7651

Model 7651
Programmable DC Source

IM 7651 - 01E

IM 7651 - 01E
3rd Edition

INTRODUCTION

We thank you for having purchased the Model 7651 Programmable DC Source.

The Model 7651 is a result of the very long experience and technological process accumulated in our company in the areas of high accuracy and high speed measurement technologies. Further, this is an instrument designed to meet a variety of the customer's needs as it is a multi-functional high response speed and high accuracy DC current and voltage generator.

Please read this manual carefully before using the meter. It is necessary to study all the controls and functions of the meter for correct measurement and maximum utilization.

Precautions

1. To maintain stable operation and high performance for an extended time period, read Section 1.1.3 and follow the precautions described in that section.
2. This manual covers detailed operating instructions and measurement procedures, but if you have any problems or questions, contact your nearest Yokogawa representative.
3. The contents of this manual will be subject to change without notice.
4. All of part of this manual is prohibited to be copied.

Warranty

Yokogawa warrants this product, for 12 months from the date of delivery, against defects in materials and workmanship. Yokogawa will repair or replace a product which proves defective during the warranty period due to materials or workmanship defects, provided that the product is returned to Yokogawa or a Yokogawa representative authorized to perform in warranty repair of the product. Yokogawa reserves the right to determine whether product failures are due to defective materials or workmanship, or to other causes not covered by this warranty. No other warranty is expressed or implied. Yokogawa is not liable for consequential damages.

FD No. 10012-Q

This instruction manual is divided into eight chapters that describe the functions of and the methods of operating this instrument.

Persons using this instrument for the first time are advised to carefully read through this manual starting from the Chapter 1 "Outline".

Those with some familiarity with instruments of this nature can read Chapter 3 for operating the instrument immediately. In particular, Section 3.4 and Sections 4.1 to 4.6 in Chapter 4 are especially useful as they describe the basic settings and the functions of the instrument.

CONTENTS

1. OUTLINE

The Model 7651 Programmable DC Voltage / Current Generator is a general purpose generator designed with the latest technology by Yokogawa. It has been possible to obtain both high response time and high resolution because of the use of dual multiplying D-A converters besides greatly improving the accuracy as well as the stability. Further, since the sink function (absorption of current) is also provided in addition to the source function (supplying of current), this instrument can function as a true constant current source. Furthermore, this instrument is provided with a variety of very strong functions that make the instrument ideal for use in measurement systems. For example, a programming function with a maximum of 50 steps of programming is provided, and the IC memory card (sold separately) can store upto seven types of programs. In addition, the instrument comes with the GP-IB and the RS-232C interfaces as standard features. Thus, this instrument cannot only be used in research and development work but also in production lines, servicing, maintenance, and all related areas.

1.1 Operation Preliminaries

This instrument is thoroughly tested at the factory before shipment. When it is delivered, check that all accessories are included in the packing case. Also check that the instrument model and specifications are correct. Perform a visual check to ascertain that no damage occurred during shipment.

1.1.1 Model and Specifications

The instrument nameplate is located at the rear of the instrument as shown in Figures 1.1 and 1.2. Check this nameplate to confirm that the instrument model and suffix codes agree with your specification requirements. Should any questions arise which may not be answered specifically by these instructions, contact your nearest Yokogawa representative.

In this case, write the Model and Serial No.

Model Numbers and Specification Codes

Table 1.1 Model Numbers and Specification Codes

Model No.	Specification Code		Remarks
7651 01	·····		Front panel output terminals & with GP-IB interface
7651 02	·····		Front panel output terminals & with RS-232C interface
7651 11	·····		Rear panel output terminals & with GP-IB interface
7651 12	·····		Rear panel output terminals & with RS-232C interface
Version	– A·····		
Power Supply Voltage		–1·····	100V AC, 50/60Hz common use (Can be set to 115V AC)
		–3·····	115VAC, 50/60Hz common use (Can be set to 100V AC)
		–5·····	200VAC, 50/60Hz common use (Can be set to 230V AC)
		–7·····	230VAC, 50/60Hz common use (Can be set to 200V AC)

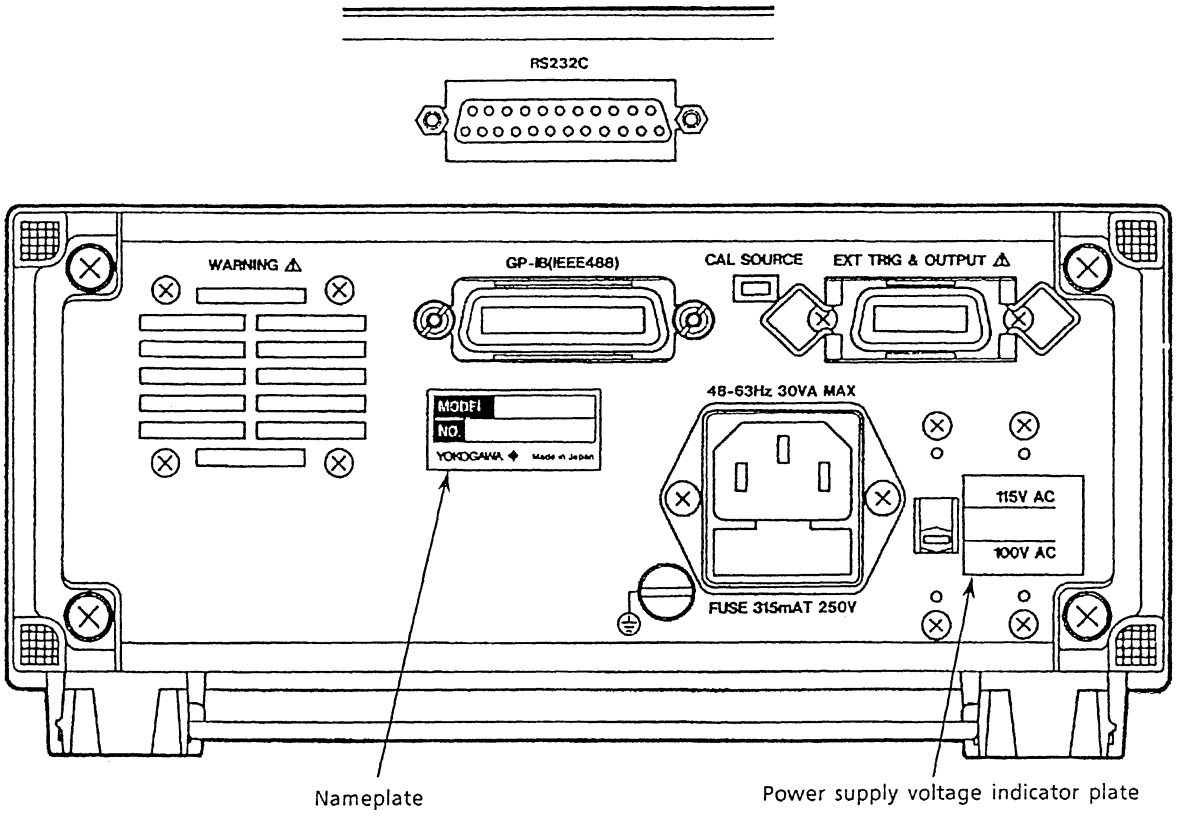


Figure 1.1 View of the Rear Panel (Front Panel Output Model)

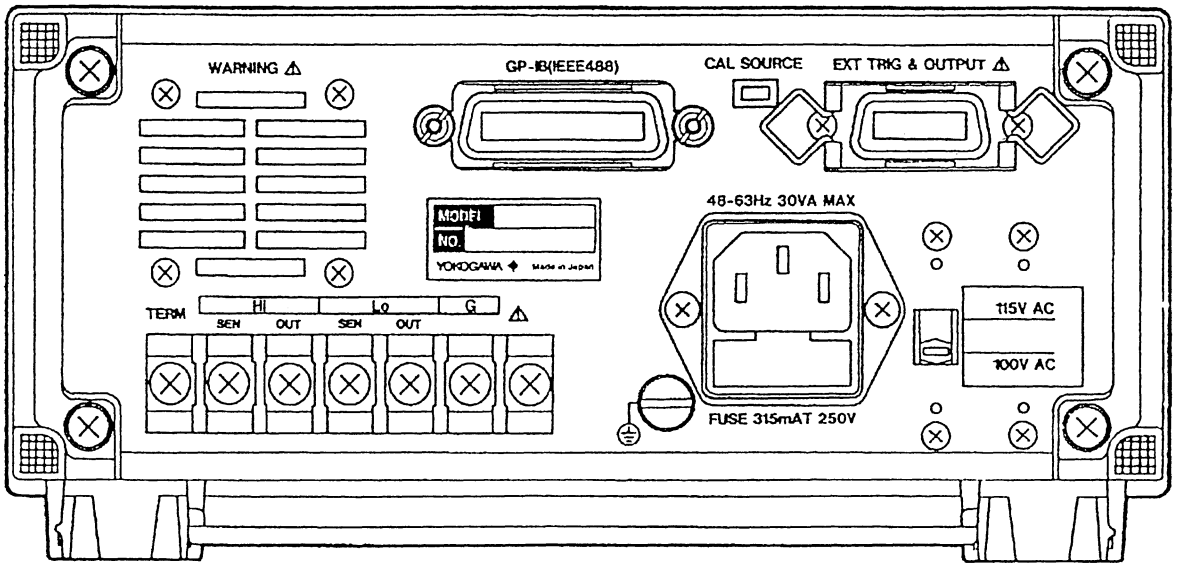


Figure 1.2 View of the Rear Panel (Rear Panel Output Model)

1.1.2 Accessories

The accessory items shown in Figure 1.3 and Table 1.2 are supplied with the instrument. Upon receipt of the instrument, check that all the accessory items are included.

If any of the accessory items are not found, contact your nearest Yokogawa representative. (See the rear cover.)

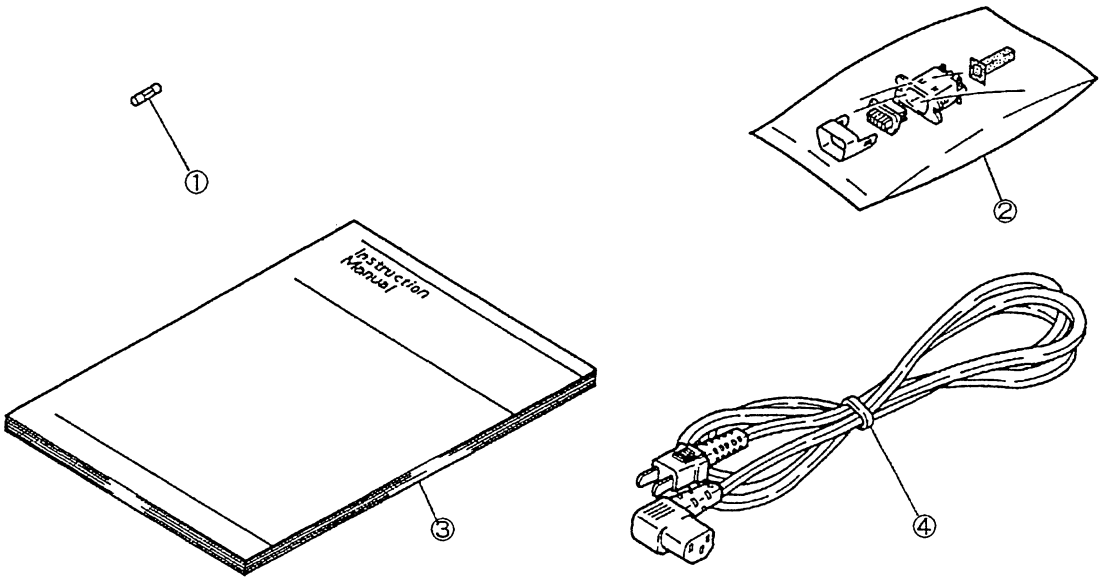


Figure 1.3 Accessories

Table 1.2

Item	Parts	Part No.	Quantity	Description
①	Fuse	A9130 KF or A9127 KF	1 1	315mA TL(100V series) (Installed in the fuse holder at the rear of the instrument.) 160mA TL(200V series)
②	Remote connector	A9024 KC	1	
③	Instruction manual	IM 7651-01E		
④	Power supply code	A9009 WD or A9008 WD or A9011 WD or A9015 WD	1 1 1 1	100V series 100V series (conforms to UL standard) 200V series (conforms to VDE standard) 200V series (conforms to SAA standard)

Note : We used to attach the manual "An Outline of PG-IB" to the product equipped with the GP-IB option. However, we feel that there is no necessity anymore to provide this manual with every unit equipped with this option, since GP-IB has become a well-known feature. Therefore the manual "TI An Outline of GP-IB" (TI 3800-01) has been prepared instead of the instruction manual. This TI is available upon request from your nearest Sales & Service Center. Addresses may be found on the back cover of each instruction manual.

1.1.3 Precautions

Always observe the following for correct and safe instrument operation.

Table 1.3 Precautions

On this instrument:	Do not put any container with water, etc. on this instrument. If liquid gets on the instrument, unplug the power cable from the power outlet and contact your nearest Yokogawa service representative. Do not put any heavy instruments on this instrument. If so, the case may be damaged and / or a bad influence may be exerted on this instrument due to bad ventilation.
Prior to carrying the instrument:	Prior to carrying the instrument, remove the power cable from the power outlet and all the external wires connected to the instrument. Do not apply shock to this instrument during transportation. If so, the instrument may be damaged.
Cleaning:	Do not use benzene or lacquer thinner to clean the case or front panel. Otherwise they will deform or the paint will fall off.
When the instrument is not used for a long time:	When the instrument is stored, remove the built-in battery from the case. Otherwise, rust may be formed due to solution leakage, thereby hindering normal operation and also damaging the memory card.
Never touch internal components and parts:	Do not remove the meter case top which covers the high-voltage circuit. Ask for internal inspection and adjustment to your nearest Yokogawa service representative.
When the instrument is abnormal:	If the instrument fails (smoke is emitted and / or abnormal sound is produced), remove the power plug from the power outlet to suspend operation. Contact your nearest Yokogawa service representative.
Power cord:	Do not put anything heavy on the power cord. Do not allow the power card to come into contact with heat sources. The faulty power cord may cause an electric shock or fire. In this case, contact your nearest Yokogawa service representative. The power cord part No. for domestic use is A9009WD
Operating environment:	Select an installation location where the instrument is well-ventilated in order to prevent the instrument from temperature rise. Do not leave the instrument in direct sunlight. Select a location where the ambient temperature varies little. An ambient temperature of about 23°C is recommended.

1.1.4 Operation Check

(1) Power Supply Connection

① After installing the instrument, connect the power supply cord (supplied with the instrument) to the power supply connector at the rear of the instrument (see Figure 1.4).

② Check that the instrument power switch (front panel) is in the OFF position. Connect the power plug to the power outlet as shown in Figure 1.4. Always use a power supply within the rated voltage. The rated power supply is indicated to the side of the power switch (see Figure 1.4).

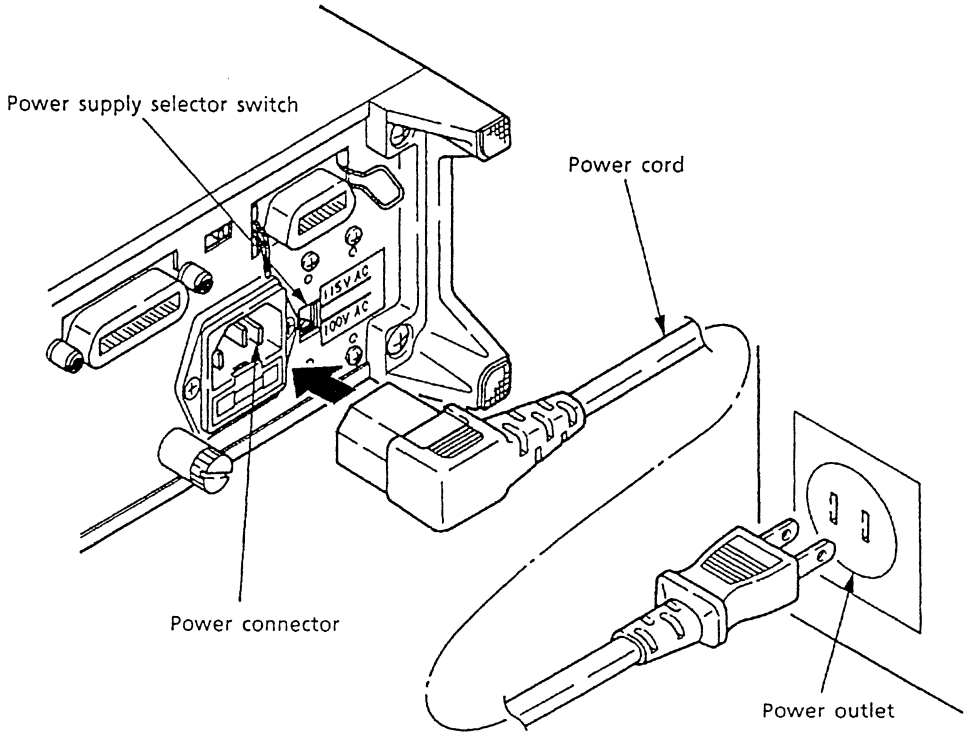
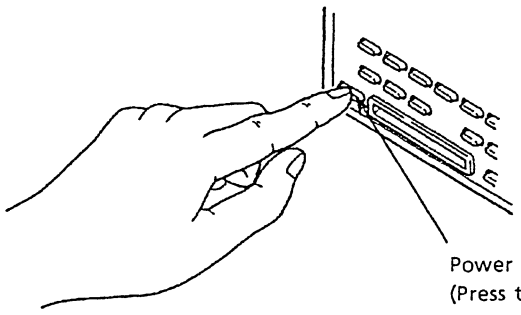


Figure 1.4 Power Supply Connection

(2) Turn ON the power

Turn ON the power and check that the instrument is automatically tested.



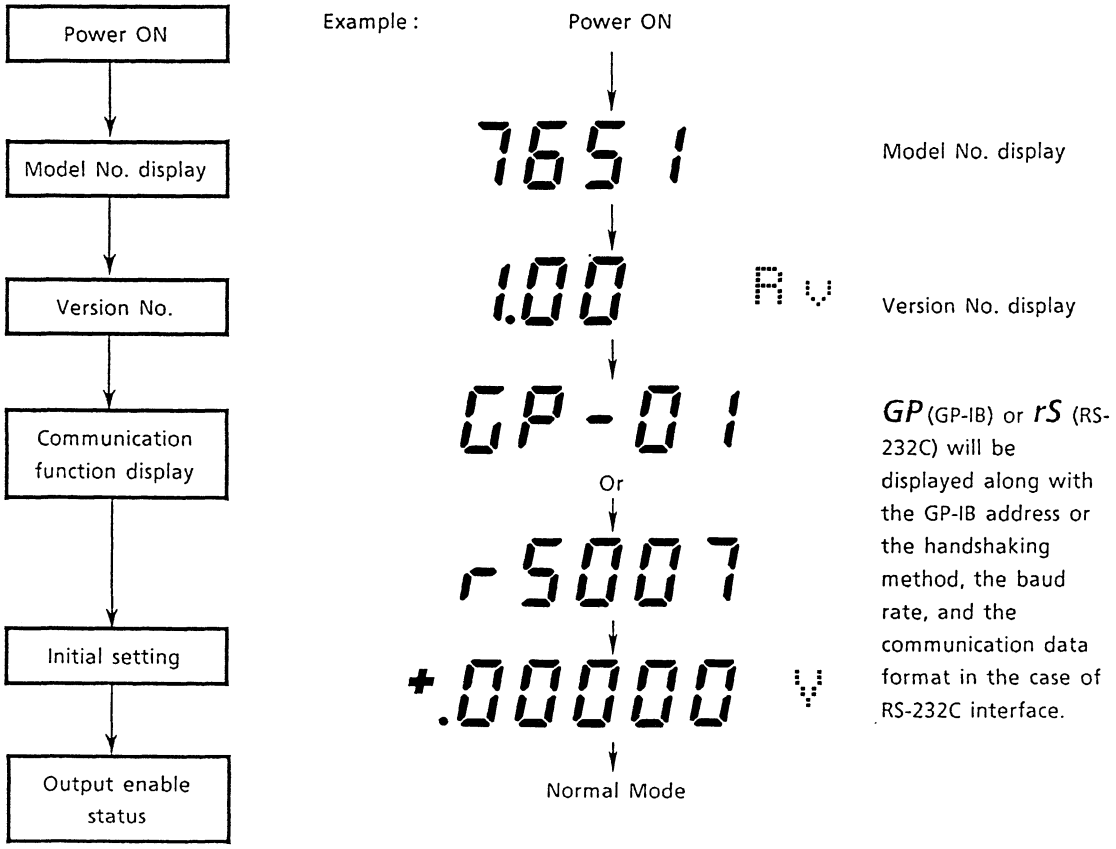
Power switch (*POWER*)
(Press the switch to turn ON the power and press again to turn OFF the power.)

Figure 1.5 Power Switch ON

- **Self test when the power is ON.**

When the power turns ON, a self-test starts automatically. Check that the following "opening" messages are displayed.

If the opening messages are not displayed in the following order, an instrument internal circuit may be defective. If so, contact your nearest Yokogawa service representative.



1.2 Features

■ High Accuracy Output

High accuracy : ±0.01% of setting ±200μV (10V range, 90 days, at 23±5°C)
±0.02% of setting ±100nA (1mA range, 90 days, at 23±5°C)
High resolution : 100nV DC (10mV range)
High response speed : 10ms/±0.1%
Low noise : 15μV_{P-P} (1V range, DC to 10Hz)

The Model 7651 uses the multiplying D-A converters for Digital to Analog conversion because of their excellent response speed characteristics. In addition, duplexed converters are provided so as to achieve high resolution. Strengthened software provides far greater linearity than ever before. High accuracy outputs are therefore guaranteed in all ranges.

■ Sinking and Sourcing

In conventional constant voltage or current generators, it was possible to supply current from the instrument (source of current) but the instrument was not capable of sinking current (absorbing current from the load).

However, the Model 7651 can act both as a source as well as a sink of current and hence it will be true constant voltage source that will be independent of the load. In addition, it can also be used as a high accuracy constant current electronic load in battery discharge characteristic tests or in measuring the loaded output characteristics of power supplies, etc.

Because of the ability of the instrument to source as well as sink current, operations are possible in all four quadrants of the I-V plane thus making it easy to drive both capacitive and inductive loads without any difficulty.

■ Bi-polar Output

The bipolar output of the Model 7651 does not use mechanical contacts for inverting the polarity, there will be no abnormal voltage (or current) generation at the time of polarity inversion. This makes it possible to truly vary the output continuously from the positive maximum value to the negative maximum value. This is very useful in evaluating comparators, or in polarity inversion in physics experiments where the thermally induced voltages need to be cancelled.

■ Output Data of 50 Steps can be Memorized

Upto 50 steps of output data can be memorized. Further, the sweep time can also be set in addition to the setting of the generation interval both of which together can be used to generate step, ramp, triangular and other types of waveforms.

In addition, the use of the IC memory card allows the user to store upto seven types of programs or patterns in each card so that any number of programs can be stored and can be recalled at any time the user wants which will greatly improve the efficiency of work in field operations.

■ Reaching Out for Greater Each of Use

● Two types of Data Set Up Modes:

One of the following two types of modes can be selected according to the need.

- Continuously variable mode : Each digit can be set to any required value using the UP (▲) and DOWN (▼) keys. The output value will change continuously when these UP or DOWN switches are kept pressed continuously.
- Data mode : The value to be set can be entered directly using the ten keys in this mode.

● Programmable Voltage / Current Limiter

The voltage limiter can be set to any value within the 1V to 30V range, and the current limiter can be set to any value within the 5 to 120A range.
Even if the limiter operates due to accidental overloading or shorting of the output, the 7651 automatically recovers to the original condition as soon as the overload is removed.

● Software Calibration Function

The 7651 is provided with built-in calibration software which makes it easy to calibrate the unit by operating the switches on the front panel or by sending appropriate commands over the communication lines. There is absolutely no need for complicated adjustments to be made after opening up the case, etc. This software calibration function makes it easy for anybody to maintain the accuracy of the Model 7651.

● Standard Equipment of GP-IB or RS-232C Interfaces

It is possible to select either the GP-IB interface or the RS-232C interface for the instrument depending on the current system being used. The following functions can be controlled because of the communication functions and a set of comprehensive commands;

- All functions controlled by the front panel keys
- Output of set data
- Output of panel set-up information
- Setting and reading of program steps
- Output of the status byte

• Selection of Front Panel or Rear Panel Output Models

The 7651 comes in two models which differ only in whether is the output is made on the front panel or on the rear panel. The model that is most suitable for the purpose, whether for bench use or for system rack mounting, can be selected by the user as per the need.

1.3 Block Diagram and Operation

(1) Block Diagram

Figure 1.6 shows the block diagram of the 7651.

The instrument consists of the set voltage generation section, the power amplifier section, the output selection circuit, the limiter control circuits, the CPU control circuits and the digital section.

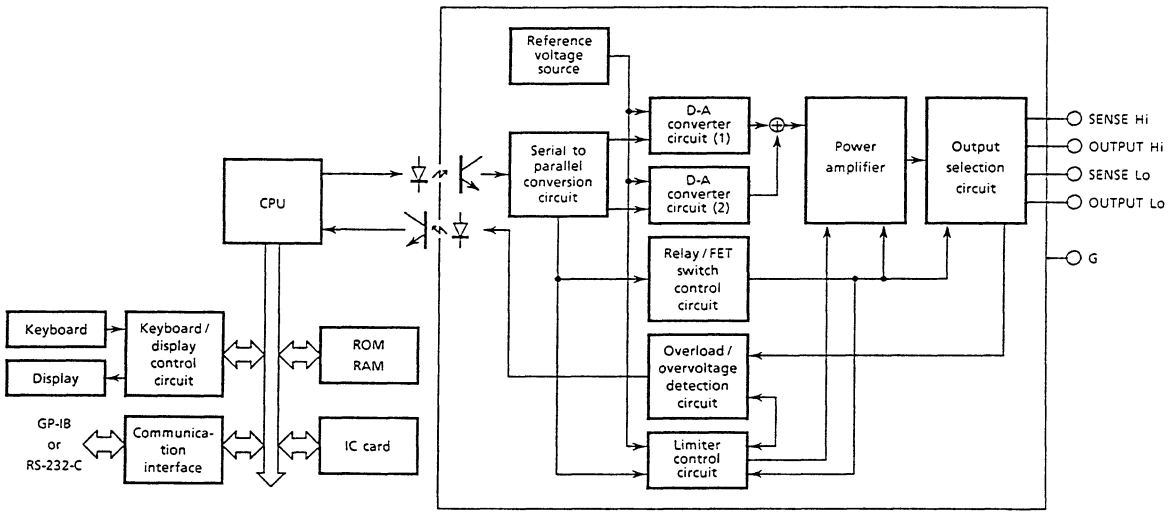


Figure 1.6 Block Diagram of the 7651

(2) Operation

(a) Generation of the Output Set-Voltage

The output set-voltage is generated from the reference voltage value by converting the digital value set by the CPU in the two D-A converters (1) and (2) into an analog voltage. The D-A converter circuit (1) generates an analog signal corresponding to the higher order 8 bits of the total 20 bits of data corresponding to the required set-voltage. The D-A converter circuit (2) generates an analog voltage corresponding to the lower order 12 bits of the required set-value and supplements the D-A converter (1). The outputs of the two D-A converter circuits are then added together and the sum is then input to the power amplifier.

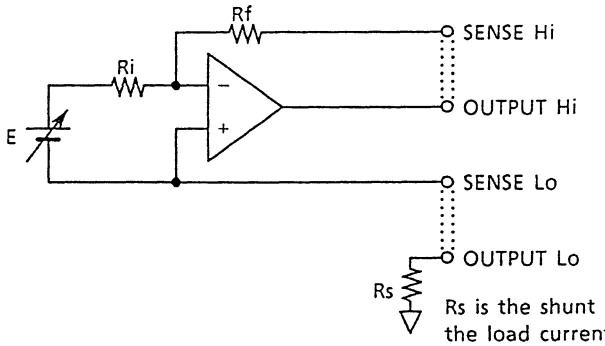
(b) Power Amplifier

The power amplifier carries out the power amplification of the output set-voltage in accordance with the function and the range selected.

(c) Output Selection Circuit

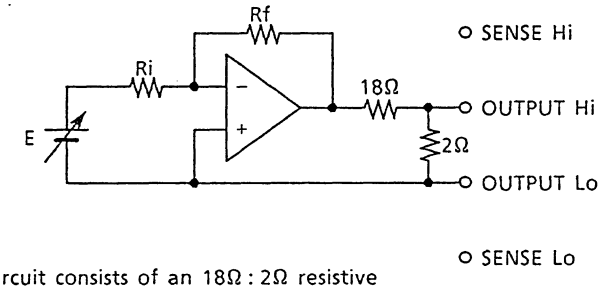
The output selection circuit switches the output of the power amplifier depending on the range. The type of output circuit used for each function is shown in Figure 1.7 below.

