Instruction Manual

Manual de Instrucción

LCR METER
Models 885 & 886

MEDIDOR LCR
Modelos 885 & 886

Contents

1. Introduction

1.1 General

The B&K Precision Models 885 & 886 Synthesized In-Circuit LCR/ESR Meter is a high accuracy hand held portable test instrument used for measuring inductors, capacitors and resistors with a basic accuracy of 0.5%. It is the most advanced handheld AC/DC impedance measurement instrument to date. The 885 or 886 can help engineers and students to understand the characteristic of electronics components as well as being an essential tool on any service bench.

The instrument is auto or manual ranging. Test frequencies of 100Hz, 120Hz, 1KHz 10KHz or 100KHz (886) may be selected on all applicable ranges. The test voltages of 50mVrms, 0.25Vrms, 1Vrms or 1VDC (DCR only) may also be selected on all applicable ranges. The dual display feature permits simultaneous measurements.

Components can be measured in the series or parallel mode as desired; the more standard method is automatically selected first but can be overridden.

The Model 885 and 886 offers three useful modes for sorting components.

The highly versatile Models can perform virtually all the functions of most bench type LCR bridges. With a basic accuracy of 0.2%, this economical LCR meter may be adequately substituted for a more expensive LCR bridge in many situations. The meter is powered from two AA Batteries and is supplied with an AC to DC charging adapter and two AA Ni-Mh Rechargeable Batteries.

The instrument has applications in electronic engineering labs, production facilities, service shops, and schools. It can be used to check ESR values of capacitors, sort values, select precision values, measure unmarked and unknown inductors, capacitors or resistors, and to measure capacitance, inductance, or resistance of cables, switches, circuit board foils, etc.

The key features are as following:

- Test condition:
    1 Frequency : 100Hz / 120Hz / 1KHz / 10KHz / 100KHz (886)
    2. Level : 1Vrms / 0.25Vrms / 50mVrms / 1VDC (DCR only)
- Measurement Parameters : Z, Ls, Lp, Cs, Cp, DCR, ESR, D, Q and θ
- Basic Accuracy: 0.2%
- Dual Liquid Crystal Display
- Fast/Slow Measurement
- Auto Range or Range Hold
- Infrared Interface Communication
- Open/Short Calibration
- Primary Parameters Display:
    Z : AC Impedance
    DCR : DC Resistance
    Ls : Serial Inductance

  - Lp : Parallel Inductance
  - Cs : Serial Capacitance
  - Cp : Parallel Capacitance
- Second Parameter Display:
  - θ : Phase Angle
  - ESR : Equivalence Serial Resistance
  - D : Dissipation Factor
  - Q : Quality Factor
- Combinations of Display:
  - Serial Mode : $Z-\theta$, Cs – D, Cs – Q, Cs – ESR, Ls – D, Ls – Q, Ls – ESR
  - Parallel Mode : Cp – D, Cp – Q, Lp – D, Lp – Q

1.2 Impedance Parameters

Due to the different testing signals on the impedance measurement instrument, there are DC impedance and AC impedance. The common digital multi-meter can only measure the DC impedance, but the Model 885 can do both. It is a very important issue to understand the impedance parameters of the electronic component.

When we analysis the impedance by the impedance measurement plane (Figure 1.1). It can be visualized by the real element on the X-axis and the imaginary element on the y-axis. This impedance measurement plane can also be seen as the polar coordinates. The Z is the magnitude and the θ is the phase of the impedance.

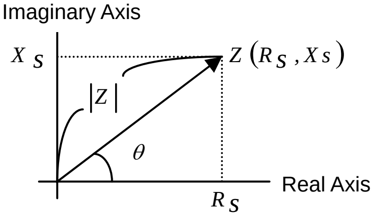


Figure 1.1

$$Z = R_s + jX_s = |Z|\angle\theta\ (\Omega)$$

$$R_s = |Z|\ Cos\ \theta \qquad |Z| = \sqrt{R_s^{\ 2} + X_s^{\ 2}}$$

$$X_s = |Z|\ Sin\ \theta \qquad \theta = Tan^{-1}\left(\frac{X_s}{R_s}\right)$$

$$Z = (\text{Impedance})$$
$$R_S = (\text{Resistance})$$
$$X_S = (\text{Reactance})$$
$$\Omega = (\text{Ohm})$$

There are two different types of reactance: Inductive (X_L) and Capacitive (X_C). It can be defined as follows:

$$X_L = \omega L = 2\pi f L$$
$$X_C = \frac{1}{\omega C} = \frac{1}{2\pi f C}$$

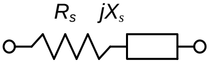
L = Inductance (H)
C = Capacitance (F)
f = Frequency (Hz)

Also, there are quality factor (Q) and the dissipation factor (D) that need to be discussed. For component, the quality factor serves as a measure of the reactance purity. In the real world, there is always some associated resistance that dissipates power, decreasing the amount of energy that can be recovered. The quality factor can be defined as the ratio of the stored energy (reactance) and the dissipated energy (resistance). Q is generally used for inductors and D for capacitors.

$$\begin{aligned}
Q &= \frac{1}{D} = \frac{1}{\tan\delta} \\
&= \frac{|X_s|}{R_s} = \frac{\omega L_s}{R_s} = \frac{1}{\omega C_s R_s} \\
&= \frac{|B|}{G} \\
&= \frac{R_p}{|X_p|} = \frac{R_p}{\omega L_p} = \omega C_p R_p
\end{aligned}$$

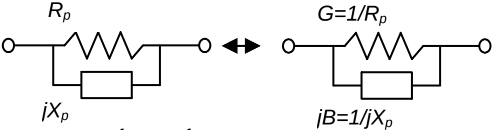
There are two types of the circuit mode. One is series mode, the other is parallel mode. See Figure 1.2 to find out the relation of the series and parallel mode.

