6144
Programmable DC Voltage/ Current Generator
Instruction Manual

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

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

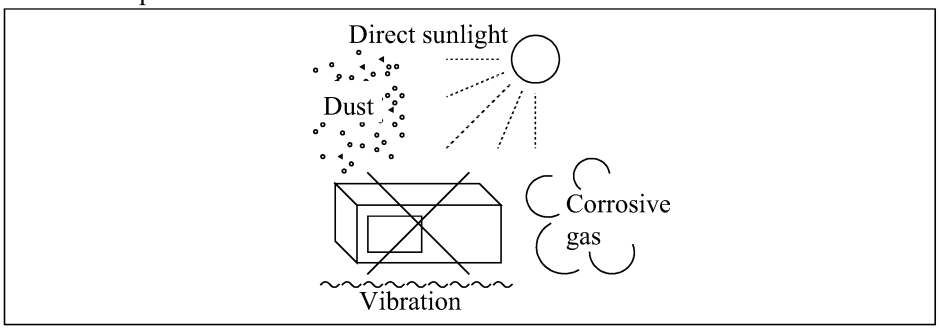


Figure-1 Environmental Conditions

- Operating position

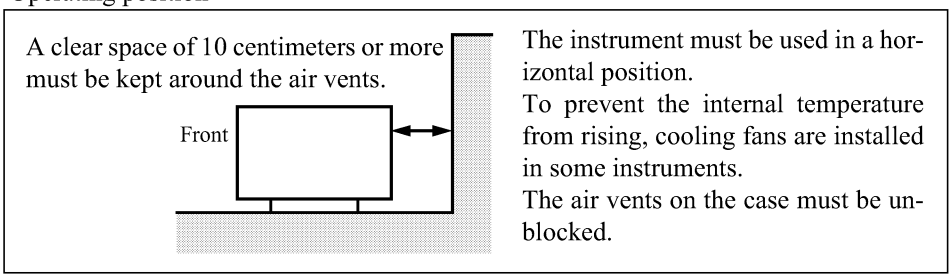


Figure-2 Operating Position

- Storage position

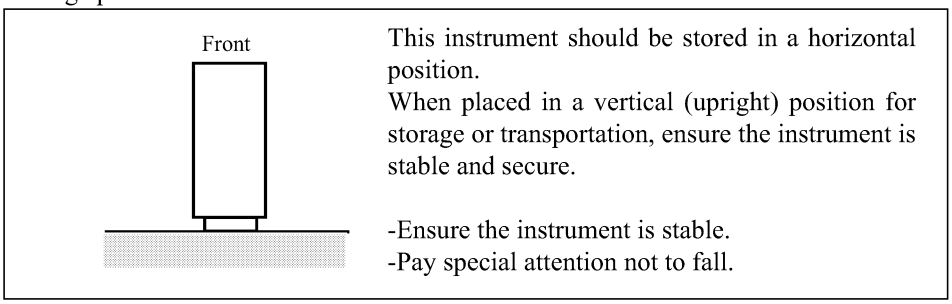


Figure-3 Storage Position

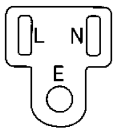
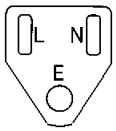
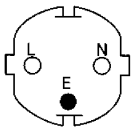
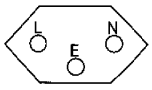
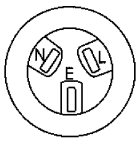
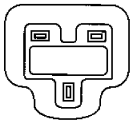
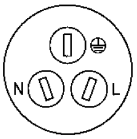
- The classification of the transient over-voltage, which exists typically in the main power supply, and the pollution degree is defined by IEC61010-1 and described below.

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

  Pollution Degree 2

Types of Power Cable

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

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

ORGANIZATION OF THIS MANUAL

This manual explains how to use the 6144 and is organized as follows:

1. OVERVIEW	This chapter outlines the functions of the 6144 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 R6144, using a block diagram.
9. SPECIFICATIONS AND ACCESSORIES	This chapter describes specifications of and accessories for the 6144.

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1. OVERVIEW

This chapter outlines the functions of the 6144 and contains notes on its use. Be sure to read this chapter before use.

1.1 Product Outline

The 6144 is a DC voltage/current generator employing a time-division D/A conversion technique.
The 6144 generates a DC voltage of 0 to ±32 V at a minimum step of one microvolt, and a DC current of 0 to ±160 mA at a minimum step of 0.1 microampere. The 6144 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 6144 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 32 V/160 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%
- 90 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 6144 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 an ADC CORPORATION sales representative.

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	——	J 6144	1	Japanese version
	——	E 6144		English version

1.2.2 Place of Use and Notes

(1) Place of use

Avoid using the 6144 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 6144 in an ambient temperature of 0°C to +50°C and a humidity of 85% or less.
- Use a grounded outlet.
- To protect the 6144 from overheating, do not block the ventilations holes on top exercise care that the unit is well ventilated. Do not place the 6144 near a heat source.
- Take antistatic measures (earth band) for the 6144 and connected devices.
- Use a line filter when using the 6144 near a noise source.

(3) Storage

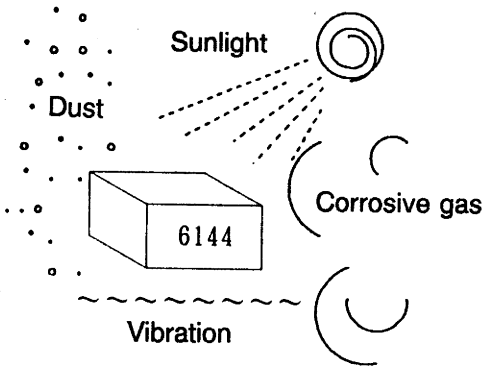
When the 6144 is not to be used for a long period of time, cover the unit with a vinyl cover or placed in a cardboard box store the unit in an areas which are not subject to direct sunlight, or high humidity and temperatures. The storage temperature should not exceed −25°C to +70°C.

(4) Cleaning

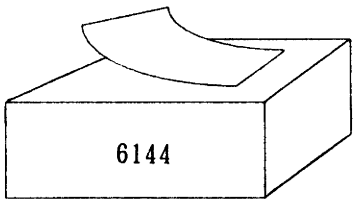
CAUTION

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 6144 through the power line.

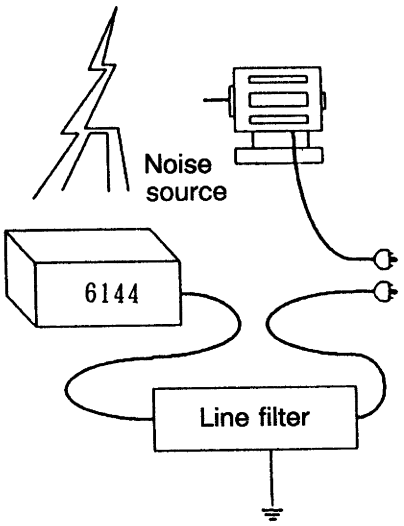


Figure 1-1 Working Environment

(5) Transport

When transporting the 6144, reuse the packing materials that were supplied with the unit on delivery. If they are not available, pack the 6144 using the following procedure:

Procedure

① Wrap the 6144 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 6144, make sure that the power switch is OFF.
- Make sure that the supply voltage to be used matches the set position of the units supply voltage selector switch. (See Fig. 1-2)
- The power frequency can be either 50 Hz or 60 Hz.

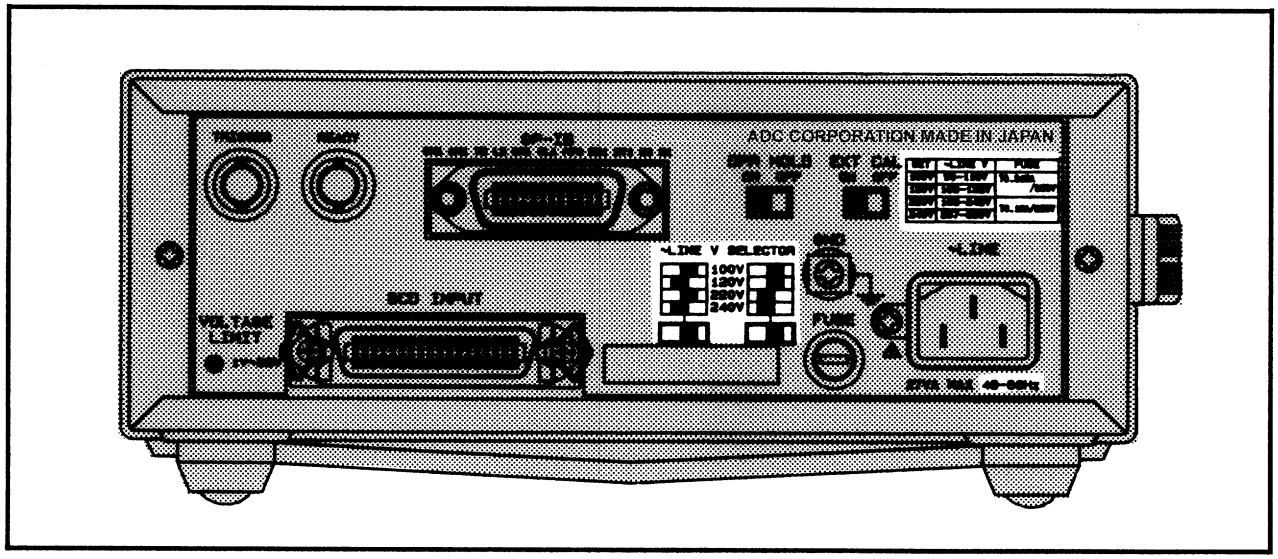


Figure 1-2 Supply Voltage Selector Switch

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). Use a grounded outlet with the unit.

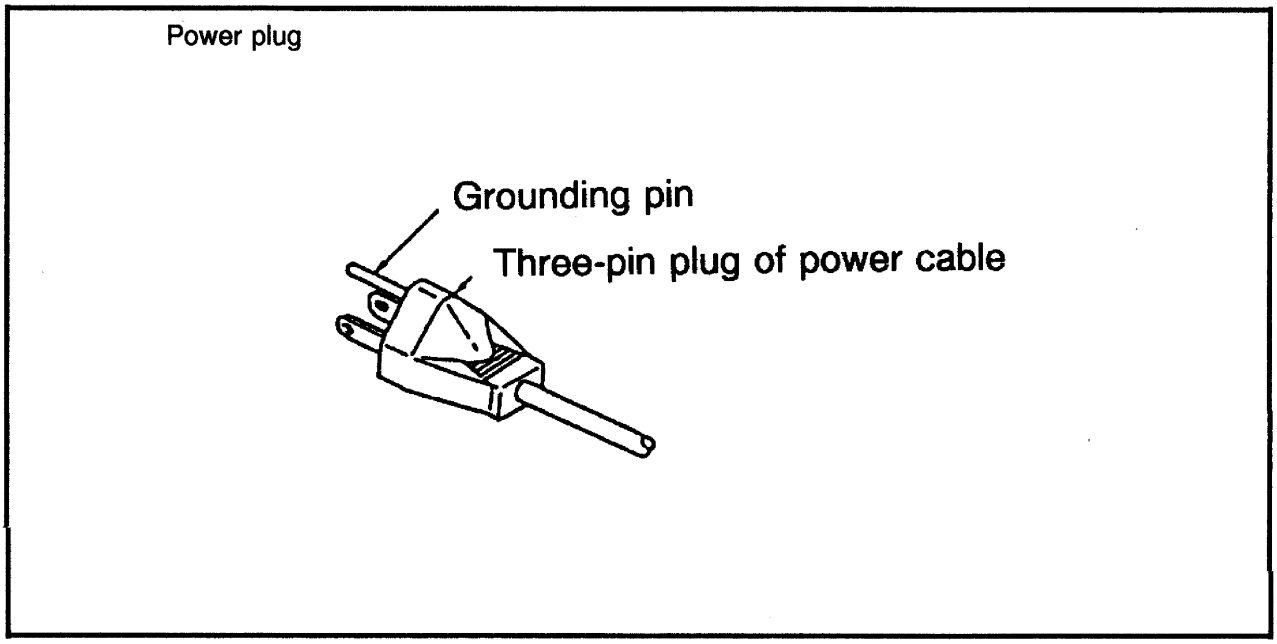


Figure 1-3 Power Cable Plug

1.2.5 Replacing Fuses

CAUTION

1. Before replacing fuses, turn the POWER switch OFF and unplug the 6144.
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 6144 are available as soon as the 6144 is turned on. However obtain the specified accuracy, allow the unit to heat up for approximately 30 minutes.

1.3 Replacing Parts with Limited Life

The 6144 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.")

<Voltage and Current Display Descriptions>

The voltages and currents displayed on terminal parts are as follows.

- Between HI OUTPUT/ HI SENSE and LO OUTPUT/ LO SENSE
  Maximum output voltage: 12 V
  Maximum output current: 120 mA
- Between LO OUTPUT/ LO SENSE and GND
  Maximum applied voltage: 500 Vpeak

CAUTION

The maximum applied voltages from the outside are as follows.
Do not apply voltage which exceeds the following ranges.

1. For 1 V or 10 V range
   For positive polarity (+): -0.5 V to +32 Vpeak
   For negative polarity (-): +0.5 V to -32 Vpeak
2. For 10 mV or 100 mV range
   Regardless of the polarities ((+) or (-)):
   -0.5 V to +0.5 Vpeak

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

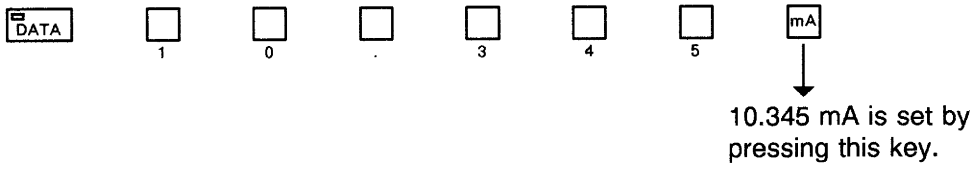
A switch to turn on or off the generator power.
When this switch is turned on, the power is supplied to the 6144. The 6144 severally displays the product name and the software revision number/update number for about three seconds, then it becomes ready for operation. (See Section 3.1 "Turning Power On.")

⑤ V, mV, and mA keys

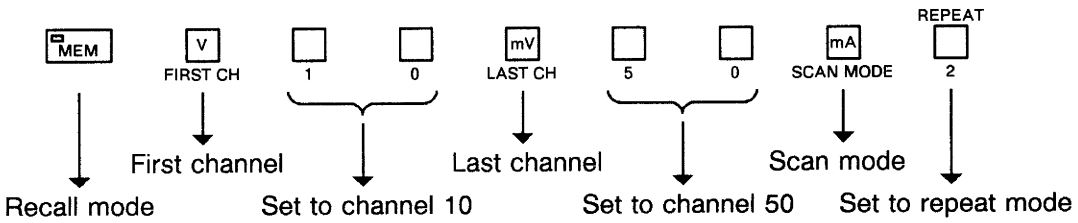
- Used to select the voltage/current output range.

  [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 △ 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 △ 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 $\square_{9}$ and $\square_{4}$.
- Used to select a calibration point in the calibration mode. Tables 2-2 and 2-3 show calibration points and associated display.

Table 2-1 Voltage/Current Output Ranges and Display

	△ and ▽ key operation	Display	Range
Voltage generation	▽ △	● 30V RANGE ● V 10.000 mV mA	30 V
	▽ △	30V RANGE ● V 10.000 mV mA	10 V
	▽ △	30V RANGE ● V 1.0000 mV mA	1 V
	▽ △	30V RANGE V 100.00 ● mV mA	100 mV
	▽ △	30V RANGE V 10.000 ● mV mA	10 mV
Current generation	▽ △	30V RANGE V 100.00 mV ● mA	100 mA
	▽ △	30V RANGE V 10.000 mV ● mA	10 mA
	▽ △	30V RANGE V 1.0000 mV ● mA	1 mA

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

△ and ▽ key operation	Display	Calibration point
▽ ↻ △	● 30V RANGE ● V mV 32.___ mA	30 V range, full scale
▽ ↻ △	● 30V RANGE ● V mV 00.___ mA	30 V range, zero
▽ ↻ △	30V RANGE ● V mV 16.___ mA	10 V range, full scale
▽ ↻ △	30V RANGE ● V mV 00.___ mA	10 V range, zero
▽ ↻ △	30V RANGE ● V mV 1.6___ mA	1 V range, full scale
▽ ↻ △	30V RANGE ● V mV 0.0___ mA	1 V range, zero
▽ ↻ △	30V RANGE V ● mV 160.__ mA	100 mV range, full scale
▽ ↻ △	30V RANGE V ● mV 000.__ mA	100 mV range, zero
▽ ↻ △	30V RANGE V ● mV 16.___ mA	10 mV range, full scale
▽ ↻ △	30V RANGE V ● mV 00.___ mA	10 mV range, zero

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

△ and ▽ key operation	Display	Calibration point
▽ ↻ △	30V RANGE V mV ● mA 160.__	100 mA range, full scale
▽ ↻ △	30V RANGE V mV ● mA 000.__	100 mA range, zero
▽ ↻ △	30V RANGE V mV ● mA 16.___	10 mA range, full scale
▽ ↻ △	30V RANGE V mV ● mA 00.___	10 mA range, zero
▽ ↻ △	30V RANGE V mV ● mA 1.6___	1 mA range, full scale
▽ ↻ △	30V RANGE V mV ● mA 0.0___	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 □ (CE) (key clear) keys in the direct setting mode.

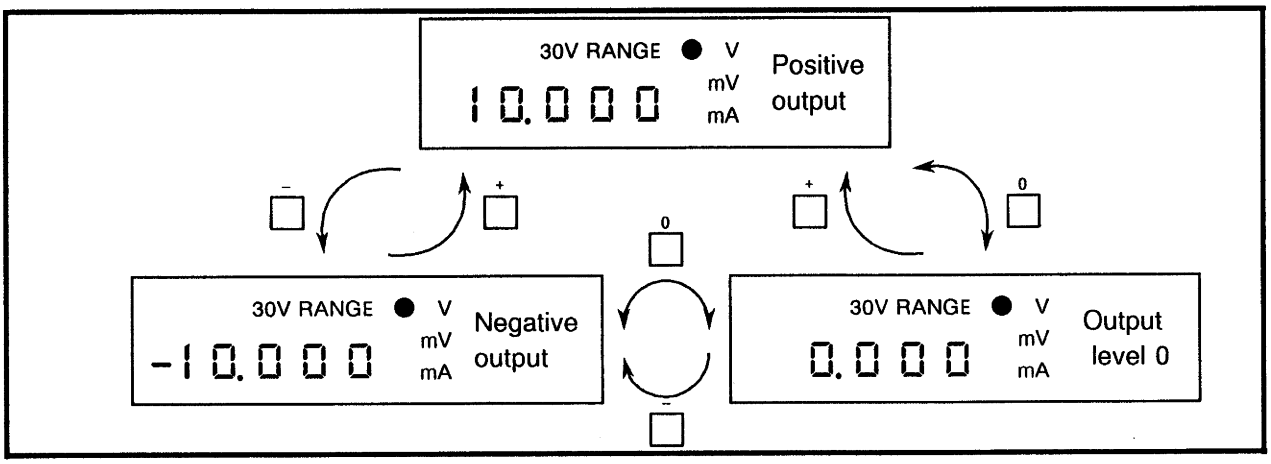


Figure 2-1 Sample Operation of POLARITY Keys

⑧ CURRENT LIMIT control

A control to adjust the current limiter when the 6144 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 160 mA. (See Section 3.5 "How to Use Limiters.")

⑨ Output level △ and ▽ keys and output level display

- Usually used to set an output level.
  Pressing a key on the △ 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 16000 (32000 for a 32 V range) or to drop below 00000, pressing the △ 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.

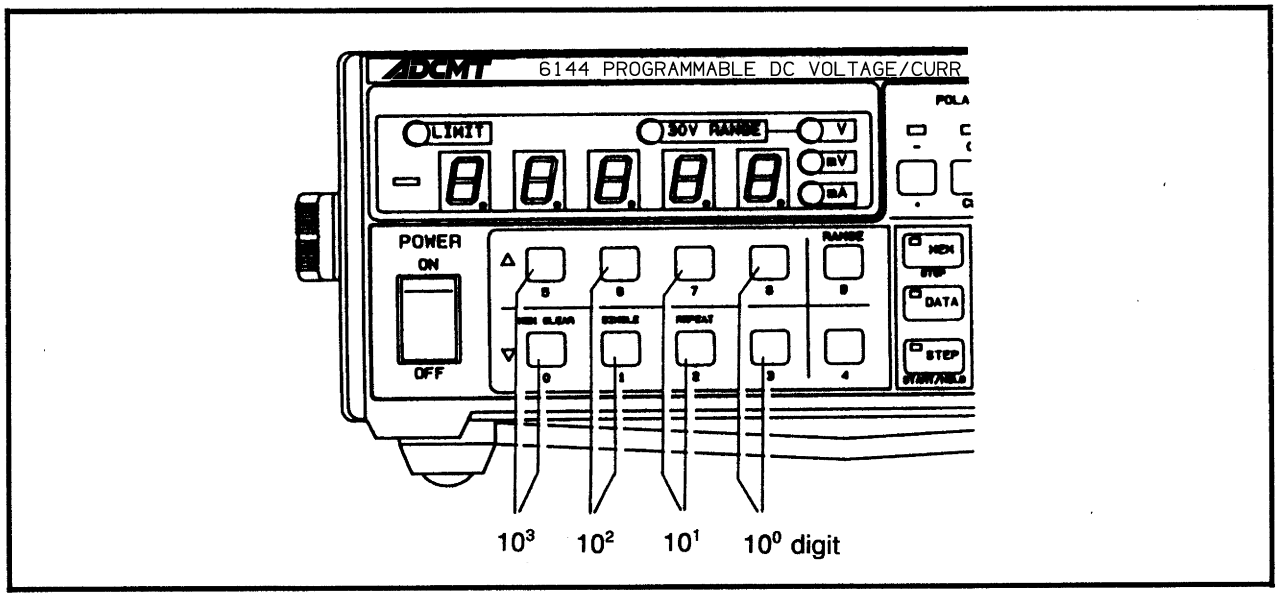


Figure 2-2 △ and ▽ Keys and Output Level Display

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 [0] to [3] and [5] to [8].
- If [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, C L E R is displayed. (See Section 3.1.4 "Initializing Parameters.")

SINGLE REPEAT
- [ ] and [ ] are used to select the type of scan in the scan mode.

  SinG : Single scan
  rEP : 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 6144 is in the recall mode.