(i) Constant Voltage Output (1V, 10V, 30V)



Rs is the shunt resistor used for monitoring the load current in the overload / overcurrent detection circuit.

(ii) 10mV, 100mV



Note : The output circuit consists of an 18Ω : 2Ω resistive voltage divider network in the 10mV and 100mV ranges.

(iii) Constant current output (1mA, 10mA, 100mA)

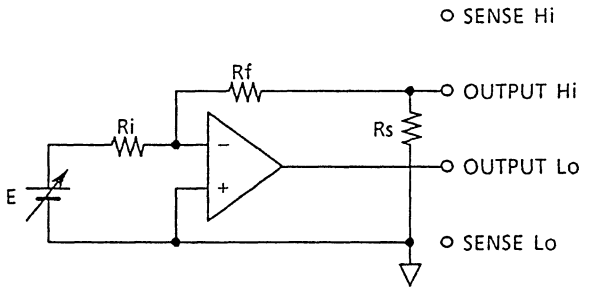


Figure 1.7 Types of Output Circuits

(d) Limiter

The overload / overvoltage / overcurrent detection circuit operates by monitoring the output voltage or the output current and comparing them with reference values. When the detector circuit detects an overload condition with respect to the limit set-values, the limiter circuit controls the output of the power amplifier so that the output is a constant voltage or current. In addition, this signal will also generate an interrupt to the CPU circuit which in turn gives out the indication "−oL−" on the display unit.

When the detection circuit detects an overvoltage of more than ±35V or an overcurrent of more than ±130mA, an interrupt is issued to the CPU circuit to turn the output OFF.

(e) CPU Control

The setting of data in the D-A converter circuits (1) and (2) and the control of the relays and FET switches are done using the serial data sent from the CPU which is first converted to parallel data before use.

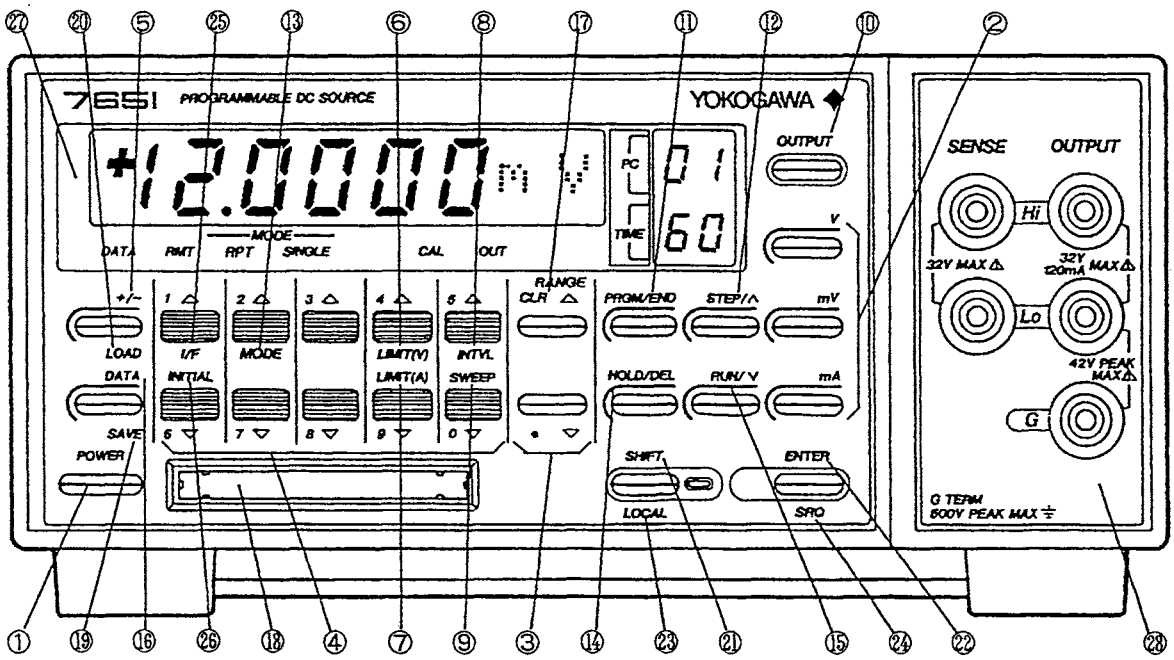
(f) Digital Section

The computation of the data to be set in the D-A converters, the program control, the processing for the display and keyboard interface, and the processings for the communication interfaces are carried out on the digital section.

2. NAME AND FUNCTION OF EACH PART

2.1 Front Panel

7651 01 / 7651 02



* The functions in blue color will become effective only when the SHIFT key is pressed.

Figure 2.1 Name of Each Part of the Front Panel of the Instrument

① *POWER* Switch

This is the switch for turning ON and OFF the power supply to the unit. The power will be switched ON when this switch is pressed once and will be turned OFF when the switch is pressed again. As soon as the power to the unit is switched ON, the instrument carries out a self-test and the opening message given in Section 1.1.4 will be displayed.

② Function Keys

These are the switches for setting the output function: namely, DC voltage (V), DC voltage (mV), and DC current (mA). The appropriate unit of the function that has been selected will be indicated in the display section.

③ Range Keys

These keys are used for setting the range.

CLR ▲ : This is the UP key for increasing the range and the range increases by one step when this key is pressed once. The maximum range that can be selected in this way is 30V (100mA). Pressing this key further will have no effect when the range selected is already in the maximum range of 30V (or 100mA).

▼ : This is the DOWN key for decreasing the range and the range decreases by one step when this key is pressed once until the minimum range is reached to 10mV (or 1mA). The range will not change any further even if this key is pressed when the range is the minimum range.

④ UP / DOWN / Ten Keys

These are the keys used for increasing (▲) or decreasing (▼) the different individual digits of the set-value and are also used for continuously varying the set value. When the SHIFT key is pressed while these keys are operated, these keys can be used as the ten keys (for numerals from 0 to 9) for inputting the output data, voltage or current limit values, interval time, sweep time, etc., in the data mode.

⑤ Polarity Changing Key

This key is used for selecting the polarity of the output data (+ or −). Every time this key is pressed, the polarity changes from + to − and from − to +.

⑥ *LIMIT(V)* Key

This is the key for setting the limiting value of the load voltage when the instrument is in the DC current output mode. This limiting voltage can be set to any value in the range of 1V to 30V in steps of 1V.

⑦ *LIMIT(A)* Key

This is the key for setting the limiting value of the load current when the instrument is in the DC voltage output mode. This limiting current can be set to any value in the range of 5mA to 120mA in steps of 1mA.

⑧ *LNTVL* Key

This is the key for setting the interval time during program execution. The interval time can be set to any value in the range of 0.1s to 3600s with a resolution of 100ms.

⑨ *SWEEP* Key

This is the key for setting the sweep time period for program execution. The sweep time period can be set to any value in the range of 0s to 3600s (1 hour) with a resolution of 100ms. The sweep time period is set to 0 seconds when a step waveform output is required.

⑩ *OUTPUT* Key

This is the key for turning ON or OFF the output. When this key is pressed, the output will appear at the output terminals with the correct set-value. When the output is being made, the OUT lamp will light up in the display section. When this key is pressed again, the output will be turned OFF and the OUT lamp will go OFF also.

Note, however, that the output can go OFF automatically if the function is changed during data output (from V to mV or vice versa), or when a overvoltage or an overcurrent condition occurs.

⑪ *PRGM* Key

This switch is for starting and stopping the program setting. When this key is pressed for the first time, the program setting mode will begin, and when this key is pressed again, the program setting mode will end and the data output mode will begin. The setting of the output data by the program utilizes the internal memory of the unit which can accommodate a program having a maximum of 50 steps.

⑫ *STEP* Key

- During program execution:
  When a program has been stored in the internal memory, pressing this key causes the program to be executed one step at a time. However, when no program has been stored in the memory, pressing this key will cause the error indication Err 05 to be displayed in the display section.
- When a program is being set:
  When this key is pressed once in the program setting mode while a previously stored program is present in the memory, the setting operation moves to the next step of the program.
  This key can be pressed in this manner until the step next to the last step stored in the memory of the program is reached (that is, when the TIME display changes to the nL display).

⑬ *MODE* Key

This switch is for setting the execution mode of the program. The following two types of program execution modes are available:

· REPEAT mode : In this mode, the program will be executed repeatedly from the starting step to the last step. To stop the repeated execution of the program in this mode, press the HOLD/DEL key. When this mode is effective, the RPT lamp in the display section will light up.

. SINGLE mode : In this mode, the program will be executed only once from the beginning to end. When this mode is effective, the SINGLE lamp will light up in the display section.

⑭ *HOLD* Key

This key is pressed for temporarily halting the execution of the program. The program execution can be started again from the step next to the one executed last by pressing this key again.

⑮ *RUN* Key

When this key is pressed, the program will be executed from the beginning with the interval set at the time of executing the program.

- Note that this key is also used during the program set-up mode for retracing the program by one step backward (∨). The backward movement in the program steps can be done upto the beginning of the program (that is, the state in which PC: 01).

⑯ *DATA* Key

This key used during set up of data for initiating the data mode in which the data is set up directly using the ten keys. The data mode will be released when this key is pressed again. When the data mode is effective, the DATA lamp in the display section will light up.

⑰ *CLR* Key

- When the data mode has been set:
  When the data mode has been set, this key is used for clearing the data being set to zero, such as when a mistake has been made.
- When setting the range:
  This key is used for increasing the range when the range is being set. See ③ above for more details.

⑱ IC Memory Card Insertion Slot

This is the slot for inserting the IC memory card. See Section 4.3 for details.

⑲ *SAVE* key

This key is pressed for saving the program that has been stored in the internal memory in the IC memory card. If this SAVE key is pressed when no IC memory card has been inserted in the IC memory card insertion slot, the error message Err 34 will be displayed in the display section. Press this key again after inserting the IC memory card.

⑳ *LOAD* Key

This key is pressed for loading the program saved in the IC memory card into the internal memory of the unit. If this key is pressed when no IC memory card has bene inserted in the IC memory card insertion slot, the error message Err 34 will be displayed. In this case, press this key again after inserting the IC memory card.

㉑ *SHIFT* Key

This key should be pressed to enter the SHIFT mode whenever the functions marked in blue color on the front panel are to be used. When the SHIFT mode has been entered, the green lamp next to this key will light up. Press this key again to release the SHIFT mode and the green lamp too will go off.

㉒ *ENTER* Key

This key validates the entries made thus far for the output settings or for the condition settings.

㉓ *LOCAL* Key

This key is pressed for entering the LOCAL mode from the REMOTE mode while using the instrument via the GP-IB or the RS-232C interface. In the LOCAL mode, the settings can be made using the keys on the front panel of the instrument. The instrument will be in the LOCAL mode as soon as the power to the instrument is switched ON.

㉔ *SRQ* Key

This key has the following functions when the instrument is being used in the remote controlled mode depending on the type of interface that is being used for remote control:

When using the GP-IB interface : When this key is pressed, a service request will be transmitted to the controller from this instrument.

When using the RS-232C interface : Outputs one item of the set data.

㉕ *I/F* Set Key

This is the key for making the basic settings for the interface, such as the interface address, the baud rate, etc.

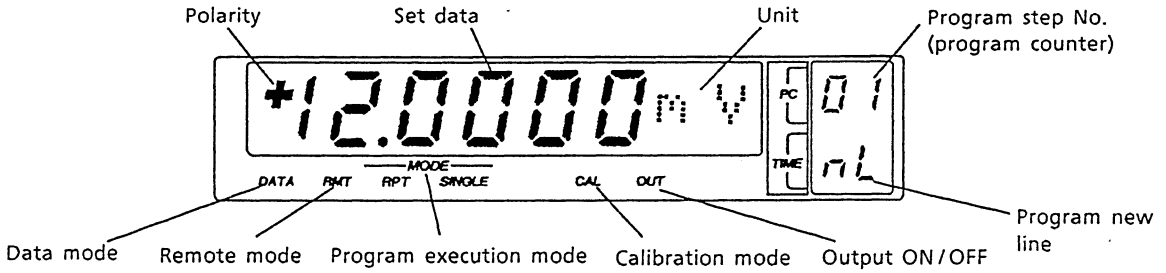
When using the GP-IB interface : This key is used for setting up the GP-IB device address of this unit.

When using the RS-232C interface : This key is pressed for setting up the handshaking method, the data format, and the baud rate. See Section 6.2 for further details.

㉖ *INITIAL* Key

This key is used for initializing either the 7651 entire unit or the IC memory card. See Section 4.1 for further details.

㉗ Display Section



Polarity : Indicates positive or negative polarity.

Set data : This display contains the data digits (maximum value = 120000), the decimal point, and the unit under normal conditions, but will display – oL– (OVERLOAD) in the event of an overload. This part also displays the error message (Err ○○) when a wrong entry has been made during data setting up or when some other incorrect operation has been made.

Unit : This part indicates the unit (V, mV, mA, s) of the function or the time being set or the menu symbols.

PC : This is the value of the program counter. That is, this is the step number in the program stored in the internal memory. The PC value can be in the range of 01 to 50, which means that each program can have a maximum of 50steps.

TIME : This part displays the remaining part of the interval time during program execution. In the program registration (set-up) mode, this section of the display is used for indicating the head nL in an as yet unprogrammed area.

㉘ Output Terminals

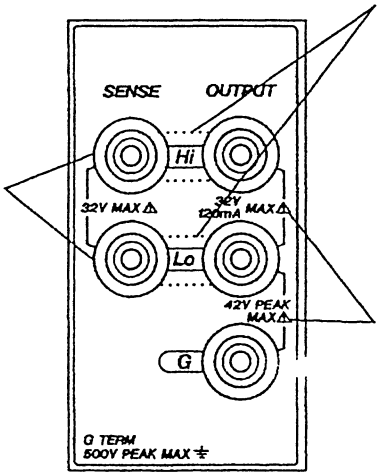
The following two models are available which differ in the shape of the output terminals.

7651 01/7651 02 : Front panel output-terminals models

7651 11/7651 12 : Rear panel output-terminals models

Note: Please note that rear panel output terminals will not be present in a front panel output-terminals model nor will there by any front panel output terminals in a rear panel output-terminals mode.

These are the 4-wire type output voltage detection terminals in combination with the OUTPUT Hi and Lo terminals.



Shorting bars:
In the case of the 4-wire type output in the DC voltage mode, these two shorting bars should be detached before connecting the instrument to the load. In all other modes, the shorting bars can either be left in place or can be opened out because the SENSE terminals will be open in any case.
Normally, it is advisable to short the terminals L and G under usual conditions of use.

These are symbols of international convention and caution the user to refer to the Instruction Manual. The same ⚠ symbols will be present in the appropriate sections of the Instruction Manual also.

2.2 Rear Panel

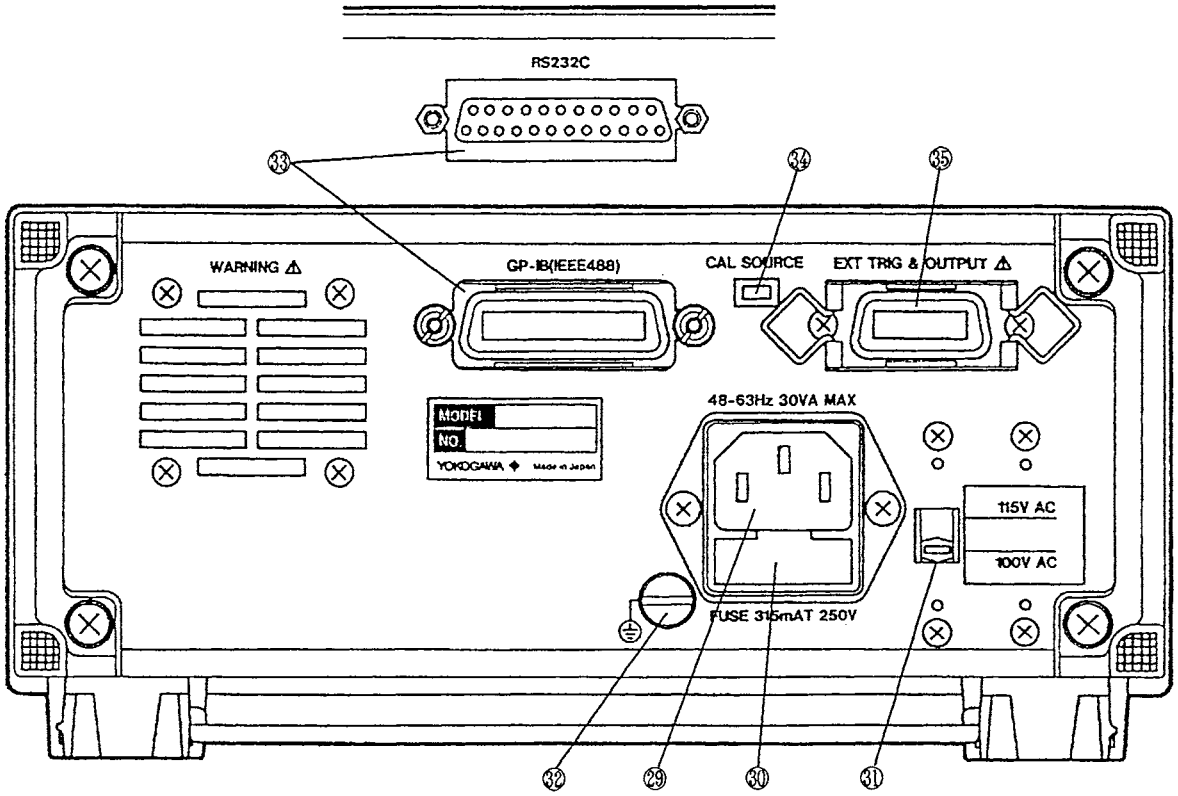


Figure 2.2 Name of Each Rear Panel Part (7651 01/7651 02)

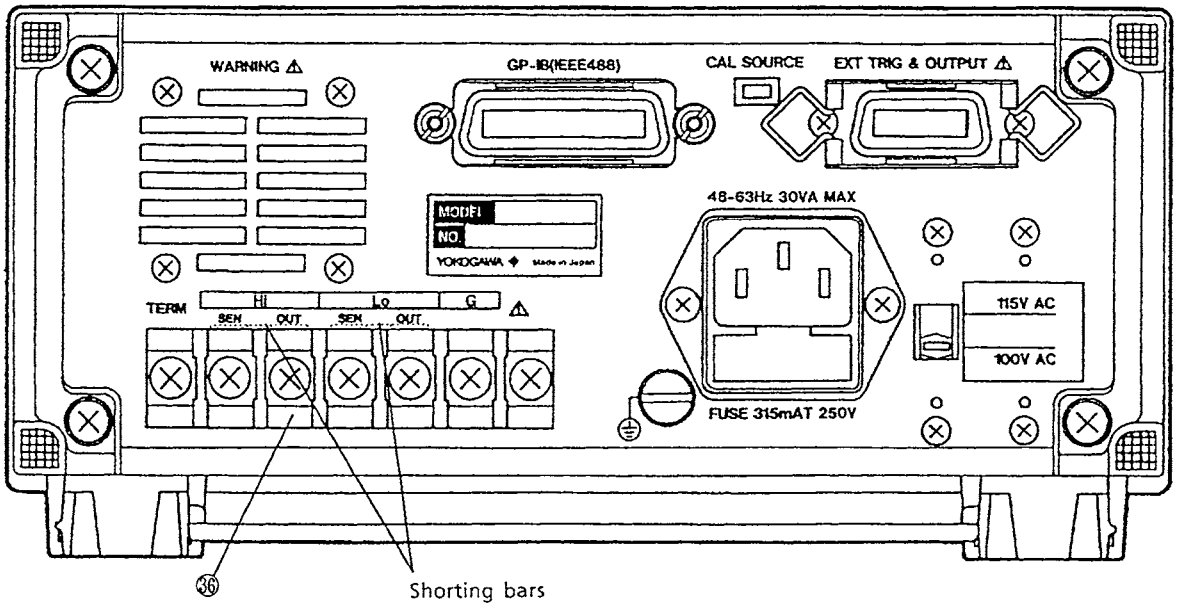


Figure 2.3 Name of Each Rear Panel Part (7651 11/7651 12)

⚠ Caution

◎ Always check if the fuse capacity is correct whenever the power supply voltage is changed!

㉙ **Power Supply Connector**

This is a three-pin connector with ground. Always make sure that the power supply voltage is within the rating of the instrument and that the frequency is also within the specified range.

㉚ **Fuse**

Use a time lag fuse of 315mA (for 100V type) or 160mA (for 200V type) rating.

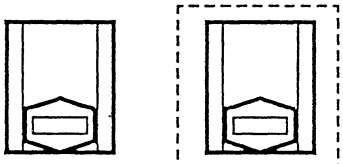
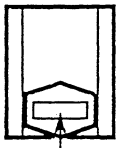
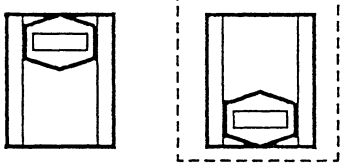
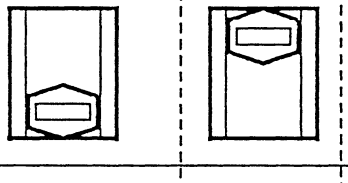
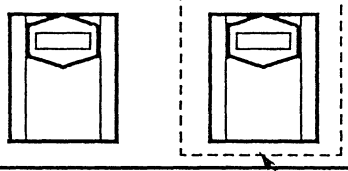
㉛ **Power Supply Voltage Selection Switch**

The instrument will have been set to the specified voltage at the time of shipment from the factory.

200V type : 100V or 115V
200V type : 200V or 230V

When the power supply voltage needs to be changed (between 100V and 115V, or between 200V and 230V), set the switches as shown in the following Table.

Table 2.1 Positions of the Power Supply Voltage Selection Switches

Power Supply Voltage	Switch Position	Fuse	Remarks
100V		315mA	 Switch position
115V			
200V		160mA	
230V			

The parts enclosed in the dashed line boxes are covered by the power supply voltage indicator name plates.

㉜ **Ground Terminal**

This is the protective ground terminal connected to the chassis. Normally, for the sake of safety, this terminal should be connected to a good ground point through resistance of 100Ω or less. (There is no need to ground this terminal separately when the power supply cable uses a ground pin and the power supply socket has been properly grounded.)

㉝ **GP-IB Connector (in Models 7651 01 and 7651 11)**

Note : The models 7651 02 and 7651 12 will have the RS-232C connectors in this place.

㉞ CAL/SOURCE, Calibration/Output Mode Switch

This switch is used for selecting between the calibration and output modes and should be set to the SOURCE position under normal conditions of use. Only when the instrument is being calibrated set this switch to the CAL position.

㉟ EXT TRIG & OUTPUT Connector (remote control input/output connector)

This is the connector for the input signals from and the output signals to external devices, such as the external trigger input (for step execution of the program), the ready signal (indicating that the change in the output is complete, etc).

㊱ Output Terminals

These terminals will have to be connected to the load after removing the shorting bars in the 4-wire DC voltage output mode (V function).

In the other modes, it does not matter whether the shorting bars are removed or not because the SENSE terminals will be open anyway.

Normally connect the terminal L to the terminal G.

The rear panel output models are supplied with a terminal cover as an accessory. Keep the output terminals covered when they are not being used.

3. OPERATING METHOD

The stand of this instrument can be fixed in the position shown in Figure 3.1.

When very high accuracy measurements are to be made, it will be advisable to keep the unit perfectly horizontal or on the stand. Also, make sure that there is no heat generating source near the unit.

This instrument can also be mounted on a rack using a rack mounting kit.

The method of mounting on a rack is shown in Figure 3.2 below.

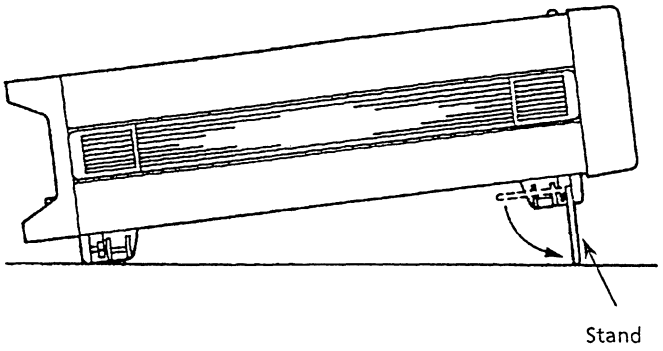
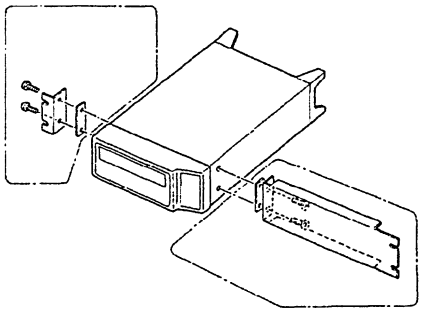
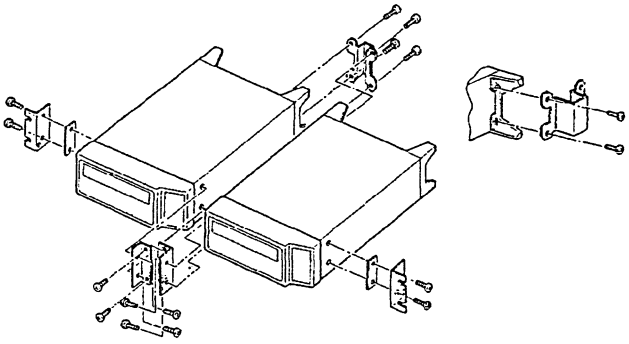


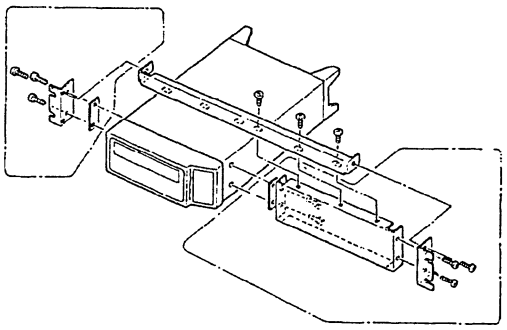
Figure 3.1 Opening Out the Stand



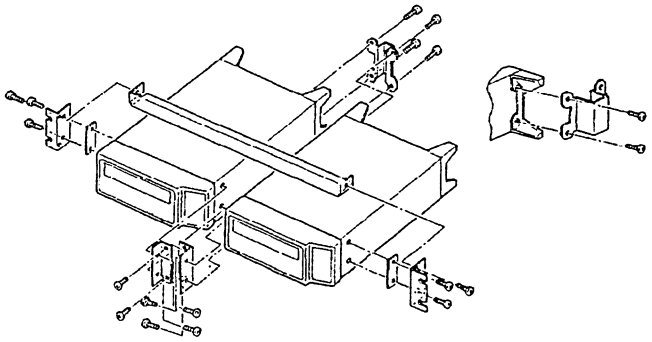
(a) Mounting EIA single unit



(b) Mounting EIA multiple units



(c) Mounting JIS single unit



(d) Mounting JIS multiple units

Figure 3.2 Diagram Showing Rack Mounting of the Instrument

Caution

◎ The window of the display section is made of thermoplastic material and hence care should be taken not to touch this with the tip of a soldering iron, etc. Also, this part should not be cleaned using thinner, benzene, alcohol, or other solvents.

3.1 Preparations Before Use

- Connect the power supply cord to the power connector in the rear panel and connect to the correct power supply.
- Switch ON the power to the unit and warm up for more than 60 minutes.

3.2 Operating Procedure

- The following is the sequence of operations for normal use.

