High Precision LCR Meter
高精密 LCR 測試器

LCR-900

100KHz With USB Interface

INSTRUCTION MANUAL
使 用 說 明 書

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High Precision LCR Meter

Safety Precautions:

⚠ WARNING:

Normal use of test equipment exposes a certain amount of danger from electrical shock. Because testing must sometimes be performed where exposed high voltage is present. An electrical shock causing 10 milliamps of current to pass through the heart will stop most humans heartbeats. Your normal work habits should include all accepted practices to prevent contact with exposed high voltage and to steer current away from your heart in case of accident contact with high voltage. You will significantly reduce the risk factor if you know and observe the following safety precaution.

(1) Don't expose high voltage needlessly. Remove housings and covers only when necessary. Turn off equipment while making test connections in high voltage circuits. Discharge high voltage capacitors after removing power.

(2) If possible. Familiarize yourself with the equipment being test and the location of its high voltage points. However, remember that high voltage may appear at unexpected points in defective equipment.

(3) Use an insulated floor material or large insulated floor to stand on and an insulated work surface on which to place equipment and make certain such surface are not damp or wet.

(4) Use the time proven "one hand in the pocket" technique while handling an instrument probe. Be particularly careful to avoid contacting a nearly metal object that could provide a good ground return path.

(5) When testing AC power equipment, remember that AC line voltage is usually present on some power input circuits such as the on-off switch, fuse, power transformer etc. ant time the equipment is connect to an AC outlet, even if the equipment is turned off.

(6) Some equipment with a two-wire AC power cord, including some with polarized power plugs, is the "hot chassis" type. A plastic wooden cabinet insulates the chassis to protect the customer. When the cabinet is removed for servicing, a serious shock hazard exists if the chassis is touched.

(7) On test instruments or any equipment with 3-wire AC power plug use only 3-wire outlet. This is a safety feature to keep the housing or other exposed elements at earth ground.

Introduction:

1. General:

LCR-900 was designed for Capacitance, Resistance, Inductance, Dissipation Factor, Quality Factor, Phase Angle, Impedance etc measurement. Operation frequency from 100Hz to 100KHz, Basic measurement accuracy, 0.3%. Dual LCD display, Measurement voltage fixed at 0.6V auto-detect function and Open circuit / short circuit compassion.

2. Primary Measurement display:

DCR: DC resistance
Lp: Parallel Inductance
Ls: Serial Inductance
Cp: Parallel Capacitance
Cs: Serial Capacitance
Rp: Parallel Resistance
Rs: Serial Resistance

3. Secondary Measurement Display

L / C mode:

θ: Phase Angle
D: Dissipation Factor
Q: Quality factor
Rp: Parallel Impedance
ESR: Serial Impedance

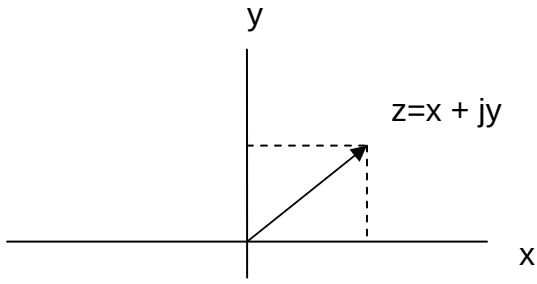
4. Impedance factor

LCR-900 provided both DC and AC impedance measurement.

The impedance measurement was very important for the electronic component, and the characteristic of the material of the parts.

When show the impedance by Vector,(Z)， set the Real Resistance as X axis and the Imaginary Reactance as Y axis. On the Cartesian coordinates system will be as the following:

$$Z = x + jy \qquad j = \sqrt{-1}$$



And on the polar coordinate system:

$Z = r\cos\theta + jr\sin\theta$

$R = r\cos\theta$

$y = r\sin\theta$

$r = (x^2 + y^2)^{1/2}$

$\theta = \tan^{-1}(y/x)$

Z= (Impedance)

R= (Resistance)

y= (Reactance)

Reactance contained **(Inductive)Y_L** and **(Capacitive)Y_C**

They are:

$Y_L = \omega L = 2\pi fL$ L = (Inductance)

$Y_C = 1/(\omega C) = 1/(2\pi fC)$ C = (Capacitance)

f = (Frequency)

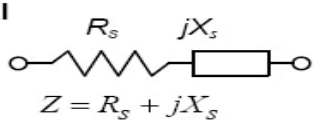
The character of the electronic component besides Resistance (R) and Reactance (Y)，there are Quality Factor,(Q) and Dissipation factor, (D)。The Character of the Reactance measurement will contained these 2 factors, In the other word, The Reactance measurement was to measure the ratio between the power store (Reactance) and consume (Resistance) of the component：

$Q = 1/D = \omega Ls/Rs = 1/\omega CsRs = \omega CpRp$

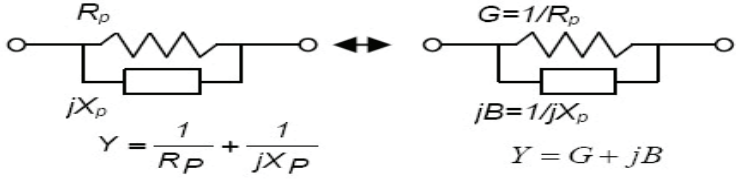
In usually, Quality factor (Q) was for the character of Inductance measurement, The Dissipation factor (D) was for the character of the capacitance measurement., These 2 factors are Reciprocal each other.

According to various requirement. The measurement of the Equivalent impedance can be calculated as Series and parallel relation between the Real and Imaginary components, their calculate equations are as the following:

Real and imaginary components are serial



Real and imaginary components are Parallel



Specifications:

1. Power Source:

115V (110V ~ 120v) 50/60Hz: Fuse 600mA

230V (220V ~ 240V) 50/60Hz: Fuse 300mA

2. Operation Environment:

Temperature: 0°C ~ 40°C

Humidity: 20% ~ 80%

3. Storage:

Temperature: -20°C ~ 70°C

Humidity: 0% ~ 90%

4. Accessory:

Power Cord, Operation manual, Test Lead RP-92(BNC Plug to Clip) x 1.

Option:

RP-92 (BNC Plug to pin, for SMD component use)

5. LCD Display:

Factor	Range
R	0.000 Ω to 9999 MΩ
L	0.000 uH to 9999 kH
C	0.000 pF to 9999 F
DCR	0.000 Ω to 9999 MΩ
ESR	0.000 Ω to 9999 Ω
Rp	0.000 Ω to 9999 Ω
D	0.000 to 9999
Q	0.000 to 9999
θ	- 90° to + 90°

6. Accuracy (Ae)

Impedance Accuracy (T=18 ~ 28°C)

Freq./Z	DCR	100/120Hz	1kHz	10kHz	100kHz
0.1-1Ω	1.0%+5d	1.0%+5d	1.0%+5d	1.0%+5d	2.0%+5d
1-10Ω	0.5%+3d	0.5%+3d	0.5%+3d	0.5%+3d	1%+5d
10-100kΩ	0.3%+2d	0.3%+2d	0.3%+2d	0.3%+2d	0.5%+3d
100k-1MΩ	0.5%+3d	0.5%+3d	0.5%+3d	0.5%+3d	1%+5d
1M-20MΩ	1.0%+5d	1.0%+5d	1.0%+5d	2.0%+5d	2.0%+5d
20M-200MΩ	2.0%+5d	2.0%+5d	2.0%+5d	N/A	(1-2MΩ)
Remark	D < 0.1				

If D > 0.1, the accuracy should be multiplied by $\sqrt{1+D^{\wedge}2}$

Zc = 1/2πfC if D<<0.1 in capacitance mode

Zl = 2πfL if D<<0.1 in inductance mode

Sub-display parameter accuracy

Ae = impedance accuracy

Definition: Q = 1/D

Rp = ESR(or Rs) x (1+1/D^2)

