REED

Model R5001

LCR Meter

Instruction Manual

www.reedinstruments.com

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Safety

- Do not operate in an explosive atmosphere
- Do not operate in the presence of flammable gases or fumes
- Keep away from live circuits
- Do not remove the instrument cover; contact REED Instruments (info@reedinstruments.com) for service or calibration on this or any other REED product
- This meter is for indoor use, altitude up to 2000m
- This manual should be read and well understood before the instrument is used
- When measuring in-circuit components, first de-energize the circuits before connecting the test leads
- Do not measure a capacitor that is not fully discharged
- When measuring within a circuit, the circuit must be de-energized before connecting the test leads
- Wipe the instrument clean when used in a dusty environment
- Do not leave the instrument exposed to direct heat for long periods of time
- Before removing the battery cover, ensure that the instrument is disconnected from any circuit and is powered OFF

Features

- Measures inductance/capacitance/resistance with secondary parameters including dissipation factor (D), quality factor (Q), phase angle (θ), equivalent series/parallel resistance (ESR or Rp)
- Auto ranging operation for AC impedance & DC resistance measurement
- Dual LCD display
- Auto LCR smart check and measurement
- Series/Parallel modes
- Ls/Lp/Cs/Cp with D/Q/θ/ESR parameters

continued ...

- Support DCR mode 200 to 200MΩ
- Multi-level battery voltage detector
- Backlight & function beep
- Auto power off
- Data hold function

Specifications

Test frequencies:	100/120/1k/10k/100kHz
Test AC signal level:	0.6mVRMS typ.
Test range (F=1kHz):	L: 200µH to 2000H C: 2000pF to 2mF R: 20Ω to 200MΩ
Primary Parameters Display:	DCR: DC resistance Ls: Serial inductance Lp: Parallel inductance Cs: Serial capacitance Cp: Parallel capacitance Rs: Serial resistance Rp: Parallel resistance
Second Parameter Display:	θ: Phase angle ESR: Equivalence Serial Resistance D: Dissipation factor Q: Quality factor
Power Supply:	6 x 1.5 AA batteries
Dimensions:	8.6 x 3.7 x 2.4" (220 x 96 x 60mm)
Weight:	0.8lb (360g)
Includes:	TL-88-4, FC-732700, FC-210, FC-209C, FC-A25 Red & Black, FC-AA25 test leads and 6 x 1.5 batteries

Accuracy

Notes:

- Measurement performed at the test socket
- Measurements performed after correct open and short calibration
- DUT and test leads must be properly shielded
- Q value is the reciprocal of DF
- Accuracies based within 10% to 100% of full scale of range; values outside of range should be used as reference only
- "---" means parallel or series measurement mode

Inductance @ Ta = 18 to 28°C (De)
Frequency = 100 Hz/120 Hz

Range	Resolution	Lx Accuracy	DF Accuracy	Measurement Mode
20.000mH	1µH	1.5% ±10d	1.5% ±50d	Series
200.00mH	0.01mH	1.4% ±15d	1.4% ±50d	Series
2000.0mH	0.1mH	1.5% ±15d	1.5% ±50d	Series
20.000H	1mH	1.6% ±10d	1.6% ±50d	---
200.00H	0.01H	1.3% ±10d	1.3% ±50d	Parallel
2000.0H	0.1H	2.0% ±15d	2.0% ±50d	Parallel
20.000kH	0.001kH	2.5% ±15d	2.5% ±50d	Parallel

Frequency = 1kHz

Range	Resolution	Lx Accuracy	DF Accuracy	Measurement Mode
2000.0µH	0.1µH	1.3% ±10d	1.3% ±50d	Series
20.000mH	1µH	1.2% ±10d	1.2% ±50d	Series
200.00mH	0.01mH	1.2% ±10d	1.2% ±50d	Series
2000.0mH	0.1mH	1.5% ±15d	1.5% ±50d	---
20.000H	1mH	1.5% ±15d	1.5% ±50d	Parallel
200.00H	0.01H	2.0% ±10d	2.0% ±50d	Parallel
2000.0H	0.1H	2.5% ±15d	2.5% ±50d	Parallel

continued ...

