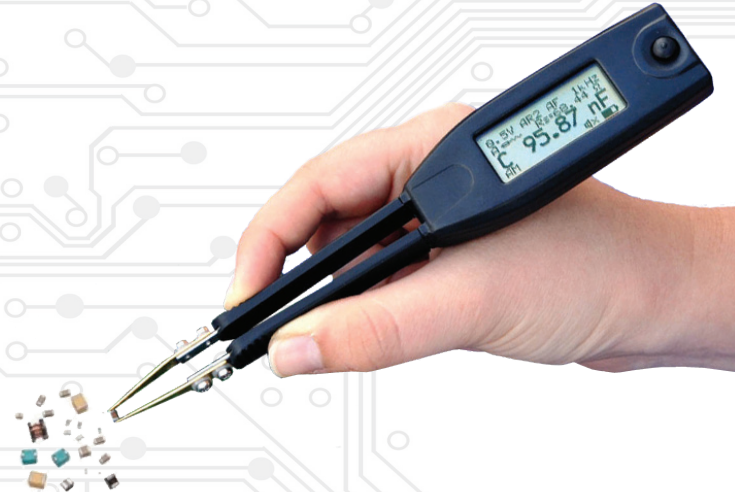


INTELLITWEEZE® R-C-L METER



by **EXCELTA®**
Precisely Right

EXCELTA®

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TM-500 User Manual

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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.

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 g 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.

GETTING STARTED

This section summarizes basic operation of Smart Tweezers. In the section:

OVERVIEW: Overview of the device Controls – Describes 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.

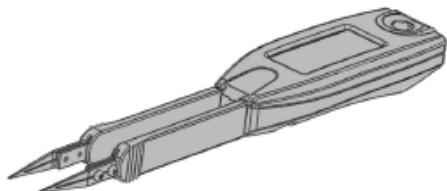
MENU STRUCTURE: Covers menu structure, system settings and features.

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.

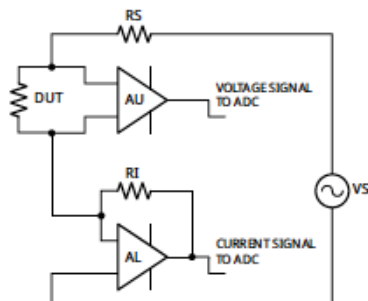
Smart Tweezers is controlled by a microcontroller that sets measurement conditions, processes data and operates the display and user interface. The device has a unique mechanical design that allows manipulation SMT components with size down to 0201.

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 V_s . Both the amplitude and frequency of V_s can be set. The voltage is applied to the device under test (DUT) through the source

output of AI provides a signal proportional to the current, $I \cdot R_i$.

Voltage across the DUT is measured by a separate signal path

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 Controller to the RIGHT.

There are three output voltage levels that can be selected: 0.25 Vrms, 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. Source impedance values are

The source impedance is selected as a function of the measurement range. For most devices, including resistors, most capacitors and many inductors, the 1.0 Vrms setting provide best result. For some inductors and active devices, the 0.25 or 0.5 Vrms setting should be used.

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.

The ST5 provides three measurement ranges (R1-R3). Each of the three ranges has the source impedance of approximately

impedance ranges for each of the measurement ranges.

Range	Source R	DUT Impedance
1		
2		
3		

Note: Measurement ranges determine an impedance range (not a value range), so the ranges for inductance and capacitance depend upon the test frequency. In addition, the impedance for capacitors is inversely proportional to its capacitance, so larger capacitors are measured in lower impedance ranges.

During normal operations the unit automatically changes to the optimal range for the DUT. There is a built-in hysteresis allowing to avoid repeated range changes when a component is near a range boundary. The auto-ranging function can be disabled by user.

Range holding is helpful if a number of parts with similar values are

CONTROLS

The Navigation Controller

The controller is used to select a function or to change a setting of Smart Tweezers. The controller 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 Controller UP, DOWN, LEFT and RIGHT as shown below.

Note: To avoid errors do not use the Quick Controls during component measurement. The Navigation Controller response time depends on the current test frequency.

The following table summarizes functions of the Navigation Controller moves:

UP – change test signal levels	LEFT – change measurement modes
DOWN – change test ranges	RIGHT – change test frequencies

POWER ON

POWER-ON - To turn the Smart Tweezers ON, press the Navigation Controller.

