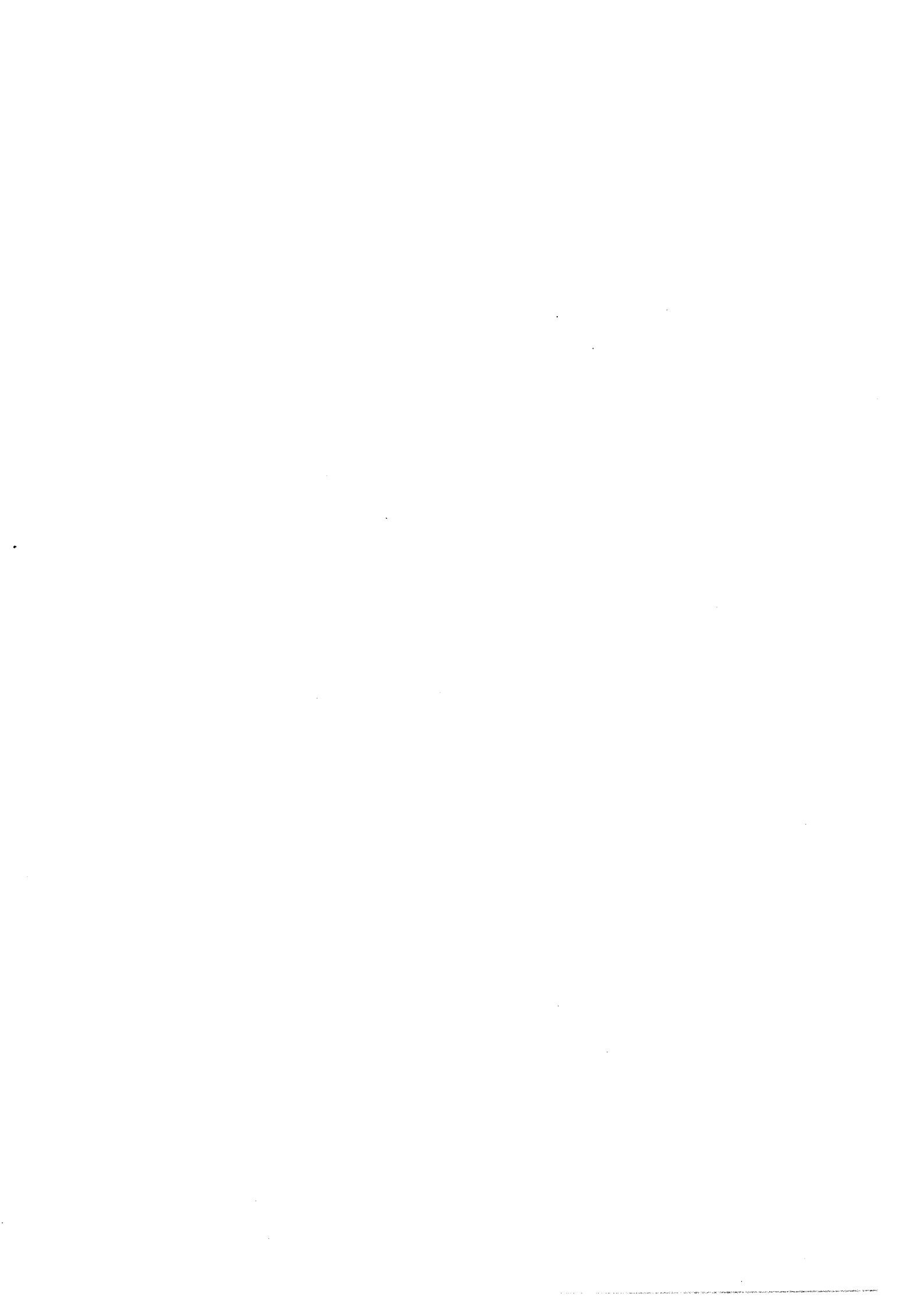


Figure 4-10 TRIGGER IN Bit Timing Chart



5. BCD PARALLEL INTERFACE

5.1 Overview

The BCD parallel interface, provided as standard, enables the R6142 to be connected with the parallel I/O port of a general-purpose computer and sequencer.

This chapter explains the specifications and functions of the BCD parallel interface.

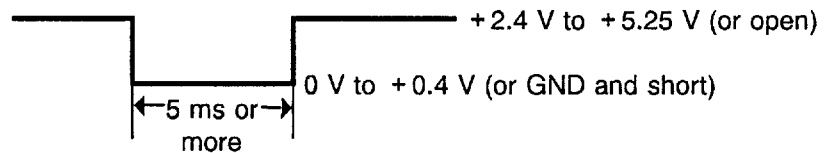
5.2 Specifications

5.2.1 Input Signals for Remote Setting

- Output level setting code : 5-digit parallel BCD code, 18 bits
- Output level setting range : 00000 to 11999
- Range : 10 V, 1 V, 100 mV, 10 mV, 100 mA, 10 mA, and 1 mA, 7 bits
- Polarity : Positive (logical 0) or negative (logical 1)
- Output ON status : ON (logical 1) or OFF (logical 0), 1 bit
- Control signal : LOAD signal, 1 bit

5.2.2 Signal and Connector Specifications

- Signal level : TTL level, negative logic
1 : 0 V to +0.4 V (or GND and short)
0 : +2.4 V to +5.25 V (or open)
- LOAD signal : TTL level, negative pulse



Full remote mode : The output level, range, polarity, and output ON status signals are taken in for setting while the signal level is 0.

Half-remote mode : The output level signal is taken in for setting while the signal level is 0.

- Input circuit : See Figure 5-1.

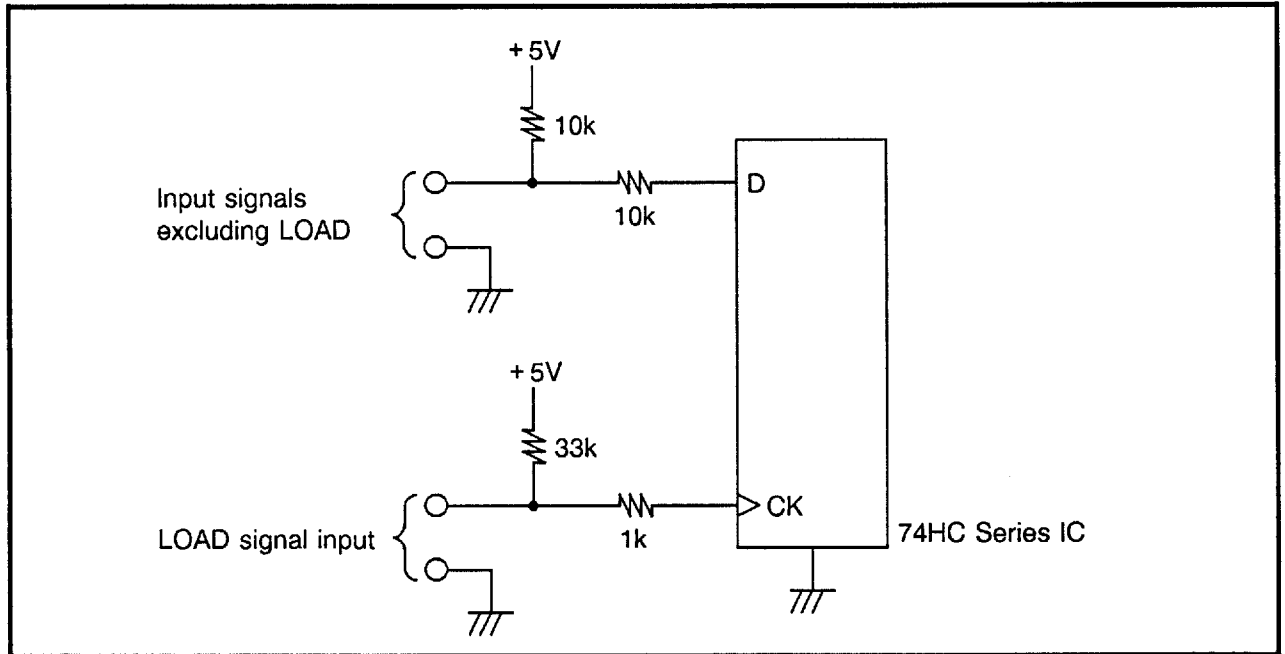


Figure 5-1 BCD Parallel Interface Input Circuit

- Connectors : For R6142 : 57LE-40360 (Amphenol) or equivalent
For cable : 57-30360 (Amphenol) or equivalent 36-pin connector

5.2.3 Connector Pin Configuration and Codes

Table 5-1 shows the pin configuration and codes.