Frequency = 10kHz

Range	Resolution	Lx Accuracy	DF Accuracy	Measurement Mode
200.00µH	0.01µH	1.8% ±10d	1.8% ±50d	Series
2000.0uH	0.1µH	1.5% ±10d	1.5% ±50d	Series
20.000mH	1µH	1.2% ±10d	1.2% ±50d	Series
200.00mH	0.01mH	1.5% ±15d	1.5% ±50d	---
2000.0mH	0.1mH	2.0% ±10d	2.0% ±50d	Parallel
20.000H	1mH	2.5% ±15d	2.5% ±50d	Parallel

Frequency = 100kHz

Range	Resolution	Lx Accuracy	DF Accuracy	Measurement Mode
20.000µH	0.001µH	2.5% ±10d	2.5% ±50d	Series
200.00µH	0.01µH	1.5% ±10d	1.5% ±50d	Series
2000.0µH	0.1µH	1.3% ±15d	1.3% ±50d	Series
20.000mH	1µH	2.0% ±15d	2.0% ±50d	Parallel
200.00mH	0.01mH	2.5% ±15d	2.5% ±50d	Parallel

Capacitance @ Ta = 18 to 28°C (De)
Frequency = 100Hz/120Hz

Range	Resolution	Cx Accuracy	DF Accuracy	Measurement Mode
20.000nF	1pF	2.5% ±10d	2.5% ±50d	Parallel
200.00nF	0.01nF	1.2% ±10d	1.2% ±50d	---
2000.0nF	0.1nF	0.9% ±10d	0.9% ±50d	---
20.000µF	1nF	1.0% ±15d	1.0% ±50d	Series
200.00µF	0.01µF	1.2% ±10d	1.2% ±50d	Series
2000.0µF	0.1µF	2.5% ±10d	2.5% ±50d	Series
20.00mF	0.01mF	5.0% ±10d	5.0% ±50d	Series

Frequency = 1kHz

Range	Resolution	Cx Accuracy	DF Accuracy	Measurement Mode
2000.0pF	0.1pF	3.5% ±15d	3.5% ±50d	Parallel
20.000nF	1pF	1.0% ±10d	1.0% ±50d	---
200.00nF	0.01nF	0.9% ±10d	0.9% ±50d	---
2000.0nF	0.1nF	1.0% ±10d	1.0% ±50d	Series
20.000µF	1nF	1.2% ±15d	1.2% ±50d	Series
200.00µF	0.01µF	2.5% ±10d	2.5% ±50d	Series
2000µF	1µF	4% ±20d	4% ±50d	Series

Frequency = 10kHz

Range	Resolution	Cx Accuracy	DF Accuracy	Measurement Mode
200.00pF	0.01pF	3.0% ±8d	3.0% ±50d	Parallel
2000.0pF	0.1pF	1.0% ±10d	1.0% ±50d	---
20.000nF	1pF	0.9% ±10d	0.9% ±50d	---
200.00nF	0.01nF	0.8% ±10d	0.8% ±50d	Series
2000.0nF	0.1nF	1.0% ±8d	1.0% ±50d	Series
20.000µF	1nF	2.0% ±8d	2.0% ±50d	Series
200.0µF	0.1µF	4.5% ±15d	4.5% ±50d	Series

Frequency = 100kHz

Range	Resolution	Cx Accuracy	DF Accuracy	Measurement Mode
200.00pF	0.01pF	2.5% ±15d	2.5% ±50d	Parallel
2000.0pF	0.1pF	1.0% ±8d	1.0% ±50d	Parallel
20.000nF	1pF	1.8% ±8d	1.8% ±50d	Parallel
200.00nF	0.01nF	1.5% ±10d	1.5% ±50d	Series
2000.0nF	0.1nF	2.5% ±15d	2.5% ±50d	Series

continued ...

