TR6845/46/47/48
DIGITAL MULTIMETER

INSTRUCTION MANUAL

MANUAL NUMBER OEH01 9307Ⓐ

This product has been discontinued.
The Operation Manual is provided by ADC Corporation under the agreement with Advantest Corporation.

OPERATIONS

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TABLE OF CONTENTS

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

List of Illustrations

LIST OF TABLES

1. READ BEFORE USING

This chapter describes how to use this instruction manual, and outlines the TR6845 Series Digital Multimeter cautions, names and operations of the front panel.

This chapter also describes accessories (optional) required to make the best use of this multimeter.

Please read these instructions before using this multimeter.

1.1 HOW TO USE THIS MANUAL

The composition of this manual is shown in Figure 1-1.

If you are not experienced in handling this type of equipment, please read this manual from the beginning.

If you are accustomed to handling digital voltmeters, read through the explanation on the panel controls in Section 1.3 "EXPLANATION OF PANELS", and 4. "MEASURING METHOD", and you will understand how to operate this equipment.

Please read "Plug-in Assembly Installation" in Chapter 2, and "Method of Operating Plug-in Accessories" in Chapters 5, 6, and 7 when using plug-in accessories.

Please read "Before requesting repair" and "Error Messages" in Chapter 19 when trouble occurs with this multimeter.

If the error cannot be removed, please contact our CE department or nearest service office.

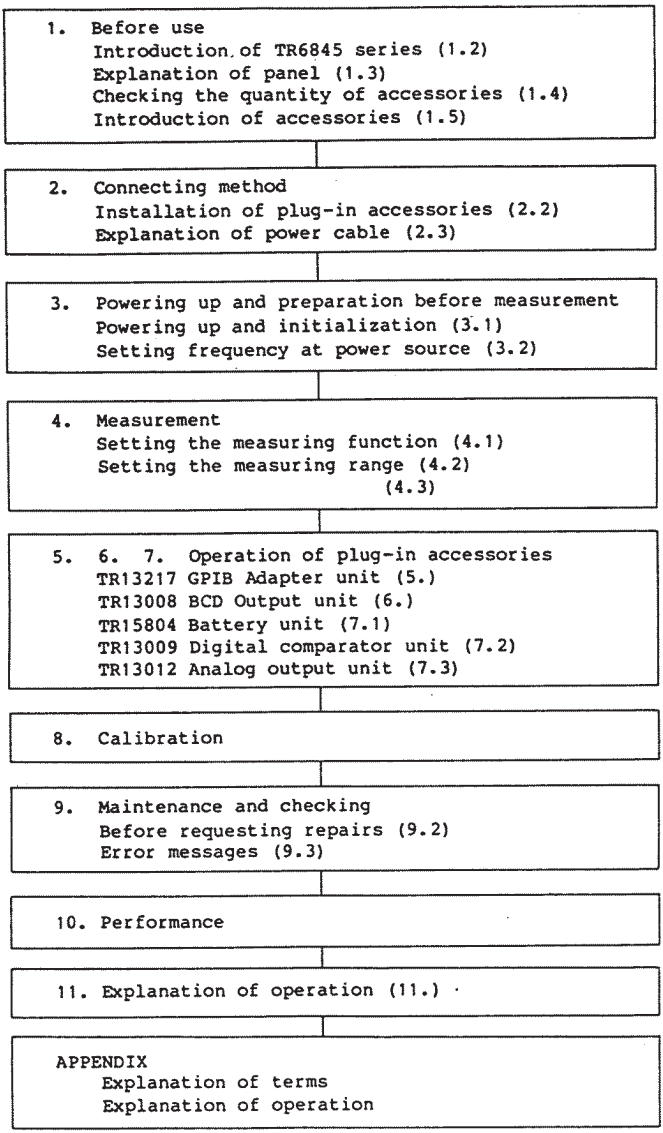


Figure 1-1 Configuration of This Manual

1.2 GENERAL DESCRIPTION

The model TR6845 series digital multimeter is a high performance measuring instrument developed by fully utilizing multi-function measurement technology, Advantest's unique A/D conversion technology, microprocessor technology, and high stability thin film making technology. Though designed as 4 1/2 digit indication a portable unit, this equipment permits full remote control through the use of the plug-in accessory.

DC voltage/current, AC voltage/current and resistance measurement function, low power resistance measurement function permitting measurement of in-circuit resistance, and continuity test function by electronic buzzer are the standard functions of this equipment. The TR6846 and 6847 are capable of measuring temperatures of -50 to 1370°C with resolution of 0.1, by using the accessory K(CA) type thermocouple. The TR6846 and 6847 also have a high speed auto range setting function, permitting high speed sampling of 5 cycles/sec, 15 cycles/sec and 100 cycles/sec for required measuring accuracy.

The maximum resolution of this equipment is 1 μV for DC voltage measurement, 1 mΩ for resistance measurement, and 10 nA (100 pA for TR6848) for DC/AC current measurement.

In AC voltage/current measurement, TR6845 and 6847 adopt the true rms measurement system, while TR6846 and 6848 adopt mean value measurement and the root mean square (rms) indication system. In addition to these, the null computing function permitting offset compensation and relative value measurement, comparator function permitting comparison between measured data and any preset value, and memory function which retains the panel setting data even when the power is turned off, are provided as standard functions.

Owing to the low power consumption design, this equipment features less generation of internal heat, hence less influence on measuring accuracy. It can be operated for a long time on the accessory battery.

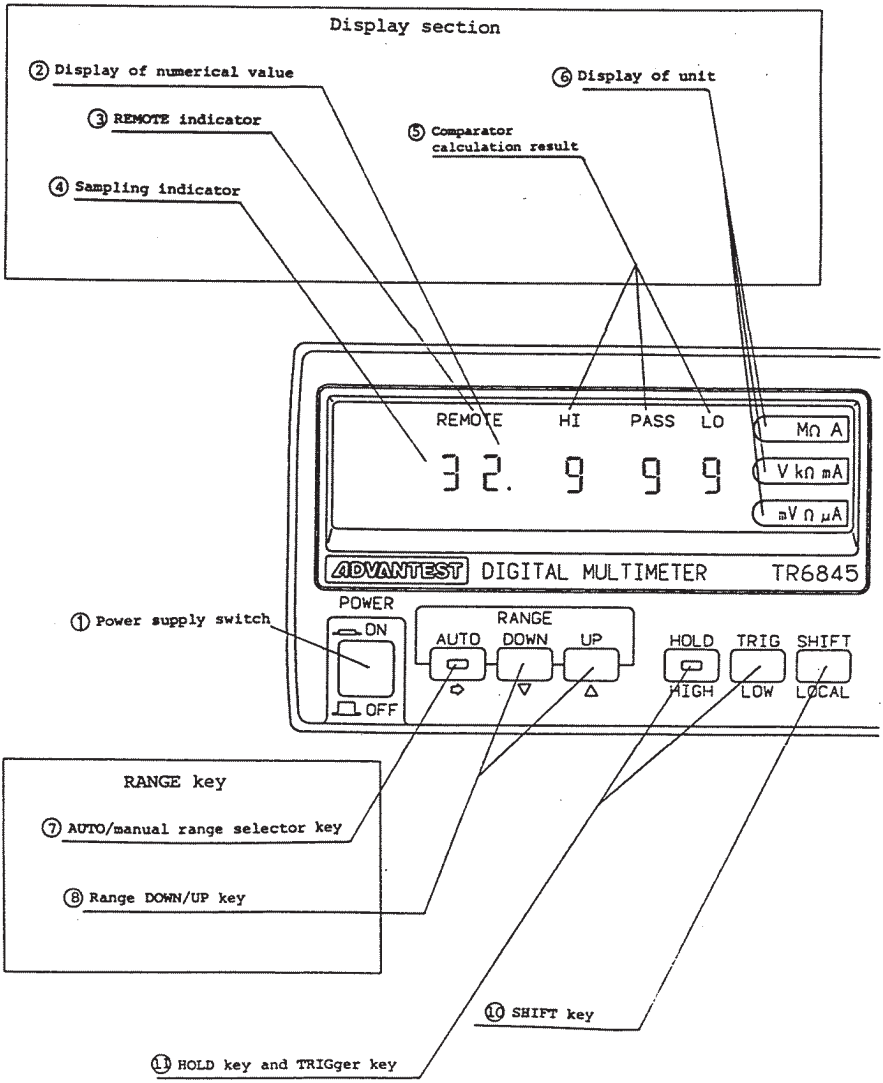
The power cable connector is provided with a shutter so as to prevent accidental contact with the connector when using the battery.

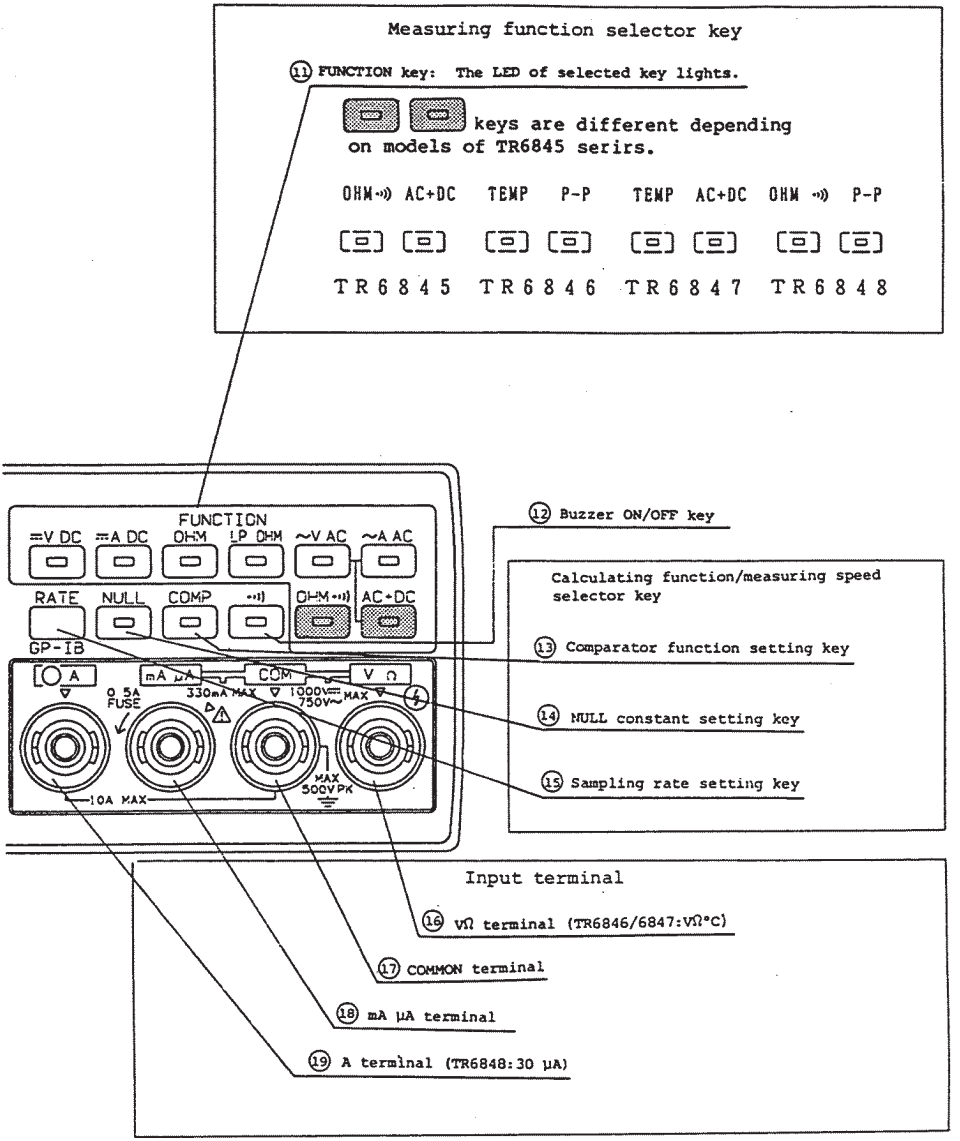
CAUTION

The TR6845 Series Digital Multimeter operates at temperatures from 0°C to 50°C and at moisture of less than 85%. The multimeter is used out of direct sunlight. Do not expose this multimeter to vibration and mechanical shock.

1.3 EXPLANATION OF PANELS

(1) Front Panel




Measuring function selector key
(11) FUNCTION key: The LED of selected key lights.
keys are different depending on models of TR6845 serirs.
OHM •)) AC+DC TEMP P-P TEMP AC+DC OHM •)) P-P
TR6845 TR6846 TR6847 TR6848
FUNCTION
=V DC =A DC OHM LP OHM ~V AC ~A AC
RATE NULL COMP •)) OHM •)) AC+DC
GP-IB
A mA µA COM V Ω
0.5A FUSE
330mA MAX
1000V= MAX
750V~
10A MAX
MAX 500V PK
(12) Buzzer ON/OFF key
Calculating function/measuring speed selector key
(13) Comparator function setting key
(14) NULL constant setting key
(15) Sampling rate setting key
Input terminal
(16) VΩ terminal (TR6846/6847:VΩ°C)
(17) COMMON terminal
(18) mA µA terminal
(19) A terminal (TR6848:30 µA)

(2) Explanation of Front Panel

① Power supply switch	Turns the power supply of this instrument on (⎓) or off (⏻).
② Display of numerical value	Displays 4-1/2 digits. For the polarity, displays "-" for minus only. The max. display is ±32999.
③ REMOTE indicator	Indicator lights during remote operation.
④ Sampling indicator	Indicator lights during measurement.
⑤ Comparator calculation result	HI : Lights when the measured value > upper limit setting value. PASS: Lights when upper limit setting value ≧ measured value ≧ lower limit setting value. LO : Lights when measured value < lower limit setting value.
⑥ Display of unit	The setting unit is shown by means of indicator "o". The unit symbols on the highest stage differ according to each device type in the TR6845 series. TR6845 : MΩ A TR6846/6847: °C MΩ A TR6848 : MΩ
⑦ AUTO/manual range selector key AUTO [▭]	Changes the range setting to AUTO or MANUAL. For AUTO range, the LED lights (See Section 4.2.)
⑧ Range DOWN/UP key DOWN [▭] UP [▭]	Increases or decreases the measuring range by one step. When the range is changed over, the mode automatically, becomes MANUAL.
⑨ HOLD key and TRIGger key HOLD [▭] TRIG [▭]	When HOLD [▭] is pressed, the measurement stops, and the display remains stationary. For the HOLD mode, the LED lights. In this case, when TRIGger [▭] is pressed, the measurement is executed only once. To cancel the HOLD mode, press HOLD [▭] once again.

⑩ SHIFT key

SHIFT + ┌┐

In the SHIFT mode

When the SHIFT mode is set, [_ _ _ _] is displayed.
When SHIFT is pressed once again, the mode returns to the set measurement mode.

- HIGH key (HIGH)
  When a comparator function is set, the upper limit value mode is set. (See Item 4.4.3, (2).)
- LOW key (LOW)
  When a comparator function is set, the lower limit value mode is set.
- LINE F key (LINE F) [TR6846/6847 only]
  The power supply frequency mode is set. (See Section 3.2.)
- GPIB key (GPIB)
  When GPIB unit is used, ON, OFF mode of GPIB, address, and header is set. (See Item 5.2.3.)

In the remote operation mode (When GPIB unit is used)

- LOCAL key (LOCAL)
  When LOCAL is pressed, the control from the outside is interrupted and input through the panel becomes possible.
  When the mode which is not displayed by the DSO command is set, if returning to LOCAL, the display comes ON. (See Figure 5-8.)

⑪ FUNCTION key

Select suitable key according to the measuring object and usage.

VDC — Select when measuring the DC voltage.

ADC — Select when measuring the DC current.

OHM — Select when measuring resistance.

LP OHM — Select when measuring the low power resistance.

~VAC — Select when measuring the AC voltage.

~AAC — Select when measuring the AC voltage.

OHM→)) — Selects the continuity test. (When there is a continuity, the buzzer sound is given.)

TEMP
[⊟]

Selects the measurement of temperature.

AC+DC
[⊟]

By pressing VAC [⊟] and AC+DC [⊟], the AC voltage measurement is selected by means of DC coupling.
By pressing AAC [⊟] and AC+DC [⊟], the AC current measurement is selected by means of DC coupling.

P-P
[⊟]

Selects the peak values measurement of the sine wave (When VAC or AAC is selected).

⑫ Buzzer ON/OFF key

[⊟]

When the key is input, the LED lights and the buzzer sounds.
For TR6846/6847, if this key is pressed in resistance measuring mode, it is set for the continuity test.

⑬ Comparator function setting key

COMP
[⊟]

The comparator is turned on, the HI, PASS, and LO indicators light. (See Item 4.4.3-(1).)

⑭ NULL constant setting key

NULL
[⊟]

When this key is pressed, if the measured value is set to zero, the display is performed after the measured value operation. Depress for one second or more. (See Item 4.4.3-(2).)

⑮ Sampling rate setting key

RATE
[⊟]

Each time this key is pressed, the sampling rate is set as follows:

FAST → MID → SLOW →

For the FAST setting of the TR6846/6847, 3 1/2 digits are displayed.
(See Item 4.4.1.)

- Input terminal (See Section 4.2.)

⑯ [VΩ] terminal

[For TR6846/6847]

[VΩ°C]

This is the input terminal on the HI side for measuring resistance, AC voltage, and DC voltage.

This terminal is also used as an input terminal on the + side to measure temperature.

⑰ [COM] terminal

This terminal is common to all functions.
For the TR6846/6847, this terminal is also used as an input terminal on the - side to measure temperature.

⑱ [mAμA] terminal

This is an input terminal on the HI side up to 300 mA.

⑲ [A] terminal

[For TR6848]

[3 / 30 μA]

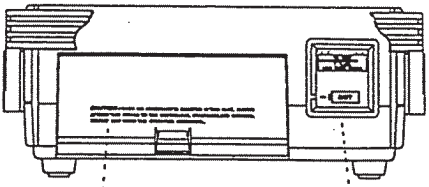
This is an input terminal on the HI side of the 3000 mA and 3A range. When this range is selected in AUTO range mode, the LED lights.

LED lights ⇨ [o A]

This is an input terminal on the HI side of ranges of 3 μA and 30 μA. When these ranges are selected in AUTO range mode, the LED lights.

LED lights ⇨ [o 3/30 μA]

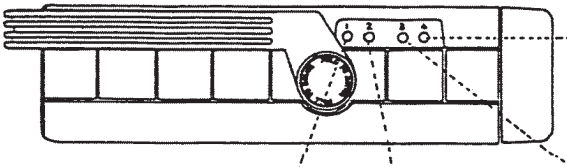
(3) Rear Panel



Accessory cover
Remove this cover when inserting a plug-in accessory. Never allow anything except the specialized accessory to get inside. Insertion of foreign matter may lead to unstable measurement, or damage to the internal circuit.

Power cable connector
The connector for AC power cable. A safety shutter is provided. Lower the shutter when connecting the power cable.

(4) Left Side Panel



HFFS
High frequency full scale calibration potentiometer for AC voltage measurement.
Range: 3 V
Frequency: 70 KHz

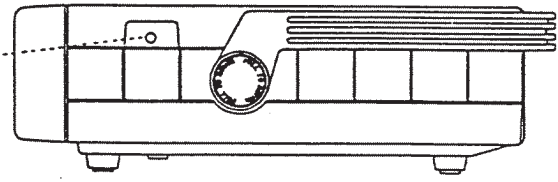
1/10FS
Zero point calibration potentiometer for AC voltage measuring absolute value amplifier
Function: AC + DC
Range: 3 V
Input value: DC ±0.3 V
Cable of adjusting the polarity of 1/10 full scale irrespective of the absolute value.

±FS
Full scale polarity adjusting potentiometer for AC voltage measurement
Function: AC + DC
Range: 3 V
Input value: DC ±3 V
Capable of adjusting the polarity of ±full scale irrespective of the absolute value.

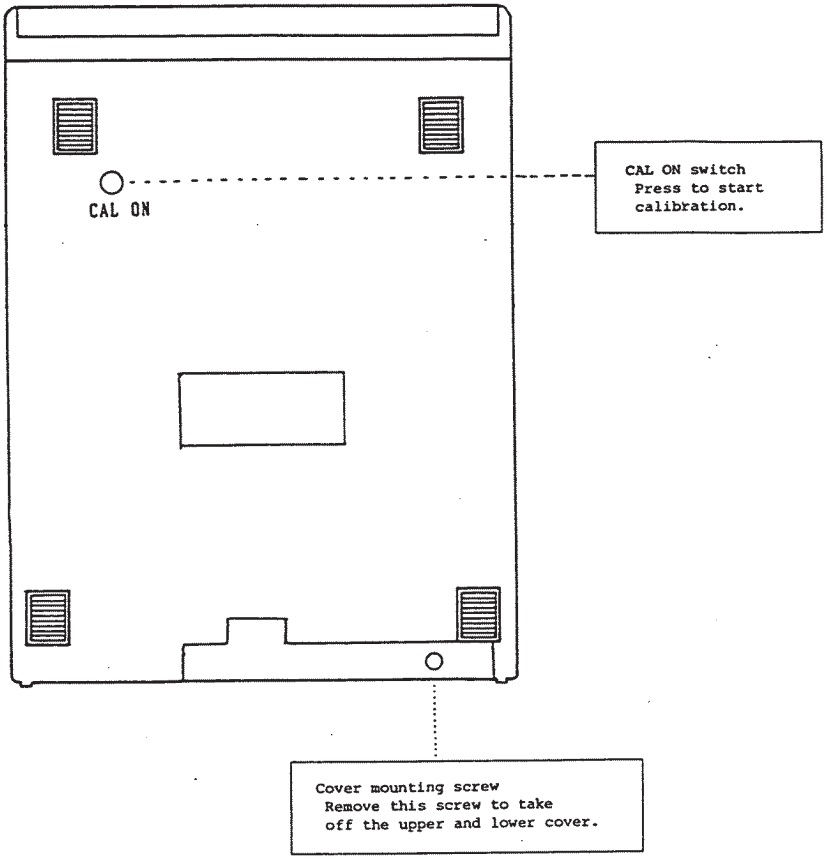
RAZ
Ranging amplifier zero point adjusting potentiometer for AC voltage measurement
Range: 300 mV

(5) Right-hand Side Panel

Input terminal section temperature calibration potentiometer.
With thermocouple connected and 0°C temperature measured, this potentiometer should be adjusted so that the 0.0°C can be displayed.



(6) Bottom Panel



1.4 CHECKING ACCESSORIES

Check names and quality of accessories of TR6845 series in Table 1-1 and Figure 1-2. Check TR6845 for damage caused during transportation. Please contact the nearest dealer or the sales and support offices if there are missing parts or damage. Addresses and telephone numbers are given below. See Section 9.2 before requesting repair.

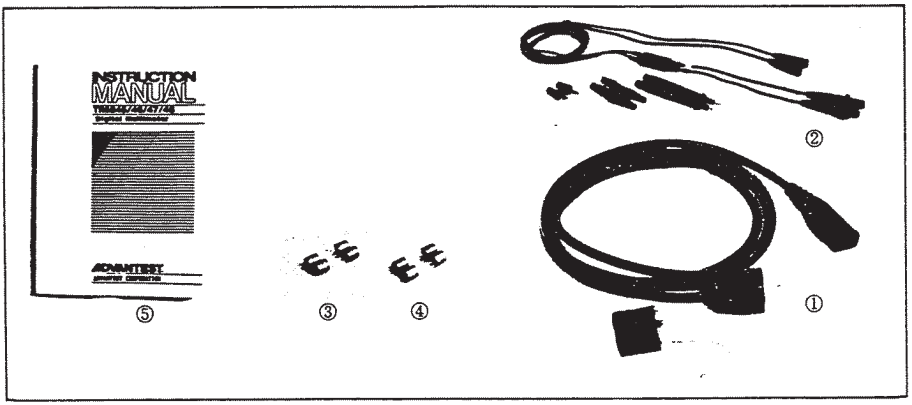


Figure 1-2 Standard Accessories of TR6845 Series

Table 1-1 Standard Accessories of TR6845 Series

Description	Specification	Stock No.	Q'ty	Remarks
① Power cable	A01402	DCB-DD2428x01	1	With 2-pin adapter
② Input cable	A01001	AAA-A01001	1	With case
③ Line fuse	EAWK0.16A	DFT-AAR16A	2	AC100/120V
	EAWK0.08A	DFT-AAR08A		AC220/240V
④ mA, μA terminal protection fuse	MF51NR0.5(250)	DFN-AAR5A	2	
⑤ Instruction manual	-	J6845	1	Japanese
	-	E6845		English

1.5 ACCESSORIES

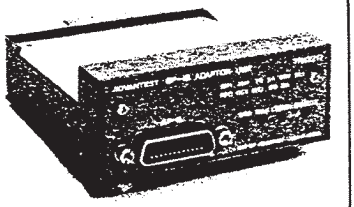
This equipment has a number of accessories which permit various measurements to be performed. Using the full remote control function by the plug-in accessory GPIB adapter unit TR13217 or BCD output unit TR13008, this equipment can be employed as a system digital multimeter in an automated measuring system. The battery unit permits this equipment to be used out-doors. Table 1-2 shows the plug-in and general-purpose accessories of this equipment.

Table 1-2 Accessories of TR6845 Series

TR13217 GPIB adapter unit

A plug-in type GPIB interface conforming to IEEE488-1978 requirements. The external controller permits full remote control of the TR6845 series.

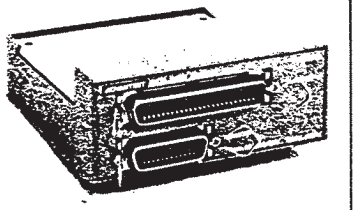
For details, see Chapter 5.



TR13008 BCD output unit

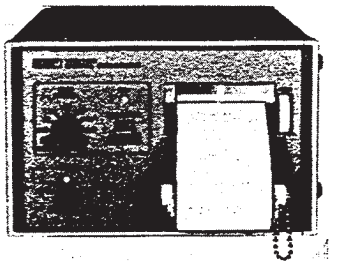
This unit outputs measured values in BCD parallel code. With this unit, the functions and ranges of the TR6845 series can be remote controlled.

For details, see Chapter 6.



TR6198 Digital recorder

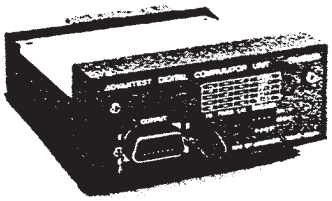
When connected to the BCD output unit TR13008, this unit records data automatically. This unit has a built-in timer.



TR13009 Digital comparator unit

This unit compares the measured value with the preset upper limit value and lower limit value, and distinguishes it at three levels of HI, PASS, and LO, then outputs the results to the relay contact or open collector. It can also generate an alarm sound by the built-in buzzer.

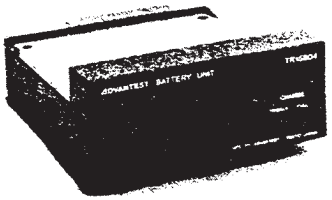
For details, see Section 7.2.



TR15804 Battery unit

A plug-in type battery permitting the equipment to be used for about four hours.

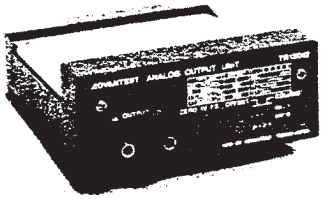
For details, see Section 7.1.



TR13012 Analog output unit

This unit outputs any three digits of the measured value (displayed value) after converting into analog value.

For details, see Section 7.3.



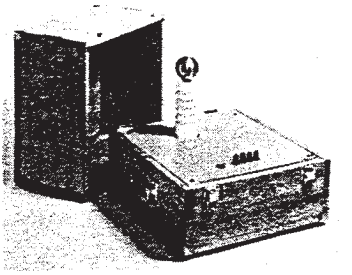
TR1116 DC high voltage probe

This is a high voltage probe with a voltage dividing ratio of 1:1000.

Input resistance: 1000 MΩ
Maximum measurable voltage:
DC 24 kV, continuous
DC 36 kV (30 sec)
Measuring accuracy: 5% of rdg ±1 digits
(Error of measuring instrument is not included.)

TR1321D/1321E High voltage potential divider

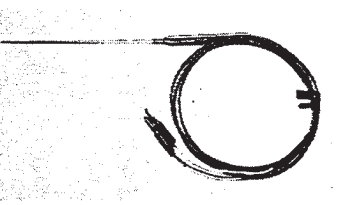
This unit permits high precision dividing of max. 40 kV to 1/1000 or 1/100.



TR1101-130, TR1102-130 Sheathed type thermocouple

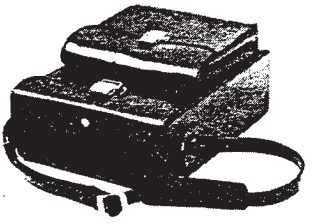
A K(CA) type temperature sensor to be connected to the TR6846/6847 for temperature measurement.
The TR1102-103 requires the terminal adapter TR1111.

Maximum measurable temperature: 600°C
Class: JIS 0.75 class
Tolerance: 2.5°C, or ±0.75% of measured temperature



TR1640 Carrying case

This case is convenient in outdoor measurement, since input cable or other small accessories can be held in it.



MEMO

2. CONNECTING METHOD

This chapter describes how to install the plug-in accessory, and how to connect the power cable to this multimeter.

Be sure to check that the power is off before connecting the plug-in accessory and power cable to this multimeter.

2.1 HANDLE

The handle of the TR6845 series can be used as a grip for transportation, and also used as a support to tilt the equipment on a table for ease when looking at the panel face. As shown in Figure 2-1, the handle can be locked in steps of 22.5°. To unlock, expand the handle right and left by holding the parts near the root of it.

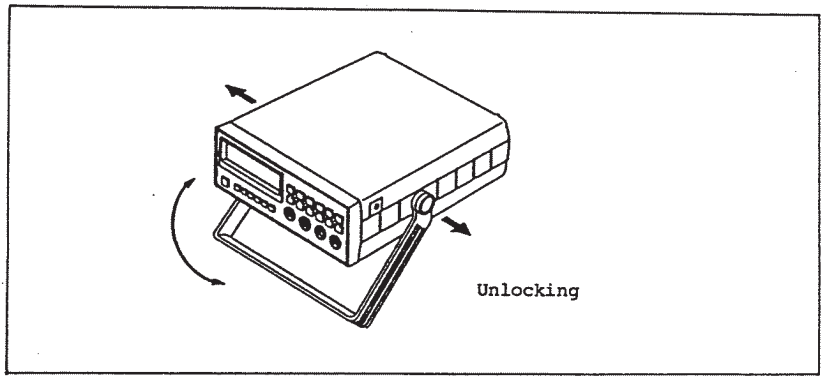


Figure 2-1 Locking and Unlocking the Handle

2.2 INSTALLATION AND REMOVAL OF PLUG-IN ACCESSORIES

When attaching a plug-in accessory of the TR6845 series, remove the accessory cover from the rear side of the equipment.

