ADVANTEST®

ADVANTEST CORPORATION

INSTRUCTION

MANUAL

TR6871

DIGITAL MULTI-METER

MANUAL NUMBER OED03 9211

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Safety Summary

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

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

- **Warning Labels**

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

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

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

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

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

- **Basic Precautions**

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

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

product.

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

- **Caution Symbols Used Within this Manual**

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

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

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

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

- **Safety Marks on the Product**

The following safety marks can be found on ADC products.

 : ATTENTION - Refer to manual.

 : Protective ground (earth) terminal.

 : DANGER - High voltage.

 : CAUTION - Risk of electric shock.

- **Replacing Parts with Limited Life**

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

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

Main Parts with Limited Life

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

- **Hard Disk Mounted Products**

The operational warnings are listed below.

- Do not move, shock and vibrate the product while the power is turned on.
  Reading or writing data in the hard disk unit is performed with the memory disk turning at a high speed. It is a very delicate process.
- Store and operate the products under the following environmental conditions.
  An area with no sudden temperature changes.
  An area away from shock or vibrations.
  An area free from moisture, dirt, or dust.
  An area away from magnets or an instrument which generates a magnetic field.
- Make back-ups of important data.
  The data stored in the disk may become damaged if the product is mishandled. The hard disc has a limited life span which depends on the operational conditions. Note that there is no guarantee for any loss of data.

- **Precautions when Disposing of this Instrument**

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

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

Example: fluorescent tubes, batteries

Environmental Conditions

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

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

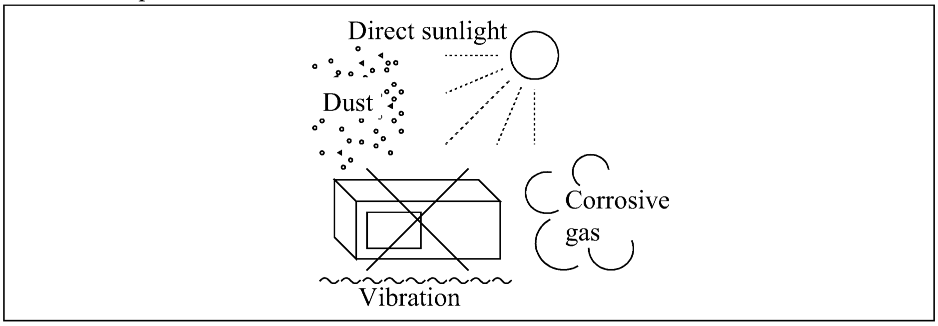
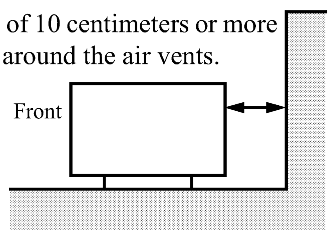


Figure-1 Environmental Conditions

- Operating position

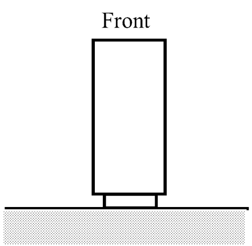
A clear space of 10 centimeters or more must be kept around the air vents.



The instrument must be used in a horizontal position.
To prevent the internal temperature from rising, cooling fans are installed in some instruments.
The air vents on the case must be unblocked.

Figure-2 Operating Position

- Storage position



This instrument should be stored in a horizontal position.
When placed in a vertical (upright) position for storage or transportation, ensure the instrument is stable and secure.

-Ensure the instrument is stable.
-Pay special attention not to fall.

Figure-3 Storage Position

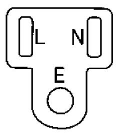
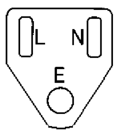
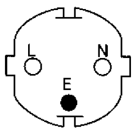
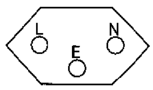
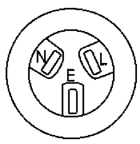
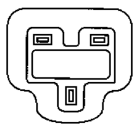
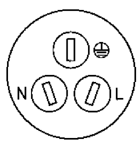
- The classification of the transient over-voltage, which exists typically in the main power supply, and the pollution degree is defined by IEC61010-1 and described below.

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

  Pollution Degree 2

Types of Power Cable

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

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

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1. BEFORE POWER ON

1.1 How to Use This Manual

This manual is intended to be used by the user who is familiar with electronic measuring devices. Figure 1 - 1 shows the basic configuration of this manual.
The user who uses a digital multimeter should read the manual from its beginning.
An experienced user is enough to read Section 2.1 of panel layout and Section 2.3 of measurement flowchart of Chapter 2.

Introduction to TR6871 (Section 1.2)
Prerequistits (Section 1.3)

Basic System Operations (Chapter 2)
Panel layout (Section 2.1)
Preparation before measurement
(Sections 2.2 to 2.7)
Measurement parameter setup (Section 2.8)

Calculation functions (Section 3.1)
Data memory function (Section 3.2)

GPIB (Chapter 4)

Plug-in Accessory Operations (Chapter 5)
TR13010 binary output unit (Section 5.1)
TR13011 BCD output unit (Section 5.2)
TR13013 relay output unit (Section 5.3)

Inspection, Calibration and
Maintenance (Chapter 6)

Performance and Specifications
(Chapter 7)

Operating Principles (Chapter 8)

Terms and Definitions (Section A.1)

Figure 1 - 1 Manual Configuration

1.2 Introduction to TR6871

The TR6871 digital multimeter provides the highly flexible measuring functions of five types of parameters: DC voltage, AC voltage (true rms), DC current, AC current, and resistance. The multimeter has two slots for module insertion. The measurement functions and measurement range can be expanded by simply adding optional modules.

Up to 2,000 times per second of high-speed sampling has been realized based on the advanced A/D conversion technologies. Typical applications are high-speed data acquisition and measurement with the automatic test equipment.

In addition, the TR6871 provides the digital memory function (allowing up to 10,000 data sets to be stored) with high-speed data sampling, pre-trigger functions allowing high-speed and individual event triggering, NULL function for easy offset calibration, digital smoothing functions, powerful arithmetic calculation for measurement data processing. The integration time, measurement cycle, and trigger delay time can be set for flexible measurement in various applications. The measurement reliability has greatly been enhanced through self-diagnostic functions and software calibration.

The TR6871 provides the standard full-remote control functions, analog output, trigger input, measurement end signal output via the GPIB. Optional accessories are: TR13010 binary data output unit, TR13011 BCD data output unit, and TR13013 relay output unit. These options allow an interface with other devices, recording of data on an analog recorder, and other applications in both the laboratories and factories.

The following summarizes features of the multimeter.

- High-precision DC voltage and resistance measurement with 6 1/2-digit display (up to 1999999) in 0.5 ppm resolution and overrange measurement of up to 7 1/2-digit display (up to 19999999)

- High-precision DC current measurement with 5 1/2-digit display in 5 ppm resolution and overrange measurement of up to 6 1/2-digit display

- High-speed data sampling (up to 2,000 times/sec in 4 1/2-digit measurement)

- Easy change of integration time setup (9 types of setup) and highly reliable measurement against noise

- Flexible module architecture allowing up to 2 optional modules to be attached for satisfying various application requirements

- Expandable measuring range

- Data memory function (for storage of up to 10,000 data) and pre and delay triggering functions

- Null function allowing one-touch offset correction

- Digital smoothing functions provided

- Software calibration allowing very easy calibration

- Panel-compatible GPIB interface, trigger input, and measurement end signal output terminals are included as standard.

- A/D converter output terminal is also provided as standard for to allow monitoring by using analog signals.

- Powerful arithmetic operation functions are also provided for dB, dBm, rms, statistic processing, and wire resistance temperature correction (20°C)

1.3 Before Use

1.3.1 Check of Attachments

Upon receipt of this equipment, run checks thereon as shown below.

① Run visual checks against any and all damages or imperfections.

② Check the guantity and rating of standard accessories to assure their conformance with Table 1-1.

Should there be any flaw, or damage, or missing or imsufficient part, contact the nearest dealer or the sales and support offices.

Request to User: When ordering add-on Attachments and the like, be good enough to stipulate the model (or stock) No. concerned.

Table 1 - 1 Standard TR6871 Attachments

Accessory	Model #	Stock No.	Q'ty	Remark
Power cable	A01412	DCB-DD3130X01	1	
Input signal cable	MI-37	DCB-MM0412-1	1	For voltage, current, and 2-wired cable resistance measurement
	A01005A	AAA-A01005A	1	For 4-wired cable resistance measurement
Power fuse	Slow blow fuse 0.6A (313.600)	DFT-AGR6A-2	2	For 100/120 VAC
	Slow blow fuse 0.3A (MDL-0.3A)	DFT-AHR3A-1		For 220/240 VAC
Protective fuse	Slow blow fuse 2A (EAWK2A)	DFT-AA2A-1	2	For DC/AC current protection during measurement Slow blow fuse 2A
Instruction manual	——	ETR6871	1	

1.3.2 Ambient Conditions

Use the multimeter in the temperature of 0°C to +40°C and relative humidity of 85% or less (70% RH or less in the 10MΩ range).
Avoid using the multimeter in the excessive dust, direct sun light, or corrosive gas. Also protect the multimeter from excessive vibration or mechanical shock.

1.3.3 Power Supply and Fuses

(1) Power Supply

The source voltage of either 100VAC (covering 120 or 220VAC) ±10% or 240VAC (covering 207 to 250VAC) can be used by setting the power connector card.

Make sure that the source voltage matches the number identified at the left-hand side of the card.

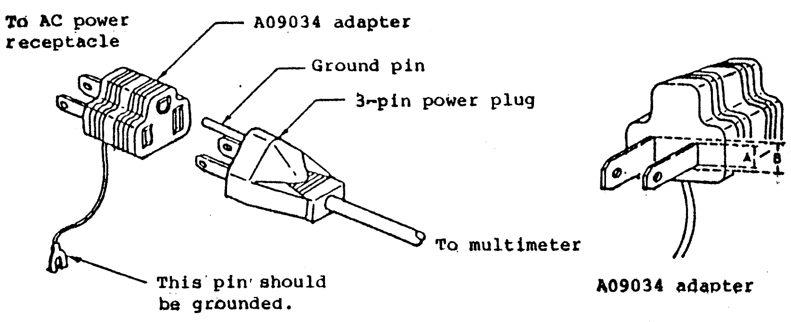
Plug the power cable only when the POWER switch is turned off.

(2) Power Cable

To prevent any possible electrical shock, always ground the multimeter if it is powered by the commercial power supply. The power cable plug has 3 pins. The center round pin should be grounded. When using the A09034 adapter of accessory kit, ground the adapter ground pin (see Figure 2 - 1 (a)) or rear panel GND terminal.

Use the A09034 adapter or equivalent that meets the applicable electric appliances safety regulations and standards.

The adapter has 2 pins whose width differs from each other. Plug the adapter into receptacle in the correct direction. Use the KPR-13 optional adapter if necessary.



(a) (b)

Figure 1 - 2 Power Cable Plug and Adapter

(3) Frequency

The line frequency should be 50 or 60Hz.

For the power frequency setup, see Subsection 2.8.18 "Line frequency".

(4) Fuse Replacement and Modification of Source Voltage

CAUTION

Before replacing a fuse, always unplug the power cable from the receptacle.

The power fuse is mounted in the power connector on the multimeter rear panel. When replacing the fuse, unplug the power cable from the multimeter power connector and slide the plastic cover of the fuse box (located at the right to the power connector) to the left. Pull out the FUSE PULL lever, and the fuse can be removed.

Replace the blown fuse with a new one that meets the fuse capacity standards (see Table 1 - 2).

Table 1 - 2 Fuse Capacity Standards

Card Setup Voltage	Fuse Capacity
100VAC	0.6A
120VAC	0.6A
220VAC	0.3A
240VAC	0.3A

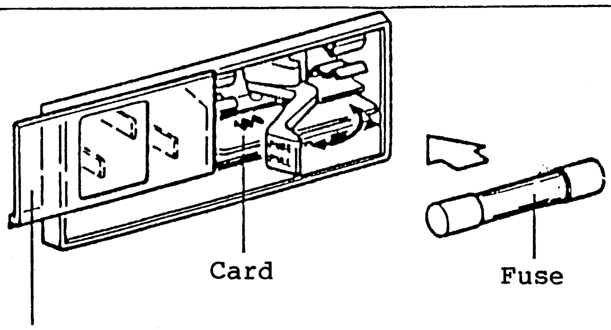


Figure 1 - 3 Replacement of Power Fuse

When using the multimeter at the power voltage different from the card setup, the new voltage should be set on the power card located below the fuse (see Figure 1 - 3).

When the fuse is removed, the power card indicating the setup voltage (100, 120, 220, or 240VAC) can be accessed below the FUSE PULL lever. Carefully pull out this card, change the card direction so that the desired power voltage mark faces upward and locates at the left side, and insert the card into the slot. Now, the multimeter can operate at the power voltage indicated by the card.

(5) Preheating Time

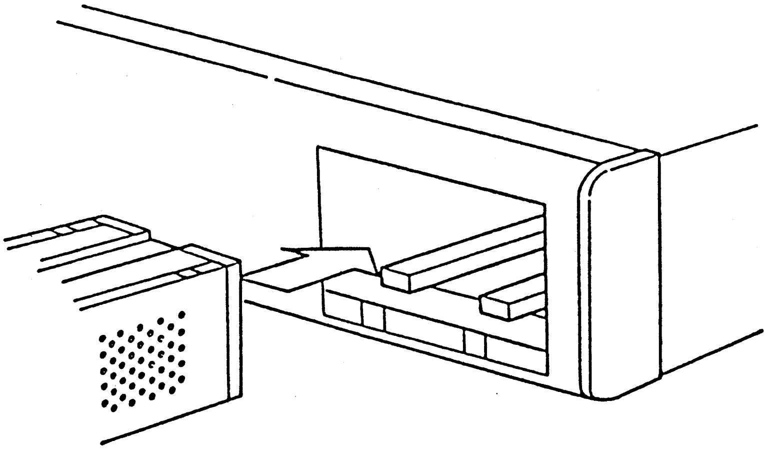
All multimeter measurement functions can be used just when the power supply is turned on. However, to obtain the measurement performance satisfying the certain accuracy, preheat the multimeter 60 minutes or more.

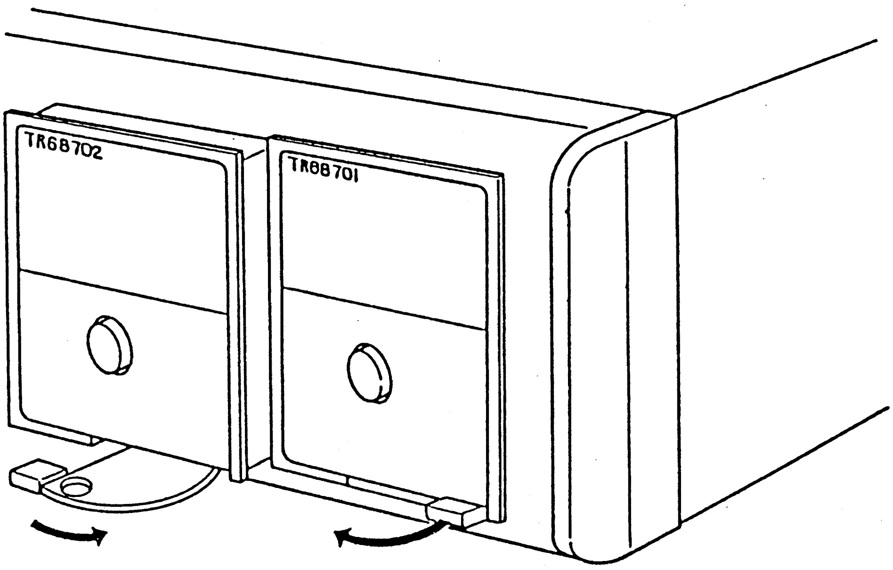
1.3.4 Module Mounting Procedure

(1) Remove the blind panel from the multimeter rear panel.

(2) Carefully insert the module along the rails mounted inside the multimeter.

(3) When the module stops sliding, rotate the lever located at the bottom of the module in the arrow direction shown below, and insert the lever into position.





Rotate the lever in the arrow direction.

Pull out the lever.

Insert

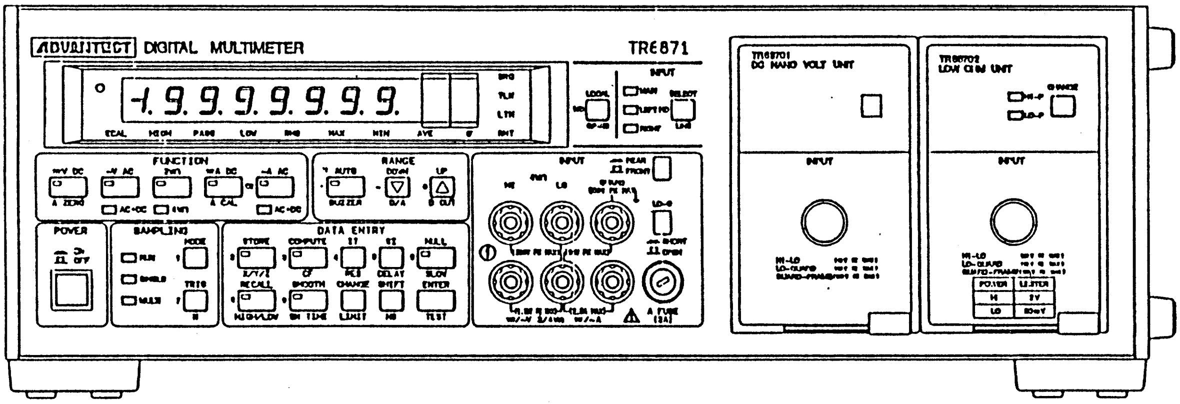
Remove

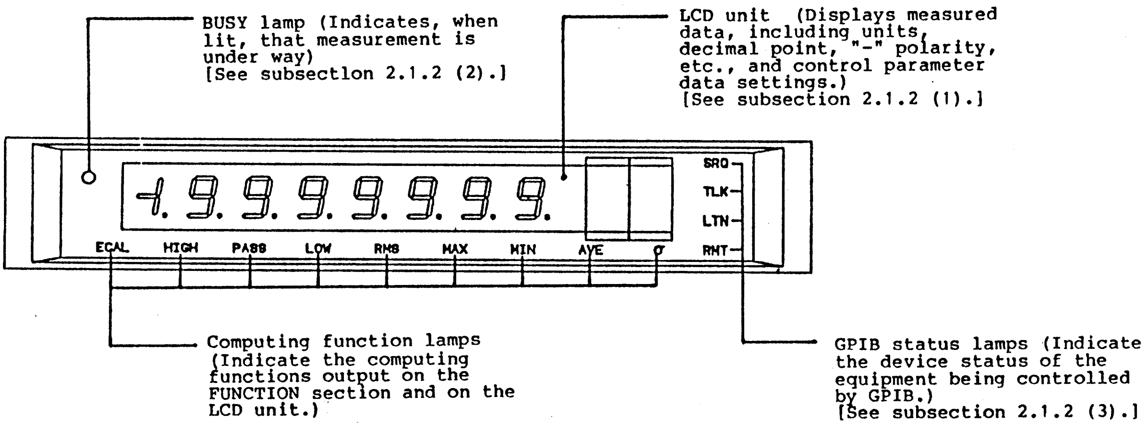
(1) Pull out the lever at the bottom of the module and carefully remove the module from the multimeter.

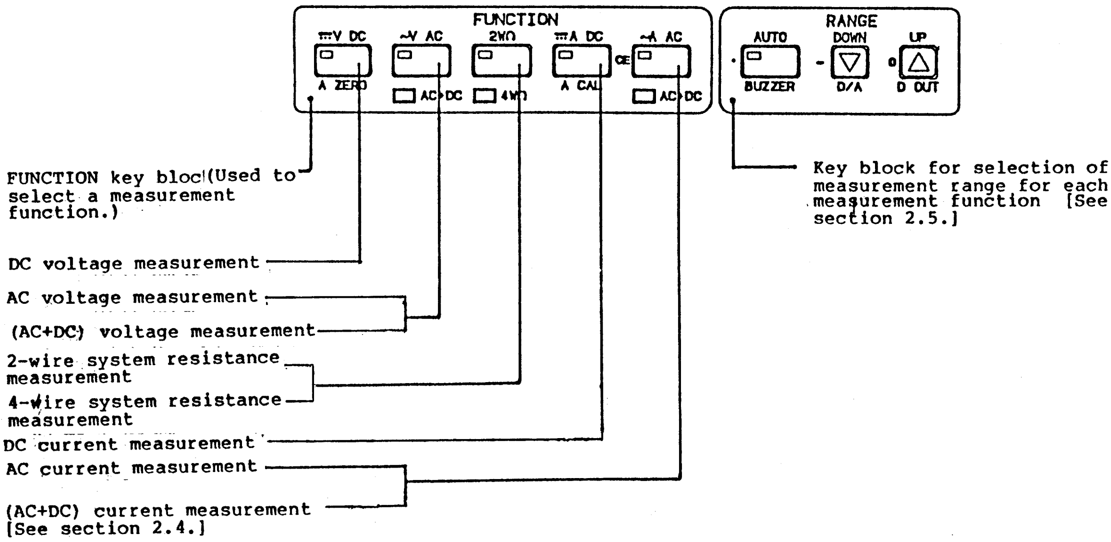
2. OPERATION METHOD - 1 (PARAMETER SETTING)

2.1 Description of Panel Functions

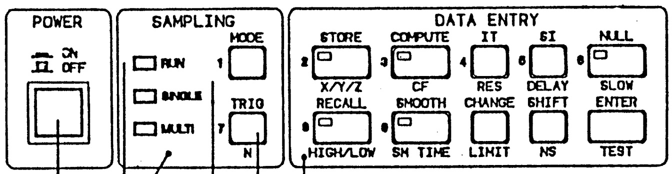
(1) Front Panel







2.1 Description of Panel Functions



Power switch

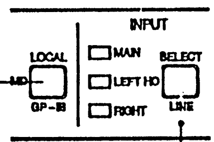
Sampling mode key/lamp block

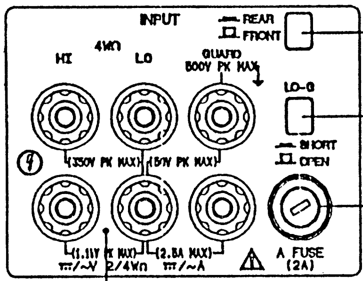
Sampling mode indicator lamps

Sampling mode (RUN, SINGLE, and MULTI) selector keys

Trigger signal input key

Parameter setting key block [See section 2.8.]





REMOTE status release key [See subsection 2.1.1 (4).]

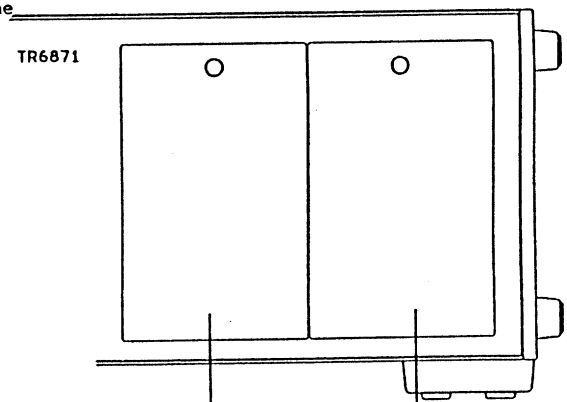
Input terminal block [See subsection 2.1.1 (7).]

Selector key for FRONT or REAR input terminals [See subsection 2.1.1 (5).]

Key used to specify whether or not the FRONT or REAR input terminals LO and GUARD are to be short-circuited [See subsection 2.1.1 (6).]

Overload protection fuse (2A) for AC/DC current measurement

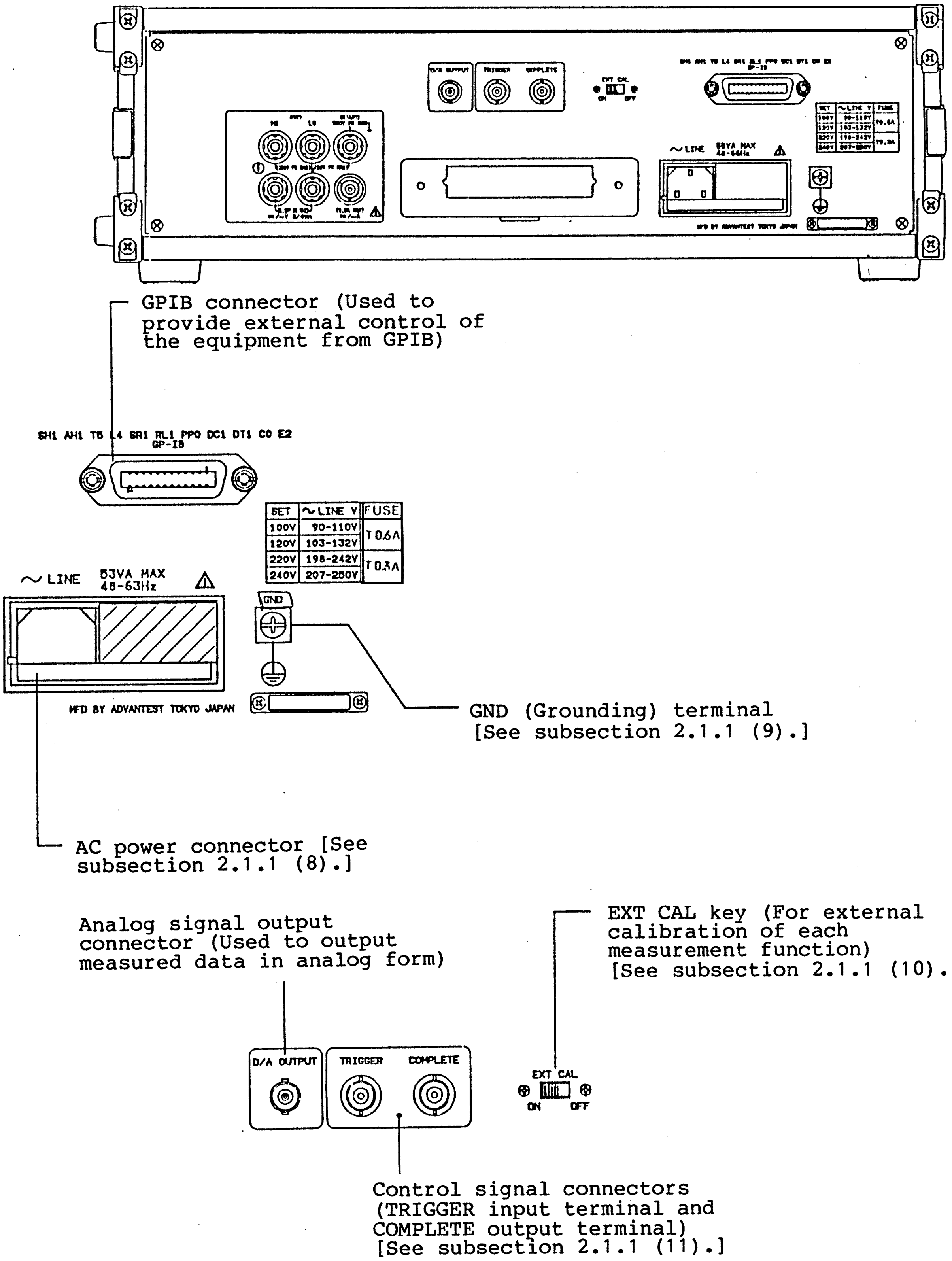
Key/lamp block for input terminals located in the left/right module of the equipment

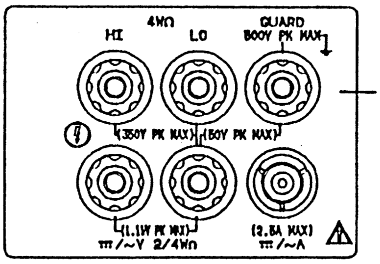


Module storage box (Left)

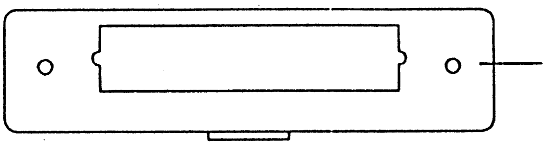
Module storage box (Right)

(2) Rear Panel


GPIB connector (Used to provide external control of the equipment from GPIB)
SH1 AH1 T6 L4 SR1 RL1 PP0 DC1 DT1 C0 E2
GP-IB
SET
~LINE V
FUSE
100V 90-110V
120V 103-132V
T0.6A
220V 198-242V
240V 207-250V
T0.3A
~ LINE 53VA MAX 48-63Hz
GND
MFD BY ADVANTEST TOKYO JAPAN
GND (Grounding) terminal [See subsection 2.1.1 (9).]
AC power connector [See subsection 2.1.1 (8).]
Analog signal output connector (Used to output measured data in analog form)
EXT CAL key (For external calibration of each measurement function) [See subsection 2.1.1 (10).]
D/A OUTPUT
TRIGGER
COMPLETE
EXT CAL
ON
OFF
Control signal connectors (TRIGGER input terminal and COMPLETE output terminal) [See subsection 2.1.1 (11).]



REAR input terminals (Rear panel input terminals for DC, AC, or AC+DC current/voltage measurement)



Accessory space (For connection of TR13010 binary output unit, TR13011 BCD output unit, and TR13013 relay output unit)

Note : Be sure to leave the accessory cover mounted when no accessories are in use.

CAUTION

For current measurement, use only one of the FRONT and REAR sets of input terminals.
Current measurement is possible only when the INPUT key is set to the FRONT position, irrespective of whether the input terminal block on the front panel is being used or that on the rear panel is being used.

2.1.1 Supplementary Description of Panel Functions

[Front Panel]

(1) LCD Unit

The LCD (liquid-crystal display) section displays measured data (including the units of measurement, the decimal point. and "-" polarity) and control parameter data settings.
Data is displayed in ten digits: the first eight digits are provided by a 7-segment LCD, and the remaining two digits are provided by an LCD of a 5x7 dot matrix. The maximum data that can be displayed is "19999999" (7 1/2-digit display).
Of the first eight digits, the least significant digit becomes blank during 6 1/2-digit display, the low-order two digits become blank during 5 1/2-digit display, and the low-order three digits become blank during 4 1/2-digit display.
If an excessive load (overcurrent or overvoltage) is applied, then the message "OL" (overload) is displayed. The decimal point is also displayed at this time to allow easy identification of the measurement range being used during an overload.

(2) BUSY Lamp

This lamp, which indicates that measurement is under way, lights up during measurement or during output of recall data.

(3) GPIB Status Lamps

These lamps indicate the device status of the equipment when it is placed under the control of GPIB.
The SRQ lamp lights up when the equipment transmits a service request signal to the controller.
The TLK lamp lights up when the equipment enters a talker status in which data can be transmitted from the equipment.
The LTN lamp lights up when the equipment enters a listener status in which data can be received by the equipment.
The RMT lamp lights up when remote control is provided to the equipment.
When the RMT lamp is lit, all panel keys are inoperative with the exception of the LOCAL key.

(4) LOCAL Key

The LOCAL switch is used to release the remote-controlled status of the equipment (RMT lamp lit), thus allowing control of the equipment from the front panel.

Note : The remote-controlled status cannot be released if the "LLO" (Local Lockout) command is set using the GPIB.

(5) INPUT Key (Selector Key for Input Terminal Block)

This key is used to select input terminals. It is possible with this key to select which of the two types of input terminals (FRONT and REAR) is to be used for each measurement.
Pressing the key allows REAR input, and re-pressing the key allows FRONT input.

(6) LO-G SHORT Key

This key is used to short-circuit the LO and GUARD terminals of the FRONT or REAR input terminals selected with the INPUT key.
Pressing the key causes short-circuiting of the above two terminals, and re-pressing the key causes opening of the terminals.

(7) FRONT Input Terminals

These input terminals, located on the front panel, are used for measurement of DC, AC, or AC+DC currents, voltages, or resistances.

[Rear Panel]

(8) AC Power Connector

This connector, which is used to connect the AC power supply to the equipment, has a safety cover. Slide this cover to the right when the power cable (supplied) is to be used.
Use of the card located within the connector makes it possible to select any of the four types of supply voltages available.

(9) GND (Grounding) Terminal

This terminal is used to ground the equipment. When using a power cable together with the 2-pin adapter (supplied), be sure to connect either the adapter pin (see Figure 1 - 2) or the GND terminal to ground.

(10) EXT CAL Key

This key is used for external calibration of each measurement function. Normally, set the key to the OFF position.
If the key is set to the ON position, the ECAL lamp below the LED display comes on.

(11) Control Signal Connectors

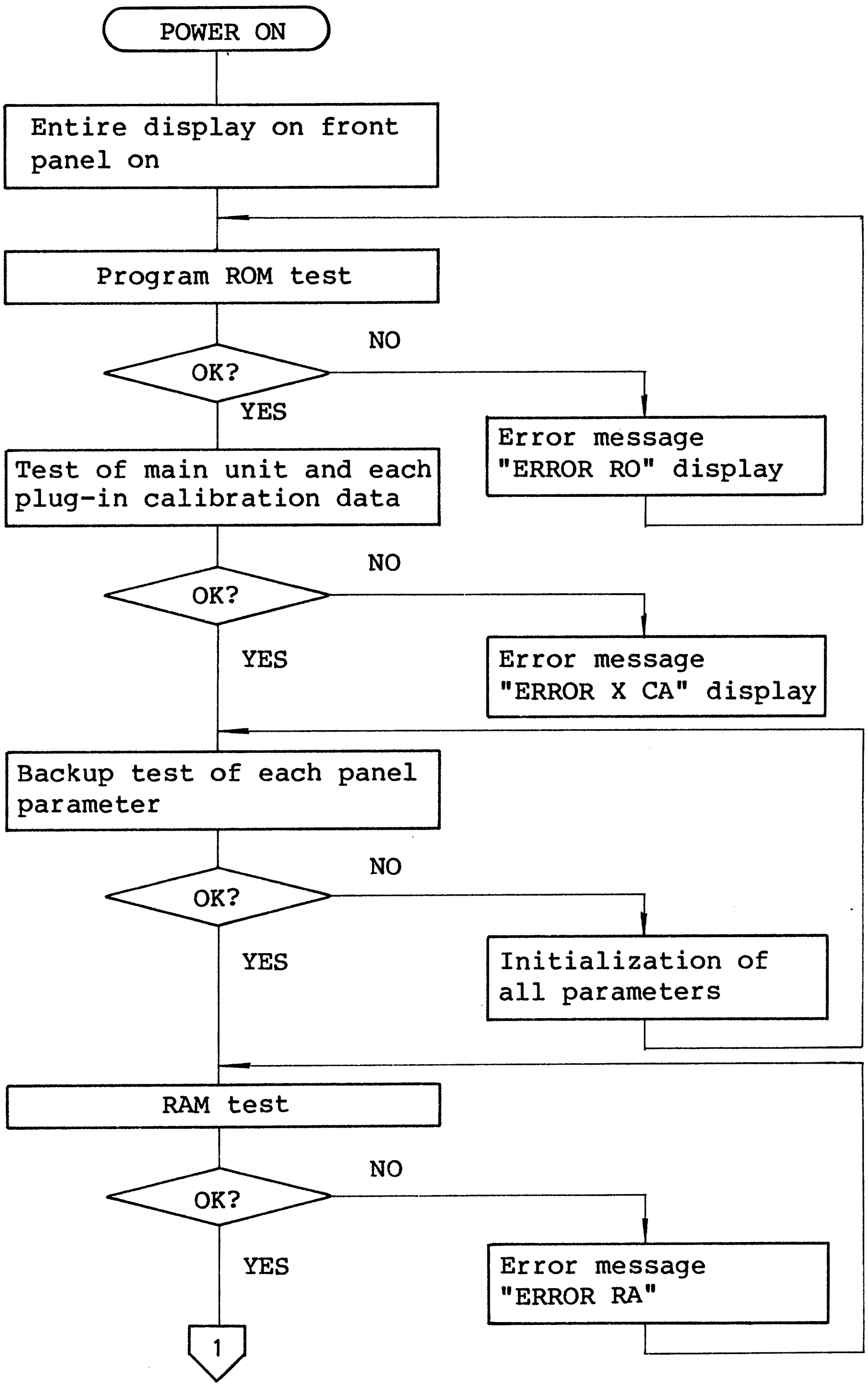
The TRIGGER input terminal is used to send a measurement start signal to the equipment from an external device. The input signal is of the TTL level, negative pulse type (pulse with : 100μsec or more).
The COMPLETE output terminal is used to generate a strobe signal for output of measured data or arithmetically processed data. The output signal is of the TTL level, negative pulse type (pulse with : 100μsec or more).

2.2 Power-On/Off Procedures

Note : Although all functions activate upon power-on, 30 minutes or more should be allowed for warm-up to ensure the required accuracy.

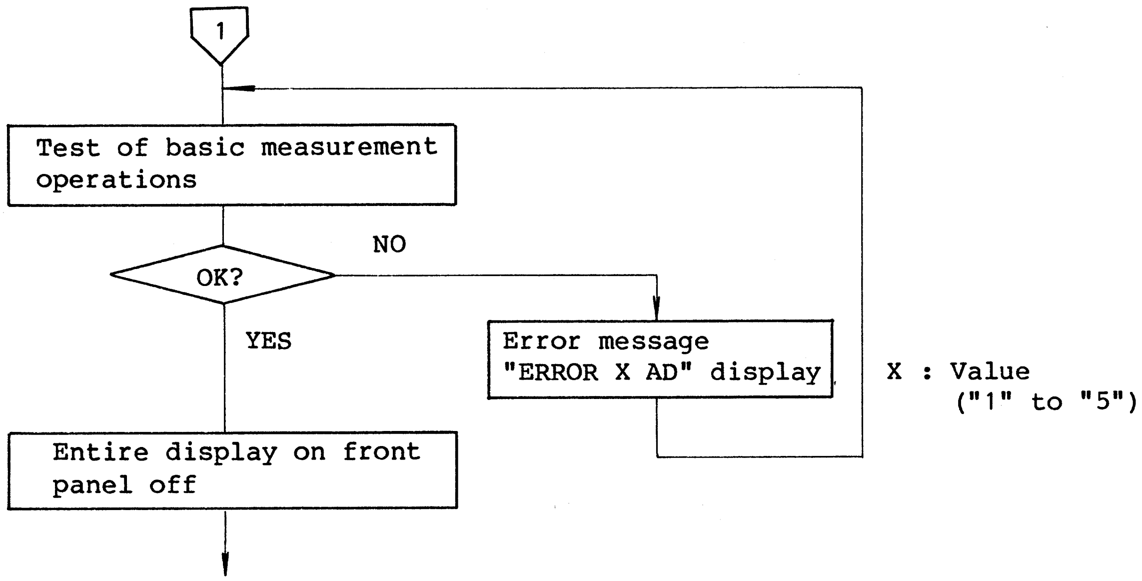
2.2.1 Power-on Procedure

① Pressing the POWER switch causes the entire display on the front panel to appear. At the same time, the various states of self-tests and TR6871 are displayed and then the equipment enters the normal measurement mode.
The following shows an operation flow starting with the power-on action:

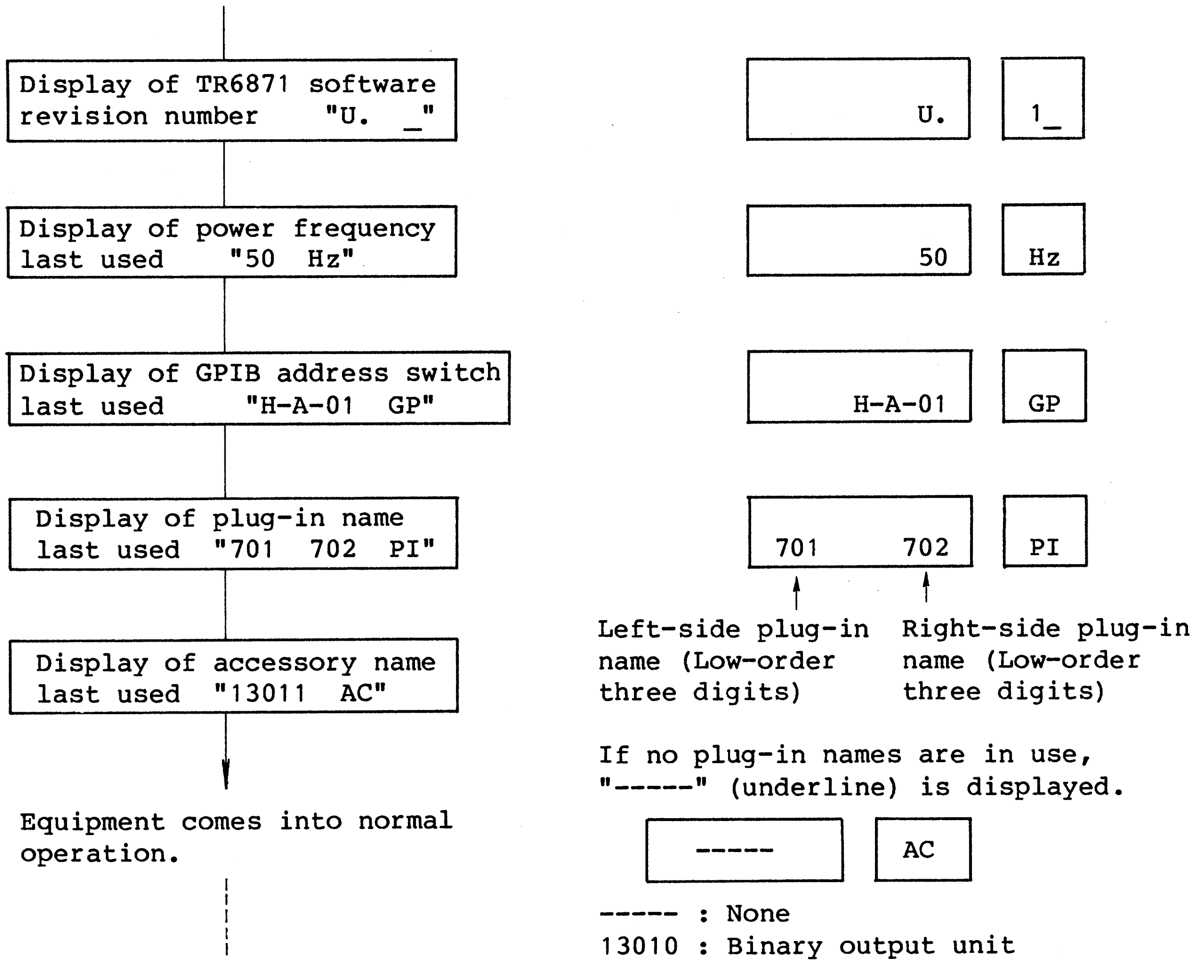


See section 7.2 for details of error messages. If error message display occurs during this power-on procedure, the equipment is malfunctioning. In such cases, turn power off with the error message left on the display and then contact the nearest dealer or the sales and support offices.

X : Value ("1" to "7")



Self-testing is now complete, followed by display of the various states of the TR6871.

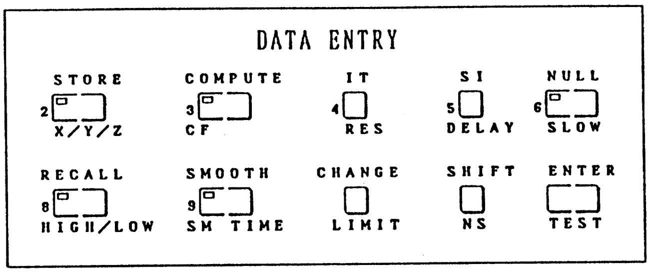


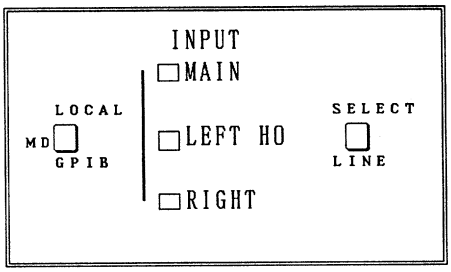
----- : None
13010 : Binary output unit
13011 : BCD output unit
13013 : Relay output unit

(2) After the equipment has come into normal operation, first set the power frequency (50Hz or 60Hz) using the following procedure:

[Setting procedure]

LINE parameter setting





(1) Press the SHIFT key. Each of the keys will then work as the parameters inscribed below the keys.

(2) Press the LINE key. The power frequency setting last used will then be displayed on the LCD unit.

Power frequency selection

(3) Select the power frequency (50Hz or 60Hz). Each time the CHANGE key is pressed, the display changes as follows:

50Hz ⇄ 60Hz

In this way, display the power frequency setting on the LCD unit.

Setting of power frequency completed

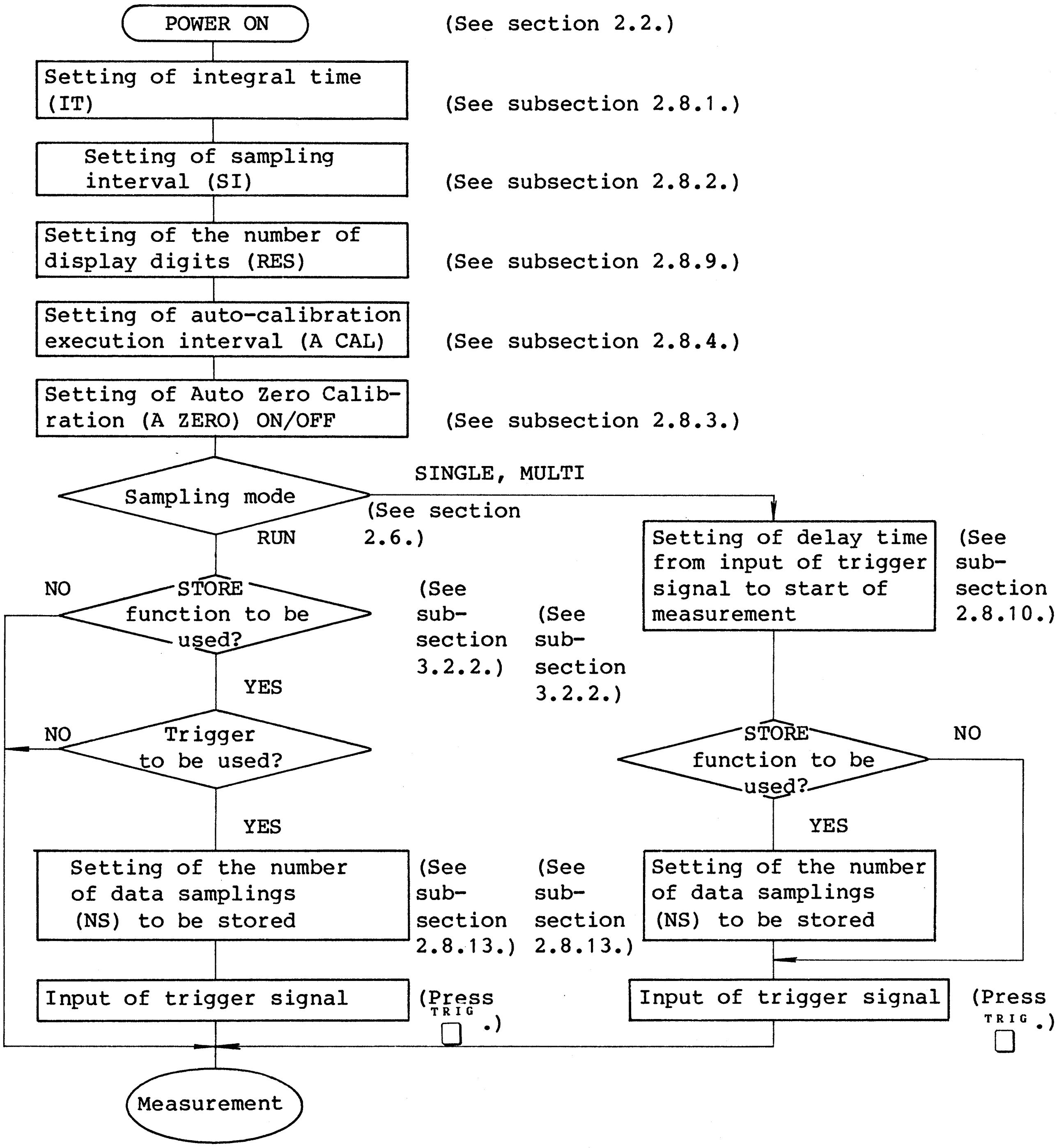
(4) Press the ENTER key. The power frequency setting being displayed will then be stored in memory. This completes the power-frequency setting sequence.

2.2.2 Power-off Procedure

Pressing the POWER switch with the power on will cause the power to turn off. Built-in batteries provide backing-up of the parameters that have been set, and thus they are retained even when power is turned off.

2.3 Measurement Flowchart

The flowchart of the operating procedure from power-on to the start of measurement is shown below. See the relevant sections (or subsections) for details of the individual procedural steps.

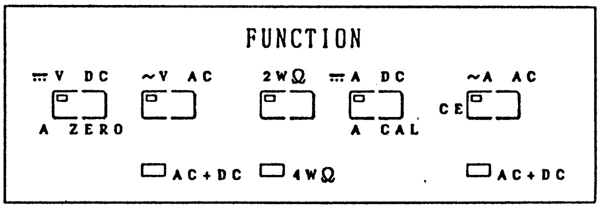


2.4 FUNCTION Section

[Functional description]

Keys in the FUNCTION section are used to select a measurement function. The following functions are available:

DC voltage measurement function	⎓V DC
AC voltage measurement function	~V AC
DC+AC voltage measurement function	AC+DC
DC current measurement function	⎓A DC
AC current measurement function	~A AC
DC+AC current measurement function	AC+DC
2-wire system resistance measurement function	2WΩ
4-wire system resistance measurement function	4WΩ

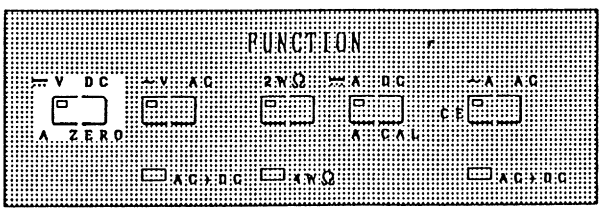


[Function setting]

Setting of a measurement function is quite easy.

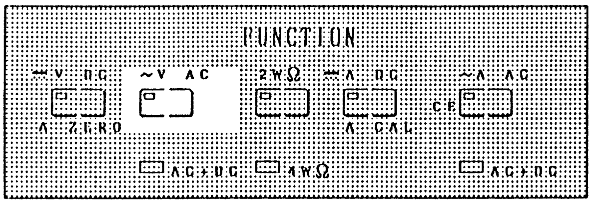
First, select the desired measurement function by pressing the corresponding function key. Setting is complete when the lamp of the selected function lights up.
The procedures for setting the individual measurement functions are described in detail below.

(a) Setting the DC voltage measurement function



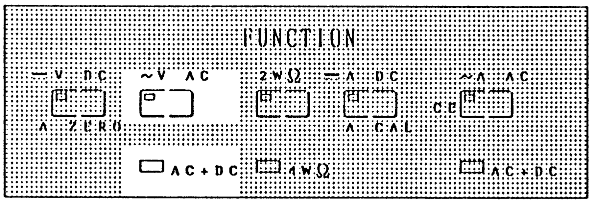
Press the ⎓V DC key. The lamp of the key will then light up to indicate that setting is complete.

(b) Setting the AC voltage measurement function



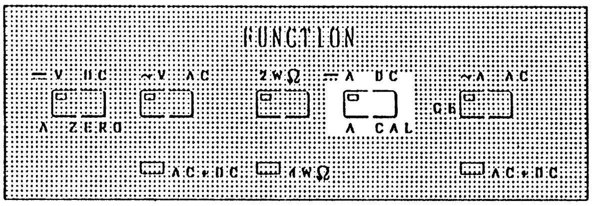
Press the ~V AC key. The lamp of the key will then light up to indicate that setting is complete.

(c) Setting the AC+DC voltage measurement function



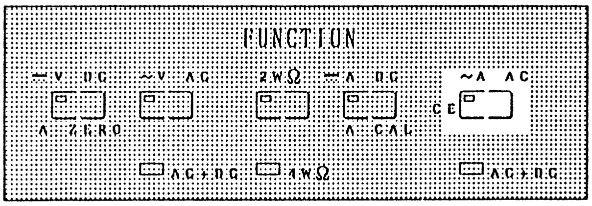
With the AC voltage measurement function set, press the ~V AC key once again. The AC+DC lamp below the key will then light to indicate that setting is complete.

(d) Setting the DC current measurement function



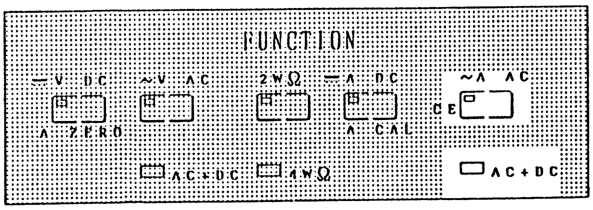
Press the ⎓A DC key. The lamp of the key will then light up to indicate that setting is complete.

(e) Setting the AC current measurement function



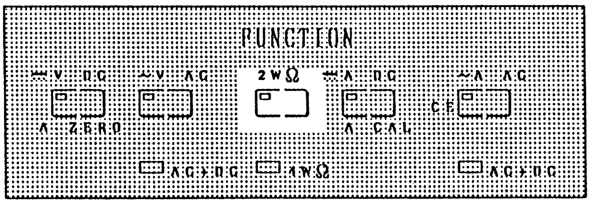
Press the ~A AC key. The lamp of the key will then light up to indicate that setting is complete.

(f) Setting the AC+DC current measurement function



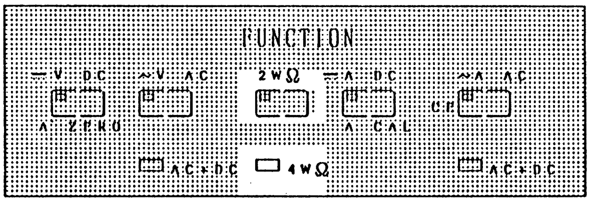
With the AC current measurement function set, press the ~A AC key once again. The AC+DC lamp below the key will then light to indicate that setting is complete.

(g) Setting the 2-wire system resistance measurement function



Press the 2WΩ key. The lamp of the key will then light up to indicate that setting is complete.

(h) Setting the 4-wire system resistance measurement function



With the 2-wire system resistance measurement function set, press the 2WΩ key once again. The 4WΩ lamp below the key will then light to indicate that setting is complete.

2.5 RANGE Section

[Functional description]

Keys in the RANGE section are used to select a measurement range. The selected measurement range can be identified by checking the corresponding unit of display and the position of the decimal point. The following table shows the range configuration of the TR6871:

Table 2 - 1 Measurement Range Configuration of the TR6871

VDC	VAC, V(AC+DC)	ADC	AAC, A(AC+DC)	2/4WΩ
200mV	200mV	2000μA	2000μA	100Ω
2000mV	2000mV	20mA	20mA	1000Ω
*1 10V	*2 20V	*2 200mA	*2 200mA	*2 10kΩ
*2 20V	200V	2000mA	2000mA	100kΩ
200V	500V			1000kΩ
1000V				10MΩ

*1 : The 10V range can be selected only when the EXT CAL key is placed in its ON position.
*2 : Initial value.

T Table 2 - 2 Automatic Range Levels

Function	Range	Max. No. of display digits	Fullscale	UP level	DOWN level
VDC	200mV 2000mV 10V 20V 200V 1000V	6½ 7½ 7½ 7½ 7½ 7½	1999999 19999999 11999999 19999999 19999999 11000000	2000000 20000000 12000000 20000000 20000000 1100***1	179999 1799999 999999 1799999 1799999 1799999
VAC V(AC+DC)	200mV 2000mV 20V 200V 500V	5½ 5½ 5½ 5½ 5½	199999 199999 199999 199999 500000	200000 200000 200000 200000 5000*1	17999 17999 17999 17999 17999
*1 ADC AAC A(AC+DC)	2000μA 20mA 200mA 2000mA	5½ 5½ 5½ 5½	199999 199999 199999 199999	200000 200000 200000 200000	17999 17999 17999 17999

*1 : ADC is displayed in a maximum of 6 and a half digits

Table 2 - 2 Automatic Range Levels (cont'd)

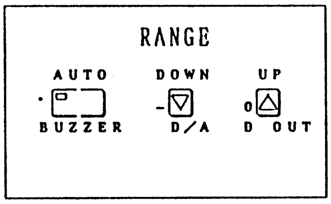
Function	Range	Max. No. of display digits	Fullscale	UP level	DOWN level
2/4WΩ	100Ω	7½	11999999	12000000	999999
	1000Ω	7½	11999999	12000000	999999
	10kΩ	7½	11999999	12000000	999999
	100kΩ	7½	11999999	12000000	999999
	1000kΩ	7½	11999999	12000000	999999
	10kΩ	7½	11999999	12000000	999999

Either the AUTO mode or the MANUAL mode is available for selection of a measurement range. If AUTO is selected, the optimum range for the input signal is automatically selected from among the table listing above.

If MANUAL is selected, select the optimum range from among those listed in the table above, with the use of the DOWN ▽ or UP △ keys.

[Selecting procedure]
The procedure for selecting a range is described below.

Range selection



(a) Select either AUTO or MANUAL with the AUTO key.
The lamp of the AUTO key lights up when AUTO is selected, and goes out when MANUAL is selected.
The mode changes between AUTO and MANUAL each time the AUTO key is pressed.

(b) Range selection in MANUAL mode.
Press UP △ to change the existing measurement range over to an upper range, and press DOWN ▽ to change to a lower range.
The range changes level-by-level each time UP △ or DOWN ▽ is pressed.

(c) Pressing UP △ or DOWN ▽ with an AUTO range selected will cause automatic change of the range.

2.6 SAMPLING Section

[Functional description]

Keys in the SAMPLING section are used to select a sampling mode (RUN, SINGLE, or MULTI).
Keys for trigger signal input are also located in this section.
In each such mode, sampling is performed as follows:

① RUN mode : Sampling is automatically repeated at the cycle that has been set using the SI parameter. (See subsection 2.8.2, "SI : Sampling interval".)

② SINGLE mode : Sampling is performed just once each time the trigger signal is input.

③ MULTI mode : Each time the trigger signal is input, sampling is performed in accordance with the NS parameter setting (number of times of sampling). The sampling cycle at this time refers to the SI parameter setting. (See subsection 2.8.13, "NS : Number of samples".)

Features of sampling in each mode are outlined below.

① RUN mode :

ⓐ Sampling is performed at the sampling interval that has been set.

ⓑ Each time a sampling operation is performed, the BUSY lamp located to the left of the LCD unit blinks just once and the measured value at that time is displayed.

② SINGLE mode :

ⓐ If this mode has been selected, sampling can be done with the TRIG key.

ⓑ Pressing TRIG causes sampling to be performed after the lapse of the trigger delay time that has been set using the DELAY parameter. (See subsection 2.8.10, "DELAY".)

ⓒ Sampling can be done only once.

ⓓ When sampling is performed, the BUSY lamp located to the left of the LCD unit will blink just once and the measured value at that time will be displayed.

ⓔ Sampling is not performed until TRIG is subsequently pressed once again.

③ MULTI mode :

ⓐ If this mode has been selected, sampling can be done with the TRIG key.

ⓑ The only one difference from the SINGLE mode is that while the SINGLE mode allows sampling to be performed just once, the MULTI mode allows continuous sampling to be performed in accordance with the specified number of times of sampling.