Real and imaginary components are serial



$$Z = R_S + jX_S$$

Real and imaginary components are Parallel



$$Y = \frac{1}{R_P} + \frac{1}{jX_P} \qquad Y = G + jB$$

Figure 1.2

1.3 Specification

- LCD Display Range:

Parameter	Range	
Z	0.000Ω	to 9999MΩ
L	0.000µH	to 9999H
C	0.000pF	to 9999F
DCR	0.000Ω	to 9999MΩ
ESR	0.000Ω	to 9999Ω
D	0.000	to 9999
Q	0.000	to 9999
θ	-180.0°	to 180.0°

- Accuracy (*Ae*):

Z Accuracy:

|Zx| Freq.	20M ~ 10M (Ω)	10M ~ 1M (Ω)	1M ~ 100K (Ω)	100K ~ 10 (Ω)	10 ~ 1 (Ω)	1 ~ 0.1 (Ω)
DCR	2% ±1 ❶	1% ±1	0 5% ±1	0 2% ±1	0 5% ±1	1% ±1 ❶
100Hz						
120Hz						
1KHz						
10KHz	5% ±1 ❶	2% ±1				
100KHz (886)	NA	5%±1 ❶	2%±1	0.4% ±1	2%±1	5%±1 ❶

Note：1.The accuracy applies when the test level is set to 1Vrms.
2.*Ae* multiplies 1.25 when the test level is set to 250mVrms.
3.*Ae* multiplies 1.50 when the test level is set to 50mVrms.
4.When measuring L and C, multiply *Ae* by $\sqrt{1+Dx^2}$ if the Dx＞0.1.

❶：*Ae* is not specified if the test level is set to 50mV.

C Accuracy :

100Hz	79 57 pF | 159 1 pF	159 1 pF | 1 591 nF	1 591 nF | 15 91 nF	15 91 nF | 159 1 uF	159 1 uF | 1591 uF	1591 uF | 15 91 mF
	2% ± 1 ❶	1% ± 1	0 5% ± 1	0 2% ± 1	0 5% ± 1	1% ± 1 ❶
120Hz	66 31 pF | 132 6 pF	132 6 pF | 1 326 nF	1 326 nF | 13 26 nF	13 26 nF | 132 6 uF	132 6 uF | 1326 uF	1326 uF | 13 26 mF
	2% ± 1 ❶	1% ± 1	0 5% ± 1	0 2% ± 1	0 5% ± 1	1% ± 1 ❶
1KHz	7 957 pF | 15 91 pF	15 91 pF | 159 1 pF	159 1 pF | 1 591 nF	1 591 nF | 15 91 uF	15 91 uF | 159 1 uF	159 1 uF | 1 591 mF
	2% ± 1 ❶	1% ± 1	0 5% ± 1	0 2% ± 1	0 5% ± 1	1% ± 1 ❶
10KHz	0 795 pF | 1 591 pF	1 591 pF | 15 91 pF	15 91 pF | 159 1 pF	159 1 pF | 1 591 uF	1 591 uF | 15 91 uF	15 91 uF | 159 1 uF
	5% ± 1 ❶	2% ± 1	0 5% ± 1	0 2% ± 1	0 5% ± 1	1% ± 1 ❶
100KHz (886)	NA	0 159 pF | 1 591 pF	1 591 pF | 15 91 pF	15 91 pF | 159 1 nF	159 1 nF | 1 591 uF	1 591 uF | 15 91 uF
	NA	5% ± 1 ❶	2%± 1	0 4% ± 1	2%± 1	5% ± 1 ❶

L Accuracy :

100Hz	31 83 KH | 15 91 KH	15 91 KH | 1591 H	1591 H | 159 1 H	159 1 H | 15 91 mH	15 91 mH | 1 591 mH	1 591 mH | 159 1 uH
	2% ± 1 ❶	1% ± 1	0 5% ± 1	0 2% ± 1	0 5% ± 1	1% ± 1 ❶
120Hz	26 52 KH | 13 26 KH	13 26 KH | 1326 H	1326 H | 132 6 H	132 6 H | 13 26 mH	13 26 mH | 1 326 mH	1 326 mH | 132 6 uH
	2% ± 1 ❶	1% ± 1	0 5% ± 1	0 2% ± 1	0 5% ± 1	1% ± 1 ❶
1KHz	31 83 KH | 1 591 KH	1 591 KH | 159 1 H	159 1 H | 15 91 H	15 91 H | 1 591 mH	1 591 mH | 159 1 uH	159 1 uH | 15 91 uH
	2% ± 1 ❶	1% ± 1	0 5% ± 1	0 2% ± 1	0 5% ± 1	1% ± 1 ❶
10KHz	318 3 H | 159 1 H	159 1 H | 15 91 H	15 91 H | 1 591 H	1 591 H | 159 1 uH	159 1 uH | 15 91 uH	15 91 uH | 1 591 uH
	5% ± 1 ❶	2% ± 1	0 5% ± 1	0 2% ± 1	0 5% ± 1	1% ± 1 ❶
100KHz (886)	31 83 H | 15 91 H	15 91 H | 1 591 H	1 591 H | 159 1 mH	159 1 mH | 15 91 uH	15 91 uH | 1 591 uH	1 591 uH | 0 159 uH
	NA	5% ± 1 ❶	2%± 1	0 4% ± 1	2%± 1	5% ± 1 ❶

D Accuracy :

|Zx| Freq	20M ~ 10M (Ω)	10M ~ 1M (Ω)	1M ~ 100K (Ω)	100K ~ 10 (Ω)	10 ~ 1 (Ω)	1 ~ 0 1 (Ω)
100Hz	±0 020 ❶	±0 010	±0 005	±0 002	±0 005	±0 010 ❶
120Hz						
1KHz						
10KHz	±0 050 ❶	±0 020				
100KHz (886)	NA	±0 050 ❶	±0 020	±0 004	±0 020	±0 050 ❶

θ Accuracy :

|Zx| Freq	20M ~ 10M (Ω)	10M ~ 1M (Ω)	1M ~ 100K (Ω)	100K ~ 10 (Ω)	10 ~ 1 (Ω)	1 ~ 0 1 (Ω)
100Hz	±1 046 ❶	±0 523	±0 261	±0 105	±0 261	±0 523 ❶
120Hz						
1KHz						
10KHz	±2 615 ❶	±1 046				
100KHz (886)	NA	±2 615 ❶	±1 046	±0 209	±1 046	±2 615 ❶

Z Accuracy:

As shown in table 1.