① Pull out the accessory cover while holding its claw.

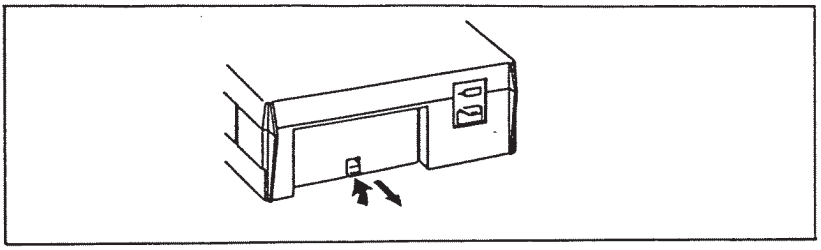


Figure 2-2 Removing the Accessory Cover

② Push the plug-in accessory into the multimeter.

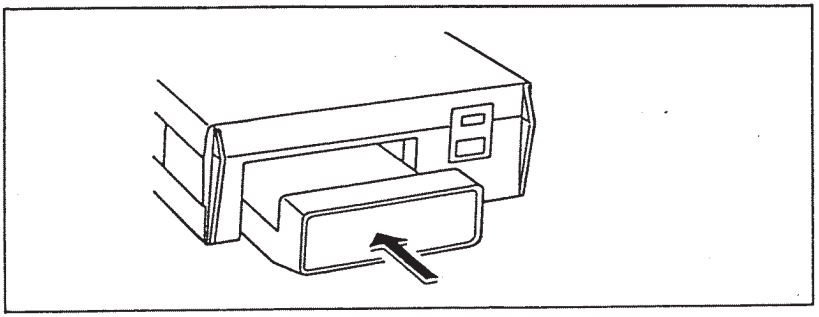


Figure 2-3 Installing the Plug-in Accessory

③ To detach the accessory, push up the square projection on the bottom of the accessory for unlocking, and draw out the accessory.

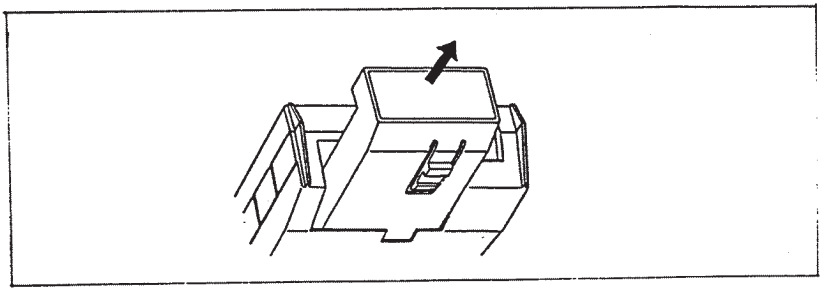


Figure 2-4 Removing the Plug-in Accessory

CAUTION

Careless insertion of foreign matter into the body of the equipment can damage the circuitry. Whenever removing the accessory, be sure to attach the accessory cover. When measuring high voltages, never attempt to touch any parts inside the cover.

Be sure to check that the power switch is off before installing and removing plug-in accessories.

2.3 POWER CABLE

When using this equipment on a commercial power line, be sure to ground the equipment so as to prevent electric shocks. Connect the accessory power cable convex side of attached power cable to an AC line receptacle. The power cable has three pins, of which the center round pin is for earthing.

When using a 2-pin adapter, connect the earth wire of the adapter directly to the ground. The pins of the accessory adapter A09034 (KPR-18) are different in width, as shown in Figure 2-5. When plugging into a receptacle, make sure the pins are positioned correctly. Contact of earth lead to a power supply terminal or AC line can cause serious damage to the equipment. Pay special attention to prevent accidental contact of the earth lead when it is close to other plugs.

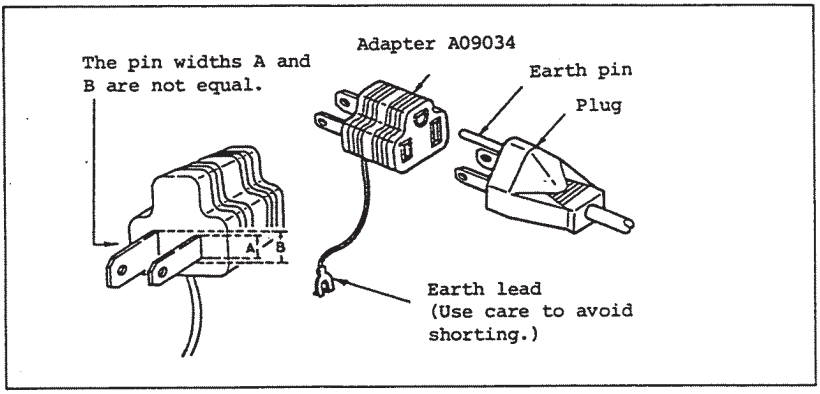


Figure 2-5 Power Cable

CAUTION

Be sure to use the attached power cable when this multimeter is operated at an AC power source. 100 VAC±10% and 50/60 Hz (115 VAC, 120 V, 220 V±10%, 230 V+8%, -10%, 240 V+4%, and -10% are available) are used for the multimeter.

Be sure to check that the power switch is off when connecting the power cable.

2.4 INPUT CABLE

The attached input cable (A01001) has a shield at the Hi side to provide stable measurement.

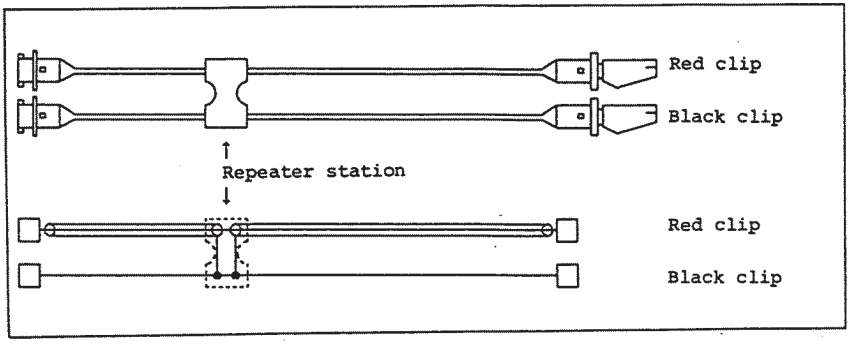


Figure 2-6 Input Cable

MEMO

3. TURNING ON THE POWER AND PREPARATION FOR MEASUREMENT

This chapter describes messages displayed when the power is turned on and the multimeter is started.

This chapter also describes the setting method of frequency for power source of TR6846/6847.

3.1 TURNING ON THE POWER AND INITIALIZATION

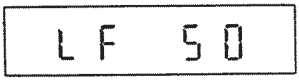
When the POWER switch is turned ON, the entire display surface is turned on for about 0.2 sec, then the following messages appear one after another.

1st message (Example) (Approx. 0.4 sec):

Indicates the model name of TR6845 series.

2nd message (Approx. 0.4 sec):

TR6846/6847 only



or

Indicates that the line frequency is 50 Hz or 60 Hz. The frequency setting of the equipment must agree with this indication.
TR6845/6848 does not need frequency setting, and this message is not displayed.

3rd message (Example) (Approx. 0.2 sec):

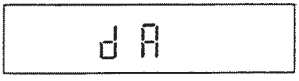
Indicates the program revision number of the internal software of this equipment. This example shows REVISION 1.

4th message (Approx. 0.4 sec): Indicates the accessory if mounted. This is omitted if battery unit or no accessory is mounted.

Indicates that GPIB adapter unit is mounted.

Indicates that BCD output unit is mounted.

Indicates that Digital comparator unit is mounted.



Indicates that Analog output unit is mounted.

After displaying the above messages, the display section is turned to the measured data display mode.

Parameter initialization

Setting of NULL function, Comparator and other measuring parameters are retained by the built-in battery even after the power is turned off.

These parameters can be initialized by pressing the $\overset{-AAC}{[\equiv]}$ while turning on the power.

3.2 PREPARATION BEFORE MEASUREMENT

(1) Line Frequency Setting [TR6846 and 6847 Only]

TR6846 and 6847: Change the line frequency setting of the equipment. Setting can be done by operating the key. When using the battery unit TR15804, also adjust the frequency setting. This frequency setting is not necessary for the TR6845 and 6848 models.

Line frequency setting of TR6846 and 6847:

Step ① Set the POWER switch to ON.

Step ② Press SHIFT [ ], and press [ ] LINE F. The current setting will appear on the display, as shown in Figure 3-1. In this Figure, line frequency of 50 Hz is indicated.

Step ③ Press DOWN [ ] UP [ ]. This will change the display to "LF 50" and "LF 60", and the line frequency setting is changed to 50 Hz, and to 60 Hz.

Step ④ Press SHIFT [ ] again, and the measurement mode is recovered.

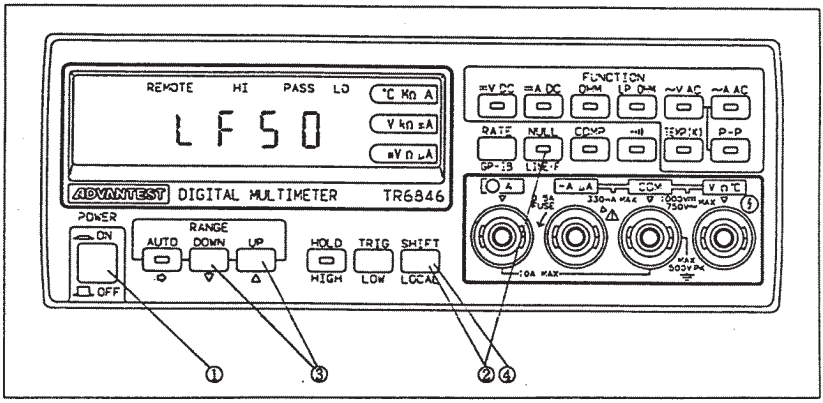


Figure 3-1 Setting the Line Frequency

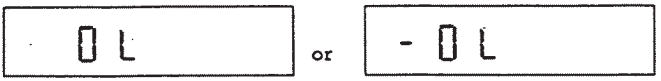
(2) Warming Up

Be sure to warm up the equipment for more than 30 minutes to assure high measuring accuracy.

3.3 VARIOUS MESSAGES

This equipment displays the following messages to indicate the occurrence of abnormal conditions during operation.

(1) Over range
The full scale value of this equipment is "32999" except the 1000 V range in DC/AC voltage measurement, 750 V range in AC voltage measurement, 10 A range in DC/AC current measurement and temperature measurement. If any input is applied in excess of this scale value in manual range setting, the following message appears to warn excessive input.



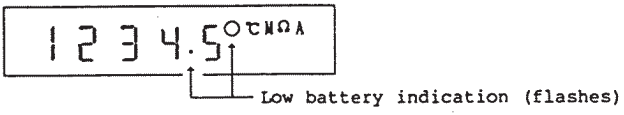
OVER LOAD (>32999) is meant. OVER LOAD (< -32999) is meant.

If this message appears, use a higher measuring range. This message may also appear when the input terminal is opened momentarily in changing the range or in resistance measurement.

(2) Overload
Buzzer activates to alarm the overload, if the input excess the defined value indicated below in the highest ranges of AC/DC voltage and current measurement.

Measurement	Range	Alarm buzzer level
AC/DC Current	10 A	10.000
DC Voltage	1000 V	1000.0
AC Voltage	750 V	750.0

(3) Low battery
If the battery voltage or AC voltage drops below the specified driving voltage level, the unit indicating LED and decimal point indicating LED begin to flash, indicating excessively low source voltage.



4. MEASURING METHOD

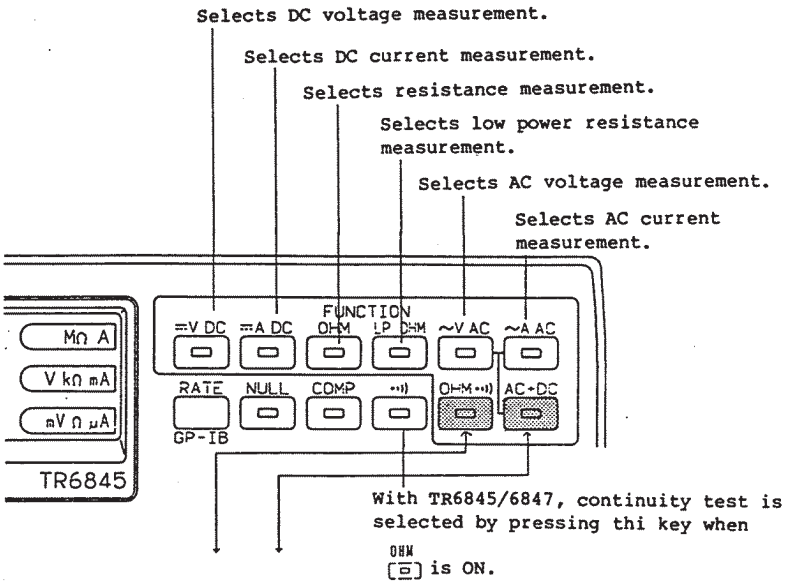
This chapter describes the actual measuring method such as current, voltage, and resistance measurements.

This chapter describes measuring function, measuring range, and basic operation method of various tests.

The chapter also describes the setting method of null and comparator arithmetic features, which can make the best use of features of the multimeter.

4.1 SELECTION OF MEASURING FUNCTIONS

The measuring functions can be selected by means of the following keys:



Case of TR6845	OHM •)) AC+DC	OHM •)) : Selects continuity test.
Case of TR6846	TEMP P-P	P-P : Selects sine wave peak-to-peak value measurement. (When VAC or AAC is selected.)
Case of TR6847	TEMP AC+DC	TEMP : Selects temperature measurement.
Case of TR6848	OHM •)) P-P	AC+DC : Selects AC voltage measurement by DC coupling if VAC AC+DC are pressed. Selects AC current measurement by DC coupling if AAC AC+DC are pressed.

4.2 SELECTION OF MEASURING RANGE

Table 4-1 lists the measuring ranges of each measuring function.

Table 4-1 Measuring Ranges of Each Measuring Function

Function	DC voltage	AC voltage AC and AC+DC	Resistance		DC current		AC current	
			OHM	L.P.OHM				
Range	30 mV		30 Ω		3 μA			
	300 mV	300 mV	300 Ω	300 Ω	30 μA	TR6848		
	3000 mV	3000 mV	3000 Ω	3000 Ω	300 μA		300 μA	TR6848
	30 V	30 V	30 kΩ	30 kΩ	3000 μA	TR6845	3000 μA	
	300 V	300 V	300 kΩ	300 kΩ	30 mA	TR6846	30 mA	
	1000 V	750 V	3000 kΩ	3000 kΩ	300 mA	TR6847	300 mA	TR6845
			30 MΩ	30 MΩ	3000 mA		3000 mA	TR6846
			300 MΩ		10 A		10 A	TR6847

(1) Manual Range Mode
The measuring range manual setting mode is attained by turning OFF the AUTO key (LED goes out), or by setting a lower/upper range by pressing the UP DOWN keys.
Work the UP DOWN buttons and the input terminal to set the measuring range.

(2) AUTO range mode:
Turn on the AUTO switch (the LED lights up) to enter the automatic setting mode.
With the equipment set in AUTO mode, it is changed to the next higher range if the reading exceeds the range 32999, or to the next lower range if the reading is less than 2999. In this way, the optimum range for the present reading is set automatically. The TR6846/6847 displays 3-1/2 digits in the FAST sampling mode, and uprange occurs when the reading exceeds 3299, and downrange occurs when the reading is below 299.

In the current measuring AUTO range mode, automatic range changeover is performed among the ranges selected by the input terminal as shown in Table 4-2. Take TR6845 as an example. When the measured value exceeds the upper limit 329.99 mA of the 300 mA range, the overload message appears; changeover to 3000 mA range does not occur.

To shift to 3000 mA range, press UP .

The LED on the INPUT TERMINAL A lights and AUTO range is changed ranging from 3000 mA to 10 A. Change the input to the INPUT TERMINAL A.

Similarly, to lower the range from 3000 mA to 300 µA to 300 mA, press DOWN ▢ .

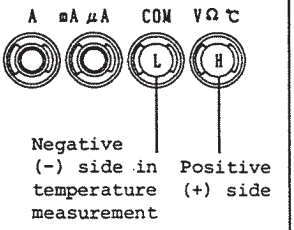
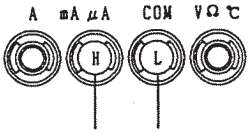
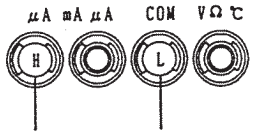
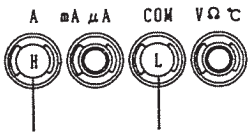
The same procedure is necessary for TR6848 between the range of 30 µAand 300 µA. Press the UP and DOWN keys to specify the range and to change the input terminal.

Table 4-2 The Ranges of the AUTO Range Selection Function in AAC and ADC Measurement

Range		Selection of INPUT TERMINAL and range to be selected by the AUTO range function. (Arrow)	
ADC	AAC	TR6845/46/47	TR6848
3 µA 30 µA			LED on ⇨ ○ µA 
300 µA 3000 µA 30 mA 300 mA		mA µA 	mA µA 
3000 mA 10 A		LED on ⇨○A 	

Table 4-3 shows the maximum input level and connection of input cable in each measuring function and range.

Table 4-3 Maximum Input Level and Connection of Input Cable in Each Measuring Function and Range

Measuring function	Range	Max. input level	Connection of input cable H: Connect HI (red) side L: Connect LO (black) side
DC voltage	30 mV, 300 mV, 3000 mV	400 V (Continuous) 1100 V (Within 10 sec) DC or AC peak	
	30 V, 300 V, 1000 V	1100 V (Continuous) DC or AC peak	
AC voltage	300 mV to 750 V	800 Vrms (Continuous) 1200 V peak	
Resistance measurement, low-power resistance measurement		DC 120 V (Continuous) AC 350 V peak	
Continuity test, low-power continuity test		350 V (Continuous) DC or AC peak	
Temperature	TR6846/6847 only	350 V (Continuous) DC or AC peak	
AC current DC current	300 μA to 300 mA	0.5 A (Protected by fuse) DC, AC rms	
	3 μA to 30 μA TR6848 only	10 mA DC or AC rms	
AC current	3 A, 10 A TR6845/6846/6847 only	20 A, 10 sec DC, AC rms	

* Note that 3 μA, 30 μA, 3 A, 10 A ranges are not protected by fuse.

4.3 EXAMPLE OF MEASUREMENT

This section explains actual operating procedure of this equipment by taking an actual measurement operation as an example. Assume that all the power supplies are turned on, and the equipment is ready for measurement.

4.3.1 Measurement of DC Voltage and Setting of Comparator

The electromotive force of a group of batteries is measured, and the comparator function is set within the range of upper limit 1.60 V and lower limit 1.45 V.

Step ① Press VDC [⎓] to select DC voltage measurement function. (LED lights.)

Step ② Press UP [△] or DOWN [▽] to set the measuring range to 3000 mV range.

Step ③ Connect the LO end of input cable to COM terminal, and HI end to VΩ°C terminal, as shown in Figure 4-1. The display of reading begins.

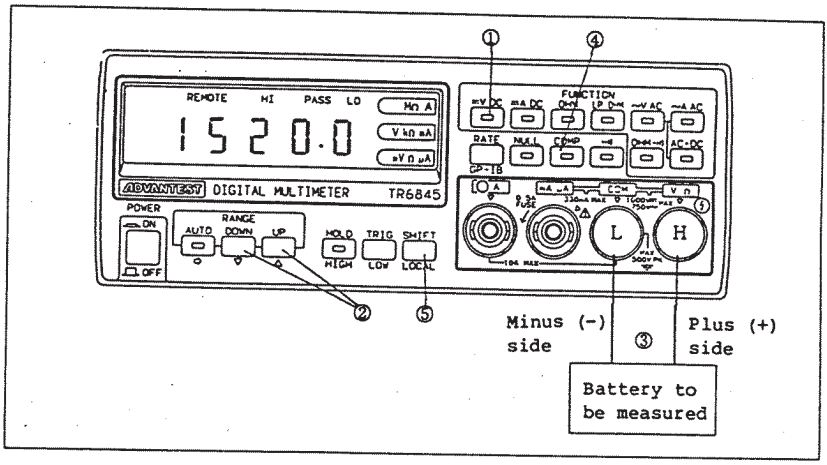
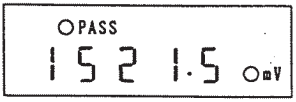


Figure 4-1 DC Voltage Measurement

Step ④ Set the comparator as follows:
Press SHIFT, and then press HIGH. The equipment is set in the upper limit setting mode.
Move the flashing digit by pressing AUTO, and change the value by pressing UP or DOWN until "1600.0 mV" is displayed.
Similarly set the equipment in the lower limit value by LOW AUTO (blinking digit is moved.) UP or DOWN, and adjust the display to "1450.0 mV". The unit that is being displayed when selecting the comparator function is selected.

Step ⑤ Press SHIFT to return to the measuring mode. Press COMP to start measurement. The HI, PASS, or LO indicator lights, corresponding to the reading.



4.3.2 AC Voltage Measurement

Step ① Press VAC to select the AC voltage measuring function. (LED lights.)

Step ② Connect the LO end of input cable to COM terminal, and the HI end to VΩ°C terminal, as shown in Figure 4-2. Display of the reading begins.

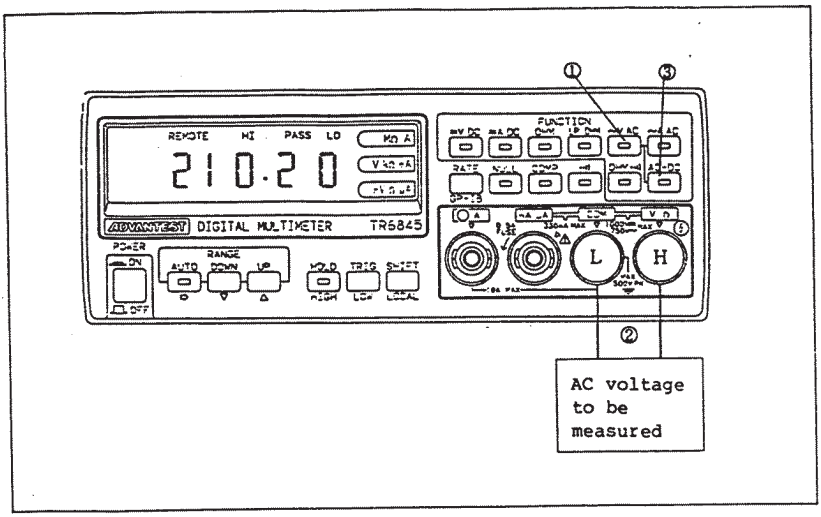
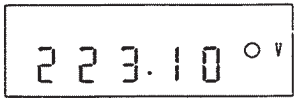


Figure 4-2 Measurement of AC Voltage

Step ③ TR6845/6847 can measure both totals of direct and alternating current when direct current is superimposed on alternating current.
Press AC+DC [⊡] to select the AC voltage (AC+DC) measurement function. (LED lights.)
If DC voltage overlaps the AC voltage to be measured, the measured value includes the DC voltage component.



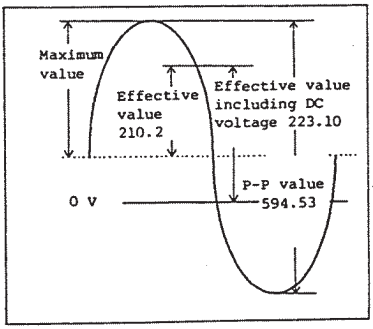
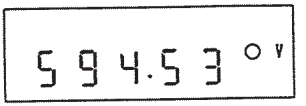


Figure 4-3 Sinusoidal Current Signal Waveform

Step ④ The TR6846/6848 has the sine wave peak-to-peak value (Figure 4-3) measuring key [P-P].

The peak-to-peak value can read directly by pressing this [P-P] key (the LED lights up), provided the signal to be measured is a sine wave.



4.3.3 Measurement of Resistance and NULL Setting

Step ① Press [OHM] to select the resistance measuring function. (LED lights.)

Step ② Connect the HI end of input cable to VΩ°C terminal, and LO end to COM terminal, as shown in Figure 4-4. Contact both cable clips for shorting.
An offset value including the cable conductor resistance is displayed as shown below.

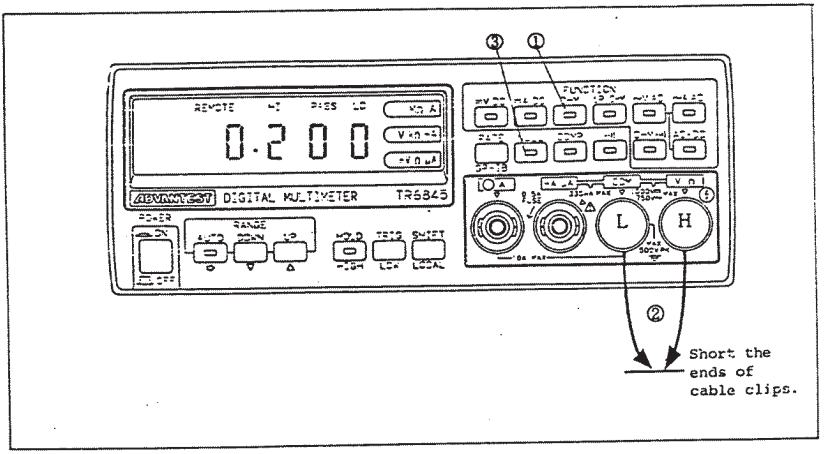


Figure 4-4 Measurement of Resistance and NULL Calculation

Step ③ Press the NULL [⊟] key to offset the displayed value 0.200 Ω (See 4.4.3-(1)). (The LED lights up) The display will be changed to "0.000".

Step ④ Connect the cable clip to the object to be measured. The offset value 0.200 Ω is subtracted from the reading, and the resultant value is displayed.

4.3.4 Low-power Resistance Measurement

Step ① Low-power resistance measurement function can be selected by the L.P.OHM [⊟] key. (The LED lights up)

In the circuit as shown in Figure 4-5, for example, it is possible to measure the resistance at a voltage level which does not turn the transistor into conduction.

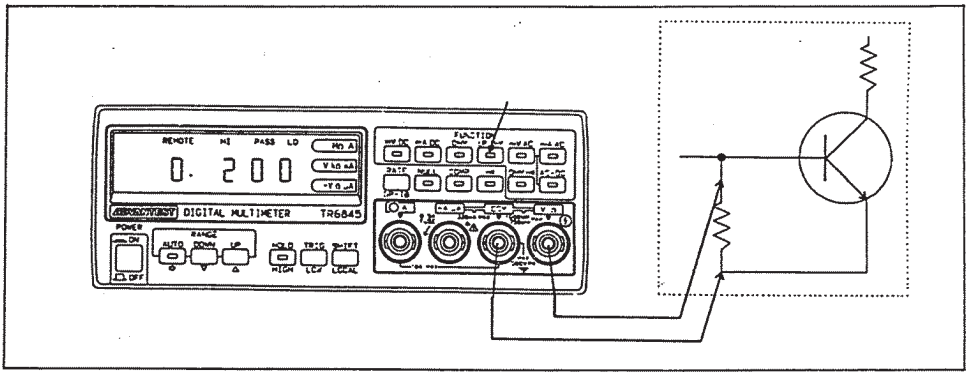


Figure 4-5 Low Power Resistance Measurement

4.3.5 Diode Test

A diode can be tested for normal operation by checking whether or not the voltage generated is within the allowable range when the specified amount of forward current is flowing through it, and by checking whether or not the reverse current flows.

The measuring current in each resistance measurement range of this equipment is as shown in Table 4-4.

Step ① Press OHM [⊟] to select the resistance measuring function. (The LED lights up)

Step ② Pass the current in the forward direction, and measure the forward voltage of the diode. The current flows from COM terminal to VΩ°C terminal. Therefore, as shown below (Figure 4-6), connect the COM side input cable to the anode of the diode, and the VΩ°C side input cable to the cathode.

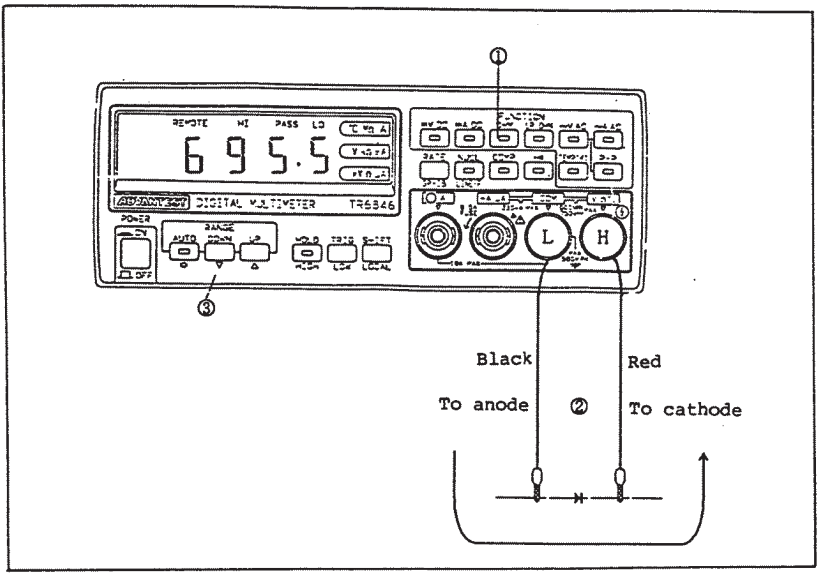


Figure 4-6 Diode Test

Step ③ Set the range by pressing AUTO [▭] or DOWN [▭] UP [▭] keys. Select the magnitude of measuring current from the values shown in Table 4-4.
In this example, the 3 kΩ range is set, and the measuring current of 1 mA is used.

Step ④ Record the measured result.
Assume that the display is 695.5 Ω. (Figure 4-6)
Since the displayed unit is ohm (Ω), this must be converted to mV value. This can be done by calculating as follows:

Forward voltage = measuring current (1 mA) x displayed resistance value 695.5 Ω = 695.5 mV.

Check whether the calculated forward voltage falls within the allowable range of the diode.

