# Hand Held LCR Meter
# SM6016

**User Manual**

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# 1. Introduction

SM6016 is designed for measuring inductance, capacitance and resistance of components. The instrument can be powered by an 8.4V 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.

SM6016 provides the primary parameter of up to 40,000 readings, secondary parameter of 0.0001 reading resolution, maximum measuring frequency up to 100kHz, constant internal resistance of 100Ω 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 menuhelp you easily take the selections of the key tone, auto power-off and storage.

SM6016 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. Technical Specifications

Below are the general specification and the accuracy specification of SM6016.

**General Specifications**

| | | |
|---|---|---|
| **Function** | | |
| Measurement Parameters | | Primary: L/C/R/Z/DCR<br>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,1.5meas/sec |
| | DCR | 3 meas/sec,2.5meas/sec |
| Correction | | Short, open |
| Tolerance Mode | | 1%，5%，10%，20% |
| Input Protection Fuse | | 0.1A / 63V |
| Interface | | Mini-USB (virtual serial port) |
| **Test Signal** | | |
| Signal Frequency(0.02% accuracy) | | 100Hz,*120Hz,1kHz,10kHz,100kHz |
| Test Signal Level(10% accuracy) | | 0.3 Vrms, 0.6Vrms, 1Vrms<br>DCR signal：1Vdc |
| Output Impedance | | 100Ω |
| **Display** | | |
| Display | | LCD primary-secondary dual display |
| Backlight | | Battery supply: when backlight is on,<br>luminance is reduced by half 15s later and automatically turned off 30s later.<br>Powered by adapter: backlight off<br>until manually turned off |
| Count | | Max. Counts of Primary Parameter:<br>40,000; D / Q / θ Min. resolution of<br>secondary parameter: 0.0001. |
| Basic Accuracy | | 0.1%（see performance check accuracy specifications for details） |
| Primary Range and Resolution | | See Performance check accuracy Specifications |

| Secondary Parameter | | Range for Display | Resolution |
|---|---|---|---|
| | ESR | 0.0000Ω – 999.9Ω | 0.0001Ω |
| | D | 0.0000 – 9.999 | 0.0001 |
| | Q | 0.0000 – 9.999 | 0.0001 |
| | θ | -179.9° -- 179.9° | 0.01° |
| **Power Supply** | | | |
| Battery Model | | LH-200H7C,8.4V Ni-MH<br>200mAH rechargeable battery | |
| AC Adapter | | Input：220V(1±10%)，50Hz(1±5%)<br>Output：12V-15V DC | |
| Operating Current (with backlight off) | | Max.:35mA<br>Typical:25mA (@1kHz, 0.6Vrms,100Ω load) | |
| 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.: 160min<br>Max. Current: 100mA | |
| Auto Power Off (valid for battery powered） | | 5min/15min/30min/60min/OFF available ;<br>factory default :5min | |
| **General** | | | |
| Operation Condition | | Temperature : 0℃ -- 40℃ | |
| | | Relative Humidity : ≤90% R.H. | |
| Weight | | 350g | |
| Dimensions (H x W x D) | | 190mm x 90mm x 41mm | |
| Safety and EMC compliance | | IEC 61010-1:2001<br>IEC 61326-2-1:2005 | |
| **Accessories** | | | |
| Standard | | 4 terminal crocodile Kelvin test leads, Banana to crocodile clip, SMD Kelvin tweezers, AC adapter, USB cable, CD containing user manual | |
| *NOTE: 120Hz is the fixed frequency. The actual frequency is 120.048Hz. | | | |

Subject to change

# 3. Safety Instructions

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 high dust, direct sunlight, high humidity, strong electromagnetic radiation, etc.

***NON-PROFESSIONALS SHUOLD NOT OPEN THE REAR COVER***

Maintaining, substituting parts or adjusting the instrument should be made by professional maintenance personnel. Please contact relevant distributor or our after-sale service department.

***DO NOT REMOVE OR MODIFY THE INSTRUMENT***

Some replacements and unauthorized modifications might cause irreversible damage to the instrument.

***SAFETY WARNING***

Strictly follow the relevant safety statements in this manual involving safety, personnel injury, damage to the instrument, operation and environmental conditions causing poor test.

## Safety Guidelines

**To ensure safe use of this instrument, follow the safety guidelines listed below:**

- This meter is for indoor use, altitude up to 2,000 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 it is possible to operate from mains using a power adapter of 12VDC/150mA. If a power adapter is selected, please be sure to meet the safety requirements of a relevant IEC standard.
- The battery using in SM6016 is rechargeable. Do not charge non-rechargeable batteries.

**Safety Symbols**

⚠ This symbol is a warning and indicates that the user should refer to the operating instructions located in the manual.

⎓ D C power

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

# 4. Front Panel Overview


**Figure 1 - Front Panel Display**

## 4.1 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/ /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. 12VDC external power input (use with an external power adapter)

*NOTE: Use 12VDC, 150mA, 4mm adapter*
*Internal battery supply will be automatically cut off when supply is from external power. If the battery is rechargeable (SM6016), the external power will charge the battery simultaneously. SM6016 is installed 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 severe damage to the instrument.

WARNING: If the battery is rechargeable (SM6016), please be sure that the polarity matches the (+) and (-) labels as indicated inside the battery compartment ant the battery is rechargeable. DO NOT charge the non-rechargeable battery!

