# TABLE OF CONTENTS

Notice ........................................... 1
Warranty ........................................... 1
Safety Precautions ................................ 2
Getting Started .................................. 3
  Overview ...................................... 3
  Controls ...................................... 6
  Power On ..................................... 7
  Menu Structures And Functions ............. 9
Measurement Features .......................... 20
  Measuring Resistance ......................... 20
  Measuring Capacitance ....................... 20
  Measuring Inductance ......................... 21
Maintenance .................................... 22
Labelling & Verification Requirements ...... 23
Appendix A. Specifications ..................... 24
Appendix B. Default Settings .................. 25
Appendix C. Accuracy Specification ......... 26
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SAFETY PRECAUTIONS

The following safety precautions should be observed prior to using this product and any associated accessories. Although devices and accessories would normally be used with non-hazardous voltages, there are situations where hazardous conditions may be present.

This product is intended for use by qualified personnel who recognize shock hazards and are familiar with the safety precautions required to avoid possible injury. Read and follow all installation, operation, and maintenance instructions carefully before using the product. Refer to the manual for complete product specifications.

If the product is used in a manner not specified, the protection provided by the product may be impaired.

Inspect the Smart Tweezers case before using. Do not use the device if it appears to be damaged.

• Do not use the device if it operates abnormally.
• Do not attempt to measure any components in-circuit when your circuit is alive or active.

To avoid possible damage to Smart Tweezers or to the equipment under test, follow these guidelines:

• Disconnect circuit power supply and discharge all high-voltage capacitors before testing resistance, inductance, or capacitance.
• Do not apply external voltages of more than 1.6 V.
• Use proper terminals and functions for your measurements.
• Only supplied charger (DC 5V) should be used to charge the battery.

SAFETY SYMBOLS AND TERMS

The WARNING heading in this manual indicates dangers that might result in personal injury or death. Always read the associated information very carefully before performing the indicated procedure.

The CAUTION heading in the manual indicates hazards that could damage the device. Such damage may invalidate the warranty.
This section summarizes basic operation of Smart Tweezers. In the section:

**OVERVIEW**: Overview of the device controls.

**POWER-ON**: Describes the power-on and power-off sequence, the warm-up time, and default conditions.

**DISPLAY**: Discusses the display format and messages that may appear while using the device.

**MENU STRUCTURE**: Covers menu structure, system settings and features.

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**OVERVIEW**

Smart Tweezers (ST) is a portable impedance measuring device. ST is capable of measuring resistance, capacitance or inductance over a range of more than 8 orders of magnitude. The device has a basic accuracy better than 0.2% (resistance) and operates at four test frequencies.

Smart Tweezers is controlled by a microcontroller that sets measurement conditions, processes data and operates the display and user interface. The device has a unique mechanical design that allows manipulation SMT components with size down to 0201.

In actual use Smart Tweezers provides more accurate results than most of the benchtop LCR meters due to small and very predictable parasitics of its probes. Probability of measurement errors associated with setup (wires, tips, probes and etc.) is minimal.
HOW IT WORKS

ST evaluates impedance of a component by measuring the voltage across the component and current through it. The complex ratio of voltage to current is equal to the complex impedance. The unit’s processor calculates various parameters that are displayed i.e. R, C or L.

Voltage across the component is generated by the test signal source Vs. Both the amplitude and frequency of Vs can be set. The voltage is applied to the device under test (DUT) through the source resistance Rs. Current flows to the virtual ground of the current amplifier AI, and through the current conversion resistor Ri. The output of AI provides a signal proportional to the current, $I*R_i$.

Voltage across the DUT is measured by a separate signal path (amplifier AU), thus providing a pseudo 4-wire Kelvin connection.

Voltage and current signals are processed by the A/D converter. Obtained values are then corrected using calibration factors, converted to impedance and sent to the display.

There are four selectable frequencies: 100Hz, 120Hz, 1.0kHz and 10kHz. The output frequency is accurate to 50 ppm (0.005%). Frequencies are set in the menu or by moving the Navigation Control UP.

There are three output voltage levels that can be selected: 0.5 Vrms and 1.0 Vrms. The accuracy of the output voltage levels is 2 %.

The output voltage is applied to the device under test through the source impedance. The voltage across the device is always less than or equal to the output voltage. The source impedance value is 100Ω.
Certain devices require a specific test voltage, such as Z5U ceramic capacitors (test voltage = 0.5 Vrms for 25V parts and 1.0V for < 16V parts).

