Introducing a leak current measuring instrument that complies with the IEC 60601-1 standard (3rd edition, with the ST5540), the ST5540 series feature an improved measuring method and dramatically faster cycle times, thanks to its uninterrupted polarity switching. The new devices support rated currents of up to 20A, making it more than ideal for use with products built to new standards.
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.

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.

### ST5540 compliance

<table>
<thead>
<tr>
<th>(Medical) JIS standards</th>
<th>JIS T0601-1 : (1999)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Medical) IEC standards</td>
<td>IEC60601-1 : (2005) 3rd</td>
</tr>
</tbody>
</table>

Some examples of the standards with which the instrument complies are listed below. The ST5540 can be used with all standards that apply to the networks in which it is used.

#### Comparison of ST5540/ST5541 Functionality

<table>
<thead>
<tr>
<th>Measurement mode</th>
<th>Category</th>
<th>Standard compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient leak current (between parts of device that come into contact with patient and ground)</td>
<td>Medical industry (Japan Association for Clinical Engineering Technologists, etc.)</td>
<td>IEC60601-1 3rd edition, IEC60990</td>
</tr>
<tr>
<td>Patient leak current (external SIP/SOP voltage)</td>
<td>Medical device manufacturers and dealers</td>
<td></td>
</tr>
<tr>
<td>Patient leak current (external voltage at specific F-type applied part)</td>
<td>Medical device repair and maintenance businesses</td>
<td></td>
</tr>
<tr>
<td>Patient leak current (current resulting from external voltage at parts of device that come into contact with patient)</td>
<td>Hospitals</td>
<td></td>
</tr>
<tr>
<td>Patient measurement current</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total patient leak current (between parts of device that come into contact with patient and ground)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total patient leak current (external SIP/SOP voltage)</td>
<td></td>
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</tr>
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</tr>
<tr>
<td>Total patient leak current (current resulting from external voltage at parts of device that come into contact with patient)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contact current (between device enclosure and lines)</td>
<td>Public agencies</td>
<td>UL 2231-1 and UL 2231-2</td>
</tr>
<tr>
<td>Contact current (between device enclosure and ground)</td>
<td>Electric vehicle manufacturers</td>
<td>Electrical Appliances and Materials Safety Act</td>
</tr>
<tr>
<td>Contact current (between device enclosure and device enclosure)</td>
<td>Manufacturers of general electrical devices</td>
<td></td>
</tr>
<tr>
<td>Ground leak current</td>
<td>Household appliance industry</td>
<td></td>
</tr>
<tr>
<td>Free current measurement</td>
<td>Information device industry</td>
<td></td>
</tr>
</tbody>
</table>

*The ST5540 also complies with old standards.*
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.

ST5540 compliance

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 (patent pending). 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.

■ 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.

■ Improved test reliability
Blown fuse check function
When measurement starts, the instrument checks for unintentional probe misalignment using a preconfigured lower limit setting.

■ Circuit breaker for device under measurement
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.

■ 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.

■ Simple, interactive operation
The ST5540/ST5541 uses a touch panel that lets you configure settings by touching selections in response to information displayed on the panel, keeping operation simple.

■ 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.

Peak value display
Displays the type of power supply fault and the peak value for the leak current, which varies with target device operation.

Power supply polarity/device status/measurement current
The maximum allowable value under the standard in question is automatically set. Settings can also be changed as desired by the user.

Allowable value
The type of power supply fault
The maximum allowable value under the standard in question is automatically set. Settings can also be changed as desired by the user.

Current measured value
Judgment result based on set allowable value

Data storage
Measurement data:
For up to 100 target devices
Measurement conditions:
Up to 30 sets
**Expandability for the Future**

- All the switch terminals needed for standard-compliant measurement
  The ST5540/ST5541 provides the terminals needed for the user to provide external switches.

