SOURCETRONIC
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User Manual
ST2822D/E Handheld LCR Meter

Contents

1 Safety

1.1 Safety Summary

The following safety precautions are applicable to both operating and maintenance personnel and must be observed during all phases of operation, service, and repair of this instrument.

- **Do not operate in a flammable or explosive atmosphere!**

- **Do not operate the instrument in the presence of much dust, direct sunlight, high humidity, strong electromagnetic radiation, etc!**

- **Non-professionals should not open the rear cover!**
  Maintaining, substituting parts or adjusting the instrument should be made by professional maintenance personnel. Please contact relevant distributor or Sourcetronic's after-sale service department.

- **Do not remove or modify the instrument!**
  Some replacements and unauthorized modifications might cause irreversible damage to the instrument.

WARNING!
⚠️ Strictly follow the relevant safety statements in this manual involving safety to avoid personnel injury, damage to the instrument, as well as guidelines for operation and environmental conditions that may interfere with test results!

1.2 Safety Guidelines

To ensure that you use this device safely, follow the safety guidelines listed below:

- This meter is for indoor use, altitude up to 2000 m. For short-time outdoor use, precautions should be taken to avoid direct sunlight, water and moisture, electromagnetic radiation, dust and explosion.

- The warnings and safety precautions should be read and well understood before the instrument is used.

- Use the meter only as specified in this manual.

- Confirm that the circuits have been powered off and all capacitors in the circuits been discharged before measuring in-circuit components.

- Discharge all charging elements, such as capacitors, before testing.

- The power for the meter is supplied with a single standard 8.4 V battery. But also a line operation is possible using a power adapter of 12 V DC / 150 mA. If a power adapter is selected, please be sure to meet the safety requirements of a relevant IEC standard.

- The battery using in ST2822D/E is rechargeable. Do not charge non-rechargeable batteries.

1.3 Safety Symbols

This symbol is a warning and indicates that the user should refer to the operating instructions located in the manual and **must** carefully adhere to them for safety reasons.

DC power

Indicates inside pin is positive (+), outside is negative (-).

1.4 Environmental Conditions

Operating Environment:	0 °C to 40 °C
Storage Humidity:	0 ~ 80 % R.H.
Storage Environment:	-20 °C to +50 °C
Pollution degree:	2

2 Introduction

ST2822D/E is designed for measuring inductance, capacitance and resistance of components. The instrument can be powered by an 8.4 V rechargeable battery or external power adapter. This meter is not only applicable to the application occasion of bench meters but also conveniently used in the flow and handheld measurement occasions.

ST2822D/E provides the primary parameter of up to 40000 readings, secondary parameter of 0.0001 reading resolution, maximum measuring frequency up to 100 kHz, constant internal resistance of 100 Ω and three optional testing levels. The auto range can rapidly display the measuring results and automatically choose the desirable testing parameters in accordance with components properties. Its measuring accuracy is unimaginable up to 0.1 %.

Front panel push buttons maximize the convenience of function, such as FREQ, LEV, TOL and RATE. Tolerance mode can sort components, record mode aid to capture readings, convenient open/short clear function improve the measuring accuracy, utility menu help you easily take the selections of the key tone, auto power-off and storage.

ST2822D/E is equipped with the function of remote communication. The test data can be transferred to PC through a Mini USB connection, great for applications that require remote control and data acquisition.

2.1 Package List

ST2822D/E is equipped with the following contents:

- ST2822D/ST2822E handheld LCR meter
- Instruction manual
- Mini USB interface cable
- Red / black banana plugs – crocodile clip test leads
- Short-circuit plate
- 8.4 V rechargeable battery
- *AC adapter
- *ST26027A Kelvin clip test leads
- ST26009C SMD test tweezers
- *ST26029C SMD test tweezers

These can be purchased as optional accessories. All contents are subject to actual package list or box.

Please locate them from the original packaging to ensure nothing is missing. Should an item be missing, please contact Source-tronic or relevant distributor immediately.

3 Front Panel Overview

Figure 3-1 Front Panel Display (model ST2822E shown)

3.1 Front Panel Display Descriptions

1) LCD display

2) USB communication / *back light button

3) Power ON/OFF button

4) Frequency and record mode selection

5) Secondary display mode (D/Q/θ/ESR, etc.) / test level

6) Primary display mode (L/C/R/Z/DCR, etc.) / auto LCR selection

7) Rate / equivalent mode selection

8) Hold mode / utility menu

9) Tolerance mode / utility arrow key

10) Open/short clear / utility arrow key

11) 5-Terminal test sockets (direct measurement on lead components or use of test fixture)

12) 3-Terminal test jacks (for use of banana plugs – crocodile clip test leads)

13) Standard mini USB port (for remote control)

14) 12 V DC external power input (use with an external power adapter)

NOTE: Refer to the adapter's label for input parameters of it. Rated output parameter: 12 V DC, 150 mA, 4 mm.

NOTE: Use with included power adapter only or purchase the specified adapters from Sourcetronic. Use with improper power adapters may damage instrument.

NOTE: Internal battery supply will be automatically cut off when external power is connected. If the battery is rechargeable (ST2822D/E), the external power will charge the battery simultaneously. ST2822D/E is equipped with an independent charging controller – charging control is still done even at the state of power-off.

WARNING!
Before connecting an external power adapter, be sure that **the polarity matches** the (+) and (-) labels as indicated inside the battery compartment. If it is not installed correctly and connected to an external power adapter, it might cause <u>**severe damage**</u> to the instrument. If the instrument can charge the battery (ST2822D/E), please be sure **that the polarity matches** the (+) and (-) labels as indicated inside the battery compartment and the **battery is rechargeable**. <u>**DO NOT charge a non-rechargeable battery!**</u>

3.2 Front Panel Buttons

With the exception of the power button, all front panel buttons have specific colored labels on them. They are all marked in black, blue or orange color. Each color has a specific representation, as described below:

Black—the primary function, meaning that function will be set or configured upon pressing it.

Orange—the secondary function, it means that the function will be set or configured if that button is pressed and hold down for 2 seconds.

Blue—the utility function, the function will be set or configured if the UTIL button is pressed and hold down for a long time. See "Utility Menu" section for details.

NOTE: In the button operational instruction, we will use the button name to express the button operation without differentiating the type of button; Pay attention to the difference between "long press" and "press".
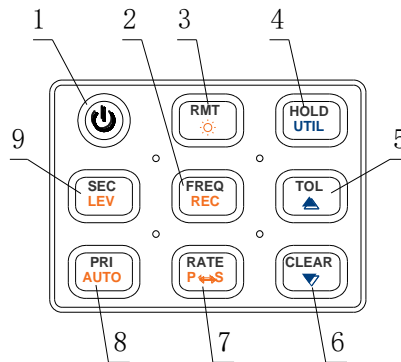
Figure 3-2 Button Display

3.2.1 Button Function Definition

1)   Power ON/OFF button

2)   Frequency / record mode button

3)   Remote control / backlight button

4)   Readings hold / utility menu button

5)   Tolerance mode / menu selection button

6)   Clear / menu selection button

7)   Rate / equivalent mode button

8)   LCR primary parameters / auto LCR

9)   Secondary parameters selection button / LEV

3.3 LCD Display Overview
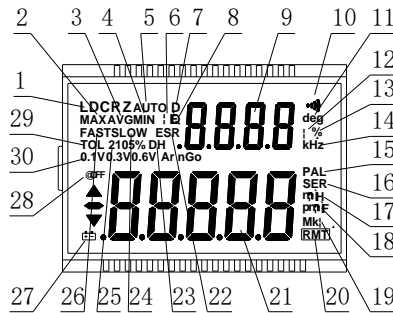
Figure 3-3 LCD Indicator Display

3.3.1 LCD Display Description

1)   LDCRZ – Primary parameters display

2)   MAX – Maximum reading indicator in the record mode

3)   AVG – Average reading indicator in the record mode

4)   MIN – Minimum reading indicator in the record mode

5)   AUTO – Automatic LCR indicator

6)   θ – Phase angle indicator for secondary display

7)   D – Dissipation indicator

8)   Q – Quality factor indicator

9)   .8.8.8.8 – Secondary parameter display

10)   ●))) – Beeper tone indicator for tolerance mode

11)   deg – Phase angle (θ) units indicator

12)   Ω – ESR(ohm) units indicator

13)   % – Percentage indicator (in tolerance mode)

14)   kHz – Frequency units indicator

15)   PAL – Parallel mode indicator

16)   SER – Series mode indicator

17)   mμH – Inductance units (L) indicator

18)   pmμF –Capacitance units (C) indicator

19)   MkΩ – Resistance(R) / impedance units indicator

20)   RMT – Remote mode indicator

21)   .8.8.8.8.8 – Primary parameter display

22)   ESR – Series mode indicator for secondary parameters

23)   DH – Data hold indicator

24)   SLOW – measuring rate indicator

25)   2105 % - Limits indicator in tolerance mode

26)   FAST- Fast measuring rate indicator

27)   ⊞ – Low battery/charging indicator

28)   @OFF – Auto power-off indicator

29) TOL – Tolerance mode indicator

30) 1 V / 0.6 V / 0.3 V – Display test level

3.4 Special Display Indicators

5Hrt   Indicates short clear if you press the CLEAR button

OPEN   Indicates open clear if you press the CLEAR button

Err   Error indication

CAL   Indicates correction (open/short clear) mode

FUSE   Indicates damaged or open fuse

E01   (UNK) AD converter error (UNK)

E02   AD converter error (END)

3.5 Test Ports

ST2822 series are creatively designed to combine 3-terminal port and 5-terminal port, which makes highly accurate testing conveniently realized in the instrument.
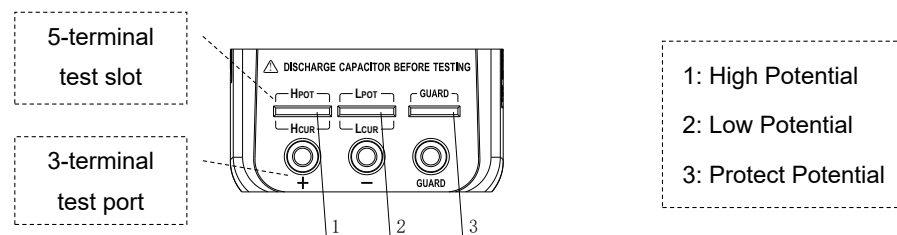
Figure 3-4 Test Ports

With the adoption of standard banana slots, the instrument can use inexpensive banana plug-crocodile clips as the test leads, which makes the test quite convenient. However this configuration has low testing accuracy especially when the DUT has low impedance.