If you want to examine the diode characteristics more closely, change the measuring current, and measure the forward voltage for each current value. The current-voltage characteristic curve of the diode can be plotted, as shown in Table 4-4 and Figure 4-7.

Table 4-4 Example of Measurement of Forward Current and Forward Voltage of Diode in Various Measuring Ranges

Measuring range	Measuring current	Reading (Example)	Forward voltage
3 kΩ	1 mA	695.5 Ω	695.5 mV
30 kΩ	100 µA	59.42 kΩ	594.2 mV
300 kΩ	10 µA	508.1 kΩ	508.1 mV
3 MΩ	1 µA	3.925 MΩ	392.5 mV
30 MΩ	100 nA	1.944 MΩ	194.4 mV
300 MΩ	10 nA	0.995 MΩ	99.5 mV

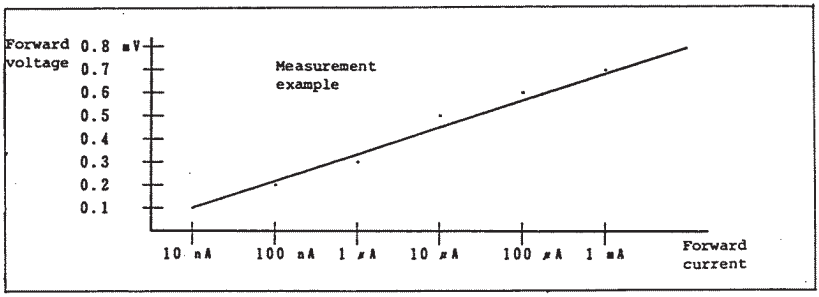


Figure 4-7 Forward Current and Forward Voltage of Diode

Step ⑤ Reverse the connection of input cable and diode, as shown in Figure 4-8. The diode can be judged as normal if over load is displayed and no flow of reverse current is confirmed.

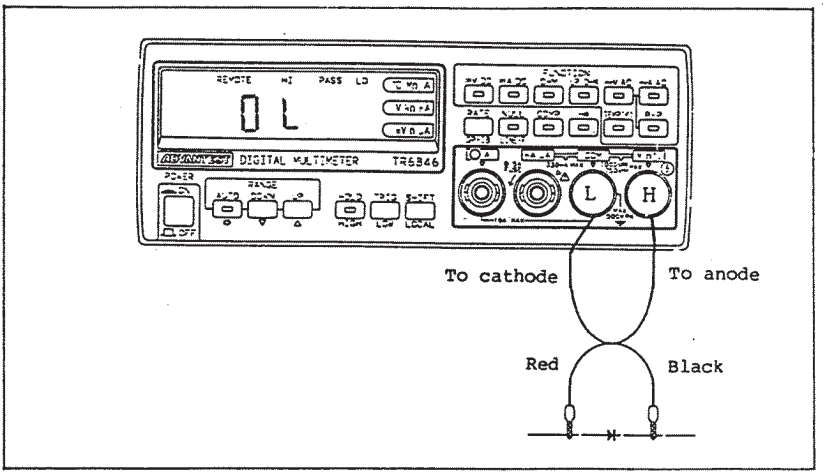


Figure 4-8 Measurement of Reverse Voltage of Diode

4.3.6 Continuity Test

TR6846/6847:
Conduct a continuity test by combining resistance measurement and buzzer function.
The continuity level is 1/10 the full scale value of each range.

Step ① Select the continuity test mode by pressing OHM or L.P.OHM. (The LED lights up)

Step ② Pressing . (The LED lights up)

Step ③ Connect the LO end of input cable to COM terminal, and the HI end to VΩ°C terminal, as shown in Figure 4-9. Detection of continuity is indicated by sounding of the buzzer.

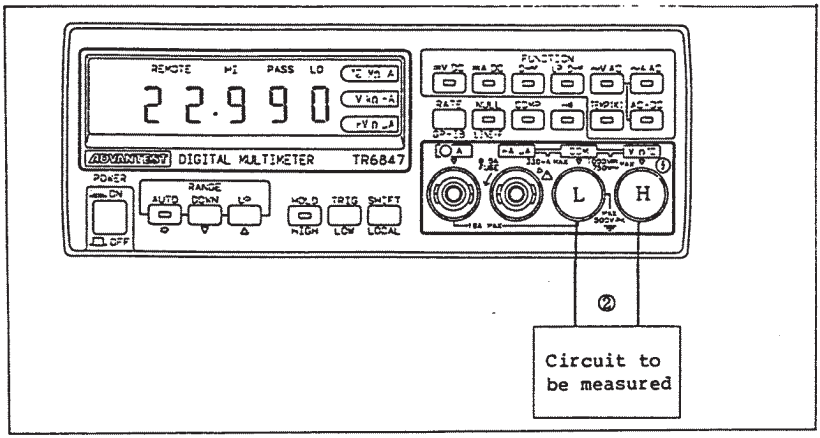


Figure 4-9 Continuity Test

Step ④ Press UP DOWN to select the measuring range, and set the continuity detection level as desired.

Table 4-5 Continuity Detection Level

Resistance measuring range	Continuity detection level (x 1/10)
300 Ω	Below 30 Ω
3 kΩ	Below 300 Ω
30 kΩ	Below 3 kΩ
300 kΩ	Below 30 kΩ
3 MΩ	Below 300 kΩ
30 MΩ	Below 3 MΩ
300 MΩ	Below 30 MΩ

TR6845/6848:
The continutity test mode is selecterd by OHM key. The buzzer sounds when the continuity resistance is below 3 Ω. Though 3-1/2 digits are displayed, the accuracy of measurement is not guaranteed.

- Select the continuity test.

  Press OHM·•)) [⊟] . (The LED light up.)

- Connect the Hi side of the input cable to the [VΩ] terminal.

4.3.7 Temperature Measurement [TR6846/6847 only]

The TR6846/6847 permits temperature measurement by using the type K(CA) thermocouple TR1101-130 and TR1102-130. When measuring with the TR1102-130, the special terminal adapter TR1111 must be used. (See Section 1.5.)

Step ① Press TEMP [⊟] to select the temperature measuring function. (The LED lights up)

Step ② Connect the minus (-) end of the special thermocouple to COM terminal, and the plus (+) end to VΩ°C terminal. Display of reading will begin.

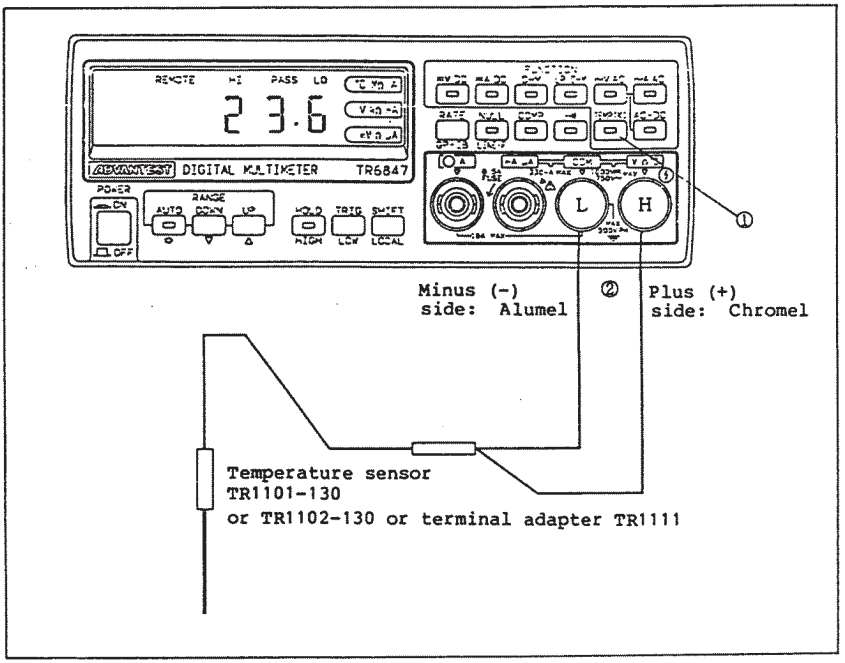


Figure 4-10 Temperature Measurement

4.4 HIGHER ACCURACY MEASUREMENT

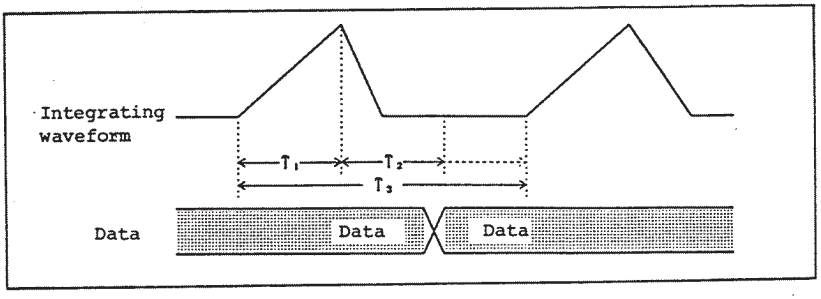
4.4.1 Sampling Control

The sampling rate is set as follows each time the RATE key is pressed. The TR6846/6847 displays 3-1/2 digits in FAST sampling.

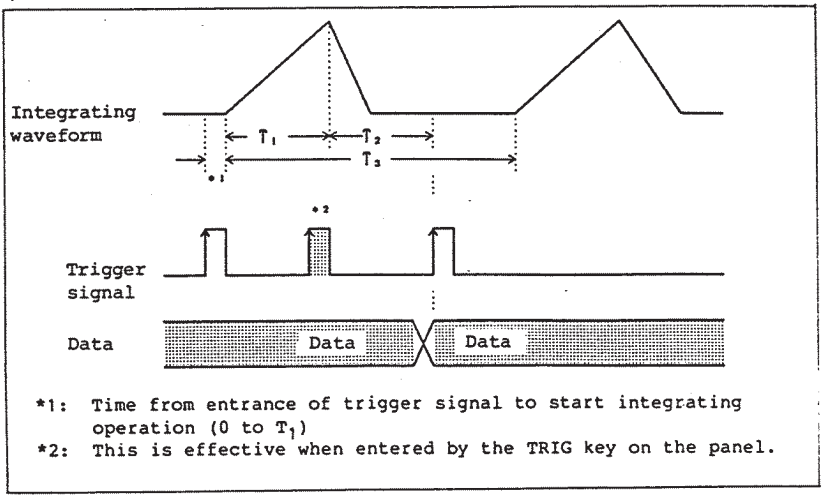
	FAST	MID	SLOW
TR6846/6847	100 cycles/sec (3-1/2 digit display)	15 cycles/sec	5 cycles/sec
TR6845/6848	5 cycles/sec	2.5 cycles/sec	1.25 cycles/sec

4.4.2 Timing of Measurement

(1) Free-running State



(2) Hold State



*1: Time from entrance of trigger signal to start integrating operation (0 to T_1)
*2: This is effective when entered by the TRIG key on the panel.

Table 4-6 Timing of Measurement

Sampling mode		Cycles /sec	Display digits	T_1		T_2	T_3
FREE RUN	FAST	100	3-1/2 digits	2 ms		2 ms to 8 ms	10 ms
	MIDDLE	15	4-1/2 digits	50 Hz	20 ms	10 ms to 20 ms	66.67 ms
				60 Hz	16.667 ms		
	SLOW	5		100 ms			200 ms
HOLD				Same as FREE RUN			

The following trigger signals are available:

(a) TRIG key on the panel
(b) External start signals A and B of BCD output unit
(c) Command "E" or "GET" of GRIP adapter unit
(d) External start signal (EXT. START) of TR13009 digital comparator unit

(3) During calibration that cycles every 30 sec., the time required from input of trigger signal to data display doubles at SLOW in sampling mode, and triples at MIDDLE and FAST.

4.4.3 Calculation

The TR6845 series is provided with the null calculation function permitting measurement in relative values and the comparator function permitting comparison between the reading obtained and preset data. The data needed for these secondary processings of the measured result are retained by the built-in battery even after the power is turned off.

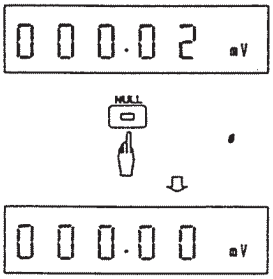
(1) NULL Calculation
The NULL calculating function, or digital offset function, may be used to compensate the resistance reading for the resistance of wire, or to perform relative measurement of voltage or current. This is a digital offset function with which a preset value is subtracted from the reading.

The measured value immediately after the NULL key is pressed can be set as the NULL constant. For example, if the NULL key is pressed, and the first value measured is "0.02 mV", this value is taken as the NULL constant. The display changes to "000.00 mV". In the subsequent measurements, the value obtained by subtracting 0.02 mV from the reading is displayed.

In the manual RANGE mode, the over range message("OL","-OL") for the NULL calculation is appeared when the reading is excessive, and also when the computed result is excessive. In case of AUTO RANGE mode the optimum range will be selected corresponding to the computed result.

CAUTION

NULL should be pressed for more than one second. This key is not operated when it is pressed momentarily, so as prevent malfunction.



(2) Comparator

With the comparator function selected, the upper limit and lower limit of a value are set, and the reading is compared with these limit values. If the reading exceeds the upper limit, the HI indicator lights. If the reading is less than the lower limit, the LOW indicator lights. If the reading is between the upper and lower limits, the PASS indicator lights, and at the same time the reading data is output to the external output terminal.

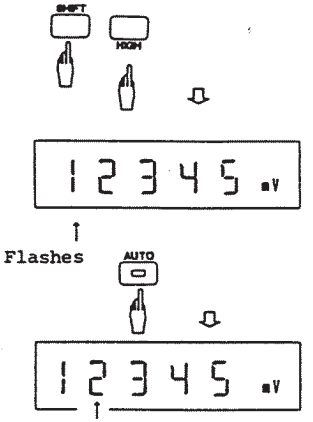
This function allows the setting of numerals for upper and lower limits in each range. Setting with units and setting beyond the manual range are not possible.

The comparator operation is performed after completion of the NULL calculation.

- Setting of upper limit "HIGH" and low limit "LOW"

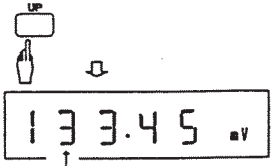
Perform as follows after setting the measuring function and range:

① Press the SHIFT key and HIGH key to set the upper limit value. You can set a value at the flashing digit position in the display. Press the AUTO key to shift the flashing digit to any desired position.



Flashing digit position changes.

Press the DOWN UP keys to change the value of the digit indicated by flashing.



Each time the key is pressed, the value of the flashing number increases.

Set the value for each digit.

② Similarly press the SHIFT LOW keys to set the equipment in the lower limit setting mode. (Set the value in the same way as ①)

③ Press the SHIFT key again to return to the measurement mode.

④ Press the COMP key to activate the comparator function, and any one or two of the HI, PASS and LO indicators lights.

4.5 INHIBITION OF UNNECESSARY FUNCTIONS

Using this setting, unneccessary functions can be inhibitted.
The inhibitted keys does not work if pressed.
Procedure to Set the Inhibit Functions.

① Press the SHIFT key while turning on the power. The following display (SELection) appears, and inhibit mode is established.

② The keys of which LEDs are lighting are valid functions. Press the function keys to turn on/off the LEDs. Required function is selected.

③ Press SHIFT again to reset normal measuring mode. Only the functions restricted at ② become selectable.

CAUTION

If all of the measuring functions are set to off at the procedure ②, pressing the SHIFT does not reset the measuring mode.

④ Two types of method are provided to release the state of the inhibition setting so as to validate all of the function keys, light all LEDs in the procedure ②.
In other way, turn off the power once and press -A AC while turning on the power (The parameter initialization (See Section 3.1.)).

MEMO

5. TR13217 GPIB ADAPTER UNIT

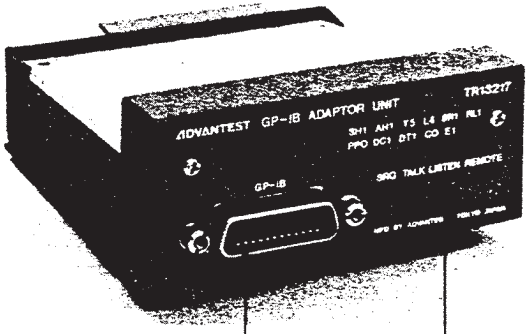
This chapter describes the GPIB adapter unit installed to this multimeter as an option.

5.1 OUTLINE OF TR13217 AND GPIB ADAPTER UNIT

The TR13217 (Figure 5-1) is the GPIB interface adapter designed as one of the plug-in accessories of the TR6845 series. Setting of various measuring functions of this multimeter, setting of measuring parameters, and input of the measurement data can be controlled externally by the GPIB (General Purpose Interface Bus), hence an automated measuring system can be configurated easily by using this adapter unit.

The GPIB signal from this unit is electrically isolated from the measuring signal system of the multimeter. Accordingly, it is possible to perform measurement without being affected by the externally connected units.

This adapter unit must be mounted to the TR6845 series multimeter as instructed in 2.2 "INSTALLATION AND REMOVAL OF PLUG-IN ACCESSORIES".



GPIB connector
24-pin piggyback type connector for bus cable conforming to IEEE-488 standard. A maximum of two connectors can be used by stacking.

GPIB status lamps
Indicate the status of TR6845 series multimeter when it is being controlled by GPIB.

SRQ	:	The multimeter is requesting the controller for service.
TALK	:	The multimeter is in the talker status for data transmission.
LISTEN	:	The multimeter is in the listener status for data reception.
REMOTE	:	The multimeter is in the status permitting external control.

Figure 5-1 TR13217 GPIB Adapter Unit Front Panel

5.2 TR13217 SPECIFICATIONS

5.2.1 General Specifications

Electrical : In accordance with IEEE 488-1978 and IEC 625-1 standards
Mechanical : In accordance with IEEE 488-1978 standard
Code used : ASCII code
Logical level: Logical 0 "High" state; Over + 2.4 V
Logical 1 "Low" state; Below + 0.4 V
Interface function: See Table 5-1.

Table 5-1 Interface Function of TR13217

Code	Function
SH1	Source handshake function
AH1	Accepter handshake function
T5	Basic talker function, talker cancellation function by listener specification, talk only mode function, serial poll function
L4	Basic listener function, listener cancellation function by talker specification
SR1	Service request function
RL1	Remote/local changeover function
PP0	Without parallel poll function
DC1	Device clear function ("SDC" and "DCL" commands usable)
DT1	Device trigger function ("GET" command usable)
C0	No controller function
E1	Open collector output

Signal wire termination: 16 bus lines are terminated as shown in Figure 5-2.

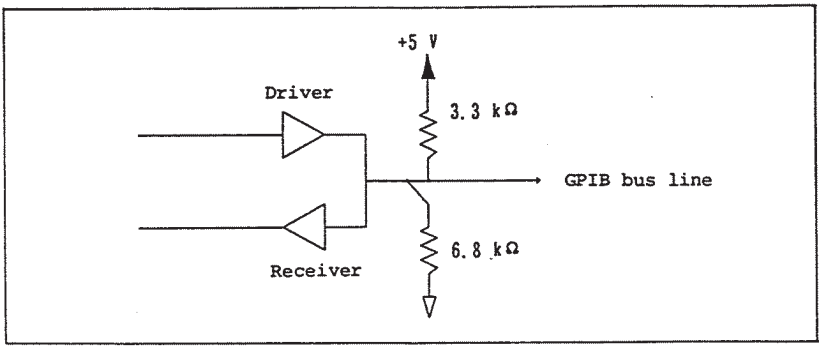
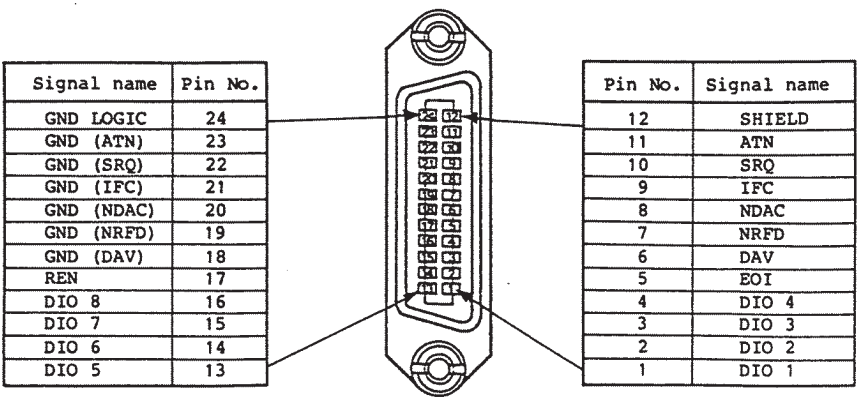


Figure 5-2 Signal Wire Termination

Driver specification	:	Try state system At below +0.4 V: "Low" state, 48 mA At over +2.4 V : "High" state, -5.2 mA
Receiver specification:		At below +0.6 V: "Low" state At over +2.0 V : "High" state
Remote programming	:	Setting of measuring function and measuring range, NULL calculation, comparation, High/Low constant, sampling mode, and external start are allowed.
Connector	:	24-pin GPIB connector See Figure 5-3. 57-20240-D35A (Product of Anphenol Corp. or equivalent)
Addressing	:	31 types of talk/listen addresses can be set arbitrarily by operating panel keys. See 5.2.3.
Data transmission	:	Sends out 8-13 bytes of measured data (data length varies with the number of measuring digits and ON/OFF of the header.) and delimiter. The delimiter can be changed by using program code.
Power supply	:	To be supplied from multimeter.
Operating ambient temperature:		0°C to +50°C
Operating ambient humidity	:	Below 85% R.H.
External dimensions	:	Approx. 116 mm (wide) x 49 mm (high) x 136 mm (long) (Excluding connectors, knobs and other projections)
Weight	:	Below 300 g



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

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

Figure 5-3 Pin Arrangement

5.2.2 Connection to the Component Equipment

The GPIB system is configurated by connecting multiple units. Pay attention to the following points when configurating a system.

(1) Before connecting TR6845, controller and peripherals, be sure to check the condition and operation of each unit according to the respective Instruction Manual.

(2) The connection cable to the measuring instrument and the bus cable to the controller must not be too long. The total cable length must not exceed 20 m. The standard bus cables as listed in Table 5-2 are available from ADVANTEST.

Table 5-2 Standard Bus Cables

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

(3) The bus cable connector uses the piggyback type, and one connector has both male and female connectors, which can be stacked for use.

When connecting the bus cable, do not stack three or more connectors. The connector must be fixed securely with the connector lock screw.

(4) Turn on the power of each component unit after making sure of the power supply condition, grounding condition, and if necessary other setting conditions. Be sure to turn ON the power of all the units connected to the bus. If the power of any one unit is not turned ON, the operation of the entire system is not guaranteed.

5.2.3 Address Setting and Selection of Header ON/OFF

The GPIB talk/listen address and header ON/OFF can be set by using the panel keys of the multimeter. Any one among the 31 addresses listed in Table 5-3 can be set in decimal code. The address can also be set by using the external controller.

Table 5-3 Address Code

Address		
Setting of lower two digits (Decimal code)	ASCII code	
	Listen	Talk
0	SP	@
1	!	A
2	"	B
3	#	C
4	$	D
5	%	E
6	&	F
7	'	G
8	(	H
9	)	I
10	*	J
11	+	K
12	,	L
13	-	M
14	.	N
15	/	O
16	0	P
17	1	Q
18	2	R
19	3	S
20	4	T
21	5	U

Table 5-3 Address Code (Cont'd)

Address		
Setting of lower two digits (Decimal code)	ASCII code	
	Listen	Talk
22	6	V
23	7	W
24	8	X
25	9	Y
26	:	Z
27	;	[
28	<	/
29	=	]
30	>	∿

① Press SHIFT, GP-IB. The following initialization is displayed, and the 10^1 digit in the address setting digit flashes.

These digits are used to select an address.

This digit is used to set/cancel the talk-only mode.
A: ADDRESSABLE
O: Talk only mode

This digit is used to set ON/OFF of the header.
H: Header ON
-: Header OFF (Under bar)

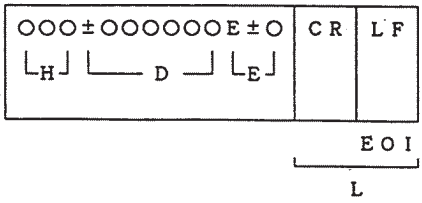
② Press AUTO to shift the digit which is flashing.

Press DOWN, UP to change the setting of each digit. Set the address using the lower two digits.

- Setting of any address in excess of 31 results in an error.
- With talk only mode set, data can be output directly to the listener such as plotter and so forth without passing through the controller. In this case, also set the listener in the only mode, and do not operate the controller at the same time.

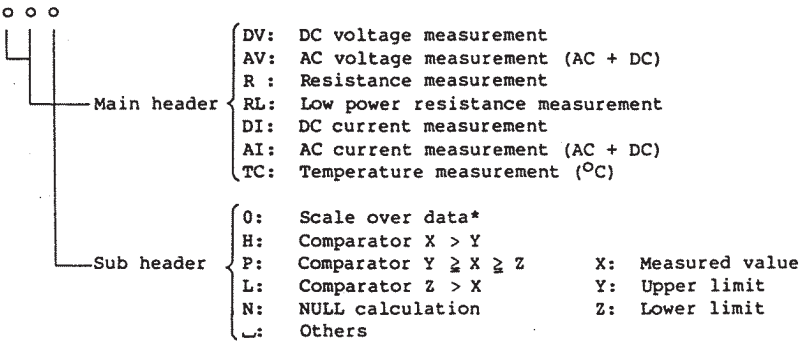
5.3 TALKER FORMAT

If the TR6845 series multimeter is specified as a talker, it outputs the measured and calculated data in the following data format.

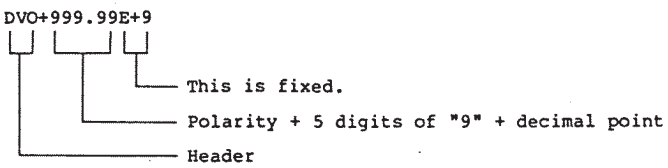


H: Header (3-character ASCII code)
D: Mantissa part (Polarity + Decimal point + 5-digit numerals)
E: Exponent part (E + Polarity + 1-digit numeral)
L: Delimiter (This is output to indicate the end of one data.)

(1) Header
The following 3-digit alphabets are output in ASCII code only when the header is ON. It is omitted if the header is OFF.



*: The data in scale-over data is output as follows:



(2) Mantissa Part and Exponent Part

The mantissa part of the measured value has the fixed length of 5 digits, and the decimal point is output corresponding to the display of the TR6845 series multimeter. In high speed sampling (3-1/2 digit measurement) of the TR6846/6847, the least significant digit is not output, and the mantissa part data has 4 digits. At the polarity digit position of the AC voltage/current, resistance, and low power ohm, a space "␣" is output. In the NULL calculation however, a "+" or "-" sign is output at that position. In DC voltage/current and temperature measurement, a "+" or "-" sign is output. The exponent part is displayed in the basic unit (V, A, Ω) corresponding to the measuring function and measuring range.

The subheaders "H, P, L" have higher priority than "N", and "0" has higher priority than "H, P, L".

Table 5-4 Mantissa Part and Exponent Part

Function	Range	Mantissa part	Exponent part
DC voltage	30 mV	±oo.ooo	E-3
	300 mV	±ooo.oo	E-3
	3000 mV	±oooo.o	E-3
	30 V	±oo.ooo	E+0
	300 V	±ooo.oo	E+0
	1000 V	±oooo.o	E+0
AC voltage	300 mV	␣ooo.oo	E-3
	3000 mV	␣oooo.o	E-3
	30 V	␣oo.ooo	E+0
	300 V	␣ooo.oo	E+0
	750 V	␣oooo.o	E+0
Resistance measurement	30 Ω	␣oo.ooo	E+0
	300 Ω	␣ooo.oo	E+0
	3000 Ω	␣oooo.o	E+0
	30 kΩ	␣oo.ooo	E+3
	300 kΩ	␣ooo.oo	E+3
	3000 kΩ	␣oooo.o	E+3
	30 MΩ	␣oo.ooo	E+6
	300 MΩ	␣ooo.oo	E+6

Table 5-4 Mantissa Part and Exponent Part (Cont'd)

Function	Range	Mantissa part	Exponent part
Low power ohm measurement L.P.OHM	300 Ω	␣ooo.oo	E+0
	3000 Ω	␣oooo.o	E+0
	30 kΩ	␣oo.ooo	E+3
	300 kΩ	␣ooo.oo	E+3
	3000 kΩ	␣oooo.o	E+3
	30 MΩ	␣oo.ooo	E+6
DC current measurement	3 µA	±o.oooo	E-6
	30 µA	±oo.ooo	E-6
	300 µA	±ooo.oo	E-6
	3000 µA	±oooo.o	E-6
	30 mA	±oo.ooo	E-3
	300 mA	±ooo.oo	E-3
	3000 mA	±oooo.o	E-3
	10 A	±oo.ooo	E+0
AC current measurement	300 µA	␣ooo.oo	E-6
	3000 µA	␣oooo.o	E-6
	30 mA	␣oo.ooo	E-3
	300 mA	␣ooo.oo	E-3
	3000 mA	␣oooo.o	E-3
	10 A	␣oo.ooo	E+0
Temperature (°C)	Thermo-couple	±oooo.o	E+0

(3) Delimiter
The delimiter can be selected among the following three types shown in Table 5-5 by the program code. When initialized, the type (1) is used.

Table 5-5 Delimiter

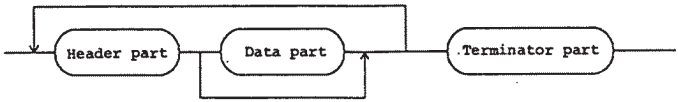
Delimiter		Setting	Command code
(1)	CR LF EOI	2-byte data of "CR"(15_8) and "LF"(12_8) is sent out. The single wire signal "EOI" is also output when sending out "LF".	DL0
(2)	LF	1-byte data of "LF"(12_8) is sent out.	DL1
(3)	Last byte EOI	Single wire signal "EOI" is output together with the last byte of the data.	DL2

5.4 REMOTE PROGRAMMING

This equipment permits selection of the measuring and calculating functions from the outside by using the controller. Table 5-6 shows the measuring function setting commands, Table 5-7 shows the range setting commands, and Table 5-8 shows miscellaneous functions setting commands.

This program module checks the data entered in accordance with the specified format, and converts the data into the internal status flag or internal code corresponding to the header code of the data.

It also performs processing of the input format when it recognizes the data terminator and the next header. The format consists of the header part (code part), data part and terminator part. Some headers, however, lack data.



