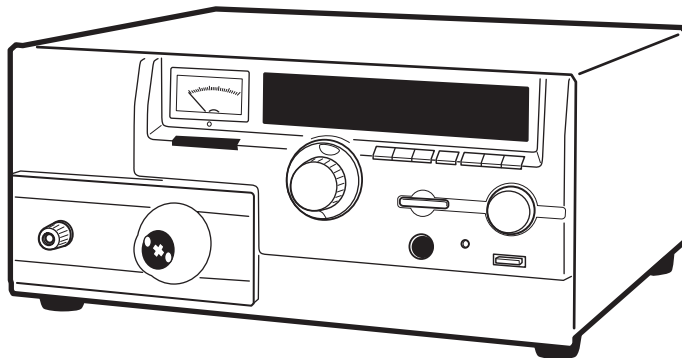


## OPERATION MANUAL

---

### WITHSTANDING VOLTAGE TESTER

# TOS5101 TOS5051 TOS5050



## DANGER

This Tester generates high voltage.

- Any incorrect handling may cause death.
- Read Chapter 3 "WARNINGS AND CAUTIONS FOR OPERATING THE TESTER" in this manual to prevent accident.
- This manual should be placed within the reach of the operator so that he or she may read it whenever necessary.

## Disposing of used Kikusui products in the EU

Under a law adopted by member nations of the European Union (EU), used electric and electronic products carrying the symbol below must be disposed of separately from general household waste.

This includes the power cords and other accessories bundled with the products. When disposing of a product subject to these regulations, please follow the guidance of your local authority, or inquire with your Kikusui distributor/agent where you purchased the product.

The symbol applies only to EU member nations.



## Disposal outside the EU

When disposing of an electric or electronic product in a country that is not an EU member, please contact your local authority and ask for the correct method of disposal.

All or any parts of this manual may not be reproduced in any forms, without express written permission of Kikusui Electronics Corporation.

The contents of this manual, including the specifications of the instrument, are subject to change without notice.

## Request to Users


### Operations

- This products must be used only by qualified personnel who understand the contents of this operation manual. If it is handled by disqualified personels. Electrical hazards may result. Be sure to handle it under supervision of qualified personnel(those who have electrical knowledge).
- If any abnormality or failure was detected in the products. Stop using it immediately and contact Kikusui or Kikusui agent.
- Make sure the AC input voltage setting and the fuse ratings are satisfied and that there is no abnormality in the AC power cable.

Be sure to unplug the power cable before checking the voltage setting, fuse ratings and AC cable.

Do not remove the cover.

### Installation

- Be sure the environmental condition where the products to be installed meets all requirements listed in the operation manual.
- Connect the ground terminal  to electrical ground (safety ground).
- When supplying power to the products from a switchboard, be sure work is performed by a qualified and licensed electrician or is conducted under the direction of such a person.
- Be sure to use the input power cable that is included along with this products from factory. Consult Kikusui or Kikusui agent if other cable than included is to be used by some reason.

### Maintenance and inspection

- To prevent electric shock, be absolutely sure to unplug the power cable before perform maintenance or inspection.
- Do not remove the cover when performing maintenance or inspection. Consult Kikusui or Kikusui agent before uncover the products in case if it is so necessary.
- To maintain performance and safe operation of the product, it is recommend to conduct a periodic maintenance, inspection, cleaning, and calibration.

### Relocation

- Disconnect all cables when relocate the product.
- Use two or more persons when relocate the product which weights more than 20 kg. The weight of the products can be found in this operation manual.
- Be careful of harming protruded parts of the products such as output terminals, terminal boards or heatsinks when moving.
- Use extra precautions such as using more people when relocating into or out of present locations including inclines or steps. Also handle carefully when relocating tall products as they can fall over easily.
- Be sure the operation manual are included whenever the product is moved, relocated or possession is passed to another party.

If your have any questions, contact Kikusui or Kikusui agent.





## **– To supervisor in charge of operation –**

- (1) If the operator does not read the language used in this manual, translate the manual into appropriate language.
- (2) Help the operator in understanding this manual before operation.
- (3) Keep this manual near the Tester for easy access by the operator.

## **– CPU Version Number –**

This manual is applicable to the Testers whose CPU version number is:

1.0X

When you contact us for any information about the Tester, please indicate the CPU version number and the serial number of the Tester. The serial number is shown on the rear panel of the Tester. To find the CPU version number, refer to Section 5.2 “Checking the Tester Operation.”

## **– Interlock Protection –**

The Tester has an interlock protection. When the Tester has arrived you and you have unpacked it, the function is effective. Therefore the Tester will not start its operation. Before operation, you must release the interlock protection. For details, see Section 6.3.3 “Interlock Function.”

**– For your own safety (to avoid electrification) –**

- (1) While the Tester is delivering its test voltage, never touch the following areas, or else, you will be electrified, and run the risk of death by electric shock.
- ☆ the output terminal
  - ☆ the test leadwires connected to the output terminal
  - ☆ the Device Under Test (DUT)
  - ☆ any part of the tester, which is electrically connected to the output terminal.
  - ☆ the same part as above immediately after the output has been cut off when in the DC mode of test (for TOS5101 and TOS5051 only).
- (2) Also, electric shock or accident may arise in the following cases:
- ☆ the tester being operated without grounding.
  - ☆ if the gloves for electrical job are not used.
  - ☆ approach to any part connected to the output terminal while the power of the tester is turned on.
  - ☆ the same action as above immediately after the power of tester has been turned off when in the DC mode of test (for TOS5101 and TOS5051 only).

# Power Requirements of this Product

Power requirements of this product have been changed and the relevant sections of the Operation Manual should be revised accordingly. (Revision should be applied to items indicated by a check mark ✓.)

**Input voltage**

The input voltage of this product is \_\_\_\_\_ VAC,  
and the voltage range is \_\_\_\_\_ to \_\_\_\_\_ VAC.

Use the product within this range only.

**Input fuse**

The rating of this product's input fuse is \_\_\_\_\_ A, \_\_\_\_\_ VAC, and \_\_\_\_\_ .



- To avoid electrical shock, always disconnect the AC power cord or turn off the switch on the switchboard before attempting to check or replace the fuse.
  - Use a fuse element having a shape, rating, and characteristics suitable for this product. The use of a fuse with a different rating or one that short circuits the fuse holder may result in fire, electric shock, or irreparable damage.
-





# COMPOSITION OF THE MANUAL

This manual is composed of the following chapters.

Chapter 1. GENERAL	Provide basic information about how to use the Tester. Be sure to read these chapters.
Chapter 2. GENERAL PRELIMINARY NOTES AND PRECAUTIONS	
Chapter 3. WARNINGS AND CAUTIONS FOR OPERATING THE TESTER	
Chapter 4. DESCRIPTION OF FRONT AND REAR PANEL ITEMS	
Chapter 5. PREPARATIVE TEST PROCEDURES	Describe how to operate the Tester.
Chapter 6. TEST PROCEDURES	
Chapter 7. OPERATING PRINCIPLE	Introduces basic operating principles of the Tester.
Chapter 8. MAINTENANCE	Introduces basic maintenance methods for the Tester.
Chapter 9. SPECIFICATIONS	Provides electrical and mechanical specifications.
Chapter 10. OPTIONS	Introduces optional devices.
INDEX	

# – TABLE OF CONTENTS –

Warnings and Cautions .....	VII
<b>1. GENERAL .....</b>	<b>1-1</b>
1.1 TOS5000 Series .....	1-2
1.2 Features .....	1-3
<b>2. GENERAL PRELIMINARY NOTES AND PRECAUTIONS .....</b>	<b>2-1</b>
2.1 Checking for Shipping Damages and Accessories .....	2-2
2.2 General Information Before Using the Tester .....	2-4
2.2.1 AC Line Requirements .....	2-4
2.2.2 Fuse Ratings .....	2-5
2.2.3 Environmental Conditions .....	2-6
2.2.4 Notes for Moving the Tester .....	2-8
<b>3. WARNINGS AND CAUTIONS FOR OPERATING THE TESTER .....</b>	<b>3-1</b>
3.1 Preparative Procedures .....	3-2
3.1.1 Wearing Insulation Gloves .....	3-2
3.1.2 Grounding the Tester .....	3-2
3.2 Warnings and Cautions when Operating the Tester .....	3-3
3.2.1 Connecting the LOW Test Leadwire .....	3-3
3.2.2 Connecting the HIGH Test Leadwire .....	3-3
3.2.3 Before Turning-ON AC Input Power .....	3-4
3.2.4 Before Changing Test Parameters .....	3-4
3.2.5 Precautions for Pausing Tests .....	3-4
3.2.6 Items Charged Up to Dangerous High Voltages .....	3-5
3.3 Warnings for Matters After Turning-OFF Power .....	3-5
3.3.1 Matters to be Sure of After Turning-OFF Power .....	3-5
3.3.2 Residual High Voltages .....	3-6
3.4 Warnings for Remote Control .....	3-7
3.5 Inhibitions .....	3-7
3.5.1 Inhibition of Rapid ON/OFF Repetitions .....	3-7
3.5.2 Inhibition of Shorting to Earth Ground .....	3-7
3.6 In Case of Emergency .....	3-7
3.6.1 Actions When in Emergency .....	3-7
3.7 Dangerous States of Failed Tester .....	3-8
3.7.1 Inhibition of Use of Failed Tester .....	3-8
3.7.2 DANGER Lamp .....	3-8
3.8 Wattage, Heat, and Other Limiting Conditions of Use .....	3-8
<b>4. DESCRIPTION OF FRONT AND REAR PANEL ITEMS .....</b>	<b>4-1</b>
4.1 Description of Front Panel Items .....	4-2

4.1.1	Turning ON/OFF the AC Input Power .....	4-3
4.1.2	Start/Stop of Test .....	4-5
4.1.3	Test Voltage .....	4-9
4.1.4	Cutoff Currents .....	4-12
4.1.5	Test Time .....	4-15
4.1.6	Others .....	4-17
4.2	Display Items .....	4-18
4.2.1	Test Voltage Display .....	4-18
4.2.2	Readout for Cutoff Current and Measured Current .....	4-21
4.2.3	Test Time Display .....	4-23
4.2.4	READY Message .....	4-24
4.2.5	TEST Message .....	4-24
4.2.6	PASS Message .....	4-24
4.2.7	FAIL Messages .....	4-24
4.2.8	PROTECTION Message .....	4-25
4.2.9	Others .....	4-25
4.3	Description of Rear Panel Items .....	4-26
<b>5.</b>	<b>PREPARATIVE TEST PROCEDURES .....</b>	<b>5-1</b>
5.1	Initial Setup .....	5-2
5.1.1	Initial Setup of Switches and Controls .....	5-2
5.1.2	Initial Test Setup Data .....	5-2
5.1.3	Procedure for the Initial Test Setup Data .....	5-3
5.2	Checking the Tester Operation .....	5-4
5.3	Checkout Before Starting Test Operation .....	5-6
<b>6.</b>	<b>TEST PROCEDURES .....</b>	<b>6-1</b>
6.1	AC Withstanding Voltage Test Procedure .....	6-2
6.1.1	Selecting an AC Test Voltage Range .....	6-2
6.1.2	Setting the Upper Cutoff Current .....	6-3
6.1.3	Setting the Lower Cutoff Current .....	6-4
6.1.4	Setting the Test Time .....	6-5
6.1.5	Setting the Test Voltage .....	6-6
6.1.6	Connecting the DUT .....	6-7
6.1.7	Executing a Test .....	6-7
6.2	DC Withstanding Voltage Test Procedure .....	6-12
6.2.1	Selecting a DC Test Voltage Range .....	6-12
6.2.2	Setting the Upper Cutoff Current .....	6-13
6.2.3	Setting the Lower Cutoff Current .....	6-14
6.2.4	Setting the Test Time .....	6-16
6.2.5	Setting the Test Voltage .....	6-17
6.2.6	Connecting the DUT .....	6-17
6.2.7	Executing a Test .....	6-18
6.3	Remote Control .....	6-22
6.3.1	Remote Control through REMOTE CONTROL Connector .....	6-23
6.3.2	Remote Control through SIGNAL I/O connector .....	6-24
6.3.3	Interlock Function .....	6-26

6.4	Output Signals .....	6-27
6.4.1	Output Signals of SIGNAL I/O Connector .....	6-27
6.4.2	Output Signal of STATUS SIGNAL OUTPUT receptacle .....	6-30
6.5	Settings for Special Test Modes .....	6-31
6.5.1	DOUBLE ACTION Switch .....	6-31
6.5.2	PASS HOLD Switch .....	6-31
6.5.3	MOMENTARY Switch .....	6-32
6.5.4	FAIL MODE Switch .....	6-32
<b>7.</b>	<b>OPERATING PRINCIPLE .....</b>	<b>7-1</b>
7.1	Block Diagrams .....	7-2
7.2	Componential Circuits and Devices .....	7-3
7.3	Zero-turn-on Switch .....	7-4
7.4	Delay Time for Pass/Fail Judgement in DC Mode .....	7-5
7.5	Automatic Discharge Function .....	7-5
<b>8.</b>	<b>MAINTENANCE .....</b>	<b>8-1</b>
8.1	Cleaning the Outer Surfaces .....	8-2
8.2	Checking the Cord and Leadwires .....	8-2
8.2.1	Checking the AC Power Cable .....	8-2
8.2.2	Checking the HV Test Leadwires .....	8-2
8.2.3	Overhaul .....	8-3
8.3	Calibration .....	8-3
<b>9.</b>	<b>SPECIFICATIONS .....</b>	<b>9-1</b>
9.1	TOS5050 .....	9-2
9.2	TOS5101 and TOS5051 .....	9-9
9.3	Overall Dimensions .....	9-18
9.3.1	Dimensions of Models TOS5050 and TOS5051 .....	9-18
9.3.2	Dimensions of Model TOS5101 .....	9-18
<b>10.</b>	<b>OPTIONS .....</b>	<b>10-1</b>
10.1	Model RC01-TOS/RC02-TOS Remote Control Box .....	10-2
10.2	Model HP01A-TOS/HP02A-TOS High Voltage Test Probe .....	10-3
10.3	Model PL01-TOS Warning Light Unit .....	10-4
10.4	Model BZ01-TOS Buzzer Unit .....	10-4
10.5	High Voltage Test Leadwires .....	10-4
<b>INDEX .....</b>	<b>I-1</b>	

## – Warnings and Cautions –

The Tester generates dangerous high voltage. You must handle it very carefully to avoid electrification to yourself and to prevent damage to peripheral devices. Warnings and cautions in this regard are given in this manual and indicated on the Tester as follows.

Warning and caution instructions given in this manual

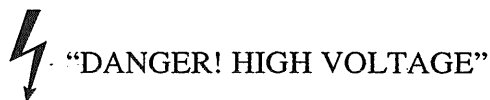
### **WARNING**

Gives instructions to avoid electrification to yourself and to prevent damage to the Tester and other devices.

### **Caution**

Gives instructions to prevent damage to the Tester and other devices.

Attention signs indicated on the Tester



This sign warns you that the area is charged up to a dangerous high voltage and you must never touch it.



This sign means that you should refer to the operation manual.

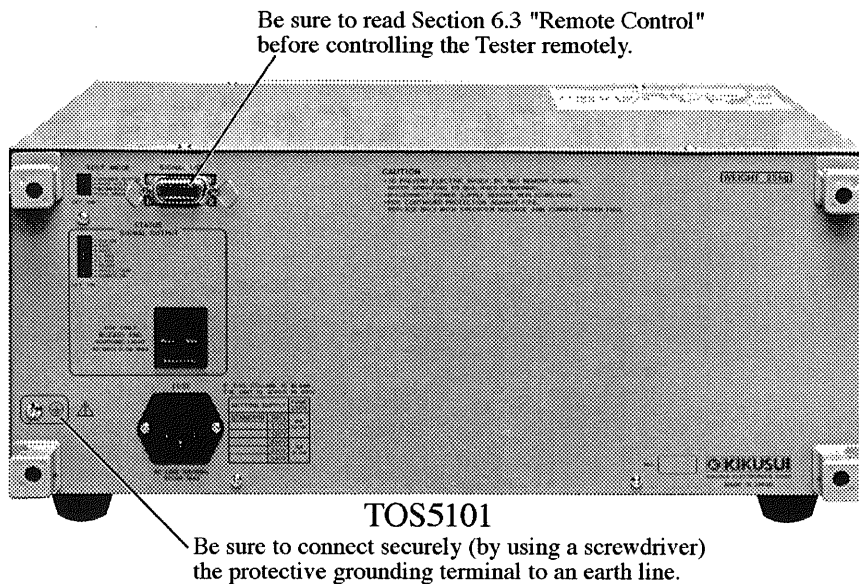
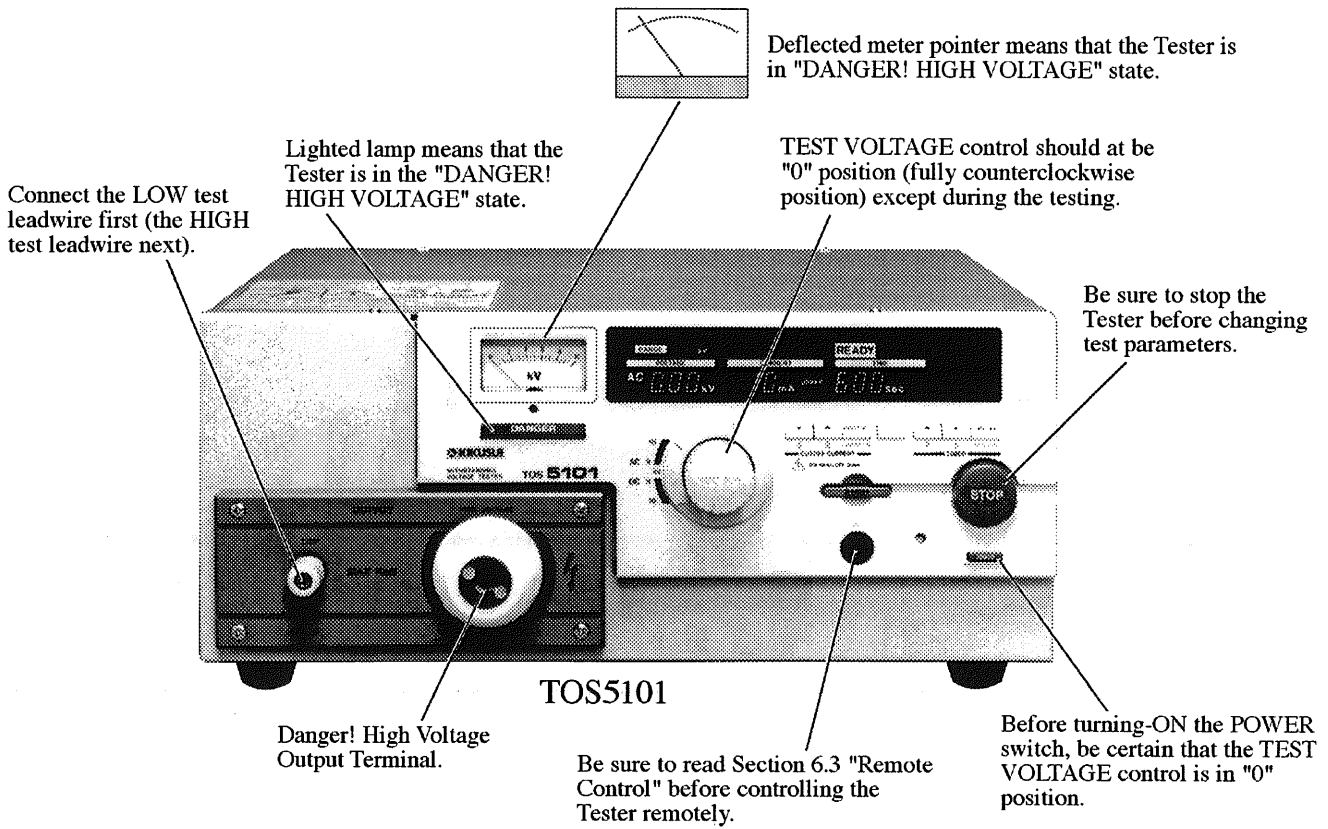
### **CAUTION**

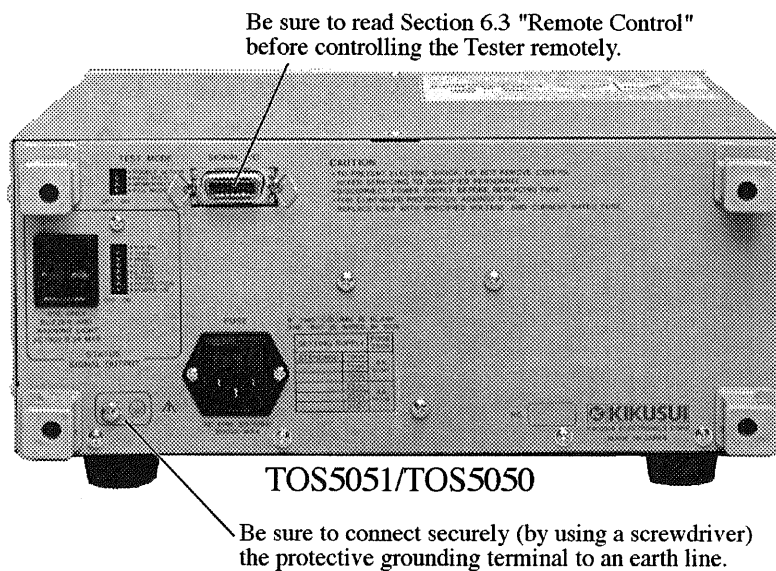
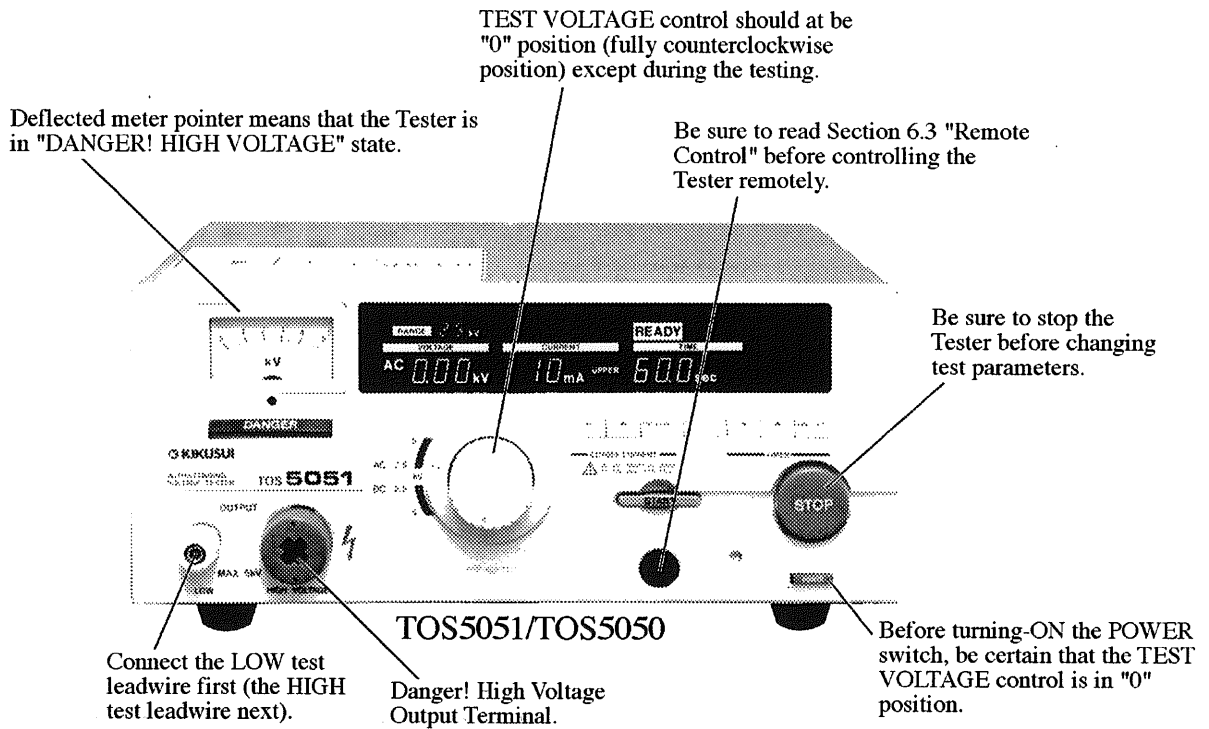
The sign means that the area involves a danger of electrification to yourself or damage to the Tester or other devices.

## WARNINGS AND CAUTIONS FOR OPERATING THE TESTER

**Caution**

- Be sure to read Chapter 3 "WARNINGS AND CAUTIONS FOR OPERATING THE TESTER."





- AC line voltage  
Be sure that the AC line voltage is within the specified range.
- AC power cable  
Be sure to use the specified type of power cable.
- AC power fuse  
Be sure to use the specified type of power fuse.
- Cover  
There are parts which are charged up to dangerous high voltages inside the Tester housing. Never attempt to open any cover of the Tester.



# Chapter 1

## GENERAL

This chapter shows the applicable scope of this manual and major features of the Testers.

Table of contents	Page
1.1 TOS5000 Series .....	1-2
1.2 Features .....	1-3

## 1.1 TOS5000 Series

Kikusui TOS5000 Series Withstanding Voltage Testers are available in four models listed below. This manual is applicable to the first three models, namely, TOS5101, TOS5051, and TOS5050. (For the last one model, namely, TOS5030, refer to the separate manual dedicated to it.)

Model	Type	AC Output	DC Output	Transformer
TOS5101	AC/DC	10kV/50mA (500VA)	10kV/5mA (50W)	500VA
TOS5051	AC/DC	5kV/100mA (500VA)	5kV/10mA (50W)	500VA
TOS5050	AC	5kV/100mA (500VA)	—	500VA
TOS5030	AC	3kV/10mA (30VA)	—	30VA

### **WARNING**

- *Each of these testers generate hazardous high voltages. Its output terminals, test leadwires, probes, and devices under tests are charged up to these voltages. Be sure to provide full protective measures to guard against electric shock hazard — such as to enclose the test area with rope fences to prevent access by unauthorized persons.*

## 1.2 Features

- **The features common to Models TOS5101, TOS5051, and TOS5050 Testers can be summarized as follows:**

1. **For tests complying with major industrial standards**

Each of the Tester allows you to conduct withstanding voltage tests (dielectric strength tests) of electrical and electronic devices and components, complying with major industrial standards including UL, CSA, BS, and JIS (Japanese Industrial Standards) and Electrical Equipment Control Ordinances of Japan.

2. **A Transformer's capacity is 500VA**

The Tester has a transformer, rated 500VA.

3. **Rational layouts of keys and switches**

The keys have a slant-plane for easy viewing and convenient operation. The switch for AC/DC select and test voltage range select and the control for test voltage adjustment are installed concentrically, allowing you to operate them conveniently with two concentric knobs. For adjustment of pass/fail-judgement limit current setting and that of timer setting, respective increment/decrement keys are provided. These keys and switches, together with the large display easy to view, are laid out rationally and will assist you to conduct your tests accurately and efficiently.

4. **A large color display**

The Tester has a large color VACUUM FLUORESCENT DISPLAY. It is a wide viewing angle type of display with high intensity, and clearly indicates information in clearly readable large letters and in color annunciators. The indicated information includes test conditions, instrument status, readback current, result of pass/fail judgement, etc., assisting you to conduct your tests accurately and efficiently.

5. **An analog voltmeter and a digital voltmeter**

The Tester has both analog voltmeter ( $\pm 5\%$  FS) and digital voltmeter ( $\pm 1.5\%$  FS) — the former for quick grasp of the voltage and the latter for more accurate readout — assisting you to conduct your tests rapidly but accurately.

6. **A digital ammeter**

The tester has a digital ammeter to measure the current that flows through the DUT (device under test).

7. **A window comparator for pass/fail judgement**

The Tester has a window comparator for pass/fail judgement with reference to both upper (U) and lower (L) criteria (cutoff current). The comparator generates a FAIL signal when the measured current that flows through the DUT is greater than the preset upper limit criterion or even when it is less than the preset lower limit criterion. The L FAIL detection function contributes to improve the test reliability by detecting open-circuiting or imperfect contacting of the test leadwires. Separately for each of U type and L type of fail, the Tester indicates a fail annunciator message on its display and delivers a fail event signal, allowing you to immediately find out the type of the fail.

You can preset the upper limit and lower limit currents (cutoff currents) mutually independently, within the ranges shown in the following table.

Model	Preset range of U/L limits	Number of steps
TOS5101	AC: 0.1mA to 55mA	145 steps
	DC: 0.1mA to 5.5mA	55 steps
TOS5051	AC: 0.1mA to 110mA	200 steps
	DC: 0.1mA to 11mA	101 steps
TOS5050	AC: 0.1mA to 110mA	200 steps

## 8. A digital timer

The timer allows you to preset the period during which the test voltage is to be applied to the DUT. The preset range is 0.5 to 999 seconds (in 1895 steps). When the timer function is ON, the preset period is decremented and the timer indicates the remaining period; when it is OFF, time is incremented and the timer indicates the elapsed period.

## 9. Remote control provision

The tester has provisions for remote start/stop control operation. That is, it has a 5-pin DIN connector (for the optional Remote Control Box or High Voltage Test Probe) on its front panel and a 14-pin Amphenol connector on its rear panel. The remote control function, together with the status signal function, will help you conduct efficient automatic labor-saving tests.

## 10. Status signals

The Tester delivers seven status signals — namely, H.V ON, TEST, PASS, U FAIL, L FAIL, READY, and PROTECTION — through its 14-pin Amphenol connector (that is used in common for the remote control signal also) on the rear panel. The signal form is open collector. The Tester can deliver a 100V AC output in response to one of eight states — namely, H.V ON, TEST, PASS, U FAIL, L FAIL, READY, PROTECTION, and POWER ON. As used in conjunction with the remote control function, these status signals will help you to conduct still more efficient automatic labor-saving tests.

## 11. Compact and light

The Testers are compact and light as shown below.

Model	Overall dimensions	Weight
TOS5101	430 mm wide, 177 mm high, 370 mm deep (16.93 wide, 6.97 high, 14.57 deep in.)	19 kg (42 lbs.)
TOS5051	320 mm wide, 132 mm high, 300 mm deep (12.60 wide, 5.20 high, 11.81 deep in.)	16 kg (36 lbs.)
TOS5050	320 mm wide, 132 mm high, 300 mm deep (12.60 wide, 5.20 high, 11.81 deep in.)	15 kg (33 lbs.)

**12. Resume of test state by nonvolatile memory**

When you turn the Tester power OFF, the Tester stores its existing test state in its nonvolatile memory. As you turn the Tester power ON for the next time, by recalling the conditions of test from the nonvolatile memory the Tester automatically restores the test state that existed when you turned OFF power last time.

**13. A safer H.V output terminal**

The leadwire insertion portion of the high voltage output terminal is structured with a restriction for safer connection.

**14. A DANGER lamp**

The Tester has a large and bright DANGER lamp. This lamp lights up so far as electric charge remains on the output terminal, warning you of a possible electric shock hazard.

**15. Interlock provision**

The Tester has an interlock provision to ensure that the Tester cannot deliver its output voltage and the Tester shutdown its output voltage under test condition unless a certain external condition is met. This interlock signal is available if there is open-circuiting or imperfect contacting in the signal line, thereby enhancing further the operation safety.

**16. Keylock function**

The Tester has a keylock function to disable all keys (except the START/STOP keys) to guard against inadvertent key operation by the operator or by key operation by unauthorized persons, thereby improving the reliability of tests.

**17. Switches for safer operation**

A rotary switch is used for AC/DC test mode selection and test voltage range selection. The START switch is of a recessed type. These features, together with the keylock function, enhance operation reliability and safety.

**18. Noise-resistant circuits**

The internal circuits of the Tester are designed to be highly resistant against noise, thereby enhancing the operation reliability.

**■ The features common to Models TOS5101 and TOS5051 (models for DC output also) can be summarized as follows:****1. Automatic discharge function**

When the DC test output voltage is turned off, the output circuit is automatically discharged, thereby discharging the charge that could remain in the device under test (DUT). This feature, together with the DANGER lamp, enhances the test operation safety.

**2. A DC/DC converter for quality DC test voltage**

The Tester has a DC/DC converter which generates a quality test voltage of high stability with less ripple.



# Chapter 2

## GENERAL PRELIMINARY NOTES AND PRECAUTIONS

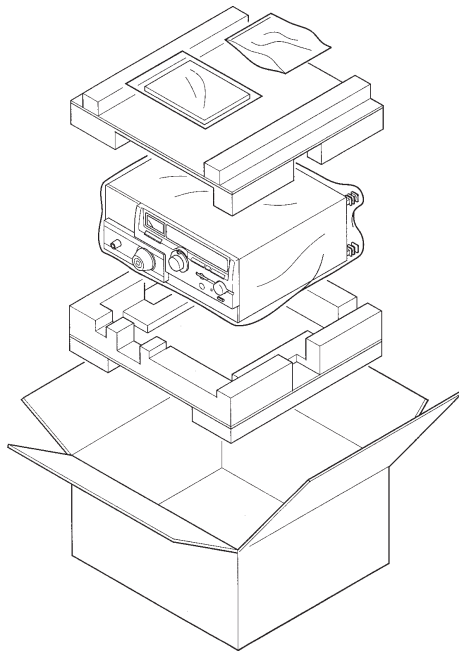
This chapter gives general notes and precautions you should take heed of, before start using the Tester.