For the improvement of accuracy when using external testing leads, ST2822 series are designed with 5-terminal testing slots and exclusive test fixture to ensure complete external 4-terminal test and measuring accuracy.

NOTE: ST26027A, ST26009C and ST26029C 4-terminal test fixtures are optional for ST2822 series. Please refer to relevant instrument accessories.

4 Powering the Instrument

There are two methods to power the instrument: Battery and external power adapter. When the two power modes are available, the external source is prior to the battery. The two power modes can be automatically shifted without interruption.

4.1 Installing the Battery

ST2822D/E can adopt battery for power supply so that you can take measurements whenever and wherever without much preparation.

8.4 V alkaline batteries used in ST2822D/E are rechargeable. Reference standard is LH-200H7C.

Do not use non-rechargeable batteries with the exception of emergency cases. The reason is that the charging circuit will operate once the instrument is connected to external source.

To Install the Battery:

1) Open up the back-flip stand, and locate the screw that tightens the battery compartment cover as indicated in the figure below. Use a screwdriver to unscrew and remove the cover.

2) Insert proper battery into compartment. Note the positive (+) and negative (-) terminals as indicated inside the battery compartment. Be sure to insert the battery with matching polarity.

3) Place the battery compartment cover piece by sliding it into the top slid first. Place screw at the bottom of the cover piece and tighten down with a screw driver.

4) Push and hold down the power ON/OFF button for 2 seconds to turn on the instrument.

Figure 4-1 Back Cover
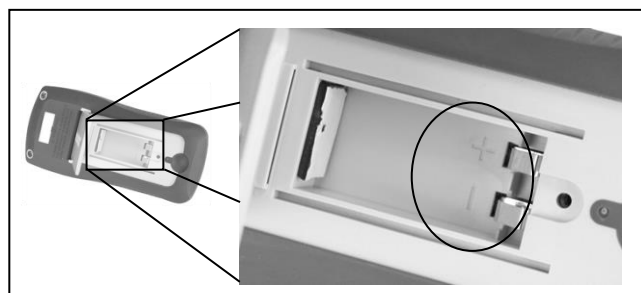
Figure 4-2 Battery Compartment

4.2 Connecting External Power Source

ST2822D/E is equipped with standard external power adapters, which can use external source.

WARNING!
⚠️ Use the included or specified adapter only. Confirm power parameters be ones that adapters require before use!

To Connect the Adapter:

1)   If a battery is installed, please check the battery compartment again that the polarity of the battery matches the polarity as indicated by the labels inside the compartment.

WARNING!
⚠️ **DO NOT**, at any time, connect an external power adapter when a battery is installed incorrectly or a non-rechargeable battery is inserted in a rechargeable instrument. Doing so will damage the instrument and void its warranty!

2)   Confirm that an appropriate power supply connects to the adapter.

3)   Connect the AC adapter connector into the right side jack of 12 V DC.

4)   Connect the AC Adapter socket into an electrical outlet.

5)   Press and hold down the power button for about 2 s to turn on the meter.
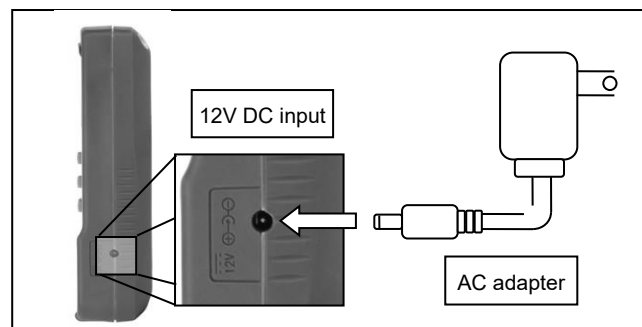
Figure 4-3 Connecting the AC Adapter

NOTE: The meter will automatically switch to consume power from the AC adapter instead of the battery when an AC adapter is plugged in and consume the power normally. In this event, if the battery installed correctly is rechargeable, charging controller will be driven at the same time no matter the instrument is on or off.

4.3 Low Battery Indication

At the use of battery for power supply, if the display starts flashing the 🔋 indicator, it means that the battery voltage is below normal working voltage (below 6.8 V). It is highly recommended that the battery be replaced as soon as possible before continuing operation. See "Installing the Battery" for instructions.

If the battery is rechargeable, when the 🔋 indicator starts flashing, please charge the battery before continuing operation. When the external source is plugged in, the flash of RMT/ ☼ indicator indicates the charging state.

4.4 Backlight Display

- In the case of lacking light, turn on the back light to help read the data.

- To turn on the back light, you should press the ⚙ button for 2 seconds.

- To turn off the back light, you should press the ⚙ button for 2 seconds.

4.4.1 When Using Battery Power

When the meter is powered by using battery, the brightness of the back light will automatically decrease to conserve battery power. When the back light have lightened for about 15 seconds, the brightness will continuously decrease; and when the back light have lightened for approximate 30 seconds, the back light will automatically turn off.

4.4.2 When Using External Power

When the meter is powered using an external AC adapter, once the back light is turned on, it will stay at its maximum brightness continuously and will not automatically turn off. Unplugging the external power to use battery power, the back light will decrease its brightness and automatically turn off.

4.5 Charge Display

The power circuit of ST2822D/E is rechargeable. When the external power adapter is plugged in, the power mode will auto-matically switched and charge the internal chargeable battery.

A single charge circle is about 160 minutes, and the charge current is approximately 120 mA. If a battery is fully charged, the charge will be automatically shut off; instead, the battery will be charged again after a charge circle.

NOTE: A new charge circle will begin as soon as an external power is connected.

WARNING!
⚠ If the instrument has rechargeable circuit, <u>**DO NOT**</u> connect to an external power when a non-rechargeable battery is installed. **Doing so will burst the battery!**

⊡: It indicates low power of a battery before the connection of external power; after the connection, it means the charging state. RMT/ ⚙ indicator will be light up in the condition of being charged no matter the instrument is off or on.

5 Operation Instruction

5.1 Data Hold Mode (HOLD)

The data hold function allows the user to freeze the display data. The data displayed on LCD will not be updated upon the phase of test.

5.1.1 Turn On Data Hold

To use data hold, press the $\boxed{\text{HOLD}}$ button. The "DH" indicator will display on the screen when data hold is active. At this moment, primary and secondary displayed on LCD is the testing result before the press of $\boxed{\text{HOLD}}$ button.

5.1.2 Turn Off Data Hold

To disable the data hold, press the $\boxed{\text{HOLD}}$ button again. The "DH" indicator will disappear on the screen, and meter will remain in normal operation mode.

5.2 Data Record Mode (REC)

If the data stability of tested components is poor and the data fluctuates in a range, data record mode can aid the reading of data. This mode is used for dynamically recording maximum, minimum, and average values in a range.

5.2.1 Enable Static Recording

Press and hold down the $\boxed{\text{REC}}$ button for a long time to enter the data recording mode. The display should indicate "MAX AVG MIN" simultaneously, which indicates the meter is in static recording mode.

5.2.2 Using Static Recording

There are four different modes that can be selected in static recording. Per press of the REC button (in recording mode, FREQ will disable), the modes will change and repeat in the following order:

Recording Mode → Maximum Mode → Minimum Mode → Average Mode

5.2.2.1 Recording State

This is the default mode when enabling static recording. In this mode, LCD will display "MAX AVG MIN" indicator. In a relatively stable range of test data, a beep tone will sound once a recording has been stored.

NOTE: When the data fluctuation range is upwards of 1 %, data record will dynamically be refreshed.

5.2.2.2 Maximum Display

Press $\boxed{\text{REC}}$ button until the "MAX" indicator is shown on display. This indicates that the value in the primary display represents the recorded maximum value.

5.2.2.3 Minimum Display

Press REC button until the "MIN" indicator is shown on display. This indicates that the value in the primary display represents the recorded minimum value.

5.2.2.4 Average Display

Press REC button until the "AVG" indicator is shown on display. This indicates that the value in the primary display represents the recorded average value.

5.2.3 Disable Static Recording

To exit this mode, press and hold the REC button for a long time. The "MAX", "MIN", or "AVG" indicator will disappear on LCD.

NOTE: Changing the type of test parameters will automatically turn off static recording.

5.3 PRI Select Mode

To select measurement mode, you should select primary parameter first.

Each press of the PRI button, the parameter will change and repeat as the following modes: L (inductance), C (capacitance), R (resistance), Z (impedance) and DCR (direct current resistance).

NOTE: After changing primary parameter, secondary display indicates the present frequency. No secondary parameter display in DCR state. If it is required to display corresponding secondary parameters, press the secondary button.

5.4 SEC Select Mode

If necessary, press the SEC button to select secondary parameters.

Each press of the SEC button, the following modes will be displayed on the screen: D (Dissipation factor), Q (Quality factor), θ (Phase angle), and ESR (Equivalent series resistance).

5.5 Test Frequency (FREQ)

ST2822D/E handheld LCR meters apply AC signal to DUT for measurement. Frequency is among the main parameters of AC signal. By the presence of component's non-ideality and distributed parameters, the effect of distributed parameters of test port and test lead, the test frequency used on the same component might cause different test result. Therefore, a proper frequency should be selected before test.

5.5.1 Selecting Frequency

To change the test frequency, push the FREQ button. If the secondary display does not indicate the frequency, it will display the actual operating frequency when you press FREQ. If the secondary display indicates frequency, at each press of the FREQ button, the meter will change among the following selectable frequencies:

- ST2822D: 100 Hz / 120 Hz / 1 kHz / 10 kHz

- ST2822E: 100 Hz / 120 Hz / 1 kHz / 10 kHz / 100 kHz

5.6 Test Electric Level

ST2822D/E handheld LCR Meter uses AC signal applied to the item measured (DUT) to test. The level is the amplitude of the AC signal, due to the level sensitivity of some component, the same component using different levels may have different test results. Therefore, a suitable test level should be selected before measurement. Long press LEV button, the instrument can switch the level between 0.6 V, 0.3 V and 1 V.

5.7 Tolerance Mode (TOL)

The tolerance mode is specifically used for component sorting purposes. In tolerance mode, secondary display indicates the range of percentage.