5.4.1 GPIB Command

Table 5-6 Measuring Function Selecting Command Codes

Code	Function		Initial value
F1	DC voltage measurement (VDC)		o
F2	AC voltage measurement (VAC)		
F3	Resistance measurement (OHM)		
F4	Low power ohm measurement (L.P.OHM)		
F5	DC current measurement (ADC)		
F6	AC current measurement (AAC)		
F7*1	Temperature measurement (TMP, ^{o}C)	TR6846/6847	
	Continuity test	TR6845/6848	
F8	AC+DC voltage measurement (VAC+VDC)	TR6845/6847	
	P-P voltage measurement	TR6846/6848	
F9	AC+DC current measurement (AAC+ADC)	TR6845/6847	
	P-P current measurement	TR6846/6848	

Table 5-7 Range Selecting Command Codes

Function /	VDC	VAC VAC(AC+DC)	OHM	L.P.OHM	ADC, AAC AAC(AC+DC)	Initial value
R0	AUTO	AUTO	AUTO	AUTO	AUTO	o
R1	- *2	- *2	- *2	- *2	3 μA *3	
R2	30 mV	- *2	30 Ω	- *2	30 μA *3	
R3	300 mV	300 mV	300 Ω	300 Ω	300 μA	
R4	3000 mV	3000 mV	3000 Ω	3000 Ω	3000 μA	
R5	30 V	30 V	30 kΩ	30 kΩ	30 mA	
R6	300 V	300 V	300 kΩ	300 kΩ	300 mA	
R7	1000 V	750 V	3000 kΩ	3000 kΩ	3000 mA *4	
R8	- *2	- *2	30 MΩ	30 MΩ	10 A *4	
R9	- *2	- *2	300 MΩ	- *2	- *2	

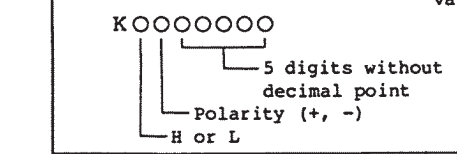
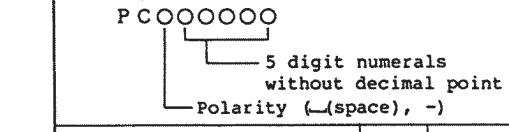
*1: "F7" temperature measurement can be set on TR6846/6847.
*2: "-" indicates non-existing range.
*3: 3 μA and 30 μA ranges can be set using the ADC function of TR6848.
*4: 3 A and 10 A ranges can be set on TR6845/6846/6847.
*5: Only "R1" can be chosen for range selection of temperature function.

Note: A syntax error will result if non-existing function or range is set.

Table 5-8 Function Selecting Command Codes

Function		Code	Initial value	Remarks
Null calculation	ON OFF	NL1 NL0	o	Even if "NL1" is received while executing NULL calculation, the multimeter continues measurement without starting calculation over again.
Sampling mode	FREE RUN HOLD	M0 M1	o	
Comparator calculation	ON OFF	CO1 CO0	o	
Buzzer	ON OFF	BZ1 BZ0	o	

Table 5-8 Function Selecting Command Codes (Cont'd)

Function		Code	Initial value	Remarks
Sampling rate	FAST MID SLOW	PR1 PR2 PR3	o	
H and L constant setting  			Initial value 0	
Header	ON OFF	PH1 PH0	o	
Calibration  				Valid only when CAL ON key is set ON. A syntax error will result if calibration data is out of range.
Delimiter mode CR/LF and EOI is output LF alone is output EOI alone is output		DL0 DL1 DL2	o	
Service request To send out Not to send out		S0 S1	o	
Start of measurement		E		Valid if set to HOLD "GET" command is equivalent to this.
Execution of equivalent routine when POWER is turned ON		C		Execution is performed from the beginning of program. (Same as for turning ON of POWER) Equivalent to "DCL" and "SDC".
Parameter initialization		Z		Parameter is initialized ("o" mark), and execution is performed from the beginning of program.
Display	Yes No	DS0 DS1	o	7-segment display ON/OFF

5.4.2 Precautions for Setting Commands

(1) When setting parameter:

- o The space is ignored.
- o Small letters are converted to capital letters before processing.
- o When undefined code is received, no setting is changed and a syntax error will rusult.

(2) A maximum of 40 characters can be written in a line.

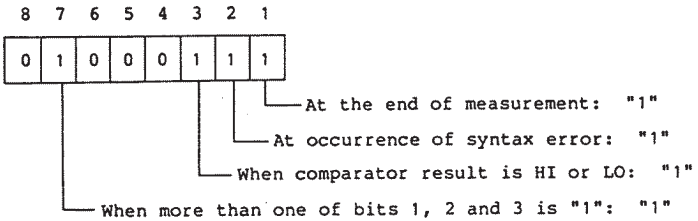
5.4.3 Service Request (SRQ)

This unit, when specified in the "S0" mode, originates the service request (SRQ) to the controller at the end of measurement or upon reception of an undefined code.

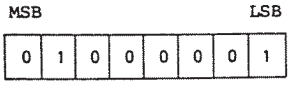
When the service request is originated, a status byte is sent out from the controller through execution of serial polling.

When this unit is specified in the "S1" mode, no service request is originated, but the status byte is sent out.

o Status byte



(1) Service request at the end of measurement
If not specified as the talker, this unit originates the service request at the end of measurement. The following status byte is sent out upon execution of serial polling, but the status byte is not cleared until this unit is specified as the talker for sending the measured data.



ASCII code: A
Decimal code: 65

(2) Service request caused by syntax error
If an undefined program code is received in remote program mode, this unit originates a service request. The status byte is as shown below. This status byte is not cleared until this unit is specified as the listener for remote setting.

MSB							LSB
0	1	0	0	0	0	1	0

ASCII code: B
Decimal code: 66

* In case of simultaneous occurrence of two factors of end of measurement and syntax error, two bits are set in the status byte. (ASCII code: C, Decimal code: 67)

(3) Service request by comparator calculation result
This unit originates a service request when the result of comparison is HI or LO.

MSB							LSB
0	1	0	0	0	1	0	1

ASCII code: E
Decimal code: 69

* In case of simultaneous occurrence of the factors of service request shown above, the bits of the status byte corresponding to such factors are all set. (ASCII code: G, Decimal code: 71)

5.4.4 Status Change upon Turning ON of Power, or upon Reception of Command

The status of this unit changes as shown in Table 5-9 corresponding to the turning on of power, and to the reception of each command.

Table 5-9 Status Change by Commands

Command	With talker lamp	With listener lamp	With SRQ lamp	Status	Send data
POWER ON	Clear	Clear	Clear	Clear	Clear
IFC	Clear	Clear			
"DCL", "SDC" or "C"			Clear	Clear	Clear
"GET" or "E"				'Send data provided' bit is cleared.	Clear
Talker specification to this unit	Set	Clear			
Talker cancel command	Clear				
Listener specification to this unit	Clear	Set			
Listener cancel command		Clear			
Serial polling			Clear		

Note: A slash (/) indicates no status change.
DCL: Device Clear
SDC: Selected Device Clear
GET: Group Execute Trigger

5.5 OPERATION FLOW CHART

Figure 5-4 shows a rough flow chart of operation.

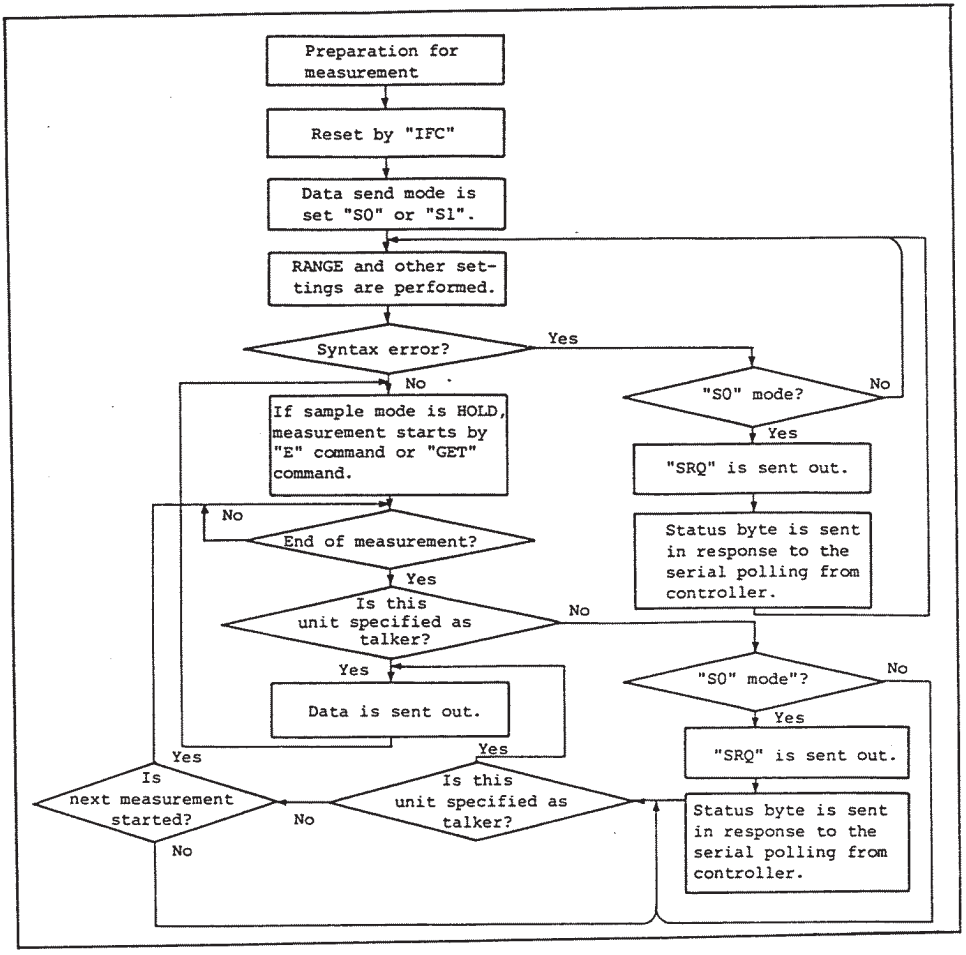


Figure 5-4 GPIB Operation Flow Chart

5.5.1 Precautions on Operation

a. Operation at the time of service request
When a service request is generated (in SO mode) due to termination of measurement or occurrence of syntax error, the operation as shown in Figure 5-5 is performed. Attention should be paid to this point when creating a program.

b. Operation when starting measurement by the program code "E" or by "GET" command
As for the operation when starting measurement by the program code "E" or "GET" command with the sample mode of TR6845 series multimeter set "HOLD", refer to Section 4.4.2 "Timing of measurement".

c. Difference in sending data by the difference in talker specification timing

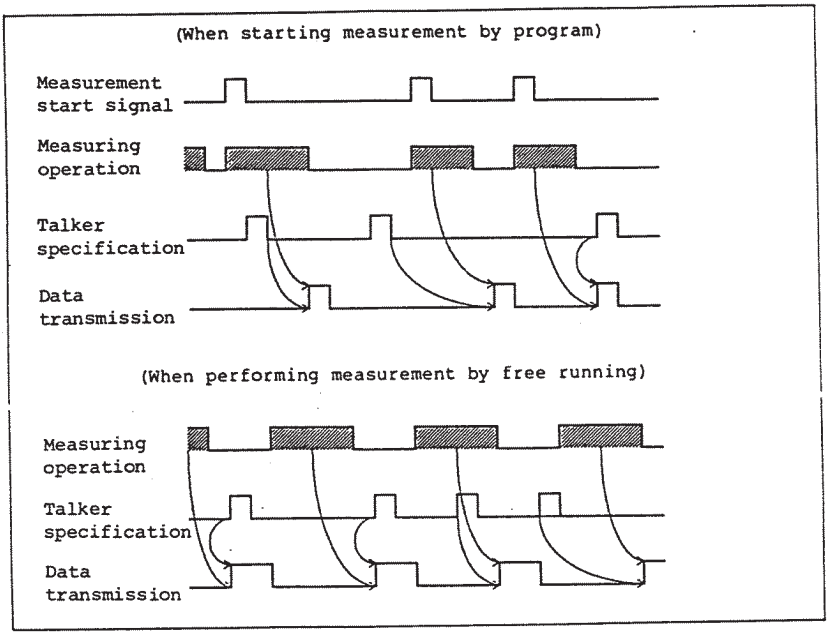


Figure 5-5 Difference in Sending Data by Talker Specification Timing

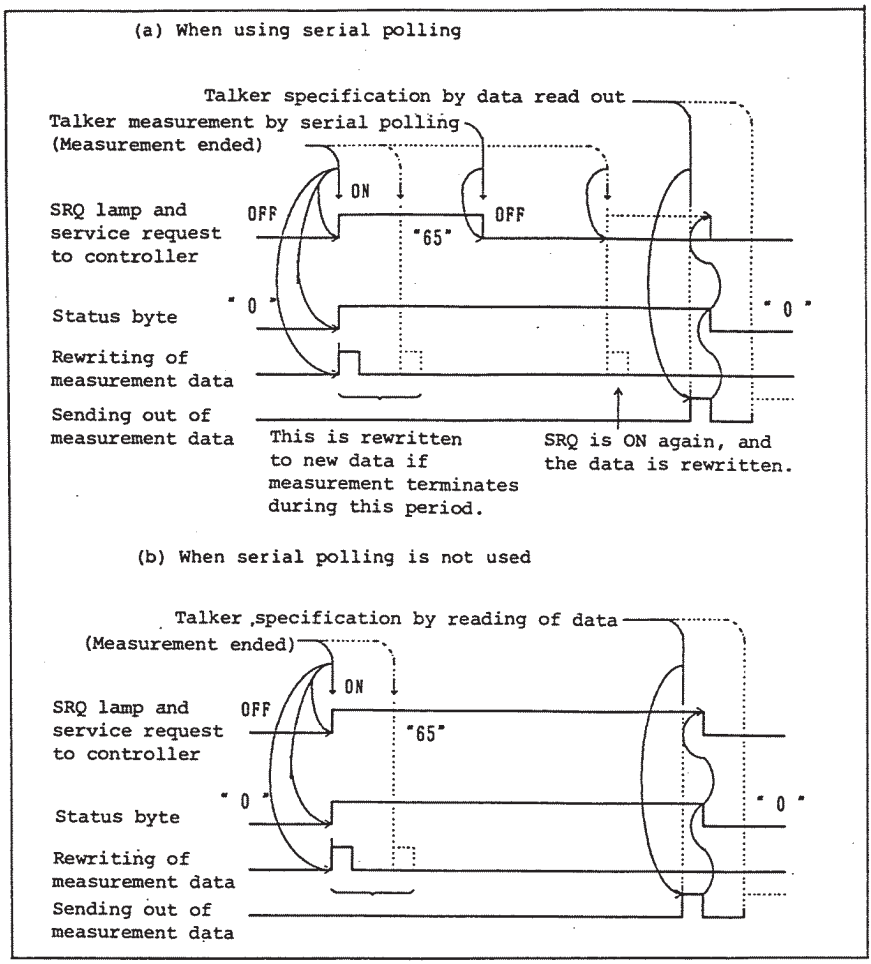


Figure 5-6 Timing of Operations When Making Service Request

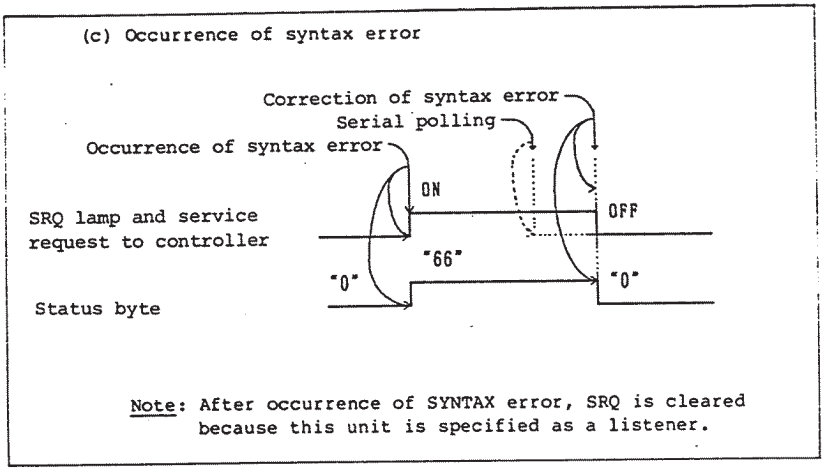


Figure 5-6 Timing of Operations When Making Service Request (Cont'd)

5.6 PROGRAM EXAMPLES

This section explains some program examples using the Hewlett Packard HP200 series and NEC PC9801.

Example 1: DC voltage measurement, 30 V range, external start with sampling hold

(a) Program example with HP200 series

```
10   !
20   !
30   !
40   DIM A$[20]
50   TR6845=701
60   !
70   CLEAR TR6845
80   OUTPUT TR6845;"F1,R5,M1"
90   OUTPUT TR6845;"PR2,DL0,S1"
100  TRIGGER TR6845
110  ENTER TR6845;A$
120  PRINT A$
130  GOTO 100
140  !
150  END
```

	Description
40	Defines data area.
50	Sets the address of TR6845 to the variable "TR6845".
70	Initializes the GPIB interface device.
80	Sets TR6845 parameter.
	"F1" ... Measurement function VDC
90	"R5" ... Measuring range 30 V
	"M1" ... Sampling mode: HOLD
	"PR2" .. Sampling rate: MID
	"DL0" .. Block delimiter: CR LF EOI
	"S1" ... SRQ sending OFF
100	Applies external start signal.
110	Receives data.
120	Displays the data.
130	Branch to line 100.
150	Program ends.

(b) Program example with PC9801

```
10   '
20   '
30   '
40   ISET IFC
50   ISET REN

60   CMD DELM=0
70   WBYTE &H3F,&H5E,&H21,&H4;
80   PRINT @1;"F1,R5,M1"
90   PRINT @1;"PR2,DL0,S1"
100  WBYTE &H3F,&H5E,&H21,&H8;
110  INPUT @1;A$
120  PRINT A$
130  GOTO 100
140  END
```

	Description
40	Clears interface.
50	Remote enable
60	Sets delimiter to CR+LF.
70	&H3F ... "UNL"
	&H5E ... Talker address of controller (PC9801)(Address No. 30)
	&H21 ... Listener address of TR6845 series (Address No. 1)
	&H4 ... "SDC"
80	Sets TR6845 parameters.
	"F1" ... Measuring function VDC
	"R5" ... Measuring range 30 V
	"M1" ... Sampling mode: HOLD
90	"PR2" .. Sampling rate: MID
	"DL0" .. Block delimiter: CR LF EOI
	"S1" ... SRQ sending OFF
100	Applies external start signal.
110	Receives data.
120	Displays.
130	Branch to line 100.
140	Program ends.

Example 2: Measurement parameters are set externally, and external start signal is applied to start measurement, and then the data is read by using SRQ.

(a) Program example with HP200 series

```
10    !
20    !
30    !
40    DIM A$[20]
50    Tr6845=701
60    ON INTR 7 GOSUB Srq
70    !
80    CLEAR Tr6845
90    OUTPUT Tr6845;"F3,R5,M1"
100   OUTPUT Tr6845;"PR2,DL0,S0"
110   ENABLE INTR 7;2
120   TRIGGER Tr6845
130   Wait_f=0
140   IF Wait_f=1 THEN 120
150   GOTO 140
160   !
170 Srq: STATUS 7,1;X
180   S=SPOLL(Tr6845)
190   IF S<>65 THEN 230
200   ENTER Tr6845;A$
210   PRINT A$
220   Wait_f=1
230   ENABLE INTR 7;2
240   RETURN
250   !
260   END
```

	Description
40	Defines data area.
50	Sets the address of TR6845 to the variable "Tr6845".
60	Defines interruption processing routine.
80	Initializes GPIB interface device.
90	Sets TR6845 parameters: "F3" ... Measuring function OHM "R5" ... Measuring range 30 kΩ "M1" ... Sampling mode: HOLD
100	"PR2" .. Sampling rate: MID "DL0" .. Block delimiter: CR LF EOI "S0" ... SRQ sending ON
110	Allows interruption by SRQ.
120	Applies external start signal.
130	Interruption and interruption wait-
↓	ing processing roop
150	
170	Reads the status by polling the
↓	interruption processing routine
180	name: TR6845.
190	Branches to line 230 if interruption is made by other than TR6845.
200	Receives data.
210	Displays.
220	Sets the interruption end flag (Wait_f).
230	Allows interruption by SRQ.
240	Returns to the main routine.
260	Program ends.

(b) Program example with PC9801

```
10    '
20    '
30    '
40    ISET IFC
50    ISET REN
60    CMD DELIM=0
70    DEF SEG=&H60
80    A%=PEEK(&H9F3)
90    A%=A% AND &HBF
100   POKE &H9F3,A%
110   WBYTE &H3F,&H5E,&H21,&H4;
120   PRINT @1;"F3,R5,M1"
130   PRINT @1;"PR2,DL0,S0"
140   ON SRQ GOSUB 210
150   SRQ ON
160   WBYTE &H3F,&H5E,&H21,&H8;
170   WAITF=0
180   IF WAITF=1 THEN 170
190   GOTO 190
200   POLL 1,S
210   IF S<>65 THEN 260
220   INPUT @1;A$
230   PRINT A$
240   WAITF=1
250   SRQ ON
260   RETURN
270   END
```

	Description
40	Interface clear
50	Remote enable
60	Sets the delimiter to CR+LF.
70	Clears SRQ signal in GPIB of PC9801. (70-100) Declares the segment base address.
80	Reads the content of address.
90	AND (Clears interruption bit.)
100	Writes data to the specified address on memory.
110	&H3F ... "UNT" &H5E ... Talker address of controller (PC9801) &H21 ... Listener address of TR6845 series &H4 ... "SDC"
120	Sets TR6845 parameters. "F3" ... Measuring function OHM "R5" ... Measuring range 30 kΩ "M1" ... Sampling mode: HOLD
130	"PR2" .. Sampling rate: MID "DL0" .. Block delimiter: CR LF EOI "S0" ... SRQ sending ON
140	Specifies the initial address of SRQ subroutine.
150	Allows reception of SRQ.
160	Applies external start signal.
170	Substitutes 0 into flag (WaitF).
180	Branches to 170 if flag (WaitF) is 1.
190	Branches to 190.
200	Serial polling.
210	Branches to 260 in case of an interruption from other than TR6845.
220	Data reception
230	Display
240	Substitutes 1 into the flag (WaitF).
250	Allows reception of SRQ.
260	Return
270	Program ends.

6. TR13008 BCD OUTPUT UNIT

This chapter describes the BCD output unit installed to this multimeter as an option.

6.1 GENERAL DESCRIPTION

The TR13008 BCD Data Output Unit is built in the TR6845 series multimeter. It converts the resultant data of measurement into BCD parallel code, and outputs to a digital recorder or other external digital units. With this unit connected, it becomes possible for the external controller to set various measuring conditions, and also to remotely control the measurement start instruction. The input-output signal line is electrically isolated from the measuring signal line of the multimeter. This prevents measurement from being affected by the external equipment.

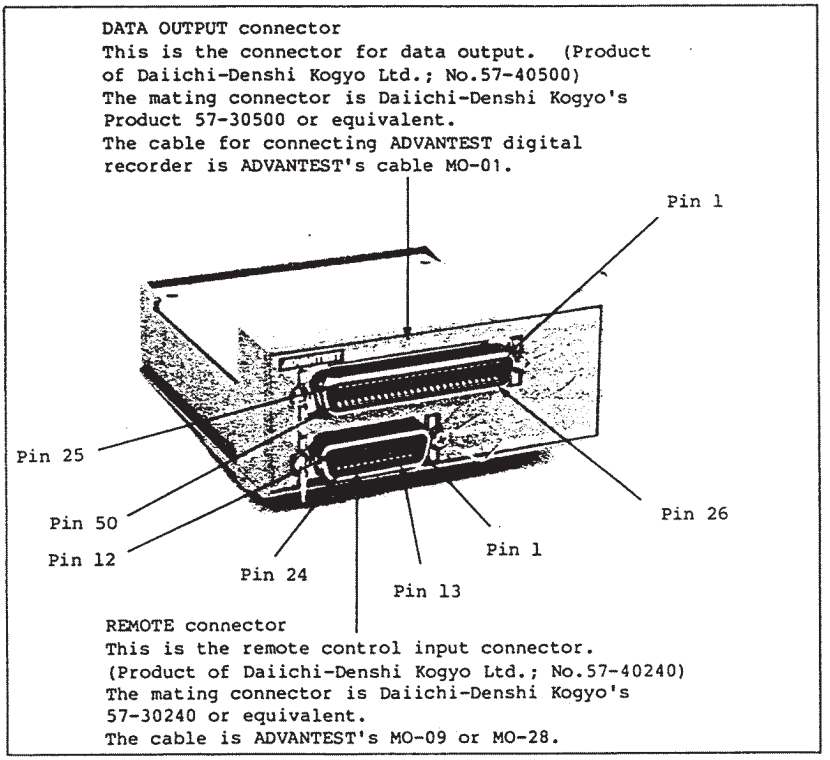


Figure 6-1 TR13008 BCD Data Output Unit

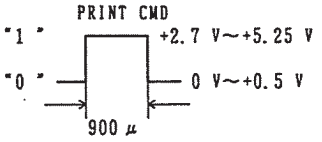
6.1.1 Specifications and Performance

- Data output

  Output code : BCD (Binary Coded Decimal) code
  Content : Measured data, decimal point, polarity sign and unit
  Signal level : TTL level, positive logic

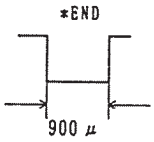
- Print request signal

  PRINT CMD : Print command signal output TTL level, positive pulse



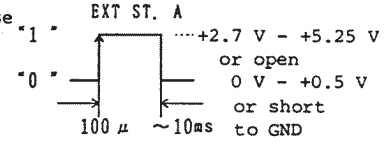
- Control signal: Controlled by 15 wires of *STROBE, *FCA, *FCB, *FCC, *FCD, *RCA, *RCB, *RCC, *RCD, *PRA, *PRB, *HOLD, *NULL, *COMP and *BUZ. TTL level negative pulse
  (* mark indicates negative pulse signal.)
  * STROBE signal is operated at trailing edge.

- *END signal: TTL level negative pulse

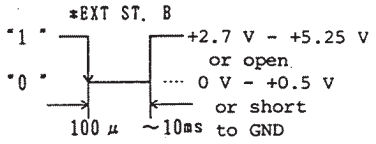


- External start signal:

  EXT ST. A : TTL level positive pulse
  The external start A pulse operates at its leading edge.



  *EXT ST. B : TTL level negative pulse
  The external start B and *STROBE pulses operate at their trailing edges.



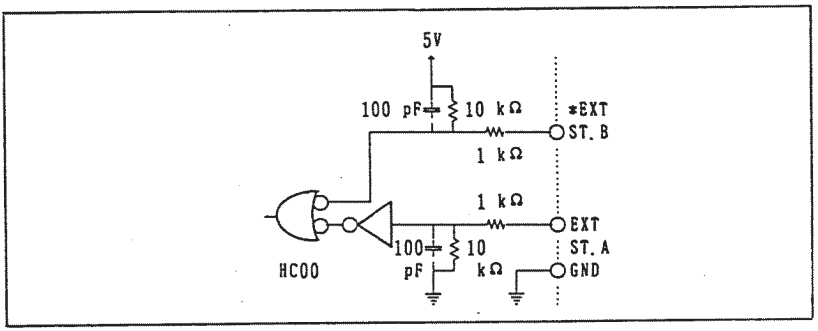


Figure 6-2 External Start Input Circuit

- Power supply : Supplied from TR6845 series multimeter.
- Operating ambient temperature : 0oC to +50oC
- Operating ambient humidity : Below RH 85%
- Storage temperature : -25oC to +70oC
- External dimensions : Approx. 116 mm (wide) x 49 mm (high) x 136 mm (long) (Connectors, knobs and other projections not included)
- Weight : Less than 300 g

6.1.2 Data Output Code

Table 6-1 BCD Data Output Code

Output name	Output signal	Code 8	4	2	1
Data	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
	-	1	0	1	0
	+	1	0	1	1
	Space	1	1	0	0
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
Function	* (OVER)	0	0	0	0
	H (HIGH)	1	1	0	1
	L (LOW)	1	1	1	0
	⎽ (PASS)	0	1	1	0
Unit	mV	0	0	0	0
	V	0	0	1	0
	Ω	0	1	0	0
	kΩ	0	1	0	1
	MΩ	1	0	1	1
	μA	1	0	0	0
	mA	1	0	1	0
	^ (Space)	1	1	1	1
	°C	0	0	1	1

- A space is output on the polarity digit of AC, AC+DC and OHM. When executing NULL calculation, + or - sign is output.
- In FAST (3-1/2 digit) mode, space is output on 10^0 digit.

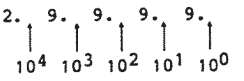
Table 6-2 Data Output Connector (Daiichi Denshi Kogyo: Product No.57-40500)

Pin arrangement

Pin			Pin		
1	SIG. GND		26	2^0	10^6 (HI)
2	2^0	10^0	27	2^1	
3	2^1		28	2^2	
4	2^2		29	2^3	
5	2^3		30	2^0	10^7 (HI)
6	2^0	10^1	31	2^1	
7	2^1		32	2^2	
8	2^2		33	2^3	
9	2^3		34	2^0	Function
10	2^0	10^2	35	2^1	
11	2^1		36	NC	(HI)
12	2^2		37	NC	
13	2^3		38	2^2	Function 10^3
14	2^0	10^3	39	2^3	
15	2^1		40	2^0	Unit
16	2^2		41	2^1	
17	2^3		42	2^2	
18	2^0	10^4	43	2^3	
19	2^1		44	2^0	Decimal point *2
20	2^2		45	2^1	
21	2^3		46	2^2	
22	2^0	10^5	47	PRINT CMD	
23	2^1		48	EXT ST. A	
24	2^2		49	NC *1	
25	2^3		50	SIG. GND	

*1: Though the pin 49 "NC" terminal is a blank terminal, it must never be used as a relay terminal.

*2: The correspondence of decimal point code is as follows:



Pins 26-33, 36 and 37 are connected to 10 kΩ pull-up resistor.

*3: Polarity (+;1011, -;1010) is output in measurements of DC voltage, AC current, and resistance.