C Accuracy:

$$|Zx| = \frac{1}{2 \cdot \pi \cdot f \cdot Cx}$$

C_{Ae} = Ae of |Zx|

f : Test Frequency (Hz)

Cx : Measured Capacitance Value (F)

|Zx| : Measured Impedance Value (Ω)

Accuracy applies when Dx (measured D value) ≦ 0.1

When Dx > 0.1, multiply C_{Ae} by $\sqrt{1 + Dx^2}$

Example:

Test Condition:

Frequency : 1KHz
Level : 1Vrms
Speed : Slow
DUT : 100nF

Then

$$|Zx| = \frac{1}{2 \cdot \pi \cdot f \cdot Cx}$$

$$= \frac{1}{2 \cdot \pi \cdot 10^3 \cdot 100 \cdot 10^{-9}} = 1590\Omega$$

Refer to the accuracy table, get C_{Ae}=±0.2%

L Accuracy:

$$\left|Zx\right| = 2 \cdot \pi \cdot f \cdot Lx$$

L_{Ae} = Ae of |Zx|
f : Test Frequency (Hz)
Lx : Measured Inductance Value (H)
|Zx| : Measured Impedance Value (Ω)
Accuracy applies when Dx (measured D value) ≦ 0.1
When Dx > 0.1, multiply L_{Ae} by $\sqrt{1+Dx^2}$

Example:
Test Condition:
Frequency : 1KHz
Level : 1Vrms
Speed : Slow
DUT : 1mH
Then

$$\left|Zx\right| = 2 \cdot \pi \cdot f \cdot Lx$$
$$= 2 \cdot \pi \cdot 10^3 \cdot 10^{-3} = 6.283\Omega$$

Refer to the accuracy table, get L_{Ae}=±0.5%

ESR Accuracy:

$$ESR_{Ae} = \pm Xx \cdot \frac{Ae}{100}$$

$$Xx = 2 \cdot \pi \cdot f \cdot Lx = \frac{1}{2 \cdot \pi \cdot f \cdot Cx}$$

ESR_{Ae} = Ae of |Zx|

f : Test Frequency (Hz)

Xx : Measured Reactance Value (Ω)

Lx : Measured Inductance Value (H)

Cx : Measured Capacitance Value (F)

Accuracy applies when Dx (measured D value) ≦ 0.1

Example:

Test Condition:

Frequency : 1KHz
Level : 1Vrms
Speed : Slow
DUT : 100nF

Then

$$|Zx| = \frac{1}{2 \cdot \pi \cdot f \cdot Cx}$$

$$= \frac{1}{2 \cdot \pi \cdot 10^3 \cdot 100 \cdot 10^{-9}} = 1590\Omega$$

Refer to the accuracy table, get

C_{Ae}=±0.2%,

$$ESR_{Ae} = \pm Xx \cdot \frac{Ae}{100} = \pm 3.18\Omega$$

D Accuracy:

$$D_{Ae} = \pm \frac{Ae}{100}$$

D_{Ae} = Ae of |Zx|
Accuracy applies when Dx (measured D value) $\leqq$ 0.1
When Dx > 0.1, multiply Dx by (1+Dx)

Example:
Test Condition:

Frequency	:	1KHz
Level	:	1Vrms
Speed	:	Slow
DUT	:	100nF

Then

$$\left|Zx\right| = \frac{1}{2 \cdot \pi \cdot f \cdot Cx}$$

$$= \frac{1}{2 \cdot \pi \cdot 10^{3} \cdot 100 \cdot 10^{-9}} = 1590\Omega$$

Refer to the accuracy table, get
C_{Ae}=±0.2%,

$$D_{Ae} = \pm \cdot \frac{Ae}{100} = \pm 0.002$$

Q Accuracy:

$$Q_{Ae} = \pm \frac{Qx^{2} \cdot De}{1 \mp Qx \cdot De}$$

Q_{Ae} = Ae of |Zx|

Qx : Measured Quality Factor Value

De : Relative D Accuracy

Accuracy applies when $Qx \cdot De < 1$

Example:

Test Condition:

Frequency : 1KHz
Level : 1Vrms
Speed : Slow
DUT : 1mH

Then

$$|Zx| = 2 \cdot \pi \cdot f \cdot Lx$$

$$= 2 \cdot \pi \cdot 10^3 \cdot 10^{-3} = 6.283\Omega$$

Refer to the accuracy table, get

L_{Ae}=±0.5%,

$$De = \pm \cdot \frac{Ae}{100} = \pm 0.005$$

If measured Qx = 20

Then

$$Q_{Ae} = \pm \frac{Qx^2 \cdot De}{1 \mp Qx \cdot De}$$

$$= \pm \frac{2}{1 \mp 0.1}$$

θ **Accuracy:**

$$\theta e = \frac{180}{\pi} \cdot \frac{Ae}{100}$$

Example:
Test Condition:

Frequency	:	1KHz
Level	:	1Vrms
Speed	:	Slow
DUT	:	100nF

Then

$$|Zx| = \frac{1}{2 \cdot \pi \cdot f \cdot Cx}$$

$$= \frac{1}{2 \cdot \pi \cdot 10^3 \cdot 100 \cdot 10^{-9}} = 1590\Omega$$

Refer to the accuracy table, get
Z_{Ae}=±0.2%,

$$\theta_{Ae} = \pm \frac{180}{\pi} \cdot \frac{Ae}{100}$$

$$= \pm \frac{180}{\pi} \cdot \frac{0.2}{100} = \pm 0.115 \deg$$

- Testing Signal:
  Level Accuracy : ± 5%
  Frequency Accuracy : 0.1%

- Output Impedance : 100Ω ± 5%

- Measuring Speed:

Fast	4.5 meas. / sec.
Slow	2.5 meas. / sec.

- General:

Temperature	0°C to 70°C (Operating) -20°C to 70°C (Storage)
Relative Humidity	Up to 85%
Battery Type	2 AA size Ni-Mh or Alkaline
Battery Charge	Constant current 150mA approximately
Battery Operating Time	2.5 Hours typical
AC Operation	110/220V AC, 60/50Hz with proper adapter
Low Power Warning	under 2.2V
Dimensions	174mm x 86mm x 48mm (L x W x H) 6.9” x 3.4” x 1.9”
Weight	470g

NOTE: Specifications and information are subject to change without notice. Please visit www.bkprecision.com for the most current product information.

Considerations

Test Frequency. The test frequency is user selectable and can be changed. Generally, a 1 KHz test signal or higher is used to measure capacitors that are 0.01uF or smaller and a 120Hz test signal is used for capacitors that are 10uF or larger. Typically a 1 kHz test signal or higher is used to measure inductors that are used in audio and RF (radio frequency) circuits. This is because these components operate at higher frequencies and require that they be measured at a higher frequency of 1 KHz. Generally, inductors below 2mH should be measured at 1 kHz and inductors above 200H should be measured at 120Hz.

