sanwa®

EM7000

FET電子テスタ

FET MULTITESTER

取扱説明書

INSTRUCTION MANUAL

CONTENTS

[1] SAFETY PRECAUTIONS: Before use, read the following safety precautions

This instruction manual explains how to use your FET multitester EM7000, safely.
Before use, please read this manual thoroughly, after reading it, keep it together with the product for reference to it when necessary.
The instruction given under the heading "⚠WARNING" "⚠CAUTION" must be followed to prevent accidental burn or electrical shock.

1-1 Warning and Caution Instruction for Safe Use

⚠ WARNING

To ensure that the meter is used safely, be sure to observe the instruction when using the instrument.

1. **Never use the meter on the electric circuits that exceed 6 kVA.**
2. **Pay special attention when measuring the voltage of AC 33 V rms (46.7 V peak) or DC 70 V or more to avoid injury.**
3. **Never apply an input signals exceeding the maximum rating input value.**
4. **Never use the meter for measuring the line connected with equipment (i.e. motors) that generates induced or surge voltage since it may exceed the maximum allowable voltage.**
5. **Never use the meter if the meter or test leads are damaged or broken.**
6. **Never use uncased meter.**
7. **Be sure to use a fuse of the specified rating or type. Never use a substitute of the fuse or never make a short circuit of the fuse.**
8. **Always keep your fingers behind the finger guards on the leads when making measurements.**
9. **Be sure to disconnect the test pins from the circuit when changing the function or range.**
10. **Before starting measurement, make sure that the function and range are properly set in accordance with the measurement.**
11. **Never use the meter with wet hands or in a damp environment.**
12. **Never open rear case except when replacing batteries or fuse.**
13. **Do not attempt any alteration of original specifications.**
14. **To ensure safety and maintain accuracy, calibrate and check the meter at least once a year.**
15. **Indoor use.**

⚠ CAUTION

1. **The use of this unit in a way other than the description in the instruction manual may void the protection given to this unit.**
2. **Please note the use of this unit in the environment where a frequency over several tens of kHz and a strong electromagnetic field exist could cause a malfunction. Take care when using this unit.**
3. **Because the instrument is super-sensitive, the meter may move by just connecting test leads, but it is not failure of the instrument.**
4. **It may malfunction when measuring voltage/current in the inverter circuit.**

1-2 Explanation of Warning Symbols

The meanings of the symbols used in this manual and attached to the product are as follows.

⚠: Very important instruction for safe use.

- The warning messages are intended to prevent accidents to operating personnel such as burn and electrical shock.
- The caution messages are intended to prevent damage to the instrument.

⎓ : DC	p-p : peak to peak
~ : AC	: zero-center meter
Ω : Resistance	: Double insulation
+ : Plus	— : Minus
∞ : Infinity	: Fuse and Diode Protection
⏚ : Ground	: High Voltage, risk of electric shock
: Fuse	

1-3 Overload Protections

Functions		Input terminals	(*1) Maximum overload protection input	
DCV	1000	[COM −] • [V•A•Ω +]	DC • AC 1000 V or peak max 1400 V	
ACV	750			
DCV	1.2/3/12/30		DC • AC 240 V or peak max 340 V	
ACV	120/300		DC • AC 750 V or peak max 1100 V	
DCV	0.3		DC • AC 50 V or peak max 70 V	
DCA	0.12 μ			
	0.3 m/3 m		DC • AC 10 mA	(*2) DC • AC 100 V or peak max 140 V
	30 m/300 m		DC • AC 500 mA	
Ω	x1～x100 k		(*2, *3) DC • AC 50 V or peak max 70 V	
DCA	6	[COM −] • [DC 6 A AC 6 A]	(*4) DC • AC 20 A	
ACA	6			

*1. The application time of the maximum overload protection input value is within 5 seconds.
Also, the input waveform of AC voltage is a sine wave.
*2. The circuits are protected with a fuse (500 mA) and a diode if overload input is voltage.
*3. The circuits are protected with a fuse (500 mA) and a diode if overload input is voltage. However, the resistors could be burnt depending on the input timing of input waveforms (or polarity in the case of direct current).
*4. The circuits are protected with a fuse (6.3 A) against the overload input.

[2] APPLICATION AND FEATURES

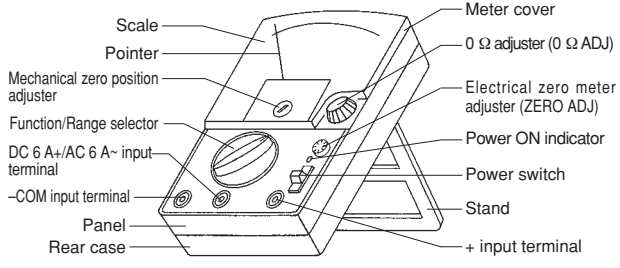
2-1 Applications

This unit is a highly sensitive tester designed for measuring electric circuits having a small capacity. It can measure voltages at various areas of compact communication equipment and household electric appliances, voltages of lamp lines and various batteries, and micro current in the mA class.

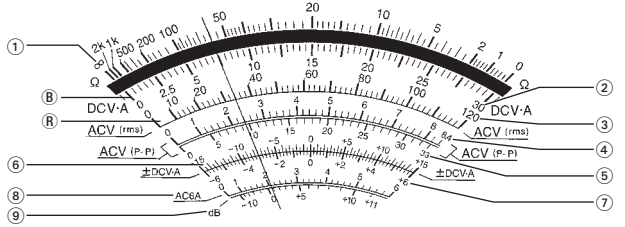
2-2 Features

- This unit is a highly sensitive "FET electronic tester" having the DC voltage function of which the internal resistance is as high as 2.5 to 12 MΩ, and also the DC current function with the 0.12 μA range.
- The zero center meter (NULL meter) function facilitates measurement of ± DC voltage and ± DC current.
- The frequency characteristic of AC low voltage ranges (3 V and 12 V ranges) is 40 Hz-1 MHz. The Vp-p value of triangular-wave, square-wave over 20 % duty cycle voltages of waveforms can also be measured at 3 V range.