Table of contents	Page
2.1 Checking for Shipping Damages and Accessories .....	2-2
2.2 General Information Before Using the Tester .....	2-4
2.2.1 AC Line Requirements .....	2-4
2.2.2 Fuse Ratings .....	2-5
2.2.3 Environmental Conditions .....	2-6
2.2.4 Notes for Moving the Tester .....	2-8

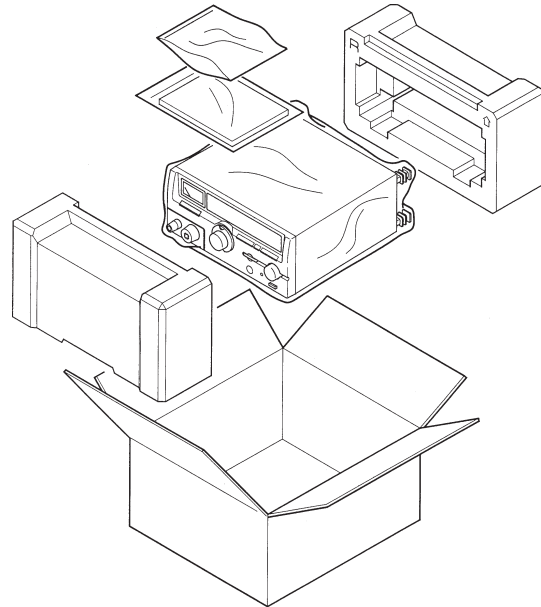
## 2.1 Checking for Shipping Damages and Accessories

When you receive the Tester, inspect it for any obvious damages that may have occurred during shipment. Immediately report any damages to the carrier and your Kikusui agent.

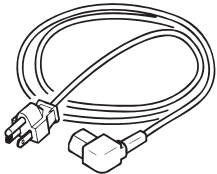
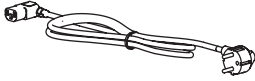
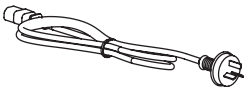
You should also find the standard accessories as shown below accompany the Tester in the same package.



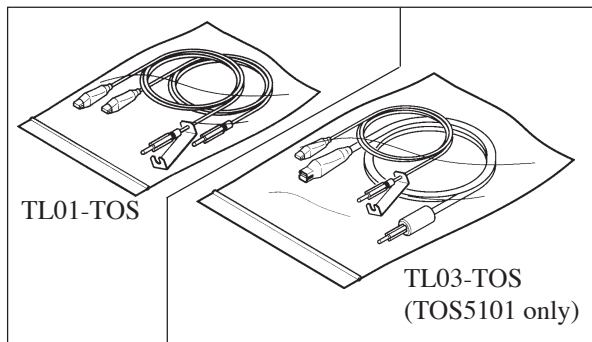
TOS5101



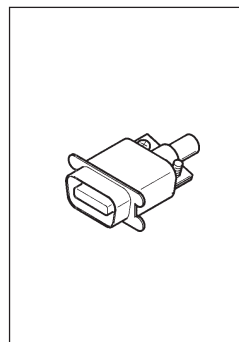
TOS5050/TOS5051

 PLUG: NEMA5-15 [85-AA-0003]	OR	 PLUG: CEE7/7 [85-AA-0005]	OR	 PLUG: GB1002 [85-10-0790]
The power cord that is provided varies depending on the destination for the product at the factory-shipment.				

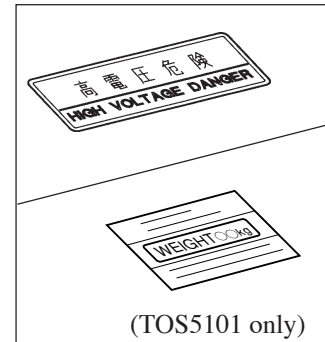
AC power cable



HV Test Leadwires

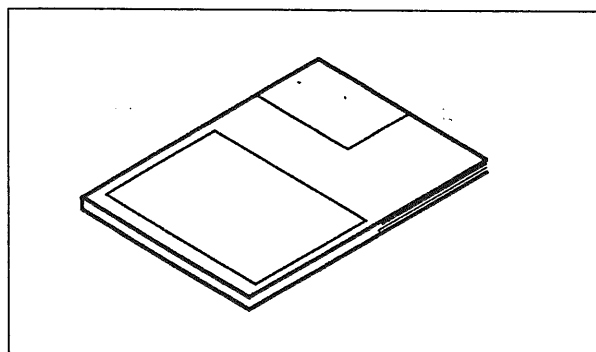


14-pin Amphenol plug (assembly type)

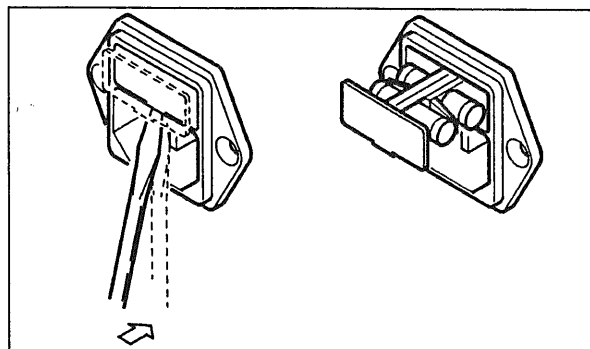


DANGER and WEIGHT sticker (TOS5101 only)





Operation manual



AC line power fuse (in fuse holder)

### ■ Standard accessories of TOS5051 or TOS5050

Item	Q'ty	Remarks	Check
AC power cable	1		
High voltage test leadwires TL01-TOS (1.5 meters)	1 set		
14-pin Amphenol connector plug	1	Assembly type	
"DANGER! HIGH VOLTAGE" sticker	1		
Operation manual	1	(This book)	
AC Power fuses	2	One in present use and the other as spare (in the fuse holder cap)	

### ■ Standard accessories of TOS5101

Item	Q'ty	Remarks	Check
AC power cable	1		
High voltage test leadwires For up to 5kV, TL01-TOS (1.5 meters)	1 set		
For up to 10kV, TL03-TOS (1.5 meters)	1 set		
14-pin Amphenol connector plug	1	Assembly type	
"DANGER! HIGH VOLTAGE" sticker	1		
"WEIGHT" sticker	1		
Operation manual	1	(This book)	
AC Power fuses	2	One in present use and the other as spare (in the fuse holder cap)	

## 2.2 General Information Before Using the Tester

This section provides general information you should acquire before start using the Tester. Be sure to read this section before start using the Tester.

### 2.2.1 AC Line Requirements

The AC line requirements of the Tester are as follows:

Nominal voltage	Voltage tolerance	Nominal frequency
100V AC	±10% of nominal voltage	50/60 Hz

The standard nominal AC line voltage of the Tester is 100V. The Tester normally operates on an AC line voltage within ±10% of the nominal voltage. If the line voltage is outside of this range, the Tester may not operate normally or may be damaged. If your AC line voltage is outside of this range, be sure to convert it into within this range by using an autotransformer or other appropriate means.

Testers to operate on other AC line voltages as shown below also are available as factory-modification options.

Optional AC line voltages	110V	120V	220V	230V	240V
---------------------------	------	------	------	------	------

A sheet that indicates the AC line setting of the Tester as shown below is posted near the AC line power input terminal of the Tester. If no particular indication is made on this indicator sheet, the AC line setting of the Tester is for the standard nominal voltage (100V AC). As an option, modification to one of the other nominal voltages is made at the factory before the Tester is shipped from the factory. When this has been done, the modified nominal AC line voltage is indicated by a marking on the indicator sheet. Before turning ON the AC input power of the Tester, be sure that your AC line voltage conforms with the nominal voltage indicated on the indicator sheet.

SETTING SUPPLY		FUSE 250V
STANDARD	100V	8A SLOW
	110V	
	120V	
	220V	4A SLOW
	230V	
	240V	

#### **WARNING**

- Do not attempt to convert your Tester for AC line voltage change for yourself. Order your Kikusui agent for conversion of your Tester.

## 2.2.2 Fuse Ratings

Be sure to check the ratings of the fuses before connecting the AC power cable to the AC LINE connector of the Tester. The fuse holder is structured in the AC LINE connector. To check the fuse ratings, remove the fuse holder cap by using a screwdriver as illustrated below. There are two fuses in the cap — one for present use and the other for spare. Take out the fuses and check their ratings.

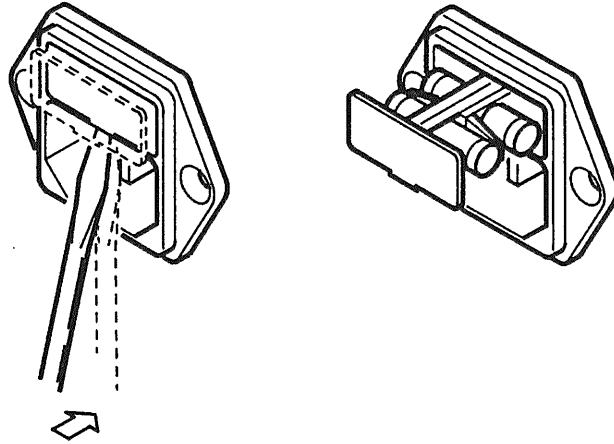


Figure 2.1 Fuse Replacement

Nominal AC line voltage	Fuse ratings
100V	250V, 8A, slow blow
110V	
120V	
220V	250V, 4A, slow blow
230V	
240V	

After checking the ratings, put back the fuses into the cap and insert the cap into the fuse holder sufficiently — that is, until the cap clicks.

When the fuse in present use has blown out, replace it with the spare one after eliminating the cause of the fuse blow. When you need further fuses, be sure to use fuses of the correct ratings.

### **WARNING**

- *Do not use a fuse of incorrect ratings. Never attempt to run the Tester by shorting the fuse circuit with a wire.*

### 2.2.3 Environmental Conditions

Be sure to observe the following precautions when installing the tester.

■ **Do not use the tester in a flammable atmosphere.**

To prevent explosion or fire, do not use the tester near alcohol, thinner, or other combustible materials, or in an atmosphere containing such vapors.

■ **Avoid locations where the tester is exposed to high temperatures or direct sunlight.**

Do not locate the tester near a heater or in areas subject to drastic temperature changes.

Operating temperature range: 0 °C to +40 °C (+32 °F to +104 °F)

Storage temperature range: -20 °C to +70 °C (-4 °F to +158 °F)

■ **Avoid humid environments.**

Do not locate the tester in a high-humidity environment-near a boiler, humidifier, or water supply.

Operating humidity range: 20 % to 80 % RH  
(no dew condensation permitted)

Storage humidity range: 80 % RH or less  
(no dew condensation permitted)

Condensation may occur even within the operating humidity range. In that case, do not start using the tester until the location is completely dry.

■ **Do not place the tester in a corrosive atmosphere.**

Do not install the tester in a corrosive atmosphere or one containing sulfuric acid mist or the like. This may cause corrosion of various conductors and imperfect contact with connectors, leading to malfunction and failure, or in the worst case, a fire.

■ **Do not locate the tester in a dusty environment.**

Dirt and dust in the tester may cause electrical shock or fire.

■ **Do not use the tester where ventilation is poor.**

Prepare sufficient space around the tester to allow for air flow.

■ **Do not place the tester on a tilted surface or in a location subject to vibrations.**

If placed on a non-level surface or in a location subject to vibration, the tester may fall, resulting in damage and injury.

■ **Do not use the tester in locations affected by strong magnetic or electric fields.**

Operation in a location subject to magnetic or electric fields may cause the tester to malfunction, resulting in electrical shock or fire.

■ **Do not use the tester in locations near a sensitive measuring instrument or receiver.**

Operation in a location subject, may cause such equipment may be affected by noise generated by the tester. At a test voltage exceeding 3 kV, corona discharge may be generated to produce substantial amounts of RF broadband emissions between grips on the test leadwire. To minimize this effect, secure a sufficient distance between alligator clips.

In addition, keep the alligator clips and test leadwire away from the surfaces of conductors (particularly sharp metal ends).

■ **Secure adequate space around the power plug.**

Do not insert the power plug to an outlet where accessibility to the plug is poor. And, do not place objects near the outlet that would result in poor accessibility to the plug.

## 2.2.4 Notes for Moving the Tester

When moving the tester to the installation site or otherwise transporting it, take the following precautions:

■ **Before moving the tester, turn off the power switch.**

Transporting the tester with its POWER switch on can lead to electric shock and damage.

■ **When moving the tester, Disconnect all wires from it.**

Moving the tester without disconnecting the cables may result in breakage of the wire or injury due to the tester tipping over.

■ **For transportation, use the special packing material for the tester.**

Transport the tester in its original package to prevent vibration and falls, which may damage the tester. If you require packing material, contact Kikusui distributor/agent.

■ **Have two or more people move the tester.**

The TOS5101 weighs approximately 21 kg. Two persons are required to carry the TOS5101. Take extreme care when moving the TOS5101.

# Chapter 3

## WARNINGS AND CAUTIONS FOR OPERATING THE TESTER

This chapter gives warnings and cautions you must observe when operating the Tester.

### **WARNING**

The Tester delivers a 5kV or 10kV test voltage which can cause electric shock hazard. When operating the Tester, be extremely careful and observe the cautions, warnings, and other instructions given in this chapter.

Table of contents	Page
3.1 Preparative Procedures .....	3-2
3.1.1 Wearing Insulation Gloves .....	3-2
3.1.2 Grounding the Tester .....	3-2
3.2 Warnings and Cautions when Operating the Tester .....	3-3
3.2.1 Connecting the LOW Test Leadwire .....	3-3
3.2.2 Connecting the HIGH Test Leadwire .....	3-3
3.2.3 Before Turning-ON AC Input Power .....	3-4
3.2.4 Before Changing Test Parameters .....	3-4
3.2.5 Precautions for Pausing Tests .....	3-4
3.2.6 Items Charged Up to Dangerous High Voltages .....	3-5
3.3 Warnings for Matters After Turning-OFF Power .....	3-5
3.3.1 Matters to be Sure of After Turning-OFF Power .....	3-5
3.3.2 Residual High Voltages .....	3-6
3.4 Warnings for Remote Control .....	3-7
3.5 Inhibitions .....	3-7
3.5.1 Inhibition of Rapid ON/OFF Repetitions .....	3-7
3.5.2 Inhibition of Shorting to Earth Ground .....	3-7
3.6 In Case of Emergency .....	3-7
3.6.1 Actions When in Emergency .....	3-7
3.7 Dangerous States of Failed Tester .....	3-8
3.7.1 Inhibition of Use of Failed Tester .....	3-8
3.7.2 DANGER Lamp .....	3-8
3.8 Wattage, Heat, and Other Limiting Conditions of Use ....	3-8

### 3.1 Preparative Procedures

#### 3.1.1 Wearing Insulation Gloves

When handling the Tester, be sure to wear insulation gloves in order to protect yourself against high voltages. If no insulation gloves are available on your market, please consult with your Kikusui agent for them.

#### 3.1.2 Grounding the Tester

Be sure to ground the Tester. To do this, connect securely (by using a tool) an earth line to the Protective grounding terminal on the rear panel of the Tester. Unless the Tester is securely grounded, when the Tester output is shorted to an earth line or to a conveyor or other device which is connected to an earth line or when it is shorted to the AC line\*, the Tester chassis can be charged up to the high voltage that can cause electric shock hazard.

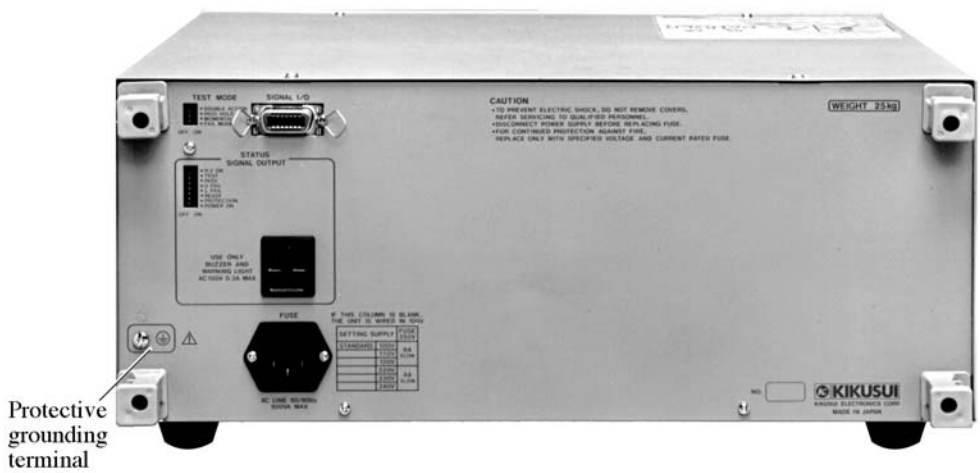


Figure 3.1 Grounding the Tester (TOS5101)

\*AC line: The term “AC line” here means the line on which the Tester is operating. That is the line to whose outlet the AC power cable of the Tester is connected. It may be of a commercial AC power line or of a private-generator AC power line.



Figure 3.2 Grounding the Tester (TOS5051 or TOS5050)



## 3.2 Warnings and Cautions when Operating the Tester

### 3.2.1 Connecting the LOW Test Leadwire

For the connection method of the LOW test leadwire to the LOW output terminal of the Tester, see Figure 3.3. Each time before start using the Tester, check that the LOW test leadwire is not broken. When connecting the Tester to a DUT (device under test), connect the LOW test leadwire first (and the HIGH test leadwire next) and be sure that it securely connects the LOW output terminal of the Tester to the corresponding terminal (chassis protective grounding terminal) of the DUT. If the connection is imperfect, overall DUT can be charged up to a hazardous high voltage.

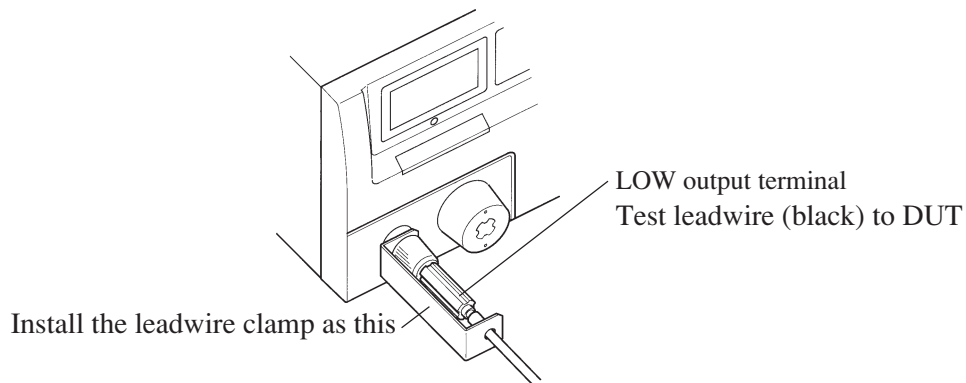


Figure 3.3 Connecting the LOW Test Leadwire (TOS5101)

### 3.2.2 Connecting the HIGH Test Leadwire

Be sure to observe the order of leadwire connections — the LOW test leadwire first and the HIGH test leadwire next. To connect the Tester to a DUT, proceed as follows:

- Step 1** Press the **STOP** switch.
- Step 2** Check that the output voltmeter reading is zero.
- Step 3** Check that the **DANGER** lamp is OFF.
- Step 4** Connect the HIGH test leadwire to the HIGH VOLTAGE output terminal.
- Step 5** Short the LOW and HIGH test leadwires, and check that no high voltage is output.
- Step 6** Connect the Tester to the DUT, with the LOW output leadwire first and and HIGH output leadwire next.

### 3.2.3 Before Turning-ON AC Input Power

Before turning-on the AC input power, be certain that the TEST VOLTAGE control knob is in the zero position (fully counterclockwise position).

### 3.2.4 Before Changing Test Parameters

Before changing test parameters, press the **STOP** switch and be certain that the TEST VOLTAGE control knob is in the zero position (fully counterclockwise position).

### 3.2.5 Precautions for Pausing Tests

When you pause a test, be sure to turn the TEST VOLTAGE control knob to the zero position (fully counterclockwise position) and press the **STOP** switch. If you are not going to resume the test soon or if you are leaving the Test area, be sure to turn-OFF the **POWER** switch.

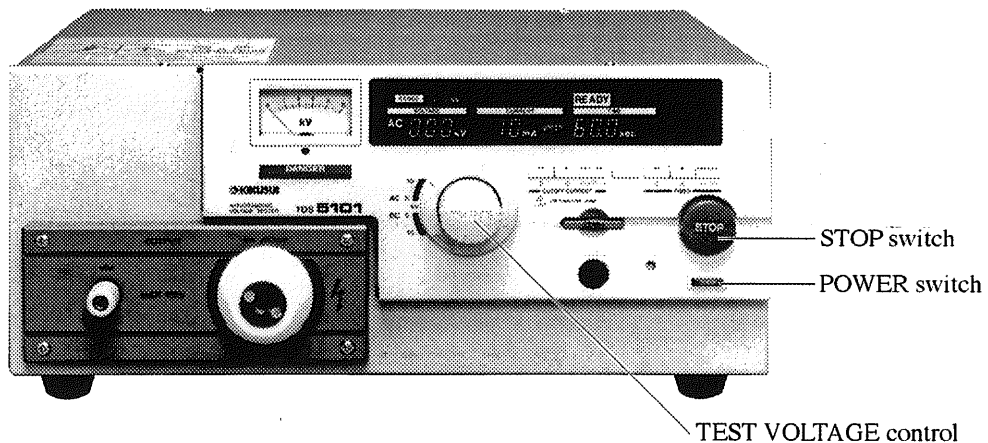


Figure 3.4 Switches and Control on Front Panel (TOS5101)

### 3.2.6 Items Charged Up to Dangerous High Voltages

When in test, the DUT, test leadwires, probes, and output terminals and their vicinities can be charged up to dangerous high voltages. Never touch them when in test.

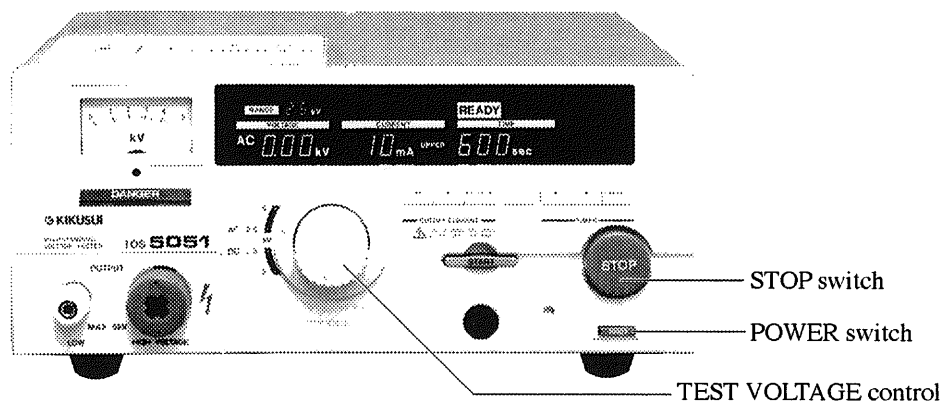


Figure 3.5 Front Panel of TOS5051/TOS5050

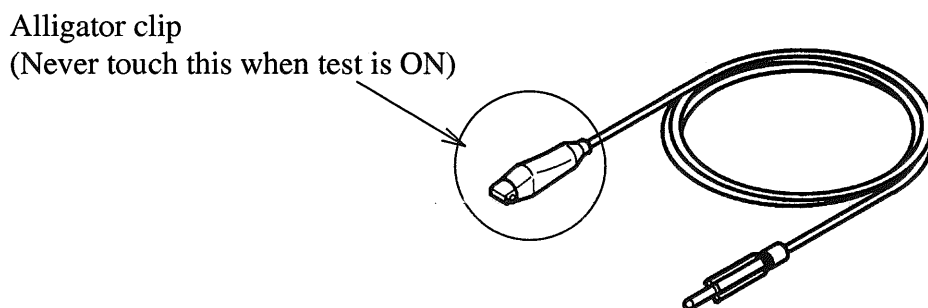


Figure 3.6 Test Leadwire

#### **WARNING**

- *The vinyl sheaths of the alligator clips of the test leadwires which are supplied accompanying the Tester have no sufficient insulation for the high test voltages. Never touch them when in test.*

## 3.3 Warnings for Matters After Turning-OFF Power

### 3.3.1 Matters to be Sure of After Turning-OFF Power

If you have to touch the DUT, test leadwires, probes, and/or output terminals and their vicinities for re-connections or other reasons, be sure of the following two matters:

- The output voltmeter indicates “zero.”
- The DANGER lamp has gone out.

When you have tested the DUT with the DC output of the Tester, the DUT will remain charged with the high test voltage for a period that depends on the conditions of test. Be sure to observe the instructions given in Section 3.3.2.

### 3.3.2 Residual High Voltages

#### Warning for Residual High Voltages

When you do a test with the DC output, the DUT, test leadwires, probes, and output terminals and their vicinities are charged up to high voltages. Even after you turned off the DC output, these voltages remain there for a period that depends on the conditions of the test. Within this period, never touch the DUT, test leadwires, probes, or output terminals or their vicinities to avoid electric shock hazard.

Before touching any of them, be sure of the following two matters and short the LOW and HIGH test leadwires.

- (a) The output voltmeter indicates “zero”.
- (b) The DANGER lamp has gone out.

#### Discharge Time of Residual High Voltages

The period of time the residual high voltages take to be discharged vary depending on test conditions — such as the properties of DUT and the test voltage delivered by Tester (Model TOS5101 or TOS5051). When no DUT is connected, the period the Tester itself (internal capacitor of the Tester) takes to be discharged is as follows:

Discharge time of Tester itself

Tester model	Discharge time of Tester itself	
	5kV	10kV
TOS5101	Approx. 22ms	Approx. 24ms
TOS5051	Approx. 16ms	—

(Period the Tester output terminal voltage takes to be reduced to 30V)

When a DUT whose capacitance is  $0.05\mu\text{F}$  is connected to the Tester, the discharge time is as follows:

Tester model	Discharge time of Tester itself	
	5kV	10kV
TOS5101	Approx. 140ms	Approx. 170ms
TOS5051	Approx. 50ms	—

(Period the Tester output terminal voltage takes to be reduced to 30V)

The Tester has an internal circuit to discharge the residual high voltage of its output circuit when its output is turned off. Do not disconnect the DUT from the Tester when in test. If you do this, the residual high voltage on the DUT may remain undischarged for a long period.

## 3.4 Warnings for Remote Control

Be extremely careful when operating the Tester in the remote control mode in which the dangerous high test voltage is ON/OFF-controlled remotely. Provide protective means as follows:

- Provide means to assure that the test setup does not become the TEST-ON state (state that the test voltage is being delivered) by inadvertent operation.
- Provide means to assure that none can touch the DUT, test leadwires, probes, output terminals and their vicinities when in the TEST-ON state (state that the test voltage is being delivered).

## 3.5 Inhibitions

### 3.5.1 Inhibition of Rapid ON/OFF Repetitions

After turning OFF the power switch, be sure to allow several seconds or more before turning it ON again. Do not repeat turning ON/OFF the power switch rapidly — if you do this, the protectors of the Tester may not be able to render their protective functions properly. Do not turn OFF the power switch without turning OFF the output switch first — you may do this only in case of emergency.

### 3.5.2 Inhibition of Shorting to Earth Ground

Pay attention so that the high test voltage line is not shorted to a nearby AC line or nearby devices (such as conveyors) which are connected to an earth ground. If it is shorted, the Tester chassis can be charged up to the hazardous high voltage.

Be sure to connect the protective grounding terminal of the Tester to an earth line. If this has been securely done, even when the HIGH output terminal is shorted to the LOW output terminal, the Tester will not be damaged and its chassis will not be charged up to the high voltage.

## 3.6 In Case of Emergency

### 3.6.1 Actions When in Emergency

In case of an emergency (such as electric shock hazard or burning of DUT), take the following actions:

- (a) Turn OFF the power switch of the Tester.
- (a) Disconnect the AC power cable of the Tester from the AC line receptacle.

You may do either (a) or (b) first. But be sure to do both.

## 3.7 Dangerous States of Failed Tester

### 3.7.1 Inhibition of Use of Failed Tester

Typical possible dangerous states of the Tester are as shown below and in which cases the most dangerous situation that “the high test voltage remains delivered and won’t be turned off!” may occur. When this situation has occurred, immediately turn OFF the power switch and disconnect the AC power cable from the AC line receptacle. Never attempt to repair the Tester for yourself--please order your Kikusui agent.

- The DANGER lamp does not go out despite you have pressed the STOP switch.
- The DANGER lamp does not light up despite the pointer of the output voltmeter is deflected indicating that the output voltage is being delivered.

Also when the Tester is in other malfunctioning states than the above, there is a possibility that the output voltage is delivered irrespective of your proper operating procedure. Never use the Tester when it has failed.

### 3.7.2 DANGER Lamp

If the DANGER lamp does not light up (due to failure of the lamp itself or other cause) when it should, this situation is very dangerous. Immediately stop using the Tester and order your Kikusui agent for repair.

## 3.8 Wattage, Heat, and Other Limiting Conditions of Use

1. The maximum output voltage of the Tester when at no load may become higher than 5kV (10kV). It may become still higher depending on AC line voltage change. With these in mind, be sure to operate the Tester at output voltage not higher than 5kV (10kV). (10kV is for TOS5101.)
2. The heat dissipation of the high voltage transformer of the AC test section is one-half of the normal wattage with respect to the rated output from the viewpoint of size, weight, and cost of the Tester. Due to this, when operating the Tester with its UPPER CUTOFF CURRENT higher than 50mA (25mA for TOS5101), provide pause periods at least identical with test periods. The allowable maximum continuous test period is 30 minutes (at ambient temperature not higher than 40 degrees C (104 degrees F)). If you operate the Tester in the TEST-ON state continuously for a period longer than this, the thermal fuse in the high voltage transformer may blow out.

TOS5101			
Ambient temperature t	Upper cutoff current I (mA)	Pause period	Maximum allowable continuous test period
$t \leq 40^{\circ}\text{C}$ ( $t \leq 104^{\circ}\text{F}$ )	$25 < I \leq 55$	Not less than test period	$\leq 30$ min
	$I \leq 25$	Not required	Infinite

TOS5051, TOS5050			
Ambient temperature t	Upper cutoff current I (mA)	Pause period	Maximum allowable continuous test period
$t \leq 40^{\circ}\text{C}$ ( $t \leq 104^{\circ}\text{F}$ )	$50 < I \leq 110$	Not less than test periods	$\leq 30$ min
	$I \leq 50$	Not required	Infinite

The above does not apply when the CUTOFF CURRENT is less than 50mA (25mA for TOS5101).

- The heat dissipation of the high voltage generator of the DC test section is one-tenth of the normal wattage with respect to the rated output from the viewpoint of size, weight, and cost of the Tester. Due to this, when operating the Tester, provide pause periods shown in the tables below. If you operate the Tester beyond these limits, the high voltage generator will be overheated and the protector may trip and the Tester may be driven into the PROTECTION status. When this has occurred, pause the test operation until the Tester cools off and then resume the test operation. As the Tester is cooled off and the cause of the PROTECTION status is eliminated, the Tester resumes its normal operating state.

TOS5101			
Ambient temperature t	Upper cutoff current I (mA)	Pause period	Maximum allowable continuous test period
$t \leq 30^{\circ}\text{C}$ ( $t < 86^{\circ}\text{F}$ )	$3 < I \leq 5.5$	At least 5 times of test period	$\leq 30$ s
	$3 < I \leq 5.5$	At least 10 times of test period	$\leq 60$ s
	$1.5 < I \leq 3$	At least 4 times of test period	$\leq 120$ s
	$0.5 < I \leq 1.5$	At least twice of test period	$\leq 120$ s
	$I \leq 0.5$	Not required	Infinite
	At $t \leq 25^{\circ}\text{C}$ , infinitive continuous operation is allowable with cutoff current of up to 1 mA.		
$30^{\circ}\text{C} < t \leq 35^{\circ}\text{C}$ ( $86^{\circ}\text{F} < t \leq 95^{\circ}\text{F}$ )	$3 < I \leq 5.5$	At least 10 times of test period	$\leq 15$ s
	$1.5 < I \leq 3$	At least 4 times of test period	$\leq 30$ s
	$1 < I \leq 1.5$	At least twice of test period	$\leq 60$ s
	$0.5 < I \leq 1$	At least twice of test period	$\leq 120$ s
	$I \leq 0.5$	Not required	Infinite
$35^{\circ}\text{C} < t \leq 40^{\circ}\text{C}$ ( $95^{\circ}\text{F} < t \leq 104^{\circ}\text{F}$ )	$0.5 < I \leq 1.5$	At least 10 times of test period	$\leq 15$ s
	$I \leq 0.5$	Not required	Infinite

TOS5051			
Ambient temperature t	Upper cutoff current I (mA)	Pause period	Maximum allowable continuous test period
t < 30°C (t < 86°F)	6 < I ≤ 11	At least 5 times of test period	≤ 30 s
	6 < I ≤ 11	At least 10 times of test period	≤ 60 s
	3 < I ≤ 6	At least 4 times of test period	≤ 120 s
	1 < I ≤ 3	At least twice of test period	≤ 120 s
	I ≤ 1	Not required	Infinite
	At t < 25°C, infinitive continuous operation is allowable with cutoff current of up to 2 mA.		
30°C < t ≤ 35°C (86°F < t ≤ 95°F)	6 < I ≤ 11	At least 10 times of test period	≤ 15 s
	3 < I ≤ 6	At least 4 times of test period	≤ 30 s
	2 < I ≤ 3	At least twice of test period	≤ 60 s
	1 < I ≤ 2	At least twice of test period	≤ 120 s
	I ≤ 1	Not required	Infinite
35°C < t ≤ 40°C (95°F < t ≤ 104°F)	1 < I ≤ 3	At least 10 times of test period	≤ 15 s
	I ≤ 1	Not required	Infinite

4. The Tester operates normally on an AC line voltage with an allowance of ±10% of the nominal line voltage. Outside this allowance range, the Tester may not operate normally and may become damaged. If your utility AC line voltage is not within this range, provide an appropriate means to convert it into this range.
5. Do not operate or store the Tester in direct sunlight or in high temperature, high humidity, or dusty atmosphere.
6. The Tester has a high voltage output transformer of 500VA and will draw a large AC input current (several tens Amperes) in the following cases:
  - For several tens milliseconds before the Tester detects a FAIL of the DUT (if the DUT is a failure).
  - For several tens milliseconds of start up period of the Tester.