  **Connection terminals**

  **S10 terminal**: Switch for connecting a function ground terminal to the measurement power supply system’s ground point. Allows connectivity to ground to be configured during leak current measurement.
  **S12 terminal**: Switch for connecting the parts of devices that come into contact with the patient to the measurement power supply circuit’s ground point. Allows connectivity to ground to be configured during leak current measurement.
  **S13 terminal**: Switch for connecting contactable metallic parts that are not protectively grounded to the ground line. Allows connectivity to ground to be configured during leak current measurement.
  **E terminal**: Connected to the E (earth) LINE IN terminal. This terminal is always connected and cannot be configured.

  * S10, S12, S13, and E are available on the ST5540 only.

- Standard USB interface
  The ST5540/ST5541’s standard USB interface simplifies testing on manufacturing lines and in similar installations.

  - Connectivity not supported for USB memory. Data communications only.

- Standard RS-232C port
  The ST5540/ST5541’s standard RS-232C port can be used to control the instrument from a computer and to print data using the 9442 printer (option).

- Separation of the instrument’s power supply and target device lines
  The instrument’s power supply and target device line power supply are separated, helping prevent damage due to the inadvertent input of an incorrect supply voltage. There’s no need to change the ST5540/ST5541’s supply voltage, even if the target device’s supply voltages changes.

- Support for rated currents of up to 20 A
  The ST5540/ST5541 supports currents of up to 20 A and voltages of up to 250 V. Its ability to accommodate large currents allows it to be used with a more extensive range of target products, including devices from new fields such as electric vehicles and household appliances.

- External control via EXT I/O
  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**
  - **Max. applied 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)

  **Output signals**
  - **TEST**: Outputs low continuously during automatic measurement.
  - **MEAS**: Outputs the measurement count automatic measurement and measurement of multiple items.
  - **PASS**: Outputs the PASS judgment result for each measurement item.
  - **FAIL**: Outputs the FAIL judgment result for each measurement item.
  - **LOW**: Generates continuous output once a low signal is encountered during automatic testing.
  - **T-FAIL**: Generates continuous output once a FAIL result is encountered during automatic testing.
  - **INT.DCV**: Generates internal 5 VDC output (not isolated from internal circuitry).
  - **INT.GND**: Generates internal GND output (same as the case ground level).

  **Input**
  - **START**: Starts automatic measurement at low.
  - **STOP**: Forcibly terminates measurement at low.
  - **LOAD (0 to 4)**: Loads saved panels (30 panels).
  - **EXT.DCV**: Accepts external power supply input from 5 VDC to 24 VDC.
  - **EXT.COM**: Accepts external COM input.
  - **KEYLOCK**: Disables switches other than the start switch.
### Specifications

**ST5540/ST5541**

<table>
<thead>
<tr>
<th>Display</th>
<th>320 x 240 dot matrix LCD (with backlight)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>8 x 6 matrix touch panel</td>
</tr>
<tr>
<td>Operating temperature and humidity range</td>
<td>0°C to 40°C, 85% RH or less (non-condensing)</td>
</tr>
<tr>
<td>Storage temperature and humidity range</td>
<td>0°C to 50°C, 85% RH or less (non-condensing)</td>
</tr>
<tr>
<td>Temperature and humidity range within which accuracy is guaranteed</td>
<td>23°C ±5°C, 80% RH or less (non-condensing)</td>
</tr>
<tr>
<td>Guaranteed accuracy period</td>
<td>1 year</td>
</tr>
<tr>
<td>Operating location</td>
<td>Indoor use at an elevation not exceeding 2,000 m</td>
</tr>
<tr>
<td>Instrument power supply</td>
<td>100/120/220/240 VAC, as specified by customer</td>
</tr>
<tr>
<td>Rated power supply frequency</td>
<td>50/60 Hz</td>
</tr>
<tr>
<td>Rated power supply</td>
<td>50/60 Hz</td>
</tr>
<tr>
<td>Line current supply</td>
<td>100 to 240 VAC</td>
</tr>
<tr>
<td>Rated current supply</td>
<td>50/60 Hz</td>
</tr>
<tr>
<td>Rated current</td>
<td>50/60 Hz</td>
</tr>
<tr>
<td>Rated input terminal block</td>
<td>20 A</td>
</tr>
<tr>
<td>Rated output terminal block</td>
<td>20 A</td>
</tr>
<tr>
<td>Outlet max. allowable current</td>
<td>30 mA</td>
</tr>
</tbody>
</table>