Tolerance mode, nominal value and sorting limit just come into play on primary parameters. The selectable range for sorting is as follows:

- 1 %
- 5 %
- 10 %
- 20 %

In tolerance mode, the data indicated in the primary display will be recorded as nominal value.

Displayed Value in Percentage:

$= 100 \times (M_x - Nom) / Nom$ %

Where…

- M_x is the primary parameter display;
- Nom is the nominal value recorded.
- The percentage value is used for sorting.

5.7.1 Use Tolerance Mode

To use the tolerance mode:

1) Select the desired primary measurement mode by pressing PRI button.

2) Configure the proper test frequency and series/parallel equivalent mode.

3) Perform the operation of CLEAR appropriately if necessary.

4) Test standard implements or components with accurate and reliable measured value.

5) Once the desired measured reading is displayed, press the TOL button once to store the reading as the nominal value. At this point, the "TOL" will be displayed on the screen, indicating that the tolerance mode is activated. A percentage mode will be shown in the secondary mode to indicate the percentage range.

   NOTE: Before the press of TOL button, the primary parameter indicated on LCD in any mode can be taken as the nominal value, including data hold, MAX, MIN, AVG data recording, etc.

6) If sorting is not necessary, you can skip this step. If it is necessary, by pressing the TOL button you can select the range of 1 %, 5 %, 10 % or 20 %, which will be shown on LCD accordingly.

7) Changing test component, an audible tone will be heard. One single "beep" or tone means the component is within tolerance. Three "beeps" or tone means the component is out of tolerance.

WARNING!	
⚠️	Be sure that the capacitor has been **fully discharged** before its test, or the instrument might be damaged!

5.7.2 Disable Tolerance Mode

Long press of TOL button will disable tolerance mode.

NOTE: Changing the test frequency, primary function, or secondary function will automatically disable tolerance mode.

5.8 Auto LCR Mode

Auto LCR function will automatically select the corresponding primary and secondary parameters and suitable series/parallel equivalent mode of L, C, R. The selection is done by judging the impedance property of component according to the test result. It is quite convenient for the measurements of mixed and unknown components.

5.8.1 Enable Auto LCR Mode

Long press of AUTO button will activate auto LCR mode. The "AUTO" indicator on LCD indicates that auto LCR mode is activated.

In auto LCR mode, the match of secondary parameter with primary parameter is shown as below:

Table 5-1 Matching Relations Between Primary and Secondary Parameters in Auto LCR Mode

Primary Parameter	Secondary Parameter
Capacitance (C)	Dissipation (D)
Inductance (L)	Quality Factor (Q)
Resistance (R)	Phase Angle (θ)

In auto LCR mode, series or parallel equivalent mode is selected in accordance with the magnitude of impedance. Parallel mode is selected at high impedance and series mode at low impedance.

5.8.2 Disable Auto LCR Mode

Long press the AUTO button again will disable auto LCR mode. In addition, this mode will not continue through changing the primary and secondary modes, series/parallel equivalent mode and frequency mode. "AUTO" indicator on LCD will disappear when auto LCR mode is turned off.

5.9 Measurement Rate (RATE)

There are two selectable measurement rates in this instrument: fast and slow.

The rate of fast measurement is about 4 to 5 times per second and slow measurement is approximately 1.5 times per second. The stability of slow measurement is higher than fast measurement.

The fast and slow rates can be directly switched by pressing RATE button. "FAST" indicator will be displayed on LCD at fast rate and "SLOW" indicator at slow rate.

5.10 Series/Parallel Equivalent Mode

For the presence of non-ideality and distributed parameters of components, actual components are frequently taken as combined network of ideal components. In general, there are two simple equivalent models used in LCR meters, which are series model and parallel model.
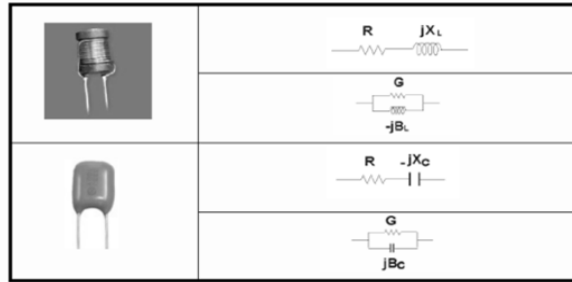
Figure 5-1 Series and Parallel Equivalent Models of Inductors and Capacitors

Appropriate equivalent modes could help to gain better measurement results. Generally, Series mode is better for components with low impedance (below 100 Ω), while parallel mode for components with high impedance (over 10 kΩ). For the components with the impedance between the two limits, equivalent mode has little effect on the testing result.

5.10.1 Selecting Measurement Mode

Long press $P{\leftarrow}{\rightarrow}S$ button, "PAL" on LCD indicates parallel equivalent mode and "SER" means series equivalent mode.

5.10.2 Default Equivalent Mode

In this mode, default equivalent mode varies with primary parameter: For capacitors and resistors, default equivalent mode is PAL; for inductors, SER.

5.11 Utility Menu (UTIL)

The LCR meter has a built-in utility menu that allows you to configure some user preferences and settings. The buttons used to set and control the menu are colored in blue. There are three buttons: UTIL, ▲, ▼. User can configure the beep tone, auto power-off timing, store/restore power-on state, view the battery voltage, etc.

5.11.1 Entering Utility Menu

Long press UTIL button will enter utility menu. Primary display is menu option and secondary display is the current settings or parameters configured for the selected option. After the entrance into utility menu, the default menu item display will show "bEEP".

5.11.2 Configuration and Settings

The following contents are included in the utility menu:

Table 5-2 Utility Menu Options and Settings

Menu Options	Settings / Parameters
dCdly	DCR trigger delay
'bEEP	ON / OFF
AoFF	5 / 15 / 30 / 60 / OFF
PuP	PrE / Set
dEF	yES / NO
bAtt	Battery Voltage

Uses of these menu options are as follows:

- DCR Trigger Delay Function: (dCdLy: DCR delay)
- Control Beep Sound: (bEEP: beep sound)；
- Set Auto Power-Off: (AoFF: auto power off)；
- Set Power-Up State: (PuP: power-up state)；
- Reset to Default Settings: (dEF: default settings)；
- Indicate Battery Voltage: (bAtt: battery voltage).

By default, press the button UTIL to change or select a different menu option.

To change the settings or parameters, use the ▲ and ▼ arrow keys. For each UTIL button press, the meter will traverse through each menu options and will repeat itself in the following order:

dCdLy →bEEP → AoFF → PuP → dEF → bAtt

NOTE: The change of settings has different application effects in accordance with different exiting mode. See "Exit Utility Menu" section (Saving and Exiting, Exiting without Saving) for details.

5.11.2.1 DCR Trigger Delay Setup (dCdLy)

The "dCdLy" menu option is used to set the trigger delay time ranging from 0000 ms to 9999 ms.

Use the ▲ and ▼ arrow keys to add or subtract 1. Long-pressing ▲ and ▼ arrow keys can move the current cursor to left or right. The setup is promptly effective once modified.

NOTE: When the setting is not 0000, the higher the setting time, the slower the DCR measurement speed. It is suggested to set the time to 0000.

Default Setting: 0000

5.11.2.2 Beep Sound Setup (bEEP)

The "bEEP" menu option allows the user to enable or disable the beep sound for every key press.

NOTE: This option only disables the beep sound for each key press. It does not disable the beep sound for "Tolerance" mode and "Static Recording", as well as the "auto power-off" warning.

Use the ▲ and ▼ arrow keys to choose ON or OFF. This setting will be immediately effective. But this state will not saved if choose"Exiting without Saving"; "Saving and Exiting"should be implemented if this setting needs to be effective after restarting.

Default Setting: ON

5.11.2.3 Auto Power-Off Setup (AoFF)

The "AoFF" menu option allows the user to select the auto power-off timer. The available timer settings are: 5 min / 15 min / 30 min / 60 min / OFF. When the primary display shows "AoFF", press the ▲ and ▼ arrow keys to select the timer setting. The settings will be shown on the secondary display as in the table below.

When AoFF is effective, this timer is always counting continuously; when the configured time is up, the meter will make an audible "beep" sound continuously to remind the user of prompt auto power-off. Before auto power-off, pressing any button will reset the timer count.

NOTE:

• Auto power-off is effective only for battery power.

• When auto power-off is efficient, the display of "@OFF" indicates the operation of timer.

• Auto power-off will not work temporally in TOL mode, REC mode and RMT mode. It will be activated after exiting of above modes.

Table 5-3 Auto Power-Off Options

Secondary Display	Representation
5	5 minutes
15	15 minutes
30	30 minutes
60	60 minutes
OFF	Manual power off only

The setting will be immediately effective. But this state will not saved if choose "Exiting without saving"; "Saving and exiting" should be implemented if this setting needs to be effective after restarting.

Default Setting: 5

5.11.2.4 Power-Up State (PuP)

The "PuP" menu option allows user to configure the power-up state of the LCR meter, allowing user to restore settings saved into internal EEPROM memory at power-up. The storable settings are as follows:

• Primary function mode (e.g. L/C/R)

• Secondary function mode (e.g. D/Q)

• Auto LCR

• Series/parallel equivalent mode

• Test frequency

• Tolerance mode

• Reference value for Tolerance mode

• Measurement rate

In the utility menu, press the ▲ and ▼ arrow keys to select"PrE"or"SEt". PrE means to preserve the previous setting while SEt means to save the current parameter, that is, cover the original data.

NOTE: Exiting mode decides whether to implement SEt. At "Exiting without saving", SEt is ineffective; while at "Saving and Exiting", SEt setting will be effective.

Default Setting: PrE

To Configure and Save Power-Up State

1) Before entering into the utility menu, configure all the measurement parameters firstly, such as frequency, primary and secondary parameters. If the meter is currently in the utility menu, exit first and enter into utility menu after measuring setup.

2) Press UTIL button for a long time to enter into utility menu.

3) Push the UTIL button to traverse through the utility menu until you see "PuP" on the primary display.

4) In order to save the current meter settings for power-up state into internal memory, use either ▲ or ▼ button to change the settings so that the secondary display shows "SEt".

5) Press the UTIL button to check whether all desirable setups have already be set. With all settings done, exit the menu by long press of the UTIL button.

6) The meter has now saved all current settings into internal memory. At next power-up, the meter will turn on and recall the saved settings.

NOTE: The meter allows one set of settings to be stored into memory. Therefore, the same procedure is used to overwrite previously stored settings into memory.