(1) D value accuracy De = ±Ae x (1+D)

(2) ESR accuracy Re = ±Zm x Ae(Ω)

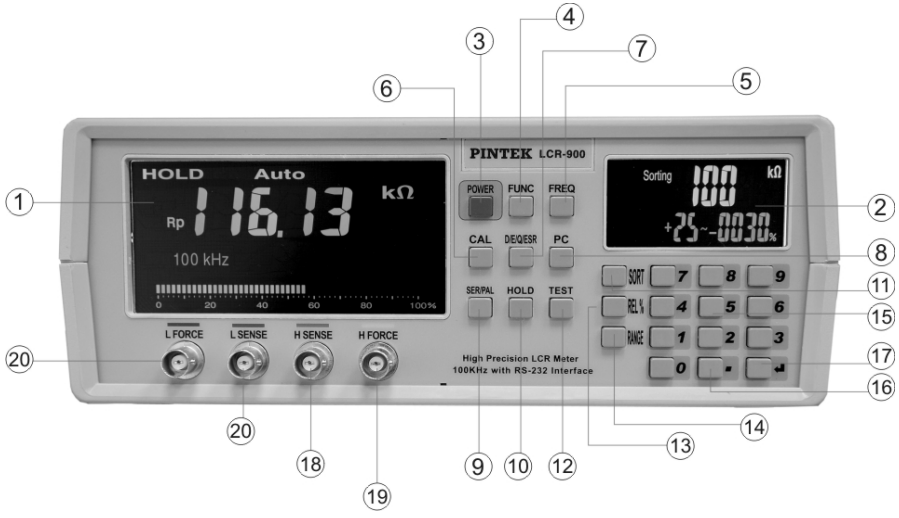
ie, Zm = impedance calculate by 1/2πfC or 2πfL

(3) Phase angle θ accuracy θe = ±(180/π) x Ae(deg)

NOTE:

Specifications abd information contained in this manual are subject to change without notice

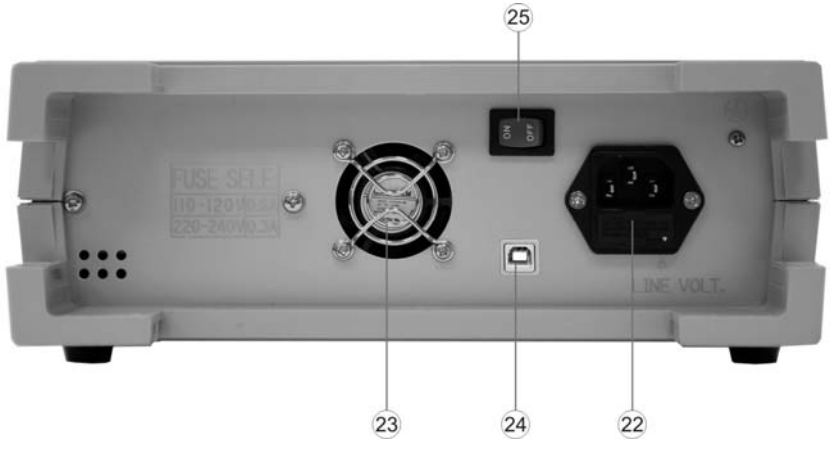
Front Panel Description:



Control/Indicator Description:
① **Main Display LCD.**
② **Second Display LCD.**
③ **Power Switch:** The key will operation only after the Line Power switch㉕ been switch on.
④ **FUNC** (Auto LCR/L/C/R/DCR Function) **Key.**
⑤ **Frequency Key.**
⑥ **CAL** (Open Circuit / Short Circuit calibration) **Key.**
⑦ **D/Q/Θ/ESR Function Key.**
⑧ **PC Function Key.**
⑨ **SER /PAL** (Series / Parallel function) **Key.**
⑩ **HOLD** (Display Hold) **Key.**
⑪ **Sorting Function Start Key.**
⑫ **TEST** (Sorting Function test Key)**.**

⑬ **REL** (Relative Value Key)**.**
⑭ **Range** (Unit Change Key)**.**
⑮ **Digits Key.**
⑯ **Decimal Point Key.**
⑰ **Enter Key.**
⑱ **HPOT Terminal.**
⑲ **HCUR Terminal.**
⑳ **LPOT Terminal.**
㉑ **LCUR Terminal**

Rear Panel Description:



Control/Indicator Description:
㉒ **Input AC power Selector and Fuse.**
㉓ **DC Fan.**
㉔ **USB terminal.**
㉕ **Lin Power Switch.** (Power switch for the transformer)

Operating Instruction:

NOTE:.

LCR-900 have 2 power switch. **Line Power Switch**㉕ on the rear panel for the transformer and then the **Power Switch**③ Key on the front panel for the operation system.

Switch “ON” the **Line Power Switch**㉕ on the rear panel then press the **Power Switch**③ key on the front panel to light the LCD.

1. Open Circuit / Short Circuit calibration:

LCR-900 provide Open Circuit ／Short Circuit calibration function so that you can measure High resistance and low resistance more accuracy.

(1) Open Circuit

Set the measuring terminal at “OPEN” condition, press **CAL**⑥ key 2 sec, the main LCD will display 『Open』, than press **CAL**⑥ again to start the open circuit calibration, to calibration will need about 30sec, after you have hear “Bi-“ and the LCD will display 『PASS』, the LCR-900 have finished the Open Circuit calibration automatically.

(2) Short Circuit

After Open circuit calibration，press **CAL**⑥ key 2 sec again，the main LCD will display『Srt』，and press **CAL**⑥ key again to start the Short circuit calibration, the same as Open Circuit Calibration, it need 30sec. and after “Bi-“, the LCD will display 『PASS』.

2. Relative Value Mode:

Press **REL**⑬ key to enter the “ Relative Value Mode” after you had key in the standard value from the **Digits**⑮ key. Press **Enter**⑰ key.

If the unit must be changed press **Range**⑭ key to change the unit. Then Insert the unit to be measured. The Second LCD will display the different between the standard value and the measuring value in “%”.

The equation are as the following:

Difference value (%) = | measuring value – standard value | / standard value x 100%

NOTE: If the difference value are high than 9999%. The LCD will display『**----**』only.

3. Sorting Function Mode:

Press **SORT**⑪ key to enter the sorting function Mode. Key in the max. difference value (%) and press **Enter**⑰ key. Then key in the standard value and the units. Press **Enter**⑰ key. After your have connect the Measuring object. Press **Test**⑫ key. The Second LCD will display 『PASS』 or 『FAIL』.

4. Display Hold Mode:

Press **HOLD**⑩ key. LCR-900 will enter the Display Hold mode. On the upper side of the main LCD will display 『HOLD』, The display value on the LCD will be kept un changed.

5. Auto Range Mode:

Press **FUNC**④ key to enter the auto range mode, the upper side of the main LCD will display『AUTO LCR』, LCR-900 will detect the object been measured and set the range to match it automatically.

Included what kind and the value etc.

6. Measuring Frequency:

Press **FREQ**⑤ key to select the measuring frequency, the range can be 1kHz, 10kHz,100kHz, 100Hz,120Hz 5 ranges.

7. DC Resistance Measurement:

Press **FUNC**④ key to change the LCR-900 range till the upper side of the main LCD display『DCR』, the LCR-900 was under “DC Resistance Measuring Mode ”.

8. Equivalent Impedance of Serial or Parallel circuit:

Press **FUNC**④ key to change the range till the upper side of the main LCD display『AUTO』, the LCP-900 will select " Serial Equivalent Resistance" or "Parallel Equivalent Resistance" mode automatically.