ⓒ Pressing TRIG causes sampling to be started after the lapse of the trigger delay time that has been set using the DELAY parameter.

ⓓ Sampling is performed at the set sampling interval.

ⓔ Each time a sampling operation is performed, the BUSY lamp located to the left of the LCD unit blinks just once and the measured value at that time is displayed.

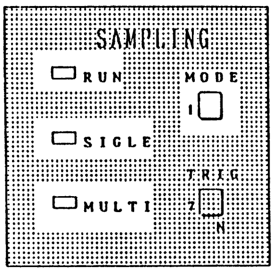
ⓕ Sampling takes place by the specified number of times and then terminates automatically.

ⓖ Sampling does not occur until the TRIG key is subsequently pressed once again.

[Setting procedure]

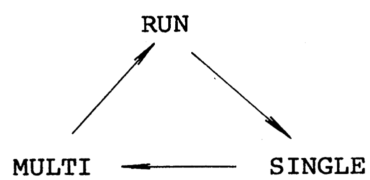
The procedure for setting the sampling mode is described below.

Setting of the sampling mode



Select a sampling mode (RUN, SINGLE, or MULTI) using the MODE key.

Each time the key is pressed, the lamps located to the left of the mode keys light up in the MODE following order:



Setting is complete when the lamp of the mode to be set comes on.

2.7 INPUT Section (Selection of Input Terminals)

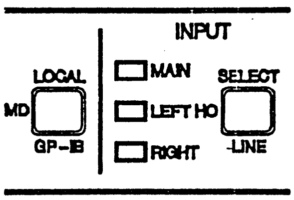
Input terminals are located in four places: two in the main unit, and two in the left- and right-hand side modules.

Use SELECT □ to select one of the three types of input terminals (located in the main unit, the left-hand side module, and the right-hand side module).

Use REAR/FRONT □ to select between the FRONT terminals and REAR terminals of the main unit.

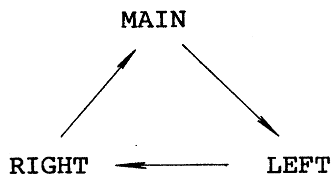
① Input-terminal selection with

Selection of input terminals



Use the SELECT □ on the front panel of the main unit to make the selection.

Each time the SELECT □ key is pressed, the lamps located to the left of the key light up in the following order:

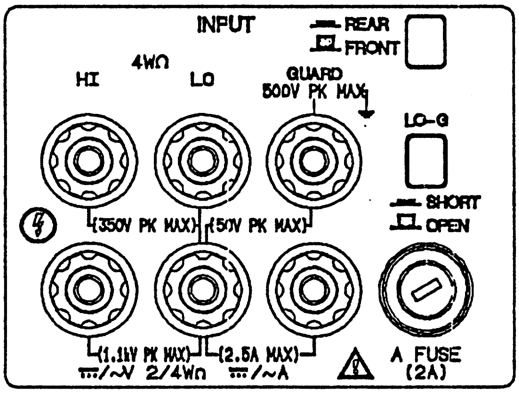


Selection is complete when the lamp of the terminal block to be selected comes on.

> **CAUTION**
>
> The TR6871 has two module slots: one for the left-hand side module, and one for the right-hand side module. The LO terminal in the left-hand side module and that in the right-hand side module are common to each other.
> If measurement is to be made using two module channels, leave the input terminals of one module open to prevent a voltage from being applied between the two LO terminals.
> (The input terminals of the TR6871 and those of each module are electrically isolated from each other.)

② FRONT/REAR terminal selection with

Selection of main-unit input terminals



Make the selection using the REAR FRONT selector switch located in the upper right section of the front panel input terminals of the main unit. This switch usually assumes either a protruding state or a recessed state. The switch changes between these two states each time it is pressed.
Place the switch in its protruding state to select the FRONT terminals, and place the switch in its recessed state to select the REAR terminals.

2.8 Description of Parameters and Their Setting Procedures

Parameters refer to the variables used to set various measurement conditions so that the TR6871 obtains accurate measurements.
Before offering a description of the parameter setting procedures, we will first describe the keys necessary to set parameters.
Parameter settings are backed up by built-in batteries, and thus they do not disappear even when power is turned off.
Since the parameters listed below are backed up by separate batteries for each of the main unit, and left-hand side module, and the right-hand side module, it is not necessary to change any module parameter settings even when the input source has been changed from the main unit to one of the two modules. (Note, however, that the settings are automatically initialized at power-on if the corresponding module is different in type from the one existing when power has last been turned off.)

[Parameters that can be set separately for each of the main unit, the left-hand side module, and the right-hand side module]

o FUNCTION
o RANGE
o SAMPLING MODE
o IT
o SI
o A ZERO
o A CAL
o BUZZER
o D/A
o CF
o RES
o DELAY
o SLOW
o N
o SM TIME
o NS
o X/Y/Z
o HIGH/LOW
o LIMIT

[Parameters that are common to the main unit and both modules]

o SELECT
o STORE (ON/OFF)
o RECALL (ON/OFF)
o COMPUTE (ON/OFF)
o NULL (ON/OFF)
o SMOOTH (ON/OFF)

Common parameters change as follows if SELECT ▢ is pressed in their ON states:

NULL ON → OFF

SMOOTH ON → ON (The number of times of smoothing is initialized.)

COMPUTE ON → ON (The key action of SELECT ▢ is ignored since the parameter key acts as a HOME key.)

RECALL ON → ON (The key action of SELECT ▢ is ignored since the parameter key acts as a HOME key.)

STORE ON → ON

[Initial value of each parameter]

The initial value of each parameter of the main unit is listed below. For the initial parameter values of the modules, parameters related to measurement operations slightly differ: for details, refer to the Operation Manual accompanying the particular module.

o GPIB	Cannot be initialized.
o LINE	Cannot be initialized.
o SELECT	MAIN
o FUNCTION	⎓ V DC
o RANGE	AUTO (20V range)
o SAMPLING MODE	RUN
o IT	5PCC
o SI	250msec
o A ZERO	ON
o A CAL	1 minute
o BUZZER	OFF
o D/A	OFF
o D OUT	Output mode 0 (Output to the entire output system)
o CF	0-0 (OFF for both primary and secondary computation)
o RES	6 1/2-digit mode
o DELAY	Omsec
o SLOW	ON (SLOW mode)
o N	2
o SM TIME	10
o NS	1
o X/Y/Z	X, Z=1 Y=0
o HIGH/LOW	HIGH1, HIGH2=1 LOW1, LOW2=0
o LIMIT	Reference value = 1 %1, %2=10%

[Parameters that are automatically initialized at power-on]

o STORE
o RECALL
o COMPUTE
o NULL
o SMOOTH
o D OUT

Next, the procedure for initializing parameters are described below.

① SHIFT

② MODE

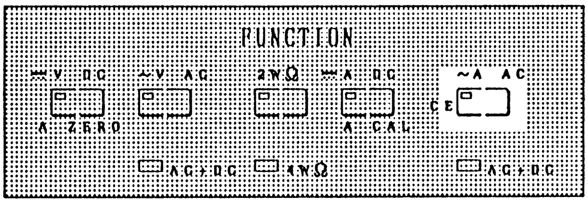
③ ENTER

CLEAR

(1) HO (HOME key)

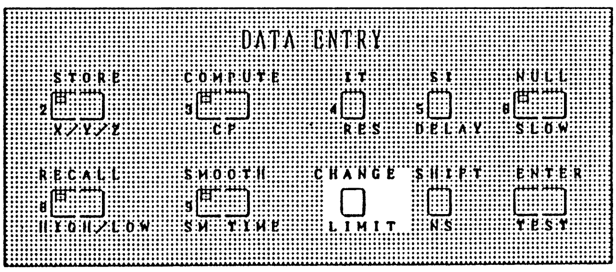
This key is used to cancel the parameter data being set (that is, the data existing before the ENTER key is pressed) and thus allows measurement to be made in the normal mode using the old data of the corresponding parameter.

(2) CE (CE key)



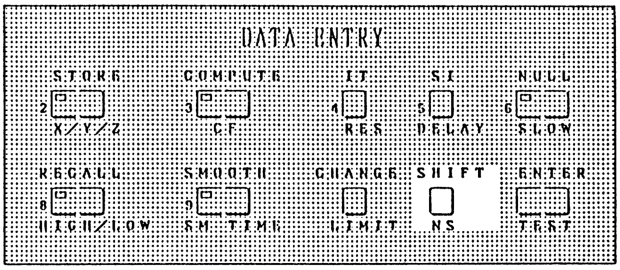
This key is used to cancel the entire set of parameter data being input (that is, the data being displayed on the LCD unit).

(3) CHANGE (CHANGE key)



This key is used to change the data settings being displayed (that is. ON/OFF of various parameters, units, and the number of display digits).

④ SHIFT (SHIFT key)

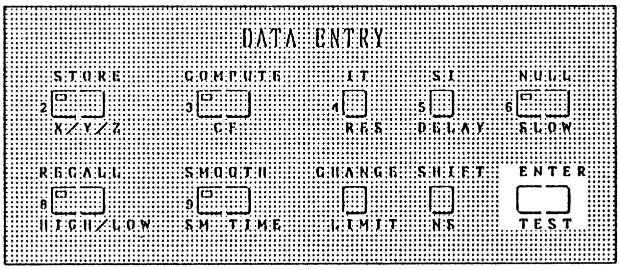


This key has the following two functions:

ⓐ calling on the display unit the RES, DELAY, SLOW, and other parameters that are printed in blue underneath the corresponding keys, and

ⓑ shifting the blinking display position.

⑤ ENTER (ENTER key)



This key is used to store data settings into the internal memory.

ⓐ When using UP 0 D OUT to SMOOTH 9 SM TIME as numeric keys:

After the following parameters (the parameters that require setting of numerics) have been set, UP 0 D OUT to SMOOTH 9 SM TIME act as numeric keys:

A CAL
CF
DELAY
D OUT
GPIB(address)
HIGH/LOW
LIMIT
N
NS
SI
SM TIME
X/Y/Z

This is, UP 0 D OUT to SMOOTH 9 SM TIME act as numeric keys after selection of a parameter that requires numerical setting.

(b) When setting the parameters that are printed in blue:

After pressing SHIFT □ , press the key under which the desired parameter is printed.

2.8.1 IT : Integrate Time

[Functional description]

The IT parameter is used to set the integral time on which the equipment is to make an A/D conversion.

Use of the IT parameter makes it possible for the integral time that matches measurement resolution and measurement speed to be selected from the following nine types:

100µs, 1ms. 10ms, 1PLC, 5PLC, 10PLC, 20PLC, 50PLC, 100PLC

where PLC stands for Power-Line Cycle. The value of 1PLC changes as follows according to the power-line frequency selected:

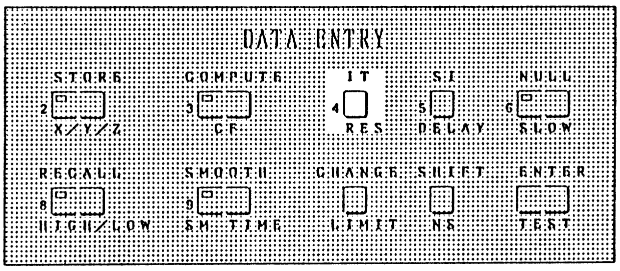
For the power-line frequency of 50Hz, 1PLC = 20msec
For the power-line frequency of 60Hz, 1PLC = 16.7msec

Measurements highly resistant to noise can be obtained by setting a large value as integral time.

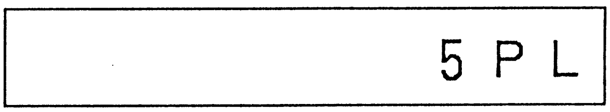
[Setting procedure]

The procedure for setting integral time is described below.

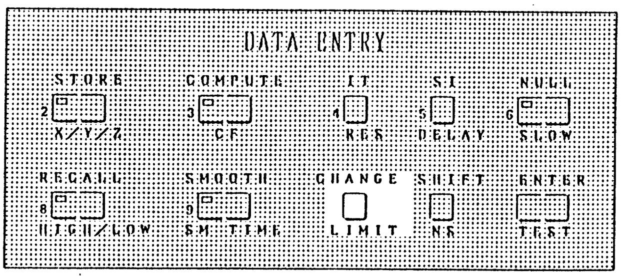
Setting the IT parameter



(1) Press the IT □ key. The integral time last set will then be displayed on the LCD unit.



Selecting integral time



(2) Select the desired integral time by pressing the CHANGE key. Each time CHANGE is pressed, the display on the LCD unit changes as follows:

100 μS → 1ms → 10ms → 1PL
↓
5PL
↓
10PL → 20PL → 50PL → 100PL → 100 μS

Display the desired integral time on the LCD unit by pressing CHANGE.

1 0 P L

Setting of integral time completed

ENTER

(3) Press the ENTER key. This causes the displayed integral time to be stored in memory. Setting of the integral time is now complete.

2.8.2 SI : Sampling Interval

[Functional description]

The SI parameter is used to set the sampling time interval (hereinafter referred to as the sampling interval). When the sampling interval is set using the SI parameter:

1. In the RUN or MULTI sampling mode, measurement is performed at the sampling interval setting.

2. Reading of the data that has been written using the data memory functions is also performed at the sampling interval setting. However, if the sampling interval setting is smaller than the repetition period (time from the start of measurement to output of data), then the minimum repetition period of the corresponding integral time becomes the sampling interval.

③ The setting range is from 0 to 60,000msec in 1msec increments.

Figure 2 - 1 below shows an operation example that represents the relationship between the DELAY parameter and the SI parameter.

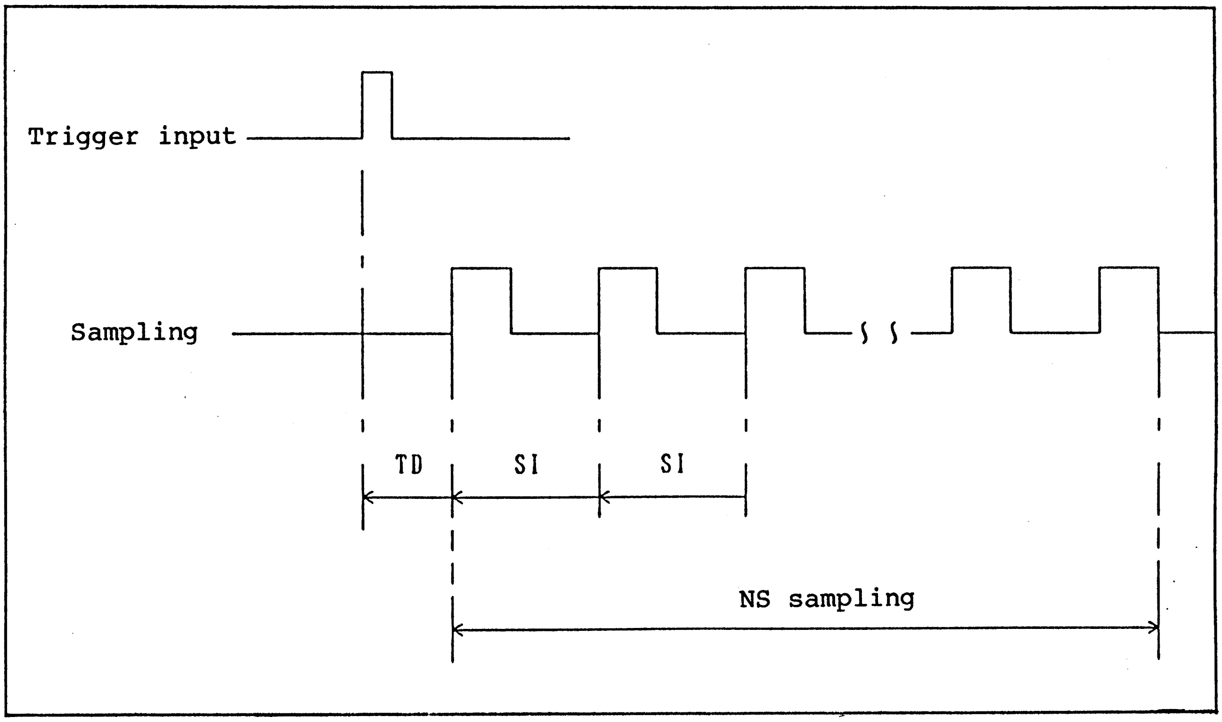
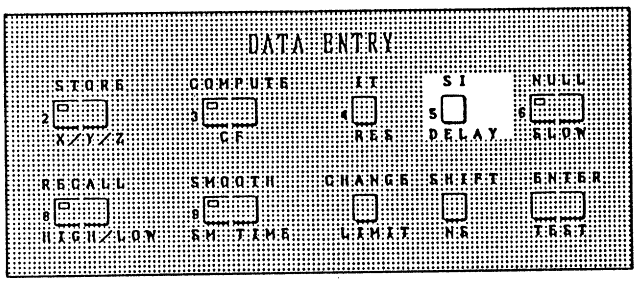


Figure 2 - 1 Operation Example That Represents the Relationship between "DELAY" and "SI" (Sampling Mode : MULTI)

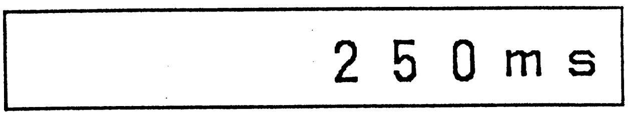
[Setting procedure]

The procedure for setting the sampling interval is described below.

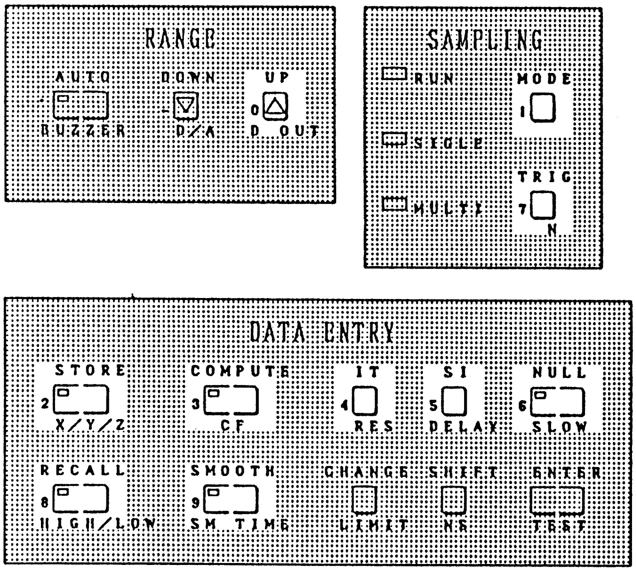
Setting of SI parameter



(1) Press the SI key. The sampling interval last set will then be displayed on the LCD unit.



Setting of sampling interval value



(2) Set the sampling interval value using the numeric keys 0 through 9. For SI parameter setting, 0 through 9 act as numeric keys. The value set here will be displayed on the LCD unit.

(Example)

To set 913, press keys 9, 1, and 3, in that order.

9 1 3 ms

Setting of the sampling interval completed

ENTER

(3) Press the ENTER key. The displayed sampling interval value will then be displayed on the LCD unit. This completes setting of the sampling interval.

2.8.3 A ZERO : Auto Zero Calibration

[Functional description]

The A ZERO parameter is used to select whether or not offset errors in the analog circuitry of the equipment are to be automatically eliminated (Auto Zero Calibration).

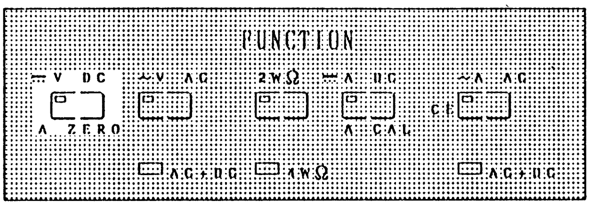
[Setting procedure]

The ON/OFF setting procedure for the Auto Zero Calibration function is described below.

A ZERO parameter setting

SHIFT

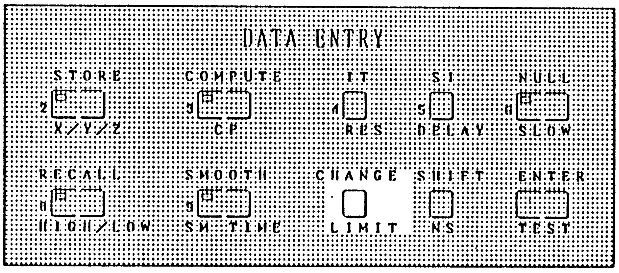
(1) Press the SHIFT key.



(2) Press the A ZERO key. The previous ON/OFF setting of the A ZERO function will then be displayed on the LCD unit.

o n A Z

A ZERO function ON/OFF setting



(3) The ON and OFF states are alternately displayed on the LCD unit each time CHANGE is pressed.

(a) To set the ON state, display "ON" on the LCD unit using the CHANGE key and then proceed to step (4).

o n A Z

(b) To set the OFF state, display "OFF" on the LCD unit using the CHANGE key and then proceed to step (4).

o F F A Z

A ZERO function setting complete

ENTER

(4) Press the ENTER key. This will cause the A ZERO function ON or OFF setting on the display to be stored in memory. ON/OFF setting of the A ZERO function is now complete.

If A ZERO is set in its ON state, measurement time becomes about twice that taken with A ZERO OFF, since the Auto Zero Calibration time (equal to integral measurement time) is required for each measurement operation.

2.8.4 A CAL : Auto Calibration Interval

[Functional description]

The A CAL parameter is used to set the execution interval of Auto Calibration.
Based on the internal reference voltage, automatic calibration of the measuring system of the equipment takes place at fixed intervals to ensure constant stability of the measuring system.
The setting range is from 0 to 999 minutes in units of one minute.
The A CAL function becomes invalid if the interval time is set to 0 minutes.

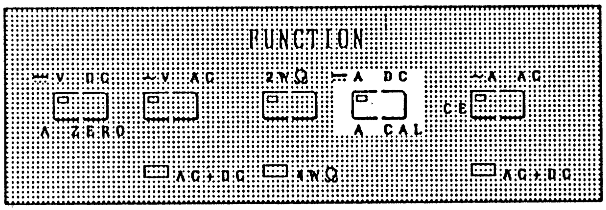
[Setting procedure]

The procedure for setting the execution interval value of the Auto Calibration function is described below.

A CAL parameter setting

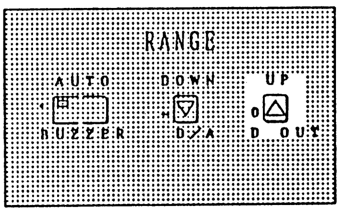
SHIFT

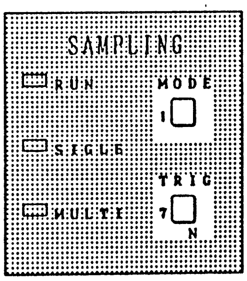
(1) Press the SHIFT key.

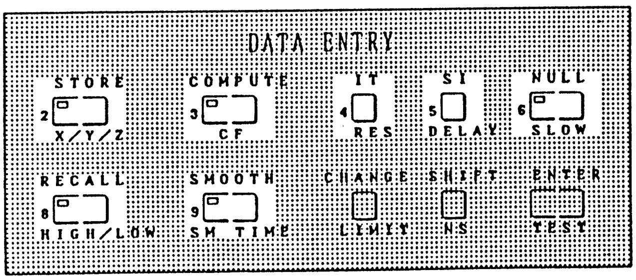


(2) Press the A CAL key. The execution interval last set will then be displayed on the LCD unit.

Execution interval value setting



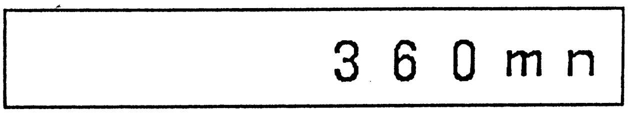




(3) Set the desired execution interval value using the numeric keys 0 through 9. For A CAL parameter setting, 0 through 9 act as numeric keys. The value set here will be displayed on the LCD unit.

(Example)

To set 360, press keys 3, 6, and 0, in that order.



Setting of the execution interval value completed

ENTER

(4) Press the ENTER key. The displayed execution interval value will then be displayed on the LCD unit. This completes setting of the execution interval.

2.8.5 BUZZER : Buzzer Mode

[Functional description]

The BUZZER parameter is used to select whether or not the buzzer function is to be used. The following three modes of buzzer are available:

(1) OFF : The buzzer function is not used.

(2) ON-1 : If this mode is selected, the buzzer sounds when the results of comparator computation are either R(H2), R(H1), R(L1), or R(L2).

(3) ON-2 : If this mode is selected, the buzzer sounds when the results of comparator computation are R(PASS).

If mode (2) or (3) is selected, the buzzer also sounds in the following cases:

o When an error occurs
o When a panel key is pressed

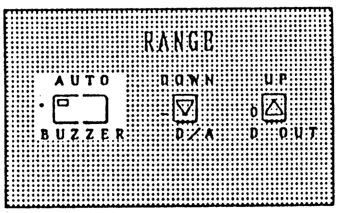
[Setting procedure]

The BUZZER parameter setting procedure is described below.

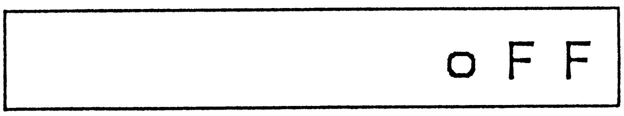
BUZZER parameter setting

SHIFT

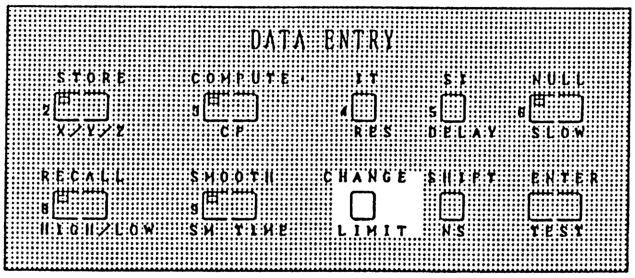
(1) Press the SHIFT key.



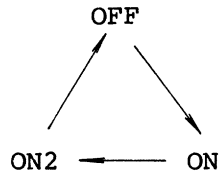
(2) Press the BUZZER key. The buzzer mode last set will then be displayed on the LCD unit.



Buzzer mode selection



(3) Select the desired buzzer mode. The available buzzer modes are OFF, ON1, and ON2. Use the CHANGE key to make the selection. The display changes as follows each time CHANGE is pressed:



In this way, display the desired mode name on the LCD unit.

Buzzer mode setting complete

ENTER

(4) Press the ENTER key. The mode name being displayed on the LCD unit will then be stored in memory. Setting of the buzzer mode is now complete.

2.8.6 D/A : D/A Output Mode

[Functional description]

The D/A parameter is used to set the mode in which analog data is to be output from the D/A output terminals.
The low-order two or three digits of the data to be output can be converted into +0.999V (at fullscale) before the data is output.
During this conversion, the data may or may not have an added offset value (500).
Five types of output modes are available, as listed below. Select the appropriate mode for the particular requirements.

1. No analog output is performed.

2. Only the low-order three digits of data are output.

3. Data is output with an offset value (500) added to the low-order three digits of the data.

④ Data is output with its low-order two digits ten-fold.

⑤ Data is output with its low-order two digits ten-fold and an added offset value (500).

Use the RES parameter to select the number of digits of data to be output.

(Example) Using the RES parameter to change the number of digits of data to be output:

① 1 9 9 9 9 9 9 9 : Low-order two digits output (Use the RES parameter with the 7 1/2-digit mode)

② 1 9 9 9 9 9 9 9 : Low-order three digits output (Use the RES parameter with the 7 1/2-digit mode)

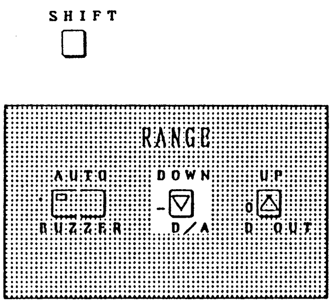
③ 1 9 9 9 9 9 9 9 : Low-order two digits output (Use the RES parameter with the 5 1/2-digit mode)

④ 1 9 9 9 9 9 9 9 : Low-order three digits output (Use the RES parameter with the 5 1/2-digit mode)

[Setting procedure]

The setting procedure for the analog output mode is described below.

D/A parameter setting

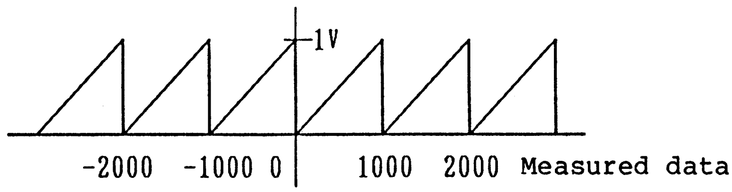


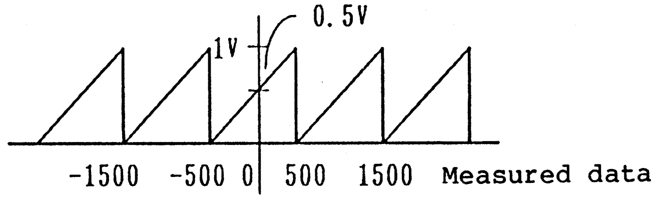
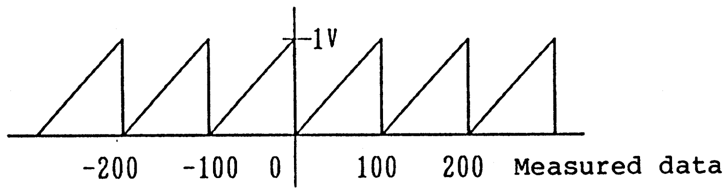
(1) Press the SHIFT key.

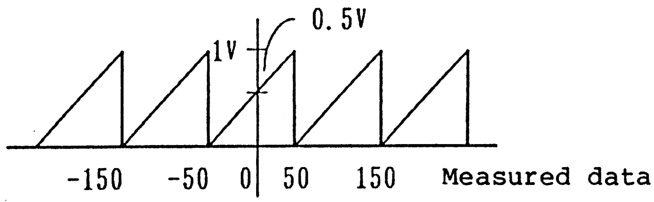
(2) Press the D/A key. The number of output digits and the offset value that were last set will then be displayed on the LCD unit. The display of the number of output digits blinks at this time.

Blinking display of the number of output digits	Display of offset value
oFF	000DA

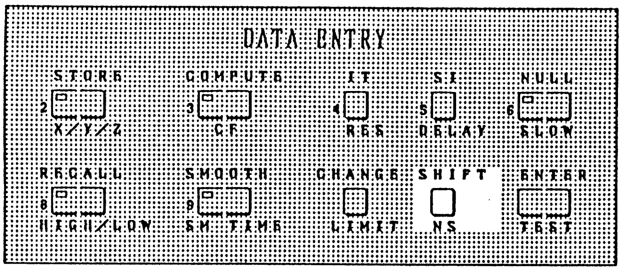
Output mode:

<table>
<tr><th>Output mode</th><th>Analog output</th></tr>
<tr><td>Low-order three digits of the displayed data</td><td>Output voltage

</td></tr>
<tr><td>Low-order three digits of the displayed data

+OFFSET(500)</td><td>Output voltage

</td></tr>
<tr><td>Low-order two digits of the displayed data</td><td>Output voltage

</td></tr>
<tr><td>Low-order two digits of the displayed data

+OFFSET(50)</td><td>Output voltage

</td></tr>
<tr><td>OFF</td><td>Output voltage 0V</td></tr>
</table>

Selecting the number of digits and an offset value



(3) Setting the analog output mode involves setting the number of output digits and setting an offset value. Here, select one of the two items of setting. The desired item of setting may come first, whichever you select.

Press the SHIFT key to select between setting of the number of output digits and setting of an offset value. This will cause the display of the selected item to blink.

Each time SHIFT is pressed, the displays of the two items of setting blink alternately.

(a) To set a mode (OFF, low-order 3 digits, or low-order 2 digits) for the number of output digits, press SHIFT to make the display of the number of output digits blink. Then, proceed to step (4).

Blinking display of the number of output digits	Normal display of offset value
888	000DA

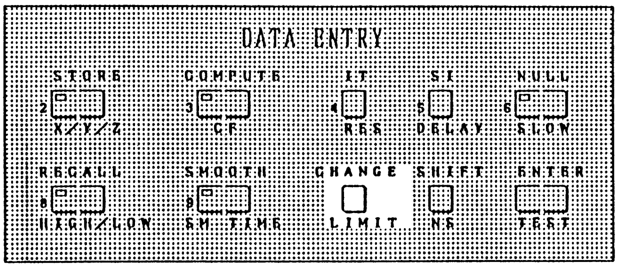
(b) To set an offset value (up to 0.500), press SHIFT to make the display of the offset value blink. Then, proceed to step (5).

Normal display of the number of output digits

Blinking display of offset value

8 8 8	0 0 0 D A

Selecting the number of output digits

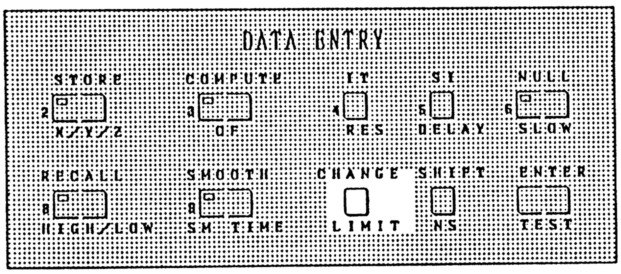


(4) Select the desired buzzer mode (OFF, low-order 3 digits, or low-order 2 digits). Use the CHANGE key to make the selection. The display changes as follows each time CHANGE is pressed:

OFF → 888 → 88 → OFF

In this way, display the selected mode name on the LCD unit.

Selecting an offset value



(5) Select the desired offset value (up to 0.500). Use CHANGE to make the selection. The display changes as follows each time CHANGE is pressed:

000 ⇄ 500

In this way, display the selected offset value on the LCD unit.

Setting of the number of output digits or the offset value completed

ENTER

(6) Press the ENTER key. The number of output digits and the offset value that are currently being displayed on the LCD unit will then be stored in memory. Setting of the analog output mode is now complete.

2.8.7 D OUT : Data Output Mode

[Functional description]

In this equipment, data can be output to the display unit, GPIB, analog outputs, and accessories. In addition, saving of data into the internal data memory is also considered as one type of data output. The mode in which data can be output to entire such output system is referred to as the normal measurement mode. In some cases, however, data may need to be output only to a specific part(s) of the output system or there may arise the needs for measurement to be done at speeds as high as possible.
The parameter that meets such requirements is D OUT.
Note that the D OUT parameter is automatically initialized whenever power is turned on.
The various modes available with the D OUT parameter are described below.

Mode 0 : Data is output to the entire output system.
1 : Data can be output only to the data memory and GPIB.
2 : Data can be output only to the data memory and accessories.
3 : Measured data is output only to the data memory.
4 : Data is output only to the data memory at the maximum available speed.

CAUTION

1. The D OUT parameter is automatically initialized whenever power is turned on. (Mode 0)

2. The COMPUTE functions are not performed if mode 3 is set.

3. Analog output is not generated if the D/A parameter is set in its OFF state.

4. In the maximum speed mode, each parameter is automatically set as follows:

o FUNCTION	: Fixed	o IT	: 100µs
o RANGE	: Fixed	o SI	: 0msec
o SAMPLING MODE	: RUN	o A ZERO	:OFF
o SELECT	: MAIN	o A CAL	:OFF
o STORE	: ON	o SLOW	:OFF
o RECALL	: OFF		
o COMPUTE	: OFF		
o NULL	: OFF		
o SMOOTH	: OFF		

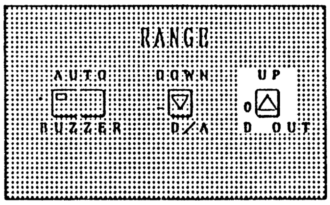
[Setting procedures]

The setting procedures for the data output modes are described below.

D OUT parameter setting

SHIFT

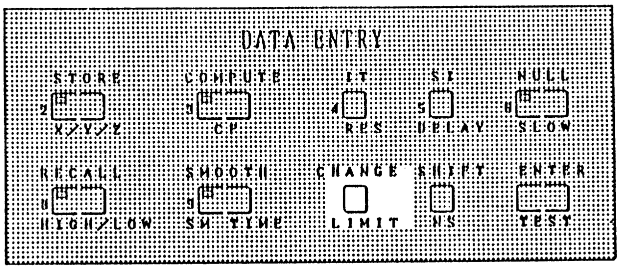
(1) Press the SHIFT key.



(2) Press the D OUT key. The data output mode last set will then be displayed on the LCD unit.

out-0D0

Selection of data output mode



(3) Select the desired mode of data output (0, 1, 2, 3, or 4). Use the CHANGE key to make the selection. The display changes as follows each time CHANGE is pressed:

$$0 \rightarrow 1 \rightarrow 2 \rightarrow 3 \rightarrow 4 \rightarrow 0$$

In this way, display the selected mode name on the LCD unit.

Setting of data output mode completed

ENTER

(4) Press the ENTER key. The name of the data output mode being displayed on the LCD unit will then be stored in memory. Setting of the data output mode is now complete.

2.8.8 CF : Computing Function

[Functional description]

The CF parameter is used to select a computing function from among those provided by the equipment.
See section 3.1, "Computing Functions", for details of the computing functions.
Table 2 - 3 gives a listing of functions available for primary computation and secondary computation.

Table 2 - 3 Computing Functions

Data	Primary computation	Secondary computation
0	OFF	OFF
1	SCALING	COMPARATOR 1
2	% DEVIATION	COMPARATOR 2
3	DELTA	Statistical processing
4	MULTIPLY	
5	Decibel conversion	
6	RMS Value	
7	dBm conversion	
8	Resistance value temperature compensation	

[Setting procedures]

The procedures for setting the computing functions are described below.

CF parameter setting

SHIFT
▢

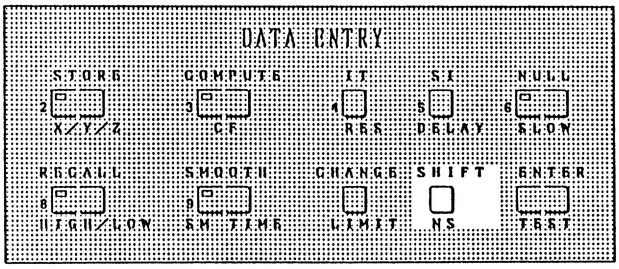
(1) Press the SHIFT ▢ key.

(2) Press the CF key. The states last set for primary and secondary computation will then be displayed on the LCD unit. The display of "0 - 0" blinks at this time.

Blinking Primary computation	Secondary computation

```
0 - 0 CF
```

Selection of computing functions

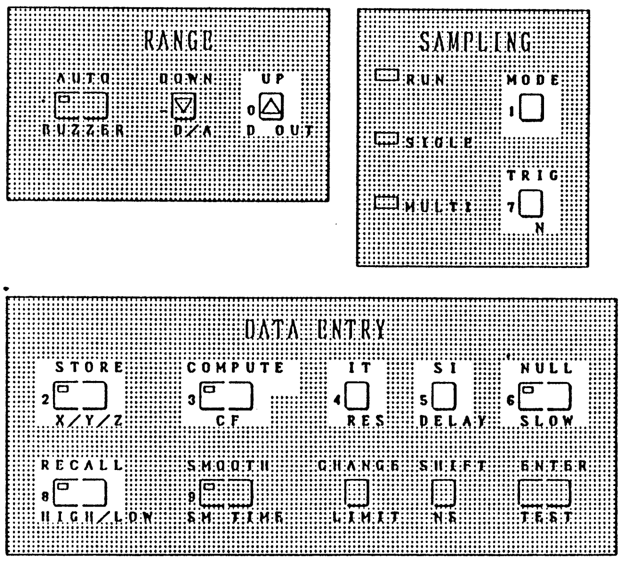


(3) Setting computation functions involves setting those for primary computation and for secondary computation. Here, select one of the two types of setting. The desired type of setting may come first, whichever you select. Press the SHIFT key to select between setting of primary computation functions and setting of secondary computation functions. This allows the display of the desired type of setting to blink. Each time SHIFT is pressed, the displays of the two types of setting blink alternately.

(Example)

o To set primary computation functions:

Make the display of primary computation functions blink by pressing SHIFT.



o To set secondary computation functions:
Make the display of secondary computation functions blink by pressing SHIFT.

[If both primary and secondary computation functions are to be set]
Functions for both primary and secondary computation can be set at one time. The setting method is described in step (4) below.

(4) Set the identification numbers of the desired computing functions using the numeric keys 0 to 8. Function numbers 0 through 8 can be set for primary computation, and function numbers 0 through 3 can be set for secondary computation. Functions being displayed in normal form (ON) or in blinking form (Blinking) can only be set.

(Example)

o To set the SCALING function used for primary computation:
Press 1.

Blinking ON

1 — 0 C F

o To set the COMPARATOR-2 function used for secondary computation: Press 2[ ].

ON Blinking

0 - 2 C F

See Table 2 - 2 for details of the primary and secondary computation function data.

[If functions for both primary and secondary computation are to be set at one time]
Set a primary (or secondary) computation function first. The display of primary computation will then come on and the display of secondary computation will blink. At this time, set a secondary computation function. This causes the display of secondary computation to come on once again and the display of primary computation to blink. After setting functions for both primary and secondary computation, ignore the blinking state of the display and proceed to step (5).

Setting of computing functions completed

ENTER

(5) Press the ENTER key. The displayed ID number of the computing function will then be stored in memory. This completes setting of the computing functions.

2.8.9 RES : Resolution

[Functional description]

The RES parameter is used to set the number of measurement digits. The following describes the precautions to be taken when carrying out the setting operation:

① The number of digits that can be set is either 4 1/2-digit, 5 1/2-digit, 6 1/2-digit, or 7 1/2-digit.

② Notes on priority of the number of measurement digits.
For the number of measurement digits, priority is given to RES parameter setting over measurement function setting or IT (integral time) parameter setting. The integral time, measurement functions, and the number of measurement digits are maintained in a predetermined relationship as listed in Table 2 - 4. That is, when the integral time is set to 100μsec using the IT parameter, the actual number of measurement digits becomes 4 1/2-digit even if the number is set to 6 1/2-digit digits using the RES parameter.

③ Notes on the relationship between the number of measurement digits and the selected measurement range
The number of digits in the integral part of the number of measurement digits becomes the same as the maximum number of digits in the selected measurement range.

(Example 1)
If 5 1/2-digit measurement is made using the 1000Ω range, the integral part and the decimal part become a 3 1/2-digit value (since 1000 takes 3 1/2-digit) and a 2-digit value, respectively, as shown on the right.

1128.83 Ω

57.26 Ω

(Example 2)
If 7 1/2-digit measurement is made using the 1000Ω range, the integral part and the decimal part become a 3 1/2-digit value (since 1000 takes 3 1/2-digit) and a 4-digit value, respectively, as shown on the right.

1128.8334 Ω

57.2616 Ω

④ Meaning of the 1/2-digit in 7 1/2-digit measurements
If the 1000Ω range is selected, for example, the maximum value of data measurements obtained will be 1199.9999Ω. At this time, it is good enough just to display "1" for the most significant digit. In actuality, only "1" can be displayed. Thus, the most significant digit is taken as a 1/2-digit.

Table 2 - 4 Relationship between Integral Time and Number of Digits Displayed

<table>
<tr><th>Integral time / Measurement function</th><th>100μs</th><th>1ms</th><th>10ms</th><th>1PLC</th><th>5PLC</th><th>10PLC</th><th>20PLC</th><th>50PLC</th><th>100PLC</th></tr>
<tr><td rowspan="4">DC voltage measurement</td><td colspan="9">4-digit display</td></tr>
<tr><td></td><td colspan="8">5 1/2-digit display</td></tr>
<tr><td></td><td></td><td colspan="7">6 1/2-digit display</td></tr>
<tr><td></td><td></td><td></td><td></td><td colspan="5">7 1/2-digit display</td></tr>
<tr><td rowspan="3">DC current measurement</td><td colspan="9">4-digit display</td></tr>
<tr><td></td><td colspan="8">5 1/2-digit display</td></tr>
<tr><td></td><td></td><td colspan="7">6 1/2-digit display ay</td></tr>
<tr><td rowspan="4">Resistance measurement (Common to 2-wire and 4-wire)</td><td colspan="9">4-digit display</td></tr>
<tr><td></td><td colspan="8">5 1/2-digit display</td></tr>
<tr><td></td><td></td><td colspan="7">6 1/2-digit display</td></tr>
<tr><td></td><td></td><td></td><td></td><td colspan="5">7 1/2-digit display</td></tr>
<tr><td rowspan="2">AC voltage measurement or DC+AC voltage measurement</td><td colspan="9">4-digit display</td></tr>
<tr><td></td><td colspan="8">5 1/2-digit display</td></tr>
<tr><td rowspan="2">AC current measurement or DC+AC current measurement</td><td colspan="9">4-digit display</td></tr>
<tr><td></td><td colspan="8">5 1/2-digit display</td></tr>
</table>

[Setting procedure]

The procedure for setting the number of measurement digits is described below.

RES parameter setting

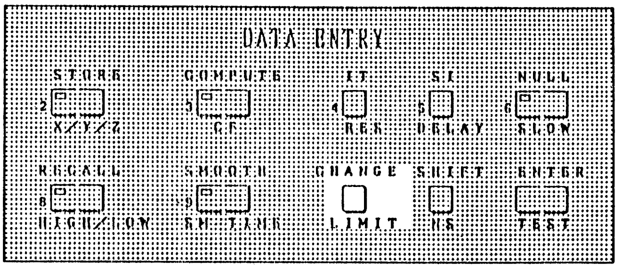
SHIFT

(1) Press the SHIFT key.

(2) Press the RES key. The number of measurement digits last set will then be displayed on the LCD unit.
4 1/2-digit display appears as follows:

0 1 2 3 4   R E

Selection of the number of measurement digits



(3) Select the desired number of measurement digits
(4 1/2-digit,
5 1/2-digit,
6 1/2-digit,
or 7 1/2-digit)
Use CHANGE to make the selection.
The display of the number of measurement digits changes as follows each time CHANGE is pressed:

4 1/2-digit → 5 1/2-digit
↑ ↓
7 1/2-digit ← 6 1/2-digit

The display of each digit is made as follows:

o 5 1/2-digit

0 1 2 3 4 5   R E

o 6 1/2-digit

0 1 2 3 4 5 6   R E

o 7 1/2-digit

0 1 2 3 4 5 6 7 R E

In this way, display the number of measurement digits to be set.

Setting of the number of measurement digits completed

ENTER

(3) Press the ENTER key. The displayed number of measurement digits will then be stored in memory. This completes setting of the number of measurement digits.

2.8.10 DELAY : Trigger Delay

[Functional description]

The DELAY parameter is used to set the delay time from input of the trigger signal to the start of the first sampling operation (this delay time will be hereinafter referred to as the trigger delay time). When the trigger delay time is set using the DELAY parameter:

1. In the SINGLE or MULTI mode, the first sampling operation begins after the lapse of the set trigger delay time which starts upon input of the trigger signal.
2. In the RUN sampling mode, the trigger delay time setting is ignored.
3. The setting range is from 0 to 60000msec in units of 1msec.

Figure 2 - 2 below shows an operation example that represents the relationship between the DELAY parameter and the SI parameter.

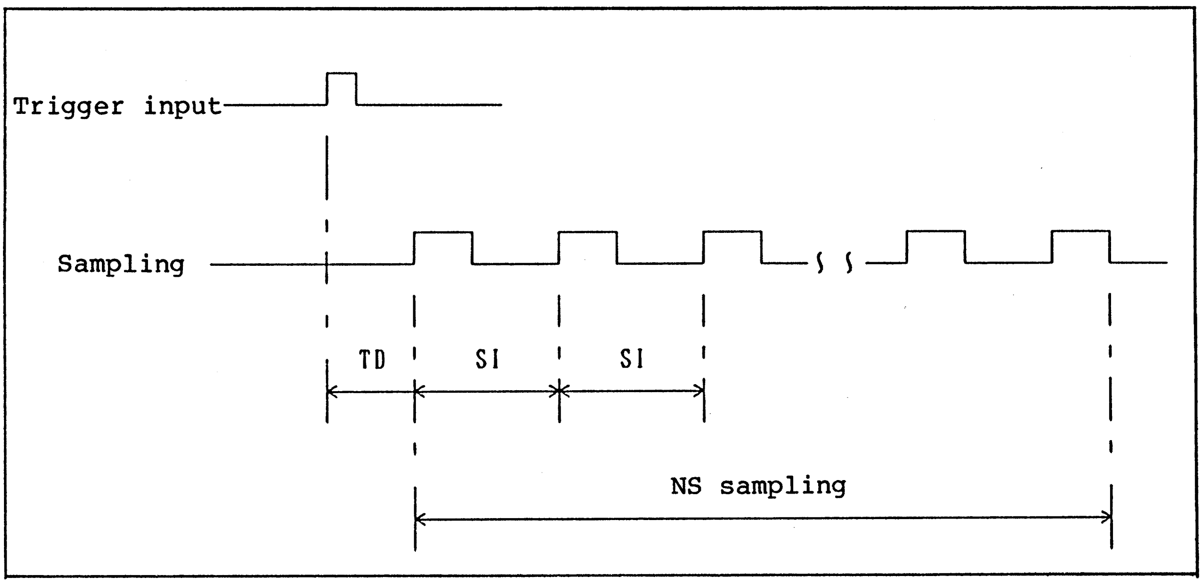


Figure 2 - 2 Operation Example That Represents the Relationship between "DELAY" and "SI" (Sampling Mode : MULTI)

[Setting procedure]

The procedure for setting the trigger delay time is described below.

Setting of DELAY parameter

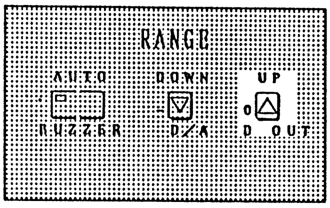
SHIFT

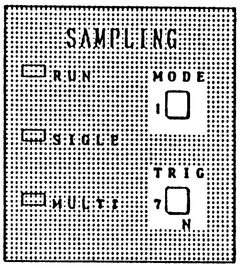
(1) Press the SHIFT key.

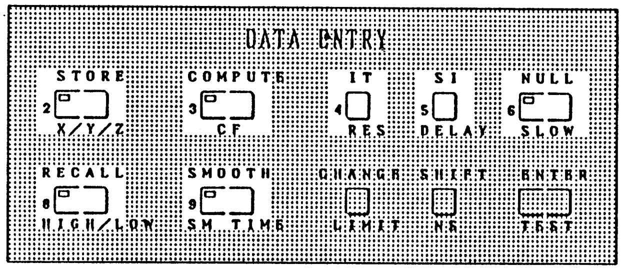
(2) Press the DELAY key.
The trigger delay time last set will then be displayed on the LCD unit.

0 ms

Setting the trigger delay time







(3) Set the desired trigger delay time using the numeric keys 0 to 9. For DELAY parameter setting, 0 through 9 act as numeric keys. The value set here will be displayed on the LCD unit.

(Example)
To set 842, press keys 8, 4, and 2, in that order.

8 4 2 ms

Setting of the trigger delay time completed

ENTER

(4) Press the ENTER key. The displayed trigger delay time will then be stored in memory. This completes setting of the trigger delay time.

2.8.11 SLOW : AC Sampling SLOW/FAST

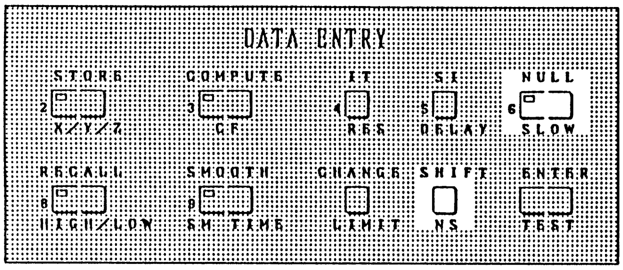
[Functional description]

The SLOW parameter key is used to select a frequency band for AC voltage measurement.
For FAST, the selectable frequency band is from 300Hz to 1MHz. For SLOW, the selectable frequency band is from 20Hz to 1MHz. That is, SLOW should be set for a wider frequency band.

[Setting procedure]

The SLOW/FAST selection procedure for AC voltage measurement is described below.

SLOW parameter setting

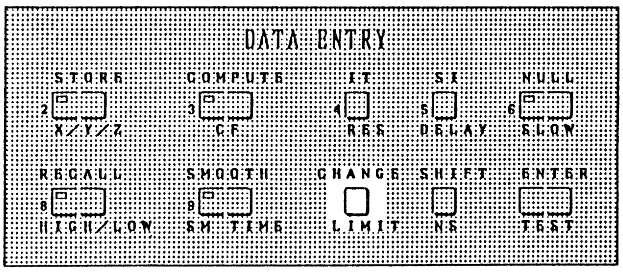


(1) Press SHIFT .

(2) Press SLOW .
The ON or OFF state of the SLOW parameter last set will then be displayed on the LCD unit.
ON : SLOW
OFF : FAST

oFF SL

SLOW/FAST selection



(3) Select SLOW or FAST with the CHANGE key.
Each time CHANGE is pressed, the display changes as follows:
ON (SLOW) ⇄ OFF (FAST)
Display either ON or OFF on the LCD unit in this manner.

oN SL

SLOW parameter setting completed

ENTER

(4) Press ENTER.
The ON or OFF state being displayed on the LCD unit will then be stored in memory. This completes setting of the SLOW parameter.

2.8.12 N

[Functional description]

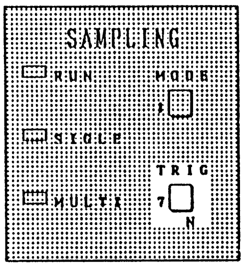
The N parameter is used to set the number of times that data is to be set for statistical computation. The setting range is from 2 to 10000.

[Setting procedure]

The procedure for setting the constant N is described below.

N parameter setting

SHIFT

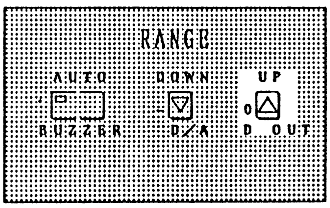


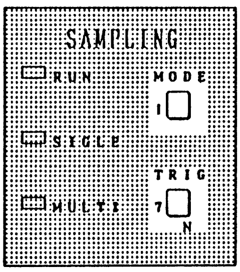
(1) Press SHIFT.

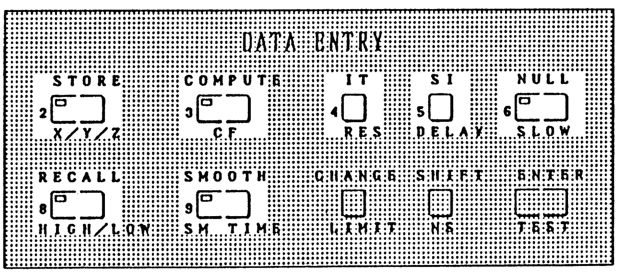
(2) Press N.
The value of the constant N last set will then be displayed on the LCD unit.

2 N

Constant setting







(3) Use numeric keys 0 through 9 to set the value of the constant N. For N parameter setting, 0 through 9 act as numeric keys. The value set here will be displayed on the LCD unit.

(Example)

To set 63, press keys 6 and 3 in that order.

6 3 N

Constant setting completed

(4) Press ENTER .
The value being displayed on the LCD unit will then be stored in memory. Setting of the constant N is now complete.

2.8.13 NS : Number of Samples

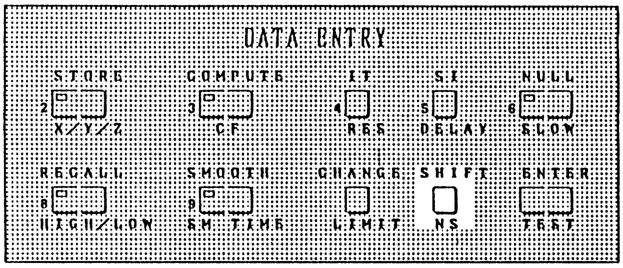
[Functional description]

The NS parameter is used to set the number of samples to be obtained in the MULTI sampling mode and the number of samples to be stored into the data memory. The setting range is from 1 to 10000.

[Setting procedure]

The procedure for setting the number of samples is described below.

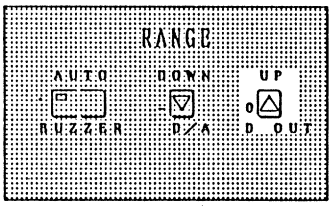
Setting the NS parameter

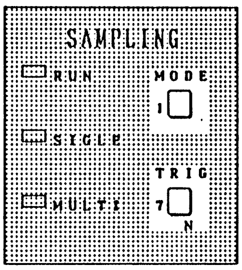


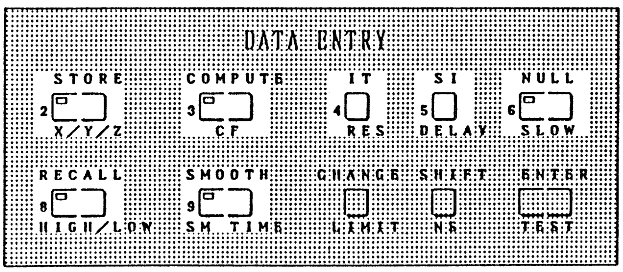
(1) Press SHIFT .
(2) Press NS .
The number of samples that was last set will then be displayed on the LCD unit.

10NS

Setting the number of samples







(3) Use numeric keys 0 through 9 to set the number of samples.
For NS parameter setting, 0 through 9 act as numeric keys.
The value set here will be displayed on the LCD unit.

(Example)
To set 25. press keys 2 and 5 in that order.

25NS

Setting of the number of samples completed

ENTER

(4) Press ENTER.
The value being displayed on the LCD unit will then be stored in memory. Setting of the NS parameter is now complete.

2.8.14 X/Y/Z

[Functional description]

The X/Y/Z parameter is used to set the constants to be included in arithmetic expressions. In addition, use of the MD key allows the data last measured (or arithmetic results) to be set as constants. The range of values that can be set is from ±19999999E-9 to ±19999999E+9.
Depending on the selected computation mode, either the X, the Y, or the Z parameter is to be used as the constant. Therefore, check the appropriate type of parameter for the particular computation mode prior to setting. (See section 3.1, "Computing Functions", for details.)

[Setting procedure]

The procedure for setting the X, Y, or Z parameter is described below.

X/Y/Z parameter setting

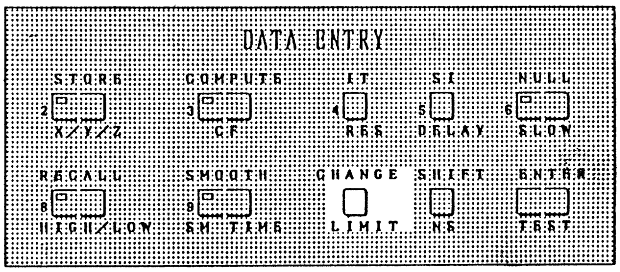
SHIFT

(1) Press the SHIFT key.

(2) Press the X/Y/Z key.
The value last set as the constant X will then be displayed on the LCD unit.

1.0000000 X

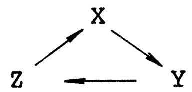
Constant selection



(3) Select the constant to be set.

Use CHANGE to make the selection.