6.1.3 Remote Control Setting Code

Setting is executed at the trailing edges of *STROBE

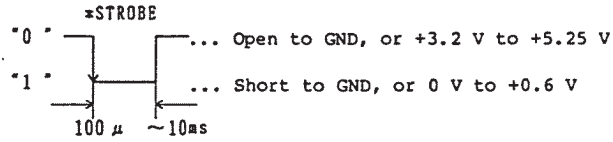


Table 6-3 Measuring Function Setting Code

Setting	Code			
Measuring function	*FCD	*FCC	*FCB	*FCA
DC voltage measurement	0	0	0	1
AC voltage measurement (AC coupling mode)	0	0	1	0
Resistance measurement	0	0	1	1
Low power ohm measurement	0	1	0	0
DC current measurement	0	1	0	1
AC current measurement (AC coupling mode)	0	1	1	0
Temperature measurement TR6846/6847 only	0	1	1	1
Continuity test TR6845/6848 only	0	1	1	1
AC voltage measurement (AC+DC mode) TR6845/6847 only	1	0	0	0
P-P voltage measurement TR6846/6848 only	1	0	0	0
AC current measurement (AC+DC mode) TR6845/6847 only	1	0	0	1
P-P current measurement TR6846/6848 only	1	0	0	1

Table 6-4 Measuring Range Setting Code

Setting				Code			
Range				*RCD	*RCC	*RCB	*RCA
DC voltage	AC voltage AC, AC+DC	OHM L.P.OHM	AC/DC current				
AUTO	AUTO	AUTO	AUTO	0	0	0	0
-	-	-	3 μA*2	0	0	0	1
30 mV	-	30 Ω*1	30 μA*2	0	0	1	0
300 mV	300 mV	300 Ω	300 μA	0	0	1	1
3000 mV	3000 mV	3000 Ω	3000 μA	0	1	0	0
30 V	30 V	30 kΩ	30 mA	0	1	0	1
300 V	300 V	300 kΩ	300 mA	0	1	1	0
1000 V	750 V	3000 kΩ	3000 mA*3	0	1	1	1
-	-	30 MΩ	10 A *3	1	0	0	0
-	-	300 MΩ*1		1	0	0	1

*1: 30 Ω and 300 MΩ ranges cannot be used in L.P.OHM measurement.
*2: 3 μA and 30 μA ranges can be used only for the ADC function of TR6848.
*3: 3000 mA and 10 A ranges can be used for TR6845, 6846 and 6847 only.

NOTE: The mark "-" indicates non-existing range. If non-existing function or range is set, such setting is regarded as non-existing, no SYNTAX error occur and measurement is continued using the previous setting.

Table 6-5 Other Setting Codes

Sampling mode		*PRB	*PRA
	FAST	0	1
	MID	1	0
	SLOW	1	1

NULL calculation		*NULL
	OFF	0
	ON	1

Buzzer		*BUZ
	OFF	0
	ON	1

Hold		*HOLD
	OFF	0
	ON	1

Comparator operation
OFF → ON: Operation is performed (zero).
ON → OFF: Operation is stopped.
ON → ON : Operation is continued.

*COMP

Comparator output
Any one of HI, PASS and LO turns "high" level corresponding to the result of comparator operation.

Output current (I out) ±35 mA

Table 6-6 Remote Control Input Connector Pin Arrangement
57-40240 (Daiichi-Denshi Kogyo)

Pin	
1	GND
2	*EXT.ST.B
3	*FCA
4	*FCB
5	*FCC
6	*FCD
7	*RCA
8	*RCB
9	*RCC
10	*RCD
11	*STROBE
12	GND
13	GND
14	*PRA
15	*PRB
16	*HOLD
17	*NULL
18	*COMP
19	*BUZZER
20	HI
21	PASS
22	LO
23	*END
24	GND

6.2 OPERATION

(1) Mounting to the multimeter
Mount the TR13008 to the TR6845 series multimeter by referring to Figure 2-2.

(2) Connection with digital recorder

(a) Use digital recorder TR6198.

(b) Connect the accessory connection cable of the digital recorder TR6198 to the DATA OUTPUT connector. (Before connecting, turn OFF the power of both units.)

(c) Operate the digital recorder TR6198 as instructed.

(3) Connection to equipment other than digital recorder
Pay attention to the following points when transferring data to any devices other than TR6198.

① Check for the input level of the equipment to be connected. The output circuit of the TR13008 is as follows. (Figure 6-3)

- Data, function, decimal point, print command signals
- Unit output (40-43 pins)
- HI level pin other than the above

② The output data is issued at each output of the print command signal. Use this print command signal as the strobe signal for fetching data to the external equipment.

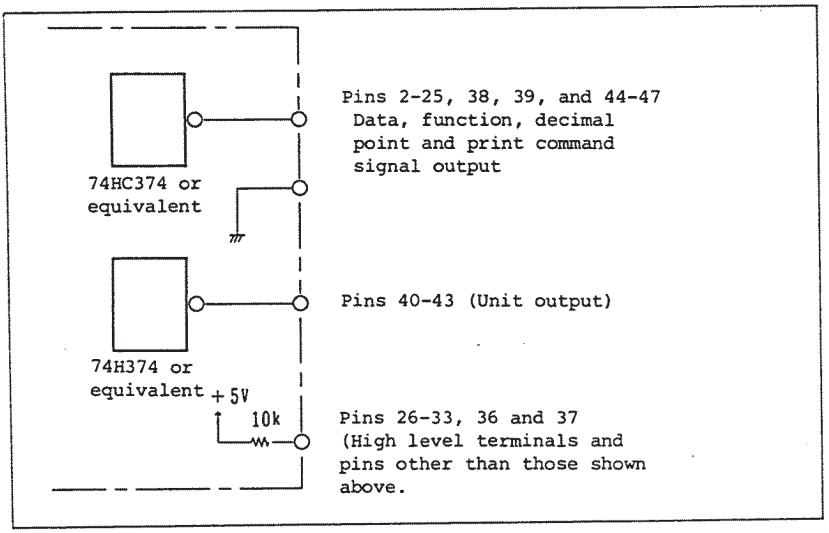


Figure 6-3 TR13008 Output Circuit

(4) Remote control

The measuring range is controlled by using five lines of *RCA, *RCB, *RCC, *RCD and *STROBE of the REMOTE connector. These five signal lines operate on negative logic. To set the status "1" (true), connect the pins of signal line to GND (pins 1 and 24). To set "0" (false), open the signal line.

The remote mode can be established by setting the code of the desired measuring range (four bits of *RCA, *RCB, *RCC, and *RCD), set the code in remote enable state (*STROBE) and by setting the strobe signal (*STROBE) to "0". The remote mode is enabled by the trailing edge of the strobe signal.

Figure 6-4 shows the input circuit of the *RCA, *RCB, *RCC, *RCD, and *STROBE signals.

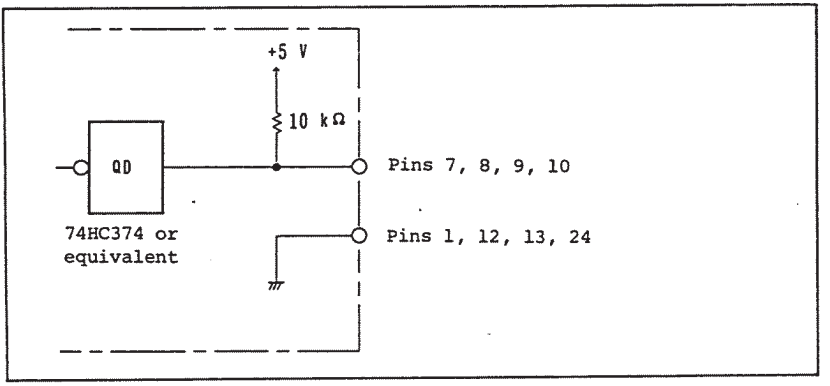


Figure 6-4 Input Circuit of *RCA, *RCB, *RCC, *RCD, *STROBE Signals

NOTE

1. When setting the measuring range of the TR6845 series by using the TR13008, note that the usable range varies with the setting of the measuring function (VDC, VAC, ADC, AAC, OHM, L.P.OHM, P-P). (See Remote control setting code in Table 6-4.) If an unusable range is set, the multimeter does not perform normal measurement. This point must be noted particularly when changing the digital multimeter measuring function while using the externally controlled measuring range.
2. When changing the measuring range that is controlled externally, under the condition where sampling is started by the external start signal, it is necessary to take the following time period between changing of the range control signal and input of the start signal.

Measuring function and measuring range		Time from changeover of measuring range to input of external start signal
All ranges of VDC/ADC		30 ms
ACV/ACI	FAST	0.3 s (Within ±20 digits) 0.7 s (Within ±2 digits)
	SLOW	4 s (Within ±20 digits) 10 s (Within ±1 digits)
OHM	30 Ω to 30 kΩ 300 kΩ 3 MΩ 30 MΩ to 300 MΩ	30 ms 100 ms 300 ms 3 s

(5) External start
Sampling start can be activated from the outside. The external start signal input has two connectors; REMOTE (pin 2) and DATA OUTPUT (pin 48). These connectors form an OR circuit inside the equipment.

The external start signal applies a pulse of 100 μs to 10 ms.

(6) Timing of measurement
When incorporating the TR6845 series multimeter with TR13008 into a measuring system, determine the system sequence by referring to the timing chart shown in Section 4.4.2 "Timing of Measurement".

MEMO

7. MISCELLANEOUS ACCESSORIES

This chapter describes the TR1504 battery unit, TR13009 digital comparator unit, and TR13012 analog output unit, which are installed to this multimeter as an option.

7.1 TR15804 BATTERY UNIT

7.1.1 General Description and Specifications

The TR15804 is a plug-in type rechargeable battery unit designed specially for the TR6845 series multimeters.

Built-in battery	:	4-6 V, by rechargeable nickel-cadmium cells (four)
Continuous operating time	:	Approx. 4 hours
Charging time	:	Approx. 15 hours with TRICKLE/FULL switch set FULL
Charging method	:	Fed by TR6845 series
External dimensions	:	Approx. 116 mm (wide) x 49 mm (high) x 136 mm (long) (Excluding connectors, knobs and other projections)
Weight	:	Less than 500 g

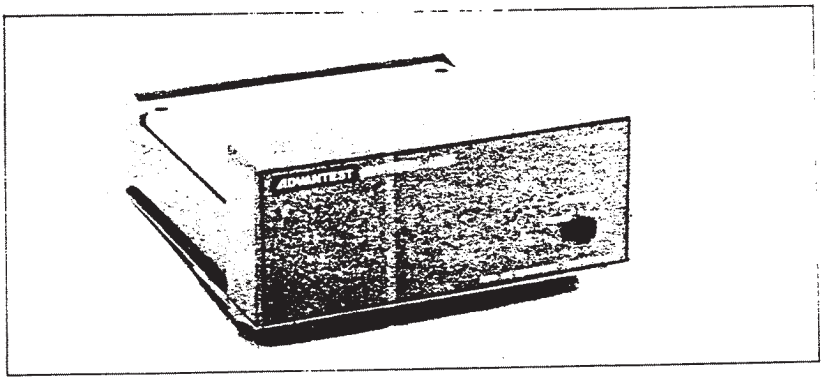


Figure 7-1 TR15804 Battery Unit

7.1.2 Preparation for Operation and Precautions

(1) Be sure to start charging with this unit fitted in the TR6845 series multimeter.

(2) When you have purchased the unit, or when this unit is not used for more than one month, set to FULL the TRICKLE/FULL switch on the panel face of this unit, and perform charging for about 15 hours.

(3) If the "Low battery" sign indicating excessive drop in the battery voltage is displayed, replace with a new battery, or recharge the discharged battery immediately.

(4) Recharge the battery fully once a month or once per 15 charge-discharge cycles so that the voltage balance can be maintained among the battery cells.

(5) The nickel-cadmium battery efficiency is at a maximum when the operating temperature is within the range of +20°C to +40°C. This battery is capable of repeating charge-discharge cycle more than 300 times until the actual battery capacity lowers below 80% of the nominal 1200 mAH.

(6) The battery should be recharged within the circulating temperature range of 0 to +45°C, and discharged within the range of -20°C to +50°C.

(7) Do not give large shocks to the nickel-cadmium battery; otherwise, the electrode of the battery may be damaged, causing a shortcircuit inside the battery.

(8) If the TRICKLE/FULL switch is set to FULL after the battery has been charged fully, an overcharging will result, reducing in the battery life. If continuous charging is needed even after full charging is reached, be sure to set the switch to the TRICKLE position.

7.1.3 Charging Method

① Fit the TR15804 battery unit to the TR6845 series multimeter.

② Set the POWER switch of the TR6845 series to ON, and supply AC 100 V ±10% (or the voltage indicated on the rear side panel of the multimeter), 50 Hz or 60 Hz power.

③ Charging can be performed irrespective of the POWER switch position of the TR6845 series.

④ Full recharging of battery after appearance of the "Low battery" sign needs about 15 hours with the FULL/TRICKLE switch set to FULL. If set to TRICKLE, the charging time takes about three times that needed with the switch set FULL. If continuous charging is needed after full recharging, the switch must be set to TRICKLE.

⑤ When operating the TR6845 series on the AC line voltage with the TR15804 built inside, the FULL/TRICKLE switch should normally be set to TRICKLE. With this switch setting, the self-discharge of the battery will be compensated for, and no overcharging will result.

7.1.4 Fuse Replacement

If the multimeter is not energized even after setting the POWER switch to ON, the cause may be a blown battery fuse. The 0.8 A slow blow fuse is used. The fuse replacement procedure is shown in Figure 7-2.

① Turn the battery unit upside down, remove the four screws of the lower case, and remove the cover.

② Take out the fuse as shown in Figure 7-2. To install, press down the fuse. A new fuse must be checked visually, to see whether the resistance value is below 15 Ω.

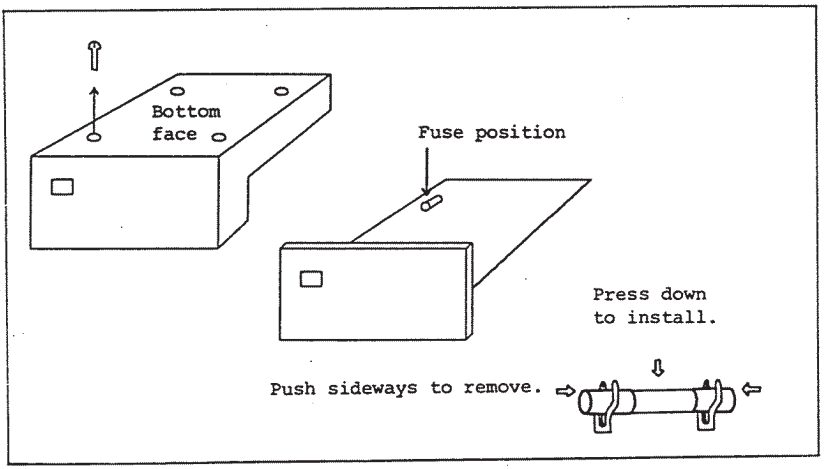
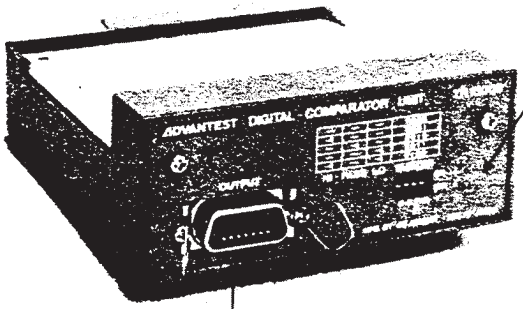


Figure 7-2 Battery Fuse Position and its Removal Procedure

7.2 TR13009 DIGITAL COMPARATOR UNIT

7.2.1 General Description

The TR13009 is a plug-in type digital comparator unit designed specially for the TR6845 series multimeters. This unit compares digitally the value measured by the multimeter with the upper and lower limit values set on the panel, and discriminates the value in three levels of HI, PASS and LO. It can issue an alarm buzzer sound. The result of comparison can be taken out to the external equipment in the form of the relay-contact, open collector output. It is also provided with the external start function. The relay-contact open collector output is electrically isolated from the measuring signal system, and hence the measurement is not affected by the external equipment.



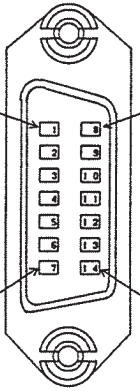
Buzzer ON/OFF switch:
Sets alarm sounding condition.

8421	
0000:	OFF
0001:	Buzzer sounds at HI.
0010:	Buzzer sounds at PASS.
0011:	Buzzer sounds at LO.
0100:	Buzzer sounds at HI or LO.

Output connector:
The result of comparison is output by relay-contact open collector.
The connector pin numbers and signal names are shown in Figure 7-4.

Figure 7-3 TR13009 Digital Comparator Unit

Signal name	Pin No.
GND	1
*EXT.START	2
*O.C.HI	3
*O.C.LO	4
RELAY HI	5
RELAY PASS	6
RELAY LO	7



Pin No.	Signal name
8	GND
9	*CMP. END
10	*O.C. PASS
11	N.C.
12	RELAY HI
13	RELAY PASS
14	RELAY LO

* : Negative pulse
O.C.: Open collector

Figure 7-4 Pin No. and Signal Name of Open Collector

7.2.2 Specifications

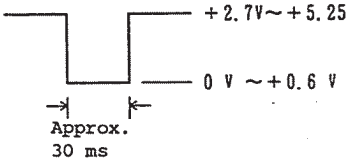
No. of digits to compare: Numeral 5 digits (00000 to ±99999)
Comparison level : Two values: Upper (HIGH LIMIT) and lower (LO LIMIT) limit values
Discriminating condition: HI ..... Measured data > High limit
PASS ... High limit ≧ Measured data ≧ Low limit
LO ..... Measured data < Low limit
Level setting : Key input from the panel face of TR6845
Display of comparison : LED of any of HI, PASS, and LO lights.
Relay contact Transistor output (Open collector)
ON ..... Relay contact make, transistor output ON
OFF .... Relay contact break, transistor output OFF

Discrimination \ Output	HI	PASS	LO
HI	ON	OFF	OFF
PASS	OFF	ON	OFF
LO	OFF	OFF	ON

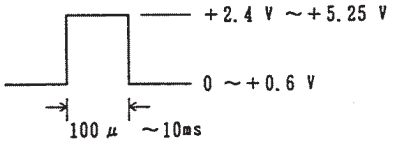
Relay contact capacity : Allowable voltage of contact DC 50 V
Allowable current of contact DC 150 mA
Contact-to-logical earth voltage: 150 V peak

Transistor output capacity : Voltage between collector and emitter: DC + 50 Vmax
Collector current: DC + 500 mA

Comparison end signal : TTL level negative pulse



External start signal : TTL level positive pulse (Continuous measurement operation is performed if set continuously to the LOW level.)
Pulse width approx. 100 µs to 10 ms



Buzzer alarm : If the comparison result is HI, PASS, LO, HI or LO, the buzzer sounds.

Output connector : 57-40140 (Daiichi-Denshi Kogyo)
The ADVANTEST cables suitable for this are MI-08 and MO-29. (Available separately)

Power supply : To be supplied from the TR6845 series multimeter

Operating ambient temperature : 0°C to +50°C

Operating ambient humidity : Less than RH85%

Storage ambient temperature : -25°C to 70°C

External dimensions : Approx. 116 mm (wide) x 49 mm (high) and 136 mm (long) (Connectors, knobs and other projections excluded)

Weight : Less than 300 g

7.2.3 Operation

① Mount the TR13009 unit to the TR6845 series.

② Turn ON the power switch of the multimeter, and connect the signal to be measured.

③ Setting the upper limit and lower limit values
These values can be set through the panel of TR6845 series multimeter. Setting procedure is the same as that of TR6845 series. Refer to 4.4.3-(2) "Comparator".

④ Measurement and comparison operation will start. At the moment comparison has been terminated, a comparison end signal (negative pulse) is output.

For the timing of measurement, refer to 4.4.2.

7.3 TR13012 ANALOG OUTPUT UNIT

7.3.1 General

The TR13012 analog output unit is built in the TR6845 series multimeter. It converts the digital measurement result of each measuring instrument into analog value, and outputs it in the form of analog voltage.

The converted output is 1 V full scale. It is possible to directly display the lower three digits of measured value in analog value, or to display it as an offset value from zero (0.5 V or 0.05 V). The output of this unit is electrically isolated from the measuring signal line, and the measured value will not be affected by external equipment.

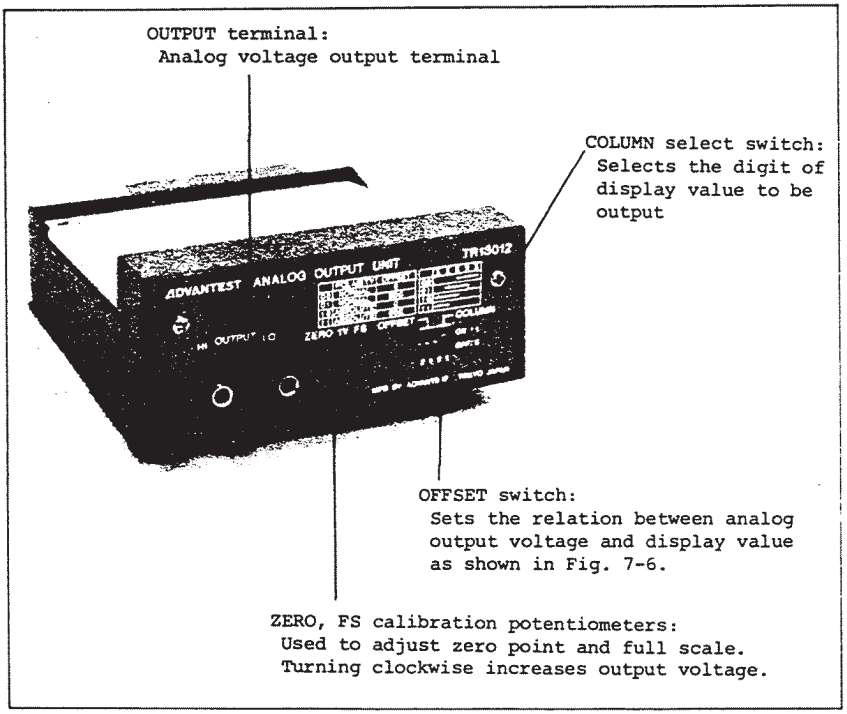


Figure 7-5 TR13012 Analog Output Unit

7.3.2 Specifications

Output voltage : 0 to +0.999 V

Number of digits to be converted : 3 digits. The three digits can be selected in four ways as shown below by the COLUMN select switch.

0 : 3 0 0 □□
1 : 3 0 □□□
2 : 3 □□□ 0
3 : □□□ 0 0

Conversion output : Selectable among NORMAL, OFFSET NORMAL, ABSOLUTE, OFFSET ABSOLUTE. The relationship between the displayed value and output voltage is shown in Figure 7-6.

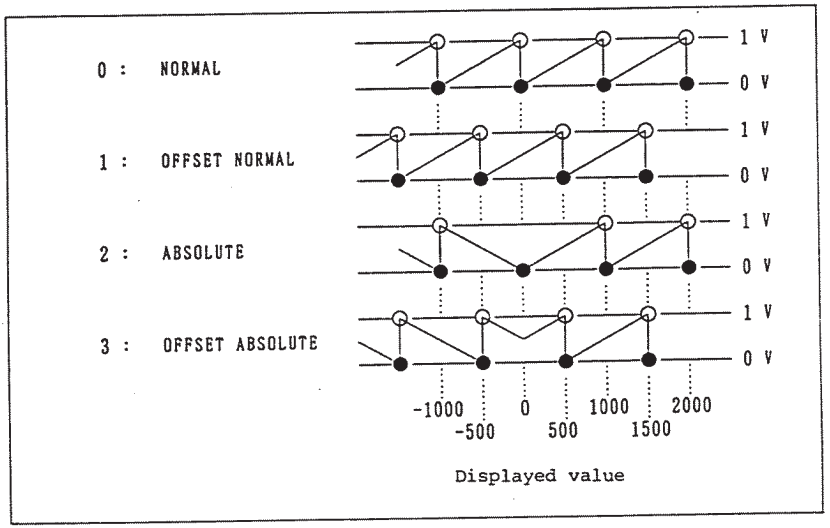


Figure 7-6 Relationship between Displayed Value and Output Voltage

Polarity : The polarity of measured result is not D/A converted. Only the absolute value is converted.

Conversion accuracy	:	±0.2% of full scale (+23°C ±5°C, less than RH85%) ±0.4% of full scale (0°C to +18°C, 18°C to +50°C, less than RH85%) This conversion accuracy is guaranteed for one year.
Response speed	:	Less than 10 ms (0 → full scale output of specified accuracy)
Output impedance	:	1 V output range Approx. 170 Ω
Power source	:	Supplied from TR6845 series multimeter
Operating ambient temperature	:	0°C to +50°C
Operating ambient humidity	:	Less than RH85%
Storage temperature	:	-25°C to +70°C
External dimensions	:	Approx. 116 mm (wide) x 49 mm (high) x 136 mm (long) (Connectors, knobs, and other projections excluded)
Weight	:	Less than 300 g

7.3.3 Operation

① Plug in the TR13012 to the multimeter.

② Turn ON the POWER switch of the multimeter.

③ Set the COLUMN switch to the digits you want to convert.

④ Set the OFFSET switch to the desired conversion output mode.

NOTE

The TR13012 only converts the absolute value of the measured result, and ignores its polarity. If recording the data that is deflecting into both plus and minus polarity sides from the zero point using a recorder or the like, the OFFSET switch should be set to "1" (OFFSET NORMAL). This will provide a satisfactory conversion output chart.

⑤ Connect the analog recorder to the output terminal of TR13012. Pay attention not to mistake the polarity.

⑥ Apply the signal to be measured to the input terminal of the digital multimeter.

This completes operation. Repeat two or three times for obtaining a satisfactory chart.

7.3.4 Calibration of D/A Output

The DCV function of the multimeter is used for this calibration.

① Setting of D/A accessory
COLUMN: 2
OFFSET: 0

② Set the multimeter to DCV function 1000 V range. A voltage of the D/A output pin is monitored with the voltimeter, the D/A output terminal voltage when the display is "0.0", and turn the zero adjusting potentiometer of TR13012 till 0 is displayed (within ±300 μV).

③ Set the multimeter to DCV function 3000 mV range. Adjust the input voltage (within ±400 μV) so that the display will be "999.0 mV*".

*: Because the COLUMN switch is set to "2", the display value of 10^0 digit does not affect the D/A output.

MEMO

8. CALIBRATION

This chapter describes the method of calibration to maintain the accuracy of measuring this voltmeter.

It is recommended to perform calibration at least once a year.

8.1 PREPARATION FOR CALIBRATION

(1) Power Supply
Use 50 Hz/60 Hz AC power line, or the battery unit TR15804.

(2) Environmental Conditions
Perform calibration at a place free from dust, vibration and noise, under the conditions of +20°C to +26°C temperature and 85% or less humidity.

(3) Warm Up
Warm up the TR6845 series multimeter for more than 30 minutes. Also warm up the other standard calibration device instruments as specified.

(4) Standard Instruments for Calibration

Table 8-1 Standard Instruments for Calibration

Standard instrument	Applicable range	Accuracy	Recommended unit
Standard DC voltage generator	0 to 1000 V	Within ±0.005%	TR6120
Standard AC voltage generator	100 kHz 300 mV to 750 V	Within ±0.05%	
Standard resistance	30 Ω to 300 MΩ	Within ±0.01%	
Digital voltmeter	DCV 10 µV resolution	Within ±0.1%	
Resistance			
Standard K(CA) thermocouple			TR1101-103
0°C Ice point unit	0°C	±0.05°C	TR7021

(5) Others
Prepare a slotted-head screwdriver for M2 screws. This is needed for turning the calibration potentiometer located on the side face of the multimeter.

After completing calibration, it is advisable to attach a sticker indicating the date of the next calibration.

8.2 CALIBRATION PROCEDURE

Zero point calibration and full scale calibration must be performed for each measuring function range. With the TR6845/6847 employing the true rms measurement system, 1/10 full scale calibration must be performed for 300 mV, 3000 mV and 750 V ranges, in addition to the ordinary full scale calibration. Table 8-2 lists the calibration items and recommended input values.

Table 8-2 List of Calibration Items

Measuring item	Range	Calibration item and calibration input value "-": Calibration not needed		
		Zero point calibration	Full scale	1/10 full scale
DC voltage	30 mV	0	30 mV	-
	300 mV	0	300 mV	-
	3000 mV	0	±3000 mV	-
	30 V	0	30 V	-
	300 V	0	300 V	-
	1000 V	0	1000 V	-
DC current	3 µA	0	3 µA	-
	30 µA } TR6848	0	30 µA	-
	300 µA	0	300 µA	-
	3000 µA TR6845	0	3000 µA	-
	30 mA } TR6846	0	30 mA	-
	300 mA TR6847	0	300 mA	-
	3000 mA	0	3000 mA	-
	10 A	0	10 A	-
Resistance	30 Ω	0	30 Ω	-
	300 Ω	0	300 Ω	-
	3000 Ω } OHM	0	3000 Ω	-
	30 kΩ L.P.	0	30 kΩ	-
	300 kΩ OHM	0	300 kΩ	-
	3000 kΩ	0	3000 kΩ	-
	30 MΩ	0	30 MΩ	-
	300 MΩ	0	300 MΩ	-

Table 8-2 List of Calibration Items (Cont'd)

Measuring item	Range	Calibration item and calibration input value "-": Calibration not needed		
		Zero point calibration	Full scale	1/10 full scale
AC voltage		TR6846/48 only	All models	TR6845/47 only
	300 mV	0	300 mV, 1 kHz	30 mV
	3000 mV	0	3000 mV	300 mV
	30 V	-	30 V	-
	300 V	-	300 V	-
	750 V	0	700 V	70 V
AC current	300 µA (TR6848)	0	300 µA, 300 Hz	30 µA
	3000 µA (TR6848)	0	3000 µA	300 µA
	30 mA (TR6845)	-	30 mA	-
	300 mA (TR6846)	-	300 mA	-
	3000 mA (TR6847)	-	3000 mA	-
	10 A	0	10 A	1 A
Temperature	TR6846/47 only	0	-	-

The calibration procedure is shown below. Calibration is valid if it is conducted for a specific range of a specific measuring function only. This section explains the calibration items listed in Table 8-2 in their listed sequence.

8.2.1 Setting the Calibration Mode

Press the CAL ON switch located on the bottom face of the TR6845 series multimeter body (Figure 8-1). Flashing of the display indicates that the equipment has been set in the calibration mode.