Pay due regards to the capacity of the AC line and to other devices connected to the same line. Do not connect the Tester to a regulated AC line which employs a current cut-out type of overcurrent protector. If the current is cut out, the Tester may generate quite a high surge voltage in its output circuit. This is very dangerous.



# Chapter 4

## DESCRIPTION OF FRONT AND REAR PANEL ITEMS

This chapter describes the items on the front and rear panels of the Tester.

Table of contents	Page
4.1 Description of Front Panel Items .....	4-2
4.1.1 Turning ON/OFF the AC Input Power .....	4-3
4.1.2 Start/Stop of Test .....	4-5
4.1.3 Test Voltage .....	4-9
4.1.4 Cutoff Currents .....	4-12
4.1.5 Test Time .....	4-15
4.1.6 Others .....	4-17
4.2 Display Items .....	4-18
4.2.1 Test Voltage Display .....	4-18
4.2.2 Readout for Cutoff Current and Measured Current .....	4-21
4.2.3 Test Time Display .....	4-23
4.2.4 READY Message .....	4-24
4.2.5 TEST Message .....	4-24
4.2.6 PASS Message .....	4-24
4.2.7 FAIL Messages .....	4-24
4.2.8 PROTECTION Messages .....	4-25
4.2.9 Others .....	4-25
4.3 Description of Rear Panel Items .....	4-26

### 4.1 Description of Front Panel Items

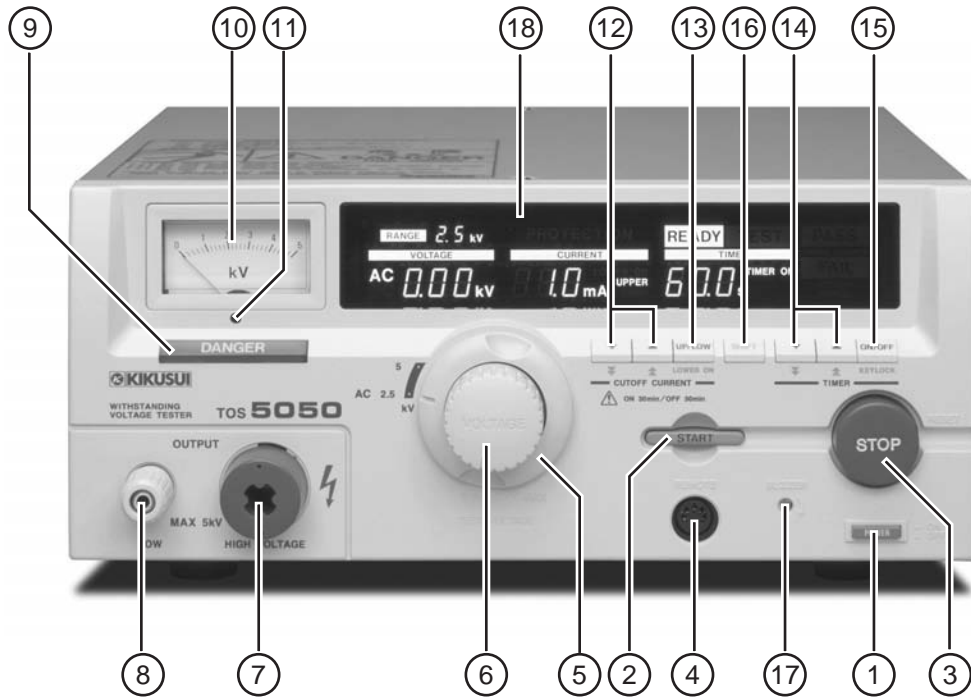


Figure 4.1 TOS5050 Front Panel

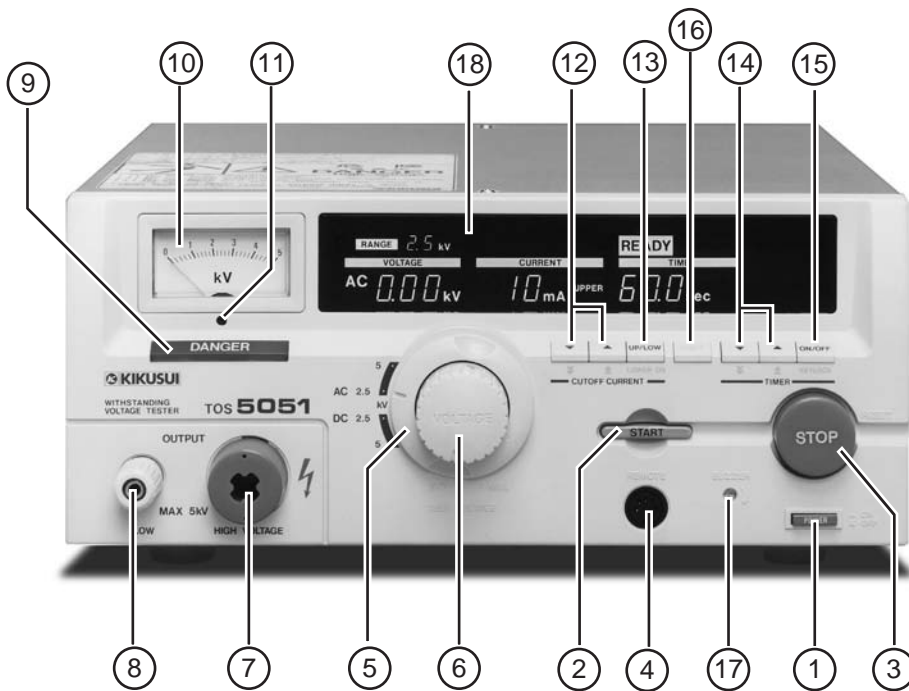


Figure 4.2 TOS5051 Front Panel

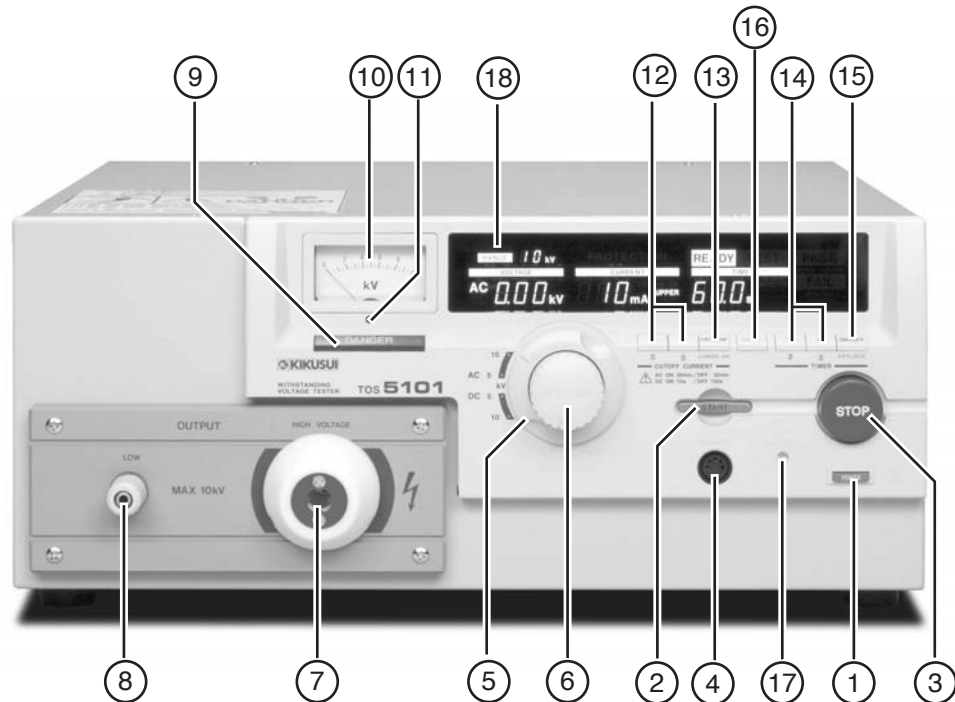


Figure 4.3 TOS5101 Front Panel

### 4.1.1 Turning ON/OFF the AC Input Power

#### ① **POWER** Switch

The **POWER** switch turns ON/OFF the AC mains power of the Tester.

The Tester has a “resume” function. When you turn ON the **POWER** switch, the Tester automatically resumes the conditions of test (settings of cutoff current, test period, etc.) that existed when you turned OFF the **POWER** switch last time.

By pressing the **POWER** switch while keeping the **SHIFT** key ⑯ depressed, you can initialize the test conditions to the initial setup (factory default setup) as shown below. If you do this, the data on the test conditions that existed when you turned OFF the **POWER** switch last time is lost.

Item	Initial setup data
Upper cutoff current	0.2mA
Lower cutoff current	0.1mA
Lower pass/fail judgement	OFF
Test period	0.5 s
Timer function	ON
Keylock function	OFF

**Caution**

- *Be sure to read Chapter 3 “WARNINGS AND CAUTIONS FOR OPERATING THE TESTER” (Page 3-1) of this manual before start using the Tester.*
- *Before turning ON the **POWER** switch, be sure that the **TEST VOLTAGE** control ⑥ is in the fully counterclockwise position (“0” position).*
- *If you want to enter a setting value you have selected, wait approximately 0.5 seconds before turning OFF the **POWER** switch. If you turn off the switch without waiting for this period, the value may not be successfully entered.*
- *Normally, as you turn ON the **POWER** switch, the **TESTER** will become the **READY** state (the **READY** lamp ⑳ will light up). However, the lamp will not light up in the following cases:*

(a) The Tester is in the **PROTECTION** status.

- i. The interlock pins of the **SIGNAL I/O** connector ⑳ on the rear panel are open.  
(For detail, refer to Section 6.3.3 “Interlock Function”)  
If the above is the case, eliminate the interlock signal and reset from the **PROTECTION** status with the **STOP** switch ③ and then start operating the Tester.
- ii. When in DC test (for TOS5101 and TOS5051 only), the high voltage supply section is overheated.

If the above is the case, wait until the Tester cools off and then reset from the **PROTECTION** status with the **STOP** switch ③ and then start operating the Tester.

(b) The lower cutoff current setting is higher than the upper cutoff current setting and the lower pass/fail judgement function is ON.

If the above is the case, make the lower cutoff current setting lower than the upper cutoff current or turn OFF the lower pass/fail judgement function and then start operating the Tester.

(c) The **POWER** switch is turned ON while the **TEST VOLTAGE** switch ⑤ is caught on a midway in turning from one range position to another range position.

When in the above state, the **TEST VOLTAGE RANGE** message ⑲ will indicate 0 kV, both **AC**/**DC** test mode message ⑳ will appear at the same time (except for TOS5050) and will blink to show that no range selection has been successfully accomplished.

If the above is the case, turn the **TEST VOLTAGE** switch ⑤ accurately to a range position you may require and then start operating the Tester.

### 4.1.2 Start/Stop of Test

#### ② START Switch

If you press the **START** switch ② when the Tester is in the **READY** state (state that the **READY** message ⑳ appears), the Tester will execute the test with parameters shown on the display screen ⑱ (Vacuum Fluorescent Display).

If the **REMOTE** message ㉔ is shown, the **START** switch ② is disabled and the remote start control signal applied through the **REMOTE CONTROL** connector ④ or the **SIGNAL I/O** connector ㉗ is enabled.

If the **MOMENTARY** switch of **TEST MODE** switch ㉘ on the rear panel is set to **ON**, the test will be executed only during the period you keep depress the **START** switch ②. For details, refer to Section 6.5 “Settings for Special Test Modes.”

#### **Caution**

- Do not remote-control the Tester simultaneously from both **REMOTE CONTROL** connector ④ and **SIGNAL I/O** connector ㉗. If you do this, the **REMOTE** message ㉔ will go out and the **START** switch ② will be enabled. For details, refer to Section 6.3 “Remote Control.”

#### ③ STOP Switch

The **STOP** switch ③ is to stop the test and reset the Tester. As you press this switch, the Tester will act as follows:

1. Reset from **TEST** status (status that the **TEST** message ㉙ appears)

The Tester will stop the test and act as follows:

- (a) Turns OFF the output with the highest priority.
- (b) Brings the discharge function into effect if the test is in the DC mode.
- (c) Turns OFF the **DANGER** lamp ⑨, provided that there is no residual test voltage in the output circuit.
- (d) Lets the **TEST** message ㉙ disappear.
- (e) Turns OFF the **TEST** signal and the **HV ON** signal fed through the **SIGNAL I/O** connector ㉗.

2. Reset from PASS status (status that the **PASS** message ③⑩ appears)

The Tester will reset from the PASS status and act as follows:

- (a) Lets the **PASS** message ③⑩ disappear.
- (b) Turns OFF the PASS signal fed through the SIGNAL I/O connector ③⑦.

3. Reset from FAIL status (status that the **FAIL** message ③① appears)

The Tester will reset from the FAIL status and act as follows:

- (a) Lets the **UPPER FAIL** message ③① disappear.
- (b) Lets the **LOWER FAIL** message ③① disappear.
- (c) Turns OFF the U FAIL (upper fail) signal fed through the SIGNAL I/O connector ③⑦.
- (d) Turns OFF the L FAIL (lower fail) signal fed through the SIGNAL I/O connector ③⑦.

4. Reset from PROTECTION status

The Tester will reset from the PROTECTION status and act follows:

- (a) Lets the **PROTECTION** message ③② disappear.
- (b) Turns OFF the PROTECTION signal fed through the SIGNAL I/O connector ③⑦.

However, the Tester will not reset from the PROTECTION status if the interlock pins of the SIGNAL I/O connector ③⑦ are open or if the high voltage supply section is overheated in DC test (for TOS5101 and TOS5051 only). If this is the case, eliminate the interlock signal (For detail refer to Section 6.3.3 “Interlock Function”) or wait until the Tester cools off and then reset from the PROTECTION status with the **STOP** switch ③.

5. Reset from READY status (status that the **READY** message ②⑧ appears)

The Tester will reset from the READY status and act as follows:

- (a) Lets the **READY** message ②⑧ disappear.
- (b) Turns OFF the READY signal fed through the SIGNAL I/O connector ③⑦.

Normally, as you release the **STOP** switch ③, the Tester will become the READY status (status that the **READY** message ⑳ appears). In the following cases, however, the Tester will not become the READY status.

1. The cause of PROTECTION status remaining un-eliminated
  - (a) The interlock pins of the SIGNAL I/O connector ㉓ on the rear panel are open. (For details, refer to Section 6.3.3 “Interlock Function.”)
  - (b) When in DC test (for TOS5101 and TOS5051 only), the high voltage supply section is overheated.
2. The test voltage remaining undischarged

This is such state that the **DANGER** lamp ⑨ remains lighted in spite of that the **TEST** message ㉑ has disappeared.

3. A period of approximately 0.5 seconds has elapsed after releasing the **STOP** switch ③ when the DOUBLE ACTION switch of the TEST MODE switch ㉔ is set for ON.

If the DOUBLE ACTION switch of the TEST MODE switch ㉔ is set for ON, the Tester will become the READY state as you release the **STOP** switch ③. Then, when a period of approximately 0.5 seconds has elapsed, the Tester will automatically reset from the READY status. For details, refer to Section 6.5 “Settings for Special Test Modes.”

4. The **STOP** switch ③ is released while the **START** switch ② is pressed.

**Caution**

- If the FAIL MODE switch of the TEST MODE switch ㉔ is set for ON, resetting from the FAIL status (status that the **FAIL** message ㉒ appears) or from the PROTECTION status (status that the **PROTECTION** message ㉓ appears) can be done with the **STOP** switch ③ only. For details, refer to Section 6.5 “Settings for Special Test Modes.”

## ④ REMOTE CONTROL Connector

This connector is for remote control of start/stop of test operation from an optional device such as Remote Control Box (RC01-TOS or RC02-TOS) or H.V Test Probe (HP01A-TOS or HP02A-TOS).

As you connect the plug of the optional device, the remote control circuit is established and the **REMOTE** message ③④ appears and the local **START** switch ② is disabled. In this case, the Tester becomes the PROTECTION status (status that the **PROTECTION** message ③② appears) and the high voltage output is cut off. The STOP operation can be done either locally from the **STOP** switch ③ on the front panel or remotely from the optional device.

As you disconnect the plug of the optional device, the **REMOTE** message ③④ disappears and the **START** switch ② is enabled. The Tester becomes the PROTECTION status (status that the **PROTECTION** message ③② appears) and the high voltage output is cut off.

**Caution**

- *For remote-control of the test start/stop operation of the Tester from other device than one of the optional devices of the Tester, do not use the REMOTE CONTROL connector ④ on the front panel but use the SIGNAL I/O connector ③⑦ on the rear panel.*
- *Of the optional H.V Test Probe (HP01A-TOS or HP02A-TOS), the maximum allowable test voltage is 4 kV when in the AC test mode or 5 kV when in the DC test mode.*
- *Do not remote-control the Tester simultaneously from both REMOTE CONTROL connector ④ and SIGNAL I/O connector ③⑦. If you do this, the REMOTE message ③④ will disappear and the START switch ② will be enabled.*
- *If the Remote Control Box is with its UNCONDITIONAL STOP function effected, the Tester will not become the PROTECTION status when the plug of the box is connected to the REMOTE CONTROL connector ④. When the plug of the HV Test Probe is connected to the REMOTE CONTROL connector ④, the Tester will not become the PROTECTION status because the probe is in the state that its UNCONDITIONAL STOP function is effected.*
- *Be sure to read Section 6.3 “Remote Control” before remote-controlling the Tester.*
- *To reset the Tester from the PROTECTION status, press the STOP switch ③.*



### 4.1.3 Test Voltage

#### ⑤ TEST VOLTAGE Switch

The TEST VOLTAGE switch ⑤ selects a test voltage range and test mode for AC or DC (TOS5050 has no DC test mode).

The TEST VOLTAGE switch ⑤ is enabled when the Tester is in the READY status (status that the **READY** message ⑳ appears); it is disabled when the Tester is in the TEST-ON status (status that the **TEST** message ㉑ appears) or when the Tester is delivering the result of PASS/FAIL judgement (when the **PASS** message ㉒ or the **FAIL** message ㉓ appears).

The Tester takes approximately 0.5 seconds to respond to a range change by this switch. The test cannot be started during this period. (If the **READY** message ㉑ has been displayed, it disappears for this period.)

When the range you selected is entered, the TEST VOLTAGE RANGE message ㉔ or **AC**/**DC** test mode message ㉕ blinks to indicated that the entry has been completed. The message can be reset from blinking by pressing the **STOP** switch ㉖ or by starting the test by pressing the **START** switch ㉗.

Model	Selectable ranges and mode			
TOS5101	10kV AC	5kV AC	10kV DC	5kV DC
TOS5051	5kV AC	2.5kV AC	5kV DC	2.5kV DC
TOS5050	5kV AC	2.5kV AC	-	-

#### **Caution**

- Before turning the TEST VOLTAGE switch ⑤, be sure that the TEST VOLTAGE control ⑥ is in the fully counterclockwise position (“0” position).
- During the TEST-ON period (period that the **TEST** message ㉑ appears), the TEST VOLTAGE switch ⑤ is disabled. During this period, it is possible that the actual position of the switch does not conform with the TEST VOLTAGE RANGE message ㉔ or the **AC**/**DC** test mode message ㉕. When the test period has elapsed, the switch is enabled and the selected test voltage range and AC/DC mode (mode selection is for TOS5101 and TOS5051 only) are effected. Do not operate the Tester in this manner — that is, do not change the TEST VOLTAGE switch ⑤ during the TEST-ON period.
- Do not let the TEST VOLTAGE switch ⑤ caught on a midway in turning it from one range position to another range position. If you turn ON the POWER switch while the TEST VOLTAGE switch ⑤ is caught on a midway, the TEST VOLTAGE RANGE message ㉔ will indicate 0 kV, both **AC**/**DC** test mode messages ㉕ will appear at the same time (except for TOS5050) and will blink to show that no range selection has been successfully accomplished. When changing the TEST VOLTAGE switch ⑤, turn it securely to the required range position.

⑥ TEST VOLTAGE Control

This control is to adjust the test voltage. As you turn the control clockwise from the “0” position, the test voltage increases. The “MAX” position is for the highest test voltage corresponding to the voltage range value selected by the TEST VOLTAGE switch ⑤.

For the AC/DC models (TOS5101 and TOS5051), the control is for both AC and DC test modes.

Model	Selectable ranges and mode	
TOS5101	0 to 10kV AC or more	0 to 5kV AC or more
	0 to 10kV DC or more	0 to 5kV DC or more
TOS5051	0 to 5kV AC or more	0 to 2.5kV AC or more
	0 to 5kV DC or more	0 to 2.5kV DC or more
TOS5050	0 to 5kV AC or more	0 to 2.5kV AC or more

**Caution**

- Be sure to keep the TEST VOLTAGE control ⑥ in the fully counterclockwise position (“0” position) whenever no test is done.
- When the TEST VOLTAGE control ⑥ is set in the fully clockwise position (“MAX” position) in the no load state, the output voltage in the DC mode may be higher than the test voltage range value you selected with the TEST VOLTAGE switch ⑤. In the AC mode, the output voltage may be higher still depending on change of the AC line voltage. Although higher voltages may be available, be sure to operate the Tester with voltages lower than the corresponding range value.

⑦ HIGH VOLTAGE Terminal

This terminal is for the high line of the Tester output. The output voltage is delivered between this terminal and the LOW terminal ⑧. For the AC/DC models (TOS5101 and TOS5051), this terminal serves in common for both AC and DC modes of test operation.

**WARNING**

- Never touch the HIGH VOLTAGE terminal ⑦ when in the TEST-ON status (status that the DANGER lamp ⑨ lights or the TEST message ⑲ appears).

⑧ LOW Terminal

This terminal is for the low line of the Tester output. This terminal is directly connected to the Tester chassis.

⑨ **DANGER** Lamp

This red lamp illuminates to indicate that the test voltage is being delivered. It remains illuminating so far as there remains the test voltage in the output circuit.

**WARNING**

- When the **DANGER** lamp ⑨ is illuminating, never touch the *HIGH VOLTAGE* terminal ⑦, test leadwires, DUT, or other charged objects.

## ⑩ Analog Voltmeter

The *VOLTAGE* display (analog voltmeter) ⑩ indicates directly the output terminal voltage. Of the AC/DC models (TOS5101 and TOS5051), the voltmeter serves in common for both AC and DC.

Model	Measuring Range	
TOS5101	0 to 10kV AC	0 to 10kV DC
TOS5051	0 to 5kV AC	0 to 5kV DC
TOS5050	0 to 5kV AC	—

## ⑪ Zero Adjustment of Analog Voltmeter



This is for mechanical zero adjustment of the analog voltmeter. Before making zero adjustment, be sure that the *POWER* switch is OFF.



### 4.1.4 Cutoff Currents



#### **Caution**

- Test time and pause period are limited by setting upper cutoff current. "ON ..." of the front panel character shows a maximum test time and "OFF ..." shows a minimum pause period. For details, refer to chapter 9 "Specifications" (Pages 9-2, 9-3, 9-9, 9-10 and 9-11).

#### ⑫ Keys

The   keys ⑫ are for increment/decrement of cutoff currents (reference currents for pass/fail judgement). The keys are enabled when the Tester is in the READY status (status that the **READY** message ⑳ appears) and the **KEYLOCK** message ㉓ has disappeared. It is disabled when in the TEST-ON status (status that the **TEST** message ㉑ appears) or when the Tester is delivering the result of PASS/FAIL judgement (when the **PASS** message ㉒ or the **FAIL** message ㉔ appears).

There are two cutoff currents, namely, UPPER cutoff current and LOWER cutoff current. You can select either cutoff current with the **UP/LOW** key ⑬ and increment/decrement the selected cutoff current with the   keys ⑫.

If you press the  or  key alone, the rate of increment/decrement is the basic resolution shown below. If you press it together with the **SHIFT** key ⑯, the rate of increment/decrement is ten times of the basic resolution. If you keep them pressed, increment/decrement repeats automatically.

#### 1. key

This key increments the cutoff current setting. The set value is shown on the CURRENT display (digital ammeter) ㉑.

#### 2. key

This key decrements the cutoff current setting. The set value is shown on the CURRENT display (digital ammeter) ㉑.

#### **Caution**

- The UPPER and LOWER cutoff currents can be set mutually independently and therefore it is possible that the latter is set at a value higher than the former. If this is the case and the pass/fail judgement function for the LOWER cutoff current is ON, however, the **mA** display (unit of current measure) blinks and the **READY** message ㉓ disappears to indicate that the test in this condition cannot be done. The READY status resumes if the LOWER cutoff current is set at a value lower than the UPPER cutoff current or if the pass/fail judgement function for the LOWER cutoff current is turned OFF.

UPPER/LOWER cutoff current range	Basic resolution	Display format
0.1 to 9.9mA	0.1mA	. mA
10 to 110mA	1mA	mA

Model	AC mode of test	
	Upper cutoff current range	Lower cutoff current range
TOS5101	0.1 to 55mA	0.1 to 55mA, OFF
TOS5051	0.1 to 110mA	0.1 to 110mA, OFF
TOS5050	0.1 to 110mA	0.1 to 110mA, OFF

Model	DC mode of test	
	Upper cutoff current range	Lower cutoff current range
TOS5101	0.1 to 5.5mA	0.1 to 5.5mA, OFF
TOS5051	0.1 to 11mA	0.1 to 11mA, OFF
TOS5050	—	—

*For the AC/DC models (TOS5101 and TOS5051), the upper and lower cutoff currents can be set for AC and DC modes of tests. The settings of cutoff currents for the AC mode and DC mode, however, are mutually independent.*

⑬ **UP/LOW** key

The key selects the upper or lower cutoff current. If you press the key while keeping the **SHIFT** key ⑯ pressed, the lower pass/fail judgement function is turned ON or OFF.

The **UP/LOW** key is enabled when the Tester is in the READY status (status that the **READY** message ⑳ appears) and the **KEYLOCK** message ㉓ has disappeared. It is disabled when in the TEST-ON status (status that the **TEST** message ㉑ appears) or when the Tester is delivering the result of judgement (when the **PASS** message ㉒ or the **FAIL** message ㉔ appears).

1. When **UP/LOW** key alone is pressed

Each time as you press the **UP/LOW** key, the upper or lower cutoff current is selected and the **UPPER** message ㉕ or the **LOWER** message ㉖ appears.

The **UPPER** message ㉕ means that the upper cutoff current has been selected, the value is displayed on the CURRENT readout ㉗, and you can adjust the value with the **△** **▽** keys ⑫.

The **LOWER** message ㉖ means that the lower cutoff current has been selected, the value is displayed on the CURRENT readout ㉗, and you can adjust the value with the **△** **▽** keys ⑫.

For the AC/DC models (TOS5101 and TOS5051), the upper and lower cutoff currents for both AC and DC modes of tests can be selected with this key. The settings of cutoff currents for the AC mode and DC mode, however, are mutually independent.



2. When **UP/LOW** key is pressed while keeping **SHIFT** key ⑯ pressed



Each time as you press the **UP/LOW** key, the **LOWER ON** message ㉙ appears or disappears indicating that the lower pass/fail judgement function has been brought into or out of effect.

For the AC/DC models (TOS5101 and TOS5051), the lower pass/fail judgement function is turned ON or OFF with the **UP/LOW** key. This test condition is applied to both AC and DC modes of tests — that is, the setting for one mode applies automatically to the other mode also.

### 4.1.5 Test Time

#### ⑭ Keys

The   keys ⑭ are for increment/decrement of test period of time. The keys are enabled when the Tester is in the READY status (status that the **READY** message ⑳ appears) and the **KEYLOCK** message ㉓ has disappeared. They are disabled when in the TEST-ON status (status that the **TEST** message ㉔ appears) or when the Tester is delivering the result of PASS/FAIL judgement (when the **PASS** message ㉕ or the **FAIL** message ㉖ appears).

If you press the  or  key alone, the rate of increment/decrement is the basic resolution shown below. If you press it while keeping the **SHIFT** key ⑯ pressed, the rate of increment/decrement is ten times of the basic resolution. If you keep them pressed, increment/decrement repeats automatically.



1.  key

This key increments the test period. The set value is shown on the TIME display ㉔.

2.  key

This key decrements the test period. The set value is shown on the TIME display ㉔.

Test period setting range	Basic resolution	Display format
0.5 to 99.9 s., OFF	0.1 s.	. s
100 to 999 s., OFF	1 s.	s

For the AC/DC models (TOS5101 and TOS5051), the test period can be set with the   keys ⑭ for both AC and DC modes of tests. This test condition applies in common to both AC and DC modes of tests.

⑮ **ON/OFF** Key

The **ON/OFF** key ⑮ turns ON or OFF the timer function.

If you press it while keeping the **SHIFT** key ⑯ pressed, it turns ON or OFF the keylock function.

1. When the **ON/OFF** key ⑮ alone is pressed

Each time as you press the key, the timer function is turned ON or OFF. If you press it while the **TIMER ON** message ⑳ has disappeared, the timer function is turned ON and the **TIMER ON** message ㉑ appears. The test done under this condition terminates when the test period indicated on the TIME display ㉒ has elapsed.

As you press the **ON/OFF** key ⑮ again, the timer function is turned OFF and the **TIMER ON** message ㉑ disappears. If in this status, the test does not terminate even when the test period indicated on the TIME display ㉒ has elapsed. When in a test with the timer function ON, the TIME display ㉒ indicates the remaining period; when in a test with the timer function OFF, the TIME display ㉒ indicates the elapsed period.

The **ON/OFF** key ⑮ is enabled when the Tester is in the READY status (status that the **READY** message ㉓ appears) and the **KEYLOCK** message ㉔ has disappeared. It is disabled when the Tester is in the TEST-ON status (status that the **TEST** message ㉕ appears) or when the Tester is delivering the result of PASS/FAIL judgement (when the **PASS** message ㉖ or the **FAIL** message ㉗ appears).

For the AC/DC models (TOS5101 and TOS5051), the timer function can be turned ON or OFF with the **ON/OFF** key ⑮ for both AC and DC modes of tests. This test condition applies in common to both AC and DC modes of tests.

2. When **ON/OFF** key ⑮ is pressed while **SHIFT** key ⑯ is kept pressed

If you press the **ON/OFF** key ⑮ while keeping the **SHIFT** key ⑯ pressed, the below-mentioned keys are locked and the **KEYLOCK** message ㉔ appears or they are unlocked and the message disappears. If you press them again, the below-mentioned keys are unlocked and the **KEYLOCK** message ㉔ disappears.

When in the keylock function is ON, the following keys are locked.

- (a) **△** **▽** keys ⑫
- (b) **UP/LOW** key ⑬
- (c) **△** **▽** keys ⑭
- (d) **ON/OFF** key ⑮



Therefore, the following conditions of test can be protected against inadvertent or unauthorized alterations.

- (a) Upper cutoff current
- (b) Lower cutoff current
- (c) ON/OFF of lower pass/fail judgement function
- (d) Test time
- (e) ON/OFF of timer function

The **ON/OFF** key ⑮ is enabled regardless of the statuses of the Tester.

For the AC/DC models (TOS5101 and TOS5051), the keylock function applies in common to both AC and DC modes of tests.

#### 4.1.6 Others

##### ⑯ **SHIFT** Key

1. If you press the **POWER** switch ① while keeping the **SHIFT** key ⑯ pressed, the conditions of test are initialized.
2. If you press the **△** key ⑫ while keeping the **SHIFT** key ⑯ pressed, the upper or lower cutoff current is incremented at a rate of ten times of that when you press the **△** key ⑫ alone.
3. If you press the **▽** key ⑫ while keeping the **SHIFT** key ⑯ pressed, the upper or lower cutoff current is decremented at a rate of ten times of that when you press the **▽** key ⑫ alone.
4. If you press the **UP/LOW** key ⑬ while keeping the **SHIFT** key ⑯ pressed, the lower pass/fail judgement function is turned ON or OFF.
5. If you press the **△** key ⑭ while keeping the **SHIFT** key ⑯ pressed, the test period is incremented at a rate of ten times of that when you press the **△** key ⑭ alone.
6. If you press the **▽** key ⑭ while keeping the **SHIFT** key ⑯ pressed, the test period is decremented at a rate of ten times of that when you press the **▽** key ⑭ alone.
7. If you press the **ON/OFF** key ⑮ while keeping the **SHIFT** key ⑯ pressed, the keylock function is turned ON or OFF.

##### ⑰ BUZZER Control

The BUZZER control ⑰ is to adjust the loudness of the buzzer that announces the results of pass/fail judgements. FAIL announcements are louder than PASS announcements. The factory default setting of this control is for the maximum loudness.

