♦ PRECISION INSTRUMENTS FOR TEST AND MEASUREMENT ♦

DE-5000

Portable, Full-Featured LCR Meter

User and Service Manual

IET LABS, INC.
534 Main Street, Westbury, NY 11590
www.ietlabs.com
TEL: (516) 334-5959 • (800) 899-8438 • FAX: (516) 334-5988

Table of Contents

Chapter 1: Introduction

1.1. Overview

The DE-500 is a portable, high-performance LCR meter that is full-featured yet cost effective. It measures in true 4-wire Kelvin mode and rivals the capabilities and options of many of its bench counterparts. It measures:

Ls/Lp -- Series and parallel inductance

Cs/Cp -- Series and parallel capacitance

Rs/Rp -- Series and parallel resistance (ac)

Rdc/Rp -- Series and parallel resistance (dc)

ESR/Rp -- Series and parallel equivalent resistance

D -- Dissipation factor

Q -- Quality factor

Θ -- Phase angle

This LCR meter can transfer data to a PC via a standard, fully isolated, optical IR-USB interface. It also features a **Sorting** mode, allowing users to quickly sort components.

DE-5000 has automatic LCR selection. This allows the user to measure the **L/C/R** components in **Auto LCR** mode without having to select the type of measurement.

To accommodate various test requirements, the DE-5000 offers selectable test frequencies: 100 Hz / 120 Hz / 1 kHz / 10 kHz / 100 kHz.

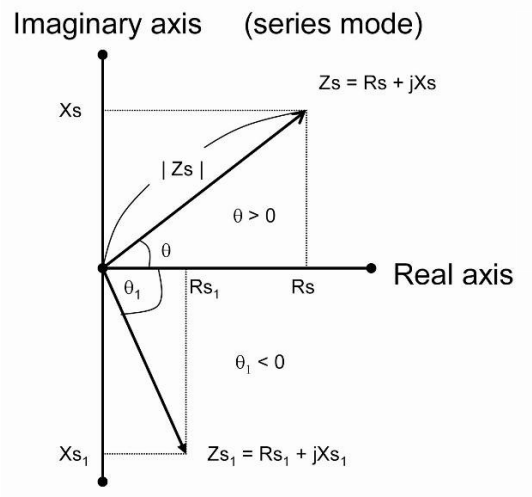
The unit is powered by a standard 9V battery. For additional convenience, it may also use an optional ac adapter (DE-5000-AC).

To transfer data to a PC, the unit comes with a built-in IR interface. IET offers an optional Data Transfer Kit (DE-5000-DTK). This kit includes: IR-USB interface adapter, a USB cable, and a CD with software for the PC.

1.2. Introduction to measuring principles

1.2.1. What is impedance

Impedance (**Z**) consists of resistance (real part) and reactance (imaginary part). Series impedance (**Zs**) can be defined as a combination of series resistance (**Rs**) and series reactance (**Xs**). It can be represented mathematically as magnitude $|\mathbf{Z}|=\sqrt{(\mathbf{Rs}^2+\mathbf{Xs}^2)}$ at a phase angle $\mathbf{\Theta}$.



$\mathbf{Zs} = \mathbf{Rs} + j\mathbf{Xs}$ or $|\mathbf{Zs}|\angle\mathbf{\Theta}$

$\mathbf{Rs} = |\mathbf{Zs}| \cos\mathbf{\Theta}$

$\mathbf{Xs} = |\mathbf{Zs}| \sin\mathbf{\Theta}$

$\mathbf{Xs/Rs} = \tan\mathbf{\Theta}$

$\mathbf{\Theta} = \tan^{-1}(\mathbf{Xs/Rs})$

There are two types of reactance. One is inductive reactance – $\mathbf{X_L}$, and the other is capacitive reactance – $\mathbf{X_C}$.

If $\mathbf{\Theta} > 0$, the reactance is inductive. If $\mathbf{\Theta} < 0$, the reactance is capacitive.