The range codes follow the priority rule shown in the table when two or more range codes become 1 concurrently. The 10 V is the highest in priority, and the 1mA range, the lowest.

Table 5-1 BCD Parallel Connector Pin Configuration and Codes

Pin No.	Signal	Pin No.	Signal
1	0 V (GND)	19	10 V
2	1	20	1 V
3	2	21	100 mV
4	4	22	10 mV
5	8	23	100 mA
6	1	24	10 mA
7	2	25	1 mA
8	4	26	NC
9	8	27	Polarity
10	1	28	NC
11	2	29	Output ON status
12	4	30	}
13	8	31	
14	1	32	} NC
15	2	33	
16	4	34	}
17	8	35	
18	1	36	LOAD

Output level

Range

Priority

High

Low

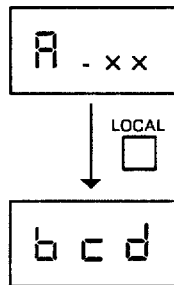
NC (non-internal connection): Never use as a junction terminal.

5.3 Selecting the BCD Parallel Interface

The R6142 has both GPIB interface and BCD parallel interface as standard. Use either one. How to select the BCD parallel interface is described below. (See Section 4.4 for how to select the GPIB interface.)

Procedure

- ① Press .
- ② Press to select "b c d."



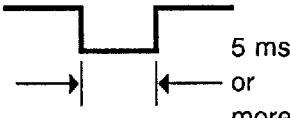
- ③ Press to exit.

5.4 Operation

The BCD parallel interface of the R6142 operates in two modes, full remote and half-remote. Table 5-2 lists the functions of the LOAD signal in the full remote and half-remote modes.

- ① Press ^{LOCAL} to alternate the full remote mode and half-remote mode.
- ^{REMOTE} (lamp OFF) : Half-remote mode
- ^{REMOTE} (lamp ON) : Full remote mode

Table 5-2 LOAD Signal Functions

LOAD signal	Half-remote mode	Full remote mode
Fixed to 0	<ul style="list-style-type: none"> • Remote setting is disabled. • Setting from the front panel is fully enabled. 	<ul style="list-style-type: none"> • The output ON status can be remotely set. • The range and polarity are reset as the output ON status changes. • The output level cannot be remotely set. • Only <input type="checkbox"/> ^{LOCAL} on the front panel is effective.
Fixed to 1	<ul style="list-style-type: none"> • Only the output level can be remotely set. • Set the range, polarity, and output ON status from the front panel. 	<ul style="list-style-type: none"> • All input parameters are remotely set. • Only <input type="checkbox"/> ^{LOCAL} on the front panel is effective.
 <p>TTL negative pulse</p>	<ul style="list-style-type: none"> • Only the output level can be remotely set. • Set the range, polarity, and output ON status from the front panel. 	<ul style="list-style-type: none"> • All items are set at one time. • Only <input type="checkbox"/> ^{LOCAL} on the front panel is effective.

6. INPUT AND OUTPUT SIGNALS

6.1 TRIGGER Input Signal

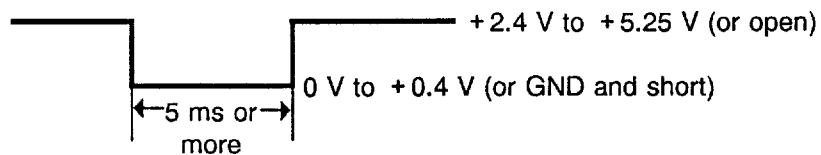
The TRIGGER signal is used to trigger the operation of the R6142 from outside. Table 6-1 lists the effect of the TRIGGER signal in various operation modes.

Table 6-1 Effect of the TRIGGER Signal

Mode	Effect of input the TRIGGER Signal	Remarks
Regular state	None	
Step mode	The channel number increments by one at the trailing edge.	See Section 3.12.2 (1) "Step mode."
Scan mode	Scanning in halt: Scanning starts at the trailing edge. During scanning: Scanning is suspended at the trailing edge.	See Section 3.12.2 (2) "Single scan mode" and (3) "Repeated scan mode."
Sweep	During sweeping: Sweeping stops at the trailing edge. When sweeping stops, the R6142 enters the regular state.	See Section 3.13.1 "Getting sweep started and stopped."

For operation timing, see Section 3.2.3 "Operation mode and operation timing."

TRIGGER signal : TTL negative pulse



Connector : For the R6142 : BNC-LR-PC (Hirose) or equivalent
 For the cable : UG88/U (Hirose) or equivalent

TRIGGER input circuit: See Figure 6-1.

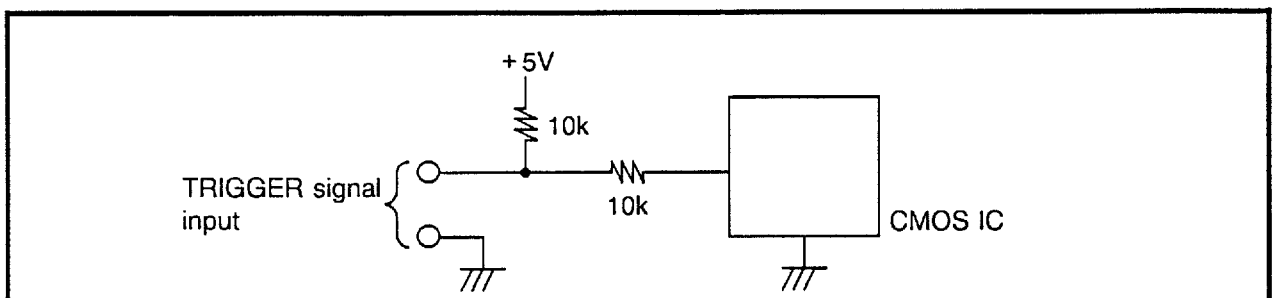


Figure 6-1 TRIGGER Input Circuit

6.2 READY Output Signal

The READY signal triggers (starts measurement) the operation of an external DMM.

The READY signal is output from the R6142 when the output level, range, and polarity are reset by setting the output ON status to ON (OPERATE ON) from the front panel, or through the BCD parallel interface or GPIB interface, or when the output is turned ON.

Figure 6-2 is the output timing chart of the READY signal.