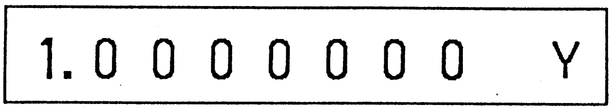
The display changes as follows each time CHANGE is pressed:



In this way. display the desired constant on the LCD unit.

(Example)

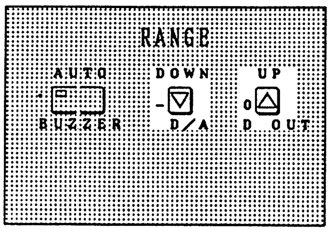
To set Y, press CHANGE once. This causes Y to be displayed.

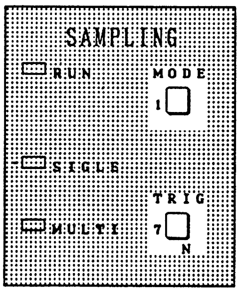


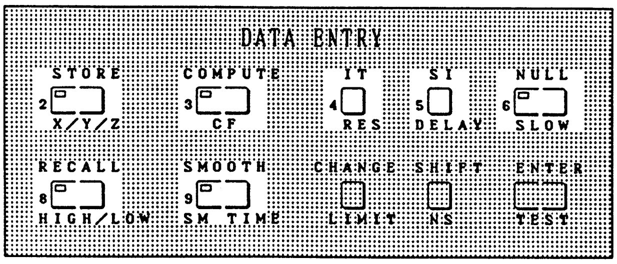
[If two or more constants are to be set]

Only one constant can be set during one setting operation. If three constants (X, Y, Z) are to be set, therefore, report the setting operation three times.

Constant setting







(4) Set each of the mantissa part and exponential part separately, in that order, for one constant.

(a) Setting the mantissa part

The value that has been displayed during constant selection is the mantissa part of the constant.

Set the mantissa part using numeric keys 0 through 9. For X/Y/Z parameter setting, 0 through 9 act as numeric keys.

The value set here will be displayed on the LCD unit.

(Example)

To set 18, press keys 1 and 8 in that order.

18 Y

(b) Setting the exponential part

To set the exponential part, it is necessary firstly to display the exponential part on the LCD unit.

This can be done by pressing the SHIFT key following the completion of setting the mantissa part. This key action will change the display as follows:

Mantissa part

Exponential part

18+0

Pressing a numeric key here will cause the value of the exponential part to change. Use numeric keys to display the desired value on the LCD unit.

(Example)

To set -3, press keys − and 3 in that order.

18−3

Constant setting completed

ENTER

(5) Press the ENTER key. This causes the displayed value to be stored in memory. Setting of the constant is now complete. Repeat the setting procedure from the beginning if another constant is to be set.

2.8.15 HIGH/LOW

[Functional description]

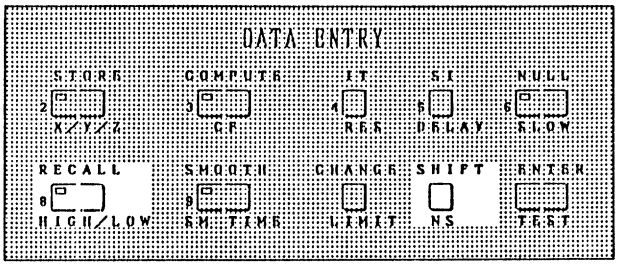
The HIGH/LOW parameter is used to set the upper and lower limit values for COMPARATOR-1 computation. The setting range is from ±19999999E-9 to ±19999999E+9.

[Setting procedure]

The setting procedure for constants HIGH-1, HIGH-2, LOW-1, or LOW-2 is described below.

HIGH/LOW parameter setting

SHIFT

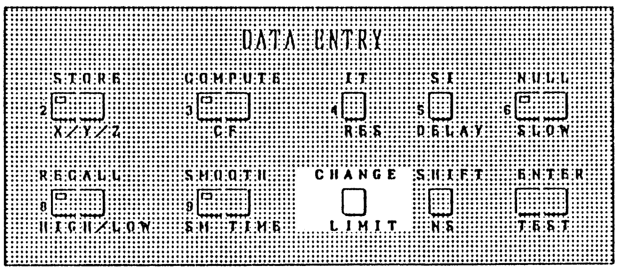


(1) Press the SHIFT key.

(2) Press the HIGH/LOW key. The value last set for constant HIGH-1 (H1) will then be displayed on the LCD unit.

1.0 0 0 0 0 0 0 H 1

Constant selection



(3) Select the constant to be set. Use CHANGE to make the selection. The display changes as follows each time CHANGE is pressed:

H1 (HIGH-1) ⟶ H2 (HIGH-2)
↑ ↓
L2 (LOW-2) ⟵ L1 (LOW-1)

In this way, display the desired constant on the LCD unit.

(Example)

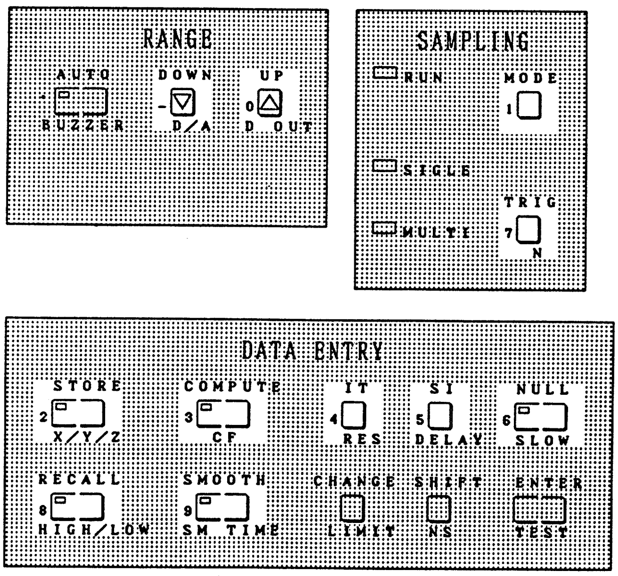
To set L2, press CHANGE three times in succession. This causes L2 to be displayed.

.0 0 0 0 0 0 L 2

[If two or more constants are to be set]

Only one constant can be set during one setting operation. Repeat the setting operation twice to set two constants (HIGH-1 and LOW-1, for example).

Constant setting



(4) Set each of the mantissa part and exponential part separately, in that order, for one constant.

(a) Setting the mantissa part

The value that has been displayed during constant selection is the mantissa part of the constant. Set the mantissa part using numeric keys 0 through 9. For HIGH/LOW parameter setting, 0 through 9 act as numeric keys. The value set here will be displayed on the LCD unit.

(Example)

To set 18, press keys 1 and 8 in that order.

1 8 L 2

(b) Setting the exponential part

To set the exponential part, it is necessary firstly to display the exponential part on the LCD unit. This can be done by pressing the SHIFT key following the completion of setting the mantissa part. This key action will change the display as follows:

Mantissa part

Exponential part

```
18+0
```

Pressing a numeric key here will cause the value of the exponential part to change. Use numeric keys to display the desired value on the LCD unit.

(Example)

To set -3, press keys - and 3 in that order.

```
18-3
```

Constant setting completed

ENTER

(5) Press the ENTER key.

This causes the displayed value to be stored in memory. Setting of the constant is now complete. Repeat the setting procedure from the beginning if another constant is to be set.

2.8.16 LIMIT

[Functional description]

The LIMIT parameter is used to set the reference value and tolerance that are to be used for COMPARATOR-2 computation. The setting ranges of both are:

For reference value : from ±19999999E-9 to ±19999999E+9 (Except 0)
For tolerance (%) : from 0.000 to 100.0 (Real number consisting of four digits or less)

[Setting procedure]

The setting procedure for LIMIT constants (reference value, %1, %2) is described below.

LIMIT parameter setting

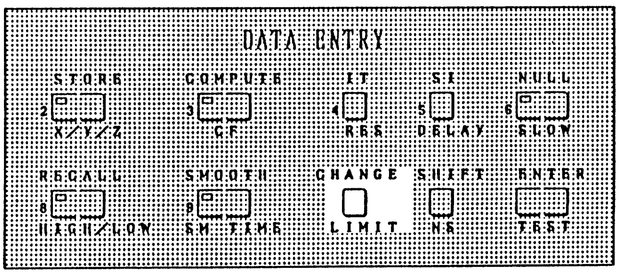
SHIFT

(1) Press the SHIFT key.

(2) Press the LIMIT key.
The value last set for reference value ℓI will then be displayed on the LCD unit.

1.0000000 ℓ I

Constant selection



(3) Select the constant to be set.
Use CHANGE to make the selection.
The display changes as follows each time CHANGE is pressed:

(Reference value)
ℓI
↗ ↘
%2 ← %1

In this way, display the desired constant on the LCD unit.

(Example)

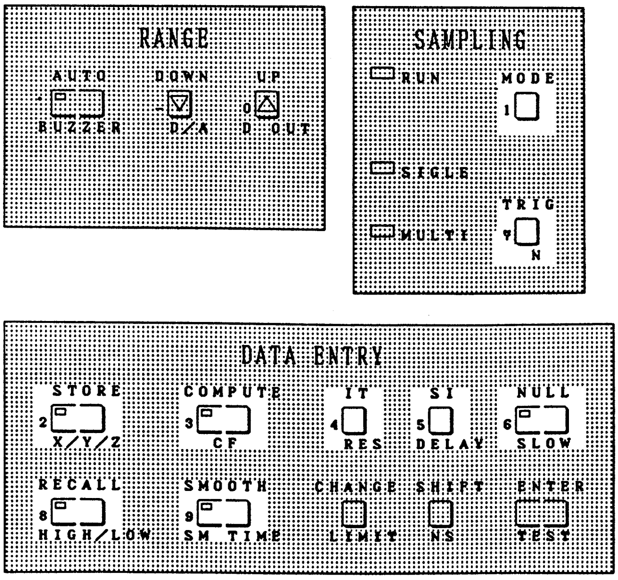
To set %1, press CHANGE once. This causes %1 to be displayed.

1 0 % 1

[If two or more constants are to be set]

Only one constant can be set during one setting operation. Repeat the setting operation three times to set three constants (reference value. %1, %2).

Constant setting



(4) When setting the LIMIT parameter, either the reference value or %1/%2 must be set.

(A) Setting the reference value

Set each of the mantissa part and exponential part separately, in that order, for the reference value.

(a) Setting the mantissa part

The value that has been displayed during constant selection is the mantissa part of the constant. Set the mantissa part using numeric keys 0 through 9. For LIMIT parameter setting, 0 through 9 act as numeric keys. The value set here will be displayed on the LCD unit.

(Example)

To set 18, press keys 1 and 8 in that order.

```
18ℓ 1
```

(b) Setting the exponential part

To set the exponential part, it is necessary firstly to display the exponential part on the LCD unit. This can be done by pressing the SHIFT key following the completion of setting the mantissa part. This key action will change the display as follows:

Mantissa part

Exponential part

```
18+0
```

Pressing a numeric key here will cause the value of the exponential part to change. Use numeric keys to display the desired value on the LCD unit.

(Example)

To set -3, press keys - and 3 in that order.

```
18-3
```

(B) Setting %1 and %2

Set %1 and %2 using numeric keys 0 through 9. For LIMIT parameter setting, 0 through 9 act as numeric keys. The value set here will be displayed on the LCD unit.

(Example)

To set 25, press keys 2 and 5 in that order.

2 5 % 1

Setting of constant completed

ENTER

(6) Press the ENTER key. This causes the displayed value to be stored in memory. Setting of the constant is now complete. Repeat the setting procedure from the beginning if another constant is to be set.

2.8.17 GPIB : GPIB Address Switch

[Functional description]

The GPIB parameter is used with GPIB to set the device address of the TR6871, the address mode, and the format mode for output of measured data.
If "Addressable" is selected as the address mode, addressing from the controller becomes possible.
If "Talk only" is selected as the address mode, data transmission takes place, irrespective of addressing from external devices.
Values 0 through 30 can be set as addresses.

[Setting procedures]

The GPIB setting procedures are described below.

GPIB parameter setting

SHIFT

(1) Press the SHIFT key.

(2) Press the GP-IB key.
The GPIB address parameter data last set will then be displayed on the LCD unit.

H-A-01GP

[Description of parameter data displayed on the LCD unit]
Parameter data consists of the following three parts:

The part where "H" is displayed : Format mode
The part where "A" is displayed : Address mode
The part where "01" is displayed : Address

Detailed description of each of these three parts is given below.

(a) Format mode

In the format mode, the header assumes either an ON or an OFF state.
"H" is displayed when the header is ON.
"-" (underline) is displayed when the header is OFF.

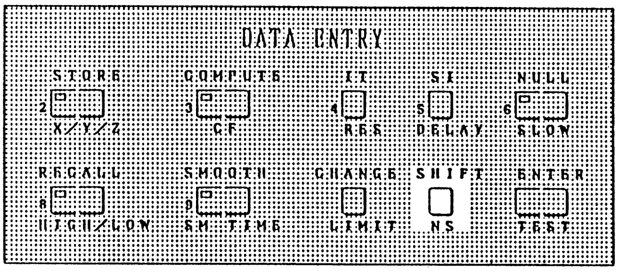
(b) Address mode

The address mode is either "Addressable or "Talk only".
"A" is displayed for "Addressable", and "O" is displayed for "Talk only".

(c) Address

The address can assume a two-digit number from "00" to "30".

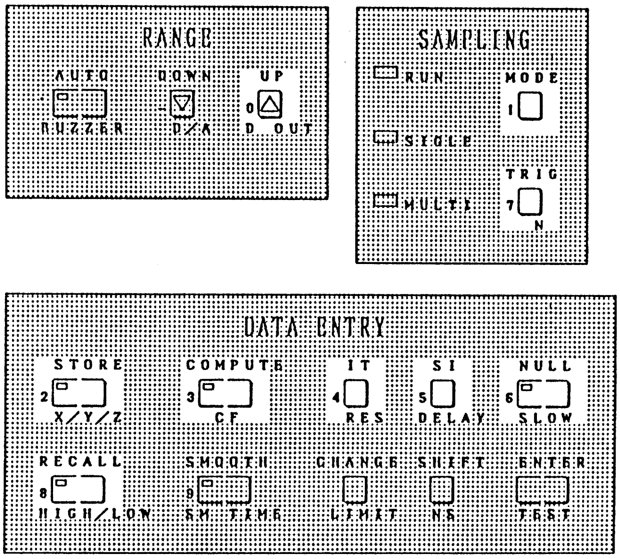
Parameter data selection



(3) Select the type of parameter data to be set. The available types of parameter data are : format mode, address mode. and address. Use SHIFT □ to make the selection. Selection of the desired type of parameter data causes the display of the data to blink. Each time SHIFT □ is pressed, the blinking display position moves as follows:

10^1-digit of address → 10^0-digit of address
↑ ↓
Address mode ← Format mode

Address setting



(4) Press SHIFT □ to make the address display blink. This allows a value to be set in the blinking display position (the 10^1 or the 10^0 digits of the address). Set the desired value using numeric keys. At this time, the blinking display position shifts through one digit to the left or to the right. (It shifts to the right if 10^1-digit data is input, and shifts to the left if 10^0-digit data is input.)
Set a 10^1-digit or a 10^0-digit value.

(Example)

To set the address to "25" in the following state:

Blinking
↓

H – A – 0 1 G P

First, press 2.

Blinking
↓

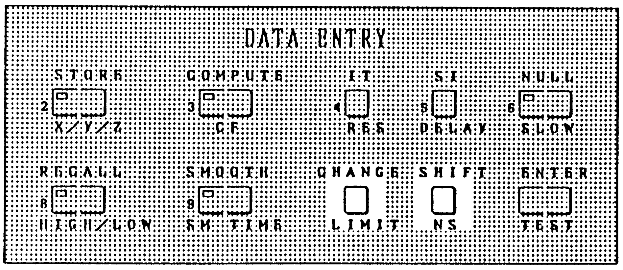
H – A – 2 1 G P

Next, press 5.

Blinking
↓

H – A – 2 5 G P

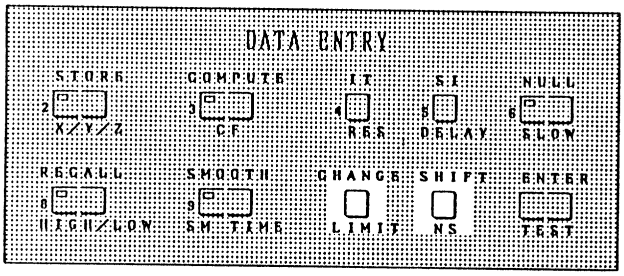
Address mode setting



(5) Make the display of the address mode blink by pressing the SHIFT key. Either "A" or "0" is available as the address mode. Select either using the CHANGE key. The display changes as follows each time CHANGE is pressed:

"A" ⇄ "0"

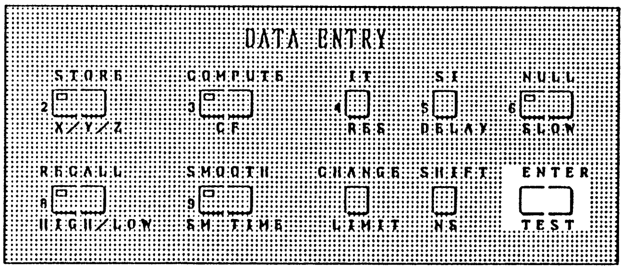
Format mode setting



(6) Using SHIFT, make the display of the address mode blink. Make the display of the format mode blink by pressing the CHANGE key. Either "H" or "_" is available as the format mode. Select either using the CHANGE key. The display changes as follows each time is pressed:

"H" ⇄ "_"

GPIB parameter setting completed



(7) Using ENTER, make the display of the format mode blink. Press the key. The parameter data being displayed on the LCD unit will then be stored in memory. This completes setting of the GPIB parameter.

2.8.18 LINE : Line Frequency

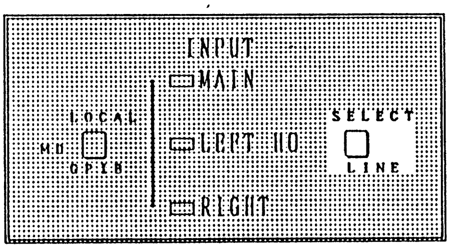
[Functional description]

The LINE parameter is used to set the line frequency of 50Hz or 60Hz at which the equipment is to be operated. The LINE parameter data is not initialized.

[Setting procedure]

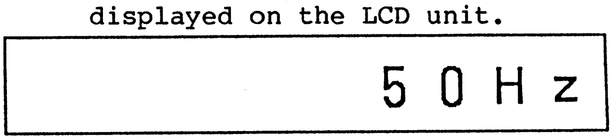
The line frequency setting procedure is described below.

LINE parameter setting

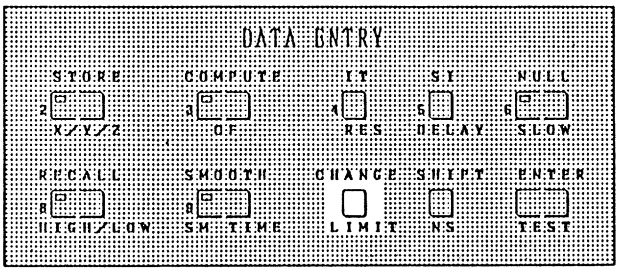


(1) Press the SHIFT key.

(2) Press the LINE key. The line frequency last set will then be displayed on the LCD unit.



Line frequency selection



(3) Select a line frequency of either 50Hz or 60Hz. Use the CHANGE key to make the selection. The display changes as follows each time the CHANGE key is pressed:

50Hz ⇄ 60Hz

In this way, display the required line frequency on the LCD unit.

Line frequency setting completed

(4) Press the ENTER key. This causes the displayed line frequency value to be stored in memory. Setting of the line frequencY is now complete.

2.8.19 SMOOTH

[Functional description]

The SMOOTH parameter is used to implement the smoothing function. The smoothing function is used to eliminate superimposed noise from measurement signals. It allows dispersion in measured data to be reduced since the moving average values previously obtained from raw data measurements during the specified number of times of smoothing are taken as measured data.
The moving average values (measured data existing after smoothing) are described below.
The moving average values refer to the average values of T number of measurements which are the total of T-1 number of measurements existing prior to smoothing and the measurements to undergo smoothing. T indicates the specified number of times of smoothing.
During the time from the start of smoothing to arrival of the specified number of times of smoothing. the average values of all measurements obtained up to that time are displayed on the LCD unit.
Figure 2 - 3 below shows the case of four times of smoothing.

Start of smoothing
↓

Raw data measurements D_1 D_2 D_3 D_4 D_5 D_6 D_7 D_8 D_9 D_{10} D_{11} D_{12}

Measurements existing after smoothing (Moving average values)

D_4
$\frac{1}{2}(D_4+D_5)$
$\frac{1}{3}(D_4+D_5+D_6)$
$\frac{1}{4}(D_4+D_5+D_6+D_7)$
$\frac{1}{4}(D_5+D_6+D_7+D_8)$
$\frac{1}{4}(D_6+D_7+D_8+D_9)$
$\frac{1}{4}(D_7+D_8+D_9+D_{10})$
$\frac{1}{4}(D_8+D_9+D_{10}+D_{11})$
$\frac{1}{4}(D_9+D_{10}+D_{11}+D_{12})$

where Dn denotes the raw data measurement that has been obtained in the nth position.

Figure 2 - 3 Relationship between Raw Data Measurements and the Data Measurements Existing after Smoothing

In general, the nth data measurement D(sm) existing after smoothing has been performed is represented by:

$$D(sm) = \sum_{i=n-T+1}^{n} Di$$

where Di = measured data existing before smoothing
D(sm) = measured data existing after smoothing
T = Number of times that the smoothing operation has been performed (Integer from 2 to 100)

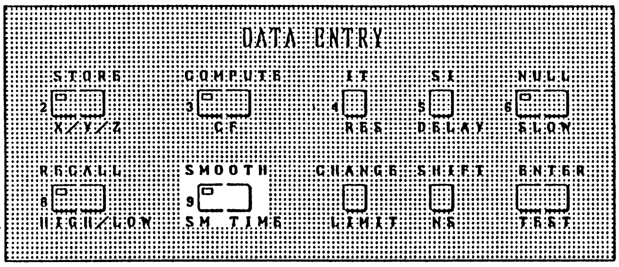
If the following parameters are changed during execution of the smoothing function, the smoothing data obtained up to that time will be initialized and the smoothing function will be performed once again from the beginning in accordance with the newly set number of times of smoothing:

o Measurement function
o Measurement range
o SELECT parameter
o IT parameter
o SLOW parameter
o SM TIME parameter

[Setting procedure]

The procedure for setting the SMOOTH function on or off is described below.

SMOOTH function on/off setting



Set the SMOOTH function on or off using the SMOOTH key. Each time the SMOOTH key is pressed, the lamp of the key alternates between on and off. When the lamp is on, this indicates that the SMOOTH function is set on. When the lamp is off, this indicates that the SMOOTH function is set off. Setting is complete when the lamp is made to turn on or off to obtain the desired state. The lamp, however. remains blinking until smoothing has been performed the specified number of times.

2.8.20 SM TIME : Smoothing Time

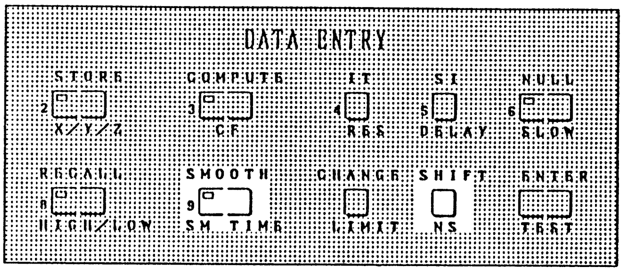
[Functional description]

The SM TIME parameter is used to set the number of times that the smoothing operation is to be performed. See the description of the SMOOTH parameter for details of the smoothing function.
The setting range is from 2 to 100 times.

[Setting procedure]

The procedure for setting the number of times of smoothing is described below.

Setting the SM TIME parameter

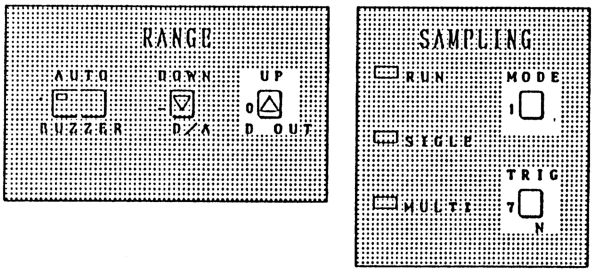


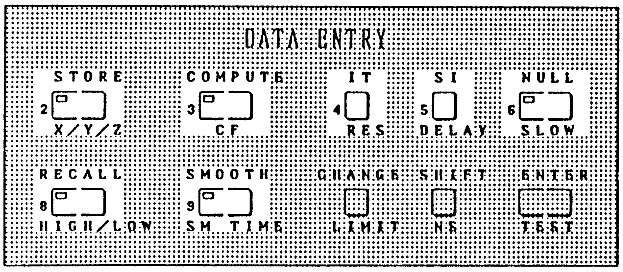
(1) Press the SHIFT Key.

(2) Press the SM TIME key. The number of times of smoothing that was last set will then be displayed on the LCD unit.

10 ST

Setting the number of times of smoothing





(3) Set the desired number of times of smoothing using the numeric keys 0 through 9. For SM TIME setting, 0 through 9 act as numeric keys. The value set here will be displayed on the LCD unit.

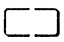
(Example)

To set 12, press keys 1 and 2 in that order.

12 ST

Setting of the number of times of smoothing completed

ENTER



(4) Press the ENTER key.

This causes the displayed value (number of times of smoothing) to be stored in memory. Setting of the number of times of smoothing is now complete.

2.8.21 NULL

[Functional description]

The NULL parameter is used to specify whether or not computation is to be performed with offset values during calculation of measured data. When the NULL key is pressed and the key lamp comes on, the NULL function becomes valid (ON).

The measurement object already connected to the input terminals at depression of the NULL key is measured and the measured values are taken as the NULL values. (Measurement is made over all ranges from the measurement range available for the specified function to the maximum range.) In subsequent measurement operations, measured values from which the NULL values have been subtracted become the measurement results.

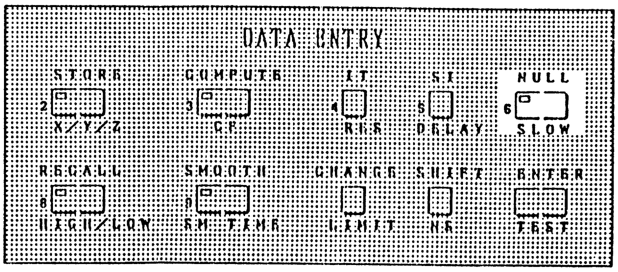
NOTE1 : The auto range function of the equipment is performed on measured data only: it is not performed on the results of NULL computation or smoothing computation.
Thus, an OVER error message may be displayed because of the auto range function even if measurement is not performed in the maximum range.

NOTE2 : The NULL function becomes invalid (OFF) if input data is changed using a measurement function or the SELECT parameter.

[Setting procedure]

The ON/OFF setting procedure for the NULL function is described below.

NULL function ON/OFF setting



Set the NULL function on or off using the NULL key. Each time the NULL key is pressed, the lamp of the key alternates between on and off. When the lamp is on, this indicates that the NULL function is set on. When the lamp is off, this indicates that the NULL function is set off. Setting is complete when the lamp is made to turn on or off to obtain the desired state.

2.8.22 TEST

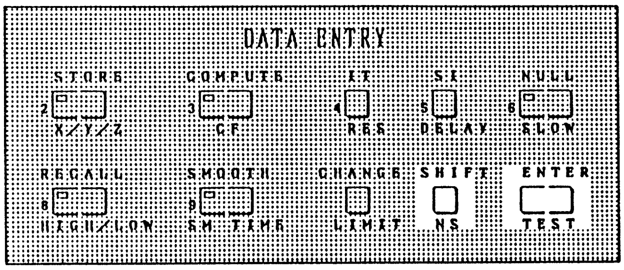
[Functional description]

The TEST parameter is used to set whether or not the self-tests of the equipment are to be performed.

[Setting procedure]

The operating procedure for the self-tests is described below.

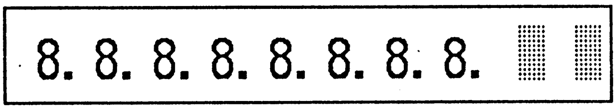
Execution of self-tests



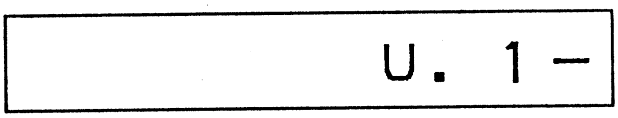
(1) Press the SHIFT key.

(2) Press the TEST key.
This causes the self-tests to be performed. Check the individual test items that are displayed in the following order:

(1) The entire display blinks five times at 1 sec intervals, and a buzzer sound is generated at the same intervals as the blinking intervals.



(2) The revision number of the software is displayed.



(3) The existing line frequency is displayed.

(4) The GPIB address of the TR6871 is displayed.

```
H-A-01GP
```

(5) The name of the module that has been mounted is displayed.

```
___ ___ PI
 ↑   ↑
```

Left-hand side module name   Right-hand side module name

The module name is indicated by the low-order three digits of the equipment model number. If the model number is TR68701, then 701 is displayed.

(6) Which accessory has been mounted is displayed. "-----" is displayed if no accessories have been mounted, and the accessory name (number) is displayed if an accessory has been mounted.

13010
13011
13010

```
_____AC
```

(7) The following display is made when the sum check of the program ROM shows correct results:

```
8.8.8.8.8.8.8.8.RO
```

(8) The following display is made when the sum check of the calibration data saved within the TR6871 and module shows correct results:

```
8.8.8.8.8.8.8.8.CA
```

(9) The following display is made when the READ/WRITE tests of the RAM show correct results:

8. 8. 8. 8. 8. 8. 8. 8. R A

(10) The following display is made when the test of the analog section shows correct results:

8. 8. 8. 8. 8. 8. 8. 8. A D

(11) Automatic calibration is performed and the results are displayed as follows:

A. C A L

(12) The entire display goes out.

2.9 Basic Methods of Operation

This section describes basic methods of operation for DC/AC voltage measurement, DC/AC current measurement, and resistance measurement.

2.9.1 Basic Operations

(1) Make sure that the operating supply voltage is the same as the voltage that has been set using the power connector card located in the rear panel.

(2) Set the POWER switch to the ON position. This causes automatic execution of the self-diagnostic functions. When the equipment is found to be normal, all panel lamps light up during execution of the self-diagnostic functions. (See subsection 2.8.22, "TEST function", for details.)
If an equipment malfunction is detected, then the appropriate error code is displayed. (See section 6.2, "Error Codes", for details.)
Following this, the equipment software revision number, the existing line frequency, the GPIB address, and the accessory mode, which indicates whether or not an accessory is already mounted in the equipment, are each displayed at 1 sec intervals. Check that all these settings match the actual operating conditions.

(3) If no errors are detected throughout the entire execution time of the self-diagnostic functions, then the equipment is set to the operating conditions preset when the POWER switch was last set to the ON position. (Note, however, that the COMPUTE, STORE, and RECALL keys are set to the OFF position whenever power is turned on.)

(4) When execution of the self-diagnostic functions is completed, check each parameter setting to ensure that they match the actual operating conditions, as described below.
First, check that the FUNCTION, RANGE, SAMPLING. and INPUT keys (these are the basic measurement parameter keys) are all set to the correct positions. Next, check that the settings of the A CAL, A ZERO, IT, SI, RES, and NULL parameters (these parameters are used to control the measurement functions and operations) are all correct.

CAUTION

In and environment where temperature suffers significant changes, set the AUTO CAL interval of the A CAL parameter to a small value.

2.9.2 DC Voltage Measurement

(1) Input Impedances

As shown in the table below, the input impedance varies according to the measurement range selected.

Range	200mV	2000mV	20V	200V	1000V
Input impedance	$10^{10}\Omega$ or more			$10M\Omega \pm 0.5\%$	

(2) Input Cables

Connect the MI-37 input cables (supplied) to the lower input terminals of the FRONT or REAR input terminals (select either with the INPUT key). (See Figure 2 - 4 below.)

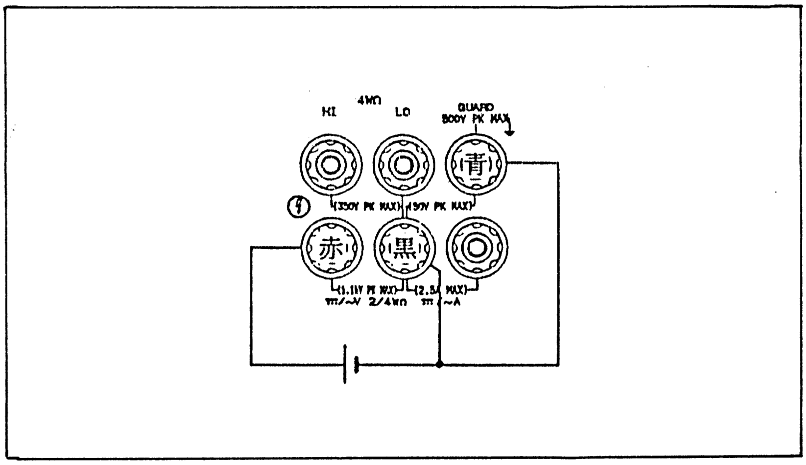


Figure 2 - 4 Input Cable Connection Diagram for DC Voltage Measurement

* The MI-37 has three leads (red, black, blue).

(3) Maximum Input Voltages

The maximum available input voltages are listed in the table below. Take great care to ensure that the maximum input voltage is not exceeded.

Voltage applied between:		Maximum input voltage
Hi terminal - LO terminal	200mV, 2000mV, 20V ranges	$\pm$1100V peak (for 10 sec) $\pm$500V peak (continuous)
	200V, 1000V ranges	$\pm$1100V peak (continuous)
GUARD terminal - chassis		$\pm$500V peak (continuous)
GUARD terminal - LO terminal		$\pm$50V peak (continuous)

(4) If a large influence is likely to result from noise included in measured signals, proceed as follows to minimize reading errors: Setting the integral time (IT) to 1PLC or more will give improved effects of line noise rejection. In addition, a larger IT setting will give more stable measurements since low-frequency-component noise included in measured voltages will also be averaged.

Note : The integral time (IT) is initially set to 5PLC.

See sections 2.8.1 through 2.8.22 for the parameter setting procedures.

CAUTION

The 200mV range (6 1/2 digit display) provides a resolution of 0.1µV/digit). When making measurements, therefore, careful attention should be paid to the occurrence of a thermal electromotive force. A thermal electromotive force of several microvoltages to ten microvoltages per degree C may develop in the form of a thermocouple effect if temperature differences occur in signal wire connections between the clip terminals of measured signals and the input section of the equipment. This thermal electromotive force, if generated, will be added up for each wire connection, appear as zero drift, and thus result in significant measurement errors. Therefore, strictly observe the following precautions:

(1) Notes on the connections of the measurement terminals

o Keep your hands away from the end of an input cable during measurement.

o Read the measured data only after a sufficient temperature balance has been attained.

o Do not make measurements in places where air circulates.

(2) Notes on the ambient conditions of the equipment

o Allow a sufficient warm-up time (approximately 60 minutes) after power has been turned on.

o Also take a sufficient warm-up time when making measurements in places where significant temperature differences occur.

o Avoid installing the equipment in places where air circulates.

2.9.3 Resistance Measurement

(1) Measurement Currents

Resistance measurement currents are listed in the table below.

Range	100Ω	1000Ω	10kΩ	100kΩ	1000kΩ	10MΩ
Measurement current	13mA	13mA	1.3mA	133μA	13μA	1.3μA

(2) Voltages between Open Terminals

Resistance measurement voltages between open terminals (current source terminals) are listed in the table below.

Range	100Ω	1000Ω	10kΩ	100kΩ	1000kΩ	10MΩ
Voltage between open terminals	30V			22V		

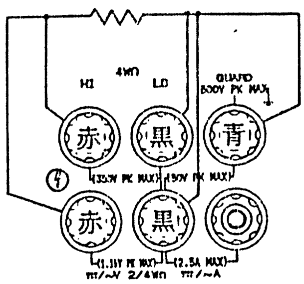
(3) Maximum Input Voltages

The maximum input voltages are listed in the table below. Take extra care to ensure that the voltages are not exceeded.

Voltage applied between:	Maximum input voltage (continuous)
Between measurement terminals	±350Vpeak
GUARD terminal - chassis	±500Vpeak
GUARD terminal - measurement terminal	±500Vpeak

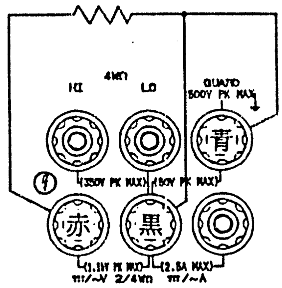
(4) Input Cables

Figure 2 - 5 shows the input cable connection diagrams for 2- wire and 4-wire system resistance measurement. For 2-wire system resistance measurement, use the A01005 input cables (supplied). For 2-wire system resistance measurement, use the MI-37 input cables (supplied).



The A01005 has five leads (red, black, blue).

4-wire system (A01005)



2-wire system (MI-37)

Figure 2 - 5 Input Cable Connection Diagrams for Resistance Measurement

(5) 2-wire System Resistance Measurement

The NULL function of the equipment is effective for measurement ranges in which the resistance of the MI-37 input cable (approximately 0.5Ω) becomes an error. (See subsection 2.8.21, "NULL".)
When using the NULL function, the end of the input cable must be short-circuited and the resistance of that cable measured in advance. Subtracting this value from subsequent measurements makes it possible to prevent the resistance of the input cable from becoming an error.

CAUTION

When measuring resistances using the 10MΩ range or higher, apply a shielding case over the resistor to be measured, in order to achieve the maximum high accuracy of measurement. (See Figure 2 - 6.) In addition, fix the input cable to prevent its sagging during measurement. and take special notice of noise induced from peripheral measuring instruments.

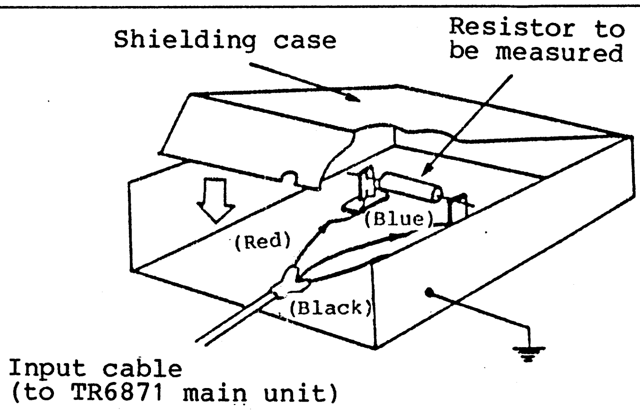


Figure 2 - 6 Shielding Example for Resistance Measurement

2.9.4 DC Current Measurement

(1) Maximum Permissible Current Applied

The maximum permissible current applied is 2.5 A for the range from 2000μA to 2000mA.
If a protective fuse has blown due to an excessive input current, replace the current fuse (A FUSE), which is located in the lower central section of the front panel, with the required one (2A).
The fuse can be removed by turning the fuse holder counterclockwise with a light push upon the fuse holder. Make the input cable connection securely: the circuit under measurement may be adversely affected if the input cable becomes disconnected during measurement.

(2) Input Impedances

Range	2000μA	20mA	200mA	2000mA
Input impedance	102Ω or less	12Ω or less	3Ω or less	2Ω or less

(3) Input Cables

Figure 2-7 shows the input cable (MI-37) connection diagram for DC current measurement.

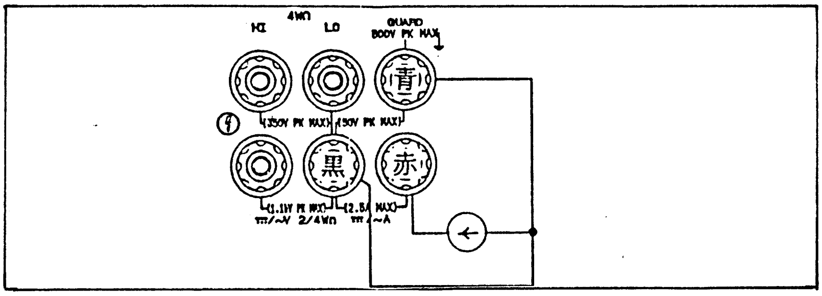


Figure 2 - 7 Input Cable Connection Diagram for DC Current Measurement

2.9.5 AC Voltage Measurement (DC Voltage + AC Voltage)

(1) Input Impedances

The input impedance varies according to the measurement range selected, as shown in the table below. The input impedance for each range is shown below.

Range	200mV	2000mV	20V	200V	500V
Input impedance	1MΩ ± 2% 300pF or less AC coupled				

(2) Input Cables

Connect the MI-37 input cables (supplied) to the lower input terminals of the FRONT or REAR input terminals (select either with the INPUT key). (See Figure 2-8 below.)

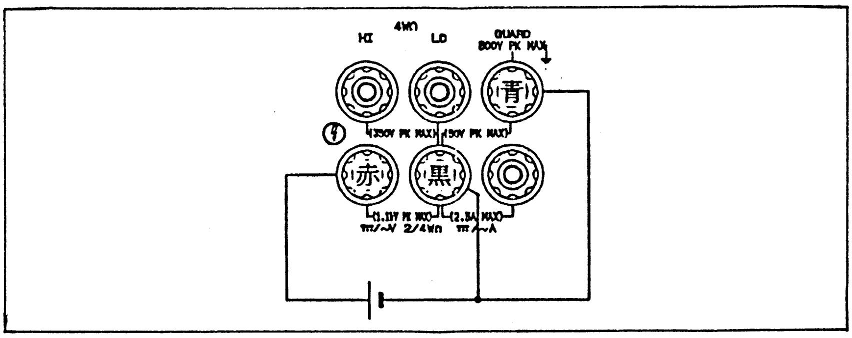


Figure 2 - 8 Input Cable Connection Diagram for AC Voltage Measurement

* The MI-37 has three leads (red, black, blue).

(3) Maximum Input Voltages

The maximum available input voltages are listed in the table below. Take great care to ensure that the maximum input voltage is not exceeded.

Voltage applied between:		Maximum input voltage
HI terminal - LO terminal	200mV, 2000mV, 20V 200V, 500V ranges	HI terminal - LO terminal 500Vrms 750V peak

(4) If a large influence is likely to result from noise included in measured signals, proceed as follows to minimize reading errors: Setting the integral time (IT) to 1PLC or more will give improved effects of line noise rejection. In addition, a larger IT setting will give more stable measurements since low-frequency-component noise included in measured voltages will also be averaged.

Note : The integral time (IT) is initially set to 5PLC.

See sections 2.8.1 through 2.8.22 for the parameter setting procedures.

2.9.6 AC Current Measurement (DC Current + AC Current)

(1) Maximum Permissible Current Applied

The maximum permissible current applied is 2.5A rms for the range from 2000μA to 2000mA.
If a protective fuse has blown due to an excessive input current, replace the current fuse (A FUSE), which is located in the lower central section of the front panel, with the required one (2A).
The fuse can be removed by turning the fuse holder counterclockwise with a light push upon the fuse holder.
Make the input cable connection securely; the circuit under measurement may be adversely affected if the input cable becomes disconnected during measurement.

(2) Input Impedances

Range	Input impedance
2000μA	102Ω or less
20mA	12Ω or less
200mA	3Ω or less
2000mA	2Ω or less

(3) Input Cables

Figure 2-9 shows the input cable (MI-37) connection diagram for AC current measurement.

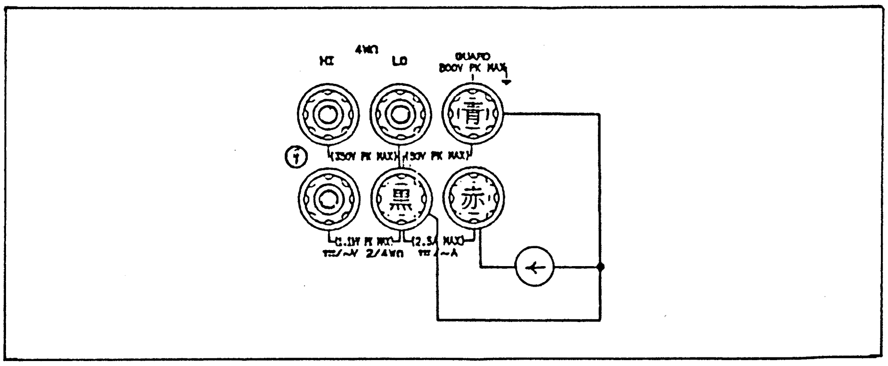


Figure 2 - 9 Input Cable Connection Diagram for AC Current Measurement

3. OPERATING METHOD - 2 (COMPUTING FUNCTIONS AND MEMORY FUNCTIONS)

3.1 Computing Functions

3.1.1 General

Two types of computing functions are provided : primary computing functions and secondary computing functions.

Only the names of the primary and secondary computing functions are listed here. Detailed description of the various functions is given in subsection 3.1.3 onward.

(1) Primary Computing Functions

① SCALING

② %DEVIATION

③ DELTA

④ MULTIPLY

⑤ DECIBEL CONVERSION

⑥ RMS VALUE

⑦ dBm CONVERSION

⑧ RESISTANCE VALUE TEMPERATURE COMPENSATION

(2) Secondary Computing Functions

① COMPARATOR-1

② COMPARATOR-2

③ STATISTICAL PROCESSING

Notes on description of each computing function

(1) Symbols Used in Calculation Expressions

* : Multiplication symbol
Σ : Cumulative addition symbol
/ : Division symbol

(2) Each of the computation results displays shown by way of example is for the case of 7 1/2-digit display.
In actuality, the symbol 'E' for the exponential part is not displayed.

Subsection 3.1.2, "Constant setting and the display of computation results", should be read before proceeding to description of each computing function.

3.1.2 Constant Setting and the Display of Computation Results

(1) Constant Setting

In principle, constants should be set in fundamental units.

Unless otherwise specified, real-number constants must be set in floating point BCD (binary coded decimal) form.

The setting range is from -19999999 E9 to 199999999 E9
(+/- 1.9.9.9.9.9.9.9. +/-E9).

Only the mantissa part can be set if the exponential part is 0, and integers can be input if the exponential part is an integer.

Constants X, Y, Z, HIGH-1, HIGH-2, LOW-1, LOW-2, and LIMIT can be set to the previous values using the MD key.

(2) Display of Computation Results

1 Computation results are rounded up or off, depending on the output digit mode.

2 OL (overload) is displayed if the particular measured value is out of the permissible range.

The units display section displays the units of measurement that correspond to the computation results.

3 For the display formats of computation results, see the description of the computation items.

CAUTION

1 Fundamental units
Voltage measurement : V
Current measurement : A
Resistance measurement : Ω

2 The COMPUTE key is automatically set to the OFF position if changes are made to the computation mode or constant settings during execution of a computing operation.

3.1.3 SCALING

[Data operated on]

SCALING allows computation to be made on the following data :
(1) Measured data
(2) Data that has been recalled from the data memory

[Calculation expression]

$$R = \frac{D - Y}{X} * Z$$

R : Results of computation
D : Data to be operated on
X : Constant (Set value)
Y : Constant (Set value)
Z : Constant (Set value)

[Setting range of constants]

X, Z : ±19999999 E-9 to ±19999999 E+9 (except 0)
Y : ±19999999 E-9 to ±19999999 E+9

[Display of computation results]

The significant digits in each measured value are automatically identified and the computation results are displayed in the following order of priority :

(1) R : -19999999 to +19999999
This value is displayed in the units of measurement.

(2) R : ±19999999 E-19 to ±19999999 E+19
This value is displayed in the fundamental units of each measurement function.
However, if the particular value has an exponential part, then the fundamental units are not displayed.

(3) In the fundamental units, a computation error message is displayed if the exponential part is larger than E+19, and "0. E-19" is displayed if the exponential part is smaller than E-19.

[Applications]

Output signals from pressure, thermal, distortion, and other such sensors and transducers can be measured. Direct reading of these measurements is possible because they can be converted into the units that correspond to the respective physical quantities.

(1) Setting "Y=0, Z=I" allows a $\frac{D}{X}$ calculation to be made, thus giving the results of division of data by the desired value (X).

Using this computation, it is also possible to measure the voltage drop (D) across the resistor (X) and directly read the value of the current flowing through the resistor.

(2) Setting "X=Z=1" allows R=D-Y calculation and hence elimination of offset values.

(3) Offset values and slope-compensated scaling factors can be obtained by first assigning to Y the sensor output value existing when the sensor input is zero and then assigning to X the span value between the zero and full-scale of the sensor input level so that Z becomes equal to 1.

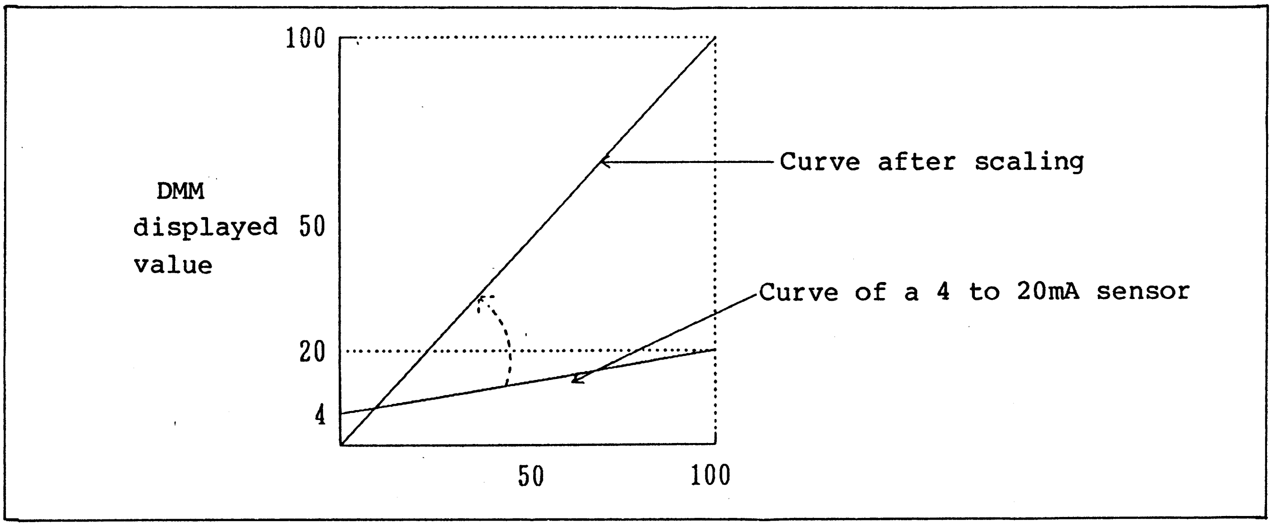


Figure 3 - 1 Sensor Inputs (Pressure, Temperature, Distortion, etc.) [Scaling for Direct Reading of 4mA to 20mA Sensor or Transmitter Values]

Calculation expression for scaling

$$R = \frac{D - Y}{X} * Z$$

R : Results of computation
D : Data to be operated on
X : 0.16
Y : 4
Z : 1

$$R = \frac{D - 4}{0.16}$$

3.1.4 %DEVIATION

[Data operated on]

DEVIATION allows computation to be made on the following data :
(1) Measured data
(2) Data that has been recalled from the data memory

[Calculation expression]

$$R = \frac{D - X}{X} * 100$$

R : Results of computation
D : Data to be operated on
X : Constant (Set value)

[Setting range of constants]

X : ±19999999 E-9 to ±19999999 E+9 (except 0)

[Display of computation results]

R : -1999.9999 to +1999.9999
Unit : Display is made in %.
A computation error message is displayed if the particular R value is out of the permissible range.

[Applications]

This function can be applied to selection, ranking, etc. of resistors or other circuit components. Setting a reference value to X makes it possible for the deviation of data D from X to be obtained in percentage terms.

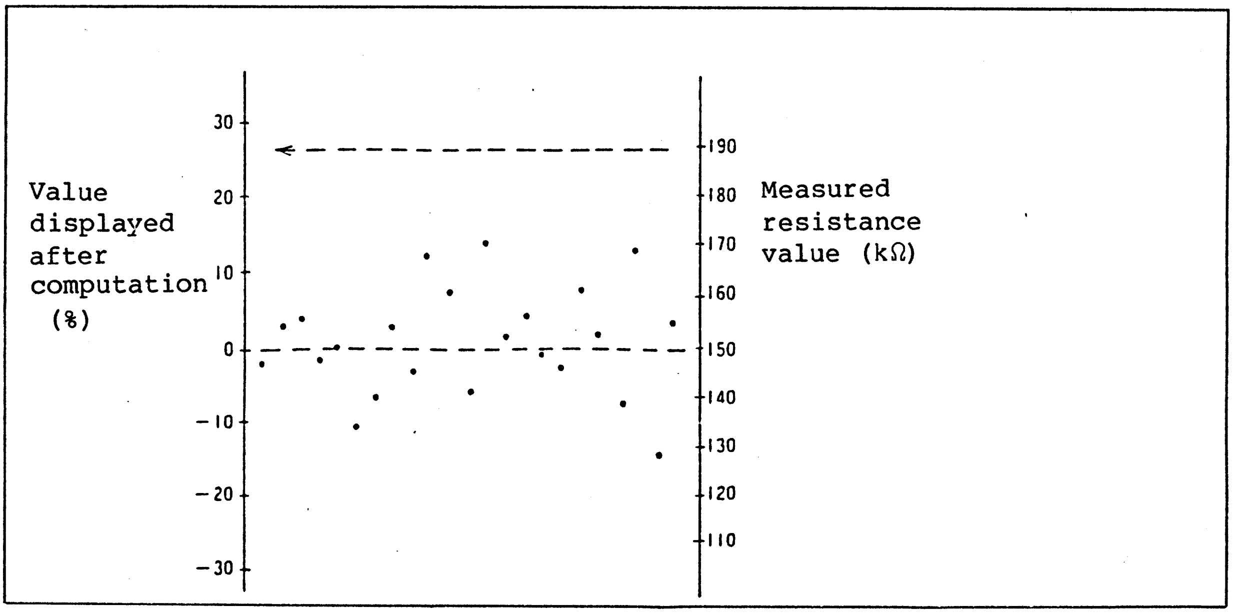


Figure 3 - 2 Application Example of Ω Deviation Calculation
(Measurement of Resistance Value Deviation
with Y Set Equal to 150kΩ)

3.1.5 DELTA

[Data operated on]

DELTA allows computation to be made on the following data :
(1) Measured data
(2) Data that has been recalled from the data memory

[Calculation expression]

R = Dt - Dt-1

R : Results of computation
Dt : Data to be measured at time t
Dt-1 : Data to be measured during the sampling operation that precedes time t

[Display of computation results]

R : -19999999 to +19999999

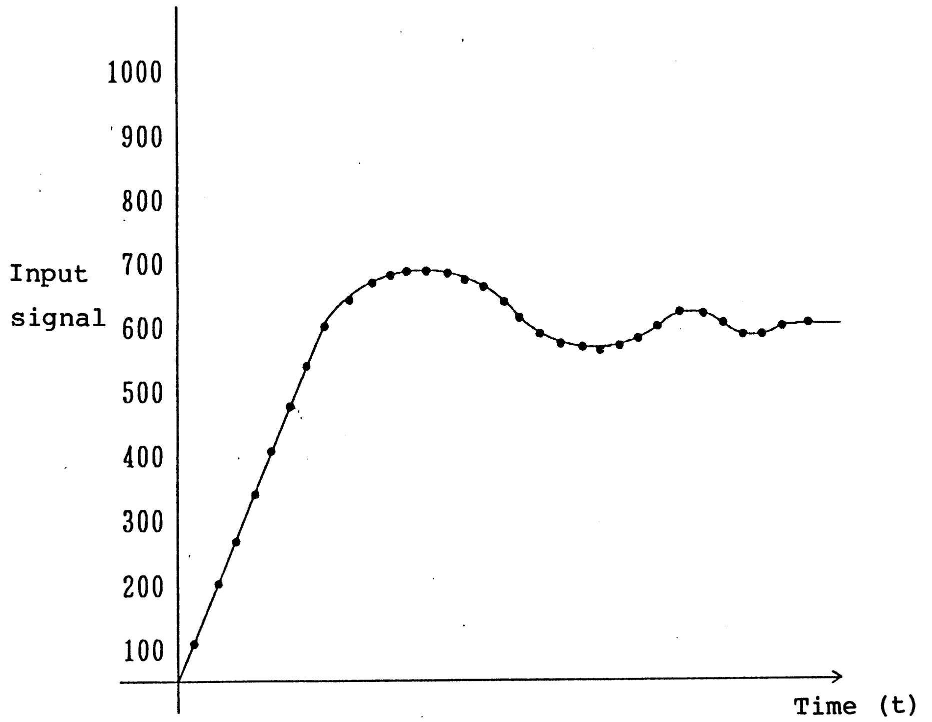
This value is displayed in the units of measurement.
A computation error message is displayed if the particular R value is out of the permissible range.

[Notes on execution of computation]

When DELTA computation is performed, the data to be operated on will be displayed as the results of the first processing operation.
In the second and subsequent processing operations, the results of computation will be displayed.

[Applications]

This function allows display of input signal variations for each sampling interval. Differential values of the input signal are therefore obtained. This computation function is effective when the input signal is judged to be in a stable state (that is, below the required level) by monitoring variations in temperature' pressure' etc.



This graph shows measure values. Variations in the measured values are shown in the graph of Figure 3 - 3.