To Prevent Overwrite of Stored Settings:

In the utility menu, the "PuP" option default setting is always "PrE". If it is required to overwrite previously stored settings for power-up state, the option should change to "SEt". Therefore, when entering the utility menu, be sure not to change to "SEt" to prevent overwriting any previously stored power-up settings.

5.11.2.5 Reset Default Settings (dEF)

The "dEF" option is used to reset the current measuring setup and optional settings in utility menu to default settings. These default settings are as below:

Table 5-4 Instrument Default Settings

Settings	Default Configuration
Primary Function	C (capacitance)
Secondary Function	None (frequency)
Auto LCR function	OFF
Equivalent Method	SER (series)
Measurement Frequency	1kHz
Measurement Level	0.6V
Measurement Speed	Slow (SLOW)
Tolerance Mode	OFF
Beep Sound	ON
Auto Power-off Timing	5 minutes
Stored Measurement Setup	clear
Stored Utility Menu Option	clear

In "dEF" option, push either ▲ or ▼ button to choose "NO" or "yES". "NO" means the instrument will not be set back to default. "yES" indicates to reset all settings to default and to clear previously stored setup.

Default Setting: No

NOTE:

- Exiting mode also decides whether or not to perform "yES" function. At the use of "exiting without saving", "yES" is ineffective; when "saving and exiting" is selected, restore operation will be efficient.

- In the case where under "PuP" option, "SEt" is selected and "dEF" is set to "yES", the "PuP" setting has priority over the "dEF" setting. This means the instrument will not be set back to default upon saving and exiting the utility menu. Instead, the power-up settings will be stored and will be recalled upon the next power-up of the instrument.

5.11.2.6 Indicate Battery Voltage (bAtt)

When menu option changes to "bAtt", the secondary display will indicate battery voltage that is for reference instead of for operational function.

5.11.3 Exit Utility Menu

There are two methods for exiting the utility menu: **Saving and Exiting**, **Exiting without Saving**. The former saves all the changed settings before exiting, and the latter exits the menu without saving any changes.

5.11.3.1 Saving and Exiting

To save all utility menu option settings and to exit the menu, press and hold down the UTIL button for a long time. After this, the meter will exit the menu. Then PuP and dEF will be performed and all settings will be saved.

"Saving" refers to preserve corresponding information in the built-in non-volatile memory. Therefore, data will not lose at the time of power-off and can be used at the time of power-on.

5.11.3.2 Exiting Without Saving

If user decides to exit the utility menu without making any changes or saving any changes to "PuP" or "dEF", it can be done by simply pressing any front panel buttons except UTIL, ▲, ▼ and POWER. PuP and dEF operation will be ineffective. Settings, such as "bEEP" and "AoFF" will not saved in non-volatile memory but still be temporarily efficient until the next power-up of the instrument.

5.12 Clear Functions (CLEAR)

There are two functions under CLEAR: Open Clear and Short Clear. Clear can decrease the distributed error caused by test leads, for instance, short clear can reduce the effects of contact resistors and test leads and open clear will minimize the influence of distributed capacitors and resistors on testing high impedance elements.

5.12.1 Enter Clear Mode

For convenience, open clear and short clear are designed to share a button. By pressing the CLEAR button, the meter will automatically choose either open clear or close clear.

5.12.2 Open Clear

First select frequency to clear and keep test clip and test slot be open. Enter into clear by the press of CLEAR, and a moment later the OPEN indicator will appear on secondary display after the automatic measurement judging. If user decides to perform open clear, another press of CLEAR should be done.

NOTE: "----" indicator on secondary display indicates that test terminal is out of open state and open clear cannot be performed.
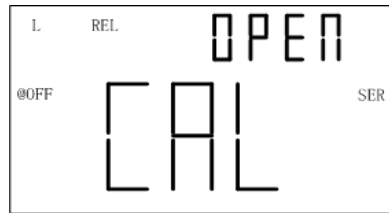
Figure 5-2 Open Clear

5.12.3 Short Clear

First choose test frequency to clear and then insert a short plate to test slot. If SMD test tweezers or test clip is used, the short plate should cut off the test terminal. Enter into clear by the press of CLEAR, and a moment later the SHrT indicator will appear on secondary display after the automatic measurement judging. If user decides to perform short clear, another press of CLEAR should be done.

NOTE: "----" indicator on secondary display indicates that test terminal is out of short state and short clear cannot be performed.

Figure 5-3 Short Clear

5.12.4 Quick Clear Procedure

Below is an example of steps to follow to do open or short clear:

1) Select the primary and secondary function mode for measurement;

2) Select test frequency;

3) Select equivalent mode;

4) Keep the test terminal open to perform open clear;

5) Short the test terminal to perform short clear;

6) Connect DUT to start testing after clear.

NOTE:

- Clear data is just temporarily stored in RAM, which means that the data will loss after power-off. Therefore "clear", prior to measurement, should be first done after power-on.

- Clear data is stored under different frequency, thus they will be still valid at the change of test frequency (for instance, under the frequency of 1 kHz, the meter has been cleared; and when the frequency is back to 1 kHz, there is no need to clear again.)

- Clear is not concerned with test parameters and series/parallel equivalent mode. In accordance with developed impedance network principle, the instrument performs clear operation. Though the complex impedance is cleared, parameter is just the element after the change of impedance.

- After a long time of continuous use, the meter will be affected by the temperature environment and test fixtures, test leads and contact resistance will change. It should be necessary to clear once more according to specific conditions so as to meet the requirement of accuracy.

5.13 Remote Control (RMT)

When the RMT button is used for remote communication, please see "REMOTE COMMUNICATION" section for details.

5.14 Fuse Detection

The meter has an internal fuse in the test signal terminal that protects the inputs from severely damaging the instrument. When the fuse is burned out, the "FUSE" indicator will appear on the primary display and an internal "beep" will sound continuously. In this situation, none of the function buttons can be operated and all other meter functions will be disabled.
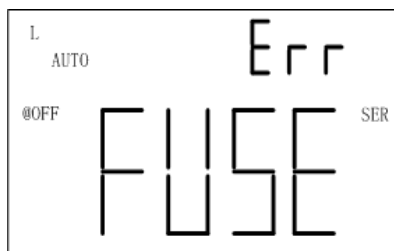
Figure 5-4 Fuse Display

In the event that the above screen is displayed, the instrument should be powered off. If this does not power off the meter, remove external AC adapter if that is used and/or remove the battery from the battery compartment. Please contact after-sale department of our company or appointed distributor for the change of fuse or maintenance.

NOTE: Both element damage and none output of test signal caused by signal source fault will make "FUSE" alarm.

6 Quick Start Guide

	WARNING!
⚠️	• Do not measure a capacitor that is not fully discharged. Connecting a charged or partially charged capacitor to the input terminals will damage the instrument. • When measuring an on- board component within a circuit, the circuit must be powered off before connecting the test leads. • When used in a dusty environment, the instrument should be wiped and cleaned regularly. The electrical conductivity carried by the accumulated dust will eventually have an effect on the use of the meter. • Do not leave the instrument exposed to explosive, direct heated and overheating environments. • Before removing the cover, ensure that none DUT is connected to the meter and the instrument is disconnected from any circuit and is powered OFF.

NOTE: To achieve optimum precision, please see "Clear Function" for details before testing.

6.1 Inductance Measurement

1) Press the POWER button for a long time to turn on the instrument.

2) Press the PRI button until "L" is displayed on the screen to select inductance measurement

3) Insert an inductor into test slots or connect a tested inductor through a proper test accessory (e.g., banana plug-crocodile clip test leads, test fixture or SMD test tweezers). See Figure 6-1 below. Figure 6-2 shows the optional 4-terminal test accessories.

4) Press the FREQ button until the desired test frequency is displayed on screen.

5) Press the LEV button until the desired test level is displayed on screen.

6) Press the SEC button to select the desired secondary parameter.

7) Read the readings on LCD for inductance measured values.
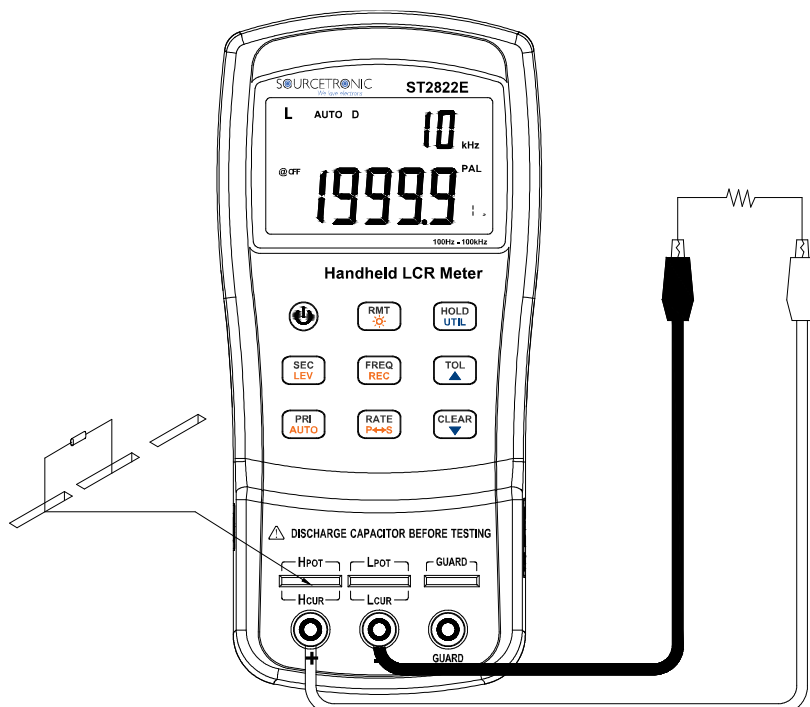
Figure 6-1 Inductance Measurement