## 4.2 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”.*

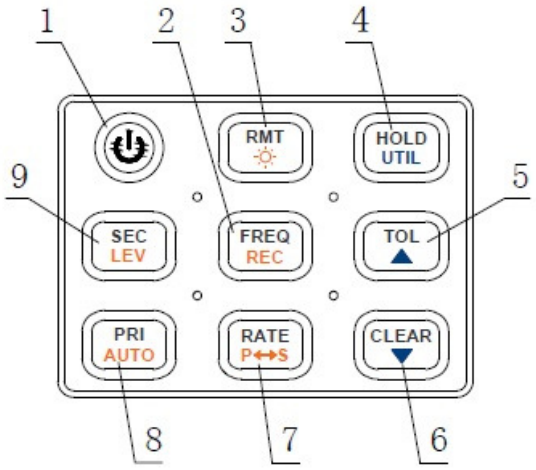



**Figure 2 – Button Display**

## 4.3 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

## 4.4 LCD Display Overview

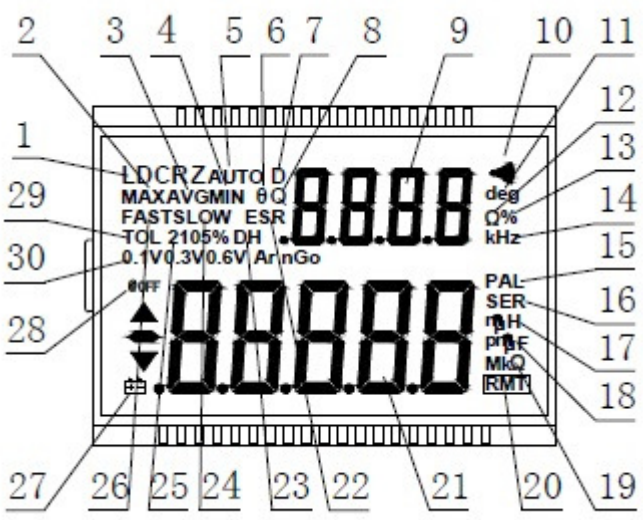


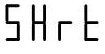

Figure 3 LCD Indicator Display

## 4.5 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. – Phase angle indicator for secondary display
7. D – Dissipation indicator
8. Q – Quality factor indicator
9. .⊟.⊟.⊟.⊟ – 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.  – 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. 1V 0.6V 0.3V- Display test level

## 4.6 Special Display Indicators

| | |
|---|---|
|  | Indicates short clear if you press the CLEAR button |
|  | Indicates open clear if you press the CLEAR button |
|  | Error indication |
|  | Indicates correction (open/short clear) mode |
|  | Indicates damaged or open fuse |
|  | AD converter error（UNK） |
|  | AD converter error (END) |

## 4.7 Test Port

SM6016 are creatively designed to combine 3-terminal port and 5-terminal port, which makes the convenient test and highly accurate test realized in the instrument.

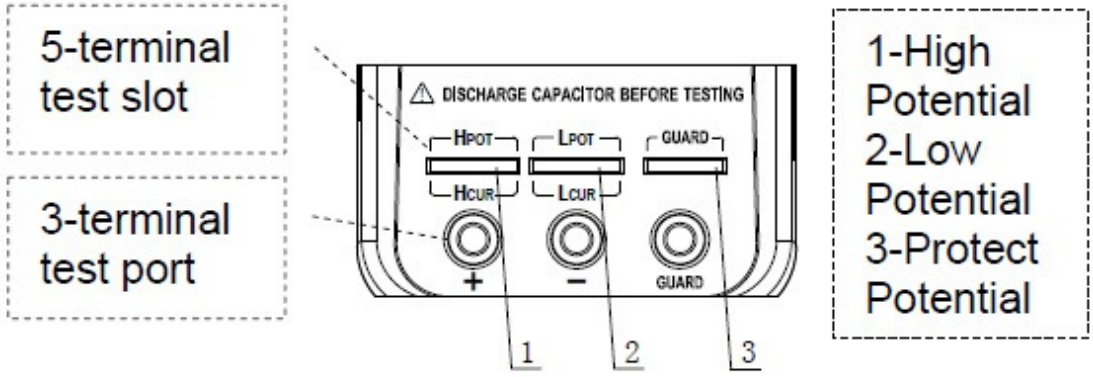



**Figure 4- test port**

With the adoption of standard banana slots, the instrument can use inexpensive banana plug-crocodile clip as the test lead, which make the test quite convenient. However this configuration has low testing accuracy.
For the improvement of accuracy when using external testing leads, SM6016 are designed with 5- terminal testing slots and exclusive test fixture to ensure complete external 4-terminal test and measuring accuracy.

***NOTE:*** *SMA26027AS (4 terminal Kelvin test Leads) and SMA26029C (SMD Tweezers with Plastic body) are standard accessory with SM6016 however SMA26009C (SMD tweezers with metallic Body) are optional with SM6016. Please refer to datasheet for relevant instrument accessories.*

Below are SMA26027As, SMA26029C and SMA26009C 4-terminal test accessories:

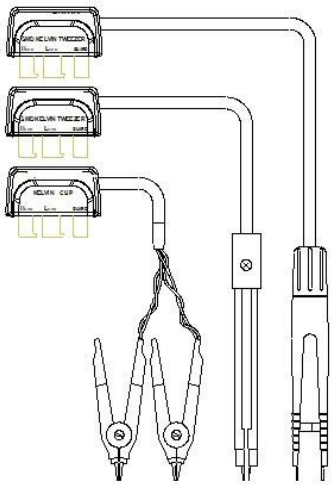


**Figure 5 : 4-terminal Test Accessories**

# 5. Powering 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.

## 5.1 Installing Battery

SM6016 can adopt battery for power supply so that you can take measurements whenever and wherever without much preparation.