It is best to check with the component manufacturers' data sheet to determine the best test frequency for the device.

Charged Capacitors

Always discharge any capacitor prior to making a measurement since a charged capacitor may seriously damage the meter.

Effect Of High D on Accuracy

A low D (Dissipation Factor) reading is desirable. Electrolytic capacitors inherently have a higher dissipation factor due to their normally high internal leakage characteristics. If the D (Dissipation Factor) is excessive, the capacitance measurement accuracy may be degraded.

It is best to check with the component manufacturers' data sheet to determine the desirable D value of a good component.

Measuring Capacitance of Cables, Switches or Other Parts

Measuring the capacitance of coaxial cables is very useful in determining the actual length of the cable. Most manufacturer specifications list the amount of capacitance per foot of cable and therefore the length of the cable can be determined by measuring the capacitance of that cable.

For example: A manufacturers, specification calls out a certain cable, to have a capacitance of 10 pF per foot, After measuring the cable a capacitance reading of 1.000 nF is displayed. Dividing 1000pF (1.000 nF) by 10 pF per foot yields the length of the cable to be approximately 100 feet.

Even if the manufacturers' specification is not known, the capacitance of a measured length of cable (such as 10 feet) can be used to determine the capacitance per foot; do not use too short a length such as one foot, because any error becomes magnified in the total length calculations.

Sometimes, the capacitance of switches, interconnect cables, circuit board foils, or other parts, affecting stray capacitance can be critical to circuit design, or must be repeatable from one unit to another.

<u>Series Vs Parallel Measurement (for Inductors)</u>

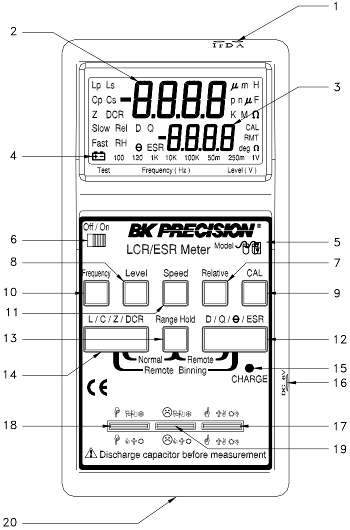
The series mode displays the more accurate measurement in most cases. The series equivalent mode is essential for obtaining an accurate Q reading of low Q inductors. Where ohmic losses are most significant, the series equivalent mode is preferred. However, there are cases where the parallel equivalent mode may be more appropriate. For iron core inductors operating at higher frequencies where hysteresis and eddy currents become significant, measurement in the parallel equivalent mode is preferred.

1.4 Accessories

Operating Manual	1 pc
2 AA Size Ni-Mh Rechargeable Batteries	2 pc
Shorting Bar	1 pc
AC to DC Adapter	1 pc
TL885A SMD Test Probe	1 pc
TL885B 4-Wire Test Clip (Optional)	
TL08C Kelvin Clip (Optional)	
Carrying Case (Optional)	

2. Operation

2.1 Physical Description



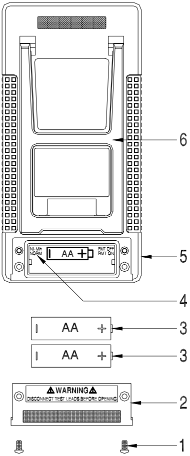
1. Infrared Port
2. Primary Parameter Display
3. Secondary Parameter Display
4. Low Battery Indicator
5. Model Number
6. Power Switch
7. Relative Key
8. Measurement Level Key
9. Open/Short Calibration Key
10. Measurement Frequency Key
11. Display Update Speed Key
12. D/Q/θ/ESR Function Key
13. Range Hold Key
14. L/C/Z/DCR Function Key
15. Battery Charge Indicator
16. DC Adapter Input Jack
17. Guard Terminal
18. HPOT/HCUR Terminal
19. LPOT/LCUR Terminal
20. Battery Compartment

2.2 Making Measurement

2.2.1 Battery Replacement

When the LOW BATTERY INDICATOR lights up during normal operation, the batteries in the Models 885 & 886 should be replaced or recharged to maintain proper operation. Please perform the following steps to change the batteries:

1. Remove the battery hatch by unscrewing the screw of the battery compartment.
2. Take out the old batteries and insert the new batteries into the battery compartment. Please watch out for battery polarity when installing new batteries.
3. Replace the battery hatch by reversing the procedure used to remove it.



1	Screws
2	Battery Compartment Hatch
3	Batteries
4	Norm/Ni-Mh Switch
5	Back Case
6	Tilt Stand

Battery Replacement

2.2.2 Battery Recharging/AC operation

Caution ⚠

Only the Models 885 or 886 standard accessory AC to DC adapter can be used with Model 885. Other battery eliminator or charger may result in damage to Modes 885 or 886.

The Models 885 & 886 works on external AC power or internal batteries. To power the Model 885 with AC source, make sure that the Models 885 or 886 is off, then plug one end of the AC to DC adapter into the DC jack on the right side of the instrument and the other end into an AC outlet.

There is a small slide switch inside the battery compartment called Battery Select Switch. If the Ni-Mh or Ni-Cd rechargeable batteries are installed in Models 885 or 886, set the Battery Select Switch to "Ni-Mh" position. The Ni-Mh or Ni-Cd batteries can be recharged when the instrument is operated by AC source. The LED for indicating battery charging will light on. If the non-rechargeable batteries (such as alkaline batteries) are installed in Models 885 or 886, set the Battery Select Switch to "NORM" position for disconnecting the charging circuit to the batteries.

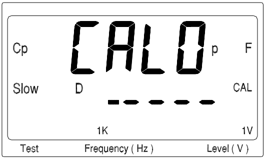
Warning ⚠

The Battery Select Switch must be set in the "NORM" position when using non-rechargeable batteries. Non-rechargeable batteries may explode if the AC adapter is used with non-rechargeable batteries. Warranty is voided if this happened.

2.2.3 Open and Short Calibration

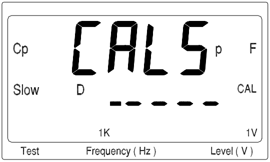
The Models 885 & 886 provides open/short calibration capability so the user can get better accuracy in measuring high and low impedance. We recommend that the user performs open/short calibration if the test level or frequency has been changed.