Below are ST26027A, ST26009C and ST26029C 4-terminal test accessories:
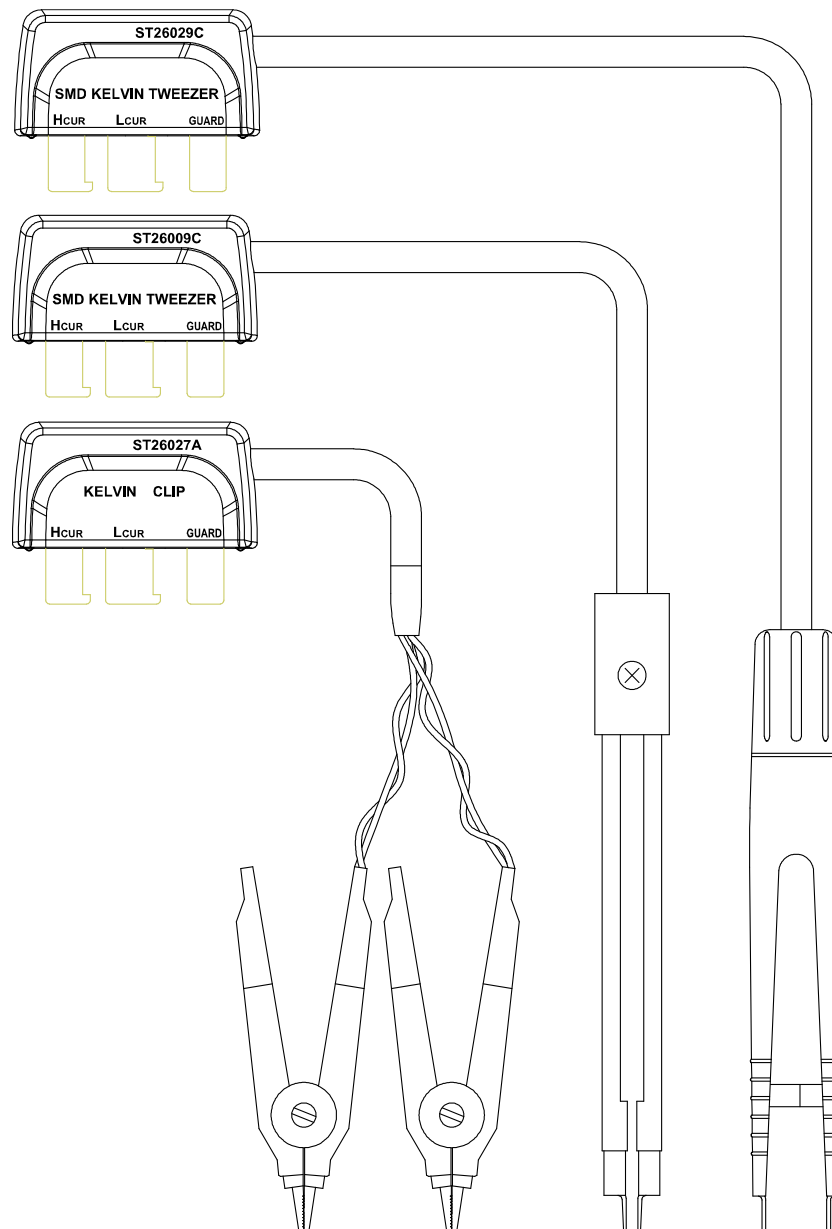
Figure 6-2 4-Terminal Test Accessories

6.2 Capacitance Measurement

WARNING!
⚠ Before testing, ensure that the tested capacitor has been fully discharged!

1) Press the ⬚POWER button for a long time to turn on the meter.

2) Press the ⬚PRI button until "C" is displayed on the screen to select capacitance measurement.

3) Insert a capacitor into test slots or connect a tested capacitor through a proper test accessory (e.g., banana plug-crocodile clip test leads, test fixture or SMD test tweezers). See Figure 6-3 below. Figure 6-2 shows the optional 4-terminal test accessories.

CAUTION!
⚠️	BEFORE inserting a capacitor or capacitive component into the input slots or terminals, be sure to fully discharge the component. Some larger capacitive components may take longer to discharge. In these cases, please allot enough time for a full discharge. If proper discharging of the component is not done correctly, it will damage the input terminals of the meter!

4)   Press the FREQ button until the desired test frequency is displayed on screen.

5)   Press the LEV button until the desired test level is displayed on screen.

6)   Press the SEC button to select the desired secondary parameter.

7)   Read the readings on LCD for capacitance measured values.
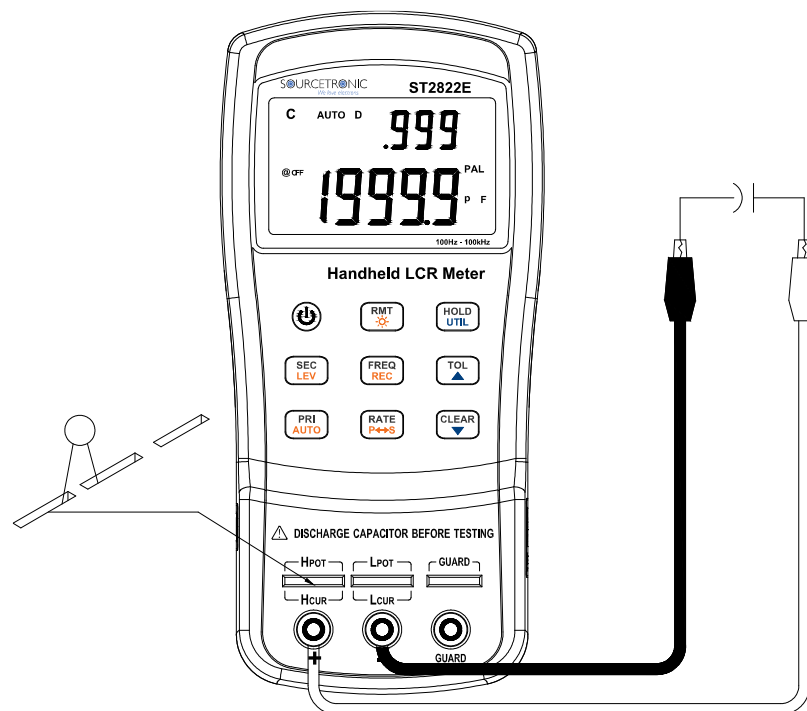
Figure 6-3 Capacitance Measurement

6.3 Resistance Measurement

1)   Press the POWER button for a long time to turn on the instrument.

2)   Press the RPI button until "R" is displayed on the screen to select inductance measurement.

3)   Insert a resistor into test slots or connect a tested resistor through a proper test accessory (e.g., banana plug-crocodile clip test leads, test fixture or SMD test tweezers). See Figure 6-4 below. Figure 6-2 shows the optional 4-terminal test accessories.

4)   Press FREQ button until the desired test frequency is displayed on screen.

5)   Press the LEV button until the desired test level is displayed on screen.

6)   Press the SEC button to select the desired secondary parameter.

7)   Read the readings on LCD for resistance measured values.

NOTE: The meter uses an AC signal for measurement of resistance, so what the test result shows is AC resistance property instead of DC resistance property.
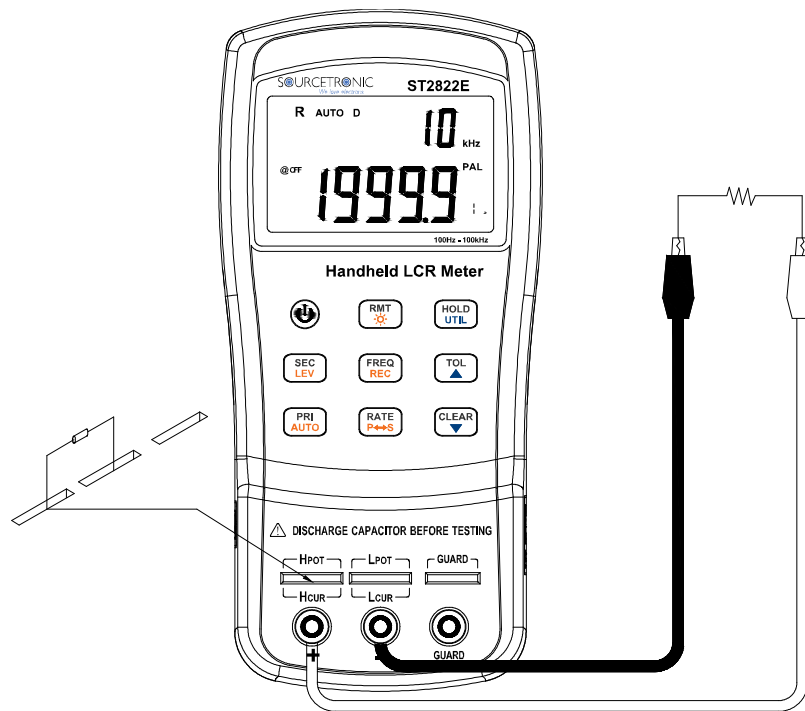
Figure 6-4 Resistance Measurement

6.4 Impedance Measurement

1)   Press the POWER button for a long time to turn on the instrument.

2)   Press the PRI button until "Z" is displayed on the screen to select impedance measurement.

3)   Insert impedance (resistor, capacitor or inductor) into test slots or connect tested impedance through a proper test accessory (i.e., banana plug-crocodile clip test leads, test fixture or SMD test tweezers).

4)   Press the FREQ button until the desired test frequency is displayed on screen.

5)   Press the LEV button until the desired test level is displayed on screen.

6)   Press the SEC button to select the desired secondary parameter.

7)   Read the readings on LCD for impedance measured values.

6.5 Direct Current Resistance Measurement

1)   Press the POWER button for a long time to turn on the instrument.

2)   Press the PRI button until "DCR" is displayed on the screen to select direct current resistance measurement.

3)   Insert impedance (resistor, capacitor or inductor) into test slots or connect tested impedance through a proper test accessory (i.e., banana plug-crocodile clip test leads, test fixture or SMD test tweezers).

4)   Read the readings on LCD for impedance measured values.

7 Remote Communication

The meter has the capability to communicate with a PC over the mini USB interface. Upon installation of a USB driver, PC can control the instrument and collect test results over virtual serial interface.

7.1 Connecting Instrument to PC

Follow the below procedures for connection setup.

1) Install USB driver from CD or download the USB drivers from www.sourcetronic.com.

2) With a Mini-USB cable, connect one end of it to the LCR meter and the other end to an available USB port on PC. Press the POWER button to turn on the meter.

3) Skip the next process when the driver has been stalled.

4) When Windows recognize the USB connection, PC will prompt user to install driver. The following process is to cancel installation guide and directly run the setup program in the setup file.

5) When completed, Windows will create a virtual serial port and distribute a serial number. See Windows device manager for details.