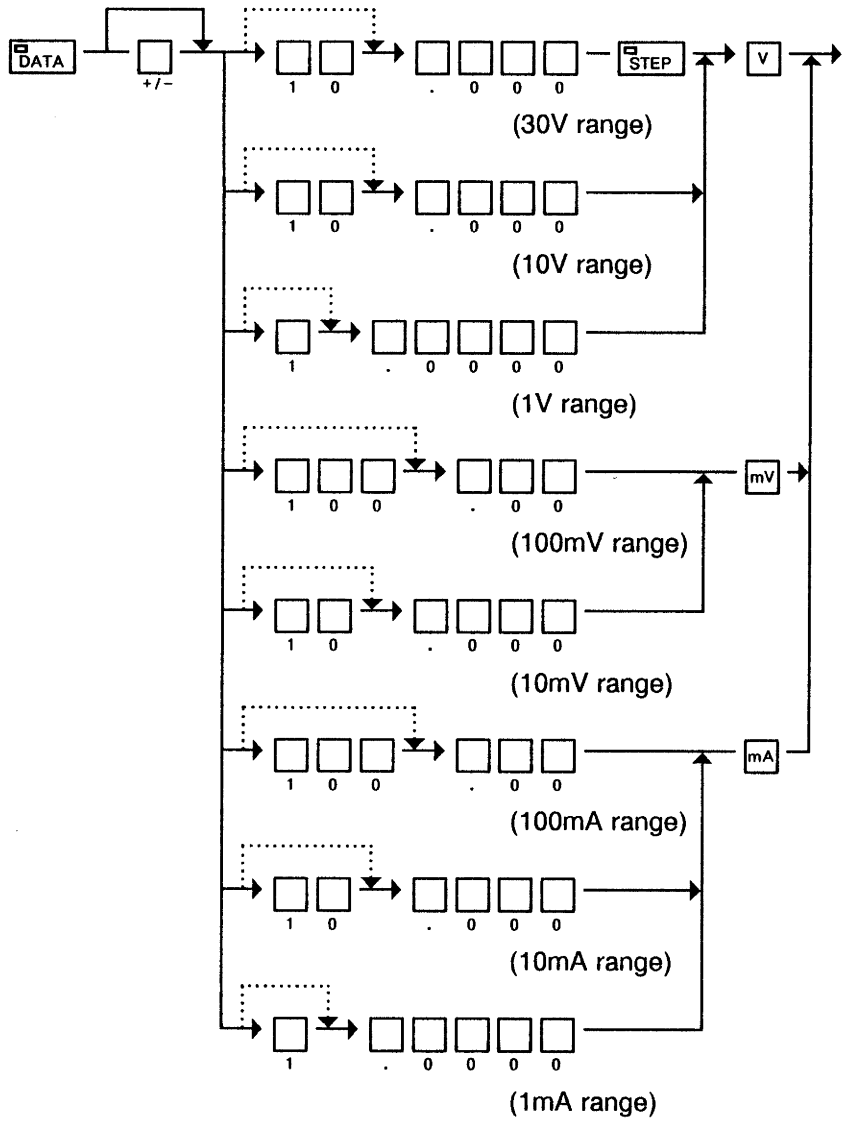
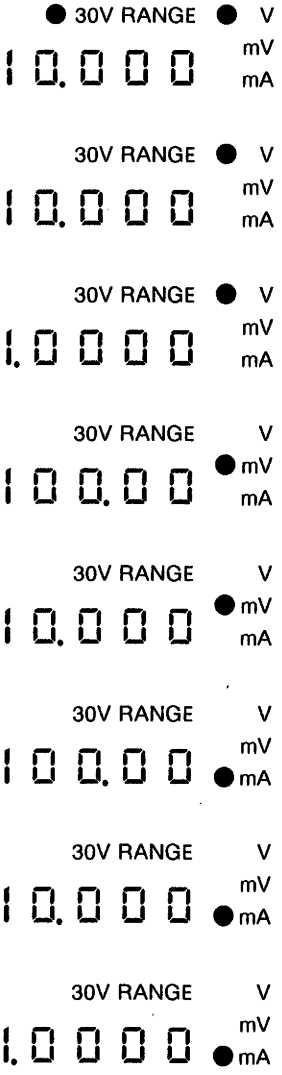
⑪ DATA key

- 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
[+/-]	Sets polarity.
[0] to [9]	Sets a value.
[.]	Sets the decimal point position (range).
[CE]	Clears setting.
[V], [mV], [mA]	Enters a set value when the range is set.
[DATA]	Exits the direct setting procedure without doing anything.

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

Key operation flow for direct setting	Display
	

Note: Follow the dotted line for setting fractional digits only.

- 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 [STEP] and enter a step time with [0] - [9] (in units of 0.1 second).
  Then press [STEP] to activate the setting.

[STEP] [0] [7] [2] [STEP]	The step time is set to 7.2 seconds.

Figure 2-3 Sample Operation of Setting the Step Time

- Used to switch the GPIB interface to and from the BCD interface.
  Press [STEP] and [LOCAL]. Then press [LOCAL] to select the GPIB or BCD interface. If the GPIB interface is selected, a device address can be set with [0] - [9].
  Press [STEP] 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.

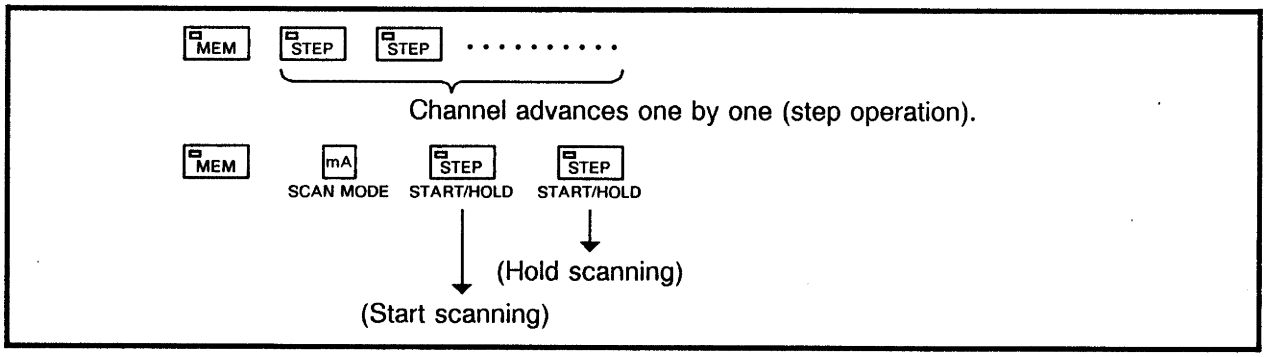


Figure 2-4 Sample Operation for Step Operation and Scanning

- Used to specify the 30 V range in the direct setting mode. (See Table 2-5 "Key Operation Flow for Direct Setting and Display".)

⑬ OPERATE key and OPERATE lamp

Used to turn ON or OFF the output.

OPERATE
[STEP] (lamp OFF) : The output is turned OFF.

OPERATE
[STEP] (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 6144 is sending a service request to the controller.

  LISTEN lamp : This lamp lights up when the 6144 is a listener that receives data.

  REMOTE lamp : This lamp lights up when the 6144 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 6144 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 6144 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 6144 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 28 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 6144 using BCD parallel signals.
(See Chapter 5 "BCD Parallel Interface.")

⑨ TRIGGER input terminal

Used to input a trigger signal into the 6144.
(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 6144 using GPIB signals.
(See Section 4.3 "Connection with Component Devices.")

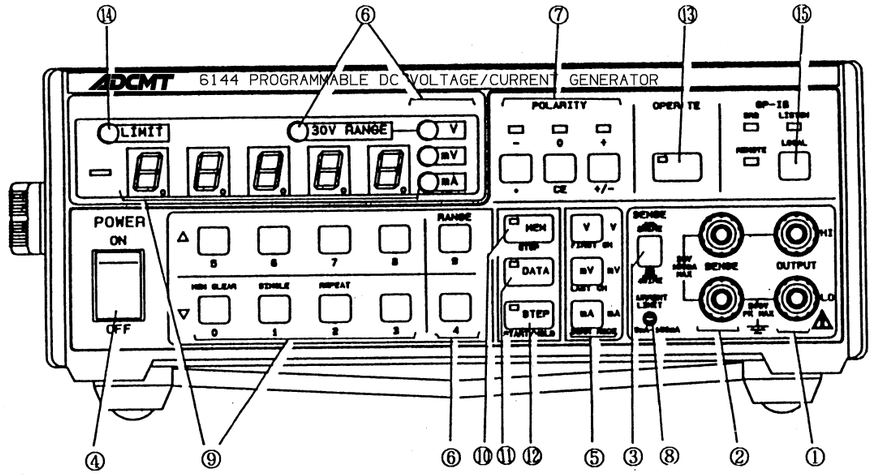


Figure 2-5 Front Panel

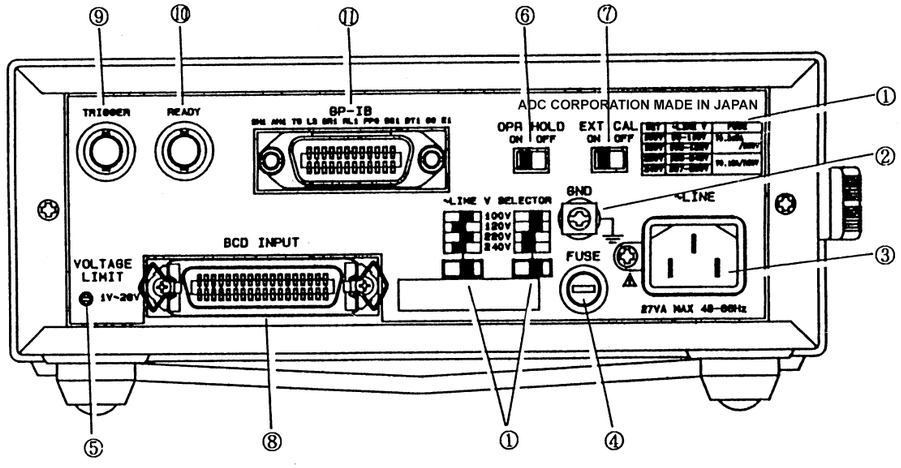


Figure 2-6 Rear Panel

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.

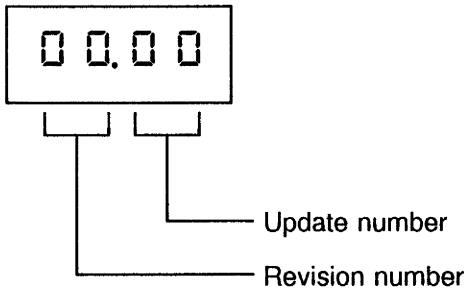
OPR HOLD switch position	Description
OFF	After the power is turned on, the 6144 enters the operate OFF (output OFF) state.
ON	After the power is turned on, the 6144 returns to the last operate state before the power was turned off. For example, if the power is turned off in the operate ON state, the 6144 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 6144 automatically performs self-diagnosis.
All LEDs on the front panel are lit during self-diagnosis if the 6144 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 product name and the internal software revision number / update number 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 6144 then returns to the operate ON state.
To cancel the automatic return, press the OPERATE key while the OPERATE lamp is blinking.

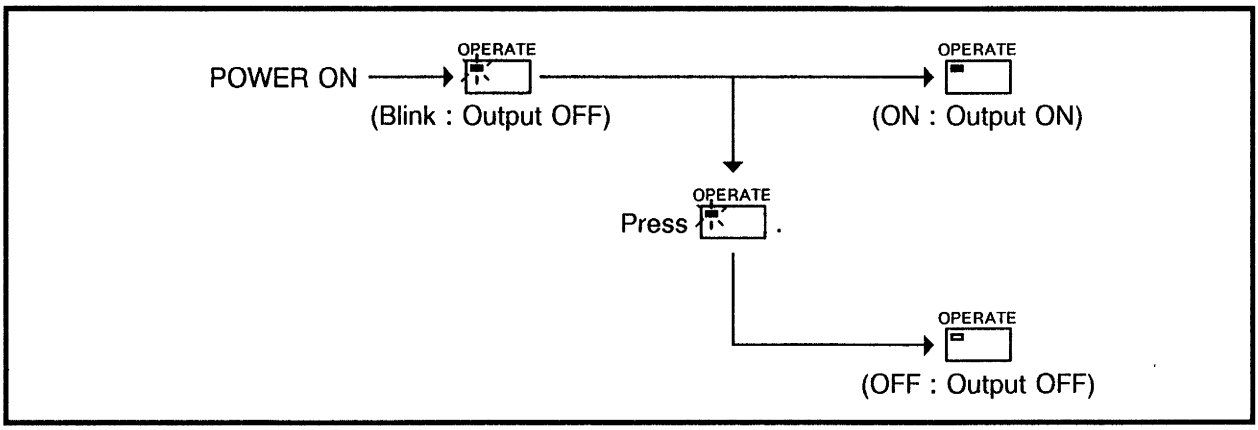


Figure 3-1 Canceling Automatic Return to the Operate ON State

3.1.3 Parameters Whose Setting Can Be Backed Up

When self-diagnosis is completed (indicating that the 6144 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 OPR 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.

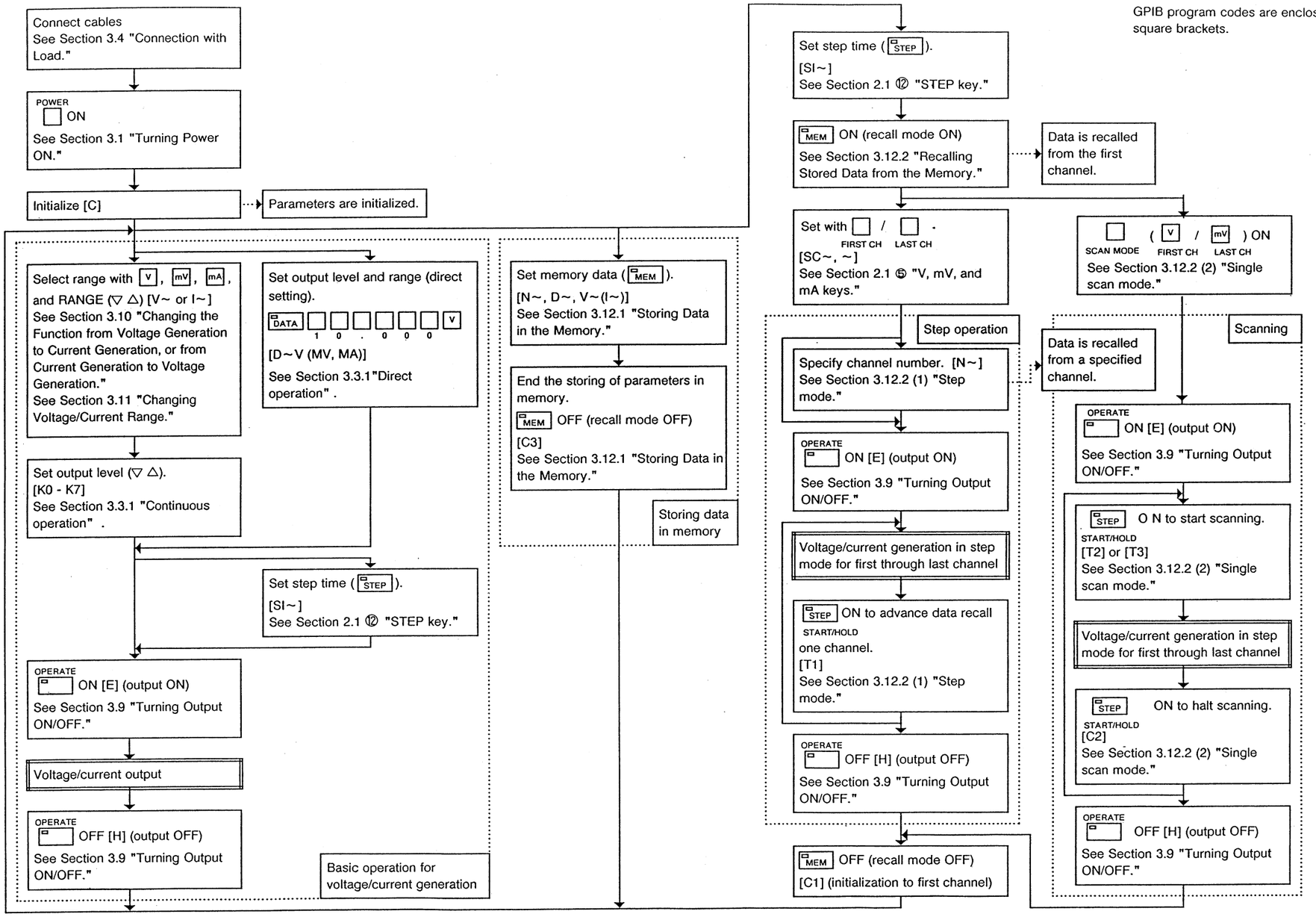
② C L E A will be displayed, indicating that the 6144 is ready for regular operation. (See Section 2.1 ⑨ "Output level △ and ▽ keys and output level display.")

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

Parameter	Initial condition
Range	1 V range
Output data	.0000 V
Step time	0.1s
Memory data (all channels)	● V 0 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

3.2 Before Getting Started

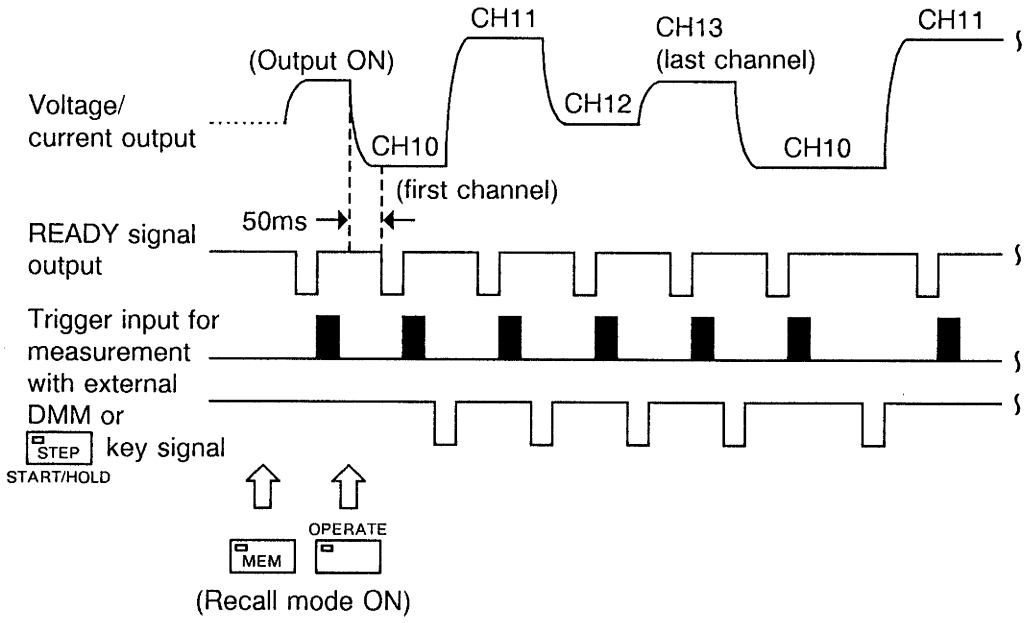
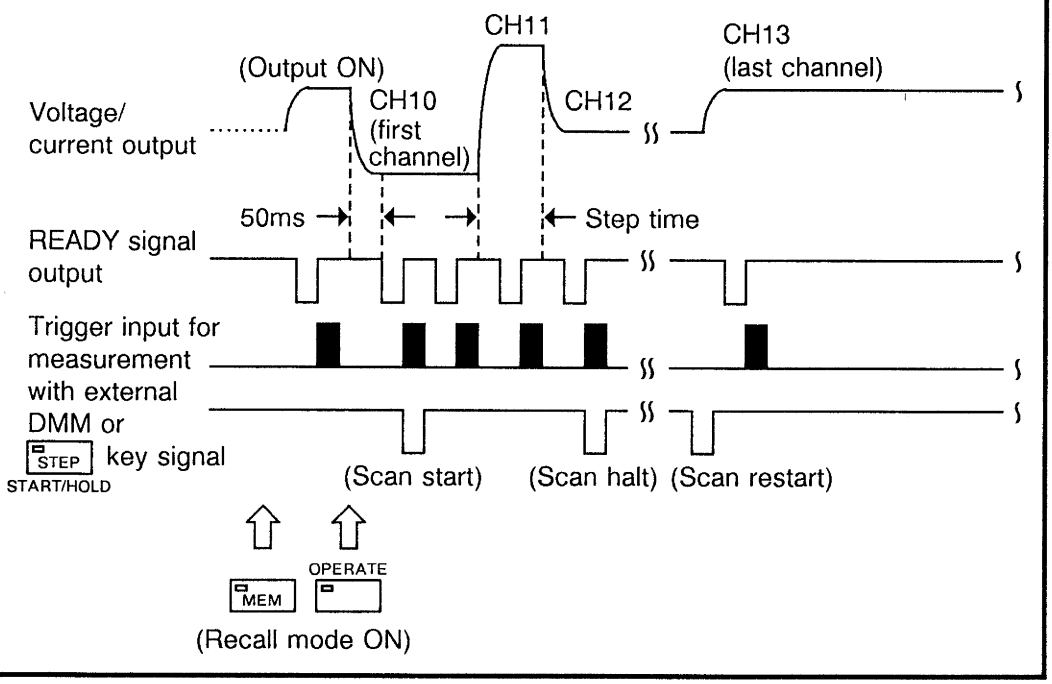
3.2.1 Basic Operation Flowchart



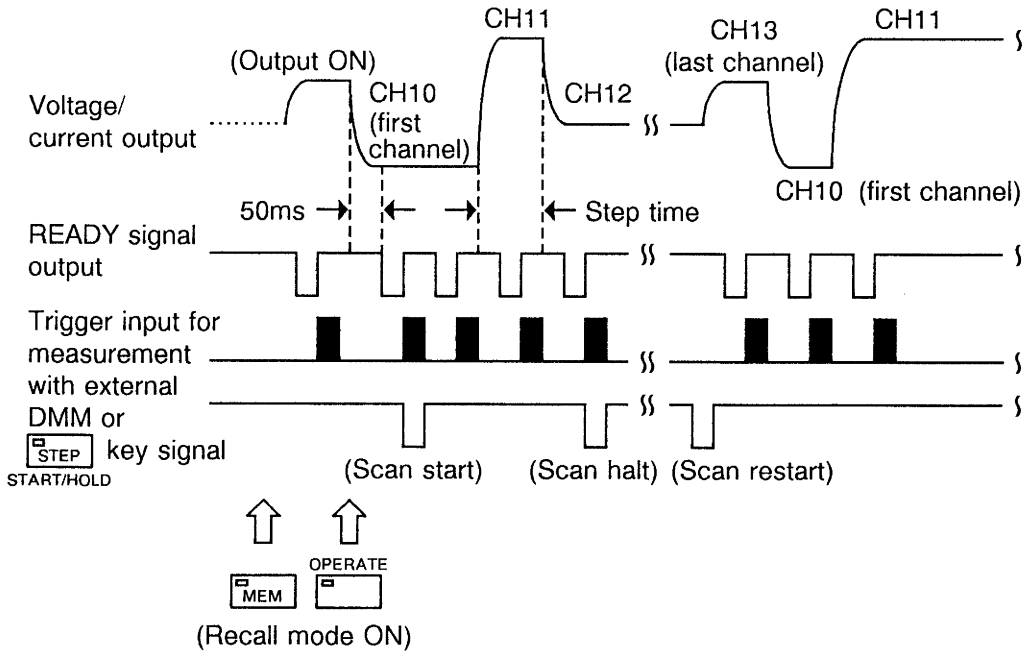
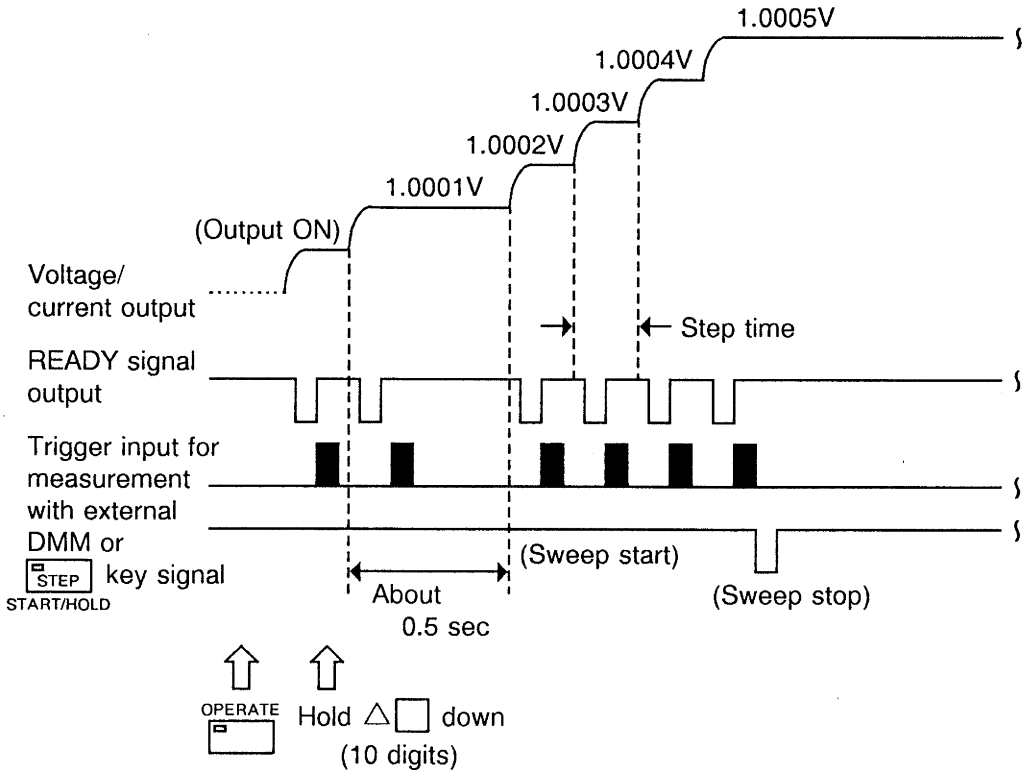
3.2.2 Parameters and Their Setting Range