Or press **SER/PAL**⑨ key LCR-900 will swift to manual control the output mode as "Serial Equivalent Resistance" or "Parallel Equivalent Resistance" mode.

The Display of the various Equivalent Impedance is as the following:

Equivalent Impedance Mode	Main LCD Display
Inductor parallel mode	Lp
Capacitor parallel mode	Cp
Resistor parallel mode	Rp
Inductor Serial mode	Ls
Capacitor Serial mode	Cs
Resistor Serial mode	Rs
DC Equivalent impedance	DCR

9. Resistance Measurement

Upon the Difference, equivalent system "Resistance Measurement" can be separated as Serial Mode (Rs, Serial Mode) and Parallel Mode (Rp，Parallel Mode), user can press **FUNC**④ key to set the range to " R " position. The LCR-900 will select Rp or Rs automatically. Or press **SER/PAL**⑨ key. The Lcr-900 will swift to manual operation to measure under Rp or Rs.

10. Capacitance Measurement

The same as Resistance Measurement. Upon the equivalent System. "Capacitance measurement" can be separated as Serial Mode (Cs，Serial Mode) and Parallel Mode(Cp, Parallel Mode), press **FUNC**④ Key to " C " position, the LCR-900 will select Cp or CS automatically.

Or press **SER/PAL**⑨ key to select Cp or Cs mode and then press **D/Q/Θ/ESR**⑦ key to select D/Q/Θ/ESR factor ◦

NOTE: D/Q/Θ/ESR can not be selected under “AUTO “mode. The factor will be fixed at the time it been under “AUTO” mode.

11. Inductance Measurement

The same as Capacitance Measurement. “Inductance measurement” can be separated as (Ls，Serial Mode) and (Lp，Parallel Mode), press **FUNC**④ key to “L” Position，The LCR-900 will be set under “AUTO” mode. As the Capacitance, press **SER/PAL**⑨ key to manual mode and press **D/Q/Θ/ESR**⑦ key to select D/Q/Θ/ESR factor.◦

NOTE:

D/Q/θ/ESR can not be selected under “AUTO” mode. As capacitance measurement.◦

12. Connect To Computer

Refer to the appendix. Key in the RS-232(USB) code to your computer and Connect the LCR-900 to your computer by RS-232(USB) cable. Press **PC**⑧ key, the second LCD will display『RS232』, the LCR-900 been connect to your computer. The output of the measuring result will transfer to the computer.

Maintenance:

1. Preventive Maintenance:

Please follow the following preventive steps to ensure the proper operation of your instrument.

(1) Never place heavy object on the instrument.

(2) Never place a hot soldering iron on or near the instrument.

(3) Never insert wires, pins or other metal object into ventilation fan.

(4) Never move or pull the instrument with power cord or input lead. Especially never move instrument when power cord is connected.

(5) Do not obstruct the ventilation holes in the rear panel. As this will increase the internal temperature.

(6) Clean and check the calibration of the instrument on a regular basis to keep the instrument looking nice and working well.

(7) When the unit is not turning "**ON**". Check if the power switch is turned "**ON**". Or check the power cord. Make sure that the power is properly connected to the unit and ensure the AC supply at your site is the same as the mentioned at the rear chassis of the unit.

2. FUSE Replacement:

If the fuse blows, both LCD will not light and the instrument will not operate. Replace only with the correct value fuse. The fuse is located on the rear panel adjacent to the power cord receptacle.

(1) Remove the fuse holder assembly as follows.

(2) Unplug the power cord from the instrument.

(3) Insert a small screwdriver in the fuse holder slot (location between fuse holder and receptacle).

(4) Change the fuse and re-insert the holder.

NOTE:

When re-inserting fuse holder, be sure that the correct line voltage is selected.

3. Cleaning:

Remove any dirt, dust and grime whenever they become noticeable. Cleaning the outside cover with a soft cloth moistened with a mild cleaning solution.

Appendix:

1. RS232 transmission format:

Push RS232 function key to enable the RS232 transmission. The packet rate is two times per second. Each transmission includes 17 bytes totally.

Baud rate	Start bit	Data bit	Stop bit	Parity
115200 bps	1bit	8 bits	1 bit	None

Data transmission configuration

Data Code:

Byte0	Byte1	Byte 2 ~ Byte13	Byte14	Byte15
BAH	10H	Data	0DH	0AH

Control Code:

Byte0	Byte1	Byte2~Byte10	Byte11	Byte12
BAH	0DH	Control	0DH	0AH

Data format description:

Byte	Data byte	Function
2	STATUS 0	Status 0 indication
3	STATUS 1	Status 1 indication
4	MMOD	Operation mode of primary display on main LCD
5	MREADH	High byte of primary display data on main LCD
6	MREADL	Low byte of primary display data on main LCD
7	MSCOPE	Ranging information of primary display data on main LCD
8	MSTATUS	Status byte of primary display data on main LCD
9	SMOD	Operation mode of secondary display on main LCD
10	SREADH	High byte of secondary display data on main LCD
11	SREADL	Low byte of secondary display data on main LCD
12	SSCOPE	Ranging information of secondary display data on main LCD
13	SSTATUS	Status byte of secondary display data on main LCD

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.1.(a). When the DUT is open, the instrument gets the conductance Yp = Gp + JωCp(Figure.1.(b)). When

the DUT is short, the instrument gets the impedance Zs = Rs + jωLs (Figure.1.(c)). After the open and short compensation, the LCR-900 has Yp and Zs that then be used for the real Zdut calculation(Figure.1.(d)) .

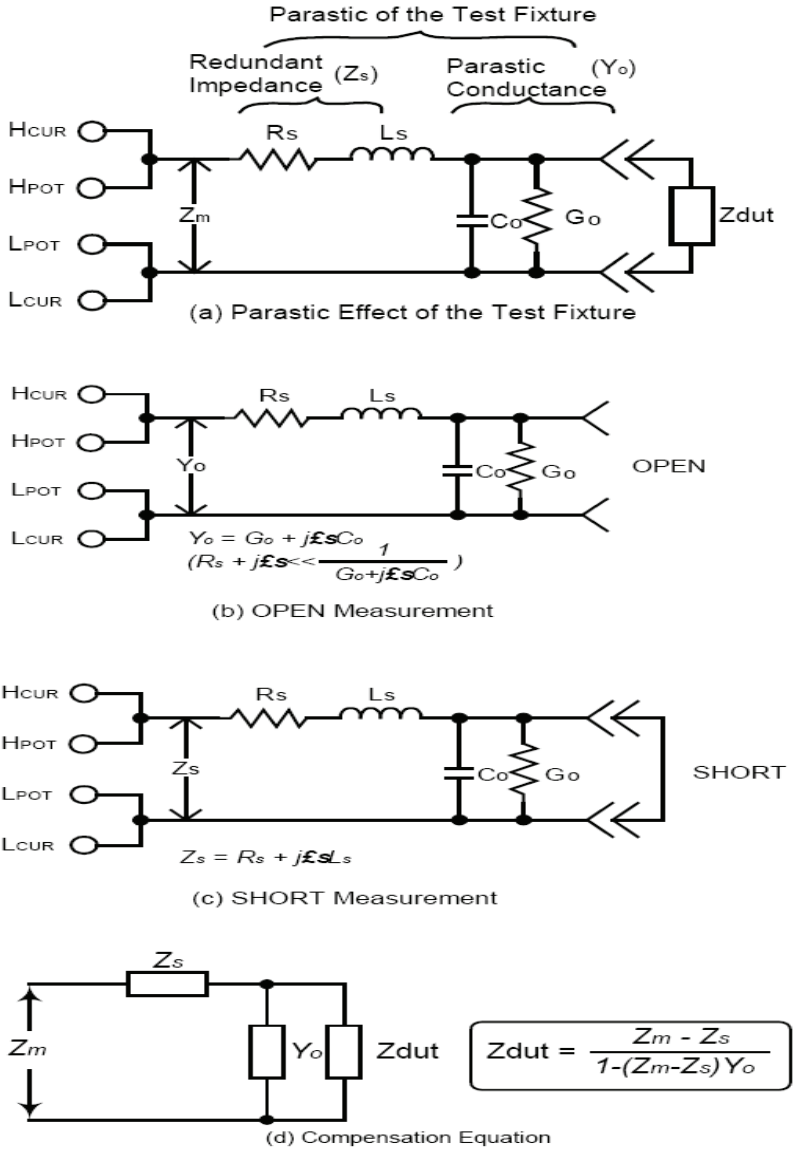


Figure.1

3. Selecting the Serial / Parallel Mode:

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

(1) Capacitor:

The impedance and capacitance in the capacitor are negatively proportional. Therefore, the larger capacitance means the lower impedance, the smaller capacitance means the higher impedance. Figure.2 shows the equivalent circuit of capacitor. If the capacitance is small, the Rp is more important than the Rs. If the capacitance is large, the Rs should not be avoided. Hence, it is properly to use parallel mode for low capacitance measurement and series mode for high capacitance measurement.

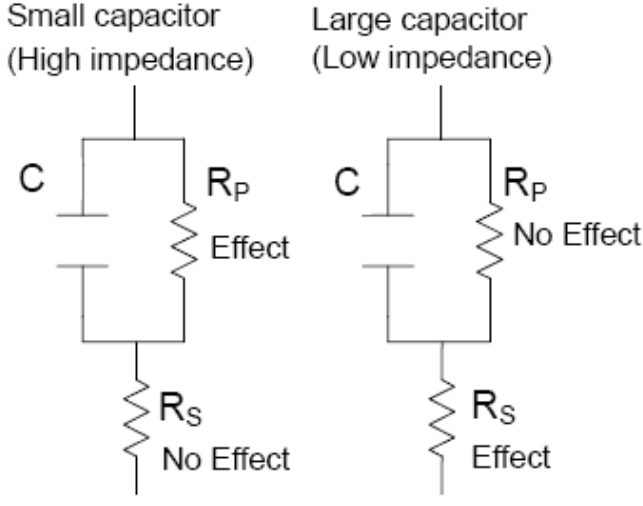


Figure.2

(2) Inductor:

The impedance and inductance of a inductor are positively when test frequency is fixed. Therefore, the larger inductance equals to higher impedance and vice versa. Figure.3 shows the equivalent circuit of inductor. When the inductance is small, the Rs becomes more important than the Rp. When the inductance is large, the Rp should be taking into consideration. Therefore, it is properly using series mode to measure an inductor with low inductance and parallel mode to measure an inductor with high inductance.

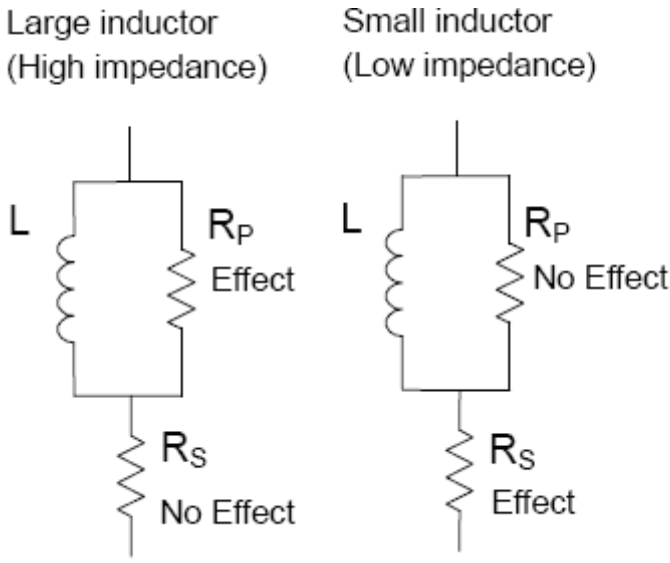


Figure.3

4. LCR-900 Calibration Sequence

NOTE:

- This operation is for the qualified engineer only. And must use the manufacture's standard resistor.
- This operation need not " switch on" the **Power Switch**③ on the front panel.

(1) Before switch "ON" the LCR-900. Open the cabin and short circuit J11.

(2) Switch "ON" the **Line Power Switch**㉕ on the rear panel. The equipment will enter the Calibration Mode automatically. Main LCD will display『u1.08』, and then 『 DCR』,『AUTO』 『10M Ω』 and twinkle『Cal』.

(3) Adjust the voltage of VR(TP6) – VRL(TP7) to -500mV±10mV.

(4) Then Calibrate The LCR-900 as the following steps：

Step	Function	Range	Standard	Action
1	DCR	10MΩ	10.000MΩ	Input a standard 10MΩ. The display will twinkle. After the display was stable. Press **CAL** key to save the value, the display 『10M Ω』will changed to 『1MΩ』.
2	DCR	1MΩ	1.0000MΩ	Input a standard 1MΩ and operate as step.1, the display will changed to 『100KΩ』.
3	DCR	100KΩ	100.00KΩ	Input the standard 100KΩ operate as Step.1, the display will be changed to 『10KΩ』.
4	DCR	10KΩ	10.000KΩ	Input a standard 10KΩ and operate as step.1, the display will changed to 『1KΩ』.
5	DCR	1KΩ	1.0000KΩ	Input a standard 1KΩ and operate as step.1, the display will changed to 『100Ω』.
6	DCR	100Ω	100.00Ω	Input a standard 100Ω and operate as step.1, the display will change to 『10Ω』.
7	DCR	10Ω	10.000Ω	Input a standard 10Ω and operate as step.1, the display will changed to 『1Ω』.
8	DCR	1Ω	1.0000Ω	Input a standard 1Ω and operate as step.1.
9	Open / Short Calibration	After Step.8, the LCD will display 『OPEN』. Keep 2 input tip at “OPEN” condition and press **CAL** key. The LCD will twinkle 30sec and display 『PASS』, then short 2 input tip, the LCE will display 『SRT』. Press **CAL** key, after 30sec. twinkle, the LCD will display 『PASS』, then go to step.10. If the LCD display 『FALL』, repeat step.9 again.		

10	1KHz	10MΩ	10.000MΩ	The same operation as step.1.
11	1KHz	1MΩ	1.0000MΩ	The same operation as step.1.After step.11, the LCR-900 will changed to 10KHz automatically. Go to step.12.
12	10KHz	1MΩ	1.0000MΩ	The same operation as step.1.
13	10KHz	100KΩ	100.00KΩ	The same operation as step.1. After step.13, the LCD will display『100KHz』Co to step.14
14	100KHz	100KΩ	100.00KΩ	On this step, the resistor should be 100KΩ / 100KHz standard resistor. Operate as step.1
15	100KHz	10KΩ	10.000KΩ	Operate as step.1
16	100KHz	10Ω	10.000Ω	Operate as step.1.
17	100KHz	1Ω	1.0000Ω	Operate as step.1
18	After finished the calibration. The unit will power off automatically. Then please switch “OFF” the power switch and “OPEN” J11 and cover the cabin.			
19	After switching “ON” the unit again, the unit will return normal operation mode. Then press **CAL** key 2 sec to operate open circuit/short circuit calibration.			

LCR-900

高精密 LCR 測試器

使用安全須知:

⚠ 警 告!