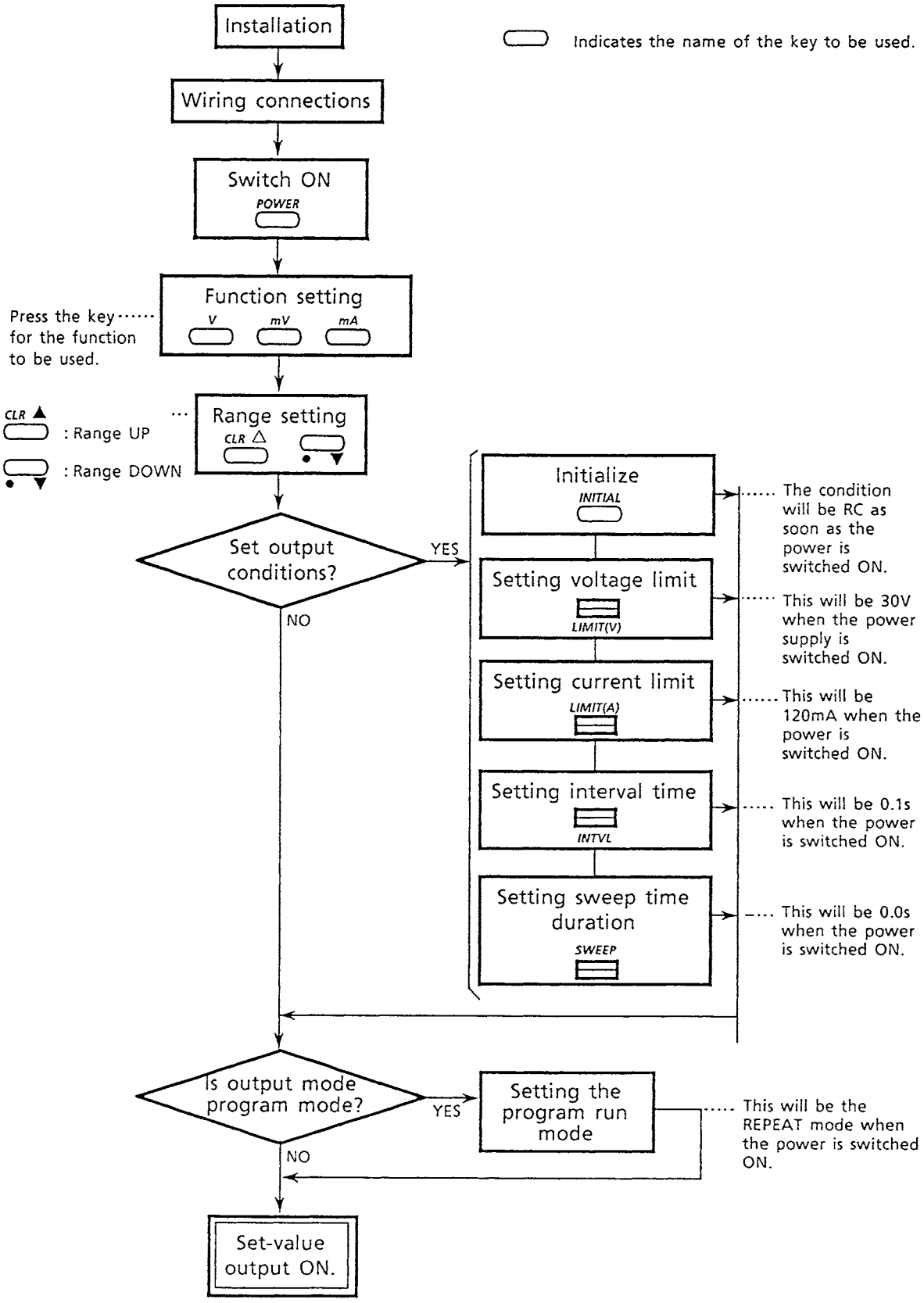


Figure 3.3 The Standard Procedure of Operation.

3.3 Connection Method and Usage Precautions

(1) DC Voltage Output (V Function)

In the DC voltage mode, this instrument functions as a constant voltage source with a low output impedance and using a 4-wire connection method (for remote sensing).

(a) Standard connection method

If the voltage is applied using only two wires to a load that draws relatively large current, the voltage drop in the lead wires upto the load may become quite large so that the set voltage will not be applied to the load correctly.

In such situations, if the voltage is applied to the load using the four wire method in which the two terminals of the SENSE lines are also connected to the two terminals of the load, the voltage drop due to the lead wires upto the load will be compensated for and it will be possible to apply the correct set-voltage to the terminals of the load. These two methods of connecting the load using the 2-wires and the 4-wire methods are shown in Figure 3.4 below.

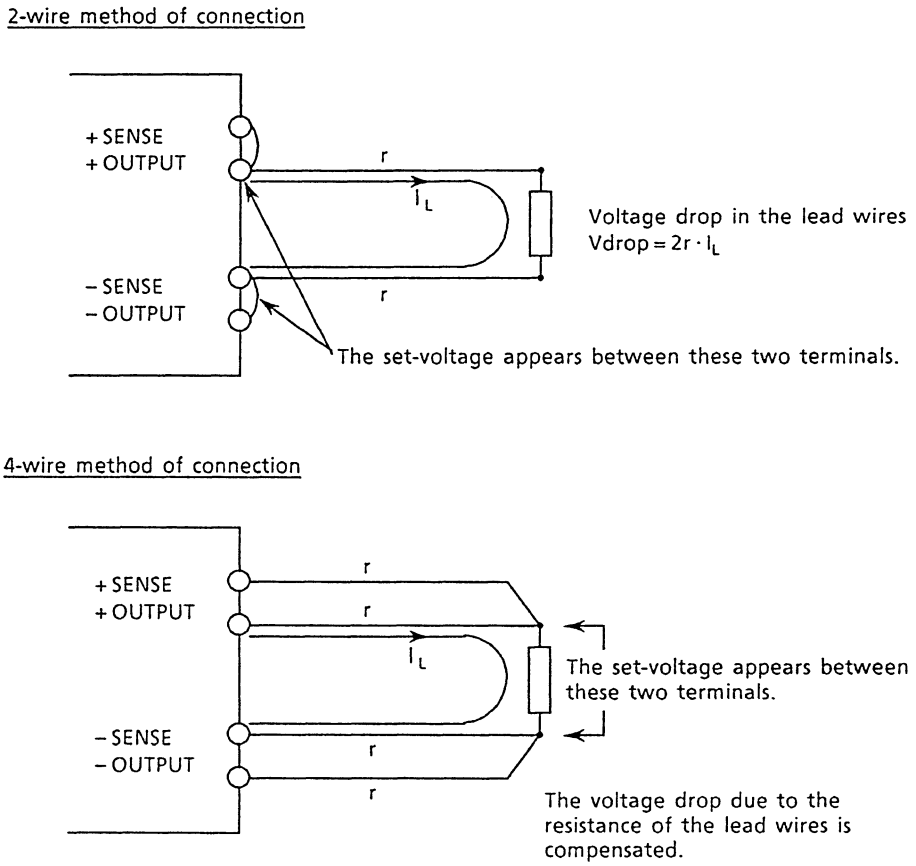
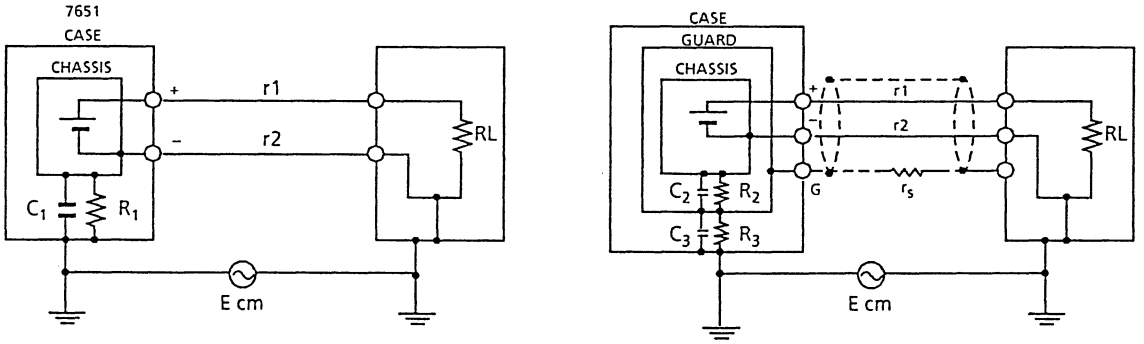


Figure 3.4 2-Wire and 4-Wire Methods of Connecting the Load

(b) Connection method using guard shield

When some other measuring instrument is connected to the 7651, in most cases, the grounding point in the other instrument will be distant from the grounding point of the 7651 and hence a common mode potential difference can be generated between these two ground points. The current due to this common mode voltage difference Ecm as shown in Figure 3.5 will flow into the measuring instrument via the stray capacitance C1 between the case and the chassis of the 7651, the insulation resistance R1 between them, and the lead wires. This current will create a voltage drop in the lead wire resistance which will be present as an error in the output voltage. In order to remove the effect of the common mode voltage, it will be necessary to make sure that the impedance between the case and the chassis is made very large and that the current due to Ecm will not flow into the lead wires.

To do this, a guard shield is placed between the case and the chassis and is connected as shown in Figure (b). In this case, the current due to Ecm will flow into the outer sheath of the shield wire via R3 and C3 and hence will not cause any voltage drop in the signal lines thereby eliminating the effect of the common mode voltage in the load voltage. In this case, because the guard is provided, the effective impedance between the case and the chassis will be very high.



(a) When there is no guard (b) When there is a guard

C_1, R_1 : Stray capacitance and insulation resistance between the case and the chassis
C_2, R_2 : Stray capacitance and the insulation resistance between the guard and the chassis
C_3, R_3 : Stray capacitance and the insulation resistance between the guard and the case
r1, r2 : Lead wire resistances
E cm : Common mode voltage

Figure 3.5 Method of Connecting the Guard Terminal

(c) Effect of lead wire resistance in the 4-wire method

- Make sure that the resistance (r) of the lead wires on the output side is less than 10Ω. If the resistance is more than 10Ω, there may be situations when the output value may be affected depending on the load current.
- The input resistance of the SENSE terminals is about 40kΩ.
  The effect of this will be $\frac{Vo}{40{,}000}(r\times 2)$mV.
  This means that the effect on the output will be 0.01% when r is 2Ω.

(d) Current limiter

The output current will be limited depending on the setting of the current limiter in all the ranges of DC voltages (V function).

The output will be turned OFF by the trip function when the voltage between the OUTPUT Hi and Lo terminals exceeds about ±35V or when the current through these terminals exceeds about ±120mA due to external voltage or current sources. For further details, see Section 4.5 on the operation of the limiters.

(2) DC Voltage Output (mV Function)

In the 10mV and 100mA ranges of the DC voltage output, the output is actually made through a 1/10 voltage divider (as explained in Section 1.2 paragraph (2) on Operation) and hence the output resistance will be about 2Ω. Therefore:

- Only the OUTPUT Hi and Lo terminals are used. Since the SENSE terminals are internally open-circuited, the 4-wire connecting method can not be used.
- The output will be switched OFF by the trip function in the 10/100mV ranges when the voltage between the Hi and Lo terminals exceeds the limiting values of ±0.6V due to the application of voltages from the external device.

Caution

◎ In the mV function mode, the thermoelectric power generated between the measurement leads and this instrument and in the connection with the measured object can create problems in measurement accuracy, etc.
Care should be taken so that there will be no temperature difference between the Hi and Lo terminals or points connected to them such as the measurement leads, or the tips of the measurement leads.

(3) DC Current (mA Function) Output

Since this instrument operates as a constant current source in the DC current output mode, the apparent output resistance of the instrument will be very high. Therefore, even when the output setting is the same, the output voltage will be higher when driving higher load resistances.

- Only the OUTPUT Hi and Lo terminals are used.
  Since the SENSE terminals are internally open-circuited, the 4-wire connecting method can not be used.
- The output voltage will be limited in the 1/10/100mA ranges to a value depending on the set value of the voltage limiter.
  The output will be turned OFF by the trip function when the voltage between the OUTPUT Hi and Lo terminals exceeds about ±35V or when the current through these terminals exceeds about ±120mA due to external voltage or current sources.

For more details, see Section 4.5 on the operation of the limiters.

3.4 Setting Procedure Using Different Keys

3.4.1 Setting of Functions

The following types of function keys are present. Whenever a key is pressed the function for the key is set and the unit corresponding to that function will be displayed. The range setting will be made as follows.

Table 3.1 Correspondence between Functions and Ranges

Key	Function	Unit	Range
V	DC voltage (V DC)	V	1V
mV	DC voltage (mV DC)	mV	10mV
mA	DC current (mA DC)	mA	1mA

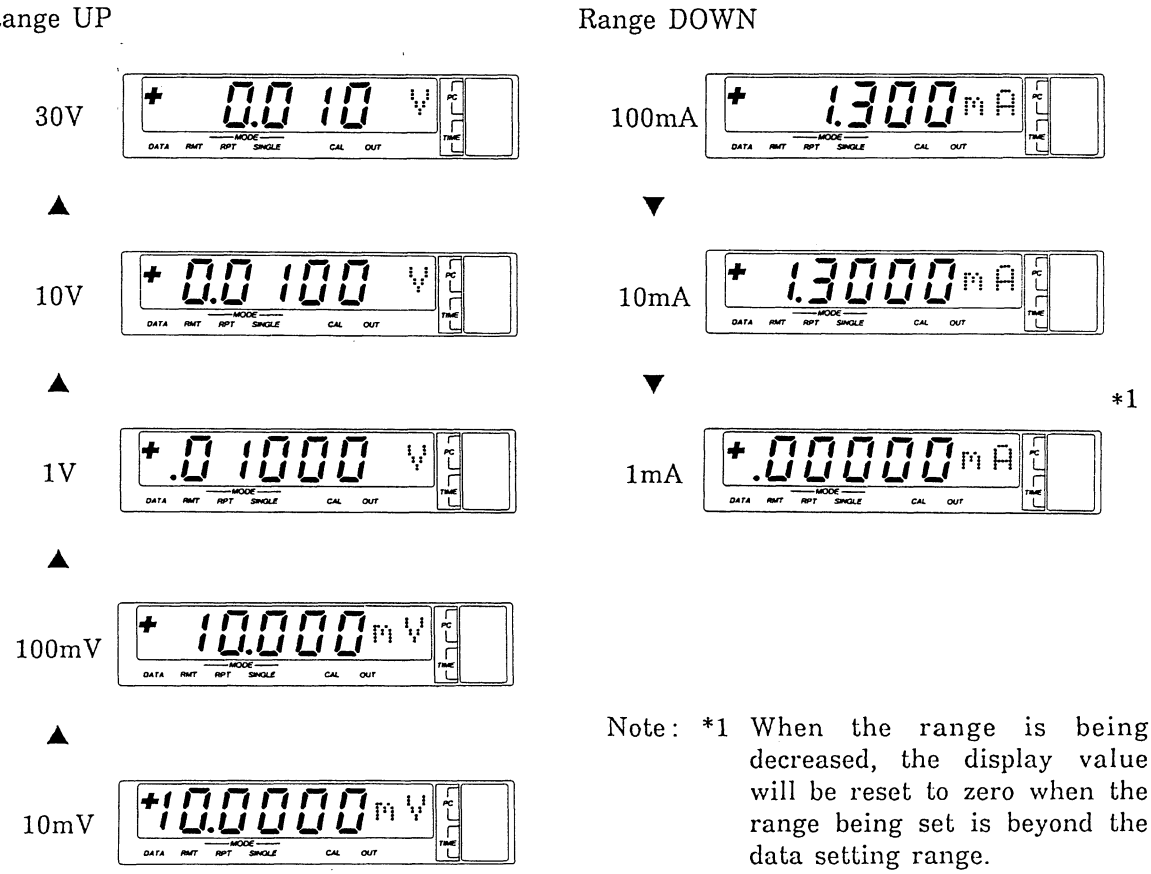
3.4.2 Setting of Ranges

The ranges are set using the following UP and DOWN keys.

CLR △ : Range UP key

▽ : Range DOWN key

Examples of changing the ranges are shown below indicating the use of the range UP and range DOWN keys.



Note: *1 When the range is being decreased, the display value will be reset to zero when the range being set is beyond the data setting range.

3.4.3 Setting Output Data

The output data setting is done in the following two modes.

- Continuously variable mode
- Data mode

The method of setting in these two modes is described below.

(1) Continuously Variable Mode

In this mode, the data is set using the UP and DOWN keys of the ten keys (for each of the digits).

The correspondence between the different digits and the keys is shown in the following figure.

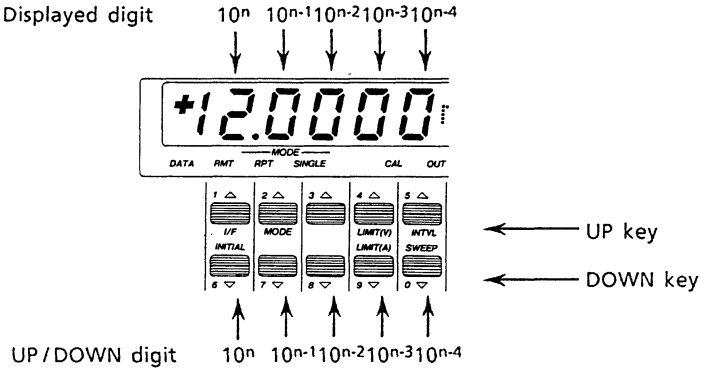
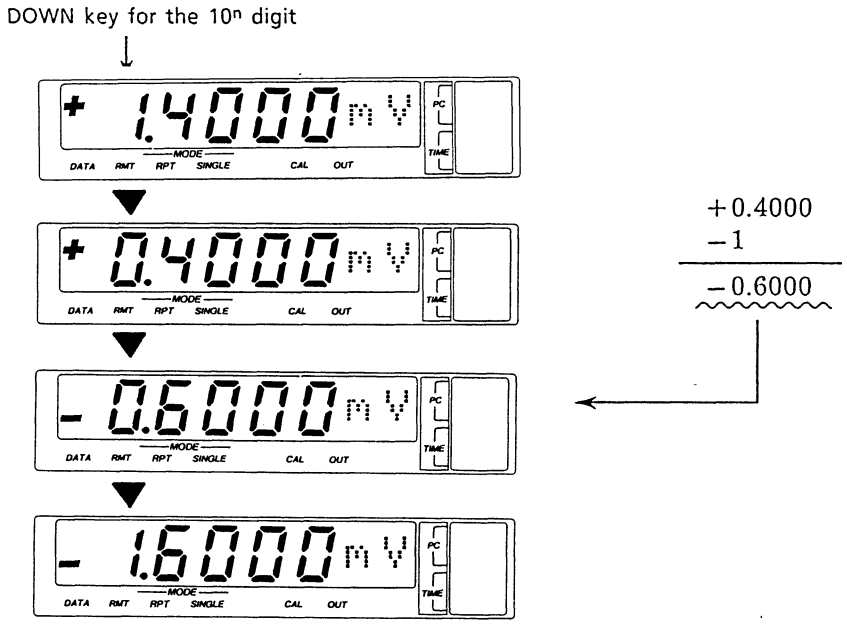


Figure 3.6 Correspondence between the Displayed Digits and the UP/DOWN Keys

As is clear from the above figure, the keys directly below the displayed digit are the UP and DOWN keys for that digit.

The following figure shows an example of operating the DOWN keys (in which the initial value is 1.4mV and the data is decreased by 1mV).



(2) Data Mode

In this mode, the data is set using the data keys.

The sequence of key operations are as shown in the figure below.

NO.	Key Operation	Display
1	DATA SAVE 1△ 2△ MODE ▼ 5△ INTVL mV	*1
2	DATA 1 1 . 1 1 V *2	
3	DATA 2 5 . 5 ENTER *3 SRQ 2 5 . 5 V	*3

Figure 3.7 Procedure for Setting the Data in the Data Mode

*1 When the DATA key is pressed, the display becomes +0. The unit will remain the same as that before this key was pressed.

*2 After a numerical value is set, it is possible to replace it using the function keys (V, mV, mA) or the ENTER key. When the function keys are used, the data replacement will be done so that the range is set automatically to suit the set value optimally (auto ranging).
For example, in the example of the above figure, the range selected automatically will be the 10V range.
When the ENTER key is used for changing the set value, the range set at that time will be used.
However, in this case, if the range is not appropriate for the set value, the error indication Err 02 will be displayed and the value set previously will not be replaced.

*3 When the set value is 25.5V as shown above, the 30V range will have to be selected (set-value range = ±32V). However, when the setting of 11.11V is made, the 10 V range has been selected in the above figure which is not suitable. In such cases, the value should be replaced using the function keys.

The relationship between the ranges and the limits over which the data can be set is shown in the table below.

Table 3.2 Data Setting Limits for Each Range

Limits of Settings	Range	
	Voltage	Current
+32.000 to −32.000	30V	———
+12.0000 to −12.0000	10V, 10mV	10mA
+120.000 to −120.000	100mV	100mA
+1.20000 to −1.20000	1V	1mA

3.4.4 Setting the Voltage (Current) Limit

(1) Limiting Value Setting Ranges and Resolution

Table 3.3 Setting Range and Resolution Limiting Values

	Setting Range	Resolution
Voltage limit LIMIT(V)	1 to 30V	1V
Current limit LIMIT(A)	5 to 120mA	1mA

(2) Setting Procedure

The setting procedure for the limiting values is shown in the figure below. The limiting values are set using the UP and DOWN keys.

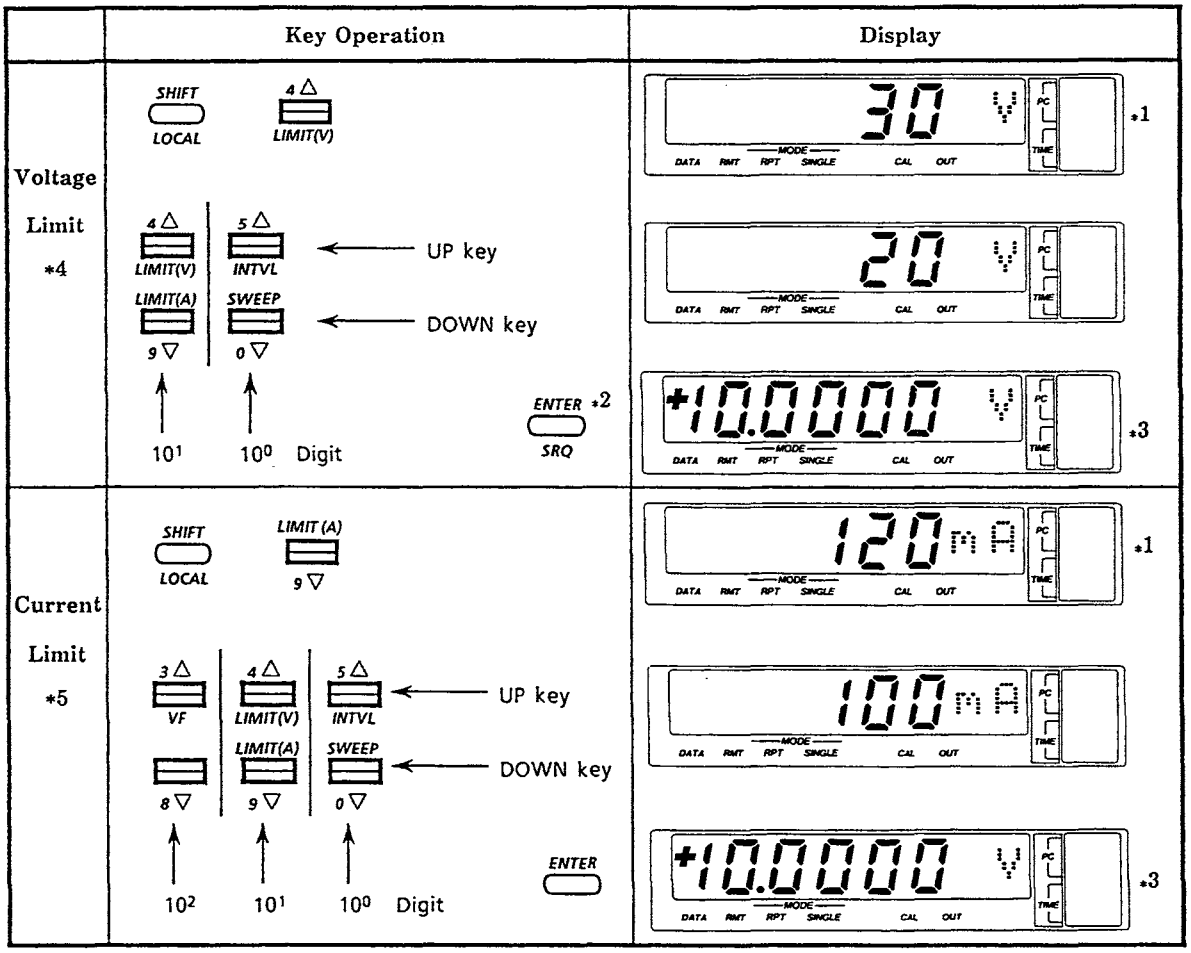


Figure 3.8 Limit Value Setting Procedure

Notes:

*1 The limit value that is currently valid will be displayed.

*2 The set value is replaced by pressing the ENTER key thereby ending the limit setting mode. When there is no need to alter the limit set value, press only the ENTER key or the SHIFT key.

*3 The data immediately prior to entering the limit setting mode will be redisplayed.

*4 Valid only during the DC current output (DC current mode).

*5 Valid only during the DC voltage output (DC voltage mode).

3.4.5 Setting Interval Time

(1) The Setting Range and the Resolution of the Interval Time

Setting range : 0.1 to 3600.0s
Resolution : 0.1s

(2) Setting Procedure

The procedure for setting the interval time is shown in the figure below. The required value is set using the UP and DOWN keys.

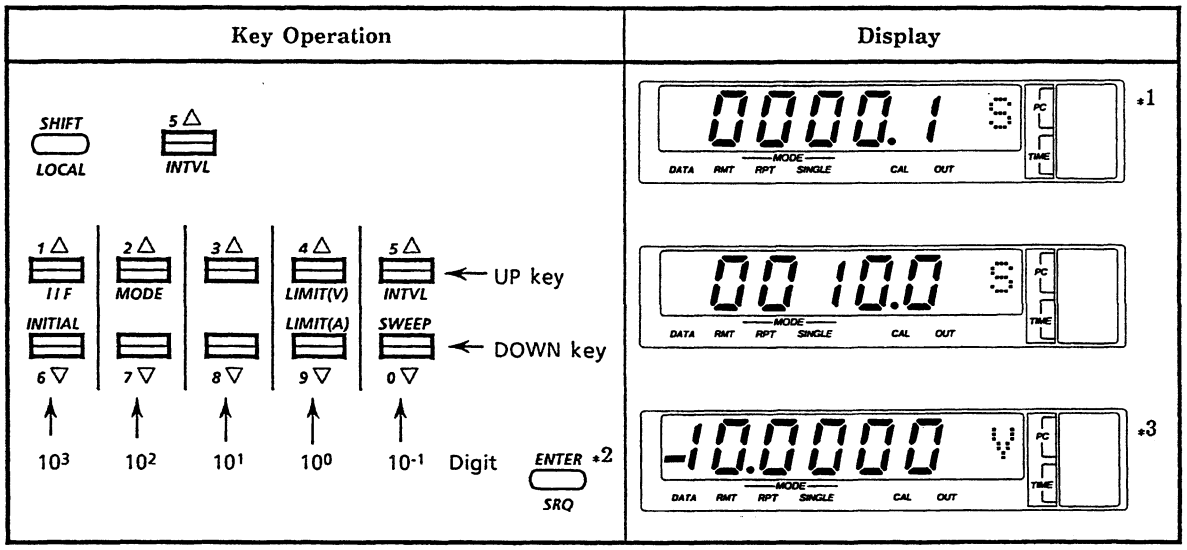


Figure 3.9 Procedure for Setting the Interval Time

Notes:

*1 The current interval time set-value is displayed.

*2 The value is replaced using the ENTER key and the interval time setting mode is terminated.

*3 The data immediately prior to entering the interval time setting mode will be displayed again.

When there is no need to alter the set value, press only the ENTER key or the SHIFT key.

Caution

The data output will be made even during the setting or altering of the interval time. If the output should not be made during this time, make sure that the output is turned OFF by pressing the appropriate button.

3.4.6 Setting the Sweep Period

(1) The Setting Range and the Resolution of the Sweep Period

Setting range : 0.0 to 3600.0s

Resolution : 0.1s

(2) Setting Procedure

The procedure for setting the sweep period is shown in the figure below. The required value is set using the UP and DOWN keys.

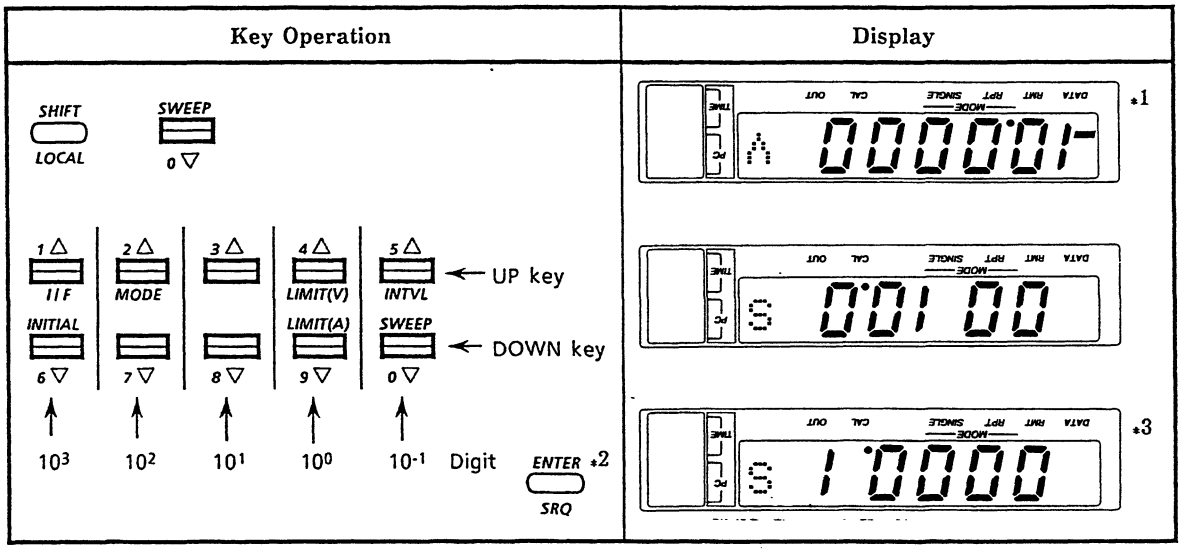


Figure 3.10 Procedure for Setting the Sweep Period

Notes:

*1 The current sweep period set-value is displayed.