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)	STEP [5] [0] STEP (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	MEM V FIRST CH [1] [0] MEM or (mV LAST CH / mA SCAN MODE) (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	MEM mV LAST CH [2] [0] MEM or (V FIRST CH / mA SCAN MODE) (Example of setting last channel to channel 20)
Scan mode	Single scan or repeated scan	SnGL or rEP	MEM mA SCAN MODE SINGLE MEM or (V FIRST CH / mV LAST CH) (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	STEP LOCAL LOCAL STEP ↑ Mode change
GPIB address	Device address in GPIB remote mode	A-00 to A-30 or LonL (Listen only)	STEP LOCAL [1] [3] STEP (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

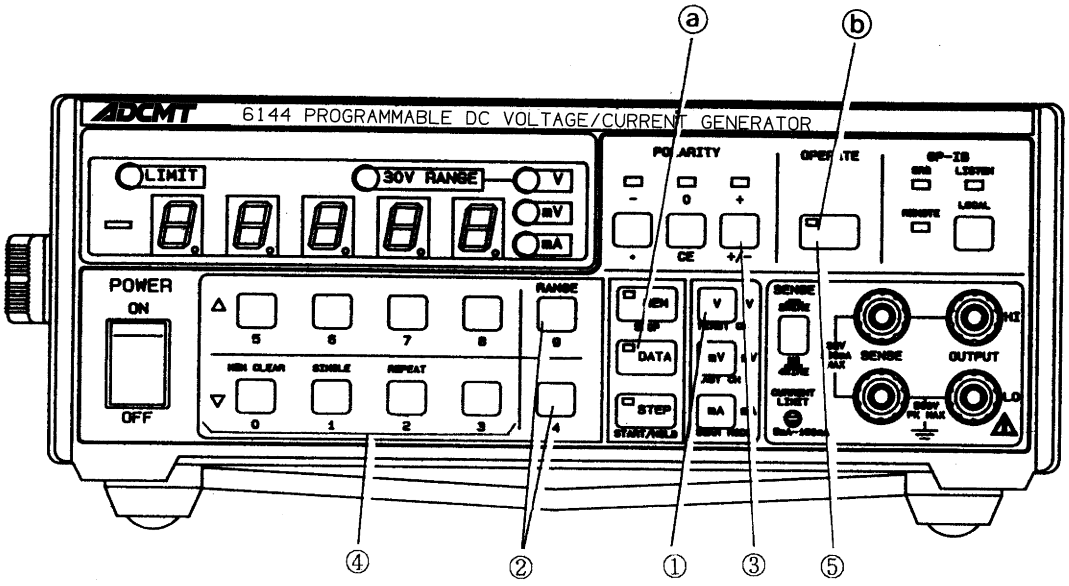
Operation mode	Operation timing
Step First channel: 10 Last channel: 13	
Single scan First channel: 10 Last channel: 13	

(cont'd)

Operation mode	Operation timing
Repeat scan First channel: 10 Last channel: 13	
Sweep (Initial setting: 1.0000 V)	

3.3 Examples of Basic Operation

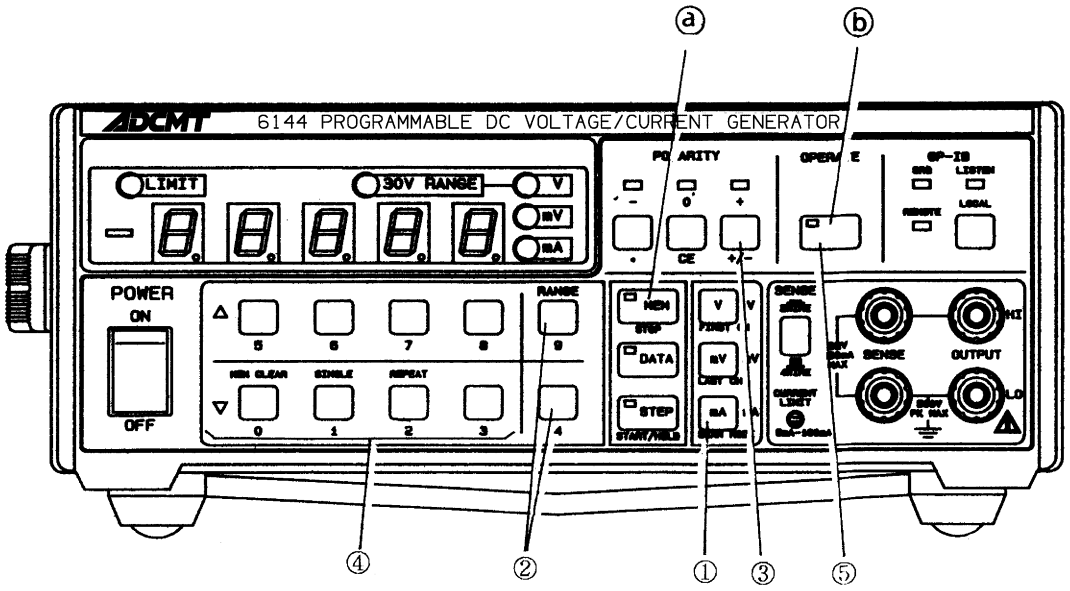
3.3.1 Generating 32 V DC



Procedure

Continuous operation	Direct operation
① Press [V] to select voltage generation. ② Press [RANGE] and set the voltage range to 30 V. (Decimal point: 4th digit from right; unit: V; 30 V RANGE: ON) ③ Press [+] to set polarity to "positive." ④ Press △ ▽ [ ] to set voltage to 32 V. ⑤ Press [OPERATE] to turn the output ON.	ⓐ Press [DATA] [3] [2] [.] [0] [0] [0] [STEP] [V] ⓑ Press [OPERATE] to turn the output ON.

3.3.2 Generating 16 Milliamperes DC



Procedure

Continuous operation	Direct operation
① Press [mA] to select current generation. ② Press [RANGE] and set the current range to 10 mA. (Decimal point: 4th digit from right) ③ Press [+] to set polarity to "positive." ④ Press △ ▽ [ ] to set current to 16 mA. ⑤ Press [OPERATE] to turn the output ON.	ⓐ Press [DATA] [1] [6] [.] [0] [0] [0] [mA] ⓑ Press [OPERATE] to turn the output ON.

3.4 Connection with Load

3.4.1 How to Use Four Output Terminals

The 6144 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, 10 V, or 30 V) is used and the load current is high because of a long distance between the 6144 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).

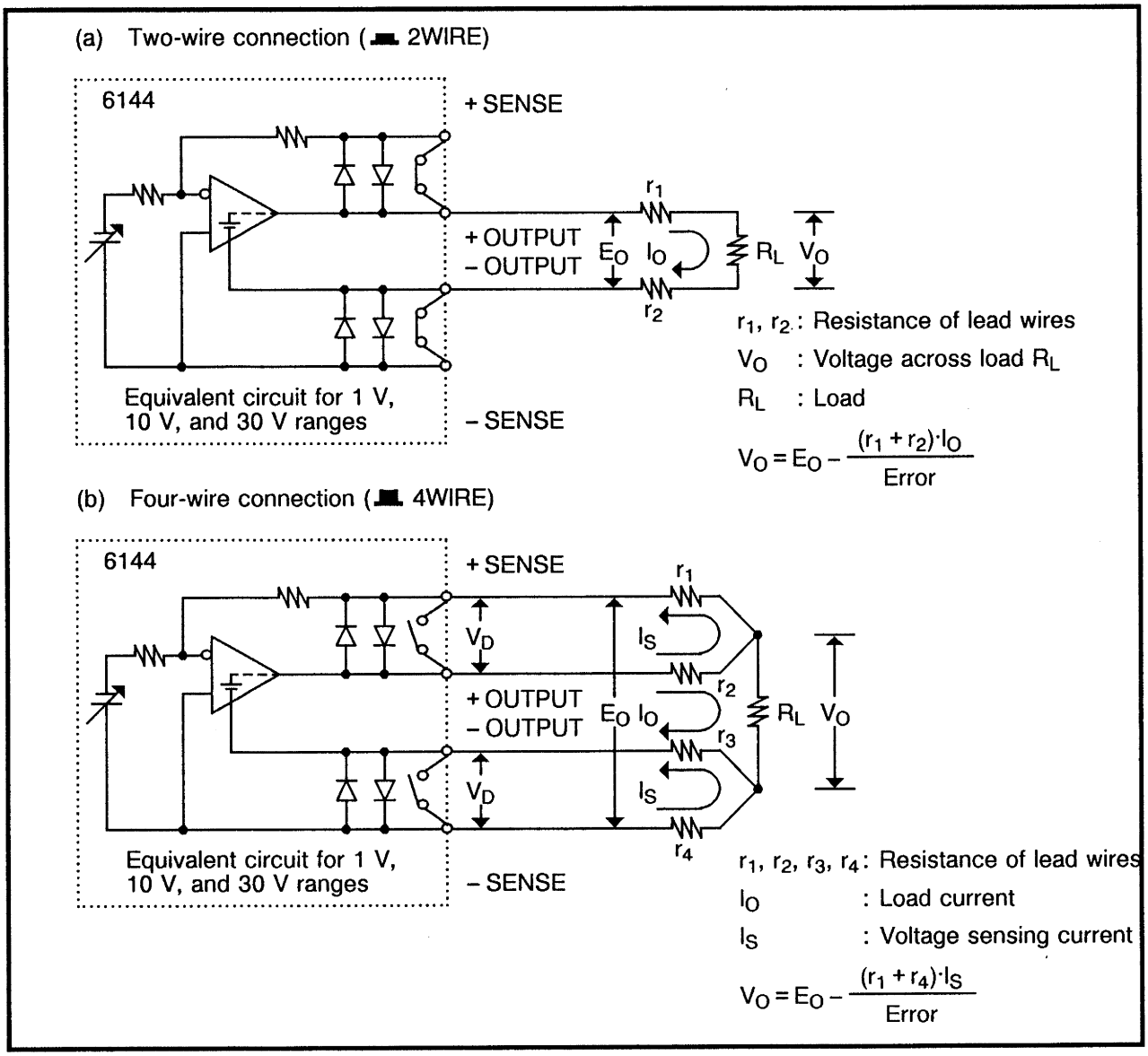


Figure 3-2 Equivalent Circuits

In the equivalent circuits, the polarity of the 6144 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 6144, 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 6144.

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	0.02%
10 V	10 Ω	0.02%
30 V	10 Ω	0.01%

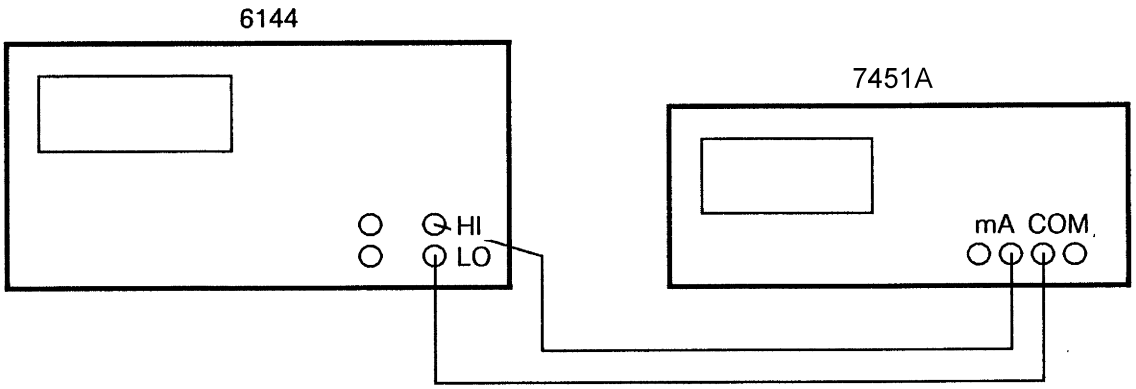
Table 3-4 Cable Resistance Per Meter

Nominal cross section	Conductor resistance
0.08 mm^2	Approx. 270 mΩ/m
0.2 mm^2	Approx. 100 mΩ/m
0.3 mm^2	Approx. 62 mΩ/m
0.5 mm^2	Approx. 37 mΩ/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 6144 : 30 V range
3 V
OPERATE ON

Setting of DMM : DCI (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.

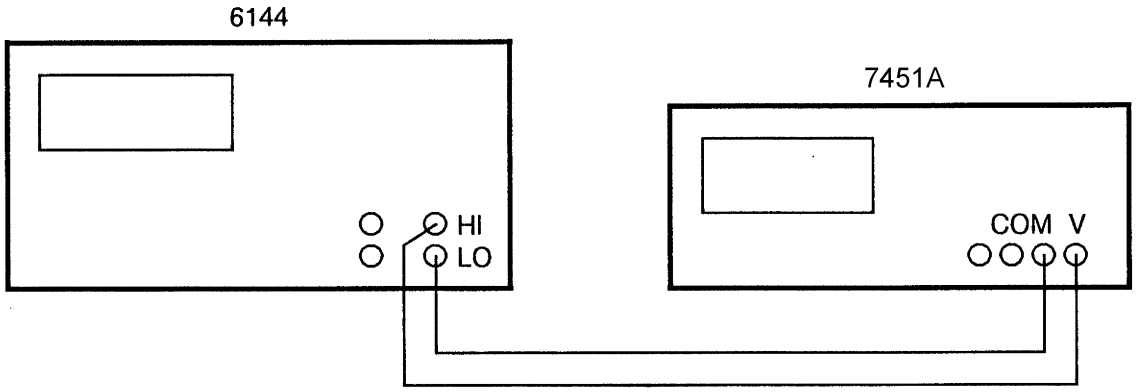
Setting range of current limiter : 5 mA to 160 mA

CAUTION

The current limiter is effective when the 6144 is in the source mode. When the 6144 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 R6144 : 100 mA range
160.00 mA
OPERATE ON

Setting of DMM : DCV (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 28 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 6144 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.

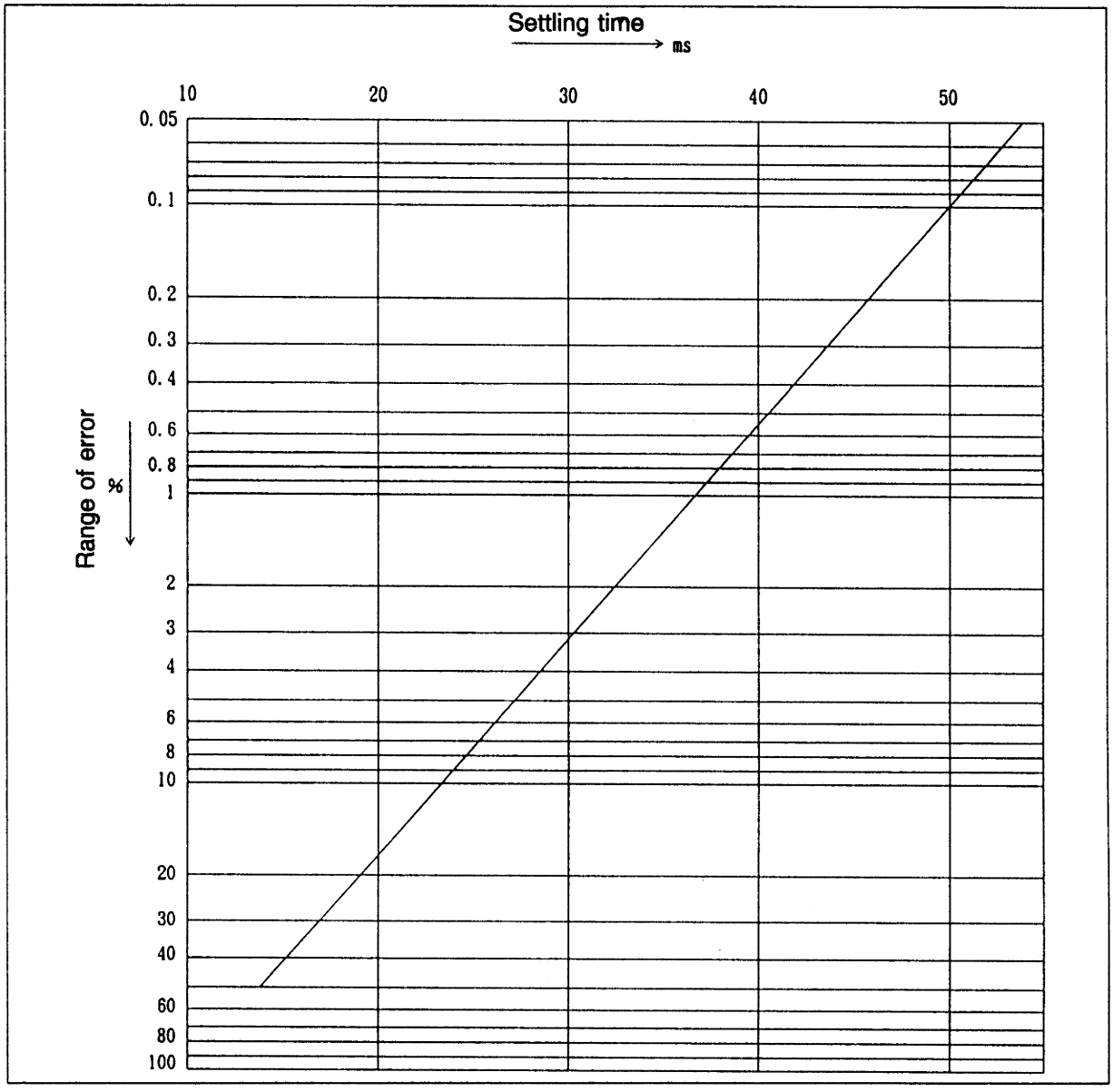


Figure 3-3 Setting Time

3.7 Prevention of Oscillation Caused by Inductance Load

When the 6144 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 kiloohm in series with the load to prevent oscillation.

3.8 Source and Sink Operation

The output from the 6144 is unipolar. When operating as a voltage source, the 6144 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.

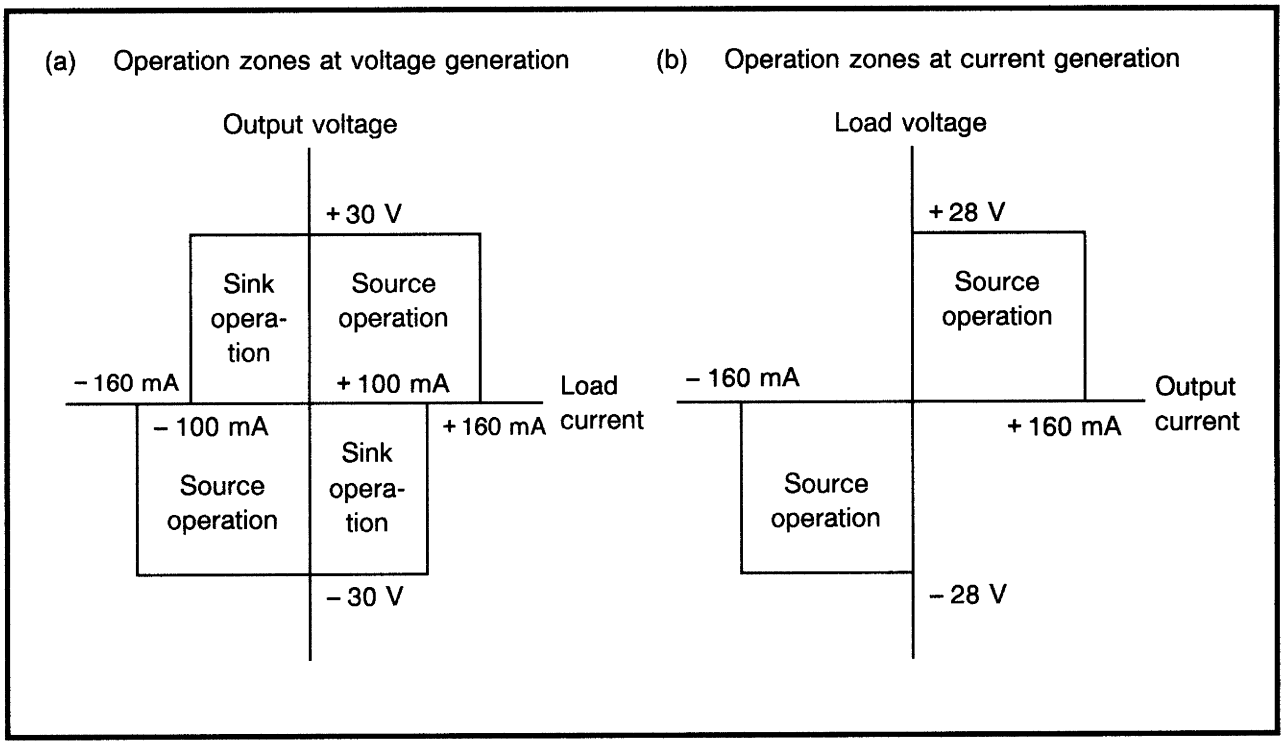


Figure 3-4 Operation Zones

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.