## 4.2 Display Items

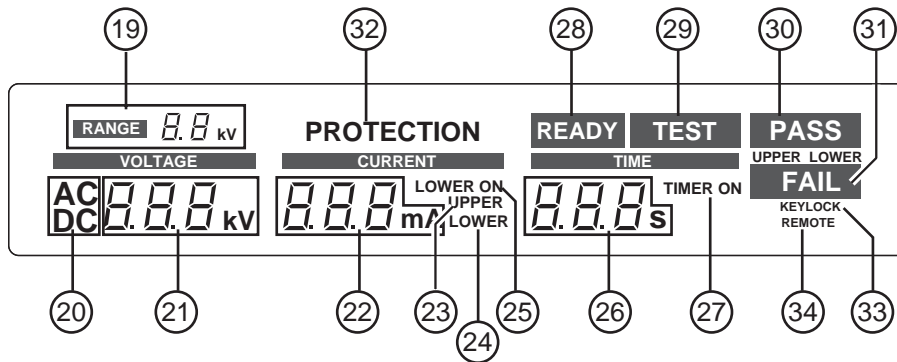


Figure 4.4 Display

### ⑱ Vacuum Fluorescent Display

The vacuum fluorescent display indicates the test conditions, test results, and other items as described in this section.

### 4.2.1 Test Voltage Display

#### ⑲ TEST VOLTAGE RANGE Message

This message, which is a 7-segment 2-digit message, indicates the test voltage range selected with the TEST VOLTAGE switch ⑤. The selectable test voltage ranges are as follows:

Model	Test voltage range	
TOS5101	10kV	5kV
TOS5051	5kV	2.5kV
TOS5050	5kV	2.5kV

#### **Caution**

- As you change test voltage ranges with the TEST VOLTAGE switch ⑤, the TEST VOLTAGE RANGE message ⑲ blinks to indicate that the ranges have been changed. Blinking stops as you press the **STOP** switch ③ or as you start the test by pressing the **START** switch ②.
- During the TEST-ON period (period that the TEST message ⑲ appears), the TEST VOLTAGE switch ⑤ is disabled. During this period, it is possible that the actual position of the switch does not conform with the TEST VOLTAGE RANGE message ⑲ or the **AC/DC** test mode message ⑳.
- Do not let the TEST VOLTAGE switch ⑤ caught on a midway in turning it from one range position to another range position. If you turn ON the **POWER** switch ① while the TEST VOLTAGE switch ⑤ is caught on a midway, the TEST VOLTAGE RANGE message ⑲

will indicate 0 kV, both **AC**/**DC** test mode messages ⑳ will appear at the same time (except for TOS5050) and will blink to show that no range selection has been successfully accomplished. When this has occurred, turn the **TEST VOLTAGE** switch ⑤ accurately to a range position. As you do so, the Tester will become the **READY** status (status that the **READY** message ㉘ appears). When in this status, blinking stops as you press the **STOP** switch ③ or as you start the test by pressing the **START** switch ②.

#### ㉘ AC/DC Test Mode Message

This message indicates whether the AC or DC test mode has been selected with the **TEST VOLTAGE** switch ⑤. The selectable modes are as follows:

Model	Test Mode	
TOS5101	AC	DC
TOS5051	AC	DC
TOS5050	AC	—

#### **Caution**

- The TOS5050 is for the AC test mode only. It has no **DC** test mode message ㉘.
- As you change the modes with the **TEST VOLTAGE** switch ⑤, the message blinks to indicate that the modes have been changed. Blinking stops as you press the **STOP** switch ③ or as you start the test by pressing the **START** switch ②.
- During the **TEST-ON** period (period that the **TEST** message ㉙ appears), the **TEST VOLTAGE** switch ⑤ is disabled. During this period, it is possible that the actual position of the switch does not conform with the **TEST VOLTAGE RANGE** message ⑲ or the **AC**/**DC** test mode message ㉘.
- Do not let the **TEST VOLTAGE** switch ⑤ caught on a midway in turning it from one range position to another range position. If you turn ON the **POWER** switch ① while the **TEST VOLTAGE** switch ⑤ is caught on a midway, the **TEST VOLTAGE RANGE** message ⑲ will indicate 0 kV, both **AC**/**DC** test mode messages ㉘ will appear at the same time (except for TOS5050) and will blink to show that no range selection has been successfully accomplished, and the **READY** message ㉘ will disappear to show that the Tester is not in the **READY** status. When this has occurred, turn the **TEST VOLTAGE** switch ⑤ accurately to a range position. As you do so, the Tester will become the **READY** status (status that the **READY** message ㉘ appears). When in this status, blinking stops as you press the **STOP** switch ③ or as you start the test by pressing the **START** switch ②.

② VOLTAGE Readout (Digital Voltmeter)

The VOLTAGE display (digital voltmeter) ② indicates the output voltage with a 3-digit 7-segment readout. It constantly monitors the output terminal voltage.

For the AC/DC models (TOS5101 and TOS5051), the digital voltmeter ② acts either as an AC voltmeter or a DC voltmeters in response to the AC or DC mode selected by the TEST VOLTAGE switch ⑤.

1. Measuring ranges and resolutions

Model	Measuring Range		Resolution
TOS5101	AC 10kV range	0 to 14.162kV	55.54V
	AC 5kV range	0 to 7.081kV	27.77V
	DC 10kV range	0 to 12.750kV	50.00V
	DC 5kV range	0 to 6.375kV	25.00V
TOS5051	AC 5kV range	0 to 7.081kV	27.77V
	AC 2.5kV range	0 to 3.540kV	13.88V
	DC 5kV range	0 to 6.375kV	25.00V
	DC 2.5kV range	0 to 3.186kV	12.50V
TOS5050	AC 5kV range	0 to 7.081kV	27.77V
	AC 2.5kV range	0 to 3.540kV	13.88V

2. Display formats

Voltage range	Display format
0.00 to 9.99kV	. kV
9.99 to kV	. kV

**Caution**

- Due to the measuring resolutions, the readout may not be “0.00 kV” when the output terminal voltage is zero volts.

## 4.2.2 Readout for Cutoff Current and Measured Current

### ② CURRENT Readout (Digital Ammeter)

When the Tester is in the TEST-ON status (status that the **TEST** message ⑲ appears), the CURRENT readout ② indicates the measured output current; when the Tester is in other status than the TEST-ON status, it indicates the preset upper or lower cutoff current. It is a 3-digit 7-segment readout.

Display change between upper and lower cutoff current settings can be done with the **UP/LOW** key ⑬ when the Tester is in the READY status (status that the **READY** message ⑳ appears) and the **KEYLOCK** message ㉓ has disappeared. The **UPPER** message ㉔ means that the Tester is in the status for setting the upper cutoff current; the **LOWER** message ㉕ means that the Tester is in the status for setting the lower cutoff current.

You can increment/decrement the upper or lower cutoff current with the **△** **▽** keys ⑫ when the Tester is in the READY status (status that the **READY** message ⑳ appears) and the **KEYLOCK** message ㉓ has disappeared. (If you press the **SHIFT** key ⑯ at the same time, the increment/decrement rate is multiplied by 10.)

If the lower cutoff current is higher than the upper cutoff current and the lower pass/fail judgement function is ON, the **mA** display (unit of measure) blink and the **READY** message ⑳ disappears to alert you to that the setting is illogical and the test cannot be done. When the lower cutoff current has become lower than the higher cutoff current or when the lower pass/fail judgement function is turned OFF, the **mA** display automatically stops blinking and the Tester resumes the READY status.

Of the AC/DC models (TOS5101 and TOS5051), the upper cutoff currents can be preset mutually independently for AC test mode and DC test mode, and the lower cutoff currents also can be preset mutually independently for AC test mode and DC test mode.

#### 1. Displayed items

When in READY status		When in TEST-ON status
When <b>UPPER</b> is ON	When <b>LOWER</b> is ON	
Upper cutoff current	Lower cutoff current	Measured current

#### 2. Setting ranges

Model	AC mode of test	
	Upper cutoff current range	Lower cutoff current range
TOS5101	0.1 to 55mA	0.1 to 55mA, OFF
TOS5051	0.1 to 110mA	0.1 to 110mA, OFF
TOS5050	0.1 to 110mA	0.1 to 110mA, OFF

Model	DC mode of test	
	Upper cutoff current range	Lower cutoff current range
TOS5101	0.1 to 5.5mA	0.1 to 5.5mA, OFF
TOS5051	0.1 to 11mA	0.1 to 11mA, OFF
TOS5050	—	—

3. Setting resolutions and display formats

UPPER/LOWER cutoff current range	Basic resolution	Display format
0.1 to 9.9mA	0.1mA	.
10 to 110mA	1mA	

②③ **UPPER** Message

This message means that the value shown on the CURRENT readout ②② is of the upper cutoff current. Switchover between the upper and lower cutoff currents can be done with the **UP/LOW** key ⑬ when the Tester is in the READY status (status that the **READY** message ②⑧ appears) and the **KEYLOCK** message ③③ has disappeared.

When in the TEST-ON status (status that the **TEST** message ②⑨ appears), both **UPPER** message ②③ and **LOWER** message ②④ disappear and the CURRENT readout ②② indicates the measured output current.

②④ **LOWER** Message

This message means that the value shown on the CURRENT readout ②② is of the lower cutoff current. Switchover between the upper and lower cutoff currents can be done with the **UP/LOW** key ⑬ when the Tester is in the READY status (status that the **READY** message ②⑧ appears) and the **KEYLOCK** message ③③ has disappeared.

When in the TEST-ON status (status that the **TEST** message ②⑨ appears), both **UPPER** message ②③ and **LOWER** message ②④ disappear and the CURRENT readout ②② indicates the measured output current.

②⑤ **LOWER ON** Message

This message means that the lower pass/fail judgement function is ON. When the function is ON, the message appears; when it is OFF, the message disappears.

The function can be turned ON or OFF by pressing the **UP/LOW** key ⑬ together with the **SHIFT** key ⑯ when the Tester is in the READY status (status that the **READY** message ②⑧ appears) and the **KEYLOCK** message ③③ has disappeared. Even when the lower pass/fail is turned OFF and the **LOWER ON** message has disappeared, display and adjustment of the preset cutoff current can be done.

For the AC/DC models (TOS5101 and TOS5051), this test condition setting is applied in common to both AC and DC modes of tests.

### 4.2.3 Test Time Display

#### ②⑥ TIME Display

When in the TEST-ON status (status that the **TEST** message ②⑨ appears), the TIME display ②⑥ indicates the remaining or elapsed test time on a 3-digit 7-segment readout.

The preset test period can be incremented/decremented with the **△** **▽** keys ①④ when the Tester is in the READY status (status that the **READY** message ②⑧ appears) and the **KEYLOCK** message ③③ has disappeared. If you press the **△** or **▽** keys together with the **SHIFT** key ①⑥, the increment/decrement rate is multiplied by a factor of 10.

If the timer function is ON (status that the **TIMER ON** message ②⑦ appears), the displayed period decreases as test time elapses and the test terminates when the preset test period has elapsed. If the timer function is OFF (status that the **TIMER ON** message ②⑦ has disappeared), the displayed period starts by zero and increases as test time elapses—the test does not terminate even when the preset test period has elapsed.

For the AC/DC models (TOS5101 and TOS5051), the preset test period applies in common to both AC and DC modes of tests.

#### 1. Displayed items

Displayed items		
When in READY status	When in TEST-ON status	
	TIMER ON appears	TIMER ON disappears
Period displayed	Remaining period	Elapsed period

#### 2. Setting ranges, resolutions, and display formats

Setting range	Basic resolution	Display format
0.5 to 99.9 s, OFF	0.1 s	.
100 to 999 s, OFF	1 s	

#### ②⑦ **TIMER ON** Message

This message appears to mean that the TIMER function is ON. If the Tester is in the TIMER-ON status (status that the **TIMER ON** message ②⑦ appears), the test terminates when the preset test time has elapsed. If Tester is in the TIMER-OFF status (status that the **TIMER ON** message ②⑦ has disappeared), the test does not terminate even when the preset test period has elapsed. When in the TIMER-ON status, the TIME display ②⑥ indicates the remaining test period; when in the TIMER-OFF status, the TIME display ②⑥ indicates the elapsed test period.

The TIMER function can be turned on or off with the **ON/OFF** key ①⑤ when the Tester is in the READY status (status that the **READY** message ②⑧ appears) and the **KEYLOCK** message ③③ has disappeared.

For the AC/DC models (TOS5101 and TOS5051), the same test condition applies in common to both AC and DC modes of tests.

## 4.2.4 READY Message

### ⑳ **READY** Message

This message means that the Tester is ready to start the test operation. As you press the **START** switch ② while this message is displayed, the Tester will start the test operation with the test parameters displayed on the display screen ⑱.

## 4.2.5 TEST Message

### ㉑ **TEST** Message

This message (red) means that the Tester is in the TEST-ON status (status that the Tester is executing the test by delivering the test voltage). When you want to reset from this status, press the **STOP** switch ③.

## 4.2.6 PASS Message

### ㉒ **PASS** Message

This message (green) appears when the result of pass/fail judgement is PASS. (It appears when the result is PASS within the test period. So it does not appear if the TIMER function is OFF or the test is aborted.)

Normally, it appears only for a short period — approximately 0.2 seconds. If you set to ON the PASS HOLD switch of TEST MODE switch ㉓, the message is held displayed continuously. To reset the message from the held state, press the **STOP** switch ③.

## 4.2.7 FAIL Messages

### ㉔ **UPPER FAIL** message

This message (yellow) appears when the result of upper pass/fail judgement is FAIL, indicating that the leak current that flowed through the DUT was larger than the preset high limit (upper cutoff current). To reset the message, press the **STOP** switch ③.

### ㉕ **LOWER FAIL** message

This message (yellow) appears when the result of lower pass/fail judgement is FAIL, indicating that the leak current that flowed through the DUT was less than the preset low limit (lower cutoff current). To reset the message, press the **STOP** switch ③.



## 4.2.8 PROTECTION Message

### ③② PROTECTION Message





This message (yellow) appears when the Tester has tripped into the PROTECTION status and its output voltage is cut off, due to any of the causes as mentioned below. To reset the Tester from the PROTECTION status, eliminate the cause of the trip and then press the STOP switch ③.

1. The plug is connected to or disconnected from the REMOTE CONTROL connector ④.
2. The status of the REMOTE ENABLE signal input pins of the SIGNAL I/O connector ③⑦ has changed.
3. The INTERLOCK signal input pins of the SIGNAL I/O connector ③⑦ are make open.
4. The high voltage supply circuit of the DC test section (TOS5101 and TOS5051 only) is overheated.

## 4.2.9 Others

### ③③ KEYLOCK Message

This message appears when the keylock function is ON; it disappears when the function is OFF. The keylock function disables the following keys:

1.   keys ⑫
2. UP/LOW key ⑬
3.   keys ⑭
4. ON/OFF key ⑮

Thus, the settings of the following test conditions are protected.

1. Upper cutoff current
2. Lower cutoff current
3. ON/OFF of lower pass/fail judgement
4. Test time
5. ON/OFF of timer function

The keylock function can be turned ON or OFF at any time, by pressing the ON/OFF key ⑮ while keeping the SHIFT key ⑯ key pressed.

### ③④ REMOTE Message

This message appears to indicate that the Tester is being remote-controlled via the REMOTE CONTROL connector ④ or the SIGNAL I/O connector ③⑦. When this message has appeared, the START switch ② is disabled. For details, refer to Section 6.3 “Remote Control.”

### 4.3 Description of Rear Panel Items

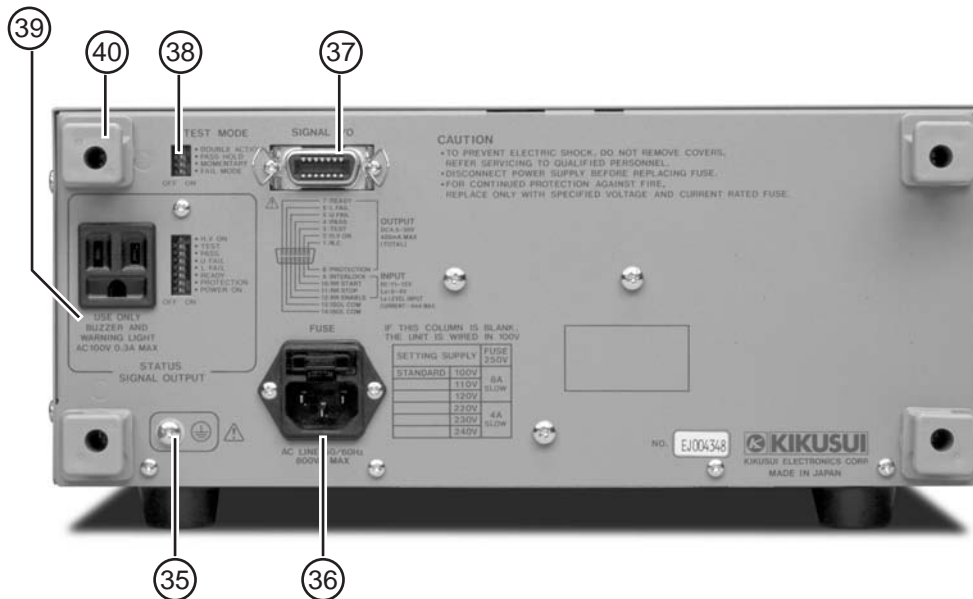


Figure 4.5 TOS5050/TOS5051 Rear Panel

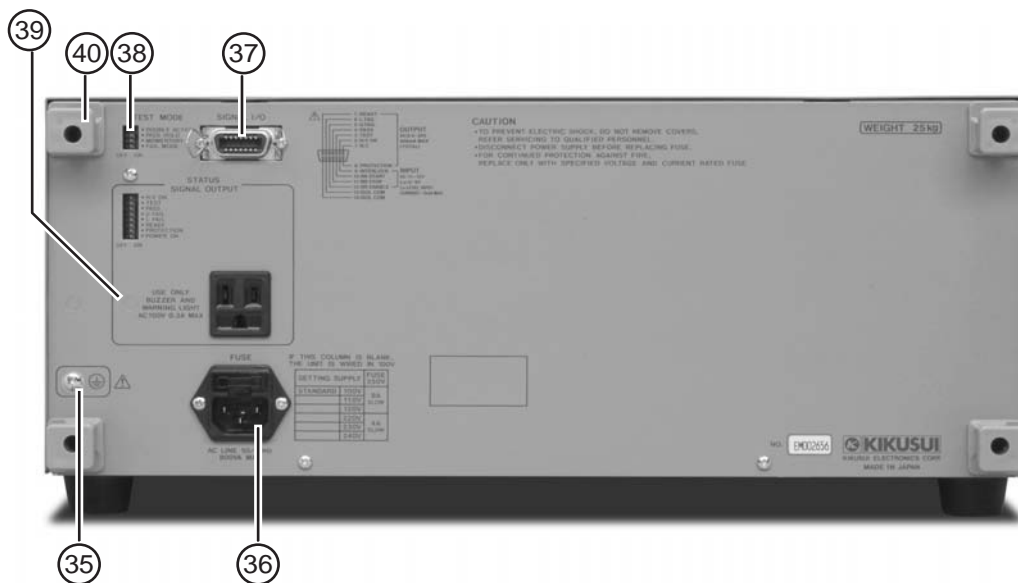


Figure 4.6 TOS 5101 Rear Panel

③⑤ Protective Grounding Terminal

This terminal is for grounding the Tester to an earth ground.

**WARNING**

- Be sure to connect securely (by using a screwdriver) an earth ground line to the Protective grounding terminal ③⑤. Unless the Tester is securely grounded, when the Tester chassis can be charged up to the high voltage than can cause electric shock hazard. For details, refer to Section 3.1.2 “Grounding the Tester.”

### ③⑥ AC LINE Connector

The AC LINE connector ③⑥ is for the AC input power. It serves also as an input power fuse holder.

### ③⑦ SIGNAL I/O Connector

The SIGNAL I/O connector ③⑦ is a 14-pin Amphenol connector for the interlock input signal, remote control signal for test start/stop, and status output signal. For details, refer to Section 6.3.3 “Interlock Function,” Section 6.3.2 “Remote Control through Signal I/O Connector,” and Section 6.4.1 “Output Signals of SIGNAL I/O Connector.”

### ③⑧ TEST MODE Switches

The TEST MODE switches ③⑧ allows you to select the following four test modes:

1. DOUBLE ACTION mode
2. PASS HOLD mode
3. MOMENTARY mode
4. FAIL mode

#### **Caution**

- Before changing the settings of these switches, be sure that the **POWER** switch ① is OFF.

For details, refer to Section 6.5 “Settings for Special Test Modes.”

### ③⑨ STATUS SIGNAL OUTPUT Receptacle and Switches

The output receptacle delivers a 100V AC signal to drive an optional Warning light Unit or a Buzzer Unit. The status signal is delivered if one of the following items is set to ON. If two or more items are set to ON, the status signal is delivered on the logical sum of such items.

- |           |               |
|-----------|---------------|
| 1. HV ON  | 5. L FAIL     |
| 2. TEST   | 6. READY      |
| 3. PASS   | 7. PROTECTION |
| 4. U FAIL | 8. POWER ON   |

For details, refer to Section 6.4.2 “Status Signal Output.”

#### **Caution**

- Even when the Tester is operating on an AC line voltage of other than nominal 100V AC, the signal output delivered through the **STATUS SIGNAL OUTPUT** receptacle ③⑨ is 100V AC.

### ④⑩ AC Power Cable Takeups

The four corrugated poles at the four corners on the rear panel are to take up the AC power cable when the Tester is not in use.

#### **Caution**

- The poles are for cable takeup and are not for legs of the Tester. Never attempt to use the poles as legs for operating the Tester in the vertical position (with its front panel faced up.). If you do, the Tester will become unstable and very dangerous.



# Chapter 5

## PREPARATIVE TEST PROCEDURES

This chapter describes the preparative procedures for test.

Table of contents	Page
5.1 Initial Setup .....	5-2
5.1.1 Initial Setup of Switches and Controls .....	5-2
5.1.2 Initial Test Setup Data .....	5-2
5.1.3 Procedure for the Initial Test Setup Data .....	5-3
5.2 Checking the Tester Operation .....	5-4
5.3 Checkout Before Starting Test Operation .....	5-6

**Caution**

- Be sure to read Section 2.2.1 “AC Line Requirements” and Section 2.2.2 “Fuse Ratings” of Section 2.2 “General Information Before Using the Tester” and observe the instructions given there.
- Be sure to read Chapter 3 “WARNINGS AND CAUTIONS FOR OPERATING THE TESTER” and observe the instructions given there.

## 5.1 Initial Setup

### 5.1.1 Initial Setup of Switches and Controls

The initial setup (factory default setup) of the switches and controls of the Tester is as shown in the following table. Before start using the Tester, be certain that the switches and controls are set as shown in the table.

Item	No.	Setting
POWER switch	①	OFF position
TEST VOLTAGE switch	⑤	AC, lower range
TEST VOLTAGE control	⑥	“0” position
Zero adjustment of analog voltmeter	⑪	“0” position
BUZZER control	⑰	Fully clockwise
TEST MODE switches	⑳	OFF for all
STATUS SIGNAL switches	㉑	OFF for all

### 5.1.2 Initial Test Setup Data

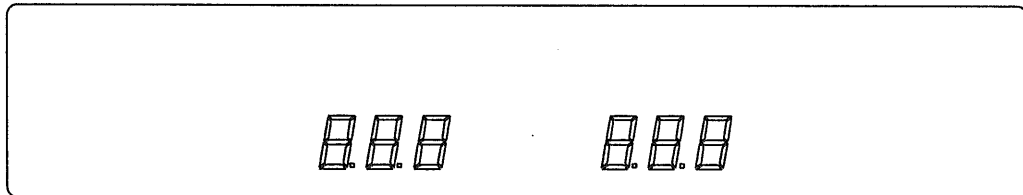
The initial setup of test data (factory default test data) of the Tester is as shown in the following table. Before start using the Tester, be certain that the initial setup of test data is as shown in the table.

Item	Initial setup data
Upper cutoff current	0.2mA
Lower cutoff current	0.1mA
Lower pass/fail judgement	OFF
Test period	0.5 s
Timer function	ON
Keylock function	OFF

### 5.1.3 Procedure for the Initial Test Setup Data

To start up the Tester with the initial test setup data, proceed as follows:

- Step 1** Be sure that the **POWER** switch ① is in the OFF state.
- Step 2** Set the switches and controls on the front panel to their initial setup positions.
- Step 3** Connect the AC input power cable (supplied as an accessory) to the AC LINE connector ③⑥ on the rear panel.
- Step 4** Connect the other end of the AC input power cable to an AC line outlet of the correct voltage.
- Step 5** Keeping the **SHIFT** key ⑩ pressed, press the **POWER** switch ①. The Vacuum Fluorescent Display will start illuminating, indicating that power has been turned ON.
- Step 6** Release both **SHIFT** key ⑩ and **POWER** switch ①.



Within several tens seconds from the above, the Version Number and Model Number of the Tester will appear on the display screen. The three digits on the left hand side indicate the version number; those on the right hand side are of the three least-significant digits of the model number.

Model No.	Three LSD
TOS5101	101
TOS5051	51
TOS5050	50



The initial test setup data will appear on the screen.

If no messages at all appear on the screen when more than 60 seconds has elapsed from the above, repeat the procedure all over again from its beginning.

**Caution**

- *Note that, if you initialize the test data with the above procedure, all test data that existed when you turned OFF the power of the Tester last time is lost.*

## 5.2 Checking the Tester Operation

Before start using the Tester, check its operation as described below.

**Caution**

- Note that, as you do this check, the Tester is initialized with the initial test setup data and consequently the previous test setup data that existed when you turned off the **POWER** switch ① of the Tester last time is lost.

**Step 1**

Be sure that the **POWER** switch ① is in the OFF state.

**Step 2**

Set the switches and controls on the front panel to their initial setup positions.

**Step 3**

Be sure that nothing is connected to the SIGNAL I/O connector ③⑦ on the rear panel.

**Step 4**

Connect the AC input power cable (supplied as an accessory) to the AC LINE connector ③⑥ on the rear panel.

**Step 5**

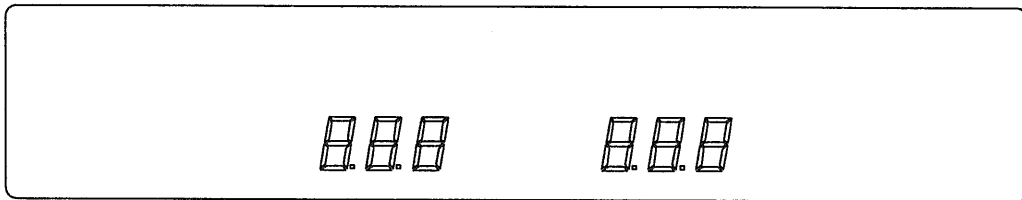
Connect the other end of the AC input power cable to an AC line outlet of the correct voltage.

**Step 6**

Keeping the **SHIFT** key ①⑥ pressed, press the **POWER** switch ①. The Vacuum Fluorescent Display will start illuminating, indicating that power has been turned ON.

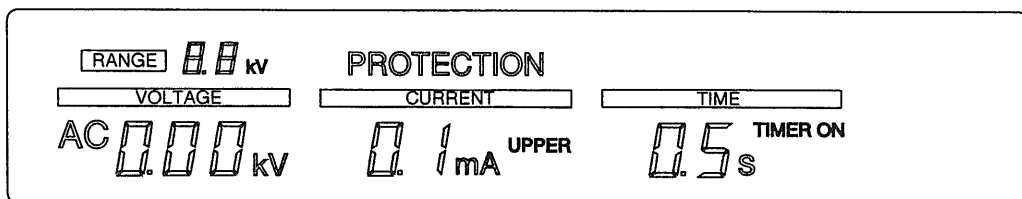
**Step 7**

Release both **SHIFT** key ①⑥ and **POWER** switch ①.



Within several tens seconds from the above, the Version Number and Model Number of the Tester will appear on the display screen. The three digits on the left hand side indicate the version number; those on the right hand side are of the three least-significant digits of the model number.

Model No.	Three LSD
TOS5101	101
TOS5051	51
TOS5050	50





Within several seconds from the above, the initial test setup data will appear and the Tester will become the PROTECTION status due to the interlock function. The test voltage range differs depending on the model as follows:

Model No.	Voltage range
TOS5101	5kV
TOS5051	2.5kV
TOS5050	2.5kV

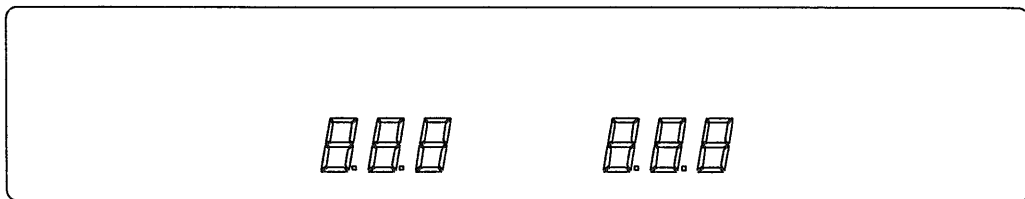
**Caution**

- Do not let the TEST VOLTAGE switch ⑤ caught on a midway in turning it from one range position to another range position. If you turn ON the POWER switch while the TEST VOLTAGE switch ⑤ is caught on a midway, the TEST VOLTAGE RANGE message ⑱ will indicate 0 kV, both AC / DC test mode messages ⑳ will appear at the same time (except for TOS5050) and will blink to show that no range selection has been successfully accomplished. When this has occurred, turn the TEST VOLTAGE switch ⑤ accurately to a range position. As you do so, the Tester will become the READY status (status that the READY message ㉘ appears). When in this status, blinking stops as you press the STOP switch ③.

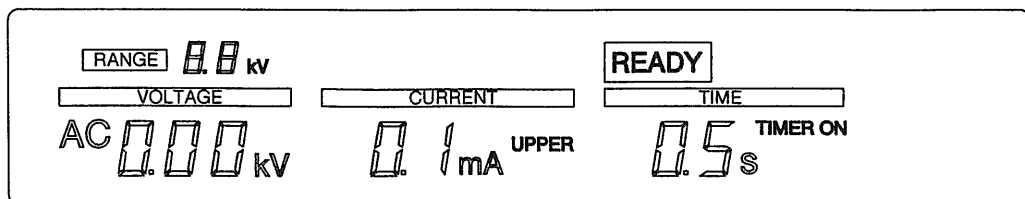
**Step 8** Turn OFF the POWER switch ①.

**Step 9** Connect the 14-pin Amphenol connector (supplied as an accessory) to the SIGNAL I/O connector ③⑦.

**Step 10** Wait for 60 seconds or more. Turn ON again the POWER switch ①.



Within several seconds from the above, the Version Number and Model Number of the Tester will appear on the display screen.



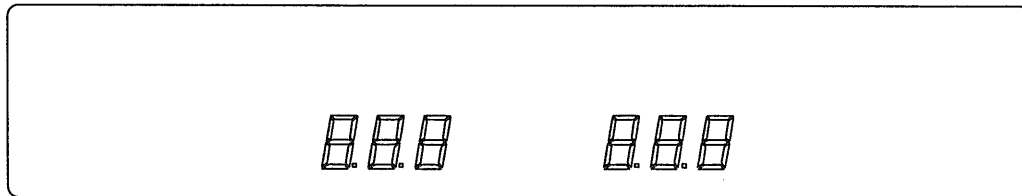
Within several seconds from the above, the initial test setup data will appear again.

### 5.3 Checkout Before Starting Test Operation

Before starting test operation with the Tester, check and adjust certain items of the Tester as mentioned in the following:

1. Before turning ON the **POWER** switch ①, check that the pointer of the analog voltmeter ⑩ indicates the "0" position. If it does not, adjust it to the "0" position with the zero adjustment ⑪. If the Tester power is ON when you intend this check, turn it OFF to do this check.
2. Before start operating the Tester, be sure that the test system is protected with an appropriate interlock provision. (Refer to Section 6.3.3 "Interlock Function.")
3. For several seconds after the **POWER** switch ① is turned ON, the Tester checks its internal memory. During this period, the following messages appear on the display screen. The three digits on the left hand side indicate the version number; those on the right hand side are of the three least-significant digits of the model number.

Model No.	Three LSD
TOS5101	101
TOS5051	51
TOS5050	50



When the internal memory check proved to be OK, the Tester resumes the test parameters (cutoff currents, test time, etc.) that existed when the Tester power was turned OFF last time.

4. If the Tester is in the PROTECTION status (status that the **PROTECTION** message ⑳ appears), the Tester does not start the test operation and does not deliver the test voltage even when you press the **START** switch ②. To reset from the PROTECTION status, eliminate the cause that has driven the Tester into the PROTECTION status and then press the **STOP** switch ③. Causes that drive the Tester into the PROTECTION status are as follows :
  - (a) The mating connector is connected to or disconnected from the REMOTE CONTROL connector ④.
  - (b) The status of the REMOTE ENABLE input signal pins of the SIGNAL I/O connector ⑦ is altered.
  - (c) The INTERLOCK input signal pins of the SIGNAL I/O connector ⑦ are made open.
  - (d) The H.V power supply section of the DC high voltage test section is overheated (for models TOS5101 and TOS5051 only).

5. Depending on the test conditions required by DUT, select either the AC or DC mode of test. For the former, refer to Section 6.1 “AC Withstanding Voltage Test”; for the latter, refer to Section 6.2 “DC Withstanding Voltage Test.”

**Caution**

- *The TOS5050 is for AC withstanding voltage test only. It is not intended for DC withstanding voltage test.*



# Chapter 6

## TEST PROCEDURES

This chapter describes the procedures for individual types of withstanding voltage tests.