- Open Calibration
  First, remaining the measurement terminals with the open status, then press the CAL key shortly (no more than two second), the LCD will display:



  This calibration takes about 10 seconds. After it is finished, the Model 885 will beep to show that the calibration is done.

- Short Calibration
  To perform the short calibration, insert the Shorting Bar into the measurement terminals. Press the CAL key for more than two second, the LCD will display:



  This calibration takes about 10 seconds. After it is finished, the Model 885 will beep to show that the calibration is done.

2.2.4 Display Speed

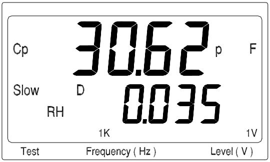
The Models 885 & 886 provides two different display speeds (Fast/Slow). It is controlled by the Speed key. When the speed is set to fast, the display will update 4.5 readings every second. When the speed is set to slow, it's only 2.5 readings per second.

2.2.5 Relative Mode

The relative mode lets the user to make quick sort of a bunch of components. First, insert the standard value component to get the standard value reading. (Approximately 5 seconds in Fast Mode to get a stable reading.) Then, press the Relative key, the primary display will reset to zero. Remove the standard value component and insert the unknown component, the LCD will show the value that is the difference between the standard value and unknown value.

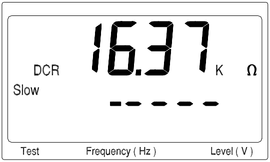
2.2.6 Range Hold

To set the range hold, insert a standard component in that measurement range. (Approximately 5 seconds in Fast Mode to get a stable reading.) Then, by pressing the Range Hold key it will hold the range within 0.5 to 2 times of the current measurement range. When the Range Hold is press the LCD display:



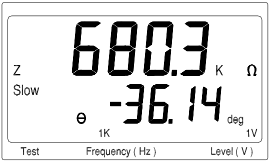
2.2.7 DC Resistance Measurement

The DC resistance measurement measures the resistance of an unknown component by 1VDC. Select the L/C/Z/DCR key to make the DCR measurement. The LCD display:



2.2.8 AC Impedance Measurement

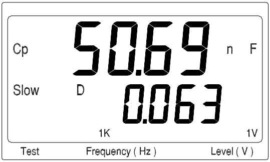
The AC impedance measurement measures the Z of an unknown device. Select the L/C/Z/DCR key to make the Z measurement. The LCD display:

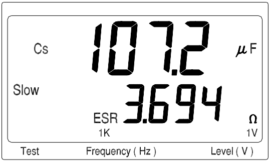


The testing level and frequency can by selected by pressing the Level key and Frequency key, respectively.

2.2.9 Capacitance Measurement

To measure the capacitance of a component, select the L/C/Z/DCR key to Cs or Cp mode. Due to the circuit structure, there are two modes can by selected (Serial Mode – Cs and Parallel Mode – Cp). If the serial mode (Cs) is selected, the D, Q and ESR can be shown on the secondary display. If the parallel mode (Cp) is selected, only the D and Q can be shown on the secondary display. The following shows some examples of capacitance measurement:

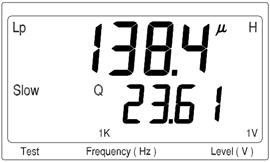


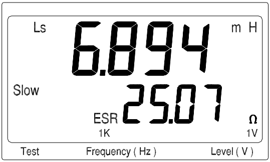


The testing level and frequency can by selected by pressing the Level key and Frequency key, respectively.

2.2.10 Inductance Measurement

Select the L/C/Z/DCR key to Ls or Lp mode for measuring the inductance in serial mode or parallel mode. If the serial mode (Ls) is selected, the D, Q and ESR can be shown on the secondary display. If the parallel mode (Lp) is selected, only the D and Q can be shown on the secondary display. The following shows some examples of capacitance measurement:

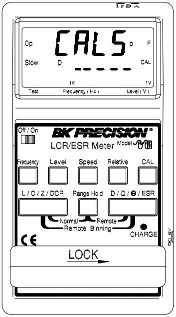




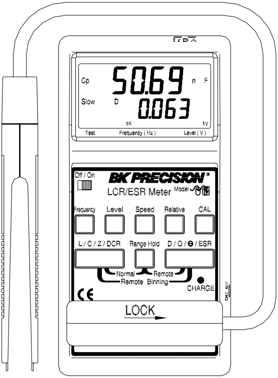
The testing level and frequency can by selected by pressing the Level key and Frequency key, respectively.

2.3 Accessory Operation

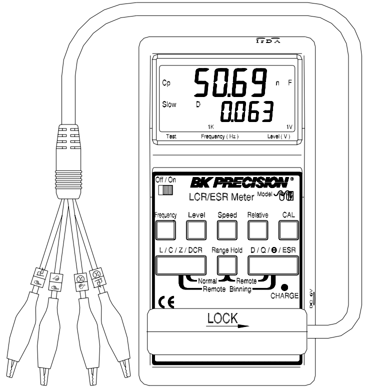
Follow the figures below to attach the test probes for making measurement.



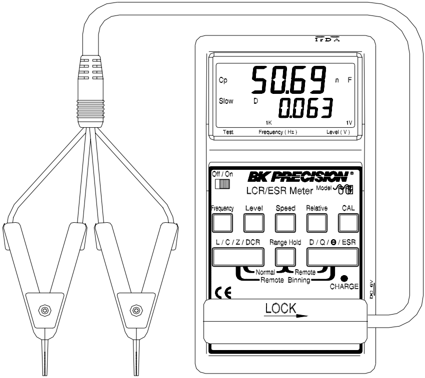
Shorting Bar



TL885A SMD Test Probe



TL885B 4-Wire Test Clip



TL08C Kelvin Clip

3. Infrared Operation

There are three operation modes in the infrared operation of Models 885 & 886. They are **Normal**, **Remote** and **Remote Binning** modes.

- **Normal**:

  The **Normal** mode is the default power on local mode. Press the **Normal** keys to switch back to local operation from **Remote** or **Remote Binning** modes.

- **Remote**:

  In the **Remote** mode, the Models 885 & 886 is capable of communicating to infrared equipped PC or terminal through the build-in infrared interface. The connection setting is as follow:

  Transmission Mode : Half Duplex
  Baud Rate : 9600
  Parity Bit : None
  Data Bits : 8
  Stop Bit : 1
  Handshake : None

  In this mode, the keyboard and LCD will be locked. And, these Models measurement is controlled by the external program through the infrared port.