*2 The value is replaced using the ENTER key and the sweep period setting mode is terminated.

*3 The data immediately prior to entering the sweep period setting mode will be displayed again.

When there is no need to alter the set value, press only the ENTER key or the SHIFT key.

- When the sweep period is set to 0.0s, the SWEEP operation will be turned OFF.

Caution

The data output will be made even during the setting or altering of the sweep period. If the output should not be made during this time, make sure that the output is turned OFF by pressing the appropriate button.

Caution

- The sweep operation when the set ranges are different in different program steps are shown in the following table :

Table 3.4 An Example in which the Ranges are Different in Different Program Steps

Program Step	Set Data	Set Range	Sweep Operation
PC 01	4.0V	10V	Operates.
PC 02	2.0V	10V	Does not operate.
PC 03	0.0V	1V	Does not operate.
PC 04	−2.0V	10V	Operates.
PC 05	−4.0V	10V	

When the ranges are different as shown in the above example in different program steps (PC 03 : 1V), the sweep operation will not be made between the two pairs of steps PC02 to PC03 and PC03 to PC04 as is shown in Figure 3.11 below.
However, the sweep operation over the entire range of program steps will be made if the 10V range has been selected in all the program steps as shown by the broken lines ----- in the following figure.

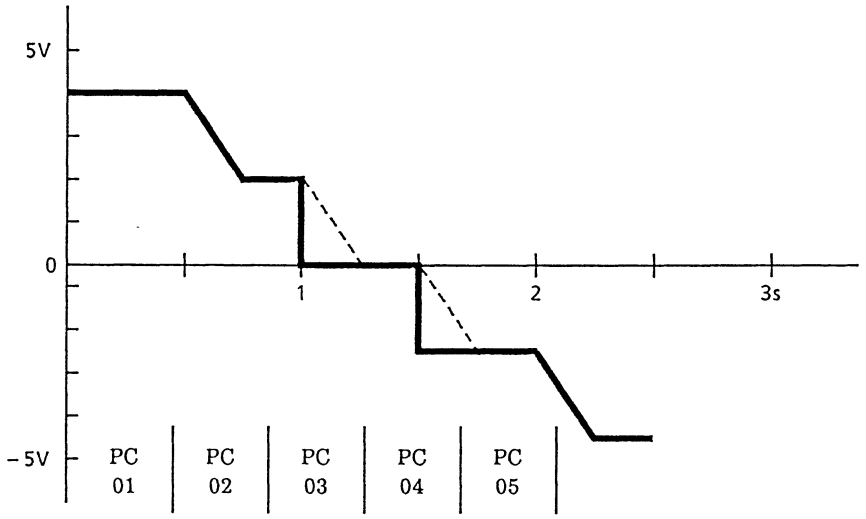


Figure 3.11 Sweep Operation when the Ranges are Different in Different Program Steps

4. FUNCTIONAL DESCRIPTION

4.1 Initialization

This function carries out the initialization of the program, and setting the various conditions of the 7651 to their initial values. In addition, this function also lets the user initialize the IC memory card.

Note: During these initialization operations, the calibration values and the parameters of communication (the device address, communication mode, etc.,) will be left unaltered.

(1) Initializing the Set Conditions

When this function is executed, the internal set-up conditions, the ranges, the limiter set-values, and the program (unsaved ones), etc., will be reset to their initial values as when the power to the instrument is switched ON. The conditions that are initialized are those listed in Appendix 1 List of Set Values.

(2) Initialization of the IC Memory Card

This function allows the user to carry out the formatting and the content initialization of the IC memory card. Whenever a new IC memory card is used in this instrument for the first time, carry out its initialization without fail.

(3) Operating Procedure

The following two methods are available for carrying out the initialization function.

- Operation Using the Front Panel Keys (manual operation)
- Operation via the Communication Interface (via GP-IB or RS-232C : remote operation)

These two methods are described below.

Table 4.1 Initialization Methods

Item Initialized / Method	7651 Main Unit	IC Memory Card
Manual initialization	init RC	init CI
Remote initialization	Communication command: RC	Communication command : CI

(a) Manual Initialization

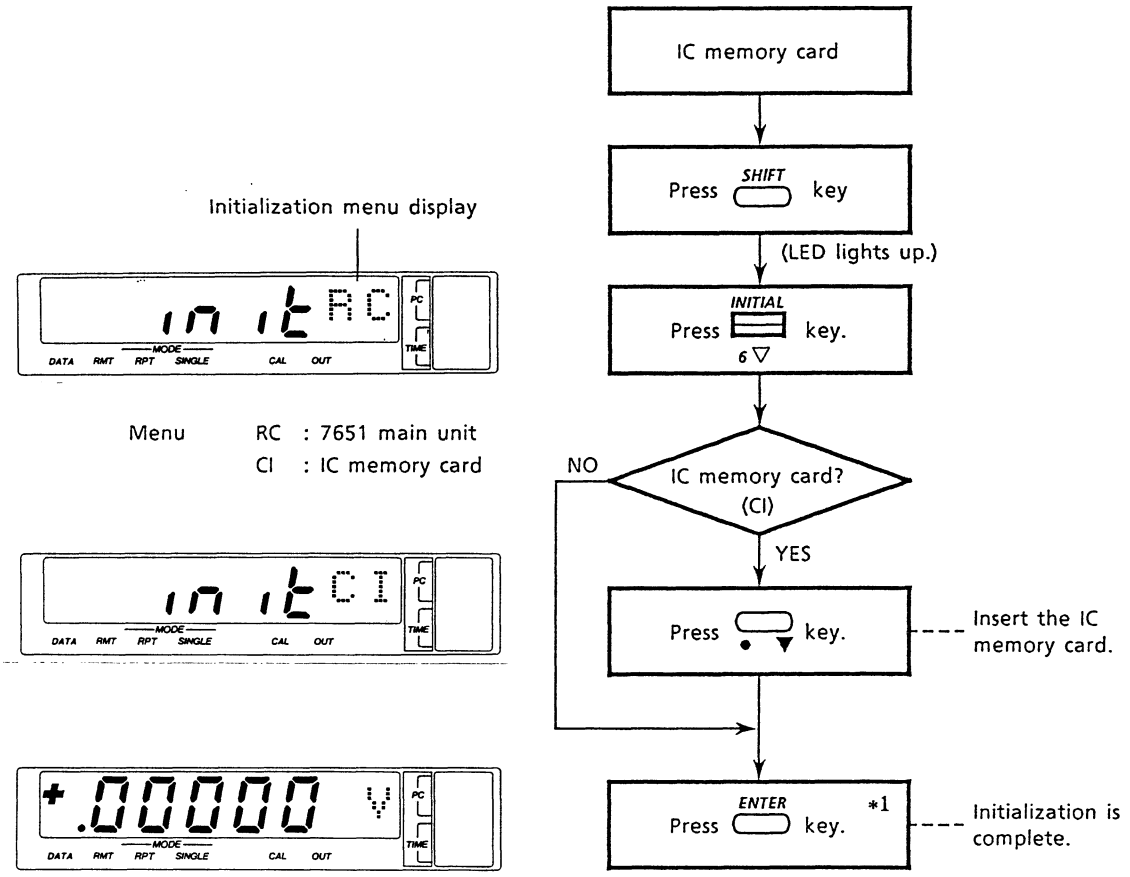


Figure 4.1 Operating Procedure for Initialization

*1 When no IC memory card has been inserted, the error indication Err34 will be displayed. When this appears, insert again the IC memory card correctly and again press the ENTER key.

(b) Remote Initialization

The communication commands that need to be sent to this instrument when carrying out the initialization operations via the communication interface such as the GP-IB or the RS-232C interface are the following. For more details, see the descriptions for the communication commands RS and CI.

(i) Initialization of the Set-up Conditions

- Initial setting via GP-IB

  SYNTAX • RC <Terminator>

- Initial setting via RS-232C

  SYNTAX • RC <Terminator>

Note 1: When the RC command is executed, the system will be reset completely and the same operations will be made as when the power supply to the instrument is switched ON.

(ii) Initialization of the IC Memory Card

- Initial setting via GP-IB

  SYNTAX • CI <Terminator>

- Initial setting via RS-232C

  SYNTAX • CI <Terminator>

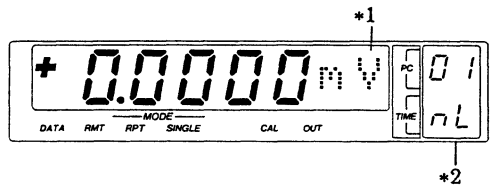
4.2 Program (PRGM) Function

(1) Outline of the Program Function

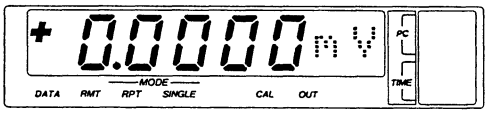
The 7651 has an internal memory using which it is possible to memorize upto 50 steps of output data. Also, it is possible to set the interval of generation and the sweep period. Therefore, by suitable combining these facilities, it is possible to generate a variety of waveforms such as the step waveform, the ramp waveform, triangular waveform, etc.

In addition, by using the IC memory card, it will be possible to store upto 7 program patterns in each card which can be recalled any time the user requires them. In effect, this means that any number of different programs can be stored and recalled for use instantly at any time thereby greatly increasing the work efficiency in production or engineering environment.

(2) Procedure for Registering a Program



See Section 3.4 for the methods of setting up the various parameters of the output data.



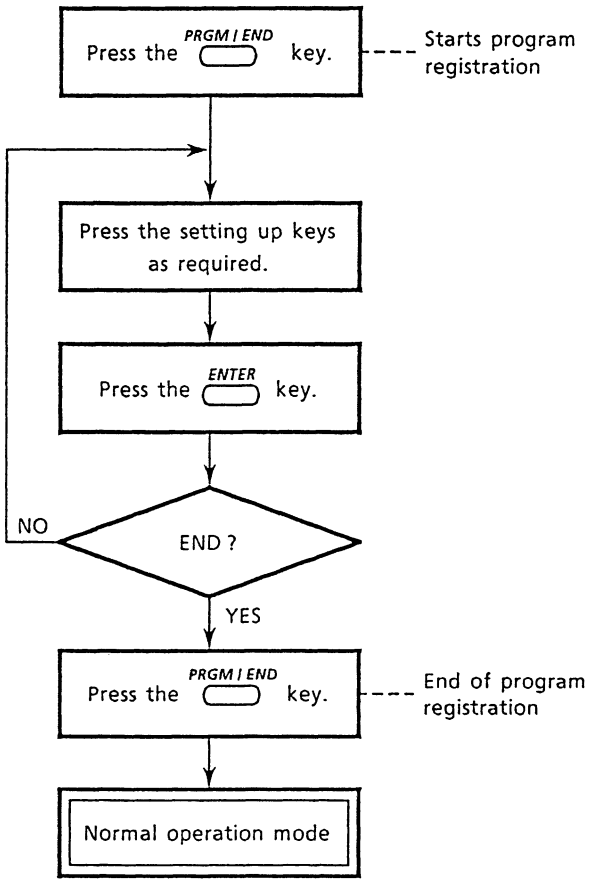


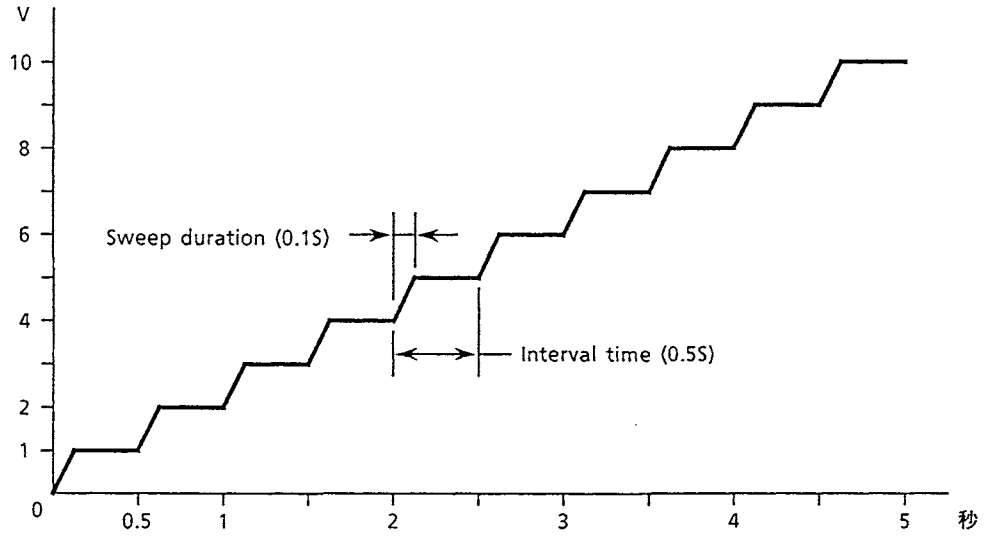
Figure 4.2 Procedure for Registering a Program

*1 The data immediately prior to entering the program registration mode is being displayed.

*2 This part indicates nL when no program steps have been stored in the internal memory. The display in this part will be blanked when at least one step of the program has been registered in the memory.

(3) Programming Example

An example of registering a program is described below for the example of the staircase waveform shown in the following figure.



V RANGE CLR △ : Setting the voltage (V) function

: Range of 10V

SHIFT INTVL DATA 5△ ENTER : Setting interval time to 0.5s

SHIFT SWEEP DATA 1△ ENTER : Setting the sweep period to 0.1s

SHIFT MODE (This operation is made only when the RPT lamp is already ON.) : Setting single mode

Setting in the data mode:

PRGM / END : Set program registration mode (begin program registration).

DATA 1△ ENTER : Setting 1V

DATA 2△ ENTER : Setting 2V

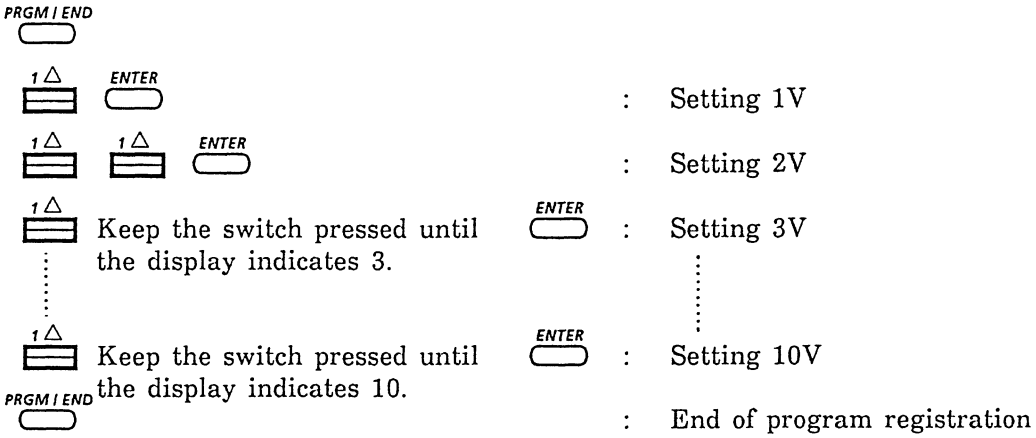
DATA 3△ ENTER : Setting 3V

⋮

DATA 1△ 0△ ENTER : Setting 10V

PRGM / END : End of program registration

Setting in the continuously variable mode:



(4) Saving and Loading Programs (SAVE / LOAD)

As was mentioned earlier, the 7651 is capable of memorizing a program of upto 50 output data steps. However, this program will be lost when the power supply to the instrument goes OFF. Therefore, it is advisable to store the programs that need to be saved or that are likely to be used very often in an IC memory card. When a program is saved in the IC memory card, the panel control settings will also be stored simultaneously.

The storing (SAVE) of program data from the internal memory of the 7651 into an IC memory card and the restoring (LOAD) of program data from an IC memory card into the internal memory of the instrument can be done in one of the following two methods.

- Operation using the front panel keys (manual operation)
- Operation via the communication interface (remote operation)

(a) Manual Operation

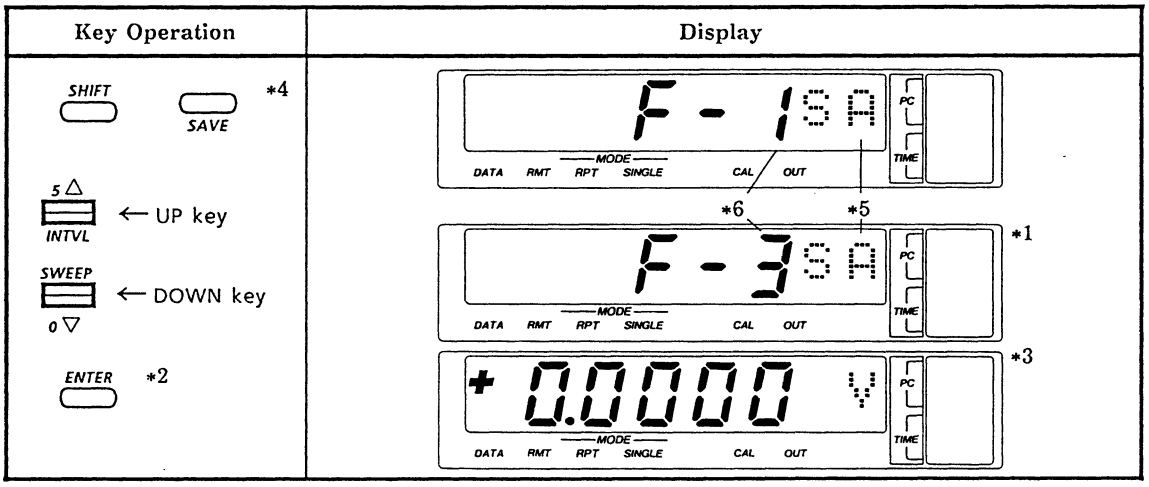


Figure 4.3 Procedure for Saving a Program

*1 Set the required pattern using the UP and DOWN keys.

*2 When the ENTER key is pressed, the program will be saved and the SAVE mode will be terminated. If an IC memory card has not been inserted, an error indication will be displayed in the form of Err.

*3 The data immediately prior to entering the SAVE mode is being displayed.

*4, *5 The switch will be LOAD and the display indication will be LD in the case of the load operation.

*6 The pattern number should be in the range 1 to 7. Any value outside this range is invalid.

(b) Remote Operation

These operations of program saving and loading via the GP-IB or the RS-232C communication interface can be done by sending the communication commands SV and LD. For further details, see the descriptions for the communication commands SV and LD.

(5) Auto Load

If the power to the instrument is switched ON after an IC memory card is inserted into the card slot, the program and the panel settings for the pattern *1 in the DC memory card will be loaded automatically into the instrument (that is, these data will be loaded into the internal memory of the instrument).

(6) Program Execution

The following procedure is to be followed for running a program.

RUN/∨ : The program execution will be started from the first program data (PC01) at the set interval of time.

HOLD/DEL : This key stops the execution of the program temporarily. The program execution starts again from the current step when this key is pressed again.

STEP/∧ : The program will be executed for only one step. The step that will be executed will be that whose number has been set in the program counter (PC) immediately prior to pressing the STEP key.

Note: Note that the next step will not be executed during the intervals time. Hence, set the interval time to the lowest value (0.1 s) if the next step has to be executed immediately after the previous one.

(7) Program Execution Modes

The program execution is done in one of the following two modes.

- Repeat mode (RPT) : The program is executed repetitively from the beginning till the end.
- Single mode (SINGLE) : The program is executed only once from the beginning to the end.

The selection of the RPT/SINGLE modes is done by the following operations.

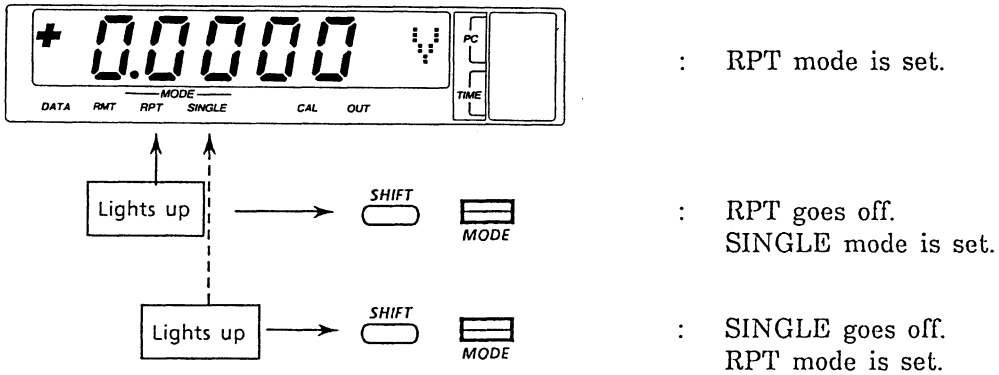


Figure 4.4 Procedure for Setting the Program Execution Mode

The mode changes every time SHIFT + MODE is keyed in.

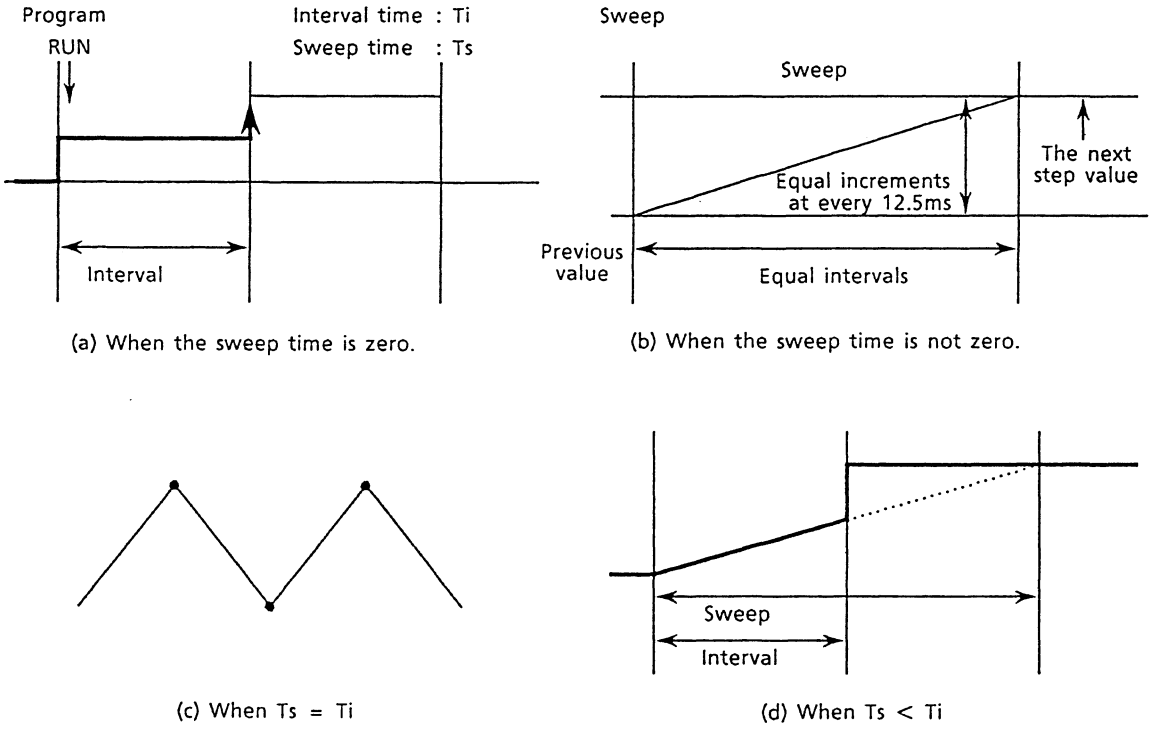
- When the SINGLE mode is selected while RPT mode is being executed.

```
PC    1
      2
      3
      4
      5
      1
      2
      3   ←  SHIFT  MODE     Changed to SINGLE mode
      4
      5
      END
```

The program being executed will be continued until the end before stepping.

(8) Interval and Sweep

The relationship between the interval time and the sweep time is shown in the following figure.



(a) When the sweep time is zero.

(b) When the sweep time is not zero.

(c) When Ts = Ti

(d) When Ts < Ti

Figure 4.5 Interval and Sweep Time Durations

Note: As is shown in the above figure.

Ts=0 : Gives a step waveform

Ts≠0 : Gives a ramp waveform

Ts=Ti : Gives a triangular waveform

Because the waveform will be as shown in (d) above when Ti<Ts, always make sure that Ts≦Ti.

4.3 Using the IC Memory Card

- An IC memory card is a miniature PCB with memory and other devices and which is enclosed in a package. The stored contents of the card are backed up by battery.
- The function of an IC memory card is to store and save programs.
- The IC memory card has a capacity of 8KB bytes and can store upto 7 programs.

Note 1 : Avoid inserting the card immediately after switching ON the power.

Note 2 : For changing the battery in our IC memory card see the illustration below. The memory contents will be lost when the battery is removed. To save the data in the IC memory card while replacing the battery, insert the card in the main unit, switch ON the power supply to the instrument and then replace the battery with the card still inserted in the unit. The battery life is about 5 years.

Note 3 : Do not touch or stain the ground terminal.

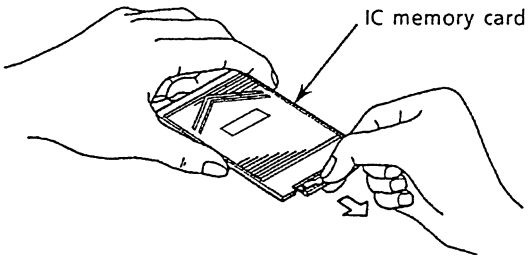


Figure 4.6 Removing the Battery

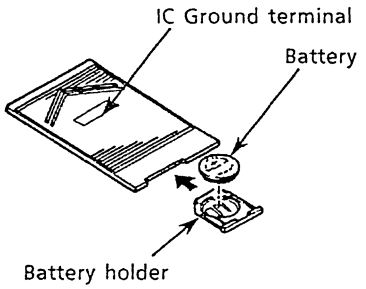
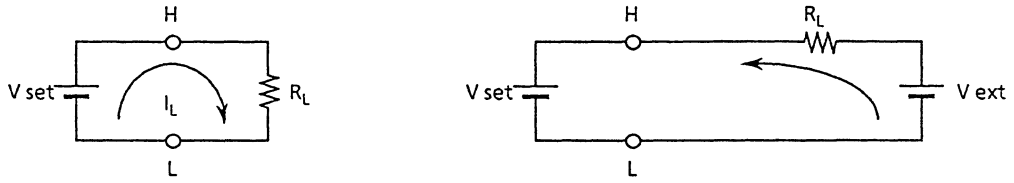


Figure 4.7 Loading the Battery

4.4 On the Source and Sink Operations

The 7651 is capable of both source and sink operations depending on the condition of the load.

- In the DC voltage mode, if the load is resistive the current flows from H to L. This is called the source operation.



However, the current flows from L to H if an external voltage source is connected with a voltage higher than the set voltage. This is called the sink operation.
This is the same even when the set value is negative.

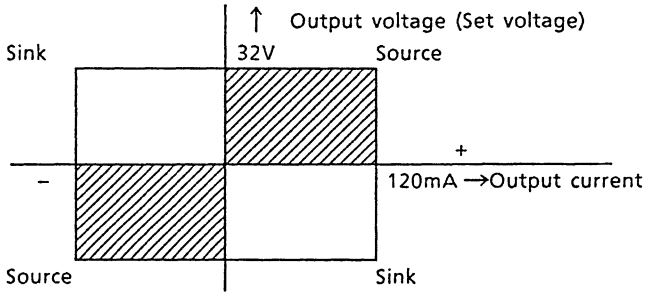
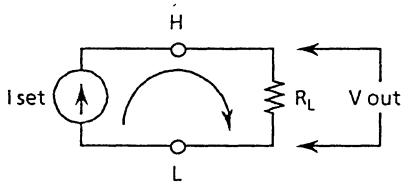
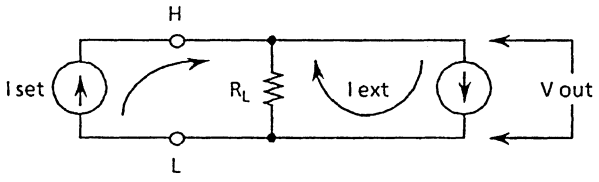


Figure 4.8 Source and Sink Operations and Output Range (DC Voltage Mode)

- With a resistive load in the DC current mode, the output terminal voltage will be H>L.



However, if a large external current source is connected with a value greater than the set voltage, then the output terminal voltage will be H<L even if the set value of the current is correct.