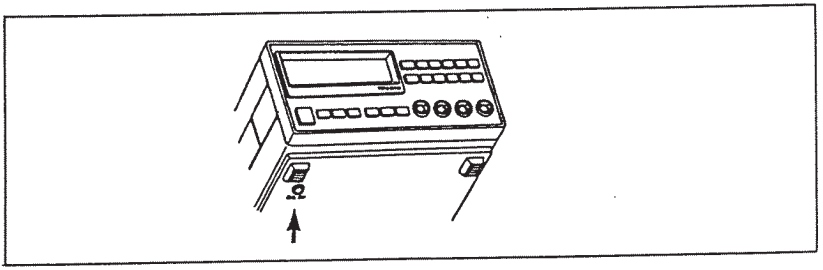


Figure 8-1 CAL ON Switch Position

8.2.2 Calibrating the DC Voltage Measuring Function

Set the measuring function and range to be calibrated.

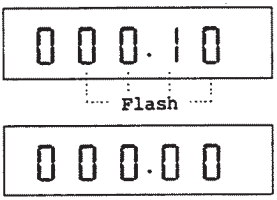
VDC DOWN
[▭] [ ]

(1) Calibrate the zero point of each range.

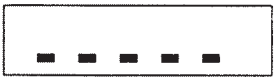
① Short the input terminal to provide zero input.

② Press SHIFT [ ]. The digit whose numeral can be changed stops flashing. Change the numeral to "0" by pressing DOWN [ ] UP [ ]. The digit position can be shifted by pressing the AUTO [▭] key.

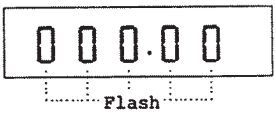
Set all the numerals to "0". With approximately zero input, the multimeter should read "000.00".



③ Press SHIFT [ ]. Calibration is executed. During calibration, the display remains as shown as follows.



④ As calibration completes, the displayed numerals begin to flash again.



This indicates that the zero point calibration of this range has been completed.

Set the next range by pressing UP [ ] or DOWN [ ] key, and perform zero point calibration, beginning from Step 2. above. After completing zero point calibration on all ranges, proceed to the full scale calibration of each range.

(2) Calibrating the full scale value of each range

NOTE

Perform calibration of the zero and ± full scale of the 3000 mV range first. The sequence of calibration of other ranges is not important. Calibration of - full scale is not needed.

① Set the multimeter to the 3000 mV range to be calibrated first, and set the input to 3 V. (See Table 8-2.)

② After selecting the range, perform calibration using the same procedure as Step ② and subsequent steps of Para. (1) above. Set the display to "3000.0 mV", and press the SHIFT [ ] key for calibration. After completing calibration, the multimeter displays the full scale value measured.

③ Enter -3 V, and set the display to "-3000.0 mV" using the same procedure as Step ② and subsequent steps of Para. (1). Then press the SHIFT [ ] key to calibrate the - full scale.

In this way, calibrate the full scale of the 30 mV, 300 mV, 30 V, 300 V and 1000 V range.

8.2.3 Calibrating the DC Current Measuring Function

Set the DC current measuring function, and perform calibration of the zero point and full scale of each range, in this order, using the same procedure as (1) above.

8.2.4 Calibrating the Resistance Measuring Function

Set the resistance measuring function, and perform calibration of the zero point and full scale, in this order, using the same procedure as (1) above.

8.2.5 Calibrating the AC Voltage/Current Measuring Function

The calibration procedure for AC voltage/current measuring function is different between the true rms measuring type TR6845/47 multimeter and the mean value measuring and rms displaying type TR6846/48 multimeter.

(1) Calibration of ± full scale and ±1/10 full scale of AC+DC function

TR6845/47 only

① Press the CAL ON switch to cancel the calibration mode.

② Turn on the POWER switch while pressing the [AC+DC] key.

③ Enter DC 3 V. The display will be approx. 1.6 V.

④ Enter DC -3 V. Turn the ± full scale adjusting potentiometer until the display is equal to the value displayed in step ② above.

⑤ Enter DC +0.3 V. The display will be approx. 0.16 V.

⑥ Enter DC -0.3 V. Turn the ±1/10 full scale adjusting potentiometer until the display is equal to the value displayed in step ④ above.

⑦ The - full scale value will be changed as the ±1/10 full scale potentiometer is turned. Repeat the steps ② to ⑤ until correct display is obtained.
The relative error of the ±1/10 full scale must be calibrated to within 3 counts.

NOTE

To cancel the calibration mode, press the [SHIFT] key.

(2) Calibrating the zero point of ranging amplifier TR6845/47 only

① Set the multimeter to the AC+DC mode of AC voltage measurement function, and set the range to 300 mV.

② Enter DC +300 mV and -300 mV alternately, and turn the RAZ potentiometer located on the side of the multimeter (see Section 1.3 (4)) until the difference in reading is at a minimum.

(3) Calibrating the frequency characteristics of AC voltage function

Common to all models

① With CAL ON switch OFF, set the multimeter to ACV, 3000 mV range.

② Connect the multimeter to the standard AC voltage generator, and enter 3 V, 70 kHz signal. Adjust the HFFS potentiometer (see Section 1.3 (4)) located on the left side face of the equipment so that the display value is 3000.0 mV ±15 counts.

(4) Calibrating the AC voltage (true rms) function TR6845/47 only

NOTE

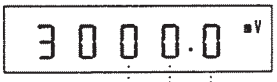
1. The 3000 mV range must be calibrated first. The sequence of calibration of other ranges is not important.
2. The 3000 mV, 300 mV and 750 V ranges must be calibrated in the sequence of full scale → 1/10 full scale.
3. Calibration of full scale only is required for the 30 V and 300 V ranges.

① Set the CAL ON key to ON. (See Section 8.2.1.)

② Select the AC voltage measuring function by the VAC keys, and set the multimeter to the 3000 mV range by the DOWN UP keys.

③ Enter the standard signal of 3 V, 1 kHz.

④ After the display has stabilized (wait for about 10 seconds), press the SHIFT key. The digits shown below will begin to flash.



To cancel this state, press any key other than AUTO, DOWN, UP and SHIFT .

⑤ Press again the SHIFT key, and calibration will begin, with the display remaining as shown below.

After completing calibration, the display becomes nearly the same as the input value.

⑥ Next, enter the 1/10 full scale (0.3 V, 1 kHz), then press the SHIFT key.

⑦ Press the DOWN UP keys until the display is "300.0 mV". The display will be "300.0 mV" without key operation when measuring a value that is nearly the same as the 1/10 full scale value.

⑧ After entering the 1/10 full scale value (wait for more than 5 seconds), press the SHIFT key to perform calibration like Step ⑤ above. Upon terminating calibration, the 1/10 full scale value is displayed.

Similarly to the above Steps ① thru ⑧, calibrate the 300 mV, 30 V, 300 V and 750 V ranges by entering the voltages corresponding to the values shown below.

300 mV range: 300.00 mV → 30.00 mV
30 V range: 30.000 V
300 V range: 300.00 V
750 V range: 700.00 V → 70.0 V

(5) Calibrating the AC current (true rms) function TR6845/47 only

NOTE

1. The 3000 μA range must be calibrated first. The sequence of calibration of other ranges is not important.
2. The 3000 μA, 300 μA and 10 A ranges must be calibrated in the sequence of full scale and 1/10 full scale.
3. Calibration of full scale only is required for the 30 mA, 300 mA, 3000 mA.

Calibration should be executed in the sequence of Steps ① to ⑧ in Para.(6). That is, Turning ON of CAL ON key → Selection of AAC function → Selection of range (3000 μA) → Input of standard signal (3 mA, 300 Hz) → ...

(6) Calibration of AC voltage (mean average measuring and rms displaying) function TR6846/48 only

NOTE

1. The 3000 mV range must be calibrated first. The sequence of calibration of other ranges is not important.
2. Range of 3000 mV, 300 mV and 750 V must be calibrated in the sequence of zero and full scale.
3. Range of 30 V, 300 V is calibrated at full scale.
4. Frequency characteristics must be calibrated after calibrating the 3000 mV range. (See Para.(3).)

① Set CAL ON switch to ON. (See Subsection 8.2.1.)

② Press the VAC key to select the AC voltage measuring function, and set the range to 3000 mV range using DOWN or UP.

③ Short the ends of input cables.

The oscilloscope or DVM+10kl carbon resistance is used to calibrate the zero point of the amplifier having absolute value.

1. Calibration with the oscilloscope

   Connect the oscilloscope earth line to the input line, and connect the oscilloscope probe to the plating line which you can see from the RAZ volume hole. (See Section 1.3-(4).)

   100 mV/div
   1 ms/div

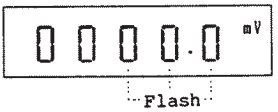
   Adjust the waveform central value to zero with the 1/10FS volume (See Section 1.3-(4)). (less than ±50 mV)

2. Calibration with DVM+10kl carbon resistance

   Connect the DVM earth line to the input line. Provide 10kl carbon resistance to the plating line which you can see from the RAZ volume hole (3), and connect the end of the plating line to the Hi line. (DVM: VDC/1 mV resolution range)

   Adjust the waveform central value to less than +50 mV with the 1/10FS volume (See Section 1.3 (4).).

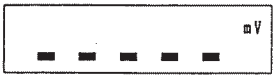
④ After the display has stabilized (wait for about 10 seconds), press the SHIFT key. The digits shown below will flash.



NOTE

To cancel this state, press any key other than the AUTO, DOWN, UP and SHIFT keys.

⑤ Press the SHIFT key again to start calibration. The marks displayed as shown below indicate that calibration is being performed.



After completing calibration, a value that is roughly equal to zero is displayed.

⑥ Next, enter the full scale value (standard output: 3 V, 1 kHz), then press the SHIFT key.

⑦ Control the DOWN and UP keys until "3000.0 mV" is displayed.
If the measured value is approximately equal to the full scale, "3000.0 mV" display will be obtained without key operation.

⑧ After entering the signal (wait for about 10 seconds), press the SHIFT key for calibration, like the case of ⑤ above.
Upon termination of calibration, the multimeter measures the full scale value, and displays the measured value.

(7) Calibrating the AC current (mean average measuring and rms displaying) function TR6846/48 only

NOTE

1. The 3000 µA range must be calibrated first. The sequence of calibration of other ranges is not important.
2. The 3000 µA, 300 µA and 10 A ranges must be calibrated in the sequence of zero and full scale.
3. Calibration of full scale only is required for the 30 mA and 3000 mA ranges.

Calibration should be executed in the sequence of steps ① to ⑧ in Para.(6). That is, Turning ON of CAL ON key → Selection of AAC function → Selection of range (3000 µA) → Input of standard signal (3 mA, 300 Hz) → ...

8.2.6 Termination and Cancellation of Calibration

To terminate or cancel the calibration mode, press the CAL ON switch. (See Subsection 8.2.1.)

8.2.7 Calibrating Zero Point for Temperature Measurement TR6846/47 Only

Prepare: Standard K(CA) thermocouple, 0°C ice unit.

① Connect the K(CA) thermocouple to the input terminal.

② Press the TEMP key to measure the temperature of the 0°C ice unit. (Figure 8-2)

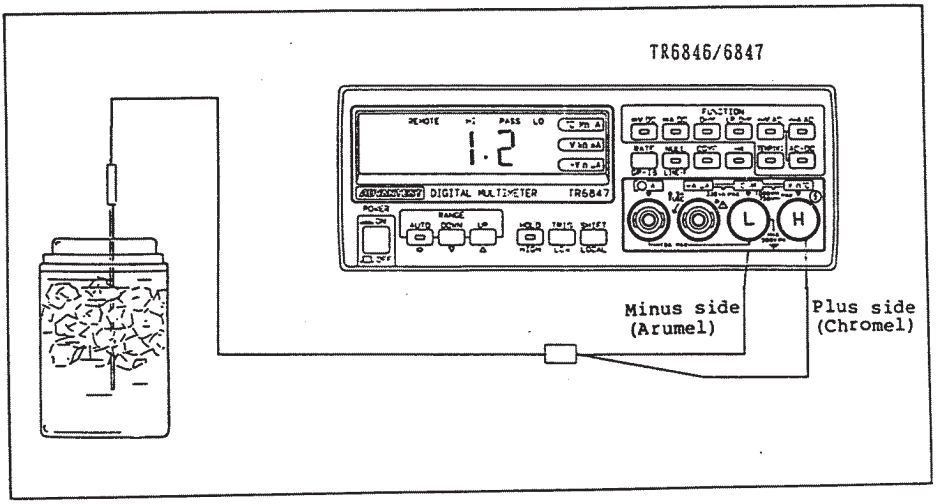


Figure 8-2 Zero Point Calibration in Temperature Measurement

③ Turn the potentiometer (Figure 8-3) with a slotted head screwdriver until the value obtained by subtracting the error caused by thermocouple and the error of the 0°C ice unit from the displayed value is 0.0°C ±2 digits.

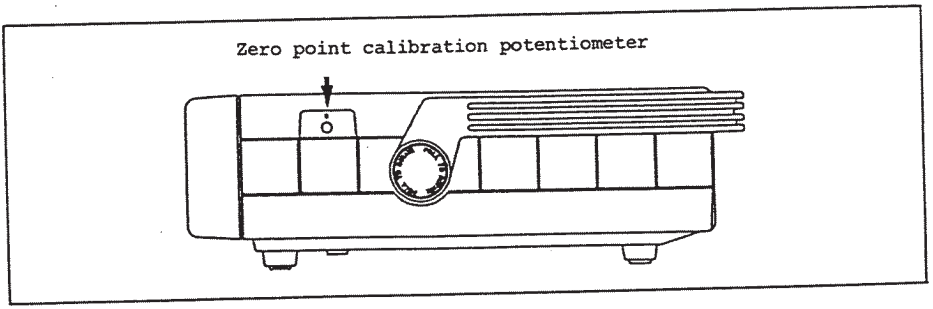


Figure 8-3 Location of Temperature Measurement Zero Point Calibration Potentiometer

MEMO

9. MAINTENANCE AND INSPECTION

This chapter describes how to store the multimeter when not in use, and checking points to avoid trouble.

9.1 STORAGE

When the TR6845 series is not to be used for a long time, wrap it in a vinyl cover and put it into a carton box, and store it away from humidity and direct sunlight. The allowable temperature range for storage is -25°C to +70°C.

Use the same method when storing the TR15804 battery unit. However, the storage temperature range is -20°C to +35°C.

9.2 BEFORE ASKING FOR REPAIR

In case trouble with the operation of the TR6845 series, please check the following points, and contact the nearest ADVANTEST representative.

Phenomenon	Cause	Action
"Low battery" sign appears.	o Battery voltage is low. (When TR15804 is used)	o Recharge battery, referring to 7.1.3.
No display	o Power line fuse is blown.	o Replace with accessory fuse, referring to 9.4.1.
	o When TR15804 is used, battery fuse is blown.	o Exchange the battery fuse, and recharge battery, referring to 7.1.3.
Unstable or abnormal reading	o Wrong setting of function or range o Wrong setting of line frequency 50/60 Hz	o Set the correct function or range. o Set correctly according to the AC line frequency connected.
Does not measure even when input signal is applied.	o Cable is connected to the wrong input terminal.	o Connect the cable to the correct terminal.

9.3 IF AN ERROR MESSAGE IS DISPLAYED

Error message	Description
Err 3	The parameters backed up by battery are destroyed. If this message appears, turn on power while pressing ~AAC [⊟], and the parameters will be initialized.
Err 5	Panel setting contains an error. Recheck the panel to be set.
Err 6	GPIB setting contains an error. Recheck the GPIB to be set.
Err 9	Displayed when calibration range is out of tolerance value. Displayed when input data and set value differ largely. If this error is displayed, recheck the calibration data and set value.

NOTE

If error message other than shown above is displayed, this multimeter is considered to be out of order if an error message is displayed although data and setting are appropriate. Contact the nearest dealer or the sales and support offices.

9.4 FUSE

In addition to the power fuse, this equipment is provided with a protection fuse at the current measurement input terminal so as to protect the internal circuit.

9.4.1 Replacement of Power Line Fuse

CAUTION

1 When replacing the fuse, turn OFF the POWER switch, and also disconnect the power cable.
Remember that the power is supplied to the primary side of the transformer, creating a dangerous situation, if the power cable is not disconnected after turning OFF the POWER switch.

2 Replace with a fuse of the same rating.
The ratings of the fuses are shown in Table 9-1.

3 Visual fuse inspection alone is not enough. Measure the resistance value. The fuse is normal if the resistance is below 15 Ω.

Table 9-1 Fuse Ratings

	Specification	Stock No.	Q'ty	Remarks
Power line fuse	EAWK0.16A	DFT-AAR16A	2	AC 100/120V
	EAWK0.08A	DFT-AAR08A		AC 220/240V
Protection fuse	MF51NR0.5(250)	DFN-AAR5A	2	

① Turn OFF the power switch, and disconnect the power cable. Also remove the options such as input cable and TR13217. (See Section 2.2.)

② Remove one screw from the accessory insertion port located on the bottom face of the equipment body.

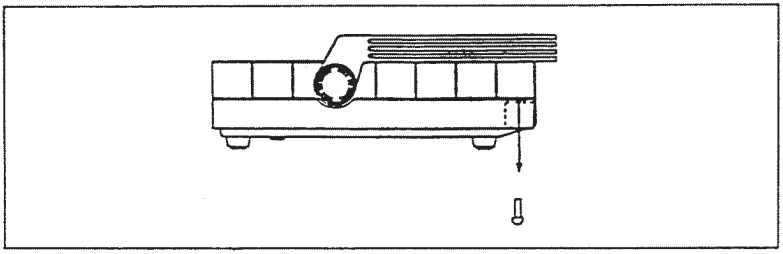


Figure 9-1 Removing the Screw from the Bottom of This Multimeter

③ Remove the upper part of equipment by sliding.

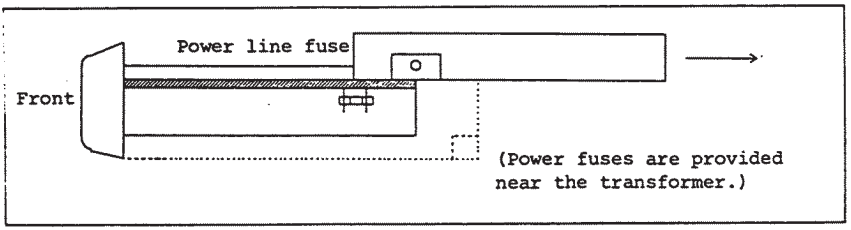


Figure 9-2 Removing the Upper Cover of Multimeter

④ Push the fuse sidewise as shown for removal.

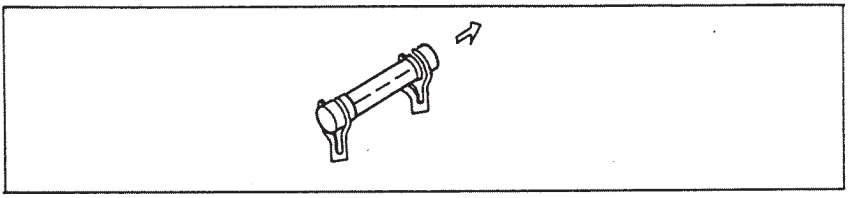


Figure 9-3 Removal of Fuse

⑤ To install, push the fuse into position from above.

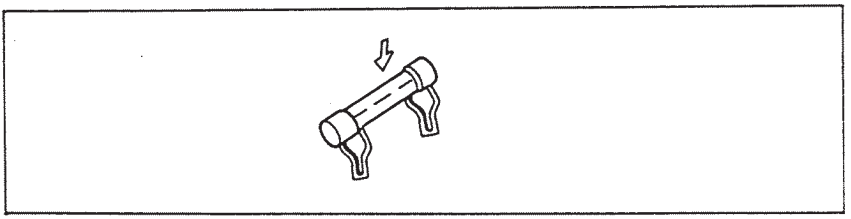


Figure 9-4 Installation of Fuse

9.4.2 Replacement of Circuit Protection Fuse

Turn the mA-μA terminal counterclockwise by about 70° while pressing down, and the connector will come off. The current measurement protection fuse is fitted on the rear side of this connector. To install the connector, push it into the mA-μA terminal, and turn clockwise.

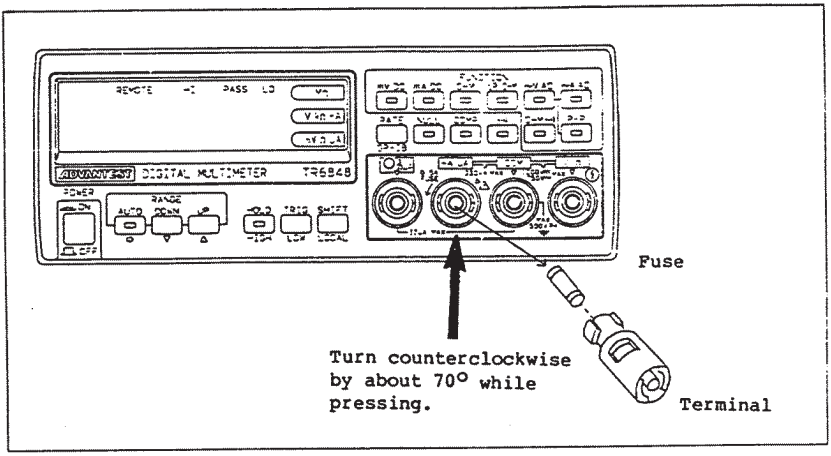


Figure 9-5 Replacement of Circuit Protection Fuse in mA-μA Terminal

10. SPECIFICATIONS

This chapter describes the performance of TR6845/6846/6847/6848, which are tabled.

10.1 SPECIFICATIONS OF TR6845

Measuring accuracy: Guaranteed for one year at temperature of 23°C ± 5°C and relative humidity of less than 85%. Display format is ± % of reading ± number of digits.

Temperature coefficient: At 0°C to 18°C, and + 28°C to + 50°C. Display format is (± % of reading ± number of digits) / °C

(1) DC Voltage Measurement

d: digit

Range	30 mV	300 mV	3000 mV	30 V	300 V	1000 V
Resolution	1 µV	10 µV	100 µV	1 mV	10 mV	100 mV
Measuring accuracy	±0.07%±8d	±0.07%±2d				
Temperature coefficient	±0.004%±0.8d	±0.004%±0.2d				
Input impedance	1000 MΩ or over			10 MΩ ±1%		
Maximum allowable input voltage	400 V (DC or AC peak, continuous) 1100 V(DC or AC peak, for 10 sec)			1100 V (DC or AC peak, continuous)		

Noise reduction ratio	ECMRR unbalance resistance 1 kΩ	Effective common mode noise reduction ratio (ECMRR)		Normal mode noise reduction ratio (NMRR)
		AC 50/60 Hz ±0.1%	DC	AC 50/60 HZ ±0.1%
		Approx. 120 dB		Approx. 60 dB

(2) AC Voltage Measurement
(True rms, AC+DC): With 5% or greater input of full scale

<table>
<tr><td colspan="3">Range</td><td>300 mV</td><td>3000 mV</td><td>30 V</td><td>300 V</td><td>750 V</td></tr>
<tr><td colspan="3">Resolution</td><td>10 µV</td><td>100 µV</td><td>1 mV</td><td>10 mV</td><td>100 mV</td></tr>
<tr><td rowspan="6">Measuring accuracy</td><td rowspan="4">AC</td><td>20 Hz to 45 Hz</td><td colspan="5">±0.4%±30d</td></tr>
<tr><td>45 Hz to 30 kHz</td><td colspan="2">±0.3%±30d</td><td colspan="2">±0.6%±30d</td><td>±0.5%
±30d
(Up to
1 kHz)</td></tr>
<tr><td>30 kHz to 50 kHz</td><td colspan="2">±0.9%±50d</td><td colspan="2">±1.5%±50d</td><td>-</td></tr>
<tr><td>50 kHz to 100 kHz</td><td colspan="2">±3%±100d</td><td colspan="2">±5%±100d</td><td>-</td></tr>
<tr><td rowspan="4">AC+DC</td><td>20 Hz to 45 Hz</td><td colspan="2">±0.3%±40d</td><td colspan="3">±0.4%±40d</td></tr>
<tr><td>45 Hz to 30 kHz</td><td colspan="2">±0.3%±40d</td><td colspan="2">±0.6%±40d</td><td>±0.5%
±40d
(Up to
1 kHz)</td></tr>
<tr><td>30 kHz to 50 kHz</td><td colspan="2">±0.9%±50d</td><td colspan="2">±1.5%±50d</td><td>-</td></tr>
<tr><td>50 kHz to 100 kHz</td><td colspan="2">±3%±100d</td><td colspan="2">±5%±100d</td><td>-</td></tr>
<tr><td colspan="3">Temperature coefficient</td><td colspan="5">At each range and each frequency range:
(1/10 of measuring accuracy) / °C</td></tr>
<tr><td colspan="3">Crest factor</td><td colspan="5">At full scale: 3:1
(750 V range: With input of below 300 V)</td></tr>
<tr><td colspan="3">Input impedance</td><td colspan="5">2 MΩ ±2% Less than 100 pF</td></tr>
<tr><td colspan="3">Maximum allowable input voltage</td><td colspan="5">800 Vrms (Continuous)
1200 V (Peak)
10^7 V Hz (Continuous)</td></tr>
<tr><td colspan="3">Response time</td><td colspan="5">Approx. 4 sec</td></tr>
</table>

(3) Resistance Measurement

Range		30 Ω	300 Ω	3000 Ω	30 kΩ	300 kΩ	3000 kΩ	30 MΩ	300 MΩ
Resolution		1 mΩ	10 mΩ	100 mΩ	1 Ω	10 Ω	100 Ω	1 kΩ	10 kΩ
Resistance measurement	Measuring current	1 mA			100 µA	10 µA	1 µA	100 nA	10 nA
	Measuring voltage	0.03 V	0.3 V	3 V					
	Measuring accuracy*1	±0.08% ±10d	±0.08%±2d				±0.1% ±2d	±0.3% ±5d	±3% ±10d
	Temperature coefficient	±0.004% ±1.5d	±0.004% ±0.2d				±0.01% ±0.2d	±0.04% ±0.2d	±0.4% ±0.2d
In-circuit resistance measurement	Measuring current	-	100 µA		10 µA	1 µA	10 nA	10 nA	-
	Measuring voltage	-	0.03 V	0.3 V					-
	Measuring accuracy*1	-	±0.2% ±10d	±0.3%±5d			±0.3% ±10d	±3% ±15d	-
	Temperature coefficient	-	±0.2% ±1d	±0.02%±0.8d			±0.04% ±0.8d	±0.4% ±0.8d	-
Voltage between open terminal		Max. 5.8 V							
Maximum allowable input voltage		350 V peak (Continuous)							

*1: The accuracy for 30 Ω to 300 Ω ranges is for NULL function.

(4) DC Current Measurement

Range	300 µA	3 mA	30 mA	300 mA	3 A	10 A
Resolution	10 nA	100 nA	1 µA	10 µA	100 µA	1 mA
Measuring accuracy	±0.25%±5d				±0.7%±5d	
Temperature coefficient	±0.02%±1d					
Resistance between input terminals	102 Ω or less		2 Ω or less		0.02Ω or less	
Maximum allowable input current	0.5 A fuse protection				20 A (for 10 sec)	

(5) AC Current Measurement
(True RMS, AC+DC): With input of over 5% full scale

Range	300 µA	3 mA	30 mA	300 mA	3 A	10 A
Resolution	10 nA	100 nA	1 µA	10 µA	100 µA	1 mA
Measuring accuracy (20 Hz to 1 kHz)	±0.8%±40d					
Temperature coefficient	(1/10 measuring accuracy)/°C of each range					
Crest factor	At full scale 3:1					
Resistance between input terminals	102 Ω or less		2 Ω or less		0.02Ω or less	
Maximum allowable input current	0.5 A fuse protection				20 A (for 10 sec)	

(6) Integrating time, number of display digits, and measuring speed

Integrating time		100 ms
No. of display digits		4-1/2 digits
Measuring speed	FAST	5 cycles/sec
	MID	2.5 cycles/sec
	SLOW	1.25 cycles/sec

10.2 SPECIFICATIONS OF TR6846

(1) DC Voltage Measurement

Range	30 mV	300 mV	3000 mV	30 V	300 V	1000 V
Resolution	1 µV	10 µV	100 µV	1 mV	10 mV	100 mV
Measuring accuracy	±0.04%±5d	±0.04%±2d				
Temperature coefficient	±0.004%±0.8d	±0.004%±0.2d				
Input impedance	1000 MΩ or over			10 MΩ ±1%		
Maximum allowable input voltage	400 V (DC or AC peak, continuous) 1100 V (DC or AC peak, for 10 sec)			1100 V (DC or AC peak, continuous)		

Noise reduction ratio	ECMRR unbalance resistance 1 kΩ	Effective common mode noise reduction ratio (ECMRR)		Normal mode noise reduction ratio (NMRR)
		AC 50/60 Hz ±0.1%	DC	AC 50/60 HZ ±0.1%
	4-1/2 digits	Approx. 120 dB	Approx. 120 dB	Approx. 60 dB
	3-1/2 digits	Approx. 60 dB		0 dB

(2) AC Voltage Measurement
(Mean value measuring, and RMS indicating system)

Range			300 mV	3000 mV	30 V	300 V	750 V
Resolution			10 µV	100 µV	1 mV	10 mV	100 mV
Measuring accuracy*	AC	20 Hz to 45 Hz	±0.4%±10d				
		45 Hz to 10 kHz	±0.2%±10d		±0.3%±10d		±0.5% ±10d (Up to 1 kHz)
		10 kHz to 30 kHz	±0.3%±20d		±0.5%±20d		-
		30 kHz to 50 kHz	±0.8%±30d		±1%±30d		-
		50 kHz to 100 kHz	±3%±50d		±5%±50d		-
Temperature coefficient			(1/10 of measuring accuracy) / °C at each range and each frequency range				
Input impedance			2 MΩ ±2% Less than 100 pF				
Maximum allowable input voltage			800 Vrms (Continuous) 1200 V (Peak) 10^7 V Hz (Continuous)				
Response time			FAST, MID sampling rate (300 Hz or more): Approx. 2 sec SLOW sampling rate (20 Hz to 300 Hz): Approx. 4 sec				

*: SLOW sampling rate: 20 Hz to 100 kHz
FAST, MID sampling rate: 300 Hz to 100 kHz
In 20 Hz to 300 Hz FAST and MID sampling measurement, measuring operation is performed, but its measuring accuracy is not guaranteed.