#### Leak current measurement unit

- **Measurement current**: DC / AC / AC+DC / AC peak
- **Allowable measurement current**: Max. 50 mA (DC / AC / AC+DC mode)
- **Max. 50 mA (AC peak)**
- **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
- **Max. 75 mA (AC peak mode)**
- **Input resistance**: 1 MΩ ±1% (single-end)
- **Input capacitance**: 150 pF or less
- **A/D conversion method**: True rms measurement
- **Calculation and display of current values**: Current monitor accuracy (Measurement methods: Average value response, rms calculation)
- **Trigger method**: Manual: Generates trigger automatically, free-run measurement. AUTO/HOLD: Starts measurement based on external start signal
- **Range Guaranteed accuracy range**: ±4.0%f.s. ±2.0%f.s. ±2.0%f.s.

#### Network (body simulated resistance)

- **Medical-use electronic devices**: Basic measurement element: 1 kΩ
- **Network B (ST5540 only)**: Filter: 10 kΩ ±15 nF
- **Electrical Appliances and Materials Safety Act.**: Basic measurement element: 1 kΩ
- **IEC 60950**: Basic measurement element: 1.5 kΩ ±300 μF
- **General-purpose 1**: Basic measurement element: 1.5 kΩ
- **General-purpose 2**: Basic measurement element: 2 kΩ
- **IEC 61110-1**: Basic measurement element: ±25 V ±500 μA
- **Safety conductor current**: Basic measurement element (35 Ω)

#### Accuracy (current measurement unit)

**Range**

- **50.00 mA**: From 4 mA to 10 μA
- **5.000 mA**: From 400 μA to 100 μA
- **500.0 μA**: From 4 μA to 1 μA
- **50.00 μA**: From 4 μA to 1 μA

**Guaranteed accuracy range**

- **50.00 mA**: From 4 mA to 10 μA
- **5.000 mA**: From 400 μA to 100 μA
- **500.0 μA**: From 4 μA to 1 μA
- **50.00 μA**: From 4 μA to 1 μA

**Accuracy**

- **50.00 mA**: ±4.0% (+6% of readings)
- **5.000 mA**: ±4.0% (+6% of readings)
- **500.0 μA**: ±4.0% (+6% of readings)
- **50.00 μA**: ±4.0% (+6% of readings)

#### Voltage monitor accuracy

**Range**

- **300.0 V**: From 65 V to 300 V

**Guaranteed accuracy range**

- **300.0 V**: ±3% (±10% of reading)

**Accuracy**

- **300.0 V**: ±3% (±10% of reading)

#### Current monitor accuracy

**Range**

- **300.0 V**: From 65 V to 300 V

**Guaranteed accuracy range**

- **300.0 V**: ±3% (±10% of reading)

**Accuracy**

- **300.0 V**: ±3% (±10% of reading)

#### Safety conductor current accuracy

- **Measurements mode: DC / AC / AC+DC / AC peak**: ±20% of reading

#### Diagnostics

- **Diagnostics strength**: Between power supply terminals and protective ground: 1.9 kW (5 kA), 1 Hz
- **Between measurement terminals and power supply terminals: 2.8 kW (50 kA), 1 Hz
- **Between measurement terminals and instrument: 2.8 kW (50 kA), 1 Hz