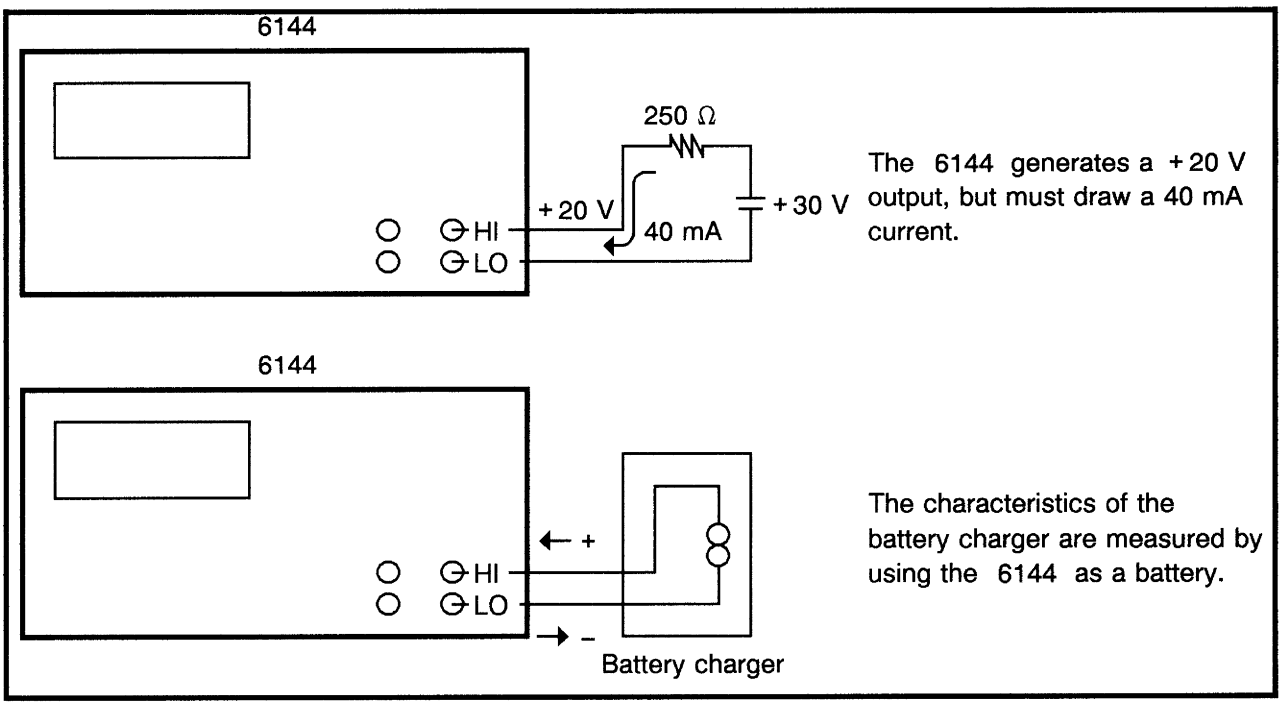


Figure 3-5 Example of Sink Operation

CAUTION

The maximum applied voltages from the outside are as follows.
Do not apply voltage which exceeds the following ranges.

1. For 1 V or 10 V range
   For positive polarity (+): -0.5 V to +32 Vpeak
   For negative polarity (-): +0.5 V to -32 Vpeak
2. For 10 mV or 100 mV range
   Regardless of the polarities ((+) or (-)):
   -0.5 V to +0.5 Vpeak

3.9 Turning Output ON/OFF

3.9.1 Automatically Turning Output ON at Power ON

The 6144 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 OPERATE LED.	Turn off the OPERATE 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.

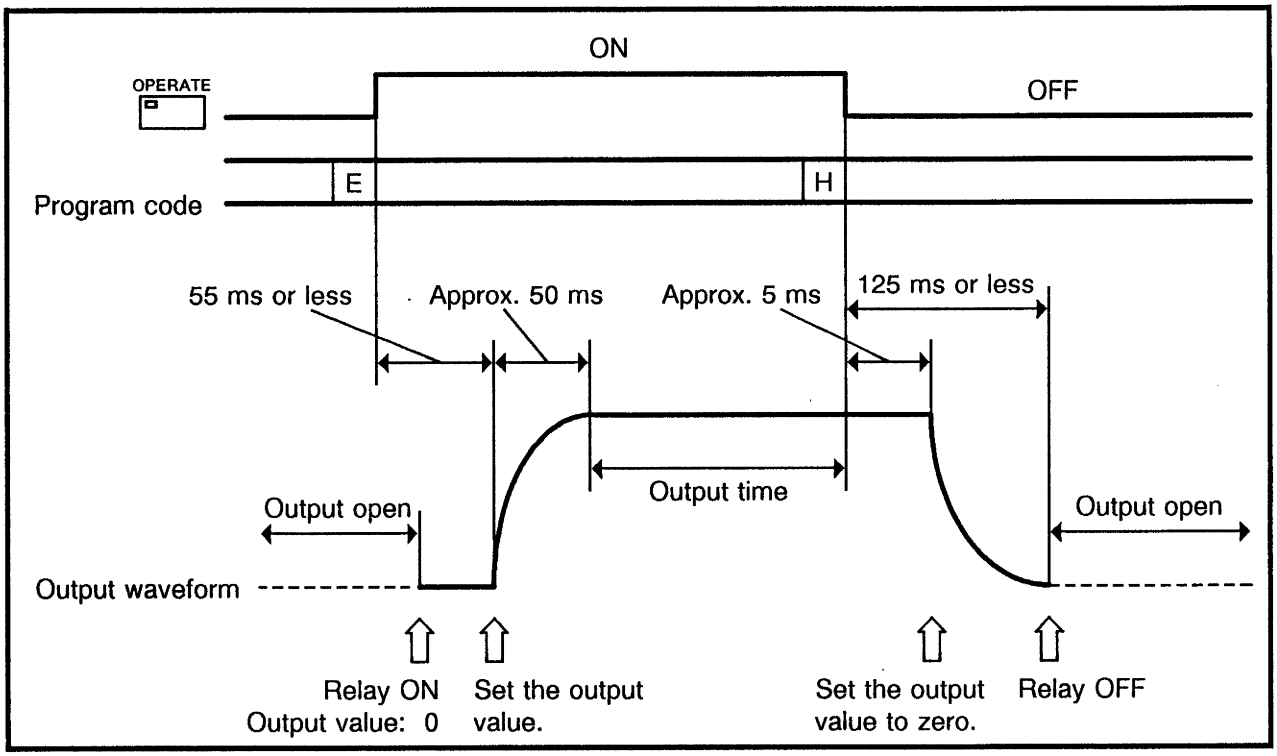


Figure 3-6 Output ON/OFF Timing

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 ⑤ "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 30 V Range

Since the output level resolution is 2 mV at the 30 V range, the lowest digit is rounded down to 0, 2, 4, 6, or 8.

Note: The setting of an odd output level is not accepted at the 30 V range.

See Section 2.1 ⑥ "RANGE △ and ▽ keys and range display" for the regular procedure to change the range.

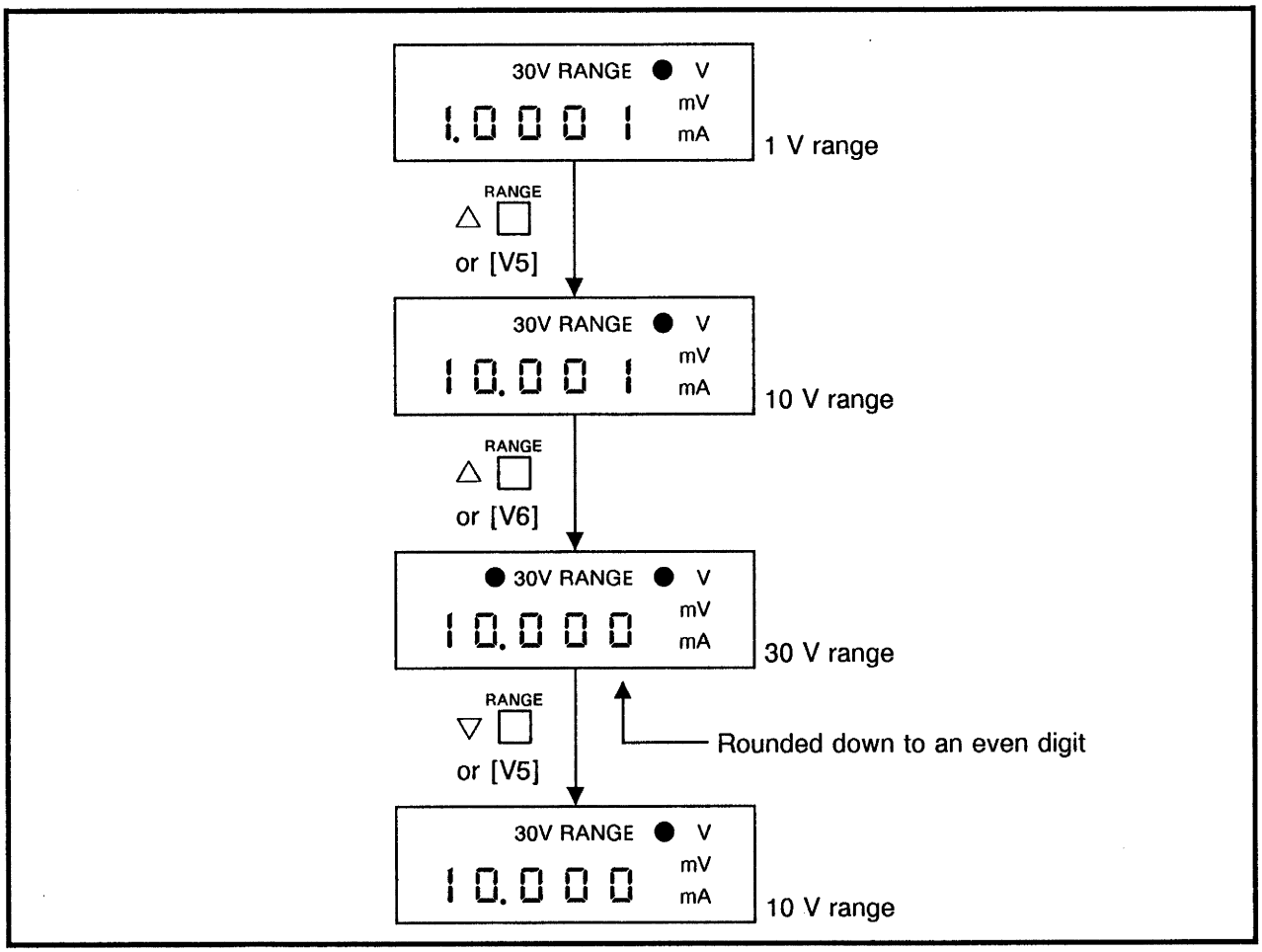


Figure 3-7 Example of Changing the Voltage Range and Display

3.11.2 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.

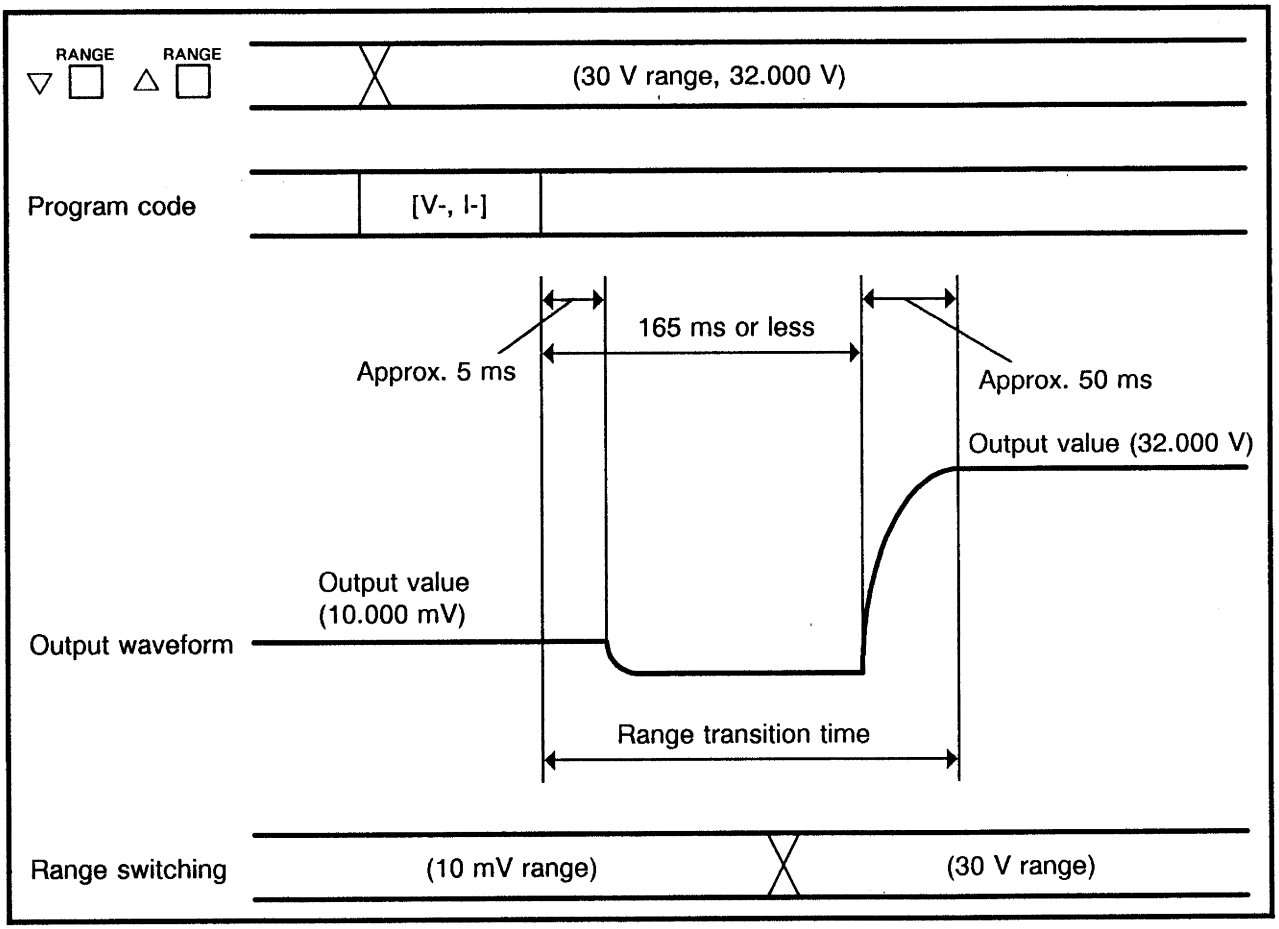


Figure 3-8 Timing of Range Switching

3.12 How to Use the Memory

3.12.1 Storing Data in the Memory

The memory of the 6144 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.

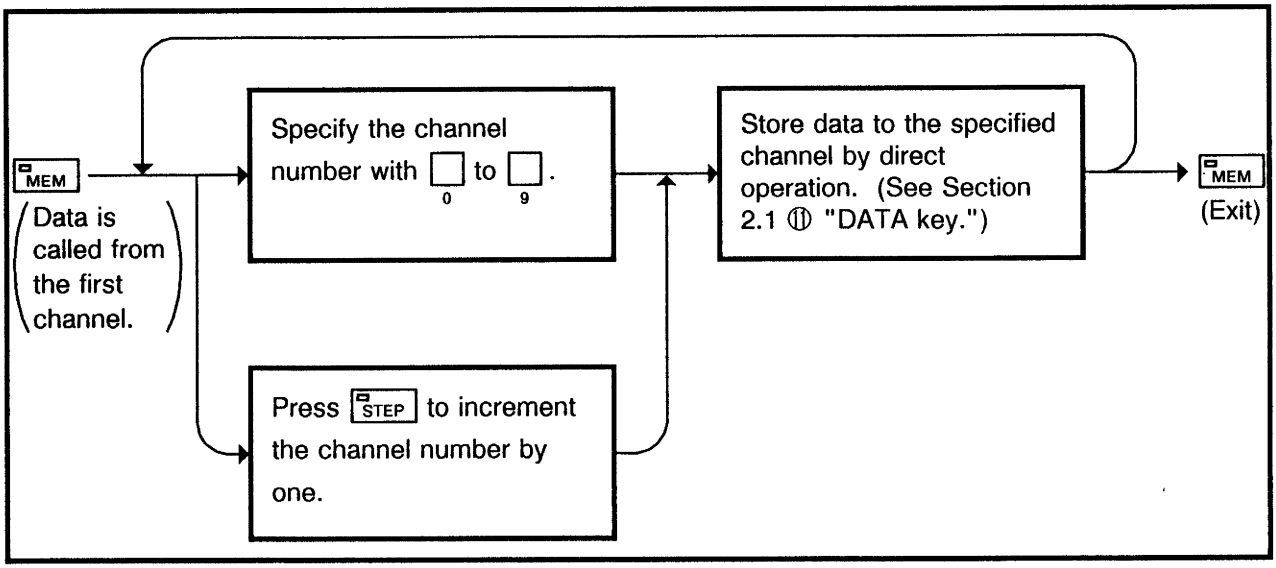


Figure 3-9 Key Operation Flow to Store Data in the Memory

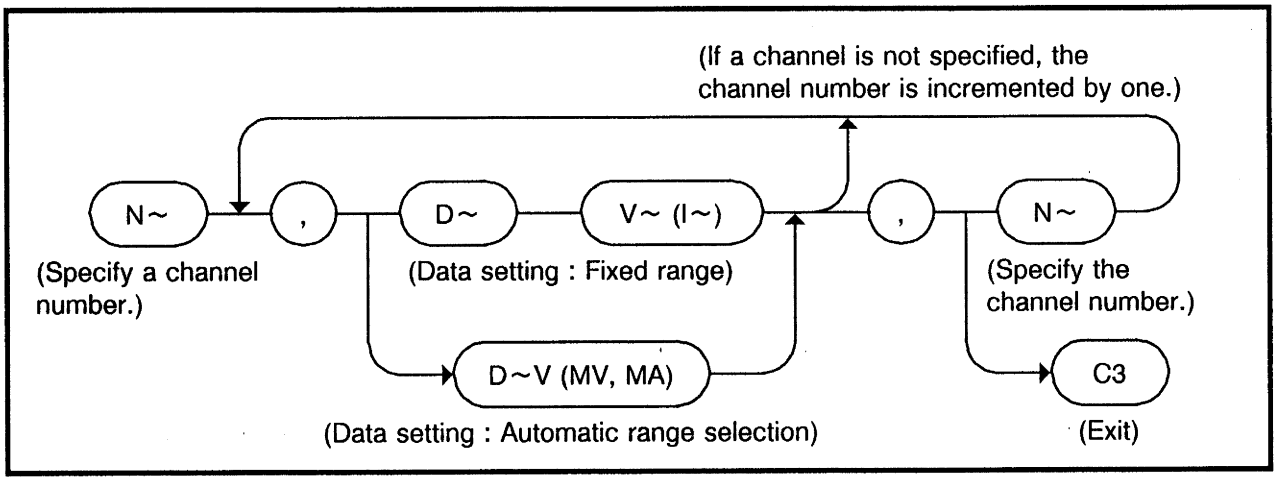


Figure 3-10 Program Code Operation Flow to Store Data in the Memory

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 3-11 shows the operation flow in the step mode.

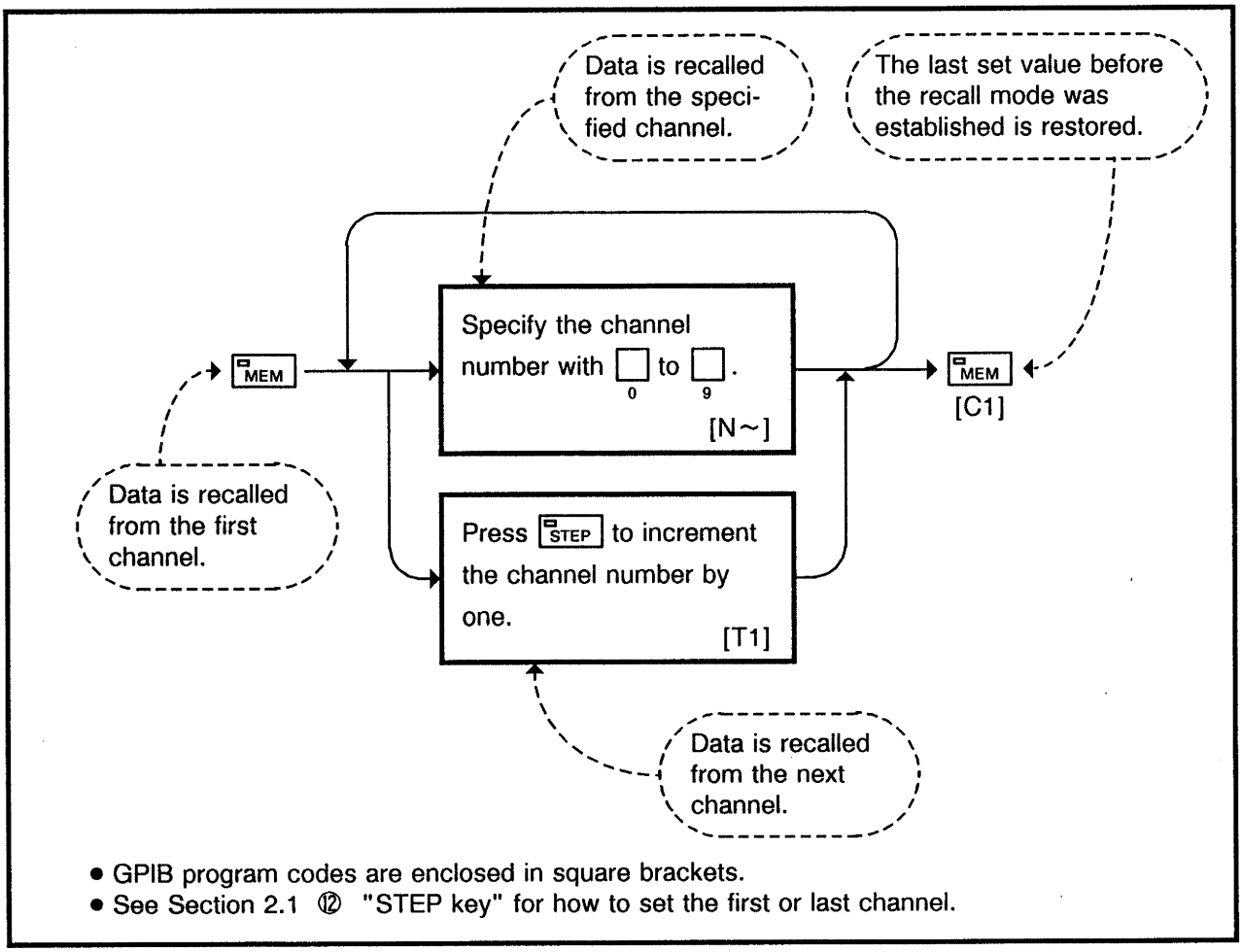


Figure 3-11 Operation Flow in the Step Mode

(2) Single scan mode

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

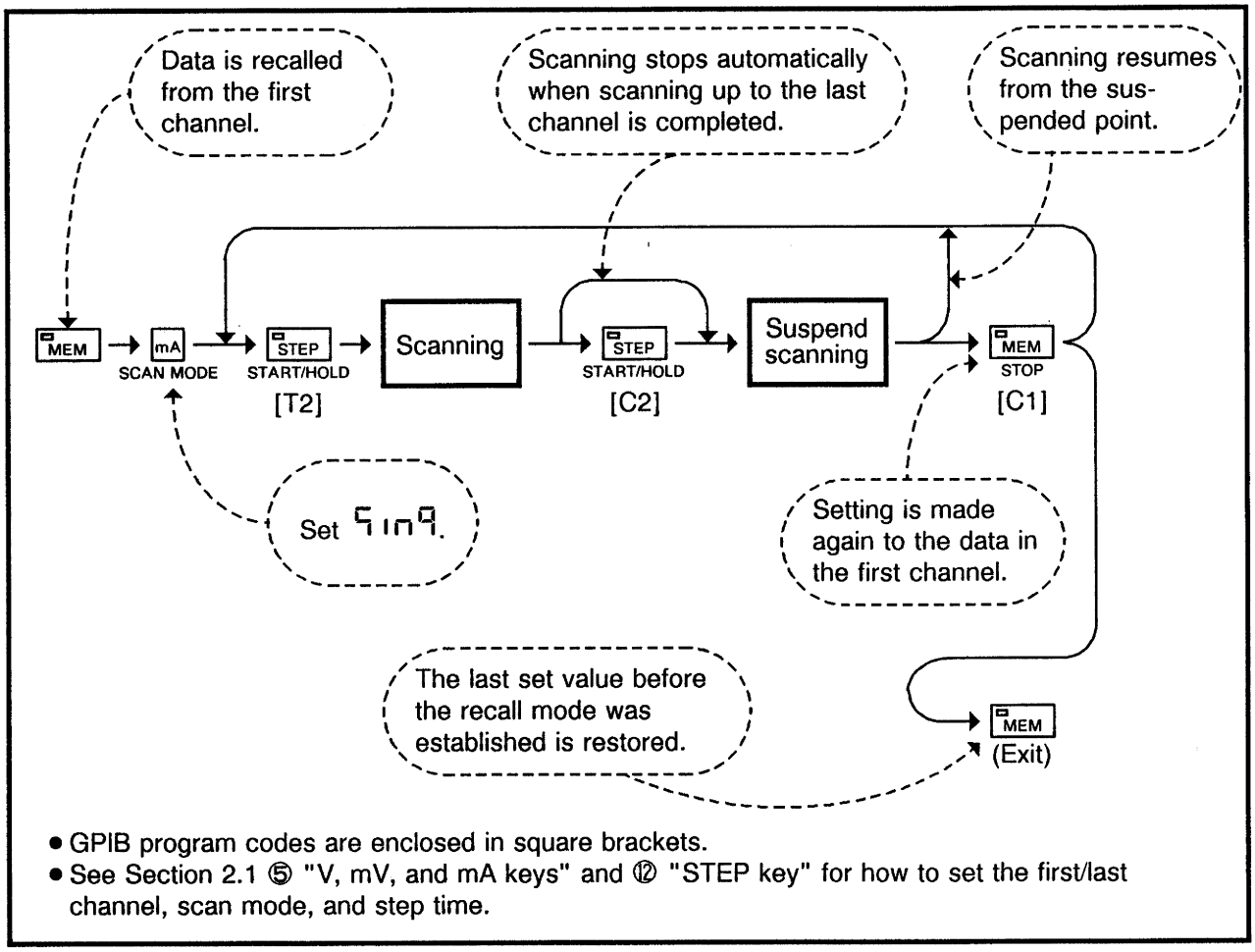


Figure 3-12 Operation Flow in the Single Scan Mode

(3) Repeated scan mode

The first through last channels are repeatedly scanned at a specified step time to automatically recall the stored data. Figure 3-13 shows the operation flow in the repeated scan mode.