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

POWER-OFF - ST powers off automatically if neither a measurement is performed nor the navigation controller 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.

DISPLAY

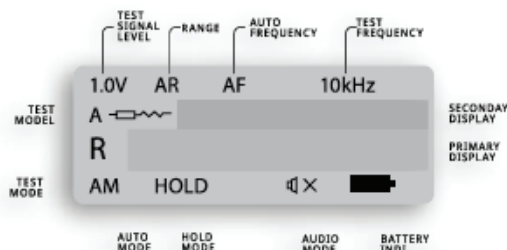
The screen is divided in four areas:

Primary Display

Secondary Display

Test Parameters

Device Status with Test Mode Indicator



PRIMARY 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 The resistance displayed is either the equivalent series or parallel resistance

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

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_p is shown on the Secondary Display. The units

($C < 500$ 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

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

ESR MODE: The equivalent series resistance of the capacitor is

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 (R_p) is used.

For $C \geq 500$ pF Serial circuit diagram (R_s) 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

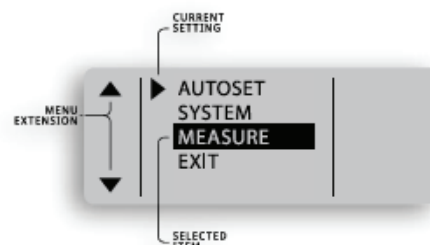
Measurement menu – measurement functions and settings

Mode menu – measurement modes

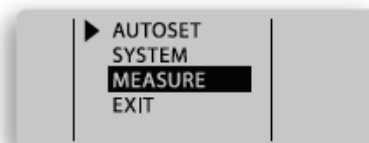
Setting menu – measurement parameters settings

NAVIGATING MENUS

Move the Navigation Controller 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.

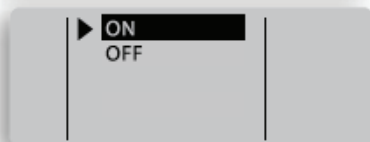
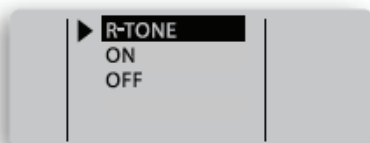
Select MEASURE to specify measurement settings.

SYSTEM MENU


System menu is used to access system settings and functions.




SOUND MENU



Sound menu is used to change the sound setting

Select ON 

Select OFF  X to disable sound for all functions except for the Navigation Controller 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



Display menu is used to change display's settings

Select RIGHT to set the "Right Handed" display mode

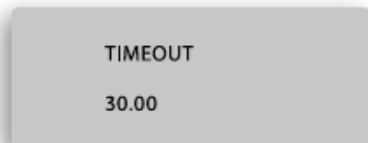
Select LEFT to set the "Left Handed" display mode

CONTRAST



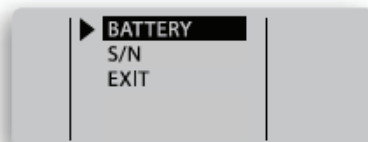
Select CONTR to adjust display contrast. Move Navigation Controller UP or DOWN to change contrast. PRESS to exit menu at the adjusted contrast level.

TIME OUT



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

SERVICE MENU



BATTERY

4.18V

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

SERIAL NUMBER

NNN.NNN.NN.NN

VERSION 1.01

Select S/N to display the device Serial Number

MEASUREMENT MENU

► MODE
SETTING
HOLD
PERIOD
EXIT

Measurement modes and settings

MODE MENU

► AUTO
RES
IND
CAP
IMP
▼ ESR
DIODE
EXIT

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.

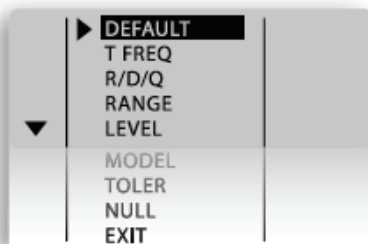
ESR MODE: Enables the ESR measurement mode. See section MEASUREMENT FEATURES for more information.