Table of contents	Page
6.1 AC Withstanding Voltage Test Procedure .....	6-2
6.1.1 Selecting an AC Test Voltage Range .....	6-2
6.1.2 Setting the Upper Cutoff Current .....	6-3
6.1.3 Setting the Lower Cutoff Current .....	6-4
6.1.4 Setting the Test Time .....	6-5
6.1.5 Setting the Test Voltage .....	6-6
6.1.6 Connecting the DUT .....	6-7
6.1.7 Executing a Test .....	6-7
6.2 DC Withstanding Voltage Test Procedure .....	6-12
6.2.1 Selecting a DC Test Voltage Range .....	6-12
6.2.2 Setting the Upper Cutoff Current .....	6-13
6.2.3 Setting the Lower Cutoff Current .....	6-14
6.2.4 Setting the Test Time .....	6-16
6.2.5 Setting the Test Voltage .....	6-17
6.2.6 Connecting the DUT .....	6-17
6.2.7 Executing a Test .....	6-18
6.3 Remote Control .....	6-22
6.3.1 Remote Control through REMOTE CONTROL Connector ④ .....	6-23
6.3.2 Remote Control through SIGNAL I/O Connector ③⑦ .....	6-24
6.3.3 Interlock Function .....	6-26
6.4 Output Signals .....	6-27
6.4.1 Output Signals of SIGNAL I/O Connector ③⑦ .....	6-27
6.4.2 Output Signal of STATUS SIGNAL OUTPUT receptacle ③⑨ .....	6-30
6.5 Settings for Special Test Modes .....	6-31
6.5.1 DOUBLE ACTION Switch .....	6-31
6.5.2 PASS HOLD Switch .....	6-31
6.5.3 MOMENTARY Switch .....	6-32
6.5.4 FAIL MODE Switch .....	6-32

## 6.1 AC Withstanding Voltage Test Procedure

Set the test parameters as you may require to test your DUT. The ranges of test parameters available with the Tester are as follows:

Model	Test voltage	Criterion for upper cutoff current	Criterion for lower cutoff current	Test time
TOS5101	0 to 10kV	0.1 to 55mA	0.1 to 55mA	0.5 to 999 s, OFF
TOS5051	0 to 5kV	0.1 to 110mA	0.1 to 110mA	0.5 to 999 s, OFF
TOS5050	0 to 5kV	0.1 to 110mA	0.1 to 110mA	0.5 to 999 s, OFF

### 6.1.1 Selecting an AC Test Voltage Range

With the TEST VOLTAGE switch ⑤, select an AC test voltage range and the AC test mode message ⑳ will appear and the TEST VOLTAGE RANGE message ⑲ will indicate the test voltage range you have selected.

Model	Selectable Ranges	
TOS5101	10kV	5kV
TOS5051	5kV	2.5kV
TOS5050	5kV	2.5kV

**Caution**

- Before turning the TEST VOLTAGE switch ⑤, be sure that the TEST VOLTAGE control ⑥ is in the fully counterclockwise position (“0” position).
- During the TEST-ON period (period that the **TEST** message ㉑ appears), the TEST VOLTAGE switch ⑤ is disabled. During this period, it is possible that the actual position of the switch does not conform with the TEST VOLTAGE RANGE message ⑲ or the **AC**/**DC** test mode message ㉒. When the test period has elapsed, the switch is enabled and the selected test voltage range and AC/DC mode (mode selection is for TOS5101 and TOS5051 only) are effected. Do not operate the Tester in this manner — that is, do not change the TEST VOLTAGE switch ⑤ during the TEST-ON period.
- Do not let the TEST VOLTAGE switch ⑤ caught on a midway in turning it from one range position to another range position. If you turn ON the **POWER** switch ① while the TEST VOLTAGE switch ⑤ is caught on a midway, the TEST VOLTAGE RANGE message ⑲ will indicate 0 kV, both **AC**/**DC** test mode messages ㉒ will appear at the same time (except for TOS5050) and will blink to show that no range selection has been successfully accomplished. When changing the TEST VOLTAGE switch ⑤, turn it accurately to a range position.

## 6.1.2 Setting the Upper Cutoff Current

This procedure is to set the upper cutoff current — criterion for pass/fail judgement on the DUT. If the leak current that flows through the DUT is larger than this limit, the DUT is judged to be FAIL.

### Caution

- *Test time and pause period are limited by setting upper cutoff current. "ON ..." of the front panel character shows a maximum test time and "OFF ..." shows a minimum pause period. For details, refer to chapter 9 "Specifications" (Pages 9-2, 9-3, 9-9 and 9-10).*

### Setting Procedure

#### Step 1

Select the upper cutoff current setting mode with the **UP/LOW** key ⑬ and the **UPPER** message ⑳ will appear and the preset upper limit current will be indicated on the CURRENT readout ㉑.

#### Step 2

Adjust the preset upper cutoff current value as you may require, with the **△** **▽** keys ⑫. If you press the **SHIFT** key ⑯ at the same time, the adjusting speed is increased by a factor of 10. The current value is displayed on the CURRENT readout ㉑.

### Upper Cutoff Current Setting Range

Model	Upper cutoff current range
TOS5101	0.1 to 55mA
TOS5051	0.1 to 110mA
TOS5050	0.1 to 110mA

### Resolution and Display Formats

Upper cutoff current range	Basic resolution	Display format
0.1 to 9.9mA	0.1mA	. mA
10 to 110mA	1mA	mA

### Caution

- *The **△** **▽** keys ⑫ are enabled when the Tester is in the READY status (status that the **READY** message ㉘ appears) and the **KEYLOCK** message ㉙ has disappeared. It is disabled when in the TEST-ON status (status that the **TEST** message ㉚ appears) or when the Tester is delivering the result of PASS/FAIL judgement (when the **PASS** message ㉛ or the **FAIL** message ㉜ appears).*
- *The upper and lower cutoff currents can be set mutually independently and therefore it is possible that the latter is set at a value higher than the former. If this is the case and the pass/fail judgement function for the lower cutoff current is ON, however, the **mA** display (unit of current measure) blinks and the **READY** message ㉘ disappears to indicate that the test in this condition cannot be done. The READY status resumes and the blinking stops if the lower cutoff current is set at a value lower than the upper cutoff current or if the pass/fail judgement function for the lower cutoff current is turned OFF.*

### 6.1.3 Setting the Lower Cutoff Current

This procedure is to set the lower cutoff current — criterion for pass/fail judgement on the DUT. If the leak current that flows through the DUT is less than this limit, the DUT is judged to be FAIL.

If dispersion of leak currents of DUTs is within a predictable range and their lowest values are within the range detectable with the Tester, you may set the low cutoff current at a value slightly less than the lowest leak currents. By this setting, you can discriminate DUTs whose leak currents are exceptionally small and can guard against open-circuiting of the test leadwires, thereby improving the reliability of test. If this setting is inconvenient for your test, you can turn OFF the lower pass/fail judgement function.

#### Setting Procedure

- Step 1** Select the lower cutoff current setting mode with the **UP/LOW** key ⑬ and the **LOWER** message ⑭ will appear and the preset lower limit current will be indicated on the CURRENT readout ⑮.
- Step 2** Adjust the preset lower cutoff current value as you may require, with the **▲ ▼** keys ⑯. If you press the **SHIFT** key ⑰ at the same time, the adjusting speed is increased by a factor of 10. The current value is displayed on the CURRENT readout ⑮.
- Step 3** Keeping the **SHIFT** key ⑰ pressed, press the **UP/LOW** key ⑬ and the lower pass/fail judgement function will be brought into effect and the **LOWER ON** message ⑰ will appear.

#### Lower Cutoff Current Setting Range

Model	Lower cutoff current range
TOS5101	0.1 to 55mA, OFF
TOS5051	0.1 to 110mA, OFF
TOS5050	0.1 to 110mA, OFF

#### Resolutions and Display Formats

Lower cutoff current range	Basic resolution	Display format
0.1 to 9.9mA	0.1mA	□.□mA
10 to 110mA	1mA	□□□mA

#### Caution

- The **▲ ▼** keys ⑯ keys are enabled when the Tester is in the READY status (status that the **READY** message ⑳ appears) and the **KEYLOCK** message ㉑ has disappeared. It is disabled when in the TEST-ON status (status that the **TEST** message ㉒ appears) or when the Tester is delivering the result of PASS/FAIL judgement (when the **PASS** message ㉓ or the **FAIL** message ㉔ appears).



- The upper and lower cutoff currents can be set mutually independently and therefore it is possible that the latter is set at a value higher than the former. If this is the case and the pass/fail judgement function for the lower cutoff current is ON, however, the mA display (unit of current measure) blinks and the READY message ⑳ disappears to indicate that the test in this condition cannot be done. The READY status resumes and the blinking stops if the lower cutoff current is set at a value lower than the upper cutoff current or if the pass/fail judgement function for the lower cutoff current is turned OFF.
- As noted in Chapter 9 “SPECIFICATIONS” (Note 4 for TOS5050 and Note 5 for TOS5101 and TOS5051), when a test is done with a high AC voltage and a high sensitivity, the lower pass/fail judgement may not be correctly done in a particular case that the output current that flows due to the stray capacitances of the output circuit (such as test leadwires, etc.) is larger than the preset lower cutoff current. Normally, if no DUT is connected, since no end-load current is drawn, the output current should be smaller than the preset lower cutoff current and the Tester should deliver a FAIL judgement. In the above particular case, however, as the output current is larger than the preset lower cutoff current, the Tester will give a PASS judgement even when no DUT is connected. Be careful when using the pass/fail judgement function — take into consideration the various factors that can affect the reliability of judgement. Before starting a tests, disconnect the DUT and be certain that the FAIL judgement is correctly done.

#### 6.1.4 Setting the Test Time

This procedure is to set the test period of time during which the Tester remains in the TEST-ON status (status that the Tester delivers the test voltage). When this period has elapsed without any FAIL judgement, the Tester terminates the test and gives a PASS judgement. You can turn OFF the timer function if you don't need it.

#### **Caution**

- Test time and pause period are limited by setting upper cutoff current. "ON ..." of the front panel character shows a maximum test time and "OFF ..." shows a minimum pause period. For details, refer to chapter 9 "Specifications" (Pages 9-2, 9-3, 9-9 and 9-10).

#### Setting Procedure

#### **Step 1**

Adjust the preset test period with the  $\Delta$   $\nabla$  keys ⑭. If you press the SHIFT key ⑮ at the same time, the adjusting speed is increased by a factor of 10. The test period is displayed on the TIME display ⑯.

#### **Step 2**

To turn ON (or OFF) the timer function, press the ON/OFF key ⑰. When it is turned ON, the TIMER ON message ⑱ appears.

## Resolutions and Display Formats

Test period	Basic resolution	Display format
0.5 to 99.9 s, OFF	0.1 s	□□.□
100 to 999 s, OFF	1 s	□□□

**Caution**

- The **ON/OFF** key ⑮ is enabled when the Tester is in the READY status (status that the **READY** message ⑳ appears) and the **KEYLOCK** message ㉓ has disappeared. They are disabled when in the TEST-ON status (status that the **TEST** message ㉔ appears) or when the Tester is delivering the result of PASS/FAIL judgement (when the **PASS** message ㉕ or the **FAIL** message ㉖ appears).
- The timer function is not in effect unless the **TIMER ON** message ㉗ is displayed, even when the test period is displayed on the TIME display ㉘. As the timer function is not in effect, the test does not terminate even when the preset test period has elapsed and the Tester makes no PASS judgement.
- The accuracy of the test period is  $\pm 20$  ms. If your test specification requires that the test period for the DUT must not be shorter than the specified test period even by a very short period, increase the preset test period by one digit.

## 6.1.5 Setting the Test Voltage

This procedure is to set the test voltage (output voltage of the Tester) to be applied to the DUT.

## Setting Procedure

- Step 1** Turn OFF the lower pass/fail judgement function by pressing the **UP/LOW** key ⑬ while keeping the **SHIFT** key ⑯ pressed, and the **LOWER ON** message ㉔ will disappear.
- Step 2** Turn OFF the timer function by pressing the **ON/OFF** key ⑮, and the **TIMER ON** message ㉗ will disappear.
- Step 3** Check that the TEST VOLTAGE control ⑥ is in the “0” position (fully counterclockwise position) and that the Tester is in the READY status (status that the **READY** message ⑳ appears) and, when in this state, press the **START** switch ②
- Step 4** Monitoring the output voltage on the analog voltmeter ⑩ or VOLTAGE readout ㉑, raise the output voltage to a value you may require by turning gradually the TEST VOLTAGE control ⑥ clockwise.

- Step 5** Press the **STOP** switch ③ to cut off the output voltage.
- Step 6** Turn ON the timer function by pressing the **ON/OFF** key ⑮ and the **TIMER ON** message ⑳ will appear.
- Step 7** If you need the lower pass/fail judgement function also, press the **UP/LOW** key ⑬ while keeping the **SHIFT** key ⑯ pressed. The **LOWER ON** message ㉑ will appear.

### 6.1.6 Connecting the DUT

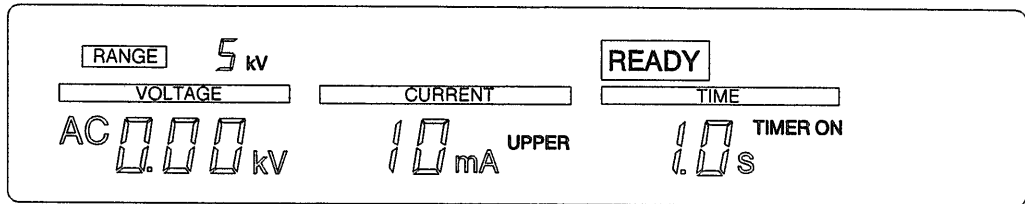
This procedure is to connect the DUT.

- Step 1** Be sure that the analog voltmeter ⑩ indicates 0 volts.
- Step 2** Be sure that the the **DANGER** lamp ⑨ is has gone out.
- Step 3** Be sure that the **READY** message ㉒ has appeared.
- Step 4** Connect the LOW test leadwire to the LOW terminal ⑧.
- Step 5** To check that the high output voltage is not being delivered, by hitting the HIGH VOLTAGE terminal ⑦ with the other end of the LOW test leadwire.
- Step 6** Connect the LOW test leadwire to the DUT.
- Step 7** Connect the HIGH test leadwire to the HIGH VOLTAGE terminal ⑦.
- Step 8** Connect the other end of the HIGH test leadwire to the DUT.

### 6.1.7 Executing a Test

This procedure is to execute a test. Let's assume that the test parameters are as shown in the following table. The items displayed when in the READY status will be as shown below.

Test voltage range	5kV
Test voltage	1.2kV
Upper cutoff current	10mA
Lower pass/fail judgement function	OFF
Test time	1 s



Test Procedure

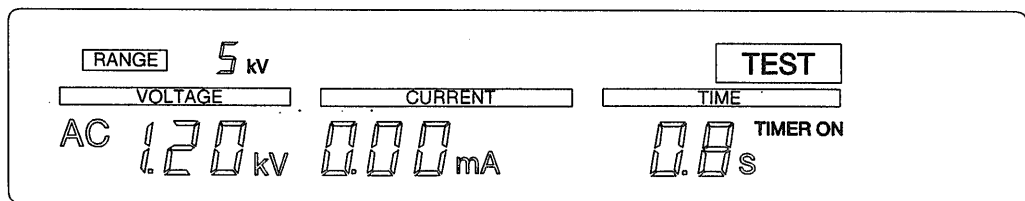
**Step 1**

To start the test, press the **START** switch ② when the Tester is in the **READY** status (status that the **READY** message ⑳ appears). The Tester will commence the test and the following actions will take place.

- The **DANGER** lamp ⑨ lights up.
- The H.V ON signal of the SIGNAL I/O connector ⑳ is turned ON.
- The **TEST** message ㉑ appears.
- The TEST signal of the SIGNAL I/O connector ㉒ is turned ON.
- The test voltage is delivered between the HIGH VOLTAGE terminal ⑦ and the LOW terminal ⑧.
- The analog voltmeter ⑩ indicates the test voltage. (The voltmeter indicates the voltage even when the Tester is not in the TEST-ON status.)
- The VOLTAGE readout ㉓ displays the test voltage. (The readout displays the voltage even when the Tester is not in the TEST-ON status.)
- The CURRENT readout ㉔ displays the measured output current.
- The TIME display ㉕ shows the remaining test time or the elapsed test time.

The Vacuum Fluorescent Display will show the following items, assuming that the test voltage is 1.20kV, the measured output current is 0.00mA, and the remaining test time is 0.8 s.

**TEST**



**Caution**

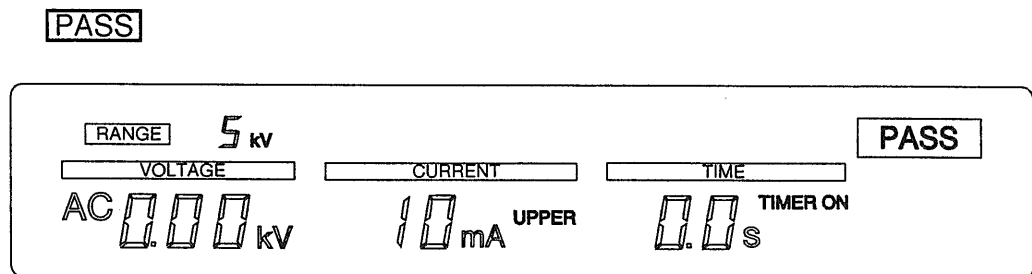
- The Tester will not start the test if it is in the *PROTECTION* state.
- The Tester will not start the test if a *STOP* signal is being applied.

## If the test result is PASS

When the preset test time has elapsed, the Tester will make a PASS judgement. If the test result is a PASS, the following actions will take place.

- The Tester terminates the test and cuts off the test voltage.
- The **TEST** message ⑳ disappears.
- The TEST signal of the SIGNAL I/O connector ㉓ is turned OFF.
- The **DANGER** lamp ⑨ goes out. (It does not go out so far as there remains a residual test voltage in the output circuit.)
- The H.V ON signal of the SIGNAL I/O connector ㉓ is turned OFF. (It is not turned off so far as there remains a residual test voltage in the output circuit.)
- The **PASS** message ㉔ appears.
- The buzzer sounds.
- The PASS signal of the SIGNAL I/O connector ㉓ is turned ON.

The Vacuum Fluorescent Display in this case will be as follows:



When in the normal state, the Tester will automatically reset to the READY status (status that the **READY** message ㉕ appears) within approximately 0.2 seconds from the PASS status and the following actions will take place.

- The **PASS** message ㉔ disappears.
- The buzzer stops.
- The PASS signal of the SIGNAL I/O connector ㉓ is turned OFF.

### Caution

- The Tester will not automatically reset to the READY status when in any of the following cases:
  - When the PASS HOLD switch of the TEST MODE switches ㉘ on the rear panel has been set to ON. In this case the PASS status is held continuously. To reset it, press the **STOP** switch ③. (For details, refer to Section 6.5 "Settings for Special Test Modes.")

- When there remains the cause of the PROTECTION status. (For details, refer to Section 4.2.8 “PROTECTION Messages.”)
- When the **STOP** switch ③ is pressed (including the STOP switch of the Remote Control Box).
- When the **START** switch ② remains in the pressed state (including the STOP switch of the Remote Control Box).

If the timer is set to OFF

If the timer function is OFF and the **TIMER ON** message ⑳ has disappeared, the test does not terminate automatically. You must manually stop the test by pressing the **STOP** switch ③. In this case the Tester does not make the PASS judgement and the following actions will take place.

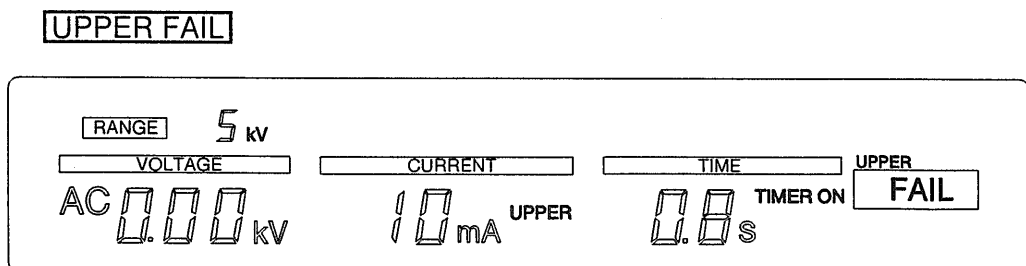
- The tester terminates the test and cuts off the test voltage.
- The **TEST** message ㉑ disappears.
- The TEST signal of the SIGNAL I/O connector ㉓ is turned OFF.
- The **DANGER** lamp ⑨ goes out. (It does not go out so far as there remains a residual test voltage in the output circuit.)
- The H.V ON signal of the SIGNAL I/O connector ㉓ is turned OFF. (It is not turned off so far as there remains a residual test voltage in the output circuit.)

If the test result is FAIL

If the leak current measured during the test is beyond the limits shown below, the Tester will give a FAIL judgement and cut off the test voltage and terminate the test.

- When the measured current is larger than the upper cutoff current:

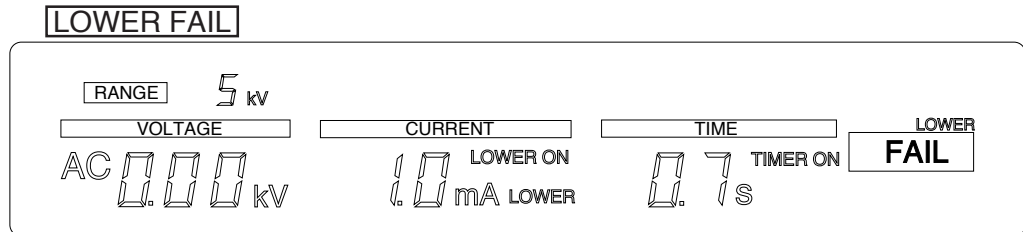
The items shown on the Vacuum Fluorescent Display will be as follows.



In this case, the **UPPER FAIL** message ㉒ will appear.

- When the measured current is less than the lower cutoff current:

Assuming that the lower cutoff current is set at 1 mA and the lower pass/fail judgement function is ON, the items shown on the Vacuum Fluorescent Display will be as follows.



When the Tester has made a FAIL judgement, the **LOWER FAIL** message ③① will appear and the following actions will take place.

- The tester terminates the test and cuts off the test voltage.
- The **TEST** message ②⑨ disappears.
- The TEST signal of the SIGNAL I/O connector ③⑦ is turned OFF.
- The **DANGER** lamp ⑨ goes out. (It does not go out so far as there remains a residual test voltage in the output circuit.)
- The H.V ON signal of the SIGNAL I/O connector ③⑦ is turned OFF. (It is not turned off so far as there remains a residual test voltage in the output circuit.)
- The **UPPER FAIL** or **LOWER FAIL** message ③① disappears.
- The U FAIL or L FAIL signal of the SIGNAL I/O connector ③⑦ is turned OFF.
- The buzzer stops.

The FAIL judgement does not reset automatically. To reset it, press the **STOP** switch ③.

## Repeating the test

To repeat the test, proceed as follows:

Within approximately 0.2 seconds after the test was successfully terminated with a PASS judgement, the Tester will automatically reset to the READY status, allowing you to repeat the test simply by pressing the **START** switch ②. The same applies

**Caution**

- The Tester will not automatically reset to the READY status when in any of the following cases:
  - When the PASS HOLD switch of the TEST MODE switches ③⑧ on the rear panel has been set to ON. (For details, refer to Section 6.5 “Settings for Special Test Modes.”)
  - When there remains the cause of the PROTECTION status. (For details, refer to Section 4.2.8 “PROTECTION Messages.”)
  - When the **STOP** switch ③ is pressed (including the STOP switch of the Remote Control Box).
  - When the **START** switch ② remains in the pressed state (including the STOP switch of the Remote Control Box).

When the test is terminated with a FAIL judgement, press the **STOP** switch ③ to reset the Tester to the READY status and then press the **START** switch ②. The same applies also when the Tester is controlled remotely.

## 6.2 DC Withstanding Voltage Test Procedure

Set the test parameters as you may require to test your DUTs. The ranges of test parameters available with the Tester are as follows:

Model	Test voltage	Criterion for upper cutoff current	Criterion for lower cutoff current	Test time
TOS5101	0 to 10kV	0.1 to 55mA	0.1 to 55mA, OFF	0.5 to 999 s, OFF
TOS5051	0 to 5kV	0.1 to 110mA	0.1 to 110mA, OFF	0.5 to 999 s, OFF
TOS5050	—	—	—	—

**Caution**

- The TOS5050 is for AC tests only. It has no DC ranges.

### 6.2.1 Selecting a DC Test Voltage Range

With the TEST VOLTAGE switch ⑤, select a DC test voltage range and the **DC** test mode message ⑳ will appear and the TEST VOLTAGE RANGE message ⑲ will indicate the test voltage range you have selected.

Model	Selectable Ranges	
TOS5101	10kV	5kV
TOS5051	5kV	2.5kV
TOS5050	—	—



**Caution**

- Before turning the *TEST VOLTAGE* switch (5), be sure that the *TEST VOLTAGE* control (6) is in the fully counterclockwise position (“0” position).
- During the *TEST-ON* period (period that the **TEST** message (29) appears), the *TEST VOLTAGE* switch (5) is disabled. During this period, it is possible that the actual position of the switch does not conform with the *TEST VOLTAGE RANGE* message (19) or the **AC/DC** test mode message (20). When the test period has elapsed, the switch is enabled and the selected test voltage range and AC/DC mode (mode selection is for TOS5101 and TOS5051 only) are effected. Do not operate the Tester in this manner — that is, do not change the *TEST VOLTAGE* switch (5) during the *TEST-ON* period.
- Do not let the *TEST VOLTAGE* switch (5) caught on a midway in turning it from one range position to another range position. If you turn ON the **POWER** switch (1) while the *TEST VOLTAGE* switch (5) is caught on a midway, the *TEST VOLTAGE RANGE* message (19) will indicate 0 kV, both **AC/DC** test mode messages (20) will appear at the same time (except for TOS5050) and will blink to show that no range selection has been successfully accomplished. When changing the *TEST VOLTAGE* switch (5), turn it accurately to a range position.

## 6.2.2 Setting the Upper Cutoff Current

This procedure is to set the upper cutoff current — criterion for pass/fail judgement on the DUT. If the leak current that flows through the DUT is larger than this limit, the DUT is judged to be FAIL.

**Caution**

- Test time and pause period are limited by setting upper cutoff current. “ON ...” of the front panel character shows a maximum test time and “OFF ...” shows a minimum pause period. For details, refer to chapter 9 “Specifications” (Pages 9-9, 9-10 and 9-11).

### Setting Procedure

**Step 1**

Select the upper cutoff current setting mode with the **UP/LOW** key (13) and the **UPPER** message (23) will appear and the preset upper limit current will be indicated on the CURRENT readout (22).

**Step 2**

Adjust the preset upper cutoff current value as you may require, with the **▲▼** keys (12). If you press the **SHIFT** key (16) at the same time, the adjusting speed is increased by a factor of ten. The current value is displayed on the CURRENT readout (22).

### Upper Cutoff Current Setting Range

Model	Upper cutoff current range
TOS5101	0.1 to 5.5mA
TOS5051	0.1 to 11mA
TOS5050	—

## Resolution and Display Formats

Upper cutoff current range	Basic resolution	Display format
0.1 to 9.9mA	0.1mA	□.□mA
10 to 11mA	1mA	□□□mA

**Caution**

- The keys are enabled when the Tester is in the **READY** status (status that the **READY** message ⑳ appears) and the **KEYLOCK** message ㉓ has disappeared. They are disabled when in the **TEST-ON** status (status that the **TEST** message ㉑ appears) or when the Tester is delivering the result of **PASS/FAIL** judgement (when the **PASS** message ㉔ or the **FAIL** message ㉕ appears).
- The upper and lower cutoff currents can be set mutually independently and therefore it is possible that the latter is set at a value higher than the former. If this is the case and the pass/fail judgement function for the lower cutoff current is **ON**, however, the **mA** display (unit of current measure) blinks and the **READY** message ㉔ disappears to indicate that the test in this condition cannot be done. The **READY** status resumes and the blinking stops when the lower cutoff current is set at a value lower than the upper cutoff current or when the pass/fail judgement function for the lower cutoff current is turned **OFF**.

### 6.2.3 Setting the Lower Cutoff Current

This procedure is to set the lower cutoff current — criterion for pass/fail judgement on the DUT. If the leak current that flows through the DUT is less than this limit, the DUT is judged to be **FAIL**.

If dispersion of leak currents of DUTs is within a predictable range and their lowest values are within the range detectable with the Tester, you may set the low cutoff current at a value slightly less than the lowest leak currents. By this setting, you can discriminate DUTs whose leak currents are exceptionally small and can guard against open-circuiting of the test leadwires, thereby improving the reliability of test. If this setting is inconvenient for your test, you can turn **OFF** the lower pass/fail judgement function.

#### Setting Procedure

**Step 1**

Select the lower cutoff current setting mode with the **UP/LOW** key ㉑ and the **LOWER** message ㉔ will appear and the preset lower cutoff current will be indicated on the **CURRENT** readout ㉒.

**Step 2**

Adjust the preset lower cutoff current value as you may require, with the **△** **▽** keys ㉒. If you press the **SHIFT** key ㉒ at the same time, the adjusting speed is increased by a factor of ten. The current value is displayed on the **CURRENT** readout ㉒.

**Step 3**

Keeping the **SHIFT** key ㉒ pressed, press the **UP/LOW** key ㉑ and the lower pass/fail judgement function will be brought into effect and the **LOWER ON** message ㉕ will appear.

## Lower Cutoff Current Setting Range

Model	Lower cutoff current range
TOS5101	0.1 to 5.5mA, OFF
TOS5051	0.1 to 11mA, OFF
TOS5050	—

## Resolutions and Display Formats

Lower cutoff current range	Basic resolution	Display format
0.1 to 9.9mA	0.1mA	□.□mA
10 to 11mA	1mA	□□□mA

**Caution**

- The  $\Delta$   $\nabla$  keys ⑫ are enabled when the Tester is in the **READY** status (status that the **READY** message ⑳ appears) and the **KEY LOCK** message ㉓ has disappeared. They are disabled when in the **TEST-ON** status (status that the **TEST** message ㉔ appears) or when the Tester is delivering the result of **PASS/FAIL** judgement (when the **PASS** message ㉕ or the **FAIL** message ㉖ appears).
- The upper and lower cutoff currents can be set mutually independently and therefore it is possible that the latter is set at a value higher than the former. If this is the case and the pass/fail judgement function for the lower cutoff current is **ON**, however, the **mA** display (unit of current measure) blinks and the **READY** message ⑳ disappears to indicate that the test in this condition cannot be done. The **READY** status resumes and the blinking stops if the lower cutoff current is set at a value lower than the upper cutoff current or if the pass/fail judgement function for the lower cutoff current is turned **OFF**.

## 6.2.4 Setting the Test Time

This procedure is to set the test period of time during which the Tester remains in the TEST-ON status (status that the Tester delivers the test voltage). When this period has elapsed without any FAIL judgement events, the Tester terminates the test and gives a PASS judgement. You can turn OFF the timer function if you don't need it.

### Caution

- Test time and pause period are limited by setting upper cutoff current. "ON ..." of the front panel character shows a maximum test time and "OFF ..." shows a minimum pause period. For details, refer to chapter 9 "Specifications" (Pages 9-9, 9-10 and 9-11).

### Setting Procedure

#### Step 1

Adjust the preset test period with the  $\Delta$   $\nabla$  keys (14). If you press the **SHIFT** key (16) at the same time, the adjusting speed is increased by a factor of ten. The test period is displayed on the TIME display (26).

#### Step 2

To turn ON (or OFF) the timer function, press the **ON/OFF** key (15). When it is turned ON, the **TIMER ON** message (27) appears.

### Resolutions and Display Formats

Test period	Basic resolution	Display format
0.5 to 99.9 s	0.1 s	.
100 to 999 s	1 s	

### Caution

- The keys are enabled when the Tester is in the READY status (status that the **READY** message (28) appears) and the **KEYLOCK** message (33) has disappeared. They are disabled when in the TEST-ON status (status that the **TEST** message (29) appears) or when the Tester is delivering the result of PASS/FAIL judgement (when the **PASS** message (30) or the **FAIL** message (31) appears).
- The timer function is not in effect unless the **TIMER ON** message (27) is displayed, even when the test period is displayed on the TIME display (26). As the timer function is not in effect, the test does not terminate even when the preset test period has elapsed and the Tester makes no PASS judgement.
- The accuracy of the test period is  $\pm 20$  ms. If your test specifications require that the test period for the DUT must not be shorter than the specified test period even by a very short period, increase the preset test period by one digit.

## 6.2.5 Setting the Test Voltage

This procedure is to set the test voltage (output voltage of the Tester) to be applied to the DUT.