The inductive and capacitive reactances ($\mathbf{X_L}$ and $\mathbf{X_C}$) can be defined as:

$$\mathbf{X_L} = 2\pi f\mathbf{L}$$

$$\mathbf{X_C} = 1 \div (2\pi f\mathbf{C})$$

Where:

L = Inductance

C = Capacitance

f = signal frequency)

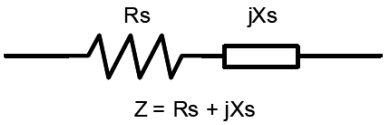
1.2.2. Measuring impedance

Impedance can be measured in series or in parallel. In parallel mode, impedance can be represented as reciprocal of admittance (**Y**). The admittance can be defined as **Y = G + jB**, where:

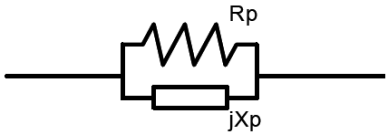
G = Conductance

B = Susceptance

Series impedance



Parallel admittance



$$\mathbf{Y} = 1/\mathbf{Z} = 1/\mathbf{Rp} + 1/j\mathbf{Xp} = \mathbf{G}+j\mathbf{B}$$

Rs = Series resistance
Xs = Series reactance
Cs = Series capacitance
Ls = Series Inductance

Rp = Parallel resistance
Xp = Parallel reactance
Cp = Parallel capacitance
Lp = Parallel inductance

To understand the ratio of resistance and reactance, it is important to consider two factors: quality factor (**Q**) and dissipation factor (**D**). Usually **Q** is used when measuring inductance and **D** is used when measuring capacitance. **D** is defined as the reciprocal of **Q**.

$$\mathbf{Q} = 1/\mathbf{D} = \tan\Theta$$

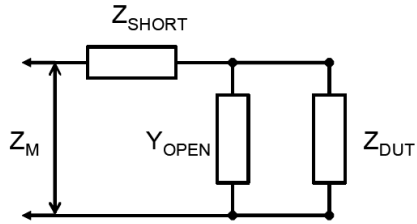
$$\mathbf{Q} = \mathbf{Xs}/\mathbf{Rs} = 2\pi f\,\mathbf{Ls}/\mathbf{Rs} = \tfrac{1}{2}\pi f\,\mathbf{CsRs}$$

$$\mathbf{Q} = \mathbf{B}/\mathbf{G} = \mathbf{Rp}/|\mathbf{Xp}| = \mathbf{Rp}/2\pi f\,\mathbf{Lp} = 2\pi f\,\mathbf{CpRp}$$

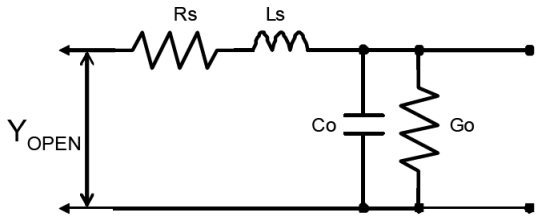
Both **Rs** and **Rp** are part of the equivalent circuit of capacitors and inductors. When measuring capacitance and inductance, it is best to use the settings as shown in the table below.

	Value	**Setting**
Capacitance	Low	Parallel
	High	Series
Inductance	Low	Series
	High	Parallel