Resistance @ Ta = 18 to 28°C (De)
Frequency = 100Hz/120Hz

Range	Resolution	Rx Accuracy	Measurement Mode
200.00Ω	0.01Ω	1.2% ±10d	---
2.0000kΩ	0.1Ω	0.8% ±5d	---
20.000kΩ	1Ω	0.9% ±5d	---
200.00kΩ	0.01kΩ	0.7% ±3d	---
2.0000MΩ	0.1kΩ	1.0% ±5d	---
20.000MΩ	1kΩ	2.2% ±10d	---
200.0MΩ	0.1MΩ	2.5% ±10d	---

Frequency = 1kHz

Range	Resolution	Rx Accuracy	Measurement Mode
20.000Ω	1mΩ	1.2% ±10d	---
200.00Ω	0.01Ω	0.8% ±5d	---
2.0000kΩ	0.1Ω	0.8% ±3d	---
20.000kΩ	1Ω	0.7% ±3d	---
200.00kΩ	0.01kΩ	1.0% ±5d	---
2.0000MΩ	0.1kΩ	1.5% ±10d	---
20.000MΩ	1kΩ	1.8% ±10d	---
200.0MΩ	0.1MΩ	6.0% ±50d	---

Frequency = 10kHz

Range	Resolution	Rx Accuracy	Measurement Mode
20.000Ω	1mΩ	1.5% ±10d	---
200.00Ω	0.01Ω	0.8% ±10d	---
2.0000kΩ	0.1Ω	0.9% ±5d	---
20.000kΩ	1Ω	0.8% ±3d	---
200.00kΩ	0.01kΩ	1.0% ±5d	---
2.0000MΩ	0.1kΩ	2.5% ±10d	---
20.00MΩ	0.01MΩ	2.8% ±10d	---

Frequency = 100kHz

Range	Resolution	Rx Accuracy	Measurement Mode
20.000Ω	1mΩ	2.3% ±10d	---
200.00Ω	0.01Ω	1.5% ±5d	---
2.0000kΩ	0.1Ω	0.8% ±20d	---
20.000kΩ	1Ω	0.8% ±20d	---
200.00kΩ	0.01kΩ	1.5% ±10d	---
2.000MΩ	1kΩ	2.5% ±30d	---

DC resistance @ Ta = 18 to 28°C (De)
Frequency = 100Hz/120Hz/1kHz/10kHz/100KHz

Range	Resolution	Rx Accuracy	Measurement Mode
200.00Ω	0.01Ω	1.8% ±10d	---
2.0000kΩ	0.1Ω	0.6% ±20d	---
20.000kΩ	1Ω	0.6% ±10d	---
200.00kΩ	0.01kΩ	0.5% ±3d	---
2.0000MΩ	0.1kΩ	1.5% ±5d	---
20.000MΩ	1kΩ	2.0% ±5d	---
200.0MΩ	0.1MΩ	2.5% ±5d	---

D value Accuracy @ Ta =18 to 28°C (De)

Freq./Z	0.1- 1Ω	1–10Ω	10–100kΩ	100k–1MΩ	1–20MΩ	20–200MΩ
100/120Hz	±0.03	±0.01	0.009	±0.010	±0.02	±0.04
1kHz	±0.03	±0.01	0.009	±0.010	±0.02	±0.09
10kHz	±0.03	±0.01	0.009	±0.009	±0.01	±0.04
100kHz	±0.04	±0.03	0.010	±0.010	±0.02	±0.04

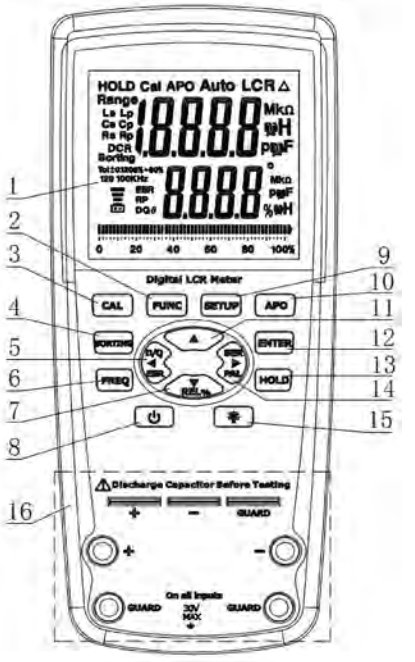
continued ...