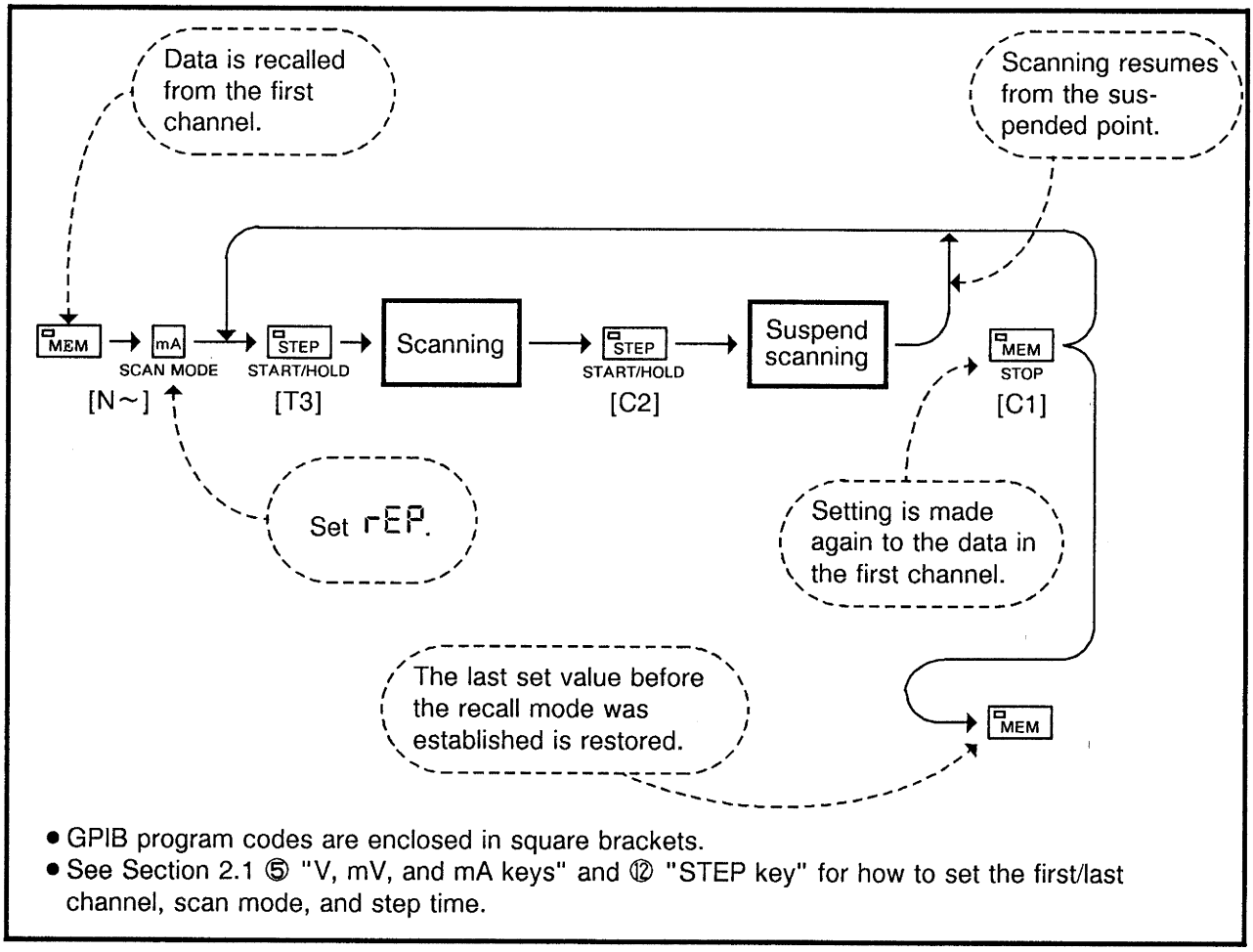


Figure 3-13 Operation Flow in the Repeated Scan Mode

3.13 Sweep Function

3.13.1 Start/Stop Sweep

The 6144 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 3-14 shows the sweep operation flow.

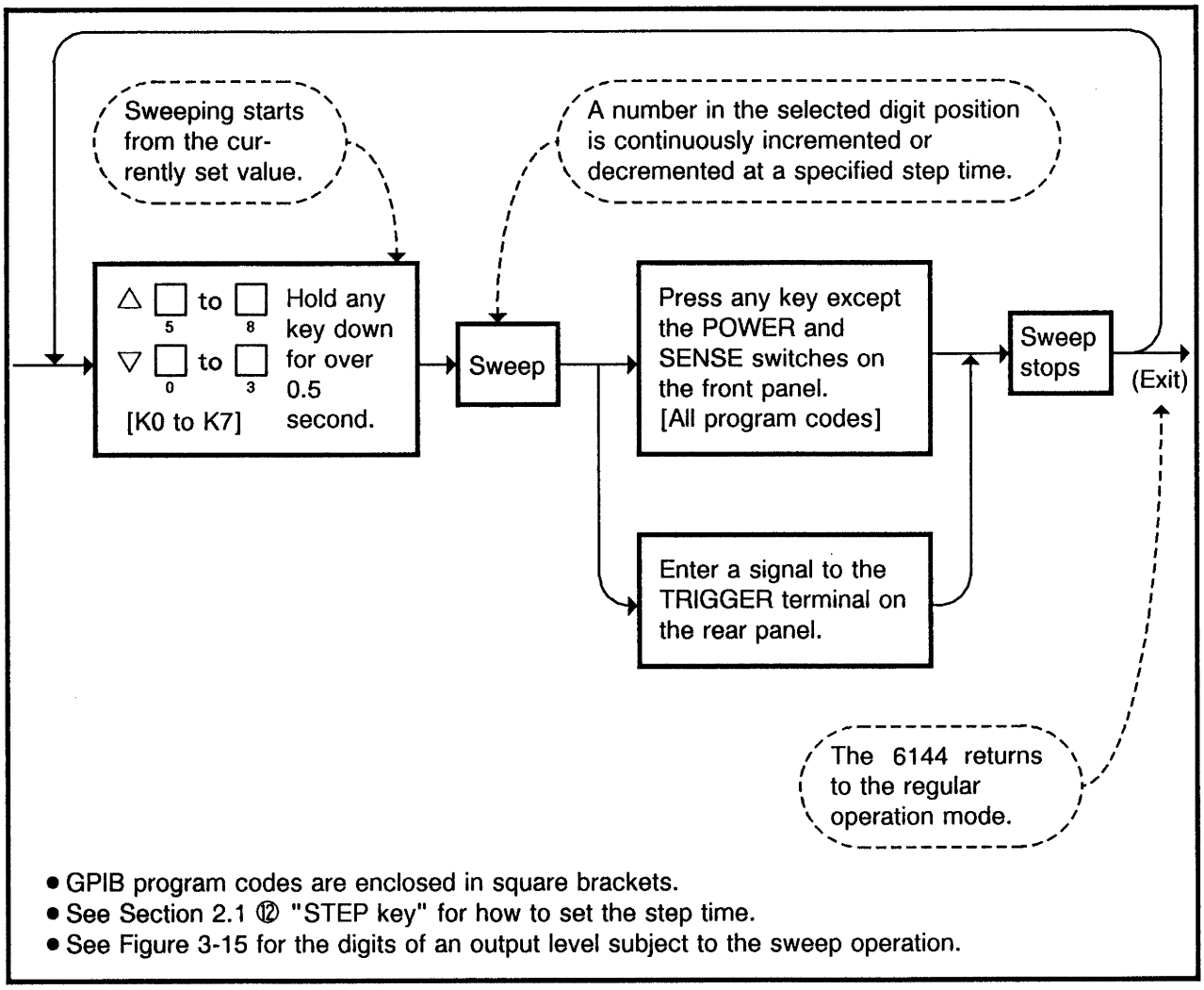
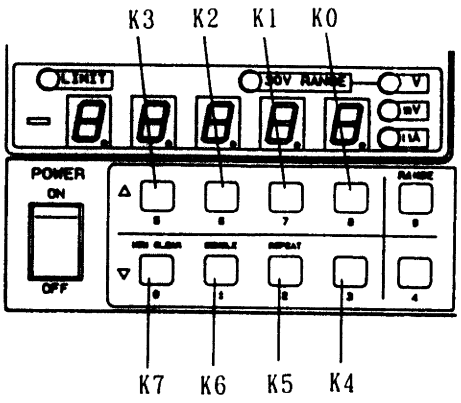


Figure 3-14 Sweep Operation Flow



Program code	Description
K0	Continuously increments a number in 10^0 digit position.
K1	Continuously increments a number in 10^1 digit position.
K2	Continuously increments a number in 10^2 digit position.
K3	Continuously increments a number in 10^3 digit position.
K4	Continuously decrements a number in 10^0 digit position.
K5	Continuously decrements a number in 10^1 digit position.
K6	Continuously decrements a number in 10^2 digit position.
K7	Continuously decrements a number in 10^3 digit position.

Figure 3-15 Sweep Operation for the Digits of Output Level

4. GPIB INTERFACE AND PROGRAMMING

The GPIB interface, provided as standard, enables the 6144 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.

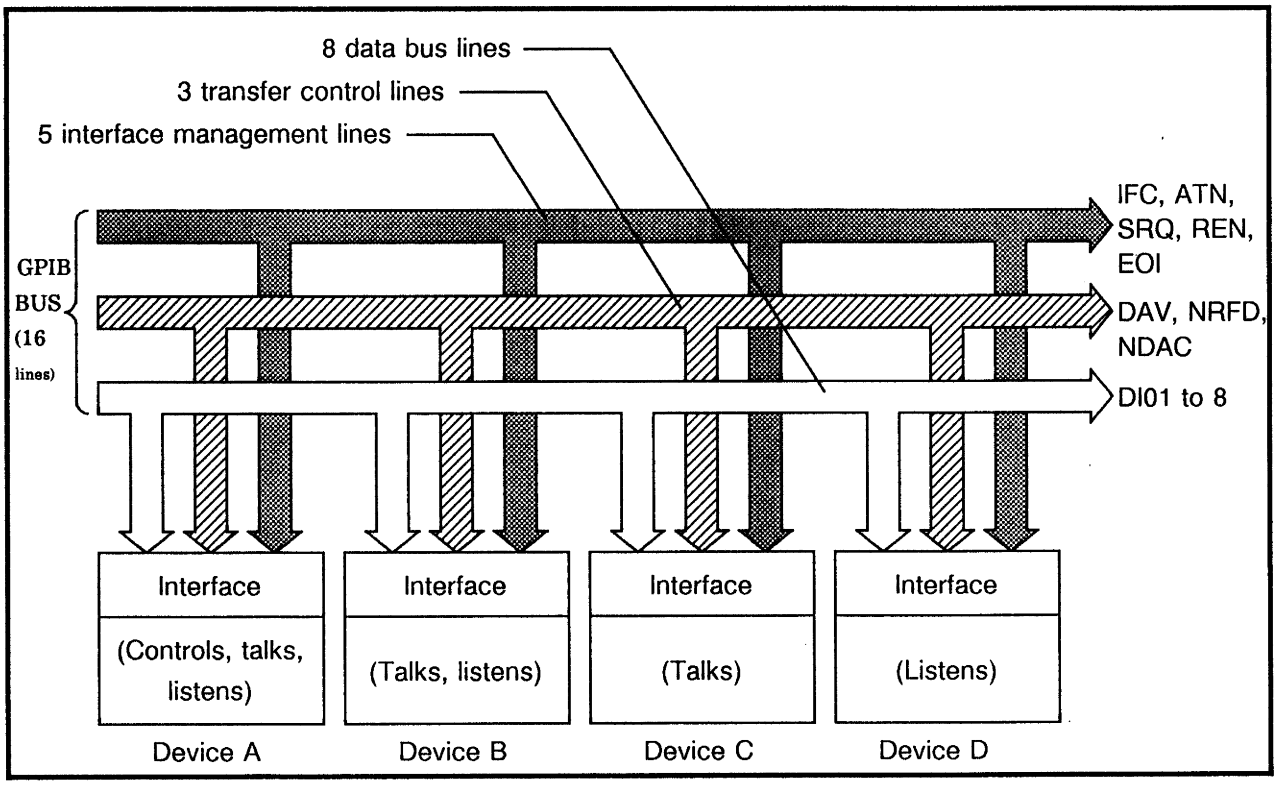


Figure 4-1 GPIB Configuration

- 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:

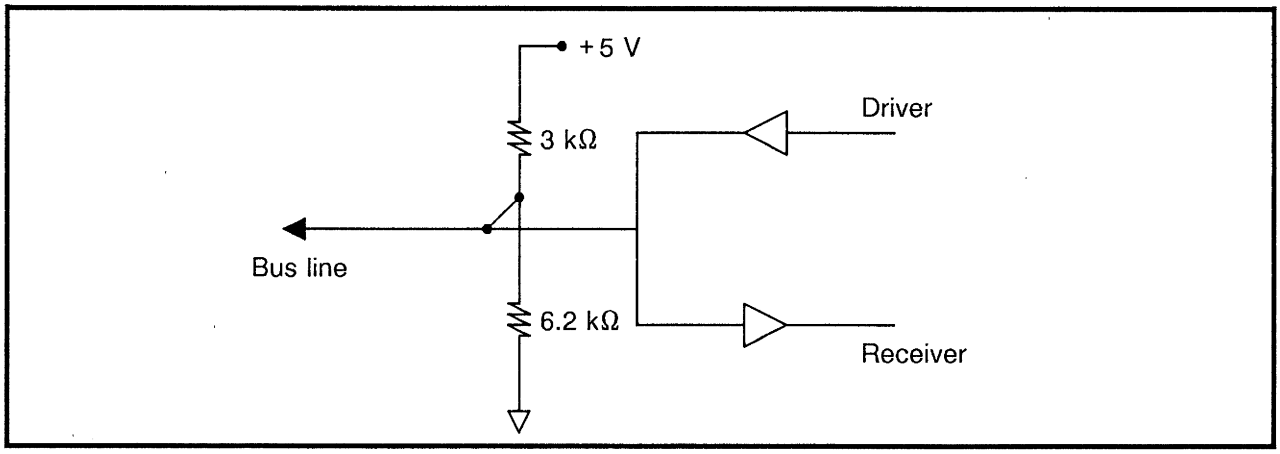


Figure 4-2 Signal Termination

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

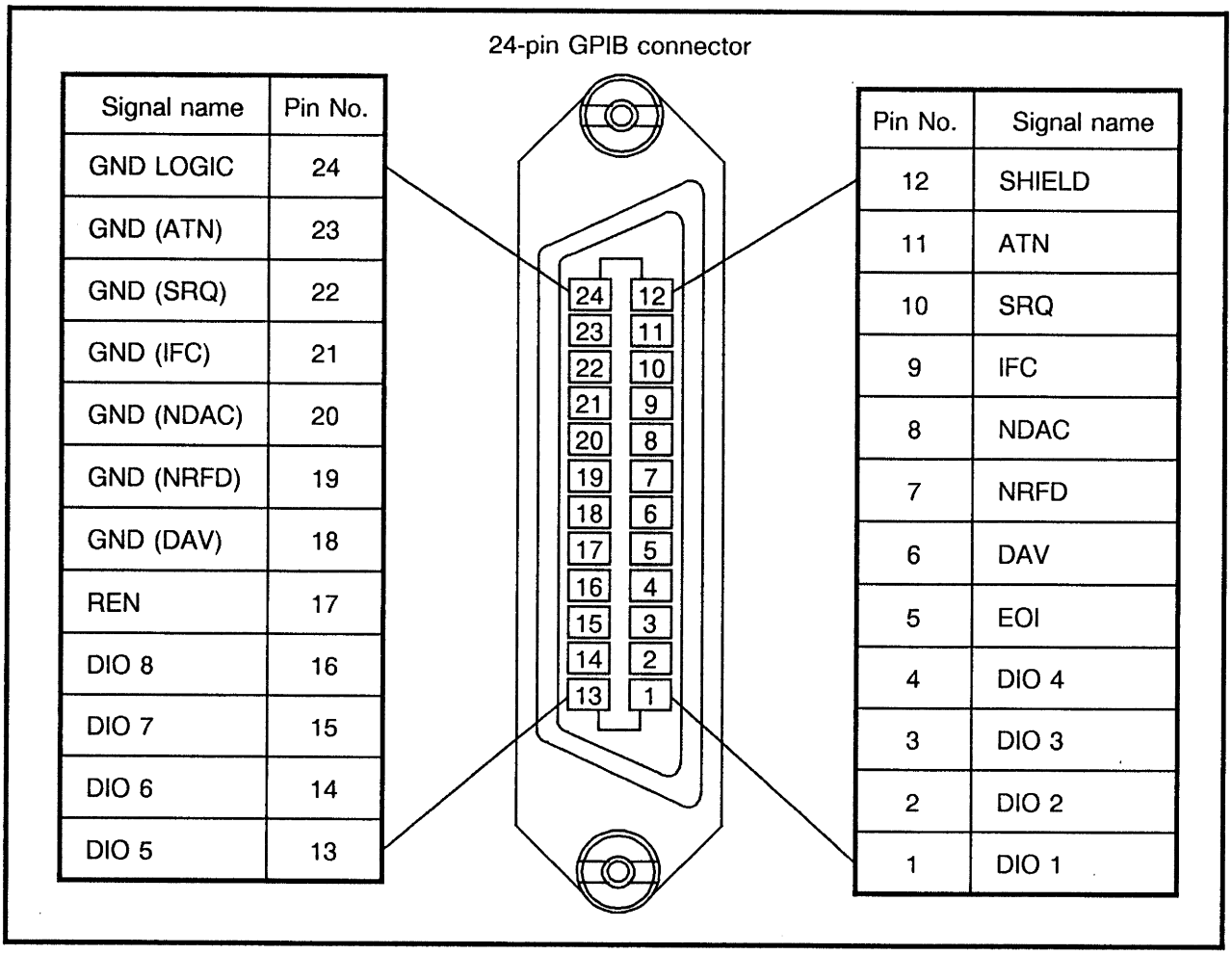


Figure 4-3 GPIB Connector Pin Configuration

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

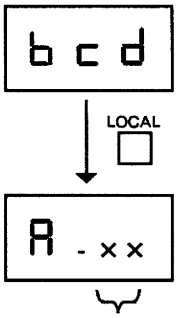
4.4 Selecting the GPIB Interface

The 6144 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 STEP LOCAL.

② Press LOCAL again to select "A-××."



③ Press STEP to return to the regular operation mode.

4.5 Addressing and Selecting the Listen Only Mode

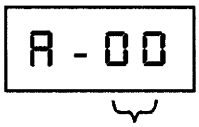
The GPIB talk/listen can be addressed and the listen only mode can be selected by key operation from the front panel. Table 4-3 lists 31 addresses in decimal code for selection.

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	>	~

Procedure

① Press [STEP] and [LOCAL]. The following display will appear.



Specify these digits to select an address.

② Specify the address with numeric keys [0] to [9].