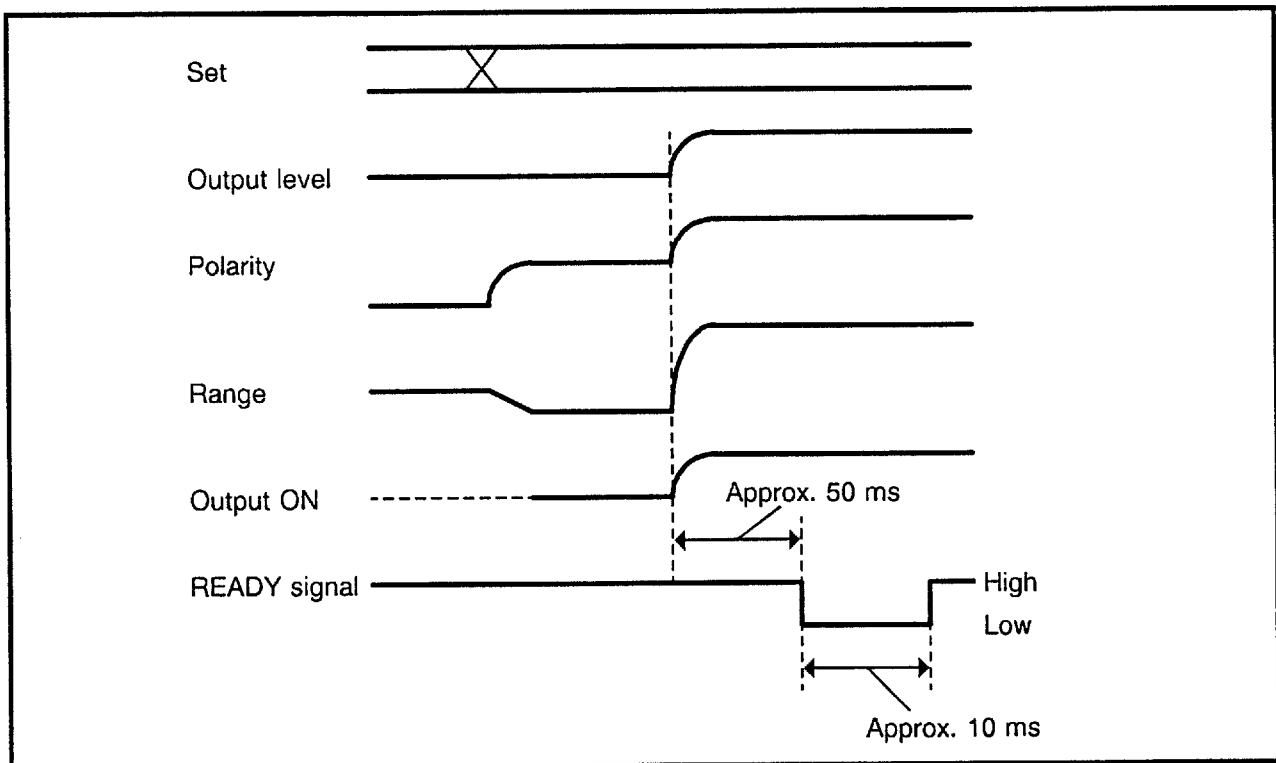


Figure 6-2 READY Signal Output Timing

READY signal specifications

High : +2.7 V to +5.25 V, 100 μ A max

Low : 0 V to +0.6 V, -5 mA max

Pulse width : Approx. 10 ms (negative pulse)

Connectors : For the R6142 : BNC-LR-P (Hirose) or equivalent

For the cable : UG88/U (Hirose) or equivalent

7. INSPECTION AND CALIBRATION

7.1 Before Requesting for Service


If any problem arises, or if an error code is displayed during operation of the R6142, check the R6142 in accordance with Tables 7-1 and 7-2 before requesting service. If the problem still remains unsolved, contact ATCE or our nearest local sales office. Their locations and telephone numbers can be found at the end of this manual.

If we are asked to do repairs in conjunction with the tables, the user will be charged for them.

(1) User actions to problems

If any problem arises during operation of the R6142, take the actions listed in Table 7-1.

Table 7-1 User Actions to Problems

Problem	Cause	User action	Remarks
No display	1. Improper supply voltage	Check the supply voltage used.	See Section 2.2 ① " ~LINE V SELECTOR and supply voltage list."
	2. Power fuse blowout	Replace with an accessory fuse.	See Section 1.2.5 "Replacing Fuses."
 is displayed.		Follow the instructions in Table 7-2.	See Table 7-2 "Error Codes and User Actions."
Voltage or current cannot be set as desired.	1. Improper voltage/ current range	Check the voltage/ current range of setting.	
	2. Polarity is set to 0.	Press <input type="checkbox"/> ⁺ or <input type="checkbox"/> ⁻ to cancel polarity "0".	See Section 2.1 ⑦ "POLARITY keys -, 0, and +."

R6142
PROGRAMMABLE DC VOLTAGE/CURRENT GENERATOR
INSTRUCTION MANUAL

7.1 Before Requesting for Service

Table 7-1 User Actions to Problems (Cont'd)

Problem	Cause	User action	Remarks
A set voltage/ current is not generated.	1. Improper connection with load	Check the SENSE switch position and the connection between the output terminals and the load.	See Section 3.4 "Connection with Load."
	2. Improper load	Check the voltage- current characteristic of the load, set value, and limit value.	
	3. Improper calibration	Disconnect cables from the output terminals and check the output value with the DMM.	See Section 7.2.2 (1) "Connection and operation check."
The R6142 operates normally in the manual mode, but does not operate in the GPIB system.	1. The GPIB interface is not selected.	Check that the GPIB interface is selected.	See Section 4.4 "Selecting the GPIB Interface."
	2. A device of the same address is connected to the GPIB bus.	Connect only the R6142 to the GPIB bus and check. Change the address of the R6142 and check.	See Section 4.5 "Addressing and Selecting the Listen Only Mode."
	3. A syntax error in a program code	Execute program codes one by one for operation check.	See Section 4.7 "Program Code Table."
The R6142 operates normally in the manual mode, but does not operate in the remote mode through the BCD interface.	1. The BCD interface is not selected.	Check that the BCD interface is selected.	See Section 5.3 "Selecting the BCD Parallel Interface."
	2. Improper signal connection	Check the connector connection.	See Section 5.2 "Specifications."
	3. Improper logical level of signal	Disconnect the connector and check the level of signals.	
	4. The range signals are all logical 0.		

R6142
PROGRAMMABLE DC VOLTAGE/CURRENT GENERATOR
INSTRUCTION MANUAL

7.1 Before Requesting for Service

(2) Error codes and user actions

If an error occurs, an associated error code is displayed. Take adequate action in accordance with Table 7-2.

Table 7-2 Error Codes and User Actions

Error code	Cause	User action	Remarks
E r r 0 1	An error has been detected during CPU RAM read/write check.	Contact the nearest dealer or the sales and support office.	
E r r 0 2	An error has been detected during ROM check (sum check).		
E r r 0 3	An error has been detected during RAM read/ write check.		
E r r 0 4	An error has been detected in calibration parameters during sum check.	Set the EXT CAL switch on the rear panel to the ON position. Turn the POWER switch ON and press <input type="checkbox"/> . The internal calibration parameters will be initialized. Conduct calibration again.	See Section 7.2 "Calibration."
E r r 0 5	An error in RAM backup battery	Set the EXT CAL switch on the rear panel to the OFF position. Turn the POWER switch ON and press <input type="checkbox"/> . The R6144 will be initialized and become ready for operation.	
E r r 0 6	An error has been detected in the limit detection circuit.	Contact the nearest dealer or the sales and support office.	

7.2 Calibration

This section explains how to calibrate the R6142 to maintain the accuracy of output voltage and current listed in Chapter 9 "Specifications and Accessories" for a period of six months.

7.2.1 Preparation and Precautions

(1) Instruments required for calibration

Use the instruments recommended in Table 7-3 or similar equipment which meet these specifications.

Table 7-3 Instruments Required for Calibration

Standard instrument	Range of use	Accuracy	Recommended model	
Digital voltmeter	100 nV to 100 V	± 0.004%	TR6871, R6871E, TR6878 (Advantest)	
Digital ammeter or standard resistor	1 μ A to 200 mA	± 0.009%		
	10 nA to 20 mA	± 0.006%		
	Standard resistor	1 Ω (120 mA)	± 0.005%	
		100 Ω (12 mA)	± 0.002%	TR1332-100 (Advantest)
		1k Ω (1.2 mA)		TR1332-1k (Advantest)

(2) Cables required for calibration

Table 7-4 Cables Required for Calibration

Name	Model	Remarks
Input cable	MI-40	Two cables are needed if a standard resistor is to be used.

(3) Precautions for calibration

- ① Use a specified AC power supply. (See Section 2.2 ① " ~LINE V SELECTOR and supply voltage list.")
- ② Before connecting the power cable, make sure that the POWER switch is OFF.

- ③ Environmental conditions for calibration should be as follows:
Temperature : 23°C ± 3°C
Humidity : 70% RH or less
Environment : Free of dust, vibration, and noise
- ④ Warm up the R6142 for at least two hours. Warm up calibration instruments for as long as specified.
- ⑤ After calibrating the R6142, enter the date of calibration and the required date of next calibration on to a card or sticker.

7.2.2 Calibration Procedure

Figure 7-1 shows the calibration flow.