[3] NAME OF FUNCTIONS



[4] SCALE READING



	Range	Multiplier
①	Ω X 100 k	X 100 k
	Ω X 10 k	X 10 k
	Ω X 1 k	X 1 k
	Ω X 100	X 100
	Ω X 10	X 10
	Ω X 1	X 1
②	DCV 300	X 10
	DCV 30	X 1
	DCV 3	X 0.1
*	DCV 0.3	X 0.01
	DCA 300 m	X 10
	DCA 30 m	X 1
	DCA 3 m	X 0.1
	DCA 0.3 m	X 0.01

	Range	Multiplier
* ②	ACV 300	X 10
	ACV 30	X 1
	ACV 3	X 0.1
③	DCV 1000	X 10
	DCV 120	X 1
	DCV 12	X 0.1
*	DCV 1.2	X 0.01
	DCA 0.12 μ	X 0.001
	ACV 750	X 10
	ACV 120	X 1
	ACV 12	X 0.1
④	ACV (P-P) 840	X 100
	ACV (P-P) 84	X 10
	ACV (P-P) 8.4	X 1

	Range	Multiplier
⑤	ACV (P-P) 330	X 10
	ACV (P-P) 33	X 1
⑥	± DCV 150	X 10
	± DCV 15	X 1
	± DCV 1.5	X 0.1
	± DCV 0.15	X 0.01
	± DCA 150 m	X 10
	± DCA 15 m	X 1
	± DCA 1.5 m	X 0.1
	± DCA 0.15 m	X 0.01
⑦	± DCV 600	X 100
	± DCV 60	X 10
	± DCV 6	X 1
	± DCV 0.6	X 0.1
	± DCA 0.06 μ	X 0.01
⑧	± ACA 6	X 1
⑨	11 dB	X 1

* The DCV and DCA functions use black scale lines (B), and the ACV (rms) function uses red scale lines (R). The scale figures are common to the DCV and ACV (rms) functions. The ACV (p-p) function uses exclusive red scal liens and scale figures ④, ⑤.

●Examples in a figure pointer place.

Function	Range	Scale No.	Conversion	Reading
Ω	X 100	①	60X100	6000 Ω (6 kΩ)
DCV	120 V	Ⓑ and ③	30X1	30 V
ACV (rms)	300 V	Ⓡ and ②	8.5X10	85 V
ACV (P-P)	840 V	④	2.4X100	240 V P-P
±DCA	±1.5 m	⑥	–7.5X0.1	–0.75 mA

[5] DESCRIPTION OF FUNCTIONS

5-1 Switches and Adjusters

① Function/Range selector
Selecting the desired function or range.

② Mechanical zero meter adjuster
Adjusting zero position by turning it with a screwdriver (see the figure at the bottom on the next page. At this time, the power switch must be kept OFF.

③ Power switch and power ON indicator lamp
Sliding the switch upward (ON direction) turns on the power and the power ON indicator lamp blinks, indicating that the unit is ready to be operated.
Sliding the switch downward (OFF direction) turns off the power and the power ON indicator lamp goes off.

> ⚠ Be sure to turn off the power switch after use, as the built-in batteries are consumed.

④ Electrical zero meter adjuster (ZERO ADJ) : Operates with layer-built cell (6F22)
Operate this adjuster after the mechanical zero meter adjustment and turning on the power switch.
- In the measurement of ±DC voltage (±DCV) and ±DC current (±DCA), turn on the power switch, and then turn this adjuster to adjust the pointer to the zero position at the center of ± DCV•A scales.
- In the measurement of the functions other than the above, turn on the power switch, and then turn this adjuster to adjust the pointer to the zero position.

⑤ 0 Ω adjuster (0 Ω ADJ) : Operates with model R6P (SUM-3 battery 1.5 V)
Use this for the resistance measurement. Before measurement, turn on the power switch and short-circuit the test pins of test leads and turn this adjuster to adjust the pointer to the 0 Ω position.

5-2 How to Use the Stand

Tilt the stand attached to the rear case as shown in the figure on the next page.

5-3 Time to Replace Internal Batteries

Model R6P (SUM-3 battery 1.5 V) :
When 0 Ω adjustment in the Ω x 1 range cannot be made.
Model 6F22 (layer-built cell 9 V) :
When blink interval of ON indicator lamp becomes shorter than that with a new battery or when continuously lighted.

[6] MEASURING PROCEDURE

6-1 Startup Inspection (See the flowchart on the next page.)

⚠ WARNING

1. To prevent an electric shock, do not use the tester if the tester itself or test leads are damaged.
2. Make sure that the test leads are not broken or the fuses are not blown.

6-2 How to select an appropriate range

① Voltage (DCV, ±DCV, ACV (rms), ACV (p-p), Current (DCA, ±DCA)
As a rule, select the range whose maximum scale value is larger than the value to be measured.
For example, when measuring the voltage of 9 V, the measuring range should not be 3 V range or 30 V range but be 12 V range, and when measuring 15 V, it should be 30 V range.

② Resistance (Ω)
Select the range in which the pointer indicates the approximate center of the Ω scales.

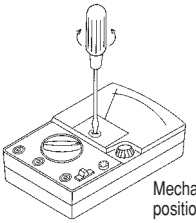
6-3 Preparation for Measurement

① If the pointer does not indicate correctly the zero position at the left end of the scale plate, turn the mechanical zero meter adjuster with a screwdriver to adjust it. (See the figure below.)

② Connect the test leads to the input terminals, and select the desired function/range with the function/range selector.

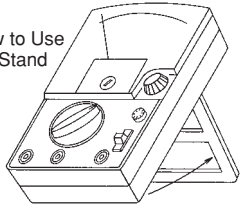
③ Turn on the power switch (power ON), and turn the electrical zero meter adjuster (ZERO ADJ) to adjust the electrical zero meter position. Adjust the pointer to the zero position at the center of the meter for the ±DCV and ±DCA functions, and to the zero position at the left end of the meter for other functions.