**8.4V alkaline batteries used in SM6016 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 Figure 6. 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 (See Figure 7). 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 6- Back Cover**

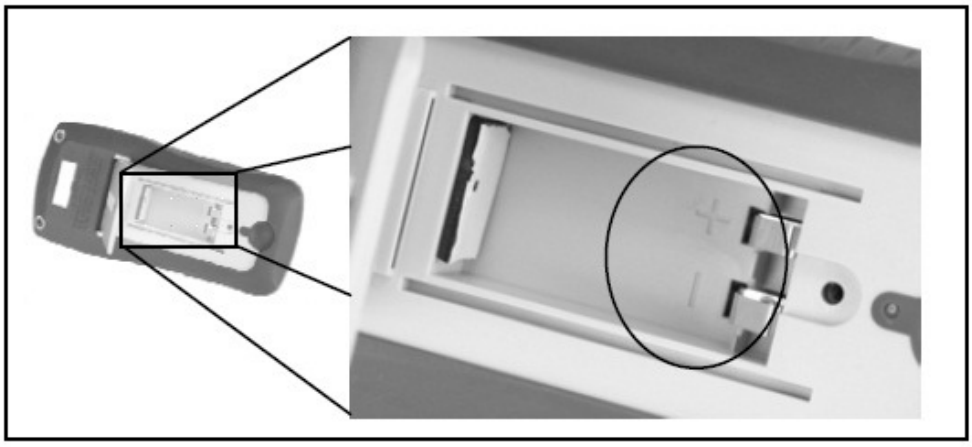


**Figure 7- Battery Compartment**

## 5.2 Connecting External Power Source

SM6016 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, do the following:

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 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 avoid 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 12VDC.
4. Connect the AC Adapter socket into an electrical outlet.
5. Press and hold down the power button for about 2s to turn on the meter.

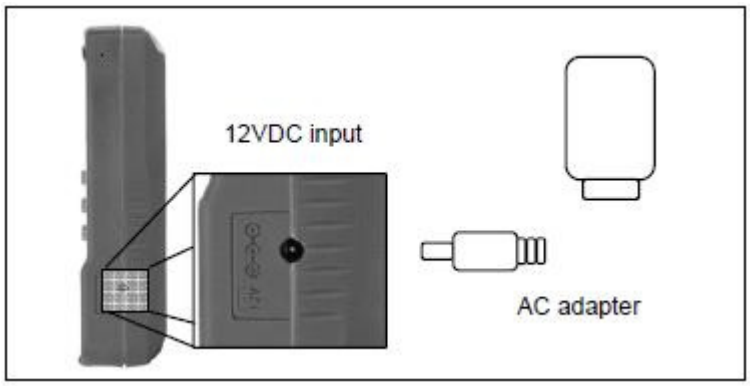



**Figure 8-Connecting AC Adapter to Meter**

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.

## 5.3 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 6.8V). It is highly recommended that the battery be replaced as soon as possible before continuing operation. See “Installing 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.

## 5.4 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.

### *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.

### *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.

## 5.5 Charge Display

The power circuit of SM6016 is rechargeable. When the external power adapter is plugged in, the power mode will automatically switched and charge the internal chargeable battery.
Single charge circle is about 160 minutes and charge current is approximate 120mA.
If a battery is full 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, DO NOT connect to an external power when a non-rechargeable battery is installed. Doing so will cause the burst of 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.

# 6. Operation Instruction

## 6.1 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.

### *Turn On Data Hold*

To use data hold, press the 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 HOLD button.

### *Turn Off Data Hold*

To disable the data hold, press the HOLD button again. The “DH” indicator will disappear on the screen, and meter will remain in normal operation mode.

## 6.2 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.

### *Enable Static Recording*

Press and hold down the 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.

### *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 .**

*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.*

*Maximum Display*

Press REC button until the “ MAX ” indicator is shown on display. This indicates that the value in the primary display represents the recorded maximum value.

*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.

*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.

### *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.*

## 6.3 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.*

## 6.4 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).

## 6.5 Test Frequency（FREQ）

SM6016 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.

### *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:
SM6016：100Hz/120Hz/1kHz/10kHz/100kHz

## 6.6 Test Electric Level

SM6016 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 0.6V, 0.3V and 1V.

## 6.7 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*(Mx-Nom)/Nom%
Where, Mx: the primary parameter display; Nom: the nominal value recorded.
The percentage value is used for sorting.

### *Use Tolerance Mode*

To use the tolerance mode as the process shown below:

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.**

### *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.*

## 6.8 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.

### *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:

**Table1-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.

### *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.

## 6.9 Measurement Rate (RATE)

There are two selectable measurement rates in this instrument: fast and slow. The rate of fast measurement is about 4~5times/sec and slow measurement is approximate 1.5 times/sec. 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.

## 6.10 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.

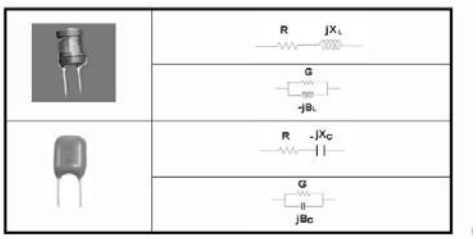



**Figure 9-Series and Parallel Equivalent Models of Inductors and Capacitors**

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

### *Selecting Measurement Mode*

Long press P<->S button, "PAL" on LCD indicates parallel equivalent mode and "SER" means series equivalent mode.

### *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.

## 6.11 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.

### *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".

### *Configuration and Settings*

The following contents are included in the utility menu:

**Table 2-Utility Menu Options and Settings**

| MenuOptions | Settings/Parameters |
|---|---|
| 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:

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:

**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.*

*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.