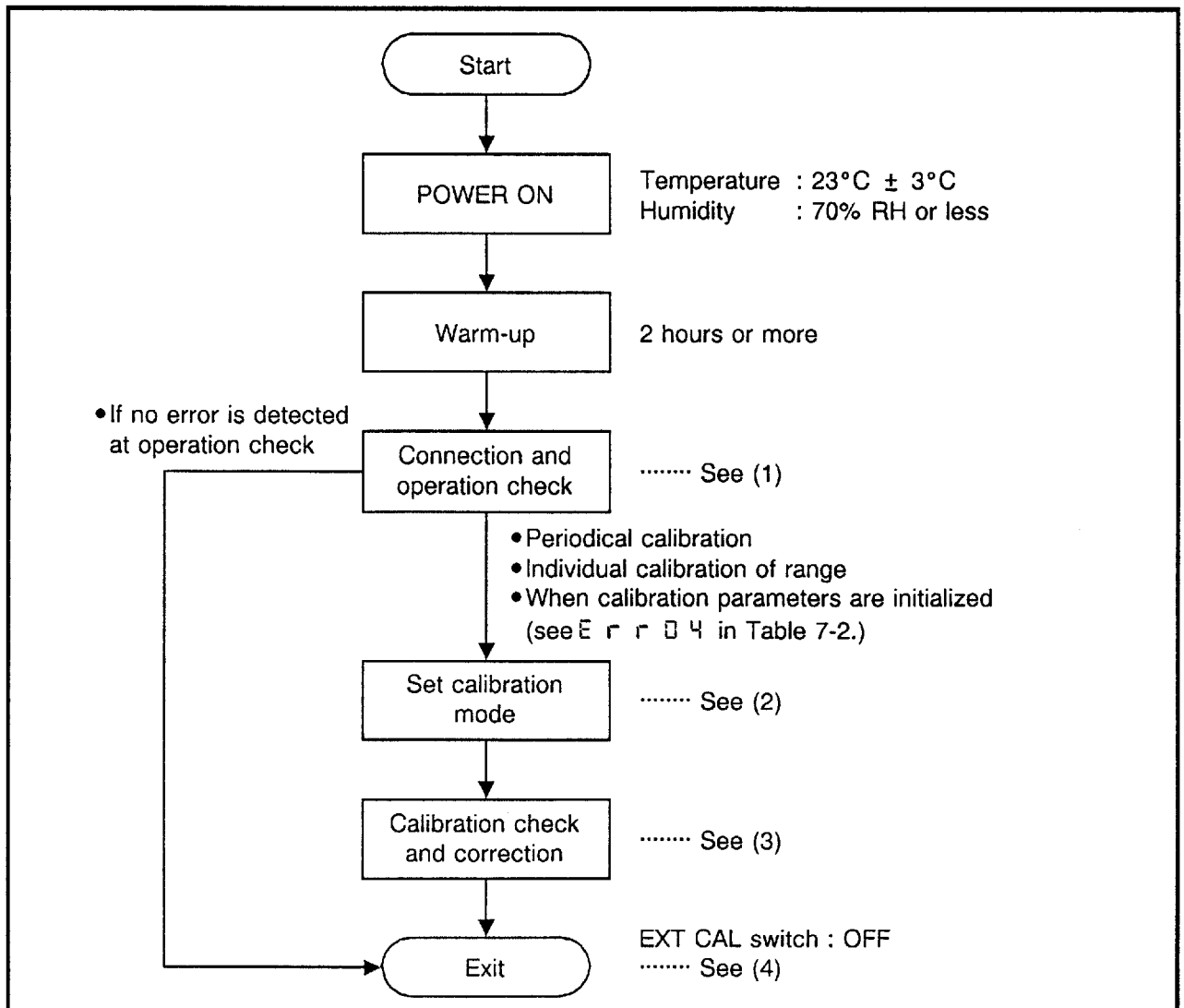


Figure 7-1 Calibration Flowchart

(1) Connection and operation check

- ① Connect the R6142 and a standard instrument. Figure 7-2 shows the connection and basic conditions of setting.

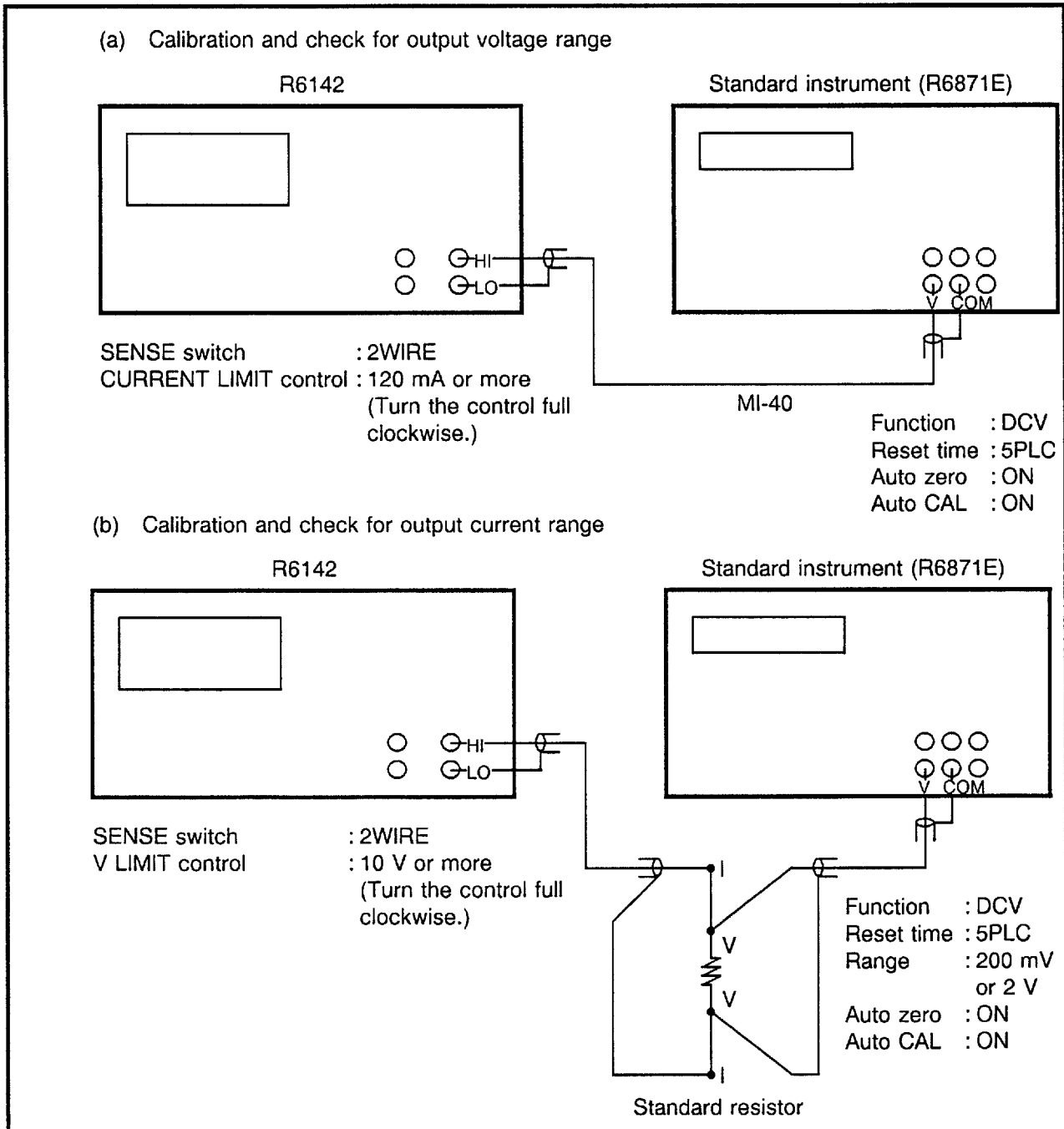


Figure 7-2 Connection with Calibration Instruments and Basic Conditions of Setting

R6142
PROGRAMMABLE DC VOLTAGE/CURRENT GENERATOR
INSTRUCTION MANUAL





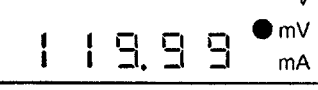




7.2 Calibration

② Operation check

Before starting calibration, measure the output from the R6142 with a DMM to make sure that the reading of the DMM falls within the required range. Table 7-5 shows the setting of the R6142 and standard instrument and the range of DMM reading.

If the reading of the DMM does not fall within the required range, it denotes that the output from the R6142 fails to satisfy the required overall accuracy. The R6142 needs to be calibrated.