在使用本機前請先仔細閱讀以下的安全防範措施以避免損壞本機或任何連接到它的產品，爲了避免潛在的危險，因爲即使只有10 mA的交流電通過人們的心臟亦會造成嚴重的傷害，故請依所指示的方法使用本機本機只供合格的人員使用。

(1) 除非必要，請勿打開上下蓋，在打開上下蓋前請確認電源線已拔除。

(2) 如果可能，請先參考其他已經測試過的類似儀器，記住有高電壓的位置，但請記住，在故障的儀器內，高壓有可能存在任何區域。

(3) 請在絕緣的地板或工作檯上操作本儀器，並確認上物件均無潮濕。

(4) 在操作本機時，請注意切勿碰觸任何金屬物品。

(5) 本儀器使用交流電源，請注意只要聯接電源，即使未開機但在某些地方仍有電，例如變壓器，電源開關等。

簡介:

1. 一般說明:

LCR-900用以測試電容、電阻，並量測其在各種狀態下之損耗因素和品因素、相位差、阻抗等而設計之儀器，操作頻率爲100Hz ~ 100KHz，基本量測誤差爲0.3%，測試電壓固定爲0.6V，具有自動偵測功能以及開路/閉路補償功能，並有雙LCD顯示。

2. 測量條件:

- 頻率: 100Hz/120Hz/1KHz/10KHz/100KHz
- 準位: 0.6Vrms
- 測量參數: Z，L，C，DCR，ESR，D，Q，θ
- 基本精確度: 0.3%
- Dual LCD
- 快速測量
- 自動偵測/畫面鎖定
- 開路/短路補償

- 主參數顯示:

  DCR: 直流電阻值

  Lp: 並聯電感量

  Ls: 串聯電感量

  Cp: 並聯電容量

  Cs: 串聯電容量

  Rp: 並聯電阻量

  Rs: 串聯電阻量

- 副參數顯示:

  L / C模式:

  θ: 相位角

  D: 損耗因素

  Q: 品質因素

  Rp: 等效並聯阻抗

  ESR: 等效串聯阻抗

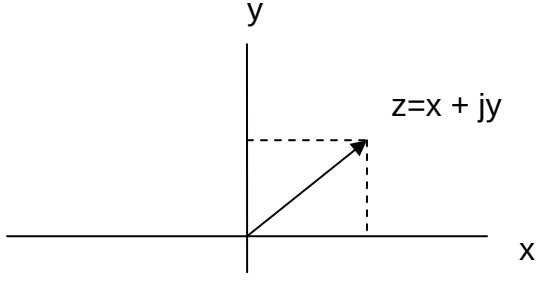
3. 阻抗參數說明:

LCR-900兼具直流及交流阻抗測量能力。阻抗測量對於電子電路的特性、電子零件及電子零件製造的材質而言，都是一項重要的參數。

當我們以向量的方式來探討阻抗(Z)時，在直角座標上它分成實數軸的電阻(x)及虛數軸的電抗(y)

在直角座標系的表示法是:

$$Z = x + jy \qquad j = \sqrt{-1}$$



若以極座標表示時:

$Z = r\cos\theta + jr\sin\theta$

$R = r\cos\theta$

$y = r\sin\theta$

$r = (x^2 + y^2)^{1/2}$

$\theta = \tan^{-1}(y/x)$

Z= (Impedance)阻抗

R= (Resistance)阻值

y= (Reactance)容抗

容抗包含**(電感度)Y_L** and **(電容值)Y_C**

They are:

$Y_L = \omega L = 2\pi fL$　　L = (Inductance)電感量

$Y_C = 1/(\omega C) = 1/(2\pi fC)$　　C = (Capacitance)電容量

f = (Frequency)頻率

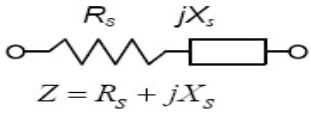
此外電子元件的特性除了電阻(R)及電抗(Y)外，尚有品質因素Q(Quality Factor)及耗損因素D(Dissipation Factor)。此二者是被定義來測量電抗的純度，也就是元件中儲存能量(電抗)與消耗能量(電阻)的比例，其關係如下：

$Q = 1/D = \omega Ls/Rs = 1/\omega CsRs = \omega CpRp$

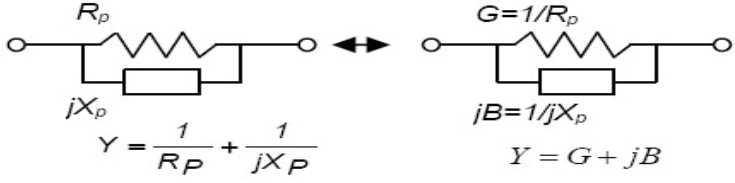
品質因素Q: 通常都應用在電感特性的測量，而消耗因素D: 則應用在電容特性的測量; 兩者互爲倒數。

此外，可將測量的結果，依據不同的使用需求，將等效電路分成兩種基本的連接表示方式: 串聯(Series)及並聯(Parallel)。在串聯模式時，阻抗可以簡單的加法求得等效阻抗; 而在並聯模式下，若以阻抗計算則須經過倒數的運算才可求得。

真實元件和虛擬元件爲串聯時:



真實元件和虛擬元件爲並聯時:



規格:

1. 電源:

115V (110V ~ 120v) 50/60Hz: 保險絲 600mA

230V (220V ~ 240V) 50/60Hz: 保險絲 300mA

2. 操作環境:

溫度: 0°C ~ 40°C

濕度: 20% ~ 80%

3. 儲存環境:

溫度: -20°C ~ 70°C

濕度: 0% ~ 90%

4. 附件:

電源線, 使用說明書, RP-91測試棒(BNC 接頭至鱷魚夾) x 1.

選購:

RP-92 (BNC至探針, SMD零件專用)。

5. LCD 顯示範圍:

參數	範圍
R	0.000 Ω to 9999 MΩ
L	0.000 uH to 9999 kH
C	0.000 pF to 9999 F
DCR	0.000 Ω to 9999 MΩ
ESR	0.000 Ω to 9999 Ω
Rp	0.000 Ω to 9999 Ω
D	0.000 to 9999
Q	0.000 to 9999
θ	- 90° to + 90°

6. 精確度(Ae):

阻抗精確度 Impedance Accuracy (T=18 ~ 28°C)

Freq./Z	DCR	100/120Hz	1kHz	10kHz	100kHz
0.1-1Ω	1.0%+5d	1.0%+5d	1.0%+5d	1.0%+5d	2.0%+5d
1-10Ω	0.5%+3d	0.5%+3d	0.5%+3d	0.5%+3d	1%+5d
10-100kΩ	0.3%+2d	0.3%+2d	0.3%+2d	0.3%+2d	0.5%+3d
100k-1MΩ	0.5%+3d	0.5%+3d	0.5%+3d	0.5%+3d	1%+5d
1M-20MΩ	1.0%+5d	1.0%+5d	1.0%+5d	2.0%+5d	2.0%+5d
20M-200MΩ	2.0%+5d	2.0%+5d	2.0%+5d	N/A	(1-2MΩ)
Remark	D < 0.1				