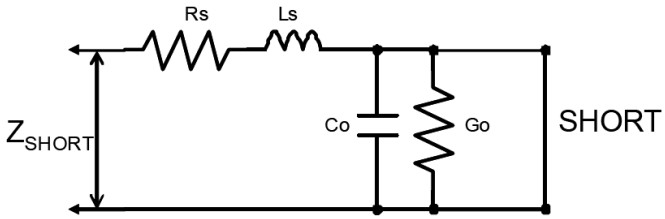
1.3. Equivalent circuit



$$Z_{DUT} = \frac{Z_M - Z_{SHORT}}{1-(Z_M-Z_{SHORT})Y_{OPEN}}$$

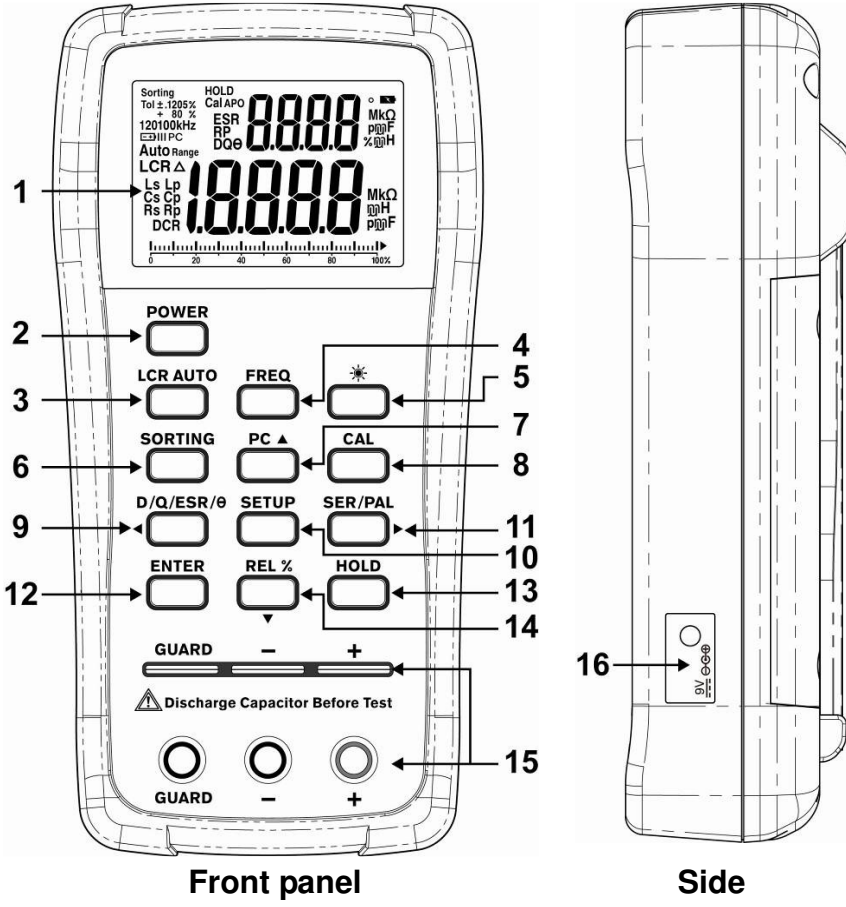


If $Rs+j\omega Ls << 1/(Go + j\omega Co)$
$Y_{OPEN} = Go + j\omega Co$



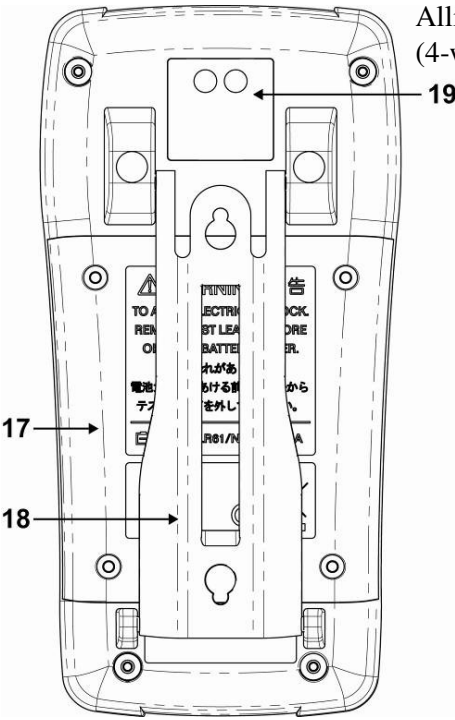
$Z_{SHORT} = Rs + j\omega Ls$

1.4. Instrument layout



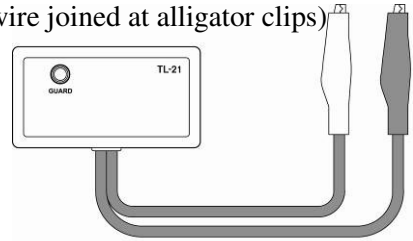
Front panel **Side**

GUARD provides a shield to reduce noise for device under test (DUT), test leads, and other equipment.