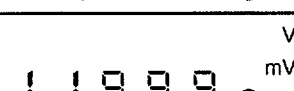
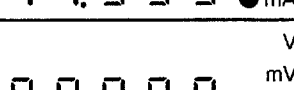
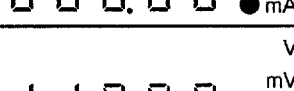
Table 7-5 Operation Check

Setting of R6142	Connection	Setting of standard instrument		Range of DMM reading (R6871E)	
		Measurement range of DMM	Standard resistor		
	See Fig. 7-2 (a)	200 mV	Not required	-0.0050mV to 0.0050mV	
				11.9904mV to 12.0076mV	
				-11.9904mV to -12.0076mV	
				-0.0250mV to 0.0250mV	
				119.9290mV to 120.0510mV	
				2 V	-0.2000mV to 0.2000mV
				1199.3400mV to 1200.4600mV	
				20 V	-2.000mV to 2.0000mV
				11.993400V to 12.004600V	

R6142
PROGRAMMABLE DC VOLTAGE/CURRENT GENERATOR
INSTRUCTION MANUAL

7.2 Calibration

Table 7-5 Operation Check (Cont'd)

Setting of R6142	Connection	Setting of standard instrument		Range of DMM reading (R61871E)
		Measurement range of DMM	Standard resistor	
	See Fig. 7-2 (b)	2 V	1 k Ω	- 0.3000 mV to 0.3000 mV
				1199.1800 mV to 1200.6200 mV
			100 Ω	- 0.3000 mV to 0.3000 mV
				1199.1800 mV to 1200.6200 mV
		200 mV	1 Ω	- 0.0300 mV to 0.0300 mV
				119.9120.0 mV to 120.0680 mV

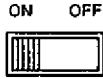
R6142
PROGRAMMABLE DC VOLTAGE/CURRENT GENERATOR
INSTRUCTION MANUAL

7.2 Calibration

(2) Calibration mode setting

Procedure

- ① Set the EXT CAL switch on the rear panel to the ON position.



- ② Press and to set the R6142 to the calibration mode.

(3) Calibration check and correction

Procedure

- ① Press or to specify the function to be calibrated.

: Voltage generation

: Current generation

- ② Connect a calibration instrument.

(See Figure 7-2 "Connection with Calibration Instruments and Basic Conditions of Setting.")

- ③ Press the RANGE Δ and ∇ keys to select a range to be calibrated. Set the standard instrument to proper conditions.

(See Table 7-6 "Ranges to Be Calibrated and Calibration Error.")

- ④ Press to turn the operate state ON.

- ⑤ Conduct calibration and check for + zero and then + full-scale using RANGE Δ and ∇ ,

and .

(See Section 7.2.3 "Flowchart of Calibration for One Range and Correction.")

- ⑥ Press to turn the operate state OFF.

- ⑦ Repeat steps ③ to ⑥ to conduct calibration for the ranges of the selected function.







- ⑧ Do steps ① to ⑦ to calibrate the other function.

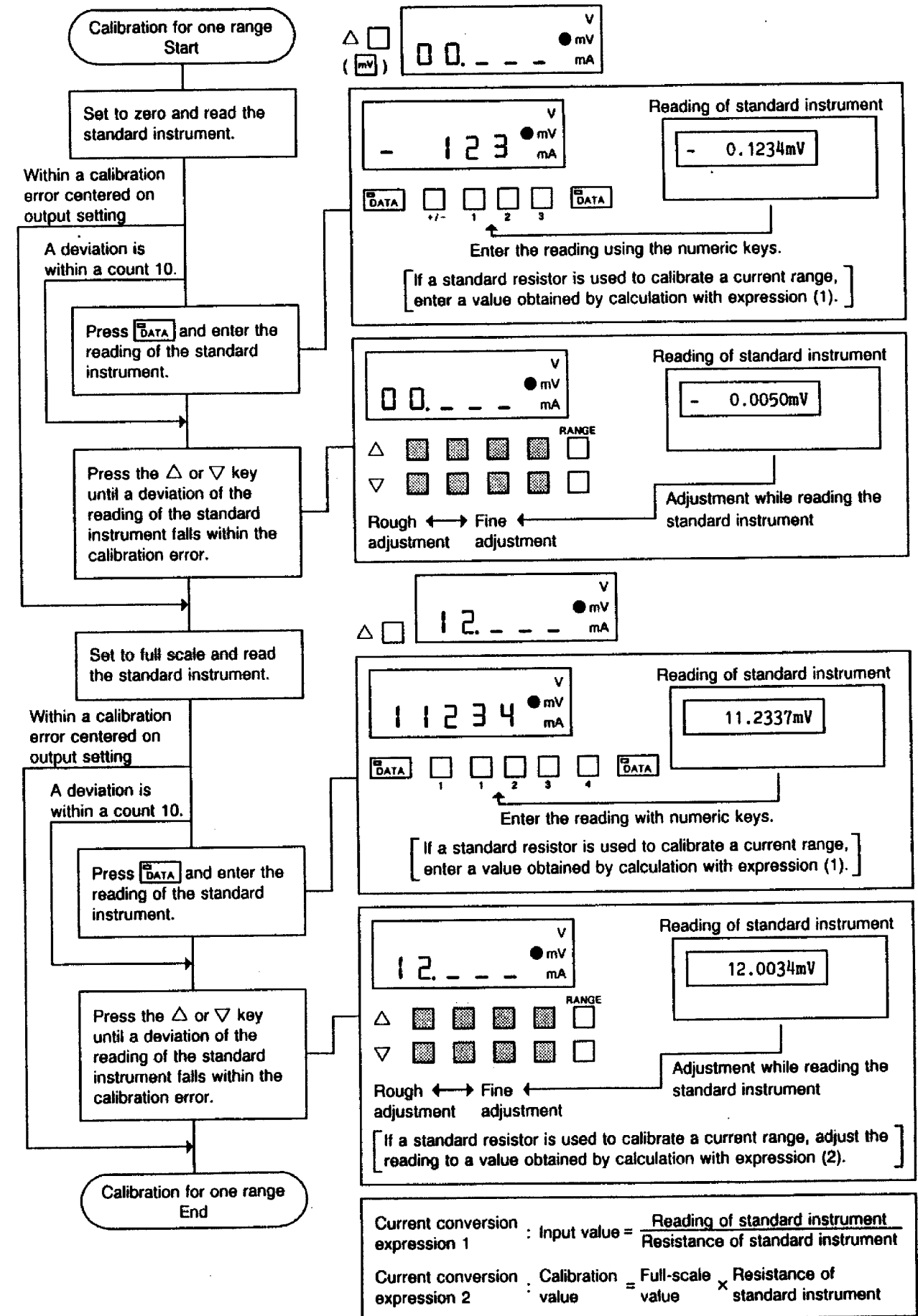
(4) Exit from the calibration mode

Set the EXT CAL switch to the OFF position and press .

7.2.3 Flowchart of Calibration for One Range and Correction

Table 7-6 Ranges to Be Calibrated and Range with Calibration Error

Key operation	Range to be calibrated	Output value	Display	Calibration error centered on output setting
  	10 mV	Zero	00. --- ● mV mA	± 0.5 μV
		Full scale	12. --- ● mV mA	11.999 mV ± 0.8 μV
	100 mV	Zero	000. --- ● mV mA	± 5 μV
		Full scale	120. --- ● mV mA	119.99 mV ± 8 μV
1 V	Zero	0.0 --- ● V mV mA	± 50 μV	
	Full scale	1.2 --- ● V mV mA	1.1999 V ± 80 μV	
10 V	Zero	00. --- ● V mV mA	± 500 μV	
	Full scale	12. --- ● V mV mA	11.999 V ± 0.8 mV	
  	1 mA	Zero	0.0 --- ● V mV mA	± 50 nA
		Full scale	1.2 --- ● V mV mA	1.1999 mA ± 80 nA
	10 mA	Zero	00. --- ● V mV mA	± 500 nA
		Full scale	12. --- ● V mV mA	11.999 mA ± 0.8 μA
	100 mA	Zero	000. --- ● V mV mA	± 5 μA
		Full scale	120. --- ● V mV mA	119.99 mA ± 8 μA



8. OPERATING PRINCIPLE

8.1 Block Diagram

The R6142 is a DC voltage generator that applies pulse width modulation (PWM), which is used widely in communications and magnetic recording areas, for voltage division by the time division method.