### Setting Procedure

- Step 1** Turn OFF the lower pass/fail judgement function by pressing the **UP/LOW** key ⑬ while keeping the **SHIFT** key ⑯ pressed, and the **LOWER ON** message ⑳ will disappear.
- Step 2** Turn OFF the timer function by pressing the **ON/OFF** key ⑮, and the **TIMER ON** message ㉑ will disappear.
- Step 3** Check that the TEST VOLTAGE control ⑥ is in the “0” position (fully counterclockwise position) and that the Tester is in the READY status (status that the **READY** message ㉒ appears) and, when in this state, press the **START** switch ②.
- Step 4** Monitoring the output voltage on the analog voltmeter ⑩ or VOLTAGE readout ㉓, raise the output voltage to a value you may require by turning gradually the TEST VOLTAGE control ⑥ clockwise.
- Step 5** Press the **STOP** switch ③ to cut off the output voltage.
- Step 6** Turn ON the timer function by pressing the **ON/OFF** key ⑮ and the **TIMER ON** message ㉑ will appear.
- Step 7** If you need the lower pass/fail judgement function also, press the **UP/LOW** key ⑬ while keeping the **SHIFT** key ⑯ pressed. The **LOWER ON** message ⑳ will appear.

## 6.2.6 Connecting the DUT

This procedure is to connect the DUT.

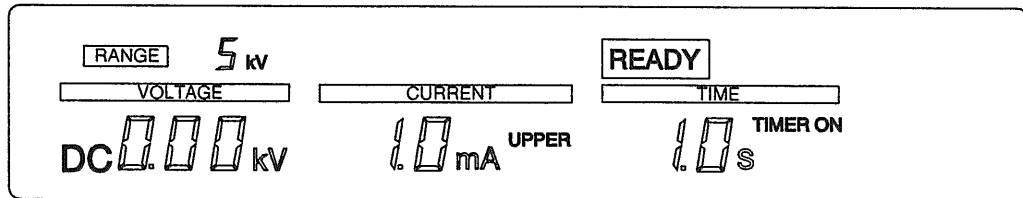
### Setting Procedure

- Step 1** Be sure that the analog voltmeter ⑩ indicates 0 volts.
- Step 2** Be sure that the the **DANGER** lamp ⑨ has gone out.
- Step 3** Be sure that the **READY** message ㉒ has appeared.
- Step 4** Connect the LOW test leadwire to the LOW terminal ⑧.
- Step 5** To check that the high output voltage is not being delivered, hit the HIGH VOLTAGE terminal ⑦ with the other end of the LOW test leadwire.
- Step 6** Connect the LOW test leadwire to the DUT.
- Step 7** Connect the HIGH test leadwire to the HIGH VOLTAGE terminal ⑦.
- Step 8** Connect the other end of the HIGH test leadwire to the DUT.

## 6.2.7 Executing a Test

This procedure is to execute a test. Let's assume that the test parameters are as shown in the following table. The test parameters displayed when in the READY status will be as shown below.

Test voltage range	5kV
Test voltage	1.7kV
Upper cutoff current	1mA
Lower pass/fail judgement function	OFF
Test time	1 s



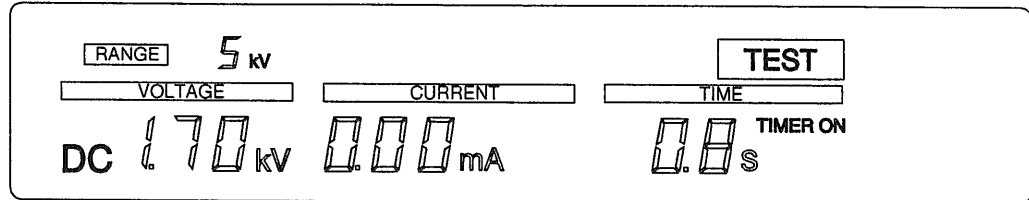
### Test Procedure

#### Step 1

To start the test, press the **START** switch ② when the Tester is in the READY status (status that the **READY** message ⑳ appears). The Tester will commence the test and the following actions will take place.

- The **DANGER** lamp ⑨ lights up.
- The H.V ON signal of the SIGNAL I/O connector ⑳ is turned ON.
- The **TEST** message ㉑ appears.
- The TEST signal of the SIGNAL I/O connector ⑳ is turned ON.
- The test voltage is delivered between the HIGH VOLTAGE terminal ⑦ and the LOW terminal ⑧.
- The analog voltmeter ⑩ indicates the test voltage. (The voltmeter indicates the voltage even when the Tester is not in the TEST-ON status.)
- The VOLTAGE readout ㉒ displays the test voltage. (The readout displays the voltage even when the Tester is not in the TEST-ON status.)
- The CURRENT readout ㉓ displays the measured output current.
- The TIME display ㉔ shows the remaining test time or the elapsed test time.

The Vacuum Fluorescent Display will show the following items, assuming that the test voltage is 1.70kV, the measured output current is 0.00mA, and the remaining test time is 0.8 s.

**TEST****Caution**

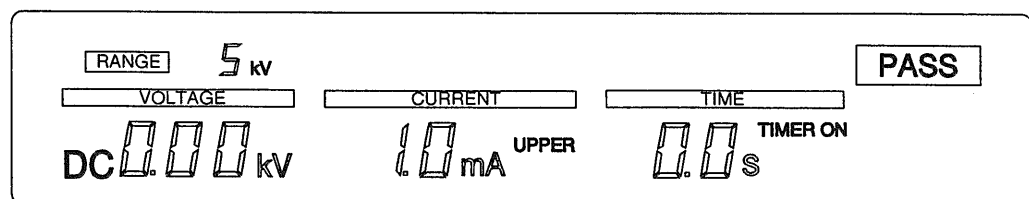
- The Tester will not start the test if it is in the PROTECTION state.
- The Tester will not start the test if a STOP signal is being applied.

If the test result is PASS

When the preset test time has elapsed, the Tester will make a PASS judgement. When the test result is a PASS, the following actions will take place.

- The tester terminates the test and cuts off the test voltage.
- The **TEST** message ⑳ disappears.
- The TEST signal of the SIGNAL I/O connector ⑳ is turned OFF.
- The **DANGER** lamp ⑨ goes out. (It does not go out so far as there remains a residual test voltage in the output circuit.)
- The H.V ON signal of the SIGNAL I/O connector ⑳ is turned OFF. (It is not turned off so far as there remains a residual test voltage in the output circuit.)
- The **PASS** message ㉑ appears.
- The buzzer sounds.
- The PASS signal of the SIGNAL I/O connector ⑳ is turned ON.

The Vacuum Fluorescent Display in this case will be as follows:

**PASS**

When in the normal state, the Tester will automatically reset to the READY status (status that the **READY** message ㉒ appears) within approximately 0.2 seconds from the PASS status and the following actions will take place.

- The **PASS** message ⑩ disappears.
- The buzzer stops.
- The PASS signal of the SIGNAL I/O connector ⑳ is turned OFF.

**Caution**

- *The Tester will not automatically reset to the READY status when in any of the following cases:*
  - *When the PASS HOLD switch of the TEST MODE switches ㉔ on the rear panel has been set to ON. In this case the PASS status is held continuously. To reset it, press the **STOP** switch ③. (For details, refer to Section 6.5 “Settings for Special Test Modes.”)*
  - *When there remains the cause of the PROTECTION status. (For details, refer to Section 4.2.8 “PROTECTION Messages.”)*
  - *When the **STOP** switch ③ is pressed (including the STOP switch of the Remote Control Box).*
  - *When the **START** switch ② remains in the pressed state (including the STOP switch of the Remote Control Box).*

If the timer functions is set to OFF

If the timer function is OFF and the **TIMER ON** message ㉗ has disappeared, the test does not terminate automatically. You must manually stop the test by pressing the **STOP** switch ③. In this case the Tester makes no PASS judgement and the following actions will take place.

- The tester terminates the test and cuts off the test voltage.
- The **TEST** message ㉙ disappears.
- The TEST signal of the SIGNAL I/O connector ㉗ is turned OFF.
- The **DANGER** lamp ⑨ goes out. (It does not go out so far as there remains a residual test voltage in the output circuit.)
- The H.V ON signal of the SIGNAL I/O connector ㉗ is turned OFF. (It is not turned off so far as there remains a residual test voltage in the output circuit.)

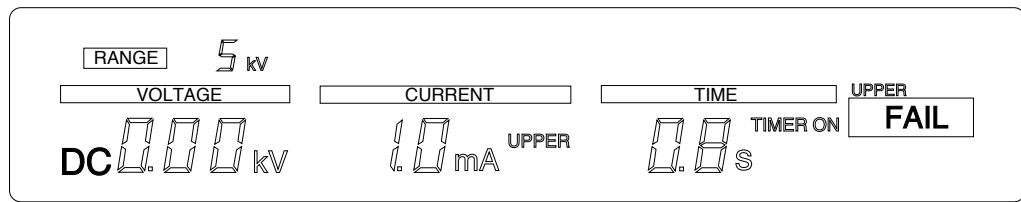
If the test result is FAIL

If the leak current measured during the test is beyond the limits shown below, the Tester will give a FAIL judgement and cut off the test voltage and terminate the test.

- When the measured current is larger than the upper cutoff current:

The items shown on the Vacuum Fluorescent Display will be as follows.

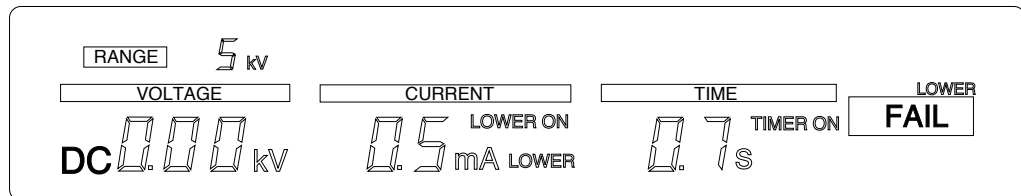


**UPPER FAIL**

In this case, the **UPPER FAIL** message ③① will appear.

- When the measured current is less than the lower cutoff current:

Assuming that the lower cutoff current is set at 0.5 mA and the lower pass/fail judgement function is ON, the items shown on the display screen will be as follows.

**LOWER FAIL**

When the Tester has made a FAIL judgement, the **LOWER FAIL** message ③① will appear and the following actions will take place.

- The tester terminates the test and cuts off the test voltage.
- The **TEST** message ②⑨ disappears.
- The TEST signal of the SIGNAL I/O connector ③⑦ is turned OFF.
- The **DANGER** lamp ⑨ goes out. (It does not go out so far as there remains a residual test voltage in the output circuit.)
- The H.V ON signal of the SIGNAL I/O connector ③⑦ is turned OFF. (It is not turned off so far as there remains a residual test voltage in the output circuit.)
- The **UPPER FAIL** or **LOWER FAIL** message ③① appears.
- The U FAIL or L FAIL signal of the SIGNAL I/O connector ③⑦ is turned ON.
- The buzzer sounds.

The FAIL judgement does not reset automatically. To reset it, press the **STOP** switch ③.

## Repeating the test

To repeat the test, proceed as follows:

Within approximately 0.2 seconds after the test was successfully terminated with a PASS judgement, the Tester will automatically reset to the READY status, allowing you to repeat the test simply by pressing the **START** switch ②. The same applies also when the Tester is controlled remotely.

### **Caution**

- *The Tester will not automatically reset to the READY status when in any of the following cases:*
  - *When the PASS HOLD switch of the TEST MODE switches ⑳ on the rear panel has been set to ON. (For details, refer to Section 6.5 “Settings for Special Test Modes.”)*
  - *When there remains the cause of the PROTECTION status. (For details, refer to Section 4.2.8 “PROTECTION Messages.”)*
  - *When the **STOP** switch ③ is pressed (including the STOP switch of the Remote Control Box).*
  - *When the **START** switch ② remains in the pressed state (including the STOP switch of the Remote Control Box).*

*When the test is terminated with a FAIL judgement, press the **STOP** switch ③ to reset the Tester to the READY status and then press the **START** switch ②. The same applies also when the Tester is controlled remotely.*

## 6.3 Remote Control

This section describes the procedure to control remotely the start/stop of the test operation (on/off of the output voltage of the Tester).

### **WARNING**

- *Be extremely careful when operating the Tester in the remote control mode in which the dangerous high test voltage is ON/OFF-controlled remotely. Provide means to assure that the Tester does not become the TEST-ON state (state that the test voltage is being delivered) by inadvertent operation. Provide means to assure that none can touch the DUT, test leadwires, probes, output terminals and their vicinities when in the TEST-ON state. When any of these protective provisions are unavailable, do not attempt to control the Tester remotely.*

### 6.3.1 Remote Control through REMOTE CONTROL Connector ④

The REMOTE CONTROL connector ④ is for remote control of the Tester from an optional device — a Remote Control Box (RC01-TOS or RC02-TOS) or an H.V Test Probe (HP01A-TOS or HP02A-TOS). For the remote control mode of operation, connect the REMOTE CONTROL connector ④ to the optional device through the 5-pin DIN cable. As you make this connection, the **START** switch ② is disabled and the **REMOTE** message ③④ appears to indicate that the remote control function has been brought into effect. Although the start operation can be controlled only remotely, the **STOP** switch ③ remains enabled and the stop operation can be controlled both locally and remotely. In this case, the Tester is driven into the PROTECTION status (the **PROTECTION** message ③② appears) and the test voltage is cut off.

As you disconnect the cable, the **REMOTE** message ③④ goes out and the **START** switch ② is enabled. In this case also, the Tester is driven into the PROTECTION status (the **PROTECTION** message ③② appears) and the test voltage is cut off.

#### **Caution**

- For remote-control of test start/stop operation of the Tester from other device than one of the optional devices of the Tester, do not use the REMOTE CONTROL connector ④ on the front panel but use the SIGNAL I/O connector ③⑦ on the rear panel.
- Of the optional H.V Test Probe (HP01A-TOS or HP02A-TOS), the maximum allowable test voltage is 5kV DC or 4kV AC.
- Do not remote-control the Tester simultaneously from both REMOTE CONTROL connector ④ and SIGNAL I/O connector ③⑦. If you do this, the **REMOTE** message ③④ will disappear and the **START** switch ② will be enabled.
- If the Remote Control Box is with its UNCONDITIONAL STOP function effected, the Tester will not become the PROTECTION status when the cable of the box is connected to the REMOTE CONTROL connector ④. When the cable of the H.V Test Probe is connected to the REMOTE CONTROL connector ④, the Tester will not become the PROTECTION status because the probe is in the state that its UNCONDITIONAL STOP function is effected.
- If the FAIL MODE switch of TEST MODE switches ③⑧ is set to ON, the FAIL status and PROTECTION status cannot be remotely reset by applying a remote STOP signal. They must be locally reset with the **STOP** switch ③.
- Lay the control signal wires apart (more than 500 mm) from the H.V test leadwires and DUT. Never let the H.V test leadwire shorted to a signal wire — if you do it, it may utterly damage the internal circuits of the Tester.

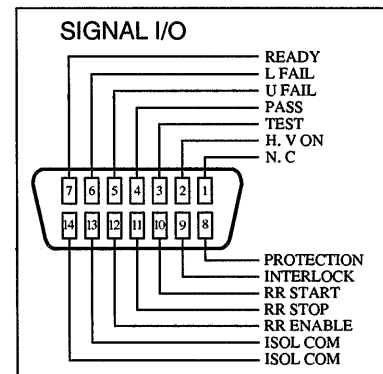
### 6.3.2 Remote Control through SIGNAL I/O Connector ③

The REMOTE CONTROL connector ④ is for remote control of the Tester from a device other than the optional devices, namely, Remote Control Boxes (RC01-TOS and RC02-TOS) and H.V Test Probes (HP01A-TOS and HP02A-TOS). To connect the remote control signals, use the 14-pin Amphenol connector (supplied). The pin assignment of the connector is as follows:

#### SIGNAL I/O Connector ④

Pin No.	Signal	I/O	Description
9	INTERLOCK	I	Interlock signal input pin
10	RR START	I	Start signal input pin
11	RR STOP	I	Stop signal input pin
12	RR ENABLE	I	Remote control enable signal input pin
13	ISOL COM		Circuit common pin
14	ISOL COM		Circuit common pin

Conditions of low-active control inputs	
• High level input voltage	11 to 15V
• Low level input voltage	0 to 4V
• Low level input current	-5mA maximum
• Input time duration	5 ms. minimum



1. Each of the above signal input pins are isolated from the internal circuit by a photocoupler (rated 30V DC, 30V rms AC MAX). Note, however, that its common circuit is directly connected to that of the signal output circuit.
2. Each of the signal input pins is pulled up to +15V with a resistor. If you make the input pin circuit open, it is equivalent to that a HIGH level signal is applied.

As you turn the RR ENABLE signal (remote control enable signal) to the LOW level, the **REMOTE** message ③ appears and the test can be started by the RR START signal (remote control start signal) and the **START** switch ② is disabled. Although the start operation can be controlled only remotely, the stop operation can be controlled both locally with the **STOP** switch ③ and remotely with the RR STOP signal. In this case, the Tester is driven into the PROTECTION status (the **PROTECTION** message ③ appears) and the test voltage is cut off.

As you turn the RR ENABLE signal to the HIGH level, the **REMOTE** message ③ disappears and the RR START signal is disabled and the **START** switch ② is enabled. In this case also, the Tester is driven into the PROTECTION status (the **PROTECTION** message ③ appears) and the test voltage is cut off.

**Caution**

- *Of the 14-pin Amphenol plug that is supplied as an accessory, pins 9 and 14 are connected together. Be sure to provide an appropriate interlock provision when using the Tester. For details, refer to Section 6.3.3 “Interlock Function.”*
- *Do not remote-control the Tester simultaneously from both REMOTE CONTROL connector ④ and SIGNAL I/O connector ③⑦. If you do this, the REMOTE message ③④ will disappear and the START switch ② will be enabled.*
- *If the FAIL MODE switch of TEST MODE switches ③⑧ is set to ON, the FAIL status and PROTECTION status cannot be remotely reset by applying a remote STOP signal. They must be locally reset with the STOP switch ③.*
- *The internal control circuits of the Tester has been designed to be resistant against interference by noise generated by the Tester and its peripheral devices. However, it is not recommendable to connect non-shielded wires to the pins of the SIGNAL I/O connector. Such wires may act as antennas and may cause interference to the devices.*

*For the mating plug of the 14-pin Amphenol connector plug, cables, and external circuits, use a shielded metallic 14-pin Amphenol connector plug, shielded cables, and external circuits fabricated in a shielded casing. Connect the chassis of the Tester to that of the external device. (Do not connect the ISOL COM pins to the shielding line or an earth ground.) This will isolate the SIGNAL I/O circuits from the external environments and will become more resistant against noise.*

- *Lay the control signal wires apart (more than 500 mm) from the H.V test leadwires and DUT. Never let the H.V test leadwire shorted to a signal wire — if you do it, it may utterly damage the internal circuits of the Tester.*

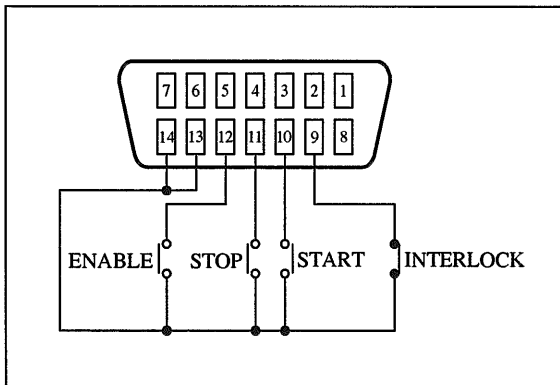
**REMARKS**

Shorting of the H.V output terminals of the Tester may generate noise that can cause interference to peripheral devices. If you need to suppress the interference, connect a resistor (470 ohms or thereabout) between the end of the HIGH test leadwire and the DUT and another resistor of the same resistance between the end of the LOW test leadwire and the DUT (in positions as close to the DUT as possible). These resistors are very effective for suppression of the noise interference. Pay attention to the wattage and the maximum working voltage of the resistors. When the upper cutoff current is not greater than 10 mA, resistors of 470 ohms (Rated Power : 3 W, Impulse Dielectric Withstanding Voltage : 30 kV ) will be appropriate.

When you have connected these resistors, the test voltage that is actually applied to the DUT will be slightly lower (approximately 10 V when the current that flows through the DUT is 10 mA) than the output terminal voltage due to the voltage drops caused by the resistors.

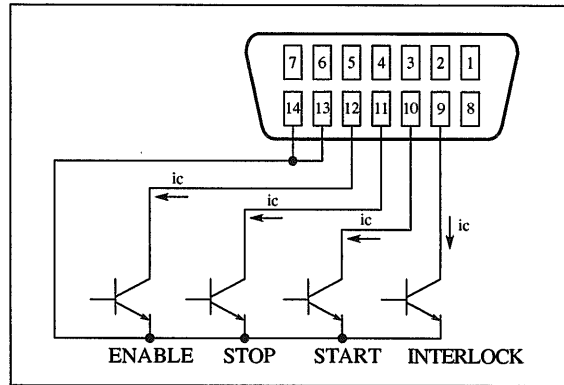
As for the external ON/OFF control devices, use devices as shown below.

To control with make-contact devices such as relays and switches



You may replace the contacts with logic element transistors, FETs, or photocouplers.

To control with logic elements (Low-active control)



**Caution**

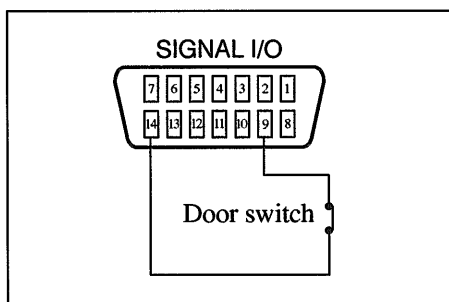
- Each "ic" rating must be 5 mA or more.

### 6.3.3 Interlock Function

The Tester has an interlock function as a safety feature. When the interlock circuit is made open, the Tester falls into the PROTECTION status (the **PROTECTION** message 32 appears). When in this status, the Tester cuts off the test voltage, and does not respond to the start signal applied either locally from the **START** switch 2 or remotely via the remote-control connector or to the stop signal applied either locally from the **STOP** switch 3 or remotely via the remote-control connector.

To make use of the interlock function, proceed as follows: Pin 9 of the SIGNAL I/O connector 37 is the input terminal for the interlock signal. The interlock function comes into effect when the signal level is high (the circuit is made open); it is released when the signal level is low (the circuit is closed). To close the circuit, connect Pin 9 to Pin 13 or 14 (ISOL COM terminal).

To reset the Tester from the PROTECTION status caused by the interlock function, turn the interlock signal to the low level and then press the **STOP** switch 3 or apply a remote-controlled STOP signal.



In this example, as you open the door, the contact of the door switch opens and drives the interlock signal to the high level (interlock signal circuit open) and the interlock function is brought into effect.

**Caution**

*If you turn ON the Tester power directly without doing any procedure regarding the interlock function (in the very state as it was when the Tester was shipped from the factory), the interlock function will be brought into effect and the Tester will not start operating. The Tester is accompanied by a 14-pin Amphenol plug whose Pins 9 and 14 are shorted. You may tentatively release the interlock function by capping the SIGNAL I/O connector 37 with the plug. Do not operate, however, the Tester in this manner for routine use. For the routine use, you should provide a proper external interlock circuit.*

## 6.4 Output Signals

This section describes the output signals that are delivered through the SIGNAL I/O connector (37) or the STATUS SIGNAL OUTPUT receptacle (39).

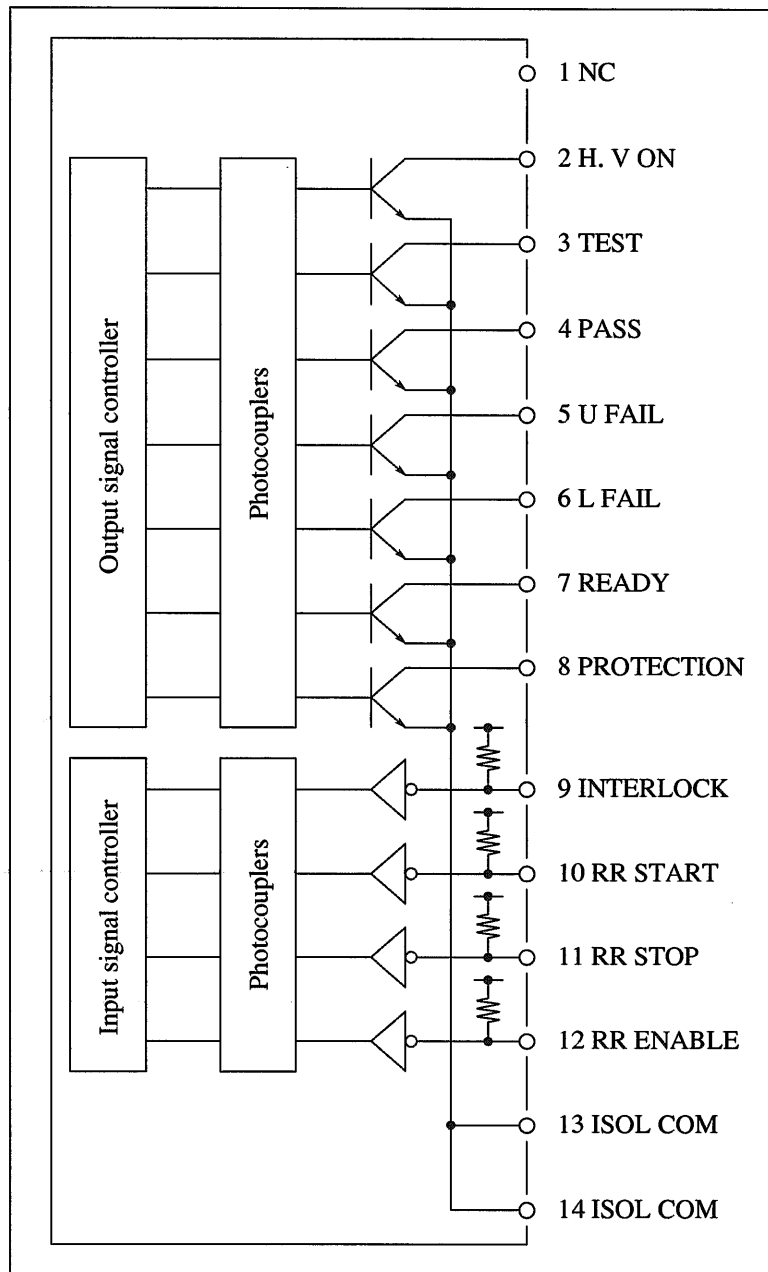
### 6.4.1 Output Signals of SIGNAL I/O Connector (37)

The Tester delivers the following output signals through the SIGNAL I/O connector (37).

Pin No.	Signal Name	I/O	Conditions for signal delivery
2	H.V ON	O	During the period the test voltage is delivered to the output terminal.
3	TEST	O	During the period the test is in progress.
4	PASS	O	When a PASS judgement is made. Delivered for approximately 0.2 seconds (delivered continuously if PASS HOLD has been set to ON).
5	U FAIL	O	When a current larger than the preset upper cutoff current is detected and the DUT is judged to be a failure. Delivered continuously.
6	L FAIL	O	When a current less than the preset upper cutoff current is detected and the DUT is judged to be a failure. Delivered continuously.
7	READY	O	When the Tester is in the READY status.
8	PROTECTION	O	When the Tester is in the PROTECTION status.
13	ISOL COM		Circuit common pin
14	ISOL COM		Circuit common pin

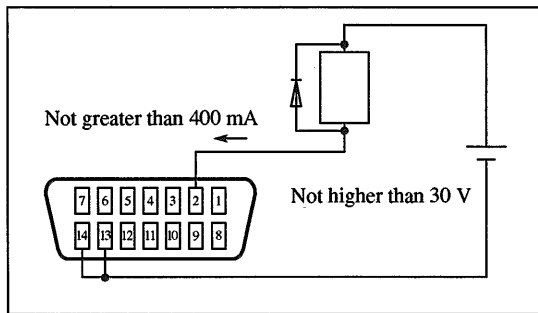
Properties of the output signals delivered through the SIGNAL I/O connector (37) are as follows:

SIGNAL I/O	
Type of output	Open collector output
Output withstanding voltage	30V DC
Output saturation voltage	Approx. 1.1V, at 25°C (77°F)
Maximum output current	400mA (in total)
Isolation	Photocoupler (30V DC/30V rms AC MAX)
Pin layout	

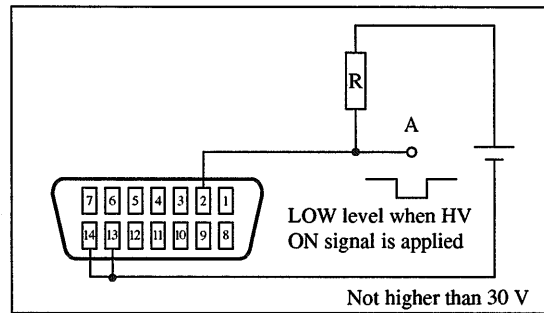




To drive a load (a relay, for example) with the H.V ON signal, prepare a setup as shown below.



To obtain a digital LOW level signal as driven by the H.V ON signal, for example, prepare a setup as shown below.



**Caution**

- The common lines of these output signal circuits are connected to those of the input signal circuits of the SIGNAL I/O connector.
- When driving an inductive load (such as a relay), be sure to connect a diode in parallel to the coil of the load.
- The open-collector circuit elements and board can be damaged if the output circuit is shorted. It is recommended to provide a protective fuse in the output circuit.
- The internal control circuits of the Tester has been designed to be resistant against interference by noise generated by the Tester and its peripheral devices. However, it is not recommendable to connect non-shielded wires to the pins of the SIGNAL I/O connector. Such wires may act as antennas and may cause interference to the devices.

For the mating plug of the 14-pin Amphenol connector plug, cables, and external circuits, use a shielded metallic 14-pin Amphenol connector plug, shielded cables, and external circuits fabricated in a shielded casing. Connect the chassis of the Tester to that of the external device. (Do not connect the ISOL COM pins to the shielding line or an earth ground.) This will isolate the SIGNAL I/O circuits from the external environments and will become more resistant against noise.

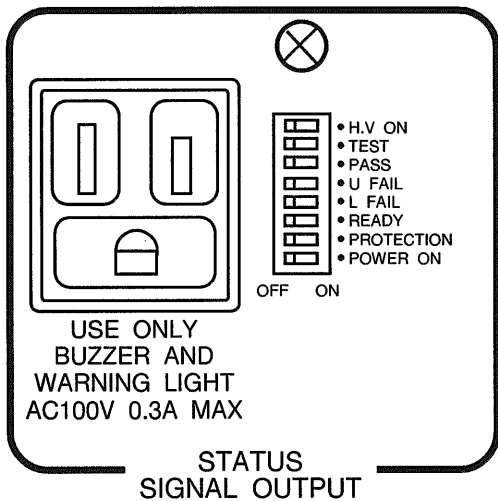
- Lay the control signal wires apart (more than 500 mm) from the H.V test leadwire and DUT. Never let the H.V test leadwire shorted to a signal wire — if you do it, it may utterly damage the internal circuits of the Tester.

### 6.4.2 Output Signal of STATUS SIGNAL OUTPUT receptacle ③

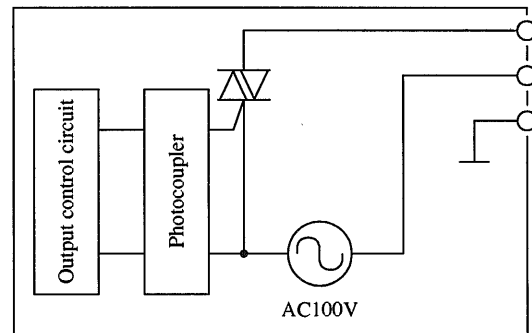
This is a 100 V AC signal with which to drive the optional Warning Light Unit or the Buzzer Unit. The status signal is delivered when the corresponding status has occurred if one of the DIP switches is set to ON. If two or more switches are set to ON, the status signal is delivered on the logical sum of the corresponding statuses. If you set both Switches 4 and 5 to ON, the status signal output is delivered when both upper fail and lower fail have occurred simultaneously. If you set Switch 8 to ON, the status signal output is delivered during the period the Tester power is ON.

Status Signal Output		
Conditions for delivery of status signal	Properties of Status Signal	
Select one of the DIP switches shown below, and the status signal will be delivered when the corresponding status has occurred. If you select two or more switches, the status signal will be delivered upon logical sum of the corresponding statuses.	Type of signal	Transformer (Triac) output signal
	Output voltage	Approx. 100V AC
	Leak current	1mA or less
	Maximum output current	0.3A
	Isolation	Photocoupler
	1. H.V ON      5. L FAIL 2. TEST        6. READY 3. PASS        7. PROTECTION 4. U FAIL      8. POWER ON	

Rear panel



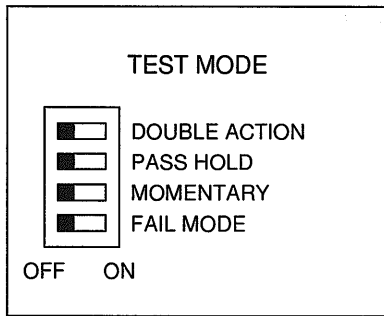
Internal circuit



**Caution**

- Even when the Tester is operating on an AC line voltage of other than nominal 100V AC, the status signal output delivered through the STATUS SIGNAL output receptacle ③ is 100V AC.

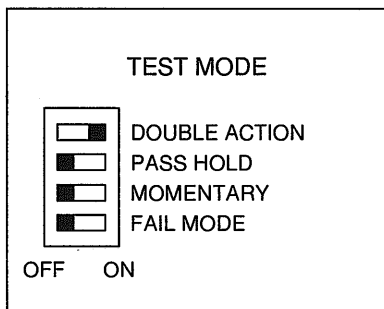
## 6.5 Settings for Special Test Modes



Four special test modes are selectable with the DIP switches. The factory-default settings of these switches as the Tester is shipped from the factory are as shown in the left. You may select two or more modes in combination.