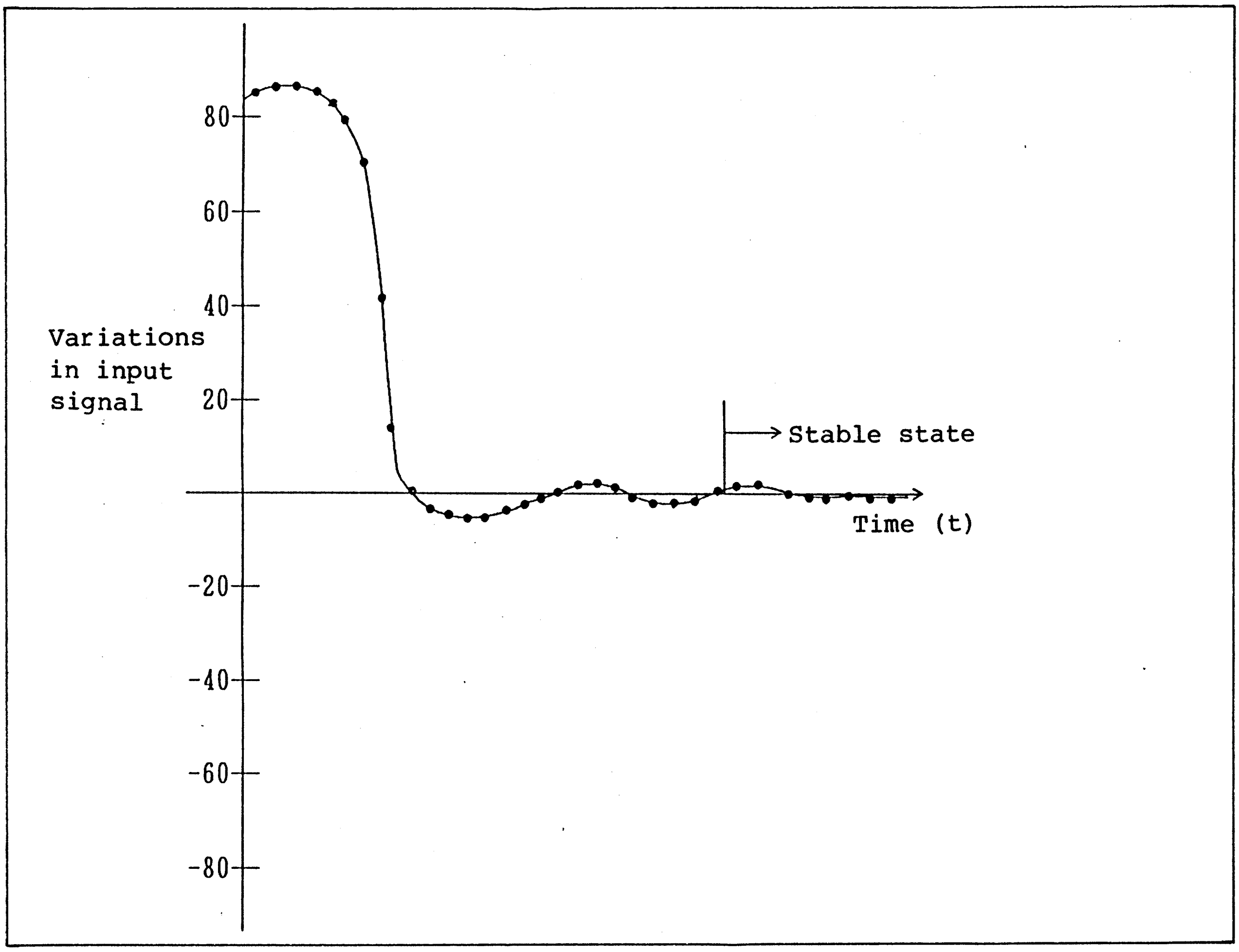


Figure 3 - 3 Application Example of DELTA Processing

3.1.6 MULTIPLY

[Data operated on]

MULTIPLY allows computation to be made on the following data :
(1) Measured data
(2) Data that has been recalled from the data memory

[Calculation expression]

R = Dt * Dt-1

R : Results of computation
Dt : Data to be measured at time t
Dt-1 : Data to be measured during the sampling operation that precedes time t

[Display of computation results]

R : ±19999999 E-19 to ±19999999 E+19

This value is displayed without units.
A computation error message is displayed if the exponential part of the value is out of the E+19 range.
"0. E-19" is displayed if the exponential part of the value is out of the E-19 range.

[Notes on execution of computation]

① When MULTIPLY computation is performed, the data to be operated on will be displayed as the results of the first processing operation. In the second and subsequent processing operations, the results of computation will be displayed.

② MULTIPLY computation continues even if changes are made to the measurement function settings during the computing operation. (The product between V, A, and Ω can be obtained.)

3.1.7 dB (Decibel Conversion)

Decibel conversion allows the following data to be operated on :
(1) Measured data
(2) Data that has been recalled from the data memory

[Calculation expression]

$$R = 20 * Y * \log_{10} \left| \frac{D}{X} \right|$$

R : Results of computation
D : Data to be operated on
X : Constant (Set value)
Y : Constant (Set value)

[Setting range of constants]

X : ±19999999 E-9 to ±19999999 E+9 (except 0)
Y : ±19999999 E-9 to ±19999999 E+9

[Display of computation results]

R : -1999.9999 to +1999.9999
This value is displayed in dB.
A computation error message is displayed if the output range has been overstepped.

[Notes on execution of computation]

A computation error message is displayed if the data to be operated on (D) has become zero during dB computation.

[Applications]

This function is effective typically for the following two cases :

(1) When obtaining the voltage gain level
Setting the input signal voltage value to "Y=1, X" and then measuring the output voltage will cause :

$$Gv = 20\log_{10}\left|\frac{D}{X}\right|$$

The voltage gain level can be obtained from this expression.

(2) When obtaining the current gain level
Setting the input signal current value to "Y=1, X" and then measuring the output current will cause :

$$Gi = 20\log_{10}\left|\frac{D}{X}\right|$$

The current gain level can be obtained from this expression.

3.1.8 RMS Value (Effective Value)

[Data to be operated on]

RMS Value allows the following data to be operated on :
(1) Measured data
(2) Data that has been recalled from the data memory

[Calculation expression]

$$R = \sqrt{\frac{\sum_{K=1}^{X} Dk^2}{X}}$$

R : Results of computation
Dk : Data to be operated on
X : Constant (Set value)
K : Variable that takes an integer from 1 to X

[Setting range of constants]

X : Integer from 2 to 10000
(If a real number is input, it will be rounded into an integer.)

[Display of computation results]

The significant digits in the final measured value are automatically identified and the computation results are displayed in the following order of priority :

(1) R : 0 to 19999999
Display is made in the measurement unit of the final data.

(2) R : 19999999 E-19 to 19999999 E+19
Display is made in the fundamental units of each measurement function.
However, if the particular value has an exponential part, then the exponential part is displayed and the fundamental units are not displayed.

(3) In the fundamental units, a computation error message is displayed if the exponential part is larger than E+19, and "0. E-19" is displayed if the exponential part is smaller than E-19.

[Notes on execution of computation]

① When RMS computation is selected, the RMS lamp under the display section will light and the entire display will go out until the first results of computation are obtained. The computation results are displayed when measurement has been performed the number of times that has been set using the constant X.

② If the data range that has been previously set is overstepped during RMS computation, then the data measurements become invalid and are excluded from the total number of measurements.

③ Changes to the measurement function settings during RMS computation causes initialization of the data that has been set using the old settings of the measurement functions. In that case, computation restarts from the beginning.

[Operating notes]

① When the HOME key is pressed during execution of the RMS function, the result of the RMS function for measured number is displayed and the function is continued newly.

② When the HOME key is pressed during execution of function in the data memory recall mode, the conventional function data is initialized and the store data is displayed again (initial state of recall mode).

3.1.9 dBm (dBm conversion)

[Data to be operated on]

dBm conversion allows the following data to be operated on :
(1) Measured data
(2) Data that has been recalled from the data memory

[Calculation expression]

$$R = 10 * \log_{10} \frac{D^2/X}{1mW}$$

R : Results of computation
D : Data to be operated on
X : Reference resistance value (Ω)

[Starting range of constants]

X : 0 to 19999999E9 (except 0)

[Display of computation results]

R : -1999.9999 to +1999.9999

Unit : dBm
Display is made in Bm.
A computation error message is displayed if the output range has been overstepped.

[Applications]

This function is affective for calculation of power gain.
If the resistance value at which the voltage D has been measured is set to X, then the calculation expression is given and the power gain can be obtained from the expression.

$$G_w = 10 * \log_{10} \frac{D^2/X}{1mw}$$

[Operating notes]

dBm computation is effective only for voltage measurement.
The COMPUTE key is automatically turned off if the voltage measurement function is changed over to another function during dBm computation.

3.1.10 Resistance Value Compensation (20 degrees Centigrade)

[Data to be operated on]

Resistance value compensation allows the following data to be operated on :
(1) Measured data
(2) Data that has been recalled from the data memory

[Calculation expression]

$$R20 = \frac{Rx}{1 + 0.00393\ (X-20)} * \frac{1000}{Y}$$

R20 : Electric wire with resistance value as converted into 20°C (per km)
Rx : Resistance value measured at a temperature of X°C (Ω)
X : Room temperature during measurement (°C)
Y : Length of measured cable (m)

[Setting range of constants]

X : Room temperature during measurement (°C)
(±19999999 E-9 to ±19999999 E+9)
Y : Length of measured cable (m)
(0 to 19999999E9) (except 0)

[Display of computation results]

The significant digits in the final measured value are automatically identified and the computation results are displayed in the following order of priority :

(1) R : -19999999 to +19999999
Display is made in the measurement unit.

(2) R : ±19999999 E-19 to ±19999999 E+19
Display is made in the fundamental unit (Ω).
However, if the particular value has an exponential part, then the exponential part is displayed and the fundamental unit is not displayed.

(3) For the fundamental unit, a computation error message is displayed if the exponential part is out of the E+19 range, and "0. E-19" is displayed if the exponential part is out of the E-19 range.

[Applications]

This computation expression is used mainly in electric wire manufacturers to convert the resistance values of annealed copper wires (IEC standard type) at $20^{\circ}C$ into those existing at $X^{\circ}C$.

[Operating notes]

Resistance value compensation is effective only for resistance measurement.
The COMPUTE key is automatically turned off if the resistance measurement function is changed over to another function during resistance value compensation computation.

3.1.11 COMPARATOR-1

[Data to be operated on]

COMPARATOR-1 allows the following data to be operated on :
(1) Measured data
(2) Data that has undergone primary computation processing
(3) Data that has been recalled from the data memory

[Calculation expression]

If HIGH 2 < D, then R (H2)
If HIGH 1 < D ≤ HIGH 2, then R (H1)
If LOW 1 ≤ D ≤ HIGH 1, then R (PASS)
If LOW 2 ≤ D < LOW 1, then R (L1)
D < LOW 2, then R (L2)

R( ) : Results of computation of each item
D : Data to be operated on
HIGH 1 : Constant (set value), upper-limit value 1
HIGH 2 : Constant (set value), upper-limit value 2
LOW 1 : Constant (set value), upper-limit value 1
LOW 2 : Constant (set value), upper-limit value 2

[Setting range of constants]

HIGH 1, HIGH 2, LOW 1, LOW 2 : ±19999999 E-9 to ±19999999 E+9
where HIGH 1 ≤ HIGH 2
LOW 2 ≤ LOW 1 (Permitted if HIGH < LOW)

[Display computation results]

The computation results are indicated by lamps as follows according to the classification of the results :

If R (H2), the HIGH lamp lights.
If R (H2), the HIGH lamp flashes.
If R (PASS), the PASS lamp lights.
If R (L1), the LOW lamp flashes.
If R (L2), the LOW lamp lights.

The data on which COMPARATOR-1 computation has been performed is displayed on the LCD unit.

[When the BUZZER parameter has been set]

(1) If the BUZZER parameter setting is ON-1 :
A buzzer sound is generated when the computation results are R (H2), R (H1), R (L1), or R (L2).

(2) If the BUZZER parameter setting is ON-2 :
A buzzer sound is generated when the computation results are R (PASS).

[Applications]

The R (H2), R (H1), R (PASS), R (L1), or R (L2) signals can be used to control external devices through relay output units.

3.1.12 COMPARATOR-2

[Data to be operated on]

COMPARATOR-2 allows the following data to be operated on :
(1) Measured data
(2) Data that has undergone primary computation processing
(3) Data that has been recalled from the data memory

[Calculation expression]

If H2 = LIMIT + %2
If H1 = LIMIT + %1
If L1 = LIMIT - %1
If L2 = LIMIT - %2

then data D is compared with H1, H2, L1, and L2 and the results are sorted out according to which is larger.

If H2 $<$ D, then R (H2)
If H1 $<$ D $\leq$ H2, then R (H1)
If L1 $\leq$ D $\leq$ H1, then R (PASS)
If L2 $\leq$ D $<$ L1, then R (L1)
D $<$ L2, then R (L2)

R( ) : Results of computation of each item
D : Data to be operated on
LIMIT : Constant (set value); reference value
%1 : Constant (set value); tolerance (% deviation from reference value)
%2 : Constant (set value), tolerance (% deviation from reference value)

[Setting range of constants]

LIMIT : Reference value
±19999999 E-9 to ±19999999 E+9 (except 0)
%1, %2 : Tolerance (in %)
0.000 to 100.0 (Real number consisting of four digits or less)
where %1 $\leq$ %2

[Display computation results]

The computation results are indicated by lamps as follows according to the classification of the results :

If R (H2), the HIGH lamp lights.
If R (H1), the HIGH lamp flashes.
If R (PASS), the PASS lamp lights.
If R (L1), the LOW lamp flashes.
If R (L2), the LOW lamp lights.

The % deviation value into which the operated data has been converted with respect to the reference value is displayed on the LCD unit.

[When the BUZZER parameter has been set]

(1) If the BUZZER parameter setting is ON-1 :
A buzzer sound is generated when the computation results are R (H2), R (H1), R (L1), or R (L2).

(2) If the BUZZER parameter setting is ON-2 :
A buzzer sound is generated when the computation results are R (PASS).

3.1.13 STATISTICS (Statistical processing)

[Data to be operated on]

Statistical processing allows the following data to be operated on :
(1) Measured data
(2) Data that has undergone primary computation processing
(3) Data that has been recalled from the data memory

[Calculation expression]

The meaning of computation results and the calculation expression are shown below.

R (COUNT) : Number of samples
R (MAX) : Maximum value
R (MIN) : Minimum value
R (AVE) : Average value

$$R(AVE) = \frac{\sum_{K=1}^{N} Dk}{N}$$

R (P-P) : Disparation range
$R(P-P) = | R(MAX) - R(MIN) |$

$R(\sigma)$: Standard deviation

$$R(\sigma) = \sqrt{\frac{\sum_{K=1}^{N} (D_K - \overline{D})^2}{N-1}}$$

$$\text{where } \overline{D} = \left(\frac{\sum_{K=1}^{N} D_K}{N} \right) = R(AVE)$$

R(UCL) : Upper Control Line
$R(AVE) + 3R(\sigma)$

R(LCL) : Lower Control Line
$R(AVE) - 3R(\sigma)$

R(   ) : Results of computation of each item
Dk   : Data to be operated on
N   : Constant (set value); number of data sets

[Setting range of constants]

N : Number of data sets
    Integer from 2 to 10000

[Display of computation results]

R (COUNT) : Integer from 2 to 10000
R (MAX), R (MIN), R (AVE), R (P-P), R (UCL), R (LCL) :
The output ranges and units of these values are displayed in the same manner as done for the data that is to be operated on.
If the data to be operated on is measured data or the results of scaling computation, RMS computation, resistance value temperature compensation, then the significant digits and the unit of measurement are judged from the final data that has been operated on.

R (σ)   : ±1999 E-19 to ±1999 E+19
This value is displayed in percentage terms (%).
A computation error message is displayed if the exponential part has overstepped the E+19 range.
"0. E-19" is displayed if the exponential part has overstepped the E-19 range.

[Operating procedure]

The operating procedure for statistical processing computation is described below.

Outline

An example of execution of statistical processing computation with 1000 samples is given here.

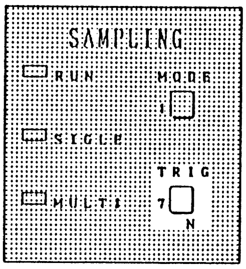
The proceeding procedure is outlined below.

I. Setting of the number of samples (N parameter)
II. Setting of the computing function (CF parameter)
III. Execution of the computing operation
IV. Output of the computation results

I. Setting of the number of samples

Setting the N parameter

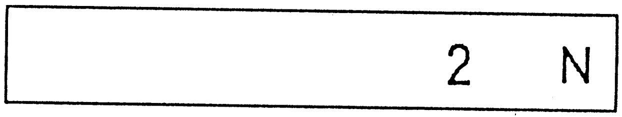
SHIFT



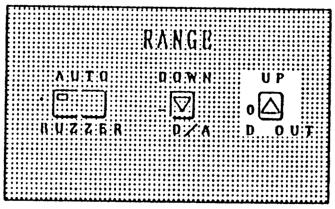
(1) Press the SHIFT key.

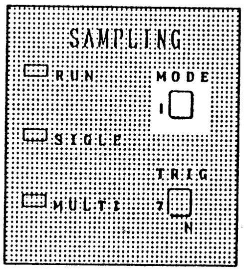
(2) Press the N key.

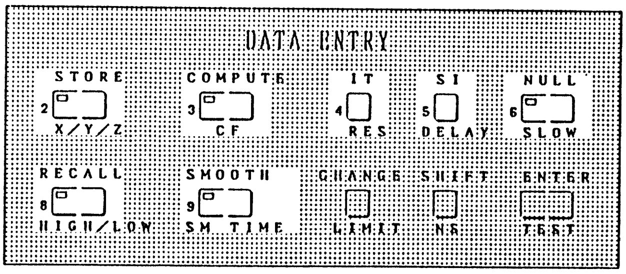
The existing setting of the constant N will then be displayed on the LCD unit.



Setting a constant

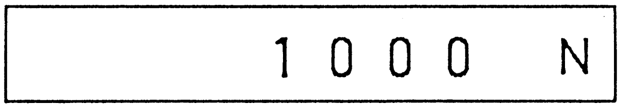






(3) Set the sample quantity of 1000 as the constant N.

To do this, press keys 1 0 0 0 in that order.



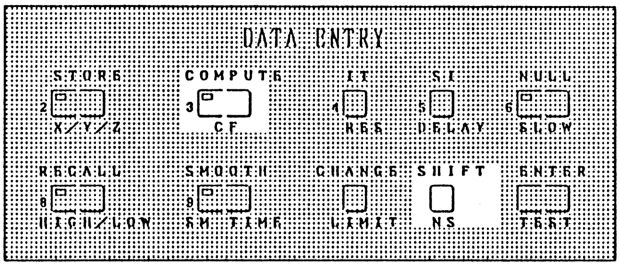
Constant setting completed

ENTER

(4) Press the ENTER key.

II. Setting of the computing function

CF parameter setting



(5) Press the SHIFT key.

(6) Press the CF key.

The primary and secondary computing function codes last set will then be displayed on the LCD unit.

Blinking — Primary computation — Secondary computation

0 – 0 CF

Computing function selection

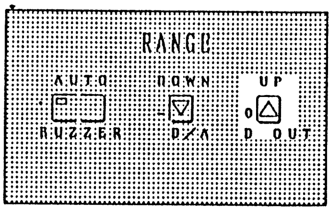
SHIFT

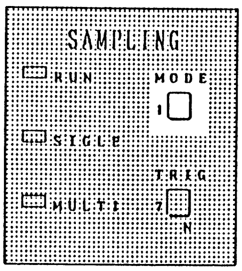
(7) Press the SHIFT key. This causes blinking of the secondary computing display, enabling setting of the statistical computation function.

Primary computation — Blinking secondary computation

0 – 0 CF

Computing function setting

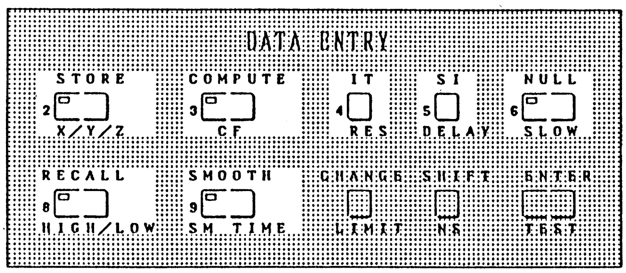




(8) Input the statistical computation function code '3'.

Blinking — Primary computation — Secondary computation

0 – 3 CF

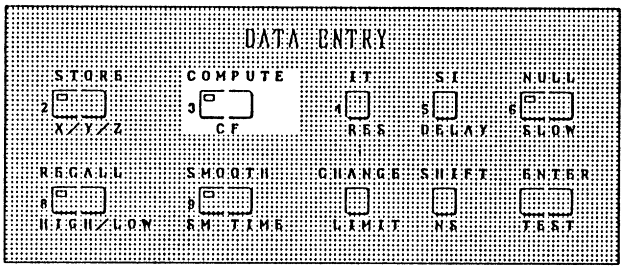


Setting of the computing function completed

(9) Press the ENTER key.

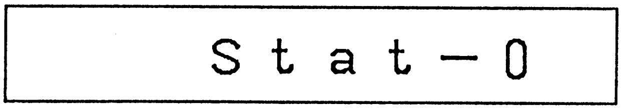
III. Execution of the computing operation

Execution of computation



(10) Press the COMPUTE key.

This initiates the computing operation.
Computation is performed on 1000 samplings and the data that is currently undergoing processing is displayed on the LCD unit.
When computation is completed, the waiting state for input of an output mode will be displayed on the LCD unit.
The output mode, which refers to the computation results output method, is available in two versions : stepped output mode and continuous output mode.
The output mode last set will be displayed at this point of time.



Output mode

[Stepped output mode]

The stepped output mode refers to the mode in which eight types of computation results are output one by one. If this mode is desired, set "0" in the display position shown above.

[Continuous output mode]

The continuous output mode refers to the mode in which eight types of computation results are all output at one time.
If this mode is desired, set "1" in the display position shown above.

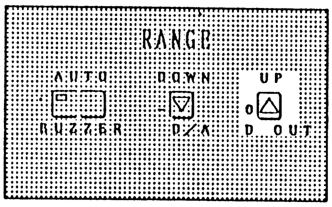
Note : If data is to be both displayed and output, the stepped output mode should be selected. If the output object is to be displayed only, then the display speed will become too high to see.

IV. Output of the computation results

The operating procedures for data output in the stepped output mode and in the continuous output mode are described here.

[Data output in the stepped output mode]

Setting of the stepped output mode



(11) Press the o△ key.

This causes the stepped output mode to be displayed on the LCD unit.

```
S t a t - 0
```

Execution of stepped output

ENTER

(12) Press the ENTER key.
This causes the number of samples to be output first.
Subsequent computation results are output each time the SHIFT key is pressed.

No. of samples

1 0 0 0 N

[Output order]

The computation results are output in the following order each time the SHIFT key is pressed :

Number of samples	
Maximum value	R (MAX)
Minimum value	R (MIN)
Average value	R (AVE)
Dispersion range	R (P-P)
Sigma	R (σ)
Average value + 3 sigma	R (UCL)
Average value - 3 sigma	R (LCL)

If the SHIFT key is pressed following the completion of output of all the eight types of computation results, then the output mode input awaiting display (the display appearing in procedural step (10)) reappears.

Execution of stepped output

SHIFT

(13) Press the SHIFT key.
This causes display of the maximum value and lighting of the MAX lamp located below the display section.

−6.11633 V

MAX

Execution of stepped output

SHIFT
▢

(14) Press the SHIFT ▢ key.
This causes display of the minimum value and lighting of the MIN lamp located below the display section.

−6.11926 V

MIN

Execution of stepped output

SHIFT
▢

(15) Press the SHIFT ▢ key.
This causes display of the average value and lighting of the AVE lamp located below the display section.

−6.11752 V

AVE

Execution of stepped output

SHIFT
▢

(16) Press the SHIFT ▢ key.
This causes display of the dispersion range and lighting of the MAX and MIN lamps located below the display section.

0.00293 V

MAX MIN

Execution of stepped output

SHIFT
▢

(17) Press the SHIFT ▢ key.
This causes display of the sigma value (σ) and lighting of the lamp located below the display section.

1.014 −3

σ

Execution of stepped output

SHIFT

(18) Press the SHIFT key.
This causes display of the UCL value and lighting of the   and HIGH lamps located below the display section.

−6.11448   V
HIGH   σ

Execution of stepped output

SHIFT

(19) Press the SHIFT key.
This causes display of the LCL value and lighting of the σ and LOW lamps located below the display section.

−6.12056   V
LOW   σ

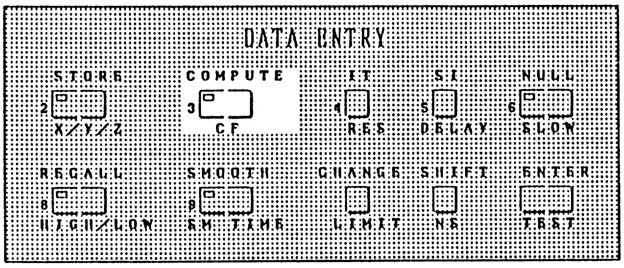
Execution of stepped output

SHIFT

(20) Press the SHIFT key.
Output of all the eight types of computation results has been completed when step (19) above was carried out.
If this step (20) is carried out, then the output mode input awaiting display (the display appearing in step (10)) reappears.

Stat−0

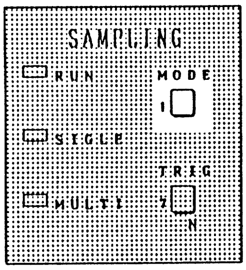
End of the stepped output mode



(21) Press the COMPUTE key.
This causes the COMPUTE lamp to go out, the stepped output mode to terminate, and the equipment to return to the measurement mode.

[Data output in the continuous output mode]

Setting of the continuous output mode



(11) Press the 1 key.
This causes the continuous output mode to be displayed on the LCD unit.

Stat-1

Execution of continuous output

ENTER

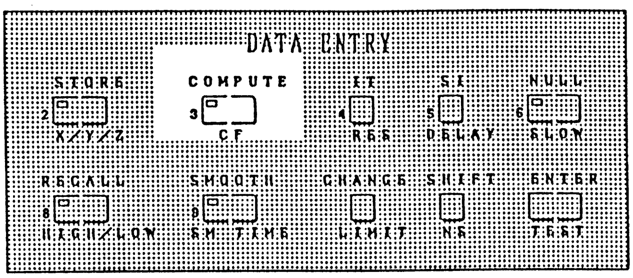
(12) Press the ENTER key.
This causes the eight types of computation results to be continuously output.
These computation results are output in the following order :
Number of samples

Maximum value	R (MAX)
Minimum value	R (MIN)
Average value	R (AVE)
Dispersion range	R (P-P)
Sigma	R (σ)
Average value + 3 sigma	R (UCL)
Average value - 3 sigma	R (LCL)

When output of all the eight types of computation results is completed, the output mode input awaiting display (the display appearing in procedural step (10) reappears automatically.

Stat-1

End of the continuous output mode



(13) Press the COMPUTE key.
This causes the COMPUTE lamp to go out, the continuous output mode to terminate, and the equipment to return to the measurement mode.

[Notes on the display made until the specified number of samplings is reached]

If statistical processing computation is selected, the data that is subjected to computation will be displayed until the specified number of samplings is reached.

When the specified number of samplings is reached, the computer will wait for input of an output mode. The results of statistical processing computation will be displayed according to the readout mode selected.

[Notes on execution of computation]

(1) If the particular data oversteps the selected data range during execution of statistical processing computation, then the data becomes invalid and is excluded from the total measurement count.

(2) If the measurement function being used is changed over to another function during execution of statistical processing computation, then the data that has been obtained using the previous function is initialized and computation restarts from the beginning.

[Operating notes]

(1) If the HO (HOME) key is pressed during execution of statistical processing computation, then the computing operation will terminate at that time and the display indicating the waiting state for input of an output mode will appear.

(2) If the HO (HOME) key is pressed during readout of the statistical computation results, then the readout operation will terminate immediately. (The lamp of the COMPUTE key will stay lit and statistical computation will start anew.)

(3) If the COMPUTE key is pressed during setting of the readout mode, then the statistical computing operation will terminate. At the same time, the readout mode of the statistical computation results will end and the equipment will resume the measurement mode.

(4) The HO (HOME) and COMPUTE keys may be pressed at any time.

[Notes on accessories]

The 500ms timer automatically turns on at the start of statistical processing computation if BCD DATA OUTPUT is connected to the equipment.

3.2 Data Memory Functions

Two data memory functions are provided : the function that allows data measurements to be stored into the internal memory of the equipment, and the function that allows the desired number of stored data measurements to be read out. The TR6871 can store up to a maximum of 1000 data samplings (measurements) into its internal memory.

This section describes the methods of storing data measurements into the memory and the methods of reading out stored data.

The data memory functions provide a wide variety of applications because they make it possible to capture high speed events, to capture single events due to pre-triggering and delayed triggering, and to make various types of computations on the same type of data prior to readout operations.

3.2.1 Data Numbers (Required for Storage of Measured Data)

The data numbers refer to the numbers that are automatically assigned to all sets of measured data prior to storage of the data into the internal memory (hereinafter referred to as the data memory).

With the data numbers, it becomes possible to read out the desired data from the data memory.

If data were stored without being numbered, it would become impossible to specify data since no distinction would be drawn between the desired data and other data.

Thus, data is automatically numbered by the corresponding function of the data memory prior to storage. Numbering of data makes it possible to read out the desired data directly from the data memory.

Please note that the manner of automatic data numbering differs according to the method of storing measured data into the data memory.

3.2.2 Methods of Storing Measured Data into the Data Memory

(1) When measured data is stored into the data memory :

If the STORE key lamp is on at the occurrence of measured data, then the data is stored into the data memory.

The STORE key lamp turns on when the STORE key is pressed.

The STORE key lamp alternates between its 'on' and 'off' states each time the STORE key is pressed. It should be noted, however, that the data numbering manner differs according to the manner of data storage, that is, according to the type of sampling mode selected or the presence/absence of connected trigger inputs.

(2) When stored data disappears :

① Stored data disappears from the data memory if : Power is turned off.

② The STORE key lamp is made to go out and then come back on.

(3) Parameters related to storage

Parameters related to storage of measured data into the data memory are listed in Table 3 - 1, in which the parameters are classified according to the type of sampling mode (RUN, SINGLE, or MULTI) and the presence/absence of connected trigger inputs.

Check the relationship between 'SI', 'TD', or 'NS' parameters and storage operation prior to setting these parameters.

(4) Parameters related to store operation

Parameters 'SI', 'TD', and 'NS' are related to store operation when measured data is stored into the data memory. These parameters, however, do or do not become concerned with store operation, depending on the sampling mode and the presence/absence of trigger inputs. This relationship is shown in Table 3 - 1. Set these parameters only after checking their relationship to storage operation.

Table 3 - 1 Relationship Between the Parameters and Storage Operation

	RUN		SINGLE	MULTI
	Without trigger	With trigger		
SI	①	②		③
TD			④	⑤
NS		⑥	⑦	⑧

(Description)

The relationship between the three parameters and storage operation is described follows.

① ② ③ : Measured data is stored into the data memory at the sampling interval that has been set using the 'SI' parameter.

④ ⑤ : Storage operation starts after the trigger delay time that has been set using the 'TD' parameter elapses following input of the trigger signal.

⑥ ⑦ ⑧ : The volume or measured data that corresponds to the number of sampling operations that has been set using the 'NS' is stored into the data memory after the trigger signal has been input.

In the RUN mode, however, storage operation starts when the STORE key lamp has come on. In this case, data numbers are involved.

In the above description, trigger input refers to the following cases :

① When the TRIG key on the TR6871 front panel has been pressed

② When an external signal has been input via the EXT. TRIGGER connector located on the TR6871 rear panel

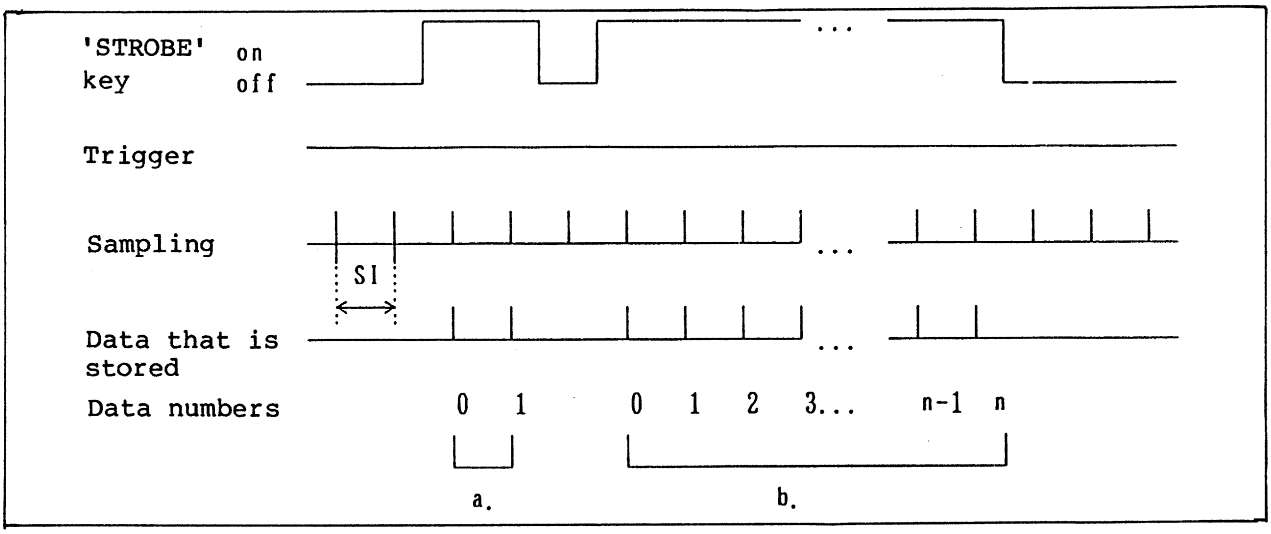
③ When the 'E' or 'GET' command, which corresponds to a trigger, has been input via GPIB

④ When the EXT.START signal, which corresponds to a trigger, has been input via accessories

(5) Sampling mode : RUN

If the selected sampling mode is RUN, take care when reading out data from the data memory, because the data numbers that are assigned to data stored differ according to the presence or absence of trigger signal inputs.

① If trigger signals are not input



(Description)

ⓐ In the RUN mode, data can be stored at any time while the STORE key lamp stays on.

ⓑ If no trigger signal inputs are present, the first data stored when the STORE key lamp has turned on is numbered "0".

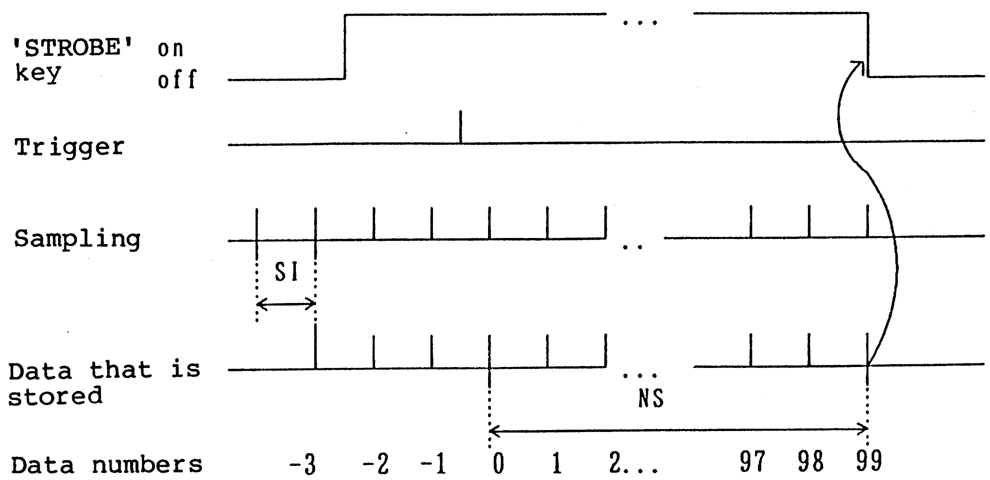
ⓒ Data storage terminates immediately if the STORE key is turned off.

ⓓ Data in the section, , disappears next time the STORE key lamp turns on.

ⓔ If the total number of data samplings has exceeded 1000, then the excess amount of data disappears starting with the oldest data first.

ⓕ Data is stored at the interval that has been set using the 'SI' parameter.

② If trigger signals are input



(In the case of 'NS'=100)

(Description)

ⓐ In the RUN mode, data can be stored at any time while the STORE key lamp stays on.

ⓑ If trigger signal inputs are present, the first data that stored when the trigger signal has been input is numbered "0".

ⓒ Data storage terminates immediately if the STORE key is turned off.

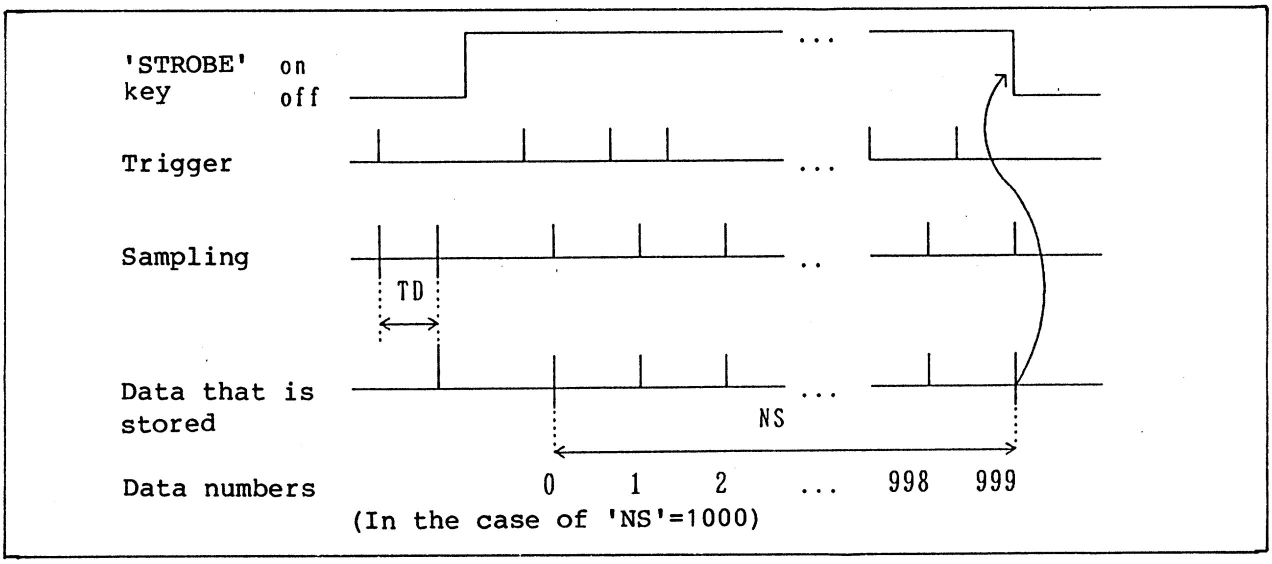
ⓓ The STORE key lamp automatically turns off when the number of data samplings that has been set using the 'NS' parameter is stored into the data memory following input of the trigger signal.

ⓔ Data is stored at the interval that has been set using the 'SI' parameter.

[Applications]

This mode can be applied when it is desired that during data storage into the data memory, trigger signals be automatically input at the time of the occurrence of a storage error in order to make an error-cause check from the data existing before and after the error (that is, the data immediately preceding and succeeding the one numbered 0).

(6) Sampling mode : SINGLE



(Description)

ⓐ If the STORE key lamp is on, input of a trigger signal causes data firstly to be sampled after the trigger delay time that has been set using the 'TD' parameter has elapsed an then to be stored into the data memory.

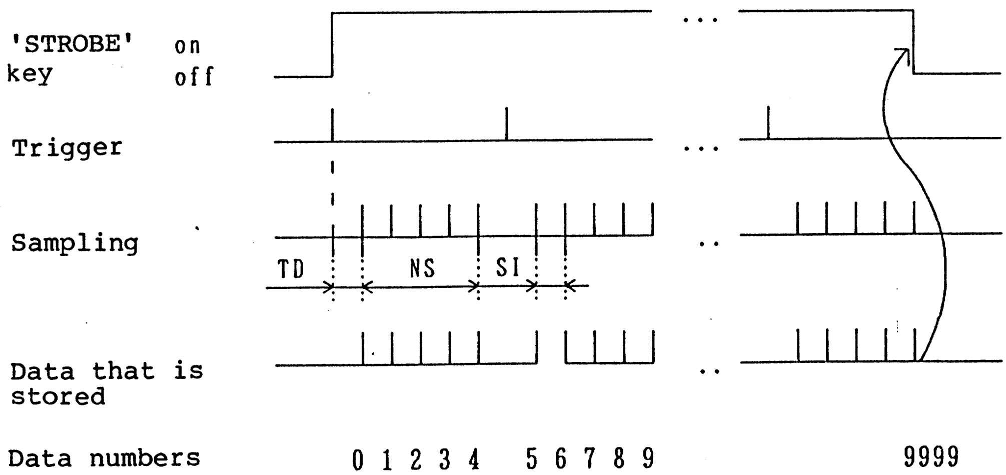
ⓑ One data sampling is stored by one trigger signal input.

ⓒ The STORE key lamp automatically turns off when trigger signals as many as there have been data samplings set using the 'NS' parameter are input and the corresponding volume of data is stored.

ⓓ Data storage terminate immediately if the STORE key is turned.

ⓔ The data storage internal is the same as the trigger signal input interval.
If the next trigger signal is input before the end of sampling, that signal will be ignored.

(7) Sampling mode : MULTI



(In the case of 'NS'=5)

(Description)

ⓐ If the STORE key lamp is on, input of a trigger causes data firstly to be sampled after the trigger delay time that has been set using the 'TD' parameter has elapsed and then to be stored into the data memory.

ⓑ The number of data sampling that has been set using the 'NS' parameter are stored by one trigger signal input.

ⓒ Data storage terminates immediately if the STORE key is turned off.

ⓓ Data is stored at the interval that has been set using the 'SI' parameter.

ⓔ The STORE key lamp automatically turns off when up to a maximum of 10000 data samplings are stored into the data memory.

If the next trigger signals is input before completion of sampling of the number of data sets that has been set using the 'NS' parameter is completed, that signal will be ignored.

3.2.3 Methods of Reading Out Data from the Data Memory

(1) Types of data readout modes available

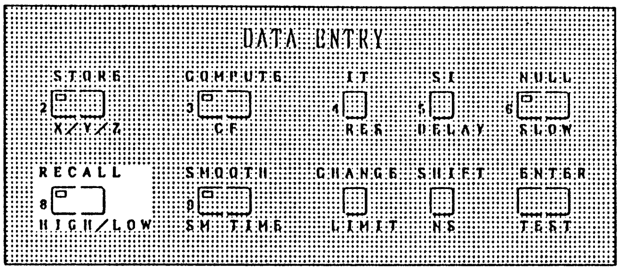
Either the stepped output mode or the continuous output mode is available for reading out data from the data memory.

In the stepped output mode, the desired number of data samplings can be read out, one at a time, from the data memory.

In the continuous output mode, the desired number of data samplings can be read out continuously from the data memory.

(2) Data output in the stepped output mode

Setting of the recall mode

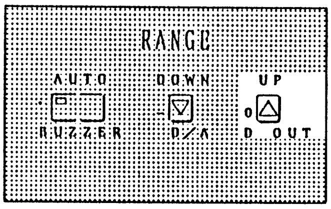


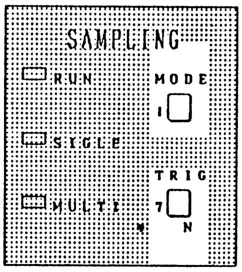
(1) Press the RECALL key. The RECALL key lamp will light the recall mode that allows data reading from the data memory will be set, and the existing number of data samplings stored within the data memory will be displayed on the LCD unit.

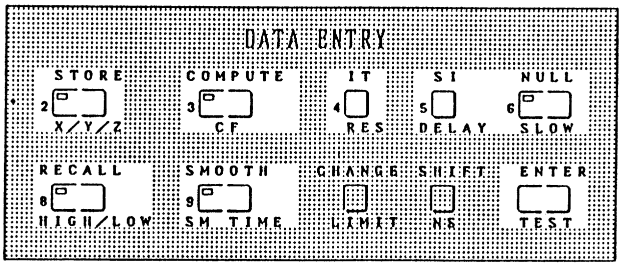
```
nnnnnMR
```

nnnnn : Number of stored data samplings (Integer from 1 to 10000)

Setting of the data number and display of the desired data







(2) Input the data number of the desired data.

(Example)

To input 23, press SHIFT, 2 → 3 in that order.

```
23NO
```

↑ Data number

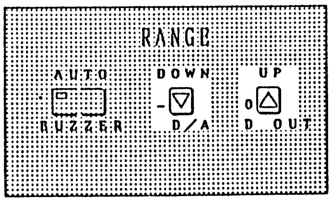
Data number : -9999 to 9999

(3) Press the ENTER key.
The data that has the input data number will then be displayed on the LCD unit.

CAUTION

Be sure to press SHIFT before setting values (data number and the number of data sampling to be output.)

Stepped output of data



(4)

ⓐ If data that is larger by one data number than that currently being displayed is to be displayed :

Press UP just once.

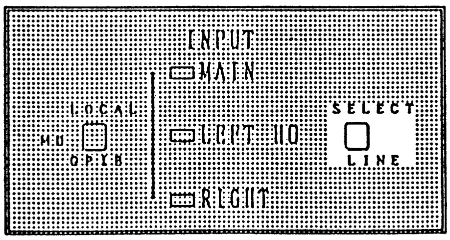
Every keystroke of UP causes display of the data that is larger by one data number than that being displayed at that time.

ⓑ If data that is smaller by one data number than that currently being displayed is to be displayed :

Press DOWN just once.

Every keystroke of DOWN causes display of the data that is smaller by one data number than that being displayed at that time.

End of the stepped output mode



(5) Press HO .
The LCD display will then return to the state exiting when the recall mode was set, that is, the display of the existing number of data samplings stored within the data memory.

The HO key functions as the HOME key while the recall mode remains set.

Execution of stepped output

SHIFT

[Selection between data number display and data display]

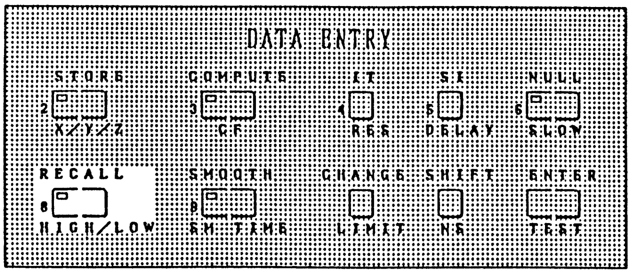
While data stays on the display, press CHANGE if it is desired to know the data number of the displayed data or if is desired to change the data number display state over to the data display state.

Every keystroke of CHANGE causes the LCD display to alternate between data number display and data display.

[If data that is greatly different in data number is to be read out]

Readout of data that is greatly different in data number takes time if UP or DOWN are used. In such a case, therefore, first press just once (this causes the display made in procedural step (1) above to reappear) and then set the desired data number and read out the data.

End of the recall mode



(6) Press RECALL .

When RECALL is pressed, the recall mode will end and the RECALL key lamp will go out.

[An example of operations in the stepped output mode]

An outline of the operation example given below :

ⓐ The method that has been described in the section of the sampling mode SINGLE is taken as an example.

ⓑ The number of data samplings that have been stored is 1000.

Key input and data display	Explanation
(1) Press RECALL .	The equipment enters the recall mode, and the total number of data samplings that have been stored is displayed on the LCD unit.
`1 0 0 0 M R`	
(2) Press SHIFT .	The data number input mode is set.
`N O`	
(3) Press keys 1 0 0 ENTER , in that order.	Data that has data number "100" is read out.
`1 7.8 9 0 0 1   V`	
(4) Press UP .	Data that has data number "101" ("100" plus "1") is displayed.
`1 7.8 9 0 0 0   V`	
(5) Press UP .	Data that has data number "102" ("101" plus "1") is displayed.
`1 7.8 9 9 9 9   V`	

(6) Press CHANGE ☐ .

The display changes from data display over to data number display.

1 0 2 N O

(7) Press DOWN ▽ DOWN ▽ keys in that order.

Data that has data number "100" ("102" minus "2") is read out once again.

1 0 0 N O

(8) Press CHANGE ☐ .

The display changes from data number display over to data display.

1 7.8 9 0 0 1 V

(9) Press HO☐ .

The display state existing when the recall mode was set is resumed.

1 0 0 0 M R

(10) Press SHIFT ☐ .

The data number input mode is set.

N O

(11) Press 1☐ 0△ 0△ 0△ ENTER ☐ , in that order.

Although an attempt has been made to read out data that has data number "1000", the data does not exist and thus an error message is displayed.

E r r o r 8

(12) Press SHIFT ☐ .

The data number input mode is set.

N O

(13) Press 9 [ ] 9 [ ] 9 [ ] ENTER [ ] , in that order.

Data that has data number "999" is read out.

```
17.89010 V
```

(14) Press UP [△] .

Although an attempt has been made to read out data that has data number "1000" ("999" plus "1"), the data does not exist and thus an error message is displayed. At his time, data number "999" stays on the display.

```
Error 8
```

(15) Press DOWN [▽] .

Data that has data number "998" ("999" minus "1") is read out.

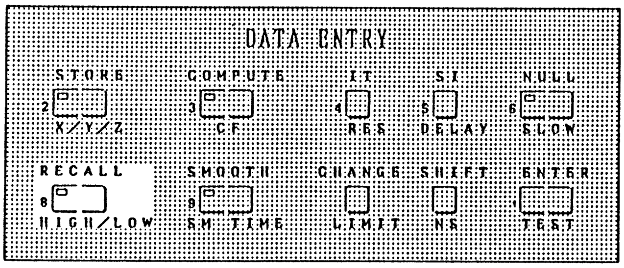
```
17.89009 V
```

(16) Press RECALL [ ] .

The recall mode ends.

(3) Data output in the continuous output mode

Setting of the recall mode

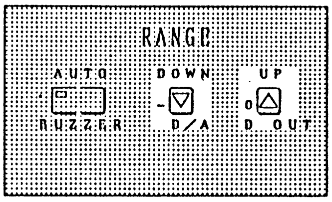


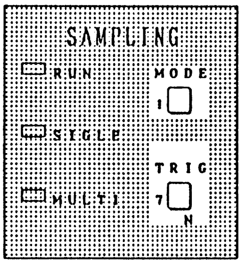
(1) Press the RECALL key. The RECALL key lamp will light, the recall mode that allows data reading from the data memory will be set, and the existing number of data samplings stored within the data memory will be displayed on the LCD unit.

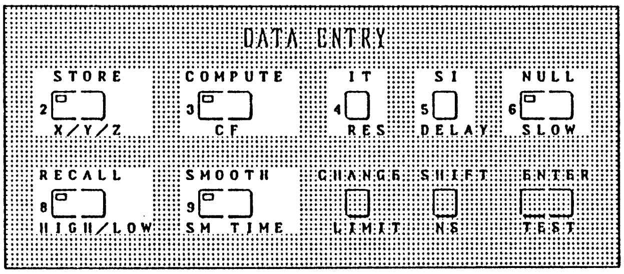
nnnnnMR

nnnnn : Number of stored data samplings
(Integer from 1 to 10000)

Setting of the data number







(2) Input the data number of the desired data.

(Example)
To input 35, press
SHIFT 3 → 5 , in that order.

35NO

↑
Data number

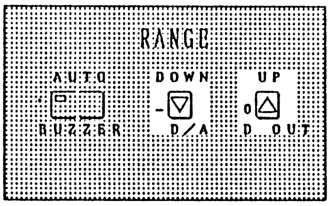
Data number : -9999 to 9999

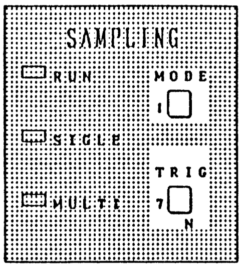
(3) Press SHIFT to set the desired number of data samplings to be read out.

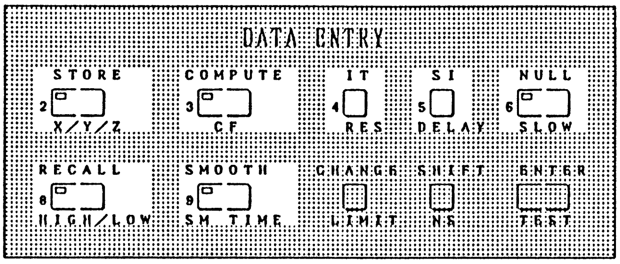
CAUTION

Be sure to press SHIFT before setting values (data number and the number of data samplings to be output).

Setting of the number of data samplings to be read out



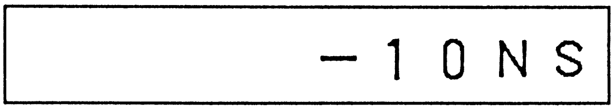




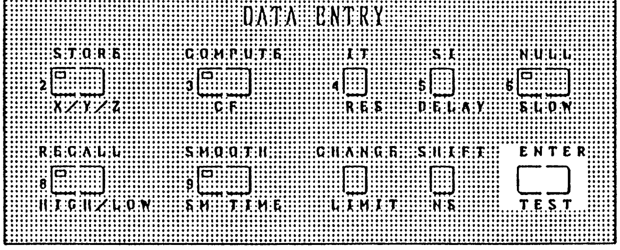
(4) Set the desired number of data samplings to be read out.
This value must be input with either a plus or a minus sign preceding the value.
If a plus value is input, data will be read out starting sequentially with the input data number through subsequent ones.
If a minus value is input, data will be read out starting sequentially from the input data number to preceding ones.

(Example)
To read out 10 data samplings from data number 20 through 29 in that order, input data number 20 in procedural step (2) and then set 10 (or +10) as the number of data samplings to be read out.

(Example)
To read out 10 data samplings from data number 20 back to 11 in that order, input data number 20 in procedural step (2) and then set -10 as the number of data samplings to be read out.

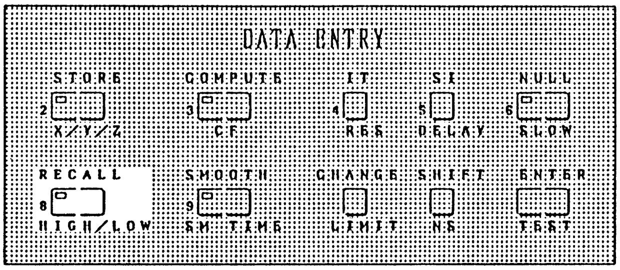


Data readout



(5) Press ENTER .
The specified number of data samplings will then be read out starting sequentially with the input data number first.
After completion of readout of the specified range of data, the display state becomes that which existed in procedural step (1) above.

End of the recall mode



(6) Press RECALL .

When RECALL is pressed, the recall mode will end and the RECALL key lamp will go out.

[An example of operations in the continuous output mode]

An outline of the operation example given below :

ⓐ The method that has been described in the section of the sampling mode RUN is taken as an example.

ⓑ The 'NS' parameter has been set to 10 and trigger signals are have been input during storage.

ⓒ The number of data samplings that have been stored is 103.

Key input and data display	Explanation
(1) Press RECALL .	The equipment enters the recall mode, and the total number of data samplings that have been stored is displayed on the LCD unit.
103MR	
(2) Press SHIFT .	The data number input mode is set.
NO	
(3) Press keys -▽ 2 , in that order.	Data number "-2" is set.
-2NO	

(4) Press SHIFT .

```
NS
```

The display state changes from data number display to display of the number of data samplings to be read out. This allows setting of the number of data samplings to be read out.

(5) Press keys 1 0 ENTER , in that order.

```
123.456    KΩ
      ⋮
123.450    KΩ
```

```
103MR
```

The total number of data samplings to be read out is set to 10 and the readout operation begins. Ten data samplings starting with data number "-2" (that is "-2", "-1", "0", "1", "2", ----, in that order) are read out continuously.
[Two data samplings (data number -2 and -1) existing before a trigger was input and eight data samplings (data number 0 through 7) existing after the trigger was input are read out continuously.] After complete of readout, the display state existing when the recall mode was entered (that is, the display of 103 as the total stored number of data samplings) will be resumed.

(6) Press SHIFT ..

```
NO
```

The data number input mode is set.

(7) Press 9 .

```
9NO
```

Data number "9" is set.

(8) Press SHIFT .

```
NS
```

The display state changes from data number display over to display of the number of data samplings to be read out. This allows setting of the number of data samplings to be read out.

(9) Press keys - 1 0 3 ENTER, in that order.

The total number of data samplings to be read out is set to -103 and the readout operation begins. 103 data samplings starting with data number "9" (that is, "9", "8", "6", "5", ---, in that order) are read out continuously. [10 data samplings (data number 9, 8, 7, ---) existing after a trigger was input and 93 data samplings (data number -1, -2, ---, up to -93) existing before the trigger was input are read out continuously.]

```
-103NS
```

```
123.450   KΩ
```

⋮

```
123.457   KΩ
```

```
103MR
```

After completion of readout, the display state existing when the recall mode was entered (that is, the display of 103 as the total stored number of data samplings) will be resumed.

(10) Press RECALL.

The recall mode terminates.

MEMO

4. GPIB INTERFACE

4.1 General

The TR6871 is equipped with the GPIB interface in standard configuration, allowing connection with the IEEE standard 488-1978 measurement bus GPIB.

The standard and functions of the GPIB interface are described here in this chapter.

4.2 Outline of the GPIB

The GPIB is an interface system that can connect the measuring device with the controller and peripheral devices with a simple cable (bus line).

Compared with conventional interfaces, the GPIB is superior in its expandability, easy to use, and has electrical as well as mechanical and functional compatibility with products of other manufacturers. A single bus cable can structure simple to high function automatic measuring systems.

In the GPIB system, the "address" of the various devices connected to the bus line must first be set. These devices can act as the controller, the talker, and/or the listener.

During system operation, a single "talker" can send data to the bus line, but multiple "listener" can receive the data.

The controller specifies the address of the "talker" and the"listener", to transmit data form the "talker" to the "listener" or the controller itself ("talker") can set measurement conditions to the "listener".

8 data lines of bit parallel, byte serial form are used for data transmission between each device, and transmission is done to both direction asynchronously. As the system is an asynchronous system, high-speed devices and low-speed devices can freely be mixed and connected together.

The data (message) transmitted and received between the devices includes measurement data, measurement conditions (program), or various commands. The data is expressed in ASCII codes.

Besides the above 8 data lines, the GPIB has 3 hand-shake lines to control asynchronous data exchange between devices as well as 5 control lines to control the information flow on the bus.

o The hand-shake line uses the following signals.

DAV (data valid)	:	A symbol that indicates whether the data is effective.
NRFD (not ready for data)	:	A symbol that indicates the data reception ready status.
NDAC (data not accepted)	:	A symbol that indicates end of reception.

o The following signals are used in the control line ATN (attention) : A signal used to distinguish whether the signal on the data line is address, command, or other information.

IFC (interface clear)	:	A signal used to clear the interface.
EOI (end or identify)	:	A signal used to end transmission of information.

SRQ (service request) : A signal used to request service from an optional device to the controller.