Note: Use the largest voltage possible for the best SNR and accuracy.

**CONTROLS**

**The Navigation Control**

The navigation switch is used to select a function or to change a setting of Smart Tweezers. The navigation switch can be moved (rocked) in 4 directions (UP, DOWN, LEFT, RIGHT). Selection is performed by pressing along the vertical axis (PRESS).

**Quick Controls**

The Quick Controls allow changing test parameters or modes without entering the general menu by moving the Navigation Control UP, DOWN, LEFT and RIGHT as shown below.

*Note:* To avoid errors do not use the Quick Controls during component measurement.
To turn the Smart Tweezers ON, press the navigation switch twice.

**Note:** Once powered on, the unit will perform the last selected function.

ST6 powers off automatically if neither a measurement is performed nor the navigation control is operated for approximately 30 seconds (default value).

The power off timeout value can be set by changing the TIMEOUT setting in the SYSTEM menu.

The default power-off timeout is 30 seconds in a measurement mode and 30 seconds in the MENU mode.

**Note:** Automatic power-off does not occur if test frequency is manually set to 10kHz.

The screen is divided in four areas:

- Primary Display
- Secondary Display
- Test Parameters
- Device Status with Test Mode Indicator

**Primary Display**

**Secondary Display**

**Test Parameters**

**Device Status with Test Mode Indicator**
PRIMAR Y DISPLAY: The Primary Display is located in the middle of the screen and uses the largest font. It shows the dominant impedance parameter reading typically with 5 digits displayed.

SECONDARY DISPLAY: The Secondary Display is located just above the Primary Display. It shows the minor impedance parameter reading.

TEST PARAMETERS: The Test Parameters area is at the top of the screen and provides information about current test conditions such as Test Frequency, Range, Test Signal level, Test Model.

DEVICE STATUS: The Device Status area is at the bottom of the screen and provides information about the current Test Mode and settings of the device: Hold, Audio and Battery Status.

TEST MODE INDICATOR: The Test Mode Indicator sign is located immediately to the left of the Primary Display.

Symbols A, R, L, C, |Z|, ESR and Diode indicate Auto, Resistance, Inductance, Capacitance, Impedance and ESR measurement and Diode Test mode respectively.

DISPLAYED PARAMETERS

The measurement mode setting (R, L+R, C+R, C+D, L+Q, |Z|, ESR and AUTO) determines the measurement type and the displayed parameters

R MODE: Resistance is shown on the Primary Display. The resistance displayed is either the equivalent series or parallel resistance of the DUT. Resistance units are mΩ, Ω, kΩ, or MΩ.

L+R MODE: Inductance is shown on the Primary Display and the series resistance on the Secondary Display. The units of inductance are µH, mH or H. Resistance is the real part of the impedance. Resistance units are mΩ or Ω. Serial equivalent circuit is used in this mode.

L+Q MODE: Inductance is shown on the Primary Display and the quality factor Q on the Secondary Display. Inductance units are µH, mH or H. Q is the ratio of the imaginary part of the impedance to the real part of the impedance. Q is dimensionless and the same for both series and parallel representations. A good inductance has a large L and a small R and thus a high Q.
**C+R MODE:** Capacitance is shown on the Primary Display and the parallel resistance R, is shown on the Secondary Display. The units of capacitance are pF, nF, or μF. Resistance units are Ω or kΩ. Parallel (C < 500 pF) or serial (C > 500 pF) equivalent circuit diagram is used.

**C+D MODE:** Capacitance is shown on the Primary Display and dissipation factor D on the Secondary Display. The capacitance is either the equivalent series or parallel capacitance of the DUT. The units of capacitance are pF, nF, μF or mF. D is the ratio of the real part of the impedance to the imaginary part of the impedance, or 1/Q. D is dimensionless and the same for series and parallel representations. A good capacitor has a large C (imaginary) and a small R (real) and thus a low D.

**|Z| MODE:** The Impedance of the component is shown on Primary Display. Units are mΩ, Ω, kΩ, or MΩ.

**ESR MODE:** The equivalent series resistance of the capacitor is shown on the Primary Display. ESR units are mΩ, Ω, kΩ, or MΩ.