θ value Accuracy @ Ta =18 to 28°C

Freq./Z	0.1-1Ω	1–10Ω	10–100kΩ	100k–1MΩ	1–20MΩ	20–200MΩ
100/120Hz	±0.65°	±0.36°	±0.23°	±0.45°	±0.65°	±1.35°
1kHz	±0.65°	±0.36°	±0.23°	±0.45°	±0.65°	±3.63°
10kHz	±0.65°	±0.36°	±0.23°	±0.45°	±1.35°	N/A
100kHz	±1.27°	±0.65°	±0.49°	±0.65°	±1.35°	±1.35°

Instrument Description

1. LCD Display
2. Function Button
3. Calibration Button
4. Sorting Button
5. Secondary Display/ Left Button
6. Frequency Button
7. Relative/Down Button
8. Power Button
9. Setup Button
10. Auto Power Off Button
11. Up Button
12. Enter
13. Hold Button
14. Parallel/Series/ Right Button
15. Backlight Button
16. Input sockets (banana jack inputs) and terminals for positive, negative, and guard



Operating Instructions

Power ON/OFF

Press and hold the Power Button for 2 seconds; the LCD screen will light up indicating the unit is on. The meter turns on to a default mode of AUTO LCR Smart Mode with a test frequency of 1kHz.

Auto power off

This feature can be turned on and off by pressing the Auto Power Off Button, which will be indicated on the LCD. If the meter is actively taking measurements and the impedance changes, but no buttons have been pushed for a 5-minute period, the meter will turn off after three warning beeps. If a button is pushed during the three beeps, the meter will continue measuring.

Function Beep

This meter will beep once if the function selected is available, and beep twice if the function selected is unavailable.

◆ = Active functions

Button	FUNC	HOLD	DQθ	S/P	BKLIT	SORT	REL%	FREQ
AUTOLCR	◆	◆			◆		◆	
L	◆	◆	◆	◆	◆	◆	◆	◆
C	◆	◆	◆	◆	◆	◆	◆	◆
ACR	◆	◆		◆	◆	◆	◆	◆
DCR	◆	◆			◆	◆	◆	

Backlight

Press the Backlight Button to turn the backlight on and off. The backlight will stay on for 60 seconds before turning off automatically.

Battery Charge

The three horizontal bars above the battery symbol on the LCD screen indicate the charge left in the batteries currently in the meter. When the three bars are no longer visible the battery needs replacement; please see Battery Replacement for instructions.

Test Frequency Functions

Test frequency can greatly affect the results of measurement reading, especially when measuring inductors and capacitors. This section provides some recommendations and suggestions to consider.

Capacitance

When measuring capacitance, selecting the right frequency is important in obtaining the most accurate results. Generally a 1kHz test frequency is used to measure capacitors that are 0.01µF or smaller. For capacitors that are 10µF or larger, a lower frequency of 120Hz is used. Following this trend, high-test frequencies are best for testing very low capacitance components. For large capacitance components, low frequency would be optimal.

For example the capacitance of the component is in the mF range, when selecting 100Hz or 120Hz for the test frequency it would give more accurate results. The results will also be obvious because if the same component was tested with 1kHz or 10kHz, the measured readings may look erroneous on the display. In all cases, it is best to check with the manufacturer's data sheet in order to determine the best test frequency to use for measurement.

Inductance

Typically a 1kHz or 10kHz test frequency is used to measure inductors that are used in audio and RF circuits because these components operate at higher frequencies. However, a 120Hz test signal is used to measure inductors that are used for applications such as filter chokes in power supplies, in which are typically operated at 60Hz AC (in US) with 120Hz filter frequencies. In general, inductors below 2 mH should be measured at 1kHz frequency while inductors above 200H should be measured at 120Hz. In all cases, it is best to check with the manufacturer's data sheet in order to determine the best test frequency to use for measurement.

Test Frequency Select

The meter has five test frequencies: 100Hz/120Hz/1kHz/10kHz/100kHz. Press the Frequency Button to scroll through the five frequencies sequentially. The test frequency can affect the accuracy of the results depending on what frequency is selected and what type and value of a component is being measured or tested.

Primary Impedance with Secondary Parameter Test

The default test mode for this meter is Auto-LCR Mode, which checks the type of impedance and automatically enters L/C/R Mode. The secondary parameter will follow the L/C/R measurement, meaning that (L+Q), (C+D)*****, (R+θ)****** are combined in one group respectively.