⚠Do not touch the electrical zero meter adjuster during measurement.



Mechanical zero position adjustment

How to Use the Stand



START

Main unit and test leads damaged ?

Damaged

Stop using it, and have it repaired.

No damaged

Check continuity of test leads and fuse.

① Connect the black plug of the test lead to the − terminal.

② Connect the red plug of the test lead to the + terminal.

③ Set the function/ range selector at Ω x 1 range.

④ Set the power switch to ON position.

⑤ Short the red and black test pins.

⑥ Did the pointer move to right side ?

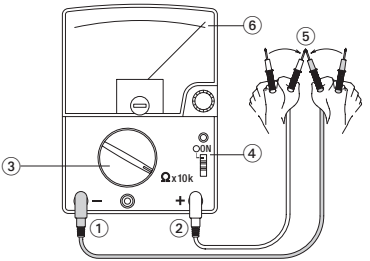
NO

Stop using it and have it repaired.

Replace the battery and fuse, and starting to ③ once more.

YES

No problem. Start measurement.



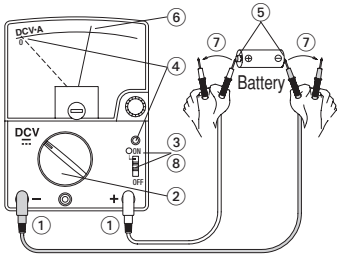
6-4 Voltage Measurement

⚠ WARNING

1. Do not apply an input that exceeds the maximum rating of each range.
2. Do not change over to other function or range during measurement.
3. Measure in the maximum measuring range if you cannot estimate a value to measure.
4. Do not hold the test pins on the leading end side from the flanges on the test leads during measurement.
5. Be sure to perform measurement with parallel connection to the load.

6-4-1 DCV (DCV⎓) Maximum measurable voltage DC 1000 V

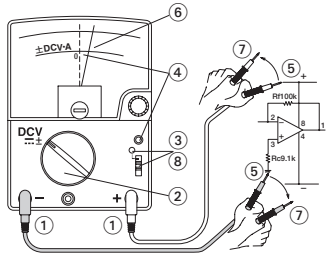
1) Objects of measurement
   Voltages of batteries and DC circuits.
2) Measuring ranges (8 ranges) : 0.3/1.2/3/12/30/120/300/1000 V
3) Measurement procedure
   ① Insert the red plug of test leads in to the +input terminal, and the black plug into the –COM terminal.
   ② Turn the function/range selector to the appropriate range of DCV.
   ③ Turn on the power switch (power ON: Lamp blinks).



   ④ Turn the electrical zero adjuster (ZERO ADJ), to adjust the pointer to the zero position at the left end of black DCV•A scales.
   ⑤ Apply the black test pin to the negative (–) potential side of the circuit to be measured and the red test pin to the positive (+) potential side (parallel connection to the load).
   ⑥ Read the indication on the DCV•A scales in a unit of V (volt).
   ⑦ Detach the test pins from the circuit to be measured.
   ⑧ Turn off the power switch (power OFF: Lamp blinking goes off).
   ● Read the indication in the 1000 V range by multiplying 0 - 120 scales by 10. However, never measure voltages exceeding 1000 V to ensure safety.
   ● It will be convenient to use the ±DCV function for circuits where positive voltage and negative voltage are present.

6-4-2 ±DCV (±DCV ⎓) Maximum measurable voltage DC±600 V

1) Objects of measurement
   Voltages of DC circuits where positive voltage and negative voltage are present on the reference such as IC circuits.
2) Measuring ranges (8 ranges)
   ±0.15/±0.6/±1.5/±6/±15/±60/±150/±600 V
3) Measurement procedure

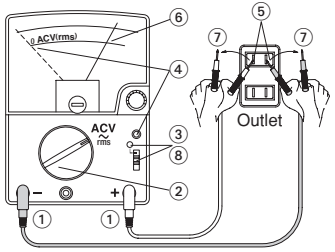


   ① Insert the red plug of test leads into the +input terminal, and the black plug into the –COM terminal.
   ② Turn the function/range selector to the appropriate blue ±DCV range at upper left.
   ③ Turn on the power switch (power ON : Lamp blinks).
   ④ Turn the electrical zero adjuster (ZERO ADJ) to adjust the pointer to the zero position at the center of blue ±DCV·A scales.
   ⑤ Apply the black test pin to the reference measures point, and the red test pin to the desired measuring point.
   ⑥ Read the indication on the ±DCV·A scales in a unit of V (volt).
   If the indication is on the right side of the zero position, the red test lead is on the positive potential (voltage), and the black test lead is on the negative potential (voltage).
   If the indication is on the left side of the zero position, the red test lead is on the negative potential (voltage), and the black test lead is on the positive potential (voltage).
   ⑦ Detach the test pins from the circuit to be measured.
   ⑧ Turn off the power switch (power OFF: Lamp blinking goes off).

- Before measurement, make sure that the meter pointer is adjusted correctly to the zero position at the center of ±DCV·A scales.
  If shifted, an indication error occurs by the amount of shift.
- The zero meter position of the functions expect ±DCV and ±DCA functions is at the left end of black DCV·A scales.

6-4-3 ACV (ACV～rms) Maximum measurable voltage AC 750 V

1) Objects of measurement
   Voltages of sine wave alternating current such as lamp line circuits converted to root-mean-square (rms) values.
2) Measuring ranges (6 ranges)
   3/12/30/120/300/750 V
3) Measurement procedure



   ① Insert the red plug of test leads into the +input terminal, and the black plug into the –COM terminal.
   ② Turn the function/range selector to the appropriate ACV ～ rms range.
   ③ Turn on the power switch (power ON: Lamp blinks).
   ④ Turn the electrical zero adjuster (ZERO ADJ) to adjust the pointer to the zero position of red ACV (rms) scales.
   ⑤ Apply the red and black test pins to two measuring points (parallel connection to the load). In the case of alternating current, the polarity of test leads may be ignored.
   ⑥ Read the meter indication on red ACV (rms) scales in a unit of V (volt). The figures are black figures common to DCV.
   ⑦ Detach the test pins from the circuit to be measured.
   ⑧ Turn off the power switch (power OFF: Lamp blinking goes off).