#### Standard compliance

- **EMC**: EN 61326
- **EN 61000-3-2**
- **EN 61000-3-3**
- **Safety**: EN 61010

#### Conductive RF

- 3 V ±1 or less at 3 V

#### Magnetic field effects

- **Representative value when conducting measurements in the AC 500 μA range**
- **TEST LEAD L9170-10 × 1 set, ENCLOSURE PROBE 9195 × 1**, alligator clips x 1 set, power cord x 1 for instrument and 2 for measuring instrument, fully shielded, one free end (120 V VS 30 mA, measurement use)

#### Dimensions

- Approx. 320 (W) x 110 (H) x 253 (D) mm

#### Weight

- Approx. 4.5 kg

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*1 When using AC measurement mode, the high-pass filter frequency characteristics (fc = 4 Hz) are added.
*2 When ST5540 only.
*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.”
AC GROUNDING HiTESTER 3157

An essential safety conductor measuring instrument for standards testing

- Measuring between the grounding center and grounding terminal
  Verify that the electrical resistance between the medical outlet’s grounding electrode connector or medical ground terminal and medical ground center is less than or equal to 0.1 Ω by applying a current of approximately 25 A with an AC current with a no-load voltage of 6 V or less and measuring the resistance using the voltage droop method.

  *This measurement requires an extension cable (available separately). The extension cable is a special-order item; please contact your HIOKI distributor for more information.

**Combination of Instruments for Leak Current Testing and Safety Conductor Testing**

The following are key parts of any safety inspection of electrical equipment:
- Leak current test: Measure with the ST5540 and ST5541.
- Safety conductor test (also known as a ground line resistance test or ground conductor test): Measure with the 3157.

The 3157 can also be used for conducting measurements under the JIS T 1022:2006 safety standard for hospital electrical equipment.

**Standard compliance (examples)**
- IEC 60065
- IEC 60335-1
- IEC 60601-1
- IEC 60950-1
- IEC 61010-1
- JIS-C1010-1
- Electrical Appliances and Materials Safety Act
- UL (various applicable standards)

**Options**
- SAFETY TEST DATA MANAGEMENT SOFTWARE 9267
- REMOTE CONTROL BOX 9613 (single) (start/stop control use)
- GP-IB INTERFACE 9518-02
- GP-IB CONNECTOR CABLE 9151-02 (2 m)
- RS-232C INTERFACE 9593-02

*The 9442 printer can be used with the 9593-02 and CONNECTION CABLE 9446.

*When using the RS-232C CABLE 9638, the 3157’s handshake functionality is not available.

Instrument alone cannot perform measurements. Purchase either two CURRENT PROBE 9296 units or one each CURRENT PROBE 9296 and CURRENT APPLY PROBE 9297.

Safety Standard for Hospital Electrical Equipment

JIS T 1022:2006 Measurement

3157

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- Leak current test: Measure with the ST5540 and ST5541.
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- IEC 60950-1
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Instrument alone cannot perform measurements. Purchase either two CURRENT PROBE 9296 units or one each CURRENT PROBE 9296 and CURRENT APPLY PROBE 9297.
The optional PRINTER 9442 can be used to print data via the instrument’s RS-232C interface, providing a convenient way to attach a hard copy of test data.

### PRINTABLE DATA

Printable data (printed data can be selected from the following):

- Measurement date
- Allowable values
- Instrument name
- Maximum value
- Control number
- Judgment results
- Class (applied part)
- Measurement current (AC, DC, AC+DC, AC peak)
- Network
- Measurement mode
- Instrument status (normal, ground line broken)
- Filter settings

*CONNECTION CABLE 9444 and AC ADAPTER 9443 are required in order to connect the 9442 printer.