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 [STEP] 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

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 90	Interface clear Remote enable
100	Comment
110	Assign address 1 to the 6144.
120	Initialize the device with the GPIB interface.
130 140 150 160 170 180 190 200	Comment Set the output value from the 6144. D5V .... 5 V at the 10 V range (automatic range selection) Turn ON the output from the 6144. Hold the output ON for several seconds. Turn OFF the output from the 6144. Wait and maintain the remote mode. Release the 6144 from the remote mode. 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

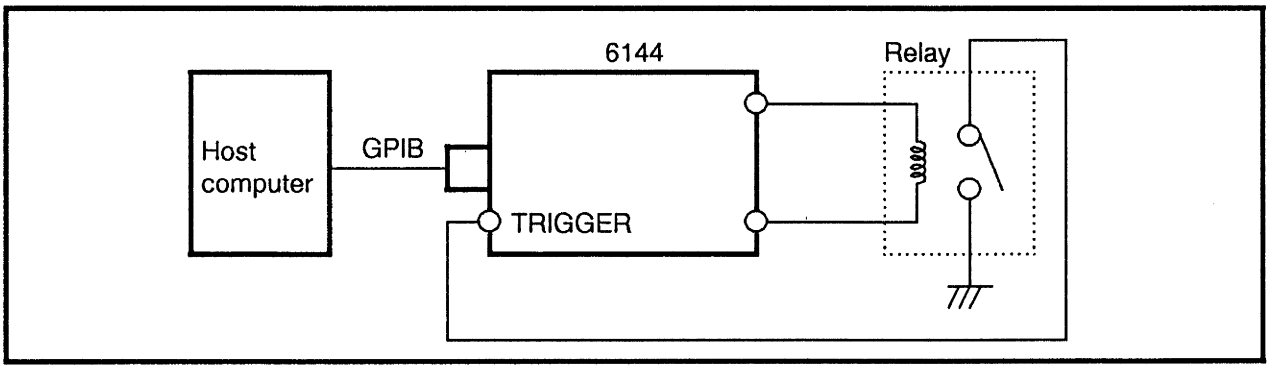


Figure 4-4 Connection Diagram for Sweep Operation

(1) Sample program

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
```

(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 6144.
290	Initialize the device (6144) connected to the GPIB interface.
300 310	Initialize the parameters of the 6144. 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 6144 to +1.000 V. Start changing the output from the 6144 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 6144. Display the set values of the 6144 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 6144. Jump to NOSRQ if the 6144 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.

(1) Sample program

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"             ! 6144 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;"SC0,";Maxch-1
430   !
440       WAIT 1
450       LOCAL 7
460       STOP
470   !
480   !
490   !
500   !*****************
510   !*****************
520   !
530   Dtable: !
540         DATA 41
550   !
```