$V\,out = R_L \times (I\,set - I\,ext)$

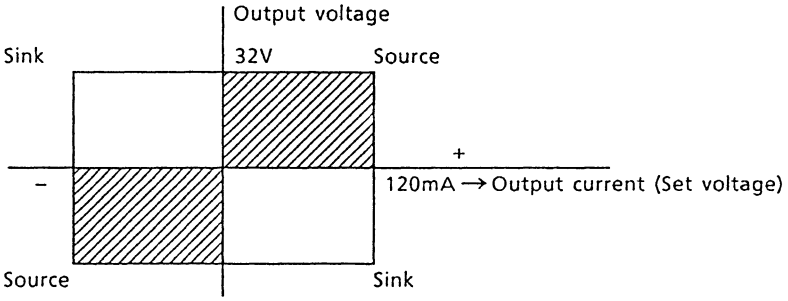


Figure 4.9 Source and Sink Operations and Output Range (DC Current Mode)

4.5 On the Limiter Operation

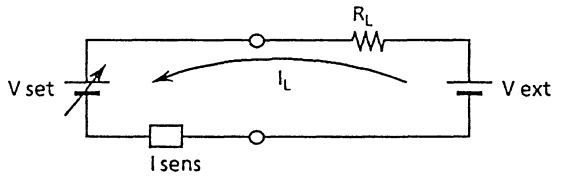
The 7651 possesses two protective functions of the limiter which limits the value applied to the load and of the trip function which switches OFF the output.

(1) **Limiter**

- The limiter operates in such a way that the output current in the voltage mode (DC V) or the output voltage in the current mode will not exceed set values. The operation of the limiter automatically returns to normal when the load is reduced to below the set value.
- The limiter set-value can be selected in the range of 5mA to 120mA for the current limiter and in the range of 1 to 30V for the voltage limiter. (See Section 3.44 for the setting operations.)
- The limiter does not operate in the DC mV mode because of the presence of the voltage divider in the output.
- The limiter action is effective during both source and sink operations and will operate in both positive and negative limits even when there are external voltage / current sources connected to the output.

<Notes>

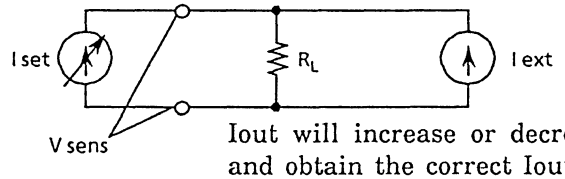
(a) When the limiter operates during a sink operation in the voltage output mode, the output voltage can rise above the set value or can become opposite in polarity because the current will be limited.



$$I\,limit = \left| \frac{V\,ext - V\,out}{R_L} \right|$$

Vout will increase or decrease so as to limit the output current and obtain the correct Vout.

(b) When the limiter operates during a sink operation in the current output mode, the output current can increase above the set value because the limiter operates to limit the output voltage.



$$V\,out = | (I\,ext - I\,out) \times RL |$$

Iout will increase or decrease so as to limit the output voltage and obtain the correct Iout.

(c) The voltage limiter will not operate in the voltage mode and the current limiter will not operate in the current mode.

(2) **Trip Function**

In order to prevent overloading and to protect this instrument, the output will be turned off when the output current exceeds about 130mA or when the output voltage exceeds about ±35V.

This function operates in the DC V and DC mA ranges.

The output will be turned off in the DC mV range when the output terminal voltage exceeds about ±0.6V.

To turn ON the output again, reduce the load and switch ON the output.

Voltage Mode

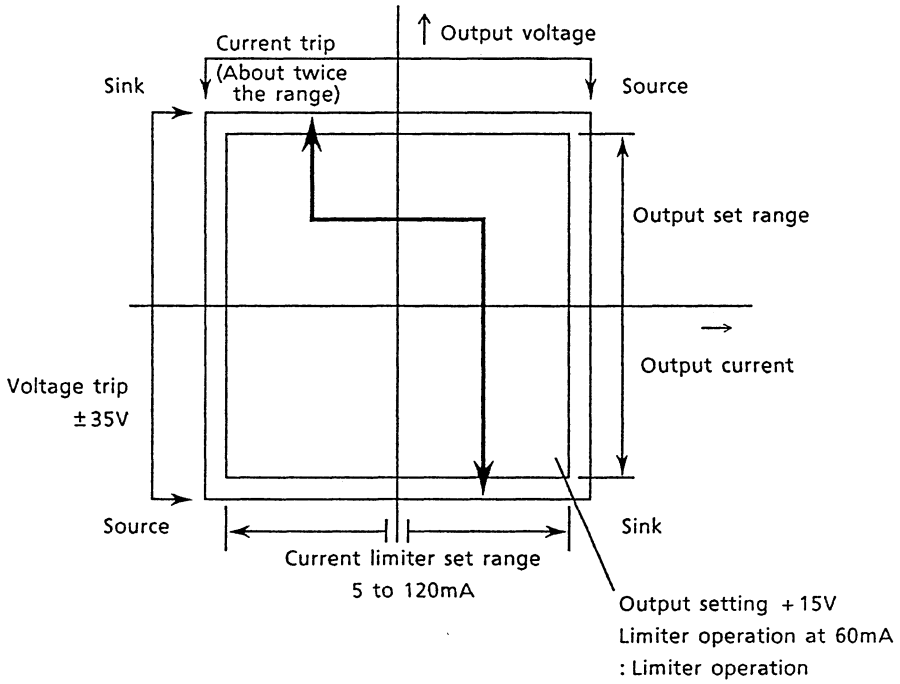


Figure 4.10 Current Limiter and Current Trip Functions

Current Mode

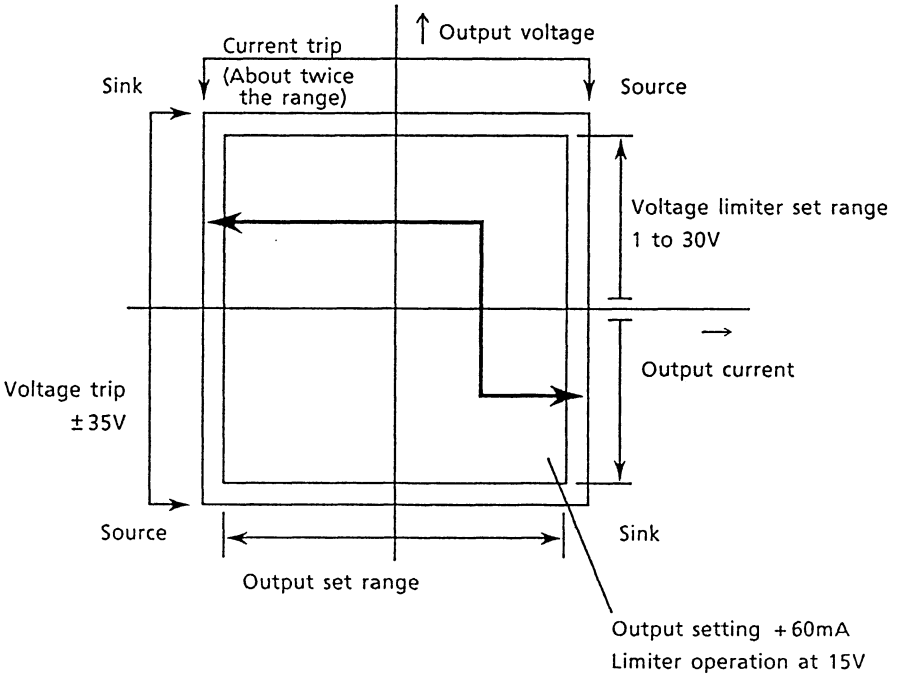


Figure 4.11 Voltage Limiter and Voltage Trip Functions

4.6 On Different Load Conditions

Both the voltage and current functions operate within the ranges given in Section 4.5 in the source and sink modes while within the normal operating conditions as well as in the limiter operating conditions.

- When the load capacitance exceeds 10μF in the voltage (DC V) mode, the response time is likely to become long.
- If the output setting is suddenly changed in the voltage mode with a capacitive load, the limiter is likely to operate due to a current surge.
- On inductive loads
  When an inductive load is connected in the constant current mode, oscillations can occur at about 1mH or more depending on the nature of the load. In such situations, stable operations can be obtained if the series resistance is in the range of 10 to 100Ω. The same is true at 0.1mH loads in the voltage mode after the limiter has operated.
  When the output is changed suddenly with an inductive load, the limiter can operate or the trip function can operate due to the induced voltage. In these situations, it is advisable to increase the output slowly using sweep operation in the program mode. Contact us when your load conditions are special.

5. INPUT OUTPUT SIGNALS

The external trigger signal is input to the instrument and the ready signal output (output change end signal) is obtained from the instrument via the input / output signal connector (see Figure 5.1) at the rear panel of the 7651.

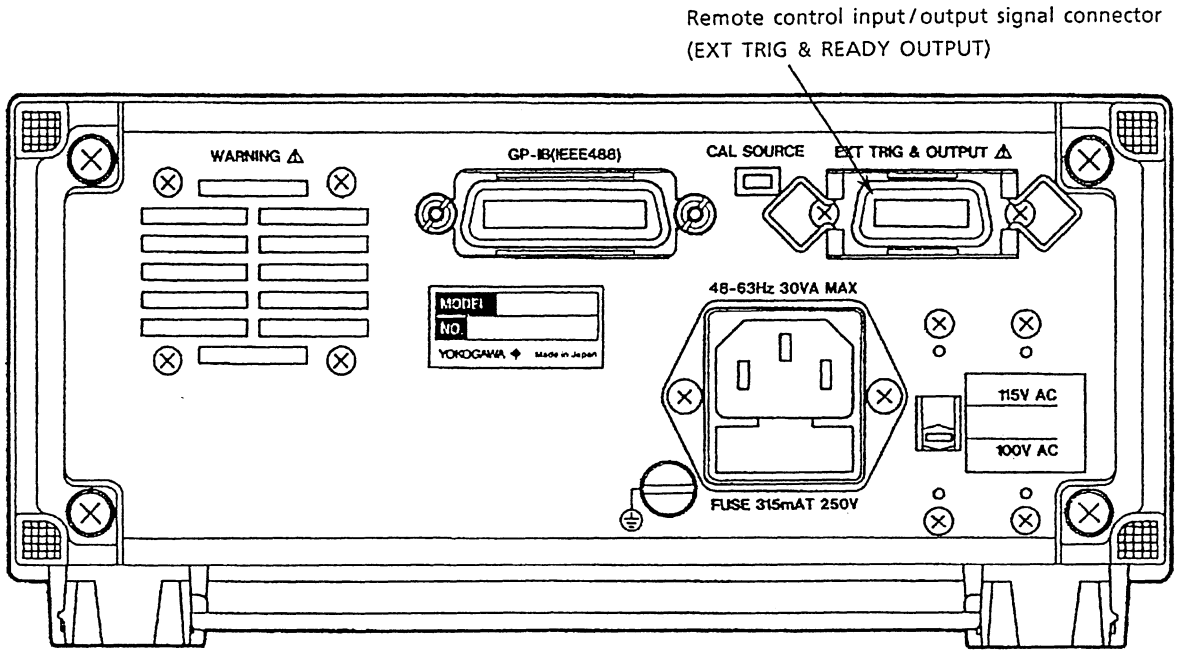


Figure 5.1 Position of the Remote Control Input/Output Signal Connector

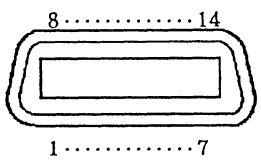
5.1 Remote Control Signal

5.1.1 Signal Connector and I/O Levels

(1) The connector for the remote control signals is of the AMPHENOL57-30140 type. The signal names and pin connections are shown in Table 5.1.

Table 5.1 Signal Names and Pin Nos.

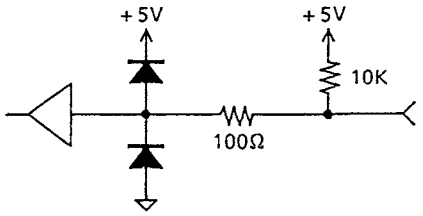
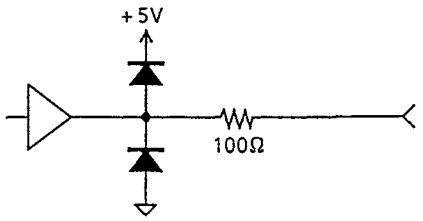
Pin No.	Signal Name	Pin No.	Signal Name
①	EXT TRIGGER	⑧	
②	READY	⑨	
③		⑩	
④		⑪	
⑤		⑫	
⑥		⑬	
⑦	DIGITAL COMMON	⑭	DIGITAL COMMON



(2) Circuit Types and Levels of Remote Control Signals

The circuit types and signal levels of remote control signals are shown in Table 5.2.

Table 5.2 Circuit Types and Signal Levels of Remote Control Signals

Signal Name		Circuit Type	Logic Level
Program control signals	EXT TRIGGER (Input)		L : 0 to 0.6V H : 2.4 to 5V
	READY (Output)		TTL Level L : 1mA H : −400μA

5.1.2 Remote Control Functions

The functions of the signals and their pulse width conditions are shown in the table below.

Table 5.3 Functions of Signals and Their Pulse Width Conditions

Signal Name	Function	Signal Type
EXT TRIGGER	The signal for incrementing the program step from outside (Corresponds to the STEP key)	Effective edge: Falling edge
READY	Signal indicating that measurements can be made.	Pulse width: 10μs or more

When incrementing the program step of this instrument from the outside, a contact signal or a TTL logic level signal between pins ① and ⑦ should be input. The timing chart of set-value output is shown below.

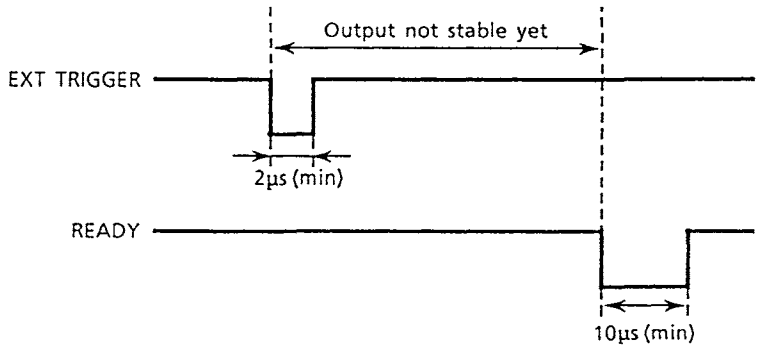


Figure 5.2 Timing Chart for Step Execution

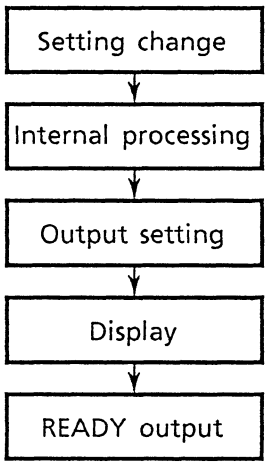
5.2 Timing Charts

Although the processing conditions determining the timing charts vary with on the set conditions, the sequence of processing is fixed.

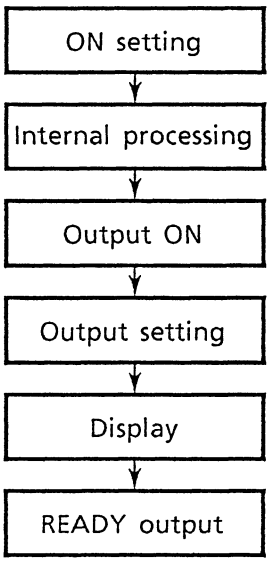
(1) Processing Sequence

The internal processings in this instrument are carried out in the following sequence.

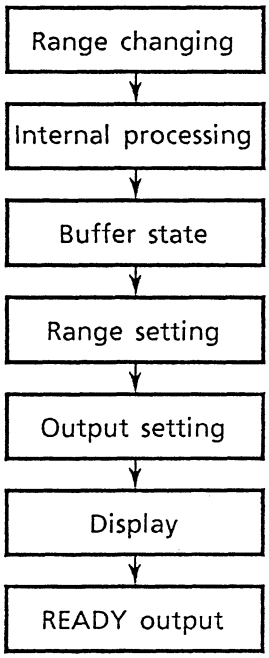
① Output Setting



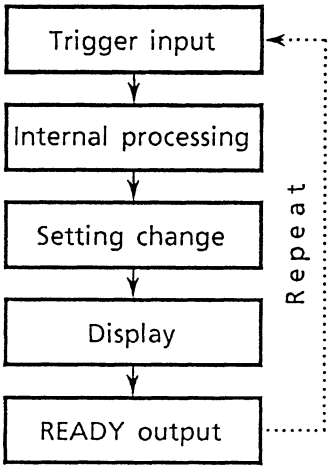
② Output ON



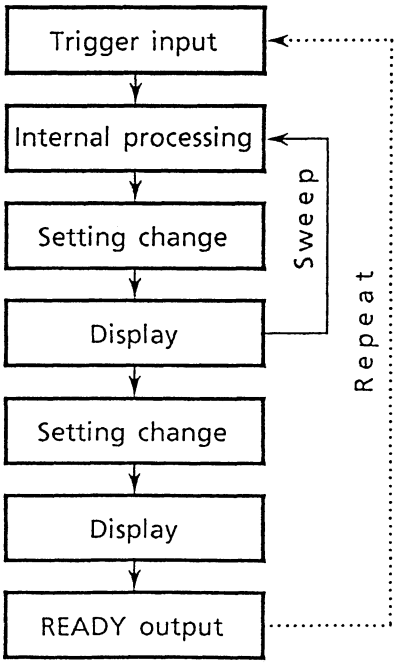
③ Range Changing



④ Program Step

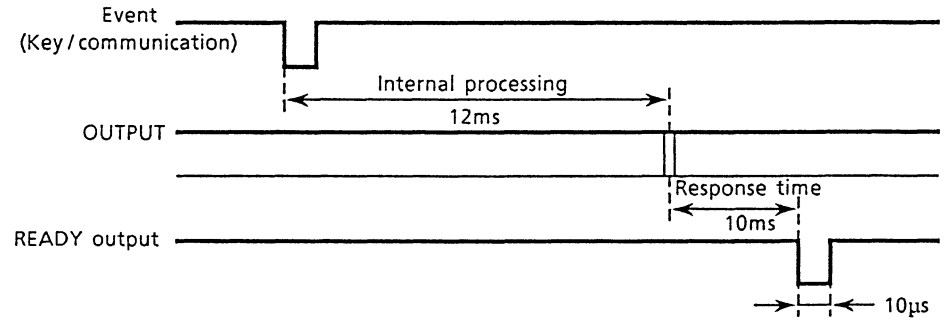


⑤ Program Sweep

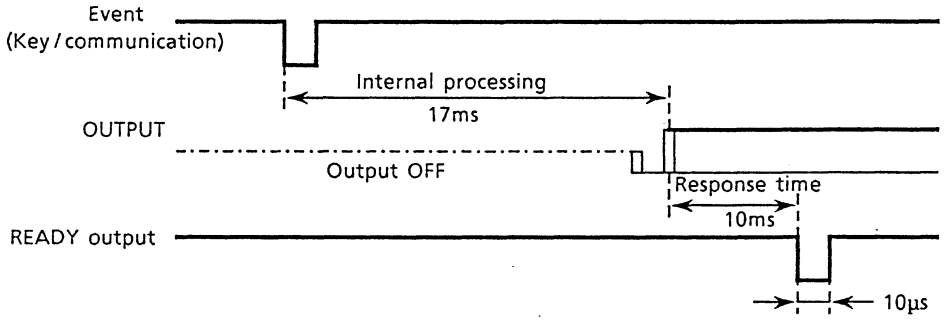


(2) Timing Charts

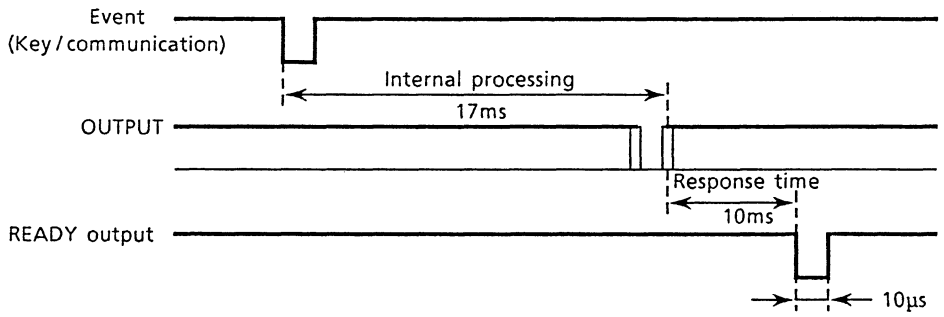
① Output Setting



② Output ON



③ Range Changing



④ Program Step

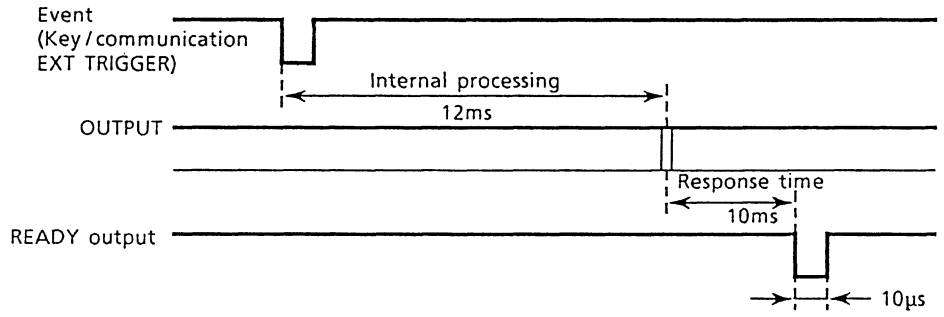


Figure 5.3 Timing Chart (1)

⑤ Program Sweep

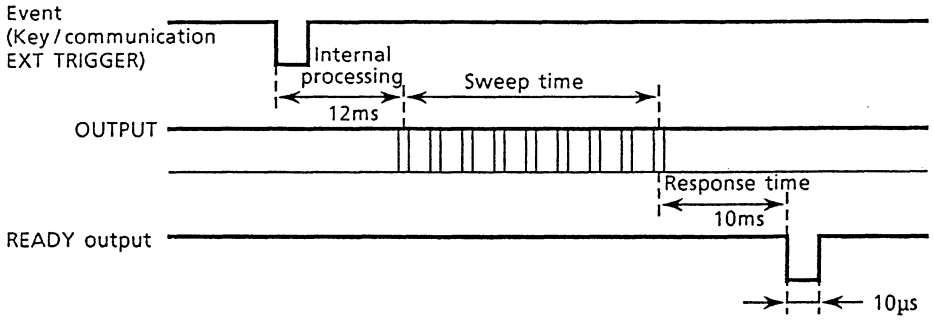


Figure 5.4 Timing Chart (2)

On the internal processing time

The internal processing time durations shown in the above figures are only typical values. Also, the event is restricted as follows depending on the trigger condition.

Table 5.4 Trigger Conditions and Events

Trigger Condition	Event
Keyboard	When a keyboard interrupt course to the CPU
EXT TRIGGER	The falling edge of the EXT TRIGGER
GP-IB	When the reception of the program data is complete.
RS-232-C	

Note: The internal processing times when GP-IB or RS-232C is used are determined as shown in Table 5.4. Hence, these times are different from the time from the beginning of transmission of program data by the controller.

6. COMMUNICATION FUNCTIONS

6.1 The GP-IB Interface (Standard Feature on Models 7651 01 and 7651 11)

6.1.1 Outline

(1) Summary

Since the Programmable DC Voltage / Current Generator Models 7651 01 and 7651 11 are equipped with the GP-IB interface as the standard communication function, these models are capable of being remote controlled by a controller and of outputting various data to the GP-IB interface.

◎ Functions that can be performed via the GP-IB interface.

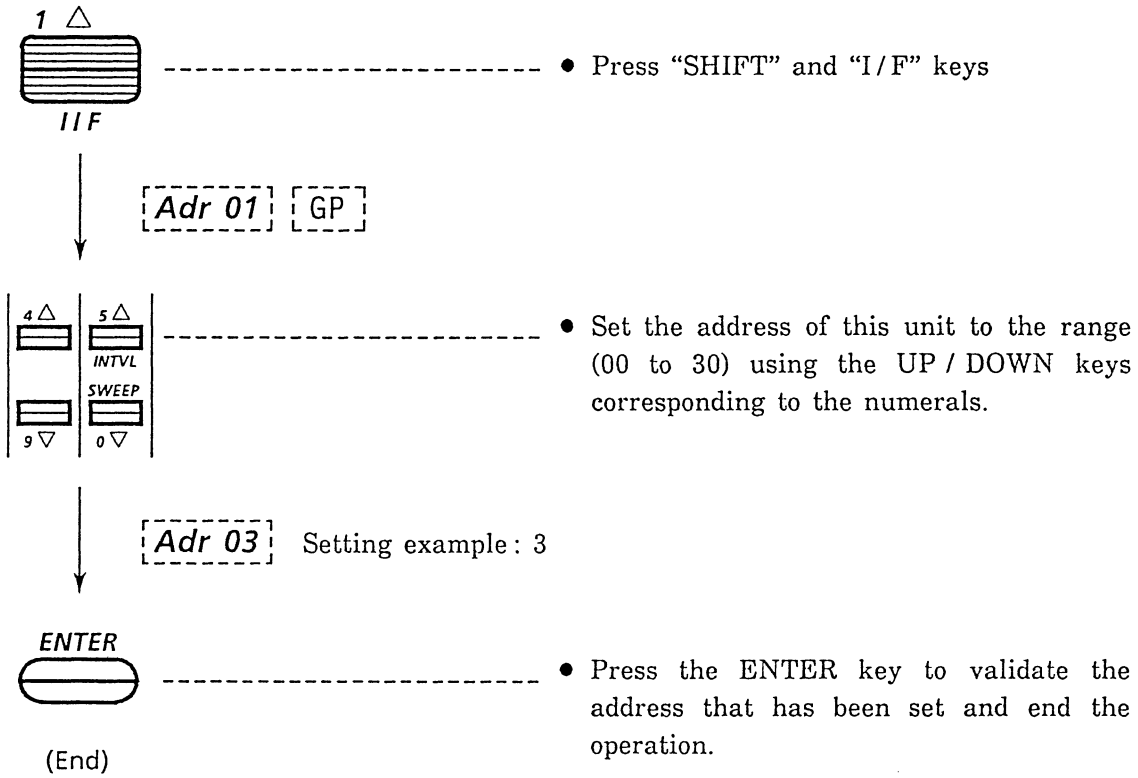
Table 6.1 Functions of GP-IB Interface

Function	Functions that Can Be Executed
Listener Functions	• All functions that can be executed by the panel keys excepting the POWER and SRQ keys • Output request for set output data • Output request for panel setting information • Program step output request • Status output request
Talker Functions	• Output of set output data • Output of panel setting information • Output of program step • Status byte output • Status output

(2) Address Setting

The controller can specify the address and control the functions of this unit by issuing communication commands. This unit has the talker and listener functions. In order for this unit to respond to the address specification from the controller, it is necessary to determine the address of this unit before beginning communication. The setting of the address of this unit is made by pressing the panel keys and checking the display as follows.

(Key Operation)



- Press "SHIFT" and "I/F" keys
- Set the address of this unit to the range (00 to 30) using the UP / DOWN keys corresponding to the numerals.
- Press the ENTER key to validate the address that has been set and end the operation.

- The GP-IB address will be retained even after the power is switched OFF.

(3) Specifications

- Electrical and Mechanical Specifications : Conforms to IEEE Std 488-1978
- Functional Specifications : SH1, AH1, T6, L4, SR1, RL1, PPO, DC1, DT1, CO
- Code Used : ISO (ASCII) code
- Address Setting : Setting by means of "I / F" front panel keys.
- Remote State Release : Remote state can be released by pressing the LOCAL key on the front panel. (This key will be ineffective when the unit has been put in the LOCAL LOCK OUT state by the controller.)

Table 6.2 Functional Specifications of the GP-IB Interface

FUNCTION	Description
SH1	All functions of send handshake
AH1	All functions of receive handshake
T6	Basic talker functions, serial pull functions, talker release function using MLA (My Listen Address)
L4	Basic listener functions, listener release function using MTA (My Talk Address)
SR1	All service request functions
RL1	All remote / local functions
PP0	No parallel poll functions
DC1	All device clear functions
DT1	All device trigger functions
C0	No controller functions

- Response to Interface Messages
- Device Trigger : <GET> ..... Executes commands (O, S, SA, UP, DW, SG, Fm, Rm) changing the output setting. (Same as the command "E")
- Device Clear : <SDC>, <DCL> ... Makes the panel setting information the same as when power is switched ON.
- SRQ Key : The SRQ key is valid irrespective of the remote or local state

* For GP-IB general specifications, see the manual "GP-IB Outline".

Note: Since device clear will reset this instrument, it requires a few seconds for execution during which the interface functions will all be non-operative.

6.1.2 The Listener Functions

In this unit, it is possible to remotely control all the functions of front panel key operations, excepting those of the POWER switch, the SRQ key and the communication settings, using the listener functions. Also, it is possible to output setting information upon reserving commands from the controller.

The listener functions carry out the specific operations based on the communication commands received from the talker when the ATN (Attention) signal line is in the "False" state.

The communication commands accepted by this unit consist of ASCII codes in the format: [Command] + [Parameters] + [Terminator]

Note: The length of command + parameters should be within 50 characters. The 51st character and beyond will be ignored.