6) Open the control software and use the assigned serial number to communicate with the handheld LCR meter. Download the FastAccess PC communication software from our web site (www.sourcetronic.com).
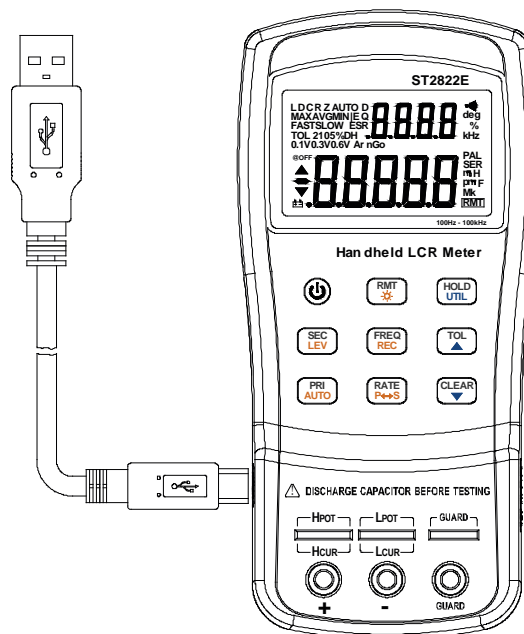
Figure 7-1 Connection to PC

7.2 Virtual Serial Port Configuration

Below is the serial communication configuration of ST2822D/E:

- **Baud Rate:** 9600
- **Data Bits:** 8
- **Parity:** None
- **Stop Bits:** 1
- **Flow Control:** None

Upon the installation of USB driver, if the default assigned by serial port does not conform to above configuration, please modify it as the following process:

Open **Windows Device Manager**→ **Port**→ **Corresponding Serial Interface**→ **Right**→ **Property**→ **Port Setup**

7.3 RMT Operation

In the case of communication, the RMT button is used to change the running modes:

Change to Local Operation in Remote Control Mode; Change to Auto Fetch function in Local Operation mode.

NOTE: Auto Fetch means to send testing result automatically without needing the initiative inquiry of PC.

7.3.1 Remote Mode

Upon the acceptance of any commands from PC, the meter will be automatically set into remote mode. In this mode, the LCD display will show "RMT" indicator. When this is shown, all front panel button will be locked and disabled, except for RMT and POWER buttons. If the meter has been in Auto Fetch mode before receiving remote control commands, Auto Fetch mode will be terminated.

That is to say, among panel operation, Auto Fetch and Remote Control, remote control has the highest priority.

To exit remote control, press the RMT button. When the "RMT" indicator disappears on the LCD display, the meter goes back to local operation.

NOTE: If the local operation is locked, RMT button will be ineffective as well. See *LLO Common Command in Command section for details.

Out of remote mode, press RMT button to change to Auto Fetch. See the description below.

7.3.2 Auto Fetch

When the meter is out of remote control, it can be changed to Auto Fetch mode. That is, the meter will automatically send data to the interface bus upon every measurement. Therefore, PC will obtain data by direct reading with no need to send any commands. It is quite useful in the recording of simple data.

7.3.2.1 Enable/Disable Auto Fetch

To toggle between enabling and disabling auto fetching when the meter is not under remote control, press the RMT button. In Auto Fetch, every flash of "RMT" means a measurement result is sent.

NOTE: Auto Fetch can be disabled by remote control. When a remote command is sent to the meter, Auto Fetch will be disabled. To re-enable Auto Fetch after remote command, first press the RMT button to return panel operation and then enter into Auto Fetch mode by another press of RMT.

7.4 Command Protocols

7.4.1 Overview

ST2822D/E employs SCPI commands with ASCII character strings transmitting control commands and returning query information and data and with a specified terminator identifying the termination of a command line or query data line.

The adoption of SCPI commands brings convenience for the interaction control of PC on the meter through programming. Command format is compliance with specifications and easy for understanding and use.

7.4.2 Common Command

The IEEE 488 standard defines the common commands for general use in all kinds of instrument. Common commands usually come with the asterisk "*" character, and may include parameters. Some examples of Common command like: *IDN?, *GTL, *LLO. ST2822 series support a few common commands. See the following command descriptions for more details.

7.4.3 Termination Character

A terminator is a character sent by a host, which identifies the end of a command string. Only when a termination character is received, the instrument will analyze and deal with command character string. Terminators can be any one of the following character strings:

        <CR>   (Carriage Return, ASC(&H0D)) ;

        <LF>   (Line Feed, ASC(&H0A));

        <CR><LF>

7.4.4 Returned Result

After the meter executes a query command, the return of the result will be in the following format:

        <Result> + <CR> <LF>

CR is Carriage Return and LF, Line Feed.

For example, in inquiring measured results (FETCH?), the format of the printed data will be shown as the following:

        <Primary Measured Data, Secondary Measured Data, Tolerance Result> <CR> <LF>

7.4.5 Data Types

The table below explains the different data types transmitted on bus with ASCII characters:

Table 7-1 Data Type

Data Type	Explanation	Example
<NR1>	Integer	+800, -200, 100, -50
<NR2>	Integer	+ 1.56, -0.001, 10.5
<NR3>	This representation has an explicit radix point and an exponent	+ 2.345678E+04 -1.345678E-01
<Boolean>	A parameter for Boolean setting. Always return "0" or "1" for Boolean query command	ON or OFF
<Literal>	A string is used as command parameters with short literal form	HOLD

7.4.6 Symbol Convention

7.4.6.1 Syntax Symbols in Commands

The table below lists the symbols that are relevant for the commands:

Table 7-2 Syntax Symbols

Syntax Symbol	Explanation
:	Colon means to enter into next command level
;	Same command level
*	Common command
,	Multi-parameter delimiter
?	Inquiry
	Space, separate commands from parameters
" "	Quoting part

7.4.6.2 Command Specifier

The table below lists symbols that are used for the description of the command format, which are not the constituting part of the command.

Table 7-3 Command Specifier

Mark Symbol	Explanation
[ ]	Optional; can be omitted
|	Exclusive OR
< >	Defined element
( )	Comment

7.4.6.3 Abbreviation (Uppercase and Lowercase Commands)

1)   There are two command formats: complete format and abbreviated format. In the following command description, upper case commands are abbreviated commands. It has the same effect of sending abbreviated and complete commands.

2)   Abbreviation command is generally shown in the form of 4-letter. Any abbreviation absent from command table is taken as incorrect command.

3)   It is not important to distinguish the real transmitted ASCII commands or parameter letters on bus.

8 Command Reference

8.1 Common Commands

8.1.1.1 *IDN?

Queries the instrument model and version information.

Syntax:

Query Message: *IDN?

Example:

Query: *IDN?

Return: <instrument model>, <firmware version>, <serial number> is returned.

8.1.1.2 *LLO

Local Lockout. This means that all front panel buttons, including the RMT key is not available. (POWER button is enabled.)

8.1.1.3 *GTL

Go to local and remove local lockout. If *LLO is sent, the only way to operate front panel is to go to *GTL.

8.1.1.4 *TRG

Trigger the instrument to take a measurement. Due to the automatically continuous test, *TRG command is of no use.

8.2 SCPI Commands

8.2.1 FREQuency Subsystem Commands

8.2.1.1 FREQuency

Sets/queries the test frequency.

Syntax:

Command Message: FREQ<frequency value>

Query Message: FREQ?

Program Data<frequency value>:

Data Range: 100
                                        120
                                        1000
                                        10000
                                        100000

Unit: Hz

Example:

To set the test frequency to 100 Hz…

Command: FREQ 100

Example:

Query: FREQ?

Return: The currently set frequency is returned.

8.2.2 VOLTage Subsystem

8.2.2.1 VOLTage

Sets/queries the test level (only effective in L, C, R, Z).

Syntax:

Command Message: VOLT<voltage value>

Query Message: VOLT?

Program Data<voltage value>:

Data Range: 0.3 (3e-1)
                                  0.6 (6e-1)
                                  1 (1e0)

Unit: V

Example:

To set the test frequency to 0.3 V…

Command: VOLT 0.3

Example:

Query: VOLT?

Return: The currently set test level is returned.

8.2.3 FUNCtion Subsystem

8.2.3.1 FUNCtion:impa

Sets/queries the primary parameter.

Syntax:

Command Message: FUNCtion:impa

Query Message: FUNCtion:impa?

Program Data<parameter>:

Data Range: L
                                  C

R
Z
DCR
NULL

Example:

To set L as the primary parameter…

Command: FUNCtion:impa L

Example:

Query: FUNCtion:impa?

Return: The currently set primary parameter is returned.

8.2.3.2 FUNCtion:impb

Sets/queries the secondary parameter (only effective in L, C, R, Z).

Syntax:

Command Message: FUNCtion:impb

Query Message: FUNCtion:impb?

Program Data<parameter>:

Data Range: D
                                        Q
                                        THETA
                                        ESR
                                        NULL

Example:

To set D as the secondary parameter…

Command: FUNCtion:impb D

Example:

Query: FUNCtion:impb?

Return: The currently set secondary parameter is returned.

8.2.3.3 FUNCtion:EQUivalent

Sets/queries the equivalent mode.

Syntax:

Command Message: FUNCtion:EQUivalent<mode>

Query Message: FUNCtion:EQUivalent?

Program Data<mode>:

Data Range: SER (series)
                                        PAL (parallel)

Example:

To set the equivalent mode to series mode…

Command: FUNCtion:EQUivalent SERies

Example:

Query: FUNCtion:EQUivalent?

Return: The currently set equivalent mode is returned.

8.2.4 CALCulate Subsystem

8.2.4.1 CALCulate:TOLerance:STATe

Sets/queries the tolerance mode.

Syntax:

Command Message: CALCulate:TOLerance:STATe<ON/OFF>

Query Message: CALCulate:TOLerance:STATe?

Example:

To set the tolerance mode to ON…

Command: CALCulate:TOLerance:STATe ON

Example:

Query: CALCulate:TOLerance:STATe?

Return: The current status of the tolerance mode setting is returned.

8.2.4.2 CALCulate:TOLerance:NOMinal?

Queries the nominal value.

Syntax:

Query Message: CALCulate:TOLerance:NOMinal?

Example:

Query: CALCulate:TOLerance:NOMinal?

Return: NR3 or "-----" (exceeding data range) is returned.

8.2.4.3 CALCulate:TOLerance:VALUe?

Queries the percentage value of tolerance.

Syntax:

Query Message: CALCulate:TOLerance:VALUe?

Example:

Query:	CALCulate:TOLerance:VALUe?
Return:	NR3 or "-----" (exceeding data range) is returned.

8.2.4.4 CALCulate:TOLerance:RANGe

Sets/queries the tolerance range.