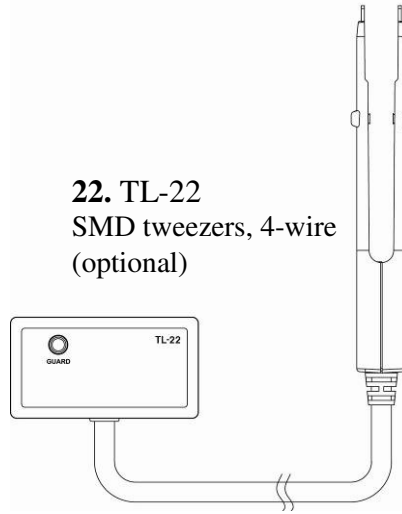


Rear

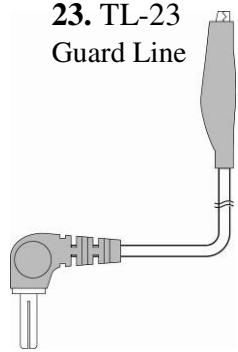
21. TL-21
Alligator –lead test-lead adapter
(4-wire joined at alligator clips)

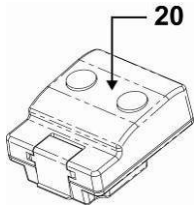


22. TL-22
SMD tweezers, 4-wire
(optional)



23. TL-23
Guard Line

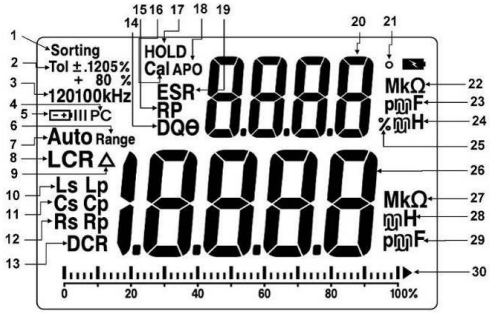




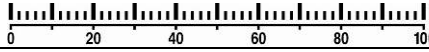
IR- USB interface
(optional)

1.	**LCD display**	
2.	POWER	Turns the instrument on/off.
3.	LCR AUTO	**LCR auto** mode, Inductance, Capacitance, Resistance and DC resistance measurement selection
4.	FREQ	Testing frequency selection
5.	☼	Backlight display
6.	SORTING	Sorting mode control
7.	PC ▲	UART output control
8.	CAL	Open/Short calibration mode
9.	D/Q/ESR/Θ	**D/Q/ ESR/Θ** parameters selection
10.	SETUP	Setup menu control (in sorting mode)
11.	SER/PAL	Series and Parallel selection
12.	ENTER	Setup menu control (in sorting mode)
13.	REL%	Relative mode
14.	HOLD	Data hold
15.	Input sockets and Terminals (4-terminal)	
16.	AC adapter plug	
17.	Battery cover	
18.	Tilt-Stand	
19.	IR Slot	
20.	IR-USB adapter (optional)	
21.	TL-21 Alligator-clip test-lead adapter	
22.	TL-22 SMD tweezers (optional)	
23.	TL-23 Guard Line	

1.5. LCD display layout



1.	**Sorting**	Sorting function is enabled
2.	**Tol**	Tolerance indicator in sorting mode : ±0.25%, ±0.5%, ± 1%, ±2%, ±5%, ±10%, ±20%, & +80%-20%
3.	**kHz**	Testing frequency indicator: 1kHz,10kHz,100kHz,100Hz & 120Hz
4.	**PC**	PC connection is active
5.		Battery capacity indicator
6.	**Range**	Range selection is enabled on setup menu of sorting mode
7.	**Auto**	Auto range for **L**, **C** or R measurements
8.	**LCR**	Checking for **L/C/R** mode automatically
9.	**Δ**	Relative function is enabled
10.	**Ls/Lp**	Inductance in series or parallel mode is active
11.	**Cs/Cp**	Capacitance in series or parallel mode is active
12.	**Rs/Rp**	ac resistance in series or parallel mode is active
13.	**DCR**	dc resistance mode is selected