(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
```

(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 6144. Define the starting address of the data statement. Transfer the C command (initialization command) to the 6144.
310 320 330 340 350 360	Set the number of data items in MAXCH. Transfer the N0 command that initiates the storage of data in the memory of the 6144 from address 0. Store the contents of the table in the memory of the 6144 as specified in MAXCH. Set the temperature data of the 6144 in TEMP(I). Set the thermocouple data (JIS standard data) of the 6144 in JISDT(I). Convert the JIS standard data in the 6144 from μV to mV.
370	Comment
380 390	Store the data in the memory of the 6144 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 6144 in the local mode. End

(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)

4.7 Program Code Table (Comparison Table between TR6142 and 6144)

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	6144		
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			

(Cont'd)

Item	Code	Description		State after initialization with C command	Effective command during step operation
		TR6142	6144		
	I? V?		Query on function/range Response : V2 to V6 (voltage generation) I1 to I3 (current generation)		○
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 and Response to Data Query."		○
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		○

(Cont'd)

<table>
<tr><th rowspan="2">Item</th><th rowspan="2">Code</th><th colspan="2">Description</th><th rowspan="2">State after initialization with C command</th><th rowspan="2">Effective command during step operation</th></tr>
<tr><th>TR6142</th><th>6144</th></tr>
<tr><td>Memory setting</td><td>N to C3</td><td colspan="2">Memory setting format
CH, data, range, CH, data, range, ···· CRLF
① ② ③ ④ ⑤
···· C3
⑥

① Channel
Nnnn: N ···· Header; when "N" is detected, the device enters the memory setting mode.
nnn ···· Channel number, 0 to 159

② Data
D-dd.ddd (Fixed range)
D-dd.dddV (Automatic range selection)
└ Unit: V, MV, MA
If the fixed range mode is selected, use the range code in ③.

③ Range
<table><tr><th>Range code</th><th>TR6142</th><th>6144</th></tr><tr><td>V2</td><td colspan="2">10 mV range</td></tr><tr><td>V3</td><td colspan="2">100 mV range</td></tr><tr><td>V4</td><td colspan="2">1 V range</td></tr><tr><td>V5</td><td colspan="2">10 V range</td></tr><tr><td>V6</td><td></td><td>30 V range</td></tr><tr><td>I1</td><td colspan="2">1 mA range</td></tr><tr><td>I2</td><td colspan="2">10 mA range</td></tr><tr><td>I3</td><td colspan="2">100 mA range</td></tr></table>
If the automatic range selection is specified for data, the range code can be omitted.</td><td>Channel = First channel

Memory setting mode OFF</td><td></td></tr>
</table>

(Cont'd)

Item	Code	Description		State after initialization with C command	Effective command during step operation
		TR6142	6144		
Memory setting		④ Channel Omissible. If the channel is omitted, the channel is automatically incremented by one for the storage of the next data. ⑤ Block delimiter Any of the following delimiters can be used: CR LF LF CR EOI ⑥ Memory setting end code If program code C3 is input, the memory setting mode ends. See Section 3.12 "How to Use the Memory."			
	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)		○

(Cont'd)

Item	Code	Description		State after initialization with C command	Effective command during step operation
		TR6142	6144		
Query command on external switch status	0?		Query on OPR HOLD switch Response: O0 (OFF) O1 (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."			

(Cont'd)

Item	Code	Description		State after initialization with C command	Effective command during step operation
		TR6142	6144		
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."			○

(Cont'd)

Item	Code	Description		State after initialization with C command	Effective command during step operation
		TR6142	6144		
Scanning start/stop	T?		Query about the type of scanning Response: T2 (single scanning) T3 (repeated scanning)		○
Step time setting	SI~	SI ddd 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~	SC mmm , nnn ① ② ③ ④ ① SC : Header ② mmm : First channel (0 to 159) ③ , : String delimiter ④ nnn : Last channel (0 to 159) SC nnn 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

Head ± ddddd E ±dd : Fixed-range format
① ② ③ ④

Head ± ddddd Unit : Automatic-range-selection format
① ② ③ ④

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

The data specification is as follows:

Item	Set value
Format	Decimal point + Number of up to 5 digits
Special processing	At the 30 V range, the lowest digit is rounded down to an even number.

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

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 ± 16
100 mV	D ± 12 MV to D ± 119.99 MV D ± 0.012 V to D ± 0.11999 V	D ± 0 to D ± 160
1 V	D ± 120 MV to D ± 1199.9 MV D ± 0.12 V to D ± 1.1999 V	D ± 0 to D ± 1.6
10 V	D ± 1200 MV to D ± 11999 MV D ± 1.2 V to D ± 11.999 V	D ± 0 to D ± 16
30 V	D ± 12000 MV to D ±32000MV D ± 12 V to D ± 32 V	D ± 0 to D ± 32
1 mA	D ± 0 MA to D ± 1.1999 MA	D ± 0 to D ± 1.6
10 mA	D ± 1.2 MA to D ± 11.999 MA	D ± 0 to D ± 16
100 mA	D ± 12 MA to D ± 160 MA	D ± 0 to D ± 160

CAUTION

In the automatic range selection mode, an upper range is selected for data equivalent to a count of 12000 to 16000 to attain identical operation with the TR6142.

To set an output value to a count of 12000 to 16000, set the range first and then the output value in the fixed range mode.

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.dddd E–2 100 mV : DV ±d.dddd E–1 1 V : DV ±d.dddd E+0 10 V : DV ±d.dddd E+1 30 V : DV ±d.dddd E+1 1 mA : DI ±d.dddd E–3 10 mA : DI ±d.dddd E–2 100 mA : DI ±d.dddd E–1 No data : DD ±9.9999 E+9
Step time : SI?	SIddd Step time ddd = 001 to 100
First/last channel setting : SC?	SCmmm _ nnn Last channel Space Start channel mmm, nnn = 000 to 159
Memory channel : N?	Nddd Memory channel ddd = 000 to 159

4.10 Service Request

Service Request of the GPIB enables the user to detect the status of the 6144. 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 6144 is polled, the SRQ bit is held set until the 6144 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 6144 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 6144 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 6144 starts another scanning or is polled.
4	SCAN BUSY	This bit is set while the 6144 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 6144 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)

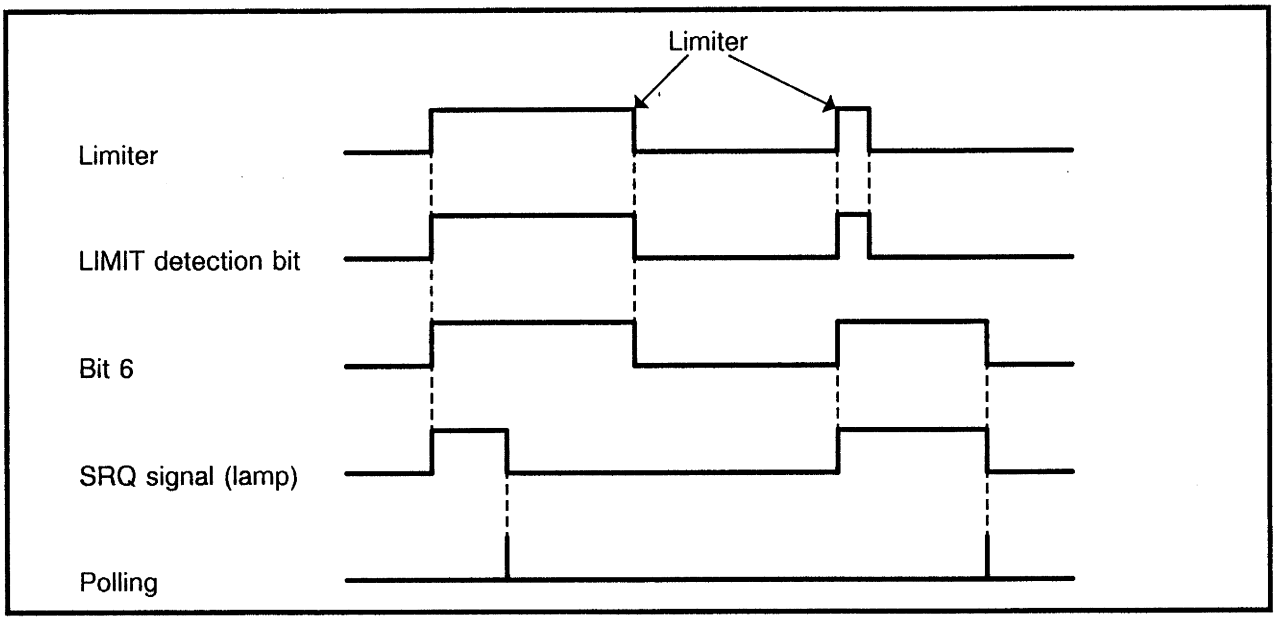


Figure 4-5 LIMIT Bit Timing Chart

(2) SYNTAX ERROR bit (bit 1)

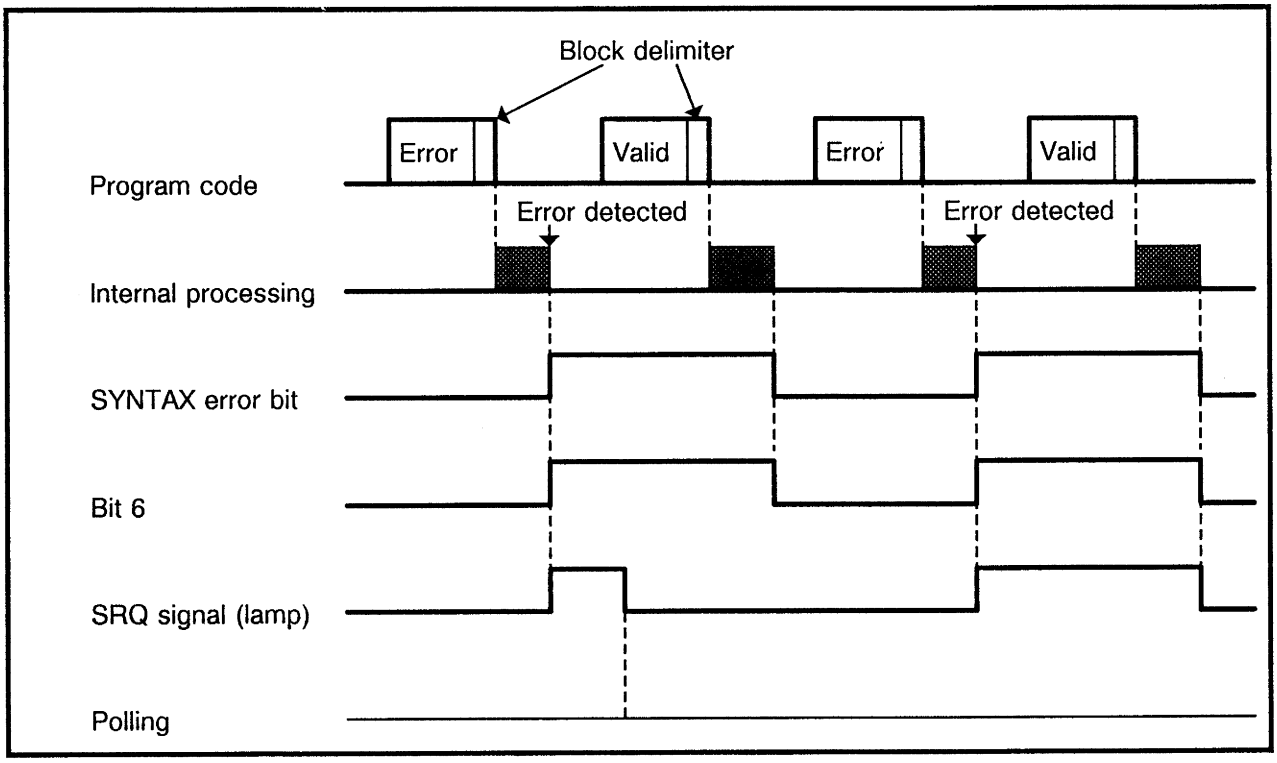


Figure 4-6 SYNTAX Error Bit Timing Chart

(3) READY bit (bit 2)

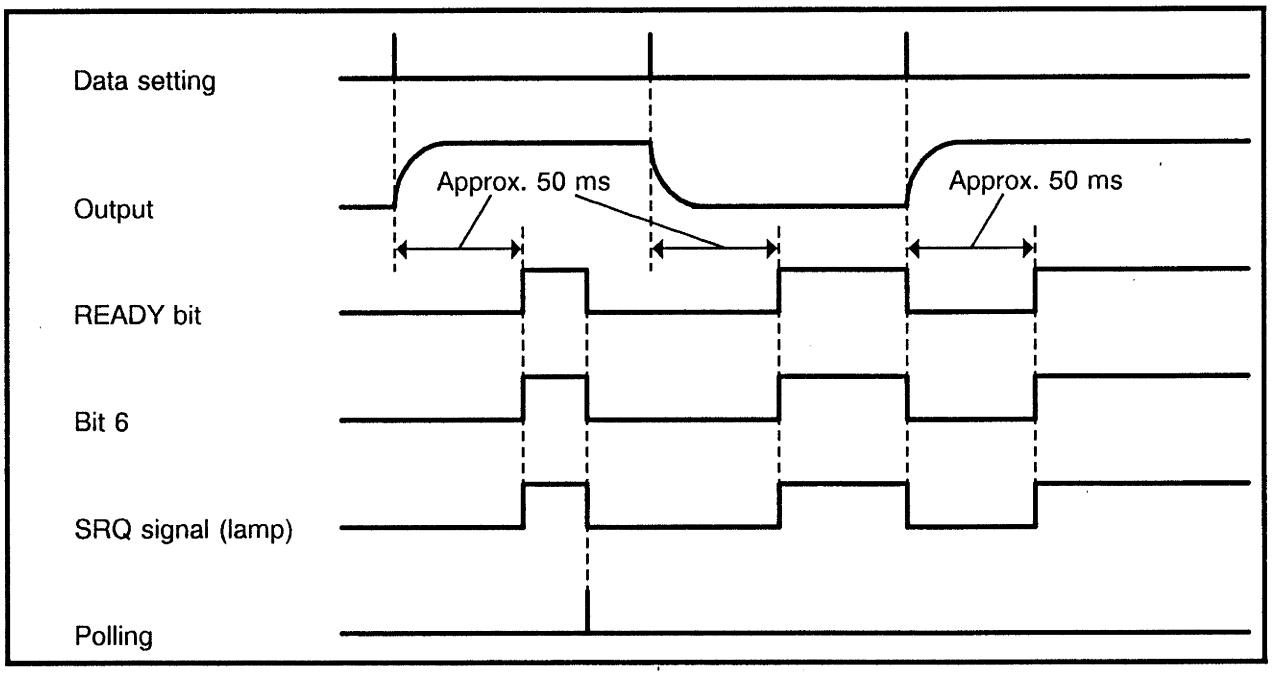


Figure 4-7 READY Bit Timing Chart

(4) SCAN END bit (bit 3)

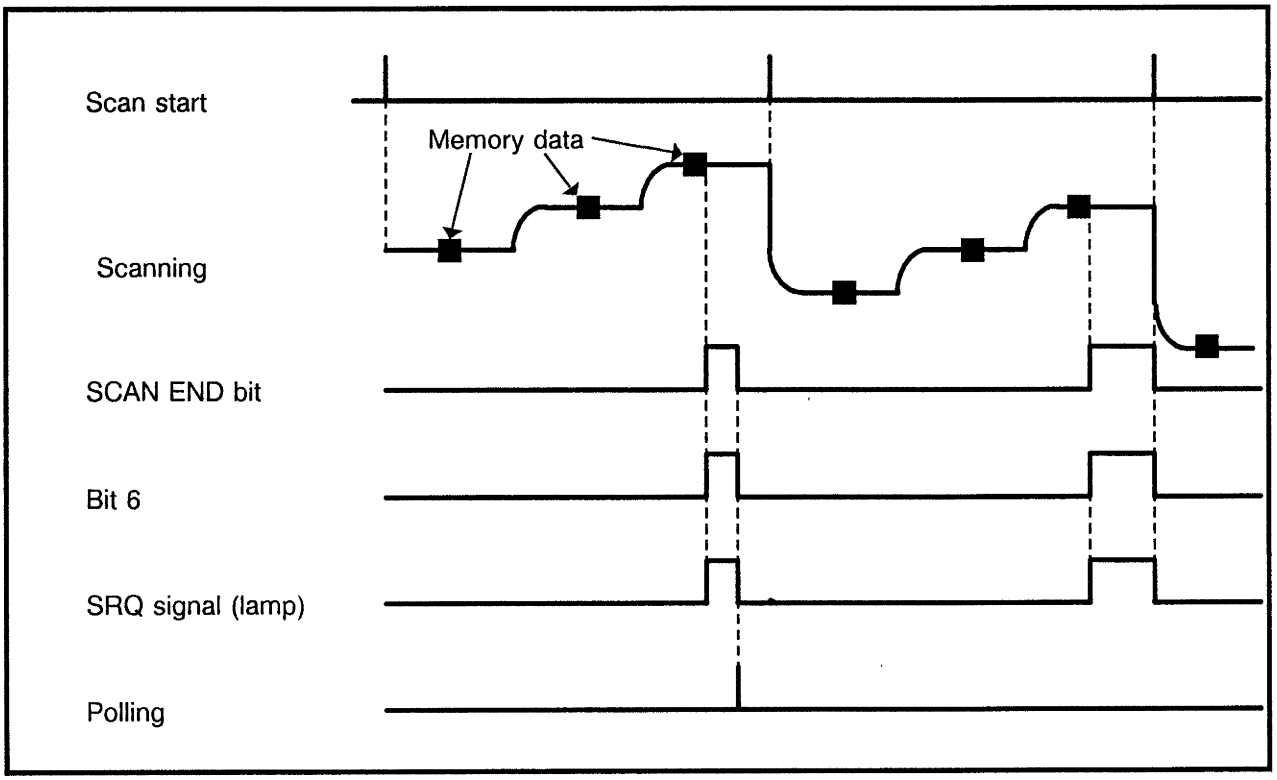


Figure 4-8 SCAN END Bit Timing Chart

(5) SCAN BUSY bit (bit 4)

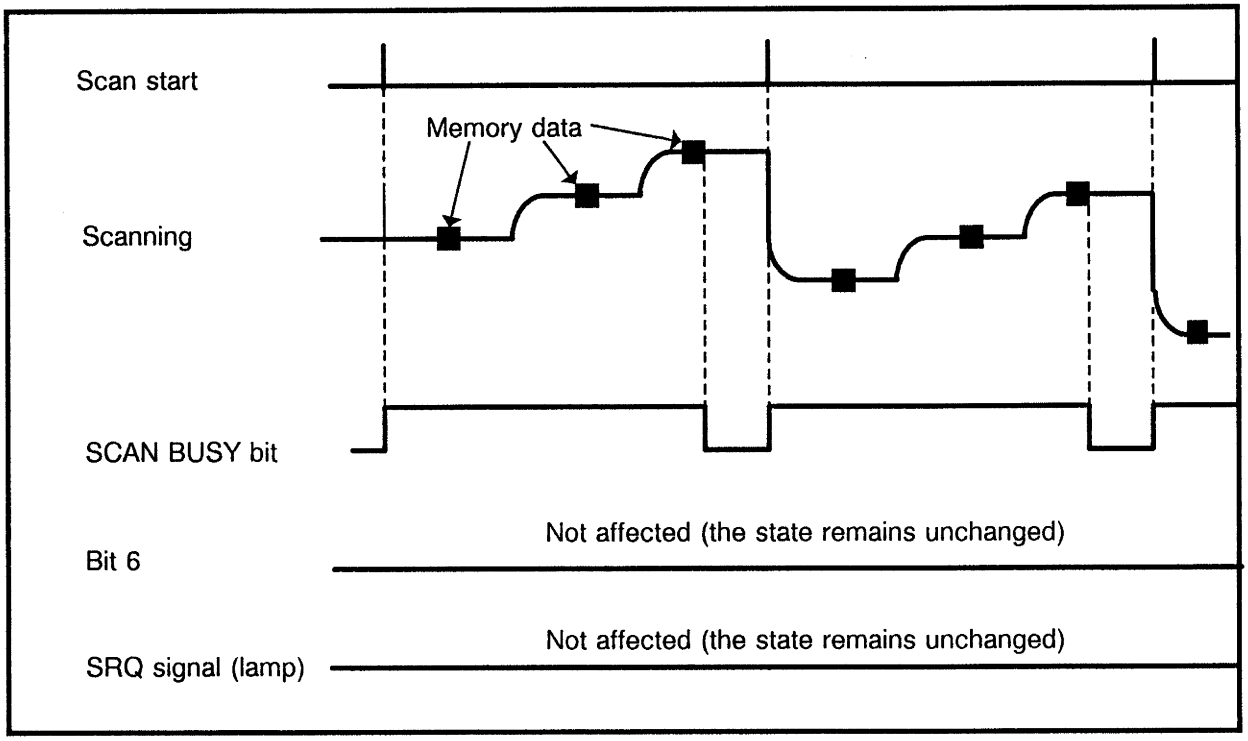


Figure 4-9 SCAN BUSY Bit Timing Chart

(6) TRIGGER IN bit (bit 5)

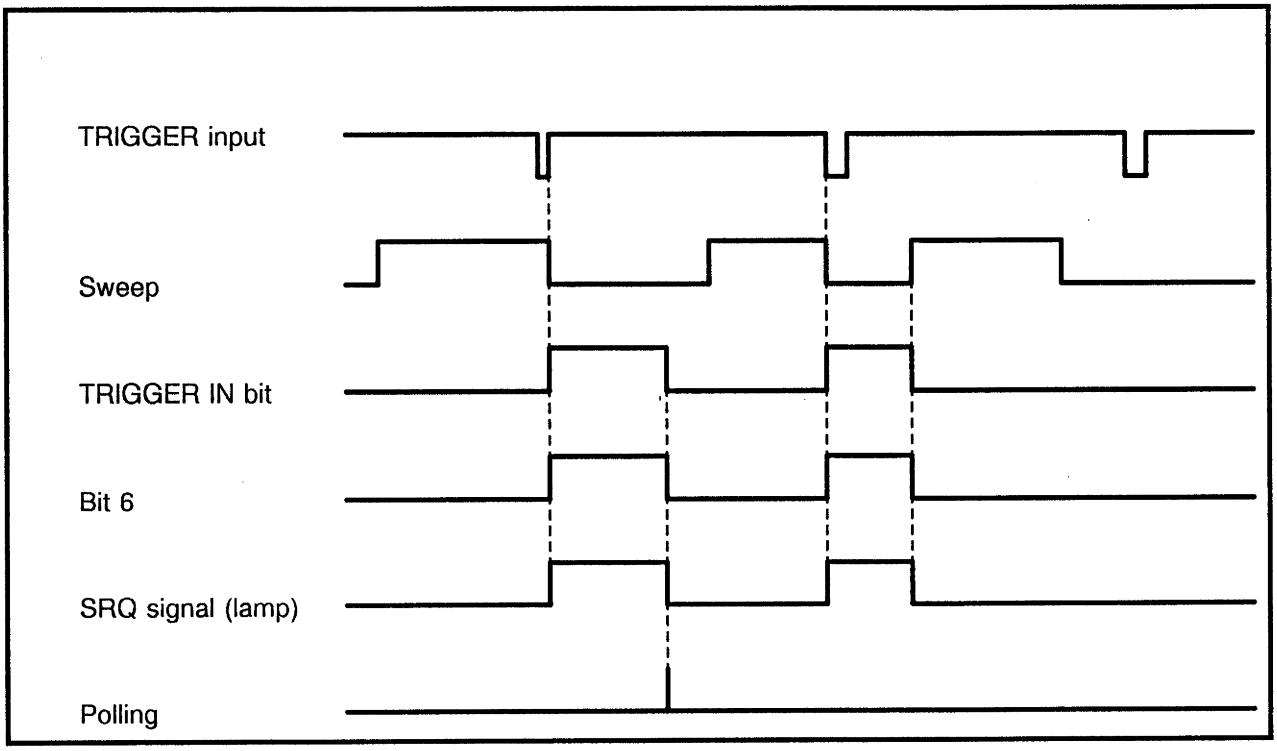


Figure 4-10 TRIGGER IN Bit Timing Chart

5. BCD PARALLEL INTERFACE

5.1 Overview

The BCD parallel interface, provided as standard, enables the 6144 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.

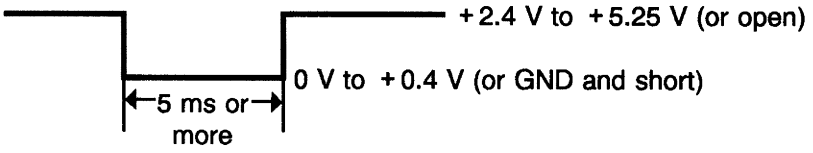
5.2 Specifications

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 16000 for all ranges except 30 V range
  00000 to 32000 for 30 V range
- Range : 30 V, 10 V, 1 V, 100 mV, 10 mV, 100 mA, 10 mA, and 1 mA, 8 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.

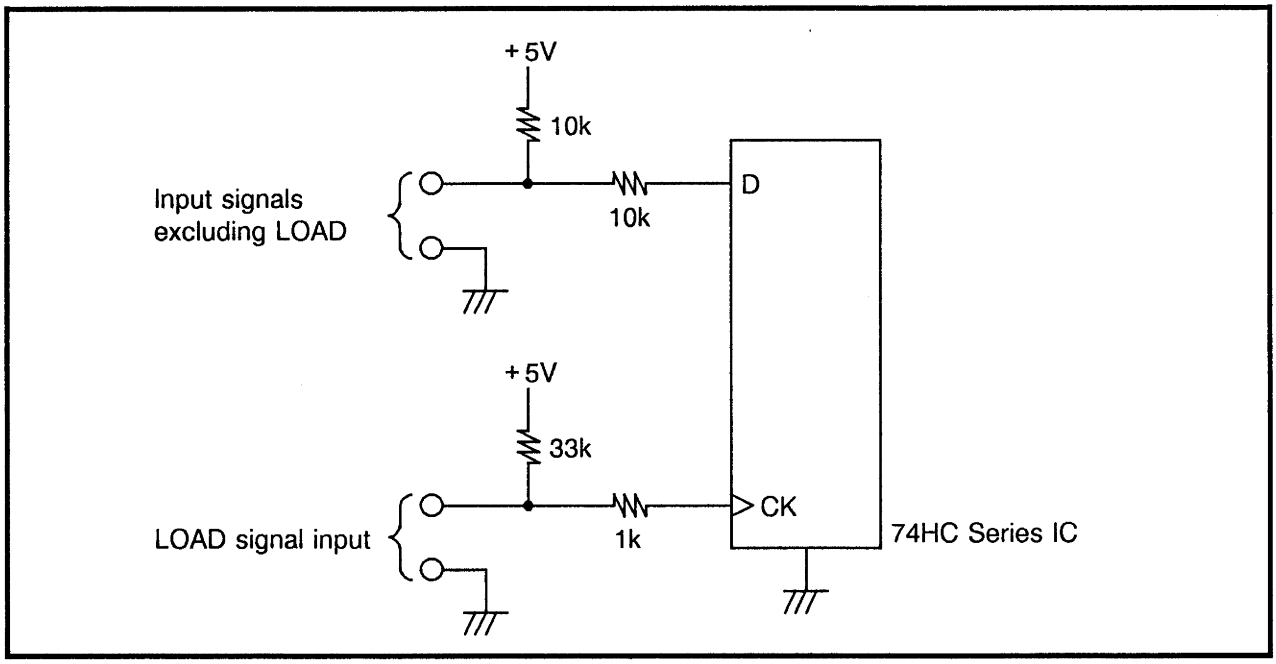


Figure 5-1 BCD Parallel Interface Input Circuit

- Connectors : For 6144 : 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 30 V 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	30 V
9	8	27	Polarity
10	1	28	2
11	2	29	Output ON status
12	4	30	
13	8	31	
14	1	32	
15	2	33	
16	4	34	
17	8	35	
18	1	36	LOAD

10^0 digit
10^1 digit
10^2 digit
10^3 digit
10^4 digit
Output level
High
Range
Priority
Low
10^4 digit of output level
NC

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

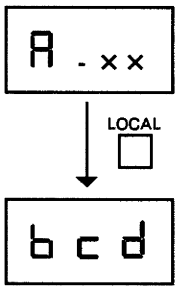
5.3 Selecting the BCD Parallel Interface

The 6144 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 STEP LOCAL.

② Press LOCAL to select "b c d."



③ Press STEP to exit.

5.4 Operation

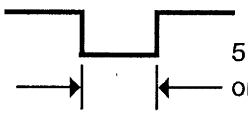
The BCD parallel interface of the 6144 operates in two modes, full remote and half-remote. Table 5-2 lists the functions of the LOAD signal in the full remote and half-remote modes.

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	• Remote setting is disabled. • Setting from the front panel is fully enabled.	• 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 LOCAL □ on the front panel is effective.
Fixed to 1	• Only the output level can be remotely set. • Set the range, polarity, and output ON status from the front panel.	• All input parameters are remotely set. • Only LOCAL □ on the front panel is effective.
 TTL negative pulse	• Only the output level can be remotely set. • Set the range, polarity, and output ON status from the front panel.	• All items are set at one time. • Only LOCAL □ on the front panel is effective.

6. INPUT AND OUTPUT SIGNALS

6.1 TRIGGER Input Signal

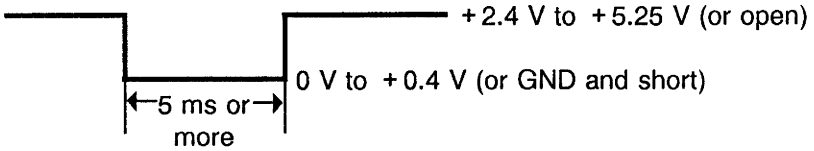
The TRIGGER signal is used to trigger the operation of the 6144 from outside.
Table 6-1 lists the effect of the TRIGGER signal in various operation modes.

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 6144 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 6144 : BNC-LR-PC (Hirose) or equivalent
For the cable : UG88/U (Hirose) or equivalent

TRIGGER input circuit: See Figure 6-1.

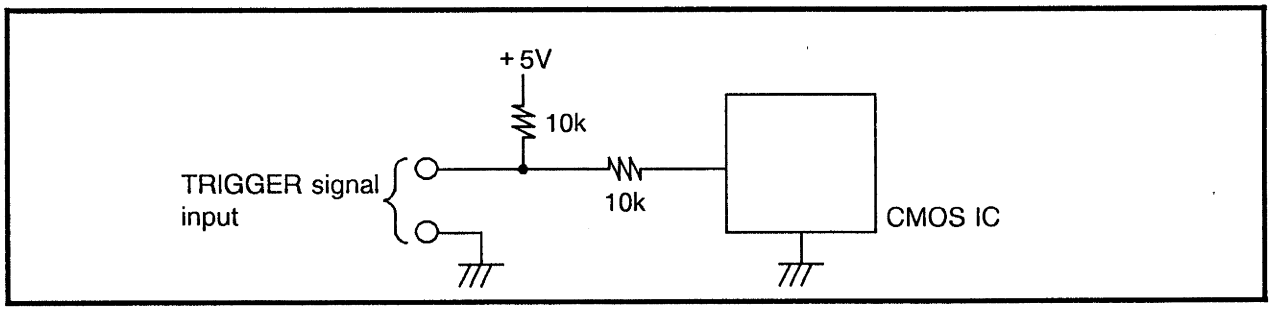


Figure 6-1 TRIGGER Input Circuit

6.2 READY Output Signal

The READY signal triggers (starts measurement) the operation of an external DMM.
The READY signal is output from the 6144 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.

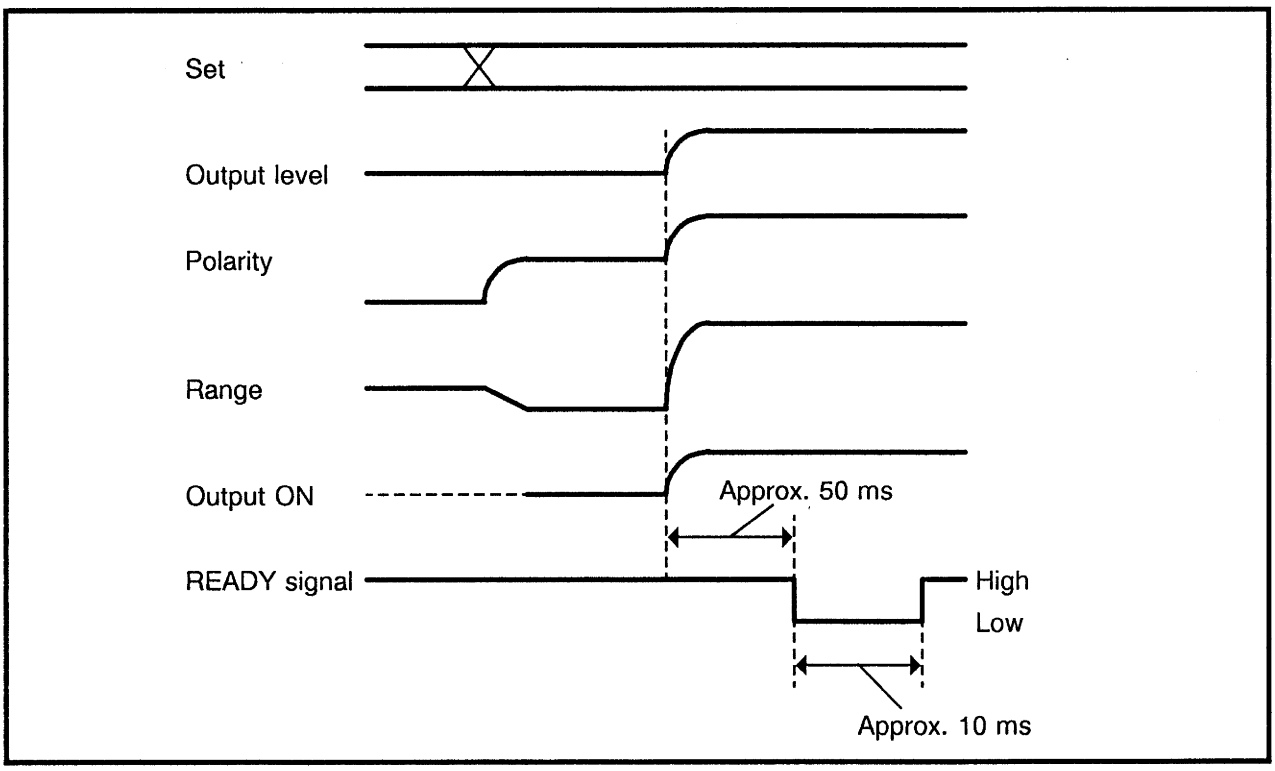


Figure 6-2 READY Signal Output Timing

READY signal specifications

High	:	+2.7 V to +5.25 V, 100 μA max
Low	:	0 V to +0.6 V, −5 mA max
Pulse width	:	Approx. 10 ms (negative pulse)
Connectors	:	For the 6144 : 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 6144 , check the 6144 in accordance with Tables 7-1 and 7-2 before requesting service. If the problem still remains unsolved, contact an ADC CORPORATION sales representative.
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 6144 , 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."
Err 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 + or − to cancel polarity "0".	See Section 2.1 ⑦ "POLARITY keys −, 0, and +."