REN (remote enable) : A signal used for remote control of remote-programmable devices

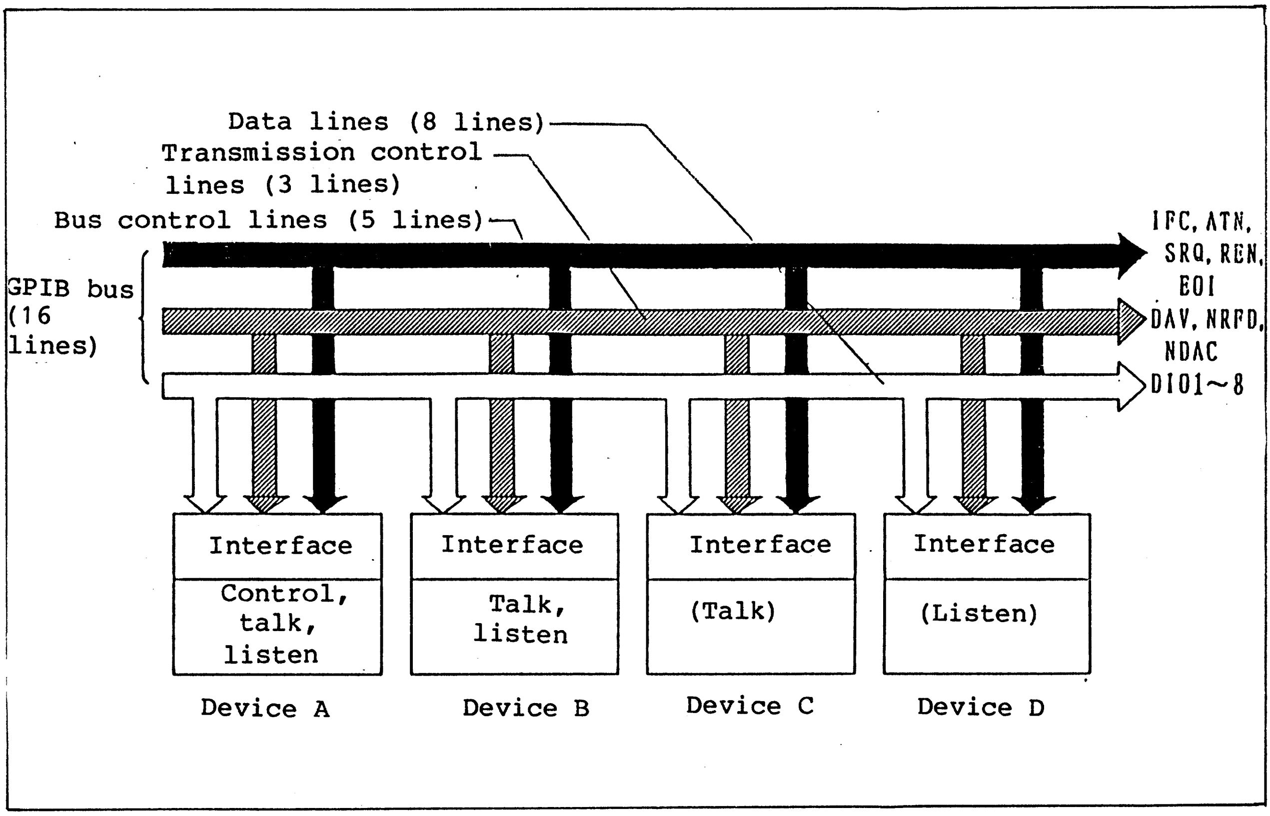


Figure 4 - 1 GPIB

4.3 Specification

Standard : IEEE standard 488-1987
Used code : ASCII code
Logical level : Logical 0 "High" state : +2.4V or more
Logical 1 "Low" state : +0.4V or less
Signal line termination : The 16 bus lines are terminated as shown below.

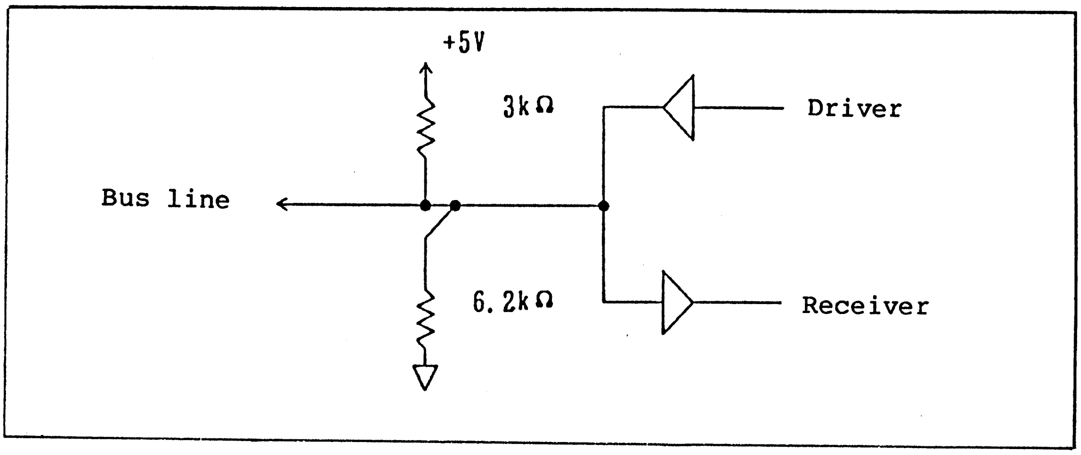
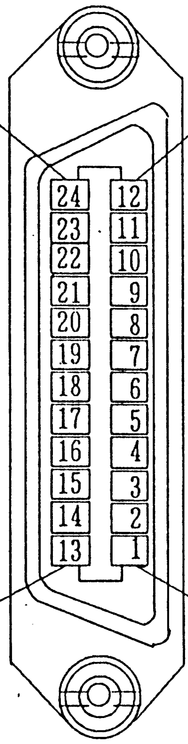


Figure 4 - 2 Termination of Signal Lines

Driver specification : Try state system
"Low" status output voltage : +0.4V or less 4.8mA
"High" status output voltage : +2.4V or less -5.2mA
Receiver specifications :
"Low" status with +0.6V or less "High" status with +2.0V or more
Bus cable length :
Total length of bus cable is (devices connected to the bus) x 2m or less, and must not exceed 20m.
Address designation :
By selecting the GPIB key on the front panel, 31 kinds of talk address/listen address can be optionally set.
Connector :
24-pin GPIB connector
57FE-20240-20SD35 (Daiichi Denshi Kogyo's product or equivalent)

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

24-pin GPIB connector



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

Figure 4 - 3 GPIB Connector Pin Arrangement

Interface functions : See Table 4 - 1.

Table 4 - 1 Interface Functions

Code	Function and description
SH1	Source hand-shake function
AH1	Acceptor hand-shake function
T5	Basic talker function, serial pole function, talk only mode function, talker reset function by listener designation
L4	Basic listener function, listener reset function by talker designation
SR1	Service request function
RL1	Remote/local switching function
PP0	No parallel function
DC1	Device-clear function ("SDC", "DCL" commands can be used)
DT1	Device trigger function ("GET" command can be used)
C0	No controller function
E2	3-state bus driver is used

4.4 How to Handle the GPIB

4.4.1 Connection with the System Devices

The GPIB system is structured by multiple devices, and preparation of the entire system must be done taking care of the following points.

(1) Refer to the instruction manuals of the TR6871, controller and peripheral devices, to check the status and operation of each devices, before connection.

(2) Be careful not to leave the connection cable with the measuring device and the bus cables connected to the controller, etc. unnecessarily long. The bus cable length must not exceed the standard. The length of all bus cables must be kept (number of devices connected to the bus) x 2m or less, and must not exceed 20m.

We also offer the following standard bus cables.

Table 4 - 2 Standard Bus Cable (Option)

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

(3) When connecting the bus cable, be careful not to connect 3 or more connectors. Also tighten the connector firmly with the fix-screws. The bus cable connector are piggy-back type with both male and female on a single connector, and can be connected together.

(4) Check the electrical conditions, grounding state, or if necessary, the setting conditions of each system device before supplying power to each system device.
The power of all devices connected to the bus must be turned ON. If there is a single device which power is not supplied, the operation of the entire system cannot be assured.

(5) Before fitting or removing the bus cable, always remove the power cable out of the wall outlet.

4.4.2 Preparation for Operation

The following preparation must be done before measurement from the GPIB.

(1) Connect the object of measurement to the TR6871.

(2) Check the following three points by the GPIB key on the front panel.

(a) Device address (0 to 30)

(b) TR6871 address mode (Addressible/Talk only)

(c) Format mode when outputting measurement data (Header ON/OFF)

(3) If other panel setting is required, set as necessary.

*1 Refer to Section 2.8 for how to set.

*2 On device address
There are also controllers in which addresses 0 to 30 as well as the corresponding ASCII code must be written.
Refer to the following Table 4 - 3 for the corresponding ASCII codes.

Table 4 - 3 ASCII Code - Address Code Cross Reference Table

ASCII Code Character		Decimal Codes
LISTEN	TALK	
SP	@	00
!	A	01
"	B	02
#	C	03
$	D	04
%	E	05
&	F	06
'	G	07
(	H	08
)	I	09
*	J	10
+	K	11
,	L	12
-	M	13
.	N	14
/	O	15
0	P	16
1	Q	17
2	R	18
3	S	19
4	T	20
5	U	21
6	V	22
7	W	23
8	X	24
9	Y	25
:	Z	26
;	[	27
<	\	28
=	]	29
>	-	30

4.4.3 General notes on Operation

(1) Notes on using the only-mode

CAUTION

When using the only-mode, do not use (operate) the controller at the same time.
When the controller is used under the only-mode, normal operation cannot be guaranteed.

(a) Refer to Section 2.8 for how to set the only-mode.

(b) Also set the address mode of the other device connected via the bus line to only-mode.

(2) Notes on changing the address setting during operation
When the address of the main device is changed during operation, operation can be continued, but in case the old address is specified from the controller, it will be ignored.

(3) The status of this device is as shown in the following Table 4 - 4 when power is supplied or when various commands are received.

(4) In case "ATN" interrupts message transmission between devices, the "ATN" is granted priority, and the previous state will be cleared.

Table 4 - 4 Status Transition By Each Command

Command Code	Talker (with lamp)	Listener (with lamp)	Remote (with lamp)	SRQ (with lamp)	Status byte	Trans-mission data
POWER ON	Clear	Clear	Local	Clear	Clear	Clear
IFC	Clear	Clear				
"DCL", "SDC" command	Clear			Clear	Clear	Clear
"C"*, "Z"* code	Clear	Set	Remote	Clear	Clear	Clear
"GET" command	Clear				Clear bit b0	Clear
"E"* code	Clear	Set	Remote		Clear bit b0	Clear
Talker designation to this device	Set	Clear				
Talker reset command	Clear					
Listener designation to this device	Clear	Set				
Listener reset command		Clear				
Serial poling		Clear		Clear		

(Note) "*" is the program code.

4.5 Talker Format

The output data is output in ASCII code.

The talker format can be divided into basic format, data memory output format, and statistical operation output format. Next comes explanation on these formats.

4.5.1 Basic Format

The basic format is expressed in the following form.

$$\underbrace{\text{XXYZ}}_{①}\ \ \underbrace{\text{+/-dd.dddddd}}_{②}\ \ \underbrace{\text{E+/-dd}}_{③}\ \ \underbrace{\text{CR/LF(EOI)}}_{④}\cdots\cdots\cdots\text{(1)}$$

The explanation on the above ①② .... are given below.

① Header

② Mantissa part

③ Exponential part

④ Delimiter

The following is a part of the basic format given in the above (1). There are 12 patterns of basic format.

```
ⓐ XXYZ +/- dd.ddd     E+/-dd CR/LF(EOI)
ⓑ XXYZ +/- dd.ddd     E+/-dd    LF
ⓒ XXYZ +/- dd.ddd     E+/-dd       (EOI)
ⓓ      +/- dd.ddd     E+/-dd CR/LF(EOI)
ⓔ      +/- dd.ddd     E+/-dd    LF
ⓕ      +/- dd.ddd     E+/-dd       (EOI)
ⓖ XXYZ +/- dd.dddd    E+/-dd CR/LF(EOI)
ⓗ      +/- dd.dddd    E+/-dd       (EOI)
ⓘ XXYZ +/- dd.ddddd   E+/-dd CR/LF(EOI)
ⓙ      +/- dd.ddddd   E+/-dd       (EOI)
ⓚ XXYZ +/- dd.dddddd  E+/-dd CR/LF(EOI)
ⓛ      +/- dd.dddddd  E+/-dd       (EOI)
```

When the above is arranged with headers, measurement digits, delimiters, number of characters (bytes), it becomes as shown in the following table.

Table 4 - 5 Basic Format

	Header	Measurement digits	Delimiter	Number of characters (bytes)
ⓐ	ON	4 1/2-digits	CR/LF(EOI)	17
ⓑ	ON	4 1/2-digits	LF	16
ⓒ	ON	4 1/2-digits	(EOI)	15
ⓓ	OFF	4 1/2-digits	CR/LF(EOI)	13
ⓔ	OFF	4 1/2-digits	LF	12
ⓕ	OFF	4 1/2-digits	(EOI)	11 (Minimum)
ⓖ	ON	5 1/2-digits	CR/LF(EOI)	18
ⓗ	OFF	5 1/2-digits	(EOI)	12
ⓘ	ON	6 1/2-digits	CR/LF(EOI)	19
ⓙ	OFF	6 1/2-digits	(EOI)	13
ⓚ	ON	7 1/2-digits	CR/LF(EOI)	20 (Maximum)
ⓛ	OFF	7 1/2-digits	(EOI)	14

CAUTION

Both "CR" and "LF" already exist as ASCII codes, so they are both counted as 1 byte.
The single line signal "EOI" is transmitted by another signal line, and is not counted as a character (byte).

① Header (4-digit alpha-numerical character or omitted) : XXYZ

The header expressed the type of output data. Structure by 2 main header characters (XX) and 2 subheader characters (YZ).
The main header (XX) and subheader (YZ) represents the following.

ⓐ Main header (XX) .... Type of measurement function

ⓑ Subheader (Y) .... Type of primary operation

ⓒ Subheader (Z) .... Type of secondary operation

The header is omitted when the header mode is set OFF. The types of measurement function, primary operation, and secondary operation of the main and subheaders are given in the following 3 tables.

Table 4 - 6 Basic Format Header

Main header (XX)	Type of output data
DV	Direct current voltage measurement
AV	Alternative current voltage measurement (alternative current + direct current)
DI	Direct current measurement
AI	Alternative current measurement (alternative current + direct current)
R	Resistance measurement
RL	Resistance measurement by low current

Subheader (Y)	Type of primary operation, etc.
␣ (Space)	Off
S	Scaling
P	% deviation
D	Difference from the previous measurement value (delta)
M	Multiplication with the previous measurement value (multiply)
B	dB conversion
R	Real value (rms)
W	dBm conversion
T	Resistance value temperature conversion
O	Over-scale data
E	Operation error data

Subheader (Z)	Type of secondary operation
␣ (Space)	Off
H	Comparator (HIGH)
P	Comparator (PASS)
L	Comparator (LOW)
C	Statistical operation (number of samples)
X	Statistical operation (MAX)
N	Statistical operation (MIN)
A	Statistical operation (AVE)
K	Statistical operation (P-P)
S	Statistical operation (σ)
Y	Statistical operation (UCL, AVE+3σ)
Z	Statistical operation (LCL, AVE+3σ)

(Example) Actual example of basic format header

DV␣␣ : Direct current voltage measurement data

DVM␣ : Data gained by primary operation processing (multiplication with the previous measurement value) after measurement of the direct current voltage.

R␣TH : Data gained by primary operation processing (resistance value temperature conversion), secondary operation processing (comparator (HIGH)) after measurement of the resistance.

(Note) The result of secondary operation comparator becomes the same header in both HIGH/LOW or LIMIT settings. Header "H" is output when it becomes either HIGH1 or HIGH2 state, and header "L" is output when it becomes either LOW1 or LOW2 state. The header is space " " when the result of comparator operation becomes HIGH/LOW.

② Mantissa part (polarity + decimal point + 4 1/2 to 7 1/2-digit number) : +/- dd.dddddd

The mantissa part of the measured value outputs digits and decimal position corresponding to the display of this device in 7 to 10-byte variable length including polarity and decimal point.
"+" or "-" code is output as polarity for direct current voltage/current and 2-line resistance measurement.
The space code " " is output in other cases.
The mantissa part and exponential part under various measurement conditions are shown in Table 4 - 7.

③ Exponential part ("E" + polarity + 2-digit numeral) : E+/- dd

The exponential part data is decided according to the measurement function and measurement range. This is done to express all measurement data by the basic units (V, A, Ω).
Table 4 - 7 is the mantissa part and exponential part under various measurement conditions.
The exponential part is related to the unit of the measurement range. Note the measurement range unit in the table and the numeral of the exponential part. The following relation can be observed.

μA 、 μV ………………… E-06
mA 、 mV 、 mΩ ……… E-03
A 、 V 、 Ω ……… E+00
kΩ ……… E+03
MΩ ……… E+06

(Example) 2000mV range
When the mantissa part display is 30.0000, it is 30mV. The exponential part of this range is -3, so
$30\times10^{-3}=0.03$ (V)
The above 0.03 is 30mV expressed in the basic unit (V).

Table 4 - 7 Mantissa and Exponential Parts Under Various Measurement Conditions

Function	Range	Mantissa Part	Expo-nential Part
Direct current voltage measurement	200mV	+/-ddd.dddd	E-03
	2000mV	+/-dddd.dddd	E-03
	10V, 20V	+/-dd.dddddd	E+00
	200V	+/-ddd.ddddd	"
	1000V	+/-dddd.dddd	"
Alternative current voltage measurement (Alternative current + Direct current)	200mV	ddd.ddd	E-03
	2000mV	dddd.dd	E-03
	20V	dd.dddd	E+00
	200V	ddd.ddd	"
	500V	0ddd.ddd	"
Direct current voltage measurement	2000μA	+/-dddd.dd	E-06
	20 mA	+/-dd.dddd	E-03
	200 mA	+/-ddd.ddd	"
	2000 mA	+/-ddd.ddd	"
Alternative current voltage measurement (Alternative current + Direct current)	2000μA	dddd.dd	E-06
	20 mA	dd.dddd	E-03
	200 mA	ddd.ddd	"
	2000 mA	dddd.dd	"
Resistance measurement (2WΩ)	100Ω	+/-ddd.ddddd	E+00
	1000Ω	+/-dddd.dddd	"
	10kΩ	+/-dd.dddddd	E+03
	100kΩ	+/-ddd.ddddd	"
	1000kΩ	+/-dddd.dddd	"
	10MΩ	+/-dd.dddddd	E+06
Resistance measurement (4WΩ)	100Ω	ddd.ddddd	E+00
	1000Ω	dddd.dddd	"
	10kΩ	dd.dddddd	E+03
	100kΩ	ddd.ddddd	"
	1000kΩ	dddd.dddd	"
	10MΩ	dd.dddddd	E+06

d : Numerals from 0 to 9 (Depends on the measurement data)

* The following message is displayed in case of measurement-over.
  XX) +/-99999.E+19 (4 1/2-digit measurement)
  XX) +/-999999.E+19 (5 1/2-digit measurement)
  XX) +/-9999999.E+19 (6 1/2-digit measurement)
  XX) +/-99999999.E+195 (7 1/2-digit measurement)

* The following message is displayed in case of operation error.
  XX) +/-99999.E+19 (4 1/2-digit measurement)
  XX) +/-999999.E+19 (5 1/2-digit measurement)
  XX) +/-9999999.E+19 (6 1/2-digit measurement)
  XX) +/-99999999.E+19 (7 1/2-digit measurement)

(Note) As in the basic format, both the mantissa and exponential parts outputs the digits and decimal position corresponding to the display of this device on execution of operation.
See 4.5.3 for details on the output format of the result of statistical operation.

④ Block delimiter

Output to indicate end of one data.
The block delimiter can be selected from the following 3 types, according to the program code "DlD".

(a) Outputs 2-byte data of "CR", "LF". When "LF" is output, the single line signal "EOI" is also output at the same time.

(b) Outputs the 1-byte data of "LF".

(c) Outputs the signal lien signal "EOI" at the same time as the final byte of the data.

CAUTION

Both "CR" and "LF" already exist as ASCII code, so "CR" is counted as 1 byte.
The single line signal "EOI" is sent by another signal line, and is not counted as a character (byte).

4.5.2 Data Memory Output Format

(1) The data stored in the data memory can be output at once by the following output format. (By program code "B0".)

```
DCNT ddddd     CR/LF(EOI)
:..........:   :..........:
     ①              ②
NO+/- dddd  ,   XXYZ+/- dd.dddddd E+/- dd   ,
:..........:    :...........................: :
      ③                   ④                   ⑤
         ..............................       ,

         ..............................       ,
NO+/- dddd, XXYZ+/- dd.ddddddE+/-  : CR/LF(EOI) :
                                   :............:
                                         ②
```

① Number of header + output data
A header (fixed to "DCNT") indicating that the next data is the number of output data, and the number of output data are output in a 5-digit numeral.

② Block delimiter
Same as 4.5.1 ④ "Block delimiter". Output to indicate the end of one data.

③, ④ Recall data
③ indicates the data number. The format is 2-character header ("NO") + polarity + 4-digit numeral.
④ indicates the data. The format is the same as the basic format of 4.5.1.

⑤ String delimiter
Output to indicate the end of one string (1 string is the data number plus the recall data).
The string delimiter can be selected from the following 3 kinds, by program code "SLd".

(a) ","
(b) " " (space)
(c) "CR/LF"

(2) The format to output as many data as specified form the specified data number is the format 3 and after of the above (1).
(By program code "RD/1-d..d,+/-d...d")

*1 Program code "NOd" is used to specify whether to output the data number or not.
When outputting the data number, "," is output as the delimiter between the data number and the data.
*2 The output format of the step output mode to recall from the data memory is as follows.

```
NO+/- dddd, XXYZ+/- dd.dddddd E+/-DD  CR/LF(EOI)
\_________/ \_______________________/ \________/
     ③                 ④                  ②
```

4.5.3 Output format for execution of statistical operation

The output format on execution of the statistical operation is as shown below.

```
XXYC ddddd  ,
:.........: :                          ...... Number of samples
     ①      ②
XXYX+/-ddd.dddddE+/-dd,                ...... Maximum value
XXYN+/-ddd.dddddE+/-dd,                ...... Minimum value
XXYA+/-ddd.dddddE+/-dd,                ...... Average value
XXYK+/-ddd.dddddE+/-dd,                ......peak to peak
XXYS+/-d.dddddddE+/-dd,                ...... σ
XXYY+/-ddd.dddddE+/-dd,                ...... Average value +3
XXYZ+/-ddd.dddddE+/-dd   CR/LF(EOI)    ...... Average value -3
                         :..........:
                              ③
```

The result of statistical operation (8 items) is output.

① Number of samples
Header + 5-digit numeral as well as 7 items
(maximum value to average value -3σ)
The same as the basic format of 4.5.1.

② String delimiter
The same as ⑤ of 4.5.2 (1) "string delimiter".

③ Block delimiter
The same as 4.5.1 ④ "block delimiter".

* In step output mode, the block delimiter is used instead of the the string delimiter in the above format.

4.6 Listener Format

Setting the parameters and control of the operation can be done by the controller of this device.

Table 4 - 8 is the parameters and the corresponding program codes.

Table 4 - 8 Program Codes

Item	Code	Description
Measurement function	F1 (Initial value) F2 F3 F4 F5 F6 F8 F9	Direct current voltage measurement (VDC) Alternative current voltage measurement (VAC) 2-line resistance measurement (2WΩ) 4-line resistance measurement (4WΩ) Direct current current measurement (ADC) Alternative current current measurement (AAC) (Alternative current + Direct current) Voltage measurement V (AC + DC) (Alternative current + Direct current) Current measurement A (AC + DC)
	P0 (Initial value) P1	Hi.P (High power) mode Lo.P (Low power) mode
Measurment range	Rd d=0 (Initial value)	d = 0 to 9 See Table 4 - 9.
Sampling mode	M0 (Initial value) M1 M2	RUN SINGLE MULTI
Input designation	IN0 (Initial value) IN1 IN2	TR6871 (MAIN) Plug-in (LEFT) Plug-in (RIGHT)
Control parameter	 AB0 (Initial value) AB1	Specifies the AC band. SLOW FAST
	AC	Specifies execution of auto-calibration.

Table 4 - 8 Program Codes (cont'd)

Item	Code	Description
Control parameter	CI ddd d=1 (Initial value)	ddd : 0 to 999 Specifies the interval for execution of auto-calibration. The unit is minutes. 0 : off 1 to 999 : Setting can be done in 1-minute interval.
	  AZ0 AZ1 (Initial value)	Specifies whether to include the auto-zero-calibration function. off on
	 BZ0 BZ1 BZ2	Specifies the buzzer mode. off on (When the comparator operation result is HIGH/LOW) on (When the comparator operation result is PASS)
	CFd1.d2 d1.d2=0 (Initial value)	Specifies the operation function. d1 : 0 to 8, primary operation mode 0 : off 1 : scaling 2 : % deviation 3 : Delta (difference between the previous measurement value) 4 : Multiply (multiplication with the previous measurement value) 5 : dB conversion 6 : rms (execution value) 7 : dBm conversion 8 : Resistance value temperature conversion d2 : 0 to 3, secondary operation mode 0 : off 1 : Comparator 1 (using HIGH/LOW constant) 2 : Comparator 2 (using LIMIT constant) 3 : Statistical operation o The d2 data cannot be omitted.

Table 4 - 8 Program Codes (cont'd)

Item	Code	Description
Control parameter		Specifies whether the operation function is executed.
	C00 (Initial value)	off
	C01	on
		Specifies the analog output mode. off
	DA0 (Initial value)	off
	DA1	The lower 3 digits of the display data is output.
	DA2	The lower 3 digits of the display data plus the offset (500) are output.
	DA3	The lower 2 digits of the display data is output.
	DA4	The lower 2 digits of the display data plus the offset (50) are output.
		The data output mode is specified.
	D00 (Initial value)	The output data is all output systems.
	D01	The output data can be output to the data memory, GPIB.
	D02	The output data can be output to the data memory, accessory.
	D03	The measurement data is output to the data memory.
	D04	High-speed mode (output to the data memory alone.)
		The GPIB output format is specified.
	H0	The header is not added on data output.
	H1 (Initial value)	(The header is added on data output.
		Specifies the integral time on A/D measurement.
	IT0	100µs
	IT1	1ms
	IT2	10ms
	IT3	1PLC
	IT4 (Initial value)	5PLC
	IT5	10PLC
	IT6	20PLC
	IT7	50PLC
	IT8	100PLC

Table 4 - 8 Program Codes (cont'd)

Item	Code	Description
Control parameter	KNd..d d=2 (Initial value)	d..d : 2 to 1000 Specifies the number of statistical operation samples.
	Kn+/-d..d E+/-d KnMD n=X, Y, Z Initial value X, Z=1 Y=0	+/-d..d : Mantissa data Sign + Numeral of 8 digits or less + decimal point -19999999 to 19999999 E+/-d : Exponential data 'E' + Sign + 1-digit numeral 0 to 9 Sets the constant used for operation. o The sign (+) and decimal point can be omitted. o When setting the previous measurement value as the constant, use "KnMD" (n = X, Y, Z). o The exponential data can be omitted.
	HI1+/-d..d E+/-d HI2+/-d..d E+/-d LO1+/-d..d E+/-d LO2+/-d..d E+/-d Initial value HI=1,LO=0	+/=d..d : Mantissa data Sign + Numeral of 8 digits or less + decimal point -19999999 to 19999999 E+/-d : Exponential data 'E' + Sign + 1-digit numeral 0 to 9 Sets the constant used for comparator operation. o The sign (+) and decimal point can be omitted. o The exponential data can be omitted.
	L1+/-d..d E+/-d d..d,d..d	+/-d..dE+/-d, d..d, d..d Percent 2 (%1) Percent 1 (%2) Reference value

Table 4 - 8 Program Codes (cont'd)

Item	Code	Description
Control parameter	Initial value Reference value = 1 %1=10 %2=10	Reference value : Mantissa data Sign + Numeral of 8 digits or less + decimal point -19999999 to 19999999 Exponential data 'E' + Sign + 1-digit numeral 0 to 9 %1, %2 : 0.000 to 100.0 Decimal point + numeral of 4 digits or less Used for comparator operation. The judgment level is set as +/-% of the reference value. o The sign (+) and decimal point can be omitted. o The exponential data of the reference value can be omitted. o The %1, %2 data cannot be omitted.
		Specifies the power frequency used. 50 Hz
	LF50	50Hz
	LF60	60Hz
		Specifies the measurement digits
	RE4	4 1/2-digit (19999)
	RE5	5 1/2-digit (199999)
	RE6 (Initial value)	6 1/2-digit (1999999)
	RE7	7 1/2-digit (19999999)
		Specifies whether to execute the NULL function.
	NL0 (Initial value)	off
	NL1	on
		Specifies whether to execute the smoothing function.
	SM0 (Initial value)	off
	SM1	on

Table 4 - 8 Program Codes (cont'd)

Item	Code	Description
Control parameter	TId..d d=10 (Initial value)	d : 2 to 100 Specifies the count of smoothing.
	SId..d d=250 (Initial value)	d..d : 0 to 6000 Specifies the measurement interval. The unit is ms.
	TDd..d d=0 (Initial value)	d..d : 0 to 6000 Specifies the trigger delay time. The unit is ms.
	NSd..d d=1 (Initial value)	d..d : 1 to 10000 Specifies the number of samples for multi-sampling, the constant (number of samples) used when using the data memory function.
	SH0 (Initial value) SH1	Specifies the output mode for result of statistical operation. Step output mode in which output is done data by data (use the "RN" code from the 2nd data and after.) Consecutive output mode which outputs 8 data consecutively.
	ST0 (Initial value) ST1	Specifies whether to store the measurement value to the data memory. off on
		Parameters used for recall operation
	RO0 (Initial value) RO1	Specifies whether to recall data from the data memory. off on
	B0	Commands start of batch output of data stored in the data memory.

Table 4 - 8 Program Codes (cont'd)

Item	Code	Description
Control parameter	RD+/-d..d, +/-d..d	+/-d...d, +/-d...d Number of sequential recall data 1 to 10000 Direction of sequential recall + : Old → New data - : New → Old data The first data number to be recalled.
		o The sign can be omitted. o 1-data recall (", number of data +/-d...d" can be omitted when executing step output mode.)
	RN, RP	This code is effective when step output mode (data by data output) is specified. RN : Recall one data ahead to the new direction of the data number. RP : Recall one data ahead to the old direction of the data number.
	 NO0 N01 (Initial value)	Specifies whether to output the data number. Do not output. Output.
Others	E	Measurement start command code. The same meaning with the "TRIG" of panel. The same processing as the "GET" is done.
	C	Initializes the setting of GPIB. The same processing as the "DCL" and "SDC" is done.
	Z	The initial value is set to each parameter. Also executes the processing of program code "C".
	 S0 S1 (Initial value)	Specifies whether to transmit the SRQ signal. Transmit the SRQ signal. Do not transmit the SRQ signal.

Table 4 - 8 Program Codes (cont'd)

Item	Code	Description
Others		Specifies the data (string delimiter) to be output as the delimiters, when outputting multiple data (output of the recall data, result of statistical operation). "," is output.
	SL0 (Initial value)	"," is output.
	SL1	" " (space) is output.
	SL2	"CR/LF" is output.
		Specifies the block delimiter of data output.
	DL0 (Initial value)	Single line signal (EOI) is output when "CR/LF" and "LF" is output.
	DL1	"LF" is output.
	DL2	The single line signal (EOI) is output on output of the final data.
	CS	The status byte is cleared to 0. When SRQ is generated, the SRQ signal is made FALSE (cancel transmission).
	MSddd d=0 (Initial value)	ddd : 0-255 The specified bit in the status byte is masked. The bit to be masked is specified by ddd. The bit where "1" is set is masked (the decimal number set by ddd is converted in binary value to be masked). Note that bit 6 (RQS) cannot be masked. (Setting can be done.) Bit: 7 6 5 4 3 2 1 0 Status Bytes: --- --- --- --- --- --- --- --- 128 64 32 16 8 4 2 1
	TE	Executes the self diagnosis function.

Table 4 - 8 Program Codes (cont'd)

Item	Code	Description
Others	SD+/-d..d	Setting and calibration of the +/-d..d : sign + numeral of 8 digits or less + decimal point calibration value. The +/-d..d value specifies whether the calibration is on the zero point or a full-scale calibration. See the chapter on calibration for the setting range. o d..d allows data of fixed decimal point form only. (No data with exponential part is allowed.) o Set d..d with data corresponding to the display. o (If it is 20V range, it is d..d = 18, and 18V.) o The sign (+) can be omitted.

Table 4 - 9 TR6871 Measurement Range Code 2

code	VDC	VAC V(AC+DC)	ADC, AAC A(AC+DC)	2/4WΩ
0	auto	auto	auto	auto
1	——	——	——	——
2	——	——	——	——
3	200mV	200mV		100Ω
4	2000mV	2000mV	2000μA	1000Ω
5	20 V	20 V	20mA	10kΩ
6	200 V	200 V	200mA	100kΩ
7	1000 V	500 V	2000mA	1000kΩ
8	——	——	——	10MΩ
9	10 V	——	——	——

Notes on setting the program codes

1. 50 characters is the maximum number of program code characters that can be received at once.

   (Explanation)
   In this device, the reception program codes are sequentially read in the internal buffer, and the processing corresponding to the program code is performed as soon as the terminator is received. Therefore, the number of program code characters that can be received at once is limited to 50 characters. The " " (space) code in the terminator and string is not included as a character.

2. Transmit a "LF" (¥12) code at the end of the string of 1 line.

   (Explanation)
   Transmit a "LF" (¥12) code (or "CR", "LF") at the end of the 1-line string. If "LF" is not transmitted, output the single line signal "EOI" when transmitting the final character. (Both "LF" and "EOI" can be output.) If neither the "LF" code nor "EOI" signal is output, the end of the string cannot be detected, and the operation stops in a hand-shake wait status. The following terminators can be used.

   o CR/LF (EOI) o LF (EOI) o CR (EOI) o CR/LF o LF

3. Each program code can make multiple descriptions in a single string.

   (Explanation)
   Example :
   "F1R4M1" ..... The delimiter of each program code is not required.
   "F1, R4" ..... "," is used as the delimiter of each program code.
   "F1 R4" ..... " " (space) is used as the delimiter of each program code.

   The following program codes must be set individually.
   "INd", "Pd", "COd", "STd", "ROd", "BO"

4. The following characters can be used in remote programming.

   (Explanation)
   The following characters can be used in remote programming.

Numerals	"1" to "9", "0"
Alphabets	"A" to "Z", "a" to "z"
Symbols	",", ".", "+", "-"
Others	"CR", "LF", " " (space)

   It becomes setting error if characters other than the above are set. (Small letters "a" to "z" are handled in the same way as capital letters "A" to "Z".)

5. When a code which format cannot be used in the setting program was found.

   (Explanation)
   When a code which format cannot be used in the setting program was found, processing will be done normally till immediately before the code, but all later codes will be ignored.

6. The following are factors for generation of syntax errors.

   (Explanation)
   The following are factors for generation of syntax errors.
   o When the received string exceeded 50 characters (the received string is completely ignored)
   o When an unexciting program code is received
   o When the preset data exceeded the specified allowable range.
   o When a character that cannot be used is received.

   In case the above occurs, error code is displayed on the panel display unit.

7. The following listener codes can be received under calibration mode (when the "EXT CAL" switch on the rear panel is on).

   "AC", "CS", "DLd", "INd", "LFdd", "MSddd", "SD+/-d..d", "SLd"
   "C", "Fd", "Hd", "Pd", "Rd", "Sd", "Z" 8.

8 The following listener codes can be received under data memory recall mode (when the "RECALL" key on the front panel is on).
   "BO", "COd", "CS", "DLd", "MSddd", "NOd", "RD+/-d..d, +/d..d",
   "RN", "ROd", "RP", "SLd"
   "C", "Hd", "Sd", "Z"

9. The following listener codes can be received under statistical operation result output mode. "COd", "CS", "DLd", "MSddd", "RN", "SHd", "SLd" "C", "Hd", "Sd", "Z"

10. Note the following on data memory operation.
   "BO", "RD+/-d..d,+/-d..d", "NOd" are accepted only under store data number display status.
   "RN", "RP" are accepted only when it is under step output mode.
   No sequential output mode setting can be done once it enters the step output mode. Exit the recall mode once by "ROO" if necessary.

4.7 Service Request ("SRQ")

4.7.1 General

The service request is a function that informs the operation status by interrupting the controller as soon as the device enters the specified operation status.

The operation status is notified by the status byte. When the device transmits the service request, the controller searches the device one by one in sequence. (This is called serial polling.)

As soon as the device is found, the controller transmits the SPE (serial poll enable) command to this device, to inform that it is ready to accept the status byte. As soon as the device receives this command, it transmits a status byte to the controller. The controller judges the operation status of the device by this status byte.

4.7.2 Service Request and Status Byte

When specified to the "S0" mode, this device transmits service requests to the controller by the operation statues of the following (1) to (7).

When a service request is transmitted, the status byte is transmitted to the controller by execution of the serial polling of the controller.

When specified to the "S1" mode, no service request is transmitted by the status byte is transmitted.

The bits of the status byte is set according to the operation status of (1) to (7).

Each bit in the status byte can also be masked by program code "MSnnn".

All bits can be cleared by program code "CS".

The following is the relation of the operation status and each bit.

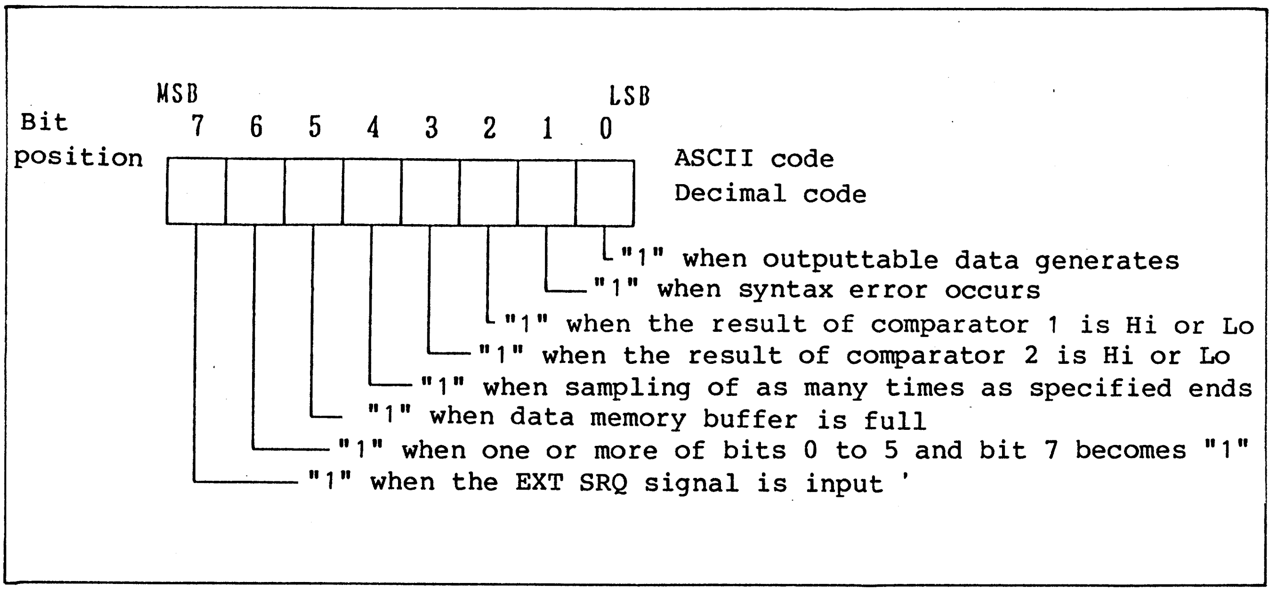


Figure 4 - 4 Relation of the Operation Status and Each Bit on Service Request

(1) Service request by generation of outputtable data The following is the status byte in this case.

Bit position	7 (MSB)	6	5	4	3	2	1	0 (LSB)
	0	1	0	0	0	0	0	1

ASCII code : A
Decimal code : 65

The service request is dispatched when data that can be output as the measurement data, operation result, or data recalled from the data memory, generates.
The status byte is cleared to 0 when the following status occurs.

1. When output of the outputtable data is completed.
2. When program code "E" or "GET" command is received while the sampling mode is set at SINGLE or MULTI.
3. When program code "ROd" is received, and when program code "RN" or "RP" is received while data is recalled from the data memory in step output mode.
4. When program code "SHd" is received, and when program code "RN" is received while outputting the result of statistical operation in step output mode.

(2) Service request by generation of syntax error The following is the status byte in this case.

	MSB							LSB	
	7	6	5	4	3	2	1	0	
Bit position	0	1	0	0	0	0	1	0	ASCII code : B Decimal code : 66

The service request is dispatched when there is a setting error in the remote program code. The status byte is cleared to 0 by the next remote program code.

(3) Service request by result of comparator 1, comparator 2
(When the result of operation is HIGH1 or LOW1.)
The following is the status byte in this case.

	MSB							LSB	
	7	6	5	4	3	2	1	0	
Bit position	0	1	0	0	0	1	0	0	ASCII code : D Decimal code : 68

The service request is dispatched when the result of comparator operation is HIGH1 or LOW1. The status byte is cleared to 0 as soon as the output of operation result data is completed.

(4) Service request by result of comparator 2, comparator 2
(When the result of operation is HIGH2 or LOW2.)
The following is the status byte in this case.

	MSB							LSB	
	7	6	5	4	3	2	1	0	
Bit position	0	1	0	0	1	0	0	0	ASCII code : H Decimal code : 72

The service request is dispatched when the result of comparator operation is HIGH2 or LOW2. The status byte is cleared to 0 as soon as the output of operation result data is completed.

(5) Service request by end of sampling as many times as specified
The following is the status byte in this case.

	MSB 7	6	5	4	3	2	1	LSB 0	
Bit position	0	1	0	1	0	0	0	0	ASCII code : P Decimal code : 80

① When the sampling mode is MULTI
The service request is dispatched after input of the trigger (measurement start command signal, command) and after sampling is completed for as many times as specified.
The status byte is cleared to 0 when the trigger is input, or when output of 1 data is completed.

② When operation requesting a certain number of sampling is executed.
The service request is dispatched as soon as the sampling for as many times as specified (the value of constant "N" for total operation, and the value of constant "X" for RMS operation) is completed.
Cleared when COMPUTE is turned OFF or when program code "SHd" is cleared.

③ When smoothing operation is executed
The service request is dispatched when it reaches the specified count (the value of constant "SM TIME") and the result of smoothing operation of as many times as specified is output.

④ When the data memory function is used
The service request is dispatched after trigger input when sampling of as many times as specified ends and STORE turns ON or OFF.
The status byte is cleared to 0 when STORE is turned ON again, or when RECALL is turned ON.

(6) Service request by data memory buffer full status The following is the status byte in this case.

	MSB 7	6	5	4	3	2	1	LSB 0	
Bit position	0	1	1	0	0	0	0	0	ASCII code : Decimal code : 96

The service request is dispatched when 10000 data is stored in the data memory (the buffer is full).
The status byte is cleared to 0 when STORE is turned ON again, or when RECALL is turned ON.

(7) Service request by input of external SRQ signal The following is the status byte in this case.

Bit position	MSB 7	6	5	4	3	2	1	LSB 0	
	1	1	0	0	0	0	0	0	Decimal code : 192

The service request is dispatched when the EXT SRQ signal is input from accessory TR13013.
The status bytes is cleared to 0 when serial polling is executed.

Note that status byte, bit 6 is a bit that indicates the service request. "1" is set to bit 6 when one or more bits of bits 0 to 5 and bit 7 become "1".
When all bits of bit 0 to 5 and bit 7 are cleared to 0, bit 6 is also cleared to 0.
The status bytes shown above are all cleared to 0 on power supply, on reception of the "SDC", "DCL" commands, and on reception of program codes "C", "Z", "CS".

4.8 Operation Flow Chart

A rough operation flow chart is given in Figure 4 - 5.

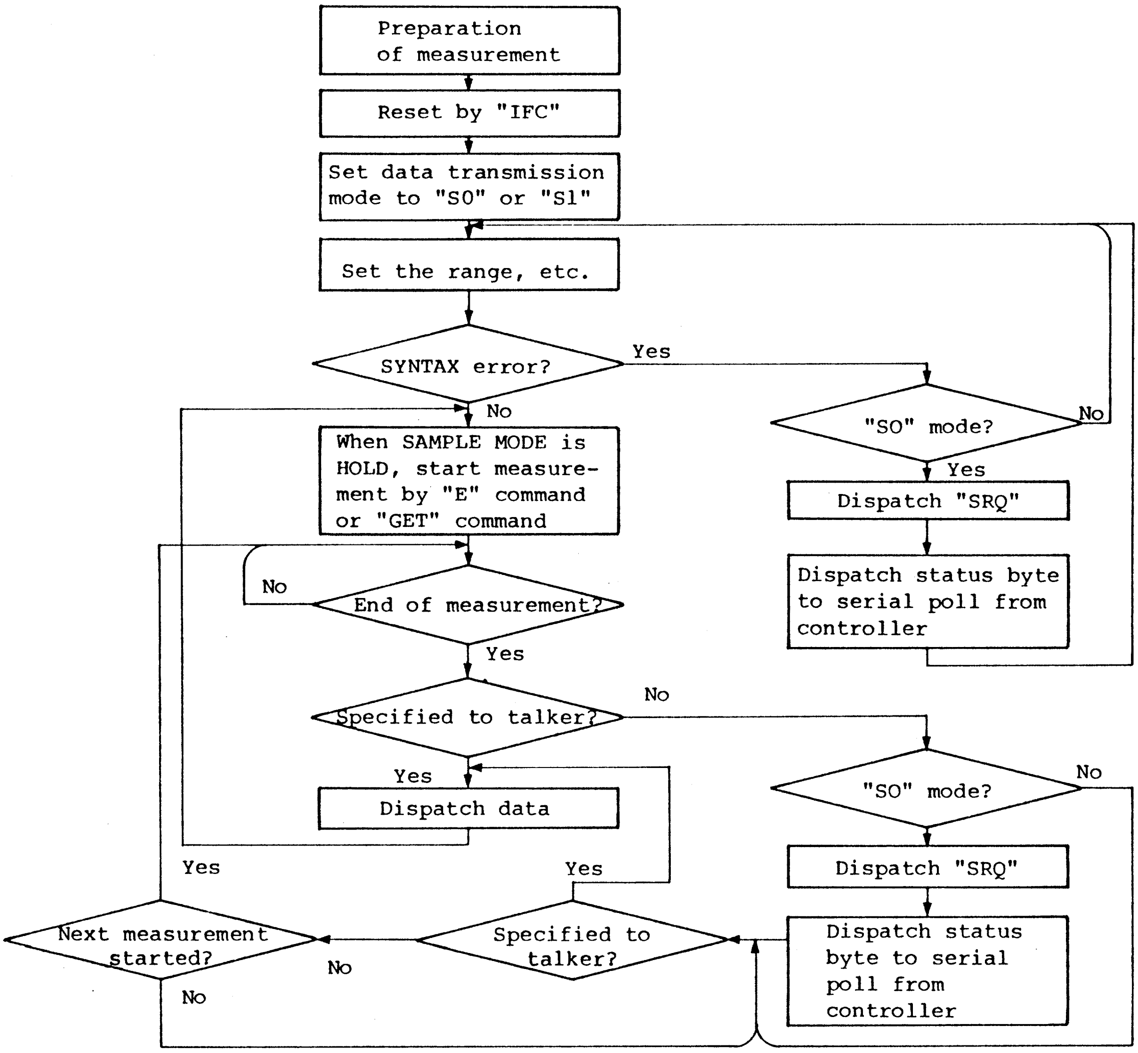


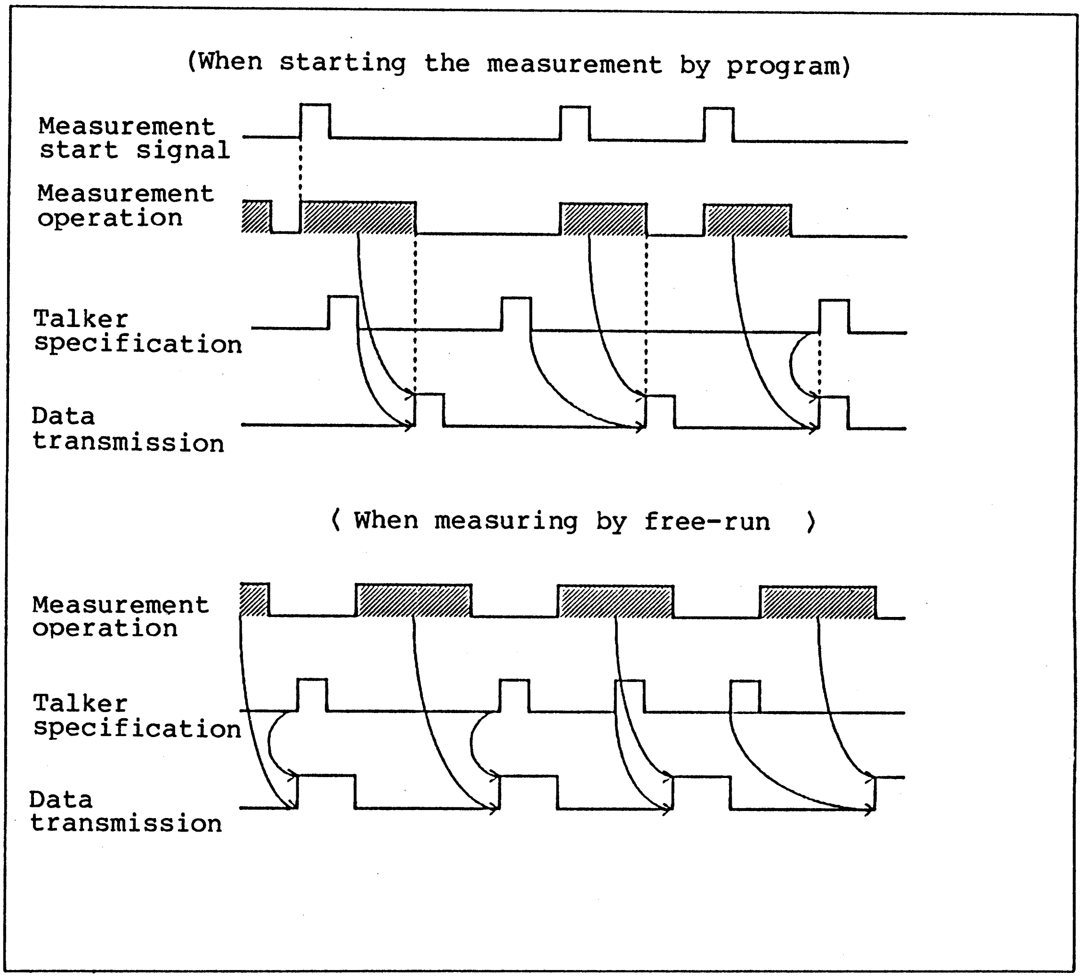
Figure 4 - 5 GPIB Flow Chart

4.9 Notes on Operation

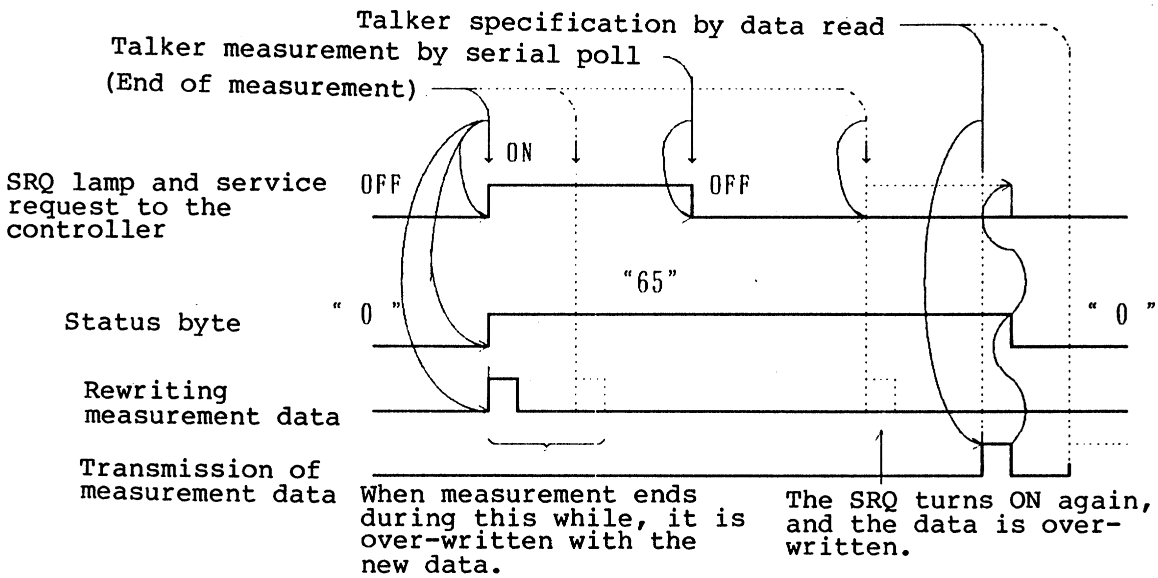
(1) Operation on service request

Be careful when creating the program, because if service request is generated (under S0 mode) by end of measurement and syntax error, the operation will become as shown in Figure 4 - 6.

(2) Difference of transmission data by talker-specified timing



(a) When using serial polling



(b) When not using serial polling

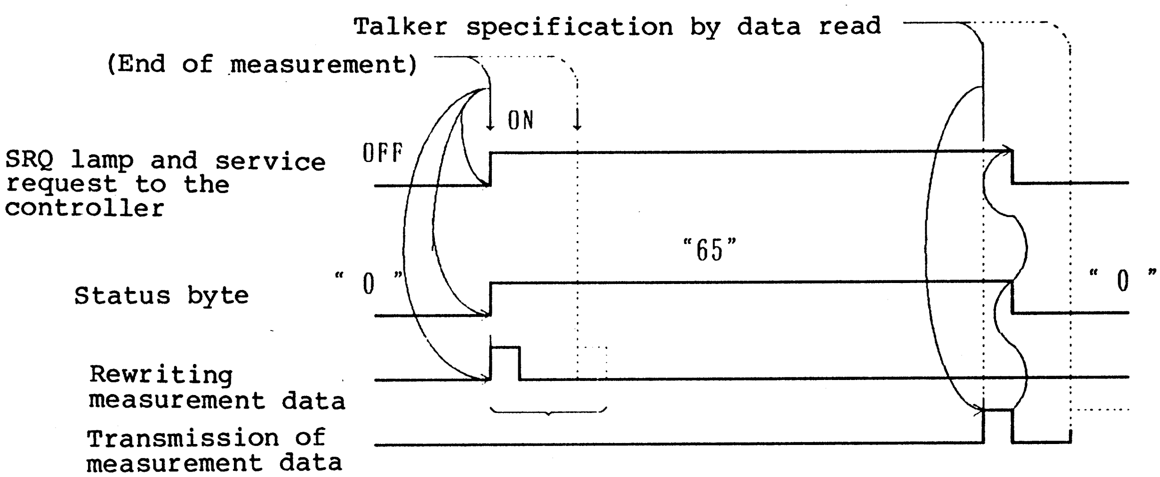
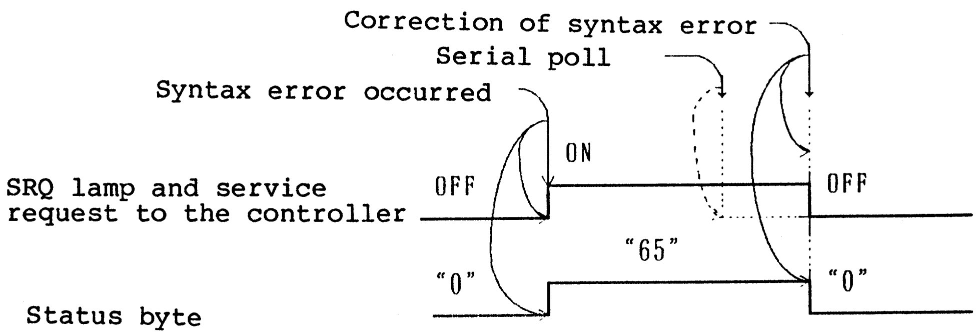


Figure 4 - 6 Operation Timing on Service Request

(c) In case syntax error occurred



Note : The SRQ is cleared by specification by the listener once syntax error occurrs.

Figure 4 - 6 Operation Timing on Service Request (cont'd)

4.10 Program Examples

The following are some program examples using Hewlet Paccard's HP200 series.

Example 1 : External start is commanded to start the direct current voltage measurement, 20V-range, SIGNLE sampling.

Example of program using the HP200 series [table]

```
10    !
20    !
30    !
40    DIM A$ [20]
50    TR6871=701
60    !
70    CLEAR TR6871
80    OUTPUT TR6871; "F1,R5,M1"
90    OUTPUT TR6871; "IT4,DL0,S1"
100   TRIGGER TR6871
110   ENTER TR6871;A$
120   PRINT A$
130   GOTO 100
140   !
150   END
```

	Description
40	Data area is defined
50	The TR6871 address is set at variable "Tr6871".
70	The GPIB interface device is initialized
80	The TR6871 parameter is set
	"F1" ... Direct current voltage
to	measurement function
	"R5" ... Measurement range 20V
90	"M1" ... Sampling mode : SINGLE
	"IT4" .. Integral time : 5PLC
	"DL0" .. Block delimiter : CR LF EOI
	"S1" ... SRQ transmission OFF
100	External start is commanded
110	Data is received.
120	Displayed.
130	It branches to line number 100.
150	End of program.

Example 2 : The measurement parameter is set externally. Measurement is started by external start, and data is read using the SRQ.

Example of program using the HP200 series

```
10    !
20    !
30    !
40    DIM A$ (20)
50    Tr6871=701
60    ON INTR 7 GOSUB Srq
70    !
80    CLEAR Tr6871
90    OUTPUT Tr6871; "F4,R5,M1"
100   OUTPUT Tr6871; "IT3,DLO,SO"
110   ENABLE INTR 7;2
120   TRIGGER Tr6871
130   Wait_f=0
140   IF Wait_f=1 THEN 120
150   GOTO 140
160   !
170 Srq: STATUS 7,1;X
180   S=SPOLL(Tr6871)
190   IF S<>65 THEN 230
200   ENTER Tr6871;A$
210   PRINT A$
220   Wait_f=1
230   ENABLE INTR 7;2
240   RETURN
250   !
260   END
```

	Description
40	Data area is defined
50	The TR6871 address is set at a "Tr6871" variable.
60	The interruption processing routine is defined
80	The GPIB interface device is initialized
90	The TR6871 parameter is set "F4" ... 4-line resistance measurement function "R5" ... Measurement range 10KΩ "M1" ... Sampling mode : SINGLE
100	"IT3" .. Integral time : 1PLC "DLO" .. Block delimiter : CR LF EOI "SO" ... SRQ transmission ON
110	Allows interruption by SRQ
120	External start is commanded
130 to 150	Interruption and interruption-wait processing loop
170 to 180	Interruption processing routine name : TR6871 is polled and the status is read
190	When interrupting from other than the TR6871, it branches to line number 230.
200	Data reception
210	Displayed
220	Interruption processing end flag (Wait_f) is set
230	Interruption by SRQ is allowed
240	Return to main routine
260	End of program

Example 3 : Example of program using the data memory function

```
10     !*****************************************************
20     !         DATA-MEMORY PROGRAM
30     !
40     !         MULTI SAMPLING, NS=50
50     !*****************************************************
60     !
70     DIM  M_data$ [30]
80     Tr6871=701
90     Ns_end=0
100    CLEAR Tr6871
110    ON INTR 7 GOSUB Srq
120    GOSUB Set_para
130    OUTPUT Tr6871;"ST1"
140    TRIGGER Tr6871
150    ENABLE INTR 7;2
160 Wait_srq:  IF Ns_end=0 THEN Wait_srq
170          OUTPUT Tr6871;"RO0"
180          STOP
190          !
200          !
210    !*****************************************************
220    !       INTERRUPT !!
230    !*****************************************************
240    !
250 Srq:     STATUS 7,1;X
260          S=SPOLL(Tr6871)
270          IF BIT(S,4)=0 THEN Rtn
280          OUTPUT Tr6871;"RO1"
290          OUTPUT Tr6871;"N01"
300          OUTPUT Tr6871;"RD0"
310          GOSUB Rec_data
320          FOR N=1 TO 49
330              OUTPUT Tr6871;"RN"
340              GOSUB Rec_data
350          NEXT N
360          Ns_end=1
370 Rtn:     ENABLE INTR 7;2
380          RETURN
390          !
400          !
410    !*****************************************************
420    !      SET TR6871 PARAMETER!!
430    !*****************************************************
440 Set_para:  OUTPUT Tr6871;"IN0"
450            OUTPUT Tr6871;"F1,R4,M2,IT1,SI0,TD0,AZ0,NS50"
460            OUTPUT Tr6871;"H1,S0,SL2,DL0,CS,MS47"
470            RETURN
480            !
490            !
```

(cont'd)

```
500   !*******************************************************
510   !          READ DATA-MEMORY DATA !!
520   !*******************************************************
530   !
540 Rec_data:     ENTER Tr6871;M_data$
550               PRINT M_data$
560               RETURN
570               !
580  END
```

Description	
70	The data area is defined.
80	The address of TR6871 is set in the "Tr6871" variable.
90	The end of recall output flag is cleared.
100	The device of GPIB interface is initialized.
110	The interruption processing routine is defined.
120	The subroutine "Set_para" that sets the parameters of the TR6871 is executed.
130	The data memory storage function is enabled.
140	External start is commanded
150	SRQ interruption is allowed.
160	Interruption wait loop (looped here till 150 samplings end).
170	The data memory recall function is turned off.
250 to 260	The interruption processing routine name : TR6871 is polled and the status is read.
270	The status byte bit 4 (service request by end of specified counts) is tested.
280	The data memory recall function is set on.
300	Data number "0" is read.
310	Subroutine "Rec_data" to receive data from the TR6871 is executed.
320 to 350	Process to read data numbers "1" to "49" is executed. Each data is read under step output mode by the "RN" code.
360	Recall output end flag is set.
370	Interruption by SRQ is allowed.
380	Returns to the main routine.

