## ΗΙΟΚΙ

### LEAK CURRENT HITESTER ST5540, ST5541



## Leak Current Measurement – Essential to Electrical Safety

- Uninterrupted polarity switching function dramatically reduces cycle time
- Support for rated currents up to 20 A gives the instrument more than adequate capability for testing products designed to comply with new standards

### For medical-use electrical devices and essential to electrical safety Compliance with IEC 60601-1:2005 Ed 3.0, JIS T 0601-1:2012

(\*Starting on June 1, 2012, medical electrical equipment sold in the EU must comply). Model ST5540 comply with IEC 60601-1:2005 +A1:2012 (Ed 3.1), and IEC 62353 of 2017

## Compliance with Electrical Appliances and Materials Safety Act,

JIS, IEC, and UL standards for general-use electrical devices



# For Medical Electrical Devices ST5540

## Complies with all standards (suitable for use with all networks)

Leak current parameters as defined for medical-use electrical devices include ground leak current, contact current, patient leak current, and patient measurement current. The ST5540 provides a single solution for measuring all of these leak current variants.

## Complies with IEC 60601-1:2005 +A1:2012 (Ed 3.1)

In order to prevent the danger of electric shock, electrical devices use power supplies that are isolated from parts of the device that may come into contact with the body. However, it is impossible to achieve infinite insulation resistance. Some leak current always exists, and its magnitude changes as the insulation degrades over time. The LEAK CURRENT HITESTER ST5540/ST5541 provides an easy-to-operate solution for measuring leak current in electrical devices, making it eminently suitable for use in an extensive array of applications, ranging from production lines to equipment maintenance and inspections.



	Measurement mode	Category	Standard compliance
ST5540 Medical- use electrical devices	<ul> <li>Patient leak current (between parts of device that come into contact with patient and ground)</li> <li>Patient leak current (external SIP/SOP voltage)</li> <li>Patient leak current (external voltage at specific F-type applied part)</li> <li>Patient leak current (current resulting from external voltage at parts of device that come into contact with patients)</li> <li>Patient measurement current</li> <li>Total patient leak current (external SIP/SOP voltage)</li> <li>Total patient leak current (current resulting from external voltage at parts of device that come into contact with patient)</li> </ul>	<ul> <li>Medical industry (Japan Association for Clinical Engineering Technologists, etc.)</li> <li>Medical device manufacturers and dealers</li> <li>Medical device repair and maintenance businesses</li> <li>Hospitals</li> </ul>	<ul> <li>IEC60601-1 (Ed 3.1)</li> <li>IEC60990</li> <li>IEC62353</li> </ul>
General- use electrical devices	<ul> <li>Contact current (between device enclosure and lines)</li> <li>Contact current (between device enclosure and ground)</li> <li>Contact current (between device enclosure and device enclosure)</li> <li>Ground leak current</li> <li>Free current measurement</li> </ul>	<ul> <li>Public agencies</li> <li>Electric vehicle manufacturers</li> <li>Manufacturers of general electrical devices</li> <li>Household appliance industry</li> <li>Information device industry</li> </ul>	<ul> <li>Electrical vehicle standards UL 2231-1 and UL 2231-2</li> <li>Electrical Appliances and Materials Safety Act</li> <li>IEC, JIS, and UL standards</li> </ul>
	*The ST5540 also complies with old standards.		

# For Standard- and Regulation-compliance ST5541

## **Measurement of General-use Electrical Devices**

ST5541 provides standard support for standard-compliant networks (excluding medical-use electrical devices).



There are various standards in place concerning networks (body simulated resistance), and a standard-compliant network is required in order to make measurements.

Comparison of ST5541 Functionality



#### Category

- Public agencies
- Electric vehicle manufacturers
- Manufacturers of general electrical devices · Electrical Appliances and
- Household appliance industry
- Information device industry

#### Standard compliance

- Electrical vehicle standards UL 2231-1 and UL 2231-2
- Electrical Appliances and Materials Safety Act
- · IEC, JIS, and UL standards

## A single, robust solution for leak current measurement





## ST5540/ST5541 Features

#### Uninterrupted polarity switching function

The ability to conduct tests without turning off the power when switching the power supply polarity dramatically reduces cycle times.