**AUTO MODE:** ST determines which component model is the most accurate representation of the DUT and automatically selects the appropriate parameter set. The determination is made as follows:

- For |Q| < 0.15 the R mode is selected.
- For Q > +0.15 the L+R or L+Q mode is selected (depends on user settings).
- For Q < -0.15 the C+R or C+D mode is selected.
- For C < 500 pF Parallel circuit diagram (Rp) is used.
- For C >= 500 pF Serial circuit diagram (Rs) is used.

**MENU STRUCTURES AND FUNCTIONS**

This section describes menu structure and device parameters setting. Smart Tweezers menu system contains

- Main menu — main menu items
- System menu — system menu items
- Sound menu – sound settings
- Display menu — display settings
• Service menu — service functions
• Measurement menu – measurement functions and settings
• Mode menu – measurement modes
• Setting menu – measurement parameters settings

NAVIGATING MENUS

Move the Navigation Control UP or DOWN to move cursor to the desired menu item and PRESS it to select the item. The Current Setting cursor indicates the current setting.

MAIN MENU

Main menu is used to access System menu, Measurement menu or to restore measurement parameters to the default state using Autoset.
• Select AUTOSET to reset parameters to the default settings.
• Select SYSTEM to change user interface and operation parameters.
• Select MEASURE to specify measurement settings.
**SYSTEM MENU**

System menu is used to access system settings and functions.

- SOUND
- DISPLAY
- TIMEOUT
- SERVICE
- EXIT

**SOUND MENU**

- R-TONE
  - ON
  - OFF

Sound menu is used to change the sound setting for measurement confirmation.

Select ON ⬅️ to enable the measurement confirmation sound.

Select OFF ⬅️ ⏯️ to disable sound for all functions except for the Navigation Control operation.

Select R-TONE to enable a special mode when beep frequency varies depending on the measured resistance value in the Resistance Mode (see the Measurement Menu section). Resistance thresholds for the R-TONE variations are preset to

- Higher than 20 Ohm
- 10 Ohm
- 5 Ohm
- Ohm
- 0.5 Ohm and lower.
The mode could be used for locating shorted part of a circuit e.g. on a PCB.

**DISPLAY MENU**

<table>
<thead>
<tr>
<th>RIGHT</th>
<th>LEFT</th>
<th>CONTR</th>
<th>EXIT</th>
</tr>
</thead>
</table>

Display menu is used to change display’s settings
- Select RIGHT to set the “Right Handed” display mode
- Select LEFT to set the “Left Handed” display mode

**CONTRAST**

```
CONTRAST
CONTRAST
```

Select CONTR to adjust display contrast. Move Navigation Control UP or DOWN to change contrast. PRESS to exit menu at the adjusted contrast level.

**TIME OUT**

```
TIMEOUT
30.00
```

Select TIMEOUT to adjust the timeout before the unit goes to sleep mode. Move Navigation Control UP or DOWN to change the timeout value (10sec – 200sec) PRESS to exit the menu.

**SERVICE MENU**

<table>
<thead>
<tr>
<th>BATTERY</th>
<th>S/N</th>
<th>EXIT</th>
</tr>
</thead>
</table>

11
BATTERY

Select BATTERY to measure the actual battery voltage. PRESS to exit

SERIAL NUMBER

Select S/N to display the device Serial Number and the firmware version.

MEASUREMENT MENU

Measurement modes and settings

MODE MENU

The Mode menu is used to set the measurement mode. Select RES, IND, CAP, IMP or ESR menu items to measure desirable component or parameter as Resistance, Inductance, Capacitance, Impedance and ESR accordingly. For automatic measurement select AUTO (default).
**AUTO MODE:** Select AUTO mode (AM sign appears at the left bottom corner of display) for automatic measurement of inductance, capacitance or resistance.

**Note:** In the AUTO mode ST uses 1kHz test frequency by default and has a limited sensitivity. Automatic detection may not work for small value capacitors and inductors. In this case 10kHz test frequency must be used.

**RESISTANCE MODE:** Enables Resistance measurement mode. See section MEASUREMENT FEATURES for more information.

**INDUCTANCE MODE:** Enables Capacitance measurement mode. See section MEASUREMENT FEATURES for more information.

**CAPACITANCE MODE:** Enables Capacitance measurement mode. See section MEASUREMENT FEATURES for more information.

**IMPEDANCE MODE:** Enables the Impedance measurement mode.

**Note:** See section MEASUREMENT FEATURES for more information.

**ESR MODE:** Enables the ESR measurement mode. See section MEASUREMENT FEATURES for more information.

**DIODE TEST MODE:** Enables diode test mode showing diode polarity or SHORT indicating a faulty diode

**DCR MODE:** Enables DCR resistance measurement mode. The DCR measurement measures the resistance of an unknown component by applying DC voltage.
SETTING MENU

Use this menu to set specific measurement parameter.