(cont'd)

Description	
440 to 470	Each parameter of subroutine name : TR6871 is set. "INO" ... TR6871 (MAIN) input selection "F1" .... Measurement function : VDC "R4" .... Measurement range : 2000mV "M2" .... Sampling mode : MULTI "IT1" ... Integral time : 1ms "SI0" ... Sampling interval : 0ms "TD0" ... Trigger delay time : 0ms "AZ0" ... Auto-zero calibration : OFF "NS50" .. Count of samples : 50 counts "H1" .... Header output : ON "S0" .... SRQ mode : ON "SL2" ... String delimiter : "CR/LF" "DL0" ... Block delimiter : "CR/LF OI)" "CS" .... Clear status byte "MS47" .. Mask status byte except bits 4, 6, and 7. 4
540 to 570	Receive recall data from subroutine name : TR6871.
580	End of program

(Output data)

```
NO+0000,DV  +1000.05E-03
NO+0001,DV  +1000.05E-03
NO+0002,DV  +1000.03E-03
NO+0003,DV  +1000.02E-03
NO+0004,DV  +1000.06E-03
NO+0005,DV  +1000.05E-03
NO+0006,DV  +1000.04E-03
NO+0007,DV  +1000.06E-03
NO+0008,DV  +1000.07E-03
NO+0009,DV  +1000.05E-03
NO+0010,DV  +1000.05E-03
NO+0011,DV  +1000.07E-03
NO+0012,DV  +1000.06E-03
NO+0013,DV  +1000.03E-03
NO+0014,DV  +1000.06E-03
NO+0015,DV  +1000.07E-03
NO+0016,DV  +1000.06E-03
NO+0017,DV  +1000.05E-03
NO+0018,DV  +1000.07E-03
NO+0019,DV  +1000.03E-03
NO+0020,DV  +1000.02E-03
NO+0021,DV  +1000.06E-03
NO+0022,DV  +1000.05E-03
NO+0023,DV  +1000.05E-03
NO+0024,DV  +1000.05E-03
NO+0025,DV  +1000.05E-03
NO+0026,DV  +1000.04E-03
NO+0027,DV  +1000.02E-03
NO+0028,DV  +1000.06E-03
NO+0029,DV  +1000.04E-03
NO+0030,DV  +1000.03E-03
NO+0031,DV  +1000.06E-03
NO+0032,DV  +1000.06E-03
NO+0033,DV  +1000.04E-03
NO+0034,DV  +1000.03E-03
NO+0035,DV  +1000.06E-03
NO+0036,DV  +1000.03E-03
NO+0037,DV  +1000.04E-03
NO+0038,DV  +1000.06E-03
NO+0039,DV  +1000.06E-03
NO+0040,DV  +1000.06E-03
NO+0041,DV  +1000.05E-03
NO+0042,DV  +1000.07E-03
NO+0043,DV  +1000.04E-03
NO+0044,DV  +1000.03E-03
NO+0045,DV  +1000.06E-03
NO+0046,DV  +1000.06E-03
NO+0047,DV  +1000.05E-03
NO+0048,DV  +1000.07E-03
NO+0049,DV  +1000.07E-03
```

Example 4 : Unlike (Example 3), the recall is done by specifying "," as the string delimiter, to reach the recall data as a character string.
When the "BO" code is sent to the TR6871, the number of data stored in the data memory is output.

```
10    !*****************************************************
20    !         DATA-MEMORY PROGRAM
30    !
40    !         MULTI SAMPLING, NS=200
50    !*****************************************************
60    !
70    DIM  M_data$ (2500)
80    Tr6871=701
90    Ns_end=0
100   CLEAR Tr6871
110   ON INTR 7 GOSUB Srq
120   GOSUB Set_para
130   TRIGGER Tr6871
140   ENABLE INTR 7;2
150 Wait_srq:   IF Ns_end=0 THEN Wait_srq
160         OUTPUT Tr6871;"R00"
170         STOP
180         !
190         !
200   !*****************************************************
210   !        INTERRUPT !!
220   !*****************************************************
230   !
240 Srq:      STATUS 7,1;X
250           S=SPOLL(Tr6871)
260           IF BIT(S,4)=0 THEN Rtn
270           OUTPUT Tr6871;"R01"
280           OUTPUT Tr6871;"N00"
290           OUTPUT Tr6871;"BO"
300           ENTER Tr6871;Count
310           PRINT "SAMPLE = ";Count
320           ENTER Tr6871;M_data$
330           PRINT M_data$
340           Ns_end=1
350 Rtn:      ENABLE INTR 7;2
360           RETURN
370           !
380           !
```

(cont'd)

```
390    !*******************************************************
400    !      SET TR6871 PARAMETER !!
410    !*******************************************************
420 Set_para:  OUTPUT Tr6871;"IN0"
430            OUTPUT Tr6871;"F1,R3,M2,IT0,SI0,TD0,AZ0,NS200"
440            OUTPUT Tr6871;"H0,S0,SL0,DL0,CS,MS47"
450            OUTPUT Tr6871;"ST1"
460            RETURN
470            !
480    END
```

(Output data)

```
SAMPLE =  200
-099.94E-03,-099.86E-03,-099.79E-03,-099.88E-03,-099.61E-03,-100.03E-03,-099.95E
-03,-099.85E-03,-100.07E-03,-099.79E-03,-100.02E-03,-099.80E-03,-099.72E-03,-099
.91E-03,-099.65E-03,-100.15E-03,-099.74E-03,-099.84E-03,-099.89E-03,-099.72E-03,
-100.12E-03,-099.69E-03,-099.81E-03,-100.08E-03,-099.69E-03,-099.99E-03,-099.25E
-03,-099.79E-03,-099.87E-03,-099.65E-03,-099.86E-03,-099.46E-03,-100.11E-03,-099
.93E-03,-099.97E-03,-100.09E-03,-099.42E-03,-100.00E-03,-099.83E-03,-099.66E-03,
-099.91E-03,-099.56E-03,-100.23E-03,-099.87E-03,-099.83E-03,-100.14E-03,-099.60E
-03,-100.16E-03,-099.46E-03,-099.81E-03,-099.84E-03,-099.66E-03,-100.18E-03,-099
.56E-03,-099.79E-03,-100.06E-03,-099.59E-03,-100.05E-03,-099.64E-03,-099.91E-03,
-099.80E-03,-099.57E-03,-099.86E-03,-099.35E-03,-100.51E-03,-099.93E-03,-099.90E
-03,-100.09E-03,-099.38E-03,-100.00E-03,-099.73E-03,-099.61E-03,-099.89E-03,-099
.57E-03,-100.22E-03,-099.90E-03,-099.84E-03,-100.15E-03,-099.65E-03,-100.12E-03,
-099.61E-03,-099.84E-03,-099.89E-03,-099.63E-03,-100.05E-03,-099.37E-03,-099.69E
-03,-099.96E-03,-099.70E-03,-100.04E-03,-099.61E-03,-100.01E-03,-100.06E-03,-099
.89E-03,-100.17E-03,-099.63E-03,-099.95E-03,-099.80E-03,-099.78E-03,-099.92E-03,
-099.64E-03,-100.09E-03,-099.93E-03,-099.86E-03,-100.08E-03,-099.84E-03,-100.02E
-03,-099.01E-03,-099.65E-03,-099.93E-03,-099.64E-03,-100.09E-03,-099.67E-03,-099
.84E-03,-099.86E-03,-099.72E-03,-099.98E-03,-099.61E-03,-099.84E-03,-100.03E-03,
-099.88E-03,-100.02E-03,-099.40E-03,-099.88E-03,-099.88E-03,-099.68E-03,-099.90E
-03,-099.57E-03,-100.14E-03,-099.90E-03,-099.89E-03,-100.07E-03,-099.67E-03,-100
.03E-03,-099.97E-03,-099.85E-03,-099.93E-03,-099.70E-03,-100.11E-03,-099.76E-03,
-099.82E-03,-100.11E-03,-099.73E-03,-100.07E-03,-099.67E-03,-099.87E-03,-100.03E
-03,-099.92E-03,-100.08E-03,-099.49E-03,-099.94E-03,-099.86E-03,-099.79E-03,-099
.92E-03,-099.69E-03,-099.87E-03,-099.88E-03,-099.70E-03,-099.91E-03,-099.56E-03,
-099.95E-03,-099.91E-03,-099.90E-03,-100.07E-03,-099.82E-03,-100.04E-03,-099.81E
-03,-099.79E-03,-099.94E-03,-099.76E-03,-100.06E-03,-099.74E-03,-099.85E-03,-100
.09E-03,-099.74E-03,-100.06E-03,-099.68E-03,-099.91E-03,-100.05E-03,-099.94E-03,
-100.10E-03,-099.49E-03,-099.83E-03,-099.85E-03,-099.77E-03,-099.90E-03,-099.62E
-03,-100.00E-03,-099.97E-03,-099.89E-03,-100.11E-03,-099.81E-03,-099.97E-03,-099
.82E-03,-099.75E-03,-099.93E-03,-099.67E-03,-100.10E-03,-099.79E-03,-099.87E-03
```

Description
Setting status of each TR6871 parameters "IN0" ... TR6871 (MAIN) input selection "F1" .... Measurement function : VDC "R3" .... Measurement range : 200mV "M2" .... Sampling mode : MULTI "IT0" ... Integral time : 100μs "SI0" ... Sampling interval : 0ms "TD0" ... Trigger delay time : 0ms "AZ0" ... Auto-zero calibration : OFF "NS200".. Count of samples : 200 counts "H0" .... Header output : OFF "S0" .... SRQ mode : ON "SL0" ... String delimiter : "," "DL0" ... Block delimiter : "CR/LF (EOI)" "CS" .... Clear status byte "MS47" .. Mask status byte except bits 4, 6, and 7. "ST1" ... Set data memory store function ON.

Example 5 : Example of a program where sampling is executed under the highest-speed mode using the data memory function

```
10   !*****************************************************
20   !          DATA-MEMORY PROGRAM (FAST SAMPLING)
30   !
40   !          SAMPLING MODE :RUN,    NS:  1000
50   !*****************************************************
60   !
70   DIM Rec_data$(10000) [20]
80   INTEGER Data_count,N
90   Tr6871=701
100  Ns_end=0
110  CLEAR Tr6871
120  ON INTR 7 GOSUB Srq
130  GOSUB Set_para
140  TRIGGER Tr6871
150  ENABLE INTR 7;2
160 Wait_srq:   IF Ns_end=0 THEN Wait_srq
170       OUTPUT Tr6871;"R00"
180       STOP
190       !
200  !*****************************************************
210  !       INTERRUPT !!
220  !*****************************************************
230  !
240 Srq:      STATUS 7,1;X
250           S=SPOLL(Tr6871)
260           IF BIT(S,4)=0 THEN Rtn
270           OUTPUT Tr6871;"R01"
280           OUTPUT Tr6871;"N00"
290           GOSUB Rec_data
300           Ns_end=1
310 Rtn:      ENABLE INTR 7;2
320           RETURN
330           !
340  !*****************************************************
350  !      SET TR6871 PARAMETER !!
360  !*****************************************************
370 Set_para:  OUTPUT Tr6871;"IN0"
380            OUTPUT Tr6871;"F1,R3,TD0,NS1000"
390            OUTPUT Tr6871;"H0,S0,SL2,DL0,CS,MS47"
400            OUTPUT Tr6871;"D04"
410            WAIT .5
420            RETURN
430            !
```

(cont'd)

```
440    !**************************************************
450    !        GET DATA-MEMORY DATA !!
460    !**************************************************
470 Rec_data:     OUTPUT Tr6871;"BO"
480               ENTER Tr6871;Data_count
490               FOR N=1 TO Data_count
500                   ENTER Tr6871;Rec_data$(N)
510               NEXT N
520               PRINT "DATA COUNT= ";Data_count
530               PRINT
540               FOR N=1 TO Data_count
550                   PRINT Rec_data$(N)
560               NEXT N
570               RETURN
580               !
590    END
```

	Description
70	Defines the data area
90	The address of TR6871 is set in the "Tr6871" variable.
100	The end of recall output flag is cleared.
110	The device of GPIB interface is initialized.
120	The interruption processing routine is defined.
130	The subroutine "Set_para" that sets the parameters of the TR6871 parameters is executed.
140	External start is commanded
150	SRQ interruption is allowed.
160	Interruption wait loop (looped here till 1000 samplings end after external start is commanded).
170	The data memory recall function is turned off.
180	The program is stopped.

(Output data)

```
+000.04E-03
+000.04E-03
+000.07E-03
+000.03E-03
+000.06E-03
+000.04E-03
+000.03E-03
+000.06E-03
+000.04E-03
+000.05E-03
+000.05E-03
+000.04E-03
+000.05E-03
+000.02E-03
+000.02E-03
+000.03E-03
+000.02E-03
+000.05E-03
+000.05E-03
+000.02E-03
+000.04E-03
+000.03E-03
+000.02E-03
+000.02E-03
+000.00E-03
-000.01E-03
+000.01E-03
-000.01E-03
+000.00E-03
+000.03E-03
+000.02E-03
+000.01E-03
+000.04E-03
+000.02E-03
+000.02E-03
+000.05E-03
+000.01E-03
+000.01E-03
+000.03E-03
+000.02E-03
+000.02E-03
+000.04E-03
+000.01E-03
-000.00E-03
+000.03E-03
+000.02E-03
+000.05E-03
+000.02E-03
+000.02E-03
+000.04E-03
+000.08E-03
+000.05E-03
+000.04E-03
+000.06E-03
+000.03E-03
+000.05E-03
+000.03E-03
+000.02E-03
      :
      :
```

(cont'd)

Description	
240 to 250	The interruption processing routine name : TR6871 is polled and the status is read.
260	The status byte bit 4 (service request by end of specified is counts) tested.
270	The data memory recall function is set on.
280	It is set so that the recall data is output without data number.
290	Subroutine "Rec_data" to receive data from the TR6871 is executed.
300	Recall output end flag is set.
310	Interruption by SRQ is allowed.
320	Returns to the main routine.
370 to 420	Each parameter of subroutine name : TR6871 is set. "INO" ... TR6871 (MAIN) input selection "F1" .... Measurement function : VDC "R3" .... Measurement range : 200mV "TD0" ... Trigger delay time : 0ms "NS1000". Count of samples : 1000 counts "H0" .... Header output : OFF "S0" .... SRQ mode : ON "SL2" ... String delimiter : "CR/LF" "DL0" ... Block delimiter : "CR/LF (EOI)" "CS" .... Clear status byte "MS47" .. Mask status byte except bits 4, 6, and 7. "DO4" ... Data output mode : 4 (Highest-speed mode) The 0.5-second timer takes "DO4" processing time.
470	Batch output from data memory by subroutine name : "BO"
480	Reads number of data stored in the data memory
490 to 510	Reads data from the data memory, to save the data to the Rec_data buffer.
520	Displays number of data
530 to 560	Displays all recalled data
570	Return to the main routine.
590	End of program

Example 6 : Example of a program that executes the statistical operation of the operation function

```
10     !*******************************************************
20     !          COMPUTING FUNCTION : STATISTICS
30     !
40     !          20V range.SAMPLE : 10
50     !*******************************************************
60     !
70     DIM M_data$ [30]
80     Tr6871=701
90     Ns_end=0
100    CLEAR Tr6871
110    ON INTR 7 GOSUB Srq
120    GOSUB Set_para
130    TRIGGER Tr6871
140    ENABLE INTR 7;2
150 Wait_srq:   IF Ns_end=0 THEN Wait_srq
160         OUTPUT Tr6871;"C00"
170         STOP
180         !
190         !
200    !***************************************************
210    !       INTERRUPT !!
220    !***************************************************
230    !
240 Srq:    STATUS 7,1;X
250         S=SPOLL(Tr6871)
260         IF BIT(S,4)=0 THEN Rtn
270         OUTPUT Tr6871;"SH0"
280         GOSUB Comp_data
290         FOR N=1 TO 7
300            OUTPUT Tr6871;"RN"
310            GOSUB Comp_data
320         NEXT N
330         Ns_end=1
340 Rtn:    ENABLE INTR 7;2
350         RETURN
360         !
370         !
380    !***************************************************
390    !      SET TR6871 PARAMETER !!
400    !***************************************************
410 Set_para: OUTPUT Tr6871;"IN0"
420           OUTPUT Tr6871;"F1,R5,M2,IT5,RE7,SI0,TD1000,NS10,CF0,3,KN10"
430           OUTPUT Tr6871;"H1,S0,SL2,DL0,CS,MS47"
440           OUTPUT Tr6871;"C01"
450           RETURN
460           !
470           !
```

(cont'd)

```
480     !**************************************************
490     !       READ COMPUTING DATA !!
500     !**************************************************
510     !
520 Comp_data:  ENTER Tr6871;M_data$
530             PRINT M_data$
540             RETURN
550             !
560  END
```

(Output data)

```
DV C00010
DV X+11.234576E+00
DV N+11.234569E+00
DV A+11.234573E+00
DV K+00.000007E+00
DV S+1.9340000E-06
DV Y+11.234579E+00
DV Z+11.234567E+00
```

	Description
70	Defines the data area
80	The address of TR6871 is set in the "Tr6871" variable.
90	The end of statistical operation result output flag is cleared.
100	The device of GPIB interface is initialized.
110	The interruption processing routine is defined.
120	The subroutine "Set_para" that sets the parameters of the TR6871 parameters is executed.
130	External start is commanded
140	SRQ interruption is allowed.
150	Interruption wait loop (looped here till 10 samplings end).
160	The operation function is turned off.
170	The program is stopped.
240 to 250	The interruption processing routine name : TR6871 is polled and the status is read.
260	The status byte bit 4 (service request by end of specified counts) is tested.
270	Specify 'step' as the statistical operation result output mode.
280	Subroutine "Comp_data" that receives data from the TR6871 is executed. (As many data as sampled is received.)

(cont'd)

	Description
290 to 320	Process to receive the MAX, MIN, AVE, P-P, σ, UCL, LCL data of the statistical operation result.
330	End of operation result output flag is set.
340	Interruption by SRQ is allowed.
350	Returns to the main routine.
410 to 450	Each parameter of subroutine name : TR6871 is set. "INO" ... TR6871 (MAIN) input selection "F1" ... Measurement function : VDC "R5" ... Measurement range : 20mV "M2" ... Sampling mode : MULTI "IT5" ... Integral time : 10PLC "RE7" ... Displayed digits : 7 1/2-digit mode "SI0" ... Sampling interval : 0ms "TD1000" ... Trigger delay time : 1000ms "NS10" ... Count of samples : 10 counts "CF0, 3" ... Operation function : Statistical process is set for 2-dimensional operation "KN10" ... Number of statistical operation object samples : 10 samples "H1" ... Header output : ON "S0" ... SRQ mode : ON "SL2" ... String delimiter : "CR/LF" "DL0" ... Block delimiter : "CR/LF (EOI)" "CS" ... Clear status byte "MS47" ... Mask status byte except bits 4, 6, and 7. "CO1" ... Set operation function ON.
520 to 540	Result of operation is received from subroutine name : TR6871
560	End of program

5. ACCESSORIES

5.1 TR13010 Binary Data Output Unit

5.1.1 General

The TR13010 binary data output unit converts the result of measurement on various measuring device (displayed value) into binary parallel data, and outputs the data to the external devices.

The external start input signal terminal allows starting the measurement from locations away from the measuring device.

The data output and external start signal are electrically isolated from the measurement input signal system of the digital multi-meter, so as not to affect the measurement value even when connecting external devices to structure the system.

5.1.2 Output Operation of Result of Measurement

The binary output unit expresses the result of measurement in binary representation, and outputs the data to the external devices. The relation between the result of measurement with the output signal pins and output signal levels is explained here, with examples. Also refer to the pin number table of [Section 5.1.3] and the output format of [Section 5.2.6].

(Example) When the result of measurement for direct current voltage measurement is 119.6032V in 6 1/2-digit representation. The measurement range is 200V.

When 1196032 is displayed in binary representation, the digits of 2^{12}, 2^{15}, 2^{20}, are 1 and all remaining digits are 0.
This is expressed with pin-numbers and output signal levels as follows.

Pin No.	Binary digits	Output signal level	Binary re-presentation
2	0	LOW	0
3	1	LOW	0
4	2	LOW	0
5	3	LOW	0
6	4	LOW	0
7	5	LOW	0
8	6	LOW	0
9	7	LOW	0
10	8	LOW	0
11	9	LOW	0
12	10	LOW	0
13	11	LOW	0
14	12	HIGH	1
15	13	LOW	0
16	14	LOW	0
17	15	HIGH	1
18	16	LOW	0
19	17	LOW	0
20	18	LOW	0
21	19	LOW	0
22	20	HIGH	1

The position of the decimal point is decided by the measurement range. The measurement range is expressed by pins No. 32, 33, 34, and 35. The 200V range is expressed by 0100, so the measurement range is as shown in the following table.

Pin No.	Output signal level	Binary re-presentation
32	LOW	0
33	LOW	0
34	HIGH	1
35	LOW	0

The position of the decimal point is judged as follows,

(1) Calculate the value of the following N.

N = Displayed digits - digits of the measurement range
Note that the displayed digits and the digits of the measurement are converted as follows.

Displayed digits
7½ ⟶ 8
6½ ⟶ 7
5½ ⟶ 6
4½ ⟶ 5

Measurement range digits	
2000μX ⟶ 1	1000 X ⟶ 4
20mX ⟶ 2	10 kX ⟶ 2
200mX ⟶ 3	100 kX ⟶ 3
2000mX ⟶ 4	1000 kX ⟶ 4
20 X ⟶ 2	10 MX ⟶ 2
200 X ⟶ 3	
500 X ⟶ 3	

Note that X is the basic unit (V, A, Ω)

(2) The decimal position is judged using N as follows.

In this example,
the result of measurement is "1196032", 6 1/2-digit display, 200V-range, so
N = 7 - 3 = 4

```
1 . 1 . 9 . 6 . 0 . 3 . 2
  ↑   ↑   ↑   ↑   ↑   ↑
 N=6 N=5 N=4 N=3 N=2 N=1
```

Now, N = 4, so
the result of measurement becomes 119.6032V. If the result of measurement is "119603", 6 1/2-digit display, and 200V-range,
N = 7 - 3 = 4

```
1 . 1 . 9 . 6 . 0 . 3
  ↑   ↑   ↑   ↑   ↑
 N=5 N=4 N=3 N=2 N=1
```

Now, N = 4, so
the result of measurement becomes 11.9603V.

The measurement function is expressed by pin numbers 28, 29, 30, and 31.
The direct current voltage measurement is expressed 0000 in binary representation, so the measurement function is expressed as shown in the following table.

Pin No.	Output signal level	Binary representation
28	LOW	0
29	LOW	0
30	LOW	0
31	LOW	0

The polarity is express by pin No. 27.
Plus is 0 in binary representation, so the polarity is expressed as follows.

Pin No.	Output signal level	Binary representation
27	LOW	0

Measurement-over and operation error are expressed by pin No. 23.
In this example, there is no measurement-over or operation error, so this state is expressed as 0 in binary representation.

Pin No.	Output signal level	Binary representation
23	LOW	0

The output data is output to the pins described above parallel (simultaneously). The data output timing is recognized by the output signal (pin-47).

5.1.3 Connectors and Pin Numbers

(1) Connector used

TR13010 side .... 57-40500 (Daiichi Denshi Kogyo)
Connection cable side ...... 57-30500 (Daiichi Denshi Kogyo)

(2) Pin numbers

Function		Pin No.	Pin No.	Function	
SIGNAL GND		1	26	SIGNAL GND	
2^0	Data	2	27	Polarity	
2^1		3	28	1	Measurement function
2^2		4	29	2	
2^3		5	30	4	
2^4		6	31	8	
2^5		7	32	1	Measurement range
2^6		8	33	2	
2^7		9	34	4	
2^8		10	35	8	
2^9		11	36		NC
2^{10}		12	37		
2^{11}		13	38		
2^{12}		14	39		
2^{13}		15	40		
2^{14}		16	41		
2^{15}		17	42		
2^{16}		18	43		
2^{17}		19	44		
2^{18}		20	45		
2^{19}		21	46		
2^{20}		22	47	Data output signal	
Measurement-over/ operation error		23	48	External start input signal	
LOW level		24	49	A/D conversion end signal	
SIGNAL GND		25	50	SIGNAL GND	

Note 1 : Pins 36 to 46 are idle pins.

Note 2 : When measuring in 4 1/2 to 4 1/2 digits, the data corresponding to the display is converted into binary value and output. When measuring in 7 1/2-digit, the lowest digit is left blank and the higher order 6 1/2-digit is converted into binary digits to be output.

- o 4 1/2-digit measurement
  Output to pins 2^0 to 2^{14}. Pins 2^{15} to 2^{20} are LOW level.
- o 5 1/2-digit measurement
  Output to pins 2^0 to 2^{17}. Pins 2^{18} to 2^{20} are LOW level.
- o 6 1/2-digit, 7 1/2-digit measurement
  Output to pins 2^U to 2^{20}.

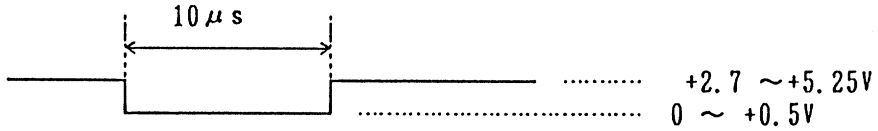
5.1.4 Input/Output Level

(1) Data output (2^0 to 2^{20}, measurement-over, operation error, polarity, measurement function, measurement range)

TTL level, positive logic
"1" : High, +2.7 to +5.25V
"0" : Low, 0 to +0.5V

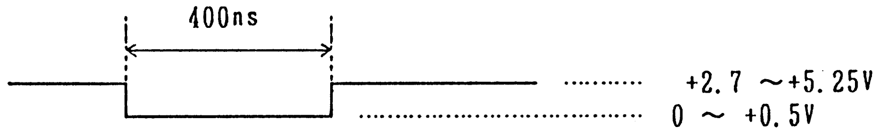
(2) Data output signal

TTL level, negative pulse (the pulse width is approx.. 10µs)



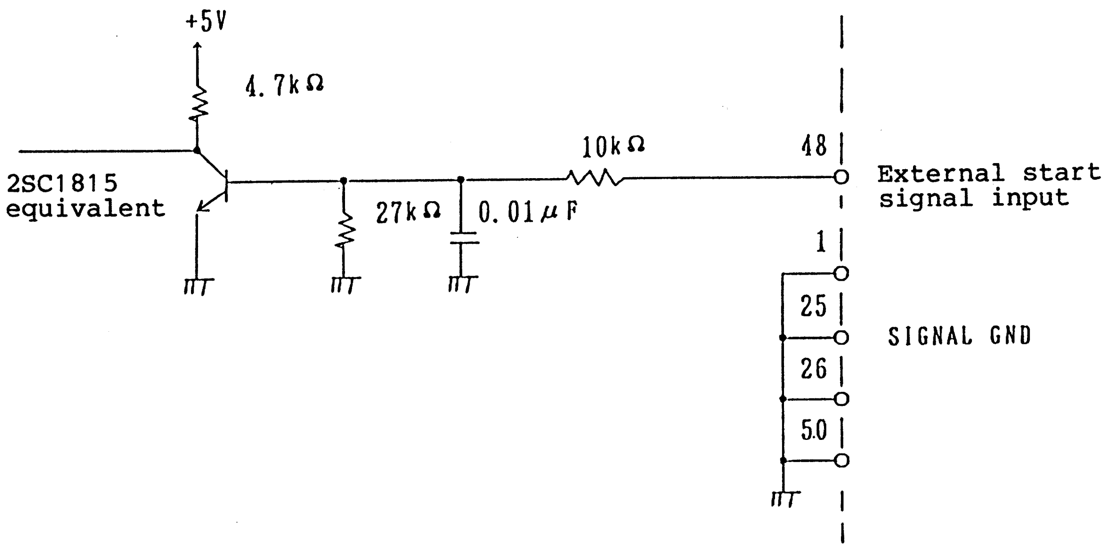
(3) A/D conversion end signal

TTL level, negative pulse (the pulse width is approx.. 400µs)



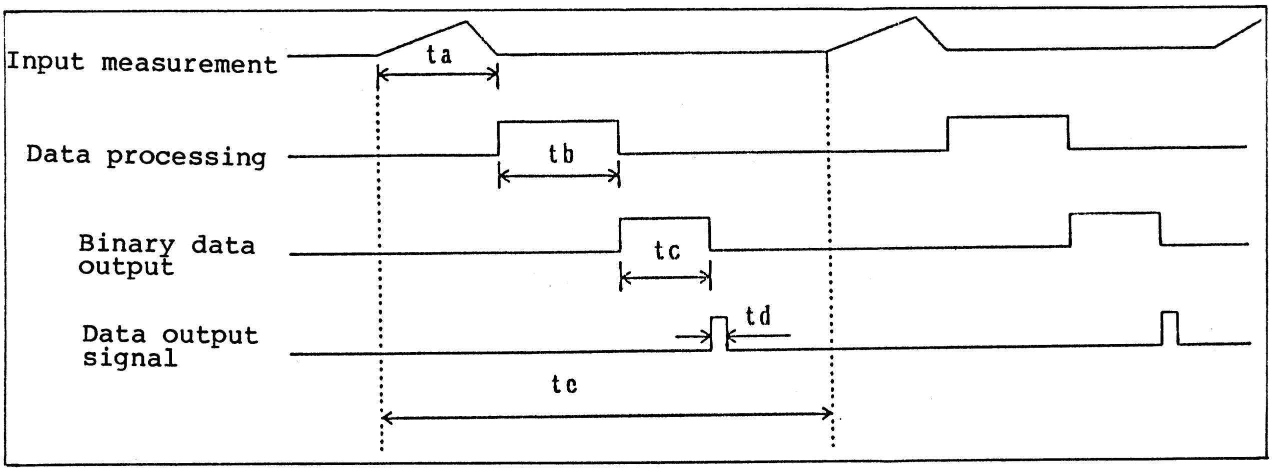
(4) External start signal input

TTL level, positive pulse (the pulse width is 10µs to 10ms)
Ignored when the sampling mode is "RUN".



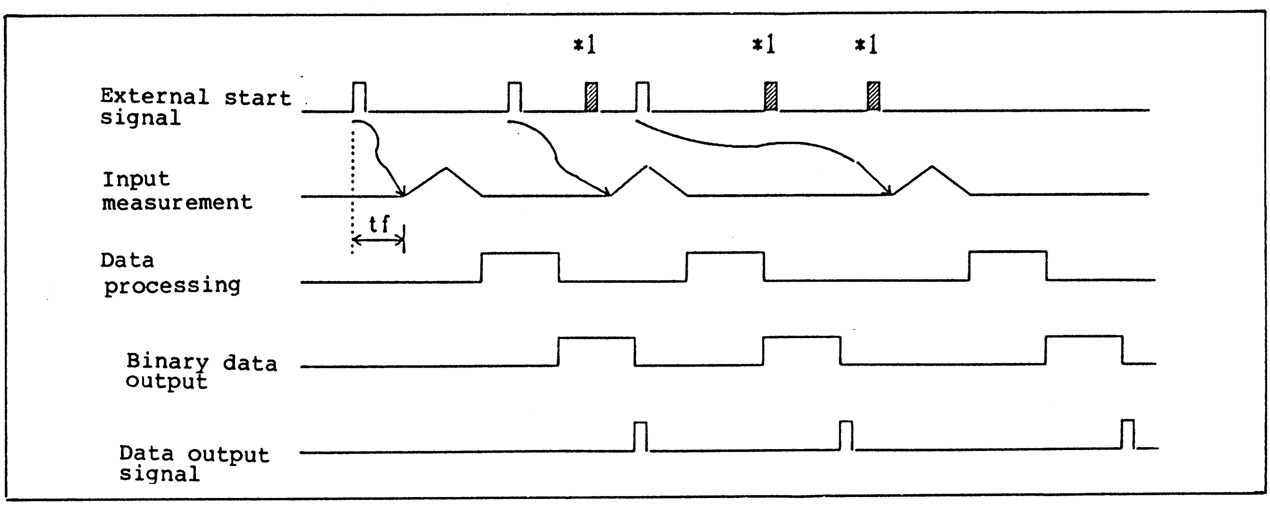
5.1.5 Operation Timing

(1) Sampling mode : RUN



ta : Depends on the measurement function and the integrated time (IT).
tb : True calculation time
tc : Format conversion time and output time of binary data output
td : Approx.. 10μs
te : Depends on the sampling interval (SI)

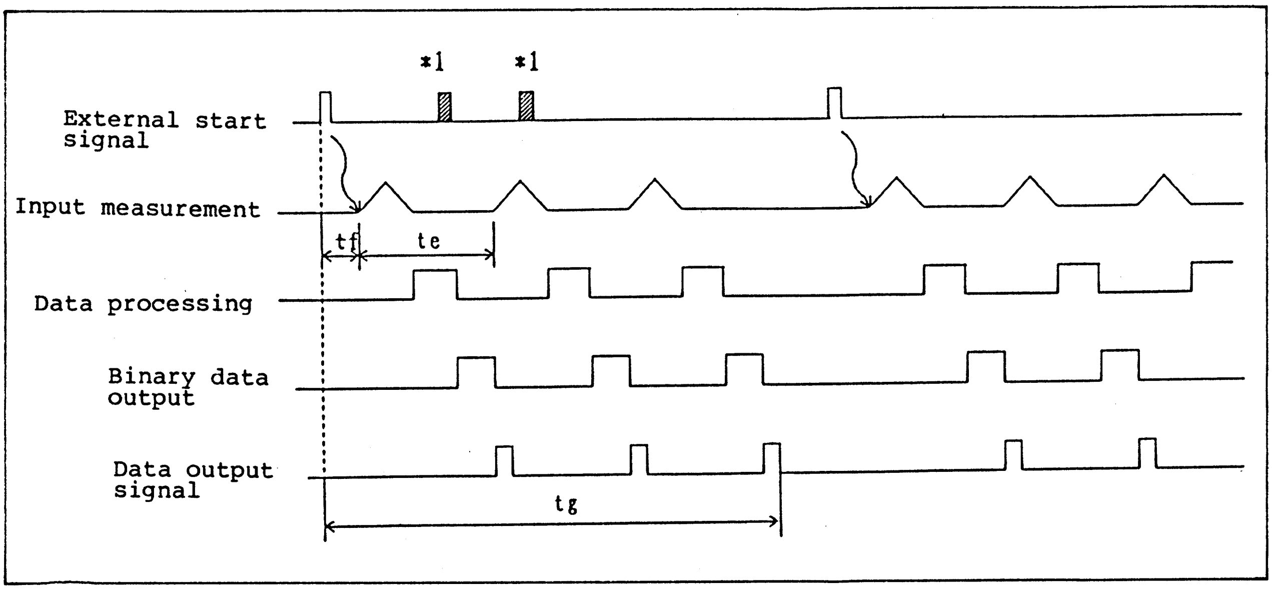
(2) Sampling mode : SINGLE



Note : The 2nd external start signal and after before the input measurement start are ignored. (*1)

tf : The time from external start signal input to input measurement start.
When "TD"   0ms, it depends on "TD".
When "TD" = 0ms, it is the internal delay time after the external start signal is accepted to the start of the input measurement.

(3) Sampling mode : MULTI (Example : "NS" = 3)



Note : The external start signal and before start of the "NS" final sample measurement is ignored. (*1)

te : Depends on "SI".
tf : "TD" and internal delay time.
tg : From reception of the external start signal to the "NS sample end".

5.1.6 Output Format

Output name	Output data	Code 8 4 2 1
Data (2^{0} ~ 2^{20})	0 (low-level) 1 (high-level)	0 1
Measurement-over/ Operation error	0 (low-level) 1 (high-level)	0 1
Polarity	Space, plus, minus	0 1
Measurement function	VDC	0 0 0 0
	VAC	0 0 0 1
	V(AC+DC)	0 0 1 0
	ADC	0 0 1 1
	AAC	0 1 0 0
	A(AC+DC)	0 1 0 1
	4WΩ (Hi-P)	0 1 1 0
	4WΩ (Lo-P)	0 1 1 1
	2WΩ (Hi-P)	1 0 0 0
	2WΩ (Lo-P)	1 0 0 1
	Others	1 1 1 1

The code of the measurement range becomes as follows, when the object connected to the TR6871 input terminal is measured. When measured from "plug-in", codes 0, 1, 2 ... are output from th minimum range to maximum range.

VDC	VAC 、 V(AC+DC)	ADC 、 AAC 、 A(AC+DC)	2/4WΩ	8 4 2 1
200mV	200mV	2000μA	100Ω	0 0 0 0
2000mV	2000mV	20 mA	1000Ω	0 0 0 1
*1 10 V	20 V	200 mA	10kΩ	0 0 1 0
20 V	200 V	2000 mA	100kΩ	0 0 1 1
200 V	500 V		1000kΩ	0 1 0 0
1000 V			10MΩ	0 1 0 1
				0 1 1 0
				0 1 1 1
				1 0 0 0
				1 0 0 1

Note 1 : When the operation result data includes exponential part, the exponential part data will not be output.

Note 2 : Pin-23 becomes HIGH in case of measurement-over and operation error.

5.1.7 Specification

Data output	: Binary parallel code
Output data	: Measurement data, polarity, measurement function, measurement range
Data output signal level	: TTL level, positive logic
Data output signal	: TTL level, negative pulse (pulse width, approx. 10µs)
A/D conversion end signal	: TTL level, negative pulse (pulse width, approx. 400ns)
External start input signal	: TTL level, positive pulse (pulse width, approx. 10µs to 10ms)
Data output connector	: 57-40500 (Daiichi Denshi Kogyo's product or equivalent)

5.2 TR13011 BCD Data Output Unit

5.2.1 General

The TR13011 BCD data output unit converts the result of measurement of each measuring device (displayed value) into BCD parallel code, and outputs the data to the external device.

The external start input signal terminal allows starting the measurement from locations away from the measuring device.

The data output and external start input signal are electrically isolated from the measurement input signal system of the digital multi-meter, so as not to affect the measurement value even when connecting external devices to structure the system.

5.2.2 Output Operation of Result of Measurement

The BCD output unit expresses and outputs the result of measurement in BCD code and outputs the data to the external devices.

The relation between the result of measurement with the output signal pins and output signal levels is explained here, with examples. Also refer to the pin number table of [Section 5.1.3] and the output format of [Section 5.2.6].

(Example)
Measurement of direct current voltage : 7 1/2 -digit representation.
The measurement result is 123.45678V

1	2	3 .	4	5 .	6	7	8
↑	↑	↑	↑	↑	↑	↑	↑
10^7 -digit	10^6 -digit	10^5 -digit	10^4 -digit	10^3 -digit	10^2 -digit	10^1 -digit	10^0 -digit

(1) The data is destructured into 10^0-digit to 10^7-digit one by one, and expressed in BCD code.

o The 10^0-digit is 8, and is expressed by pins No. 2, 3, 4, and 5.
8 is expressed as 1000 in BCD code.
Therefore, 8 is expressed as follows.

Pin No.	Output signal level	BCD code
2	LOW	0
3	LOW	0
4	LOW	0
5	HIGH	1

o The 10^1-digit is 7, and is expressed by pins No. 6, 7, 8, and 9.
7 is expressed as 0111 in BCD code.
Therefore, 7 is expressed as follows.

Pin No.	Output signal level	BCD code
6	HIGH	1
7	HIGH	1
8	HIGH	1
9	LOW	0

o The 10^2-digit is 6, and is expressed by pins No. 10, 11, 12, and 13.
6 is expressed as 0110 in BCD code.
Therefore, 6 is expressed as follows.

Pin No.	Output signal level	BCD code
10	LOW	0
11	HIGH	1
12	HIGH	1
13	LOW	0

o The 10^3-digit is 5, and is expressed by pins No. 14, 15, 16, and 17.
5 as expressed as 0101 in BCD code.
Therefore, 5 is expressed as follows.

Pin No.	Output signal level	BCD code
14	HIGH	1
15	LOW	0
16	HIGH	1
17	LOW	0

o The 10^4-digit is 4, and is expressed by pins No. 18, 19, 20, and 21.
4 as expressed as 0100 in BCD code.
Therefore, 4 is expressed as follows.

Pin No.	Output signal level	BCD code
18	LOW	0
19	LOW	0
20	HIGH	1
21	LOW	0

o The 10^5-digit is 3, and is expressed by pins No. 22, 23, 24, and 25.
3 as expressed as 0011 in BCD code.
Therefore, 3 is expressed as follows.

Pin No.	Output signal level	BCD code
22	HIGH	1
23	HIGH	1
24	LOW	0
25	LOW	0

o The 10^6-digit is 2, and is expressed by pins No. 26, 27, 28, and 29.
2 as expressed as 0010 in BCD code.
Therefore, 2 is expressed as follows. [fig]

Pin No.	Output signal level	BCD code
26	LOW	0
27	HIGH	1
28	LOW	0
29	LOW	0

o The 10^7-digit is 1, and is expressed by pins No. 30, 31, 32, and 33.
1 as expressed as 0001 in BCD code.
Therefore, 1 is expressed as follows.

Pin No.	Output signal level	BCD code
30	HIGH	1
31	LOW	0
32	LOW	0
33	LOW	0

(2) The decimal position is expressed by pins No. 44, 45, and 46.
The decimal position of this data is 10^5-digit, and is expressed 101.
Therefore, the decimal position is expressed as shown in the following table. (See to 5.2.6-(2), output format 7 1/2-digit measurement.)

Pin No.	Output signal level	BCD code
44	HIGH	1
45	LOW	0
46	HIGH	1

(3) The unit is expressed by pins No. 40, 41, and 42.
The unit of this data is V, and is expressed 0010.
Therefore, the unit is expressed as shown in the following table.
(See to 5.2.6-(2), output format 7 1/2-digit measurement.)

Pin No.	Output signal level	BCD code
40	LOW	0
41	HIGH	1
42	LOW	0
43	LOW	0

(4) The polarity is expressed by pins No. 34, 35, 38, and 39.
The polarity of this data is +, and is expressed 1011.
Therefore, the polarity is expressed as shown in the following table.
(See to 5.2.6-(2), output format 7 1/2-digit measurement.)

Pin No.	Output signal level	BCD code
34	HIGH	1
35	HIGH	1
38	LOW	0
39	HIGH	1

The data is output simultaneously to each pins described above. The timing for data output is recognized by the printing command output signal (pin-47). The output data will not change till a new measurement data is generated, so the output can be read after the printing command output data generates till a new data generates.

5.2.3 Connectors and Pin Numbers

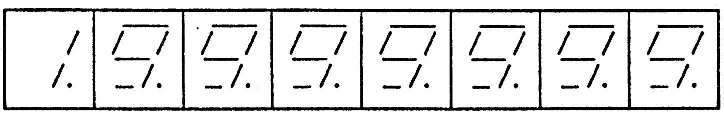
(1) Connector used

TR13011 side .... 57-40500 (Daiichi Denshi Kogyo's Product or Equivalent)
Connection cable side ...... 57-30500 (Daiichi Denshi Kogyo's Product or Equivalent)

(2) Pin numbers

Function	Pin No.	Pin No.	Function
SIGNAL GND	1	26	1 Data 10^6-digit
1 Data 10^0-digit	2	27	2 Data 10^6-digit
2 Data 10^0-digit	3	28	4 Data 10^6-digit
4 Data 10^0-digit	4	29	8 Data 10^6-digit
8 Data 10^0-digit	5	30	1 Data 10^7-digit (Polarity)
1 Data 10^1-digit	6	31	2 Data 10^7-digit (Polarity)
2 Data 10^1-digit	7	32	4 Data 10^7-digit (Polarity)
4 Data 10^1-digit	8	33	8 Data 10^7-digit (Polarity)
8 Data 10^1-digit	9	34	1 Polarity (Function)
1 Data 10^2-digit	10	35	2 Polarity (Function)
2 Data 10^2-digit	11	36	HIGH level
4 Data 10^2-digit	12	37	HIGH level
8 Data 10^2-digit	13	38	4 Polarity (Function)
1 Data 10^3-digit	14	39	8 Polarity (Function)
2 Data 10^3-digit	15	40	1 Unit
4 Data 10^3-digit	16	41	2 Unit
8 Data 10^3-digit	17	42	4 Unit
1 Data 10^4-digit	18	43	8 Unit
2 Data 10^4-digit	19	44	1 Decimal point
4 Data 10^4-digit	20	45	2 Decimal point
8 Data 10^4-digit	21	46	4 Decimal point
1 Data 10^5-digit	22	47	Print command output signal
2 Data 10^5-digit	23	48	External start input signal
4 Data 10^5-digit	24	49	N.C.
8 Data 10^5-digit	25	50	SIGNAL GND

Note 1 : The high-level pins 36 and 37 are connected to +5V at output impedance 330Ω.
Note 2 : Pin 96 is an idle pin.
Note 3 : The following are the data and decimal points corresponding to the display.

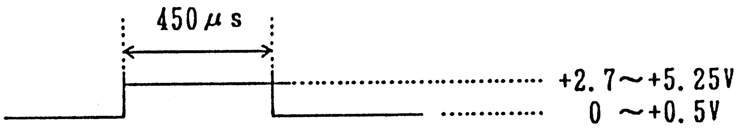
Display


↑ 10^7-digit ↑ 10^6-digit ↑ 10^5-digit ↑ 10^4-digit ↑ 10^3-digit ↑ 10^2-digit ↑ 10^1-digit ↑ 10^0-digit

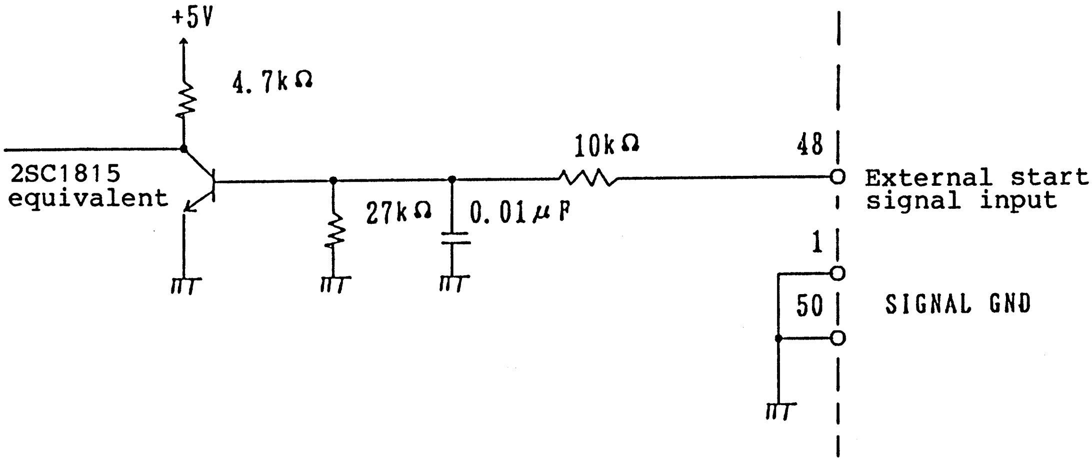
5.2.4 Input/Output Level

- Data output (10^0 - 10^7, polarity, function, unit, decimal point)
  TTL level, positive logic
  "1" : High, + 2.7 to + 5.25V
  "0" : Low, 0 to + 0.5V

- Printing command output
  TTL level, positive pulse (the pulse width is approx.. 450µs)

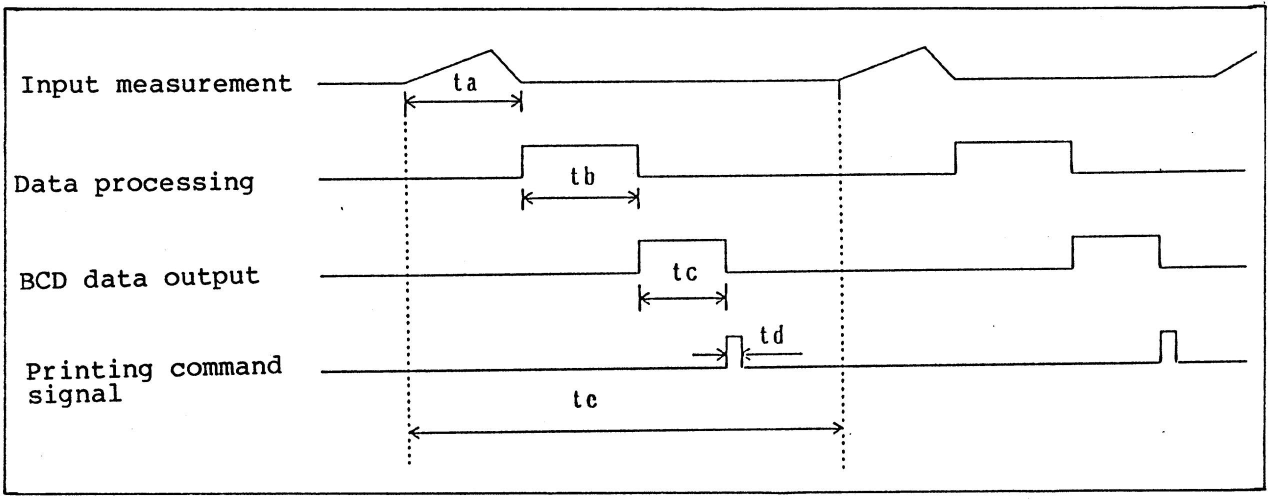


- External start signal input
  TTL level, positive pulse (the pulse width is 100µs to 10ms)
  Ignored when the sampling mode is "RUN".



5.2.5 Operation Timing

(1) Sampling mode : RUN

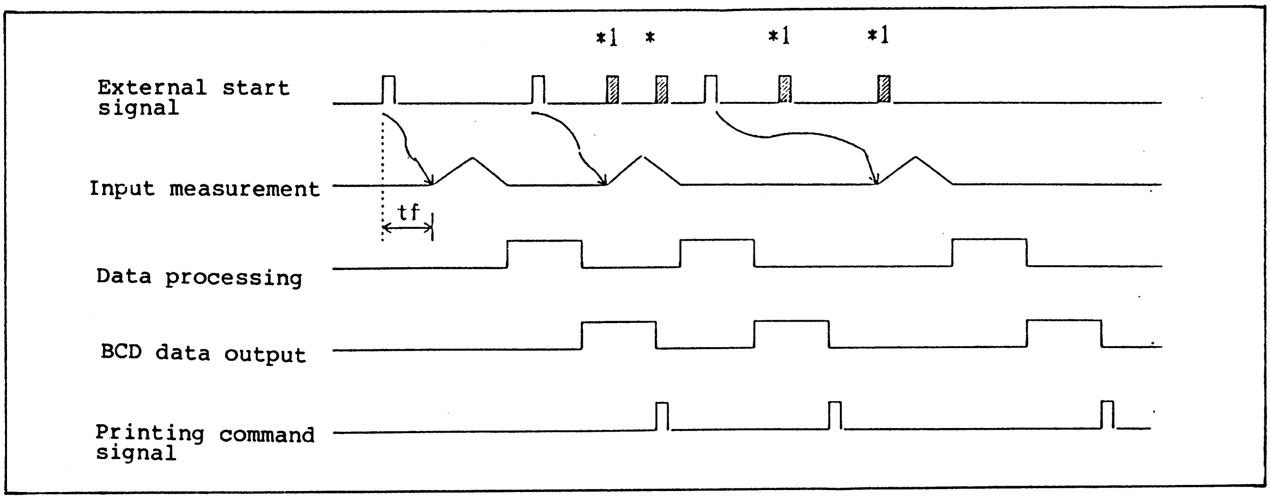


ta : Depends on the measurement function and the integrated time (IT).
tb : True calculation time
tc : Format conversion time and output time of BCD data output
td : Approx.. 450μs
te : Depends on the sampling interval (SI)

Note 1 : When the printing command signal is output, the BCD output data is already ready to be read from external devices. This status is kept till the next output data generates.

Note 2 : When connected to the TR6198 (FREE mode), it must be set so that "SI" ≥ 500ms. When set as "SI" < 500ms, the data in the middle may be lost.

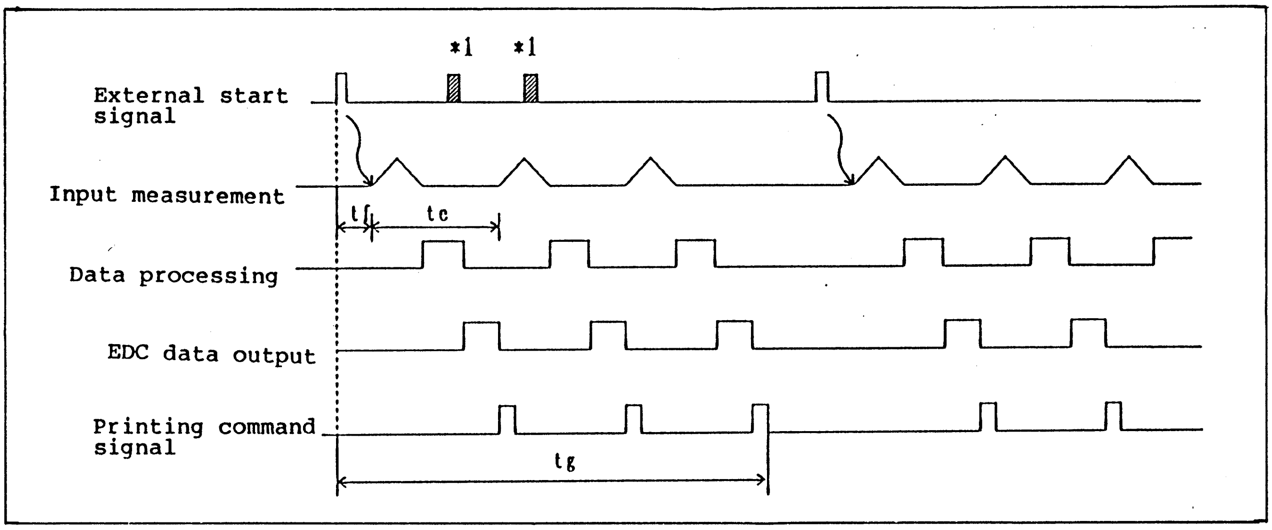
(2) Sampling mode : SINGLE



tf : The time from external start signal input to input measurement start.
When "TD"   0ms, it depends on "TD".
When "TD" = 0ms, it is the internal delay time after the external start signal is accepted to the start of the input measurement. (Approx. 900μs)

Note 1 : The external start signals during input measurement are ignored. (*1)

(3) Sampling mode : MULTI (Example : When "NS" = 3)



te : Depends on "SI".
tf : "TD" and internal delay time.
tg : From reception of the external start signal till the "NS" sample ends.

Note 1 : The external start signals given till end of the "NS" final sample measurement are ignored. (*1)

Note 2 : When connected to the TR6198 (FREE mode), it must be set so that "SI"   500ms. When set as "SI"   500ms, as many as "NS" data may not be output.

Note 3 : When TR6198 is connected (CONTINUOUS mode), the tg operation is repeated.

5.2.6 Output Format

(1) 4 1/2 to 6 1/2-digit measurement

Output name	Output data (Example of print-out)	Code			
		8	4	2	1
Data $(10^0 \sim 10^6)$	0	0	0	0	0
	1	0	0	0	1
	2	0	0	1	0
	3	0	0	1	1

(Continued to the next page)

Output name	Output data (Example of print-out)	Code			
		8	4	2	1
Data ($10^0 \sim 10^6$)	4	0	1	0	0
	5	0	1	0	1
	6	0	1	1	0
	7	0	1	1	1
	8	1	0	0	0
	9	1	0	0	1
	Blank (space)	1	1	1	1
Polarity	Minus(-)	1	0	1	0
	Plus (+)	1	0	1	1
	Space	1	1	1	1
Decimal point	10^0		0	0	0
	10^1		0	0	1
	10^2		0	1	0
	10^3		0	1	1
	10^4		1	0	0
	10^5		1	0	1
	10^6		1	1	0
	10^7		1	1	1
Function	Measurement-over (*)	0	0	0	0
	Result of comparator operation: PASS (space)	0	1	1	0
	Result of comparator operation: HIGH (H)	1	1	0	1
	Result of comparator operation: LOW (L)	1	1	1	0
	Result of statistical operation: MAX (A)	1	0	1	0
	Result of statistical operation: MIN (B)	1	0	1	1
	Result of statistical operation: AVE (C)	1	1	0	0
	Result of statistical operation: UCL (<)	1	0	0	1
	Result of statistical operation: LCL (>)	1	0	0	0
	Others (space)	1	1	1	1
Unit	μV (μV)	1	1	0	1
	mV (mV)	0	0	0	0
	V (V)	0	0	1	0
	μA (μA)	1	0	0	0
	mA (mA)	1	0	1	0
	A (space)	1	1	1	1
	mΩ (mΩ)	1	1	0	0
	Ω (Ω)	0	1	0	0
	kΩ (kΩ)	0	1	0	1
	MΩ (MΩ)	1	0	1	1
	% (%)	0	1	1	0
	dB (dB)	1	1	1	0
	Others (space)	1	1	1	1

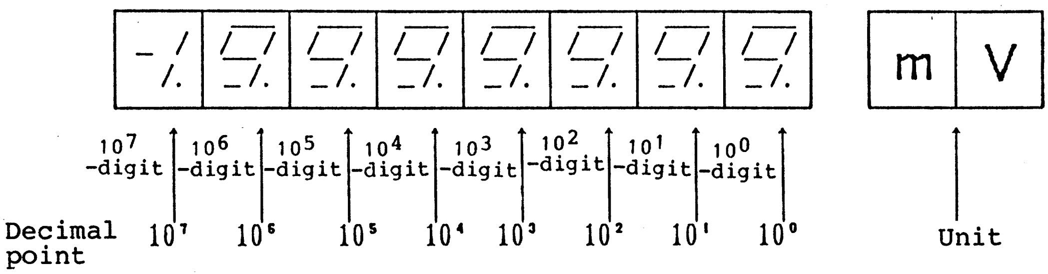
(2) 7 1/2-digit measurement

Output name	Output data (Example of print-out)	Code 8	4	2	1
Data ($10^0 \sim 10^7$)	0	0	0	0	0
	1	0	0	0	1
	2	0	0	1	0
	3	0	0	1	1
	4	0	1	0	0
	5	0	1	0	1
	6	0	1	1	0
	7	0	1	1	1
	8	1	0	0	0
	9	1	0	0	1
	Blank (space)	1	1	1	1
Measurement-over Polarity	Measurement-over (*)	0	0	0	0
	Minus(-)	0	1	0	1
	Plus (+)	0	1	0	0
	Space	1	1	1	1
Decimal point	10^0		0	0	0
	10^1		0	0	1
	10^2		0	1	0
	10^3		0	1	1
	10^4		1	0	0
	10^5		1	0	1
	10^6		1	1	0
	10^7		1	1	1
Unit	µV (µV)	1	1	0	1
	mV (mV)	0	0	0	0
	V (V)	0	0	1	0
	µA (µA)	1	0	0	0
	mA (mA)	1	0	1	0
	A (space)	1	1	1	1
	mΩ (mΩ)	1	1	0	0
	Ω (Ω)	0	1	0	0
	kΩ (kΩ)	0	1	0	1
	MΩ (MΩ)	1	0	1	1
	% (%)	0	1	1	0
	dB (dB)	1	1	1	0
	Others (space)	1	1	1	1

*1 : The difference between the 4 1/2 to 6 1/2-digit measurement is that the function data part is used as the polarity data.