14.	**D/Q/Θ**	Dissipation factor, Quality factor or Phase angle is active for L/C measurement mode
15.	**Rp**	ac Resistance in parallel mode is active
16.	**Cal**	Open/Short calibration mode
17.	**HOLD**	Data Hold
18.	**APO**	Auto power off mode
19.	**ESR**	Series equivalent resistance mode
20.	8888	Secondary Display
21.	°	Phase angle
22.	**MkΩ**	Unit for Resistance (Ω, kΩ and MΩ) – on secondary display
23.	**pmF**	Unit for Capacitance (pF, nF, μF and mF) – on secondary display
24.	**mH**	Unit for Inductance (μH, mH and H) – on secondary display
25.	**%**	The percentage display in relative mode – on secondary display
26.	18888	Primary Display
27.	**MkΩ**	Unit for Resistance (Ω, kΩ and MΩ) – on primary display
28.	**mH**	Unit for Inductance (μH, mH and H) – on primary display
29.	**pmF**	Unit for Capacitance (pF, nF, μF and mF) – on primary display
30.		Bar-graph display

Special Indication Characters

SrE	Indicates short calibration
OPEn	Indicates open calibration

Chapter 2: Operation

2.1. How to obtain optimum precision

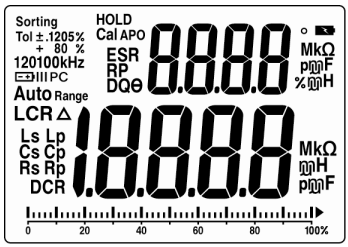
To access optimum precision for all **L**, **C**, and **R** measurements, especially at the highest and the lowest ranges, zero the instrument before use (pages 16-18).

To secure the specified accuracy, connect the device under test (DUT) to the measuring socket, or use either TL-21 (standard accessory) or TL-22 (optional accessory).

If you are using test leads other than the ones specified above, use 4-wire leads and avoid using long lead wires to reduce measurement errors.

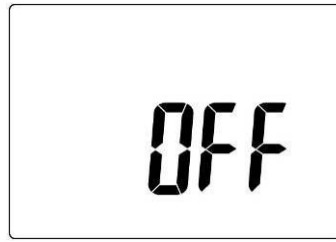
2.2. Default settings

When the power is turned on, the monitor displays all symbols for 2 seconds as shown below.



When the meter is powered by the battery, it is in an automatic-power-off mode. **APO** is shown on the display. In this mode, if the unit is inactive for 5 minutes, it shuts itself off. First, the buzzer beeps three times to remind the user, then **OFF** is displayed on the monitor as shown below while the unit powers down.

Note that when the unit is powered via an ac adapter, the automatic-power-off mode is inactive.



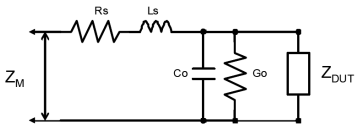
The default settings for the meter set LCR in auto mode and test frequency at 1 kHz.

The battery condition is continuously displayed. means that the battery capacity is full. means that battery power is low and the battery needs to be replaced.

The LCR meter uses beeps to indicate whether a particular key has a function in a given mode. If a functional key is pressed, there is a single beep. If a non-functional key is pressed, there is a dual beep.

2.3. Zeroing the meter

Zeroing the instrument gets better accuracy for impedance measurements. The purpose of this procedure is to reduce the parasitic effect of the test fixture.