Figure 8-1 shows the block diagram of the R6142.

The R6142 consists of the following three basic blocks: controller, reference voltage generator, and output amplifier.

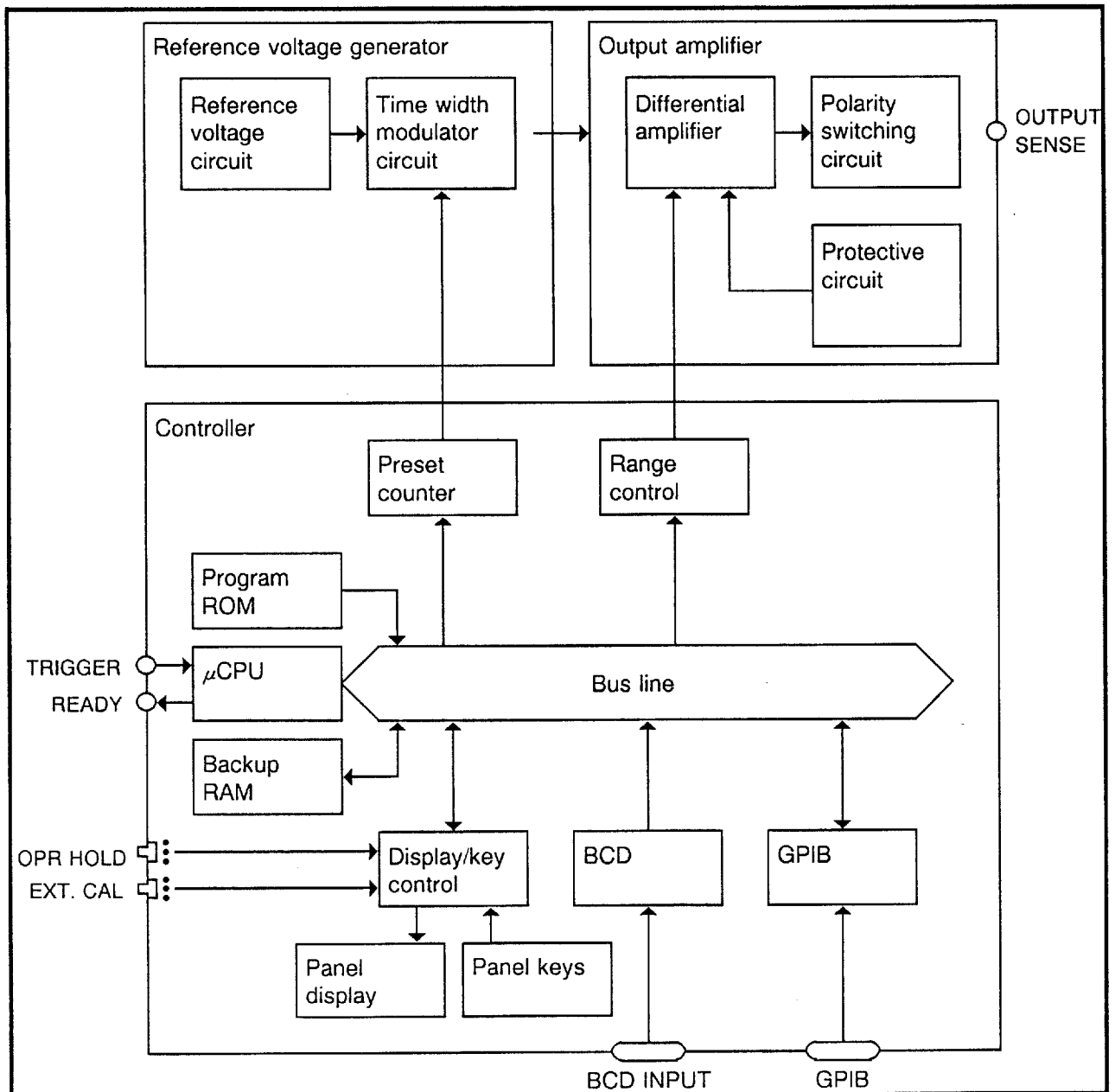


Figure 8-1 Block Diagram

8.2 Block Description

This section briefly describes the blocks.

(1) Controller

The μ CPU controls inputs by key operation from the panel and display on the panel. Data received through the selected BCD parallel interface or GPIB interface is processed by the μ CPU, converted to PWM modulated pulses by the preset counter, and sent to the reference voltage generator.

(2) Reference voltage generator

The reference voltage generator consists of a time width modulator circuit and a reference voltage circuit which divides voltage by the time division method. Figure 8-2 (a) is an equivalent circuit of voltage division by the time division method.

Input reference voltage E_z is converted to an intermittent signal with time and averaged by the low-pass filter, R and C. The ratio between reference voltage E_z and averaged output voltage E_s , i.e. voltage division ratio, depends on the time ratio of the intermittence. The intermittent signal, that is produced by switching reference voltage E_z on and off with switch SW, is a square wave which is made up of reference voltage E_z lasting for time T_1 and zero voltage lasting for T_2 . Average voltage E_s of the square waves in Figure 8-2 (b) is calculated as follows:

$$E_s = \frac{T_1}{T_1 + T_2} \cdot E_z$$

Any output level can be obtained by changing time T_1 for a fixed time of T_1 plus T_2 .

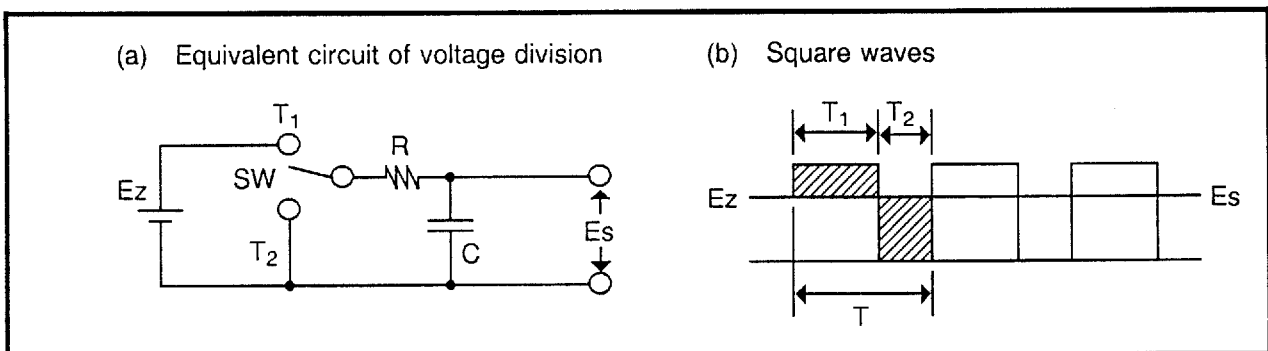


Figure 8-2 Time Division Method

The reference voltage circuit generates reference voltage E_z . The time width modulator circuit generates pulses with pulse width T_1 corresponding to a set output level. Reference voltage E_z is switched and the low-pass filter averages the pulses to generate a required voltage.

(3) Output amplifier

The output amplifier consists of a differential amplifier, a polarity switching circuit, and a protective circuit. Figure 8-3 shows the principle of the output amplifier and polarity switching circuit.

The R6142 switches ranges by changing R_f , R_1 , and R_s .