Press the Function Button to switch from Auto-LCR Mode to Auto-L Mode, Auto-C Mode, Auto-R Mode, and DCR Mode. When Auto-L or Auto-C Mode are selected, the impedance measurement is auto ranging. The primary LCD display will show the inductance or capacitance of DUT (device under test); the secondary LCD display will show the quality or dissipation factor. Press the Secondary Display/Left Button to display the D/Q/ θ/ESR value. When Auto-R (ACR mode) or DCR mode is selected the secondary parameter is omitted.

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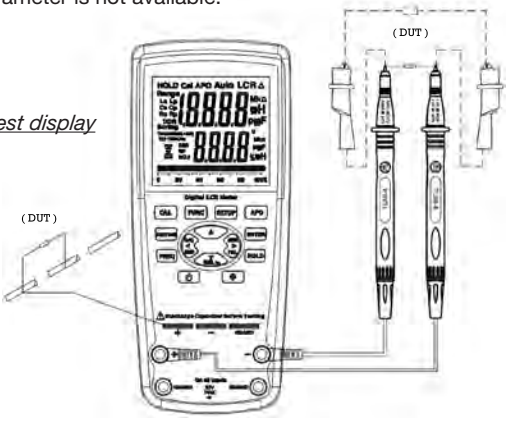
* When Auto-LCR mode is active, the secondary parameter will show the equivalent resistance in parallel mode (Rp) to replace the D factor if the C measured value of the DUT is less than 5pF.

** Auto-LCR mode only. During Auto-R Mode or DCR Mode, the secondary parameter is not available.

Device under test display



Series or Parallel Functions

Just as test frequency can greatly affect measurement results, selecting between series or parallel measurement mode can also affect the accuracy of the meter, especially for capacitive and inductive components.

Capacitance

Most capacitance measurements will obtain best results with parallel mode selected. The majority of capacitors have a very low dissipation factor (high internal resistance) compared to the impedance of the capacitance. In these cases, the paralleled internal resistance has negligible impact upon the measurement. There will be some cases where series mode would be used for a capacitance measurement, or the readings will appear inaccurate. Series mode is useful when large capacitors have higher dissipation factor and lower internal resistance.

Inductance

Most inductance measurements will obtain best results with series mode selected. In series mode, accurate Q (quality factor) readings can be obtained from reading low Q inductors and ohmic losses are significant. There will be some cases where parallel mode would be used for an inductance measurement, for example iron core inductors operating at higher frequencies where hysteresis and eddy currents become significant.

Series/Parallel Measurements

When any L/C/R function is selected, the default measurement will be automatically selected. If the impedance is greater than 10kΩ, parallel mode will be selected, and "Lp/Cp/Rp" will display on the LCD screen. If the impedance is less than 10kΩ, series mode will be selected, and "Ls/Cs/Rs" will display on the LCD. When the Parallel/Series/Right Button is pressed, the impedance measurement will be set in series mode or in parallel mode sequentially.

Data Hold

The data hold function allows the user to freeze the current measurement displayed on the LCD. Press the Hold Button to activate data hold, and press the Hold Button again to deactivate it.

Relative mode

To reserve the current DUT readings (DCUR) on the primary display as a reference value (DREF), press the Relative/Down Button. The symbol Δ will then appear on the LCD screen indicating this. The secondary display will show the percentage of the relative value (REL%). Press the Relative/Down Button again to show the reference value (DREF) on the primary display; the Δ symbol will start to blink.
REL% = (DCUR – DREF) / DREF x 100%

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The percentage range is -99.9% to 99.9%. When the relative value is larger than double the reference value (DREF), the symbol “OL%” will appear on the secondary display. Press and hold down the Down/Relative Button for 2 seconds to exit relative mode.

Accuracy Discrepancies

In some special cases, inaccuracies may occur in the measurement of capacitive, inductive, and resistive components.

Capacitance

It is strongly recommended to have the dissipation factor low when measuring capacitors. Electrolytic capacitors inherently have a higher dissipation factor due to their normally high internal leakage characteristics. In some cases, if the D (dissipation factor) is excessive, measurement accuracy may degrade and even read out of specification.