● The AC function of this unit uses the p-p rectifying system that indicates the value between positive and negative peak values of sine wave alternating current (p-p value) by converting into the root-mean-square value.
  Accordingly, the correct rms value is indicated for the sine wave AC, but an indication error will occur according to waveforms in AC voltage measurement of waveforms other than sine wave AC.
  Even for the voltage of two waveforms having the same rms value, different values will be indicated if the voltage between positive and negative peak values are different. On the contrary, for the voltage of two waveforms having different rms values, the same value will be indicated if the voltage between positive and negative peak values are the same.

- The frequency characteristics are good, but an indication error will increase for high frequencies. (See 8-3)
- Read the indication by multiplying 0 - 120 graduations by 10 in the 750 V range. Never perform measurement exceeding 750 V to ensure safety.
- After over voltage was applied, the meter will swing out for a while even if the input is removed, but this is not a problem, and the pointer will return to the zero position in a few seconds.
- Because the instrument is super-sensitive, the meter may move by just connecting test leads, but it is not failure of the instrument.
- It may malfunction when measuring voltage/current in the inverter circuit.

■ Differences of indicated values between general testers and this unit according to measuring waveforms

1. Measurement of sine wave AC
   Both general testers and this unit indicate root-mean-square values.
2. Measurement of distorted wave AC
   ① General testers: Indicate a value proportional to the mean value.
   Accordingly, the read value is lower than the actual root-mean-square value.
   ② This unit: Indicates a value proportional to the p-p value regardless of waveforms.
   Accordingly, the indicated value on the rms scales ACV (rms) is higher or lower than the actual root-mean-square value depending on voltage waveforms.

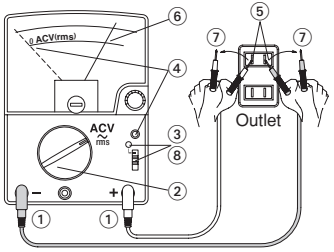
6-4-4 ACV (ACV ～p-p) Maximum measurable voltage AC 840 Vp-p

1) Objects of measurement
   Voltages (p-p values) between maximum and minimum values of sine wave and distorted wave alternating current.
   ① Sine wave (frequency characteristics : See 8-3)
   ② Distorted wave (Range : 8.4 Vp-p range only, frequency characteristics : 40 Hz - 50 kHz)
   - Triangular-wave, square-wave over 20 % duty cycle, or pursuant voltage with repetitive waveform.
   - Triangular-wave, square-wave over 20 % duty cycle, or voltage with half-wave retification wavefrom.
     However, frequency must be in between 40 Hz - 50 kHz, and + side of rectified voltage must be connected to +input terminal of the instrument.

   ⚠CAUTION
   Above is only for measuring distorted wave voltage of 8.4 Vp-p range.
   The reading is approximate value when measuring non-sine wave AC at range of 33 Vp-p or higher.

2) Measuring ranges (5 ranges)
   8.4/33/84/330/840 V

3) Measurement procedure
   ① Insert the red plug of test leads into the +input terminal, and the black plug into the –COM terminal.
   ② Turn the function/range selector to the appropriate ACV ～ p-p range.
   ③ Turn on the power switch (power ON: Lamp blinks).

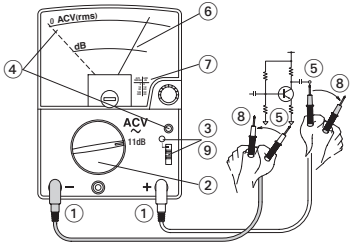


   ④ Turn the electrical zero adjuster (ZERO ADJ) to adjust the pointer to the zero position of red ACV (p-p) scales.
   ⑤ Apply the red and black test pins to two measuring points (parallel connection to the load). The polarity of test leads may be ignored.

⑥ Read the meter indication using ACV (p-p) scales and red figures in a unit of V p-p (peak-to-peak volt).
⑦ Detach the test pins from the circuit to be measured.
⑧ Turn off the power switch (power OFF: Lamp blinking goes off).
● Observe the same precautions as those for the AC voltage (ACV ∼ rms) measurement.

6-5 AF Output (dB) Measurement

1) Objects of measurement
   Low frequency signals such as audio outputs of amplifiers.
2) Measuring ranges
   11 dB (Addition table attached: Lower right of scale plate)
3) Measurement procedure



① Insert the red plug of test leads into the +input terminal, and the black plug into the –COM terminal.
② Turn the function/range selector to the appropriate ACV ∼ rms range, for instance, 3 V range (11 dB).
③ Turn on the power switch (power ON: Lamp blinks).
④ Turn the electrical zero adjuster (ZERO ADJ) to adjust the pointer to the zero position of red ACV (rms) scales.
⑤ Apply the red and black test pins to two measuring points. The polarity of test leads may be ignored.
⑥ Read the meter indication on dB scale in a unit of dB (decibel).
⑦ Further, according to the set range (ACV ∼ rms), obtain a value to add from the addition table at the lower right of scale plate, and add it to the read value. This value is the dB value at the measuring point. (*Note)

⑧ Detach the test pins from the circuit to be measured.
⑨ Turn off the power switch (power OFF: Lamp blinking goes off).

*Note : The dB scale of this unit are drawn in accordance with the AC 3 V range, assuming that the output level is 0 dB when the impedance (Z) at the measuring point is 600 Ω and the output is 1 mW. If 0dB is converted to the voltage, 0dB is 0.775 V (1 mW = E^2/Z). When the impedance at the measuring point is other than 600 Ω, obtain a value to add from the following table according to impedance values, and add it to the value obtained in ⑥ and ⑦.