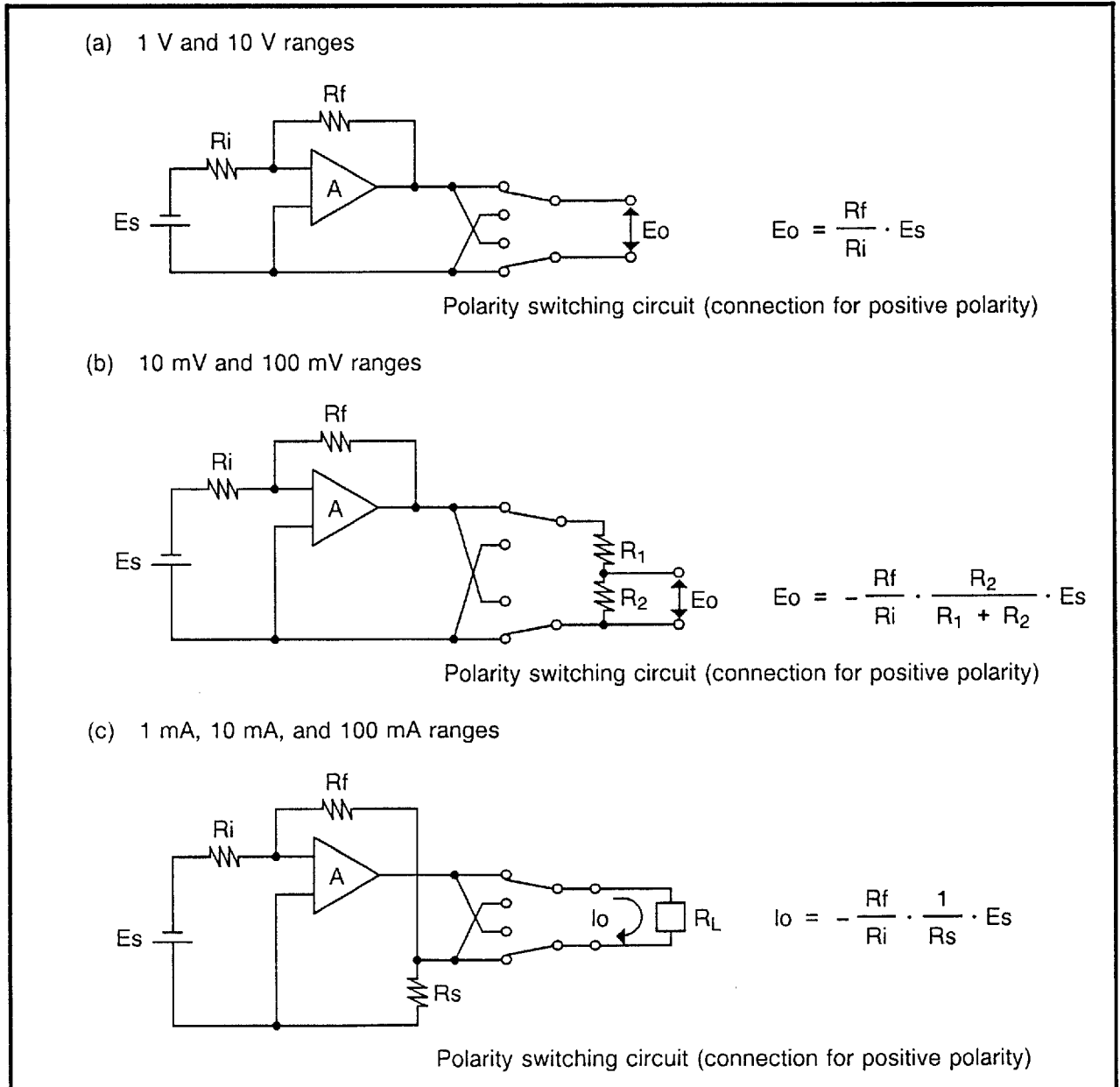


Figure 8-3 Principle of the Output Amplifier and Polarity Switching Circuit

9. SPECIFICATIONS AND ACCESSORIES

9.1 Voltage/Current Generation

- Output range, accuracy, and stability:

Range	Output range	Resolution	Overall accuracy (6 months) ± (% of setting + X)	Stability (1 day) ± (% of setting + X)	Temperature coefficient ± (ppm/°C of setting + X/°C)
10 mV	0 to ± 11.999 mV	1 μ V	0.03 + 5 μ V	0.01 + 4 μ V	20 + 200 μ V
100 mV	0 to ± 119.99 mV	10 μ V	0.03 + 25 μ V	0.01 + 10 μ V	20 + 2 μ V
1 V	0 to ± 1.1999 V	100 μ V	0.03 + 200 μ V	0.01 + 50 μ V	20 + 10 μ V
10 V	0 to ± 11.999 V	1 mV	0.03 + 2 mV	0.01 + 200 μ V	20 + 40 μ V
1 mA	0 to ± 1.1999 mA	100 nA	0.035 + 300 nA	0.01 + 20 nA	20 + 4 nA
10 mA	0 to ± 11.999 mA	1 μ A	0.035 + 3 μ A	0.01 + 200 nA	20 + 40 nA
100 mA	0 to ± 119.99 mA	10 μ A	0.04 + 30 μ A	0.01 + 2 μ A	20 + 400 nA

- The overall accuracy and stability are at $23 \pm 5^\circ\text{C}$, 70% RH or less, and a constant power supply and load.
- The temperature coefficient is at 0 to 50°C .
- The overall accuracy includes a linearity error.

- Linearity:

± 110 ppm for the full scale of all ranges.

R6142
PROGRAMMABLE DC VOLTAGE/CURRENT GENERATOR
INSTRUCTION MANUAL

9.1 Voltage/Current Generation

- Maximum load, output resistance, and output noise:

Range	Maximum load current/voltage		Output resistance	Output noise (P-P)		
				DC to 100Hz	DC to 10kHz	20Hz to 20MHz
10 mV	0.6 μ A	(20 k Ω load that causes a 0.01% error)	Approx. 2 Ω	5 μ V	10 μ V	3 mV
100 mV	6 μ A			15 μ V	30 μ V	
1 V	Source : 120 mA Rank : 100 mA		0.4 m Ω or less	80 μ V	150 μ V	
10 V			4 m Ω or less	200 μ V	500 μ V	
1 mV	10 V Output following voltage		100 M Ω or more	30 nA	150 nA	6 μ A
10 mV			10 M Ω or more	300 nA	400 nA	
100 mV			1 M Ω or more	3 μ A	4 μ A	

- The output noise for the 1 mA, 10 mA, and 100 mA ranges is at a load resistance of 1 k Ω .
- The output resistance for the 1 V and 10 V ranges is at 4-wire connection. The output resistance for other ranges is at 2-wire connection.

- Noise elimination ratio in common mode:
80 dB or more at an unbalanced impedance of 1 k Ω , DC and 50/60 Hz
- Line regulation:
 $\pm 0.007\%$ of a range at rated-voltage fluctuations of -15% to $+10\%$
- Load regulation:
 $\pm 0.005\%$ of a range (excluding the 10 mV and 100 mV ranges) at the maximum load of 4-wire connection

R6142
PROGRAMMABLE DC VOLTAGE/CURRENT GENERATOR
INSTRUCTION MANUAL

9.1 Voltage/Current Generation

- Maximum load capacitance and inductance:

Range	Maximum load capacitance	Maximum load inductance
1/10 V	1000 μ F	500 μ H
1/10/100 mV	100 μ F	1 mH

- The maximum load inductance for the 1/10 V range and the maximum load capacitance for the 1/10/100 mA range are those while the limiter is operating at the maximum setting.

9.2 Execution Speed

- Settling time:

The time interval, following the start of output changing, required for the output to enter $\pm 0.1\%$ centered on the final value of the output when the output changes from zero to the full scale at the maximum limiter setting

Range	Load condition	Overshoot/ undershoot	Settling time
All ranges	Maximum resistance load	$\pm 0.1\%$ centered on final value	50 ms or less
1 V and 10 V ranges	30 μF capacitance connected		50 ms or less
	100 μF capacitance connected		60 ms or less

- Execution time:

The time interval between the reception of a program code through the GPIB interface or an output level through the BCD interface and the start of output changing, 5 ms or less (The execution time for the use of the GPIB interface assumes that model 216 of HP 9000 Series is used.)

9.3 Voltage/Current Limiter

- Range of setting and stability:

	Range of setting	6-month stability \pm (% of setting + X)
Current limiter	5 mA to 120 mA	10 + 1 mA
Voltage limiter	1 V to 10 V	5 + 100 mV

- The stability is at $23 \pm 5^\circ\text{C}$.
- The current limiter is effective when the R6142 is engaged in source operation.

9.4 Memory

- Number of storage portions:
160 channels
- Recall mode:
 - Random : A channel is specified to recall data from.
 - Step : The TRIGGER signal is input or the STEP key is pressed to recall data channel by channel.
 - Scan : Data is recalled from channels at a step time specified on the built-in timer.
- Scan mode:
 - Single : Scanning starts from the first channel and ends at the last channel.
 - Repeated : Scanning is repeated over the first channel through the last channel.
- Step time:
The time interval when one-channel data is output in the scan mode or sweep mode. The step time can be varied from 0.1 second to 10 seconds at an interval of 0.1 second.