(3) Resistance Measurement

Range		30 Ω	300 Ω	3000 Ω	30 kΩ	300 kΩ	3000 kΩ	30 MΩ	300 MΩ
Resolution		1 mΩ	10 mΩ	100 mΩ	1 Ω	10 Ω	100 Ω	1 kΩ	10 kΩ
Resistance measurement	Measuring current	1 mA			100 µA	10 µA	1 µA	100 nA	10 nA
	Measuring voltage	0.03 V	0.3 V	3 V					
	Measuring accuracy*1	±0.07% ±10d	±0.07%±2d				±0.1% ±2d	±0.3% ±5d	±3% ±10d
	Temperature coefficient	±0.004% ±1.5d	±0.004% ±0.2d				±0.01% ±0.2d	±0.04% ±0.2d	±0.4% ±0.2d
In-circuit resistance measurement	Measuring current	-	100 µA	10 µA		1 µA	10 nA	10 nA	-
	Measuring voltage	-	0.03 V	0.3 V					-
	Measuring accuracy*1	-	±0.2% ±10d	±0.2%±5d			±0.3% ±10d	±3% ±15d	-
	Temperature coefficient	-	±0.2% ±1d	±0.02%±0.8d			±0.04% ±0.8d	±0.4% ±0.8d	-
Voltage between open terminal		Max. 5.8 V							
Maximum allowable input voltage		350 V peak (Continuous)							

*1: The accuracy for 30 Ω to 300 Ω ranges is for NULL function.

(4) DC Current Measurement

Range	300 µA	3 mA	30 mA	300 mA	3 A	10 A
Resolution	10 nA	100 nA	1 µA	10 µA	100 µA	1 mA
Measuring accuracy	±0.2%±5d				±0.6%±5d	
Temperature coefficient	±0.02%±1d					
Resistance between input terminals	102 Ω or less		2 Ω or less		0.02Ω or less	
Maximum allowable input current	0.5 A fuse protection				20 A (for 10 sec)	

(5) AC Current Measurement
(Mean value measuring and RMS indicating system)

Range		300 µA	3000 µA	30 mA	300 mA	3 A	10 A
Resolution		10 nA	100 nA	1 µA	10 µA	100 µA	1 mA
Measuring accuracy*	20Hz to 45Hz	±0.6%±30d		±0.7%±30d			
	45Hz to 1kHz	±0.5%±30d		±0.6%±30d			
Temperature coefficient		(1/10 of measuring accuracy)/°C at each range and each frequency range					
Resistance between input terminals		102 Ω or less		2 Ω or less		0.02Ω or less	
Maximum allowable input current		0.5 A fuse protection				20 A (for 10 sec)	

*: SLOW sampling rate: 20 Hz to 1 kHz
FAST, MID sampling rate: 300 Hz to 1 kHz
In 20 Hz to 300 Hz FAST and MID sampling measurement, the measuring operation is performed, but its measuring accuracy is not guaranteed.

(6) Temperature Measurement

Thermocouple	K(CA)
Resolution	0.1°C
Measuring range	-50°C to 1370°C
Measuring accuracy	±0.1%of rdg ±1.5°C

(7) Integration Time and Number of Display Digits

Integration time		No. of display digits
FAST	2 ms	3-1/2
MID	20 ms 16.667 ms	4-1/2
SLOW	100 ms	

(8) Measuring speed

	Sampling rate	FAST	MID	SLOW
Measuring speed	DC voltage measurement	100 cycles /sec	15 cycles /sec	5 cycles /sec
	DC current measurement			
	Resistance measurement*			
	AC voltage measurement	15 cycles/sec		
	AC current measurement			

*: Resistance measurement 3 MΩ and 30 MΩ ranges and low power ohm measurement 3 MΩ FAST range: Sampling rate is 15 cycles/sec and integration time is 20 ms or 16.667 ms. Resistance measurement 300 MΩ range and low power ohm measurement 30 MΩ range FAST and MID: Sampling rate is 5 cycles/sec and integration time is 100 ms.

The measuring speed of temperature measurement is 1/2 the speed of DC voltage measurement.

10.3 SPECIFICATIONS OF TR6847

(1) DC Voltage Measurement

Range	30 mV	300 mV	3000 mV	30 V	300 V	1000 V
Resolution	1 μV	10 μV	100 μV	1 mV	10 mV	100 mV
Measuring accuracy	±0.04%±5d	±0.04%±2d				
Temperature coefficient	±0.004%±0.8d	±0.004%±0.2d				
Input impedance	1000 MΩ or over			10 MΩ ±1%		
Maximum allowable input voltage	400 V (DC or AC peak, continuous) 1100 V (DC or AC peak, for 10 sec)			1100 V (DC or AC peak, continuous)		

Noise reduction ratio	ECMRR unbalance resistance 1 kΩ	Effective common mode noise reduction ratio (ECMRR)		Normal mode noise reduction ratio (NMRR)
		AC 50/60 Hz ±0.1%	DC	AC 50/60 Hz ±0.1%
	4-1/2 digits	Approx. 120 dB	Approx. 120 dB	Approx. 60 dB
	3-1/2 digits	Approx. 60 dB		0 dB

(2) AC Voltage Measurement
(True rms, AC+DC): With 5% or greater input of full scale

Range			300 mV	3000 mV	30 V	300 V	750 V
Resolution			10 µV	100 µV	1 mV	10 mV	100 mV
Measuring accuracy*	AC	20 Hz to 45 Hz	±0.4% ±30d		±0.3%±30d		
		45 Hz to 10 kHz	±0.2%±30d		±0.3%±30d		±0.5% ±30d (Up to 1 kHz)
		10 kHz to 30 kHz	±0.3%±30d		±0.5%±30d		-
		30 kHz to 50 kHz	±0.8%±50d		±1%±50d		-
		50 Hz to 100 kHz	±3%±100d		±5%±100d		-
	AC+DC	20 Hz to 45 Hz	±0.25%±40d		±0.25%±40d		
		45 Hz to 10 kHz	±0.2%±40d		±0.3%±40d		±0.5% ±40d (Up to 1 kHz)
		10 kHz to 30 kHz	±0.3%±40d		±0.5%±40d		-
		30 kHz to 50 kHz	±0.8%±50d		±1%±50d		-
		50 kHz to 100 kHz	±3%±100d		±5%±100d		-
Temperature coefficient			(1/10 of measuring accuracy) / °C at each range and each frequency range				
Crest factor			At full scale: 3:1 (750 V range: With input of below 300 V)				
Input impedance			2 MΩ ±2% Less than 100 pF				
Maximum allowable input voltage			800 Vrms (Continuous) 1200 V (Peak) 10^7 V Hz (Continuous)				
Response time			FAST, MID sampling rate (300 Hz or more): Approx. 0.3 sec SLOW sampling rate (20 Hz to 300 Hz): Approx. 4 sec				

*: SLOW sampling rate: 20 Hz to 100 kHz
FAST, MID sampling rate: 300 Hz to 100 kHz
In 20 Hz to 300 Hz FAST and MID sampling measurement, the measuring operation is performed, but its measuring accuracy is not guaranteed.

(3) Resistance Measurement

Range		30 Ω	300 Ω	3000 Ω	30 kΩ	300 kΩ	3000 kΩ	30 MΩ	300 MΩ
Resolution		1 mΩ	10 mΩ	100 mΩ	1 Ω	10 Ω	100 Ω	1 kΩ	10 kΩ
Resistance measurement	Measuring current	1 mA			100 µA	10 µA	1 µA	100 nA	10 nA
	Measuring voltage	0.03 V	0.3 V	3 V					
	Measuring accuracy*1	±0.07% ±10d	±0.07%±2d				±0.1% ±2d	±0.3% ±5d	±3% ±10d
	Temperature coefficient	±0.004% ±1.5d	±0.004% ±0.2d				±0.01% ±0.2d	±0.04% ±0.2d	±0.4% ±0.2d
In-circuit resistance measurement	Measuring current	-	100 µA		10 µA	1 µA	100 nA	10 nA	-
	Measuring voltage	-	0.03 V	0.3 V					-
	Measuring accuracy*1	-	±0.2% ±10d	±0.2%±5d			±0.3% ±10d	±3% ±15d	-
	Temperature coefficient	-	±0.2% ±1d	±0.02%±0.8d			±0.04% ±0.8d	±0.4% ±0.8d	-
Voltage between open terminal		Max. 5.8 V							
Maximum allowable input voltage		350 V peak (Continuous)							

*1: The accuracy for 30 Ω to 300 Ω ranges is for NULL function.

(4) DC Current Measurement

Range	300 µA	3 mA	30 mA	300 mA	3 A	10 A
Resolution	10 nA	100 nA	1 µA	10 µA	100 µA	1 mA
Measuring accuracy	±0.2%±5d				±0.6%±5d	
Temperature coefficient	±0.02%±1d					
Resistance between input terminals	102 Ω or less		2 Ω or less		0.02Ω or less	
Maximum allowable input current	0.5 A fuse protection				20 A (for 10 sec)	

(5) AC Current Measurement
(True RMS, AC+DC): With input of over 5% full scale

Range	300 µA	3 mA	30 mA	300 mA	3 A	10 A
Resolution	10 nA	100 nA	1 µA	10 µA	100 µA	1 mA
Measuring accuracy* (20 Hz to 1 kHz)	±0.5%±40d		±0.6%±40d			
Temperature coefficient	(1/10 of measuring accuracy)/°C at each measuring range and each frequency range					
Crest factor	At full scale 3:1					
Resistance between input terminals	102 Ω or less		2 Ω or less		0.02Ω or less	
Maximum allowable input current	0.5 A fuse protection				20 A (for 10 sec)	

SLOW sampling rate: 20 Hz to 1 kHz
FAST, MID sampling rate: 300 Hz to 1 kHz
In 20 Hz to 300 Hz FAST and MID sampling measurement, the mesuring operation is performed, but its measuring accuracy is not guaranteed.

(6) Temperature Measurement

Thermocouple	K(CA)
Resolution	0.1°C
Measuring range	-50°C to 1370°C
Measuring accuracy	±0.1% of rdg ±1.5°C

(7) Integration Time and Number of Display Digits

Integration time		No. of display digits
FAST	2 ms	3-1/2
MID	20 ms 16.667 ms	4-1/2
SLOW	100 ms	

(9) Measuring Speed

Sampling rate		FAST	MID	SLOW
Measuring speed	DC voltage measurement	100 cycles /sec	15 cycles /sec	5 cycles /sec
	DC current measurement			
	Resistance measurement*			
	AC voltage measurement	15 cycles/sec		
	AC current measurement			

*: Resistance measurement 3 MΩ and 30 MΩ ranges and low power ohm measurement 3 MΩ FAST range: Sampling rate is 15 cycles/sec and integration time is 20 ms or 16.667 ms. Resistance measurement 300 MΩ range and low power ohm measurement 30 MΩ range FAST and MID: Sampling rate is 5 cycles/sec and integration time is 100 ms.

The measuring speed of temperature measurement is 1/2 the speed of DC voltage measurement.

10.4 SPECIFICATIONS OF TR6848

(1) DC Voltage Measurement

Range	30 mV	300 mV	3000 mV	30 V	300 V	1000 V
Resolution	1 µV	10 µV	100 µV	1 mV	10 mV	100 mV
Measuring accuracy	±0.05%±5d	±0.05%±2d				
Temperature coefficient	±0.004%±0.8d	±0.004%±0.2d				
Input impedance	1000 MΩ or over			10 MΩ ±1%		
Maximum allowable input voltage	400 V (DC or AC peak, continuous) 1100 V (DC or AC peak, for 10 sec)			1100 V (DC or AC peak, continuous)		

Noise reduction ratio	ECMRR unbalance resistance 1 kΩ	Effective common mode noise reduction ratio (ECMRR)		Normal mode noise reduction ratio (NMRR)
		AC 50/60 Hz ±0.1%	DC	AC 50/60 Hz ±0.1%
		Approx. 120 dB		Approx. 60 dB

(2) AC Voltage Measurement
(Mean value measuring, and RMS indicating system)

Range			300 mV	3000 mV	30 V	300 V	750 V
Resolution			10 µV	100 µV	1 mV	10 mV	100 mV
Measuring accuracy	AC	20 Hz to 45 Hz	±0.4%±15d				
		45 Hz to 10 kHz	±0.2%±15d		±0.3%±15d		±0.5% ±15d (Up to 1 kHz)
		10 kHz to 30 kHz	±0.3%±25d		±0.5%±25d		-
		30 kHz to 50 kHz	±0.8%±35d		±1%±35d		-
		50 kHz to 100 kHz	±3%±55d		±5%±55d		-
Temperature coefficient			(1/10 of measuring accuracy) / °C at each range and each frequency range				
Input impedance			2 MΩ ±2% Less than 100 pF				
Maximum allowable input voltage			800 Vrms (Continuous) 1200 V (Peak) 10^7 V Hz (Continuous)				
Response time			Approx. 4 sec				

(3) Resistance Measurement

<table>
<tr><td colspan="2">Range</td><td>30 Ω</td><td>300 Ω</td><td>3000 Ω</td><td>30 kΩ</td><td>300 kΩ</td><td>3000 kΩ</td><td>30 MΩ</td><td>300 MΩ</td></tr>
<tr><td colspan="2">Resolution</td><td>1 mΩ</td><td>10 mΩ</td><td>100 mΩ</td><td>1 Ω</td><td>10 Ω</td><td>100 Ω</td><td>1 kΩ</td><td>10 kΩ</td></tr>
<tr><td rowspan="4">Resist-ance measure-ment</td><td>Measuring current</td><td colspan="3">1 mA</td><td>100 µA</td><td>10 µA</td><td>1 µA</td><td>100 nA</td><td>10 nA</td></tr>
<tr><td>Measuring voltage</td><td>0.03 V</td><td>0.3 V</td><td colspan="6">3 V</td></tr>
<tr><td>Measuring accuracy*1</td><td>±0.07% ±10d</td><td colspan="4">±0.07%±2d</td><td>±0.1% ±2d</td><td>±0.3% ±5d</td><td>±3% ±10d</td></tr>
<tr><td>Temperature coefficient</td><td>±0.004% ±1.5d</td><td colspan="4">±0.004%±0.2d</td><td>±0.01% ±0.2d</td><td>±0.04% ±0.2d</td><td>±0.4% ±0.2d</td></tr>
<tr><td rowspan="4">In-circuit resist-ance measure-ment</td><td>Measuring current</td><td>-</td><td colspan="2">100 µA</td><td>10 µA</td><td>1 µA</td><td>100 nA</td><td>10 nA</td><td>-</td></tr>
<tr><td>Measuring voltage</td><td>-</td><td>0.03 V</td><td colspan="5">0.3 V</td><td>-</td></tr>
<tr><td>Measuring accuracy*1</td><td>-</td><td>±0.2% ±10d</td><td colspan="3">±0.2%±5d</td><td>±0.3% ±10d</td><td>±3% ±15d</td><td>-</td></tr>
<tr><td>Temperature coefficient</td><td>-</td><td>±0.02% ±1d</td><td colspan="3">±0.02%±0.8d</td><td>±0.04% ±0.8d</td><td>±0.4% ±0.8d</td><td>-</td></tr>
<tr><td colspan="2">Voltage between open terminal</td><td colspan="8">Max. 5.8 V</td></tr>
<tr><td colspan="2">Maximum allowable input voltage</td><td colspan="8">350 V peak (Continuous)</td></tr>
</table>

*1: The accuracy for 30 Ω to 300 Ω ranges is for NULL function.

(4) DC current measurement

Range	3 µA	30 µA	300 µA	3 mA	30 mA	300 mA
Resolution	100 pA	1 nA	10 nA	100 nA	1 µA	10 µA
Measuring accuracy	±0.3%±5d		±0.2%±5d			
Temperature coefficient	±0.02%±1d					
Resistance between input terminals	Approx. 10 kΩ or less		102 Ω or less		2 Ω or less	
Maximum allowable input current	Max. 10 mA		0.5 A fuse protection			

The response time for 3 µA, 30 µA (Required for measuring accuracy)
1. When Input changes Zero to Full Scale: Approx. 15 sec
2. When Input changes Full Scale to Zero: Approx. 3 sec

(5) AC Current Measurement
(Mean value measuring and RMS indicating system)

Range	300 µA	3 mA	30 mA	300 mA
Resolution	10 nA	100 nA	1 µA	10 µA
Measuring accuracy 20Hz to 45Hz	±0.7%±25d		±0.8%±25d	
Measuring accuracy 45Hz to 1kHz	±0.6%±25d		±0.7%±25d	
Temperature coefficient	(1/10 of measuring accuracy)/°C at each range and each frequency range			
Resistance between input terminals	102 Ω or less		2 Ω or less	
Maximum allowable input current	0.5 A fuse protection			

(6) Integrating Time, Number of Display Digits, and Measuring Speed

Integrating time		100 ms
No. of display digits		4-1/2 digits
Measuring speed	FAST	5 cycles/sec
	MID	2.5 cycles/sec
	SLOW	1.25 cycles/sec

10.5 GENERAL SPECIFICATIONS (All TR6845 series models)

Measuring system	:	Integrating system
Input system	:	Floating input
Range selection	:	Automatic and manual Automatic ranging (Up level 33000, down level 2999)
Display	:	Decimal, 5 digits, 7-segment LED Polarity: Minus "-" sign only is displayed, with zero blanking.
Over-load indication	:	"OL" is displayed if input exceeds the measurable range.
Low battery indication	:	The unit indicating LED and decimal point begin to flash if the AC line voltage or battery voltage drops below the driving voltage level.
NULL function	:	Subtracts NULL set value from the measured value, and displays the result.
Comparator function	:	Compares the measured value with preset upper and lower limits
Continuity test	:	TR6846/6847 generates buzzer sound at 1/10 full scale of each range in resistance measurement. TR6845/6848 generates buzzer sound when resistance is less than 3 Ω.
P-P value	:	TR6846/6848 calculates, output the peak-to-peak value of sine wave signal.
Withstanding voltage	:	500 V (DC and AC peak) between COM terminal - casing and AC power line. 1000 V when powered by battery.
Operating environment	:	0°C to +50°C. With TR15804 battery unit, 0°C to +40°C, 85% RH or less. With resistance measuring 30 MΩ and 300 MΩ ranges, 0°C to +35°C, 75% RH or less.
Storage temperature	:	-25°C to +70°C
Power supply	:	AC power supply: 90 V to 110 V, 50/60 Hz DC power supply: TR15804 battery unit permits continuous operation of more than 4 hours.
Power consumption	:	Less than 7 VA (multimeter only) Less than 14 VA (with accessory)
AC line voltage	:	This is set to the line voltage specified at ordering.

Option No.	Std	32	42	44
Line voltage (V)	90-110	103-132	198-242	207-250

External dimensions	:	Approx. 190 (wide) x 76 (high) x 260 mm (long)
Weight (Multimeter)	:	Less than 2.1 kg

MEMO

11. PRINCIPLE OF OPERATION

This chapter provides a general description of the operating principle of the TR6845 series digital multimeter.

11.1 OPERATING PRINCIPLE OF TR6845 SERIES DIGITAL MULTIMETER

The TR6845 series digital multimeter uses a microcomputer controlled 4-1/2 digit A/D converter. It also uses the thin film resistances developed by ADVANTEST in the input attenuator section and ranging amplifier circuit for maintaining high measuring accuracy.

The TR6845 series is composed of the following various blocks:

- Attenuator section which divides DC and AC voltage to 1/1, 1/100 and 1/1000
- Switches for selecting input corresponding to voltage measurement, resistance measurement, and current measurement
- Ranging amplifier which normalizes the input to the A/D converter to 3000 mV (full scale)
- AC/DC converter which converts AC voltage to DC voltage
- A/D converter which converts analog signal to digital signal
- OHM/DC converter which passes the reference current through the resistance to be measured in resistance measurement mode
- Current/voltage converter which converts the current to be measured into voltage by the shunt resistance in current measurement mode
- Circuit for measuring the reference contact temperature in temperature measurement mode
- Function/range controller which controls the range of each function
- LED display indicating measured results
- Reference voltage generator
- Optical isolator for exchanging data between analog signal system and microcomputer
- Microcomputer section for controlling operation of the whole system
- Power supply

The DC voltage to be measured enters the attenuator from the input terminal (between V and COM). The function and range controller section divides the input voltage according to the attenuation ratio set in advance, and the ranging amplifier section outputs the attenuated input voltage and zero voltage alternately to the A/D converter. This operation, generally known as auto-zero system, is used to correct the offset voltage of the amplifiers (ranging amplifier and the amplifier used in the A/D converter). The amplitude of the ranging amplifier is also set by the function and range controller section.

The A/D converter converts the ranging amplifier output to a digital signal using the integration system. The converted signal is transferred to the CPU of system control, and displayed on an LED. At the same time, it is also output to the range controller and checked to determine whether the range setting is proper. If range setting is not proper, the function and range controller continues the upranging or downranging operation until the proper range for the input signal is obtained.

Resistance, AC voltage, DC and AC current are measured in this way by the OHM/DC converter, AC/DC converter, and A/D converter, respectively.

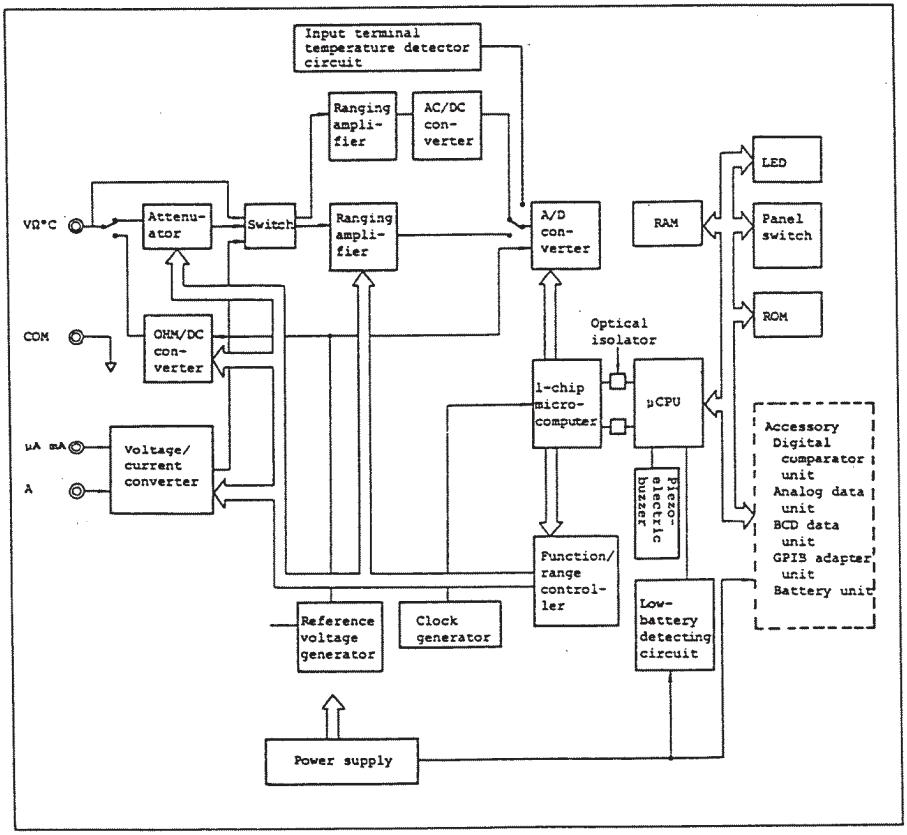


Figure 11-1 TR6845 Series Block Diagram

11.2 A/D CONVERTER

The TR6845 series digital multimeter uses the input integration variable type A/D converter. By selecting the most suitable integration time among 100 ms, 20 ms (when using line frequency 50 Hz), and 2 ms, it is possible to obtain stabilized measurement with high noise elimination ratio or high speed sampling, corresponding to the objectives of measurement. Figure 8-2 illustrates the operation of A/D converter.

If S_1 is turned ON, integration of the input voltage V_{in} begins. After a certain period of time, if the output value of the integrator U_1 is negative, switch S_2 is turned ON, and the reference voltage V_{ref} is applied until the integrator output turns positive, and the time needed is measured. This operation is repeated during the input integration time, and when the input integration time terminates, the switch S_1 is turned OFF. S_2 is kept ON until the integrator output polarity turns positive, and the integration terminates. The polarity of the integrator output is judged by comparing with the output of the comparator U_2 connected to the integrator output.

The time length counted during the S_2 is ON is used as the A/D converted data. This A/D converted data is displayed or used for further calculation, and the zero and full-scale values set at the time of calibration are used as reference values.

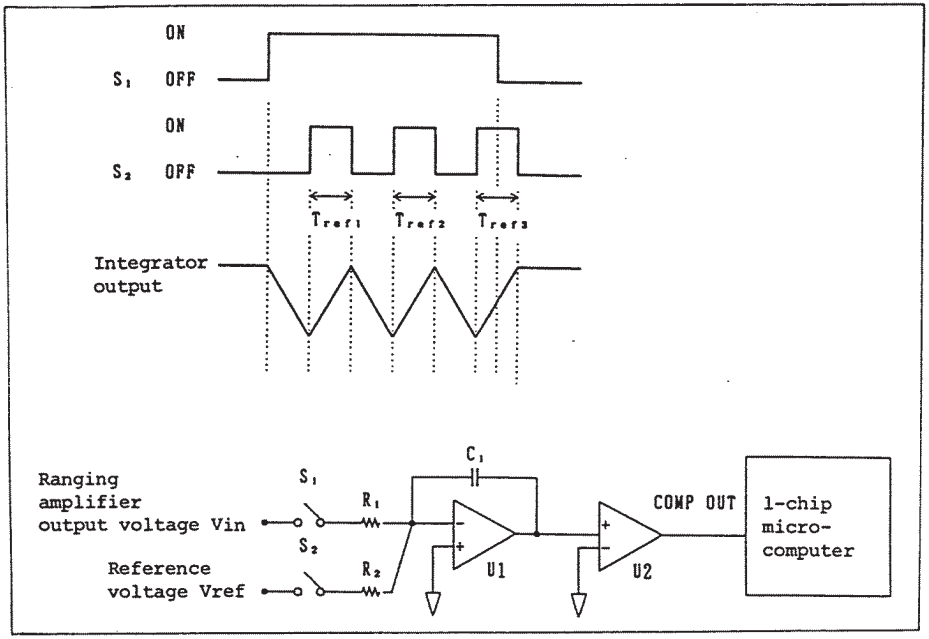


Figure 11-2 Operation of A/D Converter

APPENDIX

This chapter describes technical terms, and presents an outline drawing of this multimeter.

A.1 EXPLANATION OF TERMS

Sensitivity and Resolution

The resolution of a digital voltmeter indicates the minimum unit of quantization. For example, the highest sensitivity range of this multimeter is 30 mV, hence the resolution is expressed as 1 μV.

This value also represents the sensitivity of the multimeter. This value for expressing resolution and sensitivity is the most important value for digital voltmeter selection, this value also indicates the limit of performance of the digital voltimeter.

Measuring Accuracy

The measuring accuracy is defined as follows:

$$\text{Measuring accuracy} = \frac{\text{(Reading - true value)}}{\text{Full scale value}} + 1 \text{ digit}$$

(Reading - true value) is the reading error, and this is expressed as "±0.00XX% of reading" for this multimeter. The full-scale error is expressed as "of fs (or digit)". The full-scale error is not the same in nature as the quantizing error, but it is sometimes indicated in addition to the quantizing error for ease of calculation of the measuring accuracy. This full-scale error is mainly caused by drifting of zero point. The automatic zero point correcting circuit of this multimeter automatically corrects zero point drifting.

The error of ±1 digit is called the quantizing error. It is an unavoidable error which occurs when converting from analog to digital values.

Input Impedance

The digital voltmeter has inherent input resistance Rin, which is generally called the input impedance. As shown in Figure A-1, the voltage Es at power source to be measured is divided by the signal source resistance Rs and this Rin, and the value actually indicated by the digital voltmeter is Es' which is smaller than Es. To minimize this loading error between Es and Es', a large input impedance Rin must be used for the digital voltmeter. All the ADVANTEST digital voltmeters incorporate a specially developed input impedance circuit for accurate AC voltage measurement.

In addition to the error caused by the signal source output resistance Rs and input impedance of the digital voltmeter, there is an error caused by the current offset. This current offset originates from the internal circuit of the digital voltmeter. We must also consider the voltage offset, but this has little affect on the measurement even though Rs is large. The current offset is caused by the element used at the first stage of the input amplifier. To eliminate this error, the ADVANTEST multimeters use the field effect transistor (FET). Accordingly, if there is an output resistance Rs in the signal source to be measured, the voltage Es' appearing actually between the digital voltmeter input terminals is expressed in the following equation. Pay attention to Rs/Rin value and Rs x I offset value.

$$Es' = \frac{1}{1 + \frac{Rs}{Rin}} Es - Rs \times I\ offset$$

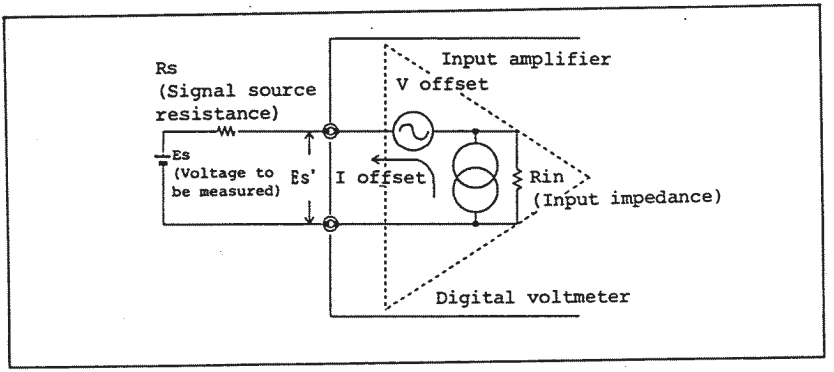


Figure A-1 Input Equivalent Circuit Considering the Current and Voltage Offset and Input Impedance

Normal Mode Noise Voltage Rejection Ratio : NMRR
Common Mode Noise Voltage Rejection Ratio : CMRR

Any measurement is more or less affected by noise, which causes error (Dispersion). In precision measurement of microvoltages below 10 μV, the measurement error can be caused by the quality of ground, incompleted cable connection, presence of ground current, and induction noise from power source, etc. These factors sometimes prevent measurement from being conducted. The ADVANTEST digital voltmeters are adopted the integrating system and the noise rejector in the power supply section etc.

The noise sources that must be considered in measurement can be represented in the following equivalent circuit. The noise voltage "en" is called the normal mode noise voltage or series mode noise voltage. This noise enters in series with the signal source, and contains the line frequency and its harmonics. The influence of this noise component related to the measured value, or the degree of its rejection, is called the normal mode noise voltage rejection ratio, which can be expressed as follows:

$$NMRR = 20 \log \frac{en}{en}$$

en is the error value caused by "en" upon the measurement. The "ecm" is the noise known as common mode noise voltage, and this is generated between the signal source and the ground of the measuring instrument. The amount of this error increases with the distance.