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 6144 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 6144 to the GPIB bus and check. Change the address of the 6144 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 6144 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.		

(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
Err01	An error has been detected during CPU RAM read/write check.	Contact an ADC CORPORATION sales representative.	
Err02	An error has been detected during ROM check (sum check).		
Err03	An error has been detected during RAM read/ write check.		
Err04	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 $\square_0$. The internal calibration parameters will be initialized. Conduct calibration again.	See Section 7.2 "Calibration."
Err05	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 $\square_0$. The 6144 will be initialized and become ready for operation.	
Err06	An error has been detected in the limit detection circuit.	Contact an ADC CORPORATION sales representative.	

7.2 Calibration

This section explains how to calibrate the 6144 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%	6871E (Advantest)
Digital ammeter or standard resistor	1 μA to 200 mA		±0.009%	
	10 nA to 20 mA		±0.006%	
	Standard resistor	1 Ω (160 mA)	±0.005%	
		100 Ω (16 mA)	±0.002%	
		1k Ω (1.6 mA)		

(2) Cables required for calibration

Table 7-4 Cables Required for Calibration

Name	Model	Remarks
Input cable	A01035	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 6144 for at least two hours. Warm up calibration instruments for as long as specified.

⑤ After calibrating the 6144 , 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.

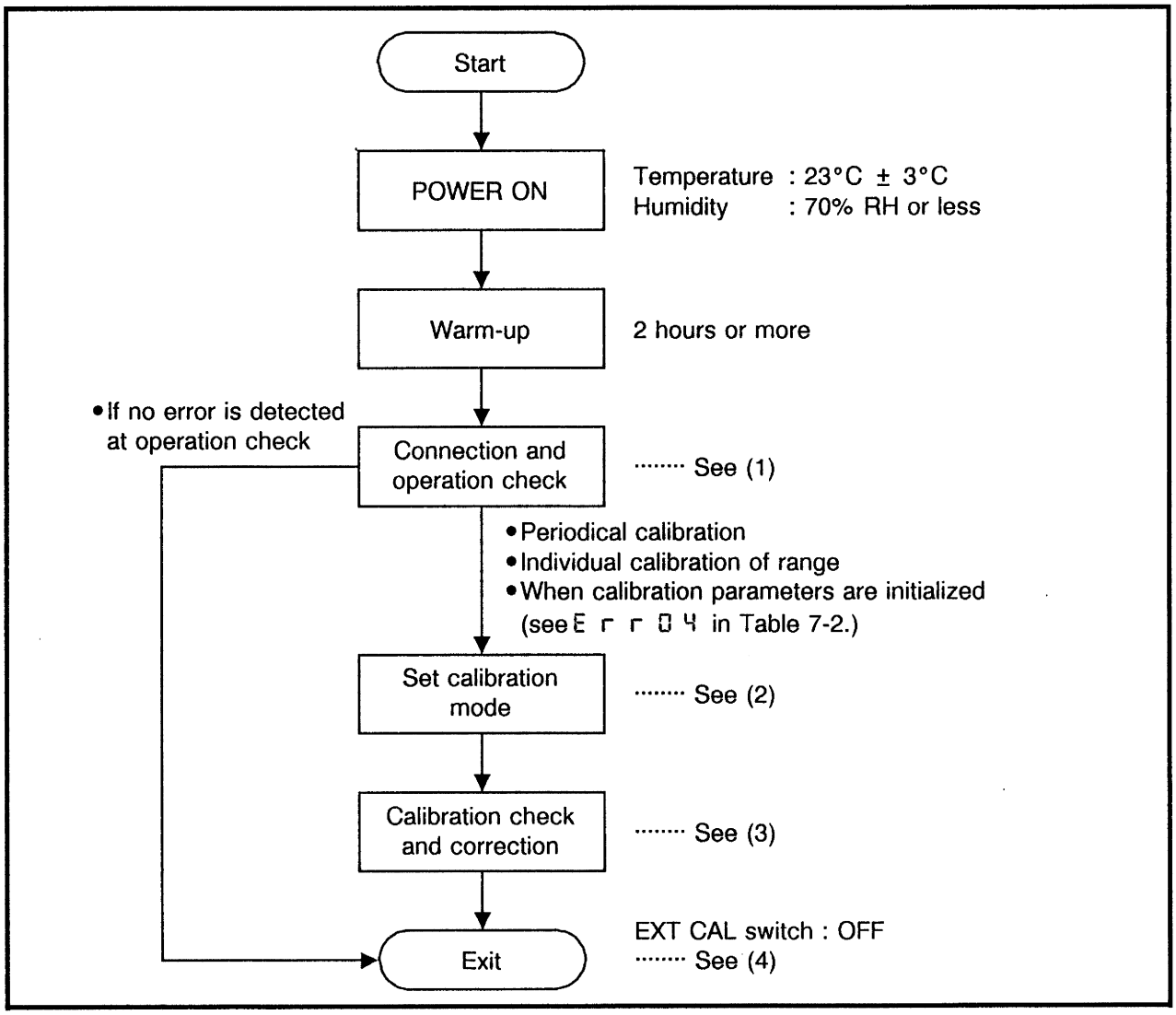


Figure 7-1 Calibration Flowchart

(1) Connection and operation check

① Connect the 6144 and a standard instrument. Figure 7-2 shows the connection and basic conditions of setting.

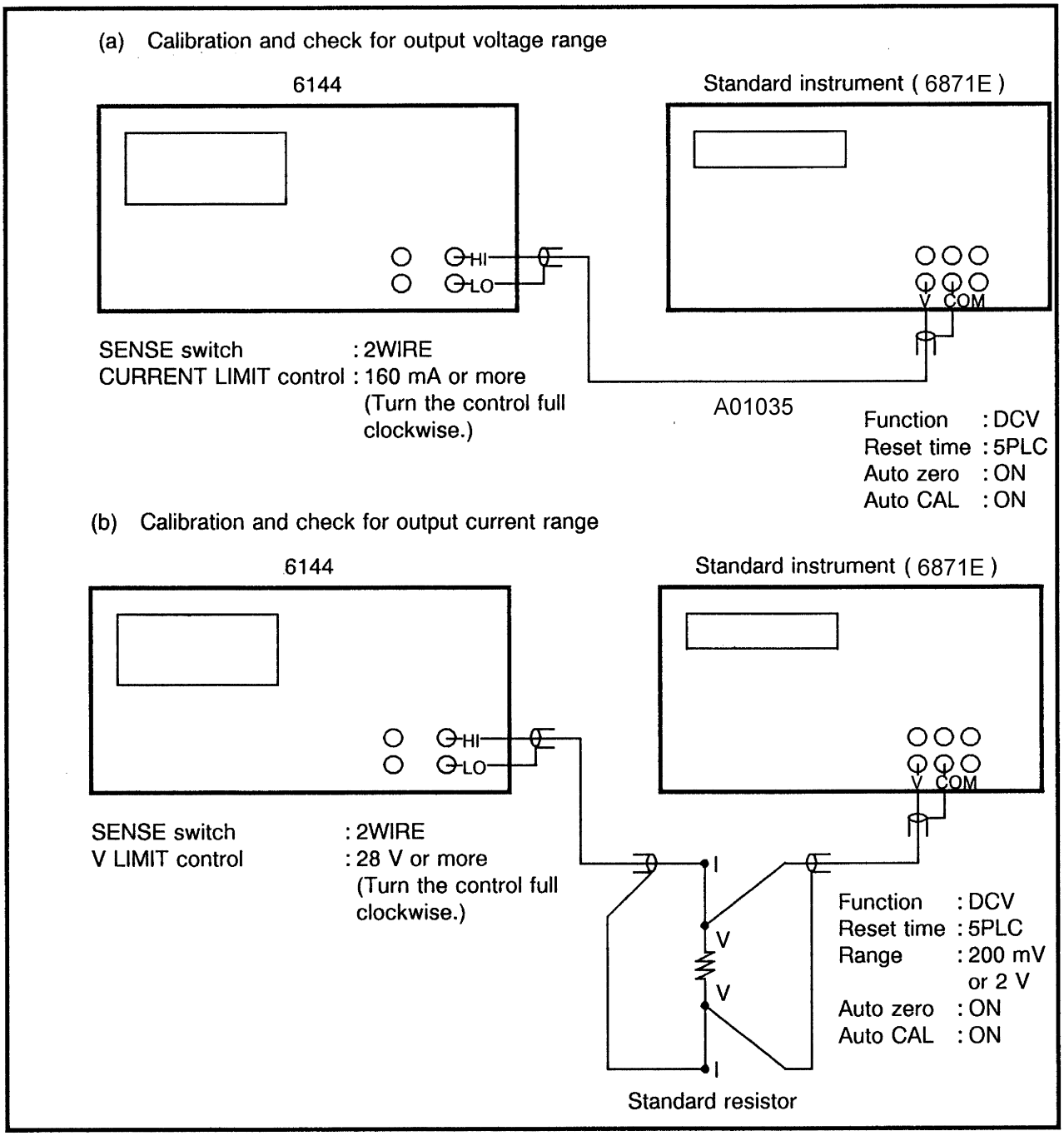


Figure 7-2 Connection with Calibration Instruments and Basic Conditions of Setting

② Operation check

Before starting calibration, measure the output from the 6144 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 6144 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 6144 fails to satisfy the required overall accuracy. The 6144 needs to be calibrated.

Table 7-5 Operation Check

Setting of 6144	Connection	Setting of standard instrument		Range of DMM reading (6871E)
		Measurement range of DMM	Standard resistor	
30V RANGE V ● mV mA 00.000	See Fig. 7-2 (a)	200 mV	Not required	−0.0050 mV to 0.0050 mV
30V RANGE V ● mV mA 16.000				15.9902 mV to 16.0098 mV
30V RANGE V ● mV mA -16.000				−15.9902 mV to −16.0098 mV
30V RANGE V ● mV mA 000.00				−0.0250 mV to 0.0250 mV
30V RANGE V ● mV mA 160.00				159.9270 mV to 160.0730 mV
30V RANGE ● V mV mA 0.0000		2 V		−0.2000 mV to 0.2000 mV
30V RANGE ● V mV mA 1.6000				1599.3200 mV to 1600.6800 mV
30V RANGE ● V mV mA 00.000		20 V		−2.000 mV to 2.0000 mV
30V RANGE ● V mV mA 16.000				15.993200 V to 16.006800 V

Table 7-5 Operation Check (Cont'd)

Setting of 6144	Connection	Setting of standard instrument		Range of DMM reading (6871E)
		Measurement range of DMM	Standard resistor	
● 30V RANGE ● V 00.000 mV mA	See Fig. 7-2 (a)	200 V	Not required	– 0.00300 V to 0.00300 V
● 30V RANGE ● V 32.000 mV mA				31.98740 mV to 32.01260 mV
30V RANGE V 0.0000 mV ● mA	See Fig. 7-2 (b)	2 V	1 kΩ	– 0.3000 mV to 0.3000 mV
30V RANGE V 1.6000 mV ● mA				1599.1400 mV to 1600.8600 mV
30V RANGE V 00.000 mV ● mA			100 Ω	– 0.3000 mV to 0.3000 mV
30V RANGE V 16.000 mV ● mA				1599.1400 mV to 1600.8600 mV
30V RANGE V 000.00 mV ● mA		200 mV	1 Ω	– 0.0300 mV to 0.0300 mV
30V RANGE V 160.00 mV ● mA				159.91400 mV to 160.0860 mV

(2) Calibration mode setting

Procedure

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

② Press [STEP] and [mV] to set the 6144 to the calibration mode.

(3) Calibration check and correction

Procedure

① Press [mV] or [mA] to specify the function to be calibrated.

[mV] : Voltage generation
[mA] : Current generation

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

③ Press the RANGE △ 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 OPERATE [ ] to turn the operate state ON.

⑤ Conduct calibration and check for +zero and then +full-scale using RANGE △ and ▽,

[+] and [−].

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

⑥ Press OPERATE [ ] 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.

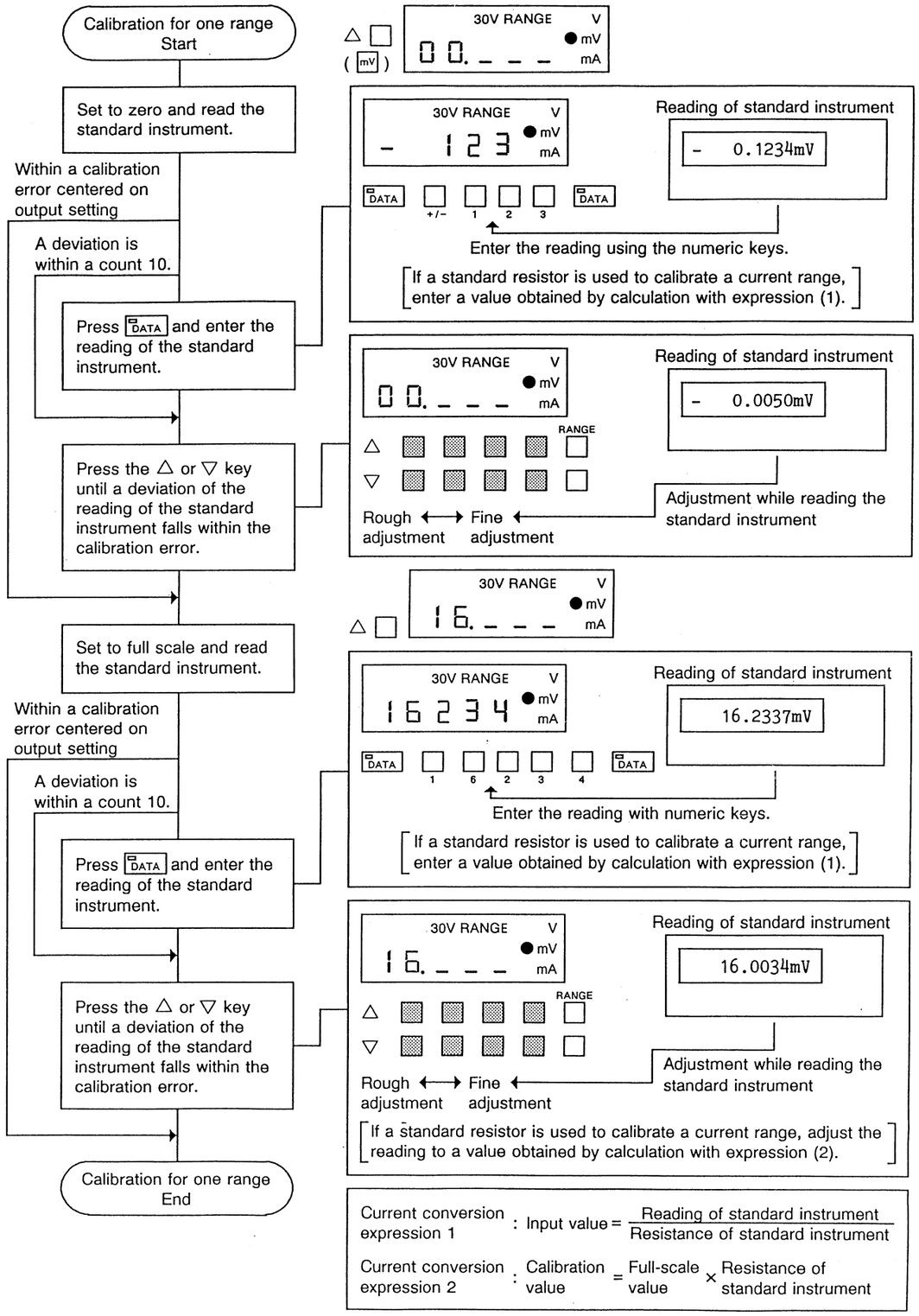
(4) Exit from the calibration mode

Set the EXT CAL switch to the OFF position and press [STEP].

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
mV, ▽□	10 mV	Zero	30V RANGE V ● mV mA 00._ _ _	± 0.5 μV
		Full scale	30V RANGE V ● mV mA 16._ _ _	16.000 mV ± 1 μV
	100 mV	Zero	30V RANGE V ● mV mA 000._ _	± 5 μV
		Full scale	30V RANGE V ● mV mA 160._ _	160.00 mV ± 10 μV
	1 V	Zero	30V RANGE ● V mV mA 0.0_ _ _	± 50 μV
		Full scale	30V RANGE ● V mV mA 1.6_ _ _	1.6000 V ± 100 μV
	10 V	Zero	30V RANGE ● V mV mA 00._ _ _	± 500 μV
		Full scale	30V RANGE ● V mV mA 16._ _ _	16.000 V ± 1 mV
△□	30 V	Zero	● 30V RANGE ● V mV mA 00._ _ _	± 1 mV
		Full scale	● 30V RANGE ● V mV mA 32._ _ _	32.000 V ± 2 mV
mA, ▽□	1 mA	Zero	30V RANGE V mV ● mA 0.0_ _ _	± 50 nA
		Full scale	30V RANGE V mV ● mA 1.6_ _ _	1.6000 mA ± 100 nA
	10 mA	Zero	30V RANGE V mV ● mA 00._ _ _	± 500 nA
		Full scale	30V RANGE V mV ● mA 16._ _ _	16.000 mA ± 1 μA
	100 mA	Zero	30V RANGE V mV ● mA 000._ _	± 5 μA
△□		Full scale	30V RANGE V mV ● mA 160._ _	160.00 mA ± 10 μA



8. OPERATING PRINCIPLE

8.1 Block Diagram

The 6144 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 6144.

The 6144 consists of the following three basic blocks: controller, reference voltage generator, and output amplifier.

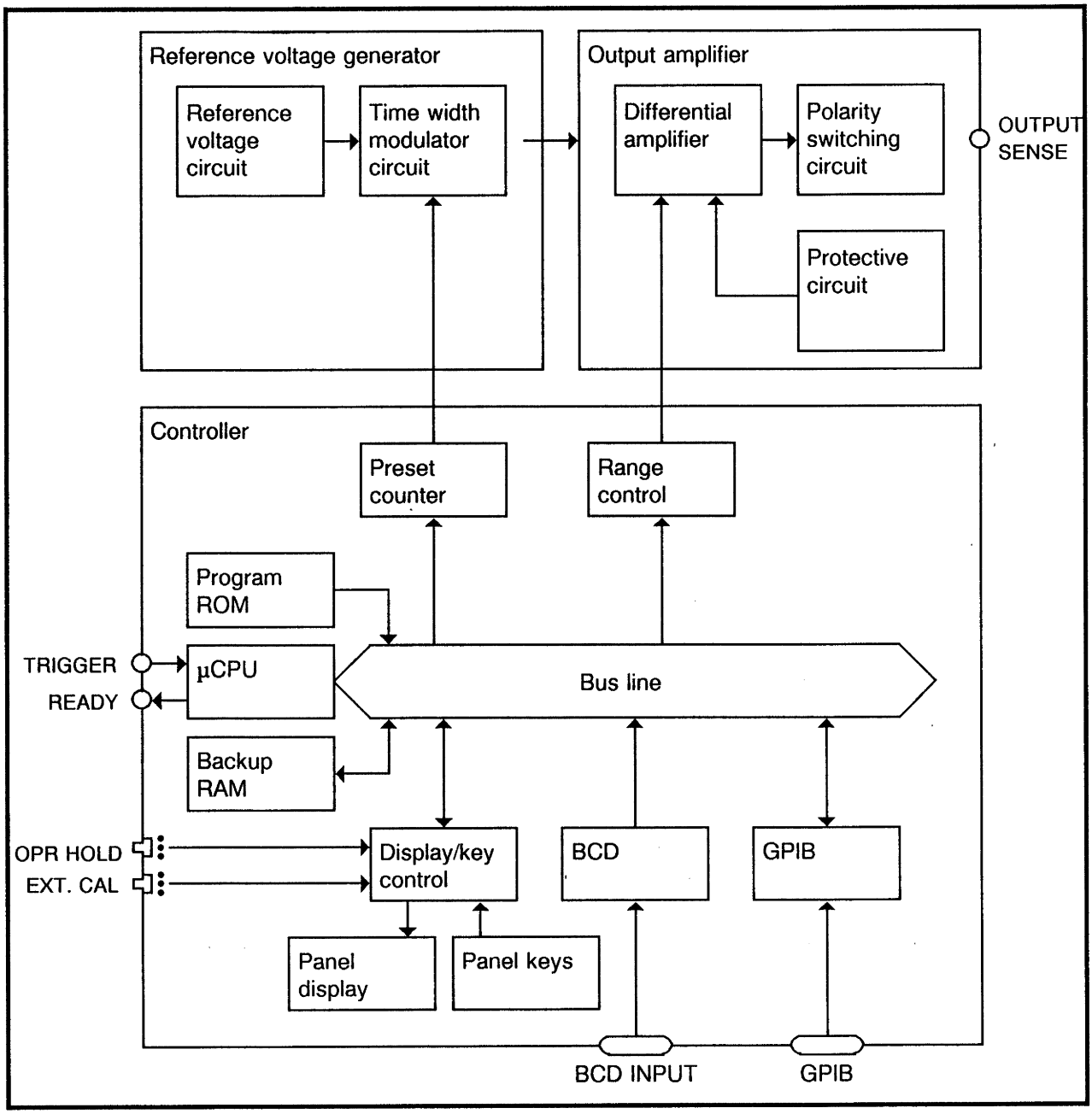


Figure 8-1 Block Diagram

8.2 Block Description

This section briefly describes the blocks.

(1) Controller

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

$$Es = \frac{T_1}{T_1 + T_2} \cdot Ez$$

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

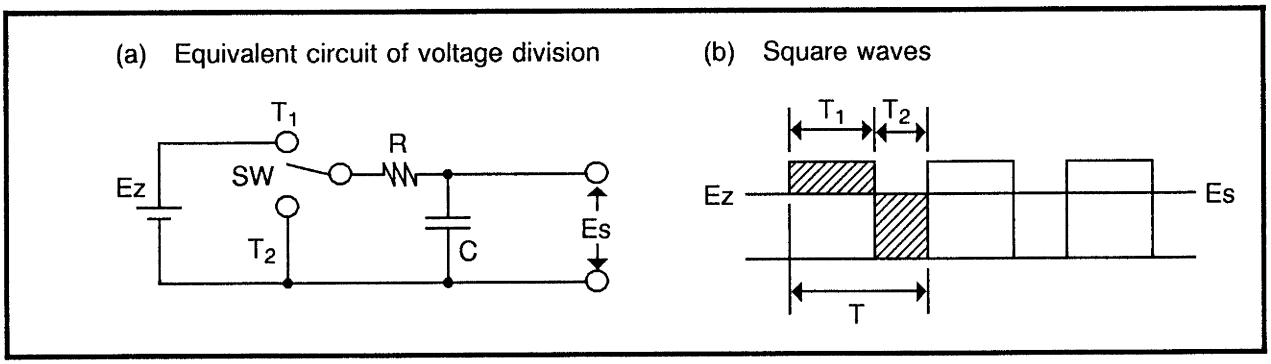


Figure 8-2 Time Division Method

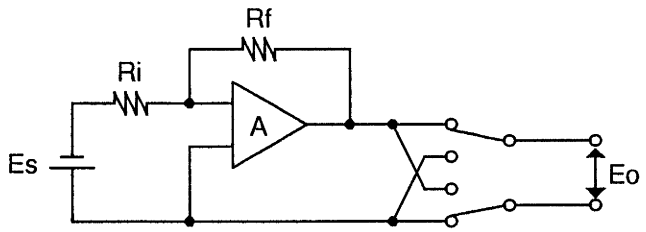
The reference voltage circuit generates reference voltage Ez. The time width modulator circuit generates pulses with pulse width T_1 corresponding to a set output level. Reference voltage Ez is switched and the low-pass filter averages the pulses to generate a required voltage.

(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 6144 switches ranges by changing Rf, R_1, and Rs.

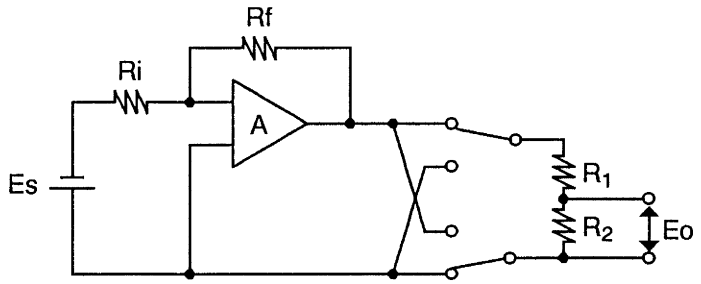
(a) 1 V, 10 V, and 30 V ranges



$$Eo = \frac{Rf}{Ri} \cdot Es$$

Polarity switching circuit (connection for positive polarity)

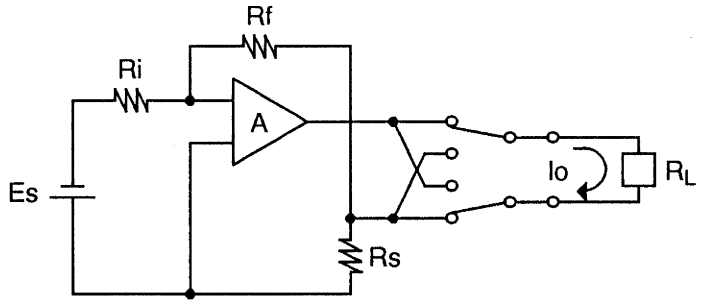
(b) 10 mV and 100 mV ranges



$$Eo = -\frac{Rf}{Ri} \cdot \frac{R_2}{R_1 + R_2} \cdot Es$$

Polarity switching circuit (connection for positive polarity)

(c) 1 mA, 10 mA, and 100 mA ranges



$$Io = -\frac{Rf}{Ri} \cdot \frac{1}{Rs} \cdot Es$$

Polarity switching circuit (connection for positive polarity)

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 ± 16.000 mV	1 µV	0.03 + 5 µV	0.01 + 4 µV	20 + 200 µV
100 mV	0 to ± 160.00 mV	10 µV	0.03 + 25 µV	0.01 + 10 µV	20 + 2 µV
1 V	0 to ± 1.6000 V	100 µV	0.03 + 200 µV	0.01 + 50 µV	20 + 10 µV
10 V	0 to ± 16.000 V	1 mV	0.03 + 2 mV	0.01 + 200 µV	20 + 40 µV
30 V	0 to ± 32.000 V	2 mV	0.03 + 4 mV	0.01 + 300 µV	20 + 60 µV
1 mA	0 to ± 1.6000 mA	100 nA	0.035 + 300 nA	0.01 + 20 nA	20 + 4 nA
10 mA	0 to ± 16.000 mA	1 µA	0.035 + 3 µA	0.01 + 200 nA	20 + 40 nA
100 mA	0 to ± 160.00 mA	10 µA	0.04 + 30 µA	0.01 + 2 µA	20 + 400 nA

- The overall accuracy and stability are at 23 ± 5°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:

  ± 90 ppm for the full scale of all ranges.

- 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	0.8 μA	(20 kΩ load that causes a 0.01% error)	Approx. 2 Ω	5 μV	10 μV	3 mV
100 mV	8 μA			15 μV	30 μV	
1 V	Source: 160 mA Rank : 100 mA		0.4 mΩ or less	80 μV	150 μV	
10 V			4 mΩ or less	200 μV	500 μV	
30 V			8 mΩ or less	400 μV	1 mV	
1 mA	28 V Output following voltage		100 MΩ or more	30 nA	150 nA	6 μA *
10 mA			10 MΩ or more	300 nA	400 nA	
100 mA			1 MΩ or more	3 μA	4 μA	

* The output is positive when the ground side of the load is connected to the HI terminal.
The output is negative when the ground side of the load is connected to the LO terminal.

- The output noise for the 1 mA, 10 mA, and 100 mA ranges is at a load resistance of 1 kΩ.
- The output resistance for the 1 V, 10 V, and 30 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 kΩ ,DC and 50/60 Hz
- Line regulation:
  ± 0.005% of a range at rated-voltage fluctuations of − 15% to + 10%
- Load regulation:
  ± 0.005% of a range (excluding the 10 mV and 100 mV ranges) at the maximum load of 4-wire connection

- Maximum load capacitance and inductance:

Range	Maximum load capacitance	Maximum load inductance
1/10/30 V	1000 μF	500 μH
1/10/100 mV	100 μF	1 mH

· The maximum load inductance for the 1/10/30 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 ±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	±0.1% centered on final value	50 ms or less
1 V, 10 V, and 30 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 ±(% of setting + X)
Current limiter	5 mA to 160 mA	10 + 1 mA
Voltage limiter	1 V to 28 V	5 + 100 mV

· The stability is at 23 ± 5°C.

· The current limiter is effective when the 6144 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 △ 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 terminal-to-terminal applied voltage:

Terminal	Range	Maximum applied voltage	
		Positive output voltage	Negative output voltage
HI to LO	1 V, 10 V	– 0.5 V to + 32 Vpeak	+ 0.5 V to – 32 Vpeak
	10 mV, 100 mV	-0.5 V to + 0.5 Vpeak	
LO to GND	-500 V to + 500 Vpeak		

- 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 △ 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

- 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, 48-66 Hz
- Supply voltage selection:
  The supply voltage can be changed with the selector switch on the rear panel.

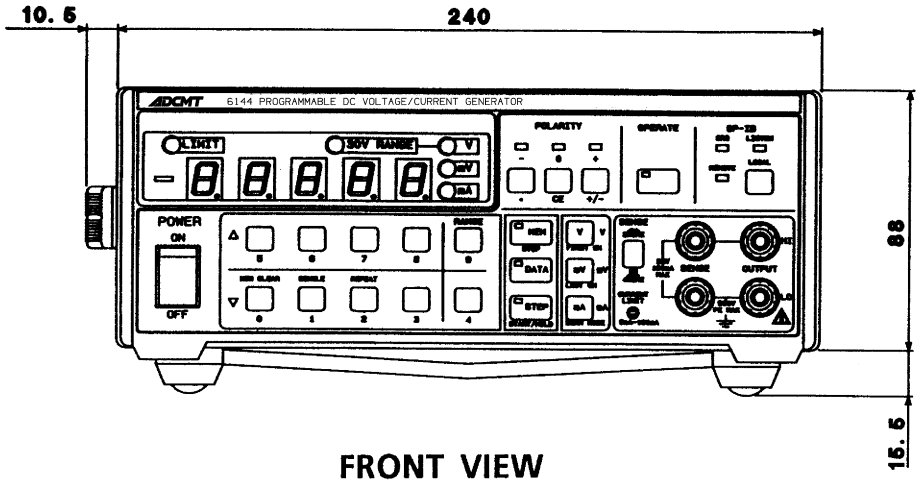
Option No.	Standard	Opt. 32	Opt. 42	Opt. 44
Supply voltage	90 V to 110 V	103 V to 132 V	198 V to 242 V	207 V to 250 V

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

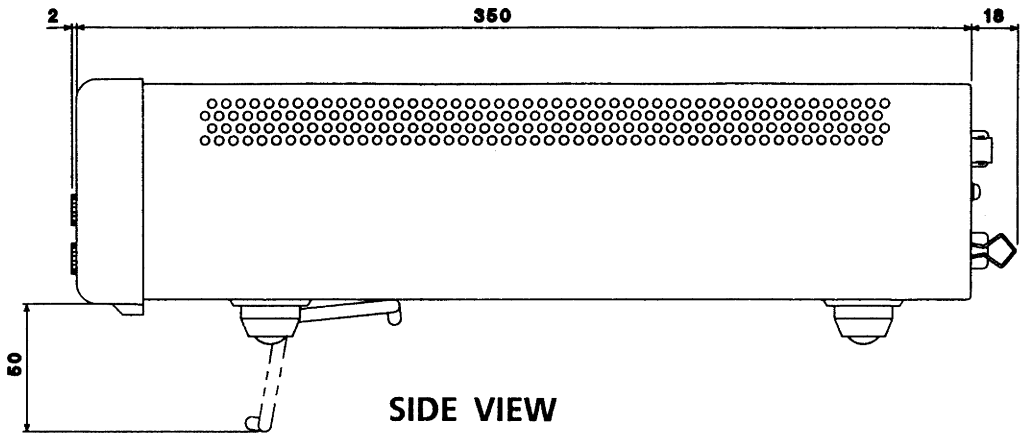
- Power consumption:
  27 VA or less
- Dimensions:
  Approx. 240 (width) × 88 (height) × 360 (depth) mm
- Mass : Approx. 4 kg

9.8 Accessories

Name	Model	Remarks
Connection cable	A01035	Plug end and clip end, 3-wire cable, 120 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

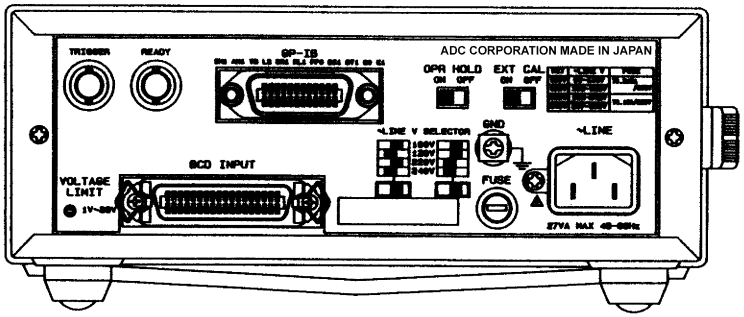


FRONT VIEW



SIDE VIEW

Unit; mm



REAR VIEW

6144
EXTERNAL VIEW

6144EXT1-9107-A

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1) When required parts cannot be procured.

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

ADCMT® ADC CORPORATION

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