CAUTION

1. In 7 1/2-digit output measurement, no function data is output.
2. The decimal point, data, and unit corresponds to the main panel indicator as follows.



3. The following are output in case of measurement-over.

* +/-9999999.	4 1/2 to 6 1/2-digit
* 99999999.	7 1/2-digit

The following are output in case of operation error.

* 9999999.	4 1/2 to 6 1/2-digit
* 99999999.	7 1/2-digit

The following are output in case the result of operation includes exponential part.

* 0.	4 1/2 to 6 1/2-digit
* 0.	7 1/2-digit

When the data has exponential part, space will fill the unit data.

5.2.7 Specification

Data output	: BCD parallel code
Output data	: Measurement data, decimal point, polarity, unit, operation function
Data output signal level	: TTL level, positive logic
Printing command signal output	: TTL level, positive pulse (pulse width, approx. 450μs)
External start signal input	: TTL level, positive pulse (pulse width, 100μs to 10ms)
Data output connector	: 57-40500 (Daiichi Denshi Kogyo's product or equivalent)

5.2.8 Example of TR6198 Print-out

```
+1802.390  mV
-1787.045  mV
+17.99984   V
-17.85983   V
+1831.437  μA
-1802.642  μA
+18.33117  mA
-18.04830  mA
    0.620   Ω
  0.00620  kΩ
  0.00619  MΩ
```

The measurement data of each function is printed out.

```
 -0000.496  %
 -0004.918  %
L-0005.471  %
H+0005.584  %
H+0005.031  %
 +0002.267  %
 +0000.609  %
 +0000.715  %
 +0001.715  %
 +0001.162  %
```

The result of operation in comparator 2 is printed out.

```
LIMIT 1    5%  ┐
               ├─ Setting
LIMIT 2   10%  ┘
```

```
 +10.00609  V
 +10.00620  V
 +10.00629  V
 +10.00639  V
 +10.00649  V
 +10.00640  V
 +10.00628  V
 +10.00619  V
 +10.00609  V
 +10.00599  V
       10.
A+10.00649  V
B+10.00599  V
C+10.00624  V
 +00.00050  V
*       0.
<+10.00672  V
>+10.00577  V
```

It is set as N = 10, and statistical operation is executed.

Measurement data (10 samples)

Result of statistical operation (output in sequence of number of samples, maximum, minimum, average, P-P, σ, UCL, LCL.)

5.3 TR13013 Relay Output Unit

5.3.1 General

The TR13013 relay output unit sorts the result of measurement in each measuring device (displayed value) according to the result of comparator operation, and outputs the signal to other external devices.

A remote control function is also equipped in the measurement start instruction and external SRQ (service request) instruction.

The data output and remote control signal are electrically isolated from the measurement input signal system of the digital multi-meter, so as not to affect the measurement value even when connecting external devices to structure the measurement system.

5.3.2 Result of Comparator Operation and Output Operation

The relay output unit sorts the result of comparator operation to the output signal pin according to each level, and outputs the result to the external devices.

The result of the comparator operation as well as the relation of the output signal pins and output signal levels are explained here in this Section.

There are five kinds of result of comparator operation; HIGH2, HIGH1, PASS, LOW1, and LOW2. The five kinds of operation results correspond to five output signal pins as follows.

Operation result	Output signal pin No.
HIGH2	1
HIGH1	2
PASS	3
LOW1	4
LOW2	5

The pin levels become as follows, according to the above result.

(1) When the operation result is HIGH2

Pin No.	Output signal level
1	HIGH
2	HIGH
3	LOW
4	LOW
5	LOW

(2) When the operation result is HIGH1

Pin No.	Output signal level
1	LOW
2	HIGH
3	LOW
4	LOW
5	LOW

(3) When the operation result is PASS

Pin No.	Output signal level
1	LOW
2	LOW
3	HIGH
4	LOW
5	LOW

(4) When the operation result is LOW1

Pin No.	Output signal level
1	LOW
2	LOW
3	LOW
4	HIGH
5	LOW

(5) When the operation result is LOW2

Pin No.	Output signal level
1	LOW
2	LOW
3	LOW
4	HIGH
5	HIGH

5.3.3 Connectors and Pin Numbers

(1) Connector used

TR13013 side .... 57-40140 (Daiichi Denshi Kogyo's product or equivalent)
Connection cable side ... 57-30140 (Daiichi Denshi Kogyo's product or equivalent)

(2) Pin numbers

Function	Pin No.	Pin No.	Function
Relay output of HIGH2 (+)	1	8	(C) HIGH2 relay output common
Relay output of HIGH1 (+)	2	9	(C) HIGH1 relay output common
Relay output of PASS (+)	3	10	(C) PASS relay output common
Relay output of LOW 1 (+)	4	11	(C) LOW 1 relay output common
Relay output of LOW 2 (+)	5	12	(C) LOW 2 relay output common
External start signal	6	13	External SRQ signal
GND	7	14	GND

5.3.4 Input/Output Signals

(1) External start signal (input)

Used to send external signal to start the measurement. When the sampling mode is RUN, or when measurement is already started, this signal is ignored. Input a contact make signal (within 10ms pulse width) between pin-6 and pin-7 to send this signal.

(2) External SRQ signal (input)

Used to dispatch external SRQ (service request) to personal computer connected to the main device. In this case, the main device must be programmed to "S0" (SRQ output) mode in advance.

Input the contact make signal (pulse width 10ms or less) between pin-13 and pin-14.

(3) HIGH1/HIGH2/LOW1/LOW2 alarm relay signal (output signal)

In case the following results of comparator operation cause the following alarms,

When	HIGH2 $<$ Output data,	HIGH2 alarm
	HIGH1 $<$ Output data $\leq$ HIGH2,	HIGH2 alarm
	LOW1 $\leq$ Output data $\leq$ HIGH1,	PASS alarm
	LOW2 $\leq$ Output data $<$ LOW1,	LOW1 alarm
	Output data $<$ LOW2,	LOW2 alarm

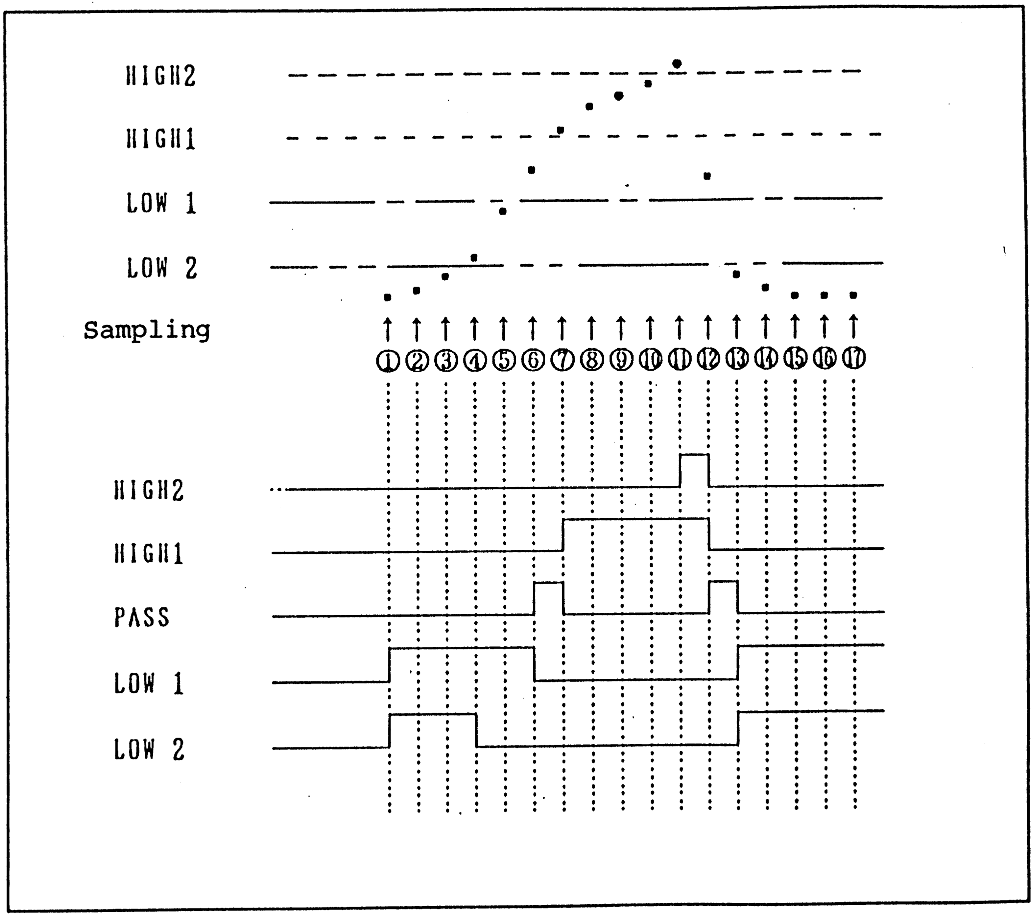
the alarm relay is driven.

The relay is driven in level-output, and as sequential make signal while alarm is generated.

Contact capacity : Approx. 0.2A/50VDC

5.3.5 Operation

The following is the alarm relay output state when HIGH1/HIGH2, LOW1/LOW2 are set as follows.



5.3.6 Specification

Data output	: Comparator contact x 5
Output data	: H2 (high-level 1), H2 (high-level 2), L1 (low-level 1), L2 (low-level 2), PASS (pass-level)
External start signal	: Contact make signal
External SRQ signal	: Contact make signal
Data output connector	: 57-40140 (Daiichi Denshi Kogyo's product or equivalent)

MEMO

6. MAINTENANCE, CHECK, CALIBRATION

6.1 Before Asking for Repair

In case trouble occurs while using the TR6871, always check the following check items before contact the nearest dealer or the sales and support offices. The locations and phone numbers are given at the back of this manual. Once we are called, the repair will be charged, even if the repair is as simple as shown below. Please check the following check items well before calling.

Condition	Cause	Treatment
The display does not appear.	o The power fuse is broken.	o Replace the broken fuse with the attached fuse, referring to Section 1.3.3-(4).
The measurement value is unstable, or the value is abnormal.	o The setting of the function range, etc. is incorrect. o The setting of the frequency (50/60 Hz) is wrong.	o Check the function and range again. o Set the correct frequency matching the AC power source. [See Section 2.8.18.]
Measurement is not done even when input signal is applied.	o The cable is connected to the wrong input terminal. o The key setting of the input terminal is wrong.	o Connect the input cable to the correct input terminal. o Set the key correctly.

6.2 Error Messages

(1) Errors that may Occur During Normal Operation

Error 1		o Error occurred during measurement with this device. (hardware failure)
Error 2		o Tried to execute calibration, but the EXT CAL switch on the rear panel is not ON. Tried to execute calibration, but the calibration value input via the panel or the GPIB is out of the setting range.
Error 3		o Tried to execute calibration, but the calibration value is out of the allowable range.
Error 4		o Tried to set the parameter via the panel, but the setting value is out of the setting range.
Error 5		o Tried to execute operation, but the setting of the constant is inappropriate.
Error 6		o Operation error occurred.
Error 7		o The RECALL key was pressed to enter the recall mode, but no stored data exists.
Error 8		o The data number recalled form the data memory does not exist.
Error 10		o Data corresponding to the listener code sent from the GPIB is not found.
Error 11		o The string length of the listener code sent from the GPIB exceeded 50 characters.

Error 12		o Inappropriate use conditions or data for the listener code sent from the GPIB.

(2) Error that may Occur During Self Test

Error	RO	o Error occurred during program ROM test.
Error 1	CA	o Error occurred during calibration data test. (Error numbers 1 to 7 are displayed.)
Error	RA	o Error occurred during RAM test.
Error 1	AD	o Error occurred in the basic measurement operation test. (Error numbers 1 to 5 are displayed.)

In case "Error 1" or self test error occurred, the TR6871 main unit must be failing. Turn off the power, and contact the nearest dealer or the sales and support offices.

6.3 Storage

When not using the TR6871 for a considerable time, cover the device with vinyl cover, place it in a carton box, and store the box where there is little humidity and not affected by direct sun ray. The storage temperature range is -25°C to +70°C.

6.4 Calibration

This section gives explanation on how to calibrate this device. Calibration must be done at least once every guaranteed period (6 months) to satisfy the likelihood of measurement.

The TR6871 can perform calibration of each range of direct current/alternative current voltage and direct current/alternative current current measurement or resistance measurement via the front panel keys or by the GPIB program.

6.4.1 Preparation for Calibration

(1) Devices Necessary for Calibration

The devices necessary for calibration are as shown in Table 6-1. Use devices with performance as shown in the following table or equivalent.

Table 6 - 1 Devices Necessary for Calibration

Calibration device	Range	Likelihood
Standard direct current voltage generator	±20mV to ±1000V	±0.0005% or more
Standard direct current current generator	±1μA to ±2A	±0.01% or more
Standard alternative current voltage generator	10mVrms to 500Vrms Frequency 20Hz to 1MHz	±0.005% or more
Standard alternative current current generator	±1μA to ±2A	±0.01% or more
Standard resistor	100Ω 1kΩ 10kΩ 100kΩ 1MΩ	±0.001% or more
	10kΩ	±0.003% or more

(2) Power Supply and Frequency

The AC power supply must be within the specified voltage (100V±10%, 120V±10%, 220V±10%, 240V (+10V, -33V)).

The power supply frequency is 50Hz or 60Hz.

(3) Environment for Calibration

Calibration must be done under the following environment.
Temperature : +23°C ±5°C
Humidity : 85% or less
Also avoid dust, vibration, noise, etc.

(4) Pre-heating Time

60 minutes or more pre-heating time must be taken before calibration. The devices used must also be pre-heated for the prescribed pre-heating times.

(5) It is useful to log the date of calibration and the deadline for the next calibration on cards or stickers after each calibration ends.

CAUTION

When connecting the power cable, always check that the POWER switch is OFF.

6.4.2 Common Operation and Notes

(1) Perform the following before each measurement calibration.

1 Set the EXT CAL switch on the rear side of the panel ON.

2 Check that the ECAL lamp on the lower left of the front panel is on.

(2) The calibration of the direct current voltage measurement must be done first.

The remaining calibrations can be done in any order.

6.4.3 Calibration of Direct Current Voltage Measurement

Device used : Standard direct current voltage generator

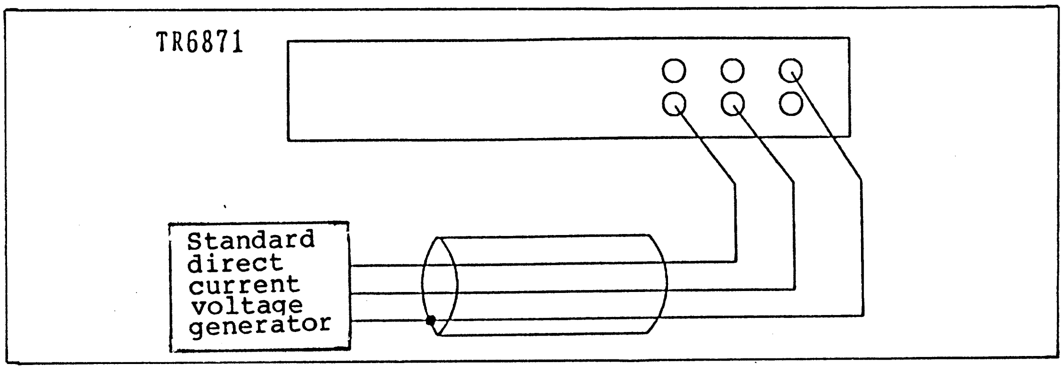
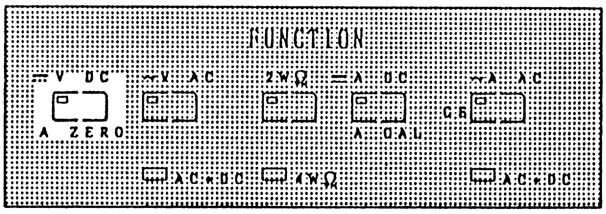


Figure 6 - 1 Calibration of Direct Current Voltage Measurement

0-point calibration and full-scale calibration of each range is done as calibration of the direct current voltage measurement.

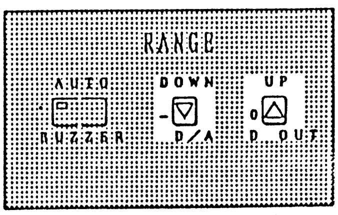
[Calibration]

Setting the function



(1) Press $\overline{\text{V DC}}$ key, to set the function at direct current voltage measurement.

Setting 10V-range



(2) Use the UP、 DOWN keys to set the measurement range at 10V.
(The 10V-range can be set when the external calibration is ON.)

Connecting the standard direct current voltage generator

(3) As shown in Figure 6 - 1, connect the standard direct current voltage generator with the attached cable (MI-37) between the HI-LO terminals of the lower input terminal.

20V-range 0-point calibration

20V-range 0-point calibration is performed by the following procedure.

(1) Set the measurement range at 20V.

(2) Set the output of the standard direct current voltage generator at 0V.

(3) Press SHIFT.

(4) Press 0△.

(5) Press ENTER.

0V
0.000000V

20V-range +full-scale calibration

20V-range +full-scale calibration is performed by the following procedure.

(1) Set the output of the standard direct current voltage generator at 18V.

(2) Press SHIFT.

(3) Press 1 8, in this order.

(4) Press ENTER.

18V
18.000000V

20V-range -full-scale calibration

20V-range -full-scale calibration is performed by the following procedure.

(1) Set the output of the standard direct current voltage generator at -18V.

(2) Press SHIFT.

(3) Press -▽ 1 8, in this order.

(4) Press ENTER.

-18V
-18.000000V

10V-range 0-point calibration

10V-range 0-point calibration is performed by the following procedure.

(1) Set the output of the standard direct current voltage generator at 0V.

(2) Press SHIFT □ .

(3) Press 0△ .

0V

(4) Press ENTER □ .

0.000000V

o When there is offset voltage

[When there is offset voltage in the generator, and does not become 0V]
If there is offset voltage in the generator and it does not become 0V even if the standard direct current voltage generator is set at 0V, operate as follows.

(Example)
When there is 20μV offset voltage

(1) Press SHIFT □ .

(2) Press .□ 0△ 0△ 0△ 0△ 2□ , in this order.

.00002V

(3) Press ENTER □ .

0.000020V

10V-range full-scale calibration

10V-range full-scale calibration is performed by the following procedure.

(1) Set the output of the standard direct current voltage generator at 10V.

(2) Press SHIFT □ .

(3) Press 1□ 0△ , in this order.

10V

(4) Press ENTER □ .

10.000000V

o When there is setting error

[Operate as follows, for 10V-range full-scale calibration when -0.0005% error is known in the standard direct current voltage generator.]

(1) Set the output of the standard direct current voltage generator at 10V.

(2) Press SHIFT □ .

(3) Press 9 □ . □ 9 □ 9 □ 9 □ 9 □ 5 □ , in this order.

9.99995V

(4) Press ENTER □ .

9.999950V

200mV-range 0-point calibration

200mV-range 0-point calibration is performed by the following procedure.

(1) Use the UP △、 DOWN ▽ keys to set the measurement range at 200mV.

(2) Set the output of the standard direct current voltage generator at 0V.

(3) Press SHIFT □ .

0mV

(4) Press 0 △ .

(5) Press ENTER □ .

0.0000mV

200mV-range full-scale calibration

200mV-range full-scale calibration is performed by the following procedure.

(1) Set the output of the standard direct current voltage generator at 180mV.

(2) Press SHIFT .

(3) Press 1 8 0, in this order.

(4) Press ENTER .

180mV
180.0000mV

2000mV-range 0-point calibration

2000mV-range 0-point calibration is performed by the following procedure.

(1) Press the UP key to set the measurement range at 2000mV.

(2) Set the output of the standard direct current voltage generator at 0V.

(3) Press SHIFT .

(4) Press 0 .

(5) Press ENTER .

0mV
0.0000mV

2000mV-range full-scale calibration

2000mV-range full-scale calibration is performed by the following procedure.

(1) Set the output of the standard direct current voltage generator at 1.8V.

(2) Press SHIFT .

(3) Press 1 8 0 0 , in this order.

(4) Press ENTER .

1800mV
1800.0000mV

200V-range 0-point calibration

200V-range 0-point calibration is performed by the following procedure.

(1) Set the measurement range at 200V.

(2) Set the output of the standard direct current voltage generator at 0V.

0V

(3) Press SHIFT .

0.00000V

(4) Press 0△ .

(5) Press ENTER .

200V-range full-scale calibration

200V-range full-scale calibration is performed by the following procedure.

(1) Set the output of the standard direct current voltage generator at 180V.

(2) Press SHIFT .

180V

(3) Press 1 8 0△ , in this order.

180.00000V

(4) Press ENTER .

1000V-range 0-point calibration

1000V-range 0-point calibration is performed by the following procedure.

(1) Set the measurement range at 1000V.

(2) Set the output of the standard direct current voltage generator at 0V.

0V

(3) Press SHIFT ▢ .

(4) Press 0△ .

(5) Press ENTER ▭ .

0.0000V

1000V-range full-scale calibration

1000V-range full-scale calibration is performed by the following procedure.

(1) Set the output of the standard direct current voltage generator at 1000V.

1000V

(2) Press SHIFT ▢ .

(3) Press 1▢ 0△ 0△ 0△, in this order.

(4) Press ENTER ▭ .

1000.0000V

The internal electric parts will be heated by the 1000V-range calibration. Wait enough till the parts are well cooled, till performing the calibration of the next function.

CAUTION

[In case error was found after pressing the ENTER ▭ key]

For instance, when the 200V-range full-scale calibration was done with the wrong value, perform the 200V-range full-scale calibration from the beginning again.

6.4.4 Calibration of Alternative Current Voltage Measurement

Device used : Standard alternative current voltage generator

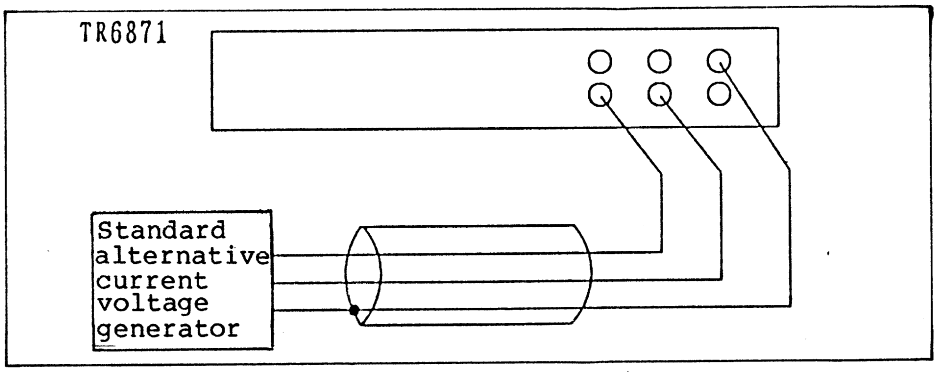
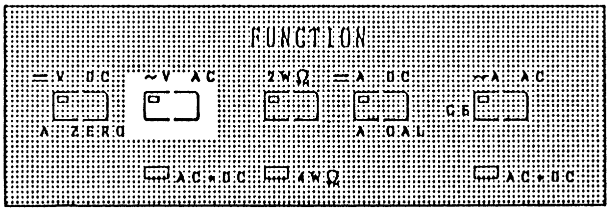


Figure 6 - 2 Calibration of Alternative Current Voltage Measurement

1/10 full-scale calibration and full-scale calibration of each range are done in the calibration of the alternative current voltage measurement.

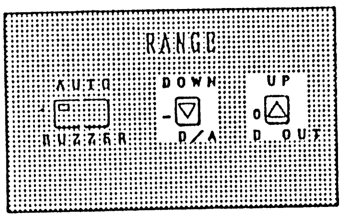
[Calibration]

Setting the function



(1) Press ~V AC , to set the function at alternative current voltage measurement.

Setting 20V-range



(2) Use the UP、 DOWN keys to set the measurement range at 20V.

Connecting the standard alternative current voltage generator

(3) As shown in Figure 6 - 2, connect the standard alternative current voltage generator with the attached cable (MI-37) between the HI-LO terminals of the lower input terminal.

20V-range full-scale calibration

20V-range full-scale calibration is performed by the following procedure.

(1) Set the output of the standard alternative current voltage generator at 18V, 1kHz.

(2) Press SHIFT .

(3) Press 1 8 in this order.

(4) Press ENTER .

18V
18.0000V

20V-range 1/10-scale calibration

20V-range 1/10-scale calibration is performed by the following procedure.

(1) Set the output of the standard alternative current voltage generator at 1.8V, 1kHz.

(2) Press SHIFT .

(3) Press 1 . 8 in this order.

(4) Press ENTER .

1.8V
1.8000V

200mV-range full-scale calibration

200mV-range full-scale calibration is performed by the following procedure.

(1) Set the measurement rage at 200mV.

(2) Set the output of the standard alternative current voltage generator at 180mV, 1kHz.

(3) Press SHIFT .

(4) Press 1 8 0 in this order.

(5) Press ENTER .

180mV
180.000mV

200mV-range 1/10-scale calibration

200mV-range 1/10-scale calibration is performed by the following procedure.

(1) Set the output of the standard alternative current voltage generator at 18mV, 1kHz.

(2) Press SHIFT .

(3) Press 1 8 in this order.

(4) Press ENTER .

18mV

18.000mV

2000mV-range full-scale calibration

2000mV-range full-scale calibration is performed by the following procedure.

(1) Set the measurement rage at 2000mV.

(2) Set the output of the standard alternative current voltage generator at 1800mV, 1kHz.

(3) Press SHIFT .

(4) Press 1 8 0 0 in this order.

(5) Press ENTER .

1800mV

1800.00mV

2000mV-range 1/10-scale calibration

2000mV-range 1/10-scale calibration is performed by the following procedure.

(1) Set the output of the standard alternative current voltage generator at 180mV, 1kHz.

(2) Press SHIFT .

(3) Press 1 8 0 in this order.

(4) Press ENTER .

180mV

180.00mV

200V-range full-scale calibration

200V-range full-scale calibration is performed by the following procedure.

(1) Set the measurement rage at 200V.

(2) Set the output of the standard alternative current voltage generator at 180V, 1kHz.

(3) Press SHIFT.

(4) Press 1 8 0, in this order.

(5) Press ENTER.

180V
180.000V

200V-range 1/10-scale calibration

200V-range 1/10-scale calibration is performed by the following procedure.

(1) Set the output of the standard alternative current voltage generator at 18V, 1kHz.

(2) Press SHIFT.

(3) Press 1 8, in this order.

(4) Press ENTER.

18V
18.0000V

500V-range full-scale calibration

500V-range full-scale calibration is performed by the following procedure.

(1) Set the measurement rage at 500V.

(2) Set the output of the standard alternative current voltage generator at 480V, 1kHz.

(3) Press SHIFT.

(4) Press 4 8 0, in this order.

(5) Press ENTER.

480V
480.00V

500V-range 1/10-scale calibration

500V-range 1/10-scale calibration is performed by the following procedure.

(1) Set the output of the standard alternative current voltage generator at 48V, 1kHz.

48V
48.00V

(2) Press SHIFT [ ] .

(3) Press 4[ ] 8[ ] , in this order.

(4) Press ENTER [ ] .

CAUTION

[In case error was found after pressing the ENTER [ ] key]

For instance, when the 200V-range full-scale calibration was done with the wrong value, perform the 200V-range full-scale calibration from the beginning again.

6.4.5 Calibration of Direct Current Current Measurement

Device used : Standard direct current current generator

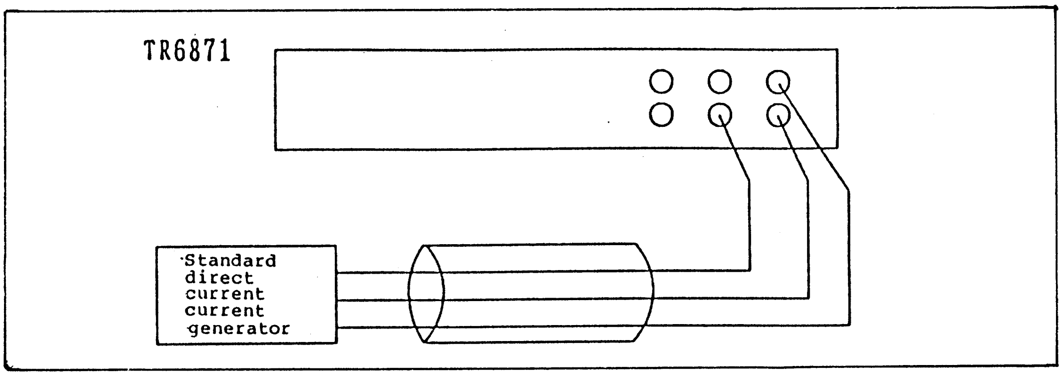
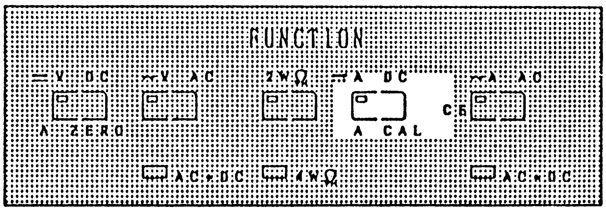


Figure 6 - 3 Calibration of Direct Current Current Measurement

0-point calibration and full-scale calibration of each range are done as calibration of the direct current current measurement.

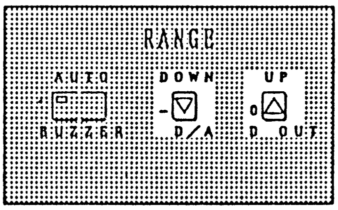
[Calibration]

Setting the function



(1) Press A DC , to set the function at direct current current measurement.

Setting 200mA-range



(2) Use the UP、 DOWN keys to set the measurement range at 200mA.

Connecting the standard direct current current generator

(3) As shown in Figure 6 - 3, connect the standard direct current current generator with the attached cable (MI-37) between the HI-LO terminals of the lower input terminal.

200mA-range 0-point calibration

200mA-range 0-point calibration is performed by the following procedure.

(1) Set the output of the standard direct current current generator at 0mA.

0 mA

(2) Press SHIFT .

(3) Press 0 .

(4) Press ENTER .

0.0000 mA

200mA-range full-scale calibration

200mA-range full-scale calibration is performed by the following procedure.

(1) Set the output of the standard direct current current generator at 180mA.

180 mA

(2) Press SHIFT .

(3) Press 1 8 0, in this order.

(4) Press ENTER .

180.0000 mA

2000μA-range 0-point calibration

2000μA-range 0-point calibration is performed by the following procedure.

(1) Set the measurement range at 2000μA.

(2) Set the output of the standard direct current current generator at 0μA.

0 μA

(3) Press SHIFT .

(4) Press 0 .

(5) Press ENTER .

0.000 μA

2000μA-range full-scale calibration

2000μA-range full-scale calibration is performed by the following procedure.

(1) Set the output of the standard direct current current generator at 1800μA.

1 8 0 0 μA

(2) Press [SHIFT] .

(3) Press [1] [8] [0] [0], in this order.

(4) Press [ENTER] .

1 8 0 0.0 0 0 μA

20mA-range 0-point calibration

20mA-range 0-point calibration is performed by the following procedure.

(1) Set the measurement range at 20mA.

(2) Set the output of the standard direct current current generator at 0mA.

0 mA

(3) Press [SHIFT] .

(4) Press [0] .

(5) Press [ENTER] .

0.0 0 0 0 0 mA

20mA-range full-scale calibration

20mA-range full-scale calibration is performed by the following procedure.

(1) Set the output of the standard direct current current generator at 18mA.

1 8 mA

(2) Press [SHIFT] .

(3) Press [1] [8], in this order.

(4) Press [ENTER] .

1 8.0 0 0 0 0 mA

<u>2000mA-range 0-point calibration</u>

2000mA-range 0-point calibration is performed by the following procedure.

(1) Set the measurement rage at 2000mA.

(2) Set the output of the standard direct current current generator at 0mA.

0 mA

(3) Press SHIFT .

(4) Press 0△ .

0.000 mA

(5) Press ENTER .

<u>2000mA-range full-scale calibration</u>

2000mA-range full-scale calibration is performed by the following procedure.

(1) Set the output of the standard direct current current generator at 1800mA.

1800 mA

(2) Press SHIFT .

(3) Press 1 8 0△ 0△, in this order.

1800.000 mA

(4) Press ENTER .

CAUTION

[In case error was found after pressing the ENTER key]

For instance, when the 200mA-range full-scale calibration was done with the wrong value, perform the 200mA-range full-scale calibration from the beginning again.

6.4.6 Calibration of Alternative Current Current Measurement

Device used : Standard alternative current current generator

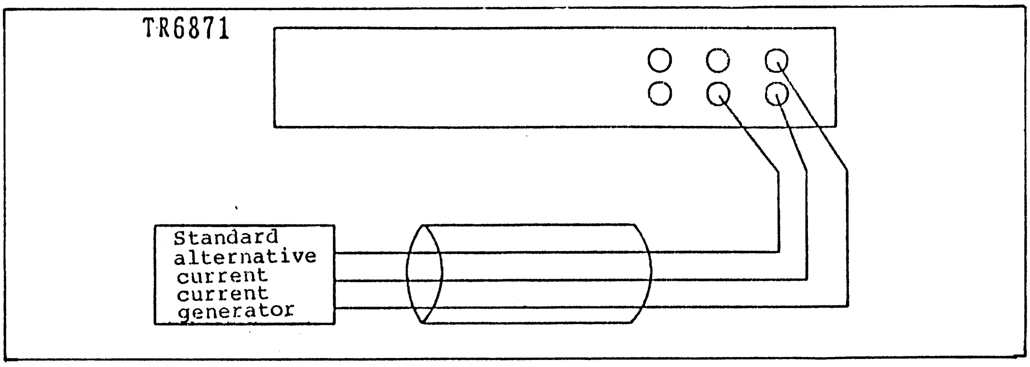
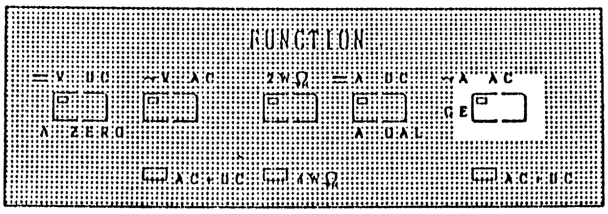


Figure 6 - 4 Calibration of Alternative Current Current Measurement

1/10 full-scale calibration and full-scale calibration of each range are done as calibration of the alternative current current measurement.

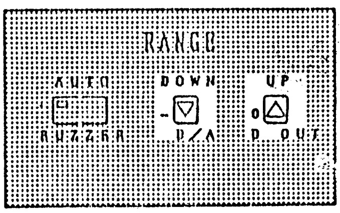
[Calibration]

Setting the function



(1) Press ~A AC , to set the function at alternative current current measurement.

Setting 200mA-range



(2) Use the UP、 DOWN keys to set the measurement range at 200mA.

Connecting the standard alternative current current generator

(3) As shown in Figure 6 - 4, connect the standard alternative current current generator with the attached cable (MI-37) to the lower input terminal.

200mA-range full-scale calibration

200mA-range full-scale calibration is performed by the following procedure.

(1) Set the output of the standard alternative current current generator at 180mA, 1kHz.

180 mA

(2) Press SHIFT.

(3) Press 1 8 0, in this order.

(4) Press ENTER.

180.000 mA

200mA-range 1/10-full-scale calibration

200mA-range 1/10-full-scale calibration is performed by the following procedure.

(1) Set the output of the standard alternative current current generator at 18mA, 1kHz.

18 mA

(2) Press SHIFT.

(3) Press 1 8, in this order.

(4) Press ENTER.

18.000 mA

2000μA-range full-scale calibration

2000μA-range full-scale calibration is performed by the following procedure.

(1) Set the measurement range at 2000μA.

1800 μA

(2) Set the output of the standard alternative current current generator at 1800μA, 1kHz.

(3) Press SHIFT.

(4) Press 1 8 0 0, in this order.

1800.00 μA

(5) Press ENTER.

2000μA-range 1/10 full-scale calibration

2000μA-range 1/10 full-scale calibration is performed by the following procedure.

(1) Set the output of the standard alternative current current generator at 180μA.

180 μA

(2) Press SHIFT .

(3) Press 1 8 0 , in this order.

180.00 μA

(4) Press ENTER .

20mA-range full-scale calibration

20mA-range full-scale calibration is performed by the following procedure.

(1) Set the measurement range at 20mA.

18 mA

(2) Set the output of the standard alternative current current generator at 18mA, 1kHz.

(3) Press SHIFT .

(4) Press 1 8, in this order.

18.0000 mA

(5) Press ENTER .

20mA-range 1/10 full-scale calibration

20mA-range 1/10 full-scale calibration is performed by the following procedure.

(1) Set the output of the standard alternative current current generator at 1.8mA.

1.8 mA

(2) Press SHIFT .

(3) Press 1 . 8, in this order.

1.8000 mA

(4) Press ENTER .

2000mA-range full-scale calibration

2000mA-range full-scale calibration is performed by the following procedure.

(1) Set the measurement range at 2000mA.

1800mA

(2) Set the output of the standard alternative current current generator at 1800mA, 1kHz.

(3) Press SHIFT .

(4) Press 1 8 0 0, in this order.

1800.00 mA

(5) Press ENTER .

2000mA-range 1/10 full-scale calibration

2000mA-range 1/10 full-scale calibration is performed by the following procedure.

(1) Set the output of the standard alternative current current generator at 180mA.

180mA

(2) Press SHIFT .

(3) Press 1 8 0 , in this order.

180.00 mA

(4) Press ENTER .

CAUTION

[In case error was found after pressing the ENTER key]

For instance, when the 200mA-range full-scale calibration was done with the wrong value, perform the 200mA-range full-scale calibration from the beginning again.

6.4.7 Calibration of Direct Current Voltage + Alternative Current Voltage Measurement

Device used : Standard direct current voltage generator

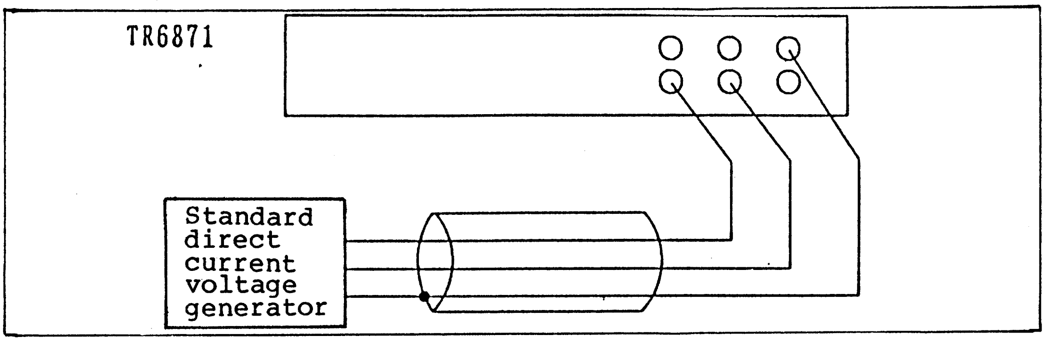
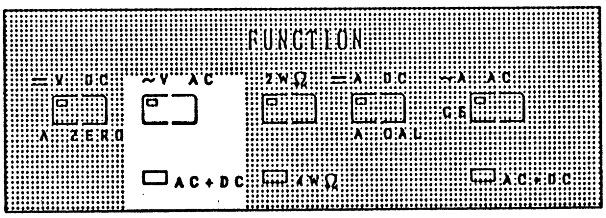


Figure 6 - 5 Calibration of Direct Current Voltage + Alternative Current Voltage Measurement

Direct current voltage 1/10 full-scale calibration and full-scale calibration of each direct current voltage range are done as calibration of the direct current voltage + alternative current current measurement.

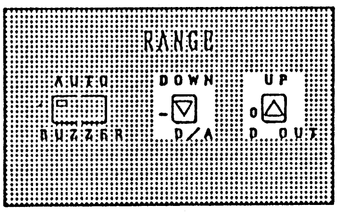
[Calibration]

Setting the function



(1) Press ~VAC, to light the AC + DC lamp, and to set the function at direct current voltage + alternative current voltage measurement.

Setting 20V-range



(2) Use the UP、 DOWN keys to set the measurement range at 20V.

Connecting the standard direct current voltage generator

(3) As shown in Figure 6 - 5, connect the standard direct current voltage generator with the attached cable (MI-37) between the HI-LO terminals of the lower input terminal.

20V-range 1/10 full-scale calibration

20V-range 1/10 full-scale calibration is performed by the following procedure.

(1) Set the measurement range at 20V.

(2) Set the output of the standard direct current voltage generator at 1.8V.

1.8 V

(3) Press SHIFT .

(4) Press 1 8 , in this order.

1.8000 V

(5) Press ENTER .

20V-range full-scale calibration

20V-range full-scale calibration is performed by the following procedure.

(1) Set the output of the standard direct current voltage generator at 18V.

18 V

(2) Press SHIFT .

(3) Press 1 8 , in this order.

18.0000 V

(4) Press ENTER .

200mV-range 1/10 full-scale calibration

200mV-range 1/10 full-scale calibration is performed by the following procedure.

(1) Use the UP DOWN keys to set the measurement range at 200mV

18 mV

(2) Set the output of the standard direct current voltage generator at 18mV.

(3) Press SHIFT .

(4) Press 1 8 , in this order.

18.000 mV

(5) Press ENTER .

200mV-range full-scale calibration

200mV-range full-scale calibration is performed by the following procedure.

(1) Set the output of the standard direct current voltage generator at 180mV.

180mV

(2) Press SHIFT.

(3) Press 1 8 0, in this order.

(4) Press ENTER.

180.000 mV

2000mV-range 1/10 full-scale calibration

2000mV-range 1/10 full-scale calibration is performed by the following procedure.

(1) Set the measurement range at 2000mV.

(2) Set the output of the standard direct current voltage generator at 180mV.

180mV

(3) Press SHIFT.

(4) Press 1 8 0, in this order.

(5) Press ENTER.

180.00 mV

2000mV-range full-scale calibration

2000mV-range full-scale calibration is performed by the following procedure.

(1) Set the output of the standard direct current voltage generator at 1.8V.

1800mV

(2) Press SHIFT.

(3) Press 1 8 0 0, in this order.

(4) Press ENTER.

1800.00 mV

200V-range 1/10 full-scale calibration

200V-range 1/10 full-scale calibration is performed by the following procedure.

(1) Set the measurement range at 200V.

(2) Set the output of the standard direct current voltage generator at 18V.

18 V

(3) Press SHIFT .

(4) Press 1 8, in this order.

18.000 V

(5) Press ENTER .

200V-range full-scale calibration

200V-range full-scale calibration is performed by the following procedure.

(1) Set the output of the standard direct current voltage generator at 180V.

180 V

(2) Press SHIFT .

(3) Press 1 8 0, in this order.

180.000 V

(4) Press ENTER .

500V-range 1/10 full-scale calibration

500V-range 1/10 full-scale calibration is performed by the following procedure.

(1) Set the measurement range at 500V.

(2) Set the output of the standard direct current voltage generator at 48V.

48 V

(3) Press SHIFT .

(4) Press 4 8, in this order.

48.00 V

(5) Press ENTER .

500V-range full-scale calibration

500V-range full-scale calibration is performed by the following procedure.

(1) Set the output of the standard direct current voltage generator at 480V.

480 V

(2) Press [SHIFT].

(3) Press [4] [8] [0], in this order.

48.0.0 0 V

(4) Press [ENTER].

CAUTION

[In case error was found after pressing the [ENTER] key]

For instance, when the 200V-range full-scale calibration was done with the wrong value, perform the 200V-range full-scale calibration from the beginning again.

6.4.8 Calibration of Direct Current Current + Alternative Current Current Measurement

Device used : Standard direct current current generator

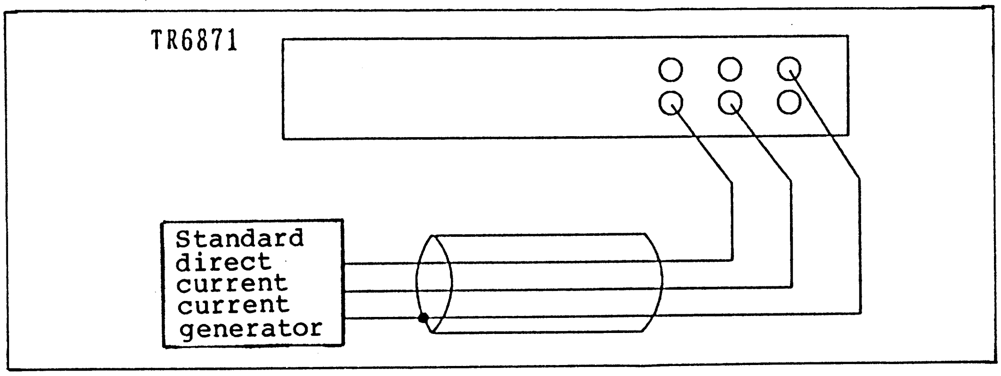
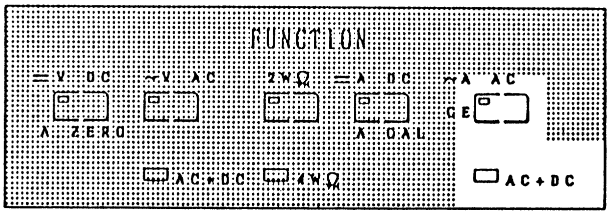


Figure 6 - 6 Calibration of Direct Current Current + Alternative Current Current Measurement

1/10 full-scale calibration and full-scale calibration of each direct current range are done as calibration of the direct current current + alternative current current measurement.

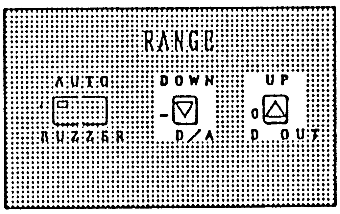
[Calibration]

Setting the function



(1) Press ~A AC key, and light the AC + DC lamp to set the function at direct current current + alternative current current measurement.

Setting 200mA-range



(2) Use the UP, DOWN keys to set the measurement range at 200mA.

Connecting the standard direct current current generator

(3) As shown in Figure 6 - 6, connect the standard direct current current generator with the attached cable (MI-37) between the HI-LO terminals of the lower input terminal.

200mA-range 1/10 full-scale calibration

200mA-range 1/10 full-scale calibration is performed by the following procedure.

(1) Set the output of the standard direct current current generator at 18mA.

`18 mA`

(2) Press SHIFT.

(3) Press 1, 8, in this order.

(4) Press ENTER.

`18.000 mA`

200mA-range full-scale calibration

200mA-range full-scale calibration is performed by the following procedure.

(1) Set the output of the standard direct current current generator at 180mA.

`180 mA`

(2) Press SHIFT.

(3) Press 1, 8, 0, in this order.

(4) Press ENTER.

`180.000 mA`

2000µA-range 1/10 full-scale calibration

2000µA-range 1/10 full-scale calibration is performed by the following procedure.

(1) Set the measurement range at 2000µA.

`180 µA`

(2) Set the output of the standard direct current current generator at 180µA.

(3) Press SHIFT.

(4) Press 1, 8, 0, in this order.

(5) Press ENTER.

`180.00 µA`

2000μA-range full-scale calibration

2000μA-range full-scale calibration is performed by the following procedure.

(1) Set the output of the standard direct current current generator at 1800μA.

1 8 0 0 μA

(2) Press SHIFT .

(3) Press 1 8 0 0, in this order.

(4) Press ENTER .

1 8 0 0. 0 0 μA

20mA-range 1/10 full-scale calibration

20mA-range 1/10 full-scale calibration is performed by the following procedure.

(1) Set the measurement range at 20mA.

(2) Set the output of the standard direct current current generator at 1.8mA.

1. 8 mA

(3) Press SHIFT .

(4) Press 1 . 8, in this order.

(5) Press ENTER .

1. 8 0 0 0 mA

20mA-range full-scale calibration

20mA-range full-scale calibration is performed by the following procedure.

(1) Set the output of the standard direct current current generator at 18mA.

1 8 mA

(2) Press SHIFT .

(3) Press 1 8, in this order.

(4) Press ENTER .

1 8. 0 0 0 0 mA

2000mA-range 1/10 full-scale calibration

2000mA-range 1/10 full-scale calibration is performed by the following procedure.

(1) Set the measurement rage at 2000mA.

(2) Set the output of the standard direct current current generator at 180mA.

180 mA

(3) Press SHIFT .

(4) Press 1 8 0 .

(5) Press ENTER .

180.00 mA

2000mA-range full-scale calibration

2000mA-range full-scale calibration is performed by the following procedure.

(1) Set the output of the standard direct current current generator at 1800mA.

1800 mA

(2) Press SHIFT .

(3) Press 1 8 0 0 , in this order.

(4) Press ENTER .

1800.00 mA

CAUTION

[In case error was found after pressing the ENTER key]

For instance, when the 200mA-range full-scale calibration was done with the wrong value, perform the 200mA-range full-scale calibration from the beginning again.

6.4.9 Calibration of Resistance Measurement

Calibration of 2-wire resistance measurement and 4-wire resistance measurement is done by a single process.

Device used : Standard resistor

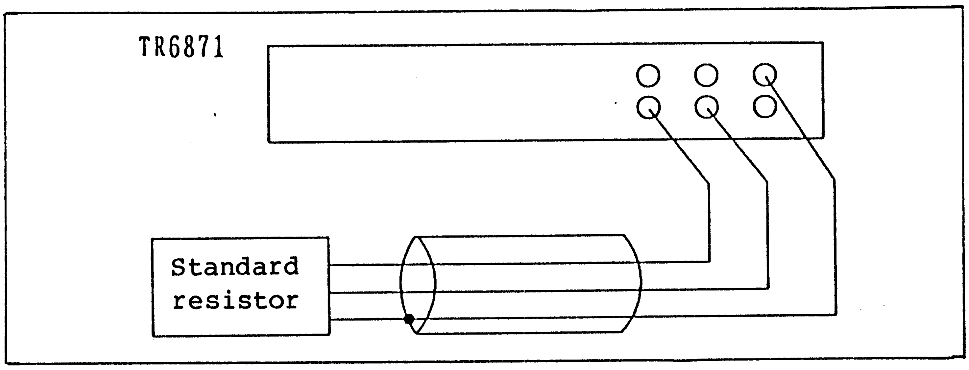


Figure 6 - 7 0-point Calibration of 2-wire Resistance Measurement

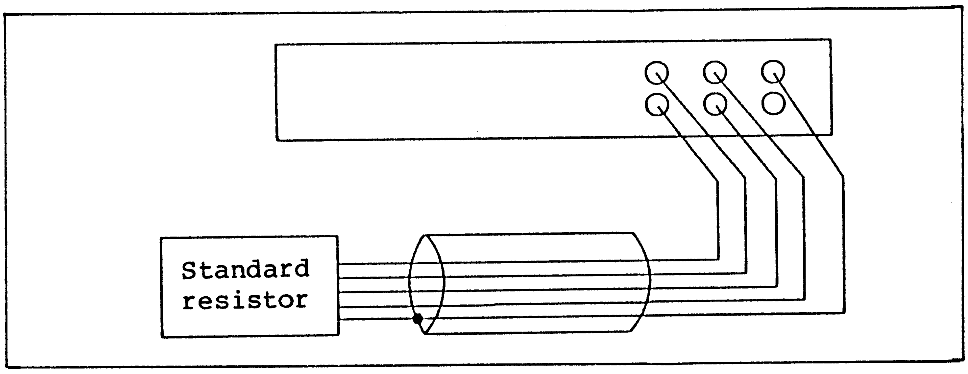


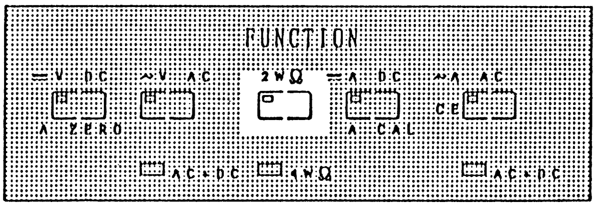
Figure 6 - 8 Full-scale Calibration of 4-wire Resistance Measurement

0-point calibration of 2-wire resistance measurement and 0-point calibration and full-scale calibration of 4-wire resistance measurement of each range is done in calibration of the resistance measurement.

[Calibration]

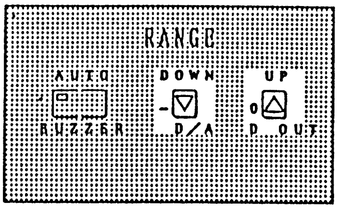
0-point calibration of 2-wire resistance is first performed, and then, 0-point and full-scale calibration of 4-wire resistance is performed.

Setting the function



(1) Press 2WΩ, to set the function at 2-wire resistance measurement. measurement.

Setting the 100Ω range



(2) Use the UP, DOWN keys to set the measurement range at 100Ω.

Connection of the standard resistor

(3) As shown in Figure 6 - 7, connect the attached cable (MI37) between the HI-LO terminals of the lower input terminal.

(4) Calibration of all the 2-wire resistance range is executed at once by performing 0-point calibration of a single range.

<u>100Ω-range 0-point calibration</u>

100Ω-range 0-point calibration is performed by the following procedure.

(1) Set the measurement range at 100Ω.

(2) Short-circuit the clip at the end of the cable.

0 Ω

(3) Press SHIFT .

(4) Press 0△ .

(5) Press ENTER .

0.00000 Ω

Next, as shown in Figure 6 - 8, connect the attached cable (A01005) between the HI - LO terminals of the input terminal, to perform full-scale calibration for 4-wire resistance measurement. Set the measurement function at 4WΩ (light the 4WΩ lamp.)

<u>100Ω-range 0-point calibration</u>

The 0-point calibration of 4-wire resistance is performed on all the range, once executed on a single range. This is the same as with the 2-wire resistance.

<u>100Ω-range full-scale calibration</u>

100Ω-range full-scale calibration is performed by the following procedure.

(1) Set the measurement range at 100Ω.

(2) Connect the 100Ω standard resistor.

100 Ω

(3) Press SHIFT □ .

(4) Press 1□ 0△ 0△, in this order.

(5) Press ENTER □ .

100.00000 Ω

<u>1000Ω-range full-scale calibration</u>

1000Ω-range full-scale calibration is performed by the following procedure.

(1) Set the measurement range at 1000Ω.

(2) Connect the 1000Ω standard resistor.

1000 Ω

(3) Press SHIFT □ .

(4) Press 1□ 0△ 0△ 0△ , in this order.

(5) Press ENTER □ .

1000.0000 Ω

10kΩ-range full-scale calibration

10kΩ-range full-scale calibration is performed by the following procedure.

(1) Set the measurement range at 10kΩ.

(2) Connect the 10kΩ standard resistor.

(3) Press SHIFT □ .

(4) Press 1□ 0△, in this order.

(5) Press ENTER □ .

10 kΩ

10.000000 kΩ

100kΩ-range full-scale calibration

100kΩ-range full-scale calibration is performed by the following procedure.

(1) Set the measurement range at 100kΩ.

(2) Connect the 100kΩ standard resistor.

(3) Press SHIFT □ .

(4) Press 1□ 0△ 0△ , in this order.

(5) Press ENTER □ .

100 kΩ

100.00000 kΩ

1000kΩ-range full-scale calibration

1000kΩ-range full-scale calibration is performed by the following procedure.

(1) Set the measurement range at 1000kΩ.

(2) Connect the 1000kΩ standard resistor.

(3) Press SHIFT □ .

(4) Press 1□ 0△ 0△ 0△, in this order.

(5) Press ENTER □ .

1000 kΩ

1000.0000 kΩ

<u>10MΩ-range full-scale calibration</u>

10MΩ-range full-scale calibration is performed by the following procedure.

(1) Set the measurement range at 10MΩ.

(2) Connect the 10MΩ standard resistor.

(3) Press SHIFT .

(4) Press 1, 0, in this order.

(5) Press ENTER .

10 MΩ

10.000000 MΩ

CAUTION

[In case error was found after pressing the ENTER key]

- For instance, when the 1000Ω-range full-scale calibration was done with the wrong value, perform the 1000Ω-range full-scale calibration from the beginning again.

- The GUARD terminal must always be short-circuited with the Lo terminal at the cable end, and the front panel LO-G SHORT switch must be set at LO-G OPEN.

- When calibrating ranges of 1 MΩ or more, the display value will change if the input cable vibrates. Fix the input cable firmly.
  If it is affected by external noise, shield the standard resistor.

7. SPECIFICATION

7.1 Measurement Functions

7.1.1 DC Voltage Measurement

Range, maximum voltage display, resolution, input impedance, and maximum input voltage :

Range	7 1/2-digit display		6 1/2-digit display		5 1/2-digit display	
	Maximum Display	Resolution	Maximum Display	Resolution	Maximum Display	Resolution
200mV	199.9999mV	0.1μV	199.9999mV	0.1μV	199.999mV	1μV
2000mV	1999.9999 V	0.1μV	1999.999 V	1μV	1999.99 V	10μV
20 V	19.999999 V	1μV	19.99999 V	10μV	19.9999 V	100μV
200 V	199.99999 V	10μV	199.9999 V	100μV	199.999 V	1mV
1000 V	1100.0000 V	100μV	1100.000 V	1 mV	1100.00 V	10mV

<table>
<tr><th rowspan="2">Range</th><th colspan="2">4 1/2-digit display</th><th rowspan="2">Input Impedance</th><th colspan="3">Maximum Input Voltage</th></tr>
<tr><th>Maximum Display</th><th>Resolution</th><th>Bet. InputHi and Lo Terminals</th><th>Bet. Guard and Chassis</th><th>Bet. Guard and Terminal</th></tr>
<tr><td>200mV</td><td>199.99mV</td><td>10μV</td><td rowspan="3">10^{10}Ω or more</td><td rowspan="3">±1100V peak 10sec, or ±500V peak continuous</td><td rowspan="3">±500V peak continuous</td><td rowspan="5">±50V peak continuous</td></tr>
<tr><td>2000mV</td><td>1999.9 V</td><td>100μV</td></tr>
<tr><td>20 V</td><td>19.999 V</td><td>1mV</td></tr>
<tr><td>200 V</td><td>199.99 V</td><td>10mV</td><td rowspan="2">10MΩ ±0.5%</td><td rowspan="2">±1100V peak continuous</td><td rowspan="2"></td></tr>
<tr><td>1000 V</td><td>1100.0 V</td><td>100mV</td></tr>
</table>

Measurement accuracy : A value is displayed with a positive and negative allowance (±xx% of reading + digit) when the Auto Zero and Auto Calibration functions are turned on (with the calibration time interval of 1 hour or less).