如果D大於0.1, 測精確應必須乘以 $\sqrt{1+D^{\wedge}2}$

在電容測試時且D小於0.1則Zc = 1/2**π**fC

在電感測試時且D小於0.1則Zl = 2**π**fL

副參數顯示器精確度

Ae = 阻抗精確度

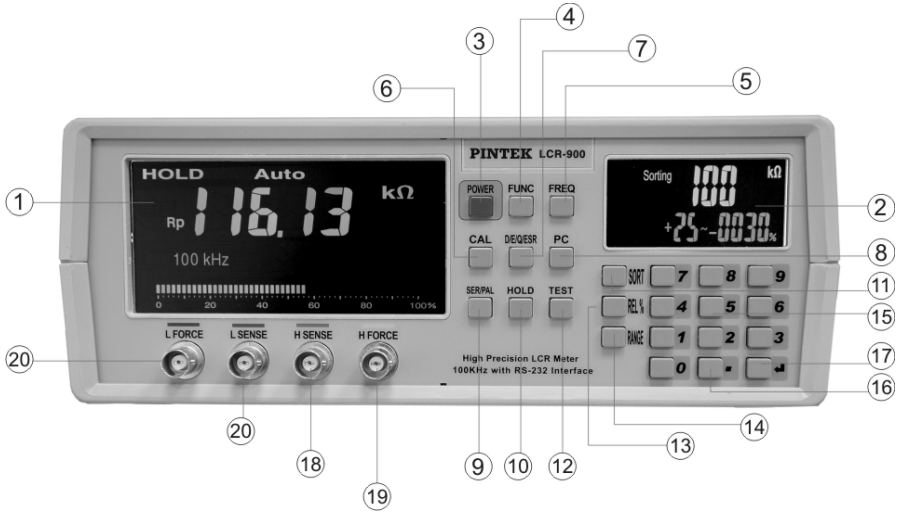
定義: Q = 1/D

Rp = ESR(or Rs) * (1+1/D^2)

1. 損耗因素 D 之精確度　De = ±Ae * (1+D)
2. ESR 之精確度　Re = ±Zm * Ae(Ω)

   ie., Zm = impedance calculate by 1/2πfC or 2πfL
3. 相位差之精確度= ±(180/π) * Ae(deg)

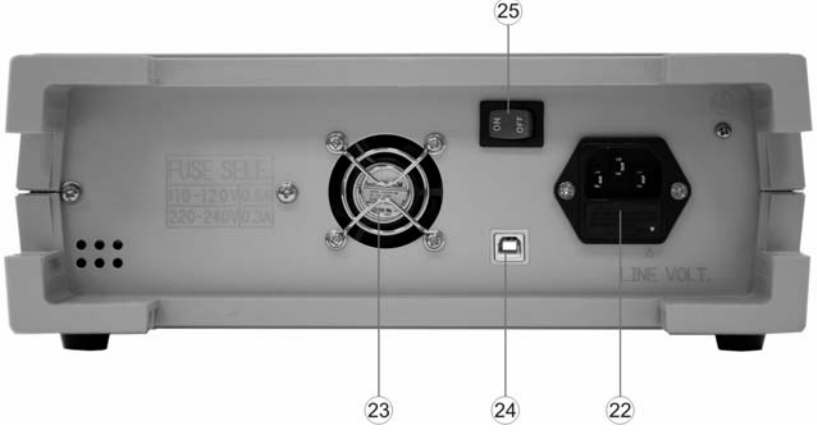
前面板配置與說明:



說明:
① 主顯示 LCD。
② 副顯示 LCD。
③ 電源開關。
④ Auto LCR/L/C/R/DCR 功能鍵。
⑤ 頻率功能鍵。
⑥ 開路/短路校正功能鍵。
⑦ D/Q/ϴ/ESR 功能鍵。
⑧ PC 功能鍵。

⑨ 串/並聯功能鍵。
⑩ 讀值保留功能鍵。
⑪ 排序啓動功能鍵。
⑫ 排序測試功能鍵。
⑬ 相對值功能鍵。
⑭ 單位切換功能鍵。
⑮ 數字功能鍵。
⑯ 小數點功能鍵。
⑰ 輸入確定功能鍵。
⑱ HPOT 端。
⑲ HCUR 端。
⑳ LPOT 端。
㉑ LCUR 端。

背板配置與說明:



說明:
㉒ 電源插座以及保絲座。
㉓ 散熱風扇。
㉔ USB 端子。
㉕ 主電源開關。

操作說明:

注意!

本機有兩個電源開關，**主電源開關**㉕於後蓋(背板)，控制電源到變壓器，另一**開關按鍵**③於前面板，控制測試系統的運作。

後蓋**主電源開關**㉕打開後, LCR-900 進入準備狀態，前面板的**開關按鍵**③打開後，系統開始運作 LCD 背燈亮起。

1. 開路／短路校正:

LCR-900 提供開路／短路校正的功能讓使用者可以更精準的量測高阻抗及低阻抗。

(1) 開路校正

首先保持測量端處於開路狀態, **CAL 鍵**⑥按住超過 2 秒，此時主顯示 LCD 部份應顯示『Open』字樣，再按 **CAL 鍵**⑥啓動開路校正，校正時間須 30 秒，之後會嗶一聲同時主顯示 LCD 部分應顯示『PASS』字樣，代表機器已經完成開路校正。

(2) 短路校正

完成開路校正後，按 **CAL 鍵**⑥，此時主顯示 LCD 部份顯示『Srt』字樣，再按 **CAL 鍵**⑥啓動短路校正，校正時間須 30 秒，之後會嗶一聲同時主顯示 LCD 部分應顯示『PASS』字樣，代表機器已經完成短路校正。

2. 相對值模式:

LCR-900 的相對值模式，是指使用者按 **REL 鍵**⑬進入相對值模式後，可以利用**數字功能鍵**⑮先輸入一個標準值，輸入完成後按**輸入確定功能鍵**⑰。若需變更標準值單位則按**單位切換功能鍵**⑭。之後插入待測物,副顯示 LCD 即會顯示待測物與標準值之相對誤差百分比，其公式如下：

相對誤差百分比 = | 待測物 – 標準值 | / 標準值 * 100%

註：當誤差過大時則顯示爲『**----**』。

3. 排序模式:

LCR-900 的排序模式，是指使用者按 **SORT 鍵**⑪進入排序模式後，LCR-900 會要求使用者利用**數字功能鍵**⑮先輸入一個誤差範圍值，在輸入完成按**輸入確定功能鍵**⑰後，再要求輸入一個標準值，然後再按一次**輸入確定功能鍵**⑰完成輸入動作。若需變更標準值單位則按**單位切換功能鍵**⑭。之後插入待測物，當待測物穩定後按 **Test 鍵**⑫，副顯示 LCD 即會顯示待測物是否在標準值的誤差範圍內，通過則顯示『PASS』，未通過則顯示『FAIL』。

4. 螢幕保留模式:

LCR-900 的螢幕保留模式，是指使用者按 **HOLD 鍵**⑩進入螢幕保留模式。主顯示 LCD 上方會出現『HOLD』，此時主顯示 LCD 的數值會被保留在螢幕上，不隨待測物而變化。

5. 自動跳檔模式:

LCR-900 的自動跳檔模式，是指使用者按 **FUNC 鍵**④進入自動跳檔模式。主顯示 LCD 上方會出現『AUTO LCR』，此時可以直接量測待測物, LCR-900 會自動判定待測物的種類及大小，同時調整至適合的檔位。

6. 交流量測頻率:

使用者按 **FREQ 鍵**⑤，可切換量測頻率，範圍爲 100Hz / 120Hz / 1kHz / 10KHz / 100KHz。

7. 直流阻抗量測:

使用者按 **FUNC 鍵**④切換 L/C/R 檔位，直至主顯示 LCD 出現『DCR』，即代表已經處於『直流阻抗量測』模式。

8. 串/並聯等效阻抗量測:

使用者按 **FUNC 鍵**④切換 L/C/R 檔位，直至主顯示 LCD 上方出現『AUTO』，此時表示 LCR-900 自動選擇串並聯等效阻抗輸出模式。

按 **SER/PAL 鍵**⑨可手動切換串並聯等效阻抗輸出模式。

各種等效阻抗量測模式文字顯示如下：

等效阻抗輸出模式	主顯示LCD文字
電感並聯等效阻抗	Lp
電容並聯等效阻抗	Cp
電阻並聯等效阻抗	Rp
電感串聯等效阻抗	Ls
電容串聯等效阻抗	Cs
電阻串聯等效阻抗	Rs
直流等效阻抗	DCR