Using 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.

*Auto power-off Setup(AoFF)*

The "AoFF" menu option allows the user to select the auto power-off timer. The available timer settings are: 5min/15min/30min/60min/OFF. When the primary display shows "AoFF", push the ▲ and ▼ arrow keys to select the timer setting. The settings will be shown on the secondary display as Table 3.
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.*

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

*NOTE: 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 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

*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*

### Configure and Save Power-up State

Procedure to configure and save power-up state is as follows:

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 ▲ and ▼ 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.*

### 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.

*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 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 MenuOption | clear |

In “dEF” option, push either ▲ and ▼ 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.*

***NOTE:*** *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.*

*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.

## 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.

*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.

*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 ▼ 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.

## 6.12 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.

### 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.

### 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.*

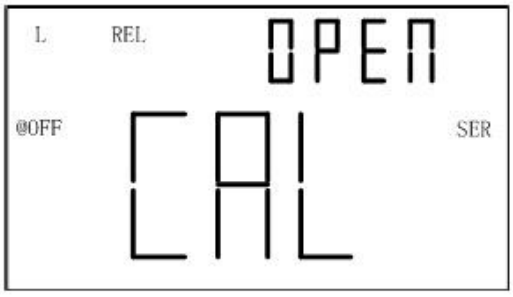



**Figure 10 - Open Clear**

### 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.*

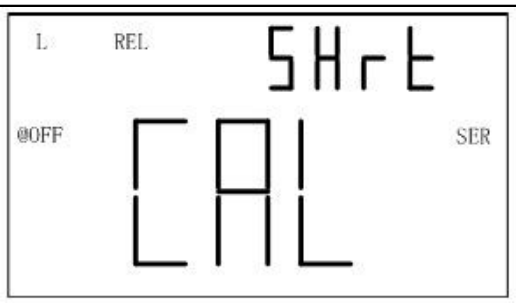



Figure11-Short Clear

**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:*

1. *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.*
2. *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 1kHz, the meter has been cleared; and when the frequency is back to 1kHz, there is no need to clear again.)*
3. *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.*
4. *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.*

## 6.13 Remote Control (RMT)

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

## 6.14 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.

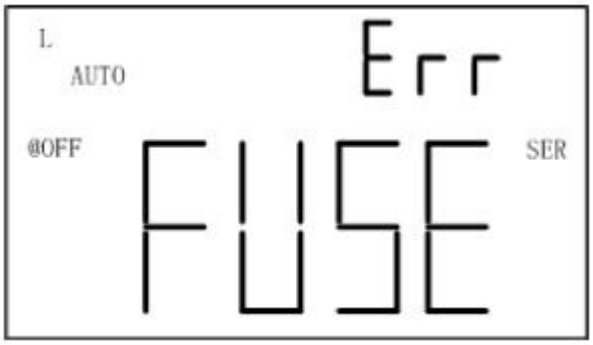



**Figure 12-Fuse Display**

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.*

# 7. Quick Start Guide

## 7.1 CAUTION ⚠

- 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.*

## 7.2 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 figures 13 below. Figure 5 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.

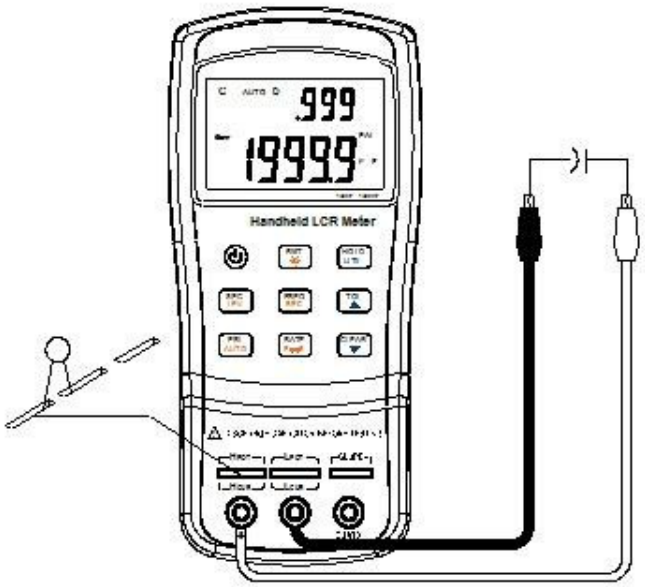



**Figure 13- Inductance Measurement**

## 7.3 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 figures 14 below. Figure 5 shows the optional 4-terminal test accessories.
4. **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.**
5. Press the FREQ button until the desired test frequency is displayed on screen.
6. Press the LEV button until the desired test level is displayed on screen.
7. Press the SEC button to select the desired secondary parameter.
8. Read the readings on LCD for capacitance measured values.