The Tester reads the switch settings when its POWER switch is turned ON. So, when you have changed the settings, turn OFF once the POWER switch and then turn it ON again.

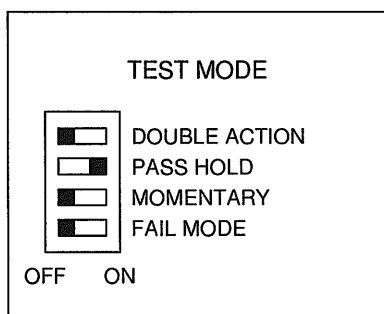
### 6.5.1 DOUBLE ACTION Switch



If you set this switch to ON, the Tester does not start the test operation unless you press the **START** switch ② within approximately 0.5 seconds after releasing the **STOP** switch ③. When more than 0.5 seconds has elapsed, the test operation cannot be started with the **START** switch ② alone. It can be started by double actions — namely, by pressing the **STOP** switch ③ and then the **START** switch ② in close successions — thereby enhancing the safety of test although the procedure is a little more sophisticated.

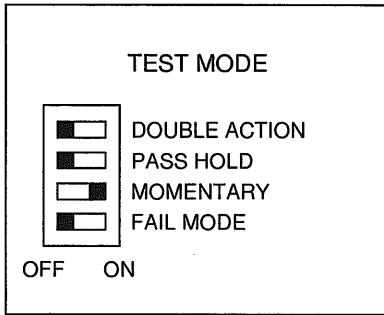
This function is applicable also when in the remote control mode.

### 6.5.2 PASS HOLD Switch



If you set this switch to ON, the Tester does not reset to the READY status within approximately 200 milliseconds after the PASS judgement is made. To reset to the READY status you need to press the **STOP** switch ③ or apply a STOP signal from the remote control circuit.

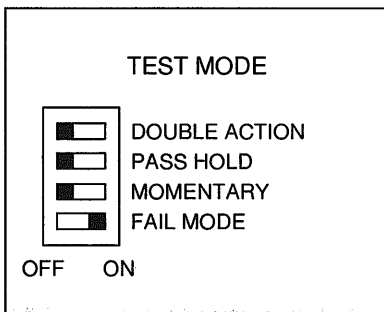
### 6.5.3 MOMENTARY Switch



If you set this switch to ON, the test is executed only during the period you keep pressed the **START** switch ②. As you release the switch, the test terminates. Thus, the safety of test is enhanced.

This function is applicable also when in the remote control mode. If you use this function together with the both-hand type Remote Control Box (RC02-TOS), the safety of test is enhanced still more.

### 6.5.4 FAIL MODE Switch



If you set this switch to ON, the Tester cannot be reset from the FAIL judgement or PROTECTION status with the STOP signal applied from the remote control circuit. To reset the Tester, you need to press the **STOP** switch ③.

You may use this function in order to be sure of the FAIL status or PROTECTION status when you are making tests with the optional High Voltage Test Probe (HP01A-TOS or HP02A-TOS).

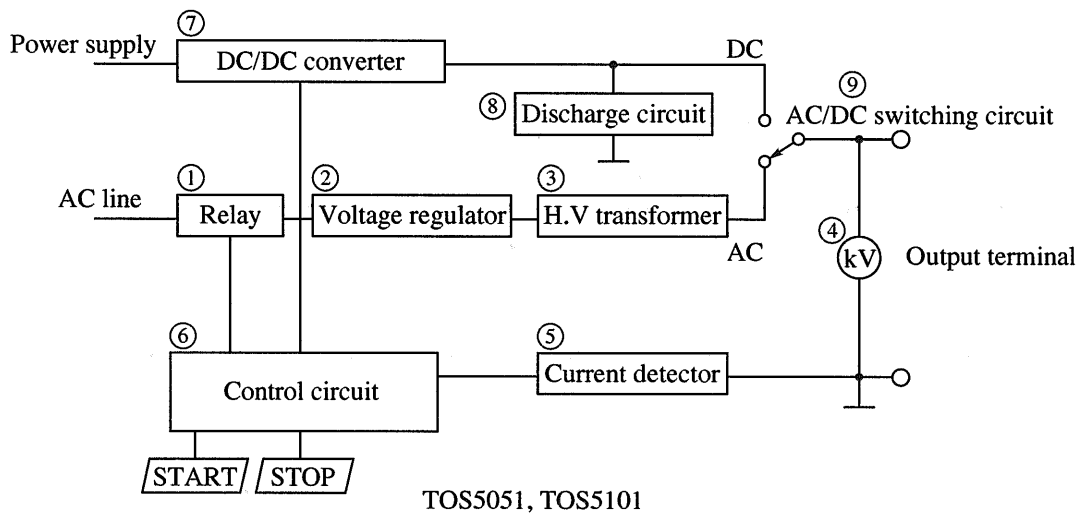
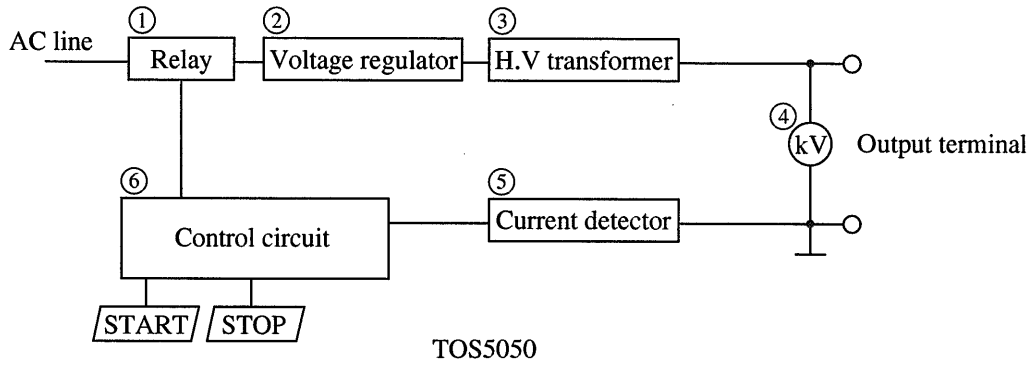
# Chapter 7

## OPERATING PRINCIPLE

This chapter describes the operating principle of the Tester.

Table of contents	Page
7.1 Block Diagrams .....	7-2
7.2 Componential Circuits and Devices .....	7-3
7.3 Zero-turn-on Switch .....	7-4
7.4 Delay Time for Pass/Fail Judgement in DC Mode .....	7-5
7.5 Automatic Discharge Function .....	7-5

### 7.1 Block Diagrams

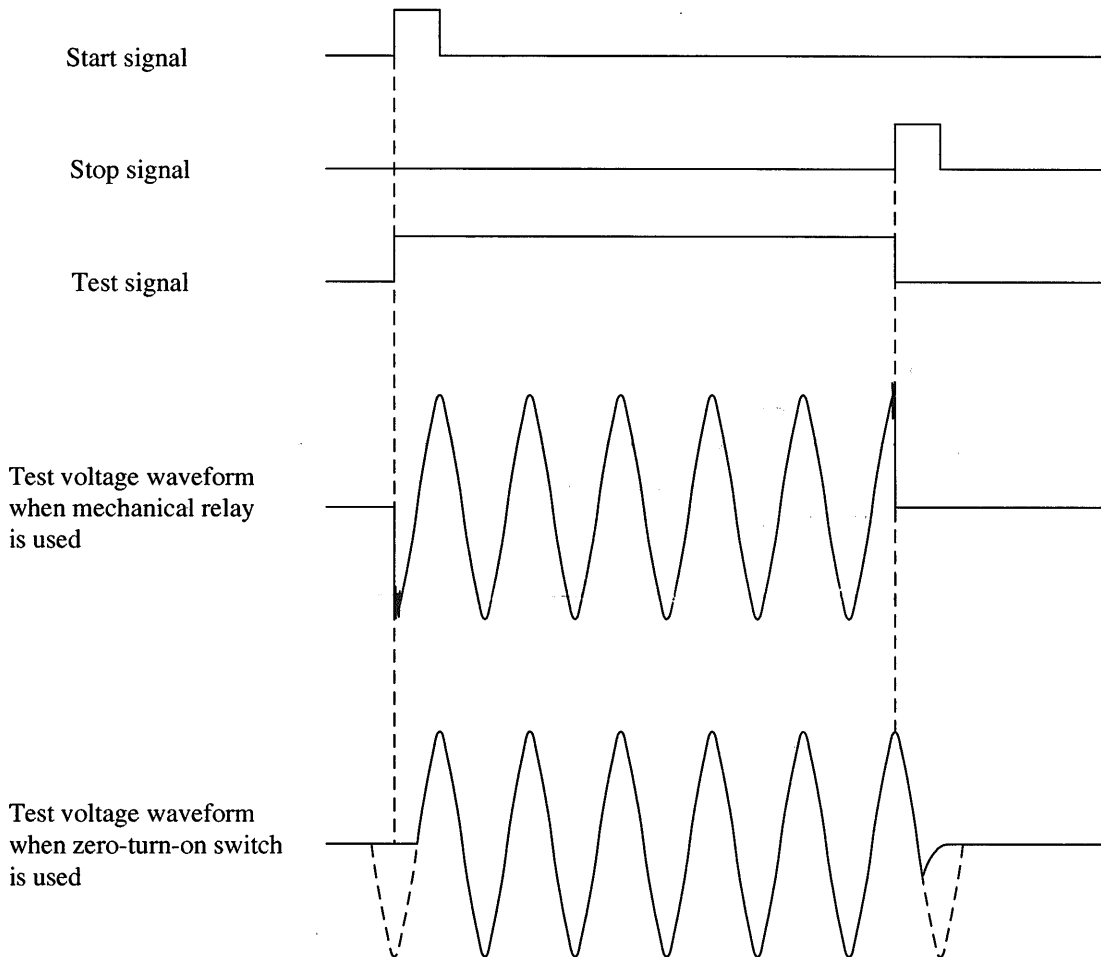


## 7.2 Componential Circuits and Devices

- |   |                          |  |
|---|--------------------------|--|
| ① | Relay                    | The relay turns ON/OFF the line power supplied to the voltage regulator for AC withstanding voltage test. The relay employs a solid-state zero-turn-on circuit to minimize transient spike voltages caused when the relay is turned on or off.   |
| ② | Voltage regulator        | A slide transformer is used to control the output voltage.   |
| ③ | High voltage transformer | The transformer boosts the voltage regulator output with a ratio of approximately 1:25 or 1:50 (approximately 1:50 or 1:100) into a high output voltage of 0 to 2.5kV or 0 to 5kV (0 to 5kV or 0 to 10kV). The AC rating is 5kV, 100mA (10kV, 50mA), 500 VA. (These stand when the AC line voltage is at its nominal voltage.) (The values enclosed in the parentheses are for TOS5101.)   |
| ④ | Voltmeter                | The voltmeter indicates the output voltage (the voltage of the output terminal).   |
| ⑤ | Current detector         | The current detector measures the leakage current. It consists of an absolute-value circuit, current detecting resistors, and an integrating circuit.  |
| ⑥ | Control circuit          | The circuit controls overall operation of the Tester, including voltage measurement, current measurement, pass/fail judgement, test time management, and test sequence control. The circuit is fabricated on an 8-bit one-chip CPU.  |
| ⑦ | DC/DC converter          | The converter provides a stable high voltage for the DC mode of test. Its rating is 5kV, 10mA (10kV, 5mA for TOS5101) when the AC line voltage is at its nominal voltage.  |
| ⑧ | Discharge circuit        | When in the DC mode of test, the test leadwires, probe, DUT and other items connected to the output circuit can be charged up to the high DC test voltage. Even after the test is over and the test voltage is cut off, these items can remain in the charged state for a substantial period of time. The discharge circuit is to rapidly discharge the charges stored in these items. The circuit consists of a high voltage relay and a discharge resistor (125k $\Omega$ for TOS5051 and 500k $\Omega$ for TOS5101).<br><br>When the output voltage is cut off, the discharge circuit is automatically brought into effect and it discharges the internal output circuit of the Tester, test leadwires, probe, and DUT. |
| ⑨ | AC/DC switching circuit  | This is a high voltage rotary switch which selects either the AC or DC test voltage.   |

### 7.3 Zero-turn-on Switch

If a regular mechanical contact type relay is used for on-off control operation of the primary circuit of the high voltage transformer, transient spike voltages may be produced, thereby applying an abnormal high voltage to the DUT and causing a possibility of rejecting an acceptable DUT or damaging it. The zero-turn-on switch, which employs a solid-state switching circuit, turns on and off the power line at approximately 0 volt level, thereby reducing transient overshoots.



**Caution**

- Be sure to observe the following instructions when using a High Voltage Test Probe (HP01A-TOS or HP02A-TOS).

*Do not connect the probe to or disconnect it from the DUT while letting it deliver the test voltage. If you do this, the effects of the “zero” switching may be spoiled and the DUT may be damaged. Be sure to turn-on the test voltage after connecting the probe to the DUT and to disconnect the probe from the DUT after turning-off the test voltage.*



## 7.4 Delay Time for Pass/Fail Judgement in DC Mode

When testing in the DC mode a DUT which has a larger capacitance, the DUT will draw a larger initial charge current. Lest the pass/fail judgement should be affected by this current, a delay time is rendered before making the pass/fail judgement. The delay time is set at approximately 0.3 seconds.

## 7.5 Automatic Discharge Function

When in the DC mode of test, the test leadwires, probe, DUT and other items connected to the output circuit can be charged up to the high DC test voltage. Even after the test is over and the test voltage is cut off, these items can remain in the charged state for a substantial period of time. The discharge circuit is to rapidly discharge the charges stored in these items. When the output voltage is cut off, the discharge circuit is automatically brought into effect and it rapidly discharges the internal output circuit of the Tester, test leadwires, probe, and DUT.

### **Caution**

- *Be sure to observe the following instructions when using a High Voltage Test Probe (HP01A-TOS or HP02A-TOS).*

*Do not disconnect the probe from the DUT while letting it deliver the test voltage. If you do this, the effects of the automatic discharge circuit may be lost and the items on the output circuit may remain charged up to the high test voltage. Before disconnecting the probe from the DUT, be sure that the LED on the top of the Test Probe has gone out.*



# Chapter 8

## MAINTENANCE

This chapter describes the maintenance procedures for the Tester.

Table of contents	Page
8.1 Cleaning the Outer Surfaces .....	8-2
8.2 Checking the Cord and Leadwires .....	8-2
8.2.1 Checking the AC Power Cable .....	8-2
8.2.2 Checking the HV Test Leadwires .....	8-2
8.2.3 Overhaul .....	8-3
8.3 Calibration.....	8-3

To make the best use of the Tester, have your Tester subjected to periodical maintenance, inspection and calibration services as described in this chapter.

**Caution**

- *The Tester generates a hazardously high voltage of 5kV (10kV). Never attempt to calibrate the Tester for yourself. For such service, contact your Kikusui agent.*

## 8.1 Cleaning the Outer Surfaces

When the panels of the Tester has become dirty, clean them by wiping them with a soft cloth moistened with neutral soapsuds.

**Caution**

- *Be sure to turn OFF the power of the Tester before start cleaning it.*
- *Never use benzine, thinner or other volatile detergent for cleaning the Tester. If you do, the panels may be discolored, letters printed on the panels may be erased, the display screen may become cloudy, and finishing of the top panel and rear panel may peel off.*

## 8.2 Checking the Cord and Leadwires

### 8.2.1 Checking the AC Power Cable

Check the AC input power cable for broken sheath and for loose or cracked plug.

### 8.2.2 Checking the HV Test Leadwires

Check the HIGH and LOW test leadwires each time before using them, in order to be sure of the following:

1. Visually inspect the leadwires and be sure that they have no indications of broken sheaths or other signs of damage.
2. Electrically check that the leadwires are not open-circuited (by using a circuit tester or other instrument).

**WARNING**

- *If the test leadwire is damaged (its sheath is damaged or its core wire is open-circuited), it can be a cause of electric shock hazards. Never use imperfect test leadwires.*

### 8.2.3 Overhaul

**WARNING**

- *For the sake of your safety, never attempt to overhaul the Tester for yourself. Please order your Kikusui agent for such service.*

#### High Voltage Relay

The high voltage relay of the internal discharge circuit (for TOS5101 and TOS5051 only) is a wearable component. In this regard, it is recommended to order your Kikusui agent to overhaul the Tester at every approximately 200,000 repetitions of DC tests (although the service intervals may differ depending on the conditions of use).

#### Cooling Fan

The cooling fan (for TOS5101 and TOS5051 only) is a wearable component. In this regard, it is recommended to order your Kikusui agent to overhaul the Tester at every approximately 30000 hours of run time (although the service intervals may differ depending on the conditions of use).

## 8.3 Calibration

The Tester should be calibrated at appropriate intervals.

**Caution**

- *The Tester generates a hazardously high voltage of 5kV (10kV). Never attempt to calibrate the Tester for yourself. For such service, contact your Kikusui agent.*



# Chapter 9

## SPECIFICATIONS

This chapter indicates the specifications of Models TOS5101, TOS5051, and TOS5050.

Table of contents	Page
9.1 TOS5050 .....	9-2
9.2 TOS5101 and TOS5051 .....	9-9
9.3 Overall Dimensions .....	9-18
9.3.1 Dimensions of Models TOS5050 and TOS5051 .....	9-18
9.3.2 Dimensions of Model TOS5101 .....	9-18

## 9.1 TOS5050

Model		TOS5050	
Test voltage	Applied voltage		0 to 2.5 or 0 to 5kV AC
	Output rating (Note 1)		500VA/5kV, 100mA (with nominal AC line voltage)
	Transformer rating		500VA
	Short-circuit current (Note 2)		200 mA or more (when the output voltage is 900 V or more at 2.5 kV range or 1.3 kV or more at 5 kV range.)
	Waveform (Note 3)		AC line voltage waveform
	Voltage regulation (with nominal AC line voltage)		15% or better (against change from maximum rated load to no load)
	Switching		With zero-turn-on (zero-start) switch
Output voltmeters	Analog voltmeter	Scale	5kV fs (no mirror)
		Class	JIS Class 2.5
		Accuracy	$\pm 5\%$ fs
		Response, graduation	Mean-value response, rms-value graduation
	Digital voltmeter	Full scale	2.5kV/5kV fs
		Accuracy	$\pm 1.5\%$ fs
		Response, display	Mean-value response, rms-value display
Ammeter	Digital ammeter	Accuracy	$\pm [(5\% \text{ of upper cutoff current}) + 20\mu\text{A}]$
		Response, display	Mean-value response, rms-value display
Pass/fail judgement	Type of judgement		<ul style="list-style-type: none"> <li>Window comparator type</li> <li>If the current detected is larger than the preset upper cutoff current, the Tester gives a FAIL judgement.</li> <li>If the current detected is less than the preset lower cutoff current, the Tester gives a FAIL judgement.</li> <li>As the Tester gives a FAIL judgement, it cuts off the output and delivers a FAIL signal.</li> <li>If the test period elapses without any unacceptable conditions, the Tester gives a PASS judgement.</li> </ul>
	Upper cutoff current setting range		0.1 to 110mA
	Lower cutoff current setting range		0.1 to 110mA
	Judgement accuracy		$\pm [(5\% \text{ of upper cutoff current}) + 20\mu\text{A}]$ (Note 4)
	Current detection		The absolute value of current is integrated and compared with the preset cutoff current value.
	Calibration		Calibrated for r.m.s, value of sine wave, with pure-resistive load
	No-load output voltage		Approx. 460V, at 100mA setting required for detection (Note 5)
Test time	Setting range		0.5 to 999 s. (with Timer-off function)
	Accuracy		$\pm 20$ ms

\*JIS: Japanese Industrial Standards



Note 1: Pay attention to the limitations on output voltage delivery time as follows: The heat dissipation of the high voltage generator section of the Tester is one-half of the normal wattage with respect to the rated output from the viewpoints of size, weight, and cost of the Tester. Due to this, be sure to operate the Tester within the limits shown in the below tables. If you operate the Tester exceeding these limits, the thermal fuse in the Tester may blow out.

TOS5050			
Ambient temperature t	Upper cutoff current I (mA)	Pause period	Maximum allowable continuous test period
t ≤ 40°C (t ≤ 104°F)	50 < I ≤ 110	Not less than test period	≤ 30 min
	I ≤ 50	Not required	Infinite

Note 2: When the nominal power supply voltage can be maintained with the output shorted.

Note 3: Test voltage waveform:

When an AC test voltage is applied to a capacitive DUT, it is possible that the voltage becomes higher even than that when in the no load state. Furthermore, waveform distortion also may occur if the capacitance of the DUT is voltage-dependent (such as of ceramics capacitors). When the test voltage is not higher than 1.5kV and the capacitance is not larger than 1000 pF, such test voltage changes are only of negligible levels.

Note 4: When in the AC mode, the current which flows through the stray capacitances of the test leadwires, test jigs, and other items on the test circuit also causes measuring errors. The total judgement accuracy is the sum of this current and the above-mentioned judgement accuracy. Approximate values of such currents are shown in the following table. Note that, in high-sensitivity high-voltage test, the current which flows through the stray capacitances may become larger than the preset lower cutoff current and the LOWER PASS/FAIL judgement may not be successfully done.

Output voltage	1kV	2kV	3kV	4kV	5kV
When 350-mm-long test leadwires are used being suspended in air	2μA	4μA	6μA	8μA	10μA
When accessory test leadwires TL01-TOS are used (typical)	16μA	32μA	48μA	64μA	80μA

When other test leadwires than the above are used, the values of the currents may differ depending on the conditions.

Note 5: In order to be able to make a FAIL judgement when in the state that the output terminals are shorted, a certain minimal level of no-load output voltage is necessary due to the internal resistance of the output circuit. This item indicates such minimal output voltage.

Model		TOS5050
Ambient temperature and humidity	Specification range	5 to 35°C (41 to 95°F), 20 to 80% RH
	Operable range	0 to 40°C (32 to 104°F), 20 to 80% RH
	Storage range	-20 to 70°C (-4 to 158°F), ≤ 80% RH
SAFETY (Note 6)		<p>Conforms to the requirements of the following standard.</p> <ul style="list-style-type: none"> <li>• UL1244 (The UL-approved products with input voltage of 120VAC satisfy the UL1244 standard.)</li> </ul>
Electromagnetic compatibility (EMC) (Note 6)		<p>Conforms to the requirements of the following standard.</p> <p>EN61326</p> <p><b>Under following conditions</b></p> <ol style="list-style-type: none"> <li>1. Used HV test leadwires which is supplied.</li> <li>2. No discharge in testing.</li> <li>3. Used the shielded cable which length is less than three meters when the SIGNAL I/O is used.</li> </ol>
AC line power requirements	Voltage and frequency	<p>100V±10%, 50/60 Hz</p> <p>(Factory modification options: Nomal 110/120/220/230/240V)</p>
	<p>Power consumption</p> <p>Without load (READY status)</p> <p>100V line ≤ 15VA</p> <p>110V line ≤ 20VA</p> <p>120V line ≤ 20VA</p> <p>220V line ≤ 25VA</p> <p>230V line ≤ 25VA</p> <p>240V line ≤ 25VA</p> <p>With rated load</p> <p>100V line Approx. 600VA</p> <p>110V line Approx. 600VA</p> <p>120V line Approx. 600VA</p> <p>220V line Approx. 610VA</p> <p>230V line Approx. 640VA</p> <p>240V line Approx. 610VA</p>	

Model	TOS5050
Insulation resistance	$\geq 30M\Omega$ , with 500V DC
Withstanding voltage	1390 V AC (2 seconds), between AC line and chassis
	1200V AC (1 second), UL-approved products only
Dimensions Excluding protrusions	320 W $\times$ 132 H $\times$ 300 D mm (12.6 W $\times$ 5.20 H $\times$ 11.8 D in.)
Including protrusions	320 W $\times$ 150 H $\times$ 365 D mm (12.6 W $\times$ 5.91 H $\times$ 14.4 D in.)
Weight (Note 7)	15 kg (33 lbs)

Note 6: Not applicable to custom order models.

Note 7: When a Tester is modified to operate on an optional AC line voltage by factory modification, the Tester will become heavier by approximately 2 kg (4.41 lbs) for the 110/120V line or by approximately 3 kg (6.61 lbs) for the 220/230/240V line.

Model	TOS5050	
Remote control function	The Tester has the following provisions for remote-control of test start/stop.	
	REMOTE connector (5-pin DIN connector, on front panel)	<ul style="list-style-type: none"> <li>• To control the Tester from an optional Remote Control Box RC01-TOS or RC02-TOS.</li> <li>• To control the Tester from an optional High Voltage Test Probe HP01A-TOS or HP02A-TOS (when the test voltage is less than 4kV rms AC or 5kV DC).</li> </ul>
Interlock	SIGNAL I/O connector (14-pin Amphenol connector, on rear panel)	<ul style="list-style-type: none"> <li>• To control the Tester from a make-contact device (such as a relay or a switch).</li> <li>• To control the Tester with a low-active control signal from a logic circuit.</li> </ul> <p>Conditions of low-active control signal (Note 8):</p> <ul style="list-style-type: none"> <li>• High level input voltage : 11 to 15V</li> <li>• Low level input voltage : 0 to 4V</li> <li>• Low level input current : -5mA Max.</li> <li>• Input time requirement : ≥ 5 ms.</li> </ul>
	The Tester accepts an interlock input signal applied through function the SIGNAL I/O connector (14-pin Amphenol connector on the rear panel). When this signal is applied, the Tester drives itself into the PROTECTION status.	

Note 8: SIGNAL I/O input

The control signal input circuits are isolated from other internal circuits, except that the common lines of the input circuits are directly connected to those of the signal output circuits. The ratings are 30V DC, 30V rms AC MAX.

The input terminals are pulled up to +15V with resistors. To make the input terminals open is equivalent to that the high level signals are applied to the terminals.

## Signal Output Functions

Signal Name	Conditions for Signal Generation	Types of Signals
H.V ON	During the test time (period the Tester delivers the test voltage)	Open-collector signal (Note 9), DANGER lamp
TEST	During the test time (period the Tester delivers the test voltage)	Open-collector signal (Note 9), Vacuum Fluorescent Display
PASS	For PASS judgement. Delivered for approximately 0.2 s.	Open-collector signal (Note 9), Vacuum Fluorescent Display, buzzer (Note 10)
U FAIL	For U FAIL judgement (detected current is larger than upper cutoff current)	Open-collector signal (Note 9), Vacuum Fluorescent Display, buzzer (Note 10)
L FAIL	For L FAIL judgement (detected current is less than lower cutoff current)	Open-collector signal (Note 9), Vacuum Fluorescent Display, buzzer (Note 10)
READY	When the Tester is ready to execute the test	Open-collector signal (Note 9), Vacuum Fluorescent Display
PROTECTION	When the Tester is in the PROTECTION status	Open-collector signal (Note 9), Vacuum Fluorescent Display
STATUS SIGNAL OUTPUT	When one of the DIP switches for the following items is set to ON and the corresponding status has occurred. If two or more items are set to ON, the signal is delivered on the logical sum of such items.  1: H.V ON 2: TEST 3: PASS 4: U FAIL 5: L FAIL 6: READY 7: PROTECTION 8: POWER ON	100V AC (Note 11) (even when the AC line voltage is other than 100V)

Note 9: The ratings of the open-collector signal are 4.5 to 30V DC, 400mA (maximum, in total). The above open-collector output circuits are isolated from other internal circuits, except that the common lines of the output circuits are directly connected to those of the signal input circuits. The common lines of all open-collector circuits are connected together. The ratings are 30V DC, 30V rms AC MAX.

Note 10: Loudness of the buzzer for PASS/FAIL annunciations can be controlled with the buzzer control. It is in common for both PASS and FAIL annunciations — it does not control them separately.

Note 11: The ratings of the STATUS OUTPUT signal are 100V AC, 0.3A (maximum).

## Accessories

Item	Q'ty	Remarks
AC input power cable	1	
H.V test leadwires TL01-TOS (1.5 meters long)	1 set	
14-pin Amphenol plug	1	Assembly type
“DANGER! HIGH VOLTAGE” sticker	1	
Operation manual	1	
AC power fuses	2	In fuse holder cap (one for present use and the other for spare)

## 9.2 TOS5101 and TOS5051

Model			TOS5101	TOS5051	
Test voltage	Applied voltage		AC/DC		
			0 ~ 5/0 ~ 10kV	0 ~ 2.5/0 ~ 5KV	
	AC	Output rating (Note 1)	500VA/10kV, 50mA (with nominal line voltage)	500VA/5kV, 50mA (with nominal line voltage)	
		Transformer rating	500VA		
		Short-circuit current (Note 2)	200 mA or more (when the output voltage is 4 kV or more at 5 kV range or 6 kV or more at 10 kV range)	200 mA or more (when the output voltage is 900 V or more at 2.5 kV range or 1.3 kV or more at 5 kV range)	
		Waveform (Note 3)	AC line voltage waveform		
		Voltage regulation (with nominal line voltage)	15% or better (against change from maximum rated load to no load)		
		Switching	With zero-turn-on (zero-start) switch		
		DC	Output rating (Note 4)	50W/10kV, 5mA (with nominal line voltage)	50W/5kV, 10mA (with nominal line voltage)
	Ripple		At 10kV, no load: 100Vp-p typical	At 5kV, no load: 50Vp-p typical	
			At rated max. output: 200 Vp-p typical	At rated max. output: 100Vp-p typical	
	Voltage regulation (with nominal line voltage)		3% or better (against change from maximum rated load to no load)		
	Output voltmeters	Analog voltmeter	Scale	Common for AC/DC	
				10kV fs (no mirrors)	5kV fs (no mirrors)
Class			JIS Class 2.5		
Accuracy			±5% fs		
AC indication		Mean-value response, rms-value graduation			
Digital voltmeter		Full scale	5kV/10kV fs	2.5kV/5kV fs	
		Accuracy	±1.5% fs		
	AC response	Mean-value response, rms-value display			
Ammeter	Digital ammeter	Accuracy	±[(5% of upper cutoff current) + 20μA]		
		AC response	Mean-value response, rms-value display		

\*JIS : Japanese Industrial Standards

Note 1: Pay attention to the limitations on AC output voltage delivery time as follows: The heat dissipation of the high voltage generator section of the Tester is one-half of the normal wattage with respect to the rated output from the viewpoints of size, weight, and cost of the Tester. Due to this, be sure to operate the Tester within the limits shown in the below tables. If you operate the Tester exceeding these limits, the thermal fuse in the Tester may blow out.

TOS5101			
Ambient temperature t	Upper cutoff current I (mA)	Pause period	Maximum allowable continuous test period
t ≤ 40°C (t ≤ 104°F)	25 < I ≤ 55	Not less than test period	≤ 30 min
	I ≤ 25	Not required	Infinite

TOS5051			
Ambient temperature t	Upper cutoff current I (mA)	Pause period	Maximum allowable continuous test period
t ≤ 40°C (t ≤ 104°F)	50 < I ≤ 110	Not less than test period	≤ 30 min
	I ≤ 50	Not required	Infinite

Note 2: When the nominal power supply voltage can be maintained with the output shorted.

Note 3: Test voltage waveform:

When an AC test voltage is applied to a capacitive DUT, it is possible that the voltage becomes higher even than that when in the no load state. Furthermore, waveform distortion also may occur if the capacitance of the DUT is voltage-dependent (such as of ceramics capacitors). When the test voltage is not higher than 1.5kV and the capacitance is not larger than 1000 pF, however, such test voltage changes are only of negligible levels.

Note 4: The heat dissipation of the high voltage generator of the DC test section is one-tenth of the normal wattage with respect to the rated output from the viewpoint of size, weight, and cost of the Tester. Due to this, when operating the Tester, provide pause periods shown in the tables below. If you operate the Tester beyond these limits, the high voltage generator will be overheated and the protector may trip and the Tester may be driven into the PROTECTION status. When this has occurred, pause the test operation until the Tester cools off and then resume the test operation. As the Tester is cooled off and the cause of the PROTECTION status is eliminated, the Tester resumes its normal operating state.