### Example printout

<table>
<thead>
<tr>
<th>Date</th>
<th>2010/09/10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instrument</td>
<td>ELECTRIC</td>
</tr>
<tr>
<td>Name</td>
<td>123456789123</td>
</tr>
<tr>
<td>No.</td>
<td>1231-B</td>
</tr>
<tr>
<td>Stat</td>
<td>G2</td>
</tr>
<tr>
<td>Network</td>
<td>TOUCH</td>
</tr>
<tr>
<td>Mode</td>
<td>ON</td>
</tr>
<tr>
<td>Filter</td>
<td>ON</td>
</tr>
<tr>
<td>Allowable values (upper limit)</td>
<td>150.0 mA</td>
</tr>
<tr>
<td>Allowable values (lower limit)</td>
<td>25.0 mA</td>
</tr>
<tr>
<td>Maximum value</td>
<td>48.24 mA</td>
</tr>
<tr>
<td>Judgement result</td>
<td>PASS</td>
</tr>
<tr>
<td>Polarity</td>
<td>REVERSE</td>
</tr>
<tr>
<td>Condition</td>
<td>EARTH</td>
</tr>
<tr>
<td>Other Condition</td>
<td>NAPPLY</td>
</tr>
<tr>
<td>Status</td>
<td>S10:ON</td>
</tr>
<tr>
<td></td>
<td>S12:ON</td>
</tr>
<tr>
<td></td>
<td>S13:OFF</td>
</tr>
</tbody>
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### CONVENIENCE

- The optional PRINTER 9442 can be used to print data via the instrument’s RS-232C interface, providing a convenient way to attach a hard copy of test data.

### LEAK CURRENT HiTESTER ST5540/ST5541

- **OPTION**
  - RS-232C CABLE 9637 (9-pin to 9-pin, cross, 1.8 m)
  - RS-232C CABLE 9638 (9-pin to 25-pin, cross, 1.8 m)
  - PRINTER 9442
  - AC ADAPTER 9443-01 (for printer, Japanese version)
  - AC ADAPTER 9443-02 (for printer, EU version)
  - CONNECTION CABLE 9444 (for printer)
  - RECORDING PAPER 1196 (25 m, 10 rolls)

### LEAK CURRENT HiTESTER ST5540

- **ST5540**
  - LEAK CURRENT HiTESTER ST5540
  - LEAK CURRENT HiTESTER ST5541

### Options

- RS-232C CABLE 9637 (9-pin to 9-pin, cross, 1.8 m)
- RS-232C CABLE 9638 (9-pin to 25-pin, cross, 1.8 m)
- PRINTER 9442
- AC ADAPTER 9443-01 (for printer, Japanese version)
- AC ADAPTER 9443-02 (for printer, EU version)
- CONNECTION CABLE 9444 (for printer)
- RECORDING PAPER 1196 (25 m, 10 rolls)

### PRINTABLE DATA

Printable data (printed data can be selected from the following):

- Measurement date
- Allowable values
- Instrument name
- Maximum value
- Control number
- Judgment results
- Class (applied part)
- Measurement current (AC, DC, AC+DC, AC peak)
- Network
- Measurement mode
- Instrument status (normal, ground line broken)
- Filter settings

*CONNECTION CABLE 9444 and AC ADAPTER 9443 are required in order to connect the 9442 printer.

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<tr>
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<tr>
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<tr>
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<td>EARTH</td>
</tr>
<tr>
<td>Other Condition</td>
<td>NAPPLY</td>
</tr>
<tr>
<td>Status</td>
<td>S10:ON</td>
</tr>
<tr>
<td></td>
<td>S12:ON</td>
</tr>
<tr>
<td></td>
<td>S13:OFF</td>
</tr>
</tbody>
</table>

### LEAK CURRENT HiTESTER ST5540/ST5541

- **ST5540**
  - LEAK CURRENT HiTESTER ST5540
  - LEAK CURRENT HiTESTER ST5541

### Options

- RS-232C CABLE 9637 (9-pin to 9-pin, cross, 1.8 m)
- RS-232C CABLE 9638 (9-pin to 25-pin, cross, 1.8 m)
- PRINTER 9442
- AC ADAPTER 9443-01 (for printer, Japanese version)
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