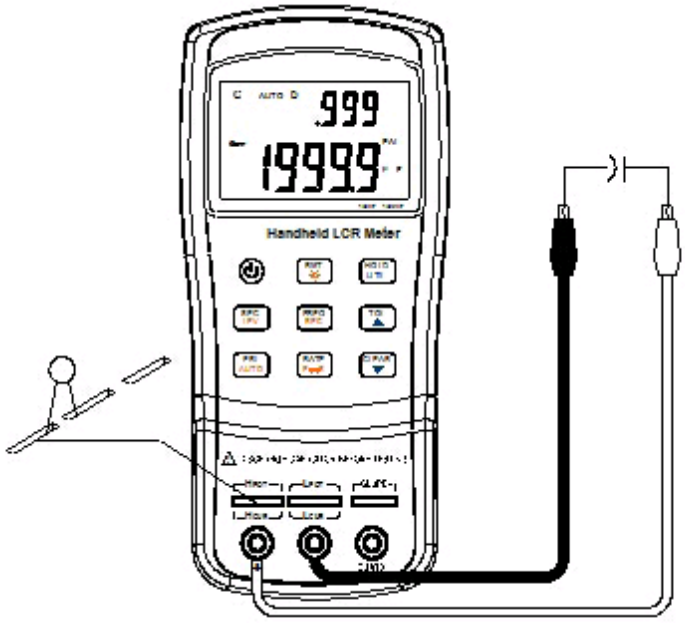



**Figure 14- Capacitance Measurement**

## 7.4 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 figures 15 below.
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.*

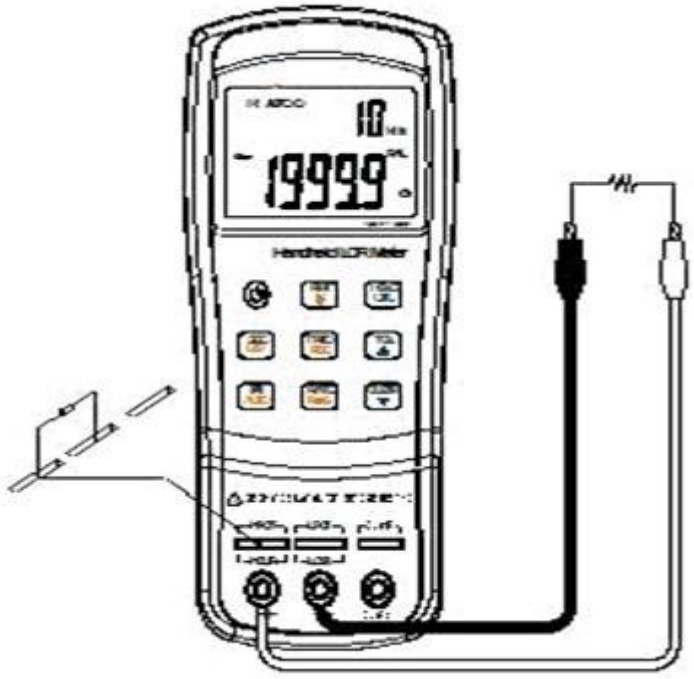


Figure 15-Resistance Measurement

## 7.5 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.

## 7.6 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.

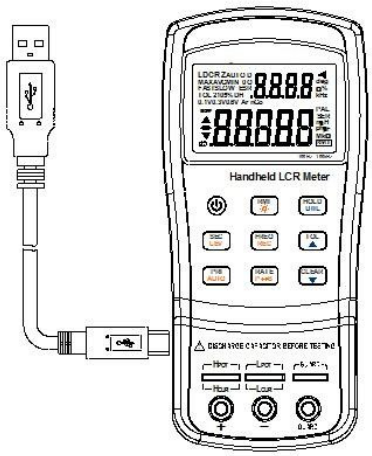
# 8. Remote Communication

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.

## 8.1 Connecting Instrument to PC

Follow the below procedures for connection setup.

1. Install USB driver from CD or download the USB drivers.
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.




## 8.2 Virtual Serial Port Configuration

Below is the serial communication configuration of SM6016:

- Baudrate : **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

## 8.3 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.*

### *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.*
Be out of remote mode, press RMT button to change to Auto Fetch. See the description below.

### *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.

*Enable/Disable Auto Fetch*

To toggle between enabling and disabling auto fetching when the meter is out of remote control, press the RMT button. In Auto Fetch, every flash of "RMT" means send a measurement result.

*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.*

## 8.4 Command Protocols

### *Overview*

SM6016 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.

### *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. SM6016 support a few common commands. See the following command descriptions for more details.

### *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>

#### *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>**

#### *Data Types*

Table 5 below explains the different data types transmitted on bus with ASCII characters:

**Table 5 – 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<br>-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 |

***Symbol Convention***

*Syntax Symbols in Commands*

Below symbols is a part of commands:

| 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 |

*Command Specifier*

Below symbols are used for the description of command format, which are not the constituting part of command.

**Table 6-Command Specifier**

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

*Abbreviation, upper case and lower case 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.

# *Command Reference*

## *Common Command*

***IDN?**
Query instrument ID.
Return: <instrument model>, <firmware version>, <serial number>

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

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

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

## *SCPI Commands*

### FREQuency Subsystem commands

**FREQuency <value>**
Description: Set the test frequency Parameters: 100, 120, 1000, 10000,100000 or 100Hz,120Hz,1kHz,10kHz,100kHz
Example: FREQuency 100Hz
Set the frequency to 100Hz

**FREQuency?**
Description: Query the current test frequency
Return: <100Hz|120Hz|1kHz|10kHz|100kHz>

**VOLTage subsystem**
**VOLTage <value>**
Description：set the test level (only effective in L,C,R,Z)
Parameters are 0.3, 0.6, 1 or 3e-1, 6e-1,1e0
Example： VOLTage 0.3
Set the test level to 0.3 V

**VOLTage?**
Description: set the current test level
Return：<0.3V|0.6V|1V>

### FUNCtion subsystem

**FUNCtion:impa < L | C | R | Z | DCR >**
Description: Select the primary parameter
Example: FUNCtion:impa L
Selects L as the primary parameter

**FUNCtion:impa?**
Description: Query the primary parameter
Return: <L, C, R, Z, DCR, NULL >

**FUNCtion:impb < D | Q | THETA | ESR >**
Description: Select the secondary parameter (only effective in L,C,R,Z)
Example: FUNCtion:impb D
Select D as the secondary parameter