The influence of this noise component related to the measured value, or the degree of its rejection, is called the common mode noise voltage rejection ratio, which can be expressed as follows:

$$CMRR = 20 \log \frac{ecm}{ecm}$$

The ecm is the voltage value appearing at the input terminal of digital voltmeter. The sum of the above-mentioned two ratios is expressed as the effective CMR. The ADVANTEST digital voltmeter uses the integration system for assuring higher NMR.

The CMR varies largely with the frequency of noise voltage, circuit of signal source, shielding method, input cable type and input connection method. Accordingly, even though the catalog value is CMR: 120 dB, for example, you should not conclude that the error is always $1/10^6$ of ecm. On the contrary, you should use shield wiring as the lead to the digital voltmeter for preventing induction, and connect the earth lead of the power cable to the ground. The digital display section (counter section) and A-D section of the voltmeter are also shielded. A high common mode noise rejection ratio, as specified in the catalog, can be obtained through double electrostatic shielding of the measuring circuit against the earth.

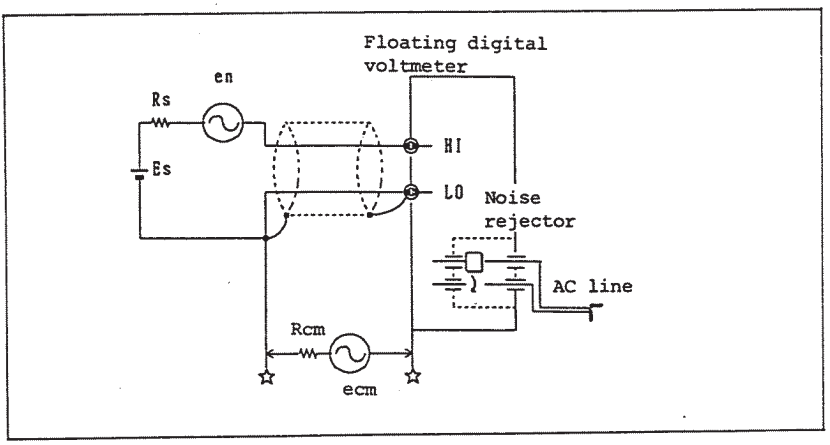


Figure A-2 Measuring Circuit Considering Noise

A.2 EXPLANATION ON TECHNOLOGY

Measurement of DC Voltage

The input impedance in DC voltage measurement between input terminals is as follows:

30 mV, 300 mV, 3 V ranges: Over 1000 MΩ
30 V, 300 V, 1000 V ranges: 10 MΩ ±1%

(1) Precautions for Reducing Measurement Error
The 30 mV, 300 mV and 3 V ranges feature high resolution of 1 μV, 10 μV and 100 μV, respectively. If the input cable end and the terminal of the equipment to be measured use different metals, or if there is a temperature difference between terminals, a thermoelectromotive force is generated, causing measurement error. To prevent this, only copper cable should be used, and if the temperature difference is large at the point of connection with the measuring system, a heat sink should be adopted. It is also necessary to position this equipment or use a cover so as to avoid air from a room air conditioner or the like.

Directly after the measurement of a large current, the thermal balance of the input terminal position may be lost, with generation of thermoelectromotive force and shifting of the zero point. In this case, wait for about 10 minutes until the thermal balance is obtained and the zero point is recovered before conducting measurement.

Avoid measurement in the vicinity of motor, transformer, or other inductive equipment. If unavoidable, use a shielded input cable, or twist the input cable for eliminating the interference.

It is recommended to connect the object to be measured to the ground for avoiding application of common mode voltage between the device under test and this multimeter. If connection to ground is unapplicable, perform measurement by referring to the effective noise reduction ratio of this equipment.

(2) Precautions in DC High Voltage Measurement

(a) The withstanding voltage between the LO and GND of the input terminal is 500 Vmax (DC and AC peak). If the LO side has a potential with respect to the GND side, it is necessary to limit the potentials from the input terminal COM and GND below that value.

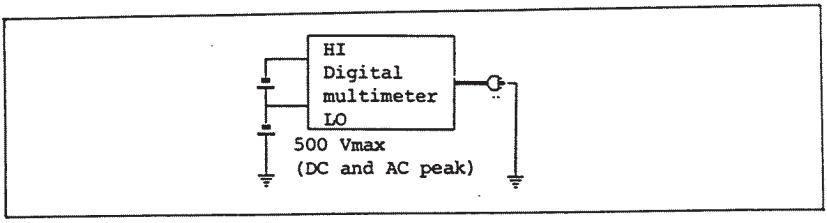


Figure A-3 Withstanding Voltage of COM Terminal in DC High Voltage Measurement

(b) When measuring a high voltage circuit using a DC high voltage probe TR1116, it is necessary to ground the GND of this multimeter, and also to ground the GND of the high voltage circuit. Use the one-point earth system to avoid generation of common mode voltage. (Figure A-4)

If not grounded, high tension pulse noise may be generated between the input terminal and GND of this multimeter when connecting the input cable, and such high tension voltage may cause damage to the equipment.

When a DC high voltage probe is connected to the device under measurement, be sure to first connect the probe to the LO terminal, and next connect to the HI terminal of this equipment. When disconnecting, first disconnect the HI side, and next disconnect the LO side. If this sequence is reversed, a high voltage may be applied to the input terminals, causing damage to the equipment.

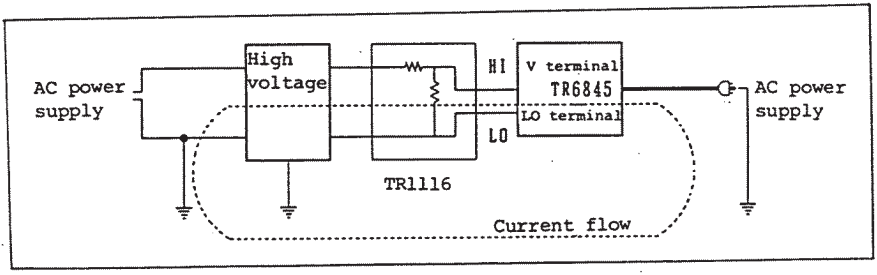


Figure A-4 Grounding Instruction in Measurement of DC High Voltage Circuit

AC Voltage Measurement

The input impedance is less than 2 MΩ ±2%, 100 pF for each range.

(1) Measurement of True rms Value

The magnitude of alternating current signal can be expressed as the mean value, rms value, or maximum value. The maximum value is the largest value among the instantaneous values within a cycle. The mean value and rms value can be expressed by the following equations:

Instantaneous value	:	e(t)
Mean value	:	Eave
Root-mean-square value	:	Erms
Period	:	T
Maximum value	:	Em

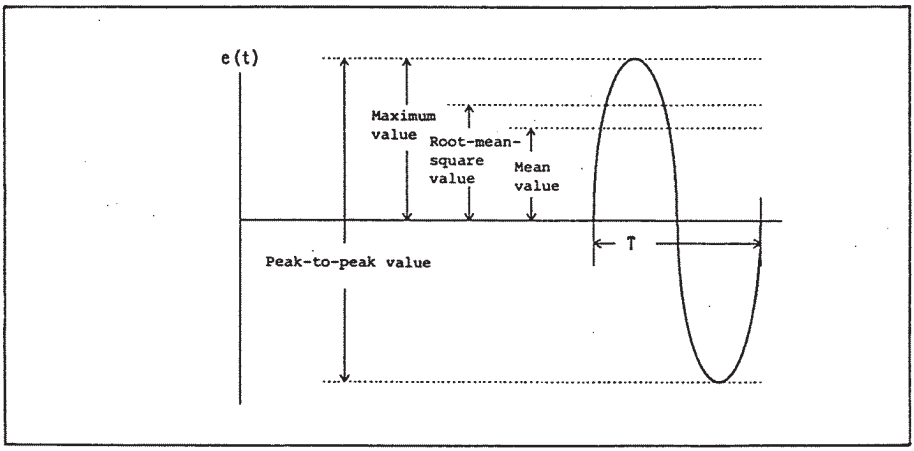
$$Eave = \frac{2}{T}\int_0^{T/2} e(t)dt$$

$$Erms = \sqrt{\frac{2}{T}\int_0^{T} [e(t)^2]\ dt}$$

If e(t) is sine wave Em sin t, the following approximate values are used.

$$Eave = \frac{2}{\pi} Em \fallingdotseq 0.636\ Em$$

$$Erms = \frac{1}{\sqrt{2}} Em \fallingdotseq 0.707\ Em$$

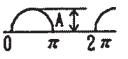
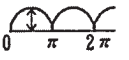
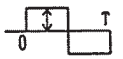
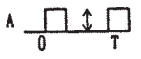
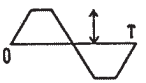


Among these, the rms value is most suitable to express the quantity of electricity or quantity to be heated of an alternating current signal. The quantity of Joule heat generated by application of an AC voltage to resistance R for a period of T is equivalent to the quantity of Joule heat generated by the DC voltage of the same value.

Therefore, if the AC voltage is represented in the rms value, it becomes possible to directly compare the effect of the DC signal and AC signal, irrespective of the waveform. The TR6846/6848 and other ordinary mean value measuring and rms value displaying type instruments measure the mean value of AC signal, and calculate the rms value for displaying.

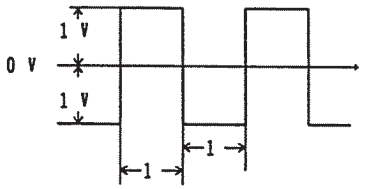
Accordingly, when the waveform and the degree of distortion are known and the wave factor and crest factor are also known for such waveforms as shown in Figure A-5, it is also possible for the mean value measuring and rms value displaying instrument to calculate, modify the measurement error. But since the measurement of such instruments is based on the sine wave, the measurement error becomes larger for distortional waveform, non-sine waves such as rectangular wave, pulse wave, triangle wave, inverter, SCR, noise, etc., and they cannot measure the true root-mean-square value. Figure A-6 shows the difference in the measured value between the rms measuring system and the mean value measuring system, taking the case of rectangular wave measurement as an example.

Measurement of the true rms value needs a circuit which is capable of squaring and averaging the AC signal, and then obtaining its square root value. The TR6845/6847 multimeter is equipped with such circuitry, hence it can measure the true rms value of any AC signal irrespective of its waveform.

Waveform	Mean average	rms value	Wave factor*1	Crest factor*2
Sine wave 	$\frac{2A}{\pi}$	$\frac{A}{\sqrt{2}}$	$\frac{\pi}{2\sqrt{2}}$	$\sqrt{2}$
Half-wave rectified wave 	$\frac{A}{\pi}$	$\frac{A}{2}$	$\frac{\pi}{2}$	2
Full-wave rectified wave 	$\frac{2A}{\pi}$	$\frac{A}{\sqrt{2}}$	$\frac{\pi}{2\sqrt{2}}$	$\sqrt{2}$
Triangle wave 	$\frac{A}{2}$	$\frac{A}{\sqrt{3}}$	$\frac{2}{\sqrt{3}}$	$\sqrt{3}$
Rectangular wave 	A	A	1	1
Impulse wave 	$\frac{\tau}{T}A$	$A\sqrt{\frac{\tau}{T}}$	$\sqrt{\frac{T}{\tau}}$	$\sqrt{\frac{T}{\tau}}$
Trapezoidal wave 	$(1 - 2\frac{\tau}{T})A$	$A\sqrt{1 - \frac{8\tau}{3T}}$	$\frac{\sqrt{1 - \frac{8\tau}{3T}}}{1 - 2\frac{\tau}{T}}$	$\frac{1}{\sqrt{1 - \frac{8\tau}{3T}}}$

*1 Wave factor = rms value / mean average value
*2 Crest factor = Maximum value / rms value

Figure A-5 AC Signals of Simple Waveform



True rms value measuring type $V = \sqrt{V_{IN}^2} = 1$ V

Mean average measuring and rms value displaying type
V = mean average x constant*
= 1 x 1.11
= 1.11 V

* The constant for full-wave rectified wave is 1.11.

Hence, the measurement error is 0.11 (11%).

Figure A-6 Measurement of Rectangular Wave

The TR6845/6847 is equipped with the analog computing type AC/DC converter using transistor array for obtaining the true rms value output (DC). This equipment can therefore be used for measurement of pulse waves having crest factor of up to 3, that is, a maximum value of three times the full scale value, and duty factor of up to 1:9.

-- Precautions for correct measurement of true rms

When measuring the true rms value, it is also necessary to consider the performance of the True rms measuring device crest factor, duty factor and harmonic wave component specifications of the rms measuring instrument, in addition to the induction, noise, grounding current and other external factors.

(a) Crest Factor
The crest factor is defined as the value obtained by dividing the maximum value of a signal by its rms value. The crest factor of the TR6845/6847 is 3:1 at full scale. Since the rms value can be measured up to the full scale value of each range,

Maximum value = crest factor x rms value
= 3 x full scale value of each range ..... (1)

If 3 V range is used, the maximum value is:

3 x 3.3 V = 9.9 V

This means that for example, 3 x 3.3 V = 9.9 V in the range of 3 V the equipment permits application of maximum ±9 V. If the input voltage is larger than this value, both the upper and lower ends of the signal are clamped, and correct measurement cannot be obtained. (Figure A-7)

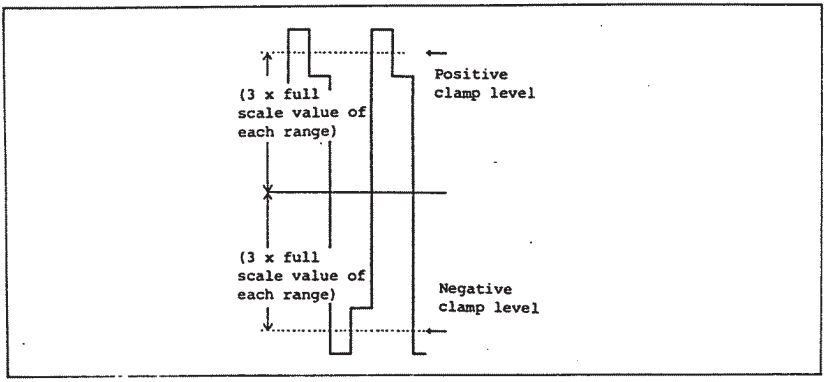


Figure A-7 Crest Factor

(b) Duty Factor

When measuring rectangular waves, the duty factor is restricted. The duty factor is defined as the ratio of pulse width to pulse repetition cycle. When measuring pulse strings having small duty factor or other asymmetrical waveforms, the signal applied to the measuring instrument have very high peak value, several times the rms value. This high peak voltage causes an over input and resultant distortion of signal, and the measuring accuracy lowers. The duty factor for each range can be calculated as follows:

Erms: rms value up to the full scale value of each range
Em : Maximum value obtained by Eq. (1)
T : Pulse repetition period
: Pulse width

$$Erms = Em\sqrt{\frac{\tau}{T}} \qquad 3\ Vrms = 9(V)\sqrt{\frac{\tau}{T}}$$

$$\frac{1}{3} = \sqrt{\frac{\tau}{T}}$$

$$\text{Hence,} \quad \frac{\tau}{T} = \frac{1^2}{3^2} = \frac{1}{9}$$

This means that, when measuring the rectangular wave having maximum value of 9 V in 3 V range, an over display error will result unless the duty factor $\frac{\tau}{T}$ is smaller than $\frac{1}{9}$.

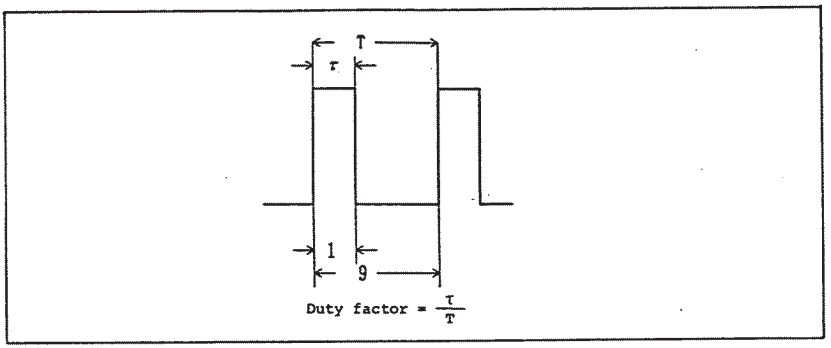


Figure A-8 Duty Factor

(c) Harmonic Component

The electrical performance data and measuring accuracy of this equipment can be directly applied when measuring sine wave input signals. When measuring non-sine wave signals, it is necessary to know the frequency component of the input signal because it contains harmonic waves. The fundamental wave and the harmonic waves within the guaranteed frequency range can be measured satisfactorily, but frequencies of over 100 kHz are not guaranteed for each range. (The 750 V range does not guarantee frequencies over 1 kHz.) Care should therefore be taken when measuring input signals that contain a higher frequency component.

(Example) The frequency component of the rectangular wave is expressed in the following Fourier series.

$$F(t) = \frac{4A}{\pi}\left(\sin\omega t + \frac{1}{3}\sin 3\omega t + \frac{1}{5}\sin 5\omega t + \ldots\right)$$

From this equation, it can be known that the rectangular wave contains a number of odd harmonics. Accordingly, as the frequency of the fundamental wave becomes high, the harmonics are pushed outside the guaranteed frequency range, and a large measurement error results.

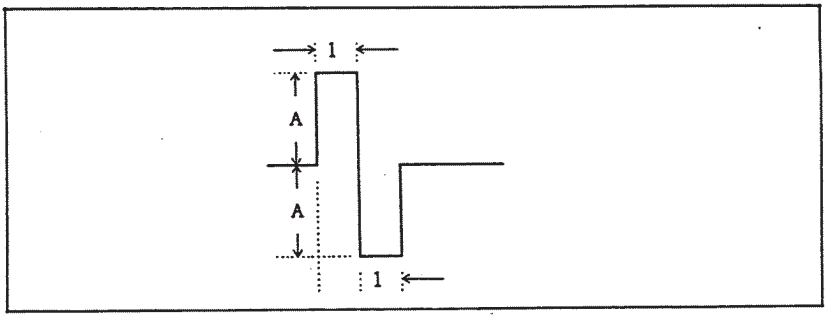


Figure A-9 Harmonic Component

(2) Measurement of AC and AC+DC
When measuring an AC waveform containing DC component, the TR6845/6847 is capable of measuring the AC component only (AC measurement) or both the AC and DC components (AC + DC measurement) by simply changing over the $\overset{AC+DC}{[\equiv]}$ key.

Generally, the DC component is small in magnitude, and can often be ignored in measurement. However, it cannot be ignored when measuring AC signal accurately by limiting the error to below 1%. The AC signal containing a DC component is often seen in the motor speed control circuit and other power control circuitry where a part of sine wave is cut off for operation.

(Example) When measuring AC 100 V signal on which DC 100 V is superposed.

With AC measurement function, $Vrms = \sqrt{AC^2} = \sqrt{(100\ V)^2} = 100\ (V)$, and the AC component only can be measured.
With AC + DC measurement function,

$$Vrms = \sqrt{DC^2 + AC^2} = \sqrt{(100\ V)^2 + (100\ V)^2} = 141.42(V),$$

and the rms value of the signal containing both DC component and AC component can be measured.

(3) Measurement of Peak-to-peak Value
The mean average measuring and rms displaying type TR6846/6848 multimeter directly displays the peak-to-peak value of a sine wave signal when the $\overset{P-P}{[\equiv]}$ key is pressed.

Resistance Measurement

(1) Measuring Current and Measuring Voltage
The open circuit voltage across the input terminal is a maximum 5.8 V. The measuring current and measuring voltage at each measurement range are as shown in Table A-1.

Table A-1 Measuring Current and Measuring Voltage at Each Resistance Measurement Range

	Measurement range	Measuring current	Measuring voltage
OHM	30 Ω	1 mA	30 mV
	300 Ω	1 mA	300 mV
	3 kΩ	1 mA	3 V
	30 kΩ	100 μA	3 V
	300 kΩ	10 μA	3 V
	3 MΩ	1 μA	3 V
	30 MΩ	100 nA	3 V
	300 MΩ	10 nA	3 V
L.P.OHM	300 Ω	100 μA	30 mV
	3 kΩ	100 μA	300 mV
	30 kΩ	10 μA	300 mV
	300 kΩ	1 μA	300 mV
	3 MΩ	100 nA	300 mV
	30 MΩ	10 nA	300 mV

(2) Precautions for Minimizing Zero Point Adjustment and Measurement Error
Where the resistance of lead wire can not be ignored for measurement error in measurements using 30 Ω or 300 Ω range, short the ends of both input cables before measurement and press the NULL [▭] key to correct for

the resistance for obtaining the optimum measuring accuracy.

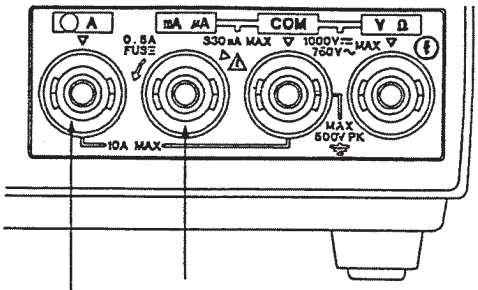
If any voltage exists across the resistance to be measured, accurate measurement cannot be obtained.

Pay attention to the thermoelectromotive force at the connection point of the input cable and resistance to be measured. When measuring high resistance value of over 3 MΩ, securely fix the input cable to prevent swaying. Also pay attention to the induction caused by the near-by measuring instruments.

DC/AC Current Measurement

In the DC/AC current measurement, the different input terminals must be used between measurement of small current of below 300 mA and measurement of 3 A and 10 A current ranges. A circuit protection fuse is built in the input terminal for small current of up to 300 mA.

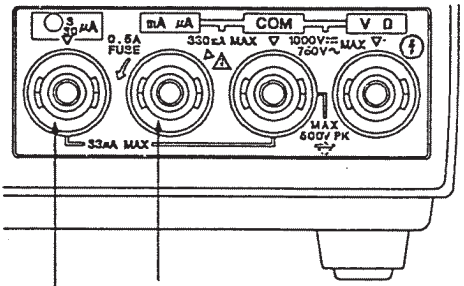
-- Input terminals of TR6845, TR6846, and TR6847



HI input terminal for up to 300 mA range, with protection fuse

HI input terminal for 3 A and 10 A ranges

-- Input terminal of TR6848

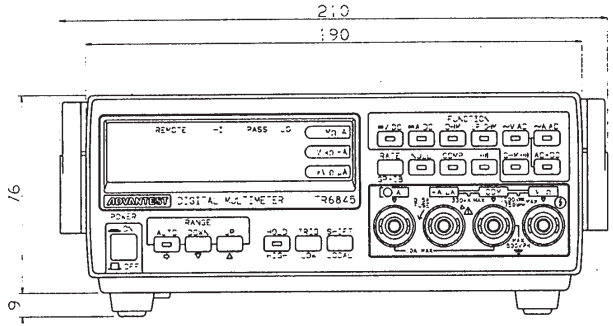


HI input terminal for up to 300 mA range, with protection fuse

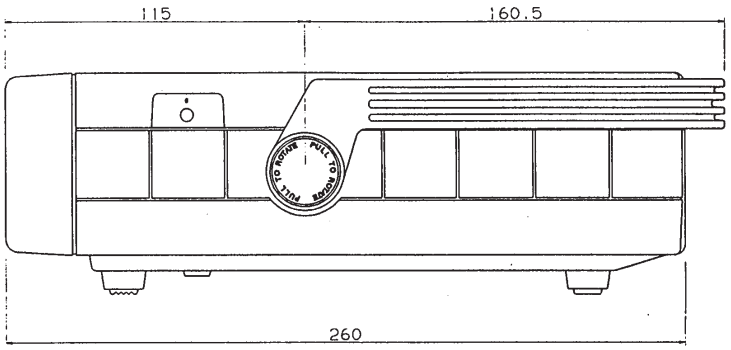
HI input terminal for 3 μA and 30 μA ranges, without protection fuse

ALPHABETICAL INDEX

ALPHABETICAL INDEX

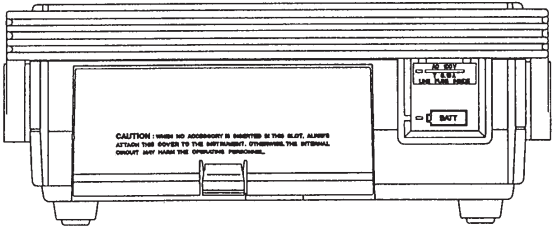


FRONT VIEW



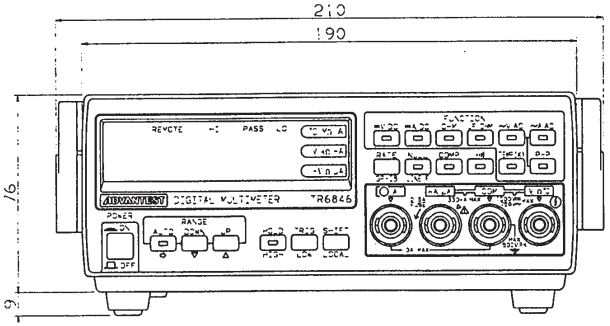
SIDE VIEW

Unit:mm

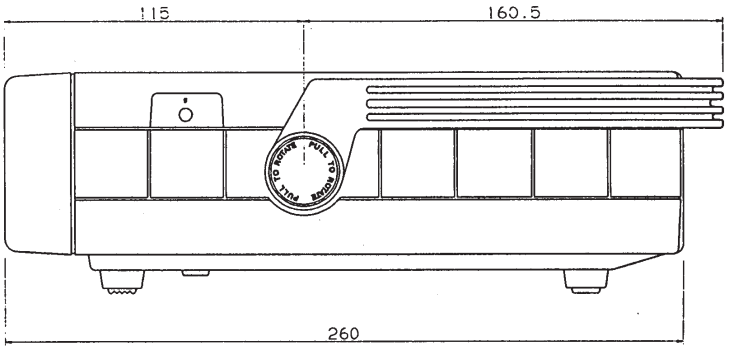


REAR VIEW

TR6845
EXTERNAL VIEW

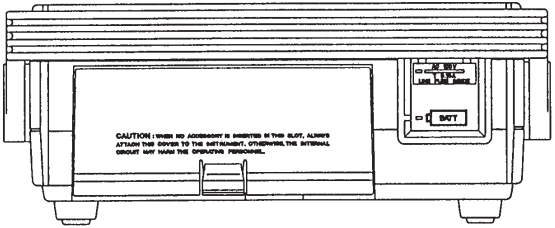


FRONT VIEW



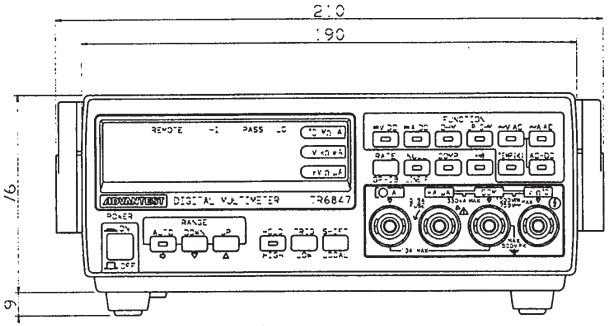
SIDE VIEW

Unit:mm

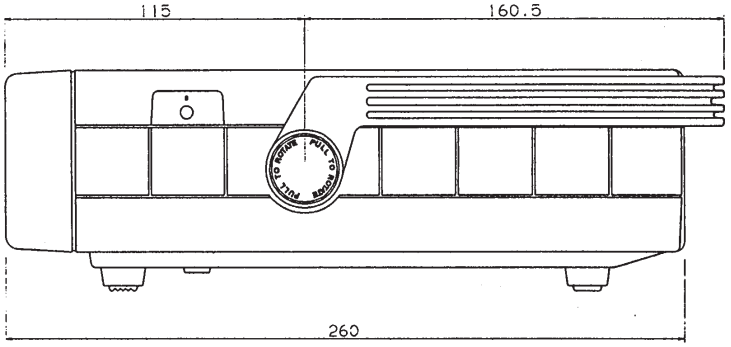


REAR VIEW

TR6846
EXTERNAL VIEW

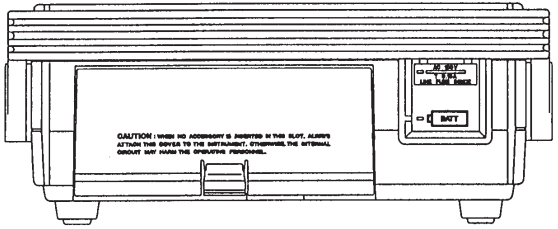


FRONT VIEW



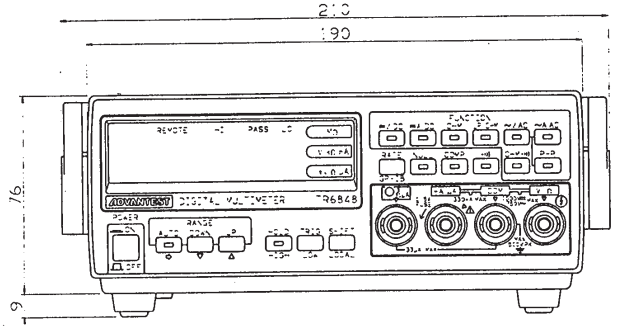
SIDE VIEW

Unit:mm

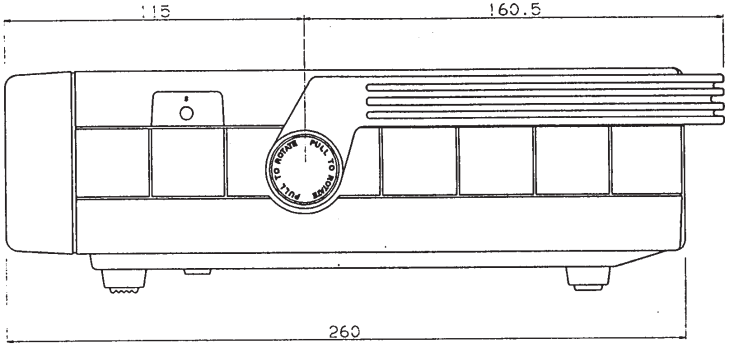


REAR VIEW

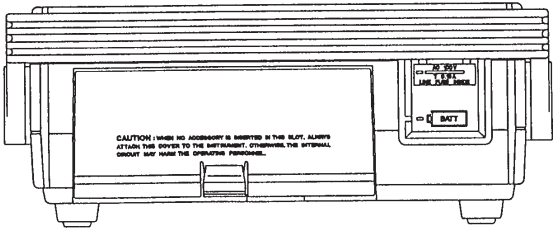
TR6847
EXTERNAL VIEW



FRONT VIEW



SIDE VIEW



REAR VIEW

Unit:mm

TR6848
EXTERNAL VIEW