Inductance

Some inductors are intended to operate at a certain DC bias to achieve a certain inductance value, however this meter cannot produce such a biasing scheme. External biasing should not be attempted because external power would be applied to the instrument and cause serious damage to the meter. Therefore, in some cases, the inductance reading may not agree with manufacturer’s specification. It is important to check if the specification pertains to DC biasing or not.

Resistance

When measuring resistance of devices, it is important to know that there are two types or ways of measurement. One type is DC resistance measurement. Another type is AC resistance measurement. The LCR meter provide both of types for measurement.

When measuring a resistive component that is designed to be measured with DC, readings will be incorrect or inaccurate. Before using the meter to measure resistance, please verify whether the DUT (device under test) requires DC or AC resistance measurement method. Depending on the method, results will vary greatly.

Guard Terminal

One of the input sockets and terminals is labeled as “GUARD”. This terminal does not have to be used in all instances for the meter to make measurements. But in some instances, it is very useful. Guard terminal generally serves two purposes.

If user is using test leads, the guard terminal can be used to connect to the shielding of the test leads. Doing so can be useful when making large resistive component measurements. For example, when measuring a 10 MΩ resistor with test leads, at the high range the reading may seem to be unstable as a few digits may continuously be changing. Having the shield of the test leads connected to the guard terminal will help stabilize the reading in some instances.

Guard terminal is also used to minimize noise and to help minimize parasitic effects coming from the component to be measured, thus allowing high precision results.

Calibration mode

It is recommended to calibrate this meter to improve the accuracy of high/low impedance measurements. You will need a shorting bar or a short piece of conductive metal (i.e. paper clip) to complete the calibration procedure.

Be sure nothing is connected to the meter, and turn it on. Press and hold down the Calibration Button for 2 seconds to enter calibration mode. The screen will display “OPEN”, indicating the input terminals have nothing connected. Press the Calibration Button again and a 30 second countdown will appear on the screen. After the countdown is complete, a “PASS” or “FAIL” will show on the display.

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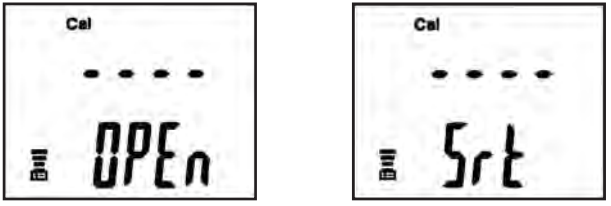
Press the Calibration Button again, and “SRT” will appear on the LCD screen, indicating to the user to put the shorting bar across the “+” and “-” input terminals. Press the Calibration Button again, and a 30 second countdown will appear on the screen. After the calibration procedure is finished a “PASS” or “FAIL” will appear on the LCD screen. Press the Calibration Button again; the data will be saved if “PASS” was displayed for both the Open & Short calibrations.



Open Calibration (left) and Short Calibration (right)

Sorting mode

Sorting mode helps the user quickly sort through multiple components. Select the primary measurement mode (L/C/R) based on the type of components to be measured. Insert the component to be used as the standard or good reference value that will be used for testing against all other components.

The meter needs a component connected to either the input sockets or terminals for sorting mode to activate. Turn the meter on and press the Sorting Button to enter to the sorting mode. Press the Setup Button and adjust the range setting by pressing the Up Button. Press Enter to save the value. Adjust the reference value by pressing the Up Button. Press Enter to save the value. Adjust the tolerance setting by pressing the Up Button. Press Enter to save the value. The LCD will say “PASS” or “FAIL”, depending on weather the impedance measured exceeds tolerance range. The current measurement result will display on the LCD screen. Press the Sorting Button to exit Sorting Mode.

Battery Replacement

When the Battery Charge symbol has no lines above it, it is time to replace the battery.

1. Place the meter upside down. Open up the back flip stand, remove the battery cover screw, and lift up the battery cover.
2. Insert 6 1.5V batteries into the battery compartment. Be sure to insert the battery with matching polarity.
3. Replace the battery cover and battery cover screw.

Notes

Notes