Measurement accuracy during 4 1/2-digit display :

Integration Time (IT)	Range	Measurement Accuracy 24 Hours (at 23°C ±1°C)	Measurement Accuracy 90 Days (at 23°C ±5°C)	Measurement Accuracy 180 Days (at 23°C ±5°C)
100μs	200mV	0.06 + 10	Same as for 24 Hours	
	2000mV	0.05 + 4		
	20 V			
	200 V			
	1000 V	0.05 + 3		
1 ms	200mV to 1000 V	1/10 of the digit value of 5 1/2-digit display measurement accuracy		
10 ms to 1PLC	200mV to 1000 V	1/100 of the digit value of 6 1/2-digit display measurement accuracy		
5PLC to 100PLC	200mV to 1000 V	1/100 of the digit value of 6 1/2-digit display measurement accuracy		

Measurement accuracy during 5 1/2-digit display :

Integration Time (IT)	Range	Measurement Accuracy		
		24 Hours (at 23°C ±1°C)	90 Days (at 23°C ±5°C)	180 Days (at 23°C ±5°C)
1 ms	200mV	0.008 + 50	Same as for 24 Hours	
	2000mV	0.006 + 6		
	20 V	0.006 + 4		
	200 V	0.006 + 6		
	1000 V	0.006 + 3		
10 ms to 1PLC	200mV to 1000 V	1/10 of the digit value of 6 1/2-digit display measurement accuracy		
5PLC to 100PLC	200mV to 1000 V	1/10 of the digit value of 6 1/2-digit display measurement accuracy		

Measurement Accuracy during 6 1/2-digit Display :

Integration Time (IT)	Range	Measurement Accuracy		
		24 Hours (at 23°C ±1°C)	90 Days (at 23°C ±5°C)	180 Days (at 23°C ±5°C)
10 ms	200mV	0.007 + 300	0.008 + 300	Same as for 90 Days
	2000mV	0.007 + 60	Same as for 24 Hours	
	20 V	0.006 + 40		
	200 V	0.006 + 60		
	1000 V	0.006 + 20		
1PLC	200mV	0.0025 + 40	0.004 + 40	0.005 + 40
	2000mV	0.0015 + 8	0.003 + 8	0.004 + 8
	20 V	0.0012 + 5	0.0027 + 5	0.0037 + 5
	200 V	0.0015 + 8	0.003 + 8	0.004 + 8
	1000 V	0.0015 + 4	0.003 + 4	0.004 + 4
5PLC to 100PLC	200mV	0.0025 + 35	0.004 + 35	0.005 + 35
	2000mV	0.0015 + 6	0.003 + 6	0.004 + 6
	20 V	0.0012 + 4	0.0027 + 4	0.0037 + 4
	200 V	0.0015 + 6	0.003 + 6	0.004 + 6
	1000 V	0.0015 + 3	0.003 + 3	0.004 + 3

Measurement accuracy during 7 1/2-digit display :

Integration Time (IT)	Range	Measurement Accuracy		
		24 Hours (at 23°C ±1°C)	90 Days (at 23°C ±5°C)	180 Days (at 23°C ±5°C)
5PLC to 100PLC	200mV	10 of the digit value of 6 1/2-digit display measurement accuracy		
	2000mV			
	20 V			
	200 V			
	1000 V			

Temperature coefficient : Indicated as a value (±xx% of reading + digit) per temperature (°C) in the temperature range of +18 to +28°C. 0.0001 is added to this value if the temperature is between 0 to +18°C or between +28 to +40°C.

Range	7 1/2-digit Display	6 1/2-digit Display	5 1/2-digit Display	4 1/2-digit Display
200mV	———	0.0003 + 3	0.0003 + 0.3	0.0003 + 0.03
2000mV	0.0003 + 3	0.0003 + 0.3	0.0003 + 0.03	0.0003 + 0.003
20 V	0.0002 + 2	0.0002 + 0.2	0.0002 + 0.02	0.0002 + 0.002
200 V	0.0003 + 3	0.0003 + 0.3	0.0003 + 0.03	0.0003 + 0.003
1000 V	0.0003 + 1	0.0003 + 0.1	0.0003 + 0.01	0.0003 + 0.001

Noise suppression : Between Guard and Lo terminals with the 1KΩ unbalanced impedance

Integration Time	Effective CMR		NMR
	50/60Hz ±0.09%	DC	50/60Hz ±0.09%
10msec or Less	100dB	140dB	0dB
1PLC or More	160dB	140dB	60dB

7.1.2 DC Current Measurement

Range, maximum voltage display, maximum resolution, and input impedance :

Range	6 1/2-digit Display		5 1/2-digit Display		4 1/2-digit Display		Input Impedance	Over-current Protection
	Maximum Display	Resolu-tion	Maximum Display	Resolu tion	Maximum Display	Resolu-tion		
2000μA	1999.999μA	1nA	1999.99μA	10nA	1999.9μA	100nA	102Ω or less	2A current fuse
20mA	19.99999mA	10nA	19.9999mA	100nA	1.9999mA	1μA	12Ω or less	
200mA	199.9999mA	100nA	199.999mA	1μA	199.99mA	10μA	3Ω or less	
2000mA	1999.999mA	1μA	1999.99mA	10μA	1999.9mA	100μA	2Ω or less	

Measurement accuracy : A value is displayed with a positive and negative allowance (±xx% of reading + digit) when the Auto Zero and Auto Calibration functions are turned on (with the calibration time interval of 1 hour or less).

Measurement accuracy during 4 1/2-digit display :

Integra-tion Time (IT)	Range	Measurement Accuracy		
		24 Hours (at 23°C ±1°C)	90 Days (at 23°C ±5°C)	180 Days (at 23°C ±5°C)
100μs	2000μA	0.12 + 10	0.15 + 10	0.18 + 10
	20mA		0.14 + 10	0.16 + 10
	200mA		0.12 + 10	0.13 + 10
	2000mA	0.125 + 10	0.145 + 10	0.17 + 10
1 ms	2000μA to 2000mA	1/10 of the digit value of 5 1/2-digit display measurement accuracy		
10 ms to 1PLC	2000μA to 2000mA	1/100 of the digit value of 6 1/2-digit display measurement accuracy		
5PLC to 100PLC	2000μA to 2000mA	1/100 of the digit value of 6 1/2-digit display measurement accuracy		

Measurement accuracy during 5 1/2-digit display :

Integration Time (IT)	Range	Measurement Accuracy		
		24 Hours (at 23°C ±1°C)	90 Days (at 23°C ±5°C)	180 Days (at 23°C ±5°C)
1 ms	2000μA	0.06 + 50	0.1 + 50	0.13 + 50
	20mA		0.09 + 50	0.11 + 50
	200mA		0.07 + 50	0.075 + 50
	2000mA	0.065 + 50	0.09 + 50	0.125 + 50
10 ms to 1PLC	2000μA to 2000mA	1/10 of the digit value of 6 1/2-digit display measurement accuracy		
5PLC to 100PLC	2000μA to 2000mA	1/10 of the digit value of 6 1/2-digit display measurement accuracy		

Measurement accuracy during 6 1/2-digit display :

Integration Time (IT)	Range	Measurement Accuracy		
		24 Hours (at 23°C ±1°C)	90 Days (at 23°C ±5°C)	180 Days (at 23°C ±5°C)
10 ms	2000μA	0.06 + 300	0.1 + 300	0.13 + 300
	20mA		0.085 + 300	0.11 + 300
	200mA		0.065 + 300	0.075 + 300
	2000mA	0.065 + 300	0.09 + 300	0.115 + 300
1PLC	2000μA	0.06 + 40	0.1 + 40	0.13 + 40
	20mA		0.085 + 40	0.11 + 40
	200mA		0.065 + 40	0.075 + 40
	2000mA	0.065 + 40	0.09 + 40	0.115 + 40
5PLC to 100PLC	2000μA	0.06 + 35	0.1 + 35	0.13 + 35
	20mA		0.085 + 35	0.11 + 35
	200mA		0.065 + 35	0.075 + 35
	2000mA	0.065 + 35	0.09 + 35	0.115 + 35

Temperature coefficient : Indicated as a value (±xx% of reading + digit) per temperature (°C) in the temperature range of 0 to +40°C.

Range	6 1/2-digit Display	5 1/2-digit Display	4 1/2-digit Display
2000μA	0.0035 + 5	0.0035 + 0.5	0.0035 + 0.05
20mA			
200mA	0.0015 + 5	0.0015 + 0.5	0.0015 + 0.05
2000mA			

7.1.3 Resistance Measurement

Range, maximum resistance display, maximum resolution, measurement current, voltage between open terminals, and maximum input voltage :

Range	Maximum Resistance Display (7 1/2-digit Display)	Resolution				Measurement Current
		7 1/2-digit	6 1/2-digit	5 1/2-digit	4 1/2-digit	
100Ω	119.99999 Ω	10μΩ	100μΩ	1 mΩ	10 mΩ	10mA
1000Ω	1199.9999kΩ	100μΩ	1 mΩ	10 mΩ	100 mΩ	10mA
10kΩ	11.999999kΩ	1 mΩ	10 mΩ	100 mΩ	1 Ω	1mA
100kΩ	119.99999kΩ	10 mΩ	100 mΩ	1 Ω	10 Ω	100μA
1000kΩ	1199.9999MΩ	100 mΩ	1 Ω	10 Ω	100 Ω	10μA
10MΩ	11.999999MΩ	1 Ω	10 Ω	100 Ω	1 kΩ	1μA

Range	Max. Voltage bet. Open Terminals	Maximum Input Voltage		
		Bet. Terminals	Bet. Guard and Chassis	Bet. Terminal and Guard
100Ω	24V	±350V peak continuous	±500V peak continuous	±500V peak continuous
1000Ω				
10kΩ				
100kΩ	18V			
1000kΩ				
10MΩ				

Measurement accuracy : Values measured at 4 terminals are displayed with a positive and negative allowance (±xx% of reading + digit) when the Auto Zero and Auto Calibration functions are turned on (with the calibration time interval of 1 hour or less).

The measurement accuracy for 2WΩ (measurement at 2 terminals) is equal to the measurement accuracy for 4WΩ (measurement at 4 terminals) added by 0.2Ω maximum.

Note : If a cable, whose line resistance is less than that of the cable used for 2WΩ calibration (measurement at 2 terminals), a negative sign (-) is displayed during zero point measurement.

Measurement accuracy during 4 1/2-digit display :

Integration Time (IT)	Range	Measurement Accuracy		
		24 Hours (at 23°C ±1°C)	90 Days (at 23°C ±5°C)	180 Days (at 23°C ±5°C)
100μs	100Ω	0.07 + 4	Same as for 24 hours	
	1000Ω	0.06 + 4		
	10kΩ			
	100kΩ			
	1000K	0.07 + 4		
	10M	0.09 + 4		
1 ms	100 Ω to 10MΩ	1/10 of the digit value of 5 1/2-digit display measurement accuracy		
10 ms to 1PLC	100 Ω to 10MΩ	1/10 of the digit value of 5 1/2-digit display measurement accuracy		
5PLC to 100PLC	100 Ω to 10MΩ	1/100 of the digit value of 6 1/2-digit display measurement accuracy		

Measurement accuracy during 5 1/2-digit display :

Integration Time (IT)	Range	Measurement Accuracy		
		24 Hours (at 23°C ±1°C)	90 Days (at 23°C ±5°C)	180 Days (at 23°C ±5°C)
1 ms	100 Ω	0.009 + 6	Same as for 24 hours	
	1000Ω	0.008 + 4		
	10kΩ			
	100kΩ			
	1000kΩ	0.01 + 4		
	10MΩ	0.036 + 4		
10 ms to 1PLC	100 Ω to 10MΩ	1/10 of the digit value of 6 1/2-digit display measurement accuracy		
5PLC to 100PLC	100 Ω to 10MΩ	1/10 of the digit value of 6 1/2-digit display measurement accuracy		

Measurement accuracy during 6 1/2-digit display :

Integration Time (IT)	Range	Measurement Accuracy		
		24 Hours (at 23°C ±1°C)	90 Days (at 23°C ±5°C)	180 Days (at 23°C ±5°C)
10 ms	100 Ω	0.008 + 60	0.009 + 60	Same as for 90 days
	1000Ω	0.007 + 40	0.008 + 40	
	10kΩ			
	100kΩ			
	1000kΩ	0.009 + 40	0.01 + 40	
	10MΩ	0.03 + 40	0.036 + 40	
1PLC	100 Ω	0.003 + 8	0.005 + 8	0.006 + 8
	1000Ω	0.002 + 5	0.004 + 5	0.006 + 5
	10kΩ			
	100kΩ			
	1000kΩ	0.004 + 5	0.006 + 5	0.007 + 5
	10MΩ	0.022 + 5	0.028 + 5	0.03 + 5
5PLC to 100PLC	100 Ω	0.003 + 6	0.005 + 6	0.006 + 6
	1000Ω	0.002 + 4	0.004 + 4	0.006 + 4
	10kΩ			
	100kΩ			
	1000kΩ	0.004 + 4	0.006 + 4	0.007 + 4
	10MΩ	0.022 + 4	0.028 + 4	0.03 + 4

Measurement accuracy during 7 1/2-digit display
(10 times of smoothing turned on) :

Integration Time (IT)	Range	Measurement Accuracy		
		24 Hours (at 23°C ±1°C)	90 Days (at 23°C ±5°C)	180 Days (at 23°C ±5°C)
5 to 100PLC	100 Ω	0.003 + 40	0.005 + 40	0.006 + 40
	1000Ω	0.002 + 30	0.004 + 30	0.006 + 30
	10kΩ			
	100kΩ			
	1000kΩ	0.004 + 30	0.006 + 30	0.007 + 30
	10MΩ	0.022 + 30	0.028 + 30	0.03 + 30

Temperature coefficient : Indicated as a value for 4WΩ (±xx% of reading + digit) per temperature (°C) in the temperature range of 0 to +40°C. (The coefficient for 2WΩ is equal to this value added by 0.02Ω per temperature (°C).)

Range	7 1/2-digit display	6 1/2-digit display	5 1/2-digit display	4 1/2-digit display
100 Ω	———	0.0004 + 0.3	0.0004 + 0.03	0.0004 + 0.003
1000Ω to 1000kΩ	0.0004 + 2	0.0004 + 0.2	0.0004 + 0.02	0.0004 + 0.002
10MΩ	0.0015 + 2	0.0015 + 0.2	0.0015 + 0.02	0.0015 + 0.002

7.1.4 AC Current Voltage Measurement (true RMS)

Range, maximum voltage display, maximum resolution, input impedance, and maximum applicable voltage :

Range	Maximum Voltage Display (5 1/2-digit Display)	Resolution: 5 1/2-digit Display	Resolution: 4 1/2-digit Display	Input Impedance	Maximum Applicable Voltage
200mV	199.999mV	1 μV	10 μV	1MΩ ±2%, 300pF or less, AC coupling	520Vrms (750V peak) between Hi and Lo terminals
2000mV	1999.99 V	10 μV	100 μV		
20 V	19.9999 V	100 μV	1 mV		
200 V	199.999 V	1 mV	10 mV		
500 V	500.00 V	10 mV	100 mV		

Measurement accuracy : The value is displayed with a positive and negative allowance (±xx% of reading + digit) when the Auto Zero and Auto Calibration functions are turned on (with the calibration time interval of 1 hour or less).

This value is reliable for the input in 5% or more of the full scale or 1 x 10^7VHz or less.

Measurement accuracy (ACV) during 5 1/2-digit display :

Integration Time (IT)	1ms ~ 10ms		1PLC ~ 100PLC	
Frequency Range	24 Hours (at 23°C ±1°C)	180 Days (at 23°C ±5°C)	24 Hours (at 23°C ±5°C)	180 Days (at 23°C ±5°C)
20Hz to 45Hz	0.25 + 800	0.35 + 800	0.25 + 70	0.35 + 90
45Hz to 300Hz	0.1 + 400	0.2 + 400	0.1 + 70	0.2 + 90
300Hz to 10kHz	0.1 + 400	0.2 + 400	0.1 + 70	0.2 + 90
10kHz to 100kHz	0.8 + 700	1 + 900	0.8 + 700	1 + 900
100kHz to 1MHz	7 + 3000	8 + 4000	7 + 3000	8 + 4000

For 200mV range, the above listed accuracy should be added by 100 digits.
Measurement accuracy during 4 1/2-digit display; Equal to 1/10 of the measurement accuracy during 5 1/2-digit display

Temperature coefficient : 1/10 of the 24-hour measurement accuracy of 1 to 100PLC (per temperature (℃))

Crest factor : 1:4

Response time : Time period required for setup within 0.2% of input step
Fast : Approx. 200msec
Slow : Approx. 2sec

Note : Slow : 20Hz to 1MHz
Fast : 300Hz to 1MHz
In the fast sampling of 20 to 300Hz frequency, data is measured but the measurement accuracy is unreliable.

Measurement accuracy of AC and DC voltages
: Equal to the ACV measurement accuracy + 70 digits

7.1.5 AC Current Measurement (true RMS)

Range, maximum current display, maximum resolution, and input impedance :

Range	5 1/2-digit Display		4 1/2-digit Display		Input Impedance	Over current Protection
	Maximum Current Display	Resolution	Maximum Current Display	Resolution		
2000μA	1999.99mA	10 nA	1999.9mA	100 nA	102Ω or less	2 A (with fuse)
20mA	19.9999mA	100 nA	19.999mA	1μA	12Ω or less	
200mA	199.999mA	1μA	199.99mA	10μA	3Ω or less	
2000mA	1999.99 A	10μA	1999.9 A	100μA	2Ω or less	

Measurement accuracy : The value is displayed with a positive and negative allowance (±xx% of reading + digit) when the Auto Zero and Auto Calibration functions are turned on (with the calibration time interval of 1 hour or less).

Measurement accuracy during 5 1/2-digit display
(reliable for input of 5% or more on the full scale) :

Integration Time (IT)	1ms ~ 10ms		1PLC ~ 100PLC	
Frequency Range	24 Hours (at 23°C ±1°C)	180 Days (at 23°C ±5°C)	24 Hours (at 23°C ±1°C)	180 Days (at 23°C ±5°C)
20Hz to 45Hz	0.5 + 200	0.65 + 220	0.5 + 180	0.65 + 200
45Hz to 5kHz	0.35 + 200	0.5 + 220	0.35 + 180	0.5 + 200

Measurement accuracy during 4 1/2-digit display
: Equal to 1/10 of the measurement accuracy during 5 1/2-digit display

Temperature coefficient : 1/10 of the 24-hour measurement accuracy of 1 to 100PLC (per temperature (°C)) for each measurement range and frequency range

Crest factor : 1:4

Response time : Same as for AC voltage measurement

Measurement accuracy of AC and DC voltages
: Equal to the measurement accuracy of AC current + 70 digits

7.2 Measurement Speed

(1) For DATA OUT, mode 0 (mode enable to output for all output systems)
For display output only

Parameter conditions

Sampling mode	; RUN	Sample interval	; 0 ms
Compute	; OFF	Auto zero	; OFF
Store	; OFF	Auto calibration	; OFF
Smoothing	; OFF	Line	; 50Hz
Null	; OFF		

Measurement function / Integrate time(IT)	Direct voltage	Alter-nate voltage (AC+DC)	Direct voltage	Alter-nate current (AC+DC)	2WΩ (100Ω ~ 10MΩ)	4WΩ (100Ω ~ 100kΩ)	4WΩ (1000kΩ)	4WΩ (10MΩ)
100μS (4 1/2-digit)	3.6ms	5.0ms	4.8ms	5.0ms	4.8ms	26.5ms	111ms	428ms
1ms (5 1/2-digit)	4.6ms	6.0ms	5.8ms	6.0ms	5.8ms	28.5ms	113ms	430ms
10ms (6 1/2-digit)	13.6ms	15.0ms	14.8ms	15.0ms	14.8ms	46.5ms	131ms	448ms
5PLC (7 1/2-digit)	104ms	105ms	105ms	105ms	105ms	227ms	311ms	628ms

* Except 4W ohms, the measurement cycle of integrate time from 1 ms to 100 PLC is determined by measurement cycle of 100 μs + each integrate time. the measurement cycle of 4W ohms is determined by measurement cycle of 100 μs + each integrate time X 2.

For output to GP-IB
Controller:HP200 series

GPIB output format; Minimum with header=off and block delimiter=EOI

Measurement function / Integrate time(IT)	Direct voltage	Alter-nate voltage (AC+DC)	Direct voltage	Alter-nate current (AC+DC)	2WΩ (100Ω ~ 10MΩ)	4WΩ (100Ω ~ 100kΩ)	4WΩ (1000kΩ)	4WΩ (10MΩ)
100μS (4 1/2-digit)	4.0ms	5.5ms	5.3ms	5.5ms	5.3ms	26.7ms	111ms	428ms
1ms (5 1/2-digit)	5.2ms	7.4ms	7.2ms	7.4ms	6.4ms	29.7ms	114ms	431ms
10ms (6 1/2-digit)	14.3ms	16.8ms	16.5ms	16.8ms	15.4ms	47.7ms	132ms	449ms
5PLC (7 1/2-digit)	108ms	110ms	110ms	110ms	110ms	230ms	313ms	630ms

*1 When the GP-IB output format is standard (header=ON, block delimiter=CR/LR(EOI)), about 300 μs is added.
*2 In sampling=single mode (Hold-Trigger), about 1.5 ms is added.

(2) For DATA OUT, mode 3 (mode output to data memory only, and data to be saved after calculation of true value)

Parameter conditions

Select	; MAIN	Function	; VDC
Compute	; OFF	Range	; 20 V
Store	; ON	Sampling mode	; RUN
Smoothing	; OFF	Sample interval	; 0 ms
Null	; OFF	Auto zero	; OFF
Auto calibration	; OFF	Line	; 50 Hz

Integrate time(IT)	100μS	1ms	10ms	1PLC	5PLC	10PLC	20PLC	50PLC	100PLC
Measurement cycle	3.0ms	4.0ms	13.0ms	23.0ms	103ms	203ms	403ms	1003ms	2003ms

(3) For DATA OUT, mode 4 (mode output to data memory only in the maximum rate mode, and raw data to be saved)

Parameter conditions

Select	; MAIN	Function	; Previous state
Range	; Previous state	Sampling mode	; RUN
Integrate time	; 100 µs	Sample interval	; 0 ms
Auto zero	; OFF	Auto calibration	; OFF
Compute	; OFF	Store	; ON
Smoothing	; OFF	Null	; OFF

Measurement function (measurement range)	Direct Voltage	Current voltage (AC+DC)	Direct Current	Alternate current (AC+DC)	2WΩ (100Ω ~ 10MΩ)	4WΩ (100Ω ~ 100kΩ)	4WΩ (1000kΩ)	4WΩ (10MΩ)
Measurement cycle	500µs	500µs	500µs	500µs	500µs	21.5ms	105ms	415ms

7.3 Integration Time

The following integration times can be set :

100μsec, 1msec, 10msec, 1PLC, 5PLC, 10PLC, 20PLC, 50PLC, or 100PLC (9 modes)

Note : PLC is the sorted power line cycle.

In the 4 1/2-digit display mode, the integration time can be set within the range of 100μsec to 100PLC.

In the 5 1/2-digit display mode, it can be set within the range of 1msec to 100PLC.

In the 6 1/2-digit display mode, it can be set within the range of 10msec to 100PLC.

In the 7 1/2-digit display mode, it can be set within the range of 5PLC to 100PLC.

7.4 Null Function

When the Null function is turned on, the null value is measured and the subsequent measurement data is automatically subtracted by the null value.

The correction range is within 1% of each range.

7.5 Input Terminals

One of the Front Input, Rear Input, Modular Left, and Modular Right inputs can be selected using either the selector switch on the panel or a remote signal. The Front Input and Relay Input must be selected by the selector switch on the panel.

o Front Input	DC/AC V, DC/AC I, 2WΩ, 4WΩ
o Rear Input	DC/AC V, *DC/AC I, 2WΩ, 4WΩ Note : Signal can be input to the rear current input terminal only when the Front/Rear selector switch is set to the Front position.
o Modular Input	Can be set on each module.

7.6 Smoothing Function

When the smoothing function is turned on, the moving average is determined based on the data measured for the number of times set by the SM TIME key.

7.7 Sampling

- o RUN : Data sampling continues at the interval specified by SI (Sample Interval).
- o SINGLE : Data is sampled only once for a single trigger input signal after the TD (Trigger Delay)
- o MULTI : Data is sampled for the specified number of times when a single trigger input signal is received. Data sampling starts after the TD has passed and data is sampled at the SI interval.

SI (Sample Interval)	: 0 to 60000ms
TD (Trigger Delay)	: 0 to 60000ms
NS (No. of Sample)	: 1 to 10000

o Trigger source

- o Panel switch
- o GET command of GPIB "E"
- o TRIGGER single line signal (negative TTL pulse ⌉⌊⌋⌈)

7.8 Data Memory Functions

o Memory function on/off control	: Measurement data storage is controlled by the STORE key.
o No. of memory data	: Any 10,000 data before and after trigger point can be stored in memory. (Available pre-trigger and post-trigger)
o Measurement data acquisition	: Any single data can be read from memory by using the RECALL key or data number setup (single mode). Any number of data can also be read sequentially (continuous mode). The read data is output to the display, GPIB, or analog output terminal. The data is output continuously at the SI interval in the continuous mode.

7.9 Calculation Functions

7.9.1 Primary Calculation Functions

The following calculations can be made for measurement value D :

(1) Scaling $R = \frac{D - Y}{X} * Z$ (X, Y, Z, and W are constants.)

(2) Percent Deviation $R = \frac{D - X}{|X|} * 100$ (%)

(3) Delta $R(\ D) = Dt - Dt_{-1}$ (Data before single sampling)

(4) Multiply $R = Dt * Dt_{-1}$ (The previous data is multiplied by the current data.)

(5) Decibel $R(dB) = 20 * Y * \log |D/X|$

(6) RMS value

$$R = \sqrt{\frac{1}{X} \sum_{K=1}^{X} Dk^2}$$

(7) dBm

$$R\ (dBm) = 10 \log_{10} \frac{D^2/X}{1mW}$$ (D : Measurement voltage)

Set the reference resistance in constant X. The measurement voltage according to the reference resistance is converted into the dBm value based on the value of 1 mW = 0 (dBm).

(8) Temperature Correction of Resistance

$$R_{20} = \frac{Rx}{1 + 0.00393 * (X-20)} * \frac{1000}{Y} [\Omega / km]$$

where
- Rx : Measurement resistance (Ω) at temperature X°C
- X : Room temperature (X°C) during measurement
- Y : Cable length measures (meters)
- R_{20} : Resistance of leads (Ω/km) at the room temperature (20°C)

7.9.2 Secondary Calculation Functions

There are 3 types of secondary calculation functions : calculation of measurement data, calculation of primary calculation results, and calculation of data recalled from memory.

Calculation Type, Item and Expression	Constant Setup Range	Calculation Result Display
(1) COMPARATOR 1 (comparator-1) R(H2):HIGH2<D R(H1):HIGH1<D<=HIGF2 R(PASS):LOW1<D=<=<HIGH1 R(L1):LOW2<=D<LOW1 R(L2): D<LOW1	HIGH1, HIGH2, LOW1, LOW2: Upper and lower limits if: HIGH1<=HIGH2 LOW2<=LOW1 (HIGH<LOW is also allowed)	Indicated by the lamp as follows: R(H2):HIGH lamp lights. R(H1):HIGH lamp lights. R(PASS):PASS lamp lights. R(L1):LOW lamp lights. R(L2):LOW lamp lights. Display values: The measurement value is displayed if the primary calculation is not set. The primary calculation result is displayed if it is set.
(2) COMPARATOR 2 (comparator-2) H2=LIMIT + %2 H1=LIMIT + %1 L2=LIMIT - %2 L1=LIMIT - %1 R(H2):HIGH2<D R(H1):HIGH1<D<=HIGF2 R(PASS):LOW1<D=<=<HIGH1 R(L1):LOW2<=D<LOW1 R(L2): D<LOW1	LIMIT: Reference value (except 0) %1 and %2: Tolerance (%), 0.000 to 100.0 where, %1 <= %2	Indicated by the lamp as follows: R(H1):HIGH lamp lights. R(H1):HIGH lamp lights. R(PASS):PASS lamp lights. R(L1):LOW lamp lights. R(L2):LOW lamp lights. Display values: The measurement value or primary calculation result is converted into percent deviation and displayed based on the reference. -1999.9990 to 1999.9990 (effective up to 3 decimal points) Unit in percent (%)

(3) Statistical Preocessing

Maximum number obtained through 'n' times of measurement
Minimum number obtained through 'n' times of measurement

R (AVE) : $\frac{1}{N} * \sum_{K=1}^{x} Dk$

R (P-P) : $| R(MAX)-R(MIN) |$

R (σ) : $\sqrt{\frac{1}{N-1} * \sum_{K=1}^{x} (Dk-\overline{D})^2}$

R (UCL) : R (AVE) + 3R (σ)
R (LCL) : R (AVE) - 3R (σ)
R (COUNT) : Sample count

7.10 GPIB Interface

(1) Standard IEEE-488-1978

(2) Interfacing Functions

SH1, AH1, T5, L4, SR1, RL1, DC1, DT1, C0, and B2

(3) Remote Programming

Anylyzer front panel key functions (except for POWER switch and front/rear input selector switch)

(4) Data Output

ASCII format

7.11 Analog Output

(1) Output Mode

- o OFF (no analog output)
- o Low-order 3 digits of output data
- o Low-order 3 digits of output data + OFFSET (500)
- o Low-order 2 digits of output data
- o Low-order 2 digits of output data + OFFSET (500)

(2) Output Voltage : 0 to 0.999 VDC

(3) Conversion Voltage :

Digital display	Low-order 3 digits	: -999 to +999
	Low-order 2 digits	: -99 to +90
Analog display (Absolute value)	Low-order 3 digits	: 000 to 999
	Low-order 2 digits	: 000 to 990

Note : The number of output digits is defined by the RES parameter.

(4) Conversion Accuracy :

±0.3% of full scale (at 23 ±5°C, 85% RH or less, and 6 months)

(5) Output Impedance : Approx. 670Ω

(6) Output Terminal : BNC connectors

7.12 Control Signals (Single Line Signals)

- o TRIGGER input signal (TTL negative pulse, 100μsec or more)
- o COMPLETE output signal (TTL negative pulse, approx. 100μsec)
- o Input terminals : BNC connectors

7.13 Buzzer Function (with ON/OFF Switching)

The buzzer sounds when :

- o Data is entered from panel keys.
- o An error occurs.
- o Comparator calculation is executed.

7.14 General Specifications

Measurement technique : Integration measurement
Data input : Floating and guarded
Range selection modes : Auto, manual, or remote
Data display : 7-segment red LEDs
Polarity indication : Negative polarity indication
Display unit : 5x7-dot matrix LEDs
Software calibration : Each function and range of DC voltage/current, AC voltage/current, and resistance can be calibrated through main panel key operation or GPIB program.
Environment conditions : Temperature of 0 to +40 C and relative humidity of 85% or less (70% or less in the 10-μΩ resistance range)
Power supply : Should be determined during ordering

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

Dimensions : 424(W) x 132(H) x 450(D)mm
Weight : 12.5kg or less
Power consumption : 55 VA MAX.

7.15 Accessories

(1) A02602 EIA rack mount
(2) A02602-J JIS rack mount
(3) A02610 front handle
(4) A02615 sliding rail set
(5) TR16032 transit case
(6) TR13010 binary data output unit
(7) TR13011 BCD data output unit
(8) TR13013 relay output unit

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8. OPERATIONS

8.1 General

By using the built-in microprocessor, the TR6871 digital multimeter can process various measurement data required for output (to data memory, display, GPIB, analog output, and accessories).

This chapter explains the general operation of multimeter by using operational diagrams and charts.

Figure 8 - 1 shows the operation concept of the multimeter from data measurement to data output. Figure 8 - 2 shows the block diagram of the multimeter.

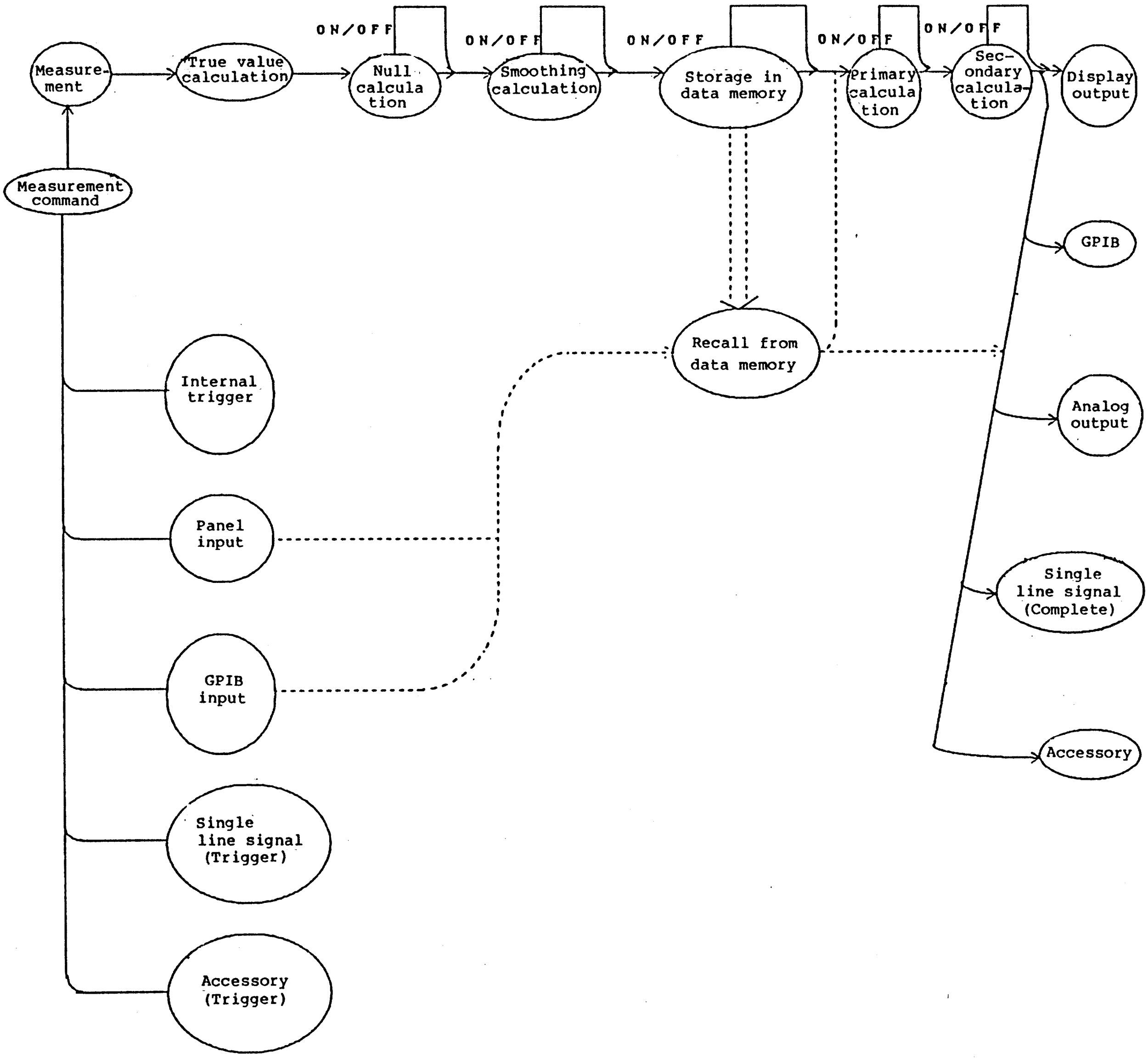

Figure 8 - 1 TR6871 Multimeter Operation Concept

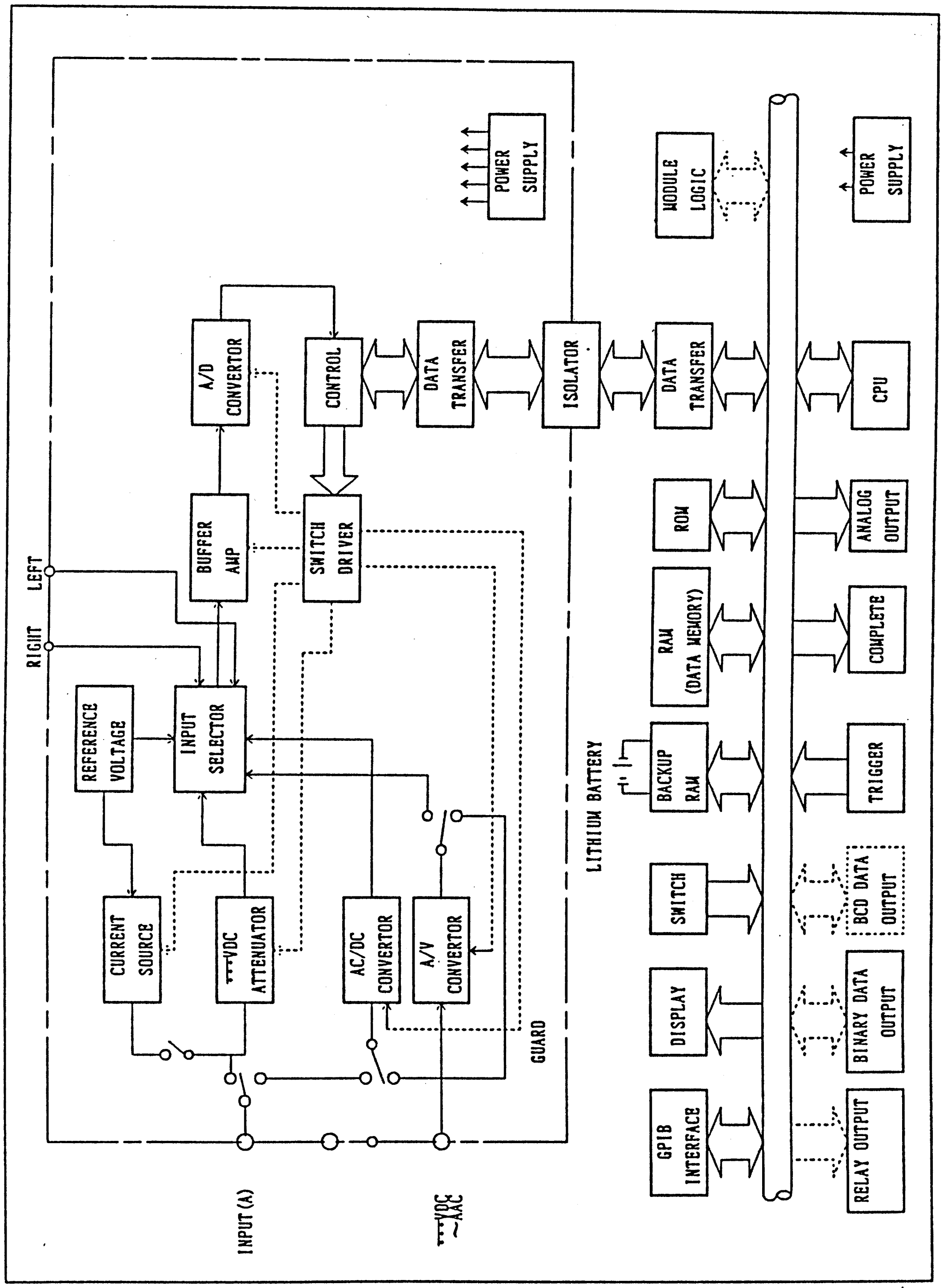

Figure 8 - 2 TR6871 Block Diagram

8.2 Operations

Figure 8 - 3 shows the TR6871 data processing timing chart.

The multimeter starts measurement when receiving an internal or external measurement command. After the measurement has completed, the multimeter calculates and determines the true value by using various measurement functions.

The measurement value of input is determined. If the Auto Range mode has been selected (by turning on the AUTO key), the measurement range selection appropriate to the input can be checked. If not selected, the measurement range should be changed and the same operation (input measurement or true value calculation) should be repeated.

After the data has been measured, it is processed by various data processing functions (such as Null and smoothing functions) which are turned on.

If the data memory function is on (that is, if the lamp of STORE key is on), the measured data or the resulting data of Null or smoothing calculation stored in the data memory.

The data is processed through primary and secondary calculation in succession.

When the sequential data processing is complete, the data is output to each output (such as display, GPIB, analog output, and accessory). Single line signals (approximately 100-µsec negative pulses output from the COMPLETE output terminal) are also output simultaneously.

To increase the sampling rate, turn off all function that can be turned on or off (such as Null, smoothing, data memory, and calculation functions), set the SI parameter of 0msec, and turn off the Auto Zero function.

Analog data is calibrated in the cycle set by the A CAL parameter during automatic calibration. This calibration precedes the measurement commands.

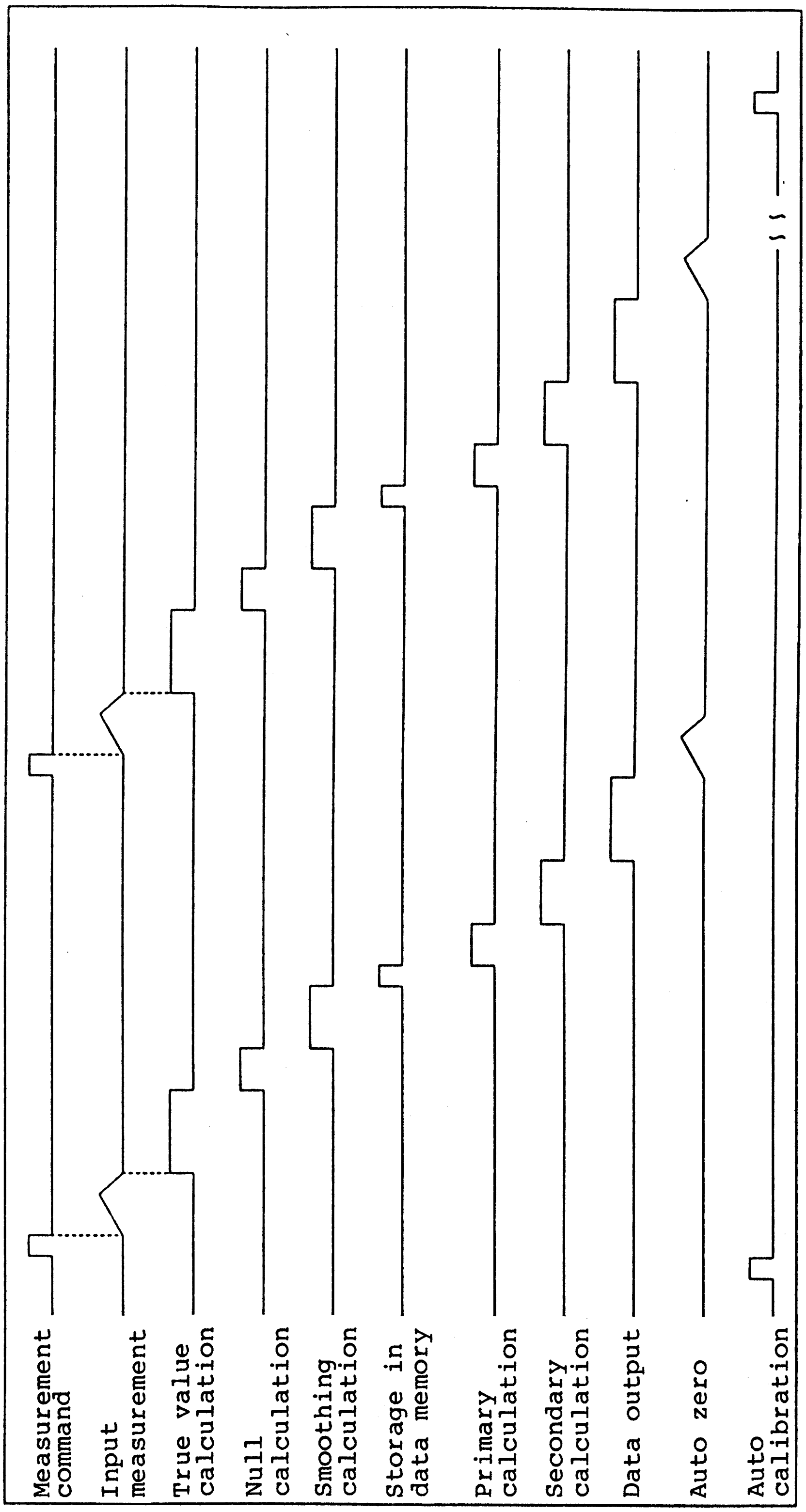

Figure 8 - 3 Data Processing Timing Chart

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APPENDIX

A.1 Terminologies

[Sensitivity and Resolution]

The resolution of a digital voltmeter is the minimum unit of quantization. For example, the maximum sensitivity range of the TR6871 digital multimeter is 200mV and the resolution if, therefore, 0.1μV/digit.

This value also represents the sensitivity. The values indicating the sensitivity and resolution of a digital multimeter are vital factors for multimeter selection. They also indicates the limit of multimeter performance.

[Measurement Accuracy]

The measurement accuracy is defined as follows:

$$\text{Measurement accuracy} = \frac{(\text{Reading value} - \text{True value})}{(\text{Full scale value})} + 1 \text{ digit}$$

The reading value minus true value is called a reading error. The reading error of this multimeter is indicated as ±0.00XX% of rdg. The full-scale error is indicated as of fs (or digits). The full-scale error and quantization error (explained below) result from different causes. However, the full-scale error may be added the quantization error and displayed for simple calculation of measurement accuracy. The full-scale error is primary caused by zero-point drifting. This drifting is automatically corrected by the automatic zero point correction circuit.

An error within ±1 digit is called the quantization error. This may occur during data conversion from analog into digital form.

[Input Impedance]

A digital voltmeter has its inherent input resistance (Rin). This is usually called as an input impedance. Voltage Es of the power supply (shown in Figure A - 1) to be measured is reduced by the output resistance (Rs) of the power supply and the input impedance (Rin), and voltage Es' is displayed on the digital multimeter. To reduce the loading error, the input impedance (Rin) of the digital multimeter must be increased.

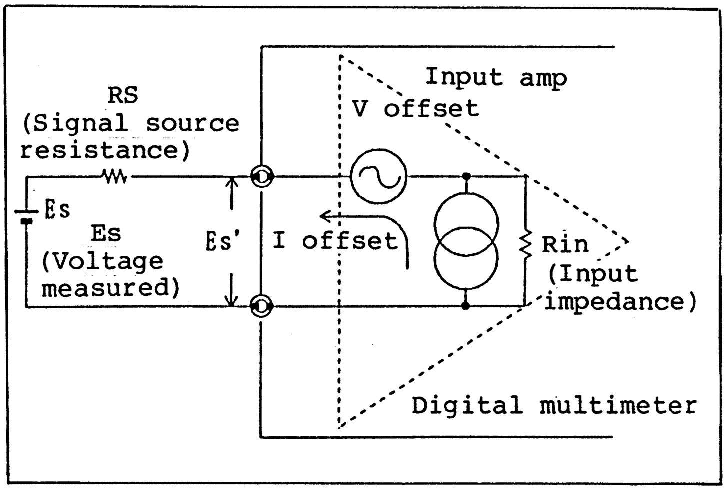

Figure A - 1 Input Equivalent Circuit by Considering Current and Voltage Offsets and Input Impedance

In addition to the error due to the output resistance (Rs) of p]power supply and the input impedance of multimeter, an error due to current offset exists. This current offset occurs inside the multimeter. A voltage offset may also occur, but it can be ignored even when output resistance Rs increases.

The current offset is caused by elements used in the primary stage of input amplifier. To minimize the the offset, field effect transistors (FETs) are used. Therefore, if the power supply to be measured has output resistance Rs, voltage Es' appearing at the input terminal of digital multimeter can be defined in the following equation. Resistance Rs divided by resistance Rin, and resistance Rs multiplied by I offset should be considered.

$$Es' = \frac{1}{1 + \frac{Rs}{Rin}} Es - Rs \times I\ offset$$

[Normal Mode Noise Voltage Rejection Ratio (NMRR) and Common Mode Noise Voltage Rejection Ratio (CMRR)]

A certain level of noise always exit during measurement and this noise causes a measurement error. During low-voltage signal measurement below 10μV, a measurement error is often caused by troubles of grounding or cables, ground current, or induction noise from the power supply. The measurement may fail due to errors. To solve such measurement problems, the TR6871 digital multimeter involves the integration measurement and the noise rejectors are included in its power supply.

The noise source can be eliminated during measurement by using the measuring circuit shown in Figure A - 2. Noise voltage 'en' is called the normal mode noise voltage or series mode noise voltage. The noise voltage is fed in series in the signal line. This noise usually consists of power frequency components and their subharmonics. The affection of these noise components on the measurement or the noise elimination efficiency is called the normal mode noise voltage rejection ratio (NMRR). The NMRR can be determined by the following equation:

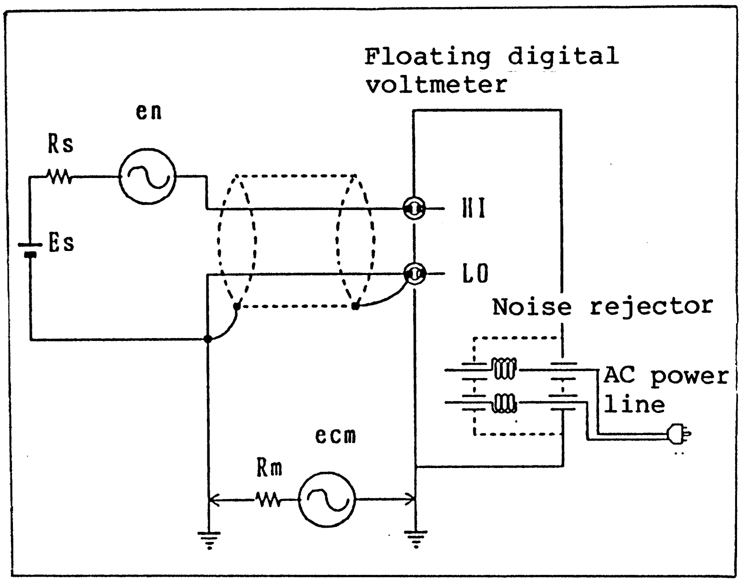

Figure A - 2 Measuring Circuit Featuring Effective Noise Elimination

$$NMRR = 20 \log \frac{en}{\Delta en}$$

'Δen' is the measurement error caused by 'en'. 'ecm' is a noise, called the common mode noise voltage, and occurs between the signal line and the ground of multimeter. The noise level increase if the distance between them increases.

The affection of the noise components on the measurement, or its noise elimination efficiency is called the common mode noise voltage rejection ratio (CMRR). The CMRR can be defined by the following equation:

$$\mathrm{CMRR} = 20 \log \frac{\mathrm{ecm}}{\Delta\,\mathrm{ecm}}$$

'Δecm' is the voltage that appears at the input terminal of the multimeter. The combination efficiency of the above two noise voltage rejection ratios is indicated as the effective CMR. The TR6871 multimeter using the integration calculation can provide the higher NMR.

The CMR greatly varies depending on the frequency of noise voltage, signal source circuit, shielding, input cable type, and input connection. If the CMR of 120dB is shown on the multimeter document and if the errors are ignored in the 'ecm' voltage exceeding $1/10^6$, the measured data is unreliable. A shielded cable should be connected to the multimeter to eliminate any induction, and the ground lead of the power cable should be connected directly to the ground. The multimeter digital display (calculation) section is electrically disconnected from the A/D converter section. Dual shielding of the measuring circuits from the ground allows the highest common mode noise voltage rejection ratio.

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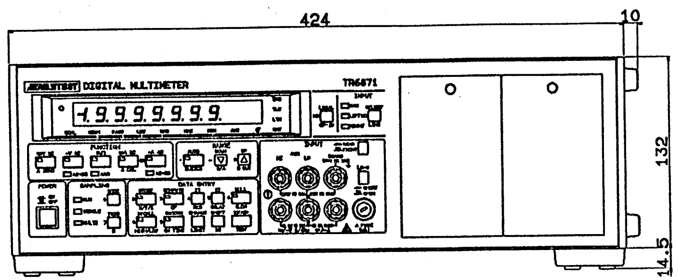
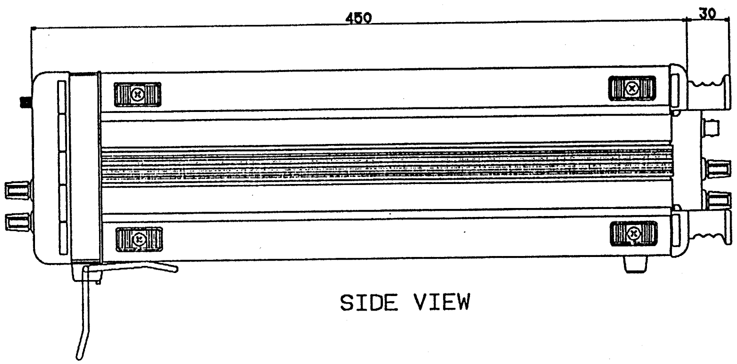
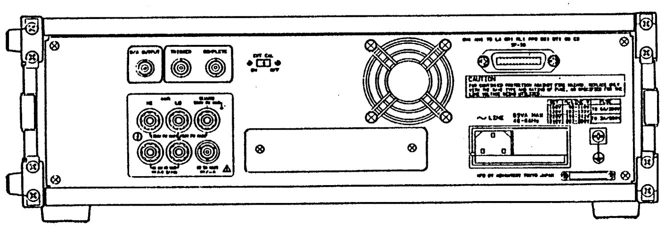


FRONT VIEW



SIDE VIEW

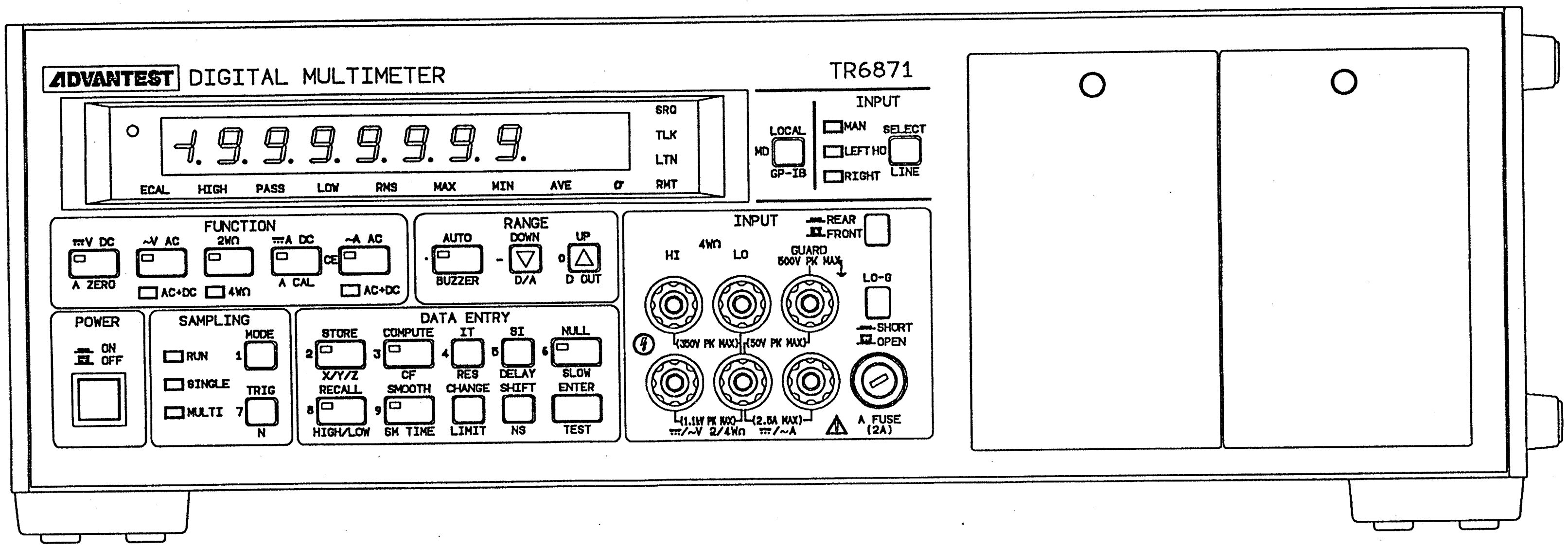
Unit : mm



REAR VIEW

6871-EXT1-709B

TR6871
EXTERNAL VIEW



6871EXT2-709-A

TR6871
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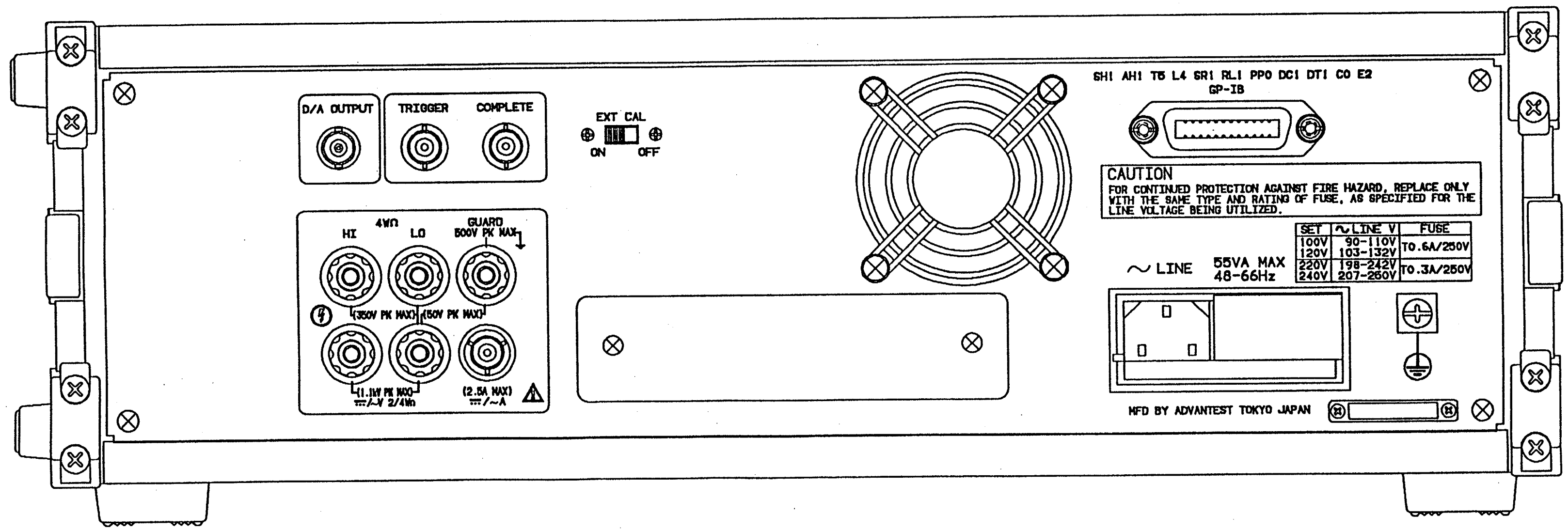

6871EXT3-709-C

TR6871
REAR VIEW

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