- **Command** : Defined by 1 to 3 upper case alphabets.
- **Parameters** : Defined by (ASCII) numeric values.
- **Terminator** : . CR LF
  . LF
  . EOI
  . ; (Semicolon)

  } (All are accepted.)

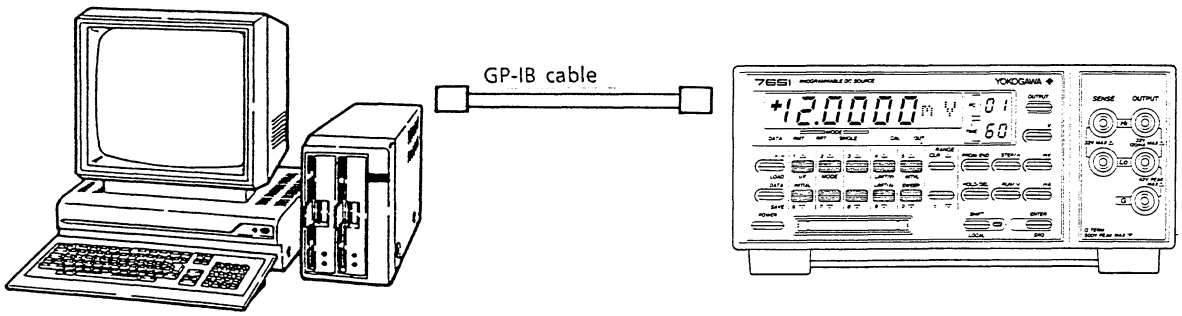


Figure 6.1 Connection between this Unit and a Personal Computer Using a GP-IB Cable

6.1.3 Talker Functions

(1) Talker Functions

The talker functions allow the unit to output the data of the set output and the panel setting information (in the program step condition).

The talker functions can be used to output set data, panel setting information, program step, status byte, and the condition code. The set data output can be made in real time. See Section 6.1.1 Paragraph (2) for the method of setting the address.

(2) Data Output Format ····· Output by the [OD] command

① Output Data

Header	Data	Terminator

- **Header** : $a_1a_2a_3a_4$ (4 alphabets)
  - a_1 ; N ····· Normal
    E ····· Overload
  - a_2a_3 ; DC ····· DC
  - a_4 ; V ····· Voltage
    A ····· Current
- **Data** : $m_1m_2m_3m_4m_5m_6m_7E+\ m_8$
  - $m_1m_2m_3m_4m_5m_6m_7$: Number with a maximum of 6 digits + Decimal point
  - m_8: Exponent
- **Terminator** : CR LF (+EOI)
  LF
  EOI
  ; (Semicolon)

② Output Data During Program Execution

Header	Data	,	Program counter	Terminator

- **Header, Data Terminator** : Same as above
- **Program Counter** : Pm_1m_2
  - m_1m_2: Program counter value (01 to 50)

Example of Output

		GP-IB output	
• Set output		NDCV	+0000.99E+3
• Overload	····· +−oL−mV	EDCV	+9999.99E−3
• Header OFF	·····		+19.9999E+0

(3) Output Format of Panel Setting Information

The panel setting information will be output when the OS command is received. The output sequence and contents are as follows.

Table 6.3 Output Format of Panel Setting Information

Line Number	Output Contents
1st line	Model name and software version number
2nd line	Function, range, output data
3rd line	Interval time, sweep time, program execution mode
4th line	Voltage limit value, current limit value
5th line	END

(4) Program Step Data Output Format

This data will be output upon receiving the OP command.

Table 6.4 Program Step Data Output Format

Line #1	PRS
Line #2	Step data of PC01
Line #3	Step data of PC02
⋮	⋮
Line # m−1	Step data of PCm
Line # (Last line−1)	PRE
Last line	END

- Step Data Format

Function, Range	Output Data	Terminator

m=01 to 50

<Example> F1R5S+07.0000E+0 $^{C_R}{}_{L_F}$

(5) Status Byte Output Format

The following is the output format of the status byte which is output by this unit during a serial poll of the talker function.

Table 6.5 Status Byte Output Format

bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1
DI08	DI07	DI06	DI05	DI04	DI03	DI02	DI01
0	SRQ	ERR	PRGM END	OL	SYN ERR	SRQ SW	READY
Mask value			16	8	4	2	1

- bit 8 ; Fixed to 0
- bit 7 ; Service request. Will be set to "1" when at least one of the bits 6, 5, 4, 3, 2, 1 is set to 1.
- bit 6 ; Set when an error has occurred (at least one of bits 4, 3 is set to 1).
- bit 5 ; Will be set when the program step ends.
- bit 4 ; Will be set during an overload.
- bit 3 ; Will be set in the event of a syntax error.
- bit 2 : Will be set when the SRQ key of the front panel has been pressed.
- bit 1 ; Will be set when the output change has been completed.

* The mask values will be set to 0 immediately after the power is switched ON.

The status byte will be cleared when the controller reads it.

All the causes in the status byte will be maintained as such until the controller reads the status byte.

(6) Status Code Output Format

The status code will be output upon receiving the OC command. See Section 6.3 Para (18) "OC Command" for more details.

STS1=	Status Code	Terminator

Status Code ..... "0" to "255"

6.2 RS-232C Interface (Standard Feature in Models 7651 02 and 7651 12)

6.2.1 Outline

The RS-232C interface is an interface between a data terminal equipment (DTE) and a modem (DCE) standardized for use with common telephone lines by the Electronic Industry Association (EIA) of the U.S.A.

(1) Summary

Since the Models 7651 02 and 7651 12 are equipped with the RS-232C interface as the standard communication feature, it is possible to carry out remote control of these models from and output of various data to a personal computer.

◎ Functions that can be achieved using RS-232C

Table 6.6 Functions of RS-232C

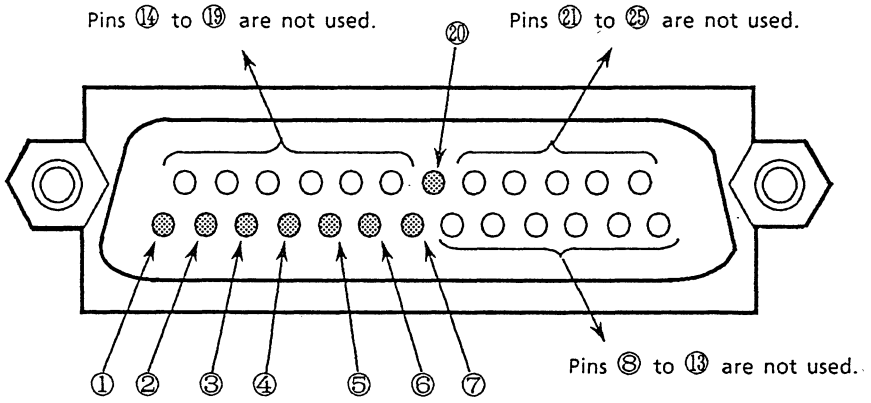
Function	Functions that Can Be Realized
Setting Functions	• The functions of all front panel keys except the POWER and SRQ keys • Output request of set output data • Output request of panel setting information • Program step output request • Status byte output request • Status code output request
Output Functions	• Output of set output data • Output of panel setting information • Output of program step • Status byte output • Status code output

(2) General Specifications

- Connection Method : Point-to-point
- Communication Method : Full duplex
- Synchronization Method : Start-stop synchronization
- Transmission Speed (bps) : 75, 150, 300, 600, 1200, 2400, 4800, 9600
  Select one of the above 8 transmission speeds
- Start Bit : 1 bit
  The start bit length is fixed to 1 bit.
- Data Length (word length) : 7 or 8 bits
  Select the data (word) length in bits as either 7 or 8 bits.
- Parity : Even, odd, or no parity
  Select one of the above three.
- Stop bits : 1 or 2 bits
  Select the number of stop bits as 1 or 2.
- Electrical Characteristics : Conforms to EIA RS-232C standard
- Connector : EIA RS-232-C (Present on the rear panel)
  When connecting to this RS-232C interface connector, use a cable equivalent to DB-25P.
- Hardware Handshake : It is possible to keep the signals CA, CB, CC, and CD always at the 'True' level or to use them as control signals.
- Software Handshake : During data communication, it is possible to select the control of only the send data or both the send and receive data using X-on and X-off signals.
  - X-on ··· ASCII 11H
  - X-off ··· ASCII 13H
- Receive Buffer Length : 64 bytes

6.2.2 RS-232C Interface Functional Description

(1) Connector and Signal Names



The numbers in the figure are the pin numbers.

Figure 6.2 RS-232C Connector (Equivalent to DBSP-JB25S)

Reference: The list of RS-232C signals is given below along with their JIS and CCITT symbols.

Table 6.7 List of RS-232C Signals

Pin No. (25-pin Connector)	Symbol			Name
	RS-232-C	CCITT	JIS	
①	AA (GND)	101	FG	Frame ground
⑦	AB (GND)	102	SG	Signal ground
②	BA (TXD)	103	SD	Send data
③	BB (RXD)	104	RD	Receive data
④	CA (RTS)	105	<RS	Request to send
⑤	CB (CTS)	106	CS	Clear to send
⑥	CC (DSR)	107	DR	Data set ready
⑳	CD (DTR)	108/2	ER	Data terminal ready
㉒	CE (RI)	125	CI	Call indication
⑧	CF (DCD)	109	CD	Data channel receive carrier defect
㉑	CG (—)	110	SQD	Data signal quality defect
㉓	CH/CI (—)	111	SRS	Data signal speed selection
㉔	DA/DB (—)	113/114	ST1/ST2	Send signal element timing
⑰	DD (RXC)	115	RT	Receive signal element timing
⑭	SBA (—)	118	BSD	Slave station send data
⑯	SBB (—)	119	BRD	Slave station receive data
⑲	SCA (—)	120	BRS	Slave station send request
⑬	SCB (—)	121	BCS	Slave station clear to send
⑫	SCF (—)	122	BCD	Slave station receive carrier defect

① AA (GND ; Protective Ground) : Connected to the case of the 7651

② BA (TXD ; Transmitted Data) : This is the send data to the personal computer. Signal direction ··· output.

③ BB(RXD ; Received Data) : This is the receive data from the personal computer. Signal direction ··· input.

④ CA(RTS ; Request to Send) : This is a signal for handshaking when receiving signals from the personal computer. Signal direction ··· output.

⑤ CB(CTS ; Clear to Send) : This is a signal for handshaking when sending signals to the personal computer. Signal direction ··· input.

⑥ CC(DSR ; Data Set Ready) : This is a signal for handshaking when sending data to a personal computer. Signal direction ··· input.

⑦ AB(GND ; Signal Ground) : Signal ground

⑳ CD(DTR ; Data Terminal Ready) : This is a handshaking signal used when receiving data from the personal computer. Signal direction ··· output.

Note: Pins ⑧ to ⑲ and ㉑ to ㉕ are not used.

(2) Combination of the Handshaking Method

When this instrument is connected via the RS-232C interface to a personal computer, several procedures will be followed by the electrical signals so that data is properly exchanged between the two equipment. This procedure is called handshaking and can have several methods based on the combination with the personal computer. Follow the same method of handshaking for proper communication to take place.

In this instrument, it is possible to select 8 methods using the panel keys as shown in Table 6.8.

For more details on the method of making the settings, see Section 6.2.3 para (1).

(○ indicates that the function is present.)

Table 6.8 Selection of the Handshake Mode

Mode selection No.	Send data control (The control method for sending data to the personal computer.)				Receive data control (The control method for receiving data from the personal computer.)			
	Software handshake	Hardware handshake		No handshake	Software handshake	Hardware handshake		No handshake
	Stopping transmission upon reception of X-off and restarting transmission upon reception of X-on	Stopping transmission when CB (CTS) becomes false and restarting transmission when true.	Stopping transmission when CC (DSR) becomes false and restarting transmission when it becomes true.		Sending X-off when the receive buffer becomes 3/4 full and sending X-on when the receive buffer becomes only 1/4 full	Making CD(DTR) false when the receive buffer becomes 3/4 full and making it true when the receive buffer becomes 1/4 full	Making CA (RTS) false when the receive buffer becomes 3/4 full and making it true when the receive buffer becomes 1/4 full	
0				○				○
1	○				○			
2	○					○		
3	○						○	
4		○				○		
5		○					○	
6			○			○		
7			○				○	

(3) Data Control

It is possible that data is sent from the personal computer even when handshaking is being done in receive data control.

In such cases, irrespective of whether handshaking is being done, as soon as the buffer becomes full, the excess received data will be lost, and data will be stored again in the buffer as soon as empty space becomes available in the buffer.

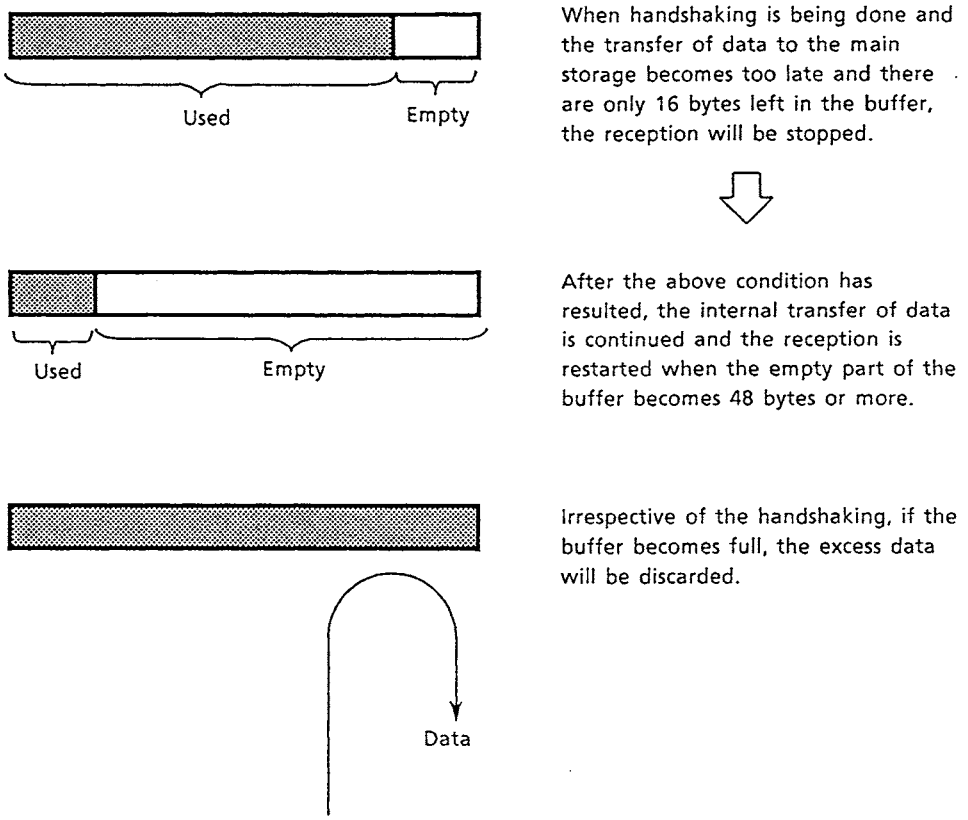


Figure 6.3 Data Control Configuration Diagram

(4) Communication Data Format

The RS-232C interface of this instrument uses the start-stop method of synchronization. In this method of communication, at the beginning of each character that is transmitted a start bit is added which is followed by the data bits, the parity bit, and then finally the stop bit(s) as shown in the following figure.

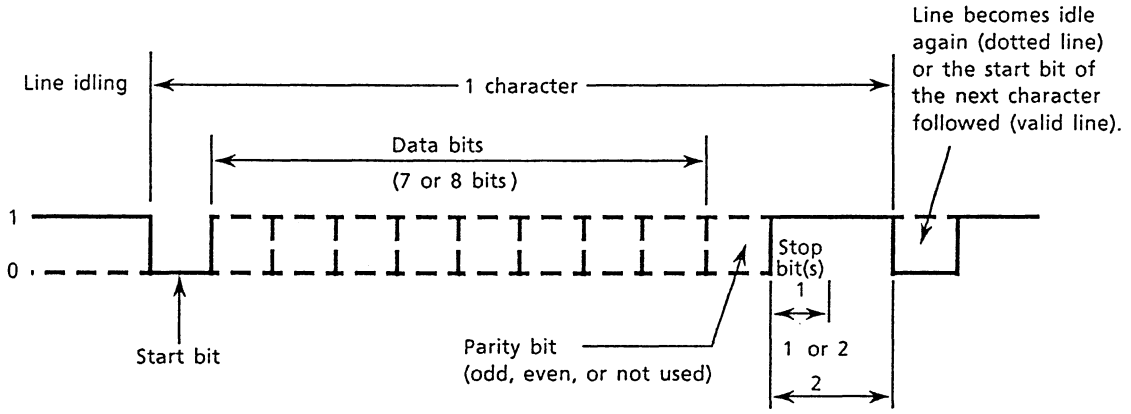


Figure 6.4 Communication Data Format

Table 6.9 Data Format List

Set Value	Start Bit	Data Length	Parity	Stop Bit
0	1	8	None	1
1	1	7	Odd	1
2	1	7	Even	1
3	1	7	None	2

The data format is set using the "I/F" key on the front panel. For details, see Section 6.2.3 para (2).

(5) Connection with Computer

When connecting this unit with a computer, set the handshaking method, the data transfer rate, and the data format, etc., using the panel keys so that they match with most being used by the computer.

The details of the method of making these settings is given in Section 6.2.3 para (2). Also, make sure that the interface cable used for interconnection is of the correct type.

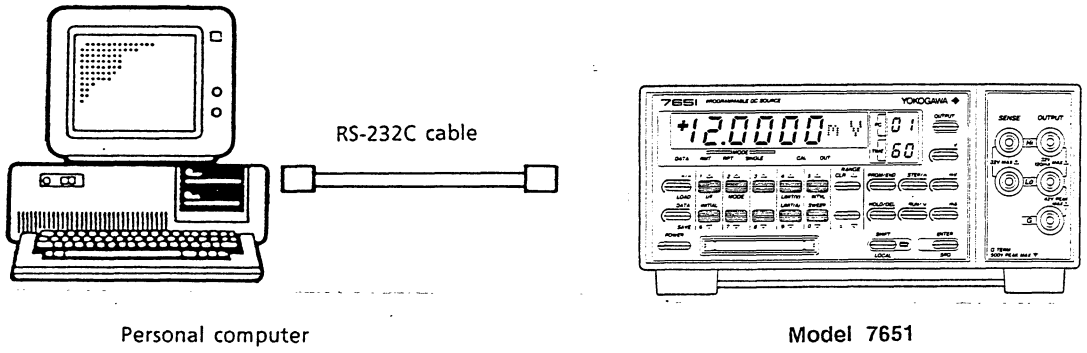
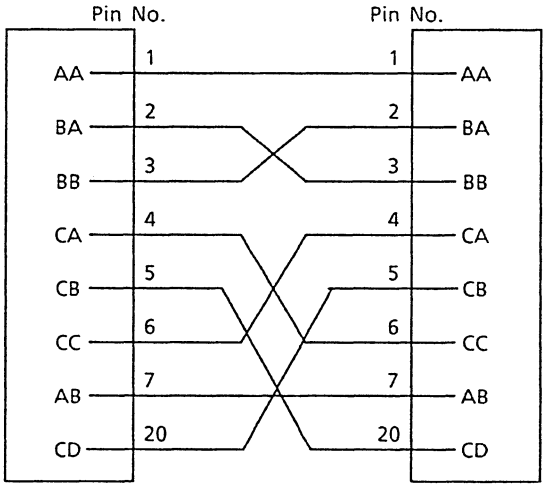


Figure 6.5 Connecting This Instrument with a Personal Computer Using an RS-232C Cable

- Cable Wiring Diagram (NEC PC-9801 and 7651)



Communication mode : 2
Recommended cable : B9801LB

Figure 6.6 RS-232C Cable Wiring Diagram

6.2.3 Remote Control Functions

In this instrument, it is possible to remotely control all the functions of the front panel keys except the POWER switch, the SRQ key, and the communication setting keys during the normal mode of operation via the communication interface.

(1) General Procedure

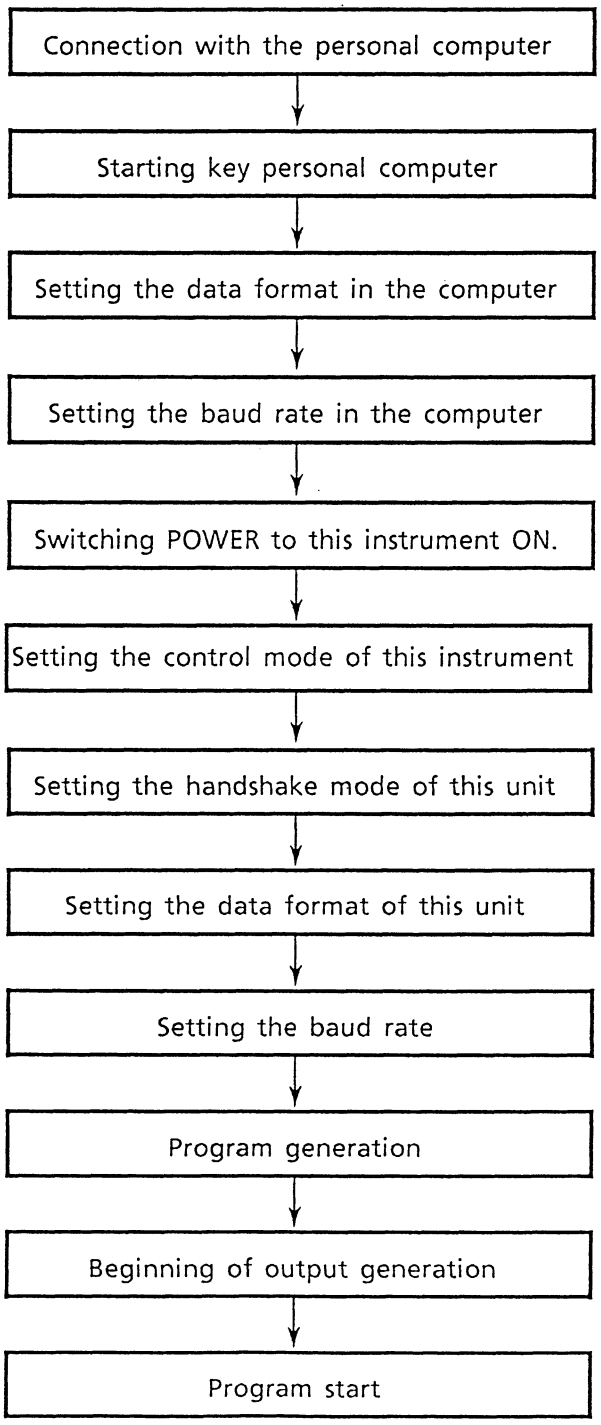
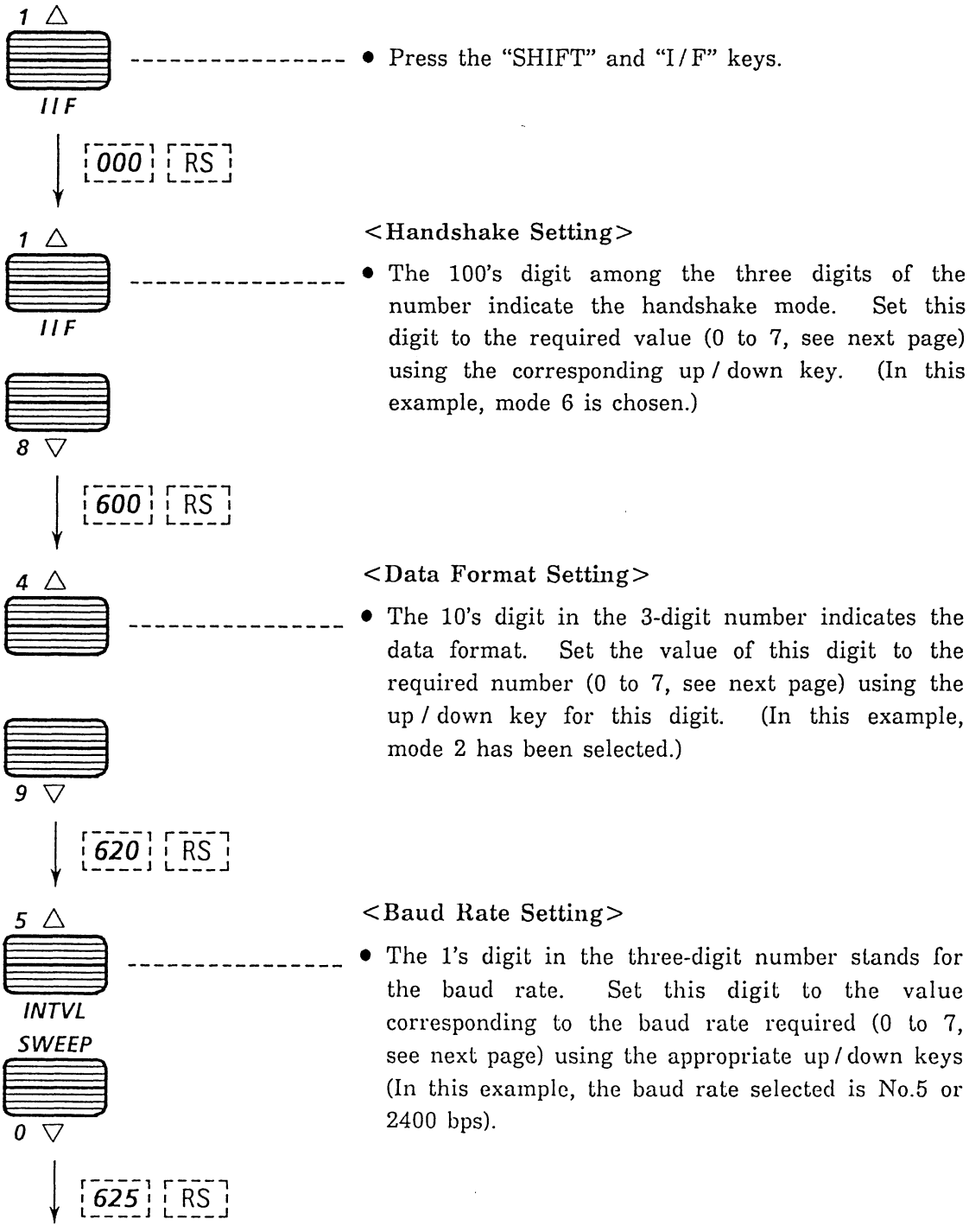


Figure 6.7 General Operating Procedure for Remote Control

(2) Setting the RS-232C Interface

The functions that can be controlled in this unit by commands from the personal computer are the setting functions and the output function. The setting needed for this instrument for communication are done using the panel keys while observing the display as follows.

(Key Operation)



• Press the "SHIFT" and "I/F" keys.

<Handshake Setting>

• The 100's digit among the three digits of the number indicate the handshake mode. Set this digit to the required value (0 to 7, see next page) using the corresponding up / down key. (In this example, mode 6 is chosen.)

<Data Format Setting>

• The 10's digit in the 3-digit number indicates the data format. Set the value of this digit to the required number (0 to 7, see next page) using the up / down key for this digit. (In this example, mode 2 has been selected.)

<Baud Rate Setting>

• The 1's digit in the three-digit number stands for the baud rate. Set this digit to the value corresponding to the baud rate required (0 to 7, see next page) using the appropriate up / down keys (In this example, the baud rate selected is No.5 or 2400 bps).

(To next page)

(From previous page)

(End)

- After the baud rate has been correctly selected, press the ENTER key to validate all the selections that have been made.
  With this the selection will be complete and the setting operations are also complete.

<Reference>

① Handshake mode ..... See Section 6.2.2 (2).
② Data format ..... See Section 6.2.2 (4).
③ Baud rate ..... The value for setting the baud rate is as follows.

No.	
0	75bps
1	150bps
2	300bps
3	600bps
4	1200bps
5	2400bps
6	4800bps
7	9600bps

- These settings will be retained even if the power to the instrument is switched OFF.

(3) Basic Type of Programming

The remote control of this unit is carried out by sending communication commands (commands and parameters) to this unit from the personal computer.

The communication command for this unit has the general format of [Command] + [Parameter] + [Terminator] all expressed in the ASCII code.

Note: The total length of the command + parameters must be within 50 characters. The 51st and further characters will be ignored.

(Command)	(Parameter)	(Terminator)
RU	m	CR LF LF ;

- Command ..... Defined using 1 to 3 upper case alphabets
- Parameter ..... A number in the ASCII code
- Terminator
  - CR LF
  - LF
  - ; (Semicolon)

  } (All will be accepted.)

Notes:
- The panel setting information that are read out by the program, communication, and IC card read out will not be retained when the power is switched OFF.
- When the output terminator of the personal computer is only CR, use also a semicolon in addition this code.

6.2.4 Data Output Function

(1) The Data Output Function

In this unit, it is possible to output the data of the set output, the panel setting information, the program step, the status byte, and the condition code.

(2) Data Output Format ····· This is output upon receiving the OD command.