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



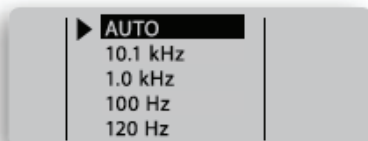
SHORT

SETTING MENU



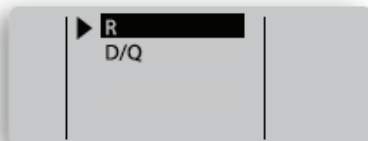
TEST FREQUENCY MENU

Use this menu to set desired test frequency.



RDQ MENU

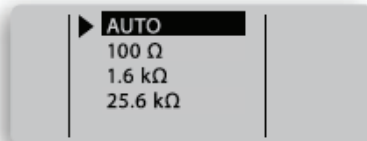
Use this menu to set secondary display parameter.



The following combinations are allowed:

- C+R capacitance + resistance
- C+D capacitance + dissipation factor
- L+R inductance + resistances
- L+Q inductance + quality factor

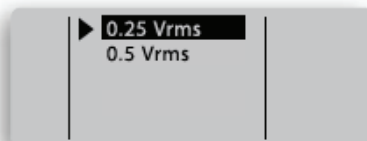
RANGE MENU



Use this menu to set desirable source impedance range. Default value is auto-ranging (AUTO).

Note: Auto-ranging procedure starts from R2 (1kOhm)

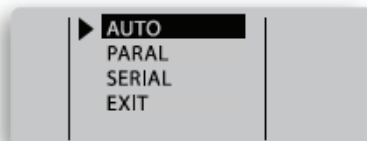
LEVEL MENU



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.

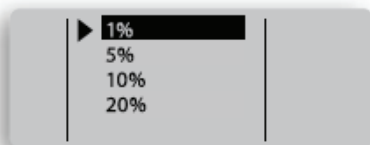
Series model is set as the default setting

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%.

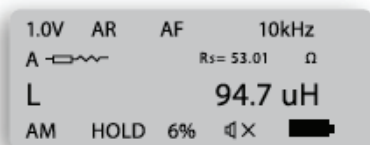
To preset a tolerance range:

- 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 AUTOSSET 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

- 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)

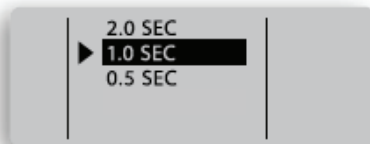
Enter the NULL menu and select ZERO

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.

MEASUREMENT FEATURES

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

increase if the gold on the tweezer tips wears out. The offset value should be used in calculation of the actual resistance.

MEASURING CAPACITANCE

Test frequency

0.1kHz/1 kHz/10kHz

Test signal amplitude

0.25/0.5/1.0 Vrms Sine wave

Source impedance

Test period

1 Sec (default)

Equivalent circuit diagram

Parallel (C < 500 pF),
Serial (C > 500 pF)

measurement at 1kHz and then automatically selects the best test frequency. The device is capable of measuring capacitance

To measure capacitance lower than 4 pF select 10kHz test frequency

DUT	Optimal test frequency
<10000pF	10 kHz
	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:

Component size	Offset, pF
1206	0.58
0805	0.6
0603	0.65
0402	0.7

MEASURING INDUCTANCE

Test frequency	0.1kHz/1 kHz/10kHz
Test signal amplitude	0.25/0.5/1.0 Vrms Sine wave
Source impedance	62.5/1k/16k ohm
Test period	1 Sec (default)
Equivalent circuit diagram	Serial

In AUTO mode ST automatically selects the best test frequency and is

DUT	Optimal test frequency
	10 kHz
	1 kHz
> 100 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
Test signal amplitude	0.25/0.5/1.0Vrms Sine wave
Source impedance	
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/1kHz/10kHz
Test signal amplitude	0.25/0.5/1.0 Vrms Sine wave
Source impedance	
Test period	1 Sec (default)
Equivalent circuit diagram	Serial

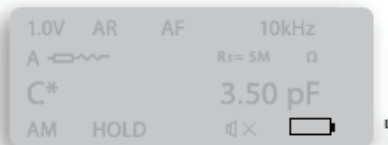
MAINTENANCE

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 front lead removal).

CAUTION: Smart Tweezers repairs should only be performed by

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.