- **Remote Binning**:

  In the **Remote Binning** mode, the “RMT” on the LCD will flash. The Models 885 & 886 performs as a TALK ONLY instrument. That means, the measurement of Models 885 & 886 is controlled by key pads, but the measured value will display on the LCD as well as output to the infrared port. By this way, the user can purchase the optional application program provided by B&K Precision Corp. to obtain the GO/NO GO comparator and the component sorting comparator.

3.1 Command Syntax

The command syntax of Models 885 & 886 is as following:

COMMAND(?) (PARAMETER)

The format of COMMAND and PARAMETER is as following:

1. There is at least one space between COMMAND and PARAMETER.
2. The PARAMETER should use only ASCII string not numerical code.
3. Value parameter can be integer, floating or exponent with the unit. For example:
   50mV
   0.05V
   5.0e1mV
4. The question mark (?) at the end of COMMAND means a query or measure back command. For example:
   "CpD" sets the measurement mode to Cp and D.
   "CpD?" sets the measurement mode to Cp and D as well as measures the values and send it back.
5. The COMMAND and PARAMETER can be either upper or lower case. But the unit to describe the value in the PARAMETER should have different between milli (m) and mega (M). For example:
   1mV equals 0.001V.
   1MV equals 1000000V.
6. The "end of command" character should be placed at the end. They are:
   ASCII CR (0DH) or
   ASCII LF (0AH)

3.2 Commands

Measurement Setting (or Querying) Command

The following measurement mode-setting and the query commands are supported in the Model 885/886. When a mode-setting command is entered the Model 885/886 will return "**OK**" follows the ASCII CR (0DH) and ASCII LF (0AH) after setting is complete. When query command is entered, the Model 885/886 will send back the values of measurement. After a command is entered, the meter shall respond within 2.5 seconds with the return values follow the ASCII CR and ASCII LF. If an illegal command is entered, there is no response from the meter.

● **DCR(?)**	DC resistance measurement mode setting or querying command.
● **CpRp(?)**	Parallel capacitance and parallel resistance measurement mode setting or querying command.
● **CpQ(?)**	Parallel capacitance and quality factor measurement mode setting or querying command.
● **CpD(?)**	Parallel capacitance and dissipation factor measurement mode setting or querying command.
● **CsRs(?)**	Serial capacitance and serial resistance measurement mode setting or querying command.
● **CsQ(?)**	Serial capacitance and quality factor measurement mode setting or querying command.
● **CsD(?)**	Serial capacitance and dissipation factor measurement mode setting or querying command.
● **LpRp(?)**	Parallel inductance and parallel resistance

measurement mode setting or querying command.

- **LpQ(?)** Parallel inductance and quality factor measurement mode setting or querying command.
- **LpD(?)** Parallel inductance and dissipation factor measurement mode setting or querying command.
- **LsRs(?)** Serial inductance and serial resistance measurement mode setting or querying command.
- **LsQ(?)** Serial inductance and quality factor measurement mode setting or querying command.
- **LsD(?)** Serial inductance and dissipation factor measurement mode setting or querying command.
- **RsXs(?)** Serial resistance and serial reactance measurement mode setting or querying command.
- **RpXp(?)** Parallel resistance and parallel reactance measurement mode setting or querying command.
- **ZTD(?)** Impedance and angle (Deg) measurement mode setting or querying command.
- **ZTR(?)** Impedance and angle (Rad) measurement mode setting or querying command.

Example:

CPD (*set to Cp-D measurement mode)*

CPD?
0.22724 0.12840 (*return value*)

DCR?
5.1029 (*return value*)

- ***IDN?** Queries and identifies the LCR Meter. This command is used to identify the basic information of LCR Meter.

***RST**

Reset the Models 885 & 886 to the power on default status. The default status is:

1KHz 1Vrms SLOW CpD uF mH Ohm

After the Models 885 & 886 is reset, it will beep once and returns the “BEEP” string back.

ASC

Set the format of the return value. This command sets the ASCII string return or the numerical code.

PARAMETER:

ON	ASCII string
OFF	Numerical code

Example:

ASC ON
FREQ?
1KHz (*return value*)

ASC OFF
FREQ?
2 (*return value*)

CORR OPEN

Perform the open calibration. This command sets the Models 885 & 886 to do the open calibration. After the calibration is done, the Models 885 & 886 will beep once and returns the “BEEP” string back.

CORR SHORT

Perform the short calibration. This command sets the Models 885 & 886 to do the short calibration. After the calibration is done, the Model 885 will beep once and returns the “BEEP” string back.

FREQ(?) PARAMETER

Set (queries) the measurement frequency.

- **FREQ PARAMETER**

  Set the measurement frequency according to the parameter. There is no return value.

  PARAMETER:

ASCII string	Numerical code
100Hz	0
120Hz	1
1KHz	2
10KHz	3
100KHz	4

  Example:

  ```
  FREQ 100KHz
  ```

- **FREQ?**

  Return the current measurement frequency setting.

  Example:

  ASC ON
  FREQ?
  1KHz (*return value*)

  ASC OFF
  FREQ?
  2 (*return value*)

LEV(?) PARAMETER

Set (queries) the measurement level.

- **LEV PARAMETER**

  Set the measurement level according to the parameter. There is no return value.

PARAMETER:

ASCII string	Numerical code
1VDC	0
1Vrms	1
250mVrms	2
50mVrms	3

Example:

```
LEV 1V
```

- **LEV?**

  Return the current measurement level setting.

  Example:

  ASC ON
  LEV?
  1Vrms (*return value*)

  ASC OFF
  LEV?
  1 (*return value*)

MODE?

Query the measurement mode. Six fields will be returned.

1. Frequency
2. Level
3. Speed
4. Measurement mode
5. Unit of primary display
6. Unit of secondary display

The existence of field 6 depends on the measurement mode. For example, there's no field 6 if the measurement mode is DCR. The separation between fields is space (ASCII 20H).

Example:

```
ASC ON
CPD
MODE?
1KHz 1Vrms SLOW CpD uF (return value)

ASC ON
CPRP
MODE?
1KHz 1Vrms SLOW CpRp uF Ohm (return value)
```

RANG(?) PARAMETER

Set (queries) the measurement unit.

- **RANG PARAMETER**

  Set the measurement unit according to the parameter. There is no return value.