9.5 Sweep

- Sweep : The current set value is continuously incremented to the full scale or decremented to zero at a specified step time. The TRIGGER signal input or pressing the \triangle or ∇ key stops the sweep.
Resolution : Count 1, 10, 100, and 1000

9.6 Input/Output

- TRIGGER input:

A TTL negative-logic pulse with a 5 milliseconds or more width that is input to the TRIGGER input terminal on the rear panel to start/stop the step operation, scanning, or to stop the sweep operation.

Input terminal : BNC connector

- READY output:

A TTL negative-logic pulse with about a 10 milliseconds width that is output from the READY output terminal on the rear panel about 50 milliseconds after the output level changes in the operate ON state.

Output terminal : BNC connector

- GPIB interface:

Standard : IEEE STD488-1978

Interface function : SH1, AH1, T6, L3, SR1, RL1, PP0, DC1, DT1, C0, E1

Output data : Setting on the front panel

Remote programming : Functions and control excluding the POWER, SENSE, EXT CAL, and OPR HOLD switches, limiter setting, and device addressing

- BCD parallel interface:

Connector : BCD INPUT connector (36-pin, Amphenol type) on the rear panel

Remote programming : Output level (BCD parallel, negative logic, up to 5 digits), polarity, range, operate status, and load signal

9.7 General Specifications

- Output : Floating unipolar output
- Output terminals:
 Binding post terminals on the front panel (High output, High sense, Low output, Low sense)
- Maximum Applied Voltages between Terminals:

Terminals	Range	Maximum Applied Voltage	
		Positive (+) Output Polarity	Negative (-) Output Polarity
Hi and Lo	1V, 10 V	- 0.5 V peak to + 32 V peak	+ 0.5 V peak to - 32 V peak
	10 mV, 100 mV	- 0.5 V peak to + 0.5 V peak	
Lo and GND	- 500 V peak to + 500 V peak		

- Remote sensing system:
 4-wire (4WIRE) or 2-wire (2WIRE) connection can be selected with the SENSE switch on the front panel.
- Maximum remote sensing voltage:
 0.3 V between High/Low output and sense lines including a voltage drop caused by cable resistance
- Setting method:
 Manual setting : All-digit sweep setting with Δ and ∇ keys, and direct setting with numeric keys
 Remote setting : Setting through GPIB interface or BCD parallel interface
- Display and indication:
 Output setting : Polarity + 5-digit 7-segment display + Unit
 Operation : Limiter, operate status (LED lamp)
 Mode : Direct, memory, step (LED lamp)
 GPIB : LISTEN, SRQ, REMOTE (LED lamp)
- Backup parameters:
 Output level, polarity, range, memory data, step time, first/last channel, scan mode, operate ON state (OPR HOLD switch ON), GPIB/BCD remote mode, device address
- Warm-up time:
 The time interval required until a specified accuracy is attained, 30 minutes

R6142
PROGRAMMABLE DC VOLTAGE/CURRENT GENERATOR
INSTRUCTION MANUAL

9.7 General Specifications

- Operating environment:
 - Ambient temperature : 0°C to +50°C
 - Relative humidity : 85% or less, dew condensation not acceptable
- Storage environment:
 - Ambient temperature : -25°C to +70°C
- Power supply:
 - 90 to 110 Volts AC, 48 to 66 Hz

- Supply voltage selection:
 - The supply voltage can be changed with the selector switch on the rear panel.

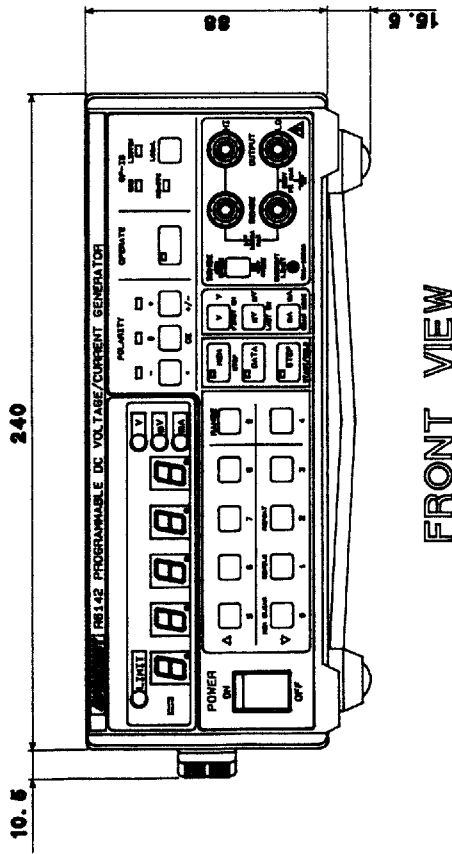
Option No.	Standard	Opt. 32	Opt. 42	Opt. 44
Supply voltage	90 V to 110 V	103 V to 132 V	198 V to 242 V	207 V to 250 V

· Use 120 V and 240 V for 115 V and 230 V respectively.

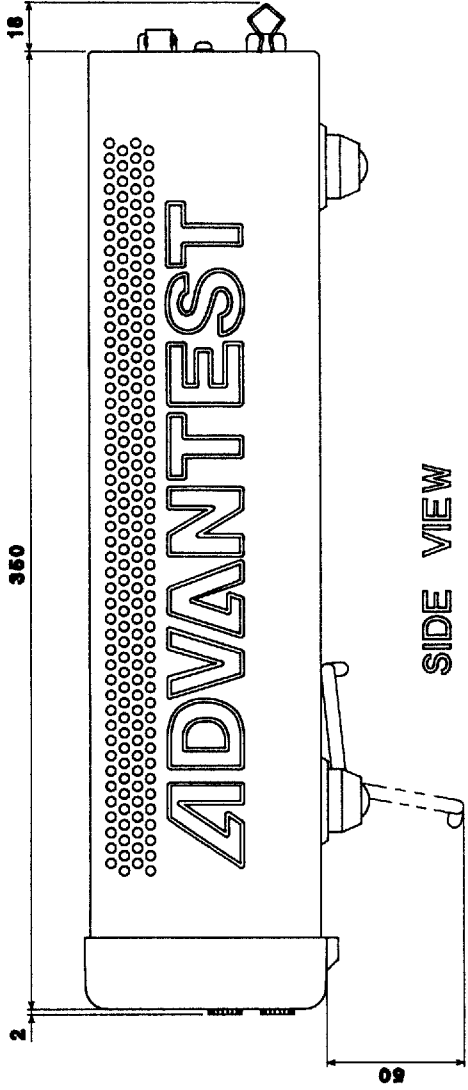
- Power consumption:
 - 26 VA or less
- Dimensions:
 - Approx. 240 (width) × 88 (height) × 360 (depth) mm
- Mass : Approx. 4 kg

9.8 Accessories

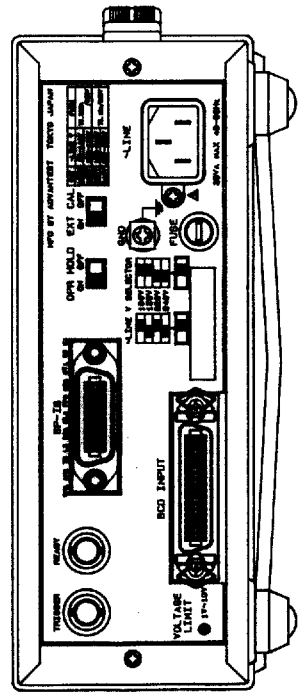
Name	Model	Remarks
Connection cable	MI-40	Plug end and clip end, 2-wire cable, 150 cm
	A01023	Plug end and clip end, 4-wire cable, 80 cm, 100 cm, 150 cm, or 250 cm
Panel mount kit	A02017	
Rack mount kit	A02621-J	JIS standard
	A02621	EIA standard
Carrying case	TR16204A	



FRONT VIEW



SIDE VIEW



REAR VIEW

R6142
EXTERNAL VIEW

EXT1-9105-A

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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.