The ST5540/ST5541 can switch polarity without stopping the supply of power to the device under measurement. Old models require that the device under measurement be turned off and then back on again when switching polarity, but the ST5540 and ST5541 let you progress smoothly to the next testing process.



#### Circuit breaker for device under measurement

Simple, interactive operation

displayed on the panel, keeping operation simple.

The ST5540/ST5541 uses a touch panel that lets you configure

settings by touching selections in response to information

The instrument's workbench-type design features a terminal block and a circuit breaker on the front panel, making it deal for embedding in test lines and simplifying connectivity with the device being measured, even while rack-mounted.



#### Improved test reliability

Blown fuse check function

When measurement starts, the instrument checks for unintentional probe misalignment using of a preconfigured lower limit setting.

■ Safety conductor current measurement function The ST5540/ST5541 can perform safety conductor current measurement as defined in standards such as IEC 60990 and IEC 60950-1.

#### Automatic measurement functionality

Simple operation allows you to switch power supply polarity and automatically make measurements with the target device in the normal and single-fault states, displaying the peak values. You can also set the measurement time and wait time. These capabilities help reduce operation time.

#### 110% voltage application jack

The instrument's 110% voltage application jack, which is used during testing of medical devices, outputs the target device line power supply voltage as-is. The polarity can be switched (ST5540 only).

#### Save measurement data for 100 devices

Measurement data (peak values) can be stored in the instrument's built-in memory. Saved data can be checked on the stored data reference screen after measurement is complete. Data can be stored for up to 100 test targets, with each target being identified by a registered device name and control number. Additionally, the instrument can store a maximum of 2,000 peak value data points. Together, these capabilities eliminate the need to jot down measured values at the measurement site.

#### Ability to store up to 30 sets of measurement conditions

The instrument can save and load up to 30 sets of measurement conditions, allowing you to immediately switch between conditions.



## **Expandability for the Future**



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( Line power supply terminal block for device under test )

EXT I/O description

#### External control via EXT I/O

changes.

Start of measurement and loading of measurement conditions can be controlled from an external source. Additionally, judgment results, test signals, and other data can be output, making it possible to use the instrument to develop an automated line.

Input signals	Active-low input	
Max. pplied voltage	EXT.DCV terminal input voltage	
High level	EXT.DCV terminal input voltage or open	
Low level	0.3 VDC or less	
Output signal	Open collector output	
Max. load voltage	24 VDC (when not using the EXT.DCV terminal)	
Max. output current	60 mA DC per signal (low level)	

In addition to outputting judgment results for each measurement item, the instrument also provides T-FAIL output, which is generated continuously once a FAIL result is encountered during automatic testing.

Output		
ST	:	Outputs low continuously during automatic measurement.
EAS	:	Outputs the measurement count automatic measurement and measurement of multiple items.
SS	:	Outputs the PASS judgment result for each measurement item.
JL	:	Outputs the FAIL judgment result for each measurement item.
W	:	Generates continuous output once a low signal is encountered during automatic testing.
FAIL	:	Generates continuous output once a FAIL result is encountered during automatic testing.
T.DCV	:	Generates internal 5 VDC output (not isolated from internal circuitry).
T.GND	:	Generates internal GND output (same as the case ground level).
Input		
ART	:	Starts automatic measurement at low.
OP	:	Forcibly terminates measurement at low.
DAD (0 to 4)	:	Loads saved panels (30 panels).
T.DCV	:	Accepts external power supply input from 5 VDC to 24 VDC.
T.COM	:	Accepts external COM input.
YLOCK	:	Disables switches other than the start switch.