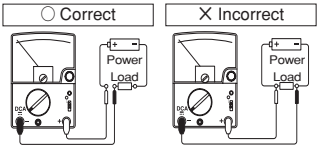
Impedance	Value to add	Impedance	Value to add	Impedance	Value to add
2 kΩ	-5.2 dB	300 Ω	+3 dB	16 Ω	+15.8 dB
1 kΩ	-2.2 dB	150 Ω	+6 dB	8 Ω	+18.8 dB
500 Ω	+0.8 dB	50 Ω	+10.8 dB	4 Ω	+21.8 dB

● Observe the same precautions as those for the measurement of AC voltage (ACV ∼ rms).

6-6 Current Measurement

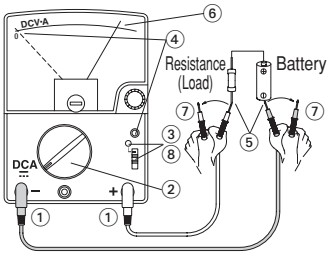
⚠ WARNING

1. **Never apply voltage to the input terminals.**
2. **Be sure to make a series connection via load.**
3. **Do not apply an input exceeding the maximum rated current to the input terminals.**



6-6-1 DCA (DCA ⎓) Maximum measurable current DC 300 mA

1) Objects of measurement
   Current that flows in batteries and DC circuits.
2) Measuring ranges (5 ranges) : 0.12 µ/0.3 m/3 m/30 m/300 mA
3) Measurement procedure

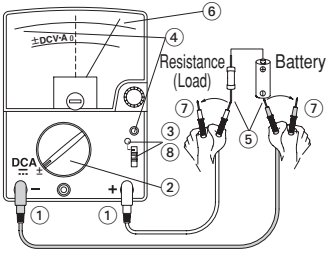


   ① Insert the red plug of test leads into the +input terminal, and the black plug into the –COM terminal.
   ② Turn the function/range selector to the appropriate DCA range.
   ③ Turn on the power switch (power ON: Lamp blinks).
   ④ Turn the electrical zero adjuster (ZERO ADJ) to adjust the pointer to the zero position of black DCV·A scales.
   ⑤ Connect the black test pin to the negative potential side of the circuit to be measured, and the red test pin to the positive potential side through the load (in series).
   ⑥ Read the indication on the DCV·A scales in a unit of µA (microampere) or mA (milliampere) depending on the range used.
   ⑦ Detach the test pins from the circuit to be measured.
   ⑧ Turn off the power switch (power OFF: Lamp blinking goes off).

- In the current measurement, the internal resistance of the current range is inserted in series in the circuit to be measured, and therefore the measured value will be smaller than the actual current value depending on the intensity of internal resistance.
- The fuse (500 mA) in this unit shuts off the circuit if a voltage or current over 500 mA (0.5 A) is applied.

6-6-2 ±DCA (±DCA ⎓) Maximum measurable current ±DC 150 mA

1) Objects of measurement
   This function is useful for measuring circuits where the current directions ± are not constant such as a detection circuit.
2) Measuring ranges (5 ranges)
   ±0.06 μ/±0.15 m/±1.5 m/±15 m/±150 mA
3) Measurement procedure

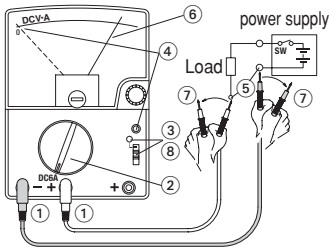


① Insert the red plug of test leadsinto the +input terminal, andthe black plug into the –COM terminal.
② Turn the function/range selector to the appropriate blue ±DCA range at the lower left.
③ Turn on the power switch (power ON: Lamp blinks).
④ Turn the electrical zero adjuster (ZERO ADJ) to adjust the pointer to the zero position at the center of blue ±DCV•A scales.
⑤ Connect the black test pin to a measuring point on one side of the circuit to be measured, and the red test pin to a measuring point on another side through the load (in series).
⑥ Read the indication on the ±DCV•A scales in a unit of mA (microampere) or mA (milliampere) depending on the range used.
   If the indication is on the right side of the zero position, the red test lead is on the positive potential (voltage), and the black test lead is on the negative one.
   If the indication is on the left side of the zero position, the red test lead is on the negative potential (voltage), and the black test lead is on the positive one.
⑦ Detach the test pins from the circuit to be measured.
⑧ Turn off the power switch (power OFF: Lamp blinking goes off).

● Observe the same precautions as those for the DC Current (DCA ⎓) measurement.

6-6-3 DCA (DC 6 A)

1) Objects of measurement
   DC current below 6 A in compact power supply circuits, etc.
2) Measurement procedure



① Insert the red plug of test leads into the DC 6 A+/ AC 6 A ∼ input terminal, and the black plug into the –COM terminal.

② Turn the function/range selector to the DC 6 A range at the lower center.

③ Turn on the power switch of this unit (power ON: Lamp blinks).

④ Turn the electrical zero adjuster (ZERO ADJ) to adjust the pointer to the zero position of black DCV·A scales.

⑤ Connect the black test pin to the negative potential side of the circuit to be measured, and the red test pin to the positive potential side through the load (in series).
(To ensure safety, turn off the power switch of the circuit to be measured before the test pins are connected, and after that, turn on the power switch of the circuit to be measured.)

⑥ Read the meter indication on black DCV·A scale by multiplying 0 - 30 figures by 0.2. The unit is A (ampere).

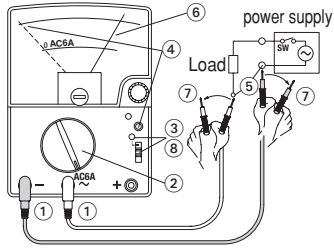
⑦ Detach the test pins from the circuit to be measured.

⑧ Turn off the power switch (power OFF: Lamp blinking goes off).