TEST FREQUENCY MENU

Use this menu to set desired test frequency.

The following combinations are allowed:

• C+R capacitance + resistance
• C+D capacitance + dissipation factor
• L+R inductance + resistances
• L+Q inductance + quality factor
LEVEL MENU

Use this menu to set desirable test signal level. Default value is 1.0 Vrms.

Note: 1.0 Vrms is equal to 2.8 Vp-p

MODEL MENU

Any non-ideal component can be represented as a resistive component in series or in parallel with a reactive component. Depending upon the characteristics of the component the series or parallel model will be more accurate. In most cases, parts are best approximated by the series model. Manufacturers often specify which representation should be used when testing their devices.

The LCR meter can display Automatic (A) Parallel ( S ) or Series ( P ) model data. Use this menu to choose the parallel and series model.

Series model is set as the default setting

TOLERANCE MENU

This function is designed for component sorting. It checks whether the measured component is within preset tolerance from the reference component. The tolerance ranges available are 1%, 5%, 10%, and 20%.
To preset a tolerance range:

• Select manual L, C or R measurement mode (see MODE menu)
• Enable the HOLD mode (see HOLD menu)
• Connect to an appropriate component selected as a reference value
• Enter the TOLERance menu and select desired tolerance range

Smart Tweezers will display difference in percent from the reference value and the beeper will beep

• 1 time when the component is within the setting tolerance.
• 3 times whenever the component under test exceeds the setting tolerance.

To reset the tolerance mode select AUTOSET from the main menu or DEFAULT from the settings menu.

NULL MENU

Allows storing of measurement offsets to perform relative measurements (NULL).

When relative measurements are performed, also called null, each reading is the difference between a stored (measured) relative value or offset and the input signal.

One common application is to increase the accuracy of a small resistance measurement by storing (nulling) the test lead resistance (test leads shorted).

Obtaining the leads offset (nulling) is also particularly important prior to making small capacitance measurements (test leads open).

Smart Tweezers allows to store measurement offset for L, C, R component separately.
To store an offset

• Select manual L, C or R measurement mode (see MODE menu)
• Enable the HOLD mode (see HOLD menu)
• Obtain offset value by measuring a component or by nulling test leads (see examples below)
• Enter the NULL menu and select SET

**Example 1:** Nulling test leads for small resistance measurement

- Select manual R measurement mode (see MODE menu)
- Enable the HOLD mode (see HOLD menu)
- Short tweezers leads to obtain offset value
- Enter the NULL menu and select SET

**Example 2:** Nulling test leads for small capacitance measurement

- Select manual C measurement mode (see MODE menu) and 10KHz test frequency (see SETTINGS menu)
- Enable the HOLD mode (see HOLD menu)
- Bring tweezers leads to the distance equal to the size of the component to measure (e.g. 0.5 mm) to obtain capacitance offset value
- Enter the NULL menu and select SET

During measurements an asterisk will appear beside the test mode indicator for which the offset has been stored indicating relative measurement.
To reset (set to zero) the stored offset for a particular test mode
- Select manual L, C or R measurement mode (see MODE menu)
- Enable the HOLD mode (see HOLD menu)
- Enter the NULL menu and select ZERO

To reset the NULL mode completely select AUTOSET from the main menu or DEFAULT from the SETTINGS menu.

**HOLD MENU**
Allows to hold last reading on display.

**PERIOD MENU**
Period menu is used to set the time period between measurements. This setting does not affect measurement accuracy.
Default setting is 1sec.

**Note:** Short period may reduce the battery life.
This section describes specific ST functions and settings.

Measuring resistance | Covers resistance measurements.
Measuring capacitance | Covers capacitance measurements.
Measuring inductance | Covers inductance measurements.
Testing diodes | Describes testing general-purpose diodes.

**MEASURING SMALL RESISTANCE**

There is some small resistance offset due to the resistance of the tweezer tips, and resistance of the contacts between the tips and DUT. Typical offset value is less than 25 mΩ and may increase if the gold on the tweezer tips wears out. The offset value should be used in calculation of the actual resistance.