  PARAMETER:

ASCII string	Numerical code
pF	0
nF	1
uF	2
mF	3
F	4
nH	8
uH	9
mH	10
H	11
KH	12
mOhm	17
Ohm	18
KOhm	19
MOhm	20

Example:

```
RANG pF
```

- **RANG?**
  Return the current measurement unit setting.
  Example:

```
ASC ON
RANG?
pF (return value)

ASC OFF
RANG?
0 (return value)
```

READ?

Return the measurement value. This command will perform a measurement according to the current measurement mode and return the measured value.

Example:

```
CPD
READ?
0.22724 0.12840 (return value)

DCR
READ?
5.1029 (return value)
```

The “DCR” measurement will send only one measured value. The other measurement modes will send two measured values separated by space (ASCII 20H).

SPEED(?) PARAMETER

Set (queries) the measurement speed.

- **SPEED PARAMETER**

  Sets the measurement speed according to the parameter. There is no return value.

  PARAMETER:

ASCII string	Numerical code
SLOW	0
FAST	1

  Example:

  ```
  SPEED FAST
  ```

- **SPEED?**

  Return the current measurement speed setting.

  Example:

  ASC ON
  SPEED?
  SLOW (*return value*)

  ASC OFF
  SPEED?
  0 (*return value*)

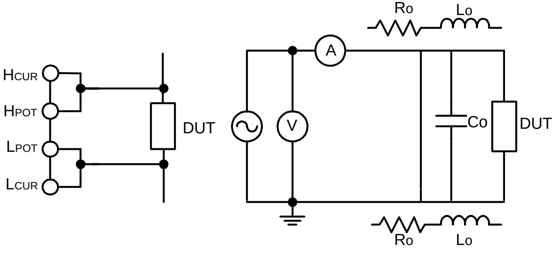
4. Application

4.1 Test Leads Connection

Auto balancing bridge has four terminals (H_{CUR}, H_{POT}, L_{CUR} and L_{POT}) to connect to the device under test (DUT). It is important to understand what connection method will affect the measurement accuracy.

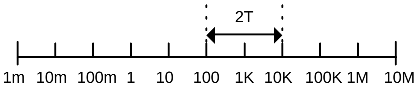
- 2-Terminal (2T)

  2-Terminal is the easiest way to connect the DUT, but it contents many errors which are the inductor and resistor as well as the parasitic capacitor of the test leads (Figure 3.1). Due to these errors in measurement, the effective impedance measurement range will be limited at 100Ω to 10KΩ.



(a) CONNECTION

(b) BLOCK DIAGRAM

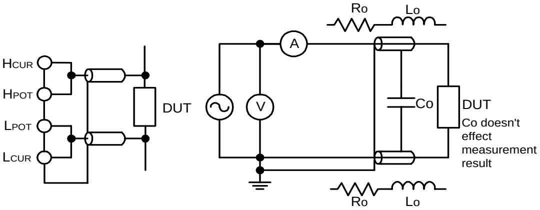


(c) TYPICAL MPEDANCE MEASUREMENT RANGE(£[)

Figure 3.1

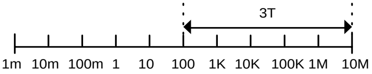
- 3-Terminal (3T)

  3-Terminal uses coaxial cable to reduce the effect of the parasitic capacitor (Figure 3.2). The shield of the coaxial cable should connect to guard of the instrument to increase the measurement range up to 10MΩ.

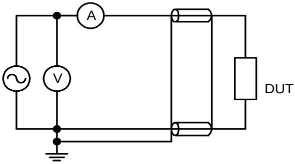


(a) CONNECTION

(b) BLOCK DIAGRAM



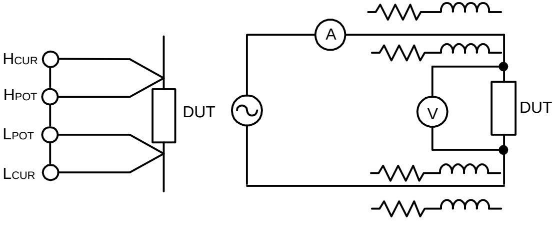
(c) TYPICAL IMPEDANCE MEASUREMENT RANGE(£[)



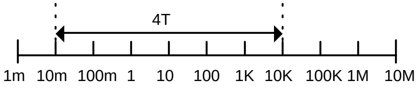
(d) 2T CONNECTION WITH SHILDING

Figure 3.2

- 4-Terminal (4T)
  4-Terminal connection reduces the effect of the test lead resistance (Figure 3.3). This connection can improve the measurement range down to 10mΩ. However, the effect of the test lead inductance can’t be eliminated.



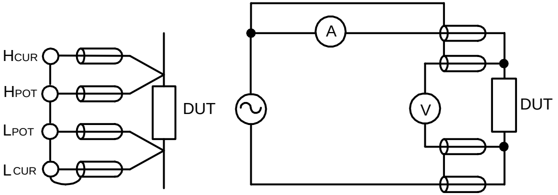
(a) CONNECTION (b) BLOCK DIAGRAM



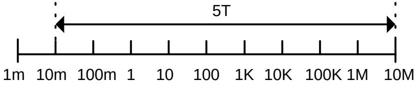
(c) TYPICAL MPEDANCE MEASUREMENT RANGE (£[)

Figure 3.3

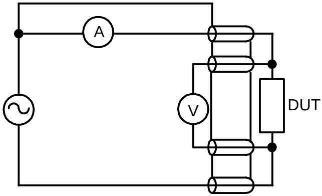
- 5-Terminal (5T)
  5-Terminal connection is the combination of 3T and 4T (Figure 3.4). It has four coaxial cables. Due to the advantage of the 3T and 4T, this connection can widely increase the measurement range for 10mΩ to 10MΩ.