TOS5101			
Ambient temperature t	Upper cutoff current I (mA)	Pause period	Maximum allowable continuous test period
$t \leq 30^{\circ}\text{C}$ ( $t \leq 86^{\circ}\text{F}$ )	$3 < I \leq 5.5$	At least 5 times of test period	$\leq 30$ s
	$3 < I \leq 5.5$	At least 10 times of test period	$\leq 60$ s
	$1.5 < I \leq 3$	At least 4 times of test period	$\leq 120$ s
	$0.5 < I \leq 1.5$	At least twice of test period	$\leq 120$ s
	$I \leq 0.5$	Not required	Infinite
	At $t \leq 25^{\circ}\text{C}$ , infinitive continuous operation is allowable with cutoff current of up to 1 mA.		
$30^{\circ}\text{C} < t \leq 35^{\circ}\text{C}$ ( $86^{\circ}\text{F} < t \leq 95^{\circ}\text{F}$ )	$3 < I \leq 5.5$	At least 10 times of test period	$\leq 15$ s
	$1.5 < I \leq 3$	At least 4 times of test period	$\leq 30$ s
	$1 < I \leq 1.5$	At least twice of test period	$\leq 60$ s
	$0.5 < I \leq 1$	At least twice of test period	$\leq 120$ s
	$I \leq 0.5$	Not required	Infinite
$35^{\circ}\text{C} < t \leq 40^{\circ}\text{C}$ ( $95^{\circ}\text{F} < t \leq 104^{\circ}\text{F}$ )	$0.5 < I \leq 1.5$	At least 10 times of test period	$\leq 15$ s
	$I \leq 0.5$	Not required	Infinite

TOS5051			
Ambient temperature t	Upper cutoff current I (mA)	Pause period	Maximum allowable continuous test period
$t \leq 30^{\circ}\text{C}$ ( $t \leq 86^{\circ}\text{F}$ )	$6 < I \leq 11$	At least 5 times of test period	$\leq 30$ s
	$6 < I \leq 11$	At least 10 times of test period	$\leq 60$ s
	$3 < I \leq 6$	At least 4 times of test period	$\leq 120$ s
	$1 < I \leq 3$	At least twice of test period	$\leq 120$ s
	$I \leq 1$	Not required	Infinite
	At $t \leq 25^{\circ}\text{C}$ , infinitive continuous operation is allowable with cutoff current of up to 2 mA.		
$30^{\circ}\text{C} < t \leq 35^{\circ}\text{C}$ ( $86^{\circ}\text{F} < t \leq 95^{\circ}\text{F}$ )	$6 < I \leq 11$	At least 10 times of test period	$\leq 15$ s
	$3 < I \leq 6$	At least 4 times of test period	$\leq 30$ s
	$2 < I \leq 3$	At least twice of test period	$\leq 60$ s
	$1 < I \leq 2$	At least twice of test period	$\leq 120$ s
	$I \leq 1$	Not required	Infinite
$35^{\circ}\text{C} < t \leq 40^{\circ}\text{C}$ ( $95^{\circ}\text{F} < t \leq 104^{\circ}\text{F}$ )	$1 < I \leq 3$	At least 10 times of test period	$\leq 15$ s
	$I \leq 1$	Not required	Infinite

Model		TOS5101	TOS5051
Pass/fail judgement	Type of judgement	<ul style="list-style-type: none"> <li>Window comparator type</li> <li>If the current detected is larger than the preset upper cutoff current, the Tester gives a FAIL judgement.</li> <li>If the current detected is less than the preset lower cutoff current, the Tester gives a FAIL judgement.</li> <li>As the Tester gives a FAIL judgement, it cuts off the output and delivers a FAIL signal.</li> <li>If the test period elapses without any unacceptable conditions, the Tester gives a PASS judgement.</li> </ul>	
	Upper cutoff current setting range	0.1 to 55mA AC 0.1 to 5.5mA DC	0.1 to 110mA AC 0.1 to 11mA DC
	Lower cutoff current setting range	0.1 to 55mA AC 0.1 to 5.5mA DC	0.1 to 110mA AC 0.1 to 11mA DC
	Judgement accuracy	$\pm[(5\% \text{ of upper cutoff current}) + 20\mu\text{A}]$ (Note 5)	
	Current detection	The absolute value of current is integrated and compared with the preset cutoff current value.	
	Calibration	Calibrated for r.m.s. value of sine wave, with pure-resistive load	
	No-load output voltage required for detection (Note 6)	Approx. 970V when at 50mA AC setting Approx. 160V when at 5mA DC setting	Approx. 460V when at 100mA AC setting Approx. 100V when at 10mA DC setting
Test time	Setting range	0.5 to 999 s. (with Timer-off function)	
	Accuracy	$\pm 20$ ms	

Note 5: When in the AC mode, the current which flows through the stray capacitances of the test leadwires, test jigs, and other items on the test circuit also causes measuring errors. The total judgement accuracy is the sum of this current and the above-mentioned judgement accuracy. Approximate values of such currents are shown in the following table. Note that, in high-sensitivity high-voltage test, the current which flows through the stray capacitances may become larger than the preset lower cutoff current and the LOWER PASS/FAIL judgement may not be successfully done.

Output voltage	1kV	2kV	3kV	4kV	5kV	10kV
When 350-mm-long test leadwires are used being suspended in air (typical values)	$2\mu\text{A}$	$4\mu\text{A}$	$6\mu\text{A}$	$8\mu\text{A}$	$10\mu\text{A}$	$20\mu\text{A}$
When accessory test leadwires TL03-TOS are used (typical values)	$16\mu\text{A}$	$32\mu\text{A}$	$48\mu\text{A}$	$64\mu\text{A}$	$80\mu\text{A}$	$160\mu\text{A}$

When other test leadwires than the above are used, the current may differ depending on the conditions of use.

Note 6: In order to be able to make a FAIL judgement when in the state that the output terminals are shorted, a certain minimal level of no-load output voltage is necessary due to the internal resistance of the output circuit. This item indicates such minimal output voltage.

Model		TOS5101																							
Ambient temperature and humidity	Specification range	5 to 35°C (41 to 95°F), 20 to 80% RH																							
	Operable range	0 to 40°C (32 to 104°F), 20 to 80% RH																							
	Storage range	-20 to 70°C (-4 to 158°F), ≤ 80% RH																							
SAFETY (Notes 7 and 8)		<p>Conforms to the requirements of the following directive and standard.</p> <ul style="list-style-type: none"> <li>• Low Voltage Directive 2006/95/EC</li> <li>• EN 61010-1 Pollution degree 2</li> <li>• UL1244 (The UL-approved products with input voltage of 120VAC satisfy the UL1244 standard.)</li> </ul>																							
Electromagnetic compatibility (EMC) (Note 7)		<p>Conforms to the requirements of the following directive and standard.</p> <p>EMC Directive 2004/108/EC EN 61326-1 EN 61000-3-2 EN 61000-3-3</p> <p>Under following conditions</p> <ol style="list-style-type: none"> <li>1. Used HV test leadwires which is supplied.</li> <li>2. No discharge in testing.</li> <li>3. Used the shielded cable which length is less than three meters when the SIGNAL I/O is used.</li> </ol>																							
AC line power requirements	Voltage and frequency	100V±10%, 50/60 Hz (Factory modification options: Nominal 110/120/220/230/240V)																							
	Power consumption Without load (READY status) <table style="width: 100%; border: none;"> <tr><td style="width: 60%;">100V line</td><td style="text-align: right;">≤ 30VA</td></tr> <tr><td>110V line</td><td style="text-align: right;">≤ 40VA</td></tr> <tr><td>120V line</td><td style="text-align: right;">≤ 40VA</td></tr> <tr><td>220V line</td><td style="text-align: right;">≤ 50VA</td></tr> <tr><td>230V line</td><td style="text-align: right;">≤ 50VA</td></tr> <tr><td>240V line</td><td style="text-align: right;">≤ 50VA</td></tr> </table> With rated load <table style="width: 100%; border: none;"> <tr><td style="width: 60%;">100V line</td><td style="text-align: right;">Approx. 600VA</td></tr> <tr><td>110V line</td><td style="text-align: right;">Approx. 600VA</td></tr> <tr><td>120V line</td><td style="text-align: right;">Approx. 600VA</td></tr> <tr><td>220V line</td><td style="text-align: right;">Approx. 610VA</td></tr> <tr><td>230V line</td><td style="text-align: right;">Approx. 610VA</td></tr> <tr><td>240V line</td><td style="text-align: right;">Approx. 610VA</td></tr> </table>	100V line	≤ 30VA	110V line	≤ 40VA	120V line	≤ 40VA	220V line	≤ 50VA	230V line	≤ 50VA	240V line	≤ 50VA	100V line	Approx. 600VA	110V line	Approx. 600VA	120V line	Approx. 600VA	220V line	Approx. 610VA	230V line	Approx. 610VA	240V line	Approx. 610VA
100V line	≤ 30VA																								
110V line	≤ 40VA																								
120V line	≤ 40VA																								
220V line	≤ 50VA																								
230V line	≤ 50VA																								
240V line	≤ 50VA																								
100V line	Approx. 600VA																								
110V line	Approx. 600VA																								
120V line	Approx. 600VA																								
220V line	Approx. 610VA																								
230V line	Approx. 610VA																								
240V line	Approx. 610VA																								
Insulation resistance		≥ 30 MΩ, with 500V DC																							

Note 7: Only on models that have CE marking on the panel.

Not applicable to custom order models.

Note 8: This instrument is a Class I equipment. Be sure to ground the protective conductor terminal of the instrument. The safety of the instrument is not guaranteed unless the instrument is grounded properly.

Model		TOS5051																							
Ambient temperature and humidity	Specification range	5 to 35°C (41 to 95°F), 20 to 80% RH																							
	Operable range	0 to 40°C (32 to 104°F), 20 to 80% RH																							
	Storage range	-20 to 70°C (-4 to 158°F), ≤ 80% RH																							
SAFETY (Note 15)		<p>Conforms to the requirements of the following standard.</p> <ul style="list-style-type: none"> <li>• UL1244 (The UL-approved products with input voltage of 120VAC satisfy the UL1244 standard.)</li> </ul>																							
Electromagnetic compatibility (EMC) (Note 15)		<p>Conforms to the requirements of the following standard.</p> <p>EN61326</p> <p>Under following conditions</p> <ol style="list-style-type: none"> <li>1. Used HV test leadwires which is supplied.</li> <li>2. No discharge in testing.</li> <li>3. Used the shielded cable which length is less than three meters when the SIGNAL I/O is used.</li> </ol>																							
AC line power requirements	Voltage and frequency	100V±10%, 50/60 Hz (Factory modification options: Nominal 110/120/220/230/240V)																							
	Power consumption Without load (READY status) <table style="margin-left: 20px; border: none;"> <tr><td>100V line</td><td>≤ 30VA</td></tr> <tr><td>110V line</td><td>≤ 40VA</td></tr> <tr><td>120V line</td><td>≤ 40VA</td></tr> <tr><td>220V line</td><td>≤ 50VA</td></tr> <tr><td>230V line</td><td>≤ 50VA</td></tr> <tr><td>240V line</td><td>≤ 50VA</td></tr> </table> With rated load <table style="margin-left: 20px; border: none;"> <tr><td>100V line</td><td>Approx. 610 VA</td></tr> <tr><td>110V line</td><td>Approx. 600 VA</td></tr> <tr><td>120V line</td><td>Approx. 630 VA</td></tr> <tr><td>220V line</td><td>Approx. 620 VA</td></tr> <tr><td>230V line</td><td>Approx. 640 VA</td></tr> <tr><td>240V line</td><td>Approx. 640 VA</td></tr> </table>	100V line	≤ 30VA	110V line	≤ 40VA	120V line	≤ 40VA	220V line	≤ 50VA	230V line	≤ 50VA	240V line	≤ 50VA	100V line	Approx. 610 VA	110V line	Approx. 600 VA	120V line	Approx. 630 VA	220V line	Approx. 620 VA	230V line	Approx. 640 VA	240V line	Approx. 640 VA
100V line	≤ 30VA																								
110V line	≤ 40VA																								
120V line	≤ 40VA																								
220V line	≤ 50VA																								
230V line	≤ 50VA																								
240V line	≤ 50VA																								
100V line	Approx. 610 VA																								
110V line	Approx. 600 VA																								
120V line	Approx. 630 VA																								
220V line	Approx. 620 VA																								
230V line	Approx. 640 VA																								
240V line	Approx. 640 VA																								
Insulation resistance		≥ 30 MΩ, with 500V DC																							

Note 15: Not applicable to custom order models.

Model		TOS5101	TOS5051
Withstanding voltage		1390 V AC (2 seconds), between AC line and chassis	
		1200V AC (1 second), UL-approved products only	
Dimensions	Excluding protrusions	430 W × 177 H × 370 D mm (16.9 W × 6.97 H × 14.6 D in.)	320 W × 132 H × 300 D mm (12.6 W × 5.20 H × 11.8 D in.)
	Including protrusions	430 W × 195 H × 450 D mm (16.9 W × 7.68 H × 17.7 D in.)	320 W × 150 H × 365 D mm (12.6 W × 5.91H × 14.4 D in.)
Weight (Note 9)		21 kg (46.3 lbs)	16 kg (35.3 lbs)

Note 9: When a Tester is modified to operate on an optional AC line voltage by factory modification, the Tester will become heavier by approximately 2 kg (4.41 lbs) for the 110/120V line or by approximately 3 kg (6.61 lbs) for the 220/230/240V line.

Model	TOS5101/5051	
Remote control function	The Tester has the following provisions for remote-control of test start/stop.  REMOTE connector (5-pin DIN connector, on front panel)	<ul style="list-style-type: none"> <li>To control the Tester from an optional Remote Control Box RC01-TOS or RC02-TOS.</li> <li>To control the Tester from an optional High Voltage Test Probe HP01A-TOS or HP02A-TOS (when the test voltage is less than 4kV rms AC or 5kV DC).</li> </ul>
	SIGNAL I/O connector (14-pin Amphenol connector, on rear panel)	<ul style="list-style-type: none"> <li>To control the Tester from a make-contact device (such as a relay or a switch).</li> <li>To control the Tester with a low-active control signal from a logic circuit.</li> </ul> Conditions of low-active control signal (Note 10): <ul style="list-style-type: none"> <li>High level input voltage : 11 to 15V</li> <li>Low level input voltage : 0 to 4V</li> <li>Low level input current : -5mA Max.</li> <li>Input time requirement : ≥ 5 ms.</li> </ul>
Interlock function	The Tester accepts an interlock input signal applied through the SIGNAL I/O connector (14-pin Am phenol connector on the rear panel). When this signal is applied, the Tester drives itself into the PROTECTION status.	

Note 10: SIGNAL I/O input

The control signal input circuits are isolated from other internal circuits, except that the common lines of the input circuits are directly connected to those of the signal output circuits. The ratings are 30V DC, 30V rms AC MAX.

The input terminals are pulled up to +15V with resistors. To make the input terminals open is equivalent to that the high level signals are applied to the terminals.

## Signal Output Functions

Signal Name	Conditions for Signal Generation	Types of Signals
H.V ON	During the test time (period the Tester delivers the test voltage)	Open-collector signal (Note 11), DANGER lamp
TEST	During the test time (period the Tester delivers the test voltage)	Open-collector signal (Note 11), Vacuum Fluorescent Display
PASS	For PASS judgement. Delivered for approximately 0.2 s.	Open-collector signal (Note 11), Vacuum Fluorescent Display, buzzer (Note12)
U FAIL	For U FAIL judgement (detected current is larger than upper cutoff current)	Open-collector signal (Note 11), Vacuum Fluorescent Display, buzzer (Note12)
L FAIL	For L FAIL judgement (detected current is less than lower cutoff current)	Open-collector signal (Note 11), Vacuum Fluorescent Display, buzzer (Note12)
READY	When the Tester is ready to execute the test	Open-collector signal (Note 11), Vacuum Fluorescent Display
PROTECTION	When the Tester is in the PROTECTION status	Open-collector signal (Note 11), Vacuum Fluorescent Display
STATUS SIGNAL OUTPUT	When one of the DIP switches for the following items is set to ON and the corresponding status has occurred. If two or more items are set to ON, the signal is delivered on the logical sum of such items.  1: H.V ON 2: TEST 3: PASS 4: U FAIL 5: L FAIL 6: READY 7: PROTECTION 8: POWER ON	100V AC (Note 13) (even when the AC line voltage is other than 100V)

Note 11: The ratings of the open-collector signals are 4.5 to 30V DC, 400mA (maximum, in total). The above open-collector output circuits are isolated from other internal circuits, except that the common lines of the output circuits are directly connected to those of the signal input circuits. The common lines of all open-collector circuits are connected together. The ratings are 30V DC, 30V rms AC MAX.

Note 12: Loudness of the buzzer for PASS/FAIL annunciations can be controlled with the buzzer control. It is in common for both PASS and FAIL annunciations — it does not control them separately.

Note 13: The ratings of the STATUS OUTPUT signal are 100V AC, 0.3A (maximum).

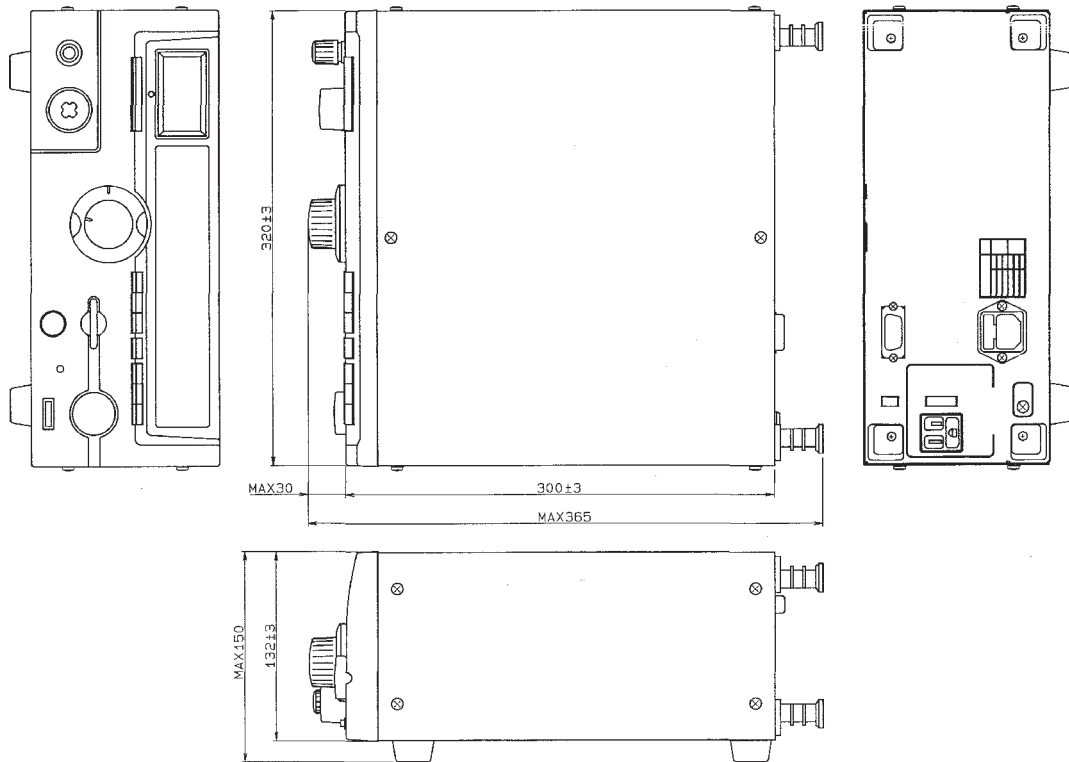
## Accessories

Item	Q'ty	Remarks
AC input power cable	1	
H.V test leadwires Up to 5kV : TL01-TOS (1.5 m) Up to 10kV : TL03-TOS (1.5 m)	1 set 1 set	For TOS5101 only (Note 14)
14-pin Amphenol plug	1	Assembly type
“DANGER! HIGH VOLTAGE” sticker	1	
“WEIGHT” sticker	1	For TOS5101 only
Operation manual	1	
AC power fuses	2	In fuse holder cap (one for present use and the other for spare)

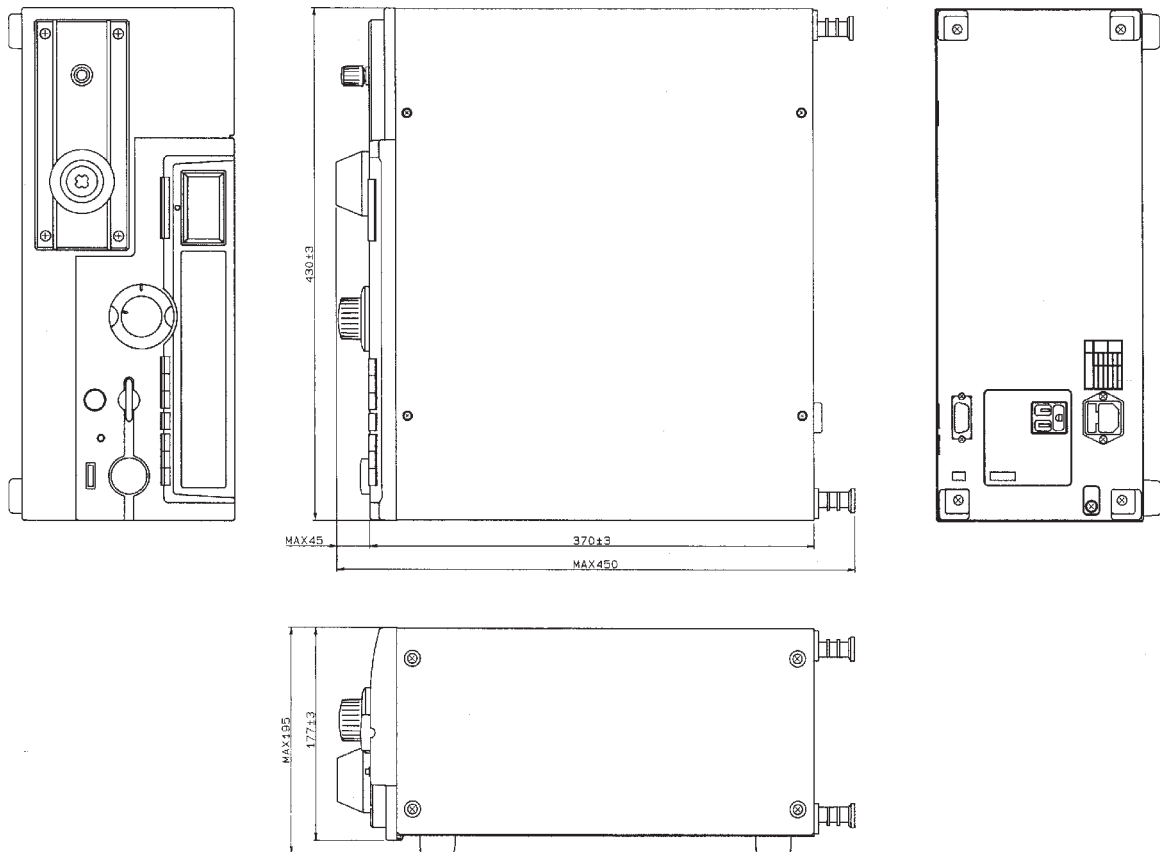
Note 14: The TL03-TOS H.V Test Leadwires (for test voltages up to 10kV) that accompany the TOS5101 Tester are H.V silicone leadwires whose diameter is approximately 12 mm. Be sure to use these leadwires when the test voltage is higher than 5kV.

### 9.3 Overall Dimensions

#### 9.3.1 Dimensions of Models TOS5050 and TOS5051



#### 9.3.2 Dimensions of Model TOS5101





# Chapter 10

## OPTIONS

This chapter introduces optional devices for the Tester.

Table of contents	Page
10.1 Model RC01-TOS/RC02-TOS Remote Control Box .....	10-2
10.2 Model HP01A-TOS/HP02A-TOS High Voltage Test Probe .....	10-3
10.3 Model PL01-TOS Warning Light Unit.....	10-4
10.4 Model BZ01-TOS Buzzer Unit .....	10-4
10.5 High Voltage Test Leadwires .....	10-4

## 10.1 Model RC01-TOS/RC02-TOS Remote Control Box

Model RC01-TOS or RC02-TOS Remote Control Box is for remote control of start/stop of test operation of the Tester. For remote control, connect the Control Box to the REMOTE connector on the front panel of the Tester. The RC01-TOS has one START switch; RC02-TOS has two START switches and the test starts as you press both switches at the same time with your both hands, thereby enhancing the operating safety.

### Functions of switches:

**OPERATE switch:** This switch enables (when ON) or disables (when OFF) the START switch or switches.

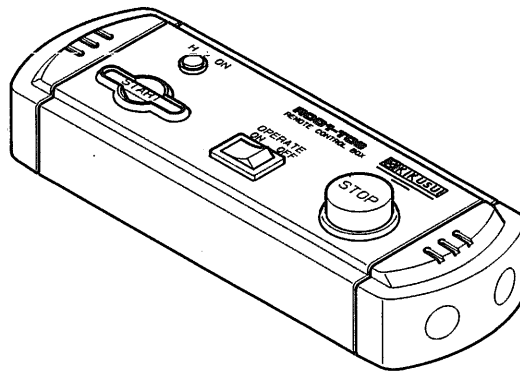
**START switch** : The test starts as you press this switch (or switches) when the OPERATE switch is ON and the Tester is in the READY status.

**STOP switch** : This switch terminates the test (cuts off the test voltage or resets the Tester from the FAIL or other particular status — its functions are the same with those of the STOP switch on the front panel of the Tester.

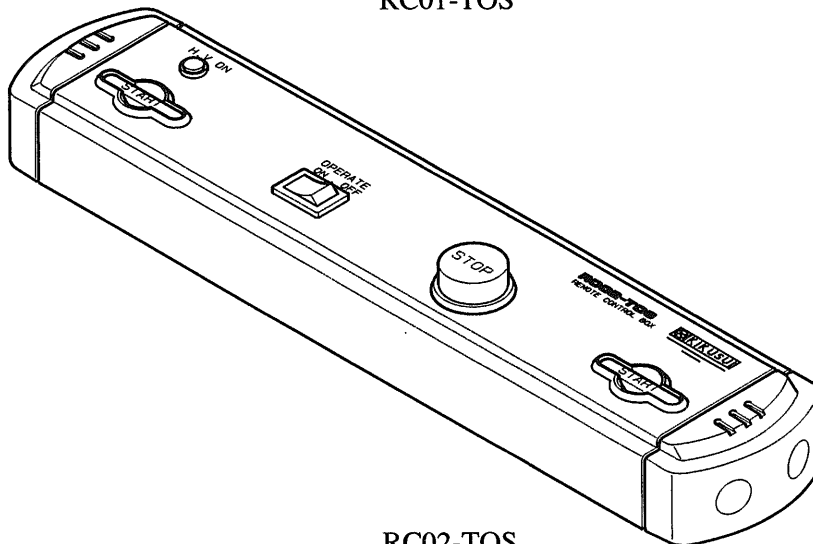
### Dimensions

RC01-TOS : 200 W × 70 H × 39 D mm (7.9 W × 2.8 H × 1.5 D in.)

RC02-TOS : 330 W × 70 H × 39 D mm (13 W × 2.8 H × 1.5 D in.)



RC01-TOS



RC02-TOS

## 10.2 Model HP01A-TOS/HP02A-TOS High Voltage Test Probe

The High Voltage Test Probe renders a three-fold operating safety, namely, the test voltage is not delivered unless you squeeze with one hand the slide lever of the grip of the probe and pull the trigger and you press with the other hand the switch on top of the probe, thereby occupying your both hands. As you release even a single one of these, the probe immediately and forcefully delivers the STOP signal to cut off the test voltage.

Voltage ratings : 4kV (rms) AC, 50/60 Hz;  
5kV DC

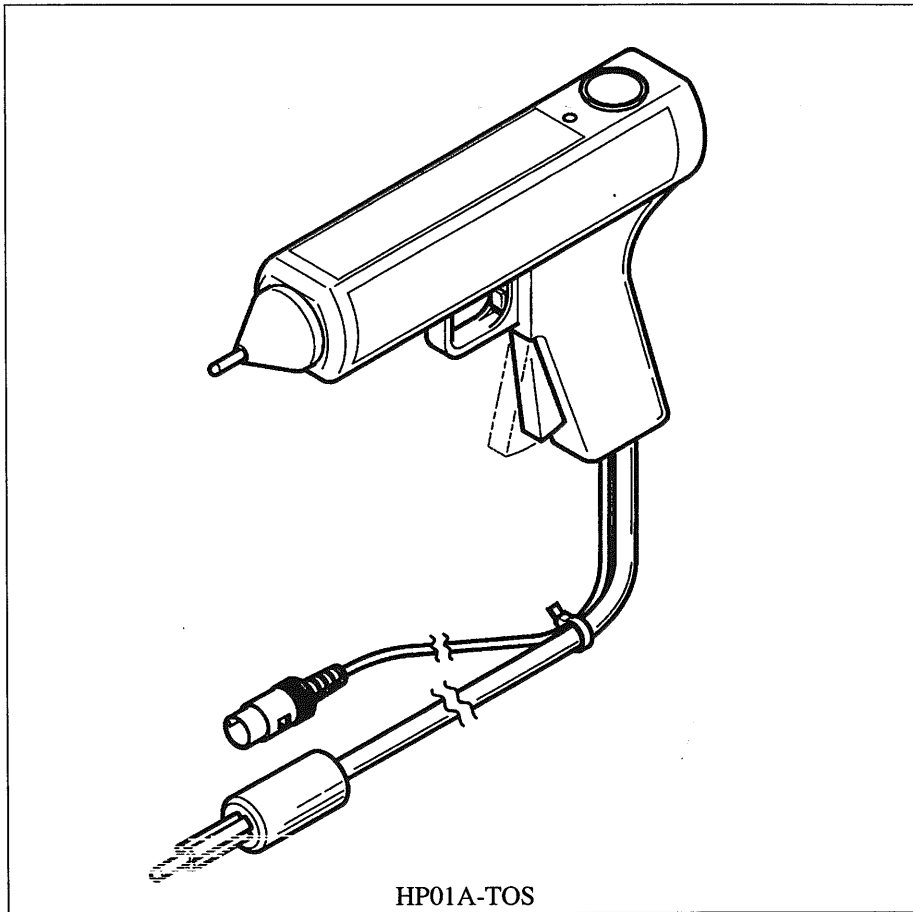
Length of cable: Approx. 1.8 m (HP01A-TOS)  
Approx. 3.5 m (HP02A-TOS)

### **WARNING**

- *The maximum voltage ratings of the probe is 4kV rms AC or 5kV DC. Never let it subjected to voltages higher than these limits.*
- *Do not connect the probe to or disconnect it from the DUT while letting it deliver the test voltage — if you do this, the DUT may be damaged. If you disconnect the probe from the DUT while letting it deliver the test voltage, the items of the tested circuit may remain charged up to the high test voltage. Before connecting the probe to the DUT, be sure that the test voltage is OFF (the LED on top of the probe is OFF); before disconnecting the probe from the DUT, be sure that the test voltage is OFF (the LED is OFF).*

### **Caution**

- *If you need a test in compliance to the UL Standard by using the probe, set the FAIL MODE switch (DIP switch on the rear panel) of the Tester to ON. If you have set this switch to ON, the Tester is not reset from the FAIL status has gone out or PROTECTION status even when you have released your hand from the probe. To reset it, you have to press the **STOP** switch of the Tester. Thus, you will be securely informed of the FAIL judgement. For details, refer to Section 6.5.4 “FAIL MODE Switch.”*



### 10.3 Model PL01-TOS Warning Light Unit

This unit indicates that the Tester is in the TEST-ON status (delivering the test voltage).

### 10.4 Model BZ01-TOS Buzzer Unit

This unit may be used when the sound generated by the buzzer housed in the Tester is insufficient. This unit can be driven by the FAIL status signal of the tester.

### 10.5 High Voltage Test Leadwires

Model	Voltage rating	Length	Remarks
TL01-TOS	AC: 5kV rms, 50/60 Hz DC: 5kV	Approx. 1.5 m	Accessories of TOS5050, TOS5051, and TOS5101
TL02-TOS	AC: 5kV rms, 50/60 Hz DC: 5kV	Approx. 3.0 m	
TL03-TOS	AC: 10kV rms, 50/60 Hz DC: 10kV	Approx. 1.5 m	Accessories of TOS5101 only

# INDEX

## A

AC line ..... 4-27  
AC line requirements ..... 2-4  
AC power cable takeup  
    High voltage test leadwires ..... 10-4  
AC/DC test Mode Message ..... 4-19  
Automatic discharge function ..... 1-5, 7-5

## B

Buzzer ..... 4-17, 9-7, 9-16

## D

DANGER lamp ..... 1-5, 3-8, 4-11  
Digital ammeter ..... 1-3, 4-21  
Digital timer ..... 1-4, 4-23  
Digital voltmeter ..... 1-3, 4-20  
Display of preset cutoff current and  
    measured current ..... 4-21

## F

FAIL Message ..... 4-24

## H

HIGH VOLTAGE Terminal ..... 4-10  
HIGH Test Leadwire ..... 3-3  
H.V ON ..... 1-4, 6-27

## I

Initial Test Setup Data ..... 5-2, 5-3  
Interlock function ..... 6-26  
Interlock Provision ..... 1-5

## K

KEYLOCK Message ..... 4-25  
Keylock function ..... 1-5, 4-25

## L

L FAIL ..... 1-4, 6-27  
LOW Terminal ..... 4-10  
LOW Test Leadwire ..... 3-3  
Lower cutoff current display ..... 4-22  
Lower pass/fail judgement ON/OFF ..... 4-22

## M

Memory backup function ..... 1-5, 4-3

## O

ON/OFF Key ..... 4-16  
Output Signals ..... 1-4, 6-27  
Output voltage display ..... 4-20

## P

PASS ..... 1-4, 4-24, 6-27  
Pass/fail judgement, window comparator ..... 1-3  
POWER switch ..... 4-3  
PROTECTION ..... 1-4, 4-25  
Protective rubber gloves ..... 3-2

## R

READY ..... 1-4, 4-24  
REMOTE CONTROL Connector ..... 4-8  
REMOTE Message ..... 4-25  
Remote Control ..... 1-4, 6-22

## S

Safety ground ..... 3-2  
Safety protective grounding terminal .... 3-2, 4-26  
SHIFT Key ..... 4-17  
SIGNAL I/O Connector ..... 4-27, 6-24  
START Switch ..... 4-5  
STATUS SIGNAL OUTPUT ..... 4-27, 6-27  
STOP Switch ..... 4-5

## T

TEST ..... 1-4, 4-24, 6-27  
TEST MODE ..... 4-27  
TEST VOLTAGE Switch ..... 4-9  
Test Time Display ..... 4-23

## U

U FAIL ..... 1-4, 6-27  
UP/LOW key ..... 4-14

## V

Version number ..... 5-6  
Voltmeter, analog ..... 1-3, 4-11  
Voltmeter, analog, zero adjustment ..... 4-11