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Models

885 & 886

LCR METER

OPERATING

MANUAL

MANUAL DE INSTRUCCIÓNES

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 0.2%. 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
- 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 – θ , 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.

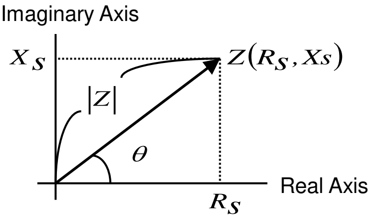


Figure 1.1

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

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

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

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

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

$$X_L = \omega L = 2\pi f L \qquad L = \textit{Inductance (H)}$$

$$X_C = \frac{1}{\omega C} = \frac{1}{2\pi f C} \qquad C = \textit{Capacitance (F)}$$

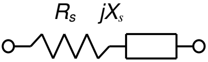
$$f = \textit{Frequency (Hz)}$$

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.

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

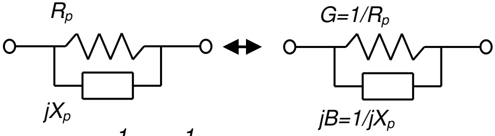
There are two types of the circuit mode. One is series mode, the other is parallel mode. See Figure 1.2 to find out the relation of the series and parallel mode.

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

● Accuracy (*Ae*):

Z Accuracy:

<table>
<tr><th>|Zx|
Freq.</th><th>20M ~
10M
(Ω)</th><th>10M ~
1M
(Ω)</th><th>1M ~
100K
(Ω)</th><th>100K ~
10
(Ω)</th><th>10 ~ 1
(Ω)</th><th>1 ~ 0.1
(Ω)</th></tr>
<tr><td>DCR</td><td rowspan="4">2% ±1
❶</td><td rowspan="4">1% ±1</td><td rowspan="5">0.5% ±1</td><td rowspan="5">0.2% ±1</td><td rowspan="5">0.5% ±1</td><td rowspan="5">1% ±1
❶</td></tr>
<tr><td>100Hz</td></tr>
<tr><td>120Hz</td></tr>
<tr><td>1KHz</td></tr>
<tr><td>10KHz</td><td>5% ±1
❶</td><td>2% ±1</td></tr>
<tr><td>100KHz
(886)</td><td>NA</td><td>5%±1
❶</td><td>2%±1</td><td>0.4% ±1</td><td>2%±1</td><td>5%±1
❶</td></tr>
</table>

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 :

<table>
<tr><td rowspan="2">100Hz</td><td>79.57
pF
|
159.1
pF</td><td>159.1
pF
|
1.591
nF</td><td>1.591
nF
|
15.91
nF</td><td>15.91
nF
|
159.1
uF</td><td>159.1
uF
|
1591
uF</td><td>1591
uF
|
15.91
mF</td></tr>
<tr><td>2% ± 1
❶</td><td>1% ± 1</td><td>0.5%
± 1</td><td>0.2%
± 1</td><td>0.5%
± 1</td><td>1% ± 1
❶</td></tr>
<tr><td rowspan="2">120Hz</td><td>66.31
pF
|
132.6
pF</td><td>132.6
pF
|
1.326
nF</td><td>1.326
nF
|
13.26
nF</td><td>13.26
nF
|
132.6
uF</td><td>132.6
uF
|
1326
uF</td><td>1326
uF
|
13.26
mF</td></tr>
<tr><td>2% ± 1
❶</td><td>1% ± 1</td><td>0.5%
± 1</td><td>0.2%
± 1</td><td>0.5%
± 1</td><td>1% ± 1
❶</td></tr>
<tr><td rowspan="2">1KHz</td><td>7.957
pF
|
15.91
pF</td><td>15.91
pF
|
159.1
pF</td><td>159.1
pF
|
1.591
nF</td><td>1.591
nF
|
15.91
uF</td><td>15.91
uF
|
159.1
uF</td><td>159.1
uF
|
1.591
mF</td></tr>
<tr><td>2% ± 1
❶</td><td>1% ± 1</td><td>0.5%
± 1</td><td>0.2%
± 1</td><td>0.5%
± 1</td><td>1% ± 1
❶</td></tr>
<tr><td rowspan="2">10KHz</td><td>0.795
pF
|
1.591
pF</td><td>1.591
pF
|
15.91
pF</td><td>15.91
pF
|
159.1
pF</td><td>159.1
pF
|
1.591
uF</td><td>1.591
uF
|
15.91
uF</td><td>15.91
uF
|
159.1
uF</td></tr>
<tr><td>5% ± 1
❶</td><td>2% ± 1</td><td>0.5%
± 1</td><td>0.2%
± 1</td><td>0.5%
± 1</td><td>1% ± 1
❶</td></tr>
<tr><td rowspan="2">100KHz
(886)</td><td>NA</td><td>0.159
pF
|
1.591
pF</td><td>1.591
pF
|
15.91
pF</td><td>15.91
pF
|
159.1
nF</td><td>159.1
nF
|
1.591
uF</td><td>1.591
uF
|
15.91
uF</td></tr>
<tr><td>NA</td><td>5% ± 1
❶</td><td>2%± 1</td><td>0.4%
± 1</td><td>2%± 1</td><td>5% ± 1
❶</td></tr>
</table>

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 :

$\lvert Zx \rvert$ / 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 :

$\lvert Zx \rvert$ / 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:

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

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

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

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

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

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

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

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

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

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

Q Accuracy:

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

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

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

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

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

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.

Series Vs Parallel Measurement (for Inductors)

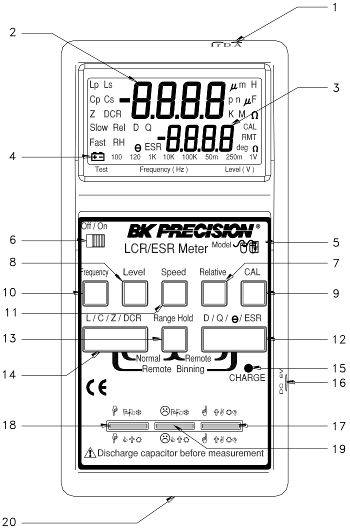
The series mode displays the more accurate measurement in most cases. The series equivalent mode is essential for obtaining an accurate Q reading of low Q inductors. Where ohmic losses are most significant, the series equivalent mode is preferred. However, there are cases where the parallel equivalent 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

- 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



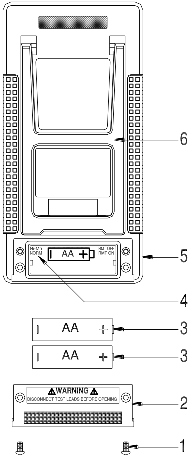
1. NA
2. Primary Parameter Display
3. Secondary Parameter Display
4. Low Battery Indicator
5. Model Number
6. Power Switch
7. Relative Key
8. Measurement Level Key
9. Open/Short Calibration Key
10. Measurement Frequency Key
11. Display Update Speed Key
12. D/Q/ θ /ESR Function Key
13. Range Hold Key
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.