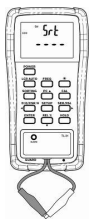
$\mathbf{Z_M}$ is the total impedance measured on the device under test (DUT) by a test fixture which has some parasitic impedance.

$$\mathbf{Z_M} = (\mathbf{Rs} + j\omega\mathbf{Ls}) + ((\mathbf{Go}+j\omega\mathbf{Co})^{-1} \parallel \mathbf{Z_{DUT}})$$

$\mathbf{Z_{DUT}}$ is the target impedance user wants to measure. It is necessary to use the zeroing process to cancel the effect of **Rs+jωLs** and **Go+jωCo**.

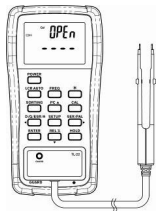
Ex. Operation for open and short calibration with TL-21

Open Cal.

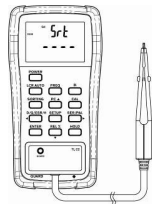


Short Cal.

Ex. Operation for open and short calibration with .TL-22



Open Cal.

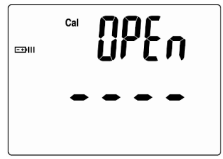


Short Cal.

To zero the meter, proceed as follows:

1. Make sure the leads are completely disconnected.
2. Press the CAL key for 2 seconds.

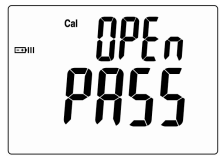
   The monitor should display **OPEn** as shown below.



3. Pres the CAL key again.

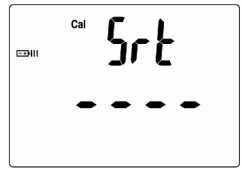
   The unit should begin a countdown as it performs OPEN calibration.

   After the countdown is complete, the monitor should say **PASS** as shown below. If it says fail, the procedure has to be restarted.



4. Connect the test leads for form a short circuit.

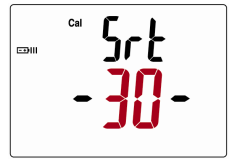
5. Press the CAL key again.



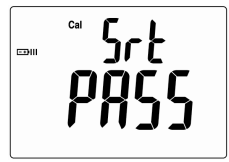
The monitor should display Srt as shown below.

6. Press the CAL key one more time.

The unit should begin a countdown as it performs SHORT calibration.



After the countdown is complete, the monitor should say **PASS** as shown below. If it says fail, the procedure has to be restarted.

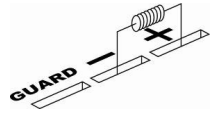


7. Press the CAL key one more time to exit OPEN/SHORT calibration mode.

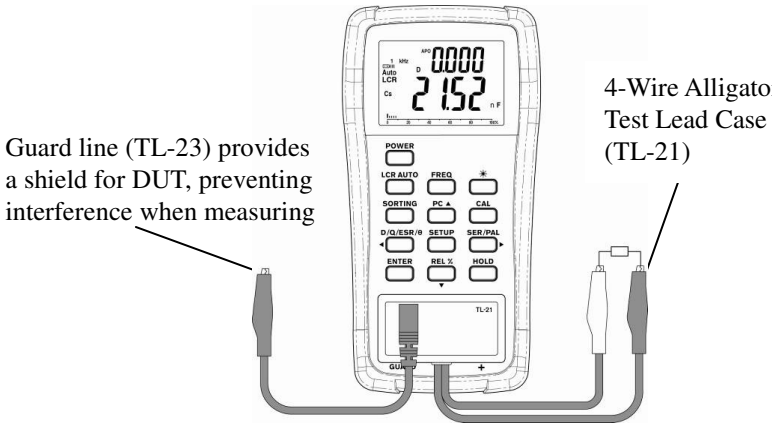
2.4. Attaching DUT's to the meter

Devices under test (DUT's) may be connected to the meter as follows:

- Insert DIP component leads to the sockets directly.



- Attach Alligator-clip test-lead adapter (TL-21)



♦ PRECISION INSTRUMENTS FOR TEST AND MEASUREMENT ♦

IET LABS, INC.
534 Main Street, Westbury, NY 11590
www.ietlabs.com
TEL: (516) 334-5959 • (800) 899-8438 • FAX: (516) 334-5988