(a) CONNECTION (b) BLOCK DIAGRAM



(c) TYPICAL MPEDANCE MEASUREMENT RANGE (£[)

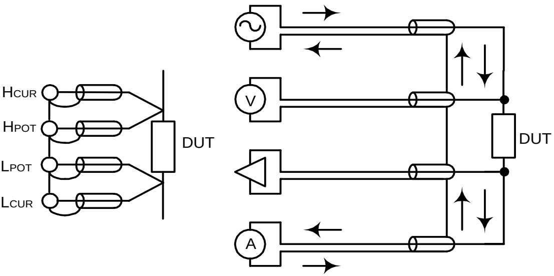


(d) WRONG 4T CONNECTION

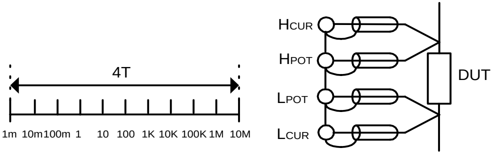
Figure 3.4

- 4-Terminal Path (4TP)

  4-Terminal Path connection solves the problem that caused by the test lead inductance. 4TP uses four coaxial cables to isolate the current path and the voltage sense cable (Figure 3.5). The return current will flow through the coaxial cable as well as the shield. Therefore, the magnetic flux that generated by internal conductor will cancel out the magnetic flux generated by external conductor (shield). The 4TP connection increases the measurement range from 1mΩ to 10MΩ.



(a) CONNECTION (b) BLOCK DIAGRAM



(c) TYPICAL IMPEDANCE MEASUREMENT RANGE(£[) (d) 4T CONNECTION WITH SH LDING

Figure 3.5

- Eliminating the Effect of the Parasitic Capacitor

  When measuring the high impedance component (i.e. low capacitor), the parasitic capacitor becomes an important issue (Figure 3.6). In figure 3.6(a), the parasitic capacitor Cd is paralleled to DUT as well as the Ci and Ch. To correct this problem, add a guard plane (Figure 3.6(b)) in between H and L terminals to break the Cd. If the guard plane is connected to instrument guard, the effect of Ci and Ch will be removed.

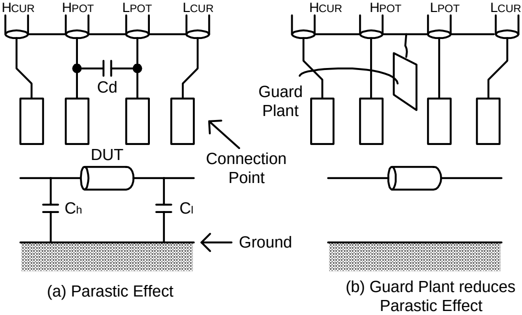
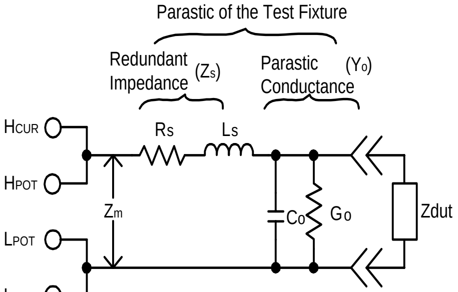


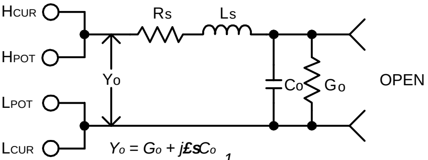
Figure 3.6

4.2 Open/Short Compensation

For those precision impedance measuring instrument, the open and short compensation need to be used to reduce the parasitic effect of the test fixture. The parasitic effect of the test fixture can be treated like the simple passive components in figure 3.7(a). When the DUT is open, the instrument gets the conductance Yp = Gp + jωCp (Figure 3.7(b)). When the DUT is short, the instrument gets the impedance Zs = Rs + jωLs (Figure 3.7(c)). After the open and short compensation, Yp and Zs are for calculating the real Zdut (Figure 3.7(d)).



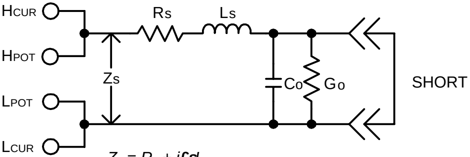
(a) Parastic Effect of the Test Fixture



$Y_o = G_o + j\omega C_o$

$(R_s + j\omega << \frac{1}{G_o + j\omega C_o})$

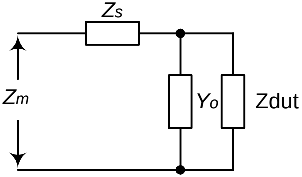
(b) OPEN Measurement



$Z_s = R_s + j\omega L_s$

(c) SHORT Measurement

Figure 3.7



$$\boxed{Zdut = \frac{Z_m - Z_s}{1-(Z_m-Z_s)Y_o}}$$

(d) Compensation Equation

Figure 3.7 (Continued)

4.3 Selecting the Series or Parallel Mode

According to different measuring requirement, there are series and parallel modes to describe the measurement result. It is depending on the high or low impedance value to decide what mode to be used.

- Capacitor

  The impedance and capacitance in the capacitor are negatively proportional. Therefore, the large capacitor means the low impedance; the small capacitor means the high impedance. Figure 3.8 shows the equivalent circuit of capacitor. If the capacitor is small, the Rp is more important than the Rs. If the capacitor is large, the Rs shouldn’t be avoided. Hence, uses parallel mode to measure low capacitor and series mode to measure high capacitor.

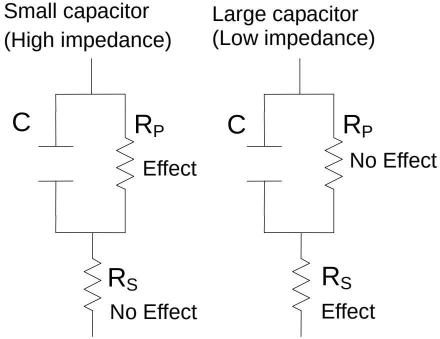


Figure 3.8

- Inductor

  The impedance and inductive in the inductor are positively proportional. Therefore, the large inductor equals to the high impedance and vice versa. Figure 3.9 shows the equivalent circuit of inductor. If the inductor is small, the Rs is more important than the Rp. If the inductor is large, the Rp should be taking care of. So, uses series mode to measure low inductor and parallel mode to measure high inductor.

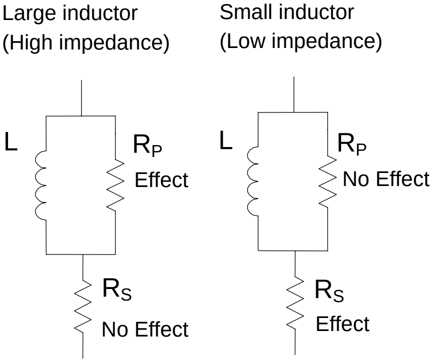

Large inductor
(High impedance)
Small inductor
(Low impedance)
L
R_P
Effect
L
R_P
No Effect
R_S
No Effect
R_S
Effect

Figure 3.9

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