**FUNCtion:impb?**
Description: Query the secondary parameter (only effective in L,C,R,Z)
Return: <D, Q, THETA, ESR, NULL>

**FUNCtion:EQUivalent < SERies | parallel | PAL >**
Description: Set the equivalent mode (only effective in L,C,R,Z)
Parameters: SERies — series mode
Parallel — parallel mode
Pal — parallel mode
Example: FUNCtion:EQUivalent SERies
Set the equivalent mode to series mode

**FUNCtion:EQUivalent?**
Description: Query the equivalent mode
Return: <SER, PAL>

## CALCulate subsystem

**CALCulate:TOLerance:STATe < ON | OFF >**
Description: Enable or disable tolerance mode
Example: CALCulate: TOLerance:STATe ON

**CALCulate:TOLerance:STATe?**
Description: Query the tolerance mode
Return: <ON, OFF >

**CALCulate:TOLerance:NOMinal?**
Description: Query the nominal value
Return: NR3 or -----(exceeding data range)

**CALCulate:TOLerance:VALUe?**
Description: Query the percentage value of tolerance
Return: NR3 or ----- (exceeding data range)

**CALCulate:TOLerance:RANGe < 1 | 5 | 10 | 20 >**
Description: Set tolerance range as 1%,5%,10% or 20%
Example: CALCulate:TOLerance:RANGe 1
Set the tolerance range to 1%

**CALCulate:TOLerance:RANGe?**
Description: Query the tolerance range
Return: <BIN1, BIN2, BIN3, BIN4 or ---- > “----” means unset bin

**CALCulate:RECording:STATe < ON | OFF >**
Description: Enable or disable recording function
Example: CALCulate:RECording:STATe ON

**CALCulate:RECording:STATe?**
Description: Query the recording state
Return: <ON or OFF>

**CALCulate:RECording:MAXimum?**
Description: Query the maximum value of recording function
Return: <NR3, NR3> ( primary and secondary parameters, when data exceeds limits or there is no data, what returns is"----".)

**CALCulate:RECording:MINimum?**
Description: Query the minimum value of recording function
Return: <NR3, NR3> ( primary and secondary parameters, when data exceeds limits or there is no data, what returns is"----".)

**CALCulate:RECording:AVERage?**
Description: Query the average value of recording function
Return: <NR3, NR3> ( primary and secondary parameters, when data exceeds limits or there is no data, what returns is"----".)

**CALCulate:RECording:PRESent?**
Description: Query the present value of recording function
Return: <NR3, NR3> ( primary and secondary parameters, when data exceeds limits or there is no data, what returns is"----".)

### FETCh Subsystem

**FETCh?**
Description: Returns the primary, secondary display value and tolerance compared result (BIN no.).
Return: <NR3, NR3, NR1> when the primary parameter is LCR, Primary parameter, secondary parameter and BIN no.
<NR3,NR1> when the primary parameter is DCR, Primary parameter and BIN no.
Example: FETCh?

## *Summary of Supported SCPI Commands*

**Table 7 - Summary of SCPI Commands**

| Command | Parameter | Explanation |
|---|---|---|
| FREQuency | <Value> | Set the Test Frequency |
| FREQuency? | | Query the Test Frequency |
| VOLTage | <Value> | Set the Test level |
| VOLTage? | | Query the Test level |
| FUNCtion | | |
| :impa | <Literal> | Select the primary display parameter |
| :impa? | | Query the primary display parameter |
| :impb | <Literal> | Select the secondary display parameter |
| :impb? | | Query the secondary display parameter |

| | | |
|---|---|---|
| :EQUivalent | <Literal> | Set the equivalent mode |
| :EQUivalent? | | Query the equivalent mode |
| CALCulate | | |
| :TOLerance | | |
| :STATe | <Boolean> | Enable/disable the tolerance mode |
| :STATe? | | Query the tolerance mode |
| :NOMinal? | | Query the nominal value |
| :VALUe? | | Query the percent of tolerance |
| :RANG | <Value> | Set the limit bin |
| :RANGe? | | Query the limit bin |
| :RECording | | |
| :STATe | <Boolean> | 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 |
| FETCh? | | Query the measurement result |

***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. Performance Check

**Accuracy Specifications**

*Notice*

1. Environment temperature： 23 ℃ ± 5 ℃ ; Humidity: ≤75% R.H.
2. Valid after 10 minutes of warm up time.
3. Test in measuring slots on front panel.
4. Measurements performed after correct open and short correction.
5. Test in the recommended equivalent mode.
6. Percentage discrepancy Indication: ±（%reading+ number of least significant digits）
7. Actual measurement and display range exceed the ranges specified in table, but we do not assign accuracy for measurement values exceeding these ranges.
8. When the test level is 0.3V: accuracy*2
9. Subscript Explanation: S—series equivalent; p—parallel equivalent; e: accuracy
10. Some parameters cannot be expressed as the way of data sheet; therefore they can just be converted by formulas according to corresponding results.