- The continuous measurable time of the current 3 - 6 A is within 30 seconds as the shunt resistor in this unit overheats.
- The internal resistance of the DC 6 A range is very small and therefore if a voltage is applied by mistake to this range, very large current will flow, causing a danger. Though this current is shut off by the built-in fuse (6.3 A), take care not to make a wrong measurement.

6-6-4 ACA (AC 6 A)

1) Objects of measurement
   AC current below 6 A in compact power supply circuits, etc.
2) Measurement procedure



   ① Insert the red plug of test leads into the DC 6 A+/AC 6 A ∼ input terminal, and the black plug into the –COM terminal.
   ② Turn the function/range selector to the AC 6 A range at the lower center.
   ③ Turn on the power switch of this unit (power ON: Lamp blinks).
   ④ Turn the electrical zero adjuster (ZERO ADJ) to adjust the pointer to the zero position of red AC 6 A scale at the bottom.
   ⑤ Connect the black test pin to a measuring point on one side of the circuit to be measured, and the red test pin to a measuring point on another side through the load (in series).
   (To ensure safety, turn off the power switch of the circuit to be measured before the test pins are connected, and after that, turn on the power switch of the circuit to be measured.)
   ⑥ Read the meter indication on red AC 6 A scale and 0 - 6 figures in a unit of A (ampere).
   ⑦ Detach the test pins from the circuit to be measured.
   ⑧ Turn off the power switch (power OFF: Lamp blinking goes off).

- The continuous measurable time of the current 3 - 6 A is within 30 seconds as the shunt resistor in this unit overheats.
- The internal resistance of the AC 6 A range is very small and therefore if a voltage is applied by mistake to this range, very large current will flow, causing a danger. Though this current is shut off by the built-in fuse (6.3 A), take care not to make a wrong measurement.
- Further, observe the same precautions as those for the measurement of DC current (DCA ⎓).

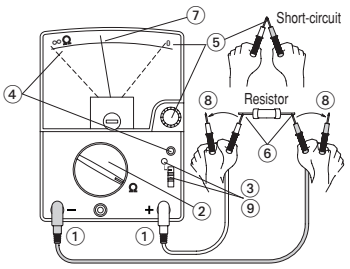
6-7 Resistance (Ω) Measurement

Maximum measurable resistance 100MΩ

⚠ WARNING

Measuring resistance of a part which is under voltage not only causes a failure of this unit but also poses a danger to the human body.

1) Objects of measurement
   Resistance of resistors and circuits, and also the continuity of parts and circuits.
2) Measuring ranges (6 ranges) : X1/X10/X100/X1 k/X10 k/X100 k
3) Measurement procedure



   ① Insert the red plug of test leads into the +input terminal, and the black plug into the –COM terminal.
   ② Turn the function/range selector to the appropriate Ω range.
   ③ Turn on the power switch (power ON: Lamp blinks).
   ④ Turn the electrical zero adjuster (ZERO ADJ) to adjust the pointer to the ∞ position at the left end of blue Ω scales at the top.
   ⑤ Short-circuiting red and black test pins, turn the 0 Ω adjuster (0 Ω ADJ) to adjust the pointer to the 0 Ω position at the right end of the Ω scale.
   ⑥ Release the short circuit by the red and black test pins, and reconnect the test pins to the object to be measured (such as a resistor).
   ⑦ Read the indication on the Ω scale in a unit of Ω (ohm).
   ⑧ Detach the test pins from the circuit to be measured.
   ⑨ Turn off the power switch (power OFF: Lamp blinking goes off).

- At Ω range, the polarity of +/– is reverse from that marked on the body panel.
- If a voltage is applied to the Ω function, a fuse (500 mA) built in this unit shuts off the voltage for safety. However, the shunt resistor in the range used may be burnt simultaneously depending on the waveform timing of the input voltage.

- Operating voltage for Ω range of this tester is 3 V, so lighting test of LED can be performed. Appropriate range is Ω x 10 range.
- For the Ω function, the measured current will be different largely depending on the ranges used. Also, the resistance of a semiconductor will vary largely depending on the intensity of the measured current. Accordingly, even for the same semiconductor (for instance, diode), the measured value will vary largely depending on the ranges used.
- If a test pin is touched by a finger during measurement , measurement will be influenced by the resistance in the human body to result in measurement error.
- Be sure to use the rated fuse (ϕ 5 x 20, 500 mA/250 V, parts No.F1176) for the instrument. In case a fuse other than the rated one is used, indication errors may occur, and/or circuit protection is become unable.
- If the pointer does not move to 0 line even when the 0 Ω adjuster is turned fully, replace the internal batteries (R6P:1.5 V x 2) to new ones.
- The reading may vary because of external inductance when measuring high resistance value.

6-8 DC High Voltage (HV) Measurement (Optional HV Probe)
Max. measurement value 30 kV DC

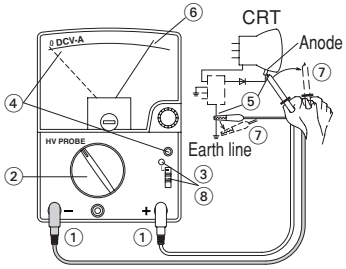
⚠ WARNING

1. The probe are designed for the measurement of very small direct current circuit. Never use the probe to measurement high voltage in power lines, such as transmission and distribution lines; it is very dangerous.
2. Never apply input signals that exceed 30kV.
3. Be sure to disconnect the test pins from the circuit when changing the function/ range selector.
4. Always keep your fingers behind the finger guards on the probe when making measurements.

1) Application
The probe is suitable for measuring voltage of high impedance circuits, such as CRT anode voltage of TV sets.

2) Measuring range:
HV PROBE

3) Measurement procedure



① Insert the black plug of the HV probe into the –COM input terminal and the red plug into the +input terminal.

② Turn the function/range selector to the HV PROBE position.

③ Turn on the power switch (power ON: Lamp blinks).

④ Turn the electrical zero adjuster (ZERO ADJ) to adjust the pointer to the zero position of black DCV•A scales.