#### General specifications

Display	320 × 240 dot matrix LCD (with backlight)		
Control	$6 \times 6$ matrix touch panel		
Operating temperature and	0°C to 40°C, 80% RH or less (non-condensing)		
humidity range			
Storage temperature and	-10°C to 50°C, 80% RH or less (non-condensing)		
humidity range			
Temperature and humidity	23°C ±5°C, 80% RH or less (non-condensing)		
range within which accuracy			
is guaranteed			
Guaranteed accuracy period	1 year		
Operating location	Indoor use at an elevation not exceeding 2,000 m		
Instrument power supply	100/120/220/240 VAC, as specified by customer		
	Rated power supply frequency: 50/60 Hz		
	Rated power: 30 VA		
Line power supply for device	Rated supply voltage: 100 to 250 VAC		
being measured and outlet	Rated power supply frequency: 50/60 Hz		
	Rated current: Input, terminal block: 20 A		
	Output, terminal block: 20 A		

Outlet max. allowable leak current	50 mA
Dielectric strength	Between power supply terminals and protective ground: 1.39 kV AC (5 mA), 15 sec
	Between measurement terminals and power supply terminals: 2.30 kV AC (10 mA), 15 sec
	Between measurement terminals and control circuit: 2.30 kV AC (10 mA), 15 sec
Standard compliance	EMC: EN 61326
	Safety: EN 61010
Conductive RF	3% f.s. or less at 3 V
Magnetic field effects	(Representative value when conducting measurements in
	the AC 500 µA range)
Accessories	ST5540: One set of L2200 test leads (one red, one black) + one red L2200 test lead
	ST5541, One set of L2200 test leads (one red, one block)
	S13341: One set of L2200 lest leads (one fed, one black)
	Eliciosule Piole 9195 X 1, CD-ROM X 1 (USB Driver)
	power cord × 3 (1 for instrument and 2 for measuring instrument line supply use)
	spare fuse × 1 (250 V F 50 mA L, measurement use)
Dimensions	Approx. 320 (W) × 110 (H) × 253 (D) mm
Mass	Approx. 4.5 kg

#### Leak current measurement unit

Measurement current	DC / AC / AC+DC / AC peak		
Allowable measurement current	Max. 50 mA (DC / AC / AC+DC mode)		
	Max. 75 mA (AC peak mode)		
Measurement ranges	DC / AC / AC+DC mode:50 µA/500 µA/5 mA/50 mA		
	AC peak mode:500 µA/1 mA/10 mA/75 mA		
Range switching	AUTO/HOLD		
Trigger method	Manual: Generates trigger automatically internally, free-run measurement.		
	Automatic: Starts measurement based on external start signal.		
Measurement terminals	T1 terminal, T2 terminal (with built-in fuse holder), T3		
	terminal (110% voltage application terminal: ST5540 only)		
	(*Step-up isolation transformer required for 110% application.)		
Measurement methods	Measurement of voltage drop across body simulated resistance points		
	Calculation and display of current values		
	True rms measurement		
	Measurement unit floats relative to instrument ground.		
A/D conversion method	$\Delta\Sigma$ method (20-bit)		
Instrument-to-ground capacitance	200 pF or less (between T1/T2 terminal and case ground)		
Input resistance	1 MΩ ±1% (single-end input)		
	Not including voltage measurement unit, body simulated resistance (current detection circuit)		
Input capacitance	150 pF or less (between T1 and T2 terminals)		
	(f = 100 kHz, isolated network circuit, including cables)		

CMRR (between T1 and	60 dB or greater at 60 Hz / 60 dB or greater at 10 kHz
T2 terminals and case)	40 dB or greater at 100 kHz / 40 dB or greater at 1 MHz
	(Isolated from network circuit with fuse shorted)