***Inductance (L) and Quality Factor (Q)***

| Range | | Display Range | Accuracy | | Recommended Equivalent Mode |
|---|---|---|---|---|---|
| | | | Le | De* | |
| 100Hz/120Hz | 1000H | 400.0H - 1000.0H | 1.00%+3 digits | 0.0100 | Parallel |
| | 400H | 40.00H - 399.99H | 0.35%+2 digits | 0.0035 | Parallel |
| | 40H | 4.000H - 39.999H | 0.25%+2 digits | 0.0025 | Parallel |
| | 4H | 400.0mH - 3.9999H | 0.25%+2 digits | 0.0025 | ---- |
| | 400mH | 40.00mH - 399.99mH | 0.25%+2 digits | 0.0025 | Series |
| | 40mH | 4.000mH - 39.999 | 0.45%+2 digits | 0.0045 | Series |
| | 4mH | 0uH - 3.999mH | 1.40%+5 digits | ------ | Series |
| 1kHz | 100H | 40.00H - 100.00H | 1.00%+3 digits | 0.0100 | Parallel |
| | 40H | 4.000H - 39.999H | 0.35%+2 digits | 0.0035 | Parallel |
| | 4H | 400.0mH - 3.9999H | 0.25%+2 digits | 0.0025 | Parallel |
| | 400mH | 40.00mH - 399.99 | 0.25%+2 digits | 0.0025 | ---- |
| | 40mH | 4.000mH - 39.999mH | 0.25%+2 digits | 0.0025 | Series |
| | 4mH | 400.0uH - 3.9999 | 0.45%+2 digits | 0.0045 | Series |
| | 400μH | 0.0uH - 399.9μH | 1.40%+5 digits | ------ | Series |
| 10kHz | 1000mH | 400.0mH 999.99 mH | 0.80%+3 digits | 0.0080 | Parallel |
| | 400mH | 40.00mH 399.99 mH | 0.35%+2 digits | 0.0035 | Parallel |
| | 40mH | 4.000mH 39.999 mH | 0.25%+2 digits | 0.0025 | ---- |
| | 4mH | 400.0uH 3.9999 mH | 0.30%+2 digits | 0.0030 | Series |

| | | | | | |
|---|---|---|---|---|---|
| | 400μH | 40.00uH 399.99μ H | 0.45%+2 digits | 0.0045 | Series |
| | 40μH | 0.00uH 39.99μH | 1.40%+5 digits | ------ | Series |
| 100kHz | 100mH | 40.00mH 399.99 mH | 1.20%+5 digits | 0.0120 | Parallel |
| | 40mH | 4.000mH 39.999 mH | 0.80%+2 digits | 0.0080 | Parallel |
| | 4mH | 400.0uH 3.9999 mH | 0.50%+2 digits | 0.0050 | ---- |
| | 400μH | 40.00uH 399.99 μH | 0.50%+2 digits | 0.0050 | Series |
| | 40μH | 4.000uH 39.999μH | 0.80%+5 digits | 0.0080 | Series |
| | 4μH | 0.000uH 3.999μH | 2.50%+10 digits | ------ | Series |

*Note: Accuracy of De is assessed when De <0.5
Quality factor Q and Accuracy Qe is calculated by the following formula:

For $Q_x \times D_e \leqslant 1$,

$$Q_e = \pm \frac{Q_x^2 \times D_e}{1 \mp Q_x \times D_e}$$

$Q_x$ is the measurement value.

***Capacitance(c) and Dissipation (D)***

| Range | | Display Range | Accuracy | | Recommended Equivalent Mode |
|---|---|---|---|---|---|
| | | | Ce | De* | |
| 100Hz/120Hz | 20mF | 4.000mF - 20.000mF | 5.00%+5 digits | ±0.0500 | Series |
| | 4mF | 400.0μF - 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 | 0.25%+2 digits | ±0.0025 | Series |
| | 4μF | 400.0nF - 3.9999μF | 0.25%+2 digits | ±0.0025 | ---- |
| | 400nF | 40.00nF - 399.99nF | 0.25%+2 digits | ±0.0025 | Parallel |
| | 40nF | 4.000nF - 39.999nF | 0.35%+3 digits | ±0.0035 | Parallel |
| | 4nF | 0pF - 3.999nF | 1.25%+5 digits | ----- | Parallel |
| 1kHz | 1000μF | 400.0μF - 999.99μF | 2.00%+5 digits | ±0.0200 | Series |
| | 400μF | 40.00μF - 399.99μF | 1.00%+3 digits | ±0.0100 | Series |
| | 40μF | 4.000μF - 39.999μF | 0.35%+2 digits | ±0.0035 | Series |
| | 4μF | 400.0nF - 3.9999μF | 0.25%+2 digits | ±0.0025 | Series |
| | 400nF | 40.00nF - 399.99nF | 0.25%+2 digits | ±0.0025 | ---- |

| | | | | | |
|---|---|---|---|---|---|
| | 40nF | 4.000nF - 39.999nF | 0.25%+2 digits | ±0.0025 | Parallel |
| | 4nF | 400.0pF - 3.9999nF | 0.35%+3 digits | ±0.0035 | Parallel |
| | 400pF | 0.0pF - 39.99nF | 1.25%+5 digits | ------ | Parallel |
| 10kHz | 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 | 400.0nF - 3.9999μF | 0.35%+2 digits | ±0.0035 | Series |
| | 400nF | 40.00nF - 399.99nF | 0.25%+2 digits | ±0.0025 | Series |
| | 40nF | 4.000nF - 39.999nF | 0.25%+2 digits | ±0.0025 | ---- |
| | 4nF | 400.0pF - 3.9999nF | 0.25%+2 digits | ±0.0025 | Parallel |
| | 400pF | 40.00pF - 399.99pF | 0.35%+3 digits | ±0.0035 | Parallel |
| | 40pF | 0.00pF - 39.99pF | 1.25%+5 digits | ------ | Parallel |
| 100kHz | 10μF | 4.000μF - 10.000μF | 6.00%+20 digits | ±0.0600 | Series |
| | 4μF | 400.0nF - 3.9999μF | 2.50%+10 digits | ±0.0250 | Series |
| | 400nF | 40.00nF - 399.99nF | 0.80%+5 digits | ±0.0080 | Series |
| | 40nF | 4.000nF - 39.999nF | 0.50%+2 digits | ±0.0050 | Series |
| | 4nF | 400.0pF - 3.9999nF | 0.50%+2 digits | ±0.0050 | ---- |
| | 400pF | 40.00pF - 399.99pF | 0.80%+2 digits | ±0.0080 | Parallel |
| | 40pF | 4.000pF - 39.999pF | 1.20%+5 digits | ±0.0120 | Parallel |
| | 4pF | 0.000pF - 4.999pF | 3.00%+10 digits | ------ | Parallel |