**MEASURING CAPACITANCE**

<table>
<thead>
<tr>
<th>Test frequency</th>
<th>0.1kHz/1 kHz/10kHz/120Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test signal amplitude</td>
<td>0.5/1.0 Vrms Sine wave</td>
</tr>
<tr>
<td>Source impedance</td>
<td>100 Ω</td>
</tr>
<tr>
<td>Test period</td>
<td>1 Sec (default)</td>
</tr>
<tr>
<td>Equivalent circuit diagram</td>
<td>Parallel (C &lt; 500 pF), Serial( C &gt; 500 pF)</td>
</tr>
</tbody>
</table>

In AUTO mode the Smart Tweezers first tries to perform measurement at 1kHz and then automatically selects the best test frequency. The device is capable of measuring capacitance from approximately 3 pF to 199 μF in AUTO mode.

To measure capacitance lower than 4 pF select 10kHz test frequency manually. To measure capacitance higher than 200 μF use 100Hz or 120Hz.
DUT | Optimal test frequency
---|---
<10000pF | 10 kHz
10001pF- 10μF | 1 kHz

There is some small capacitance offset due to capacitance of the tips. The offset depends on the distance between the tips (i.e. measured component size). The offset value should be used in calculation of the actual capacitance.

Table below shows typical offset values for different component sizes:

<table>
<thead>
<tr>
<th>Component size</th>
<th>Offset, pF</th>
</tr>
</thead>
<tbody>
<tr>
<td>1206</td>
<td>0.58</td>
</tr>
<tr>
<td>0805</td>
<td>0.6</td>
</tr>
<tr>
<td>0603</td>
<td>0.65</td>
</tr>
<tr>
<td>0402</td>
<td>0.7</td>
</tr>
</tbody>
</table>

**MEASURING INDUCTANCE**

Test frequency | 0.1kHz/1 kHz/10kHz/120Hz
Test signal amplitude | 0.5/1.0 Vrms Sine wave
Source impedance | 100 Ω
Test period | 1 Sec (default)
Equivalent circuit diagram | Serial

In AUTO mode ST automatically selects the best test frequency and is capable of measuring inductance from 1 μH to 1kH. To measure inductance lower than 5μH or more than 500mH select test frequency manually:

DUT | Optimal test frequency
---|---
<1 mH | 10 kHz
1 mH - 1000 mH | 1 kHz
> 1000 mH | 100 Hz
ESR MEASUREMENTS

Use the ESR measurement to measure the equivalent series resistance of a capacitor independent of its capacitance.

Test frequency 0.1kHz/1 kHz/10kHz/120Hz
Test signal amplitude 0.5/1.0 Vrms Sine wave
Source impedance 100 Ω
Test period 1 Sec (default)
Equivalent circuit diagram Serial

MEASURING IMPEDANCE (|Z|)

All circuit components, resistors, capacitors, and inductors have parasitic components. Thus, simple components should be modeled as complex impedances.

Test frequency 0.1kHz/1 kHz/10kHz/120Hz
Test signal amplitude 0.5/1.0 Vrms Sine wave
Source impedance 100 Ω
Test period 1 Sec (default)
Equivalent circuit diagram Serial

MAINTENANCE

GENERAL MAINTENANCE: Dirt or moisture on the tips may affect measurement accuracy. Clean the tips regularly. Do not use abrasives or solvents.

To clean the tips:
1. Shake off any dirt that may be on the tips.
2. Soak a swab in alcohol. Work the swab around each tip.
LOW BATTERY INDICATION

The empty battery icon on the display indicates that device’s battery voltage is low and it should be recharged. The warning appears when the battery voltage drops below 3.55V, i.e. the batteries are about 90% depleted. The unit is still operational for a short time; however the batteries should be recharged as soon as possible.

**Note:** To charge the battery use supplied USB (5V) charger or a computer USB port.

TROUBLESHOOTING

If there appears to be a malfunction during an operation of the device, the following steps could be performed in order to troubleshoot the problem:

1. Check battery voltage and recharge if necessary.
2. Review this manual for possible mistakes in the operating procedure.
3. Reset device by reconnecting battery (requires top lid and the circuit board removal).

**CAUTION:** Smart Tweezers repairs should only be performed by an Authorized Service Center or by qualified service personnel.