9. 電阻量測:

『電阻量測』依等效電路架構的不同可分成串聯模式(Rs, Serial Mode)與並聯模式(Rp, Parallel Mode)兩種，使用者可依據需要按 **FUNC 鍵**④切換至 R 檔位。

10. 電容量測:

『電容量測』依等效電路架構的不同可分成串聯模式(Cs, Serial Mode)與並聯模式(Cp, Parallel Mode)兩種，使用者可依據需要按 **FUNC 鍵**④切換至 C 檔位，然後再按 **SER/PAL 鍵**⑨切換串並聯模式。此時可以按 **D/Q/Θ/ESR 鍵**⑦選擇 D/Q/Θ/ESR 四種參數。

註：自動跳檔模式時無法選擇 D/Q/Θ/ESR 四種參數。

11. 電感量測:

『電感量測』依等效電路架構的不同可分成串聯模式(Ls, Serial Mode)與並聯模式(Lp, Parallel Mode)兩種，使用者可依據需要按 **FUNC 鍵**④切換至 L 檔位，然後再按 **SER/PAL 鍵**⑨切換串並聯模式。此時可以按 **D/Q/Θ/ESR 鍵**⑦選擇 D/Q/Θ/ESR 四種參數。

註：自動跳檔模式時無法選擇 D/Q/Θ/ESR 四種參數。

12. 與電腦連接:

使用者按 **PC 鍵**⑧可啓動將 LCR-900 量測數值傳輸到電腦，此時副顯

示 LCD 會出現『RS232』字樣，代表開啓與電腦連接。

維護:

1. 日常保養注意事項::

(1) 請勿在機器上面放置重物。

(2) 請勿在機器上面或附近放至發熱物體。

(3) 請勿將任何細線或針狀物插入散熱風扇孔。

(4) 請勿拉扯電源線或測試線來移動機器，尤其是供電狀態下。

(5) 請勿將散熱風扇孔阻擋。

(6) 機器使用中請勿將上蓋打開。

(7) 請定期校正機器以保持準確性並保持機器清潔。

(8) 如果機器未能正常開啓，請確認電源開關是否在"開啓"狀態，或者請檢查電源線，確認電源線正確連接並且電壓亦正確符合機器設定。

2. 更換保險絲:

當機器接上電源並開機後, LED 無法顯示時，請更換保險絲。

(1) 移去電源線，斷開電源。

(2) 以小一字起子掀開保險絲座蓋(在本機電源插座上)。

(3) 取出舊的保險絲並換上新的正確保險絲(請注意保險絲座之插入方向，分爲 115V /230V 兩種)。

(4) 蓋回保險絲座，重新接上電源線，開機即可。

(註: 如機器仍無法正常操作，請與指定之經銷商聯絡。)

3. 清潔:

請保持機器清潔，如需清除灰塵及髒污時，請使用輕軟乾淨的布沾上微量的中性清潔液輕輕的在產品外觀擦拭。

附錄:

附錄一 RS232 程式編碼:

按下 RS-232 功能鍵以進入 RS-232 操作模式. 資料封包會以每秒兩次的速度輸出. 每次傳輸都包含 16 bytes 的資料。

Baud rate	Start bit	Data bit	Stop bit	Parity
115200 bps	1bit	8 bits	1 bit	None

資料傳輸格式:

資料碼:

Byte0	Byte1	Byte 2 ~ Byte13	Byte14	Byte15
BAH	10H	Data	0DH	0AH

控制碼:

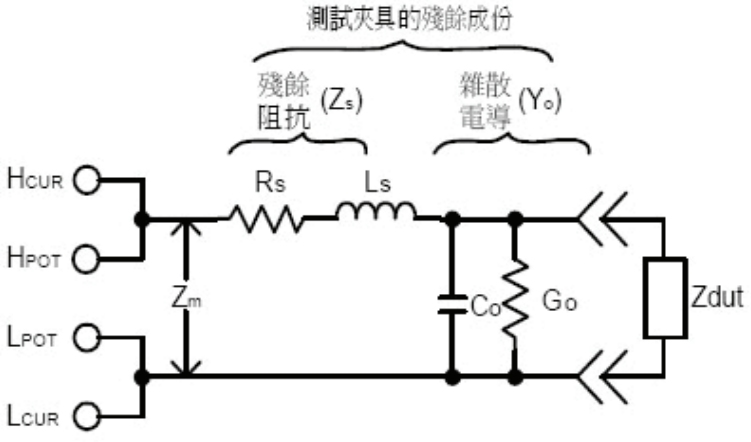
Byte0	Byte1	Byte2~Byte10	Byte11	Byte12
BAH	0DH	Control	0DH	0AH

資料格式敘述:

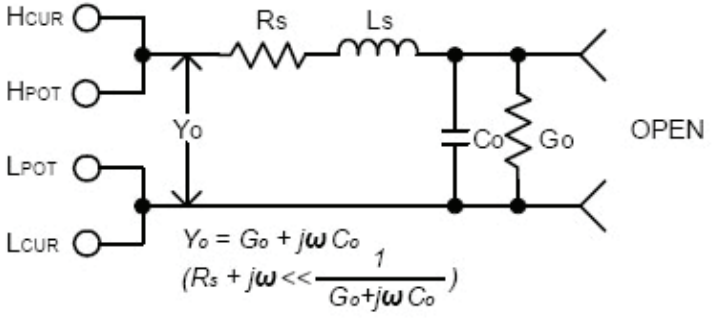
Byte	Data byte	Function
2	STATUS 0	狀態 0 簡介
3	STATUS 1	狀態 1 簡介
4	MMOD	主顯示 LCD 工作模式
5	MREADH	主顯示 LCD 高位元資料
6	MREADL	主顯示 LCD 低位元資料
7	MSCOPE	主顯示 LCD 資料範圍
8	MSTATUS	主顯示 LCD 資料狀態
9	SMOD	主顯示 LCD 第二視窗工作模式
10	SREADH	主顯示 LCD 第二視窗高位元資料
11	SREADL	主顯示 LCD 第二視窗低位元資料
12	SSCOPE	主顯示 LCD 第二視窗資料範圍
13	SSTATUS	主顯示 LCD 第二視窗資料狀態

附錄二 OPEN/SHORT 補償:

對於精細級的阻抗分析儀，通常都必須利用 OPEN/SHORT 的補償技巧來降低測試夾具的殘餘雜散效應。測試夾具的殘餘雜散效應，可以用簡單的被動元件來表示，如下圖所示。