① Output data

Header	Data	Terminator

- Header : $a_1a_2a_3a_4$ (4 alphabets)
  - a_1 ; N ..... Normal
    E ..... Overload
  - a_2a_3 ; DC ..... DC
  - a_4 ; V ..... Voltage
    A ..... Current
- Data : $m_1m_2m_3m_4m_5m_6m_7E+\ m_8$
  - $m_1m_2m_3m_4m_5m_6m_7$: Maximum of 6 digits + decimal point
  - m_8: Exponent
- Terminator : CR LF
  LF

② Output Data During Program Execution

Header	Data	,	Program Counter	Terminator

- Header, Data, Terminator : Same as above
- Program Counter : Pm_1m_2
  - m_1m_2: Program counter value (01 to 50)

Note

◎ The terminator in RS-232C communication.
When the set data of the 7651 is read out and processed by a personal computer, the terminator of the 7651 data output format (CR LF or LF) and the terminator of the personal computer will have to match.

---

(3) Panel Set Information Output Format

The panel set information will be output when the OS commands is received. The sequence of output and the contents are as follows.

Table 6.10 Panel Set Information Output Format

Line Number	Output Contents
Line #1	Model name, software version number
Line #2	Function, range, output data
Line #3	Interval time, sweep time, program execution mode
Line #4	Voltage limit value/current limit value
Line #5	END

(4) Program Step Data Output Format

The program step data is output in the following format when the OP command is received.

Table 6.11 Program Step Data Output Format

Line #1	PRS
Line #2	Step data of PC01
Line #3	Step data of PC02
Line #4	Step data of PC03
⋮	⋮
Line # m+1	Step data of PCm
Line # m+2	PRE
Line # m+3	END

m=01 to 50

- Format

Function Range	Output Data	Terminator

<Example> F1R5S+07.0000E+0 C_R L_F

(5) Status Byte Output Format

The output format of the status byte which is output when the ESC S command is received is as follows.

Table 6.12 Status Byte Output Format

bit 8	Fixed to 0	
bit 7	Service request	
bit 6	Error	..... This will be set to 1 when an error has occurred (at least one of bit 4 and bit 3 is set).
bit 5	End of program step	..... This will be set when the interval time is reached (end of execution of one step) during program execution.
bit 4	Limit error	..... This will be set when a voltage limit or a current limit has been exceeded (overload or trip).
bit 3	Syntax error	
bit 2	Fixed to 0	
bit 1	End of output change	..... This bit will be set after the output has become stable when the output value is changed while the output is ON, or when the range is changed, or after the output is switched ON from OFF, or at the end of sweep output during program execution.

- RS-232C status byte output ..... STS0=0 to STS0=125
- Output format

STS0=	Status Byte	Terminator

Status byte ..... 1 to 3 ASCII characters ("0" to "125")
Terminator ..... CRLF
LF

(6) Status Code Output Format

The status code is output with the following format when the "OG" command is received. For details, see Section 6.3 para (18) on the "OC" command.

STS1=	Status Code	Terminator

Status Code ..... "0" to "255"

6.3 Communication Commands (Common to GP-IB and RS-232C)

Table 6.13 List of GP-IB/RS-232C Communication Commands

Item	Function Details	Communication Commands	Page
(1)	Function Setting	Fm1	6-22
(2)	Range Setting	Rm2	6-22
(3)	Output Data Setting	Sm, SAm, UPm, DWm, SGm	6-23
(4)	Output ON/OFF	O0, O1	6-25
(5)	Trigger	E, <GET>	6-25
(6)	Setting Initialization	RC	6-26
(7)	IC memory Card Initialization	CI	6-26
(8)	Program Run/Halt	RUm	6-26
(9)	Start/End Program Setting	PRS, PRE	6-27
(10)	Program Interval/Sweep Setting	PI, SW	6-28
(11)	RUN Mode Section	M1, M0	6-29
(12)	PC (Program counter) Value Setting	PCm	6-29
(13)	Save/Load of IC Memory Card	SVm, LDm	6-30
(14)	Limit Setting	LVm, LAm	6-31
(15)	Set Information Output	OS	6-32
(16)	Program Output	OP	6-32
(17)	Output Value Data Output	OD	6-32
(18)	Status Code Output	OC	6-33
(19)	Output Data Terminator Setting	DLm	6-34
(20)	Header Setting	Hm	6-34
(21)	Status Byte Mask Information	MSm	6-35
(22)	Calibration Function Setting (Can only be executed in the calibration mode.)	YZPm, YZSm, YZW, YZE, YZO	6-36
(23) (RS)	Remote Control Setting	<ESC> R	6-37
(24) (RS)	Local Control Setting	<ESC> L	6-37
(25) (RS)	Device Clear	<ESC> C	6-37

Items with no markings in the Sl No.column are common for both GP-IB and RS-232C. Those marked (RS) are only for RS-232C.

(1) Function Setting

Fm1

(2) Range Setting

Rm2

Function

Selects the DC voltage at the DC current to be generated (Fm1).
Specifies the output range of the DC voltage or the DC current (Rm1).

Syntax

- Fm1/Rm2 <Terminator>
  m1=1 or 5 (depending on the function) ··· See table below.
  m2=2to 6 (depends on the range) ··· See table below.
- The function and the range can be set independently also.
  Fm1<Terminator>
  Rm1<Terminator>
- The communication command for each function and range is determined as follows.

Function	Communication Command (Fm1)	Range	Communication Command (Rm2)
DC current (DC V)	F1	10mV	R2
		100mV	R3
		1V	R4
		10V	R5
		30V	R6
DC current (DC A)	F5	1mA	R4
		10mA	R5
		100mA	R6

(3) Output Data Setting

Sm

Function Sets the value of the voltage or current that is output in a fixed range.

Syntax S−XX.XXEXX

Description

S−XX.XXEXX
- Set data (in floating point format or fixed point plus exponent format)
- Polarity (+ or −; + can be omitted)

- The command is executed upon a trigger (E,<GET>)
- The polarity of a positive set-value can be omitted.
- Assign the set data in units of a volt for voltage and in amps for current.
- The set data can be specified in either formats of floating point representation and fixed point plus exponent representation.

Example: S−100.000E−3 (−100.000mV or −100.00mA)
S−0.1 (−100.000mV or −100.00mA)

SAm

Function Sets the value of a voltage or a current that is output in the auto ranging mode.

Syntax SA−XX.XXEXX

Description

SA−XX.XXEXX
- Set data (in floating point format or fixed point plus exponent format)
- Polarity (+ or −; + can be omitted)

- The command is executed upon a trigger (E,<GET>)
- The polarity of a positive set-value can be omitted.
- Assign the set value for a voltage in volts and for a current in Amps.
- In the auto range data setting, the output range will be determined automatically to the best range suitable for the set value.

Example: SA.1E
SA10E−4
:

UPm

Function The set output data will be incremented by one in the specified digit only.

Syntax UP { 0 / to / 4 }

Description The relation between the communication command and the incremented digit is as follows.

Communication Command	Function
UP0	The value of the 1's digit will be incremented.
UP1	The value of the 10's digit will be incremented.
UP2	The value of the 100's digit will be incremented.
UP3	The value of the 1,000's digit will be incremented.
UP4	The value of the 10,000's digit will be incremented.

- This command is executed by a trigger (E,<GET>)

DWm

Function The set output data will be decremented by one in the specified digit only.

Syntax DW { 0 / to / 4 }

Description The value of the 1's digit will be decremented.

Communication Command	Function
DW0	The value of the 1's digit will be decremented.
DW1	The value of the 10's digit will be decremented.
DW2	The value of the 100's digit will be decremented.
DW3	The value of the 1,000's digit will be decremented.
DW4	The value of the 10,000's digit will be decremented.

- This command is executed by a trigger (E,<GET>)

SGm

Function Specifies or alters the polarity of the set value.

Syntax SG { 0 / to / 2 }

Description The relation between the communication command and the polarity is as follows.

Communication Command	Function
SG0	Specifies positive polarity.
SG1	Specifies negative polarity.
SG2	Inverts the polarity.

- This command is executed upon a trigger (E, <GET>).

(4)Output ON/OFF Control

Om

Function Sets the ON/OFF condition of the output.

Syntax Om
m=0 (output OF) or 1 (output ON)
- This command is executed upon a trigger (E,<GET>).

(5) Trigger

E,<GET>

Function This executes the setting of a function, range, output data, or the output ON/OFF control.

Syntax E
<GET>
- <GET> is valid only for GP-IB communication.
- The communication buffer liable to be triggered will be updated when the key setting of the function, range, output data, output ON/OFF is made or when <DCL>, setting initialization, IC memory card loading is done.

(6) Setting Initialization

RC

Function Initializes the entire setting data of the 7651.

Syntax RC

(7) IC Memory Card Initialization

CI

Function The contents of the IC memory card will be cleared to the initial state.

Syntax CI

Description Always initialize a newly bought IC card before using it in the instrument. Also, this command can be used for the entire contents of the card.

(8) Program Run / Halt Control

RUm

Function This selects the execution or halting of a program.

Syntax

Communication Command	Function
RU0	Halt
RU1	STEP execution
RU2	RUN execution
RU3	Continue execution

Description

- Halt (RU0) is the function of halting the program currently under execution and corresponds to pressing the HOLD key on the panel.
- STEP execution (RU1) is the function of changing to the next program step and corresponds to pressing the STEP key on the front panel.
- RUN execution (RU2) is the function of executing the program from the beginning (the first step) and corresponds to pressing the RUN key on the front panel.
- Continuous execution (RU3) is the function of halting the program under execution and restarting the execution from the halted state. This function corresponds to releasing the HOLD key on the front panel.

(9) Start / End Program Setting

PRS

Function Starts program setting.

Syntax PRS

Description

- After starting the program setting, set the function, range, and the output data. At the end of setting the data for one step, move to the next step.
- Set the output data for each step in the end of the step.
- There is no need for a trigger (E,<GET>).
- The PC (program count) value will become 1 upon receiving this command.
- When a program setting is made, the previous settings will be erased.

PRE

Function Ends program setting.

Syntax PRE

(10) Interval and Sweep Setting of Program

PIm

Function Sets the generation interval at the time of running the program.

Syntax

PI { 0.1 / to / 3600.0 }

Description

- The interval setting can be made upto 3600.0 seconds (1 hour) with a resolution of 0.1 sec.
  When the 7651 power is switched ON, PI0.1 will be set.

SWm

Function Sets the sweep time during program execution.

Syntax

SW { 0 / to / 3600.0 }

Description

- The sweep time can be set to a maximum of 3600s with a resolution of 0.1 seconds.
- Set the sweep time to zero (SW0) when the sweep function is not required.
- When the 7651 power is switched ON, the sweep setting of SW0 will be made.

(11) RUN Mode Selection

M1

Function Sets the program execution mode to the SINGLE mode.

Syntax M1

M0

Function Sets the program execution mode to the REPEAT mode.

Syntax M0

Description

- In the SINGLE mode, the program will be executed once till the last step and thereafter the set value of the last step will be made continuously.
- In the REPEAT mode, the program will be executed repeatedly from beginning to end.

(12) PC Value (Program counter) Setting

PCm

Function Sets the program counter value.

Syntax PC { 1 to 50 }

Description

- This is used for running the program from the set program step.

(13) Save / Load of IC Memory Card

SVm

Function Saves the program that has been generated and the current set data in the IC memory card.

Syntax SV { 1 / to / 7 }

Description
- Upto 7 patterns of program scan be stored in the IC memory card (3789 01 : 8k bytes).

LDm

Function The program and the set data stored in the IC memory card is loaded into this unit.

Syntax LD { 1 / to / 7 }

Description
- This is the function of reading the program and set data stored in the IC memory card using the SV command.
- If loading is done when the output is ON, the output will automatically be turned OFF.

(14) Limit Setting

LVm

Function Sets the voltage limit.

Syntax LV { 1 / to / 30 }

Description
- This is the function of limiting applied voltage when a DC current is being generated.
- The limit value can be set in the range 1 to 30 (V).

LAm

Function Sets the current limit.

Syntax LA { 5 / to / 120 }

Description
- This is the function of limiting the current flowing through the load when a DC voltage is being generated.
- The limit value can be set in the range 5 to 120 (mA).

(15) Setting Information Output

OS

Function Outputs the current panel setting information.

Syntax OS

(16) Program Output

OP

Function Outputs the contents of the program step.

Syntax OP

(17) Output Value Data Output

OD

Function Outputs the data of the set output value.

Syntax OD

(18) Status Code Output

OC

Function Outputs the current status.

Syntax OC

Description

bit 8	CAL switch	0:OFF/1:ON
bit 7	IC memory card	0:OUT/1:IN
bit 6	Normal/calibration mode	0: Normal mode/1: Calibration mode
bit 5	Output ON/OFF	0:OFF/1:ON
bit 4	Output not stable	0: Normal/1: Unstable
bit 3	Previous communication command error information	0:OK/1:Error
bit 2	Program being executed	0: Normal/1: Under execution
bit 1	Program setting under execution	0: Normal/1: Under setting

- The output not stable is the condition in which the output is being made but either the output value is being changed, the range is being changed, or the output has been changed from OFF to ON, but the output is not yet stable. Further, this indication is also given when the output is ON but the program sweep operation is being mode.
- The previous communication command error information is the communication command error check information for commands other than <GET>.

Output Format "STS1=m" m="0"~"255"

Example: STS1=16 bit 5 (output ON / OFF) only is 1 (output ON condition), other bits are 0.

(19) Output Data Terminator Setting

DLm

Function Sets the terminator for the output data.

Syntax DL { 0 / to / 2 }

Description The relation between the communication command and the function s are as follows.

- GP-IB

Communication Command	Function
DL0	CR/LF/EOI
DL1	LF
DL2	EOI

- RS-232-C

Communication Command	Function
DL0	CR/LF
DL1	LF

(20) Header Setting

Hm

Function Sets whether or not a header is to be added to the output data.

Syntax H { 0 / 1 }

Description The relation between the communication command and the header contents is shown below.

Communication Command	Header Contents
H0	No header
H1	Header present

(21) Status Byte Mask Setting

MSm

Function

Sets the interrupt generation cause in the status byte. The cause (mask value) that has been set becomes effective and the interrupt corresponding to that cause will be generated.

Syntax

MS { 0 to 31 }

Description

bit 8	Fixed to 0
bit 7	Service request
bit 6	Error ※1
bit 5	Program end ※2
bit 4	Limit error ※3
bit 3	Syntax error
bit 2	SRQ key ON ※4
bit 1	End of output change ※5

※1 This will be set when an error occurs (at least one of the bits 3, 4, is set to 1).
※2 This will be set when the interval time is reached during program execution.
※3 This will be set when the voltage or current limit is exceeded.
※4 Not present in RS-232C (Fixed to 0).
※5 This will be set until the output becomes stable after the output value is changed, or the range is changed, output is changed from OFF to ON, or when the sweep output ends during program execution.

(22) Setting the Calibration Function (Can be executed only in the calibration mode)

YZPm

Function Selects the calibration point.

Syntax YZP { 0 / to / 3 }

Description

- The relation between the communication command and the calibration points is as follows.

Communication Command	Calibration Point
YZP0	+0 calibration
YZP1	+Full scale calibration
YZP2	−0 calibration
YZP3	−Full scale calibration

- The initial calibration point (YZP0) is selected using this command and the setting is made based on the measured value of the DMM.
- After making the setting, count up using YZPm (for example, change from YZP0 to YZP1) and repeat the setting. When all the settings are completed carry out EEPROM SET.
- The set value is specified using $6\frac{1}{2}$ digits.

YZSm

Function Sets the calibration value. (Done for all ranges with the fixed range mode.)

Syntax YZS {Calibration value ($6\frac{1}{2}$ digits)}

YZW

Function When the setting of all the calibration values in completed, these values will be written in the EEPROM.

Syntax YZW

YZE

Function Cancels the calibration operation.

Syntax YZE

YZO

Function The calibration points of all the ranges will be output. (The four points of +0, −0, +F.S., and −F.S. in each range will be output.)

Syntax YZO

(23) Remote Control Setting

ESC R (For RS-232C only)

Function This commands puts the unit ready for remote control via the RS-232C interface. Once the remote mode is entered, the panel key operations will be ineffective.

Syntax ESC R <Terminator>
*ESC=1BH

(24) local Control Setting

ESC L (For RS-232C only)

Function Puts the Model 7651 in the local control mode from the remote control mode via the RS-232C interface.
The panel key operations will become effective after the local mode is entered into.

Syntax ESC L <Terminator>
*ESC=1BH

(25) Device Clear

ESC C (For RS-232C only)

Function Resets the panel setting information of the unit to those set immediately after power is switched ON.

Syntax ESC C <Terminator>
*ESC=1BH

7. MAINTENANCE AND CALIBRATION

7.1 Maintenance

7.1.1 Storage

Avoid the following types of places for storing this instrument.

- Where the humidity is high.
- Where the temperature is high or direct sunlight is present.
- Near a source of high heat.
- Where the vibration is too strong.
- Where dust, dirt, corrosive gas, or salty atmosphere is present.

When the instrument does not operate properly and requires repair, contact Yokogawa service office or your nearest Yokogawa representative.

The repair work of Yokogawa instruments that are not covered under the warranty and are charged can be done at the repair centers listed at the end of this booklet.

7.1.2 Fuse Replacement

■ **Rear Fuse**

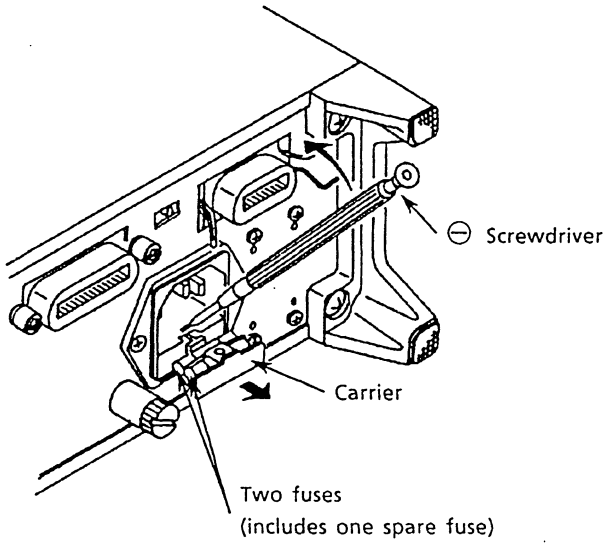


Figure 7.1 Replacing the Fuse

When replacing the fuse, remote the power supply plug from the power supply socket, remove the fuse holder by pushing it out using a small screwdriver, etc., and replace the fuse. The fuse holder has one spare fuse.

7.2 Calibration

To get high performance and precision from the unit at all times, we suggest that the instrument is calibrated every 90 days.

(1) Selecting the Standard Equipment

The standard units used for calibration must be the following equipment or better.

Table 7.1 Standard Equipment for Calibration

Item to Be Calibrated		Maximum Measured Value	Accuracy	Remarks
DC voltage	10mV	12.00000mV	± (40ppm + 1μV)	Use the HP 3458A DMM or equivalent
	100mV	120.0000mV	± (40ppm + 2μV)	
	1V	1.200000V	± (20ppm + 20μV)	
	10V	12.00000V	± (20ppm + 40μV)	
	30V	32.0000V	± (20ppm + 100μV)	
DC current	1mA	1.200000mA	± (40ppm + 0.02μA)	Use the HP 3458A or standard resistor and DMM.
	10mA	12.00000mA	± (40ppm + 0.1μA)	
	100mA	120.0000mA	± (40ppm + 1μA)	

(2) Environmental and Other Conditions during Calibration

- Ambient Temperature : 23±1°C
- Relative Humidity : 45 to 75% RH
- Power Supply Voltag : Rated voltage ±5%
- Power Supply Frequency : Rated frequency ±1Hz
- Vibration : Should be small enough to ignore the effect on the instrument.
- Electric and Magnetic Fields : Should be small enough not to affect the measured value.
- Environment : The presence of corrosive gases, steam, salty atmosphere, dust, etc., should be small enough not to affect the measured value.
- Warm-up : The standard equipment should be warmed up for more than 2 hours and the equipment being calibrated should be warmed up for more than 60 minutes before calibration.
- Load Conditions : The load conditions during calibration must be the following:
  10mV, 100mV range : 100MΩ or more
  1V, 10V, 30V range : 1MΩ or more
  1mA, 10mA range : 1kΩ or less
  100mA range : 100Ω or less

(3) Precautions during Calibration

- Ground the ⏚ terminal during calibration.

(4) Calibration Procedure

The calibration procedure is given below.

* The 0 point and the output set point should both be calibrated in each function and in each range.

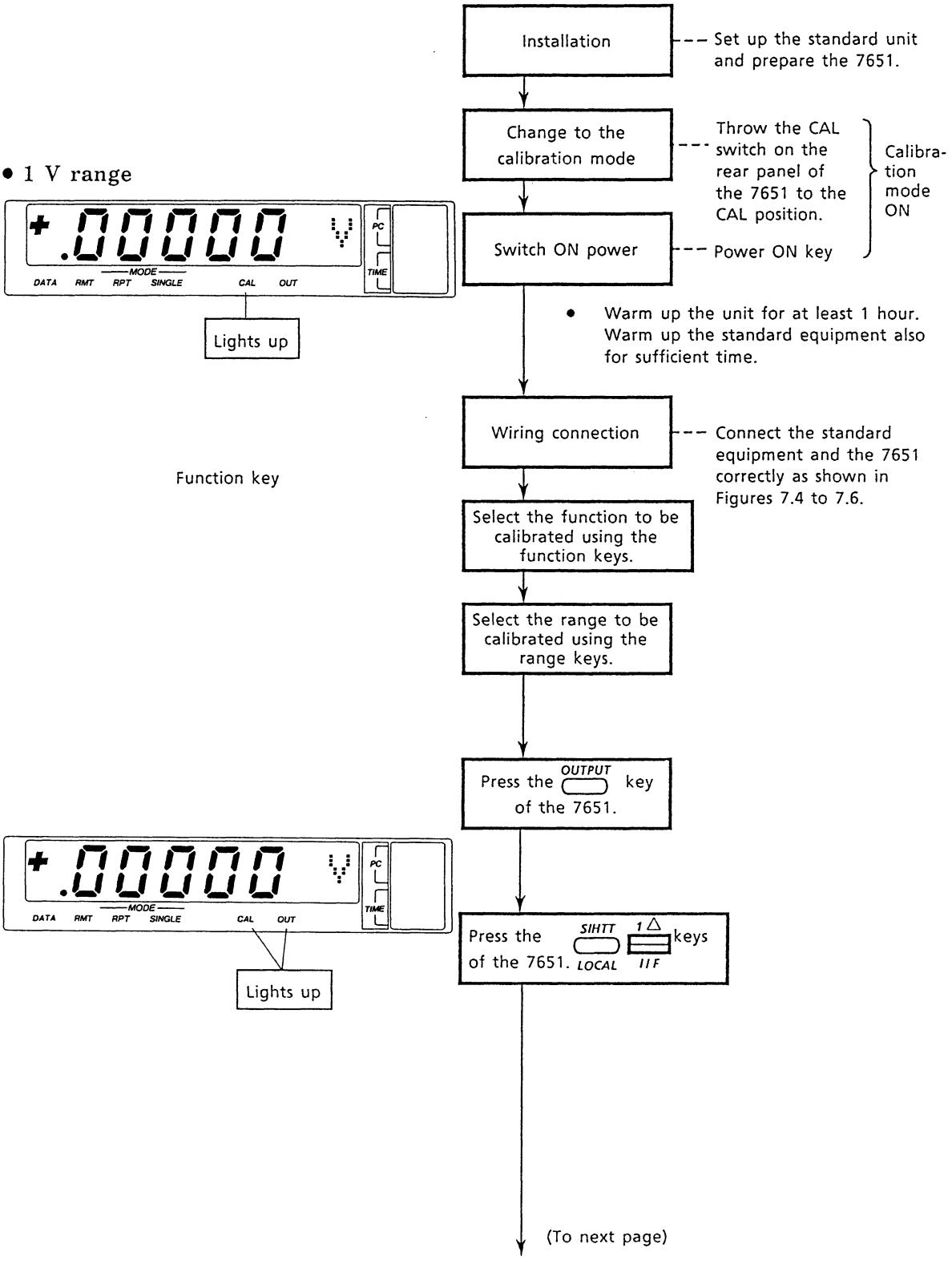


Figure 7.2 Calibration Procedure (1)

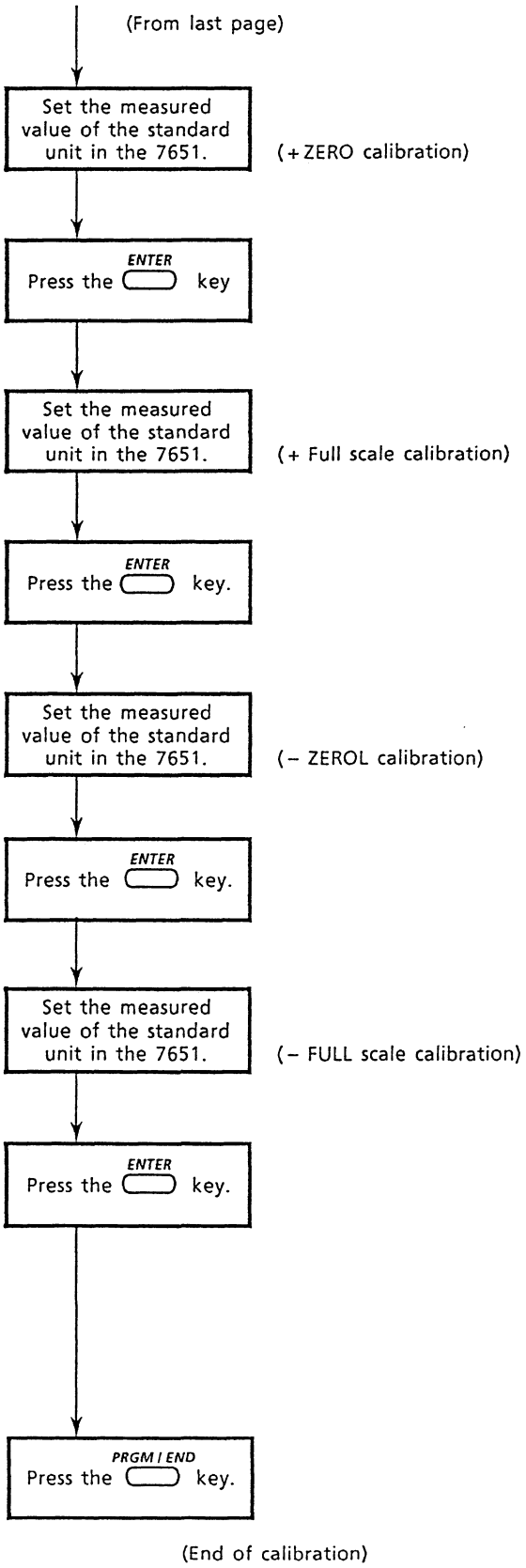


Figure 7.3 Calibration Procedure (2)

(5) Calibration Points

The calibration points in each function and each range are the following.

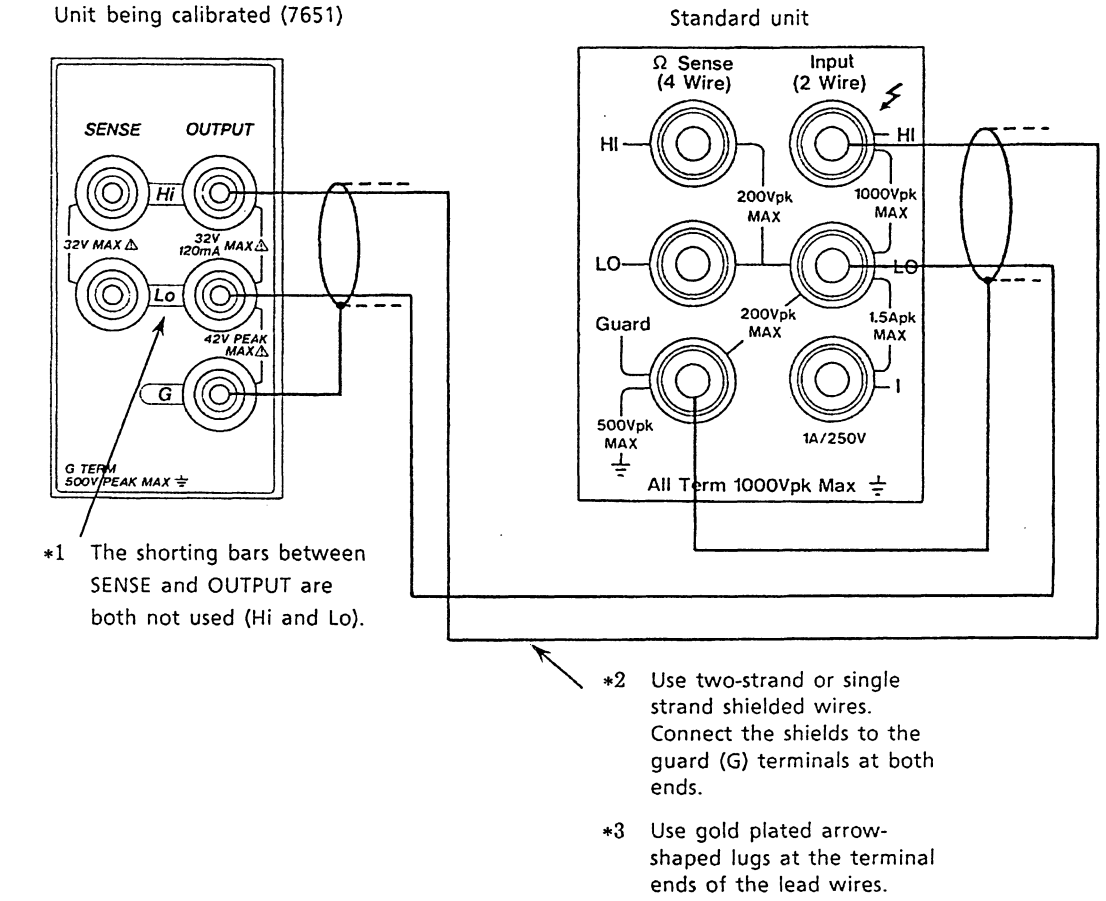
Table 7.2 Calibration Points in Each Range

Function	Range	Calibration Point	Remarks
mV	10mV	+0.0000mV +10.0000mV −0.0000mV −10.0000mV	
	100mV	+00.000mV +100.000mV −00.000mV −100.000mV	
V	1V	+ .00000V +1.00000V − .00000V −1.00000V	
	10V	+0.0000V +10.0000V −0.0000V −10.0000V	
	30V	+00.000V +27.000V −00.000V −27.000V	
mA	1mA	+ .00000mA +1.00000mA − .00000mA −1.00000mA	
	10mA	+0.0000mA +10.0000mA −0.0000mA −10.0000mA	
	100mA	+00.000mA +100.000mA −00.000mA −100.000mA	

(6) Connection Method

The method of connecting the standard unit and the 7651 is described. Note that the connections differ slightly depending on the function and the range.