#### Network (body simulated resistance)

Medical-use electrical devices:	Basic measurement element: 1 kΩ		
Network B (ST5540 only)	Filter: $10 \text{ k}\Omega + 15 \text{ nF}$		
<ul> <li>Electrical Appliances and</li> </ul>	Basic measurement element: 1 kΩ		
Materials Safety Act: Network A	Filter: $10 \text{ k}\Omega + 11.22 \text{ nF} + 579 \Omega$		
IEC 60990: Network C	Basic measurement element: $1.5 \text{ k}\Omega + 500 \Omega$		
	Filter 1: 10 k $\Omega$ + 22 nF		
	Filter 2: $10 \text{ k}\Omega + (20 \text{ k}\Omega + 6.2 \text{ nF}) //9.1 \text{ nF}$		
UL: Network D	Basic measurement element: $1.5 \text{ k}\Omega / 0.15 \mu\text{F}$		
General-purpose 1: Network E	Basic measurement element: 1 kΩ		
General-purpose 2: Network F	Basic measurement element: 2 kΩ		
IEC 61010-1: Network G	Basic measurement element: 375 $\Omega$ + 500 $\Omega$		
	Filter: 375 $\Omega$ //0.22 $\mu$ F + 500 $\Omega$		
<ul> <li>Safety conductor current</li> </ul>	Basic measurement element (35 $\Omega$ )		

#### Accuracy (current measurement unit)

- Temperature and humidity range within which accuracy is guaranteed: 23°C ±5°C, 80% RH or less, non-condensing
   Temperature coefficient: Add 0.1 x basic accuracy x (T-23) for operating temperature T (°C) Warm-up time: 20 min
   The range within which accuracy is guaranteed when using Network D and Network F (full-scale value for each range) is approximately 1/1.5 and 1/2, respectively.
   Calculated value when the voltage is detected across both ends of a network consisting of non-inductive resistance with a theoretical value of 1 kΩ
- The following accuracy values also apply when using voltmeter mode.

#### Measurement mode: AC\*1 / AC+DC

Guaranteed		Bosolution	Accuracy		
nanye	accuracy range		0.1 Hz≤f<15 Hz*2	DC ≤ f ≤ 100 kHz	100 kHz < f ≤ 1 MHz
50.00mA	From 4 mA	10 µA			
5.000mA	From 400 µA	1 µA	±(4.0%rdg.+10dgt.)	±(2.0%rdg.+6dgt.)	±(2.0%rdg.+10dgt.)
500.0µA	From 40 µA	0.1 µA			
50.00µA	From 4 µA	0.01 µA	±4.0%f.s.	±2.0%f.s.	±2.0%f.s.

#### Measurement mode: AC peak\*3

Name         Resolution         15Hzsfs10Hz         10Hz <fs10hz< th="">         10Hz<fs10hz< th="">           75.0mA         From 8 mA         100 μA         ±(2.0%rdg.+6dgt.)         ±(2.0%rdg.+6dgt.)         ±15.0%fs.         ±15.0%fs.           10.00mA         From 100 μA         1 μA         ±2.5%fs.         ±5.0%fs.         ±10.0%fs.         ±10.0%fs.</fs10hz<></fs10hz<>	Bango	Guaranteed		Accuracy		
75.0mA         From 8 mA         100 $\mu$ A $\pm (2.0\% rdg.+6dgt.)$ $\pm 15.0\% f.s.$ 10.00mA         From 0.8 mA         10 $\mu$ A $\pm (2.0\% rdg.+6dgt.)$ $\pm 5.0\% f.s.$ $\pm 15.0\% f.s.$ 1.000mA         From 100 $\mu$ A         1 $\mu$ A $\pm 2.5\% f.s.$ $\pm 5.0\% f.s.$ $\pm 0.0\% f.s.$	nange	accuracy range	Resolution	15 Hz ≤ f ≤ 10 kHz	10 kHz < f ≤ 100 kHz	100 kHz < f ≤ 1 MHz
10.00mA         From $0.8 \text{ mA}$ 10 $\mu$ A $\pm 2.5\% \text{ fs.}$ $\pm 15.0\% \text{ fs.}$ 1.000mA         From $100 \mu$ A         1 $\mu$ A $\pm 2.5\% \text{ fs.}$ $\pm 5.0\% \text{ fs.}$ 500.0 $\mu$ A         From $40 \mu$ A         0 $\mu$ A $\pm 2.5\% \text{ fs.}$ $\pm 0.0\% \text{ fs.}$	75.0mA	From 8 mA	100 µA	1(2007 nda 16dat)		
1.000mA         From 100 μA         1 μA         ±2.5% f.s.         ±5.0% I.s.           500.0 μA         From 40 μA         0 μA         ±2.5% f.s.         ±2.0% f.s.	10.00mA	From 0.8 mA	10 µA	±(2.0%rug.+ougt.)	- 000	±15.0%f.s.
<b>500 0 UA</b> From 40 UA 0 1 UA +2 5% f s $(20.0\%)$ f s	1.000mA	From 100 µA	1 µA	±2.5%f.s.	±5.0%1.s.	
$\pm 20.0\%$ i.s. $\pm 20.0\%$ i.s.	500.0 μA	From 40 µA	0.1 µA	±2.5%f.s.		±20.0%f.s.