Syntax:

Command Message:	CALCulate:TOLerance:RANGe<range value>
Query Message:	CALCulate:TOLerance:RANGe?

Program Data<range value>:

Data Range:	1
	5
	10
	15
	20 (not available for all models)
Unit:	%

Example:

To set the tolerance range to 1 %…

Command:	CALCulate:TOLerance:RANGe 1

Example:

Query:	CALCulate:TOLerance:RANGe?
Return:	BIN1, BIN2, BIN3, BIN4 or "-----" (unset BIN) is returned.

8.2.4.5 CALCulate:RECording:STATe

Sets/queries the status of the recording function.

Syntax:

Command Message:	CALCulate:RECording:STATe<ON/OFF>
Query Message:	CALCulate:RECording:STATe?

Example:

To set the recording function status to ON…

Command:	CALCulate:RECording:STATe ON

Example:

Query:	CALCulate:RECording:STATe?
Return:	The current status of the recording function is returned.

8.2.4.6 CALCulate:RECording:MAXimum?

Queries the maximum value of the recording function.

Syntax:

Query Message: CALCulate:RECording:MAXimum?

Example:

Query: CALCulate:RECording:MAXimum?

Return: <NR3, NR3> (primary and secondary parameters) or "-----" (data exceeds limits or there is no data) is returned.

8.2.4.7 CALCulate:RECording:MINimum?

Queries the minimum value of the recording function.

Syntax:

Query Message: CALCulate:RECording:MINimum?

Example:

Query: CALCulate:RECording:MINimum?

Return: <NR3, NR3> (primary and secondary parameters) or "-----" (data exceeds limits or there is no data) is returned.

8.2.4.8 CALCulate:RECording:AVERage?

Queries the average value of the recording function.

Syntax:

Query Message: CALCulate:RECording:AVERage?

Example:

Query: CALCulate:RECording:AVERage?

Return: <NR3, NR3> (primary and secondary parameters) or "-----" (data exceeds limits or there is no data) is returned.

8.2.4.9 CALCulate:RECording:PRESent?

Queries the present value of the recording function.

Syntax:

Query Message: CALCulate:RECording:PRESent?

Example:

Query: CALCulate:RECording:PRESent?

Return: <NR3, NR3> (primary and secondary parameters) or "-----" (data exceeds limits or there is no data) is returned.

8.2.5 FETCh Subsystem

8.2.5.1 FETCh?

Returns the primary, secondary display value and tolerance compared result (BIN no.).

Syntax:

Query Message: FETCh?

Example:

Query: FETCh?

Return: <NR3, NR3, NR1> (primary parameter, secondary parameter, BIN no.) when the primary
                                  parameter is LCR.

                                  <NR3, NR1> (primary parameter, BIN no.) when the primary parameter is DCR.

8.2.6 Summary of Supported SCPI Commands

Table 8-1 Summary of SCPI Commands

Command	Parameter	Explanation
FREQuency	<frequency value>	Set the test frequency
FREQuency?	–	Query the test frequency
VOLTage	<voltage value>	Set the test level
VOLTage?	–	Query the test level
FETCh?		Query the measurement result
FUNCtion		
:impa	<parameter>	Select the primary display parameter
:impa?	–	Query the primary display parameter
:impb	<parameter>	Select the secondary display parameter
:impb?	–	Query the secondary display parameter
:EQUivalent	<parameter>	Set the equivalent mode
:EQUivalent?	–	Query the equivalent mode
CALCulate		
:TOLerance		
:STATe	<ON/OFF>	Enable/disable the tolerance mode
:STATe?		Query the tolerance mode
:NOMinal?	–	Query the nominal value
:VALUe?		Query the percent of tolerance
:RANG	<range value>	Set the limit bin
:RANGe?	–	Query the limit bin
:RECording		
:STATe	<ON/OFF>	Enable/disable the recording function
:STATe?		Query the recording state
:MAXimum?		Query the max. value of recording
:MINimum?	–	Query the min. value of recording
:AVERage?		Query the average value of recording
:PRESent?		Query the test value of recording

8.2.7 Error Codes

If codes or parameters, originated from bus and transmitted to the meter, are fault, the meter will terminate the analysis and execution codes. At the same time, error code will be displayed on LCD and beep will be sound.

Below defines the error description based on the error code.

• E10: Unknown command

• E11: Parameter Error

• E12: Syntax Error

9 Specifications

Below are the general specification and the accuracy specification of ST2822D and ST2822E.

The specifications are subject to change without notice.

NOTE: 120 Hz is the listed frequency. The actual frequency is 120.048 Hz.

9.1 General Specifications

Function		
Measurement Parameters		Primary: L / C / R / Z / DCR Secondary: D / Q / θ / ESR
Equivalent Mode		Series, Parallel
Auto LCR Function		Manual, Auto
Ranging Mode		Auto
Test Terminals		3-terminal, 5-terminal
Measurement Speed	**LCRZ**	4 meas/sec, 1.5 meas/sec
	DCR	3 meas/sec, 2.5 meas/sec
Correction		Short, open
Tolerance Mode		1 %, 5 %, 10 %, 20 %
Input Protection Fuse		0.1 A / 63 V
Interface		Mini-USB (virtual serial port)
Test Signal		
Signal Frequency (0.02 % accuracy)	**ST2822D**	100 Hz, 120 Hz*, 1 kHz, 10 kHz
	ST2822E	100 Hz, 120 Hz*, 1 kHz, 10 kHz, 100 kHz
Test Signal Level (10 % accuracy)		0.3 Vrms, 0.6 Vrms, 1 Vrms; DCR signal: 1 V DC
Output Impedance		100 Ω
Display		
Display		LCD primary-secondary dual display
Backlight		Battery supply: when backlight is on, luminance is reduced by half 15 s later and automatically turned off 30 s later. Powered by adapter: backlight off until manually turned off
Count		Max. counts of primary parameter: 40000; D / Q / θ Min. resolution of secondary parameter: 0.0001.
Basic Accuracy		0.1 % (see accuracy specifications for details)
Primary Range and Resolution		See Accuracy Specifications

		Range for Display	Resolution
Secondary Parameter	ESR	0.0000 W ~ 999.9 Ω	0.0001 Ω
	D	0.0000 ~ 9.999	0.0001

	Q	0.0000 ~ 9999	0.0001
	θ	-179.9 ° ~ 179.9 °	0.01 °
Power Supply			
Battery Model	LH-200H7C, 8.4 V Ni-MH 200 mAH rechargeable battery		
AC Adapter	Input: 220 V (± 10 %), 50 Hz (± 5 %) Output: 12 V ~ 15 V DC		
Operating Current **(with backlight off)**	Max.: 35 mA Typical: 25 mA (@1 kHz, 0.6 Vrms,100 Ω load)		
Standby (Power Off) Current	Max. :11 µA		
Battery Life	16 hours (typical) based on backlight off and new alkaline		
	6 hours (typical) based on backlight off and new fully charged Ni-MH battery		
Charge Time and Current	Max. time: 160 min Max. current: 100 mA		
Auto Power Off **(valid for battery powered)**	5 min / 15 min / 30 min / 60 min / OFF available; Factory default: 5 min		
Low Voltage Indicator	When battery voltage drops below 6.8 V, Low Voltage Indicator turns on		
General			
Operation **Condition**	**Temperature**	0 °C ~ 40 °C	
	Relative **Humidity**	≤ 90 % RH	
Weight	350 g		
Dimensions (H ´ W ´ D)	190 mm × 90 mm × 41 mm		
Safety and EMC compliance	IEC 61010-1:2001 IEC 61326-2-1:2005		

9.2 Accuracy Specifications

9.2.1.1 Notices

1)   Environment temperature: 23 °C ± 5 °C

2)   Humidity: ≤ 75 % R.H.

3)   Requires 10 minutes of warm up time.

4)   Test in measuring slots on front panel.

5)   Measurements performed after correct open and short correction.

6)   Test in the recommended equivalent mode.

7)   Percentage discrepancy Indication:
     ± (% reading + number of least significant digits)

8)   Actual measurement and display range exceed the ranges specified in table, but we do not assign accuracy for measurement values exceeding these ranges.

9) When the test level is 0.3 V: accuracy × 2

10) Subscript Explanation:

   S—series equivalent;

   p—parallel equivalent;

   e: accuracy

11) Some parameters cannot be expressed as the way of data sheet; therefore they can just be converted by formulas according to corresponding results.

9.2.1.2 Inductance (L) and Quality Factor (Q)

Range		Display Range	Accuracy L_e	Accuracy D_e*	Rec. Equivalent Mode
100 Hz / 120 Hz	1000 H	400.0 H ~ 1000.0 H	1.00 % + 3 digits	0.0100	Parallel
	400 H	40.00 H ~ 399.99 H	0.35 % + 2 digits	0.0035	Parallel
	40 H	4.000 H ~ 39.999 H	0.10 % + 2 digits	0.0010	Parallel
	4 H	400.0 mH ~ 3.9999 H	0.10 % + 2 digits	0.0010	----
	400 mH	40.00 mH ~ 399.99 mH	0.10 % + 2 digits	0.0010	Series
	40 mH	4.000 mH ~ 39.999 mH	0.45 % + 2 digits	0.0045	Series
	4 mH	0 µH ~ 3.999 mH	1.40 % + 5 digits	------	Series
1 kHz	100 H	40.00 H ~ 100.00 H	1.00 % + 3 digits	0.0100	Parallel
	40 H	4.000 H ~ 39.999 H	0.35 % + 2 digits	0.0035	Parallel
	4 H	400.0 mH ~ 3.9999 H	0.10 % + 2 digits	0.0010	Parallel
	400 mH	40.00 mH ~ 399.99 mH	0.10 % + 2 digits	0.0010	----
	40 mH	4.000 mH ~ 39.999 mH	0.10 % + 2 digits	0.0010	Series
	4 mH	400.0 µH ~ 3.9999 mH	0.45 % + 2 digits	0.0045	Series
	400 µH	0.0 µH ~ 399.9 µH	1.40 % + 5 digits	------	Series
10 kHz	1000 mH	400.0 mH ~ 999.99 mH	0.80 % + 3 digits	0.0080	Parallel
	400 mH	40.00 mH ~ 399.99 mH	0.35 % + 2 digits	0.0035	Parallel
	40 mH	4.000 mH ~ 39.999 mH	0.10 % + 2 digits	0.0010	----
	4 mH	400.0 µH ~ 3.9999 mH	0.30 % + 2 digits	0.0030	Series
	400 µH	40.00 µH ~ 399.99 µH	0.45 % + 2 digits	0.0045	Series
	40 µH	0.00 µH ~ 39.99 µH	1.40 % + 5 digits	------	Series
100 kHz	100 mH	40.00 mH ~ 399.99 mH	1.20 % + 5 digits	0.0120	Parallel
	40 mH	4.000 mH ~ 39.999 mH	0.80 % + 2 digits	0.0080	Parallel
	4 mH	400.0 µH ~ 3.9999 mH	0.50 % + 2 digits	0.0050	----
	400 µH	40.00 µH ~ 399.99 µH	0.50 % + 2 digits	0.0050	Series
	40 µH	4.000 µH ~ 39.999 µH	0.80 % + 5 digits	0.0080	Series
	4 µH	0.000 µH ~ 3.999 µH	2.50 % + 10 digits	------	Series

Note: Accuracy of D_e is assessed when D_e < 0.5.