(a) Function: mV (Ranges: 10/100mV)



In the case of rear panel output models (7651 11/12)

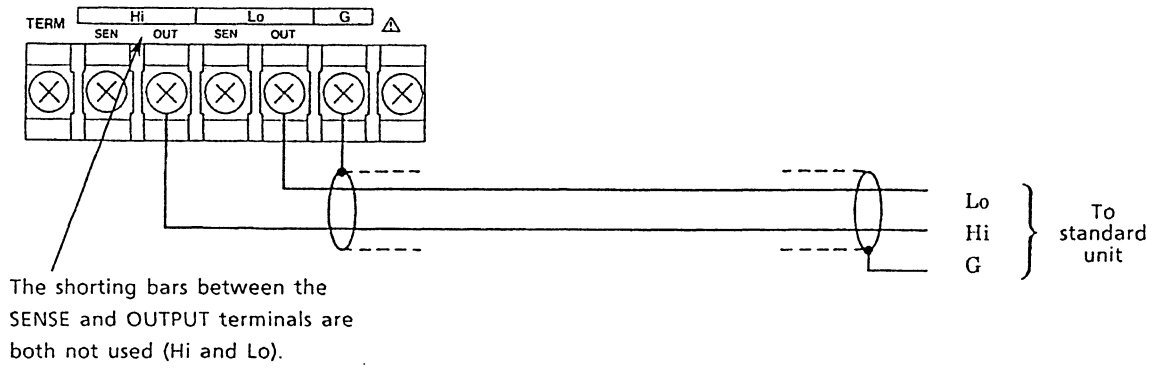
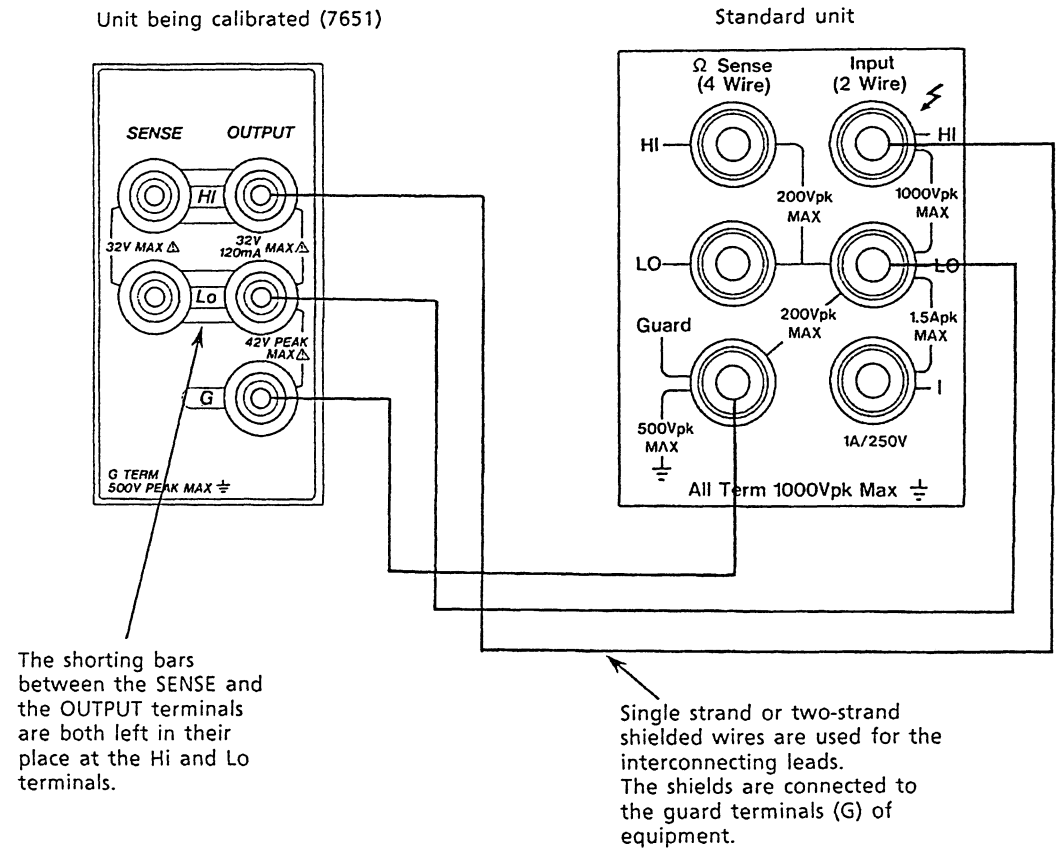


Figure 7.4 Method of Connecting the 7651 and the Standard Unit (1)

(b) Function: V (Ranges: 1/10/30V)



In the case of Models 7651 11/12 with output terminals on the rear panel

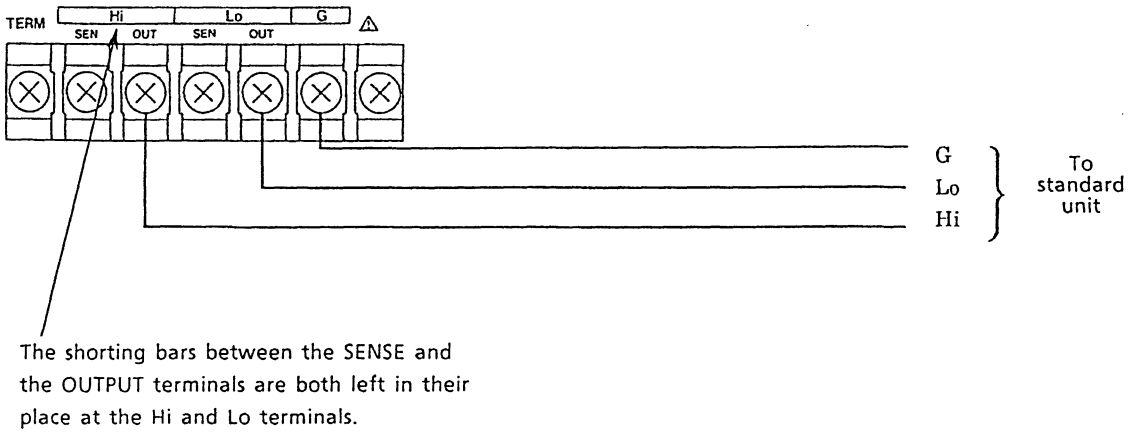
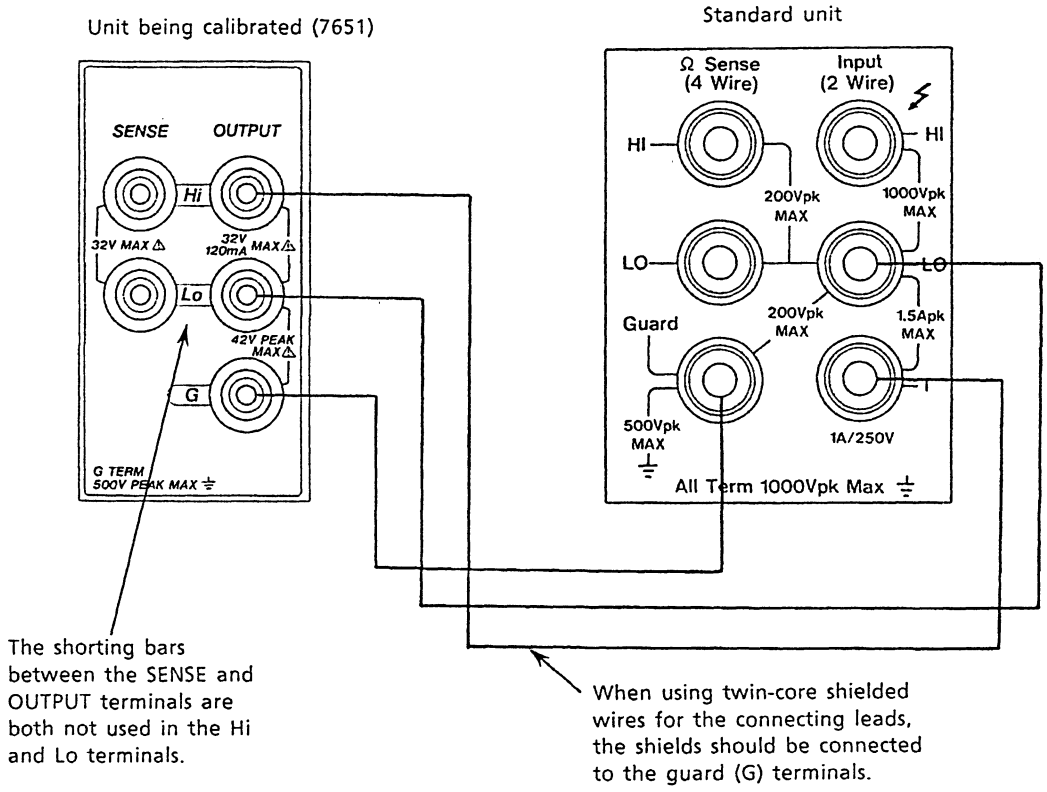


Figure 7.5 Method of Connecting the 7651 and the Standard Unit (2)

(c) Function: mA (Ranges 1/10/100mA)



Method of connecting when using a standard resistor

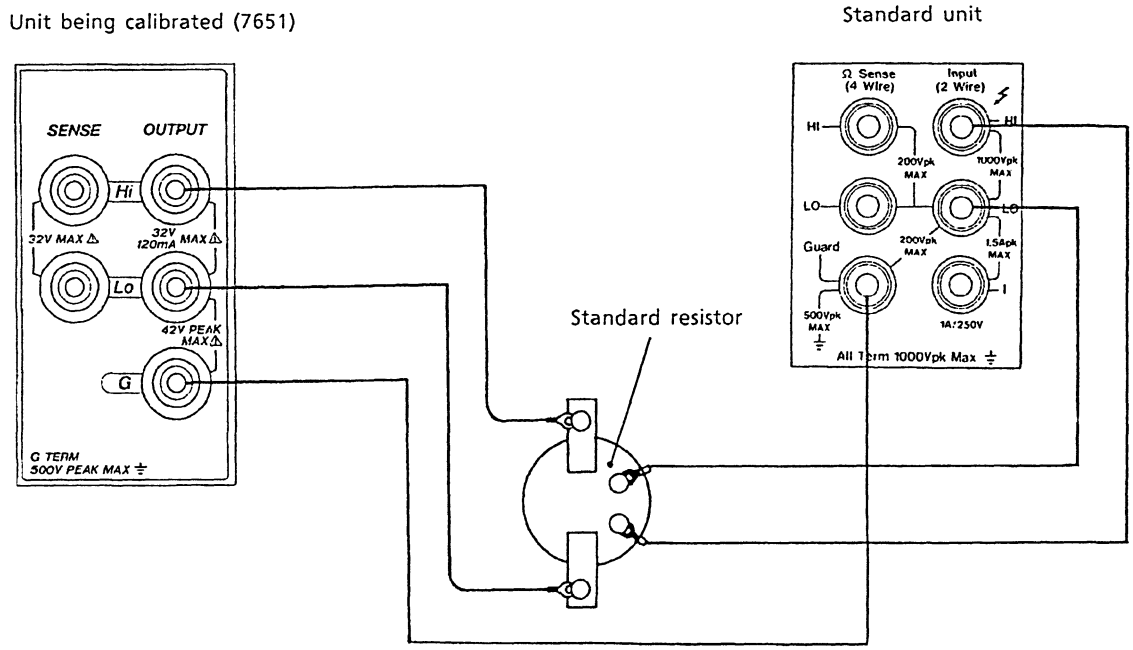


Figure 7.6 Method of Connecting the 7651 and the Standard Unit (3)

8. SPECIFICATIONS

■ DC Voltage

Range	Maximum Output	Resolution	Stability (24h) ±(% of setting +μV)	Accuracy (90 days) ±(% of setting +μV)	Accuracy (90 days) ±(% of setting +μV)	Accuracy (1 year) ±(% of setting +μV)	Temperature Coefficient ±(% of setting +μV)/°C
10mV	±12.0000mV	100nV	0.002+3	0.014+4	0.018+4	0.025+5	0.0018+0.7
100mV	±120.000mV	1μV	0.003+3	0.014+5	0.018+10	0.025+10	0.0018+0.7
1V	±1.20000V	10μV	0.001+10	0.008+50	0.01+100	0.016+120	0.0009+7
10V	±12.0000V	100μV	0.001+20	0.008+100	0.01+200	0.016+240	0.0008+10
30V	±32.000V	1mV	0.001+50	0.008+200	0.01+500	0.016+600	0.0008+30

The 24h stability is the value at 23±1°C.
The 90 days stability, the 90 days accuracy, and the 1 year accuracy are values at 23±5°C
The temperature coefficients are values at 5 to 18°C, 28 to 40°C.

Range	Maximum Output Current	Output Resistance	Output Noise	
			DC to 10Hz	DC to 10kHz (Typical data)
10mV	—	Approx. 2Ω	3μ Vp-p	30μ Vp-p
100mV	—	Approx. 2Ω	5μ Vp-p	30μ Vp-p
1V	±120mA	2mΩ or less	15μ Vp-p	60μ Vp-p
10V	±120mA	2mΩ or less	50μ Vp-p	100μ Vp-p
30V	±120mA	2mΩ or less	150μ Vp-p	200μ Vp-p

Common mode rejection ratio: 120dB or more (except for 30V range. DC, 50/60Hz)
100dB or more (30V range. DC, 50/60Hz)

■ DC Current

Range	Maximum Output	Resolution	Stability (24h) ±(% of setting +μA)	Accuracy (90 days) ±(% of setting +μA)	Accuracy (90 days) ±(% of setting +μA)	Accuracy (1 year) ±(% of setting +μA)	Temperature Coefficient ±(% of setting +μA)/°C
1mA	±1.20000mA	10nA	0.0015+0.03	0.016+0.1	0.02+0.1	0.03+0.1	0.0015+0.01
10mA	±12.0000mA	100nA	0.0015+0.3	0.016+0.5	0.02+0.5	0.03+0.5	0.0015+0.1
100mA	±120.000mA	1μA	0.004+3	0.016+5	0.02+5	0.03+5	0.002+1

The 24h stability is the value at 23±1°C.
The 90 days stability, the 90 days accuracy, and the 1 year accuracy are values at 23±5°C
The temperature coefficients are values at 5 to 18°C, 28 to 40°C.

Range	Maximum Output Current	Output Resistance	Output Noise	
			DC to 10Hz	DC to 10kHz (Typical data)
1mA	±30V	100MΩ or more	0.02μ Ap-p	0.1μ Ap-p
10mA	±30V	100MΩ or more	0.2μ Ap-p	0.3μ Ap-p
100mA	±30V	10MΩ or more	2μ Ap-p	3μ Ap-p

Common mode rejection ratio: 100nA/V or more (DC, 50/60 Hz)

● Response Times

Setting delay times : About 10ms ··· When the setting value is changed within the same range.

Response time : 10ms or less ... From the beginning of change till the output reaches to within ±0.1% of the final value for the maximum output and maximum load in each range, provided the load is purely resistive and the limiter does not operate.

● Limiter

	Setting Range	Setting Resolution	Remarks
Current limiter	5 to 120mA	1mA	During voltage output
Voltage limiter	1 to 30V	1V	During current output

The limited condition will be automatically released when the overload condition is removed after limiter operation.

● Data Setting

- Continuously variable mode (each digit can be set using up/down keys)
- Data mode (Direct numerical value can be input using the ten keys)

● Communication Functions

- GP-IB or RS-232C is standard feature
- GP-IB interface

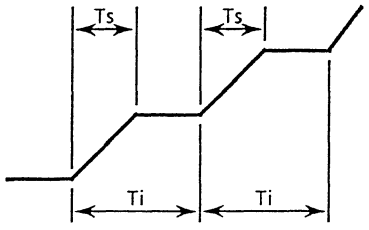
  Electrical specifications : Conform to IEEE Std 488-1978
  Mechanical specificatoins : Conform to IEEE Std 488-1978
  Functional specifications : SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, C0
  Address setting and header ON/OFF control possible
- RS-232C interface

  Data transfer mode : Start-stop synchronization
  Baud rate : 75, 150, 300, 600, 1200, 2400, 4800, 9600bps
  The setting of the handshake mode, baud rate, number bits in the data word, parity, etc. can be set.

● Program Functions

- Built in memory : Upto 40 steps can be set.
- IC memory card : Upto 7 patterns of a maximum of 50-steps of programs each can be stored.
  (IC memory card: 8K bytes capacity, optional)
- Program starting by external trigger is possible.
- Interval and sweep times can be set for each pattern as follows.

	Setting Range	Resolution
Interval time (Ti)	0.1s to 1h	0.1s
Sweep time (Ts)	0 to 1h	0.1s



- Execution modes SINGLE ..... The programmed pattern is executed only once.
  REPEAT ..... The programmed pattern is executed repeatedly.

● External Trigger

- Step execution of the program is possible under external trigger.
- Has the output ready output which is suitable for integration of the instrument in a system.

■ General Specifications

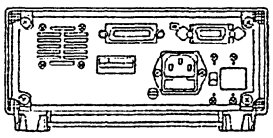
Operating method	:	Multiplying dual D-A conversion method
Output setting	:	±120000 (setting range), ±32000 for 30V range only Continuously variable mode Data mode
Numeric display	:	7-segment LED
Unit display	:	5×7 dot-matrix LED, mV / V / mA
Overload display	:	Displayed as " − oL − "
Maximum permissible applied voltage	:	Between Hi and Lo terminals : 32V / 120mA Between Lo and G : 42V peak Between G and case : 500V peak
Operating temperature range	:	5 to 40°C, 20 to 80%RH
Warm up time	:	About 60 minutes
Power supply voltage	:	100 / 115V AC +10%, 50 / 60Hz (Switch selectable) * Units can be supplied on request supply voltages of 200 / 230V
Power consumption	:	About 30VA
External dimensions	:	About 88 (H)×213 (W)×350 (D) mm
Weight	:	3.6kg approx.
Standard accessories	:	Power supply cord-1, fuses (315mA time lag type)-2, Remote connector-1, Instruction manual-1

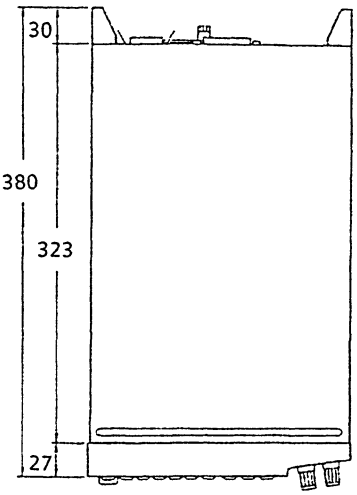
8.1 External Dimensions Diagram

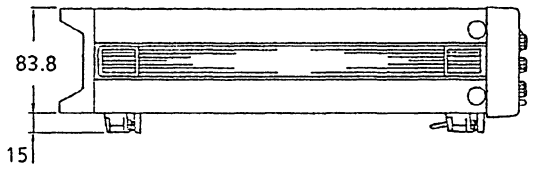
Model 7651 01 / 7651 02

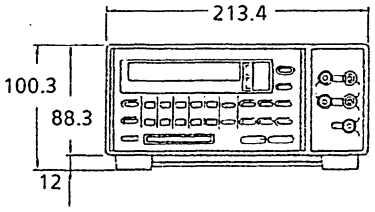
Unit : mm

Rear View



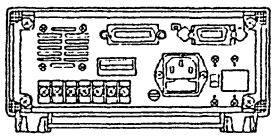


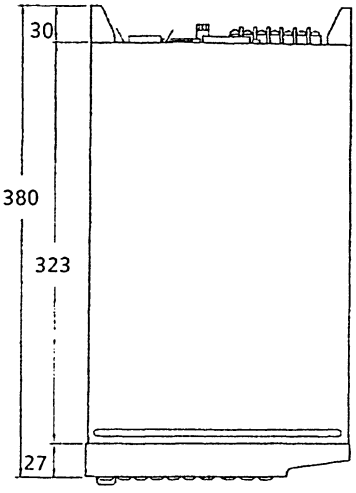


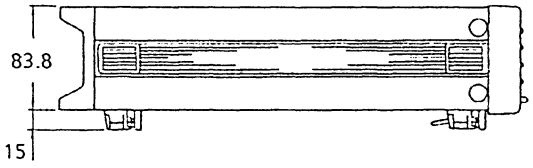


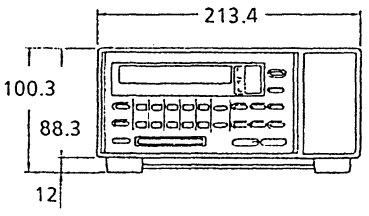
Model 7652 11 / 7651 12

Rear View







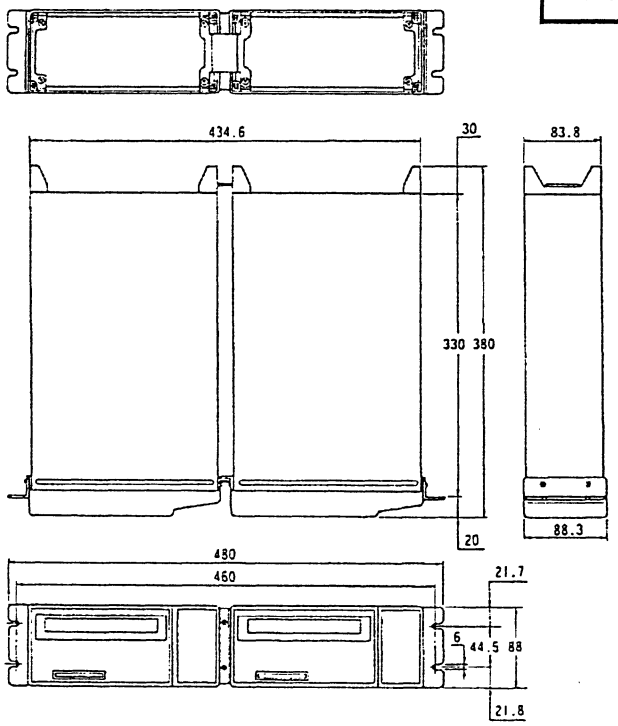


EIA Rack Mounting Type

Model No.	Item Name	Specifications
751501	Kit for rack mounting	EIA single mounting
751502	Kit for rack mounting	EIA double mounting

Unit: mm

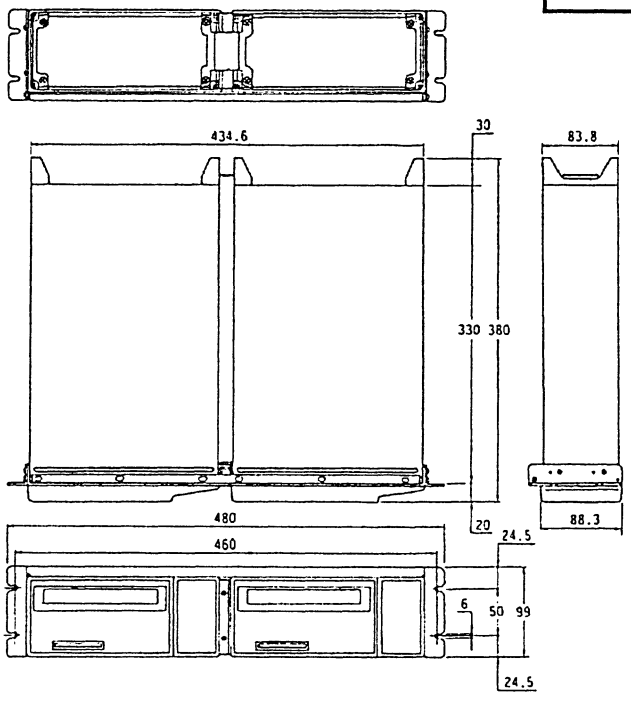
For EIA double mounting



JIS Rack Mounting Type

Model No.	Item Name	Specifications
751503	Kit for rack mounting	For JIS single mounting
751504	Kit for rack mounting	For JIS double mounting

For JIS double mounting



8.2 Accessories (Optional)

Accessories

Name	Model No./Part No.	Specifications	Q'ty for sale
IC memory card	3789 01	8K bytes (50 steps×7 patterns)	1
Dummy card for the memory card slot	B9586NG	Dust proofing cover	2
Shielded measurement leads	B9409LA	0.8m with crocodile chips	1
Kit for rack mounting	7515 01	For EIA single mounting (Generator 1 unit)	1
Kit for rack mounting	7515 02	For EIA double mounting (Generator 2 units)	1
Kit for rack mounting	7515 03	For JIS single mounting (Generator 1 unit)	1
Kit for rack mounting	7515 04	For JIS double mounting (Generator 2 units)	1

Recommended Communication Cables

Name	Model No./part No.	Specifications
GP-IB cable	10833A (YHP)	1m
GP-IB cable	10833B (YHP)	2m
GP-IB cable	10833C (YHP)	4m
GP-IB cable	10833D (YHP)	0.5m
RS-232C cable	B9801LB	For connecting to PC-9801

APPENDIX

Appendix 1 List of Set Values

Table A.1 lists the initial values at the time of shipment from the factory, at POWER ON, and upon initialization.

Table A.1 List of Initial Values of Each Set Values

Item	Data that is retained even after switching OFF power. (Only items set from the panel)	Initial value immediately after switching ON power and initialization	Remarks
Calibration data	○		
GP-IB address	○		
RS-232C mode	○		
Initialization menu		RC	Initialization of 7651 main unit
Voltage limit value		30 V	
Current limit value		120 mA	
Interval time		0.1 s	
Sweep time		0.0 s	Step waveform output
Program execution mode		RPT	Repeat mode
Function/range		1 V	
Output data		0.0000	
OUTPUT		OFF	
PC		01	Program counter
Status byte mask value		0	

Appendix 2 List of Error Messages

Table A.2 List of Error Messages

Error No.	Error Description	Error Cause
1	Command error	Error in the communication command received
2	Parameter error	The parameter input value is out of range.
5	Program execution error	A program execution was attempted even though no program has been registered.
6	<GET> Error	During program execution, etc., a <GET> or E trigger was issued at illegal timings.
7	UP/DOWN limit error	The upper or lower limits were exceeded by the UP/DOWN commands.
10	OUTPUT ON error	The output was made ON during the data mode, the menu setting mode, or the program setting mode.
11	Current/voltage limit setting error	An attempt was made to set the voltage limit in the voltage function mode or the current limit in the current function mode.
22	EEPROM error	The contents of the EEPROM (calibration or communication setting data) were destroyed.
31	The IC memory card has not been initialized.	The IC memory card must be initialized before use.
32	There is no file in the IC memory card.	There is no file that can be read in the IC memory card.
33	Insufficient memory	The memory space in the IC memory card is not sufficient for saving data.
34	No IC memory card	The IC memory card has not been inserted into the card slot.
35	The IC memory card cannot be initialized.	The IC memory card cannot be formatted (the IC memory card is faulty).
36	IC memory card error	The card was inserted when the memory card is being processed.
37	IC memory card battery error	Battery back up error (or there is no battery in the IC memory card).
39	No file in the 7651	This indicates that a memory card of some other instrument type was inserted and a file loading was attempted although the card is of the Yokogawa format.
40	Calibration error	The set value during calibration is out of range.

Appendix 3 Figures List

Table A.3 Figures List (1/2)

Table A.3 Figures List (2/2)

Appendix 4 Tables List

Table A.4 Table List (1/2)

Table A.4 Table List (2/2)