⑤ First, connect the clip (black) of the probe to the earth line (–COM) in the circuit to be measured, and then apply the measuring pin on the probe body to your measuring point.

⑥ Read the pointer on DCV•A (0 - 30) scale in a unit of kV.

⑦ After measurement, remove the measuring pin from the measured circuit, and then remove the clip.

⑧ Turn off the power switch (power OFF: Lamp blinking goes off).

- The HV-60 probes cannot be used for AC voltage measurement.
- In the measurement of circuits having high internal resistance such as high voltage circuits of TV sets, a large voltage drop occurs in high voltage circuits when the measured current flows, and thus a meter indication may be lower by several percents than the actual voltage.

6-9 End of Measurement

When measurement is end, be sure to return the power switch to the OFF position and the function/range selector to the ACV 750 position.

⚠ Be sure to turn off the power switch after use, as the built-in batteries are consumed.

[7] MAINTENANCE

⚠ WARNING

1. This section is very important for safety. Read and understand the following instruction fully and maintain your instrument properly.
2. The instrument must be calibrated and inspected at least once a year to maintain the safety.

7-1 Maintenance and inspection

1) Appearance
   - Is the appearance not damaged by falling ?

2) Test leads and fuse
   - Are the test leads not damaged ?
   - Are the core wire not exposed at any place of the test leads ?
   - Make sure that the test leads are not cut, referring to the section 6.1.

If your instrument fails any of above check, do not use it, and have it repaired or replace it to new one.

7-2 Calibration

The manufacturer may conduct calibration and inspection. For more information, please contact the dealer or manufacturer.

7-3 How to Replace Built in Battery and Fuse

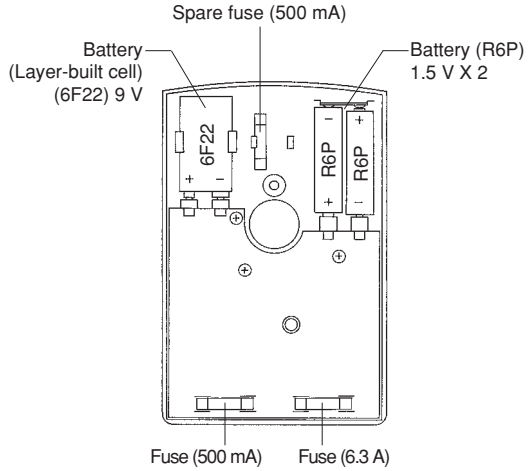
⚠ WARNING

1. If the rear case is removed with input applied to the input terminals, you may get electrical shock. Before starting the work, always make sure that no inputs is applied.
2. Be sure to use a fuse that has the same rating so as to ensure safety and performance of tester.
3. When removing the rear case do not touch the internal parts or wire with hand.
4. Two types of fuses (500 mA and 6.3 A) are used. Be careful not to confuse them.

＜How to replace the battery or fuse＞

① Remove the rear case screw with a screwdriver.
② Remove the rear case.
③ Take out the battery or fuse and replace it with a new one.
④ Attach the rear case and fix it with the screw .

⚠Check and see whether or not indications of respective ranges are normal.
⚠Set batteries in correct polarity.



Fuse of the specified rating and type
• F500 mAH/250 V (ϕ 5 x 20 mm, ceramic tube) part No.F1176
• F6.3 AL/250 V (ϕ 5 x 20 mm, ceramic tube) part No.F1177

7-4 Cleaning and Storage

⚠ CAUTION

1. **The panel, rear case, and meter cover are weak to volatile solvents (such as thinner and alcohol), and therefore should be cleaned with soft dry cloth or slightly water-damped cloth.**
2. **The panel and the rear case are not resistant to heat. Do not place the instrument near heat-generating devices (such as a soldering iron).**
3. **Do not store the instrument in a place where it may be subjected to vibration or where it may fall.**
4. **For storing the instrument, avoid hot, cold or humid places or places under direct sunlight or where condensation is anticipated.**
5. **If this unit will not be used for a long period, be sure to remove the batteries from the unit.**

Following the above instructions, store the instrument in good environment. (See 8.1)

[8] SPECIFICATIONS

8-1 General Specification

Meter :Internal magnet, Taut band meter (48 μA)
AC Rectifying System :p-p voltage rectifying system
Meter Drive Circuit :FET differential amplifier
Accuracy Assurance Temperature/ Humidity Range
:23 ℃±2 ℃ 75 %RH max. No condensation
Operating Temperature and Humidity
:5~31 ℃, 80 %RH max.
:31 ℃<~40 ℃, 80~50 %RH (decreasing linearly) No condensation
Storage Temperature/Humidity Range
:–10~50 ℃, 70 %RH max. No condensation
Environmental Conditions
:Indoor use, Altitude up to 2000mm
Built-in Battery :R6P or SUM-3 (1.5 V x 2), 6F22 (9 V x 1)
Built-in Fuse :F500 mAH/250 V (ϕ 5 x 20 mm, ceramic tube) part No.F1176
:F6.3 AL/250 V (ϕ 5 x 20 mm, ceramic tube) part No.F1177
(Fast acting fuse, Blowout capacity : 1500 A)
Built-in Battery Life (6F22,for Meter Drive Circuit)
:Continuous 500 hours (When power sw ON/input terminals open)

✻Factory-preinstalled built-in battery
A battery for monitoring is preinstalled before shipping, therefore it may run down sooner than the battery life specified in the instruction manual.

The “battery for monitoring” is a battery to inspect the functions and specifications of the product.