Quality factor Q and Accuracy Q_e is calculated by the following formula:

For $Q_x \times D_e \leq 1$;

$Q_e = \pm \dfrac{Q_x^2 \times D_e}{1 \mp Q_x \times D_e}$; Q_x is the measurement value.

9.2.1.3 Capacitance (C) and Dissipation (D)

	Range	Display Range	Accuracy C_e	Accuracy D_e*	Rec. Equivalent Mode
100 Hz / 120 Hz	2 mF	4.000 mF ~ 20.000 mF	5.00 %+ 5 digits	± 0.0500	Series
	4 mF	400.0 µF ~ 3.9999 mF	1.00 %+ 3 digits	± 0.0100	Series
	400µF	40.00µF ~ 399.99µF	0.35 %+ 2 digits	± 0.0035	Series
	40µF	4.000µF ~ 39.999µF	0.10 %+ 2 digits	± 0.0010	Series
	4µF	400.0 mF ~ 3.9999µF	0.10 %+ 2 digits	± 0.0010	----
	400 mF	40.00 nF ~ 399.99 nF	0.10 %+ 2 digits	± 0.0010	Parallel
	40 nF	4.000 nF ~ 39.999 nF	0.35 %+ 3 digits	± 0.0035	Parallel
	4 nF	0 pF ~ 3.999 nF	1.25 %+ 5 digits	------	Parallel
1 kHz	1000µF	400.0µF ~ 999.99 µF	2.00 %+ 5 digits	± 0.0200	Series
	400µF	40.00µF ~ 399.99 µF	1.00 %+ 3 digits	± 0.0100	Series
	40µF	4.000µF ~ 39.999 µF	0.35 %+ 2 digits	± 0.0035	Series
	4µF	400.0 nF ~ 3.9999 µF	0.10 %+ 2 digits	± 0.0010	Series
	400 nF	40.00 nF ~ 399.99 nF	0.10 %+ 2 digits	± 0.0010	----
	40 nF	4.000 nF ~ 39.999 nF	0.10 %+ 2 digits	± 0.0010	Parallel
	4 nF	400.0 pF ~ 3.9999 nF	0.35 %+ 3 digits	± 0.0035	Parallel
	400 pF	0.0 pF ~ 39.99 nF	1.25 %+ 5 digits	------	Parallel
10 kHz	100µF	40.00µF ~ 100.00µF	3.00 %+ 5 digits	± 0.0300	Series
	40µF	4.000µF ~ 39.999µF	1.50 %+ 3 digits	± 0.0150	Series
	4µF	400.0 nF ~ 3.9999µF	0.35 %+ 2 digits	± 0.0035	Series
	400 nF	40.00 nF ~ 399.99 nF	0.10 %+ 2 digits	± 0.0010	Series
	40 nF	4.000 nF ~ 39.999 nF	0.10 %+ 2 digits	± 0.0010	----
	4 nF	400.0 pF ~ 3.9999 nF	0.10 %+ 2 digits	± 0.0010	Parallel
	400 pF	40.00 pF ~ 399.99 pF	0.35 %+ 3 digits	± 0.0035	Parallel
	40 pF	0.00 pF ~ 39.99 pF	1.25 %+ 5 digits	------	Parallel
100 kHz	10µF	4.000µF ~ 10.000µF	6.00 %+20 digits	± 0.0600	Series
	4µF	400.0 nF ~ 3.9999µF	2.50 %+10 digits	± 0.0250	Series
	400 nF	40.00 nF ~ 399.99 nF	0.80 %+ 5 digits	± 0.0080	Series
	40 nF	4.000 nF ~ 39.999 nF	0.50 %+ 2 digits	± 0.0050	Series
	4 nF	400.0 pF ~ 3.9999 nF	0.50 %+ 2 digits	± 0.0050	----
	400 pF	40.00 pF ~ 399.99 pF	0.80 %+ 2 digits	± 0.0080	Parallel
	40 pF	4.000 pF ~ 39.999 pF	1.20 %+ 5 digits	± 0.0120	Parallel
	4 pF	0.000 pF ~ 4.999 pF	3.00 %+10 digits	------	Parallel

9.2.1.4 Impedance (Z), Phase Angle (θ)and DCR

	Range	Display Range	Accuracy Z_e	Accuracy θ_e	Rec. Equivalent Mode
100 Hz ~ 10 kHz	10 MΩ	4.000 MΩ ~ 10.000 MΩ	3.00 %+ 5 digits	± 1.75 °	Parallel
	4 MΩ	400.0 kΩ ~ 3.9999 MΩ	1.25 %+ 3 digits	± 0.75 °	Parallel
	400 kΩ	40.00 kΩ ~ 399.99 kΩ	0.35 %+ 2 digits	± 0.25 °	Parallel
	40 kΩ	4.000 kΩ ~ 39.999 kΩ	0.10 %+ 2 digits	± 0.10 °	Parallel
	4 kΩ	400.0 Ω ~ 3.9999 kΩ	0.10 %+ 2 digits	± 0.10 °	----
	400 Ω	40.00 Ω ~ 399.99 Ω	0.10 %+ 2 digits	± 0.10 °	Series
	40 Ω	4.000 Ω ~ 39.999 Ω	0.35 %+ 2 digits	± 0.25 °	Series
	4 Ω	0.4000 Ω ~ 3.9999 Ω	1.00 %+ 3 digits	± 0.60 °	Series
	0.4 Ω	0.0000 Ω ~ 0.3999 Ω	3.00 %+ 5 digits	------	Series
100 kH	10 MΩ	4.000 MΩ ~ 10.000 MΩ	8.00 %+20 digits	± 4.60 °	Parallel
	4 MΩ	400.0 kΩ ~ 3.9999 MΩ	3.00 %+10 digits	± 1.75 °	Parallel

	400 kΩ	40.00 kΩ ~ 399.99 kΩ	1.20 %+ 5 digits	± 0.69 °	Parallel
	40 kΩ	4.000 kΩ ~ 39.999 kΩ	0.80 %+ 2 digits	± 0.46 °	Parallel
	4 kΩ	400.0 Ω ~ 3.9999 kΩ	0.50 %+ 2 digits	± 0.30 °	----
	400 Ω	40.00 Ω ~ 399.99 Ω	0.50 %+ 2 digits	± 0.30 °	Series
	40 Ω	4.000 Ω ~ 39.999 Ω	0.80 %+ 5 digits	± 0.46 °	Series
	4 Ω	0.4000 Ω ~ 3.9999 Ω	2.50 %+10 digits	± 1.43 °	Series
	0.4 Ω	0.0000 Ω ~ 0.3999 Ω	6.00 %+20 digits	------	Series
DCR	20 MΩ	4.000 MΩ ~ 20.000 MΩ	2.00 %+20 digits	------	------
	4 MΩ	400.0 kΩ ~ 3.9999 MΩ	1.00 %+10 digits	------	------
	400 kΩ	40.00 kΩ ~ 399.99 kΩ	0.50 %+ 5 digits	------	------
	40 kΩ	4.000 kΩ ~ 39.999 kΩ	0.10 %+ 2 digits	------	------
	4 kΩ	400.0 Ω ~ 3.9999 kΩ	0.10 %+ 2 digits	------	------
	400 Ω	40.00 Ω ~ 399.99 Ω	0.10 %+ 2 digits	------	------
	40 Ω	4.000 Ω ~ 39.999 Ω	0.10 %+ 2 digits	------	------
	4 Ω	0.4000 Ω ~ 3.9999 Ω	0.50 %+10 digits	------	------
	0.4 Ω	0.0000 Ω ~ 0.3999 Ω	2.00 %+20 digits	------	------

9.2.1.5 Equivalent Series Resistance

Accuracy of equivalent series resistance is calculated according to the below formula:

$$R_{se} = \pm X_x \times \phi_e$$

X_x : actual impedance; $X_x = 2\pi f L_x$

Or…

$$X_x = \frac{1}{2\pi f C_x}$$

$$\phi_e = \theta_e \times \frac{\pi}{180};$$

ϕ_e is the phase angle accuracy.

NOTE: The accuracies of ESR and R_s are same.

9.2.1.6 Equivalent Parallel Resistance

Accuracy of equivalent series resistance is calculated according to the below formula:

$$R_{pe} = \pm \frac{R_{px} \times \phi_e}{D_x \mp \phi_e};$$

R_{px} is the measurement value of R_p, D_x is the dissipation value.

10 Maintenance

	WARNING!
⚠	**Do not** perform any maintenance work by yourself! Service must only be done by **qualified personnel** and trained technicians.
	Beware of liquid and residues, especially conductive matter!

10.1 Service

If the instrument fails to power on, first check battery, external source and power sockets and the validity of buttons.

If the measurement result is abnormal, first inspect the condition of test accessories and damage of reed in test slots. See operation manual for conformation of correct operation.

Do not replace components. Contact the after-sale department of our company or relevant distributors for uncertain maintenance.

The meter must be turned off or removed from external power before replacing battery. See Installing Battery section for details.

10.2 Cleaning

Before cleaning this meter, make sure the power is OFF and remove external AC adapter if one is used.

To avoid electrical shock or damaging the meter, prevent water from getting inside the case. In the case that water gets inside, remove the battery immediately and do not operate the instrument immediately.

To clean the meter, wipe the dirty parts with a soft cloth soaked with diluted neutral detergent. Avoid having the instrument too wet to prevent the detergent from penetrating into the inside components of the meter, causing damages.

After cleaning, make sure the instrument is completely dried before operating it again.

$C\,E$