LABELLING & VERIFICATION REQUIREMENTS

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference; and,
2. This device must accept any interference received, including interference that may cause undesired operation.
APPENDIX A. SPECIFICATIONS

TECHNICAL SPECIFICATIONS

AC test mode Test frequency:
- 1 kHz, 10 kHz, 120Hz, 100 Hz

Test frequency accuracy:
- 50 PPM (0.005%)  

Test signal level:
- 0.5/1.0 +/- 5% Vrms Sine wave

Source impedance:
- 100Ω +/- 1%

TYPICAL OFFSET:

Resistance ≤ 25 mΩ

Capacitance 0.65 pF

Inductance 100 μH

Offset value should be subtracted from measurement result for small value components (R < 10Ω, C < 100 pF, L < 10 μH).

MEASUREMENT RANGES

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Measurement Range</th>
<th>Test frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistance</td>
<td>&lt; 9.9 MΩ</td>
<td>1 kHz</td>
</tr>
<tr>
<td>Capacitance</td>
<td>&lt; 9999 pF</td>
<td>10 kHz</td>
</tr>
<tr>
<td></td>
<td>10000 pF to 10 μF</td>
<td>1 kHz</td>
</tr>
<tr>
<td></td>
<td>&gt; 10 μF</td>
<td>100 Hz</td>
</tr>
<tr>
<td>Inductance</td>
<td>0.5 μH to 1 mH</td>
<td>10 kHz</td>
</tr>
<tr>
<td></td>
<td>1 mH to 1000 mH</td>
<td>1 kHz</td>
</tr>
<tr>
<td></td>
<td>&gt; 1000 mH</td>
<td>100 Hz</td>
</tr>
</tbody>
</table>
### MAXIMUM MEASUREMENT RANGES

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistance R:</td>
<td>0.05 Ω to 9.9 MΩ</td>
</tr>
<tr>
<td>Capacitance C:</td>
<td>0.5 pF to 999 μF</td>
</tr>
<tr>
<td>Inductance L:</td>
<td>0.5 μH to 999 mH</td>
</tr>
<tr>
<td>Quality factor Q:</td>
<td>0.001 to 1000 *</td>
</tr>
<tr>
<td>Dissipation factor D:</td>
<td>0.001 to 1000 *</td>
</tr>
</tbody>
</table>

### MAXIMUM RESOLUTION

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacitance C:</td>
<td>0.1 pF</td>
</tr>
<tr>
<td>Inductance L:</td>
<td>0.1 μH</td>
</tr>
<tr>
<td>Quality factor Q:</td>
<td>0.001</td>
</tr>
<tr>
<td>Dissipation factor D:</td>
<td>0.001</td>
</tr>
<tr>
<td>Phase angle F:</td>
<td>0.1 deg</td>
</tr>
</tbody>
</table>

* indication of the parameter not implemented in some versions

### Auto mode Read-out:

- Equivalent circuit diagram
- Serial/Parallel for C/R
- Serial for L/R

### Manual Mode Read-out

- Equivalent circuit diagram: Parallel or serial
- Measurement update rate: Up to 4 measurements per second

### Battery Type:

3.7V LiPO rechargeable 180mAH

### Typical charge time:

2.5 hours, current <100mA

### Calibration:

Recommended interval 1 year
NIST traceable calibration
APPENDIX B. DEFAULT SETTINGS

Default settings after AUTOSET command

- SOUND mode: OFF
- DISPLAY mode: No change
- Contrast: No change
- Readings PERIOD: 1 sec
- Measurement mode: AUTO
- Test frequency mode: AUTO
- Offset CALIBRATION: No change

APPENDIX C. ACCURACY SPECIFICATION

RESISTANCE, IMPEDANCE.