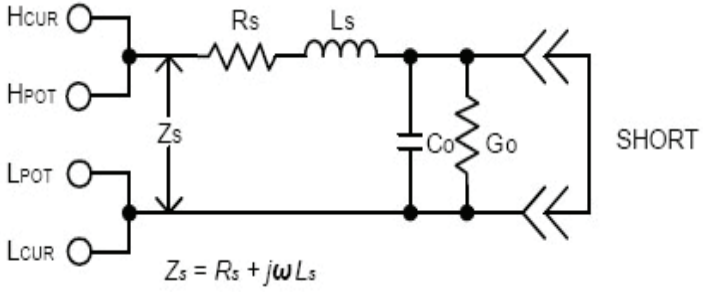


當待測端(Zdut)爲開路時，如下圖所示。



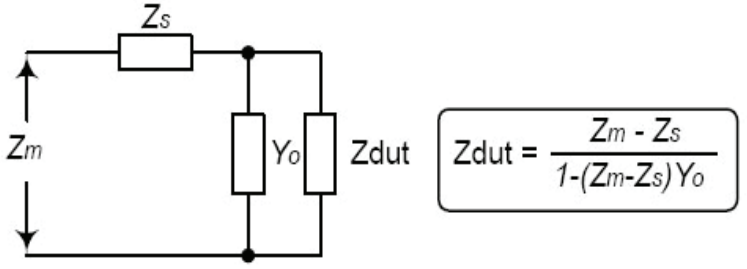
儀器所測得的阻值是雜散電導 Go + jωCo 。

當待測端變爲短路時，如下圖所示。



儀器所測得的阻值爲 Rs +j ω Ls。

最後當我們接上真正的待測元件 Zdut 後，如下圖所示。



此時儀器所測得阻值(Zm)是待測元件與夾具的殘餘雜散所合成的效應。所以我們就可以利用公式來計算待測元件的真正阻抗。

附錄三 串聯/並聯模式的選擇:

依據不同的使用需求，可將測量的結果，依等效電路分成兩種基本的連接表示方式—串聯(Series)及並聯(Parallel) 模式。至於如何決定或使用何種模式最好，則視阻抗大小而定。

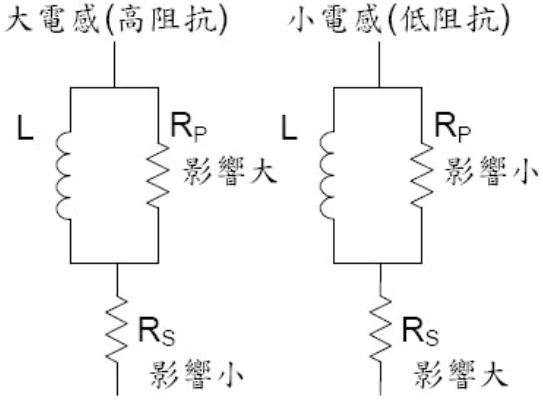
(1) 電容

由於電容的阻抗值與電容量成反比，因此大的電容量對阻抗值而言，所代表的意義就是小阻抗值，小的電容量對阻抗值而言，所代表的意義就是大阻抗值。下圖爲電容等效電路，由於 Rp 的阻抗值一般而言都很高。故而，C 愈小與其並聯的 Rp 影響力愈大，所以不可忽略；但是與其串聯的 Rs 影響力則愈小，所以可忽略。同樣的，C 愈大與其並聯的 Rp 影響力愈小，

所以可忽略；但是與其串聯的 Rs 影響力愈大，所以不可忽略。因此，小電容測量宜使用並聯模式爲佳，大電容測量則串聯模式較佳。

(2) 電感

由於電感的阻抗值與電感量成正比，因此大的電感量對阻抗值而言，所代表的意義就是大阻抗值，小的電感量所代表的意義就是小阻抗值。下圖爲電感等效電路，由於 Rp 的阻抗值一般而言都很高。故而，L 愈大與其並聯的 Rp 影響力愈大，所以不可忽略；但是與其串聯的 Rs 影響力則愈小，所以可忽略。同樣的，L 愈小與其並聯的 Rp 影響力愈小，所以可忽略；但是與其串聯的 Rs 影響力愈大，所以不可忽略。因此，大電感測量宜使用並聯模式爲佳，小電感測量則串聯模式較佳。



根據上面的討論，可以得到大略的規則：

- . 阻抗值小於 10Ω，使用串聯模式。
- . 阻抗值大於 10KΩ，使用並聯模式。
- . 兩者之間則視需求而定。

附錄四 LCR-900 校正步驟:

注意!

此項操作謹限合格之電子工程師或經過特殊訓練之人員且須使用原廠之標準電阻., 此項操作不須打開前蓋面板之**開關按鍵**③。

(1) 打開 LCR-900 之**主電源開關**㉕之前請先打開 LCR-900 之上塑膠蓋, 然後把 J11 之兩隻針短路。

(2) 打開後蓋之**主電源開關**㉕, LCR-900 會自動進入校正模式, 主 LCD 會顯示 Swi『u1.08』, 然後轉爲『 DCR』,『AUTO』,『10MΩ』並閃爍『Cal』。.

(3) 調整 VR(TP6) – VRL(TP7) 之電庄到 -500mV±10mV。

(4) 按下列步驟校正 LCR-900:

步驟	功能	阻值	標準電阻	操 作
1	DCR	10MΩ	10.000MΩ	輸入 10MΩ 之標準電阻,.LCD 顯示會閃爍, 等到穩定後按下 **CAL** 鍵以儲存之, 然後 LCD 顯示會從『10MΩ』轉爲『1MΩ』。
2	DCR	1MΩ	1.0000MΩ	輸入 1MΩ 之標準電阻, 按照步驟 1 操作. 然後 LCD 會轉爲 “100KΩ”。
3	DCR	100KΩ	100.00KΩ	輸入 100KΩ 標準電阻並按照步驟 1 之操作, 然俊 LCD 會轉爲顯示 10KΩ。
4	DCR	10KΩ	10.000KΩ	輸入 10KΩ 標準電阻, 同上操作, 然俊 LCD 顯示會自動轉爲 1KΩ
5	DCR	1KΩ	1.0000KΩ	輸入 1KΩ 標準電阻, 同上操作, 然後 LCD 顯示會自動轉爲 100Ω。
6	DCR	100Ω	100.00Ω	輸入 100Ω標準電阻, 同上操作然後 LCD 顯示會自動轉爲 10Ω。
7	DCR	10Ω	10.000Ω	輸入 10Ω 標準電阻同上操作然後 LCD 顯示會自動轉爲 1Ω。
8	DCR	1Ω	1.0000Ω	輸入 1Ω 標準電阻同上操作。

9	開路 / 短路校正	在步驟 8 以後, LCD 會顯示『OPEN』, 把兩支輸入棒保持開路狀態, 不要互相接觸, 按下 **CAL** 鍵. LCD 會閃爍 30 秒然後顯示『PASS』, 將兩支輸入棒相互短路,LCD 會顯示"SRT", 按下 **CAL** 鍵, LCD 會閃爍 30 秒, 然後顯示『PASS』, 然後進入步驟 10, 如果 LCD 顯示『FALL』, 則-須重複此步驟 9, 直到 LCD 顯示『PASS』。		
10	1KHz	10MΩ	10.000MΩ	按照步驟 1 方式操作, 在完成步驟 9 後 LCR-900 會自動轉爲 1KHz。
11	1KHz	1MΩ	1.0000MΩ	同上一步操作, 在完成此項校正後, LCR-900 會自動轉爲 10KHz 以便進入下一步操作。
12	10KHz	1MΩ	1.0000MΩ	按照步驟 1 方式操作。
13	10KHz	100KΩ	100.00KΩ	按照步驟 1 方式操作在完成此項校正後 LCR-900 會自動轉爲 100KHz 以便下一步校正。
14	100KHz	100KΩ	100.00KΩ	在此項校正必須使用 100KΩ/100KHz 之標準電阻, 按照步驟 1 方式操作。
15	100KHz	10KΩ	10.000KΩ	按照步驟 1 方式操作。
16	100KHz	10Ω	10.000Ω	按照步驟 1 方式操作。
17	100KHz	1Ω	1.0000Ω	按照步驟 1 方式操作。
18	在完成上列校正後, LCR-900 會自動關閉電源, 請記得把**主電源開關**㉕關閉, 然後打開 J11 之短路接線, 並蓋上塑膠上蓋。			
19	在完成步驟 18 後打開**主電源開關**㉕, LCR-900 會自動回復到正常操作狀態。然後按 **CAL** 鍵 2 秒後, 執行開路/短路校正。			

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