***Impedance（Z） and Phase Angle （θ）***

| Range | | Display Range | Accuracy | | Recommended Equivalent Mode |
|---|---|---|---|---|---|
| | | | Ze | θ e | |
| 100Hz/10kHz | 10MΩ | 4.000MΩ - 10.000MΩ | 3.00% +5 digits | ±1.75° | Parallel |
| | 4MΩ | 400.0kΩ – 3.9999MΩ | 1.25% +3 digits | ±0.75° | Parallel |
| | 400kΩ | 40.00kΩ – 399.99kΩ | 0.35% +2 digits | ±0.25° | Parallel |
| | 40kΩ | 4.000kΩ – 39.999kΩ | 0.25% +2 digits | ±0.15° | Parallel |
| | 4kΩ | 400.0Ω – 3.9999kΩ | 0.25% +2 digits | ±0.15° | ----- |
| | 400Ω | 40.00Ω – 399.99Ω | 0.25% +2 digits | ±0.15° | Series |
| | 40Ω | 4.000Ω – 39.999Ω | 0.35% +2 digits | ±0.25° | Series |
| | 4Ω | 0.4000Ω – 3.9999Ω | 1.00% +5 digits | ±0.60° | Series |
| | 0.4Ω | 0.0000Ω – 0.3999Ω | 3.00% +5 digits | --- | Series |

| | | | | | |
|---|---|---|---|---|---|
| 100kHz | 10MΩ | 4.000MΩ - 10.000MΩ | 8.00%+2 digits | ±4.60° | Parallel |
| | 4MΩ | 400.0kΩ – 3.9999MΩ | 3.00%+1 digits | ±1.75° | Parallel |
| | 400kΩ | 40.00kΩ – 399.99kΩ | 1.20%+5 digits | ±0.69° | Parallel |
| | 40kΩ | 4.000kΩ – 39.999kΩ | 0.80%+2 digits | ±0.46° | Parallel |
| | 4kΩ | 400.0Ω – 3.9999kΩ | 0.50%+2 digits | ±0.30° | --- |
| | 400Ω | 40.00Ω – 399.99Ω | 0.50%+2 digits | ±0.30° | Series |
| | 40Ω | 4.000Ω – 39.999Ω | 0.80%+5 digits | ±0.46° | Series |
| | 4Ω | 0.4000Ω – 3.9999Ω | 2.50%+1 digits | ±1.43° | Series |
| | 0.4Ω | 0.0000Ω – 0.3999Ω | 6.00%+2 digits | --- | Series |

*Note: Accuracy of De is assessed when De <0.5

## ***Equivalent Series Resistance***

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

$$Rse = \pm X_x \times \phi_e$$

$X_x$ : actual impedance,

$X_x = 2\pi f L_x$

Or

$$X_x = 1/2\pi f C_x$$

φe is the phase angle accuracy, $\phi_e = \theta_e \times \frac{\pi}{180}$

## ***Equivalent Parallel Resistance***

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

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

Rpx is the measurement value of Rp, Dx is the measured value of dissipation.

# 10. Maintenance, Service & Warranty condition

## 10.1 Maintenance

There are no user serviceable part inside LCR Meter. Your LCR Meter is thoughtfully engineered for ease of use, accuracy and reliability. The instrument is carefully tested and calibrated using standards traceable to National Laboratories. Take care of your instrument by cleaning the exterior of the instrument regularly with a dusting brush. Dirt which is difficult to remove on the casing & plastic parts, can be removed with a moist cloth ( 99% water, 1% mild detergent) spirit or washing benzene(petroleum ether) can be used to remove greasy dirt. The display may be cleaned with water or washing benzene (but not with spirit- alcohol solvents), it must then be wiped with a dry clean lint-free cloth. Under no circumstances the cleaning fluid should get into the instrument. The use of cleaning agents can attack the plastic & paint surfaces.

## 10.2 Dispatch Procedure For Service

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

No user serviceable parts are inside the instrument, should it become necessary to send back the instrument to factory for service , please observe the following procedure :

Before dispatching the instrument please write to us giving full details of the fault noticed.

1. After receipt of your communication, our service department will advise you whether it is necessary to send the instrument back to us for repairs or the adjustment is possible in your premises.
2. Dispatch the instrument (only on the receipt of our advise) securely packed in original packing duly insured and freight paid along with accessories and a copy of the faults details noticed at our Service Center listed on last page of this manual, nearest to you.

## 10.3 Limited Warranty

The instrument, component parts and accessories will be free from defects in workmanship and materials for a period of two years from date of purchase.
We will, without charge, repair or replace, at its option, defective product or component parts. Returned product must be accompanied by proof of the purchase date in the form of a sales receipt and the included accessories.
This warranty does not apply in the event of misuse or abuse of the product or as a result of unauthorized alterations or repairs.
The warranty is void if the serial number is altered, defaced or removed.