<table>
<thead>
<tr>
<th>Range</th>
<th>Resolution</th>
<th>100 Hz</th>
<th>1 kHz</th>
<th>10kHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Ω</td>
<td>0.001 Ω</td>
<td>0.7% + 50</td>
<td>0.7% + 50</td>
<td>0.7% + 50</td>
</tr>
<tr>
<td>10 Ω</td>
<td>0.01 Ω</td>
<td>0.7% + 8</td>
<td>0.7% + 8</td>
<td>0.7% + 8</td>
</tr>
<tr>
<td>100 Ω</td>
<td>0.01 Ω</td>
<td>0.2% + 3</td>
<td>0.2% + 3</td>
<td>0.2% + 3</td>
</tr>
<tr>
<td>1000 Ω</td>
<td>0.1 Ω</td>
<td>0.2% + 3</td>
<td>0.2% + 3</td>
<td>0.2% + 3</td>
</tr>
<tr>
<td>10 kΩ</td>
<td>0.001 kΩ</td>
<td>0.2% + 3</td>
<td>0.2% + 3</td>
<td>0.2% + 3</td>
</tr>
<tr>
<td>100 kΩ</td>
<td>0.01 kΩ</td>
<td>0.5% + 5</td>
<td>0.5% + 5</td>
<td>0.5% + 5</td>
</tr>
<tr>
<td>1000 kΩ</td>
<td>0.1 kΩ</td>
<td>0.5% + 5</td>
<td>0.5% + 5</td>
<td>0.5% + 5</td>
</tr>
<tr>
<td>10 MΩ</td>
<td>0.001 MΩ</td>
<td>2.0% + 8</td>
<td>2.0% + 8</td>
<td>5.0% + 8</td>
</tr>
</tbody>
</table>

Accuracy for the ranges 1 Ω ~ 100 Ω is specified after subtract of the offset resistance.
## CAPACITANCE

<table>
<thead>
<tr>
<th>Range</th>
<th>Resolution</th>
<th>100 Hz</th>
<th>120 Hz</th>
<th>1 kHz</th>
<th>10 kHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000 µF</td>
<td>0.1 µF</td>
<td>0.5% + 5</td>
<td>0.5% + 5</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>100 µF</td>
<td>0.01 µF</td>
<td>NA</td>
<td>0.3% + 3</td>
<td>0.5% + 5</td>
<td>NA</td>
</tr>
<tr>
<td>10 µF</td>
<td>0.001 µF</td>
<td>NA</td>
<td>0.2% + 3</td>
<td>0.2% + 3</td>
<td>NA</td>
</tr>
<tr>
<td>1 µF</td>
<td>0.1 nF</td>
<td>NA</td>
<td>0.2% + 3</td>
<td>0.2% + 3</td>
<td>0.2% + 3</td>
</tr>
<tr>
<td>100 nF</td>
<td>0.01 nF</td>
<td>NA</td>
<td>0.2% + 3</td>
<td>0.2% + 3</td>
<td>0.5% + 3</td>
</tr>
<tr>
<td>10 nF</td>
<td>0.001 nF</td>
<td>NA</td>
<td>0.5% + 5</td>
<td>0.2% + 3</td>
<td>0.5% + 3</td>
</tr>
<tr>
<td>1000 pF</td>
<td>0.1 pF</td>
<td>NA</td>
<td>NA</td>
<td>0.5% + 5</td>
<td>0.5% + 3</td>
</tr>
<tr>
<td>100 pF</td>
<td>0.01 pF</td>
<td>NA</td>
<td>NA</td>
<td>0.5% + 10</td>
<td>0.8% + 20</td>
</tr>
<tr>
<td>10 pF</td>
<td>0.001 pF</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>1.0% + 50</td>
</tr>
</tbody>
</table>

Accuracy for the ranges of 10 pF~1000 pF is specified after subtract of the stray capacitances for test leads.

## INDUCTANCE

<table>
<thead>
<tr>
<th>Range</th>
<th>Resolution</th>
<th>100 Hz</th>
<th>1 kHz</th>
<th>10 kHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 µH</td>
<td>0.001 µH</td>
<td>NA</td>
<td>NA</td>
<td>1.0% + 5</td>
</tr>
<tr>
<td>100 µH</td>
<td>0.01 µH</td>
<td>NA</td>
<td>1.0% + 5</td>
<td>0.7% + 3</td>
</tr>
<tr>
<td>1 mH</td>
<td>0.1 µH</td>
<td>0.7% + 10</td>
<td>0.5% + 3</td>
<td>0.5% + 3</td>
</tr>
<tr>
<td>10 mH</td>
<td>0.001 mH</td>
<td>0.5% + 3</td>
<td>0.2% + 3</td>
<td>0.5% + 3</td>
</tr>
<tr>
<td>100 mH</td>
<td>0.01 mH</td>
<td>0.5% + 3</td>
<td>0.2% + 3</td>
<td>NA</td>
</tr>
<tr>
<td>1 H</td>
<td>0.1 mH</td>
<td>0.2% + 3</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

* at optimum test frequency, ranges, without calibration offset