Overload circuit protection
: Circuit protection by diode and fuse. However, for the Ω function, the circuit is protected only at the input of positive

Dimension and Mass : 165(*H*) X 106(*W*) X 46(*D*) mm 375 g

Accessories : Instruction manual (EM7000) 1 Test leads (TL-21a) 1
Spare fuse (500 mA/250 V) 1

8-2 Optional Accessories

• Carrying case (C-CA) • HV probe (HV-60):30 kV • Clip adapter (CL-11)

8-3 Measurement Range and Accuracy

Accuracy assurance range : 23 ℃±2 ℃, 75 %RH max. No condensation
Attitude : Horizontal ± 5°
**mark : ACV accuracy in the case of sine wave (50~60 Hz)

Function	Full scale value	Accuracy	Remarks
DCV (⎓)	0.3 V	± 3 % Against full scale	Internal resistance Approx. 2.5 MΩ
	1.2 V		Internal resistance Approx. 12 MΩ
	3 V		Internal resistance Approx. 11 MΩ
	12/30/120/300/1000 V		Internal resistance Approx. 10 MΩ
	30 kV	± 20 % Against full scale	The tolerance depends on a combination of optional probes.
±DCV (⎓)	±0.15/0.6/1.5/6/ 15/60/150/600 V	± 7 % Against full scale	Same as the internal resistance of corresponding DCV range.
ACV (∼) rms p-p	3 V (rms) 8.4 V (p-p)	** ± 3 % Against full scale [50 Hz basis / 40 Hz~1 MHz : within ± 3 %]	Internal impedance Approx. 2.5 MΩ (50/60 Hz)
	12 V (rms) 33 V (p-p)	** ± 3 % Against full scale [50 Hz basis / 40 Hz~1 MHz : within ± 5 %]	Internal impedance Approx. 1.1 MΩ (50/60 Hz)
	30 V (rms) 84 V (p-p)	** ± 3% Against full scale [50 Hz basis / 40 Hz~10 kHz : within ± 5 %]	Internal impedance Approx. 800 kΩ (50/60 Hz)
	120/300 V (rms) 330/840 V (p-p)	** ± 3 % Against full scale [50 Hz basis / 40 Hz~1 kHz : within ± 5 %]	Internal impedance Approx. 800 kMΩ (50/60 Hz)
	750 V (rms)	± 3 % Against full scale	Internal impedance Approx. 10 MΩ (50/60 Hz)

Function	Full scale value	Accuracy	Remarks
ACV (～) p-p	8.4 Vp-p *	Square symmetric wave (50 Hz Duty 50 %) ± 6 % Against full scale [50 Hz basis 40 Hz~100 kHz : within ± 3 %]	Internal impedance Approx. 2.5 MΩ (50/60 Hz)
		Triangular symmetric wave (50 Hz) ± 6 % Against full scale [50 Hz basis 40 Hz~100 kHz : within ± 3 %]	
AF output (dB)	−10~51 dB [0 dB=0.775 V(1 mW) in 600 Ω inpedance circuit]	± 3 % of arc	
DCA (⎓)	0.12 μA 0.3 m/3 m/30 m/300 mA	± 3 % Against full scale	A voltage drop by fuses is excluded : 300 mV
	6 A	± 4 % Against full scale	Continuous measurable time max. 30 s
±DCA (⎓)	±0.06 μA ±0.15 m/1.5 m /15 m/150 mA	± 7 % Against full scale	A voltage drop by fuses is excluded : 150 mV
ACA (～)	6 A	± 5 % Against full scale (sine wave 50~60 Hz)	Continuous measurable time max. 30 s
Resistance (Ω)	2 k(X1)/20 k(X10)/ 200 k(X100)/2 M(X1 k)/ 20 M(X10 k)/ 200 M(X100 k)	± 3 % of arc	Center value 20 Ω (X1 range) Max. value 2 kΩ (X1 range) Release voltage : Approx. 3 V

* Above is only for measuring distorted wave voltage of 8.4 Vp-p range. The reading is approximate value when measuring non-sine wave AC at range of 33 Vp-p or higher.

Specifications and external appearance of the product described above may be revised for modification without prior notice.

[9] AFTER-SALES SERVICE

9-1 Warranty and Provision

Sanwa offers comprehensive warranty services to its end-users and to its product resellers. Under Sanwa's general warranty policy, each instrument is warranted to be free from defects in workmanship or material under normal use for the period of one (1) year from the date of purchase.

This warranty policy is valid within the country of purchase only, and applied only to the product purchased from Sanwa authorized agent or distributor.

Sanwa reserves the right to inspect all warranty claims to determine the extent to which the warranty policy shall apply. This warranty shall not apply to test leades, fuses, disposables batteries, or any product or parts, which have been subject to one of the following causes:

1. A failure due to improper handling or use that deviates from the instruction manual.
2. A failure due to inadequate repair or modification by people other than Sanwa service personnel.
3. A failure due to causes not attributable to this product such as fire, flood and other natural disaster.
4. Non-operation due to a discharged battery.
5. A failure or damage due to transportation, relocation or dropping after the purchase.

9-2 Repair

Customers are asked to provide the following information when requesting services:

1. Customer name, address, and contact information
2. Description of problem
3. Description of product configuration
4. Model Number
5. Product Serial Number
6. Proof of Date-of-Purchase
7. Where you purchased the product

1) Prior to requesting repair, please check the following:
   Capacity of the built-in battery, polarity of installation and discontinuity of the test leads.

2) Repair during the warranty period:
The failed meter will be repaired in accordance with the conditions stipulated in 9-1 Warranty and Provision.

3) Repair after the warranty period has expired:
In some cases, repair and transportation cost may become higher than the price of the product. Please contact Sanwa authorized agent / service provider in advance.
The minimum retention period of service functional parts is 6 years after the discontinuation of manufacture. This retention period is the repair warranty period. Please note, however, if such functional parts become unavailable for reasons of discontinuation of manufacture, etc., the retention period may become shorter accordingly.

4) Precautions when sending the product to be repaired:
To ensure the safety of the product during transportation, place the product in a box that is larger than the product 5 times or more in volume and fill cushion materials fully and then clearly mark “Repair Product Enclosed” on the box surface. The cost of sending and returning the product shall be borne by the customer.

9-3 SANWA web site

http://www.sanwa-meter.co.jp
E-mail: exp_sales@sanwa-meter.co.jp

MEMO

MEMO

sanwa®

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