#### Measurement: mode DC

Range	Guaranteed accuracy range	Resolution	Accuracy
50.00mA	From 4 mA	10 µA	
5.000mA	From 400 µA	1 µA	±(2.0%rdg.+6dgt.)
500.0 μA	From 40 µA	0.1 µA	
50.00 µA	From 4 µA	0.01 µA	±2.0%f.s.

#### Voltage monitor accuracy

		-	
Range	Guaranteed accuracy range	Resolution	Accuracy
300.0 V	85 V* <sup>4</sup> to 275V	0.1 V	±(5.0%rdg.+10dgt.)

#### Current monitor accuracy (Measurement methods: Average value response, rms calculation)

	respense, me calculation,						
Range	Guaranteed accuracy range	Resolution	Accuracy				
300.0 V	From 85 V*5	0.1 V	±(2.0%rdg.+5dgt.)				

#### Safety conductor current accuracy

#### Measurement mode: DC / AC\*4 / AC+DC

Banga	Guaranteed accuracy	Resolution	Accuracy		
nange	range	nesolution	DC, 15 Hz ≤ f ≤ 100 kHz	100 kHz < f≤1 MHz	
50.00 mA	12.00 mA to 50.00 mA	10 µA	±(2.0%rdg.+6dgt.)	±(5.0%rdg.+20dgt.)	
10.00mA	1.30 mA to 13.00 mA	10 µA	±(2.0%rdg.+6dgt.)	±(5.0%rdg.+20dgt.)	

\*1 When using AC measurement mode, the high-pass filter frequency characteristics (fc = 4 Hz) are added. \*2 ST5540 only.

#### Measurement mode: AC peak

Panga	Guaranteed accuracy	Resolution	Accuracy			
пануе	range		15 Hz ≤ f ≤ 10 kHz	1 kHz < f ≤ 100 kHz	100 kHz < f ≤ 1 MHz	
75.0 mA	12.0 mA to 75.00 mA	100 µA	±(2.0%rdg.+6dgt.)	±5.0%f.s.	±25.0%f.s.	
10.00 mA	1.30 mA to 13.00 mA	10 µA	±2.5%f.s.	±5.0%f.s.	±25.0%f.s.	

\*3 Setting not available with Network A, B, or C (when filter off).

\*4 Voltages of less than 80 V are displayed as "Less than 80 V." \*5 Currents of less than 0.5 A are displayed as "Less than 0.5 A."





Model : LEAK CURRENT HITESTER ST5541

(For electrical devices)

Model No. (Order Code) (Note)

ST5541

Model : LEAK CURRENT HITESTER ST5540 Model No. (Order Code) (Note)

ST5540 (For medical-use and electrical devices)

#### ST5540, ST5541 shared options



#### Leak current tester supplies

Standards require use of an isolation transformer when measuring medical-use electrical devices. Please purchase a transformer with the necessary rated capacity.

Isolation transformer Model numbers 100 to 110 V (Japan): HSW-2KSP 240 to 264 V (overseas): HSW-5KSP For more information: Tokyo Rikosha Co., Ltd. Phone: +81-48-856-3851 (reception) https://www.tokyorikosha.co.jp



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